



AWS Whitepaper

# Secure Content Delivery with Amazon CloudFront



# Secure Content Delivery with Amazon CloudFront: AWS Whitepaper

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### Abstract

Securing delivery over the public internet is an important part of cloud security. This whitepaper describes how Amazon CloudFront, a highly secure, managed service, can help architects and developers secure the delivery of their applications and content by providing useful, security-supporting features.

# Introduction

As more businesses move to cloud computing, public awareness of the significance of cloud security increases as well. Cloud computing uses public internet to deliver content to users. Securing this delivery is one of the important parts of cloud security.

[Amazon CloudFront](#) is a fast content delivery network (CDN) service that securely delivers data, videos, applications, and APIs to customers globally, with low latency and high transfer speeds. CloudFront is integrated with Amazon Web Services (AWS). The physical [points of presence](#) (PoPs) are directly connected with AWS global infrastructure, and the service works seamlessly with AWS services, including [Amazon Simple Storage Service](#) (Amazon S3), [AWS Shield](#), [AWS WAF](#), [Amazon CloudWatch](#), and [Lambda@Edge](#). Because CloudFront is the component nearest to end users (sometimes called “viewers”) in many workloads, and by default its endpoint is open to public internet, CloudFront is one of the first points to secure for a customer’s application.

AWS follows the [shared responsibility](#) security model, and because CloudFront is a fully managed service, AWS responsibility includes physical infrastructure, network, servers, operating systems, and software. Securing the data itself is still the customer’s responsibility. To strengthen your applications’ security posture, it is crucial to understand what kind of security measures are used in CloudFront, and what kind of security features you can utilize.

This document discusses how AWS protects CloudFront infrastructure (security *of* the cloud) and how you can harden your applications’ security (security *in* the cloud) by leveraging CloudFront features.

# How AWS Provides Security of the Cloud for Amazon CloudFront

## AWS security processes

AWS operates the global cloud infrastructure that you use to provision a variety of basic computing resources and services such as compute and storage. The AWS global infrastructure is designed and managed according to security best practices, as well as a variety of security compliance standards. As an AWS customer, be assured that you're building web architectures on some of the most secure computing infrastructure in the world.

As a managed service, CloudFront is protected by these AWS global infrastructure security processes. The implemented controls include physical and environmental security such as fire detection and suppression, logical AWS access controls such as account review and audit, network security (fault-tolerant design), and other important secure design principles and practices.

Security is built into every layer of the AWS infrastructure, and carries into each of the services that run in it. AWS services, including CloudFront, are architected to work efficiently and securely with all AWS networks and platforms. Each service provides extensive security features designed to help you protect sensitive data and applications. For more information, see the [Best Practices for Security, Identity, and Compliance](#).

## Compliance validation for CloudFront

Third-party auditors assess the security and compliance of CloudFront as part of multiple AWS compliance programs. You can download the third-party audit reports using [AWS Artifact](#), a central resource for compliance-related information that provides on-demand access to AWS security and compliance reports, and select online agreements. Reports available in AWS Artifact include our Service Organization Control (SOC) reports and Payment Card Industry (PCI) reports, among other certifications.

Your compliance responsibility when using CloudFront is determined by the sensitivity of your data, your company's compliance objectives, and applicable laws and regulations. AWS provides the following resources to help you determine and approach your compliance requirements:

- [Security and Compliance Quick Start guides](#) — These deployment guides discuss architectural considerations, and provide steps for deploying security- and compliance-focused baseline environments on AWS.
- [Architecting for HIPAA Security and Compliance](#) whitepaper: — This whitepaper describes how companies can use AWS to create Health Insurance Portability and Accountability Act (HIPAA)-compliant applications. The AWS HIPAA compliance program includes Amazon CloudFront (excluding content delivery through CloudFront Embedded POPs) as a HIPAA eligible service. If you have an executed Business Associate Addendum (BAA) with AWS, you can use CloudFront (excluding content delivery through CloudFront Embedded POPs) to deliver content that contains protected health information (PHI). For more information, see [HIPAA Compliance](#).
- [AWS Compliance Resources](#) — This collection of workbooks and guides might apply to your industry and location.
- [AWS Config](#) — This AWS Service enables you to evaluate the configuration settings of your AWS resources and assess how well your resource configurations comply with internal practices, industry guidelines, and regulations.
- [AWS Security Hub](#) — This AWS Service provides a comprehensive view of your security state within AWS. This helps you check your compliance with security industry standards and best practices.

