AWS CloudHSM

User Guide
AWS CloudHSM: User Guide
Copyright © 2023 Amazon Web Services, Inc. and/or its affiliates. All rights reserved.

Amazon's trademarks and trade dress may not be used in connection with any product or service that is not Amazon's, in any manner that is likely to cause confusion among customers, or in any manner that disparages or discredits Amazon. All other trademarks not owned by Amazon are the property of their respective owners, who may or may not be affiliated with, connected to, or sponsored by Amazon.
# Table of Contents

What is AWS CloudHSM? ...................................................................................................................... 1
Use cases .............................................................................................................................................. 1
How it works ........................................................................................................................................ 3
  Clusters ............................................................................................................................................. 3
  HSM users ......................................................................................................................................... 3
  HSM keys .......................................................................................................................................... 4
Client SDKs ......................................................................................................................................... 4
Backups .............................................................................................................................................. 5
Regions ............................................................................................................................................... 5
Pricing ................................................................................................................................................ 6
Getting started .................................................................................................................................... 7
  Create IAM administrators ............................................................................................................. 7
    Create an IAM user and administrator group ............................................................................. 7
  Create a VPC .................................................................................................................................... 9
  Create a cluster ................................................................................................................................. 9
  Review the cluster security group .................................................................................................... 11
  Launch an EC2 client ....................................................................................................................... 11
  Configure EC2 instance security groups ....................................................................................... 12
    Modify the default security group ............................................................................................... 13
  Connect the Amazon EC2 instance to the AWS CloudHSM cluster ............................................ 13
  Create an HSM ............................................................................................................................... 14
Verify HSM identity (optional) .......................................................................................................... 15
  Overview ......................................................................................................................................... 15
    Get certificates from the HSM ....................................................................................................... 17
    Get the root certificates ................................................................................................................ 19
    Verify certificate chains .............................................................................................................. 20
    Extract and compare public keys ............................................................................................... 20
  Initialize the cluster ....................................................................................................................... 21
    Get the cluster CSR ..................................................................................................................... 21
    Sign the CSR ................................................................................................................................ 23
    Initialize the cluster ..................................................................................................................... 24
Install CloudHSM CLI ....................................................................................................................... 25
  Install the AWS CloudHSM client and command line tools ....................................................... 26
Activate the cluster ............................................................................................................................ 28
Reconfigure SSL (optional) ................................................................................................................ 30
  Create a key, a CSR, and then sign the CSR ............................................................................... 30
  Enable custom SSL for AWS CloudHSM ....................................................................................... 31
Build an application ............................................................................................................................. 34
Best practices ....................................................................................................................................... 36
AWS CloudHSM basic operational guidelines .................................................................................. 36
  ......................................................................................................................................................... 36
  ......................................................................................................................................................... 36
  ......................................................................................................................................................... 36
Managing clusters ............................................................................................................................... 37
  Cluster architecture ......................................................................................................................... 37
  Cluster synchronization .................................................................................................................... 38
  Cluster high availability and load balancing .................................................................................. 39
Connecting to the cluster .................................................................................................................... 40
  Place the issuing certificate on each EC2 instance ....................................................................... 40
  Specify the location of the issuing certificate .............................................................................. 40
  Bootstrap the Client SDK .............................................................................................................. 41
Adding or removing HSMs .................................................................................................................. 44
  Adding an HSM ............................................................................................................................... 44
Removing an HSM ................................................................................................................... 46
Deleting a cluster ..................................................................................................................... 47
Creating clusters from backups ............................................................................................... 48
Create clusters from backups (console) ................................................................................... 48
Create clusters from backups (AWS CLI) ................................................................................ 48
Create clusters from backups (AWS CloudHSM API) .............................................................. 49
Managing backups ................................................................................................................. 50
Working with backups ............................................................................................................ 50
Removing expired keys or inactive users ............................................................................. 50
Considering disaster recovery ............................................................................................... 50
Deleting and restoring backups .............................................................................................. 51
Delete and restore backups (console) .................................................................................... 51
Delete and restore backups (AWS CLI) .................................................................................. 51
Delete and restore backups (AWS CloudHSM API) ................................................................. 52
Configuring backup retention ................................................................................................. 52
Understanding backup retention policy ................................................................................... 52
Configure backup retention (console) .................................................................................... 53
Configure backup retention (AWS CLI) .................................................................................. 53
Configure backup retention (AWS CloudHSM API) ................................................................. 55
Copying backups across Regions ............................................................................................ 55
Copy backups to different Regions (console) ......................................................................... 55
Copy backups to different Regions (AWS CLI) ...................................................................... 56
Copy backups to different Regions (AWS CloudHSM API) ................................................... 56
Tagging resources .................................................................................................................. 57
Adding or updating tags .......................................................................................................... 57
Listing tags ............................................................................................................................ 58
Removing tags ....................................................................................................................... 58
Managing HSM users and keys ............................................................................................. 60
Managing HSM users ............................................................................................................ 60
Using CloudHSM CLI ........................................................................................................... 60
Using CMU ............................................................................................................................ 93
Managing keys ...................................................................................................................... 123
Key sync and durability ........................................................................................................ 123
AES key wrapping .................................................................................................................. 129
Trusted keys ........................................................................................................................ 131
Managing keys with CloudHSM CLI .................................................................................... 134
Managing keys with the KMU and CMU ............................................................................ 150
Managing cloned clusters .................................................................................................... 156
Get an IP address for an HSM .............................................................................................. 157
Related topics ....................................................................................................................... 157
Command line tools .............................................................................................................. 158
Understanding command line tools ..................................................................................... 158
Configure tool ....................................................................................................................... 159
Latest configure tool ............................................................................................................... 159
Previous configure tool ......................................................................................................... 177
CloudHSM CLI ..................................................................................................................... 183
Supported platforms ............................................................................................................. 183
Getting started ..................................................................................................................... 184
Interactive and single command modes ............................................................................... 186
Key attributes ....................................................................................................................... 187
Reference ............................................................................................................................. 190
CloudHSM Management Utility ............................................................................................. 252
Supported platforms .............................................................................................................. 253
Getting started ..................................................................................................................... 253
Install the client (Linux) ......................................................................................................... 256
Install the client (Windows) ..................................................................................................... 259
Reference ............................................................................................................................. 259
Microsoft SignTool .......................................................... 578
Microsoft SignTool with AWS CloudHSM step 1: Set up the prerequisites ........................................ 578
Microsoft SignTool with AWS CloudHSM step 2: Create a signing certificate .............................. 579
Microsoft SignTool with AWS CloudHSM step 3: Sign a file ......................................................... 580
Java Keytool and Jarsigner .................................................. 581
Use Client SDK 5 to integrate with Java Keytool and Jarsigner .................................................... 581
Use Client SDK 3 to integrate with Java Keytool and Jarsigner .................................................... 589
Other third-party vendor integrations .......................................................... 599
Monitoring .................................................................................. 601
Client SDK logs ........................................................................ 601
Client SDK 5 logging ................................................................... 601
Client SDK 3 logging ................................................................... 602
AWS CloudTrail ......................................................................... 603
AWS CloudHSM information in CloudTrail .................................................. 604
Understanding AWS CloudHSM log file entries .............................................. 604
Audit logs ................................................................................. 605
How logging works ..................................................................... 606
Viewing logs .............................................................................. 606
Interpreting logs ......................................................................... 608
Log reference ............................................................................... 618
CloudWatch metrics ..................................................................... 620
Performance ............................................................................. 622
Performance data ......................................................................... 622
HSM throttling ............................................................................. 622
Security ..................................................................................... 623
Data protection ........................................................................... 623
Encryption at rest .......................................................................... 624
Encryption in transit ......................................................................... 624
End-to-end encryption ....................................................................... 624
Cluster backups ............................................................................ 625
Identity and access management .......................................................... 626
Grant permissions using IAM policies .................................................. 626
API actions for AWS CloudHSM .................................................. 627
Condition keys for AWS CloudHSM ................................................. 628
Predefined AWS managed policies for AWS CloudHSM ............................................. 628
Customer managed policies for AWS CloudHSM ............................................. 628
Service-linked roles ....................................................................... 630
Compliance ................................................................................. 631
PCI-PIN FAQs ........................................................................... 632
Deprecation Notifications ............................................................. 633
Resilience .................................................................................. 634
Infrastructure security .................................................................... 634
Network isolation ............................................................................ 634
Authorization of users ....................................................................... 634
VPC endpoints (AWS PrivateLink) ................................................... 635
Considerations for AWS CloudHSM VPC endpoints ............................................. 635
Creating an interface VPC endpoint for AWS CloudHSM ............................................. 635
Creating a VPC endpoint policy for AWS CloudHSM ............................................. 635
Update management ....................................................................... 636
Troubleshooting ........................................................................ 637
Known issues .............................................................................. 637
Known issues for all HSM instances .................................................. 637
Known issues for the PKCS #11 library .................................................. 640
Known issues for the JCE SDK .............................................................................. 644
Known issues for the OpenSSL Dynamic Engine ........................................................................ 647
Known issues for Amazon EC2 instances running Amazon Linux 2 ............................................. 649
What is AWS CloudHSM?

AWS CloudHSM combines the benefits of the AWS cloud with the security of hardware security modules (HSMs). A hardware security module (HSM) is a computing device that processes cryptographic operations and provides secure storage for cryptographic keys. With AWS CloudHSM, you have complete control over high availability HSMs that are in the AWS Cloud, have low-latency access, and a secure root of trust that automates HSM management (including backups, provisioning, configuration, and maintenance).

AWS CloudHSM offers customers a variety of benefits:

**HSMs are FIPS 140-2 level-3 validated**

AWS CloudHSM uses general purpose HSMs that are standards-compliant, single-tenant, and FIPS 140-2 level-3 validated. They provide more flexibility when compared to the fully-managed AWS services that have predetermined algorithms and key lengths for your application.

**E2E encryption is not visible to AWS**

Because your data plane is end-to-end (E2E) encrypted and not visible to AWS, you control your own user management (outside of IAM roles). The trade off for this control is you have more responsibility than if you used a managed AWS service.

**Full control of your keys, algorithms, and application development**

AWS CloudHSM gives you full control of the algorithms and keys you use. You can generate, store, import, export, manage, and use cryptographic keys (including, session keys, token keys, symmetric keys and asymmetric key pairs). Additionally, AWS CloudHSM SDKs give you full control over application development, application language, threading, and where your applications physically exist.

**Migrate your cryptographic workloads to the cloud**

Customers migrating public key infrastructure that use Public Key Cryptography Standards #11 (PKCS #11), Java Cryptographic Extension (JCE), Cryptography API: Next Generation (CNG), or key storage provider (KSP) can migrate to AWS CloudHSM with fewer changes to their application.

To learn more about what you can do with AWS CloudHSM, see the following topics. When you are ready to get started with AWS CloudHSM, see [Getting started](#).

**Note**

If you want a managed service for creating and controlling your encryption keys but you don’t want or need to operate your own HSMs, consider using [AWS Key Management Service](#).

If you are looking for an elastic service that manages payment HSMs and keys for payment processing applications in the cloud, consider using [AWS Payment Cryptography](#).

### Contents

- AWS CloudHSM use cases (p. 1)
- How AWS CloudHSM works (p. 3)
- Pricing (p. 6)

### AWS CloudHSM use cases

AWS CloudHSM can be used to accomplish a variety of goals. The content in this topic provides an overview of what you can do with AWS CloudHSM.
Achieve regulatory compliance

Businesses that need to align with enterprise security standards can use AWS CloudHSM to manage private keys that protect highly confidential data. The HSMs provided by AWS CloudHSM are FIPS 140-2 level 3 certified and comply with PCI DSS. Additionally, AWS CloudHSM is PCI PIN compliant and PCI-3DS compliant. For more information, see Compliance (p. 631).

Encrypt and decrypt data

Use AWS CloudHSM to manage private keys that protect highly confidential data, encryption in transit, and encryption at rest. Additionally, AWS CloudHSM offers standards-compliant integration with multiple cryptographic SDKs.

Sign and verify documents with private and public keys

In cryptography, using a private key to sign a document allows recipients to use a public key to verify that you (and not someone else) actually sent the document. Use AWS CloudHSM to create asymmetric public and private key pairs that are specifically designed for this purpose.

Authenticate messages using HMACs and CMACs

In cryptography, Cipher Message Authentication Codes (CMACs) and Hash-based Message Authentication Codes (HMACs) are used to authenticate and ensure the integrity of messages sent over unsafe networks. With AWS CloudHSM, you can securely create and manage symmetric keys that support HMACs and CMACs.

Leverage the benefits of AWS CloudHSM and AWS Key Management Service

Customers can combine AWS CloudHSM and AWS KMS to store key material in a single-tenant environment that is FIPS 140-2 Level 3 certified while also getting the key management, scaling, and cloud integration benefits of AWS KMS. For details on how to do this, see AWS CloudHSM key stores in the AWS Key Management Service Developer Guide.

Offload SSL/TLS processing for web servers

To securely send data over the internet, web servers use public–private key pairs and SSL/TLS public key certificate to establish HTTPS sessions. This process involves a lot of computation for web servers, but you can reduce computational burden while providing extra security by offloading some of this to your AWS CloudHSM cluster. For information about setting up SSL/TLS offload with AWS CloudHSM, see SSL/TLS offload (p. 507).

Enable transparent data encryption (TDE)

Transparent Data Encryption (TDE) is used to encrypt database files. Using TDE, database software encrypts data before storing it on disk. You can achieve greater security by storing the TDE master encryption key in HSMs in your AWS CloudHSM. For information about setting up Oracle TDE with AWS CloudHSM, see Oracle database encryption (p. 574).

Manage the private keys of an issuing certificate authority (CA)

A certificate authority (CA) is a trusted entity that issues digital certificates that bind a public key to an identity (a person or organization). To operate a CA, you must maintain trust by protecting the private key that signs certificates issued by your CA. You can store such private keys in your AWS CloudHSM cluster and then use your HSMs to perform cryptographic signing operations.
Generate random numbers

Generating random numbers to create encryption keys is core to online security. AWS CloudHSM can be used to securely generate random numbers in HSMs you control and are only visible to you.

How AWS CloudHSM works

This topic provides an overview of the basic concepts and architecture you use to securely encrypt data and perform cryptographic operations in HSMs. AWS CloudHSM operates in your own Amazon Virtual Private Cloud (VPC). Before you can use AWS CloudHSM, you first create a cluster, add HSMs to it, create users and keys, and then use Client SDKs to integrate your HSMs with your application. Once this is done, you use Client SDK logs, AWS CloudTrail, audit logs, and Amazon CloudWatch to monitor AWS CloudHSM (p. 601).

Learn AWS CloudHSM's basic concepts and how they work together to help protect your data.

Topics
- AWS CloudHSM clusters (p. 3)
- HSM users (p. 3)
- HSM keys (p. 4)
- Client SDKs (p. 4)
- AWS CloudHSM cluster backups (p. 5)
- Regions (p. 5)

AWS CloudHSM clusters

Making individual HSMs work together in a synchronized, redundant, highly-available cluster can be difficult, but AWS CloudHSM does the heavy lifting for you by providing hardware security modules (HSMs) in clusters. A cluster is a collection of individual HSMs that AWS CloudHSM keeps in sync. When you perform a task or operation on one HSM in a cluster, the other HSMs in that cluster are automatically kept up to date. To meet your availability, durability, and scalability goals, you set the number of HSMs in your cluster across multiple availability zones.

You can create a cluster that has 1 to 28 HSMs (the default limit (p. 669) is 6 HSMs per AWS account per AWS Region). You can place the HSMs in different Availability Zones in an AWS region. Adding more HSMs to a cluster provides higher performance. Spreading clusters across Availability Zones provides redundancy and high availability.

For more information about clusters, see Managing AWS CloudHSM clusters (p. 37).

To create a cluster, see Getting started (p. 7).

HSM users

Unlike most AWS services and resources, you do not use AWS Identity and Access Management (IAM) users or IAM policies to access resources within your cluster. Instead, you use HSM users directly on HSMs in your AWS CloudHSM cluster.

HSM users are distinct from IAM users. IAM users who have the correct credentials can create HSMs by interacting with resources through the AWS API. Since E2E encryption is not visible to AWS, you must use HSM user credentials to authenticate operations on the HSM because credentials takes place directly on the HSM. The HSM authenticates each HSM user by means of credentials that you define and manage. Each HSM user has a type that determines which operations that user can perform on the HSM. Each HSM authenticates each HSM user by means of credentials that you define using CloudHSM CLI (p. 183).
If you are using the previous SDK version series (p. 454), then you will use CloudHSM Management Utility (CMU) (p. 252).

HSM keys

AWS CloudHSM allows you to securely generate, store, and manage your encryption keys in single-tenant HSMs that are in your AWS CloudHSM cluster. Keys can be symmetric or asymmetric, can be session keys (ephemeral keys) for single sessions and token keys (persistent keys) for long-term use, and can be exported and imported into AWS CloudHSM. Keys can also be used to complete common cryptographic tasks and functions:

- Perform cryptographic data signing and signature verification with both symmetric and asymmetric encryption algorithms.
- Work with hash functions to compute message digests and hash-based message authentication codes (HMACs).
- Wrap and protect other keys.
- Access cryptographically secure random data.

Additionally, AWS CloudHSM follows a few foundational principles for key usage and management:

Many key types and algorithms to choose from

To allow you to customize your own solutions, AWS CloudHSM provides many key types and algorithms to choose from. Algorithms support a range of key sizes. For more information, refer to the attributes and mechanism pages of each AWS CloudHSM Client SDKs (p. 392).

How you manage keys

AWS CloudHSM keys are managed through SDKs and command line tools. For information on how to use these tools to manage keys, see Managing keys in AWS CloudHSM (p. 123) and Best practices for AWS CloudHSM (p. 36).

Who owns keys

In AWS CloudHSM, the crypto user (CU) who creates the key owns it. The owner can use the key share and key unshare commands to share and unshare the key with other CUs. For more information, see Using CloudHSM CLI to share and unshare keys (p. 140).

Access and usage can be controlled with attribute-based encryption

AWS CloudHSM allows you to use attribute-based encryption, a form of encryption that lets you use key attributes to control who can decrypt data based on policies.

Client SDKs

When using AWS CloudHSM, you perform cryptographic operations with AWS CloudHSM Client Software Development Kits (SDKs) (p. 392). AWS CloudHSM Client SDKs include:

- Public Key Cryptography Standards #11 (PKCS #11)
- JCE provider
- OpenSSL Dynamic Engine
- Cryptography API: Next Generation (CNG) and key storage provider (KSP) for Microsoft Windows
You can use any or all of these SDKs in your AWS CloudHSM cluster. Write your application code to use these SDKs to perform cryptographic operations in your HSMs.

Utility and command line tools are needed not only to use SDKs but also to configure the credentials, policies, and settings of your application. For more information, refer to [AWS CloudHSM command line tools](p. 158).

For more information about installing and using the Client SDK or the security of the client connection, see [Client SDKs](p. 392) and [End-to-end encryption](p. 624).

### AWS CloudHSM cluster backups

AWS CloudHSM makes periodic backups of the users, keys, and policies in the cluster. Backups are secure, durable, and updated on a predictable schedule. The following illustration shows the relationship of your backups to the cluster.

For more information about working with backups, see [Managing backups](p. 50).

**Security**

When AWS CloudHSM makes a backup from the HSM, the HSM encrypts all of its data before sending it to AWS CloudHSM. The data never leaves the HSM in plaintext form. Additionally, backups cannot be decrypted by AWS because AWS doesn’t have access to key used to decrypt the backups. For more information, see [Security of cluster backups](p. 625).

**Durability**

AWS CloudHSM stores backups in a service-controlled Amazon Simple Storage Service (Amazon S3) bucket in the same region as your cluster. Backups have a 99.999999999% durability level, the same as any object stored in Amazon S3.

### Regions

For information about the supported Regions for AWS CloudHSM, see [AWS CloudHSM Regions and Endpoints](p. 36) in the AWS General Reference, or the [Region Table]. AWS CloudHSM might not be available in all Availability Zones in a given Region. However, this should not affect performance, as AWS CloudHSM automatically load balances across all HSMs in a cluster.
Like most AWS resources, clusters and HSMs are regional resources. You cannot reuse or extend a cluster across Regions. You must perform all the required steps listed in *Getting started with AWS CloudHSM* (p. 7) to create a cluster in a new Region.

For disaster recovery purposes, AWS CloudHSM allows you to copy backups of your AWS CloudHSM Cluster from one region to another. For more information, see *AWS CloudHSM cluster backups* (p. 5).

**Pricing**

With AWS CloudHSM, you pay by the hour with no long-term commitments or upfront payments. For more information, see *AWS CloudHSM Pricing* on the AWS website.
Getting started with AWS CloudHSM

The following topics help you create, initialize, and activate an AWS CloudHSM cluster. After you complete these procedures, you’ll be ready to manage users, manage clusters, and use the included software libraries to perform cryptographic operations.

Contents

• Create IAM administrative groups (p. 7)
• Create a virtual private cloud (VPC) (p. 9)
• Create a cluster (p. 9)
• Review the cluster security group (p. 11)
• Launch an Amazon EC2 client instance (p. 11)
• Configure the Client Amazon EC2 instance security groups (p. 12)
• Create an HSM (p. 14)
• Verify the identity and authenticity of your cluster's HSM (optional) (p. 15)
• Initialize the cluster (p. 21)
• Install and configure CloudHSM CLI (p. 25)
• Activate the cluster (p. 28)
• Reconfigure SSL with a new certificate and private key (optional) (p. 30)
• Build an application (p. 34)

Create IAM administrative groups

As a best practice, don't use your AWS account root user to interact with AWS, including AWS CloudHSM. Instead, use AWS Identity and Access Management (IAM) to create an IAM user, IAM role, or federated user. Follow the steps in the section Create an IAM user and administrator group (p. 7) to create an administrator group and attach the AdministratorAccess policy to it. Then create a new administrator user and add the user to the group. Add additional users to the group as needed. Each user you add inherits the AdministratorAccess policy from the group.

Another best practice is to create an AWS CloudHSM administrator group that has only the permissions required to run AWS CloudHSM. Add individual users to this group as needed. Each user inherits the limited permissions that are attached to the group rather than full AWS access. The Customer managed policies for AWS CloudHSM (p. 628) section that follows contains the policy that you should attach to your AWS CloudHSM administrator group.

AWS CloudHSM defines a service-linked role for your AWS account. The service-linked role currently defines permissions that allow your account to log AWS CloudHSM events. The role can be created automatically by AWS CloudHSM or manually by you. You cannot edit the role, but you can delete it. For more information, see Service-linked roles for AWS CloudHSM (p. 630).

Create an IAM user and administrator group

Start by creating an IAM user along with an administrator group for that user.
Sign up for an AWS account

If you do not have an AWS account, complete the following steps to create one.

To sign up for an AWS account

2. Follow the online instructions.

Part of the sign-up procedure involves receiving a phone call and entering a verification code on the phone keypad.

When you sign up for an AWS account, an AWS account root user is created. The root user has access to all AWS services and resources in the account. As a security best practice, assign administrative access to an administrative user, and use only the root user to perform tasks that require root user access.

AWS sends you a confirmation email after the sign-up process is complete. At any time, you can view your current account activity and manage your account by going to https://aws.amazon.com/ and choosing My Account.

Create an administrative user

After you sign up for an AWS account, create an administrative user so that you don't use the root user for everyday tasks.

Secure your AWS account root user

1. Sign in to the AWS Management Console as the account owner by choosing Root user and entering your AWS account email address. On the next page, enter your password.

   For help signing in by using root user, see Signing in as the root user in the AWS Sign-In User Guide.

2. Turn on multi-factor authentication (MFA) for your root user.

   For instructions, see Enable a virtual MFA device for your AWS account root user (console) in the IAM User Guide.

Create an administrative user

- For your daily administrative tasks, grant administrative access to an administrative user in AWS IAM Identity Center.

   For instructions, see Getting started in the AWS IAM Identity Center User Guide.

Sign in as the administrative user

- To sign in with your IAM Identity Center user, use the sign-in URL that was sent to your email address when you created the IAM Identity Center user.

   For help signing in using an IAM Identity Center user, see Signing in to the AWS access portal in the AWS Sign-In User Guide.

For example policies for AWS CloudHSM that you can attach to your IAM user group, see Identity and access management for AWS CloudHSM (p. 626).
Create a virtual private cloud (VPC)

If you don't already have a virtual private cloud (VPC), follow the steps in this topic to create one.

**Note**
Following these steps will result in the creation of public and private subnets.

**To create a VPC**

1. Open the Amazon VPC console at [https://console.aws.amazon.com/vpc/](https://console.aws.amazon.com/vpc/).
2. On the navigation bar, use the region selector to choose one of the [AWS Regions where AWS CloudHSM is currently supported](https://aws.amazon.com/cloudhsm/regions/).
3. Select the Create VPC button.
4. For **Resources to create**, choose **VPC and more**.
5. For **Name tag auto-generation**, type an identifiable name such as `CloudHSM`.
6. Leave all other options set to their defaults.
7. Choose Create VPC.
8. After the VPC is created, select View VPC to view the VPC you just created.

Create a cluster

A cluster is a collection of individual HSMs. AWS CloudHSM synchronizes the HSMs in each cluster so that they function as a logical unit.

When you create a cluster, AWS CloudHSM creates a security group for the cluster on your behalf. This security group controls network access to the HSMs in the cluster. It allows inbound connections only from Amazon Elastic Compute Cloud (Amazon EC2) instances that are in the security group. By default, the security group doesn't contain any instances. Later, you launch a client instance and configure the cluster's security group to allow communication and connections with the HSM.

**Important**
When you create a cluster, AWS CloudHSM creates a service-linked role named AWSServiceRoleForCloudHSM. If AWS CloudHSM cannot create the role or the role does not already exist, you may not be able to create a cluster. For more information, see Resolving cluster creation failures (p. 665). For more information about service–linked roles, see Service-linked roles for AWS CloudHSM (p. 630).

You can create a cluster from the AWS CloudHSM console, the AWS Command Line Interface (AWS CLI), or the AWS CloudHSM API.

**To create a cluster (console)**

2. On the navigation bar, use the region selector to choose one of the [AWS Regions where AWS CloudHSM is currently supported](https://aws.amazon.com/cloudhsm/regions/).
3. Choose Create cluster.
4. In the **Cluster configuration** section, do the following:
   a. For **VPC**, select the VPC that you created in Create a virtual private cloud (VPC) (p. 9).
   b. For **Availability Zone(s)**, next to each Availability Zone, choose the private subnet that you created.

**Note**
Even if AWS CloudHSM is not supported in a given Availability Zone, performance should not be affected, as AWS CloudHSM automatically load balances across all HSMs
in a cluster. See AWS CloudHSM Regions and Endpoints in the AWS General Reference to see Availability Zone support for AWS CloudHSM.

5. Choose Next.

6. Specify how long the service should retain backups.

   **Note**

   Accept the default retention period of 90 days or type a new value between 7 and 379 days. The service will automatically delete backups in this cluster older than the value you specify here. You can change this later. For more information, see Configuring backup retention (p. 52).

7. Choose Next.

8. (Optional) Type a tag key and an optional tag value. To add more than one tag to the cluster, choose Add tag.

9. Choose Review.

10. Review your cluster configuration, and then choose Create cluster.

**To create a cluster (AWS CLI)**

- At a command prompt, run the create-cluster command. Specify the HSM instance type, the backup retention period, and the subnet IDs of the subnets where you plan to create HSMs. Use the subnet IDs of the private subnets that you created. Specify only one subnet per Availability Zone.

```bash
$ aws cloudhsmv2 create-cluster --hsm-type hsm1.medium \
  --backup-retention-policy Type=DAYS,Value=<number of days> \
  --subnet-ids <subnet ID>

{
  "Cluster": {
    "BackupPolicy": "DEFAULT",
    "BackupRetentionPolicy": {
      "Type": "DAYS",
      "Value": 90
    },
    "VpcId": "vpc-50ae0636",
    "SubnetMapping": {
      "us-west-2b": "subnet-49a1bc00",
      "us-west-2c": "subnet-6f950334",
      "us-west-2a": "subnet-fd54af9b"
    },
    "SecurityGroup": "sg-6cb2c216",
    "HsmType": "hsm1.medium",
    "Certificates": {},
    "State": "CREATE_IN_PROGRESS",
    "Hsms": [],
    "ClusterId": "cluster-igklspoyj5v",
    "CreateTimestamp": 1502423370.069
  }
}
```

**To create a cluster (AWS CloudHSM API)**

- Send a CreateCluster request. Specify the HSM instance type, the backup retention policy, and the subnet IDs of the subnets where you plan to create HSMs. Use the subnet IDs of the private subnets that you created. Specify only one subnet per Availability Zone.

If your attempts to create a cluster fail, it might be related to problems with the AWS CloudHSM service-linked roles. For help on resolving the failure, see Resolving cluster creation failures (p. 665).
Review the cluster security group

When you create a cluster, AWS CloudHSM creates a security group with the name `cloudhsm-cluster-<clusterID>-sg`. This security group contains a preconfigured TCP rule that allows inbound and outbound communication within the cluster security group over ports 2223-2225. This SG allows your EC2 instances to use your VPC to talk to HSMs in your cluster.

**Warning**

- Do not delete or modify the preconfigured TCP rule, which is populated in the cluster security group. This rule can prevent connectivity issues and unauthorized access to your HSMs.
- The cluster security group prevents unauthorized access to your HSMs. Anyone that can access instances in the security group can access your HSMs. Most operations require a user to log in to the HSM. However, it's possible to zeroize HSMs without authentication, which destroys the key material, certificates, and other data. If this happens, data created or modified after the most recent backup is lost and unrecoverable. To prevent unauthorized access, ensure that only trusted administrators can modify or access the instances in the default security group.

In the next step, you can launch an Amazon EC2 instance (p. 11) and connect it to your HSMs by attaching the cluster security group (p. 12) to it.

Launch an Amazon EC2 client instance

To interact with and manage your AWS CloudHSM cluster and HSM instances, you must be able to communicate with the elastic network interfaces of your HSMs. The easiest way to do this is to use an EC2 instance in the same VPC as your cluster. You can also use the following AWS resources to connect to your cluster:

- Amazon VPC Peering
- AWS Direct Connect
- VPN Connections

The AWS CloudHSM documentation typically assumes that you are using an EC2 instance in the same VPC and Availability Zone (AZ) in which you create your cluster.

**To create an EC2 instance**

2. Select Launch instance. From the drop-down menu, choose Launch instance.
3. In the Name field, enter a name for your EC2 instance.
4. In the Applications and OS Images (Amazon Machine Image) section, choose an Amazon Machine Image (AMI) that corresponds to a platform CloudHSM supports. For more information, see [Client SDK 5 supported platforms](p. 392).
5. In the Instance Type section, choose an instance type.
6. In the Key pair section, use an existing key pair or select Create new key pair and complete the following steps:
   a. For Key pair name, enter a name for the key pair.
   b. For Key pair type, choose a key pair type.
   c. For Private key file format, choose the private key file format.
   d. Select Create key pair.
Configure the Client Amazon EC2 instance security groups

When you launched an Amazon EC2 instance, you associated it with a default Amazon VPC security group. This topic explains how to associate the cluster security group with the EC2 instance. This association allows the AWS CloudHSM client running on your EC2 instance to communicate with your
HSMs. To connect your EC2 instance to your AWS CloudHSM cluster, you must properly configure the VPC default security group and associate the cluster security group with the instance.

**Modify the default security group**

You need to modify the default security group to permit the SSH or RDP connection so that you can download and install client software, and interact with your HSM.

**To modify the default security group**

2. Select **Instances (running)** and then select the check box next to the EC2 instance you want to install the AWS CloudHSM client.
3. Under the **Security** tab, choose the security group named **Default**.
4. At the top of the page, choose **Actions**, and then **Edit Inbound Rules**.
5. Select **Add Rule**.
6. For **Type**, do one of the following:
   - For a Windows Server Amazon EC2 instance, choose **RDP**. The port 3389 is automatically populated.
   - For a Linux Amazon EC2 instance, choose **SSH**. The port range 22 is automatically populated.
7. For either option, set **Source** to **My IP** to allow you to communicate with your Amazon EC2 instance.
   
   **Important**
   
   Do not specify 0.0.0.0/0 as the CIDR range to avoid allowing anyone to access your instance.
8. Choose **Save**.

**Connect the Amazon EC2 instance to the AWS CloudHSM cluster**

You must attach the cluster security group to the EC2 instance so that the EC2 instance can communicate with HSMs in your cluster. The cluster security group contains a preconfigured rule that allows inbound communication over ports 2223-2225.

**To connect the EC2 instance to the AWS CloudHSM cluster**

2. Select **Instances (running)** and then select the check box for the EC2 instance on which you want to install the AWS CloudHSM client.
3. At the top of the page, choose **Actions**, **Security**, and then **Change Security Groups**.
4. Select the security group with the group name that matches your cluster ID, such as `cloudhsm-cluster-<clusterID>-sg`.
5. Choose **Add Security Groups**.
6. Select **Save**.

**Note**

You can assign a maximum of five security groups to an Amazon EC2 instance. If you have reached the maximum limit, you must modify the default security group of the Amazon EC2 instance and the cluster security group:

In the default security group, do the following:

- Add an outbound rule to permit traffic on all ports to 0.0.0.0/0.
• Add an inbound rule to permit traffic using the TCP protocol over ports 2223–2225 from the cluster security group.

In the cluster security group, do the following:
• Add an outbound rule to permit traffic on all ports to 0.0.0.0/0.
• Add an inbound rule to permit traffic using the TCP protocol over ports 2223–2225 from the default security group.

Create an HSM

After you create a cluster, you can create an HSM. However, before you can create an HSM in your cluster, the cluster must be in the uninitialized state. To determine the cluster's state, view the clusters page in the AWS CloudHSM console, use the AWS CLI to run the describe-clusters command, or send a DescribeClusters request in the AWS CloudHSM API. You can create an HSM from the AWS CloudHSM console, the AWS CLI, or the AWS CloudHSM API.

To create an HSM (console)
2. Select the radio button next to the ID of the cluster you want to create an HSM for.
3. Select Actions. From the drop down menu, choose Initialize.
4. Choose an Availability Zone (AZ) for the HSM that you are creating.
5. Select Create.

To create an HSM (AWS CLI)
• At a command prompt, run the create-hsm command. Specify the cluster ID of the cluster that you created previously and an Availability Zone for the HSM. Specify the Availability Zone in the form of us-west-2a, us-west-2b, etc.

```bash
$ aws cloudhsmv2 create-hsm --cluster-id <cluster ID> --availability-zone <Availability Zone>
```

```
{
    "Hsm": {
        "HsmId": "hsm-ted36yp5b2x",
        "EniIp": "10.0.1.12",
        "AvailabilityZone": "us-west-2a",
        "ClusterId": "cluster-igklspoyj5v",
        "EniId": "eni-5d7ade72",
        "SubnetId": "subnet-fd54af9b",
        "State": "CREATE_IN_PROGRESS"
    }
}
```

To create an HSM (AWS CloudHSM API)
• Send a CreateHsm request. Specify the cluster ID of the cluster that you created previously and an Availability Zone for the HSM.
After you create a cluster and HSM, you can optionally verify the identity of the HSM (p. 15), or proceed directly to Initialize the cluster (p. 21).

Verify the identity and authenticity of your cluster's HSM (optional)

To initialize your cluster, you sign a certificate signing request (CSR) generated by the cluster’s first HSM. Before you do this, you might want to verify the identity and authenticity of the HSM.

**Note**
This process is optional. However, it works only until a cluster is initialized. After the cluster is initialized, you cannot use this process to get the certificates or verify the HSMs.

**Topics**
- Overview (p. 15)
- Get certificates from the HSM (p. 17)
- Get the root certificates (p. 19)
- Verify certificate chains (p. 20)
- Extract and compare public keys (p. 20)

**Overview**

To verify the identity of your cluster’s first HSM, complete the following steps:

1. **Get the certificates and CSR (p. 17)** – In this step, you get three certificates and a CSR from the HSM. You also get two root certificates, one from AWS CloudHSM and one from the HSM hardware manufacturer.

2. **Verify the certificate chains (p. 20)** – In this step, you construct two certificate chains, one to the AWS CloudHSM root certificate and one to the manufacturer root certificate. Then you verify the HSM certificate with these certificate chains to determine that AWS CloudHSM and the hardware manufacturer both attest to the identity and authenticity of the HSM.

3. **Compare public keys (p. 20)** – In this step, you extract and compare the public keys in the HSM certificate and the cluster CSR, to ensure that they are the same. This should give you confidence that the CSR was generated by an authentic, trusted HSM.

The following diagram shows the CSR, the certificates, and their relationship to each other. The subsequent list defines each certificate.
AWS Root Certificate

This is AWS CloudHSM's root certificate.

Manufacturer Root Certificate

This is the hardware manufacturer's root certificate.

AWS Hardware Certificate

AWS CloudHSM created this certificate when the HSM hardware was added to the fleet. This certificate asserts that AWS CloudHSM owns the hardware.

Manufacturer Hardware Certificate

The HSM hardware manufacturer created this certificate when it manufactured the HSM hardware. This certificate asserts that the manufacturer created the hardware.

HSM Certificate

The HSM certificate is generated by the FIPS-validated hardware when you create the first HSM in the cluster. This certificate asserts that the HSM hardware created the HSM.
Cluster CSR

The first HSM creates the cluster CSR. When you sign the cluster CSR (p. 23), you claim the cluster. Then, you can use the signed CSR to initialize the cluster (p. 24).

Get certificates from the HSM

To verify the identity and authenticity of your HSM, start by getting a CSR and five certificates. You get three of the certificates from the HSM, which you can do with the AWS CloudHSM console, the AWS Command Line Interface (AWS CLI), or the AWS CloudHSM API.

To get the CSR and HSM certificates (console)

2. Select the radio button next to the cluster ID with the HSM you want to verify.
3. Select Actions. From the drop down menu, choose Initialize.
4. If you did not complete the previous step (p. 14) to create an HSM, choose an Availability Zone (AZ) for the HSM that you are creating. Then select Create.
5. When the certificates and CSR are ready, you see links to download them.
6. Choose each link to download and save the CSR and certificates. To simplify the subsequent steps, save all of the files to the same directory and use the default file names.

**To get the CSR and HSM certificates (AWS CLI)**

- At a command prompt, run the `describe-clusters` command four times, extracting the CSR and different certificates each time and saving them to files.
  
a. Issue the following command to extract the cluster CSR. Replace `<cluster ID>` with the ID of the cluster that you created previously.

```bash
$ aws cloudhsmv2 describe-clusters --filters clusterIds=<cluster ID> \
  --output text \n  --query 'Clusters[].Certificates.ClusterCsr' \n  > <cluster ID>_ClusterCsr.csr
```
b. Issue the following command to extract the HSM certificate. Replace `<cluster ID>` with the ID of the cluster that you created previously.

```
$ aws cloudhsmv2 describe-clusters --filters clusterIds=<cluster ID> \
   --output text \
   --query 'Clusters[].Certificates.HsmCertificate' \
   > <cluster ID>_HsmCertificate.crt
```

c. Issue the following command to extract the AWS hardware certificate. Replace `<cluster ID>` with the ID of the cluster that you created previously.

```
$ aws cloudhsmv2 describe-clusters --filters clusterIds=<cluster ID> \
   --output text \
   --query 'Clusters[].Certificates.AwsHardwareCertificate' \
   > <cluster ID>_AwsHardwareCertificate.crt
```

d. Issue the following command to extract the manufacturer hardware certificate. Replace `<cluster ID>` with the ID of the cluster that you created previously.

```
$ aws cloudhsmv2 describe-clusters --filters clusterIds=<cluster ID> \
   --output text \
   --query 'Clusters[].Certificates.ManufacturerHardwareCertificate' \
   > <cluster ID>_ManufacturerHardwareCertificate.crt
```

To get the CSR and HSM certificates (AWS CloudHSM API)

- Send a DescribeClusters request, then extract and save the CSR and certificates from the response.

**Get the root certificates**

Follow these steps to get the root certificates for AWS CloudHSM and the manufacturer. Save the root certificate files to the directory that contains the CSR and HSM certificate files.

**To get the AWS CloudHSM and manufacturer root certificates**

1. Download the AWS CloudHSM root certificate: `AWS_CloudHSM_Root-G1.zip`
2. Download the manufacturer root certificate: `liquid_security_certificate.zip`


You might need to right-click the Download Certificate link and then choose Save Link As... to save the certificate file.

3. After you download the files, extract (unzip) the contents.
Verify certificate chains

In this step, you construct two certificate chains, one to the AWS CloudHSM root certificate and one to the manufacturer root certificate. Then use OpenSSL to verify the HSM certificate with each certificate chain.

To create the certificate chains, open a Linux shell. You need OpenSSL, which is available in most Linux shells, and you need the root certificate (p. 19) and HSM certificate files (p. 17) that you downloaded. However, you do not need the AWS CLI for this step, and the shell does not need to be associated with your AWS account.

To verify the HSM certificate with the AWS CloudHSM root certificate

1. Navigate to the directory where you saved the root certificate (p. 19) and HSM certificate files (p. 17) that you downloaded. The following commands assume that all of the certificates are in the current directory and use the default file names.

   Use the following command to create a certificate chain that includes the AWS hardware certificate and the AWS CloudHSM root certificate, in that order. Replace `<cluster ID>` with the ID of the cluster that you created previously.

   ```
   $ cat <cluster ID>_AwsHardwareCertificate.crt 
   AWS_CloudHSM_Root-G1.crt 
   > <cluster ID>_AWS_chain.crt
   ```

2. Use the following OpenSSL command to verify the HSM certificate with the AWS certificate chain. Replace `<cluster ID>` with the ID of the cluster that you created previously.

   ```
   $ openssl verify -CAfile <cluster ID>_AWS_chain.crt <cluster ID>_HsmCertificate.crt
   <cluster ID>_HsmCertificate.crt: OK
   ```

To verify the HSM certificate with the manufacturer root certificate

1. Use the following command to create a certificate chain that includes the manufacturer hardware certificate and the manufacturer root certificate, in that order. Replace `<cluster ID>` with the ID of the cluster that you created previously.

   ```
   $ cat <cluster ID>_ManufacturerHardwareCertificate.crt 
   liquid_security_certificate.crt 
   > <cluster ID>_manufacturer_chain.crt
   ```

2. Use the following OpenSSL command to verify the HSM certificate with the manufacturer certificate chain. Replace `<cluster ID>` with the ID of the cluster that you created previously.

   ```
   $ openssl verify -CAfile <cluster ID>_manufacturer_chain.crt <cluster ID>_HsmCertificate.crt
   <cluster ID>_HsmCertificate.crt: OK
   ```

Extract and compare public keys

Use OpenSSL to extract and compare the public keys in the HSM certificate and the cluster CSR, to ensure that they are the same.
To compare the public keys, use your Linux shell. You need OpenSSL, which is available in most Linux shells, but you do not need the AWS CLI for this step. The shell does not need to be associated with your AWS account.

**To extract and compare the public keys**

1. Use the following command to extract the public key from the HSM certificate.

   ```bash
   $ openssl x509 -in <cluster ID>_HsmCertificate.crt -pubkey -noout > <cluster ID>_HsmCertificate.pub
   ```

2. Use the following command to extract the public key from the cluster CSR.

   ```bash
   $ openssl req -in <cluster ID>_ClusterCsr.csr -pubkey -noout > <cluster ID>_ClusterCsr.pub
   ```

3. Use the following command to compare the public keys. If the public keys are identical, the following command produces no output.

   ```bash
   $ diff <cluster ID>_HsmCertificate.pub <cluster ID>_ClusterCsr.pub
   ```

After you verify the identity and authenticity of the HSM, proceed to Initialize the cluster (p. 21).

**Initialize the cluster**

Complete the steps in the following topics to initialize your AWS CloudHSM cluster.

**Note**

Before you initialize the cluster, review the process by which you can verify the identity and authenticity of the HSMs (p. 15). This process is optional and works only until a cluster is initialized. After the cluster is initialized, you cannot use this process to get your certificates or verify the HSMs.

**Topics**

- Get the cluster CSR (p. 21)
- Sign the CSR (p. 23)
- Initialize the cluster (p. 24)

**Get the cluster CSR**

Before you can initialize the cluster, you must download and sign a certificate signing request (CSR) that is generated by the cluster’s first HSM. If you followed the steps to verify the identity of your cluster’s HSM (p. 15), you already have the CSR and you can sign it. Otherwise, get the CSR now by using the AWS CloudHSM console, the AWS Command Line Interface (AWS CLI), or the AWS CloudHSM API.

**Important**

To initialize your cluster, your trust anchor must comply with RFC 5280 and meet the following requirements:

- If using X509v3 extensions, the X509v3 Basic Constraints extension must be present.
- The trust anchor must be a self-signed certificate.
- Extension values must not conflict with each other.
To get the CSR (console)

2. Select the radio button next to the cluster ID with the HSM you want to verify.
3. Select Actions. From the drop down menu, choose Initialize.
4. If you did not complete the previous step (p. 14) to create an HSM, choose an Availability Zone (AZ) for the HSM that you are creating. Then select Create.
5. When the CSR is ready, you see a link to download it.

6. Choose Cluster CSR to download and save the CSR.

To get the CSR (AWS CLI)

- At a command prompt, run the following describe-clusters command, which extracts the CSR and saves it to a file. Replace `<cluster ID>` with the ID of the cluster that you created previously (p. 9).
To get the CSR (AWS CloudHSM API)

1. Send a `DescribeClusters` request.
2. Extract and save the CSR from the response.

Sign the CSR

Currently, you must create a self-signed signing certificate and use it to sign the CSR for your cluster. You do not need the AWS CLI for this step, and the shell does not need to be associated with your AWS account. To sign the CSR, you must do the following:

1. Complete the previous section (see Get the cluster CSR (p. 21)).
2. Create a private key.
3. Use the private key to create a signing certificate.
4. Sign your cluster CSR.

Create a private key

**Note**

For a production cluster, the key you are about to create should be created in a secure manner using a trusted source of randomness. We recommend that you use a secured offsite and offline HSM or the equivalent. Store the key safely. The key establishes the identity of the cluster and your sole control over the HSMs it contains.

For development and testing, you can use any convenient tool (such as OpenSSL) to create and sign the cluster certificate. The following example shows you how to create a key. After you have used the key to create a self-signed certificate (see below), you should store it in a safe manner.

To sign into your AWS CloudHSM instance, the certificate must be present, but the private key does not.

Use the following command to create a private key. When initializing an AWS CloudHSM cluster, you must use the RSA 2048 certificate or the RSA 4096 certificate.

```sh
$ openssl genrsa -aes256 -out customerCA.key 2048
Generating RSA private key, 2048 bit long modulus
........+++
............+++ e is 65537 (0x10001)
Enter pass phrase for customerCA.key:
Verifying - Enter pass phrase for customerCA.key:
```

Use the private key to create a self-signed certificate

The trusted hardware that you use to create the private key for your production cluster should also provide a software tool to generate a self-signed certificate using that key. The following example uses OpenSSL and the private key that you created in the previous step to create a signing certificate. The certificate is valid for 10 years (3652 days). Read the on-screen instructions and follow the prompts.
$ openssl req -new -x509 -days 3652 -key customerCA.key -out customerCA.crt
Enter pass phrase for customerCA.key:
You are about to be asked to enter information that will be incorporated into your certificate request.
What you are about to enter is what is called a Distinguished Name or a DN.
There are quite a few fields but you can leave some blank. For some fields there will be a default value, If you enter '.', the field will be left blank.
-----
Country Name (2 letter code) [AU]:
State or Province Name (full name) [Some-State]:
Locality Name (eg, city) []:
Organization Name (eg, company) [Internet Widgits Pty Ltd]:
Organizational Unit Name (eg, section) []:
Common Name (e.g. server FQDN or YOUR name) []:
Email Address []:

This command creates a certificate file named customerCA.crt. Put this certificate on every host from which you will connect to your AWS CloudHSM cluster. If you give the file a different name or store it in a path other than the root of your host, you should edit your client configuration file accordingly. Use the certificate and the private key you just created to sign the cluster certificate signing request (CSR) in the next step.

Sign the cluster CSR

The trusted hardware that you use to create your private key for your production cluster should also provide a tool to sign the CSR using that key. The following example uses OpenSSL to sign the cluster's CSR. The example uses your private key and the self-signed certificate that you created in the previous step.

$ openssl x509 -req -days 3652 -in <cluster ID>_ClusterCsr.csr 
   -CA customerCA.crt 
   -CAkey customerCA.key 
   -CAcreateserial 
   -out <cluster ID>_CustomerHsmCertificate.crt

Signature ok
subject=/C=US/ST=CA/O=Cavium/OU=N3FIPS/L=SanJose/CN=HSM:<HSM identifier>:PARTN:<partition number>, for FIPS mode
Getting CA Private Key
Enter pass phrase for customerCA.key:

This command creates a file named <cluster ID>_CustomerHsmCertificate.crt. Use this file as the signed certificate when you initialize the cluster.

Initialize the cluster

Use your signed HSM certificate and your signing certificate to initialize your cluster. You can use the AWS CloudHSM console, the AWS CLI, or the AWS CloudHSM API.

To initialize a cluster (console)

2. Select the radio button next to the cluster ID with the HSM you want to verify.
3. Select Actions. From the drop down menu, choose Initialize.
4. If you did not complete the previous step (p. 14) to create an HSM, choose an Availability Zone (AZ) for the HSM that you are creating. Then select Create.
5. On the Download certificate signing request page, choose Next. If Next is not available, first choose one of the CSR or certificate links. Then choose Next.

6. On the Sign certificate signing request (CSR) page, choose Next.

7. On the Upload the certificates page, do the following:
   a. Next to Cluster certificate, choose Upload file. Then locate and select the HSM certificate that you signed previously. If you completed the steps in the previous section, select the file named `<cluster ID>_CustomerHsmCertificate.crt`.
   b. Next to Issuing certificate, choose Upload file. Then select your signing certificate. If you completed the steps in the previous section, select the file named `customerCA.crt`.
   c. Choose Upload and initialize.

**To initialize a cluster (AWS CLI)**

- At a command prompt, run the `initialize-cluster` command. Provide the following:
  - The ID of the cluster that you created previously.
  - The HSM certificate that you signed previously. If you completed the steps in the previous section, it's saved in a file named `<cluster ID>_CustomerHsmCertificate.crt`.
  - Your signing certificate. If you completed the steps in the previous section, the signing certificate is saved in a file named `customerCA.crt`.

```bash
$ aws cloudhsmv2 initialize-cluster --cluster-id <cluster ID> \
   --signed-cert file://<cluster ID>_CustomerHsmCertificate.crt \ 
   --trust-anchor file://customerCA.crt
```

```
{
  "State": "INITIALIZE_IN_PROGRESS",
  "StateMessage": "Cluster is initializing. State will change to INITIALIZED upon completion."
}
```

**To initialize a cluster (AWS CloudHSM API)**

- Send an `InitializeCluster` request with the following:
  - The ID of the cluster that you created previously.
  - The HSM certificate that you signed previously.
  - Your signing certificate.

---

**Install and configure CloudHSM CLI**

To interact with the HSM in your AWS CloudHSM cluster, you need the CloudHSM CLI.

**Tasks**

- [Install the AWS CloudHSM client and command line tools (p. 26)]
Install the AWS CloudHSM client and command line tools

Connect to your client instance and run the following commands to download and install the AWS CloudHSM client and command line tools. For more information, see [Launch an Amazon EC2 client instance](p. 11).

Use the following commands to download and install the CloudHSM CLI.

**Amazon Linux**

Amazon Linux on x86_64 architecture:

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL6/cloudhsm-cli-latest.el6.x86_64.rpm
$ sudo yum install ./cloudhsm-cli-latest.el6.x86_64.rpm
```

**Amazon Linux 2**

Amazon Linux 2 on x86_64 architecture:

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-cli-latest.el7.x86_64.rpm
$ sudo yum install ./cloudhsm-cli-latest.el7.x86_64.rpm
```

Amazon Linux 2 on ARM64 architecture:

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-cli-latest.el7.aarch64.rpm
$ sudo yum install ./cloudhsm-cli-latest.el7.aarch64.rpm
```

**CentOS 7**

CentOS 7 on x86_64 architecture:

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-cli-latest.el7.x86_64.rpm
$ sudo yum install ./cloudhsm-cli-latest.el7.x86_64.rpm
```

**CentOS 8**

CentOS 8 on x86_64 architecture:

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL8/cloudhsm-cli-latest.el8.x86_64.rpm
$ sudo yum install ./cloudhsm-cli-latest.el8.x86_64.rpm
```
Install the AWS CloudHSM client and command line tools

RHEL 7
RHEL 7 on x86_64 architecture:

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-cli-latest.el7.x86_64.rpm
```

```
$ sudo yum install ./cloudhsm-cli-latest.el7.x86_64.rpm
```

RHEL 8
RHEL 8 on x86_64 architecture:

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL8/cloudhsm-cli-latest.el8.x86_64.rpm
```

```
$ sudo yum install ./cloudhsm-cli-latest.el8.x86_64.rpm
```

Ubuntu 18.04 LTS
Ubuntu 18.04 LTS on x86_64 architecture:

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Bionic/cloudhsm-cli_latest_u18.04_amd64.deb
```

```
$ sudo apt install ./cloudhsm-cli_latest_u18.04_amd64.deb
```

Ubuntu 20.04 LTS
Ubuntu 20.04 LTS on x86_64 architecture:

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Focal/cloudhsm-cli_latest_u20.04_amd64.deb
```

```
$ sudo apt install ./cloudhsm-cli_latest_u20.04_amd64.deb
```

Ubuntu 22.04 LTS
Ubuntu 22.04 LTS on x86_64 architecture:

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Jammy/cloudhsm-cli_latest_u22.04_amd64.deb
```

```
$ sudo apt install ./cloudhsm-cli_latest_u22.04_amd64.deb
```

Windows Server 2016
For Windows Server 2016 on x86_64 architecture, open PowerShell as an administrator and run the following command:

```
```
Activate the cluster

When you activate an AWS CloudHSM cluster, the cluster’s state changes from initialized to active. You can then manage the hardware security module (HSM) users (p. 60) and use the HSM (p. 392).

Important
Before you can activate the cluster, you must first copy the issuing certificate to the default location for the platform on each EC2 instance that connects to the cluster (you create the issuing certificate when you initialize the cluster).

Linux

/opt/cloudhsm/etc/customerCA.crt

Windows

C:\ProgramData\Amazon\CloudHSM\customerCA.crt

After placing the issuing certificate, install CloudHSM CLI and run the `cluster activate` (p. 192) command on your first HSM. You will notice the admin account on the first HSM in your cluster has the

---

**Windows Server 2019**

For Windows Server 2019 on x86_64 architecture, open PowerShell as an administrator and run the following command:

```
PS C:\> Start-Process msiexec.exe -ArgumentList '/i C:\AWSCloudHSMCLI-latest.msi /quiet /norestart /log C:\client-install.txt' -Wait
```

Use the following commands to configure CloudHSM CLI.

To bootstrap a Linux EC2 instance for Client SDK 5

- Use the configure tool to specify the IP address of the HSM(s) in your cluster.

```
$ sudo /opt/cloudhsm/bin/configure-cli -a <The ENI IP addresses of the HSMs>
```

To bootstrap a Windows EC2 instance for Client SDK 5

- Use the configure tool to specify the IP address of the HSM(s) in your cluster.

```
"C:\Program Files\Amazon\CloudHSM\bin\configure-cli.exe" -a <The ENI IP addresses of the HSMs>
```

---

**Activate the cluster**

When you activate an AWS CloudHSM cluster, the cluster’s state changes from initialized to active. You can then manage the hardware security module (HSM) users (p. 60) and use the HSM (p. 392).

Important
Before you can activate the cluster, you must first copy the issuing certificate to the default location for the platform on each EC2 instance that connects to the cluster (you create the issuing certificate when you initialize the cluster).

Linux

/opt/cloudhsm/etc/customerCA.crt

Windows

C:\ProgramData\Amazon\CloudHSM\customerCA.crt

After placing the issuing certificate, install CloudHSM CLI and run the `cluster activate` (p. 192) command on your first HSM. You will notice the admin account on the first HSM in your cluster has the
unactivated-admin (p. 60) role. This a temporary role that only exists prior to cluster activation. When you activate your cluster, the unactivated-admin role changes to admin.

**Activate a cluster**

1. Connect to the client instance that you previously launched in. For more information, see [Launch an Amazon EC2 client instance (p. 11)](#). You can launch a Linux instance or a Windows Server.
2. Run the CloudHSM CLI in interactive mode.

   **Linux**
   
   ```bash
   $ /opt/cloudhsm/bin/cloudhsm-cli interactive
   ```
   
   **Windows**
   
   ```bash
   C:\Program Files\Amazon\CloudHSM\bin\> .\cloudhsm-cli.exe interactive
   ```

3. (Optional) Use the **user list** command to display the existing users.

   ```json
   aws-cloudhsm > user list
   {
   "error_code": 0,
   "data": {
   "users": [
   {
   "username": "admin",
   "role": "unactivated-admin",
   "locked": "false",
   "mfa": [],
   "cluster-coverage": "full"
   },
   {
   "username": "app_user",
   "role": "internal(APPLIANCE_USER)",
   "locked": "false",
   "mfa": [],
   "cluster-coverage": "full"
   }
   ]
   }
   }
   ```

4. Use the **cluster activate** command to set the initial admin password.

   ```json
   aws-cloudhsm > cluster activate
   Enter password:<NewPassword>
   Confirm password:<NewPassword>
   {
   "error_code": 0,
   "data": "Cluster activation successful"
   }
   ```

We recommend that you write down the new password on a password worksheet. Do not lose the worksheet. We recommend that you print a copy of the password worksheet, use it to record your critical HSM passwords, and then store it in a secure place. We also recommended that you store a copy of this worksheet in secure off-site storage.
5. (Optional) Use the **user list** command to verify that the user's type changed to admin/CO (p. 94).

```json
aws-cloudhsm > user list
{
  "error_code": 0,
  "data": {
    "users": [
      {
        "username": "admin",
        "role": "admin",
        "locked": "false",
        "mfa": [],
        "cluster-coverage": "full"
      },
      {
        "username": "app_user",
        "role": "internal(APPLIANCE_USER)",
        "locked": "false",
        "mfa": [],
        "cluster-coverage": "full"
      }
    ]
  }
}
```

6. Use the **quit** command to stop the CloudHSM CLI tool.

```bash
aws-cloudhsm > quit
```

For more information about working with CloudHSM CLI or the CMU, see Understanding HSM Users (p. 60) and Understanding HSM User Management with CMU (p. 95).

## Reconfigure SSL with a new certificate and private key (optional)

AWS CloudHSM uses an SSL certificate to establish a connection to an HSM. A default key and SSL certificate are included when you install the client. You can, however, create and use your own. Note that you will need the self–signed certificate (*customerCA.crt*) that you created when you initialized (p. 23) your cluster.

At a high level, this is a two-step process:

1. First, you create a private key, then use that key to create a certificate signing request (CSR). Use the issuing certificate, the certificate you created when you initialized the cluster, to sign the CSR.
2. Next, you use the configure tool to copy the key and certificate to the appropriate directories.

## Create a key, a CSR, and then sign the CSR

The steps are the same for Client SDK 3 or Client SDK 5.

To reconfigure SSL with a new certificate and private key

1. Create a private key using the following OpenSSL command:
2. Use the following OpenSSL command to create a certificate signing request (CSR). You will be asked a series of questions for your certificate.

```
openssl req -new -sha256 -key ssl-client.key -out ssl-client.csr
```

Enter pass phrase for ssl-client.key:
You are about to be asked to enter information that will be incorporated into your certificate request.
What you are about to enter is what is called a Distinguished Name or a DN.
There are quite a few fields but you can leave some blank
For some fields there will be a default value,
If you enter ".", the field will be left blank.
-----
Country Name (2 letter code) [XX]:
State or Province Name (full name) []:
Locality Name (eg, city) [Default City]:
Organization Name (eg, company) [Default Company Ltd]:
Organizational Unit Name (eg, section) []:
Common Name (eg, your name or your server's hostname) []:
Email Address []:
Please enter the following 'extra' attributes to be sent with your certificate request
A challenge password []:
An optional company name []:

3. Sign the CSR with the `customerCA.crt` certificate that you created when you initialized your cluster.

```
openssl x509 -req -days 3652 -in ssl-client.csr
  -CA customerCA.crt
  -CAkey customerCA.key
  -CAcreateserial
  -out ssl-client.crt
```

Signature ok
subject=/C=US/ST=WA/L=Seattle/O=Example Company/OU=sales
Getting CA Private Key

Enable custom SSL for AWS CloudHSM

The steps are different for Client SDK 3 or Client SDK 5. For more information about working with the configure command line tool, see ???(p. 159).

Topics
- Custom SSL for Client SDK 3 (p. 32)
- Custom SSL for Client SDK 5 (p. 32)
**Custom SSL for Client SDK 3**

Use the configure tool for Client SDK 3 to enable custom SSL. For more information about configure tool for Client SDK 3, see ?? (p. 177).

**To use a custom certificate and key for TLS client-server mutual authentication with Client SDK 3 on Linux**

1. Copy your key and certificate to the appropriate directory.

   ```
   sudo cp ssl-client.crt /opt/cloudhsm/etc
   sudo cp ssl-client.key /opt/cloudhsm/etc
   ```

2. Use the configure tool to specify `ssl-client.crt` and `ssl-client.key`.

   ```
   sudo /opt/cloudhsm/bin/configure --ssl
   --pkey /opt/cloudhsm/etc/ssl-client.key
   --cert /opt/cloudhsm/etc/ssl-client.crt
   ```

3. Add the `customerCA.crt` certificate to the trust store. Create a hash of the certificate subject name. This creates an index to allow the certificate to be looked up by that name.

   ```
   openssl x509 -in /opt/cloudhsm/etc/customerCA.crt -hash | head -n 1
   1234abcd
   ```

   Create a directory.

   ```
   mkdir /opt/cloudhsm/etc/certs
   ```

   Create a file that contains the certificate with the hash name.

   ```
   sudo cp /opt/cloudhsm/etc/customerCA.crt /opt/cloudhsm/etc/certs/1234abcd.0
   ```

**Custom SSL for Client SDK 5**

Use any of the Client SDK 5 configure tools to enable custom SSL. For more information about configure tool for Client SDK 5, see ?? (p. 159).

**PKCS #11 library**

**To use a custom certificate and key for TLS client-server mutual authentication with Client SDK 5 on Linux**

1. Copy your key and certificate to the appropriate directory.

   ```
   $ sudo cp ssl-client.crt /opt/cloudhsm/etc
   sudo cp ssl-client.key /opt/cloudhsm/etc
   ```

2. Use the configure tool to specify `ssl-client.crt` and `ssl-client.key`.

   ```
   $ sudo /opt/cloudhsm/bin/configure-pkcs11
   --server-client-cert-file /opt/cloudhsm/etc/ssl-client.crt
   --server-client-key-file /opt/cloudhsm/etc/ssl-client.key
   ```
To use a custom certificate and key for TLS client-server mutual authentication with Client SDK 5 on Windows

1. Copy your key and certificate to the appropriate directory.

   ```
   cp ssl-client.crt C:\ProgramData\Amazon\CloudHSM\ssl-client.crt
   cp ssl-client.key C:\ProgramData\Amazon\CloudHSM\ssl-client.key
   ```

2. With a PowerShell interpreter, use the configure tool to specify `ssl-client.crt` and `ssl-client.key`.

   ```
   & "C:\Program Files\Amazon\CloudHSM\bin\configure-pkcs11.exe"  
   --server-client-cert-file C:\ProgramData\Amazon\CloudHSM\ssl-client.crt
   --server-client-key-file C:\ProgramData\Amazon\CloudHSM\ssl-client.key
   ```

OpenSSL Dynamic Engine

To use a custom certificate and key for TLS client-server mutual authentication with Client SDK 5 on Linux

1. Copy your key and certificate to the appropriate directory.

   ```
   $ sudo cp ssl-client.crt /opt/cloudhsm/etc
   sudo cp ssl-client.key /opt/cloudhsm/etc
   ```

2. Use the configure tool to specify `ssl-client.crt` and `ssl-client.key`.

   ```
   $ sudo /opt/cloudhsm/bin/configure-dyn  
   --server-client-cert-file /opt/cloudhsm/etc/ssl-client.crt 
   --server-client-key-file /opt/cloudhsm/etc/ssl-client.key
   ```

JCE provider

To use a custom certificate and key for TLS client-server mutual authentication with Client SDK 5 on Linux

1. Copy your key and certificate to the appropriate directory.

   ```
   $ sudo cp ssl-client.crt /opt/cloudhsm/etc
   sudo cp ssl-client.key /opt/cloudhsm/etc
   ```

2. Use the configure tool to specify `ssl-client.crt` and `ssl-client.key`.

   ```
   $ sudo /opt/cloudhsm/bin/configure-jce  
   --server-client-cert-file /opt/cloudhsm/etc/ssl-client.crt 
   --server-client-key-file /opt/cloudhsm/etc/ssl-client.key
   ```

To use a custom certificate and key for TLS client-server mutual authentication with Client SDK 5 on Windows

1. Copy your key and certificate to the appropriate directory.

   ```
   cp ssl-client.crt C:\ProgramData\Amazon\CloudHSM\ssl-client.crt
   ```
Build an application

Build applications and work with keys using AWS CloudHSM.

To get started creating and using keys in your new cluster, you must first create a hardware security module (HSM) user with CloudHSM Management Utility (CMU). For more information, see Understanding HSM User Management Tasks (p. 95), Getting started with AWS CloudHSM Command Line Interface (CLI) (p. 184), and How to Manage HSM Users (p. 60).

Note
If using Client SDK 3, use CloudHSM Management Utility (CMU) (p. 252) instead of CloudHSM CLI.
With HSM users in place, you can log in to the HSM and create and use keys with any of the following options:

- Use key management utility, a command line tool (p. 301)
- Build a C application using the PKCS #11 library (p. 394)
- Build a Java application using the JCE provider (p. 422)
- Use the OpenSSL Dynamic Engine directly from the command line (p. 418)
- Use the OpenSSL Dynamic Engine for TLS offload with NGINX and Apache web servers (p. 507)
- Use the CNG and KSP providers to use AWS CloudHSM with Microsoft Windows Server Certificate Authority (CA) (p. 570)
- Use the CNG and KSP providers to use AWS CloudHSM with Microsoft Sign Tool (p. 578)
- Use the CNG and KSP providers for TLS offload with Internet Information Server (IIS) web server (p. 507)
Best practices for AWS CloudHSM

Learn best practices for working with AWS CloudHSM. As new best practices are identified, we'll update this section.

AWS CloudHSM basic operational guidelines

Use the following guidelines when working with AWS CloudHSM. The AWS CloudHSM Service Level Agreement requires that you follow these guidelines.

Administration: We recommend you create at least two admins/cryptographic officers (COs) to administer your cluster. Before setting quorum (MofN) policy, you must create at least M+1 admin/CO accounts. Delete admins/CO accounts with caution. If you fall below the quorum number of admins/COs, you will no longer be able to administer your cluster.

For more information, refer to Using CloudHSM CLI to manage quorum authentication (M of N access control) (p. 77).

Cluster Configuration: For production clusters, you should have at least two HSM instances spread across different availability zones in a region. For latency-sensitive workloads, we recommend +1 redundancy. For applications requiring durability of newly generated keys, we recommend at least three HSM instances spread across different availability zones in a region.

For more information, refer to Managing AWS CloudHSM clusters (p. 37).

Cluster Capacity: We recommend load testing your cluster to determine the peak load you should anticipate, and then add one more HSM to it to ensure high availability. You should consider both audit log capacity and cryptographic capacity when deciding how many HSMs to create in a cluster.

For more information, refer to Managing AWS CloudHSM clusters (p. 37).

Protecting keys and extracting keys from an HSM: AWS CloudHSM lets you choose which cleartext keys can be extracted and not extracted, so it is important that you identify which should be extractable and which should not be. Once identified, use each key's attributes to ensure they are set correctly:

- Keys with their WRAP_WITH_TRUSTED attribute do not allow keys to be exported in cleartext, and is suitable for a variety of use cases. For more information see Using trusted keys to control key unwraps (p. 155).
- Keys with their EXTRACTABLE attribute set to false can never leave the HSM, and there is no way to unset this property after it has been set.
Managing AWS CloudHSM clusters

You can manage your AWS CloudHSM clusters from the AWS CloudHSM console or one of the AWS SDKs or command line tools. For more information, see the following topics.

To create a cluster, see Getting started (p. 7).

Cluster architecture

When you create a cluster, you specify an Amazon Virtual Private Cloud (VPC) in your AWS account and one or more subnets in that VPC. We recommend that you create one subnet in each Availability Zone (AZ) in your chosen AWS Region. You can create private subnets when you create a VPC. To learn more, see Create a virtual private cloud (VPC) (p. 9).

Each time you create an HSM, you specify the cluster and Availability Zone for the HSM. By putting the HSMs in different Availability Zones, you achieve redundancy and high availability in case one Availability Zone is unavailable.

When you create an HSM, AWS CloudHSM puts an elastic network interface (ENI) in the specified subnet in your AWS account. The elastic network interface is the interface for interacting with the HSM. The HSM resides in a separate VPC in an AWS account that is owned by AWS CloudHSM. The HSM and its corresponding network interface are in the same Availability Zone.

To interact with the HSMs in a cluster, you need the AWS CloudHSM client software. Typically you install the client on Amazon EC2 instances, known as client instances, that reside in the same VPC as the HSM ENIs, as shown in the following figure. That's not technically required though; you can install the client on any compatible computer, as long as it can connect to the HSM ENIs. The client communicates with the individual HSMs in your cluster through their ENIs.

The following figure represents an AWS CloudHSM cluster with three HSMs, each in a different Availability Zone in the VPC.
Cluster synchronization

In an AWS CloudHSM cluster, AWS CloudHSM keeps the keys on the individual HSMs in sync. You don't need to do anything to synchronize the keys on your HSMs. To keep the users and policies on each HSM
in sync, update the AWS CloudHSM client configuration file before you manage HSM users (p. 60). For more information, see Keep HSM users in sync (p. 660).

When you add a new HSM to a cluster, AWS CloudHSM makes a backup of all keys, users, and policies on an existing HSM. It then restores that backup onto the new HSM. This keeps the two HSMs in sync.

If the HSMs in a cluster fall out of synchronization, AWS CloudHSM automatically resynchronizes them. To enable this, AWS CloudHSM uses the credentials of the appliance user (p. 60). This user exists on all HSMs provided by AWS CloudHSM and has limited permissions. It can get a hash of objects on the HSM and can extract and insert masked (encrypted) objects. AWS cannot view or modify your users or keys and cannot perform any cryptographic operations using those keys.

## Cluster high availability and load balancing

When you create an AWS CloudHSM cluster with more than one HSM, you automatically get load balancing. Load balancing means that the AWS CloudHSM client (p. 4) distributes cryptographic operations across all HSMs in the cluster based on each HSM’s capacity for additional processing.

When you create the HSMs in different AWS Availability Zones, you automatically get high availability. High availability means that you get higher reliability because no individual HSM is a single point of failure. We recommend that you have a minimum of two HSMs in each cluster, with each HSM in different Availability Zones within an AWS Region.

For example, the following figure shows an Oracle database application that is distributed to two different Availability Zones. The database instances store their master keys in a cluster that includes an HSM in each Availability Zone. AWS CloudHSM automatically synchronizes the keys to both HSMs so that they are immediately accessible and redundant.
Connect the client SDK to the AWS CloudHSM cluster

To connect to the cluster with either Client SDK 5 or Client SDK 3, you must first do two things:

• Have an issuing certificate in place on the EC2 instance
• Bootstrap the Client SDK to the cluster

Place the issuing certificate on each EC2 instance

You create the issuing certificate when you initialize the cluster. Copy the issuing certificate to the default location for the platform on each EC2 instance that connects to the cluster.

Linux

/ opt/cloudhsm/etc/customerCA.crt

Windows

C:\ProgramData\Amazon\CloudHSM\customerCA.crt

Specify the location of the issuing certificate

With Client SDK 5, you use the configure tool to specify the location of the issuing certificate.

PKCS #11 library

To place the issuing certificate on Linux for Client SDK 5

• Use the configure tool to specify a location for the issuing certificate.

$ sudo /opt/cloudhsm/bin/configure-pkcs11 --hsm-ca-cert <customerCA certificate file>

To place the issuing certificate on Windows for Client SDK 5

• Use the configure tool to specify a location for the issuing certificate.

"C:\Program Files\Amazon\CloudHSM\configure-pkcs11.exe" --hsm-ca-cert <customerCA certificate file>

OpenSSL Dynamic Engine

To place the issuing certificate on Linux for Client SDK 5

• Use the configure tool to specify a location for the issuing certificate.
Bootstrap the Client SDK

The bootstrap process is different depending on the version of the Client SDK you're using, but you must have the IP address of one of the hardware security modules (HSM) in the cluster. You can use the IP

*JCE provider*

**To place the issuing certificate on Linux for Client SDK 5**

- Use the configure tool to specify a location for the issuing certificate.

```bash
$ sudo /opt/cloudhsm/bin/configure-dyn --hsm-ca-cert <customerCA certificate file>
```

**To place the issuing certificate on Windows for Client SDK 5**

- Use the configure tool to specify a location for the issuing certificate.

```bash
"C:\Program Files\Amazon\CloudHSM\configure-jce.exe" --hsm-ca-cert <customerCA certificate file>
```

*CloudHSM CLI*

**To place the issuing certificate on Linux for Client SDK 5**

- Use the configure tool to specify a location for the issuing certificate.

```bash
$ sudo /opt/cloudhsm/bin/configure-cli --hsm-ca-cert <customerCA certificate file>
```

**To place the issuing certificate on Windows for Client SDK 5**

- Use the configure tool to specify a location for the issuing certificate.

```bash
"C:\Program Files\Amazon\CloudHSM\configure-cli.exe" --hsm-ca-cert <customerCA certificate file>
```

For more information, see [Configure Tool](#) (p. 159).

For more information about initializing the cluster or creating and signing the certificate, see [Initialize the Cluster](#) (p. 24).

**Bootstrap the Client SDK**

The bootstrap process is different depending on the version of the Client SDK you're using, but you must have the IP address of one of the hardware security modules (HSM) in the cluster. You can use the IP

```bash
"C:\Program Files\Amazon\CloudHSM\configure-cli.exe" --hsm-ca-cert <customerCA certificate file>
```
address of any HSM attached to your cluster. After the Client SDK connects, it retrieves the IP addresses of any additional HSMs and performs load balancing and client-side key synchronization operations.

**To get an IP address for the cluster**

**To get an IP address for a HSM (console)**

2. To change the AWS Region, use the Region selector in the upper-right corner of the page.
3. To open the cluster detail page, in the cluster table, choose the cluster ID.
4. To get the IP address, on the HSMs tab, choose one of the IP addresses listed under **ENI IP address**.

**To get an IP address for a HSM (AWS CLI)**

- Get the IP address of an HSM by using the `describe-clusters` command from the AWS CLI. In the output from the command, the IP address of the HSMs are the values of `EniIp`.

```bash
$ aws cloudhsmv2 describe-clusters
{
   "Clusters": [
      { ...
         "Hsms": [
            { ...
               "EniIp": "10.0.0.9",
               ...
            },
            { ...
               "EniIp": "10.0.1.6",
               ...
            }
         ],
         ...
      }
   ]
}
```

For more information about bootstrapping, see [Configure Tool (p. 159)](#).

**To bootstrap Client SDK 5**

**PKCS #11 library**

**To bootstrap a Linux EC2 instance for Client SDK 5**

- Use the configure tool to specify the IP address of a HSM in your cluster.

```bash
$ sudo /opt/cloudhsm/bin/configure-pkcs11 -a <HSM IP addresses>
```

**To bootstrap a Windows EC2 instance for Client SDK 5**

- Use the configure tool to specify the IP address of a HSM in your cluster.

"C:\Program Files\Amazon\CloudHSM\bin\configure-pkcs11.exe" -a <HSM IP addresses>
OpenSSL Dynamic Engine

To bootstrap a Linux EC2 instance for Client SDK 5

- Use the configure tool to specify the IP address of a HSM in your cluster.

$ sudo /opt/cloudhsm/bin/configure-dyn -a <HSM IP addresses>

JCE provider

To bootstrap a Linux EC2 instance for Client SDK 5

- Use the configure tool to specify the IP address of a HSM in your cluster.

$ sudo /opt/cloudhsm/bin/configure-jce -a <HSM IP addresses>

To bootstrap a Windows EC2 instance for Client SDK 5

- Use the configure tool to specify the IP address of a HSM in your cluster.

"C:\Program Files\Amazon\CloudHSM\bin\configure-jce.exe" -a <HSM IP addresses>

CloudHSM CLI

To bootstrap a Linux EC2 instance for Client SDK 5

- Use the configure tool to specify the IP address of the HSM(s) in your cluster.

$ sudo /opt/cloudhsm/bin/configure-cli -a <The ENI IP addresses of the HSMs>

To bootstrap a Windows EC2 instance for Client SDK 5

- Use the configure tool to specify the IP address of the HSM(s) in your cluster.

"C:\Program Files\Amazon\CloudHSM\bin\configure-cli.exe" -a <The ENI IP addresses of the HSMs>

Note

You can use the --cluster-id parameter in place of -a <HSM_IP_ADDRESSES>. To see requirements for using --cluster-id, see Client SDK 5 configure tool (p. 159).
Adding or removing HSMs

To bootstrap Client SDK 3

To bootstrap a Linux EC2 instance for Client SDK 3

• Use `configure` to specify the IP address of a HSM in your cluster.

```
sudo /opt/cloudhsm/bin/configure -a <IP address>
```

To bootstrap a Windows EC2 instance for Client SDK 3

• Use `configure` to specify the IP address of a HSM in your cluster.

```
C:\Program Files\Amazon\CloudHSM\bin\configure-jce.exe -a <HSM IP address>
```

For more information about `configure`, see ?? (p. 159).

Adding or removing HSMs in an AWS CloudHSM cluster

To scale up or down your AWS CloudHSM cluster, add or remove HSMs by using the AWS CloudHSM console or one of the AWS SDKs or command line tools. We recommend load testing your cluster to determine the peak load you should anticipate, and then add one more HSM to it to ensure high availability.

Topics

• Adding an HSM (p. 44)
• Removing an HSM (p. 46)

Adding an HSM

The following figure illustrates the events that occur when you add an HSM to a cluster.
1. You add a new HSM to a cluster. The following procedures explain how to do this from the AWS CloudHSM console, the AWS Command Line Interface (AWS CLI), and the AWS CloudHSM API.

   This is the only action that you take. The remaining events occur automatically.

2. AWS CloudHSM makes a backup copy of an existing HSM in the cluster. For more information, see Backups (p. 5).

3. AWS CloudHSM restores the backup onto the new HSM. This ensures that the HSM is in sync with the others in the cluster.

4. The existing HSMs in the cluster notify the AWS CloudHSM client that there's a new HSM in the cluster.

5. The client establishes a connection to the new HSM.
To add an HSM (console)
2. Choose a cluster for the HSM that you are adding.
3. On the HSMs tab, choose Create HSM.
4. Choose an Availability Zone (AZ) for the HSM that you are creating. Then choose Create.

To add an HSM (AWS CLI)
- At a command prompt, issue the create-hsm command, specifying a cluster ID and an Availability Zone for the HSM that you are creating. If you don't know the cluster ID of your preferred cluster, issue the describe-clusters command. Specify the Availability Zone in the form of us-east-2a, us-east-2b, etc.

```bash
$ aws cloudhsmv2 create-hsm --cluster-id <cluster ID> --availability-zone <Availability Zone>
{
  "Hsm": {
    "State": "CREATE_IN_PROGRESS",
    "ClusterId": "cluster-5a75d5qzrdh",
    "HsmId": "hsm-lgavqitns2a",
    "SubnetId": "subnet-0e358c43",
    "AvailabilityZone": "us-east-2c",
    "EniId": "eni-bab18892",
    "EniIp": "10.0.3.10"
  }
}
```

To add an HSM (AWS CloudHSM API)
- Send a CreateHsm request, specifying the cluster ID and an Availability Zone for the HSM that you are creating.

Removing an HSM

You can remove an HSM by using the AWS CloudHSM console, the AWS CLI, or the AWS CloudHSM API.

To remove an HSM (console)
2. Choose the cluster that contains the HSM that you are removing.
3. On the HSMs tab, choose the HSM that you are removing. Then choose Delete HSM.
4. Confirm that you want to delete the HSM. Then choose Delete.

To remove an HSM (AWS CLI)
- At a command prompt, issue the delete-hsm command. Pass the ID of the cluster that contains the HSM that you are deleting and one of the following HSM identifiers:
  - The HSM ID (--hsm-id)
  - The HSM IP address (--eni-ip)
  - The HSM's elastic network interface ID (--eni-id)
If you don't know the values for these identifiers, issue the `describe-clusters` command.

```bash
$ aws cloudhsmv2 delete-hsm --cluster-id <cluster ID> --eni-ip <HSM IP address>
{
    "HsmId": "hsm-lgavqitns2a"
}
```

To remove an HSM (AWS CloudHSM API)

- Send a `DeleteHsm` request, specifying the cluster ID and an identifier for the HSM that you are deleting.

Deleting an AWS CloudHSM cluster

Before you can delete a cluster, you must remove all HSMs from the cluster. For more information, see Removing an HSM (p. 46).

After you remove all HSMs, you can delete a cluster by using the AWS CloudHSM console, the AWS Command Line Interface (AWS CLI), or the AWS CloudHSM API.

To delete a cluster (console)

2. Choose the cluster that you are deleting. Then choose Delete cluster.
3. Confirm that you want to delete the cluster, then choose Delete.

To delete a cluster (AWS CLI)

- At a command prompt, issue the `delete-cluster` command, passing the ID of the cluster that you are deleting. If you don't know the cluster ID, issue the `describe-clusters` command.

```bash
$ aws cloudhsmv2 delete-cluster --cluster-id <cluster ID>
{
    "Cluster": {
        "Certificates": {
            "ClusterCertificate": "<certificate string>"
        },
        "SourceBackupId": "backup-rtq2dwi2gq6",
        "SecurityGroup": "sg-40399d28",
        "CreateTimestamp": 1504903546.035,
        "SubnetMapping": {
            "us-east-2a": "subnet-f1d6e798",
            "us-east-2c": "subnet-0e358c43",
            "us-east-2b": "subnet-40ed9d3b"
        },
        "ClusterId": "cluster-kdmrayrc7gi",
        "VpcId": "vpc-641d3c0d",
        "State": "DELETE_IN_PROGRESS",
        "HsmType": "hsm1.medium",
        "StateMessage": "The cluster is being deleted.",
        "Hsms": [],
        "BackupPolicy": "DEFAULT"
    }
}
```
Creating clusters from backups

To restore an AWS CloudHSM cluster from a backup, follow the steps in this topic. Your cluster will contain the same users, key material, certificates, configuration, and policies that were in the backup. For more information about managing backups, see Managing backups (p. 50).

Create clusters from backups (console)

2. Choose Create cluster.
3. In the Cluster configuration section, do the following:
   a. For VPC, choose a VPC for the cluster that you are creating.
   b. For AZ(s), choose a private subnet for each Availability Zone that you are adding to the cluster.
4. In the Cluster source section, do the following:
   a. Choose Restore cluster from existing backup.
   b. Choose the backup that you are restoring.
5. Choose Next: Review.
6. Review your cluster configuration, then choose Create cluster.
7. Specify how long the service should retain backups.

   Accept the default retention period of 90 days or type a new value between 7 and 379 days. The service will automatically delete backups in this cluster older than the value you specify here. You can change this later. For more information, see Configuring backup retention (p. 52).

8. Choose Next.
9. (Optional) Type a tag key and an optional tag value. To add more than one tag to the cluster, choose Add tag.
10. Choose Review.
11. Review your cluster configuration, and then choose Create cluster.

Tip
To create a HSM in this cluster that contains the same users, key material, certificates, configuration, and policies that were in the backup that you restored, add a HSM (p. 44) to the cluster.

Create clusters from backups (AWS CLI)

To determine the backup ID, issue the describe-backups command.

- At a command prompt, issue the create-cluster command. Specify the HSM instance type, the subnet IDs of the subnets where you plan to create HSMs, and the backup ID of the backup that you are restoring.

```bash
$ aws cloudhsmv2 create-cluster --hsm-type hsm1.medium \ 
  --subnet-ids <subnet ID 1> <subnet ID 2> <subnet ID N>
```
Create clusters from backups (AWS CloudHSM API)

Refer to the following topic to learn how to create clusters from backups by using the API.

- **CreateCluster**
Managing AWS CloudHSM backups

AWS CloudHSM makes periodic backups of your cluster at least once every 24 hours. Each backup contains encrypted copies of the following data:

- Users (COs, CUs, and AUs)
- Key material and certificates
- Hardware security module (HSM) configuration and policies

You can't instruct the service to make backups, but you can take certain actions that force the service to create a backup. The service makes a backup when you perform any of the following actions:

- Activate a cluster
- Add an HSM to an active cluster
- Remove an HSM from an active cluster

AWS CloudHSM deletes backups based on the backup retention policy you set when you create clusters. For information about managing backup retention policy, see Configuring backup retention (p. 52).

Topics
- Working with backups (p. 50)
- Deleting and restoring backups (p. 51)
- Configuring AWS CloudHSM backup retention policy (p. 52)
- Copying backups across AWS Regions (p. 55)

Working with backups

When you add an HSM to a cluster that previously contained one or more active HSMs, the service restores the latest backup onto the new HSM. Use backups to manage HSMs you use infrequently. When you don't need the HSM, delete it to trigger a backup. Later, when you need the HSM, create a new one in the same cluster, and this action will restore the backup you previously created with the delete HSM operation.

Removing expired keys or inactive users

You may want to remove unwanted cryptographic materials from your environment such as expired keys or inactive users. This is a two-step process. First, delete these materials from your HSM. Next, delete all existing backups. Following this process ensures you do not restore deleted information when initializing a new cluster from backup. For more information, see the section called “Deleting and restoring backups” (p. 51).

Considering disaster recovery

You can create a cluster from a backup. You might want to do this to set a recovery point for your cluster. Nominate a backup that contains all the users, key material, certificates that you want in your recovery point, and then use that backup to create a new cluster. For more information about creating a cluster from a backup, see Creating clusters from backups (p. 48).

You can also copy a backup of a cluster into a different region, where you can create a new cluster as a clone of the original. You may want to do this for a number of reasons, including simplification of the
Deleting and restoring backups

After you delete a backup, the service holds the backup for seven days, during which time you can restore the backup. After the seven-day period, you can no longer restore the backup. For more information about managing backups, see Managing backups (p. 50).

Delete and restore backups (console)

To delete a backup (console)

2. To change the AWS Region, use the Region selector in the upper-right corner of the page.
3. In the navigation pane, choose Backups.
4. Choose a backup to delete.
5. To delete the selected backup, choose Actions, Delete.
   The Delete backups dialog box appears.
6. Choose Delete.
   The state of the backup changes to PENDING_DELETE. You can restore a backup that is pending deletion for up to 7 days after you request the deletion.

To restore a backup (console)

2. To change the AWS Region, use the Region selector in the upper-right corner of the page.
3. In the navigation pane, choose Backups.
4. Choose a backup in the PENDING_DELETE state to restore.
5. To restore the selected backup, choose Actions, Restore.

Delete and restore backups (AWS CLI)

Check the status of a backup or find its ID by using the describe-backups command from the AWS CLI.

To delete a backup (AWS CLI)

- At a command prompt, run the delete-backup command, passing the ID of the backup to be deleted.

```bash
$ aws cloudhsmv2 delete-backup --backup-id <backup ID>  
{
    "Backup": {
        "CreateTimestamp": 1534661854.64,
        "ClusterId": "cluster-dygnwhmscg5",
        "BackupId": "backup-ro5c4er4aac",
        "BackupState": "PENDING_DELETION",
        "DeleteTimestamp": 1536339805.522
    }
}
```
To restore a backup (AWS CLI)

To restore a backup, issue the `restore-backup` command, passing the ID of a backup that is in the PENDING_DELETION state.

```
$ aws cloudhsmv2 restore-backup --backup-id <backup ID>
```

```
{
    "Backup": {
        "ClusterId": "cluster-dygnwhmscg5",
        "CreateTimestamp": 1534461854.64,
        "BackupState": "READY",
        "BackupId": "backup-ro5c4er4aac"
    }
}
```

To list backups (AWS CLI)

To see a list of all backups in the PENDING_DELETION state, run the `describe-backups` command and include `states=PENDING_DELETION` as a filter.

```
$ aws cloudhsmv2 describe-backups --filters states=PENDING_DELETION
```

```
{
    "Backups": [
        {
            "BackupId": "backup-ro5c4er4aac",
            "BackupState": "PENDING_DELETION",
            "CreateTimestamp": 1534461854.64,
            "ClusterId": "cluster-dygnwhmscg5",
            "DeleteTimestamp": 1536339805.522,
        }
    ]
}
```

Delete and restore backups (AWS CloudHSM API)

Refer to the following topics to learn how to delete and restore backups by using the API.

- **DeleteBackup**
- **RestoreBackup**

Configuring AWS CloudHSM backup retention policy

With the exemption of clusters created before 18 November 2020 (p. 53), the default backup retention policy for clusters is 90 days. You can set this period to any number between 7 and 379 days. AWS CloudHSM does not delete a cluster's last backup. For more information about managing backups, see Managing backups (p. 50).

Understanding backup retention policy

AWS CloudHSM purges backups based on the backup retention policy you set when you create a cluster. Backup retention policy applies to clusters. If you move a backup to a different region, that backup is no longer associated with a cluster and has no backup retention policy. You must manually delete any backups not associated with a cluster. AWS CloudHSM does not delete a cluster's last backup.
AWS CloudHSM User Guide
Configure backup retention (console)

AWS CloudTrail (p. 603) reports backups marked for deletion. You can restore backups the service purges just as you would restore manually deleted backups (p. 51). To prevent a race condition, you should change the backup retention policy for the cluster before you restore a backup deleted by the service. If you want to keep the retention policy the same and preserve select backups, you can specify that the service exclude backups (p. 53) from the cluster backup retention policy.

Existing-cluster exemption

AWS CloudHSM launched managed backup retention on 18 November 2020. Clusters created before 18 November 2020 have a backup retention policy of 90 days plus the age of the cluster. For example, if you created a cluster on 18 November 2019, the service would assign your cluster a backup retention policy of one year plus 90 days (455 days).

**Note**
You can opt out of managed backup retention altogether by contacting support (https://aws.amazon.com/support).

Configure backup retention (console)

**To configure backup retention policy (console)**
2. To change the AWS Region, use the Region selector in the upper-right corner of the page.
3. Click the cluster ID of a cluster in the Active state to manage the backup retention policy for that cluster.
4. To change the backup retention policy, choose Actions, Change backup retention period.
   The Change backup retention period dialog box appears.
5. In Backup retention period (in days), type a value between 7 and 379 days.
6. Choose Change backup retention period.

**To exclude or include a backup from backup retention policy (console)**
2. To view your backups, in the navigation pane choose Backups.
3. Click the backup ID of a backup in the Ready state to exclude or include.
4. On the Backup details page, take one of the following actions.
   - To exclude a backup with a date in Expiration time, choose Actions, Disable expiration.
   - To include a backup that does not expire, choose Actions, Use cluster retention policy.

Configure backup retention (AWS CLI)

Check the status of a backup or find its ID by using the describe-backups command from the AWS CLI.

**To configure backup retention policy (AWS CLI)**

- At a command prompt, issue the modify-cluster command. Specify the cluster ID and the backup retention policy.

```bash
$ aws cloudhsmv2 modify-cluster --cluster-id <cluster ID> --backup-retention-policy Type=DAYS,Value=<number of days to retain backups>
```
To exclude a backup from backup retention policy (AWS CLI)

- At a command prompt, issue the `modify-backup-attributes` command. Specify the backup ID and set the never-expires flag to preserve the backup.

```bash
$ aws cloudhsmv2 modify-backup-attributes --backup-id <backup ID> \
   --never-expires

{ "Backup": { "BackupId": "backup-ro5c4er4aac", "BackupState": "READY", "ClusterId": "cluster-dygnwhmscg5", "NeverExpires": true } }
```

To include a backup in backup retention policy (AWS CLI)

- At a command prompt, issue the `modify-backup-attributes` command. Specify the backup ID and set the no-never-expires flag to include the backup in backup retention policy, which means the service will eventually delete the backup.

```bash
$ aws cloudhsmv2 modify-backup-attributes --backup-id <backup ID> \
   --no-never-expires

{ "Backup": { "BackupId": "backup-ro5c4er4aac", "BackupState": "READY", "ClusterId": "cluster-dygnwhmscg5", "NeverExpires": false } }
```
Configure backup retention (AWS CloudHSM API)

Refer to the following topics to learn how to manage backup retention by using the API.

- ModifyCluster
- ModifyBackupAttributes

Copying backups across AWS Regions

You can copy backups across regions for many reasons, including cross-region resilience, global workloads, and disaster recovery (p. 50). After you copy backups, they appear in the destination region with a CREATE_IN_PROGRESS status. Upon successful completion of the copy, the status of the backup changes to READY. If the copy fails, the status of the backup changes to DELETED. Check your input parameters for errors and ensure that the specified source backup is not in a DELETED state before rerunning the operation. For information about backups or how to create a cluster from a backup, see Managing backups (p. 50) or Creating clusters from backups (p. 48).

Note the following:

- To copy a cluster backup to a destination region, your account must have the proper IAM policy permissions. In order to copy the backup to a different region, your IAM policy must allow access to the source region in which the backup is located. Once copied across regions, your IAM policy must allow access to the destination region in order to interact with the copied backup, which includes using the CreateCluster operation. For more information, see Create IAM administrators (p. 7).
- The original cluster and the cluster that may be built from a backup in the destination region are not linked. You must manage each of these clusters independently. For more information, see Managing clusters (p. 37).
- Backups cannot be copied between AWS restricted regions and standard regions. Backups can be copied between the AWS GovCloud (US-East) and AWS GovCloud (US-West) regions.

Copy backups to different Regions (console)

To copy backups to different Regions (console)

2. To change the AWS Region, use the Region selector in the upper-right corner of the page.
3. In the navigation pane, choose Backups.
4. Choose a backup to copy to a different region.
5. To copy the selected backup, choose Actions, Copy backup to another region.

The Copy backup to another region dialog box appears.

6. In Destination region, choose a region from Select a region.
7. (Optional) Type a tag key and an optional tag value. To add more than one tag to the cluster, choose Add tag.
8. Choose Copy backup.
Copy backups to different Regions (AWS CLI)

To determine the backup ID, run the `describe-backups` command.

To copy backups to different regions (AWS CLI)

- At a command prompt, run the `copy-backup-to-region` command. Specify the destination region and the backup ID of the source backup. If you specify a backup ID, the associated backup is copied.

```
$ aws cloudhsmv2 copy-backup-to-region --destination-region <destination region> \  
   --backup-id <backup ID>
```

Copy backups to different Regions (AWS CloudHSM API)

Refer to the following topic to learn how to copy backups to different regions by using the API.

- `CopyBackupToRegion`
Tagging AWS CloudHSM resources

A tag is a label that you assign to an AWS resource. You can assign tags to your AWS CloudHSM clusters. Each tag consists of a tag key and a tag value, both of which you define. For example, the tag key might be Cost Center and the tag value might be 12345. Tag keys must be unique for each cluster.

You can use tags for a variety of purposes. One common use is to categorize and track your AWS costs. You can apply tags that represent business categories (such as cost centers, application names, or owners) to organize your costs across multiple services. When you add tags to your AWS resources, AWS generates a cost allocation report with usage and costs aggregated by tags. You can use this report to view your AWS CloudHSM costs in terms of projects or applications, instead of viewing all AWS CloudHSM costs as a single line item.

For more information about using tags for cost allocation, see Using Cost Allocation Tags in the AWS Billing User Guide.

You can use the AWS CloudHSM console or one of the AWS SDKs or command line tools to add, update, list, and remove tags.

Topics
- Adding or updating tags (p. 57)
- Listing tags (p. 58)
- Removing tags (p. 58)

Adding or updating tags

You can add or update tags from the AWS CloudHSM console, the AWS Command Line Interface (AWS CLI), or the AWS CloudHSM API.

To add or update tags (console)

2. Choose the cluster that you are tagging.
3. Choose Tags.
4. To add a tag, do the following:
   a. Choose Edit Tag and then choose Add Tag.
   b. For Key, type a key for the tag.
   c. (Optional) For Value, type a value for the tag.
   d. Choose Save.
5. To update a tag, do the following:
   a. Choose Edit Tag.
   b. Type the new tag value.
   c. Choose Save.
To add or update tags (AWS CLI)

1. At a command prompt, issue the `tag-resource` command, specifying the tags and the ID of the cluster that you are tagging. If you don’t know the cluster ID, issue the `describe-clusters` command.

   ```
   $ aws cloudhsmv2 tag-resource --resource-id <cluster ID> 
   --tag-list Key="<tag key>",Value="<tag value>"
   ```

2. To update tags, use the same command but specify an existing tag key. When you specify a new tag value for an existing tag, the tag is overwritten with the new value.

To add or update tags (AWS CloudHSM API)

- Send a `TagResource` request. Specify the tags and the ID of the cluster that you are tagging.

Listing tags

You can list tags for a cluster from the AWS CloudHSM console, the AWS CLI, or the AWS CloudHSM API.

To list tags (console)

2. Choose the cluster whose tags you are listing.
3. Choose Tags.

To list tags (AWS CLI)

- At a command prompt, issue the `list-tags` command, specifying the ID of the cluster whose tags you are listing. If you don’t know the cluster ID, issue the `describe-clusters` command.

   ```
   $ aws cloudhsmv2 list-tags --resource-id <cluster ID>
   {
   "TagList": [
   {
   "Key": "Cost Center",
   "Value": "12345"
   }
   ]
   }
   ```

To list tags (AWS CloudHSM API)

- Send a `ListTags` request, specifying the ID of the cluster whose tags you are listing.

Removing tags

You can remove tags from a cluster by using the AWS CloudHSM console, the AWS CLI, or the AWS CloudHSM API.

To remove tags (console)

Removing tags

2. Choose the cluster whose tags you are removing.
3. Choose Tags.
4. Choose Edit Tag and then choose Remove tag for the tag you want to remove.
5. Choose Save.

To remove tags (AWS CLI)

- At a command prompt, issue the `untag-resource` command, specifying the tag keys of the tags that you are removing and the ID of the cluster whose tags you are removing. When you use the AWS CLI to remove tags, specify only the tag keys, not the tag values.

```bash
$ aws cloudhsmv2 untag-resource --resource-id <cluster ID> \
  --tag-key-list "<tag key>"
```

To remove tags (AWS CloudHSM API)

- Send an UnTagResource request in the AWS CloudHSM API, specifying the ID of the cluster and the tags that you are removing.
Managing HSM users and keys in AWS CloudHSM

Before you can use your AWS CloudHSM cluster for cryptoprocessing, you must create users and keys on the HSMs in your cluster. See the following topics for more information about managing HSM users and keys in AWS CloudHSM. You can also learn how to use quorum authentication (also known as M of N access control).

Topics

- Managing HSM users in AWS CloudHSM (p. 60)
- Managing keys in AWS CloudHSM (p. 123)
- Managing cloned clusters (p. 156)

Managing HSM users in AWS CloudHSM

In AWS CloudHSM, you must use CloudHSM CLI (p. 184) or CloudHSM Management Utility (CMU) (p. 253) command line tools to create and manage the users on your HSM. CloudHSM CLI is designed to be used with the latest SDK version series (p. 392), while the CMU is designed to be used with the previous SDK version series (p. 454).

Topics

- Managing HSM users with CloudHSM CLI (p. 60)
- Managing HSM users with CloudHSM Management Utility (CMU) (p. 93)

Managing HSM users with CloudHSM CLI

Use CloudHSM CLI (p. 184) command line tools to create and manage the users on your HSM with the latest SDK.

Topics

- Understanding HSM users (p. 60)
- HSM user permissions table (p. 61)
- Using CloudHSM CLI to manage users (p. 62)
- Using CloudHSM CLI to manage MFA (p. 67)
- Using CloudHSM CLI to manage quorum authentication (M of N access control) (p. 77)

Understanding HSM users

Most operations that you perform on the HSM require the credentials of an HSM user. The HSM authenticates each HSM user and each HSM user has a type that determines which operations you can perform on the HSM as that user.

**Note**

HSM users are distinct from IAM users. IAM users who have the correct credentials can create HSMs by interacting with resources through the AWS API. After the HSM is created, you must use HSM user credentials to authenticate operations on the HSM.

User types
• **Unactivated admin (p. 61)**
• **Admin (p. 61)**
• **Crypto user (CU) (p. 61)**
• **Appliance user (AU) (p. 61)**

**Unactivated admin**

In CloudHSM CLI, The unactivated admin is a temporary user that exists only on the first HSM in an AWS CloudHSM cluster that has never been activated. To *activate a cluster* (p. 28), run the `cluster activate` command in CloudHSM CLI. After running this command, unactivated admin are prompted to change the password. After changing the password, the unactivated admin becomes an admin.

**Admin**

In CloudHSM CLI, admin can perform user management operations. For example, they can create and delete users and change user passwords. For more information about admins, see the *HSM user permissions table* (p. 61).

**Crypto user (CU)**

A crypto user (CU) can perform the following key management and cryptographic operations.

- **Key management** – Create, delete, share, import, and export cryptographic keys.
- **Cryptographic operations** – Use cryptographic keys for encryption, decryption, signing, verifying, and more.

For more information, see the *HSM user permissions table* (p. 61).

**Appliance user (AU)**

The appliance user (AU) can perform cloning and synchronization operations on your cluster's HSMs. AWS CloudHSM uses the AU to synchronize the HSMs in an AWS CloudHSM cluster. The AU exists on all HSMs provided by AWS CloudHSM, and has limited permissions. For more information, see the *HSM user permissions table* (p. 61).

AWS cannot perform any operations on your HSMs. AWS cannot view or modify your users or keys and cannot perform any cryptographic operations using those keys.

**HSM user permissions table**

The following table lists HSM operations sorted by the type of HSM user or session that can perform the operation.

<table>
<thead>
<tr>
<th></th>
<th>Admin</th>
<th>Crypto User (CU)</th>
<th>Appliance User (AU)</th>
<th>Unauthenticated Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>Get basic cluster info¹</td>
<td>✔ Yes</td>
<td>✔ Yes</td>
<td>✔ Yes</td>
<td>✔ Yes</td>
</tr>
<tr>
<td>Change own password</td>
<td>✔ Yes</td>
<td>✔ Yes</td>
<td>✔ Yes</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Change any user's password</td>
<td>✔ Yes</td>
<td>✗ No</td>
<td>✗ No</td>
<td>✗ No</td>
</tr>
<tr>
<td>Add, remove users</td>
<td>✔ Yes</td>
<td>✗ No</td>
<td>✗ No</td>
<td>✗ No</td>
</tr>
</tbody>
</table>

[^1]: The 'Get basic cluster info' operation is performed by the admin, crypto user (CU), and appliance user (AU) session.
Using CloudHSM CLI to manage users

This topic provides step-by-step instruction on managing hardware security module (HSM) users with CloudHSM CLI. For more information about CloudHSM CLI or HSM users, see CloudHSM CLI (p. 183) and Using CloudHSM CLI (p. 60).

Sections

Understanding HSM user management with CloudHSM CLI (p. 62)
Download CloudHSM CLI (p. 63)
How to manage HSM users with CloudHSM CLI (p. 63)

Understanding HSM user management with CloudHSM CLI

To manage HSM users, you must log in to the HSM with the user name and password of an admin (p. 61). Only admins can manage users. The HSM contains a default admin named admin. You set the password for admin when you activated the cluster (p. 28).

To use CloudHSM CLI, you must use the configure tool to update the local configuration. For instructions on running the configure tool with CloudHSM CLI, see Getting started with CloudHSM Command Line Interface (CLI) (p. 184). The -a parameter requires you to add the IP address of an HSM in your cluster. If you have multiple HSMs, you can use any IP address. This ensures CloudHSM CLI can propagate any changes you make across the entire cluster. Remember that CloudHSM CLI uses its local file to track cluster information. If the cluster has changed since the last time you used CloudHSM CLI from a

<table>
<thead>
<tr>
<th></th>
<th>Admin</th>
<th>Crypto User (CU)</th>
<th>Appliance User (AU)</th>
<th>Unauthenticated Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>Get sync status²</td>
<td>☑ Yes</td>
<td>☑ Yes</td>
<td>☑ Yes</td>
<td>☒ No</td>
</tr>
<tr>
<td>Extract, insert masked objects³</td>
<td>☑ Yes</td>
<td>☑ Yes</td>
<td>☑ Yes</td>
<td>☒ No</td>
</tr>
<tr>
<td>Key management functions⁴</td>
<td>☒ No</td>
<td>☑ Yes</td>
<td>☒ No</td>
<td>☒ No</td>
</tr>
<tr>
<td>Encrypt, decrypt</td>
<td>☒ No</td>
<td>☑ Yes</td>
<td>☒ No</td>
<td>☒ No</td>
</tr>
<tr>
<td>Sign, verify</td>
<td>☒ No</td>
<td>☑ Yes</td>
<td>☒ No</td>
<td>☒ No</td>
</tr>
<tr>
<td>Generate digests and HMACs</td>
<td>☒ No</td>
<td>☑ Yes</td>
<td>☒ No</td>
<td>☒ No</td>
</tr>
</tbody>
</table>

- [1] Basic cluster information includes the number of HSMs in the cluster and each HSM’s IP address, model, serial number, device ID, firmware ID, etc.
- [2] The user can get a set of digests (hashes) that correspond to the keys on the HSM. An application can compare these sets of digests to understand the synchronization status of HSMs in a cluster.
- [3] Masked objects are keys that are encrypted before they leave the HSM. They cannot be decrypted outside of the HSM. They are only decrypted after they are inserted into an HSM that is in the same cluster as the HSM from which they were extracted. An application can extract and insert masked objects to synchronize the HSMs in a cluster.
- [4] Key management functions include creating, deleting, wrapping, unwrapping, and modifying the attributes of keys.
particular host, you must add those changes to the local configuration file stored on that host. Never remove a HSM while you're using CloudHSM CLI.

To get an IP address for a HSM (console)

2. To change the AWS Region, use the Region selector in the upper-right corner of the page.
3. To open the cluster detail page, in the cluster table, choose the cluster ID.
4. To get the IP address, on the HSMs tab, choose one of the IP addresses listed under **ENI IP address**.

To get an IP address for a HSM (AWS CLI)

- Get the IP address of an HSM by using the **describe-clusters** command from the AWS CLI. In the output from the command, the IP address of the HSMs are the values of **EniIp**.

```bash
$ aws cloudhsmv2 describe-clusters
{
  "Clusters": [
    { ... }
    "Hsms": [
      { ... "EniIp": "10.0.0.9",
      { ... "EniIp": "10.0.1.6",
      ...}
}
```

Download CloudHSM CLI

The latest version of CloudHSM CLI is available for HSM user management tasks for Client SDK 5. To download and install CloudHSM CLI, follow the instructions in Install and configure CloudHSM CLI (p. 25).

How to manage HSM users with CloudHSM CLI

This section includes basic commands to manage HSM users with CloudHSM CLI.

**Note**

Note: CloudHSM CLI user commands are listed in the CloudHSM CLI user command reference (p. 233)

Topics

- To create an admin (p. 63)
- To create a crypto user (p. 64)
- To list all HSM users in the cluster (p. 65)
- To change HSM user passwords (p. 65)
- To delete HSM users (p. 67)

To create an admin

Follow these steps to create an admin.
1. Use the following command to start CloudHSM CLI interactive mode.

   Linux
   
   $ /opt/cloudhsm/bin/cloudhsm-cli interactive
   
   Windows
   
   C:\Program Files\Amazon\CloudHSM\bin\> .\cloudhsm-cli.exe interactive

2. Use the login command and log in to the cluster as the admin.

   aws-cloudhsm > login --username <USERNAME> --role admin

3. The system prompts you for your password. Enter the password, and the output shows that the command was successful.

   
   Enter password:
   
   {
     "error_code": 0,
     "data": {
       "username": "admin",
       "role": "admin"
     }
   }

4. Enter the following command to create an admin:

   aws-cloudhsm > user create --username <USERNAME> --role admin

5. Enter the password for the new user.

6. Re-enter the password to confirm the password you entered is correct.

To create a crypto user

Follow these steps to create a user.

1. Use the following command to start CloudHSM CLI interactive mode.

   Linux
   
   $ /opt/cloudhsm/bin/cloudhsm-cli interactive
   
   Windows
   
   C:\Program Files\Amazon\CloudHSM\bin\> .\cloudhsm-cli.exe interactive

2. Use the login command and log in to the cluster as the admin.

   aws-cloudhsm > login --username <USERNAME> --role admin

3. The system prompts you for your password. Enter the password, and the output shows that the command was successful.

   
   Enter password:
   
   {
   
   }
4. Enter the following command to create a crypto user:

```
aws-cloudhsm > user create --username <USERNAME> --role crypto-user
```

5. Enter the password for the new crypto user.

6. Re-enter the password to confirm the password you entered is correct.

**To list all HSM users in the cluster**

Use `user list` command to list all the users in the cluster. You do not have to log in to run `user list`. All user types can list users.

**Follow these steps to list all users in the cluster**

1. Use the following command to start CloudHSM CLI interactive mode.

   Linux
   
   ```
   $ /opt/cloudhsm/bin/cloudhsm-cli interactive
   ```

   Windows
   
   ```
   C:\Program Files\Amazon\CloudHSM\bin\> .\cloudhsm-cli.exe interactive
   ```

2. Enter the following command to list all the users in the cluster:

   ```
   aws-cloudhsm > user list
   ```

For more information about `user list`, see [user list (p. 243)](#).

**To change HSM user passwords**

Use the `user change-password` command to change a password.

User types and passwords are case sensitive, but user names are not case sensitive.

Admin, crypto user (CU), and appliance user (AU) can change their own password. To change the password of another user, you must log in as an admin. You cannot change the password of a user who is currently logged in.

**To change your own password**

1. Use the following command to start CloudHSM CLI interactive mode.

   Linux
   
   ```
   $ /opt/cloudhsm/bin/cloudhsm-cli interactive
   ```
Windows

C:\Program Files\Amazon\CloudHSM\bin\> .\cloudhsm-cli.exe interactive

2. Use the `login` command and log in as the user with the password you want to change.

aws-cloudhsm > login --username <USERNAME> --role <ROLE>

3. Enter the user’s password.

Enter password:
{
  "error_code": 0,
  "data": {
    "username": "admin1",
    "role": "admin"
  }
}

4. Enter the `user change-password` command.

aws-cloudhsm > user change-password --username <USERNAME> --role <ROLE>

5. Enter the new password.

6. Re-enter the new password.

To change the password of another user

1. Use the following command to start CloudHSM CLI interactive mode.

Linux

$ /opt/cloudhsm/bin/cloudhsm-cli interactive

Windows

C:\Program Files\Amazon\CloudHSM\bin\> .\cloudhsm-cli.exe interactive

2. Use the `login` command and log in as an admin.

aws-cloudhsm > login --username <USERNAME> --role admin

3. Enter the admin’s password.

Enter password:
{
  "error_code": 0,
  "data": {
    "username": "admin1",
    "role": "admin"
  }
}

4. Enter the `user change-password` command along with the username of the user whose password you want to change.
5. Enter the new password.
6. Re-enter the new password.

For more information about `user change-password`, see `user change-password (p. 235)`.

To delete HSM users

Use `user delete` to delete a user. You must log in as an admin to delete another user.

**Tip**
You can't delete crypto users (CU) that own keys.

To delete a user

1. Use the following command to start CloudHSM CLI interactive mode.

   **Linux**
   ```bash
   $ /opt/cloudhsm/bin/cloudhsm-cli interactive
   ```

   **Windows**
   ```bash
   C:\Program Files\Amazon\CloudHSM\bin\> .\cloudhsm-cli.exe interactive
   ```

2. Use the `login` command and log in to the cluster as the admin.

   ```bash
   aws-cloudhsm > login --username <USERNAME> --role admin
   ```

3. The system prompts you for your password. Enter the password, and the output shows that the command was successful.

   ```json
   Enter password:
   {
     "error_code": 0,
     "data": {
       "username": "admin",
       "role": "admin"
     }
   }
   ```

4. Use the `user delete` command to delete the user.

   ```bash
   aws-cloudhsm > user delete --username <USERNAME> --role <ROLE>
   ```

For more information about `user delete`, see `deleteUser (p. 241)`.

Using CloudHSM CLI to manage MFA

For increased security, you can configure multi-factor authentication (MFA) to help protect the cluster. For more information, see the topics below.

**Topics**
- **Understanding MFA for HSM users (p. 68)**
Understanding MFA for HSM users

When you log in to a cluster with an MFA enabled HSM user account, you provide the CloudHSM CLI with your password—the first factor, what you know—and CloudHSM CLI provides you with a token and prompts you to have the token signed.

To provide the second factor—what you have—you sign the token with a private key from a key pair you’ve already created and associated with the HSM user. To access the cluster, you provide the signed token to CloudHSM CLI.

For more information on setting up MFA for a user please see Set up MFA for CloudHSM CLI (p. 69)

Quorum authentication and MFA

The cluster uses the same key for quorum authentication and for MFA. This means a user with MFA enabled is effectively registered for MoF(N) or Quorum access control. To successfully use MFA and quorum authentication for the same HSM user, consider the following points:

• If you are using quorum authentication for a user today, you should use the same key pair you created for the quorum user to enable MFA for the user.
• If you add the MFA requirement for a non-MFA user who is not a quorum authentication user, then you register that user as a Quorum (MofN) registered user with MFA authentication.
• If you remove the MFA requirement or change the password for an MFA user who is also a registered quorum authentication user, you will also remove the user’s registration as a quorum (MofN) user.
• If you remove the MFA requirement or change the password for an MFA user who is also a quorum authentication user, but you still want that user to participate in quorum authentication, then you must register that user again as a Quorum (MofN) user.

For more information about quorum authentication, see Managing quorum (M of N) (p. 77).

Working with MFA for HSM users

This topic provides information and instructions for using CloudHSM CLI to manage Multifactor Authentication (MFA). For more information about CloudHSM CLI, see CloudHSM Command Line Interface (CLI) (p. 183).

Topics

• MFA Key Pair Requirements (p. 68)
• Set up MFA for CloudHSM CLI (p. 69)
• Create users with MFA enabled (p. 71)
• Log in users with MFA enabled (p. 72)
• Rotate keys for users with MFA enabled (p. 74)
• Deregister an MFA public key for admin users when MFA public key is registered (p. 76)
• Token file reference (p. 76)

For more information about working with HSM users, refer to CloudHSM Command Line Interface (CLI) (p. 183)

MFA Key Pair Requirements

To enable MFA for an HSM user, you can create a new key pair or use an existing key that meets the following requirements:
• **Key type:** Asymmetric
• **Key usage:** Sign and verify
• **Key spec:** RSA_2048
• **Signing algorithm includes:** sha256WithRSAEncryption

**Note**
If you are using quorum authentication or plan to use quorum authentication, see [Quorum authentication and MFA](p. 68)

You can use CloudHSM CLI and the key pair to create a new admin user with MFA enabled.

**Set up MFA for CloudHSM CLI**

Follow these steps to set up MFA for CloudHSM CLI.

1. To setup MFA using the Token Sign Strategy you must first generate a 2048 bit RSA private key and associated public key.

   ```bash
   $ openssl genrsa -out officer1.key 2048
   Generating RSA private key, 2048 bit long modulus (2 primes)
   ...........................................................+++++
   ....................................................................+++++
   e is 65537 (0x010001)
   $ openssl rsa -in officer1.key -outform PEM -pubout -out officer1.pub
   writing RSA key
   ```

2. Using the CloudHSM CLI, login to your user account.

   ```bash
   $ cloudhsm-cli interactive
   aws-cloudhsm > login --username admin --role admin
   Enter password:
   {
     "error_code": 0,
     "data": {
       "username": "admin",
       "role": "admin"
     }
   }
   ```

3. Next, execute the command to change you MFA strategy. You must provide the parameter `--token`.
   This parameter specifies a file that will have unsigned tokens written to it.

   ```bash
   aws-cloudhsm > user change-mfa token-sign --token unsigned-tokens.json --username <USERNAME> --role crypto-user --change-quorum
   Enter password:
   Confirm password:
   ```

4. You now have a file with unsigned tokens that need to be signed: `unsigned-tokens.json`. The number of tokens in this file depends on the number of HSMs in your cluster. Each token represents one HSM. This file is JSON formatted and contains tokens that need to be signed to prove you have a private key.

   ```bash
   $ cat unsigned-tokens.json
   {
     "version": "2.0",
     "tokens": [
       ]
   ```
5. The next step is to sign these tokens with the private key created in step 1. Place the signatures back in the file. First, you have to extract and decode the base64 encoded tokens.

```bash
$ echo "Vtf/9QOFY45v/E1osvpEMr59JsnP/hLdm4It002vqL8=" > token1.b64
$ echo "wVbC0/SIKwjuZK2N8pdFLy17BiayZ24YcdUd1cxLwZ4=" > token2.b64
$ echo "z6Aw9RzErJBL5KqFg5h8lhTVt9oLbxxpjjod0Ebyydw=" > token3.b64
$ base64 -d token1.b64 > token1.bin
$ base64 -d token2.b64 > token2.bin
$ base64 -d token3.b64 > token3.bin
```

6. Now, you have binary tokens that you can sign using the RSA private key created in step 1.

```bash
$ openssl pkeyutl -sign -inkey officer1.key -pkeyopt digest:sha256 -keyform PEM -in token1.bin
$ openssl pkeyutl -sign -inkey officer1.key -pkeyopt digest:sha256 -keyform PEM -in token2.bin
$ openssl pkeyutl -sign -inkey officer1.key -pkeyopt digest:sha256 -keyform PEM -in token3.bin
```

7. Now, you have binary signatures of the tokens. You have to encode them using base64, and place them back in your token file.

```bash
$ base64 -w0 token1.sig.bin > token1.sig.b64
$ base64 -w0 token2.sig.bin > token2.sig.b64
$ base64 -w0 token3.sig.bin > token3.sig.b64
```

8. Finally, you can copy and paste the base64 values back into your token file:

```json
{
  "version": "2.0",
  "tokens": [
    {
```
9. Now that your token file has all the required signatures, you can proceed. Enter the name of the file containing the signed tokens and press the enter key. Finally, enter the path of your public key.

Enter signed token file path (press enter if same as the unsigned token file):
Enter public key PEM file path: officer1.pub

Now you have setup your user with MFA.

Create users with MFA enabled

Follow these steps to create users with MFA enabled.

1. Use CloudHSM CLI to log in to the HSM as an admin.
2. Use the `user create` (p. 240) command to create a user of your choice. Then follow the steps in Set up MFA for CloudHSM CLI (p. 69) to setup MFA for the user.
Log in users with MFA enabled

Follow these steps to log in users with MFA enabled.

1. Use the `login mfa-token-sign` command in CloudHSM CLI to start the login process with MFA for a user who has MFA enabled.

   ```bash
   aws-cloudhsm > login --username <USERNAME> --role <ROLE> mfa-token-sign --token unsigned-tokens.json
   Enter password:
   ```

2. Enter your password. You will then be prompted to enter the path to the token file which contains unsigned/signed token pairs, where signed tokens are those generated by using your private key.

   ```bash
   aws-cloudhsm > login --username <USERNAME> --role <ROLE> mfa-token-sign --token unsigned-tokens.json
   Enter password:
   Enter signed token file path (press enter if same as the unsigned token file):
   ```

3. While prompted to enter the signed token file path, you can inspect the unsigned token file in a separate terminal. Identify the file with unsigned tokens that need to be signed: `unsigned-tokens.json`. The number of tokens in this file depends on the number of HSMs in your cluster. Each token represents one HSM. This file is JSON formatted and contains tokens that need to be signed to prove you have a private key.

   ```bash
   $ cat unsigned-tokens.json
   {
   "version": "2.0",
   "tokens": [
   {
   "unsigned": "Vtf/9Q0FY45v/E1osvpEMz59JsnP/hLDm4It002vql8=",
   "signed": ""
   },
   {
   "unsigned": "wVbC0/5IKwjyZK2NBpdFLyI7BiayZ24YcdUd1cxLwZ4=",
   "signed": ""
   },
   {
   "unsigned": "z6aW9RzEr3BL5KqFGh81hTVt9oLbxxppjod0Ebysydw=",
   "signed": ""
   }
   ]
   }
   ```

4. Sign the unsigned tokens with the private key created in step 2. First you have to extract and decode the base64 encoded tokens.

   ```bash
   $ echo "Vtf/9Q0FY45v/E1osvpEMz59JsnP/hLDm4It002vql8=" > token1.b64
   $ echo "wVbC0/5IKwjyZK2NBpdFLyI7BiayZ24YcdUd1cxLwZ4=" > token2.b64
   $ echo "z6aW9RzEr3BL5KqFGh81hTVt9oLbxxppjod0Ebysydw=" > token3.b64
   $ base64 -d token1.b64 > token1.bin
   $ base64 -d token2.b64 > token2.bin
   $ base64 -d token3.b64 > token3.bin
   ```

5. You now have binary tokens. Sign them using the RSA private key you previously created in step 1 of MFA setup.

   ```bash
   $ openssl pkeyutl -sign -inkey officer1.key -pkeyopt digest:sha256 -keyform PEM
   ```
Using CloudHSM CLI

```bash
$ openssl pkeyutl -sign \
  -inkey officer1.key \
  -pkeyopt digest:sha256 \
  -keyform PEM \
  -in token1.bin \
  -out token1.sig.bin

$ openssl pkeyutl -sign \
  -inkey officer1.key \
  -pkeyopt digest:sha256 \
  -keyform PEM \
  -in token2.bin \
  -out token2.sig.bin

$ openssl pkeyutl -sign \
  -inkey officer1.key \
  -pkeyopt digest:sha256 \
  -keyform PEM \
  -in token3.bin \
  -out token3.sig.bin
```

6. You now have binary signatures of the tokens. Encode them using base64, and place them back in your token file.

```bash
$ base64 -w0 token1.sig.bin > token1.sig.b64
$ base64 -w0 token2.sig.bin > token2.sig.b64
$ base64 -w0 token3.sig.bin > token3.sig.b64
```

7. Finally, copy and paste the base64 values back into your token file:

```json
{
  "version": "2.0",
  "tokens": [
  {
    "unsigned": "1jqwxb9b3OUQLiNb7mxXS1uBJsEXh09njo5Bq9nPsE=",
    "signed": "e1w3fZeCKY5S042zPeg9Rt90molq3wlJh6YWx7xm4nFe9ETL39+9M
+rUgDWMRZJaBfaMbQ5dwyDkz5p13U7ch2t1F9LoVabsWutkT014KRq/rcYMvFsU9n/ey/TK0PvaxLN42X
+pebVjuwMHn4mK4CZfFJg+UGbOj4y99recP0BBKKQ0F5p3ALSEdQyUc/mS1Edq3rU0int6+4NKuL0jpr
+LSE1WZX26g+MND2vXGskCkHjadCQ09L77z8CvkJkdbxJcB16Kvkyoqoz19rzGo8FA3WHBmwiAG51Merrx77ZGY4PFRe37+j/
+YMSC14pCNI5DtrMrVz2a15Gsb4w=="
  },
  {
    "unsigned": "LMMFc34ASPnWPFbMBz9FPro5/zu2P8zf/xzk5hVqC=",
    "signed": "HbImkNHmwe+6R27pFepfAg4+hu2pFNnWn43CnhKPKn2higEhUUD0V1
+4MreSyVu/VN79fL4yVoDv9Ito+jplR0jtfTGEoIey8uAv1/Bzh+Hjm5OS5QpZaJ/ VXGlgApD0myuuy/
+ZGNKQ7C5kL7/V81FgyR1nMn22JUeGa75S5vH/ +cenvZdy0VXs6A7WwWli3EKK8w6eBi178wbaW
+PTdCuIRd4xU76Syv/fcFsxcGlC7cwSwh8MgXzIZm1R/hdy2j9AqAXORTlmlwuyOYUYoPY0VUhe
+s83hX36QpGwGc7TrRA0pT50tX7PHd0N1CL+Ww9y1We8y1OFBS6xooR7w=="
  },
  {
    "unsigned": "dzeHbwhivXVQcUGj563z51/7sLUdxL9350b0Uy2Rjh8=",
    "signed": "VgQPv7st51g1VBFxHnswdug16x82zmmxcYVFy/
+N7geEl4at35G0s2E2ZTwA0Dv50uGhdkYpIapHgjZ7PDWmGcTk1XVDZ1FyppcGN1szkYlftsr5Oqj59ZjYEgguB4g/
+MxaBpRbJai/6B1eE92ndBusTtre1m5yYpHjX1NAV0eR5mkfuwE7zCL9Qok1BiWjUoSh/
+psYuVeIVtIwFMHeffoRC0t
+Vhmn1FnkjGPa9w3apr2zRRvFMSR2ZTDvMc10YDzUCd436FtGq2LfxH3qSD51oFhlHQYo0jyyvzz1Avu85Hq0t0QdeEr1e00/"
  }
  ]
}
```

8. Now that your token file has all the required signatures, you can proceed. Enter the name of the file containing the signed tokens and press the enter key. You should now log in successfully.
Rotate keys for users with MFA enabled

Follow these steps to rotate keys for users with MFA enabled.

You have signed the generated JSON formatted token file with your private key and registered a new MFA public key.

1. Use CloudHSM CLI to log in to the HSM as any admin or as the specific user who has MFA enabled (see Log in users with MFA enabled for details).

2. Next, execute the command to change you MFA strategy. You must provide the parameter --token. This parameter specifies a file that will have unsigned tokens written to it.

```
aws-cloudhsm > user change-mfa token-sign --token unsigned-tokens.json --username <USERNAME> --role crypto-user --change-quorum
```

3. Identify the file with unsigned tokens that need to be signed: unsigned-tokens.json. The number of tokens in this file depends on the number of HSMs in your cluster. Each token represents one HSM. This file is JSON formatted and contains tokens that need to be signed to prove you have a private key. This will be the new private key from the new RSA public/private key pair you wish to use for rotating the currently registered public key.

```
$ cat unsigned-tokens.json
{
   "version": "2.0",
   "tokens": [
   {
      "unsigned": "Vtf/9QOFY45v/E1osvpEMzS9JsnP/hLDm4It002vql8=",
      "signed": ""
   },
   {
      "unsigned": "wVbC0/5IKw7yZK2NbpdlFyI7BiayZ24YcdUd1cxLwZ4=",
      "signed": ""
   },
   {
      "unsigned": "z6aW9RzEzJBL5KqF5Gh81hTVt9oLbxppjod0Ebyydw=",
      "signed": ""
   }
   ]
}
```

4. Sign these tokens with the private key you previously created during setup. First we have to extract and decode the base64 encoded tokens.

```
$ echo "Vtf/9QOFY45v/E1osvpEMzS9JsnP/hLDm4It002vql8=" > token1.b64
$ echo "wVbC0/5IKw7yZK2NbpdlFyI7BiayZ24YcdUd1cxLwZ4=" > token2.b64
$ echo "z6aW9RzEzJBL5KqF5Gh81hTVt9oLbxppjod0Ebyydw=" > token3.b64
$ base64 -d token1.b64 > token1.bin
$ base64 -d token2.b64 > token2.bin
```
$ base64 -d token3.b64 > token3.bin

5. You now have binary tokens. Sign them using the RSA private key you previously created during setup.

$ openssl pkeyutl -sign \
   -inkey officer1.key \
   -pkeyopt digest:sha256 \
   -keyform PEM \
   -in token1.bin \
   -out token1.sig.bin
$ openssl pkeyutl -sign \
   -inkey officer1.key \
   -pkeyopt digest:sha256 \
   -keyform PEM \
   -in token2.bin \
   -out token2.sig.bin
$ openssl pkeyutl -sign \
   -inkey officer1.key \
   -pkeyopt digest:sha256 \
   -keyform PEM \
   -in token3.bin \
   -out token3.sig.bin

6. You now have binary signatures of the tokens. Encode them using base64, and place them back in your token file.

$ base64 -w0 token1.sig.bin > token1.sig.b64
$ base64 -w0 token2.sig.bin > token2.sig.b64
$ base64 -w0 token3.sig.bin > token3.sig.b64

7. Finally, copy and paste the base64 values back into your token file:

```json
{
   "version": "2.0",
   "tokens": [
      {
         "unsigned": "1jqwxb9b30UUQLiNb7mxXS1u8J5sEXh0b9nj05BqnPsE=",
         "signed": "eiw3fZeCkIY50C4peq9t90M1qLq3WJh6Y7xMx4nF6e9ETLE39+9M +zQgQWMRzja8FamBg5d9y9Dzep5I3U7ch2I1F9L0vAhsWutkT0l4KQziycyFvS69n/ENy/TK0PVaxLN42X +peBV4jwMNk4CzdFA3ghU6B0j4y9grecp0BB9KQF5p2ZALSEdOgUc/mS1eBq3ruU6nt6+4NKuL0jpR +LSEIWZR6g6+MND2vXGskxHj1adCQ09L7728VcVkJKbxJcB16KvkgqyozI9zG6o8F3iHbwmv1AgS61Mezz77ZG4PVFR37+j/ YMSC14piC15dMr2xA15S5b4w="
      },
      {
         "unsigned": "LMMFc34ASPvNPzBbMz9FpP0S/Zu2PBzF/xzkSHVQ=",
         "signed": "HB1mKnHm6r6R2PPEPfiA6g+h2pRNyn43LhKPKn2higbEhUD0JVi +M4erSyvU/NN791WxVdiv9It+jp1r0jTf7GEoIteyuAr1v/Bzh+Hjmo5S30q2aJ/VXGiaP0dmyuu/ ZGNKQyTSSkjL+V81pF7ryRJn22jueGa735szvm+EccnV3M9V6x6A7weWz13JEKBWhebH1+7BwbaW +PTdCuIRd4uG7S5y+cFeysvC1ik7cMw0bHMGzX2Z2m/ffydy2j8Ax8RDLmwyU0YWvPYOVUHc +s83hx3eOpGwpcD7RA0bPSTQzTx7PH0N1CL+Wwy91Ie8yI0FBS6nxxo1R7w="
      },
      {
         "unsigned": "dzeHBw8rVXQqcUGj5G3s51/7sLUdJxJL935B0Uy2RjH8=",
         "signed": "Vq0PvrTsvGljYBFxHnswdnq16x8ZmxcfcYVYGf/ N7qElzAt3Dgs2zEVWTrd5Su0GdhKmFyp1apHqjJZPDvbGcTkIXD2IFyppcQN1zBkYltte5EOjqs9ZjYEqQGhB4g/ Mx4a8Ab3ai/68cLe92NidBus7tveIm3ylTpjINXAVoerSknfuw7wZcL9GQk1Nbl1WUuShw +psUyeIvTfWMHEF6fOrC0t +VhmmlnFmkjGp9W3Apwr2dRRvFMSR2ZTDvMC10YdZUCd436ftGq2LfxH3qSD5oFHglHQVOY0jyVzz1Avub5Hqd8QdEe00/"
   ]
}
```
8. Now that your token file has all the required signatures, you can proceed. Enter the name of the file containing the signed tokens and press the enter key. Finally, enter the path of your new public key. Now you will see the following as part of the output of `user list`.

```
Enter signed token file path (press enter if same as the unsigned token file):
Enter public key PEM file path: officer1.pub
```  

```
{  
  "error_code": 0,  
  "data": {  
    "username": "<USERNAME>"  
  
  ,  
  "role": "crypto-user"  

}
}
```

Now we have setup our user with MFA.

```
{  
  "username": "<USERNAME>"  
  "role": "crypto-user",  
  "locked": "false",  
  "mfa": [  
    {  
      "strategy": "token-sign",  
      "status": "enabled"  

    },  
  
  ,  
  "cluster-coverage": "full"  

]
```

Deregister an MFA public key for admin users when MFA public key is registered

Follow these steps to deregister an MFA public key for admin users when MFA public key is registered.

1. Use CloudHSM CLI to log in to the HSM as an admin with MFA enabled.
2. Use the `user change-mfa token-sign` command to remove MFA for a user.

```
aws-cloudhsm > user change-mfa token-sign --username <USERNAME> --role admin --deregister --change-quorum
```

```
Enter password:
Confirm password:
```  

```
{  
  "error_code": 0,  
  "data": {  
    "username": "<USERNAME>"  
  
  ,  
  "role": "admin"  

}

```

Token file reference

The token file generated when either registering a MFA public key or when attempting to login using MFA consists of the following:

- **Tokens**: An array base64 encoded unsigned/signed token pairs in the form of JSON object literals.
- **Unsigned**: A base64 encoded and SHA256 hashed token.
• **Signed**: A base64 encoded signed token (signature) of the unsigned token, using the RSA 2048-bit private key.

```json
{
  "version": "2.0",
  "tokens": [
    {
      "unsigned": "1jqwxb9jbOUUQLnB7mxXS1uBjsExh0B9nj05Bqns=",
      "signed": "eiw3fZeCKY50C4zPeg9RT90M1QlqW1IhBYw7Xm4nF6e9TEL39+9M+
      +tUqDWNRMZjaBfaMbg59yDkzsp12U7ch2tIF9LoYabsWutkT014KRp/iccYmFsU9n/Ey/TK0PVaxLF42X
      +pebV4juwMhNumK4CzdFA3gM+UGBOj4yB9recp0BB9KQfSpJZAL5EdGuc/m51eDq5rU0int6+4NKuLqjPR
      +L5E1WRZ6g6+MN2vXGskxHjadCQ907LTz8VcWjKDbx3cBiGKvkqoyol9zroGo8fA3WYHmwiAgS61Merx77ZGY4PFR37+j/
      YMSC14prCN15dTMrVx2xAISG5b4w="
    },
    {
      "unsigned": "LMMFc34A5PnvNPFzBbMrz9FtcoS/zu2P8Zf/Zxk5hVQ=",
      "signed": "HBI6KnHmu+6R2r6PfEpiAq4+hu2pFBnwn4C1hKpn2hiqsEuHdU0Vi
      +4MerSvyU/NN791wVx0v93Ito+jpiRQjTF/GeOtgyuAr1v/Bzh/HJmz05300pza1/JXG1qAPd0myuu/
      ZGNK0TCSkL7vV81FG7yR1Nm22jUeGa735zvm/E+cenvZdy0VvxA7eWrl3JEKKBweHbi+78wbaW
      +P7dCuIrD4jU765y+cFhsvcGik7CmDh8MgXZtZnl/mf/hdyZj8AxORTLmwyUOypY0UHC
      +s83xh36QpGwGcD7RA0bPT50x7PhdO2INCL+wWy91we8yOFBS6Gxo1R7w="
    },
    {
      "unsigned": "dzeHbwhiVXQqcUGj56z3s51/7sLudxj9L35sb0YuVZrJh8=",
      "signed": "VqQPzvTsvGljYVBFhnsduq16x8BZnxPCYVYf7/N7qEZiA55G0sE2ZwTRdV50UGHdKPy1p189qJZ7PDW6cGctKXVD2J/Fypcgn15szkY1fctz5EOjgS9z1YEegGWABDf//
      MxaBabRjC1a/j6E1cE29NIDwBStteiM3y5PzjXJXNvveR5nKfuw7wZcL9G6ok1B1WusHw+/p5UyeITi1wFMHEFfoRC0t
      +VhmnlFnkj6Pb9W3Apzw2DrrVFm3R2ZTDwMC10YDzUcD4GftG2fLfxH83q5D5oFHg1HQVOY/jvyZzALuvSHQdt0ODe1Ee00/9dGx
      ]
  }
}
```

### Using CloudHSM CLI to manage quorum authentication (M of N access control)

The HSMs in your AWS CloudHSM cluster support quorum authentication, which is also known as M of N access control. With quorum authentication, no single user on the HSM can do quorum-controlled operations on the HSM. Instead, a minimum number of HSM users (at least 2) must cooperate to do these operations. With quorum authentication, you can add an extra layer of protection by requiring approvals from more than one HSM user.

Quorum authentication can control the following operations:

- HSM user management by [admin (p. 61)] – Creating and deleting HSM users, and changing a different HSM user's password. For more information, see [Using quorum authentication for admins (p. 86)].

The following topics provide more information about quorum authentication in AWS CloudHSM.

**Topics**

- [Overview of quorum authentication with token-sign strategy (p. 78)]
- [Additional details about quorum authentication (p. 78)]
- [Service names and types that support quorum authentication (p. 78)]
- [Using quorum authentication for admins: first time setup (p. 79)]
- [Using quorum authentication for admins (p. 86)]
- [Change the quorum minimum value for admins (p. 91)]

77
Overview of quorum authentication with token-sign strategy

The following steps summarize the quorum authentication processes. For the specific steps and tools, see Using quorum authentication for admins (p. 86).

1. Each HSM user creates an asymmetric key for signing. Users do this outside of the HSM, taking care to protect the key appropriately.
2. Each HSM user logs in to the HSM and registers the public part of their signing key (the public key) with the HSM.
3. When an HSM user wants to do a quorum-controlled operation, the same user logs in to the HSM and gets a quorum token.
4. The HSM user gives the quorum token to one or more other HSM users and asks for their approval.
5. The other HSM users approve by using their keys to cryptographically sign the quorum token. This occurs outside the HSM.
6. When the HSM user has the required number of approvals, the same user logs in to the HSM and runs the quorum-controlled operation with the --approval argument, supplying the signed quorum token file, which contains all necessary approvals (signatures).
7. The HSM uses the registered public keys of each signer to verify the signatures. If the signatures are valid, the HSM approves the token and the quorum-controlled operation is performed.

Additional details about quorum authentication

Note the following additional information about using quorum authentication in AWS CloudHSM.

- An HSM user can sign his or her own quorum token—that is, the requesting user can provide one of the required approvals for quorum authentication.
- You choose the minimum number of quorum approvers for quorum-controlled operations. The smallest number you can choose is two (2), and the largest number you can choose is eight (8).
- The HSM can store up to 1024 quorum tokens. If the HSM already has 1024 tokens when you try to create a new one, the HSM purges one of the expired tokens. By default, tokens expire ten minutes after their creation.
- If MFA is enabled, the cluster uses the same key for quorum authentication and for multi-factor authentication (MFA). For more information about using quorum authentication and 2FA, see Using CloudHSM CLI to manage MFA (p. 67).
- Each HSM can only contain one token per service at a time.

Service names and types that support quorum authentication

Admin Services: Quorum authentication is used for admin privileged services like creating users, deleting users, changing user passwords, setting quorum values, and deactivating quorum and MFA capabilities.

Each service type is further broken down into a qualifying service name, which contains a specific set of quorum supported service operations that can be performed.

<table>
<thead>
<tr>
<th>Service name</th>
<th>Service type</th>
<th>Service operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>user</td>
<td>Admin</td>
<td>• user create</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• user delete</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• user change-password</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• user change-mfa</td>
</tr>
</tbody>
</table>
Using quorum authentication for admins: first time setup

The following topics describe the steps that you must complete to configure your hardware security module (HSM) so that admins (p. 61) can use quorum authentication. You need to do these steps only once when you first configure quorum authentication for admins. After you complete these steps, see Using quorum authentication for admins (p. 86).

Topics
- Prerequisites (p. 79)
- Create and register a key for signing (p. 80)
- Set the quorum minimum value on the HSM (p. 84)

Prerequisites

To understand this example, you should be familiar with CloudHSM CLI (p. 183). In this example, the AWS CloudHSM cluster has two HSMs, each with the same admins, as shown in the following output from the user list command. For more information about creating users, see Using CloudHSM CLI (p. 60).

```
aws-cloudhsm>user list
{
    "error_code": 0,
    "data": {
        "users": [
            {
                "username": "admin",
                "role": "admin",
                "locked": "false",
                "mfa": [],
                "quorum": [],
                "cluster-coverage": "full"
            },
            {
                "username": "admin2",
                "role": "admin",
                "locked": "false",
                "mfa": [],
                "quorum": [],
                "cluster-coverage": "full"
            },
            {
                "username": "admin3",
                "role": "admin",
                "locked": "false",
                "mfa": [],
                "quorum": [],
                "cluster-coverage": "full"
            },
            {
                "username": "admin4",
                "role": "admin",
                "locked": "false",
                "mfa": [],
                "quorum": [],
```
Create and register a key for signing

To use quorum authentication, each admin must complete all of the following steps:

Topics
• Create an RSA key pair (p. 80)
• Create and sign a registration token (p. 80)
• Register the public key with the HSM (p. 82)

Create an RSA key pair

There are many different ways to create and protect a key pair. The following examples show how to do it with OpenSSL.

Example – Create a private key with OpenSSL

The following example demonstrates how to use OpenSSL to create a 2048-bit RSA key that is protected by a pass phrase. To use this example, replace <admin.key> with the name of the file where you want to store the key.

```
$ openssl genrsa -out <admin.key> -aes256 2048
Generating RSA private key, 2048 bit long modulus
.....................................+++
.e is 65537 (0x10001)
Enter pass phrase for admin.key:
Verifying - Enter pass phrase for admin.key:
```

Next, generate the public key using the private key that you just created.

Example – Create a public key with OpenSSL

The following example demonstrates how to use OpenSSL to create a public key from the private key you just created.

```
$ openssl rsa -in admin.key -outform PEM -pubout -out admin1.pub
Enter pass phrase for admin.key:
writing RSA key
```

Create and sign a registration token

You create a token and sign it with the private key you just generated in the previous step.
Example – Create a registration token

1. Use the following command to start the CloudHSM CLI:

   **Linux**
   
   ```bash
   $ /opt/cloudhsm/bin/cloudhsm-cli interactive
   ```

   **Windows**
   
   ```bash
   C:\Program Files\Amazon\CloudHSM\bin> .\cloudhsm-cli.exe interactive
   ```

2. Create a registration token by running the `quorum token-sign generate` (p. 246) command:

   ```sh
   aws-cloudhsm > quorum token-sign generate --service registration --token /path/tokenfile
   ```

   ```json
   {  
     "error_code": 0,  
     "data": {  
       "path": "/path/tokenfile"
     }
   }
   ```

3. The `quorum token-sign generate` (p. 246) command generates a registration token at the specified file path. Inspect the token file:

   ```bash
   $ cat /path/tokenfile
   ```

   ```json
   {  
     "version": "2.0",  
     "tokens": [  
       {  
         "approval_data": "<approval data in base64 encoding>",  
         "unsigned": "<unsigned token in base64 encoding>",  
         "signed": ""
       }
     ]
   }
   ```

   The token file consists of the following:

   - **approval_data**: A base64 encoded randomized data token whose raw data doesn’t exceed the maximum of 245 bytes.
   - **unsigned**: A base64 encoded and SHA256 hashed token of the approval_data.
   - **signed**: A base64 encoded signed token (signature) of the unsigned token, using the RSA 2048-bit private key previously generated with OpenSSL.

   You sign the unsigned token with the private key to demonstrate that you have access to the private key. You will need the registration token file fully populated with a signature and the public key to register the admin as a quorum user with the AWS CloudHSM cluster.

Example – Sign the unsigned registration token

1. Decode the base64 encoded unsigned token and place it into a binary file:

   ```bash
   $ echo -n '6BMUj6mUjjko6ZLCEdzG1wP5sIhF3fQhW1ej3Oq1g=' | base64 -d > admin.bin
   ```
2. Use OpenSSL and the private key to sign the now binary unsigned registration token and create a binary signature file:

```
$ openssl pkeyutl -sign \
  -inkey admin.key \
  -pkeyopt digest:sha256 \
  -keyform PEM \
  -in admin.bin \
  -out admin.sig.bin
```

3. Encode the binary signature into base64:

```
$ base64 -w0 admin.sig.bin > admin.sig.b64
```

4. Copy and paste the base64 encoded signature into the token file:

```json
{
  "version": "2.0",
  "tokens": [
    {
      "approval_data": "<approval data in base64 encoding>",
      "unsigned": "<unsigned token in base64 encoding>",
      "signed": "<signed token in base64 encoding>
    }
  ]
}
```

Register the public key with the HSM

After creating a key, the admin must register the public key with the AWS CloudHSM cluster.

To register a public key with the HSM

1. Use the following command to start CloudHSM CLI:

   Linux

   ```sh
   $ /opt/cloudhsm/bin/cloudhsm-cli interactive
   ```

   Windows

   ```sh
   C:\Program Files\Amazon\CloudHSM\bin> .\cloudhsm-cli.exe interactive
   ```

2. Using CloudHSM CLI, log in as an admin.

   ```sh
   aws-cloudhsm > login --username admin --role admin
   Enter password:
   {
     "error_code": 0,
     "data": {
       "username": "admin",
       "role": "admin"
     }
   }
   ```

3. Use the `user change-quorum token-sign register` (p. 238) command to register the public key. For more information, see the following example or use the `help user change-quorum token-sign register` command.
Example – Register a public key with AWS CloudHSM cluster

The following example shows how to use the `user change-quorum token-sign register` command in CloudHSM CLI to register an admin’s public key with the HSM. To use this command, the admin must be logged in to the HSM. Replace these values with your own:

```bash
aws-cloudhsm > user change-quorum token-sign register --public-key </path/admin.pub> --signed-token </path/tokenfile>
{
    "error_code": 0,
    "data": {
        "username": "admin",
        "role": "admin"
    }
}
```

**Note**

`/path/admin.pub`: The filepath to the public key PEM file  
**Required**: Yes  
`/path/tokenfile`: The filepath with token signed by user private key  
**Required**: Yes

After all admins register their public keys, the output from the `user list` command shows this in the quorum field, stating the enabled quorum strategy in use, as shown below:

```bash
aws-cloudhsm > user list
{
    "error_code": 0,
    "data": {
        "users": [
            {
                "username": "admin",
                "role": "admin",
                "locked": "false",
                "mfa": [],
                "quorum": [
                    {
                        "strategy": "token-sign",
                        "status": "enabled"
                    }
                ],
                "cluster-coverage": "full"
            },
            {
                "username": "admin2",
                "role": "admin",
                "locked": "false",
                "mfa": [],
                "quorum": [
                    {
                        "strategy": "token-sign",
                        "status": "enabled"
                    }
                ],
                "cluster-coverage": "full"
            },
            {
                "username": "admin3",
                "role": "admin",
                "locked": "false",
                "mfa": [],
                "quorum": [
                {
```
Set the quorum minimum value on the HSM

To use quorum authentication, an admin must log in to the HSM and then set the quorum minimum value. This is the minimum number of admin approvals that are required to perform HSM user management operations. Any admin on the HSM can set the quorum minimum value, including admins who have not registered a key for signing. You can change the quorum minimum value at any time. for more information, see Change the minimum value (p. 91).

To set the quorum minimum value on the HSM

1. Use the following command to start CloudHSM CLI:

   Linux
   
   ```
   $ /opt/cloudhsm/bin/cloudhsm-cli interactive
   ```
   
   Windows
   
   ```
   C:\Program Files\Amazon\CloudHSM\bin> .\cloudhsm-cli.exe interactive
   ```

2. Using CloudHSM CLI, log in as an admin.

   ```
   aws-cloudhsm > login --username admin --role admin
   Enter password:
   {
   "error_code": 0,
   "data": {
   "username": "admin",
   "role": "admin"
   }
   ```
3. Use the **quorum token-sign set-quorum-value (p. 250)** command to set the quorum minimum value. For more information, see the following example or use the **help quorum token-sign set-quorum-value** command.

**Example – Set the quorum minimum value on the HSM**

This example uses a quorum minimum value of two (2). You can choose any value from two (2) to eight (8), up to the total number of admins on the HSM. In this example, the HSM has four (4) admins, so the maximum possible value is four (4).

To use the following example command, replace the final number (<2>) with the preferred quorum minimum value.

```
aws-cloudhsm > quorum token-sign set-quorum-value --service user --value <2>
{
    "error_code": 0,
    "data": "Set quorum value successful"
}
```

In this example, the service identifies the HSM service whose quorum minimum value you are setting. The **quorum token-sign list-quorum-values (p. 249)** command lists the HSM service types, names, and descriptions that are included in the service.

**Admin Services**: Quorum authentication is used for admin privileged services like creating users, deleting users, changing user passwords, setting quorum values, and deactivating quorum and MFA capabilities.

Each service type is further broken down into a qualifying service name, which contains a specific set of quorum supported service operations that can be performed.

<table>
<thead>
<tr>
<th>Service name</th>
<th>Service type</th>
<th>Service operations</th>
</tr>
</thead>
</table>
| user         | Admin        | • user create
               |               | • user delete
               |               | • user change-password
               |               | • user change-mfa
| quorum       | Admin        | • quorum token-sign set-quorum-value       |

To get the quorum minimum value for a service, use the **quorum token-sign list-quorum-values** command:

```
aws-cloudhsm > quorum token-sign list-quorum-values
{
    "error_code": 0,
    "data": {
        "user": 2,
        "quorum": 1
    }
}
```

The output from the preceding **quorum token-sign list-quorum-values** command shows that the quorum minimum value for HSM user service, responsible for user management operations, is now two (2). After you complete these steps, see **Using quorum (M of N) (p. 86)**.
Using quorum authentication for admins

An admin (p. 61) on the HSM can configure quorum authentication for the following operations in the AWS CloudHSM cluster:

- `user create` (p. 240)
- `user delete` (p. 241)
- `user change-password` (p. 235)
- `user change-mfa` (p. 233)

After the AWS CloudHSM cluster is configured for quorum authentication, admins cannot perform HSM user management operations on their own. The following example shows the output when an admin attempts to create a new user on the HSM. The command fails with an error, stating that quorum authentication is required.

```
aws-cloudhsm > user create --username user1 --role crypto-user
Enter password:
Confirm password:
{
  "error_code": 1,
  "data": "Quorum approval is required for this operation"
}
```

To perform an HSM user management operation, an admin must complete the following tasks:

Topics

- Get a quorum token (p. 86)
- Get signatures from approving admins (p. 88)
- Approve the token on the AWS CloudHSM cluster and execute a user management operation (p. 89)

Get a quorum token

First, the admin must use CloudHSM CLI to request a quorum token.

To get a quorum token

1. Use the following command to start CloudHSM CLI.

   Linux
   ```
   $ /opt/cloudhsm/bin/cloudhsm-cli interactive
   ```

   Windows
   ```
   C:\Program Files\Amazon\CloudHSM\bin\> .\cloudhsm-cli.exe interactive
   ```

2. Use the `login` command and log in to the cluster as an admin.

   ```
   aws-cloudhsm> login --username admin --role admin
   ```

3. Use the `quorum token-sign generate` command to generate a quorum token. For more information, see the following example or use the `help quorum token-sign generate` command.
Example – Generate a quorum token

This example gets a quorum token for the admin with user name admin and saves the token to a file named admin.token. To use the example command, replace these values with your own:

- `<admin>` – The name of the admin who is getting the token. This must be the same admin who is logged in to the HSM and is running this command.
- `<admin.token>` – The name of the file to use for storing the quorum token.

In the following command, `user` identifies the service name for which you can use the token that you are generating. In this case, the token is for HSM user management operations (`user` service).

```bash
aws-cloudhsm > login --username <ADMIN> --role <ADMIN> --password <PASSWORD>
{
  "error_code": 0,
  "data": {
    "username": "admin",
    "role": "admin"
  }
}
aws-cloudhsm > quorum token-sign generate --service user --token </path/admin.token>
{
  "error_code": 0,
  "data": {
    "path": "/home/tfile"
  }
}
```

The `quorum token-sign generate` command generates a user service quorum token at the specified file path. The token file can be inspected:

```bash
$ cat </path/admin.token>
{
  "version": "2.0",
  "approval_data": "AAEAAwAAABgAAAAAIAJ9eFkfcP3mNzJAlfKvWbNhZG1pbqAABeAABj5vebAAABAAAAAQADAADFQAAAAAAAIAAAA/ vSeuk83amq1fj0zyv02FkbWuAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAGPm9t4AABAAAAAAAABAAAAAAUAAAAAAAD +b23gAAAAAAA",
  "token": "01LzkmAHZyAc1hPhyck0oWvW35aGrgG77qmDHWQ3JC8=",
  "signatures": []
}
```

The token file consists of the following:

- **approval_data**: A base64 encoded raw data token generated by the HSM.
- **token**: A base64 encoded and SHA-256 hashed token of the approval_data
- **signatures**: An array of base64 encoded signed tokens (signatures) of the unsigned token, where each signature of an approver is in the form of a JSON object literal:

```json
{
  "username": "<APPROVER_USERNAME>",
  "signature": "<APPROVER_RSA2048_BIT_SIGNATURE>
}
```

Each signature is created from the result of an approver using their corresponding RSA 2048-bit private key whose public key was registered with the HSM.
The generated user service quorum token can be confirmed to exist on the CloudHSM cluster by running the **quorum token-sign list** command:

```bash
aws-cloudhsm > quorum token-sign list
{
  "error_code": 0,
  "data": {
    "tokens": [
      {
        "username": "admin",
        "service": "user",
        "approvals-required": {
          "value": 2
        },
        "number-of-approvals": {
          "value": 0
        },
        "token-timeout-seconds": {
          "value": 597
        },
        "cluster-coverage": "full"
      }
    ]
  }
}
```

The `token-timeout-seconds` time indicates the timeout period in seconds for a generated token to be approved before it expires.

**Get signatures from approving admins**

An admin who has a quorum token must get the token approved by other admins. To give their approval, the other admins use their signing key to cryptographically sign the token. They do this outside the HSM.

There are many different ways to sign the token. The following example shows how to do it with **OpenSSL**. To use a different signing tool, make sure that the tool uses the admin's private key (signing key) to sign a SHA-256 digest of the token.

**Example – Get signatures from approving admins**

In this example, the admin that has the token (`admin`) needs at least two (2) approvals. The following example commands show how two (2) admins can use OpenSSL to cryptographically sign the token.

1. Decode the base64 encoded unsigned token and place it into a binary file:

   ```bash
   $echo -n '0l2LZkmAHZyAc1hPhyck00VW33a6BgG776mDHW3C3CJ8=' | base64 -d > admin.bin
   ```

2. Use OpenSSL and the respective private key of the approver (`admin3`) to sign the now binary quorum unsigned token for the user service and create a binary signature file:

   ```bash
   $openssl pkeyutl -sign \\
   -inkey admin3.key \\
   -pkeyopt digest:sha256 \\
   -keyform PEM \\
   -in admin.bin \\
   -out admin.sig.bin
   ```

3. Encode the binary signature into base64:

   ```bash
   $base64 -w0 admin.sig.bin > admin.sig.b64
   ```
4. Finally, copy and paste the base64 encoded signature into the token file, following the JSON object literal format specified earlier for approver signature:

```json
{
  "version": "2.0",
  "approval_data": "AAEAAwAAABgAAAAAAAAAAJ9eFkfcP3mNzJAlfK
+0WbNhZG1pbgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/ v5EukB3amq1fj8yzvD2FkbWuAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/wb25gAAAAAA",
  "token": "012L2kmAHZyAc1hPhyckOoVW35aGrg77qmDHWQ3CJ8=",
  "signatures": [
    {
      "username": "admin2",
      "signature": "O6qx7/mUaVkYYVr1PW7l8Jko+Kh3e8zBIqd3tAiNy
+1rW+0sDtvyujhEU4UoGFVLCzUfmyB/CX90QmgJLgx/pyK+ZPEH
+Go3gqk9YZ7Xn0XwZRP9g7hKV+7XCtg9TuDFtHvWdp8fz2jw1u2fxFk/
+jTs4f2x1fFfIPKcSw8FhxjQ63xEcCFljjxHa6czDMu4xUNWdEtgF77um7E9jdXNoHqLB7cTzphaubNaEFbFPXQVsiGmXKmvETlq
ssktwyruGFLpXs1n0tJ0e1g1hX2qbyTs+omK7z0R15WIEWXIIXw/DgSvV0bzNpV0eZEK08nSMc7+cyPySc
+ZbNw="
    },
    {
      "username": "admin3",
      "signature": "O6qx7/mUaVkYYVr1PW7l8Jko+Kh3e8zBIqd3tAiNy
+1rW+0sDtvyujhEU4UoGFVLCzUfmyB/CX90QmgJLgx/pyK+ZPEH
+Go3gqk9YZ7Xn0XwZRP9g7hKV+7XCtg9TuDFtHvWdp8fz2jw1u2fxFk/
+jTs4f2x1fFfIPKcSw8FhxjQ63xEcCFljjxHa6czDMu4xUNWdEtgF77um7E9jdXNoHqLB7cTzphaubNaEFbFPXQVsiGmXKmvETlq
ssktwyruGFLpXs1n0tJ0e1g1hX2qbyTs+omK7z0R15WIEWXIIXw/DgSvV0bzNpV0eZEK08nSMc7+cyPySc
+ZbNw="
    }
  ]
}
```

Approve the token on the AWS CloudHSM cluster and execute a user management operation

After an admin has the necessary approvals/signatures, as detailed in the previous section, the admin can supply that token to the AWS CloudHSM cluster along with one of the following user management operations:

- `create (p. 240)`
- `delete (p. 241)`
- `change-password (p. 235)`
- `user change-mfa (p. 233)`

For more information about using these commands, see Using CloudHSM CLI (p. 60).

During the transaction, the token will be approved within the AWS CloudHSM cluster and execute the requested user management operation. The success of the user management operation is contingent upon both a valid approved quorum token and a valid user management operation.

The admin can use the token for only one operation. When that operation succeeds, the token is no longer valid. To do another HSM user management operation, the admin must repeat the above outlined process. That is, the admin must generate a new quorum token, get new signatures from approvers, and then approve and consume the new token on the HSM with the requested user management operation.

**Note**

The quorum token is only valid as long as your current login session is open. If you log out of CloudHSM CLI or if the network disconnects, the token is no longer valid. Similarly, an authorized token can only be used within CloudHSM CLI. It cannot be used to authenticate in a different application.
Example Creating a new user as an admin

In the following example, a logged in admin creates a new user on the HSM:

```bash
aws-cloudhsm > user create --username user1 --role crypto-user --approval /path/admin.token
Enter password:
Confirm password:
{
   "error_code": 0,
   "data": {
       "username": "user1",
       "role": "crypto-user"
   }
}
```

The admin then enters the `user list` command to confirm the creation of the new user:

```bash
aws-cloudhsm > user list
{
   "error_code": 0,
   "data": {
       "users": [
           {
               "username": "admin",
               "role": "admin",
               "locked": "false",
               "mfa": [],
               "quorum": [
                   {
                       "strategy": "token-sign",
                       "status": "enabled"
                   }
               ],
               "cluster-coverage": "full"
           },
           {
               "username": "admin2",
               "role": "admin",
               "locked": "false",
               "mfa": [],
               "quorum": [
                   {
                       "strategy": "token-sign",
                       "status": "enabled"
                   }
               ],
               "cluster-coverage": "full"
           },
           {
               "username": "admin3",
               "role": "admin",
               "locked": "false",
               "mfa": [],
               "quorum": [
                   {
                       "strategy": "token-sign",
                       "status": "enabled"
                   }
               ],
               "cluster-coverage": "full"
           },
           {
               "username": "admin4",
               "role": "admin",
               "locked": "false",
               "mfa": [],
               "quorum": [
                   {
                       "strategy": "token-sign",
                       "status": "enabled"
                   }
               ],
               "cluster-coverage": "full"
           }
       ]
    }
}
```
If the admin tries to perform another HSM user management operation, it fails with a quorum authentication error:

```
aws-cloudhsm > user delete --username user1 --role crypto-user
{
    "error_code": 1,
    "data": "Quorum approval is required for this operation"
}
```

As shown below, the `quorum token-sign list` command shows that the admin has no approved tokens. To perform another HSM user management operation, the admin must generate a new quorum token, get new signatures from approvers, and execute the desired user management operation with the `--approval` argument to supply the quorum token to be approved and consumed during execution of the user management operation.

```
aws-cloudhsm > quorum token-sign list
{
    "error_code": 0,
    "data": {
        "tokens": []
    }
}
```

**Change the quorum minimum value for admins**

After you set the quorum minimum value (p. 84) so admins (p. 61) can use quorum authentication, you might want to change the quorum minimum value. The HSM allows you to change the quorum minimum value only when the number of approvers is the same or higher than the current quorum minimum value. For example, if the quorum minimum value is two (2), at least two (2) admins must approve to change the quorum minimum value.
**Note**

The quorum value of the user service must always be less than the quorum value of the quorum service. For information on service names, like quorum service and user service, see Service names and types that support quorum authentication (p. 78).

To get quorum approval to change the quorum minimum value, you need a *quorum token* for the quorum service using the `quorum token-sign set-quorum-value` command. To generate a quorum token for the for the quorum service using the `quorum token-sign set-quorum-value` command, the quorum service must be higher than one (1). This means that before you can change the quorum minimum value for *user service*, you might need to change the quorum minimum value for *quorum service*.

**To change the quorum minimum value for admins**

1. Use the following command to start CloudHSM CLI interactive mode.

   **Linux**
   
   ```bash
   $ /opt/cloudhsm/bin/cloudhsm-cli interactive
   ```

   **Windows**
   
   ```bash
   C:\Program Files\Amazon\CloudHSM\bin> .\cloudhsm-cli.exe interactive
   ```

2. Use the `login` command and log in to the cluster as the admin.

   ```bash
   aws-cloudhsm> login --username <admin> --role admin
   ```

3. Use the `quorum token-sign list-quorum-values` command to get the quorum minimum values for all service names. For more information, see the example below.

4. If the quorum minimum value for quorum service is lower than the value for user service, use the `quorum token-sign set-quorum-value` command to change the value for *quorum service*. Change the value for quorum service to one (1) that is the same or higher than the value for user service. For more information, see the following example.

5. Generate a quorum token (p. 86), taking care to specify quorum service as the service for which you can use the token.

6. Get approvals (signatures) from other admins (p. 88).

7. Approve the token on the AWS CloudHSM cluster and execute a user management operation. (p. 89).

8. Use the `quorum token-sign set-quorum-value` command to change quorum minimum value for user service.

**Example – Get quorum minimum values and change the value for *quorum service***

The following example command shows that the quorum minimum value for *user service* is currently two (2).

```bash
aws-cloudhsm > quorum token-sign list-quorum-values{
   "error_code": 0,
   "data": {
     "user": 2,
     "quorum": 1
   }
}
```
AWS CloudHSM User Guide
Using CMU

To change the quorum minimum value for quorum service, use the quorum token-sign set-quorumvalue command, setting a value that is the same or higher than the value for user service. The following
example sets the quorum minimum value for quorum service to two (2), the same value that is set for
user service.
aws-cloudhsm > quorum token-sign set-quorum-value --service quorum --value 2{
"error_code": 0,
"data": "Set quorum value successful"
}

The following command shows that the quorum minimum value is now two (2) for user service and
quorum service.
aws-cloudhsm > quorum token-sign list-quorum-values{
"error_code": 0,
"data": {
"user": 2,
"quorum": 2
}
}

Managing HSM users with CloudHSM Management
Utility (CMU)
In AWS CloudHSM, you must use CloudHSM CLI (p. 184) or CloudHSM Management Utility
(CMU) (p. 253) command line tools to create and manage the users on your HSM. CloudHSM CLI is
designed to be used with the latest SDK, while the CMU is designed to be used with previous SDKs.
Topics
• Understanding HSM users (p. 93)
• HSM user permissions table (p. 94)
• Using CloudHSM Management Utility (CMU) to manage users (p. 95)
• Using CloudHSM Management Utility (CMU) to manage two-factor authentication (2FA) for crypto
oﬃcers (p. 104)
• Using CloudHSM Management Utility (CMU) to manage quorum authentication (M of N access
control) (p. 110)

Understanding HSM users
Most operations that you perform on the HSM require the credentials of an HSM user. The HSM
authenticates each HSM user and each HSM user has a type that determines which operations you can
perform on the HSM as that user.

Note

HSM users are distinct from IAM users. IAM users who have the correct credentials can create
HSMs by interacting with resources through the AWS API. After the HSM is created, you must
use HSM user credentials to authenticate operations on the HSM.
User types
• Precrypto oﬃcer (PRECO) (p. 94)
• Crypto oﬃcer (CO) (p. 94)
• Crypto user (CU) (p. 94)
• Appliance user (AU) (p. 94)

93


Precrypto officer (PRECO)

In both the cloud management utility (CMU) and the key management utility (KMU), the PRECO is a temporary user that exists only on the first HSM in an AWS CloudHSM cluster. The first HSM in a new cluster contains an PRECO user indicating that this cluster has never been activated. To activate a cluster (p. 28), you execute the cloudhsm-cli and run the cluster activate command. Log in to the HSM and change the PRECO's password. When you change the password, this user becomes the crypto officer (CO).

Crypto officer (CO)

In both the cloud management utility (CMU) and the key management utility (KMU), a crypto officer (CO) can perform user management operations. For example, they can create and delete users and change user passwords. For more information about CO users, see the HSM user permissions table (p. 94). When you activate a new cluster, the user changes from a PREcrypto Officer (p. 94) (PRECO) to a crypto officer (CO).

Crypto user (CU)

A crypto user (CU) can perform the following key management and cryptographic operations.

- **Key management** – Create, delete, share, import, and export cryptographic keys.
- **Cryptographic operations** – Use cryptographic keys for encryption, decryption, signing, verifying, and more.

For more information, see the HSM user permissions table (p. 94).

Appliance user (AU)

The appliance user (AU) can perform cloning and synchronization operations on your cluster's HSMs. AWS CloudHSM uses the AU to synchronize the HSMs in an AWS CloudHSM cluster. The AU exists on all HSMs provided by AWS CloudHSM, and has limited permissions. For more information, see the HSM user permissions table (p. 94).

AWS cannot perform any operations on your HSMs. AWS cannot view or modify your users or keys and cannot perform any cryptographic operations using those keys.

