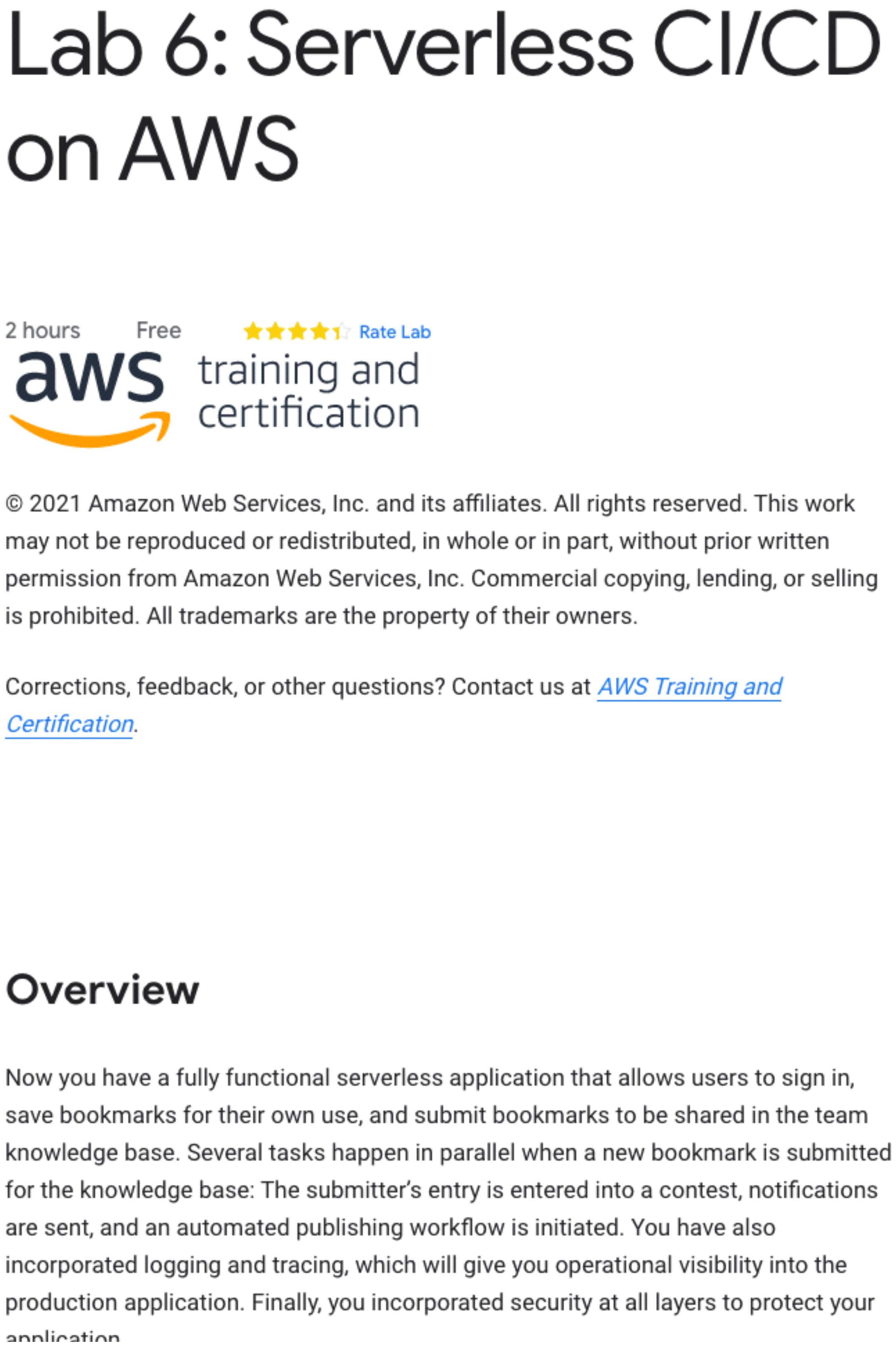
Lab 6: Serverless CI/CD on AWS v1.0.2

Monday, March 29, 2021 11:00 AM



Lab 6: Serverless CI/CD on AWS

2 hours Free ★★★★½ Rate Lab

aws training and certification

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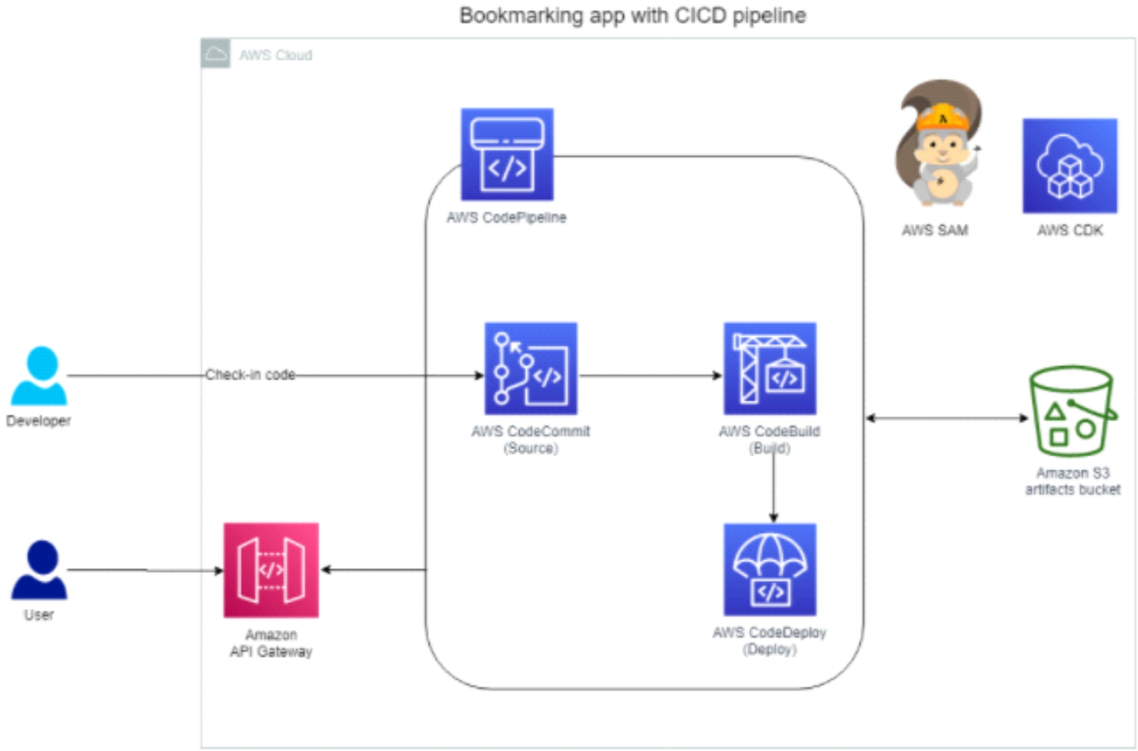
Overview

Now you have a fully functional serverless application that allows users to sign in, save bookmarks for their own use, and submit bookmarks to be shared in the team knowledge base. Several tasks happen in parallel when a new bookmark is submitted for the knowledge base: The submitter's entry is entered into a contest, notifications are sent, and an automated publishing workflow is initiated. You have also incorporated logging and tracing, which will give you operational visibility into the production application. Finally, you incorporated security at all layers to protect your application incorporated logging and tracing, which will give you operational visibility into the production application. Finally, you incorporated security at all layers to protect your application.

As you have learned, a key part of developing serverless applications is to use your visibility into how the application is used in production to determine where to make future modifications. You should continue to monitor the production application to understand access patterns, resolve operational errors, and iteratively optimize your application to minimize costs and continually improve the user experience. Because your application uses small decoupled components, you can more easily modify components independently.

