AWS Serverless Application Model

Developer Guide

AWS Serverless Application Model: Developer Guide

Table of Contents

What Is the AWS Serverless Application Model (AWS SAM)?

The AWS Serverless Application Model (AWS SAM) is an open-source framework that you can use to build serverless applications on AWS.

A **serverless application** is a combination of Lambda functions, event sources, and other resources that work together to perform tasks. Note that a serverless application is more than just a Lambda function—it can include additional resources such as APIs, databases, and event source mappings.

You can use AWS SAM to define your serverless applications. AWS SAM consists of the following components:

- **AWS SAM template specification**. You use this specification to define your serverless application. It provides you with a simple and clean syntax to describe the functions, APIs, permissions, configurations, and events that make up a serverless application. You use an AWS SAM template file to operate on a single, deployable, versioned entity that's your serverless application. For the full AWS SAM template specification, see AWS Serverless Application Model Specification.

- **AWS SAM command line interface (AWS SAM CLI)**. You use this tool to build serverless applications that are defined by AWS SAM templates. The CLI provides commands that enable you to verify that AWS SAM template files are written according to the specification, invoke Lambda functions locally, step-through debug Lambda functions, package and deploy serverless applications to the AWS Cloud, and so on. For details about how to use the AWS SAM CLI, including the full AWS SAM CLI Command Reference, see AWS SAM CLI (p. 70).

This guide shows you how to use AWS SAM to define, test, and deploy a simple serverless application. It also provides an example application (p. 15) that you can download, test locally, and deploy to the AWS Cloud. You can use this example application as a starting point for developing your own serverless applications.

Benefits of Using AWS SAM

Because AWS SAM integrates with other AWS services, creating serverless applications with AWS SAM provides the following benefits:

- **Single-deployment configuration**. AWS SAM makes it easy to organize related components and resources, and operate on a single stack. You can use AWS SAM to share configuration (such as memory and timeouts) between resources, and deploy all related resources together as a single, versioned entity.

- **Extension of AWS CloudFormation**. Because AWS SAM is an extension of AWS CloudFormation, you get the reliable deployment capabilities of AWS CloudFormation. You can define resources by using AWS CloudFormation in your AWS SAM template. Also, you can use the full suite of resources, intrinsic functions, and other template features that are available in AWS CloudFormation.

- **Built-in best practices**. You can use AWS SAM to define and deploy your infrastructure as config. This makes it possible for you to use and enforce best practices such as code reviews. Also, with a few lines of configuration, you can enable safe deployments through CodeDeploy, and can enable tracing by using AWS X-Ray.

- **Local debugging and testing**. The AWS SAM CLI lets you locally build, test, and debug serverless applications that are defined by AWS SAM templates. The CLI provides a Lambda-like execution environment locally. It helps you catch issues upfront by providing parity with the actual Lambda execution environment. To step through and debug your code to understand what the code is doing, you can use AWS SAM with AWS toolkits like the AWS Toolkit for JetBrains, AWS Toolkit for PyCharm, AWS Toolkit for IntelliJ, and AWS Toolkit for Visual Studio Code. This tightens the feedback loop by making it possible for you to find and troubleshoot issues that you might run into in the cloud.

- **Deep integration with development tools**. You can use AWS SAM with a suite of AWS tools for building serverless applications. You can discover new applications in the AWS Serverless Application Repository. For authoring, testing, and debugging AWS SAM–based serverless applications, you can use the AWS Cloud9 IDE. To build a deployment pipeline for your serverless applications, you can use CodeBuild, CodeDeploy, and CodePipeline. You can also use AWS CodeStar to get started with a project structure, code repository, and a CI/CD pipeline that's automatically configured for you. To deploy your serverless application, you can use the Jenkins plugin. You can use the Stackery.io toolkit to build production-ready applications.

Next Step

Getting Started with AWS SAM (p. 3)

Getting Started with AWS SAM

To get started with AWS SAM, use the AWS SAM CLI to create a serverless application that you can package and deploy in the AWS Cloud. You can run the application both in the AWS Cloud or locally on your development host.

To install the AWS SAM CLI, including everything that needs to be installed or configured to use the AWS SAM CLI, see Installing the AWS SAM CLI (p. 3). After the AWS SAM CLI is installed, you can run through the following tutorial.

Topics

Installing the AWS SAM CLI

AWS SAM provides you with a command line tool, the AWS SAM CLI, that makes it easy for you to create and manage serverless applications. You need to install and configure a few things in order to use the AWS SAM CLI.

To install the AWS SAM CLI, see the following instructions for your development host:

Topics

Installing the AWS SAM CLI on Linux

The following steps help you to install and configure the required prerequisites for using the AWS SAM CLI on your Linux host:

1. Create an AWS account.
2. Configure IAM permissions.
3. Install the AWS CLI.
4. Create an Amazon S3 bucket.
5. Install Docker. Note: Docker is only a prerequisite for testing your application locally.
6. Install Homebrew.
7. Install the AWS SAM CLI.

Step 1: Create an AWS Account

If you don't already have an AWS account, see aws.amazon.com and choose **Create an AWS Account**. For detailed instructions, see Create and Activate an AWS Account.

Step 2: Create an IAM User with Administrator Permissions

If you don't already have an IAM user with administrator permissions, see Creating Your First IAM Admin User and Group in the *IAM User Guide*.

Step 3: Install and Configure the AWS CLI

If you don't already have the AWS CLI installed, this step shows you how install and configure it. You can check whether you have the AWS CLI installed by executing **`aws --version`** at a command line.

This section has two substeps: a) Install the AWS CLI using a bundled installer, and b) Configure the AWS CLI to use your credentials, default AWS Region, and desired output format.

Step 3a: Install the AWS CLI

We recommend that you use a bundled installer to avoid issues with existing Python installations when you have multiple versions.

The following commands assume that you want to install the AWS CLI for all users of a development host using sudo, and that the system default version of Python should be used. For alternative installation options, see Installing the AWS CLI.

```
curl "https://s3.amazonaws.com/aws-cli/awscli-bundle.zip" -o "awscli-bundle.zip"
unzip awscli-bundle.zip
sudo ./awscli-bundle/install -i /usr/local/aws -b /usr/local/bin/aws
```

You should see the following output as the last line of a successful installation:

```
You can now run: /usr/local/bin/aws --version
```

Step 3b: Configure the AWS CLI

After you've verified installing the AWS CLI, you can configure it with your credentials, default AWS Region, and desired output format. To do this, you first create the necessary access keys by following these steps:

1. Sign in to the AWS Management Console and open the IAM console at https://console.aws.amazon.com/iam/.
2. In the navigation pane, choose **Users**.
3. Choose the name of the user whose access keys you want to create, and then choose the **Security credentials** tab.
4. In the **Access keys** section, choose **Create access key**.
5. To view the new access key pair, choose **Show**. You will not have access to the secret access key again after this dialog box closes. Your credentials will look something like this:

   - Access key ID: AKIAIOSFODNN7EXAMPLE
   - Secret access key: wJalrXUtnFEMI/K7MDENG/bPxRfiCYEXAMPLEKEY
6. To download the key pair, choose **Download .csv file**. Store the keys in a secure location. You will not have access to the secret access key again after this dialog box closes.

   Keep the keys confidential in order to protect your AWS account and never email them. Do not share them outside your organization, even if an inquiry appears to come from AWS or Amazon.com. No one who legitimately represents Amazon will ever ask you for your secret key.

7. After you download the `.csv` file, choose **Close**. When you create an access key, the key pair is active by default, and you can use the pair right away.

Configure the AWS CLI with your using the access keys you just created by executing the following command:

```
aws configure
```

When you're prompted, replace the following examples with your access keys:

```
AWS Access Key ID [None]: AKIAIOSFODNN7EXAMPLE                          # Enter your access
key
AWS Secret Access Key [None]: wJalrXUtnFEMI/K7MDENG/bPxRfiCYEXAMPLEKEY # Enter your secret
key
Default region name [None]: us-east-1                                   # Example regions:
us-east-1, ap-east-1, eu-central-1, sa-east-1
Default output format [None]: json                                      # Or 'text'
```

Additional configuration options are available in configuring the AWS CLI.

Step 4: Create an Amazon S3 Bucket

AWS SAM uses an Amazon S3 bucket in your AWS account as a repository to store deployment artifacts. To use the package and deployment functionality of AWS SAM, you must have an Amazon S3 bucket in the Region that you're working in.

If you need to create an Amazon S3 bucket, you can run the following command:

```
aws s3 mb s3://bucketname --region region # Example regions: us-east-1, ap-east-1, eu-
central-1, sa-east-1
```

You should see the following output for a successfully created Amazon S3 bucket:

```
make_bucket: bucketname
```

Remember to keep track of your Amazon S3 bucket name, because you need it to package your serverless application.

Step 5: Install Docker

> **Note**
> Docker is only a prerequisite for testing your application locally and to build deployment packages using the `--use-container` flag. You may skip this section or install Docker at a later time if you do not plan to use these features initially.

Docker is an application that runs containers on your Linux machines. AWS SAM provides a local environment that's similar to AWS Lambda to use as a Docker container. You can use this container to build, test, and debug your serverless applications.

You must have Docker installed and working to be able to run serverless projects and functions locally with the AWS SAM CLI. The AWS SAM CLI uses the `DOCKER_HOST` environment variable to contact the

Docker daemon. The following steps describe how to install, configure, and verify a Docker installation to work with the AWS SAM CLI.

Docker is available on many different operating systems, including most modern Linux distributions, like CentOS, Debian, Ubuntu, etc. For more information about how to install Docker on your particular operating system, go to the Docker installation guide.

If you are using Amazon Linux 2, follow these steps to install Docker:

1. Update the installed packages and package cache on your instance.

```
sudo yum update -y
```

2. Install the most recent Docker Community Edition package.

```
sudo amazon-linux-extras install docker
```

3. Start the Docker service.

```
sudo service docker start
```

4. Add the `ec2-user` to the `docker` group so you can execute Docker commands without using `sudo`.

```
sudo usermod -a -G docker ec2-user
```

5. Log out and log back in again to pick up the new `docker` group permissions. You can accomplish this by closing your current SSH terminal window and reconnecting to your instance in a new one. Your new SSH session will have the appropriate `docker` group permissions.
6. Verify that the `ec2-user` can run Docker commands without `sudo`.

```
docker ps
```

You should see the following output, showing Docker is installed and running:

```
CONTAINER ID        IMAGE               COMMAND             CREATED             STATUS
             PORTS               NAMES
```

Note
In some cases, you may need to reboot your instance to provide permissions for the `ec2-user` to access the Docker daemon. Try rebooting your instance if you see the following error:

```
Cannot connect to the Docker daemon. Is the docker daemon running on this host?
```

If you run into issues installing Docker, see the Troubleshooting (p. 7) section later in this guide, or the Docker installation guide for additional troubleshooting tips.

Step 6: Install Homebrew

The recommended approach for installing the AWS SAM CLI on Linux is to use the Homebrew package manager. For more information about Homebrew, see Homebrew Documentation.

To install Homebrew, run the following:

```
sh -c "$(curl -fsSL https://raw.githubusercontent.com/Linuxbrew/install/master/install.sh)"
```

Next, add Homebrew to your PATH by running the following commands. These commands work on all major flavors of Linux by adding either `~/.profile` on Debian/Ubuntu or `~/.bash_profile` on CentOS/Fedora/RedHat:

```
test -d ~/.linuxbrew && eval $(~/.linuxbrew/bin/brew shellenv)
test -d /home/linuxbrew/.linuxbrew && eval $(/home/linuxbrew/.linuxbrew/bin/brew shellenv)
test -r ~/.bash_profile && echo "eval \$($(brew --prefix)/bin/brew shellenv)"
 >>~/.bash_profile
echo "eval \$($(brew --prefix)/bin/brew shellenv)" >>~/.profile
```

Verify that Homebrew is installed:

```
brew --version
```

You should see output like the following on successful installation of Homebrew:

```
Homebrew 2.1.6
Homebrew/homebrew-core (git revision ef21; last commit 2019-06-19)
```

Step 7: Install the AWS SAM CLI

Follow these steps to install the AWS SAM CLI using Homebrew:

```
brew tap aws/tap
brew install aws-sam-cli
```

Verify the installation:

```
sam --version
```

You should see output like the following after successful installation of the AWS SAM CLI:

```
SAM CLI, version 0.19.0
```

You're now ready to start development.

Troubleshooting

Docker Error: "Cannot connect to the Docker daemon. Is the docker daemon running on this host?"

In some cases, you may need to reboot your instance to provide permissions for the `ec2-user` to access the Docker daemon. If you receive this error, try rebooting your instance.

Shell error: "command not found"

Your shell is not able to locate the AWS SAM CLI executable in the path. If you receive this error, verify the location of directory where the AWS SAM CLI executable was installed, and verify that directory is on your path.

For example, if you used the instructions in this topic to both 1) Install Homebrew, and 2) Use Homebrew to install the AWS SAM CLI, then the AWS SAM CLI executable will be installed to the following location:

```
/home/homebrew/.homebrew/bin/sam
```

Next Steps

You're now ready to begin building your own serverless applications using AWS SAM! If you want to start with sample serverless applications, choose one of the following links:

- Tutorial: Deploying a Hello World Application (p. 15) – Step-by-step instructions to download, build, and deploy a simple serverless application.
- AWS SAM example applications in GitHub – Sample applications in the AWS SAM GitHub repository that you can further experiment with.

Installing the AWS SAM CLI on Windows

The following steps help you to install and configure the required prerequisites for using the AWS SAM CLI on your Windows host:

1. Create an AWS account.
2. Configure IAM permissions.
3. Install the AWS CLI.
4. Create an Amazon S3 bucket.
5. Install Docker. Note: Docker is only a prerequisite for testing your application locally.
6. Install the AWS SAM CLI.

Step 1: Create an AWS Account

If you don't already have an AWS account, see aws.amazon.com and choose **Create an AWS Account**. For detailed instructions, see Create and Activate an AWS Account.

Step 2: Create an IAM User with Administrator Permissions

If you don't already have an IAM user with administrator permissions, see Creating Your First IAM Admin User and Group in the *IAM User Guide*.

Step 3: Install and Configure the AWS CLI

If you don't already have the AWS CLI installed, this step shows you how to install and configure it. You can check whether you have the AWS CLI installed by executing **`aws --version`** at a command line.

This section has two substeps: a) Install the AWS CLI using an MSI installation package, and b) Configure the AWS CLI to use your credentials, default AWS Region, and desired output format.

Step 3a: Install the AWS CLI

We recommend that you use one of the MSI installation packages. These offer a familiar and convenient way to install the AWS CLI without installing any other prerequisites.

Installing the AWS CLI using an MSI installation package is supported on Microsoft Windows XP or later. For alternative installation options, see Installing the AWS CLI.

To install the AWS CLI using the MSI installer

1. Download the appropriate MSI installer.
   - Download the AWS CLI MSI installer for Windows (64-bit).
   - Download the AWS CLI MSI installer for Windows (32-bit).
   - Download the AWS CLI setup file (includes both the 32-bit and 64-bit MSI installers, and automatically installs the correct version).
2. Run the downloaded MSI installer or the setup file.
3. Follow the onscreen instructions.

By default, the CLI installs to `C:\Program Files\Amazon\AWSCLI` (64-bit version) or `C:\Program Files (x86)\Amazon\AWSCLI` (32-bit version). To confirm the installation, use the `aws --version` command at a command line.

Step 3b: Configure the AWS CLI

After you've verified installing the AWS CLI, you can configure it with your credentials, default AWS Region, and desired output format. To do this, you first create the necessary access keys by following these steps:

1. Sign in to the AWS Management Console and open the IAM console at https://console.aws.amazon.com/iam/.
2. In the navigation pane, choose **Users**.
3. Choose the name of the user whose access keys you want to create, and then choose the **Security credentials** tab.
4. In the **Access keys** section, choose **Create access key**.
5. To view the new access key pair, choose **Show**. You won't have access to the secret access key again after this dialog box closes. Your credentials look something like this:
   - Access key ID: AKIAIOSFODNN7EXAMPLE
   - Secret access key: wJalrXUtnFEMI/K7MDENG/bPxRfiCYEXAMPLEKEY
6. To download the key pair, choose **Download .csv file**. Store the keys in a secure location. You won't have access to the secret access key again after this dialog box closes.

   Keep the keys confidential in order to protect your AWS account, and never email them. Don't share them outside your organization, even if an inquiry appears to come from AWS or Amazon.com. No one who legitimately represents Amazon will ever ask you for your secret key.
7. After you download the `.csv` file, choose **Close**. When you create an access key, the key pair is active by default, and you can use the pair right away.

Configure the AWS CLI with the access keys that you just created by executing the following command:

```
aws configure
```

When you're prompted, replace the following examples with your access keys:

```
AWS Access Key ID [None]: AKIAIOSFODNN7EXAMPLE                    # Enter your access
key
```

```
AWS Secret Access Key [None]: wJalrXUtnFEMI/K7MDENG/bPxRfiCYEXAMPLEKEY # Enter your secret
key
Default region name [None]: us-east-1                                   # Example regions:
us-east-1, ap-east-1, eu-central-1, sa-east-1
Default output format [None]: json                                      # Or 'text'
```

Additional configuration options are available in configuring the AWS CLI.

Step 4: Create an Amazon S3 Bucket

AWS SAM uses an Amazon S3 bucket in your AWS account as a repository to store deployment artifacts. To use the package and deployment functionality of AWS SAM, you must have an Amazon S3 bucket in the Region that you're working in.

If you need to create an Amazon S3 bucket, you can run the following command:

```
aws s3 mb s3://bucketname --region region # Example regions: us-east-1, ap-east-1, eu-
central-1, sa-east-1
```

You should see the following output for a successfully created Amazon S3 bucket:

```
make_bucket: bucketname
```

Remember to keep track of your Amazon S3 bucket name because you need it to package your serverless application.

Step 5: Install Docker

> **Note**
> Docker is only a prerequisite for testing your application locally and building deployment packages using the `--use-container` flag. You can skip this section or install Docker at a later time if you don't plan to use these features initially.

Docker is an application that runs containers on your Linux machines. AWS SAM provides a local environment that's similar to AWS Lambda to use as a Docker container. You can use this container to build, test, and debug your serverless applications.

You must have Docker installed and working to be able to run serverless projects and functions locally with the AWS SAM CLI. The AWS SAM CLI uses the `DOCKER_HOST` environment variable to contact the Docker daemon. The following steps describe how to install, configure, and verify a Docker installation to work with the AWS SAM CLI.

1. Install Docker.

   Docker Desktop supports the most recent Windows operating system. For legacy versions of Windows, the Docker Toolbox is available. Choose your version of Windows for the correct Docker installation steps:

   - To install Docker for Windows 10, see Install Docker Desktop for Windows.
   - To install Docker for older versions of Windows, see Install Docker Toolbox on Windows.
2. Configure your shared drives.

   The AWS SAM CLI requires that the project directory, or any parent directory, is listed in a shared drive. Choose your version of Windows below for the correct shared drive instructions:

- To share drives on Windows 10, see Docker Shared Drives.
- To share drives on older versions of Windows, see Add Shared Directories.

3. Verify the installation.

   After Docker is installed, verify that it's working. Also confirm that you can run Docker commands from the AWS SAM CLI (for example, `docker ps`). You don't need to install, fetch, or pull any containers—the AWS SAM CLI does this automatically as required.

If you run into issues installing Docker, see the Docker installation guide for troubleshooting tips.

Step 6: Install the AWS SAM CLI

Windows Installer (MSI) files are the package installer files for the Windows operating system.

Follow these steps to install the AWS SAM CLI using the MSI file.

1. Install the AWS SAM CLI 64-bit.

   Note
   If you operate on 32-bit machine, execute the following command: **`pip install aws-sam-cli`**

2. Verify the installation.

   After completing the installation, verify it by opening a new command prompt or PowerShell prompt. You should be able to invoke `sam` from the command line.

```
sam --version
```

   You should see output like the following after successful installation of the AWS SAM CLI:

```
SAM CLI, version 0.19.0
```

You're now ready to start development.

Next Steps

You're now ready to begin building your own serverless applications using AWS SAM! If you want to start with sample serverless applications, choose one of the following links:

- Tutorial: Deploying a Hello World Application (p. 15) – Step-by-step instructions to download, build, and deploy a simple serverless application.
- AWS SAM example applications in GitHub – Sample applications in the AWS SAM GitHub repository that you can further experiment with.

Installing the AWS SAM CLI on macOS

The following steps help you to install and configure the required prerequisites for using the AWS SAM CLI on your macOS host:

1. Create an AWS account.

2. Configure IAM permissions.
3. Install the AWS CLI.
4. Create an Amazon S3 bucket.
5. Install Docker. Note: Docker is only a prerequisite for testing your application locally.
6. Install Homebrew.
7. Install the AWS SAM CLI.

Step 1: Create an AWS Account

If you don't already have an AWS account, see aws.amazon.com and choose **Create an AWS Account**. For detailed instructions, see Create and Activate an AWS Account.

Step 2: Create an IAM User with Administrator Permissions

If you don't already have an IAM user with administrator permissions, see Creating Your First IAM Admin User and Group in the *IAM User Guide*.

Step 3: Install and Configure the AWS CLI

If you don't already have the AWS CLI installed, this step shows you how install and configure it. You can check whether you have the AWS CLI installed by executing **`aws --version`** at a command line.

This section has two substeps: a) Install the AWS CLI using a bundled installer, and b) Configure the AWS CLI to use your credentials, default AWS Region, and desired output format.

Step 3a: Install the AWS CLI

We recommend that you use a bundled installer to avoid issues with existing Python installations when you have multiple versions.

The following commands assume that you want to install the AWS CLI for all users of a development host using sudo, and that the system default version of Python should be used. For alternative installation options, see Installing the AWS CLI.

```
curl "https://s3.amazonaws.com/aws-cli/awscli-bundle.zip" -o "awscli-bundle.zip"
unzip awscli-bundle.zip
sudo ./awscli-bundle/install -i /usr/local/aws -b /usr/local/bin/aws
```

You should see the following output as the last line of a successful installation:

```
You can now run: /usr/local/bin/aws --version
```

Step 3b: Configure the AWS CLI

After you've verified installing the AWS CLI, you can configure it with your credentials, default AWS Region, and desired output format. To do this, you first create the necessary access keys by following these steps:

1. Sign in to the AWS Management Console and open the IAM console at https://console.aws.amazon.com/iam/.
2. In the navigation pane, choose **Users**.

3. Choose the name of the user whose access keys you want to create, and then choose the **Security credentials** tab.
4. In the **Access keys** section, choose **Create access key**.
5. To view the new access key pair, choose **Show**. You will not have access to the secret access key again after this dialog box closes. Your credentials will look something like this:

   - Access key ID: AKIAIOSFODNN7EXAMPLE
   - Secret access key: wJalrXUtnFEMI/K7MDENG/bPxRfiCYEXAMPLEKEY
6. To download the key pair, choose **Download .csv file**. Store the keys in a secure location. You will not have access to the secret access key again after this dialog box closes.

   Keep the keys confidential in order to protect your AWS account and never email them. Do not share them outside your organization, even if an inquiry appears to come from AWS or Amazon.com. No one who legitimately represents Amazon will ever ask you for your secret key.
7. After you download the `.csv` file, choose **Close**. When you create an access key, the key pair is active by default, and you can use the pair right away.

Configure the AWS CLI with your using the access keys you just created by executing the following command:

```
aws configure
```

When you're prompted, replace the following examples with your access keys:

```
AWS Access Key ID [None]: AKIAIOSFODNN7EXAMPLE                          # Enter your access
key
AWS Secret Access Key [None]: wJalrXUtnFEMI/K7MDENG/bPxRfiCYEXAMPLEKEY # Enter your secret
key
Default region name [None]: us-east-1                                   # Example regions:
us-east-1, ap-east-1, eu-central-1, sa-east-1
Default output format [None]: json                                      # Or 'text'
```

Additional configuration options are available in configuring the AWS CLI.