## Securing HTTPS delivery

HTTPS is a compulsory requirement to deliver data securely over the internet. CloudFront has security controls for handling the Transport Layer Security (TLS) certificates and private keys used in the TLS handshake. During the TLS handshake between the viewer and CloudFront, CloudFront must provide the correct TLS certificate, and use its private key to decrypt a shared secret that will be used in the TLS session. These TLS certificates are issued or uploaded in [AWS Certificate Manager](#) (ACM).

CloudFront encrypts the TLS certificate private key with a data encryption key provided by [AWS Key Management Service](#) (AWS KMS). After KMS encryption, CloudFront encrypts data again with its own internal encryption, and deploys the encrypted TLS certificates to each CloudFront edge server. The encryption keys used for the transfer mechanism are rotated every 24 hours by CloudFront. Decrypted private keys are never physically stored on CloudFront edge servers. The server decrypts the private key each time the it is loaded into memory, and CloudFront records the access request to the private key information for auditing.

CloudFront uses the [s2n-tls library for TLS communication](#), an open-source library which is comparably new and more lightweight than [OpenSSL](#). OpenSSL, initially released in 1998, is a software library that includes TLS implementation. Open SSL has been used by many web servers. OpenSSL has more than 500,000 lines of code, which makes it challenging to do code audits or reviews. The [s2n-tls](#) implementation has around 6,000 lines of code which are regularly reviewed and tested, as well as being tested by [Amazon's Automated Reasoning Group](#).

## Resilience and availability

Several forms of DDoS mitigation are included automatically with AWS services. All AWS customers benefit from the automatic protections of AWS Shield Standard at no additional charge. AWS Shield Standard defends against most common, frequently occurring network and [transport layer](#) (Layer 3 and Layer 4) Distributed Denial-of-Service (DDoS) attacks that target your website or applications. DDoS attacks are detected by a system that automatically [baselines](#) traffic, identifies anomalies, and, as necessary, implements mitigations. Use AWS Shield Standard as part of a DDoS-resilient architecture to protect both web and non-web applications. For more information about how to architect for DDoS resiliency, see the [AWS Best Practices for DDoS Resiliency](#) whitepaper.

Using services like CloudFront, which are part of the [Amazon Global Edge Network](#), can further improve the DDoS resilience of your application by applying Shield Standard DDoS protection inline when you serve web application traffic from edge locations distributed around the world. The scale of the Amazon Global Edge Network spans hundreds of PoPs, across dozens of cities and countries, adding new PoPs frequently. This scale offers resiliency and global presence, and provides protection against localized availability problems.

The benefits of using CloudFront include:

- AWS Shield DDoS mitigation systems that are directly integrated with AWS edge services, reducing time-to-mitigate from minutes to sub-seconds.
- Stateless [SYN flood](#) mitigation techniques that proxy and verify incoming connections before passing them to the protected service.
- Automatic traffic engineering systems that can disperse or isolate the impact of large volumetric DDoS attacks.
- Application layer defense, when combined with [AWS Web Application Firewall](#) (AWS WAF), that does not require changing your current application architecture (for example, in an AWS Region or on-premises datacenter).



- CloudFront enables you to cache static content and serve it from AWS edge locations, which can help reduce the load on your [origin server](#). It can also help reduce server load by preventing non-web traffic from reaching your origin server.
- CloudFront can automatically close connections from [slow reading](#) or slow writing attackers (for example, a [Slowloris attack](#)).
- Protection from [HTTP desync attacks](#), by integration with [HTTP Desync Guardian](#).
- Built-in application layer (L7) attack mitigations
- There is no charge for data transfer out from AWS services to CloudFront.

# How CloudFront Can Help You Ensure Security in the Cloud

This section of the whitepaper focuses on how you can harden your application's security posture by using various features that CloudFront provides.

## Using HTTPS with CloudFront

When you use Hypertext Transfer Protocol (HTTP) to deliver data, your data is exposed to public internet, because the protocol transmits data in a clear text format. This can be exploited with [man-in-the-middle attacks](#), which attempt to steal or tamper with private data. Hypertext Transfer Protocol Secure (HTTPS) is an extension of HTTP that provides secure and reliable communication over the internet. HTTPS uses TLS, which encrypts the transmitted data and checks the message integrity. TLS also provides a TLS certificate which authenticates a server's identity. Some security standards, including [Payment Card Industry Data Security Standard](#) (PCI DSS) or industry standard Apple iOS App Transport Security (ATS), require the use of HTTPS. There are other benefits, such as better search engine optimization, when using HTTPS.

CloudFront comes with native HTTPS support. You can configure CloudFront to deliver contents via HTTPS from viewer to origin, end to end.