HSM user permissions table

The following table lists HSM operations sorted by the type of HSM user or session that can perform the operation.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Crypto officer (CO)</th>
<th>Crypto User (CU)</th>
<th>Appliance User (AU)</th>
<th>Unauthenticated Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>Get basic cluster info¹</td>
<td>✔️ Yes</td>
<td>✔️ Yes</td>
<td>✔️ Yes</td>
<td>✔️ Yes</td>
</tr>
<tr>
<td>Change own password</td>
<td>✔️ Yes</td>
<td>✔️ Yes</td>
<td>✔️ Yes</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Change any user's password</td>
<td>✔️ Yes</td>
<td>✗ No</td>
<td>✗ No</td>
<td>✗ No</td>
</tr>
<tr>
<td>Add, remove users</td>
<td>✔️ Yes</td>
<td>✗ No</td>
<td>✗ No</td>
<td>✗ No</td>
</tr>
<tr>
<td>Get sync status²</td>
<td>✔️ Yes</td>
<td>✔️ Yes</td>
<td>✔️ Yes</td>
<td>✗ No</td>
</tr>
</tbody>
</table>
AWS CloudHSM User Guide
Using CMU

<table>
<thead>
<tr>
<th></th>
<th>Crypto officer (CO)</th>
<th>Crypto User (CU)</th>
<th>Appliance User (AU)</th>
<th>Unauthenticated Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extract, insert</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>masked objects³</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Key management functions⁴</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Encrypt, decrypt</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Sign, verify</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Generate digests and HMACs</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

- [1] Basic cluster information includes the number of HSMs in the cluster and each HSM’s IP address, model, serial number, device ID, firmware ID, etc.
- [2] The user can get a set of digests (hashes) that correspond to the keys on the HSM. An application can compare these sets of digests to understand the synchronization status of HSMs in a cluster.
- [3] Masked objects are keys that are encrypted before they leave the HSM. They cannot be decrypted outside of the HSM. They are only decrypted after they are inserted into an HSM that is in the same cluster as the HSM from which they were extracted. An application can extract and insert masked objects to synchronize the HSMs in a cluster.
- [4] Key management functions include creating, deleting, wrapping, unwrapping, and modifying the attributes of keys.

Using CloudHSM Management Utility (CMU) to manage users

This topic provides step-by-step instruction on managing hardware security module (HSM) users with CloudHSM Management Utility (CMU), a command line tool that comes with the Client SDK. For more information about CMU or HSM users, see CloudHSM Management Utility (p. 252) and Understanding HSM users (p. 60).

Sections
- Understanding HSM user management with CMU (p. 95)
- Download CloudHSM Management Utility (p. 96)
- How to manage HSM users with CMU (p. 98)

Understanding HSM user management with CMU

To manage HSM users, you must log in to the HSM with the user name and password of a cryptographic officer (p. 94) (CO). Only COs can manage users. The HSM contains a default CO named admin. You set the password for admin when you activated the cluster (p. 28).

To use CMU, you must use the configure tool to update the local configuration. CMU creates its own connection to the cluster and this connection is not cluster aware. To track cluster information, CMU maintains a local configuration file. This means that each time you use CMU, you should first update the configuration file by running the `configure` command line tool with the `-c` parameter. If you are using Client SDK 3.2.1 or earlier, you must use a different parameter than `-c`. For more information, see the section called “Using CMU with Client SDK 3.2.1 and earlier” (p. 96).

The `-c` parameter requires you to add the IP address of an HSM in your cluster. If you have multiple HSMs, you can use any IP address. This ensures CMU can propagate any changes you make across the
entire cluster. Remember that CMU uses its local file to track cluster information. If the cluster has changed since the last time you used CMU from a particular host, you must add those changes to the local configuration file stored on that host. Never add or remove a HSM while you're using CMU.

To get an IP address for a HSM (console)

2. To change the AWS Region, use the Region selector in the upper-right corner of the page.
3. To open the cluster detail page, in the cluster table, choose the cluster ID.
4. To get the IP address, on the HSMs tab, choose one of the IP addresses listed under ENI IP address.

To get an IP address for a HSM (AWS CLI)

- Get the IP address of an HSM by using the describe-clusters command from the AWS CLI. In the output from the command, the IP address of the HSMs are the values of EniIp.

```bash
$ aws cloudhsmv2 describe-clusters
{
  "Clusters": [
    { ... }]
  "Hsms": [
    { ... "EniIp": "10.0.0.9",
      { ... "EniIp": "10.0.1.6",
      ...
    ]
}
```

Using CMU with Client SDK 3.2.1 and earlier

With Client SDK 3.3.0, AWS CloudHSM added support for the --cmu parameter, which simplifies the process of updating the configuration file for CMU. If you're using a version of CMU from Client SDK 3.2.1 or earlier, you must continue to use the -a and -m parameters to update the configuration file. For more information about these parameters, see Configure Tool (p. 159).

Download CloudHSM Management Utility

The latest version of CMU is available for HSM user management tasks whether you are using Client SDK 5 and Client SDK 3.

To download and install CMU

- Download and install CMU.

  Amazon Linux

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL6/cloudhsm-mgmt-util-latest.el6.x86_64.rpm
$ sudo yum install ./cloudhsm-mgmt-util-latest.el6.x86_64.rpm
```
Amazon Linux 2

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-mgmt-util-latest.el7.x86_64.rpm

$ sudo yum install ./cloudhsm-mgmt-util-latest.el7.x86_64.rpm

CentOS 7.8+

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-mgmt-util-latest.el7.x86_64.rpm

$ sudo yum install ./cloudhsm-mgmt-util-latest.el7.x86_64.rpm

CentOS 8.3+

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL8/cloudhsm-mgmt-util-latest.el8.x86_64.rpm

$ sudo yum install ./cloudhsm-mgmt-util-latest.el8.x86_64.rpm

RHEL 7.9+

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-mgmt-util-latest.el7.x86_64.rpm

$ sudo yum install ./cloudhsm-mgmt-util-latest.el7.x86_64.rpm

RHEL 8.3+

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL8/cloudhsm-mgmt-util-latest.el8.x86_64.rpm

$ sudo yum install ./cloudhsm-mgmt-util-latest.el8.x86_64.rpm

Ubuntu 16.04 LTS

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Xenial/cloudhsm-mgmt-util_latest_amd64.deb

$ sudo apt install ./cloudhsm-mgmt-util_latest_amd64.deb

Ubuntu 18.04 LTS

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Bionic/cloudhsm-mgmt-util_latest_u18.04_amd64.deb

$ sudo apt install ./cloudhsm-mgmt-util_latest_u18.04_amd64.deb
Windows Server 2012

1. Download CloudHSM Management Utility.
2. Run the CMU installer (`AWSCloudHSMManagementUtil-latest.msi`) with Windows administrative privilege.

Windows Server 2012 R2

1. Download CloudHSM Management Utility.
2. Run the CMU installer (`AWSCloudHSMManagementUtil-latest.msi`) with Windows administrative privilege.

Windows Server 2016

1. Download CloudHSM Management Utility.
2. Run the CMU installer (`AWSCloudHSMManagementUtil-latest.msi`) with Windows administrative privilege.

How to manage HSM users with CMU

This section includes basic commands to manage HSM users with CMU.

To create HSM users

Use `createUser` to create new users on the HSM. You must log in as a CO to create a user.

To create a new CO user

1. Use the configure tool to update the CMU configuration.

   Linux

   ```
   $ sudo /opt/cloudhsm/bin/configure --cmu <IP address>
   ```

   Windows

   ```
   C:\Program Files\Amazon\CloudHSM\bin\ configure.exe --cmu <IP address>
   ```

2. Start CMU.

   Linux

   ```
   $ /opt/cloudhsm/bin/cloudhsm_mgmt_util /opt/cloudhsm/etc/cloudhsm_mgmt_util.cfg
   ```

   Windows

   ```
   C:\Program Files\Amazon\CloudHSM> .\cloudhsm_mgmt_util.exe C:\ProgramData\Amazon
   \CloudHSM\data\cloudhsm_mgmt_util.cfg
   ```

3. Log in to the HSM as a CO user.

   ```
   aws-cloudhsm> loginHSM CO admin co12345
   ```
Make sure the number of connections CMU lists match the number of HSMs in the cluster. If not, log out and start over.

4. Use `createUser` to create a CO user named `example_officer` with a password of `password1`.

    aws-cloudhsm> createUser CO example_officer password1

CMU prompts you about the create user operation.

```
*************************CAUTION****************************
This is a CRITICAL operation, should be done on all nodes in the
cluster. AWS does NOT synchronize these changes automatically with the
nodes on which this operation is not executed or failed, please
ensure this operation is executed on all nodes in the cluster.
****************************************************************
Do you want to continue(y/n)?
```

5. Type `y`.

To create a new CU user

1. Use the configure tool to update the CMU configuration.

    Linux
    
    $ sudo /opt/cloudhsm/bin/configure --cmu <IP address>

    Windows
    
    C:\Program Files\Amazon\CloudHSM\bin\configure.exe --cmu <IP address>

2. Start CMU.

    Linux
    
    $ /opt/cloudhsm/bin/cloudhsm_mgmt_util /opt/cloudhsm/etc/cloudhsm_mgmt_util.cfg

    Windows
    
    C:\Program Files\Amazon\CloudHSM> .\cloudhsm_mgmt_util.exe C:\ProgramData\Amazon\CloudHSM\data\cloudhsm_mgmt_util.cfg

3. Log in to the HSM as a CO user.

    aws-cloudhsm> loginHSM CO admin co12345

    Make sure the number of connections CMU lists match the number of HSMs in the cluster. If not, log out and start over.

4. Use `createUser` to create a CU user named `example_user` with a password of `password1`.

    aws-cloudhsm> createUser CU example_user password1

    CMU prompts you about the create user operation.
This is a CRITICAL operation, should be done on all nodes in the cluster. AWS does NOT synchronize these changes automatically with the nodes on which this operation is not executed or failed, please ensure this operation is executed on all nodes in the cluster.

Do you want to continue (y/n)?

5. Type y.

For more information about `createUser`, see `createUser (p. 265)`.

To list all HSM users on the cluster

Use `listUsers` command to list all the users on the cluster. You do not have to log in to run `listUsers` and all user types can list users.

To list all users on the cluster

1. Use the configure tool to update the CMU configuration.

   Linux

   ```bash
   $ sudo /opt/cloudhsm/bin/configure --cmu <IP address>
   ```

   Windows

   ```bash
   C:\Program Files\Amazon\CloudHSM\bin\ configure.exe --cmu <IP address>
   ```

2. Start CMU.

   Linux

   ```bash
   $ /opt/cloudhsm/bin/cloudhsm_mgmt_util /opt/cloudhsm/etc/cloudhsm_mgmt_util.cfg
   ```

   Windows

   ```bash
   C:\Program Files\Amazon\CloudHSM> .\cloudhsm_mgmt_util.exe C:\ProgramData\Amazon \CloudHSM\data\cloudhsm_mgmt_util.cfg
   ```

3. Use `listUsers` to list all the users on the cluster.

   ```bash
   aws-cloudhsm> listUsers
   ```

   CMU lists all the users on the cluster.

---

<table>
<thead>
<tr>
<th>User Id</th>
<th>User Type</th>
<th>User Name</th>
<th>MofnPubKey</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2FA</td>
<td>app_user</td>
<td>NO</td>
</tr>
<tr>
<td></td>
<td>AU</td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td>Number of users found: 4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Users on server 0(10.0.2.9):
Users on server 1(10.0.3.11):
Number of users found:4

<table>
<thead>
<tr>
<th>User Id</th>
<th>User Type</th>
<th>User Name</th>
<th>LoginFailureCnt</th>
<th>MofnPubKey</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>CO</td>
<td>example_officer</td>
<td>0</td>
<td>NO</td>
</tr>
<tr>
<td>3</td>
<td>CU</td>
<td>example_user</td>
<td>0</td>
<td>NO</td>
</tr>
</tbody>
</table>

Users on server 2(10.0.1.12):
Number of users found:4

<table>
<thead>
<tr>
<th>User Id</th>
<th>User Type</th>
<th>User Name</th>
<th>LoginFailureCnt</th>
<th>MofnPubKey</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AU</td>
<td>app_user</td>
<td>0</td>
<td>NO</td>
</tr>
<tr>
<td>2</td>
<td>CO</td>
<td>example_officer</td>
<td>0</td>
<td>NO</td>
</tr>
<tr>
<td>3</td>
<td>CU</td>
<td>example_user</td>
<td>0</td>
<td>NO</td>
</tr>
</tbody>
</table>

For more information about `listUsers`, see [listUsers](p. 284).

**To change HSM user passwords**

Use `changePswd` to change a password.

User types and passwords are case sensitive, but user names are not case sensitive.

CO, Crypto user (CU), and appliance user (AU) can change their own password. To change the password of another user, you must log in as a CO. You cannot change the password of a user who is currently logged in.

**To change your own password**

1. Use the configure tool to update the CMU configuration.

   **Linux**

   ```bash
   $ sudo /opt/cloudhsm/bin/configure --cmu <IP address>
   ```

   **Windows**

   ```
   C:\Program Files\Amazon\CloudHSM\bin\ configure.exe --cmu <IP address>
   ```

2. Start CMU.

   **Linux**

   ```
   $ /opt/cloudhsm/bin/cloudhsm_mgmt_util /opt/cloudhsm/etc/cloudhsm_mgmt_util.cfg
   ```
3. Log in to the HSM.

```bash
aws-cloudhsm> loginHSM CO admin col2345
```

Make sure the number of connections CMU lists match the number of HSMs in the cluster. If not, log out and start over.

4. Use `changePswd` to change your own password.

```bash
aws-cloudhsm> changePswd CO example_officer <new password>
```

CMU prompts you about the change password operation.

```
*************************CAUTION********************************
This is a CRITICAL operation, should be done on all nodes in the cluster. AWS does NOT synchronize these changes automatically with the nodes on which this operation is not executed or failed, please ensure this operation is executed on all nodes in the cluster.
****************************************************************
Do you want to continue(y/n)?
```

5. Type `y`.

CMU prompts you about the change password operation.

```
Changing password for example_officer(CO) on 3 nodes
```

**To change the password of another user**

1. Use the configure tool to update the CMU configuration.

   **Linux**
   ```bash
   $ sudo /opt/cloudhsm/bin/configure --cmu <IP address>
   ```

   **Windows**
   ```python
   C:\Program Files\Amazon\CloudHSM\bin\ configure.exe --cmu <IP address>
   ```

2. Start CMU.

   **Linux**
   ```bash
   $ /opt/cloudhsm/bin/cloudhsm_mgmt_util /opt/cloudhsm/etc/cloudhsm_mgmt_util.cfg
   ```
3. Log in to the HSM as a CO user.

```
aws-cloudhsm> loginHSM CO admin co12345
```

Make sure the number of connections CMU lists match the number of HSMs in the cluster. If not, log out and start over.

4. Use `changePswd` to change the password of another user.

```
aws-cloudhsm> changePswd CU example_user <new password>
```

CMU prompts you about the change password operation.

```
*******************************************************************************
This is a CRITICAL operation, should be done on all nodes in the cluster. AWS does NOT synchronize these changes automatically with the nodes on which this operation is not executed or failed, please ensure this operation is executed on all nodes in the cluster.
*******************************************************************************
```

Do you want to continue(y/n)?

5. Type `y`.

CMU prompts you about the change password operation.

```
Changing password for example_user(CU) on 3 nodes
```

For more information about `changePswd`, see `changePswd` (p. 261).

To delete HSM users

Use `deleteUser` to delete a user. You must log in as a CO to delete another user.

**Tip**

You can't delete crypto users (CU) that own keys.

To delete a user

1. Use the configure tool to update the CMU configuration.

   **Linux**

   ```
   $ sudo /opt/cloudhsm/bin/configure --cmu <IP address>
   ```

   **Windows**

   ```
   C:\Program Files\Amazon\CloudHSM\bin\ configure.exe --cmu <IP address>
   ```
2. Start CMU.

   Linux

   $ /opt/cloudhsm/bin/cloudhsm_mgmt_util /opt/cloudhsm/etc/cloudhsm_mgmt_util.cfg

   Windows

   C:\Program Files\Amazon\CloudHSM> .\cloudhsm_mgmt_util.exe C:\ProgramData\Amazon\CloudHSM\data\cloudhsm_mgmt_util.cfg

3. Log in to the HSM as a CO user.

   aws-cloudhsm> loginHSM CO admin co12345

   Make sure the number of connections CMU lists match the number of HSMs in the cluster. If not, log out and start over.

4. Use **deleteUser** to delete a user.

   aws-cloudhsm> deleteUser CO example_officer

   CMU deletes the user.

   Deleting user example_officer(CO) on 3 nodes
   deleteUser success on server 0(10.0.2.9)
   deleteUser success on server 1(10.0.3.11)
   deleteUser success on server 2(10.0.1.12)

For more information about **deleteUser**, see *deleteUser* (p. 268).

**Using CloudHSM Management Utility (CMU) to manage two-factor authentication (2FA) for crypto officers**

For increased security, you can configure two-factor authentication (2FA) to help protect the cluster. You can only enable 2FA for crypto officers (CO).

**Note**

You cannot enable 2FA for crypto users (CU) or applications. Two-factor authentication (2FA) is only for CO users.

**Topics**

- **Understanding 2FA for HSM users** (p. 104)
- **Working with 2FA for HSM users** (p. 105)

**Understanding 2FA for HSM users**

When you log in to a cluster with a 2FA-enabled hardware service module (HSM) account, you provide cloudhsm_mgmt_util (CMU) with your password—the first factor, what you know—and CMU provides you with a token and prompts you to have the token signed. To provide the second factor—what you have—you sign the token with a private key from a key pair you've already created and associated with the HSM user. To access the cluster, you provide the signed token to CMU.
Quorum authentication and 2FA

The cluster uses the same key for quorum authentication and for 2FA. This means a user with 2FA enabled is effectively registered for M-of-N-access-control (MofN). To successfully use 2FA and quorum authentication for the same HSM user, consider the following points:

- If you are using quorum authentication for a user today, you should use the same key pair you created for the quorum user to enable 2FA for the user.
- If you add the 2FA requirement for a non-2FA user that is not a quorum authentication user, then you register that user as an MofN user with 2FA authentication.
- If you remove the 2FA requirement or change the password for a 2FA user that is also a quorum authentication user, you will also remove the registration of the quorum user as an MofN user.
- If you remove the 2FA requirement or change the password for a 2FA user that is also a quorum authentication user, but you still want that user to participate in quorum authentication, then you must register that user again as an MofN user.

For more information about quorum authentication, see Using CMU to manage quorum authentication (p. 110).

Working with 2FA for HSM users

This section describes how to work with 2FA for HSM users, including creating 2FA HSM users, rotating keys, and logging in to the HSM as 2FA-enabled users. For more information about working with HSM users, see ??? (p. 60), ??? (p. 95), ??? (p. 265), ??? (p. 286), and ??? (p. 261).

Creating 2FA users

To enable 2FA for an HSM user, use a key that meets the following requirements.

2FA key pair requirements

You can create a new key pair or use an existing key that meets the following requirements.

- Key type: Asymmetric
- Key usage: Sign and Verify
- Key spec: RSA_2048
- Signing algorithm includes:
  - sha256WithRSAEncryption

Note
If you are using quorum authentication or plan to use quorum authentication, see the section called “Quorum authentication and 2FA” (p. 105).

Use CMU and the key pair to create a new CO user with 2FA enabled.

To create CO users with 2FA enabled

1. In one terminal, perform the following steps:
   a. Access your HSM and log in to the CloudHSM Management utility:

   ```bash
   /opt/cloudhsm/bin/cloudhsm_mgmt_util /opt/cloudhsm/etc/cloudhsm_mgmt_util.cfg
   ```
   
   b. Log in as a CO and use the following command to create a new user MFA with 2FA:

   ```bash
   aws-cloudhsm>createUser CO MFA <CO USER NAME> -2fa /home/ec2-user/authdata
   ```
This is a CRITICAL operation, should be done on all nodes in the cluster. AWS does NOT synchronize these changes automatically with the nodes on which this operation is not executed or failed, please ensure this operation is executed on all nodes in the cluster.

Do you want to continue (y/n)?

Creating User exampleuser3(C0) on 1 nodes

Authentication data written to: "/home/ec2-user/authdata"

Generate Base64-encoded signatures for SHA256 digests in the authentication datafile.

To generate the signatures, use the RSA private key, which is the second factor of authentication for this user. Paste the signatures and the corresponding public key into the authentication data file and provide the file path below. Leave this field blank to use the path initially provided. Enter filename:

c. Leave the above terminal in this state. Do not press enter or enter any filename.

2. In another terminal, perform the following steps:

a. Access your HSM and log in to the CloudHSM Management utility:

   `/opt/cloudhsm/bin/cloudhsm_mgmt_util /opt/cloudhsm/etc/cloudhsm_mgmt_util.cfg`

b. Generate a public-private key-pair using the following commands:

   `openssl genpkey -algorithm RSA -out private_key.pem -pkeyopt rsa_keygen_bits:2048`
   
   `openssl rsa -pubout -in private_key.pem -out public_key.pem`

c. Run the following command to install a json querying feature for extracting the Digest from authdata file:

   `sudo yum install jq`

d. To extract the digest value, first find the following data in the authdata file:

   ```json
   {
   "Version": "1.0",
   "PublicKey": "",
   "Data": [
   {
   "HsmId": "<HSM ID>",
   "Digest": "<DIGEST>",
   "Signature": ""
   }
   ]
   }
   ```

   **Note**

   The obtained Digest is base64 encoded, however to sign the digest, you need the file to be decoded first and then signed. The following command will decode the digest and store the decoded content in ‘digest1.bin’

   ```bash
   cat authdata | jq '.Data[0].Digest' | cut -c2- | rev | cut -c2- | rev | base64 -d > digest1.bin
   ```

e. Convert the public key content, adding "\n" and removing spaces as shown here:
Important
The above command shows how "\n" is added immediately after BEGIN PUBLIC KEY------, spaces between \n and the first character of the public key are removed, \n is added before -----END PUBLIC KEY, and spaces are removed between "\n" and the end of the public key.

This is the PEM format for public key which is accepted in the authdata file.

f. Paste the public key pem format content in the public key section in the authdata file.

vi authdata

{
   "Version": "1.0",
   "PublicKey": "-----BEGIN PUBLIC KEY------\n<PUBLIC KEY>\n-----END PUBLIC KEY------",
   "Data": [
   {
      "HsmId": "<HSM ID>",
      "Digest": "<DIGEST>",
      "Signature": ""
   }
   ]
}

g. Sign the token file using the following command:

openssl pkeyutl -sign -in digest1.bin -inkey private_key.pem -pkeyopt digest:sha256 | base64

Output Expected:
'<"THE SIGNATURE"'>

Note
As shown in the above command, use openssl pkeyutl instead of openssl dgst for signing.

h. Add the signed digest in the Authdata File in "Signature" field.

vi authdata

{
   "Version": "1.0",
   "PublicKey": "-----BEGIN PUBLIC KEY------ ... -----END PUBLIC KEY------",
   "Data": [
   {
      "HsmId": "<HSM ID>",
      "Digest": "<DIGEST>",
      "Signature": "Kkd1 ... rkrvJ6Q=="
   },
   {
      "HsmId": "<HSM ID>",
      "Digest": "<DIGEST>",
      "Signature": "K1hxy ... Q261Q=="
   }
   ]
}
3. Go back to the first terminal and press **Enter**:  

   Generate Base64-encoded signatures for SHA256 digests in the authentication datafile. To generate the signatures, use the RSA private key, which is the second factor of authentication for this user. Paste the signatures and the corresponding public key into the authentication data file and provide the file path below. Leave this field blank to use the path initially provided. Enter filename: >>>> Press Enter here  

   createUser success on server 0(10.0.1.11)

### Managing 2FA for HSM users

Use change password to change the password for a 2FA user, or to enable or disable 2FA, or to rotate the 2FA key. Each time you enable 2FA, you must provide a public key for 2FA logins.

Change password performs any of the following scenarios:

- Change the password for a 2FA user
- Change the password for a non-2FA user
- Add 2FA to a non-2FA user
- Remove 2FA from a 2FA user
- Rotate the key for a 2FA user

You can also combine tasks. For example, you can remove 2FA from a user and change the password at the same time, or you might rotate the 2FA key and change the user password.

### To change passwords or rotate keys for CO users with 2FA enabled

1. Use CMU to log in to the HSM as a CO with 2FA enabled.
2. Use **changePswd** to change the password or rotate the key from CO users with 2FA enabled. Use the `-2fa` parameter and include a location in the file system for the system to write the authdata file. This file includes a digest for each HSM in the cluster.

   ```
   aws-cloudhsm> changePswd CO example-user <new-password> -2fa /path/to/authdata
   ```

   CMU prompts you to use the private key to sign the digests in the authdata file and return the signatures with the public key.

3. Use the private key to sign the digests in the authdata file, add the signatures and the public key to the JSON formatted authdata file and then provide CMU with the location of the authdata file. For more information, see the section called “Configuration reference” (p. 109).

   **Note**
   The cluster uses the same key for quorum authentication and 2FA. If you are using quorum authentication or plan to use quorum authentication, see the section called “Quorum authentication and 2FA” (p. 105).

### To disable 2FA for CO users with 2FA enabled

1. Use CMU to log in to the HSM as a CO with 2FA enabled.
2. Use **changePswd** to remove 2FA from CO users with 2FA enabled.
aws-cloudhsm> `changePswd CO example-user <new password>`

CMU prompts you to confirm the change password operation.

**Note**
If you remove the 2FA requirement or change the password for a 2FA user that is also a quorum authentication user, you will also remove the registration of the quorum user as an MofN user. For more information about quorum users and 2FA, see the section called "Quorum authentication and 2FA" (p. 105).

3. Type `y`.

CMU confirms the change password operation.

**Configuration reference**

The following is an example of the 2FA properties in the authdata file for both the CMU-generated request and your responses.

```json
{
  "Version": "1.0",
  "PublicKey": "-----BEGIN PUBLIC KEY----- ... -----END PUBLIC KEY-----",
  "Data": [
    {
      "HsmId": "hsm-lgavqitns2a",
      "Digest": "k5D1p3f6foQRVQH7S8Rjcau6h3TYqsSdr16A54+qG8=",
      "Signature": "Kkdl ... rkrvJ6Q=="
    },
    {
      "HsmId": "hsm-lgavqitns2a",
      "Digest": "IyBcx4I5Vy1jztwvXinCBQd9lDx80qe7iRrWjBAi1w=",
      "Signature": "K1hxy ... Q261Q=="
    }
  ]
}
```

**Data**

Top-level node. Contains a subordinate node for each HSM in the cluster. Appears in requests and responses for all 2FA commands.

**Digest**

This is what you must sign to provide the second factor of authentication. CMU generated in requests for all 2FA commands.

**HsmId**

The ID of your HSM. Appears in requests and responses for all 2FA commands.

**PublicKey**

The public key portion of the key pair you generated inserted as PEM-formatted string. You enter this in responses for `createUser` and `changePswd`.

**Signature**

The Base 64 encoded signed digest. You enter this in responses for all 2FA commands.

**Version**

The version of the authentication data JSON formatted file. Appears in requests and responses for all 2FA commands.
Using CloudHSM Management Utility (CMU) to manage quorum authentication (M of N access control)

The HSMs in your AWS CloudHSM cluster support quorum authentication, which is also known as M of N access control. With quorum authentication, no single user on the HSM can do quorum-controlled operations on the HSM. Instead, a minimum number of HSM users (at least 2) must cooperate to do these operations. With quorum authentication, you can add an extra layer of protection by requiring approvals from more than one HSM user.

Quorum authentication can control the following operations:

- HSM user management by crypto officers (COs) (p. 94) – Creating and deleting HSM users, and changing a different HSM user’s password. For more information, see Using quorum authentication for crypto officers (p. 116).

The following topics provide more information about quorum authentication in AWS CloudHSM.

Topics

- Overview of quorum authentication (p. 110)
- Additional details about quorum authentication (p. 110)
- Using quorum authentication for crypto officers: first time setup (p. 111)
- Using quorum authentication for crypto officers (p. 116)
- Change the quorum minimum value for crypto officers (p. 121)

Overview of quorum authentication

The following steps summarize the quorum authentication processes. For the specific steps and tools, see Using quorum authentication for crypto officers (p. 116).

1. Each HSM user creates an asymmetric key for signing. They do this outside of the HSM, taking care to protect the key appropriately.
2. Each HSM user logs in to the HSM and registers the public part of their signing key (the public key) with the HSM.
3. When an HSM user wants to do a quorum-controlled operation, each user logs in to the HSM and gets a quorum token.
4. The HSM user gives the quorum token to one or more other HSM users and asks for their approval.
5. The other HSM users approve by using their keys to cryptographically sign the quorum token. This occurs outside the HSM.
6. When the HSM user has the required number of approvals, the same user logs in to the HSM and gives the quorum token and approvals (signatures) to the HSM.
7. The HSM uses the registered public keys of each signer to verify the signatures. If the signatures are valid, the HSM approves the token.
8. The HSM user can now do a quorum-controlled operation.

Additional details about quorum authentication

Note the following additional information about using quorum authentication in AWS CloudHSM.

- An HSM user can sign their own quorum token—that is, the requesting user can provide one of the required approvals for quorum authentication.
- You choose the minimum number of quorum approvers for quorum-controlled operations. The smallest number you can choose is two (2), and the largest number you can choose is eight (8).
• The HSM can store up to 1024 quorum tokens. If the HSM already has 1024 tokens when you try to create a new one, the HSM purges one of the expired tokens. By default, tokens expire ten minutes after their creation.

• The cluster uses the same key for quorum authentication and for two-factor authentication (2FA). For more information about using quorum authentication and 2FA, see Quorum Authentication and 2FA (p. 105).

Using quorum authentication for crypto officers: first time setup

The following topics describe the steps that you must complete to configure your hardware security module (HSM) so that crypto officers (COs) (p. 94) can use quorum authentication. You need to do these steps only once when you first configure quorum authentication for COs. After you complete these steps, see Using quorum authentication for crypto officers (p. 116).

Topics

• Prerequisites (p. 111)
• Create and register a key for signing (p. 112)
• Set the quorum minimum value on the HSM (p. 114)

Prerequisites

To understand this example, you should be familiar with the cloudhsm_mgmt_util (CMU) command line tool (p. 252). In this example, the AWS CloudHSM cluster has two HSMs, each with the same COs, as shown in the following output from the listUsers command. For more information about creating users, see Managing HSM users (p. 60).

aws-cloudhsm> listUsers
Users on server 0(10.0.2.14):
Number of users found:7
User Id User Type User Name MofnPubKey
LoginFailureCnt 2FA
1 PRECO admin NO
0
2 AU app_user NO
0
3 CO officer1 NO
0
4 CO officer2 NO
0
5 CO officer3 NO
0
6 CO officer4 NO
0
7 CO officer5 NO
0

Users on server 1(10.0.1.4):
Number of users found:7
User Id User Type User Name MofnPubKey
LoginFailureCnt 2FA
1 PRECO admin NO
0
2 AU app_user NO
0
3 CO officer1 NO
0
4 CO officer2 NO
0

Create and register a key for signing

To use quorum authentication, each CO must do all of the following steps:

**Topics**

- **Create an RSA key pair (p. 112)**
- **Create and sign a registration token (p. 112)**
- **Register the public key with the HSM (p. 113)**

**Create an RSA key pair**

There are many different ways to create and protect a key pair. The following examples show how to do it with **OpenSSL**.

**Example – Create a private key with OpenSSL**

The following example demonstrates how to use OpenSSL to create a 2048-bit RSA key that is protected by a pass phrase. To use this example, replace `officer1.key` with the name of the file where you want to store the key.

```bash
$ openssl genrsa -out officer1.key -aes256 2048
Generating RSA private key, 2048 bit long modulus
.....................................+++
+++
e is 65537 (0x10001)
Enter pass phrase for officer1.key:
Verifying - Enter pass phrase for officer1.key:
```

Next, generate the public key using the private key that you just created.

**Example – Create a public key with OpenSSL**

The following example demonstrates how to use OpenSSL to create a public key from the private key you just created.

```bash
$ openssl rsa -in officer1.key -outform PEM -pubout -out officer1.pub
Enter pass phrase for officer1.key:
writing RSA key
```

**Create and sign a registration token**

You create a token and sign it with the private key you just generated in the previous step.

**Example – Create a token**

The registration token is just a file with any random data that doesn’t exceed the maximum size of 245 bytes. You sign the token with the private key to demonstrate that you have access to the private key. The following command uses echo to redirect a string to a file.
Sign the token and save it to a signature file. You will need the signed token, the unsigned token, and the public key to register the CO as an MofN user with the HSM.

**Example – Sign the token**

Use OpenSSL and the private key to sign the registration token and create the signature file.

```
$ openssl dgst -sha256 -sign officer1.key -out officer1.token.sig officer1.token
```

**Register the public key with the HSM**

After creating a key, the CO must register the public part of the key (the public key) with the HSM.

**To register a public key with the HSM**

1. Use the following command to start the cloudhsm_mgmt_util command line tool.

   ```
   $ /opt/cloudhsm/bin/cloudhsm_mgmt_util /opt/cloudhsm/etc/cloudhsm_mgmt_util.cfg
   ```

2. Use the `loginHSM` command to log in to the HSM as a CO. For more information, see ??? (p. 93).

3. Use the `registerQuorumPubKey` (p. 288) command to register the public key. For more information, see the following example or use the `help registerQuorumPubKey` command.

**Example – Register a public key with the HSM**

The following example shows how to use the `registerQuorumPubKey` command in the cloudhsm_mgmt_util command line tool to register a CO's public key with the HSM. To use this command, the CO must be logged in to the HSM. Replace these values with your own:

```
aws-cloudhsm> registerQuorumPubKey CO <officer1> <officer1.token> <officer1.token.sig> <officer1.pub>

***************************CAUTION********************************
This is a CRITICAL operation, should be done on all nodes in the cluster. AWS does NOT synchronize these changes automatically with the nodes on which this operation is not executed or failed, please ensure this operation is executed on all nodes in the cluster.
******************************************************************************

Do you want to continue(y/n)?y

registerQuorumPubKey success on server 0(10.0.2.14)
```

**<officer1.token>**

The path to a file that contains an unsigned registration token. Can have any random data of max file size of 245 bytes.

Required: Yes

**<officer1.token.sig>**

The path to a file that contains the SHA256_PKCS mechanism signed hash of the registration token.

Required: Yes
The path to the file that contains the public key of an asymmetric RSA-2048 key pair. Use the private key to sign the registration token.

Required: Yes

After all COs register their public keys, the output from the `listUsers` command shows this in the `MofnPubKey` column, as shown in the following example.

```
aws-cloudhsm> listUsers
Users on server 0(10.0.2.14):
Number of users found:7

+------------+-----------+----------------+----------------+
<table>
<thead>
<tr>
<th>User Id</th>
<th>User Type</th>
<th>User Name</th>
<th>MofnPubKey</th>
</tr>
</thead>
<tbody>
<tr>
<td>LoginFailureCnt</td>
<td>2FA</td>
<td>2FA</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>PRECO</td>
<td>admin</td>
<td>N0</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>AU</td>
<td>app_user</td>
<td>N0</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CO</td>
<td>officer1</td>
<td>Y3</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>CO</td>
<td>officer2</td>
<td>Y3</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>CO</td>
<td>officer3</td>
<td>Y3</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>CO</td>
<td>officer4</td>
<td>Y3</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>CO</td>
<td>officer5</td>
<td>Y3</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Users on server 1(10.0.1.4):
Number of users found:7

+------------+-----------+----------------+----------------+
<table>
<thead>
<tr>
<th>User Id</th>
<th>User Type</th>
<th>User Name</th>
<th>MofnPubKey</th>
</tr>
</thead>
<tbody>
<tr>
<td>LoginFailureCnt</td>
<td>2FA</td>
<td>2FA</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>PRECO</td>
<td>admin</td>
<td>N0</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>AU</td>
<td>app_user</td>
<td>N0</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CO</td>
<td>officer1</td>
<td>Y3</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>CO</td>
<td>officer2</td>
<td>Y3</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>CO</td>
<td>officer3</td>
<td>Y3</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>CO</td>
<td>officer4</td>
<td>Y3</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>CO</td>
<td>officer5</td>
<td>Y3</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

**Set the quorum minimum value on the HSM**

To use quorum authentication for COs, a CO must log in to the HSM and then set the *quorum minimum value*, also known as the *m value*. This is the minimum number of CO approvals that are required to perform HSM user management operations. Any CO on the HSM can set the quorum minimum value, including COs that have not registered a key for signing. You can change the quorum minimum value at any time; for more information, see Change the minimum value (p. 121).

**To set the quorum minimum value on the HSM**

1. Use the following command to start the cloudhsm_mgmt_util command line tool.
2. Use the `loginHSM` command to log in to the HSM as a CO. For more information, see ???(p. 93).
3. Use the `setMValue` command to set the quorum minimum value. For more information, see the following example or use the `help setMValue` command.

Example – Set the quorum minimum value on the HSM

This example uses a quorum minimum value of two. You can choose any value from two (2) to eight (8), up to the total number of COs on the HSM. In this example, the HSM has six COs, so the maximum possible value is six.

To use the following example command, replace the final number (2) with the preferred quorum minimum value.

```
aws-cloudhsm> setMValue 3 2
*******************************************************************************
This is a CRITICAL operation, should be done on all nodes in the cluster. AWS does NOT synchronize these changes automatically with the nodes on which this operation is not executed or failed, please ensure this operation is executed on all nodes in the cluster.
*******************************************************************************
Do you want to continue(y/n)?y
Setting M Value(2) for 3 on 2 nodes
```

In the preceding example, the first number (3) identifies the HSM service whose quorum minimum value you are setting.

The following table lists the HSM service identifiers along with their names, descriptions, and the commands that are included in the service.

<table>
<thead>
<tr>
<th>Service Identifier</th>
<th>Service Name</th>
<th>Service Description</th>
<th>HSM Commands</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>USER_MGMT</td>
<td>HSM user management</td>
<td>• <code>createUser</code></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• <code>deleteUser</code></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• <code>changePswd</code> (applies only when changing the password of a different HSM user)</td>
</tr>
<tr>
<td>4</td>
<td>MISC_CO</td>
<td>Miscellaneous CO service</td>
<td>• <code>setMValue</code></td>
</tr>
</tbody>
</table>

To get the quorum minimum value for a service, use the `getMValue` command, as in the following example.

```
aws-cloudhsm> getMValue 3
MValue of service 3[USER_MGMT] on server 0 : [2]
MValue of service 3[USER_MGMT] on server 1 : [2]
```

The output from the preceding `getMValue` command shows that the quorum minimum value for HSM user management operations (service 3) is now two.
After you complete these steps, see Using quorum authentication for crypto officers (p. 116).

Using quorum authentication for crypto officers

A crypto officer (CO) on the HSM can configure quorum authentication for the following operations on the HSM:

- Creating HSM users
- Deleting HSM users
- Changing another HSM user's password

After the HSM is configured for quorum authentication, COs cannot perform HSM user management operations on their own. The following example shows the output when a CO attempts to create a new user on the HSM. The command fails with a RET_MXN_AUTH_FAILED error, which indicates that quorum authentication failed.

```
aws-cloudhsm> createUser CU user1 password
*************************CAUTION********************************
This is a CRITICAL operation, should be done on all nodes in the cluster. AWS does NOT synchronize these changes automatically with the nodes on which this operation is not executed or failed, please ensure this operation is executed on all nodes in the cluster.
****************************************************************
Do you want to continue(y/n)?y
Creating User user1(CU) on 2 nodes
createUser failed: RET_MXN_AUTH_FAILED
creating user on server 0(10.0.2.14) failed
Retry/Ignore/Abort?(R/I/A):A
```

To perform an HSM user management operation, a CO must complete the following tasks:

1. **Get a quorum token** (p. 116).
2. **Get approvals (signatures) from other COs** (p. 117).
3. **Approve the token on the HSM** (p. 118).
4. **Perform the HSM user management operation** (p. 119).

If you have not yet configured the HSM for quorum authentication for COs, do that now. For more information, see **First time setup** (p. 111).

Get a quorum token

First the CO must use the cloudhsm_mgmt_util command line tool to request a quorum token.

To get a quorum token

1. Use the following command to start the cloudhsm_mgmt_util command line tool.
   ```
   $ /opt/cloudhsm/bin/cloudhsm_mgmt_util /opt/cloudhsm/etc/cloudhsm_mgmt_util.cfg
   ```
2. Use the loginHSM command to log in to the HSM as a CO. For more information, see **???** (p. 93).
3. Use the getToken command to get a quorum token. For more information, see the following example or use the help getToken command.
Example – Get a quorum token

This example gets a quorum token for the CO with user name officer1 and saves the token to a file named officer1.token. To use the example command, replace these values with your own:

- **officer1** – The name of the CO who is getting the token. This must be the same CO who is logged in to the HSM and is running this command.
- **officer1.token** – The name of the file to use for storing the quorum token.

In the following command, 3 identifies the service for which you can use the token that you are getting. In this case, the token is for HSM user management operations (service 3). For more information, see Set the quorum minimum value on the HSM (p. 114).

```bash
aws-cloudhsm> getToken 3 officer1 officer1.token
getToken success on server 0(10.0.2.14)
Token:
  Id:1
  Service:3
  Node:0
  Key Handle:0
  User:officer1
getToken success on server 1(10.0.1.4)
Token:
  Id:1
  Service:3
  Node:0
  Key Handle:0
  User:officer1
```

Get signatures from approving COs

A CO who has a quorum token must get the token approved by other COs. To give their approval, the other COs use their signing key to cryptographically sign the token. They do this outside the HSM.

There are many different ways to sign the token. The following example shows how to do it with OpenSSL. To use a different signing tool, make sure that the tool uses the CO's private key (signing key) to sign a SHA-256 digest of the token.

**Example – Get signatures from approving COs**

In this example, the CO that has the token (officer1) needs at least two approvals. The following example commands show how two COs can use OpenSSL to cryptographically sign the token.

In the first command, officer1 signs his or her own token. To use the following example commands, replace these values with your own:

- **officer1.key** and **officer2.key** – The name of the file that contains the CO's signing key.
- **officer1.token.sig1** and **officer1.token.sig2** – The name of the file to use for storing the signature. Make sure to save each signature in a different file.
- **officer1.token** – The name of the file that contains the token that the CO is signing.

```bash
$ openssl dgst -sha256 -sign officer1.key -out officer1.token.sig1 officer1.token
Enter pass phrase for officer1.key:

$ openssl dgst -sha256 -sign officer2.key -out officer1.token.sig2 officer1.token
```

In the following command, officer2 signs the same token.

```bash
$ openssl dgst -sha256 -sign officer2.key -out officer1.token.sig2 officer1.token
```
Enter pass phrase for officer2.key:

**Approve the signed token on the HSM**

After a CO gets the minimum number of approvals (signatures) from other COs, he or she must approve the signed token on the HSM.

**To approve the signed token on the HSM**

1. Create a token approval file. For more information, see the following example.
2. Use the following command to start the cloudhsm_mgmt_util command line tool.
   ```bash
   $ /opt/cloudhsm/bin/cloudhsm_mgmt_util /opt/cloudhsm/etc/cloudhsm_mgmt_util.cfg
   ```
3. Use the `loginHSM` command to log in to the HSM as a CO. For more information, see ??? (p. 93).
4. Use the `approveToken` command to approve the signed token, passing the token approval file. For more information, see the following example.

**Example – Create a token approval file and approve the signed token on the HSM**

The token approval file is a text file in a particular format that the HSM requires. The file contains information about the token, its approvers, and the approvers' signatures. The following shows an example token approval file.

```plaintext
# For "Multi Token File Path", type the path to the file that contains
# the token. You can type the same value for "Token File Path", but
# that's not required. The "Token File Path" line is required in any
# case, regardless of whether you type a value.
Multi Token File Path = officer1.token;
Token File Path = ;

# Total number of approvals
Number of Approvals = 2;

# Approver 1
# Type the approver's type, name, and the path to the file that
# contains the approver's signature.
Approver Type = 2; # 2 for CO, 1 for CU
Approver Name = officer1;
Approval File = officer1.token.sig1;

# Approver 2
# Type the approver's type, name, and the path to the file that
# contains the approver's signature.
Approver Type = 2; # 2 for CO, 1 for CU
Approver Name = officer2;
Approval File = officer1.token.sig2;
```

After creating the token approval file, the CO uses the cloudhsm_mgmt_util command line tool to log in to the HSM. The CO then uses the `approveToken` command to approve the token, as shown in the following example. Replace `approval.txt` with the name of the token approval file.

```
aws-cloudhsm>approveToken approval.txt
approveToken success on server 0(10.0.2.14)
approveToken success on server 1(10.0.1.4)
```

When this command succeeds, the HSM has approved the quorum token. To check the status of a token, use the `listTokens` command, as shown in the following example. The command's output shows that the token has the required number of approvals.

```
aws-cloudhsm>listTokens
```

118
The token validity time indicates how long the token is guaranteed to persist on the HSM. Even after the token validity time elapses (zero seconds), you can still use the token.

```
aws-cloudhsm> listTokens

Server 0(10.0.2.14)
-------- Token - 0 ----------
Token:
Id:1
Service:3
Node:1
Key Handle:0
User:officer1
Token Validity: 506 sec
Required num of approvers : 2
Current num of approvals : 2
Approver-0: officer1
Approver-1: officer2
Num of tokens = 1

Server 1(10.0.1.4)
-------- Token - 0 ----------
Token:
Id:1
Service:3
Node:0
Key Handle:0
User:officer1
Token Validity: 506 sec
Required num of approvers : 2
Current num of approvals : 2
Approver-0: officer1
Approver-1: officer2
Num of tokens = 1

listTokens success
```

**Use the token for user management operations**

After a CO has a token with the required number of approvals, as shown in the previous section, the CO can perform one of the following HSM user management operations:

- Create an HSM user with the `createUser` command
- Delete an HSM user with the `deleteUser` command
- Change a different HSM user's password with the `changePswd` command

For more information about using these commands, see **Managing HSM users**.

The CO can use the token for only one operation. When that operation succeeds, the token is no longer valid. To do another HSM user management operation, the CO must get a new quorum token, get new signatures from approvers, and approve the new token on the HSM.

**Note**

The MofN token is only valid as long as your current login session is open. If you log out of `cloudhsm_mgmt_util` or the network connection disconnects, the token is no longer valid. Similarly, an authorized token can only be used within `cloudhsm_mgmt_util`, it cannot be used to authenticate in a different application.
In the following example command, the CO creates a new user on the HSM.

```
aws-cloudhsm> createUser CU user1 password

CAUTION
This is a CRITICAL operation, should be done on all nodes in the
cluster. AWS does NOT synchronize these changes automatically with the
nodes on which this operation is not executed or failed, please
ensure this operation is executed on all nodes in the cluster.

Do you want to continue(y/n)? y
Creating User user1(CU) on 2 nodes
```

After the previous command succeeds, a subsequent `listUsers` command shows the new user.

```
aws-cloudhsm> listUsers
Users on server 0(10.0.2.14):
Number of users found:8

<table>
<thead>
<tr>
<th>User Id</th>
<th>User Type</th>
<th>User Name</th>
<th>MofnPubKey</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PCO</td>
<td>admin</td>
<td>NO</td>
</tr>
<tr>
<td>2</td>
<td>AU</td>
<td>app_user</td>
<td>NO</td>
</tr>
<tr>
<td>3</td>
<td>CO</td>
<td>officer1</td>
<td>YES</td>
</tr>
<tr>
<td>4</td>
<td>CO</td>
<td>officer2</td>
<td>YES</td>
</tr>
<tr>
<td>5</td>
<td>CO</td>
<td>officer3</td>
<td>YES</td>
</tr>
<tr>
<td>6</td>
<td>CO</td>
<td>officer4</td>
<td>YES</td>
</tr>
<tr>
<td>7</td>
<td>CO</td>
<td>officer5</td>
<td>YES</td>
</tr>
<tr>
<td>8</td>
<td>CU</td>
<td>user1</td>
<td>NO</td>
</tr>
</tbody>
</table>

Users on server 1(10.0.1.4):
Number of users found:8

<table>
<thead>
<tr>
<th>User Id</th>
<th>User Type</th>
<th>User Name</th>
<th>MofnPubKey</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PCO</td>
<td>admin</td>
<td>NO</td>
</tr>
<tr>
<td>2</td>
<td>AU</td>
<td>app_user</td>
<td>NO</td>
</tr>
<tr>
<td>3</td>
<td>CO</td>
<td>officer1</td>
<td>YES</td>
</tr>
<tr>
<td>4</td>
<td>CO</td>
<td>officer2</td>
<td>YES</td>
</tr>
<tr>
<td>5</td>
<td>CO</td>
<td>officer3</td>
<td>YES</td>
</tr>
<tr>
<td>6</td>
<td>CO</td>
<td>officer4</td>
<td>YES</td>
</tr>
<tr>
<td>7</td>
<td>CO</td>
<td>officer5</td>
<td>YES</td>
</tr>
<tr>
<td>8</td>
<td>CU</td>
<td>user1</td>
<td>NO</td>
</tr>
</tbody>
</table>
```

If the CO tries to perform another HSM user management operation, it fails with a quorum
authentication error, as shown in the following example.

```
aws-cloudhsm> deleteUser CU user1
```

120
Deleting user user1(CU) on 2 nodes
deleteUser failed: RET_MXN_AUTH_FAILED
deleteUser failed on server 0(10.0.2.14)

Retry/rollback/Ignore?(R/B/I): I
deleteUser failed: RET_MXN_AUTH_FAILED
deleteUser failed on server 1(10.0.1.4)

Retry/rollback/Ignore?(R/B/I): I

The listTokens command shows that the CO has no approved tokens, as shown in the following example. To perform another HSM user management operation, the CO must get a new quorum token, get new signatures from approvers, and approve the new token on the HSM.

```bash
aws-cloudhsm> listTokens

=====================  
| Server 0(10.0.2.14) |
| Num of tokens = 0 |

=====================  
| Server 1(10.0.1.4)  |
| Num of tokens = 0 |

listTokens success
```

**Change the quorum minimum value for crypto officers**

After you set the quorum minimum value (p. 114) so that crypto officers (COs) (p. 94) can use quorum authentication, you might want to change the quorum minimum value. The HSM allows you to change the quorum minimum value only when the number of approvers is the same or higher than the current quorum minimum value. For example, if the quorum minimum value is two, at least two COs must approve to change the quorum minimum value.

To get quorum approval to change the quorum minimum value, you need a quorum token for the setMValue command (service 4). To get a quorum token for the setMValue command (service 4), the quorum minimum value for service 4 must be higher than one. This means that before you can change the quorum minimum value for COs (service 3), you might need to change the quorum minimum value for service 4.

The following table lists the HSM service identifiers along with their names, descriptions, and the commands that are included in the service.

<table>
<thead>
<tr>
<th>Service Identifier</th>
<th>Service Name</th>
<th>Service Description</th>
<th>HSM Commands</th>
</tr>
</thead>
</table>
| 3                  | USER_MGMT     | HSM user management          | • createUser  
|                    |               |                              | • deleteUser  
|                    |               |                              | • changePswd (applies only when changing the password of a different HSM user) |
| 4                  | MISC_CO       | Miscellaneous CO service     | • setMValue                                      |
To change the quorum minimum value for crypto officers

1. Use the following command to start the cloudhsm_mgmt_util command line tool.

   ```
   $ /opt/cloudhsm/bin/cloudhsm_mgmt_util /opt/cloudhsm/etc/cloudhsm_mgmt_util.cfg
   ```

2. Use the `loginHSM` command to log in to the HSM as a CO. For more information, see ??? (p. 93).
3. Use the `getMValue` command to get the quorum minimum value for service 3. For more information, see the following example.
4. Use the `getMValue` command to get the quorum minimum value for service 4. For more information, see the following example.
5. If the quorum minimum value for service 4 is lower than the value for service 3, use the `setMValue` command to change the value for service 4. Change the value for service 4 to one that is the same or higher than the value for service 3. For more information, see the following example.
6. Get a quorum token (p. 116), taking care to specify service 4 as the service for which you can use the token.
7. Get approvals (signatures) from other COs (p. 117).
8. Approve the token on the HSM (p. 118).
9. Use the `setMValue` command to change quorum minimum value for service 3 (user management operations performed by COs).

Example – Get quorum minimum values and change the value for service 4

The following example command shows that the quorum minimum value for service 3 is currently two.

```
aws-cloudhsm>getMValue 3
MValue of service 3[USER_MGMT] on server 0 : [2]
MValue of service 3[USER_MGMT] on server 1 : [2]
```

The following example command shows that the quorum minimum value for service 4 is currently one.

```
aws-cloudhsm>getMValue 4
MValue of service 4[MISC_CO] on server 0 : [1]
MValue of service 4[MISC_CO] on server 1 : [1]
```

To change the quorum minimum value for service 4, use the `setMValue` command, setting a value that is the same or higher than the value for service 3. The following example sets the quorum minimum value for service 4 to two (2), the same value that is set for service 3.

```
aws-cloudhsm>setMValue 4 2
**********************************************************************
This is a CRITICAL operation, should be done on all nodes in the
cluster. AWS does NOT synchronize these changes automatically with the
nodes on which this operation is not executed or failed, please
ensure this operation is executed on all nodes in the cluster.
**********************************************************************

Do you want to continue(y/n)?y
Setting M Value(2) for 4 on 2 nodes
```

The following commands show that the quorum minimum value is now two for service 3 and service 4.

```
aws-cloudhsm>getMValue 3
MValue of service 3[USER_MGMT] on server 0 : [2]
```
Managing keys in AWS CloudHSM

In AWS CloudHSM, use any of the following to manage keys on the HSMs in your cluster:

- PKCS #11 library
- JCE provider
- CNG and KSP providers
- CloudHSM CLI

Before you can manage keys, you must log in to the HSM with the user name and password of a crypto user (CU). Only a CU can create a key. The CU who creates a key owns and manages that key.

Topics
- Key synchronization and durability settings in AWS CloudHSM (p. 123)
- AES key wrapping in AWS CloudHSM (p. 129)
- Using trusted keys in AWS CloudHSM (p. 131)
- Managing keys with CloudHSM CLI (p. 134)
- Managing keys with the KMU and CMU (p. 150)

Key synchronization and durability settings in AWS CloudHSM

This topic describes key synchronization settings in AWS CloudHSM, common issues customers face working with keys on a cluster, and strategies for making keys more durable.

Topics
- Concepts (p. 123)
- Understanding key synchronization (p. 124)
- Working with client key durability settings (p. 125)
- Synchronizing keys across cloned clusters (p. 129)

Concepts

Token keys

Persistent keys that you create during key generate, import or unwrap operations. AWS CloudHSM synchronizes token keys across a cluster.

Session keys

Ephemeral keys that exist only on one hardware security module (HSM) in the cluster. AWS CloudHSM does not synchronize session keys across a cluster.
Client-side key synchronization

A client-side process that clones token keys you create during key generate, import or unwrap operations. You can make token keys more durable by running a cluster with a minimum of two HSMs.

Server-side key synchronization

Periodically clones keys to every HSM in the cluster. Requires no management.

Client key durability settings

Settings you configure on the client that impact key durability. Works differently in Client SDK 5 and Client SDK 3.

- In Client SDK 5, use this setting to run a single HSM cluster.
- In Client SDK 3, use this setting to specify the number of HSMs required for key creation operations to succeed.

Understanding key synchronization

AWS CloudHSM uses key synchronization to clone token keys across all the HSMs in a cluster. You create token keys as persistent keys during key generation, import, or unwrap operations. To distribute these keys across the cluster, CloudHSM offers both client-side and server-side key synchronization.
The goal with key synchronization—both server side and client side—is to distribute new keys across the cluster as quickly as possible after you create them. This is important because the subsequent calls you make to use new keys can get routed to any available HSM in the cluster. If the call you make routes to a HSM without the key, then the call fails. You can mitigate these type failures by specifying that your applications retry subsequent calls made after key creation operations. The time required to synchronize can vary, depending on the workload of your cluster and other intangibles. Use CloudWatch metrics to determine the timing your application should employ in this type situation. For more information, see CloudWatch Metrics (p. 620).

The challenge with key synchronization in a cloud environment is key durability. You create keys on a single HSM and often begin using those keys immediately. If the HSM on which you create keys should fail before the keys have been cloned to another HSM in the cluster, you lose the keys and access to anything encrypted by the keys. To mitigate this risk, we offer **client-side synchronization**. Client side synchronization is a client-side process that clones the keys you create during key generate, import, or unwrap operations. Cloning keys as you create them makes keys more durable. Of course, you can't clone keys in a cluster with a single HSM. To make keys more durable, we also recommend you configure your cluster to use a minimum of two HSMs. With client-side synchronization and a cluster with two HSMs, you can meet the challenge of key durability in a cloud environment.

**Working with client key durability settings**

Key synchronization is mostly an automatic process, but you can manage client-side key durability settings. Client-side key durability settings works differently in Client SDK 5 and Client SDK 3.

- In Client SDK 5, we introduce the concept of **key availability quorums** which requires you to run clusters with a minimum of two HSMs. You can use client-side key durability settings to opt out of the two HSM requirement. For more information about quorums, see the section called “Client SDK 5 concepts” (p. 125).
- In Client SDK 3, you use client-side key durability settings to specify the number of HSMs on which key creation must succeed for the overall operation to be deemed a success.

**Client SDK 5 client key durability settings**

**Client SDK 5 concepts**

**Key Availability Quorum**

AWS CloudHSM specifies the number of HSMs in a cluster on which keys must exist before your application can use the key. Requires clusters with a minimum of two HSMs.

In Client SDK 5, key synchronization is a fully automatic process. With key availability quorum, newly created keys must exist on two HSMs in the cluster before your application can use the key. To use key availability quorum, your cluster must have a minimum of two HSMs.

If your cluster configuration doesn't meet the key durability requirements, any attempt to create or use a token key will fail with the following error message in the logs:

```
Key <key handle> does not meet the availability requirements - The key must be available on at least 2 HSMs before being used.
```

You can use client configuration settings to opt out of key availability quorum. You might want to opt out to run a cluster with a single HSM, for example.

**Managing client key durability settings**

To manage client key durability settings, you must use the configure tool for Client SDK 5.
PKCS #11 library

**To disable client key durability for Client SDK 5 on Linux**
- Use the configure tool to disable client key durability settings.

```bash
$ sudo /opt/cloudhsm/bin/configure-pkcs11 --disable-key-availability-check
```

**To disable client key durability for Client SDK 5 on Windows**
- Use the configure tool to disable client key durability settings.

```
"C:\Program Files\Amazon\CloudHSM\bin\configure-pkcs11.exe" --disable-key-availability-check
```

OpenSSL Dynamic Engine

**To disable client key durability for Client SDK 5 on Linux**
- Use the configure tool to disable client key durability settings.

```bash
$ sudo /opt/cloudhsm/bin/configure-dyn --disable-key-availability-check
```

**To disable client key durability for Client SDK 5 on Windows**
- Use the configure tool to disable client key durability settings.

```
"C:\Program Files\Amazon\CloudHSM\bin\configure-dyn.exe" --disable-key-availability-check
```

JCE provider

**To disable client key durability for Client SDK 5 on Linux**
- Use the configure tool to disable client key durability settings.

```bash
$ sudo /opt/cloudhsm/bin/configure-jce --disable-key-availability-check
```

**To disable client key durability for Client SDK 5 on Windows**
- Use the configure tool to disable client key durability settings.

```
"C:\Program Files\Amazon\CloudHSM\bin\configure-jce.exe" --disable-key-availability-check
```

CloudHSM CLI

**To disable client key durability for Client SDK 5 on Linux**
- Use the configure tool to disable client key durability settings.
$ sudo /opt/cloudhsm/bin/configure-cli --disable-key-availability-check

To disable client key durability for Client SDK 5 on Windows

- Use the configure tool to disable client key durability settings.

"C:\Program Files\Amazon\CloudHSM\bin\configure-cli.exe" --disable-key-availability-check

Client SDK 3 client key durability settings

In Client SDK 3, key synchronization is mostly an automatic process, but you can use the client key durability settings to make keys more durable. You specify the number of HSMs on which key creation must succeed for the overall operation to be deemed a success. Client-side synchronization always makes a best-effort attempt to clone keys to every HSM in the cluster no matter what setting you choose. Your setting enforces key creation on the number of HSMs you specify. If you specify a value and the system cannot replicate the key to that number of HSMs, then the system automatically cleans up any unwanted key material and you can try again.

**Important**

If you don’t set client key durability settings (or if you use the default value of 1), your keys are vulnerable to loss. If your current HSM should fail before the server-side service has cloned that key to another HSM, you lose the key material.

To maximize key durability, consider specifying at least two HSMs for client-side synchronization. Remember that no matter how many HSMs you specify, the workload on your cluster remains the same. Client-side synchronization always makes a best-effort attempt to clone keys to every HSM in the cluster.

**Recommendations**

- **Minimum**: Two HSMs per cluster
- **Maximum**: One fewer than the total number of HSMs in your cluster

If client-side synchronization fails, the client service cleans up any unwanted keys that may have been created and are now unwanted. This clean up is a best-effort response that may not always work. If cleanup fails, you may have to delete unwanted key material. For more information, see [Key Synchronization Failures](#).

**Setting up the configuration file for client key durability**

To specify client key durability settings, you must edit `cloudhsm_client.cfg`.

**To edit the client configuration file**

1. Open `cloudhsm_client.cfg`.

   **Linux:**

   ```
   /opt/cloudhsm/etc/cloudhsm_client.cfg
   ```
Windows:

C:\ProgramData\Amazon\CloudHSM\data\cloudhsm_client.cfg

2. In the client node of the file, add create_object_minimum_nodes and specify a value for the minimum number of HSMs on which AWS CloudHSM must successfully create keys for key creation operations to succeed.

"create_object_minimum_nodes" : 2

Note
The key_mgmt_util (KMU) command-line tool has an additional setting for client key durability. For more information, see the section called "KMU and client-side synchronization" (p. 128)

Configuration reference

These are the client-side synchronization properties, shown in an excerpt of the cloudhsm_client.cfg:

```json
{
   "client": {
      "create_object_minimum_nodes": 2,
      ...
   },
   ...
}
```

create_object_minimum_nodes

Specifies the minimum number of HSMs required to deem key generation, key import, or key unwrap operations a success. If set, the default is 1. This means that for every key create operation, the client-side service attempts to create keys on every HSM in the cluster, but to return a success, only needs to create a single key on one HSM in the cluster.

KMU and client-side synchronization

If you create keys with the key_mgmt_util (KMU) command-line tool, you use an optional command line parameter (-min_srv) to limit the number of HSMs on which to clone keys. If you specify the command-line parameter and a value in the configuration file, AWS CloudHSM honors the LARGER of the two values.

For more information, see the following topics:

- genDSAKeyPair (p. 328)
- genECCKeyPair (p. 332)
- genRSAKeyPair (p. 336)
- genSymKey (p. 341)
- importPrivateKey (p. 356)
- importPubKey (p. 359)
- imSymKey (p. 361)
- insertMaskedObject (p. 367)
**Synchronizing keys across cloned clusters**

Client-side and server-side synchronization are only for synchronizing keys within the same cluster. If you copy a backup of a cluster to another region, you can use the `syncKey` command of the `cloudhsm_mgmt_util` (CMU) for synchronizing keys between clusters. You might use cloned clusters for cross-region redundancy or to simplify your disaster recovery process. For more information, see `syncKey` (p. 298).

---

**AES key wrapping in AWS CloudHSM**

This topic describes the options for AES key wrapping in AWS CloudHSM. AES key wrapping uses an AES key (the wrapping key) to wrap another key of any type (the target key). You use key wrapping to protect stored keys or transmit keys over insecure networks.

**Topics**

- Supported algorithms (p. 129)
- Using AES key wrap in AWS CloudHSM (p. 130)

---

**Supported algorithms**

AWS CloudHSM offers three options for AES key wrapping, each based on how the target key is padded before being wrapped. Padding is done automatically, in accordance with the algorithm you use, when you call key wrap. The following table lists the supported algorithms and associated details to help you choose an appropriate wrapping mechanism for your application.

<table>
<thead>
<tr>
<th>AES Key Wrap Algorithm</th>
<th>Specification</th>
<th>Supported Target Key Types</th>
<th>Padding Scheme</th>
<th>AWS CloudHSM Client Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>AES Key Wrap with Zero Padding</td>
<td>RFC 5649 and SP 800-38F</td>
<td>All</td>
<td>Adds zeros after key bits, if necessary, to block align</td>
<td>SDK 3.1 and later</td>
</tr>
<tr>
<td>AES Key Wrap with No Padding</td>
<td>RFC 3394 and SP 800-38F</td>
<td>Block-aligned keys such as AES and 3DES</td>
<td>None</td>
<td>SDK 3.1 and later</td>
</tr>
<tr>
<td>AES Key Wrap with PKCS #5 Padding</td>
<td>None</td>
<td>All</td>
<td>At least 8 bytes are added as per PKCS #5 padding scheme to block align</td>
<td>All</td>
</tr>
</tbody>
</table>

To learn how to use the AES key wrap algorithms from the preceding table in your application, see **Using AES Key Wrap in AWS CloudHSM. (p. 130)**

---

**Understanding initialization vectors in AES key wrap**

Prior to wrapping, CloudHSM appends an initialization vector (IV) to the target key for data integrity. Each key wrap algorithm has specific restrictions on what type of IV is allowed. To set the IV in AWS CloudHSM, you have two options:
• Implicit: set the IV to NULL and CloudHSM uses the default value for that algorithm for wrap and unwrap operations (recommended)
• Explicit: set the IV by passing the default IV value to the key wrap function

Important
You must understand what IV you are using in your application. To unwrap the key, you must provide the same IV that you used to wrap the key. If you use an implicit IV to wrap, then use an implicit IV to unwrap. With an implicit IV, CloudHSM will use the default value to unwrap.

The following table describes permitted values for IVs, which the wrapping algorithm specifies.

<table>
<thead>
<tr>
<th>AES Key Wrap Algorithm</th>
<th>Implicit IV</th>
<th>Explicit IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>AES Key Wrap with Zero Padding</td>
<td>Required</td>
<td>Not allowed</td>
</tr>
<tr>
<td></td>
<td>Default value: (IV calculated internally based on specification)</td>
<td></td>
</tr>
<tr>
<td>AES Key Wrap with No Padding</td>
<td>Allowed (recommended)</td>
<td>Allowed</td>
</tr>
<tr>
<td></td>
<td>Default value: 0xA6A6A6A6A6A6A6A6A6</td>
<td>Only this value accepted: 0xA6A6A6A6A6A6A6</td>
</tr>
<tr>
<td>AES Key Wrap with PKCS #5 Padding</td>
<td>Allowed (recommended)</td>
<td>Allowed</td>
</tr>
<tr>
<td></td>
<td>Default value: 0xA6A6A6A6A6A6A6A6A6A6</td>
<td>Only this value accepted: 0xA6A6A6A6A6A6A6</td>
</tr>
</tbody>
</table>

Using AES key wrap in AWS CloudHSM

You wrap and unwrap keys as follows:

• In the PKCS #11 library (p. 394), select the appropriate mechanism for the C_WrapKey and C_UnWrapKey functions as shown in the following table.
• In the JCE provider (p. 422), select the appropriate algorithm, mode and padding combination, implementing cipher methods Cipher.WRAP_MODE and Cipher.UNWRAP_MODE as shown in the following table.
• In key_mgmt_util (KMU) (p. 301), use commands wrapKey and unWrapKey with appropriate m values as shown in the following table.
Using trusted keys in AWS CloudHSM

AWS CloudHSM supports trusted key wrapping to protect data keys from insider threats. This topic describes how to create trusted keys to secure data.

Topics

• Understanding trusted keys (p. 131)
• Trusted key attributes (p. 131)
• How to use trusted keys to wrap data keys (p. 132)
• How to unwrap a data key with a trusted key (p. 133)

Understanding trusted keys

A trusted key is a key that is used to wrap other keys and that admins and cryptographic officers (COs) specifically identify as trusted using the attribute CKA_TRUSTED. Additionally, admins and cryptographic officers (COs) use CKA_UNWRAP_TEMPLATE and related attributes to specify what actions data keys can do once they are unwrapped by a trusted key. Data keys that are unwrapped by the trusted key must also contain these attributes for the unwrap operation to succeed, which helps ensure that unwrapped data keys are only permitted for the use you intend.

Use the attribute CKA_WRAP_WITH_TRUSTED to identify all of the data keys you want to wrap with trusted keys. Doing this allows you to restrict data keys so applications can only use trusted keys to unwrap them. Once you set this attribute on the data keys, the attribute becomes read-only and you cannot change it. With these attributes in place, applications can only unwrap your data keys with the keys you trust, and unwraps always result in data keys with attributes that limit how these keys can be used.

Trusted key attributes

The following attributes allow you to mark a key as trusted, specify a data key can only be wrapped and unwrapped with a trusted key, and control what a data key can do after it is unwrapped:

• CKA_TRUSTED: Apply this attribute (in addition to CKA_UNWRAP_TEMPLATE) to the key that will wrap data keys to specify that an admin or crypto officer (CO) has done the necessary diligence and trusts this key. Only an admin or CO can set CKA_TRUSTED. The crypto user (CU) owns the key, but only a CO can set its CKA_TRUSTED attribute.

• CKA_WRAP_WITH_TRUSTED: Apply this attribute to an exportable data key to specify that you can only wrap this key with keys marked as CKA_TRUSTED. Once you set CKA_WRAP_WITH_TRUSTED to true, the attribute becomes read-only and you cannot change or remove the attribute.

• CKA_UNWRAP_TEMPLATE: Apply this attribute to the wrapping key (in addition to CKA_TRUSTED) to specify which attribute names and values the service must automatically apply to data keys that the service unwraps. When an application submits a key for unwrapping, the application can also provide its own unwrap template. If you specify an unwrap template and the application provides its own unwrap template, the HSM uses both templates to apply attribute names and values to the key. However, if a value in the CKA_UNWRAP_TEMPLATE for the wrapping key conflicts with an attribute provided by the application during the unwrap request, then the unwrap request fails.

For more information about attributes, refer to the following topics:

• PKCS #11 key attributes (p. 403)
• JCE key attributes (p. 432)
• CloudHSM CLI key attributes (p. 187)
How to use trusted keys to wrap data keys

To use a trusted key to wrap a data key, you must complete three basic steps:

1. For the data key you plan to wrap with a trusted key, set its CKA_WRAP_WITH_TRUSTED attribute to true.
2. For the trusted key you plan to wrap the data key with, set its CKA_TRUSTED attribute to true.
3. Use the trusted key to wrap the data key.

Step 1: Set the data key’s CKA_WRAP_WITH_TRUSTED to true

For the data key you want to wrap, choose one of the following options to set the key’s CKA_WRAP_WITH_TRUSTED attribute to true. Doing this restricts the data key so applications can only use trusted keys to wrap it.

Option 1: If generating a new key, set CKA_WRAP_WITH_TRUSTED to true

Generate a key using PKCS #11 (p. 394), JCE (p. 422), or CloudHSM CLI (p. 183). See the following examples for more details.

PKCS #11

To generate a key with PKCS #11, you need to set the key's CKA_WRAP_WITH_TRUSTED attribute to true. As shown in the following example, do this by including this attribute in the key's CK_ATTRIBUTE template and then setting the attribute to true:

```c
CK_BYTE_PTR label = "test_key";
CK_ATTRIBUTE template[] = {
    {CKA_WRAP_WITH_TRUSTED, &true_val, sizeof(CK_BBOOL)},
    {CKA_LABEL, label, strlen(label)},
    ...,
};
```

For more information, see our public samples demonstrating key generation with PKCS #11.

JCE

To generate a key with JCE, you need to set the key's WRAP_WITH_TRUSTED attribute to true. As shown in the following example, do this by including this attribute in the key's KeyAttributesMap and then setting the attribute to true:

```java
final String label = "test_key";
final KeyAttributesMap keySpec = new KeyAttributesMap();
keySpec.put(KeyAttribute.WRAP_WITH_TRUSTED, true);
keySpec.put(KeyAttribute.LABEL, label);
...
```

For more information, see our public samples demonstrating key generation with JCE.

CloudHSM CLI

To generate a key with CloudHSM CLI, you need to set the key's wrap-with-trusted attribute to true. Do this by including wrap-with-trusted=true in the appropriate argument for the key generation command:

- For symmetric keys, add wrap-with-trusted to the attributes argument.
- For public keys, add wrap-with-trusted to the public-attributes argument.
- For private keys, add wrap-with-trusted to the private-attributes argument.
For more information on key pair generation, see `key generate-asymmetric-pair` (p. 198).

For more information on symmetric key generation, see `key generate-symmetric` (p. 208).

Option 2: If using an existing key, use CloudHSM CLI to set its `CKA_WRAP_WITH_TRUSTED` to true

To set an existing key's `CKA_WRAP_WITH_TRUSTED` attribute to true, follow these steps:

1. Use the `login` (p. 230) command to log in as a crypto user (CU).
2. Use the `key set-attribute` (p. 220) command to set the key's `wrap-with-trusted` attribute to true.

```bash
aws-cloudhsm > key set-attribute --filter attr.label=test_key --name wrap-with-trusted --value true
```

Step 2: Set the trusted key's `CKA_TRUSTED` to true

To make a key a trusted key, its `CKA_TRUSTED` attribute must be set to true. You can either use CloudHSM CLI or the CloudHSM Management Utility (CMU) to do this.

- If using CloudHSM CLI to set a key's `CKA_TRUSTED` attribute, see [How to mark a key as trusted with CloudHSM CLI](p. 150).
- If using the CMU to set a key's `CKA_TRUSTED` attribute, see [How to mark a key as trusted with the CMU](p. 155).

Step 3. Use the trusted key to wrap the data key

To wrap the data key referenced in Step 1 with the trusted key you set in Step 2, refer to the following links for code samples. Each demonstrates how to wrap keys.

- [AWS CloudHSM PKCS #11 examples](#)
- [AWS CloudHSM JCE examples](#)

How to unwrap a data key with a trusted key

To unwrap a data key, you need a trusted key that has `CKA_UNWRAP` set to true. To be such a key, it must also meet the following criteria:

- The key's `CKA_TRUSTED` attribute must be set to true.
- The key must use `CKA_UNWRAP_TEMPLATE` and related attributes to specify what actions data keys can perform once they are unwrapped. If, for example, you want an unwrapped key to be non-exportable, you set `CKA_EXPORTABLE = FALSE` as part of the `CKA_UNWRAP_TEMPLATE`.

**Note**

`CKA_UNWRAP_TEMPLATE` is only available with PKCS #11.
When an application submits a key to be unwrapped, the application can also provide its own unwrap template. If you specify an unwrap template and the application provides its own unwrap template, the HSM uses both templates to apply attribute names and values to the key. However, if during the unwrap request a value in the trusted key’s CKA_UNWRAP_TEMPLATE conflicts with an attribute provided by the application, the unwrap request fails.

To see an example on unwrapping a data key with a trusted key, refer to this PKCS #11 example.

Managing keys with CloudHSM CLI

If using the latest SDK version series (p. 392), use CloudHSM CLI (p. 183) to manage the keys in your AWS CloudHSM cluster. For more details, see the topics below.

- Using trusted keys (p. 150) describes how to use PKCS #11 library attributes and CloudHSM CLI to create trusted keys to secure data.
- Generating keys (p. 134) includes instructions on creating keys, including symmetric keys, RSA keys, and EC keys.
- Deleting keys (p. 138) describes how key owners delete keys.
- Sharing and unsharing keys (p. 140) details how key owners share and unshare keys.
- Filtering keys (p. 145) offers guidelines on how to use filters to find keys.

Using CloudHSM CLI to generate keys

Before you can generate a key, you must start CloudHSM CLI (p. 183) and log in as a crypto user (CU). To generate keys on the HSM, use the command that corresponds to the type of key that you want to generate.

Topics
- Generate symmetric keys (p. 134)
- Generate asymmetric keys (p. 136)
- Related topics (p. 138)

Generate symmetric keys

Use the commands listed in key generate-symmetric (p. 208) to generate symmetric keys. To see all available options, use the help key generate-symmetric command.

Generate an AES key

Use the key generate-symmetric aes command to generate AES keys. To see all available options, use the help key generate-symmetric aes command.

Example

The following example generates a 32-byte AES key.

```bash
aws-cloudhsm > key generate-symmetric aes \
     --label aes-example \
     --key-length-bytes 32
```

Arguments

<LABEL>

Specifies a user-defined label for the AES key.
Managing keys with CloudHSM CLI

Required: Yes

<KEY-LENGTH-BYTES>

Specifies the key length in bytes.

Valid values:
  • 16, 24, and 32

Required: Yes

<KEY_ATTRIBUTES>

Specifies a space separated list of key attributes to set for the generated AES key in the form of
KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE (for example, token=true)

For a list of supported AWS CloudHSM key attributes, see Key attributes for CloudHSM CLI (p. 187).

Required: No

<SESSION>

Creates a key that exists only in the current session. The key cannot be recovered after the session
ends. Use this parameter when you need a key only briefly, such as a wrapping key that encrypts,
and then quickly decrypts, another key. Do not use a session key to encrypt data that you might
need to decrypt after the session ends.

To change a session key to a persistent (token) key, use key set-attribute (p. 220).

By default, when keys are generated they are persistent/token keys. Using <SESSION> changes this,
ensuring a key generated with this argument is a session/ephemeral

Required: No

Generate generic secret key

Use the key generate-symmetric generic-secret command to generate generic secret keys. To see all
available options, use the help key generate-symmetric generic-secret command.

Example

The following example generates a 32-byte generic secret key.

```
aws-cloudhsm > key generate-symmetric generic-secret
    --label generic-secret-example
    --key-length-bytes 32
```

Arguments

<LABEL>

Specifies a user-defined label for the generic secret key.

Required: Yes

<KEY-LENGTH-BYTES>

Specifies the key length in bytes.

Valid values:
  • 1 to 800
Required: Yes

**<KEY_ATTRIBUTES>**

Specifies a space separated list of key attributes to set for the generated generic secret key in the form of KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE (for example, token=true)

For a list of supported AWS CloudHSM key attributes, see [Key attributes for CloudHSM CLI](p. 187).

Required: No

**<SESSION>**

Creates a key that exists only in the current session. The key cannot be recovered after the session ends. Use this parameter when you need a key only briefly, such as a wrapping key that encrypts, and then quickly decrypts, another key. Do not use a session key to encrypt data that you might need to decrypt after the session ends.

To change a session key to a persistent (token) key, use `key set-attribute (p. 220).`

By default, when keys are generated they are persistent/token keys. Using `<SESSION>` changes this, ensuring a key generated with this argument is a session/ephemeral

Required: No

**Generate asymmetric keys**

Use the commands listed in [key generate-asymmetric-pair (p. 198)] to generate asymmetric key pairs.

**Generate an RSA key**

Use the `key generate-asymmetric-pair rsa` command to generate an RSA key pair. To see all available options, use the `help key generate-asymmetric-pair rsa` command.

**Example**

The following example generates an RSA 2048-bit key pair.

```
aws-cloudhsm > key generate-asymmetric-pair rsa \
   --public-exponent 65537 \
   --modulus-size-bits 2048 \
   --public-label rsa-public-example \
   --private-label rsa-private-example
```

**Arguments**

**<PUBLIC_LABEL>**

Specifies a user-defined label for the public-key.

Required: Yes

**<PRIVATE_LABEL>**

Specifies a user-defined label for the private-key.

Required: Yes

**<MODULUS_SIZE_BITS>**

Specifies the length of the modulus in bits. The minimum value is 2048.
Required: Yes

`<PUBLIC_EXPONENT>`

Specifies the public exponent. The value must be an odd number greater than or equal to 65537.

Required: Yes

`<PUBLIC_KEY_ATTRIBUTES>`

Specifies a space-separated list of key attributes to set for the generated RSA public key in the form of `KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE` (for example, `token=true`).

For a list of supported AWS CloudHSM key attributes, see Key attributes for CloudHSM CLI (p. 187).

Required: No

`<SESSION>`

Creates a key that exists only in the current session. The key cannot be recovered after the session ends. Use this parameter when you need a key only briefly, such as a wrapping key that encrypts, and then quickly decrypts, another key. Do not use a session key to encrypt data that you might need to decrypt after the session ends.

To change a session key to a persistent (token) key, use key set-attribute (p. 220).

By default, when keys are generated they are persistent/token keys. Using `<SESSION>` changes this, ensuring a key generated with this argument is a session/ephemeral.

Required: No

Generate EC (elliptic curve cryptography) key pairs

Use the `key generate-asymmetric-pair ec` command to generate an EC key pair. To see all available options, including a list of the supported elliptic curves, use the `help key generate-asymmetric-pair ec` command.

Example

The following example generates an EC key pair using the Secp384r1 elliptic curve.

```
aws-cloudhsm > key generate-asymmetric-pair ec \
  --curve secp384r1 \
  --public-label ec-public-example \
  --private-label ec-private-example
```

Arguments

`<PUBLIC_LABEL>`

Specifies a user-defined label for the public-key. The maximum size allowable for `label` is 126 characters.

Required: Yes

`<PRIVATE_LABEL>`

Specifies a user-defined label for the private-key. The maximum size allowable for `label` is 126 characters.

Required: Yes
<CURVE>

Specifies the identifier for the elliptic curve.

Valid values:
- prime256v1
- secp256r1
- secp224r1
- secp384r1
- secp256k1
- secp521r1

Required: Yes

<PUBLIC_KEY_ATTRIBUTES>

Specifies a space-separated list of key attributes to set for the generated EC public key in the form of KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE (for example, token=true).

For a list of supported AWS CloudHSM key attributes, see Key attributes for CloudHSM CLI (p. 187).

Required: No

<PRIVATE_KEY_ATTRIBUTES>

Specifies a space-separated list of key attributes to set for the generated EC private key in the form of KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE (for example, token=true).

For a list of supported AWS CloudHSM key attributes, see Key attributes for CloudHSM CLI (p. 187).

Required: No

<SESSION>

Creates a key that exists only in the current session. The key cannot be recovered after the session ends. Use this parameter when you need a key only briefly, such as a wrapping key that encrypts, and then quickly decrypts, another key. Do not use a session key to encrypt data that you might need to decrypt after the session ends.

To change a session key to a persistent (token) key, use key set-attribute (p. 220).

By default, keys that are generated are persistent (token) keys. Passing in <SESSION> changes this, ensuring a key generated with this argument is a session (ephemeral) key.

Required: No

Related topics
- Key attributes for CloudHSM CLI (p. 187)
- key generate-asymmetric-pair (p. 198)
- key generate-symmetric (p. 208)

Using CloudHSM CLI to delete keys

Use the example in this topic to delete a key with CloudHSM CLI (p. 183). Only key owners can delete keys.

Topics
- Example: Delete a key (p. 139)
Example: Delete a key

1. Run the key list command to identify the key you want to delete:

   ```bash
   aws-cloudhsm > key list --filter attr.label="my_key_to_delete" --verbose
   {
     "error_code": 0,
     "data": {
       "matched_keys": [
         {
           "key-reference": "0x0000000000540011",
           "key-info": {
             "key-owners": [
               {
                 "username": "my_crypto_user",
                 "key-coverage": "full"
               }
             ],
             "shared-users": [],
             "cluster-coverage": "full"
           },
           "attributes": {
             "key-type": "rsa",
             "label": "my_key_to_delete",
             "id": "",
             "check-value": "0x29bbd1",
             "class": "private-key",
             "encrypt": false,
             "decrypt": true,
             "token": true,
             "always-sensitive": true,
             "derive": false,
             "destroyable": true,
             "extractable": true,
             "local": true,
             "modifiable": true,
             "never-extractable": false,
             "private": true,
             "sensitive": true,
             "sign": true,
             "trusted": false,
             "unwrap": false,
             "verify": false,
             "wrap": false,
             "wrap-with-trusted": false,
             "key-length-bytes": 1217,
             "public-exponent": "0x010001",
             "modulus": "0x8b3a7c20618e8be08220ed84cf04f8e2be685f97eeb78fcbbad9b02cd91a3b990c2a7c7c3...e6f1c0db75050c2019f0636f65c792e1a73a49d93fb28186a969b4826c39466c0855c974d1fb723d111e4a32ab6e32b3129bc95c9206fced160015"...d15e33d8f883f16baa4a7f5e2cde4f1a6a678c5d59c11f8a4d6744c7a712e5c974d1fb723d111e4a32ab6e32b3129bc95c9206fced160015d8b2f",
             "modulus-size-bits": 2048
           }
         }
       ],
       "total_key_count": 1,
       "returned_key_count": 1
     }
   }
   ```

2. After identifying the key, run the key delete with the key's unique label attribute to delete the key:

   ```bash
   aws-cloudhsm > key delete --filter attr.label="my_key_to_delete"
   ```
3. Run the key list command with the key's unique label attribute and confirm the key has been deleted. As shown in the following example, no key with the label my_key_to_delete is in the HSM cluster:

```
aws-cloudhsm > key list --filter attr.label="my_key_to_delete"
{
  "error_code": 0,
  "data": {
    "matched_keys": [],
    "total_key_count": 0,
    "returned_key_count": 0
  }
}
```

Related topics
- Key attributes for CloudHSM CLI (p. 187)
- key delete (p. 195)

Using CloudHSM CLI to share and unshare keys

Use the commands in this topic to share and unshare keys in CloudHSM CLI (p. 183). In AWS CloudHSM, the crypto user (CU) who creates the key owns it. The owner can use the key share and key unshare commands to share and unshare the key with other CUs. Users with whom the key is shared can use the key in cryptographic operations, but they cannot export the key, delete the key, or share it with other users.

Before you can share a key, you must log in to the HSM as the crypto user (CU) who owns the key.

Topics
- Example: Sharing and unsharing a key (p. 140)
- Related topics (p. 145)

Example: Sharing and unsharing a key

Example

The following example shows how to share and unshare a key with crypto user (CU) alice. Along with the key share and key unshare commands, sharing and unsharing commands also requires a specific key using CloudHSM CLI key filters (p. 145) and the specific username of the user whom the key will be shared or unshared with.

1. Start by running the key list command with a filter to return a specific key and see whom the key is already shared with.

```
aws-cloudhsm > aws-cloudhsm > key list --filter attr.label="rsa_key_to_share" --verbose
{
  "error_code": 0,
  "data": {
    "matched_keys": [
```
"key-reference": "0x000000001c0686",
"key-info": {
  "key-owners": [
    {
      "username": "cu3",
      "key-coverage": "full"
    }
  ],
  "shared-users": [
    {
      "username": "cu2",
      "key-coverage": "full"
    },
    {
      "username": "cu1",
      "key-coverage": "full"
    },
    {
      "username": "cu4",
      "key-coverage": "full"
    },
    {
      "username": "cu5",
      "key-coverage": "full"
    },
    {
      "username": "cu6",
      "key-coverage": "full"
    },
    {
      "username": "cu7",
      "key-coverage": "full"
    }
  ],
  "cluster-coverage": "full"
},
"attributes": {
  "key-type": "rsa",
  "label": "rsa_key_to_share",
  "id": "",
  "check-value": "0xae8ff0",
  "class": "private-key",
  "encrypt": false,
  "decrypt": true,
  "token": true,
  "always-sensitive": true,
  "derive": false,
  "destroyable": true,
  "extractable": true,
  "local": true,
  "modifiable": true,
  "never-extractable": false,
  "private": true,
  "sensitive": true,
  "sign": true,
  "trusted": false,
  "unwrap": true,
  "verify": false,
  "wrap": false,
  "wrap-with-trusted": false,
  "key-length-bytes": 1219,
  "public-exponent": "0x010001",
  "modulus": "0xa8855cba933cec0c21adbf0450ec31675c024f3e65b2b215a53d2bda6dcd191f75729150b59b4d866f58254c8f518f76f5d9c307388633485657ce2e1a3deab0f985b0747ef4ed339de78147d1985d14fdd8634219321e49e3f5715e79c298f18658504bab04086bfbdcd3b",
  "modulus-size-bits": 2048
}
2. View the shared-users output to identify whom the key is currently shared with.

3. To share this key with crypto user (CU) alice, enter the following command:

```plaintext
aws-cloudhsm > key share --filter attr.label="rsa_key_to_share" attr.class=private-key --username alice --role crypto-user
```

```json
{
  "error_code": 0,
  "data": {
    "message": "Key shared successfully"
  }
}
```

Note that, along with the `key share` command, this command uses the unique label of the key and the name of the user whom the key will be shared with.

4. Run the `key list` command to confirm that the key has been shared with alice:

```plaintext
aws-cloudhsm > key list --filter attr.label="rsa_key_to_share" --verbose
```

```json
{
  "error_code": 0,
  "data": {
    "matched_keys": [
      {
        "key-reference": "0x0000000001c0686",
        "key-info": {
          "key-owners": [
            {
              "username": "cu3",
              "key-coverage": "full"
            }
          ],
          "shared-users": [
            {
              "username": "cu2",
              "key-coverage": "full"
            },
            {
              "username": "cu1",
              "key-coverage": "full"
            },
            {
              "username": "cu4",
              "key-coverage": "full"
            },
            {
              "username": "cu5",
              "key-coverage": "full"
            },
            {
              "username": "cu6",
              "key-coverage": "full"
            },
            {
              "username": "cu7",
              "key-coverage": "full"
            }
          ]
        }
      }
    ]
  }
}
```
5. To unshare the same key with alice, run the following `unshare` command:

```bash
aws-cloudhsm > key unshare --filter attr.label="rsa_key_to_share" attr.class=private-key --username alice --role crypto-user
```

```
{
    "error_code": 0,
    "data": {
        "message": "Key unshared successfully"
    }
}
```

Note that, along with the `key unshare` command, this command uses the unique label of the key and the name of the user whom the key will be shared with.

6. Run the `key list` command again and confirm the key was unshared with crypto user alice:

```bash
aws-cloudhsm > key list --filter attr.label="rsa_key_to_share" --verbose
```

```
{
    "error_code": 0,
    "data": {
    }
}
```
"matched_keys": [  
  {  
    "key-reference": "0x00000000001c0686",  
    "key-info": {  
      "key-owners": [  
        {  
          "username": "cu3",  
          "key-coverage": "full"  
        }  
      ],  
      "shared-users": [  
        {  
          "username": "cu2",  
          "key-coverage": "full"  
        },  
        {  
          "username": "cu1",  
          "key-coverage": "full"  
        },  
        {  
          "username": "cu4",  
          "key-coverage": "full"  
        },  
        {  
          "username": "cu5",  
          "key-coverage": "full"  
        },  
        {  
          "username": "cu6",  
          "key-coverage": "full"  
        },  
        {  
          "username": "cu7",  
          "key-coverage": "full"  
        }  
      ],  
      "cluster-coverage": "full"  
    }  
  },  
  "attributes": {  
    "key-type": "rsa",  
    "label": "rsa_key_to_share",  
    "id": "",  
    "check-value": "0xae8ff0",  
    "class": "private-key",  
    "encrypt": false,  
    "decrypt": true,  
    "token": true,  
    "always-sensitive": true,  
    "derive": false,  
    "destroyable": true,  
    "extractable": true,  
    "local": true,  
    "modifiable": true,  
    "never-extractable": false,  
    "private": true,  
    "sensitive": true,  
    "sign": true,  
    "trusted": false,  
    "unwrap": true,  
    "verify": false,  
    "wrap": false,  
    "wrap-with-trusted": false,  
    "key-length-bytes": 1219,  
    "public-exponent": "0x010001",  
    "modulus":  
  "0xa8855ca9933cec0c21a4df0450ec31675c024f3e65b2b215a532bda6dcd191f75729150b59b4d86df50254c8f518f731c0685a345b840f686e223f6fbb8

Related topics

- Key attributes for CloudHSM CLI (p. 187)
- key share (p. 223)
- key unshare (p. 225)
- Using CloudHSM CLI to filter keys (p. 145)

Using CloudHSM CLI to filter keys

Use the following key commands to utilize the standardized key filtration mechanisms for CloudHSM CLI (p. 183).

- key list
- key delete
- key share
- key unshare
- key set-attribute

To select and/or filter keys with CloudHSM CLI, key commands utilize a standardized filtration mechanism based on Key attributes for CloudHSM CLI (p. 187). A key or set of keys can be specified in key commands by using one or more AWS CloudHSM attributes that can identify a single key or multiple keys. The key filtration mechanism operates only on keys that the currently logged in user owns and shares, as well as all public keys in the AWS CloudHSM cluster.

Topics

- Requirements (p. 145)
- Filtering to find a single key (p. 145)
- Filtration Errors (p. 149)
- Related topics (p. 150)

Requirements

To filter keys, you must be logged in as a crypto user (CUs).

Filtering to find a single key

Please note that in the following examples, each attribute that is used as a filter must be written in the form of attr.KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE. For example, if you want to filter by the label attribute, you will write attr.label=my_label.

Example Use a single attribute to find a single key

This example demonstrates how to filter to a single unique key using only a single identifying attribute.
Example Use a multiple attributes to find a single key

The following example demonstrates how to find a single key using multiple key attributes.
aws-cloudhsm > key list --filter attr.key-type=rsa attr.class=private-key attr.check-value=0x29bbd1 --verbose

{
  "error_code": 0,
  "data": {
    "matched_keys": [
      {
        "key-reference": "0x0000000000540011",
        "key-info": {
          "key-owners": [
            {
              "username": "cu3",
              "key-coverage": "full"
            }
          ],
          "shared-users": [
            {
              "username": "cu2",
              "key-coverage": "full"
            }
          ],
          "cluster-coverage": "full"
        },
        "attributes": {
          "key-type": "rsa",
          "label": "my_crypto_user",
          "id": "",
          "check-value": "0x29bbd1",
          "class": "my_test_key",
          "encrypt": false,
          "decrypt": true,
          "token": true,
          "always-sensitive": true,
          "derive": false,
          "destroyable": true,
          "extractable": true,
          "local": true,
          "modifiable": true,
          "never-extractable": false,
          "private": true,
          "sensitive": true,
          "sign": true,
          "trusted": false,
          "unwrap": true,
          "verify": false,
          "wrap": false,
          "wrap-with-trusted": false,
          "key-length-bytes": 1217,
          "public-exponent": "0x010001",
          "modulus": "0x8b3a7c20618e8be08220ed8ab2c8550b65fc1aad8d4cf04fbf2be685f97eeb78fcbbad9b02cd91a3b15e990c2a7c7cdeff0a44e5f0e6e6fdb1f40bf83aaf1636fba5e475ad19889cfe3f28186a969b4826c39466c0855c974d1fb723d111e4a32ab6e32b3129bc95c9206fced160015d8b2f",
          "modulus-size-bits": 2048
        }
      }
    ],
    "total_key_count": 1,
    "returned_key_count": 1
  }
}

Example Filtering to find a set of keys

The following example demonstrates how to filter to find a set of private rsa keys.
```json
aws-cloudhsm > key list --filter attr.key-type=rsa attr.class=private-key --verbose
{
   "error_code": 0,
   "data": {
      "matched_keys": [
         {
            "key-reference": "0x00000000001c0686",
            "key-info": {
               "key-owners": [
                  {
                     "username": "my_crypto_user",
                     "key-coverage": "full"
                  }
               ],
               "shared-users": [
                  {
                     "username": "cu2",
                     "key-coverage": "full"
                  },
                  {
                     "username": "cu1",
                     "key-coverage": "full"
                  }
               ],
               "cluster-coverage": "full"
            },
            "attributes": {
               "key-type": "rsa",
               "label": "rsa_key_to_share",
               "id": "",
               "check-value": "0xae8ff0",
               "class": "private-key",
               "encrypt": false,
               "decrypt": true,
               "token": true,
               "always-sensitive": true,
               "derive": false,
               "destroyable": true,
               "extractable": true,
               "local": true,
               "modifiable": true,
               "never-extractable": false,
               "private": true,
               "sensitive": true,
               "sign": true,
               "trusted": false,
               "unwrap": true,
               "verify": false,
               "wrap": false,
               "wrap-with-trusted": false,
               "key-length-bytes": 1219,
               "public-exponent": "0x010001",
               "modulus": "0xa8855cba933cec0c21a4df0450ec31675c824f3e65b2b15a53d2bda6dcd191f75729150b59b4d86df58254c8f518f7d000c679fc3307388633485657ce2e1a3deab0f985b0747ef4ed339de78147d1985d14fdd8634219321e49e3f5715e79c298f18658504bab04086bfbdcd3b",
               "modulus-size-bits": 2048
            }
         },
         {
            "key-reference": "0x0000000000540011",
            "key-info": {
               "key-owners": [
                  {
                     "username": "my_crypto_user",
                     "key-coverage": "full"
                  }
               ]
            },
            "attributes": {
               "key-type": "rsa",
               "label": "rsa_key_to_share",
               "id": "",
               "check-value": "0xae8ff0",
               "class": "private-key",
               "encrypt": false,
               "decrypt": true,
               "token": true,
               "always-sensitive": true,
               "derive": false,
               "destroyable": true,
               "extractable": true,
               "local": true,
               "modifiable": true,
               "never-extractable": false,
               "private": true,
               "sensitive": true,
               "sign": true,
               "trusted": false,
               "unwrap": true,
               "verify": false,
               "wrap": false,
               "wrap-with-trusted": false,
               "key-length-bytes": 1219,
               "public-exponent": "0x010001",
               "modulus": "0xa8855cba933cec0c21a4df0450ec31675c824f3e65b2b15a53d2bda6dcd191f75729150b59b4d86df58254c8f518f7d000c679fc3307388633485657ce2e1a3deab0f985b0747ef4ed339de78147d1985d14fdd8634219321e49e3f5715e79c298f18658504bab04086bfbdcd3b",
               "modulus-size-bits": 2048
            }
         }
      ]
   }
}
Filtration Errors

Certain key operations can only be performed on a single key at a time. For these operations, the CloudHSM CLI will provide an error if the filtration criteria is not sufficiently refined and multiple keys match the criteria. One such example is shown below with the key delete.

Example Filtration Error when matching too many keys

```
aws-cloudhsm > key delete --filter attr.key-type=rsa
{
  "error_code": 1,
  "data": "Key selection criteria matched 48 keys. Refine selection criteria to select a single key."
}
```
Related topics

- Key attributes for CloudHSM CLI (p. 187)

How to mark a key as trusted with CloudHSM CLI

The content in this section provides instructions on using CloudHSM CLI to mark a key as trusted.

1. Using the CloudHSM CLI login command (p. 230), log in as a crypto user (CU).
2. Use the key list command to identify the key reference of the key you want to mark as trusted. The following example lists the key with the label `key_to_be_trusted`.

```bash
aws-cloudhsm > key list --filter attr.label=test_aes_trusted
{
    "error_code": 0,
    "data": {
        "matched_keys": [
            {
                "key-reference": "0x0000000000200333",
                "attributes": {
                    "label": "test_aes_trusted"
                }
            }
        ],
        "total_key_count": 1,
        "returned_key_count": 1
    }
}
```

3. Using the logout (p. 232) command, log out as a crypto user (CU).
4. Using the login (p. 230) command, log in as an admin.
5. Using the key set-attribute (p. 220) command with the key reference you identified in step 2, set the key's trusted value to true:

```bash
aws-cloudhsm > key set-attribute --key-reference <Key Reference> --name trusted --value true
{
    "error_code": 0,
    "data": {
        "message": "Attribute set successfully"
    }
}
```

Managing keys with the KMU and CMU

If using the latest SDK version series (p. 392), use CloudHSM CLI (p. 183) to manage the keys in your AWS CloudHSM cluster.

If using the previous SDK version series (p. 454), you can manage keys on the HSMs in your AWS CloudHSM cluster using the key_mgmt_util command line tool. Before you can manage keys, you must start the AWS CloudHSM client, start key_mgmt_util, and log in to the HSMs. For more information, see Getting Started with key_mgmt_util (p. 301).

- Using trusted keys (p. 155) describes how to use PKCS #11 library attributes and CMU to create trusted keys to secure data.
Generating keys

To generate keys on the HSM, use the command that corresponds to the type of key that you want to generate.

Topics

- Generate symmetric keys (p. 151)
- Generate RSA key pairs (p. 151)
- Generate ECC (elliptic curve cryptography) key pairs (p. 151)

Generate symmetric keys

Use the genSymKey (p. 341) command to generate AES and other types of symmetric keys. To see all available options, use the genSymKey -h command.

The following example creates a 256-bit AES key.

```
Command: genSymKey -t 31 -s 32 -l aes256
Cfm3GenerateSymmetricKey returned: 0x00 : HSM Return: SUCCESS
Symmetric Key Created. Key Handle: 524295
Cluster Error Status
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
Node id 2 and err state 0x00000000 : HSM Return: SUCCESS
```

Generate RSA key pairs

To generate an RSA key pair, use the genRSAKeyPair (p. 336) command. To see all available options, use the genRSAKeyPair -h command.

The following example generates an RSA 2048-bit key pair.

```
Command: genRSAKeyPair -m 2048 -e 65537 -l rsa2048
Cfm3GenerateKeyPair returned: 0x00 : HSM Return: SUCCESS
Cfm3GenerateKeyPair:    public key handle: 524294    private key handle: 524296
Cluster Error Status
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
Node id 2 and err state 0x00000000 : HSM Return: SUCCESS
```

Generate ECC (elliptic curve cryptography) key pairs

To generate an ECC key pair, use the genECCKeyPair (p. 332) command. To see all available options, including a list of the supported elliptic curves, use the genECCKeyPair -h command.
The following example generates an ECC key pair using the P-384 elliptic curve defined in NIST FIPS publication 186-4.

Command: `genECCKeyPair -i 14 -l ecc-p384`
Cfm3GenerateKeyPair returned: 0x00 : HSM Return: SUCCESS
Cfm3GetKeyPair: public key handle: 524297 private key handle: 524298

Cluster Error Status
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
Node id 2 and err state 0x00000000 : HSM Return: SUCCESS

Importing keys

To import secret keys—that is, symmetric keys and asymmetric private keys—into the HSM, you must first create a wrapping key on the HSM. You can import public keys directly without a wrapping key.

Topics

- Import secret keys (p. 152)
- Import public keys (p. 153)

Import secret keys

Complete the following steps to import a secret key. Before you import a secret key, save it to a file. Save symmetric keys as raw bytes, and asymmetric private keys in PEM format.

This example shows how to import a plaintext secret key from a file into the HSM. To import an encrypted key from a file into the HSM, use the `unWrapKey` command.

To import a secret key

1. Use the `genSymKey` command to create a wrapping key. The following command creates a 128-bit AES wrapping key that is valid only for the current session. You can use a session key or a persistent key as a wrapping key.

   Command: `genSymKey -t 31 -s 16 -sess -l import-wrapping-key`
   Cfm3GenerateSymmetricKey returned: 0x00 : HSM Return: SUCCESS
   Symmetric Key Created. Key Handle: 524299

   Cluster Error Status
   Node id 2 and err state 0x00000000 : HSM Return: SUCCESS

2. Use one of the following commands, depending on the type of secret key that you are importing.

   - To import a symmetric key, use the `imSymKey` command. The following command imports an AES key from a file named `aes256.key` using the wrapping key created in the previous step. To see all available options, use the `imSymKey -h` command.

     Command: `imSymKey -f aes256.key -t 31 -l aes256-imported -w 524299`
     Cfm3WrapHostKey returned: 0x00 : HSM Return: SUCCESS
     Cfm3CreateUnwrapTemplate returned: 0x00 : HSM Return: SUCCESS
     Cfm3UnWrapKey returned: 0x00 : HSM Return: SUCCESS
     Symmetric Key Unwrapped. Key Handle: 524300
To import an asymmetric private key, use the `importPrivateKey` command. The following command imports a private key from a file named `rsa2048.key` using the wrapping key created in the previous step. To see all available options, use the `importPrivateKey -h` command.

Command:

```
importPrivateKey -f rsa2048.key -l rsa2048-imported -w 524299
```

BER encoded key length is 1216

Cfm3WrapHostKey returned: 0x00 : HSM Return: SUCCESS
Cfm3CreateUnwrapTemplate returned: 0x00 : HSM Return: SUCCESS
CfmUnWrapKey returned: 0x00 : HSM Return: SUCCESS
Private Key Unwrapped. Key Handle: 524301

Import public keys

Use the `importPubKey` command to import a public key. To see all available options, use the `importPubKey -h` command.

The following example imports an RSA public key from a file named `rsa2048.pub`.

Command:

```
importPubKey -f rsa2048.pub -l rsa2048-public-imported
```

Cfm3CreatePublicKey returned: 0x00 : HSM Return: SUCCESS

Public Key Handle: 524302

Exporting keys

To export secret keys—that is, symmetric keys and asymmetric private keys—from the HSM, you must first create a wrapping key. You can export public keys directly without a wrapping key.

Only the key owner can export a key. Users with whom the key is shared can use the key in cryptographic operations, but they cannot export it. When running this example, be sure to export a key that you created.

**Important**

The `exSymKey` command writes a plaintext (unencrypted) copy of the secret key to a file. The export process requires a wrapping key, but the key in the file is **not** a wrapped key. To export a wrapped (encrypted) copy of a key, use the `wrapKey` command.

**Topics**

- Export secret keys (p. 154)
- Export public keys (p. 154)
Export secret keys

Complete the following steps to export a secret key.

To export a secret key

1. Use the `genSymKey` command to create a wrapping key. The following command creates a 128-bit AES wrapping key that is valid only for the current session.

   **Command:** `genSymKey -t 31 -s 16 -sess -l export-wrapping-key`

   Cfm3GenerateSymmetricKey returned: 0x00 : HSM Return: SUCCESS

   Symmetric Key Created. Key Handle: 524304

   Cluster Error Status
   Node id 2 and err state 0x00000000 : HSM Return: SUCCESS

2. Use one of the following commands, depending on the type of secret key that you are exporting.

   • To export a symmetric key, use the `exSymKey` command. The following command exports an AES key to a file named `aes256.key.exp`. To see all available options, use the `exSymKey -h` command.

   **Command:** `exSymKey -k 524295 -out aes256.key.exp -w 524304`

   Cfm3WrapKey returned: 0x00 : HSM Return: SUCCESS

   Cfm3UnWrapHostKey returned: 0x00 : HSM Return: SUCCESS

   Wrapped Symmetric Key written to file "aes256.key.exp"

   **Note**
   The command's output says that a "Wrapped Symmetric Key" is written to the output file. However, the output file contains a plaintext (not wrapped) key. To export a wrapped (encrypted) key to a file, use the `wrapKey` command.

   • To export a private key, use the `exportPrivateKey` command. The following command exports a private key to a file named `rsa2048.key.exp`. To see all available options, use the `exportPrivateKey -h` command.

   **Command:** `exportPrivateKey -k 524296 -out rsa2048.key.exp -w 524304`

   Cfm3WrapKey returned: 0x00 : HSM Return: SUCCESS

   Cfm3UnWrapHostKey returned: 0x00 : HSM Return: SUCCESS

   PEM formatted private key is written to rsa2048.key.exp

Export public keys

Use the `exportPubKey` command to export a public key. To see all available options, use the `exportPubKey -h` command.

The following example exports an RSA public key to a file named `rsa2048.pub.exp`.

**Command:** `exportPubKey -k 524294 -out rsa2048.pub.exp`

PEM formatted public key is written to rsa2048.pub.key

Cfm3ExportPubKey returned: 0x00 : HSM Return: SUCCESS
### Deleting keys

Use the `deleteKey` (p. 312) command to delete a key, as in the following example. Only the key owner can delete a key.

**Command:**
```
 AWS CloudHSM User Guide  Managing keys with the KMU and CMU
```
```bash
Command: deleteKey -k 524300
Cfm3DeleteKey returned: 0x00 : HSM Return: SUCCESS
```

**Cluster Error Status**
```
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
Node id 2 and err state 0x00000000 : HSM Return: SUCCESS
```

### Sharing and unsharing keys

In AWS CloudHSM, the CU who creates the key owns it. The owner manages the key, can export and delete it, and can use the key in cryptographic operations. The owner can also share the key with other CU users. Users with whom the key is shared can use the key in cryptographic operations, but they cannot export or delete the key, or share it with other users.

You can share keys with other CU users when you create the key, such as by using the `-u` parameter of the `genSymKey` (p. 341) or `genRSAKeyPair` (p. 336) commands. To share existing keys with a different HSM user, use the `cloudhsm_mgmt_util` (p. 252) command line tool. This is different from most of the tasks documented in this section, which use the `key_mgmt_util` (p. 301) command line tool.

Before you can share a key, you must start `cloudhsm_mgmt_util`, enable end-to-end encryption, and log in to the HSMs. To share a key, log in to the HSM as the crypto user (CU) that owns the key. Only key owners can share a key.

Use the `shareKey` command to share or unshare a key, specifying the handle of the key and the IDs of the user or users. To share or unshare with more than one user, specify a comma-separated list of user IDs. To share a key, use `1` as the command's last parameter, as in the following example. To unshare, use `0`.

```
avs-cloudhsm>shareKey 524295 4 1
**************************************************************************************
This is a CRITICAL operation, should be done on all nodes in the cluster. AWS does NOT synchronize these changes automatically with the nodes on which this operation is not executed or failed, please ensure this operation is executed on all nodes in the cluster.
**************************************************************************************

Do you want to continue(y/n)?y
shareKey success on server 0(10.0.2.9)
shareKey success on server 1(10.0.3.11)
shareKey success on server 2(10.0.1.12)
```

The following shows the syntax for the `shareKey` command.

```
avs-cloudhsm>shareKey <key handle> <user ID> <Boolean: 1 for share, 0 for unshare>
```

### How to mark a key as trusted with the CMU

The content in this section provides instructions on using the CMU to mark a key as trusted.

1. Using the `loginHSM` (p. 286) command, log in as a crypto officer (CO).
2. Use the `setAttribute` (p. 291) command with OBJ_ATTR_TRUSTED (value 134) set to true (1).
Managing cloned clusters

Use CloudHSM Management Utility (CMU) to synchronize a cluster in a remote region, if the cluster in that region was originally created from the backup of a cluster in another region. Let’s say you copied a cluster to another region (destination) and then later you want to synchronize changes from the original cluster (source). In scenarios like this, you use CMU to synchronize the clusters. You do this by creating a new CMU configuration file, specifying hardware security modules (HSM) from both clusters in the new file, and then using CMU to connect to the cluster with that file.

To use CMU across cloned clusters

1. Create a copy of your current configuration file and change the name of the copy to something else.
   
   For example, use the following file locations to locate and create a copy of your current configuration file, then change the name of the copy from `cloudhsm_mgmt_config.cfg` to `syncConfig.cfg`.

   - Linux: `/opt/cloudhsm/etc/cloudhsm_mgmt_config.cfg`
   - Windows: `C:\ProgramData\Amazon\CloudHSM\data\cloudhsm_mgmt_config.cfg`

2. In the renamed copy, add the Elastic Network Interface (ENI) IP of the destination HSM (the HSM in the foreign region that needs to be synced). We recommend that you add the destination HSM below the source HSM.

   ```json
   {
       "servers": [
           ...
           "hostname": "<ENI Source IP>",
           ...
       ],
       ...
       "hostname": "<ENI Destination IP>",
       ...
   }
   }
   ``

   For more information about how to get the IP address, see the section called “Get an IP address for an HSM” (p. 157).

3. Initialize CMU with the new configuration file:

   **Linux**
   ```bash
   $ /opt/cloudhsm/bin/cloudhsm_mgmt_util /opt/cloudhsm/etc/userSync.cfg
   ```

   **Windows**
   ```bash
   C:\Program Files\Amazon\CloudHSM>cloudhsm_mgmt_util.exe C:\ProgramData\Amazon\CloudHSM\data\userSync.cfg
   ```
4. Check the status messages returned to ensure that the CMU is connected to all desired HSMs and determine which of the returned ENI IPs corresponds to each cluster. Use syncUser and syncKey to manually synchronize users and keys. For more information, see syncUser (p. 299) and syncKey (p. 298).

**Get an IP address for an HSM**

Use this section to obtain an IP address for an HSM.

**To get an IP address for a HSM (console)**

2. To change the AWS Region, use the Region selector in the upper-right corner of the page.
3. To open the cluster detail page, in the cluster table, choose the cluster ID.
4. To get the IP address, on the HSMs tab, choose one of the IP addresses listed under **ENI IP address**.

**To get an IP address for a HSM (AWS CLI)**

- Get the IP address of an HSM by using the `describe-clusters` command from the AWS CLI. In the output from the command, the IP address of the HSMs are the values of `EniIp`.

```bash
$ aws cloudhsmv2 describe-clusters

{
  "Clusters": [
    { ... }
  ]
  "Hsms": [
    { ... 
      "EniIp": "10.0.0.9",
      ... 
    },
    { ... 
      "EniIp": "10.0.1.6",
      ... 
    }
  ]
}
```

**Related topics**

- [syncUser (p. 299)](https://aws.amazon.com/documentation/cloudhsm/
- [syncKey (p. 298)](https://aws.amazon.com/documentation/cloudhsm/
- [Copying Backups Across Regions (p. 55)](https://aws.amazon.com/documentation/cloudhsm/
AWS CloudHSM command line tools

This topic describes the command line tools available for managing and using AWS CloudHSM.

Topics
• Understanding command line tools (p. 158)
• Configure tool (p. 159)
• CloudHSM Command Line Interface (CLI) (p. 183)
• CloudHSM Management Utility (CMU) (p. 252)
• Key Management Utility (KMU) (p. 301)

Understanding command line tools

In addition to the AWS command-line interface (AWS CLI) that you use for managing your AWS resources, AWS CloudHSM offers command-line tools for creating and managing HSM users and keys on your HSMs. In AWS CloudHSM you use the familiar AWS CLI to manage your cluster, and the CloudHSM command line tools to manage your HSM.

These are the various command-line tools:

To manage HSMs and clusters

CloudHSMv2 commands in AWS CLI and HSM2 PowerShell cmdlets in the AWSPowerShell module
• These tools get, create, delete, and tag AWS CloudHSM clusters and HSMs:
• To use the commands in CloudHSMv2 commands in AWS CLI, you need to install and configure AWS CLI.
• HSM2 PowerShell cmdlets in the AWSPowerShell module are available in a Windows PowerShell module and a cross-platform PowerShell Core module.

To manage HSM users

CloudHSM CLI (p. 183)
• Use CloudHSM CLI (p. 183) to create users, delete users, list users, change user passwords, and update user multifactor authentication (MFA). It is not included in the AWS CloudHSM client software. For guidance on installing this tool, see Install and configure CloudHSM CLI (p. 25).

Helper Tools

Two tools help you to use AWS CloudHSM tools and software libraries:
• The configure tool (p. 159) updates your CloudHSM client configuration files. This allows AWS CloudHSM to synchronize the HSMs in a cluster.

AWS CloudHSM offers two major versions, and Client SDK 5 is the latest. It offers a variety of advantages over Client SDK 3 (the previous series).
• pkpspeed (p. 650) measures the performance of your HSM hardware independent of software libraries.
Tools for previous SDKs

Use the key management tool (KMU) create, delete, import, and export symmetric keys and asymmetric key pairs:

- key_mgmt_util (p. 301). This tool is included in the AWS CloudHSM client software.

Use the CloudHSM management tool (CMU) to create and delete HSM users, including implementing quorum authentication of user management tasks

- cloudhsm_mgmt_util (p. 252). This tool is included in the AWS CloudHSM client software.

Configure tool

AWS CloudHSM automatically synchronizes data among all hardware security modules (HSM) in a cluster. The configure tool updates the HSM data in the configuration files that the synchronization mechanisms use. Use configure to refresh the HSM data before you use the command line tools, especially when the HSMs in the cluster have changed.

AWS CloudHSM includes two major Client SDK versions:

- Client SDK 5: This is our latest and default Client SDK. For information on the benefits and advantages it provides, see Benefits of Client SDK 5 (p. 453).
- Client SDK 3: This is our older Client SDK. It includes a full set of components for platform and language-based applications compatibility and management tools.

Topics

- Client SDK 5 configure tool (p. 159)
- Client SDK 3 configure tool (p. 177)

Client SDK 5 configure tool

Use the Client SDK 5 configure tool to update client-side configuration files.

Each component in Client SDK 5 includes a configure tool with a designator of the component in the file name of the configure tool. For example, the PKCS #11 library for Client SDK 5 includes a configure tool named configure-pkcs11 on Linux or configure-pkcs11.exe on Windows.

Syntax

PKCS #11

```bash
configure-pkcs11[ .exe ]
  -a <ENI IP address>
  [-hsm-ca-cert <customerCA certificate file path>]
  [-cluster-id <cluster ID>]
  [-endpoint <endpoint>]
  [-region <region>]
  [-server-client-cert-file <client certificate file path>]
  [-server-client-key-file <client key file path>]
  [-log-level <error | warn | info | debug | trace>]
```
Default is <info>
[-log-rotation <daily | weekly>]
  Default is <daily>
[-log-file <file name with path>]
  Default is /opt/cloudhsm/run/cloudhsm-pkcs11.log
  Default for Windows is C:\Program Files\Amazon\CloudHSM\cloudhsm-pkcs11.log
  Default is <file>
  Default is <daily>
[-log-file <file name with path>]
  Default is <opt/cloudhsm/run/cloudhsm-pkcs11.log>
  Default for Windows is C:\Program Files\Amazon\CloudHSM\cloudhsm-pkcs11.log
  Default is <file>
  Default is <daily>

OpenSSL

configure-dyn[ .exe ]
  -a <ENI IP address>
  [-hsm-ca-cert <customerCA certificate file path>]
  [-cluster-id <cluster ID>]
  [-endpoint <endpoint>]
  [-region <region>]
  [-server-client-cert-file <client certificate file path>]
  [-server-client-key-file <client key file path>]
  [-log-level <error | warn | info | debug | trace>]
    Default is <error>
  [-log-rotation <daily | weekly>]
    Default is <info>
  [-log-file <file name with path>]
    Default is /opt/cloudhsm/run/cloudhsm-jce.log
    Default for Windows is C:\Program Files\Amazon\CloudHSM\cloudhsm-jce.log
  [-log-type <file | term>]
    Default is <file>
  [-h | --help]
  [-V | --version]
  [-disable-key-availability-check]
  [-enable-key-availability-check]
  [-disable-validate-key-at-init]
  [-enable-validate-key-at-init]
    This is the default for OpenSSL
    [-enable-validate-key-at-init]

JCE

configure-jce[ .exe ]
  -a <ENI IP address>
  [-hsm-ca-cert <customerCA certificate file path>]
  [-cluster-id <cluster ID>]
  [-endpoint <endpoint>]
  [-region <region>]
  [-server-client-cert-file <client certificate file path>]
  [-server-client-key-file <client key file path>]
  [-log-level <error | warn | info | debug | trace>]
    Default is <info>
  [-log-rotation <daily | weekly>]
    Default is <daily>
  [-log-file <file name with path>]
    Default is /opt/cloudhsm/run/cloudhsm-jce.log
    Default for Windows is C:\Program Files\Amazon\CloudHSM\cloudhsm-jce.log
  [-log-type <file | term>]
    Default is <file>
  [-h | --help]
  [-V | --version]
  [-disable-key-availability-check]
  [-enable-key-availability-check]
  [-disable-validate-key-at-init]
This is the default for JCE
[--enable-validate-key-at-init]

Advanced configurations

For a list of advanced configurations specific to the Client SDK 5 configure tool, refer to Advanced configurations for the Client SDK 5 configure tool (p. 176).

Important
After making any changes to your configuration, you need to restart your application for the changes to take effect.

Examples

These examples show how to use the configure tool for Client SDK 5.

Bootstrap Client SDK 5

Example

This example uses the -a parameter to update the HSM data for Client SDK 5. To use the -a parameter, you must have the IP address for one of the HSMs in your cluster.

PKCS #11 library

To bootstrap a Linux EC2 instance for Client SDK 5

- Use the configure tool to specify the IP address of a HSM in your cluster.

$ sudo /opt/cloudhsm/bin/configure-pkcs11 -a <HSM IP addresses>
To bootstrap a Windows EC2 instance for Client SDK 5

- Use the configure tool to specify the IP address of a HSM in your cluster.

"C:\Program Files\Amazon\CloudHSM\bin\configure-pkcs11.exe" -a <HSM IP addresses>

OpenSSL Dynamic Engine

To bootstrap a Linux EC2 instance for Client SDK 5

- Use the configure tool to specify the IP address of a HSM in your cluster.

$ sudo /opt/cloudhsm/bin/configure-dyn -a <HSM IP addresses>

JCE provider

To bootstrap a Linux EC2 instance for Client SDK 5

- Use the configure tool to specify the IP address of a HSM in your cluster.

$ sudo /opt/cloudhsm/bin/configure-jce -a <HSM IP addresses>

To bootstrap a Windows EC2 instance for Client SDK 5

- Use the configure tool to specify the IP address of a HSM in your cluster.

"C:\Program Files\Amazon\CloudHSM\bin\configure-jce.exe" -a <HSM IP addresses>

CloudHSM CLI

To bootstrap a Linux EC2 instance for Client SDK 5

- Use the configure tool to specify the IP address of the HSM(s) in your cluster.

$ sudo /opt/cloudhsm/bin/configure-cli -a <The ENI IP addresses of the HSMs>

To bootstrap a Windows EC2 instance for Client SDK 5

- Use the configure tool to specify the IP address of the HSM(s) in your cluster.
"C:\Program Files\Amazon\CloudHSM\bin\configure-cli.exe" -a `<The ENI IP addresses of the HSMs>`

Note
you can use the --cluster-id parameter in place of -a `<HSM_IP_ADDRESSES>`. To see requirements for using --cluster-id, see Client SDK 5 configure tool (p. 159).

For more information about the -a parameter, see the section called “Parameters” (p. 174).

Specify cluster, region, and endpoint for Client SDK 5

Example

This example uses the cluster-id parameter to bootstrap Client SDK 5 by making a DescribeClusters call.

PKCS #11 library

To bootstrap a Linux EC2 instance for Client SDK 5 with cluster-id

- Use the cluster ID `cluster-1234567` to specify the IP address of a HSM in your cluster.

$ sudo /opt/cloudhsm/bin/configure-pkcs11 --cluster-id `cluster-1234567`

To bootstrap a Windows EC2 instance for Client SDK 5 with cluster-id

- Use the cluster ID `cluster-1234567` to specify the IP address of a HSM in your cluster.

"C:\Program Files\Amazon\CloudHSM\configure-pkcs11.exe" --cluster-id `cluster-1234567`

OpenSSL Dynamic Engine

To bootstrap a Linux EC2 instance for Client SDK 5 with cluster-id

- Use the cluster ID `cluster-1234567` to specify the IP address of a HSM in your cluster.

$ sudo /opt/cloudhsm/bin/configure-dyn --cluster-id `cluster-1234567`

JCE provider

To bootstrap a Linux EC2 instance for Client SDK 5 with cluster-id

- Use the cluster ID `cluster-1234567` to specify the IP address of a HSM in your cluster.
To bootstrap a Windows EC2 instance for Client SDK 5 with `cluster-id`

- Use the cluster ID `cluster-1234567` to specify the IP address of a HSM in your cluster.

```
"C:\Program Files\Amazon\CloudHSM\configure-jce.exe" --cluster-id cluster-1234567
```

CloudHSM CLI

To bootstrap a Linux EC2 instance for Client SDK 5 with `cluster-id`

- Use the cluster ID `cluster-1234567` to specify the IP address of a HSM in your cluster.

```
$ sudo /opt/cloudhsm/bin/configure-cli --cluster-id cluster-1234567
```

To bootstrap a Windows EC2 instance for Client SDK 5 with `cluster-id`

- Use the cluster ID `cluster-1234567` to specify the IP address of a HSM in your cluster.

```
"C:\Program Files\Amazon\CloudHSM\bin\configure-cli.exe" --cluster-id cluster-1234567
```

You can use the `--region` and `--endpoint` parameters in combination with the `cluster-id` parameter to specify how the system makes the DescribeClusters call. For instance, if the region of the cluster is different than the one configured as your AWS CLI default, you should use the `--region` parameter to use that region. Additionally, you have the ability to specify the AWS CloudHSM API endpoint to use for the call, which might be necessary for various network setups, such as using VPC interface endpoints that don’t use the default DNS hostname for AWS CloudHSM.

PKCS #11 library

To bootstrap a Linux EC2 instance with a custom endpoint and region

- Use the configure tool to specify the IP address of a HSM in your cluster with a custom region and endpoint.

```
$ sudo /opt/cloudhsm/bin/configure-pkcs11 --cluster-id cluster-1234567 --region us-east-1 --endpoint https://cloudhsmv2.us-east-1.amazonaws.com
```
To bootstrap a Windows EC2 instance with a endpoint and region
• Use the configure tool to specify the IP address of a HSM in your cluster with a custom region and endpoint.

```
C:\Program Files\Amazon\CloudHSM\configure-pkcs11.exe --cluster-id cluster-1234567 --region us-east-1 --endpoint https://cloudhsmv2.us-east-1.amazonaws.com
```

OpenSSL Dynamic Engine

To bootstrap a Linux EC2 instance with a custom endpoint and region
• Use the configure tool to specify the IP address of a HSM in your cluster with a custom region and endpoint.

```
$ sudo /opt/cloudhsm/bin/configure-dyn --cluster-id cluster-1234567 --region us-east-1 --endpoint https://cloudhsmv2.us-east-1.amazonaws.com
```

JCE provider

To bootstrap a Linux EC2 instance with a custom endpoint and region
• Use the configure tool to specify the IP address of a HSM in your cluster with a custom region and endpoint.

```
$ sudo /opt/cloudhsm/bin/configure-jce --cluster-id cluster-1234567 --region us-east-1 --endpoint https://cloudhsmv2.us-east-1.amazonaws.com
```

To bootstrap a Windows EC2 instance with a endpoint and region
• Use the configure tool to specify the IP address of a HSM in your cluster with a custom region and endpoint.

```
"C:\Program Files\Amazon\CloudHSM\configure-jce.exe" --cluster-id cluster-1234567 --region us-east-1 --endpoint https://cloudhsmv2.us-east-1.amazonaws.com
```

CloudHSM CLI

To bootstrap a Linux EC2 instance with a custom endpoint and region
• Use the configure tool to specify the IP address of a HSM in your cluster with a custom region and endpoint.
To bootstrap a Windows EC2 instance with a endpoint and region

- Use the configure tool to specify the IP address of a HSM in your cluster with a custom region and endpoint.

```
"C:\Program Files\Amazon\CloudHSM\configure-cli.exe" --cluster-id cluster-1234567 --region us-east-1 --endpoint https://cloudhsmv2.us-east-1.amazonaws.com
```

For more information about the `--cluster-id`, `--region`, and `--endpoint` parameters, see the section called “Parameters” (p. 174).

Update client certificate and key for TLS client-server mutual authentication

**Example**

This examples shows how to use the `--server-client-cert-file` and `--server-client-key-file` parameters to reconfigure SSL by specifying a custom key and SSL certificate for AWS CloudHSM

**PKCS #11 library**

**To use a custom certificate and key for TLS client-server mutual authentication with Client SDK 5 on Linux**

1. Copy your key and certificate to the appropriate directory.

   ```bash
   $ sudo cp ssl-client.crt /opt/cloudhsm/etc
   sudo cp ssl-client.key /opt/cloudhsm/etc
   ```

2. Use the configure tool to specify `ssl-client.crt` and `ssl-client.key`.

   ```bash
   $ sudo /opt/cloudhsm/bin/configure-pkcs11 --server-client-cert-file /opt/cloudhsm/etc/ssl-client.crt --server-client-key-file /opt/cloudhsm/etc/ssl-client.key
   ```

**To use a custom certificate and key for TLS client-server mutual authentication with Client SDK 5 on Windows**

1. Copy your key and certificate to the appropriate directory.

   ```bash
cp ssl-client.crt C:\ProgramData\Amazon\CloudHSM\ssl-client.crt
cp ssl-client.key C:\ProgramData\Amazon\CloudHSM\ssl-client.key
   ```

2. With a PowerShell interpreter, use the configure tool to specify `ssl-client.crt` and `ssl-client.key`.

   ```bash
   & "C:\Program Files\Amazon\CloudHSM\bin\configure-pkcs11.exe" --server-client-cert-file C:\ProgramData\Amazon\CloudHSM\ssl-client.crt --server-client-key-file C:\ProgramData\Amazon\CloudHSM\ssl-client.key
   ```
OpenSSL Dynamic Engine

To use a custom certificate and key for TLS client-server mutual authentication with Client SDK 5 on Linux

1. Copy your key and certificate to the appropriate directory.

   ```
   $ sudo cp ssl-client.crt /opt/cloudhsm/etc
   sudo cp ssl-client.key /opt/cloudhsm/etc
   ```

2. Use the configure tool to specify `ssl-client.crt` and `ssl-client.key`.

   ```
   $ sudo /opt/cloudhsm/bin/configure-dyn \
      --server-client-cert-file /opt/cloudhsm/etc/ssl-client.crt \
      --server-client-key-file /opt/cloudhsm/etc/ssl-client.key
   ```

JCE provider

To use a custom certificate and key for TLS client-server mutual authentication with Client SDK 5 on Linux

1. Copy your key and certificate to the appropriate directory.

   ```
   $ sudo cp ssl-client.crt /opt/cloudhsm/etc
   sudo cp ssl-client.key /opt/cloudhsm/etc
   ```

2. Use the configure tool to specify `ssl-client.crt` and `ssl-client.key`.

   ```
   $ sudo /opt/cloudhsm/bin/configure-jce \
      --server-client-cert-file /opt/cloudhsm/etc/ssl-client.crt \n      --server-client-key-file /opt/cloudhsm/etc/ssl-client.key
   ```

To use a custom certificate and key for TLS client-server mutual authentication with Client SDK 5 on Windows

1. Copy your key and certificate to the appropriate directory.

   ```
   cp ssl-client.crt C:\ProgramData\Amazon\CloudHSM\ssl-client.crt
   cp ssl-client.key C:\ProgramData\Amazon\CloudHSM\ssl-client.key
   ```

2. With a PowerShell interpreter, use the configure tool to specify `ssl-client.crt` and `ssl-client.key`.

   ```
   & "C:\Program Files\Amazon\CloudHSM\bin\configure-jce.exe" \
   --server-client-cert-file C:\ProgramData\Amazon\CloudHSM\ssl-client.crt \
   --server-client-key-file C:\ProgramData\Amazon\CloudHSM\ssl-client.key
   ```

CloudHSM CLI

To use a custom certificate and key for TLS client-server mutual authentication with Client SDK 5 on Linux

1. Copy your key and certificate to the appropriate directory.
To use a custom certificate and key for TLS client-server mutual authentication with Client SDK 5 on Windows

1. Copy your key and certificate to the appropriate directory.

   ```bash
   cp ssl-client.crt C:\ProgramData\Amazon\CloudHSM\ssl-client.crt
   cp ssl-client.key C:\ProgramData\Amazon\CloudHSM\ssl-client.key
   
   2. With a PowerShell interpreter, use the configure tool to specify `ssl-client.crt` and `ssl-client.key`.

      ```bash
      & "C:\Program Files\Amazon\CloudHSM\bin\configure-cli.exe" 
      --server-client-cert-file C:\ProgramData\Amazon\CloudHSM\ssl-client.crt 
      --server-client-key-file C:\ProgramData\Amazon\CloudHSM\ssl-client.key
      ```

For more information about the `server-client-cert-file` and `--server-client-key-file` parameters, see the section called "Parameters" (p. 174).

**Disable client key durability settings**

**Example**

This example uses the `--disable-key-availability-check` parameter to disable client key durability settings. To run a cluster with a single HSM, you must disable client key durability settings.

**PKCS #11 library**

To disable client key durability for Client SDK 5 on Linux

- Use the configure tool to disable client key durability settings.

  ```bash
  $ sudo /opt/cloudhsm/bin/configure-pkcs11 --disable-key-availability-check
  ```

To disable client key durability for Client SDK 5 on Windows

- Use the configure tool to disable client key durability settings.

  ```bash
  "C:\Program Files\Amazon\CloudHSM\bin\configure-pkcs11.exe" --disable-key-availability-check
  ```
OpenSSL Dynamic Engine

To disable client key durability for Client SDK 5 on Linux
• Use the configure tool to disable client key durability settings.

$ sudo /opt/cloudhsm/bin/configure-dyn --disable-key-availability-check

JCE provider

To disable client key durability for Client SDK 5 on Linux
• Use the configure tool to disable client key durability settings.

$ sudo /opt/cloudhsm/bin/configure-jce --disable-key-availability-check

To disable client key durability for Client SDK 5 on Windows
• Use the configure tool to disable client key durability settings.

"C:\Program Files\Amazon\CloudHSM\bin\configure-jce.exe" --disable-key-availability-check

CloudHSM CLI

To disable client key durability for Client SDK 5 on Linux
• Use the configure tool to disable client key durability settings.

$ sudo /opt/cloudhsm/bin/configure-cli --disable-key-availability-check

To disable client key durability for Client SDK 5 on Windows
• Use the configure tool to disable client key durability settings.

"C:\Program Files\Amazon\CloudHSM\bin\configure-cli.exe" --disable-key-availability-check

For more information about the --disable-key-availability-check parameter, see the section called “Parameters” (p. 174).
Manage logging options

Example

Client SDK 5 uses the log-file, log-level, log-rotation, and log-type parameters to manage logging.

Note
To configure your SDK for serverless environments such as AWS Fargate or AWS Lambda, we recommend you configure your AWS CloudHSM log type to term. The client logs will be output to stderr and captured in the CloudWatch Logs log group configured for that environment.

PKCS #11 library

Default logging location

- If you do not specify a location for the file, the system writes logs to the following default location:

  Linux

  /opt/cloudhsm/run/cloudhsm-pkcs11.log

  Windows

  C:\Program Files\Amazon\CloudHSM\cloudhsm-pkcs11.log

To configure the logging level and leave other logging options set to default

- $ sudo /opt/cloudhsm/bin/configure-pkcs11 --log-level info

To configure file logging options

- $ sudo /opt/cloudhsm/bin/configure-pkcs11 --log-type file --log-file <file name with path> --log-rotation daily --log-level info

To configure terminal logging options

- $ sudo /opt/cloudhsm/bin/configure-pkcs11 --log-type term --log-level info

OpenSSL Dynamic Engine

Default logging location

- If you do not specify a location for the file, the system writes logs to the following default location:

  Linux

  stderr
To configure the logging level and leave other logging options set to default

- $ sudo /opt/cloudhsm/bin/configure-dyn --log-level info

To configure file logging options

- $ sudo /opt/cloudhsm/bin/configure-dyn --log-type file --log-file <file name> --log-rotation daily --log-level info

To configure terminal logging options

- $ sudo /opt/cloudhsm/bin/configure-dyn --log-type term --log-level info

JCE provider

Default logging location

- If you do not specify a location for the file, the system writes logs to the following default location:

  Linux

  /opt/cloudhsm/run/cloudhsm-jce.log

  Windows

  C:\Program Files\Amazon\CloudHSM\cloudhsm-jce.log

To configure the logging level and leave other logging options set to default

- $ sudo /opt/cloudhsm/bin/configure-jce --log-level info

To configure file logging options

- $ sudo /opt/cloudhsm/bin/configure-jce --log-type file --log-file <file name> --log-rotation daily --log-level info

To configure terminal logging options

- $ sudo /opt/cloudhsm/bin/configure-jce --log-type term --log-level info
CloudHSM CLI

**Default logging location**

- If you do not specify a location for the file, the system writes logs to the following default location:

  **Linux**
  
  `/opt/cloudhsm/run/cloudhsm-cli.log`

  **Windows**
  
  `C:\Program Files\Amazon\CloudHSM\cloudhsm-cli.log`

**To configure the logging level and leave other logging options set to default**

- $ sudo /opt/cloudhsm/bin/configure-cli --log-level info

**To configure file logging options**

- $ sudo /opt/cloudhsm/bin/configure-cli --log-type file --log-file <file name> --log-rotation daily --log-level info

**To configure terminal logging options**

- $ sudo /opt/cloudhsm/bin/configure-cli --log-type term --log-level info

For more information about the `log-file`, `log-level`, `log-rotation`, and `log-type` parameters, see the section called “Parameters” (p. 174).

**Place the issuing certificate for Client SDK 5**

**Example**

This example uses the `--hsm-ca-cert` parameter to update the location of the issuing certificate for Client SDK 5.

**PKCS #11 library**

**To place the issuing certificate on Linux for Client SDK 5**

- Use the configure tool to specify a location for the issuing certificate.

  $ sudo /opt/cloudhsm/bin/configure-pkcs11 --hsm-ca-cert <customerCA certificate file>
To place the issuing certificate on Windows for Client SDK 5

- Use the configure tool to specify a location for the issuing certificate.

"C:\Program Files\Amazon\CloudHSM\configure-pkcs11.exe" --hsm-ca-cert <customerCA certificate file>

OpenSSL Dynamic Engine

To place the issuing certificate on Linux for Client SDK 5

- Use the configure tool to specify a location for the issuing certificate.

$ sudo /opt/cloudhsm/bin/configure-dyn --hsm-ca-cert <customerCA certificate file>

JCE provider

To place the issuing certificate on Linux for Client SDK 5

- Use the configure tool to specify a location for the issuing certificate.

$ sudo /opt/cloudhsm/bin/configure-jce --hsm-ca-cert <customerCA certificate file>

To place the issuing certificate on Windows for Client SDK 5

- Use the configure tool to specify a location for the issuing certificate.

"C:\Program Files\Amazon\CloudHSM\configure-jce.exe" --hsm-ca-cert <customerCA certificate file>

CloudHSM CLI

To place the issuing certificate on Linux for Client SDK 5

- Use the configure tool to specify a location for the issuing certificate.

$ sudo /opt/cloudhsm/bin/configure-cli --hsm-ca-cert <customerCA certificate file>

To place the issuing certificate on Windows for Client SDK 5

- Use the configure tool to specify a location for the issuing certificate.
"C:\Program Files\Amazon\CloudHSM\configure-cli.exe" --hsm-ca-cert <customerCA certificate file>

For more information about the --hsm-ca-cert parameter, see the section called "Parameters" (p. 174).

**Parameters**

-a `<ENI IP address>`

Adds the specified IP address to Client SDK 5 configuration files. Enter any ENI IP address of a HSM from the cluster. For more information about how to use this option, see [Bootstrap Client SDK 5](p. 42).

Required: Yes

--hsm-ca-cert `<customerCA certificate file path>`

Path to the directory storing the certificate authority (CA) certificate used to connect EC2 client instances to the cluster. You create this file when you initialize the cluster. By default, the system looks for this file in the following locations:

Linux

```
/opt/cloudhsm/etc/customerCA.crt
```

Windows

```
C:\ProgramData\Amazon\CloudHSM\customerCA.crt
```

For more information about initializing the cluster or placing the certificate, see [???](p. 40) and [???](p. 21).

Required: No

--cluster-id `<cluster ID>`

Makes a DescribeClusters call to find all of the HSM elastic network interface (ENI) IP addresses in the cluster associated with the cluster ID. The system adds the ENI IP addresses to the AWS CloudHSM configuration files.

**Note**

If you use the --cluster-id parameter from an EC2 instance within a VPC that does not have access to the public internet, then you must create an interface VPC endpoint to connect with AWS CloudHSM. For more information about VPC endpoints, see [???](p. 635).

Required: No

--endpoint `<endpoint>`

Specify the AWS CloudHSM API endpoint used for making the DescribeClusters call. You must set this option in combination with --cluster-id.

Required: No

--region `<region>`

Specify the region of your cluster. You must set this option in combination with --cluster-id.
If you don’t supply the `--region` parameter, the system chooses the region by attempting to read the `AWS_DEFAULT_REGION` or `AWS_REGION` environment variables. If those variables aren’t set, then the system checks the region associated with your profile in your AWS config file (typically `~/.aws/config`) unless you specified a different file in the `AWS_CONFIG_FILE` environment variable. If none of the above are set, the system defaults to the `us-east-1` region.

Required: No

`--server-client-cert-file <client certificate file path>`

Path to the client certificate used for TLS client-server mutual authentication.

Only use this option if you don’t wish to use the default key and SSL/TLS certificate we include with Client SDK 5. You must set this option in combination with `--server-client-key-file`.

Required: No

`--server-client-key-file <client key file path>`

Path to the client key used for TLS client-server mutual authentication

Only use this option if you don’t wish to use the default key and SSL/TLS certificate we include with Client SDK 5. You must set this option in combination with `--server-client-cert-file`.

Required: No

`--log-level <error | warn | info | debug | trace>`

Specifies the minimum logging level the system should write to the log file. Each level includes the previous levels, with error as the minimum level and trace the maximum level. This means that if you specify errors, the system only writes errors to the log. If you specify trace, the system writes errors, warnings, informational (info) and debug messages to the log. For more information, see Client SDK 5 Logging (p. 601).

Required: No

`--log-rotation <daily | weekly>`

Specifies the frequency with which the system rotates logs. For more information, see Client SDK 5 Logging (p. 601).

Required: No

`--log-file <file name with path>`

Specifies where the system will write the log file. For more information, see Client SDK 5 Logging (p. 601).

Required: No

`--log-type <term | file>`

Specifies whether the system will write the log to a file or terminal. For more information, see Client SDK 5 Logging (p. 601).

Required: No

`-h | --help`  
Displays help.

Required: No

`-v | --version`  
Displays version.

Required: No
--disable-key-availability-check

Flag to disable key availability quorum. Use this flag to indicate AWS CloudHSM should disable key availability quorum and you can use keys that exist on only one HSM in the cluster. For more information about using this flag to set key availability quorum, see ?? (p. 125).

Required: No

--enable-key-availability-check

Flag to enable key availability quorum. Use this flag to indicate AWS CloudHSM should use key availability quorum and not allow you to use keys until those keys exist on two HSMs in the cluster. For more information about using this flag to set key availability quorum, see ?? (p. 125).

Enabled by default.

Required: No

--disable-validate-key-at-init

Improves performance by specifying that you can skip an initialization call to verify permissions on a key for subsequent calls. Use with caution.

Background: Some mechanisms in the PKCS #11 library support multi-part operations where an initialization call verifies if you can use the key for subsequent calls. This requires a verification call to the HSM, which adds latency to the overall operation. This option enables you to disable the subsequent call and potentially improve performance.

Required: No

--enable-validate-key-at-init

Specifies that you should use an initialization call to verify permissions on a key for subsequent calls. This is the default option. Use enable-validate-key-at-init to resume these initialization calls after you use disable-validate-key-at-init to suspend them.

Required: No

Related topics

- DescribeClusters API operation
- describe-clusters AWS CLI
- Get-HSM2Cluster PowerShell cmdlet
- Bootstrap Client SDK 5 (p. 42)
- AWS CloudHSM VPC endpoints (p. 635)
- Managing Client SDK 5 Key Durability Settings (p. 125)
- Client SDK 5 Logging (p. 601)

Advanced configurations for the Client SDK 5 configure tool

The Client SDK 5 configure tool includes advanced configurations that are not part of the general features most customers utilize. Advanced configurations provide additional capabilities.

- Advanced configurations for PKCS #11
  - Connecting to multiple slots with PKCS#11 (p. 414)
  - Retry commands for PKCS #11 (p. 418)
- Advanced configurations for JCE
Client SDK 3 configure tool

Use the Client SDK 3 configure tool to bootstrap the client daemon and configure CloudHSM Management Utility.

Syntax

```bash
configure -h | --help
-a <ENI IP address>
-m [-i <daemon_id>]
--ssl --pkey <private key file> --cert <certificate file>
--cmu <ENI IP address>
```

Examples

These examples show how to use the `configure` tool.

**Example : Update the HSM data for the AWS CloudHSM client and key_mgmt_util**

This example uses the `-a` parameter of `configure` to update the HSM data for the AWS CloudHSM client and `key_mgmt_util`. To use the `-a` parameter, you must have the IP address for one of the HSMs in your cluster. Use either the console or the AWS CLI to get the IP address.

**To get an IP address for a HSM (console)**

2. To change the AWS Region, use the Region selector in the upper-right corner of the page.
3. To open the cluster detail page, in the cluster table, choose the cluster ID.
4. To get the IP address, on the HSMs tab, choose one of the IP addresses listed under **ENI IP address**.

**To get an IP address for a HSM (AWS CLI)**

- Get the IP address of an HSM by using the `describe-clusters` command from the AWS CLI. In the output from the command, the IP address of the HSMs are the values of `EniIp`.

```bash
$ aws cloudhsmv2 describe-clusters

{
  "Clusters": [
    { ... }
    "Hsms": [
      { ... "EniIp": "10.0.0.9",
      ...
    }
  ...
```
To update the HSM data

1. Before updating the -a parameter, stop the AWS CloudHSM client. This prevents conflicts that might occur while configure edits the client's configuration file. If the client is already stopped, this command has no effect, so you can use it in a script.

   Amazon Linux
   
   ```bash
   $ sudo stop cloudhsm-client
   ```

   Amazon Linux 2
   
   ```bash
   $ sudo service cloudhsm-client stop
   ```

   CentOS 7
   
   ```bash
   $ sudo service cloudhsm-client stop
   ```

   CentOS 8
   
   ```bash
   $ sudo service cloudhsm-client stop
   ```

   RHEL 7
   
   ```bash
   $ sudo service cloudhsm-client stop
   ```

   RHEL 8
   
   ```bash
   $ sudo service cloudhsm-client stop
   ```

   Ubuntu 16.04 LTS
   
   ```bash
   $ sudo service cloudhsm-client stop
   ```

   Ubuntu 18.04 LTS
   
   ```bash
   $ sudo service cloudhsm-client stop
   ```

   Windows
   
   - For Windows client 1.1.2+:
     
     ```cmd
     C:\Program Files\Amazon\CloudHSM> net.exe stop AWSCloudHSMClient
     ```
   
   - For Windows clients 1.1.1 and older:

     Use Ctrl+C in the command window where you started the AWS CloudHSM client.

2. This step uses the -a parameter of configure to add the 10.0.0.9 ENI IP address to the configurations files.
Amazon Linux

```bash
$ sudo /opt/cloudhsm/bin/configure -a 10.0.0.9
```

Amazon Linux 2

```bash
$ sudo /opt/cloudhsm/bin/configure -a 10.0.0.9
```

CentOS 7

```bash
$ sudo /opt/cloudhsm/bin/configure -a 10.0.0.9
```

CentOS 8

```bash
$ sudo /opt/cloudhsm/bin/configure -a 10.0.0.9
```

RHEL 7

```bash
$ sudo /opt/cloudhsm/bin/configure -a 10.0.0.9
```

RHEL 8

```bash
$ sudo /opt/cloudhsm/bin/configure -a 10.0.0.9
```

Ubuntu 16.04 LTS

```bash
$ sudo /opt/cloudhsm/bin/configure -a 10.0.0.9
```

Ubuntu 18.04 LTS

```bash
$ sudo /opt/cloudhsm/bin/configure -a 10.0.0.9
```

Windows

```bash
C:\Program Files\Amazon\CloudHSM\bin\ configure.exe -a 10.0.0.9
```

3. Next, restart the AWS CloudHSM client. When the client starts, it uses the ENI IP address in its configuration file to query the cluster. Then, it writes the ENI IP addresses of all HSMs in the cluster to the `cluster.info` file.

Amazon Linux

```bash
$ sudo start cloudhsm-client
```

Amazon Linux 2

```bash
$ sudo service cloudhsm-client start
```
CentOS 7

$ sudo service cloudhsm-client start

CentOS 8

$ sudo service cloudhsm-client start

RHEL 7

$ sudo service cloudhsm-client start

RHEL 8

$ sudo service cloudhsm-client start

Ubuntu 16.04 LTS

$ sudo service cloudhsm-client start

Ubuntu 18.04 LTS

$ sudo service cloudhsm-client start

Windows

- For Windows client 1.1.2+:
  
  C:\Program Files\Amazon\CloudHSM>net.exe start AWSCloudHSMClient

- For Windows clients 1.1.1 and older:
  
  C:\Program Files\Amazon\CloudHSM>start "cloudhsm_client" cloudhsm_client.exe C:\ProgramData\Amazon\CloudHSM\data\cloudhsm_client.cfg

When the command completes, the HSM data that the AWS CloudHSM client and key_mgmt_util use is complete and accurate.

Example : Update the HSM Data for CMU from client SDK 3.2.1 and earlier

This example uses the -m configure command to copy the updated HSM data from the cluster.info file to the cloudhsm_mgmt_util.cfg file that cloudhsm_mgmt_util uses. Use this with CMU that ships with Client SDK 3.2.1 and earlier.

- Before running the -m, stop the AWS CloudHSM client, run the -a command, and then restart the AWS CloudHSM client, as shown in the previous example (p. 177). This ensures that the data copied into the cloudhsm_mgmt_util.cfg file from the cluster.info file is complete and accurate.
Example: Update the HSM Data for CMU from client SDK 3.3.0 and later

This example uses the --cmu parameter of the configure command to update HSM data for CMU. Use this with CMU that ships with Client SDK 3.3.0 and later. For more information about using CMU, see Using CloudHSM Management Utility (CMU) to Manage Users (p. 95) and Using CMU with Client SDK 3.2.1 and Earlier (p. 96).

- Use the --cmu parameter to pass the IP address of an HSM in your cluster.

Parameters

-h | --help
Displays command syntax.
Required: Yes

-a <ENI IP address>
Adds the specified HSM elastic network interface (ENI) IP address to AWS CloudHSM configuration files. Enter the ENI IP address of any one of the HSMs in the cluster. It does not matter which one you select.

To get the ENI IP addresses of the HSMs in your cluster, use the DescribeClusters operation, the describe-clusters AWS CLI command, or the Get-HSM2Cluster PowerShell cmdlet.

Note
Before running the -a configure command, stop the AWS CloudHSM client. Then, when the -a command completes, restart the AWS CloudHSM client. For details, see the examples (p. 177).

This parameter edits the following configuration files:
- /opt/cloudhsm/etc/cloudhsm_client.cfg: Used by AWS CloudHSM client and key_mgmt_util (p. 301).
- /opt/cloudhsm/etc/cloudhsm_mgmt_util.cfg: Used by cloudhsm_mgmt_util (p. 252).

When the AWS CloudHSM client starts, it uses the ENI IP address in its configuration file to query the cluster and update the cluster.info file (/opt/cloudhsm/daemon/1/cluster.info) with the correct ENI IP addresses for all HSMs in the cluster.
Required: Yes

-m

Updates the HSM ENI IP addresses in the configuration file that CMU uses.

Note
The -m parameter is for use with CMU from Client SDK 3.2.1 and earlier. For CMU from Client SDK 3.3.0 and later, see --cmu parameter, which simplifies the process of updating HSM data for CMU.

When you update the -a parameter of configure and then start the AWS CloudHSM client, the client daemon queries the cluster and updates the cluster.info files with the correct HSM IP addresses for all HSMs in the cluster. Running the -m configure command completes the update by copying the HSM IP addresses from the cluster.info to the cloudhsm_mgmt_util.cfg configuration file that cloudhsm_mgmt_util uses.

Be sure to run -a configure command and restart the AWS CloudHSM client before running the -m command. This ensures that the data copied into cloudhsm_mgmt_util.cfg from cluster.info is complete and accurate.

Required: Yes

-i

Specifies an alternate client daemon. The default value represents the AWS CloudHSM client.

Default: 1

Required: No

--ssl

Replaces the SSL key and certificate for the cluster with the specified private key and certificate. When you use this parameter, the --pkey and --cert parameters are required.

Required: No

--pkey

Specifies the new private key. Enter the path and file name of the file that contains the private key.

Required: Yes if --ssl is specified. Otherwise, this should not be used.

--cert

Specifies the new certificate. Enter the path and file name of the file that contains the certificate. The certificate should chain up to the customerCA.crt certificate, the self-signed certificate used to initialize the cluster. For more information, see Initialize the Cluster.

Required: Yes if --ssl is specified. Otherwise, this should not be used.

--cmu <ENI IP address>

Combines the -a and -m parameters into one parameter. Adds the specified HSM elastic network interface (ENI) IP address to AWS CloudHSM configuration files and then updates the CMU configuration file. Enter an IP address from any HSM in the cluster. For Client SDK 3.2.1 and earlier, see Using CMU with Client SDK 3.2.1 and Earlier (p. 96).

Required: Yes

Related topics

- Set up key_mgmt_util (p. 301)
CloudHSM Command Line Interface (CLI)

CloudHSM CLI helps admins manage users in their cluster. It includes tools that can be used to create users, delete users, list users, change user passwords, and update user multifactor authentication (MFA).

For defined list of CloudHSM CLI users, see Managing HSM users in AWS CloudHSM (p. 60).

For a quick start, see Getting started with CloudHSM Command Line Interface (CLI) (p. 184). For detailed information about the CloudHSM CLI commands and examples of using the commands, see Reference for CloudHSM CLI commands (p. 190).

Topics
- CloudHSM Command Line Interface (CLI) supported platforms (p. 183)
- Getting started with CloudHSM Command Line Interface (CLI) (p. 184)
- Interactive and single command modes (p. 186)
- Key attributes for CloudHSM CLI (p. 187)
- Reference for CloudHSM CLI commands (p. 190)

CloudHSM Command Line Interface (CLI) supported platforms

Linux support

<table>
<thead>
<tr>
<th>Supported platforms</th>
<th>X86_64 Architecture</th>
<th>ARM architecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amazon Linux</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Amazon Linux 2</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>CentOS 7.8+</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>CentOS 8.3+(^1)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Red Hat Enterprise Linux (RHEL) 7.8+</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Red Hat Enterprise Linux (RHEL) 8.3+</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Ubuntu 18.04 LTS(^2)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Ubuntu 20.04 LTS</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Ubuntu 22.04 LTS</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

\(^1\) Client SDK 5.4.1 is the last release that works on CentOS 8.3+.

\(^2\) Client SDK 5.10.0 is the last release that works on Ubuntu 18.04 LTS.

Windows support
- Microsoft Windows Server 2016
• Microsoft Windows Server 2019

### Getting started with CloudHSM Command Line Interface (CLI)

CloudHSM Command Line Interface (CLI) allows you to manage users in your AWS CloudHSM cluster. Use this topic to get started with basic HSM user management tasks, such as creating users, listing users, and connecting CloudHSM CLI to the cluster.

### Prerequisites

Download, install, and configure CloudHSM CLI. For detailed instructions, see Install and configure CloudHSM CLI (p. 25).

### Using CloudHSM CLI

1. Use the following command to start CloudHSM CLI.

   **Linux**
   ```bash
   $ /opt/cloudhsm/bin/cloudhsm-cli interactive
   ``

   **Windows**
   ```bash
   C:\Program Files\Amazon\CloudHSM\bin> .\cloudhsm-cli.exe interactive
   ```

2. Use the `login` command to log in to the cluster. All users can use this command.

   The command in the following example logs in `admin`, which is the default `admin` account. You set this user's password when you activated the cluster (p. 28).

   ```bash
   aws-cloudhsm > login --username admin --role admin
   ```

   The system prompts you for your password. You enter the password, and the output shows that the command was successful.

   ```json
   Enter password: 
   
   { 
     "error_code": 0, 
     "data": { 
       "username": "admin", 
       "role": "admin" 
     } 
   }
   ```

3. Run the `user list` command to list all the users on the cluster.

   ```bash
   aws-cloudhsm > user list
   ```

   ```json
   { 
     "error_code": 0, 
     "data": { 
       "users": [ 
         { 
           "username": "admin", 
           "role": "admin", 
           "locked": "false",
         },
       ],
     }
   }
   ```
4. Use `user create` to create a CU user named `example_user`.

You can create CUs because in a previous step you logged in as an admin user. Only admin users can perform user management tasks, such as creating and deleting users and changing the passwords of other users.

```
aws-cloudhsm > user create --username example_user --role crypto-user
Enter password:
Confirm password:
{
  "error_code": 0,
  "data": {
    "username": "example_user",
    "role": "crypto-user"
  }
}
```

5. Use `user list` to list all the users on the cluster.

```
aws-cloudhsm > user list
{
  "error_code": 0,
  "data": {
    "users": [
      {
        "username": "admin",
        "role": "admin",
        "locked": "false",
        "mfa": [],
        "cluster-coverage": "full"
      },
      {
        "username": "example_user",
        "role": "crypto_user",
        "locked": "false",
        "mfa": [],
        "cluster-coverage": "full"
      },
      {
        "username": "app_user",
        "role": "internal(APPLIANCE_USER)",
        "locked": "false",
        "mfa": [],
        "cluster-coverage": "full"
      }
    ]
  }
}
```
6. Use the `logout` command to log out of AWS CloudHSM cluster.

   ```bash
   aws-cloudhsm > logout
   {
     "error_code": 0,
     "data": "Logout successful"
   }
   ```

7. Use the `quit` command to stop the CLI.

   ```bash
   aws-cloudhsm > quit
   ```

**Interactive and single command modes**

In CloudHSM CLI, you can run commands two different ways: in single command mode and interactive mode. Interactive mode is designed for users, and single command mode is designed for scripts.

**Note**

All commands work in interactive mode and single command mode.

**Interactive mode**

Use the following commands to start CloudHSM CLI interactive mode

**Linux**

```bash
$ /opt/cloudhsm/bin/cloudhsm-cli interactive
```

**Windows**

```bash
C:\Program Files\Amazon\CloudHSM\bin\> .\cloudhsm-cli.exe interactive
```

When using the CLI in Interactive Mode, you can log in to a user account using the `login` command.

To list all CloudHSM CLI commands, run the following command:

```bash
aws-cloudhsm > help
```

To get the syntax for a CloudHSM CLI command, run the following command:

```bash
aws-cloudhsm > help <command-name>
```

To get a list of users on the HSMS, enter `user list`.

```bash
aws-cloudhsm > user list
```

To end your CloudHSM CLI session, run the following command:

```bash
aws-cloudhsm > quit
```

**Single Command mode**

If you run CloudHSM CLI using Single Command Mode, you need to set two environment variables to provide credentials: CLOUDHSM_PIN and CLOUDHSM_ROLE:
$ export CLOUDHSM_ROLE=admin

$ export CLOUDHSM_PIN=admin_username:admin_password

After doing this, you can execute commands using the credentials stored in your environment.

$ cloudhsm-cli user change-password --username alice --role crypto-user
Enter password:
Confirm password:
{
  "error_code": 0,
  "data": {
    "username": "alice",
    "role": "crypto-user"
  }
}

Key attributes for CloudHSM CLI

This topic describes how to use CloudHSM CLI to set key attributes. A key attribute in CloudHSM CLI can define a key's type, how a key can function, or how a key is labeled. Some attributes define unique characteristics (a key's type, for example). Other attributes can be set to true or false—changing them either activates or deactivates a part of the key's functionality.

For examples showing how to use key attributes, see the commands listed under the parent command key (p. 195).

Supported attributes

As a best practice, only set values for attributes you wish to make restrictive. If you don't specify a value, CloudHSM CLI uses the default value specified in the table below.

The following table lists the key attributes, possible values, defaults, and related notes. An empty cell in the Value column indicates that there is no specific default value assigned to the attribute.

<table>
<thead>
<tr>
<th>CloudHSM CLI attribute</th>
<th>Value</th>
<th>Modifiable with key set-attribute (p. 220)</th>
<th>Settable at key creation</th>
</tr>
</thead>
<tbody>
<tr>
<td>always-sensitive</td>
<td>The value is True if sensitive has always been set to True and has never changed.</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>check-value</td>
<td>The check value of the key. For more information, see Additional Details (p. 190).</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>class</td>
<td>Possible values: secret-key, public-key, and private-key.</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>curve</td>
<td>Elliptic curve used to generate the EC key pair.</td>
<td>No</td>
<td>Settable with RSA, not settable with EC</td>
</tr>
<tr>
<td>CloudHSM CLI attribute</td>
<td>Value</td>
<td>Modifiable with [key set-attribute](p. 220)</td>
<td>Settable at key creation</td>
</tr>
<tr>
<td>------------------------</td>
<td>----------------------------------------------------------------------</td>
<td>---------------------------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>decrypt</td>
<td>Default: False</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>derive</td>
<td>Default: False</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>destroyable</td>
<td>Default: True</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>ec-point</td>
<td>For EC keys, DER-encoding of ANSI X9.62 ECPoint value &quot;Q&quot; in a hexadecimal format. For other key types, this attribute does not exist.</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>encrypt</td>
<td>Default: False</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>extractable</td>
<td>Default: True</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>id</td>
<td>Default: Empty</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>key-length-bytes</td>
<td>Required for generating an AES key. Valid values: 16, 24, and 32 bytes.</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>key-type</td>
<td>Possible values: aes, rsa, and ec</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>label</td>
<td>Default: Empty</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>local</td>
<td>Default: True for keys generated in the HSM, False for keys imported into the HSM.</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>modifiable</td>
<td>Default: True</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>modulus</td>
<td>The modulus that was used to generate an RSA key pair. For other key types, this attribute does not exist.</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>modulus-size-bits</td>
<td>Required for generating an RSA key pair. Minimum value is 2048.</td>
<td>No</td>
<td>Settable with RSA, not settable with EC</td>
</tr>
<tr>
<td>CloudHSM CLI attribute</td>
<td>Value</td>
<td>Modifiable with [key set-attribute (p. 220)]</td>
<td>Settable at key creation</td>
</tr>
<tr>
<td>------------------------</td>
<td>-------</td>
<td>---------------------------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>never-extractable</td>
<td>The value is True if extractable has never been set to False. The value is False if extractable has ever been set to True.</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>private</td>
<td>Default: True</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>public-exponent</td>
<td>Required for generating an RSA key pair. Valid values: The value must be an odd number greater than or equal to 65537.</td>
<td>No</td>
<td>Settable with RSA, not settable with EC</td>
</tr>
</tbody>
</table>
| sensitive              | Default:  
  - The value is True for AES keys and EC and RSA private keys.  
  - The value is False for EC and RSA public keys. | No                         | Settable with private keys, not settable with public keys. |
| sign                   | Default:  
  - The value is True for AES keys.  
  - The value is False for RSA and EC keys. | Yes                       | Yes                       |
| token                  | Default: False | No                         | Yes                       |
| trusted                | Default: False | Yes                       | No                       |
| unwrap                 | Default: False | Yes                       | Yes                       |
| unwrap-template        | Values should use the attribute template applied to any key unwrapped using this wrapping key. | Yes                       | No                       |
| verify                 | Default:  
  - The value is True for AES keys.  
  - The value is False for RSA and EC keys. | Yes                       | Yes                       |
| wrap                   | Default: False | Yes                       | Yes                       |
Additional Details

Check value

The check value is a 3-byte hash or checksum of a key that is generated when the HSM imports or generates a key. You can also calculate a check value outside of the HSM, such as after you export a key. You can then compare the check value values to confirm the identity and integrity of the key. To get the check value of a key, use key list (p. 214) with the verbose flag.

AWS CloudHSM uses the following standard methods to generate a check value:

- **Symmetric keys**: First 3 bytes of the result of encrypting a zero-block with the key.
- **Asymmetric key pairs**: First 3 bytes of the SHA-1 hash of the public key.
- **HMAC keys**: KCV for HMAC keys is not supported at this time.

Related topics

- key (p. 195)
- Reference for CloudHSM CLI commands (p. 190)

Reference for CloudHSM CLI commands

CloudHSM CLI helps admins manage users in their AWS CloudHSM cluster. CloudHSM CLI can be run in two modes: Interactive Mode and Single Command Mode. For a quick start, see Getting started with CloudHSM Command Line Interface (CLI) (p. 184).

To run most CloudHSM CLI commands, you must start the CloudHSM CLI and log in to the HSM. If you add or delete HSMs, update the configuration files for CloudHSM CLI. Otherwise, the changes that you make might not be effective for all HSMs in the cluster.