Step 4: Create an Amazon S3 Bucket

AWS SAM uses an Amazon S3 bucket in your AWS account as a repository to store deployment artifacts. To use the package and deployment functionality of AWS SAM, you must have an Amazon S3 bucket in the Region that you're working in.

If you need to create an Amazon S3 bucket, you can run the following command:

```
aws s3 mb s3://bucketname --region region # Example regions: us-east-1, ap-east-1, eu-
central-1, sa-east-1
```

You should see the following output for a successfully created Amazon S3 bucket:

```
make_bucket: bucketname
```

Remember to keep track of your Amazon S3 bucket name, because you need it to package your serverless application.

Step 5: Install Docker

> **Note**
> Docker is only a prerequisite for testing your application locally and to build deployment packages using the `--use-container` flag. You may skip this section or install Docker at a later time if you do not plan to use these features initially.

Docker is an application that runs containers on your macOS machines. AWS SAM provides a local environment that's similar to AWS Lambda to use as a Docker container. You can use this container to build, test, and debug your serverless applications.

You must have Docker installed and working to be able to run serverless projects and functions locally with the AWS SAM CLI. The AWS SAM CLI uses the `DOCKER_HOST` environment variable to contact the Docker daemon. The following steps describe how to install, configure, and verify a Docker installation to work with the AWS SAM CLI.

1. Install Docker

   The AWS SAM CLI supports Docker running on macOS Sierra 10.12 or above. To install Docker see Install Docker Desktop for Mac.
2. Configure your shared drives

   The AWS SAM CLI requires that the project directory, or any parent directory, is listed in a shared drive. To share drives on macOS, see File sharing.
3. Verify the installation

   After Docker is installed, verify that it's working. Also confirm that you can run Docker commands from the AWS SAM CLI (for example, `docker ps`). You don't need to install, fetch, or pull any containers—the AWS SAM CLI does this automatically as required.

If you run into issues installing Docker, see the Docker installation guide for troubleshooting tips.

Step 6: Install Homebrew

The recommended approach for installing the AWS SAM CLI on macOS is to use the Homebrew package manager. For more information about Homebrew, see Homebrew Documentation.

To install Homebrew, run the following and follow the prompts:

```
/usr/bin/ruby -e "$(curl -fsSL https://raw.githubusercontent.com/Homebrew/install/master/
install)"
```

Verify that Homebrew is installed:

```
brew --version
```

You should see output like the following on successful installation of Homebrew:

```
Homebrew 2.1.6
Homebrew/homebrew-core (git revision ef21; last commit 2019-06-19)
```

Step 7: Install the AWS SAM CLI

Follow these steps to install the AWS SAM CLI using Homebrew:

```
brew tap aws/tap
brew install aws-sam-cli
```

Verify the installation:

```
sam --version
```

You should see output like the following after successful installation of the AWS SAM CLI:

```
SAM CLI, version 0.19.0
```

You're now ready to start development.

Next Steps

You're now ready to begin building your own serverless applications using AWS SAM! If you want to start with sample serverless applications, choose one of the following links:

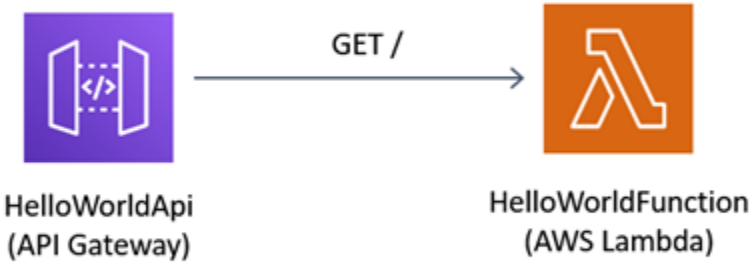
- Tutorial: Deploying a Hello World Application (p. 15) – Step-by-step instructions to download, build, and deploy a simple serverless application.
- AWS SAM example applications in GitHub – Sample applications in the AWS SAM GitHub repository that you can further experiment with.

Tutorial: Deploying a Hello World Application

In this guide, you download, build, and deploy a sample Hello World application using AWS SAM. You then test the application in the AWS Cloud, and optionally test it locally on your development host.

This application implements a simple API backend. It consists of an API Gateway endpoint and a Lambda function. When you send a GET request to the API Gateway endpoint, the Lambda function is invoked. This function returns a `hello world` message.

The following diagram shows the components of this application:



The following is a preview of commands that you run to create your Hello World application. For more details about each of these commands, see the sections later in this page

```
#Make sure that the Region for this bucket aligns with where you deploy
aws s3 mb s3://bucketname --region region  # Example regions: us-east-1, ap-east-1, eu-central-1, sa-east-1

#Step 1 - Download a sample application
sam init --runtime python3.7 --dependency-manager pip --app-template hello-world --name sam-app

#Step 2 - Build your application
cd sam-app
sam build

#Step 3 - Package your application
sam package --output-template packaged.yaml --s3-bucket bucketname

#Step 4 - Deploy your application
sam deploy --template-file packaged.yaml --region us-west-2 --capabilities CAPABILITY_IAM --stack-name aws-sam-getting-started
```

Prerequisites

This guide assumes that you've completed the steps in the Installing the AWS SAM CLI (p. 3) for your OS. It assumes that you've done the following:

1. Created an AWS account.
2. Configured IAM permissions.
3. Installed the AWS CLI.
4. Created an Amazon S3 bucket.
5. Installed Docker. Note: Docker is only a prerequisite for testing your application locally.
6. Installed Homebrew. Note: Homebrew is only a prerequisite for Linux and macOS.
7. Installed the AWS SAM CLI.

In addition, the sample application in this tutorial requires Python 3.7. If you need to download Python 3.7, see Download Python.

Step 1: Download a Sample AWS SAM Application

Command to run:

```
# With SAM CLI version 0.30.0 or later, run this command:
sam init --runtime python3.7 --dependency-manager pip --app-template hello-world --name sam-app

# With SAM CLI versions prior to 0.30.0, run this command:
sam init --runtime python3.7
```

Example output:

```
 [+] Initializing project structure...

 Project generated: ./sam-app
```

```
 Steps you can take next within the project folder
 ================================================
 [*] Invoke Function: sam local invoke HelloWorldFunction --event event.json
 [*] Start API Gateway locally: sam local start-api

 Read sam-app/README.md for further instructions

[*] Project initialization is now complete
```

What AWS SAM is doing:

This command creates a directory named `sam-app` with the following folder structure, and then makes it your current directory:

```
sam-app/
  ### README.md
  ### events/
  #   ### event.json
  ### hello_world/
  #   ### __init__.py
  #   ### app.py            #Contains your AWS Lambda handler logic.
  #   ### requirements.txt  #Contains any Python dependencies the application requires,
used for sam build
  ### template.yaml         #Contains the AWS SAM template defining your application's AWS
resources.
  ### tests/
      ### unit/
          ### __init__.py
          ### test_handler.py
```

There are three especially important files:

- `template.yaml`: Contains the AWS SAM template that defines your application's AWS resources.
- `hello_world/app.py`: Contains your actual Lambda handler logic.
- `hello_world/requirements.txt`: Contains any Python dependencies that the application requires, and is used for `sam build`.

Step 2: Build Your Application

Command to run:

From the `sam-app` directory (that is, the directory where the `template.yaml` file for the sample application is located), run this command:

```
sam build
```

Example output:

```
 Build Succeeded

 Built Artifacts  : .aws-sam/build
 Built Template   : .aws-sam/build/template.yaml
```

```
Commands you can use next
=========================
[*] Invoke Function: sam local invoke
[*] Package: sam package --s3-bucket <yourbucket>
```

What AWS SAM is doing:

The AWS SAM CLI comes with abstractions for a number of Lambda runtimes to build your dependencies, and copies the source code into staging folders so that everything is ready to be packaged and deployed. The `sam build` command builds any dependencies that your application has, and copies your application source code to folders under `aws-sam/build` to be zipped and uploaded to Lambda.

You can see the following top-level tree under `.aws-sam`:

```
.aws_sam/
  ### build/
      ### HelloWorldFunction/
      ### template.yaml
```

`HelloWorldFunction` is a directory that contains your `app.py` file, as well as third-party dependencies that your application uses.

Step 3: Package Your Application for Deployment

Command to run:

```
sam package --output-template packaged.yaml --s3-bucket bucketname
```

Example output:

```
Uploading to 8eaa458acdd2b83bd86a45d4d256ef73  558700 / 558700.0  (100.00%)
Successfully packaged artifacts and wrote output template to file packaged.yaml.
Execute the following command to deploy the packaged template:

aws cloudformation deploy --template-file packaged.yaml --stack-name <YOUR STACK NAME>
```

> **Note**
> For *bucketname* in this command, you need an Amazon S3 bucket that the `sam package` command can use to store the deployment package. The deployment package is used when you deploy your application in a later step. If you need to create a bucket for this purpose, run the following command to create an Amazon S3 bucket:
>
> ```
> aws s3 mb s3://bucketname --region region  # Example regions: us-east-1, ap-east-1,
>  eu-central-1, sa-east-1
> ```

What AWS SAM is doing:

This command takes your Lambda handler source code and any third-party dependencies, zips everything, and uploads the zip file to your Amazon S3 bucket. That bucket and file location are then noted in the `packaged.yaml` file. You use the `packaged.yaml` file to deploy the application in the next step.

Step 4: Deploy Your Application to the AWS Cloud

Command to run:

```
sam deploy --template-file packaged.yaml --region region --capabilities CAPABILITY_IAM --
stack-name aws-sam-getting-started
```

Example output:

```
Waiting for changeset to be created..
Waiting for stack create/update to complete
Successfully created/updated stack - aws-sam-getting-started
```

What AWS SAM is doing:

This command deploys your application to the AWS Cloud. It's important that this command explicitly includes both of the following:

- The AWS Region to deploy to. This Region must match the Region of the Amazon S3 source bucket.
- The `CAPABILITY_IAM` parameter, because creating new Lambda functions involves creating new IAM roles.

For more information about capabilities, see CreateStack in the *AWS CloudFormation API Reference*.

Step 5: Test Your Application in the AWS Cloud

Command to run:

```
aws cloudformation describe-stacks --stack-name aws-sam-getting-started --region region --
query "Stacks[].Outputs"
```

After running this command, you see details of the stack that you just created, including an `OutputKey` of `HelloWorldApi`, which looks something like the following:

```
{
    "OutputKey": "HelloWorldApi",
    "OutputValue": "https://<restapiid>.execute-api.us-east-1.amazonaws.com/Prod/hello/",
    "Description": "API Gateway endpoint URL for Prod stage for Hello World function"
}
```

The `OutputValue` of this object is the endpoint URL of your stack. You can use `curl` to send a request to your application using that endpoint URL. For example:

```
curl https://<restapiid>.execute-api.us-east-1.amazonaws.com/Prod/hello/
```

You should see output like the following after successfully deploying your application:

```
{"message": "hello world"}
```

What AWS SAM is doing:

For this step, AWS SAM isn't actually doing anything. Instead, you're using an AWS CloudFormation command to retrieve information about your serverless application (that is, the *AWS CloudFormation stack*), and then using `curl` to send a request to your application's endpoint URL.

If you see `{"message": "hello world"}` after executing the `curl` command, it means that you've successfully deployed your serverless application to AWS, and are calling your live Lambda function. Otherwise, see the Troubleshooting (p. 22) section later in this tutorial.

Step 6: Testing Your Application Locally (Optional)

When you're developing your application, you might also find it useful to test locally. The AWS SAM CLI provides the `sam local` command to run your application using Docker containers that simulate the execution environment of Lambda. There are two options to do this:

- Host your API locally
- Invoke your Lambda function directly

This step describes both options.

Host Your API Locally

Command to run:

```
sam local start-api
```

Example output:

```
 2019-07-12 15:27:58 Mounting HelloWorldFunction at http://127.0.0.1:3000/hello [GET]
 2019-07-12 15:27:58 You can now browse to the above endpoints to invoke your functions.
 You do not need to restart/reload SAM CLI while working on your functions, changes will be
 reflected instantly/automatically. You only need to restart SAM CLI if you update your AWS
 SAM template
 2019-07-12 15:27:58  * Running on http://127.0.0.1:3000/ (Press CTRL+C to quit)

 Fetching lambci/lambda:python3.7 Docker container
 image.....................................................................................
 2019-07-12 15:28:56 Mounting /<working-development-path>/sam-app/.aws-sam/build/
HelloWorldFunction as /var/task:ro,delegated inside runtime container
 START RequestId: 52fdfc07-2182-154f-163f-5f0f9a621d72 Version: $LATEST
 END RequestId: 52fdfc07-2182-154f-163f-5f0f9a621d72
 REPORT RequestId: 52fdfc07-2182-154f-163f-5f0f9a621d72  Duration: 4.42 ms       Billed
 Duration: 100 ms Memory Size: 128 MB     Max Memory Used: 22 MB
 2019-07-12 15:28:58 No Content-Type given. Defaulting to 'application/json'.
 2019-07-12 15:28:58 127.0.0.1 - - [12/Jul/2019 15:28:58] "GET /hello HTTP/1.1" 200 -
```

It might take a while for the Docker image to load. After it's loaded, you can use `curl` to send a request to your application that's running on your local host:

```
curl http://127.0.0.1:3000/hello
```

Example output:

```
 2019-07-12 15:29:57 Invoking app.lambda_handler (python3.7)
 2019-07-12 15:29:57 Found credentials in shared credentials file: ~/.aws/credentials

 Fetching lambci/lambda:python3.7 Docker container image......
 2019-07-12 15:29:58 Mounting /<working-development-path>/sam-app/.aws-sam/build/
HelloWorldFunction as /var/task:ro,delegated inside runtime container
 START RequestId: 52fdfc07-2182-154f-163f-5f0f9a621d72 Version: $LATEST
 END RequestId: 52fdfc07-2182-154f-163f-5f0f9a621d72
 REPORT RequestId: 52fdfc07-2182-154f-163f-5f0f9a621d72  Duration: 7.92 ms       Billed
 Duration: 100 ms Memory Size: 128 MB     Max Memory Used: 22 MB
 {"statusCode":200,"body":"{\"message\": \"hello world\"}"}
```

What AWS SAM is doing:

The `start-api` command starts up a local endpoint that replicates your REST API endpoint. It downloads an execution container that you can run your function locally in. The end result is the same output that you saw when you called your function in the AWS Cloud.

Making One-off Invocations

Command to run:

```
sam local invoke "HelloWorldFunction" -e events/event.json
```

Example output:

```
 2019-07-01 14:08:42 Found credentials in shared credentials file: ~/.aws/credentials
 2019-07-01 14:08:42 Invoking app.lambda_handler (python3.7)

 Fetching lambci/lambda:python3.7 Docker container
 image.....
 2019-07-01 14:09:39 Mounting /<working-development-path>/sam-app/.aws-sam/build/
HelloWorldFunction as /var/task:ro,delegated inside runtime container
 START RequestId: 52fdfc07-2182-154f-163f-5f0f9a621d72 Version: $LATEST
 END RequestId: 52fdfc07-2182-154f-163f-5f0f9a621d72
 REPORT RequestId: 52fdfc07-2182-154f-163f-5f0f9a621d72    Duration: 3.51 ms    Billed
 Duration: 100 ms    Memory Size: 128 MB    Max Memory Used: 22 MB
 {"statusCode":200,"body":"{\"message\": \"hello world\"}"}
```

What AWS SAM is doing:

The `invoke` command directly invokes your Lambda functions, and can pass input event payloads that you provide. With this command, you pass the event payload in the file `event.json` that's provided by the sample application.

Your initialized application came with a default `aws-proxy` event for API Gateway. A number of values are prepopulated for you. In this case, the `HelloWorldFunction` doesn't care about the particular values, so a stubbed request is OK. You can specify a number of values to be substituted in to the request to simulate what you would expect from an actual request. This following is an example of generating your own input event and comparing the output with the default `event.json` object:

```
sam local generate-event apigateway aws-proxy --body "" --path "hello" --method GET > api-
event.json
$ diff api-event.json event.json
```

Example output:

```
<   "body": "",
---
>   "body": "{\"message\": \"hello world\"}",
4,6c4,6
<   "path": "/hello",
<   "httpMethod": "GET",
<   "isBase64Encoded": true,
---
>   "path": "/path/to/resource",
>   "httpMethod": "POST",
>   "isBase64Encoded": false,
11c11
<     "proxy": "/hello"
---
>     "proxy": "/path/to/resource"
56c56
<     "path": "/prod/hello",
---
>     "path": "/prod/path/to/resource",
58c58
<     "httpMethod": "GET",
---
>     "httpMethod": "POST",
```

Troubleshooting

SAM CLI error: "no such option: --app-template"

When executing `sam init`, you see the following error:

```
Error: no such option: --app-template
```

This means that you are using an older version of the AWS SAM CLI that does not support the `--app-template` parameter. To fix this, you can either update your version of AWS SAM CLI to 0.30.0 or later, or omit the `--app-template` parameter from the `sam init` command.

Curl Error: "Missing Authentication Token"

When trying to invoke the API Gateway endpoint, you see the following error:

```
{"message":"Missing Authentication Token"}
```

This means that you've attempted to send a request to the correct domain, but the URI isn't recognizable. To fix this, verify the full URL, and update the `curl` command with the correct URL.

Curl Error: "curl: (6) Could not resolve: ..."

When trying to invoke the API Gateway endpoint, you see the following error:

```
curl: (6) Could not resolve: endpointdomain (Domain name not found)
```

This means that you've attempted to send a request to an invalid domain. This can happen if your serverless application failed to deploy successfully, or if you have a typo in your `curl` command. Verify that the application was deployed successfully by using the AWS CloudFormation console or AWS CLI, and that your `curl` command is correct.

Clean Up

If you no longer need the AWS resources you created by running this tutorial, you can remove them by deleting the AWS CloudFormation stack that you deployed.

To delete the AWS CloudFormation stack created with this tutorial using the AWS Management Console, follow these steps:

1. Sign in to the AWS Management Console and open the AWS CloudFormation console at https://console.aws.amazon.com/cloudformation.
2. In the left navigation pane, choose **Stacks**.
3. In the list of stacks, choose **aws-sam-getting-started**.
4. Choose **Delete**.

When done, the status of the of the stack will change to **DELETE_COMPLETE**.

Alternatively, you can delete the AWS CloudFormation stack by executing the following AWS CLI command:

```
aws cloudformation delete-stack --stack-name aws-sam-getting-started --region region
```

Verify Deleted Stack

For both methods of deleting the AWS CloudFormation stack, you can verify it was deleted by going to the https://console.aws.amazon.com/cloudformation, choosing **Stacks** in the left navigation pane, and choosing **Deleted** in the dropdown to the right of the search text box. You should see your stack name **aws-sam-getting-started** in the list of deleted stacks.

Conclusion

In this tutorial, you've done the following:

1. Created, built, packaged, and deployed a serverless application to AWS with AWS SAM.
2. Tested your application locally by using the AWS SAM CLI and Docker.
3. Deleted the AWS resources that you no longer need.

Next Steps

You're now ready to start building your own applications using the AWS SAM CLI.

To help you get started, you can download any of the example applications from the AWS SAM GitHub repository. To access this repository, see AWS SAM example applications.

AWS SAM Template Concepts

When you create a serverless application by using AWS SAM, your main objective is to construct an AWS SAM template file that represents the architecture of your serverless application.

The AWS SAM template file is a YAML or JSON configuration file that adheres to the open source AWS Serverless Application Model specification. You use the template to declare all of the AWS resources that comprise your serverless application.

AWS SAM templates are an extension of AWS CloudFormation templates. That is, any resource that you can declare in an AWS CloudFormation template you can also declare in an AWS SAM template. In addition, you can use the additional resource types provided by AWS SAM—for instance, the resources described in Declaring Serverless Resources (p. 25)—as shortcuts for some components of your serverless application.

For an introduction to AWS CloudFormation templates, see Learn Template Basics.

For information about the AWS SAM template specification, see AWS Serverless Application Model Specification.

The following sections describe the types of AWS resources that can be declared in AWS SAM template files.

Topics

Example

The following example AWS SAM template describes the configuration of a Lambda function and an API Gateway endpoint.

```
Transform: 'AWS::Serverless-2016-10-31'
Resources:

  ThumbnailFunction:
    # This resource creates a Lambda function.
    Type: 'AWS::Serverless::Function'

    Properties:

      # This function uses the Nodejs v8.10 runtime.
      Runtime: nodejs8.10

      # This is the Lambda function's handler.
      Handler: index.handler

      # The location of the Lambda function code.
      CodeUri: ./src

      # Event sources to attach to this function. In this case, we are attaching
      # one API Gateway endpoint to the Lambda function. The function is
```

```
    # called when a HTTP request is made to the API Gateway endpoint.
    Events:

      ThumbnailApi:
          # Define an API Gateway endpoint that responds to HTTP GET at /thumbnail
          Type: Api
          Properties:
              Path: /thumbnail
              Method: GET
```

Declaring Serverless Resources

AWS SAM defines the following resources that are specifically designed for serverless applications:

Topics

AWS::Serverless::Api

This resource type describes an API Gateway resource. It's useful for advanced use cases where you want full control and flexibility when you configure your APIs. For most scenarios, we recommend that you create APIs by specifying this resource type as an event source of your `AWS::Serverless::Function` resource.

```
Type: AWS::Serverless::Api
Properties:
  StageName: prod
  DefinitionUri: swagger.yml
```

For a list of properties, see AWS::Serverless::Api in the AWS SAM GitHub repository.

AWS::Serverless::Application

This resource type embeds a serverless application from the AWS Serverless Application Repository or from an Amazon S3 bucket as a nested application. Nested applications are deployed as nested stacks, which can contain multiple other resources. For more information about nested applications, see Nested Applications (p. 28).

The following is an example of a nested application from the AWS Serverless Application Repository:

```
Type: AWS::Serverless::Application
Properties:
  Location:
    ApplicationId: arn:aws:serverlessrepo:region:account-id:applications/application-name
    SemanticVersion: 1.0.0
  Parameters:
    StringParameter: parameter-value
    IntegerParameter: 2
```

The following is an example of a nested application that's hosted in an Amazon S3 bucket. In this example, *sam-template-object* is the name of a packaged AWS SAM template:

```
Type: AWS::Serverless::Application
Properties:
  Location: https://s3.region.amazonaws.com/bucket-name/sam-template-object
  Parameters:
    StringParameter: parameter-value
    IntegerParameter: 2
```

For a list of properties, see AWS::Serverless::Application in the AWS SAM GitHub repository.

For details about how to obtain the required values of an application that you want to nest, see Nested Applications (p. 28).

AWS::Serverless::Function

This resource type describes configuration information for creating a Lambda function. You can describe any event source that you want to attach to the Lambda function—such as Amazon S3, Amazon DynamoDB Streams, and Amazon Kinesis Data Streams.

The following is an example of a serverless function:

```
Type: AWS::Serverless::Function
Properties:
  Handler: index.js
  Runtime: nodejs8.10
  CodeUri: 's3://my-code-bucket/my-function.zip'
  Description: Creates thumbnails of uploaded images
  MemorySize: 1024
  Timeout: 15
  Policies:
   - AWSLambdaExecute # Managed Policy
   - Version: '2012-10-17' # Policy Document
     Statement:
       - Effect: Allow
         Action:
           - s3:GetObject
           - s3:GetObjectACL
         Resource: 'arn:aws:s3:::my-bucket/*'
  Environment:
    Variables:
      TABLE_NAME: my-table
  Events:
    PhotoUpload:
      Type: S3
      Properties:
        Bucket: my-photo-bucket
  Tags:
    AppNameTag: ThumbnailApp
    DepartmentNameTag: ThumbnailDepartment
```

For a list of properties, see AWS::Serverless::Function in the AWS SAM GitHub repository.