### Viewer HTTPS configuration

In CloudFront, the HTTPS setting is configurable for two different connections:

- Viewer to CloudFront
- CloudFront to your origin servers

In the context of HTTPS from viewer to CloudFront, CloudFront is a server which receives the TLS-initiating "Client Hello" in the TLS handshake process. Because the HTTPS is initiated by the client, CloudFront has options to:

- Accept both HTTP and HTTPS,
- Redirect HTTP requests to HTTPS requests, or
- Only accept HTTPS. If a viewer sends an HTTP request instead of an HTTPS request, CloudFront returns HTTP status code 403 (Forbidden) and does not return the object.

These options can be applied to a specific URI path so you can configure some part of your website to accept HTTP. However, we recommend using HTTPS for all traffic to avoid possible vulnerabilities or bad user experiences such as mixed content warnings.

When you serve your applications using your own domain name (other than the default `*.cloudfront.net`), you will need to set up a TLS certificate for your CloudFront distribution. In this case, you will leverage AWS Certificate Manager (ACM), to request the issuance of a new certificate, or import your existing certificate, at no additional cost. ACM supports certificate automatic renewals for Amazon-issued certificates.

Another important configuration is choosing the TLS [security policy](#). CloudFront provides a number of security policies, each of which defines available TLS versions and [cipher suites](#) for viewer HTTPS. The oldest security policy still includes [SSLv3](#) to support legacy clients, but we recommend that you use the latest security policy. This way the viewer HTTPS connection will not use outdated ciphers, and it will get the benefit of the latest cipher; for example, [perfect forward secrecy](#) (PFS).

By default, CloudFront will use SNI to identify the correct TLS certificate for an incoming request. SNI is a TLS extension, which enables the client to put the server name in the initial TLS handshake *Client Hello* step. Because CloudFront serves multiple domains, this extension helps CloudFront to choose the correct TLS certificate to provide to the client. CloudFront offers the ability to turn off Server Name Indication (SNI) to support legacy clients, which will incur extra cost. SNI is supported by most modern browsers and according to [caniuse.com](#), more than 99% of clients use SNI-enabled agents.

CloudFront also supports [Online Certificate Status Protocol](#) (OCSP) [stapling](#) without further configuration, which enhances the performance of HTTPS delivery by providing a certificate validation response together with TLS certification during the TLS handshake.

For Viewer-side HTTPS, TLS 1.3 is automatically supported when the client initiates a TLS 1.3 handshake. TLS 1.3 eliminates weak cipher suites, provides perfect forward secrecy, and support 1-RTT TLS handshakes. Perfect forward secrecy means each session will not be compromised, even if the private key used in session key exchange is compromised in the future. Because previous sessions are protected, attackers have limited access to private data. TLS 1.3 mandates this by using only ephemeral key exchange algorithms such as Elliptic Curve [Diffie-Hellman](#) (ECDHE).

TLS 1.3 reduces the TLS handshake from two roundtrips to one. For connections using HTTP/1 or HTTP/2, shortening the TLS handshake to one roundtrip effectively reduces connection setup time by 33%.