The following topics describe commands in CloudHSM CLI:

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
<th>User Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>cluster activate</td>
<td>Activates an CloudHSM cluster and provides confirmation the cluster is new.</td>
<td>Unactivated admin</td>
</tr>
<tr>
<td></td>
<td>This must be done before any other operations can be performed.</td>
<td></td>
</tr>
<tr>
<td>key delete</td>
<td>Deletes a key from your AWS CloudHSM cluster.</td>
<td>Crypto user (CU)</td>
</tr>
<tr>
<td>Command</td>
<td>Description</td>
<td>User Type</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td><strong>key generate-file (p. 196)</strong></td>
<td>Generates a key file in your AWS CloudHSM cluster.</td>
<td>CU</td>
</tr>
<tr>
<td><strong>key generate-asymmetric-pair rsa (p. 203)</strong></td>
<td>Generates an asymmetric RSA key pair in your AWS CloudHSM cluster.</td>
<td>CU</td>
</tr>
<tr>
<td><strong>key generate-asymmetric-pair ec (p. 198)</strong></td>
<td>Generates an asymmetric Elliptic-curve (EC) key pair in your AWS CloudHSM cluster.</td>
<td>CU</td>
</tr>
<tr>
<td><strong>key generate-symmetric aes (p. 208)</strong></td>
<td>Generates a symmetric AES key in your AWS CloudHSM cluster.</td>
<td>CU</td>
</tr>
<tr>
<td><strong>key generate-symmetric generic-secret (p. 211)</strong></td>
<td>Generates a symmetric Generic Secret key in your AWS CloudHSM cluster.</td>
<td>CU</td>
</tr>
<tr>
<td><strong>key list (p. 214)</strong></td>
<td>Finds all keys for the current user present in your AWS CloudHSM cluster.</td>
<td>CU</td>
</tr>
<tr>
<td><strong>key set-attribute (p. 220)</strong></td>
<td>Sets the attributes of keys in your AWS CloudHSM cluster.</td>
<td>CU</td>
</tr>
<tr>
<td><strong>key share (p. 223)</strong></td>
<td>Shares a key with other CUs in your AWS CloudHSM cluster.</td>
<td>CU</td>
</tr>
<tr>
<td><strong>key unshare (p. 225)</strong></td>
<td>Unshares a key with other CUs in your AWS CloudHSM cluster.</td>
<td>CU</td>
</tr>
<tr>
<td><strong>login (p. 230)</strong></td>
<td>Log in to your AWS CloudHSM cluster.</td>
<td>Admin, CU</td>
</tr>
<tr>
<td><strong>logout (p. 232)</strong></td>
<td>Log out of your AWS CloudHSM cluster.</td>
<td>Admin, CU</td>
</tr>
<tr>
<td><strong>user change-mfa (p. 233)</strong></td>
<td>Changes a user’s multi-factor authentication (MFA) strategy.</td>
<td>Admin, CU</td>
</tr>
<tr>
<td><strong>user change-password (p. 235)</strong></td>
<td>Changes the passwords of users on the HSMs. Any user can change their own password. Admins can change anyone's password.</td>
<td>Admin, CU</td>
</tr>
<tr>
<td><strong>user create (p. 240)</strong></td>
<td>Creates a user in your AWS CloudHSM cluster.</td>
<td>Admin</td>
</tr>
<tr>
<td><strong>user delete (p. 241)</strong></td>
<td>Deletes a user in your AWS CloudHSM cluster.</td>
<td>Admin</td>
</tr>
<tr>
<td><strong>user list (p. 243)</strong></td>
<td>Lists the users in your AWS CloudHSM cluster.</td>
<td>All 1, including unauthenticated users. Login is not required.</td>
</tr>
<tr>
<td><strong>user change-quorum token-sign register (p. 238)</strong></td>
<td>Registers the quorum token-sign quorum strategy for a user.</td>
<td>Admin</td>
</tr>
</tbody>
</table>
### Command

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
<th>User Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>quorum token-sign delete (p. 245)</code></td>
<td>Deletes one or more tokens for a quorum authorized service.</td>
<td>Admin</td>
</tr>
<tr>
<td><code>quorum token-sign generate (p. 246)</code></td>
<td>Generates a token for a quorum authorized service.</td>
<td>Admin</td>
</tr>
<tr>
<td><code>quorum token-sign list (p. 248)</code></td>
<td>Lists all token-sign quorum tokens present in your CloudHSM cluster.</td>
<td>All ¹, including unauthenticated users. Login is not required.</td>
</tr>
<tr>
<td><code>Quorum token-sign list-quorum-values (p. 249)</code></td>
<td>Lists the quorum values set in your CloudHSM cluster.</td>
<td>All ¹, including unauthenticated users. Login is not required.</td>
</tr>
<tr>
<td><code>quorum token-sign list-timeouts (p. 249)</code></td>
<td>Obtains the token timeout period in seconds for all token types.</td>
<td>Admin and crypto user</td>
</tr>
<tr>
<td><code>quorum token-sign set-quorum-value (p. 250)</code></td>
<td>Sets a new quorum value for a quorum authorized service.</td>
<td>Admin</td>
</tr>
<tr>
<td><code>quorum token-sign set-timeout (p. 252)</code></td>
<td>Sets the token timeout period in seconds for each token type.</td>
<td>Admin</td>
</tr>
</tbody>
</table>

### Annotations

- [1] All users includes all listed roles and users not logged in.

### cluster

**cluster** is a parent category for a group of commands that, when combined with the parent category, create a command specific to users. Currently, the user category consists of the following commands:

- [cluster activate (p. 192)]
- [cluster hsm-info (p. 193)]

#### cluster activate

Use the **cluster activate** command in CloudHSM CLI to activate a new cluster (p. 28). This command must be run before the cluster can be used to perform cryptographic operations.

### User type

The following types of users can run this command.

- unactivated admin

### Syntax

This command has no parameters.

```bash
aws-cloudhsm > help cluster activate
Activate a cluster
```
This command will set the initial Admin password. This process will cause your CloudHSM cluster to move into the ACTIVE state.

**Usage:**
```
cloudhsm-cli cluster activate [OPTIONS] [--password <PASSWORD>]
```

**Options:**
- `--password <PASSWORD>`
  Optional: Plaintext activation password. If you do not include this argument you will be prompted for it.

**Example**

This command activates your cluster by setting the initial password for your admin user.

```bash
aws-cloudhsm > cluster activate
Enter password: 
Confirm password: 
{
  "error_code": 0,
  "data": "Cluster activation successful"
}
```

**Related topics**
- [user create (p. 240)](#)
- [user delete (p. 241)](#)
- [user change-password (p. 235)](#)

### cluster hsm-info

Use the **cluster hsm-info** command in CloudHSM CLI to list the HSMs in your cluster. You do not need to be logged in to CloudHSM CLI to run this command.

**Note**

If you add or delete HSMs, update the configuration files that the AWS CloudHSM client and the command line tools use. Otherwise, the changes that you make might not be effective on all HSMs in the cluster.

**User type**

The following types of users can run this command.

- All users. You do not need to be logged in to run this command.

**Syntax**

```bash
aws-cloudhsm > help cluster hsm-info
List info about each HSM in the cluster

Usage: cloudhsm-cli cluster hsm-info [OPTIONS]

Options:
--config <CONFIG> [default: /opt/cloudhsm/etc/cloudhsm-cli.cfg]
```
Example

This command lists the HSMs present in your AWS CloudHSM cluster.

```
aws-cloudhsm > cluster hsm-info
{
  "error_code": 0,
  "data": {
    "hsms": [
      {
        "vendor": "Marvell Semiconductors, Inc.",
        "model": "NITROX-III CNN35XX-NFBE",
        "serial-number": "5.3G1941-ICM000590",
        "hardware-version-major": "5",
        "hardware-version-minor": "3",
        "firmware-version-major": "2",
        "firmware-version-minor": "6",
        "firmware-build-number": "16",
        "firmware-id": "CNN35XX-NFBE-FW-2.06-16"
        "fips-state": "2 [FIPS mode with single factor authentication]"
      },
      {
        "vendor": "Marvell Semiconductors, Inc.",
        "model": "NITROX-III CNN35XX-NFBE",
        "serial-number": "5.3G1941-ICM000625",
        "hardware-version-major": "5",
        "hardware-version-minor": "3",
        "firmware-version-major": "2",
        "firmware-version-minor": "6",
        "firmware-build-number": "16",
        "firmware-id": "CNN35XX-NFBE-FW-2.06-16"
        "fips-state": "2 [FIPS mode with single factor authentication]"
      },
      {
        "vendor": "Marvell Semiconductors, Inc.",
        "model": "NITROX-III CNN35XX-NFBE",
        "serial-number": "5.3G1941-ICM000663",
        "hardware-version-major": "5",
        "hardware-version-minor": "3",
        "firmware-version-major": "2",
        "firmware-version-minor": "6",
        "firmware-build-number": "16",
        "firmware-id": "CNN35XX-NFBE-FW-2.06-16"
        "fips-state": "2 [FIPS mode with single factor authentication]"
      }
    ]
  }
}
```

The output has the following attributes:

- **Vendor**: The vendor name of the HSM.
- **Model**: The model number of the HSM.
- **Serial-number**: The serial number of the HSM. This may change due to replacements.
- **Hardware-version-major**: The major hardware version.
- **Hardware-version-minor**: The minor hardware version.
- **Firmware-version-major**: The major firmware version.
- **Firmware-version-minor**: The minor firmware version.
- **Firmware-build-number**: The firmware build number.
- **Firmware-id**: The firmware ID, which includes the major and minor versions along with the build.
key

key is a parent category for a group of commands that, when combined with the parent category, create a command specific to keys. Currently, this category consists of the following commands:

- key delete (p. 195)
- key generate-file (p. 196)
- key generate-asymmetric-pair (p. 198)
  - key generate-asymmetric-pair rsa (p. 203)
  - key generate-asymmetric-pair ec (p. 198)
- key generate-symmetric (p. 208)
  - key generate-symmetric aes (p. 208)
  - key generate-symmetric generic-secret (p. 211)
- key list (p. 214)
- key set-attribute (p. 220)
- key share (p. 223)
- key unshare (p. 225)

key delete

Use the **key delete** command in CloudHSM CLI to delete a key from an AWS CloudHSM cluster. You can only delete one key at a time. Deleting one key in a key pair has no effect on the other key in the pair.

Only the CU who created the key and consequently owns it can delete the key. Users who share the key, but do not own it, can use the key in cryptographic operations, but can not delete it.

User type

The following types of users can run this command.

- Crypto users (CUs)

Requirements

- To run this command, you must be logged in as a CU.

Syntax

```
aws-cloudhsm > help key delete
Delete a key in the HSM cluster

Usage: key delete --filter [<KEY_ATTRIBUTES>...]

Options:
  --filter [<KEY_ATTRIBUTES>...]  Space separated list of key attributes in the form of attr.KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE to select a matching key for deletion
  -h, --help                        Print help
```
Example

aws-cloudhsm > key delete --filter attr.label="ec-test-public-key"
{
  "error_code": 0,
  "data": {
    "message": "Key deleted successfully"
  }
}

Arguments

<KEY_ATTRIBUTES>

Specifies a space separated list of key attributes in the form of attr.KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE (for example, attr.token=true) to select a matching key for file generation. 1 or more attributes may be supplied to refine selection criteria.

For a list of supported CloudHSM CLI key attributes, see Key attributes for CloudHSM CLI (p. 187)

Required: Yes

Related topics

• key list (p. 214)
• key generate-file (p. 196)
• key unshare (p. 225)
• Key attributes for CloudHSM CLI (p. 187)
• Using CloudHSM CLI to filter keys (p. 145)

key generate-file

The key generate-file command exports a private key reference from an HSM in fake PEM format. The fake PEM file, which does not contain the actual private key material but instead references the private key in the HSM, can then be used to establish SSL/TLS offloading from your web server to AWS CloudHSM. For more information, see SSL/TLS offloading (p. 507).

User type

The following types of users can run this command.

• Crypto users (CUs)

Requirements

To run this command, you must be logged in as a CU.

Syntax

aws-cloudhsm > help key generate-file
Generate a key file from a key in the HSM cluster

Usage: key generate-file --encoding <ENCODING> --path <PATH> --filter [<KEY_ATTRIBUTES>...]

Options:
  --encoding <ENCODING>
Encoding format for the key file

Possible values:
- reference-pem: PEM formatted key reference

--path <PATH>
Filepath where the key file will be written

--filter [<KEY_ATTRIBUTES>...]
Space separated list of key attributes in the form of attr.KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE to select a matching key for file generation

-h, --help
Print help (see a summary with '-h')

Example

This example shows how to use **key generate-file** to generate a key file in your AWS CloudHSM cluster.

Example

```bash
aws-cloudhsm > key generate-file --encoding reference-pem --path /tmp/ec-private-key.pem --filter attr.label="ec-test-private-key"
{
   "error_code": 0,
   "data": {
      "message": "Successfully generated key file"
   }
}
```

Arguments

**<ENCODING>**

Specifies the encoding format for the key file

Required: Yes

**<PATH>**

Specifies the file path where the key file will be written

Required: Yes

**<KEY_ATTRIBUTES>**

Specifies a space separated list of key attributes in the form of attr.KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE (for example, attr.token=true) to select a matching key for file generation. 1 or more attributes may be supplied to refine selection criteria.

For a list of supported key attributes, see [Key attributes for CloudHSM CLI](p. 187).

Required: Yes

Related topics

- [Key attributes for CloudHSM CLI](p. 187)
- [Using CloudHSM CLI to filter keys](p. 145)
- [key generate-asymmetric-pair](p. 198)
- [key generate-symmetric](p. 208)
key generate-asymmetric-pair

**key generate-asymmetric-pair** is a parent category for a group of commands that, when combined with the parent category, create a command that generates asymmetric key pairs. Currently, this category consists of the following commands:

- [key generate-asymmetric-pair ec (p. 198)]
- [key generate-asymmetric-pair rsa (p. 203)]

**key generate-asymmetric-pair ec**

Use the **key asymmetric-pair ec** command in CloudHSM CLI to generate an asymmetric Elliptic-curve (EC) key pair in your AWS CloudHSM cluster.

**User type**

The following types of users can run this command.

- Crypto users (CUs)

**Requirements**

To run this command, you must be logged in as a CU.

**Syntax**

```bash
aws-cloudhsm > help key generate-asymmetric-pair ec
Generate an Elliptic-Curve Cryptography (ECC) key pair

Usage: key generate-asymmetric-pair ec [OPTIONS] --public-label <PUBLIC_LABEL> --private-label <PRIVATE_LABEL> --curve <CURVE>

Options:
  --public-label <PUBLIC_LABEL>
  Label for the public key
  --private-label <PRIVATE_LABEL>
  Label for the private key
  --session
  Creates a session key pair that exists only in the current session. The key cannot be recovered after the session ends
  --curve <CURVE>
  Elliptic curve used to generate the key pair [possible values: prime256v1, secp256r1, secp224r1, secp384r1, secp256k1, secp521r1]
  --public-attributes [<PUBLIC_KEY_ATTRIBUTES>...]
  Space separated list of key attributes to set for the generated EC public key in the form of KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE
  --private-attributes [<PRIVATE_KEY_ATTRIBUTES>...]
  Space separated list of key attributes to set for the generated EC private key in the form of KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE
  -h, --help
  Print help
```

**Examples**

These examples show how to use the **key generate-asymmetric-pair ec** command to create an EC key pair.

**Example Example: Create an EC key pair**

```bash
aws-cloudhsm > key generate-asymmetric-pair ec \\n```
--curve secp224r1 \
--public-label ec-public-key-example \
--private-label ec-private-key-example

```json
{
  "error_code": 0,
  "data": {
    "public_key": {
      "key-reference": "0x000000000012000b",
      "key-info": {
        "key-owners": [
          {
            "username": "cu1",
            "key-coverage": "full"
          }
        ],
        "shared-users": [],
        "cluster-coverage": "session"
      },
      "attributes": {
        "key-type": "ec",
        "label": "ec-public-key-example",
        "id": "",
        "check-value": "0xd7c1a7",
        "class": "public-key",
        "encrypt": false,
        "decrypt": false,
        "token": false,
        "always-sensitive": false,
        "derive": false,
        "destroyable": true,
        "extractable": true,
        "local": true,
        "modifiable": true,
        "never-extractable": false,
        "private": true,
        "sensitive": false,
        "sign": false,
        "trusted": false,
        "unwrap": false,
        "verify": false,
        "wrap": false,
        "wrap-with-trusted": false,
        "key-length-bytes": 57,
        "ec-point": "0x047096513df542250a6b228fd9cb67fd0c903abc9348867681974d6f5710b3f01d79da8ad1e9de745fb9f38ac8622a1b",
        "curve": "secp224r1"
      }
    },
    "private_key": {
      "key-reference": "0x000000000012000c",
      "key-info": {
        "key-owners": [
          {
            "username": "cu1",
            "key-coverage": "full"
          }
        ],
        "shared-users": [],
        "cluster-coverage": "session"
      },
      "attributes": {
        "key-type": "ec",
        "label": "ec-private-key-example",
        "id": "",
        "check-value": "0xd7c1a7",
        "class": "private-key",
        "encrypt": false,
        "decrypt": false,
        "token": false,
        "always-sensitive": false,
        "derive": false,
        "destroyable": true,
        "extractable": true,
        "local": true,
        "modifiable": true,
        "never-extractable": false,
        "private": true,
        "sensitive": false,
        "sign": false,
        "trusted": false,
        "unwrap": false,
        "verify": false,
        "wrap": false,
        "wrap-with-trusted": false,
        "key-length-bytes": 57,
        "ec-point": "0x0a047096513df542250a6b228fd9cb67fd0c903abc9348867681974d6f5710b3f01d79da8ad1e9de745fb9f38ac8622a1b",
        "curve": "secp224r1"
      }
    }
  }
}```
"encrypt": false,
"decrypt": false,
"token": false,
"always-sensitive": true,
"derive": false,
"destroyable": true,
"extractable": true,
"local": true,
"modifiable": true,
"never-extractable": false,
"private": true,
"sensitive": true,
"sign": false,
"trusted": false,
"unwrap": false,
"verify": false,
"wrap": false,
"wrap-with-trusted": false,
"key-length-bytes": 122,
"ec-point": "0x047096513df542250a6b228fd9cb67fd0c903abc93488467681974d6f371083fecd1d79da8ad1e9ede745fb9f38ac8622a1b",
"curve": "secp224r1"

Example Example: Create an EC key pair with optional attributes

aws-cloudhsm > key generate-asymmetric-pair ec \
    --curve secp224r1 \
    --public-label ec-public-key-example \
    --private-label ec-private-key-example \
    --public-attributes token=true encrypt=true \
    --private-attributes token=true decrypt=true

{  
    "error_code": 0,
    "data": {
        "public_key": {  
            "key-reference": "0x0000000002806eb",
            "key-info": {  
                "key-owners": [  
                    {  
                        "username": "cu1",
                        "key-coverage": "full"
                    }
                ],
                "shared-users": [],
                "cluster-coverage": "full"
            },
            "attributes": {  
                "key-type": "ec",
                "label": "ec-public-key-example",
                "id": "",
                "check-value": "0xedef86",
                "class": "public-key",
                "encrypt": true,
                "decrypt": false,
                "token": true,
                "always-sensitive": false,
                "derive": false,
                "destroyable": true,
                "extractable": true,
                "local": true,
                "private": true,
                "sensitive": true,
                "sign": false,
                "trusted": false,
                "unwrap": false,
                "verify": false,
                "wrap": false,
                "wrap-with-trusted": false,
                "key-length-bytes": 122,
                "ec-point": "0x047096513df542250a6b228fd9cb67fd0c903abc93488467681974d6f371083fecd1d79da8ad1e9ede745fb9f38ac8622a1b",
                "curve": "secp224r1"
            }  
        }  
    }  
}
"modifiable": true,
"never-extractable": false,
"private": true,
"sensitive": false,
"sign": false,
"trusted": false,
"unwrap": false,
"verify": false,
"wrap": false,
"wrap-with-trusted": false,
"key-length-bytes": 57,
"ec-point": "0x0487af31882189ec29eddf17a48e8b9cebb075b7b5afcf5522fe9c83a029a450cc68592889a1ebf45f32240da5140d58729f1e31e0a0",
"curve": "secp224r1"
}
,"private_key": {
"key-reference": "0x0000000000280c82",
"key-info": {
  "key-owners": [
    {
      "username": "cu1",
      "key-coverage": "full"
    }
  ],
  "shared-users": [],
  "cluster-coverage": "full"
},
"attributes": {
  "key-type": "ec",
  "label": "ec-private-key-example",
  "id": "",
  "check-value": "0xed6fe86",
  "class": "private-key",
  "encrypt": false,
  "decrypt": true,
  "token": true,
  "always-sensitive": true,
  "derive": false,
  "destroyable": true,
  "extractable": true,
  "local": true,
  "modifiable": true,
  "never-extractable": false,
  "private": true,
  "sensitive": true,
  "sign": false,
  "trusted": false,
  "unwrap": false,
  "verify": false,
  "wrap": false,
  "wrap-with-trusted": false,
  "key-length-bytes": 122,
  "ec-point": "0x0487af31882189ec29eddf17a48e8b9cebb075b7b5afcf5522fe9c83a029a450cc68592889a1ebf45f32240da5140d58729f1e31e0a0",
  "curve": "secp224r1"
}
}
Arguments

<CURVE>

Specifies the identifier for the elliptic curve.

- prime256v1
- secp256r1
- secp224r1
- secp384r1
- secp256k1
- secp521r1

Required: Yes

<PUBLIC_KEY_ATTRIBUTES>

Specifies a space separated list of key attributes to set for the generated EC public key in the form of

KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE (for example, token=true)

For a list of supported key attributes, see Key attributes for CloudHSM CLI (p. 187).

Required: No

<PUBLIC_LABEL>

Specifies a user defined label for the public-key. The maximum size allowable for label is 126 characters.

Required: Yes

<PRIVATE_KEY_ATTRIBUTES>

 Specifies a space separated list of key attributes to set for the generated EC private key in the form of

KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE (for example, token=true)

For a list of supported key attributes, see Key attributes for CloudHSM CLI (p. 187).

Required: No

<PRIVATE_LABEL>

Specifies a user defined label for the private-key. The maximum size allowable for label is 126 characters.

Required: Yes

<SESSION>

Creates a key that exists only in the current session. The key cannot be recovered after the session ends.

Use this parameter when you need a key only briefly, such as a wrapping key that encrypts, and then quickly decrypts, another key. Do not use a session key to encrypt data that you might need to decrypt after the session ends.

By default, keys that are generated are persistent (token) keys. Passing in <SESSION> changes this, ensuring a key generated with this argument is a session (ephemeral) key.

Required: No

Related topics

- Key attributes for CloudHSM CLI (p. 187)
Using CloudHSM CLI to filter keys (p. 145)

key generate-asymmetric-pair rsa

Use the key generate-asymmetric-pair rsa command generates an asymmetric RSA key pair in your AWS CloudHSM cluster.

User type

The following types of users can run this command.

- Crypto users (CUs)

Requirements

To run this command, you must be logged in as a CU.

Syntax

```
aws-cloudhsm > help key generate-asymmetric-pair rsa
Generate an RSA key pair


Options:
    --public-label <PUBLIC_LABEL>
        Label for the public key
    --private-label <PRIVATE_LABEL>
        Label for the private key
    --session
        Creates a session key pair that exists only in the current session. The key cannot be recovered after the session ends
    --modulus-size-bits <MODULUS_SIZE_BITS>
        Modulus size in bits used to generate the RSA key pair
    --public-exponent <PUBLIC_EXPONENT>
        Public exponent used to generate the RSA key pair
    --public-attributes ["<PUBLIC_KEY_ATTRIBUTES>..."
        Space separated list of key attributes to set for the generated RSA public key in the form of KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE
    --private-attributes ["<PRIVATE_KEY_ATTRIBUTES>..."
        Space separated list of key attributes to set for the generated RSA private key in the form of KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE
    -h, --help
        Print help
```

Examples

These examples show how to use key generate-asymmetric-pair rsa to create a RSA key pair.

Example Example: Create an RSA key pair

```
aws-cloudhsm > key generate-asymmetric-pair rsa rsa
    --public-exponent 65537
    --modulus-size-bits 2048
    --public-label rsa-public-key-example
    --private-label rsa-private-key-example
{
    "error_code": 0,
```
"data": {
  "public_key": {
    "key-reference": "0x0000000000160010",
    "key-info": {
      "key-owners": [
        {
          "username": "cu1",
          "key-coverage": "full"
        }
      ],
      "shared-users": [],
      "cluster-coverage": "session"
    },
    "attributes": {
      "key-type": "rsa",
      "label": "rsa-public-key-example",
      "id": "",
      "check-value": "0x498e1f",
      "class": "public-key",
      "encrypt": false,
      "decrypt": false,
      "token": false,
      "always-sensitive": false,
      "derive": false,
      "destroyable": true,
      "extractable": true,
      "local": true,
      "modifiable": true,
      "never-extractable": false,
      "private": true,
      "sensitive": false,
      "sign": false,
      "trusted": false,
      "unwrap": false,
      "verify": false,
      "wrap": false,
      "wrap-with-trusted": false,
      "key-length-bytes": 512,
      "public-exponent": "0x010001",
      "modulus": "0xdca0669dc8288ed3bad9590bd21c7e6192661407021b3fcdcf4a593d93dd24f6d41af8e4e73b04c847751c6dbaf535e89a865e7daa6ce696b46b909db2ab6be871ee700fd0a448b5e975bb64caee77ac908749212463e37a577ba57ce3e574cb057bc3b7d20bd6fd91948ae336ae23b52d73b7f5b6acc2543ed6358e08d326d280ce489571f4d34316a2ea1904d513ca12bfa040782048",
      "modulus-size-bits": 2048
    }
  },
  "private_key": {
    "key-reference": "0x0000000000160011",
    "key-info": {
      "key-owners": [
        {
          "username": "cu1",
          "key-coverage": "full"
        }
      ],
      "shared-users": [],
      "cluster-coverage": "session"
    },
    "attributes": {
      "key-type": "rsa",
      "label": "rsa-private-key-example",
      "id": "",
      "check-value": "0x498e1f",
      "class": "private-key",
      "encrypt": false,
      "decrypt": false,
Example Example: Create an RSA key pair with optional attributes

```bash
aws-cloudhsm > key generate-asymmetric-pair rsa \
--public-exponent 65537 \ 
--modulus-size-bits 2048 \ 
--public-label rsa-public-key-example \ 
--private-label rsa-private-key-example \ 
--public-attributes token=true encrypt=true \ 
--private-attributes token=true decrypt=true
```

```json
{
  "error_code": 0,
  "data": {
    "public_key": {
      "key-reference": "0x000000000280cc8",
      "key-info": {
        "key-owners": [
          {
            "username": "cu1",
            "key-coverage": "full"
          }
        ],
        "shared-users": [],
        "cluster-coverage": "full"
      },
      "attributes": {
        "key-type": "rsa",
        "label": "rsa-public-key-example",
        "id": "",
        "check-value": "0x01fe6e",
        "class": "public-key",
        "encrypt": true,
        "decrypt": false,
        "token": true,
        "always-sensitive": false,
        "derive": false,
        "destroyable": true,
        "key-length-bytes": 1217,
        "public-exponent": "0x010001",
        "modulus": "0xdfca0669dc8288ed3bad995099bd21c7e6192661407021b3f4cdf4a593d939dd24f4d641af8e4e73b04c847751c6dbdff35a9d8bfe71cb54a2c3036d17415c81b7345d7804ff24c45117f0a1020dca7794df037a10aadec8653473b2088711f7b7d8b58431654e14e31af0e00511da641058fb7475ffdbe60f",
        "modulus-size-bits": 2048
      }
    }
  }
}
```
"extractable": true,
"local": true,
"modifiable": true,
"never-extractable": false,
"private": true,
"sensitive": false,
"sign": false,
"trusted": false,
"unwrap": false,
"verify": false,
"wrap": false,
"wrap-with-trusted": false,
"key-length-bytes": 512,
"public-exponent": "0x010001",
"modulus": "0xb1d27e857a876f4e9fd5de748a763c539b359f937eb4260e30d1435485a732c878cdad9c72538e2215351b1d41358c9bff09f9c573a80f9b435a57b02b6e2c0522542ef5e1f6a9964537437812b542e35cafe8592e866f0298508f7967e6a0144029d72f6e6296d6c116d5744c6d60d14d3bf3cb978fe6b75ac67b7089bafdf50d8687213b31abc7dc1bad422780d29c851d510b56f9321330226535225bd129f849110177e9e3a33e1ded83fb57af35f847e532db50cd7e726f23910d2671c6364092e8346978cc5ce720775ac3160f0ca97275d8318b7",
"modulus-size-bits": 2048
}
Arguments

<MODULUS_SIZE_BITS>

Specifies the length of the modulus in bits. The minimum value is 2048.

Required: Yes

PRIVATE_KEY_ATTRIBUTES

Specifies a space separated list of key attributes to set for the generated RSA private key in the form
of KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE (for example, token=true)

For a list of supported key attributes, see Key attributes for CloudHSM CLI (p. 187).

Required: No

PRIVATE_LABEL

Specifies a user defined label for the private-key. The maximum size allowable for label is 126
characters.

Required: Yes

PUBLIC_EXPONENT

Specifies the public exponent. The value must be an odd number greater than or equal to 65537.

Required: Yes

PUBLIC_KEY_ATTRIBUTES

Specifies a space separated list of key attributes to set for the generated RSA public key in the form
of KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE (for example, token=true)

For a list of supported key attributes, see Key attributes for CloudHSM CLI (p. 187).

Required: No

PUBLIC_LABEL

Specifies a user defined label for the public-key. The maximum size allowable for label is 126
characters.

Required: Yes

SESSION

Creates a key that exists only in the current session. The key cannot be recovered after the session
ends.

Use this parameter when you need a key only briefly, such as a wrapping key that encrypts, and
then quickly decrypts, another key. Do not use a session key to encrypt data that you might need to
decrypt after the session ends.

By default, keys that are generated are persistent (token) keys. Passing in <SESSION> changes this,
ensuring a key generated with this argument is a session (ephemeral) key.
key generate-symmetric

key generate-symmetric is a parent category for a group of commands that, when combined with the parent category, create a command that generates symmetric keys. Currently, this category consists of the following commands:

- key generate-symmetric aes (p. 208)
- key generate-symmetric generic-secret (p. 211)

key generate-symmetric aes

The key generate-symmetric aes command generates a symmetric AES key in your AWS CloudHSM cluster.

User type

The following types of users can run this command.

- Crypto users (CUs)

Requirements

To run this command, you must be logged in as a CU.

Syntax

aws-cloudhsm > help key generate-symmetric aes
Generate an AES key

Usage: key generate-symmetric aes [OPTIONS] --label <LABEL> --key-length-bytes <KEY_LENGTH_BYTES>

Options:
  --label <LABEL>
    Label for the key
  --session
    Creates a session key that exists only in the current session. The key cannot be recovered after the session ends
  --key-length-bytes <KEY_LENGTH_BYTES>
    Key length in bytes
  --attributes [...]
    Space separated list of key attributes to set for the generated AES key in the form of KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE
  -h, --help
    Print help

Examples

These examples show how to use the key generate-symmetric aes command to create an AES key.
Example Example: Create an AES key

```bash
aws-cloudhsm > key generate-symmetric aes \
--label example-aes \ 
--key-length-bytes 24 
{
  "error_code": 0,
  "data": {
    "key": {
      "key-reference": "0x00000000002e06bf",
      "key-info": {
        "key-owners": [
          {
            "username": "cu1",
            "key-coverage": "full"
          }
        ],
        "shared-users": [],
        "cluster-coverage": "session"
      },
      "attributes": {
        "key-type": "aes",
        "label": "example-aes",
        "id": "",
        "check-value": "0x9b94bd",
        "class": "secret-key",
        "encrypt": false,
        "decrypt": false,
        "token": false,
        "always-sensitive": true,
        "derive": false,
        "destroyable": true,
        "extractable": true,
        "local": true,
        "modifiable": true,
        "never-extractable": false,
        "private": true,
        "sensitive": true,
        "sign": true,
        "trusted": false,
        "unwrap": false,
        "verify": true,
        "wrap": false,
        "wrap-with-trusted": false,
        "key-length-bytes": 24
      }
    }
  }
}
```

Example Example: Create an AES key with optional attributes

```bash
aws-cloudhsm > key generate-symmetric aes \
--label example-aes \ 
--key-length-bytes 24 \ 
--attributes decrypt=true encrypt=true 
{
  "error_code": 0,
  "data": {
    "key": {
      "key-reference": "0x00000000002e06bf",
      "key-info": {
        "key-owners": [
          {
            "username": "cu1",
            "key-coverage": "full"
          }
        ],
        "shared-users": [],
        "cluster-coverage": "session"
      },
      "attributes": {
        "key-type": "aes",
        "label": "example-aes",
        "id": "",
        "check-value": "0x9b94bd",
        "class": "secret-key",
        "encrypt": false,
        "decrypt": false,
        "token": false,
        "always-sensitive": true,
        "derive": false,
        "destroyable": true,
        "extractable": true,
        "local": true,
        "modifiable": true,
        "never-extractable": false,
        "private": true,
        "sensitive": true,
        "sign": true,
        "trusted": false,
        "unwrap": false,
        "verify": true,
        "wrap": false,
        "wrap-with-trusted": false,
        "key-length-bytes": 24
      }
    }
  }
}
```
Arguments

**<KEY_ATTRIBUTES>**

Specifies a space separated list of key attributes to set for the generated AES key in the form of KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE (for example, token=true).

For a list of supported key attributes, see Key attributes for CloudHSM CLI (p. 187).

Required: No

**<KEY-LENGTH-BYTES>**

Specifies the key length in bytes.

Valid values:

- 16, 24, and 32

Required: Yes

**<LABEL>**

Specifies a user defined label for the AES key. The maximum size allowable for label is 126 characters.

Required: Yes
<SESSION>

Creates a key that exists only in the current session. The key cannot be recovered after the session ends.

Use this parameter when you need a key only briefly, such as a wrapping key that encrypts, and then quickly decrypts, another key. Do not use a session key to encrypt data that you might need to decrypt after the session ends.

By default, keys that are generated are persistent (token) keys. Passing in <SESSION> changes this, ensuring a key generated with this argument is a session (ephemeral) key.

Required: No

Related topics

- Key attributes for CloudHSM CLI (p. 187)
- Using CloudHSM CLI to filter keys (p. 145)

key generate-symmetric generic-secret

The key generate-asymmetric-pair command generates a symmetric Generic Secret key in your AWS CloudHSM cluster.

User type

The following types of users can run this command.

- Crypto users (CUs)

Requirements

To run this command, you must be logged in as a CU.

Syntax

```
aws-cloudhsm > key help generate-symmetric generic-secret
Generate a generic secret key

Usage: key generate-symmetric generic-secret [OPTIONS] --label <LABEL> --key-length-bytes <KEY_LENGTH_BYTES>

Options:
   --label <LABEL>
       Label for the key
   --session
       Creates a session key that exists only in the current session. The key cannot be recovered after the session ends
   --key-length-bytes <KEY_LENGTH_BYTES>
       Key length in bytes
   --attributes [<KEY_ATTRIBUTES>...]
       Space separated list of key attributes to set for the generated generic secret key in the form of KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE
   -h, --help
       Print help
```

Examples

These examples show how to use the key generate-symmetric generic-secret command to create a generic secret key.
Example Example: Create a generic secret key

```bash
aws-cloudhsm > key generate-symmetric generic-secret
   --label example-generic-secret
   --key-length-bytes 256
{
   "error_code": 0,
   "data": {
     "key": {
       "key-reference": "0x00000000002e08fd",
       "key-info": {
         "key-owners": [
           {
             "username": "cu1",
             "key-coverage": "full"
           }
         ],
         "shared-users": [],
         "cluster-coverage": "session"
       },
       "attributes": {
         "key-type": "generic-secret",
         "label": "example-generic-secret",
         "id": "",
         "class": "secret-key",
         "encrypt": false,
         "decrypt": false,
         "token": false,
         "always-sensitive": true,
         "derive": false,
         "destroyable": true,
         "extractable": true,
         "local": true,
         "modifiable": true,
         "never-extractable": false,
         "private": true,
         "sensitive": true,
         "sign": true,
         "trusted": false,
         "unwrap": false,
         "verify": true,
         "wrap": false,
         "wrap-with-trusted": false,
         "key-length-bytes": 256
       }
     }
   }
}
```

Example Example: Create a generic secret key with optional attributes

```bash
aws-cloudhsm > aws-cloudhsm > key generate-symmetric generic-secret
   --label example-generic-secret
   --key-length-bytes 256
   --attributes token=true encrypt=true
{
   "error_code": 0,
   "data": {
     "key": {
       "key-reference": "0x00000000002e08fd",
       "key-info": {
         "key-owners": [
           {
             "username": "cu1",
           }
         ],
         "shared-users": [],
         "cluster-coverage": "session"
       },
       "attributes": {
         "key-type": "generic-secret",
         "label": "example-generic-secret",
         "id": "",
         "class": "secret-key",
         "encrypt": false,
         "decrypt": false,
         "token": false,
         "always-sensitive": true,
         "derive": false,
         "destroyable": true,
         "extractable": true,
         "local": true,
         "modifiable": true,
         "never-extractable": false,
         "private": true,
         "sensitive": true,
         "sign": true,
         "trusted": false,
         "unwrap": false,
         "verify": true,
         "wrap": false,
         "wrap-with-trusted": false,
         "key-length-bytes": 256
       }
     }
   }
}
```
Arguments

**<KEY_ATTRIBUTES>**

Specifies a space separated list of key attributes to set for the generated AES key in the form of KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE (for example, token=true).

For a list of supported key attributes, see Key attributes for CloudHSM CLI (p. 187).

Required: No

**<KEY-LENGTH-BYTES>**

Specifies the key length in bytes.

Valid values:
- 1 to 800

Required: Yes

**<LABEL>**

Specifies a user defined label for the generic secret key. The maximum size allowable for label is 126 characters.

Required: Yes

**<SESSION>**

Creates a key that exists only in the current session. The key cannot be recovered after the session ends.
Use this parameter when you need a key only briefly, such as a wrapping key that encrypts, and then quickly decrypts, another key. Do not use a session key to encrypt data that you might need to decrypt after the session ends.

By default, keys that are generated are persistent (token) keys. Passing in `<SESSION>` changes this, ensuring a key generated with this argument is a session (ephemeral) key.

Required: No

Related topics

- Key attributes for CloudHSM CLI (p. 187)
- Using CloudHSM CLI to filter keys (p. 145)

**key list**

The key list command finds all keys for the current user present in your AWS CloudHSM cluster. The output includes keys that the user owns and shares, as well as all public keys in the CloudHSM cluster.

**User type**

The following types of users can run this command.

- Crypto users (CUs)

**Syntax**

```
aws-cloudhsm > help key list
List the keys the current user owns, shares, and all public keys in the HSM cluster
Usage: key list [OPTIONS]
Options:
  --filter [<KEY_ATTRIBUTES>...]  
      Space separated list of key attributes in the form of attr.KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE to select matching key(s) to list
  --max-items <MAX_ITEMS>
      The total number of items to return in the command's output. If the total number of items available is more than the value specified, a next-token is provided in the command's output. To resume pagination, provide the next-token value in the starting-token argument of a subsequent command [default: 10]
  --starting-token <STARTING_TOKEN>
      A token to specify where to start paginating. This is the next-token from a previously truncated response
  -v, --verbose
      If included, prints all attributes and key information for each matched key. By default each matched key only displays its key-reference and label attribute
  -h, --help
      Print help
```
**Note**  
By default, only 10 keys of the currently logged in user are displayed, and only the key-reference and label are displayed as output. Use the appropriate pagination options to display more or less keys as output.

```json
aws-cloudhsm > key list
{
   "error_code": 0,
   "data": {
      "matched_keys": [
         {
            "key-reference": "0x00000000000003d5",
            "attributes": {
               "label": "test_label_1"
            }
         },
         {
            "key-reference": "0x0000000000000626",
            "attributes": {
               "label": "test_label_2"
            }
         },...
      ],
      "total_key_count": 56,
      "returned_key_count": 10,
      "next_token": "10"
   }
}
```

**Example Example: Find all keys - verbose**

The output includes keys that the user owns and shares, as well as all public keys int the HSMs.

**Note**  
Note: By default, only 10 keys of the currently logged in user are displayed. Use the appropriate pagination options to display more or less keys as output.

```json
aws-cloudhsm > key list --verbose
{
   "error_code": 0,
   "data": {
      "matched_keys": [
         {
            "key-reference": "0x000000000012000c",
            "key-info": {
               "key-owners": [
                  {
                     "username": "cu1",
                     "key-coverage": "full"
                  }
               ],
               "shared-users": [],
               "cluster-coverage": "session"
            },
            "attributes": {
               "key-type": "ec",
               "label": "ec-test-private-key",
               "id": "",
               "check-value": "0x2a737d",
               "class": "private-key",
               "encrypt": false,
               "decrypt": false,
```
"token": false,
"always-sensitive": true,
"derive": false,
"destroyable": true,
"extractable": true,
"local": true,
"modifiable": true,
"never-extractable": false,
"private": true,
"sensitive": true,
"sign": false,
"trusted": false,
"unwrap": false,
"verify": false,
"wrap": false,
"wrap-with-trusted": false,
"key-length-bytes": 122,
"ec-point":
"0x8442d53274a6c0e1a23c165dc9ccdd72c64e98ae1a9594bb5284e752c746280667e11f1e983493c1c605e0a8071ede47c9e80406422d851f0aebf46ce8ac1e0489ef8671494c680890a2502f86d5a001766d74ed2446d10480b494f90243000",
"curve": "secp224r1"
},
{
"key-reference": "0x000000000012000d",
"key-info": {
"key-owners": [,
{,
"username": "cu1",
"key-coverage": "full"
}
],
"shared-users": [],
"cluster-coverage": "session"
},
"attributes": {
"key-type": "ec",
"label": "ec-test-public-key",
"id": "",
"check-value": "0x2a737d",
"class": "public-key",
"encrypt": false,
"decrypt": false,
"token": false,
"always-sensitive": false,
"derive": false,
"destroyable": true,
"extractable": true,
"local": true,
"modifiable": true,
"never-extractable": false,
"private": true,
"sensitive": false,
"sign": false,
"trusted": false,
"unwrap": false,
"verify": false,
"wrap": false,
"wrap-with-trusted": false,
"key-length-bytes": 57,
"ec-point":
"0x0442d53274a6c0e1a23c165dc9ccdd72c64e98ae1a9594bb5284e752c746280667e11f1e983493c1c605e0a8071ede47c9e80406422d851f0aebf46ce8ac1e0489ef8671494c680890a2502f86d5a001766d74ed2446d10480b494f90243000",
"curve": "secp224r1"
}
},
...
8 keys later...
"total_key_count": 1580,
"returned_key_count": 10
}
}

Example Example: Paginated return

The following example displays a paginated subset of the keys which shows only two keys. The example then provides a subsequent call to display the next two keys.

```bash
aws-cloudhsm > key list --verbose --max-items 2
{
  "error_code": 0,
  "data": {
    "matched_keys": [
      {
        "key-reference": "0x0000000000000030",
        "key-info": {
          "key-owners": [
            {
              "username": "cu1",
              "key-coverage": "full"
            }
          ],
          "shared-users": [],
          "cluster-coverage": "full"
        },
        "attributes": {
          "key-type": "aes",
          "label": "98a6688d1d964ed7b4b9c5c4b1909",
          "id": "",
          "check-value": "0xb28a46",
          "class": "secret-key",
          "encrypt": false,
          "decrypt": false,
          "token": true,
          "always-sensitive": true,
          "derive": false,
          "destroyable": true,
          "extractable": true,
          "local": true,
          "modifiable": true,
          "never-extractable": false,
          "private": true,
          "sensitive": true,
          "sign": true,
          "trusted": false,
          "unwrap": false,
          "verify": true,
          "wrap": false,
          "wrap-with-trusted": false,
          "key-length-bytes": 32
        }
      },
      {
        "key-reference": "0x0000000000000042",
        "key-info": {
          "key-owners": [
            {
              "username": "cu1",
              "key-coverage": "full"
            }
          ],
          "shared-users": []
        }
      }
    ]
  }
}
```
To display the next 2 keys, a subsequent call can be made:

```
aws-cloudhsm > key list --verbose --max-items 2 --starting-token 2
```

```json
{
  "error_code": 0,
  "data": {
    "matched_keys": [
    {
      "key-reference": "0x0000000000000081",
      "key-info": {
        "key-owners": [
        {
          "username": "cu1",
          "key-coverage": "full"
        }
      ],
      "shared-users": [],
      "cluster-coverage": "full"
    },
    "attributes": {
      "key-type": "aes",
      "label": "6793b8439d044046982e5b895791e47f",
      "id": "",
      "check-value": "0x3f986f",
      "class": "secret-key",
      "encrypt": false,
      "decrypt": false,
      "token": true,
      "always-sensitive": false,
      "sign": true,
      "trusted": false,
      "unwrap": true,
      "verify": true,
      "wrap": true,
      "wrap-with-trusted": false,
      "key-length-bytes": 16
    }
  }
],
"total_key_count": 1580,
"returned_key_count": 2,
"next_token": "2"
}
```
For more examples that demonstrate how the key filtration mechanism works in the CloudHSM CLI, see Using CloudHSM CLI to filter keys (p. 145).
Arguments

<KYE_ATTRIBUTES>

Specifies a space separated list of key attributes in the form of
attr.KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE (for example, attr.token=true) to
select a matching key for file generation. 1 or more attributes may be supplied to refine selection
criteria.

For a listing of supported CloudHSM CLI key attributes, see Key attributes for CloudHSM
CLI (p. 187)

Required: No

<MAX_ITEMS>

The total number of items to return in the command's output. If the total number of items available
is more than the value specified, a next-token is provided in the command's output. To resume
pagination, provide the next-token value in the starting-token argument of a subsequent command.

Required: No

<STARTING_TOKEN>

A token to specify where to start paginating. This is the next-token from a previously truncated
response.

Required: No

<VERBOSE>

If included, prints all attributes and key information for each matched key. By default each matched
key only displays its key-reference and label attribute.

Required: No

Related topics

- key delete (p. 195)
- key generate-file (p. 196)
- key unshare (p. 225)
- Key attributes for CloudHSM CLI (p. 187)
- Using CloudHSM CLI to filter keys (p. 145)

key set-attribute

Use the key set-attribute command to set the attributes of keys in your AWS CloudHSM cluster.
Only the CU who created the key and consequently owns it can change the key's attributes.

For a list of key attributes that can be used in CloudHSM CLI, see Key attributes for CloudHSM
CLI (p. 187).

User type

The following types of users can run this command.

- Crypto users (CUs) can run this command.
- Admins can set the trusted attribute.
Requirements

To run this command, you must be logged in as a CU. To set the trusted attribute, you must be logged in as an admin user.

Syntax

```
aws-cloudhsm > help key set-attribute
Set an attribute for a key in the HSM cluster

Usage: cloudhsm-cli key set-attribute [OPTIONS] --filter <KEY_ATTRIBUTES> --name <KEY_ATTRIBUTE> --value <KEY_ATTRIBUTE_VALUE>

Options:
   --filter [<KEY_ATTRIBUTES>...]  Space separated list of key attributes in the form
 of attr.KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE to select a matching key to modify
   --key-reference <KEY_REFERENCE> A hexadecimal or decimal representation of the key,
such as a key handle
   --name <KEY_ATTRIBUTE>            Name of attribute to be set
   --value <KEY_ATTRIBUTE_VALUE>...  Attribute value to be set
   -h, --help                            Print help

Example: Setting a key attribute

The following example shows how to use the `key set-attribute` command to set the label.

Example

1. Use the key with the label `my_key`, as shown here:

```
aws-cloudhsm > key set-attribute --filter attr.label=my_key --name encrypt --value false
{
   "error_code": 0,
   "data": {
         "message": "Attribute set successfully"
   }
}
```

2. Use the `key list` command to confirm the `encrypt` attribute has changed:

```
aws-cloudhsm > key list --filter attr.label=my_key --verbose
{
   "error_code": 0,
   "data": {
         "matched_keys": [
            {
               "key-reference": "0x00000000006400ec",
               "key-info": {
                  "key-owners": [
                        {
                           "username": "bob",
                           "key-coverage": "full"
                        }
                  ],
               "shared-users": [],
               "cluster-coverage": "full"
               "attributes": {
                  "key-type": "aes",
                  "label": "my_key",
                  "id": "",
                  "encrypt": true
               }
            }
         ]
   }
```
Arguments

<KEY_ATTRIBUTE>

Specifies the name of the key's attribute.

Required: Yes

<KEY_ATTRIBUTES>

Specifies a space separated list of key attributes in the form of
attr.KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE (for example, attr.token=true) to
select a matching key for file generation. One or more attributes may be supplied to refine selection
criteria.

For a list of supported key attributes, see Key attributes for CloudHSM CLI (p. 187).

Required: Yes

<KEY_ATTRIBUTE_VALUE>

Specifies the value of the key's attribute.

Required: Yes

<KEY_REFERENCE>

A hexadecimal or decimal representation of the key. (such as a key handle).

Required: No

Related topics

- Using CloudHSM CLI to filter keys (p. 145)
Key attributes for CloudHSM CLI (p. 187)

**key share**

The **key share** command shares a key with other CUs in your AWS CloudHSM cluster.

Only the CU who created the key and consequently owns it can share the key. Users with whom a key is shared can use the key in cryptographic operations, but they cannot delete, export, share, or unshare the key. Additionally, these users cannot change **key attributes (p. 187)**.

**User type**

The following types of users can run this command.

- Crypto users (CUs)

**Requirements**

To run this command, you must be logged in as a CU.

**Syntax**

```
aws-cloudhsm > help key share
Share a key in the HSM cluster with another user

Usage: key share --filter [KEY_ATTRIBUTES...] --username <USERNAME> --role <ROLE>

Options:
   --filter [KEY_ATTRIBUTES...]     Space separated list of key attributes in the form of attr.KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE to select a matching key for sharing
   --username <USERNAME>             A username with which the key will be shared
   --role <ROLE>                    Role the user has in the cluster

   Possible values:
   - crypto-user: A CryptoUser has the ability to manage and use keys
   - admin:       An Admin has the ability to manage user accounts

   -h, --help                     Print help (see a summary with '-h')
```

**Example: Share a key with another CU**

The following example shows how to use the **key share** command to share a key with the CU *alice*.

**Example**

1. Run the **key share** command to share the key with *alice*.

```
aws-cloudhsm > key share --filter attr.label="rsa_key_to_share" attr.class=private-key
   --username alice --role crypto-user
{
   "error_code": 0,
   "data": {
      "message": "Key shared successfully"
   }
```


2. Run the **key list** command.

```bash
aws-cloudhsm > key list --filter attr.label="rsa_key_to_share" attr.class=private-key --verbose
```

```
{
  "error_code": 0,
  "data": {
    "matched_keys": [
      {
        "key-reference": "0x00000000001c0686",
        "key-info": {
          "key-owners": [
            {
              "username": "cu3",
              "key-coverage": "full"
            }
          ],
          "shared-users": [
            {
              "username": "cu2",
              "key-coverage": "full"
            },
            {
              "username": "cu1",
              "key-coverage": "full"
            },
            {
              "username": "cu4",
              "key-coverage": "full"
            },
            {
              "username": "cu5",
              "key-coverage": "full"
            },
            {
              "username": "cu6",
              "key-coverage": "full"
            },
            {
              "username": "cu7",
              "key-coverage": "full"
            },
            {
              "username": "alice",
              "key-coverage": "full"
            }
          ],
          "cluster-coverage": "full"
        },
        "attributes": {
          "key-type": "rsa",
          "label": "rsa_key_to_share",
          "id": "",
          "check-value": "0xae8ff0",
          "class": "private-key",
          "encrypt": false,
          "decrypt": true,
          "token": true,
          "always-sensitive": true,
          "derive": false,
          "destroyable": true,
          "extractable": true,
          "local": true,
```
In the above list, verify alice is in the list of shared-users

Arguments

<KEY_ATTRIBUTES>

Specifies a space separated list of key attributes in the form of attr.KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE (for example, attr.token=true) to select a matching key for file generation. One or more attributes may be supplied to refine selection criteria.

For a list of supported key attributes, see Key attributes for CloudHSM CLI (p. 187).

Required: Yes

<USERNAME>

Specifies a friendly name for the user. The maximum length is 31 characters. The only special character permitted is an underscore (_). The username is not case sensitive in this command, username is always displayed in lowercase.

Required: Yes

<ROLE>

Specifies the role assigned to this user. This parameter is required. To get the user's role, use the user list command. For detailed information about the user types on an HSM, see Understanding HSM users (p. 60).

Required: Yes

Related topics

- Using CloudHSM CLI to filter keys (p. 145)
- Key attributes for CloudHSM CLI (p. 187)

key unshare

The key unshare command unshares a key with other CUs in your AWS CloudHSM cluster.
Only the CU who created the key and consequently owns it can unshare the key. Users with whom a key is shared can use the key in cryptographic operations, but they cannot delete, export, share, or unshare the key. Additionally, these users cannot change key attributes (p. 187).

User type

The following types of users can run this command.

- Crypto users (CUs)

Requirements

To run this command, you must be logged in as a CU.

Syntax

```
aws-cloudhsm > help key unshare
Unshare a key in the HSM cluster with another user

Usage: key unshare --filter [KEY_ATTRIBUTES...] --username USERNAME --role ROLE

Options:
  --filter [KEY_ATTRIBUTES...]
    Space separated list of key attributes in the form of attr.KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE to select a matching key for unsharing
  --username USERNAME
    A username with which the key will be unshared
  --role ROLE
    Role the user has in the cluster
    Possible values:
    - crypto-user: A CryptoUser has the ability to manage and use keys
    - admin: An Admin has the ability to manage user accounts
  -h, --help
    Print help (see a summary with '-h')
```

Example: Unshare a key with another CU

The following example shows how to use the key unshare command to unshare a key with the CU alice.

Example

1. Run the key list command and filter by the specific key you want to unshare with alice.

```
aws-cloudhsm > key list --filter attr.label=rsa_key_to_share attr.class=private-key --verbose
{
  "error_code": 0,
  "data": {
    "matched_keys": [
      {
        "key-reference": "0x0000000001c0686",
        "key-info": {
          "key-owners": [
            {
              "username": "cu3",
              "key-coverage": "full"
```


2. Confirm alice is in the shared-users output, and run the following key unshare command to unshare the key with alice.

```bash
aws-cloudhsm > key unshare --filter attr.label="rsa_key_to_share" attr.class=private-key --username alice --role crypto-user
{
  "error_code": 0,
  "data": {
    "message": "Key unshared successfully"
  }
}
```

3. Run the key list command again to confirm that the key has been unshared with alice.

```bash
aws-cloudhsm > key list --filter attr.label="rsa_key_to_share" attr.class=private-key --verbose
{
  "error_code": 0,
  "data": {
    "matched_keys": [
      {
        "key-reference": "0x00000000001c0606",
        "key-info": {
          "key-owner": [
            {
              "username": "cu3",
              "key-coverage": "full"
            }
          ],
          "shared-users": [
            {
              "username": "cu2",
              "key-coverage": "full"
            },
            {
              "username": "cu1",
              "key-coverage": "full"
            },
            {
              "username": "cu4",
              "key-coverage": "full"
            },
            {
              "username": "cu5",
              "key-coverage": "full"
            },
            {
              "username": "cu6",
              "key-coverage": "full"
            },
            {
              "username": "cu7",
              "key-coverage": "full"
            }
          ],
          "cluster-coverage": "full"
        },
        "attributes": {
          "key-type": "rsa",
```
- "label": "rsa_key_to_share",
- "id": "",
- "check-value": "0xae8ff0",
- "class": "private-key",
- "encrypt": false,
- "decrypt": true,
- "token": true,
- "always-sensitive": true,
- "derive": false,
- "destroyable": true,
- "extractable": true,
- "local": true,
- "modifiable": true,
- "never-extractable": false,
- "private": true,
- "sensitive": true,
- "sign": true,
- "trusted": false,
- "unwrap": true,
- "verify": false,
- "wrap": false,
- "wrap-with-trusted": false,
- "key-length-bytes": 1219,
- "public-exponent": "0x010001",
- "modulus": "0xa8855cba933cec0c21a4df0450ec31675c024f3e65b2b215a53d2bda6dcd191f75729150b59b4d86df58254c8f518f7679fc3307388633485657ce2e1a3deab0f985b0747ef4ed339de78147d1985d14fdd8634219321e49e3f5715e79c298f18658504bab04086bfbdcd3b",
- "modulus-size-bits": 2048

\}
\]
, "total_key_count": 1,
  "returned_key_count": 1
\}

Arguments

\<KEY_ATTRIBUTES>\n
Specifies a space separated list of key attributes in the form of
attr.KEY_ATTRIBUTE_NAME=KEY_ATTRIBUTE_VALUE (for example, attr.token=true) to
select a matching key for file generation. One or more attributes may be supplied to refine selection
criteria.

For a list of supported key attributes, see Key attributes for CloudHSM CLI (p. 187).

Required: Yes

\<USERNAME>\n
Specifies a friendly name for the user. The maximum length is 31 characters. The only special
character permitted is an underscore (_). The username is not case sensitive in this command,
username is always displayed in lowercase.

Required: Yes

\<ROLE>\n
Specifies the role assigned to this user. This parameter is required. To get the user's role, use the user
list command. For detailed information about the user types on an HSM, see Understanding HSM
users (p. 60).

Required: Yes
Related topics

- Using CloudHSM CLI to filter keys (p. 145)
- Key attributes for CloudHSM CLI (p. 187)

**login**

You can use the `login` command in CloudHSM CLI to log in and out of each HSM in a cluster.

**Note**

If you exceed five incorrect login attempts, your account is locked out. To unlock the account, an admin must reset your password using the `user change-password` (p. 235) command in `cloudhsm_cli`.

**To troubleshoot login and logout**

If you have more than one HSM in your cluster, you may be allowed additional incorrect login attempts before your account is locked out. This is because the CloudHSM client balances load across various HSMs. Therefore, the login attempt may not begin on the same HSM each time. If you are testing this functionality, we recommend you do so on a cluster with only one active HSM.

If you created your cluster before February 2018, your account is locked out after 20 incorrect login attempts.

**User type**

The following users can run these commands.

- Unactivated admin
- Admin
- Crypto user (CU)

**Syntax**

```
aws-cloudhsm > help login
Login to your cluster

USAGE:
    cloudhsm-cli login [OPTIONS] --username <USERNAME> --role <ROLE> [COMMAND]

Commands:
    mfa-token-sign  Login with token-sign mfa
    help            Print this message or the help of the given subcommand(s)

OPTIONS:
    --username <USERNAME>
        Username to access the Cluster

    --role <ROLE>
        Role the user has in the Cluster

        Possible values:
        - crypto-user: A CryptoUser has the ability to manage and use keys
        - admin: An Admin has the ability to manage user accounts

    --password <PASSWORD>
        Optional: Plaintext user's password. If you do not include this argument you will be prompted for it
```
Example

This command logs you in to all HSMs in a cluster with the credentials of an admin user named admin1.

```bash
aws-cloudhsm > login --username admin1 --role admin
Enter password:
{
  "error_code": 0,
  "data": {
    "username": "admin1",
    "role": "admin"
  }
}
```

Arguments

**<USERNAME>**

Specifies a friendly name for the user. The maximum length is 31 characters. The only special character permitted is an underscore (_). The username is not case sensitive in this command, username is always displayed in lowercase.

Required: Yes

**<ROLE>**

Specifies the role assigned to this user. This parameter is required. Valid values are `admin`, `crypto-user`.

To get the user’s role, use the **user list** command. For detailed information about the user types on an HSM, see [Understanding HSM users](#).

**<PASSWORD>**

Specifies the password of the user who is logging in to the HSMs.

Related topics

- [Getting Started with CloudHSM CLI](#) (p. 184)
- [Activate the Cluster](#) (p. 28)

**login mfa-token-sign**

Use the **login mfa-token-sign** command in AWS CloudHSM CloudHSM CLI log in using multifactor authentication. To use this command, you must first set up [MFA for CloudHSM CLI](#) (p. 67).

User type

The following users can run these commands.

- Admin
- Crypto user (CU)

Syntax

```bash
aws-cloudhsm > help login mfa-token-sign
```
Login with token-sign mfa

**USAGE:**
```
login --username <USERNAME> --role <ROLE> mfa-token-sign --token <TOKEN>
```

**OPTIONS:**
```
--token <TOKEN>    Filepath where the unsigned token file will be written
```

**Example**

```
aws-cloudhsm > login --username test_user --role admin mfa-token-sign --token /home/valid.token
```

Enter password:
Enter signed token file path (press enter if same as the unsigned token file):

```
{
   "error_code": 0,
   "data": {
      "username": "test_user",
      "role": "admin"
   }
}
```

**Arguments**

`<TOKEN>`

Filepath where the unsigned token file will be written.

Required: Yes

**Related topics**

- **Getting Started with CloudHSM CLI (p. 184)**
- **Activate the Cluster (p. 28)**
- **Using CloudHSM CLI to manage MFA (p. 67)**

**logout**

You can use the **logout** command in CloudHSM CLI to log out of each HSM in a cluster.

**User type**

The following users can run this command.

- Admin
- Crypto user (CU)

**Syntax**

```
aws-cloudhsm > help logout
```

Logout of your cluster

**USAGE:**
```
    logout
```
OPTIONS:
- `h, --help`  Print help information
- `V, --version`  Print version information

**Example**

This command logs you out of all HSMs in a cluster.

```
aws-cloudhsm > logout
{
    "error_code": 0,
    "data": "Logout successful"
}
```

**Related topics**

- [Getting Started with CloudHSM CLI](p. 184)
- [Activate the Cluster](p. 28)

**user**

`user` is a parent category for a group of commands that, when combined with the parent category, create a command specific to users. Currently, the user category consists of the following commands:

- [user change-mfa](p. 233)
- [user change-password](p. 235)
- [user create](p. 240)
- [user delete](p. 241)
- [user list](p. 243)

**user change-mfa**

Currently, this category consists of the following sub-command:

- [user change-mfa token-sign](p. 233)

**user change-mfa token-sign**

Use the `user change-mfa` command in CloudHSM CLI to update a user account's Multifactor Authentication (MFA) setup. Any user account can run this command. Accounts with the Admin role can run this command for other users.

**User type**

The following users can run this command:

- Admin
- Crypto user

**Syntax**

Currently, there is only a single multifactor strategy available for users: Token Sign.
aws-cloudhsm > help user change-mfa
Change a user's MFA strategy

Usage:
user change-mfa <COMMAND>

Commands:
  token-sign  Register or Deregister a public key using token-sign mfa strategy
  help        Print this message or the help of the given subcommand(s)

The Token Sign strategy asks for a Token file to write unsigned tokens to.

aws-cloudhsm > help user change-mfa token-sign
Register or Deregister a public key using token-sign mfa strategy

Usage: user change-mfa token-sign [OPTIONS] --username <USERNAME> --role <ROLE> <--token <TOKEN>|--deregister>

Options:
  --username <USERNAME>
  Username of the user that will be modified

  --role <ROLE>
  Role the user has in the cluster

  Possible values:
  - crypto-user: A CryptoUser has the ability to manage and use keys
  - admin:       An Admin has the ability to manage user accounts

  --change-password <CHANGE_PASSWORD>
  Optional: Plaintext user's password. If you do not include this argument you will be prompted for it

  --token <TOKEN>
  Filepath where the unsigned token file will be written. Required for enabling MFA for a user

  --approval <APPROVAL>
  Filepath of signed quorum token file to approve operation

  --deregister
  Deregister the MFA public key, if present

  --change-quorum
  Change the Quorum public key along with the MFA key

Example

This command will write one unsigned token per HSM in your cluster to the file specified by token. When you are prompted, sign the tokens in the file.

Example: Write one unsigned token per HSM in your cluster

aws-cloudhsm > user change-mfa token-sign --username cu1 --change-password password --role crypto-user --token /path/myfile
Enter signed token file path (press enter if same as the unsigned token file):
Enter public key PEM file path:/path/mypemfile
{
"error_code": 0,
"data": {
  "username": "test_user"},

234
Arguments

<ROLE>
Specifies the role given to the user account. This parameter is required. For detailed information about the user types on an HSM, see Understanding HSM users (p. 60).

Valid values
- **Admin**: Admins can manage users, but they cannot manage keys.
- **Crypto user**: Crypto users can create and manage keys and use keys in cryptographic operations.

<USERNAME>
Specifies a friendly name for the user. The maximum length is 31 characters. The only special character permitted is an underscore ( _ ).

You cannot change the name of a user after it is created. In CloudHSM CLI commands, the role and password are case-sensitive, but the username is not.

Required: Yes

<CHANGE_PASSWORD>
Specifies the plaintext new password of the user whose MFA is being registered/deregistered.

Required: Yes

<TOKEN>
File path where the unsigned token file will be written.

Required: Yes

<APPROVAL>
Specifies the file path to a signed quorum token file to approve operation. Only required if quorum user service quorum value is greater than 1.

<DEREGISTER>
Deregisters the MFA public key, if present.

<CHANGE_QUORUM>
Changes the quorum public key along with the MFA key.

Related topics
- Understanding 2FA for HSM users (p. 67)

**user change-password**

Use the `user change-password` command in CloudHSM CLI to change the password of an existing user in your AWS CloudHSM cluster. To enable MFA for a user, use the `user change-mfa` command.

Any user can change their own password. In addition, users with the admin role can change the password of another user in the cluster. You do not need to enter the current password to make the change.
Note
You cannot change the password of a user who is currently logged in to the cluster.

User type
The following users can run this command.
- Admin
- Crypto user (CU)

Syntax
Note
To enable multifactor authentication (MFA) for a user, use the `user change-mfa` command.

```
aws-cloudhsm > help user change-password
Change a user's password

Usage:
  cloudhsm-cli user change-password [OPTIONS] --username <USERNAME> --role <ROLE> [--password <PASSWORD>]

Options:
  --username <USERNAME>
    Username of the user that will be modified
  --role <ROLE>
    Role the user has in the cluster
    Possible values:
    - crypto-user: A CryptoUser has the ability to manage and use keys
    - admin:       An Admin has the ability to manage user accounts
  --password <PASSWORD>
    Optional: Plaintext user's password. If you do not include this argument you will be prompted for it
  --approval <APPROVAL>
    Filepath of signed quorum token file to approve operation
  --deregister-mfa <DEREGISTER-MFA>
    Deregister the user's mfa public key, if present
  --deregister-quorum <DEREGISTER-QUORUM>
    Deregister the user's quorum public key, if present
```

Example
The following examples show how to use `user change-password` to reset the password for the current user or any other user in your cluster.

Example : Change your password
Any user in the cluster can use `user change-password` to change their own password.

The following output shows that Bob is currently logged in as a crypto user (CU).
```
aws-cloudhsm > user change-password --username bob --role crypto-user
Enter password:
 Confirm password:
```
Arguments

<APPROVAL>

Specifies the file path to a signed quorum token file to approve operation. Only required if quorum user service quorum value is greater than 1.

<DEREGISTER-MFA>

Deregisters the MFA public key, if present.

<DEREGISTER-QUORUM>

Deregister the Quorum public key, if present.

<PASSWORD>

Specifies the plaintext new password of the user.

Required: Yes

<ROLE>

Specifies the role given to the user account. This parameter is required. For detailed information about the user types on an HSM, see Understanding HSM users (p. 60).

Valid values

- Admin: Admins can manage users, but they cannot manage keys.
- Crypto user: Crypto users can create an manage keys and use keys in cryptographic operations.

<USERNAME>

Specifies a friendly name for the user. The maximum length is 31 characters. The only special character permitted is an underscore (_).

You cannot change the name of a user after it is created. In CloudHSM CLI commands, the role and password are case-sensitive, but the username is not.

Required: Yes

Related topics

- user list (p. 243)
- user create (p. 240)
- user delete (p. 241)

user change-quorum

user change-quorum is a parent category for a group of commands that, when combined with the parent category, create a command specific to changing quorum for users.

user change-quorum is used to register user quorum authentication using a specified quorum strategy. As of SDK 5.8.0, there is only a single quorum strategy available for users as shown below.
Currently, this category consists of the following category and sub-command:

- **token-sign (p. 238)**
- **register (p. 238)**

**user change-quorum token-sign**

**user change-quorum token-sign** is a parent category for commands that, when combined with this parent category, create a command specific to token-sign quorum operations.

Currently, the this category consists of the following commands:

- **register (p. 238)**

**user change-quorum token-sign register**

Use the **user change-quorum token-sign register** command in CloudHSM CLI to register the token-sign quorum strategy for an admin user.

**User type**

The following users can run this command.

- Admin

**Syntax**

```bash
aws-cloudhsm > help user change-quorum token-sign register
Register a user for quorum authentication with a public key
```

Usage: user change-quorum token-sign register --public-key <PUBLIC_KEY> --signed-token <SIGNED_TOKEN>

Options:

- --public-key <PUBLIC_KEY>  Filepath to public key PEM file
- --signed-token <SIGNED_TOKEN>  Filepath with token signed by user private key

**Example**

To run this command you will need to be logged in as the user you wish to register quorum token-sign for.

```bash
aws-cloudhsm > login --username admin1 --role admin
Enter password:
{
  "error_code": 0,
  "data": {
    "username": "admin1",
    "role": "admin"
  }
}
```

The **user change-quorum token-sign register** command will register your public key with the HSM. As a result, it will qualify you as a quorum approver for quorum-required operations that need a user to obtain quorum signatures to meet the necessary quorum value threshold.
aws-cloudhsm > user change-quorum token-sign register \
   --public-key /home/mypemfile 
   --signed-token /home/mysignedtoken 
{
   "error_code": 0,
   "data": {
      "username": "admin1",
      "role": "admin"
   }
}

You can now run the user list command and confirm that quorum token-sign has been registered for this user.

aws-cloudhsm > user list 
{
   "error_code": 0,
   "data": {
      "users": [
         {
            "username": "admin",
            "role": "admin",
            "locked": "false",
            "mfa": [],
            "quorum": [],
            "cluster-coverage": "full"
         },
         {
            "username": "admin1",
            "role": "admin",
            "locked": "false",
            "mfa": [],
            "quorum": [
               {
                  "strategy": "token-sign",
                  "status": "enabled"
               }
            ],
            "cluster-coverage": "full"
         }
      ]
   }
}

Arguments

PUBLIC-KEY

Filepath to the public key PEM file.

Required: Yes

SIGNED-TOKEN

Filepath with token signed by user private key.

Required: Yes

Related topics

- Using CloudHSM CLI to manage quorum authentication (p. 77)
user create

The `user create` command in CloudHSM CLI creates a user in your AWS CloudHSM cluster. Only user accounts with the admin role can run this command.

User type

The following types of users can run this command.

- Admin

Requirements

To run this command, you must be logged in as an admin user

Syntax

```
aws-cloudhsm > help user create
Create a new user

Usage: cloudhsm-cli user create [OPTIONS] --username <USERNAME> --role <ROLE> [--password <PASSWORD>]

Options:
--username <USERNAME>
    Username to access the HSM cluster
--role <ROLE>
    Role the user has in the cluster
    Possible values:
    - crypto-user: A CryptoUser has the ability to manage and use keys
    - admin: An Admin has the ability to manage user accounts
--password <PASSWORD>
    Optional: Plaintext user's password. If you do not include this argument you will be prompted for it
--approval <APPROVAL>
    Filepath of signed quorum token file to approve operation
```

Example

These examples show how to use `user create` to create new users in your HSMs.

Example : Create a crypto user

This example creates an account in your AWS CloudHSM cluster with the crypto user role.

```
aws-cloudhsm > user create --username alice --role crypto-user
Enter password:
Confirm password:
```
Arguments

**<USERNAME>**

Specifies a friendly name for the user. The maximum length is 31 characters. The only special character permitted is an underscore (_). The username is not case sensitive in this command, username is always displayed in lowercase.

Required: Yes

**<ROLE>**

Specifies the role assigned to this user. This parameter is required. Valid values are `admin`, `crypto-user`.

To get the user's role, use the `user list` command. For detailed information about the user types on an HSM, see [Understanding HSM users](#).

**<PASSWORD>**

Specifies the password of the user who is logging in to the HSMs.

Required: Yes

**<APPROVAL>**

Specifies the file path to a signed quorum token file to approve operation. Only required if quorum user service quorum value is greater than 1.

Related topics

- [user list](#)
- [user delete](#)
- [user change-password](#)

user delete

The `user delete` command in CloudHSM CLI deletes a user from your AWS CloudHSM cluster. Only user accounts with the admin role may run this command. You cannot delete a user who is currently logged into a HSM.

User type

The following types of users can run this command.

- Admin

Requirements

- You can't delete user accounts that own keys.
- Your user account must have the admin role to run this command.
Syntax

Because this command does not have named parameters, you must enter the arguments in the order specified in the syntax diagram.

```
aws-cloudhsm > help user delete
Delete a user

Usage: user delete [OPTIONS] --username <USERNAME> --role <ROLE>

Options:
  --username <USERNAME>
    Username to access the HSM cluster
  --role <ROLE>
    Role the user has in the cluster
    Possible values:
    - crypto-user: A CryptoUser has the ability to manage and use keys
    - admin:       An Admin has the ability to manage user accounts
  --approval <APPROVAL>
    Filepath of signed quorum token file to approve operation
```

Example

```
aws-cloudhsm > user delete --username alice --role crypto-user
{
  "error_code": 0,
  "data": {
    "username": "alice",
    "role": "crypto-user"
  }
}
```

Arguments

**<USERNAME>**

Specifies a friendly name for the user. The maximum length is 31 characters. The only special character permitted is an underscore (_). The username is not case sensitive in this command, username is always displayed in lowercase.

Required: Yes

**<ROLE>**

Specifies the role assigned to this user. This parameter is required. Valid values are admin, crypto-user.

To get the user's role, use the user list command. For detailed information about the user types on an HSM, see Understanding HSM users (p. 60).

Required: Yes

**<APPROVAL>**

Specifies the file path to a signed quorum token file to approve operation. Only required if quorum user service quorum value is greater than 1.

Required: Yes
The user list command in the CloudHSM CLI lists the user accounts present in your CloudHSM cluster. You do not need to be logged in to CloudHSM CLI to run this command.

**Note**
If you add or delete HSMs, update the configuration files that the AWS CloudHSM client and the command line tools use. Otherwise, the changes that you make might not be effective on all HSMs in the cluster.

**User type**

The following types of users can run this command.

- All users. You do not need to be logged in to run this command.

**Syntax**

```
aws-cloudhsm > help user list
List the users in your cluster

USAGE:
    user list
```

**Example**

This command lists the users present in your CloudHSM cluster.

```
aws-cloudhsm > user list
{
  "error_code": 0,
  "data": [
    {
      "username": "admin",
      "role": "admin",
      "locked": "false",
      "mfa": [],
      "cluster-coverage": "full"
    },
    {
      "username": "test_user",
      "role": "admin",
      "locked": "false",
      "mfa": [
        {
          "strategy": "token-sign",
          "status": "enabled"
        }
      ],
      "cluster-coverage": "full"
    }
  ]
}```
The output includes the following user attributes:

- **Username**: Displays the user-defined friendly name for the user. Username is always displayed in lowercase.
- **Role**: Determines the operations that the user can perform on the HSM.
- **Locked**: Indicates whether this user account has been locked out.
- **MFA**: Indicates the supported multi-factor authentication mechanisms for this user account.
- **Cluster coverage**: Indicates the cluster-wide availability of this user account.

Related topics

- listUsers (p. 371) in key_mgmt_util
- user create (p. 240)
- user delete (p. 241)
- user change-password (p. 235)

**quorum**

quorum is a parent category for a group of commands that, when combined with quorum, creates a command specific to quorum authentication or M of N operations. Currently, this category consists of the token-sign sub-category which consists of its own commands. Click the link below for details.

- token-sign (p. 245)

**Admin Services**: Quorum authentication is used for admin privileged services like creating users, deleting users, changing user passwords, setting quorum values, and deactivating quorum and MFA capabilities.

Each service type is further broken down into a qualifying service name, which contains a specific set of quorum supported service operations that can be performed.

<table>
<thead>
<tr>
<th>Service name</th>
<th>Service type</th>
<th>Service operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>user</td>
<td>Admin</td>
<td>• user create</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• user delete</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• user change-password</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• user change-mfa</td>
</tr>
<tr>
<td>quorum</td>
<td>Admin</td>
<td>• quorum token-sign set-quorum-value</td>
</tr>
</tbody>
</table>
Related topics

- Using quorum authentication for admins: first time setup (p. 79)
- Using CloudHSM CLI to manage quorum authentication (M of N access control) (p. 77)

quorum token-sign

quorum token-sign is a category for a group of commands that, when combined with quorum token-sign, create a command specific to quorum authentication or M of N operations.

Currently, this category consists of the following commands:

- delete (p. 245)
- generate (p. 246)
- list (p. 248)
- list-quorum-values (p. 249)
- list-timeouts (p. 249)
- set-quorum-value (p. 250)
- set-timeout (p. 252)

quorum token-sign delete

Use the quorum token-sign delete command in CloudHSM CLI to delete one or more tokens for a quorum authorized service.

User type

The following users can run this command.

- Admin

Syntax

aws-cloudhsm > help quorum token-sign delete
Delete one or more Quorum Tokens

Usage: quorum token-sign delete --scope <SCOPE>

Options:

  --scope <SCOPE>
  Scope of which token(s) will be deleted

  Possible values:
  - user: Deletes all token(s) of currently logged in user
  - all: Deletes all token(s) on the HSM

Example

The following example shows how the quorum token-sign delete command in CloudHSM CLI can be used to delete one or more tokens for a quorum authorized service.

Example: Delete one or more tokens for a quorum authorized service

aws-cloudhsm > quorum token-sign delete --scope all
Arguments

<SCOPE>

The scope in which token(s) will be deleted in the AWS CloudHSM cluster.

Valid values

- **User**: Used to delete only tokens owned by the logged in user.
- **All**: Used to delete all tokens in the AWS CloudHSM cluster.

Related topics

- [user list](#)
- [user create](#)
- [user delete](#)

**quorum token-sign generate**

Use the **quorum token-sign generate** command in CloudHSM CLI to generate a token for a quorum authorized service.

There is a limit to obtaining one active token per user per service on an HSM cluster for services user and quorum.

**Note**

Only admins can generate a service token.

**Admin Services**: Quorum authentication is used for admin privileged services like creating users, deleting users, changing user passwords, setting quorum values, and deactivating quorum and MFA capabilities.

Each service type is further broken down into a qualifying service name, which contains a specific set of quorum supported service operations that can be performed.

<table>
<thead>
<tr>
<th>Service name</th>
<th>Service type</th>
<th>Service operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>user</td>
<td>Admin</td>
<td>• user create</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• user delete</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• user change-password</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• user change-mfa</td>
</tr>
<tr>
<td>quorum</td>
<td>Admin</td>
<td>• quorum token-sign set-quorum-value</td>
</tr>
</tbody>
</table>

**User type**

The following users can run this command.

- Admin
• Crypto user (CU)

Syntax

```bash
aws-cloudhsm > help quorum token-sign generate
Generate a token
Usage: quorum token-sign generate --service <SERVICE> --token <TOKEN>
Options:
  --service <SERVICE>
    Service the token will be used for
    Possible values:
      - user:
        User management service is used for executing quorum authenticated user
        management operations
      - quorum:
        Quorum management service is used for setting quorum values for any quorum
        service
      - registration:
        Registration service is used for registering a public key for quorum
        authentication
  --token <TOKEN>
    Filepath where the unsigned token file will be written
```

Example

This command will write one unsigned token per HSM in your cluster to the file specified by token.

**Example: Write one unsigned token per HSM in your cluster**

```bash
aws-cloudhsm > quorum token-sign generate --service user --token /home/tfile
{
  "error_code": 0,
  "data": {
    "filepath": "/home/tfile"
  }
}
```

Arguments

**<SERVICE>**

Specifies the quorum authorized service for which to generate a token. This parameter is required.

**Valid values**

- **user**: The user management service that is used for executing quorum authenticated user management operations.
- **quorum**: The quorum management service that is used for setting quorum authorized quorum values for any quorum authorized service.
- **registration**: Generates an unsigned token for use in registering a public key for quorum authorization.

**Required**: Yes

**<TOKEN>**

Filepath where the unsigned token file will be written.
**Required**: Yes

**Related topics**

- Service names and types that support quorum authentication (p. 78)

**quorum token-sign list**

Use the `quorum token-sign list` command in CloudHSM CLI to list all token-sign quorum tokens present in your AWS CloudHSM cluster.

**User type**

The following users can run this command.

- Admin
- Crypto user (CU)

**Syntax**

```
aws-cloudhsm > help quorum token-sign list
List the token-sign tokens in your cluster
Usage: quorum token-sign list
```

**Example**

This command will list all token-sign tokens present in your AWS CloudHSM cluster.

```
aws-cloudhsm > quorum token-sign list
{
  "error_code": 0,
  "data": {
    "tokens": [
      {
        "username": "admin",
        "service": "quorum",
        "approvals-required": 2,
        "number-of-approvals": 0,
        "token-timeout-seconds": 397,
        "cluster-coverage": "full"
      },
      {
        "username": "admin",
        "service": "user",
        "approvals-required": 2,
        "number-of-approvals": 2,
        "token-timeout-seconds": 588,
        "cluster-coverage": "full"
      }
    ]
  }
}
```

**Related topics**

- `quorum token-sign generate (p. 246)`
quorum token-sign list-quorum-values

Use the `quorum token-sign list-quorum-values` command in CloudHSM CLI to list the quorum values set in your AWS CloudHSM cluster.

User type

The following users can run this command.

- All users. You do not need to be logged in to run this command.

Syntax

```bash
aws-cloudhsm > help quorum token-sign list-quorum-values
List current quorum values
Usage: quorum token-sign list-quorum-values
```

Example

This command lists quorum values set in your AWS CloudHSM cluster for each service.

```bash
aws-cloudhsm > quorum token-sign list-quorum-values
{
  "error_code": 0,
  "data": {
    "user": 1,
    "quorum": 1
  }
}
```

Related topics

- [Service names and types that support quorum authentication (p. 78)](#)

quorum token-sign list-timeouts

Use the `quorum token-sign list-timeouts` command in CloudHSM CLI to obtain the token timeout period in seconds for all token types.

User type

The following users can run this command.

- All users. You do not need to be logged in to run this command.

Syntax

```bash
aws-cloudhsm > help quorum token-sign list-timeouts
List timeout durations in seconds for token validity
Usage: quorum token-sign list-timeouts
```
Example

Example

```bash
aws-cloudhsm > quorum token-sign list-timeouts
{
  "error_code": 0,
  "data": {
    "generated": 600,
    "approved": 600
  }
}
```

The output includes the following:

- **generated**: Timeout period in seconds for a generated token to be approved.
- **approved**: Timeout period in seconds for an approved token to be used to execute a quorum authorized operation.

Arguments

There are no arguments for this command.

Related topics

- [quorum token-sign set-timeout](p. 252)

**quorum token-sign set-quorum-value**

Use the **quorum token-sign set-quorum-value** command in CloudHSM CLI to set a new quorum value for a quorum authorized service.

User type

The following users can run this command.

- Admin

Syntax

```bash
aws-cloudhsm > help quorum token-sign set-quorum-value
Set a quorum value

Usage: quorum token-sign set-quorum-value [OPTIONS] --service <SERVICE> --value <VALUE>

Options:
  --service <SERVICE>
      Service the token will be used for

      Possible values:
      - user:
        User management service is used for executing quorum authenticated user management operations
      - quorum:
        Quorum management service is used for setting quorum values for any quorum service

  --value <VALUE>
      Value to set for service
```
--approval <APPROVAL>
   Filepath of signed quorum token file to approve operation

Example

Example

In the following example, this command writes one unsigned token per HSM in your cluster to the file specified by token. When you are prompted, sign the tokens in the file.

```
aws-cloudhsm > quorum token-sign set-quorum-value --service quorum --value 2
{
   "error_code": 0,
   "data": "Set Quorum Value successful"
}
```

You can then run the `list-quorum-values` command to confirm that the quorum value for the quorum management service has been set:

```
aws-cloudhsm > quorum token-sign list-quorum-values
{
   "error_code": 0,
   "data": {
      "user": 1,
      "quorum": 2
   }
}
```

Arguments

**<APPROVAL>**

The filepath of the signed token file to be approved on the HSM.

**<SERVICE>**

Specifies the quorum authorized service for which to generate a token. This parameter is required. For more information about service types and names, see Service names and types that support quorum authentication (p. 78).

**Valid values**

- **user**: The user management service. Service used for executing quorum authorized user management operations.
- **quorum**: The quorum management service. Service used for setting a quorum authorized quorum values for any quorum authorized service.
- **registration**: Generates a unsigned token for use in registering a public key for quorum authorization.

**Required**: Yes

**<VALUE>**

Specifies The quorum value to be set. The maximum quorum value is eight (8).

**Require**: Yes

Related topics

- quorum token-sign list-quorum-values (p. 249)
- Service names and types that support quorum authentication (p. 78)
### quorum token-sign set-timeout

Use the **quorum token-sign set-timeout** command in CloudHSM CLI to set the token timeout period in seconds for each token type.

**User type**

The following users can run this command.

- Admin

**Syntax**

```bash
aws-cloudhsm > help quorum token-sign set-timeout
```

Set timeout duration in seconds for token validity

Usage: quorum token-sign set-timeout --generated <GENERATED> |--approved <APPROVED>

Options:

- `--generated <GENERATED>` Timeout period in seconds for a generated (non-approved) token to be approved
- `--approved <APPROVED>` Timeout period in seconds for an approved token to be used to execute a quorum operation

**Example**

The following examples show how to use the **quorum token-sign set-timeout** command to set the token timeout period.

```bash
aws-cloudhsm > quorum token-sign set-timeout --generated 900
{
    "error_code": 0,
    "data": "Set token timeout successful"
}
```

**Arguments**

There are no arguments for this command.

**Related topics**

- quorum token-sign list-timeouts (p. 249)

---

### CloudHSM Management Utility (CMU)

The **cloudhsm_mgmt_util** command line tool helps crypto officers manage users in the HSMs. It includes tools that create, delete, and list users, and change user passwords.

KMU and CMU are part of the **Client SDK 3 suite (p. 454)**.

cloudhsm_mgmt_util also includes commands that allow crypto users (CUs) to share keys and get and set key attributes. These commands complement the key management commands in the primary key management tool, **key_mgmt_util (p. 301)**.

For a quick start, see **Managing cloned clusters (p. 253)**. For detailed information about the **cloudhsm_mgmt_util** commands and examples of using the commands, see **cloudhsm_mgmt_util command reference (p. 259)**.
Supported platforms for AWS CloudHSM management utility

**Linux support**
- Amazon Linux
- Amazon Linux 2
- CentOS 6.10+
- CentOS 7.3+
- CentOS 8
- Red Hat Enterprise Linux (RHEL) 6.10+
- Red Hat Enterprise Linux (RHEL) 7.9+
- Red Hat Enterprise Linux (RHEL) 8
- Ubuntu 16.04 LTS
- Ubuntu 18.04 LTS

**Windows support**
- Microsoft Windows Server 2012
- Microsoft Windows Server 2012 R2
- Microsoft Windows Server 2016
- Microsoft Windows Server 2019

Getting started with CloudHSM Management Utility (CMU)

CloudHSM Management Utility (CMU) enables you to manage hardware security module (HSM) users. Use this topic to get started with basic HSM user management tasks, such as creating users, listing users, and connecting CMU to the cluster.

1. To use CMU, you must first use the configure tool to update the local CMU configuration with the --cmu parameter and an IP address from one of the HSMs in your cluster. Do this each time you use CMU to ensure you’re managing HSM users on every HSM in the cluster.

   Linux

   ```
   $ sudo /opt/cloudhsm/bin/configure --cmu <IP address>
   ```
Windows

[C:\Program Files\Amazon\CloudHSM\bin\ configure.exe --cmu <IP address>]

2. Use the following command to start the CLI in interactive mode.

Linux

[Shell]$ /opt/cloudhsm/bin/cloudhsm_mgmt_util /opt/cloudhsm/etc/cloudhsm_mgmt_util.cfg

Windows

[C:\Program Files\Amazon\CloudHSM> .\cloudhsm_mgmt_util.exe C:\ProgramData\Amazon\CloudHSM\data\cloudhsm_mgmt_util.cfg]

Output should be similar to the following depending on how many HSMs you have.

Connecting to the server(s), it may take time depending on the server(s) load, please wait...
Connecting to server '10.0.2.9': hostname '10.0.2.9', port 2225...
Connected to server '10.0.2.9': hostname '10.0.2.9', port 2225.

Connecting to server '10.0.3.11': hostname '10.0.3.11', port 2225...
Connected to server '10.0.3.11': hostname '10.0.3.11', port 2225.

Connecting to server '10.0.1.12': hostname '10.0.1.12', port 2225...
Connected to server '10.0.1.12': hostname '10.0.1.12', port 2225.

The prompt changes to aws-cloudhsm> when cloudhsm_mgmt_util is running.

3. Use the loginHSM command to log in to the cluster. Any type user can use this command to log in to the cluster.

The command in the following example logs in admin, which is the default crypto officer (CO) (p. 93). You set this user's password when you activated the cluster. You can use the -hpswd parameter to hide your password.

[Shell]aws-cloudhsm> loginHSM CO admin -hpswd

The system prompts you for your password. You enter the password, the system hides the password, and the output shows that the command was successful and that you have connected to all the HSMs on the cluster.

Enter password:

loginHSM success on server 0(10.0.2.9)
loginHSM success on server 1(10.0.3.11)
loginHSM success on server 2(10.0.1.12)

4. Use listUsers to list all the users on the cluster.

[Shell]aws-cloudhsm> listUsers

CMU lists all the users on the cluster.
5. Use `createUser` to create a CU user named `example_user` with a password of `password1`.

You use CU users in your applications to perform cryptographic and key management operations. You can create CU users because in step 3 you logged in as a CO user. Only CO users can perform user management tasks with CMU, such as creating and deleting users and changing the passwords of other users.

```
aws-cloudhsm> createUser CU example_user password1
```

CMU prompts you about the create user operation.

```
*************************CAUTION*************************
This is a CRITICAL operation, should be done on all nodes in the cluster. AWS does NOT synchronize these changes automatically with the nodes on which this operation is not executed or failed, please ensure this operation is executed on all nodes in the cluster.
*************************CAUTION*************************
```

Do you want to continue(y/n)?

6. To create the CU user `example_user`, type `y`.

7. Use `listUsers` to list all the users on the cluster.

```
aws-cloudhsm> listUsers
```

CMU lists all the users on the cluster, including the new CU user you just created.

```
Users on server 0(10.0.2.9):
```

5.

6.

7.
Number of users found:3

<table>
<thead>
<tr>
<th>User Id</th>
<th>User Type</th>
<th>User Name</th>
<th>MofnPubKey</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CO</td>
<td>admin</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>AU</td>
<td>app_user</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CU</td>
<td>example_user</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Users on server 1(10.0.3.11):
Number of users found:3

<table>
<thead>
<tr>
<th>User Id</th>
<th>User Type</th>
<th>User Name</th>
<th>MofnPubKey</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CO</td>
<td>admin</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>AU</td>
<td>app_user</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CU</td>
<td>example_user</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Users on server 2(10.0.1.12):
Number of users found:3

<table>
<thead>
<tr>
<th>User Id</th>
<th>User Type</th>
<th>User Name</th>
<th>MofnPubKey</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CO</td>
<td>admin</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>AU</td>
<td>app_user</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CU</td>
<td>example_user</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8. Use the `logoutHSM` command to log out of the HSMs.

    aws-cloudhsm>logoutHSM

    logoutHSM success on server 0(10.0.2.9)
    logoutHSM success on server 1(10.0.3.11)
    logoutHSM success on server 2(10.0.1.12)

9. Use the `quit` command to stop cloudhsm_mgmt_util.

    aws-cloudhsm>quit

    disconnecting from servers, please wait...

**Install and configure the AWS CloudHSM client (Linux)**

To interact with the HSM in your AWS CloudHSM cluster, you need the AWS CloudHSM client software for Linux. You should install it on the Linux EC2 client instance that you created previously. You can also install a client if you are using Windows. For more information, see Install and configure the AWS CloudHSM client (Windows) (p. 259).

**Tasks**
- Install the AWS CloudHSM client and command line tools (p. 257)
• **Edit the client configuration (p. 258)**

### Install the AWS CloudHSM client and command line tools

Connect to your client instance and run the following commands to download and install the AWS CloudHSM client and command line tools.

**Amazon Linux**

```bash
wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL6/cloudhsm-client-latest.el6.x86_64.rpm

sudo yum install ./cloudhsm-client-latest.el6.x86_64.rpm
```

**Amazon Linux 2**

```bash
wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-latest.el7.x86_64.rpm

sudo yum install ./cloudhsm-client-latest.el7.x86_64.rpm
```

**CentOS 7**

```bash
sudo yum install wget

wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-latest.el7.x86_64.rpm

sudo yum install ./cloudhsm-client-latest.el7.x86_64.rpm
```

**CentOS 8**

```bash
sudo yum install wget

wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL8/cloudhsm-client-latest.el8.x86_64.rpm

sudo yum install ./cloudhsm-client-latest.el8.x86_64.rpm
```

**RHEL 7**

```bash
sudo yum install wget

wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-latest.el7.x86_64.rpm

sudo yum install ./cloudhsm-client-latest.el7.x86_64.rpm
```
### RHEL 8

```bash
sudo yum install wget

wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL8/cloudhsm-client-latest.el8.x86_64.rpm

sudo yum install ./cloudhsm-client-latest.el8.x86_64.rpm
```

### Ubuntu 16.04 LTS

```bash
wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Xenial/cloudhsm-client_latest_amd64.deb

sudo apt install ./cloudhsm-client_latest_amd64.deb
```

### Ubuntu 18.04 LTS

```bash
wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Bionic/cloudhsm-client_latest_u18.04_amd64.deb

sudo apt install ./cloudhsm-client_latest_u18.04_amd64.deb
```

### Edit the client configuration

Before you can use the AWS CloudHSM client to connect to your cluster, you must edit the client configuration.

#### To edit the client configuration

1. If installing Client SDK 3 on cloudhsm_mgmt_util, complete the following steps to ensure all the nodes in the cluster are synced.
   a. Run `configure -a <IP of one of the HSMs>`.
   b. Restart the client service.
   c. Run `config -m`.
2. Copy your issuing certificate—the one that you used to sign the cluster's certificate (p. 23)—to the following location on the client instance: `/opt/cloudhsm/etc/customerCA.crt`. You need instance root user permissions on the client instance to copy your certificate to this location.
3. Use the following `configure (p. 159)` command to update the configuration files for the AWS CloudHSM client and command line tools, specifying the IP address of the HSM in your cluster. To get the HSM's IP address, view your cluster in the AWS CloudHSM console, or run the `describe-clusters` AWS CLI command. In the command's output, the HSM's IP address is the value of the EniIp field. If you have more than one HSM, choose the IP address for any of the HSMs; it doesn't matter which one.

```bash
sudo /opt/cloudhsm/bin/configure -a <IP address>

Updating server config in /opt/cloudhsm/etc/cloudhsm_client.cfg
Updating server config in /opt/cloudhsm/etc/cloudhsm_mgmt_util.cfg
```
4. Go to Activate the cluster (p. 28).

Install and configure the AWS CloudHSM client (Windows)

To work with an HSM in your AWS CloudHSM cluster on Windows, you need the AWS CloudHSM client software for Windows. You should install it on the Windows Server instance that you created previously.

To install (or update) the latest Windows client and command line tools

1. Connect to your Windows Server instance.
2. Download the AWSCloudHSMClient-latest.msi installer.
3. If installing Client SDK 3 on cloudhsm_mgmt_util, complete the following steps to ensure all the nodes in the cluster are synced.
   a. Run `configure -a <IP of one of the HSMs>`.
   b. Restart the client service.
   c. Run `config -m`.
4. Go to your download location and run the installer (AWSCloudHSMClient-latest.msi) with administrative privilege.
5. Follow the installer instructions, then choose Close after the installer has finished.
6. Copy your self-signed issuing certificate—the one that you used to sign the cluster certificate (p. 23)—to the C:\ProgramData\Amazon\CloudHSM folder.
7. Run the following command to update your configuration files. Be sure to stop and start the client during reconfiguration if you are updating it:

   ```
   C:\Program Files\Amazon\CloudHSM\bin\configure.exe -a <HSM IP address>
   ```

8. Go to Activate the cluster (p. 28).

Notes:

- If you are updating the client, existing configuration files from previous installations are not overwritten.
- The AWS CloudHSM client installer for Windows automatically registers the Cryptography API: Next Generation (CNG) and key storage provider (KSP). To uninstall the client, run the installer again and follow the uninstall instructions.
- If you are using Linux, you can install the Linux client. For more information, see Install and configure the AWS CloudHSM client (Linux) (p. 256).

cloudhsm_mgmt_util command reference

The cloudhsm_mgmt_util command line tool helps crypto officers manage users in the HSMs. It also includes commands that allow crypto users (CUs) to share keys, and get and set key attributes. These commands complement the primary key management commands in the key_mgmt_util (p. 301) command line tool.

For a quick start, see Managing cloned clusters (p. 253).
Before you run any cloudhsm_mgmt_util command, you must start cloudhsm_mgmt_util and log in to the HSM. Be sure that you log in with the user account type that can run the commands you plan to use.

To list all cloudhsm_mgmt_util commands, run the following command:

```bash
aws-cloudhsm> help
```

To get the syntax for a cloudhsm_mgmt_util command, run the following command:

```bash
aws-cloudhsm> help <command-name>
```

**Note**
Use the syntax as per the documentation. While the built-in software help may provide additional options, these should not be considered supported and should not be utilized in production code.

To run a command, enter the command name, or enough of the name to distinguish it from the names of other cloudhsm_mgmt_util commands.

For example, to get a list of users on the HSMs, enter `listUsers` or `listU`.

```bash
aws-cloudhsm> listUsers
```

To end your cloudhsm_mgmt_util session, run the following command:

```bash
aws-cloudhsm> quit
```

For help interpreting the key attributes, see the [Key Attribute Reference](p. 388).

The following topics describe commands in cloudhsm_mgmt_util.

**Note**
Some commands in key_mgmt_util and cloudhsm_mgmt_util have the same names. However, the commands typically have different syntax, different output, and slightly different functionality.

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
<th>User Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>changePswd (p. 261)</td>
<td>Changes the passwords of users on the HSMs. Any user can change their own password. COs can change anyone's password.</td>
<td>CO</td>
</tr>
<tr>
<td>createUser (p. 265)</td>
<td>Creates users of all types on the HSMs.</td>
<td>CO</td>
</tr>
<tr>
<td>deleteUser (p. 268)</td>
<td>Deletes users of all types from the HSMs.</td>
<td>CO</td>
</tr>
<tr>
<td>findAllKeys (p. 270)</td>
<td>Gets the keys that a user owns or shares. Also gets a hash of the key ownership and sharing data for all keys on each HSM.</td>
<td>CO, AU</td>
</tr>
<tr>
<td>getAttribute (p. 273)</td>
<td>Gets an attribute value for an AWS CloudHSM key and writes</td>
<td>CU</td>
</tr>
<tr>
<td>Command</td>
<td>Description</td>
<td>User Type</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>getCert (p. 276)</td>
<td>Gets the certificate of a particular HSM and saves it in a desired certificate format.</td>
<td>All.</td>
</tr>
<tr>
<td>getHSMInfo (p. 277)</td>
<td>Gets information about the hardware on which an HSM is running.</td>
<td>All. Login is not required.</td>
</tr>
<tr>
<td>getKeyInfo (p. 278)</td>
<td>Gets owners, shared users, and the quorum authentication status of a key.</td>
<td>All. Login is not required.</td>
</tr>
<tr>
<td>info (p. 282)</td>
<td>Gets information about an HSM, including the IP address, hostname, port, and current user.</td>
<td>All. Login is not required.</td>
</tr>
<tr>
<td>listUsers (p. 284)</td>
<td>Gets the users in each of the HSMs, their user type and ID, and other attributes.</td>
<td>All. Login is not required.</td>
</tr>
<tr>
<td>loginHSM and logoutHSM (p. 286)</td>
<td>Log in and log out of an HSM.</td>
<td>All.</td>
</tr>
<tr>
<td>quit (p. 294)</td>
<td>Quits cloudhsm_mgmt_util.</td>
<td>All. Login is not required.</td>
</tr>
<tr>
<td>server (p. 290)</td>
<td>Enters and exits server mode on an HSM.</td>
<td>All.</td>
</tr>
<tr>
<td>registerQuorumPubKey (p. 288)</td>
<td>Associates an HSM user with an asymmetric RSA-2048 key pair.</td>
<td>CO</td>
</tr>
<tr>
<td>setAttribute (p. 291)</td>
<td>Changes the values of the label, encrypt, decrypt, wrap, and unwrap attributes of an existing key.</td>
<td>CU</td>
</tr>
<tr>
<td>shareKey (p. 295)</td>
<td>Shares an existing key with other users.</td>
<td>CU</td>
</tr>
<tr>
<td>syncKey (p. 298)</td>
<td>Syncs a key across cloned AWS CloudHSM clusters.</td>
<td>CU, CO</td>
</tr>
<tr>
<td>syncUser (p. 299)</td>
<td>Syncs a user across cloned AWS CloudHSM clusters.</td>
<td>CO</td>
</tr>
</tbody>
</table>

**changePswd**

The `changePswd` command in cloudhsm_mgmt_util changes the password of an existing user on the HSMs in the cluster.

Any user can change their own password. In addition, Crypto officers (COs and PCOs) can change the password of another CO or crypto user (CU). You do not need to enter the current password to make the change.
Note
You cannot change the password of a user who is currently logged into the AWS CloudHSM client or key_mgmt_util.

To troubleshoot changePswd

Before you run any CMU command, you must start CMU and log in to the HSM. Be sure that you log in with a user type that can run the commands you plan to use.

If you add or delete HSMs, update the configuration files for CMU. Otherwise, the changes that you make might not be effective for all HSMs in the cluster.

User type

The following users can run this command.

- Crypto officers (CO)
- Crypto users (CU)

Syntax

Enter the arguments in the order specified in the syntax diagram. Use the -hpswd parameter to mask your password. To enable two-factor authentication (2FA) for a CO user, use the -2fa parameter and include a file path. For more information, see the section called "Arguments" (p. 264).

```
changePswd <user-type> <user-name> <password> [-hpswd] [-2fa <path/to/authdata>]
```

Examples

The following examples show how to use changePswd to reset the password for the current user or any other user in your HSMs.

Example: Change your password

Any user on the HSMs can use changePswd to change their own password. Before you change the password, use info (p. 282) to get information about each of the HSMs in the cluster, including the username and the user type of the logged in user.

The following output shows that Bob is currently logged in as a crypto user (CU).

```
aws-cloudhsm> info server 0

Id  Name                    Hostname       Port  State           Partition LoginState
0   10.1.9.193              10.1.9.193      2225    Connected       hsm-jqici4covtv
    Logged in as 'bob(CU)'

aws-cloudhsm> info server 1

Id  Name                    Hostname       Port  State           Partition LoginState
1   10.1.10.7               10.1.10.7       2225    Connected       hsm-ogi3sywxbq
    Logged in as 'bob(CU)'
```

To change password, Bob runs changePswd followed with the user type, username, and a new password.
aws-cloudhsm> changePswd CU bob newPassword

******************************************************************
CAUTION
******************************************************************

This is a CRITICAL operation, should be done on all nodes in the cluster. AWS does NOT synchronize these changes automatically with the nodes on which this operation is not executed or failed, please ensure this operation is executed on all nodes in the cluster.

******************************************************************

Do you want to continue(y/n)? y
Changing password for bob(CU) on 2 nodes

Example: Change the password of another user

You must be a CO or PCO to change the password of another CO, or CU on the HSMs. Before you change the password for another user, use the \texttt{info} (p. 282) command to confirm that your user type is either CO or PCO.

The following output confirms that Alice, who is a CO, is currently logged in.

aws-cloudhsm> info server 0

Id      Name             Hostname         Port   State           Partition
LoginState
0       10.1.9.193       10.1.9.193        2225   Connected      hsm-jqici4covtv
as 'alice(CO)'

aws-cloudhsm> info server 1

Id      Name             Hostname         Port   State           Partition
LoginState
0       10.1.10.7        10.1.10.7        2225   Connected       hsm-ogi3sywxbqx
as 'alice(CO)'

Alice wants to reset the password of another user, John. Before she changes the password, she uses the \texttt{listUsers} (p. 284) command to verify John's user type.

The following output lists John as a CO user.

aws-cloudhsm> listUsers

Users on server 0(10.1.9.193):
Number of users found: 5

<table>
<thead>
<tr>
<th>User Id</th>
<th>User Type</th>
<th>User Name</th>
<th>MofnPubKey</th>
<th>LoginFailureCnt</th>
</tr>
</thead>
<tbody>
<tr>
<td>2FA</td>
<td>PCO</td>
<td>admin</td>
<td>YES</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>AU</td>
<td>jane</td>
<td>NO</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>CU</td>
<td>bob</td>
<td>NO</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>CU</td>
<td>alice</td>
<td>NO</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>CO</td>
<td>john</td>
<td>NO</td>
<td>0</td>
</tr>
</tbody>
</table>

Users on server 1(10.1.10.7):
Number of users found: 5
To change the password, Alice runs `changePswd` followed with John's user type, username, and a new password.

```
aws-cloudhsm> changePswd CO john newPassword
```

Arguments

Enter the arguments in the order specified in the syntax diagram. Use the `-hpswd` parameter to mask your password. To enable 2FA for a CO user, use the `-2fa` parameter and include a file path. For more information about working with 2FA, see Using CMU to manage 2FA (p. 104)

```
changePswd <user-type> <user-name> <password | -hpswd> [-2fa <path/to/authdata>]
```

**<user-type>**

Specifies the current type of the user whose password you are changing. You cannot use `changePswd` to change the user type.

Valid values are CO, CU, PCO, and PRECO.

To get the user type, use `listUsers` (p. 284). For detailed information about the user types on an HSM, see Understanding HSM users (p. 93).

Required: Yes

**<user-name>**

Specifies the user's friendly name. This parameter is not case-sensitive. You cannot use `changePswd` to change the user name.

Required: Yes

**<password | -hpswd>**

Specifies a new password for the user. Enter a string of 7 to 32 characters. This value is case sensitive. The password appears in plaintext when you type it. To hide your password, use the `-hpswd` parameter in place of the password and follow the prompts.

Required: Yes
[-2fa </path/to/authdata>]

Specifies enabling 2FA for this CO user. To get the data necessary for setting up 2FA, include a path to a location in the file system with a file name after the -2fa parameter. For more information about working with 2FA, see Using CMU to manage 2FA (p. 104).

Required: No

Related topics

- info (p. 282)
- listUsers (p. 284)
- createUser (p. 265)
- deleteUser (p. 268)

createUser

The createUser command in cloudhsm_mgmt_util creates a user on the HSMs. Only crypto officers (COs and PRECOs) can run this command. When the command succeeds, it creates the user in all HSMs in the cluster.

To troubleshoot createUser

If your HSM configuration is inaccurate, the user might not be created on all HSMs. To add the user to any HSMs in which it is missing, use the syncUser (p. 299) or createUser (p. 265) command only on the HSMs that are missing that user. To prevent configuration errors, run the configure (p. 159) tool with the -m option.

Before you run any CMU command, you must start CMU and log in to the HSM. Be sure that you log in with a user type that can run the commands you plan to use.

If you add or delete HSMs, update the configuration files for CMU. Otherwise, the changes that you make might not be effective for all HSMs in the cluster.

User type

The following types of users can run this command.

- Crypto officers (CO, PRECO)

Syntax

Enter the arguments in the order specified in the syntax diagram. Use the -hpswd parameter to mask your password. To create a CO user with two-factor authentication (2FA), use the -2fa parameter and include a file path. For more information, see the section called "Arguments" (p. 267).

```
createUser <user-type> <user-name> <password | -hpswd> [-2fa </path/to/authdata>]
```

Examples

These examples show how to use createUser to create new users in your HSMs.

Example: Create a crypto officer

This example creates a crypto officer (CO) on the HSMs in a cluster. The first command uses loginHSM (p. 286) to log in to the HSM as a crypto officer.
aws-cloudhsm> loginHSM CO admin 735782961

loginHSM success on server 0(10.0.0.1)
loginHSM success on server 1(10.0.0.2)
loginHSM success on server 1(10.0.0.3)

The second command uses the `createUser` command to create `alice`, a new crypto officer on the HSM.

The caution message explains that the command creates users on all of the HSMs in the cluster. But, if the command fails on any HSMs, the user will not exist on those HSMs. To continue, type `y`.

The output shows that the new user was created on all three HSMs in the cluster.

aws-cloudhsm> createUser CO alice 391019314

*************************CAUTION********************************
This is a CRITICAL operation, should be done on all nodes in the
cluster. AWS does NOT synchronize these changes automatically with the
nodes on which this operation is not executed or failed, please
ensure this operation is executed on all nodes in the cluster.
****************************************************************

Do you want to continue(y/n)?Invalid option, please type 'y' or 'n'
Do you want to continue(y/n)?y
Creating User alice(CO) on 3 nodes

When the command completes, `alice` has the same permissions on the HSM as the `admin` CO user, including changing the password of any user on the HSMs.

The final command uses the `listUsers` (p. 284) command to verify that `alice` exists on all three HSMs on the cluster. The output also shows that `alice` is assigned user ID 3. You use the user ID to identify `alice` in other commands, such as `findAllKeys` (p. 270).

aws-cloudhsm> listUsers
Users on server 0(10.0.0.1):
Number of users found:3

<table>
<thead>
<tr>
<th>User Id</th>
<th>User Type</th>
<th>User Name</th>
<th>MofnPubKey</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2FA PRECO</td>
<td>admin</td>
<td>YES</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>AU</td>
<td>app_user</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CO</td>
<td>alice</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Users on server 1(10.0.0.2):
Number of users found:3

<table>
<thead>
<tr>
<th>User Id</th>
<th>User Type</th>
<th>User Name</th>
<th>MofnPubKey</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2FA PRECO</td>
<td>admin</td>
<td>YES</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>AU</td>
<td>app_user</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CO</td>
<td>alice</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Users on server 1(10.0.0.3):
Number of users found:3

<table>
<thead>
<tr>
<th>User Id</th>
<th>User Type</th>
<th>User Name</th>
<th>MofnPubKey</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2FA PRECO</td>
<td>admin</td>
<td>YES</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>AU</td>
<td>app_user</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CO</td>
<td>alice</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Example: Create a crypto user

This example creates a crypto user (CU), bob, on the HSM. Crypto users can create and manage keys, but they cannot manage users.

After you type `y` to respond to the caution message, the output shows that bob was created on all three HSMs in the cluster. The new CU can log in to the HSM to create and manage keys.

The command used a password value of `defaultPassword`. Later, bob or any CO can use the `changePswd` command to change his password.

```
aws-cloudhsm> createUser CU bob defaultPassword
*************************CAUTION********************************
This is a CRITICAL operation, should be done on all nodes in the
cluster. AWS does NOT synchronize these changes automatically with the
nodes on which this operation is not executed or failed, please
ensure this operation is executed on all nodes in the cluster.
****************************************************************
Do you want to continue(y/n)?Invalid option, please type 'y' or 'n'
Do you want to continue(y/n)?y
Creating User bob(CU) on 3 nodes
```

Arguments

Enter the arguments in the order specified in the syntax diagram. Use the `-hpswd` parameter to mask your password. To create a CO user with 2FA enabled, use the `-2fa` parameter and include a file path. For more information about 2FA, see Using CMU to manage 2FA (p. 104).

```
createUser <user-type> <user-name> <password> [-hpswd] [-2fa <path/to/authdata>]
```

**<user-type>**

Specifies the type of user. This parameter is required.

For detailed information about the user types on an HSM, see Understanding HSM users (p. 93).

Valid values:
- **CO**: Crypto officers can manage users, but they cannot manage keys.
- **CU**: Crypto users can create and manage keys and use keys in cryptographic operations.

The PRECO is converted to a CO when you assign a password during HSM activation (p. 28).

Required: Yes

**<user-name>**

Specifies a friendly name for the user. The maximum length is 31 characters. The only special character permitted is an underscore (_).
You cannot change the name of a user after it is created. In `cloudhsm_mgmt_util` commands, the user type and password are case-sensitive, but the user name is not.

**Required:** Yes

**<password | -hpswd>**

Specifies a password for the user. Enter a string of 7 to 32 characters. This value is case-sensitive. The password appears in plaintext when you type it. To hide your password, use the `-hpswd` parameter in place of the password and follow the prompts.

To change a user password, use `changePswd` (p. 261). Any HSM user can change their own password, but CO users can change the password of any user (of any type) on the HSMs.

**Required:** Yes

**[-2fa </path/to/authdata>]**

Specifies the creation of a CO user with 2FA enabled. To get the data necessary for setting up 2FA authentication, include a path to a location in the file system with a file name after the `-2fa` parameter. For more information about setting up and working with 2FA, see `Using CMU to manage 2FA` (p. 104).

**Related topics**

- `listUsers` (p. 284)
- `deleteUser` (p. 268)
- `syncUser` (p. 299)
- `changePswd` (p. 261)

**deleteUser**

The `deleteUser` command in `cloudhsm_mgmt_util` deletes a user from the hardware security modules (HSM). Only crypto officers (CO) can run this command. You cannot delete a user who is currently logged into a HSM. For more information about deleting users, see `How to Delete HSM Users` (p. 103).

**Tip**

You can't delete crypto users (CU) that own keys.

**User type**

The following types of users can run this command.

- CO

**Syntax**

Because this command does not have named parameters, you must enter the arguments in the order specified in the syntax diagram.

```
deleteUser <user-type> <user-name>
```

**Example**

This example deletes a crypto officer (CO) from the HSMs in a cluster. The first command uses `listUsers` (p. 284) to list all users on the HSMs.
The output shows that user 3, alice, is a CO on the HSMs.

```
aws-cloudhsm> listUsers
Users on server 0(10.0.0.1):
Number of users found:3

<table>
<thead>
<tr>
<th>User Id</th>
<th>User Type</th>
<th>User Name</th>
<th>MofnPubKey</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PCO</td>
<td>admin</td>
<td>YES</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>AU</td>
<td>app_user</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CO</td>
<td>alice</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Users on server 1(10.0.0.2):
Number of users found:3

<table>
<thead>
<tr>
<th>User Id</th>
<th>User Type</th>
<th>User Name</th>
<th>MofnPubKey</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PCO</td>
<td>admin</td>
<td>YES</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>AU</td>
<td>app_user</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CO</td>
<td>alice</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Users on server 1(10.0.0.3):
Number of users found:3

<table>
<thead>
<tr>
<th>User Id</th>
<th>User Type</th>
<th>User Name</th>
<th>MofnPubKey</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PCO</td>
<td>admin</td>
<td>YES</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>AU</td>
<td>app_user</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CO</td>
<td>alice</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

The second command uses the `deleteUser` command to delete alice from the HSMs.

```
aws-cloudhsm> deleteUser CO alice
Deleting user alice(CO) on 3 nodes
deleteUser success on server 0(10.0.0.1)
deleteUser success on server 0(10.0.0.2)
deleteUser success on server 0(10.0.0.3)
```

The final command uses the `listUsers` command to verify that alice is deleted from all three of the HSMs on the cluster.

```
aws-cloudhsm> listUsers
Users on server 0(10.0.0.1):
Number of users found:2

<table>
<thead>
<tr>
<th>User Id</th>
<th>User Type</th>
<th>User Name</th>
<th>MofnPubKey</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PCO</td>
<td>admin</td>
<td>YES</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>AU</td>
<td>app_user</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Users on server 1(10.0.0.2):
Number of users found:2

<table>
<thead>
<tr>
<th>User Id</th>
<th>User Type</th>
<th>User Name</th>
<th>MofnPubKey</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PCO</td>
<td>admin</td>
<td>YES</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>AU</td>
<td>app_user</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```
Arguments

Because this command does not have named parameters, you must enter the arguments in the order specified in the syntax diagram.

```
deleteUser <user-type> <user-name>
```

**<user-type>**

Specifies the type of user. This parameter is required.

**Tip**

You can't delete crypto users (CU) that own keys.

Valid values are CO, CU.

To get the user type, use listUsers (p. 284). For detailed information about the user types on an HSM, see Understanding HSM users (p. 93).

Required: Yes

**<user-name>**

Specifies a friendly name for the user. The maximum length is 31 characters. The only special character permitted is an underscore (_).

You cannot change the name of a user after it is created. In cloudhsm_mgmt_util commands, the user type and password are case-sensitive, but the user name is not.

Required: Yes

Related topics

- listUsers (p. 284)
- createUser (p. 265)
- syncUser (p. 299)
- changePswd (p. 261)

**findAllKeys**

The findAllKeys command in cloudhsm_mgmt_util gets the keys that a specified crypto user (CU) owns or shares. It also returns a hash of the user data on each of the HSMs. You can use the hash to determine
at a glance whether the users, key ownership, and key sharing data are the same on all HSMs in the
cluster. In the output, the keys owned by the user are annotated by (o) and shared keys are annotated
by (s).

**findAllKeys** returns public keys only when the specified CU owns the key, even though all CUs on the
HSM can use any public key. This behavior is different from **findKey (p. 323)** in key_mgmt_util, which
returns public keys for all CU users.

Only crypto officers (COs and PCOs) and appliance users (AUs) can run this command. Crypto users (CUs)
can run the following commands:

- **listUsers (p. 284)** to find all users
- **findKey (p. 323)** in key_mgmt_util to find the keys that they can use
- **getKeyInfo (p. 352)** in key_mgmt_util to find the owner and shared users of a particular key they own
  or share

Before you run any CMU command, you must start CMU and log in to the HSM. Be sure that you log in
with a user type that can run the commands you plan to use.

If you add or delete HSMs, update the configuration files for CMU. Otherwise, the changes that you make
might not be effective for all HSMs in the cluster.

**User type**

The following users can run this command.

- Crypto officers (CO, PCO)
- Appliance users (AU)

**Syntax**

Because this command does not have named parameters, you must enter the arguments in the order
specified in the syntax diagram.

```
findAllKeys <user id> <key hash (0/1)> [<output file>]
```

**Examples**

These examples show how to use **findAllKeys** to find all keys for a user and get a hash of key user
information on each of the HSMs.

**Example : Find the keys for a CU**

This example uses **findAllKeys** to find the keys in the HSMs that user 4 owns and shares. The command
uses a value of 0 for the second argument to suppress the hash value. Because it omits the optional file
name, the command writes to stdout (standard output).

The output shows that user 4 can use 6 keys: 8, 9, 17, 262162, 19, and 31. The output uses an (s) to
indicate keys that are explicitly shared by the user. The keys that the user owns are indicated by an (o)
and include symmetric and private keys that the user does not share, and public keys that are available
to all crypto users.

```
aws-cloudhsm> findAllKeys 4 0
Keys on server 0(10.0.0.1):
Number of keys found 6
number of keys matched from start index 0::6
```
Example : Verify that user data is synchronized

This example uses findAllKeys to verify that all of the HSMs in the cluster contain the same users, key ownership, and key sharing values. To do this, it gets a hash of the key user data on each HSM and compares the hash values.

To get the key hash, the command uses a value of 1 in the second argument. The optional file name is omitted, so the command writes the key hash to stdout.

The example specifies user 6, but the hash value will be the same for any user that owns or shares any of the keys on the HSMs. If the specified user does not own or share any keys, such as a CO, the command does not return a hash value.

The output shows that the key hash is identical to both of the HSMs in the cluster. If one of the HSM had different users, different key owners, or different shared users, the key hash values would not be equal.

aws-cloudhsm> findAllKeys 6 1
Keys on server 0(10.0.0.1):
Number of keys found 3
number of keys matched from start index 0::3
8(s),9(s),11,17(s)
Key Hash: 55655676c95547fd4e82189a072ee1100ecfca6f10509077a0d936a976bd49
findAllKeys success on server 0(10.0.0.1)
Keys on server 1(10.0.0.2):
Number of keys found 3
number of keys matched from start index 0::3
8(s),9(s),11(o),17(s)
Key Hash: 55655676c95547fd4e82189a072ee1100ecfca6f10509077a0d936a976bd49
findAllKeys success on server 1(10.0.0.2)

This command demonstrates that the hash value represents the user data for all keys on the HSM. The command uses the findAllKeys for user 3. Unlike user 6, who owns or shares just 3 keys, user 3 own or shares 17 keys, but the key hash value is the same.

aws-cloudhsm> findAllKeys 3 1
Keys on server 0(10.0.0.1):
Number of keys found 17
number of keys matched from start index 0::17
6(o),7(o),8(s),11(o),12(o),14(o),262159(o),262160(o),17(s),262162(s),19(s),20(o),21(o),262177(o),262179(o)
Key Hash: 55655676c95547fd4e82189a072ee1100ecfca6f10509077a0d936a976bd49
findAllKeys success on server 0(10.0.0.1)
Keys on server 1(10.0.0.2):
Number of keys found 17
number of keys matched from start index 0::17
6(o),7(o),8(s),11(o),12(o),14(o),262159(o),262160(o),17(s),262162(s),19(s),20(o),21(o),262177(o),262179(o),262180(o),262181(o)
Key Hash:
55655676c95547fd4e82189a072ee1100eccfca6f10509077a0d6936a976bd49
findAllKeys success on server 1(10.0.0.2)

Arguments
Because this command does not have named parameters, you must enter the arguments in the order specified in the syntax diagram.

Arguments:

```
findAllKeys  <user id> <key hash (0/1)> [<output file>]
```

<user id>
Gets all keys that the specified user owns or shares. Enter the user ID of a user on the HSMs. To find the user IDs of all users, use `listUsers (p. 284)`.

All user IDs are valid, but `findAllKeys` returns keys only for crypto users (CUs).

Required: Yes

<key hash>
Includes (1) or excludes (0) a hash of the user ownership and sharing data for all keys in each HSM.

When the `user id` argument represents a user who owns or shares keys, the key hash is populated. The key hash value is identical for all users who own or share keys on the HSM, even though they own and share different keys. However, when the `user id` represents a user who does not own or share any keys, such as a CO, the hash value is not populated.

Required: Yes

<output file>
Writes the output to the specified file.

Required: No

Default: Stdout

Related topics
- `changePswd (p. 261)`
- `deleteUser (p. 268)`
- `listUsers (p. 284)`
- `syncUser (p. 299)`
- `findKey (p. 323)` in key_mgmt_util
- `getKeyInfo (p. 352)` in key_mgmt_util

get Attribute
The `getAttribute` command in cloudhsm_mgmt_util gets one attribute value for a key from all HSMs in the cluster and writes it to stdout (standard output) or to a file. Only crypto users (CUs) can run this command.
Key attributes are properties of a key. They include characteristics, like the key type, class, label, and ID, and values that represent actions that you can perform on the key, like encrypt, decrypt, wrap, sign, and verify.

You can use `getAttribute` only on keys that you own and key that are shared with you. You can run this command or the `getAttribute (p. 273)` command in key_mgmt_util, which writes one or all of the attribute values of a key to a file.

To get a list of attributes and the constants that represent them, use the `listAttributes (p. 370)` command. To change the attribute values of existing keys, use `setAttribute (p. 374)` in key_mgmt_util and `setAttribute (p. 291)` in cloudhsm_mgmt_util. For help interpreting the key attributes, see the Key Attribute Reference (p. 388).

Before you run any CMU command, you must start CMU and log in to the HSM. Be sure that you log in with a user type that can run the commands you plan to use.

If you add or delete HSMs, update the configuration files for CMU. Otherwise, the changes that you make might not be effective for all HSMs in the cluster.

**User type**

The following users can run this command.

- Crypto users (CU)

**Syntax**

Because this command does not have named parameters, you must enter the arguments in the order specified in the syntax diagram.

```
getAttribute <key handle> <attribute id> [<filename>]
```

**Example**

This example gets the value of the extractable attribute for a key in the HSMs. You can use a command like this to determine whether you can export a key from the HSMs.

The first command uses `listAttributes (p. 283)` to find the constant that represents the extractable attribute. The output shows that the constant for OBJ_ATTR_EXTRACTABLE is 354. You can also find this information with descriptions of the attributes and their values in the Key Attribute Reference (p. 388).

```
aws-cloudhsm> listAttributes

Following are the possible attribute values for getAttribute:

OBJ_ATTR_CLASS = 0
OBJ_ATTR_TOKEN = 1
OBJ_ATTR_PRIVATE = 2
OBJ_ATTR_LABEL = 3
OBJ_ATTR_TRUSTED = 134
OBJ_ATTR_KEY_TYPE = 256
OBJ_ATTR_ID = 258
OBJ_ATTR_SENSITIVE = 259
OBJ_ATTR_ENCRYPT = 260
OBJ_ATTR_DECRYPT = 261
OBJ_ATTR_WRAP = 262
OBJ_ATTR_UNWRAP = 263
OBJ_ATTR_SIGN = 264
OBJ_ATTR_VERIFY = 266
```
The second command uses **getAttribute** to get the value of the extractable attribute for the key with key handle 262170 in the HSMs. To specify the extractable attribute, the command uses 354, the constant that represents the attribute. Because the command does not specify a file name, **getAttribute** writes the output to stdout.

The output shows that the value of the extractable attribute is 1 on all of the HSM. This value indicates that the owner of the key can export it. When the value is 0 (0x0), it cannot be exported from the HSMs. You set the value of the extractable attribute when you create a key, but you cannot change it.

```
aws-cloudhsm> getAttribute 262170 354
Attribute Value on server 0(10.0.1.10):
OBJ_ATTR_EXTRACTABLE 0x00000001
Attribute Value on server 1(10.0.1.12):
OBJ_ATTR_EXTRACTABLE 0x00000001
Attribute Value on server 2(10.0.1.7):
OBJ_ATTR_EXTRACTABLE 0x00000001
```

**Arguments**

Because this command does not have named parameters, you must enter the arguments in the order specified in the syntax diagram.

```
getAttribute <key handle> <attribute id> [<filename>]
```

**<key-handle>**

Specifies the key handle of the target key. You can specify only one key in each command. To get the key handle of a key, use **findKey** (p. 323) in key_mgmt_util.

You must own the specified key or it must be shared with you. To find the users of a key, use **getKeyInfo** (p. 352) in key_mgmt_util.

Required: Yes

**<attribute id>**

Identifies the attribute. Enter a constant that represents an attribute, or 512, which represents all attributes. For example, to get the key type, enter 256, which is the constant for the OBJ_ATTR_KEY_TYPE attribute.
To list the attributes and their constants, use `listAttributes (p. 370)`. For help interpreting the key attributes, see the `Key Attribute Reference (p. 388)`.

**Required:** Yes

**<filename>**

Writes the output to the specified file. Enter a file path.

If the specified file exists, `getAttribute` overwrites the file without warning.

**Required:** No

**Default:** Stdout

**Related topics**

- `getAttribute (p. 347)` in `key_mgmt_util`
- `listAttributes (p. 283)`
- `setAttribute (p. 291)` in `cloudhsm_mgmt_util`
- `setAttribute (p. 374)` in `key_mgmt_util`
- `Key Attribute Reference (p. 388)`

**getCert**

With the `getCert` command in `cloudhsm_mgmt_util`, you can retrieve the certificates of a particular HSM in a cluster. When you run the command, you designate the type of certificate to retrieve. To do that, you use one of the corresponding integers as described in the `Arguments (p. 277)` section below. To learn about the role of each of these certificates, see `Verify HSM Identity (p. 15)`.

Before you run any CMU command, you must start CMU and log in to the HSM. Be sure that you log in with a user type that can run the commands you plan to use.

If you add or delete HSMs, update the configuration files for CMU. Otherwise, the changes that you make might not be effective for all HSMs in the cluster.

**User type**

The following users can run this command.

- All users.

**Prerequisites**

Before you begin, you must enter server mode on the target HSM. For more information, see `server (p. 290)`.

**Syntax**

To use the `getCert` command once in server mode:

```
server> getCert <filename> <certificate-type>
```

**Example**

First, enter server mode. This command enters server mode on an HSM with server number 0.
Then, use the `getCert` command. In this example, we use `/tmp/P0.crt` as the name of the file to which the certificate will be saved and 4 (Customer Root Certificate) as the desired certificate type:

```bash
server0> getCert /tmp/P0.crt 4
getcert Success
```

**Arguments**

`getCert <file-name> <certificate-type>`

- `<file-name>`
  - Specifies the name of the file to which the certificate is saved.
  - Required: Yes
- `<certificate-type>`
  - An integer that specifies the type of certificate to retrieve. The integers and their corresponding certificate types are as follows:
    - 1 – Manufacturer Root Certificate
    - 2 – Manufacturer Hardware Certificate
    - 4 – Customer Root Certificate
    - 8 – Cluster Certificate (signed by Customer Root Certificate)
    - 16 – Cluster Certificate (chained to the Manufacturer Root Certificate)
  - Required: Yes

**Related topics**

- `server (p. 290)`

**getHSMInfo**

The `getHSMInfo` command in `cloudhsm_mgmt_util` gets information about the hardware on which each HSM runs, including the model, serial number, FIPS state, memory, temperature, and the version numbers of the hardware and firmware. The information also includes the server ID that `cloudhsm_mgmt_util` uses to refer to the HSM.

Before you run any CMU command, you must start CMU and log in to the HSM. Be sure that you log in with a user type that can run the commands you plan to use.

If you add or delete HSMs, update the configuration files for CMU. Otherwise, the changes that you make might not be effective for all HSMs in the cluster.

**User type**

The following types of users can run this command.
• All users. You do not have to be logged in to run this command.

**Syntax**

This command has no parameters.

```bash
getHSMInfo
```

**Example**

This example uses `getHSMInfo` to get information about the HSMs in the cluster.

```bash
aws-cloudhsm> getHSMInfo
Getting HSM Info on 3 nodes
*** Server 0 HSM Info ***
Label                : cavium
Model                : NITROX-III CNN35XX-NFBE
Serial Number        : 3.0A0101-ICM000001
HSM Flags            : 0
FIPS state           : 2 [FIPS mode with single factor authentication]
Manufacturer ID      :
Device ID            : 10
Class Code           : 100000
System vendor ID     : 177D
SubSystem ID         : 10

TotalPublicMemory    : 560596
FreePublicMemory     : 294568
TotalPrivateMemory   : 0
FreePrivateMemory    : 0

Hardware Major       : 3
Hardware Minor       : 0

Firmware Major       : 2
Firmware Minor       : 03

Temperature          : 56 C
Build Number         : 13

Firmware ID          : xxxxxxxxxxxxxxxx
```

**Related topics**

• info (p. 282)

**getKeyInfo**

The `getKeyInfo` command in the `key_mgmt_util` returns the HSM user IDs of users who can use the key, including the owner and crypto users (CU) with whom the key is shared. When quorum authentication is enabled on a key, `getKeyInfo` also returns the number of users who must approve cryptographic
operations that use the key. You can run `getKeyInfo` only on keys that you own and keys that are shared with you.

When you run `getKeyInfo` on public keys, `getKeyInfo` returns only the key owner, even though all users of the HSM can use the public key. To find the HSM user IDs of users in your HSMs, use `listUsers (p. 371)`. To find the keys for a particular user, use `findKey (p. 323)` -u in `key_mgmt_util`. Crypto officers can use `findAllKeys (p. 270)` in `cloudhsm_mgmt_util`.

You own the keys that you create. You can share a key with other users when you create it. Then, to share or unshare an existing key, use `shareKey (p. 295)` in `cloudhsm_mgmt_util`.

Before you run any CMU command, you must start CMU and log in to the HSM. Be sure that you log in with a user type that can run the commands you plan to use.

If you add or delete HSMs, update the configuration files for CMU. Otherwise, the changes that you make might not be effective for all HSMs in the cluster.

**User type**

The following types of users can run this command.

- Crypto users (CU)

**Syntax**

```
getKeyInfo -k <key-handle> [<output file>]
```

**Examples**

These examples show how to use `getKeyInfo` to get information about the users of a key.

**Example: Get the users for an asymmetric key**

This command gets the users who can use the AES (asymmetric) key with key handle 262162. The output shows that user 3 owns the key and has shares it with users 4 and 6.

Only users 3, 4, and 6 can run `getKeyInfo` on key 262162.

```bash
aws-cloudhsm> getKeyInfo 262162
Key Info on server 0(10.0.0.1):
    Token/Flash Key,
    Owned by user 3
    also, shared to following 2 user(s):
      4
      6
Key Info on server 1(10.0.0.2):
    Token/Flash Key,
    Owned by user 3
    also, shared to following 2 user(s):
      4
      6
```
Example: Get the users for a symmetric key pair

These commands use `getKeyInfo` to get the users who can use the keys in an **ECC (symmetric) key pair (p. 341)**. The public key has key handle 262179. The private key has key handle 262177.

When you run `getKeyInfo` on the private key (262177), it returns the key owner (3) and crypto users (CUs) 4, with whom the key is shared.

```
aws-cloudhsm> getKeyInfo -k 262177
Key Info on server 0(10.0.0.1):
    Token/Flash Key,
    Owned by user 3
    also, shared to following 1 user(s):
        4
Key Info on server 1(10.0.0.2):
    Token/Flash Key,
    Owned by user 3
    also, shared to following 1 user(s):
        4
```

When you run `getKeyInfo` on the public key (262179), it returns only the key owner, user 3.

```
aws-cloudhsm> getKeyInfo -k 262179
Key Info on server 0(10.0.3.10):
    Token/Flash Key,
    Owned by user 3
Key Info on server 1(10.0.3.6):
    Token/Flash Key,
    Owned by user 3
```

To confirm that user 4 can use the public key (and all public keys on the HSM), use the `-u` parameter of `findKey (p. 323)` in `key_mgmt_util`.

The output shows that user 4 can use both the public (262179) and private (262177) key in the key pair. User 4 can also use all other public keys and any private keys that they have created or that have been shared with them.

```
Command:  findKey -u 4
Total number of keys present 8
    number of keys matched from start index 0:7
11, 12, 262159, 262161, 262162, 19, 20, 21, 262177, 262179
    Cluster Error Status
    Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
    CfmsFindKey returned: 0x00 : HSM Return: SUCCESS
```
Example: Get the quorum authentication value (m_value) for a key

This example shows how to get the m_value for a key. The m_value is the number of users in the quorum who must approve any cryptographic operations that use the key and operations to share the unshare the key.

When quorum authentication is enabled on a key, a quorum of users must approve any cryptographic operations that use the key. To enable quorum authentication and set the quorum size, use the -m_value parameter when you create the key.

This command uses `genSymKey` (p. 341) to create a 256-bit AES key that is shared with user 4. It uses the m_value parameter to enable quorum authentication and set the quorum size to two users. The number of users must be large enough to provide the required approvals.

The output shows that the command created key 10.

```
Command: `genSymKey -t 31 -s 32 -l aes256m2 -u 4 -m_value 2`

Cfm3GenerateSymmetricKey returned: 0x00 : HSM Return: SUCCESS
Symmetric Key Created. Key Handle: 10
Cluster Error Status
Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
```

This command uses `getKeyInfo` in cloudhsm_mgmt_util to get information about the users of key 10. The output shows that the key is owned by user 3 and shared with user 4. It also shows that a quorum of two users must approve every cryptographic operation that uses the key.

```
aws-cloudhsm> `getKeyInfo 10`

Key Info on server 0(10.0.0.1):
   Token/Flash Key,
   Owned by user 3
   also, shared to following 1 user(s):
       4
       2 Users need to approve to use/manage this key

Key Info on server 1(10.0.0.2):
   Token/Flash Key,
   Owned by user 3
   also, shared to following 1 user(s):
       4
       2 Users need to approve to use/manage this key
```

Arguments

Because this command does not have named parameters, you must enter the arguments in the order specified in the syntax diagram.

```
getKeyInfo -k <key-handle> <output file>
```
<key-handle>
Specifies the key handle of one key in the HSM. Enter the key handle of a key that you own or share. This parameter is required.
Required: Yes

<output file>
Writes the output to the specified file, instead of stdout. If the file exists, the command overwrites it without warning.
Required: No
Default: stdout

Related topics
- `getKeyInfo` (p. 352) in key_mgmt_util
- `findKey` (p. 323) in key_mgmt_util
- `findAllKeys` (p. 270) in cloudhsm_mgmt_util
- `listUsers` (p. 284)
- `shareKey` (p. 295)

info
The `info` command in cloudhsm_mgmt_util gets information about each of the HSMs in the cluster, including the host name, port, IP address and the name and type of the user who is logged in to cloudhsm_mgmt_util on the HSM.

Before you run any CMU command, you must start CMU and log in to the HSM. Be sure that you log in with a user type that can run the commands you plan to use.

If you add or delete HSMs, update the configuration files for CMU. Otherwise, the changes that you make might not be effective for all HSMs in the cluster.

User type
The following types of users can run this command.
- All users. You do not have to be logged in to run this command.

Syntax
Because this command does not have named parameters, you must enter the arguments in the order specified in the syntax diagram.

```
info server <server ID>
```

Example
This example uses `info` to get information about an HSM in the cluster. The command uses 0 to refer to the first HSM in the cluster. The output shows the IP address, port, and the type and name of the current user.

```
aws-cloudhsm> info server 0
```
Arguments

Because this command does not have named parameters, you must enter the arguments in the order specified in the syntax diagram.

```bash
info server <server ID>
```

<server id>

Specifies the server ID of the HSM. The HSMs are assigned ordinal numbers that represent the order in which they are added to the cluster, beginning with 0. To find the server ID of an HSM, use `getHSMInfo`.

Required: Yes

Related topics

- `getHSMInfo (p. 277)`
- `loginHSM and logoutHSM (p. 286)`

listAttributes

The `listAttributes` command in cloudhsm_mgmt_util lists the attributes of an AWS CloudHSM key and the constants that represent them. You use these constants to identify the attributes in `getAttribute (p. 273)` and `setAttribute (p. 291)` commands.

For help interpreting the key attributes, see the `Key Attribute Reference (p. 388)`.

Before you run any `key_mgmt_util` command, you must `start key_mgmt_util (p. 303)` and `log in (p. 304)` to the HSM as a crypto user (CU).

User type

The following users can run this command.

- All users. You do not have to be logged in to run this command.

Syntax

```bash
listAttributes [-h]
```

Example

This command lists the key attributes that you can get and change in `key_mgmt_util` and the constants that represent them. For help interpreting the key attributes, see the `Key Attribute Reference (p. 388)`.

To represent all attributes, use 512.

Command: `listAttributes`
### Description

The following are all of the possible attribute values for `getAttribute`.

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OBJ_ATTR_CLASS</td>
<td>0</td>
</tr>
<tr>
<td>OBJ_ATTR_TOKEN</td>
<td>1</td>
</tr>
<tr>
<td>OBJ_ATTR_PRIVATE</td>
<td>2</td>
</tr>
<tr>
<td>OBJ_ATTR_LABEL</td>
<td>3</td>
</tr>
<tr>
<td>OBJ_ATTR_TRUSTED</td>
<td>134</td>
</tr>
<tr>
<td>OBJ_ATTR_KEY_TYPE</td>
<td>256</td>
</tr>
<tr>
<td>OBJ_ATTR_ID</td>
<td>258</td>
</tr>
<tr>
<td>OBJ_ATTR_SENSITIVE</td>
<td>259</td>
</tr>
<tr>
<td>OBJ_ATTR_ENCRYPT</td>
<td>260</td>
</tr>
<tr>
<td>OBJ_ATTR_DECRYPT</td>
<td>261</td>
</tr>
<tr>
<td>OBJ_ATTR_WRAP</td>
<td>262</td>
</tr>
<tr>
<td>OBJ_ATTR_UNWRAP</td>
<td>263</td>
</tr>
<tr>
<td>OBJ_ATTR_SIGN</td>
<td>264</td>
</tr>
<tr>
<td>OBJ_ATTR_VERIFY</td>
<td>266</td>
</tr>
<tr>
<td>OBJ_ATTR_DERIVE</td>
<td>268</td>
</tr>
<tr>
<td>OBJ_ATTR_LOCAL</td>
<td>355</td>
</tr>
<tr>
<td>OBJ_ATTR_MODULUS</td>
<td>288</td>
</tr>
<tr>
<td>OBJ_ATTR_MODULUS_BITS</td>
<td>289</td>
</tr>
<tr>
<td>OBJ_ATTR_PUBLIC_EXPONENT</td>
<td>290</td>
</tr>
<tr>
<td>OBJ_ATTR_VALUE_LEN</td>
<td>353</td>
</tr>
<tr>
<td>OBJ_ATTR_EXTRACTABLE</td>
<td>354</td>
</tr>
<tr>
<td>OBJ_ATTR_NEVER_EXTRACTABLE</td>
<td>356</td>
</tr>
<tr>
<td>OBJ_ATTR_ALWAYS_SENSITIVE</td>
<td>357</td>
</tr>
<tr>
<td>OBJ_ATTR_DESTROYABLE</td>
<td>370</td>
</tr>
<tr>
<td>OBJ_ATTR_KCV</td>
<td>371</td>
</tr>
<tr>
<td>OBJ_ATTR_WRAP_WITH_TRUSTED</td>
<td>528</td>
</tr>
<tr>
<td>OBJ_ATTR_WRAP_TEMPLATE</td>
<td>1073742353</td>
</tr>
<tr>
<td>OBJ_ATTR_UNWRAP_TEMPLATE</td>
<td>1073742354</td>
</tr>
<tr>
<td>OBJ_ATTR_ALL</td>
<td>512</td>
</tr>
</tbody>
</table>

### Parameters

-h

Displays help for the command.

Required: Yes

### Related topics

- [getAttribute](p. 273)
- [setAttribute](p. 291)
- [Key Attribute Reference](p. 388)

### listUsers

The `listUsers` command in the `cloudhsm_mgmt_util` gets the users in each of the HSMs, along with their user type and other attributes. All types of users can run this command. You do not even need to be logged in to `cloudhsm_mgmt_util` to run this command.

Before you run any CMU command, you must start CMU and log in to the HSM. Be sure that you log in with a user type that can run the commands you plan to use.

If you add or delete HSMs, update the configuration files for CMU. Otherwise, the changes that you make might not be effective for all HSMs in the cluster.
User type

The following types of users can run this command.

- All users. You do not need to be logged in to run this command.

Syntax

This command has no parameters.

```
listUsers
```

Example

This command lists the users on each of the HSMs in the cluster and displays their attributes. You can use the User ID attribute to identify users in other commands, such as `deleteUser`, `changePswd`, and `findAllKeys`.

```
aws-cloudhsm> listUsers
Users on server 0(10.0.0.1):
Number of users found:6
User Id  User Type  User Name            MofnPubKey  LoginFailureCnt
2FA 1              PCO             admin                     YES               0
N0 2              AU              app_user                   NO               0
N0 3              CU              crypto_user1               NO               0
N0 4              CU              crypto_user2               NO               0
N0 5              CO              officer1                  YES               0
N0 6              CO              officer2                   NO               0
Users on server 1(10.0.0.2):
Number of users found:5
User Id  User Type  User Name            MofnPubKey  LoginFailureCnt
2FA 1              PCO             admin                     YES               0
N0 2              AU              app_user                   NO               0
N0 3              CU              crypto_user1               NO               0
N0 4              CU              crypto_user2               NO               0
N0 5              CO              officer1                  YES               0
```

The output includes the following user attributes:

- **UserID**: Identifies the user in `key_mgmt_util` and `cloudhsm_mgmt_util` commands.
- **User type**: Determines the operations that the user can perform on the HSM.
- **User Name**: Displays the user-defined friendly name for the user.
- **MofnPubKey**: Indicates whether the user has registered a key pair for signing quorum authentication tokens.
• LoginFailureCnt: Indicates the number of times the user has unsuccessfully logged in.
• 2FA: Indicates that the user has enabled multi-factor authentication.

Related topics
• listUsers (p. 371) in key_mgmt_util
• createUser (p. 265)
• deleteUser (p. 268)
• changePswd (p. 261)

loginHSM and logoutHSM
You can use the loginHSM and logoutHSM commands in cloudhsm_mgmt_util to log in and out of each HSM in a cluster. Any user of any type can use these commands.

Note
If you exceed five incorrect login attempts, your account is locked out. To unlock the account, a cryptographic officer (CO) must reset your password using the changePswd (p. 261) command in cloudhsm_mgmt_util.

To troubleshoot loginHSM and logoutHSM
Before you run these cloudhsm_mgmt_util commands, you must start cloudhsm_mgmt_util.

If you add or delete HSMs, update the configuration files that the AWS CloudHSM client and the command line tools use. Otherwise, the changes that you make might not be effective on all HSMs in the cluster.

If you have more than one HSM in your cluster, you may be allowed additional incorrect login attempts before your account is locked out. This is because the CloudHSM client balances load across various HSMs. Therefore, the login attempt may not begin on the same HSM each time. If you are testing this functionality, we recommend you do so on a cluster with only one active HSM.

If you created your cluster before February 2018, your account is locked out after 20 incorrect login attempts.

User type
The following users can run these commands.

• Precrypto officer (PRECO)
• Crypto officer (CO)
• Crypto user (CU)

Syntax
Enter the arguments in the order specified in the syntax diagram. Use the -hpswd parameter to mask your password. To login with two-factor authentication (2FA), use the -2fa parameter and include a file path. For more information, see the section called "Arguments" (p. 287).

```
loginHSM <user-type> <user-name> <password> [-hpswd] [-2fa </path/to/authdata>]
```

```
logoutHSM
```
Examples

These examples show how to use `loginHSM` and `logoutHSM` to log in and out of all HSMs in a cluster.

**Example : Log in to the HSMs in a cluster**

This command logs you in to all HSMs in a cluster with the credentials of a CO user named `admin` and a password of `co12345`. The output shows that the command was successful and that you have connected to the HSMs (which, in this case, are `server 0` and `server 1`).

```
aws-cloudhsm> loginHSM CO admin co12345
loginHSM success on server 0(10.0.2.9)
loginHSM success on server 1(10.0.3.11)
```

**Example : Log in with a hidden password**

This command is the same as the example above, except this time you specify that the system should hide the password.

```
aws-cloudhsm> loginHSM CO admin -hpswd
```

The system prompts you for your password. You enter the password, the system hides the password, and the output shows that the command was successful and that you have connected to the HSMs.

```
Enter password:
loginHSM success on server 0(10.0.2.9)
loginHSM success on server 1(10.0.3.11)
aws-cloudhsm>
```

**Example : Log out of an HSM**

This command logs you out of the HSMs that you are currently logged in to (which, in this case, are `server 0` and `server 1`). The output shows that the command was successful and that you have disconnected from the HSMs.

```
aws-cloudhsm> logoutHSM
logoutHSM success on server 0(10.0.2.9)
logoutHSM success on server 1(10.0.3.11)
```

Arguments

Enter the arguments in the order specified in the syntax diagram. Use the `-hpswd` parameter to mask your password. To login with two-factor authentication (2FA), use the `-2fa` parameter and include a file path. For more information about working with 2FA, see Using CMU to manage 2FA (p. 104)

```
loginHSM <user-type> <user-name> <password> [-hpswd] [-2fa <path/to/authdata>]
```

**<user type>**

Specifies the type of user who is logging in to the HSMs. For more information, see User Type (p. 286) above.

Required: Yes
<user name>

Specifies the user name of the user who is logging in to the HSMs.

Required: Yes

<password | -hpswd >

Specifies the password of the user who is logging in to the HSMs. To hide your password, use the -hpswd parameter in place of the password and follow the prompt.

Required: Yes

[-2fa </path/to/authdata>]

Specifies that the system should use a second factor to authenticate this 2FA-enabled CO user. To get the necessary data for logging in with 2FA, include a path to a location in the file system with a file name after the -2fa parameter. For more information about working with 2FA, see Using CMU to manage 2FA (p. 104).

Required: No

Related topics

• Getting Started with cloudhsm_mgmt_util (p. 253)
• Activate the Cluster (p. 28)

registerQuorumPubKey

The registerQuorumPubKey command in cloudhsm_mgmt_util associates hardware security module (HSM) users with asymmetric RSA-2048 key pairs. Once you associate HSM users with keys, those users can use the private key to approve quorum requests and the cluster can use the registered public key to verify the signature is from the user. For more information about quorum authentication, see Managing Quorum Authentication (M of N Access Control) (p. 110).

Tip

In the AWS CloudHSM documentation, quorum authentication is sometimes referred to as M of N (MoN), which means a minimum of M approvers out of a total number N approvers.

User type

The following types of users can run this command.

• Crypto officers (CO)

Syntax

Because this command does not have named parameters, you must enter the arguments in the order specified in the syntax diagram.

```
registerQuorumPubKey <user-type> <user-name> <registration-token> <signed-registration-token> <public-key>
```

Examples

This example shows how to use registerQuorumPubKey to register crypto officers (CO) as approvers on quorum authentication requests. To run this command, you must have an asymmetric RSA-2048 key pair,
a signed token, and an unsigned token. For more information about these requirements, see the section called “Arguments” (p. 289).

Example: Register a HSM user for quorum authentication

This example registers a CO named quorum_officer as an approver for quorum authentication.

```bash
aws-cloudhsm> registerQuorumPubKey CO <quorum_officer> </path/to/quorum_officer.token> </path/to/quorum_officer.token.sig> </path/to/quorum_officer.pub>

*************************CAUTION********************************
This is a CRITICAL operation, should be done on all nodes in the cluster. AWS does NOT synchronize these changes automatically with the nodes on which this operation is not executed or failed, please ensure this operation is executed on all nodes in the cluster.
****************************************************************
Do you want to continue(y/n)?y
registerQuorumPubKey success on server 0(10.0.0.1)
```

The final command uses the `listUsers` command to verify that quorum_officer is registered as an MofN user.

```bash
aws-cloudhsm> listUsers
Users on server 0(10.0.0.1):
Number of users found:5
  User Id  User Type  User Name             MofnPubKey  LoginFailureCnt  2FA
1         PCO        admin                  NO           0               NO
2         AU         app_user               NO           0               NO
3         CO         quorum_officer         YES          0               NO
```

Arguments

Because this command does not have named parameters, you must enter the arguments in the order specified in the syntax diagram.

```bash
registerQuorumPubKey <user-type> <user-name> <registration-token> <signed-registration-token> <public-key>
```

**<user-type>**

Specifies the type of user. This parameter is required.

For detailed information about the user types on a HSM, see Understanding HSM users (p. 93).

Valid values:

- **CO**: Crypto officers can manage users, but they cannot manage keys.

Required: Yes

**<user-name>**

Specifies a friendly name for the user. The maximum length is 31 characters. The only special character permitted is an underscore (_).

You cannot change the name of a user after it is created. In cloudhsm_mgmt_util commands, the user type and password are case-sensitive, but the user name is not.
Required: Yes

**<registration-token>**

Specifies the path to a file that contains an unsigned registration token. Can have any random data of max file size of 245 bytes. For more information about creating an unsigned registration token, see [Create and Sign a Registration Token](p. 112).

Required: Yes

**<signed-registration-token>**

Specifies the path to a file that contains the SHA256_PKCS mechanism signed hash of the registration-token. For more information, see [Create and Sign a Registration Token](p. 112).

Required: Yes

**<public-key>**

Specifies the path to a file that contains the public key of an asymmetric RSA-2048 key pair. Use the private key to sign the registration token. For more information, see [Create an RSA Key Pair](p. 112).

Required: Yes

**Note**

The cluster uses the same key for quorum authentication and for two-factor authentication (2FA). This means you can't rotate a quorum key for a user that has 2FA enabled using `registerQuorumPubKey`. To rotate the key, you must use `changePswd`. For more information about using quorum authentication and 2FA, see [Quorum Authentication and 2FA](p. 105).

**Related topics**

- [Create an RSA Key Pair](p. 112)
- [Create and Sign a Registration Token](p. 112)
- [Register the Public Key with the HSM](p. 113)
- [Managing Quorum Authentication (M of N Access Control)](p. 110)
- [Quorum Authentication and 2FA](p. 105)
- [listUsers](p. 284)

**server**

Normally, when you issue a command in `cloudhsm_mgmt_util`, the command effects all HSMs in the designated cluster (*global mode*). However, there may be circumstances for which you need to issue commands to a single HSM. For instance, in the event that automatic synchronization fails, you may need to sync keys and users on an HSM in order to maintain consistency across the cluster. You can use the `server` command in the `cloudhsm_mgmt_util` to enter *server mode* and interact directly with a particular HSM instance.

Upon successful initiation, the `aws-cloudhsm>` command prompt is replaced with the `server>` command prompt.

In order to exit server mode, use the `exit` command. Upon successful exit, you will be returned to the `cloudhsm_mgmt_util` command prompt.

Before you run any `cloudhsm_mgmt_util` command, you must start `cloudhsm_mgmt_util`.

**User type**

The following users can run this command.
• All users.

Prerequisites
In order to enter server mode, you must first know the server number of the target HSM. Server numbers are listed in the trace output generated by cloudhsm_mgmt_util upon initiation. Server numbers are assigned in the same order that the HSMs appear in the configuration file. For this example, we assume that server 0 is the server that corresponds to the desired HSM.

Syntax
To start server mode:

```
server <server-number>
```

To exit server mode:

```
server> exit
```

Example
This command enters server mode on an HSM with server number 0.

```
aws-cloudhsm> server 0
Server is in 'E2' mode...
```

In order to exit server mode, use the `exit` command.

```
server0> exit
```

Arguments

```
server <server-number>
```

`<server-number>`

Specifies the server number of the target HSM.

Required: Yes

There are no arguments for the `exit` command.

Related topics

• `syncKey (p. 298)`
• `createUser (p. 265)`
• `deleteUser (p. 268)`

setAttribute

The `setAttribute` command in cloudhsm_mgmt_util changes the value of the label, encrypt, decrypt, wrap, and unwrap attributes of a key in the HSMs. You can also use the [setAttribute (p. 374)](p.374) command...
in key_mgmt_util to convert a session key to a persistent key. You can only change the attributes of keys that you own.

Before you run any CMU command, you must start CMU and log in to the HSM. Be sure that you log in with a user type that can run the commands you plan to use.

If you add or delete HSMs, update the configuration files for CMU. Otherwise, the changes that you make might not be effective for all HSMs in the cluster.

**User type**

The following users can run this command.

- Crypto users (CU)

**Syntax**

Because this command does not have named parameters, you must enter the arguments in the order specified in the syntax diagram.

```
setAttribute <key handle> <attribute id>
```

**Example**

This example shows how to disable the decrypt functionality of a symmetric key. You can use a command like this one to configure a wrapping key, which should be able to wrap and unwrap other keys but not encrypt or decrypt data.

The first step is to create the wrapping key. This command uses `genSymKey` in key_mgmt_util to generate a 256-bit AES symmetric key. The output shows that the new key has key handle 14.

```
$ genSymKey -t 31 -s 32 -l aes256
Cfm3GenerateSymmetricKey returned: 0x00 : HSM Return: SUCCESS
  Symmetric Key Created. Key Handle: 14
  Cluster Error Status
  Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
```

Next, we want to confirm the current value of the decrypt attribute. To get the attribute ID of the decrypt attribute, use `listAttributes`. The output shows that the constant that represents the `OBJ_ATTR_DECRYPT` attribute is 261. For help interpreting the key attributes, see the Key Attribute Reference.

```
aws-cloudhsm> listAttributes
Following are the possible attribute values for getAttribute:

OBJ_ATTR_CLASS                  = 0
OBJ_ATTR_TOKEN                  = 1
OBJ_ATTR_PRIVATE                = 2
OBJ_ATTR_LABEL                  = 3
OBJ_ATTR_TRUSTED                = 134
OBJ_ATTR_KEY_TYPE               = 256
OBJ_ATTR_ID                     = 258
OBJ_ATTR_SENSITIVE              = 259
OBJ_ATTR_ENCRYPT                = 260
OBJ_ATTR_DECRYPT                = 261
```
To get the current value of the decrypt attribute for key 14, the next command uses `getAttribute (p. 273)` in cloudhsm_mgmt_util.

The output shows that the value of the decrypt attribute is true (1) on both HSMs in the cluster.

```
aws-cloudhsm> getAttribute 14 261
Attribute Value on server 0(10.0.0.1):
OBJ_ATTR_DECRYPT
0x00000001
Attribute Value on server 1(10.0.0.2):
OBJ_ATTR_DECRYPT
0x00000001
```

This command uses `setAttribute` to change the value of the decrypt attribute (attribute 261) of key 14 to 0. This disables the decrypt functionality on the key.

The output shows that the command succeeded on both HSMs in the cluster.

```
aws-cloudhsm> setAttribute 14 261 0
******************************************************************************
This is a CRITICAL operation, should be done on all nodes in the cluster. AWS does NOT synchronize these changes automatically with the nodes on which this operation is not executed or failed, please ensure this operation is executed on all nodes in the cluster.
******************************************************************************
Do you want to continue(y/n)? y
setAttribute success on server 0(10.0.0.1)
setAttribute success on server 1(10.0.0.2)
```

The final command repeats the `getAttribute` command. Again, it gets the decrypt attribute (attribute 261) of key 14.

This time, the output shows that the value of the decrypt attribute is false (0) on both HSMs in the cluster.

```
aws-cloudhsm>getAttribute 14 261
Attribute Value on server 0(10.0.3.6):
OBJ_ATTR_DECRYPT
0x00000000
```
Arguments

setAttribute <key handle> <attribute id>

=key-handle=

Specifies the key handle of a key that you own. You can specify only one key in each command. To
get the key handle of a key, use findKey (p. 323) in key_mgmt_util. To find the users of a key, use
getKeyInfo (p. 278).

Required: Yes

=attribute id=

Specifies the constant that represents the attribute that you want to change. You can
specify only one attribute in each command. To get the attributes and their integer values,
use listAttributes (p. 370). For help interpreting the key attributes, see the Key Attribute
Reference (p. 388).

Valid values:
• 3 – OBJ_ATTR_LABEL.
• 134 – OBJ_ATTR_TRUSTED.
• 260 – OBJ_ATTR_ENCRYPT.
• 261 – OBJ_ATTR_DECRYPT.
• 262 – OBJ_ATTR_WRAP.
• 263 – OBJ_ATTR_UNWRAP.
• 264 – OBJ_ATTR_SIGN.
• 266 – OBJ_ATTR_VERIFY.
• 268 – OBJ_ATTR_DERIVE.
• 370 – OBJ_ATTR_DESTROYABLE.
• 528 – OBJ_ATTR_WRAP_WITH_TRUSTED.
• 1073742353 – OBJ_ATTR_WRAP_TEMPLATE.
• 1073742354 – OBJ_ATTR_UNWRAP_TEMPLATE.

Required: Yes

Related topics

• setAttribute (p. 374) in key_mgmt_util
• getAttribute (p. 273)
• listAttributes (p. 283)
• Key Attribute Reference (p. 388)

quit

The quit command in the cloudhsm_mgmt_util exits the cloudhsm_mgmt_util. Any user of any type can
use this command.
Before you run any cloudhsm_mgmt_util command, you must start cloudhsm_mgmt_util.

**User type**

The following users can run this command.

- All users. You do not need to be logged in to run this command.

**Syntax**

```
quit
```

**Example**

This command exits cloudhsm_mgmt_util. Upon successful completion, you are returned to your regular command line. This command has no output parameters.

```
aws-cloudhsm$ quit
disconnecting from servers, please wait...
```

**Related topics**

- [Getting Started with cloudhsm_mgmt_util](p. 253)

**shareKey**

The `shareKey` command in cloudhsm_mgmt_util shares and unshares keys that you own with other crypto users. Only the key owner can share and unshare a key. You can also share a key when you create it.

Users who share the key can use the key in cryptographic operations, but they cannot delete, export, share, or unshare the key, or change its attributes. When quorum authentication is enabled on a key, the quorum must approve any operations that share or unshare the key.

Before you run any CMU command, you must start CMU and log in to the HSM. Be sure that you log in with a user type that can run the commands you plan to use.

If you add or delete HSMs, update the configuration files for CMU. Otherwise, the changes that you make might not be effective for all HSMs in the cluster.

**User type**

The following types of users can run this command.

- Crypto users (CU)

**Syntax**

Because this command does not have named parameters, you must enter the arguments in the order specified in the syntax diagram.

**User Type:** Crypto user (CU)

```
shareKey <key handle> <user id> <(share/unshare key?) 1/0>
```
Example

The following examples show how to use `shareKey` to share and unshare keys that you own with other crypto users.

Example: Share a key

This example uses `shareKey` to share an ECC private key (p. 341) that the current user owns with another crypto user on the HSMs. Public keys are available to all users of the HSM, so you cannot share or unshare them.

The first command uses `getKeyInfo` (p. 278) to get the user information for key 262177, an ECC private key on the HSMs.

The output shows that key 262177 is owned by user 3, but is not shared.

```
aws-cloudhsm>getKeyInfo 262177
Key Info on server 0(10.0.3.10):
    Token/Flash Key,
    Owned by user 3
Key Info on server 1(10.0.3.6):
    Token/Flash Key,
    Owned by user 3
```

This command uses `shareKey` to share key 262177 with user 4, another crypto user on the HSMs. The final argument uses a value of 1 to indicate a share operation.

The output shows that the operation succeeded on both HSMs in the cluster.

```
aws-cloudhsm>shareKey 262177 4 1
*************************CAUTION********************************
This is a CRITICAL operation, should be done on all nodes in the cluster. AWS does NOT synchronize these changes automatically with the nodes on which this operation is not executed or failed, please ensure this operation is executed on all nodes in the cluster.
****************************************************************
Do you want to continue(y/n)?
y
shareKey success on server 0(10.0.3.10)
shareKey success on server 1(10.0.3.6)
```

To verify that the operation succeeded, the example repeats the first `getKeyInfo` command.

The output shows that key 262177 is now shared with user 4.

```
aws-cloudhsm>getKeyInfo 262177
Key Info on server 0(10.0.3.10):
    Token/Flash Key,
    Owned by user 3
    also, shared to following 1 user(s):
```
Example: Unshare a key

This example unshares a symmetric key, that is, it removes a crypto user from the list of shared users for the key.

This command uses `shareKey` to remove user 4 from the list of shared users for key 6. The final argument uses a value of 0 to indicate an unshare operation.

The output shows that the command succeeded on both HSMs. As a result, user 4 can no longer use key 6 in cryptographic operations.

```bash
aws-cloudhsm> shareKey 6 4 0
*************************CAUTION********************************
This is a CRITICAL operation, should be done on all nodes in the cluster. AWS does NOT synchronize these changes automatically with the nodes on which this operation is not executed or failed, please ensure this operation is executed on all nodes in the cluster.
****************************************************************
Do you want to continue(y/n)? y
shareKey success on server 0(10.0.3.10)
shareKey success on server 1(10.0.3.6)
```

Arguments

Because this command does not have named parameters, you must enter the arguments in the order specified in the syntax diagram.

```
shareKey <key handle> <user id> <(share/unshare key?) 1/0>
```

**<key-handle>**

Specifies the key handle of a key that you own. You can specify only one key in each command. To get the key handle of a key, use `findKey` (p. 323) in key_mgmt_util. To verify that you own a key, use `getKeyInfo` (p. 278).

Required: Yes

**<user id>**

Specifies the user ID the crypto user (CU) with whom you are sharing or unsharing the key. To find the user ID of a user, use `listUsers` (p. 284).

Required: Yes

**<share 1 or unshare 0>**

To share the key with the specified user, type 1. To unshare the key, that is, to remove the specified user from the list of shared users for the key, type 0.

Required: Yes
Related topics

- getKeyInfo (p. 278)

**syncKey**

You can use the **syncKey** command in cloudhsm_mgmt_util to manually synchronize keys across HSM instances within a cluster or across cloned clusters. In general, you will not need to use this command, as HSM instances within a cluster sync keys automatically. However, key synchronization across cloned clusters must be done manually. Cloned clusters are usually created in different AWS Regions in order to simplify the global scaling and disaster recovery processes.

You cannot use **syncKey** to synchronize keys across arbitrary clusters: one of the clusters must have been created from a backup of the other. Additionally, both clusters must have consistent CO and CU credentials in order for the operation to be successful. For more information, see HSM Users (p. 93).

To use **syncKey**, you must first create an AWS CloudHSM configuration file (p. 156) that specifies one HSM from the source cluster and one from the destination cluster. This will allow cloudhsm_mgmt_util to connect to both HSM instances. Use this configuration file to start cloudhsm_mgmt_util. Then log in with the credentials of a CO or a CU who owns the keys you want to synchronize.

**User type**

The following types of users can run this command.

- Crypto officers (CO)
- Crypto users (CU)

**Note**

COs can use **syncKey** on any keys, while CUs can only use this command on keys that they own. For more information, see the section called “Understanding HSM users” (p. 93).

**Prerequisites**

Before you begin, you must know the **key handle** of the key on the source HSM to be synchronized with the destination HSM. To find the **key handle**, use the **listUsers** (p. 284) command to list all identifiers for named users. Then, use the **findAllKeys** (p. 270) command to find all keys that belong to a particular user.

You also need to know the **server IDs** assigned to the source and destination HSMs, which are shown in the trace output returned by cloudhsm_mgmt_util upon initiation. These are assigned in the same order that the HSMs appear in the configuration file.

Follow the instructions in Using CMU Across Cloned Clusters (p. 156) and initialize cloudhsm_mgmt_util with the new config file. Then, enter server mode on the source HSM by issuing the **server** (p. 290) command.

**Syntax**

**Note**

To run **syncKey**, first enter server mode on the HSM which contains the key to be synchronized.

Because this command does not have named parameters, you must enter the arguments in the order specified in the syntax diagram.

**User Type**: Crypto user (CU)

```
syncKey <key handle> <destination hsm>
```
Example

Run the `server` command to log into the source HSM and enter server mode. For this example, we assume that `server 0` is the source HSM.

```
aws-cloudhsm> server 0
```

Now run the `syncKey` command. In this example, we assume key `261251` is to be synced to `server 1`.

```
aws-cloudhsm> syncKey 261251 1
syncKey success
```

Arguments

Because this command does not have named parameters, you must enter the arguments in the order specified in the syntax diagram.

```
syncKey <key handle> <destination hsm>
```

`<key handle>`

Specifies the key handle of the key to sync. You can specify only one key in each command. To get the key handle of a key, use `findAllKeys` (p. 270) while logged in to an HSM server.

Required: Yes

`<destination hsm>`

Specifies the number of the server to which you are syncing a key.

Required: Yes

Related topics

- `listUsers (p. 284)`
- `findAllKeys (p. 270)`
- `describe-clusters` in AWS CLI
- `server (p. 290)`

**syncUser**

You can use the `syncUser` command in cloudhsm_mgmt_util to manually synchronize crypto users (CUs) or crypto officers (COs) across HSM instances within a cluster or across cloned clusters. AWS CloudHSM does not automatically synchronize users. Generally, you manage users in global mode so that all HSMs in a cluster are updated together. You might need to use `syncUser` if an HSM is accidentally desynchronized (for example, due to password changes) or if you want to rotate user credentials across cloned clusters. Cloned clusters are usually created in different AWS Regions to simplify the global scaling and disaster recovery processes.

Before you run any CMU command, you must start CMU and log in to the HSM. Be sure that you log in with a user type that can run the commands you plan to use.

If you add or delete HSMs, update the configuration files for CMU. Otherwise, the changes that you make might not be effective for all HSMs in the cluster.
User type

The following types of users can run this command.

- Crypto officers (CO)

Prerequisites

Before you begin, you must know the user ID of the user on the source HSM to be synchronized with the destination HSM. To find the user ID, use the listUsers (p. 284) command to list all users on the HSMs in a cluster.

You also need to know the server ID assigned to the source and destination HSMs, which are shown in the trace output returned by cloudhsm_mgmt_util upon initiation. These are assigned in the same order that the HSMs appear in the configuration file.

If you are synchronizing HSMs across cloned clusters, follow the instructions in Using CMU Across Cloned Clusters (p. 156) and initialize cloudhsm_mgmt_util with the new config file.

When you are ready to run syncUser, enter server mode on the source HSM by issuing the server (p. 290) command.