AWS::Serverless::LayerVersion

This resource type creates a Lambda layer version (LayerVersion) that contains library or runtime code that's needed by a Lambda function. When a serverless layer version is transformed, AWS SAM also transforms the logical ID of the resource so that old layer versions aren't automatically deleted by AWS CloudFormation when the resource is updated.

The following is an example of a layer version:

```
Type: AWS::Serverless::LayerVersion
Properties:
  LayerName: MyLayer
  Description: Layer description
  ContentUri: 's3://my-bucket/my-layer.zip'
  CompatibleRuntimes:
    - nodejs6.10
    - nodejs8.10
  LicenseInfo: 'Available under the MIT-0 license.'
  RetentionPolicy: Retain
```

For a list of properties, see AWS::Serverless::LayerVersion in the AWS SAM GitHub repository.

AWS::Serverless::SimpleTable

This resource type provides simple syntax for describing how to create DynamoDB tables. Here's an example:

```
Type: AWS::Serverless::SimpleTable
Properties:
  PrimaryKey:
    Name: id
    Type: String
  ProvisionedThroughput:
    ReadCapacityUnits: 5
    WriteCapacityUnits: 5
```

For a list of properties, see AWS::Serverless::SimpleTable in the AWS SAM GitHub repository.

For reference documentation for SAM template resources, see AWS SAM Specification on GitHub.

Declaring AWS CloudFormation Resources

AWS SAM is a higher-level abstraction of AWS CloudFormation that simplifies serverless application development. AWS SAM template files are AWS CloudFormation template files with a few additional resource types defined that are specific to serverless applications—such as API Gateway endpoints and Lambda functions. This means that AWS SAM supports the full suite of resources, intrinsic functions, and other template features that are available in AWS CloudFormation.

For example, the following AWS SAM template creates a Lambda function by using AWS SAM resource syntax. It also creates an Amazon S3 bucket by using AWS CloudFormation resource syntax:

```
Transform: 'AWS::Serverless-2016-10-31'
Resources:

  MyFunction:
    # SAM resource to create a Lambda function
    Type: 'AWS::Serverless::Function'

    Properties:
      Runtime: nodejs8.10
      ....

  MyBucket:
    # AWS CloudFormation resource to create an S3 bucket
```

```
    Type: 'AWS::S3::Bucket'
```

For an introduction to AWS CloudFormation templates, see Learn Template Basics.

For more information about working with AWS CloudFormation templates, see Working with AWS CloudFormation Templates.

For the full reference for AWS CloudFormation templates, see the AWS CloudFormation Template Reference.

Nested Applications

A serverless application can include one or more **nested applications**. You can deploy a nested application as a stand-alone artifact or as a component of a larger application.

As serverless architectures grow, common patterns emerge in which the same components are defined in multiple application templates. You can now separate out common patterns as dedicated applications, and then nest them as part of new or existing application templates. With nested applications, you can stay more focused on the business logic that's unique to your application.

To define a nested application in your serverless application, use the AWS::Serverless::Application resource type.

You can define nested applications from the following two sources:

- An **AWS Serverless Application Repository application** – You can define nested applications by using applications that are available to your account in the AWS Serverless Application Repository. These can be *private* applications in your account, applications that are *privately shared* with your account, or applications that are *publicly shared* in the AWS Serverless Application Repository. For more information about the different deployment permissions levels, see Application Deployment Permissions and Publishing Applications in the *AWS Serverless Application Repository Developer Guide*.
- A **local application** – You can define nested applications by using applications that are stored on your local file system.

See the following sections for details on how to use AWS SAM to define both of these types of nested applications in your serverless application.

> **Note**
> The maximum number of applications that can be nested in a serverless application is 200.
> The maximum number of parameters a nested application can have is 60.

Defining a Nested Application from the AWS Serverless Application Repository

You can define nested applications by using applications that are available in the AWS Serverless Application Repository. You can also store and distribute applications that contain nested applications using the AWS Serverless Application Repository. To review details of a nested application in the AWS Serverless Application Repository, you can use the AWS SDK, the AWS CLI, or the Lambda console.

To define an application that's hosted in the AWS Serverless Application Repository in your serverless application's AWS SAM template, use the **Copy as SAM Resource** button on the detail page of every AWS Serverless Application Repository application. To do this, follow these steps:

1. Make sure that you're signed in to the AWS Management Console.

2. Find the application that you want to nest in the AWS Serverless Application Repository by using the steps in the Browsing, Searching, and Deploying Applications section of the *AWS Serverless Application Repository Developer Guide*.
3. Choose the **Copy as SAM Resource** button. The SAM template section for the application that you're viewing is now in your clipboard.
4. Paste the SAM template section into the `Resources:` section of the SAM template file for the application that you want to nest in this application.

The following is an example SAM template section for a nested application that's hosted in the AWS Serverless Application Repository:

```
Transform: AWS::Serverless-2016-10-31

Resources:
  applicationaliasname:
    Type: AWS::Serverless::Application
    Properties:
      Location:
        ApplicationId: arn:aws:serverlessrepo:us-
east-1:123456789012:applications/application-alias-name
        SemanticVersion: 1.0.0
      Parameters:
        # Optional parameter that can have default value overridden
        # ParameterName1: 15 # Uncomment to override default value
        # Required parameter that needs value to be provided
        ParameterName2: YOUR_VALUE
```

If there are no required parameter settings, you can omit the `Parameters:` section of the template.

Important
Applications that contain nested applications hosted in the AWS Serverless Application Repository inherit the nested applications' sharing restrictions.
For example, suppose an application is publicly shared, but it contains a nested application that's only privately shared with the AWS account that created the parent application. In this case, if your AWS account doesn't have permission to deploy the nested application, you aren't able to deploy the parent application. For more information about permissions to deploy applications, see Application Deployment Permissions and Publishing Applications in the *AWS Serverless Application Repository Developer Guide*.

Defining a Nested Application from the Local File System

You can define nested applications by using applications that are stored on your local file system. You do this by specifying the path to the AWS SAM template file that's stored on your local file system.

The following is an example SAM template section for a nested local application:

```
Transform: AWS::Serverless-2016-10-31

Resources:
  applicationaliasname:
    Type: AWS::Serverless::Application
    Properties:
      Location: ../my-other-app/template.yaml
      Parameters:
        # Optional parameter that can have default value overridden
        # ParameterName1: 15 # Uncomment to override default value
```

```
        # Required parameter that needs value to be provided
        ParameterName2: YOUR_VALUE
```

If there are no parameter settings, you can omit the `Parameters:` section of the template.

Deploying Nested Applications

You can deploy your nested application by using the AWS SAM CLI command `sam deploy`. For more details, see Deploying Serverless Applications (p. 55).

> **Note**
> When you deploy an application that contains nested applications, you must acknowledge that. You do this by passing CAPABILITY_AUTO_EXPAND to the CreateCloudFormationChangeSet API,git status or using the `aws serverlessrepo create-cloud-formation-change-set` AWS CLI command.
> For more information about acknowledging nested applications, see Acknowledging IAM Roles, Resource Policies, and Nested Applications when Deploying Applications in the *AWS Serverless Application Repository Developer Guide*.

Controlling Access to API Gateway APIs

You can use AWS SAM to control who can access your API Gateway APIs by enabling authorization within your AWS SAM template.

AWS SAM supports several mechanisms for controlling access to your API Gateway APIs:

- **Lambda authorizers**. A Lambda authorizer (formerly known as a *custom authorizer*) is a Lambda function that you provide to control access to your API. When your API is called, this Lambda function is invoked with a request context or an authorization token that is provided by the client application. The Lambda function returns a policy document that specifies the operations that the caller is authorized to perform, if any. For more information about Lambda authorizers, see Use API Gateway Lambda Authorizers in the *API Gateway Developer Guide*. For examples of Lambda authorizers, see Example: Defining Lambda Token Authorizers (p. 31) and Example: Defining Lambda Request Authorizers (p. 32) later in this topic.

- **Amazon Cognito user pools**. Amazon Cognito user pools are user directories in Amazon Cognito. A client of your API must first sign a user in to the user pool, and obtain an identity or access token for the user. Then your API is called with one of the returned tokens. The API call succeeds only if the required token is valid. For more information about Amazon Cognito user pools, see Control Access to REST API Using Amazon Cognito User Pools as Authorizer in the *API Gateway Developer Guide*. For an example of Amazon Cognito user pools, see Example: Defining Amazon Cognito User Pools (p. 33) later in this topic.

- **IAM permissions**. You can control who can invoke your API using IAM permissions. Users calling your API must be authenticated with IAM credentials. Calls to your API only succeed if there is an IAM policy attached to the IAM user that represents the API caller, an IAM group that contains the user, or an IAM role that is assumed by the user. For more information about IAM permissions, see Control Access to an API with IAM Permissions in the *API Gateway Developer Guide*. For an example of IAM permissions, see Example: Defining IAM Permissions (p. 34) later in this topic.

- **API keys**. API keys are alphanumeric string values that you distribute to application developer customers to grant access to your API. For more information about API keys, see Create and Use Usage

Plans with API Keys in the *API Gateway Developer Guide*. For an example of API keys, see Example: Defining API Keys (p. 34) later in this topic.

- **Resource policies**. Resource policies are JSON policy documents that you can attach to an API Gateway API to control whether a specified principal (typically an IAM user or role) can invoke the API. For more information about resource policies, see Control Access to an API with Amazon API Gateway Resource Policies in the *API Gateway Developer Guide*. For an example of resource policies, see Example: Defining Resource Policies (p. 35) later in this topic.

In addition, you can use AWS SAM to customize the content of some API Gateway error responses. For more information about customizing API Gateway error responses, see Set Up Gateway Responses to Customize Error Responses. For an example of customized responses, see Example: Defining Customized Responses (p. 35) later in this topic.

Choosing a Mechanism to Control Access

The mechanism that you choose to control access to your API Gateway APIs depends on a few factors. For example, if you have a greenfield project that doesn't have either authorization or access control set up yet, then Amazon Cognito user pools might be your best option. This is because when you set up user pools, you also set up both authentication and access control automatically.

However, if your application already has authentication set up, then using Lambda authorizers might be the best option. This is because you can call your existing authentication service and return a policy document based on the response. Also, if your application requires custom authentication or access control logic that user pools don't support, then Lambda authorizers might be your best option.

After you've decided which mechanism to use, see the corresponding section in this topic to see how to use AWS SAM to configure your application to use that mechanism.

Example: Defining Lambda Token Authorizers

You can control access to your APIs by defining a Lambda Token authorizer within your AWS SAM template. To do this, you use the API Auth Object data type.

The following is an example AWS SAM template section for a Lambda Token authorizer:

```
Resources:
  MyApi:
    Type: AWS::Serverless::Api
    Properties:
      StageName: Prod
      Auth:
        DefaultAuthorizer: MyLambdaTokenAuthorizer
        Authorizers:
          MyLambdaTokenAuthorizer:
            FunctionArn: !GetAtt MyAuthFunction.Arn

  MyFunction:
    Type: AWS::Serverless::Function
    Properties:
      CodeUri: ./src
      Handler: index.handler
      Runtime: nodejs8.10
      Events:
        GetRoot:
          Type: Api
          Properties:
```

```
            RestApiId: !Ref MyApi
            Path: /
            Method: get

  MyAuthFunction:
    Type: AWS::Serverless::Function
    Properties:
      CodeUri: ./src
      Handler: authorizer.handler
      Runtime: nodejs8.10
```

For more information about API Gateway Lambda authorizers, see Use API Gateway Lambda Authorizers in the *API Gateway Developer Guide*.

For a full sample application that includes a Lambda Token authorizer, see API Gateway + Lambda TOKEN Authorizer Example.

Example: Defining Lambda Request Authorizers

You can control access to your APIs by defining a Lambda Request authorizer within your AWS SAM template. To do this, you use the API Auth Object data type.

The following is an example AWS SAM template section for a Lambda Request authorizer:

```
Resources:
  MyApi:
    Type: AWS::Serverless::Api
    Properties:
      StageName: Prod
      Auth:
        DefaultAuthorizer: MyLambdaRequestAuthorizer
        Authorizers:
          MyLambdaRequestAuthorizer:
            FunctionPayloadType: REQUEST
            FunctionArn: !GetAtt MyAuthFunction.Arn
            Identity:
              QueryStrings:
                - auth

  MyFunction:
    Type: AWS::Serverless::Function
    Properties:
      CodeUri: ./src
      Handler: index.handler
      Runtime: nodejs8.10
      Events:
        GetRoot:
          Type: Api
          Properties:
            RestApiId: !Ref MyApi
            Path: /
            Method: get

  MyAuthFunction:
    Type: AWS::Serverless::Function
    Properties:
      CodeUri: ./src
      Handler: authorizer.handler
      Runtime: nodejs8.10
```

For more information about API Gateway Lambda authorizers, see Use API Gateway Lambda Authorizers in the *API Gateway Developer Guide*.

For a full sample application that includes a Lambda Request authorizer, see API Gateway + Lambda REQUEST Authorizer Example.

Example: Defining Amazon Cognito User Pools

You can control access to your APIs by defining Amazon Cognito user pools within your AWS SAM template. To do this, you use the API Auth Object data type.

The following is an example AWS SAM template section for a user pool:

```
Resources:
  MyApi:
    Type: AWS::Serverless::Api
    Properties:
      StageName: Prod
      Cors: "'*'"
      Auth:
        DefaultAuthorizer: MyCognitoAuthorizer
        Authorizers:
          MyCognitoAuthorizer:
            UserPoolArn: !GetAtt MyCognitoUserPool.Arn

  MyFunction:
    Type: AWS::Serverless::Function
    Properties:
      CodeUri: ./src
      Handler: lambda.handler
      Runtime: nodejs8.10
      Events:
        Root:
          Type: Api
          Properties:
            RestApiId: !Ref MyApi
            Path: /
            Method: GET

  MyCognitoUserPool:
    Type: AWS::Cognito::UserPool
    Properties:
      UserPoolName: !Ref CognitoUserPoolName
      Policies:
        PasswordPolicy:
          MinimumLength: 8
      UsernameAttributes:
        - email
      Schema:
        - AttributeDataType: String
          Name: email
          Required: false

  MyCognitoUserPoolClient:
    Type: AWS::Cognito::UserPoolClient
    Properties:
      UserPoolId: !Ref MyCognitoUserPool
      ClientName: !Ref CognitoUserPoolClientName
      GenerateSecret: false
```

For more information about Amazon Cognito user pools, see Control Access to a REST API Using Amazon Cognito User Pools as Authorizer in the *API Gateway Developer Guide*.

For a full sample application that includes a user pool as an authorizer, see API Gateway + Cognito Auth + Cognito Hosted Auth Example.

Example: Defining IAM Permissions

You can control access to your APIs by defining IAM permissions within your AWS SAM template. To do this, you use the API Auth Object data type.

The following is an example AWS SAM template section for IAM permissions:

```
Resources:
  MyApi:
    Type: AWS::Serverless::Api
    Properties:
      StageName: Prod
      Auth:
        DefaultAuthorizer: AWS_IAM

  MyFunction:
    Type: AWS::Serverless::Function
    Properties:
      CodeUri: .
      Handler: index.handler
      Runtime: nodejs8.10
      Events:
        GetRoot:
          Type: Api
          Properties:
            RestApiId: !Ref MyApi
            Path: /
            Method: get
```

For more information about IAM permissions, see Control Access to an API Using IAM Permissions in the *API Gateway Developer Guide*.

For a full sample application that includes a user pool as an authorizer, see API Gateway + IAM Permissions Example.

Example: Defining API Keys

You can control access to your APIs by requiring API keys within your AWS SAM template. To do this, you use the API Auth Object data type.

The following is an example AWS SAM template section for API keys:

```
Resources:
  MyApi:
    Type: AWS::Serverless::Api
    Properties:
      StageName: Prod
      Auth:
        ApiKeyRequired: true # sets for all methods

  MyFunction:
    Type: AWS::Serverless::Function
    Properties:
      CodeUri: .
      Handler: index.handler
      Runtime: nodejs8.10
      Events:
        ApiKey:
          Type: Api
          Properties:
            RestApiId: !Ref MyApi
```

```
            Path: /
            Method: get
            Auth:
              ApiKeyRequired: true
```

For more information about API keys, see Create and Use Usage Plans with API Keys in the *API Gateway Developer Guide*.

Example: Defining Resource Policies

You can control access to your APIs by attaching a resource policy within your AWS SAM template. To do this, you use the API Auth Object data type.

The following is an example AWS SAM template section for resource policies:

```
Resources:
  ExplicitApi:
    Type: AWS::Serverless::Api
    Properties:
      StageName: Prod
      EndpointConfiguration: PRIVATE
      Auth:
        ResourcePolicy:
          CustomStatements: {
              Effect: 'Allow',
              Action: 'execute-api:Invoke',
              Resource: ['execute-api:/*/*/*'],
              Principal: '*'
            }
  MinimalFunction:
    Type: 'AWS::Serverless::Function'
    Properties:
      CodeUri: s3://sam-demo-bucket/hello.zip
      Handler: hello.handler
      Runtime: python2.7
      Events:
        AddItem:
          Type: Api
          Properties:
            RestApiId:
              Ref: ExplicitApi
            Path: /add
            Method: post
```

For more information about resource policies, see Control Access to an API with Amazon API Gateway Resource Policies in the *API Gateway Developer Guide*.

Example: Defining Customized Responses

You can customize some API Gateway error responses by defining response headers within your AWS SAM template. To do this, you use the Gateway Response Object data type.

The following is an example AWS SAM template section for API Gateway responses:

```
Resources:
  MyApi:
    Type: AWS::Serverless::Api
    Properties:
      StageName: Prod
      GatewayResponses:
```

```
      DEFAULT_4xx:
        ResponseParameters:
          Headers:
            Access-Control-Expose-Headers: "'WWW-Authenticate'"
            Access-Control-Allow-Origin: "'*'"

 GetFunction:
   Type: AWS::Serverless::Function
   Properties:
     Handler: index.get
     Runtime: nodejs6.10
     InlineCode: module.exports = async () => throw new Error('Check out the response
headers!')
     Events:
       GetResource:
         Type: Api
         Properties:
           Path: /error
           Method: get
           RestApiId: !Ref MyApi
```

For more information about customizing API Gateway messages, see Set Up Gateway Responses to Customize Error Responses in the *API Gateway Developer Guide*.

For a full sample application that includes a customized error response, see API Gateway + GatewayResponse Example.

Testing and Debugging Serverless Applications

With the AWS SAM command line interface (CLI), you can locally test and "step-through" debug your serverless applications before uploading your application to the AWS Cloud. You can verify whether your application is behaving as expected, debug what's wrong, and fix any issues, before going through the steps of packaging and deploying your application.

When you locally invoke a Lambda function in debug mode within the AWS SAM CLI, you can then attach a debugger to it. With the debugger, you can step through your code line by line, see the values of various variables, and fix issues the same way you would for any other application.

Topics

Building Applications with Dependencies

You can use the `sam build (p. 71)` command to compile dependencies for Lambda functions written in Python. For example, if you write code that uses Python packages, such as a graphics library for image processing, you need to create a deployment package that works on the Amazon Linux AMI. The `sam build` command allows you to easily create deployment artifacts that target Lambda's execution environment, so that the functions you build locally run in a similar environment in the AWS Cloud.

The `sam build` command iterates through the functions in your application, looks for a manifest file (such as `requirements.txt`) that contain the dependencies, and automatically creates deployment artifacts that you can deploy to Lambda using the `sam package` and `sam deploy` commands.

If your Lambda function depends on packages that have natively compiled programs, you can use the `--use-container` flag. The `--use-container` flag compiles your functions in a Lambda-like environment locally, so they are in the right format when you deploy them to the AWS Cloud.

Examples:

```
# Build a deployment package
```

```
$ sam build

# Run the build process inside an AWS Lambda-like Docker container
$ sam build --use-container

# Build and run your functions locally
$ sam build && sam local invoke

# Build and package for deployment
$ sam build && sam package --s3-bucket <bucketname>

# For more options
$ sam build --help
```

Invoking Functions Locally

You can invoke your function locally by using the `sam local invoke` (p. 75) command and providing its function logical ID and an event file. Alternatively, `sam local invoke` also accepts `stdin` as an event.

> **Note**
> The `sam local invoke` command described in this section corresponds to the AWS CLI command `aws lambda invoke`. You can use either version of this command to invoke a Lambda function that you've uploaded to the AWS Cloud.

You must execute `sam local invoke` in the project directory containing the function you want to invoke.

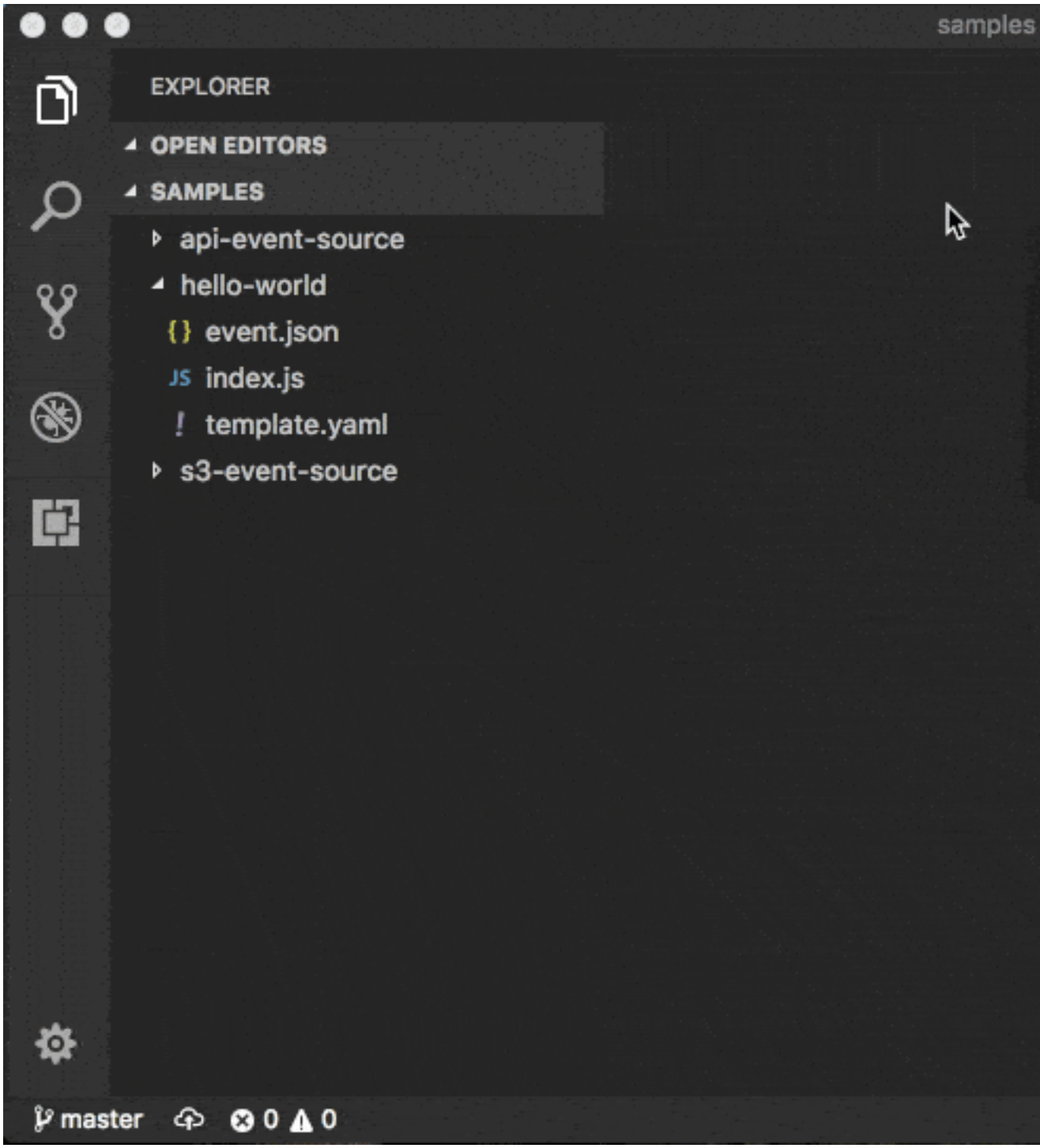
Examples:

```
# Invoking function with event file
$ sam local invoke "Ratings" -e event.json

# Invoking function with event via stdin
$ echo '{"message": "Hey, are you there?" }' | sam local invoke "Ratings"

# For more options
$ sam local invoke --help
```

This animation shows invoking a Lambda function locally using Microsoft Visual Studio Code:



Environment Variable File

You can use the `--env-vars` argument with the `invoke` or `start-api` commands. You do this to provide a JSON file that contains values to override the environment variables that are already defined in your function template. Structure the file as follows:

```
{
  "MyFunction1": {
    "TABLE_NAME": "localtable",
    "BUCKET_NAME": "testBucket"
  },
  "MyFunction2": {
    "TABLE_NAME": "localtable",
    "STAGE": "dev"
  },
}
```

For example, if you save this content in a file named `env.json`, then the following command uses this file to override the included environment variables:

```
$ sam local invoke --env-vars env.json
```

Layers

If your application includes layers, see Working with Layers (p. 42) for more information about how to debug layers issues on your local host.