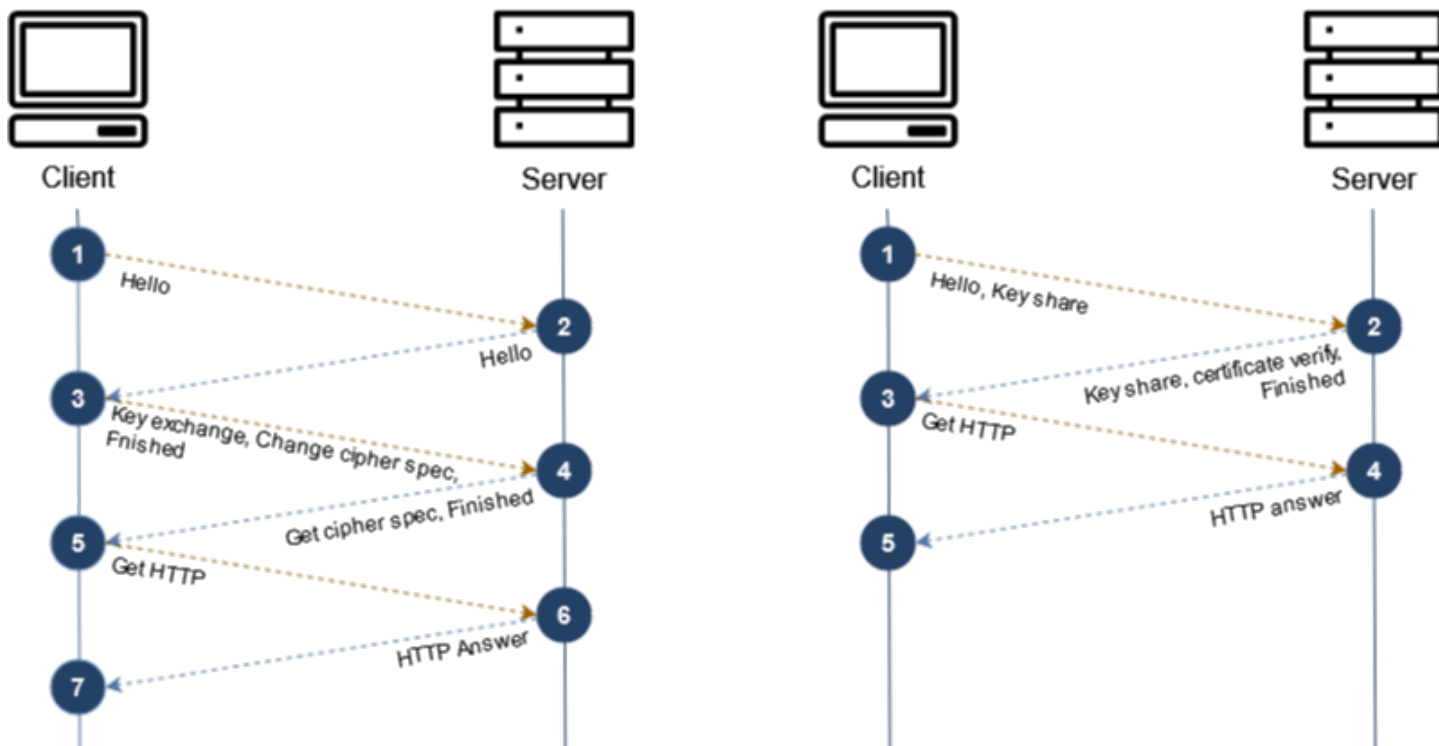


Figure 1 — 2-RTT TLS handshake (TLS 1.2) and 1-RTT TLS handshake (TLS 1.3)

## Origin HTTPS configuration

When connecting to the origin with HTTPS, CloudFront becomes a client who initiates a TLS handshake. In this context, CloudFront operation is focused on authenticating the origin to avoid possible man-in-the-middle attacks. CloudFront trusts only the origin server when the TLS certificate provided by the origin server meets the following conditions:

- The certificate matches the requested domain name
- The certificate is issued by a [trusted certificate authority](#) (CA)
- The certificate chain is correct
- The certificate is not expired

If any of these conditions are not met, CloudFront drops the connection to the origin and responds with a 502 Bad Gateway error message to the client.

By default, CloudFront validates either the Common Name (CN) or Subject Alternate Name (SAN) of the origin TLS certificate with the origin domain name that is registered in the CloudFront distribution origin settings. For example, if a CloudFront distribution is set up to deliver `https://`

`www.example.com/` to viewers and forward requests to `origin.example.com`, the origin TLS certificate must contain `origin.example.com` in its CN or SAN or in wildcard form, such as `*.example.com`.

CloudFront can be configured to use the host header value of the incoming request instead if you configure your distribution to forward the host header. In this case, the origin's TLS certificate must contain `www.example.com` in its CN or SAN or in wildcard form, such as `*.example.com`. CloudFront also uses these domain names as the SNI in its initial TLS handshake.

CloudFront enables you to specify the minimum TLS protocol version to connect to the origin. Using the latest version of TLS on both CloudFront distribution and origin settings will avoid known attacks, such as POODLE or BEAST, which exploit older versions of TLS. You can find which protocols and ciphers are supported between CloudFront and the origin in the [CloudFront developer guide](#).

## Securing your contents with CloudFront

CloudFront provides a number of methods to help protect content from unwanted access. You can specify geographically-based restrictions, have CloudFront authorize access to content based on a signature (in the query string or in a cookie), and have CloudFront encrypt sensitive data fields so that only systems with the proper rights can access them.

### Geo-based content access

When you deliver content that should have restrictions based on the viewer's location, you can use CloudFront's geographic restrictions feature. For example, video on demand (VOD) usually has a contractual condition that dictates only certain countries can play the video. When geographic restrictions are enabled and configured to allow or deny the delivery to certain counties, CloudFront validates the viewer's country information. When a viewer in a denied country tries to access the content, CloudFront responds with a 403 (Forbidden) error message to the viewer.

### Authorize access at the edge with signed URLs and cookies

Another way to help protect your content is to use [signed URLs](#) or [signed cookies](#). When privileged or confidential content, such as paid streaming or confidential reports, needs to be delivered to authenticated viewers, you can leverage CloudFront's signed URLs. Signed URLs validate parameters in the query string or cookies, and allow access only when they are correctly signed

with the private key of a pre-registered key pair. You can build an application that authenticates users and shares the signed URLs or cookies to minimize origin authentication efforts, cache the content in CloudFront, and protect against unauthenticated viewer access. Because signed URLs are based on a public-private key pair, content will not be compromised even if the public key is exposed. This provides a better security posture in comparison to shared, key-based token authorization.