Syntax

Because this command does not have named parameters, you must enter the arguments in the order specified in the syntax diagram.

```
syncUser <user ID> <server ID>
```

Example

Run the server command to log into the source HSM and enter server mode. For this example, we assume that server 0 is the source HSM.

```
aws-cloudhsm> server 0
```

Now run the syncUser command. For this example, we assume that user 6 is the user to be synced, and server 1 is the destination HSM.

```
server 0> syncUser 6 1
ExtractMaskedObject: 0x0 !
InsertMaskedObject: 0x0 !
syncUser success
```

Arguments

Because this command does not have named parameters, you must enter the arguments in the order specified in the syntax diagram.

```
syncUser <user ID> <server ID>
```

**<user ID>**

Specifies the ID of the user to sync. You can specify only one user in each command. To get the ID of a user, use listUsers (p. 284).

Required: Yes
<server ID>
Specifies the server number of the HSM to which you are syncing a user.
Required: Yes

Related topics
- listUsers (p. 284)
- describe-clusters in AWS CLI
- server (p. 290)

Key Management Utility (KMU)
The key management utility (KMU) is a command line tool that helps crypto users (CU) manage keys on the hardware security modules (HSM). KMU includes multiple commands that generate, delete, import, and export keys, get and set attributes, find keys, and perform cryptographic operations.

KMU and CMU are part of the Client SDK 3 suite (p. 454).

For a quick start, see Getting started with key_mgmt_util (p. 301). For detailed information about the commands, see key_mgmt_util command reference (p. 307). For help interpreting the key attributes, see the Key Attribute Reference (p. 388).

To use key_mgmt_util if you are using Linux, connect to your client instance and then see Install and configure the AWS CloudHSM client (Linux) (p. 304). If you are using Windows, see Install and configure the AWS CloudHSM client (Windows) (p. 306).

Topics
- Getting started with key_mgmt_util (p. 301)
- Install and configure the AWS CloudHSM client (Linux) (p. 304)
- Install and configure the AWS CloudHSM client (Windows) (p. 306)
- key_mgmt_util command reference (p. 307)

Getting started with key_mgmt_util
AWS CloudHSM includes two command line tools with the AWS CloudHSM client software (p. 305). The cloudhsm_mgmt_util (p. 259) tool includes commands to manage HSM users. The key_mgmt_util (p. 307) tool includes commands to manage keys. To get started with the key_mgmt_util command line tool, see the following topics.

Topics
- Set up key_mgmt_util (p. 301)
- Basic usage of key_mgmt_util (p. 303)

If you encounter an error message or unexpected outcome for a command, see the Troubleshooting AWS CloudHSM (p. 637) topics for help. For details about the key_mgmt_util commands, see key_mgmt_util command reference (p. 307).

Set up key_mgmt_util
Complete the following setup before you use key_mgmt_util.
Start the AWS CloudHSM client

Before you use key_mgmt_util, you must start the AWS CloudHSM client. The client is a daemon that establishes end-to-end encrypted communication with the HSMs in your cluster. The key_mgmt_util tool uses the client connection to communicate with the HSMs in your cluster. Without it, key_mgmt_util doesn't work.

To start the AWS CloudHSM client

Use the following command to start the AWS CloudHSM client.

Amazon Linux

$ sudo start cloudhsm-client

Amazon Linux 2

$ sudo service cloudhsm-client start

CentOS 7

$ sudo service cloudhsm-client start

CentOS 8

$ sudo service cloudhsm-client start

RHEL 7

$ sudo service cloudhsm-client start

RHEL 8

$ sudo service cloudhsm-client start

Ubuntu 16.04 LTS

$ sudo service cloudhsm-client start

Ubuntu 18.04 LTS

$ sudo service cloudhsm-client start

Windows

- For Windows client 1.1.2+:

  C:\Program Files\Amazon\CloudHSM> net.exe start AWSCloudHSMClient

- For Windows clients 1.1.1 and older:

  C:\Program Files\Amazon\CloudHSM> start "cloudhsm_client" cloudhsm_client.exe C:\ProgramData\Amazon\CloudHSM\data\cloudhsm_client.cfg
Start key_mgmt_util

After you start the AWS CloudHSM client, use the following command to start key_mgmt_util.

Amazon Linux

```
$ /opt/cloudhsm/bin/key_mgmt_util
```

Amazon Linux 2

```
$ /opt/cloudhsm/bin/key_mgmt_util
```

CentOS 7

```
$ /opt/cloudhsm/bin/key_mgmt_util
```

CentOS 8

```
$ /opt/cloudhsm/bin/key_mgmt_util
```

RHEL 7

```
$ /opt/cloudhsm/bin/key_mgmt_util
```

RHEL 8

```
$ /opt/cloudhsm/bin/key_mgmt_util
```

Ubuntu 16.04 LTS

```
$ /opt/cloudhsm/bin/key_mgmt_util
```

Ubuntu 18.04 LTS

```
$ /opt/cloudhsm/bin/key_mgmt_util
```

Windows

```
c:\Program Files\Amazon\CloudHSM> .\key_mgmt_util.exe
```

The prompt changes to Command: when key_mgmt_util is running.

If the command fails, such as returning a Daemon socket connection error message, try updating your configuration file (p. 661).

Basic usage of key_mgmt_util

See the following topics for the basic usage of the key_mgmt_util tool.

Topics
• Log in to the HSMs (p. 304)
• Log out from the HSMs (p. 304)
• Stop key_mgmt_util (p. 304)

Log in to the HSMs

Use the `loginHSM` command to log in to the HSMs. The following command logs in as a crypto user (CU) (p. 93) named example_user. The output indicates a successful login for all three HSMs in the cluster.

```
Command: loginHSM -u CU -s example_user -p <PASSWORD>
Cfm3LoginHSM returned: 0x00 : HSM Return: SUCCESS
Cluster Error Status
  Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
  Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
  Node id 2 and err state 0x00000000 : HSM Return: SUCCESS
```

The following shows the syntax for the `loginHSM` command.

```
Command: loginHSM -u <USER TYPE> -s <USERNAME> -p <PASSWORD>
```

Log out from the HSMs

Use the `logoutHSM` command to log out from the HSMs.

```
Command: logoutHSM
Cfm3LogoutHSM returned: 0x00 : HSM Return: SUCCESS
Cluster Error Status
  Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
  Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
  Node id 2 and err state 0x00000000 : HSM Return: SUCCESS
```

Stop key_mgmt_util

Use the `exit` command to stop key_mgmt_util.

```
Command: exit
```

Install and configure the AWS CloudHSM client (Linux)

To interact with the HSM in your AWS CloudHSM cluster, you need the AWS CloudHSM client software for Linux. You should install it on the Linux EC2 client instance that you created previously. You can also install a client if you are using Windows. For more information, see Install and configure the AWS CloudHSM client (Windows) (p. 306).

Tasks

• Install the AWS CloudHSM client and command line tools (p. 305)
• Edit the client configuration (p. 306)
Install the AWS CloudHSM client and command line tools

Connect to your client instance and run the following commands to download and install the AWS CloudHSM client and command line tools.

**Amazon Linux**

```bash
wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL6/cloudhsm-client-latest.el6.x86_64.rpm
sudo yum install ./cloudhsm-client-latest.el6.x86_64.rpm
```

**Amazon Linux 2**

```bash
wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-latest.el7.x86_64.rpm
sudo yum install ./cloudhsm-client-latest.el7.x86_64.rpm
```

**CentOS 7**

```bash
sudo yum install wget
wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-latest.el7.x86_64.rpm
sudo yum install ./cloudhsm-client-latest.el7.x86_64.rpm
```

**CentOS 8**

```bash
sudo yum install wget
wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL8/cloudhsm-client-latest.el8.x86_64.rpm
sudo yum install ./cloudhsm-client-latest.el8.x86_64.rpm
```

**RHEL 7**

```bash
sudo yum install wget
wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-latest.el7.x86_64.rpm
sudo yum install ./cloudhsm-client-latest.el7.x86_64.rpm
```

**RHEL 8**

```bash
sudo yum install wget
```
Install the client (Windows)

To work with an HSM in your AWS CloudHSM cluster on Windows, you need the AWS CloudHSM client software for Windows. You should install it on the Windows Server instance that you created previously.

**Edit the client configuration**

Before you can use the AWS CloudHSM client to connect to your cluster, you must edit the client configuration.

**To edit the client configuration**

1. Copy your issuing certificate—the one that you used to sign the cluster's certificate (p. 23)—to the following location on the client instance: /opt/cloudhsm/etc/customerCA.crt. You need instance root user permissions on the client instance to copy your certificate to this location.

2. Use the following `configure (p. 159)` command to update the configuration files for the AWS CloudHSM client and command line tools, specifying the IP address of the HSM in your cluster. To get the HSM's IP address, view your cluster in the AWS CloudHSM console, or run the `describe-clusters` AWS CLI command. In the command's output, the HSM's IP address is the value of the `EniIp` field. If you have more than one HSM, choose the IP address for any of the HSMs; it doesn't matter which one.

   ```bash
   sudo /opt/cloudhsm/bin/configure -a <IP address>
   Updating server config in /opt/cloudhsm/etc/cloudhsm_client.cfg
   Updating server config in /opt/cloudhsm/etc/cloudhsm_mgmt_util.cfg
   ```

3. Go to Activate the cluster (p. 28).

---

---
To install (or update) the latest Windows client and command line tools

1. Connect to your Windows Server instance.
2. Download the latest (AWSCloudHSMClient-latest.msi) from the downloads page.
3. Go to your download location and run the installer (AWSCloudHSMClient-latest.msi) with administrative privilege.
4. Follow the installer instructions, then choose Close after the installer has finished.
5. Copy your self-signed issuing certificate—the one that you used to sign the cluster certificate (p. 23)—to the C:\ProgramData\Amazon\CloudHSM folder.
6. Run the following command to update your configuration files. Be sure to stop and start the client during reconfiguration if you are updating it:

   C:\Program Files\Amazon\CloudHSM\bin\configure.exe -a <HSM IP address>

7. Go to Activate the cluster (p. 28).

Notes:

- If you are updating the client, existing configuration files from previous installations are not overwritten.
- The AWS CloudHSM client installer for Windows automatically registers the Cryptography API: Next Generation (CNG) and key storage provider (KSP). To uninstall the client, run the installer again and follow the uninstall instructions.
- If you are using Linux, you can install the Linux client. For more information, see Install and configure the AWS CloudHSM client (Linux) (p. 304).

key_mgmt_util command reference

The key_mgmt_util command line tool helps you to manage keys in the HSMs in your cluster, including creating, deleting, and finding keys and their attributes. It includes multiple commands, each of which is described in detail in this topic.

For a quick start, see Getting started with key_mgmt_util (p. 301). For help interpreting the key attributes, see the Key Attribute Reference (p. 388). For information about the cloudhsm_mgmt_util command line tool, which includes commands to manage the HSM and users in your cluster, see CloudHSM Management Utility (CMU) (p. 252).

Before you run any key_mgmt_util command, you must start key_mgmt_util (p. 303) and log in (p. 304) to the HSM as a crypto user (CU).

To list all key_mgmt_util commands, type:

Command: help

To get help for a particular key_mgmt_util command, type:

Command: <command-name> -h

To end your key_mgmt_util session, type:

Command: exit
The following topics describe commands in key_mgmt_util.

**Note**
Some commands in key_mgmt_util and cloudhsm_mgmt_util have the same names. However, the commands typically have different syntax, different output, and slightly different functionality.

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>aesWrapUnwrap (p. 309)</td>
<td>Encrypts and decrypts the contents of a key in a file.</td>
</tr>
<tr>
<td>deleteKey (p. 312)</td>
<td>Deletes a key from the HSMs.</td>
</tr>
<tr>
<td>Error2String (p. 313)</td>
<td>Gets the error that corresponds to a key_mgmt_util hexadecimal error code.</td>
</tr>
<tr>
<td>exit (p. 314)</td>
<td>Exits the key_mgmt_util.</td>
</tr>
<tr>
<td>exportPrivateKey (p. 315)</td>
<td>Exports a copy of a private key from an HSM to a file on disk.</td>
</tr>
<tr>
<td>exportPubKey (p. 316)</td>
<td>Exports a copy of a public key from an HSM to a file.</td>
</tr>
<tr>
<td>exSymKey (p. 318)</td>
<td>Exports a plaintext copy of a symmetric key from the HSMs to a file.</td>
</tr>
<tr>
<td>extractMaskedObject (p. 322)</td>
<td>Extracts a key from an HSM as a masked object file.</td>
</tr>
<tr>
<td>findKey (p. 323)</td>
<td>Search for keys by key attribute value.</td>
</tr>
<tr>
<td>findSingleKey (p. 327)</td>
<td>Verifies that a key exists on all HSMs in the cluster.</td>
</tr>
<tr>
<td>genDSAKeyPair (p. 328)</td>
<td>Generates a Digital Signing Algorithm (DSA) key pair in your HSMs.</td>
</tr>
<tr>
<td>genECCKeyPair (p. 332)</td>
<td>Generates an Elliptic Curve Cryptography (ECC) key pair in your HSMs.</td>
</tr>
<tr>
<td>genRSAKeyPair (p. 336)</td>
<td>Generates an RSA asymmetric key pair in your HSMs.</td>
</tr>
<tr>
<td>genSymKey (p. 341)</td>
<td>Generates a symmetric key in your HSMs</td>
</tr>
<tr>
<td>getAttribute (p. 347)</td>
<td>Gets the attribute values for an AWS CloudHSM key and writes them to a file.</td>
</tr>
<tr>
<td>getCaviumPrivKey (p. 350)</td>
<td>Creates a fake PEM-format version of a private key and exports it to a file.</td>
</tr>
<tr>
<td>getCert (p. 351)</td>
<td>Retrieves an HSM’s partitions certificates and saves them to a file.</td>
</tr>
<tr>
<td>getKeyInfo (p. 352)</td>
<td>Gets the HSM user IDs of users who can use the key.</td>
</tr>
<tr>
<td></td>
<td>If the key is quorum controlled, it gets the number of users in the quorum.</td>
</tr>
<tr>
<td>Command</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>help (p. 354)</td>
<td>Displays help information about the commands available in key_mgmt_util.</td>
</tr>
<tr>
<td>importPrivateKey (p. 356)</td>
<td>Imports a private key into an HSM.</td>
</tr>
<tr>
<td>importPubKey (p. 359)</td>
<td>Imports a public key into an HSM.</td>
</tr>
<tr>
<td>imSymKey (p. 361)</td>
<td>Imports a plaintext copy of a symmetric key from a file into the HSM.</td>
</tr>
<tr>
<td>insertMaskedObject (p. 367)</td>
<td>Inserts a masked object from a file on disk into an HSM contained by related cluster to the object's origin cluster. Related clusters are any clusters generated from a backup of the origin cluster (p. 48).</td>
</tr>
<tr>
<td>?? (p. 369)</td>
<td>Determines whether or not a given file contains a real private key or a fake PEM key.</td>
</tr>
<tr>
<td>listAttributes (p. 370)</td>
<td>Lists the attributes of an AWS CloudHSM key and the constants that represent them.</td>
</tr>
<tr>
<td>listUsers (p. 371)</td>
<td>Gets the users in the HSMs, their user type and ID, and other attributes.</td>
</tr>
<tr>
<td>loginHSM and logoutHSM (p. 372)</td>
<td>Log in and out of the HSMs in a cluster.</td>
</tr>
<tr>
<td>setAttribute (p. 374)</td>
<td>Converts a session key to a persistent key.</td>
</tr>
<tr>
<td>sign (p. 376)</td>
<td>Generate a signature for a file using a chosen private key.</td>
</tr>
<tr>
<td>unWrapKey (p. 378)</td>
<td>Imports a wrapped (encrypted) key from a file into the HSMs.</td>
</tr>
<tr>
<td>verify (p. 383)</td>
<td>Verifies whether a given key was used to sign a given file.</td>
</tr>
<tr>
<td>wrapKey (p. 385)</td>
<td>Exports an encrypted copy of a key from the HSM to a file.</td>
</tr>
</tbody>
</table>

**aesWrapUnwrap**

The **aesWrapUnwrap** command encrypts or decrypts the contents of a file on disk. This command is designed to wrap and unwrap encryption keys, but you can use it on any file that contains less than 4 KB (4096 bytes) of data.

**aesWrapUnwrap** uses **AES Key Wrap**. It uses an AES key on the HSM as the wrapping or unwrapping key. Then it writes the result to another file on disk.

Before you run any key_mgmt_util command, you must **start key_mgmt_util (p. 303)** and **log in (p. 304)** to the HSM as a crypto user (CU).

**Syntax**

```
aesWrapUnwrap -h
```
aesWrapUnwrap -m <wrap-unwrap mode> -f <file-to-wrap-unwrap> -w <wrapping-key-handle> [-i <wrapping-IV>] [-out <output-file>]

Examples

These examples show how to use `aesWrapUnwrap` to encrypt and decrypt an encryption key in a file.

Example: Wrap an encryption key

This command uses `aesWrapUnwrap` to wrap a Triple DES symmetric key that was exported from the HSM in plaintext (p. 318) into the 3DES.key file. You can use a similar command to wrap any key saved in a file.

The command uses the -m parameter with a value of 1 to indicate wrap mode. It uses the -w parameter to specify an AES key in the HSM (key handle 6) as the wrapping key. It writes the resulting wrapped key to the 3DES.key.wrapped file.

The output shows that the command was successful and that the operation used the default IV, which is preferred.

```
Command: aesWrapUnwrap -f 3DES.key -w 6 -m 1 -out 3DES.key.wrapped

Warning: IV (-i) is missing.
0xA6A6A6A6A6A6A6A6 is considered as default IV

result data:
49 49 E2 D0 11 C1 97 22
17 43 BD E3 4E F4 12 75
8D C1 34 CF 26 10 3A 8D
6D 0A 7B D5 D3 E8 4D C2
79 09 08 61 94 68 51 B7
result written to file 3DES.key.wrapped

Cfm3WrapHostKey returned: 0x00 : HSM Return: SUCCESS
```

Example: Unwrap an encryption key

This example shows how to use `aesWrapUnwrap` to unwrap (decrypt) a wrapped (encrypted) key in a file. You might want to do an operation like this one before importing a key to the HSM. For example, if you try to use the `imSymKey` (p. 361) command to import an encrypted key, it returns an error because the encrypted key doesn't have the format that is required for a plaintext key of that type.

The command unwraps the key in the 3DES.key.wrapped file and writes the plaintext to the 3DES.key.unwrapped file. The command uses the -m parameter with a value of 0 to indicate unwrap mode. It uses the -w parameter to specify an AES key in the HSM (key handle 6) as the wrapping key. It writes the resulting wrapped key to the 3DES.key.unwrapped file.

```
Command: aesWrapUnwrap -m 0 -f 3DES.key.wrapped -w 6 -out 3DES.key.unwrapped

Warning: IV (-i) is missing.
0xA6A6A6A6A6A6A6A6 is considered as default IV

result data:
14 90 D7 AD D6 E4 F5 FA
A1 95 6F 24 89 79 F3 EE
37 21 E6 54 1F 3B 8D 62
result written to file 3DES.key.unwrapped
```
Cfm3UnWrapHostKey returned: 0x00 : HSM Return: SUCCESS

Parameters

-h
Displays help for the command.
Required: Yes

-m
Specifies the mode. To wrap (encrypt) the file content, type 1; to unwrap (decrypt) the file content, type 0.
Required: Yes

-f
Specifies the file to wrap. Enter a file that contains less than 4 KB (4096 bytes) of data. This operation is designed to wrap and unwrap encryption keys.
Required: Yes

-w
Specifies the wrapping key. Enter the key handle of an AES key on the HSM. This parameter is required. To find key handles, use the findKey (p. 323) command.

To create a wrapping key, use genSymKey (p. 341) to generate an AES key (type 31).
Required: Yes

-i
Specifies an alternate initial value (IV) for the algorithm. Use the default value unless you have a special condition that requires an alternative.

Default: 0xA6A6A6A6A6A6A6A6. The default value is defined in the AES Key Wrap algorithm specification.
Required: No

-out
Specifies an alternate name for the output file that contains the wrapped or unwrapped key. The default is wrapped_key (for wrap operations) and unwrapped_key (for unwrap operations) in the local directory.

If the file exists, the aesWrapUnwrap overwrites it without warning. If the command fails, aesWrapUnwrap creates an output file with no contents.
Default: For wrap: wrapped_key. For unwrap: unwrapped_key.
Required: No

Related topics

- exSymKey (p. 318)
- imSymKey (p. 361)
- unWrapKey (p. 378)
**deleteKey**

The `deleteKey` command in `key_mgmt_util` deletes a key from the HSM. You can only delete one key at a time. Deleting one key in a key pair has no effect on the other key in the pair.

Only the key owner can delete a key. Users who share the key can use it in cryptographic operations, but not delete it.

Before you run any `key_mgmt_util` command, you must `start_key_mgmt_util (p. 303)` and `log in (p. 304)` to the HSM as a crypto user (CU).

### Syntax

```
deleteKey -h
deleteKey -k
```

### Examples

These examples show how to use `deleteKey` to delete keys from your HSMs.

**Example : Delete a key**

This command deletes the key with key handle 6. When the command succeeds, `deleteKey` returns success messages from each HSM in the cluster.

Command: `deleteKey -k 6`

```
Cfm3DeleteKey returned: 0x00 : HSM Return: SUCCESS
Cluster Error Status
Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
Node id 2 and err state 0x00000000 : HSM Return: SUCCESS
```

**Example : Delete a key (failure)**

When the command fails because no key has the specified key handle, `deleteKey` returns an invalid object handle error message.

Command: `deleteKey -k 252126`

```
Cfm3FindKey returned: 0xa8 : HSM Error: Invalid object handle is passed to this operation
Cluster Error Status
Node id 1 and err state 0x000000a8 : HSM Error: Invalid object handle is passed to this operation
Node id 2 and err state 0x000000a8 : HSM Error: Invalid object handle is passed to this operation
```

When the command fails because the current user is not the owner of the key, the command returns an access denied error.

Command: `deleteKey -k 262152`
Cfm3DeleteKey returned: 0xc6 : HSM Error: Key Access is denied.

Parameters

-h
Displays command line help for the command.
Required: Yes

-k
Specifies the key handle of the key to delete. To find the key handles of keys in the HSM, use findKey (p. 323).
Required: Yes

Related topics

- findKey (p. 323)

Error2String

The Error2String helper command in key_mgmt_util returns the error that corresponds to a key_mgmt_util hexadecimal error code. You can use this command when troubleshooting your commands and scripts.

Before you run any key_mgmt_util command, you must start key_mgmt_util (p. 303) and log in (p. 304) to the HSM as a crypto user (CU).

Syntax

Error2String -h
Error2String -r <response-code>

Examples

These examples show how to use Error2String to get the error string for a key_mgmt_util error code.

Example : Get an error description

This command gets the error description for the 0xdb error code. The description explains that an attempt to log in to key_mgmt_util failed because the user has the wrong user type. Only crypto users (CU) can log in to key_mgmt_util.

Command: Error2String -r 0xdb
Error Code db maps to HSM Error: Invalid User Type.

Example : Find the error code

This example shows where to find the error code in a key_mgmt_util error. The error code, 0xc6, appears after the string: Cfm3command-name returned: .
In this example, `getKeyInfo (p. 352)` indicates that the current user (user 4) can use the key in cryptographic operations. Nevertheless, when the user tries to use `deleteKey (p. 312)` to delete the key, the command returns error code `0xc6`.

```
Command: deleteKey -k 262162
Cfm3DeleteKey returned: 0xc6 : HSM Error: Key Access is denied
Cluster Error Status
Command: getKeyInfo -k 262162
Cfm3GetKey returned: 0x00 : HSM Return: SUCCESS
Owned by user 3
also, shared to following 1 user(s):
   4
```

If the `0xc6` error is reported to you, you can use an `Error2String` command like this one to look up the error. In this case, the `deleteKey` command failed with an access denied error because the key is shared with the current user but owned by a different user. Only key owners have permission to delete a key.

```
Command: Error2String -r 0xa8
Error Code c6 maps to HSM Error: Key Access is denied
```

**Parameters**

- **h**
  - Displays help for the command.
  - Required: Yes
- **r**
  - Specifies a hexadecimal error code. The `0x` hexadecimal indicator is required.
  - Required: Yes

**exit**

The `exit` command in key_mgmt_util exits the key_mgmt_util. Upon successful exit, you will be returned to your standard command line.

Before you run any key_mgmt_util command, you must `start key_mgmt_util (p. 303)`.

**Syntax**

```
exit
```

**Parameters**

There are no parameters for this command.
Related topics

- Start key_mgmt_util (p. 303)

exportPrivateKey

The `exportPrivateKey` command in key_mgmt_util exports an asymmetric private key from an HSM to a file. The HSM does not allow direct export of keys in cleartext. The command wraps the private key using an AES wrapping key you specify, decrypts the wrapped bytes, and copies the cleartext private key to a file.

The `exportPrivateKey` command does not remove the key from the HSM, change its key attributes (p. 388), or prevent you from using the key in further cryptographic operations. You can export the same key multiple times.

You can only export private keys that have OBJ_ATTR_EXTRACTABLE attribute value 1. You must specify an AES wrapping key that has OBJ_ATTR_WRAP and OBJ_ATTR_DECRYPT attributes value 1. To find a key's attributes, use the `getAttribute` (p. 347) command.

Before you run any key_mgmt_util command, you must start key_mgmt_util (p. 303) and log in (p. 304) to the HSM as a crypto user (CU).

Syntax

```plaintext
exportPrivateKey -h
exportPrivateKey -k <private-key-handle>
               -w <wrapping-key-handle>
               -out <key-file>
               [-m <wrapping-mechanism>]
               [-wk <wrapping-key-file>]
```

Examples

This example shows how to use `exportPrivateKey` to export a private key out of an HSM.

**Example : Export a private key**

This command exports a private key with handle 15 using a wrapping key with handle 16 to a PEM file called `exportKey.pem`. When the command succeeds, `exportPrivateKey` returns a success message.

```
Command: exportPrivateKey -k 15 -w 16 -out exportKey.pem

Cfm3WrapKey returned: 0x00 : HSM Return: SUCCESS

Cfm3UnWrapHostKey returned: 0x00 : HSM Return: SUCCESS

PEM formatted private key is written to exportKey.pem
```

Parameters

This command takes the following parameters.

- `-h`
  Displays command line help for the command.
Required: Yes

-k

Specifies the key handle of the private key to be exported.

Required: Yes

-w

Specifies the key handle of the wrapping key. This parameter is required. To find key handles, use the `findKey` command.

To determine whether a key can be used as a wrapping key, use `getAttribute` to get the value of the OBJ_ATTR_WRAP attribute (262). To create a wrapping key, use `genSymKey` to create an AES key (type 31).

If you use the -wk parameter to specify an external unwrapping key, the -w wrapping key is used to wrap, but not unwrap, the key during export.

Required: Yes

-out

Specifies the name of the file to which the exported private key will be written.

Required: Yes

-m

Specifies the wrapping mechanism with which to wrap the private key being exported. The only valid value is 4, which represents the NIST_AES_WRAP mechanism.

Default: 4 (NIST_AES_WRAP)

Required: No

-wk

Specifies the key to be used to unwrap the key being exported. Enter the path and name of a file that contains a plaintext AES key.

When you include this parameter, `exportPrivateKey` uses the key in the -w file to wrap the key being exported and uses the key specified by the -wk parameter to unwrap it.

Default: Use the wrapping key specified in the -w parameter to both wrap and unwrap.

Required: No

Related topics

- importPrivateKey (p. 356)
- wrapKey (p. 385)
- unWrapKey (p. 378)
- genSymKey (p. 341)

exportPubKey

The `exportPubKey` command in key_mgmt_util exports a public key in an HSM to a file. You can use it to export public keys that you generate in an HSM. You can also use this command to export public keys that were imported into an HSM, such as those imported with the `importPubKey` command.
The **exportPubKey** operation copies the key material to a file that you specify. But it does not remove the key from the HSM, change its **key attributes** (p. 388), or prevent you from using the key in further cryptographic operations. You can export the same key multiple times.

You can only export public keys that have a **OBJ_ATTR_EXTRACTABLE** value of 1. To find a key’s attributes, use the **getAttribute** (p. 347) command.

Before you run any **key_mgmt_util** command, you must **start key_mgmt_util** (p. 303) and **log in** (p. 304) to the HSM as a crypto user (CU).

### Syntax

```
exportPubKey -h
exportPubKey -k <public-key-handle>
    -out <key-file>
```

### Examples

This example shows how to use **exportPubKey** to export a public key from an HSM.

**Example : Export a public key**

This command exports a public key with handle 10 to a file called `public.pem`. When the command succeeds, **exportPubKey** returns a success message.

```
Command: exportPubKey -k 10 -out public.pem
PEM formatted public key is written to public.pem
Cfm3ExportPubKey returned: 0x00 : HSM Return: SUCCESS
```

### Parameters

This command takes the following parameters.

- **-h**
  
  Displays command line help for the command.
  
  Required: Yes

- **-k**
  
  Specifies the key handle of the public key to be exported.
  
  Required: Yes

- **-out**
  
  Specifies the name of the file to which the exported public key will be written.
  
  Required: Yes

### Related topics

- **importPubKey** (p. 359)
exSymKey

The **exSymKey** command in the key_mgmt_util tool exports a plaintext copy of a symmetric key from the HSM and saves it in a file on disk. To export an encrypted (wrapped) copy of a key, use **wrapKey** (p. 385). To import a plaintext key, like the ones that exSymKey exports, use **imSymKey** (p. 361).

During the export process, **exSymKey** uses an AES key that you specify (the *wrapping key*) to *wrap* (encrypt) and then *unwrap* (decrypt) the key to be exported. However, the result of the export operation is a plaintext (*unwrapped*) key on disk.

Only the owner of a key, that is, the CU user who created the key, can export it. Users who share the key can use it in cryptographic operations, but they cannot export it.

The **exSymKey** operation copies the key material to a file that you specify, but it does not remove the key from the HSM, change its key attributes (p. 388), or prevent you from using the key in cryptographic operations. You can export the same key multiple times.

**exSymKey** exports only symmetric keys. To export public keys, use **exportPubKey** (p. 316). To export private keys, use **exportPrivateKey** (p. 315).

Before you run any key_mgmt_util command, you must **start key_mgmt_util** (p. 303) and **log in** (p. 304) to the HSM as a crypto user (CU).

**Syntax**

```
 exSymKey -h
 exSymKey -k <key-to-export>  
 -w <wrapping-key>  
 -out <key-file>  
 [-m 4]  
 [-wk <unwrapping-key-file> ]
```

**Examples**

These examples show how to use **exSymKey** to export symmetric keys that you own from your HSMs.

**Example : Export a 3DES symmetric key**

This command exports a Triple DES (3DES) symmetric key (key handle 7). It uses an existing AES key (key handle 6) in the HSM as the wrapping key. Then it writes the plaintext of the 3DES key to the 3DES.key file.

The output shows that key 7 (the 3DES key) was successfully wrapped and unwrapped, and then written to the 3DES.key file.

**Warning**
Although the output says that a "Wrapped Symmetric Key" was written to the output file, the output file contains a plaintext (unwrapped) key.

```
 Command: exSymKey -k 7 -w 6 -out 3DES.key
 Cfm3WrapKey returned: 0x00 : HSM Return: SUCCESS
 Cfm3UnWrapHostKey returned: 0x00 : HSM Return: SUCCESS
```
Wrapped Symmetric Key written to file "3DES.key"

Example : Exporting with session-only wrapping key

This example shows how to use a key that exists only in the session as the wrapping key. Because the key to be exported is wrapped, immediately unwrapped, and delivered as plaintext, there is no need to retain the wrapping key.

This series of commands exports an AES key with key handle 8 from the HSM. It uses an AES session key created especially for the purpose.

The first command uses `genSymKey` to create a 256-bit AES key. It uses the `-sess` parameter to create a key that exists only in the current session.

The output shows that the HSM creates key 262168.

```
Command: genSymKey -t 31 -s 32 -l AES-wrapping-key -sess
Cfm3GenerateSymmetricKey returned: 0x00 : HSM Return: SUCCESS
Symmetric Key Created. Key Handle: 262168
Cluster Error Status
Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
```

Next, the example verifies that key 8, the key to be exported, is a symmetric key that is extractable. It also verifies that the wrapping key, key 262168, is an AES key that exists only in the session. You can use the `findKey` command, but this example exports the attributes of both keys to files and then uses `grep` to find the relevant attribute values in the file.

These commands use `getAttribute` with an `-a` value of 512 (all) to get all attributes for keys 8 and 262168. For information about the key attributes, see the section called "Key Attribute Reference".

```
getAttribute -o 8 -a 512 -out attributes/attr_8
getAttribute -o 262168 -a 512 -out attributes/attr_262168
```

These commands use `grep` to verify the attributes of the key to be exported (key 8) and the session-only wrapping key (key 262168).

```
// Verify that the key to be exported is a symmetric key.
$ grep -A 1 "OBJ_ATTR_CLASS" attributes/attr_8
OBJ_ATTR_CLASS
0x04

// Verify that the key to be exported is extractable.
$ grep -A 1 "OBJ_ATTR_KEY_TYPE" attributes/attr_8
OBJ_ATTR_EXTRACTABLE
0x00000001

// Verify that the wrapping key is an AES key
$ grep -A 1 "OBJ_ATTR_KEY_TYPE" attributes/attr_262168
OBJ_ATTR_KEY_TYPE
0x1f

// Verify that the wrapping key is a session key
$ grep -A 1 "OBJ_ATTR_TOKEN" attributes/attr_262168
OBJ_ATTR_TOKEN
```
Finally, we use an `exSymKey` command to export key 8 using the session key (key 262168) as the wrapping key.

When the session ends, key 262168 no longer exists.

```
Command:  exSymKey -k 8 -w 262168 -out aes256_H8.key
Cfm3WrapKey returned: 0x00 : HSM Return: SUCCESS
Cfm3UnWrapHostKey returned: 0x00 : HSM Return: SUCCESS

Wrapped Symmetric Key written to file "aes256_H8.key"
```

**Example: Use an external unwrapping key**

This example shows how to use an external unwrapping key to export a key from the HSM.

When you export a key from the HSM, you specify an AES key on the HSM to be the wrapping key. By default, that wrapping key is used to wrap and unwrap the key to be exported. However, you can use the `-wk` parameter to tell `exSymKey` to use an external key in a file on disk for unwrapping. When you do, the key specified by the `-w` parameter wraps the target key, and the key in the file specified by the `-wk` parameter unwraps the key.

Because the wrapping key must be an AES key, which is symmetric, the wrapping key in the HSM and unwrapping key on disk must be have the same key material. To do this, you must import the wrapping key to the HSM or export the wrapping key from the HSM before the export operation.

This example creates a key outside of the HSM and imports it into the HSM. It uses the internal copy of the key to wrap a symmetric key that is being exported, and the copy of key in the file to unwrap it.

The first command uses OpenSSL to generate a 256-bit AES key. It saves the key to the `aes256-forImport.key` file. The OpenSSL command does not return any output, but you can use several commands to confirm its success. This example uses the `wc` (wordcount) tool, which confirms that the file contains 32 bytes of data.

```
$ openssl rand -out keys/aes256-forImport.key 32
$ wc keys/aes256-forImport.key
 0  2 32 keys/aes256-forImport.key
```

This command uses the `imSymKey` (p. 361) command to import the AES key from the `aes256-forImport.key` file to the HSM. When the command completes, the key exists in the HSM with key handle 262167 and in the `aes256-forImport.key` file.

```
Command:  imSymKey -f keys/aes256-forImport.key -t 31 -l aes256-imported -w 6
Cfm3WrapHostKey returned: 0x00 : HSM Return: SUCCESS
Cfm3CreateUnwrapTemplate returned: 0x00 : HSM Return: SUCCESS
```
This command uses the key in an export operation. The command uses `exSymKey` to export key 21, a 192-bit AES key. To wrap the key, it uses key 262167, which is the copy that was imported into the HSM. To unwrap the key, it uses the same key material in the `aes256-forImport.key` file. When the command completes, key 21 is exported to the `aes192_h21.key` file.

```
Command:  exSymKey -k 21 -w 262167 -out aes192_H21.key -wk aes256-forImport.key
```

Parameters

- **-h**
  
  Displays help for the command.

  Required: Yes

- **-k**
  
  Specifies the key handle of the key to export. This parameter is required. Enter the key handle of a symmetric key that you own. This parameter is required. To find key handles, use the `findKey` (p. 323) command.

  To verify that a key can be exported, use the `getAttribute` (p. 347) command to get the value of the `OBJ_ATTR_EXTRACTABLE` attribute, which is represented by constant 354. Also, you can export only keys that you own. To find the owner of a key, use the `getKeyInfo` (p. 352) command.

  Required: Yes

- **-w**
  
  Specifies the key handle of the wrapping key. This parameter is required. To find key handles, use the `findKey` (p. 323) command.

  A wrapping key is a key in the HSM that is used to encrypt (wrap) and then decrypt (unwrap) the key to be exported. Only AES keys can be used as wrapping keys.

  You can use any AES key (of any size) as a wrapping key. Because the wrapping key wraps, and then immediately unwraps, the target key, you can use as session-only AES key as a wrapping key. To determine whether a key can be used as a wrapping key, use `getAttribute` (p. 347) to get the value of the `OBJ_ATTR_WRAP` attribute, which is represented by the constant 262. To create a wrapping key, use `genSymKey` (p. 341) to create an AES key (type 31).

  If you use the `-wk` parameter to specify an external unwrapping key, the `-w` wrapping key is used to wrap, but not to unwrap, the key during export.

  **Note**
  
  Key 4 represents an unsupported internal key. We recommend that you use an AES key that you create and manage as the wrapping key.

  Required: Yes
-out

Specifies the path and name of the output file. When the command succeeds, this file contains the exported key in plaintext. If the file already exists, the command overwrites it without warning.

Required: Yes

-m

Specifies the wrapping mechanism. The only valid value is 4, which represents the NIST_AES_WRAP mechanism.

Required: No

Default: 4

wk

Use the AES key in the specified file to unwrap the key that is being exported. Enter the path and name of a file that contains a plaintext AES key.

When you include this parameter, exSymKey uses the key in the HSM that is specified by the -w parameter to wrap the key that is being exported and it uses the key in the -wk file to unwrap it. The -w and -wk parameter values must resolve to the same plaintext key.

Required: No

Default: Use the wrapping key on the HSM to unwrap.

Related topics

- genSymKey (p. 341)
- imSymKey (p. 361)
- wrapKey (p. 385)

extractMaskedObject

The extractMaskedObject command in key_mgmt_util extracts a key from an HSM and saves it to a file as a masked object. Masked objects are cloned objects that can only be used after inserting them back into the original cluster by using the insertMaskedObject (p. 367) command. You can only insert a masked object into the same cluster from which it was generated, or a clone of that cluster. This includes any cloned versions of the cluster generated by copying a backup across regions (p. 55) and using that backup to create a new cluster (p. 48).

Masked objects are an efficient way to offload and synchronize keys, including nonextractable keys (that is, keys that have a OBJ_ATTR_EXTRACTABLE (p. 388) value of 0). This way, keys can be securely synced across related clusters in different regions without the need to update the AWS CloudHSM configure file (p. 159).

Important

Upon insertion, masked objects are decrypted and given a key handle that is different from the key handle of the original key. A masked object includes all metadata associated with the original key, including attributes, ownership and sharing information, and quorum settings. If you need to sync keys across clusters in an application, use syncKey (p. 298) in the cloudhsm_mgmt_util instead.

Before you run any key_mgmt_util command, you must start key_mgmt_util (p. 303) and log in (p. 304) to the HSM. The extractMaskedObject command can be used either by the CU who owns the key or any CO.
Syntax

extractMaskedObject -h
extractMaskedObject -o <object-handle>
   -out <object-file>

Examples

This example shows how to use `extractMaskedObject` to extract a key from an HSM as a masked object.

Example : Extract a masked object

This command extracts a masked object out of an HSM from a key with handle 524295 and saves it as a file called maskedObj. When the command succeeds, `extractMaskedObject` returns a success message.

Command: `extractMaskedObject -o 524295 -out maskedObj`

Object was masked and written to file "maskedObj"

   Cfm3ExtractMaskedObject returned: 0x00 : HSM Return: SUCCESS

Parameters

This command takes the following parameters.

-h
   Displays command line help for the command.
   Required: Yes

-o
   Specifies the handle of the key to extract as a masked object.
   Required: Yes

-out
   Specifies the name of the file to which the masked object will be saved.
   Required: Yes

Related topics

- `insertMaskedObject (p. 367)`
- `syncKey (p. 298)`
- `Copying a Backup Across Regions (p. 55)`
- `Creating an AWS CloudHSM Cluster from a Previous Backup (p. 48)`

findKey

Use the `findKey` command in key_mgmt_util to search for keys by the values of the key attributes. When a key matches all the criteria that you set, `findKey` returns the key handle. With no parameters, `findKey`
returns the key handles of all the keys that you can use in the HSM. To find the attribute values of a particular key, use `getAttribute (p. 347)`.

Like all `key_mgmt_util` commands, `findKey` is user specific. It returns only the keys that the current user can use in cryptographic operations. This includes keys that current user owns and keys that have been shared with the current user.

Before you run any `key_mgmt_util` command, you must `start_key_mgmt_util (p. 303)` and `log in (p. 304)` to the HSM as a crypto user (CU).

**Syntax**

```
findKey -h
findKey [-c <key class>]  
[-t <key type>]  
[-l <key label>]  
[-id <key ID>]  
[-sess (0 | 1)]  
[-u <user-ids>]  
[-m <modulus>]  
[-kcv <key_check_value>]
```

**Examples**

These examples show how to use `findKey` to find and identify keys in your HSMs.

**Example : Find all keys**

This command finds all keys for the current user in the HSM. The output includes keys that the user owns and shares, and all public keys in the HSMs.

To get the attributes of a key with a particular key handle, use `getAttribute (p. 347)`. To determine whether the current user owns or shares a particular key, use `getKeyInfo (p. 352)` or `findAllKeys (p. 270)` in `cloudhsm_mgmt_util`.

Command: `findKey`

```
Total number of keys present 13
number of keys matched from start index 0::12
6, 7, 524296, 9, 262154, 262155, 262156, 262157, 262158, 262159, 262160, 262161, 262162
Cluster Error Status
Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
Cfm3FindKey returned: 0x00 : HSM Return: SUCCESS
```

**Example : Find keys by type, user, and session**

This command finds persistent AES keys that the current user and user 3 can use. (User 3 might be able to use other keys that the current user cannot see.)

Command: `findKey -t 31 -sess 0 -u 3`

**Example : Find keys by class and label**

This command finds all public keys for the current user with the 2018-sept label.
Example: Find RSA keys by modulus

This command finds RSA keys (type 0) for the current user that were created by using the modulus in the m4.txt file.

Command: `findKey -t 0 -m m4.txt`

Parameters

- **-h**
  Displays help for the command.
  Required: Yes

- **-t**
  Finds keys of the specified type. Enter the constant that represents the key class. For example, to find 3DES keys, type `-t 21`.
  Valid values:
  - 0: RSA
  - 1: DSA
  - 3: EC
  - 16: GENERIC_SECRET
  - 18: RC4
  - 21: Triple DES (3DES)
  - 31: AES
  Required: No

- **-c**
  Finds keys in the specified class. Enter the constant that represents the key class. For example, to find public keys, type `-c 2`.
  Valid values for each key type:
  - 2: Public. This class contains the public keys of public–private key pairs.
  - 3: Private. This class contains the private keys of public–private key pairs.
  - 4: Secret. This class contains all symmetric keys.
  Required: No

- **-l**
  Finds keys with the specified label. Type the exact label. You cannot use wildcard characters or regular expressions in the `-l` value.
  Required: No

- **-id**
  Finds the key with the specified ID. Type the exact ID string. You cannot use wildcard characters or regular expressions in the `-id` value.
  Required: No
-sess
Finds keys by session status. To find keys that are valid only in the current session, type 1. To find persistent keys, type 0.

Required: No

-u
Finds keys the specified users and the current user share. Type a comma-separated list of HSM user IDs, such as -u 3,4,7. To find the IDs of users on an HSM, use listUsers (p. 371).

When you specify one user ID, findKey returns the keys for that user. When you specify multiple user IDs, findKey returns the keys that all the specified users can use.

Because findKey only returns keys that the current user can use, the -u results are always identical to or a subset of the current user's keys. To get all keys that are owned by or shared with any user, crypto officers (COs) can use findAllKeys (p. 270) in cloudhsm_mgmt_util.

Required: No

-m
Finds keys that were created by using the RSA modulus in the specified file. Type the path to file that stores the modulus.

-m specifies the binary file containing RSA modulus to match with (optional).

Required: No

-kcv
Finds keys with the specified key check value.

The key check value (KCV) is a 3-byte hash or checksum of a key that is generated when the HSM imports or generates a key. You can also calculate a KCV outside of the HSM, such as after you export a key. You can then compare the KCV values to confirm the identity and integrity of the key. To get the KCV of a key, use getAttribute (p. 347).

AWS CloudHSM uses the following standard method to generate a key check value:
- Symmetric keys: First 3 bytes of the result of encrypting a zero-block with the key.
- Asymmetric key pairs: First 3 bytes of the SHA-1 hash of the public key.
- HMAC keys: KCV for HMAC keys is not supported at this time.

Required: No

Output

The findKey output lists the total number of matching keys and their key handles.

<table>
<thead>
<tr>
<th>Command</th>
<th>findKey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of keys present</td>
<td>10</td>
</tr>
<tr>
<td>number of keys matched from start index</td>
<td>0::9</td>
</tr>
<tr>
<td>6, 7, 8, 9, 10, 11, 262156, 262157, 262158, 262159</td>
<td></td>
</tr>
</tbody>
</table>

Cluster Error Status
- Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
- Node id 2 and err state 0x00000000 : HSM Return: SUCCESS

Cfm3FindKey returned: 0x00 : HSM Return: SUCCESS
findSingleKey

The **findSingleKey** command in the key_mgmt_util tool verifies that a key exists on all HSMs in the cluster.

Before you run any key_mgmt_util command, you must [start key_mgmt_util (p. 303)] and [log in (p. 304)] to the HSM as a crypto user (CU).

### Syntax

```
findSingleKey -h
findSingleKey -k <key-handle>
```

### Example

**Example**

This command verifies that key 252136 exists on all three HSMs in the cluster.

```
Command: findSingleKey -k 252136
Cfm3FindKey returned: 0x00 : HSM Return: SUCCESS

Cluster Error Status
    Node id 2 and err state 0x00000000 : HSM Return: SUCCESS
    Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
    Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
```

### Parameters

**-h**

Displays help for the command.

Required: Yes

**-k**

Specifies the key handle of one key in the HSM. This parameter is required.

To find key handles, use the [findKey (p. 371)] command.

Required: Yes

### Related topics

- [findKey (p. 371)]
- [getKeyInfo (p. 352)]
- [getAttribute (p. 347)]
- [findAllKeys (p. 270)] in cloudhsm_mgmt_util
- [Key Attribute Reference (p. 388)]
genDSAKeyPair

The `genDSAKeyPair` command in the key_mgmt_util tool generates a Digital Signing Algorithm (DSA) key pair in your HSMs. You must specify the modulus length; the command generates the modulus value. You can also assign an ID, share the key with other HSM users, create nonextractable keys, and create keys that expire when the session ends. When the command succeeds, it returns the key handles that the HSM assigns to the public and private keys. You can use the key handles to identify the keys to other commands.

Before you run any key_mgmt_util command, you must start key_mgmt_util and log in to the HSM as a crypto user (CU).

**Tip**
To find the attributes of a key that you have created, such as the type, length, label, and ID, use `getAttribute(p. 347)`. To find the keys for a particular user, use `getKeyInfo(p. 352)`. To find keys based on their attribute values, use `findKey(p. 323)`.

**Syntax**

```
genDSAKeyPair -h

genDSAKeyPair -m <modulus length>
  -l <label>
  [-id <key ID>]
  [-min_srv <minimum number of servers>]
  [-m_value <0..8>]
  [-nex]
  [-sess]
  [-timeout <number of seconds>]
  [-u <user-ids>]
  [-attest]
```

**Examples**

These examples show how to use `genDSAKeyPair` to create a DSA key pair.

**Example : Create a DSA key pair**

This command creates a DSA key pair with a DSA label. The output shows that the key handle of the public key is 19 and the handle of the private key is 21.

**Command:** `genDSAKeyPair -m 2048 -l DSA`

```
Cfm3GenerateKeyPair: returned: 0x00 : HSM Retuzn: SUCCESS
Cfm3GenerateKeyPair:   public key handle: 19   private key handle: 21
Cluster Error Status
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
```

**Example : Create a session-only DSA key pair**

This command creates a DSA key pair that is valid only in the current session. The command assigns a unique ID of DSA_temp_pair in addition to the required (nonunique) label. You might want to create
a key pair like this to sign and verify a session-only token. The output shows that the key handle of the
public key is 12 and the handle of the private key is 14.

Command: `genDSAKeyPair -m 2048 -l DSA-temp -id DSA_temp_pair -sess`

Cfm3GenerateKeyPair: returned: 0x00 : HSM Return: SUCCESS

Cfm3GenerateKeyPair: public key handle: 12 private key handle: 14

Cluster Error Status
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS

To confirm that the key pair exists only in the session, use the `-sess` parameter of `findKey (p. 323)`
with a value of 1 (true).

Command: `findKey -sess 1`

Total number of keys present 2

number of keys matched from start index 0:1
12, 14

Cluster Error Status
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS

Cfm3FindKey returned: 0x00 : HSM Return: SUCCESS

Example : Create a shared, nonextractable DSA key pair

This command creates a DSA key pair. The private key is shared with three other users, and it cannot be
exported from the HSM. Public keys can be used by any user and can always be extracted.

Command: `genDSAKeyPair -m 2048 -l DSA -id DSA_shared_pair -nex -u 3,5,6`

Cfm3GenerateKeyPair: returned: 0x00 : HSM Return: SUCCESS

Cfm3GenerateKeyPair: public key handle: 11 private key handle: 19

Cluster Error Status
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS

Example : Create a quorum-controlled key pair

This command creates a DSA key pair with the label DSA-mV2. The command uses the `-u` parameter to
share the private key with user 4 and 6. It uses the `-m_value` parameter to require a quorum of at least
two approvals for any cryptographic operations that use the private key. The command also uses the `-attest`
parameter to verify the integrity of the firmware on which the key pair is generated.

The output shows that the command generates a public key with key handle 12 and a private key with
key handle 17, and that the attestation check on the cluster firmware passed.

Command: `genDSAKeyPair -m 2048 -l DSA-mV2 -m_value 2 -u 4,6 -attest`

Cfm3GenerateKeyPair: returned: 0x00 : HSM Return: SUCCESS

Cfm3GenerateKeyPair: public key handle: 12 private key handle: 17

Attestation Check : [PASS]
Cluster Error Status
Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS

This command uses `getKeyInfo (p. 352)` on the private key (key handle 17). The output confirms that the key is owned by the current user (user 3) and that it is shared with users 4 and 6 (and no others). The output also shows that quorum authentication is enabled and the quorum size is two.

Parameter:

- **-h**

  Displays help for the command.

  Required: Yes

- **-m**

  Specifies the length of the modulus in bits. The only valid value is 2048.

  Required: Yes

- **-l**

  Specifies a user-defined label for the key pair. Type a string. The same label applies to both keys in the pair. The maximum size allowable for `label` is 127 characters.

  You can use any phrase that helps you to identify the key. Because the label does not have to be unique, you can use it to group and categorize keys.

  Required: Yes

- **-id**

  Specifies a user-defined identifier for the key pair. Type a string that is unique in the cluster. The default is an empty string. The ID that you specify applies to both keys in the pair.

  Default: No ID value.

  Required: No

- **-min_srv**

  Specifies the minimum number of HSMs on which the key is synchronized before the value of the `-timeout` parameter expires. If the key is not synchronized to the specified number of servers in the time allotted, it is not created.
AWS CloudHSM automatically synchronizes every key to every HSM in the cluster. To speed up your process, set the value of min_srv to less than the number of HSMs in the cluster and set a low timeout value. Note, however, that some requests might not generate a key.

Default: 1
Required: No

-m_value

Specifies the number of users who must approve any cryptographic operation that uses the private key in the pair. Type a value from 0 to 8.

This parameter establishes a quorum authentication requirement for the private key. The default value, 0, disables the quorum authentication feature for the key. When quorum authentication is enabled, the specified number of users must sign a token to approve cryptographic operations that use the private key, and operations that share or unshare the private key.

To find the m_value of a key, use getKeyInfo (p. 352).

This parameter is valid only when the -u parameter in the command shares the key pair with enough users to satisfy the m_value requirement.

Default: 0
Required: No

-nex

Makes the private key nonextractable. The private key that is generated cannot be exported from the HSM (p. 153). Public keys are always extractable.

Default: Both the public and private keys in the key pair are extractable.
Required: No

-sess

Creates a key that exists only in the current session. The key cannot be recovered after the session ends.

Use this parameter when you need a key only briefly, such as a wrapping key that encrypts, and then quickly decrypts, another key. Do not use a session key to encrypt data that you might need to decrypt after the session ends.

To change a session key to a persistent (token) key, use setAttribute (p. 374).

Default: The key is persistent.
Required: No

-timeout

Specifies how long (in seconds) the command waits for a key to be synchronized to the number of HSMs specified by the min_srv parameter.

This parameter is valid only when the min_srv parameter is also used in the command.

Default: No timeout. The command waits indefinitely and returns only when the key is synchronized to the minimum number of servers.
Required: No
-u

Shares the private key in the pair with the specified users. This parameter gives other HSM crypto users (CU) permission to use the private key in cryptographic operations. Public keys can be used by any user without sharing.

Type a comma-separated list of HSM user IDs, such as -u 5,6. Do not include the HSM user ID of the current user. To find HSM user IDs of CUs on the HSM, use listUsers (p. 371). To share and unshare existing keys, use shareKey (p. 295) in the cloudhsm_mgmt_util.

Default: Only the current user can use the private key.
Required: No

-attest

Runs an integrity check that verifies that the firmware on which the cluster runs has not been tampered with.

Default: No attestation check.
Required: No

Related topics

• genRSAKeyPair (p. 336)
• genSymKey (p. 341)
• genECCKeyPair (p. 332)

genECCKeyPair

The genECCKeyPair command in the key_mgmt_util tool generates an Elliptic Curve Cryptography (ECC) key pair in your HSMs. When running the genECCKeyPair command, you must specify the elliptic curve identifier and a label for the key pair. You can also share the private key with other CU users, create non-extractable keys, quorum-controlled keys, and keys that expire when the session ends. When the command succeeds, it returns the key handles that the HSM assigns to the public and private ECC keys. You can use the key handles to identify the keys to other commands.

Before you run any key_mgmt_util command, you must start key_mgmt_util (p. 303) and log in (p. 304) to the HSM as a crypto user (CU).

Tip
To find the attributes of a key that you have created, such as the type, length, label, and ID, use getAttribute (p. 347). To find the keys for a particular user, use getKeyInfo (p. 352). To find keys based on their attribute values, use findKey (p. 323).

Syntax

genECCKeyPair -h

genECCKeyPair -i <EC curve id>
  -l <label>
  [-id <key ID>]
  [-min_srv <minimum number of servers>]
  [-m_value <0..8>]
  [-nex]
  [-sess]
  [-timeout <number of seconds> ]
Examples

The following examples show how to use genECCKeyPair to create ECC key pairs in your HSMs.

**Example : Create and examine an ECC key pair**

This command uses an NID_secp384r1 elliptic curve and an ecc14 label to create an ECC key pair. The output shows that the key handle of the private key is 262177 and the key handle of the public key is 262179. The label applies to both the public and private keys.

**Command:** `genECCKeyPair -i 14 -l ecc14`

```
Cfm3GenerateKeyPair returned: 0x00 : HSM Return: SUCCESS
Cfm3GenerateKeyPair:    public key handle: 262179    private key handle: 262177
```

Cluster Error Status
Node id 2 and err state 0x00000000 : HSM Return: SUCCESS
Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS

After generating the key, you can examine its attributes. Use `getAttribute` to write all of the attributes (represented by the constant 512) of the new ECC private key to the `attr_262177` file.

**Command:** `getAttribute -o 262177 -a 512 -out attr_262177`

```
got all attributes of size 529 attr cnt 19
Attributes dumped into attr_262177
Cfm3GetAttribute returned: 0x00 : HSM Return: SUCCESS
```

Then use the `cat` command to view the contents of the `attr_262177` attribute file. The output shows the key is an elliptic curve private key that can be used for signing, but not for encrypting, decrypting, wrapping, unwrapping, or verifying. The key is persistent and exportable.

```
$ cat attr_262177

OBJ_ATTR_CLASS 0x03
OBJ_ATTR_KEY_TYPE 0x03
OBJ_ATTR_TOKEN 0x01
OBJ_ATTR_PRIVATE 0x01
OBJ_ATTR_ENCRYPT 0x00
OBJ_ATTR_DECRYPT 0x00
OBJ_ATTR_WRAP 0x00
OBJ_ATTR_UNWRAP 0x00
OBJ_ATTR_SIGN 0x01
OBJ_ATTR_VERIFY 0x00
OBJ_ATTR_LOCAL 333
```
Example Using an invalid EEC curve

This command attempts to create an ECC key pair by using an NID_X9_62_prime192v1 curve. Because this elliptic curve is not valid for FIPS-mode HSMs, the command fails. The message reports that a server in the cluster is unavailable, but this does not typically indicate a problem with the HSMs in the cluster.

Command: `genECCKeyPair -i 1 -l ecc1`

```
Cfm3GenerateKeyPair returned: 0xb3 : HSM Error: This operation violates the current configured/FIPS policies

Cluster Error Status
Node id 0 and err state 0x30000085 : HSM CLUSTER ERROR: Server in cluster is unavailable
```

Parameters

-h
Displays help for the command.

Required: Yes

-i

Specifies the identifier for the elliptic curve. Enter an identifier.

Valid values:
- 2: NID_X9_62_prime256v1
- 14: NID_secp384r1
- 16: NID_secp256k1

Required: Yes

-l

Specifies a user-defined label for the key pair. Type a string. The same label applies to both keys in the pair. The maximum size allowable for label is 127 characters.

You can use any phrase that helps you to identify the key. Because the label does not have to be unique, you can use it to group and categorize keys.

Required: Yes
-id

Specifies a user-defined identifier for the key pair. Type a string that is unique in the cluster. The default is an empty string. The ID that you specify applies to both keys in the pair.

Default: No ID value.

Required: No

-min_srv

Specifies the minimum number of HSMs on which the key is synchronized before the value of the -timeout parameter expires. If the key is not synchronized to the specified number of servers in the time allotted, it is not created.

AWS CloudHSM automatically synchronizes every key to every HSM in the cluster. To speed up your process, set the value of min_srv to less than the number of HSMs in the cluster and set a low timeout value. Note, however, that some requests might not generate a key.

Default: 1

Required: No

-m_value

Specifies the number of users who must approve any cryptographic operation that uses the private key in the pair. Type a value from 0 to 8.

This parameter establishes a quorum authentication requirement for the private key. The default value, 0, disables the quorum authentication feature for the key. When quorum authentication is enabled, the specified number of users must sign a token to approve cryptographic operations that use the private key, and operations that share or unshare the private key.

To find the m_value of a key, use getKeyInfo (p. 352).

This parameter is valid only when the -u parameter in the command shares the key pair with enough users to satisfy the m_value requirement.

Default: 0

Required: No

-nex

Makes the private key nonextractable. The private key that is generated cannot be exported from the HSM (p. 153). Public keys are always extractable.

Default: Both the public and private keys in the key pair are extractable.

Required: No

-sess

Creates a key that exists only in the current session. The key cannot be recovered after the session ends.

Use this parameter when you need a key only briefly, such as a wrapping key that encrypts, and then quickly decrypts, another key. Do not use a session key to encrypt data that you might need to decrypt after the session ends.

To change a session key to a persistent (token) key, use setAttribute (p. 374).

Default: The key is persistent.
Required: No

**-timeout**

Specifies how long (in seconds) the command waits for a key to be synchronized to the number of HSMs specified by the `min_srv` parameter.

This parameter is valid only when the `min_srv` parameter is also used in the command.

Default: No timeout. The command waits indefinitely and returns only when the key is synchronized to the minimum number of servers.

Required: No

**-u**

Shares the private key in the pair with the specified users. This parameter gives other HSM crypto users (CUs) permission to use the private key in cryptographic operations. Public keys can be used by any user without sharing.

Type a comma-separated list of HSM user IDs, such as `-u 5,6`. Do not include the HSM user ID of the current user. To find HSM user IDs of CUs on the HSM, use `listUsers (p. 371)`. To share and unshare existing keys, use `shareKey (p. 295)` in the cloudhsm_mgmt_util.

Default: Only the current user can use the private key.

Required: No

**-attest**

Runs an integrity check that verifies that the firmware on which the cluster runs has not been tampered with.

Default: No attestation check.

Required: No

Related topics

- `genSymKey (p. 341)`
- `genRSAKeyPair (p. 336)`
- `genDSAKeyPair (p. 328)`

**genRSAKeyPair**

The `genRSAKeyPair` command in the key_mgmt_util tool generates an RSA asymmetric key pair. You specify the key type, modulus length, and a public exponent. The command generates a modulus of the specified length and creates the key pair. You can assign an ID, share the key with other HSM users, create nonextractable keys and keys that expire when the session ends. When the command succeeds, it returns a key handle that the HSM assigns to the key. You can use the key handle to identify the key to other commands.

Before you run any key_mgmt_util command, you must `start_key_mgmt_util (p. 303)` and `log in (p. 304)` to the HSM as a crypto user (CU).

**Tip**

To find the attributes of a key that you have created, such as the type, length, label, and ID, use `getAttribute (p. 347)`. To find the keys for a particular user, use `getKeyInfo (p. 352)`. To find keys based on their attribute values, use `findKey (p. 323)`. 

336
Syntax

```bash
genRSAKeyPair -h
genRSAKeyPair -m <modulus length>
   -e <public exponent>
   -l <label>
   [-id <key ID>]
   [-min srv <minimum number of servers>]
   [-m_value <0..8>]
   [-nex]
   [-sess]
   [-timeout <number of seconds>]
   [-u <user-ids>]
   [-attest]
```

Examples

These examples show how to use `genRSAKeyPair` to create asymmetric key pairs in your HSMs.

**Example : Create and examine an RSA key pair**

This command creates an RSA key pair with a 2048-bit modulus and an exponent of 65537. The output shows that the public key handle is 2100177 and the private key handle is 2100426.

**Command:**

```bash
genRSAKeyPair -m 2048 -e 65537 -l rsa_test
```

Cfm3GenerateKeyPair returned: 0x00 : HSM Return: SUCCESS

```
Cfm3GenerateKeyPair:    public key handle: 2100177    private key handle: 2100426
Cluster Status:
Node id 0 status: 0x00000000 : HSM Return: SUCCESS
Node id 1 status: 0x00000000 : HSM Return: SUCCESS
```

The next command uses `getAttribute (p. 347)` to get the attributes of the public key that we just created. It writes the output to the `attr_2100177` file. It is followed by a `cat` command that gets the content of the attribute file. For help interpreting the key attributes, see the Key Attribute Reference (p. 388).

```
The resulting hexadecimal values confirm that it is a public key (OBJ_ATTR_CLASS 0x02) with a type of RSA (OBJ_ATTR_KEY_TYPE 0x00). You can use this public key to encrypt (OBJ_ATTR_ENCRYPT 0x01), but not to decrypt (OBJ_ATTR_DECRYPT 0x00). The results also include the key length (512, 0x200), the modulus, the modulus length (2048, 0x800), and the public exponent (65537, 0x10001).
```

**Command:**

```bash
generate -o 2100177 -a 512 -out attr_2100177
```

Attribute size: 801, count: 26
Written to: attr_2100177 file

```
Cfm3GetAttribute returned: 0x00 : HSM Return: SUCCESS

$  cat attr_2100177
OBJ_ATTR_CLASS
0x02
OBJ_ATTR_KEY_TYPE
0x00
OBJ_ATTR_TOKEN
0x01
OBJ_ATTR_PRIVATE
```

337
Example: Generate a shared RSA key pair

This command generates an RSA key pair and shares the private key with user 4, another CU on the HSM. The command uses the m_value parameter to require at least two approvals before the private key in the pair can be used in a cryptographic operation. When you use the m_value parameter, you must also use -u in the command and the m_value cannot exceed the total number of users (number of values in -u + owner).

Command:  
```bash
genRSAKeyPair -m 2048 -e 65537 -l rsa_mofn -id rsa_mv2 -u 4 -m_value 2
```

Cfm3GenerateKeyPair returned: 0x00 : HSM Return: SUCCESS
Cfm3GenerateKeyPair: public key handle: 27 private key handle: 28

Cluster Error Status
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
Node id 1 and err state 0x00000000 : HSM Return: SUCCESS

Parameters

-h
Displays help for the command.
Required: Yes

-m
Specifies the length of the modulus in bits. The minimum value is 2048.
Required: Yes

-e
Specifies the public exponent. The value must be an odd number greater than or equal to 65537.
Required: Yes

-l
Specifies a user-defined label for the key pair. Type a string. The same label applies to both keys in the pair. The maximum size allowable for label is 127 characters.
You can use any phrase that helps you to identify the key. Because the label does not have to be unique, you can use it to group and categorize keys.
Required: Yes

-id
Specifies a user-defined identifier for the key pair. Type a string that is unique in the cluster. The default is an empty string. The ID that you specify applies to both keys in the pair.
Default: No ID value.
Required: No

-min_srv
Specifies the minimum number of HSMs on which the key is synchronized before the value of the -timeout parameter expires. If the key is not synchronized to the specified number of servers in the time allotted, it is not created.
AWS CloudHSM automatically synchronizes every key to every HSM in the cluster. To speed up your process, set the value of min_srv to less than the number of HSMs in the cluster and set a low timeout value. Note, however, that some requests might not generate a key.
Default: 1
Required: No

-m_value
Specifies the number of users who must approve any cryptographic operation that uses the private key in the pair. Type a value from 0 to 8.
This parameter establishes a quorum authentication requirement for the private key. The default value, 0, disables the quorum authentication feature for the key. When quorum authentication is
enabled, the specified number of users must sign a token to approve cryptographic operations that use the private key, and operations that share or unshare the private key.

To find the $m$ _value_ of a key, use `getKeyInfo` (p. 352).

This parameter is valid only when the `-u` parameter in the command shares the key pair with enough users to satisfy the $m$ _value_ requirement.

Default: 0

Required: No

-`nex`

Makes the private key nonextractable. The private key that is generated cannot be exported from the HSM (p. 153). Public keys are always extractable.

Default: Both the public and private keys in the key pair are extractable.

Required: No

-`sess`

Creates a key that exists only in the current session. The key cannot be recovered after the session ends.

Use this parameter when you need a key only briefly, such as a wrapping key that encrypts, and then quickly decrypts, another key. Do not use a session key to encrypt data that you might need to decrypt after the session ends.

To change a session key to a persistent (token) key, use `setAttribute` (p. 374).

Default: The key is persistent.

Required: No

-`timeout`

Specifies how long (in seconds) the command waits for a key to be synchronized to the number of HSMs specified by the `min_srv` parameter.

This parameter is valid only when the `min_srv` parameter is also used in the command.

Default: No timeout. The command waits indefinitely and returns only when the key is synchronized to the minimum number of servers.

Required: No

-`u`

Shares the private key in the pair with the specified users. This parameter gives other HSM crypto users (CUs) permission to use the private key in cryptographic operations. Public keys can be used by any user without sharing.

Type a comma-separated list of HSM user IDs, such as `-u 5,6`. Do not include the HSM user ID of the current user. To find HSM user IDs of CUs on the HSM, use `listUsers` (p. 371). To share and unshare existing keys, use `shareKey` (p. 295) in the cloudhsm_mgmt_util.

Default: Only the current user can use the private key.

Required: No

-`attest`

Runs an integrity check that verifies that the firmware on which the cluster runs has not been tampered with.
Default: No attestation check.

Required: No

Related topics

- genSymKey (p. 341)
- genDSAKeyPair (p. 328)
- genECCKeyPair (p. 332)

**genSymKey**

The **genSymKey** command in the key_mgmt_util tool generates a symmetric key in your HSMs. You can specify the key type and size, assign an ID and label, and share the key with other HSM users. You can also create nonextractable keys and keys that expire when the session ends. When the command succeeds, it returns a key handle that the HSM assigns to the key. You can use the key handle to identify the key to other commands.

Before you run any key_mgmt_util command, you must start key_mgmt_util (p. 303) and log in (p. 304) to the HSM as a crypto user (CU).

**Syntax**

```
genSymKey -h

genSymKey -t <key-type> -s <key-size> -l <label> [-id <key-ID>] [-min_srv <minimum-number-of-servers>] [-m_value <0..8>] [-nex] [-sess] [-timeout <number-of-seconds>] [-u <user-ids>] [-attest]
```

**Examples**

These examples show how to use **genSymKey** to create symmetric keys in your HSMs.

**Tip**

To use the keys you make with these examples for HMAC operations, you must set OBJ_ATTR_SIGN and OBJ_ATTR_VERIFY to TRUE after you generate the key. To set these values, use setAttribute in CloudHSM Management Utility (CMU). For more information, see setAttribute (p. 291).

**Example: Generate an AES key**

This command creates a 256-bit AES key with an aes256 label. The output shows that the key handle of the new key is 6.

**Command:**

```
genSymKey -t 31 -s 32 -l aes256
```

```
Cfm3GenerateSymmetricKey returned: 0x00 : HSM Return: SUCCESS
```
Symmetric Key Created. Key Handle: 6

Cluster Error Status
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS

**Example: Create a session key**

This command creates a nonextractable 192-bit AES key that is valid only in the current session. You might want to create a key like this to wrap (and then immediately unwrap) a key that is being exported.

Command: `genSymKey -t 31 -s 24 -l tmpAES -id wrap01 -nex -sess`

**Example: Return quickly**

This command creates a generic 512-byte key with a label of `IT_test_key`. The command does not wait for the key to be synchronized to all HSMs in the cluster. Instead, it returns as soon as the key is created on any one HSM (`-min_srv 1`) or in 1 second (`-timeout 1`), whichever is shorter. If the key is not synchronized to the specified minimum number of HSMs before the timeout expires, it is not generated. You might want to use a command like this in a script that creates numerous keys, like the for loop in the following example.

Command: `genSymKey -t 16 -s 512 -l IT_test_key -min_srv 1 -timeout 1`

```
$ for i in {1..30};
    do /opt/cloudhsm/bin/key_mgmt_util singlecmd loginHSM -u CU -s example_user -p example_pwd genSymKey -l aes -t 31 -s 32 -min_srv 1 -timeout 1;
done;
```

**Example: Create a quorum authorized generic key**

This command creates a 2048-bit generic secret key with the label `generic-mV2`. The command uses the `-u` parameter to share the key with another CU, user 6. It uses the `-m_value` parameter to require a quorum of at least two approvals for any cryptographic operations that use the key. The command also uses the `-attest` parameter to verify the integrity of the firmware on which the key is generated.

The output shows that the command generated a key with key handle 9 and that the attestation check on the cluster firmware passed.

Command: `genSymKey -t 16 -s 2048 -l generic-mV2 -m_value 2 -u 6 -attest`

```
CfmGenerateSymmetricKey returned: 0x00 : HSM Return: SUCCESS
Symmetric Key Created. Key Handle: 9
Attestation Check : [PASS]
Cluster Error Status
Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
```

**Example: Create and examine a key**

This command creates a Triple DES key with a `3DES_shared` label and an ID of `IT-02`. The key can be used by the current user, and users 4 and 5. The command fails if the ID is not unique in the cluster or if the current user is user 4 or 5.
The output shows that the new key has key handle 7.

```
Command: genSymKey -t 21 -s 24 -l 3DES_shared -id IT-02 -u 4,5

Cfm3GenerateSymmetricKey returned: 0x00 : HSM Return: SUCCESS

Symmetric Key Created. Key Handle: 7

Cluster Error Status
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
```

To verify that the new 3DES key is owned by the current user and shared with users 4 and 5, use `getKeyInfo` (p. 352). The command uses the handle that was assigned to the new key (Key Handle: 7).

The output confirms that the key is owned by user 3 and shared with users 4 and 5.

```
Command: getKeyInfo -k 7

Cfm3GetKey returned: 0x00 : HSM Return: SUCCESS

Owned by user 3
also, shared to following 2 user(s):
  4, 5
```

To confirm the other properties of the key, use `getAttribute` (p. 347). The first command uses `getAttribute` to get all attributes (`-a 512`) of key handle 7 (`-o 7`). It writes them to the `attr_7` file. The second command uses `cat` to get the contents of the `attr_7` file.

```
This command confirms that key 7 is a 192-bit (OBJ_ATTR_VALUE_LEN 0x00000018 or 24-byte) 3DES (OBJ_ATTR_KEY_TYPE 0x15) symmetric key (OBJ_ATTR_CLASS 0x04) with a label of 3DES_shared (OBJ_ATTR_LABEL 3DES_shared) and an ID of IT_02 (OBJ_ATTR_ID IT-02). The key is persistent (OBJ_ATTR_TOKEN 0x01) and extractable (OBJ_ATTR_EXTRACTABLE 0x01) and can be used for encryption, decryption, and wrapping.

Tip
To find the attributes of a key that you have created, such as the type, length, label, and ID, use `getAttribute` (p. 347). To find the keys for a particular user, use `getKeyInfo` (p. 352). To find keys based on their attribute values, use `findKey` (p. 323).

For help interpreting the key attributes, see the `Key Attribute Reference` (p. 388).
```

```
Command: getAttribute -o 7 -a 512 -out attr_7

got all attributes of size 444 attr cnt 17
Attributes dumped into attr_7 file

   Cfm3GetAttribute returned: 0x00 : HSM Return: SUCCESS

$ cat attr_7

OBJ_ATTR_CLASS
  0x04
OBJ_ATTR_KEY_TYPE
  0x15
OBJ_ATTR_TOKEN
  0x01
OBJ_ATTR_PRIVATE
```
Tip
To use the keys you make with these examples for HMAC operations, you must set
OBJ_ATTR_SIGN and OBJ_ATTR_VERIFY to TRUE after you generate the key. To set these
values, use setAttribute in CMU. For more information, see setAttribute (p. 291).

Parameters

-h
Displays help for the command.

Required: Yes

-t
Specifies the type of the symmetric key. Enter the constant that represents the key type. For
example, to create an AES key, type -t 31.

Valid values:
- 16: GENERIC_SECRET. A generic secret key is a byte array that does not conform to any particular
standard, such as the requirements for an AES key.
- 18: RC4. RC4 keys are not valid on FIPS-mode HSMs
- 21: Triple DES (3DES). Disallowed after 2023 for FIPS compliance as per NIST guidance. See FIPS
140 Compliance: 2024 Mechanism Deprecation (p. 633) for details.
- 31: AES

Required: Yes

-s
Specifies the key size in bytes. For example, to create a 192-bit key, type 24.

Valid values for each key type:
- AES: 16 (128 bits), 24 (192 bits), 32 (256 bits)
- 3DES: 24 (192 bits)
- Generic Secret: <3584 (28672 bits)

Required: Yes

-l

Specifies a user-defined label for the key. Type a string.

You can use any phrase that helps you to identify the key. Because the label does not have to be unique, you can use it to group and categorize keys.

Required: Yes

-attest

Runs an integrity check that verifies that the firmware on which the cluster runs has not been tampered with.

Default: No attestation check.

Required: No

-id

Specifies a user-defined identifier for the key. Type a string that is unique in the cluster. The default is an empty string.

Default: No ID value.

Required: No

-min_srv

Specifies the minimum number of HSMs on which the key is synchronized before the value of the -timeout parameter expires. If the key is not synchronized to the specified number of servers in the time allotted, it is not created.

AWS CloudHSM automatically synchronizes every key to every HSM in the cluster. To speed up your process, set the value of min_srv to less than the number of HSMs in the cluster and set a low timeout value. Note, however, that some requests might not generate a key.

Default: 1

Required: No

-m_value

Specifies the number of users who must approve any cryptographic operation that uses the key. Type a value from 0 to 8.

This parameter establishes a quorum authentication requirement for the key. The default value, 0, disables the quorum authentication feature for the key. When quorum authentication is enabled, the specified number of users must sign a token to approve cryptographic operations that use the key, and operations that share or unshare the key.

To find the m_value of a key, use getKeyInfo (p. 352).

This parameter is valid only when the -u parameter in the command shares the key with enough users to satisfy the m_value requirement.
-nex

Makes the key nonextractable. The key that is generated cannot be exported from the HSM (p. 153).

Default: The key is extractable.

Required: No

-sess

Creates a key that exists only in the current session. The key cannot be recovered after the session ends.

Use this parameter when you need a key only briefly, such as a wrapping key that encrypts, and then quickly decrypts, another key. Do not use a session key to encrypt data that you might need to decrypt after the session ends.

To change a session key to a persistent (token) key, use setAttribute (p. 374).

Default: The key is persistent.

Required: No

-timeout

Specifies how long (in seconds) the command waits for a key to be synchronized to the number of HSMs specified by the min_srv parameter.

This parameter is valid only when the min_srv parameter is also used in the command.

Default: No timeout. The command waits indefinitely and returns only when the key is synchronized to the minimum number of servers.

Required: No

-u

Shares the key with the specified users. This parameter gives other HSM crypto users (CUs) permission to use this key in cryptographic operations.

Type a comma-separated list of HSM user IDs, such as -u 5,6. Do not include the HSM user ID of the current user. To find HSM user IDs of CUs on the HSM, use listUsers (p. 371). To share and unshare existing keys, use shareKey (p. 295) in the cloudhsm_mgmt_util.

Default: Only the current user can use the key.

Required: No

Related topics

- exSymKey (p. 318)
- genRSAKeyPair (p. 336)
- genDSAKeyPair (p. 328)
- genECCKeyPair (p. 332)
- setAttribute (p. 291)
**getAttribute**

The `getAttribute` command in `key_mgmt_util` writes one or all of the attribute values for an AWS CloudHSM key to a file. If the attribute you specify does not exist for the key type, such as the modulus of an AES key, `getAttribute` returns an error.

*Key attributes* are properties of a key. They include characteristics, like the key type, class, label, and ID, and values that represent actions that you can perform with the key, like encrypt, decrypt, wrap, sign, and verify.

You can use `getAttribute` only on keys that you own and key that are shared with you. You can run this command or the `getAttribute` (p. 273) command in `cloudhsm_mgmt_util`, which gets one attribute value of a key from all HSMs in a cluster, and writes it to stdout or to a file.

To get a list of attributes and the constants that represent them, use the `listAttributes` (p. 370) command. To change the attribute values of existing keys, use `setAttribute` (p. 374) in `key_mgmt_util` and `setAttribute` (p. 291) in `cloudhsm_mgmt_util`. For help interpreting the key attributes, see the *Key Attribute Reference* (p. 388).

Before you run any `key_mgmt_util` command, you must start `key_mgmt_util` (p. 303) and log in (p. 304) to the HSM as a crypto user (CU).

**Syntax**

```
getAttribute -h
getAttribute -o <key handle>
    -a <attribute constant>
    -out <file>
```

**Examples**

These examples show how to use `getAttribute` to get the attributes of keys in your HSMs.

**Example : Get the key type**

This example gets the type of the key, such an AES, 3DES, or generic key, or an RSA or elliptic curve key pair.

The first command runs `listAttributes` (p. 370), which gets the key attributes and the constants that represent them. The output shows that the constant for key type is 256. For help interpreting the key attributes, see the *Key Attribute Reference* (p. 388).

**Command: listAttributes**

*Description*

The following are all of the possible attribute values for `getAttribute`.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OBJ_ATTR_CLASS</td>
<td>0</td>
</tr>
<tr>
<td>OBJ_ATTR_TOKEN</td>
<td>1</td>
</tr>
<tr>
<td>OBJ_ATTR_PRIVATE</td>
<td>2</td>
</tr>
<tr>
<td>OBJ_ATTR_LABEL</td>
<td>3</td>
</tr>
<tr>
<td>OBJ_ATTR_KEY_TYPE</td>
<td>256</td>
</tr>
<tr>
<td>OBJ_ATTR_ID</td>
<td>258</td>
</tr>
<tr>
<td>OBJ_ATTR_SENSITIVE</td>
<td>259</td>
</tr>
<tr>
<td>OBJ_ATTR_ENCRYPT</td>
<td>260</td>
</tr>
<tr>
<td>OBJ_ATTR_DECRYPT</td>
<td>261</td>
</tr>
<tr>
<td>OBJ_ATTR_WRAP</td>
<td>262</td>
</tr>
</tbody>
</table>
The second command runs `getAttribute`. It requests the key type (attribute 256) for key handle 524296 and writes it to the attribute.txt file.

**Command:** getAttribute -o 524296 -a 256 -out attribute.txt  
Attributes dumped into attribute.txt file

The final command gets the content of the key file. The output reveals that the key type is 0x15 or 21, which is a Triple DES (3DES) key. For definitions of the class and type values, see the **Key Attribute Reference** (p. 388).

```
$ cat attribute.txt  
OBJ_ATTR_KEY_TYPE  
0x00000015
```

**Example : Get all attributes of a key**

This command gets all attributes of the key with key handle 6 and writes them to the attr_6 file. It uses an attribute value of 512, which represents all attributes.

**Command:** getAttribute -o 6 -a 512 -out attr_6  
got all attributes of size 444 attr cnt 17  
Attributes dumped into attribute.txt file  
    Cfm3GetAttribute returned: 0x00 : HSM Return: SUCCESS>

This command shows the content of a sample attribute file with all attribute values. Among the values, it reports that key is a 256-bit AES key with an ID of test_01 and a label of aes256. The key is extractable and persistent, that is, not a session-only key. For help interpreting the key attributes, see the **Key Attribute Reference** (p. 388).

```
$ cat attribute.txt  
OBJ_ATTR_CLASS 0x04  
OBJ_ATTR_KEY_TYPE 0x15  
OBJ_ATTR_TOKEN 0x01  
OBJ_ATTR_PRIVATE 0x01  
OBJ_ATTR_ENCRYPT 0x01  
OBJ_ATTR_DECRYPT 0x01  
OBJ_ATTR_WRAP 0x01  
OBJ_ATTR_UNWRAP
```
Parameters

-h
Displays help for the command.
Required: Yes

-o
Specifies the key handle of the target key. You can specify only one key in each command. To get the key handle of a key, use findKey (p. 323).
Also, you must own the specified key or it must be shared with you. To find the users of a key, use getKeyInfo (p. 352).
Required: Yes

-a
Identifies the attribute. Enter a constant that represents an attribute, or 512, which represents all attributes. For example, to get the key type, type 256, which is the constant for the OBJ_ATTR_KEY_TYPE attribute.
To list the attributes and their constants, use listAttributes (p. 370). For help interpreting the key attributes, see the Key Attribute Reference (p. 388).
Required: Yes

-out
Writes the output to the specified file. Type a file path. You cannot write the output to stdout.
If the specified file exists, getAttribute overwrites the file without warning.
Required: Yes

Related topics
- getAttribute (p. 273) in cloudhsm_mgmt_util
- listAttributes (p. 370)
- setAttribute (p. 374)
The `getCaviumPrivKey` command in `key_mgmt_util` exports a private key from an HSM in fake PEM format. The fake PEM file, which does not contain the actual private key material but instead references the private key in the HSM, can then be used to establish SSL/TLS offloading from your web server to AWS CloudHSM. For more information, see [SSL/TLS Offload on Linux](#).

Before you run any `key_mgmt_util` command, you must [start `key_mgmt_util`](#) and `login` to the HSM as a crypto user (CU).

### Syntax

```
getCaviumPrivKey -h
getCaviumPrivKey -k <private-key-handle>
             -out <fake-PEM-file>
```

### Examples

This example shows how to use `getCaviumPrivKey` to export a private key in fake PEM format.

**Example: Export a fake PEM file**

This command creates and exports a fake PEM version of a private key with handle 15 and saves it to a file called `cavKey.pem`. When the command succeeds, `exportPrivateKey` returns a success message.

```
Command:  getCaviumPrivKey -k 15 -out cavKey.pem
Private Key Handle is written to cavKey.pem in fake PEM format
         getCaviumPrivKey returned: 0x00 : HSM Return: SUCCESS
```

### Parameters

This command takes the following parameters.

**-h**

Displays command line help for the command.

**Required: Yes**

**-k**

Specifies the key handle of the private key to be exported in fake PEM format.

**Required: Yes**

**-out**

Specifies the name of the file to which the fake PEM key will be written.

**Required: Yes**
Related topics

- `importPrivateKey (p. 356)`
- `SSL/TLS Offload on Linux (p. 508)`

**getCert**

The **getCert** command in key_mgmt_util retrieves an HSM's partition certificates and saves them to a file. When you run the command, you designate the type of certificate to retrieve. To do that, you use one of the corresponding integers as described in the **Parameters (p. 351)** section that follows. To learn about the role of each of these certificates, see **Verify HSM Identity (p. 15)**.

Before you run any key_mgmt_util command, you must **start key_mgmt_util (p. 303)** and **log in (p. 304)** to the HSM as a crypto user (CU).

**Syntax**

```
getCert -h
getCert -f <file-name>
    -t <certificate-type>
```

**Example**

This example shows how to use **getCert** to retrieve a cluster's customer root certificate and save it as a file.

**Example: Retrieve a customer root certificate**

This command exports a customer root certificate (represented by integer 4) and saves it to a file called `userRoot.crt`. When the command succeeds, **getCert** returns a success message.

```
Command: getCert -f userRoot.crt -s 4
Cfm3GetCert() returned 0 :HSM Return: SUCCESS
```

**Parameters**

This command takes the following parameters.

- `-h`
  
  Displays command line help for the command.
  
  Required: Yes

- `-f`
  
  Specifies the name of the file to which the retrieved certificate will be saved.
  
  Required: Yes

- `-s`
  
  An integer that specifies the type of partition certificate to retrieve. The integers and their corresponding certificate types are as follows:
1 – Manufacturer root certificate
2 – Manufacturer hardware certificate
4 – Customer root certificate
8 – Cluster certificate (signed by customer root certificate)
16 – Cluster certificate (chained to the manufacturer root certificate)

Required: Yes

Related topics
• Verify HSM Identity (p. 15)
• getCert (p. 276) (in cloudhsm_mgmt_util (p. 252))

getKeyInfo

The getKeyInfo command in the key_mgmt_util returns the HSM user IDs of users who can use the key, including the owner and crypto users (CU) with whom the key is shared. When quorum authentication is enabled on a key, getKeyInfo also returns the number of users who must approve cryptographic operations that use the key. You can run getKeyInfo only on keys that you own and keys that are shared with you.

When you run getKeyInfo on public keys, getKeyInfo returns only the key owner, even though all users of the HSM can use the public key. To find the HSM user IDs of users in your HSMs, use listUsers (p. 371). To find the keys for a particular user, use findKey (p. 295) -u.

You own the keys that you create. You can share a key with other users when you create it. Then, to share or unshare an existing key, use shareKey (p. 295) in cloudhsm_mgmt_util.

Before you run any key_mgmt_util command, you must start key_mgmt_util (p. 303) and log in (p. 304) to the HSM as a crypto user (CU).

Syntax

getKeyInfo -h
getKeyInfo -k <key-handle>

Examples

These examples show how to use getKeyInfo to get information about the users of a key.

Example : Get the users for a symmetric key

This command gets the users who can use the AES (symmetric) key with key handle 9. The output shows that user 3 owns the key and has shared it with user 4.

Command:  getKeyInfo -k 9

Cfm3GetKey returned: 0x00 : HSM Return: SUCCESS
Owned by user 3
also, shared to following 1 user(s):
Example: Get the users for an asymmetric key pair

These commands use **getKeyInfo** to get the users who can use the keys in an RSA (asymmetric) key pair. The public key has key handle 21. The private key has key handle 20.

When you run **getKeyInfo** on the private key (20), it returns the key owner (3) and crypto users (CUs) 4 and 5, with whom the key is shared.

```
Command:  getKeyInfo -k 20
          Cfm3GetKey returned: 0x00 : HSM Return: SUCCESS
          Owned by user 3
          also, shared to following 2 user(s):
            4
            5
```

When you run **getKeyInfo** on the public key (21), it returns only the key owner (3).

```
Command:  getKeyInfo -k 21
          Cfm3GetKey returned: 0x00 : HSM Return: SUCCESS
          Owned by user 3
```

To confirm that user 4 can use the public key (and all public keys on the HSM), use the `-u` parameter of **findKey** (p. 323).

The output shows that user 4 can use both the public (21) and private (20) key in the key pair. User 4 can also use all other public keys and any private keys that they have created or that have been shared with them.

```
Command:  findKey -u 4
          Total number of keys present 8
          number of keys matched from start index 0::7
            11, 12, 262159, 262161, 262162, 19, 20, 21
          Cluster Error Status
            Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
          Cfm3FindKey returned: 0x00 : HSM Return: SUCCESS
```

Example: Get the quorum authentication value (**m_value**) for a key

This example shows how to get the **m_value** for a key, that is, the number of users in the quorum who must approve any cryptographic operations that use the key.

When quorum authentication is enabled on a key, a quorum of users must approve any cryptographic operations that use the key. To enable quorum authentication and set the quorum size, use the `-m_value` parameter when you create the key.

This command uses **genRSAKeyPair** (p. 336) to create an RSA key pair that is shared with user 4. It uses the **m_value** parameter to enable quorum authentication on the private key in the pair and set the quorum size to two users. The number of users must be large enough to provide the required approvals.
The output shows that the command created public key 27 and private key 28.

Command:  `genRSAKeyPair -m 2048 -e 195193 -l rsa_mofn -id rsa_mv2 -u 4 -m_value 2`

Cfm3GenerateKeyPair returned: 0x00 : HSM Return: SUCCESS

Cfm3GenerateKeyPair:    public key handle: 27    private key handle: 28

Cluster Error Status
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
Node id 1 and err state 0x00000000 : HSM Return: SUCCESS

This command uses `getKeyInfo` to get information about the users of the private key. The output shows that the key is owned by user 3 and shared with user 4. It also shows that a quorum of two users must approve every cryptographic operation that uses the key.

Command:  `getKeyInfo -k 28`

Cfm3GetKey returned: 0x00 : HSM Return: SUCCESS

Owned by user 3
also, shared to following 1 user(s):
  4
  2 Users need to approve to use/manage this key

**Parameters**

- **-h**
  Displays command line help for the command.
  Required: Yes

- **-k**
  Specifies the key handle of one key in the HSM. Enter the key handle of a key that you own or share. This parameter is required.

  To find key handles, use the `findKey` (p. 371) command.

  Required: Yes

**Related topics**

- `getKeyInfo` (p. 278) in cloudhsm_mgmt_util
- `listUsers` (p. 371)
- `findKey` (p. 323)
- `findAllKeys` (p. 270) in cloudhsm_mgmt_util

**help**

The `help` command in key_mgmt_util displays information about all available key_mgmt_util commands.

Before you run `help`, you must `start key_mgmt_util` (p. 303).
Syntax

help

Example

This example shows the output of the help command.

Example

Command: help

Help Commands Available:

Syntax: <command> -h

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>exit</td>
<td>Exits this application</td>
</tr>
<tr>
<td>help</td>
<td>Displays this information</td>
</tr>
</tbody>
</table>

Configuration and Admin Commands

- getHSMInfo: Gets the HSM Information
- getPartitionInfo: Gets the Partition Information
- listUsers: Lists all users of a partition
- loginStatus: Gets the Login Information
- loginHSM: Login to the HSM
- logoutHSM: Logout from the HSM

M of N commands

- getToken: Initiate an MxN service and get Token
- delToken: delete Token(s)
- approveToken: Approves an MxN service
- listTokens: List all Tokens in the current partition

Key Generation Commands

- genRSAKeyPair: Generates an RSA Key Pair
- genDSAKeyPair: Generates a DSA Key Pair
- genECCKeyPair: Generates an ECC Key Pair

Symmetric Keys:

- genPBEKey: Generates a PBE DES3 key
- genSymKey: Generates a Symmetric keys

Key Import/Export Commands

- createPublicKey: Creates an RSA public key
- importPubKey: Imports RSA/DSA/EC Public key
- exportPubKey: Exports RSA/DSA/EC Public key
- importPrivateKey: Imports RSA/DSA/EC private key
- exportPrivateKey: Exports RSA/DSA/EC private key
- imSymKey: Imports a Symmetric key
- exSymKey: Exports a Symmetric key
- wrapKey: Wraps a key from from HSM using the specified handle
- unwrapKey: UnWraps a key into HSM using the specified handle

Key Management Commands

- deleteKey: Delete Key
- setAttribute: Sets an attribute of an object
- getKeyInfo: Get Key Info about shared users/sessions
Parameters

There are no parameters for this command.

Related topics

- loginHSM and logoutHSM (p. 372)

importPrivateKey

The importPrivateKey command in key_mgmt_util imports an asymmetric private key from a file to an HSM. The HSM does not allow direct import of keys in cleartext. The command encrypts the private key using an AES wrapping key you specify and unwraps the key inside the HSM. If you are trying to associate an AWS CloudHSM key with a certificate, refer to this topic (p. 447).

Note

You cannot import a password-protected PEM key using a symmetric or private key.

You must specify an AES wrapping key that has OBJ_ATTR_UNWRAP and OBJ_ATTR_ENCRYPT attribute value 1. To find a key's attributes, use the getAttribute (p. 347) command.

Note

This command does not offer the option to mark the imported key as non-exportable.

Before you run any key_mgmt_util command, you must start key_mgmt_util (p. 303) and log in (p. 304) to the HSM as a crypto user (CU).

Syntax

importPrivateKey -h
importPrivateKey -l <label> -f <key-file> -w <wrapping-key-handle>
[-sess]
[-id <key-id>]
[-m_value <0...8>]
[min_srv <minimum-number-of-servers>]
[-timeout <number-of-seconds>]
[-u <user-ids>]
[-wk <wrapping-key-file>]
[-attest]

Examples

This example shows how to use importPrivateKey to import a private key into an HSM.

Example: Import a private key

This command imports the private key from a file named rsa2048.key with the label rsa2048-imported and a wrapping key with handle 524299. When the command succeeds, importPrivateKey returns a key handle for the imported key and a success message.

Command: importPrivateKey -f rsa2048.key -l rsa2048-imported -w 524299
BER encoded key length is 1216
Cfm3WrapHostKey returned: 0x00 : HSM Return: SUCCESS
Cfm3CreateUnwrapTemplate returned: 0x00 : HSM Return: SUCCESS
Cfm3UnWrapKey returned: 0x00 : HSM Return: SUCCESS
Private Key Unwrapped. Key Handle: 524301
Cluster Error Status
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
Node id 2 and err state 0x00000000 : HSM Return: SUCCESS

Parameters

This command takes the following parameters.

-h
Displays command line help for the command.

Required: Yes

-l
Specifies the user-defined private key label.

Required: Yes

-f
Specifies the file name of the key to import.

Required: Yes

-w
Specifies the key handle of the wrapping key. This parameter is required. To find key handles, use the findKey (p. 325) command.
To determine whether a key can be used as a wrapping key, use `getAttribute` (p. 347) to get the value of the OBJ_ATTR_WRAP attribute (262). To create a wrapping key, use `genSymKey` (p. 341) to create an AES key (type 31).

If you use the `-wk` parameter to specify an external unwrapping key, the `-w` wrapping key is used to wrap, but not unwrap, the key during import.

Required: Yes

**-sess**

Specifies the imported key as a session key.

Default: The imported key is held as a persistent (token) key in the cluster.

Required: No

**-id**

Specifies the ID of the key to be imported.

Default: No ID value.

Required: No

**-m_value**

Specifies the number of users who must approve any cryptographic operation that uses the imported key. Enter a value from 0 to 8.

This parameter is valid only when the `-u` parameter in the command shares the key with enough users to satisfy the `m_value` requirement.

Default: 0

Required: No

**-min_srv**

Specifies the minimum number of HSMs on which the imported key is synchronized before the value of the `-timeout` parameter expires. If the key is not synchronized to the specified number of servers in the time allotted, it is not created.

AWS CloudHSM automatically synchronizes every key to every HSM in the cluster. To speed up your process, set the value of `min_srv` to less than the number of HSMs in the cluster and set a low timeout value. Note, however, that some requests might not generate a key.

Default: 1

Required: No

**-timeout**

Specifies the number of seconds to wait for the key to sync across HSMs when the `min_srv` parameter is included. If no number is specified, the polling continues forever.

Default: No limit

Required: No

**-u**

Specifies the list of users with whom to share the imported private key. This parameter gives other HSM crypto users (CUs) permission to use the imported key in cryptographic operations.
Enter a comma-separated list of HSM user IDs, such as `-u 5,6`. Do not include the HSM user ID of the current user. To find the HSM user IDs of CUs on the HSM, use `listUsers (p. 371)`.

Default: Only the current user can use the imported key.

Required: No

**-wk**

Specifies the key to be used to wrap the key that is being imported. Enter the path and name of a file that contains a plaintext AES key.

When you include this parameter, `importPrivateKey` uses the key in the `-wk` file to wrap the key being imported. It also uses the key specified by the `-w` parameter to unwrap it.

Default: Use the wrapping key specified in the `-w` parameter to both wrap and unwrap.

Required: No

**-attest**

Performs an attestation check on the firmware response to ensure that the firmware on which the cluster runs has not been compromised.

Required: No

### Related topics

- `wrapKey (p. 385)`
- `unWrapKey (p. 378)`
- `genSymKey (p. 341)`
- `exportPrivateKey (p. 315)`

### importPubKey

The `importPubKey` command in key_mgmt_util imports a PEM format public key into an HSM. You can use it to import public keys that were generated outside of the HSM. You can also use the command to import keys that were exported from an HSM, such as those exported by the `exportPubKey (p. 316)` command.

Before you run any key_mgmt_util command, you must `start key_mgmt_util (p. 303)` and `log in (p. 304)` to the HSM as a crypto user (CU).

### Syntax

```
importPubKey -h
importPubKey -l <label> -f <key-file> [-sess] [-id <key-id>] [min_srv <minimum-number-of-servers>] [-timeout <number-of-seconds>]
```

### Examples

This example shows how to use `importPubKey` to import a public key into an HSM.
Example: Import a public key

This command imports a public key from a file named `public.pem` with the label `importedPublicKey`. When the command succeeds, `importPubKey` returns a key handle for the imported key and a success message.

```
Command: importPubKey -l importedPublicKey -f public.pem
Cfm3CreatePublicKey returned: 0x00 : HSM Return: SUCCESS
Public Key Handle: 262230
    Cluster Error Status
    Node id 2 and err state 0x00000000 : HSM Return: SUCCESS
    Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
    Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
```

Parameters

This command takes the following parameters.

- **-h**
  Displays command line help for the command.
  Required: Yes

- **-l**
  Specifies the user-defined public key label.
  Required: Yes

- **-f**
  Specifies the file name of the key to import.
  Required: Yes

- **-sess**
  Designates the imported key as a session key.
  Default: The imported key is held as a persistent (token) key in the cluster.
  Required: No

- **-id**
  Specifies the ID of the key to be imported.
  Default: No ID value.
  Required: No

- **-min_srv**
  Specifies the minimum number of HSMs to which the imported key is synchronized before the value of the `-timeout` parameter expires. If the key is not synchronized to the specified number of servers in the time allotted, it is not created.

AWS CloudHSM automatically synchronizes every key to every HSM in the cluster. To speed up your process, set the value of `min_srv` to less than the number of HSMs in the cluster and set a low timeout value. Note, however, that some requests might not generate a key.
Default: 1
Required: No

**-timeout**

Specifies the number of seconds to wait for the key to sync across HSMs when the `min-serv` parameter is included. If no number is specified, the polling continues forever.

Default: No limit
Required: No

**Related topics**

- [exportPubKey](p. 316)
- [Generate Keys](p. 151)

**imSymKey**

The `imSymKey` command in the `key_mgmt_util` tool imports a plaintext copy of a symmetric key from a file into the HSM. You can use it to import keys that you generate by any method outside of the HSM and keys that were exported from an HSM, such as the keys that the `exSymKey` command writes to a file.

During the import process, `imSymKey` uses an AES key that you select (the *wrapping key*) to *wrap* (encrypt) and then *unwrap* (decrypt) the key to be imported. However, `imSymKey` works only on files that contain plaintext keys. To export and import encrypted keys, use the `wrapKey` and `unWrapKey` commands.

Also, the `imSymKey` command imports only symmetric keys. To import public keys, use `importPubKey` (p. 359). To import private keys, use `importPrivateKey` (p. 356) or `wrapKey` (p. 385).

**Note**

You cannot import a password-protected PEM key using a symmetric or private key.

Imported keys work very much like keys generated in the HSM. However, the value of the `OBJ_ATTR_LOCAL` attribute (p. 388) is zero, which indicates that it was not generated locally. You can use the following command to share a symmetric key as you import it. You can use the `shareKey` command in `cloudhsm_mgmt_util` (p. 252) to share the key after it is imported.

```
imSymKey -l aesShared -t 31 -f kms.key -w 3296 -u 5
```

After you import a key, be sure to mark or delete the key file. This command does not prevent you from importing the same key material multiple times. The result, multiple keys with distinct key handles and the same key material, make it difficult to track use of the key material and prevent it from exceeding its cryptographic limits.

Before you run any `key_mgmt_util` command, you must [start key_mgmt_util](p. 303) and [log in](p. 304) to the HSM as a crypto user (CU).

**Syntax**

```
<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>imSymKey -h</code></td>
<td>Show help</td>
</tr>
<tr>
<td><code>imSymKey -f &lt;key-file&gt;</code></td>
<td>Import symmetric key file</td>
</tr>
<tr>
<td></td>
<td>with wrapping key handle</td>
</tr>
</tbody>
</table>
```
Examples

These examples show how to use **imSymKey** to import symmetric keys into your HSMs.

**Example: Import an AES symmetric key**

This example uses **imSymKey** to import an AES symmetric key into the HSMs.

The first command uses OpenSSL to generate a random 256-bit AES symmetric key. It saves the key in the **aes256.key** file.

```
$ openssl rand -out aes256-forImport.key 32
```

The second command uses **imSymKey** to import the AES key from the **aes256.key** file into the HSMs. It uses key 20, an AES key in the HSM, as the wrapping key and it specifies a label of **imported**. Unlike the ID, the label does not need to be unique in the cluster. The value of the **-t** (type) parameter is 31, which represents AES.

The output shows that the key in the file was wrapped and unwrapped, then imported into the HSM, where it was assigned the key handle 262180.

```
Command:  imSymKey -f aes256.key -w 20 -t 31 -l imported

Cfm3WrapHostKey returned: 0x00 : HSM Return: SUCCESS
Cfm3CreateUnwrapTemplate returned: 0x00 : HSM Return: SUCCESS
Cfm3UnWrapKey returned: 0x00 : HSM Return: SUCCESS
Symmetric Key Unwrapped. Key Handle: 262180
Cluster Error Status
Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
Node id 2 and err state 0x00000000 : HSM Return: SUCCESS
```

The next command uses **getAttribute** ([p. 347](#)) to get the OBJ_ATTR_LOCAL attribute ([attribute 355 (p. 388)](#)) of the newly imported key and writes it to the **attr_262180** file.

```
Command:  getAttribute -o 262180 -a 355 -out attributes/attr_262180_imported
Attributes dumped into attributes/attr_262180_imported file
Cfm3GetAttribute returned: 0x00 : HSM Return: SUCCESS
```

When you examine the attribute file, you can see that the value of the OBJ_ATTR_LOCAL attribute is zero, which indicates that the key material was not generated in the HSM.

```
$ cat attributes/attr_262180_local
```
Example: Move a symmetric key between clusters

This example shows how to use `exSymKey` (p. 318) and `imSymKey` to move a plaintext AES key between clusters. You might use a process like this one to create an AES wrapping that exists on the HSMs both clusters. Once the shared wrapping key is in place, you can use `wrapKey` (p. 385) and `unWrapKey` (p. 378) to move encrypted keys between the clusters.

The CU user who performs this operation must have permission to log in to the HSMs on both clusters.

The first command uses `exSymKey` (p. 318) to export key 14, a 32-bit AES key, from the cluster 1 into the `aes.key` file. It uses key 6, an AES key on the HSMs in cluster 1, as the wrapping key.

```
Command: exSymKey -k 14 -w 6 -out aes.key
Cfm3WrapKey returned: 0x00 : HSM Return: SUCCESS
Cfm3UnWrapHostKey returned: 0x00 : HSM Return: SUCCESS
Wrapped Symmetric Key written to file "aes.key"
```

The user then logs into `key_mgmt_util` in cluster 2 and runs an `imSymKey` command to import the key in the `aes.key` file into the HSMs in cluster 2. This command uses key 252152, an AES key on the HSMs in cluster 2, as the wrapping key.

```
Command: imSymKey -f aes.key -w 262152 -t 31 -l xcluster
Cfm3WrapHostKey returned: 0x00 : HSM Return: SUCCESS
Cfm3CreateUnwrapTemplate returned: 0x00 : HSM Return: SUCCESS
Cfm3UnWrapKey returned: 0x00 : HSM Return: SUCCESS
Symmetric Key Unwrapped. Key Handle: 21
Cluster Error Status
Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
Node id 2 and err state 0x00000000 : HSM Return: SUCCESS
```

To prove that key 14 of cluster 1 and key 21 in cluster 2 have the same key material, get the key check value (KCV) of each key. If the KCV values are the same, the key material is the same.

The following command uses `getAttribute` (p. 347) in cluster 1 to write the value of the KCV attribute (attribute 371) of key 14 to the `attr_14_kcv` file. Then, it uses a `cat` command to get the content of the `attr_14_kcv` file.

```
Command: getAttribute -o 14 -a 371 -out attr_14_kcv
Attributes dumped into attr_14_kcv file
$ cat attr_14_kcv
```
This similar command uses `getAttribute (p. 347)` in cluster 2 to write the value of the KCV attribute (attribute 371) of key 21 to the `attr_21_kcv` file. Then, it uses a `cat` command to get the content of the `attr_21_kcv` file.

```
Command: getAttribute -o 21 -a 371 -out attr_21_kcv
Attributes dumped into attr_21_kcv file
$ cat attr_21_kcv
OBJ_ATTR_KCV
0xc33cbd
```

The output shows that the KCV values of the two keys are the same, which proves that the key material is the same.

Because the same key material exists in the HSMs of both clusters, you can now share encrypted keys between the clusters without ever exposing the plaintext key. For example, you can use the `wrapKey` command with wrapping key 14 to export an encrypted key from cluster 1, and then use `unWrapKey` with wrapping key 21 to import the encrypted key into cluster 2.

**Example : Import a session key**

This command uses the `-sess` parameters of `imSymKey` to import a 192-bit Triple DES key that is valid only in the current session.

The command uses the `-f` parameter to specify the file that contains the key to import, the `-t` parameter to specify the key type, and the `-w` parameter to specify the wrapping key. It uses the `-l` parameter to specify a label that categorizes the key and the `-id` parameter to create a friendly, but unique, identifier for the key. It also uses the `-attest` parameter to verify the firmware that is importing the key.

The output shows that the key was successfully wrapped and unwrapped, imported into the HSM, and assigned the key handle 37. Also, the attestation check passed, which indicates that the firmware has not been tampered.

```
Command: imSymKey -f 3des192.key -w 6 -t 21 -l temp -id test01 -sess -attest
Cfm3WrapHostKey returned: 0x00 : HSM Return: SUCCESS
Cfm3CreateUnwrapTemplate returned: 0x00 : HSM Return: SUCCESS
Cfm3UnWrapKey returned: 0x00 : HSM Return: SUCCESS
Symmetric Key Unwrapped. Key Handle: 37
Attestation Check : [PASS]
Cluster Error Status
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
```

Next, you can use the `getAttribute (p. 347)` or `findKey (p. 323)` commands to verify the attributes of the newly imported key. The following command uses `findKey` to verify that key 37 has the type, label, and ID specified by the command, and that it is a session key. A shown on line 5 of the output, `findKey` reports that the only key that matches all of the attributes is key 37.

```
Command: findKey -t 21 -l temp -id test01 -sess 1
Total number of keys present 1
```
number of keys matched from start index 0:0
37

Cluster Error Status
Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
Node id 2 and err state 0x00000000 : HSM Return: SUCCESS

Cfm3FindKey returned: 0x00 : HSM Return: SUCCESS

Parameters

-`-attest`

  Runs an integrity check that verifies that the firmware on which the cluster runs has not been tampered with.

  Default: No attestation check.

  Required: No

-`-f`

  Specifies the file that contains that key to import.

  The file must contain a plaintext copy of an AES or Triple DES key of the specified length. RC4 and DES keys are not valid on FIPS-mode HSMs.
  - `AES`: 16, 24 or 32 bytes
  - `Triple DES (3DES)`: 24 bytes

  Required: Yes

-`-h`

  Displays help for the command.

  Required: Yes

-`-id`

  Specifies a user-defined identifier for the key. Type a string that is unique in the cluster. The default is an empty string.

  Default: No ID value.

  Required: No

-`-l`

  Specifies a user-defined label for the key. Type a string.

  You can use any phrase that helps you to identify the key. Because the label does not have to be unique, you can use it to group and categorize keys.

  Required: Yes

-`-min_srv`

  Specifies the minimum number of HSMs on which the key is synchronized before the value of the `-timeout` parameter expires. If the key is not synchronized to the specified number of servers in the time allotted, it is not created.
AWS CloudHSM automatically synchronizes every key to every HSM in the cluster. To speed up your process, set the value of `min_srv` to less than the number of HSMs in the cluster and set a low timeout value. Note, however, that some requests might not generate a key.

Default: 1
Required: No

-sess

Creates a key that exists only in the current session. The key cannot be recovered after the session ends.

Use this parameter when you need a key only briefly, such as a wrapping key that encrypts, and then quickly decrypts, another key. Do not use a session key to encrypt data that you might need to decrypt after the session ends.

To change a session key to a persistent (token) key, use `setAttribute (p. 374)`.

Default: The key is persistent.
Required: No

-timeout

Specifies how long (in seconds) the command waits for a key to be synchronized to the number of HSMs specified by the `min_srv` parameter.

This parameter is valid only when the `min_srv` parameter is also used in the command.

Default: No timeout. The command waits indefinitely and returns only when the key is synchronized to the minimum number of servers.

Required: No

-t

Specifies the type of the symmetric key. Enter the constant that represents the key type. For example, to create an AES key, enter `-t 31`.

Valid values:
- 21: Triple DES (3DES).
- 31: AES

Required: Yes

-u

Shares the key you are importing with specified users. This parameter gives other HSM crypto users (CUs) permission to use this key in cryptographic operations.

Type one ID or a comma-separated list of HSM user IDs, such as `-u 5, 6`. Do not include the HSM user ID of the current user. To find the an ID, you can use the `listUsers` command in the cloudhsm_mgmt_util command line tool or the `listUsers` command in the key_mgmt_util command line tool.

Required: No

-w

Specifies the key handle of the wrapping key. This parameter is required. To find key handles, use the `findKey (p. 323)` command.
A wrapping key is a key in the HSM that is used to encrypt ("wrap") and then decrypt ("unwrap") the key during the import process. Only AES keys can be used as wrapping keys.

You can use any AES key (of any size) as a wrapping key. Because the wrapping key wraps, and then immediately unwraps, the target key, you can use as session-only AES key as a wrapping key. To determine whether a key can be used as a wrapping key, use `getAttribute` (p. 347) to get the value of the OBJ_ATTR_WRAP attribute (262). To create a wrapping key, use `genSymKey` (p. 341) to create an AES key (type 31).

If you use the -wk parameter to specify an external wrapping key, the -w wrapping key is used to unwrap, but not to wrap, the key that is being imported.

**Note**
Key 4 is an unsupported internal key. We recommend that you use an AES key that you create and manage as the wrapping key.

Required: Yes

- **wk**

Use the AES key in the specified file to wrap the key that is being imported. Enter the path and name of a file that contains a plaintext AES key.

When you include this parameter, `imSymKey` uses the key in the -wk file to wrap the key being imported and it uses the key in the HSM that is specified by the -w parameter to unwrap it. The -w and -wk parameter values must resolve to the same plaintext key.

Default: Use the wrapping key on the HSM to unwrap.

Required: No

**Related topics**
- `genSymKey` (p. 341)
- `exSymKey` (p. 318)
- `wrapKey` (p. 385)
- `unWrapKey` (p. 378)
- `exportPrivateKey` (p. 315)
- `exportPubKey` (p. 316)

**insertMaskedObject**

The `insertMaskedObject` command in key_mgmt_util inserts a masked object from a file into a designated HSM. Masked objects are cloned objects that are extracted from an HSM by using the `extractMaskedObject` (p. 322) command. They can only be used after inserting them back into the original cluster. You can only insert a masked object into the same cluster from which it was generated, or a clone of that cluster. This includes any cloned versions of the original cluster generated by copying a backup across regions (p. 55) and using that backup to create a new cluster (p. 48).

Masked objects are an efficient way to offload and synchronize keys, including nonextractable keys (that is, keys that have a OBJ_ATTR_EXTRACTABLE (p. 388) value of 0). This way, keys can be securely synced across related clusters in different regions without the need to update the AWS CloudHSM configure file (p. 159).

Before you run any key_mgmt_util command, you must `start key_mgmt_util` (p. 303) and `log in` (p. 304) to the HSM as a crypto user (CU).
Syntax

```
insertMaskedObject -h
insertMaskedObject -f <filename> [-min_srv <minimum-number-of-servers>] [-timeout <number-of-seconds>]
```

Examples

This example shows how to use `insertMaskedObject` to insert a masked object file into an HSM.

**Example : Insert a masked object**

This command inserts a masked object into an HSM from a file named `maskedObj`. When the command succeeds, `insertMaskedObject` returns a key handle for the key decrypted from the masked object, and a success message.

```
Command: insertMaskedObject -f maskedObj
Cfm3InsertMaskedObject returned: 0x00 : HSM Return: SUCCESS
  New Key Handle: 262433
  Cluster Error Status
  Node id 2 and err state 0x00000000 : HSM Return: SUCCESS
  Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
  Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
```

Parameters

This command takes the following parameters.

- **-h**
  
  Displays command line help for the command.
  
  Required: Yes

- **-f**
  
  Specifies the file name of the masked object to insert.
  
  Required: Yes

- **-min_srv**
  
  Specifies the minimum number of servers on which the inserted masked object is synchronized before the value of the `-timeout` parameter expires. If the object is not synchronized to the specified number of servers in the time allotted, it is not inserted.
  
  Default: 1
  
  Required: No

- **-timeout**
  
  Specifies the number of seconds to wait for the key to sync across servers when the `-min_srv` parameter is included. If no number is specified, the polling continues forever.
  
  Default: No limit
IsValidKeyHandlefile

The `IsValidKeyHandlefile` command in `key_mgmt_util` is used to find out whether a key file in an HSM contains a real private key or a fake PEM key. A fake PEM file does not contain the actual private key material but instead references the private key in the HSM. Such a file can be used to establish SSL/TLS offloading from your web server to AWS CloudHSM. For more information, see SSL/TLS Offload on Linux (p. 508).

Before you run any `key_mgmt_util` command, you must start `key_mgmt_util` (p. 303) and log in (p. 304) to the HSM as a crypto user (CU).

Syntax

```
IsValidKeyHandlefile -h
IsValidKeyHandlefile -f <private-key-file>
```

Examples

These examples show how to use `IsValidKeyHandlefile` to determine whether a given key file contains the real key material or fake PEM key material.

**Example : Validate a real private key**

This command confirms that the file called `privateKey.pem` contains real key material.

```
Command: IsValidKeyHandlefile -f privateKey.pem
Input key file has real private key
```

**Example : Invalidate a fake PEM key**

This command confirms that the file called `caviumKey.pem` contains fake PEM key material made from key handle 15.

```
Command: IsValidKeyHandlefile -f caviumKey.pem
Input file has invalid key handle: 15
```

Parameters

This command takes the following parameters.
The `listAttributes` command in key_mgmt_util lists the attributes of an AWS CloudHSM key and the constants that represent them. You use these constants to identify the attributes in `getAttribute` (p. 347) and `setAttribute` (p. 374) commands. For help interpreting the key attributes, see the Key Attribute Reference (p. 388).

Before you run any key_mgmt_util command, you must start key_mgmt_util (p. 303) and log in (p. 304) to the HSM as a crypto user (CU).

**Syntax**

This command has no parameters.

```
listAttributes
```

**Example**

This command lists the key attributes that you can get and change in key_mgmt_util and the constants that represent them. For help interpreting the key attributes, see the Key Attribute Reference (p. 388).

To represent all attributes in the `getAttribute` (p. 347) command in key_mgmt_util, use 512.

**Command:** `listAttributes`

Following are the possible attribute values for `getAttribute`:

- `OBJ_ATTR_CLASS` = 0
- `OBJ_ATTR_TOKEN` = 1
- `OBJ_ATTR_PRIVATE` = 2
- `OBJ_ATTR_LABEL` = 3
- `OBJ_ATTR_KEY_TYPE` = 256
- `OBJ_ATTR_ENCRYPT` = 260
- `OBJ_ATTR_DECRYPT` = 261
- `OBJ_ATTR_WRAP` = 262
- `OBJ_ATTR_UNWRAP` = 263
- `OBJ_ATTR_SIGN` = 264
- `OBJ_ATTR_VERIFY` = 266
- `OBJ_ATTR_LOCAL` = 355
- `OBJ_ATTR_MODULUS` = 288
- `OBJ_ATTR_MODULUS_BITS` = 289
- `OBJ_ATTR_PUBLIC_EXPONENT` = 290
Related topics

- listAttributes (p. 283) in cloudhsm_mgmt_util
- getAttribute (p. 347)
- setAttribute (p. 374)
- Key Attribute Reference (p. 388)

listUsers

The listUsers command in the key_mgmt_util gets the users in the HSMs, along with their user type and other attributes.

In key_mgmt_util, listUsers returns output that represents all HSMs in the cluster, even if they are not consistent. To get information about the users in each HSM, use the listUsers (p. 371) command in cloudhsm_mgmt_util.

The user commands in key_mgmt_util, listUsers and getKeyInfo (p. 352), are read-only commands that crypto users (CUs) have permission to run. The remaining user management commands are part of cloudhsm_mgmt_util. They are run by crypto officers (CO) who have user management permissions.

Before you run any key_mgmt_util command, you must start key_mgmt_util (p. 303) and log in (p. 304) to the HSM as a crypto user (CU).

Syntax

```bash
listUsers
listUsers -h
```

Example

This command lists the users of HSMs in the cluster and their attributes. You can use the User ID attribute to identify users in other commands, such as findKey (p. 323), getAttribute (p. 347), and getKeyInfo (p. 352).

Command:  listUsers

<table>
<thead>
<tr>
<th>Index</th>
<th>User ID</th>
<th>User Type</th>
<th>User Name</th>
<th>MofnPubKey</th>
</tr>
</thead>
<tbody>
<tr>
<td>LoginFailureCnt</td>
<td>1</td>
<td>PCO</td>
<td>admin</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>2</td>
<td>AU</td>
<td>app_user</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
<td>CU</td>
<td>alice</td>
<td>YES</td>
</tr>
<tr>
<td>0</td>
<td>4</td>
<td>CU</td>
<td>bob</td>
<td>NO</td>
</tr>
<tr>
<td>0</td>
<td>5</td>
<td>CU</td>
<td>trent</td>
<td>YES</td>
</tr>
</tbody>
</table>

Cfm3ListUsers returned: 0x00 : HSM Return: SUCCESS
The output includes the following user attributes:

- **User ID**: Identifies the user in `key_mgmt_util` and `cloudhsm_mgmt_util (p. 252)` commands.
- **User type (p. 93)**: Determines the operations that the user can perform on the HSM.
- **User Name**: Displays the user-defined friendly name for the user.
- **MofnPubKey**: Indicates whether the user has registered a key pair for signing `quorum authentication tokens (p. 110)`.
- **LoginFailureCnt**: Indicates the number of times the user has unsuccessfully logged in.
- **2FA**: Indicates that the user has enabled multi-factor authentication.

**Parameters**

- **-h**
  Displays help for the command.
  Required: Yes

**Related topics**

- `listUsers (p. 371)` in `cloudhsm_mgmt_util`
- `findKey (p. 323)`
- `getAttribute (p. 347)`
- `getKeyInfo (p. 352)`

**loginHSM and logoutHSM**

The `loginHSM` and `logoutHSM` commands in `key_mgmt_util` allow you to log in and out of the HSMs in a cluster. Once logged in to the HSMs, you can use `key_mgmt_util` to perform a variety of key management operations, including public and private key generation, synchronization, and wrapping.

Before you run any `key_mgmt_util` command, you must `start key_mgmt_util (p. 303)`. In order to manage keys with `key_mgmt_util`, you must log in to the HSMs as a `crypto user (CU) (p. 94)`.

**Note**

If you exceed five incorrect login attempts, your account is locked out. If you created your cluster before February 2018, your account is locked out after 20 incorrect login attempts. To unlock the account, a cryptographic officer (CO) must reset your password using the `changePswd (p. 261)` command in `cloudhsm_mgmt_util`.

If you have more than one HSM in your cluster, you may be allowed additional incorrect login attempts before your account is locked out. This is because the CloudHSM client balances load across various HSMs. Therefore, the login attempt may not begin on the same HSM each time.

If you are testing this functionality, we recommend you do so on a cluster with only one active HSM.

**Syntax**

```
loginHSM -h

loginHSM -u <user type> { -p | -hpswd } <password> -s <username>
```
**Example**

This example shows how to log in and out of the HSMs in a cluster with the `loginHSM` and `logoutHSM` commands.

**Example : Log in to the HSMs**

This command logs you into the HSMs as a crypto user (CU) with the username `example_user` and password `aws`. The output shows that you have logged into all HSMs in the cluster.

```plaintext
Command:  loginHSM -u CU -s example_user -p aws
Cfm3LoginHSM returned: 0x00 : HSM Return: SUCCESS
Cluster Status
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
Node id 2 and err state 0x00000000 : HSM Return: SUCCESS
```

**Example : Log in with a hidden password**

This command is the same as the example above, except this time you specify that the system should hide the password.

```plaintext
Command:  loginHSM -u CU -s example_user -hpswd

The system prompts you for your password. You enter the password, the system hides the password, and the output shows that the command was successful and that the you have connected to the HSMs.

Enter password:
Cfm3LoginHSM returned: 0x00 : HSM Return: SUCCESS
Cluster Status
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
Node id 2 and err state 0x00000000 : HSM Return: SUCCESS
```

**Example : Log out of the HSMs**

This command logs you out of the HSMs. The output shows that you have logged out of all HSMs in the cluster.

```plaintext
Command:  logoutHSM
Cfm3LogoutHSM returned: 0x00 : HSM Return: SUCCESS
Cluster Status
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
Node id 2 and err state 0x00000000 : HSM Return: SUCCESS
```

**Parameters**

- **-h**
  
  Displays help for this command.
Specifies the login user type. In order to use key_mgmt_util, you must log in as a CU.

Required: Yes

-s

Specifies the login username.

Required: Yes

{-p | -hpswd }

Specify the login password with -p. The password appears in plaintext when you type it. To hide your password, use the optional -hpswd parameter instead of -p and follow the prompt.

Required: Yes

Related topics

• exit (p. 314)

setAttribute

The setAttribute command in key_mgmt_util converts a key that is valid only in the current session to a persistent key that exists until you delete it. It does this by changing the value of the token attribute of the key (OBJ_ATTR_TOKEN) from false (0) to true (1). You can only change the attributes of keys that you own.

You can also use the setAttribute command in cloudhsm_mgmt_util to change the label, wrap, unwrap, encrypt, and decrypt attributes.

Before you run any key_mgmt_util command, you must start key_mgmt_util (p. 303) and log in (p. 304) to the HSM as a crypto user (CU).

Syntax

setAttribute -h
setAttribute -o <object handle>
   -a 1

Example

This example shows how to convert a session key to a persistent key.

The first command uses the -sess parameter of genSymKey (p. 341) to create a 192-bit AES key that is valid only in the current session. The output shows that the key handle of the new session key is 262154.

Command: genSymKey -t 31 -s 24 -l tmpAES -sess

Cfm3GenerateSymmetricKey returned: 0x00 : HSM Return: SUCCESS
Symmetric Key Created. Key Handle: 262154
This command uses `findKey` (p. 323) to find the session keys in the current session. The output verifies that key 262154 is a session key.

**Command:** `findKey -sess 1`

Total number of keys present 1

   number of keys matched from start index 0::0

262154

This command uses `setAttribute` to convert key 262154 from a session key to a persistent key. To do so, it changes the value of the token attribute (OBJ_ATTR_TOKEN) of the key from 0 (false) to 1 (true). For help interpreting the key attributes, see the [Key Attribute Reference](p. 388).

The command uses the `-o` parameter to specify the key handle (262154) and the `-a` parameter to specify the constant that represents the token attribute (1). When you run the command, it prompts you for a value for the token attribute. The only valid value is 1 (true); the value for a persistent key.

**Command:** `setAttribute -o 262154 -a 1`

   This attribute is defined as a boolean value.
   Enter the boolean attribute value (0 or 1): 1

Cfm3SetAttribute returned: 0x00 : HSM Return: SUCCESS

To confirm that key 262154 is now persistent, this command uses `findKey` to search for session keys (`-sess 1`) and persistent keys (`-sess 0`). This time, the command does not find any session keys, but it returns 262154 in the list of persistent keys.

**Command:** `findKey -sess 1`

Total number of keys present 0

Cluster Error Status
   Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
   Node id 0 and err state 0x00000000 : HSM Return: SUCCESS

Cfm3FindKey returned: 0x00 : HSM Return: SUCCESS

**Command:** `findKey -sess 0`

Total number of keys present 5

   number of keys matched from start index 0::4

6, 7, 524296, 9, 262154

Cluster Error Status
Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS
Cfm3FindKey returned: 0x00 : HSM Return: SUCCESS

Parameters

-h
Displays help for the command.
Required: Yes

-o
Specifies the key handle of the target key. You can specify only one key in each command. To get the key handle of a key, use findKey (p. 323).
Required: Yes

-a
Specifies the constant that represents the attribute that you want to change. The only valid value is 1, which represents the token attribute, OBJ_ATTR_TOKEN.
To get the attributes and their integer values, use listAttributes (p. 370).
Required: Yes

Related topics

• setAttribute (p. 291) in cloudhsm_mgmt_util
• getAttribute (p. 347)
• listAttributes (p. 370)
• Key Attribute Reference (p. 388)

sign

The sign command in key_mgmt_util uses a chosen private key to generate a signature for a file.

In order to use sign, you must first have a private key in your HSM. You can generate a private key with the genSymKey (p. 341), genRSAKeyPair (p. 336), or genECCKeyPair (p. 332) commands. You can also import one with the importPrivateKey (p. 356) command. For more information, see Generate Keys (p. 151).

The sign command uses a user-designated signing mechanism, represented by an integer, to sign a message file. For a list of possible signing mechanisms, see Parameters (p. 377).

Before you run any key_mgmt_util command, you must start key_mgmt_util (p. 303) and log in (p. 304) to the HSM as a crypto user (CU).

Syntax

```bash
sign -h
sign -f <file name>
-k <private key handle>
-m <signature mechanism>
```
Example

This example shows how to use `sign` to sign a file.

**Example: Sign a file**

This command signs a file named `messageFile` with a private key with handle 266309. It uses the SHA256_RSA_PKCS (1) signing mechanism and saves the resulting signed file as `signedFile`.

Command:

```
sign -f messageFile -k 266309 -m 1 -out signedFile
```

Cfm3Sign returned: 0x00 : HSM Return: SUCCESS
signature is written to file signedFile

**Parameters**

This command takes the following parameters.

- `-f`
  
  The name of the file to sign.
  
  Required: Yes

- `-k`

  The handle of the private key to be used for signing.
  
  Required: Yes

- `-m`

  An integer that represents the signing mechanism to be used for signing. The possible mechanisms correspond to the follow integers:

<table>
<thead>
<tr>
<th>Signing Mechanism</th>
<th>Corresponding Integer</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHA1_RSA_PKCS</td>
<td>0</td>
</tr>
<tr>
<td>SHA256_RSA_PKCS</td>
<td>1</td>
</tr>
<tr>
<td>SHA384_RSA_PKCS</td>
<td>2</td>
</tr>
<tr>
<td>SHA512_RSA_PKCS</td>
<td>3</td>
</tr>
<tr>
<td>SHA224_RSA_PKCS</td>
<td>4</td>
</tr>
<tr>
<td>SHA1_RSA_PKCS_PSS</td>
<td>5</td>
</tr>
<tr>
<td>SHA256_RSA_PKCS_PSS</td>
<td>6</td>
</tr>
<tr>
<td>SHA384_RSA_PKCS_PSS</td>
<td>7</td>
</tr>
</tbody>
</table>
### Signing Mechanism

<table>
<thead>
<tr>
<th>Signing Mechanism</th>
<th>Corresponding Integer</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHA512_RSA_PKCS_PSS</td>
<td>8</td>
</tr>
<tr>
<td>SHA224_RSA_PKCS_PSS</td>
<td>9</td>
</tr>
<tr>
<td>ECDSA_SHA1</td>
<td>15</td>
</tr>
<tr>
<td>ECDSA_SHA224</td>
<td>16</td>
</tr>
<tr>
<td>ECDSA_SHA256</td>
<td>17</td>
</tr>
<tr>
<td>ECDSA_SHA384</td>
<td>18</td>
</tr>
<tr>
<td>ECDSA_SHA512</td>
<td>19</td>
</tr>
</tbody>
</table>

Required: Yes

### -out

The name of the file to which the signed file will be saved.

Required: Yes

### Related topics

- verify (p. 383)
- importPrivateKey (p. 356)
- genRSAKeyPair (p. 336)
- genECCKeyPair (p. 332)
- genSymKey (p. 341)
- Generate Keys (p. 151)

### unWrapKey

The **unWrapKey** command in the key_mgmt_util tool imports a wrapped (encrypted) symmetric or private key from a file into the HSM. It is designed to import encrypted keys that were wrapped by the **wrapKey** (p. 385) command in key_mgmt_util, but it can also be used to unwrap keys that were wrapped with other tools. However, in those situations, we recommend using the PKCS#11 (p. 394) or JCE (p. 422) software libraries to unwrap the key.

Imported keys work like keys generated by AWS CloudHSM. However, the value of their OBJ_ATTR_LOCAL attribute (p. 388) is zero, which indicates that they were not generated locally.

After you import a key, ensure that you mark or delete the key file. This command does not prevent you from importing the same key material multiple times. The results—multiple keys with distinct key handles and the same key material—make it difficult to track use of the key materials and prevent them from exceeding their cryptographic limits.

Before you run any key_mgmt_util command, you must start key_mgmt_util (p. 303) and log in (p. 304) to the HSM as a crypto user (CU).

### Syntax

```
unWrapKey -h
```
unWrapKey -f <key-file-name>
   -w <wrapping-key-handle>
       [-sess]
       [-min_srv <minimum-number-of-HSMs>]
       [-timeout <number-of-seconds>]
       [-aad <additional authenticated data filename>]
       [-tag_size <tag size>]
       [-iv_file <IV file>]
       [-attest]
       [-m <wrapping-mechanism>]
       [-t <hash-type>]
       [-nex]
       [-u <user id list>]
       [-m_value <number of users needed for approval>]
       [-noheader]
       [-l <key-label>]
       [-id <key-id>]
       [-kt <key-type>]
       [-kc <key-class>]
       [-i <unwrapping-IV>]

Example

These examples show how to use unWrapKey to import a wrapped key from a file into the HSMs. In the first example, we unwrap a key that was wrapped with the wrapKey (p. 385) key_mgmt_util command, and thus has a header. In the second example, we unwrap a key that was wrapped outside of key_mgmt_util, and thus does not have a header.

Example: Unwrap a key (with header)

This command imports a wrapped copy of a 3DES symmetric key into an HSM. The key is unwrapped with an AES key with label 6, which is cryptographically identical to the one that was used to wrap the 3DES key. The output shows that the key in the file was unwrapped and imported, and that the imported key's handle is 29.

Command: unWrapKey -f 3DES.key -w 6 -m 4

Cfm3UnWrapKey returned: 0x00 : HSM Return: SUCCESS
Key Unwrapped. Key Handle: 29
Cluster Error Status
Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS

Example: Unwrap a key (no header)

This command imports a wrapped copy of a 3DES symmetric key into an HSM. The key is unwrapped with an AES key with label 6, which is cryptographically identical to the one that was used to wrap the 3DES key. As this 3DES key was not wrapped with key_mgmt_util, the noheader parameter is specified, along with its required accompanying parameters: a key label (unwrapped3DES), key class (4), and key type (21). The output shows that the key in the file was unwrapped and imported, and that the imported key's handle is 8.

Command: unWrapKey -f 3DES.key -w 6 -noheader -l unwrapped3DES -kc 4 -kt 21 -m 4

Cfm3CreateUnwrapTemplate2 returned: 0x00 : HSM Return: SUCCESS
Cfm2UnWrapWithTemplate3 returned: 0x00 : HSM Return: SUCCESS
Key Unwrapped. Key Handle: 8

Cluster Error Status
Node id 1 and err state 0x00000000 : HSM Return: SUCCESS
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS

Parameters

-h

Displays help for the command.
Required: Yes

-f

The path and name of the file that contains the wrapped key.
Required: Yes

-w

Specifies the wrapping key. Enter the key handle of an AES key or RSA key on the HSM. This parameter is required. To find key handles, use the findKey (p. 323) command.

To create a wrapping key, use genSymKey (p. 341) to generate an AES key (type 31) or genRSAKeyPair (p. 336) to generate an RSA key pair (type 0). If you are using an RSA key pair, be sure to wrap the key with one of the keys, and unwrap it with the other. To verify that a key can be used as a wrapping key, use getAttribute (p. 347) to get the value of the OBJ_ATTR_WRAP attribute, which is represented by constant 262.
Required: Yes

-sess

Creates a key that exists only in the current session. The key cannot be recovered after the session ends.
Use this parameter when you need a key only briefly, such as a wrapping key that encrypts, and then quickly decrypts, another key. Do not use a session key to encrypt data that you might need to decrypt after the session ends.

To change a session key to a persistent (token) key, use setAttribute (p. 374).
Default: The key is persistent.
Required: No

-min_srv

Specifies the minimum number of HSMs on which the key is synchronized before the value of the -timeout parameter expires. If the key is not synchronized to the specified number of servers in the time allotted, it is not created.

AWS CloudHSM automatically synchronizes every key to every HSM in the cluster. To speed up your process, set the value of min_srv to less than the number of HSMs in the cluster and set a low timeout value. Note, however, that some requests might not generate a key.
Default: 1
Required: No
-timeout

Specifies how long (in seconds) the command waits for a key to be synchronized to the number of HSMs specified by the `min_srv` parameter.

This parameter is valid only when the `min_srv` parameter is also used in the command.

Default: No timeout. The command waits indefinitely and returns only when the key is synchronized to the minimum number of servers.

Required: No

-attest

Runs an integrity check that verifies that the firmware on which the cluster runs has not been tampered with.

Default: No attestation check.

Required: No

-nex

Makes the key nonextractable. The key that is generated cannot be exported from the HSM (p. 153).

Default: The key is extractable.

Required: No

-m

The value representing the wrapping mechanism. CloudHSM supports the following mechanisms:

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>AES_KEY_WRAP_PAD_PKCS5</td>
<td>4</td>
</tr>
<tr>
<td>NIST_AES_WRAP_NO_PAD</td>
<td>5</td>
</tr>
<tr>
<td>NIST_AES_WRAP_PAD</td>
<td>6</td>
</tr>
<tr>
<td>RSA_AES</td>
<td>7</td>
</tr>
<tr>
<td>RSA_OAEP (for maximum data size, see the note later in this section)</td>
<td>8</td>
</tr>
<tr>
<td>AES_GCM</td>
<td>10</td>
</tr>
<tr>
<td>CLOUDHSM_AES_GCM</td>
<td>11</td>
</tr>
<tr>
<td>RSA_PKCS (for maximum data size, see the note later in this section). See note 1 below for an upcoming change.</td>
<td>12</td>
</tr>
</tbody>
</table>

Required: Yes

Note

When using the RSA_OAEP wrapping mechanism, the maximum key size that you can wrap is determined by the modulus of the RSA key and the length of the specified hash as follows: Maximum key size = modulusLengthInBytes-(2*hashLengthInBytes)-2.

When using the RSA_PKCS wrapping mechanism, the maximum key size that you can wrap is determined by the modulus of the RSA key as follows: Maximum key size = (modulusLengthInBytes -11).
-t

<table>
<thead>
<tr>
<th>Hash algorithm</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHA1</td>
<td>2</td>
</tr>
<tr>
<td>SHA256</td>
<td>3</td>
</tr>
<tr>
<td>SHA384</td>
<td>4</td>
</tr>
<tr>
<td>SHA512</td>
<td>5</td>
</tr>
<tr>
<td>SHA224 (valid for RSA_AES and RSA_OAEP mechanisms)</td>
<td>6</td>
</tr>
</tbody>
</table>

Required: No

-noheader

If you are unwrapping a key that was wrapped outside of key_mgmt_util, you must specify this parameter and all other associated parameters.

Required: No

Note

If you specify this parameter, you must also specify the following -noheader parameters:

- -l

Specifies the label to be added to the unwrapped key.

Required: Yes

- -kc

Specifies the class of the key to be unwrapped. The following are acceptable values:

3 = private key from a public-private key pair
4 = secret (symmetric) key

Required: Yes

- -kt

Specifies the type of key to be unwrapped. The following are acceptable values:

0 = RSA
1 = DSA
3 = ECC
16 = GENERIC_SECRET
21 = DES3
31 = AES

Required: Yes

You can also optionally specify the following -noheader parameters:

- -id
The ID to be added to the unwrapped key.
Required: No
• -i

The unwrapping initialization vector (IV) to be used.
Required: No


Related topics
• wrapKey (p. 385)
• exSymKey (p. 318)
• imSymKey (p. 361)

verify

The verify command in key_mgmt_util confirms whether or not a file has been signed by a given key. To do so, the verify command compares a signed file against a source file and analyzes whether they are cryptographically related based on a given public key and signing mechanism. Files can be signed in AWS CloudHSM with the sign (p. 376) operation.

Signing mechanisms are represented by the integers listed in the parameters (p. 384) section.

Before you run any key_mgmt_util command, you must start key_mgmt_util (p. 303) and log in (p. 304) to the HSM as a crypto user (CU).

Syntax

```
verify -h
verify -f <message-file>
    -s <signature-file>
    -k <public-key-handle>
    -m <signature-mechanism>
```

Example

These examples show how to use verify to check whether a certain public key was used to sign a given file.

Example : Verify a file signature

This command attempts to verify whether a file named hardwareCert.crt was signed by public key 262276 using the SHA256_RSA_PKCS signing mechanism to produce the hardwareCertSigned signed file. Because the given parameters represent a true signing relationship, the command returns a success message.

```
Command: verify -f hardwareCert.crt -s hardwareCertSigned -k 262276 -m 1
Signature verification successful
```
Example: Prove false signing relationship

This command verifies whether a file named `hardwareCert.crt` was signed by public key 262276 using the SHA256_RSA_PKCS signing mechanism to produce the `userCertSigned` signed file. Because the given parameters do not make up a true signing relationship, the command returns an error message.

```
Command: verify -f hardwarecert.crt -s usercertsigned -k 262276 -m 1
Cfm3Verify returned: 0x1b
CSP Error: ERR_BAD_PKCS_DATA
```

Parameters

This command takes the following parameters.

- **-f**
  - The name of the origin message file.
  - Required: Yes
- **-s**
  - The name of the signed file.
  - Required: Yes
- **-k**
  - The handle of the public key that is thought to be used to sign the file.
  - Required: Yes
- **-m**
  - An integer that represents the proposed signing mechanism that is used to sign the file. The possible mechanisms correspond to the following integers:

<table>
<thead>
<tr>
<th>Signing Mechanism</th>
<th>Corresponding Integer</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHA1_RSA_PKCS</td>
<td>0</td>
</tr>
<tr>
<td>SHA256_RSA_PKCS</td>
<td>1</td>
</tr>
<tr>
<td>SHA384_RSA_PKCS</td>
<td>2</td>
</tr>
<tr>
<td>SHA512_RSA_PKCS</td>
<td>3</td>
</tr>
<tr>
<td>SHA224_RSA_PKCS</td>
<td>4</td>
</tr>
<tr>
<td>SHA1_RSA_PKCS_PSS</td>
<td>5</td>
</tr>
<tr>
<td>SHA256_RSA_PKCS_PSS</td>
<td>6</td>
</tr>
<tr>
<td>SHA384_RSA_PKCS_PSS</td>
<td>7</td>
</tr>
<tr>
<td>SHA512_RSA_PKCS_PSS</td>
<td>8</td>
</tr>
</tbody>
</table>
### Signing Mechanism

<table>
<thead>
<tr>
<th>Signing Mechanism</th>
<th>Corresponding Integer</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHA224_RSA_PKCS_PSS</td>
<td>9</td>
</tr>
<tr>
<td>ECDSA_SHA1</td>
<td>15</td>
</tr>
<tr>
<td>ECDSA_SHA224</td>
<td>16</td>
</tr>
<tr>
<td>ECDSA_SHA256</td>
<td>17</td>
</tr>
<tr>
<td>ECDSA_SHA384</td>
<td>18</td>
</tr>
<tr>
<td>ECDSA_SHA512</td>
<td>19</td>
</tr>
</tbody>
</table>

Required: Yes

### Related topics

- [sign](#) (p. 376)
- [getCert](#) (p. 332)
- [Generate Keys](#) (p. 151)

### wrapKey

The **wrapKey** command in key_mgmt_util exports an encrypted copy of a symmetric or private key from the HSM to a file. When you run **wrapKey**, you specify the key to export, a key on the HSM to encrypt (wrap) the key that you want to export, and the output file.

The wrapKey command writes the encrypted key to a file that you specify, but it does not remove the key from the HSM or prevent you from using it in cryptographic operations. You can export the same key multiple times.

Only the owner of a key, that is, the crypto user (CU) who created the key, can export it. Users who share the key can use it in cryptographic operations, but they cannot export it.

To import the encrypted key back into the HSM, use **unWrapKey** (p. 378). To export a plaintext key from an HSM, use **exSymKey** (p. 318) or **exportPrivateKey** (p. 315) as appropriate. The **aesWrapUnwrap** (p. 309) command cannot decrypt (unwrap) keys that **wrapKey** encrypts.

Before you run any key_mgmt_util command, you must **start key_mgmt_util** (p. 303) and **log in** (p. 304) to the HSM as a crypto user (CU).

### Syntax

```
wrapKey -h
wrapKey -k <exported-key-handle>
   -w <wrapping-key-handle>
   -out <output-file>
   [-m <wrapping-mechanism>]
   [-aad <additional authenticated data filename>]
   [-t <hash-type>]
   [-noheader]
   [-i <wrapping IV>]
   [-iv_file <IV file>]
   [-tag_size <num_tag_bytes>]
```
Example

This command exports a 192-bit Triple DES (3DES) symmetric key (key handle 7). It uses a 256-bit AES key in the HSM (key handle 14) to wrap key 7. Then, it writes the encrypted 3DES key to the 3DES-encrypted.key file.

The output shows that key 7 (the 3DES key) was successfully wrapped and written to the specified file. The encrypted key is 307 bytes long.

```
Command: wrapKey -k 7 -w 14 -out 3DES-encrypted.key -m 4
Key Wrapped.
Wrapped Key written to file "3DES-encrypted.key length 307
Cfm2WrapKey returned: 0x00 : HSM Return: SUCCESS
```

Parameters

-h
Displays help for the command.

Required: Yes

-k
The key handle of the key that you want to export. Enter the key handle of a symmetric or private key that you own. To find key handles, use the findKey (p. 323) command.

To verify that a key can be exported, use the getAttribute (p. 347) command to get the value of the OBJ_ATTR_EXTRACTABLE attribute, which is represented by constant 354. For help interpreting the key attributes, see the Key Attribute Reference (p. 388).

You can export only those keys that you own. To find the owner of a key, use the getKeyInfo (p. 352) command.

Required: Yes

-w
Specifies the wrapping key. Enter the key handle of an AES key or RSA key on the HSM. This parameter is required. To find key handles, use the findKey (p. 323) command.

To create a wrapping key, use genSymKey (p. 341) to generate an AES key (type 31) or genRSAKeyPair (p. 336) to generate an RSA key pair (type 0). If you are using an RSA key pair, be sure to wrap the key with one of the keys, and unwrap it with the other. To verify that a key can be used as a wrapping key, use getAttribute (p. 347) to get the value of the OBJ_ATTR_WRAP attribute, which is represented by constant 262.

Required: Yes

-out
The path and name of the output file. When the command succeeds, this file contains an encrypted copy of the exported key. If the file already exists, the command overwrites it without warning.
Required: Yes

-m

The value representing the wrapping mechanism. CloudHSM supports the following mechanisms:

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>AES_KEY_WRAP_PAD_PKCS5</td>
<td>4</td>
</tr>
<tr>
<td>NIST_AES_WRAP_NO_PAD</td>
<td>5</td>
</tr>
<tr>
<td>NIST_AES_WRAP_PAD</td>
<td>6</td>
</tr>
<tr>
<td>RSA_AES</td>
<td>7</td>
</tr>
<tr>
<td>RSA_OAEP (for maximum data size, see the note later in this section)</td>
<td>8</td>
</tr>
<tr>
<td>AES_GCM</td>
<td>10</td>
</tr>
<tr>
<td>CLOUDHSM_AES_GCM</td>
<td>11</td>
</tr>
<tr>
<td>RSA_PKCS (for maximum data size, see the note later in this section). See note 1 below for an upcoming change.</td>
<td>12</td>
</tr>
</tbody>
</table>

Required: Yes

Note
When using the RSA_OAEP wrapping mechanism, the maximum key size that you can wrap is determined by the modulus of the RSA key and the length of the specified hash as follows: Maximum key size = (modulusLengthInBytes-2*hashLengthInBytes-2).
When using the RSA_PKCS wrapping mechanism, the maximum key size that you can wrap is determined by the modulus of the RSA key as follows: Maximum key size = (modulusLengthInBytes -11).

-t

The value representing the hash algorithm. CloudHSM supports the following algorithms:

<table>
<thead>
<tr>
<th>Hash algorithm</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHA1</td>
<td>2</td>
</tr>
<tr>
<td>SHA256</td>
<td>3</td>
</tr>
<tr>
<td>SHA384</td>
<td>4</td>
</tr>
<tr>
<td>SHA512</td>
<td>5</td>
</tr>
<tr>
<td>SHA224 (valid for RSA_AES and RSA_OAEP mechanisms)</td>
<td>6</td>
</tr>
</tbody>
</table>

Required: No

-aad

The file name containing AAD.
**Note**
Valid only for AES_GCM and CLOUDHSM_AES_GCM mechanisms.

Required: No

**-noheader**

Omits the header that specifies CloudHSM-specific key attributes (p. 307). Use this parameter only if you want to unwrap the key with tools outside of key_mgmt_util.

Required: No

**-i**

The initialization vector (IV) (hex value).

**Note**
Valid only when passed with the -noheader parameter for CLOUDHSM_AES_KEY_WRAP, and NIST_AES_WRAP mechanisms.

Required: No

**-iv_file**

The file in which you want to write the IV value obtained in response.

**Note**
Valid only when passed with the -noheader parameter for AES_GCM mechanism.

Required: No

**-tag_size**

The size of tag to be saved along with wrapped blob.

**Note**
Valid only when passed with the -noheader parameter for AES_GCM and CLOUDHSM_AES_GCM mechanisms. Minimum tag size is eight.

Required: No


**Related topics**
- exSymKey (p. 318)
- imSymKey (p. 361)
- unWrapKey (p. 378)

**Key Attribute Reference**

The key_mgmt_util commands use constants to represent the attributes of keys in an HSM. This topic can help you to identify the attributes, find the constants that represent them in commands, and understand their values.

You set the attributes of a key when you create it. To change the token attribute, which indicates whether a key is persistent or exists only in the session, use the setAttribute (p. 374) command in key_mgmt_util. To change the label, wrap, unwrap, encrypt, or decrypt attributes, use the setAttribute command in cloudhsm_mgmt_util.
To get a list of attributes and their constants, use `listAttributes` (p. 370). To get the attribute values for a key, use `getAttribute` (p. 347).

The following table lists the key attributes, their constants, and their valid values.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Constant</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>OBJ_ATTR_ALL</td>
<td>512</td>
<td>Represents all attributes.</td>
</tr>
<tr>
<td>OBJ_ATTR_ALWAYS_SENSITIVE</td>
<td>357</td>
<td>0: False. 1: True.</td>
</tr>
<tr>
<td>OBJ_ATTR_CLASS</td>
<td>0</td>
<td>2: Public key in a public–private key pair. 3: Private key in a public–private key pair. 4: Secret (symmetric) key.</td>
</tr>
<tr>
<td>OBJ_ATTR_DECRYPT</td>
<td>261</td>
<td>0: False. 1: True. The key can be used to decrypt data.</td>
</tr>
<tr>
<td>OBJ_ATTR_DERIVE</td>
<td>268</td>
<td>0: False. 1: True. The function derives the key.</td>
</tr>
<tr>
<td>OBJ_ATTR_DESTROYABLE</td>
<td>370</td>
<td>0: False. 1: True.</td>
</tr>
<tr>
<td>OBJ_ATTR_ENCRYPT</td>
<td>260</td>
<td>0: False. 1: True. The key can be used to encrypt data.</td>
</tr>
<tr>
<td>OBJ_ATTR_EXTRACTABLE</td>
<td>354</td>
<td>0: False. 1: True. The key can be exported from the HSMs.</td>
</tr>
<tr>
<td>OBJ_ATTR_ID</td>
<td>258</td>
<td>User-defined string. Must be unique in the cluster. The default is an empty string.</td>
</tr>
<tr>
<td>OBJ_ATTR_KCV</td>
<td>371</td>
<td>Key check value of the key. For more information, see Additional Details (p. 391).</td>
</tr>
<tr>
<td>Attribute</td>
<td>Constant</td>
<td>Values</td>
</tr>
<tr>
<td>------------------------</td>
<td>----------</td>
<td>-----------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>OBJ_ATTR_LABEL</td>
<td>3</td>
<td>User-defined string. It does not have to be unique in the cluster.</td>
</tr>
<tr>
<td>OBJ_ATTR_LOCAL</td>
<td>355</td>
<td>0: False. The key was imported into the HSMs. 1: True.</td>
</tr>
<tr>
<td>OBJ_ATTR_MODULUS</td>
<td>288</td>
<td>The modulus that was used to generate an RSA key pair. For EC keys, this value represents the DER-encoding of ANSI X9.62 ECPoint value “Q” in a hexadecimal format. For other key types, this attribute does not exist.</td>
</tr>
<tr>
<td>OBJ_ATTR_MODULUS_BITS</td>
<td>289</td>
<td>The length of the modulus used to generate an RSA key pair. For EC keys this represents the ID of the elliptic curve used to generate the key. For other key types, this attribute does not exist.</td>
</tr>
<tr>
<td>OBJ_ATTR_NEVER_EXTRACTABLE</td>
<td>356</td>
<td>0: False. 1: True. The key cannot be exported from the HSMs.</td>
</tr>
<tr>
<td>OBJ_ATTR_PUBLIC_EXPONENT</td>
<td>290</td>
<td>The public exponent used to generate an RSA key pair. For other key types, this attribute does not exist.</td>
</tr>
<tr>
<td>OBJ_ATTR_PRIVATE</td>
<td>2</td>
<td>0: False. 1: True. This attribute indicates whether unauthenticated users can list the attributes of the key. Since the CloudHSM PKCS#11 provider currently does not support public sessions, all keys (including public keys in a public-private key pair) have this attribute set to 1.</td>
</tr>
<tr>
<td>OBJ_ATTR_SENSITIVE</td>
<td>259</td>
<td>0: False. Public key in a public-private key pair. 1: True.</td>
</tr>
<tr>
<td>Attribute</td>
<td>Constant</td>
<td>Values</td>
</tr>
<tr>
<td>---------------------------</td>
<td>----------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>OBJ_ATTR_SIGN</td>
<td>264</td>
<td>0: False. 1: True. The key can be used for signing (private keys).</td>
</tr>
<tr>
<td>OBJ_ATTR_TOKEN</td>
<td>1</td>
<td>0: False. Session key. 1: True. Persistent key.</td>
</tr>
<tr>
<td>OBJ_ATTR_TRUSTED</td>
<td>134</td>
<td>0: False. 1: True.</td>
</tr>
<tr>
<td>OBJ_ATTR_UNWRAP</td>
<td>263</td>
<td>0: False. 1: True. The key can be used to decrypt keys.</td>
</tr>
<tr>
<td>OBJ_ATTR_UNWRAP_TEMPLATE</td>
<td>1073742354</td>
<td>Values should use the attribute template applied to any key</td>
</tr>
<tr>
<td></td>
<td></td>
<td>unwrapped using this wrapping key.</td>
</tr>
<tr>
<td>OBJ_ATTR_VALUE_LEN</td>
<td>353</td>
<td>Key length in bytes.</td>
</tr>
<tr>
<td>OBJ_ATTR_VERIFY</td>
<td>266</td>
<td>0: False. 1: True. The key can be used for verification (public keys).</td>
</tr>
<tr>
<td>OBJ_ATTR_WRAP</td>
<td>262</td>
<td>0: False. 1: True. The key can be used to encrypt keys.</td>
</tr>
<tr>
<td>OBJ_ATTR_WRAP_TEMPLATE</td>
<td>1073742353</td>
<td>Values should use the attribute template to match the key</td>
</tr>
<tr>
<td></td>
<td></td>
<td>wrapped using this wrapping key.</td>
</tr>
<tr>
<td>OBJ_ATTR_WRAP_WITH_TRUSTED</td>
<td>528</td>
<td>0: False. 1: True.</td>
</tr>
</tbody>
</table>

**Additional Details**

**Key check value (KCV)**

The key check value (KCV) is a 3-byte hash or checksum of a key that is generated when the HSM imports or generates a key. You can also calculate a KCV outside of the HSM, such as after you export a key. You can then compare the KCV values to confirm the identity and integrity of the key. To get the KCV of a key, use `getAttribute (p. 347)`.

AWS CloudHSM uses the following standard method to generate a key check value:

- **Symmetric keys**: First 3 bytes of the result of encrypting a zero-block with the key.
- **Asymmetric key pairs**: First 3 bytes of the SHA-1 hash of the public key.
- **HMAC keys**: KCV for HMAC keys is not supported at this time.
AWS CloudHSM Client SDKs

Use a Client SDK to offload cryptographic operations from platform or language-based applications to hardware security modules (HSMs).

AWS CloudHSM offers two major versions, and Client SDK 5 is the latest. It offers a variety of advantages over Client SDK 3 (the previous series). For more information, see Benefits of Client SDK 5 (p. 453). For information about platform support, see Client SDK 5 supported platforms (p. 392).

For information on using Client SDK 3, see Previous Client SDK versions (p. 454).

- **the section called “PKCS #11 library” (p. 394)**
  - PKCS #11 is a standard for performing cryptographic operations on hardware security modules (HSMs). AWS CloudHSM offers implementations of the PKCS #11 library that are compliant with PKCS #11 version 2.40.

- **the section called “OpenSSL Dynamic Engine” (p. 418)**
  - The AWS CloudHSM OpenSSL Dynamic Engine allows you to offload cryptographic operations to your CloudHSM cluster through the OpenSSL API.

- **the section called “JCE provider” (p. 422)**
  - The AWS CloudHSM JCE provider is compliant with the Java Cryptographic Architecture (JCA). The provider allows you to perform cryptographic operations on the HSM.

- **the section called “KSP and CNG providers” (p. 444)**
  - The AWS CloudHSM client for Windows includes CNG and KSP providers. Currently, only Client SDK 3 supports CNG and KSP providers.

---

Client SDK 5 supported platforms

Base support is different for each version of the AWS CloudHSM Client SDK. Platform support for components in an SDK typically matches base support, but not always. To determine platform support for a given component, first make sure the platform you want appears in the base section for the SDK, then check for an exclusions or any other pertinent information in the component section.

AWS CloudHSM supports only 64-bit operating systems.

Platform support changes over time. Earlier versions of the CloudHSM Client SDK may not support all the operating systems listed here. Use release notes to determine the operating system support for previous versions of the CloudHSM Client SDK. For more information, see Downloads for AWS CloudHSM Client SDK (p. 671).

For supported platforms for the previous Client SDK, see Client SDK 3 supported platforms (p. 456)

---

**Client SDK 5 platform support**

Client SDK 5 does not require a client daemon.
Linux support for Client SDK 5

<table>
<thead>
<tr>
<th>Supported platforms</th>
<th>X86_64 Architecture</th>
<th>ARM architecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amazon Linux</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Amazon Linux 2</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>CentOS 7.8+</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>CentOS 8.3+¹</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Red Hat Enterprise Linux (RHEL) 7.8+</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Red Hat Enterprise Linux (RHEL) 8.3+</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Ubuntu 18.04 LTS²</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Ubuntu 20.04 LTS</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Ubuntu 22.04 LTS</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

[1] Client SDK 5.4.1 is the last release that works on CentOS 8.3+.

[2] Client SDK 5.10.0 is the last release that works on Ubuntu 18.04 LTS.

Windows support for Client SDK 5

- Microsoft Windows Server 2016
- Microsoft Windows Server 2019

Serverless support for Client SDK 5

- AWS Lambda
- Docker/ECS

Components support

PKCS #11 library

The PKCS #11 library is a cross-platform component that matches Linux and Windows Client SDK 5 base support. For more information, see the section called "Linux support for Client SDK 5" (p. 393) and the section called "Windows support for Client SDK 5" (p. 393).

OpenSSL Dynamic Engine

The OpenSSL Dynamic Engine is a Linux only component that requires OpenSSL 1.0.2 or 1.1.1.

JCE provider

The JCE provider is a Java SDK which is compatible with OpenJDK 8 and OpenJDK11 on all supported platforms.
PKCS #11 library

PKCS #11 is a standard for performing cryptographic operations on hardware security modules (HSMs). AWS CloudHSM offers implementations of the PKCS #11 library that are compliant with PKCS #11 version 2.40.

For information about bootstrapping, see Connecting to the cluster (p. 40).

For information on using Client SDK 3, see Previous Client SDK versions (p. 454).

Topics

• Install Client SDK 5 for PKCS #11 library (p. 394)
• PKCS #11 library (p. 397)
• Supported key types (p. 397)
• Supported mechanisms (p. 397)
• Supported API operations (p. 402)
• Supported key attributes (p. 403)
• Code samples for the PKCS #11 library (p. 413)
• Advanced configurations for PKCS #11 (p. 414)

Install Client SDK 5 for PKCS #11 library

This topic provides instructions for installing the latest version of the PKCS #11 library from the Client SDK 5 version series. For more information about the Client SDK or PKCS #11 library, see Using the Client SDK (p. 392) and PKCS #11 library (p. 394).

Installation

With Client SDK 5, you are not required to install or run a client daemon.

To run a single HSM cluster with Client SDK 5, you must first manage client key durability settings by setting disable_key_availability_check to True. For more information, see Key Synchronization (p. 123) and Client SDK 5 Configure Tool (p. 159).

For more information about the PKCS #11 library in Client SDK 5, see PKCS #11 library (p. 394).

To install and configure the PKCS #11 library

1. Use the following commands to download and install the PKCS #11 library.

   Amazon Linux

   Install the PKCS #11 library for Amazon Linux on X86_64 architecture:

   ```bash
   $ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL6/cloudhsm-pkcs11-latest.el6.x86_64.rpm
   $ sudo yum install ./cloudhsm-pkcs11-latest.el6.x86_64.rpm
   ```

   Amazon Linux 2

   Install the PKCS #11 library for Amazon Linux 2 on X86_64 architecture:
### Installing PKCS #11 library

Install the PKCS #11 library for Amazon Linux 2 on ARM64 architecture:

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-pkcs11-latest.el7.aarch64.rpm

$ sudo yum install ./cloudhsm-pkcs11-latest.el7.aarch64.rpm
```

CentOS 7.8+

Install the PKCS #11 library for CentOS 7.8+ on X86_64 architecture:

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-pkcs11-latest.el7.x86_64.rpm

$ sudo yum install ./cloudhsm-pkcs11-latest.el7.x86_64.rpm
```

CentOS 8.3+

Install the PKCS #11 library for CentOS 8.3+ on X86_64 architecture:

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL8/cloudhsm-pkcs11-latest.el8.x86_64.rpm

$ sudo yum install ./cloudhsm-pkcs11-latest.el8.x86_64.rpm
```

RHEL 7.9+

Install the PKCS #11 library for RHEL 7.9+ on X86_64 architecture:

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-pkcs11-latest.el7.x86_64.rpm

$ sudo yum install ./cloudhsm-pkcs11-latest.el7.x86_64.rpm
```

RHEL 8.3+

Install the PKCS #11 library for RHEL 8.3+ on X86_64 architecture:

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL8/cloudhsm-pkcs11-latest.el8.x86_64.rpm

$ sudo yum install ./cloudhsm-pkcs11-latest.el8.x86_64.rpm
```
Ubuntu 18.04 LTS
Install the PKCS #11 library for Ubuntu 18.04 LTS on X86_64 architecture:

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Bionic/cloudhsm-pkcs11_latest_u18.04_amd64.deb

$ sudo apt install ./cloudhsm-pkcs11_latest_u18.04_amd64.deb
```

Ubuntu 20.04 LTS
Install the PKCS #11 library for Ubuntu 20.04 LTS on X86_64 architecture:

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Focal/cloudhsm-pkcs11_latest_u20.04_amd64.deb

$ sudo apt install ./cloudhsm-pkcs11_latest_u20.04_amd64.deb
```

Ubuntu 22.04 LTS
Install the PKCS #11 library for Ubuntu 22.04 LTS on X86_64 architecture:

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Jammy/cloudhsm-pkcs11_latest_u22.04_amd64.deb

$ sudo apt install ./cloudhsm-pkcs11_latest_u22.04_amd64.deb
```

Windows Server 2016
Install the PKCS #11 library for Windows Server 2016 on X86_64 architecture:

1. Download [PKCS #11 library for Client SDK 5](https://aws.amazon.com/cloudhsm/software/download-client-sdk/).
2. Run the PKCS #11 library installer (AWSCloudHSM PKCS11-latest.msi) with Windows administrative privilege.

Windows Server 2019
Install the PKCS #11 library for Windows Server 2019 on X86_64 architecture:

1. Download [PKCS #11 library for Client SDK 5](https://aws.amazon.com/cloudhsm/software/download-client-sdk/).
2. Run the PKCS #11 library installer (AWSCloudHSM PKCS11-latest.msi) with Windows administrative privilege.
3. Use the configure tool to specify the location of the issuing certificate. For instructions, see [Specify the location of the issuing certificate](p. 40).
4. To connect to your cluster, see [Bootstrap the Client SDK](p. 41).
5. You can find the PKCS #11 library files in the following locations:

   - Linux binaries, configuration scripts, and log files:
     `/opt/cloudhsm`

   - Windows binaries:
PKCS #11 library

When you use the PKCS #11 library, your application runs as a particular crypto user (CU) in your HSMs. Your application can view and manage only the keys that the CU owns and shares. You can use an existing CU in your HSMs or create a new CU for your application. For information on managing CUs, see Managing HSM users with CloudHSM CLI (p. 60) and Managing HSM users with CloudHSM Management Utility (CMU) (p. 93).

To specify the CU to PKCS #11 library, use the pin parameter of the PKCS #11 C_Login function. For AWS CloudHSM, the pin parameter has the following format:

<CU_user_name>:<password>

For example, the following command sets the PKCS #11 library pin to the CU with user name CryptoUser and password CUPassword123!.

CryptoUser:CUPassword123!

Supported key types

The PKCS #11 library supports the following key types.

<table>
<thead>
<tr>
<th>Key Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AES</td>
<td>Generate 128, 192, and 256-bit AES keys.</td>
</tr>
<tr>
<td>Triple DES (3DES, DESede)</td>
<td>Generate 192-bit Triple DES keys. See note [1] below for an upcoming change.</td>
</tr>
<tr>
<td>EC</td>
<td>Generate keys with the secp224r1 (P-224), secp256r1 (P-256), secp384r1 (P-384), and secp521r1 (P-521) curves.</td>
</tr>
<tr>
<td>GENERIC_SECRET</td>
<td>Generate 1 to 800 bytes generic secrets.</td>
</tr>
<tr>
<td>RSA</td>
<td>Generate 2048-bit to 4096-bit RSA keys, in increments of 256 bits.</td>
</tr>
</tbody>
</table>


Supported mechanisms

The PKCS #11 library is compliant with version 2.40 of the PKCS #11 specification. To invoke a cryptographic feature using PKCS #11, call a function with a given mechanism. The following sections summarize the combinations of functions and mechanisms supported by AWS CloudHSM.
The PKCS #11 library supports the following algorithms:

- **Encryption and decryption** – AES-CBC, AES-CTR, AES-ECB, AES-GCM, DES3-CBC, DES3-ECB, RSA-OAEP, and RSA-PKCS
- **Sign and verify** – RSA, HMAC, and ECDSA; with and without hashing
- **Hash/digest** – SHA1, SHA224, SHA256, SHA384, and SHA512
- **Key wrap** – AES Key Wrap\(^1\), AES-GCM, RSA-AES, and RSA-OAEP

**Topics**

- Generate key and key pair functions (p. 398)
- Sign and verify functions (p. 398)
- Sign recover and verify recover functions (p. 399)
- Digest functions (p. 399)
- Encrypt and decrypt functions (p. 400)
- Derive key functions (p. 400)
- Wrap and Unwrap functions (p. 400)
- Maximum data size for each mechanism (p. 400)
- Mechanism annotations (p. 401)

**Generate key and key pair functions**

The AWS CloudHSM software library for PKCS #11 library allows you to use the following mechanisms for Generate Key and Key Pair functions.