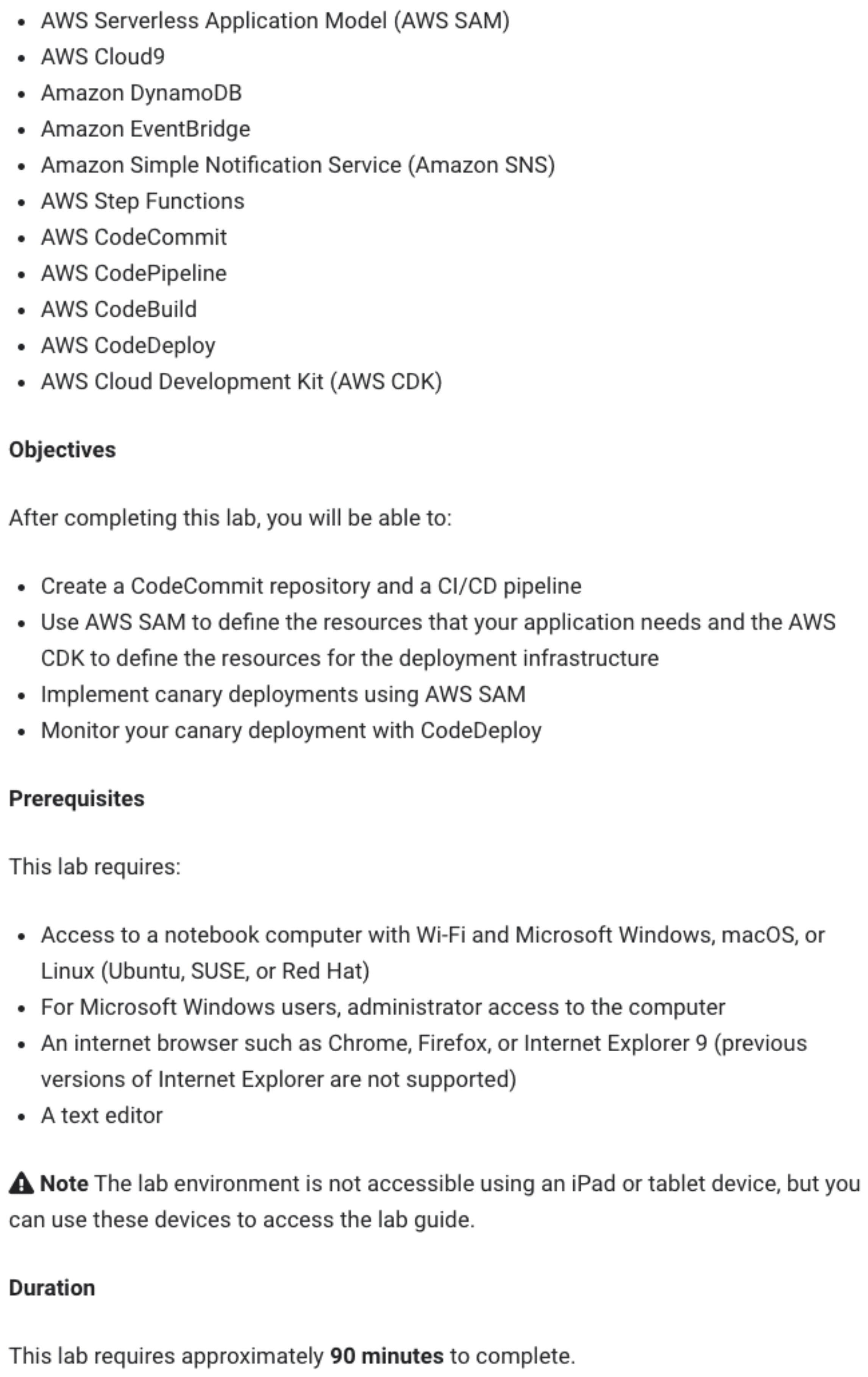
To support these types of small, frequent updates, you would like to automate the build and deployment processes so that the development team continues to focus on developing the application. In this lab, you learn how to set up a continuous integration and continuous delivery (CI/CD) pipeline and do canary deployments on AWS.

The following diagram shows the architecture components that have been or will be deployed in this lab.



This lab uses the following services:

- AWS Serverless Application Model (AWS SAM)
- AWS Cloud9



- AWS Serverless Application Model (AWS SAM)
- AWS Cloud9
- Amazon DynamoDB
- Amazon EventBridge
- Amazon Simple Notification Service (Amazon SNS)
- AWS Step Functions
- AWS CodeCommit
- AWS CodePipeline
- AWS CodeBuild
- AWS CodeDeploy
- AWS Cloud Development Kit (AWS CDK)

Objectives

After completing this lab, you will be able to:

- Create a CodeCommit repository and a CI/CD pipeline
- Use AWS SAM to define the resources that your application needs and the AWS CDK to define the resources for the deployment infrastructure
- Implement canary deployments using AWS SAM
- Monitor your canary deployment with CodeDeploy

Prerequisites

This lab requires:

- Access to a notebook computer with Wi-Fi and Microsoft Windows, macOS, or Linux (Ubuntu, SUSE, or Red Hat)
- For Microsoft Windows users, administrator access to the computer
- An internet browser such as Chrome, Firefox, or Internet Explorer 9 (previous versions of Internet Explorer are not supported)
- A text editor

⚠ **Note** The lab environment is not accessible using an iPad or tablet device, but you can use these devices to access the lab guide.

Duration

This lab requires approximately **90 minutes** to complete.

Start Lab

1. At the top of your screen, launch your lab by choosing **Start Lab**

   This starts the process of provisioning your lab resources. An estimated amount of time to provision your lab resources is displayed. You must wait for your resources to be provisioned before continuing.

   ℹ If you are prompted for a token, use the one distributed to you (or credits you have purchased).

2. Open your lab by choosing **Open Console**

   This opens an AWS Management Console sign-in page.

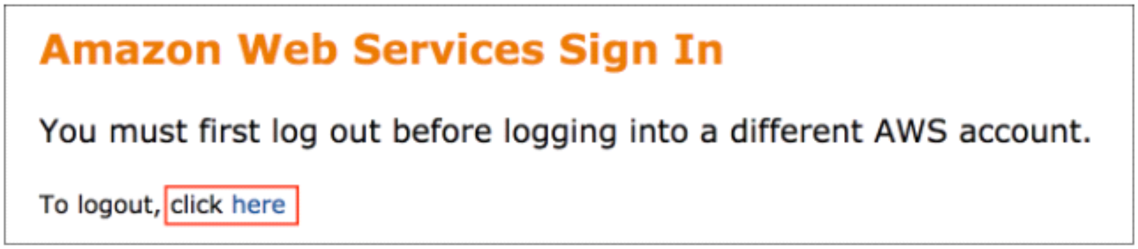
3. On the sign-in page, configure:

   - **IAM user name:** `awsstudent`
   - **Password:** Paste the value of **Password** from the left side of the lab page
   - Choose **Sign In**

⚠ **Do not change the Region unless instructed.**

Common Login Errors

Error: You must first log out

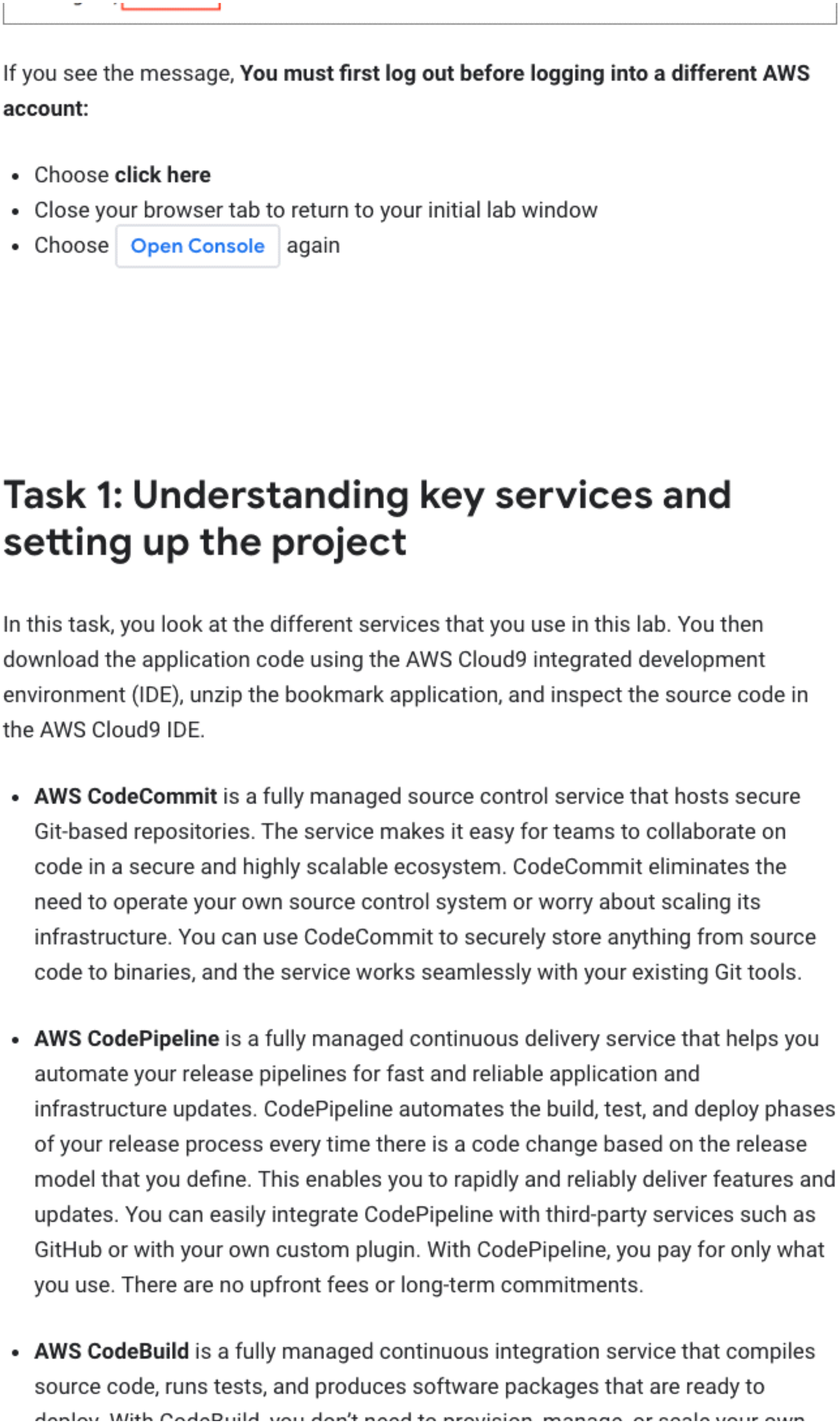


Amazon Web Services Sign In

You must first log out before logging into a different AWS account.

