AWS LAMBDA

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About the Tutorial

AWS Lambda is a service which computes the code without any server. It is said to be serverless compute. The code is executed based on the response of events in AWS services such as adding /removing files in S3 bucket, updating Amazon DynamoDB tables, HTTP request from Amazon API Gateway etc.

Audience

This tutorial is designed for software programmers who want to learn the basics of AWS Lambda and its programming concepts in simple and easy way. This tutorial will give you enough understanding on various functionalities of AWS Services to be used with AWS Lambda with illustrative examples.

Prerequisites

To work with AWS Lambda, you need a login in AWS. The details on how to get free login is discussed in tutorial. AWS Lambda supports languages like NodeJS, Java, Python, C# and Go. If you are novice to any of these technologies, we suggest you to go through tutorials related to these before proceeding with this tutorial.

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1. AWS Lambda — Overview

AWS Lambda is a service which performs serverless computing, which involves computing without any server. The code is executed based on the response of events in AWS services such as adding/removing files in S3 bucket, updating Amazon dynamo dB tables, HTTP request from Amazon API gateway etc.

To get working with **AWS Lambda,** we just have to push the code in AWS Lambda service. All other tasks and resources such as infrastructure, operating system, maintenance of server, code monitoring, logs and security is taken care by AWS.

AWS Lambda supports languages such as Java, NodeJS, Python, C# and Go. Note that AWS Lambda will work only with AWS services.

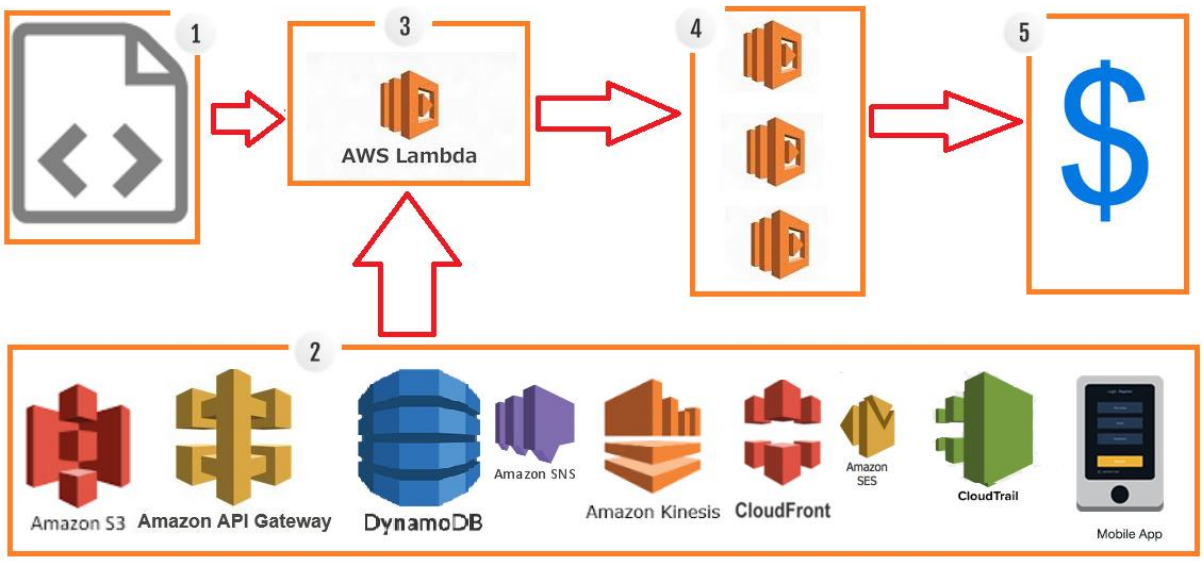
What is AWS Lambda?

Definition of AWS Lambda as given by its official documentation is as follows :

AWS Lambda is a compute service that lets you run code without provisioning or managing servers. AWS Lambda executes your code only when needed and scales automatically, from a few requests per day to thousands per second. You pay only for the compute time you consume - there is no charge when your code is not running.

How AWS Lambda Works?

The block diagram that explains the working of AWS Lambda in five easy steps is shown below:



Step 1: Upload AWS lambda code in any of languages AWS lambda supports, that is NodeJS, Java, Python , C# and Go.