- CKM_RSA_PKCS_KEY_PAIR_GEN
- CKM_RSA_X9_31_KEY_PAIR_GEN – This mechanism is functionally identical to the CKM_RSA_PKCS_KEY_PAIR_GEN mechanism, but offers stronger guarantees for p and q generation.
- CKM_EC_KEY_PAIR_GEN
- CKM_GENERIC_SECRET_KEY_GEN
- CKM_AES_KEY_GEN
- CKM_DES3_KEY_GEN – upcoming change listed in footnote 5.

**Sign and verify functions**

The AWS CloudHSM software library for PKCS #11 library allows you to use the following mechanisms for Sign and Verify functions. With Client SDK 5, the data is hashed locally in software. This means there is no limit on the size of the data that can be hashed by the SDK.

With Client SDK 5 RSA and ECDSA hashing is done locally so there is no data limit. With HMAC, there is a data limit. See footnote 2 for more info.

**RSA**

- CKM_RSA_X_509
- CKM_RSA_PKCS – single-part operations only.
- CKM_RSA_PKCS_PSS – single-part operations only.
- CKM_SHA1_RSA_PKCS
Mechanisms

- CKM_SHA224_RSA_PKCS
- CKM_SHA256_RSA_PKCS
- CKM_SHA384_RSA_PKCS
- CKM_SHA512_RSA_PKCS
- CKM_SHA512_RSA_PKCS_PSS
- CKM_SHA1_RSA_PKCS_PSS
- CKM_SHA224_RSA_PKCS_PSS
- CKM_SHA256_RSA_PKCS_PSS
- CKM_SHA384_RSA_PKCS_PSS
- CKM_SHA512_RSA_PKCS_PSS

**ECDSA**

- CKM_ECDSA – single-part operations only.
- CKM_ECDSA_SHA1
- CKM_ECDSA_SHA224
- CKM_ECDSA_SHA256
- CKM_ECDSA_SHA384
- CKM_ECDSA_SHA512

**HMAC**

- CKM_SHA_1_HMAC
- CKM_SHA224_HMAC
- CKM_SHA256_HMAC
- CKM_SHA384_HMAC
- CKM_SHA512_HMAC

**CMAC**

- CKM_AES_CMAC

**Sign recover and verify recover functions**

Client SDK 5 does not support Sign Recover and Verify Recover functions.

**Digest functions**

The AWS CloudHSM software library for PKCS #11 library allows you to use the following mechanisms for Digest functions. With Client SDK 5, the data is hashed locally in software. This means there is no limit on the size of the data that can be hashed by the SDK.

- CKM_SHA_1
- CKM_SHA224
- CKM_SHA256
- CKM_SHA384
Encrypt and decrypt functions

The AWS CloudHSM software library for PKCS #11 library allows you to use the following mechanisms for Encrypt and Decrypt functions.

- CKM_SHA512

- CKM_RSA_X_509
- CKM_RSA_PKCS – single-part operations only. Upcoming change listed in footnote 5.
- CKM_RSA_PKCS_OAEP – single-part operations only.
- CKM_AES_ECB
- CKM_AES_CTR
- CKM_AES_CBC
- CKM_AES_CBC_PAD
- CKM_DES3_CBC – upcoming change listed in footnote 5.
- CKM_DES3_ECB – upcoming change listed in footnote 5.
- CKM_DES3_CBC_PAD – upcoming change listed in footnote 5.
- CKM_AES_GCM
- CKM_CLOUDHSM_AES_GCM

Derive key functions

The AWS CloudHSM software library for PKCS #11 library allows you to use the following mechanisms for Derive functions.

- CKM_SP800_108_COUNTER_KDF

Wrap and Unwrap functions

The AWS CloudHSM software library for PKCS #11 library allows you to use the following mechanisms for Wrap and Unwrap functions.

For additional information regarding AES key wrapping, see AES Key Wrapping (p. 129).

- CKM_RSA_PKCS – single-part operations only. An upcoming change is listed in footnote 5.
- CKM_RSA_PKCS_OAEP
- CKM_AES_GCM
- CKM_CLOUDHSM_AES_GCM
- CKM_RSA_AES_KEY_WRAP
- CKM_CLOUDHSM_AES_KEY_WRAP_NO_PAD
- CKM_CLOUDHSM_AES_KEY_WRAP_PKCS5_PAD
- CKM_CLOUDHSM_AES_KEY_WRAP_ZERO_PAD

Maximum data size for each mechanism

The following table lists the maximum data size set for each mechanism:
Maximum data set size

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Maximum data size in bytes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKM_SHA_1_HMAC</td>
<td>16288</td>
</tr>
<tr>
<td>CKM_SHA224_HMAC</td>
<td>16256</td>
</tr>
<tr>
<td>CKM_SHA256_HMAC</td>
<td>16288</td>
</tr>
<tr>
<td>CKM_SHA384_HMAC</td>
<td>16224</td>
</tr>
<tr>
<td>CKM_SHA512_HMAC</td>
<td>16224</td>
</tr>
<tr>
<td>CKM_AES_CBC</td>
<td>16272</td>
</tr>
<tr>
<td>CKM_AES_GCM</td>
<td>16224</td>
</tr>
<tr>
<td>CKM_CLOUDHSM_AES_GCM</td>
<td>16224</td>
</tr>
<tr>
<td>CKM_DES3_CBC</td>
<td>16280</td>
</tr>
</tbody>
</table>

Mechanism annotations

- [1] When performing AES-GCM encryption, the HSM does not accept initialization vector (IV) data from the application. You must use an IV that it generates. The 12-byte IV provided by the HSM is written into the memory reference pointed to by the pIV element of the CK_GCM_PARAMS parameters structure that you supply. To prevent user confusion, PKCS #11 SDK in version 1.1.1 and later ensures that pIV points to a zeroized buffer when AES-GCM encryption is initialized.

- [2] When operating on data by using any of the following mechanisms, if the data buffer exceeds the maximum data size, the operation results in an error. For these mechanisms, all the data processing must occur inside the HSM. For information on maximum data size sets for each mechanism, refer to Maximum data size for each mechanism (p. 400).

- [3] Vendor-defined mechanism. In order to use the CloudHSM vendor defined mechanisms, PKCS#11 applications must include /opt/cloudhsm/include/pkcs11t.h during compilation.

CKM_CLOUDHSM_AES_GCM: This proprietary mechanism is a programmatically safer alternative to the standard CKM_AES_GCM. It prepends the IV generated by the HSM to the ciphertext instead of writing it back into the CK_GCM_PARAMS structure that is provided during cipher initialization. You can use this mechanism with C_Encrypt, C_WrapKey, C_Decrypt, and C_UnwrapKey functions. When using this mechanism, the pIV variable in the CK_GCM_PARAMS struct must be set to NULL. When using this mechanism with C_Decrypt and C_UnwrapKey, the IV is expected to be prepended to the ciphertext that is being unwrapped.

CKM_CLOUDHSM_AES_KEY_WRAP_PKCS5_PAD: AES Key Wrap with PKCS #5 Padding.

CKM_CLOUDHSM_AES_KEY_WRAP_ZERO_PAD: AES Key Wrap with Zero Padding.

- [4] The following CK_MECHANISM_TYPE and CK_RSA_PKCS_MGF_TYPE are supported as CK_RSA_PKCS_OAEP_PARAMS for CKM_RSA_PKCS_OAEP:
  - CKM_SHA_1 using CKG_MGF1_SHA1
  - CKM_SHA224 using CKG_MGF1_SHA224
  - CKM_SHA256 using CKG_MGF1_SHA256
  - CKM_SHA384 using CKG_MGF1_SHA384
  - CKM_SHA512 using CKG_MGF1_SHA512
Disallowed after 2023 for FIPS compliance as per NIST guidance. See FIPS 140 Compliance: 2024 Mechanism Deprecation (p. 633) for details.

Supported API operations

The PKCS #11 library supports the following PKCS #11 API operations.

- C_CloseAllSessions
- C_CloseSession
- C_CreateObject
- C_Decrypt
- C_DecryptFinal
- C_DecryptInit
- C_DecryptUpdate
- C_DeriveKey
- C_DestroyObject
- C_Digest
- C_DigestFinal
- C_DigestInit
- C_DigestUpdate
- C_Encrypt
- C_EncryptFinal
- C_EncryptInit
- C_EncryptUpdate
- C_Finalize
- C_FindObjects
- C_FindObjectsFinal
- C_FindObjectsInit
- C_GenerateKey
- C_GenerateKeyPair
- C_GenerateRandom
- C_GetAttributeValue
- C_GetFunctionList
- C_GetInfo
- C_GetMechanismInfo
- C_GetMechanismList
- C_GetSessionInfo
- C_GetSlotInfo
- C_GetSlotList
- C_GetTokenInfo
- C_Initialize
- C_Login
- C_Logout
- C_OpenSession
- C_Sign
- C_SignFinal
Key attributes

- C_SignInit
- C_SignUpdate
- C_UnWrapKey
- C_Verify
- C_VerifyFinal
- C_VerifyInit
- C_VerifyUpdate
- C_WrapKey

Supported key attributes

A key object can be a public, private, or secret key. Actions permitted on a key object are specified through attributes. Attributes are defined when the key object is created. When you use the PKCS #11 library, we assign default values as specified by the PKCS #11 standard.

AWS CloudHSM does not support all attributes listed in the PKCS #11 specification. We are compliant with the specification for all attributes we support. These attributes are listed in the respective tables.

Cryptographic functions such as C_CreateObject, C_GenerateKey, C_GenerateKeyPair, C_UnwrapKey, and C_DeriveKey that create, modify, or copy objects take an attribute template as one of their parameters. For more information about passing an attribute template during object creation, see Generate keys through PKCS #11 library for examples.

Interpreting the PKCS #11 library attributes table

The PKCS #11 library table contains a list of attributes that differ by key types. It indicates whether a given attribute is supported for a particular key type when using a specific cryptographic function with AWS CloudHSM.

Legend:

- ✔ indicates that CloudHSM supports the attribute for the specific key type.
- ✖ indicates that CloudHSM does not support the attribute for the specific key type.
- R indicates that the attribute value is set to read-only for the specific key type.
- S indicates that the attribute cannot be read by the GetAttributeValue as it is sensitive.
- An empty cell in the Default Value column indicates that there is no specific default value assigned to the attribute.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Key Type</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EC private</td>
<td>EC public</td>
</tr>
<tr>
<td>CKA_CLASS</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_KEY_TYPE</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_LABEL</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_ID</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Attribute</td>
<td>Key Type</td>
<td>Default Value</td>
</tr>
<tr>
<td>------------------------</td>
<td>----------</td>
<td>---------------</td>
</tr>
<tr>
<td>CKA_LOCAL</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>True</td>
<td></td>
</tr>
<tr>
<td>CKA_TOKEN</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td></td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td></td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td></td>
<td>False</td>
<td></td>
</tr>
<tr>
<td>CKA_PRIVATE</td>
<td>✔️¹</td>
<td>✔️¹</td>
</tr>
<tr>
<td></td>
<td>✔️¹</td>
<td>✔️¹</td>
</tr>
<tr>
<td></td>
<td>✔️¹</td>
<td>✔️¹</td>
</tr>
<tr>
<td></td>
<td>True</td>
<td></td>
</tr>
<tr>
<td>CKA_ENCRYPT</td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td></td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>False</td>
<td></td>
</tr>
<tr>
<td>CKA_DECRYPT</td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td></td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td></td>
<td>False</td>
<td></td>
</tr>
<tr>
<td>CKA_DERIVE</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td></td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td></td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td></td>
<td>False</td>
<td></td>
</tr>
<tr>
<td>CKA_MODIFIABLE</td>
<td>✔️¹</td>
<td>✔️¹</td>
</tr>
<tr>
<td></td>
<td>✔️¹</td>
<td>✔️¹</td>
</tr>
<tr>
<td></td>
<td>✔️¹</td>
<td>✔️¹</td>
</tr>
<tr>
<td></td>
<td>True</td>
<td></td>
</tr>
<tr>
<td>CKA_DESTROYABLE</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td></td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td></td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td></td>
<td>True</td>
<td></td>
</tr>
<tr>
<td>CKA_SIGN</td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td></td>
<td>False</td>
<td></td>
</tr>
<tr>
<td>CKA_SIGN_RECOVER</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_VERIFY</td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td></td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>False</td>
<td></td>
</tr>
<tr>
<td>CKA_VERIFY_RECOVER</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_WRAP</td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td></td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>False</td>
<td></td>
</tr>
<tr>
<td>CKA_WRAP_TEMPLATE</td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td></td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>False</td>
<td></td>
</tr>
<tr>
<td>CKA_TRUSTED</td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td></td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>False</td>
<td></td>
</tr>
<tr>
<td>CKA_WRAP_WITH_TRUSTED</td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td></td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>False</td>
<td></td>
</tr>
<tr>
<td>CKA_UNWRAP</td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td></td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>False</td>
<td></td>
</tr>
<tr>
<td>CKA_UNWRAP_TEMPLATE</td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td></td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>False</td>
<td></td>
</tr>
<tr>
<td>CKA_PRIVATE_EXPONENT</td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td></td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>False</td>
<td></td>
</tr>
</tbody>
</table>

1. R: Required, ✔️: Enabled, ✗: Disabled
AWS CloudHSM User Guide

Key attributes

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Key Type</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKA_PUBLIC_EXPONENT</td>
<td>✗ ✗ ✗ ✔️</td>
<td>2</td>
</tr>
<tr>
<td>CKA_EC_PARAMS</td>
<td>✗ ✔️ ✗ ✗</td>
<td></td>
</tr>
<tr>
<td>CKA_EC_POINT</td>
<td>✗ ✗ ✗ ✗</td>
<td></td>
</tr>
<tr>
<td>CKA_VALUE</td>
<td>✗ ✗ ✗ ✗</td>
<td></td>
</tr>
<tr>
<td>CKA_VALUE_LEN</td>
<td>✗ ✗ ✗ ✗</td>
<td></td>
</tr>
<tr>
<td>CKA_CHECK_VALUE</td>
<td>R R R R</td>
<td></td>
</tr>
</tbody>
</table>

GenerateKey

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Key Type</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AES</td>
<td>DES3</td>
</tr>
<tr>
<td>CKA_CLASS</td>
<td>✔️ ✔️ ✔️</td>
<td>✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>CKA_KEY_TYPE</td>
<td>✔️ ✔️ ✔️</td>
<td>✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>CKA_LABEL</td>
<td>✔️ ✔️ ✔️</td>
<td>✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>CKA_ID</td>
<td>✔️ ✔️ ✔️</td>
<td>✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>CKA_LOCAL</td>
<td>R R R R</td>
<td>True</td>
</tr>
<tr>
<td>CKA_TOKEN</td>
<td>✔️ ✔️ ✔️</td>
<td>✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>CKA_PRIVATE</td>
<td>✔️ ✔️ ✔️</td>
<td>✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>CKA_ENCRYPT</td>
<td>✔️ ✔️ ✔️</td>
<td>✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>CKA_DECRYPT</td>
<td>✔️ ✔️ ✔️</td>
<td>✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>CKA_DERIVE</td>
<td>✔️ ✔️ ✔️</td>
<td>✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>CKA_MODIFIABLE</td>
<td>✔️ ✔️ ✔️</td>
<td>✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>CKA_DESTROYABLE</td>
<td>✔️ ✔️ ✔️</td>
<td>✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>CKA_SIGN</td>
<td>✔️ ✔️ ✔️</td>
<td>✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>CKA_SIGN_RECOVER</td>
<td>✗ ✗ ✗ ✗</td>
<td></td>
</tr>
<tr>
<td>CKA_VERIFY</td>
<td>✔️ ✔️ ✔️</td>
<td>✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>CKA_VERIFY_RECOVER</td>
<td>✗ ✗ ✗ ✗</td>
<td></td>
</tr>
<tr>
<td>CKA_WRAP</td>
<td>✔️ ✔️ ✔️</td>
<td>✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>CKA_WRAP_TEMPLATE</td>
<td>✔️ ✔️ ✔️</td>
<td>✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>CKA_TRUSTED</td>
<td>✔️ ✔️ ✔️</td>
<td>✔️ ✔️ ✔️</td>
</tr>
</tbody>
</table>
## Key attributes

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Key Type</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKA_WRAP_WITH_TRUSTED</td>
<td>✔️ ✔️ ✔️</td>
<td>False</td>
</tr>
<tr>
<td>CKA_UNWRAP</td>
<td>✔️ ✔️ ✗</td>
<td>False</td>
</tr>
<tr>
<td>CKA_UNWRAP_TEMPLATE</td>
<td>✔️ ✔️ ✗</td>
<td></td>
</tr>
<tr>
<td>CKA_SENSITIVE</td>
<td>✗ ✔️ ✔️</td>
<td>True</td>
</tr>
<tr>
<td>CKA_ALWAYS_SENSITIVE</td>
<td>✗ ✗ ✗</td>
<td></td>
</tr>
<tr>
<td>CKA_EXTRACTABLE</td>
<td>✔️ ✔️ ✔️</td>
<td>True</td>
</tr>
<tr>
<td>CKA_NEVER_EXTRACTABLE</td>
<td>R R R</td>
<td></td>
</tr>
<tr>
<td>CKA_MODULUS</td>
<td>✗ ✗ ✗</td>
<td></td>
</tr>
<tr>
<td>CKA_MODULUS_BITS</td>
<td>✗ ✗ ✗</td>
<td></td>
</tr>
<tr>
<td>CKA_PRIME_1</td>
<td>✗ ✗ ✗</td>
<td></td>
</tr>
<tr>
<td>CKA_PRIME_2</td>
<td>✗ ✗ ✗</td>
<td></td>
</tr>
<tr>
<td>CKA_COEFFICIENT</td>
<td>✗ ✗ ✗</td>
<td></td>
</tr>
<tr>
<td>CKA_EXPONENT_1</td>
<td>✗ ✗ ✗</td>
<td></td>
</tr>
<tr>
<td>CKA_EXPONENT_2</td>
<td>✗ ✗ ✗</td>
<td></td>
</tr>
<tr>
<td>CKA_PRIVATE_EXPONENT</td>
<td>✗ ✗ ✗</td>
<td></td>
</tr>
<tr>
<td>CKA_PUBLIC_EXPONENT</td>
<td>✗ ✗ ✗</td>
<td></td>
</tr>
<tr>
<td>CKA_EC_PARAMS</td>
<td>✗ ✗ ✗</td>
<td></td>
</tr>
<tr>
<td>CKA_EC_POINT</td>
<td>✗ ✗ ✗</td>
<td></td>
</tr>
<tr>
<td>CKA_VALUE</td>
<td>✗ ✗ ✗</td>
<td></td>
</tr>
<tr>
<td>CKA_VALUE_LEN</td>
<td>✔️ ² ✗</td>
<td>²</td>
</tr>
<tr>
<td>CKA_CHECK_VALUE</td>
<td>R R R</td>
<td></td>
</tr>
</tbody>
</table>

### CreateObject

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Key Type</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKA_CLASS</td>
<td>EC private: ²</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EC public: ²</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RSA private: ²</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RSA public: ²</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AES: ²</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DES3: ²</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Generic Secret: ²</td>
<td></td>
</tr>
<tr>
<td>CKA_KEY_TYPE</td>
<td>EC private: ²</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EC public: ²</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RSA private: ²</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RSA public: ²</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AES: ²</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DES3: ²</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Generic Secret: ²</td>
<td></td>
</tr>
<tr>
<td>CKA_LABEL</td>
<td>✔️ ✔️ ✔️ ✔️</td>
<td></td>
</tr>
<tr>
<td>CKA_ID</td>
<td>✔️ ✔️ ✔️ ✔️</td>
<td></td>
</tr>
</tbody>
</table>

406
<table>
<thead>
<tr>
<th>Attribute</th>
<th>Key Type</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKA_LOCAL</td>
<td>R</td>
<td>False</td>
</tr>
<tr>
<td>CKA_TOKEN</td>
<td>✔️</td>
<td>False</td>
</tr>
<tr>
<td>CKA_PRIVATE</td>
<td>✔️ 1</td>
<td>True</td>
</tr>
<tr>
<td>CKA_ENCRYPT</td>
<td>✗</td>
<td>False</td>
</tr>
<tr>
<td>CKA_DECRYPT</td>
<td>✗</td>
<td>False</td>
</tr>
<tr>
<td>CKA_DERIVE</td>
<td>✔️</td>
<td>False</td>
</tr>
<tr>
<td>CKA_MODIFIABLE</td>
<td>✔️ 1</td>
<td>True</td>
</tr>
<tr>
<td>CKA_DESTROYABLE</td>
<td>✔️</td>
<td>True</td>
</tr>
<tr>
<td>CKA_SIGN</td>
<td>✔️ 1</td>
<td>False</td>
</tr>
<tr>
<td>CKA_SIGN_RECOVER</td>
<td>✗</td>
<td>False</td>
</tr>
<tr>
<td>CKA_VERIFY</td>
<td>✗</td>
<td>False</td>
</tr>
<tr>
<td>CKA_VERIFY_RECOVER</td>
<td>✗</td>
<td>False</td>
</tr>
<tr>
<td>CKA_WRAP</td>
<td>✗</td>
<td>False</td>
</tr>
<tr>
<td>CKA_WRAP_TEMPLATE</td>
<td>✔️ 1</td>
<td>False</td>
</tr>
<tr>
<td>CKA_TRUSTED</td>
<td>✔️</td>
<td>True</td>
</tr>
<tr>
<td>CKA_WRAP_WITH_TRUSTED</td>
<td>✗</td>
<td>False</td>
</tr>
<tr>
<td>CKA_UNWRAP</td>
<td>✗</td>
<td>False</td>
</tr>
<tr>
<td>CKA_UNWRAP_TEMPLATE</td>
<td>✔️ 1</td>
<td>False</td>
</tr>
<tr>
<td>CKA_SENSITIVE</td>
<td>✔️ 1</td>
<td>True</td>
</tr>
<tr>
<td>CKA_ALWAYS_SENSITIVE</td>
<td>R</td>
<td>False</td>
</tr>
<tr>
<td>CKA_EXTRACTABLE</td>
<td>✔️ 1</td>
<td>True</td>
</tr>
<tr>
<td>CKA_NEVER_EXTRACTABLE</td>
<td>R</td>
<td>False</td>
</tr>
<tr>
<td>CKA_MODULUS</td>
<td>✗</td>
<td>✗ 2</td>
</tr>
<tr>
<td>CKA_MODULUS_BITS</td>
<td>✗</td>
<td>✗ 2</td>
</tr>
<tr>
<td>CKA_PRIME_1</td>
<td>✗</td>
<td>✗ 2</td>
</tr>
<tr>
<td>CKA_PRIME_2</td>
<td>✗</td>
<td>✗ 2</td>
</tr>
<tr>
<td>CKA_COEFFICIENT</td>
<td>✗</td>
<td>✗ 2</td>
</tr>
<tr>
<td>CKA_EXPONENT_1</td>
<td>✗</td>
<td>✗ 2</td>
</tr>
<tr>
<td>CKA_EXPONENT_2</td>
<td>✗</td>
<td>✗ 2</td>
</tr>
<tr>
<td>CKA_PRIVATE_EXPONENT</td>
<td>✗</td>
<td>✗ 2</td>
</tr>
</tbody>
</table>
## Key attributes

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Key Type</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKA_PUBLIC_EXPONENT</td>
<td>✗ ✗ ✓ ✓ ✓ ✓</td>
<td></td>
</tr>
<tr>
<td>CKA_EC_PARAMS</td>
<td>✓ ✓ × × × ×</td>
<td></td>
</tr>
<tr>
<td>CKA_EC_POINT</td>
<td>× ✓ ✓ ✓ ✓ ✓</td>
<td></td>
</tr>
<tr>
<td>CKA_VALUE</td>
<td>✓ ✓ × × ✓ ✓</td>
<td></td>
</tr>
<tr>
<td>CKA_VALUE_LEN</td>
<td>× ✓ × × × ×</td>
<td></td>
</tr>
<tr>
<td>CKA_CHECK_VALUE</td>
<td>R R R R R R</td>
<td></td>
</tr>
</tbody>
</table>

### UnwrapKey

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Key Type</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EC private</td>
<td>RSA private</td>
</tr>
<tr>
<td>CKA_CLASS</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td></td>
</tr>
<tr>
<td>CKA_KEY_TYPE</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td></td>
</tr>
<tr>
<td>CKA_LABEL</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td></td>
</tr>
<tr>
<td>CKA_ID</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td></td>
</tr>
<tr>
<td>CKA_LOCAL</td>
<td>R R R R R R</td>
<td>False</td>
</tr>
<tr>
<td>CKA_TOKEN</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td></td>
</tr>
<tr>
<td>CKA_PRIVATE</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td>True</td>
</tr>
<tr>
<td>CKA_ENCRYPT</td>
<td>× ✓ ✓ ✓ ✓ ✓</td>
<td>False</td>
</tr>
<tr>
<td>CKA_DECRYPT</td>
<td>× ✓ ✓ ✓ ✓ ✓</td>
<td>False</td>
</tr>
<tr>
<td>CKA_DERIVE</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td>False</td>
</tr>
<tr>
<td>CKA_MODIFIABLE</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td>True</td>
</tr>
<tr>
<td>CKA_DESTROYABLE</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td>True</td>
</tr>
<tr>
<td>CKA_SIGN</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td>False</td>
</tr>
<tr>
<td>CKA_SIGN_RECOVER</td>
<td>× ✓ × × × ×</td>
<td>False</td>
</tr>
<tr>
<td>CKA_VERIFY</td>
<td>× × ✓ ✓ ✓ ✓</td>
<td>False</td>
</tr>
<tr>
<td>CKA_VERIFY_RECOVER</td>
<td>× × ✓ ✓ ✓ ✓</td>
<td>False</td>
</tr>
<tr>
<td>CKA_WRAP</td>
<td>× × ✓ ✓ ✓ ✓</td>
<td>False</td>
</tr>
<tr>
<td>CKA_UNWRAP</td>
<td>× ✓ ✓ ✓ ✓ ✓</td>
<td>False</td>
</tr>
</tbody>
</table>
### Attribute

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Key Type</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKASENSITIVE</td>
<td>✔ ✔ ✔ ✔ ✔ ✔</td>
<td>True</td>
</tr>
<tr>
<td>CKAEXTRACTABLE</td>
<td>✔ ✔ ✔ ✔ ✔ ✔</td>
<td>True</td>
</tr>
<tr>
<td>CKANEVEREXTRACTABLE</td>
<td>R R R R R R</td>
<td>✔ ✔ ✔ ✔ ✔ ✔</td>
</tr>
<tr>
<td>CKAALWAYSSENSITIVE</td>
<td>R R R R R R</td>
<td>✔ ✔ ✔ ✔ ✔ ✔</td>
</tr>
<tr>
<td>CKA_MODULUS</td>
<td>✗ ✗ ✗ ✗ ✗ ✗</td>
<td>❌ ❌ ❌ ❌ ❌ ❌</td>
</tr>
<tr>
<td>CKA_MODULUS_BITS</td>
<td>✗ ✗ ✗ ✗ ✗ ✗</td>
<td>❌ ❌ ❌ ❌ ❌ ❌</td>
</tr>
<tr>
<td>CKA_PRIME_1</td>
<td>✗ ✗ ✗ ✗ ✗ ✗</td>
<td>❌ ❌ ❌ ❌ ❌ ❌</td>
</tr>
<tr>
<td>CKA_PRIME_2</td>
<td>✗ ✗ ✗ ✗ ✗ ✗</td>
<td>❌ ❌ ❌ ❌ ❌ ❌</td>
</tr>
<tr>
<td>CKA_COEFFICIENT</td>
<td>✗ ✗ ✗ ✗ ✗ ✗</td>
<td>❌ ❌ ❌ ❌ ❌ ❌</td>
</tr>
<tr>
<td>CKA_EXPONENT_1</td>
<td>✗ ✗ ✗ ✗ ✗ ✗</td>
<td>❌ ❌ ❌ ❌ ❌ ❌</td>
</tr>
<tr>
<td>CKA_EXPONENT_2</td>
<td>✗ ✗ ✗ ✗ ✗ ✗</td>
<td>❌ ❌ ❌ ❌ ❌ ❌</td>
</tr>
<tr>
<td>CKA_PRIVATE_EXPONENT</td>
<td>✗ ✗ ✗ ✗ ✗ ✗</td>
<td>❌ ❌ ❌ ❌ ❌ ❌</td>
</tr>
<tr>
<td>CKA_PUBLIC_EXPONENT</td>
<td>✗ ✗ ✗ ✗ ✗ ✗</td>
<td>❌ ❌ ❌ ❌ ❌ ❌</td>
</tr>
<tr>
<td>CKA_EC_PARAMS</td>
<td>✗ ✗ ✗ ✗ ✗ ✗</td>
<td>❌ ❌ ❌ ❌ ❌ ❌</td>
</tr>
<tr>
<td>CKA_EC_POINT</td>
<td>✗ ✗ ✗ ✗ ✗ ✗</td>
<td>❌ ❌ ❌ ❌ ❌ ❌</td>
</tr>
<tr>
<td>CKA_VALUE</td>
<td>✗ ✗ ✗ ✗ ✗ ✗</td>
<td>❌ ❌ ❌ ❌ ❌ ❌</td>
</tr>
<tr>
<td>CKA_VALUE_LEN</td>
<td>✗ ✗ ✗ ✗ ✗ ✗</td>
<td>❌ ❌ ❌ ❌ ❌ ❌</td>
</tr>
<tr>
<td>CKA_CHECK_VALUE</td>
<td>R R R R R R</td>
<td>✔ ✔ ✔ ✔ ✔ ✔</td>
</tr>
</tbody>
</table>

### DeriveKey

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Key Type</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AES</td>
<td>DES3</td>
</tr>
<tr>
<td>CKA_CLASS</td>
<td>✔ ✔ ✔ ✔ ✔</td>
<td>✔ ✔ ✔ ✔ ✔</td>
</tr>
<tr>
<td>CKA_KEY_TYPE</td>
<td>✔ ✔ ✔ ✔ ✔</td>
<td>✔ ✔ ✔ ✔ ✔</td>
</tr>
<tr>
<td>CKA_LABEL</td>
<td>✔ ✔ ✔ ✔ ✔</td>
<td>✔ ✔ ✔ ✔ ✔</td>
</tr>
<tr>
<td>CKA_ID</td>
<td>✔ ✔ ✔ ✔ ✔</td>
<td>✔ ✔ ✔ ✔ ✔</td>
</tr>
<tr>
<td>CKA_LOCAL</td>
<td>R R R R R</td>
<td>✔ ✔ ✔ ✔ ✔</td>
</tr>
<tr>
<td>CKA_TOKEN</td>
<td>✔ ✔ ✔ ✔ ✔</td>
<td>✔ ✔ ✔ ✔ ✔</td>
</tr>
<tr>
<td>CKA_PRIVATE</td>
<td>✔ ✔ ✔ ✔ ✔</td>
<td>✔ ✔ ✔ ✔ ✔</td>
</tr>
</tbody>
</table>

409
<table>
<thead>
<tr>
<th>Attribute</th>
<th>Key Type</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKA_ENCRYPT</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_DECRYPT</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_DERIVE</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_MODIFIABLE</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_DESTROYABLE</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_SIGN</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_SIGN_RECOVER</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_VERIFY</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_VERIFY_RECOVER</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_WRAP</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_UNWRAP</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_SENSITIVE</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_EXTRACTABLE</td>
<td>✔</td>
<td>True</td>
</tr>
<tr>
<td>CKA_NEVER_EXTRACTABLE</td>
<td>✔</td>
<td>True</td>
</tr>
<tr>
<td>CKA_ALWAYS_SENSITIVE</td>
<td>✔</td>
<td>True</td>
</tr>
<tr>
<td>CKA_MODULUS</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_MODULUS_BITS</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_PRIME_1</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_PRIME_2</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_COEFFICIENT</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_EXPONENT_1</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_EXPONENT_2</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_PRIVATE_EXPONENT</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_PUBLIC_EXPONENT</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_EC_PARAMS</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_EC_POINT</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_VALUE</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_VALUE_LEN</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_CHECK_VALUE</td>
<td>✔</td>
<td>False</td>
</tr>
</tbody>
</table>
**GetAttributeValue**

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Key Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EC private</td>
</tr>
<tr>
<td>CKA_CLASS</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_KEY_TYPE</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_LABEL</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_ID</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_LOCAL</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_TOKEN</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_PRIVATE</td>
<td>✔ ¹</td>
</tr>
<tr>
<td>CKA_ENCRYPT</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_DECRYPT</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_DERIVE</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_MODIFIABLE</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_DESTROYABLE</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_SIGN</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_SIGN_RECOVER</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_VERIFY</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_VERIFY_RECOVER</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_WRAP</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_WRAP_TEMPLATE</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_TRUSTED</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_WRAP_WITH_TRUSTED</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_UNWRAP</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_UNWRAP_TEMPLATE</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_SENSITIVE</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_EXTRACTABLE</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_NEVER_EXTRACTABLE</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_ALWAYS_SENSITIVE</td>
<td>R</td>
</tr>
<tr>
<td>CKA_MODULUS</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_MODULUS_BITS</td>
<td>✗</td>
</tr>
</tbody>
</table>

411
## Key attributes

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Key Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKA_PRIME_1</td>
<td>✖ ✖ S</td>
</tr>
<tr>
<td>CKA_PRIME_2</td>
<td>✖ ✖ S</td>
</tr>
<tr>
<td>CKA_COEFFICIENT</td>
<td>✖ ✖ S</td>
</tr>
<tr>
<td>CKA_EXPONENT_1</td>
<td>✖ ✖ S</td>
</tr>
<tr>
<td>CKA_EXPONENT_2</td>
<td>✖ ✖ S</td>
</tr>
<tr>
<td>CKA_PRIVATE_EXPONENT</td>
<td>✖ ✖ S</td>
</tr>
<tr>
<td>CKA_PUBLIC_EXPONENT</td>
<td>✖ ✖ ✗</td>
</tr>
<tr>
<td>CKA_EC_PARAMS</td>
<td>✔ ✔ ✖</td>
</tr>
<tr>
<td>CKA_EC_POINT</td>
<td>✖ ✔ ✖</td>
</tr>
<tr>
<td>CKA_VALUE</td>
<td>S ✖ ✖ ✗</td>
</tr>
<tr>
<td>CKA_VALUE_LEN</td>
<td>✖ ✖ ✗ ✔</td>
</tr>
<tr>
<td>CKA_CHECK_VALUE</td>
<td>✔ ✔ ✔ ✔</td>
</tr>
</tbody>
</table>

### Attribute annotations

- [1] This attribute is partially supported by the firmware and must be explicitly set only to the default value.

### Modifying attributes

Some attributes of an object can be modified after the object has been created, whereas some cannot. To modify attributes, use the `setAttribute` command from cloudhsm_mgmt_util. You can also derive a list of attributes and the constants that represent them by using the `listAttribute` command from cloudhsm_mgmt_util.

The following list displays attributes that are allowed for modification after object creation:

- CKA_LABEL
- CKA_TOKEN

### Note

Modification is allowed only for changing a session key to a token key. Use the `setAttribute` command from key_mgmt_util to change the attribute value.
• **CKA_DERIVE**
  
  **Note**
  This attribute supports key derivation. It must be False for all public keys and cannot be set to True. For secret and EC private keys, it can be set to True or False.

• **CKA_TRUSTED**
  
  **Note**
  This attribute can be set to True or False by Crypto Officer (CO) only.

• **CKA_WRAP_WITH_TRUSTED**
  
  **Note**
  Apply this attribute to an exportable data key to specify that you can only wrap this key with keys marked as CKA_TRUSTED. Once you set CKA_WRAP_WITH_TRUSTED to true, the attribute becomes read-only and you cannot change or remove the attribute.

### Interpreting error codes

Specifying in the template an attribute that is not supported by a specific key results in an error. The following table contains error codes that are generated when you violate specifications:

<table>
<thead>
<tr>
<th>Error Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKR_TEMPLATE_INCONSISTENT</td>
<td>You receive this error when you specify an attribute in the attribute template, where the attribute complies with the PKCS #11 specification, but is not supported by CloudHSM.</td>
</tr>
<tr>
<td>CKR_ATTRIBUTE_TYPE_INVALID</td>
<td>You receive this error when you retrieve value for an attribute, which complies with the PKCS #11 specification, but is not supported by CloudHSM.</td>
</tr>
<tr>
<td>CKR_ATTRIBUTE_INCOMPLETE</td>
<td>You receive this error when you do not specify the mandatory attribute in the attribute template.</td>
</tr>
<tr>
<td>CKR_ATTRIBUTE_READ_ONLY</td>
<td>You receive this error when you specify a read-only attribute in the attribute template.</td>
</tr>
</tbody>
</table>

### Code samples for the PKCS #11 library

The code samples on GitHub show you how to accomplish basic tasks using the PKCS #11 library.

**Prerequisites**

Before running samples, perform the following steps to set up your environment:

- Install and configure the [PKCS #11 library](#) for Client SDK 5.
- Set up a [cryptographic user (CUI)](#) for Client SDK 5. Your application uses this HSM account to run the code samples on the HSM.

**Code samples**

Code Samples for the AWS CloudHSM Software Library for PKCS#11 are available on GitHub. This repository includes examples on how to do common operations using PKCS#11 including encryption, decryption, signing and verifying.
• Generate keys (AES, RSA, EC)
• List key attributes
• Encrypt and decrypt data with AES_GCM
• Encrypt and decrypt data with AES_CTR
• Encrypt and decrypt data with 3DES
• Sign and verify data with RSA
• Derive keys using HMAC KDF
• Wrap and unwrap keys with AES using PKCS #5 padding
• Wrap and unwrap keys with AES using no padding
• Wrap and unwrap keys with AES using zero padding
• Wrap and unwrap keys with AES-GCM
• Wrap and unwrap keys with RSA

Advanced configurations for PKCS #11

The AWS CloudHSM PKCS #11 provider includes the following advanced configuration, which is not part of the general configurations most customers utilize. These configurations provide additional capabilities.

• Connecting to multiple slots with PKCS #11 (p. 414)
• Retry configuration for PKCS #11 (p. 418)

Connecting to multiple slots with PKCS#11

A single slot in Client SDK 5 PKCS #11 library represents a single connection to a cluster in AWS CloudHSM. With Client SDK 5, you can configure your PKCS11 library to allow multiple slots to connect users to multiple CloudHSM clusters from a single PKCS#11 application.

Use the instructions in this topic to make your application use multi-slot functionality to connect with multiple clusters.

Topics
• Multi-slot prerequisites (p. 414)
• Configure the PKCS #11 Library for multi-slot functionality (p. 415)
• configure-pkcs11 add-cluster (p. 415)
• configure-pkcs11 remove-cluster (p. 417)

Multi-slot prerequisites

• Two or more AWS CloudHSM clusters to which you’d like to connect to, along with their cluster certificates (that is, the customerCA.crt file for each cluster)
• An EC2 instance with Security Groups correctly configured to connect to all of the clusters above. For more information about how to set up a cluster and the client instance, refer to Getting started with AWS CloudHSM (p. 7).
• To set up multi-slot functionality, you must have already downloaded and installed the PKCS #11 library. If you have not already done this, refer to the instructions in ??? (p. 394).
Configure the PKCS #11 Library for multi-slot functionality

To configure your PKCS #11 library for multi-slot functionality, follow these steps:
1. Identify the clusters you want to connect to using multi-slot functionality.
2. Add these clusters to your PKCS #11 configuration by following the instructions in ??? (p. 415)
3. The next time your PKCS#11 application runs, it will have multi-slot functionality.

configure-pkcs11 add-cluster

When connecting to multiple slots with PKCS #11 (p. 414), use the configure-pkcs11 add-cluster command to add a cluster to your configuration.

Syntax

```bash
configure-pkcs11 add-cluster [OPTIONS]
    --cluster-id <CLUSTER ID>
    [--region <REGION>]
    [--endpoint <ENDPOINT>]
    [--hsm-ca-cert <HSM CA CERTIFICATE FILE>]
    [--server-client-cert-file <CLIENT CERTIFICATE FILE>]
    [--server-client-key-file <CLIENT KEY FILE>]
    [-h, --help]
```

Examples

Add a cluster using the cluster-id parameter

**Example**

Use the configure-pkcs11 add-cluster along with the cluster-id parameter to add a cluster (with the ID of cluster-1234567) to your configuration.

Linux

```bash
$ sudo /opt/cloudhsm/bin/configure-pkcs11 add-cluster --cluster-id cluster-1234567
```

Windows

```bash
C:\Program Files\Amazon\CloudHSM> .\configure-pkcs11.exe add-cluster --cluster-id cluster-1234567
```

**Tip**

If using configure-pkcs11 add-cluster with the cluster-id parameter doesn't result in the cluster being added, refer to the following example for a longer version of this command that also requires --region and endpoint parameters to identify the cluster being added. If, for example, the region of the cluster is different than the one configured as your AWS CLI default, you should use the --region parameter to use the correct region. Additionally, you have the ability to specify the AWS CloudHSM API endpoint to use for the call, which may be necessary for various network setups, such as using VPC interface endpoints that don't use the default DNS hostname for AWS CloudHSM.
Add a cluster using cluster-id, endpoint, and region parameters

Example

Use the `configure-pkcs11 add-cluster` along with the cluster-id, endpoint, and region parameters to add a cluster (with the ID of cluster-1234567) to your configuration.

Linux

```bash
$ sudo /opt/cloudhsm/bin/configure-pkcs11 add-cluster --cluster-id cluster-1234567 --region us-east-1 --endpoint https://cloudhsmv2.us-east-1.amazonaws.com
```

Windows

```bash
C:\Program Files\Amazon\CloudHSM> .\configure-pkcs11.exe add-cluster --cluster-id cluster-1234567 --region us-east-1 --endpoint https://cloudhsmv2.us-east-1.amazonaws.com
```

For more information about the `--cluster-id`, `--region`, and `--endpoint` parameters, see the section called “Parameters” (p. 174).

Parameters

`--cluster-id <Cluster ID>`

Makes a DescribeClusters call to find all of the HSM elastic network interface (ENI) IP addresses in the cluster associated with the cluster ID. The system adds the ENI IP addresses to the AWS CloudHSM configuration files.

Note

If you use the `--cluster-id` parameter from an EC2 instance within a VPC that does not have access to the public internet, then you must create an interface VPC endpoint to connect with AWS CloudHSM. For more information about VPC endpoints, see ??? (p. 635).

Required: Yes

`--endpoint <Endpoint>`

Specify the AWS CloudHSM API endpoint used for making the DescribeClusters call. You must set this option in combination with `--cluster-id`.

Required: No

`--hsm-ca-cert <HsmCA/Certificate/file>`

Specifies the HSM CA certificate file

Required: No

`--region <Region>`

Specify the region of your cluster. You must set this option in combination with `--cluster-id`.

If you don’t supply the `--region` parameter, the system chooses the region by attempting to read the `AWS_DEFAULT_REGION` or `AWS_REGION` environment variables. If those variables aren’t set, then the system checks the region associated with your profile in your AWS config file (typically
~/.aws/config) unless you specified a different file in the AWS_CONFIG_FILE environment variable. If none of the above are set, the system defaults to the us-east-1 region.

Required: No

--server-client-cert-file <Client/certificate/file>

Path to the client certificate used for TLS client-server mutual authentication.

Only use this option if you don't wish to use the default key and SSL/TLS certificate we include with Client SDK 5. You must set this option in combination with --server-client-key-file.

Required: No

--server-client-key-file <Client/key/file>

Path to the client key used for TLS client-server mutual authentication

Only use this option if you don't wish to use the default key and SSL/TLS certificate we include with Client SDK 5. You must set this option in combination with --server-client-cert-file.

Required: No

configure-pkcs11 remove-cluster

When connecting to multiple slots with PKCS#11 (p. 414), use the configure-pkcs11 remove-cluster command to remove a cluster from available PKCS #11 slots.

Syntax

```
configure-pkcs11 remove-cluster [OPTIONS]
    --cluster-id <CLUSTER ID>
    [-h, --help]
```

Examples

Remove a cluster using the cluster-id parameter

Example

Use the configure-pkcs11 remove-cluster along with the cluster-id parameter to remove a cluster (with the ID of cluster-1234567) from your configuration.

Linux

```
$ sudo /opt/cloudhsm/bin/configure-pkcs11 remove-cluster --cluster-id cluster-1234567
```

Windows

```
C:\Program Files\Amazon\CloudHSM> .\configure-pkcs11.exe remove-cluster --cluster-id cluster-1234567
```

For more information about the --cluster-id parameter, see the section called “Parameters” (p. 174).
Parameter

--cluster-id <Cluster ID>

The ID of the cluster to remove from the configuration

Required: Yes

Retry commands for PKCS #11

Client SDK 5.8.0 and later have a built-in automatic retry strategy which will retry HSM-throttled operations from the client side. When an HSM throttles operations because it is too busy performing previous operations and cannot take more requests, client SDKs will attempt to retry throttled operations up to 3 times while exponentially backing off. This automatic retry strategy can be set to one of two modes: off and standard.

- **off**: The Client SDK will not perform any retry strategy for any throttled operations by the HSM.
- **standard**: This is the default mode for Client SDK 5.8.0 and later. In this mode, client SDKs will automatically retry throttled operations by exponentially backing off.

For more information, see [HSM Throttling (p. 659)](#).

Set retry commands to off mode

**Linux**

To set retry commands to off for Client SDK 5 on Linux

- You can use the following command to set retry configuration to off mode:

  ```bash
  $ sudo /opt/cloudhsm/bin/configure-pkcs11 --default-retry-mode off
  ```

**Windows**

To set retry commands to off for Client SDK 5 on Windows

- You can use the following command to set retry configuration to off mode:

  ```cmd
  C:\Program Files\Amazon\CloudHSM\bin\configure-pkcs11.exe --default-retry-mode off
  ```

OpenSSL Dynamic Engine

The AWS CloudHSM OpenSSL Dynamic Engine allows you to offload cryptographic operations to your CloudHSM cluster through the OpenSSL API. OpenSSL Dynamic Engine supports the following operations:

- RSA key generation for 2048, 3072, and 4096-bit keys.
- RSA sign/verify. Verification is offloaded to OpenSSL software.
- ECDSA sign/verify for P-256, P-384, and secp256k1 key types.

To generate EC keys that are interoperable with the OpenSSL engine, see [key generate-file (p. 196)](#).
AWS CloudHSM provides an OpenSSL Dynamic Engine, which you can read about in SSL/TLS offload on Linux (p. 508). For an example on using AWS CloudHSM with OpenSSL, refer to this AWS security blog.

For information about platform support for SDKs, see the section called “Supported platforms” (p. 392).

For information on using Client SDK 3, see Previous Client SDK versions (p. 454).

Topics
• Installing the OpenSSL Dynamic Engine (p. 419)
• Advanced configurations for OpenSSL (p. 421)

Installing the OpenSSL Dynamic Engine

To install and configure the OpenSSL Dynamic Engine

1. Use the following commands to download and install the OpenSSL engine.

Amazon Linux

Install OpenSSL Dynamic Engine for Amazon Linux on X86_64 architecture:

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL6/cloudhsm-dyn-latest.el6.x86_64.rpm

$ sudo yum install ./cloudhsm-dyn-latest.el6.x86_64.rpm

Amazon Linux 2

Install OpenSSL Dynamic Engine for Amazon Linux 2 on X86_64 architecture:

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-dyn-latest.el7.x86_64.rpm

$ sudo yum install ./cloudhsm-dyn-latest.el7.x86_64.rpm

Install OpenSSL Dynamic Engine for Amazon Linux 2 on ARM64 architecture:

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-dyn-latest.el7.aarch64.rpm

$ sudo yum install ./cloudhsm-dyn-latest.el7.aarch64.rpm

CentOS 7

Install OpenSSL Dynamic Engine for CentOS 7 on X86_64 architecture:

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-dyn-latest.el7.x86_64.rpm

$ sudo yum install ./cloudhsm-dyn-latest.el7.x86_64.rpm
CentOS 8

Install OpenSSL Dynamic Engine for CentOS 8 on X86_64 architecture:

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL8/cloudhsm-dyn-latest.el8.x86_64.rpm

$ sudo yum install ./cloudhsm-dyn-latest.el8.x86_64.rpm

RHEL 7

Install OpenSSL Dynamic Engine for RHEL 7 on X86_64 architecture:

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-dyn-latest.el7.x86_64.rpm

$ sudo yum install ./cloudhsm-dyn-latest.el7.x86_64.rpm

RHEL 8

Install OpenSSL Dynamic Engine for RHEL 8 on X86_64 architecture:

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL8/cloudhsm-dyn-latest.el8.x86_64.rpm

$ sudo yum install ./cloudhsm-dyn-latest.el8.x86_64.rpm

Ubuntu 18.04 LTS

Install OpenSSL Dynamic Engine for Ubuntu 18.04 LTS on X86_64 architecture:

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Bionic/cloudhsm-dyn_latest_u18.04_amd64.deb

$ sudo apt install ./cloudhsm-dyn_latest_u18.04_amd64.deb

Ubuntu 20.04 LTS

Install OpenSSL Dynamic Engine for Ubuntu 20.04 LTS LTS on X86_64 architecture:

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Focal/cloudhsm-dyn_latest_u20.04_amd64.deb

$ sudo apt install ./cloudhsm-dyn_latest_u20.04_amd64.deb

Ubuntu 22.04 LTS

Support for OpenSSL Dynamic Engine is not yet available.

You have installed the shared library for the dynamic engine at /opt/cloudhsm/lib/libcloudhsm_openssl_engine.so.
2. Bootstrap Client SDK 5. For more information about bootstrapping, see Bootstrap the Client SDK (p. 41).

3. Set an environment variable with the credentials of a crypto user (CU). For information about creating CUs, see Using CMU to manage users (p. 95).

```
$ export CLOUDHSM_PIN=<HSM user name>:<password>
```

**Note**
Client SDK 5 introduces the CLOUDHSM_PIN environment variable for storing the credentials of the CU. In Client SDK 3 you store the CU credentials in the n3fips_password environment variable. Client SDK 5 supports both environment variables, but we recommend using CLOUDHSM_PIN.

4. Connect your installation of OpenSSL Dynamic Engine to the cluster. For more information, see Connect to the Cluster (p. 40).

5. Bootstrap the Client SDK 5. For more information, see the section called “Bootstrap the Client SDK” (p. 41).

### Verify the OpenSSL Dynamic Engine for Client SDK 5

Use the following command to verify your installation of OpenSSL Dynamic Engine.

```
$ openssl engine -t cloudhsm
```

The following output verifies your configuration:

```
(cloudhsm) CloudHSM OpenSSL Engine
     [ available ]
```

### Advanced configurations for OpenSSL

The AWS CloudHSM OpenSSL provider includes the following advanced configuration, which is not part of the general configurations most customers utilize. These configurations provide additional capabilities.

- **Retry commands for OpenSSL** (p. 421)

### Retry commands for OpenSSL

Client SDK 5.8.0 and later have a built-in automatic retry strategy which will retry HSM-throttled operations from the client side. When an HSM throttles operations because it is too busy performing previous operations and cannot take more requests, client SDKs will attempt to retry throttled operations up to 3 times while exponentially backing off. This automatic retry strategy can be set to one of two modes: **off** and **standard**.

- **off**: The Client SDK will not perform any retry strategy for any throttled operations by the HSM.
- **standard**: This is the default mode for Client SDK 5.8.0 and later. In this mode, client SDKs will automatically retry throttled operations by exponentially backing off.

For more information, see [HSM Throttling](p. 659).
Set retry commands to off mode

Linux

To set retry commands to off for Client SDK 5 on Linux

- You can use the following command to set retry commands to off mode:

  ```
  $ sudo /opt/cloudhsm/bin/configure-dyn --default-retry-mode off
  ```

Windows

To set retry commands to off for Client SDK 5 on Windows

- You can use the following command to set retry commands to off mode:

  ```
  C:\Program Files\Amazon\CloudHSM\bin\ configure-dyn.exe --default-retry-mode off
  ```

JCE provider

The AWS CloudHSM JCE provider is a provider implementation built from the Java Cryptographic Extension (JCE) provider framework. The JCE allows you to perform cryptographic operations using the Java Development Kit (JDK). In this guide, the AWS CloudHSM JCE provider is sometimes referred to as the JCE provider. Use the JCE provider and the JDK to offload cryptographic operations to the HSM.

For information on using Client SDK 3, see Previous Client SDK versions (p. 454).

Topics

- Install and use the AWS CloudHSM JCE provider for Client SDK 5 (p. 422)
- Supported key types (p. 426)
- Supported mechanisms (p. 427)
- Supported Java key attributes (p. 432)
- Code samples for the AWS CloudHSM software library for Java (p. 436)
- AWS CloudHSM JCE provider Javadocs (p. 436)
- Using AWS CloudHSM KeyStore Java class (p. 437)
- Advanced configurations for JCE (p. 439)

Install and use the AWS CloudHSM JCE provider for Client SDK 5

The JCE provider is compatible with OpenJDK 8 and OpenJDK11. You can download both from the OpenJDK website.

Topics

- Install the JCE provider (p. 423)
- Provide credentials to the JCE provider (p. 425)
- Key management basics in the JCE provider (p. 426)
Install the JCE provider

1. Use the following commands to download and install the JCE provider.

Amazon Linux

Amazon Linux on x86_64 architecture:

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL6/cloudhsm-
    jce-latest.el6.x86_64.rpm

$ sudo yum install ./cloudhsm-jce-latest.el6.x86_64.rpm
```

Amazon Linux 2

Amazon Linux 2 on x86_64 architecture:

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-
    jce-latest.el7.x86_64.rpm

$ sudo yum install ./cloudhsm-jce-latest.el7.x86_64.rpm
```

Amazon Linux 2 on ARM64 architecture:

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-
    jce-latest.el7.aarch64.rpm

$ sudo yum install ./cloudhsm-jce-latest.el7.aarch64.rpm
```

CentOS 7

CentOS 7 on x86_64 architecture:

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-
    jce-latest.el7.x86_64.rpm

$ sudo yum install ./cloudhsm-jce-latest.el7.x86_64.rpm
```

CentOS 8

CentOS 8 on x86_64 architecture:

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL8/cloudhsm-
    jce-latest.el8.x86_64.rpm

$ sudo yum install ./cloudhsm-jce-latest.el8.x86_64.rpm
```

RHEL 7

RHEL 7 on x86_64 architecture:
Installing the JCE provider

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-jce-latest.el7.x86_64.rpm

$ sudo yum install ./cloudhsm-jce-latest.el7.x86_64.rpm

RHEL 8

RHEL 8 on x86_64 architecture:

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL8/cloudhsm-jce-latest.el8.x86_64.rpm

$ sudo yum install ./cloudhsm-jce-latest.el8.x86_64.rpm

Ubuntu 18.04 LTS

Ubuntu 18.04 LTS on x86_64 architecture:

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Bionic/cloudhsm-jce_latest_u18.04_amd64.deb

$ sudo apt install ./cloudhsm-jce_latest_u18.04_amd64.deb

Ubuntu 20.04 LTS

Ubuntu 20.04 LTS on x86_64 architecture:

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Focal/cloudhsm-jce_latest_u20.04_amd64.deb

$ sudo apt install ./cloudhsm-jce_latest_u20.04_amd64.deb

Ubuntu 22.04 LTS

Ubuntu 22.04 LTS on x86_64 architecture:

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Jammy/cloudhsm-jce_latest_u22.04_amd64.deb

$ sudo apt install ./cloudhsm-jce_latest_u22.04_amd64.deb

Windows Server 2016

For Windows Server 2016 on x86_64 architecture, open PowerShell as an administrator and run the following command:

Installing the JCE provider

Windows Server 2019

For Windows Server 2019 on x86_64 architecture, open PowerShell as an administrator and run the following command:

```
```

```
PS C:\> Start-Process msiexec.exe -ArgumentList '/i C:\AWSCloudHSMJCE-latest.msi /quiet /norestart /log C:\client-install.txt' -Wait
```

2. Bootstrap Client SDK 5. For more information about bootstrapping, see Bootstrap the Client SDK (p. 41).

3. Locate the following JCE provider files:

   **Linux**
   - /opt/cloudhsm/java/cloudhsm\-version.jar
   - /opt/cloudhsm/bin/configure-jce
   - /opt/cloudhsm/bin/jce-info

   **Windows**
   - C:\Program Files\Amazon\CloudHSM\java\cloudhsm-\version.jar
   - C:\Program Files\Amazon\CloudHSM\bin\configure-jce.exe
   - C:\Program Files\Amazon\CloudHSM\bin\jce_info.exe

Provide credentials to the JCE provider

Before your Java application can use an HSM, the HSM needs to first authenticate the application. HSMs authenticate using either an explicit login or implicit login method.

**Explicit login** – This method lets you provide AWS CloudHSM credentials directly in the application. It uses the method from the `AuthProvider`, where you pass a CU username and password in the pin pattern. For more information, see Login to an HSM code example.

**Implicit login** – This method lets you set AWS CloudHSM credentials either in a new property file, system properties, or as environment variables.

- **System properties** – Set credentials through system properties when running your application. The following examples show two different ways that you can do this:

  **Linux**
  ```
  $ java -DHSMS_USER=<HSM user name> -DHSMS_PASSWORD=<password>
  ```
  ```
  System.setProperty("HSM_USER","<HSM user name>");
  System.setProperty("HSM_PASSWORD","<password>");
  ```
Windows

```java
java -DHSM_USER=<HSM user name> -DHSM_PASSWORD=<password>
```

```java
System.setProperty("HSM_USER","<HSM user name>" );
System.setProperty("HSM_PASSWORD","<password>" );
```

- **Environment variables** – Set credentials as environment variables.

Linux

```bash
export HSM_USER=<HSM user name>
export HSM_PASSWORD=<password>
```

Windows

```bash
$ Env:HSM_USER="<HSM user name>"
$ Env:HSM_PASSWORD="<password>"
```

Credentials might not be available if the application does not provide them or if you attempt an operation before the HSM authenticates session. In those cases, the CloudHSM software library for Java searches for the credentials in the following order:

1. System properties
2. Environment variables

**Key management basics in the JCE provider**

The basics on key management in the JCE provider involve importing keys, exporting keys, loading keys by handle, or deleting keys. For more information on managing keys, see the Manage keys code example.

You can also find more JCE provider code examples at [Code samples (p. 436)](#).

**Supported key types**

The AWS CloudHSM software library for Java enables you to generate the following key types.

<table>
<thead>
<tr>
<th>Key Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AES</td>
<td>Generate 128, 192, and 256-bit AES keys.</td>
</tr>
<tr>
<td>Triple DES (3DES, DESede)</td>
<td>Generate a 192-bit Triple DES Key. See footnote 1 for an upcoming change.</td>
</tr>
<tr>
<td>EC</td>
<td>Generate EC key pairs – NIST curves secp224r1 (P-224), secp256r1 (P-256), secp256k1 (Blockchain), secp384r1 (P-384), and secp521r1 (P-521).</td>
</tr>
<tr>
<td>GENERIC_SECRET</td>
<td>Generate 1 to 800 bytes generic secrets.</td>
</tr>
<tr>
<td>HMAC</td>
<td>Hash support for SHA1, SHA224, SHA256, SHA384, SHA512.</td>
</tr>
<tr>
<td>Key Type</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
</tr>
<tr>
<td>RSA</td>
<td>Generate 2048-bit to 4096-bit RSA keys, in increments of 256 bits.</td>
</tr>
</tbody>
</table>


## Supported mechanisms

For information about the Java Cryptography Architecture (JCA) interfaces and engine classes supported by AWS CloudHSM, see the following topics.

### Topics

- Generate key and key pair functions (p. 427)
- Cipher functions (p. 427)
- Sign and verify functions (p. 429)
- Digest functions (p. 430)
- Hash-based message authentication code (HMAC) functions (p. 430)
- Cipher-based message authentication code (CMAC) functions (p. 431)
- Convert keys to key specifications using key factories (p. 431)
- Mechanism annotations (p. 431)

## Generate key and key pair functions

The AWS CloudHSM software library for Java allows you to use the following operations for generate key and key pair functions.

- RSA
- EC
- AES
- DESede (Triple DES) [see note 1](#)
- GenericSecret

## Cipher functions

The AWS CloudHSM software library for Java supports the following algorithm, mode, and padding combinations.

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Mode</th>
<th>Padding</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>AES</td>
<td>CBC</td>
<td>AES/CBC/NoPadding AES/CBC/PKCS5Padding</td>
<td>Implements Cipher.ENCRYPT_MODE and Cipher.DECRYPT_MODE. Implements Cipher.UNWRAP_MODE for AES/CBC NoPadding</td>
</tr>
</tbody>
</table>

[1] Note 1
<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Mode</th>
<th>Padding</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>AES</td>
<td>ECB</td>
<td>AES/ECB/NoPadding</td>
<td>Implements Cipher.ENCRYPT_MODE and Cipher.DECRYPT_MODE.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AES/ECB/PKCS5Padding</td>
<td></td>
</tr>
<tr>
<td>AES</td>
<td>CTR</td>
<td>AES/CTR/NoPadding</td>
<td>Implements Cipher.ENCRYPT_MODE and Cipher.DECRYPT_MODE.</td>
</tr>
</tbody>
</table>
| AES          | GCM   | AES/GCM/NoPadding        | Implements Cipher.WRAP_MODE, Cipher.UNWRAP_MODE, Cipher.ENCRYPT_MODE, and Cipher.DECRYPT_MODE.  
<p>|              |       |                          | When performing AES-GCM encryption, the HSM ignores the initialization vector (IV) in the request and uses an IV that it generates. When the operation completes, you must call Cipher.getIV() to get the IV. |
| AESWrap      | ECB   | AESWrap/ECB/NoPadding    | Implements Cipher.WRAP_MODE and Cipher.UNWRAP_MODE.                  |
|              |       | AESWrap/ECB/PKCS5Padding |                                                                        |
|              |       | AESWrap/ECB/ZeroPadding  |                                                                        |
| DESede (Triple DES) | CBC   | DESede/CBC/NoPadding     | Implements Cipher.ENCRYPT_MODE and Cipher.DECRYPT_MODE. See note 1 below for an upcoming change. |
|              |       | DESede/CBC/PKCS5Padding  |                                                                        |
| DESede (Triple DES) | ECB   | DESede/ECB/NoPadding     | Implements Cipher.ENCRYPT_MODE and Cipher.DECRYPT_MODE. See note 1 below for an upcoming change. |
|              |       | DESede/ECB/PKCS5Padding  |                                                                        |</p>
<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Mode</th>
<th>Padding</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSA</td>
<td>ECB</td>
<td>RSA/ECB/ PKCS1Padding see note 1</td>
<td>Implements Cipher.WRAP_MODE, Cipher.UNWRAP_MODE, Cipher.ENCRYPT_MODE, and Cipher.DECRYPT_MODE.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RSA/ECB/ OAEPPadding</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>RSA/ECB/ OAEPWithSHA-1ANDMGF1Padding</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>RSA/ECB/ OAEPWithSHA-224ANDMGF1Padding</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>RSA/ECB/ OAEPWithSHA-256ANDMGF1Padding</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>RSA/ECB/ OAEPWithSHA-384ANDMGF1Padding</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>RSA/ECB/ OAEPWithSHA-512ANDMGF1Padding</td>
<td></td>
</tr>
<tr>
<td>RSA</td>
<td>ECB</td>
<td>RSA/ECB/NoPadding</td>
<td>Implements Cipher.ENCRYPT_MODE and Cipher.DECRYPT_MODE.</td>
</tr>
<tr>
<td>RSAAESWrap</td>
<td>ECB</td>
<td>RSAAESWrap/ECB/ OAEPPadding</td>
<td>Implements Cipher.WRAP_MODE and Cipher.UNWRAP_MODE.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RSAAESWrap/ECB/ OAEPWithSHA-1ANDMGF1Padding</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>RSAAESWrap/ECB/ OAEPWithSHA-224ANDMGF1Padding</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>RSAAESWrap/ECB/ OAEPWithSHA-256ANDMGF1Padding</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>RSAAESWrap/ECB/ OAEPWithSHA-384ANDMGF1Padding</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>RSAAESWrap/ECB/ OAEPWithSHA-512ANDMGF1Padding</td>
<td></td>
</tr>
</tbody>
</table>

**Sign and verify functions**

The AWS CloudHSM software library for Java supports the following types of signature and verification. With Client SDK 5 and signature algorithms with hashing, the data is hashed locally in software before being sent to the HSM for the signature/verification. This means there is no limit on the size of the data that can be hashed by the SDK.

**RSA Signature Types**

- NONE with RSA
Mechanisms

- RSASSA-PSS
- SHA1withRSA
- SHA1withRSA/PSS
- SHA1withRSAandMGF1
- SHA224withRSA
- SHA224withRSAandMGF1
- SHA224withRSA/PSS
- SHA256withRSA
- SHA256withRSAandMGF1
- SHA256withRSA/PSS
- SHA384withRSA
- SHA384withRSAandMGF1
- SHA384withRSA/PSS
- SHA512withRSA
- SHA512withRSAandMGF1
- SHA512withRSA/PSS

ECDSA Signature Types

- NONEwithECDSA
- SHA1withECDSA
- SHA224withECDSA
- SHA256withECDSA
- SHA384withECDSA
- SHA512withECDSA

Digest functions

The AWS CloudHSM software library for Java supports the following message digests. With Client SDK 5, the data is hashed locally in software. This means there is no limit on the size of the data that can be hashed by the SDK.

- SHA-1
- SHA-224
- SHA-256
- SHA-384
- SHA-512

Hash-based message authentication code (HMAC) functions

The AWS CloudHSM software library for Java supports the following HMAC algorithms.

- HmacSHA1 (Maximum data size in bytes: 16288)
- HmacSHA224 (Maximum data size in bytes: 16256)
- HmacSHA256 (Maximum data size in bytes: 16288)
- HmacSHA384 (Maximum data size in bytes: 16224)
- HmacSHA512 (Maximum data size in bytes: 16224)
Cipher-based message authentication code (CMAC) functions

CMACs (Cipher-based message authentication codes) create message authentication codes (MACs) using a block cipher and a secret key. They differ from HMACs in that they use a block symmetric key method for the MACs rather than a hashing method.

The AWS CloudHSM software library for Java supports the following CMAC algorithms.

- AESCMAC

Convert keys to key specifications using key factories

You can use key factories to convert keys to key specifications. AWS CloudHSM has two types of key factories for JCE:

**SecretKeyFactory:** Used to import or derive symmetric keys. Using SecretKeyFactory, you can pass a supported Key or a supported KeySpec to import or derive symmetric keys into AWS CloudHSM. Following are the supported specs for KeyFactory:

- For SecretKeyFactory's `generateSecret` method following `KeySpec` classes are supported:
  - `KeySpec` can be used to import a symmetric key spec as a CloudHSM Key. An example can be found here [here](#).
  - `SecretKeySpec` can be used to import a symmetric key spec as a CloudHSM Key.
  - `AesCmacKdfParameterSpec` can be used to derive symmetric keys using another CloudHSM AES Key.

  **Note**
  SecretKeyFactory's `translateKey` method takes any key that implements the `key` interface.

**KeyFactory:** Used for importing asymmetric keys. Using KeyFactory, you can pass a supported Key or supported KeySpec to import an asymmetric key into AWS CloudHSM. For more information, refer to the following resources:

- For KeyFactory's `generatePublic` method, following `KeySpec` classes are supported:
  - `KeySpec` for both RSA and EC KeyTypes, including:
    - `CloudHSM KeyAttributesMap` for both RSA and EC public KeyTypes. An example can be found here [here](#).
    - `X509EncodedKeySpec` for both RSA and EC Public Key
    - `RSAPublicKeySpec` for RSA Public Key
    - `ECPrivateKeySpec` for RSA Private Key

- For KeyFactory's `generatePrivate` method, following `KeySpec` classes are supported:
  - `KeySpec` for both RSA and EC KeyTypes, including:
    - `PKCS8EncodedKeySpec` for both EC and RSA Private Key
    - `RSAPrivateCrtKeySpec` for RSA Private Key
    - `ECPrivateKeySpec` for EC Private Key

  For KeyFactory's `translateKey` method, it takes any Key that implements the `Key Interface`.

Mechanism annotations

**Supported Java key attributes**

This topic describes how to use a proprietary extension for the JCE provider to set key attributes. Use this extension to set supported key attributes and their values during these operations:

- Key generation
- Key import

For examples of how to use key attributes, see the section called “Code samples” (p. 436).

**Topics**

- Understanding attributes (p. 432)
- Supported attributes (p. 432)
- Setting attributes for a key (p. 435)

**Understanding attributes**

Use key attributes to specify what actions are permitted on key objects, including public, private or secret keys. Key attributes and values are defined during key object creation operations.

The Java Cryptography Extension (JCE) does not specify how you should set values on key attributes, so most actions were permitted by default. In contrast, the PKCS# 11 standard defines a comprehensive set of attributes with more restrictive defaults. Starting with the JCE provider 3.1, AWS CloudHSM provides a proprietary extension that enables you to set more restrictive values for commonly used attributes.

**Supported attributes**

You can set values for the attributes listed in the following table. As a best practice, only set values for attributes you wish to make restrictive. If you don’t specify a value, AWS CloudHSM uses the default value specified in the table below. An empty cell in the Default Value columns indicates that there is no specific default value assigned to the attribute.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>DECRYPT</td>
<td>TRUE</td>
<td>True indicates you can use the key to decrypt any buffer. You generally set this to FALSE for a key whose WRAP is set to true.</td>
</tr>
<tr>
<td>DERIVE</td>
<td></td>
<td>Allows a key to be used to derive other keys.</td>
</tr>
<tr>
<td>ENCRYPT</td>
<td>TRUE</td>
<td>True indicates you can use the key to encrypt any buffer.</td>
</tr>
<tr>
<td>EXTRACTABLE</td>
<td>TRUE</td>
<td>True indicates you can export this key out of the HSM.</td>
</tr>
<tr>
<td>Attribute</td>
<td>Default Value</td>
<td>Notes</td>
</tr>
<tr>
<td>---------------</td>
<td>---------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>KEY_TYPE</td>
<td></td>
<td>Used to identify the type of key (AES, DESede, generic secret, EC, or RSA).</td>
</tr>
<tr>
<td>LABEL</td>
<td></td>
<td>A user-defined string allowing you to conveniently identify keys on your HSM. To follow best practice, use a unique label for each key so it is easier to find later.</td>
</tr>
<tr>
<td>LOCAL</td>
<td></td>
<td>Indicates a key generated by the HSM.</td>
</tr>
<tr>
<td>OBJECT_CLASS</td>
<td></td>
<td>Used to identify the Object Class of a key (SecretKey, PublicKey or PrivateKey).</td>
</tr>
<tr>
<td>PRIVATE</td>
<td>TRUE</td>
<td>True indicates that a user may not access the key until the user is authenticated. For clarity, users cannot access any keys on AWS CloudHSM until they are authenticated, even if this attribute is set to FALSE.</td>
</tr>
<tr>
<td>SIGN</td>
<td>TRUE</td>
<td>True indicates you can use the key to sign a message digest. This is generally set to FALSE for public keys and for private keys that you have archived.</td>
</tr>
<tr>
<td>Attribute</td>
<td>Default Value</td>
<td>Notes</td>
</tr>
<tr>
<td>-----------</td>
<td>---------------</td>
<td>-------</td>
</tr>
<tr>
<td>SIZE</td>
<td></td>
<td>An attribute that defines the size of a key. For more details about supported key sizes, refer to Supported mechanisms for Client SDK 5.</td>
</tr>
<tr>
<td>TOKEN</td>
<td>FALSE</td>
<td>FALSE</td>
</tr>
<tr>
<td>UNWRAP</td>
<td>TRUE</td>
<td></td>
</tr>
<tr>
<td>VERIFY</td>
<td>TRUE</td>
<td></td>
</tr>
<tr>
<td>WRAP</td>
<td>TRUE</td>
<td></td>
</tr>
</tbody>
</table>
### Key attributes

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>WRAP_WITH_TRUSTED</td>
<td>FALSE</td>
<td>True indicates a key can only be wrapped and unwrapped with keys that have the TRUSTED attribute set to true. Once a key has WRAP_WITH_TRUSTED set to true, that attribute is read-only and can't be set to false. To read about trust wrapping, see [Using trusted keys to control key unwraps](p. 403).</td>
</tr>
</tbody>
</table>

**Note**
You get broader support for attributes in the PKCS#11 library. For more information, see [Supported PKCS #11 Attributes](p. 403).

### Setting attributes for a key

`KeyAttributesMap` is a Java Map-like object, which you can use to set attribute values for key objects. The methods for `KeyAttributesMap` function similar to the methods used for Java map manipulation.

To set custom values on attributes, you have two options:
- Use the methods listed in the following table
- Use builder patterns demonstrated later in this document

Attribute map objects support the following methods to set attributes:

<table>
<thead>
<tr>
<th>Operation</th>
<th>Return Value</th>
<th><code>KeyAttributesMap</code> method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Get the value of a key attribute for an existing key</td>
<td>Object (containing the value) or <em>null</em></td>
<td><code>get(keyAttribute)</code></td>
</tr>
<tr>
<td>Populate the value of one key attribute</td>
<td>The previous value associated with key attribute, or <em>null</em> if there was no mapping for a key attribute</td>
<td><code>put(keyAttribute, value)</code></td>
</tr>
<tr>
<td>Populate values for multiple key attributes</td>
<td>N/A</td>
<td><code>putAll(keyAttributesMap)</code></td>
</tr>
<tr>
<td>Remove a key-value pair from the attribute map</td>
<td>The previous value associated with key attribute, or <em>null</em> if there was no mapping for a key attribute</td>
<td><code>remove(keyAttribute)</code></td>
</tr>
</tbody>
</table>
Note
Any attributes you do not explicitly specify are set to the defaults listed in the preceding table in the section called "Supported attributes" (p. 432).

Setting attributes for a key pair

Use the Java class KeyPairAttributesMap to handle key attributes for a key pair. KeyPairAttributesMap encapsulates two KeyAttributesMap objects; one for a public key and one for a private key.

To set individual attributes for the public key and private key separately, you can use the put() method on corresponding KeyAttributesMap map object for that key. Use the getPublic() method to retrieve the attribute map for the public key, and use getPrivate() to retrieve the attribute map for the private key. Populate the value of multiple key attributes together for both public and private key pairs using the putAll() with a key pair attributes map as its argument.

Code samples for the AWS CloudHSM software library for Java

Prerequisites

Before running the samples, you must set up your environment:

- Install and configure the Java Cryptographic Extension (JCE) provider (p. 423).
- Set up a valid HSM user name and password (p. 60). Cryptographic user (CU) permissions are sufficient for these tasks. Your application uses these credentials to log in to the HSM in each example.
- Decide how to provide credentials to the JCE provider (p. 425).

Code samples

The following code samples show you how to use the AWS CloudHSM JCE provider (p. 422) to perform basic tasks. More code samples are available on GitHub.

- Log in to an HSM
- Manage keys
- Generate Symmetric Keys
- Generate Asymmetric Keys
- Encrypt and decrypt with AES-GCM
- Encrypt and decrypt with AES-CTR
- Encrypt and decrypt with DESede-ECB
- Sign and Verify with RSA Keys
- Sign and Verify with EC Keys
- Use supported key attributes
- Use the CloudHSM key store

Use the JCE provider Javadocs to get usage information on Java types and methods defined in the AWS CloudHSM JCE SDK. To download the latest Javadocs for AWS CloudHSM, see the Latest releases (p. 671) section on the Downloads page.

You can import Javadocs into an integrated development environment (IDE) or view them in a web browser.

**Using AWS CloudHSM KeyStore Java class**

The AWS CloudHSM KeyStore class provides a special-purpose PKCS12 key store. This key store can store certificates along with your key data and correlate them to key data stored on AWS CloudHSM. The AWS CloudHSM KeyStore class implements the KeyStore Service Provider Interface (SPI) of the Java Cryptography Extension (JCE). For more information about using KeyStore, see Class KeyStore.

**Note**

Because certificates are public information, and to maximize storage capacity for cryptographic keys, AWS CloudHSM does not support storing certificates on HSMs.

**Choosing the appropriate key store**

The AWS CloudHSM Java Cryptographic Extension (JCE) provider offers a special-purpose AWS CloudHSM KeyStore. The AWS CloudHSM KeyStore class supports offloading key operations to the HSM, local storage of certificates and certificate-based operations.

Load the special-purpose CloudHSM KeyStore as follows:

```java
KeyStore ks = KeyStore.getInstance("CloudHSM")
```

**Initializing AWS CloudHSM KeyStore**

Log into the AWS CloudHSM KeyStore the same way that you log into the JCE provider. You can use either environment variables or the system property file, and you should log in before you start using the CloudHSM KeyStore. For an example of logging into an HSM using the JCE provider, see Login to an HSM.

If desired, you can specify a password to encrypt the local PKCS12 file which holds key store data. When you create the AWS CloudHSM Keystore, you set the password and provide it when using the load, set and get methods.

Instantiate a new CloudHSM KeyStore object as follows:

```java
ks.load(null, null);
```

Write keystore data to a file using the store method. From that point on, you can load the existing keystore using the load method with the source file and password as follows:

```java
ks.load(inputStream, password);
```

**Using AWS CloudHSM KeyStore**

AWS CloudHSM KeyStore complies with the JCE Class KeyStore specification and provides the following functions.

- load
Loads the key store from the given input stream. If a password was set when saving the key store, this same password must be provided for the load to succeed. Set both parameters to null to initialize an new empty key store.

```java
KeyStore ks = KeyStore.getInstance("CloudHSM");
ks.load(inputStream, password);
```

- **aliases**

  Returns an enumeration of the alias names of all entries in the given key store instance. Results include objects stored locally in the PKCS12 file and objects resident on the HSM.

  **Sample code:**

  ```java
  KeyStore ks = KeyStore.getInstance("CloudHSM");
  for(Enumeration<String> entry = ks.aliases(); entry.hasMoreElements();)
  {
    String label = entry.nextElement();
    System.out.println(label);
  }
  ```

- **ContainsAlias**

  Returns true if the key store has access to at least one object with the specified alias. The key store checks objects stored locally in the PKCS12 file and objects resident on the HSM.

- **DeleteEntry**

  Deletes a certificate entry from the local PKCS12 file. Deleting key data stored in an HSM is not supported using the AWS CloudHSM KeyStore. You can delete keys using the `destroy` method of the `Destroyable` interface.

  ```java
  ((Destroyable) key).destroy();
  ```

- **GetCertificate**

  Returns the certificate associated with an alias if available. If the alias does not exist or references an object which is not a certificate, the function returns NULL.

  ```java
  KeyStore ks = KeyStore.getInstance("CloudHSM");
  Certificate cert = ks.getCertificate(alias);
  ```

- **GetCertificateAlias**

  Returns the name (alias) of the first key store entry whose data matches the given certificate.

  ```java
  KeyStore ks = KeyStore.getInstance("CloudHSM");
  String alias = ks.getCertificateAlias(cert);
  ```

- **GetCertificateChain**

  Returns the certificate chain associated with the given alias. If the alias does not exist or references an object which is not a certificate, the function returns NULL.

- **GetCreationDate**

  Returns the creation date of the entry identified by the given alias. If a creation date is not available, the function returns the date on which the certificate became valid.

- **GetKey**
GetKey is passed to the HSM and returns a key object corresponding to the given label. As getKey directly queries the HSM, it can be used for any key on the HSM regardless of whether it was generated by the KeyStore.

```java
Key key = ks.getKey(keyLabel, null);
```

- **IsCertificateEntry**

  Checks if the entry with the given alias represents a certificate entry.

- **IsKeyEntry**

  Checks if the entry with the given alias represents a key entry. The action searches both the PKCS12 file and the HSM for the alias.

- **SetCertificateEntry**

  Assigns the given certificate to the given alias. If the given alias is already being used to identify a key or certificate, a KeyStoreException is thrown. You can use JCE code to get the key object and then use the KeyStore SetKeyEntry method to associate the certificate to the key.

- **SetKeyEntry with byte[] key**

  This API is currently unsupported with Client SDK 5.

- **SetKeyEntry with Key object**

  Assigns the given key to the given alias and stores it inside the HSM. If the key does not already exist inside the HSM, it will be imported into the HSM as an extractable session key.

  If the Key object is of type PrivateKey, it must be accompanied by a corresponding certificate chain.

  If the alias already exists, the SetKeyEntry call throws a KeyStoreException and prevents the key from being overwritten. If the key must be overwritten, use KMU or JCE for that purpose.

- **EngineSize**

  Returns the number of entries in the keystore.

- **Store**

  Stores the key store to the given output stream as a PKCS12 file and secures it with the given password. In addition, it persists all loaded keys (which are set using setKey calls).

### Advanced configurations for JCE

The AWS CloudHSM JCE provider includes the following advanced configurations, which are not part of the general configurations most customers utilize.

- **Connecting to multiple clusters (p. 440)**

- **Key extraction using JCE (p. 442)**

- **Retry configuration for JCE (p. 442)**
Connecting to multiple clusters with the JCE provider

This configuration allows a single client instance to communicate to multiple clusters. Compared to having a single instance only communicate with a single cluster, this can be a cost-savings feature for some use cases. The CloudHsmProvider class is AWS CloudHSM's implementation of Java Security's Provider class. Each instance of this class represents a connection to your entire AWS CloudHSM cluster. You instantiate this class and add it to Java Security provider's list so that you can interact with it using standard JCE classes.

The following example instantiates this class and adds it to Java Security provider's list:

```java
if (Security.getProvider(CloudHsmProvider.PROVIDER_NAME) == null) {
    Security.addProvider(new CloudHsmProvider());
}
```

CloudHsmProvider configuration

CloudHsmProvider can be configured in two ways:

1. Configure with file (default configuration)
2. Configure using code

Configure with file (Default configuration)

When you instantiate CloudHsmProvider using default constructor, by default it will look for configuration file in /opt/cloudhsm/etc/cloudhsm-jce.cfg path in Linux. This configuration file can be configured using the configure-jce.

An object created using the default constructor will use the default CloudHSM provider name CloudHSM. The provider name is useful to interact with JCE to let it know which provider to use for various operation. An example to use CloudHSM provider name for Cipher operation is as below:

```java
Cipher cipher = Cipher.getInstance("AES/GCM/NoPadding", "CloudHSM");
```

Configure using code

As of Client SDK version 5.8.0, you can also configure the CloudHsmProvider using Java code. The way to do this is using an object of CloudHsmProviderConfig class. You can build this object using CloudHsmProviderConfigBuilder.

CloudHsmProvider has another constructor which takes the CloudHsmProviderConfig object, as the following sample shows.

Example

```java
CloudHsmProviderConfig config = CloudHsmProviderConfig.builder()
    .withCluster(CloudHsmCluster.builder()
        .withHsmCAFilePath(hsmCAFilePath)
        .withClusterUniqueIdentifier("CloudHsmCluster1")
        .withServer(CloudHsmServer.builder().withHostIP(hostName).build())
        .build());
```
CloudHsmProvider provider = new CloudHsmProvider(config);

In this example, the name of the JCE provider is CloudHsmCluster1. This is the name that application can then use to interact with JCE:

**Example**

```java
Cipher cipher = Cipher.getInstance("AES/GCM/NoPadding", "CloudHsmCluster1");
```

Alternatively, applications can also use the provider object created above to let JCE know to use that provider for the operation:

```java
Cipher cipher = Cipher.getInstance("AES/GCM/NoPadding", provider);
```

If a unique identifier is not specified with the `withClusterUniqueIdentifier` method, a randomly generated provider name is created for you. To get this randomly generated identifier, applications can call `provider.getName()` to get the identifier.

**Connecting to multiple clusters**

As stated above, each `CloudHsmProvider` represents a connection to your CloudHSM Cluster. If you want to talk to another cluster from the same application, you can create another object of `CloudHsmProvider` with configurations for your other cluster and you can interact with this other cluster either using the provider object or using the provider name, as shown in the following example.

**Example**

```java
CloudHsmProviderConfig config = CloudHsmProviderConfig.builder()
    .withCluster(
        CloudHsmCluster.builder()
            .withHsmCAFilePath(hsmCAFilePath)
            .withClusterUniqueIdentifier("CloudHsmCluster1")
            .withServer(CloudHsmServer.builder().withHostIP(hostName).build())
            .build())
    .build();
CloudHsmProvider provider1 = new CloudHsmProvider(config);
if (Security.getProvider(provider1.getName()) == null) {
    Security.addProvider(provider1);
}

CloudHsmProviderConfig config2 = CloudHsmProviderConfig.builder()
    .withCluster(
        CloudHsmCluster.builder()
            .withHsmCAFilePath(hsmCAFilePath2)
            .withClusterUniqueIdentifier("CloudHsmCluster2")
            .withServer(CloudHsmServer.builder().withHostIP(hostName2).build())
            .build())
    .build();
CloudHsmProvider provider2 = new CloudHsmProvider(config2);
if (Security.getProvider(provider2.getName()) == null) {
    Security.addProvider(provider2);
}
```

Once you have configured both the providers (both the clusters) above, you can interact with them either using the provider object or using the provider name.
Expanding upon this example that shows how to talk to `cluster1`, you could use the following sample for a AES/GCM/NoPadding operation:

```java
Cipher cipher = Cipher.getInstance("AES/GCM/NoPadding", provider1);
```

And in the same application to do "AES" Key generation on the second cluster using the provider name, you could also use the following sample:

```java
Cipher cipher = Cipher.getInstance("AES/GCM/NoPadding", provider2.getName());
```

## Retry commands for JCE

Client SDK 5.8.0 and later have a built-in automatic retry strategy which will retry HSM-throttled operations from the client side. When an HSM throttles operations because it is too busy performing previous operations and cannot take more requests, client SDKs will attempt to retry throttled operations up to 3 times while exponentially backing off. This automatic retry strategy can be set to one of two modes: `off` and `standard`.

- **off**: The Client SDK will not perform any retry strategy for any throttled operations by the HSM.
- **standard**: This is the default mode for Client SDK 5.8.0 and later. In this mode, client SDKs will automatically retry throttled operations by exponentially backing off.

For more information, see [HSM Throttling](p. 659).

### Set retry commands to off mode

**Linux**

To set retry commands to `off` for Client SDK 5 on Linux

- You can use the following command to set retry configuration to `off` mode:

```bash
$ sudo /opt/cloudhsm/bin/configure-jce --default-retry-mode off
```

**Windows**

To set retry commands to `off` for Client SDK 5 on Windows

- You can use the following command to set retry configuration to `off` mode:

```bash
C:\Program Files\Amazon\CloudHSM\bin\ .\configure-jce.exe --default-retry-mode off
```

## Key extraction using JCE

The Java Cryptography Extension (JCE) uses an architecture that allows different cryptography implementations to be plugged in. AWS CloudHSM ships one such JCE provider that offloads cryptographic operations to the HSM. For most other JCE providers to work with keys stored in AWS CloudHSM, they must extract the key bytes from your HSMs in clear text into your machine's memory for their use. HSMs typically only allow keys to be extracted as wrapped objects (p. 155), not clear text. However, to support inter-provider integration use cases, AWS CloudHSM allows an opt-in configuration option to enable extraction of the key bytes in the clear.
Important
JCE offloads operations to AWS CloudHSM whenever the AWS CloudHSM provider is specified or an AWS CloudHSM key object is used. You do not need to extract keys in clear if you expect your operation to happen inside the HSM. Key extraction in clear text is only needed when your application cannot use secure mechanisms such as wrapping and unwrapping a key due to restrictions from a third party library or JCE provider.

The AWS CloudHSM JCE Provider allows extraction of public keys to work with external JCE providers by default. The following methods are always allowed:

<table>
<thead>
<tr>
<th>Class</th>
<th>Method</th>
<th>Format (getEncoded)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EcPublicKey</td>
<td>getEncoded()</td>
<td>X.509</td>
</tr>
<tr>
<td></td>
<td>getW()</td>
<td>N/A</td>
</tr>
<tr>
<td>RSAPublicKey</td>
<td>getEncoded()</td>
<td>X.509</td>
</tr>
<tr>
<td></td>
<td>getPublicExponent()</td>
<td>N/A</td>
</tr>
<tr>
<td>CloudHsmRsaPrivateCrtKey</td>
<td>getPublicExponent()</td>
<td>N/A</td>
</tr>
</tbody>
</table>

The AWS CloudHSM JCE Provider doesn’t allow extraction of key bytes in clear for the private or secret keys by default. If your use case requires it, you can enable extraction of key bytes in clear for private or secret keys under the following conditions:

1. The EXTRACTABLE attribute for private and secret keys is set to true.
   - By default, the EXTRACTABLE attribute for private and secret keys is set to true. EXTRACTABLE keys are keys that are permitted to be exported out of the HSM. For more information see Supported Java attributes for Client SDK 5.

2. The WRAP_WITH_TRUSTED attribute for the private and secret keys is set to false.
   - getEncoded, getPrivateExponent, and getS cannot be used with private keys that cannot be exported in clear. WRAP_WITH_TRUSTED doesn’t allow your private keys to exported out of the HSM in clear. For more information see Using trusted keys to control key unwraps.

Allowing the AWS CloudHSM JCE provider to extract private key secrets out of AWS CloudHSM

Important
This configuration change allows extraction of all EXTRACTABLE key bytes in clear from your HSM cluster. For better security, you should consider using key wrapping methods to extract the key out of the HSM securely. This prevents unintentional extraction of your key bytes from the HSM.

1. Use the following commands to enable your private or secret keys to be extracted in JCE:

   Linux
   ```
   $ /opt/cloudhsm/bin/configure-jce --enable-clear-key-extraction-in-software
   ```

   Windows
2. Once you enable your clear key extraction, the following methods are enabled for extracting private keys into memory.

<table>
<thead>
<tr>
<th>Class</th>
<th>Method</th>
<th>Format (getEncoded)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key</td>
<td>getEncoded()</td>
<td>RAW</td>
</tr>
<tr>
<td>ECPrivateKey</td>
<td>getEncoded()</td>
<td>PKCS#8</td>
</tr>
<tr>
<td></td>
<td>getS()</td>
<td>N/A</td>
</tr>
<tr>
<td>RSAPrivateCrtKey</td>
<td>getEncoded()</td>
<td>X.509</td>
</tr>
<tr>
<td></td>
<td>getPrivateExponent()</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>getPrimeP()</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>getPrimeQ()</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>getPrimeExponentP()</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>getPrimeExponentQ()</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>getCrtCoefficient()</td>
<td>N/A</td>
</tr>
</tbody>
</table>

If you want to restore the default behavior and not allow JCE to export keys in clear, run the following command:

**Linux**

```
$ /opt/cloudhsm/bin/configure-jce --disable-clear-key-extraction-in-software
```

**Windows**

```
C:\Program Files\Amazon\CloudHSM\> .\configure-jce.exe --disable-clear-key-extraction-in-software
```

Cryptography API: Next Generation (CNG) and key storage providers (KSP) for Microsoft Windows

The AWS CloudHSM client for Windows includes CNG and KSP providers. Currently, only Client SDK 3 supports CNG and KSP providers.

**Key storage providers** (KSPs) enable key storage and retrieval. For example, if you add the Microsoft Active Directory Certificate Services (AD CS) role to your Windows server and choose to create a new private key for your certificate authority (CA), you can choose the KSP that will manage key storage. When you configure the AD CS role, you can choose this KSP. For more information, see [Create Windows Server CA](p. 572).
Cryptography API: Next Generation (CNG) is a cryptographic API specific to the Microsoft Windows operating system. CNG enables developers to use cryptographic techniques to secure Windows-based applications. At a high level, the AWS CloudHSM implementation of CNG provides the following functionality:

- **Cryptographic Primitives** - enable you to perform fundamental cryptographic operations.
- **Key Import and Export** - enables you to import and export asymmetric keys.
- **Data Protection API (CNG DPAPI)** - enables you to easily encrypt and decrypt data.
- **Key Storage and Retrieval** - enables you to securely store and isolate the private key of an asymmetric key pair.

### Topics
- [Verifying the KSP and CNG Providers for Windows](p. 445)
- [Windows AWS CloudHSM prerequisites](p. 446)
- [Associate an AWS CloudHSM key with a certificate](p. 447)
- [Code sample for CNG provider](p. 449)

## Verifying the KSP and CNG Providers for Windows

The KSP and CNG providers are installed when you install the Windows AWS CloudHSM client. You can install the client by following the steps at [Install the client (Windows)](p. 306).

### Configure and run the Windows AWS CloudHSM client

To start the Windows CloudHSM client, you must first satisfy the [Prerequisites](p. 446). Then, update the configuration files that the providers use and start the client by completing the steps below. You need to do these steps the first time you use the KSP and CNG providers and after you add or remove HSMs in your cluster. This way, AWS CloudHSM is able to synchronize data and maintain consistency across all HSMs in the cluster.

**Step 1: Stop the AWS CloudHSM client**

Before you update the configuration files that the providers use, stop the AWS CloudHSM client. If the client is already stopped, running the stop command has no effect.

- **For Windows client 1.1.2+:**
  
  ```
  C:\Program Files\Amazon\CloudHSM>net.exe stop AWSCloudHSMClient
  ```

- **For Windows clients 1.1.1 and older:**

  Use **Ctrl+C** in the command window where you started the AWS CloudHSM client.

**Step 2: Update the AWS CloudHSM configuration files**

This step uses the `-a` parameter of the [Configure tool](p. 159) to add the elastic network interface (ENI) IP address of one of the HSMs in the cluster to the configuration file.

```
C:\Program Files\Amazon\CloudHSM configure.exe -a <HSM ENI IP>
```

To get the ENI IP address of an HSM in your cluster, navigate to the AWS CloudHSM console, choose **clusters**, and select the desired cluster. You can also use the [DescribeClusters operation](#), the `describe-`
Step 3: Start the AWS CloudHSM client

Next, start or restart the AWS CloudHSM client. When the AWS CloudHSM client starts, it uses the ENI IP address in its configuration file to query the cluster. Then it adds the ENI IP addresses of all HSMs in the cluster to the cluster information file.

- For Windows client 1.1.2+:

  C:\Program Files\Amazon\CloudHSM> net.exe start AWSCloudHSMClient

- For Windows clients 1.1.1 and older:

  C:\Program Files\Amazon\CloudHSM> start "cloudhsm_client" cloudhsm_client.exe C:\ProgramData\Amazon\CloudHSM\data\cloudhsm_client.cfg

Checking the KSP and CNG providers

You can use either of the following commands to determine which providers are installed on your system. The commands list the registered KSP and CNG providers. The AWS CloudHSM client does not need to be running.

C:\Program Files\Amazon\CloudHSM>ksp_config.exe -enum

C:\Program Files\Amazon\CloudHSM>cng_config.exe -enum

To verify that the KSP and CNG providers are installed on your Windows Server EC2 instance, you should see the following entries in the list:

Cavium CNG Provider
Cavium Key Storage Provider

If the CNG provider is missing, run the following command.

C:\Program Files\Amazon\CloudHSM>cng_config.exe -register

If the KSP provider is missing, run the following command.

C:\Program Files\Amazon\CloudHSM>ksp_config.exe -register

Windows AWS CloudHSM prerequisites

Before you can start the Windows AWS CloudHSM client and use the KSP and CNG providers, you must set the login credentials for the HSM on your system. You can set credentials through either Windows Credentials Manager or system environment variable. We recommend you use Windows Credential Manager for storing credentials. This option is available with AWS CloudHSM client version 2.0.4 and later. Using environment variable is easier to set up, but less secure than using Windows Credential Manager.
Windows Credential Manager

You can use either the set_cloudhsm_credentials utility or the Windows Credentials Manager interface.

- **Using the set_cloudhsm_credentials utility:**
  
  The set_cloudhsm_credentials utility is included in your Windows installer. You can use this utility to conveniently pass HSM login credentials to Windows Credential Manager. If you want to compile this utility from source, you can use the Python code that is included in the installer.
  
  1. Go to the C:\Program Files\Amazon\CloudHSM\tools\ folder.
  2. Run the set_cloudhsm_credentials.exe file with the CU username and password parameters.

      set_cloudhsm_credentials.exe --username <CU USER> --password <CU PASSWORD>

- **Using the Credential Manager interface:**
  
  You can use the Credential Manager interface to manually manage your credentials.
  
  1. To open Credential Manager, type credential manager in the search box on the taskbar and select **Credential Manager**.
  2. Select **Windows Credentials** to manage Windows credentials.
  3. Select **Add a generic credential** and fill out the details as follows:
     
     - In **Internet or Network Address**, enter the target name as cloudhsm_client.
     - In **Username** and **Password** enter the CU credentials.
     - Click **OK**.

System environment variables

You can set system environment variables that identify an HSM and a crypto user (CU) for your Windows application. You can use the `setx` command to set system environment variables, or set permanent system environment variables programmatically or in the Advanced tab of the Windows System Properties Control Panel.

**Warning**

When you set credentials through system environment variables, the password is available in plaintext on a user's system. To overcome this problem, use Windows Credential Manager.

Set the following system environment variables:

- `n3fips_password=CU USERNAME:CU PASSWORD`

  Identifies a crypto user (CU) in the HSM and provides all required login information. Your application authenticates and runs as this CU. The application has the permissions of this CU and can view and manage only the keys that the CU owns and shares. To create a new CU, use `createUser (p. 265)`. To find existing CUs, use `listUsers (p. 284)`.

  For example:

      setx /m n3fips_password test_user:password123

Associate an AWS CloudHSM key with a certificate

Before you can use AWS CloudHSM keys with third-party tools, such as Microsoft's SignTool, you must import the key's metadata into the local certificate store and associate the metadata with a certificate.
To import the key's metadata, use the import_key.exe utility which is included in CloudHSM version 3.0 and higher. The following steps provide additional information, and sample output.

**Step 1: Import your certificate**

On Windows, you should be able to double-click the certificate to import it to your local certificate store. However, if double-clicking doesn't work, use the [Microsoft Certreq tool](https://support.microsoft.com/en-us/kb/269837) to import the certificate into the certificate manager. For example:

```
certreq -accept certificatename
```

If this action fails and you receive the error, Key not found, continue to Step 2. If the certificate appears in your key store, you've completed the task and no further action is necessary.

**Step 2: Gather certificate-identifying information**

If the previous step wasn't successful, you'll need to associate your private key with a certificate. However, before you can create the association, you must first find the certificate's Unique Container Name and Serial Number. Use a utility, such as certutil, to display the needed certificate information. The following sample output from certutil shows the container name and the serial number.

```
Certificate 1
Serial Number: 72000000047f7f7a9d41851b4e00000000004
Issuer: CN=Enterprise-CA
NotBefore: 10/8/2019 11:50 AM
NotAfter: 11/8/2020 12:00 PM
Subject: CN=www.example.com, OU=Certificate Management, O=Information Technology, L=Seattle, S=Washington, C=US
Non-root Certificate
Hash (sha1): 7f d8 5c 00 27 bf 37 74 3d 71 5b 4e 0c 94 20 45 75 65
Simple container name: CertReq-39c04db0-6aa9-4310-93db-db0d9669f42c
Unique container name: CertReq-39c04db0-6aa9-4310-93db-db0d9669f42c
```

**Step 3: Associate the AWS CloudHSM private key with the certificate**

To associate the key with the certificate, first be sure to [start the AWS CloudHSM client daemon](p. 302). Then, use import_key.exe (which is included in CloudHSM version 3.0 and higher) to associate the private key with the certificate. When specifying the certificate, use its simple container name. The following example shows the command and the response. This action only copies the key's metadata; the key remains on the HSM.

```
$> import_key.exe –RSA CertReq-39c04db0-6aa9-4310-93db-db0d9669f42c
Successfully opened Microsoft Software Key Storage Provider : 0NCryptOpenKey failed : 80090016
```

**Step 4: Update the certificate store**

Be certain the AWS CloudHSM client daemon is still running. Then, use the certutil verb, -repairstore, to update the certificate serial number. The following sample shows the command and output. See the Microsoft documentation for information about the -repairstore verb.

```
C:\Program Files\Amazon\CloudHSM>certutil -f -csp "Cavium Key Storage Provider" -repairstore
"72000000047f7f7a9d41851b4e00000000004" -my "Personal"
Certificate 1
Serial Number: 72000000047f7f7a9d41851b4e00000000004
Issuer: CN=Enterprise-CA
```

448
After updating the certificate serial number you can use this certificate and the corresponding AWS CloudHSM private key with any third-party signing tool on Windows.

**Code sample for CNG provider**

**Example code only - Not for production use**
This sample code is for illustrative purposes only. Do not run this code in production.

The following sample shows how to enumerate the registered cryptographic providers on your system to find the CNG provider installed with CloudHSM client for Windows. The sample also shows how to create an asymmetric key pair and how to use the key pair to sign data.

**Important**
Before you run this example, you must set up the HSM credentials as explained in the prerequisites. For details, see [Windows AWS CloudHSM prerequisites](p. 446).

```cpp
// CloudHsmCngExampleConsole.cpp : Console application that demonstrates CNG capabilities.
// This example contains the following functions.
//
//   VerifyProvider() - Enumerate the registered providers and retrieve Cavium KSP and CNG providers.
//   GenerateKeyPair() - Create an RSA key pair.
//   SignData() - Sign and verify data.
//
#include "stdafx.h"
#include <Windows.h>

#ifndef NT_SUCCESS
#define NT_SUCCESS(Status) ((NTSTATUS)(Status) >= 0)
#endif

#define CAVIUM_CNG_PROVIDER L"Cavium CNG Provider"
#define CAVIUM_KEYSTORE_PROVIDER L"Cavium Key Storage Provider"

// Enumerate the registered providers and determine whether the Cavium CNG provider and the Cavium KSP provider exist.
//
// bool VerifyProvider()
//{
    NTSTATUS status;
    ULONG cbBuffer = 0;
    PCRYPT_PROVIDERS pBuffer = NULL;
    bool foundCng = false;
    bool foundKeystore = false;

    // Retrieve information about the registered providers.
    // cbBuffer - the size, in bytes, of the buffer pointed to by pBuffer.
    // pBuffer - pointer to a buffer that contains a CRYPT_PROVIDERS structure.
    status = BCryptEnumRegisteredProviders(&cbBuffer, &pBuffer);
```
// If registered providers exist, enumerate them and determine whether the
// Cavium CNG provider and Cavium KSP provider have been registered.
if (NT_SUCCESS(status))
{
    if (pBuffer != NULL)
    {
        for (ULONG i = 0; i < pBuffer->cProviders; i++)
        {
            // Determine whether the Cavium CNG provider exists.
            if (wcscmp(CAVIUM_CNG_PROVIDER, pBuffer->rgpszProviders[i]) == 0)
            {
                printf("Found %S\n", CAVIUM_CNG_PROVIDER);
                foundCng = true;
            }
            // Determine whether the Cavium KSP provider exists.
            else if (wcscmp(CAVIUM_KEYSTORE_PROVIDER, pBuffer->rgpszProviders[i]) == 0)
            {
                printf("Found %S\n", CAVIUM_KEYSTORE_PROVIDER);
                foundKeystore = true;
            }
        }
    }
    else
    {
        printf("BCryptEnumRegisteredProviders failed with error code 0x%08x\n", status);
    }

    // Free memory allocated for the CRYPT_PROVIDERS structure.
    if (NULL != pBuffer)
    {
        BCryptFreeBuffer(pBuffer);
    }

    return foundCng == foundKeystore == true;
}

// Generate an asymmetric key pair. As used here, this example generates an RSA key pair
// and returns a handle. The handle is used in subsequent operations that use the key
// pair.
// The key material is not available.
// The key pair is used in the SignData function.
//NTSTATUS GenerateKeyPair(BCRYPT_ALG_HANDLE hAlgorithm, BCRYPT_KEY_HANDLE *hKey)
//{
//    NTSTATUS status;
//    // Generate the key pair.
//    status = BCryptGenerateKeyPair(hAlgorithm, hKey, 2048, 0);
//    if (!NT_SUCCESS(status))
//    {
//        printf("BCryptGenerateKeyPair failed with code 0x%08x\n", status);
//        return status;
//    }
//    // Finalize the key pair. The public/private key pair cannot be used until this
//    // function is called.
//    status = BCryptFinalizeKeyPair(*hKey, 0);
//    if (!NT_SUCCESS(status))
//    {
//        printf("BCryptFinalizeKeyPair failed with code 0x%08x\n", status);
//        return status;
//    }
//}
return status;
}

// Sign and verify data using the RSA key pair. The data in this function is hardcoded
// and is for example purposes only.

NTSTATUS SignData(BCRYPT_KEY_HANDLE hKey)
{
    NTSTATUS status;
PBYTE sig;
ULONG sigLen;
ULONG resLen;
BCRYPT_PKCS1_PADDING_INFO pInfo;

    // Hardcode the data to be signed (for demonstration purposes only).
    PBYTE message = (PBYTE)"d83e7716bed8a203455d0dc6845e57447";
    ULONG messageLen = strlen((char*)message);

    // Retrieve the size of the buffer needed for the signature.
    status = BCryptSignHash(hKey, NULL, message, messageLen, NULL, 0, &sigLen, 0);
    if (!NT_SUCCESS(status))
    {
        printf("BCryptSignHash failed with code 0x%08x\n", status);
        return status;
    }

    // Allocate a buffer for the signature.
    sig = (PBYTE)HeapAlloc(GetProcessHeap(), 0, sigLen);
    if (sig == NULL)
    {
        return -1;
    }

    // Use the SHA256 algorithm to create padding information.
    pInfo.pszAlgId = BCRYPT_SHA256_ALGORITHM;

    // Create a signature.
    status = BCryptSignHash(hKey, &pInfo, message, messageLen, sig, sigLen, &resLen,
BCRYPT_PAD_PKCS1);
    if (!NT_SUCCESS(status))
    {
        printf("BCryptSignHash failed with code 0x%08x\n", status);
        return status;
    }

    // Verify the signature.
    status = BCryptVerifySignature(hKey, &pInfo, message, messageLen, sig, sigLen,
BCRYPT_PAD_PKCS1);
    if (!NT_SUCCESS(status))
    {
        printf("BCryptVerifySignature failed with code 0x%08x\n", status);
        return status;
    }

    // Free the memory allocated for the signature.
    if (sig != NULL)
    {
        HeapFree(GetProcessHeap(), 0, sig);
        sig = NULL;
    }

    return 0;
}

// Main function.
int main()
{
    NTSTATUS status;
    BCRYPT_ALG_HANDLE hRSAAlg;
    BCRYPT_KEY_HANDLE hKey = NULL;

    // Enumerate the registered providers.
    printf("Searching for Cavium providers...\n");
    if (VerifyProvider() == false) {
        printf("Could not find the CNG and Keystore providers\n");
        return 1;
    }

    // Get the RSA algorithm provider from the Cavium CNG provider.
    printf("Opening RSA algorithm\n");
    status = BCryptOpenAlgorithmProvider(&hRSAAlg, BCRYPT_RSA_ALGORITHM, CAVIUM_CNG_PROVIDER, 0);
    if (!NT_SUCCESS(status)) {
        printf("BCryptOpenAlgorithmProvider RSA failed with code 0x%08x\n", status);
        return status;
    }

    // Generate an asymmetric key pair using the RSA algorithm.
    printf("Generating RSA Keypair\n");
    GenerateKeyPair(hRSAAlg, &hKey);
    if (hKey == NULL) {
        printf("Invalid key handle returned\n");
        return 0;
    }
    printf("Done!\n");

    // Sign and verify [hardcoded] data using the RSA key pair.
    printf("Sign/Verify data with key\n");
    SignData(hKey);
    printf("Done!\n");

    // Remove the key handle from memory.
    status = BCryptDestroyKey(hKey);
    if (!NT_SUCCESS(status)) {
        printf("BCryptDestroyKey failed with code 0x%08x\n", status);
        return status;
    }

    // Close the RSA algorithm provider.
    status = BCryptCloseAlgorithmProvider(hRSAAlg, NULL);
    if (!NT_SUCCESS(status)) {
        printf("BCryptCloseAlgorithmProvider RSA failed with code 0x%08x\n", status);
        return status;
    }
    return 0;
}
Benefits of Client SDK 5

Compared to Client SDK 3, Client SDK 5 is easier to manage, offers superior configurability, and increased reliability. Client SDK 5 also provides some additional key advantages to Client SDK 3.

**Designed for serverless architecture**

Client SDK 5 does not require a client daemon, so you no longer need to manage a background service. This helps users in a few important ways:

- Simplifies the application startup process. All you need to do to get started with CloudHSM is configure the SDK before running your application.
- You don't need a constantly running process, which makes integration with serverless components like Lambda and Elastic Container Service (ECS) easier.

**Better third party integrations and easier portability**

Client SDK 5 follows the JCE specification closely and provides easier portability between different JCE providers and better third party integrations.

**Improved user experience and configurability**

Client SDK 5 improves log message readability and provides clearer exceptions and error-handling mechanisms, all of which makes self-service triaging much easier for users. SDK 5 also offers a variety of configurations, which are listed in the [Configure Tool page](#).

**Broader platform support**

Client SDK 5 offers more support for modern operating platforms. This includes support for ARM technologies and greater support for JCE, PKCS#11, and OpenSSL. For more information, refer to the [Supported Platforms page](#).

**Additional features and mechanisms**

Client SDK 5 includes additional features and mechanisms that are not available in Client SDK 3, and Client SDK 5 will continue to add more mechanisms in the future.

**Topics**

- [Migrating from Client SDK 3 to Client SDK 5](#) (p. 453)

## Migrating from Client SDK 3 to Client SDK 5

### Getting started with Client SDK 5

Use this table to understand how to get started with Client SDK 5.

<table>
<thead>
<tr>
<th>If you did this in Client SDK 3</th>
<th>You do this in Client SDK 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manage HSM users with CloudHSM CLI or CloudHSM Management Utility (CMU).</td>
<td>To manage HSM users with Client SDK 5, you must use a standalone version of CloudHSM CLI or the CMU. For more information, see <a href="#">Managing HSM users with CloudHSM CLI</a> (p. 60) and <a href="#">Managing</a>.</td>
</tr>
</tbody>
</table>
If you did this in Client SDK 3 | You do this in Client SDK 5
---|---
HSM users with CloudHSM Management Utility (CMU) (p. 93).
Run a single HSM cluster. | To run a single HSM cluster with Client SDK 5, you must first manage client key durability settings by setting `disable_key_availability_check` to True. For more information, see Key Synchronization (p. 123) and Client SDK 5 Configure Tool (p. 159).
Use the same key handles across different runs of an application. | To successfully use key handles in Client SDK 5, you must obtain key handles each time you run an application. If you have existing applications that expect to use the same key handles across different runs, you must modify your code to obtain the key handle each time you run the application. This change is in compliance with the PKCS #11 2.40 specification.

Previous Client SDK versions

AWS CloudHSM includes two major Client SDK versions:

- Client SDK 5: This is our latest and default Client SDK. For information on the benefits and advantages it provides, see Benefits of Client SDK 5 (p. 453).
- Client SDK 3: This is our older Client SDK. It includes a full set of components for platform and language-based applications compatibility and management tools.

Client SDK 3 documentation is listed in this section.

To download, see Downloads (p. 671).

Check your client SDK version

Amazon Linux

Use the following command:

```
rpm -qa | grep ^cloudhsm
```

Amazon Linux 2

Use the following command:

```
rpm -qa | grep ^cloudhsm
```

CentOS 6

Use the following command:

```
rpm -qa | grep ^cloudhsm
```
Check your client SDK version

CentOS 7

Use the following command:

```
rpm -qa | grep ^cloudhsm
```

CentOS 8

Use the following command:

```
rpm -qa | grep ^cloudhsm
```

RHEL 6

Use the following command:

```
rpm -qa | grep ^cloudhsm
```

RHEL 7

Use the following command:

```
rpm -qa | grep ^cloudhsm
```

RHEL 8

Use the following command:

```
rpm -qa | grep ^cloudhsm
```

Ubuntu 16.04 LTS

Use the following command:

```
apt list --installed | grep ^cloudhsm
```

Ubuntu 18.04 LTS

Use the following command:

```
apt list --installed | grep ^cloudhsm
```

Ubuntu 20.04 LTS

Use the following command:

```
apt list --installed | grep ^cloudhsm
```

Windows Server

Use the following command:

```
wmic product get name,version
```
Client SDK component comparison

In addition to the command-line tools, Client SDK 3 contains components that enable off-loading cryptographic operations to the HSM from various platform or language-based applications. Client SDK 5 does not have parity with Client SDK 3 at this time, but parity is the goal. The following table compares component availability in Client SDK 3 and Client SDK 5.

<table>
<thead>
<tr>
<th>Component</th>
<th>Client SDK 5</th>
<th>Client SDK 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>PKCS #11 library</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>JCE provider</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>OpenSSL Dynamic Engine</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>CNG and KSP providers</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>CloudHSM Management Utility (CMU)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Key Management Utility (KMU)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Configure tool</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

[1] CMU and KMU components are included in CloudHSM CLI with Client SDK 5.

[2] Only key management operations are supported.

Topics

- Client SDK 3 supported platforms (p. 456)
- Upgrading Client SDK 3 on Linux (p. 458)
- PKCS #11 library for Client SDK 3 (p. 464)
- Installing Client SDK 3 for OpenSSL Dynamic Engine (p. 485)
- Client SDK 3 for JCE provider (p. 488)

Client SDK 3 supported platforms

Client SDK 3 requires a client daemon and offers command-line tools including, CloudHSM Management Utility (CMU), key management utility (KMU), and the configure tool.

Base support is different for each version of the AWS CloudHSM Client SDK. Typically platform support for components in an SDK matches base support, but not always. To determine platform support for a given component, first make sure the platform you want appears in the base section for the SDK, then check for any exclusions or any other pertinent information in the component section.

Platform support changes over time. Earlier versions of the CloudHSM Client SDK may not support all the operating systems listed here. Use release notes to determine the operating system support for previous versions of the CloudHSM Client SDK. For more information, see Downloads for AWS CloudHSM Client SDK (p. 671).

AWS CloudHSM supports only 64-bit operating systems.

Contents
• **Linux support (p. 457)**
• **Windows support (p. 457)**
• **Components support (p. 457)**
  • PKCS #11 library (p. 457)
  • JCE provider (p. 457)
  • OpenSSL Dynamic Engine (p. 458)
  • CNG and KSP providers (p. 458)

**Linux support**

• Amazon Linux
• Amazon Linux 2
• CentOS 6.10+ ²
• CentOS 7.3+
• CentOS 8 ¹,⁴
• Red Hat Enterprise Linux (RHEL) 6.10+ ²
• Red Hat Enterprise Linux (RHEL) 7.3+
• Red Hat Enterprise Linux (RHEL) 8 ¹
• Ubuntu 16.04 LTS ³
• Ubuntu 18.04 LTS ¹

[1] No support for OpenSSL Dynamic Engine. For more information, see [OpenSSL Dynamic Engine (p. 458)](#).

[2] No support for Client SDK 3.3.0 and later.

[3] SDK 3.4 is the last supported release on Ubuntu 16.04.

[4] SDK 3.4 is the last supported release on CentOS 8.3+.

**Windows support**

• Microsoft Windows Server 2012
• Microsoft Windows Server 2012 R2
• Microsoft Windows Server 2016
• Microsoft Windows Server 2019

**Components support**

**PKCS #11 library**

The PKCS #11 library is a Linux only component that matches Linux base support. For more information, see the section called “Linux support” (p. 457).

**JCE provider**

The JCE provider is a Linux only component that matches Linux base support. For more information, see the section called “Linux support” (p. 457).
- Requires OpenJDK 1.8

**OpenSSL Dynamic Engine**

The OpenSSL Dynamic Engine is Linux only component that does not match Linux base support. See the exclusions below.

- Requires OpenSSL 1.0.2+[f+]

**Unsupported platforms:**

- CentOS 8
- Red Hat Enterprise Linux (RHEL) 8
- Ubuntu 18.04 LTS

These platforms ship with a version of OpenSSL incompatible with OpenSSL Dynamic Engine for Client SDK 3. AWS CloudHSM supports these platforms with OpenSSL Dynamic Engine for Client SDK 5.

**CNG and KSP providers**

The CNG and KSP providers is a Windows only component that matches Windows base support. For more information, see [Windows support (p. 457)](#).

**Upgrading Client SDK 3 on Linux**

With AWS CloudHSM Client SDK 3.1 and higher, the version of the client daemon and any components you install must match to upgrade. For all Linux-based systems, you must use a single command to batch upgrade the client daemon with the same version of the PKCS #11 library, the Java Cryptographic Extension (JCE) provider, or the OpenSSL Dynamic Engine. This requirement does not apply to Windows-based systems because the binaries for the CNG and KSP providers are already included in the client daemon package.

**To check the client daemon version**

- On a Red Hat-based Linux system (including Amazon Linux and CentOS), use the following command:

  `rpm -qa | grep ^cloudhsm`

- On an Debian-based Linux system, use the following command:

  `apt list --installed | grep ^cloudhsm`

- On a Windows system, use the following command:

  `wmic product get name,version`

**Topics**

- [Prerequisites (p. 459)](#)
- [Step 1: Stop the client daemon (p. 462)](#)
- [Step 2: Upgrade the client SDK (p. 462)](#)
- [Step 3: Start the client daemon (p. 463)](#)
Prerequisites

Download the latest version of AWS CloudHSM client daemon and choose your components.

**Note**
You do not have to install all the components. For every component you have installed, you must upgrade that component to match the version of the client daemon.

**Latest Linux client daemon**

**Amazon Linux**

```
wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL6/cloudhsm-client-latest.el6.x86_64.rpm
```

**Amazon Linux 2**

```
wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-latest.el7.x86_64.rpm
```

**CentOS 7**

```
sudo yum install wget
```

```
wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-latest.el7.x86_64.rpm
```

**CentOS 8**

```
sudo yum install wget
```

```
wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL8/cloudhsm-client-latest.el8.x86_64.rpm
```

**RHEL 7**

```
sudo yum install wget
```

```
wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-latest.el7.x86_64.rpm
```

**RHEL 8**

```
sudo yum install wget
```

```
wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL8/cloudhsm-client-latest.el8.x86_64.rpm
```

**Ubuntu 16.04 LTS**

```
wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Xenial/cloudhsm-client_latest_amd64.deb
```
Ubuntu 18.04 LTS

wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Bionic/cloudhsm-client_latest_u18.04_amd64.deb

Latest PKCS #11 library

Amazon Linux

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL6/cloudhsm-client-pkcs11-latest.el6.x86_64.rpm

Amazon Linux 2

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-pkcs11-latest.el7.x86_64.rpm

CentOS 7

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-pkcs11-latest.el7.x86_64.rpm

CentOS 8

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL8/cloudhsm-client-pkcs11-latest.el8.x86_64.rpm

RHEL 7

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-pkcs11-latest.el7.x86_64.rpm

RHEL 8

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL8/cloudhsm-client-pkcs11-latest.el8.x86_64.rpm

Ubuntu 16.04 LTS

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Xenial/cloudhsm-client-pkcs11_latest_amd64.deb

Ubuntu 18.04 LTS

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Bionic/cloudhsm-client-pkcs11_latest_u18.04_amd64.deb

Latest OpenSSL Dynamic Engine

Amazon Linux

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL6/cloudhsm-client-dyn-latest.el6.x86_64.rpm
Amazon Linux 2

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-dyn-latest.el7.x86_64.rpm
```

CentOS 7

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-dyn-latest.el7.x86_64.rpm
```

RHEL 7

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-dyn-latest.el7.x86_64.rpm
```

Ubuntu 16.04 LTS

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Xenial/cloudhsm-client-dynLatest_amd64.deb
```

**Latest JCE provider**

Amazon Linux

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL6/cloudhsm-client-jce-latest.el6.x86_64.rpm
```

Amazon Linux 2

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-jce-latest.el7.x86_64.rpm
```

CentOS 7

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-jce-latest.el7.x86_64.rpm
```

CentOS 8

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL8/cloudhsm-client-jce-latest.el8.x86_64.rpm
```

RHEL 7

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-jce-latest.el7.x86_64.rpm
```

RHEL 8

```
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL8/cloudhsm-client-jce-latest.el8.x86_64.rpm
```
Ubuntu 16.04 LTS

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Xenial/cloudhsm-client-jce_latest_amd64.deb

Ubuntu 18.04 LTS

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Bionic/cloudhsm-client-jce_latest_u18.04_amd64.deb

**Step 1: Stop the client daemon**

Use the following command to stop the client daemon.

Amazon Linux

$ sudo stop cloudhsm-client

Amazon Linux 2

$ sudo service cloudhsm-client stop

CentOS 7

$ sudo service cloudhsm-client stop

CentOS 8

$ sudo service cloudhsm-client stop

RHEL 7

$ sudo service cloudhsm-client stop

RHEL 8

$ sudo service cloudhsm-client stop

Ubuntu 16.04 LTS

$ sudo service cloudhsm-client stop

Ubuntu 18.04 LTS

$ sudo service cloudhsm-client stop

**Step 2: Upgrade the client SDK**

The following command shows the syntax required to upgrade the client daemon and components. Before you run the command, remove any components you don't intend to upgrade.
Step 3: Start the client daemon

Use the following command to start the client daemon.
PKCS #11 library for Client SDK 3

PKCS #11 is a standard for performing cryptographic operations on hardware security modules (HSM).

For information about bootstrapping, see Connecting to the cluster (p. 40).

Topics
- Installing Client SDK 3 for PKCS #11 library (p. 465)
- Authenticating to the PKCS #11 library (Client SDK 3) (p. 467)
- Supported key types (Client SDK 3) (p. 467)
- Supported mechanisms (Client SDK 3) (p. 468)
- Supported API operations (Client SDK 3) (p. 473)
Installing Client SDK 3 for PKCS #11 library

Prerequisites for Client SDK 3

The PKCS #11 library requires the AWS CloudHSM client.

If you haven’t installed and configured the AWS CloudHSM client, do that now by following the steps at Install the client (Linux) (p. 256). After you install and configure the client, use the following command to start it.

Amazon Linux

```
$ sudo start cloudhsm-client
```

Amazon Linux 2

```
$ sudo systemctl cloudhsm-client start
```

CentOS 7

```
$ sudo systemctl cloudhsm-client start
```

CentOS 8

```
$ sudo systemctl cloudhsm-client start
```

RHEL 7

```
$ sudo systemctl cloudhsm-client start
```

RHEL 8

```
$ sudo systemctl cloudhsm-client start
```

Ubuntu 16.04 LTS

```
$ sudo systemctl cloudhsm-client start
```

Ubuntu 18.04 LTS

```
$ sudo systemctl cloudhsm-client start
```

Ubuntu 20.04 LTS

```
$ sudo systemctl cloudhsm-client start
```

Install the PKCS #11 library for Client SDK 3

The following command downloads and installs the PKCS #11 library.
Amazon Linux

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL6/cloudhsm-client-pkcs11-latest.el6.x86_64.rpm

$ sudo yum install ./cloudhsm-client-pkcs11-latest.el6.x86_64.rpm
```

Amazon Linux 2

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-pkcs11-latest.el7.x86_64.rpm

$ sudo yum install ./cloudhsm-client-pkcs11-latest.el7.x86_64.rpm
```

CentOS 7

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-pkcs11-latest.el7.x86_64.rpm

$ sudo yum install ./cloudhsm-client-pkcs11-latest.el7.x86_64.rpm
```

CentOS 8

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL8/cloudhsm-client-pkcs11-latest.el8.x86_64.rpm

$ sudo yum install ./cloudhsm-client-pkcs11-latest.el8.x86_64.rpm
```

RHEL 7

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-pkcs11-latest.el7.x86_64.rpm

$ sudo yum install ./cloudhsm-client-pkcs11-latest.el7.x86_64.rpm
```

RHEL 8

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL8/cloudhsm-client-pkcs11-latest.el8.x86_64.rpm

$ sudo yum install ./cloudhsm-client-pkcs11-latest.el8.x86_64.rpm
```

Ubuntu 16.04 LTS

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Xenial/cloudhsm-client-pkcs11_latest_amd64.deb

$ sudo apt install ./cloudhsm-client-pkcs11_latest_amd64.deb
```
Ubuntu 18.04 LTS

$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Bionic/cloudhsm-client-pkcs11_latest_u18.04_amd64.deb

$ sudo apt install ./cloudhsm-client-pkcs11_latest_u18.04_amd64.deb

- If the EC2 instance on which you installed the PKCS #11 library has no other components from Client SDK 3 installed, you must bootstrap Client SDK 3. You only have to do this once on each instance with a component from Client SDK 3.
- You can find the PKCS #11 library files in the following locations:

  Linux binaries, configuration scripts, certificates, and log files:

  /opt/cloudhsm/lib

Authenticating to the PKCS #11 library (Client SDK 3)

When you use the PKCS #11 library, your application runs as a particular crypto user (CU) in your HSMs. Your application can view and manage only the keys that the CU owns and shares. You can use an existing CU in your HSMs or create a new CU. For information on managing CUs, see Managing HSM users with CloudHSM CLI (p. 60) and Managing HSM users with CloudHSM Management Utility (CMU) (p. 93).

To specify the CU to PKCS #11 library, use the pin parameter of the PKCS #11 C_Login function. For AWS CloudHSM, the pin parameter has the following format:

<CU_user_name>:<password>

For example, the following command sets the PKCS #11 library pin to the CU with user name CryptoUser and password CUPassword123!.

CryptoUser:CUPassword123!

Supported key types (Client SDK 3)

The PKCS #11 library supports the following key types.

<table>
<thead>
<tr>
<th>Key Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSA</td>
<td>Generate 2048-bit to 4096-bit RSA keys, in increments of 256 bits.</td>
</tr>
<tr>
<td>EC</td>
<td>Generate keys with the secp224r1 (P-224), secp256r1 (P-256), secp256k1 (Blockchain), secp384r1 (P-384), and secp521r1 (P-521) curves.</td>
</tr>
<tr>
<td>AES</td>
<td>Generate 128, 192, and 256-bit AES keys.</td>
</tr>
<tr>
<td>DES3 (Triple DES)</td>
<td>Generate 192-bit DES3 keys. See note 1 below for an upcoming change.</td>
</tr>
<tr>
<td>GENERIC_SECRET</td>
<td>Generate 1 to 64 bytes generic secrets.</td>
</tr>
</tbody>
</table>
• [1] Disallowed after 2023 for FIPS compliance as per NIST guidance. See FIPS 140 Compliance: 2024 Mechanism Deprecation (p. 633) for details.

Supported mechanisms (Client SDK 3)

The PKCS #11 library supports the following algorithms:

- **Encryption and decryption** – AES-CBC, AES-CTR, AES-ECB, AES-GCM, DES3-CBC, DES3-ECB, RSA-OAEP, and RSA-PKCS
- **Sign and verify** – RSA, HMAC, and ECDSA; with and without hashing
- **Hash/digest** – SHA1, SHA224, SHA256, SHA384, and SHA512
- **Key wrap** – AES Key Wrap, AES-GCM, RSA-AES, and RSA-OAEP
- **Key derivation** – ECDH, SP800-108 CTR KDF

The PKCS #11 library mechanism-function table

The PKCS #11 library is compliant with version 2.40 of the PKCS #11 specification. To invoke a cryptographic feature using PKCS #11, call a function with a given mechanism. The following table summarizes the combinations of functions and mechanisms supported by AWS CloudHSM.

Interpreting the supported PKCS #11 mechanism-function table

A ✔ mark indicates that AWS CloudHSM supports the mechanism for the function. We do not support all possible functions listed in the PKCS #11 specification. A ✗ mark indicates that AWS CloudHSM does not yet support the mechanism for the given function, even though the PKCS #11 standard allows it. Empty cells indicate that PKCS #11 standard does not support the mechanism for the given function.

Supported PKCS #11 library mechanisms and functions

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Generate Key or Key Pair</th>
<th>Sign &amp; Verify</th>
<th>SR &amp; VR</th>
<th>Digest</th>
<th>Encrypt &amp; Decrypt</th>
<th>Derive Key</th>
<th>Wrap &amp; UnWrap</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKM_RSA_PKCS_KEY_PAIR_GEN</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKM_RSA_X9_31_KEYPAIR_GEN</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKM_RSA_X_509</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKM_RSA_PKCS&lt;sup&gt;8&lt;/sup&gt;</td>
<td>✔&lt;sup&gt;2&lt;/sup&gt;</td>
<td>✗&lt;sup&gt;8&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKM_SHA1_RSA_PKCS</td>
<td>✔&lt;sup&gt;2&lt;/sup&gt;&lt;sup&gt;3&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKM_SHA224_RSA_PKCS</td>
<td>✔&lt;sup&gt;3&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKM_SHA256_RSA_PKCS</td>
<td>✔&lt;sup&gt;3&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKM_SHA384_RSA_PKCS</td>
<td>✔&lt;sup&gt;3&lt;/sup&gt;&lt;sup&gt;2&lt;/sup&gt;&lt;sup&gt;(p. 471)&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKM_SHA512_RSA_PKCS</td>
<td>✔&lt;sup&gt;3&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

468
<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKM_RSA_PKCS_PSS</td>
<td>✓ 1</td>
</tr>
<tr>
<td>CKM_SHA1_RSA_PKCS_PSS</td>
<td>✓ 3.2</td>
</tr>
<tr>
<td>CKM_SHA224_RSA_PKCS_PSS</td>
<td>✓ 3.2</td>
</tr>
<tr>
<td>CKM_SHA256_RSA_PKCS_PSS</td>
<td>✓ 3.2</td>
</tr>
<tr>
<td>CKM_SHA384_RSA_PKCS_PSS</td>
<td>✓ 3.2, 3.2</td>
</tr>
<tr>
<td>CKM_SHA512_RSA_PKCS_PSS</td>
<td>✓ 3.2</td>
</tr>
<tr>
<td>CKM_EC_KEY_PAIR_GEN</td>
<td>✓</td>
</tr>
<tr>
<td>CKM_ECDSA</td>
<td>✓ 1</td>
</tr>
<tr>
<td>CKM_ECDSA_SHA1</td>
<td>✓ 3.2</td>
</tr>
<tr>
<td>CKM_ECDSA_SHA224</td>
<td>✓ 3.2</td>
</tr>
<tr>
<td>CKM_ECDSA_SHA256</td>
<td>✓ 3.2</td>
</tr>
<tr>
<td>CKM_ECDSA_SHA384</td>
<td>✓ 3.2</td>
</tr>
<tr>
<td>CKM_ECDSA_SHA512</td>
<td>✓ 3.2</td>
</tr>
<tr>
<td>CKM_ECDH1_DERIVE</td>
<td>✓ 5</td>
</tr>
<tr>
<td>CKM_SP800_108_COUNTER_KDF</td>
<td>✓</td>
</tr>
<tr>
<td>CKM_GENERIC_SECRET_KEY_GEN</td>
<td>✓</td>
</tr>
<tr>
<td>CKM_AES_KEY_GEN</td>
<td>✓</td>
</tr>
<tr>
<td>CKM_AES_ECB</td>
<td>✓ ✔</td>
</tr>
<tr>
<td>CKM_AES_CTR</td>
<td>✓ ✔</td>
</tr>
<tr>
<td>CKM_AES_CBC</td>
<td>✓ ✔</td>
</tr>
<tr>
<td>CKM_AES_CBC_PAD</td>
<td>✓ ✔</td>
</tr>
<tr>
<td>CKM_DES3_KEY_GEN</td>
<td>✓</td>
</tr>
<tr>
<td>see note 8</td>
<td></td>
</tr>
<tr>
<td>CKM_DES3_CBC</td>
<td>✓ ✔</td>
</tr>
<tr>
<td>see note 8</td>
<td></td>
</tr>
<tr>
<td>CKM_DES3_CBC_PAD</td>
<td>✓ ✔</td>
</tr>
<tr>
<td>see note 8</td>
<td></td>
</tr>
<tr>
<td>CKM_DES3_ECB</td>
<td>✓ ✔</td>
</tr>
<tr>
<td>see note 8</td>
<td></td>
</tr>
<tr>
<td>CKM_AES_GCM</td>
<td>✓ ✔</td>
</tr>
<tr>
<td></td>
<td>✔ 7.1</td>
</tr>
<tr>
<td>Mechanism</td>
<td>Functions</td>
</tr>
<tr>
<td>-------------------------------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>CKM_CLOUDHSM_AES_GCM</td>
<td>✔ 7.1</td>
</tr>
<tr>
<td>CKM_SHA_1</td>
<td>✔ 3.1</td>
</tr>
<tr>
<td>CKM_SHA_1_HMAC</td>
<td>✔ 3.1</td>
</tr>
<tr>
<td>CKM_SHA224</td>
<td>✔ 3.1</td>
</tr>
<tr>
<td>CKM_SHA224_HMAC</td>
<td>✔ 3.1</td>
</tr>
<tr>
<td>CKM_SHA256</td>
<td>✔ 3.1</td>
</tr>
<tr>
<td>CKM_SHA256_HMAC</td>
<td>✔ 3.1</td>
</tr>
<tr>
<td>CKM_SHA384</td>
<td>✔ 3.1</td>
</tr>
<tr>
<td>CKM_SHA384_HMAC</td>
<td>✔ 3.1</td>
</tr>
<tr>
<td>CKM_SHA512</td>
<td>✔ 3.1</td>
</tr>
<tr>
<td>CKM_SHA512_HMAC</td>
<td>✔ 3.1</td>
</tr>
<tr>
<td>CKM_RSA_AES_KEY_WRAP</td>
<td>✔</td>
</tr>
<tr>
<td>CKM_AES_KEY_WRAP</td>
<td>✔</td>
</tr>
<tr>
<td>CKM_AES_KEY_WRAP_PAD</td>
<td>✔</td>
</tr>
<tr>
<td>CKM_CLOUDHSM_AES_KEY_WRAP_NO_PAD</td>
<td>✔ 7.1</td>
</tr>
<tr>
<td>CKM_CLOUDHSM_AES_KEY_WRAP_PKCS5_PAD</td>
<td>✔ 7.1</td>
</tr>
<tr>
<td>CKM_CLOUDHSM_AES_KEY_WRAP_ZERO_PAD</td>
<td>✔ 7.1</td>
</tr>
</tbody>
</table>

**Mechanism annotations**

- [1] Single-part operations only.
- [2] Mechanism is functionally identical to the CKM_RSA_PKCS_KEY_PAIR_GEN mechanism, but offers stronger guarantees for p and q generation.
- [3.1] AWS CloudHSM approaches hashing differently based on the Client SDK. For Client SDK 3, where we do the hashing depends on data size and whether you’re using single-part or multipart operations.

**Single-part operations in Client SDK 3**

Table 3.1 lists the maximum data set size for each mechanism for Client SDK 3. The entire hash is computed inside the HSM. No support for data sizes greater than 16KB.

**Table 3.1, Maximum data set size for single-part operations**

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Maximum Data Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKM_SHA_1</td>
<td>16296</td>
</tr>
<tr>
<td>CKM_SHA224</td>
<td>16264</td>
</tr>
</tbody>
</table>
### Mechanism | Maximum Data Size
---|---
CKM_SHA256 | 16296
CKM_SHA384 | 16232
CKM_SHA512 | 16232

**Multipart operations Client SDK 3**

Support for data sizes greater than 16 KB, but data size determines where the hashing takes place. Data buffers less than 16 KB are hashed inside the HSM. Buffers between 16 KB and the maximum data size for your system are hashed locally in software. *Remember:* Hash functions do not require cryptographic secrets, so you can safely compute them outside of the HSM.

- [3.2] AWS CloudHSM approaches hashing differently based on the Client SDK. For Client SDK 3, where we do the hashing depends on data size and whether you're using single-part or multipart operations.

**Single-part operations Client SDK 3**

Table 3.2 lists the maximum data set size for each mechanism for Client SDK 3. No support for data sizes greater than 16KB.

**Table 3.2, Maximum data set size for single-part operations**

| Mechanism                      | Maximum Data Size |
---|---|
CKM_SHA1_RSA_PKCS               | 16296             |
CKM_SHA224_RSA_PKCS             | 16264             |
CKM_SHA256_RSA_PKCS             | 16296             |
CKM_SHA384_RSA_PKCS             | 16232             |
CKM_SHA512_RSA_PKCS             | 16232             |
CKM_SHA1_RSA_PKCS_PSS           | 16296             |
CKM_SHA224_RSA_PKCS_PSS         | 16264             |
CKM_SHA256_RSA_PKCS_PSS         | 16296             |
CKM_SHA384_RSA_PKCS_PSS         | 16232             |
CKM_SHA512_RSA_PKCS_PSS         | 16232             |
CKM_ECDSA_SHA1                  | 16296             |
CKM_ECDSA_SHA224                | 16264             |
CKM_ECDSA_SHA256                | 16296             |
CKM_ECDSA_SHA384                | 16232             |
CKM_ECDSA_SHA512                | 16232             |

**Multipart operations Client SDK 3**


Support for data sizes greater than 16 KB, but data size determines where the hashing takes place. Data buffers less than 16 KB are hashed inside the HSM. Buffers between 16 KB and the maximum data size for your system are hashed locally in software. Remember: Hash functions do not require cryptographic secrets, so you can safely compute them outside of the HSM.

- [3.3] When operating on data by using any of the following mechanisms, if the data buffer exceeds the maximum data size, the operation results in an error. For these mechanisms, all the data processing must occur inside the HSM. The following table lists maximum data size set for each mechanism:

### Table 3.3, Maximum data set size

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Maximum Data Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKM_SHA_1_HMAC</td>
<td>16288</td>
</tr>
<tr>
<td>CKM_SHA224_HMAC</td>
<td>16256</td>
</tr>
<tr>
<td>CKM_SHA256_HMAC</td>
<td>16288</td>
</tr>
<tr>
<td>CKM_SHA384_HMAC</td>
<td>16224</td>
</tr>
<tr>
<td>CKM_SHA512_HMAC</td>
<td>16224</td>
</tr>
<tr>
<td>CKM_AES_CBC</td>
<td>16272</td>
</tr>
<tr>
<td>CKM_AES_GCM</td>
<td>16224</td>
</tr>
<tr>
<td>CKM_CLOUDHSM_AES_GCM</td>
<td>16224</td>
</tr>
<tr>
<td>CKM_DES3_CBC</td>
<td>16280</td>
</tr>
</tbody>
</table>

- [4] When performing AES-GCM encryption, the HSM does not accept initialization vector (IV) data from the application. You must use an IV that it generates. The 12-byte IV provided by the HSM is written into the memory reference pointed to by the pIV element of the CK_GCM_PARAMS parameters structure that you supply. To prevent user confusion, PKCS #11 SDK in version 1.1.1 and later ensures that pIV points to a zeroized buffer when AES-GCM encryption is initialized.

- [5] **Client SDK 3 only.** Mechanism is implemented to support SSL/TLS offload cases and is executed only partially within the HSM. Before using this mechanism, see "Issue: ECDH key derivation is executed only partially within the HSM" in Known issues for the PKCS #11 library (p. 640). CKM_ECDH1_DERIVE does not support the secp521r1 (P-521) curve.

- [6] The following CK_MECHANISM_TYPE and CK_RSA_PKCS_MGF_TYPE are supported as CK_RSA_PKCS_OAEP_PARAMS for CKM_RSA_PKCS_OAEP:
  - CKM_SHA_1 using CKG_MGF1_SHA1
  - CKM_SHA224 using CKG_MGF1_SHA224
  - CKM_SHA256 using CKG_MGF1_SHA256
  - CKM_SHA384 using CKG_MGF1_SHA384
  - CKM_SHA512 using CKG_MGF1_SHA512

- [7.1] Vendor-defined mechanism. In order to use the CloudHSM vendor defined mechanisms, PKCS#11 applications must include /opt/cloudhsm/include/pkcs11t.h during compilation.

**CKM_CLOUDHSM_AES_GCM:** This proprietary mechanism is a programmatically safer alternative to the standard CKM_AES_GCM. It prepends the IV generated by the HSM to the ciphertext instead of writing it back into the CK_GCM_PARAMS structure that is provided during cipher initialization. You can use this mechanism with C_Encrypt, C_WrapKey, C_Decrypt, and C_UnwrapKey functions. When using this mechanism, the pIV variable in the CK_GCM_PARAMS struct must be set to NULL. When using this mechanism with C_Decrypt and C_UnwrapKey, the IV is expected to be prepended to the ciphertext that is being unwrapped.
**CKM_CLOUDHSM_AES_KEY_WRAP_PKCS5_PAD**: AES Key Wrap with PKCS #5 Padding

**CKM_CLOUDHSM_AES_KEY_WRAP_ZERO_PAD**: AES Key Wrap with Zero Padding

For additional information regarding AES key wrapping, see [AES Key Wrapping](#) (p. 129).


### Supported API operations (Client SDK 3)

The PKCS #11 library supports the following PKCS #11 API operations.

- `C_CloseAllSessions`
- `C_CloseSession`
- `C_CreateObject`
- `C_Decrypt`
- `C_DecryptFinal`
- `C_DecryptInit`
- `C_DecryptUpdate`
- `C_DeriveKey`
- `C_DestroyObject`
- `C_Digest`
- `C_DigestFinal`
- `C_DigestInit`
- `C_DigestUpdate`
- `C_Encrypt`
- `C_EncryptFinal`
- `C_EncryptInit`
- `C_EncryptUpdate`
- `C_Finalize`
- `C_FindObjects`
- `C_FindObjectsFinal`
- `C_FindObjectsInit`
- `C_GenerateKey`
- `C_GenerateKeyPair`
- `C_GenerateRandom`
- `C_GetAttributeValue`
- `C_GetFunctionList`
- `C_GetInfo`
- `C_GetMechanismInfo`
- `C_GetMechanismList`
- `C_GetSessionInfo`
- `C_GetSlotInfo`
- `C_GetSlotList`
Supported key attributes (Client SDK 3)

A key object can be a public, private, or secret key. Actions permitted on a key object are specified through attributes. Attributes are defined when the key object is created. When you use the PKCS #11 library, we assign default values as specified by the PKCS #11 standard.

AWS CloudHSM does not support all attributes listed in the PKCS #11 specification. We are compliant with the specification for all attributes we support. These attributes are listed in the respective tables.

Cryptographic functions such as C_CreateObject, C_GenerateKey, C_GenerateKeyPair, C_UnWrapKey, and C_DeriveKey that create, modify, or copy objects take an attribute template as one of their parameters. For more information about passing an attribute template during object creation, see Generate keys through PKCS #11 library sample.

Interpreting the PKCS #11 library attributes table

The PKCS #11 library table contains a list of attributes that differ by key types. It indicates whether a given attribute is supported for a particular key type when using a specific cryptographic function with AWS CloudHSM.

Legend:

- ✔ indicates that CloudHSM supports the attribute for the specific key type.
- ✗ indicates that CloudHSM does not support the attribute for the specific key type.
- R indicates that the attribute value is set to read-only for the specific key type.
- S indicates that the attribute cannot be read by the GetAttributeValue as it is sensitive.
- An empty cell in the Default Value column indicates that there is no specific default value assigned to the attribute.
### GenerateKeyPair

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Key Type</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EC private</td>
<td>EC public</td>
</tr>
<tr>
<td>CKA_CLASS</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_KEY_TYPE</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_LABEL</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_ID</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_LOCAL</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>CKA_TOKEN</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_PRIVATE</td>
<td>✔️¹</td>
<td>✔️¹</td>
</tr>
<tr>
<td>CKA_ENCRYPT</td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_DECRYPT</td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_DERIVE</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_MODIFIABLE</td>
<td>✔️¹</td>
<td>✔️¹</td>
</tr>
<tr>
<td>CKA_DESTROYABLE</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_SIGN</td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_SIGN_RECOVER</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_VERIFY</td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_VERIFY_RECOVER</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_WRAP</td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_WRAP_TEMPLATE</td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_TRUSTED</td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_WRAP_WITH_TRUSTED</td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_UNWRAP</td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_UNWRAP_TEMPLATE</td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_SENSITIVE</td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_ALWAYS_SENSITIVE</td>
<td>R</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_EXTRACTABLE</td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_NEVER_EXTRACTABLE</td>
<td>R</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_MODULUS</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>
### Attribute Key Type Default Value

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Key Type</th>
<th></th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKA_MODULUS_BITS</td>
<td>✘</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_PRIME_1</td>
<td>✘</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_PRIME_2</td>
<td>✘</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_COEFFICIENT</td>
<td>✘</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_EXPONENT_1</td>
<td>✘</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_EXPONENT_2</td>
<td>✘</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_PRIVATE_EXPONENT</td>
<td>✘</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_PUBLIC_EXPONENT</td>
<td>✘</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_EC_PARAMS</td>
<td>✘</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_EC_POINT</td>
<td>✘</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_VALUE</td>
<td>✘</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_VALUE_LEN</td>
<td>✘</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_CHECK_VALUE</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
</tbody>
</table>

### GenerateKey

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Key Type</th>
<th>AES</th>
<th>DES3</th>
<th>Generic Secret</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKA_CLASS</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td>True</td>
</tr>
<tr>
<td>CKA_KEY_TYPE</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td>True</td>
</tr>
<tr>
<td>CKA_LABEL</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td>True</td>
</tr>
<tr>
<td>CKA_ID</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td>True</td>
</tr>
<tr>
<td>CKA_LOCAL</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>True</td>
</tr>
<tr>
<td>CKA_TOKEN</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td>False</td>
</tr>
<tr>
<td>CKA_PRIVATE</td>
<td>✔️ 1</td>
<td>✔️ 1</td>
<td>✔️ 1</td>
<td></td>
<td>True</td>
</tr>
<tr>
<td>CKA_ENCRYPT</td>
<td>✔</td>
<td>✔</td>
<td>✗</td>
<td></td>
<td>False</td>
</tr>
<tr>
<td>CKA_DECRYPT</td>
<td>✔</td>
<td>✔</td>
<td>✗</td>
<td></td>
<td>False</td>
</tr>
<tr>
<td>CKA_DERIVE</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td>False</td>
</tr>
<tr>
<td>CKA_MODIFIABLE</td>
<td>✔️ 1</td>
<td>✔️ 1</td>
<td>✔️ 1</td>
<td></td>
<td>True</td>
</tr>
<tr>
<td>CKA_DESTROYABLE</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td>True</td>
</tr>
<tr>
<td>Attribute</td>
<td>Key Type</td>
<td>Default Value</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------------</td>
<td>----------</td>
<td>---------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_SIGN</td>
<td>✔️</td>
<td>✔️ ✔️ ✔️</td>
<td>True</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_SIGN_RECOVER</td>
<td>✗</td>
<td>✗ ✗ ✗</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_VERIFY</td>
<td>✔️</td>
<td>✔️ ✔️ ✔️</td>
<td>True</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_VERIFY_RECOVER</td>
<td>✗</td>
<td>✗ ✗ ✗</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_WRAP</td>
<td>✔️</td>
<td>✔️ ✗ ✔️</td>
<td>False</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_WRAP_TEMPLATE</td>
<td>✔️</td>
<td>✔️ ✗ ✗</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_TRUSTED</td>
<td>✔️</td>
<td>✔️ ✗ ✗</td>
<td>False</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_WRAP_WITH_TRUSTED</td>
<td>✔️</td>
<td>✔️ ✔️ ✔️</td>
<td>False</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_UNWRAP</td>
<td>✔️</td>
<td>✔️ ✗ ✗</td>
<td>False</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_UNWRAP_TEMPLATE</td>
<td>✔️</td>
<td>✔️ ✔️ ✗</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKASENSITIVE</td>
<td>✔️</td>
<td>✔️ ✔️ ✔️</td>
<td>True</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_ALWAYS_SENSITIVE</td>
<td>✗</td>
<td>✗ ✗ ✗</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_EXTRACTABLE</td>
<td>✔️</td>
<td>✔️ ✔️ ✔️</td>
<td>True</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_NEVER_EXTRACTABLE</td>
<td>R</td>
<td>R R R</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_MODULUS</td>
<td>✗</td>
<td>✗ ✗ ✗</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_MODULUS_BITS</td>
<td>✗</td>
<td>✗ ✗ ✗</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA.PRIME_1</td>
<td>✗</td>
<td>✗ ✗ ✗</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA.PRIME_2</td>
<td>✗</td>
<td>✗ ✗ ✗</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_COEFFICIENT</td>
<td>✗</td>
<td>✗ ✗ ✗</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_EXPONENT_1</td>
<td>✗</td>
<td>✗ ✗ ✗</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_EXPONENT_2</td>
<td>✗</td>
<td>✗ ✗ ✗</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_PRIVATE_EXPONENT</td>
<td>✗</td>
<td>✗ ✗ ✗</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_PUBLIC_EXPONENT</td>
<td>✗</td>
<td>✗ ✗ ✗</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_EC_PARAMS</td>
<td>✗</td>
<td>✗ ✗ ✗</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_EC_POINT</td>
<td>✗</td>
<td>✗ ✗ ✗</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_VALUE</td>
<td>✗</td>
<td>✗ ✗ ✗</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_VALUE_LEN</td>
<td>✔️²</td>
<td>✗ ✔️²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKA_CHECK_VALUE</td>
<td>R</td>
<td>R R R</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CreateObject

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Key Type</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EC</td>
<td>EC</td>
</tr>
<tr>
<td></td>
<td>public</td>
<td>public</td>
</tr>
<tr>
<td></td>
<td>RSA</td>
<td>RSA</td>
</tr>
<tr>
<td></td>
<td>private</td>
<td>public</td>
</tr>
<tr>
<td></td>
<td>AES</td>
<td>DES3</td>
</tr>
<tr>
<td></td>
<td>Generic</td>
<td>Secret</td>
</tr>
<tr>
<td>CKA_CLASS</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_KEY_TYPE</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_LABEL</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_ID</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_LOCAL</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>CKA_TOKEN</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_PRIVATE</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_ENCRYPT</td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_DECRYPT</td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_DERIVE</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_MODIFIABLE</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_DESTROYABLE</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_SIGN</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_SIGN_RECOVER</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_VERIFY</td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_VERIFY_RECOVER</td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_WRAP</td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_WRAP_TEMPLATE</td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_TRUSTED</td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_WRAP_WITH_TRUSTED</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_UNWRAP</td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_UNWRAP_TEMPLATE</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_SENSITIVE</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_ALWAYS_SENSITIVE</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>CKA_EXTRACTABLE</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>CKA_NEVER_EXTRACTABLE</td>
<td>R</td>
<td>✔️</td>
</tr>
</tbody>
</table>
## PKCS #11 library

### Attribute Key Type Default Value

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Key Type</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKA_MODULUS</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_MODULUS_BITS</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_PRIME_1</td>
<td>✗</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_PRIME_2</td>
<td>✗</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_COEFFICIENT</td>
<td>✗</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_EXPONENT_1</td>
<td>✗</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_EXPONENT_2</td>
<td>✗</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_PRIVATE_EXPONENT</td>
<td>✗</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_PUBLIC_EXPONENT</td>
<td>✗</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_EC_PARAMS</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_EC_POINT</td>
<td>✗</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_VALUE</td>
<td>✗</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_VALUE_LEN</td>
<td>✗</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_CHECK_VALUE</td>
<td>R</td>
<td>✔</td>
</tr>
</tbody>
</table>

### UnwrapKey

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Key Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKA_CLASS</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_KEY_TYPE</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_LABEL</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_ID</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_LOCAL</td>
<td>R</td>
</tr>
<tr>
<td>CKA_TOKEN</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_PRIVATE</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_ENCRYPT</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_DECRYPT</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_DERIVE</td>
<td>✔</td>
</tr>
</tbody>
</table>

### Default Value

<table>
<thead>
<tr>
<th>EC private</th>
<th>RSA private</th>
<th>AES</th>
<th>DES3</th>
<th>Generic Secret</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
</tbody>
</table>

479
### Attribute

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Key Type</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKA_MODIFIABLE</td>
<td>✔</td>
<td>True</td>
</tr>
<tr>
<td>CKA.Destroyable</td>
<td>✔</td>
<td>True</td>
</tr>
<tr>
<td>CKA.SIGN</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA.SIGN_recovery</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_VERIFY</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_VERIFY_RECOVER</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA.WRAP</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA.UNWRAP</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_SENSITIVE</td>
<td>✔</td>
<td>True</td>
</tr>
<tr>
<td>CKA_EXTRACTABLE</td>
<td>✔</td>
<td>True</td>
</tr>
<tr>
<td>CKA.Never.Extractable</td>
<td>✔</td>
<td>True</td>
</tr>
<tr>
<td>CKA ALWAYS_SENSITIVE</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA.MODULUS</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA.MODULUS_BITS</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA.PRIME_1</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA.PRIME_2</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA.COEFFICIENT</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA.EXPONENT_1</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA.EXPONENT_2</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_PRIVATE_EXPONENT</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_PUBLIC_EXPONENT</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_EC_PARAMS</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_EC_POINT</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_VALUE</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_VALUE_LEN</td>
<td>✔</td>
<td>False</td>
</tr>
<tr>
<td>CKA_CHECK_VALUE</td>
<td>✔</td>
<td>False</td>
</tr>
</tbody>
</table>

### DeriveKey

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Key Type</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>AES</td>
<td></td>
<td>Generic Secret</td>
</tr>
<tr>
<td>Attribute</td>
<td>Key Type</td>
<td>Default Value</td>
</tr>
<tr>
<td>-----------------------</td>
<td>----------</td>
<td>---------------</td>
</tr>
<tr>
<td>CKA_CLASS</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_KEY_TYPE</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_LABEL</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_ID</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_LOCAL</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>CKA_TOKEN</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_PRIVATE</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_ENCRYPT</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_DECRYPT</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_DERIVE</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_MODIFIABLE</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_DESTROYABLE</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_SIGN</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_SIGN_RECOVER</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_VERIFY</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_VERIFY_RECOVER</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_WRAP</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_UNWRAP</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_SENSITIVE</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CKA_EXTRACTABLE</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CKA.Never_Extractable</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>CKA.ALWAYS_SENSITIVE</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>CKA.MODULUS</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA.MODULUS_BITS</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA.PRIME_1</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA.PRIME_2</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA.COEFFICIENT</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA.EXPONENT_1</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA.EXPONENT_2</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA.PRIVATE_EXPONENT</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>
## Attribute Key Type Default Value

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Key Type</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CKA_PUBLIC_EXPONENT</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_EC_PARAMS</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_EC_POINT</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_VALUE</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_VALUE_LEN</td>
<td>✓²</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_CHECK_VALUE</td>
<td>R</td>
<td>R</td>
</tr>
</tbody>
</table>

### GetAttributeValue

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Key Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EC private</td>
</tr>
<tr>
<td>CKA_CLASS</td>
<td>✓</td>
</tr>
<tr>
<td>CKA_KEY_TYPE</td>
<td>✓</td>
</tr>
<tr>
<td>CKA_LABEL</td>
<td>✓</td>
</tr>
<tr>
<td>CKA_ID</td>
<td>✓</td>
</tr>
<tr>
<td>CKA_LOCAL</td>
<td>✓</td>
</tr>
<tr>
<td>CKA_TOKEN</td>
<td>✓</td>
</tr>
<tr>
<td>CKA_PRIVATE</td>
<td>✓¹</td>
</tr>
<tr>
<td>CKA_ENCRYPT</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_DECRYPT</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_DERIVE</td>
<td>✓</td>
</tr>
<tr>
<td>CKA_MODIFIABLE</td>
<td>✓</td>
</tr>
<tr>
<td>CKA_DESTROYABLE</td>
<td>✓</td>
</tr>
<tr>
<td>CKA_SIGN</td>
<td>✓</td>
</tr>
<tr>
<td>CKA_SIGN_RECOVER</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_VERIFY</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_VERIFY_RECOVER</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_WRAP</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_WRAP_TEMPLATE</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_TRUSTED</td>
<td>✗</td>
</tr>
<tr>
<td>CKA_WRAP_WITH_TRUSTED</td>
<td>✓</td>
</tr>
<tr>
<td>Attribute</td>
<td>Key Type</td>
</tr>
<tr>
<td>----------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>CKA_UNWRAP</td>
<td>✗ ✗ ✔</td>
</tr>
<tr>
<td>CKA_UNWRAP_TEMPLATE</td>
<td>✔ ✗ ✔</td>
</tr>
<tr>
<td>CKA_SENSITIVE</td>
<td>✔ ✗ ✔</td>
</tr>
<tr>
<td>CKA_EXTRACTABLE</td>
<td>✔ ✗ ✔</td>
</tr>
<tr>
<td>CKA_NEVER_EXTRACTABLE</td>
<td>✔ ✗ ✔</td>
</tr>
<tr>
<td>CKA_ALWAYSSENSITIVE</td>
<td>R R; R R R R R</td>
</tr>
<tr>
<td>CKA_MODULUS</td>
<td>✗ ✗ ✔</td>
</tr>
<tr>
<td>CKA_MODULUS_BITS</td>
<td>✗ ✗ ✗ ✔</td>
</tr>
<tr>
<td>CKA_PRIME_1</td>
<td>✗ ✗ S ✗</td>
</tr>
<tr>
<td>CKA_PRIME_2</td>
<td>✗ ✗ S ✗</td>
</tr>
<tr>
<td>CKA_COEFFICIENT</td>
<td>✗ ✗ S ✗</td>
</tr>
<tr>
<td>CKA_EXPONENT_1</td>
<td>✗ ✗ ✗ ✗</td>
</tr>
<tr>
<td>CKA_EXPONENT_2</td>
<td>✗ ✗ S ✗</td>
</tr>
<tr>
<td>CKA_PRIVATE_EXPONENT</td>
<td>✗ ✗ S ✗</td>
</tr>
<tr>
<td>CKA_PUBLIC_EXPONENT</td>
<td>✗ ✗ ✔</td>
</tr>
<tr>
<td>CKA_EC_PARAMS</td>
<td>✔ ✔ ✗</td>
</tr>
<tr>
<td>CKA_EC_POINT</td>
<td>✔ ✗ ✗</td>
</tr>
<tr>
<td>CKA_VALUE</td>
<td>✗ ✗ ✗ ✔</td>
</tr>
<tr>
<td>CKA_VALUE_LEN</td>
<td>✗ ✗ ✔</td>
</tr>
<tr>
<td>CKA_CHECK_VALUE</td>
<td>✔ ✔ ✔</td>
</tr>
</tbody>
</table>

**Attribute annotations**

- [1] This attribute is partially supported by the firmware and must be explicitly set only to the default value.
- [3] **Client SDK 3 only.** The CKA_SIGN_RECOVER attribute is derived from the CKA_SIGN attribute. If being set, it can only be set to the same value that is set for CKA_SIGN. If not set, it derives the default value of CKA_SIGN. Since CloudHSM only supports RSA-based recoverable signature mechanisms, this attribute is currently applicable to RSA public keys only.
- [4] **Client SDK 3 only.** The CKA_VERIFY_RECOVER attribute is derived from the CKA_VERIFY attribute. If being set, it can only be set to the same value that is set for CKA_VERIFY. If not set, it derives the default value of CKA_VERIFY. Since CloudHSM only supports RSA-based recoverable signature mechanisms, this attribute is currently applicable to RSA public keys only.
Modifying attributes

Some attributes of an object can be modified after the object has been created, whereas some cannot. To modify attributes, use the `setAttribute` command from cloudhsm_mgmt_util. You can also derive a list of attributes and the constants that represent them by using the `listAttribute` command from cloudhsm_mgmt_util.

The following list displays attributes that are allowed for modification after object creation:

- `CKA_LABEL`
- `CKA_TOKEN`
  
  **Note**
  Modification is allowed only for changing a session key to a token key. Use the `setAttribute` command from key_mgmt_util to change the attribute value.

- `CKA_ENCRYPT`
- `CKA_DECRYPT`
- `CKA_SIGN`
- `CKA_VERIFY`
- `CKA_WRAP`
- `CKA_UNWRAP`
- `CKA_LABEL`
- `CKA_SENSITIVE`
- `CKA_DERIVE`
  
  **Note**
  This attribute supports key derivation. It must be `False` for all public keys and cannot be set to `True`. For secret and EC private keys, it can be set to `True` or `False`.

- `CKA_TRUSTED`
  
  **Note**
  This attribute can be set to `True` or `False` by Crypto Officer (CO) only.

- `CKA_WRAP_WITH_TRUSTED`
  
  **Note**
  Apply this attribute to an exportable data key to specify that you can only wrap this key with keys marked as `CKA_TRUSTED`. Once you set `CKA_WRAP_WITH_TRUSTED` to `true`, the attribute becomes read-only and you cannot change or remove the attribute.

Interpreting error codes

Specifying in the template an attribute that is not supported by a specific key results in an error. The following table contains error codes that are generated when you violate specifications:

<table>
<thead>
<tr>
<th>Error Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKR_TEMPLATE_INCONSISTENT</td>
<td>You receive this error when you specify an attribute in the attribute template, where the attribute complies with the PKCS #11 specification, but is not supported by CloudHSM.</td>
</tr>
<tr>
<td>CKR_ATTRIBUTE_TYPE_INVALID</td>
<td>You receive this error when you retrieve value for an attribute, which complies with the PKCS #11 specification, but is not supported by CloudHSM.</td>
</tr>
</tbody>
</table>

484
<table>
<thead>
<tr>
<th>Error Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKR_ATTRIBUTE_INCOMPLETE</td>
<td>You receive this error when you do not specify the mandatory attribute in the attribute template.</td>
</tr>
<tr>
<td>CKR_ATTRIBUTE_READ_ONLY</td>
<td>You receive this error when you specify a read-only attribute in the attribute template.</td>
</tr>
</tbody>
</table>

**Code samples for the PKCS #11 library (Client SDK 3)**

The code samples on GitHub show you how to accomplish basic tasks using the PKCS #11 library.

**Sample code prerequisites**

Before running the samples, perform the following steps to set up your environment:

- Install and configure the [PKCS #11 library](p.465) for Client SDK 3.
- Set up a [cryptographic user (CU)](p.60). Your application uses this HSM account to run the code samples on the HSM.

**Code samples**

Code Samples for the AWS CloudHSM Software Library for PKCS#11 are available on [GitHub](https://github.com). This repository includes examples on how to do common operations using PKCS#11 including encryption, decryption, signing and verifying.

- Generate keys (AES, RSA, EC)
- List key attributes
- Encrypt and decrypt data with AES GCM
- Encrypt and decrypt data with AES_CTR
- Encrypt and decrypt data with 3DES
- Sign and verify data with RSA
- Derive keys using HMAC KDF
- Wrap and unwrap keys with AES using PKCS #5 padding
- Wrap and unwrap keys with AES using no padding
- Wrap and unwrap keys with AES using zero padding
- Wrap and unwrap keys with AES-GCM
- Wrap and unwrap keys with RSA

**Installing Client SDK 3 for OpenSSL Dynamic Engine**

Client SDK 3 does require a client daemon to connect to the cluster. It supports:

- RSA key generation for 2048, 3072, and 4096-bit keys.
- RSA sign/verify.
- RSA encrypt/decrypt.
- Random number generation that is cryptographically secure and FIPS-validated.

**Topics**
• Prerequisites for OpenSSL Dynamic Engine with Client SDK 3 (p. 486)
• Install the OpenSSL Dynamic Engine for Client SDK 3 (p. 486)
• Use the OpenSSL Dynamic Engine for Client SDK 3 (p. 488)

Prerequisites for OpenSSL Dynamic Engine with Client SDK 3

For information about platform support, see the section called “Supported platforms” (p. 392).

Before you can use the AWS CloudHSM dynamic engine for OpenSSL, you need the AWS CloudHSM client.

The client is a daemon that establishes end-to-end encrypted communication with the HSMs in your cluster, and the OpenSSL engine communicates locally with the client. To install and configure the AWS CloudHSM client, see Install the client (Linux) (p. 256). Then use the following command to start it.

Amazon Linux

$ sudo start cloudhsm-client

Amazon Linux 2

$ sudo systemctl cloudhsm-client start

CentOS 6

$ sudo systemctl start cloudhsm-client

CentOS 7

$ sudo systemctl cloudhsm-client start

RHEL 6

$ sudo systemctl start cloudhsm-client

RHEL 7

$ sudo systemctl cloudhsm-client start

Ubuntu 16.04 LTS

$ sudo systemctl cloudhsm-client start

Install the OpenSSL Dynamic Engine for Client SDK 3

The following steps describe how to install and configure the AWS CloudHSM dynamic engine for OpenSSL. For information about upgrading, see Upgrading Client SDK 3 (p. 458).

To install and configure the OpenSSL engine

1. Use the following commands to download and install the OpenSSL engine.
Amazon Linux

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL6/cloudhsm-client-dyn-latest.el6.x86_64.rpm

$ sudo yum install ./cloudhsm-client-dyn-latest.el6.x86_64.rpm
```

Amazon Linux 2

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-dyn-latest.el7.x86_64.rpm

$ sudo yum install ./cloudhsm-client-dyn-latest.el7.x86_64.rpm
```

CentOS 6

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL6/cloudhsm-client-dyn-latest.el6.x86_64.rpm

$ sudo yum install ./cloudhsm-client-dyn-latest.el6.x86_64.rpm
```

CentOS 7

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-dyn-latest.el7.x86_64.rpm

$ sudo yum install ./cloudhsm-client-dyn-latest.el7.x86_64.rpm
```

RHEL 6

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL6/cloudhsm-client-dyn-latest.el6.x86_64.rpm

$ sudo yum install ./cloudhsm-client-dyn-latest.el6.x86_64.rpm
```

RHEL 7

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-dyn-latest.el7.x86_64.rpm

$ sudo yum install ./cloudhsm-client-dyn-latest.el7.x86_64.rpm
```

Ubuntu 16.04 LTS

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/Xenial/cloudhsm-client-dyn_latest_amd64.deb

$ sudo apt install ./cloudhsm-client-dyn_latest_amd64.deb
```
The OpenSSL engine is installed at `/opt/cloudhsm/lib/libcloudhsm_openssl.so`.

2. Use the following command to set an environment variable named `n3fips_password` that contains the credentials of a crypto user (CU).

```
$ export n3fips_password=<HSM user name>:<password>
```

**Use the OpenSSL Dynamic Engine for Client SDK 3**

To use the AWS CloudHSM dynamic engine for OpenSSL from an OpenSSL-integrated application, ensure that your application uses the OpenSSL dynamic engine named `cloudhsm`. The shared library for the dynamic engine is located at `/opt/cloudhsm/lib/libcloudhsm_openssl.so`.