To logout, click here

If you see the message **You must first log out before logging into a different AWS**



If you see the message, **You must first log out before logging into a different AWS account:**

- Choose **click here**
- Close your browser tab to return to your initial lab window
- Choose Open Console again

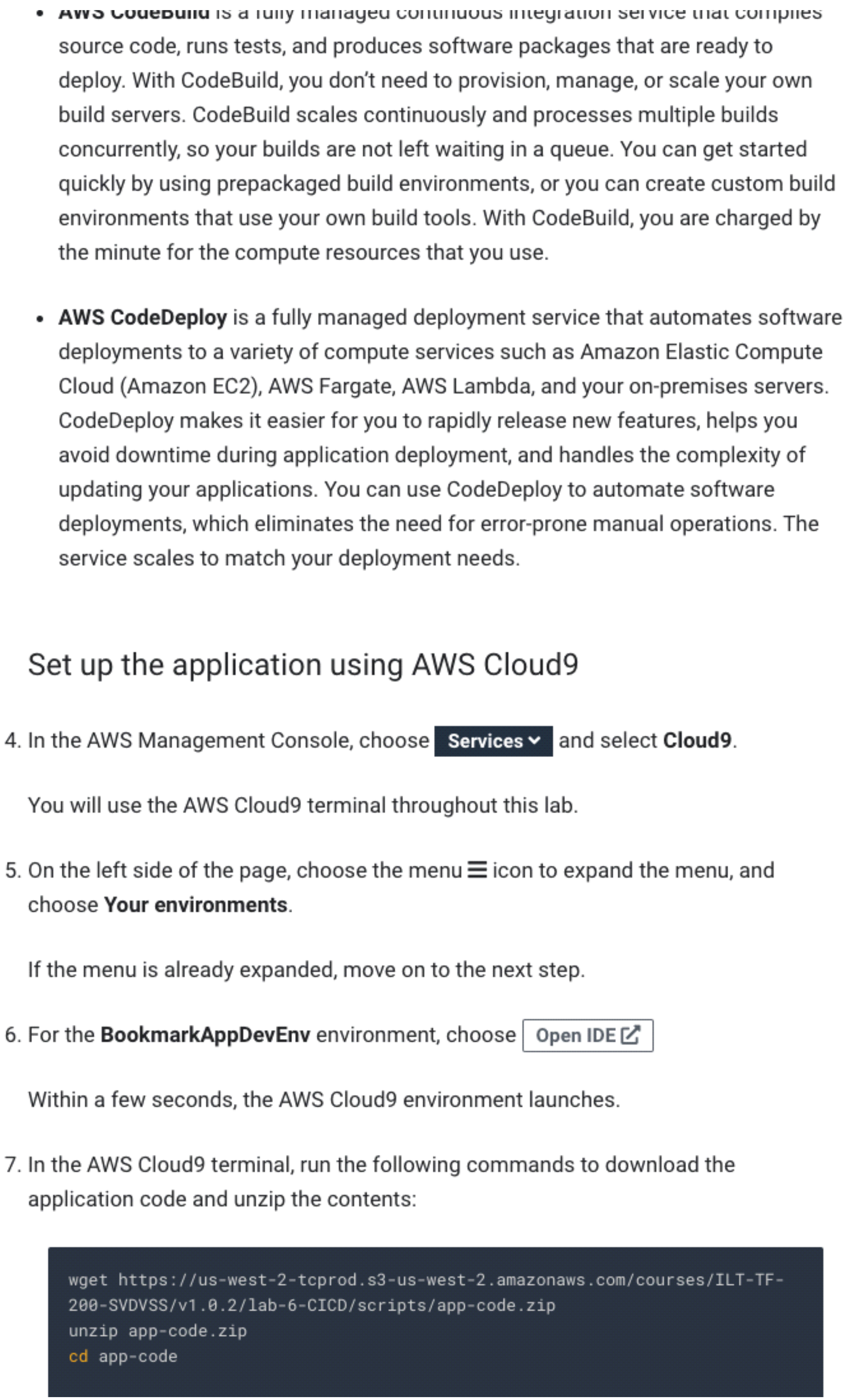
Task 1: Understanding key services and setting up the project

In this task, you look at the different services that you use in this lab. You then download the application code using the AWS Cloud9 integrated development environment (IDE), unzip the bookmark application, and inspect the source code in the AWS Cloud9 IDE.

- **AWS CodeCommit** is a fully managed source control service that hosts secure Git-based repositories. The service makes it easy for teams to collaborate on code in a secure and highly scalable ecosystem. CodeCommit eliminates the need to operate your own source control system or worry about scaling its infrastructure. You can use CodeCommit to securely store anything from source code to binaries, and the service works seamlessly with your existing Git tools.

- **AWS CodePipeline** is a fully managed continuous delivery service that helps you automate your release pipelines for fast and reliable application and infrastructure updates. CodePipeline automates the build, test, and deploy phases of your release process every time there is a code change based on the release model that you define. This enables you to rapidly and reliably deliver features and updates. You can easily integrate CodePipeline with third-party services such as GitHub or with your own custom plugin. With CodePipeline, you pay for only what you use. There are no upfront fees or long-term commitments.

- **AWS CodeBuild** is a fully managed continuous integration service that compiles source code, runs tests, and produces software packages that are ready to deploy. With CodeBuild, you don't need to provision, manage, or scale your own



- **AWS CodeBuild** is a fully managed continuous integration service that compiles source code, runs tests, and produces software packages that are ready to deploy. With CodeBuild, you don't need to provision, manage, or scale your own build servers. CodeBuild scales continuously and processes multiple builds concurrently, so your builds are not left waiting in a queue. You can get started quickly by using prepackaged build environments, or you can create custom build environments that use your own build tools. With CodeBuild, you are charged by the minute for the compute resources that you use.

- **AWS CodeDeploy** is a fully managed deployment service that automates software deployments to a variety of compute services such as Amazon Elastic Compute Cloud (Amazon EC2), AWS Fargate, AWS Lambda, and your on-premises servers. CodeDeploy makes it easier for you to rapidly release new features, helps you avoid downtime during application deployment, and handles the complexity of updating your applications. You can use CodeDeploy to automate software deployments, which eliminates the need for error-prone manual operations. The service scales to match your deployment needs.

Set up the application using AWS Cloud9

4. In the AWS Management Console, choose **Services ⌄** and select **Cloud9**.

   You will use the AWS Cloud9 terminal throughout this lab.

5. On the left side of the page, choose the menu ☰ icon to expand the menu, and choose **Your environments**.

   If the menu is already expanded, move on to the next step.

6. For the **BookmarkAppDevEnv** environment, choose **Open IDE ↗**

   Within a few seconds, the AWS Cloud9 environment launches.

7. In the AWS Cloud9 terminal, run the following commands to download the application code and unzip the contents:

```
wget https://us-west-2-tcprod.s3-us-west-2.amazonaws.com/courses/ILT-TF-200-SVDVSS/v1.0.2/lab-6-CICD/scripts/app-code.zip
unzip app-code.zip
cd app-code
```

```
unzip app-code.zip
cd app-code
```

Inspect the source code in AWS Cloud9

8. In the left navigation pane of the AWS Cloud9 terminal, choose the arrow next to the **app-code** folder to expand it.

9. In the **app-code** folder, choose the arrow next to the **backend** folder to expand it.

   Inspect the Lambda functions and the AWS SAM template that has been created.

10. In the **backend** folder, open the **template.yaml** file.

11. In the **Parameters** section toward the end of the file, replace the following fields (including the parentheses) with the values on the left side of the lab instructions:

    - *(AWS:AccountId)*: **AWS Account**
    - *(SamDeploymentRole)*: **SamDeploymentRole**

    Note The **template.yaml** file also contains **${AWS::AccountId}**. Do not replace this value with the **AWS Account** information. The **SamDeploymentRole** is used when the AWS SAM template is automatically deployed through the CI/CD process.

12. Choose **File > Save** to save your changes to the **template.yaml** file.

Task 2: Checking the application source code in to the CodeCommit repo

In this task, you create a repository (repo) and check in the source code. You could use any source repo (for example, GitHub), but for this lab, use CodeCommit.