Running API Gateway Locally

Use the `sam local start-api (p. 77)` command to start a local instance of API Gateway that you will use to test HTTP request/response functionality. This functionality features hot reloading to enable you to quickly develop and iterate over your functions.

> **Note**
> "Hot reloading" is when only the files that changed are refreshed without losing the state of the application. In contrast, "live reloading" is when the entire application is refreshed, such that the state of the application is lost.

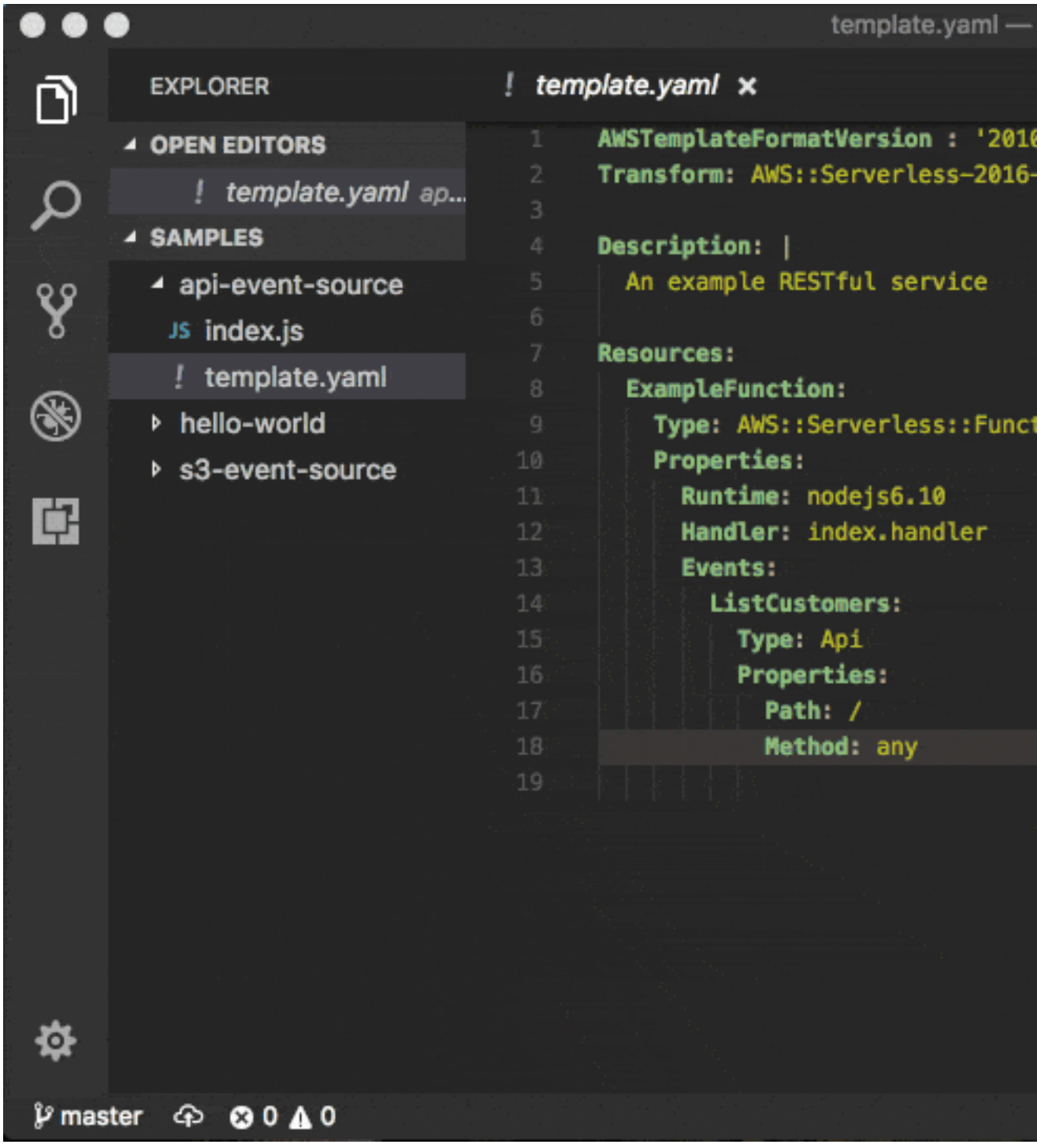
You must execute `sam local invoke` in the project directory containing the function you want to invoke.

Example:

```
$ sam local start-api
```

AWS SAM automatically finds any functions within your AWS SAM template that have `Api` event sources defined. Then, it mounts them at the defined HTTP paths.

This animation shows running API Gateway locally using Microsoft Visual Studio Code:



In the following example, the `Ratings` function mounts `ratings.py:handler()` at `/ratings` for `GET` requests:

```
Ratings:
  Type: AWS::Serverless::Function
  Properties:
    Handler: ratings.handler
```

```
    Runtime: python3.6
    Events:
      Api:
        Type: Api
        Properties:
          Path: /ratings
          Method: get
```

By default, AWS SAM uses Proxy Integration and expects the response from your Lambda function to include one or more of the following: `statusCode`, `headers`, or `body`.

For example:

```
// Example of a Proxy Integration response
exports.handler = (event, context, callback) => {
    callback(null, {
        statusCode: 200,
        headers: { "x-custom-header" : "my custom header value" },
        body: "hello world"
    });
}
```

For examples in other AWS Lambda languages, see Proxy Integration.

Environment Variable File

You can use the `--env-vars` argument with the `invoke` or `start-api` commands to provide a JSON file that contains values to override the environment variables already defined in your function template. Structure the file as follows:

```
{
  "MyFunction1": {
    "TABLE_NAME": "localtable",
    "BUCKET_NAME": "testBucket"
  },
  "MyFunction2": {
    "TABLE_NAME": "localtable",
    "STAGE": "dev"
  },
}
```

For example, if you save this content in a file named `env.json`, then the following command uses this file to override the included environment variables:

```
$ sam local start-api --env-vars env.json
```

Layers

If your application includes layers, see Working with Layers (p. 42) for more information about how to debug layers issues on your local host.

Working with Layers

The AWS SAM CLI supports applications that include layers. For more information about layers, see Lambda Layers.

The following is an example AWS SAM template with a Lambda function that includes a layer:

```
ServerlessFunction:
  Type: AWS::Serverless::Function
  Properties:
    CodeUri: .
    Handler: my_handler
    Runtime: Python3.7
    Layers:
        - <LayerVersion ARN>
```

For more information about including layers in your application, see either AWS::Serverless::Function in the AWS SAM GitHub repository, or AWS::Lambda::Function in the *AWS CloudFormation User Guide*.

When you invoke your function using one of the sam local CLI subcommands, the layers package of your function is downloaded and cached on your local host. See the following chart for default cache directory locations. After the package is cached, the AWS SAM CLI overlays the layers onto a Docker image that's used to invoke your function. The AWS SAM CLI generates the names of the images it builds, as well as the LayerVersions that are held in the cache. You can find more details about the schema in the following sections.

To inspect the overlaid layers, execute the following command to start a bash session in the image that you want to inspect:

```
docker run -it --entrypoint=/bin/bash samcli/lambda:<Tag following the schema outlined in
 Docker Image Tag Schema> -i
```

Layer Caching Directory name schema

Given a LayerVersionArn that's defined in your template, the AWS SAM CLI extracts the LayerName and Version from the ARN. It creates a directory to place the layer contents in named `LayerName-Version-<first 10 characters of sha256 of ARN>`.

Example:

```
ARN = arn:aws:lambda:us-west-2:111111111111:layer:myLayer:1
Directory name = myLayer-1-926eeb5ff1
```

Docker Images tag schema

To compute the unique layers hash, combine all unique layer names with a delimiter of '-', take the SHA256 hash, and then take the first 25 characters.

Example:

```
ServerlessFunction:
  Type: AWS::Serverless::Function
  Properties:
    CodeUri: .
    Handler: my_handler
    Runtime: Python3.7
    Layers:
        - arn:aws:lambda:us-west-2:111111111111:layer:myLayer:1
        - arn:aws:lambda:us-west-2:111111111111:layer:mySecondLayer:1
```

Unique names are computed the same as the Layer Caching Directory name schema:

```
arn:aws:lambda:us-west-2:111111111111:layer:myLayer:1 = myLayer-1-926eeb5ff1
arn:aws:lambda:us-west-2:111111111111:layer:mySecondLayer:1 = mySecondLayer-1-6bc1022bdf
```

To compute the unique layers hash, combine all unique layer names with a delimiter of '-', take the sha256 hash, and then take the first 25 characters:

```
myLayer-1-926eeb5ff1-mySecondLayer-1-6bc1022bdf = 2dd7ac5ffb30d515926aef
```

Then combine this value with the function's runtime, with a delimiter of '-':

```
python3.7-2dd7ac5ffb30d515926aefffd
```

Default Cache Directory Locations

OS	Location
Windows 7	C:\Users\<user>\AppData\Roaming\AWS SAM
Windows 8	C:\Users\<user>\AppData\Roaming\AWS SAM
Windows 10	C:\Users\<user>\AppData\Roaming\AWS SAM
macOS	~/.aws-sam/layers-pkg
Unix	~/.aws-sam/layers-pkg

Running Automated Tests

You can use the `sam local invoke` command to manually test your code by running Lambda functions locally. With the AWS SAM CLI, you can easily author automated integration tests by first running tests against local Lambda functions before deploying to the AWS Cloud.

The `sam local start-lambda` command starts a local endpoint that emulates the AWS Lambda invoke endpoint. You can invoke it from your automated tests. Because this endpoint emulates the AWS Lambda invoke endpoint, you can write tests once, and then run them (without any modifications) against the local Lambda function, or against a deployed Lambda function. You can also run the same tests against a deployed AWS SAM stack in your CI/CD pipeline.

This is how the process works:

1. Start the local Lambda endpoint.

   Start the local Lambda endpoint by running the following command in the directory that contains your AWS SAM template:

   ```
   sam local start-lambda
   ```

   This command starts a local endpoint at `http://127.0.0.1:3001` that emulates AWS Lambda. You can run your automated tests against this local Lambda endpoint. When you invoke this endpoint using the AWS CLI or SDK, it locally executes the Lambda function that's specified in the request, and returns a response.
2. Run an integration test against the local Lambda endpoint.

In your integration test, you can use the AWS SDK to invoke your Lambda function with test data, wait for response, and verify that the response is what you expect. To run the integration test locally, you should configure the AWS SDK to send a Lambda Invoke API call to invoke the local Lambda endpoint that you started in previous step.

The following is a Python example (the AWS SDKs for other languages have similar configurations):

```
import boto3
import botocore

# Set "running_locally" flag if you are running the integration test locally
running_locally = True

if running_locally:

    # Create Lambda SDK client to connect to appropriate Lambda endpoint
    lambda_client = boto3.client('lambda',
        region_name="us-west-2",
        endpoint_url="http://127.0.0.1:3001",
        use_ssl=False,
        verify=False,
        config=botocore.client.Config(
            signature_version=botocore.UNSIGNED,
            read_timeout=0,
            retries={'max_attempts': 0},
        )
    )
else:
    lambda_client = boto3.client('lambda')


# Invoke your Lambda function as you normally usually do. The function will run
# locally if it is configured to do so
response = lambda_client.invoke(FunctionName="HelloWorldFunction")

# Verify the response
assert response == "Hello World"
```

You can use this code to test deployed Lambda functions by setting `running_locally` to `False`. This sets up the AWS SDK to connect to AWS Lambda in the AWS Cloud.

Generating Sample Event Payloads

To make local development and testing of Lambda functions easier, you can generate and customize event payloads for a number of AWS services like API Gateway, AWS CloudFormation, Amazon S3, and so on.

For the full list of services that you can generate sample event payloads for, use this command:

```
sam local generate-event --help
```

For the list of options you can use for a particular service, use this command:

```
sam local generate-event [SERVICE] --help
```

Examples:

```
#Generates the event from S3 when a new object is created
$ sam local generate-event s3 put

# Generates the event from S3 when an object is deleted
$ sam local generate-event s3 delete
```

Working with Logs

To simplify troubleshooting, the AWS SAM CLI has a command called `sam logs (p. 80)`. This command lets you fetch logs generated by your Lambda function from the command line.

> **Note**
> The `sam logs` command works for all AWS Lambda functions, not just the ones you deploy using AWS SAM.

Fetching Logs by AWS CloudFormation Stack

When your function is a part of an AWS CloudFormation stack, you can fetch logs by using the function's logical ID:

```
sam logs -n HelloWorldFunction --stack-name mystack
```

Fetching Logs by Lambda Function Name

Or, you can fetch logs by using the function's name:

```
sam logs -n mystack-HelloWorldFunction-1FJ8PD
```

Tailing Logs

Add the `--tail` option to wait for new logs and see them as they arrive. This is helpful during deployment or when you're troubleshooting a production issue.

```
sam logs -n HelloWorldFunction --stack-name mystack --tail
```

Viewing Logs for a Specific Time Range

You can view logs for a specific time range by using the `-s` and `-e` options:

```
sam logs -n HelloWorldFunction --stack-name mystack -s '10min ago' -e '2min ago'
```

Filtering Logs

Use the `--filter` option to quickly find logs that match terms, phrases, or values in your log events:

```
sam logs -n HelloWorldFunction --stack-name mystack --filter "error"
```

In the output, the AWS SAM CLI underlines all occurrences of the word "error" so you can easily locate the filter keyword within the log output.

Error Highlighting

When your Lambda function crashes or times out, the AWS SAM CLI highlights the timeout message in red. This helps you easily locate specific executions that are timing out within a giant stream of log output.

JSON Pretty Printing

If your log messages print JSON strings, the AWS SAM CLI automatically pretty prints the JSON to help you visually parse and understand the JSON.

Step-Through Debugging Lambda Functions Locally

You can use AWS SAM with a number of AWS toolkits to test and debug your serverless applications locally.

For example, you can perform step-through debugging of your Lambda functions. Step-through debugging makes it easier to understand what the code is doing. It tightens the feedback loop by making it possible for you to find and troubleshoot issues that you might run into in the cloud.

Using AWS Toolkits

AWS toolkits are plugins that provide you with the ability to perform many common debugging tasks, like setting breakpoints, executing code line by line, and inspecting the values of variables. Toolkits make it easier for you to develop, debug, and deploy serverless applications that are built using AWS. They provide an experience for building, testing, debugging, deploying, and invoking Lambda functions that's integrated into the integrated development environment (IDE).

For more information about AWS toolkits that you can use with AWS SAM, see the following:

- AWS Toolkit for JetBrains
- AWS Toolkit for PyCharm
- AWS Toolkit for IntelliJ
- AWS Toolkit for Visual Studio Code

Running AWS SAM Locally

The commands `sam local invoke` and `sam local start-api` both support local step-through debugging of your Lambda functions. To run AWS SAM locally with step-through debugging support enabled, specify `--debug-port` or `-d` on the command line. For example:

```
# Invoke a function locally in debug mode on port 5858
$ sam local invoke -d 5858 <function logical id>
```

```
# Start local API Gateway in debug mode on port 5858
$ sam local start-api -d 5858
```

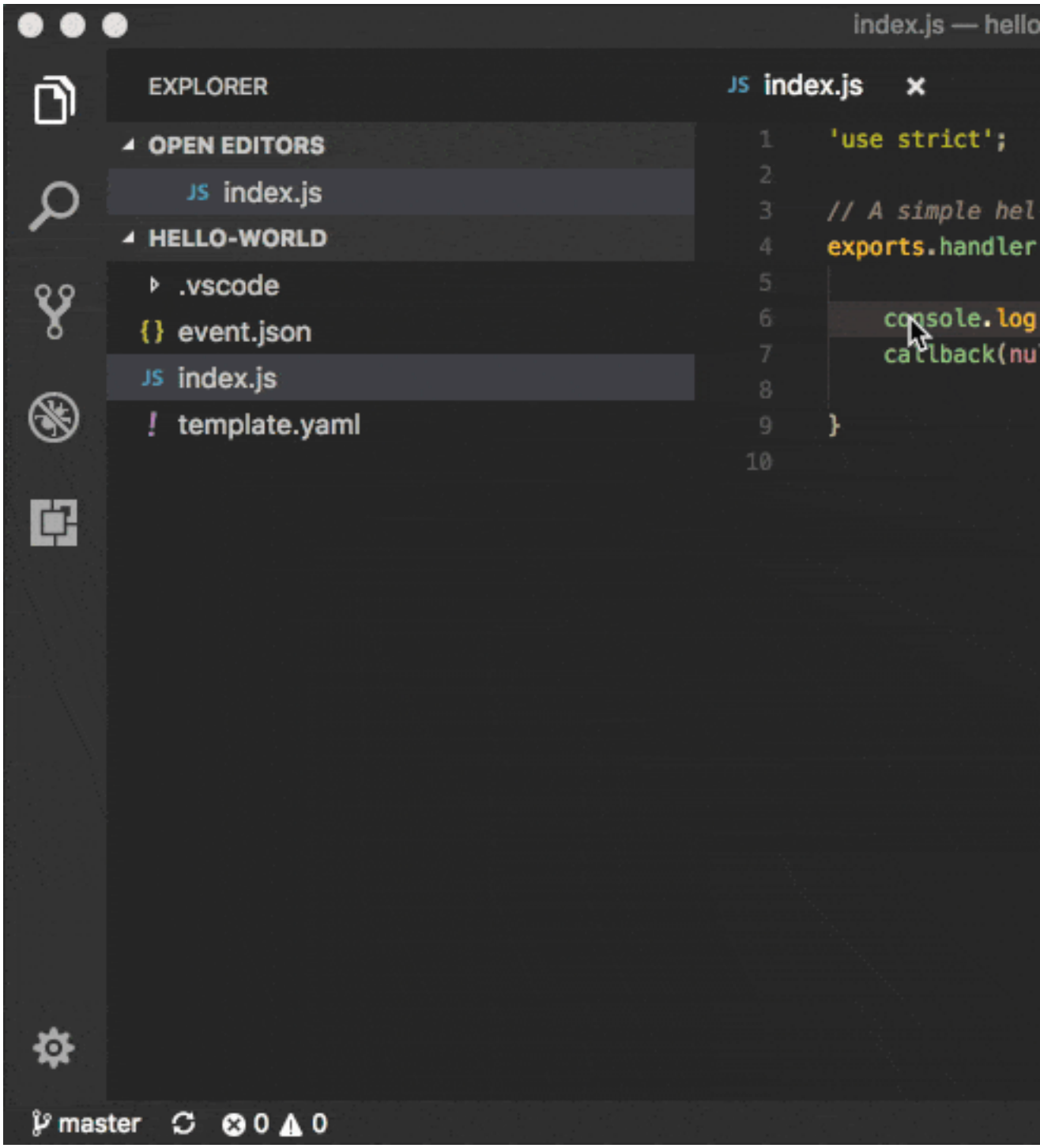
Note
If you're using `sam local start-api`, the local API Gateway instance exposes all of your Lambda functions. However, because you can specify a single debug port, you can only debug one function at a time. You need to call your API before the AWS SAM CLI binds to the port, which allows the debugger to connect.

Topics

The following topics provide examples of how to set up your environment to test and debug your serverless applications locally.

Step-Through Debugging Node.js Functions Locally

The following is an example that shows how to debug a Node.js function with Microsoft Visual Studio Code:



To set up Microsoft Visual Studio Code for step-through debugging Node.js functions with the AWS SAM CLI, use the following launch configuration. Before you do this, set the directory where the `template.yaml` file is located as the workspace root in Microsoft Visual Studio Code:

```
{
    "version": "0.2.0",
    "configurations": [
```

```
        {
            "name": "Attach to SAM CLI",
            "type": "node",
            "request": "attach",
            "address": "localhost",
            "port": 5858,
            // From the sam init example, it would be "${workspaceRoot}/hello-world"
            "localRoot": "${workspaceRoot}/{directory of node app}",
            "remoteRoot": "/var/task",
            "protocol": "inspector",
            "stopOnEntry": false
        }
    ]
}
```

Note
The `localRoot` is set based on what the CodeUri points at in the `template.yaml` file. If there are nested directories within the CodeUri, that needs to be reflected in the `localRoot`.

Note
Node.js versions earlier than 7 (for example, Node.js 4.3 and Node.js 6.10) use the `legacy` protocol, while Node.js versions including and later than 7 (for example, Node.js 8.10) use the `inspector` protocol. Be sure to specify the corresponding protocol in the `protocol` entry of your launch configuration. This was tested with Microsoft Visual Studio Code versions 1.26, 1.27, and 1.28 for the `legacy` and `inspector` protocols.

Step-Through Debugging Python Functions Locally

Python step-through debugging requires you to enable remote debugging in your Lambda function code. This is a two-step process:

1. Install the ptvsd library and enable it within your code.
2. Configure your IDE to connect to the debugger that you configured for your function.

Because this might be your first time using the AWS SAM CLI, start with a boilerplate Python application, and install both the application's dependencies and ptvsd:

```
sam init --runtime python3.6 --name python-debugging
cd python-debugging/

# Install dependencies of our boilerplate app
pip install -r hello_world/requirements.txt -t hello_world/build/

# Install ptvsd library for step through debugging
pip install ptvsd -t hello_world/build/

cp hello_world/app.py hello_world/build/
```

Ptvsd Configuration

Next, you need to enable ptvsd within your code. To do this, open `hello_world/build/app.py`, and add the following ptvsd specifics:

```
import ptvsd

# Enable ptvsd on 0.0.0.0 address and on port 5890 that we'll connect later with our IDE
ptvsd.enable_attach(address=('0.0.0.0', 5890), redirect_output=True)
ptvsd.wait_for_attach()
```

Use `0.0.0.0` instead of `localhost` for listening across all network interfaces. `5890` is the debugging port that you want to use.

Microsoft Visual Studio Code

Now that you have the dependencies and ptvsd enabled within your code, you can configure Microsoft Visual Studio Code debugging. Assuming that you're still in the application folder and have the code command in your path, open Microsoft Visual Studio Code by using this command:

```
code .
```

> **Note**
> If you don't have code in your path, open a new instance of Microsoft Visual Studio Code from the `python-debugging/` folder that you created earlier.