To use signed URLs or signed cookies, you need a signer. Each signer that you use to create CloudFront signed URLs or signed cookies must have a public-private key pair. The signer uses its private key to sign the URL or cookies, and CloudFront uses the public key to verify the signature. A signer is either a trusted key group that you create in CloudFront, or an AWS account that contains a CloudFront key pair. We recommend that you use trusted key groups. The way that you create a key pair that depends on whether you use a trusted key group as the signer (recommended), or a CloudFront key pair. We also recommend that you periodically rotate (change) your key pairs for signed URLs and signed cookies.

When a group of URLs, defined by a path pattern, is set to use signed URLs or cookies, CloudFront looks for the required parameters and validates their values on the request of those URLs. These parameters can be in the query string or cookie, where the former takes precedence if both are present. The fields in signed URLs or cookies vary slightly, based on which policy they use. A policy defines conditions which must be matched to access the contents.

There are two types of policies that you can use: a canned policy or a custom policy.

- A *canned policy* is the simpler of the two, and allows access if the request is made before the expiration time as a condition and the URL matches the URL pattern as a resource defined in the policy.
- A *custom policy* offers more conditions, such as start date time, end date time, and IP address range in Classless Inter-domain Routing (CIDR) form, and allows the wildcard character (\*) in the URL (resource) parameter.

When a policy is created, signed URLs can be generated by signing the policy statement with the private key. See code examples in the [Amazon CloudFront Developer Guide](#).

## Using CloudFront to encrypt sensitive data at the edge

If there is more than one application or service behind the origin end point, you may want to protect sensitive data that the viewer submits via HTTP POST to the origin application stack. By

using end-to-end HTTPS with CloudFront, you ensure that sensitive data is encrypted from the client to the origin. CloudFront's Field-Level Encryption (FLE) allows you to add an additional layer of security by encrypting fields in the POST form with a public key at the edge, allowing only certain applications to decrypt it. For example, if an e-commerce system receives sensitive information like a customer's phone number or address, it can be separately encrypted at the edge before sending them to origin applications. The origin application can decrypt the sensitive data using the private keys.

To use CloudFront's FLE, you first need to upload the public key of a private-public key pair. With this public key, you can make an FLE profile that defines which fields should be encrypted. Next, create a configuration that defines which content type (decided by an HTML form element's `enctype` attribute) is associated with an FLE profile. When these fields are encrypted by CloudFront and forwarded to the origin, the relevant application can decrypt them using a private key.

## Protecting your origin by allowing access to CloudFront only

Controlling access to your origin is necessary, along with controlling viewer access, to have secure delivery via CloudFront. Your origin should allow requests only from CloudFront, and shut down attempts from any others.

### Amazon S3 origins with CloudFront

Amazon Simple Storage Service (Amazon S3) provides access controls in conjunction with [AWS Identity and Access Management](#) (IAM), [bucket policy](#), [bucket ACL](#), and [object ACL](#). When using Amazon S3 origins with CloudFront, you can use [CloudFront Origin Access Control](#) (OAC) to secure Amazon S3 bucket access. When setting up OAC, CloudFront will provide an IAM policy that can be used in your Amazon S3 bucket policy. The bucket policy creates a service principal that allows your CloudFront distribution to authenticate with Amazon S3. By allowing the CloudFront service principal, an `s3:GetObject` action in the bucket policy, Amazon S3 allows CloudFront distribution to access to the content.

```
{
  "Version": "2012-10-17",
  "Statement": {
    "Sid": "AllowCloudFrontServicePrincipalReadOnly",
    "Effect": "Allow",
    "Principal": {
```

```

    "Service": "cloudfront.amazonaws.com"
  },
  "Action": "s3:GetObject",
  "Resource": "arn:aws:s3:::<S3 bucket name>/*",
  "Condition": {
    "StringEquals": {
      "AWS:SourceArn": "arn:aws:cloudfront::<AWS account ID>:distribution/
<CloudFront distribution ID>"
    }
  }
}
}
}

```

With this bucket policy set, you can turn on “Block all public access” to make the S3 bucket reachable only through CloudFront.

## Custom origin with CloudFront

Unlike Amazon S3, which is a static object storage system, custom origins such as web servers can inspect incoming HTTP requests and decide to discard the request. You can allow only trusted CloudFront distribution to access your origin by adding a custom header with a secret value to the origin request in CloudFront, and setting up header inspection from the origin side. ALB has a rule that can be used for this header inspection purpose, if the origin web server is on AWS.