13. In the AWS Cloud9 terminal, run the following command to create a new CodeCommit repository:

13. In the AWS Cloud9 terminal, run the following command to create a new CodeCommit repository:

    ```
    aws codecommit create-repository --repository-name app-code
    ```

    The terminal displays the following output:

    ```
    {
        "repositoryMetadata": {
            "accountId": "${AccountId}",
            "repositoryId": "xxxxxxx",
            "repositoryName": "app-code",
            "lastModifiedDate": 1603210225.175,
            "creationDate": 1603210225.175,
            "cloneUrlHttp": "https://git-codecommit.us-west-
    2.amazonaws.com/v1/repos/app-code",
            "cloneUrlSsh": "ssh://git-codecommit.us-west-
    2.amazonaws.com/v1/repos/app-code",
            "Arn": "arn:aws:codecommit:us-west-2:${AccountId}:app-code"
        }
    }
    ```

14. From the output, copy and paste the **cloneUrlHttp** value to a text editor to use later in the lab.

    CodeCommit supports AWS Identity and Access Management (IAM) authentication, and because you are running this from an AWS Cloud9 workspace, you can leverage the fact that your terminal is already pre-authenticated with valid AWS credentials.

15. In the AWS Cloud9 terminal, run the following commands:

    ```
    git config --global credential.helper '!aws codecommit credential-helper
    $@'
    git config --global credential.UseHttpPath true
    ```

    Note These commands specify the use of the Git credential helper with the AWS credential profile and enable the Git credential helper to send the path to repositories. The credential helper uses the default AWS credential profile or the Amazon EC2 instance role.

16. In the AWS Cloud9 terminal, run the following commands to do an initial commit of

Amazon EC2 instance role.

16. In the AWS Cloud9 terminal, run the following commands to do an initial commit of the code:

```
cd ~/environment/app-code
git init
git checkout -b main
git add .
git commit -m "Initial commit"
```

Push the code

17. In the following code, replace *(REPLACE_WITH_HTTP_CLONE_URL)* with the **cloneUrlHttp** value that you copied earlier, and then run this command in the AWS Cloud9 terminal.

```
git remote add origin (REPLACE_WITH_HTTP_CLONE_URL)
```

Note This code adds your CodeCommit repository URL as a remote on your local git project.

18. To push the code to CodeCommit, run the following command:

```
git push -u origin main
```

Verify in CodeCommit

19. In the AWS Management Console, choose **Services ⌄** and select CodeCommit.

20. In the CodeCommit console, under **Repositories**, choose the **app-code** repository to view its contents.

Task 3: Building the CI/CD pipeline

In this task, you learn how to automate the bookmark application build process and deployment by creating a pipeline using CodePipeline.

Introducing the AWS CDK

You use the AWS CDK as the pipeline vending mechanism in this lab. The AWS CDK is a software development framework for defining cloud infrastructure in code and provisioning it through AWS CloudFormation.

You can describe your infrastructure by writing code in TypeScript, C#, Python, or Java. Your code is then synthesized into CloudFormation templates and, by using the AWS CDK CLI, can then be deployed into your AWS environment.

Understand how AWS SAM and the AWS CDK work together

Serverless developers use the AWS SAM framework to define their applications, the AWS SAM CLI to build and deploy them, and the AWS CDK to provision any infrastructure-related resources, such as the CI/CD pipeline. All of these tools share one underlying service: CloudFormation.

21. In the AWS Cloud9 terminal, run the following commands to uninstall any older versions of the AWS CDK and install the latest version:

```
npm uninstall -g aws-cdk
npm install -g aws-cdk --force
```

22. Run the following commands to create a folder in the **app-code** directory where the pipeline code will reside:

```
cd ~/environment/app-code
mkdir pipeline
```

```
cd ~/environment/app-code
mkdir pipeline
cd pipeline
```

23. Run the following command to initialize a new AWS CDK project within the pipeline folder:

```
cdk init --language typescript
```

24. Run the following commands to install the AWS CDK modules that are used to build the pipeline:

```
npm install --save @aws-cdk/aws-codedeploy @aws-cdk/aws-codebuild
npm install --save @aws-cdk/aws-codecommit @aws-cdk/aws-codepipeline-
actions
npm install --save @aws-cdk/aws-s3
```

Project structure

After a few seconds, the project should have the following structure, which shows only the most relevant files and folders. Within the AWS CDK project, the main file that you interact with is **pipeline-stack.ts**.

```
app-code                        # SAM application root
├── backend
    ├── src                     # Lambda functions
    └──template.yaml            # SAM template
└── pipeline                    # CDK project root
    └── bin
        └── pipeline.ts         # Entry point for CDK project
    └── lib
        └── pipeline-stack.ts   # Pipeline definition
    ├── cdk.json
    ├── jest.config.js
    ├── package.json
    └── tsconfig.json
└── test
    ├── fake-bookmark.js         # Lambda code
    ├── simple-get.yaml
    test
    ├── fake-bookmark.js         # Lambda code
    ├── simple-get.yaml
    ├── simple-post.yaml
```

25. In the AWS Cloud9 IDE, choose the arrow next to the **pipeline** folder to open it, and then choose the arrow next to the **bin** folder to open it.

26. In the **bin** folder, open the **pipeline.ts** file.

    This file is the entry point to the AWS CDK project.

27. In the **pipeline.ts** file, find the code that reads **(app, 'PipelineStack');** and replace *PipelineStack* with the following:

    `bookmark-app-cicd`

    Note Leave other instances of *PipelineStack* as is in the **pipeline.ts** file.

28. Choose **File > Save** to save your changes to the **pipeline.ts** file.

Pipeline as code

29. In your AWS Cloud9 workspace, under the **pipeline** folder, choose the arrow next to the **lib** folder to open it.

30. In the **lib** folder, open the **pipeline-stack.ts** file.

    Note You will add code to this file later to build the CI/CD pipeline.

31. In the AWS Cloud9 terminal, run the following commands to build the AWS CDK project:

```
cd ~/environment/app-code/pipeline
npm run build
```

32. Run the following command to deploy the pipeline project by using the AWS CDK CLI:

```
cdk deploy
cdk deploy
```

A new cloud stack has been created in your account: **bookmark-app-cicd**.

33. In the AWS Management Console, choose **Services ⌄** and select **CloudFormation**.

34. Verify that the new **bookmark-app-cicd** cloud stack is deployed without any errors.

Task 4: Creating stages

In this task, you build the artifacts bucket and add the source stage, build stage, and deploy stage to your pipeline.

Note To correct the indentation in the file in the following steps, inside the Cloud 9 IDE, select **Edit > Code Formatting > Apply Code Formatting**, or use the keyboard shortcut CTRL + SHIFT + B.

Artifacts bucket

Each CodePipeline needs an artifacts bucket, also known as an artifact store. CodePipeline uses this bucket to pass artifacts to the downstream jobs, and it's also where AWS SAM uploads the artifacts during the build process.

35. In the AWS Cloud9 workspace, find the **pipeline-stack.ts** file that you opened earlier, and replace the entire code snippet in the file with the following code:

```
// lib/pipeline-stack.ts

import * as cdk from '@aws-cdk/core';
import s3 = require('@aws-cdk/aws-s3');
import codecommit = require('@aws-cdk/aws-codecommit');
import codepipeline = require('@aws-cdk/aws-codepipeline');
import codepipeline_actions = require('@aws-cdk/aws-codepipeline-
actions');
```

```
import codepipeline = require('@aws-cdk/aws-codepipeline');
import codepipeline_actions = require('@aws-cdk/aws-codepipeline-
actions');
import codebuild = require('@aws-cdk/aws-codebuild');

export class PipelineStack extends cdk.Stack {
  constructor(scope: cdk.Construct, id: string, props?: cdk.StackProps) {
    super(scope, id, props);

    // The code that defines your stack goes here
    const artifactsBucket = new s3.Bucket(this, "ArtifactsBucket");
  }
}
```

Note This code creates the artifacts bucket.

36. Save the file.

37. In the AWS Cloud9 terminal, run the following commands to build and deploy the project:

```
npm run build
cdk deploy
```

Note If you get a build error, make sure that all of the @aws-cdk dependencies in the **package.json** file have the same version number. If not, fix the version numbers, delete the node_modules, and run npm install.

38. In the AWS Management Console, choose **Services ⌄** and select **CloudFormation**.

39. Verify the updated **bookmark-app-cicd** cloud stack. An Amazon Simple Storage Service (Amazon S3) bucket has been created.

Source stage

The source stage is the first step of any CI/CD pipeline, and it represents your source code. This stage is in charge of initiating the pipeline based on new code changes (that is, Git push or pull requests). In this section of the lab, use CodeCommit as the source provider, but CodePipeline also supports Amazon S3, GitHub, and Amazon Elastic Container Registry (Amazon ECR) as source providers.

40. In the **pipeline-stack.ts** file, append the following code snippet after your bucket

Elastic Container Registry (Amazon ECR) as source providers.