To set up Microsoft Visual Studio Code for debugging with the AWS SAM CLI, use the following launch configuration:

```
{
    "version": "0.2.0",
    "configurations": [
        {
            "name": "SAM CLI Python Hello World",
            "type": "python",
            "request": "attach",
            "port": 5890,
            "host": "localhost",
            "pathMappings": [
                {
                    "localRoot": "${workspaceFolder}/hello_world/build",
                    "remoteRoot": "/var/task"
                }
            ]
        }
    ]
}
```

For Microsoft Visual Studio Code, the property `localRoot` under the `pathMappings` key is important. There are two reasons that help explain this setup:

- **localRoot**: This path is to be mounted in the Docker container, and needs to have both the application and dependencies at the root level.
- **workspaceFolder**: This path is the absolute path where the Microsoft Visual Studio Code instance was opened.

If you opened Microsoft Visual Studio Code in a different location other than `python-debugging/`, you need to replace it with the absolute path where `python-debugging/` is located.

After the Microsoft Visual Studio Code debugger configuration is complete, make sure to add a breakpoint anywhere you want to in `hello_world/build/app.py`, and then proceed as follows:

1. Run the AWS SAM CLI to invoke your function.
2. Send a request to the URL to invoke the function and initialize ptvsd code execution.
3. Start the debugger within Microsoft Visual Studio Code.

```
# Remember to hit the URL before starting the debugger in Microsoft Visual Studio Code
```

```
sam local start-api -d 5890

# OR

# Change HelloWorldFunction to reflect the logical name found in template.yaml
sam local generate-event apigateway aws-proxy | sam local invoke HelloWorldFunction -d 5890
```

Step-Through Debugging Golang Functions Locally

Golang function step-through debugging is slightly different when compared to Node.js, Java, and Python. We require Delve as the debugger, and wrap your function with it at runtime. The debugger is run in headless mode, listening on the debug port.

When you're debugging, you must compile your function in debug mode:

```
GOARCH=amd64 GOOS=linux go build -gcflags='-N -l' -o <output path> <path to code directory>
```

Delve Debugger

You must compile Delve to run in the container and provide its local path with the `--debugger-path` argument.

Build Delve locally as follows:

```
GOARCH=amd64 GOOS=linux go build -o <delve folder path>/dlv github.com/go-delve/delve/cmd/
dlv
```

Delve Debugger Path

The output path needs to end in `/dlv`. The Docker container expects the dlv binary file to be in the `<delve folder path>`. If it's not, a mounting issue occurs.

> **Note**
> The `--debugger-path` is the path to the directory that contains the dlv binary file that's compiled from the previous code.

Example:

Invoke AWS SAM similar to the following:

```
sam local start-api -d 5986 --debugger-path <delve folder path>
```

Delve Debugger API Version

To run the Delve debugger with an API version of your choice, specify the desired API version using an additional debug argument (p. 53) `-delveAPI`.

> **Note**
> For IDEs such as GoLand, Microsoft Visual Studio Code, etc., it is important to run Delve in API version **2** mode.

Example

Invoke AWS SAM with the Delve debugger in API version 2 mode:

```
sam local start-api -d 5986 --debugger-path <delve folder path> --debug-args "-delveAPI=2"
```

Example

The following is an example launch configuration for Microsoft Visual Studio Code to attach to a debug session.

```
{
  "version": "0.2.0",
  "configurations": [
  {
      "name": "Connect to Lambda container",
      "type": "go",
      "request": "launch",
      "mode": "remote",
      "remotePath": "",
      "port": <debug port>,
      "host": "127.0.0.1",
      "program": "${workspaceRoot}",
      "env": {},
      "args": [],
    },
  ]
}
```

Passing Additional Runtime Debug Arguments

To pass additional runtime arguments when you're debugging your function, use the environment variable `DEBUGGER_ARGS`. This passes a string of arguments directly into the run command that the AWS SAM CLI uses to start your function.

For example, if you want to load a debugger like iKPdb at the runtime of your Python function, you could pass the following as `DEBUGGER_ARGS: -m ikpdb --ikpdb-port=5858 --ikpdb-working-directory=/var/task/ --ikpdb-client-working-directory=/myApp --ikpdb-address=0.0.0.0`. This would load iKPdb at runtime with the other arguments you've specified.

In this case, your full AWS SAM CLI command would be:

```
$ DEBUGGER_ARGS="-m ikpdb --ikpdb-port=5858 --ikpdb-working-directory=/var/task/ --ikpdb-
client-working-directory=/myApp --ikpdb-address=0.0.0.0" echo {} | sam local invoke -d 5858
 myFunction
```

You can pass debugger arguments to the functions of all runtimes.

Validating AWS SAM Template Files

Validate your templates with `sam validate (p. 82)`. Currently, this command validates that the template provided is valid JSON / YAML. As with most AWS SAM CLI commands, it looks for a `template.[yaml|yml]` file in your current working directory by default. You can specify a different template file/location with the `-t` or `--template` option.

Example:

```
$ sam validate
<path-to-file>/template.yml is a valid SAM Template
```

Note
The `sam validate` command requires AWS credentials to be configured. For more information, see Configuration and Credential Files.

Deploying Serverless Applications

AWS SAM uses AWS CloudFormation as the underlying deployment mechanism. For more information, see What Is AWS CloudFormation?.

You can deploy your application by using AWS SAM command line interface (CLI) commands. You can also use other AWS services that integrate with AWS SAM to automate your deployments.

Packaging and Deploying Using the AWS SAM CLI

After you develop and test your serverless application locally, you can deploy your application by using the `sam package` and `sam deploy` commands.

> **Note**
> Both the `sam package` and `sam deploy` commands described in this section are identical to their AWS CLI equivalent commands `aws cloudformation package` and `aws cloudformation deploy`, respectively.

The `sam package` command zips your code artifacts, uploads them to Amazon S3, and produces a packaged AWS SAM template file that's ready to be used. The `sam deploy` command uses this file to deploy your application. For example, the following command generates a `packaged.yaml` file:

```
# Package SAM template
$ sam package --template-file sam.yaml --s3-bucket mybucket --output-template-file
 packaged.yaml
```

The following `sam deploy` command takes the packaged AWS SAM template file that was created earlier, and deploys your serverless application:

```
# Deploy packaged SAM template
$ sam deploy --template-file ./packaged.yaml --stack-name mystack --capabilities
 CAPABILITY_IAM
```

> **Note**
> To deploy an application that contains one or more nested applications, you must include the `CAPABILITY_AUTO_EXPAND` capability in the `sam deploy` command.

Publishing Serverless Applications

The AWS Serverless Application Repository is a service that hosts serverless applications that are built using AWS SAM. If you want to share serverless applications with others, you can publish them in the AWS Serverless Application Repository. You can also search, browse, and deploy serverless applications that have been published by others. For more information, see What Is the AWS Serverless Application Repository?.

Automating Deployments

You can use AWS SAM with a number of other AWS services to automate the deployment process of your serverless application.

- **CodeBuild**: You use CodeBuild to build, locally test, and package your serverless application. For more information, see What Is CodeBuild?.

- **CodeDeploy**: You use CodeDeploy to gradually deploy updates to your serverless applications. For more information on how to do this, see Gradual Code Deployment (p. 56).
- **CodePipeline**: You use CodePipeline to model, visualize, and automate the steps that are required to release your serverless application. For more information, see What Is CodePipeline?.

Topics

Gradual Code Deployment

If you use AWS SAM to create your serverless application, it comes built-in with CodeDeploy to help ensure safe Lambda deployments. With just a few lines of configuration, AWS SAM does the following for you:

- Deploys new versions of your Lambda function, and automatically creates aliases that point to the new version.
- Gradually shifts customer traffic to the new version until you're satisfied that it's working as expected, or you roll back the update.
- Defines pre-traffic and post-traffic test functions to verify that the newly deployed code is configured correctly and your application operates as expected.
- Rolls back the deployment if CloudWatch alarms are triggered.

> **Note**
> If you enable gradual deployments through your AWS SAM template, a CodeDeploy resource is automatically created for you. You can view the CodeDeploy resource directly through the AWS Management Console.

Example

The following example demonstrates a simple version of using CodeDeploy to gradually shift customers to your newly deployed version:

```
Resources:
 MyLambdaFunction:
   Type: AWS::Serverless::Function
   Properties:
     Handler: index.handler
     Runtime: nodejs4.3
     CodeUri: s3://bucket/code.zip

     AutoPublishAlias: live

     DeploymentPreference:
       Type: Canary10Percent10Minutes
       Alarms:
         # A list of alarms that you want to monitor
         - !Ref AliasErrorMetricGreaterThanZeroAlarm
         - !Ref LatestVersionErrorMetricGreaterThanZeroAlarm
       Hooks:
         # Validation Lambda functions that are run before & after traffic shifting
         PreTraffic: !Ref PreTrafficLambdaFunction
         PostTraffic: !Ref PostTrafficLambdaFunction
```

These revisions to the AWS SAM template do the following:

- **AutoPublishAlias**: By adding this property and specifying an alias name, AWS SAM:
  - Detects when new code is being deployed, based on changes to the Lambda function's Amazon S3 URI.
  - Creates and publishes an updated version of that function with the latest code.
  - Creates an alias with a name that you provide (unless an alias already exists), and points to the updated version of the Lambda function. Function invocations should use the alias qualifier to take advantage of this. If you aren't familiar with Lambda function versioning and aliases, see AWS Lambda Function Versioning and Aliases .
- **Deployment Preference Type**: In the previous example, 10 percent of your customer traffic is immediately shifted to your new version. After 10 minutes, all traffic is shifted to the new version. However, if your pre-hook/post-hook tests fail, or if a CloudWatch alarm is triggered, CodeDeploy rolls back your deployment. The following table outlines other traffic-shifting options that are available beyond the one used earlier. Note the following:
  - **Canary**: Traffic is shifted in two increments. You can choose from predefined canary options. The options specify the percentage of traffic that's shifted to your updated Lambda function version in the first increment, and the interval, in minutes, before the remaining traffic is shifted in the second increment.
  - **Linear**: Traffic is shifted in equal increments with an equal number of minutes between each increment. You can choose from predefined linear options that specify the percentage of traffic that's shifted in each increment and the number of minutes between each increment.
  - **All-at-once**: All traffic is shifted from the original Lambda function to the updated Lambda function version at once.

Deployment Preference Type
Canary10Percent30Minutes
Canary10Percent5Minutes
Canary10Percent10Minutes
Canary10Percent15Minutes
Linear10PercentEvery10Minutes
Linear10PercentEvery1Minute
Linear10PercentEvery2Minutes
Linear10PercentEvery3Minutes
AllAtOnce

- **Alarms**: These are CloudWatch alarms that are triggered by any errors raised by the deployment. They automatically roll back your deployment. An example is if the updated code you're deploying is creating errors within the application. Another example is if any AWS Lambda or custom CloudWatch metrics that you specified have breached the alarm threshold.
- **Hooks**: These are pre-traffic and post-traffic test functions that run sanity checks before traffic shifting starts to the new version, and after traffic shifting completes.
  - **PreTraffic**: Before traffic shifting starts, CodeDeploy invokes the pre-traffic hook Lambda function. This Lambda function must call back to CodeDeploy and indicate success or failure. If the function fails, it aborts and reports a failure back to AWS CloudFormation. If the function succeeds, CodeDeploy proceeds to traffic shifting.
  - **PostTraffic**: After traffic shifting completes, CodeDeploy invokes the post-traffic hook Lambda function. This is similar to the pre-traffic hook, where the function must call back to CodeDeploy to report a success or failure. Use post-traffic hooks to run integration tests or other validation actions.

For more information, see SAM Reference to Safe Deployments.

Publishing Serverless Applications Using the AWS SAM CLI

You can use the AWS SAM CLI to publish your application to the AWS Serverless Application Repository to make it available for others to find and deploy. To make an AWS SAM application public, you must create it, and all of the other Amazon or AWS resources it uses, in us-east-1 or us-east-2.

The application you want to publish must be one that you've defined using AWS SAM, and that you've tested locally and/or in the AWS Cloud. The application's deployment package and AWS SAM template are the inputs to the steps below.

The following instructions either create a new application, create a new version of an existing application, or update the metadata of an existing application. This depends on whether the application already exists in the AWS Serverless Application Repository, and whether any application metadata is changing. For more information about application metadata that's used to publish applications, see AWS SAM Template Metadata Section Properties (p. 61).

Prerequisites

Before you publish an application to the AWS Serverless Application Repository, you need the following:

- A valid AWS account with an IAM user that has administrator permissions. See Set Up an AWS Account.
- Version 1.16.77 or later of the AWS CLI installed. See Installing the AWS Command Line Interface. If you have the AWS CLI installed, you can get the version by running the following command:

```
aws --version
```

- The AWS SAM CLI (command line interface) installed. See Installing the AWS SAM CLI. You can determine whether the AWS SAM CLI is installed by running the following command:

```
sam --version
```

- A valid AWS Serverless Application Model (AWS SAM) template. You can copy the example template from AWS SAM Template Concepts (p. 24) and save to something like `MyTemplate.yaml`.
- Your application code and dependencies referenced by the AWS SAM template.
- A semantic version for your application (required to share your application publicly). This value can be as simple as 1.0.
- A URL that points to your application's source code.
- A README.md file. This file should describe how customers can use your application, and how to configure it before deploying it in their own AWS accounts.
- A LICENSE.txt file (required to share your application publicly).
- A valid Amazon S3 bucket policy that grants the service read permissions for artifacts uploaded to Amazon S3 when you packaged your application. To do this, follow these steps:

  1. Open the Amazon S3 console at https://console.aws.amazon.com/s3/.
  2. Choose the Amazon S3 bucket that you used to package your application.
  3. Choose the **Permissions** tab.
  4. Choose the **Bucket Policy** button.
  5. Paste the following policy statement into the **Bucket policy editor**. Make sure to substitute your bucket name in the Resource property value.

```
{
    "Version": "2012-10-17",
    "Statement": [
        {
            "Effect": "Allow",
            "Principal": {
                "Service":  "serverlessrepo.amazonaws.com"
            },
            "Action": "s3:GetObject",
            "Resource": "arn:aws:s3:::<your-bucket-name>/*"
        }
    ]
}
```

6. Choose the **Save** button.

Step 1: Add a Metadata Section to the AWS SAM Template

First add a `Metadata` section to your AWS SAM template. Provide the application information to be published to the AWS Serverless Application Repository.

The following is an example `Metadata` section:

```
Metadata:
  AWS::ServerlessRepo::Application:
    Name: my-app
    Description: hello world
    Author: user1
    SpdxLicenseId: Apache-2.0
    LicenseUrl: LICENSE.txt
    ReadmeUrl: README.md
    Labels: ['tests']
    HomePageUrl: https://github.com/user1/my-app-project
    SemanticVersion: 0.0.1
    SourceCodeUrl: https://github.com/user1/my-app-project

Resources:
  HelloWorldFunction:
    Type: AWS::Lambda::Function
      Properties:
        ...
        CodeUri: source-code1
        ...
```

For more information about the properties of the `Metadata` section in the AWS SAM template, see AWS SAM Template Metadata Section Properties (p. 61).

Step 2: Package the Application

Execute the following AWS SAM CLI command:

```
sam-app> sam package \
    --template-file template.yaml \
    --output-template-file packaged.yaml \
```

```
    --s3-bucket <your-bucket-name>
```

The command uploads the application artifacts to Amazon S3 and outputs a new template file called `packaged.yaml`. You use this file in the next step to publish the application to the AWS Serverless Application Repository. The `packaged.yaml` template file is similar to the original template file (`template.yaml`), but has a key difference—the `CodeUri`, `LicenseUrl`, and `ReadmeUrl` properties point to the Amazon S3 bucket and objects that contain the respective artifacts.

The following snippet from an example `packaged.yaml` template file shows the `CodeUri` property:

```
MySampleFunction:
    Type: AWS::Serverless::Function
    Properties:
      CodeUri: s3://bucketname/fbd77a3647a4f47a352fcObjectGUID

...
```

Step 3: Publish the Application

Execute the following AWS SAM CLI command:

```
sam-app> sam publish \
    --template packaged.yaml \
    --region us-east-1
```

The output of the `sam publish` command includes a link to the AWS Serverless Application Repository directly to your application. You can also go to the AWS Serverless Application Repository landing page directly and search for your application.

Your application is set to private by default, so it isn't visible to other AWS accounts. In order to share your application with others, you must either make it public or grant permission to a specific list of AWS accounts. For information on sharing your application by using the AWS CLI, see Using Resource-based Policies for the AWS Serverless Application Repository. For information on sharing your application using the console, see Sharing an Application Through the Console.

Additional Topics

AWS SAM Template Metadata Section Properties

This table provides information about the properties of the `Metadata` section of the AWS SAM template. The template is needed to publish applications to the AWS Serverless Application Repository using the AWS SAM CLI.

Property	Type	Required	Description
Name	String	TRUE	The name of the application. Minimum length=1. Maximum length=140. Pattern: "[a-zA-Z0-9\\-]+";

Property	Type	Required	Description
Description	String	TRUE	The description of the application. Minimum length=1. Maximum length=256.
Author	String	TRUE	The name of the author publishing the application. Minimum length=1. Maximum length=127. Pattern "^[a-z0-9](([a-z0-9]|-(?!-))*[a-z0-9])?$";
SpdxLicenseId	String	FALSE	A valid license identifier: https://spdx.org/licenses/
LicenseUrl	String	FALSE	Reference to a local license file, or an Amazon S3 link to a license file, of the application that matches the spdxLicenseID value of your application. An AWS SAM template file that has not been packaged using the `sam package` command can have a reference to a local file for this property. However, to be published using the `sam publish` command, this property must be a reference to an Amazon S3 bucket. Maximum size: 5 MB. You must provide a value for this property in order to make your application public. Note that you cannot update this property after your application has been published. So, to add a license to an application, you must either delete it first, or publish a new application with a different name.
ReadmeUrl	String	FALSE	Reference to a local readme file, or an Amazon S3 link to the readme file that contains a more detailed description of the application and how it works. An AWS SAM template file that has not been packaged using the `sam package` command can have a reference to a local file for this property. However, to be published using the `sam publish` command, this property must be a reference to an Amazon S3 bucket. Maximum size: 5 MB.
Labels	String	FALSE	Labels to improve discovery of applications in search results. Minimum length=1. Maximum length=127. Maximum number of labels: 10. Pattern: "^[a-zA-Z0-9+\\-_:\\/@]+$";
HomePageUrl	String	FALSE	A URL with more information about the application—for example, the location of your GitHub repository for the application.

Property	Type	Required	Description
SemanticVersion	String	FALSE	The semantic version of the application: https://semver.org/ You must provide a value for this property in order to make your application public.
SourceCodeUrl	String	FALSE	A link to a public repository for the source code of your application.

Use Cases

The use cases for publishing applications are listed below, along with the `Metadata` properties that are processed for that use case. Properties that are *not* listed for a given use case are ignored.

- **Create New Application** – A new application is created if there is no application in the AWS Serverless Application Repository with a matching name for an account.
  - Name
  - SpdxLicenseId
  - LicenseUrl
  - Description
  - Author
  - ReadmeUrl
  - Labels
  - HomePageUrl
  - SourceCodeUrl
  - SemanticVersion
  - The content of the SAM template (for example, any event sources, resources, Lambda function code, etc.)

- **Create Application Version** – An application version is created if there is already an application in the AWS Serverless Application Repository with a matching name for an account *and* the SemanticVersion *is* changing.
  - Description
  - Author
  - ReadmeUrl
  - Labels
  - HomePageUrl
  - SourceCodeUrl
  - SemanticVersion
  - The content of the SAM template (for example, any Event Sources, Resources, Lambda function code, etc.)

- **Update Application** – An application is updated if there is already an application in the AWS Serverless Application Repository with a matching name for an account *and* the SemanticVersion *is not* changing.
  - Description
  - Author

- ReadmeUrl
- Labels
- HomePageUrl

Example Serverless Applications

The following examples show you how to download, test, and deploy a number of additional serverless applications—including how to configure event sources and AWS resources.

Topics

Process DynamoDB Events

With this example application, you build on what you learned in the overview and the Quick Start guide, and install another example application. This application consists of a Lambda function that's invoked by a DynamoDB table event source. The Lambda function is very simple—it logs data that was passed in through the event source message.

This exercise shows you how to mimic event source messages that are passed to Lambda functions when they're invoked.

Before You Begin

Make sure that you've completed the required setup in the Installing the AWS SAM CLI (p. 3).

Step 1: Initialize the Application

In this section, you download the application package, which consists of an AWS SAM template and application code.

To initialize the application

1. Run the following command at an AWS SAM CLI command prompt.

```
sam init \
--location gh:aws-samples/cookiecutter-aws-sam-dynamodb-python \
--no-input
```

2. Review the contents of the directory that the command created (`dynamodb_event_reader/`):

   - `template.yaml` – Defines two AWS resources that the Read DynamoDB application needs: a Lambda function and a DynamoDB table. The template also defines mapping between the two resources.
   - `read_dynamodb_event/` directory – Contains the DynamoDB application code.

Step 2: Test the Application Locally

For local testing, use the AWS SAM CLI to generate a sample DynamoDB event and invoke the Lambda function:

```
$ sam local generate-event dynamodb update | sam local invoke ReadDynamoDBEvent
```

The `generate-event` command creates a test event source message like the messages that are created when all components are deployed to the AWS Cloud. This event source message is piped to the Lambda function ReadDynamoDBEvent.

Verify that the expected messages are printed to the console, based on the source code in `app.py`.

Step 3: Package the Application

After testing your application locally, you use the AWS SAM CLI to create a deployment package, which you use to deploy the application to the AWS Cloud.

To create a Lambda deployment package

1. Create an S3 bucket in the location where you want to save the packaged code. If you want to use an existing S3 bucket, skip this step.

   ```
   sam-app> aws s3 mb s3://bucketname
   ```

2. Create the deployment package by running the following `package` CLI command at the command prompt.

   ```
   sam-app> sam package \
       --template-file template.yaml \
       --output-template-file packaged.yaml \
       --s3-bucket bucketname
   ```

   You specify the new template file, `packaged.yaml`, when you deploy the application in the next step.

Step 4: Deploy the Application

Now that you've created the deployment package, you use it to deploy the application to the AWS Cloud. You then test the application.

To deploy the serverless application to the AWS Cloud

- In the AWS SAM CLI, use the `deploy` CLI command to deploy all of the resources that you defined in the template.

  ```
  sam-app> sam deploy \
      --template-file packaged.yaml \
      --stack-name sam-app \
      --capabilities CAPABILITY_IAM \
      --region us-east-1
  ```

  In the command, the `--capabilities` parameter allows AWS CloudFormation to create an IAM role.

  AWS CloudFormation creates the AWS resources that are defined in the template. You can access the names of these resources in the AWS CloudFormation console.

To test the serverless application in the AWS Cloud

1. Open the DynamoDB console.
2. Insert a record into the table that you just created.

3. Go to the **Metrics** tab of the table, and choose **View all CloudWatch metrics**. In the CloudWatch console, choose **Logs** to be able to view the log output.

Process Amazon S3 Events

With this example application, you build on what you learned in the previous examples, and install a more complex application. This application consists of a Lambda function that's invoked by an Amazon S3 object upload event source. This exercise shows you how to access AWS resources and make AWS service calls through a Lambda function.

This sample serverless application processes object-creation events in Amazon S3. For each image that's uploaded to a bucket, Amazon S3 detects the object-created event and invokes a Lambda function. The Lambda function invokes Amazon Rekognition to detect text that's in the image. It then stores the results returned by Amazon Rekognition in a DynamoDB table.