To use the AWS CloudHSM dynamic engine for OpenSSL from the OpenSSL command line, use the `-engine` option to specify the OpenSSL dynamic engine named `cloudhsm`. For example:

```
$ openssl s_server -cert server.crt -key server.key -engine cloudhsm
```

**Client SDK 3 for JCE provider**

**Topics**

- Install and use the AWS CloudHSM JCE provider for Client SDK 3 (p. 488)
- Supported mechanisms for Client SDK 3 (p. 493)
- Supported Java key attributes for Client SDK 3 (p. 496)
- Code samples for the AWS CloudHSM software library for Java for Client SDK 3 (p. 502)
- Using AWS CloudHSM KeyStore Java class for Client SDK 3 (p. 503)

**Install and use the AWS CloudHSM JCE provider for Client SDK 3**

Before you can use the JCE provider, you need the AWS CloudHSM client.

The client is a daemon that establishes end-to-end encrypted communication with the HSMs in your cluster. The JCE provider communicates locally with the client. If you haven’t installed and configured the AWS CloudHSM client package, do that now by following the steps at Install the client (Linux) (p. 256). After you install and configure the client, use the following command to start it.

Note that the JCE provider is supported only on Linux and compatible operating systems.

Amazon Linux

```
$ sudo start cloudhsm-client
```

Amazon Linux 2

```
$ sudo systemctl cloudhsm-client start
```

CentOS 7

```
$ sudo systemctl cloudhsm-client start
```
Installing the JCE provider

Use the following commands to download and install the JCE provider. This provider is supported only on Linux and compatible operating systems.

**Note**
For upgrading, see [Upgrading Client SDK 3 (p. 458)](#).

### Amazon Linux

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL6/cloudhsm-client-jce-latest.el6.x86_64.rpm

$ sudo yum install ./cloudhsm-client-jce-latest.el6.x86_64.rpm
```

### Amazon Linux 2

```bash
$ wget https://s3.amazonaws.com/cloudhsmv2-software/CloudHsmClient/EL7/cloudhsm-client-jce-latest.el7.x86_64.rpm

$ sudo yum install ./cloudhsm-client-jce-latest.el7.x86_64.rpm
```
After you run the preceding commands, you can find the following JCE provider files:

- /opt/cloudhsm/java/cloudhsm-<version>.jar
- /opt/cloudhsm/java/cloudhsm-test-<version>.jar
- /opt/cloudhsm/java/hamcrest-all-1.3.jar
- /opt/cloudhsm/java/junit.jar
Validating the installation

Perform basic operations on the HSM to validate the installation.

To validate JCE provider installation

1. (Optional) If you don't already have Java installed in your environment, use the following command to install it.
   
   **Linux (and compatible libraries)**

   ```bash
   $ sudo yum install java-1.8.0-openjdk
   ```

   **Ubuntu**

   ```bash
   $ sudo apt-get install openjdk-8-jre
   ```

2. Use the following commands to set the necessary environment variables. Replace `<HSM user name>` and `<password>` with the credentials of a crypto user (CU).

   ```bash
   $ export LD_LIBRARY_PATH=/opt/cloudhsm/lib
   $ export HSM_PARTITION=PARTITION_1
   $ export HSM_USER=<HSM user name>
   $ export HSM_PASSWORD=<password>
   ```

3. Use the following command to run the basic functionality test. If successful, the command's output should be similar to the one that follows.

   ```bash
   $ java8 -classpath "/opt/cloudhsm/java/*" org.junit.runner.JUnitCore
   TestBasicFunctionality
   ```

   JUnit version 4.11
   (TestBasicFunctionality.java:33) - Adding provider.
   2018-08-20 17:53:48,612 DEBUG [main] TestBasicFunctionality
   (TestBasicFunctionality.java:42) - Logging in.
   2018-08-20 17:53:48,613 INFO [main] cfm2.LoginManager
   (LoginManager.java:104) - Looking for credentials in HsmCredentials.properties
   2018-08-20 17:53:48,613 INFO [main] cfm2/LoginManager
   (LoginManager.java:122) - Looking for credentials in System.properties
   2018-08-20 17:53:48,613 INFO [main] cfm2/LoginManager
   (LoginManager.java:130) - Looking for credentials in System.env
   SDK Version: 2.03
   2018-08-20 17:53:48,655 DEBUG [main] TestBasicFunctionality
   (TestBasicFunctionality.java:54) - Generating AES Key with key size 256.
   2018-08-20 17:53:48,698 DEBUG [main] TestBasicFunctionality
   (TestBasicFunctionality.java:63) - Encrypting with AES Key.
   2018-08-20 17:53:48,705 DEBUG [main] TestBasicFunctionality
   (TestBasicFunctionality.java:84) - Deleting AES Key.
Providing credentials to the JCE provider

HSMs need to authenticate your Java application before the application can use them. Each application can use one session. HSMs authenticate a session by using either explicit login or implicit login method.

**Explicit login** – This method lets you provide CloudHSM credentials directly in the application. It uses the `LoginManager.login()` method, where you pass the CU user name, password, and the HSM partition ID. For more information about using the explicit login method, see the [Login to an HSM](#) code example.

**Implicit login** – This method lets you set CloudHSM credentials either in a new property file, system properties, or as environment variables.

- **New property file** – Create a new file named `HsmCredentials.properties` and add it to your application’s `CLASSPATH`. The file should contain the following:

  ```properties
  HSM_PARTITION = PARTITION_1
  HSM_USER = <HSM user name>
  HSM_PASSWORD = <password>
  ```

- **System properties** – Set credentials through system properties when running your application. The following examples show two different ways that you can do this:

  ```bash
  $ java -D{HSM_PARTITION}=PARTITION_1 -D{HSM_USER}={HSM user name} -D{HSM_PASSWORD}={password}
  ```

  ```java
  System.setProperty("HSM_PARTITION","PARTITION_1");
  System.setProperty("HSM_USER","{HSM user name}");
  System.setProperty("HSM_PASSWORD","{password}");
  ```

- **Environment variables** – Set credentials as environment variables.

  ```bash
  $ export HSM_PARTITION=PARTITION_1
  $ export HSM_USER={HSM user name}
  $ export HSM_PASSWORD={password}
  ```

Credentials might not be available if the application does not provide them or if you attempt an operation before the HSM authenticates session. In those cases, the CloudHSM software library for Java searches for the credentials in the following order:

1. `HsmCredentials.properties`
2. System properties
3. Environment variables

**Error handling**

The error handling is easier with the explicit login than the implicit login method. When you use the `LoginManager` class, you have more control over how your application deals with failures. The implicit login method makes error handling difficult to understand when the credentials are invalid or the HSMs are having problems in authenticating session.
Key management basics in the JCE provider

The basics on key management in the JCE provider involve importing keys, exporting keys, loading keys by handle, or deleting keys. For more information on managing keys, see the Manage keys code example.

You can also find more JCE provider code examples at Code samples (p. 502).

Supported mechanisms for Client SDK 3

For information about the Java Cryptography Architecture (JCA) interfaces and engine classes supported by AWS CloudHSM, see the following topics.

Topics
- Supported keys (p. 493)
- Supported ciphers (p. 493)
- Supported digests (p. 495)
- Supported hash-based message authentication code (HMAC) algorithms (p. 496)
- Supported sign/verify mechanisms (p. 496)
- Mechanism annotations (p. 496)

Supported keys

The AWS CloudHSM software library for Java enables you to generate the following key types.

- AES – 128, 192, and 256-bit AES keys.
- DESede – 92 bit 3DES key. See note 1 below for an upcoming change.
- ECC key pairs for NIST curves secp256r1 (P-256), secp384r1 (P-384), and secp256k1 (Blockchain).
- RSA – 2048-bit to 4096-bit RSA keys, in increments of 256 bits.

In addition to standard parameters, we support the following parameters for each key that is generated.

- **Label**: A key label that you can use to search for keys.
- **isExtractable**: Indicates whether the key can be exported from the HSM.
- **isPersistent**: Indicates whether the key remains on the HSM when the current session ends.

**Note**
Java library version 3.1 provides the ability to specify parameters in greater detail. For more information, see Supported Java Attributes (p. 496).

Supported ciphers

The AWS CloudHSM software library for Java supports the following algorithm, mode, and padding combinations.

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Mode</th>
<th>Padding</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>AES</td>
<td>CBC</td>
<td>AES/CBC/NoPadding</td>
<td>Implements Cipher.ENCRYPT_MODE and Cipher.DECRYPT_MODE.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AES/CBC/PKCS5Padding</td>
<td></td>
</tr>
<tr>
<td>AES</td>
<td>ECB</td>
<td>AES/ECB/NoPadding</td>
<td>Implements Cipher.ENCRYPT_MODE</td>
</tr>
<tr>
<td>Algorithm</td>
<td>Mode</td>
<td>Padding</td>
<td>Notes</td>
</tr>
<tr>
<td>--------------------</td>
<td>------</td>
<td>------------------------</td>
<td>-----------------------------------------------------------------------</td>
</tr>
<tr>
<td>AES</td>
<td>ECB</td>
<td>AESWrap/ECB/NoPadding</td>
<td>Implements Cipher.WRAP_MODE, Cipher.UNWRAP_MODE. Use Transformation AES.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AESWrap/ECB/ZeroPadding</td>
<td></td>
</tr>
<tr>
<td>AESWrap</td>
<td>ECB</td>
<td>AESWrap/ECB/NoPadding</td>
<td>Implements Cipher.WRAP_MODE, Cipher.UNWRAP_MODE. Use Transformation AES.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AESWrap/ECB/ZeroPadding</td>
<td></td>
</tr>
<tr>
<td>AES</td>
<td>CTR</td>
<td>AES/CTR/NoPadding</td>
<td>Implements Cipher.ENCRYPT_MODE and Cipher.DECRYPT_MODE.</td>
</tr>
<tr>
<td>AES</td>
<td>GCM</td>
<td>AES/GCM/NoPadding</td>
<td>Implements Cipher.ENCRYPT_MODE and Cipher.DECRYPT_MODE, Cipher.WRAP_MODE, Cipher.UNWRAP_MODE. When performing AES-GCM encryption, the HSM ignores the initialization vector (IV) in the request and uses an IV that it generates. When the operation completes, you must call Cipher.getIV() to get the IV.</td>
</tr>
<tr>
<td>DESede (Triple DES)</td>
<td>CBC</td>
<td>DESede/CBC/NoPadding</td>
<td>Implements Cipher.ENCRYPT_MODE and Cipher.DECRYPT_MODE.</td>
</tr>
</tbody>
</table>

The key generation routines accept a size of 168 or 192 bits. However, internally, all DESede keys are 192 bits.

See note 1 below for an upcoming change.
<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Mode</th>
<th>Padding</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESede (Triple DES)</td>
<td>ECB</td>
<td>DESede/ECB/NoPadding</td>
<td>Implements Cipher.ENCRYPT.MODE and Cipher.DECRYPT_MODE.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DESede/ECB/PKCS5Padding</td>
<td>The key generation routines accept a size of 168 or 192 bits. However, internally, all DESede keys are 192 bits. See note 1 below for an upcoming change.</td>
</tr>
<tr>
<td>RSA</td>
<td>ECB</td>
<td>RSA/ECB/NoPadding</td>
<td>Implements Cipher.ENCRYPT_MODE and Cipher.DECRYPT_MODE.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RSA/ECB/PKCS1Padding</td>
<td>See note 1 below for an upcoming change.</td>
</tr>
<tr>
<td>RSA</td>
<td>ECB</td>
<td>RSA/ECB/OAEPNoPadding</td>
<td>Implements Cipher.ENCRYPT_MODE, Cipher.DECRYPT_MODE, Cipher.WRAP_MODE, Cipher.UNWRAP_MODE. OAEPPadding is OAEP with the SHA-1 padding type.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RSA/ECB/OAEPWithSHA-1AndMGF1Padding</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>RSA/ECB/OAEPWithSHA-224AndMGF1Padding</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>RSA/ECB/OAEPWithSHA-256AndMGF1Padding</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>RSA/ECB/OAEPWithSHA-384AndMGF1Padding</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>RSA/ECB/OAEPWithSHA-512AndMGF1Padding</td>
<td></td>
</tr>
<tr>
<td>RSAAESWrap</td>
<td>ECB</td>
<td>OAEPPADDING</td>
<td>Implements Cipher.WRAP_MODE and Cipher.UNWRAP_MODE.</td>
</tr>
</tbody>
</table>

**Supported digests**

The AWS CloudHSM software library for Java supports the following message digests.

- SHA-1
- SHA-224
- SHA-256
- SHA-384
- SHA-512
Note
Data under 16 KB in length are hashed on the HSM, while larger data are hashed locally in software.

Supported hash-based message authentication code (HMAC) algorithms

The AWS CloudHSM software library for Java supports the following HMAC algorithms.

- HmacSHA1
- HmacSHA224
- HmacSHA256
- HmacSHA384
- HmacSHA512

Supported sign/verify mechanisms

The AWS CloudHSM software library for Java supports the following types of signature and verification.

**RSA Signature Types**

- NONEwithRSA
- SHA1withRSA
- SHA224withRSA
- SHA256withRSA
- SHA384withRSA
- SHA512withRSA
- SHA1withRSA/PSS
- SHA224withRSA/PSS
- SHA256withRSA/PSS
- SHA384withRSA/PSS
- SHA512withRSA/PSS

**ECDSA Signature Types**

- NONEwithECDSA
- SHA1withECDSA
- SHA224withECDSA
- SHA256withECDSA
- SHA384withECDSA
- SHA512withECDSA

**Mechanism annotations**


**Supported Java key attributes for Client SDK 3**

This topic describes how to use a proprietary extension for the Java library version 3.1 to set key attributes. Use this extension to set supported key attributes and their values during these operations:
• Key generation
• Key import
• Key unwrap

**Note**
The extension for setting custom key attributes is an optional feature. If you already have code that functions in Java library version 3.0, you do not need to modify that code. Keys you create will continue to contain the same attributes as before.

**Topics**
• Understanding attributes (p. 497)
• Supported attributes (p. 497)
• Setting attributes for a key (p. 499)
• Putting it all together (p. 501)

**Understanding attributes**
You use key attributes to specify what actions are permitted on key objects, including public, private or secret keys. You define key attributes and values during key object creation operations.

However, the Java Cryptography Extension (JCE) does not specify how you should set values on key attributes, so most actions were permitted by default. In contrast, the PKCS# 11 standard defines a comprehensive set of attributes with more restrictive defaults. Starting with the Java library version 3.1, CloudHSM provides a proprietary extension that enables you to set more restrictive values for commonly used attributes.

**Supported attributes**
You can set values for the attributes listed in the table below. As a best practice, only set values for attributes you wish to make restrictive. If you don’t specify a value, CloudHSM uses the default value specified in the table below. An empty cell in the Default Value columns indicates that there is no specific default value assigned to the attribute.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKA_TOKEN</td>
<td>FALSE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Symmetric Key</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Public Key</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Private Key</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in Key Pair</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in Key Pair</td>
<td></td>
</tr>
</tbody>
</table>

A permanent key which is replicated across all HSMs in the cluster and included in backups. CKA_TOKEN = FALSE implies a session key, which is only loaded onto one HSM and automatically erased when the connection to the HSM is broken.
<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKA_LABEL</td>
<td></td>
<td>A user-defined string. It allows you to conveniently identify keys on your HSM.</td>
</tr>
<tr>
<td>CKA_EXTRACTABLE</td>
<td>TRUE</td>
<td>True indicates you can export this key out of the HSM.</td>
</tr>
<tr>
<td>CKA_ENCRYPT</td>
<td>TRUE</td>
<td>True indicates you can use the key to encrypt any buffer.</td>
</tr>
<tr>
<td>CKA_DECRYPT</td>
<td>TRUE</td>
<td>True indicates you can use the key to decrypt any buffer. You generally set this to FALSE for a key whose CKA_WRAP is set to true.</td>
</tr>
<tr>
<td>CKA_WRAP</td>
<td>TRUE</td>
<td>True indicates you can use the key to wrap another key. You will generally set this to FALSE for private keys.</td>
</tr>
<tr>
<td>CKA_UNWRAP</td>
<td>TRUE</td>
<td>True indicates you can use the key to unwrap (import) another key.</td>
</tr>
<tr>
<td>CKA_SIGN</td>
<td>TRUE</td>
<td>True indicates you can use the key to sign a message digest. This is generally set to FALSE for public keys and for private keys that you have archived.</td>
</tr>
<tr>
<td>CKA_VERIFY</td>
<td>TRUE</td>
<td>True indicates you can use the key to verify a signature. This is generally set to FALSE for private keys.</td>
</tr>
</tbody>
</table>
### Attribute Table

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Default Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKA_PRIVATE</td>
<td>TRUE</td>
<td>TRUE</td>
</tr>
</tbody>
</table>

**Note**
You get broader support for attributes in the PKCS#11 library. For more information, see [Supported PKCS #11 Attributes](p. 403).

### Setting attributes for a key

CloudHsmKeyAttributesMap is a Java Map-like object, which you can use to set attribute values for key objects. The methods for CloudHsmKeyAttributesMap function similar to the methods used for Java map manipulation.

To set custom values on attributes, you have two options:

- Use the methods listed in the following table
- Use builder patterns demonstrated later in this document

Attribute map objects support the following methods to set attributes:

<table>
<thead>
<tr>
<th>Operation</th>
<th>Return Value</th>
<th>CloudHSMKeyAttributesMap method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Get the value of a key attribute for an existing key</td>
<td>Object (containing the value) or null</td>
<td>get(keyAttribute)</td>
</tr>
<tr>
<td>Populate the value of one key attribute</td>
<td>The previous value associated with key attribute, or null if there was no mapping for a key attribute</td>
<td>put(keyAttribute, value)</td>
</tr>
<tr>
<td>Populate values for multiple key attributes</td>
<td>N/A</td>
<td>putAll(keyAttributesMap)</td>
</tr>
<tr>
<td>Remove a key-value pair from the attribute map</td>
<td>The previous value associated with key attribute, or null if there was no mapping for a key attribute</td>
<td>remove(keyAttribute)</td>
</tr>
</tbody>
</table>

**Note**
Any attributes you do not explicitly specify are set to the defaults listed in the preceding table in the section called “Supported attributes” (p. 497).
Builder pattern example

Developers will generally find it more convenient to utilize classes through the Builder pattern. As examples:

```java
import com.amazonaws.cloudhsm.CloudHsmKeyAttributes;
import com.amazonaws.cloudhsm.CloudHsmKeyAttributesMap;
import com.amazonaws.cloudhsm.CloudHsmKeyPairAttributesMap;

CloudHsmKeyAttributesMap keyAttributesSessionDecryptionKey =
    new CloudHsmKeyAttributesMap.Builder()
        .put(CloudHsmKeyAttributes.CKA_LABEL, "ExtractableSessionKeyEncryptDecrypt")
        .put(CloudHsmKeyAttributes.CKA_WRAP, false)
        .put(CloudHsmKeyAttributes.CKA_UNWRAP, false)
        .put(CloudHsmKeyAttributes.CKA_SIGN, false)
        .put(CloudHsmKeyAttributes.CKA_VERIFY, false)
        .build();

CloudHsmKeyAttributesMap keyAttributesTokenWrappingKey =
    new CloudHsmKeyAttributesMap.Builder()
        .put(CloudHsmKeyAttributes.CKA_LABEL, "TokenWrappingKey")
        .put(CloudHsmKeyAttributes.CKA_TOKEN, true)
        .put(CloudHsmKeyAttributes.CKA_ENCRYPT, false)
        .put(CloudHsmKeyAttributes.CKA_DECRYPT, false)
        .put(CloudHsmKeyAttributes.CKA_SIGN, false)
        .put(CloudHsmKeyAttributes.CKA_VERIFY, false)
        .build();

Developers may also utilize pre-defined attribute sets as a convenient way to enforce best practices in key templates. As an example:

```java
//best practice template for wrapping keys
CloudHsmKeyAttributesMap commonKeyAttrs = new CloudHsmKeyAttributesMap.Builder()
    .put(CloudHsmKeyAttributes.CKA_EXTRACTABLE, false)
    .put(CloudHsmKeyAttributes.CKA_DECRYPT, false)
    .build();

// initialize a new instance of CloudHsmKeyAttributesMap by copying commonKeyAttrs // but with an appropriate label
CloudHsmKeyAttributesMap firstKeyAttrs = new CloudHsmKeyAttributesMap(commonKeyAttrs);
firstKeyAttrs.put(CloudHsmKeyAttributes.CKA_LABEL, "key label");

// alternatively, putAll() will overwrite existing values to enforce conformance
CloudHsmKeyAttributesMap secondKeyAttrs = new CloudHsmKeyAttributesMap();
secondKeyAttrs.put(CloudHsmKeyAttributes.CKA_DECRYPT, true);
secondKeyAttrs.put(CloudHsmKeyAttributes.CKA_ENCRYPT, true);
secondKeyAttrs.put(CloudHsmKeyAttributes.CKA_LABEL, "safe wrapping key");
secondKeyAttrs.putAll(commonKeyAttrs); // will overwrite CKA_DECRYPT to be FALSE
```

Setting attributes for a key pair

Use the Java class CloudHsmKeyPairAttributesMap to handle key attributes for a key pair. CloudHsmKeyPairAttributesMap encapsulates two CloudHsmKeyAttributesMap objects; one for a public key and one for a private key.

To set individual attributes for the public key and private key separately, you can use the put() method on corresponding CloudHsmKeyAttributes map object for that key. Use the getPublic() method to retrieve the attribute map for the public key, and use getPrivate() to retrieve the attribute map for
the private key. Populate the value of multiple key attributes together for both public and private key pairs using the `putAll()` with a key pair attributes map as its argument.

**Builder pattern example**

Developers will generally find it more convenient to set key attributes through the Builder pattern. For example:

```java
import com.amazonaws.cloudhsm.CloudHsmKeyAttributes;
import com.amazonaws.cloudhsm.CloudHsmKeyAttributesMap;
import com.amazonaws.cloudhsm.CloudHsmKeyPairAttributesMap;

//specify attributes up-front
CloudHsmKeyAttributesMap keyAttributes =
    new CloudHsmKeyAttributesMap.Builder()
        .put(CloudHsmKeyAttributes.CKA_SIGN, false)
        .put(CloudHsmKeyAttributes.CKA_LABEL, "PublicCertSerial12345")
        .build();

CloudHsmKeyPairAttributesMap keyPairAttributes =
    new CloudHsmKeyPairAttributesMap.Builder()
        .withPublic(keyAttributes)
        .withPrivate(
            new CloudHsmKeyAttributesMap.Builder() //or specify them inline
                .put(CloudHsmKeyAttributes.CKA_LABEL, "PrivateCertSerial12345")
                .put(CloudHsmKeyAttributes.CKA_WRAP, false)
                .build()
        ).build();
```

**Note**

For more information about this proprietary extension, see the [Javadoc](archive) and the [sample](sample) on GitHub. To explore the Javadoc, download and expand the archive.

**Putting it all together**

To specify key attributes with your key operations, follow these steps:

1. Instantiate `CloudHsmKeyAttributesMap` for symmetric keys or `CloudHsmKeyPairAttributesMap` for key pairs.
2. Define the attributes object from step 1 with the required key attributes and values.
3. Instantiate a `Cavium*ParameterSpec` class, corresponding to your specific key type, and pass into its constructor this configured attributes object.
4. Pass this `Cavium*ParameterSpec` object into a corresponding crypto class or method.

For reference, the following table contains the `Cavium*ParameterSpec` classes and methods which support custom key attributes.

<table>
<thead>
<tr>
<th>Key Type</th>
<th>Parameter Spec Class</th>
<th>Example Constructors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Class</td>
<td><code>CaviumKeyGenAlgorithmParameterSpec</code></td>
<td><code>CaviumKeyGenAlgorithmParameterSpec(CloudHsmKeyAttributesMap)</code></td>
</tr>
<tr>
<td>DES</td>
<td><code>CaviumDESKeyGenParameterSpec</code></td>
<td><code>CaviumDESKeyGenParameterSpec(int keySize, byte[] iv, CloudHsmKeyAttributesMap)</code></td>
</tr>
</tbody>
</table>
### Key Type | Parameter Spec Class | Example Constructors
--- | --- | ---
RSA | CaviumRSAKeyGenParameterSpec | CaviumRSAKeyGenParameterSpec(int keysize, BigInteger publicExponent, CloudHsmKeyPairAttributesMap keyPairAttributesMap)
| Secret | CaviumGenericSecretKeyGenParameterSpec | CaviumGenericSecretKeyGenParameterSpec(int size, CloudHsmKeyAttributesMap keyAttributesMap)
| AES | CaviumAESKeyGenParameterSpec | CaviumAESKeyGenParameterSpec(int keySize, byte[] iv, CloudHsmKeyAttributesMap keyAttributesMap)
| EC | CaviumECGenParameterSpec | CaviumECGenParameterSpec(String stdName, CloudHsmKeyPairAttributesMap keyPairAttributesMap)

**Sample code: Generate and wrap a key**

These brief code samples demonstrate the steps for two different operations: Key Generation and Key Wrapping:

```java
// Set up the desired key attributes
KeyGenerator keyGen = KeyGenerator.getInstance("AES", "Cavium");
CaviumAESKeyGenParameterSpec keyAttributes = new CaviumAESKeyGenParameterSpec(
    256,
    new CloudHsmKeyAttributesMap.Builder()
        .put(CloudHsmKeyAttributes.CKA_LABEL, "MyPersistentAESKey")
        .put(CloudHsmKeyAttributes.CKA_EXTRACTABLE, true)
        .put(CloudHsmKeyAttributes.CKA_TOKEN, true)
        .build()
);

// Assume we already have a handle to the myWrappingKey
// Assume we already have the wrappedBytes to unwrap
// Unwrap a key using Custom Key Attributes
CaviumUnwrapParameterSpec unwrapSpec = new
    CaviumUnwrapParameterSpec(myInitializationVector, keyAttributes);
Cipher unwrapCipher = Cipher.getInstance("AESWrap", "Cavium");
unwrapCipher.init(Cipher.UNWRAP_MODE, myWrappingKey, unwrapSpec);
Key unwrappedKey = unwrapCipher.unwrap(wrappedBytes, "AES", Cipher.SECRET_KEY);
```

**Code samples for the AWS CloudHSM software library for Java for Client SDK 3**

**Prerequisites**

Before running the samples, you must set up your environment:
• Install and configure the Java Cryptographic Extension (JCE) provider (p. 489) and the AWS CloudHSM client package (p. 256).
• Set up a valid HSM user name and password (p. 60). Cryptographic user (CU) permissions are sufficient for these tasks. Your application uses these credentials to log in to the HSM in each example.
• Decide how to provide credentials to the JCE provider (p. 492).

Code samples

The following code samples show you how to use the AWS CloudHSM JCE provider (p. 422) to perform basic tasks. More code samples are available on GitHub.

• Log in to an HSM
• Manage keys
• Generate an AES key
• Encrypt and decrypt with AES-GCM
• Encrypt and decrypt with AES-CTR
• Encrypt and decrypt with D3DES-ECB [see note 1]
• Wrap and unwrap keys with AES-GCM
• Wrap and unwrap keys with AES
• Wrap and unwrap keys with RSA
• Use supported key attributes
• Enumerate keys in the key store
• Use the CloudHSM key store
• Sign messages in a multi-threaded sample
• Sign and Verify with EC Keys


Using AWS CloudHSM KeyStore Java class for Client SDK 3

The AWS CloudHSM KeyStore class provides a special-purpose PKCS12 key store that allows access to AWS CloudHSM keys through applications such as keytool and jarsigner. This key store can store certificates along with your key data and correlate them to key data stored on AWS CloudHSM.

Note
Because certificates are public information, and to maximize storage capacity for cryptographic keys, AWS CloudHSM does not support storing certificates on HSMs.

The AWS CloudHSM KeyStore class implements the KeyStore Service Provider Interface (SPI) of the Java Cryptography Extension (JCE). For more information about using KeyStore, see Class KeyStore.

Choosing the appropriate key store

The AWS CloudHSM Java Cryptographic Extension (JCE) provider comes with a default pass-through, read-only key store that passes all transactions to the HSM. This default key store is distinct from the special-purpose AWS CloudHSM KeyStore. In most situations, you will obtain better runtime performance and throughput by using the default. You should only use the AWS CloudHSM KeyStore for applications where you require support for certificates and certificate-based operations in addition to offloading key operations to the HSM.

Although both key stores use the JCE provider for operations, they are independent entities and do not exchange information with each other.
Load the default key store for your Java application as follows:

```java
KeyStore ks = KeyStore.getInstance("Cavium");
```

Load the special-purpose CloudHSM KeyStore as follows:

```java
KeyStore ks = KeyStore.getInstance("CloudHSM")
```

**Initializing AWS CloudHSM KeyStore**

Log into the AWS CloudHSM KeyStore the same way that you log into the JCE provider. You can use either environment variables or the system property file, and you should log in before you start using the CloudHSM KeyStore. For an example of logging into an HSM using the JCE provider, see [Login to an HSM](#).

If desired, you can specify a password to encrypt the local PKCS12 file which holds key store data. When you create the AWS CloudHSM Keystore, you set the password and provide it when using the load, set and get methods.

Instantiate a new CloudHSM KeyStore object as follows:

```java
ks.load(null, null);
```

Write keystore data to a file using the `store` method. From that point on, you can load the existing keystore using the `load` method with the source file and password as follows:

```java
ks.load(inputStream, password);
```

**Using AWS CloudHSM KeyStore**

A CloudHSM KeyStore object is generally used through a third-party application such as [jarsigner](#) or [keytool](#). You can also access the object directly with code.

AWS CloudHSM KeyStore complies with the JCE [Class KeyStore](#) specification and provides the following functions.

- **load**

  Loads the key store from the given input stream. If a password was set when saving the key store, this same password must be provided for the load to succeed. Set both parameters to null to initialize an new empty key store.

  ```java
  KeyStore ks = KeyStore.getInstance("CloudHSM");
  ks.load(inputStream, password);
  ```

- **aliases**

  Returns an enumeration of the alias names of all entries in the given key store instance. Results include objects stored locally in the PKCS12 file and objects resident on the HSM.

  **Sample code:**

  ```java
  KeyStore ks = KeyStore.getInstance("CloudHSM");
  for(Enumeration<String> entry = ks.aliases(); entry.hasMoreElements();)
  {
    String label = entry.nextElement();
    System.out.println(label);
  }
  ```
• ContainsAlias

Returns true if the key store has access to at least one object with the specified alias. The key store checks objects stored locally in the PKCS12 file and objects resident on the HSM.

• DeleteEntry

Deletes a certificate entry from the local PKCS12 file. Deleting key data stored in an HSM is not supported using the AWS CloudHSM KeyStore. You can delete keys with CloudHSM's `key_mgmt_util` tool.

• GetCertificate

Returns the certificate associated with an alias if available. If the alias does not exist or references an object which is not a certificate, the function returns NULL.

```java
KeyStore ks = KeyStore.getInstance("CloudHSM");
Certificate cert = ks.getCertificate(alias)
```

• GetCertificateAlias

Returns the name (alias) of the first key store entry whose data matches the given certificate.

```java
KeyStore ks = KeyStore.getInstance("CloudHSM");
String alias = ks.getCertificateAlias(cert)
```

• GetCertificateChain

Returns the certificate chain associated with the given alias. If the alias does not exist or references an object which is not a certificate, the function returns NULL.

• GetCreationDate

Returns the creation date of the entry identified by the given alias. If a creation date is not available, the function returns the date on which the certificate became valid.

• GetKey

GetKey is passed to the HSM and returns a key object corresponding to the given label. As getKey directly queries the HSM, it can be used for any key on the HSM regardless of whether it was generated by the KeyStore.

```java
Key key = ks.getKey(keyLabel, null);
```

• IsCertificateEntry

Checks if the entry with the given alias represents a certificate entry.

• IsKeyEntry

Checks if the entry with the given alias represents a key entry. The action searches both the PKCS12 file and the HSM for the alias.

• SetCertificateEntry

Assigns the given certificate to the given alias. If the given alias is already being used to identify a key or certificate, a KeyStoreException is thrown. You can use JCE code to get the key object and then use the KeyStore SetKeyEntry method to associate the certificate to the key.

• SetKeyEntry with byte[] key

This API is currently unsupported with Client SDK 3.
• **SetKeyEntry** with **Key** object

Assigns the given key to the given alias and stores it inside the HSM. If the Key object is not of type CaviumKey, the key is imported into the HSM as an extractable session key.

If the Key object is of type PrivateKey, it must be accompanied by a corresponding certificate chain.

If the alias already exists, the SetKeyEntry call throws a KeyStoreException and prevents the key from being overwritten. If the key must be overwritten, use KMU or JCE for that purpose.

• **EngineSize**

Returns the number of entries in the keystore.

• **Store**

Stores the key store to the given output stream as a PKCS12 file and secures it with the given password. In addition, it persists all loaded keys (which are set using setKey calls).
Integrating third-party applications with AWS CloudHSM

Some of the use cases (p. 1) for AWS CloudHSM involve integrating third-party software applications with the HSM in your AWS CloudHSM cluster. By integrating third-party software with AWS CloudHSM, you can accomplish a variety of security-related goals. The following topics describe how to accomplish some of these goals.

Topics
- Improve your web server security with SSL/TLS offload in AWS CloudHSM (p. 507)
- Configure Windows Server as a certificate authority (CA) with AWS CloudHSM (p. 570)
- Oracle database transparent data encryption (TDE) with AWS CloudHSM (p. 574)
- Use Microsoft SignTool with AWS CloudHSM to sign files (p. 578)
- Java Keytool and Jarsigner (p. 581)
- Other third-party vendor integrations (p. 599)

Improve your web server security with SSL/TLS offload in AWS CloudHSM

Web servers and their clients (web browsers) can use Secure Sockets Layer (SSL) or Transport Layer Security (TLS) protocols to confirm the identity of the web server and establish a secure connection that sends and receives webpages or other data over the internet. This is commonly known as HTTPS. The web server uses a public–private key pair and an SSL/TLS public key certificate to establish an HTTPS session with each client. This process involves a lot of computation for web servers, but you can offload some of this to your AWS CloudHSM cluster, which is referred to as SSL acceleration. Offloading reduces the computational burden on your web servers and provides extra security by storing servers’ private keys in HSMs.

The following topics provide an overview of how SSL/TLS offload with AWS CloudHSM works and tutorials for setting up SSL/TLS offload with AWS CloudHSM on the following platforms.

For Linux, use OpenSSL Dynamic Engine on the NGINX or Apache HTTP Server web server software

For Windows, use the Internet Information Services (IIS) for Windows Server web server software

Topics
- How SSL/TLS offload with AWS CloudHSM works (p. 507)
- SSL/TLS offload on Linux (p. 508)
- Using IIS with CNG for SSL/TLS offload on Windows (p. 558)
- Add a load balancer with Elastic Load Balancing (optional) (p. 566)

How SSL/TLS offload with AWS CloudHSM works

To establish an HTTPS connection, your web server performs a handshake process with clients. As part of this process, the server offloads some of the cryptographic processing to the HSMs, as shown in the following figure. Each step of the process is explained below the figure.
Note
The following image and process assumes that RSA is used for server verification and key exchange. The process is slightly different when Diffie–Hellman is used instead of RSA.

1. The client sends a hello message to the server.
2. The server responds with a hello message and sends the server's certificate.
3. The client performs the following actions:
   a. Verifies that the SSL/TLS server certificate is signed by a root certificate that the client trusts.
   b. Extracts the public key from the server certificate.
   c. Generates a premaster secret and encrypts it with the server's public key.
   d. Sends the encrypted premaster secret to the server.
4. To decrypt the client's premaster secret, the server sends it to the HSM. The HSM uses the private key in the HSM to decrypt the premaster secret and then it sends the premaster secret to the server. Independently, the client and server each use the premaster secret and some information from the hello messages to calculate a master secret.
5. The handshake process ends. For the rest of the session, all messages sent between the client and the server are encrypted with derivatives of the master secret.

To learn how to configure SSL/TLS offload with AWS CloudHSM, see one of the following topics:

- SSL/TLS offload on Linux (p. 508)
- Using IIS with CNG for SSL/TLS offload on Windows (p. 558)

SSL/TLS offload on Linux

With AWS CloudHSM, you can perform SSL/TLS offload on Linux with NGINX, Apache, and Tomcat. For more information, see the related topics below.

Topics
- Using NGINX or Apache with OpenSSL for SSL/TLS offload on Linux (p. 509)
- Using Tomcat with JSSE for SSL/TLS offload on Linux (p. 551)
Using NGINX or Apache with OpenSSL for SSL/TLS offload on Linux

This topic provides step-by-step instructions for setting up SSL/TLS offload with AWS CloudHSM on a Linux web server.

Topics
- Overview (p. 509)
- Step 1: Set up the prerequisites (p. 509)
- Step 2: Generate or import a private key and SSL/TLS certificate (p. 514)
- Step 3: Configure the web server (p. 520)
- Step 4: Enable HTTPS traffic and verify the certificate (p. 550)

Overview

On Linux, the NGINX and Apache HTTP Server web server software integrate with OpenSSL to support HTTPS. The AWS CloudHSM dynamic engine for OpenSSL (p. 418) provides an interface that enables the web server software to use the HSMs in your cluster for cryptographic offloading and key storage. The OpenSSL engine is the bridge that connects the web server to your AWS CloudHSM cluster.

To complete this tutorial, you must first choose whether to use the NGINX or Apache web server software on Linux. Then the tutorial shows you how to do the following:

- Install the web server software on an Amazon EC2 instance.
- Configure the web server software to support HTTPS with a private key stored in your AWS CloudHSM cluster.
- (Optional) Use Amazon EC2 to create a second web server instance and Elastic Load Balancing to create a load balancer. Using a load balancer can increase performance by distributing the load across multiple servers. It can also provide redundancy and higher availability if one or more servers fail.

When you're ready to get started, go to Step 1: Set up the prerequisites (p. 509).

Step 1: Set up the prerequisites

Different platforms require different prerequisites. Use the prerequisites section below that matches your platform.

Topics
- Prerequisites for Client SDK 5 (p. 509)
- Prerequisites for Client SDK 3 (p. 512)

Prerequisites for Client SDK 5

To set up web server SSL/TLS offload with Client SDK 5, you need the following:

- An active AWS CloudHSM cluster with at least two hardware security modules (HSM)
  
  **Note**
  You can use a single HSM cluster, but you must first disable client key durability. For more information, see Manage Client Key Durability Settings (p. 125) and Client SDK 5 Configure Tool (p. 159).

- An Amazon EC2 instance running a Linux operating system with the following software installed:
• A web server (either NGINX or Apache)
• The OpenSSL Dynamic Engine for Client SDK 5
• A crypto user (p. 61) (CU) to own and manage the web server's private key on the HSM.

To set up a Linux web server instance and create a CU on the HSM

1. Install and configure the OpenSSL Dynamic Engine for AWS CloudHSM. For more information about installing OpenSSL Dynamic Engine, see OpenSSL Dynamic Engine for Client SDK 5 (p. 419).
2. On an EC2 Linux instance that has access to your cluster, install either NGINX or Apache web server:

Amazon Linux

• NGINX

$ sudo yum install nginx

• Apache

$ sudo yum install httpd24 mod24_ssl

Amazon Linux 2

• For information on how to download the latest version of NGINX on Amazon Linux 2, see the NGINX website.

The latest version of NGINX available for Amazon Linux 2 uses a version of OpenSSL that is newer than the system version of OpenSSL. After installing NGINX, you need to create a symbolic link from the AWS CloudHSM OpenSSL Dynamic Engine library to the location that this version of OpenSSL expects

$ sudo ln -sf /opt/cloudhsm/lib/libcloudhsm_openssl_engine.so /usr/lib64/engines-1.1/cloudhsm.so

• Apache

$ sudo yum install httpd mod_ssl

CentOS 7

• For information on how to download the latest version of NGINX on CentOS 7, see the NGINX website.

The latest version of NGINX available for CentOS 7 uses a version of OpenSSL that is newer than the system version of OpenSSL. After installing NGINX, you need to create a symbolic link from the AWS CloudHSM OpenSSL Dynamic Engine library to the location that this version of OpenSSL expects

$ sudo ln -sf /opt/cloudhsm/lib/libcloudhsm_openssl_engine.so /usr/lib64/engines-1.1/cloudhsm.so

• Apache

$ sudo yum install httpd mod_ssl
Red Hat 7

- For information on how to download the latest version of NGINX on Red Hat 7, see the [NGINX website](#).

The latest version of NGINX available for Red Hat 7 uses a version of OpenSSL that is newer than the system version of OpenSSL. After installing NGINX, you need to create a symbolic link from the AWS CloudHSM OpenSSL Dynamic Engine library to the location that this version of OpenSSL expects

```
$ sudo ln -sf /opt/cloudhsm/lib/libcloudhsm_openssl_engine.so /usr/lib64/engines-1.1/cloudhsm.so
```

- Apache

```
$ sudo yum install httpd mod_ssl
```

CentOS 8

- NGINX

```
$ sudo yum install nginx
```

- Apache

```
$ sudo yum install httpd mod_ssl
```

Red Hat 8

- NGINX

```
$ sudo yum install nginx
```

- Apache

```
$ sudo yum install httpd mod_ssl
```

Ubuntu 18.04

- NGINX

```
$ sudo apt install nginx
```

- Apache

```
$ sudo apt install apache2
```

Ubuntu 20.04

- NGINX
**SSL/TLS offload on Linux**

1. Complete the steps in **Getting started (p. 7)**. You will then have an active cluster with one HSM and an Amazon EC2 client instance. Your EC2 instance will be configured with the command line tools. Use this client instance as your web server.

2. Connect to your client instance. For more information, see **connecting to your linux instance using ssh** or **Connecting to Your Linux Instance from Windows Using PuTTY** in the Amazon EC2 documentation.

---

**Notes**

- To use Security-Enhanced Linux (SELinux) and web servers, you must allow outbound TCP connections on port 2223, which is the port Client SDK 3 uses to communicate with the HSM.
- To create and activate a cluster and give an EC2 instance access to the cluster, complete the steps in **Getting Started with AWS CloudHSM (p. 7)**. The getting started offers step-by-step instruction for creating an active cluster with one HSM and an Amazon EC2 client instance. You can use this client instance as your web server.
- To avoid disabling client key durability, add more than one HSM to your cluster. For more information, see **Adding an HSM (p. 44)**.
- To connect to your client instance, you can use SSH or PuTTY. For more information, see **Connecting to Your Linux Instance Using SSH** or **Connecting to Your Linux Instance from Windows Using PuTTY** in the Amazon EC2 documentation.

---

**Prerequisites for Client SDK 3**

To set up web server SSL/TLS offload with Client SDK 3, you need the following:

- An active AWS CloudHSM cluster with at least one HSM.
- An Amazon EC2 instance running a Linux operating system with the following software installed:
  - The AWS CloudHSM client and command line tools.
  - The NGINX or Apache web server application.
  - The AWS CloudHSM dynamic engine for OpenSSL.
- A **crypto user (p. 61)** (CU) to own and manage the web server's private key on the HSM.
3. On an EC2 Linux instance that has access to your cluster, install either NGINX or Apache web server:

Amazon Linux
- NGINX

    $ sudo yum install nginx

- Apache

    $ sudo yum install httpd24 mod24_ssl

Amazon Linux 2
- NGINX version 1.19 is the latest version of NGINX compatible with the Client SDK 3 engine on Amazon Linux 2.

    For more information and to download NGINX version 1.19, see the [NGINX website](https://nginx.org).

- Apache

    $ sudo yum install httpd mod_ssl

CentOS 7
- NGINX version 1.19 is the latest version of NGINX compatible with the Client SDK 3 engine on CentOS 7.

    For more information and to download NGINX version 1.19, see the [NGINX website](https://nginx.org).

- Apache

    $ sudo yum install httpd mod_ssl

Red Hat 7
- NGINX version 1.19 is the latest version of NGINX compatible with the Client SDK 3 engine on Red Hat 7.

    For more information and to download NGINX version 1.19, see the [NGINX website](https://nginx.org).

- Apache

    $ sudo yum install httpd mod_ssl

Ubuntu 16.04
- NGINX

    $ sudo apt install nginx

- Apache

    $ sudo apt install apache2
Ubuntu 18.04

- NGINX
  
  ```
  $ sudo apt install nginx
  ```

- Apache
  
  ```
  $ sudo apt install apache2
  ```

4. (Optional) Add more HSMs to your cluster. For more information, see Adding an HSM (p. 44).

5. Use cloudhsm_mgm_util to create a CU. For more information, see Managing HSM users (p. 60).

  Keep track of the CU user name and password. You will need them later when you generate or import the HTTPS private key and certificate for your web server.

After you complete these steps, go to Step 2: Generate or import a private key and SSL/TLS certificate (p. 514).

**Step 2: Generate or import a private key and SSL/TLS certificate**

To enable HTTPS, your web server application (NGINX or Apache) needs a private key and a corresponding SSL/TLS certificate. To use web server SSL/TLS offload with AWS CloudHSM, you must store the private key in an HSM in your AWS CloudHSM cluster. You can accomplish this in one of the following ways:

- If you don't yet have a private key and a corresponding certificate, generate a private key in an HSM. You use the private key to create a certificate signing request (CSR), which you use to create the SSL/TLS certificate.
- If you already have a private key and corresponding certificate, import the private key into an HSM.

Regardless of which of the preceding methods you choose, you export a *fake PEM private key* from the HSM, which is a private key file in PEM format which contains a reference to the private key stored on the HSM (it's not the actual private key). Your web server uses the fake PEM private key file to identify the private key on the HSM during SSL/TLS offload.

**Do one of the following:**

- Generate a private key and certificate (p. 514)
- Import an existing private key and certificate (p. 518)

**Generate a private key and certificate**

**Generate a private key**

This section shows you how to generate a keypair using the Key Management Utility (KMU) (p. 301) from Client SDK 3. Once you have a key pair generated inside the HSM, you can export it as a fake PEM file, and generate the corresponding certificate.

Private keys generated with the Key Management Utility (KMU) can be used with both Client SDK 3 and Client SDK 5.

**Install and configure the Key Management Utility (KMU)**

1. Connect to your client instance.
2. Install and Configure (p. 256) Client SDK 3.
3. Run the following command to start the AWS CloudHSM client.

Amazon Linux

```
$ sudo start cloudhsm-client
```

Amazon Linux 2

```
$ sudo service cloudhsm-client start
```

CentOS 7

```
$ sudo service cloudhsm-client start
```

CentOS 8

```
$ sudo service cloudhsm-client start
```

RHEL 7

```
$ sudo service cloudhsm-client start
```

RHEL 8

```
$ sudo service cloudhsm-client start
```

Ubuntu 16.04 LTS

```
$ sudo service cloudhsm-client start
```

Ubuntu 18.04 LTS

```
$ sudo service cloudhsm-client start
```

Ubuntu 20.04 LTS

```
$ sudo service cloudhsm-client start
```

Ubuntu 22.04 LTS

```
$ sudo service cloudhsm-client start
```

Support for OpenSSL Dynamic Engine is not yet available.

4. Run the following command to start the key_mgmt_util command line tool.

```
$ /opt/cloudhsm/bin/key_mgmt_util
```

5. Run the following command to log in to the HSM. Replace <user name> and <password> with the user name and password of the cryptographic user (CU).

Command: `loginHSM -u CU -s <user name> -p <password>`
Depending on your use case, you can either generate an RSA or an EC key pair. Do one of the following:

• To generate an RSA private key on an HSM

Use the `genRSAKeyPair` command to generate an RSA key pair. This example generates an RSA key pair with a modulus of 2048, a public exponent of 65537, and a label of `tls_rsa_keypair`.

Command: `genRSAKeyPair -m 2048 -e 65537 -l tls_rsa_keypair`

If the command was successful, you should see the following output indicating that you've successfully generated an RSA key pair.

```
Cfm3GenerateKeyPair returned: 0x00 : HSM Return: SUCCESS
    Cfm3GenerateKeyPair:    public key handle: 7    private key handle: 8
    Cluster Status:       Node id 1 status: 0x00000000 : HSM Return: SUCCESS
```

• To generate an EC private key on an HSM

Use the `genECCKeyPair` command to generate an EC key pair. This example generates an EC key pair with a curve ID of 2 (corresponding to the `NID_X9_62_prime256v1` curve) and a label of `tls_ec_keypair`.

Command: `genECCKeyPair -i 2 -l tls_ec_keypair`

If the command was successful, you should see the following output indicating that you've successfully generated an EC key pair.

```
Cfm3GenerateKeyPair returned: 0x00 : HSM Return: SUCCESS
    Cfm3GenerateKeyPair:    public key handle: 7    private key handle: 8
    Cluster Status:       Node id 1 status: 0x00000000 : HSM Return: SUCCESS
```

**Export a fake PEM private key file**

Once you have a private key on the HSM, you must export a fake PEM private key file. This file does not contain the actual key data, but it allows the OpenSSL Dynamic Engine to identify the private key on the HSM. You can then use the private key to create a certificate signing request (CSR) and sign the CSR to create the certificate.

**Note**
Fake PEM files generated with the Key Management Utility (KMU) can be used with both Client SDK 3 and Client SDK 5.

Identify the key handle that corresponds to the key that you would like to export as a fake PEM, then run the following command to export the private key in fake PEM format and save it to a file. Replace the following values with your own.

- `<private_key_handle>` – Handle of the generated private key. This handle was generated by one of the key generation commands in the preceding step. In the preceding example, the handle of the private key is 8.
- `<web_server_fake_PEM.key>` – Name of the file that your fake PEM key will be written to.
**SSL/TLS offload on Linux**

**Command:**

```bash
getCaviumPrivKey -k <private_key_handle> -out <web_server_fake_PEM.key>
```

**Exit**

Run the following command to stop the key_mgmt_util.

**Command:**

```bash
exit
```

You should now have a new file on your system, located at the path specified by `<web_server_fake_PEM.key>` in the preceding command. This file is the fake PEM private key file.

**Generate a self-signed certificate**

Once you have generated a fake PEM private key, you can use this file to generate a certificate signing request (CSR) and certificate.

In a production environment, you typically use a certificate authority (CA) to create a certificate from a CSR. A CA is not necessary for a test environment. If you do use a CA, send the CSR file to them and use signed SSL/TLS certificate that they provide you in your web server for HTTPS.

As an alternative to using a CA, you can use the AWS CloudHSM OpenSSL Dynamic Engine to create a self-signed certificate. Self-signed certificates are not trusted by browsers and should not be used in production environments. They can be used in test environments.

**Warning**

Self-signed certificates should be used in a test environment only. For a production environment, use a more secure method such as a certificate authority to create a certificate.

**Install and configure the OpenSSL Dynamic Engine**

1. Connect to your client instance.
2. To install and configure, do one of the following:
   - the section called "Installing the OpenSSL Dynamic Engine" (p. 419)
   - the section called "OpenSSL Dynamic Engine" (p. 485)

**Generate a certificate**

1. Obtain a copy of your fake PEM file generated in an earlier step.
2. Create a CSR

   Run the following command to use the AWS CloudHSM OpenSSL Dynamic Engine to create a certificate signing request (CSR). Replace `<web_server_fake_PEM.key>` with the name of the file that contains your fake PEM private key. Replace `<web_server.csr>` with the name of the file that contains your CSR.

   ```bash
   openssl req -engine cloudhsm -new -key <web_server_fake_PEM.key> -out <web_server.csr>
   ```

3. Create a self-signed certificate

   Run the following command to use the AWS CloudHSM OpenSSL Dynamic Engine to sign your CSR with your private key on your HSM. This creates a self-signed certificate. Replace the following values in the command with your own.

   ```bash
   openssl req -engine cloudhsm -new -key <web_server_fake_PEM.key> -out <web_server.csr>
   ```

   - `<web_server.csr>` - Name of the file that contains the CSR.
SSL/TLS offload on Linux

- `<web_server_fake_PEM.key>` – Name of the file that contains the fake PEM private key.
- `<web_server.crt>` – Name of the file that will contain your web server certificate.

```
$ openssl x509 -engine cloudhsm -req -days 365 -in <web_server.csr> -signkey <web_server_fake_PEM.key> -out <web_server.crt>
```

After you complete these steps, go to Step 3: Configure the web server (p. 520).

Import an existing private key and certificate

You might already have a private key and a corresponding SSL/TLS certificate that you use for HTTPS on your web server. If so, you can import that key into an HSM by following the steps in this section.

**Note**
Some notes on private key imports and Client SDK compatibility:

- Importing an existing private key requires Client SDK 3.
- You can use private keys from Client SDK 3 with Client SDK 5.
- OpenSSL Dynamic Engine for Client SDK 3 does not support the latest Linux platforms, but the implementation of OpenSSL Dynamic Engine for Client SDK 5 does. You can import an existing private key using the Key Management Utility (KMU) provided with Client SDK 3, then use that private key and the implementation of OpenSSL Dynamic Engine with Client SDK 5 to support SSL/TLS offload on the latest Linux platforms.

To import an existing private key into an HSM with Client SDK 3

1. Connect to your Amazon EC2 client instance. If necessary, copy your existing private key and certificate to the instance.
2. Install and Configure (p. 256) Client SDK 3
3. Run the following command to start the AWS CloudHSM client.

   Amazon Linux

   ```
   $ sudo start cloudhsm-client
   ```

   Amazon Linux 2

   ```
   $ sudo service cloudhsm-client start
   ```

   CentOS 7

   ```
   $ sudo service cloudhsm-client start
   ```

   CentOS 8

   ```
   $ sudo service cloudhsm-client start
   ```

   RHEL 7

   ```
   $ sudo service cloudhsm-client start
   ```
RHEL 8

$ sudo service cloudhsm-client start

Ubuntu 16.04 LTS

$ sudo service cloudhsm-client start

Ubuntu 18.04 LTS

$ sudo service cloudhsm-client start

Ubuntu 20.04 LTS

$ sudo service cloudhsm-client start

Ubuntu 22.04 LTS

Support for OpenSSL Dynamic Engine is not yet available.

4. Run the following command to start the key_mgmt_util command line tool.

$ /opt/cloudhsm/bin/key_mgmt_util

5. Run the following command to log in to the HSM. Replace <user name> and <password> with the user name and password of the cryptographic user (CU).

Command: loginHSM -u CU -s <user name> -p <password>

6. Run the following commands to import your private key into an HSM.

a. Run the following command to create a symmetric wrapping key that is valid for the current session only. The command and output are shown. Replace the following values with your own:

Command: genSymKey -t 31 -s 16 -sess -l wrapping_key_for_import

Cfm3GenerateSymmetricKey returned: 0x00 : HSM Return: SUCCESS
Symmetric Key Created. Key Handle: 6
Cluster Error Status
Node id 0 and err state 0x00000000 : HSM Return: SUCCESS

b. Run the following command to import your existing private key into an HSM. The command and output are shown. Replace the following values with your own:

• <web_server_existing.key> – Name of the file that contains your private key.
• <web_server_imported_key> – Label for your imported private key.
• <wrapping_key_handle> – Wrapping key handle generated by the preceding command. In the previous example, the wrapping key handle is 6.

Command: importPrivateKey -f <web_server_existing.key> -l <web_server_imported_key> -w <wrapping_key_handle>

BER encoded key length is 1219
Cfm3WrapHostKey returned: 0x00 : HSM Return: SUCCESS
Cfm3CreateUnwrapTemplate returned: 0x00 : HSM Return: SUCCESS
7. Run the following command to export the private key in fake PEM format and save it to a file. Replace the following values with your own.

- `<private_key_handle>` – Handle of the imported private key. This handle was generated by the second command in the preceding step. In the preceding example, the handle of the private key is 8.
- `<web_server_fake_PEM.key>` – Name of the file that contains your exported fake PEM private key.

Command: `getCaviumPrivKey -k <private_key_handle> -out <web_server_fake_PEM.key>`

8. Run the following command to stop key_mgmt_util.

Command: `exit`

After you complete these steps, go to Step 3: Configure the web server (p. 520).

**Step 3: Configure the web server**

Update your web server software's configuration to use the HTTPS certificate and corresponding fake PEM private key that you created in the previous step (p. 514). Remember to backup your existing certificates and keys before you start. This will finish setting up your Linux web server software for SSL/TLS offload with AWS CloudHSM.

Complete the steps from one of the following sections.

**Topics**

- Configure NGINX web server (p. 520)
- Configure Apache web server (p. 536)

**Configure NGINX web server**

Use this section to configure NGINX on supported platforms.

**To update the web server configuration for NGINX**

1. Connect to your client instance.
2. Run the following command to create the required directories for the web server certificate and the fake PEM private key.

   ```bash
   $ sudo mkdir -p /etc/pki/nginx/private
   ```

3. Run the following command to copy your web server certificate to the required location. Replace `<web_server.crt>` with the name of your web server certificate.

   ```bash
   $ sudo cp <web_server.crt> /etc/pki/nginx/server.crt
   ```

4. Run the following command to copy your fake PEM private key to the required location. Replace `<web_server_fake_PEM.key>` with the name of the file that contains your fake PEM private key.

   ```bash
   $ sudo cp <web_server_fake_PEM.key> /etc/pki/nginx/server.key
   ```
5. Run the following command to change the file ownership so that the user named nginx can read them.

```bash
$ sudo chown nginx /etc/pki/nginx/server.crt /etc/pki/nginx/private/server.key
```

6. Run the following command to back up the /etc/nginx/nginx.conf file.

```bash
$ sudo cp /etc/nginx/nginx.conf /etc/nginx/nginx.conf.backup
```

7. Update the NGINX configuration.

   **Note**
   Each cluster can support a maximum of 1000 NGINX worker processes across all NGINX web servers.

**Amazon Linux**

Use a text editor to edit the /etc/nginx/nginx.conf file. This requires Linux root permissions. At the top of the file, add the following lines:

- If using Client SDK 3

```bash
ssl_engine cloudhsm;
env n3fips_password;
```

- If using Client SDK 5

```bash
ssl_engine cloudhsm;
env CLOUDHSM_PIN;
```

Then add the following to the TLS section of the file:

```bash
# Settings for a TLS enabled server.
server {
    listen 443 ssl http2 default_server;
    listen [::]:443 ssl http2 default_server;
    server_name _;
    root /usr/share/nginx/html;

    ssl_certificate "/etc/pki/nginx/server.crt";
    ssl_certificate_key "/etc/pki/nginx/private/server.key";
    # It is *strongly* recommended to generate unique DH parameters
    # Generate them with: openssl dhparam -out /etc/pki/nginx/dhparams.pem 2048
    #ssl_dhparam "/etc/pki/nginx/dhparams.pem";
    ssl_session_cache shared:SSL:1m;
    ssl_session_timeout 10m;
    ssl_protocols TLSv1.2;
    ssl_prefer_server_ciphers on;

    # Load configuration files for the default server block.
    include /etc/nginx/default.d/*.conf;
```
location / {
}

error_page 404 /404.html;
location = /40x.html {
}

error_page 500 502 503 504 /50x.html;
location = /50x.html {
}

Amazon Linux 2

Use a text editor to edit the /etc/nginx/nginx.conf file. This requires Linux root permissions. At the top of the file, add the following lines:

- If using Client SDK 3

  ```
  ssl_engine cloudhsm;
  env n3fips_password;
  ```

- If using Client SDK 5

  ```
  ssl_engine cloudhsm;
  env CLOUDHSM_PIN;
  ```

Then add the following to the TLS section of the file:

```
# Settings for a TLS enabled server.
server {
  listen 443 ssl http2 default_server;
  listen [::]:443 ssl http2 default_server;
  server_name _;
  root /usr/share/nginx/html;
  
  ssl_certificate "/etc/pki/nginx/server.crt";
  ssl_certificate_key "/etc/pki/nginx/private/server.key";
  # It is *strongly* recommended to generate unique DH parameters
  # Generate them with: openssl dhparam -out /etc/pki/nginx/dhparams.pem 2048
  #ssl_dhparam "/etc/pki/nginx/dhparams.pem";
  ssl_session_cache shared:SSL:1m;
  ssl_session_timeout  10m;
  ssl_protocols TLSv1.2;
  ssl_prefer_server_ciphers on;
  
  # Load configuration files for the default server block.
  include /etc/nginx/default.d/*.conf;

  location / {
  }

  error_page 404 /404.html;
```
CentOS 7

Use a text editor to edit the `/etc/nginx/nginx.conf` file. This requires Linux root permissions. At the top of the file, add the following lines:

- If using Client SDK 3

  ```
ssl_engine cloudhsm;
env n3fips_password;
```

- If using Client SDK 5

  ```
ssl_engine cloudhsm;
env CLOUDHSM_PIN;
```

Then add the following to the TLS section of the file:

```
# Settings for a TLS enabled server.
server {
  listen 443 ssl http2 default_server;
  listen [::]:443 ssl http2 default_server;
  server_name _;
  root /usr/share/nginx/html;

  ssl_certificate "/etc/pki/nginx/server.crt";
  ssl_certificate_key "/etc/pki/nginx/private/server.key";
  # It is *strongly* recommended to generate unique DH parameters
  # Generate them with: openssl dhparam -out /etc/pki/nginx/dhparams.pem 2048
  # ssl_dhparam "/etc/pki/nginx/dhparams.pem";
  ssl_session_cache shared:SSL:1m;
  ssl_session_timeout 10m;
  ssl_protocols TLSv1.2;
  ssl_prefer_server_ciphers on;

  # Load configuration files for the default server block.
  include /etc/nginx/default.d/*.conf;

  location / {
  }

  error_page 404 /404.html;
  location = /40x.html {
  }

  error_page 500 502 503 504 /50x.html;
  location = /50x.html {
  }
```
CentOS 8

Use a text editor to edit the `/etc/nginx/nginx.conf` file. This requires Linux root permissions. At the top of the file, add the following lines:

```bash
ssl_engine cloudhsm;
env CLOUDHSM_PIN;
```

Then add the following to the TLS section of the file:

```bash
# Settings for a TLS enabled server.
server {
    listen 443 ssl http2 default_server;
    listen [::]:443 ssl http2 default_server;
    server_name _;
    root /usr/share/nginx/html;

    ssl_certificate "/etc/pki/nginx/server.crt";
    ssl_certificate_key "/etc/pki/nginx/private/server.key";
    # It is *strongly* recommended to generate unique DH parameters
    # Generate them with: openssl dhparam -out /etc/pki/nginx/dhparams.pem 2048
    #ssl_dhparam "/etc/pki/nginx/dhparams.pem";
    ssl_session_cache shared:SSL:1m;
    ssl_session_timeout 10m;
    ssl_protocols TLSv1.2 TLSv1.3;
    ssl_prefer_server_ciphers on;

    # Load configuration files for the default server block.
    include /etc/nginx/default.d/*.conf;

    location / {
    
    }

    error_page 404 /404.html;
    location = /40x.html {
    
    }

    error_page 500 502 503 504 /50x.html;
    location = /50x.html {
    
    }
}
```

Red Hat 7

Use a text editor to edit the `/etc/nginx/nginx.conf` file. This requires Linux root permissions. At the top of the file, add the following lines:

- If using Client SDK 3

  ```bash
  ssl_engine cloudhsm;
  ```
env n3fips_password;

- If using Client SDK 5

ssl_engine cloudhsm;
env CLOUDHSM_PIN;

Then add the following to the TLS section of the file:

```conf
# Settings for a TLS enabled server.
server {
    listen 443 ssl http2 default_server;
    listen [::]:443 ssl http2 default_server;
    server_name _;
    root /usr/share/nginx/html;

    ssl_certificate "/etc/pki/nginx/server.crt";
    ssl_certificate_key "/etc/pki/nginx/private/server.key";
    # It is *strongly* recommended to generate unique DH parameters
    # Generate them with: openssl dhparam -out /etc/pki/nginx/dhparams.pem 2048
    #ssl_dhparam "/etc/pki/nginx/dhparams.pem";
    ssl_session_cache shared:SSL:1m;
    ssl_session_timeout 10m;
    ssl_protocols TLSv1.2;
    ssl_prefer_server_ciphers on;

    # Load configuration files for the default server block.
    include /etc/nginx/default.d/*.conf;

    location / {
    }

    error_page 404 /404.html;
    location = /40x.html {
    }

    error_page 500 502 503 504 /50x.html;
    location = /50x.html {
    }
}
```

Red Hat

Use a text editor to edit the `/etc/nginx/nginx.conf` file. This requires Linux root permissions. At the top of the file, add the following lines:

```conf
ssl_engine cloudhsm;
env CLOUDHSM_PIN;
```

Then add the following to the TLS section of the file:

```conf
# Settings for a TLS enabled server.
server {
```
listen 443 ssl http2 default_server;
listen [::]:443 ssl http2 default_server;
server_name _;
root /usr/share/nginx/html;

ssl_certificate "/etc/pki/nginx/server.crt";
ssl_certificate_key "/etc/pki/nginx/private/server.key";
# It is *strongly* recommended to generate unique DH parameters
# Generate them with: openssl dhparam -out /etc/pki/nginx/dhparams.pem 2048
#ssl_dhparam "/etc/pki/nginx/dhparams.pem";
ssl_session_cache shared:SSL:1m;
ssl_session_timeout 10m;
ssl_protocols TLSv1.2 TLSv1.3;
ssl_prefer_server_ciphers on;

# Load configuration files for the default server block.
include /etc/nginx/default.d/*.conf;

location / {
}

error_page 404 /404.html;
location = /40x.html {
}

error_page 500 502 503 504 /50x.html;
location = /50x.html {
}

Ubuntu 16.04 LTS

Use a text editor to edit the /etc/nginx/nginx.conf file. This requires Linux root permissions. At the top of the file, add the following lines:

ssl_engine cloudhsm;
  env n3fips_password;

Then add the following to the TLS section of the file:

# Settings for a TLS enabled server.
server {
  listen 443 ssl http2 default_server;
  listen [::]:443 ssl http2 default_server;
  server_name _;
  root /usr/share/nginx/html;

  ssl_certificate "/etc/pki/nginx/server.crt";
  ssl_certificate_key "/etc/pki/nginx/private/server.key";
  # It is *strongly* recommended to generate unique DH parameters
  # Generate them with: openssl dhparam -out /etc/pki/nginx/dhparams.pem 2048
  #ssl_dhparam "/etc/pki/nginx/dhparams.pem";
  ssl_session_cache shared:SSL:1m;
  ssl_session_timeout 10m;
  ssl_protocols TLSv1.2;

ssl_prefer_server_ciphers on;

# Load configuration files for the default server block.
include /etc/nginx/default.d/*.conf;

location / {
}

error_page 404 /404.html;
location = /40x.html {
}

error_page 500 502 503 504 /50x.html;
location = /50x.html {
}

Ubuntu 18.04 LTS

Use a text editor to edit the /etc/nginx/nginx.conf file. This requires Linux root permissions. At the top of the file, add the following lines:

```
ssl_engine cloudhsm;
env CLOUDHSM_PIN;
```

Then add the following to the TLS section of the file:

```
# Settings for a TLS enabled server.
server {
    listen 443 ssl http2 default_server;
    listen [::]:443 ssl http2 default_server;
    server_name _;
    root /usr/share/nginx/html;

    ssl_certificate /etc/pki/nginx/server.crt;
    ssl_certificate_key /etc/pki/nginx/private/server.key;
    # It is *strongly* recommended to generate unique DH parameters
    # Generate them with: openssl dhparam -out /etc/pki/nginx/dhparams.pem 2048
    #ssl_dhparam "/etc/pki/nginx/dhparams.pem";
    ssl_session_cache shared:SSL:1m;
    ssl_session_timeout 10m;
    ssl_protocols TLSv1.2 TLSv1.3;

    # Load configuration files for the default server block.
    include /etc/nginx/default.d/*.conf;

    location / {
    }
```

527
error_page 404 /404.html;
location = /40x.html {
}

error_page 500 502 503 504 /50x.html;
location = /50x.html {
}

Ubuntu 20.04 LTS

Use a text editor to edit the /etc/nginx/nginx.conf file. This requires Linux root permissions. At the top of the file, add the following lines:

```
ssl_engine cloudhsm;
env CLOUDHSM_PIN;
```

Then add the following to the TLS section of the file:

```
# Settings for a TLS enabled server.
server {
  listen 443 ssl http2 default_server;
  listen [::]:443 ssl http2 default_server;
  server_name _;
  root /usr/share/nginx/html;

  ssl_certificate "/etc/pki/nginx/server.crt";
  ssl_certificate_key "/etc/pki/nginx/private/server.key";
  # It is *strongly* recommended to generate unique DH parameters
  # Generate them with: openssl dhparam -out /etc/pki/nginx/dhparams.pem 2048
  #ssl_dhparam "/etc/pki/nginx/dhparams.pem";
  ssl_session_cache shared:SSL:1m;
  ssl_session_timeout 10m;
  ssl_protocols TLSv1.2 TLSv1.3;
  ssl_prefer_server_ciphers on;

  # Load configuration files for the default server block.
  include /etc/nginx/default.d/*.conf;

  location / {
  }

  error_page 404 /404.html;
  location = /40x.html {
  }

  error_page 500 502 503 504 /50x.html;
  location = /50x.html {
  }
}
```

Ubuntu 22.04 LTS

Support for OpenSSL Dynamic Engine is not yet available.
Save the file.

8. Back up the `systemd` configuration file, and then set the `EnvironmentFile` path.

Amazon Linux

No action required.

Amazon Linux 2

1. Back up the `nginx.service` file.

   
   ```bash
   $ sudo cp /lib/systemd/system/nginx.service /lib/systemd/system/
   nginx.service.backup
   ```

2. Open the `/lib/systemd/system/nginx.service` file in a text editor, and then under the `[Service]` section, add the following path:

   ```
   EnvironmentFile=/etc/sysconfig/nginx
   ```

CentOS 7

No action required.

CentOS 8

1. Back up the `nginx.service` file.

   
   ```bash
   $ sudo cp /lib/systemd/system/nginx.service /lib/systemd/system/
   nginx.service.backup
   ```

2. Open the `/lib/systemd/system/nginx.service` file in a text editor, and then under the `[Service]` section, add the following path:

   ```
   EnvironmentFile=/etc/sysconfig/nginx
   ```

Red Hat 7

No action required.

Red Hat 8

1. Back up the `nginx.service` file.

   
   ```bash
   $ sudo cp /lib/systemd/system/nginx.service /lib/systemd/system/
   nginx.service.backup
   ```

2. Open the `/lib/systemd/system/nginx.service` file in a text editor, and then under the `[Service]` section, add the following path:

   ```
   EnvironmentFile=/etc/sysconfig/nginx
   ```

Ubuntu 16.04

1. Back up the `nginx.service` file.
2. Open the `/lib/systemd/system/nginx.service` file in a text editor, and then under the [Service] section, add the following path:

   `EnvironmentFile=/etc/sysconfig/nginx`

**Ubuntu 18.04**

1. Back up the `nginx.service` file.

   `$ sudo cp /lib/systemd/system/nginx.service /lib/systemd/system/nginx.service.backup`

2. Open the `/lib/systemd/system/nginx.service` file in a text editor, and then under the [Service] section, add the following path:

   `EnvironmentFile=/etc/sysconfig/nginx`

**Ubuntu 20.04 LTS**

1. Back up the `nginx.service` file.

   `$ sudo cp /lib/systemd/system/nginx.service /lib/systemd/system/nginx.service.backup`

2. Open the `/lib/systemd/system/nginx.service` file in a text editor, and then under the [Service] section, add the following path:

   `EnvironmentFile=/etc/sysconfig/nginx`

**Ubuntu 22.04 LTS**

Support for OpenSSL Dynamic Engine is not yet available.

9. Check if the `/etc/sysconfig/nginx` file exists, and then do one of the following:

   - If the file exists, back up the file by running the following command:

     `$ sudo cp /etc/sysconfig/nginx /etc/sysconfig/nginx.backup`

   - If the file doesn't exist, open a text editor, and then create a file named `nginx` in the `/etc/sysconfig/` folder.

10. Configure the NGINX environment.

    **Note**
    
    Client SDK 5 introduces the `CLOUDHSM_PIN` environment variable for storing the credentials of the CU.

**Amazon Linux**

Open the `/etc/sysconfig/nginx` file in a text editor. This requires Linux root permissions. Add the Cryptography User (CU) credentials:
• If using Client SDK 3

\texttt{n3fips\_password=<CU\ user\ name>:<password>}

• If using Client SDK 5

\texttt{CLOUDHSM\_PIN=<CU\ user\ name>:<password>}

Replace \texttt{<CU\ user\ name>} and \texttt{<password>} with the CU credentials.

Save the file.

Amazon Linux 2

Open the \texttt{/etc/sysconfig/nginx} file in a text editor. This requires Linux root permissions. Add the Cryptography User (CU) credentials:

• If using Client SDK 3

\texttt{n3fips\_password=<CU\ user\ name>:<password>}

• If using Client SDK 5

\texttt{CLOUDHSM\_PIN=<CU\ user\ name>:<password>}

Replace \texttt{<CU\ user\ name>} and \texttt{<password>} with the CU credentials.

Save the file.

CentOS 7

Open the \texttt{/etc/sysconfig/nginx} file in a text editor. This requires Linux root permissions. Add the Cryptography User (CU) credentials:

• If using Client SDK 3

\texttt{n3fips\_password=<CU\ user\ name>:<password>}

• If using Client SDK 5

\texttt{CLOUDHSM\_PIN=<CU\ user\ name>:<password>}

Replace \texttt{<CU\ user\ name>} and \texttt{<password>} with the CU credentials.

Save the file.

CentOS 8

Open the \texttt{/etc/sysconfig/nginx} file in a text editor. This requires Linux root permissions. Add the Cryptography User (CU) credentials:

\texttt{CLOUDHSM\_PIN=<CU\ user\ name>:<password>}

Replace \texttt{<CU\ user\ name>} and \texttt{<password>} with the CU credentials.
Save the file.

Red Hat 7

Open the /etc/sysconfig/nginx file in a text editor. This requires Linux root permissions. Add the Cryptography User (CU) credentials:

- If using Client SDK 3

```bash
n3fips_password=<CU user name>:<password>
```

- If using Client SDK 5

```bash
CLOUDHSM_PIN=<CU user name>:<password>
```

Replace `<CU user name>` and `<password>` with the CU credentials.

Save the file.

Red Hat 8

Open the /etc/sysconfig/nginx file in a text editor. This requires Linux root permissions. Add the Cryptography User (CU) credentials:

```bash
CLOUDHSM_PIN=<CU user name>:<password>
```

Replace `<CU user name>` and `<password>` with the CU credentials.

Save the file.

Ubuntu 16.04 LTS

Open the /etc/sysconfig/nginx file in a text editor. This requires Linux root permissions. Add the Cryptography User (CU) credentials:

```bash
n3fips_password=<CU user name>:<password>
```

Replace `<CU user name>` and `<password>` with the CU credentials.

Save the file.

Ubuntu 18.04 LTS

Open the /etc/sysconfig/nginx file in a text editor. This requires Linux root permissions. Add the Cryptography User (CU) credentials:

```bash
CLOUDHSM_PIN=<CU user name>:<password>
```

Replace `<CU user name>` and `<password>` with the CU credentials.

Save the file.

Ubuntu 20.04 LTS

Open the /etc/sysconfig/nginx file in a text editor. This requires Linux root permissions. Add the Cryptography User (CU) credentials:
Replace `<CU user name>` and `<password>` with the CU credentials.

Save the file.

Ubuntu 22.04 LTS

Support for OpenSSL Dynamic Engine is not yet available.

11. Start the NGINX web server.

Amazon Linux

Open the `/etc/sysconfig/nginx` file in a text editor. This requires Linux root permissions. Add the Cryptography User (CU) credentials:

```sh
$ sudo service nginx start
```

Amazon Linux 2

Stop any running NGINX process

```sh
$ sudo systemctl stop nginx
```

Reload the systemd configuration to pick up the latest changes

```sh
$ sudo systemctl daemon-reload
```

Start the NGINX process

```sh
$ sudo systemctl start nginx
```

CentOS 7

Stop any running NGINX process

```sh
$ sudo systemctl stop nginx
```

Reload the systemd configuration to pick up the latest changes

```sh
$ sudo systemctl daemon-reload
```

Start the NGINX process

```sh
$ sudo systemctl start nginx
```

CentOS 8

Stop any running NGINX process

```sh
$ sudo systemctl stop nginx
```
Reload the systemd configuration to pick up the latest changes

$ sudo systemctl daemon-reload

Start the NGINX process

$ sudo systemctl start nginx

Red Hat 7

Stop any running NGINX process

$ sudo systemctl stop nginx

Reload the systemd configuration to pick up the latest changes

$ sudo systemctl daemon-reload

Start the NGINX process

$ sudo systemctl start nginx

Red Hat 8

Stop any running NGINX process

$ sudo systemctl stop nginx

Reload the systemd configuration to pick up the latest changes

$ sudo systemctl daemon-reload

Start the NGINX process

$ sudo systemctl start nginx

Ubuntu 16.04 LTS

Stop any running NGINX process

$ sudo systemctl stop nginx

Reload the systemd configuration to pick up the latest changes

$ sudo systemctl daemon-reload

Start the NGINX process

$ sudo systemctl start nginx
Ubuntu 18.04 LTS

Stop any running NGINX process

$ sudo systemctl stop nginx

Reload the systemd configuration to pick up the latest changes

$ sudo systemctl daemon-reload

Start the NGINX process

$ sudo systemctl start nginx

Ubuntu 20.04 LTS

Stop any running NGINX process

$ sudo systemctl stop nginx

Reload the systemd configuration to pick up the latest changes

$ sudo systemctl daemon-reload

Start the NGINX process

$ sudo systemctl start nginx

Ubuntu 22.04 LTS

Support for OpenSSL Dynamic Engine is not yet available.

12. (Optional) Configure your platform to start NGINX at start-up.

Amazon Linux

$ sudo chkconfig nginx on

Amazon Linux 2

$ sudo systemctl enable nginx

CentOS 7

No action required.

CentOS 8

$ sudo systemctl enable nginx

Red Hat 7

No action required.
Red Hat 8

$ sudo systemctl enable nginx

Ubuntu 16.04 LTS

$ sudo systemctl enable nginx

Ubuntu 18.04 LTS

$ sudo systemctl enable nginx

Ubuntu 20.04 LTS

$ sudo systemctl enable nginx

Ubuntu 22.04 LTS

Support for OpenSSL Dynamic Engine is not yet available.

After you update your web server configuration, go to Step 4: Enable HTTPS traffic and verify the certificate (p. 550).

Configure Apache web server

Use this section to configure Apache on supported platforms.

**To update the web server configuration for Apache**

1. Connect to your Amazon EC2 client instance.
2. Define default locations for certificates and private keys for your platform.

Amazon Linux

In the `/etc/httpd/conf.d/ssl.conf` file, ensure these values exist:

<table>
<thead>
<tr>
<th>SSOLCertificateFile</th>
<th><code>/etc/pki/tls/certs/localhost.crt</code></th>
</tr>
</thead>
<tbody>
<tr>
<td>SSLCertificateKeyFile</td>
<td><code>/etc/pki/tls/private/localhost.key</code></td>
</tr>
</tbody>
</table>

Amazon Linux 2

In the `/etc/httpd/conf.d/ssl.conf` file, ensure these values exist:

<table>
<thead>
<tr>
<th>SSOLCertificateFile</th>
<th><code>/etc/pki/tls/certs/localhost.crt</code></th>
</tr>
</thead>
<tbody>
<tr>
<td>SSLCertificateKeyFile</td>
<td><code>/etc/pki/tls/private/localhost.key</code></td>
</tr>
</tbody>
</table>

CentOS 7

In the `/etc/httpd/conf.d/ssl.conf` file, ensure these values exist:

<table>
<thead>
<tr>
<th>SSOLCertificateFile</th>
<th><code>/etc/pki/tls/certs/localhost.crt</code></th>
</tr>
</thead>
<tbody>
<tr>
<td>SSLCertificateKeyFile</td>
<td><code>/etc/pki/tls/private/localhost.key</code></td>
</tr>
</tbody>
</table>
CentOS 8

In the `/etc/httpd/conf.d/ssl.conf` file, ensure these values exist:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSLCertificateFile</td>
<td><code>/etc/pki/tls/certs/localhost.crt</code></td>
</tr>
<tr>
<td>SSLCertificateKeyFile</td>
<td><code>/etc/pki/tls/private/localhost.key</code></td>
</tr>
</tbody>
</table>

Red Hat 7

In the `/etc/httpd/conf.d/ssl.conf` file, ensure these values exist:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSLCertificateFile</td>
<td><code>/etc/pki/tls/certs/localhost.crt</code></td>
</tr>
<tr>
<td>SSLCertificateKeyFile</td>
<td><code>/etc/pki/tls/private/localhost.key</code></td>
</tr>
</tbody>
</table>

Red Hat 8

In the `/etc/httpd/conf.d/ssl.conf` file, ensure these values exist:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSLCertificateFile</td>
<td><code>/etc/pki/tls/certs/localhost.crt</code></td>
</tr>
<tr>
<td>SSLCertificateKeyFile</td>
<td><code>/etc/pki/tls/private/localhost.key</code></td>
</tr>
</tbody>
</table>

Ubuntu 16.04 LTS

In the `/etc/apache2/sites-available/default-ssl.conf` file, ensure these values exist:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSLCertificateFile</td>
<td><code>/etc/ssl/certs/localhost.crt</code></td>
</tr>
<tr>
<td>SSLCertificateKeyFile</td>
<td><code>/etc/ssl/private/localhost.key</code></td>
</tr>
</tbody>
</table>

Ubuntu 18.04 LTS

In the `/etc/apache2/sites-available/default-ssl.conf` file, ensure these values exist:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSLCertificateFile</td>
<td><code>/etc/ssl/certs/localhost.crt</code></td>
</tr>
<tr>
<td>SSLCertificateKeyFile</td>
<td><code>/etc/ssl/private/localhost.key</code></td>
</tr>
</tbody>
</table>

Ubuntu 20.04 LTS

In the `/etc/apache2/sites-available/default-ssl.conf` file, ensure these values exist:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSLCertificateFile</td>
<td><code>/etc/ssl/certs/localhost.crt</code></td>
</tr>
<tr>
<td>SSLCertificateKeyFile</td>
<td><code>/etc/ssl/private/localhost.key</code></td>
</tr>
</tbody>
</table>

Ubuntu 22.04 LTS

Support for OpenSSL Dynamic Engine is not yet available.

3. Copy your web server certificate to the required location for your platform.

Amazon Linux

```bash
$ sudo cp <web_server.crt> /etc/pki/tls/certs/localhost.crt
```

Replace `<web_server.crt>` with the name of your web server certificate.
Amazon Linux 2

$ sudo cp <web_server.crt> /etc/pki/tls/certs/localhost.crt

Replace <web_server.crt> with the name of your web server certificate.

CentOS 7

$ sudo cp <web_server.crt> /etc/pki/tls/certs/localhost.crt

Replace <web_server.crt> with the name of your web server certificate.

CentOS 8

$ sudo cp <web_server.crt> /etc/pki/tls/certs/localhost.crt

Replace <web_server.crt> with the name of your web server certificate.

Red Hat 7

$ sudo cp <web_server.crt> /etc/pki/tls/certs/localhost.crt

Replace <web_server.crt> with the name of your web server certificate.

Red Hat 8

$ sudo cp <web_server.crt> /etc/pki/tls/certs/localhost.crt

Replace <web_server.crt> with the name of your web server certificate.

Ubuntu 16.04 LTS

$ sudo cp <web_server.crt> /etc/ssl/certs/localhost.crt

Replace <web_server.crt> with the name of your web server certificate.

Ubuntu 18.04 LTS

$ sudo cp <web_server.crt> /etc/ssl/certs/localhost.crt

Replace <web_server.crt> with the name of your web server certificate.

Ubuntu 20.04 LTS

$ sudo cp <web_server.crt> /etc/ssl/certs/localhost.crt

Replace <web_server.crt> with the name of your web server certificate.

Ubuntu 22.04 LTS

Support for OpenSSL Dynamic Engine is not yet available.

4. Copy your fake PEM private key to the required location for your platform.

Amazon Linux

$ sudo cp <web_server_fake_PEM.key> /etc/pki/tls/private/localhost.key
Replace <web_server_fake_PEM.key> with the name of the file that contains your fake PEM private key.

**Amazon Linux 2**

```bash
$ sudo cp <web_server_fake_PEM.key> /etc/pki/tls/private/localhost.key
```

Replace <web_server_fake_PEM.key> with the name of the file that contains your fake PEM private key.

**CentOS 7**

```bash
$ sudo cp <web_server_fake_PEM.key> /etc/pki/tls/private/localhost.key
```

Replace <web_server_fake_PEM.key> with the name of the file that contains your fake PEM private key.

**CentOS 8**

```bash
$ sudo cp <web_server_fake_PEM.key> /etc/pki/tls/private/localhost.key
```

Replace <web_server_fake_PEM.key> with the name of the file that contains your fake PEM private key.

**Red Hat 7**

```bash
$ sudo cp <web_server_fake_PEM.key> /etc/pki/tls/private/localhost.key
```

Replace <web_server_fake_PEM.key> with the name of the file that contains your fake PEM private key.

**Red Hat 8**

```bash
$ sudo cp <web_server_fake_PEM.key> /etc/pki/tls/private/localhost.key
```

Replace <web_server_fake_PEM.key> with the name of the file that contains your fake PEM private key.

**Ubuntu 16.04 LTS**

```bash
$ sudo cp <web_server_fake_PEM.key> /etc/ssl/private/localhost.key
```

Replace <web_server_fake_PEM.key> with the name of the file that contains your fake PEM private key.

**Ubuntu 18.04 LTS**

```bash
$ sudo cp <web_server_fake_PEM.key> /etc/ssl/private/localhost.key
```

Replace <web_server_fake_PEM.key> with the name of the file that contains your fake PEM private key.

**Ubuntu 20.04 LTS**

```bash
$ sudo cp <web_server_fake_PEM.key> /etc/ssl/private/localhost.key
```
Replace `<web_server_fake_PEM.key>` with the name of the file that contains your fake PEM private key.

Ubuntu 22.04 LTS

Support for OpenSSL Dynamic Engine is not yet available.

5. Change ownership of these files if required by your platform.

Amazon Linux

$ sudo chown apache /etc/pki/tls/certs/localhost.crt /etc/pki/tls/private/localhost.key

Provides read permission to the user named `apache`.

Amazon Linux 2

$ sudo chown apache /etc/pki/tls/certs/localhost.crt /etc/pki/tls/private/localhost.key

Provides read permission to the user named `apache`.

CentOS 7

$ sudo chown apache /etc/pki/tls/certs/localhost.crt /etc/pki/tls/private/localhost.key

Provides read permission to the user named `apache`.

CentOS 8

$ sudo chown apache /etc/pki/tls/certs/localhost.crt /etc/pki/tls/private/localhost.key

Provides read permission to the user named `apache`.

Red Hat 7

$ sudo chown apache /etc/pki/tls/certs/localhost.crt /etc/pki/tls/private/localhost.key

Provides read permission to the user named `apache`.

Red Hat 8

$ sudo chown apache /etc/pki/tls/certs/localhost.crt /etc/pki/tls/private/localhost.key

Provides read permission to the user named `apache`.

Ubuntu 16.04 LTS

No action required.

Ubuntu 18.04 LTS

No action required.

Ubuntu 20.04 LTS

No action required.
Ubuntu 22.04 LTS

Support for OpenSSL Dynamic Engine is not yet available.

6. Configure Apache directives for your platform.

Amazon Linux

Locate the SSL file for this platform:

/etc/httpd/conf.d/ssl.conf

This file contains Apache directives which define how your server should run. Directives appear on the left, followed by a value. Use a text editor to edit this file. This requires Linux root permissions.

Update or enter the following directives with these values:

```
SSLCryptoDevice  cloudhsm
```

Save the file.

Amazon Linux 2

Locate the SSL file for this platform:

/etc/httpd/conf.d/ssl.conf

This file contains Apache directives which define how your server should run. Directives appear on the left, followed by a value. Use a text editor to edit this file. This requires Linux root permissions.

Update or enter the following directives with these values:

```
SSLCryptoDevice  cloudhsm
```

Save the file.

CentOS 7

Locate the SSL file for this platform:

/etc/httpd/conf.d/ssl.conf

This file contains Apache directives which define how your server should run. Directives appear on the left, followed by a value. Use a text editor to edit this file. This requires Linux root permissions.
Update or enter the following directives with these values:

```
SSLCryptoDevice  cloudhsm
SSLProtocol  TLSv1.2 TLSv1.3
SSLProxyCipherSuite  HIGH:!aNULL
```

Save the file.

CentOS 8

Locate the SSL file for this platform:

```
/etc/httpd/conf.d/ssl.conf
```

This file contains Apache directives which define how your server should run. Directives appear on the left, followed by a value. Use a text editor to edit this file. This requires Linux root permissions.

Update or enter the following directives with these values:

```
SSLCryptoDevice  cloudhsm
SSLProtocol  TLSv1.2 TLSv1.3
SSLProxyCipherSuite  HIGH:!aNULL
```

Save the file.

Red Hat 7

Locate the SSL file for this platform:

```
/etc/httpd/conf.d/ssl.conf
```

This file contains Apache directives which define how your server should run. Directives appear on the left, followed by a value. Use a text editor to edit this file. This requires Linux root permissions.

Update or enter the following directives with these values:

```
SSLCryptoDevice  cloudhsm
SSLProtocol  TLSv1.2 TLSv1.3
SSLProxyCipherSuite  HIGH:!aNULL
```

Save the file.
Red Hat 8

Locate the SSL file for this platform:

/etc/httpd/conf.d/ssl.conf

This file contains Apache directives which define how your server should run. Directives appear on the left, followed by a value. Use a text editor to edit this file. This requires Linux root permissions.

Update or enter the following directives with these values:

```
SSLCryptoDevice cloudhsm
SSLProtocol TLSv1.2 TLSv1.3
SSLProxyCipherSuite HIGH:!aNULL
```

Save the file.

Ubuntu 16.04 LTS

Locate the SSL file for this platform:

/etc/apache2/mods-available/ssl.conf

This file contains Apache directives which define how your server should run. Directives appear on the left, followed by a value. Use a text editor to edit this file. This requires Linux root permissions.

Update or enter the following directives with these values:

```
SSLCryptoDevice cloudhsm
```

Save the file.

Enable the SSL module and default SSL site configuration:

```
$ sudo a2enmod ssl
$ sudo a2ensite default-ssl
```

Ubuntu 18.04 LTS

Locate the SSL file for this platform:

/etc/apache2/mods-available/ssl.conf
This file contains Apache directives which define how your server should run. Directives appear on the left, followed by a value. Use a text editor to edit this file. This requires Linux root permissions.

Update or enter the following directives with these values:

```
SSLCryptoDevice cloudhsm
SSLProtocol TLSv1.2 TLSv1.3
```

Save the file.

Enable the SSL module and default SSL site configuration:

```
$ sudo a2enmod ssl
$ sudo a2ensite default-ssl
```

Ubuntu 20.04 LTS

Locate the SSL file for this platform:

```
/etc/apache2/mods-available/ssl.conf
```

This file contains Apache directives which define how your server should run. Directives appear on the left, followed by a value. Use a text editor to edit this file. This requires Linux root permissions.

Update or enter the following directives with these values:

```
SSLCryptoDevice cloudhsm
SSLProtocol TLSv1.2 TLSv1.3
```

Save the file.

Enable the SSL module and default SSL site configuration:

```
$ sudo a2enmod ssl
$ sudo a2ensite default-ssl
```

Ubuntu 22.04 LTS

Support for OpenSSL Dynamic Engine is not yet available.

7. Configure an environment-values file for your platform.
Amazon Linux

No action required. Environment values go in /etc/sysconfig/httpd

Amazon Linux 2

Open the httpd service file:

/lib/systemd/system/httpd.service

Under the [Service] section, add the following:

EnvironmentFile=/etc/sysconfig/httpd

CentOS 7

Open the httpd service file:

/lib/systemd/system/httpd.service

Under the [Service] section, add the following:

EnvironmentFile=/etc/sysconfig/httpd

CentOS 8

Open the httpd service file:

/lib/systemd/system/httpd.service

Under the [Service] section, add the following:

EnvironmentFile=/etc/sysconfig/httpd

Red Hat 7

Open the httpd service file:

/lib/systemd/system/httpd.service

Under the [Service] section, add the following:

EnvironmentFile=/etc/sysconfig/httpd

Red Hat 8

Open the httpd service file:

/lib/systemd/system/httpd.service

Under the [Service] section, add the following:
8. In the file that stores environment variables for your platform, set an environment variable that contains the credentials of the cryptographic user (CU):

Amazon Linux

Use a text editor to edit the `/etc/sysconfig/httpd`.

- If using Client SDK 3

```
N3FIPS_PASSWORD=<CU user name>:<password>
```

- If using Client SDK 5

```
CLOUDHSM_PIN=<CU user name>:<password>
```

Replace `<CU user name>` and `<password>` with the CU credentials.

Amazon Linux 2

Use a text editor to edit the `/etc/sysconfig/httpd`.

- If using Client SDK 3

```
N3FIPS_PASSWORD=<CU user name>:<password>
```

- If using Client SDK 5

```
CLOUDHSM_PIN=<CU user name>:<password>
```

Replace `<CU user name>` and `<password>` with the CU credentials.

CentOS 7

Use a text editor to edit the `/etc/sysconfig/httpd`.

- If using Client SDK 3

```
N3FIPS_PASSWORD=<CU user name>:<password>
```

- If using Client SDK 5

```
CLOUDHSM_PIN=<CU user name>:<password>
```
Replace `<CU user name>` and `<password>` with the CU credentials.

CentOS 8

Use a text editor to edit the `/etc/sysconfig/httpd`.

```
CLOUDHSM_PIN=<CU user name>:<password>
```

Replace `<CU user name>` and `<password>` with the CU credentials.

Red Hat 7

Use a text editor to edit the `/etc/sysconfig/httpd`.

- If using Client SDK 3

```
n3fips_password=<CU user name>:<password>
```

- If using Client SDK 5

```
CLOUDHSM_PIN=<CU user name>:<password>
```

Replace `<CU user name>` and `<password>` with the CU credentials.

Red Hat 8

Use a text editor to edit the `/etc/sysconfig/httpd`.

```
CLOUDHSM_PIN=<CU user name>:<password>
```

Replace `<CU user name>` and `<password>` with the CU credentials.

Ubuntu 16.04 LTS

Use a text editor to edit the `/etc/apache2/envvars`.

```
export n3fips_password=<CU user name>:<password>
```

Replace `<CU user name>` and `<password>` with the CU credentials.

Ubuntu 18.04 LTS

Use a text editor to edit the `/etc/apache2/envvars`.

```
export CLOUDHSM_PIN=<CU user name>:<password>
```

Replace `<CU user name>` and `<password>` with the CU credentials.
**Note**
Client SDK 5 introduces the CLOUDHSM_PIN environment variable for storing the credentials of the CU. In Client SDK 3 you stored the CU credentials in the n3fips_password environment variable. Client SDK 5 supports both environment variables, but we recommend using CLOUDHSM_PIN.

Ubuntu 20.04 LTS

Use a text editor to edit the /etc/apache2/envvars.

```bash
export CLOUDHSM_PIN=<CU user name>:<password>
```

Replace `<CU user name>` and `<password>` with the CU credentials.

**Note**
Client SDK 5 introduces the CLOUDHSM_PIN environment variable for storing the credentials of the CU. In Client SDK 3 you stored the CU credentials in the n3fips_password environment variable. Client SDK 5 supports both environment variables, but we recommend using CLOUDHSM_PIN.

Ubuntu 22.04 LTS

Support for OpenSSL Dynamic Engine is not yet available.

9. Start the Apache web server.

Amazon Linux

```bash
$ sudo systemctl daemon-reload
$ sudo service httpd start
```

Amazon Linux 2

```bash
$ sudo systemctl daemon-reload
$ sudo service httpd start
```

CentOS 7

```bash
$ sudo systemctl daemon-reload
$ sudo service httpd start
```

CentOS 8

```bash
$ sudo systemctl daemon-reload
$ sudo service httpd start
```

Red Hat 7

```bash
$ sudo systemctl daemon-reload
$ sudo service httpd start
```

Red Hat 8

```bash
$ sudo systemctl daemon-reload
$ sudo service httpd start
```
Ubuntu 16.04 LTS

$ sudo service apache2 start

Ubuntu 18.04 LTS

$ sudo service apache2 start

Ubuntu 20.04 LTS

$ sudo service apache2 start

Ubuntu 22.04 LTS

Support for OpenSSL Dynamic Engine is not yet available.

10. (Optional) Configure your platform to start Apache at start-up.

Amazon Linux

$ sudo chkconfig httpd on

Amazon Linux 2

$ sudo chkconfig httpd on

CentOS 7

$ sudo chkconfig httpd on

CentOS 8

$ systemctl enable httpd

Red Hat 7

$ sudo chkconfig httpd on

Red Hat 8

$ systemctl enable httpd

Ubuntu 16.04 LTS

$ sudo systemctl enable apache2

Ubuntu 18.04 LTS

$ sudo systemctl enable apache2
Ubuntu 20.04 LTS

$ sudo systemctl enable apache2

Ubuntu 22.04 LTS

Support for OpenSSL Dynamic Engine is not yet available.

After you update your web server configuration, go to Step 4: Enable HTTPS traffic and verify the certificate (p. 550).

Step 4: Enable HTTPS traffic and verify the certificate

After you configure your web server for SSL/TLS offload with AWS CloudHSM, add your web server instance to a security group that allows HTTPS traffic. This allows clients, such as web browsers, to establish an HTTPS connection with your web server. Then make an HTTPS connection to your web server and verify that it's using the certificate that you configured for SSL/TLS offload with AWS CloudHSM.

Topics
- Enable inbound HTTPS connections (p. 550)
- Verify that HTTPS uses the certificate that you configured (p. 551)

Enable inbound HTTPS connections

To connect to your web server from a client (such as a web browser), create a security group that allows inbound HTTPS connections. Specifically, it should allow inbound TCP connections on port 443. Assign this security group to your web server.

To create a security group for HTTPS and assign it to your web server

1. Open the Amazon EC2 console at https://console.aws.amazon.com/ec2/.
2. Choose Security groups in the navigation pane.
3. Choose Create security group.
4. For Create Security Group, do the following:
   a. For Security group name, type a name for the security group that you are creating.
   b. (Optional) Type a description of the security group that you are creating.
   c. For VPC, choose the VPC that contains your web server Amazon EC2 instance.
   d. Select Add Rule.
   e. For Type, select HTTPS from the drop-down window.
   f. For Source, enter a source location.
   g. Choose Create security group.
5. In the navigation pane, choose Instances.
6. Select the check box next to your web server instance.
7. Select the Actions drop-down menu at the top of the page. Select Security and then Change Security Groups.
8. For Associated security groups, select the search box and choose the security group that you created for HTTPS. Then choose Add Security Groups.
9. Select Save.
Verify that HTTPS uses the certificate that you configured

After you add the web server to a security group, you can verify that SSL/TLS offload is using your self-signed certificate. You can do this with a web browser or with a tool such as OpenSSL s_client.

To verify SSL/TLS offload with a web browser

1. Use a web browser to connect to your web server using the public DNS name or IP address of the server. Ensure that the URL in the address bar begins with https://. For example, https://ec2-52-14-212-67.us-east-2.compute.amazonaws.com/.

   **Tip**
   You can use a DNS service such as Amazon Route 53 to route your website's domain name (for example, https://www.example.com/) to your web server. For more information, see Routing Traffic to an Amazon EC2 Instance in the Amazon Route 53 Developer Guide or in the documentation for your DNS service.

2. Use your web browser to view the web server certificate. For more information, see the following:
   - For Mozilla Firefox, see View a Certificate on the Mozilla Support website.
   - For Google Chrome, see Understand Security Issues on the Google Tools for Web Developers website.

   Other web browsers might have similar features that you can use to view the web server certificate.

3. Ensure that the SSL/TLS certificate is the one that you configured your web server to use.

To verify SSL/TLS offload with OpenSSL s_client

1. Run the following OpenSSL command to connect to your web server using HTTPS. Replace `<server name>` with the public DNS name or IP address of your web server.

   ```bash
   openssl s_client -connect <server name>:443
   ```

   **Tip**
   You can use a DNS service such as Amazon Route 53 to route your website's domain name (for example, https://www.example.com/) to your web server. For more information, see Routing Traffic to an Amazon EC2 Instance in the Amazon Route 53 Developer Guide or in the documentation for your DNS service.

2. Ensure that the SSL/TLS certificate is the one that you configured your web server to use.

You now have a website that is secured with HTTPS. The private key for the web server is stored in an HSM in your AWS CloudHSM cluster.

To add a load balancer, see Add a load balancer with Elastic Load Balancing (optional) (p. 566).

Using Tomcat with JSSE for SSL/TLS offload on Linux

This topic provides step-by-step instructions for setting up SSL/TLS offload using Java Secure Socket Extension (JSSE) with the AWS CloudHSM JCE SDK.

Topics

- Overview (p. 552)
- Step 1: Set up the prerequisites (p. 552)
- Step 2: Generate or import a private key and SSL/TLS certificate (p. 553)
• **Step 3: Configure the Tomcat web server (p. 555)**
• **Step 4: Enable HTTPS traffic and verify the certificate (p. 556)**

### Overview

In AWS CloudHSM, Tomcat web servers work on Linux to support HTTPS. The AWS CloudHSM JCE SDK provides an interface that can be used with JSSE (Java Secure Socket Extension) to enable use of HSMs for such web servers. AWS CloudHSM JCE is the bridge that connects JSSE to your AWS CloudHSM cluster. JSSE is a Java API for Secure Sockets Layer (SSL) and Transport Layer Security (TLS) protocols.

### Step 1: Set up the prerequisites

Follow these prerequisites to use a Tomcat web server with AWS CloudHSM for SSL/TLS offload on Linux. These prerequisites must be met to set up web server SSL/TLS offload with Client SDK 5 and a Tomcat web server.

**Note**
Different platforms require different prerequisites. Always follow the correct installation steps for your platform.

#### Prerequisites

- An Amazon EC2 instance running a Linux operating system with Tomcat web server installed.
- A crypto user (CU) to own and manage the web server's private key on the HSM.
- An active AWS CloudHSM cluster with at least two hardware security modules (HSMs) that have [JCE for Client SDK 5](p. 422) installed and configured.

**Note**
You can use a single HSM cluster, but you must first disable client key durability. For more information, see [Manage Client Key Durability Settings](p. 125) and [Client SDK 5 Configure Tool](p. 159).

#### How to meet the prerequisites

1. Install and configure the JCE for AWS CloudHSM on an active AWS CloudHSM cluster with at least two hardware security modules (HSMs). For more information about installation, see [JCE for Client SDK 5](p. 422).
2. On an EC2 Linux instance that has access to your AWS CloudHSM cluster, follow the [Apache Tomcat instructions](p. 183) to download and install the Tomcat web server.
3. Use [CloudHSM CLI](p. 183) to create a crypto user (CU). For more information about managing HSM users, see [Managing HSM users with CloudHSM CLI](p. 60).

**Tip**
Keep track of the CU user name and password. You will need them later when you generate or import the HTTPS private key and certificate for your web server.

4. To setup JCE with Java Keytool, follow the instructions in [Using Client SDK 5 to integrate with Java Keytool and Jarsigner](p. 581).

After you complete these steps, go to **Step 2: Generate or import a private key and SSL/TLS certificate (p. 553).**

#### Notes

- To use Security-Enhanced Linux (SELinux) and web servers, you must allow outbound TCP connections on port 2223, which is the port Client SDK 5 uses to communicate with the HSM.
• To create and activate a cluster and give an EC2 instance access to the cluster, complete the steps in Getting Started with AWS CloudHSM (p. 7). This section offers step-by-step instructions for creating an active cluster with one HSM and an Amazon EC2 client instance. You can use this client instance as your web server.

• To avoid disabling client key durability, add more than one HSM to your cluster. For more information, see Adding an HSM (p. 44).

• To connect to your client instance, you can use SSH or PuTTY. For more information, see Connecting to Your Linux Instance Using SSH or Connecting to Your Linux Instance from Windows Using PuTTY in the Amazon EC2 documentation.

Step 2: Generate or import a private key and SSL/TLS certificate

To enable HTTPS, your Tomcat web server application needs a private key and a corresponding SSL/TLS certificate. To use web server SSL/TLS offload with AWS CloudHSM, you must store the private key in an HSM in your AWS CloudHSM cluster.

Note
If you don't yet have a private key and a corresponding certificate, generate a private key in an HSM. You use the private key to create a certificate signing request (CSR), which you use to create the SSL/TLS certificate.

You create a local AWS CloudHSM KeyStore file that contains a reference to your private key on the HSM and the associated certificate. Your web server uses the AWS CloudHSM KeyStore file to identify the private key on the HSM during SSL/TLS offload.

Topics
• Generate a private key (p. 553)
• Generate a self-signed certificate (p. 554)

Generate a private key

This section shows you how to generate a keypair using the KeyTool from JDK. Once you have a key pair generated inside the HSM, you can export it as a KeyStore file, and generate the corresponding certificate.

Depending on your use case, you can either generate an RSA or an EC key pair. The following steps show how to generate an RSA key pair.

Use the genkeypair command in KeyTool to generate an RSA key pair

1. After replacing the <VARIABLES> below with your specific data, use the following command to generate a keystore file named jsse_keystore.keystore, which will have a reference of your private key on the HSM.

```bash
$ keytool -genkeypair -alias <UNIQUE ALIAS FOR KEYS> -keyalg <KEY ALGORITHM> -keysize <KEY SIZE> -sigalg <SIGN ALGORITHM> \
   -keystore <PATH>/<JSSE KEYSTORE NAME>.keystore -storetype CLOUDHSM \
   -dname CERT_DOMAIN_NAME \
   -J-classpath '-J'$JAVA_LIB'/*:/opt/cloudhsm/java/*:/' \
   -provider "com.amazonaws.cloudhsm.jce.provider.CloudHsmProvider" \
   -providerpath "$CLOUDHSM_JCE_LOCATION" \
   -keypass <KEY PASSWORD> -storepass <KEYSTORE PASSWORD>
```

• <PATH>: The path that you want to generate your keystore file.
• <UNIQUE ALIAS FOR KEYS>: This is used to uniquely identify your key on the HSM. This alias will be set as the LABEL attribute for the key.
SSL/TLS offload on Linux

- `<KEY_PASSWORD>`: We store reference to your key in the local keystore file, and this password protects that local reference.
- `<KEYSTORE PASSWORD>`: This is the password for your local keystore file.
- `<JSSE KEYSTORE NAME>`: Name of the Keystore file.
- `<CERT DOMAIN NAME>`: X.500 Distinguished name.
- `<KEY ALGORITHM>`: Key algorithm to generate key pair (e.g., RSA and EC).
- `<KEY SIZE>`: Key size to generate key pair (e.g., 2048, 3072, and 4096).
- `<SIGN ALGORITHM>`: Key size to generate key pair (e.g., SHA1withRSA, SHA224withRSA, SHA256withRSA, SHA384withRSA, and SHA512withRSA).

2. To confirm the command was successful, enter the following command and verify you have successfully generated an RSA key pair.

```
$ ls <PATH>/<JSSE KEYSTORE NAME>.keystore
```

Generate a self-signed certificate

Once you have generated a private key along with the keystore file, you can use this file to generate a certificate signing request (CSR) and certificate.

In a production environment, you typically use a certificate authority (CA) to create a certificate from a CSR. A CA is not necessary for a test environment. If you do use a CA, send the CSR file to them and use signed SSL/TLS certificate that they provide you in your web server for HTTPS.

As an alternative to using a CA, you can use the KeyTool to create a self-signed certificate. Self-signed certificates are not trusted by browsers and should not be used in production environments. They can be used in test environments.

**Warning**

Self-signed certificates should be used in a test environment only. For a production environment, use a more secure method, such as a certificate authority to create a certificate.

**Generate a certificate**

1. Obtain a copy of your keystore file generated in an earlier step.
2. Run the following command to use the KeyTool to create a certificate signing request (CSR).

```
$ keytool -certreq -keyalg RSA -alias unique_alias_for_key -file certreq.csr \
  -keystore <JSSE KEYSTORE NAME>.keystore -storetype CLOUDHSM \
  -J-classpath '-J$JAVA_LIB/*:/opt/cloudhsm/java/*:./*' \
  -keypass <KEY_PASSWORD> -storepass <KEYSTORE PASSWORD>
```

**Note**

The output file of the certificate signing request is `certreq.csr`.

**Sign a certificate**

- After replacing the `<VARIABLES>` below with your specific data, run the following command to sign your CSR with your private key on your HSM. This creates a self-signed certificate.

```
$ keytool -gencert -infile certreq.csr -outfile certificate.crt \
  -alias <UNIQUE ALIAS FOR KEYS> -keypass <KEY_PASSWORD> - \
  storepass <KEYSTORE_PASSWORD> -sigalg SIG_ALG \
  -storetype CLOUDHSM -J-classpath '-J$JAVA_LIB/*:/opt/cloudhsm/java/*:./*'
```
**Import a certificate in Keystore**

- After replacing the `<VARIABLES>` below with your specific data, run the following command to import a signed certificate as a trusted certificate. This step will store certificate in the keystore entry identified by alias.

```
$ keytool -import -alias <UNIQUE ALIAS FOR KEYS> -keystore jsse_keystore.keystore \
   -file certificate.crt -storetype CLOUDHSM \
   -v -Jclasspath '-J$JAVA_LIB/*:/opt/cloudhsm/java/*:./*' \
   -keypass <KEY PASSWORD> -storepass <KEYSTORE PASSWORD>
```

**Convert a certificate to a PEM**

- Run following command to convert the signed certificate file (.crt) to a PEM. The PEM file will be used to send the request from the http client.

```
$ openssl x509 -inform der -in certificate.crt -out certificate.pem
```

After you complete these steps, go to Step 3: Configure the web server (p. 555).

**Step 3: Configure the Tomcat web server**

Update your web server software’s configuration to use the HTTPS certificate and corresponding PEM file that you created in the previous step. Remember to backup your existing certificates and keys before you start. This will finish setting up your Linux web server software for SSL/TLS offload with AWS CloudHSM. For more information, refer to the Apache Tomcat 9 Configuration Reference.

**Stop the server**

- After replacing the `<VARIABLES>` below with your specific data, run following command to stop Tomcat Server before updating configuration

```
$ /<TOMCAT_DIRECTORY>/bin/shutdown.sh
```

- `<TOMCAT_DIRECTORY>`: Your Tomcat installation directory.

**Update Classpath of Tomcat**

1. Connect to your client instance.
2. Locate the Tomcat installation folder.
3. After replacing the `<VARIABLES>` below with your specific data, use the following command to add Java library and Cloudhsm Java path in Tomcat classpath, located in Tomcat/bin/catalina.sh file.

```
$ sed -i 's@CLASSPATH="$CLASSPATH""$CATALINA_HOME"/bin/\nbootstrap.jar@CLASSPATH="$CLASSPATH""$CATALINA_HOME"/bin/\nbootstrap.jar:" \
<JAVA_LIBRARY>""\":\"/opt/cloudhsm/\java""\":\"/\" "@<TOMCAT PATH>@ /bin/
catalina.sh
```
Add an HTTPS connector in the server configuration.

1. Go to the Tomcat installation folder.
2. After replacing the `<VARIABLES>` below with your specific data, use the following command to add an HTTPS connector to use certificates generated in prerequisites:

```bash
$ sed -i '/<Connector port="8080"/i <Connector port="443" maxThreads="200" scheme="https" secure="true" SSLEnabled="true" keystoreFile="<CUSTOM DIRECTORY>/<JSSE KEYSTORE NAME>.keystore" keystorePass="<KEYSTORE PASSWORD>" keyPass="<KEY PASSWORD>" keyAlias="<UNIQUE ALIAS FOR KEYS>" clientAuth="false" sslProtocol="TLS"/>
</TOMCAT PATH>/conf/server.xml
```

- `<CUSTOM DIRECTORY>`: Directory where keystore file is located.
- `<JSSE KEYSTORE NAME>`: Name of the Keystore file.
- `<KEYSTORE PASSWORD>`: This is the password for your local keystore file.
- `<KEY PASSWORD>`: We store reference to your key in the local keystore file, and this password protects that local reference.
- `<UNIQUE ALIAS FOR KEYS>`: This is used to uniquely identify your key on the HSM. This alias will be set as the LABEL attribute for the key.
- `<TOMCAT PATH>`: The path to your Tomcat folder.

Start Server

- After replacing the `<VARIABLES>` below with your specific data, use the following command to start Tomcat Server:

```bash
$ /<TOMCAT DIRECTORY>/bin/startup.sh
```

Note

<TOMCAT DIRECTORY> is the name of your Tomcat installation directory.

After you update your web server configuration, go to Step 4: Enable HTTPS traffic and verify the certificate (p. 556).

Step 4: Enable HTTPS traffic and verify the certificate

After you configure your web server for SSL/TLS offload with AWS CloudHSM, add your web server instance to a security group that allows inbound HTTPS traffic. This allows clients, such as web browsers, to establish an HTTPS connection with your web server. Then make an HTTPS connection to your web server and verify that it's using the certificate that you configured for SSL/TLS offload with AWS CloudHSM.

Topics

- Enable inbound HTTPS connections (p. 557)
- Verify that HTTPS uses the certificate that you configured (p. 557)
Enable inbound HTTPS connections

To connect to your web server from a client (such as a web browser), create a security group that allows inbound HTTPS connections. Specifically, it should allow inbound TCP connections on port 443. Assign this security group to your web server.

To create a security group for HTTPS and assign it to your web server

1. Open the Amazon EC2 console at https://console.aws.amazon.com/ec2/.
2. Choose Security groups in the navigation pane.
3. Choose Create security group.
4. For Create Security Group, do the following:
   a. For Security group name, type a name for the security group that you are creating.
   b. (Optional) Type a description of the security group that you are creating.
   c. For VPC, choose the VPC that contains your web server Amazon EC2 instance.
   d. Select Add Rule.
   e. For Type, select HTTPS from the drop-down window.
   f. For Source, enter a source location.
   g. Choose Create security group.
5. In the navigation pane, choose Instances.
6. Select the check box next to your web server instance.
7. Select the Actions drop-down menu at the top of the page. Select Security and then Change Security Groups.
8. For Associated security groups, select the search box and choose the security group that you created for HTTPS. Then choose Add Security Groups.
9. Select Save.

Verify that HTTPS uses the certificate that you configured

After you add the web server to a security group, you can verify that SSL/TLS offload is using your self-signed certificate. You can do this with a web browser or with a tool such as OpenSSL s_client.

To verify SSL/TLS offload with a web browser

1. Use a web browser to connect to your web server using the public DNS name or IP address of the server. Ensure that the URL in the address bar begins with https://. For example, https://ec2-52-14-212-67.us-east-2.compute.amazonaws.com/.
   
   **Tip**
   
   You can use a DNS service such as Amazon Route 53 to route your website’s domain name (for example, https://www.example.com/) to your web server. For more information, see Routing Traffic to an Amazon EC2 Instance in the Amazon Route 53 Developer Guide or in the documentation for your DNS service.
2. Use your web browser to view the web server certificate. For more information, see the following:
   - For Mozilla Firefox, see View a Certificate on the Mozilla Support website.
   - For Google Chrome, see Understand Security Issues on the Google Tools for Web Developers website.

   Other web browsers might have similar features that you can use to view the web server certificate.
3. Ensure that the SSL/TLS certificate is the one that you configured your web server to use.
To verify SSL/TLS offload with OpenSSL s_client

1. Run the following OpenSSL command to connect to your web server using HTTPS. Replace `<server name>` with the public DNS name or IP address of your web server.

   ```bash
   openssl s_client -connect <server name>:443
   ```

   **Tip**
   You can use a DNS service such as Amazon Route 53 to route your website's domain name (for example, https://www.example.com/) to your web server. For more information, see Routing Traffic to an Amazon EC2 Instance in the Amazon Route 53 Developer Guide or in the documentation for your DNS service.

2. Ensure that the SSL/TLS certificate is the one that you configured your web server to use.

You now have a website that is secured with HTTPS. The private key for the web server is stored in an HSM in your AWS CloudHSM cluster.

To add a load balancer, see Add a load balancer with Elastic Load Balancing (optional) (p. 566).

Using IIS with CNG for SSL/TLS offload on Windows

This tutorial provides step-by-step instructions for setting up SSL/TLS offload with AWS CloudHSM on a Windows web server.

**Topics**
- Overview (p. 558)
- Step 1: Set up the prerequisites (p. 558)
- Step 2: Create a certificate signing request (CSR) and certificate (p. 560)
- Step 3: Configure the web server (p. 563)
- Step 4: Enable HTTPS traffic and verify the certificate (p. 564)

**Overview**

On Windows, the Internet Information Services (IIS) for Windows Server web server application natively supports HTTPS. The AWS CloudHSM key storage provider (KSP) for Microsoft's Cryptography API: Next Generation (CNG) provides the interface that allows IIS to use the HSMs in your cluster for cryptographic offloading and key storage. The AWS CloudHSM KSP is the bridge that connects IIS to your AWS CloudHSM cluster.

This tutorial shows you how to do the following:
- Install the web server software on an Amazon EC2 instance.
- Configure the web server software to support HTTPS with a private key stored in your AWS CloudHSM cluster.
- (Optional) Use Amazon EC2 to create a second web server instance and Elastic Load Balancing to create a load balancer. Using a load balancer can increase performance by distributing the load across multiple servers. It can also provide redundancy and higher availability if one or more servers fail.

When you're ready to get started, go to **Step 1: Set up the prerequisites (p. 558)**.

**Step 1: Set up the prerequisites**

To set up web server SSL/TLS offload with AWS CloudHSM, you need the following:
• An active AWS CloudHSM cluster with at least one HSM.
• An Amazon EC2 instance running a Windows operating system with the following software installed:
  • The AWS CloudHSM client software for Windows.
  • Internet Information Services (IIS) for Windows Server.
• A crypto user (p. 61) (CU) to own and manage the web server's private key on the HSM.

Note
This tutorial uses Microsoft Windows Server 2016. Microsoft Windows Server 2012 is also supported, but Microsoft Windows Server 2012 R2 is not.

To set up a Windows Server instance and create a CU on the HSM

1. Complete the steps in Getting started (p. 7). When you launch the Amazon EC2 client, choose a Windows Server 2016 or Windows Server 2012 AMI. When you complete these steps, you have an active cluster with at least one HSM. You also have an Amazon EC2 client instance running Windows Server with the AWS CloudHSM client software for Windows installed.

2. (Optional) Add more HSMs to your cluster. For more information, see Adding an HSM (p. 44).

3. Connect to your Windows server. For more information, see Connect to Your Instance in the Amazon EC2 User Guide for Windows Instances.

4. Use CloudHSM CLI to create a crypto user (CU). Keep track of the CU user name and password. You will need them to complete the next step.

   Note
   For information on creating a user, see Managing HSM users with CloudHSM CLI (p. 60).

5. Set the login credentials for the HSM (p. 446), using the CU user name and password that you created in the previous step.

6. In step 5, if you used Windows Credentials Manager to set HSM credentials, download psexec.exe from SysInternals to run the following command as NT Authority\SYSTEM:

   psexec.exe -s "C:\Program Files\Amazon\CloudHsm\tools\set_cloudhsm_credentials.exe" --username <USERNAME> --password <PASSWORD>

   Replace <USERNAME> and <PASSWORD> with the HSM credentials.

To install IIS on your Windows Server

1. If you haven't already done so, connect to your Windows server. For more information, see Connect to Your Instance in the Amazon EC2 User Guide for Windows Instances.

2. On your Windows server, start Server Manager.

3. In the Server Manager dashboard, choose Add roles and features.

4. Read the Before you begin information, and then choose Next.

5. For Installation Type, choose Role-based or feature-based installation. Then choose Next.

6. For Server Selection, choose Select a server from the server pool. Then choose Next.

7. For Server Roles, do the following:
   a. Select Web Server (IIS).
   b. For Add features that are required for Web Server (IIS), choose Add Features.
   c. Choose Next to finish selecting server roles.

8. For Features, accept the defaults. Then choose Next.

9. Read the Web Server Role (IIS) information. Then choose Next.
10. For **Select role services**, accept the defaults or change the settings as preferred. Then choose **Next**.
11. For **Confirmation**, read the confirmation information. Then choose **Install**.
12. After the installation is complete, choose **Close**.

After you complete these steps, go to [Step 2: Create a certificate signing request (CSR) and certificate](p. 560).

### Step 2: Create a certificate signing request (CSR) and certificate

To enable HTTPS, your web server needs an SSL/TLS certificate and a corresponding private key. To use SSL/TLS offload with AWS CloudHSM, you store the private key in the HSM in your AWS CloudHSM cluster. To do this, you use the [AWS CloudHSM key storage provider (KSP) for Microsoft's Cryptography API: Next Generation (CNG)](p. 444) to create a certificate signing request (CSR). Then you give the CSR to a certificate authority (CA), which signs the CSR to produce a certificate.

**Topics**
- [Create a CSR](p. 560)
- [Get a signed certificate and import it](p. 561)

#### Create a CSR

Use the AWS CloudHSM KSP on your Windows Server to create a CSR.

**To create a CSR**

1. If you haven’t already done so, connect to your Windows server. For more information, see [Connect to Your Instance](in the Amazon EC2 User Guide for Windows Instances).
2. Use the following command to start the AWS CloudHSM client daemon.

   **Amazon Linux**
   ```bash
   $ sudo start cloudhsm-client
   ```

   **Amazon Linux 2**
   ```bash
   $ sudo service cloudhsm-client start
   ```

   **CentOS 7**
   ```bash
   $ sudo service cloudhsm-client start
   ```

   **CentOS 8**
   ```bash
   $ sudo service cloudhsm-client start
   ```

   **RHEL 7**
   ```bash
   $ sudo service cloudhsm-client start
   ```

   **RHEL 8**
   ```bash
   $ sudo service cloudhsm-client start
   ```
Ubuntu 16.04 LTS

$ sudo service cloudhsm-client start

Ubuntu 18.04 LTS

$ sudo service cloudhsm-client start

Windows

- For Windows client 1.1.2+:

  C:\Program Files\Amazon\CloudHSM> net.exe start AWSCloudHSMClient

- For Windows clients 1.1.1 and older:

  C:\Program Files\Amazon\CloudHSM> start "cloudhsm_client" cloudhsm_client.exe C:\ProgramData\Amazon\CloudHSM\data\cloudhsm_client.cfg

3. On your Windows Server, use a text editor to create a certificate request file named IISCertRequest.inf. The following shows the contents of an example IISCertRequest.inf file. For more information about the sections, keys, and values that you can specify in the file, see Microsoft's documentation. Do not change the ProviderName value.

   [Version]
   Signature = "$Windows NT$
   [NewRequest]
   Subject = "CN=example.com,C=US,ST=Washington,L=Seattle,O=ExampleOrg,OU=WebServer"
   HashAlgorithm = SHA256
   KeyAlgorithm = RSA
   KeyLength = 2048
   ProviderName = "Cavium Key Storage Provider"
   KeyUsage = 0xf0
   MachineKeySet = True
   [EnhancedKeyUsageExtension]
   OID=1.3.6.1.5.5.7.3.1

4. Use the Windows certreq command to create a CSR from the IISCertRequest.inf file that you created in the previous step. The following example saves the CSR to a file named IISCertRequest.csr. If you used a different file name for your certificate request file, replace IISCertRequest.inf with the appropriate file name. You can optionally replace IISCertRequest.csr with a different file name for your CSR file.

   C:\>certreq -new IISCertRequest.inf IISCertRequest.csr
   SDK Version: 2.03
   CertReq: Request Created

   The IISCertRequest.csr file contains your CSR. You need this CSR to get a signed certificate.

Get a signed certificate and import it

In a production environment, you typically use a certificate authority (CA) to create a certificate from a CSR. A CA is not necessary for a test environment. If you do use a CA, send the CSR file (IISCertRequest.csr) to it and use the CA to create a signed SSL/TLS certificate.
As an alternative to using a CA, you can use a tool like OpenSSL to create a self-signed certificate.

**Warning**
Self-signed certificates are not trusted by browsers and should not be used in production environments. They can be used in test environments.

The following procedures show how to create a self-signed certificate and use it to sign your web server's CSR.

**To create a self-signed certificate**

1. Use the following OpenSSL command to create a private key. You can optionally replace `SelfSignedCA.key` with the file name to contain your private key.

   ```bash
   openssl genrsa -aes256 -out SelfSignedCA.key 2048
   Generating RSA private key, 2048 bit long modulus
   ......................................................................+++ 
   .........................................+++ 
   e is 65537 (0x10001)
   Enter pass phrase for SelfSignedCA.key:
   Verifying - Enter pass phrase for SelfSignedCA.key:
   ```

2. Use the following OpenSSL command to create a self-signed certificate using the private key that you created in the previous step. This is an interactive command. Read the on-screen instructions and follow the prompts. Replace `SelfSignedCA.key` with the name of the file that contains your private key (if different). You can optionally replace `SelfSignedCA.crt` with the file name to contain your self-signed certificate.

   ```bash
   openssl req -new -x509 -days 365 -key SelfSignedCA.key -out SelfSignedCA.crt
   Enter pass phrase for SelfSignedCA.key:
   You are about to be asked to enter information that will be incorporated into your certificate request.
   What you are about to enter is what is called a Distinguished Name or a DN.
   There are quite a few fields but you can leave some blank
   For some fields there will be a default value,
   If you enter '.', the field will be left blank.
   ----- 
   Country Name (2 letter code) [AU]:
   State or Province Name (full name) [Some-State]:
   Locality Name (eg, city) []:
   Organization Name (eg, company) [Internet Widgits Pty Ltd]:
   Organizational Unit Name (eg, section) []:
   Common Name (e.g. server FQDN or YOUR name) []:
   Email Address []:
   ```

**To use your self-signed certificate to sign your web server's CSR**

- Use the following OpenSSL command to use your private key and self-signed certificate to sign the CSR. Replace the following with the names of the files that contain the corresponding data (if different).

  - `IISCertRequest.csr` – The name of the file that contains your web server's CSR
  - `SelfSignedCA.crt` – The name of the file that contains your self-signed certificate
  - `SelfSignedCA.key` – The name of the file that contains your private key
  - `IISCert.crt` – The name of the file to contain your web server's signed certificate

   ```bash
   openssl x509 -req -days 365 -in IISCertRequest.csr \ 
   -CA SelfSignedCA.crt \
   ```
### Step 3: Configure the web server

Update your IIS website's configuration to use the HTTPS certificate that you created at the end of the previous step (p. 560). This will finish setting up your Windows web server software (IIS) for SSL/TLS offload with AWS CloudHSM.

If you used a self-signed certificate to sign your CSR, you must first import the self-signed certificate into the Windows Trusted Root Certification Authorities.

**To import your self-signed certificate into the Windows Trusted Root Certification Authorities**

1. If you haven't already done so, connect to your Windows server. For more information, see [Connect to Your Instance](https://docs.aws.amazon.com/AmazonEC2/latest/UserGuide/g_getting_started.html) in the Amazon EC2 User Guide for Windows Instances.
2. Copy your self-signed certificate to your Windows server.
3. On your Windows Server, open the Control Panel.
4. For Search Control Panel, type certificates. Then choose Manage computer certificates.
5. In the Certificates - Local Computer window, double-click Trusted Root Certification Authorities.
6. Right-click on Certificates and then choose All Tasks, Import.
7. In the Certificate Import Wizard, choose Next.
8. Choose Browse, then find and select your self-signed certificate. If you created your self-signed certificate by following the instructions in the [previous step of this tutorial](https://docs.aws.amazon.com/CloudHSM/latest/APIReference/Getting-Private-Key.html) (p. 560), your self-signed certificate is named SelfSignedCA.crt. Choose Open.
9. Choose Next.
10. For Certificate Store, choose Place all certificates in the following store. Then ensure that Trusted Root Certification Authorities is selected for Certificate store.
11. Choose Next and then choose Finish.

**To update the IIS website's configuration**

1. If you haven't already done so, connect to your Windows server. For more information, see [Connect to Your Instance](https://docs.aws.amazon.com/AmazonEC2/latest/UserGuide/g_getting_started.html) in the Amazon EC2 User Guide for Windows Instances.
2. Start the AWS CloudHSM client daemon.
3. Copy your web server's signed certificate—the one that you created at the end of this tutorial's previous step (p. 560)—to your Windows server.
4. On your Windows Server, use the Windows certreq command to accept the signed certificate, as in the following example. Replace IISCert.crt with the name of the file that contains your web server's signed certificate.

```cmd
C:\>certreq -accept IISCert.crt
```
5. On your Windows server, start **Server Manager**.

6. In the **Server Manager** dashboard, in the top right corner, choose **Tools**, **Internet Information Services (IIS) Manager**.

7. In the **Internet Information Services (IIS) Manager** window, double-click your server name. Then double-click **Sites**. Select your website.

8. Select **SSL Settings**. Then, on the right side of the window, choose **Bindings**.

9. In the **Site Bindings** window, choose **Add**.

10. For **Type**, choose **https**. For **SSL certificate**, choose the HTTPS certificate that you created at the end of this tutorial's previous step (p. 560).

    **Note**
    If you encounter an error during this certificate binding, restart your server and retry this step.

11. Choose **OK**.

After you update your website's configuration, go to **Step 4: Enable HTTPS traffic and verify the certificate** (p. 564).

### Step 4: Enable HTTPS traffic and verify the certificate

After you configure your web server for SSL/TLS offload with AWS CloudHSM, add your web server instance to a security group that allows inbound HTTPS traffic. This allows clients, such as web browsers, to establish an HTTPS connection with your web server. Then make an HTTPS connection to your web server and verify that it's using the certificate that you configured for SSL/TLS offload with AWS CloudHSM.

**Topics**

- Enable inbound HTTPS connections (p. 564)
- Verify that HTTPS uses the certificate that you configured (p. 565)

#### Enable inbound HTTPS connections

To connect to your web server from a client (such as a web browser), create a security group that allows inbound HTTPS connections. Specifically, it should allow inbound TCP connections on port 443. Assign this security group to your web server.

**To create a security group for HTTPS and assign it to your web server**

1. Open the Amazon EC2 console at [https://console.aws.amazon.com/ec2/](https://console.aws.amazon.com/ec2/).
2. Choose **Security groups** in the navigation pane.
3. Choose **Create security group**.
4. For **Create Security Group**, do the following:
   a. For **Security group name**, type a name for the security group that you are creating.
   b. (Optional) Type a description of the security group that you are creating.
   c. For **VPC**, choose the VPC that contains your web server Amazon EC2 instance.
   d. Select **Add Rule**.
   e. For **Type**, select **HTTPS** from the drop-down window.
   f. For **Source**, enter a source location.
Choose **Create security group**.

5. In the navigation pane, choose **Instances**.
6. Select the check box next to your web server instance.
7. Select the **Actions** drop-down menu at the top of the page. Select **Security** and then **Change Security Groups**.
8. For **Associated security groups**, select the search box and choose the security group that you created for HTTPS. Then choose **Add Security Groups**.
9. Select **Save**.

**Verify that HTTPS uses the certificate that you configured**

After you add the web server to a security group, you can verify that SSL/TLS offload is using your self-signed certificate. You can do this with a web browser or with a tool such as **OpenSSL s_client**.

**To verify SSL/TLS offload with a web browser**

1. Use a web browser to connect to your web server using the public DNS name or IP address of the server. Ensure that the URL in the address bar begins with https://. For example, https://ec2-52-14-212-67.us-east-2.compute.amazonaws.com/.

   **Tip**
   You can use a DNS service such as Amazon Route 53 to route your website's domain name (for example, https://www.example.com/) to your web server. For more information, see **Routing Traffic to an Amazon EC2 Instance** in the **Amazon Route 53 Developer Guide** or in the documentation for your DNS service.

2. Use your web browser to view the web server certificate. For more information, see the following:

   - For Mozilla Firefox, see **View a Certificate** on the Mozilla Support website.
   - For Google Chrome, see **Understand Security Issues** on the Google Tools for Web Developers website.

   Other web browsers might have similar features that you can use to view the web server certificate.

3. Ensure that the SSL/TLS certificate is the one that you configured your web server to use.

**To verify SSL/TLS offload with OpenSSL s_client**

1. Run the following OpenSSL command to connect to your web server using HTTPS. Replace `<server name>` with the public DNS name or IP address of your web server.

   ```sh
cross.pem
openssl s_client -connect <server name>:443
```

   **Tip**
   You can use a DNS service such as Amazon Route 53 to route your website's domain name (for example, https://www.example.com/) to your web server. For more information, see **Routing Traffic to an Amazon EC2 Instance** in the **Amazon Route 53 Developer Guide** or in the documentation for your DNS service.

2. Ensure that the SSL/TLS certificate is the one that you configured your web server to use.

You now have a website that is secured with HTTPS. The private key for the web server is stored in an HSM in your AWS CloudHSM cluster.

To add a load balancer, see **Add a load balancer with Elastic Load Balancing (optional)** (p. 566).
Add a load balancer with Elastic Load Balancing (optional)

After you set up SSL/TLS offload with one web server, you can create more web servers and an Elastic Load Balancing load balancer that routes HTTPS traffic to the web servers. A load balancer can reduce the load on your individual web servers by balancing traffic across two or more servers. It can also increase the availability of your website because the load balancer monitors the health of your web servers and only routes traffic to healthy servers. If a web server fails, the load balancer automatically stops routing traffic to it.

Topics
- Create a subnet for a second web server (p. 566)
- Create the second web server (p. 567)
- Create the load balancer (p. 569)

Create a subnet for a second web server

Before you can create another web server, you need to create a new subnet in the same VPC that contains your existing web server and AWS CloudHSM cluster.

To create a new subnet
1. Open the Subnets section of the Amazon VPC console.
2. Choose Create Subnet.
3. In the Create Subnet dialog box, do the following:
   a. For Name tag, type a name for your subnet.
   b. For VPC, choose the AWS CloudHSM VPC that contains your existing web server and AWS CloudHSM cluster.
   c. For Availability Zone, choose an Availability Zone that is different from the one that contains your existing web server.
   d. For IPv4 CIDR block, type the CIDR block to use for the subnet. For example, type 10.0.10.0/24.
   e. Choose Yes, Create.
4. Select the check box next to the public subnet that contains your existing web server. This is different from the public subnet that you created in the previous step.
5. In the content pane, choose the Route Table tab. Then choose the link for the route table.
6. Select the check box next to the route table.
7. Choose the Subnet Associations tab. Then choose Edit.
8. Select the check box next to the public subnet that you created earlier in this procedure. Then choose Save.

Create the second web server

Complete the following steps to create a second web server with the same configuration as your existing web server.

To create a second web server

1. Open the Instances section of the Amazon EC2 console at.
2. Select the check box next to your existing web server instance.
3. Choose Actions, Image, and then Create Image.
4. In the Create Image dialog box, do the following:
   a. For Image name, type a name for the image.
   b. For Image description, type a description for the image.
   c. Choose Create Image. This action reboots your existing web server.
   d. Choose the View pending image ami-<AMI_ID> link.

   In the Status column, note your image status. When your image status is available (this might take several minutes), go to the next step.
5. In the navigation pane, choose Instances.
6. Select the check box next to your existing web server.
7. Choose Actions and choose Launch More Like This.
8. Choose Edit AMI.
AMI Details

9. In the left navigation pane, choose My AMIs. Then clear the text in the search box.

10. Next to your web server image, choose Select.

11. Choose Yes, I want to continue with this AMI (<image name> - ami-<AMI ID>).

12. Choose Next.

13. Select an instance type, and then choose Next: Configure Instance Details.

14. For Step 3: Configure Instance Details, do the following:
   a. For Network, choose the VPC that contains your existing web server.
   b. For Subnet, choose the public subnet that you created for the second web server.
   c. For Auto-assign Public IP, choose Enable.
   d. Change the remaining instance details as preferred. Then choose Next: Add Storage.

15. Change the storage settings as preferred. Then choose Next: Add Tags.

16. Add or edit tags as preferred. Then choose Next: Configure Security Group.

17. For Step 6: Configure Security Group, do the following:
   a. For Assign a security group, choose Select an existing security group.
   b. Select the check box next to the security group named cloudhsm-<cluster ID>-sg. AWS CloudHSM created this security group on your behalf when you created the cluster (p. 9). You must choose this security group to allow the web server instance to connect to the HSMs in the cluster.
   c. Select the check box next to the security group that allows inbound HTTPS traffic. You created this security group previously (p. 564).
   d. (Optional) Select the check box next to a security group that allows inbound SSH (for Linux) or RDP (for Windows) traffic from your network. That is, the security group must allow inbound TCP traffic on port 22 (for SSH on Linux) or port 3389 (for RDP on Windows). Otherwise, you cannot connect to your client instance. If you don't have a security group like this, you must create one and then assign it to your client instance later.

Choose Review and Launch.

18. Review your instance details, and then choose Launch.

19. Choose whether to launch your instance with an existing key pair, create a new key pair, or launch your instance without a key pair.

   • To use an existing key pair, do the following:
     1. Choose Choose an existing key pair.
     2. For Select a key pair, choose the key pair to use.
     3. Select the check box next to I acknowledge that I have access to the selected private key file (<private key file name>.pem), and that without this file, I won't be able to log into my instance.

   • To create a new key pair, do the following:
     1. Choose Create a new key pair.
     2. For Key pair name, type a key pair name.
3. Choose **Download Key Pair** and save the private key file in a secure and accessible location.

   **Warning**
   You cannot download the private key file again after this point. If you do not download the private key file now, you will be unable to access the client instance.

   • To launch your instance without a key pair, do the following:
     1. Choose **Proceed without a key pair**.
     2. Select the check box next to **I acknowledge that I will not be able to connect to this instance unless I already know the password built into this AMI**.

      Choose **Launch Instances**.

### Create the load balancer

Complete the following steps to create an Elastic Load Balancing load balancer that routes HTTPS traffic to your web servers.

#### To create a load balancer

1. Open the **Load balancers** section of the Amazon EC2 console.
2. Choose **Create Load Balancer**.
3. In the **Network Load Balancer** section, choose **Create**.
4. For **Step 1: Configure Load Balancer**, do the following:
   a. For **Name**, type a name for the load balancer that you are creating.
   b. In the **Listeners** section, for **Load Balancer Port**, change the value to 443.
   c. In the **Availability Zones** section, for **VPC**, choose the VPC that contains your web servers.
   d. In the **Availability Zones** section, choose the subnets that contain your web servers.
   e. Choose **Next: Configure Routing**.
5. For **Step 2: Configure Routing**, do the following:
   a. For **Name**, type a name for the target group that you are creating.
   b. For **Port**, change the value to 443.
   c. Choose **Next: Register Targets**.
6. For **Step 3: Register Targets**, do the following:
   a. In the **Instances** section, select the check boxes next to your web server instances. Then choose **Add to registered**.
   b. Choose **Next: Review**.
7. Review your load balancer details, then choose **Create**.
8. When the load balancer has been successfully created, choose **Close**.

After you complete the preceding steps, the Amazon EC2 console shows your Elastic Load Balancing load balancer.

When your load balancer's state is active, you can verify that the load balancer is working. That is, you can verify that it's sending HTTPS traffic to your web servers with SSL/TLS offload with AWS CloudHSM. You can do this with a web browser or a tool such as **OpenSSL s_client**.
To verify that your load balancer is working with a web browser

1. In the Amazon EC2 console, find the **DNS name** for the load balancer that you just created. Then select the DNS name and copy it.

2. Use a web browser such as Mozilla Firefox or Google Chrome to connect to your load balancer using the load balancer’s DNS name. Ensure that the URL in the address bar begins with https://.

   **Tip**
   You can use a DNS service such as Amazon Route 53 to route your website's domain name (for example, https://www.example.com/) to your web server. For more information, see Routing Traffic to an Amazon EC2 Instance in the Amazon Route 53 Developer Guide or in the documentation for your DNS service.

3. Use your web browser to view the web server certificate. For more information, see the following:
   - For Mozilla Firefox, see View a Certificate on the Mozilla Support website.
   - For Google Chrome, see Understand Security Issues on the Google Tools for Web Developers website.

   Other web browsers might have similar features that you can use to view the web server certificate.

4. Ensure that the certificate is the one that you configured the web server to use.

To verify that your load balancer is working with OpenSSL s_client

1. Use the following OpenSSL command to connect to your load balancer using HTTPS. Replace `<DNS name>` with the DNS name of your load balancer.

   ```
   openssl s_client -connect <DNS name>:443
   ```

   **Tip**
   You can use a DNS service such as Amazon Route 53 to route your website's domain name (for example, https://www.example.com/) to your web server. For more information, see Routing Traffic to an Amazon EC2 Instance in the Amazon Route 53 Developer Guide or in the documentation for your DNS service.

2. Ensure that the certificate is the one that you configured the web server to use.

You now have a website that is secured with HTTPS, with the web server's private key stored in an HSM in your AWS CloudHSM cluster. Your website has two web servers and a load balancer to help improve efficiency and availability.

**Configure Windows Server as a certificate authority (CA) with AWS CloudHSM**

In a public key infrastructure (PKI), a certificate authority (CA) is a trusted entity that issues digital certificates. These digital certificates bind a public key to an identity (a person or organization) by means of public key cryptography and digital signatures. To operate a CA, you must maintain trust by protecting the private key that signs the certificates issued by your CA. You can store the private key in the HSM in your AWS CloudHSM cluster, and use the HSM to perform the cryptographic signing operations.

In this tutorial, you use Windows Server and AWS CloudHSM to configure a CA. You install the AWS CloudHSM client software for Windows on your Windows server, then add the Active Directory Certificate Services (AD CS) role to your Windows Server. When you configure this role, you use an AWS
Prerequisites

CloudHSM key storage provider (KSP) to create and store the CA's private key on your AWS CloudHSM cluster. The KSP is the bridge that connects your Windows server to your AWS CloudHSM cluster. In the last step, you sign a certificate signing request (CSR) with your Windows Server CA.

For more information, see the following topics:

Topics

- Windows Server CA step 1: Set up the prerequisites (p. 571)
- Windows Server CA step 2: Create a Windows Server CA with AWS CloudHSM (p. 572)
- Windows Server CA step 3: Sign a certificate signing request (CSR) with your Windows Server CA with AWS CloudHSM (p. 573)

Windows Server CA step 1: Set up the prerequisites

To set up Windows Server as a certificate authority (CA) with AWS CloudHSM, you need the following:

- An active AWS CloudHSM cluster with at least one HSM.
- An Amazon EC2 instance running a Windows Server operating system with the AWS CloudHSM client software for Windows installed. This tutorial uses Microsoft Windows Server 2016.
- A cryptographic user (CU) to own and manage the CA's private key on the HSM.

To set up the prerequisites for a Windows Server CA with AWS CloudHSM

1. Complete the steps in Getting started (p. 7). When you launch the Amazon EC2 client, choose a Windows Server AMI. This tutorial uses Microsoft Windows Server 2016. When you complete these steps, you have an active cluster with at least one HSM. You also have an Amazon EC2 client instance running Windows Server with the AWS CloudHSM client software for Windows installed.
2. (Optional) Add more HSMs to your cluster. For more information, see Adding an HSM (p. 44).
3. Connect to your client instance. For more information, see Connect to Your Instance in the Amazon EC2 User Guide for Windows Instances.
4. Create a crypto user (CU) using Managing HSM users with CloudHSM CLI (p. 60) or Managing HSM users with CloudHSM Management Utility (CMU) (p. 93). Keep track of the CU user name and password. You will need them to complete the next step.
5. Set the login credentials for the HSM (p. 446), using the CU user name and password that you created in the previous step.
6. In step 5, if you used Windows Credentials Manager to set HSM credentials, download psexec.exe from SysInternals to run the following command as NT Authority\SYSTEM:

   ```
   psexec.exe -s "C:\Program Files\Amazon\CloudHsm\tools\set_cloudhsm_credentials.exe" --username <USERNAME> --password <PASSWORD>
   ```

   Replace `<USERNAME>` and `<PASSWORD>` with the HSM credentials.

   To create a Windows Server CA with AWS CloudHSM, go to Create Windows Server CA (p. 572).

571
Windows Server CA step 2: Create a Windows Server CA with AWS CloudHSM

To create a Windows Server CA, you add the Active Directory Certificate Services (AD CS) role to your Windows Server. When you add this role, you use an AWS CloudHSM key storage provider (KSP) to create and store the CA’s private key on your AWS CloudHSM cluster.

**Note**
When you create your Windows Server CA, you can choose to create a root CA or a subordinate CA. You typically make this decision based on the design of your public key infrastructure and the security policies of your organization. This tutorial explains how to create a root CA for simplicity.

**To add the AD CS role to your Windows Server and create the CA's private key**

1. If you haven't already done so, connect to your Windows server. For more information, see Connect to Your Instance in the Amazon EC2 User Guide for Windows Instances.
2. On your Windows server, start Server Manager.
3. In the Server Manager dashboard, choose Add roles and features.
4. Read the Before you begin information, and then choose Next.
5. For Installation Type, choose Role-based or feature-based installation. Then choose Next.
6. For Server Selection, choose Select a server from the server pool. Then choose Next.
7. For Server Roles, do the following:
   b. For Add features that are required for Active Directory Certificate Services, choose Add Features.
   c. Choose Next to finish selecting server roles.
8. For Features, accept the defaults, and then choose Next.
9. For AD CS, do the following:
   a. Choose Next.
   b. Select Certification Authority, and then choose Next.
10. For Confirmation, read the confirmation information, and then choose Install. Do not close the window.
11. Choose the highlighted Configure Active Directory Certificate Services on the destination server link.
12. For Credentials, verify or change the credentials displayed. Then choose Next.
13. For Role Services, select Certification Authority. Then choose Next.
14. For Setup Type, select Standalone CA. Then choose Next.
15. For CA Type, select Root CA. Then choose Next.
   **Note**
   You can choose to create a root CA or a subordinate CA based on the design of your public key infrastructure and the security policies of your organization. This tutorial explains how to create a root CA for simplicity.
16. For Private Key, select Create a new private key. Then choose Next.
17. For Cryptography, do the following:
   a. For Select a cryptographic provider, choose one of the Cavium Key Storage Provider options from the menu. These are the AWS CloudHSM key storage providers. For example, you can choose RSA#Cavium Key Storage Provider.
b. For **Key length**, choose one of the key length options.

c. For **Select the hash algorithm for signing certificates issued by this CA**, choose one of the hash algorithm options.

Choose **Next**.

18. For **CA Name**, do the following:

   a. (Optional) Edit the common name.
   b. (Optional) Type a distinguished name suffix.

Choose **Next**.

19. For **Validity Period**, specify a time period in years, months, weeks, or days. Then choose **Next**.

20. For **Certificate Database**, you can accept the default values, or optionally change the location for the database and the database log. Then choose **Next**.

21. For **Confirmation**, review the information about your CA; Then choose **Configure**.

22. Choose **Close**, and then choose **Close** again.

You now have a Windows Server CA with AWS CloudHSM. To learn how to sign a certificate signing request (CSR) with your CA, go to [Sign a CSR (p. 573)](#).

### Windows Server CA step 3: Sign a certificate signing request (CSR) with your Windows Server CA with AWS CloudHSM

You can use your Windows Server CA with AWS CloudHSM to sign a certificate signing request (CSR). To complete these steps, you need a valid CSR. You can create a CSR in several ways, including the following:

- Using OpenSSL
- Using the Windows Server Internet Information Services (IIS) Manager
- Using the certificates snap-in in the Microsoft Management Console
- Using the `certreq` command line utility on Windows

The steps for creating a CSR are outside the scope of this tutorial. When you have a CSR, you can sign it with your Windows Server CA.

#### To sign a CSR with your Windows Server CA

1. If you haven't already done so, connect to your Windows server. For more information, see [Connect to Your Instance](#) in the Amazon EC2 User Guide for Windows Instances.
2. On your Windows server, start **Server Manager**.
3. In the **Server Manager** dashboard, in the top right corner, choose **Tools, Certification Authority**.
4. In the **Certification Authority** window, choose your computer name.
5. From the **Action** menu, choose **All Tasks, Submit new request**.
6. Select your CSR file, and then choose **Open**.
7. In the **Certification Authority** window, double-click **Pending Requests**.
8. Select the pending request. Then, from the **Action** menu, choose **All Tasks, Issue**.
9. In the **Certification Authority** window, double-click **Issued Requests** to view the signed certificate.

10. (Optional) To export the signed certificate to a file, complete the following steps:

   a. In the **Certification Authority** window, double-click the certificate.
   b. Choose the **Details** tab, and then choose **Copy to File**.
   c. Follow the instructions in the **Certificate Export Wizard**.

You now have a Windows Server CA with AWS CloudHSM, and a valid certificate signed by the Windows Server CA.

**Oracle database transparent data encryption (TDE) with AWS CloudHSM**

Transparent Data Encryption (TDE) is used to encrypt database files. Using TDE, database software encrypts data before storing it on disk. The data in the database's table columns or tablespaces are encrypted with a table key or tablespace key. Some versions of Oracle's database software offer TDE. In Oracle TDE, these keys are encrypted with a TDE master encryption key. You can achieve greater security by storing the TDE master encryption key in the HSMs in your AWS CloudHSM cluster.

In this solution, you use Oracle Database installed on an Amazon EC2 instance. Oracle Database integrates with the **AWS CloudHSM software library for PKCS #11** (p. 394) to store the TDE master key in the HSMs in your cluster.
Important

- We recommend installing Oracle Database on an Amazon EC2 instance.

Complete the following steps to accomplish Oracle TDE integration with AWS CloudHSM.

To configure Oracle TDE integration with AWS CloudHSM

1. Follow the steps in Set up prerequisites (p. 575) to prepare your environment.
2. Follow the steps in Configure the database (p. 576) to configure Oracle Database to integrate with your AWS CloudHSM cluster.

Oracle TDE with AWS CloudHSM: Set up the prerequisites

To accomplish Oracle TDE integration with AWS CloudHSM, you need the following:

- An active AWS CloudHSM cluster with at least one HSM.
- An Amazon EC2 instance running the Amazon Linux operating system with the following software installed:
  - The AWS CloudHSM client and command line tools.
  - The AWS CloudHSM software library for PKCS #11.
  - Oracle Database. AWS CloudHSM supports Oracle TDE integration. Client SDK 5.6 and higher support Oracle TDE for Oracle Database 19c. Client SDK 3 supports Oracle TDE for Oracle Database versions 11g and 12c.
  - A cryptographic user (CU) to own and manage the TDE master encryption key on the HSMs in your cluster.

Complete the following steps to set up all of the prerequisites.

To set up the prerequisites for Oracle TDE integration with AWS CloudHSM

1. Complete the steps in Getting started (p. 7). After you do so, you'll have an active cluster with one HSM. You will also have an Amazon EC2 instance running the Amazon Linux operating system. The AWS CloudHSM client and command line tools will also be installed and configured.
2. (Optional) Add more HSMs to your cluster. For more information, see Adding an HSM (p. 44).
3. Connect to your Amazon EC2 client instance and do the following:
   a. Install the AWS CloudHSM software library for PKCS #11 (p. 394).
   b. Install Oracle Database. For more information, see the Oracle Database documentation. Client SDK 5.6 and higher support Oracle TDE for Oracle Database 19c. Client SDK 3 supports Oracle TDE for Oracle Database versions 11g and 12c.
   c. Use the cloudhsm_mgmt_util command line tool to create a cryptographic user (CU) on your cluster. For more information about creating a CU, see How to Manage HSM Users with CMU (p. 98) and Managing HSM users (p. 60).

After you complete these steps, you can Configure the database (p. 576).
Oracle TDE with AWS CloudHSM: Configure the database and generate the master encryption key

To integrate Oracle TDE with your AWS CloudHSM cluster, see the following topics:

1. Update the Oracle database configuration (p. 576) to use the HSMs in your cluster as the external security module. For information about external security modules, see Introduction to Transparent Data Encryption in the Oracle Database Advanced Security Guide.

2. Generate the Oracle TDE master encryption key (p. 577) on the HSMs in your cluster.

Update the Oracle database configuration

To update the Oracle Database configuration to use an HSM in your cluster as the external security module, complete the following steps. For information about external security modules, see Introduction to Transparent Data Encryption in the Oracle Database Advanced Security Guide.

To update the Oracle configuration

1. Connect to your Amazon EC2 client instance. This is the instance where you installed Oracle Database.

2. Make a backup copy of the file named sqlnet.ora. For the location of this file, see the Oracle documentation.

3. Use a text editor to edit the file named sqlnet.ora. Add the following line. If an existing line in the file begins with encryption_wallet_location, replace the existing line with the following one.

   ```
   encryption_wallet_location=(source=(method=hsm))
   ```

   Save the file.

4. Run the following command to create the directory where Oracle Database expects to find the library file for the AWS CloudHSM PKCS #11 software library.

   ```
   sudo mkdir -p /opt/oracle/extapi/64/hsm
   ```

5. Run the following command to copy the AWS CloudHSM software library for PKCS #11 file to the directory that you created in the previous step.

   ```
   sudo cp /opt/cloudhsm/lib/libcloudhsm_pkcs11.so /opt/oracle/extapi/64/hsm/
   ```

   **Note**
   The /opt/oracle/extapi/64/hsm directory must contain only one library file. Remove any other files that exist in that directory.

6. Run the following command to change the ownership of the /opt/oracle directory and everything inside it.

   ```
   sudo chown -R oracle:dba /opt/oracle
   ```

7. Start the Oracle Database.
Configure the database

Generate the Oracle TDE master encryption key

To generate the Oracle TDE master key on the HSMs in your cluster, complete the steps in the following procedure.

To generate the master key

1. Use the following command to open Oracle SQL*Plus. When prompted, type the system password that you set when you installed Oracle Database.

   sqlplus / as sysdba

   Note
   For Client SDK 3, you must set the CLOUDHSM_IGNORE_CKA_MODIFIABLE_FALSE environment variable each time you generate a master key. This variable is only needed for master key generation. For more information, see "Issue: Oracle sets the PKCS #11 attribute CKA_MODIFIABLE during master key generation, but the HSM does not support it" in Known Issues for Integrating Third-Party Applications (p. 649).

2. Run the SQL statement that creates the master encryption key, as shown in the following examples. Use the statement that corresponds to your version of Oracle Database. Replace <CU user name> with the user name of the cryptographic user (CU). Replace <password> with the CU password.

   Important
   Run the following command only once. Each time the command is run, it creates a new master encryption key.

   • For Oracle Database version 11, run the following SQL statement.

   SQL> alter system set encryption key identified by "<CU user name>:<password>";

   • For Oracle Database version 12 and version 19c, run the following SQL statement.

   SQL> administer key management set key identified by "<CU user name>:<password>";

   If the response is System altered or keystore altered, then you successfully generated and set the master key for Oracle TDE.

3. (Optional) Run the following command to verify the status of the Oracle wallet.

   SQL> select * from v$encryption_wallet;

   If the wallet is not open, use one of the following commands to open it. Replace <CU user name> with the name of the cryptographic user (CU). Replace <password> with the CU password.

   • For Oracle 11, run the following command to open the wallet.

   SQL> alter system set encryption wallet open identified by "<CU user name>:<password>";

   To manually close the wallet, run the following command.

   SQL> alter system set encryption wallet close identified by "<CU user name>:<password>";

   • For Oracle 12 and Oracle 19c, run the following command to open the wallet.
To manually close the wallet, run the following command.

```
SQL> administer key management set keystore close identified by "<CU user name>:<password>";
```

Use Microsoft SignTool with AWS CloudHSM to sign files

In cryptography and public key infrastructure (PKI), digital signatures are used to confirm that data has been sent by a trusted entity. Signatures also indicate that the data has not been tampered with in transit. A signature is an encrypted hash that is generated with the sender's private key. The receiver can verify the data's integrity by decrypting its hash signature with the sender's public key. In turn, it is the sender's responsibility to maintain a digital certificate. The digital certificate demonstrates the sender's ownership of the private key and provides the recipient with the public key that is needed for decryption. As long as the private key is owned by the sender, the signature can be trusted. AWS CloudHSM provides secure FIPS 140-2 level 3 validated hardware for you to secure these keys with exclusive single-tenant access.

Many organizations use Microsoft SignTool, a command line tool that signs, verifies, and timestamps files to simplify the code signing process. You can use AWS CloudHSM to securely store your key pairs until they are needed by SignTool, thus creating an easily automatable workflow for signing data.

The following topics provide an overview of how to use SignTool with AWS CloudHSM:

**Topics**

- Microsoft SignTool with AWS CloudHSM step 1: Set up the prerequisites (p. 578)
- Microsoft SignTool with AWS CloudHSM step 2: Create a signing certificate (p. 579)
- Microsoft SignTool with AWS CloudHSM step 3: Sign a file (p. 580)

**Microsoft SignTool with AWS CloudHSM step 1: Set up the prerequisites**

To use Microsoft SignTool with AWS CloudHSM, you need the following:

- An Amazon EC2 client instance running a Windows operating system.
- A certificate authority (CA), either self-maintained or established by a third-party provider.
- An active AWS CloudHSM cluster in the same virtual public cloud (VPC) as your EC2 instance. The cluster must contain at least one HSM.
- A crypto user (CU) to own and manage keys in the AWS CloudHSM cluster.
- An unsigned file or executable.
- The Microsoft Windows Software Development Kit (SDK).
To set up the prerequisites for using AWS CloudHSM with Windows SignTool

1. Follow the instructions in the Getting Started (p. 7) section of this guide to launch a Windows EC2 instance and an AWS CloudHSM cluster.

2. If you would like to host your own Windows Server CA, follow steps 1 and 2 in Configuring Windows Server as a Certificate Authority with AWS CloudHSM (p. 570). Otherwise, continue to use your publically trusted third-party CA.

3. Download and install one of the following versions of the Microsoft Windows SDK on your Windows EC2 instance:
   - Microsoft Windows SDK 10
   - Microsoft Windows SDK 8.1
   - Microsoft Windows SDK 7

   The SignTool executable is part of the Windows SDK Signing Tools for Desktop Apps installation feature. You can omit the other features to be installed if you don't need them. The default installation location is:

   ```c:\Program Files (x86)\Windows Kits\<SDK version>\bin\<version number>\<CPU architecture>\signtool.exe```

You can now use the Microsoft Windows SDK, your AWS CloudHSM cluster, and your CA to Create a Signing Certificate (p. 579).

Microsoft SignTool with AWS CloudHSM step 2: Create a signing certificate

Now that you've downloaded the Windows SDK on to your EC2 instance, you can use it to generate a certificate signing request (CSR). The CSR is an unsigned certificate that is eventually passed to your CA for signing. In this example, we use the certreq executable that's included with the Windows SDK to generate the CSR.

To generate a CSR using the certreq executable

1. If you haven't already done so, connect to your Windows EC2 instance. For more information, see Connect to Your Instance in the Amazon EC2 User Guide for Windows Instances.

2. Create a file called request.inf that contains the lines below. Replace the Subject information with that of your organization. For an explanation of each parameter, see Microsoft's documentation.

   ```
   [Version]
   Signature=$Windows NT$
   [NewRequest]
   Subject = "C=<Country>, CN=<www.website.com>, O=<Organization>, OU=<Organizational-Unit>, L=<City>, S=<State>"
   RequestType=PKCS10
   HashAlgorithm = SHA256
   KeyAlgorithm = RSA
   KeyLength = 2048
   ProviderName = Cavium Key Storage Provider
   KeyUsage = "CERT_DIGITAL_SIGNATURE_KEY_USAGE"
   MachineKeySet = True
   Exportable = False
   ```
3. Run `certreq.exe`. For this example, we save the CSR as `request.csr`.

   ```
   certreq.exe -new request.inf request.csr
   ```

   Internally, a new key pair is generated on your AWS CloudHSM cluster, and the pair's private key is used to create the CSR.

4. Submit the CSR to your CA. If you are using a Windows Server CA, follow these steps:
   a. Enter the following command to open the CA tool:

      ```
      certsrv.msc
      ```

   b. In the new window, right-click the CA server's name. Choose All Tasks, and then choose Submit new request.

   c. Navigate to `request.csr`'s location and choose Open.

   d. Navigate to the Pending Requests folder by expanding the Server CA menu. Right-click on the request you just created, and under All Tasks choose Issue.

   e. Now navigate to the Issued Certificates folder (above the Pending Requests folder).

   f. Choose Open to view the certificate, and then choose the Details tab.

   g. Choose Copy to File to start the Certificate Export Wizard. Save the DER-encoded X.509 file to a secure location as `signedCertificate.cer`.

   h. Exit the CA tool and use the following command, which moves the certificate file to the Personal Certificate Store in Windows. It can then be used by other applications.

      ```
      certreq.exe -accept signedCertificate.cer
      ```

You can now use your imported certificate to Sign a File (p. 580).

**Microsoft SignTool with AWS CloudHSM step 3: Sign a file**

You are now ready to use SignTool and your imported certificate to sign your example file. In order to do so, you need to know the certificate's SHA-1 hash, or thumbprint. The thumbprint is used to ensure that SignTool only uses certificates that are verified by AWS CloudHSM. In this example, we use PowerShell to get the certificate's hash. You can also use the CA's GUI or the Windows SDK's `certutil` executable.

**To obtain a certificate's thumbprint and use it to sign a file**

1. Open PowerShell as an administrator and run the following command:

   ```
   Get-ChildItem -path cert:\LocalMachine\My
   ```

   Copy the Thumbprint that is returned.
2. Navigate to the directory within PowerShell that contains SignTool.exe. The default location is C:\Program Files (x86)\Windows Kits\10\bin\10.0.17763.0\x64.

3. Finally, sign your file by running the following command. If the command is successful, PowerShell returns a success message.

   ```
   signtool.exe sign /v /fd sha256 /sha1 <thumbprint> /sm /as C:\Users\Administrator\Desktop\<test>.ps1
   ```

4. (Optional) To verify the signature on the file, use the following command:

   ```
   signtool.exe verify /v /pa C:\Users\Administrator\Desktop\<test>.ps1
   ```

---

### Java Keytool and Jarsigner

AWS CloudHSM offers integration with the Java Keytool and Jarsigner utilities through Client SDK 3 and Client SDK 5. The steps to use these tools will vary depending on the version of the client SDK in which you currently have downloaded:

- Using Client SDK 5 to integrate with Java Keytool and Jarsigner (p. 581)
- Using Client SDK 3 to integrate with Java Keytool and Jarsigner (p. 589)

---

#### Using Client SDK 5 to integrate with Java Keytool and Jarsigner

AWS CloudHSM key store is a special-purpose JCE key store that utilizes certificates associated with keys on your HSM through third-party tools such as keytool and jarsigner. AWS CloudHSM does not store certificates on the HSM, as certificates are public, non-confidential data. The AWS CloudHSM key store stores the certificates in a local file and maps the certificates to corresponding keys on your HSM.

When you use the AWS CloudHSM key store to generate new keys, no entries are generated in the local key store file – the keys are created on the HSM. Similarly, when you use the AWS CloudHSM key store to
search for keys, the search is passed on to the HSM. When you store certificates in the AWS CloudHSM key store, the provider verifies that a key pair with the corresponding alias exists on the HSM, and then associates the certificate provided with the corresponding key pair.

Topics
- Prerequisites (p. 582)
- Using AWS CloudHSM key store with keytool (p. 583)
- Using AWS CloudHSM key store with Jarsigner (p. 587)
- Known issues (p. 589)

Prerequisites
To use the AWS CloudHSM key store, you must first initialize and configure the AWS CloudHSM JCE SDK.

Step 1: Install the JCE
To install the JCE, including the AWS CloudHSM client prerequisites, follow the steps for installing the Java library (p. 422).

Step 2: Add HSM login credentials to environment variables
Set up environment variables to contain your HSM login credentials.

Linux

```bash
$ export HSM_USER=<HSM user name>
$ export HSM_PASSWORD=<HSM password>
```

Windows

```powershell
PS C:\> $Env:HSM_USER=<HSM user name>
PS C:\> $Env:HSM_PASSWORD=<HSM password>
```

Note
The AWS CloudHSM JCE offers various login options. To use the AWS CloudHSM key store with third-party applications, you must use implicit login with environment variables. If you want to use explicit login through application code, you must build your own application using the AWS CloudHSM key store. For additional information, see the article on Using AWS CloudHSM Key Store (p. 437).

Step 3: Registering the JCE provider
To register the JCE provider in the Java CloudProvider configuration, follow these steps:

1. Open the java.security configuration file in your Java installation for editing.
2. In the java.security configuration file, add
   ```
   com.amazonaws.cloudhsm.jce.provider.CloudHsmProvider as the last provider. For example, if there are nine providers in the java.security file, add the following provider as the last provider in the section:
   ```
Use Client SDK 5 to integrate with Java Keytool and Jarsigner

security.provider.10=com.amazonaws.cloudhsm.jce.provider.CloudHsmProvider

**Note**

Adding the AWS CloudHSM provider as a higher priority may negatively impact your system's performance because the AWS CloudHSM provider will be prioritized for operations that may be safely offloaded to software. As a best practice, **always** specify the provider you wish to use for an operation, whether it is the AWS CloudHSM or a software-based provider.

**Note**

Specifying `-providerName`, `-providerclass`, and `-providerpath` command line options when generating keys using keytool with the AWS CloudHSM key store may cause errors.

### Using AWS CloudHSM key store with keytool

**Keytool** is a popular command line utility for common key and certificate tasks. A complete tutorial on keytool is out of scope for AWS CloudHSM documentation. This article explains the specific parameters you should use with various keytool functions when utilizing AWS CloudHSM as the root of trust through the AWS CloudHSM key store.

When using keytool with the AWS CloudHSM key store, specify the following arguments to any keytool command:

**Linux**

```
-storetype CLOUDHSM -J-classpath '-J/opt/cloudhsm/java/*'
```

**Windows**

```
-storetype CLOUDHSM -J-classpath '-J"C:\Program Files\Amazon\CloudHSM\java\*"'
```

If you want to create a new key store file using AWS CloudHSM key store, see Using AWS CloudHSM KeyStore (p. 504). To use an existing key store, specify its name (including path) using the `-keystore` argument to keytool. If you specify a non-existent key store file in a keytool command, the AWS CloudHSM key store creates a new key store file.

### Create new keys with keytool

You can use keytool to generate RSA, AES, and DESede type of key supported by AWS CloudHSM's JCE SDK.

**Important**

A key generated through keytool is generated in software, and then imported into AWS CloudHSM as an extractable, persistent key.

We strongly recommend generating non-exportable keys outside of keytool, and then importing corresponding certificates to the key store. If you use extractable RSA or EC keys through keytool and Jarsigner, the providers export keys from the AWS CloudHSM and then use the key locally for signing operations.

If you have multiple client instances connected to your AWS CloudHSM cluster, be aware that importing a certificate on one client instance's key store won't automatically make the certificates available on other client instances. To register the key and associated certificates on each client instance you need to run a Java application as described in the section called “Generate a CSR using keytool” (p. 584). Alternatively, you can make the necessary changes on one client and copy the resulting key store file to every other client instance.
Example 1: To generate a symmetric AES-256 key and save it in a key store file named, "my_keystore.store", in the working directory. Replace <secret label> with a unique label.

Linux

```bash
$ keytool -genseckey -alias <secret label> -keyalg aes \\
    -keysize 256 -keystore my_keystore.store \\
    -storetype CloudHSM -J-classpath '-J/opt/cloudhsm/java/*'
```

Windows

```powershell
PS C:\> keytool -genseckey -alias <secret label> -keyalg aes \\
    -keysize 256 -keystore my_keystore.store \\
    -storetype CloudHSM -J-classpath '-J"C:\Program Files\Amazon\CloudHSM\java\*"'
```

Example 2: To generate an RSA 2048 key pair and save it in a key store file named, "my_keystore.store" in the working directory. Replace <RSA key pair label> with a unique label.

Linux

```bash
$ keytool -genkeypair -alias <RSA key pair label> \\
    -keyalg rsa -keysize 2048 \\
    -sigalg sha512withrsa \\
    -keystore my_keystore.store \\
    -storetype CloudHSM \\
    -J-classpath '-J/opt/cloudhsm/java/*'
```

Windows

```powershell
PS C:\> keytool -genkeypair -alias <RSA key pair label> \\
    -keyalg rsa -keysize 2048 \\
    -sigalg sha512withrsa \\
    -keystore my_keystore.store \\
    -storetype CloudHSM \\
    -J-classpath '-J"C:\Program Files\Amazon\CloudHSM\java\*"
```

You can find a list of supported signature algorithms (p. 429) in the Java library.

Delete a key using keytool

The AWS CloudHSM key store doesn't support deleting keys. You can delete keys using the destroy method of the Destroyable interface.