40. In the **pipeline-stack.ts** file, append the following code snippet after your bucket definition inside the constructor:

```
// Import existing CodeCommit app-code repository
const codeRepo = codecommit.Repository.fromRepositoryName(
  this,
  'AppRepository', // Logical name within CloudFormation
  'app-code' // Repository name
);

// Pipeline creation starts
const pipeline = new codepipeline.Pipeline(this, 'Pipeline', {
  artifactBucket: artifactsBucket
});

// Declare source code as an artifact
const sourceOutput = new codepipeline.Artifact();

// Add source stage to pipeline
pipeline.addStage({
  stageName: 'Source',
  actions: [
    new codepipeline_actions.CodeCommitSourceAction({
      actionName: 'CodeCommit_Source',
      repository: codeRepo,
      output: sourceOutput,
      branch: 'main',
    }),
  ],
});
```

Note Because you already created the CodeCommit repository, you do not need to create a new one; rather, you need to import it using the repository name.

Also notice how a **sourceOutput** object is defined as a pipeline artifact. This is necessary for any files that you want CodePipeline to pass to downstream stages. In this case, the source code should be passed to the build stage.

41. Save the file.

Build stage

The build stage is where AWS SAM builds and packages your serverless application. Use CodeBuild as the build provider for your pipeline.

The build stage is where AWS SAM builds and packages your serverless application. Use CodeBuild as the build provider for your pipeline.

CodeBuild is a great option because you pay for only the time when your build is running, which makes it cost-effective compared to running a dedicated build server 24 hours a day. The service is also container based, which means that you can bring your own Docker container image where your build runs or use a managed image that CodeBuild provides.

42. In the **pipeline-stack.ts** file, append the following code snippet after the source stage definition in the constructor to add a build stage to the file:

```
// Declare build output as artifacts
const buildOutput = new codepipeline.Artifact();

// Declare a new CodeBuild project
const buildProject = new codebuild.PipelineProject(this, 'Build', {
  environment: { buildImage: codebuild.LinuxBuildImage.AMAZON_LINUX_2_2
},
  environmentVariables: {
    'PACKAGE_BUCKET': {
      value: artifactsBucket.bucketName
    }
  }
});

// Add the build stage to our pipeline
pipeline.addStage({
  stageName: 'Build',
  actions: [
    new codepipeline_actions.CodeBuildAction({
      actionName: 'Build',
      project: buildProject,
      input: sourceOutput,
      outputs: [buildOutput],
    }),
  ],
});
```

43. Save the file.

44. In the AWS Cloud9 terminal, run the following commands to deploy the pipeline:

```
npm run build
cdk deploy
cdk deploy
```

Note The CLI will ask you to confirm the changes before deploying. This occurs because you are giving admin permissions to the IAM role that deploys the application. This is generally not a bad practice because only CloudFormation—not a user—can assume this role. However, if your organization has a stricter security posture, you may want to consider creating a custom IAM deployment role with a fine-grained policy.

45. When the message **Do you wish to deploy these changes (y/n)?** appears, enter **y** and press ENTER.

46. In the AWS Management Console, choose **Services ⌄** and select **CodePipeline**.

47. Choose the newly created pipeline with **bookmark** in the name.

    The build step should have failed. This is expected because you haven't specified what commands to run during the build yet, so CodeBuild doesn't know how to build the serverless application.

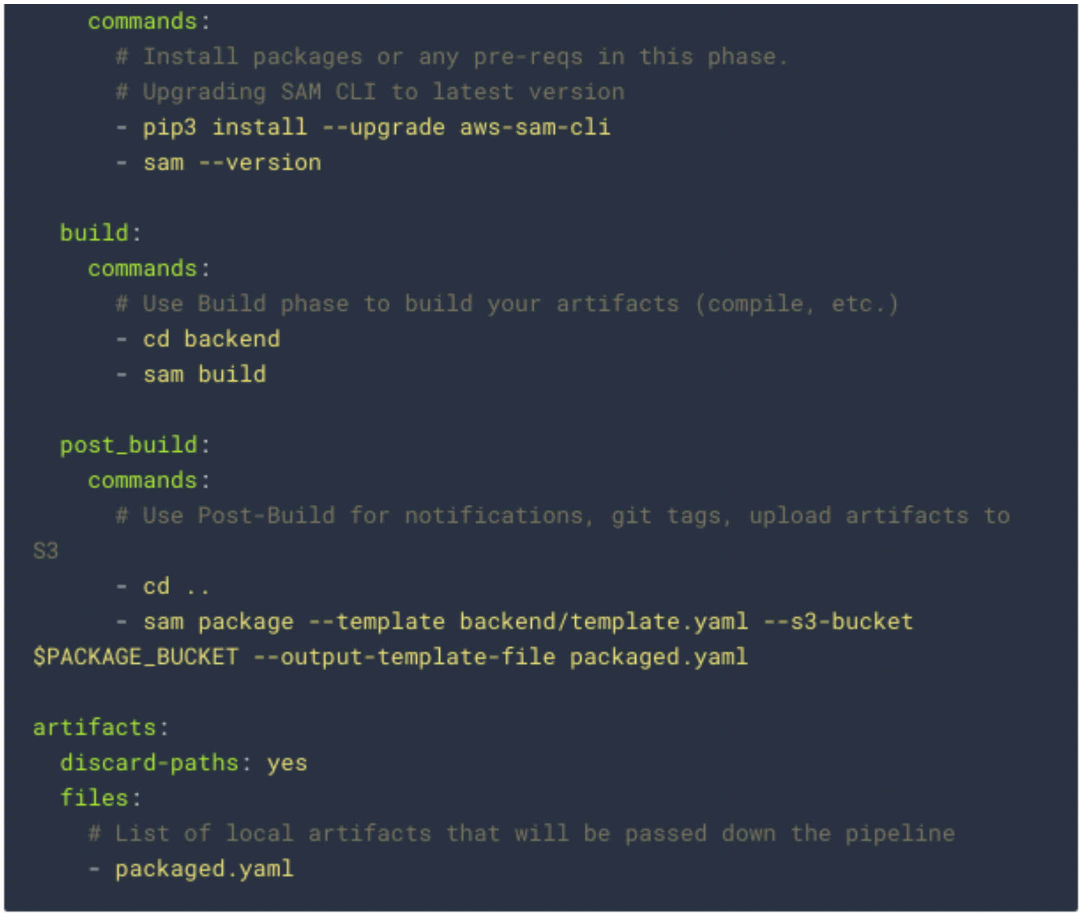
    To fix this issue, you need to build the **buildspec** file. A **buildspec** file is a series of commands in YAML format that CodeBuild runs to build your application. This file is placed in the root folder of an AWS SAM application, and CodeBuild automatically finds it and runs it during build time.

48. In the AWS Cloud9 workspace, to create the **buildspec** file, open the context (right-click) menu for the **app-code** folder, and select **New File**.

    Note The extension of the file can be either .yml or .yaml, and CodeBuild finds it either way.

49. Copy and paste the following content into the **buildspec.yml** file:

```
# ~/environment/app-code/buildspec.yml

version: 0.2
phases:
  install:
    runtime-versions:
      nodejs: 12
    commands:
      # Install packages or any pre-reqs in this phase.
      # Upgrading SAM CLI to latest version
```



```
    commands:
      # Install packages or any pre-reqs in this phase.
      # Upgrading SAM CLI to latest version
      - pip3 install --upgrade aws-sam-cli
      - sam --version

  build:
    commands:
      # Use Build phase to build your artifacts (compile, etc.)
      - cd backend
      - sam build

  post_build:
    commands:
      # Use Post-Build for notifications, git tags, upload artifacts to
S3
      - cd ..
      - sam package --template backend/template.yaml --s3-bucket
$PACKAGE_BUCKET --output-template-file packaged.yaml

artifacts:
  discard-paths: yes
  files:
    # List of local artifacts that will be passed down the pipeline
    - packaged.yaml
```

50. Save the file.

    Note Take a moment to understand the structure of the file. For more information, see Build Specification Reference for CodeBuild for more information.

    Examine the commands in the **buildspec.yml** file:

    - The sam build command is used to build the AWS SAM app.
    - The sam build command iterates through the functions in the application, looking for the manifest file (such as **requirements.txt** or **package.json**) that contains the dependencies and automatically creates deployment artifacts.
    - The sam package command packages an AWS SAM application.
    - The sam package command creates a ZIP file of your code and dependencies, and uploads it to Amazon S3.
    - The sam package command then returns a copy of your AWS SAM template, replacing references to local artifacts with the Amazon S3 location where the command uploaded the artifacts.

51. In the AWS Cloud9 terminal, run the following commands to commit your changes and push them to the repository:

and push them to the repository:

```
cd ~/environment/app-code
git add .
git commit -m "Added buildspec.yml"
git push
```

Deploy stage

The deploy stage is where your AWS SAM application and all of its resources are created in an AWS account. The most common way to do this is by using CloudFormation ChangeSets to deploy. This means that this stage has two actions: CreateChangeSet and Deploy.