> **Note**
> With this example application, you perform steps in a slightly different order than in previous examples. The reason for this is that this example requires that AWS resources are created and IAM permissions are configured *before* you can test the Lambda function locally. We're going to leverage AWS CloudFormation to create the resources and configure the permissions for you. Otherwise, you would need to do this manually before you can test the Lambda function locally. Because this example is more complicated, be sure that you're familiar with installing the previous example applications before executing this one.

Before You Begin

Make sure that you've completed the required setup in the Installing the AWS SAM CLI (p. 3).

Step 1: Initialize the Application

In this section, you download the sample application, which consists of an AWS SAM template and application code.

To initialize the application

1. Run the following command at an AWS SAM CLI command prompt.

```
sam init \
--location https://github.com/aws-samples/cookiecutter-aws-sam-s3-rekognition-dynamodb-python \
--no-input
```

2. Review the contents of the directory that the command created (`aws_sam_ocr/`):

   - `template.yaml` – Defines three AWS resources that the Amazon S3 application needs: a Lambda function, an Amazon S3 bucket, and a DynamoDB table. The template also defines the mappings and permissions between these resources.
   - `src/` directory – Contains the Amazon S3 application code.
   - `SampleEvent.json` – The sample event source, which is used for local testing.

Step 2: Package the Application

Before you can test this application locally, you must use the AWS SAM CLI to create a deployment package, which you use to deploy the application to the AWS Cloud. This deployment creates the necessary AWS resources and permissions that are required to test the application locally.

To create a Lambda deployment package

1. Create an S3 bucket in the location where you want to save the packaged code. If you want to use an existing S3 bucket, skip this step.

```
aws_sam_ocr> aws s3 mb s3://bucketname
```

2. Create the deployment package by running the following `package` CLI command at the command prompt.

```
aws_sam_ocr> sam package \
    --template-file template.yaml \
    --output-template-file packaged.yaml \
    --s3-bucket bucketname
```

   You specify the new template file, `packaged.yaml`, when you deploy the application in the next step.

Step 3: Deploy the Application

Now that you've created the deployment package, you use it to deploy the application to the AWS Cloud. You then test the application by invoking it in the AWS Cloud.

To deploy the serverless application to the AWS Cloud

- In the AWS SAM CLI, use the `deploy` command to deploy all of the resources that you defined in the template.

```
aws_sam_ocr> sam deploy \
    --template-file packaged.yaml \
    --stack-name aws-sam-ocr \
    --capabilities CAPABILITY_IAM \
    --region us-east-1
```

  In the command, the `--capabilities` parameter allows AWS CloudFormation to create an IAM role.

  AWS CloudFormation creates the AWS resources that are defined in the template. You can access the names of these resources in the AWS CloudFormation console.

To test the serverless application in the AWS Cloud

1. Upload an image to the Amazon S3 bucket that you created for this sample application.
2. Open the DynamoDB console and find the table that was created. See the table for results returned by Amazon Rekognition.
3. Verify that the DynamoDB table contains new records that contain text that Amazon Rekognition found in the uploaded image.

Step 4: Test the Application Locally

Before you can test the application locally, you must first retrieve the names of the AWS resources that were created by AWS CloudFormation.

- Retrieve the Amazon S3 key name and bucket name from AWS CloudFormation. Modify the `SampleEvent.json` file by replacing the values for the object key, bucket name, and bucket ARN.
- Retrieve the DynamoDB table name. This name is used for the following `sam local invoke` command.

Use the AWS SAM CLI to generate a sample Amazon S3 event and invoke the Lambda function:

```
$ TABLE_NAME=Table name obtained from AWS CloudFormation console sam local invoke --event
 SampleEvent.json
```

The `TABLE_NAME=` portion sets the DynamoDB table name. The `--event` parameter specifies the file that contains the test event message to pass to the Lambda function.

You can now verify that the expected DynamoDB records were created, based on the results returned by Amazon Rekognition.

AWS SAM Reference

AWS SAM Specification

The AWS SAM specification is an open-source specification under the Apache 2.0 license. The current version of the AWS SAM specification is available in the AWS SAM GitHub repo.

AWS SAM templates are an extension of AWS CloudFormation templates. That is, any resource that you can declare in an AWS CloudFormation template, you can also declare in an AWS SAM template. For the full reference for AWS CloudFormation templates, see AWS CloudFormation Template Reference.

AWS SAM CLI

The **AWS SAM CLI** is a command line tool that operates on an AWS SAM template and application code. With the AWS SAM CLI, you can invoke Lambda functions locally, create a deployment package for your serverless application, deploy your serverless application to the AWS Cloud, and so on.

You can use the AWS SAM CLI commands to develop, test, and deploy your serverless applications to the AWS Cloud. The following are some examples of AWS SAM CLI commands:

- `sam init` – If you're a first-time AWS SAM CLI user, you can run the `sam init` command without any parameters to create a Hello World application. The command generates a preconfigured AWS SAM template and example application code in the language that you choose.
- `sam local invoke` and `sam local start-api` – Use these commands to test your application code locally, before deploying it to the AWS Cloud.
- `sam logs` – Use this command to fetch logs generated by your Lambda function to help with testing and debugging your application after you've deployed it to the AWS Cloud.
- `sam package` – Use this command to bundle your application code and dependencies into a "deployment package" that's needed in order to upload to the AWS Cloud.
- `sam deploy` – Use this command to deploy your serverless application to the AWS Cloud. It creates the AWS resources and sets permissions and other configurations that are defined in the AWS SAM template.

Topics

AWS SAM CLI Command Reference

This section is the reference for the AWS SAM CLI commands.

Topics

sam build

Use this command to build your Lambda source code and generate deployment artifacts that target Lambda's execution environment. By doing this, the functions that you build locally run in a similar environment in the AWS Cloud.

The `sam build` command iterates through the functions in your application, looks for a manifest file (such as `requirements.txt`) that contains the dependencies, and automatically creates deployment artifacts that you can deploy to Lambda using the `sam package` and `sam deploy` commands. You that can also use `sam build` in combination with other commands like `sam local invoke` to test your application locally.

To use this command, update your AWS SAM template to specify the path to your function's source code in the resource's Code or CodeUri property.

Usage:

```
sam build [OPTIONS]
```

Examples:

```
To build on your workstation, run this command in folder containing
SAM template. Built artifacts will be written to .aws-sam/build folder
$ sam build

To build inside a AWS Lambda like Docker container
$ sam build --use-container

To build & run your functions locally
$ sam build && sam local invoke

To build and package for deployment
$ sam build && sam package --s3-bucket <bucketname>
```

Options:

Option	Description
-b, --build-dir DIRECTORY	The path to a folder where the built artifacts are stored.
-s, --base-dir DIRECTORY	Resolves relative paths to the function's source code with respect to this folder. Use this if the AWS SAM template and your source code aren't in the same enclosing folder. By default, relative paths are resolved with respect to the template's location.

Option	Description
-u, --use-container	If your functions depend on packages that have natively compiled dependencies, use this flag to build your function inside an AWS Lambda-like Docker container.
-m, --manifest PATH	The path to a custom dependency manifest (ex: package.json) to use instead of the default one.
-t, --template PATH	The AWS SAM template file [default: template.[yaml|yml]].
--parameter-overrides	Optional. A string that contains AWS CloudFormation parameter overrides, encoded as key-value pairs. Use the same format as the AWS CLI—for example, 'ParameterKey=KeyPairName, ParameterValue=MyKey ParameterKey=InstanceType, ParameterValue=t1.micro'.
--skip-pull-image	Specifies whether the command should skip pulling down the latest Docker image for Lambda runtime.
--docker-network TEXT	Specifies the name or id of an existing Docker network to Lambda Docker containers should connect to, along with the default bridge network. If not specified, the Lambda containers will only connect to the default bridge Docker network.
--profile TEXT	Selects a specific profile from your credential file to get AWS credentials.
--region TEXT	Sets the AWS Region of the service (for example, us-east-1).
--debug	Turns on debug logging to print debug message generated by the AWS SAM CLI.
--help	Shows this message and exits.

sam deploy

Deploys an AWS SAM application. This is an alias for `aws cloudformation deploy`.

Usage:

```
sam deploy [OPTIONS] [ARGS]...
```

Options:

Option	Description
--template-file PATH	Required. The path where your AWS SAM template file is located.
--stack-name TEXT	Required. The name of the AWS CloudFormation stack you're deploying to. If you specify an existing stack, the command updates the stack. If you specify a new stack, the command creates it.
--profile TEXT	Select a specific profile from your credential file to get AWS credentials.
--region TEXT	Sets the AWS Region of the service (for example, us-east-1).
--debug	Turns on debug logging.

Option	Description
--help	Shows this message and exits.

sam init

Initializes a serverless application with an AWS SAM template. The template provides a folder structure for your Lambda functions, and is connected to an event source such as APIs, S3 buckets, or DynamoDB tables. This application includes everything you need to get started and to eventually extend it into a production-scale application.

Usage:

```
sam init [OPTIONS]
```

Note
With AWS SAM version 0.30.0 or later, you can initialize your application using one of two modes: 1) Interactive workflow, or 2) Providing all required parameters.

- *Interactive Workflow:* Through the interactive initialize workflow you can input either 1) your project name, preferred runtime, and template file, or 2) the location of a custom template.

- *Providing Parameters:* Provide all required parameters.

If you provide a subset of required parameters, you will be prompted for the additional required information.

Examples:

```
Initializes a new SAM project with required parameters passed as parameters

$ sam init --runtime python3.7 --dependency-manager pip --app-template hello-world --name
 sam-app

Initializes a new SAM project using custom template in a Git/Mercurial repository

# gh being expanded to github url
$ sam init --location gh:aws-samples/cookiecutter-aws-sam-python

$ sam init --location git+ssh://git@github.com/aws-samples/cookiecutter-aws-sam-python.git

$ sam init --location hg+ssh://hg@bitbucket.org/repo/template-name

$ sam init --location hg+ssh://hg@bitbucket.org/repo/template-name

Initializes a new SAM project using custom template in a Zipfile

$ sam init --location /path/to/template.zip

$ sam init --location https://example.com/path/to/template.zip

Initializes a new SAM project using custom template in a local path

$ sam init --location /path/to/template/folder
```

Options:

Option	Description
--no-interactive	Disable interactive prompting for init parameters, and fail if any required values are missing.
-l, --location TEXT	The template location (Git, Mercurial, HTTP/HTTPS, ZIP, path). This parameter is required if `--no-interactive` is specified and `--runtime`, `--name`, and `--app-template` are not provided.
-r, --runtime [python2.7 | nodejs6.10 | ruby2.5 | java8 | python3.7 | nodejs8.10 | dotnetcore2.0 | nodejs10.x | dotnetcore2.1 | dotnetcore1.0 | python3.6 | go1.x]	The Lambda runtime of your application. This parameter is required if `--no-interactive` is specified and `--location` is not provided.
-d, --dependency-manager [gradle | mod | maven | bundler | npm | cli-package | pip]	Dependency manager of your Lambda runtime
-o, --output-dir PATH	The location where the initialized application is output.
-n, --name TEXT	The name of your project to be generated as a folder. This parameter is required if `--no-interactive` is specified and `--location` is not provided.
--app-template TEXT	Identifier of the managed application template you want to use. If not sure, call 'sam init' without options for an interactive workflow. This parameter is required if `--no-interactive` is specified and `--location` is not provided. This parameter is only available in SAM CLI version 0.30.0 or later. Specifying this parameter with an earlier version will result in an error.
--no-input	Disables Cookiecutter prompting and accept default values that are defined in the template configuration.
--debug	Turns on debug logging.
-h, --help	Shows this message and exits.

sam local generate-event

Generates sample payloads from different event sources, such as Amazon S3, Amazon API Gateway, and Amazon SNS. These payloads contain the information that the event sources send to your Lambda functions.

Usage:

```
sam local generate-event [OPTIONS] COMMAND [ARGS]...
```

Examples:

```
Generate the event that S3 sends to your Lambda function when a new object is uploaded
$ sam local generate-event s3 [put/delete]

You can even customize the event by adding parameter flags. To find which flags apply to
 your command,
run:

$ sam local generate-event s3 [put/delete] --help

Then you can add in those flags that you wish to customize using

$ sam local generate-event s3 [put/delete] --bucket <bucket> --key <key>

After you generate a sample event, you can use it to test your Lambda function locally
$ sam local generate-event s3 [put/delete] --bucket <bucket> --key <key> | sam local invoke
 <function logical id>
```

Options:

Option	Description
--help	Shows this message and exits.

Commands:

- alexa-skills-kit
- alexa-smart-home
- apigateway
- batch
- cloudformation
- cloudfront
- cloudwatch
- codecommit
- codepipeline
- cognito
- config
- dynamodb
- kinesis
- lex
- rekognition
- s3
- ses
- sns
- sqs
- stepfunctions

sam local invoke

Invokes a local Lambda function once and quits after invocation completes.

This is useful for developing serverless functions that handle asynchronous events (such as Amazon S3 or Amazon Kinesis events). It can also be useful if you want to compose a script of test cases. The event body can be passed in either by `stdin` (default), or by using the `--event` parameter. The runtime output (logs etc) is output to `stderr`, and the Lambda function result is output to `stdout`.

Usage:

```
sam local invoke [OPTIONS] [FUNCTION_IDENTIFIER]
```

Options:

Option	Description
-e, --event PATH	The JSON file that contains event data that's passed to the Lambda function when it's invoked. If you don't specify this option, the default is reading the JSON from `stdin`.
--no-event	Invokes the function with an empty event.
-t, --template PATH	The AWS SAM template file [default: template.[yaml|yml]].
-n, --env-vars PATH	The JSON file that contains values for the Lambda function's environment variables. For more information about environment variables files, see Environment Variable File (p. 39).
--parameter-overrides	Optional. A string that contains AWS CloudFormation parameter overrides encoded as key-value pairs. Use the same format as the AWS CLI—for example, 'ParameterKey=KeyPairName, ParameterValue=MyKey ParameterKey=InstanceType,ParameterValue=t1.micro'.
-d, --debug-port TEXT	When specified, starts the Lambda function container in debug mode and exposes this port on the local host.
--debugger-path TEXT	The host path to a debugger that will be mounted into the Lambda container.
--debug-args TEXT	Additional arguments to be passed to the debugger.
-v, --docker-volume-basedir TEXT	The location of the base directory where the AWS SAM file exists. If Docker is running on a remote machine, you must mount the path where the AWS SAM file exists on the Docker machine, and modify this value to match the remote machine.
--docker-network TEXT	The name or ID of an existing Docker network that Lambda Docker containers should connect to, along with the default bridge network. If this isn't specified, the Lambda containers only connect to the default bridge Docker network.
-l, --log-file TEXT	The log file to send runtime logs to.
--layer-cache-basedir DIRECTORY	Specifies the location basedir where the layers your template uses are downloaded to.
--skip-pull-image	Specifies whether the CLI should skip pulling down the latest Docker image for the Lambda runtime.
--force-image-build	Specifies whether the CLI should rebuild the image used for invoking functions with layers.
--profile TEXT	The AWS credentials profile to use.

Option	Description
--region TEXT	Sets the AWS Region of the service (for example, us-east-1).
--debug	Turns on debug logging.
--help	Shows this message and exits.

sam local start-api

Allows you to run your serverless application locally for quick development and testing. When you run this command in a directory that contains your serverless functions and your AWS SAM template, it creates a local HTTP server that hosts all of your functions.

When it's accessed (through a browser, CLI, and so on), it starts a Docker container locally to invoke the function. It reads the CodeUri property of the AWS::Serverless::Function resource to find the path in your file system that contains the Lambda function code. This could be the project's root directory for interpreted languages like Node.js and Python, or a build directory that stores your compiled artifacts or a Java Archive (JAR) file.

If you're using an interpreted language, local changes are available immediately in the Docker container on every invoke. For more compiled languages or projects that require complex packing support, we recommend that you run your own building solution, and point AWS SAM to the directory or file that contains the build artifacts.

Usage:

```
sam local start-api [OPTIONS]
```

Options:

Option	Description
--host TEXT	The local hostname or IP address to bind to (default: '127.0.0.1').
-p, --port INTEGER	The local port number to listen on (default: '3000').
-s, --static-dir TEXT	Any static asset (for example, CSS/JavaScript/HTML) files located in this directory are presented at /.
-t, --template PATH	The AWS SAM template file [default: template.[yaml|yml]].
-n, --env-vars PATH	The JSON file that contains values for the Lambda function's environment variables.
--parameter-overrides	Optional. A string that contains AWS CloudFormation parameter overrides encoded as key-value pairs. Use the same format as the AWS CLI—for example, 'ParameterKey=KeyPairName, ParameterValue=MyKey ParameterKey=InstanceType,ParameterValue=t1.micro'.
-d, --debug-port TEXT	When specified, starts the Lambda function container in debug mode and exposes this port on the local host.
--debugger-path TEXT	The host path to a debugger that will be mounted into the Lambda container.
--debug-args TEXT	Additional arguments to be passed to the debugger.

Option	Description
-v, --docker-volume-basedir TEXT	The location of the base directory where the AWS SAM file exists. If Docker is running on a remote machine, you must mount the path where the AWS SAM file exists on the Docker machine, and modify this value to match the remote machine.
--docker-network TEXT	The name or ID of an existing Docker network that the Lambda Docker containers should connect to, along with the default bridge network. If this isn't specified, the Lambda containers only connect to the default bridge Docker network.
-l, --log-file TEXT	The log file to send runtime logs to.
--layer-cache-basedir DIRECTORY	Specifies the location basedir where the Layers your template uses are downloaded to.
--skip-pull-image	Specifies whether the CLI should skip pulling down the latest Docker image for the Lambda runtime.
--force-image-build	Specifies whether CLI should rebuild the image used for invoking functions with layers.
--profile TEXT	The AWS credentials profile to use.
--region TEXT	Sets the AWS Region of the service (for example, us-east-1).
--debug	Turns on debug logging.
--help	Shows this message and exits.

sam local start-lambda

Enables you to programmatically invoke your Lambda function locally by using the AWS CLI or SDKs. This command starts a local endpoint that emulates AWS Lambda. You can run your automated tests against this local Lambda endpoint. When you send an invoke to this endpoint using the AWS CLI or SDK, it locally executes the Lambda function that's specified in the request.

Usage:

```
sam local start-lambda [OPTIONS]
```

Examples:

```
SETUP
------
Start the local Lambda endpoint by running this command in the directory that contains your
 AWS SAM template.
$ sam local start-lambda

USING AWS CLI
-------------
Then, you can invoke your Lambda function locally using the AWS CLI
$ aws lambda invoke --function-name "HelloWorldFunction" --endpoint-url
 "http://127.0.0.1:3001" --no-verify-ssl out.txt

USING AWS SDK
-------------
```

```
You can also use the AWS SDK in your automated tests to invoke your functions
 programatically.
Here is a Python example:
    self.lambda_client = boto3.client('lambda',
                                      endpoint_url="http://127.0.0.1:3001",
                                      use_ssl=False,
                                      verify=False,
                                      config=Config(signature_version=UNSIGNED,
                                                    read_timeout=0,
                                                    retries={'max_attempts': 0}))
    self.lambda_client.invoke(FunctionName="HelloWorldFunction")
```

Options:

Option	Description
--host TEXT	The local hostname or IP address to bind to (default: '127.0.0.1').
-p, --port INTEGER	The local port number to listen on (default: '3001').
-t, --template PATH	The AWS SAM template file [default: template.[yaml|yml]].
-n, --env-vars PATH	The JSON file that contains values for the Lambda function's environment variables.
--parameter-overrides	Optional. A string that contains AWS CloudFormation parameter overrides encoded as key-value pairs. Use the same format as the AWS CLI—for example, 'ParameterKey=KeyPairName, ParameterValue=MyKey ParameterKey=InstanceType,ParameterValue=t1.micro'.
-d, --debug-port TEXT	When specified, starts the Lambda function container in debug mode, and exposes this port on the local host.
--debugger-path TEXT	The host path to a debugger to be mounted into the Lambda container.
--debug-args TEXT	Additional arguments to be passed to the debugger.
-v, --docker-volume-basedir TEXT	The location of the base directory where the AWS SAM file exists. If Docker is running on a remote machine, you must mount the path where the AWS SAM file exists on the Docker machine, and modify this value to match the remote machine.
--docker-network TEXT	The name or ID of an existing Docker network that Lambda Docker containers should connect to, along with the default bridge network. If this is specified, the Lambda containers only connect to the default bridge Docker network.
-l, --log-file TEXT	The log file to send runtime logs to.
--layer-cache-basedir DIRECTORY	Specifies the location basedir where the layers your template uses are downloaded to.
--skip-pull-image	Specifies whether the CLI should skip pulling down the latest Docker image for the Lambda runtime.
--force-image-build	Specify whether the CLI should rebuild the image used for invoking functions with layers.
--profile TEXT	The AWS credentials profile to use.
--region TEXT	Sets the AWS Region of the service (for example, us-east-1).

Option	Description
--debug	Turns on debug logging.
--help	Shows this message and exits.

sam logs

Fetches logs that are generated by your Lambda function.

When your functions are a part of an AWS CloudFormation stack, you can fetch logs by using the function's logical ID when you specify the stack name.

Usage:

```
sam logs [OPTIONS]
```

Examples:

```
$ sam logs -n HelloWorldFunction --stack-name mystack

Or, you can fetch logs using the function's name.
$ sam logs -n mystack-HelloWorldFunction-1FJ8PD36GML2Q

You can view logs for a specific time range using the -s (--start-time) and -e (--end-time)
 options
$ sam logs -n HelloWorldFunction --stack-name mystack -s '10min ago' -e '2min ago'

You can also add the --tail option to wait for new logs and see them as they arrive.
$ sam logs -n HelloWorldFunction --stack-name mystack --tail

Use the --filter option to quickly find logs that match terms, phrases or values in your
 log events.
$ sam logs -n HelloWorldFunction --stack-name mystack --filter "error"
```

Options:

Option	Description
-n, --name TEXT	The name of your Lambda function. If this function is part of an AWS CloudFormation stack, this can be the logical ID of the function resource in the AWS CloudFormation/AWS SAM template. [required]
--stack-name TEXT	The name of the AWS CloudFormation stack that the function is a part of.
--filter TEXT	Lets you specify an expression to quickly find logs that match terms, phrases, or values in your log events. This can be a simple keyword (for example, "error") or a pattern that's supported by Amazon CloudWatch Logs. For the syntax, see the Amazon CloudWatch Logs documentation.
-s, --start-time TEXT	Fetches logs starting at this time. The time can be relative values like '5mins ago', 'yesterday', or a formatted timestamp like '2018-01-01 10:10:10'. It defaults to '10mins ago'.
-e, --end-time TEXT	Fetches logs up to this time. The time can be relative values like '5mins ago', 'tomorrow', or a formatted timestamp like '2018-01-01 10:10:10'.

Option	Description
-t, --tail	Tails the log output. This ignores the end time argument and continues to fetch logs as they become available.
--profile TEXT	Selects a specific profile from your credential file to get AWS credentials.
--region TEXT	Sets the AWS Region of the service (for example, us-east-1).
--debug	Turns on debug logging to print debug messages that are generated by the AWS SAM CLI.
--help	Shows this message and exits.

sam package

Packages an AWS SAM application. This is an alias for `aws cloudformation package`.

> **Note**
> If the AWS SAM template contains a `Metadata` section for ServerlessRepo, and the `LicenseUrl` or `ReadmeUrl` properties contain references to local files, you must update AWS CLI to version 1.16.77 or later. For more information about the `Metadata` section of AWS SAM templates and publishing applications with AWS SAM CLI, see Publishing Serverless Applications Using the AWS SAM CLI (p. 59).