Step 2: These are few AWS services on which AWS lambda can be triggered.

Step 3: AWS Lambda which has the upload code and the event details on which the trigger has occurred. For example, event from Amazon S3, Amazon API Gateway, Dynamo dB, Amazon SNS, Amazon Kinesis, CloudFront, Amazon SES, CloudTrail , mobile app etc.

Step 4: Executes AWS Lambda Code only when triggered by AWS services under the scenarios such as:

- User uploads files in *S3* bucket
- http get/post endpoint URL is hit
- data is added/updated/deleted in dynamo dB tables
- push notification
- data streams collection
- hosting of website
- email sending
- mobile app, etc.

Step 5 : Remember that AWS charges only when the AWS lambda code executes, and not otherwise.

Advantages of using AWS Lambda

AWS Lambda offers multiple benefits when you are working on it. This section discusses them in detail:

Ease of working with code

AWS Lambda gives you the infrastructure to upload your code. It takes care of maintaining the code and triggers the code whenever the required event happens. It allows you to choose the memory and the timeout required for the code.

AWS Lambda can also execute parallel requests as per the event triggers.

Log Provision

AWS Lambda gives the details of number of times a code was executed and time taken for execution, the memory consumed etc. AWS CloudWatch collects all the logs, which helps in understanding the execution flow and in the debugging of the code.

Billing based on Usage

AWS Lambda billing is done on memory usage, request made and the execution, which is billed in increments of minimum 100ms. So for a 500ms execution, the billing will be after every 100ms. If you specify your AWS lambda code to be executed in 500ms and the time taken to execute is just 200ms, AWS will bill you only for the time taken, that is 200ms of execution instead of 500ms. AWS always charges for the execution time used. You need not pay if the function is not executed.

Multi Language Support

AWS Lambda supports popular languages such as Node.js, Python, Java, C# and Go. These are widely used languages and any developer will find it easy to write code for AWS Lambda.

Ease of code authoring and deploying

There are many options available for Lambda for authoring and deploying code. For writing your code, you can use AWS online editor, Visual Studio IDE, or Eclipse IDE. It also has support for serverless framework which makes writing and deploying of AWS Lambda code easy. Besides AWS console, we have AWS-cli to create and deploy code.

Other features

You can use AWS Lambda for free by getting a login to AWS free tier. It gives you service for free for 1 year. Take a look at the free services offered by AWS free tier.

Disadvantages of using AWS Lambda

In spite of many advantages, AWS Lambda possesses the following disadvantages:

- It is not suitable for small projects.
- You need to carefully analyze your code and decide the memory and timeout. Incase if your function needs more time than what is allocated, it will get terminated as per the timeout specified on it and the code will not be fully executed.
- Since AWS Lambda relies completely on AWS for the infrastructure, you cannot install anything additional software if your code demands it.

Events that Trigger AWS Lambda

The events can trigger AWS Lambda are as follows:

- Entry into a S3 object
- Insertion, updation and deletion of data in Dynamo DB table
- Push notifications from SNS
- GET/POST calls to API Gateway
- Headers modification at viewer or origin request/response in CloudFront
- Log entries in AWS Kinesis data stream
- Log history in CloudTrail

Use Cases of AWS Lambda

AWS Lambda is a compute service mainly used to run background processes. It can trigger when used with other AWS services. The list of AWS services where we can use AWS Lambda is given below:

S3 Object and AWS Lambda

Amazon S3 passes the event details to AWS Lambda when there is any file upload in S3. The details of the file upload or deletion of file or moving of file is passed to the AWS Lambda. The code in AWS Lambda can take the necessary step for when it receives the event details. For example, creating thumbnail of the image inserted into S3.

DynamoDB and AWS Lambda

DynamoDB can trigger AWS Lambda when there is data added , updated and deleted in the table. AWS Lambda event has all the details of the AWS DynamoDB table about the insert /update or delete.

API Gateway and AWS Lambda

API Gateway can trigger AWS Lambda on GET/POST methods. We can create a form and share details with API Gateway endpoint and use it with AWS Lambda for further processing, for example, making an entry of the data in DynamoDB table.

SNS and AWS Lambda

SNS is used for push notification, sending SMS etc. We can trigger AWS lambda when there is any push notification happening in SNS. We can also send SMS to the phone number from AWS Lambda when it receives the trigger.