52. In the **pipeline-stack.ts** file, append the following code snippet after the build stage definition in the constructor to add a deploy stage to the file:

```
// Deploy stage
pipeline.addStage({
  stageName: 'Dev',
  actions: [
    new codepipeline_actions.CloudFormationCreateReplaceChangeSetAction({
      actionName: 'CreateChangeSet',
      templatePath: buildOutput.atPath("packaged.yaml"),
      stackName: 'bookmark-app',
      adminPermissions: true,
      changeSetName: 'bookmark-app-dev-changeset',
      runOrder: 1
    }),
    new codepipeline_actions.CloudFormationExecuteChangeSetAction({
      actionName: 'Deploy',
      stackName: 'bookmark-app',
      changeSetName: 'bookmark-app-dev-changeset',
      runOrder: 2
    }),
  ],
});
```

53. Save the file.

54. In the AWS Cloud9 terminal, run the following commands from within the pipeline directory:

54. In the AWS Cloud9 terminal, run the following commands from within the pipeline directory:

```
cd ~/environment/app-code/pipeline
npm run build
cdk deploy
```

Note The CLI asks you to confirm the changes before deploying because you are giving admin permissions to the IAM role that deploys the application.

55. When the message **Do you wish to deploy these changes (y/n)?** appears, enter **y** and press ENTER.

56. Navigate to the CodePipeline console, and refresh the page.

57. Choose the pipeline with **bookmark** in the name.

    The deploy stage has been added; however, it is currently grayed out because it hasn't been initiated.

58. Choose **Release Change**

    Note This initiates a new run of the pipeline.

59. In the pop-up window, choose **Release**

    The pipeline runs each stage. After it finishes, all stages will be green.

    Congratulations! You have created a CI/CD pipeline for a serverless application.

    Note It takes several minutes for the pipeline to run.

60. In the AWS Management Console, choose **Services ⌄** and select **CloudFormation**.

61. Choose the **Resources** tab to verify the new cloud stack, named **bookmark-app**.

    This tab lists all of the resources created that are defined in the AWS SAM template.

Task 5: Updating a Lambda function to test the automated deployment

In this task, you start by using Artillery, which is a load testing and functionality tool. You run the **simple-post.yaml** file from the test folder under **app-code** in AWS Cloud9. This adds bookmarks by invoking the **createBookmark** function.

Note To correct the indentation in the file in the following steps, inside the Cloud 9 IDE, select **Edit > Code Formatting > Apply Code Formatting**, or use the keyboard shortcut CTRL + SHIFT + B.

62. In the AWS Management Console, choose **Services ⌄** and open **API Gateway** in a new tab.

63. Choose the **Bookmark App**.

64. In the left navigation pane, select **Stages**.

65. In the **Stages** pane, choose the ▸ **dev** stage.

66. Copy the **Invoke URL** value to a text editor to use later.

67. In the AWS Cloud9 workspace, choose the arrow next to the **app-code** folder to expand it, if it is not already expanded.

68. Choose the arrow next to the **test** folder to expand it.

    Note The AWS Cloud9 workspace contains two **test** folders. Expand the **test** folder that is a subfolder of **app-code** and not the **test** folder that is a subfolder of the **pipeline** folder.

69. In the **app-code > test** folder, open the **simple-post.yaml** file.

70. Find the line of code that reads *(Replace with API Gateway Invoke URL)*, and replace it with the Amazon API Gateway **Invoke URL** value that you copied previously.

71. Save the file.

71. Save the file.

72. In the AWS Cloud9 terminal, run the following code to install Artillery and Faker and launch the **simple-post.yaml** script:

```
cd ../test
npm install artillery -g
npm install faker
artillery run simple-post.yaml
```

    The **simple-post.yaml** script runs for 30 seconds, adding data through the API and then invoking the **createBookmark** function.

73. In the AWS Management Console, choose **Services ⌄** and open **DynamoDB** in a new tab.

74. In the left navigation pane, choose **Tables**.

75. Choose the **bookmark-app-bookmarksTable**.

76. Choose the **Items** tab.

77. From the **id** column in the table, choose one of the IDs.

78. In the pop-up window, copy **id** value.

79. In the following curl command, replace *(InvokeURL)* with the **Invoke URL** value, and replace *(id)* with the **id** value:

```
curl (InvokeURL)/bookmarks/(id)
```

    Note You will use this adjusted curl command throughout the rest of this lab, so copy it to a text editor to use later.

80. In the AWS Cloud9 terminal, run the adjusted curl command to retrieve the bookmark data.

    Note The bookmark details are retrieved for the provided ID.

Now, update the **getBookmark** Lambda function and observe how the function is

Note The bookmark details are retrieved for the provided ID.

Now, update the **getBookmark** Lambda function and observe how the function is automatically deployed with the pipeline.

81. In the AWS Cloud9 workspace, under the **backend** folder, expand the **src** folder.

82. In the **src** folder, expand the **getBookmark** folder, and open the **index.js** file.

83. In the **index.js** file, replace the **return** block in the function with the following code snippet:

```
  return {
    statusCode: 200,
    headers: {},
    body: JSON.stringify([('Successfully retrieved bookmark
'),results.Item])
  };
```

84. Save the file.

85. In the AWS Cloud9 terminal, run the following commands to check in the changes you made in the previous steps:

```
cd ~/environment/app-code
git add .
git commit -m "updated getBookmark function"
git push
```

The pipeline should automatically begin the build process and deploy the AWS SAM template with the changes.

86. Navigate to the CodePipeline console to observe the build process.

Make sure that the deployment is completed successfully before moving on to the next step.

87. In the AWS Management Console, choose **Services ⌄** and open **Lambda** in a new tab.

88. In the search field, enter `getBookmark` and choose the function with **getBookmark** in the name.

88. In the search field, enter `getBookmark` and choose the function with **getBookmark** in the name.

    View the function code to review the updates that have been deployed.

89. In the AWS Cloud9 workspace, run the adjusted curl command again to test the changes. This is the same curl command that you used earlier in this task.

    ```
    curl (InvokeURL)/bookmarks/(id)
    ```

    Note The bookmark details are retrieved for the provided bookmark ID, along with the updated text **Successfully retrieved bookmark**.

    The changes that you made were automatically deployed using the CI/CD pipeline.

Task 6: Understanding canary deployments and how to implement them

In this task, you learn about canary deployments and how they play an important role in rolling out changes to production.

A canary deployment is a technique that reduces the risk of deploying a new version of an application by slowly rolling out the changes to a small subset of users before rolling the new version out to the entire customer base. Using blue/green and canary deployments is well established as a best practice for reducing the risk of software deployments. In traditional applications, you slowly and incrementally update the servers in your fleet while simultaneously verifying application health. However, these concepts don't map directly to a serverless world. You can’t incrementally deploy your software across a fleet of servers when there are no servers.

However, a couple of services and features make this possible.

Lambda versions and aliases

Lambda versions and aliases

Lambda allows you to publish multiple versions of the same function. Each version has its own code and associated dependencies, and its own function settings (such as memory allocation, timeout, and environment variables). You can then refer to a given version by using a Lambda alias. An alias is a name that can be pointed to a given version of a Lambda function.

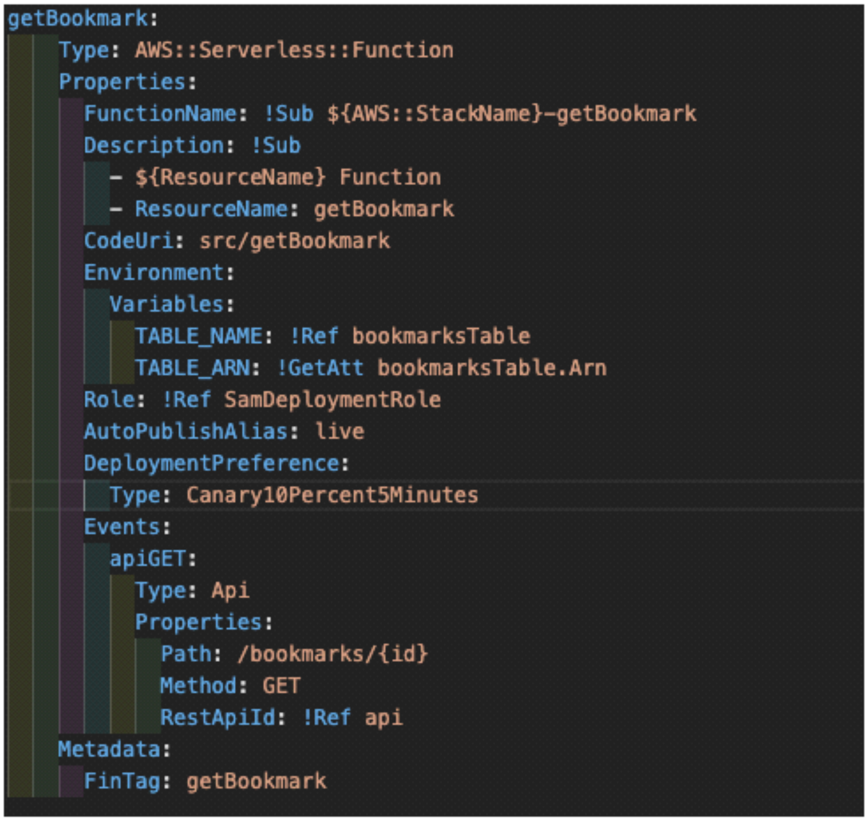
90. In the AWS Cloud9 workspace, under the **backend** folder, open the **template.yaml** file.