Origin Custom Headers	Header Name	Value	
	Secret-Header	fqnuqSkoW9TPrfqm	+

Figure 2 — Adding a secret header from the CloudFront console

CloudFront publishes [its IP address ranges](#) along with other Amazon services, which enables you to allowlist CloudFront IP address ranges in your origin firewall, or add them into security groups. You may need more than one security group to allow all CloudFront IP ranges.

To find the IP address ranges that are associated with CloudFront edge servers, search *ip-ranges.json* for the following string: "service": "CLOUDFRONT". Or directly, you can view only the CloudFront IP ranges. Alternatively, when your origin is hosted on AWS and protected by an Amazon VPC security group, you can use the CloudFront managed prefix list that contains the IP address ranges of all of CloudFront's globally distributed origin-facing servers. With the prefix list, you don't need to read or maintain a list of IP address ranges yourself. The CloudFront managed prefix list is named *com.amazonaws.global.cloudfront.origin-facing*.



By using an IP allowed list and header inspection together, your custom origin allows only traffic from chosen CloudFront distributions to access your private content.

## Improving security by enabling security specific headers

To improve the security of your content, you can use HTTP security headers that are natively supported by the HTTP protocol and most modern browsers. These security headers tell the browser how to behave when handling website content. They can do things such as enforced communications over HTTPS, or defining from where JavaScript content can be loaded.

The [Open Web Application Security Project](#) (OWASP), provides guidance and best practices on the implementation of HTTP security headers to improve the security of your application, through its secure headers project, the latest guidance includes examples and best practices.

Security headers are commonly implemented using web application configurations, but alternatively you can configure CloudFront to add these security response headers for your application if required. CloudFront provides this configuration through a response headers policy, and it comes with some managed policies that already have security headers such as `Strict-Transport-Security`, `X-Frame-Options`, `X-Content-Type-Options`, and so on.

Another consideration for enhanced security using HTTP headers is the use of [Cross-origin resource sharing](#) (CORS). In modern applications, the use of cross-domain resources is common. Browsers will allow certain content from the same origin (domain). To allow requests that have different origins (domain, protocol, or port), CORS must be enabled. For more information on which browser requests require CORS, see [What requests use CORS](#).

A number of HTTP headers relate to CORS, but two response headers are most important for security:

- `Access-Control-Allow-Origin` specifies which origin can access a site.
- `Access-Control-Allow-Methods` specifies which HTTP request methods (GET, PUT, DELETE, and others) can be used to access resources.

CloudFront supports the configuration of these CORS response headers with a response headers policy. You can choose to use managed policies, or you can customize CORS behaviors to allow only a specific origin web site to use the resources that you're sharing.

To understand more about configuring the response headers policy, refer the [Amazon CloudFront Developer Guide](#).

## Protecting from external threats at the edge

When your application runs on AWS, you can combine CloudFront and AWS WAF to help defend against application layer attacks. AWS WAF is a web application firewall you can use to monitor web requests to your applications and to control access to your content.

You use AWS WAF to control how your protected resources respond to HTTP(S) web requests. You can do this by defining a web access control list (web ACL) and then associating it with one or more web application resources that you want to protect, in this case CloudFront distributions. For ease of configuration, you can use [CloudFront one-click protection](#) in the console; it creates a web ACL, configures rules to protect your applications from common web threats, and attaches the web ACL to the CloudFront distribution for you. Optionally, you can later configure additional security protections for other threats specific to your application.

CloudFront forwards incoming requests to AWS WAF for inspection by the web ACL. In your web ACL, you create rules to define traffic patterns in requests and specify the actions to take on matching requests. The actions include: allow or block requests, count requests, or [Run CAPTCHA or challenge checks](#) against requests to verify human users.

You can define rules that inspect for criteria, like scripts that are likely to be malicious, IP addresses or address ranges, strings that appear in the request, [labels](#) that prior rules in the web ACL have added to the request, and many more combinations. You can also create rate limiting rules that will count requests. The rule aggregates requests and rate limits the aggregate groupings, based on the rule's limit and action settings.

CloudFront also provides security recommendations for your distributions based on elements of your CloudFront configuration, including path patterns or your origin type. Additionally, to help protect against HTTP floods, you can use a guided workflow to rate limit requests, which will capture metrics and allow you to adjust configuration as needed. You can select the rules you'd like to enable and CloudFront automatically adds those rules to your AWS WAF configuration.