```java
((Destroyable) key).destroy();
```

Generate a CSR using keytool

You receive the greatest flexibility in generating a certificate signing request (CSR) if you use the OpenSSL Dynamic Engine (p. 418). The following command uses keytool to generate a CSR for a key pair with the alias, my-key-pair.

Linux

```bash
$ keytool -certreq -alias <key pair label> \\
    -file my_csr.csr \\
    -keystore my_keystore.store \\
```
Use Client SDK 5 to integrate with Java Keytool and Jarsigner

Windows

PS C:\> keytool -certreq -alias <key pair label> `-storetype CLOUDHSM `-J-classpath '-J/opt/cloudhsm/java/*'

Note
To use a key pair from keytool, that key pair must have an entry in the specified key store file. If you want to use a key pair that was generated outside of keytool, you must import the key and certificate metadata into the key store. For instructions on importing the keystore data see the section called “Using keytool to import intermediate and root certificates into AWS CloudHSM key store” (p. 585).

Using keytool to import intermediate and root certificates into AWS CloudHSM key store

To import a CA certificate you must enable verification of a full certificate chain on a newly imported certificate. The following command shows an example.

Linux

$ keytool -import -trustcacerts -alias rootCAcert `-storetype CLOUDHSM `-J-classpath '-J/opt/cloudhsm/java/*'

Windows

PS C:\> keytool -import -trustcacerts -alias rootCAcert `-storetype CLOUDHSM `-J-classpath '-J"C:\Program Files\Amazon\CloudHSM\java\*"

If you connect multiple client instances to your AWS CloudHSM cluster, importing a certificate on one client instance's key store won't automatically make the certificate available on other client instances. You must import the certificate on each client instance.

Using keytool to delete certificates from AWS CloudHSM key store

The following command shows an example of how to delete a certificate from a Java keytool key store.

Linux

$ keytool -delete -alias mydomain `-storetype CLOUDHSM `-J-classpath '-J/opt/cloudhsm/java/*'

Windows

PS C:\> keytool -delete -alias mydomain
Use Client SDK 5 to integrate with Java Keytool and Jarsigner

-keystore my_keystore.store 
-storetype CLOUDHSM 
-J-classpath '-J"C:\Program Files\Amazon\CloudHSM\java\*"'

If you connect multiple client instances to your AWS CloudHSM cluster, deleting a certificate on one client instance’s key store won’t automatically remove the certificate from other client instances. You must delete the certificate on each client instance.

Importing a working certificate into AWS CloudHSM key store using keytool

Once a certificate signing request (CSR) is signed, you can import it into the AWS CloudHSM key store and associate it with the appropriate key pair. The following command provides an example.

**Linux**

```bash
$ keytool -importcert -noprompt -alias <key pair label> 
-file my_certificate.crt 
-keystore my_keystore.store 
-storetype CLOUDHSM 
-J-classpath '-J/opt/cloudhsm/java/*'
```

**Windows**

```bash
PS C:\> keytool -importcert -noprompt -alias <key pair label> 
-file my_certificate.crt 
-keystore my_keystore.store 
-storetype CLOUDHSM 
-J-classpath '-J"C:\Program Files\Amazon\CloudHSM\java\*"'
```

The alias should be a key pair with an associated certificate in the key store. If the key is generated outside of keytool, or is generated on a different client instance, you must first import the key and certificate metadata into the key store.

The certificate chain must be verifiable. If you can’t verify the certificate, you might need to import the signing (certificate authority) certificate into the key store so the chain can be verified.

Exporting a certificate using keytool

The following example generates a certificate in binary X.509 format. To export a human readable certificate, add -rfc to the -exportcert command.

**Linux**

```bash
$ keytool -exportcert -alias <key pair label> 
-file my_exported_certificate.crt 
-keystore my_keystore.store 
-storetype CLOUDHSM 
-J-classpath '-J/opt/cloudhsm/java/*'
```

**Windows**

```bash
PS C:\> keytool -exportcert -alias <key pair label> 
-file my_exported_certificate.crt 
-keystore my_keystore.store 
-storetype CLOUDHSM 
-J-classpath '-J"C:\Program Files\Amazon\CloudHSM\java\*"'
```

586
Using AWS CloudHSM key store with Jarsigner

Jarsigner is a popular command line utility for signing JAR files using a key securely stored on a HSM. A complete tutorial on Jarsigner is out of scope for the AWS CloudHSM documentation. This section explains the Jarsigner parameters you should use to sign and verify signatures with AWS CloudHSM as the root of trust through the AWS CloudHSM key store.

Setting up keys and certificates

Before you can sign JAR files with Jarsigner, make sure you have set up or completed the following steps:

1. Follow the guidance in the AWS CloudHSM key store prerequisites (p. 582).
2. Set up your signing keys and the associated certificates and certificate chain which should be stored in the AWS CloudHSM key store of the current server or client instance. Create the keys on the AWS CloudHSM and then import associated metadata into your AWS CloudHSM key store. If you want to use keytool to set up the keys and certificates, see the section called “Create new keys with keytool” (p. 583). If you use multiple client instances to sign your JARs, create the key and import the certificate chain. Then copy the resulting key store file to each client instance. If you frequently generate new keys, you may find it easier to individually import certificates to each client instance.
3. The entire certificate chain should be verifiable. For the certificate chain to be verifiable, you may need to add the CA certificate and intermediate certificates to the AWS CloudHSM key store. See the code snippet in the section called “Sign a JAR file using AWS CloudHSM and Jarsigner” (p. 587) for instruction on using Java code to verify the certificate chain. If you prefer, you can use keytool to import certificates. For instructions on using keytool, see the section called “Using keytool to import intermediate and root certificates into AWS CloudHSM key store” (p. 585).

Sign a JAR file using AWS CloudHSM and Jarsigner

Use the following command to sign a JAR file:

Amazon Linux

For OpenJDK8

```
jarsigner -keystore my_keystore.store \
  -signedjar sighthisclass_signed.jar \
  -sigalg sha512withrsa \
  -storetype CloudHSM \
  -J-classpath '-J/opt/cloudhsm/java/*:/usr/lib/jvm/java-1.8.0/lib/tools.jar' \
  -J-Djava.library.path=/opt/cloudhsm/lib \
  sighthisclass.jar <key pair label>
```

For OpenJDK11

```
jarsigner -keystore my_keystore.store \
  -signedjar sighthisclass_signed.jar \
  -sigalg sha512withrsa \
  -storetype CloudHSM \
  -J-classpath '-J/opt/cloudhsm/java/*' \
  -J-Djava.library.path=/opt/cloudhsm/lib \
  sighthisclass.jar <key pair label>
```

Windows

For OpenJDK8

```
jarsigner -keystore my_keystore.store \
  -signedjar sighthisclass_signed.jar \
  -sigalg sha512withrsa \
  -storetype CloudHSM \
  -J-classpath '-J/opt/cloudhsm/java/*' \
  -J-Djava.library.path=/opt/cloudhsm/lib \
  sighthisclass.jar <key pair label>
```
Use Client SDK 5 to integrate with Java Keytool and Jarsigner

For OpenJDK8

```
jarsigner -verify \
-keystore my_keystore.store \
-sigalg sha1-with-RSA \
-storetype CloudHSM \
-J-classpath '-J:/opt/cloudhsm/java/*:/usr/lib/jvm/java-1.8.0_331/lib/tools.jar' \
-J-Djava.library.path=/opt/cloudhsm/lib \
signthisclass_signed.jar <key pair label>
```

For OpenJDK11

```
jarsigner -verify \
-keystore my_keystore.store \
-sigalg sha1-with-RSA \
-storetype CloudHSM \
-J-classpath '-J:/opt/cloudhsm/java/*' \
-J-Djava.library.path=/opt/cloudhsm/lib \
signthisclass_signed.jar <key pair label>
```

Windows

For OpenJDK8

```
jarsigner -verify \
-keystore my_keystore.store \
-sigalg sha1-with-RSA \
-storetype CloudHSM \
-J-classpath '-J:/Program Files\Amazon\CloudHSM\java/*;C:\Program Files\Java \jdk1.8.0_331\lib\tools.jar' \
-J-Djava.library.path='C:\Program Files\Amazon\CloudHSM\lib' \
signthisclass_signed.jar <key pair label>
```
Use Client SDK 3 to integrate with Java Keytool and Jarsigner

For OpenJDK11

```
jarsigner -verify \
-keystore my_keystore.store \
-sigalg sha512withrsa \
-storetype CloudHSM \
-J-classpath '-JC:\Program Files\Amazon\CloudHSM\java\' \
"-J-Djava.library.path='C:\Program Files\Amazon\CloudHSM\lib\'' \\nsignthisclass_signed.jar <key pair label>
```

Known issues

1. We do not support EC keys with Keytool and Jarsigner.

Using Client SDK 3 to integrate with Java Keytool and Jarsigner

AWS CloudHSM key store is a special-purpose JCE key store that utilizes certificates associated with keys on your HSM through third-party tools such as keytool and jarsigner. AWS CloudHSM does not store certificates on the HSM, as certificates are public, non-confidential data. The AWS CloudHSM key store stores the certificates in a local file and maps the certificates to corresponding keys on your HSM.

When you use the AWS CloudHSM key store to generate new keys, no entries are generated in the local key store file – the keys are created on the HSM. Similarly, when you use the AWS CloudHSM key store to search for keys, the search is passed on to the HSM. When you store certificates in the AWS CloudHSM key store, the provider verifies that a key pair with the corresponding alias exists on the HSM, and then associates the certificate provided with the corresponding key pair.

Topics
- Prerequisites (p. 589)
- Using AWS CloudHSM key store with keytool (p. 590)
- Using AWS CloudHSM key store with jarsigner (p. 587)
- Known issues (p. 594)
- Registering pre-existing keys with AWS CloudHSM key store (p. 594)

Prerequisites

To use the AWS CloudHSM key store, you must first initialize and configure the AWS CloudHSM JCE SDK.

Step 1: Install the JCE

To install the JCE, including the AWS CloudHSM client prerequisites, follow the steps for installing the Java library (p. 488).

Step 2: Add HSM login credentials to environment variables

Set up environment variables to contain your HSM login credentials.
New AWS CloudHSM User Guide
Use Client SDK 3 to integrate
with Java Keytool and Jarsigner

```
export HSM_PARTITION=PARTITION_1
export HSM_USER=<HSM user name>
export HSM_PASSWORD=<HSM password>
```

**Note**
The CloudHSM JCE offers various login options. To use the AWS CloudHSM key store with third-
party applications, you must use implicit login with environment variables. If you want to use
explicit login through application code, you must build your own application using the AWS
CloudHSM key store. For additional information, see the article on [Using AWS CloudHSM Key
Store](p. 503).

**Step 3: Registering the JCE provider**

To register the JCE provider, in the Java CloudProvider configuration.

1. Open the java.security configuration file in your Java installation, for editing.
2. In the java.security configuration file, add `com.cavium.provider.CaviumProvider` as the last
   provider. For example, if there are nine providers in the java.security file, add the following provider as
   the last provider in the section. Adding the Cavium provider as a higher priority may negatively impact
   your system's performance.

   ```
   security.provider.10=com.cavium.provider.CaviumProvider
   ```

   **Note**
   Power users may be accustomed to specifying `-providerName`, `-providerclass`, and
   `-providerpath` command line options when using keytool, instead of updating the security
   configuration file. If you attempt to specify command line options when generating keys with
   AWS CloudHSM key store, it will cause errors.

**Using AWS CloudHSM key store with keytool**

*Keytool* is a popular command line utility for common key and certificate tasks on Linux systems. A
complete tutorial on keytool is out of scope for AWS CloudHSM documentation. This article explains the
specific parameters you should use with various keytool functions when utilizing AWS CloudHSM as the
root of trust through the AWS CloudHSM key store.

When using keytool with the AWS CloudHSM key store, specify the following arguments to any keytool
command:

```
-storetype CLOUDHSM \n-J-classpath '-J/opt/cloudhsm/java/*' \n-J-Djava.library.path=/opt/cloudhsm/lib
```

If you want to create a new key store file using AWS CloudHSM key store, see [Using AWS CloudHSM
KeyStore](p. 504). To use an existing key store, specify its name (including path) using the `–keystore`
argument to keytool. If you specify a non-existent key store file in a keytool command, the AWS
CloudHSM key store creates a new key store file.

**Create new keys with keytool**

You can use keytool to generate any type of key supported by AWS CloudHSM's JCE SDK. See a full list of
keys and lengths in the [Supported Keys](p. 493) article in the Java Library.

**Important**
A key generated through keytool is generated in software, and then imported into AWS
CloudHSM as an extractable, persistent key.
Instructions for creating non-extractable keys directly on the HSM, and then using them with keytool or Jarsigner, are shown in the code sample in Registering Pre-existing Keys with AWS CloudHSM Key Store (p. 594). We strongly recommend generating non-exportable keys outside of keytool, and then importing corresponding certificates to the key store. If you use extractable RSA or EC keys through keytool and jarsigner, the providers export keys from the AWS CloudHSM and then use the key locally for signing operations.

If you have multiple client instances connected to your CloudHSM cluster, be aware that importing a certificate on one client instance's key store won't automatically make the certificates available on other client instances. To register the key and associated certificates on each client instance you need to run a Java application as described in Generate a CSR using Keytool (p. 591). Alternatively, you can make the necessary changes on one client and copy the resulting key store file to every other client instance.

**Example 1:** To generate a symmetric AES-256 key and save it in a key store file named, "my_keystore.store", in the working directory. Replace `<secret label>` with a unique label.

```
keytool -genseckey -alias <secret label> -keyalg aes \
    -keysize 256 -keystore my_keystore.store \
    -storetype CloudHSM -J-classpath '-J/opt/cloudhsm/java/*' \
    -J-Djava.library.path=/opt/cloudhsm/lib/
```

**Example 2:** To generate an RSA 2048 key pair and save it in a key store file named, "my_keystore.store" in the working directory. Replace `<RSA key pair label>` with a unique label.

```
keytool -genkeypair -alias <RSA key pair label> \
    -keyalg rsa -keysize 2048 \
    -sigalg sha512withrsa \
    -keystore my_keystore.store \
    -storetype CLOUDHSM \
    -J-classpath '-J/opt/cloudhsm/java/*' \
    -J-Djava.library.path=/opt/cloudhsm/lib/
```

**Example 3:** To generate a p256 ED key and save it in a key store file named, "my_keystore.store" in the working directory. Replace `<ec key pair label>` with a unique label.

```
keytool -genkeypair -alias <ec key pair label> \
    -keyalg ec -keysize 256 \
    -sigalg SHA512withECDSA \
    -keystore my_keystore.store \
    -storetype CLOUDHSM \
    -J-classpath '-J/opt/cloudhsm/java/*' \
    -J-Djava.library.path=/opt/cloudhsm/lib/
```

You can find a list of supported signature algorithms (p. 496) in the Java library.

**Delete a key using keytool**

The AWS CloudHSM key store doesn't support deleting keys. To delete key, you must use the deleteKey function of AWS CloudHSM's command line tool, deleteKey (p. 312).

**Generate a CSR using keytool**

You receive the greatest flexibility in generating a certificate signing request (CSR) if you use the OpenSSL Dynamic Engine (p. 418). The following command uses keytool to generate a CSR for a key pair with the alias, my-key-pair.

```
keytool -certreq -alias <key pair label> \
    -file my_csr.csr \
```

You can find a list of supported signature algorithms (p. 496) in the Java library.
Use Client SDK 3 to integrate with Java Keytool and Jarsigner

```bash
-keystore my_keystore.store 
-storetype CLOUDHSM 
-J-classpath '-J/opt/cloudhsm/java/**' 
-J-Djava.library.path=/opt/cloudhsm/lib/
```

**Note**
To use a key pair from keytool, that key pair must have an entry in the specified key store file. If you want to use a key pair that was generated outside of keytool, you must import the key and certificate metadata into the key store. For instructions on importing the keystore data see [Importing Intermediate and root certificates into AWS CloudHSM Key Store using Keytool](p. 592).

**Using keytool to import intermediate and root certificates into AWS CloudHSM key store**

To import a CA certificate you must enable verification of a full certificate chain on a newly imported certificate. The following command shows an example.

```bash
keytool -import -trustcacerts -alias rootCAcert 
-file rootCAcert.cert -keystore my_keystore.store 
-storetype CLOUDHSM 
-J-classpath '-J/opt/cloudhsm/java/**' 
-J-Djava.library.path=/opt/cloudhsm/lib/
```

If you connect multiple client instances to your AWS CloudHSM cluster, importing a certificate on one client instance’s key store won’t automatically make the certificate available on other client instances. You must import the certificate on each client instance.

**Using keytool to delete certificates from AWS CloudHSM key store**

The following command shows an example of how to delete a certificate from a Java keytool key store.

```bash
keytool -delete -alias mydomain -keystore 
-keystore my_keystore.store 
-storetype CLOUDHSM 
-J-classpath '-J/opt/cloudhsm/java/**' 
-J-Djava.library.path=/opt/cloudhsm/lib/
```

If you connect multiple client instances to your AWS CloudHSM cluster, deleting a certificate on one client instance’s key store won’t automatically remove the certificate from other client instances. You must delete the certificate on each client instance.

**Importing a working certificate into AWS CloudHSM key store using keytool**

Once a certificate signing request (CSR) is signed, you can import it into the AWS CloudHSM key store and associate it with the appropriate key pair. The following command provides an example.

```bash
keytool -importcert -noprompt -alias <key pair label> 
-file my_certificate.crt 
-keystore my_keystore.store 
-storetype CLOUDHSM 
-J-classpath '-J/opt/cloudhsm/java/**' 
-J-Djava.library.path=/opt/cloudhsm/lib/
```

The alias should be a key pair with an associated certificate in the key store. If the key is generated outside of keytool, or is generated on a different client instance, you must first import the key and certificate metadata into the key store. For instructions on importing the certificate metadata, see the code sample in [Registering Pre-existing Keys with AWS CloudHSM Key Store](p. 594).
The certificate chain must be verifiable. If you can’t verify the certificate, you might need to import the signing (certificate authority) certificate into the key store so the chain can be verified.

**Exporting a certificate using keytool**

The following example generates a certificate in binary X.509 format. To export a human readable certificate, add `-rfc` to the `-exportcert` command.

```
keytool -exportcert -alias <key pair label> \
-file my_exported_certificate.crt \
-keystore my_keystore.store \
-storetype CLOUDHSM \
-classpath '-J/opt/cloudhsm/java/*' \
-Djava.library.path=/opt/cloudhsm/lib/
```

**Using AWS CloudHSM key store with jarsigner**

Jarsigner is a popular command line utility for signing JAR files using a key securely stored on a HSM. A complete tutorial on Jarsigner is out of scope for the AWS CloudHSM documentation. This section explains the Jarsigner parameters you should use to sign and verify signatures with AWS CloudHSM as the root of trust through the AWS CloudHSM key store.

**Setting up keys and certificates**

Before you can sign JAR files with Jarsigner, make sure you have set up or completed the following steps:

1. Follow the guidance in the [AWS CloudHSM Key store prerequisites](p. 589).
2. Set up your signing keys and the associated certificates and certificate chain which should be stored in the AWS CloudHSM key store of the current server or client instance. Create the keys on the AWS CloudHSM and then import associated metadata into your AWS CloudHSM key store. Use the code sample in [Registering Pre-existing Keys with AWS CloudHSM Key Store](p. 594) to import metadata into the key store. If you want to use keytool to set up the keys and certificates, see [Create new keys with keytool](p. 590). If you use multiple client instances to sign your JARs, create the key and import the certificate chain. Then copy the resulting key store file to each client instance. If you frequently generate new keys, you may find it easier to individually import certificates to each client instance.
3. The entire certificate chain should be verifiable. For the certificate chain to be verifiable, you may need to add the CA certificate and intermediate certificates to the AWS CloudHSM key store. See the code snippet in [Sign a JAR file using AWS CloudHSM and Jarsigner](p. 594) for instruction on using Java code to verify the certificate chain. If you prefer, you can use keytool to import certificates. For instructions on using keytool, see [Using Keytool to import intermediate and root certificates into AWS CloudHSM Key Store](p. 592).

**Sign a JAR file using AWS CloudHSM and jarsigner**

Use the following command to sign a JAR file:

```
jarsigner -keystore my_keystore.store \
  -signedjar signthisclass_signed.jar \
  -sigalg sha512withrsa \
  -storetype CloudHSM \
  -classpath '-J/opt/cloudhsm/java/*:/usr/lib/jvm/java-1.8.0/lib/tools.jar' \
  -Djava.library.path=/opt/cloudhsm/lib \
  signthisclass.jar <key pair label>
```

Use the following command to verify a signed JAR:
Use Client SDK 3 to integrate with Java Keytool and Jarsigner

```
jarsigner -verify \
    -keystore my_keystore.store \
    -sigalg sha512withrsa \
    -storetype CloudHSM \
    -J-classpath '-J/opt/cloudhsm/java/*:/usr/lib/jvm/java-1.8.0/lib/tools.jar' \
    -J-Djava.library.path=/opt/cloudhsm/lib \
    signthisclass_signed.jar <key pair label>
```

**Known issues**

The following list provides the current list of known issues.

- When generating keys using keytool, the first provider in provider configuration cannot be CaviumProvider.

- When generating keys using keytool, the first (supported) provider in the security configuration file is used to generate the key. This is generally a software provider. The generated key is then given an alias and imported into the AWS CloudHSM HSM as a persistent (token) key during the key addition process.

- When using keytool with AWS CloudHSM key store, do not specify -providerName, -providerClass, or -providerPath options on the command line. Specify these options in the security provider file as described in the Key store prerequisites (p. 589).

- When using non-extractable EC keys through keytool and Jarsigner, the SunEC provider needs to be removed/disabled from the list of providers in the java.security file. If you use extractable EC keys through keytool and Jarsigner, the providers export key bits from the AWS CloudHSM HSM and use the key locally for signing operations. We do not recommend you use exportable keys with keytool or Jarsigner.

**Registering pre-existing keys with AWS CloudHSM key store**

For maximum security and flexibility in attributes and labeling, we recommend you generate your signing keys using key_mgmt_util (p. 151). You can also use a Java application to generate the key in AWS CloudHSM.

The following section provides a code sample that demonstrates how to generate a new key pair on the HSM and register it using existing keys imported to the AWS CloudHSM key store. The imported keys are available for use with third-party tools such as keytool and Jarsigner.

To use a pre-existing key, modify the code sample to look up a key by label instead of generating a new key. Sample code for looking up a key by label is available in the KeyUtilitiesRunner.java sample on GitHub.

**Important**

Registering a key stored on AWS CloudHSM with a local key store does not export the key. When the key is registered, the key store registers the key's alias (or label) and correlates locally store certificate objects with a key pair on the AWS CloudHSM. As long as the key pair is created as non-exportable, the key bits won't leave the HSM.
package com.amazonaws.cloudhsm.examples;
import com.cavium.key.CaviumKey;
import com.cavium.key.parameter.CaviumAESKeyGenParameterSpec;
import com.cavium.key.parameter.CaviumRSAKeyGenParameterSpec;
import com.cavium.asn1.Encoder;
import com.cavium.cfm2.Util;
import javax.crypto.KeyGenerator;
import java.io.ByteArrayInputStream;
import java.io.FileInputStream;
import java.io.FileOutputStream;
import java.io.FileNotFoundException;
import java.math.BigInteger;
import java.security.
import java.security.cert.Certificate;
import java.security.cert.CertificateException;
import java.security.cert.CertificateFactory;
import java.security.interfaces.RSAPrivateKey;
import java.security.interfaces.RSAPublicKey;
import java.security.KeyStore.PasswordProtection;
import java.security.KeyStore.PrivateKeyEntry;
import java.security.KeyStore.Entry;
import java.util.Calendar;
import java.util.Date;
import java.util.Enumeration;

// KeyStoreExampleRunner demonstrates how to load a keystore, and associate a certificate
// with a
// key in that keystore.
// This example relies on implicit credentials, so you must setup your environment
correctly.
// https://docs.aws.amazon.com/cloudhsm/latest/userguide/java-library-install.html#java-
library-credentials
public class KeyStoreExampleRunner {

    private static byte[] COMMON_NAME_OID = new byte[] { (byte) 0x55, (byte) 0x04, (byte) 0x05 };
    private static byte[] COUNTRY_NAME_OID = new byte[] { (byte) 0x55, (byte) 0x04, (byte) 0x04 };
    private static byte[] LOCALITY_NAME_OID = new byte[] { (byte) 0x55, (byte) 0x04, (byte) 0x07 };
    private static byte[] STATE_OR_PROVINCE_NAME_OID = new byte[] { (byte) 0x55, (byte) 0x04, (byte) 0x08 };
    private static byte[] ORGANIZATION_NAME_OID = new byte[] { (byte) 0x55, (byte) 0x04, (byte) 0x10 };

private static byte[] ORGANIZATION_UNIT_OID = new byte[] { (byte) 0x55, (byte) 0x04, (byte) 0x0B };

private static String helpString = "KeyStoreExampleRunner%n" +
  "This sample demonstrates how to load and store keys using a keystore.%n%n" +
  "Options%n" +
  "--help			Display this message.%n" +
  "--store <filename>		Path of the keystore.%n" +
  "--password <password>		Password for the keystore (not your CU password).%n" +
  "--label <label>		Label to store the key and certificate under.%n" +
  "--list		List all the keys in the keystore.%n%n";

public static void main(String[] args) throws Exception {
  Security.addProvider(new com.cavium.provider.CaviumProvider());
  KeyStore keyStore = KeyStore.getInstance("CloudHSM");

  String keystoreFile = null;
  String password = null;
  String label = null;
  boolean list = false;
  for (int i = 0; i < args.length; i++) {
    String arg = args[i];
    switch (args[i]) {
      case "--store":
        keystoreFile = args[++i];
        break;
      case "--password":
        password = args[++i];
        break;
      case "--label":
        label = args[++i];
        break;
      case "--list":
        list = true;
        break;
      case "--help":
        help();
        return;
    }
  }

  if (null == keystoreFile || null == password) {
    help();
    return;
  }

  if (list) {
    listKeys(keystoreFile, password);
    return;
  }

  if (null == label) {
    label = "Keystore Example Keypair";
  }

  // This call to keyStore.load() will open the pkcs12 keystore with the supplied
  // password and connect to the HSM. The CU credentials must be specified using
  // standard CloudHSM login methods.
  //
  try {
    FileInputStream instream = new FileInputStream(keystoreFile);
    keyStore.load(instream, password.toCharArray());
  } catch (FileNotFoundException ex) {
    System.err.println("Keystore not found, loading an empty store");
  }
}
Use Client SDK 3 to integrate with Java Keytool and Jarsigner

```java
keyStore.load(null, null);

PasswordProtection passwd = new PasswordProtection(password.toCharArray());
System.out.println("Searching for example key and certificate...");

PrivateKeyEntry keyEntry = (PrivateKeyEntry) keyStore.getEntry(label, passwd);
if (null == keyEntry) {
    // No entry was found, so we need to create a key pair and associate a certificate.
    // The private key will get the label passed on the command line. The keystore alias
    // needs to be the same as the private key label. The public key will have ":public"
    // appended to it. The alias used in the keystore will We associate the certificate
    // with the private key.
    System.out.println("No entry found, creating...");
    KeyPair kp = generateRSAKeyPair(2048, label + ":public", label);
    System.out.printf("Created a key pair with the handles %d/%d\n", ((CaviumKey) kp.getPrivate()).getHandle(), ((CaviumKey) kp.getPublic()).getHandle());

    // Generate a certificate and associate the chain with the private key.
    Certificate self_signed_cert = generateCert(kp);
    Certificate[] chain = new Certificate[1];
    chain[0] = self_signed_cert;
    PrivateKeyEntry entry = new PrivateKeyEntry(kp.getPrivate(), chain);

    // Set the entry using the label as the alias and save the store.
    // The alias must match the private key label.
    keyStore.setEntry(label, entry, passwd);
    FileOutputStream outstream = new FileOutputStream(keystoreFile);
    keyStore.store(outstream, password.toCharArray());
    outstream.close();

    keyEntry = (PrivateKeyEntry) keyStore.getEntry(label, passwd);
}

long handle = ((CaviumKey) keyEntry.getPrivateKey()).getHandle();
String name = keyEntry.getCertificate().toString();
System.out.printf("Found private key %d with certificate %s\n", handle, name);
}

private static void help() {
    System.out.println(helpString);
}

// Generate a non-extractable / non-persistent RSA keypair.
// This method allows us to specify the public and private labels, which
// will make KeyStore aliases easier to understand.
//
// public static KeyPair generateRSAKeyPair(int keySizeInBits, String publicLabel, String privateLabel)
//    throws InvalidAlgorithmParameterException, NoSuchAlgorithmException, NoSuchProviderException {
//    boolean isExtractable = false;
//    boolean isPersistent = false;
```
KeyPairGenerator keyPairGen = KeyPairGenerator.getInstance("rsa", "Cavium");
CaviumRSAKeyGenParameterSpec spec = new CaviumRSAKeyGenParameterSpec(keySizeInBits,
new BigInteger("65537"), publicLabel, privateLabel, isExtractable, isPersistent);

keyPairGen.initialize(spec);
return keyPairGen.generateKeyPair();
}

// Generate a certificate signed by a given keypair.
private static Certificate generateCert(KeyPair kp) throws CertificateException {
    CertificateFactory cf = CertificateFactory.getInstance("X509");
    PublicKey publicKey = kp.getPublic();
    PrivateKey privateKey = kp.getPrivate();
    byte[] version = Encoder.encodeConstructed((byte) 0,
    Encoder.encodePositiveBigInteger(new BigInteger("2"))); // version 1
    byte[] serialNo = Encoder.encodePositiveBigInteger(new BigInteger(1,
    Util.computeKCV(publicKey.getEncoded())));
    // Use the SHA512 OID and algorithm.
    byte[] signatureOid = new byte[] {
        (byte) 0x2A, (byte) 0x86, (byte) 0x48, (byte) 0xF7, (byte) 0x0D,
        (byte) 0x01, (byte) 0x01, (byte) 0x0D
    };
    String sigAlgoName = "SHA512WithRSA";

    byte[] signatureId = Encoder.encodeSequence(
        Encoder.encodeOid(signatureOid),
        Encoder.encodeNull());

    byte[] issuer = Encoder.encodeSequence(
        encodeName(COUNTRY_NAME_OID, "<Country>"),
        encodeName(STATE_OR_PROVINCE_NAME_OID, "<State>"),
        encodeName(LOCALITY_NAME_OID, "<City>"),
        encodeName(ORGANIZATION_NAME_OID, "<Organization>"),
        encodeName(ORGANIZATION_UNIT_OID, "<Unit>"),
        encodeName(COMMON_NAME_OID, "<CN>"
    )
    );

    Calendar c = Calendar.getInstance();
    c.add(Calendar.DAY_OF_YEAR, -1);
    Date notBefore = c.getTime();
    c.add(Calendar.YEAR, 1);
    Date notAfter = c.getTime();
    byte[] validity = Encoder.encodeSequence(
        Encoder.encodeUTCTime(notBefore),
        Encoder.encodeUTCTime(notAfter)
    );

    byte[] key = publicKey.getEncoded();

    byte[] certificate = Encoder.encodeSequence(
        version,
        serialNo,
        signatureOid,
        signatureId,
        issuer,
        validity,
        issuer,
        key);

    Signature sig;
    byte[] signature = null;
    try {
        sig = Signature.getInstance(sigAlgoName, "Cavium");
        sig.initSign(privateKey);
        sig.update(certificate);
        signature = Encoder.encodeBitstring(sig.sign());
Other third-party vendor integrations

Several third-party vendors support AWS CloudHSM as a root of trust. This means that you can utilize a software solution of your choice while creating and storing the underlying keys in your CloudHSM cluster. As a result, your workload in AWS can rely on the latency, availability, reliability, and elasticity benefits of CloudHSM. The following list includes third-party vendors that support CloudHSM.

**Note**

AWS does not endorse or vouch for any third-party vendor.
• **Hashicorp Vault** is a secrets management tool designed to enable collaboration and governance across organizations. It supports AWS Key Management Service and AWS CloudHSM as roots of trust for additional protection.

• **Thycotic Secrets Server** helps customers manage sensitive credentials across privileged accounts. It supports AWS CloudHSM as a root of trust.

• **P6R's KMIP adapter** allows you to utilize your AWS CloudHSM instances through a standard KMIP interface.

• **PrimeKey EJBCA** is a popular open source solution for PKI. It allows you to create and store key pairs securely with AWS CloudHSM.

• **Box KeySafe** provides encryption key management for cloud content to many organizations with strict security, privacy, and regulatory compliance requirements. Customers can further secure KeySafe keys directly in AWS Key Management Service or indirectly in AWS CloudHSM via AWS KMS Custom Key Store.

• **Insyde Software** supports AWS CloudHSM as a root of trust for firmware signing.

• **F5 BIG-IP LTM** supports AWS CloudHSM as a root of trust.

• **Cloudera Navigator Key HSM** allows you to use your CloudHSM cluster to create and store keys for Cloudera Navigator Key Trustee Server.

• **Venafi Trust Protection Platform** provides comprehensive machine identity management for TLS, SSH, and code signing with AWS CloudHSM key generation and protection.
Monitoring AWS CloudHSM

In addition to the logging features built into the Client SDK, you can also use AWS CloudTrail, Amazon CloudWatch Logs, and Amazon CloudWatch to monitor AWS CloudHSM.

**Client SDK logs**

Use Client SDK logging to monitor diagnostic and troubleshooting information from the applications you create.

**CloudTrail**

Use CloudTrail to monitor all API calls in your AWS account, including the calls you make to create and delete clusters, hardware security modules (HSM), and resource tags.

**CloudWatch Logs**

Use CloudWatch Logs to monitor the logs from your HSM instances, which include events for create and delete HSM users, change user passwords, create and delete keys, and more.

**CloudWatch**

Use CloudWatch to monitor the health of your cluster in real time.

**Topics**

- Working with client SDK logs (p. 601)
- Working with AWS CloudTrail and AWS CloudHSM (p. 603)
- Working with Amazon CloudWatch Logs and AWS CloudHSM Audit Logs (p. 605)
- Getting CloudWatch metrics for AWS CloudHSM (p. 620)

Working with client SDK logs

You can retrieve logs generated by the Client SDK. AWS CloudHSM offers an implementation of logging with Client SDK 3 and Client SDK 5.

**Topics**

- Client SDK 5 logging (p. 601)
- Client SDK 3 logging (p. 602)

**Client SDK 5 logging**

Client SDK 5 logs contain information for each component in a file named for the component. You can use the configure tool for Client SDK 5 to configure logging for each component.

If you do not specify a location for the file, the system writes logs to the default location:

**PKCS #11 library**

- **Linux**

  `/opt/cloudhsm/run/cloudhsm-pkcs11.log`
Client SDK 3 logging

Client SDK 3 logs contain detailed information from the AWS CloudHSM client daemon. The location of the logs depends on the operating system of the Amazon EC2 client instance where you run the client daemon.

Amazon Linux

In Amazon Linux, the AWS CloudHSM client logs are written to the file named `/opt/cloudhsm/run/cloudhsm_client.log`. You can use `logrotate` or a similar tool to rotate and manage these logs.

Amazon Linux 2

In Amazon Linux 2, the AWS CloudHSM Client logs are collected and stored in the `journal`. You can use `journalctl` to view and manage these logs. For example, use the following command to view the AWS CloudHSM Client logs.

```
journalctl -f -u cloudhsm-client
```

CentOS 7

In CentOS 7, the AWS CloudHSM Client logs are collected and stored in the `journal`. You can use `journalctl` to view and manage these logs. For example, use the following command to view the AWS CloudHSM Client logs.

```
journalctl -f -u cloudhsm-client
```
CentOS 8

In CentOS 8, the AWS CloudHSM Client logs are collected and stored in the journal. You can use journalctl to view and manage these logs. For example, use the following command to view the AWS CloudHSM Client logs.

```
journalctl -f -u cloudhsm-client
```

RHEL 7

In Red Hat Enterprise Linux 7, the AWS CloudHSM Client logs are collected and stored in the journal. You can use journalctl to view and manage these logs. For example, use the following command to view the AWS CloudHSM Client logs.

```
journalctl -f -u cloudhsm-client
```

RHEL 8

In Red Hat Enterprise Linux 8, the AWS CloudHSM Client logs are collected and stored in the journal. You can use journalctl to view and manage these logs. For example, use the following command to view the AWS CloudHSM Client logs.

```
journalctl -f -u cloudhsm-client
```

Ubuntu 16.04

In Ubuntu 16.04, the AWS CloudHSM Client logs are collected and stored in the journal. You can use journalctl to view and manage these logs. For example, use the following command to view the AWS CloudHSM Client logs.

```
journalctl -f -u cloudhsm-client
```

Ubuntu 18.04

In Ubuntu 18.04, the AWS CloudHSM Client logs are collected and stored in the journal. You can use journalctl to view and manage these logs. For example, use the following command to view the AWS CloudHSM Client logs.

```
journalctl -f -u cloudhsm-client
```

Windows

- For Windows client 1.1.2+:  
  
  AWS CloudHSM client logs are written to a cloudhsm.log file in the AWS CloudHSM program files folder (C:\Program Files\Amazon\CloudHSM\). Each log file name is suffixed with a timestamp indicating when the AWS CloudHSM client was started.

- For Windows client 1.1.1 and older:
  
  The client logs are not written to a file. The logs are displayed at the command prompt or in the PowerShell window where you started the AWS CloudHSM client.

Working with AWS CloudTrail and AWS CloudHSM

AWS CloudHSM is integrated with AWS CloudTrail, a service that provides a record of actions taken by a user, role, or an AWS service in AWS CloudHSM. CloudTrail captures all API calls for AWS CloudHSM.
as events. The calls captured include calls from the AWS CloudHSM console and code calls to the AWS CloudHSM API operations. If you create a trail, you can enable continuous delivery of CloudTrail events to an Amazon S3 bucket, including events for AWS CloudHSM. If you don't configure a trail, you can still view the most recent events in the CloudTrail console in Event history. Using the information collected by CloudTrail, you can determine the request that was made to AWS CloudHSM, the IP address from which the request was made, who made the request, when it was made, and additional details.

To learn more about CloudTrail, see the AWS CloudTrail User Guide. For a full list of AWS CloudHSM API operations, see Actions in the AWS CloudHSM API Reference.

**AWS CloudHSM information in CloudTrail**

CloudTrail is enabled on your AWS account when you create the account. When activity occurs in AWS CloudHSM, that activity is recorded in a CloudTrail event along with other AWS service events in Event history. You can view, search, and download recent events in your AWS account. For more information, see Viewing Events with CloudTrail Event History.

For an ongoing record of events in your AWS account, including events for AWS CloudHSM, create a trail. A trail enables CloudTrail to deliver log files to an Amazon S3 bucket. By default, when you create a trail in the console, the trail applies to all AWS Regions. The trail logs events from all Regions in the AWS partition and delivers the log files to the Amazon S3 bucket that you specify. Additionally, you can configure other AWS services to further analyze and act upon the event data collected in CloudTrail logs. For more information, see the following:

- Overview for Creating a Trail
- CloudTrail Supported Services and Integrations
- Configuring Amazon SNS Notifications for CloudTrail
- Receiving CloudTrail Log Files from Multiple Regions and Receiving CloudTrail Log Files from Multiple Accounts

CloudTrail logs all AWS CloudHSM operations, including read-only operations, such as DescribeClusters and ListTags, and management operations, such as InitializeCluster, CreateHsm, and DeleteBackup.

Every event or log entry contains information about who generated the request. The identity information helps you determine the following:

- Whether the request was made with root or AWS Identity and Access Management (IAM) user credentials.
- Whether the request was made with temporary security credentials for a role or federated user.
- Whether the request was made by another AWS service.

For more information, see the CloudTrail userIdentity Element.

**Understanding AWS CloudHSM log file entries**

A trail is a configuration that enables delivery of events as log files to an Amazon S3 bucket that you specify. CloudTrail log files contain one or more log entries. An event represents a single request from any source and includes information about the requested action, the date and time of the action, request parameters, and so on. CloudTrail log files aren't an ordered stack trace of the public API calls, so they don't appear in any specific order.

The following example shows a CloudTrail log entry that demonstrates the AWS CloudHSM CreateHsm action.
Working with Amazon CloudWatch Logs and AWS CloudHSM Audit Logs

When an HSM in your account receives a command from the AWS CloudHSM command line tools (p. 158) or software libraries (p. 392), it records its execution of the command in audit log form. The HSM audit logs include all client-initiated management commands (p. 618), including those that create and delete the HSM, log into and out of the HSM, and manage users and keys. These logs provide a reliable record of actions that have changed the state of the HSM.

AWS CloudHSM collects your HSM audit logs and sends them to Amazon CloudWatch Logs on your behalf. You can use the features of CloudWatch Logs to manage your AWS CloudHSM Audit Logs,
including searching and filtering the logs and exporting log data to Amazon S3. You can work with your HSM audit logs in the Amazon CloudWatch console or use the CloudWatch Logs commands in the AWS CLI and CloudWatch Logs SDKs.

Topics
- How HSM audit logging works (p. 606)
- Viewing HSM audit logs in CloudWatch Logs (p. 606)
- Interpreting HSM audit logs (p. 608)
- HSM audit log reference (p. 618)

How HSM audit logging works

Audit logging is automatically enabled in all AWS CloudHSM clusters. It cannot be disabled or turned off, and no settings can prevent AWS CloudHSM from exporting the logs to CloudWatch Logs. Each log event has a time stamp and sequence number that indicate the order of events and help you detect any log tampering.

Each HSM instance generates its own log. The audit logs of various HSMs, even those in the same cluster, are likely to differ. For example, only the first HSM in each cluster records initialization of the HSM. Initialization events do not appear in the logs of HSMs that are cloned from backups. Similarly, when you create a key, the HSM that generates the key records a key generation event. The other HSMs in the cluster record an event when they receive the key via synchronization.

AWS CloudHSM collects the logs and posts them to CloudWatch Logs in your account. To communicate with the CloudWatch Logs service on your behalf, AWS CloudHSM uses a service-linked role (p. 630). The IAM policy that is associated with the role allows AWS CloudHSM to perform only the tasks required to send the audit logs to CloudWatch Logs.

Important
If you created a cluster before January 20, 2018, and have not yet created an attached service-linked role, you must manually create one. This is necessary for CloudWatch to receive audit logs from your AWS CloudHSM cluster. For more information about service-linked role creation, see Understanding Service-Linked Roles (p. 630), as well as Creating a Service-Linked Role in the IAM User Guide.

Viewing HSM audit logs in CloudWatch Logs

Amazon CloudWatch Logs organizes the audit logs into log groups and, within a log group, into log streams. Each log entry is an event. AWS CloudHSM creates one log group for each cluster and one log stream for each HSM in the cluster. You do not have to create any CloudWatch Logs components or change any settings.

- The log group name is /aws/cloudhsm/<cluster ID>; for example /aws/cloudhsm/cluster-likphkxygsn. When you use the log group name in a AWS CLI or PowerShell command, be sure to enclose it in double quotation marks.
- The log stream name is the HSM ID; for example, hsm-nwbbiqbj4jk.

In general, there is one log stream for each HSM. However, any action that changes the HSM ID, such as when an HSM fails and is replaced, creates a new log stream.

For more information about CloudWatch Logs concepts, see Concepts in the Amazon CloudWatch Logs User Guide.

You can view the audit logs for an HSM from the CloudWatch Logs page in the AWS Management Console, the CloudWatch Logs commands in the AWS CLI, the CloudWatch Logs PowerShell cmdlets, or
the CloudWatch Logs SDKs. For instructions, see View Log Data in the Amazon CloudWatch Logs User Guide.

For example, the following image shows the log group for the cluster-likphkxygsn cluster in the AWS Management Console.

When you choose the cluster log group name, you can view the log stream for each of the HSMs in the cluster. The following image shows the log streams for the HSMs in the cluster-likphkxygsn cluster.

When you choose an HSM log stream name, you can view the events in the audit log. For example, this event, which has a sequence number of 0x0 and an Opcode of CN_INIT_TOKEN, is typically the first event for the first HSM in each cluster. It records the initialization of the HSM in the cluster.

You can use all the many features in CloudWatch Logs to manage your audit logs. For example, you can use the Filter events feature to find particular text in an event, such as the CN_CREATE_USER Opcode.

To find all events that do not include the specified text, add a minus sign (-) before the text. For example, to find events that do not include CN_CREATE_USER, enter -CN_CREATE_USER.
Interpreting HSM audit logs

The events in the HSM audit logs have standard fields. Some event types have additional fields that capture useful information about the event. For example, user login and user management events include the user name and user type of the user. Key management commands include the key handle.

Several of the fields provide particularly important information. The Opcode identifies the management command that is being recorded. The Sequence No identifies an event in the log stream and indicates the order in which it was recorded.

For example, the following example event is the second event (Sequence No: 0x1) in the log stream for an HSM. It shows the HSM generating a password encryption key, which is part of its startup routine.

The following fields are common to every AWS CloudHSM event in the audit log.

**Time**

The time that the event occurred in the UTC time zone. The time is displayed as a human-readable time and Unix time in microseconds.

**Reboot counter**

A 32-bit persistent ordinal counter that is incremented when the HSM hardware is rebooted.

All events in a log stream have the same reboot counter value. However, the reboot counter might not be unique to a log stream, as it can differ across different HSM instances in the same cluster.
Interpreting logs

Sequence No

A 64-bit ordinal counter that is incremented for each log event. The first event in each log stream has a sequence number of 0x0. There should be no gaps in the Sequence No values. The sequence number is unique only within a log stream.

Command type

A hexadecimal value that represents the category of the command. Commands in the AWS CloudHSM log streams have a command type of CN_MGMT_CMD (0x0) or CN_CERT_AUTH_CMD (0x9).

Opcode

Identifies the management command that was executed. For a list of Opcode values in the AWS CloudHSM audit logs, see HSM audit log reference (p. 618).

Session handle

Identifies the session in which the command was run and the event was logged.

Response

Records the response to the management command. You can search the Response field for SUCCESS and ERROR values.

Log type

Indicates the log type of the AWS CloudHSM log that recorded the command.

- MINIMAL_LOG_ENTRY (0)
- MGMT_KEY_DETAILS_LOG (1)
- MGMT_USER_DETAILS_LOG (2)
- GENERIC_LOG

Examples of audit log events

The events in a log stream record the history of the HSM from its creation to deletion. You can use the log to review the lifecycle of your HSMs and gain insight into its operation. When you interpret the events, note the Opcode, which indicates the management command or action, and the Sequence No, which indicates the order of events.

Topics

- Example: Initialize the first HSM in a cluster (p. 609)
- Login and logout events (p. 611)
- Example: Create and delete users (p. 609)
- Example: Create and delete a key pair (p. 613)
- Example: Generate and synchronize a key (p. 614)
- Example: Export a key (p. 616)
- Example: Import a key (p. 617)
- Example: Share and unshare a key (p. 618)

Example: Initialize the first HSM in a cluster

The audit log stream for the first HSM in each cluster differs significantly from the log streams of other HSMs in the cluster. The audit log for the first HSM in each cluster records its creation and initialization. The logs of additional HSMs in the cluster, which are generated from backups, begin with a login event.
Important

The following initialization entries will not appear in the CloudWatch logs of clusters initialized before the release of the CloudHSM audit logging feature (August 30, 2018). For more information, see Document History (p. 739).

The following example events appear in the log stream for the first HSM in a cluster. The first event in the log — the one with Sequence No 0x0 — represents the command to initialize the HSM (CN_INIT_TOKEN). The response indicates that the command was successful (Response: 0: HSM Return: SUCCESS).

Time: 12/19/17 21:01:16.962174, usecs:1513717276962174
Sequence No: 0x0
Reboot counter: 0xe8
Command Type(hex): CN_MGMT_CMD (0x0)
Opcode: CN_INIT_TOKEN (0x1)
Session Handle: 0x1004001
Response: 0:HSM Return: SUCCESS
Log type: MINIMAL_LOG_ENTRY (0)

The second event in this example log stream (Sequence No 0x1) records the command to create the password encryption key that the HSM uses (CN_GEN_PSWD_ENC_KEY).

This is a typical startup sequence for the first HSM in each cluster. Because subsequent HSMs in the same cluster are clones of the first one, they use the same password encryption key.

Time: 12/19/17 21:01:17.140812, usecs:1513717277140812
Sequence No: 0x1
Reboot counter: 0xe8
Command Type(hex): CN_MGMT_CMD (0x0)
Opcode: CN_GEN_PSWD_ENC_KEY (0x1d)
Session Handle: 0x1004001
Response: 0:HSM Return: SUCCESS
Log type: MINIMAL_LOG_ENTRY (0)

The third event in this example log stream (Sequence No 0x2) is the creation of the appliance user (AU) (p. 94), which is the AWS CloudHSM service. Events that involve HSM users include extra fields for the user name and user type.

Time: 12/19/17 21:01:17.174902, usecs:1513717277174902
Sequence No: 0x2
Reboot counter: 0xe8
Command Type(hex): CN_MGMT_CMD (0x0)
Opcode: CN_CREATE_APPLIANCE_USER (0xfc)
Session Handle: 0x1004001
Response: 0:HSM Return: SUCCESS
Log type: MGMT_USER_DETAILS_LOG (2)
User Name: app_user
User Type: CN_APPLIANCE_USER (5)

The fourth event in this example log stream (Sequence No 0x3) records the CN_INIT_DONE event, which completes the initialization of the HSM.

Time: 12/19/17 21:01:17.298914, usecs:1513717277298914
Sequence No: 0x3
Reboot counter: 0xe8
Command Type(hex): CN_MGMT_CMD (0x0)
Opcode: CN_INIT_DONE (0x95)
Session Handle: 0x1004001
Response: 0:HSM Return: SUCCESS
Log type: MINIMAL_LOG_ENTRY (0)
You can follow the remaining events in the startup sequence. These events might include several login and logout events, and the generation of the key encryption key (KEK). The following event records the command that changes the password of the *precrypto officer (PRECO)* (p. 94). This command activates the cluster.

```
Time: 12/13/17 23:04:33.846554, usecs:1513206273846554
Sequence No: 0x1d
Reboot counter: 0xe8
Command Type(hex): CN_MGMT_CMD (0x0)
Opcode: CN_CHANGE_PSWD (0x9)
Session Handle: 0x2010003
Response: 0:HSM Return: SUCCESS
Log type: MGMT_USER_DETAILS_LOG (2)
User Name: admin
User Type: CN_CRYPTO_PRE_OFFICER (6)
```

### Login and logout events

When interpreting your audit log, note events that record users logging and in and out of the HSM. These events help you to determine which user is responsible for management commands that appear in sequence between the login and logout commands.

For example, this log entry records a login by a crypto officer named *admin*. The sequence number, 0x0, indicates that this is the first event in this log stream.

When a user logs into an HSM, the other HSMs in the cluster also record a login event for the user. You can find the corresponding login events in the log streams of other HSMs in the cluster shortly after the initial login event.

```
Time: 01/16/18 01:48:49.824999, usecs:1516067329824999
Sequence No : 0x0
Reboot counter : 0x107
Command Type(hex) : CN_MGMT_CMD (0x0)
Opcode : CN_LOGIN (0xd)
Session Handle : 0x7014006
Response : 0:HSM Return: SUCCESS
Log type : MGMT_USER_DETAILS_LOG (2)
User Name : admin
User Type : CN_CRYPTO_OFFICER (2)
```

The following example event records the *admin* crypto officer logging out. The sequence number, 0x2, indicates that this is the third event in the log stream.

If the logged in user closes the session without logging out, the log stream includes an `CN_APP_FINALIZE` or close session event (`CN_SESSION_CLOSE`), instead of a `CN_LOGOUT` event. Unlike the login event, this logout event typically is recorded only by the HSM that executes the command.

```
Time: 01/16/18 01:49:55.993404, usecs:1516067395993404
Sequence No : 0x2
Reboot counter : 0x107
Command Type(hex) : CN_MGMT_CMD (0x0)
Opcode : CN_LOGOUT (0xe)
Session Handle : 0x7014000
Response : 0:HSM Return: SUCCESS
Log type : MGMT_USER_DETAILS_LOG (2)
User Name : admin
User Type : CN_CRYPTO_OFFICER (2)
```

If a login attempt fails because the user name is invalid, the HSM records a `CN_LOGIN` event with the user name and type provided in the login command. The response displays error message 157, which explains that the user name does not exist.
Interpreting logs

If a login attempt fails because the password is invalid, the HSM records a CN_LOGIN event with the user name and type provided in the login command. The response displays the error message with the RET_USER_LOGIN_FAILURE error code.

Example: Create and delete users

This example shows the log events that are recorded when a crypto officer (CO) creates and deletes users.

The first event records a CO, admin, logging into the HSM. The sequence number of 0x0 indicates that this is the first event in the log stream. The name and type of the user who logged in are included in the event.

The next event in the log stream (sequence 0x1) records the CO creating a new crypto user (CU). The name and type of the new user are included in the event.
Then, the CO creates another crypto officer, alice. The sequence number indicates that this action followed the previous one with no intervening actions.

```
Time: 01/16/18 01:49:55.993404, usecs:1516067395993404
Sequence No : 0x2
Reboot counter : 0x107
Command Type(hex) : CN_MGMT_CMD (0x0)
Opcode : CN_CREATE_CO (0x4)
Session Handle : 0x7014007
Response : 0:HSM Return: SUCCESS
Log type : MGMT_USER_DETAILS_LOG (2)
User Name : alice
User Type : CN_CRYPTO_OFFICER (2)
```

Later, the CO named admin logs in and deletes the crypto officer named alice. The HSM records a CN_DELETE_USER event. The name and type of the deleted user are included in the event.

```
Time: 01/23/18 19:58:23.451420, usecs:1516737503451420
Sequence No : 0xb
Reboot counter : 0x107
Command Type(hex) : CN_MGMT_CMD (0x0)
Opcode : CN_DELETE_USER (0xa1)
Session Handle : 0x7014007
Response : 0:HSM Return: SUCCESS
Log type : MGMT_USER_DETAILS_LOG (2)
User Name : alice
User Type : CN_CRYPTO_OFFICER (2)
```

**Example: Create and delete a key pair**

This example shows the events that are recorded in an HSM audit log when you create and delete a key pair.

The following event records the crypto user (CU) named crypto_user logging in to the HSM.

```
Time: 12/13/17 23:09:04.648952, usecs:1513206544648952
Sequence No: 0x28
Reboot counter: 0xe8
Command Type(hex): CN_MGMT_CMD (0x0)
Opcode: CN_LOGIN (0xd)
Session Handle: 0x2014005
Response: 0:HSM Return: SUCCESS
Log type: MGMT_USER_DETAILS_LOG (2)
User Name: crypto_user
User Type: CN_CRYPTO_USER (1)
```

Next, the CU generates a key pair (CN_GENERATE_KEY_PAIR). The private key has key handle 131079. The public key has key handle 131078.

```
Time: 12/13/17 23:09:04.761594, usecs:1513206544761594
Sequence No: 0x29
Reboot counter: 0xe8
Command Type(hex): CN_MGMT_CMD (0x0)
Opcode: CN_GENERATE_KEY_PAIR (0x19)
Session Handle: 0x2014004
Response: 0:HSM Return: SUCCESS
Log type: MGMT_KEY_DETAILS_LOG (1)
Priv/Secret Key Handle: 131079
Public Key Handle: 131078
```
The CU immediately deletes the key pair. A CN_DESTROY_OBJECT event records the deletion of the public key (131078).

| Time: 12/13/17 23:09:04.813977, usecs:1513206544813977 |
| Sequence No: 0x2a |
| Reboot counter: 0xe8 |
| Command Type(hex): CN_MGMT_CMD (0x0) |
| Opcode: CN_DESTROY_OBJECT (0x11) |
| Session Handle: 0x2014004 |
| Response: 0:HSM Return: SUCCESS |
| Log type: MGMT_KEY_DETAILS_LOG (1) |
| Priv/Secret Key Handle: 131078 |
| Public Key Handle: 0 |

Then, a second CN_DESTROY_OBJECT event records the deletion of the private key (131079).

| Time: 12/13/17 23:09:04.815530, usecs:1513206544815530 |
| Sequence No: 0x2b |
| Reboot counter: 0xe8 |
| Command Type(hex): CN_MGMT_CMD (0x0) |
| Opcode: CN_DESTROY_OBJECT (0x11) |
| Session Handle: 0x2014004 |
| Response: 0:HSM Return: SUCCESS |
| Log type: MGMT_KEY_DETAILS_LOG (1) |
| Priv/Secret Key Handle: 131079 |
| Public Key Handle: 0 |

Finally, the CU logs out.

| Time: 12/13/17 23:09:04.817222, usecs:1513206544817222 |
| Sequence No: 0x2c |
| Reboot counter: 0xe8 |
| Command Type(hex): CN_MGMT_CMD (0x0) |
| Opcode: CN_LOGOUT (0xe) |
| Session Handle: 0x2014004 |
| Response: 0:HSM Return: SUCCESS |
| Log type: MGMT_USER_DETAILS_LOG (2) |
| User Name: crypto_user |
| User Type: CN_CRYPTO_USER (1) |

**Example: Generate and synchronize a key**

This example shows the effect of creating a key in a cluster with multiple HSMs. The key is generated on one HSM, extracted from the HSM as a masked object, and inserted in the other HSMs as a masked object.

*Note*

The client tools might fail to synchronize the key. Or the command might include the **min_srv** parameter, which synchronizes the key only to the specified number of HSMs. In either case, the AWS CloudHSM service synchronizes the key to the other HSMs in the cluster. Because the HSMs record only client-side management commands in their logs, the server-side synchronization is not recorded in the HSM log.

First consider the log stream of the HSM that receives and executes the commands. The log stream is named for HSM ID, hsm-abcde123456, but the HSM ID does not appear in the log events.

First, the testuser crypto user (CU) logs in to the hsm-abcde123456 HSM.

| Time: 01/24/18 00:39:23.172777, usecs:1516754363172777 |
| Sequence No: 0x0 |
| Reboot counter: 0x107 |
The CU runs an **exSymKey (p. 341)** command to generate a symmetric key. The hsm-abcde123456 HSM generates a symmetric key with a key handle of 262152. The HSM records a CN_GENERATE_KEY event in its log.

The next event in the log stream for hsm-abcde123456 records the first step in the key synchronization process. The new key (key handle 262152) is extracted from the HSM as a masked object.

Now consider the log stream for HSM hsm-zyxwv987654, another HSM in the same cluster. This log stream also includes a login event for the testuser CU. The time value shows that occurs shortly after the user logs in to the hsm-abcde123456 HSM.

This log stream for this HSM does not have a CN_GENERATE_KEY event. But it does have an event that records synchronization of the key to this HSM. The CN_INSERT_MASKED_OBJECT_USER event records the receipt of key 262152 as a masked object. Now key 262152 exists on both HSMs in the cluster.
Interpreting logs

Opcode : CN_INSERT_MASKED_OBJECT_USER (0xf1)
Session Handle : 0x7004003
Response : 0:HSM Return: SUCCESS
Log type : MGMT_KEY_DETAILS_LOG (1)
Priv/Secret Key Handle : 262152
Public Key Handle : 0

When the CU user logs out, this CN_LOGOUT event appears only in the log stream of the HSM that received the commands.

Example: Export a key

This example shows the audit log events that are recorded when a crypto user (CU) exports keys from a cluster with multiple HSMs.

The following event records the CU (testuser) logging into key_mgmt_util (p. 301).

Time: 01/24/18 19:42:22.695884, usecs:1516822942695884
Sequence No : 0x26
Reboot counter : 0x107
Command Type(hex) : CN_MGMT_CMD (0x0)
Opcode : CN_LOGIN (0xd)
Session Handle : 0x7004004
Response : 0:HSM Return: SUCCESS
Log type : MGMT_USER_DETAILS_LOG (2)
User Name : testuser
User Type : CN_CRYPTO_USER (1)

The CU runs an exSymKey (p. 318) command to export key 7, a 256-bit AES key. The command uses key 6, a 256-bit AES key on the HSMs, as the wrapping key.

The HSM that receives the command records a CN_WRAP_KEY event for key 7, the key that is being exported.

Time: 01/24/18 19:51:12.860123, usecs:1516823472860123
Sequence No : 0x27
Reboot counter : 0x107
Command Type(hex) : CN_MGMT_CMD (0x0)
Opcode : CN_WRAP_KEY (0x1a)
Session Handle : 0x7004003
Response : 0:HSM Return: SUCCESS
Log type : MGMT_KEY_DETAILS_LOG (1)
Priv/Secret Key Handle : 7
Public Key Handle : 0

Then, the HSM records a CN_NIST_AES_WRAP event for the wrapping key, key 6. The key is wrapped and then immediately unwrapped, but the HSM records only one event.

Time: 01/24/18 19:51:12.905257, usecs:1516823472905257
Sequence No : 0x28
Reboot counter : 0x107
Command Type(hex) : CN_MGMT_CMD (0x0)
Opcode : CN_NIST_AES_WRAP (0x1e)
Session Handle : 0x7004003
Response : 0:HSM Return: SUCCESS
Log type : MGMT_KEY_DETAILS_LOG (1)
Priv/Secret Key Handle : 6
Public Key Handle : 0

The exSymKey command writes the exported key to a file but does not change the key on the HSM. Consequently, there are no corresponding events in the logs of other HSMs in the cluster.
Example: Import a key

This example shows the audit log events that are recorded when you import keys into the HSMs in a cluster. In this example, the crypto user (CU) uses the `imSymKey` command to import an AES key into the HSMs. The command uses key 6 as the wrapping key.

The HSM that receives the commands first records a `CN_NIST_AES_WRAP` event for key 6, the wrapping key.

```
Time: 01/24/18 19:58:23.170518, usecs:1516823903170518
Sequence No : 0x29
Reboot counter : 0x107
Command Type(hex) : CN_MGMT_CMD (0x0)
Opcode : CN_NIST_AES_WRAP (0x1e)
Session Handle : 0x7004003
Response : 0:HSM Return: SUCCESS
Log type : MGMT_KEY_DETAILS_LOG (1)
Priv/Secret Key Handle : 6
Public Key Handle : 0
```

Then, the HSM records a `CN_UNWRAP_KEY` event that represents the import operation. The imported key is assigned a key handle of 11.

```
Time: 01/24/18 19:58:23.200711, usecs:1516823903200711
Sequence No : 0x2a
Reboot counter : 0x107
Command Type(hex) : CN_MGMT_CMD (0x0)
Opcode : CN_UNWRAP_KEY (0x1b)
Session Handle : 0x7004003
Response : 0:HSM Return: SUCCESS
Log type : MGMT_KEY_DETAILS_LOG (1)
Priv/Secret Key Handle : 11
Public Key Handle : 0
```

When a new key is generated or imported, the client tools automatically attempt to synchronize the new key to other HSMs in the cluster. In this case, the HSM records a `CN_EXTRACT_MASKED_OBJECT_USER` event when key 11 is extracted from the HSM as a masked object.

```
Time: 01/24/18 19:58:23.203350, usecs:1516823903203350
Sequence No : 0x2b
Reboot counter : 0x107
Command Type(hex) : CN_MGMT_CMD (0x0)
Opcode : CN_EXTRACT_MASKED_OBJECT_USER (0xf0)
Session Handle : 0x7004003
Response : 0:HSM Return: SUCCESS
Log type : MGMT_KEY_DETAILS_LOG (1)
Priv/Secret Key Handle : 11
Public Key Handle : 0
```

The log streams of other HSMs in the cluster reflect the arrival of the newly imported key.

For example, this event was recorded in the log stream of a different HSM in the same cluster. This `CN_INSERT_MASKED_OBJECT_USER` event records the arrival of a masked object that represents key 11.

```
Time: 01/24/18 19:58:23.286793, usecs:1516823903286793
Sequence No : 0xb
Reboot counter : 0x107
Command Type(hex) : CN_MGMT_CMD (0x0)
Opcode : CN_INSERT_MASKED_OBJECT_USER (0xf1)
Session Handle : 0xc008004
```
Response : 0:HSM Return: SUCCESS
Log type : MGMT_KEYDETAILS_LOG (1)
Priv/Secret Key Handle : 11
Public Key Handle : 0

Example: Share and unshare a key

This example shows the audit log event that is recorded when a crypto user (CU) shares or unshares ECC private key with other crypto users. The CU uses the shareKey (p. 295) command and provides the key handle, the user ID, and the value 1 to share or value 0 to unshare the key.

In the following example, the HSM that receives the command, records a CM_SHARE_OBJECT event that represents the share operation.

Time: 02/08/19 19:35:39.480168, usecs:1549654539480168
Sequence No : 0x3f
Reboot counter : 0x38
Command Type(hex) : CN_MGMT_CMD (0x0)
Opcode : CN_SHARE_OBJECT (0x12)
Session Handle : 0x3014007
Response : 0:HSM Return: SUCCESS
Log type : UNKNOWN_LOG_TYPE (5)

HSM audit log reference

AWS CloudHSM records HSM management commands in audit log events. Each event has an operation code (Opcode) value that identifies the action that occurred and its response. You can use the Opcode values to search, sort, and filter the logs.

The following table defines the Opcode values in an AWS CloudHSM audit log.

<table>
<thead>
<tr>
<th>Operation Code (Opcode)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>User Login</strong>: These events include the user name and user type</td>
<td></td>
</tr>
<tr>
<td>CN_LOGIN (0xd)</td>
<td>User login (p. 286) (excludes appliance user [AU])</td>
</tr>
<tr>
<td>CN_LOGOUT (0xe)</td>
<td>User logout (p. 286) (excludes appliance user [AU])</td>
</tr>
<tr>
<td>CN_APP_FINALIZE</td>
<td>App finalize (logged only when user did not explicitly log out)</td>
</tr>
<tr>
<td>CN_CLOSE_SESSION</td>
<td>Close session (logged only when user did not explicitly log out)</td>
</tr>
<tr>
<td><strong>User Management</strong>: These events include the user name and user type</td>
<td></td>
</tr>
<tr>
<td>CN_CREATE_USER (0x3)</td>
<td>Create a crypto user (CU) (p. 265)</td>
</tr>
<tr>
<td>CN_CREATE_CO</td>
<td>Create a crypto officer (CO) (p. 265)</td>
</tr>
<tr>
<td>CN_CREATE_APPLIANCE_USER</td>
<td>Create an appliance user (AU) (p. 265)</td>
</tr>
<tr>
<td>CN_DELETE_USER</td>
<td>Delete a user (p. 268)</td>
</tr>
<tr>
<td>CN_CHANGE_PSWD</td>
<td>Change a user password (p. 261)</td>
</tr>
<tr>
<td>CN_SET_M_VALUE</td>
<td>Set quorum authentication (M of N) for a user action</td>
</tr>
<tr>
<td>Operation Code (Opcode)</td>
<td>Description</td>
</tr>
<tr>
<td>------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>CN_APPROVE_TOKEN</td>
<td>Approve a quorum authentication token for a user action</td>
</tr>
<tr>
<td>CN_DELETE_TOKEN</td>
<td>Delete one or more quorum tokens</td>
</tr>
<tr>
<td>CN_GET_TOKEN</td>
<td>Request a signing token to initiate a quorum operation</td>
</tr>
</tbody>
</table>

**Key Management:** These events include the key handle

| CN_GENERATE_KEY         | Generate a symmetric key (p. 341) |
| CN_GENERATE_KEY_PAIR (0x19) | Generate a key pair (DSA (p. 328), ECC (p. 332), or RSA (p. 336)) |
| CN_CREATE_OBJECT        | Import a public key (without wrapping) |
| CN_MODIFY_OBJECT        | Set a key attribute in key_mgmt_util (p. 374) or cloudhsm_mgmt_util (p. 291) |
| CN_DESTROY_OBJECT (0x11) | Delete a key (p. 312) |
| CN_TOMBSTONE_OBJECT     | Mark the key for deletion, but do not remove it |
| CN_SHARE_OBJECT         | Share or unshare a key (p. 295) |
| CN_WRAP_KEY             | Export an encrypted copy of a key (wrapKey (p. 385)) |
| CN_UNWRAP_KEY           | Import an encrypted copy of a key (unwrapKey (p. 378)) |
| CN_DERIVE_KEY           | Derive a symmetric key from an existing key |
| CN_NIST_AES_WRAP        | Encrypt or decrypt a file (aesWrapUnwrap (p. 309)) |
| CN_INSERT_MASKED_OBJECT_USER | Receive a key (as a masked object) from another HSM in the cluster; this event is recorded when a client action synchronizes the key |
| CN_EXTRACT_MASKED_OBJECT_USER | Send a key (as a masked object) to other HSMs in the cluster; this event is recorded when a client action synchronizes the key |

**Back up HSMs**

| CN_BACKUP_BEGIN         | Begin the backup process |
| CN_BACKUP_END           | Complete backup process |
| CN_RESTORE_BEGIN        | Begin restoring a backup |
| CN_RESTORE_END          | Complete the restore process for a backup |

**Certificate-Based Authentication**

| CN_CERT_AUTH_STORE_CERT | Store a certificate |
**Operation Code (Opcode)**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CN_CERT_AUTH_VALIDATE_PEER_CERTS</td>
<td>Validate a certificate</td>
</tr>
<tr>
<td>CN_CERT_AUTH_SOURCE_KEY_EXCHANGE</td>
<td>Source key exchange</td>
</tr>
<tr>
<td>CN_CERT_AUTH_TARGET_KEY_EXCHANGE</td>
<td>Target key exchange</td>
</tr>
</tbody>
</table>

**HSM Instance Commands**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CN_INIT_TOKEN (0x1)</td>
<td>Initialize the HSM: Start</td>
</tr>
<tr>
<td>CN_INIT_DONE</td>
<td>Initialize the HSM: Complete</td>
</tr>
<tr>
<td>CN_GEN_KEY_ENC_KEY</td>
<td>Generate a key encryption key (KEK)</td>
</tr>
<tr>
<td>CN_GEN_PSWD_ENC_KEY (0x1d)</td>
<td>Generate a password encryption key (PEK)</td>
</tr>
<tr>
<td>CN_CLOSE_PARTITION_SESSIONS</td>
<td>Close a session on the HSM</td>
</tr>
<tr>
<td>CN_STORE_KBK_SHARE</td>
<td>Store the key backup key (KBK)</td>
</tr>
<tr>
<td>CN_SET_NODEID</td>
<td>Set the node ID of the HSM in the cluster</td>
</tr>
<tr>
<td>CN_ZEROIZE</td>
<td>Zeroize the HSM</td>
</tr>
</tbody>
</table>

**HSM crypto commands**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CN_FIPS_RAND</td>
<td>Generate a FIPS-compliant random number</td>
</tr>
</tbody>
</table>

---

**Getting CloudWatch metrics for AWS CloudHSM**

Use CloudWatch to monitor your AWS CloudHSM cluster in real time. The metrics can be grouped by region, cluster ID, or cluster ID and HSM ID.

The AWS/CloudHSM namespace includes the following metrics:

<table>
<thead>
<tr>
<th>Metric</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HsmUnhealthy</td>
<td>The HSM instance is not performing properly. AWS CloudHSM automatically replaces unhealthy instances for you. You may choose to proactively expand cluster size to reduce performance impact while we are replacing the HSM.</td>
</tr>
<tr>
<td>HsmTemperature</td>
<td>The junction temperature of the hardware processor. The system shuts down if temperature reaches 110 degrees Centigrade.</td>
</tr>
<tr>
<td>HsmKeysSessionOccupied</td>
<td>Number of session keys being used by the HSM instance.</td>
</tr>
<tr>
<td>HsmKeysTokenOccupied</td>
<td>Number of token keys being used by the HSM instance and the cluster.</td>
</tr>
<tr>
<td>HsmSslCtxsOccupied</td>
<td>The number of end-to-end encrypted channels currently established for the HSM instance. Up to 2,048 channels are allowed.</td>
</tr>
<tr>
<td>HsmSessionCount</td>
<td>The number of open connections to the HSM instance. Up to 2,048 are allowed. By default, the client daemon is configured to open two sessions with each HSM instance under one end-to-end encrypted channel. AWS CloudHSM may also have up to 2 connections open with the HSM to monitor the health of the HSMs.</td>
</tr>
</tbody>
</table>
**AWS CloudHSM User Guide**

**CloudWatch metrics**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HsmUsersAvailable</strong></td>
<td>The number of additional users that can be created. This equals the maximum number of users (listed in <strong>HsmUsersMax</strong>) minus the users created to date.</td>
</tr>
<tr>
<td><strong>HsmUsersMax</strong></td>
<td>The maximum number of users that can be created on the HSM instance. Currently this is 1,024.</td>
</tr>
<tr>
<td><strong>InterfaceEth2OctetsInput</strong></td>
<td>Cumulative sum of incoming traffic to the HSM to date.</td>
</tr>
<tr>
<td><strong>InterfaceEth2OctetsOutput</strong></td>
<td>Cumulative sum of outgoing traffic to the HSM to date.</td>
</tr>
</tbody>
</table>
AWS CloudHSM Performance

For production clusters, you should have at least two HSM instances spread across different availability zones in a region. We recommend load testing your cluster to determine the peak load you should anticipate, and then add one more HSM to it to ensure high availability. For applications requiring durability of newly generated keys, we recommend at least three HSM instances spread across different availability zones in a region.

Performance data

The performance of AWS CloudHSM clusters vary based on specific workload. The table below shows approximate performance for common cryptographic algorithms running on an EC2 instance. To increase performance, you can add additional HSM instances to your clusters. Performance can vary based on configuration, data size, and additional application load on your EC2 instances. We encourage load testing your application to determine scaling needs.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Two-HSM cluster</th>
<th>Three-HSM cluster</th>
<th>Six-HSM cluster</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSA 2048-bit sign</td>
<td>2,000 ops/sec</td>
<td>3,000 ops/sec</td>
<td>5,000 ops/sec</td>
</tr>
<tr>
<td>EC P256 sign</td>
<td>500 ops/sec</td>
<td>750 ops/sec</td>
<td>1,500 ops/sec</td>
</tr>
</tbody>
</table>

- [1] A two-HSM cluster with the Java multi-threaded application running on one c4.large EC2 instance with one HSM in the same AZ as the EC2 instance.
- [2] A three-HSM cluster with the Java multi-threaded application running on one c4.large EC2 instance with one HSM in the same AZ as the EC2 instance.
- [3] A six-HSM cluster with the Java multi-threaded application running on one c4.large EC2 instance with two HSMs in the same AZ as the EC2 instance.

HSM throttling

When your workload exceeds your cluster’s HSM capacity, you will receive error messages stating HSMs are busy or throttled. For details on what to do when this happens, see HSM Throttling (p. 659)
Security in AWS CloudHSM

Cloud security at AWS is the highest priority. As an AWS customer, you benefit from a data center and network architecture that is built to meet the requirements of the most security-sensitive organizations.

Security is a shared responsibility between AWS and you. The shared responsibility model describes this as security of the cloud and security in the cloud:

- **Security of the cloud** – AWS is responsible for protecting the infrastructure that runs AWS services in the AWS Cloud. AWS also provides you with services that you can use securely. Third-party auditors regularly test and verify the effectiveness of our security as part of the AWS Compliance Programs. To learn about the compliance programs that apply to AWS CloudHSM, see AWS Services in Scope by Compliance Program.
- **Security in the cloud** – Your responsibility is determined by the AWS service that you use. You are also responsible for other factors including the sensitivity of your data, your company’s requirements, and applicable laws and regulations.

This documentation helps you understand how to apply the shared responsibility model when using AWS CloudHSM. The following topics show you how to configure AWS CloudHSM to meet your security and compliance objectives. You also learn how to use other AWS services that help you to monitor and secure your AWS CloudHSM resources.

Contents
- Data protection in AWS CloudHSM (p. 623)
- Identity and access management for AWS CloudHSM (p. 626)
- Compliance (p. 631)
- Resilience in AWS CloudHSM (p. 634)
- Infrastructure security in AWS CloudHSM (p. 634)
- AWS CloudHSM and VPC endpoints (p. 635)
- Update management in AWS CloudHSM (p. 636)

Data protection in AWS CloudHSM

The AWS shared responsibility model applies to data protection in AWS CloudHSM. As described in this model, AWS is responsible for protecting the global infrastructure that runs all of the AWS Cloud. You are responsible for maintaining control over your content that is hosted on this infrastructure. This content includes the security configuration and management tasks for the AWS services that you use. For more information about data privacy, see the Data Privacy FAQ. For information about data protection in Europe, see the AWS Shared Responsibility Model and GDPR blog post on the AWS Security Blog.

For data protection purposes, we recommend that you protect AWS account credentials and set up individual users with AWS IAM Identity Center or AWS Identity and Access Management (IAM). That way, each user is given only the permissions necessary to fulfill their job duties. We also recommend that you secure your data in the following ways:

- Use multi-factor authentication (MFA) with each account.
- Use SSL/TLS to communicate with AWS resources. We require TLS 1.2 and recommend TLS 1.3.
- Set up API and user activity logging with AWS CloudTrail.
- Use AWS encryption solutions, along with all default security controls within AWS services.
- Use advanced managed security services such as Amazon Macie, which assists in discovering and securing sensitive data that is stored in Amazon S3.
If you require FIPS 140-2 validated cryptographic modules when accessing AWS through a command line interface or an API, use a FIPS endpoint. For more information about the available FIPS endpoints, see Federal Information Processing Standard (FIPS) 140-2.

We strongly recommend that you never put confidential or sensitive information, such as your customers' email addresses, into tags or free-form text fields such as a Name field. This includes when you work with AWS CloudHSM or other AWS services using the console, API, AWS CLI, or AWS SDKs. Any data that you enter into tags or free-form text fields used for names may be used for billing or diagnostic logs. If you provide a URL to an external server, we strongly recommend that you do not include credentials information in the URL to validate your request to that server.

Encryption at rest

When AWS CloudHSM makes a backup from an HSM, the HSM encrypts its data before sending it to AWS CloudHSM. The data is encrypted using a unique, ephemeral encryption key. For more information, see AWS CloudHSM cluster backups (p. 5).

Encryption in transit

Communication between the AWS CloudHSM client and the HSM in your cluster is encrypted from end to end. This communication can be decrypted only by your client and your HSM. For more information, see End-to-end encryption (p. 624).

AWS CloudHSM client end-to-end encryption

Communication between the client instance and the HSMs in your cluster is encrypted from end to end. Only your client and your HSMs can decrypt the communication.

The following process explains how the client establishes end-to-end encrypted communication with an HSM.

1. Your client establishes a Transport Layer Security (TLS) connection with the server that hosts your HSM hardware. Your cluster's security group allows inbound traffic to the server only from client instances in the security group. The client also checks the server's certificate to ensure that it's a trusted server.
2. Next, the client establishes an encrypted connection with the HSM hardware. The HSM has the cluster certificate that you signed with your own certificate authority (CA), and the client has the CA’s root certificate. Before the client–HSM encrypted connection is established, the client verifies the HSM’s cluster certificate against its root certificate. The connection is established only when the client successfully verifies that the HSM is trusted.

Security of cluster backups

When AWS CloudHSM makes a backup from the HSM, the HSM encrypts all of its data before sending it to AWS CloudHSM. The data never leaves the HSM in plaintext form. Additionally, backups cannot be decrypted by AWS because AWS doesn’t have access to key used to decrypt the backups.

To encrypt its data, the HSM uses a unique, ephemeral encryption key known as the ephemeral backup key (EBK). The EBK is an AES 256-bit encryption key generated inside the HSM when AWS CloudHSM makes a backup. The HSM generates the EBK, then uses it to encrypt the HSM’s data with a FIPS-approved AES key wrapping method that complies with NIST special publication 800-38F. Then the HSM gives the encrypted data to AWS CloudHSM. The encrypted data includes an encrypted copy of the EBK.

To encrypt the EBK, the HSM uses another encryption key known as the persistent backup key (PBK). The PBK is also an AES 256-bit encryption key. To generate the PBK, the HSM uses a FIPS-approved key derivation function (KDF) in counter mode that complies with NIST special publication 800-108. The inputs to this KDF include the following:

- A manufacturer key backup key (MKBK), permanently embedded in the HSM hardware by the hardware manufacturer.
- An AWS key backup key (AKBK), securely installed in the HSM when it’s initially configured by AWS CloudHSM.

The encryption processes are summarized in the following figure. The backup encryption key represents the persistent backup key (PBK) and the ephemeral backup key (EBK).
AWS CloudHSM can restore backups onto only AWS-owned HSMs made by the same manufacturer. Because each backup contains all users, keys, and configuration from the original HSM, the restored HSM contains the same protections and access controls as the original. The restored data overwrites all other data that might have been on the HSM prior to restoration.

A backup consists of only encrypted data. Before the service stores a backup in Amazon S3, the service encrypts the backup again using AWS Key Management Service (AWS KMS).

Identity and access management for AWS CloudHSM

AWS uses security credentials to identify you and to grant you access to your AWS resources. You can use features of AWS Identity and Access Management (IAM) to allow other users, services, and applications to use your AWS resources fully or in a limited way. You can do this without sharing your security credentials.

By default, IAM users don't have permission to create, view, or modify AWS resources. To allow an IAM user to access resources such as a load balancer, and to perform tasks, you:

1. Create an IAM policy that grants the IAM user permission to use the specific resources and API actions they need.
2. Attach the policy to the IAM user or the group that the IAM user belongs to.

When you attach a policy to a user or group of users, it allows or denies the users permission to perform the specified tasks on the specified resources.

For example, you can use IAM to create users and groups under your AWS account. An IAM user can be a person, a system, or an application. Then you grant permissions to the users and groups to perform specific actions on the specified resources using an IAM policy.

Grant permissions using IAM policies

When you attach a policy to a user or group of users, it allows or denies the users permission to perform the specified tasks on the specified resources.
An IAM policy is a JSON document that consists of one or more statements. Each statement is structured as shown in the following example.

```json
{
    "Version": "2012-10-17",
    "Statement": [{
        "Effect": "effect",
        "Action": "action",
        "Resource": "resource-arn",
        "Condition": {
            "condition": {
                "key": "value"
            }
        }
    }]
}
```

- **Effect**— The `effect` can be `Allow` or `Deny`. By default, IAM users don’t have permission to use resources and API actions, so all requests are denied. An explicit allow overrides the default. An explicit deny overrides any allows.
- **Action**— The `action` is the specific API action for which you are granting or denying permission. For more information about specifying `action`, see [API actions for AWS CloudHSM](p. 627).
- **Resource**— The resource that's affected by the action. AWS CloudHSM does not support resource-level permissions. You must use the `*` wildcard to specify all AWS CloudHSM resources.
- **Condition**— You can optionally use conditions to control when your policy is in effect. For more information, see [Condition keys for AWS CloudHSM](p. 628).

For more information, see the [IAM User Guide](#).

## API actions for AWS CloudHSM

In the `Action` element of your IAM policy statement, you can specify any API action that AWS CloudHSM offers. You must prefix the action name with the lowercase string `cloudhsm:`, as shown in the following example.

```
"Action": "cloudhsm:DescribeClusters"
```

To specify multiple actions in a single statement, enclose them in square brackets and separate them with a comma, as shown in the following example.

```
"Action": [
    "cloudhsm:DescribeClusters",
    "cloudhsm:DescribeHsm"
]
```

You can also specify multiple actions using the `*` wildcard. The following example specifies all API action names for AWS CloudHSM that start with `List`.

```
"Action": "cloudhsm:List*"
```

To specify all API actions for AWS CloudHSM, use the `*` wildcard, as shown in the following example.

```
"Action": "cloudhsm:*"
```

For the list of API actions for AWS CloudHSM, see [AWS CloudHSM Actions](#).
Condition keys for AWS CloudHSM

When you create a policy, you can specify the conditions that control when the policy is in effect. Each condition contains one or more key-value pairs. There are global condition keys and service-specific condition keys.

AWS CloudHSM has no service-specific context keys.

For more information about global condition keys, see AWS Global Condition Context Keys in the IAM User Guide.

Predefined AWS managed policies for AWS CloudHSM

The managed policies created by AWS grant the required permissions for common use cases. You can attach these policies to your IAM users, based on the access to AWS CloudHSM that they require:

- **AWSCloudHSMFullAccess** — Grants full access required to use AWS CloudHSM features.
- **AWSCloudHSMReadOnlyAccess** — Grants read-only access to AWS CloudHSM features.

Customer managed policies for AWS CloudHSM

We recommend that you create an IAM administrators group for AWS CloudHSM that contains only the permissions required to run AWS CloudHSM. Attach the policy with the appropriate permissions to this group. Add IAM users to the group as needed. Each user that you add inherits the policy from the administrators group.

Also, we recommend that you create additional user groups based on the permissions that your users need. This ensures that only trusted users have access to critical API actions. For example, you could create a user group that you use to grant read-only access to clusters and HSMs. Because this group does not allow a user to delete clusters or HSMs, an untrusted user cannot affect the availability of a production workload.

As new AWS CloudHSM management features are added over time, you can ensure that only trusted users are given immediate access. By assigning limited permissions to policies at creation, you can manually assign new feature permissions to them later.

The following are example policies for AWS CloudHSM. For information about how to create a policy and attach it to an IAM user group, see Creating Policies on the JSON Tab in the IAM User Guide.

Examples

- **Read Only Permissions** (p. 628)
- **Power User Permissions** (p. 629)
- **Admin Permissions** (p. 629)

**Example Example: Read-only permissions**

This policy allows access to the DescribeClusters and DescribeBackups API actions. It also includes additional permissions for specific Amazon EC2 API actions. It does not allow the user to delete clusters or HSMs.

```json
{
    "Version": "2012-10-17",
```
Example: Power user permissions

This policy allows access to a subset of the AWS CloudHSM API actions. It also includes additional permissions for specific Amazon EC2 actions. It does not allow the user to delete clusters or HSMs. You must include the `iam:CreateServiceLinkedRole` action to allow AWS CloudHSM to automatically create the `AWSServiceRoleForCloudHSM` service-linked role in your account. This role allows AWS CloudHSM to log events. For more information, see Service-linked roles for AWS CloudHSM (p. 630).

**Note**

To see the specific permissions for each API, refer to Actions, resources, and condition keys for AWS CloudHSM in the Service Authorization Reference.

Example: Admin permissions

This policy allows access to all AWS CloudHSM API actions, including the actions to delete HSMs and clusters. It also includes additional permissions for specific Amazon EC2 actions. You must include the `iam:CreateServiceLinkedRole` action to allow AWS CloudHSM to automatically create the
**AWS CloudHSM User Guide**

**Service-linked roles**

**AWSServiceRoleForCloudHSM** service-linked role in your account. This role allows AWS CloudHSM to log events. For more information, see [Service-linked roles for AWS CloudHSM](#) (p. 630).

```json
{
    "Version": "2012-10-17",
    "Statement": [
        {
            "Effect": "Allow",
            "Action": [
                "cloudhsm:*",
                "ec2:CreateNetworkInterface",
                "ec2:DescribeNetworkInterfaces",
                "ec2:DescribeNetworkInterfaceAttribute",
                "ec2:DetachNetworkInterface",
                "ec2:DeleteNetworkInterface",
                "ec2:CreateSecurityGroup",
                "ec2:AuthorizeSecurityGroupIngress",
                "ec2:AuthorizeSecurityGroupEgress",
                "ec2:DescribeSecurityGroups",
                "ec2:DeleteSecurityGroup",
                "ec2:CreateTags",
                "ec2:DescribeVpcs",
                "ec2:DescribeSubnets",
                "iam:CreateServiceLinkedRole"
            ],
            "Resource": "*"
        }
    ]
}
```

**Service-linked roles for AWS CloudHSM**

The IAM policy that you created previously to [Customer managed policies for AWS CloudHSM](#) (p. 628) includes the `iam:CreateServiceLinkedRole` action. AWS CloudHSM defines a service-linked role named **AWSServiceRoleForCloudHSM**. The role is predefined by AWS CloudHSM and includes permissions that AWS CloudHSM requires to call other AWS services on your behalf. The role makes setting up your service easier because you don’t need to manually add the role policy and trust policy permissions.

The role policy allows AWS CloudHSM to create Amazon CloudWatch Logs log groups and log streams and write log events on your behalf. You can view it below and in the IAM console.

```json
{
    "Version": "2018-06-12",
    "Statement": [
        {
            "Effect": "Allow",
            "Action": [
                "logs:CreateLogGroup",
                "logs:CreateLogStream",
                "logs:PutLogEvents",
                "logs:DescribeLogStreams"
            ],
            "Resource": [
                "arn:aws:logs:*:*:*"
            ]
        }
    ]
}
```

The trust policy for the **AWSServiceRoleForCloudHSM** role allows AWS CloudHSM to assume the role.
Creating a service-linked role (automatic)

AWS CloudHSM creates the AWS::ServiceRoleForCloudHSM role when you create a cluster if you include the iam:CreateServiceLinkedRole action in the permissions that you defined when you created the AWS CloudHSM administrators group. See Customer managed policies for AWS CloudHSM (p. 628).

If you already have one or more clusters and just want to add the AWS::ServiceRoleForCloudHSM role, you can use the console, the create-cluster command, or the CreateCluster API operation to create a cluster. Then use the console, the delete-cluster command, or the DeleteCluster API operation to delete it. Creating the new cluster creates the service-linked role and applies it to all clusters in your account. Alternatively, you can create the role manually. See the following section for more information.

Note
You do not need to perform all of the steps outlined in Getting started with AWS CloudHSM (p. 7) to create a cluster if you are only creating it to add the AWS::ServiceRoleForCloudHSM role.

Creating a service-linked role (manual)

You can use the IAM console, AWS CLI, or API to create the AWS::ServiceRoleForCloudHSM role. For more information, see Creating a Service-Linked Role in the IAM User Guide.

Editing the service-linked role

AWS CloudHSM does not allow you to edit the AWS::ServiceRoleForCloudHSM role. After the role is created, for example, you cannot change its name because various entities might reference the role by name. Also, you cannot change the role policy. You can, however, use IAM to edit the role description. For more information, see Editing a Service–Linked Role in the IAM User Guide.

Deleting the service-linked role

You cannot delete a service-linked role as long as a cluster to which it has been applied still exists. To delete the role, you must first delete each HSM in your cluster and then delete the cluster. Every cluster in your account must be deleted. You can then use the IAM console, AWS CLI, or API to delete the role. For more information about deleting a cluster, see Deleting an AWS CloudHSM cluster (p. 47). For more information, see Deleting a Service-Linked Role in the IAM User Guide.

Compliance

AWS CloudHSM provides FIPS-approved security policies for the HSMs. Additionally, AWS CloudHSM meets PCI-PIN, PCI-3DS, and SOC2 compliance requirements. Relying on a FIPS-validated HSM can help
you meet corporate, contractual, and regulatory compliance requirements for data security in the AWS Cloud. For more information, refer to the information below.

**FIPS 140-2 Compliance**

The Federal Information Processing Standard (FIPS) Publication 140-2 is a US government security standard that specifies security requirements for cryptographic modules that protect sensitive information. The HSMs provided by AWS CloudHSM are FIPS 140-2 level 3 certified (Certificate #4218). For more information on about this, refer to FIPS validation for hardware.

**PCI DSS Compliance**

The Payment Card Industry Data Security Standard (PCI DSS) is a proprietary information security standard administered by the PCI Security Standards Council. The HSMs provided by AWS CloudHSM comply with PCI DSS.

**PCI PIN Compliance** *(p. 632)*

PCI PIN provides security requirement and assessment standards for transmitting, processing, and managing personal identification number (PIN) data, information that is used for transactions at ATMs and point-of-sale (POS) terminals. AWS CloudHSM has been PCI PIN compliant since January 2023. For more information, refer to the article [AWS CloudHSM is now PCI PIN certified](#).

**PCI-3DS Compliance**

PCI 3DS (or Three Domain Secure, 3-D Secure) provides security of data for EMV 3D secure e-commerce payments. PCI 3DS provides another layer of security for online shopping. AWS CloudHSM is PCI-3DS compliant.

**SOC2**

SOC2 is a framework to help service organizations demonstrate their cloud and data center security controls. AWS CloudHSM has implemented SOC2 controls in critical areas to adhere to the trusted service principles. For further information, refer to The AWS SOC FAQs page.

---

**AWS CloudHSM PCI-PIN compliance FAQs**

PCI PIN provides security requirement and assessment standards for transmitting, processing, and managing personal identification number (PIN) data, information that is used for transactions at ATMs and point-of-sale (POS) terminals.

The PCI-PIN Attestation of Compliance (AOC) and Responsibility Summary is available to customers through AWS Artifact, a self-service portal for on-demand access to AWS compliance reports. For more information, sign in to AWS Artifact in the AWS Management Console, or learn more at Getting Started with AWS Artifact.

**FAQs**

**Q: What is the Attestation of Compliance and Responsibility Summary?**

Attestation Of Compliance (AOC) is produced by a Qualified PIN Assessor (QPA) attesting AWS CloudHSM meets the applicable controls in the PCI-PIN standard. The responsibility summary matrix describes the controls which are the respective responsibilities of AWS CloudHSM and its customers.

**Q: How do I obtain the AWS CloudHSM Attestation of Compliance?**

The PCI-PIN Attestation of Compliance (AOC) is available to customers through AWS Artifact, a self-service portal for on-demand access to AWS compliance reports. For more information, sign in to AWS Artifact in the AWS Management Console, or learn more at Getting Started with AWS Artifact.
Q: How can I learn which PCI PIN controls I am responsible for?
For detailed information please see "AWS CloudHSM PCI PIN Responsibility Summary" from the AWS PCI PIN Compliance Package, available to customers through AWS Artifact, a self-service portal for on-demand access to AWS compliance reports. For more information, sign in to AWS Artifact in the AWS Management Console, or learn more at Getting Started with AWS Artifact.

Q: As an AWS CloudHSM customer, can I rely on PCI-PIN Attestion of Compliance (AOC)?
Customers must manage their own PCI-PIN compliance. You are required to go through a formal PCI-PIN attestation process through a Qualified PIN Assessor (QPA) to verify that your payment workload satisfies all PCI-PIN controls/requirements. However, for the controls which AWS is responsible for, your QPA can rely on AWS CloudHSM Attestation of Compliance (AOC) without further testing.

Q: Is AWS CloudHSM responsible for PCI-PIN requirements related to Key Management Life cycle?
AWS CloudHSM is responsible for the physical device lifecycle of the HSMs. Customers are responsible for the key management life cycle requirements in the PCI-PIN standard.

Q: Which AWS CloudHSM controls are PCI-PIN compliant?
The AOC summarizes the AWS CloudHSM controls which are assessed by QPA. The PCI-PIN Responsibility Summary is available to customers through AWS Artifact, a self-service portal for on-demand access to AWS compliance reports.

Q: Does AWS CloudHSM support payment functions such as PIN translation and DUKPT?
No, AWS CloudHSM provides general purpose HSMs. Over time we may provide payment functions. Although the service does not perform payment functions directly, the AWS CloudHSM PCI PIN attestation of compliance enables customers to attain their own PCI compliance for their services running on AWS CloudHSM. If you are interested in using AWS Payment Cryptography services for your workload, please refer to the blog "Move Payment Processing to the Cloud with AWS Payment Cryptography."

Deprecation Notifications
From time to time, AWS CloudHSM may deprecate functionality in order to remain compliant with the requirements of FIPS 140, PCI-DSS, PCI-PIN, PCI-3DS and SOC2. This page lists the changes that currently apply.

FIPS 140 Compliance: 2024 Mechanism Deprecation
The National Institute of Standards and Technology (NIST) advises that support for Triple DES (DESede, 3DES, DES3) encryption and RSA key wrap and unwrap with PKCS#1 v1.5 padding is disallowed after December 31, 2023. Therefore, support for these end on January 1, 2024 in our Federal Information Processing Standard (FIPS) compliant instances.

This guidance applies to the following cryptographic operations:

- Triple DES key generation
  - CKM_DES3_KEY_GEN for the PKCS#11 Library
  - DESede Keygen for the JCE Provider
  - genSymKey with -t=21 for the KMU
- Encryption with Triple DES keys (note: decrypt operations are allowed)
  - For the PKCS #11 Library: CKM_DES3_CBC encrypt, CKM_DES3_CBC_PAD encrypt, and CKM_DES3_ECB encrypt
• For the JCE Provider: DESede/CBC/PKCS5Padding encrypt, DESede/CBC/NoPadding encrypt, DESede/ECB/Padding encrypted, and DESede/ECB/NoPadding encrypt
• RSA key wrap, unwrap, encrypt, and decrypt with PKCS#1 v1.5 padding
• CKM_RSA_PKCS wrap, unwrap, encrypt, and decrypt for the PKCS#11 SDK
• RSA/ECB/PKCS1Padding wrap, unwrap, encrypt, and decrypt for the JCE SDK
• wrapKey and unwrapKey with -m 12 for the KMU (note 12 is the value for mechanism RSA_PKCS)

[1] For details on this change, refer to Table 1 and Table 5 in Transitioning the Use of Cryptographic Algorithms and Key Lengths.

Resilience in AWS CloudHSM

The AWS global infrastructure is built around AWS Regions and Availability Zones. AWS Regions provide multiple physically separated and isolated Availability Zones, which are connected with low-latency, high-throughput, and highly redundant networking. With Availability Zones, you can design and operate applications and databases that automatically fail over between zones without interruption. Availability Zones are more highly available, fault tolerant, and scalable than traditional single or multiple data center infrastructures.

For more information about AWS Regions and Availability Zones, see AWS Global Infrastructure. For more information about AWS CloudHSM features to support resiliency, see Cluster high availability and load balancing (p. 39).

Infrastructure security in AWS CloudHSM

As a managed service, AWS CloudHSM is protected by the AWS global network security procedures that are described in the Amazon Web Services: Overview of Security Processes whitepaper.

You use AWS published API calls to access AWS CloudHSM through the network. Additionally, requests must be signed by using an access key ID and a secret access key that is associated with an IAM principal. Or you can use the AWS Security Token Service (AWS STS) to generate temporary security credentials to sign requests.

Network isolation

A virtual private cloud (VPC) is a virtual network in your own logically isolated area in the AWS cloud. You can create a cluster in a private subnet in your VPC. You can create private subnets when you create a VPC. For more information, see Create a virtual private cloud (VPC) (p. 9).

When you create an HSM, AWS CloudHSM put an elastic network interface (ENI) in your subnet so that you can interact with your HSMs. For more information, see Cluster architecture (p. 37).

AWS CloudHSM creates a security group that allows inbound and outbound communication between HSMs in your cluster. You can use this security group to enable your EC2 instances to communicate with the HSMs in your cluster. For more information, see Configure the Client Amazon EC2 instance security groups (p. 12).

Authorization of users

With AWS CloudHSM, operations performed on the HSM require the credentials of an authenticated HSM user. For more information, see the section called “Understanding HSM users” (p. 60).
AWS CloudHSM and VPC endpoints

You can establish a private connection between your VPC and AWS CloudHSM by creating an interface VPC endpoint. Interface endpoints are powered by AWS PrivateLink, a technology that enables you to privately access AWS CloudHSM APIs without an internet gateway, NAT device, VPN connection, or AWS Direct Connect connection. Instances in your VPC don't need public IP addresses to communicate with AWS CloudHSM APIs. Traffic between your VPC and AWS CloudHSM does not leave the Amazon network.

Each interface endpoint is represented by one or more Elastic Network Interfaces in your subnets.

For more information, see Interface VPC endpoints (AWS PrivateLink) in the Amazon VPC User Guide.

Considerations for AWS CloudHSM VPC endpoints

Before you set up an interface VPC endpoint for AWS CloudHSM, ensure that you review Interface endpoint properties and limitations in the Amazon VPC User Guide.

- AWS CloudHSM supports making calls to all of its API actions from your VPC.

Creating an interface VPC endpoint for AWS CloudHSM

You can create a VPC endpoint for the AWS CloudHSM service using either the Amazon VPC console or the AWS Command Line Interface (AWS CLI). For more information, see Creating an interface endpoint in the Amazon VPC User Guide.

To create a VPC endpoint for AWS CloudHSM, use the following service name:

```
com.amazonaws.region.cloudhsmv2
```

For example, in the US West (Oregon) Region (us-west-2), the service name would be:

```
com.amazonaws.us-west-2.cloudhsmv2
```

To make it easier to use the VPC endpoint, you can enable a private DNS hostname for your VPC endpoint. If you select the Enable Private DNS Name option, the standard AWS CloudHSM DNS hostname (https://cloudhsmv2.<region>.amazonaws.com) resolves to your VPC endpoint.

This option makes it easier to use the VPC endpoint. The AWS SDKs and AWS CLI use the standard AWS CloudHSM DNS hostname by default, so you do not need to specify the VPC endpoint URL in applications and commands.

For more information, see Accessing a service through an interface endpoint in the Amazon VPC User Guide.

Creating a VPC endpoint policy for AWS CloudHSM

You can attach an endpoint policy to your VPC endpoint that controls access to AWS CloudHSM. The policy specifies the following information:

- The principal that can perform actions.
- The actions that can be performed.
• The resources on which actions can be performed.

For more information, see Controlling access to services with VPC endpoints in the Amazon VPC User Guide.

Example: VPC endpoint policy for AWS CloudHSM actions

The following is an example of an endpoint policy for AWS CloudHSM. When attached to an endpoint, this policy grants access to the listed AWS CloudHSM actions for all principals on all resources. See Identity and access management for AWS CloudHSM (p. 626) for other AWS CloudHSM actions and their corresponding IAM permissions.

```
{
   "Statement": [ 
       {
           "Principal": "*",
           "Effect": "Allow",
           "Action": [ "cloudhsm:DescribeBackups",
                        "cloudhsm:DescribeClusters",
                        "cloudhsm:ListTags" ],
           "Resource": "*"
       }
   ]
}
```

Update management in AWS CloudHSM

AWS manages the firmware. Firmware is maintained by a third party, and must be evaluated by NIST for FIPS 140-2 Level 3 compliance. Only firmware that has been cryptographically signed by the FIPS key, which AWS does not have access to, can be installed.
Troubleshooting AWS CloudHSM

If you encounter problems with AWS CloudHSM, the following topics can help you resolve them.

Topics
- Known issues (p. 637)
- Client SDK 3 key synchronization failures (p. 649)
- Client SDK 3: Verify HSM performance with the pkpspeed tool (p. 650)
- Client SDK 5 user contains inconsistent values (p. 655)
- Error seen during key availability check (p. 658)
- Extracting keys using JCE (p. 659)
- HSM Throttling (p. 659)
- Keep HSM users in sync across HSMs in the cluster (p. 660)
- Lost connection to the cluster (p. 661)
- Missing AWS CloudHSM audit logs in CloudWatch (p. 663)
- Custom IVs with non-compliant length for AES key wrap (p. 663)
- Resolving cluster creation failures (p. 665)
- Retrieving client configuration logs (p. 666)

Known issues

AWS CloudHSM has the following known issues. Choose a topic to learn more.

Topics
- Known issues for all HSM instances (p. 637)
- Known issues for the PKCS #11 library (p. 640)
- Known issues for the JCE SDK (p. 644)
- Known issues for the OpenSSL Dynamic Engine (p. 647)
- Known issues for Amazon EC2 instances running Amazon Linux 2 (p. 649)
- Known issues for integrating third-party applications (p. 649)

Known issues for all HSM instances

The following issues impact all AWS CloudHSM users regardless of whether they use the key_mgmt_util command line tool, the PKCS #11 SDK, the JCE SDK, or the OpenSSL SDK.

Topics
- Issue: AES key wrapping uses PKCS #5 padding instead of providing a standards-compliant implementation of key wrap with zero padding (p. 638)
- Issue: The client daemon requires at least one valid IP address in its configuration file to successfully connect to the cluster (p. 638)
- Issue: There was an upper limit of 16 KB on data that can be hashed and signed by AWS CloudHSM (p. 638)
- Issue: Imported keys could not be specified as nonexportable (p. 639)
• Issue: The default mechanism for the wrapKey and unWrapKey commands in the key_mgmt_util has been removed (p. 639)

• Issue: If you have a single HSM in your cluster, HSM failover does not work correctly (p. 639)

• Issue: If you exceed the key capacity of the HSMs in your cluster within a short period of time, the client enters an unhandled error state (p. 639)

• Issue: Digest operations with HMAC keys of size greater than 800 bytes are not supported (p. 639)

• Issue: The client_info tool, distributed with Client SDK 3, deletes the contents of the path specified by the optional output argument (p. 640)

• Issue: You receive an error when running the SDK 5 configure tool using the --cluster-id argument in containerized environments (p. 640)

Issue: AES key wrapping uses PKCS #5 padding instead of providing a standards-compliant implementation of key wrap with zero padding

Additionally, key wrap with no padding and zero padding is not supported.

• Impact: There is no impact if you wrap and unwrap using this algorithm within AWS CloudHSM. However, keys wrapped with AWS CloudHSM cannot be unwrapped within other HSMs or software that expects compliance to the no-padding specification. This is because eight bytes of padding data might be added to the end of your key data during a standards-compliant unwrap. Externally wrapped keys cannot be properly unwrapped into an AWS CloudHSM instance.

• Workaround: To externally unwrap a key that was wrapped with AES Key Wrap with PKCS #5 Padding on an AWS CloudHSM instance, strip the extra padding before you attempt to use the key. You can do this by trimming the extra bytes in a file editor or copying only the key bytes into a new buffer in your code.

• Resolution status: With the 3.1.0 client and software release, AWS CloudHSM provides standards-compliant options for AES key wrapping. For more information, see AES Key Wrapping (p. 129).

Issue: The client daemon requires at least one valid IP address in its configuration file to successfully connect to the cluster

• Impact: If you delete every HSM in your cluster and then add another HSM, which gets a new IP address, the client daemon continues to search for your HSMs at their original IP addresses.

• Workaround: If you run an intermittent workload, we recommend that you use the IpAddress argument in the CreateHsm function to set the elastic network interface (ENI) to its original value. Note that an ENI is specific to an Availability Zone (AZ). The alternative is to delete the /opt/cloudhsm/daemon/1/cluster.info file and then reset the client configuration to the IP address of your new HSM. You can use the client -a <IP address> command. For more information, see Install and Configure the AWS CloudHSM Client (Linux) (p. 256) or Install and Configure the AWS CloudHSM Client (Windows) (p. 259).

Issue: There was an upper limit of 16 KB on data that can be hashed and signed by AWS CloudHSM

• Resolution status: Data less than 16KB in size continues to be sent to the HSM for hashing. We have added capability to hash locally, in software, data between 16KB and 64KB in size. The client and the SDKs will explicitly fail if the data buffer is larger than 64KB. You must update your client and SDK(s) to version 1.1.1 or higher to benefit from the fix.
Issue: Imported keys could not be specified as nonexportable

- **Resolution Status:** This issue is fixed. No action is required on your part to benefit from the fix.

Issue: The default mechanism for the wrapKey and unWrapKey commands in the key_mgmt_util has been removed

- **Resolution:** When using the wrapKey or unWrapKey commands, you must use the `-m` option to specify the mechanism. See the examples in the wrapKey (p. 385) or unWrapKey (p. 378) articles for more information.

Issue: If you have a single HSM in your cluster, HSM failover does not work correctly

- **Impact:** If the single HSM instance in your cluster loses connectivity, the client will not reconnect with it even if the HSM instance is later restored.

- **Workaround:** We recommend at least two HSM instances in any production cluster. If you use this configuration, you will not be impacted by this issue. For single-HSM clusters, bounce the client daemon to restore connectivity.

- **Resolution status:** This issue has been resolved in the AWS CloudHSM client 1.1.2 release. You must upgrade to this client to benefit from the fix.

Issue: If you exceed the key capacity of the HSMs in your cluster within a short period of time, the client enters an unhandled error state

- **Impact:** When the client encounters the unhandled error state, it freezes and must be restarted.

- **Workaround:** Test your throughput to ensure you are not creating session keys at a rate that the client is unable to handle. You can lower your rate by adding an HSM to the cluster or slowing down the session key creation.

- **Resolution status:** This issue has been resolved in the AWS CloudHSM client 1.1.2 release. You must upgrade to this client to benefit from the fix.

Issue: Digest operations with HMAC keys of size greater than 800 bytes are not supported

- **Impact:** HMAC keys larger than 800 bytes can be generated on or imported into the HSM. However, if you use this large key in a digest operation via the JCE or key_mgmt_util, the operation will fail. Note that if you are using PKCS11, HMAC keys are limited to a size of 64 bytes.

- **Workaround:** If you will be using HMAC keys for digest operations on the HSM, ensure the size is smaller than 800 bytes.

- **Resolution status:** None at this time.
**Issue:** The client_info tool, distributed with Client SDK 3, deletes the contents of the path specified by the optional output argument

- **Impact:** All existing files and sub-directories under the specified output path may be permanently lost.
- **Workaround:** Do not use the optional argument `-output path` when using the client_info tool.
- **Resolution status:** This issue has been resolved in the Client SDK 3.3.2 release. You must upgrade to this client to benefit from the fix.

**Issue:** You receive an error when running the SDK 5 configure tool using the `--cluster-id` argument in containerized environments

You receive the following error when using the `--cluster-id` argument with the Configure Tool:

```plaintext
No credentials in the property bag
```

This error is caused by an update to Instance Metadata Service Version 2 (IMDSv2). For more information, see the IMDSv2 documentation.

- **Impact:** This issue will impact users running the configure tool on SDK versions 5.5.0 and later in containerized environments and utilizing EC2 instance metadata to provide credentials.
- **Workaround:** Set the PUT response hop limit to at least two. For guidance on how to do this, see Configure the instance metadata options.

**Known issues for the PKCS #11 library**

**Topics**

- **Issue:** AES key wrap in version 3.0.0 of the PKCS #11 library does not validate IVs before use (p. 641)
- **Issue:** PKCS#11 SDK 2.0.4 and earlier versions always used the default IV of 0xA6A6A6A6A6A6A6A6A6A6A6A6A6 for AES key wrap and unwrap (p. 641)
- **Issue:** The CKA_DERIVE attribute was not supported and was not handled (p. 641)
- **Issue:** The CKA_SENSITIVE attribute was not supported and was not handled (p. 642)
- **Issue:** Multipart hashing and signing are not supported (p. 642)
- **Issue:** C_GenerateKeyPair does not handle CKA_MODULUS_BITS or CKA_PUBLIC_EXPONENT in the private template in a manner that is compliant with standards (p. 642)
- **Issue:** You could not hash more than 16KB of data (p. 642)
- **Issue:** Buffers for the C_Encrypt and C_Decrypt API operations cannot exceed 16 KB when using the CKM_AES_GCM mechanism (p. 642)
- **Issue:** Elliptic-curve Diffie-Hellman (ECDH) key derivation is executed partially within the HSM (p. 643)
- **Issue:** Verification of secp256k1 signatures fails on EL6 platforms such as CentOS6 and RHEL6 (p. 643)
- **Issue:** Incorrect sequence of function calls gives undefined results instead of failing (p. 643)
- **Issue:** Read Only Session is not supported in SDK 5 (p. 644)
Known issues for the PKCS #11 library

• **Issue:** cryptoki.h header file is Windows-only (p. 644)

**Issue: AES key wrap in version 3.0.0 of the PKCS #11 library does not validate IVs before use**

If you specify an IV shorter than 8 bytes in length, it is padded with unpredictable bytes before use.

*Note*  
This impacts C_WrapKey with CKM_AES_KEY_WRAP mechanism only.

• **Impact:** If you provide an IV that is shorter than 8 bytes in version 3.0.0 of PKCS #11 library, you may be unable to unwrap the key.

• **Workarounds:**
  - We strongly recommend you upgrade to version 3.0.1 or higher of the PKCS #11 library, which properly enforces IV length during AES key wrap. Amend your wrapping code to pass a NULL IV, or specify the default IV of 0xA6A6A6A6A6A6A6A6. For more information, see [Custom IVs with Non-Compliant Length for AES Key Wrap](p. 663).
  - If you wrapped any keys with version 3.0.0 of the PKCS #11 library using an IV shorter than 8 bytes, reach out to us for support.
  - **Resolution status:** This issue has been resolved in version 3.0.1 of the PKCS #11 library. To wrap keys using AES key wrap, specify an IV that is NULL or 8 bytes long.

**Issue: PKCS#11 SDK 2.0.4 and earlier versions always used the default IV of 0xA6A6A6A6A6A6A6A6 for AES key wrap and unwrap**

User-provided IVs were silently ignored.

*Note*  
This impacts C_WrapKey with CKM_AES_KEY_WRAP mechanism only.

• **Impact:**
  - If you used PKCS#11 SDK 2.0.4 or an earlier version and a user-provided IV, your keys are wrapped with the default IV of 0xA6A6A6A6A6A6A6A6.
  - If you used PKCS#11 SDK 3.0.0 or later and a user-provided IV, your keys are wrapped with the user-provided IV.

• **Workarounds:**
  - To unwrap keys wrapped with PKCS#11 SDK 2.0.4 or earlier use the default IV of 0xA6A6A6A6A6A6A6A6.
  - To unwrap keys wrapped with PKCS#11 SDK 3.0.0 or later, use the user-provided IV.

• **Resolution status:** We strongly recommend that you amend your wrapping and unwrapping code to pass a NULL IV, or specify the default IV of 0xA6A6A6A6A6A6A6A6.

**Issue: The CKA_DERIVE attribute was not supported and was not handled**

• **Resolution status:** We have implemented fixes to accept CKA_DERIVE if it is set to FALSE. CKA_DERIVE set to TRUE will not be supported until we begin to add key derivation function support to AWS CloudHSM. You must update your client and SDK(s) to version 1.1.1 or higher to benefit from the fix.
Issue: The CKA_SENSITIVE attribute was not supported and was not handled

- **Resolution status:** We have implemented fixes to accept and properly honor the CKA_SENSITIVE attribute. You must update your client and SDK(s) to version 1.1.1 or higher to benefit from the fix.

Issue: Multipart hashing and signing are not supported

- **Impact:** C_DigestUpdate and C_DigestFinal are not implemented. C_SignFinal is also not implemented and will fail with CKR_ARGUMENTS_BAD for a non-NULL buffer.
- **Workaround:** Hash your data within your application and use AWS CloudHSM only for signing the hash.
- **Resolution status:** We are fixing the client and the SDKs to correctly implement multipart hashing. Updates will be announced in the AWS CloudHSM forum and on the version history page.

Issue: C_GenerateKeyPair does not handle CKA_MODULUS_BITS or CKA_PUBLIC_EXPONENT in the private template in a manner that is compliant with standards

- **Impact:** C_GenerateKeyPair should return CKA_TEMPLATE_INCONSISTENT when the private template contains CKA_MODULUS_BITS or CKA_PUBLIC_EXPONENT. It instead generates a private key for which all usage fields are set to FALSE. The key cannot be used.
- **Workaround:** We recommend that your application check the usage field values in addition to the error code.
- **Resolution status:** We are implementing fixes to return the proper error message when an incorrect private key template is used. The updated PKCS #11 library will be announced on the version history page.

Issue: You could not hash more than 16KB of data

For larger buffers, only the first 16KB will be hashed and returned. The excess data would have been silently ignored.

- **Resolution status:** Data less than 16KB in size continues to be sent to the HSM for hashing. We have added capability to hash locally, in software, data between 16KB and 64KB in size. The client and the SDKs will explicitly fail if the data buffer is larger than 64KB. You must update your client and SDK(s) to version 1.1.1 or higher to benefit from the fix.

Issue: Buffers for the C_Encrypt and C_Decrypt API operations cannot exceed 16 KB when using the CKM_AES_GCM mechanism

AWS CloudHSM does not support multipart AES-GCM encryption.

- **Impact:** You cannot use the CKM_AES_GCM mechanism to encrypt data larger than 16 KB.
- **Workaround:** You can use an alternative mechanism such as CKM_AES_CBC or you can divide your data into pieces and encrypt each piece individually. You must manage the division of your data and subsequent encryption. AWS CloudHSM does not perform multipart AES-GCM encryption for you.
Note that FIPS requires that the initialization vector (IV) for AES-GCM be generated on the HSM. Therefore, the IV for each piece of your AES-GCM encrypted data will be different.

- **Resolution status:** We are fixing the SDK to fail explicitly if the data buffer is too large. We return CKR_MECHANISM_INVALID for the C_EncryptUpdate and C_DecryptUpdate API operations. We are evaluating alternatives to support larger buffers without relying on multipart encryption. Updates will be announced in the AWS CloudHSM forum and on the version history page.

**Issue: Elliptic-curve Diffie-Hellman (ECDH) key derivation is executed partially within the HSM**

Your EC private key remains within the HSM at all times, but the key derivation process is performed in multiple steps. As a result, intermediate results from each step are available on the client.

- **Impact:** The key derived using the CKM_ECDH1_DERIVE mechanism is first available on the client and is then imported into the HSM. A key handle is then returned to your application.

- **Workaround:** If you are implementing SSL/TLS Offload in AWS CloudHSM, this limitation may not be an issue. If your application requires your key to remain within an FIPS boundary at all times, consider using an alternative protocol that does not rely on ECDH key derivation.

- **Resolution status:** We are developing the option to perform ECDH key derivation entirely within the HSM. The updated implementation will be announced on the version history page once available.

**Issue: Verification of secp256k1 signatures fails on EL6 platforms such as CentOS6 and RHEL6**

This happens because the CloudHSM PKCS#11 library avoids a network call during initialization of the verification operation by using OpenSSL to verify EC curve data. Since Secp256k1 is not supported by the default OpenSSL package on EL6 platforms, the initialization fails.

- **Impact:** Secp256k1 signature verification will fail on EL6 platforms. The verify call will fail with a CKR_HOST_MEMORY error.

- **Workaround:** We recommend using either Amazon Linux 1 or any EL7 platform if your PKCS#11 application needs to verify secp256k1 signatures. Alternatively, upgrade to a version of the OpenSSL package that supports the secp256k1 curve.

- **Resolution status:** We are implementing fixes to fall back to the HSM if local curve validation is not available. The updated PKCS#11 library will be announced on the [version history page](#).

**Issue: Incorrect sequence of function calls gives undefined results instead of failing**

- **Impact:** If you call an incorrect sequence of functions, the final result is incorrect even though the individual function calls return success. For instance, decrypted data may not match the original plaintext or signatures may fail to verify. This issue affects both single part and multi-part operations.

Examples of incorrect function sequences:
- C_EncryptInit/C_EncryptUpdate followed by C_Encrypt
- C_DecryptInit/C_DecryptUpdate followed by C_Decrypt
- C_SignInit/C_SignUpdate followed by C_Sign
- C_VerifyInit/C_VerifyUpdate followed by C_Verify
- C_FindObjectsInit followed by C_FindObjectsInit
• **Workaround:** Your application should, in compliance with the PKCS #11 specification, use the right sequence of function calls for both single and multi-part operations. Your application should not rely on the CloudHSM PKCS #11 library to return an error under this circumstance.

### Issue: Read Only Session is not supported in SDK 5

- **Issue:** SDK 5 does not support opening Read-Only sessions with `C_OpenSession`.
- **Impact:** If you attempt to call `C_OpenSession` without providing `CKF_RW_SESSION`, the call will fail with the error `CKR_FUNCTION_FAILED`.
- **Workaround:** When opening a session, you must pass the `CKF_SERIAL_SESSION` | `CKF_RW_SESSION` flags to the `C_OpenSession` function call.

### Issue: `cryptoki.h` header file is Windows-only

- **Issue:** With AWS CloudHSM Client SDK 5 versions 5.0.0 through 5.4.0 on Linux, the header file `/opt/cloudhsm/include/pkcs11/cryptoki.h` is only compatible with Windows operating systems.
- **Impact:** You may encounter issues when trying to include this header file in your application on Linux-based operating systems.
- **Resolution status:** Upgrade to AWS CloudHSM Client SDK 5 version 5.4.1 or above, which includes a Linux-compatible version of this header file.

### Known issues for the JCE SDK

#### Topics

- **Issue:** When working with asymmetric key pairs, you see occupied key capacity even when you are not explicitly creating or importing keys (p. 644)
- **Issue:** The JCE KeyStore is read only (p. 645)
- **Issue:** Buffers for AES-GCM encryption cannot exceed 16,000 bytes (p. 645)
- **Issue:** Elliptic-curve Diffie-Hellman (ECDH) key derivation is executed partially within the HSM (p. 645)
- **Issue:** `KeyGenerator` and `KeyAttribute` incorrectly interprets key size parameter as number of bytes instead of bits (p. 646)
- **Issue:** Client SDK 5 throws the warning “An illegal reflective access operation has occurred” (p. 646)
- **Issue:** JCE session pool is exhausted (p. 646)

### Issue: When working with asymmetric key pairs, you see occupied key capacity even when you are not explicitly creating or importing keys

- **Impact:** This issue can cause your HSMs to unexpectedly run out of key space and occurs when your application uses a standard JCE key object for crypto operations instead of a CaviumKey object. When you use a standard JCE key object, CaviumProvider implicitly imports that key into the HSM as a session key and does not delete this key until the application exits. As a result, keys build up while the application is running and can cause your HSMs to run out of free key space, thus freezing your application.
- **Workaround:** When using the CaviumSignature class, CaviumCipher class, CaviumMac class, or the CaviumKeyAgreement class, you should supply the key as a CaviumKey instead of a standard JCE key object.
You can manually convert a normal key to a CaviumKey using the `ImportKey` class, and can then manually delete the key after the operation is complete.

- **Resolution status:** We are updating the CaviumProvider to properly manage implicit imports. The fix will be announced on the version history page once available.

**Issue: The JCE KeyStore is read only**

- **Impact:** You cannot store an object type that is not supported by the HSM in the JCE keystore today. Specifically, you cannot store certificates in the keystore. This precludes interoperability with tools like jarsigner, which expect to find the certificate in the keystore.
- **Workaround:** You can rework your code to load certificates from local files or from an S3 bucket location instead of from the keystore.
- **Resolution status:** We are adding support for certificate storage in the keystore. The feature will be announced on the version history page once available.

**Issue: Buffers for AES-GCM encryption cannot exceed 16,000 bytes**

Multi-part AES-GCM encryption is not supported.

- **Impact:** You cannot use AES-GCM to encrypt data larger than 16,000 bytes.
- **Workaround:** You can use an alternative mechanism, such as AES-CBC, or you can divide your data into pieces and encrypt each piece individually. If you divide the data, you must manage the divided ciphertext and its decryption. Because FIPS requires that the initialization vector (IV) for AES-GCM be generated on the HSM, the IV for each AES-GCM-encrypted piece of data will be different.
- **Resolution status:** We are fixing the SDK to fail explicitly if the data buffer is too large. We are evaluating alternatives that support larger buffers without relying on multi-part encryption. Updates will be announced in the AWS CloudHSM forum and on the version history page.

**Issue: Elliptic-curve Diffie-Hellman (ECDH) key derivation is executed partially within the HSM**

Your EC private key remains within the HSM at all times, but the key derivation process is performed in multiple steps. As a result, intermediate results from each step are available on the client. An ECDH key derivation sample is available in the Java code samples (p. 502).

- **Impact:** Software version 3.0 adds ECDH functionality to the JCE. When you use the `CKM_ECDH1_DERIVE` mechanism to derive the key, it is first available on the client and is then imported into the HSM. A key handle is then returned to your application.
- **Workaround:** If you are implementing SSL/TLS Offload in AWS CloudHSM, this limitation may not be an issue. If your application requires your key to remain within an FIPS boundary at all times, consider using an alternative protocol that does not rely on ECDH key derivation.
- **Resolution status:** We are developing the option to perform ECDH key derivation entirely within the HSM. When available, we'll announce the updated implementation on the version history page.
Issue: KeyGenerator and KeyAttribute incorrectly interprets key size parameter as number of bytes instead of bits

When generating a key using the `init` function of the `KeyGenerator class` or the `SIZE` attribute of the AWS CloudHSM `KeyAttribute enum (p. 432)`, the API incorrectly expects the argument to be the number of key bytes, when it should instead be the number of key bits.

- **Impact:** Client SDK versions 5.4.0 through 5.4.2 incorrectly expects the key size to be provided to the specified APIs as bytes.
- **Workaround:** Convert the key size from bits to bytes before using the KeyGenerator class or KeyAttribute enum to generate keys using the AWS CloudHSM JCE provider if using Client SDK versions 5.4.0 through 5.4.2.
- **Resolution status:** Upgrade your client SDK version to 5.5.0 or later, which includes a fix to correctly expect key sizes in bits when using the KeyGenerator class or KeyAttribute enum to generate keys.

Issue: Client SDK 5 throws the warning “An illegal reflective access operation has occurred”

When using Client SDK 5 with Java 11, CloudHSM throws the following Java warning:

```
WARNING: An illegal reflective access operation has occurred
WARNING: Illegal reflective access by com.amazonaws.cloudhsm.jce.provider.CloudHsmKeyStore
(file:/opt/cloudhsm/java/cloudhsm-jce-5.6.0.jar) to field
java.security.KeyStore.keyStoreSpi
WARNING: Please consider reporting this to the maintainers of
com.amazonaws.cloudhsm.jce.provider.CloudHsmKeyStore
WARNING: Use --illegal-access=warn to enable warnings of further illegal reflective access
operations
WARNING: All illegal access operations will be denied in a future release
```  

These warnings have no impact. We are aware of this issue and are working to resolve it. No resolution nor workaround is needed.

Issue: JCE session pool is exhausted

**Impact:** You may not be able to perform operations in JCE after seeing the following message:

```
com.amazonaws.cloudhsm.jce.jni.exception.InternalException: There are too many operations happening at the same time: Reached max number of sessions in session pool: 1000
```

**Workarounds:**

- Restart your JCE application if you're experiencing impact.
- When performing an operation, you may need to complete the JCE operation before losing reference to the operation.

  **Note**
  Depending on the operation, a completion method may be needed.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Completion method(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cipher</td>
<td><code>doFinal()</code> in encrypt or decrypt mode</td>
</tr>
<tr>
<td>Operation</td>
<td>Completion method(s)</td>
</tr>
<tr>
<td>--------------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>wrap() in wrap mode</td>
</tr>
<tr>
<td></td>
<td>unwrap() in unwrap mode</td>
</tr>
<tr>
<td>KeyAgreement</td>
<td>generateSecret() or generateSecret(String)</td>
</tr>
<tr>
<td>KeyPairGenerator</td>
<td>generateKeyPair(), genKeyPair(), or reset()</td>
</tr>
<tr>
<td>KeyStore</td>
<td>No method needed</td>
</tr>
<tr>
<td>MAC</td>
<td>doFinal() or reset()</td>
</tr>
<tr>
<td>MessageDigest</td>
<td>digest() or reset()</td>
</tr>
<tr>
<td>SecretKeyFactory</td>
<td>No method needed</td>
</tr>
<tr>
<td>SecureRandom</td>
<td>No method needed</td>
</tr>
<tr>
<td>Signature</td>
<td>sign() in sign mode</td>
</tr>
<tr>
<td></td>
<td>verify() in verify mode</td>
</tr>
</tbody>
</table>

**Resolution status:** We are improving the JCE provider to resolve this issue. Updates will be announced in the AWS CloudHSM forum and on the version history page.

**Known issues for the OpenSSL Dynamic Engine**

**Topics**
- **Issue:** You cannot install AWS CloudHSM OpenSSL Dynamic Engine on RHEL6 and CentOS6 (p. 647)
- **Issue:** Only RSA offload to the HSM is supported by default (p. 648)
- **Issue:** RSA encryption and decryption with OAEP padding using a key on the HSM is not supported (p. 648)
- **Issue:** Only private key generation of RSA and ECC keys is offloaded to the HSM (p. 648)
- **Issue:** You cannot install OpenSSL Dynamic Engine for Client SDK 3 on RHEL 8, CentOS 8, or Ubuntu 18.04 LTS (p. 648)

**Issue:** You cannot install AWS CloudHSM OpenSSL Dynamic Engine on RHEL6 and CentOS6

- **Impact:** The OpenSSL Dynamic Engine only supports OpenSSL 1.0.2[f+] (p. 392). By default, RHEL 6 and CentOS 6 ship with OpenSSL 1.0.1.
- **Workaround:** Upgrade the OpenSSL library on RHEL 6 and CentOS 6 to version 1.0.2[f+].
Issue: Only RSA offload to the HSM is supported by default

- **Impact:** To maximize performance, the SDK is not configured to offload additional functions such as random number generation or EC-DH operations.
- **Workaround:** Please contact us through a support case if you need to offload additional operations.
- **Resolution status:** We are adding support to the SDK to configure offload options through a configuration file. The update will be announced on the version history page once available.

Issue: RSA encryption and decryption with OAEP padding using a key on the HSM is not supported

- **Impact:** Any call to RSA encryption and decryption with OAEP padding fails with a divide-by-zero error. This occurs because the OpenSSL dynamic engine calls the operation locally using the fake PEM file instead of offloading the operation to the HSM.
- **Workaround:** You can perform this procedure by using either the [PKCS #11 library](p. 394) or the [JCE provider](p. 422).
- **Resolution status:** We are adding support to the SDK to correctly offload this operation. The update will be announced on the version history page once available.

Issue: Only private key generation of RSA and ECC keys is offloaded to the HSM

For any other key type, the OpenSSL AWS CloudHSM engine is not used for call processing. The local OpenSSL engine is used instead. This generates a key locally in software.

- **Impact:** Because the failover is silent, there is no indication that you have not received a key that was securely generated on the HSM. You will see an output trace that contains the string "..............++++++" if the key is locally generated by OpenSSL in software. This trace is absent when the operation is offloaded to the HSM. Because the key is not generated or stored on the HSM, it will be unavailable for future use.
- **Workaround:** Only use the OpenSSL engine for key types it supports. For all other key types, use PKCS #11 or JCE in applications, or use `key_mgmt_util` in the AWS CLI.

Issue: You cannot install OpenSSL Dynamic Engine for Client SDK 3 on RHEL 8, CentOS 8, or Ubuntu 18.04 LTS

- **Impact:** By default, RHEL 8, CentOS 8, and Ubuntu 18.04 LTS ship a version of OpenSSL that is not compatible with OpenSSL Dynamic Engine for Client SDK 3.
- **Workaround:** Use a Linux platform that provides support for OpenSSL Dynamic Engine. For more information about supported platforms, see [Supported Platforms](p. 392).
- **Resolution status:** AWS CloudHSM supports these platforms with OpenSSL Dynamic Engine for Client SDK 5. For more information, see [Supported Platforms](p. 392) and [OpenSSL Dynamic Engine](p. 418).
Known issues for Amazon EC2 instances running Amazon Linux 2

Issue: Amazon Linux 2 version 2018.07 uses an updated ncurses package (version 6) that is currently incompatible with the AWS CloudHSM SDKs

You see the following error returned upon running the AWS CloudHSM cloudhsm_mgmt_util (p. 252) or key_mgmt_util (p. 301):

```
/opt/cloudhsm/bin/cloudhsm_mgmt_util: error while loading shared libraries: libncurses.so.5: cannot open shared object file: No such file or directory
```

- **Impact:** Instances running on Amazon Linux 2 version 2018.07 will be unable to use all AWS CloudHSM utilities.
- **Workaround:** Issue the following command on your Amazon Linux 2 EC2 instances to install the supported ncurses package (version 5):

  ```
sudo yum update && yum install ncurses-compat-libs
  ```

- **Resolution status:** This issue has been resolved in the AWS CloudHSM client 1.1.2 release. You must upgrade to this client to benefit from the fix.

Known issues for integrating third-party applications

Issue: Client SDK 3 does not support Oracle setting PKCS #11 attribute CKA_MODIFIABLE during master key generation

This limit is defined in the PKCS #11 library. For more information, see annotation 1 on Supported PKCS #11 Attributes (p. 403).

- **Impact:** Oracle master key creation fails.
- **Workaround:** Set the special environment variable CLOUDHSM_IGNORE_CKA_MODIFIABLE_FALSE to TRUE when creating a new master key. This environment variable is only needed for master key generation and you do not need to use this environment variable for anything else. For example, you would use this variable for the first master key you create and then you would only use this environment variable again if you wanted to rotate your master key edition. For more information, see Generate the Oracle TDE Master Encryption Key (p. 577).
- **Resolution status:** We are improving the HSM firmware to fully support the CKA_MODIFIABLE attribute. Updates will be announced in the AWS CloudHSM forum and on the version history page.

Client SDK 3 key synchronization failures

In Client SDK 3, if client-side synchronization fails, AWS CloudHSM makes a best-effort response to clean up any unwanted keys that may have been created (and are now unwanted). This process involves removing unwanted key material immediately or marking unwanted material for later removal. In both these cases, the resolution does not require any action from you. In the rare case that AWS CloudHSM cannot remove and cannot mark unwanted key material, you must delete the key material.
**Problem:** You attempt a token key generation, import, or unwrap operation and see errors that specify a failure to **tombstone**.

```
2018-12-24T18:28:54Z liquidSecurity ERR: print_node_ts_status:
[create_object_min_nodes]Key: 264617 failed to tombstone on node:1
```

**Cause:** AWS CloudHSM was unsuccessful removing **and** marking unwanted key material.

**Resolution:** An HSM in your cluster contains unwanted key material that is not marked as unwanted. You must manually remove the key material. To manually delete unwanted key material, use key_mgmt_util (KMU) or an API from the PKCS #11 library or the JCE provider. For more information, see deleteKey (p. 312) or Client SDKs (p. 392).

To make token keys more durable, AWS CloudHSM fails key creation operations that don’t succeed on the minimum number of HSMs specified in client-side synchronization settings. For more information, see Key Synchronization in AWS CloudHSM (p. 123).

---

**Client SDK 3: Verify HSM performance with the pkpspeed tool**

This topic describes how to verify HSM performance with Client SDK 3.

To verify the performance of the HSMs in your AWS CloudHSM cluster, you can use the pkpspeed (Linux) or pkpspeed_blocking (Windows) tool that is included with Client SDK 3. The pkpspeed tool executes under ideal conditions and directly calls the HSM to execute operations without going through an SDK such as PKCS11. We recommend load testing your application independently to determine your scaling needs. We do not recommend running the following tests: Random (I), ModExp (R), and EC point mul (Y).

For more information about installing the client on a Linux EC2 instance, see Install and configure the AWS CloudHSM client (Linux) (p. 256). For more information about installing the client on a Windows instance, see Install and configure the AWS CloudHSM client (Windows) (p. 259).

After you install and configure the AWS CloudHSM client, run the following command to start it.

**Amazon Linux**

```
$ sudo start cloudhsm-client
```

**Amazon Linux 2**

```
$ sudo service cloudhsm-client start
```

**CentOS 7**

```
$ sudo service cloudhsm-client start
```

**CentOS 8**

```
$ sudo service cloudhsm-client start
```

**RHEL 7**

```
$ sudo service cloudhsm-client start
```

---
RHEL 8

```bash
$ sudo service cloudhsm-client start
```

Ubuntu 16.04 LTS

```bash
$ sudo service cloudhsm-client start
```

Ubuntu 18.04 LTS

```bash
$ sudo service cloudhsm-client start
```

Windows

- For Windows client 1.1.2+:

  ```bash
  C:\Program Files\Amazon\CloudHSM> net.exe start AWSCloudHSMClient
  ```

- For Windows clients 1.1.1 and older:

  ```bash
  C:\Program Files\Amazon\CloudHSM> start "cloudhsm_client" cloudhsm_client.exe C:\ProgramData\Amazon\CloudHSM\data\cloudhsm_client.cfg
  ```

If you have already installed the client software, you might need to download and install the latest version to get pkpspeed. You can find the pkpspeed tool at `/opt/cloudhsm/bin/pkpspeed` in Linux or `C:\Program Files\Amazon\CloudHSM\` in Windows.

To use pkpspeed, run the `pkpspeed` command or `pkpspeed_blocking.exe`, specifying the user name and password of a crypto user (CU) on the HSM. Then set the options to use while considering the following recommendations.

**Test recommendations**

- To test the performance of RSA sign and verify operations, choose the `RSA_CRT` cipher in Linux or option B in Windows. Don't choose RSA (option A in Windows). The ciphers are equivalent, but `RSA_CRT` is optimized for performance.
- Start with a small number of threads. For testing AES performance, one thread is typically enough to show maximum performance. For testing RSA performance (`RSA_CRT`), three or four threads is typically enough.

**Configurable options for the pkpspeed tool**

- **FIPS Mode**: AWS CloudHSM is always in FIPS mode (See AWS CloudHSM FAQs for details). This can be verified by using the CLI tools as documented in the AWS CloudHSM User Guide and running the `getHSMInfo` command which will indicate the FIPS mode status.
- **Test type (blocking versus non-blocking)**: This specifies how operations are performed in a threaded manner. You will most likely get better numbers using non-blocking. This is because they utilize threads and concurrency.
- **Number of threads**: Number of threads to run the test with.
- **Time in seconds to run the test (max = 600)**: pkpspeed produces results measured in "OPERATIONS/second" and reports this value for each second that the test is run. For example, if the test is run for 5 seconds the output may look like the following sample values:
Tests that can be ran with the pkpspeed tool

- **AES GCM**: Tests AES GCM mode encryption.
- **Basic 3DES CBC**: Tests 3DES CBC mode encryption. See note 1 below for an upcoming change.
- **Basic AES**: Tests AES CBC/ECB encryption.
- **Digest**: Tests hash digest.
- **ECDSA Sign**: Tests ECDSA sign.
- **ECDSA Verify**: Tests ECDSA verify.
- **FIPS Random**: Tests generation of a FIPS-compliant random number (Note: this can only be used in blocking mode).
- **HMAC**: Tests HMAC.
- **Random**: This test is not relevant because we are using FIPS 140-2 HSM’s.
- **RSA non-CRT versus RSA_CRT**: Tests RSA sign and verify operations.
- **RSA OAEP Enc**: Tests RSA OAEP encryption.
- **RSA OAEP Dec**: Tests RSA OAEP decryption.
- **RSA private dec non-CRT**: Tests RSA Private key encryption (non-optimized).
- **RSA private key dec CRT**: Tests RSA Private key encryption (optimized).
- **RSA PSS Sign**: Tests RSA PSS sign.
- **RSA PSS Verify**: Tests RSA PSS verify.
- **RSA public key enc**: Tests RSA Public key encryption.

RSA public key encryption, RSA private decryption non-CRT, and RSA private key decryption CRT will also prompt the user to answer the following:

Do you want to use static key [y/n]

If y is entered, a pre-computed key is imported into the HSM.

If n is entered, a new key is generated.


Examples

The following examples show the options that you can choose with pkpspeed (Linux) or pkpspeed_blocking (Windows) to test the HSM’s performance for RSA and AES operations.

**Example – Using pkpspeed to test RSA performance**

You can run this example on Windows, Linux, and compatible operating systems.
Linux

Use these instructions for Linux and compatible operating systems.

/opt/cloudhsm/bin/pkpspeed -s *CU user name* -p *password*

SDK Version: 2.03

Available Ciphers:
- AES_128
- AES_256
- 3DES
- RSA (non-CRT. modulus size can be 2048/3072)
- RSA_CRT (same as RSA)

For RSA, Exponent will be 65537

Current FIPS mode is: 00002
Enter the number of thread [1-10]: 3
Enter the cipher: RSA_CRT
Enter modulus length: 2048
Enter time duration in Secs: 60
Starting non-blocking speed test using data length of 245 bytes...
[Test duration is 60 seconds]

Do you want to use static key[y/n] (Make sure that KEK is available)? n

Windows

c:\Program Files\Amazon\CloudHSM>pkpspeed_blocking.exe -s *CU user name* -p *password*

Please select the test you want to run

- RSA non-CRT------------------->A
- RSA CRT----------------------->B
- Basic 3DES CBC---------------->C
- Basic AES-------------------->D
- FIPS Random------------------>H
- Random------------------------>I
- AES GCM---------------------->K
- eXit------------------------>X

B

Running 4 threads for 25 sec

Enter mod size(2048/3072):2048
Do you want to use Token key[y/n]?n
Do you want to use static key[y/n] (Make sure that KEK is available)? n

OPERATIONS/second 821/1
OPERATIONS/second 833/1
OPERATIONS/second 845/1
OPERATIONS/second 835/1
OPERATIONS/second 837/1
OPERATIONS/second 836/1
OPERATIONS/second 837/1
OPERATIONS/second 849/1
OPERATIONS/second 841/1
OPERATIONS/second 856/1
OPERATIONS/second 841/1
OPERATIONS/second 847/1
OPERATIONS/second 838/1
OPERATIONS/second 843/1
OPERATIONS/second 852/1
OPERATIONS/second 837/
Example – Using pkpspeed to test AES performance

Linux

Use these instructions for Linux and compatible operating systems.

```
/opt/cloudhsm/bin/pkpspeed -s <CU user name> -p <password>
```

SDK Version: 2.03

Available Ciphers:
- AES_128
- AES_256
- 3DES
- RSA (non-CRT. modulus size can be 2048/3072)
- RSA_CRT (same as RSA)

For RSA, Exponent will be 65537

Current FIPS mode is: 00000002
Enter the number of thread [1-10]: 1
Enter the cipher: AES_256
Enter the data size [1-16200]: 8192
Enter time duration in Secs: 60
Starting non-blocking speed test using data length of 8192 bytes...

Windows

```
c:\Program Files\Amazon\CloudHSM>pkpspeed_blocking.exe -s CU user name -p password
login as USER
Initializing CfM2 library
SDK Version: 2.03

Current FIPS mode is: 00000002
Please enter the number of threads [MAX=400] : 1
Please enter the time in seconds to run the test [MAX=600]: 20

Please select the test you want to run

RSA non-CRT------------------------->A
RSA CRT------------------------------>B
Basic 3DES CBC----------------------->C
Basic AES---------------------------=>D
FIPS Random------------------------->H
Random-----------------------------=>I
AES GCM ----------------------------->K

eXit--------------------------------->X
D

Running 1 threads for 20 sec

Enter the key size(128/192/256):256
Enter the size of the packet in bytes[1-16200]:8192
OPERATIONS/second 9/1
OPERATIONS/second 10/1
OPERATIONS/second 11/1
OPERATIONS/second 10/1
OPERATIONS/second 10/1
OPERATIONS/second 10/1
...
Client SDK 5 user contains inconsistent values

The `user list` command returns a list of all users, and user properties, in your cluster. If any of a user's properties have the value "inconsistent", this user is not synchronized across your cluster. This means that the user exists with different properties on different HSMs in the cluster. Based on which property is inconsistent, different repair steps can be taken.

The following table includes steps to resolve inconsistencies for a single user. If a single user has multiple inconsistencies, resolve them by following these steps from top to bottom. If there are multiple users with inconsistencies, work through this list for each user, fully resolving the inconsistencies for that user before moving on the next.

**Note**

To perform these steps you should ideally be logged in as an admin. If your admin account is not consistent, go through these steps logging in with the admin and repeating the steps until all properties are consistent. After your admin account is consistent, you can proceed to use that admin to synchronize other users in the cluster.

<table>
<thead>
<tr>
<th>Inconsistent property</th>
<th>Example output of user list</th>
<th>Implication</th>
<th>Recovery method</th>
</tr>
</thead>
</table>
| User "role" is "inconsistent" | `{ "username": "test_user", "role": "inconsistent", "locked": "false", "mfa": [], "cluster-coverage": "full" }` | This user is a CryptoUser on some HSMs, and an Admin on other HSMs. This can happen if two SDKs attempt to create the same user, at the same time, with different roles. You must remove this user, and re-create it with the desired role. | 1. Login as an admin.  
2. Delete the user on all HSMs: `user delete --username <user's name> --role admin`  
3. Create the user with the desired role: `user create --username <user's name> --role <desired role>` |
| User "cluster-coverage" is "inconsistent" | `{ "username": "test_user", "role": "crypto-user", "locked": "false", "mfa": [], "cluster-coverage": "inconsistent" }` | This user exists on a subset of HSMs in the cluster. This can happen if a `user create` partially succeeded, or if a `user delete` partially succeeded. You must finish your previous operation, either creating or removing this user from your cluster. | If the user should not exist, follow these steps:  
1. Login as an admin.  
2. Run this command: `user delete --username <user's name> --role admin`  
3. Now, run the following command: `user delete --username <user's name>` |
### AWS CloudHSM User Guide

**Client SDK 5 user contains inconsistent values**

<table>
<thead>
<tr>
<th>Inconsistent property</th>
<th>Example output of user list</th>
<th>Implication</th>
<th>Recovery method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>name&gt; --role crypto-user</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>If the user should exist, follow these steps:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1. Login as an admin.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. Run the following command:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>user create --username &lt;user's name&gt; --role &lt;desired role&gt;</td>
</tr>
<tr>
<td>Inconsistent property</td>
<td>Example output of user list</td>
<td>Implication</td>
<td>Recovery method</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>User &quot;locked&quot; parameter is &quot;inconsistent&quot; or &quot;true&quot;</td>
<td>{ &quot;username&quot;: &quot;test_user&quot;, &quot;role&quot;: &quot;crypto-user&quot;, &quot;locked&quot;: inconsistent, &quot;mfa&quot;: [], &quot;cluster-coverage&quot;: &quot;full&quot; }</td>
<td>This user is locked out on a subset of HSMs. This can happen if a user uses the wrong password and only connects to a subset of HSMs in the cluster. You must change the user's credentials to be consistent across the cluster.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>If the user has MFA activated, follow these steps:</td>
<td>1. Login as an admin. 2. Run the following command to temporarily deactivate MFA: user change-mfa token-sign -- username &lt;user's name&gt; --role &lt;desired role&gt; --disable 3. Change the user's password so they can log into all HSMs: user change-password -- username &lt;user's name&gt; --role &lt;desired role&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If MFA should be active for the user, follow these steps:</td>
<td>1. Have the user log in and re-enable MFA (this will require them to sign tokens and provide their public key in a PEM file): user change-mfa token-sign -- username &lt;user's name&gt; --role &lt;desired role&gt; -- token &lt;File&gt;</td>
</tr>
</tbody>
</table>
Error seen during key availability check

Problem: An HSM is returning the following error:

```
658
```

MFA status is "inconsistent"

Inconsistent property | Example output of user list | Implication | Recovery method |
-----------------------|-----------------------------|-------------|-----------------|
MFA status is "inconsistent" | `{ "username": "test_user", "role": "crypto-user", "locked": "false", "mfa": [ { "strategy": "token-sign", "status": "inconsistent" } ], "cluster-coverage": "full" }` | This user has different MFA flags on different HSMs in the cluster. This can happen if an MFA operation only completed on a subset of HSMs.
You must reset the user's password, and allow them to re-enable MFA. | If the user has MFA activated, follow these steps:
1. Login as an admin.
2. Run the following command to temporarily deactivate MFA:
   ```bash
   user change-mfa token-sign --username <user's name> --role <desired role> --disable
   ```
3. You will also need to then change the user's password so they can log into all HSMs:
   ```bash
   user change-password --username <user's name> --role <desired role>
   ```

If MFA should be active for the user, follow these steps:
1. Have the user log in and re-enable MFA (this will require them to sign tokens and provide their public key in a PEM file):
   ```bash
   user change-mfa token-sign --username <user's name> --role <desired role> --token <File>
   ```
Key `<KEY_HANDLE>` does not meet the availability requirements - The key must be available on at least 2 HSMs before being used.

**Cause:** Key availability checks look for keys that, under rare but possible conditions, could be lost. This error usually occurs in clusters with only one HSM or in clusters with two HSMs during a period in which one of them is being replaced. In these situations, the following customer operations likely prompted the above error:

- A new key was generated using a command like `genRSAKeyPair (p. 336).`
- A `findKey (p. 323)` operation was started.
- A new client was started.

**Note**
OpenSSL frequently starts new clients.

**Resolution/recommendation:** Choose from the following actions to prevent this error from occurring:

- Use the `--disable-key-availability-check` parameter to set key availability to false in the configure file of your `configure tool (p. 159).` For more information, see the `Parameters (p. 174)` section of the Configure tool.
- If using a cluster with two HSMs, avoid using the operations that prompted the error, except during initialization code.
- Increase the amount of HSMs in your cluster to at least three.

---

**Extracting keys using JCE**

**getEncoded, getPrivateExponent, or getS returns null**

`getEncoded, getPrivateExponent, and getS will return null because they are by default disabled. To enable them, refer to `Key extraction using JCE (p. 442).`

If `getEncoded, getPrivateExponent, and getS return null after being enabled, your key does not meet the right prerequisites. For more information, refer to `Key extraction using JCE (p. 442).`

**getEncoded, getPrivateExponent, or getS return key bytes outside of the HSM**

You or someone with access to your system has enabled clear key extraction. See the following pages for more information, including how to reset this configuration to the default disabled state.

- `Key extraction using JCE (p. 442)`
- `Protecting and extracting keys from an HSM (p. 36)`

---

**HSM Throttling**

When your workload exceeds your cluster's HSM capacity, you will receive error messages stating HSMs are busy or throttled. When this happens, you may see reduced throughput or an increased rate of rejection requests from HSMs. Additionally, HSMs may send the following busy errors.
For Client SDK 5

- In PKCS11, busy errors map to CKR_FUNCTION_FAILED. This error can happen for multiple reasons, but if HSM throttling causes this error the following log lines will appear in your log:
  - [cloudhsm_provider::hsm1::hsm_connection::e2e_encryption::error] Failed to prepare E2E response. Error: Received error response code from Server. Response Code: 187
  - [cloudhsm_pkcs11::decryption::aes_gcm] Received error from the server. Error: This operation is already in progress. Internal error code: 0x000000BB
- In JCE, busy errors map to com.amazonaws.cloudhsm.jce.jni.exception.InternalException: Unexpected error with the Provider: The HSM could not queue the request for processing.
- Other SDKs' busy errors print out the following message: Received error response code from Server. Response Code: 187.

For Client SDK 3

- In PKCS11, busy errors map to CKR_OPERATION_ACTIVE errors.
- In JCE, busy errors map to CFM2Exception with status of 0xBB (187). Applications can use getStatus() function on CFM2Exception to check what status is returned by the HSM.
- Other SDKs' busy errors will print out the following message: HSM Error: HSM is already busy generating the keys(or random bytes) for another request.

Resolution

You can resolve these issues by completing one or more of the following actions:

- Add retry commands for rejected HSM operations in your application layer. Before enabling retry commands, ensure your cluster is adequately sized to meet peak loads.

  **Note**
  For Client SDK 5.8.0 and above, retry commands are turned on by default. For details on each SDK's retry command configuration, refer to [Advanced configurations for the Client SDK 5 configure tool](p. 176).

- Add more HSMs to your cluster by following the instructions in [Adding or removing HSMs in an AWS CloudHSM cluster](p. 44).

  **Important**
  We recommend load testing your cluster to determine the peak load you should anticipate, and then add one more HSM to it to ensure high availability.

Keep HSM users in sync across HSMs in the cluster

To manage your HSM's users (p. 60), you use a AWS CloudHSM command line tool known as cloudhsm_mgmnt_util. It communicates only with the HSMs that are in the tool's configuration file. It's not aware of other HSMs in the cluster that are not in the configuration file.

AWS CloudHSM synchronizes the keys on your HSMs across all other HSMs in the cluster, but it doesn't synchronize the HSM's users or policies. When you use cloudhsm_mgmnt_util to manage HSM
Lost connection to the cluster

When you configured the AWS CloudHSM client (p. 258), you provided the IP address of the first HSM in your cluster. This IP address is saved in the configuration file for the AWS CloudHSM client. When the client starts, it tries to connect to this IP address. If it can't—for example, because the HSM failed or you deleted it—you might see errors like the following:

```
LIQUIDSECURITY: Daemon socket connection error

LIQUIDSECURITY: Invalid Operation
```

To resolve these errors, update the configuration file with the IP address of an active, reachable HSM in the cluster.

To update the configuration file for the AWS CloudHSM client

1. Use one of the following ways to find the IP address of an active HSM in your cluster.
   - View the **HSMs** tab on the cluster details page in the AWS CloudHSM console.
   - Use the AWS Command Line Interface (AWS CLI) to issue the `describe-clusters` command.

   You need this IP address in a subsequent step.

2. Use the following command to stop the client.

   Amazon Linux

   ```
   $ sudo stop cloudhsm-client
   
   Amazon Linux 2
   
   $ sudo service cloudhsm-client stop
   
   CentOS 7
   
   $ sudo service cloudhsm-client stop
   
   CentOS 8
   
   $ sudo service cloudhsm-client stop
   
   RHEL 7
   
   $ sudo service cloudhsm-client stop
   ```
RHEL 8

$ sudo service cloudhsm-client stop

Ubuntu 16.04 LTS

$ sudo service cloudhsm-client stop

Ubuntu 18.04 LTS

$ sudo service cloudhsm-client stop

Windows

- For Windows client 1.1.2+:

  C:\Program Files\Amazon\CloudHSM> net.exe stop AWSCloudHSMClient

- For Windows clients 1.1.1 and older:

  Use Ctrl+C in the command window where you started the AWS CloudHSM client.

3. Use the following command to update the client's configuration file, providing the IP address that you found in a previous step.

$ sudo /opt/cloudhsm/bin/configure -a <IP address>

4. Use the following command to start the client.

Amazon Linux

$ sudo start cloudhsm-client

Amazon Linux 2

$ sudo service cloudhsm-client start

CentOS 7

$ sudo service cloudhsm-client start

CentOS 8

$ sudo service cloudhsm-client start

RHEL 7

$ sudo service cloudhsm-client start

RHEL 8

$ sudo service cloudhsm-client start
Missing AWS CloudHSM audit logs in CloudWatch

If you created a cluster before January 20th, 2018, you will need to manually configure a service-linked role (p. 630) in order to enable the delivery of that cluster's audit logs. For instructions on how to enable a service-linked role on an HSM cluster, see Understanding Service-Linked Roles (p. 630), as well as Creating a Service-Linked Role in the IAM User Guide.

Custom IVs with non-compliant length for AES key wrap

This troubleshooting topic helps you determine if your application generates irrecoverable wrapped keys. If you are impacted by this issue, use this topic to address the problem.

Topics

- Determine whether your code generates irrecoverable wrapped keys (p. 663)
- Actions you must take if your code generates irrecoverable wrapped keys (p. 664)

Determine whether your code generates irrecoverable wrapped keys

You are impacted only if you meet all the conditions below:

<table>
<thead>
<tr>
<th>Condition</th>
<th>How do I know?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Your application uses PKCS #11 library</td>
<td>The PKCS #11 library is installed as the libpkcs11.so file in your /opt/cloudhsm/</td>
</tr>
</tbody>
</table>
### AWS CloudHSM User Guide

**Actions you must take if your code generates irrecoverable wrapped keys**

<table>
<thead>
<tr>
<th>Condition</th>
<th>How do I know?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>lib folder. Applications written in the C language generally use the PKCS #11 library directly, while application written in Java may be using the library indirectly via a Java abstraction layer. If you're using Windows, you are NOT affected, as PKCS #11 library is not presently available for Windows.</strong></td>
<td></td>
</tr>
<tr>
<td>Your application specifically uses version 3.0.0 of the PKCS #11 library</td>
<td>If you received an email from the AWS CloudHSM team, you are likely using version 3.0.0 of the PKCS #11 library. To check the software version on your application instances, use this command: `rpm -qa</td>
</tr>
<tr>
<td>You wrap keys using AES key wrapping</td>
<td>AES key wrapping means you use an AES key to wrap out some other key. The corresponding mechanism name is CKM_AES_KEY_WRAP. It is used with the function C_WrapKey. Other AES based wrapping mechanisms that use initialization vectors (IVs), such as CKM_AES_GCM and CKM_CLOUDHSM_AES_GCM, are not affected by this issue. Learn more about functions and mechanisms (p. 397).</td>
</tr>
</tbody>
</table>
| You specify a custom IV when calling AES key wrapping, and the length of this IV is shorter than 8 | AES key wrap is generally initialized using a CK_MECHANISM structure as follows: 

```c
CK_MECHANISM mech = {CKM_AES_KEY_WRAP, IV_POINTER, IV_LENGTH};
```

This issue applies to you only if:

- `IV_POINTER` is not NULL
- `IV_LENGTH` is less than 8 bytes |

If you do not meet all the conditions above, you may stop reading now. Your wrapped keys can be unwrapped properly, and this issue does not impact you. Otherwise, see the section called “Actions you must take if your code generates irrecoverable wrapped keys” (p. 664).

### Actions you must take if your code generates irrecoverable wrapped keys

You should take the following three steps:

1. **Immediately upgrade your PKCS #11 library to a newer version**
   - Latest PKCS #11 library for Amazon Linux, CentOS 6 and RHEL 6 (p. 458)
   - Latest PKCS #11 library for Amazon Linux 2, CentOS 7 and RHEL 7 (p. 458)
   - Latest PKCS #11 library for Ubuntu 16.04 LTS (p. 458)

2. **Update your software to use a standards-compliant IV**
We strongly recommend you follow our sample code and simply specify a NULL IV, which causes the HSM to utilize the standards-compliant default IV. Alternatively, you may explicitly specify the IV as 0xA6A6A6A6A6A6A6A6 with a corresponding IV length of 8. We do not recommend using any other IV for AES key wrapping, and will explicitly disable custom IVs for AES key wrapping in a future version of the PKCS #11 library.

Sample code for properly specifying the IV appears in `aes_wrapping.c` on GitHub.

3. **Identify and recover existing wrapped keys**

You should identify any keys you wrapped using version 3.0.0 of the PKCS #11 library, and then contact support for assistance ([https://aws.amazon.com/support](https://aws.amazon.com/support)) in recovering these keys.

**Important**

This issue only impacts keys wrapped with version 3.0.0 of the PKCS #11 library. You can wrap keys using earlier versions (2.0.4 and lower-numbered packages) or later versions (3.0.1 and higher-numbered packages) of the PKCS #11 library.

### Resolving cluster creation failures

When you create a cluster, AWS CloudHSM creates the AWSServiceRoleForCloudHSM service-linked role, if the role does not already exist. If AWS CloudHSM cannot create the service-linked role, your attempt to create a cluster might fail.

This topic explains how to resolve the most common problems so you can create a cluster successfully. You need to create this role only one time. Once the service-linked role is created in your account, you can use any of the supported methods to create additional clusters and to manage them.

The following sections offer suggestions to troubleshoot cluster creation failures that are related to the service-linked role. If you try them but are still unable to create a cluster, contact [AWS Support](https://aws.amazon.com/support). For more information about the AWSServiceRoleForCloudHSM service-linked role, see [Service-linked roles for AWS CloudHSM](p. 630).

**Topics**

- Add the missing permission (p. 665)
- Create the service-linked role manually (p. 666)
- Use a nonfederated user (p. 666)

### Add the missing permission

To create a service-linked role, the user must have the `iam:CreateServiceLinkedRole` permission. If the IAM user who is creating the cluster does not have this permission, the cluster creation process fails when it tries to create the service-linked role in your AWS account.

When a missing permission causes the failure, the error message includes the following text.

```
This operation requires that the caller have permission to call iam:CreateServiceLinkedRole to create the CloudHSM Service Linked Role.
```

To resolve this error, give the IAM user who is creating the cluster the `AdministratorAccess` permission or add the `iam:CreateServiceLinkedRole` permission to the user's IAM policy. For instructions, see [Adding Permissions to a New or Existing User](https://aws.amazon.com).
Then try to **create the cluster (p. 9)** again.

## Create the service-linked role manually

You can use the IAM console, CLI, or API to create the AWSServiceRoleForCloudHSM service-linked role. For more information, see [Creating a Service-Linked Role](#) in the **IAM User Guide**.

## Use a nonfederated user

Federated users, whose credentials originate outside of AWS, can perform many of the tasks of a nonfederated user. However, AWS does not allow users to make the API calls to create a service-linked role from a federated endpoint.

To resolve this problem, **create a non-federated user (p. 7)** with the iam:CreateServiceLinkedRole permission, or give an existing non-federated user the iam:CreateServiceLinkedRole permission. Then have that user **create a cluster (p. 9)** from the AWS CLI. This creates the service-linked role in your account.

Once the service-linked role is created, if you prefer, you can delete the cluster that the nonfederated user created. Deleting the cluster does not affect the role. Thereafter, any user with the required permissions, included federated users, can create AWS CloudHSM clusters in your account.

To verify that the role was created, open the IAM console at [https://console.aws.amazon.com/iam/](https://console.aws.amazon.com/iam/) and choose **Roles**. Or use the IAM **get-role** command in the AWS CLI:

```bash
$ aws iam get-role --role-name AWSServiceRoleForCloudHSM
{
  "Role": {
    "Description": "Role for CloudHSM service operations",
    "AssumeRolePolicyDocument": {
      "Version": "2012-10-17",
      "Statement": [
        {
          "Action": "sts:AssumeRole",
          "Effect": "Allow",
          "Principal": {
            "Service": "cloudhsm.amazonaws.com"
          }
        }
      ]
    },
    "RoleId": "AROAJ4IGWNSQVG65G7CBY",
    "CreateDate": "2017-12-19T20:53:12Z",
    "RoleName": "AWSServiceRoleForCloudHSM",
    "Path": "/aws-service-role/cloudhsm.amazonaws.com/",
    "Arn": "arn:aws:iam::111122223333:role/aws-service-role/cloudhsm.amazonaws.com/AWSServiceRoleForCloudHSM"
  }
}
```

## Retrieving client configuration logs

AWS CloudHSM offers tools for Client SDK 3 and Client SDK 5 to gather information about your environment for AWS Support to troubleshoot problems.

**Topics**
Client SDK 5 support tool

The script extracts the following information:

- The configuration file for the Client SDK 5 component
- Available log files
- Current version of the operating system
- Package information

Running the info tool for Client SDK 5

Client SDK 5 includes a client support tool for each component, but all tools function the same. Run the tool to create an output file with all the gathered information.

The tools use a syntax like this:

```
[pkcs11 | dyn | jce]_info
```

For example, to gather information for support from a Linux host running PKCS #11 library and have the system write to the default directory, you would run this command:

```
/opt/cloudhsm/bin/pkcs11_info
```

The tool creates the output file inside the `/tmp` directory.

PKCS #11 library

To gather support data for PKCS #11 library on Linux

- Use the support tool to gather data.

```
/opt/cloudhsm/bin/pkcs11_info
```

To gather support data for PKCS #11 library on Windows

- Use the support tool to gather data.

```
C:\Program Files\Amazon\CloudHSM\bin\pkcs11_info.exe
```

OpenSSL Dynamic Engine

To gather support data for OpenSSL Dynamic Engine on Linux

- Use the support tool to gather data.

```
/opt/cloudhsm/bin/dyn_info
```
JCE provider

To gather support data for JCE provider on Linux

- Use the support tool to gather data.

  /opt/cloudhsm/bin/jce_info

To gather support data for JCE provider on Windows

- Use the support tool to gather data.

  C:\Program Files\Amazon\CloudHSM\bin\jce_info.exe

Retrieving logs from a serverless environment

To configure for serverless environments, like Fargate or Lambda, we recommend you configure your AWS CloudHSM log type to term. Once configured to term, the serverless environment will be able to output to CloudWatch.

To get the client logs from CloudWatch, see Working with log groups and log streams in the Amazon CloudWatch Logs User Guide.

Client SDK 3 support tool

The script extracts the following information:

- Operating system and its current version
- Client configuration information from cloudhsm_client.cfg, cloudhsm_mgmt_util.cfg, and application.cfg files
- Client logs from the location specific to the platform
- Cluster and HSM information by using cloudhsm_mgmt_util
- OpenSSL information
- Current client and build version
- Installer version

Running the info tool for Client SDK 3

The script creates an output file with all the gathered information. The script creates the output file inside the /tmp directory.