Usage:

```
sam package [OPTIONS] [ARGS]...
```

Options:

Option	Description
--template-file PATH	The path where your AWS SAM template is located.
--s3-bucket BUCKET	The name of the S3 bucket where this command uploads the artifacts that are referenced in your template.
--output-template-file PATH	The path to the file where the command writes the packaged template. If you don't specify a path, the command writes the template to the standard output.
--profile TEXT	Select a specific profile from your credential file to get AWS credentials.
--region TEXT	Sets the AWS Region of the service (for example, us-east-1).
--debug	Turns on debug logging.
--help	Shows this message and exits.

sam publish

Publish an AWS SAM application to the AWS Serverless Application Repository. This command takes a packaged AWS SAM template and publishes the application to the specified region.

This command expects the AWS SAM template to include a `Metadata` containing application metadata required for publishing. Furthermore, these properties must include references to Amazon S3 buckets for `LicenseUrl` and `ReadmeUrl` values, and not references to local files. For more details about the `Metadata` section of the AWS SAM template, see Publishing Serverless Applications Using the AWS SAM CLI (p. 59).

This command creates the application as private by default, so you must share the application before other AWS accounts are allowed to view and deploy the application. For more information on sharing applications see Using Resource-Based Policies for the AWS Serverless Application Repository.

Usage:

```
sam publish [OPTIONS]
```

Examples:

```
To publish an application
$ sam publish --template packaged.yaml --region us-east-1
```

Options:

Option	Description
-t, --template PATH	AWS SAM template file [default: template.[yaml|yml]].
--semantic-version TEXT	Optional. The semantic version of the application provided by this parameter overrides SemanticVersion in the `Metadata` section of the template file. https://semver.org/
--profile TEXT	Select a specific profile from your credential file to get AWS credentials.
--region TEXT	Sets the AWS Region of the service (for example, us-east-1).
--debug	Turns on debug logging.
--help	Shows this message and exits.

sam validate

Validates an AWS SAM template.

Usage:

```
sam validate [OPTIONS]
```

Options:

Option	Description
-t, --template PATH	The AWS SAM template file [default: template.[yaml|yml]].
--profile TEXT	Selects a specific profile from your credential file to get AWS credentials.
--region TEXT	Sets the AWS Region of the service (for example, us-east-1).
--debug	Turns on debug logging.

Option	Description
--help	Shows this message and exits.

AWS SAM Policy Templates

AWS SAM allows you to choose from a list of policy templates to scope the permissions of your Lambda functions to the resources that are used by your application.

AWS SAM applications in the AWS Serverless Application Repository that use policy templates don't require any special customer acknowledgments to deploy the application from the AWS Serverless Application Repository.

If you want to request a new policy template to be added, do the following:

1. Submit a pull request against the policy_templates.json source file in the `develop` branch of the AWS SAM GitHub project. You can find the source file in policy_templates.json on the GitHub website.
2. Submit an issue in the AWS SAM GitHub project that includes the reasons for your pull request and a link to the request. Use this link to submit a new issue: AWS Serverless Application Model: Issues.

Examples

There are two AWS SAM template examples in this section: one with a policy template that includes placeholder values, and one that doesn't include placeholder values.

Example 1: Policy Template with Placeholder Values

The following example shows that the SQSPollerPolicy (p. 87) policy template expects a `QueueName` as a resource. The AWS SAM template retrieves the name of the "`MyQueue`" Amazon SQS queue, which you can create in the same application or requested as a parameter to the application.

```
MyFunction:
  Type: 'AWS::Serverless::Function'
  Properties:
    CodeUri: ${codeuri}
    Handler: hello.handler
    Runtime: python2.7
    Policies:
      - SQSPollerPolicy:
          QueueName:
            !GetAtt MyQueue.QueueName
```

Example 2: Policy Template with No Placeholder Values

The following example contains the CloudWatchPutMetricPolicy (p. 88) policy template, which has no placeholder values.

```
MyFunction:
  Type: 'AWS::Serverless::Function'
  Properties:
    CodeUri: ${codeuri}
    Handler: hello.handler
    Runtime: python2.7
    Policies:
```

```
    - CloudWatchPutMetricPolicy: {}
```

Policy Template Table

The following is a table of the available policy templates.

Policy Template	Description		
SQSPollerPolicy (p. 87)	Gives permission to poll an Amazon SQS Queue.		
LambdaInvokePolicy (p. 87)	Gives permission to invoke a Lambda function, alias, or version.		
CloudWatchPutMetricPolicy (p. 88)	Gives permission to put metrics to CloudWatch.		
EC2DescribePolicy (p. 88)	Gives permission to describe Amazon EC2 instances.		
DynamoDBCrudPolicy (p. 88)	Gives create, read, update, and delete permissions to a DynamoDB table.		
DynamoDBReadPolicy (p. 89)	Gives read-only permission to a DynamoDB table.		
DynamoDBReconfigurePolicy (p. 89)	Gives permission to reconfigure a DynamoDB table.		
SESSendBouncePolicy (p. 90)	Gives SendBounce permission to an Amazon SES identity.		
ElasticsearchHttpPostPolicy (p. 90)	Gives POST permission to Amazon Elasticsearch Service.		
S3ReadPolicy (p. 91)	Gives read-only permission to objects in an Amazon S3 bucket.		
S3CrudPolicy (p. 91)	Gives create, read, update, and delete permission to objects in an Amazon S3 bucket.		
AMIDescribePolicy (p. 92)	Gives permission to describe Amazon Machine Images (AMIs).		
CloudFormationDescribeStacksPolicy (p. 92)	Gives permission to describe AWS CloudFormation stacks.		
RekognitionDetectOnlyPolicy (p. 93)	Gives permission to detect faces, labels, and text.		
RekognitionNoDataAccessPolicy (p. 93)	Gives permission to compare and detect faces and labels.		
RekognitionReadPolicy (p. 94)	Gives permission to list and search faces.		
RekognitionWriteOnlyAccessPolicy (p. 94)	Gives permission to create collection and index faces.		

Policy Template	Description		
SQSSendMessagePolicy (p. 95)	Gives permission to send message to an Amazon SQS queue.		
SNSPublishMessagePolicy (p. 95)	Gives permission to publish a message to an Amazon SNS topic.		
VPCAccessPolicy (p. 95)	Gives access to create, delete, describe, and detach Elastic Network Interfaces.		
DynamoDBStreamReadPolicy (p. 96)	Gives permission to describe and read DynamoDB streams and records.		
KinesisStreamReadPolicy (p. 96)	Gives permission to list and read an Amazon Kinesis stream.		
SESCrudPolicy (p. 97)	Gives permission to send email and verify identity.		
SNSCrudPolicy (p. 97)	Gives permission to create, publish, and subscribe to Amazon SNS topics.		
KinesisCrudPolicy (p. 98)	Gives permission to create, publish, and delete an Amazon Kinesis stream.		
KMSDecryptPolicy (p. 98)	Gives permission to decrypt with an AWS KMS key.		
PollyFullAccessPolicy (p. 99)	Gives full access permission to Amazon Polly lexicon resources.		
S3FullAccessPolicy (p. 99)	Gives full access permission to objects in an Amazon S3 bucket.		
CodePipelineLambdaExecutionPolicy (p. 100)	Gives permission for a Lambda function invoked by CodePipeline to report the status of the job.		
ServerlessRepoReadWriteAccessPolicy (p. 101)	Gives permission to create and list applications in the AWS Serverless Application Repository service.		
EC2CopyImagePolicy (p. 101)	Gives permission to copy Amazon EC2 images.		
AWSSecretsManagerRotationPolicy (p. 101)	Gives permission to rotate a secret in AWS Secrets Manager.		
AWSSecretsManagerGetSecretValuePolicy (p. 102)	Gives permission to GetSecretValue for the specified AWS Secrets Manager secret.		
CodePipelineReadOnlyPolicy (p. 103)	Gives read permission to get details about a CodePipeline pipeline.		
RekognitionFacesPolicy (p. 103)	Gives permission to compare and detect faces and labels.		
RekognitionLabelsPolicy (p. 103)	Gives permission to detect object and moderation labels.		

Policy Template	Description		
DynamoDBBackupFullAccessPolicy (p. 103)	Gives read and write permission to DynamoDB on-demand backups for a table.		
DynamoDBRestoreFromBackupPolicy (p. 104)	Gives permission to restore a DynamoDB table from backup.		
ComprehendBasicAccessPolicy (p. 105)	Gives permission for detecting entities, key phrases, languages, and sentiments.		
MobileAnalyticsWriteOnlyAccessPolicy (p. 105)	Gives write only permission to put event data for all application resources.		
PinpointEndpointAccessPolicy (p. 106)	Gives permission to get and update endpoints for an Amazon Pinpoint application.		
FirehoseWritePolicy (p. 106)	Gives permission to write to a Kinesis Data Firehose delivery stream.		
FirehoseCrudPolicy (p. 106)	Gives permission to create, write, update, and delete a Kinesis Data Firehose delivery stream.		
EKSDescribePolicy (p. 107)	Gives permission to describe or list Amazon EKS clusters.		
CostExplorerReadOnlyPolicy (p. 107)	Gives read-only permission to the read-only Cost Explorer APIs for billing history.		
OrganizationsListAccountsPolicy (p. 108)	Gives read-only permission to list child account names and IDs.		
SESBulkTemplatedCrudPolicy (p. 108)	Gives permission to send email, templated email, templated bulk emails and verify identity.		
SESEmailTemplateCrudPolicy (p. 108)	Gives permission to create, get, list, update and delete Amazon SES email templates.		
FilterLogEventsPolicy (p. 109)	Gives permission to filter log events from a specified log group.		
SSMParameterReadPolicy (p. 109)	Gives permission to access a parameter to load secrets in this account.		
StepFunctionsExecutionPolicy (p. 110)	Gives permission to access a parameter to load secrets in this account.		
CodeCommitCrudPolicy (p. 110)	Gives permissions to create/read/update/delete objects within a specific codecommit repository.		
CodeCommitReadPolicy (p. 111)	Gives permissions to read objects within a specific codecommit repository.		

Policy Template List

The following are the available policy templates, along with the permissions that are applied to each one. AWS SAM automatically populates the placeholder items (such as AWS Region and account ID) with the appropriate information.

SQSPollerPolicy

Gives permission to poll an Amazon SQS Queue.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "sqs:ChangeMessageVisibility",
              "sqs:ChangeMessageVisibilityBatch",
              "sqs:DeleteMessage",
              "sqs:DeleteMessageBatch",
              "sqs:GetQueueAttributes",
              "sqs:ReceiveMessage"
            ],
            "Resource": {
              "Fn::Sub": [
                "arn:${AWS::Partition}:sqs:${AWS::Region}:${AWS::AccountId}:${queueName}",
                {
                  "queueName": {
                    "Ref": "QueueName"
                  }
                }
              ]
            }
          }
        ]
```

LambdaInvokePolicy

Gives permission to invoke a Lambda function, alias, or version.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "lambda:InvokeFunction"
            ],
            "Resource": {
              "Fn::Sub": [
                "arn:${AWS::Partition}:lambda:${AWS::Region}:${AWS::AccountId}:function:
${functionName}*",
                {
                  "functionName": {
                    "Ref": "FunctionName"
                  }
                }
              ]
            }
          }
        ]
```

CloudWatchPutMetricPolicy

Gives permission to put metrics to CloudWatch.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "cloudwatch:PutMetricData"
            ],
            "Resource": "*"
          }
        ]
```

EC2DescribePolicy

Gives permission to describe Amazon EC2 instances.

```
         "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "ec2:DescribeRegions",
              "ec2:DescribeInstances"
            ],
            "Resource": "*"
          }
        ]
```

DynamoDBCrudPolicy

Gives create, read, update, and delete permissions to a DynamoDB table.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "dynamodb:GetItem",
              "dynamodb:DeleteItem",
              "dynamodb:PutItem",
              "dynamodb:Scan",
              "dynamodb:Query",
              "dynamodb:UpdateItem",
              "dynamodb:BatchWriteItem",
              "dynamodb:BatchGetItem",
              "dynamodb:DescribeTable"
            ],
            "Resource": [
              {
                "Fn::Sub": [
                  "arn:${AWS::Partition}:dynamodb:${AWS::Region}:${AWS::AccountId}:table/
${tableName}",
                  {
                    "tableName": {
```

```
                    "Ref": "TableName"
                  }
                }
              ]
            },
            {
              "Fn::Sub": [
                "arn:${AWS::Partition}:dynamodb:${AWS::Region}:${AWS::AccountId}:table/
${tableName}/index/*",
                {
                  "tableName": {
                    "Ref": "TableName"
                  }
                }
              ]
            }
          ]
        }
      ]
```

DynamoDBReadPolicy

Gives read-only permission to a DynamoDB table.

```
      "Statement": [
        {
          "Effect": "Allow",
          "Action": [
            "dynamodb:GetItem",
            "dynamodb:Scan",
            "dynamodb:Query",
            "dynamodb:BatchGetItem",
            "dynamodb:DescribeTable"
          ],
          "Resource": [
            {
              "Fn::Sub": [
                "arn:${AWS::Partition}:dynamodb:${AWS::Region}:${AWS::AccountId}:table/
${tableName}",
                {
                  "tableName": {
                    "Ref": "TableName"
                  }
                }
              ]
            },
            {
              "Fn::Sub": [
                "arn:${AWS::Partition}:dynamodb:${AWS::Region}:${AWS::AccountId}:table/
${tableName}/index/*",
                {
                  "tableName": {
                    "Ref": "TableName"
                  }
                }
              ]
            }
          ]
        }
      ]
```

DynamoDBReconfigurePolicy

Gives permission to reconfigure a DynamoDB table.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "dynamodb:UpdateTable"
            ],
            "Resource": {
              "Fn::Sub": [
                "arn:${AWS::Partition}:dynamodb:${AWS::Region}:${AWS::AccountId}:table/
${tableName}",
                {
                  "tableName": {
                    "Ref": "TableName"
                  }
                }
              ]
            }
          }
        ]
```

SESSendBouncePolicy

Gives SendBounce permission to an Amazon SES identity.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "ses:SendBounce"
            ],
            "Resource": {
              "Fn::Sub": [
                "arn:${AWS::Partition}:ses:${AWS::Region}:${AWS::AccountId}:identity/
${identityName}",
                {
                  "identityName": {
                    "Ref": "IdentityName"
                  }
                }
              ]
            }
          }
        ]
```

ElasticsearchHttpPostPolicy

Gives POST and PUT permission to Amazon Elasticsearch Service.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
```

```
              "es:ESHttpPost",
              "es:ESHttpPut"
            ],
            "Resource": {
              "Fn::Sub": [
                "arn:${AWS::Partition}:es:${AWS::Region}:${AWS::AccountId}:domain/
${domainName}/*",
                {
                  "domainName": {
                    "Ref": "DomainName"
                  }
                }
              ]
            }
          }
        ]
```

S3ReadPolicy

Gives read-only permission to objects in an Amazon S3 bucket.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "s3:GetObject",
              "s3:ListBucket",
              "s3:GetBucketLocation",
              "s3:GetObjectVersion",
              "s3:GetLifecycleConfiguration"
            ],
            "Resource": [
              {
                "Fn::Sub": [
                  "arn:${AWS::Partition}:s3:::${bucketName}",
                  {
                    "bucketName": {
                      "Ref": "BucketName"
                    }
                  }
                ]
              },
              {
                "Fn::Sub": [
                  "arn:${AWS::Partition}:s3:::${bucketName}/*",
                  {
                    "bucketName": {
                      "Ref": "BucketName"
                    }
                  }
                ]
              }
            ]
          }
        ]
```

S3CrudPolicy

Gives create, read, update, and delete permission to objects in an Amazon S3 bucket.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "s3:GetObject",
              "s3:ListBucket",
              "s3:GetBucketLocation",
              "s3:GetObjectVersion",
              "s3:PutObject",
              "s3:PutObjectAcl",
              "s3:GetLifecycleConfiguration",
              "s3:PutLifecycleConfiguration",
              "s3:DeleteObject"
            ],
            "Resource": [
              {
                "Fn::Sub": [
                  "arn:${AWS::Partition}:s3:::${bucketName}",
                  {
                    "bucketName": {
                      "Ref": "BucketName"
                    }
                  }
                ]
              },
              {
                "Fn::Sub": [
                  "arn:${AWS::Partition}:s3:::${bucketName}/*",
                  {
                    "bucketName": {
                      "Ref": "BucketName"
                    }
                  }
                ]
              }
            ]
          }
        ]
```

AMIDescribePolicy

Gives permission to describe Amazon Machine Images (AMIs).

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "ec2:DescribeImages"
            ],
            "Resource": {
              "Fn::Sub": "arn:${AWS::Partition}:ec2:${AWS::Region}:${AWS::AccountId}:image/
*"
            }
          }
        ]
```

CloudFormationDescribeStacksPolicy

Gives permission to describe AWS CloudFormation stacks.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "cloudformation:DescribeStacks"
            ],
            "Resource": {
              "Fn::Sub": "arn:${AWS::Partition}:cloudformation:${AWS::Region}:
${AWS::AccountId}:stack/*"
            }
          }
        ]
```

RekognitionDetectOnlyPolicy

Gives permission to detect faces, labels, and text.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "rekognition:DetectFaces",
              "rekognition:DetectLabels",
              "rekognition:DetectModerationLabels",
              "rekognition:DetectText"
            ],
            "Resource": "*"
          }
        ]
```

RekognitionNoDataAccessPolicy

Gives permission to compare and detect faces and labels.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "rekognition:CompareFaces",
              "rekognition:DetectFaces",
              "rekognition:DetectLabels",
              "rekognition:DetectModerationLabels"
            ],
            "Resource": {
              "Fn::Sub": [
                "arn:${AWS::Partition}:rekognition:${AWS::Region}:
${AWS::AccountId}:collection/${collectionId}",
                {
                  "collectionId": {
                    "Ref": "CollectionId"
                  }
                }
```

```
            ]
          }
        }
      ]
```

RekognitionReadPolicy

Gives permission to list and search faces.

```
      "Statement": [
        {
          "Effect": "Allow",
          "Action": [
            "rekognition:ListCollections",
            "rekognition:ListFaces",
            "rekognition:SearchFaces",
            "rekognition:SearchFacesByImage"
          ],
          "Resource": {
            "Fn::Sub": [
              "arn:${AWS::Partition}:rekognition:${AWS::Region}:
${AWS::AccountId}:collection/${collectionId}",
              {
                "collectionId": {
                  "Ref": "CollectionId"
                }
              }
            ]
          }
        }
      ]
```

RekognitionWriteOnlyAccessPolicy

Gives permission to create collection and index faces.

```
      "Statement": [
        {
          "Effect": "Allow",
          "Action": [
            "rekognition:CreateCollection",
            "rekognition:IndexFaces"
          ],
          "Resource": {
            "Fn::Sub": [
              "arn:${AWS::Partition}:rekognition:${AWS::Region}:
${AWS::AccountId}:collection/${collectionId}",
              {
                "collectionId": {
                  "Ref": "CollectionId"
                }
              }
            ]
          }
        }
      ]
```

SQSSendMessagePolicy

Gives permission to send message to an Amazon SQS queue.

```
"Statement": [
  {
    "Effect": "Allow",
    "Action": [
      "sqs:SendMessage*"
    ],
    "Resource": {
      "Fn::Sub": [
        "arn:${AWS::Partition}:sqs:${AWS::Region}:${AWS::AccountId}:${queueName}",
        {
          "queueName": {
            "Ref": "QueueName"
          }
        }
      ]
    }
  }
]
```

SNSPublishMessagePolicy

Gives permission to publish a message to an Amazon SNS topic.

```
"Statement": [
  {
    "Effect": "Allow",
    "Action": [
      "sns:Publish"
    ],
    "Resource": {
      "Fn::Sub": [
        "arn:${AWS::Partition}:sns:${AWS::Region}:${AWS::AccountId}:${topicName}",
        {
          "topicName": {
            "Ref": "TopicName"
          }
        }
      ]
    }
  }
]
```

VPCAccessPolicy

Gives access to create, delete, describe, and detach Elastic Network Interfaces.

```
"Statement": [
  {
    "Effect": "Allow",
    "Action": [
      "ec2:CreateNetworkInterface",
```

```
              "ec2:DeleteNetworkInterface",
              "ec2:DescribeNetworkInterfaces",
              "ec2:DetachNetworkInterface"
            ],
            "Resource": "*"
          }
        ]
```

DynamoDBStreamReadPolicy

Gives permission to describe and read DynamoDB streams and records.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "dynamodb:DescribeStream",
              "dynamodb:GetRecords",
              "dynamodb:GetShardIterator",
              "dynamodb:ListStreams"
            ],
            "Resource": {
              "Fn::Sub": [
                "arn:${AWS::Partition}:dynamodb:${AWS::Region}:${AWS::AccountId}:table/
${tableName}/${streamName}",
                {
                  "tableName": {
                    "Ref": "TableName"
                  },
                  "streamName": {
                    "Ref": "StreamName"
                  }
                }
              ]
            }
          }
        ]
```

KinesisStreamReadPolicy

Gives permission to list and read an Amazon Kinesis stream.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "kinesis:ListStreams",
              "kinesis:DescribeLimits"
            ],
            "Resource": {
              "Fn::Sub": "arn:${AWS::Partition}:kinesis:${AWS::Region}:
${AWS::AccountId}:stream/*"
            }
          },
          {
            "Effect": "Allow",
            "Action": [
              "kinesis:DescribeStream",
```

```
              "kinesis:GetRecords",
              "kinesis:GetShardIterator"
            ],
            "Resource": {
              "Fn::Sub": [
                "arn:${AWS::Partition}:kinesis:${AWS::Region}:${AWS::AccountId}:stream/
${streamName}",
                {
                  "streamName": {
                    "Ref": "StreamName"
                  }
                }
              ]
            }
          }
        ]
```

SESCrudPolicy

Gives permission to send email and verify identity.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "ses:GetIdentityVerificationAttributes",
              "ses:SendEmail",
              "ses:VerifyEmailIdentity"
            ],
            "Resource": {
              "Fn::Sub": [
                "arn:${AWS::Partition}:ses:${AWS::Region}:${AWS::AccountId}:identity/
${identityName}",
                {
                  "identityName": {
                    "Ref": "IdentityName"
                  }
                }
              ]
            }
          }
        ]
```

SNSCrudPolicy

Gives permission to create, publish, and subscribe to Amazon SNS topics.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "sns:ListSubscriptionsByTopic",
              "sns:CreateTopic",
              "sns:SetTopicAttributes",
              "sns:Subscribe",
              "sns:Publish"
            ],
            "Resource": {
```

```
              "Fn::Sub": [
                "arn:${AWS::Partition}:sns:${AWS::Region}:${AWS::AccountId}:${topicName}*",
                {
                  "topicName": {
                    "Ref": "TopicName"
                  }
                }
              ]
            }
          }
        ]
```

KinesisCrudPolicy

Gives permission to create, publish, and delete an Amazon Kinesis stream.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "kinesis:AddTagsToStream",
              "kinesis:CreateStream",
              "kinesis:DecreaseStreamRetentionPeriod",
              "kinesis:DeleteStream",
              "kinesis:DescribeStream",
              "kinesis:GetShardIterator",
              "kinesis:IncreaseStreamRetentionPeriod",
              "kinesis:ListTagsForStream",
              "kinesis:MergeShards",
              "kinesis:PutRecord",
              "kinesis:PutRecords",
              "kinesis:SplitShard",
              "kinesis:RemoveTagsFromStream"
            ],
            "Resource": {
              "Fn::Sub": [
                "arn:${AWS::Partition}:kinesis:${AWS::Region}:${AWS::AccountId}:stream/
${streamName}",
                {
                  "streamName": {
                    "Ref": "StreamName"
                  }
                }
              ]
            }
          }
        ]
```

KMSDecryptPolicy

Gives permission to decrypt with an AWS KMS key.

```
        "Statement": [
          {
            "Action": "kms:Decrypt",
            "Effect": "Allow",
            "Resource": {
              "Fn::Sub": [
```

```
                "arn:${AWS::Partition}:kms:${AWS::Region}:${AWS::AccountId}:key/${keyId}",
                {
                  "keyId": {
                    "Ref": "KeyId"
                  }
                }
              ]
            }
          }
        ]
```

PollyFullAccessPolicy

Gives full access permission to Amazon Polly lexicon resources.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "polly:GetLexicon",
              "polly:DeleteLexicon"
            ],
            "Resource": [
              {
                "Fn::Sub": [
                  "arn:${AWS::Partition}:polly:${AWS::Region}:${AWS::AccountId}:lexicon/
${lexiconName}",
                  {
                    "lexiconName": {
                      "Ref": "LexiconName"
                    }
                  }
                ]
              }
            ]
          },
          {
            "Effect": "Allow",
            "Action": [
              "polly:DescribeVoices",
              "polly:ListLexicons",
              "polly:PutLexicon",
              "polly:SynthesizeSpeech"
            ],
            "Resource": [
              {
                "Fn::Sub": "arn:${AWS::Partition}:polly:${AWS::Region}:
${AWS::AccountId}:lexicon/*"
              }
            ]
          }
        ]
```

S3FullAccessPolicy

Gives full access permission to objects in an Amazon S3 bucket.