91. In the **template.yaml** file, find the line that reads *Role: !Ref SamDeploymentRole** (line 117). This line is in the **getBookmark** function under the **Properties** section.

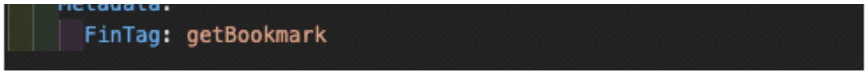
92. Add the following lines after the **Role: !Ref SamDeploymentRole** line:

```
AutoPublishAlias: live
DeploymentPreference:
    Type: Canary10Percent5Minutes
```

Note The indentation for the code snippet above should appear as follows when pasted into the **template.yaml** file:



```
getBookmark:
  Type: AWS::Serverless::Function
  Properties:
    FunctionName: !Sub ${AWS::StackName}-getBookmark
    Description: !Sub
      - ${ResourceName} Function
      - ResourceName: getBookmark
    CodeUri: src/getBookmark
    Environment:
      Variables:
        TABLE_NAME: !Ref bookmarksTable
        TABLE_ARN: !GetAtt bookmarksTable.Arn
    Role: !Ref SamDeploymentRole
    AutoPublishAlias: live
    DeploymentPreference:
      Type: Canary10Percent5Minutes
    Events:
      apiGET:
        Type: Api
        Properties:
          Path: /bookmarks/{id}
          Method: GET
          RestApiId: !Ref api
  Metadata:
    FinTag: getBookmark
```



```
Metadata:
  FinTag: getBookmark
```

93. Save the file.

Deployment preference types

Use the *Canary10Percent5Minutes* strategy for this lab, which means that traffic is shifted in two increments. In the first increment, only 10 percent of the traffic is shifted to the new Lambda version, and after 5 minutes, the remaining 90 percent is shifted. You can choose other deployment strategies in CodeDeploy, such as the following:

- Canary10Percent30Minutes
- Canary10Percent5Minutes
- Canary10Percent10Minutes
- Canary10Percent15Minutes
- Linear10PercentEvery10Minutes
- Linear10PercentEvery1Minute
- Linear10PercentEvery2Minutes
- Linear10PercentEvery3Minutes
- AllAtOnce

The *Linear* strategy means that traffic is shifted in equal increments with an equal time interval between each increment.

94. In the AWS Cloud9 terminal, run the following commands to validate the AWS SAM template:

```
cd ~/environment/app-code/backend
sam validate
```

If the template is correct, a line appears that says the **template.yaml** file is a valid AWS SAM template. If an error appears, then you likely have an indentation issue on the .yaml file.

95. In the AWS Cloud9 terminal, run the following commands from the root directory of the **app-code** project to push the changes:

the **app-code** project to push the changes:

```
cd ~/environment/app-code
git add .
git commit -m "Canary deployments with SAM"
git push
```

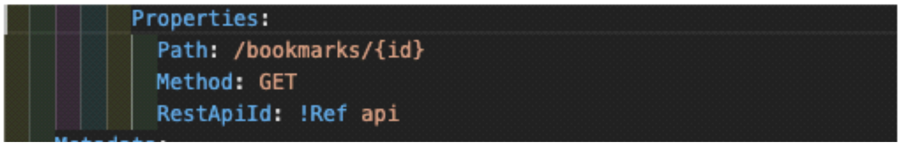
Canary deployments are considerably more successful if the code is monitored during the deployment. You can configure CodeDeploy to automatically roll back the deployment if a specified Amazon CloudWatch metric has breached the alarm threshold. Common metrics to monitor are Lambda invocation errors or invocation duration (latency).

96. In the AWS Cloud9 workspace, in the **template.yaml** file, add the following code snippet after the line that reads **FinTag: getBookmark**. This line is at the end of the **getBookmark** function definition.

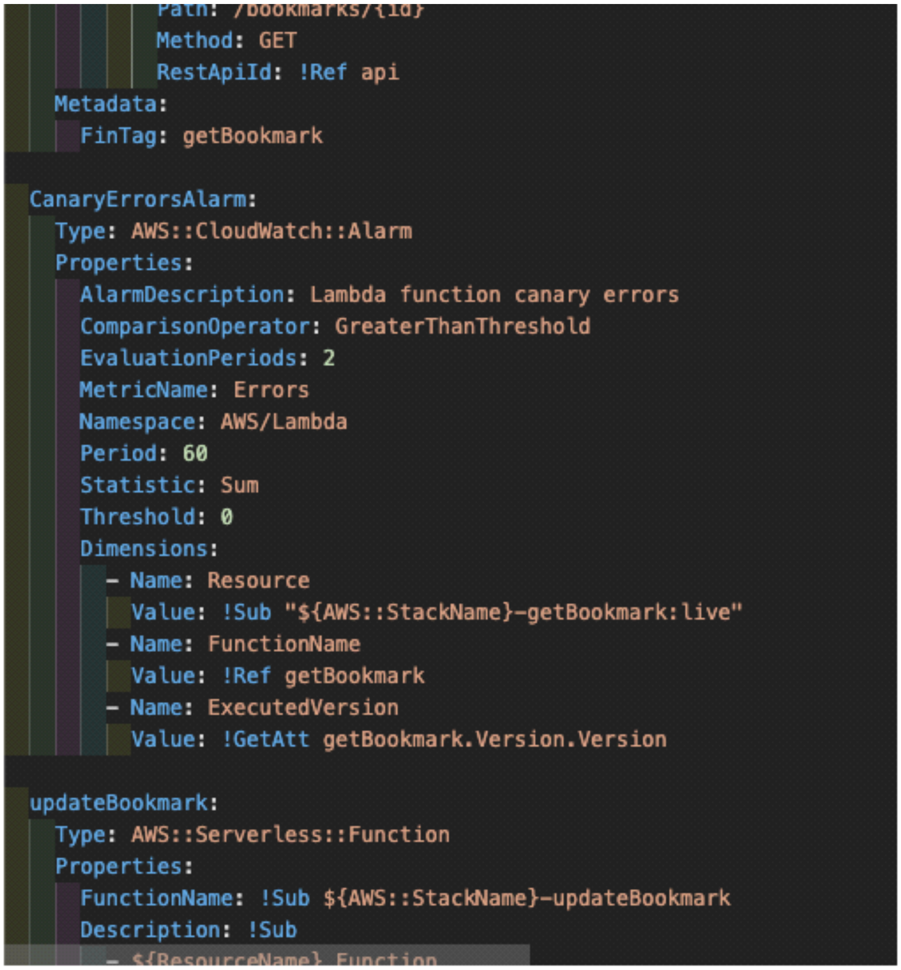
    The following code defines a CloudWatch alarm.

```
CanaryErrorsAlarm:
  Type: AWS::CloudWatch::Alarm
  Properties:
    AlarmDescription: Lambda function canary errors
    ComparisonOperator: GreaterThanThreshold
    EvaluationPeriods: 2
    MetricName: Errors
    Namespace: AWS/Lambda
    Period: 60
    Statistic: Sum
    Threshold: 0
    Dimensions:
      - Name: Resource
        Value: !Sub "${AWS::StackName}-getBookmark:live"
      - Name: FunctionName
        Value: !Ref getBookmark
      - Name: ExecutedVersion
        Value: !GetAtt getBookmark.Version.Version
```

Note It is important to maintain the indentation when inserting the new code. The indentation should look like the following under the **getBookmark** function definition:



```
          Properties:
            Path: /bookmarks/{id}
            Method: GET
            RestApiId: !Ref api
```