Besides creating your own rules, you can use AWS-managed AWS WAF rules, or use Managed Rules for AWS WAF offered by sellers in the [AWS Marketplace](#). The AWS-Managed rules identify malicious IP addresses that are included in IP reputation lists and common malicious request signatures, including options for intelligent threat mitigation using AWS WAF Bot Control. Both AWS WAF and CloudFront enable you to set geo-restrictions to block or allow requests from selected countries. This can help block attacks originating from geographic locations where you do not expect to serve users.

If you are subscribed to [AWS Shield Advanced](#), you can configure it to automatically mitigate application layer (OSI model layer 7) attacks against your protected CloudFront distributions by counting or blocking web requests that are part of the attack. This option is in addition to the application layer protection that you add through Shield Advanced with an AWS WAF web ACL and rate-based rules. You can engage the AWS Shield Response Team (SRT) to help create rules to mitigate attacks impacting your application's availability. For more information, see [Configure AWS SRT support](#).

You can use [AWS Firewall Manager](#) to centrally configure and manage AWS WAF rules for your CloudFront distributions across your organization. Your [AWS Organizations](#) management account can designate an administrator account, which is authorized to create Firewall Manager policies. These policies allow you to define criteria, such as resource type and tags, which determine where rules are applied. This is useful when you have many accounts and want to standardize protections across your organization. Firewall Manager also allows you to create policies that manage AWS Shield Advanced protected resources, Network Firewall policies, and VPC security groups.

- To learn more about using geo-restriction to limit access to your CloudFront distribution, see [Restricting the Geographic Distribution of Your Content](#).
- To learn more about using AWS WAF, see [Getting started with AWS WAF](#).
- To learn more about configuring rate-based rules, see [Rate-based rules examples](#).
- To learn more about enabling AWS WAF protections with one click and set up rate limiting, see [Using AWS WAF to protect your application](#).
- To learn how to manage the deployment of AWS WAF rules across your AWS resources with AWS Firewall Manager, see [Getting started with AWS Firewall Manager AWS WAF policies](#).

## Managing access permissions to your CloudFront resources

To perform operations to your CloudFront resources, such as creating a distribution or invalidating an object, you can use AWS Identity and Access Management (IAM). IAM helps you securely control access to AWS resources by enabling you to control who is authenticated (signed in) and authorized (has permissions) to use resources. You can create and manage AWS users, groups, roles, and permissions to allow or deny actions within AWS services.

IAM offers AWS managed policies created and administrated by AWS that are designed to provide permissions for many common use cases. For example, the policy `CloudFrontFullAccess` provides full access to the CloudFront console plus the ability to list S3 buckets.

`CloudFrontReadOnlyAccess` provides access to CloudFront distribution configuration

information, and list distributions, but users can't modify any distribution settings. In some scenarios, you might want to grant a specific level of access to a resource that you specify. For example, you might allow update, delete, and create invalidations access to a distribution. To do this, you can create your own IAM policies, called [customer-managed policies](#), and they allow you to customize permissions and update them as needed.

You can attach these policies to multiple principal entities to give each entity the permissions that are defined in the policy. These are referred to as *Identity-Based* policies. You can also attach policies to resources, referred to as *resource-based* policies. Even though CloudFront does not support resource-based policies, it does support [resource-level](#) policies that enable you to use ARNs to specify individual resources in a policy.

You can define more granular permissions with [tag-based](#) policies by granting access to specific resources, based on an authorization strategy that defines permissions based on tag attributes. You can define which users can perform actions on a distribution based on the tag. For example, tagging resources and using tags in policy statement conditions helps you grant access to specific resources and as the number of those resources grows over time, you won't need to continuously add them to the policy.

```
"Condition": {
  "StringEquals": {
    "aws:RequestTag/stage": [
      "gamma",
      "prod"
    ]
  }
}
```

For a list of actions and permissions, see [Actions, resources, and condition keys for Amazon CloudFront](#) in the IAM User Guide.

## Logging and monitoring in CloudFront

AWS provides several tools for monitoring your CloudFront resources and activity logs to help you respond to potential incidents.

When you enable AWS WAF for your distribution, CloudFront creates a [security dashboard](#) for each of your distributions. The unified dashboards can help you focus on making decisions and taking

actions inline without writing security rules. Dynamic visual cues like aggregation by IP address, country, HTTP method, and URI path can help you simplify the investigative process while visual blocking actions make it easy to apply mitigating actions in one click.

CloudFront is also integrated with [Amazon CloudWatch](#), which provides data and actionable insights from your AWS resources. CloudFront automatically publishes six operational metrics per distribution to CloudWatch. You can monitor these metrics to detect anomalous behavior and create alarms. You can watch metrics over defined time periods and if the metric exceeds a given threshold, a notification is sent to an [Amazon SNS](#) topic or an [AWS Auto Scaling](#) policy.