```
        "Statement": [
```

```
      {
        "Effect": "Allow",
        "Action": [
          "s3:GetObject",
          "s3:GetObjectAcl",
          "s3:GetObjectVersion",
          "s3:PutObject",
          "s3:PutObjectAcl",
          "s3:DeleteObject",
          "s3:DeleteObjectTagging",
          "s3:DeleteObjectVersionTagging",
          "s3:GetObjectTagging",
          "s3:GetObjectVersionTagging",
          "s3:PutObjectTagging",
          "s3:PutObjectVersionTagging"
        ],
        "Resource": [
          {
            "Fn::Sub": [
              "arn:${AWS::Partition}:s3:::${bucketName}/*",
              {
                "bucketName": {
                  "Ref": "BucketName"
                }
              }
            ]
          }
        ]
      },
      {
        "Effect": "Allow",
        "Action": [
          "s3:ListBucket",
          "s3:GetBucketLocation",
          "s3:GetLifecycleConfiguration",
          "s3:PutLifecycleConfiguration"
        ],
        "Resource": [
          {
            "Fn::Sub": [
              "arn:${AWS::Partition}:s3:::${bucketName}",
              {
                "bucketName": {
                  "Ref": "BucketName"
                }
              }
            ]
          }
        ]
      }
    ]
```

CodePipelineLambdaExecutionPolicy

Gives permission for a Lambda function invoked by CodePipeline to report the status of the job.

```
    "Statement": [
      {
        "Effect": "Allow",
        "Action": [
          "codepipeline:PutJobSuccessResult",
          "codepipeline:PutJobFailureResult"
```

```
            ],
            "Resource": "*"
          }
        ]
```

ServerlessRepoReadWriteAccessPolicy

Gives permission to create and list applications in the AWS Serverless Application Repository service.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "serverlessrepo:CreateApplication",
              "serverlessrepo:CreateApplicationVersion",
              "serverlessrepo:GetApplication",
              "serverlessrepo:ListApplications",
              "serverlessrepo:ListApplicationVersions"
            ],
            "Resource": [
              {
                "Fn::Sub": "arn:${AWS::Partition}:serverlessrepo:${AWS::Region}:
${AWS::AccountId}:applications/*"
              }
            ]
          }
        ]
```

EC2CopyImagePolicy

Gives permission to copy Amazon EC2 images.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "ec2:CopyImage"
            ],
            "Resource": {
              "Fn::Sub": [
                "arn:${AWS::Partition}:ec2:${AWS::Region}:${AWS::AccountId}:image/
${imageId}",
                {
                  "imageId": {
                    "Ref": "ImageId"
                  }
                }
              ]
            }
          }
        ]
```

AWSSecretsManagerRotationPolicy

Gives permission to rotate a secret in AWS Secrets Manager.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "secretsmanager:DescribeSecret",
              "secretsmanager:GetSecretValue",
              "secretsmanager:PutSecretValue",
              "secretsmanager:UpdateSecretVersionStage"
            ],
            "Resource": {
              "Fn::Sub": "arn:${AWS::Partition}:secretsmanager:${AWS::Region}:
${AWS::AccountId}:secret:*"
            },
            "Condition": {
              "StringEquals": {
                "secretsmanager:resource/AllowRotationLambdaArn": {
                  "Fn::Sub": [
                    "arn:${AWS::Partition}:lambda:${AWS::Region}:
${AWS::AccountId}:function:${functionName}",
                    {
                      "functionName": {
                        "Ref": "FunctionName"
                      }
                    }
                  ]
                }
              }
            }
          },
          {
            "Effect": "Allow",
            "Action": [
              "secretsmanager:GetRandomPassword"
            ],
            "Resource": "*"
          }
        ]
```

AWSSecretsManagerGetSecretValuePolicy

Gives permission to GetSecretValue for the specified AWS Secrets Manager secret.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "secretsmanager:GetSecretValue"
            ],
            "Resource": {
              "Fn::Sub": [
                "${secretArn}",
                {
                  "secretArn": {
                    "Ref": "SecretArn"
                  }
                }
              ]
            }
          }
        ]
```

CodePipelineReadOnlyPolicy

Gives read permission to get details about a CodePipeline pipeline.

```
"Statement": [
  {
    "Effect": "Allow",
    "Action": [
      "cloudwatch:GetDashboard",
      "cloudwatch:ListDashboards",
      "cloudwatch:PutDashboard",
      "cloudwatch:ListMetrics"
    ],
    "Resource": "*"
  }
]
```

RekognitionFacesPolicy

Gives permission to compare and detect faces and labels.

```
"Statement": [{
  "Effect": "Allow",
  "Action": [
    "rekognition:CompareFaces",
    "rekognition:DetectFaces"
  ],
  "Resource": "*"
  }
]
```

RekognitionLabelsPolicy

Gives permission to detect object and moderation labels.

```
"Statement": [{
  "Effect": "Allow",
  "Action": [
    "rekognition:DetectLabels",
    "rekognition:DetectModerationLabels"
  ],
  "Resource": "*"
 }
]
```

DynamoDBBackupFullAccessPolicy

Gives read and write permission to DynamoDB on-demand backups for a table.

```
        "Statement": [{
          "Effect": "Allow",
          "Action": [
            "dynamodb:CreateBackup",
            "dynamodb:DescribeContinuousBackups"
          ],
          "Resource": {
            "Fn::Sub": [
              "arn:${AWS::Partition}:dynamodb:${AWS::Region}:${AWS::AccountId}:table/
${tableName}",
              {
                "tableName": {
                  "Ref": "TableName"
                }
              }
            ]
          }
        },
          {
            "Effect": "Allow",
            "Action": [
              "dynamodb:DeleteBackup",
              "dynamodb:DescribeBackup",
              "dynamodb:ListBackups"
            ],
            "Resource": {
              "Fn::Sub": [
                "arn:${AWS::Partition}:dynamodb:${AWS::Region}:${AWS::AccountId}:table/
${tableName}/backup/*",
                {
                  "tableName": {
                    "Ref": "TableName"
                  }
                }
              ]
            }
          }
        ]
```

DynamoDBRestoreFromBackupPolicy

Gives permission to restore a DynamoDB table from backup.

```
        "Statement": [{
          "Effect": "Allow",
          "Action": [
            "dynamodb:RestoreTableFromBackup"
          ],
          "Resource": {
            "Fn::Sub": [
              "arn:${AWS::Partition}:dynamodb:${AWS::Region}:${AWS::AccountId}:table/
${tableName}/backup/*",
              {
                "tableName": {
                  "Ref": "TableName"
                }
              }
            ]
          }
        },
          {
            "Effect": "Allow",
```

```
            "Action": [
              "dynamodb:PutItem",
              "dynamodb:UpdateItem",
              "dynamodb:DeleteItem",
              "dynamodb:GetItem",
              "dynamodb:Query",
              "dynamodb:Scan",
              "dynamodb:BatchWriteItem"
            ],
            "Resource": {
              "Fn::Sub": [
                "arn:${AWS::Partition}:dynamodb:${AWS::Region}:${AWS::AccountId}:table/
${tableName}",
                {
                  "tableName": {
                    "Ref": "TableName"
                  }
                }
              ]
            }
          }
        ]
```

ComprehendBasicAccessPolicy

Gives permission for detecting entities, key phrases, languages, and sentiments.

```
        "Statement": [{
          "Effect": "Allow",
          "Action": [
            "comprehend:BatchDetectKeyPhrases",
            "comprehend:DetectDominantLanguage",
            "comprehend:DetectEntities",
            "comprehend:BatchDetectEntities",
            "comprehend:DetectKeyPhrases",
            "comprehend:DetectSentiment",
            "comprehend:BatchDetectDominantLanguage",
            "comprehend:BatchDetectSentiment"
          ],
          "Resource": "*"
          }
        ]
```

MobileAnalyticsWriteOnlyAccessPolicy

Gives write-only permission to put event data for all application resources.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "mobileanalytics:PutEvents"
            ],
            "Resource": "*"
          }
        ]
```

PinpointEndpointAccessPolicy

Gives permission to get and update endpoints for an Amazon Pinpoint application.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "mobiletargeting:GetEndpoint",
              "mobiletargeting:UpdateEndpoint",
              "mobiletargeting:UpdateEndpointsBatch"
            ],
            "Resource": {
              "Fn::Sub": [
                "arn:${AWS::Partition}:mobiletargeting:${AWS::Region}:
${AWS::AccountId}:apps/${pinpointApplicationId}/endpoints/*",
                {
                  "pinpointApplicationId": {
                    "Ref": "PinpointApplicationId"
                  }
                }
              ]
            }
          }
        ]
```

FirehoseWritePolicy

Gives permission to write to a Kinesis Data Firehose delivery stream.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "firehose:PutRecord",
              "firehose:PutRecordBatch"
            ],
            "Resource": {
              "Fn::Sub": [
                "arn:${AWS::Partition}:firehose:${AWS::Region}:
${AWS::AccountId}:deliverystream/${deliveryStreamName}",
                {
                  "deliveryStreamName": {
                    "Ref": "DeliveryStreamName"
                  }
                }
              ]
            }
          }
        ]
```

FirehoseCrudPolicy

Gives permission to create, write, update, and delete a Kinesis Data Firehose delivery stream.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "firehose:CreateDeliveryStream",
              "firehose:DeleteDeliveryStream",
              "firehose:DescribeDeliveryStream",
              "firehose:PutRecord",
              "firehose:PutRecordBatch",
              "firehose:UpdateDestination"
            ],
            "Resource": {
              "Fn::Sub": [
                "arn:${AWS::Partition}:firehose:${AWS::Region}:
${AWS::AccountId}:deliverystream/${deliveryStreamName}",
                {
                  "deliveryStreamName": {
                    "Ref": "DeliveryStreamName"
                  }
                }
              ]
            }
          }
        ]
```

EKSDescribePolicy

Gives permission to describe or list Amazon EKS clusters.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "eks:DescribeCluster",
              "eks:ListClusters"
            ],
            "Resource": "*"
          }
        ]
```

CostExplorerReadOnlyPolicy

Gives read-only permission to the read-only Cost Explorer APIs for billing history.

```
        "Statement": [{
          "Effect": "Allow",
          "Action": [
            "ce:GetCostAndUsage",
            "ce:GetDimensionValues",
            "ce:GetReservationCoverage",
            "ce:GetReservationPurchaseRecommendation",
            "ce:GetReservationUtilization",
            "ce:GetTags"
          ],
          "Resource": "*"
        }]
```

OrganizationsListAccountsPolicy

Gives read-only permission to list child account names and IDs.

```
        "Statement": [{
          "Effect": "Allow",
          "Action": [
            "organizations:ListAccounts"
          ],
          "Resource": "*"
        }]
```

SESBulkTemplatedCrudPolicy

Gives permission to send email, templated email, templated bulk emails and verify identity.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "ses:GetIdentityVerificationAttributes",
              "ses:SendEmail",
              "ses:SendRawEmail",
              "ses:SendTemplatedEmail",
              "ses:SendBulkTemplatedEmail",
              "ses:VerifyEmailIdentity"
            ],
            "Resource": {
              "Fn::Sub": [
                "arn:${AWS::Partition}:ses:${AWS::Region}:${AWS::AccountId}:identity/
${identityName}",
                {
                  "identityName": {
                    "Ref": "IdentityName"
                  }
                }
              ]
            }
          }
        ]
```

SESEmailTemplateCrudPolicy

Gives permission to create, get, list, update and delete Amazon SES email templates.

```
        "Statement": [{
          "Effect": "Allow",
          "Action": [
            "ses:CreateTemplate",
            "ses:GetTemplate",
            "ses:ListTemplates",
            "ses:UpdateTemplate",
            "ses:DeleteTemplate",
            "ses:TestRenderTemplate"
          ],
          "Resource": "*"
```

```
        }]
```

FilterLogEventsPolicy

Gives permission to filter log events from a specified log group.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "logs:FilterLogEvents"
            ],
            "Resource": {
              "Fn::Sub": [
                "arn:${AWS::Partition}:logs:${AWS::Region}:${AWS::AccountId}:log-group:
${logGroupName}:log-stream:*",
                {
                  "logGroupName": {
                    "Ref": "LogGroupName"
                  }
                }
              ]
            }
          }
        ]
```

SSMParameterReadPolicy

Gives permission to access a parameter to load secrets in this account.

Note
If you are not using default key, you will also need `KMSDecryptPolicy`.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
              "ssm:DescribeParameters"
            ],
            "Resource": "*"
          },
          {
            "Effect": "Allow",
            "Action": [
              "ssm:GetParameters",
              "ssm:GetParameter",
              "ssm:GetParametersByPath"
            ],
            "Resource": {
              "Fn::Sub": [
                "arn:${AWS::Partition}:ssm:${AWS::Region}:${AWS::AccountId}:parameter/
${parameterName}",
                {
                  "parameterName": {
                    "Ref": "ParameterName"
                  }
                }
              ]
            }
```

```
        }
      ]
```

StepFunctionsExecutionPolicy

Gives permission to start a Step Functions state machine execution.

```
      "Statement": [
        {
          "Effect": "Allow",
          "Action": [
            "states:StartExecution"
          ],
          "Resource": {
            "Fn::Sub": [
              "arn:${AWS::Partition}:states:${AWS::Region}:
${AWS::AccountId}:stateMachine:${stateMachineName}",
              {
                "stateMachineName": {
                  "Ref": "StateMachineName"
                }
              }
            ]
          }
        }
      ]
```

CodeCommitCrudPolicy

Gives permissions to create/read/update/delete objects within a specific codecommit repository.

```
      "Statement": [
        {
          "Effect": "Allow",
          "Action": [
            "codecommit:GitPull",
            "codecommit:GitPush",
            "codecommit:CreateBranch",
            "codecommit:DeleteBranch",
            "codecommit:GetBranch",
            "codecommit:ListBranches",
            "codecommit:MergeBranchesByFastForward",
            "codecommit:MergeBranchesBySquash",
            "codecommit:MergeBranchesByThreeWay",
            "codecommit:UpdateDefaultBranch",
            "codecommit:BatchDescribeMergeConflicts",
            "codecommit:CreateUnreferencedMergeCommit",
            "codecommit:DescribeMergeConflicts",
            "codecommit:GetMergeCommit",
            "codecommit:GetMergeOptions",
            "codecommit:BatchGetPullRequests",
            "codecommit:CreatePullRequest",
            "codecommit:DescribePullRequestEvents",
            "codecommit:GetCommentsForPullRequest",
            "codecommit:GetCommitsFromMergeBase",
            "codecommit:GetMergeConflicts",
            "codecommit:GetPullRequest",
            "codecommit:ListPullRequests",
```

```
              "codecommit:MergePullRequestByFastForward",
              "codecommit:MergePullRequestBySquash",
              "codecommit:MergePullRequestByThreeWay",
              "codecommit:PostCommentForPullRequest",
              "codecommit:UpdatePullRequestDescription",
              "codecommit:UpdatePullRequestStatus",
              "codecommit:UpdatePullRequestTitle",
              "codecommit:DeleteFile",
              "codecommit:GetBlob",
              "codecommit:GetFile",
              "codecommit:GetFolder",
              "codecommit:PutFile",
              "codecommit:DeleteCommentContent",
              "codecommit:GetComment",
              "codecommit:GetCommentsForComparedCommit",
              "codecommit:PostCommentForComparedCommit",
              "codecommit:PostCommentReply",
              "codecommit:UpdateComment",
              "codecommit:BatchGetCommits",
              "codecommit:CreateCommit",
              "codecommit:GetCommit",
              "codecommit:GetCommitHistory",
              "codecommit:GetDifferences",
              "codecommit:GetObjectIdentifier",
              "codecommit:GetReferences",
              "codecommit:GetTree",
              "codecommit:GetRepository",
              "codecommit:UpdateRepositoryDescription",
              "codecommit:ListTagsForResource",
              "codecommit:TagResource",
              "codecommit:UntagResource",
              "codecommit:GetRepositoryTriggers",
              "codecommit:PutRepositoryTriggers",
              "codecommit:TestRepositoryTriggers",
              "codecommit:GetBranch",
              "codecommit:GetCommit",
              "codecommit:UploadArchive",
              "codecommit:GetUploadArchiveStatus",
              "codecommit:CancelUploadArchive"
            ],
            "Resource": {
              "Fn::Sub": [
                "arn:${AWS::Partition}:codecommit:${AWS::Region}:${AWS::AccountId}:
${repositoryName}",
                {
                  "repositoryName": {
                    "Ref": "RepositoryName"
                  }
                }
              ]
            }
          }
        ]
```

CodeCommitReadPolicy

Gives permissions to read objects within a specific codecommit repository.

```
        "Statement": [
          {
            "Effect": "Allow",
            "Action": [
```

```
              "codecommit:GitPull",
              "codecommit:GetBranch",
              "codecommit:ListBranches",
              "codecommit:BatchDescribeMergeConflicts",
              "codecommit:DescribeMergeConflicts",
              "codecommit:GetMergeCommit",
              "codecommit:GetMergeOptions",
              "codecommit:BatchGetPullRequests",
              "codecommit:DescribePullRequestEvents",
              "codecommit:GetCommentsForPullRequest",
              "codecommit:GetCommitsFromMergeBase",
              "codecommit:GetMergeConflicts",
              "codecommit:GetPullRequest",
              "codecommit:ListPullRequests",
              "codecommit:GetBlob",
              "codecommit:GetFile",
              "codecommit:GetFolder",
              "codecommit:GetComment",
              "codecommit:GetCommentsForComparedCommit",
              "codecommit:BatchGetCommits",
              "codecommit:GetCommit",
              "codecommit:GetCommitHistory",
              "codecommit:GetDifferences",
              "codecommit:GetObjectIdentifier",
              "codecommit:GetReferences",
              "codecommit:GetTree",
              "codecommit:GetRepository",
              "codecommit:ListTagsForResource",
              "codecommit:GetRepositoryTriggers",
              "codecommit:TestRepositoryTriggers",
              "codecommit:GetBranch",
              "codecommit:GetCommit",
              "codecommit:GetUploadArchiveStatus"
            ],
            "Resource": {
              "Fn::Sub": [
                "arn:${AWS::Partition}:codecommit:${AWS::Region}:${AWS::AccountId}:
${repositoryName}",
                {
                  "repositoryName": {
                    "Ref": "RepositoryName"
                  }
                }
              ]
            }
          }
        ]
```

Telemetry in the AWS SAM CLI

At AWS, we develop and launch services based on what we learn from interactions with customers. We use customer feedback to iterate on our product. Telemetry is additional information that helps us to better understand our customers' needs, diagnose issues, and deliver features that improve the customer experience.

The AWS SAM CLI collects telemetry, such as generic usage metrics, system and environment information, and errors. For details of the types of telemetry collected, see Types of Information Collected (p. 113).

The AWS SAM CLI does **not** collect personal information, such as usernames or email addresses. It also does not extract sensitive project-level information.

Customers control whether telemetry is enabled, and can change their settings at any point of time. If telemetry remains enabled, the AWS SAM CLI sends telemetry data in the background without requiring any additional customer interaction.

Disabling Telemetry for a Session

In macOS and Linux operating systems, you can disable telemetry for a single session. To disable telemetry for your current session, run the following command to set the environment variable `SAM_CLI_TELEMETRY` to `false`. You must repeat the command for each new terminal or session.

```
export SAM_CLI_TELEMETRY=0
```

Disabling Telemetry for Your Profile in All Sessions

Run the following commands to disable telemetry for all sessions when you're running the AWS SAM CLI on your operating system.

To disable telemetry in Linux

1. Run:

   ```
   echo "export SAM_CLI_TELEMETRY=0" >>~/.profile
   ```

2. Run:

   ```
   source ~/.profile
   ```

To disable telemetry in macOS

1. Run:

   ```
   echo "export SAM_CLI_TELEMETRY=0" >>~/.profile
   ```

2. Run:

   ```
   source ~/.profile
   ```

To disable telemetry in Windows

1. Run:

   ```
   setx SAM_CLI_TELEMETRY 0
   ```

2. Run:

   ```
   refreshenv
   ```

Types of Information Collected

- **Usage information** – The generic commands and subcommands that are run.

- **Errors and diagnostic information** – The status and duration of commands that are run, including exit codes, internal exception names, and failures when connecting to Docker.
- **System and environment information** – The Python version, operating system (Windows, Linux, or macOS), and environment in which the AWS SAM CLI is executed (for example, AWS CodeBuild, an AWS IDE toolkit, or a terminal).

Learn More

The telemetry data that's collected adheres to the AWS data privacy policies. For more information, see the following:

- AWS Service Terms
- Data Privacy

Document History for AWS Serverless Application Model

The following table describes the important changes in each release of the *AWS Serverless Application Model Developer Guide*. For notification about updates to this documentation, you can subscribe to an RSS feed by choosing the RSS button in the top menu panel.

- **Latest documentation update:** August 29, 2019

update-history-change	update-history-description	update-history-date
New options for controlling access to API Gateway APIs and policy template updates (p. 115)	Added new options for controlling access to API Gateway APIs: IAM permissions, API keys, and resource policies. For more information, see Controlling Access to API Gateway APIs. Also updated two policy templates: RekognitionFacesPolicy and ElasticsearchHttpPostPolicy. For more information, see AWS SAM Policy Templates.	August 29, 2019
Getting Started updates (p. 115)	Updated Getting Started chapter with improved installation instructions for the AWS SAM CLI and the Hello World tutorial. For more information, see Getting Started.	July 25, 2019
Controlling access to API Gateway APIs (p. 115)	Added support for controlling access to API Gateway APIs. For more information, see Controlling Access to API Gateway APIs.	March 21, 2019
Added sam publish to the AWS SAM CLI (p. 115)	The new `sam publish` command in the AWS SAM CLI simplifies the process for publishing serverless applications in the AWS Serverless Application Repository. For more information, see Publishing Serverless Applications Using the AWS SAM CLI.	December 21, 2018
Nested applications and layers support (p. 115)	Added support for nested applications and layers. For more information, see Nested Applications and Working with Layers.	November 29, 2018

Added sam build to the AWS SAM CLI (p. 115)	The new `sam build` command in the AWS SAM CLI simplifies the process for compiling serverless applications with dependencies so you can locally test and deploy these applications. For more information, see Building Applications with Dependencies.	November 19, 2018
Added new installation options for the AWS SAM CLI (p. 115)	Added Linuxbrew (Linux), MSI (Windows), and Homebrew (macOS) installation options for the AWS SAM CLI. For more information, see Installing the AWS SAM CLI.	November 7, 2018
New guide (p. 115)	This is the first release of the *AWS Serverless Application Model Developer Guide*.	October 17, 2018