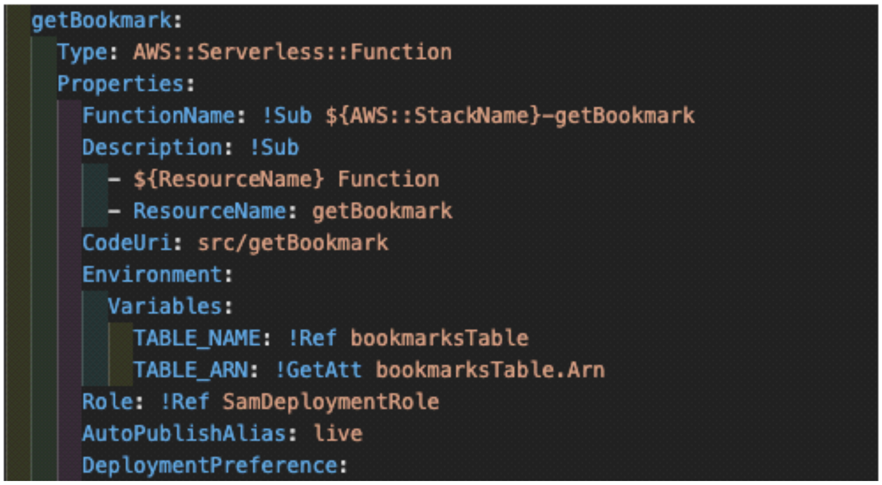


```
            Path: /bookmarks/{id}
            Method: GET
            RestApiId: !Ref api
    Metadata:
      FinTag: getBookmark

  CanaryErrorsAlarm:
    Type: AWS::CloudWatch::Alarm
    Properties:
      AlarmDescription: Lambda function canary errors
      ComparisonOperator: GreaterThanThreshold
      EvaluationPeriods: 2
      MetricName: Errors
      Namespace: AWS/Lambda
      Period: 60
      Statistic: Sum
      Threshold: 0
      Dimensions:
        - Name: Resource
          Value: !Sub "${AWS::StackName}-getBookmark:live"
        - Name: FunctionName
          Value: !Ref getBookmark
        - Name: ExecutedVersion
          Value: !GetAtt getBookmark.Version.Version

  updateBookmark:
    Type: AWS::Serverless::Function
    Properties:
      FunctionName: !Sub ${AWS::StackName}-updateBookmark
      Description: !Sub
        - ${ResourceName} Function
```

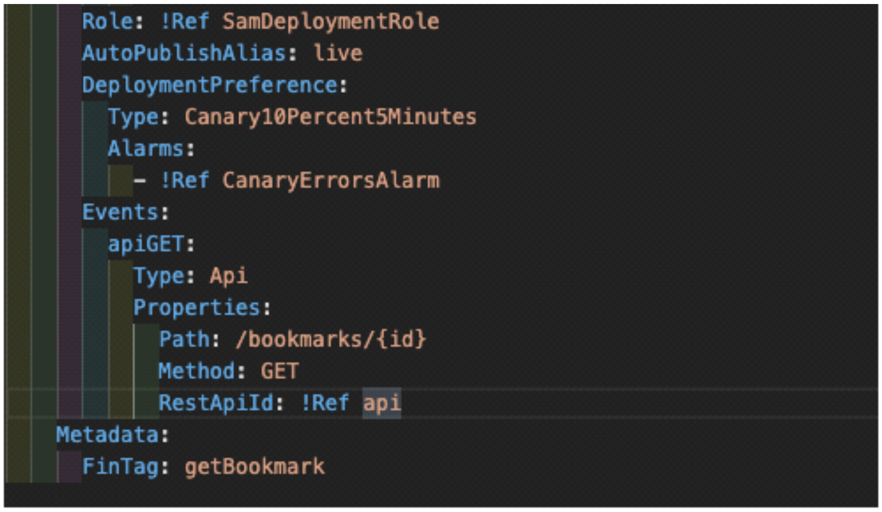
97. In the **template.yaml** file, copy and paste the following lines under the **DeploymentPreference** section of the **getBookmark** function definition:

```
Alarms:
  - !Ref CanaryErrorsAlarm
```

Note It is important to maintain the indentation when inserting the new lines. The indentation should align with the **DeploymentPreference** section as follows:



```
  getBookmark:
    Type: AWS::Serverless::Function
    Properties:
      FunctionName: !Sub ${AWS::StackName}-getBookmark
      Description: !Sub
        - ${ResourceName} Function
        - ResourceName: getBookmark
      CodeUri: src/getBookmark
      Environment:
        Variables:
          TABLE_NAME: !Ref bookmarksTable
          TABLE_ARN: !GetAtt bookmarksTable.Arn
      Role: !Ref SamDeploymentRole
      AutoPublishAlias: live
      DeploymentPreference:
```



```
      Role: !Ref SamDeploymentRole
      AutoPublishAlias: live
      DeploymentPreference:
        Type: Canary10Percent5Minutes
        Alarms:
          - !Ref CanaryErrorsAlarm
      Events:
        apiGET:
          Type: Api
          Properties:
            Path: /bookmarks/{id}
            Method: GET
            RestApiId: !Ref api
    Metadata:
      FinTag: getBookmark
```

98. In the **template.yaml** file, in the **api** section, find the following **uri** for the **/bookmarks/{id}** get method:

```
uri: !Sub arn:aws:apigateway:${AWS::Region}:lambda:path/2015-03-
31/functions/${getBookmark.Arn}/invocations
```

99. Change that **uri** to the following:

```
uri: !Sub arn:aws:apigateway:${AWS::Region}:lambda:path/2015-03-
31/functions/${getBookmark.Arn}:live/invocations
```

Note This update ensures that API Gateway can correctly return the version of the **getBookmark** Lambda function that is being invoked.

100. Save the file.

101. In the AWS Cloud9 terminal, run the following commands to validate the AWS SAM template:

```
cd ~/environment/app-code/backend
sam validate
```

If the template is correct, a line appears that says the **template.yaml** file is a valid AWS SAM template. If an error appears, then you likely have an indentation issue on the .yaml file.

102. In the AWS Cloud9 workspace, in the **getBookmark** folder, open the **index.js** file.

102. In the AWS Cloud9 workspace, in the **getBookmark** folder, open the **index.js** file.

103. In the **index.js** file, replace the **return** block in the function with the following code to create a new version:

```
  return {
    statusCode: 200,
    headers: {},
    body: JSON.stringify(['Successfully retrieved bookmark using the new
version' , results.Item])
  };
```

104. Save the file.

105. In the AWS Cloud9 terminal, run the following commands to push the changes:

```
cd ~/environment/app-code
git add .
git commit -m "Added CloudWatch alarm to monitor the canary"
git push
```

106. Navigate to the browser tab with the CodePipeline console, and wait for the pipeline to get to the deployment stage (Deploy).

When the Deploy stage is **In Progress**, navigate to the CodeDeploy console to watch the deployment progress.

107. In the left navigation pane, select the arrow next to **Deploy**, and choose **Deployments**.

108. Choose the **Deployment id** to review the details.

The deployment status shows that 10 percent of the traffic has been shifted to the new version of the Lambda function (the canary). CodeDeploy holds the remaining percent until the specified time interval has elapsed. In this case, the specified interval is 5 minutes.

109. In the following code snippet, replace *curl (InvokeURL)/bookmarks/(id)* with the adjusted curl command that you used earlier in the lab:

```
counter=1
while [ $counter -le 100 ]
```

```
counter=1
while [ $counter -le 120 ]
do
    curl (InvokeURL)/bookmarks/(id)
    sleep 1
    ((counter++))
    printf "\n"
done
```

Note You will use this adjusted command throughout the rest of this lab, so copy it to a text editor to use later.

110. In the AWS Cloud9 terminal, run the adjusted code snippet to test the Lambda version invocation.

     Note The difference in the return statement value during the deployment process indicates that the different versions of the Lambda function are being invoked.

     Wait 5 minutes until the remaining traffic is shifted to the new version. You can verify this shift by checking the **Deployment** details in the CodeDeploy console.

111. After the traffic has shifted to the new version, go to the AWS Cloud9 workspace, and run the adjusted code snippet again to see only the new version of the Lambda function being invoked.

Rollbacks

Monitoring the health of your canary allows CodeDeploy to make a decision about whether a rollback is needed or not. If any of the specified CloudWatch alarms gets to ALARM status, CodeDeploy rolls back the deployment automatically.

Next, you break the Lambda function on purpose so that the **CanaryErrorsAlarm** alarm is invoked during deployment.

112. In the AWS Cloud9 workspace, in the **getBookmark** folder, open the **index.js** file.

113. Replace the entire function code with the following code to create an error on every invocation:

```
const AWS = require('aws-sdk');
const AWS = require('aws-sdk');
var dynamodb = new AWS.DynamoDB()

exports.handler = async message => {
  throw new Error("this will cause a deployment rollback");
}
```

114. Save the file.

115. In the AWS Cloud9 terminal, run the following commands to push the changes:

```
git add .
git commit -m "Breaking the lambda function on purpose"
git push
```

In the CodePipeline console, wait for the pipeline to reach the deployment phase (Deploy). It should turn blue when it begins.

While the deployment is running, you need to generate traffic to the new Lambda function to make it fail and invoke the CloudWatch alarm. In a real production environment, your users would likely generate organic traffic to the canary function, so you might not need to do this.

116. In the AWS Cloud9 terminal, rerun the code snippet that you ran in the **Deployment preference types** section of this task to test the canary deployment, replacing (InvokeURL) & (id) as before.

```
counter=1
while [ $counter -le 120 ]
do
```

[redacted]

[redacted]