For example, receiving a notification when the 4xx error rate exceeds 1% (which helps you identify clients receiving 403 Forbidden errors) allows you to quickly identify the start of a possible DDoS attack. So does receiving a notification that the total amount of requests exceeds an expected value.

There are up to eight additional CloudFront metrics that you can enable for an additional cost. These metrics must be enabled for each individual distribution that require them. For example, you can monitor and combine error rate and cache hit rate to measure CloudFront efficiency or monitor a drop in the cache hit ratio. For more information, see [Turning on additional CloudFront distribution metrics](#).

Default metrics like requests, data transfer, error rate and additional metrics, if enabled, are also displayed in a set of graphs in the [CloudFront console](#) and are also accessible through the AWS CLI or the CloudWatch API.

Another service that can provide valuable monitoring and visibility is Amazon Route 53, which offers the option to create health checks to monitor the health and performance of your web applications, and alert when there are significant changes based on your configured settings. For health check examples to set for CloudFront distributions, see [Amazon CloudFront distributions health check examples](#).

You have also the option to enable [CloudFront access logs](#), which provide detailed records about requests that are made to a distribution. This access log information is useful in security and access audits. You can enable standard logs at no additional cost, which are delivered to the Amazon S3 bucket of your choice. Another option is CloudFront Real-Time Logs, which, for a [cost](#), are delivered within seconds of receiving the requests to [Amazon Kinesis Data Streams](#). Querying both standard access and real-time logs enables you to explore usage patterns across your web properties that are served by CloudFront. For example, you can query for detailed HTTP status code responses on a certain day or hour, or statistics based on the URI paths.

It's good practice to review CloudFront service activity with [AWS CloudTrail](#), which provides a record of actions taken by a user, role, or AWS service in CloudFront by automatically recording and storing event logs. Using the information collected by CloudTrail, you can determine API calls made to CloudFront, the IP address from which the call was made, who made it, when it was made, and other additional details. For example, calls to the `CreateDistribution`, `GetDistribution`, and `ListInvalidation` APIs generate entries in CloudTrail log files.

CloudTrail helps you track and automatically respond to activity threatening the security of your AWS resources with [Amazon EventBridge](#) integration. You can monitor specific CloudFront API requests by creating EventBridge rules. A rule matches incoming events and routes them to targets for processing. For example, you can create a rule to trigger an Amazon SNS topic when the API `UpdateDistribution` is requested.

## Configuration management

To record and evaluate configurations of your AWS resources, you can use [AWS Config](#), which provides you with a detailed view of the configuration of your distributions. This includes how the resources are related to one another and how they were configured in the past, so you can review changes over time. Examples of CloudFront-related resources are [AWS WAF WebACL](#), [AWS Certificate Manager](#), and [S3 buckets](#).

You can also evaluate configurations against desired configurations with [AWS Config Rules](#). For example, AWS Config Rules helps you to evaluate whether your CloudFront resources comply with common security best practices. You can choose managed rules like viewer policy HTTPS, SNI enabled, OAC enabled, origin failover enabled, AWS WAF WebACL, or Shield Advanced resource policies to be triggered when the configuration changes. Managed rules can periodically run evaluations at a frequency that you choose; for example, every 24 hours. [AWS Firewall Manager](#) relies on AWS Config for automatic alerts and remediations. You can find the list of all AWS Config managed rules that apply to CloudFront distributions in the [AWS Config Developer Guide](#).

In addition to AWS Config, you can consider using AWS Security Hub. Security Hub uses security controls to evaluate resource configurations and security standards to help you comply with various compliance frameworks. For more information about using Security Hub to evaluate CloudFront resources, see [Amazon CloudFront controls](#) in the Security Hub User Guide.

## Conclusion

This document has reviewed the security measures in Amazon CloudFront infrastructure, and reviewed how data can be securely delivered using CloudFront. CloudFront provides private data protection with HTTPS and various supporting features, and protects the application from external threats such as DDoS attacks. By combining other services, CloudFront can support your holistic security governance requirements.

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## Further Reading

For additional information, see:

- [AWS Best Practices for DDoS Resiliency](#) (whitepaper)
- [Guidelines for Implementing AWS WAF](#)
- [Securing your Content Delivery with Amazon CloudFront](#) (tech talk)
- [SIEM Solution using OpenSearch Service](#)

# Document revisions

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Change	Description	Date
<a href="#">Whitepaper updated</a>	Updates throughout to reflect latest AWS recommendations	April 11, 2024
<a href="#">Update</a>	Minor updates to align with new OWASP recommendations	January 11, 2022
<a href="#">Update</a>	Significant updates	February 13, 2021
<a href="#">Initial publication</a>	Whitepaper first published	July 1, 2017

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