Linux: /opt/cloudhsm/bin/client_info

Windows: C:\Program Files\Amazon\CloudHSM\client_info

Warning

This script has a known issue for Client SDK 3 versions 3.1.0 through 3.3.1. We strongly recommend you upgrade to version 3.3.2 which includes a fix for this issue. Please refer to the Known Issues page for more information before using this tool.
AWS CloudHSM quotas

Quotas, formerly known as limits, are the assigned values for AWS resources. The following quotas apply to your AWS CloudHSM resources per AWS Region and AWS account. The default quota is the initial value applied by AWS, and these values are listed in the table below. An adjustable quota can be increased above the default quota.

### Service quotas

<table>
<thead>
<tr>
<th>Resource</th>
<th>Default Quota</th>
<th>Adjustable?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clusters</td>
<td>4</td>
<td>Yes</td>
</tr>
<tr>
<td>HSMs</td>
<td>6</td>
<td>Yes</td>
</tr>
<tr>
<td>HSMs per cluster</td>
<td>28</td>
<td>No</td>
</tr>
</tbody>
</table>

The recommended way of requesting a quota increase is to open the Service Quotas console. In the console, choose your service and quota, and submit your request. For more information, see the Service Quotas documentation.

The quotas in the following System Quotas table are not adjustable.

### System quotas

<table>
<thead>
<tr>
<th>Resource</th>
<th>Quota</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum keys per cluster</td>
<td>3,300</td>
</tr>
<tr>
<td>Maximum users per cluster</td>
<td>1,024</td>
</tr>
<tr>
<td>Maximum length of a user name</td>
<td>31 characters</td>
</tr>
<tr>
<td>Required password length</td>
<td>7 to 32 characters</td>
</tr>
<tr>
<td>Maximum number of concurrent client connections per cluster</td>
<td>900</td>
</tr>
<tr>
<td>Maximum number of PKCS#11 sessions per application</td>
<td>1,024</td>
</tr>
</tbody>
</table>

[1] A client connection for Client SDK 3 is a client daemon. For Client SDK 5, a client connection is an application.

For more information, see System resources (p. 669).

---

System resources

System resource quotas are quotas on what the AWS CloudHSM client is allowed to use when it runs.

File descriptors are an operating system's mechanism to identify and manage open files on a per-process basis.
The CloudHSM client daemon utilizes file descriptors to manage connections between applications and the client, as well as between the client and the server.

By default, the CloudHSM client configuration will allocate 3000 file descriptors. This default value is designed to yield an optimal session and threading capacity between the client daemon and your HSMs.

In rare circumstances, if you are running your client in a restricted-resource environment, it may become necessary to alter these default values.

**Note**
By changing these values, your CloudHSM client performance may suffer and/or your application may become inoperable.

1. Edit the `/etc/security/limits.d/cloudhsm.conf` file.

   ```
   #
   # DO NOT EDIT THIS FILE
   #
   hsmuser soft nofile 3000
   hsmuser hard nofile 3000
   ```

2. Edit the numeric values, as needed.

   **Note**
   The soft quota must be less than or equal to the hard quota.

3. Restart your CloudHSM client daemon process.

   **Note**
   This configuration option is not available on Microsoft Windows platforms.
AWS CloudHSM User Guide
Downloads

Downloads for AWS CloudHSM

Client SDK

Downloads

In March 2021, AWS CloudHSM released Client SDK version 5.0.0, which introduces an all-new Client SDK with different requirements, capabilities, and platform support. You now have two versions of the Client SDK to choose from, Client SDK 5 and Client SDK 3. For more information, see the section called "Previous Client SDK versions" (p. 454).

Latest releases

This section includes the latest version of each Client SDK.

Client SDK 5 is fully supported for production environments, but it does not offer every component or the same level of support for cryptographic operations as Client SDK 3. For more information, see the section called "Client SDK component comparison" (p. 456).

Versions

- Latest Client SDK 5 release: Version 5.10.0 (p. 671)
- Latest Client SDK 3 release: Version 3.4.4 (p. 674)

Latest Client SDK 5 release: Version 5.10.0

Amazon Linux

Download version 5.10.0 software for Amazon Linux on x86_64 architecture:

- PKCS #11 library (SHA256 checksum d63ad5e96c9b2d6f89bd9f2d0b0398993050b1356bd93a36aa5acab)
- OpenSSL Dynamic Engine (SHA256 checksum 4daa5e31f5b7f791c8f3759c41a38867f5e521f15927ae3a837b4c5)
- JCE provider (SHA256 checksum 61e3a94d3080f1c609d9da8bc1480811b0e6f4c4edf6f211b377da9b477)
- Javadoc for AWS CloudHSM (SHA256 checksum dcb870c6bd58c770ba7a2b616c61035e5e8d3bda0b851ce89c9820c09a987f0)
- CloudHSM CLI (SHA256 checksum c12617fcd7990ba53e96f477979b410e3a5f17842ca7a912861b8b20809b5b5)

Amazon Linux 2

Download version 5.10.0 software for Amazon Linux 2 on x86_64 architecture:

- PKCS #11 library (SHA256 checksum fc47e05e57a9b6f4433f7b46c9477a70df5c442a8ad9c2969bce5f3e328a4933)
- OpenSSL Dynamic Engine (SHA256 checksum 0aca262df6780995c9b884fcb8765bbd6acaf21b2286ec4d05a9a90ed35d4cb)
AWS CloudHSM User Guide
Latest Client SDK 5 release: Version 5.10.0

• **JCE provider** (SHA256 checksum b5be7f73c4bcff5da6f89f324e6b3db5b091610464c8bd38dbddff0484b2c)
  • **Javadocs for AWS CloudHSM** (SHA256 checksum dcbb70c6bd58c6770ba7a2b1616c103a5efb3deab831ce89f82cc09a9870f)
  • **CloudHSM CLI** (SHA256 checksum e8c09fe66890b88a61e95dca34874a445093300359d5d6a86b5a546803920bb)

Download version 5.10.0 software for Amazon Linux 2 on ARM64 architecture:

• **PKCS #11 library** (SHA256 checksum 5d8dfd835f1ed5a7f5a4f5f7f7b46c94777a70df5c442a8ad9c2969bcf38e328e4933)
• **OpenSSL Dynamic Engine** (SHA256 checksum 0aca2b2df6780995c9b884fcb8765bb64ca4a2f1b2286ec4d05a9a90edeb3d4cb)
• **JCE provider** (SHA256 checksum b5be7f73c4bcff5da6f89f324e6b3db5b091610464c8bd38dbddff0484b2c)
• **Javadocs for AWS CloudHSM** (SHA256 checksum dcbb70c6bd58c6770ba7a2b1616c103a5efb3deab831ce89f82cc09a9870f)
• **CloudHSM CLI** (SHA256 checksum e8c09fe66890b88a61e95dca34874a445093300359d5d6a86b5a546803920bb)

CentOS 7

Download version 5.10.0 software for CentOS 7 on x86_64 architecture:

• **PKCS #11 library** (SHA256 checksum fc47e705e57a0bf4d433f7b46c94777a70df5c442a8ad9c2969bcf38e328e4933)
• **OpenSSL Dynamic Engine** (SHA256 checksum 0aca2b2df6780995c9b884fcb8765bb64ca4a2f1b2286ec4d05a9a90edeb3d4cb)
• **JCE provider** (SHA256 checksum b5be7f73c4bcff5da6f89f324e6b3db5b091610464c8bd38dbddff0484b2c)
• **Javadocs for AWS CloudHSM** (SHA256 checksum dcbb70c6bd58c6770ba7a2b1616c103a5efb3deab831ce89f82cc09a9870f)
• **CloudHSM CLI** (SHA256 checksum e8c09fe66890b88a61e95dca34874a445093300359d5d6a86b5a546803920bb)

RHEL 7

Download version 5.10.0 software for RHEL 7 on x86_64 architecture:

• **PKCS #11 library** (SHA256 checksum fc47e705e57a0bf4d433f7b46c94777a70df5c442a8ad9c2969bcf38e328e4933)
• **OpenSSL Dynamic Engine** (SHA256 checksum 0aca2b2df6780995c9b884fcb8765bb64ca4a2f1b2286ec4d05a9a90edeb3d4cb)
• **JCE provider** (SHA256 checksum b5be7f73c4bcff5da6f89f324e6b3db5b091610464c8bd38dbddff0484b2c)
• **Javadocs for AWS CloudHSM** (SHA256 checksum dcbb70c6bd58c6770ba7a2b1616c103a5efb3deab831ce89f82cc09a9870f)
• **CloudHSM CLI** (SHA256 checksum e8c09fe66890b88a61e95dca34874a445093300359d5d6a86b5a546803920bb)

RHEL 8

Download version 5.10.0 software for RHEL 8 on x86_64 architecture:

• **PKCS #11 library** (SHA256 checksum e96f3b7042a148ddc7a60ab235b49e176d0460d1c2957bd76ca3d8406ac1cb03)
• **OpenSSL Dynamic Engine** (SHA256 checksum 2caad2b2f0afe87f5c9ad22d0977e8f3ce0f7f80a7be19020e6a107eadf6e)
• **JCE provider** (SHA256 checksum 3543551f08f8fe390821ea2d4ea14bb4e86e2334cb94d70ef6f3831457c7d1)
• **Javadocs for AWS CloudHSM** (SHA256 checksum dcb870c6bd58c6770ba7a2b1616c103a5efb3deab831ce89f82cc09a9870f)
• **CloudHSM CLI** (SHA256 checksum 812ecaaacafc490f13bcd0ba85e5f8f3ad4d44ad7e0a237de476dd24509525)
Ubuntu 18.04 LTS

Download version 5.10.0 software for Ubuntu 18.04 LTS on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum be4c61766b8b46e1f6c14c3dcf90aab9f38204fc9c68b4009704276c56f4a)
- **OpenSSL Dynamic Engine** (SHA256 checksum 64db8af427b6d5c37b86ea8ad28858bc4e6a0ffdd7416fa0945f427eddcf5f02858)
- **JCE provider** (SHA256 checksum 9fbdf08e93641468588b608173f26f18781bcb029ed95b2e086da29a968cc00)
- **Javadocs for AWS CloudHSM** (SHA256 checksum dcb870c6bd58c6770b7a7a2b616c6103a5efb3bdeeab831ce8f9c82cc09a9870f)
- **CloudHSM CLI** (SHA256 checksum 13808bbddd7eedd2b8486d23a9976c7fa8d9220149a6b9400626bc9ff3b513)

**Note**
Due to the recent end of life for Ubuntu 18.04 LTS, we will no longer be able to support this platform with the next release.

Ubuntu 20.04 LTS

Download version 5.10.0 software for Ubuntu 20.04 LTS on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum 99ae96504580ff85ed495a8582903a847f666bdaafafbe887a5a76db5f824500)
- **OpenSSL Dynamic Engine** (SHA256 checksum 13e5f6e08af9617b163f6e939f1f973da583f3b9322d163c396aa29f3c611d)
- **JCE provider** (SHA256 checksum 44562cebd9a1aa965840cd9bcb237e518d24c7153c38bca1405c9c1871835e2)
- **Javadocs for AWS CloudHSM** (SHA256 checksum dcbb870c6bd58c6770b7a7a2b616c6103a5efb3bdeeab831ce8f9c82cc09a9870f)
- **CloudHSM CLI** (SHA256 checksum ab71b4ec531c5e6d05c91539c7edc1d07e6c748052ebf6200f14b6b812538c5)

Ubuntu 22.04 LTS

Download version 5.10.0 software for Ubuntu 22.04 LTS on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum ee331a44f4be4936ec98a3ae45d58e67ed38e8bbf0a4f4ce8b1bd8239b7587b7)
- **Support for OpenSSL Dynamic Engine is not yet available for this platform.**
- **JCE provider** (SHA256 checksum 9e444d14dd356246fe3671633013ec7e4a93f4d4635e08900546113ded6e3d)
- **Javadocs for AWS CloudHSM** (SHA256 checksum dcbb870c6bd58c6770b7a7a2b616c6103a5efb3bdeeab831ce8f9c82cc09a9870f)
- **CloudHSM CLI** (SHA256 checksum 2df361546848cd3f8965b1007dca42a9c959eb10d9e3f4995e8e1c852406751d)

Windows Server 2016

Download version 5.10.0 software for Windows Server 2016 on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum 7aae9bdf99a6dd0f4d3762227c206c01847f83a9ef7744d1063d76c6fdaa89f)
- **JCE provider** (SHA256 checksum 1c58fd651e51be2ba59051a87aceca0452990b29837b8a7efabcdf510ccbf8c1f)
- **Javadocs for AWS CloudHSM** (SHA256 checksum dcbb870c6bd58c6770b7a7a2b616c6103a5efb3bdeeab831ce8f9c82cc09a9870f)
- **CloudHSM CLI** (SHA256 checksum f745a2236c9eb9f6f128313eddc35795bd5e47fd67332bedeb2554201b61a24)

Windows Server 2019

Download version 5.10.0 software for Windows Server 2019 on x86_64 architecture:
• **PKCS #11 library** (SHA256 checksum 7aae9bf99a6dd0f4d376c227c206d01847f83a9efdf774d1063d76cc6fdaa89f)
• **JCE provider** (SHA256 checksum 1c58fd651e51be2ba59051a87aceca0452990b29837b8a7efabcdf50ccbf8c1f)
• **Javadocs for AWS CloudHSM** (SHA256 checksum dcb870c6b58c6779ba7a2b616c6103a5efb3bdeab831ce8f9c82c09a8870f)
• **CloudHSM CLI** (SHA256 checksum f745a2236c9eb9f6f128313eddc35795bd5e47df67332bedeb2554201b61a24)

Client SDK 5.10.0 improves stability and includes bug fixes for all SDKs.

**CloudHSM CLI**

- Added new commands that allow customers to manage keys using CloudHSM CLI, including:
  - Create symmetric keys and asymmetric key pairs
  - Share and unshare keys
  - List and filter keys using key attributes
  - Set key attributes
  - Generate key reference files
  - Delete keys
  - Improved error logging.
  - Added support for multi-line unicode commands in interactive mode.

**Bug fixes/Improvements**

- Improved performance for importing, unwrapping, deriving, and creating sessions keys for all SDKs.
- Fixed a bug in the JCE Provider that prevented temp files to be removed on exit.
- Fixed a bug that caused a connection error under certain conditions after HSMs in the cluster are replaced.
- Modified JCE `getVersion` output format to handle large minor version numbers and include patch number.

**Platform support**

- Added support for Ubuntu 22.04 with JCE, PKCS #11, and CloudHSM CLI (support for OpenSSL Dynamic Engine is not yet available).

**Latest Client SDK 3 release: Version 3.4.4**

To upgrade Client SDK 3 on Linux platforms, you must use a batch command that upgrades the client daemon and all the libraries at the same time. For more information about upgrade, see [Client SDK 3 Upgrade (p. 458)].

To download the software, choose the tab for your preferred operating system, then choose the link to each software package.

**Amazon Linux**

Download the version 3.4.4 software for Amazon Linux:

- **AWS CloudHSM Client** (SHA256 checksum 900de424d70f41e661aa636f256a679cc43bea6b0fe6eb95c2aa63e5289505)
- **PKCS #11 library** (SHA256 checksum a3f93f084d59fee5d7c859292bc02cb7e7f15fbo6e971171ebf9b52bbd229c30)
AWS CloudHSM User Guide
Latest Client SDK 3 release: Version 3.4.4

- **OpenSSL Dynamic Engine** (SHA256 checksum 8db07b58435d49016bb6f6ec46d3d9881d94e426faac1cee2747be14af9331bb0)
- **JCE provider** (SHA256 checksum 360617c55bf4c4aa8e6e78ede079ca68cf9ef11473e7918154c22ba908a219843)
- **AWS CloudHSM Management Utility** (SHA256 checksum c9961ffe38921131bd6f3702e10d73588e68b8ab10fbb241723e676fa8c4fa)

Amazon Linux 2

Download the version 3.4.4 software for Amazon Linux 2:

- **AWS CloudHSM Client** (SHA256 checksum 7d61d835ae38c6ce121d102b516527f342a76ac31733768097d5cab88bc482610)
- **PKCS #11 library** (SHA256 checksum 209f324ff625e1a46d96c1d5084263ca1d650424d7465ead43fe767d6687f36)
- **OpenSSL Dynamic Engine** (SHA256 checksum 6d8e81ad1208652904fe4b6abcb4f174e866303f2302a6551c3fbeb617337e663)
- **JCE provider** (SHA256 checksum 70e3cde143c45a76e155ffbb5969841e0153e011f59eb9ff2c6e6e0707030abf)
- **AWS CloudHSM Management Utility** (SHA256 checksum 5a702fe50dc6055daa723df71a0874317c9f5844eea30104587a61097ecf4)

CentOS 6

AWS CloudHSM does not support CentOS 6 with Client SDK Version 3.4.4.

Use the section called “Version 3.2.1” (p. 728) for CentOS 6 or choose a supported platform.

CentOS 7

Download the version 3.4.4 software for CentOS 7:

- **AWS CloudHSM Client** (SHA256 checksum 7d61d835ae38c6ce121d102b516527f342a76ac31733768097d5cab88bc482610)
- **PKCS #11 library** (SHA256 checksum 209f324ff625e1a46d96c1d5084263ca1d650424d7465ead43fe767d6687f36)
- **OpenSSL Dynamic Engine** (SHA256 checksum 6d8e81ad1208652904fe4b6abcb4f174e866303f2302a6551c3fbeb617337e663)
- **JCE provider** (SHA256 checksum 70e3cde143c45a76e155ffbb5969841e0153e011f59eb9ff2c6e6e0707030abf)
- **AWS CloudHSM Management Utility** (SHA256 checksum 5a702fe50dc6055daa723df71a0874317c9f5844eea30104587a61097ecf4)

CentOS 8

Download the version 3.4.4 software for CentOS 8:

- **AWS CloudHSM Client** (SHA256 checksum 81639c9ec83e501709c4117ba9d98b23dea7838a206ed244c9c6c0d65130f8c)
- **PKCS #11 library** (SHA256 checksum 9a15dada87b8b616cf03a6b6b375f3451ef448dbc54bf2c27fbc2be7823fc63)
- **JCE provider** (SHA256 checksum 2b1c420899230c7f8bcc669c1392c59a6f0fbc82e010c626ffaf58d0cb8e9126b)
- **AWS CloudHSM Management Utility** (SHA256 checksum 3adbecc802e0854c23aa4b8db0540d1748903c8daa93b6c8042fb7885051c360)

**Note**

Due to the recent End of Life of CentOS 8, we will no longer be able to support this platform with next release.

RHEL 6

AWS CloudHSM does not support RedHat Enterprise Linux 6 with Client SDK Version 3.4.4.
Use the section called “Version 3.2.1” (p. 728) for RedHat Enterprise Linux 6 or choose a supported platform.

RHEL 7

Download the version 3.4.4 software for RedHat Enterprise Linux 7:

- AWS CloudHSM Client (SHA256 checksum 7d61d835ae38c6ce121d102b516527f342a76a3c1737368097d5cab8b4c82610)
- PKCS #11 library (SHA256 checksum 2099f324f262e1a46d96c1d5084263ca1d650424d746e4a43fe767d6687f3)
- OpenSSL Dynamic Engine (SHA256 checksum 6d8e81ad1208652904fe4b6abc4f7174e866303f2302a6551c3fbef617337e663)
- JCE provider (SHA256 checksum 70e3ccde143c45a76e155ff596984e0153e011f59ebf92c6e6be607030abf)
- AWS CloudHSM Management Utility (SHA256 checksum 5a702fe50dc6055da723d7f7a0874317c9ff5844ee3a3010587a61097ecf4)

RHEL 8

Download the version 3.4.4 software for RedHat Enterprise Linux 8:

- AWS CloudHSM Client (SHA256 checksum 81639c9ec83e051709c4177ba9d988b23dea7838a206ed244c9c6c065130f8c)
- PKCS #11 library (SHA256 checksum 9a15da87b8616c0f3ab66b375f3451ef448dc54bf2c27fbc2be7823563)
- JCE provider (SHA256 checksum 2b1c4208992903cf7bcc669c1392c59a64fbfc82e010c626fa58d0c8e9126b)
- AWS CloudHSM Management Utility (SHA256 checksum 3adbecc802e0854c23a4a8d8040d1748903c8d9b956c8042fa7885051c360)

Ubuntu 16.04 LTS

Download the version 3.4.4 software for Ubuntu 16.04 LTS:

- AWS CloudHSM Client (SHA256 checksum 317c92c2e0b5d60afab18eb947f053d13daaeb9944ccc2c2b898e997e3e29b9)
- PKCS #11 library (SHA256 checksum 91451c420c51488a022569fd32f052a3b988a283ea4c2ac952acb61a2fe37c)
- OpenSSL Dynamic Engine (SHA256 checksum 4098771a0e38df9f14d50520ca49b395f819f0387e2cb35e61aab5888e66)
- JCE provider (SHA256 checksum e136ff183271c2f95909afdec886ba7eb809506866b070e3854df1b8686c6641)
- AWS CloudHSM Management Utility (SHA256 checksum cbf2a4032f395aa19a988b1b27036392104e8e05d911cabb84049b2bca2541)

Note
Due to the impending EOL of Ubuntu 16.04, we intend to drop support for this platform with the next release.

Ubuntu 18.04 LTS

Download the version 3.4.4 software for Ubuntu 18.04 LTS:

- AWS CloudHSM Client (SHA256 checksum cf57d5e0e95efbf3022aacc887aebd59ac88c0e97c973f9dad40873734f8e)
- PKCS #11 library (SHA256 checksum 428f8bbad7925db401112f707942e8f3ca554f4ab53fa92237996e69144d2f)
- JCE provider (SHA256 checksum 1ff17fb7688e84f70f0bfc96383564dca598a1cab2f2c52c888d0361682f2b9e)
- AWS CloudHSM Management Utility (SHA256 checksum afe253046146ed6177c520b681efc680dac1048c4a95b3d8ad0f305e79bb6e93e)

Windows Server
AWS CloudHSM supports 64-bit versions of Windows Server 2012, Windows Server 2012 R2, Windows Server 2016, and Windows Server 2019. The AWS CloudHSM 3.4.4 client software for Windows Server includes the required CNG and KSP providers. For details, see Install and Configure the AWS CloudHSM Client (Windows) (p. 259). Download the latest version (3.4.4) software for Windows Server:

- **AWS CloudHSM for Windows Server** (SHA256 checksum d51a7db588e9121d8f0b0351606bd986e1c4de6547f2c8235200dc8a5ffbe53e)
- **AWS CloudHSM Management Utility** (SHA256 checksum 0c12d7da9086735c0f189535937a8e036163009c5018dcaf2ee9cdbb6bd4c06f)

Version 3.4.4 adds updates to JCE provider.

**AWS CloudHSM Client Software**

- Updated the version for consistency.

**PKCS #11 library**

- Updated the version for consistency.

**OpenSSL Dynamic Engine**

- Updated the version for consistency.

**JCE provider**

- Update log4j to version 2.17.1.

**Windows (CNG and KSP providers)**

- Updated the version for consistency.

---

### Previous Client SDK 5 releases

This section lists previous Client SDK 5 releases. For the current Client SDK 5 release, see the section called "Latest releases" (p. 671).

#### Version 5.9.0

**Amazon Linux**

Download version 5.9.0 software for Amazon Linux on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum 4f368be41f006b751ac41b14e1435c27841f60bbde0f032ec02a359fe637dcf)
- **OpenSSL Dynamic Engine** (SHA256 checksum 81af0d54683825cd6ff844ccac9c8f4b42a4ba76e9875a89121d09a286b4490)
- **JCE provider** (SHA256 checksum e8e5bc09d8e0b3cb24f30ab420fe08902a19073012355aca94382ec55fccc45ab)
- **Javadocs for AWS CloudHSM** (SHA256 checksum 6343427177180c8f611ee0341e827fbba29420ed2033c0e4b4803d49a3df7763)
- **CloudHSM CLI** (SHA256 checksum 17284144b45043204ce012fe8b62b1973f10068950abedbd9c2c6172ed0979c6)
Amazon Linux 2

Download version 5.9.0 software for Amazon Linux 2 on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum e5affca37abc4ff76369237649830feb32fcd3fa05199cc2021230137093c56)
- **OpenSSL Dynamic Engine** (SHA256 checksum 848aza2e515500bc2b0223468877ba2a8cda3131ef8537856b31db22655c4170)
- **JCE provider** (SHA256 checksum 884f483ef3e9c7deff92e3ff01b226e5cbf276d96dcb26f56009516f19d41dc0)
  - Javadocs for AWS CloudHSM (SHA256 checksum 63454277177180c8f61ee0341e827bba29420ed2035c0e4b803d49a3df7763)
- **CloudHSM CLI** (SHA256 checksum 2e62d5a27ccf46d9fb47d656afeccd9dbfb5413bdf2267dd3c8fb7960ef7f26)

Download version 5.9.0 software for Amazon Linux 2 on ARM64 architecture:

- **PKCS #11 library** (SHA256 checksum 4337dca5a08c5194b1118fa1977bba4a4f7988df4e1b961ef6f2e367295ba99d61d)
- **OpenSSL Dynamic Engine** (SHA256 checksum 4f08689934e877662a77c64554fb4e04b4b2c2139d36018609ff187d100e34a85)
- **JCE provider** (SHA256 checksum b337b80271a2d508949d5911977fe6ad5df4e34876a41f7347f1d897fe39)
- Javadocs for AWS CloudHSM (SHA256 checksum 63454277177180c8f61ee0341e827bba29420ed2035c0e4b803d49a3df7763)
- **CloudHSM CLI** (SHA256 checksum a4d466e6bf744dcd283a22c9d87441941d5e5a05936b7c2b4cc7e85eb1071)

CentOS 7

Download version 5.9.0 software for CentOS 7 on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum e5affca37abc4ff76369237649830feb32fcd3fa05199cc2021230137093c56)
- **OpenSSL Dynamic Engine** (SHA256 checksum 848aza2e515500bc2b0223468877ba2a8cda3131ef8537856b31db22655c4170)
- **JCE provider** (SHA256 checksum 884f483ef3e9c7deff92e3ff01b226e5cbf276d96dcb26f56009516f19d41dc0)
- Javadocs for AWS CloudHSM (SHA256 checksum 63454277177180c8f61ee0341e827bba29420ed2035c0e4b803d49a3df7763)
- **CloudHSM CLI** (SHA256 checksum 2e62d5a27ccf46d9fb47d656afeccd9dbfb5413bdf2267dd3c8fb7960ef7f26)

RHEL 7

Download version 5.9.0 software for RHEL 7 on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum e5affca37abc4ff76369237649830feb32fcd3fa05199cc2021230137093c56)
- **OpenSSL Dynamic Engine** (SHA256 checksum 848aza2e515500bc2b0223468877ba2a8cda3131ef8537856b31db22655c4170)
- **JCE provider** (SHA256 checksum 884f483ef3e9c7deff92e3ff01b226e5cbf276d96dcb26f56009516f19d41dc0)
- Javadocs for AWS CloudHSM (SHA256 checksum 63454277177180c8f61ee0341e827bba29420ed2035c0e4b803d49a3df7763)
- **CloudHSM CLI** (SHA256 checksum 2e62d5a27ccf46d9fb47d656afeccd9dbfb5413bdf2267dd3c8fb7960ef7f26)

RHEL 8

Download version 5.9.0 software for RHEL 8 on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum 0818876ea1d9df9d1e409b2b5bde8e965c42229acbe1b950c8fe478361edc)
AWS CloudHSM User Guide
Previous Client SDK 5 releases

- **OpenSSL Dynamic Engine** (SHA256 checksum 6b0500a42df57c39f076f14e507f8f0145b6eb2c2441395761eb04600c07bda5)
- **JCE provider** (SHA256 checksum 2bc7ac26b259af92a65fbd5a30ed5eb2a92ce0e70efe41feb53bf82f168aa90bb)
- **Javadocs for AWS CloudHSM** (SHA256 checksum 634342771780c8f61e0341e827fbba29420ed2033ce4b4803d49a3df7763)
- **CloudHSM CLI** (SHA256 checksum 79ecbe9b4c5316ccf447d8c59b76b5ac2cc854bd79c5d0c1f29197aa8cb080db)

Ubuntu 18.04 LTS

Download version 5.9.0 software for Ubuntu 18.04 LTS on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum bc6d2227edd7b5a53fed32741fa9cb1756d5df89ebbb3435d9f609a180db65)
- **OpenSSL Dynamic Engine** (SHA256 checksum 2d6a2643fa6afaf337f1df24de03320f405a9a85d4540e27963a03b3ee69d)
- **JCE provider** (SHA256 checksum e12afe12f49ec026452ce31c25625b1accba58663d470488f10f047f1873)
- **Javadocs for AWS CloudHSM** (SHA256 checksum 634342771780c8f61e0341e827fbba29420ed2033ce4b4803d49a3df7763)
- **CloudHSM CLI** (SHA256 checksum f0bcabe594db3e8f886cc0f65c2a10858d34452eb669c337daac05c0f5f4f50)

Ubuntu 20.04 LTS

Download version 5.9.0 software for Ubuntu 20.04 LTS on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum 15dde8182f432de9e7d369b05e3b84e1f2d80dca85db3b16ec26ce6f1a34bb9)
- **OpenSSL Dynamic Engine** (SHA256 checksum c8ba94a99038af87d4905b7c1fe4b4c8e720e0d17763a32e6f6fd11ee008baa896)
- **JCE provider** (SHA256 checksum de33c4e8130a069da5207079533ac8276a1319ac435a537b54f65bd8972)
- **Javadocs for AWS CloudHSM** (SHA256 checksum 634342771780c8f61e0341e827fbba29420ed2033ce4b4803d49a3df7763)
- **CloudHSM CLI** (SHA256 checksum f0bcabe594db3e8f886cc0f65c2a10858d5a452eb66b9c337daac05c0f5f4f50)

Windows Server 2016

Download version 5.9.0 software for Windows Server 2016 on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum ab5380805b06e17d89ddbe0d5fda854da3c140f82e9f3d021850c31837bbe3)
- **JCE provider** (SHA256 checksum f0941d7a20193818133de8a742d3b848ea19abaf25f5a71ac65949ce5a37c533)
- **Javadocs for AWS CloudHSM** (SHA256 checksum 634342771780c8f61e0341e827fbba29420ed2033ce4b4803d49a3df7763)
- **CloudHSM CLI** (SHA256 checksum cfa3515359a9a5113946c06fbace38e9593491aca9bb031a18b51075973e68)

Windows Server 2019

Download version 5.9.0 software for Windows Server 2019 on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum ab5380805b06e17d89ddbe0d5fda854da3c140f82e9f3d021850c31837bbe3)
- **JCE provider** (SHA256 checksum f0941d7a20193818133de8a742d3b848ea19abaf25f5a71ac65949ce5a37c533)
- **Javadocs for AWS CloudHSM** (SHA256 checksum 634342771780c8f61e0341e827fbba29420ed2033ce4b4803d49a3df7763)
- **CloudHSM CLI** (SHA256 checksum cfa3515359a9a5113946c06fbace38e9593491aca9bb031a18b51075973e68)
Client SDK 5.9.0 improves stability and includes bug fixes for all SDKs. An optimization has been made for all SDKs to inform applications of operation failure immediately when an HSM is determined unavailable. This release includes performance enhancements for JCE.

**JCE provider**
- Enhanced performance

## Version 5.8.0

### Amazon Linux

Download version 5.8.0 software for Amazon Linux on x86_64 architecture:
- **PKCS #11 library** (SHA256 checksum 6d8f3b173488bb4d4837639c0d7ba9c800a7c8748540cd36bab6a5c55e17ea5)
- **OpenSSL Dynamic Engine** (SHA256 checksum fed2060bed652cbbca6792e41c41b364e82a147e0e8b9d574a4a84bb1b)
- **JCE provider** (SHA256 checksum d8a3bc0d9665700146b96286d970c88fa370732b0437f16990c94efc4d96a7b)
- **Javadocs for AWS CloudHSM** (SHA256 checksum 2faa3336c23eadd82a8b215bd5bd32508ba81bcf1af06e64f13a88d9b92a3f5)
- **CloudHSM CLI** (SHA256 checksum 41d28867f7f8452bfa42b045abd27bb6fc71bd538302a12ac680174fa58d91c)

### Amazon Linux 2

Download version 5.8.0 software for Amazon Linux 2 on x86_64 architecture:
- **PKCS #11 library** (SHA256 checksum f6724da43ff65b9a40daedbb080a184250c3d97f347e080b57565d9810)
- **OpenSSL Dynamic Engine** (SHA256 checksum b5a77ab04dcb3e4deec521b8cfd11be95e184ee433b21185e6ba666df05724be)
- **JCE provider** (SHA256 checksum b54184c6f76f6867c838fd13b9ccaf2ff33d5e68d521b559e3bad1fa1ee)
- **Javadocs for AWS CloudHSM** (SHA256 checksum 2faa3336c23eadd82a8b215bd5bd32508ba81bcf1af06e64f13a88d9b92a3f5)
- **CloudHSM CLI** (SHA256 checksum c8e5182a7ccafed0d42c78806e7e64ce77ee37d62713ce8f5ac97ee03593083ae1)

Download version 5.8.0 software for Amazon Linux 2 on ARM64 architecture:
- **PKCS #11 library** (SHA256 checksum f01231b2507ec4bc985225d9276c3f66e79e57845317b42ee04702eed369f)
- **OpenSSL Dynamic Engine** (SHA256 checksum 81b98507d95f3e1769c6d3712b01e7feff2841b3d9b9fde64ec572d7874e0ec)
- **JCE provider** (SHA256 checksum 3e4626a81e1bba432f473ccc19171cd1f74b135679efbc820978351ac54c9f)
- **Javadocs for AWS CloudHSM** (SHA256 checksum 2faa3336c23eadd82a8b215bd5bd32508ba81bcf1af06e64f13a88d9b92a3f5)
- **CloudHSM CLI** (SHA256 checksum 3e12566d7e02d3d877625b275df32657b2597d6a4ecce5796220a4cafe343c8)

### CentOS 7

Download version 5.8.0 software for CentOS 7 on x86_64 architecture:
- **PKCS #11 library** (SHA256 checksum f6724da43ff65b9a40daedbb080a184250c3d97f347e080b57565d9810)
- **OpenSSL Dynamic Engine** (SHA256 checksum b5a77ab04dcb3e4ddec521b8cfd11be95e184ee43c2b185e6ba666df05724be)
AWS CloudHSM User Guide
Previous Client SDK 5 releases

- **JCE provider** (SHA256 checksum b54184cf7f68687c838fd13b9ccaf2ff335ee5bddf6521b55e93bad1fabe1ee)
- **Javadocs for AWS CloudHSM** (SHA256 checksum 2fa3336c23ead82ab21b5d4bd5d32508baa81bcf1a0ce6f413a88db902a3f5)
- **CloudHSM CLI** (SHA256 checksum c8e5182accaff0d042c78806e7e64ce77ee37d627133ebf5ac97ee0359083ae1)

RHEL 7

Download version 5.8.0 software for RHEL 7 on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum f67224aa43fffe65b9a40daad0b650bd080a184250c3d97f3147e080b57565d9810)
- **OpenSSL Dynamic Engine** (SHA256 checksum b5a77ab04db3e4dec521bbcf1a0ce6f413a88db902a3f5)
- **JCE provider** (SHA256 checksum b54184cf7f68687c838fd13b9ccaf2ff335ee5bddf6521b55e93bad1fabe1ee)
- **Javadocs for AWS CloudHSM** (SHA256 checksum 2ffa3336c23eadd82ab21b5d4bd5d32508baa81bcf1a0ce6f413a88db902a3f5)
- **CloudHSM CLI** (SHA256 checksum c8e5182accaff0d042c78806e7e64ce77ee37d627133ebf5ac97ee0359083ae1)

RHEL 8

Download version 5.8.0 software for RHEL 8 on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum fdfeca89815475ed0180221ae2a250f4e56d482a7493ede24d87b0fc01b05f01cd)
- **OpenSSL Dynamic Engine** (SHA256 checksum 7829c894eccec81efb0ba28b42459d99193f0549f6a614bd1f2d4be7e95c28cf98)
- **JCE provider** (SHA256 checksum 3ebe55cbe86c93b3516f50e2c9bccc0b83055d164e5edcb2c6db4509df25)
- **Javadocs for AWS CloudHSM** (SHA256 checksum 2fa3336c23ead82ab21b5d4bd5d32508baa81bcf1a0ce6f413a88db902a3f5)
- **CloudHSM CLI** (SHA256 checksum 979c623ae96c601eb1a8f3ab56005d56c88957535f33fdd6513621c0cd73336fc)

Ubuntu 18.04 LTS

Download version 5.8.0 software for Ubuntu 18.04 LTS on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum 648460bfdf897dae5de8f9675b6216df1e1bd5f9d307f8db4c4482c535d52977)
- **OpenSSL Dynamic Engine** (SHA256 checksum 2e4ef2ff94000bc682a2a04df2d45d22bd61a612e41334af66d1eb2efcf8ca)
- **JCE provider** (SHA256 checksum b4ac6c4f0290eb783e4845d4386fd6d759bf2ba2ba7709eb942725028e62e3)
- **Javadocs for AWS CloudHSM** (SHA256 checksum 2fa3336c23ead82ab21b5d4bd5d32508baa81bcf1a0ce6f413a88db902a3f5)
- **CloudHSM CLI** (SHA256 checksum 24b34d1206d453c0427c40b5d5b12f83670b7501d0153dea208487758f7f22366)

Ubuntu 20.04 LTS

Download version 5.8.0 software for Ubuntu 20.04 LTS on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum c50e50ccec9ebc9f04cf45737dacf945ab723f2a2616f9174ceab26757c017b)
- **OpenSSL Dynamic Engine** (SHA256 checksum 0131559a039836f241544bb18c2e741950b8ca5e02759fa9f27340ce37b3d)
- **JCE provider** (SHA256 checksum 73c2f597e81ee2193aa0c9a3ac8ebbd51fc6951358d87e50bb9c94ac00c9d2)
- **Javadocs for AWS CloudHSM** (SHA256 checksum 2fa3336c23ead82ab21b5d4bd5d32508baa81bcf1a0ce6f413a88db902a3f5)
Windows Server 2016

Download version 5.8.0 software for Windows Server 2016 on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum c3fc54fa01599a65c67a1f8c280d13f2dcebfb8655fa7202dd4e7317aa90bc25c)
- **JCE provider** (SHA256 checksum 500f5d2ca9681547fe8474fdcd3ba16a5ec119b09a054f79dba4d97baad8773)
- **Javadocs for AWS CloudHSM** (SHA256 checksum 2ffa3336c23eadd82ab21b5d4b5d32508aba81bcf1afa0ec6f413a88db902a3f5)
- **CloudHSM CLI** (SHA256 checksum 9d61c1a6b95c05ebda7b2c94ae4355988206f6addf60fb22ad4ba5b6413a0e51)

Version 5.8.0 introduces quorum authentication for CloudHSM CLI, SSL/TLS offload with JSSE, multi-slot support for PKCS #11, multi-cluster/multi-user support for JCE, key extraction with JCE, supported keyFactory for JCE, new retry configurations for non-terminal return codes, and includes improved stability and bug fixes for all SDKs.

**PKCS #11 library**
- Added support for multi-slot configuration.

**JCE provider**
- Added configuration based key extraction.
- Added support for multi-cluster and multi-user configurations.
- Added support for SSL and TLS offload with JSSE.
- Added unwrap support for AES/CBC/NoPadding.
- Added new types of key factories: SecretKeyFactory and KeyFactory.

**CloudHSM CLI**
- Added support for quorum authentication

**Version 5.7.0**

Amazon Linux

Download version 5.7.0 software for Amazon Linux on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum 847cf948df64cf8f1b59d9e81fee86d70338f0922e5e88c46239f26028ac2d8)
- **OpenSSL Dynamic Engine** (SHA256 checksum 35ff996798d29cd0ab1bca301e7417970e6060fe8485de7d77a442fb88e526d4)
• **JCE provider** (SHA256 checksum 0bee58bf3f0909d7e0ad39f2c8a19284bbfc72187b2f03516c85201ac33b39f6)
• **Javadoc for AWS CloudHSM** (SHA256 checksum 1443a8587da9e9b9b67e1c39f7c7fd6da4a12f89341bbca6ab6d65ab803f7359)
• **CloudHSM CLI** (SHA256 checksum fd3ebdaae0e942109bf2f23ea76d8f7c9b7efcafa1df8d0dcc4e6eaf6a2)

**Amazon Linux 2**

Download version 5.7.0 software for Amazon Linux 2 on x86_64 architecture:

• **PKCS #11 library** (SHA256 checksum cf3f65b361a369b1eda49c188fb33d8319a1ef163402f9e61a23225399ce21a8f)
• **OpenSSL Dynamic Engine** (SHA256 checksum b71339f5e6e6f71bf4ff851b欣慰e890186d815fd8dd8b2a4e9a96c989d866)
• **JCE provider** (SHA256 checksum ed85b35e9d77f5c76bffb05221e4422968b419d0b5ef00c5cc657883bbff5c3a)
• **Javadoc for AWS CloudHSM** (SHA256 checksum 1443a8587da9e9b9b67e1c39f7c7fd6da4a12f89341bbca6ab6d65ab803f7359)
• **CloudHSM CLI** (SHA256 checksum 35d4d4a8341aa4ab51fa5dc072f44b711e06e6102323c88d1d4d7e0a03c00309)

Download version 5.7.0 software for Amazon Linux 2 on ARM64 architecture:

• **PKCS #11 library** (SHA256 checksum 526d603d17c0bd13d0f0a58a807aba1258c9cb009f51500112e257a10b8a1b6c)
• **OpenSSL Dynamic Engine** (SHA256 checksum 73b85d065c979816db51f3bd92340b34e177cf915c8462648818c03e57e7a9)
• **JCE provider** (SHA256 checksum 2953b51f7c4879d444ca5a6888de77d39f7ba8758d3a8100e3886fcd1826863)
• **Javadoc for AWS CloudHSM** (SHA256 checksum 1443a8587da9e9b9b67e1c39f7c7fd6da4a12f89341bbca6ab6d65ab803f7359)
• **CloudHSM CLI** (SHA256 checksum e736bed399409c3c8f51416c3f6ea68ddee6ec5a8c0e6d088a0cb95b52a)

**CentOS 7**

Download version 5.7.0 software for CentOS 7 on x86_64 architecture:

• **PKCS #11 library** (SHA256 checksum cf3f65b361a369b1eda49c188fb33d8319a1ef163402f9e61a23225399ce21a8f)
• **OpenSSL Dynamic Engine** (SHA256 checksum b71339f5e6e6f71bf4ff851b欣慰e890186d815fd8dd8b2a4e9a96c989d866)
• **JCE provider** (SHA256 checksum ed85b35e9d77f5c76bffb05221e4422968b419d0b5ef00c5cc657883bbff5c3a)
• **Javadoc for AWS CloudHSM** (SHA256 checksum 1443a8587da9e9b9b67e1c39f7c7fd6da4a12f89341bbca6ab6d65ab803f7359)
• **CloudHSM CLI** (SHA256 checksum 35d4d4a8341aa4ab51fa5dc072f44b711e06e6102323c88d1d4d7e0a03c00309)

**RHEL 7**

Download version 5.7.0 software for RHEL 7 on x86_64 architecture:

• **PKCS #11 library** (SHA256 checksum cf3f65b361a369b1eda49c188fb33d8319a1ef163402f9e61a23225399ce21a8f)
• **OpenSSL Dynamic Engine** (SHA256 checksum b71339f5e6e6f71bf4ff851b欣慰e890186d815fd8dd8b2a4e9a96c989d866)
• **JCE provider** (SHA256 checksum ed85b35e9d77f5c76bffb05221e4422968b419d0b5ef00c5cc657883bbff5c3a)
• **Javadoc for AWS CloudHSM** (SHA256 checksum 1443a8587da9e9b9b67e1c39f7c7fd6da4a12f89341bbca6ab6d65ab803f7359)
• **CloudHSM CLI** (SHA256 checksum 35d4d4a8341aa4ab51fa5dc072f44b711e06e6102323c88d1d4d7e0a03c00309)
RHEL 8

Download version 5.7.0 software for RHEL 8 on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum 90227569a1a5225833aad73c1bb57ae503f1d1fc2635b08d1ac8412b1db56720)
- **OpenSSL Dynamic Engine** (SHA256 checksum a4291e2f4a79a8fbeb586e1f262ba394f19c33ae4b5f60e087c0464d428)
- **JCE provider** (SHA256 checksum fa3d83c03b011b5bf886c32329771ef73d3f4a6375e428344beceda21c0292b)
  - Javadocs for AWS CloudHSM (SHA256 checksum 1443a8587da8e9b067e1c39f7c7f3db64a12f89341b8cca6ab6d65ab803f7359)
  - **CloudHSM CLI** (SHA256 checksum 7d3d0de2e0e062d3420fa1a4502ce7c372f1f059b4db0c690a46f006038a)

Ubuntu 18.04 LTS

Download version 5.7.0 software for Ubuntu 18.04.04 LTS on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum 4fd9c59d5d7b38d4c1c7cc17bdbe7839ee1040bd18ce9f640719faaf68f8db8a)
- **OpenSSL Dynamic Engine** (SHA256 checksum 6afdd452f1526dbfcfd8c69ced2f81f862028eb89d4d7005d53d433b95ce05)
- **JCE provider** (SHA256 checksum e12bc3a0e2b5ed2f317d58ef33d920523133b2c7a1783334f1c5d58be75e46b0e)
  - Javadocs for AWS CloudHSM (SHA256 checksum 1443a8587da8e9b067e1c39f7c7f3db64a12f89341b8cca6ab6d65ab803f7359)
  - **CloudHSM CLI** (SHA256 checksum 1dbfe0010572f6b0c985123730f63a1b4472ebce11dc96b09a7989ad001a)

Ubuntu 20.04 LTS

Download version 5.7.0 software for Ubuntu 20.04 LTS on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum 4e18891e1831208d90bf8ee40d7cde031284549a25d5d9b14fb12175efaa01)
- **OpenSSL Dynamic Engine** (SHA256 checksum ef0eb28c3269506e808d9176c71756e5290244250472bed134f1c0a713d5a18)
- **JCE provider** (SHA256 checksum 43c2dbb69505810dc10fc1db8620fb777e18e3c31c364142dc2228b4c6f1de49)
  - Javadocs for AWS CloudHSM (SHA256 checksum 1443a8587da8e9b067e1c39f7c7f3db64a12f89341b8cca6ab6d65ab803f7359)
  - **CloudHSM CLI** (SHA256 checksum b831d6edf9775189f2c99283df2404b8b969db8be4537690e21a2fd10b0cc4152)

Windows Server 2016

Download version 5.7.0 software for Windows Server 2016 on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum 2c677d2f01216766741d0044735977714bb9e093472ae7e57a1c6eab3b7388e5)
- **JCE provider** (SHA256 checksum eceb49e2c1d2af7f5fadb7c656820723fa00672c2f46b9f6e8a64bb2de63d54a)
  - Javadocs for AWS CloudHSM (SHA256 checksum 1443a8587da8e9b067e1c39f7c7f3db64a12f89341b8cca6ab6d65ab803f7359)
  - **CloudHSM CLI** (SHA256 checksum 854bcee5053e3d7ed9771044c8921de6c9019a6eb4ae0376a6df9d78345d58)

Windows Server 2019

Download version 5.7.0 software for Windows Server 2019 on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum 2c677d2f01216766741d0044735977714bb9e093472ae7e57a1c6eab3b7388e5)
Version 5.7.0 introduces CloudHSM CLI and includes a new cipher-based message authentication code (CMAC) algorithm. This release adds ARM architecture on Amazon Linux 2. JCE provider Javadocs are now available for AWS CloudHSM.

**PKCS #11 library**

- Improved stability and bug fixes.
- Now supported on ARM architecture with Amazon Linux 2.

  - Algorithms
    - CKM_AES_CMAC (sign and verify)

**OpenSSL Dynamic Engine**

- Improved stability and bug fixes.
- Now supported on ARM architecture with Amazon Linux 2.

**JCE provider**

- Improved stability and bug fixes.
- Algorithms
  - AESCMAC

## Version 5.6.0

### Amazon Linux

Download version 5.6.0 software for Amazon Linux on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum e8fe11034dfc8bc324da7eb9f84fa304b3186e6ba02474c1ebde7ff91c2e7fa)
- **OpenSSL Dynamic Engine** (SHA256 checksum 62aa8ff356bd2701d52a39c12e2ba0ea7170cab9c5541b6e28f0f1f1e1209)
- **JCE provider** (SHA256 checksum 99b80a2e11f3b6c0b510f27213a8c903ec5baac0aaed48d6424152d244e17ea)

### Amazon Linux 2

Download version 5.6.0 software for Amazon Linux 2 on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum 2a08cf1266abac4ae776a8c779ac0e086fb1d94a888bf0f5e4e03e31f0b5b)
- **OpenSSL Dynamic Engine** (SHA256 checksum 2e327a6483b5f3f3e2d29491e15045cdd88ab4d86d46928d09)
- **JCE provider** (SHA256 checksum e98c5c7977b34a0c73e366b1d2ff85891fa5dc094a38dd7226da5b11ea1b4003)

Download version 5.6.0 software for Amazon Linux 2 on ARM64 architecture:

- **JCE provider** (SHA256 checksum eeb6af4e6b89b1602499125c61ed1f45858b252b12363c45b9ea21bdc0f8d85b)
CentOS 7

Download version 5.6.0 software for CentOS 7 on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum 2a08cf126c6aabb4ae776a8c79ac0e086fb1d94a888bf5fc0e4e03e31fab5b)
- **OpenSSL Dynamic Engine** (SHA256 checksum 2e327a6483b5f3fab9e556e19a41bd4229499ae15045c5dbd88ab4d86eb46928d09)
- **JCE provider** (SHA256 checksum e086e773b40ac4babe366b1d2ff85891fa3d0c94a388dd722d6da5b11ea1b4003)

RHEL 7

Download version 5.6.0 software for RHEL 7 on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum 2a08cf126c6aabb4ae776a8c79ac0e086fb1d94a888bf5fc0e4e03e31fab5b)
- **OpenSSL Dynamic Engine** (SHA256 checksum 2e327a6483b5f3fab9e556e19a41bd4229499ae15045c5dbd88ab4d86eb46928d09)
- **JCE provider** (SHA256 checksum e086e773b40ac4babe366b1d2ff85891fa3d0c94a388dd722d6da5b11ea1b4003)

RHEL 8

Download version 5.6.0 software for RHEL 8 on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum 442df60ffeb577498e429339941bcfa8adb377bb0c0edce1d19e870f996a9e312)
- **OpenSSL Dynamic Engine** (SHA256 checksum c70ec51e00d697b541052ee53b485e20037202b561c74db1a4a0976fc59ec1937)
- **JCE provider** (SHA256 checksum b761ee7f3a0b372931e7d0b94bdc00b62ddc60a3929c2412675c6e224cd8de7b)

Ubuntu 18.04 LTS

Download version 5.6.0 software for Ubuntu 18.04 LTS on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum 115e40ca45ee8e177cc34d9d1f1fe137dcb476467043e827d5322456dbae293)
- **OpenSSL Dynamic Engine** (SHA256 checksum a646ae0839157d576e8539eeb2bb14a7e147d9060ce8947c5c14df3345c5d6cb34)
- **JCE provider** (SHA256 checksum 9330ec740aaf854a811090dec93fe40e4fa2dbbfe88a61fc978b2159124f531a)

Ubuntu 20.04 LTS

Download version 5.6.0 software for Ubuntu 20.04 LTS on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum d86664326b3f74693c88bbd2d2d8ddbac786c390cb5a7053f3827e70347018)
- **OpenSSL Dynamic Engine** (SHA256 checksum 4e6e264050f6f9561cca61ec884c0f6e98e5f9ab2bfa7a1d4e5a0e8d79a5)
- **JCE provider** (SHA256 checksum 361a4a3ee695995e0d3367660533910d243a2945dcbf4f58f12f544425d6d8d9)

Windows Server 2016

Download version 5.6.0 software for Windows Server 2016 on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum 32cd12c80aef58e2dba74851578ae5498bee078bbf5480ba0b383270f43b0a5)
- **JCE provider** (SHA256 checksum c595166d549e8d8df0d959c43ab0eb29fc08ed8df32cc2d01ce57d22c704b672)
Windows Server 2019

Download version 5.6.0 software for Windows Server 2019 on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum 32cd12c08e58e2db74851578ea5498bee078bbf548b0ba0b585270f43b0a5)
- **JCE provider** (SHA256 checksum c595166d549e8d8d60959c43ab0eb29f08ed8df32c2d01ce57d22c704b672)

Version 5.6.0 includes new mechanism support for PKCS #11 library and JCE provider. Additionally, version 5.6 supports Ubuntu 20.04.

**PKCS #11 library**

- Improved stability and bug fixes.
- Mechanisms
  - CKM_RSA_X_509, for encrypt, decrypt, sign, and verify modes

**OpenSSL Dynamic Engine**

- Improved stability and bug fixes.

**JCE provider**

- Improved stability and bug fixes.
- Ciphers
  - RSA/ECB/NoPadding, for encrypt and decrypt modes

**Supported keys**

- EC with curves secp224r1 and secp521r1

**Platform support**

- Added support for Ubuntu 20.04.

**Version 5.5.0**

Amazon Linux

Download version 5.5.0 software for Amazon Linux on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum d26d4f1850f1ace52a386496063fb1e4a7692f34a1f00d1e4e61a8f59b3363)
- **OpenSSL Dynamic Engine** (SHA256 checksum 098d3ee5d3b037e803ae6badff5c57e758164a2d2f2b789bf2e8e5ff851910b)
- **JCE provider** (SHA256 checksum 3106dcf572870fba0645d82705d509677c2439527b5ad35ec8456ad5d68161)

Amazon Linux 2

Download version 5.5.0 software for Amazon Linux 2 on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum c08f71fe022d0041c897f3265cf17ca2ed5b3d308e9801d7889ca9e920698e)
- **OpenSSL Dynamic Engine** (SHA256 checksum bbb90f0b7bbac9594177b7a9ff92d04bc16853a78b5016f7f5cd40b8a3ed539)
Download version 5.5.0 software for Amazon Linux 2 on ARM64 architecture:

- **JCE provider** (SHA256 checksum 65f1d6360985f4a5225b89b0cc2d76b15408a4d09ceb41489c4fa743970315bae)

CentOS 7

Download version 5.5.0 software for CentOS 7 on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum 958ede0815636e77cb79e0b60d4b7214d4b7a13652f8d50366bd038b202b1e6)
- **OpenSSL Dynamic Engine** (SHA256 checksum 65f1d6360985f4a5225b89b0cc2d76b15408a4d09ceb41489c4fa743970315bae)

RHEL 7

Download version 5.5.0 software for RHEL 7 on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum 558ddf1e080372036f4a5225b89b0cc2d76b15408a4d09ceb41489c4fa743970315bae)
- **OpenSSL Dynamic Engine** (SHA256 checksum 65f1d6360985f4a5225b89b0cc2d76b15408a4d09ceb41489c4fa743970315bae)

Ubuntu 18.04 LTS

Download version 5.5.0 software for Ubuntu 18.04 LTS on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum 558ddf1e080372036f4a5225b89b0cc2d76b15408a4d09ceb41489c4fa743970315bae)
- **OpenSSL Dynamic Engine** (SHA256 checksum 65f1d6360985f4a5225b89b0cc2d76b15408a4d09ceb41489c4fa743970315bae)

Windows Server 2016

Download version 5.5.0 software for Windows Server 2016 on x86_64 architecture:

- **PKCS #11 library** (SHA256 checksum 558ddf1e080372036f4a5225b89b0cc2d76b15408a4d09ceb41489c4fa743970315bae)
- **JCE provider** (SHA256 checksum b8dca7a54715596c0eb406e97978850230ecf176ac926fe6d2e622b2ac0b3)

Windows Server 2019

Download version 5.5.0 software for Windows Server 2019 on x86_64 architecture:
PKCS #11 library

- Improved stability and bug fixes.

JCE provider

- Support for the Keytool and Jarsigner utilities
- Support for OpenJDK 11 on all platforms
- Ciphers
  - AES/CBC/NoPadding Encrypt and Decrypt mode
  - AES/ECB/PKCS5Padding Encrypt and Decrypt mode
  - AES/CTR/NoPadding Encrypt and Decrypt mode
  - AES/GCM/NoPadding Wrap and Unwrap mode
  - DESede/ECB/PKCS5Padding Encrypt and Decrypt mode
  - DESede/CBC/NoPadding Encrypt and Decrypt mode
  - AESWrap/ECB/NoPadding Wrap and Unwrap mode
  - AESWrap/ECB/PKCS5Padding Wrap and Unwrap mode
  - AESWrap/ECB/ZeroPadding Wrap and Unwrap mode
  - RSA/ECB/PKCS1Padding Wrap and Unwrap mode
  - RSA/ECB/OAEPPadding Wrap and Unwrap mode
  - RSA/ECB/OAEPWithSHA-1ANDMGF1Padding Wrap and Unwrap mode
  - RSA/ECB/OAEPWithSHA-224ANDMGF1Padding Wrap and Unwrap mode
  - RSA/ECB/OAEPWithSHA-256ANDMGF1Padding Wrap and Unwrap mode
  - RSA/ECB/OAEPWithSHA-384ANDMGF1Padding Wrap and Unwrap mode
  - RSA/ECB/OAEPWithSHA-512ANDMGF1Padding Wrap and Unwrap mode
  - RSAAESWrap/ECB/OAEPPadding Wrap and Unwrap mode
  - RSAAESWrap/ECB/OAEPWithSHA-1ANDMGF1Padding Wrap and Unwrap mode
  - RSAAESWrap/ECB/OAEPWithSHA-224ANDMGF1Padding Wrap and Unwrap mode
  - RSAAESWrap/ECB/OAEPWithSHA-256ANDMGF1Padding Wrap and Unwrap mode
  - RSAAESWrap/ECB/OAEPWithSHA-384ANDMGF1Padding Wrap and Unwrap mode
  - RSAAESWrap/ECB/OAEPWithSHA-512ANDMGF1Padding Wrap and Unwrap mode
- KeyFactory and SecretKeyFactory
  - RSA – 2048-bit to 4096-bit RSA keys, in increments of 256 bits
  - AES – 128, 192, and 256-bit AES keys
  - EC key pairs for NIST curves secp256r1 (P-256), secp384r1 (P-384), and secp256k1
  - DESede (3DES)
  - GenericSecret

Version 5.5.0 adds support for OpenJDK 11, Keytool and Jarsigner integration, and additional mechanisms to the JCE provider. Resolves a known issue regarding a KeyGenerator class incorrectly interpreting key size parameter as number of bytes instead of bits.
• HMAC – with SHA1, SHA224, SHA256, SHA384, SHA512 hash support
• Sign/Verify
  • RSASSA-PSS
  • SHA1withRSA/PSS
  • SHA224withRSA/PSS
  • SHA256withRSA/PSS
  • SHA384withRSA/PSS
  • SHA512withRSA/PSS
  • SHA1withRSAandMGF1
  • SHA224withRSAandMGF1
  • SHA256withRSAandMGF1
  • SHA384withRSAandMGF1
  • SHA512withRSAandMGF1

Version 5.4.2

Amazon Linux

Download the version 5.4.2 software for Amazon Linux:

- **PKCS #11 library** (SHA256 checksum 690)
- **OpenSSL Dynamic Engine** (SHA256 checksum 690)
- **JCE provider** (SHA256 checksum 690)

Amazon Linux 2

Download the version 5.4.2 software for Amazon Linux 2:

- **PKCS #11 library** (SHA256 checksum 690)
- **OpenSSL Dynamic Engine** (SHA256 checksum 690)
- **JCE provider** (SHA256 checksum 690)

CentOS 7

Download the version 5.4.2 software for CentOS 7:

- **PKCS #11 library** (SHA256 checksum 690)
- **OpenSSL Dynamic Engine** (SHA256 checksum 690)
- **JCE provider** (SHA256 checksum 690)

CentOS 8

Download the version 5.4.2 software for CentOS 8:

- **PKCS #11 library** (SHA256 checksum 690)
- **OpenSSL Dynamic Engine** (SHA256 checksum 690)
AWS CloudHSM User Guide

Previous Client SDK 5 releases

• **JCE provider** (SHA256 checksum d5d1d813dfdb54e98873209606d8a55d56181598b1a539a0a62d4ef0addf2)

**Note**
Due to the recent End of Life of CentOS 8, we will no longer be able to support this platform with next release.

RHEL 7

Download the version 5.4.2 software for RHEL 7:

• **PKCS #11 library** (SHA256 checksum 8d892210db097a942ae99213cf0f7e879f8840d208b0c5329baa9eda6783b9e)
• **OpenSSL Dynamic Engine** (SHA256 checksum 68cb82352a9880d16035181bd14ee4085f16b489d8d501df352d0fb214009)
• **JCE provider** (SHA256 checksum 891a99f9c85182dd11c62f1745363b1fbeb2ae442abbae01c9681cd2d32ffe1c)

RHEL 8

Download the version 5.4.2 software for RHEL 8:

• **PKCS #11 library** (SHA256 checksum bf3f9a7ba1c4df7b9c5909e4f7c83a013dbdaea362c4caf6ed278730fa43a0da0)
• **OpenSSL Dynamic Engine** (SHA256 checksum 2da93322f9f7f2ba32edf4b676f49f23d83eb43985ea7a51c6a0f132ddc9b)
• **JCE provider** (SHA256 checksum 891a99f9c85182dd11c62f1745363b1fbeb2ae442abbae01c9681cd2d32ffe1c)

Ubuntu 18.04 LTS

Download the version 5.4.2 software for Ubuntu 18.04 LTS:

• **PKCS #11 library** (SHA256 checksum 6e78e18f64d2a6a3f9ebe1e2b846b29c91340816e2f15cd9b77fa959188716ab)
• **OpenSSL Dynamic Engine** (SHA256 checksum 2f52ddbd73a242ed0458747fd5b25beb94328d813fb62d9e4dc1c273362120744)
• **JCE provider** (SHA256 checksum d5d1d813dfdb54e98873209606d8a55d56181598b1a539a0a62d4ef0addf2)

Windows Server 2016

Download the version 5.4.2 software for Windows Server 2016:

• **PKCS #11 library** (SHA256 checksum e0b4a2753f1f940614a697ec91a7777b411ff3c3ae3f0d52b61e94f62f6b5149c)
• **JCE provider** (SHA256 checksum 0d502232118e5508ee6f68a405a50f1cde0d6e7905553e9bb2c7f7e87735c7f4)

Windows Server 2019

Download the version 5.4.2 software for Windows Server 2019:

• **PKCS #11 library** (SHA256 checksum e0b4a2753f1f940614a697ec91a7777b411ff3c3ae3f0d52b61e94f62f6b5149c)
• **JCE provider** (SHA256 checksum 0d502232118e5508ee6f68a405a50f1cde0d6e7905553e9bb2c7f7e87735c7f4)

Version 5.4.2 includes improved stability and bug fixes for all SDKs. This is also the last release for the CentOS 8 platform. For more information, see the [CentOS website](https://centos.org).

**PKCS #11 library**

• Improved stability and bug fixes.
OpenSSL Dynamic Engine

- Improved stability and bug fixes.

JCE provider

- Improved stability and bug fixes.

Version 5.4.1

Amazon Linux

Download the version 5.4.1 software for Amazon Linux:

- **PKCS #11 library** (SHA256 checksum e9a87d12874933f3bc943232c9de9efc6020f6d907272e10b461d0300375a784)
- **OpenSSL Dynamic Engine** (SHA256 checksum 8a8b17895e0e473b2ee3f7bd15dd9deb445f3f0af1b33c89e4c2dafa7d9f452b)
- **JCE provider** (SHA256 checksum 9dc53f4bcfab4a062534f82e65e2708a60c9b965b1ec7eb61e9cae57863c7aa)

Amazon Linux 2

Download the version 5.4.1 software for Amazon Linux 2:

- **PKCS #11 library** (SHA256 checksum 17e28ef5a0921aa4a0832aebb5c4451836f2c238f8034d6270cd50d93b61920)
- **OpenSSL Dynamic Engine** (SHA256 checksum 75225f3b06a85262614b5c1f657c6eb1aed6fcf87dec631072aba1764c6def1506)
- **JCE provider** (SHA256 checksum c71b1a314844adb623f14dcdfbdafa0a7ca68a94021e51d48c32371d92d8e6a)

CentOS 7

Download the version 5.4.1 software for CentOS 7:

- **PKCS #11 library** (SHA256 checksum 17e28ef5a0921aa4a0832aebb5c4451836f2c238f8034d6270cd50d93b61920)
- **OpenSSL Dynamic Engine** (SHA256 checksum 75225f3b06a85262614b5c1f657c6eb1aed6fcf87dec631072aba1764c6def1506)
- **JCE provider** (SHA256 checksum c71b1a314844adb623f14dcdfbdafa0a7ca68a94021e51d48c32371d92d8e6a)

CentOS 8

Download the version 5.4.1 software for CentOS 8:

- **PKCS #11 library** (SHA256 checksum 5a01dcf5f1be7f081a4e47b686d266fd7bc94c7a26f502eaaaf62b2c99bec2b2)
- **OpenSSL Dynamic Engine** (SHA256 checksum 62776a4bb8a7a540c6578d747635d32a2f52c54080ba45cc450206a08a5a4a428)
- **JCE provider** (SHA256 checksum 1311d64d916b27c15c0890a25f6aa7f6f62ff37a8203e8bde6524bc94e661860)

Note
Due to the recent end of life for CentOS 8, we will no longer be able to support this platform with the next release.

RHEL 7

Download the version 5.4.1 software for RHEL 7:
RHEL 8

Download the version 5.4.1 software for RHEL 8:

- **PKCS #11 library** (SHA256 checksum 5a01dcf5f1be7f081a4e47b686d266fd7bc94c7a26f502eaafcf6f2bc99bec2b2)
- **OpenSSL Dynamic Engine** (SHA256 checksum 62776a4b8a7a540c6578d747636525a25f5169b9c502060a08a5a4a428)
- **JCE provider** (SHA256 checksum 1311d64d916b27c13c0890a25f6aa7f6f62ff37a82038e8bde6524bc94e661860)

Ubuntu 18.04 LTS

Download the version 5.4.1 software for Ubuntu 18.04 LTS:

- **PKCS #11 library** (SHA256 checksum 91db61b4306654b685436ecf819785ab6d22379978d4fbcf2488f70eab8679)
- **OpenSSL Dynamic Engine** (SHA256 checksum ef9b8ba5ac3fba1d21ce5bd36ff69d1bb7514d7afa30927af4ba64cafd8a8d05)
- **JCE provider** (SHA256 checksum 3a008934485a3c6be354792e21c4c48bc7ab9c30f5b76af272fa9c79f148c98eb)

Windows Server 2016

Download the version 5.4.1 software for Windows Server 2016:

- **PKCS #11 library** (SHA256 checksum f86f3f170bb12c5f512d1d5b1717906548cc295f3c1d45afbb005b89bb5cd26474)
- **JCE provider** (SHA256 checksum 1205867ee6a5b19f3bda7df13719edc98e6cb67b0561f4b7d775b91a30626cf)

Windows Server 2019

Download the version 5.4.1 software for Windows Server 2019:

- **PKCS #11 library** (SHA256 checksum f86f3f170bb12c5f512d1d5b1717906548cc295f3c1d45afbb005b89bb5cd26474)
- **JCE provider** (SHA256 checksum 1205867ee6a5b19f3bda7df13719edc98e6cb67b0561f4b7d775b91a30626cf)

Version 5.4.1 resolves a known issue ([p. 644](#)) with the PKCS #11 library. This is also the last release for the CentOS 8 platform. For more information, see the CentOS website.

PKCS #11 library

- Improved stability and bug fixes.

OpenSSL Dynamic Engine

- Improved stability and bug fixes.

JCE provider

- Improved stability and bug fixes.
Version 5.4.0

Amazon Linux

Download the version 5.4.0 software for Amazon Linux:

- **PKCS #11 library** (SHA256 checksum 8e643e52ba4690bbe75c26d871fa3af67a41dca7d41f57002e5a4e31795)
- **OpenSSL Dynamic Engine** (SHA256 checksum be6e50291eafe50d9ffca6a9367e47fl7b2e4c3ae9ee3dab5289eae2f72f)
- **JCE provider** (SHA256 checksum 0634c36c1e4a0c04ce161be55a4145748ccadeae04510066a9b4ce784b0531)

Amazon Linux 2

Download the version 5.4.0 software for Amazon Linux 2:

- **PKCS #11 library** (SHA256 checksum 7cd01f3632c06a118e7c33c2b19e70d669ff0ca96f6944a878d1f55fbd23a)
- **OpenSSL Dynamic Engine** (SHA256 checksum a7e63134bbf5f67ab893178e9a15602193818ed64f3a11bc1e98dd1c000324)
- **JCE provider** (SHA256 checksum ca6dfc9b9d96b3514455320570b8e73ef761d4f7bc6954d61b51302c6532c020)

CentOS 7

Download the version 5.4.0 software for CentOS 7:

- **PKCS #11 library** (SHA256 checksum 7cd01f3632c06a118e7c33c2b19e70d669ff0ca96f6944a878d1f55fbd23a)
- **OpenSSL Dynamic Engine** (SHA256 checksum a7e63134bbf5f67ab893178e9a15602193818ed64f3a11bc1e98dd1c000324)
- **JCE provider** (SHA256 checksum ca6dfc9b9d96b3514455320570b8e73ef761d4f7bc6954d61b51302c6532c020)

CentOS 8

Download the version 5.4.0 software for CentOS 8:

- **PKCS #11 library** (SHA256 checksum 661e8a42dbdbdc6e98f060fe8e19d8bc0f5207558afe7a1dbfd8e6f02b6d871)
- **OpenSSL Dynamic Engine** (SHA256 checksum 536ccfd4a0e4d2a76726eed3343536e5ed85522099ad96fc980de59b463855119)
- **JCE provider** (SHA256 checksum ca6dfc9b9d96b3514455320570b8e73ef761d4f7bc6954d61b51302c6532c020)

RHEL 7

Download the version 5.4.0 software for RHEL 7:

- **PKCS #11 library** (SHA256 checksum 7cd01f3632c06a118e7c33c2b19e70d669ff0ca96f6944a878d1f55fbd23a)
- **OpenSSL Dynamic Engine** (SHA256 checksum a7e63134bbf5f67ab893178e9a15602193818ed64f3a11bc1e98dd1c000324)
- **JCE provider** (SHA256 checksum ca6dfc9b9d96b3514455320570b8e73ef761d4f7bc6954d61b51302c6532c020)

RHEL 8

Download the version 5.4.0 software for RHEL 8:

- **PKCS #11 library** (SHA256 checksum 661e8a42dbdbdc6e98f060fe8e19d8bc0f5207558afe7a1dbfd8e6f02b6d871)
• **OpenSSL Dynamic Engine** (SHA256 checksum 536ccfdd4a0e4d2a762f6eed334536e5ed8522009ad96fc980de59b463855119)
  • **JCE provider** (SHA256 checksum 2d8c64a301e585f00bb52676e240ceaa415a0dad63dc392428d8dfc36c552165)

Ubuntu 18.04 LTS

Download the version 5.4.0 software for Ubuntu 18.04 LTS:

  • **PKCS #11 library** (SHA256 checksum a477dd926049663cbda3d7a534eda360023f54a149aa3d8308e34b575b87e70d)
  • **OpenSSL Dynamic Engine** (SHA256 checksum d04823a20ebe4c26135b9587f3a219fe9148e3850fe85e9fd43c818e8ee75e)
  • **JCE provider** (SHA256 checksum 7101b3fc98760a3110021b9c2e16868f7b8d6ac6d24023d3550f7af1252ca86)

Windows Server 2016

Download the version 5.4.0 software for Windows Server 2016:

  • **PKCS #11 library** (SHA256 checksum 08607f7f7690946df7c1ebe7f8b5012c5383c12afe1cbfdd5db2a326efcb13709)
  • **JCE provider** (SHA256 checksum fa4052f6fa2865a410d3582f8a1d76e90ff68e8950067cb6fb962a38a0a432b6)

Windows Server 2019

Download the version 5.4.0 software for Windows Server 2019:

  • **PKCS #11 library** (SHA256 checksum 08607f7f7690946df7c1ebe7f8b5012c5383c12afe1cbfdd5db2a326efcb13709)
  • **JCE provider** (SHA256 checksum fa4052f6fa2865a410d3582f8a1d76e90ff68e8950067cb6fb962a38a0a432b6)

Version 5.4.0 adds initial support for the JCE provider for all platforms. The JCE provider is compatible with OpenJDK 8.

**PKCS #11 library**

  • Improved stability and bug fixes.

**OpenSSL Dynamic Engine**

  • Improved stability and bug fixes.

**JCE provider**

  • **Key types**
    • RSA – 2048-bit to 4096-bit RSA keys, in increments of 256 bits.
    • AES – 128, 192, and 256-bit AES keys.
    • ECC key pairs for NIST curves secp256r1 (P-256), secp384r1 (P-384), and secp256k1.
    • DESede (3DES)
    • HMAC – with SHA1, SHA224, SHA256, SHA384, SHA512 hash support.
  • **Ciphers (encrypt and decrypt only)**
    • AES/GCM/NoPadding
    • AES/ECB/NoPadding
    • AES/CBC/PKCS5Padding
- DESede/ECB/NoPadding
- DESede/CBC/PKCSSPadding
- AES/CTR/NoPadding
- RSA/ECB/PKCS1Padding
- RSA/ECB/OAEPPadding
- RSA/ECB/OAEPWithSHA-1ANDMGF1Padding
- RSA/ECB/OAEPWithSHA-224ANDMGF1Padding
- RSA/ECB/OAEPWithSHA-256ANDMGF1Padding
- RSA/ECB/OAEPWithSHA-384ANDMGF1Padding
- RSA/ECB/OAEPWithSHA-512ANDMGF1Padding

**Digests**
- SHA-1
- SHA-224
- SHA-256
- SHA-384
- SHA-512

**Sign/Verify**
- NONEwithRSA
- SHA1withRSA
- SHA224withRSA
- SHA256withRSA
- SHA384withRSA
- SHA512withRSA
- NONEwithECDSA
- SHA1withECDSA
- SHA224withECDSA
- SHA256withECDSA
- SHA384withECDSA
- SHA512withECDSA

Integration with the Java KeyStore

**Version 5.3.0**

Amazon Linux

Download the version 5.3.0 software for Amazon Linux:

- **PKCS #11 library** (SHA256 checksum 66f34388dd6188b33d3b41c9f520be4504ad4f5a5eee758ba53106e9f3a264be)
- **OpenSSL Dynamic Engine** (SHA256 checksum 33e5245592b43157f0658472e70c341f0e4fb7342bd4e6c221a5472663face81)

Amazon Linux 2

Download the version 5.3.0 software for Amazon Linux 2:

- **PKCS #11 library** (SHA256 checksum a66cbb9158e1555977093dd155577625adc3d57be2b7345714711a541d14eb31ee)
• **OpenSSL Dynamic Engine** (SHA256 checksum 14fa042bdf7cb290b7e3f9ee3f3eb2d1345672f362ed25da01cbedaf8cf1511)

CentOS 7

Download the version 5.3.0 software for CentOS 7:

• **PKCS #11 library** (SHA256 checksum a66cb515a2155977093dd15577625ad3557be2b7345714711a541d14e831ee)
• **OpenSSL Dynamic Engine** (SHA256 checksum 14fa042bdf7cb290b7e3f9ee3f3eb2d1345672f362ed25da01cbedaf8cf1511)

CentOS 8

Download the version 5.3.0 software for CentOS 8:

• **PKCS #11 library** (SHA256 checksum f4a0451cdccf87240a23ab4f18fcd0d32a2edd0806b1d1669b831523f762b4c)
• **OpenSSL Dynamic Engine** (SHA256 checksum 71173b74a9c20364f5aff64553d0eb6984dc91ec84c8f6a6b7ff2ceca0db27c3)

RHEL 7

Download the version 5.3.0 software for RHEL 7:

• **PKCS #11 library** (SHA256 checksum a66cb515a2155977093dd15577625ad3557be2b7345714711a541d14e831ee)
• **OpenSSL Dynamic Engine** (SHA256 checksum 14fa042bdf7cb290b7e3f9ee3f3eb2d1345672f362ed25da01cbedaf8cf1511)

RHEL 8

Download the version 5.3.0 software for RHEL 8:

• **PKCS #11 library** (SHA256 checksum f4a0451cdccf87240a23ab4f18fcd0d32a2edd0806b1d1669b831523f762b4c)
• **OpenSSL Dynamic Engine** (SHA256 checksum 71173b74a9c20364f5aff64553d0eb6984dc91ec84c8f6a6b7ff2ceca0db27c3)

Ubuntu 18.04 LTS

Download the version 5.3.0 software for Ubuntu 18.04 LTS:

• **PKCS #11 library** (SHA256 checksum dc1b378f0cd554f588ed783cf0dd7b209352347f8a888fa63e24554f27bac91a)
• **OpenSSL Dynamic Engine** (SHA256 checksum 9a8373497882ccc325ee4a533b1e7bfc9e5ad43eb6b11f2d104a3b41303a90a)

Windows Server 2016

Download the version 5.3.0 software for Windows Server 2016: **PKCS #11 library** (SHA256 checksum 1d262717746aa1ed33db380b78ac0babbb8bb45a444425f4518c09b4288f7f4de)

Windows Server 2019

Download the version 5.3.0 software for Windows Server 2019: **PKCS #11 library** (SHA256 checksum 1d262717746aa1ed33db380b78ac0babbb8bb45a444425f4518c09b4288f7f4de)
• Improved stability and bug fixes.

OpenSSL Dynamic Engine
• Add support for ECDSA sign/verify with curves P-256, P-384, and secp256k1.
• Add support for the platforms: Amazon Linux, Amazon Linux 2, Centos 7.8+, RHEL 7.9+.
• Add support for OpenSSL version 1.0.2.
• Improved stability and bug fixes.

JCE provider
• Key types
  • RSA – 2048-bit to 4096-bit RSA keys, in increments of 256 bits.
  • AES – 128, 192, and 256-bit AES keys.
  • EC key pairs for NIST curves secp256r1 (P-256), secp384r1 (P-384), and secp256k1.
  • DESede (3DES)
  • HMAC – with SHA1, SHA224, SHA256, SHA384, SHA512 hash support.
• Ciphers (encrypt and decrypt only)
  • AES/GCM/NoPadding
  • AES/ECB/NoPadding
  • AES/CBC/PKCS5Padding
  • DESede/ECB/NoPadding
  • DESede/CBC/PKCS5Padding
  • AES/CTR/NoPadding
  • RSA/ECB/PKCS1Padding
  • RSA/ECB/OAEPPadding
  • RSA/ECB/OAEPWithSHA-1ANDMGF1Padding
  • RSA/ECB/OAEPWithSHA-224ANDMGF1Padding
  • RSA/ECB/OAEPWithSHA-256ANDMGF1Padding
  • RSA/ECB/OAEPWithSHA-384ANDMGF1Padding
  • RSA/ECB/OAEPWithSHA-512ANDMGF1Padding
• Digests
  • SHA-1
  • SHA-224
  • SHA-256
  • SHA-384
  • SHA-512
• Sign/Verify
  • NONEwithRSA
  • SHA1withRSA
  • SHA224withRSA
  • SHA256withRSA
  • SHA384withRSA
  • SHA512withRSA
  • NONEwithECDSA
• SHA1withECDSA
• SHA224withECDSA
• SHA256withECDSA
• SHA384withECDSA
• SHA512withECDSA
• Integration with the Java KeyStore

Version 5.2.1

Amazon Linux

Download the version 5.2.1 software for Amazon Linux:

- **PKCS #11 library** (SHA256 checksum 710654ef82794e2cda4b49ee621ac83b64c23b38b2d935e2fd0d04a311994730f5)

Amazon Linux 2

Download the version 5.2.1 software for Amazon Linux 2:

- **PKCS #11 library** (SHA256 checksum b3ac4b0d4a27d58a3ae3df45702c2c1197dafa5703fb8d403813019451a9f36)

CentOS 7.8+

Download the version 5.2.1 software for CentOS 7.8+:

- **PKCS #11 library** (SHA256 checksum b3ac4b0d4a27d58a3ae3df45702c2c1197dafa5703fb8d403813019451a9f36)

CentOS 8.3+

Download the version 5.2.1 software for CentOS 8.3+:

- **PKCS #11 library** (SHA256 checksum 57909c25f0c95c2af8b78a833aec7acdd09d7dc448c266b89893d8a03c7b9a45)
- **OpenSSL Dynamic Engine** (SHA256 checksum e9d3daecd68f66acade6036bd5aa108ac59cb91d3f31ee9b758c5590812086)

RHEL 7.9+

Download the version 5.2.1 software for RedHat Enterprise Linux 7.8+:

- **PKCS #11 library** (SHA256 checksum b3ac4b0d4a27d58a3ae3df45702c2c1197dafa5703fb8d403813019451a9f36)

RHEL 8.3+

Download the version 5.2.1 software for RedHat Enterprise Linux 8.3+:

- **PKCS #11 library** (SHA256 checksum 57909c25f0c95c2af8b78a833aec7acdd09d7dc448c266b89893d8a03c7b9a45)
- **OpenSSL Dynamic Engine** (SHA256 checksum e9d3daecd68f66acade6036bd5aa108ac59cb91d3f31ee9b758c5590812086)

Ubuntu 18.04 LTS

Download the version 5.2.1 software for Ubuntu 18.04 LTS:
• **PKCS #11 library** (SHA256 checksum 29ab3ea6fc9ff84ce94f5e4e79c254190e4a6d0af5d4c5583416a892998019f0)

• **OpenSSL Dynamic Engine** (SHA256 checksum 55e48b58358e6a2e701ba42dd0fd29bcae57d08b0af77a3f44c62b397edd8b9a)

Windows Server 2016

Download the latest version 5.2.1 software for Windows Server 2016:

• **PKCS #11 library** (SHA256 checksum b82c2afa1e8353fb47fa392ba20be480e0d2cobe361acb6d8aca8af8f8803545)

For information about Windows Server platform support for Client SDK 5, see ?? (p. 392).

Windows Server 2019

Download the latest version 5.2.1 software for Windows Server 2019:

• **PKCS #11 library** (SHA256 checksum b82c2afa1e8353fb47fa392ba20be480e0d2cobe361acb6d8aca8af8f8803545)

For information about Windows Server platform support for Client SDK 5, see ?? (p. 392).

**PKCS #11 library**

• Improved stability and bug fixes.

**OpenSSL Dynamic Engine**

• Improved stability and bug fixes.

**Version 5.2.0**

Amazon Linux

Download the version 5.2.0 software for Amazon Linux:

• **PKCS #11 library** (SHA256 checksum 6ba98c1cd05e80d96e690c146c4d870f34a8971f542a3b7c3b0c96ac2bfd940)

Amazon Linux 2

Download the version 5.2.0 software for Amazon Linux 2:

• **PKCS #11 library** (SHA256 checksum 3df6395a9d15ad3d1b1c19be78dbac96a704be304d96f9ae9101a78f7573797)

CentOS 7.8+

Download the version 5.2.0 software for CentOS 7.8+:

• **PKCS #11 library** (SHA256 checksum 3df6395a9d15ad3d1b1c19be78dbac96a704be304d96f9ae9101a78f7573797)

CentOS 8.3+

Download the version 5.2.0 software for CentOS 8.3+:

• **PKCS #11 library** (SHA256 checksum d1d3f8d2ec98e7bdc4fffc8e3f6affd4b7d11113ab8480ba2c7dd6ed17c280e)
AWS CloudHSM User Guide
Previous Client SDK 5 releases

• **OpenSSL Dynamic Engine** (SHA256 checksum
  f5d8fd6d694c481f6c51a1e9ff2c45873f31df1000db671901a26f5041f905f8)

RHEL 7.9+

Download the version 5.2.0 software for RedHat Enterprise Linux 7.8+:

• **PKCS #11 library** (SHA256 checksum 3df6395a9d15a3d5d1bc19bae78dbac96a704e3d049f9ae9101a787f7573797)

RHEL 8.3+

Download the version 5.2.0 software for RedHat Enterprise Linux 8.3+:

• **PKCS #11 library** (SHA256 checksum d1d3f8d2ec98ae7bdcc4ff8f3e6affd47d11113ab8480ba2c7dd6ed17c280e)
• **OpenSSL Dynamic Engine** (SHA256 checksum
  f5d8fd6d694c481f6c51a1e9ff2c45873f31df1000db671901a26f5041f905f8)

Ubuntu 18.04 LTS

Download the version 5.2.0 software for Ubuntu 18.04 LTS:

• **PKCS #11 library** (SHA256 checksum 25448e26a2f600ee53143779001bb001111aa37d34b861f4a88a7e507eb6ec44)
• **OpenSSL Dynamic Engine** (SHA256 checksum
  797061b4c4a2550172ec0d49e694ca76ddef0f157a2ce39a5f39a650767c36)

Windows Server 2016

Download the latest version 5.2.0 software for Windows Server 2016:

• **PKCS #11 library** (SHA256 checksum 64c9afa1856a7166707d563ab4eeedc2dc27132df7f5e76c0467ca996828fff0b)

For information about Windows Server platform support for Client SDK 5, see ??? (p. 392).

Windows Server 2019

Download the latest version 5.2.0 software for Windows Server 2019:

• **PKCS #11 library** (SHA256 checksum 64c9afa1856a7166707d563ab4eeedc2dc27132df7f5e76c0467ca996828fff0b)

For information about Windows Server platform support for Client SDK 5, see ??? (p. 392).

Version 5.2.0 adds support additional key types and mechanisms to the PKCS #11 library.

**PKCS #11 library**

Key Types

• ECDSA– P-224, P-256, P-384, P-521 and secp256k1 curves
• Triple DES (3DES)

Mechanisms

• CKM_EC_KEY_PAIR_GEN
• CKM_DES3_KEY_GEN
• CKM_DES3_CBC
• CKM_DES3_CBC_PAD
• CKM_DES3_ECB
• CKM_ECDSA
• CKM_ECDSA_SHA1
• CKM_ECDSA_SHA224
• CKM_ECDSA_SHA256
• CKM_ECDSA_SHA384
• CKM_ECDSA_SHA512
• CKM_RSA_PKCS for Encrypt/Decrypt

OpenSSL Dynamic Engine
• Improved stability and bug fixes.

Version 5.1.0

Amazon Linux

Download the version 5.1.0 software for Amazon Linux:

• PKCS #11 library (SHA256 checksum cd9016efeb1d7339be1fda4c0f0d32f9144a119077da9f409f7e6f27c1d54c8b)

Amazon Linux 2

Download the version 5.1.0 software for Amazon Linux 2:

• PKCS #11 library (SHA256 checksum 9674d705032b39087a8ddaa793647fa0e31968c3ede3ca67f3e65be4f0d77a1)

CentOS 7.8+

Download the version 5.1.0 software for CentOS 7.8+:

• PKCS #11 library (SHA256 checksum 9674d705032b39087a8ddaa793647fa0e31968c3ede3ca67f3e65be4f0d77a1)

CentOS 8.3+

Download the version 5.1.0 software for CentOS 8.3+:

• PKCS #11 library (SHA256 checksum 9674d705032b39087a8ddaa793647fa0e31968c3ede3ca67f3e65be4f0d77a1)

• OpenSSL Dynamic Engine (SHA256 checksum fd2f8f5fca5ed3d92f602c6673e8b92daa70d904c7428d8be90e6a7b5492c8b)

RHEL 7.9+

Download the version 5.1.0 software for RedHat Enterprise Linux 7.8+:

• PKCS #11 library (SHA256 checksum 9674d705032b39087a8ddaa793647fa0e31968c3ede3ca67f3e65be4f0d77a1)

RHEL 8.3+

Download the version 5.1.0 software for RedHat Enterprise Linux 8.3+:
• **PKCS #11 library** (SHA256 checksum 0c0de23d884500b47cf0df89943f902c5a52cb48a6088693c51e31a240bc0bc3)
• **OpenSSL Dynamic Engine** (SHA256 checksum fd2f8f5ca5ed3d92ff602c667e8b92daa70d904c7428d8b5e90ea6a7b5492cde)

**Ubuntu 18.04 LTS**

Download the version 5.1.0 software for Ubuntu 18.04 LTS:

• **PKCS #11 library** (SHA256 checksum f03e683f37fe82209451b95704d42716c1e6155611c6c02e7838e5e41c429019)
• **OpenSSL Dynamic Engine** (SHA256 checksum 956b51bb5a20a302c938c8ad29542a487b2c85fe7a7c9e3386f7d280d6913058)

**Windows Server 2016**

Download the latest version 5.1.0 software for Windows Server 2016:

• **PKCS #11 library** (SHA256 checksum 520c9cd19fc48dcf61b2e3f2d1951c6fa9ba5e41874a9db7c926a04e03147c8d)

For information about Windows Server platform support for Client SDK 5, see [??](p. 392).

**Windows Server 2019**

Download the latest version 5.1.0 software for Windows Server 2019:

• **PKCS #11 library** (SHA256 checksum 520c9cd19fc48dcf61b2e3f2d1951c6fa9ba5e41874a9db7c926a04e03147c8d)

For information about Windows Server platform support for Client SDK 5, see [??](p. 392).

**Version 5.1.0 adds support for additional mechanisms to the PKCS #11 library.**

**PKCS #11 library**

Mechanisms

• CKM_RSA_PKCS for Wrap/Unwrap
• CKM_RSA_PKCS_PSS
• CKM_SHA1_RSA_PKCS_PSS
• CKM_SHA224_RSA_PKCS_PSS
• CKM_SHA256_RSA_PKCS_PSS
• CKM_SHA384_RSA_PKCS_PSS
• CKM_SHA512_RSA_PKCS_PSS
• CKM_AES ECB
• CKM_AES CTR
• CKM_AES CBC
• CKM_AES_CBC_PAD
• CKM_SP800_108_COUNTER_KDF
• CKM_GENERIC_SECRET_KEY_GEN
• CKM_SHA_1 HMAC
• CKM_SHA224 HMAC
• CKM_SHA256 HMAC

703
• CKM_SHA384_HMAC
• CKM_SHA512_HMAC
• CKM_RSA_PKCS_OAEP Wrap/Unwrap only
• CKM_RSA_AES_KEY_WRAP
• CKM_CLOUDHSM_AES_KEY_WRAP_NO_PAD
• CKM_CLOUDHSM_AES_KEY_WRAP_PKCS5_PAD
• CKM_CLOUDHSM_AES_KEY_WRAP_ZERO_PAD

API Operations
• C_CreateObject
• C_DeriveKey
• C_WrapKey
• C_UnWrapKey

OpenSSL Dynamic Engine
• Improved stability and bug fixes.

Version 5.0.1

Amazon Linux
Download the version 5.0.1 software for Amazon Linux:
• PKCS #11 library (introductory support)

Amazon Linux 2
Download the version 5.0.1 software for Amazon Linux 2:
• PKCS #11 library (introductory support)

CentOS 7.8+
Download the version 5.0.1 software for CentOS 7.8+:
• PKCS #11 library (introductory support)

CentOS 8.3+
Download the version 5.0.1 software for CentOS 8.3+:
• PKCS #11 library (introductory support)
• OpenSSL Dynamic Engine (introductory support)

RHEL 7.9+
Download the version 5.0.1 software for RedHat Enterprise Linux 7.8+:
• PKCS #11 library (introductory support)
RHEL 8.3+

Download the version 5.0.1 software for RedHat Enterprise Linux 8.3+:

- **PKCS #11 library** (introductory support)
- **OpenSSL Dynamic Engine** (introductory support)

Ubuntu 18.04 LTS

Download the version 5.0.1 software for Ubuntu 18.04 LTS:

- **PKCS #11 library** (introductory support)
- **OpenSSL Dynamic Engine** (introductory support)

Windows Server 2016

Download the latest version 5.0.1 software for Windows Server 2016:

- **PKCS #11 library** (introductory support)

For information about Windows Server platform support for Client SDK 5, see ??? (p. 392).

Windows Server 2019

Download the latest version 5.0.1 software for Windows Server 2019:

- **PKCS #11 library** (introductory support)

For information about Windows Server platform support for Client SDK 5, see ??? (p. 392).

Version 5.0.1 adds initial support for OpenSSL Dynamic Engine.

**PKCS #11 library**

- Improved stability and bug fixes.

**OpenSSL Dynamic Engine**

- Initial release of OpenSSL Dynamic Engine.
- This release offers introductory support for key types and OpenSSL APIs:
  - RSA key generation for 2048, 3072, and 4096-bit keys
  - OpenSSL APIs:
    - **RSA Sign** using RSA PKCS with SHA1/224/256/384/512 & RSA PSS
    - **RSA Key Generation**

For more information, see **OpenSSL Dynamic Engine (p. 418).**

- Platforms supported: CentOS 8.3+, Red Hat Enterprise Linux (RHEL) 8.3+, and Ubuntu 18.04 LTS
- Requires: OpenSSL 1.1.1

For more information, see **Supported Platforms (p. 392).**

- Support for SSL/TLS Offload on CentOS 8.3+, Red Hat Enterprise Linux (RHEL) 8.3, and Ubuntu 18.04 LTS, including NGINX 1.19 (for select cipher suites).

For more information, see **Using SSL/TLS Offload on Linux (p. 508).**

705
Version 5.0.0

Amazon Linux

Download the version 5.0.0 software for Amazon Linux:

- **PKCS #11 library**

Amazon Linux 2

Download the version 5.0.0 software for Amazon Linux 2:

- **PKCS #11 library**

CentOS 7.8+

Download the version 5.0.0 software for CentOS 7.8+:

- **PKCS #11 library**

CentOS 8.3+

Download the version 5.0.0 software for CentOS 8.2:

- **PKCS #11 library**

RHEL 7.9+

Download the version 5.0.0 software for RedHat Enterprise Linux 7.8+:

- **PKCS #11 library**

RHEL 8.3+

Download the version 5.0.0 software for RedHat Enterprise Linux 8.2:

- **PKCS #11 library**

Ubuntu 18.04 LTS

Download the version 5.0.0 software for Ubuntu 18.04 LTS:

- **PKCS #11 library**

Windows Server 2016

Download the latest version 5.0.0 software for Windows Server 2016:

- **PKCS #11 library**

For information about Windows Server platform support for Client SDK 5, see ?? (p. 392).

Windows Server 2019

Download the latest version 5.0.0 software for Windows Server 2019:
• **PKCS #11 library**

For information about Windows Server platform support for Client SDK 5, see ?? (p. 392).

Version 5.0.0 is the first release.

**PKCS #11 library**

• This is the initial release.

**Introductory PKCS #11 library support in client SDK version 5.0.0**

This section details support for key types, mechanisms, API operations and attributes Client SDK version 5.0.0.

**Key Types:**

• **AES**– 128, 192, and 256-bit AES keys
• **RSA**– 2048-bit to 4096-bit RSA keys, in increments of 256 bits

**Mechanisms:**

• CKM_AES_GCM
• CKM_AES_KEY_GEN
• CKM_CLOUDHSM_AES_GCM
• CKM_RSA_PKCS
• CKM_RSA_X9_31_KEY_PAIR_GEN
• CKM_SHA1
• CKM_SHA1_RSA_PKCS
• CKM_SHA224
• CKM_SHA224_RSA_PKCS
• CKM_SHA256
• CKM_SHA256_RSA_PKCS
• CKM_SHA384
• CKM_SHA384_RSA_PKCS
• CKM_SHA512
• CKM_SHA512_RSA_PKCS

**API Operations:**

• C_CloseAllSessions
• C_CloseSession
• C_Decrypt
• C_DecryptFinal
• C_DecryptInit
• C_DecryptUpdate
• C_DestroyObject
• C_Digest
• C_DigestFinal
• C_DigestInit
• C_DigestUpdate
• C_Encrypt
• C_EncryptFinal
• C_EncryptInit
• C_EncryptUpdate
• C_Finalize
• C_FindObjects
• C_FindObjectsFinal
• C_FindObjectsInit
• C_GenerateKey
• C_GenerateKeyPair
• C_GenerateRandom
• C_GetAttributeValue
• C_GetFunctionList
• C_GetInfo
• C_GetMechanismInfo
• C_GetMechanismList
• C_GetSessionInfo
• C_GetSlotInfo
• C_GetSlotList
• C_GetTokenInfo
• C_Initialize
• C_Login
• C_Logout
• C_OpenSession
• C_Sign
• C_SignFinal
• C_SignInit
• C_SignUpdate
• C_Verify
• C_VerifyFinal
• C_VerifyInit
• C_VerifyUpdate

Attributes:
• GenerateKeyPair
  • All RSA Key attributes
• GenerateKey
  • All AES Key attributes
• GetAttributeValue
  • All RSA Key attributes
  • All AES Key attributes
Previous Client SDK 3 releases

This section lists previous Client SDK 3 releases. For the current Client SDK 3 release, see the section called "Latest releases" (p. 671).

Version 3.4.3

To download the software, choose the tab for your preferred operating system, then choose the link to each software package.

Amazon Linux

Download the version 3.4.3 software for Amazon Linux:

- **AWS CloudHSM Client** (SHA256 checksum a92337e0f1d8a7d5db89b16f7530555746af1affd609df0d7381cfeab2e04fd)
- **PKCS #11 library** (SHA256 checksum 49be5d60d07ea90cc70522875f9ba477e4a356f37051086c51e31d0f6196501)
- **OpenSSL Dynamic Engine** (SHA256 checksum 5605a34334f120af2e2ecf6bc5eab0cc30a46abe2e51edd8f48091bbd8819ebb)
- **JCE provider** (SHA256 checksum a3d78eb4f8195e37a1f263bc3e16f1e767a78db8e6b9d276b1e64e6ed003f9)
- **AWS CloudHSM Management Utility** (SHA256 checksum 82c0dbf9eb522a2462a66105cc93dd6c3f11d59e8e9845b3d93419286130a10c)

Amazon Linux 2

Download the version 3.4.3 software for Amazon Linux 2:

- **AWS CloudHSM Client** (SHA256 checksum 16e5fd76c19216f270219524bdb4ab82a0ccdbec04175b4a7e34615cadd741ac)
- **PKCS #11 library** (SHA256 checksum 0f9ac194bc5fbc615e4735d87e6174f4630d737f221cebed5e2cc9061095f)
- **OpenSSL Dynamic Engine** (SHA256 checksum ca0007b6b0d050f0bb6baebebc9bf353c2f0eeefc1cd51437d46c9db2781046d7353)
- **JCE provider** (SHA256 checksum 0109c40792414beae32e78f61000248db79cf1216dfdb3b52bd458fb6610)
- **AWS CloudHSM Management Utility** (SHA256 checksum 045af33133c0a809c45876fdc45f81234613f1cb718e10b138df06b08427365)

CentOS 6

AWS CloudHSM does not support CentOS 6 with Client SDK Version 3.4.3.

Use the section called “Version 3.2.1” (p. 728) for CentOS 6 or choose a supported platform.

CentOS 7

Download the version 3.4.3 software for CentOS 7:

- **AWS CloudHSM Client** (SHA256 checksum 16e3fd76c19216f270219524bdb4ab82a0ccdbec04175b4a7e34615cadd741ac)
previous client SDK 3 releases

- **PKCS #11 library** (SHA256 checksum 0f9ac194bc3fcb615e4735d87e6174f4630d776f2211cbe9d5e2cc90631095f)
- **OpenSSL Dynamic Engine** (SHA256 checksum ca0007b6b0d5f0bb6beaebc9bf59c2fefeefc1d54747c9d6b2781046d7353)
- **JCE provider** (SHA256 checksum 0109c40792414beaea32e78f6100024d8db79cf1216fddfba36b5f2bd458fb6610)
- **AWS CloudHSM Management Utility** (SHA256 checksum 045af33133c0a809c45876f6dc45f81234613f1cb718e10b138d0f6b08427365)

**CentOS 8**

Download the version 3.4.3 software for CentOS 8:

- **AWS CloudHSM Client** (SHA256 checksum 5436a0b1c2df34cf846c79a5479a986e125dbb04234a2b1fa38db19bb9ba0b8)
- **PKCS #11 library** (SHA256 checksum 9d5abe25513294e3e35677f0c896547fc7671e19db6f6514066161d933b84fed1)
- **JCE provider** (SHA256 checksum 04e48e47cfdbcea47b45f988c95832244af2ab18bc3c040249c91ad2a99ab64)
- **AWS CloudHSM Management Utility** (SHA256 checksum da50c29bbee65f84d9b4769b3f3539a9b5189c51c7e0ae8981b85290a4f5d152)

**RHEL 6**

AWS CloudHSM does not support RedHat Enterprise Linux 6 with Client SDK Version 3.4.3.

Use the section called “Version 3.2.1” (p. 728) for RedHat Enterprise Linux 6 or choose a supported platform.

**RHEL 7**

Download the version 3.4.3 software for RedHat Enterprise Linux 7:

- **AWS CloudHSM Client** (SHA256 checksum 16e3fd76c19216f270219524dbd4ab82a0ccdbec04175b4a7e34615cadd741ac)
- **PKCS #11 library** (SHA256 checksum 0f9ac194bc3fcb615e4735d87e6174f4630d776f2211cbe9d5e2cc90631095f)
- **OpenSSL Dynamic Engine** (SHA256 checksum ca0007b6b0d5f0bb6beaebc9bf59c2fefeefc1d54747c9d6b2781046d7353)
- **JCE provider** (SHA256 checksum 04e48e47cfdbcea47b45f988c95832244af2ab18bc3c040249c91ad2a99ab64)
- **AWS CloudHSM Management Utility** (SHA256 checksum 045af33133c0a809c45876f6dc45f81234613f1cb718e10b138d0f6b08427365)

**RHEL 8**

Download the version 3.4.3 software for RedHat Enterprise Linux 8:

- **AWS CloudHSM Client** (SHA256 checksum 5436a0b1c2df34cf846c79a5479a986e125dbb04234a2b1fa38db19bb9ba0b8)
- **PKCS #11 library** (SHA256 checksum 9d5abe25513294e3e35677f0c896547fc7671e19db6f6514066161d933b84fed1)
- **JCE provider** (SHA256 checksum 04e48e47cfdbcea47b45f988c95832244af2ab18bc3c040249c91ad2a99ab64)
- **AWS CloudHSM Management Utility** (SHA256 checksum da50c29bbee65f84d9b4769b3f3539a9b5189c51c7e0ae8981b85290a4f5d152)

**Ubuntu 16.04 LTS**

Download the version 3.4.3 software for Ubuntu 16.04 LTS:

- **AWS CloudHSM Client** (SHA256 checksum ab6cf9173c4023f0766f2b67e66d507cdd597302576cfc9507c23734560f67f9)
- **PKCS #11 library** (SHA256 checksum 71a72147a6c593d3b1061879dbbf891640dab2909ca9efdef4dad3b66013863)
AWS CloudHSM User Guide
Previous Client SDK 3 releases

- **OpenSSL Dynamic Engine** (SHA256 checksum 20b8a764e341a2d2b6e4a7197e5f32ec9e215fc5314d309f14f7d38e18f6e986)
- **JCE provider** (SHA256 checksum 6deb8ad0c7950f55302a3d9828e7f7a1ed7faba7148f738e1c8d324b631163)
- **AWS CloudHSM Management Utility** (SHA256 checksum 0a74107394bca140dfab44dbcd486c5969df7d3e51b601db787398531d2)

**Note**
Due to the impending EOL of Ubuntu 16.04, we intend to drop support for this platform with the next release.

Ubuntu 18.04 LTS

Download the version 3.4.3 software for Ubuntu 18.04 LTS:

- **AWS CloudHSM Client** (SHA256 checksum 03db8b339494c5b6d7f84fb96225f64f2a10e60070aba9f9b9c9e04bb7b5916)
- **PKCS #11 library** (SHA256 checksum 8fffc5b2988bb2845476177e881b4a62785fbed2a383cd656765921d552eac)
- **JCE provider** (SHA256 checksum b6a103606f5c54e85ac98da257eef872139148727cb573ac43e55d6952c547e4)
- **AWS CloudHSM Management Utility** (SHA256 checksum 5d611d31132a9e667027a1143b9d3e744ef701beef4660977c31b8658db3b1)

Windows Server

AWS CloudHSM supports 64-bit versions of Windows Server 2012, Windows Server 2012 R2 and Windows Server 2016. The AWS CloudHSM 3.4.3 client software for Windows Server includes the required CNG and KSP providers. For details, see Install and Configure the AWS CloudHSM Client (Windows) (p. 259). Download the latest version (3.4.3) software for Windows Server:

- **AWS CloudHSM for Windows Server** (SHA256 checksum 56b32ed4d4c26b3a4e5476cb83defe6b5db0881954d0ec859fb1d7122a7d07d)
- **AWS CloudHSM Management Utility** (SHA256 checksum fe2cda7eb83a6add0d56bac1ace467767e80520d325b78b6012c8f05e8a903cc1)

Version 3.4.3 adds updates to JCE provider.

**AWS CloudHSM Client Software**

- Updated the version for consistency.

**PKCS #11 library**

- Updated the version for consistency.

**OpenSSL Dynamic Engine**

- Updated the version for consistency.

**JCE provider**

- Update log4j to version 2.17.0.

**Windows (CNG and KSP providers)**

- Updated the version for consistency.
Version 3.4.2

To download the software, choose the tab for your preferred operating system, then choose the link to each software package.

Amazon Linux

Download the version 3.4.2 software for Amazon Linux:

- **AWS CloudHSM Client** (SHA256 checksum 5fcb89ace8bb30f2ecaed54eddb125157d4c5da48016428d08212bcb4a56fc6)
- **PKCS #11 library** (SHA256 checksum d85b2ae769bbcc96efa86b1bfc7bac22ddeb1b237ad6bab6b74022b61c9db638578)
- **OpenSSL Dynamic Engine** (SHA256 checksum 8c36f8a8701b738294ce9d66b1a366f1b139d4dbb8f52b3b7f8c5bfcd8391c4)
- **JCE provider** (SHA256 checksum 589d74275c525090248909c67ee756fc35f5f8932d08a4a981f4b275b981)
- **AWS CloudHSM Management Utility** (SHA256 checksum ba55f0dee3bf728f9609b41b82f817bde5a2f17563c850a7480d7ff2782f44)

Amazon Linux 2

Download the version 3.4.2 software for Amazon Linux 2:

- **AWS CloudHSM Client** (SHA256 checksum 8110f2d5f5ec0dbdc1f7c49511610ad678b0a27823edcba2e3c4c79f6859aa8f)
- **PKCS #11 library** (SHA256 checksum 2c2225f29a30347810b0bdef6170366b64b6a98955bd5cb1c588e8230a7dbd24)
- **OpenSSL Dynamic Engine** (SHA256 checksum 3b07f158e1093c6b667f2c8810239679b9a42ac9472a065bf97fd4d75a4a9f28)
- **JCE provider** (SHA256 checksum ec9e9e834ef51c58ab360124d28264a23173b19f101806403cf1addb1a808)
- **AWS CloudHSM Management Utility** (SHA256 checksum 2ee1625ab2634e96a2bf5f6a3df87d085991a4bf404e9b6e99358de2902db2)

CentOS 6

AWS CloudHSM does not support CentOS 6 with Client SDK Version 3.4.2.

Use the section called “Version 3.2.1” (p. 728) for CentOS 6 or choose a supported platform.

CentOS 7

Download the version 3.4.2 software for CentOS 7:

- **AWS CloudHSM Client** (SHA256 checksum 8110f2d5f5ec0dbdc1f7c49511610ad678b0a27823edcba2e3c4c79f6859aa8f)
- **PKCS #11 library** (SHA256 checksum 2c2225f29a30347810b0bdef6170366b64b6a98955bd5cb1c588e8230a7dbd24)
- **OpenSSL Dynamic Engine** (SHA256 checksum 3b07f158e1093c6b667f2c8810239679b9a42ac9472a065bf97fd4d75a4a9f28)
- **JCE provider** (SHA256 checksum ec9e9e834ef51c58ab360124d28264a23173b19f101806403cf1addb1a808)
- **AWS CloudHSM Management Utility** (SHA256 checksum 2ee1625ab2634e96a2bf5f6a3df87d085991a4bf404e9b6e99358de2902db2)

CentOS 8

Download the version 3.4.2 software for CentOS 8:

- **AWS CloudHSM Client** (SHA256 checksum 1a1f9f4924ac5d0778f40d5af827e270e67074744ec2ff84eb44f3f2bb3cb71)
- **PKCS #11 library** (SHA256 checksum 922ff0f24ee129f57bddd7a7a57521d1117e4e910f17047c674b395121760fe)
• **JCE provider** (SHA256 checksum e68dd76218eb476b235d7fd1aa911b5c8567511bd9787ed45744d6d146c519ac)
• **AWS CloudHSM Management Utility** (SHA256 checksum f9a8c5046c8b3df10d098dc299a921158ca820c0d015a167b1498036c33b0bd)

**RHEL 6**

AWS CloudHSM does not support RedHat Enterprise Linux 6 with Client SDK Version 3.4.2.

Use the section called “Version 3.2.1” (p. 728) for RedHat Enterprise Linux 6 or choose a supported platform.

**RHEL 7**

Download the version 3.4.2 software for RedHat Enterprise Linux 7:

• **AWS CloudHSM Client** (SHA256 checksum 8110f2d5f3ec0dbd1cf7c49511610ad678b0a27823edcba2e3c4c79f6859aa8f)
• **PKCS #11 library** (SHA256 checksum 2c2225f29a303547810b0bdef6170566b4a698955bd5cb1c588e8230a7dbd24)
• **OpenSSL Dynamic Engine** (SHA256 checksum 3b07f1588e1095c5cb67f2c8810235967909a42ac9472a065bf97fd4d75a4af9f28)
• **JCE provider** (SHA256 checksum e9a98e3aeef51c58ab5601248d28264a23173b19f10180604c3cf1adbd1a808)
• **AWS CloudHSM Management Utility** (SHA256 checksum 2ee1625ab263496a2b5f6e3df87d085991a4b4f04e9bee993c58de2902db2)

**RHEL 8**

Download the version 3.4.2 software for RedHat Enterprise Linux 8:

• **AWS CloudHSM Client** (SHA256 checksum 1a1f9a4924ac5d0778f40d5af827e270e67074744ec2ff84eb44f3f2bb3cb71)
• **PKCS #11 library** (SHA256 checksum 922f0f24ee129f57bddd7d7a757521d11174e910f7047674ab395121760fe)
• **JCE provider** (SHA256 checksum e68dd76218eb476b235d7fd1aa911b5c8567511bd9787ed45744d6d146c519ac)
• **AWS CloudHSM Management Utility** (SHA256 checksum f9a8c5046c8b3df10d098dc299a921158ca820c0d015a167b1498036c33b0bd)

**Ubuntu 16.04 LTS**

Download the version 3.4.2 software for Ubuntu 16.04 LTS:

• **AWS CloudHSM Client** (SHA256 checksum f8e20b397cc5fa78c400c59b94f6fa2313b6df310a55477bb6002c943259e)
• **PKCS #11 library** (SHA256 checksum f9f7e8619d1e05a837028f103315ed50461tcb79d249fa9e5fc8601b6381)
• **OpenSSL Dynamic Engine** (SHA256 checksum 827d686f7bd961c70a35b262a7003edec5d4b05f5f4eb9c5c05f585c15543ee)
• **JCE provider** (SHA256 checksum 74ce4fba33f6b1f4a79a6d62ace011b215904483397b676e2740a094c058d76d)
• **AWS CloudHSM Management Utility** (SHA256 checksum 35bbcf5be6b1ab68da11db61c28e1t1b4bee0d7c03be6430d7ee77a8d23ae28)

**Note**

Due to the impending EOL of Ubuntu 16.04, we intend to drop support for this platform with the next release.

**Ubuntu 18.04 LTS**

Download the version 3.4.2 software for Ubuntu 18.04 LTS:

• **AWS CloudHSM Client** (SHA256 checksum 555c659973e24e7dcb788c80e57fae982844b14f35381a808b212991141a24fe6)
AWS CloudHSM User Guide
Previous Client SDK 3 releases

- **PKCS #11 library** (SHA256 checksum 7dcb31b5db1b0f75ea2ed1f9f14dc62198a0d2fe0b8278183b958b125cf969a)
- **JCE provider** (SHA256 checksum 67893de5e86202bb73bd9541b5a7c6afa53c6fd030aad321af4a384af0f2e690)
- **AWS CloudHSM Management Utility** (SHA256 checksum cc79e50155bd1bb2ff3b538b80e768292f83b3fc0fa9237a46fb745f4112c1)

**Windows Server**

AWS CloudHSM supports 64-bit versions of Windows Server 2012, Windows Server 2012 R2 and Windows Server 2016. The AWS CloudHSM 3.4.2 client software for Windows Server includes the required CNG and KSP providers. For details, see Install and Configure the AWS CloudHSM Client (Windows) (p. 259). Download the latest version (3.4.2) software for Windows Server:

- **AWS CloudHSM for Windows Server** (SHA256 checksum 551d0b584aa320097c5c5c8ae64d43ba2922fd2ed1fe6b60e8b235909fad873)
- **AWS CloudHSM Management Utility** (SHA256 checksum b06695e6da332771b097f637d27f5c82b8c7e86e1976a5817e617d2ba8d8013)

**Version 3.4.2 adds updates to JCE provider.**

**AWS CloudHSM Client Software**

- Updated the version for consistency.

**PKCS #11 library**

- Updated the version for consistency.

**OpenSSL Dynamic Engine**

- Updated the version for consistency.

**JCE provider**

- Update log4j to version 2.16.0.

**Windows (CNG and KSP providers)**

- Updated the version for consistency.

**Version 3.4.1**

To download the software, choose the tab for your preferred operating system, then choose the link to each software package.

**Amazon Linux**

Download the version 3.4.1 software for Amazon Linux:

- **AWS CloudHSM Client** (SHA256 checksum ca038e1219d6999ed62b680fde18e0b992af082eaf9360f351a21ee2d42f786)
- **PKCS #11 library** (SHA256 checksum 6f532aba4e15a802beefae15c69874bc0e01c8076b98c7b43e4722f2209124dfb)
- **OpenSSL Dynamic Engine** (SHA256 checksum b26af7b7b4d95ac1d5a0d1a0de53c48ddac6d0b32306b0d3f72d4927647efc06)
• **JCE provider** (SHA256 checksum 76fa2c963cb23cea11644e03151a33f6fad249e872ec7609af6ab1f54371a4d5)
• **AWS CloudHSM Management Utility** (SHA256 checksum a1cd92cb4ce229aa33905f33ac9e65f147acc2e2e1b672453c0e87a2ba6d1896)

Amazon Linux 2

Download the version 3.4.1 software for Amazon Linux 2:

• **AWS CloudHSM Client** (SHA256 checksum dff54434429e24100c66f78aba4ca44a6c44dd0017b9e6f533399065bd13eefb8)
• **PKCS #11 library** (SHA256 checksum ca6a9b3f42d9f765992906380638099a04dd8bf2d3d24e2b616b2cf2f836fdd)
• **OpenSSL Dynamic Engine** (SHA256 checksum b14c1718b3d68205d7447bf467bdaa0c21b8bc0e6cd25c7065ff06f270807)
• **JCE provider** (SHA256 checksum 55327fc3f0eaac4f1c3c0a0eafac49d77c9f47d07e18b4332fed9f559c11c97e769)
• **AWS CloudHSM Management Utility** (SHA256 checksum 2e830f22bee0cee1273c512f14d437e321f716166f619aa0b5d7490374648573)

CentOS 6

AWS CloudHSM does not support CentOS 6 with Client SDK Version 3.4.1.

Use the section called “Version 3.2.1” (p. 728) for CentOS 6 or choose a supported platform.

CentOS 7

Download the version 3.4.1 software for CentOS 7:

• **AWS CloudHSM Client** (SHA256 checksum dff54434429e24100c66f78aba4ca44a6c44dd0017b9e6f533399065bd13eefb8)
• **PKCS #11 library** (SHA256 checksum ca6a9b3f42d9f765992906380638099a04dd8bf2d3d24e2b616b2cf2f836fdd)
• **OpenSSL Dynamic Engine** (SHA256 checksum b14c1718b3d68205d7447bf467bdaa0c21b8bc0e6cd25c7065ff06f270807)
• **JCE provider** (SHA256 checksum 55327fc3f0eaac4f1c3c0a0eafac49d77c9f47d07e18b4332fed9f559c11c97e769)
• **AWS CloudHSM Management Utility** (SHA256 checksum 2e830f22bee0cee1273c512f14d437e321f716166f619aa0b5d7490374648573)

CentOS 8

Download the version 3.4.1 software for CentOS 8:

• **AWS CloudHSM Client** (SHA256 checksum cd7770e2ada3f8b85250b9c18f23cb8def576be6b79ee5293e1f670f6ab9aaac4)
• **PKCS #11 library** (SHA256 checksum 3ecbfce9a61c616f2767d984c27296547c68894a3b83878077c0f2b0c0d8c157)
• **JCE provider** (SHA256 checksum 7762c85a113f9b8090f89dab1eb7529f2327b84345ea05a592c491773b7b3c104)
• **AWS CloudHSM Management Utility** (SHA256 checksum 2495720d53b332f3dab4055a7d23666f462e57e8424d69d75191841ed6960d2c0be)

RHEL 6

AWS CloudHSM does not support RedHat Enterprise Linux 6 with Client SDK Version 3.4.1.

Use the section called “Version 3.2.1” (p. 728) for RedHat Enterprise Linux 6 or choose a supported platform.

RHEL 7

Download the version 3.4.1 software for RedHat Enterprise Linux 7:
AWS CloudHSM supports 64-bit versions of Windows Server 2012, Windows Server 2012 R2 and Windows Server 2016. The AWS CloudHSM 3.4.1 client software for Windows Server includes the required CNG and KSP providers. For details, see Install and Configure the AWS CloudHSM Client (Windows) (p. 259). Download the latest version (3.4.1) software for Windows Server:
• AWS CloudHSM for Windows Server (SHA256 checksum 9164495d9716adb19b42a02be53b7ae2c796b3a76e592f9aa29443de34dcbbec)
• AWS CloudHSM Management Utility (SHA256 checksum b6192d23912feefc0ced0ff45d27479792d06a41e824a664fdd112202ca0c)

Version 3.4.1 adds updates to JCE provider.

AWS CloudHSM Client Software
• Updated the version for consistency.

PKCS #11 library
• Updated the version for consistency.

OpenSSL Dynamic Engine
• Updated the version for consistency.

JCE provider
• Update log4j to version 2.15.0.

Windows (CNG and KSP providers)
• Updated the version for consistency.

Version 3.4.0

To download the software, choose the tab for your preferred operating system, then choose the link to each software package.

Amazon Linux

Download the version 3.4.0 software for Amazon Linux:
• AWS CloudHSM Client (SHA256 checksum e5ca8d26805ea1d11da3d8801e706423d766071a7ede0bedfcae45e561f45d17)
• PKCS #11 library (SHA256 checksum 3851c30ca0d426dc054000ad6929016fc783043404ef98a4035fd964d29f6c)
• OpenSSL Dynamic Engine (SHA256 checksum ae19c864fe4b0a96ed983c03a41b84b2f0d4a91ec65485d54624e86f964f9c0)
• JCE provider (SHA256 checksum 3251d7c1152b55eda386c9c250ad9178acf503832136c6b267a0b9f825436c4b)
• AWS CloudHSM Management Utility (SHA256 checksum 9f87b47b7bd219df05905c132a7322fcb2544a3c9a68af0859c6434d5c7747e7)

Amazon Linux 2

Download the version 3.4.0 software for Amazon Linux 2:
• AWS CloudHSM Client (SHA256 checksum 4b520de05217ff7e6077bd94af6788da60e19d1b3f28e5a17669232d519c83857)
• PKCS #11 library (SHA256 checksum 64262f71751b617727c0da0ab74136097c2b7a1641e3b284ae827f1486fbbc56b)
• OpenSSL Dynamic Engine (SHA256 checksum 0532077c49a622bd02844dd505c8ae5a13c1669f0e4b75873e53b5a7c074e6)
AWS CloudHSM User Guide
Previous Client SDK 3 releases

- **JCE provider** (SHA256 checksum 845b2788a6548b1a5bbaf19c8fd7865ceab8a7c779d927eb282eea86b0819007)
- **AWS CloudHSM Management Utility** (SHA256 checksum ce6741813d29a41c6b23722f6b0d140a2fed90a44a0ddcac39a607457eabe91a)

CentOS 6

AWS CloudHSM does not support CentOS 6 with Client SDK Version 3.4.0.

Use [the section called “Version 3.2.1” (p. 728)] for CentOS 6 or choose a supported platform.

CentOS 7

Download the version 3.4.0 software for CentOS 7:

- **AWS CloudHSM Client** (SHA256 checksum 4b520de05217f7e6077bd94af6788da60e19d1b3f28e5a17669232d519c83857)
- **PKCS #11 library** (SHA256 checksum 64262f7157861727c70da0ab74136097c2b7a1641e3b284ae827f14866fbc56b)
- **OpenSSL Dynamic Engine** (SHA256 checksum 05320772c49a622bda0284dd505c8ae5a13c166694e4b475873e53b5a7c074ae6)
- **JCE provider** (SHA256 checksum 845b2788a6548b1a5bbaf19c8fd7865ceab8a7c779d927eb282eea86b0819007)
- **AWS CloudHSM Management Utility** (SHA256 checksum ce6741813d29a41c6b23722f6b0d140a2fed90a44a0ddcac39a607457eabe91a)

CentOS 8

Download the version 3.4.0 software for CentOS 8:

- **AWS CloudHSM Client** (SHA256 checksum 853b05e6ea6e239f42e1bbf70be26adcc8205d2d172d4f3d57342c14d0060a1e)
- **PKCS #11 library** (SHA256 checksum 51415be53ee10ddc8e85d5bcb0f052a4e290864347fac152b57c7ac37bc3f5)
- **JCE provider** (SHA256 checksum e7a39e46084cab6e193c13c57e021f0570246ce90b21863d6b40f60a7a8cd7)
- **AWS CloudHSM Management Utility** (SHA256 checksum 5de8d9d9a88deae2fffacd4923e429aadd8856d00a0de81b0d8bd771da177fae647)

RHEL 6

AWS CloudHSM does not support RedHat Enterprise Linux 6 with Client SDK Version 3.4.0.

Use [the section called “Version 3.2.1” (p. 728)] for RedHat Enterprise Linux 6 or choose a supported platform.

RHEL 7

Download the version 3.4.0 software for RedHat Enterprise Linux 7:

- **AWS CloudHSM Client** (SHA256 checksum 4b520de05217f7e6077bd94af6788da60e19d1b3f28e5a17669232d519c83857)
- **PKCS #11 library** (SHA256 checksum 64262f7157861727c70da0ab74136097c2b7a1641e3b284ae827f14866fbc56b)
- **OpenSSL Dynamic Engine** (SHA256 checksum 05320772c49a622bda0284dd505c8ae5a13c166694e4b475873e53b5a7c074ae6)
- **JCE provider** (SHA256 checksum 845b2788a6548b1a5bbaf19c8fd7865ceab8a7c779d927eb282eea86b0819007)
- **AWS CloudHSM Management Utility** (SHA256 checksum ce6741813d29a41c6b23722f6b0d140a2fed90a44a0ddcac39a607457eabe91a)

RHEL 8

Download the version 3.4.0 software for RedHat Enterprise Linux 8:
AWS CloudHSM User Guide

Previous Client SDK 3 releases

- **AWS CloudHSM Client** (SHA256 checksum 853b05e6ea6e239f42e1bfb70be26adcc8205d2d172dfc3d57342c14d0060a1e)
- **PKCS #11 library** (SHA256 checksum s1415be53ee10dddce85d5bcb0f052a4e29c086434c7faca152b57c7ac37bc3f5)
- **JCE provider** (SHA256 checksum e7a39e46084cab6e193c1537ae021f0570246ce90b21863d6b40f60a7a8c7d)
- **AWS CloudHSM Management Utility** (SHA256 checksum 5de8d9d9a88dea2fffacd4923e429aad885d600adeb1d0db771da177fae647)

**Ubuntu 16.04 LTS**

Download the version 3.4.0 software for Ubuntu 16.04 LTS:

- **AWS CloudHSM Client** (SHA256 checksum 1f80e1a7e2fc35481cc4a6e7fa3869e863becbc09aba32ef2a2a494c24e9)
- **PKCS #11 library** (SHA256 checksum 8fb002f8d8b100e453b8ef020831372a3a9d0f57a35ca23f7d95a274a63b)
- **OpenSSL Dynamic Engine** (SHA256 checksum 2c1717f99cb4a56d478517a97847c64411120a0f7a455898f77cc794a508)
- **JCE provider** (SHA256 checksum 9f0708e2ec644f5b87db66f6b683f690e78371f3ef866d1384ab80e3b4a1c1a6)
- **AWS CloudHSM Management Utility** (SHA256 checksum fed30e64467571f6e5b384b85215712637fe6139fc45832095fb945fb4317d1)

**Note**
Due to the impending EOL of Ubuntu 16.04, we intend to drop support for this platform with the next release.

**Ubuntu 18.04 LTS**

Download the version 3.4.0 software for Ubuntu 18.04 LTS:

- **AWS CloudHSM Client** (SHA256 checksum a78832a1666b41a85869fc0362c19ec33113243970a4cc8e9ae993c4d7c1)
- **PKCS #11 library** (SHA256 checksum f9610a82d55b17202c2ad064650199abb2f8412fe28ef24819a899633f6ea80)
- **JCE provider** (SHA256 checksum 5b450c1519594b9630f06620c6e2307dfcdca2f999852ea95768c699461585eb)
- **AWS CloudHSM Management Utility** (SHA256 checksum cfe730e64467571f6e5b384b85215712637fe6139fc45832095fb945fb4317d)

**Windows Server**

AWS CloudHSM supports 64-bit versions of Windows Server 2012, Windows Server 2012 R2 and Windows Server 2016. The AWS CloudHSM 3.4.0 client software for Windows Server includes the required CNG and KSP providers. For details, see [Install and Configure the AWS CloudHSM Client (Windows)](p. 259). Download the latest version (3.4.0) software for Windows Server:

- **AWS CloudHSM for Windows Server** (SHA256 checksum 95dea3a5df195e7b4ce55f1870af9402c49655f4febae996bf131c9c90c6a)
- **AWS CloudHSM Management Utility** (SHA256 checksum a529a47a63a8ecd110ee59b686b217bf9c154903d738bff5c75bb79506f014714)

Version 3.4.0 adds updates to all components.

**AWS CloudHSM Client Software**
- Improved stability and bug fixes.

**PKCS #11 library**

719
• Improved stability and bug fixes.

OpenSSL Dynamic Engine

• Improved stability and bug fixes.

JCE provider

• Improved stability and bug fixes.

Windows (CNG and KSP providers)

• Improved stability and bug fixes.

Version 3.3.2

To download the software, choose the tab for your preferred operating system, then choose the link to each software package.

Amazon Linux

Download the version 3.3.2 software for Amazon Linux:

- AWS CloudHSM Client (SHA256 checksum 1f73c4e86ff4c8a8b465f6d21bd81c7c767267476f242c29e45ebab7f470f9a8)
- PKCS #11 library (SHA256 checksum d9a4335bdcb7807a34806ff46a63802bc9f4a021358230f1c8292357cd8f43a)
- OpenSSL Dynamic Engine (SHA256 checksum 16153d539667b16905bd0ec0de3d023c8af6bdf4eb03eba8f945152322e2e6)
- JCE provider (SHA256 checksum 568324f6484049156026e903b886195c1f2e46efa338bb5d5a0a5501a7714aa)
- AWS CloudHSM Management Utility (SHA256 checksum df9c833de5c828b0de11b5ef93ec4198ba7c17bc3950d772c7dc9674876d745f)

Amazon Linux 2

Download the version 3.3.2 software for Amazon Linux 2:

- AWS CloudHSM Client (SHA256 checksum 2cd5e0b022fe9091e027f019be1eaa81923392ca6d065bfcca6532aa5b9492a99)
- PKCS #11 library (SHA256 checksum ae062f467f5747639a8696d39ce11afec09db09afa6ded6e355b2a81025ab993)
- OpenSSL Dynamic Engine (SHA256 checksum a0676a42f802c0fbc67e5301045c4354a4a9494ed84110b87cfc3524e9af29a)
- JCE provider (SHA256 checksum 640c7e3e43ca27178c003ca153a90814f7c78ada3e86a4aa4e663bb784c4bb)
- AWS CloudHSM Management Utility (SHA256 checksum cf76cf044b01d9168a408d78aedae79295626bc4b6e040d82663c5d8d814f6e)

CentOS 6

AWS CloudHSM does not support CentOS 6 with Client SDK Version 3.3.2.

Use the section called “Version 3.2.1” (p. 728) for CentOS 6 or choose a supported platform.

CentOS 7

Download the version 3.3.2 software for CentOS 7:

- AWS CloudHSM Client (SHA256 checksum 2cd5e0b022fe9091e027f019be1eaa81923392ca6d065bfcca6532aa5b9492a99)
AWS CloudHSM User Guide
Previous Client SDK 3 releases

- **PKCS #11 library** (SHA256 checksum ae062f4675f7547639a8696d39ceca1fc09db09fa6ded6e3355b2a81025ab993)
- **OpenSSL Dynamic Engine** (SHA256 checksum a0876a2f802c0fbc67e5301045c4355a4a9494de84110b87c8fbc3524e9af2ca9a)
- **JCE provider** (SHA256 checksum 6407c3e453ca27178c003ca153a90814f7c78ada3e86a4a4ce663bb784c4b8d)
- **AWS CloudHSM Management Utility** (SHA256 checksum cf76c044b0d9168a408d78aedae79295626bc4b6eb040d82663c5d8d814f6e)

**CentOS 8**

Download the version 3.3.2 software for CentOS 8:

- **AWS CloudHSM Client** (SHA256 checksum 696bb3d67b3aca379106a409a8de814174df5bb8308a2d4500bee5cf89f40070)
- **PKCS #11 library** (SHA256 checksum c58992e14d75c0cc7aef57746b40be5a4dcb1f2769e9d387ae59107650749)
- **JCE provider** (SHA256 checksum 95e519d2bf656446141cd227e504476b67d485008e8b38151ea31f2a9ca855b49)
- **AWS CloudHSM Management Utility** (SHA256 checksum e1ab86404d162e1169bb80364510119ce2c072fe30fbeb0a06bd2497f980f840)

**RHEL 6**

AWS CloudHSM does not support RedHat Enterprise Linux 6 with Client SDK Version 3.3.2.

Use the section called “Version 3.2.1” (p. 728) for RedHat Enterprise Linux 6 or choose a supported platform.

**RHEL 7**

Download the version 3.3.2 software for RedHat Enterprise Linux 7:

- **AWS CloudHSM Client** (SHA256 checksum 2cd5e0b022fe9091e027f019be1eaa81923392ca6d065bfcca65232a5b9492a99)
- **PKCS #11 library** (SHA256 checksum ae062f4675f7547639a8696d39ceca1fc09db09fa6ded6e3355b2a81025ab993)
- **OpenSSL Dynamic Engine** (SHA256 checksum a0876a2f802c0fbc67e5301045c4355a4a9494de84110b87c8fbc3524e9f2ca9a)
- **JCE provider** (SHA256 checksum 95e519d2bf656446141cd227e504476b67d485008e8b38151ea31f2a9ca855b49)
- **AWS CloudHSM Management Utility** (SHA256 checksum cf76c044b0d9168a408d78aedae79295626bc4b6eb040d82663c5d8d814f6e)

**RHEL 8**

Download the version 3.3.2 software for RedHat Enterprise Linux 8:

- **AWS CloudHSM Client** (SHA256 checksum 696bb3d67b3aca379106a409a8de814174df5b8308a2d4500bee5cf89f40070)
- **PKCS #11 library** (SHA256 checksum c58992e14d75c0cc7aef57746b40be5a4dcb1f2769e9d387ae59107650749)
- **JCE provider** (SHA256 checksum 95e519d2bf656446141cd227e504476b67d485008e8b38151ea31f2a9ca855b49)
- **AWS CloudHSM Management Utility** (SHA256 checksum e1ab86404d162e1169bb80364510119ce2c072fe30fbeb0a06bd2497f980f840)

**Ubuntu 16.04 LTS**

Download the version 3.3.2 software for Ubuntu 16.04 LTS:

- **AWS CloudHSM Client** (SHA256 checksum 5797aa27b9eb0aa52189b0a48a933a7a8ab404e651cbc34ec8dfe73f03b66c)
- **PKCS #11 library** (SHA256 checksum 155cfb95e95ee03bce298bd43ca3f5a883ae4ed69192d83ef34df2c6a117c7)
• **OpenSSL Dynamic Engine** (SHA256 checksum b313ad3f3c31f603f707916567ee30d461a14511328db0b37c00ff0affa42608)

• **JCE provider** (SHA256 checksum 0c0307054bfbff8c15830c5d43119a21f96409a7969fda1b12379ce544a56c1)

• **AWS CloudHSM Management Utility** (SHA256 checksum e34e317cf3fe11a9b70f6fabc35824f06800f3e2386d8ea02c977564eb3308a4)

**Note**
Due to the impending EOL of Ubuntu 16.04, we intend to drop support for this platform with the next release.

Ubuntu 18.04 LTS

Download the version 3.3.2 software for Ubuntu 18.04 LTS:

• **AWS CloudHSM Client** (SHA256 checksum cce515a4375e81b1493d641d523eac4599ad813d4fccc062bb872f16d57b094)

• **PKCS #11 library** (SHA256 checksum 25b5a4341d7e6594f13c7accdbac177241a610e82955bde248b82531236a52)

• **JCE provider** (SHA256 checksum 31cf9953ce86243b73863e1c3b0db21d9dcc4f26fa1c4741a9f0cc9489f389a2)

• **AWS CloudHSM Management Utility** (SHA256 checksum 1b6ff0c96c9df7209c16ae69debb669f881a7a920f37226801456f6ec328c612d)

Windows Server

AWS CloudHSM supports 64-bit versions of Windows Server 2012, Windows Server 2012 R2 and Windows Server 2016. The AWS CloudHSM 3.3.2 client software for Windows Server includes the required CNG and KSP providers. For details, see [Install and Configure the AWS CloudHSM Client (Windows)](p. 259). Download the latest version (3.3.2) software for Windows Server:

• **AWS CloudHSM for Windows Server** (SHA256 checksum 6e319786e92bbace07/dd14e4bb9ce3d95d5ebf5xc91434c75d8db728a9e44f2b)

• **AWS CloudHSM Management Utility** (SHA256 checksum fdb72c3d488f82b8f537e5e9e94c09b167806de556ff22dd1e53f50edf23f1b2)

Version 3.3.2 resolves an issue with the client_info script.

**AWS CloudHSM Client Software**

• Updated the version for consistency.

**PKCS #11 library**

• Updated the version for consistency.

**OpenSSL Dynamic Engine**

• Updated the version for consistency.

**JCE provider**

• Updated the version for consistency.

**Windows (CNG and KSP providers)**

• Updated the version for consistency.
Version 3.3.1

To download the software, choose the tab for your preferred operating system, then choose the link to each software package.

Amazon Linux

Download the version 3.3.1 software for Amazon Linux:

- AWS CloudHSM Client
- PKCS #11 library
- OpenSSL Dynamic Engine
- JCE provider
- AWS CloudHSM Management Utility

Amazon Linux 2

Download the version 3.3.1 software for Amazon Linux 2:

- AWS CloudHSM Client
- PKCS #11 library
- OpenSSL Dynamic Engine
- JCE provider
- AWS CloudHSM Management Utility

CentOS 6

AWS CloudHSM does not support CentOS 6 with Client SDK Version 3.3.1.

Use the section called "Version 3.2.1" (p. 728) for CentOS 6 or choose a supported platform.

CentOS 7

Download the version 3.3.1 software for CentOS 7:

- AWS CloudHSM Client
- PKCS #11 library
- OpenSSL Dynamic Engine
- JCE provider
- AWS CloudHSM Management Utility

CentOS 8

Download the version 3.3.1 software for CentOS 8:

- AWS CloudHSM Client
- PKCS #11 library
- JCE provider
- AWS CloudHSM Management Utility

RHEL 6

AWS CloudHSM does not support RedHat Enterprise Linux 6 with Client SDK Version 3.3.1.
Use the section called “Version 3.2.1” (p. 728) for RedHat Enterprise Linux 6 or choose a supported platform.

RHEL 7

Download the version 3.3.1 software for RedHat Enterprise Linux 7:

- AWS CloudHSM Client
- PKCS #11 library
- OpenSSL Dynamic Engine
- JCE provider
- AWS CloudHSM Management Utility

RHEL 8

Download the version 3.3.1 software for RedHat Enterprise Linux 8:

- AWS CloudHSM Client
- PKCS #11 library
- JCE provider
- AWS CloudHSM Management Utility

Ubuntu 16.04 LTS

Download the version 3.3.1 software for Ubuntu 16.04 LTS:

- AWS CloudHSM Client
- PKCS #11 library
- OpenSSL Dynamic Engine
- JCE provider
- AWS CloudHSM Management Utility

Note

Due to the impending EOL of Ubuntu 16.04, we intend to drop support for this platform with the next release.

Ubuntu 18.04 LTS

Download the version 3.3.1 software for Ubuntu 18.04 LTS:

- AWS CloudHSM Client
- PKCS #11 library
- JCE provider
- AWS CloudHSM Management Utility

Windows Server

AWS CloudHSM supports 64-bit versions of Windows Server 2012, Windows Server 2012 R2 and Windows Server 2016. The AWS CloudHSM 3.3.1 client software for Windows Server includes the required CNG and KSP providers. For details, see Install and Configure the AWS CloudHSM Client (Windows) (p. 259). Download the latest version (3.3.1) software for Windows Server:

- AWS CloudHSM for Windows Server
• **AWS CloudHSM Management Utility**

Version 3.3.1 adds updates to all components.

**AWS CloudHSM Client Software**

• Improved stability and bug fixes.

**PKCS #11 library**

• Improved stability and bug fixes.

**OpenSSL Dynamic Engine**

• Improved stability and bug fixes.

**JCE provider**

• Improved stability and bug fixes.

**Windows (CNG and KSP providers)**

• Improved stability and bug fixes.

---

**Version 3.3.0**

To download the software, choose the tab for your preferred operating system, then choose the link to each software package.

**Amazon Linux**

Download the version 3.3.0 software for Amazon Linux:

• [AWS CloudHSM Client](#)
• [PKCS #11 library](#)
• [OpenSSL Dynamic Engine](#)
• [JCE provider](#)
• [AWS CloudHSM Management Utility](#)

**Amazon Linux 2**

Download the version 3.3.0 software for Amazon Linux 2:

• [AWS CloudHSM Client](#)
• [PKCS #11 library](#)
• [OpenSSL Dynamic Engine](#)
• [JCE provider](#)
• [AWS CloudHSM Management Utility](#)

**CentOS 6**

AWS CloudHSM does not support CentOS 6 with Client SDK Version 3.3.0.
Use the section called “Version 3.2.1” (p. 728) for CentOS 6 or choose a supported platform.

CentOS 7

Download the version 3.3.0 software for CentOS 7:

- AWS CloudHSM Client
- PKCS #11 library
- OpenSSL Dynamic Engine
- JCE provider
- AWS CloudHSM Management Utility

CentOS 8

Download the version 3.3.0 software for CentOS 8:

- AWS CloudHSM Client
- PKCS #11 library
- JCE provider
- AWS CloudHSM Management Utility

RHEL 6

AWS CloudHSM does not support RedHat Enterprise Linux 6 with Client SDK Version 3.3.0.

Use the section called “Version 3.2.1” (p. 728) for RedHat Enterprise Linux 6 or choose a supported platform.

RHEL 7

Download the version 3.3.0 software for RedHat Enterprise Linux 7:

- AWS CloudHSM Client
- PKCS #11 library
- OpenSSL Dynamic Engine
- JCE provider
- AWS CloudHSM Management Utility

RHEL 8

Download the version 3.3.0 software for RedHat Enterprise Linux 8:

- AWS CloudHSM Client
- PKCS #11 library
- JCE provider
- AWS CloudHSM Management Utility

Ubuntu 16.04 LTS

Download the version 3.3.0 software for Ubuntu 16.04 LTS:

- AWS CloudHSM Client
- PKCS #11 library
- OpenSSL Dynamic Engine
Ubuntu 18.04 LTS

Download the version 3.3.0 software for Ubuntu 18.04 LTS:

- AWS CloudHSM Client
- PKCS #11 library
- JCE provider
- AWS CloudHSM Management Utility

Windows Server

AWS CloudHSM supports 64-bit versions of Windows Server 2012, Windows Server 2012 R2 and Windows Server 2016. The AWS CloudHSM 3.3.0 client software for Windows Server includes the required CNG and KSP providers. For details, see Install and Configure the AWS CloudHSM Client (Windows) (p. 259). Download the latest version (3.2.1) software for Windows Server:

- AWS CloudHSM for Windows Server
- AWS CloudHSM Management Utility

Version 3.3.0 adds two-factor authentication (2FA) and other improvements.

AWS CloudHSM Client Software

- Added 2FA authentication for crypto officers (CO). For more information, see Managing Two-Factor Authentication for Crypto Officers (p. 104).
- Removed platform support for RedHat Enterprise Linux 6 and CentOS 6. For more information, see Linux Support (p. 457).
- Added a standalone version of CMU for use with Client SDK 5 or Client SDK 3. This is the same version of CMU included with the client daemon of version 3.3.0, and now you can download CMU without downloading the client daemon.

PKCS #11 library

- Improved stability and bug fixes.
- Removed platform support for RedHat Enterprise Linux 6 and CentOS 6. For more information, see Linux Support (p. 457).

OpenSSL Dynamic Engine

- Updated the version for consistency
- Removed platform support for RedHat Enterprise Linux 6 and CentOS 6. For more information, see Linux Support (p. 457).

JCE provider

- Improved stability and bug fixes.
- Removed platform support for RedHat Enterprise Linux 6 and CentOS 6. For more information, see Linux Support (p. 457).
Windows (CNG and KSP providers)

- Updated the version for consistency

**Version 3.2.1**

To download the software, choose the tab for your preferred operating system, then choose the link to each software package.

**Amazon Linux**

Download the version 3.2.1 software for Amazon Linux:

- [AWS CloudHSM Client](#)
- [PKCS #11 library](#)
- [OpenSSL Dynamic Engine](#)
- [JCE provider](#)

**Amazon Linux 2**

Download the version 3.2.1 software for Amazon Linux 2:

- [AWS CloudHSM Client](#)
- [PKCS #11 library](#)
- [OpenSSL Dynamic Engine](#)
- [JCE provider](#)

**CentOS 6**

Download the version 3.2.1 software for CentOS 6:

- [AWS CloudHSM Client](#)
- [PKCS #11 library](#)
- [OpenSSL Dynamic Engine](#)
- [JCE provider](#)

**CentOS 7**

Download the version 3.2.1 software for CentOS 7:

- [AWS CloudHSM Client](#)
- [PKCS #11 library](#)
- [OpenSSL Dynamic Engine](#)
- [JCE provider](#)

**CentOS 8**

Download the version 3.2.1 software for CentOS 8:

- [AWS CloudHSM Client](#)
- [PKCS #11 library](#)
- [JCE provider](#)
RHEL 6

Download the version 3.2.1 software for RedHat Enterprise Linux 6:

- AWS CloudHSM Client
- PKCS #11 library
- OpenSSL Dynamic Engine
- JCE provider

RHEL 7

Download the version 3.2.1 software for RedHat Enterprise Linux 7:

- AWS CloudHSM Client
- PKCS #11 library
- OpenSSL Dynamic Engine
- JCE provider

RHEL 8

Download the version 3.2.1 software for RedHat Enterprise Linux 8:

- AWS CloudHSM Client
- PKCS #11 library
- JCE provider

Ubuntu 16.04 LTS

Download the version 3.2.1 software for Ubuntu 16.04 LTS:

- AWS CloudHSM Client
- PKCS #11 library
- OpenSSL Dynamic Engine
- JCE provider

Ubuntu 18.04 LTS

Download the version 3.2.1 software for Ubuntu 18.04 LTS:

- AWS CloudHSM Client
- PKCS #11 library
- JCE provider

Windows Server

AWS CloudHSM supports 64-bit versions of Windows Server 2012, Windows Server 2012 R2 and Windows Server 2016. The AWS CloudHSM 3.2.1 client software for Windows Server includes the required CNG and KSP providers. For details, see Install and Configure the AWS CloudHSM Client (Windows) (p. 259). Download the latest version (3.2.1) software for Windows Server:

- AWS CloudHSM for Windows Server
Version 3.2.1 adds a compliance analysis between the AWS CloudHSM implementation of the PKCS #11 library and the PKCS #11 standard, new platforms, and other improvements.

AWS CloudHSM Client Software

- Add platform support for CentOS 8, RHEL 8, and Ubuntu 18.04 LTS. For more information, see ?? (p. 392).

PKCS #11 library

- PKCS #11 library compliance report for client SDK 3.2.1
- Add platform support for CentOS 8, RHEL 8, and Ubuntu 18.04 LTS. For more information, see ?? (p. 392).

OpenSSL Dynamic Engine

- No support for CentOS 8, RHEL 8, and Ubuntu 18.04 LTS. For more information, see ?? (p. 647).

JCE provider

- Add platform support for CentOS 8, RHEL 8, and Ubuntu 18.04 LTS. For more information, see ?? (p. 392).

Windows (CNG and KSP providers)

- Improved stability and bug fixes.

Version 3.2.0

To download the software, choose the tab for your preferred operating system, then choose the link to each software package.

Amazon Linux

Download the version 3.2.0 software for Amazon Linux:

- AWS CloudHSM Client
- PKCS #11 library
- OpenSSL Dynamic Engine
- JCE provider

Amazon Linux 2

Download the version 3.2.0 software for Amazon Linux 2:

- AWS CloudHSM Client
- PKCS #11 library
- OpenSSL Dynamic Engine
- JCE provider

CentOS 6

Download the version 3.2.0 software for CentOS 6:
- AWS CloudHSM Client
- PKCS #11 library
- OpenSSL Dynamic Engine
- JCE provider

CentOS 7

Download the version 3.2.0 software for CentOS 7:
- AWS CloudHSM Client
- PKCS #11 library
- OpenSSL Dynamic Engine
- JCE provider

RHEL 6

Download the version 3.2.0 software for Red Hat Enterprise Linux 6:
- AWS CloudHSM Client
- PKCS #11 library
- OpenSSL Dynamic Engine
- JCE provider

RHEL 7

Download the version 3.2.0 software for Red Hat Enterprise Linux 7:
- AWS CloudHSM Client
- PKCS #11 library
- OpenSSL Dynamic Engine
- JCE provider

Ubuntu 16.04 LTS

Download the version 3.2.0 software for Ubuntu 16.04 LTS:
- AWS CloudHSM Client
- PKCS #11 library
- OpenSSL Dynamic Engine
- JCE provider

Windows Server

AWS CloudHSM supports 64-bit versions of Windows Server 2012, Windows Server 2012 R2 and Windows Server 2016. The AWS CloudHSM 3.2.0 client software for Windows Server includes the required CNG and KSP providers. For details, see Install and Configure the AWS CloudHSM Client (Windows) (p. 259). Download the latest version (3.2.0) software for Windows Server:
- AWS CloudHSM for Windows Server
Version 3.2.0 adds support for masking passwords and other improvements.

**AWS CloudHSM Client Software**

- Adds support for hiding your password when using command-line tools. For more information, see `loginHSM and logoutHSM` (p. 286) (cloudhsm_mgmt_util) and `loginHSM and logoutHSM` (p. 372) (key_mgmt_util).

**PKCS #11 library**

- Adds support for hashing large data in software for some PKCS #11 mechanisms that were previously unsupported. For more information, see Supported Mechanisms (p. 397).

**OpenSSL Dynamic Engine**

- Improved stability and bug fixes.

**JCE provider**

- Updated the version for consistency.

**Windows (CNG and KSP providers)**

- Improved stability and bug fixes.

### Version 3.1.2

To download the software, choose the tab for your preferred operating system, then choose the link to each software package.

**Amazon Linux**

Download the version 3.1.2 software for Amazon Linux:

- [AWS CloudHSM Client](#)
- [PKCS #11 library](#)
- [OpenSSL Dynamic Engine](#)
- [JCE provider](#)

**Amazon Linux 2**

Download the version 3.1.2 software for Amazon Linux 2:

- [AWS CloudHSM Client](#)
- [PKCS #11 library](#)
- [OpenSSL Dynamic Engine](#)
- [JCE provider](#)

**CentOS 6**

Download the version 3.1.2 software for CentOS 6:

- [AWS CloudHSM Client](#)
• PKCS #11 library
• OpenSSL Dynamic Engine
• JCE provider

CentOS 7

Download the version 3.1.2 software for CentOS 7:

• AWS CloudHSM Client
• PKCS #11 library
• OpenSSL Dynamic Engine
• JCE provider

RHEL 6

Download the version 3.1.2 software for RedHat Enterprise Linux 6:

• AWS CloudHSM Client
• PKCS #11 library
• OpenSSL Dynamic Engine
• JCE provider

RHEL 7

Download the version 3.1.2 software for RedHat Enterprise Linux 7:

• AWS CloudHSM Client
• PKCS #11 library
• OpenSSL Dynamic Engine
• JCE provider

Ubuntu 16.04 LTS

Download the version 3.1.2 software for Ubuntu 16.04 LTS:

• AWS CloudHSM Client
• PKCS #11 library
• OpenSSL Dynamic Engine
• JCE provider

Windows Server

AWS CloudHSM supports 64-bit versions of Windows Server 2012, Windows Server 2012 R2, and Windows Server 2016. The AWS CloudHSM 3.1.2 client software for Windows Server includes the required CNG and KSP providers. For details, see Install and Configure the AWS CloudHSM Client (Windows) (p. 259). Download the latest version (3.1.2) software for Windows Server:

• AWS CloudHSM for Windows Server

Version 3.1.2 adds updates to JCE provider.
**AWS CloudHSM Client Software**

- Updated the version for consistency

**PKCS #11 library**

- Updated the version for consistency

**OpenSSL Dynamic Engine**

- Updated the version for consistency

**JCE provider**

- Update log4j to version 2.13.3

**Windows (CNG and KSP providers)**

- Updated the version for consistency

**Version 3.1.1**

To download the software, choose the tab for your preferred operating system, then choose the link to each software package.

**Amazon Linux**

Download the version 3.1.1 software for Amazon Linux:

- [AWS CloudHSM Client](#)
- [PKCS #11 Library](#)
- [OpenSSL Dynamic Engine](#)
- [JCE provider](#)

**Amazon Linux 2**

Download the version 3.1.1 software for Amazon Linux 2:

- [AWS CloudHSM Client](#)
- [PKCS #11 Library](#)
- [OpenSSL Dynamic Engine](#)
- [JCE provider](#)

**CentOS 6**

Download the version 3.1.1 software for CentOS 6:

- [AWS CloudHSM Client](#)
- [PKCS #11 Library](#)
- [OpenSSL Dynamic Engine](#)
- [JCE provider](#)
CentOS 7

Download the version 3.1.1 software for CentOS 7:

- AWS CloudHSM Client
- PKCS #11 Library
- OpenSSL Dynamic Engine
- JCE provider

RHEL 6

Download the version 3.1.1 software for RedHat Enterprise Linux 6:

- AWS CloudHSM Client
- PKCS #11 Library
- OpenSSL Dynamic Engine
- JCE provider

RHEL 7

Download the version 3.1.1 software for RedHat Enterprise Linux 7:

- AWS CloudHSM Client
- PKCS #11 Library
- OpenSSL Dynamic Engine
- JCE provider

Ubuntu 16.04 LTS

Download the version 3.1.1 software for Ubuntu 16.04 LTS:

- AWS CloudHSM Client
- PKCS #11 Library
- OpenSSL Dynamic Engine
- JCE provider

Windows Server

AWS CloudHSM supports 64-bit versions of Windows Server 2012, Windows Server 2012 R2 and Windows Server 2016. The AWS CloudHSM 3.1.1 client software for Windows Server includes the required CNG and KSP providers. For details, see Install and Configure the AWS CloudHSM Client (Windows) (p. 259). Download the latest version (3.1.1) software for Windows Server:

- AWS CloudHSM for Windows Server

AWS CloudHSM Client Software

- Updated the version for consistency.

PKCS #11 Library
• Updated the version for consistency.

**OpenSSL Dynamic Engine**

• Updated the version for consistency.

**JCE provider**

• Bug fixes and performance improvements.

**Windows (CNG, KSP)**

• Updated the version for consistency.

**Version 3.1.0**

To download the software, choose the tab for your preferred operating system, then choose the link to each software package.

**Amazon Linux**

Download the version 3.1.0 software for Amazon Linux:

• [AWS CloudHSM Client](#)
• PKCS #11 Library
• [OpenSSL Dynamic Engine](#)
• JCE provider

**Amazon Linux 2**

Download the version 3.1.0 software for Amazon Linux 2:

• [AWS CloudHSM Client](#)
• PKCS #11 Library
• [OpenSSL Dynamic Engine](#)
• JCE provider

**CentOS 6**

Download the version 3.1.0 software for CentOS 6:

• [AWS CloudHSM Client](#)
• PKCS #11 Library
• [OpenSSL Dynamic Engine](#)
• JCE provider

**CentOS 7**

Download the version 3.1.0 software for CentOS 7:

• [AWS CloudHSM Client](#)
• PKCS #11 Library
• **OpenSSL Dynamic Engine**
• **JCE provider**

RHEL 6

Download the version 3.1.0 software for RedHat Enterprise Linux 6:

• **AWS CloudHSM Client**
• **PKCS #11 Library**
• **OpenSSL Dynamic Engine**
• **JCE provider**

RHEL 7

Download the version 3.1.0 software for RedHat Enterprise Linux 7:

• **AWS CloudHSM Client**
• **PKCS #11 Library**
• **OpenSSL Dynamic Engine**
• **JCE provider**

Ubuntu 16.04 LTS

Download the version 3.1.0 software for Ubuntu 16.04 LTS:

• **AWS CloudHSM Client**
• **PKCS #11 Library**
• **OpenSSL Dynamic Engine**
• **JCE provider**

Windows Server

AWS CloudHSM supports 64-bit versions of Windows Server 2012, Windows Server 2012 R2 and Windows Server 2016. The AWS CloudHSM 3.1.0 client software for Windows Server includes the required CNG and KSP providers. For details, see Install and Configure the AWS CloudHSM Client (Windows) (p. 259). Download the latest version (3.1.0) software for Windows Server:

• **AWS CloudHSM for Windows Server**

Version 3.1.0 adds standards-compliant AES key wrapping (p. 129).

**AWS CloudHSM Client Software**

• A new requirement for upgrade: the version of your client must match the version of any software libraries you are using. To upgrade, you must use a batch command that updates the client and all the libraries at the same time. For more information, see Client SDK 3 Upgrade (p. 458).
• Key_mgmt_util (KMU) includes the following updates:
  • Added two new AES key wrap methods – standards-compliant AES key wrap with zero padding and AES key wrap with no padding. For more information, see wrapKey (p. 385) and unwrapKey (p. 378).
  • Disabled ability to specify custom IV when wrapping a key using AES_KEY_WRAP_PAD_PKCS5. For more information, see AES Key Wrapping (p. 129).
PKCS #11 Library

- Added two new AES key wrap methods - standards-compliant AES key wrap with zero padding and AES key wrap with no padding. For more information, see AES Key Wrapping (p. 129).
- You can configure salt length for RSA-PSS signatures. To learn how to use this feature, see Configurable salt length for RSA-PSS signatures on GitHub.

OpenSSL Dynamic Engine

- **BREAKING CHANGE**: TLS 1.0 and 1.2 cipher suites with SHA1 are not available in OpenSSL Engine 3.1.0. This issue will be resolved shortly.
- If you intend to install the OpenSSL Dynamic Engine library on RHEL 6 or CentOS 6, see a known issue (p. 647) about the default OpenSSL version installed on those operating systems.
- Improved stability and bug fixes

JCE provider

- **BREAKING CHANGE**: To address an issue with Java Cryptography Extension (JCE) compliance, AES wrap and unwrap now properly use the AESWrap algorithm instead of the AES algorithm. This means Cipher.WRAP_MODE and Cipher.UNWRAP_MODE no longer succeed for AES/ECB and AES/CBC mechanisms.

To upgrade to client version 3.1.0, you must update your code. If you have existing wrapped keys, you must pay particular attention to the mechanism you use to unwrap and how IV defaults have changed. If you wrapped keys with client version 3.0.0 or earlier, then in 3.1.1 you must use AESWrap/ECB/PKCS5Padding to unwrap your existing keys. For more information, see AES Key Wrapping (p. 129).
- You can list multiple keys with the same label from the JCE provider. To learn how to iterate through all available keys, see Find all keys on GitHub.
- You can set more restrictive values for attributes during key creation, including specifying different labels for public and private keys. For more information, see Supported Java Attributes (p. 496).

Windows (CNG, KSP)

- Improved stability and bug fixes.

### Deprecated releases

Versions 3.0.1 and earlier are deprecated. We do not recommend using deprecated releases in production workloads. We do not provide backwards compatible updates for deprecated releases, nor do we host deprecated releases for download. If you experience production impact while using deprecated releases, you must upgrade to obtain software fixes.

### End-of-life releases

AWS CloudHSM announces end of life for releases no longer compatible with the service. To preserve the safety of your application, we reserve the right to actively refuse connections from end-of-life releases.

- Currently no versions of the client SDK are end-of-life releases.
Document history

This topic describes significant updates to the AWS CloudHSM User Guide.

Topics

- Recent updates (p. 739)
- Earlier updates (p. 742)

Recent updates

The following table describes significant changes to this documentation since April 2018. In addition to major changes listed here, we also update the documentation frequently to improve the descriptions and examples, and to address the feedback you send us. To be notified about significant changes, use the link in the upper right corner to subscribe to the RSS feed.

For details on new releases, see Downloads for AWS CloudHSM Client SDK (p. 671)

<table>
<thead>
<tr>
<th>Change</th>
<th>Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 5.10.0.</td>
<td>July 28, 2023</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 5.9.0.</td>
<td>May 23, 2023</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 5.8.0.</td>
<td>March 16, 2023</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 5.7.0.</td>
<td>November 16, 2022</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 5.6.0.</td>
<td>September 1, 2022</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 5.5.0.</td>
<td>May 13, 2022</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 5.4.2.</td>
<td>March 18, 2022</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 5.4.1.</td>
<td>February 10, 2022</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released the AWS CloudHSM JCE provider version 5.4.0 for Windows platforms.</td>
<td>February 1, 2022</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released the AWS CloudHSM client version 5.4.0, which adds initial support for the JCE provider for all Linux platforms.</td>
<td>January 28, 2022</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 5.3.0.</td>
<td>January 3, 2022</td>
</tr>
</tbody>
</table>
### AWS CloudHSM User Guide

**Recent updates**

<table>
<thead>
<tr>
<th>Added new release</th>
<th>Released AWS CloudHSM client version 3.4.4.</th>
<th>January 3, 2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 3.4.3.</td>
<td>December 20, 2021</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 3.4.2.</td>
<td>December 15, 2021</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 3.4.1.</td>
<td>December 10, 2021</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 5.2.1.</td>
<td>October 4, 2021</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 3.4.0.</td>
<td>August 25, 2021</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 5.2.0.</td>
<td>August 3, 2021</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 3.3.2.</td>
<td>July 2, 2021</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 5.1.0.</td>
<td>June 1, 2021</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 3.3.1.</td>
<td>April 26, 2021</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 5.0.1.</td>
<td>April 8, 2021</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 5.0.0.</td>
<td>March 12, 2021</td>
</tr>
<tr>
<td>Added new content</td>
<td>Added interface VPC endpoint, an AWS feature that allows you to create a private connection between your VPC and AWS CloudHSM without requiring access over the internet or through a NAT device, a VPN connection, or an AWS Direct Connect connection.</td>
<td>February 10, 2021</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 3.3.0.</td>
<td>February 3, 2021</td>
</tr>
<tr>
<td>Add new content</td>
<td>Added managed backup retention, a feature that automatically deletes old backups.</td>
<td>November 18, 2020</td>
</tr>
<tr>
<td>Add new content</td>
<td>Added a compliance report that analyzes the AWS CloudHSM Client SDK 3.2.1 implementation of the PKCS #11 library with the PKCS #11 standard.</td>
<td>October 29, 2020</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 3.2.1.</td>
<td>October 8, 2020</td>
</tr>
<tr>
<td>Added new content</td>
<td>Added documentation that describes key synchronization settings in AWS CloudHSM.</td>
<td>September 1, 2020</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 3.2.0.</td>
<td>August 31, 2020</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 3.1.2.</td>
<td>July 30, 2020</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 3.1.1.</td>
<td>June 3, 2020</td>
</tr>
<tr>
<td>Added new release</td>
<td>Released AWS CloudHSM client version 3.1.0.</td>
<td>May 21, 2020</td>
</tr>
<tr>
<td>Added new release (p. 739)</td>
<td>Released AWS CloudHSM client version 3.0.1.</td>
<td>April 20, 2020</td>
</tr>
<tr>
<td>Added new release (p. 739)</td>
<td>Released AWS CloudHSM client version 3.0.0 for Windows Server platform.</td>
<td>October 30, 2019</td>
</tr>
<tr>
<td>Added new release (p. 739)</td>
<td>Released AWS CloudHSM client version 3.0.0 for all platforms, except Windows.</td>
<td>October 22, 2019</td>
</tr>
<tr>
<td>Added new release (p. 739)</td>
<td>Released AWS CloudHSM client version 2.0.4.</td>
<td>August 26, 2019</td>
</tr>
<tr>
<td>Added new release (p. 739)</td>
<td>Released AWS CloudHSM client version 2.0.3.</td>
<td>May 13, 2019</td>
</tr>
<tr>
<td>Added new release (p. 739)</td>
<td>Released AWS CloudHSM client version 2.0.1.</td>
<td>March 21, 2019</td>
</tr>
<tr>
<td>Added new release (p. 739)</td>
<td>Released AWS CloudHSM client version 2.0.0.</td>
<td>February 6, 2019</td>
</tr>
<tr>
<td>Added region support (p. 739)</td>
<td>Added AWS CloudHSM support for the EU (Stockholm) and AWS GovCloud (US-East) regions.</td>
<td>December 19, 2018</td>
</tr>
<tr>
<td>Added new release (p. 739)</td>
<td>Released AWS CloudHSM client version 1.1.2 for Windows.</td>
<td>November 20, 2018</td>
</tr>
<tr>
<td>Updated known issues</td>
<td>New content was added to the Troubleshooting guide.</td>
<td>November 8, 2018</td>
</tr>
<tr>
<td>Added new release (p. 739)</td>
<td>Released AWS CloudHSM client version 1.1.2 for Linux platforms.</td>
<td>November 8, 2018</td>
</tr>
<tr>
<td>Added region support (p. 739)</td>
<td>Added AWS CloudHSM support for the EU (Paris) and Asia Pacific (Seoul) regions.</td>
<td>October 24, 2018</td>
</tr>
</tbody>
</table>
Earlier updates

The following table describes the important changes to the AWS CloudHSM prior to 2018.

<table>
<thead>
<tr>
<th>Change</th>
<th>Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Added new content</td>
<td>Added the ability to delete and restore AWS CloudHSM backups.</td>
<td>September 10, 2018</td>
</tr>
<tr>
<td>Added new content</td>
<td>Added automatic audit log delivery to Amazon CloudWatch Logs.</td>
<td>August 13, 2018</td>
</tr>
<tr>
<td>Added new content</td>
<td>Added the ability to copy an AWS CloudHSM cluster backup across regions.</td>
<td>July 30, 2018</td>
</tr>
<tr>
<td>Added region support</td>
<td>Added AWS CloudHSM support for the EU (London) region.</td>
<td>June 13, 2018</td>
</tr>
<tr>
<td>Added new content</td>
<td>Added AWS CloudHSM client and library support for Amazon Linux 2, Red Hat</td>
<td>May 10, 2018</td>
</tr>
<tr>
<td></td>
<td>Enterprise Linux (RHEL) 6, Red Hat Enterprise Linux (RHEL) 7, CentOS 6,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CentOS 7, and Ubuntu 16.04 LTS.</td>
<td></td>
</tr>
<tr>
<td>Added new release</td>
<td>Added a Windows AWS CloudHSM client.</td>
<td>April 30, 2018</td>
</tr>
</tbody>
</table>

Earlier updates

The following table describes the important changes to the AWS CloudHSM prior to 2018.

<table>
<thead>
<tr>
<th>Change</th>
<th>Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>New content</td>
<td>Added quorum authentication (M of N access control) for crypto officers (COs). For more information, see Using CloudHSM Management Utility (CMU) to manage quorum authentication (M of N access control) (p. 110).</td>
<td>November 9, 2017</td>
</tr>
<tr>
<td>Update</td>
<td>Added documentation about using the key_mgmt_util command line tool. For more information, see key_mgmt_util command reference (p. 307).</td>
<td>November 9, 2017</td>
</tr>
<tr>
<td>New content</td>
<td>Added Oracle Transparent Data Encryption. For more information, see Oracle database encryption (p. 574).</td>
<td>October 25, 2017</td>
</tr>
<tr>
<td>New content</td>
<td>Added SSL Offload. For more information, see SSL/TLS offload (p. 507).</td>
<td>October 12, 2017</td>
</tr>
</tbody>
</table>
## Earlier updates

<table>
<thead>
<tr>
<th>Change</th>
<th>Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>New guide</td>
<td>This release introduces AWS CloudHSM</td>
<td>August 14, 2017</td>
</tr>
</tbody>
</table>