Scheduled Events and AWS Lambda

Scheduled Events can be used for cron jobs. It can trigger AWS Lambda to carry out the task at regular time pattern.

CloudTrail and AWS Lambda

CloudTrail can be helpful in monitoring the logs on the account. We can use AWS Lambda to further process the CloudTrail logs .

Kinesis and AWS Lambda

Kinesis is used to capture/store real time tracking data coming from website clicks, logs, social media feeds and a trigger to AWS Lambda can do additional processing on this logs.

CloudFront and Lambda@Edge

CloudFront is a content delivery network where you can host your website and Lambda@Edge can be used to process the headers coming from viewer request, origin request, origin response and viewer response. The headers modification includes tasks such as modifying cookie data, URL rewrite, used for AB testing to change the response send to the user back, adding extra headers info for security purpose etc.

2. AWS Lambda — Environment Setup

Before you start working with AWS Lambda, you need to have a login with Amazon console. AWS Lambda supports two IDEs: **Visual studio** and **Eclipse**. In this chapter, we will discuss about the installation of AWS Lambda stepwise in detail.

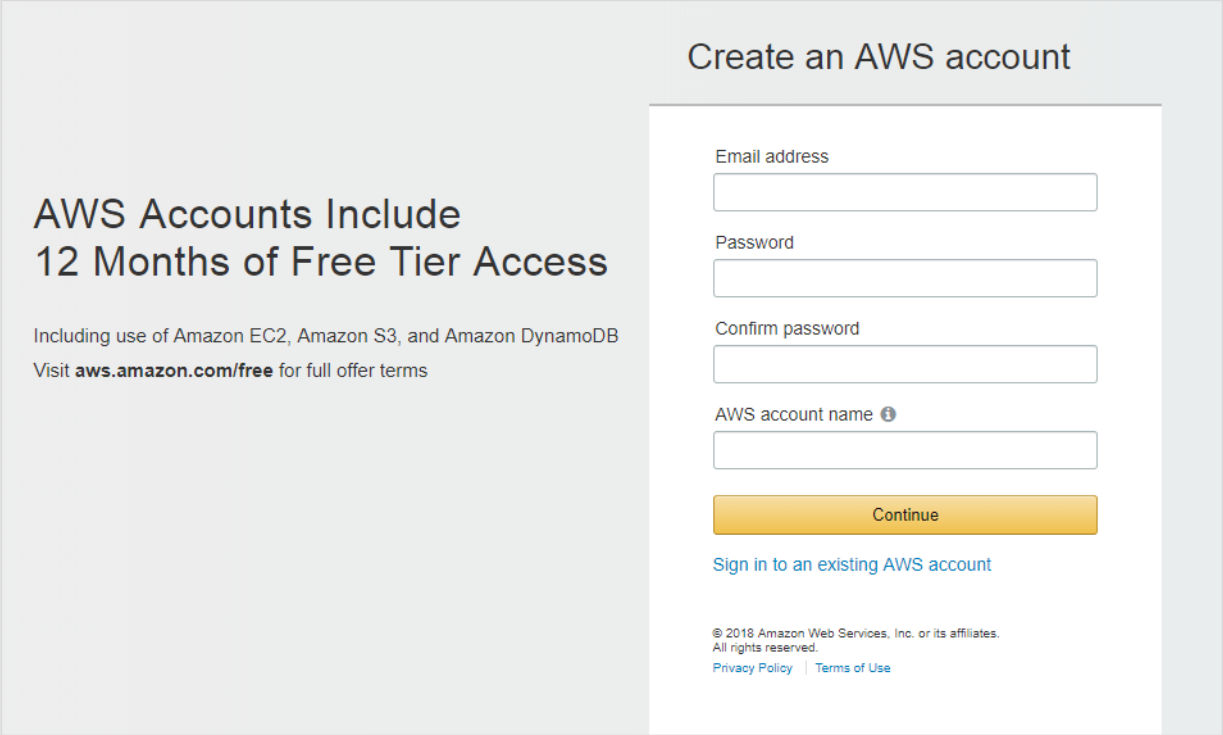
Create login in AWS Console

You can create your login in AWS Console for free using Amazon free tier. You can follow these steps given below to create a login with amazon to make use of the Amazon services:

Step 1

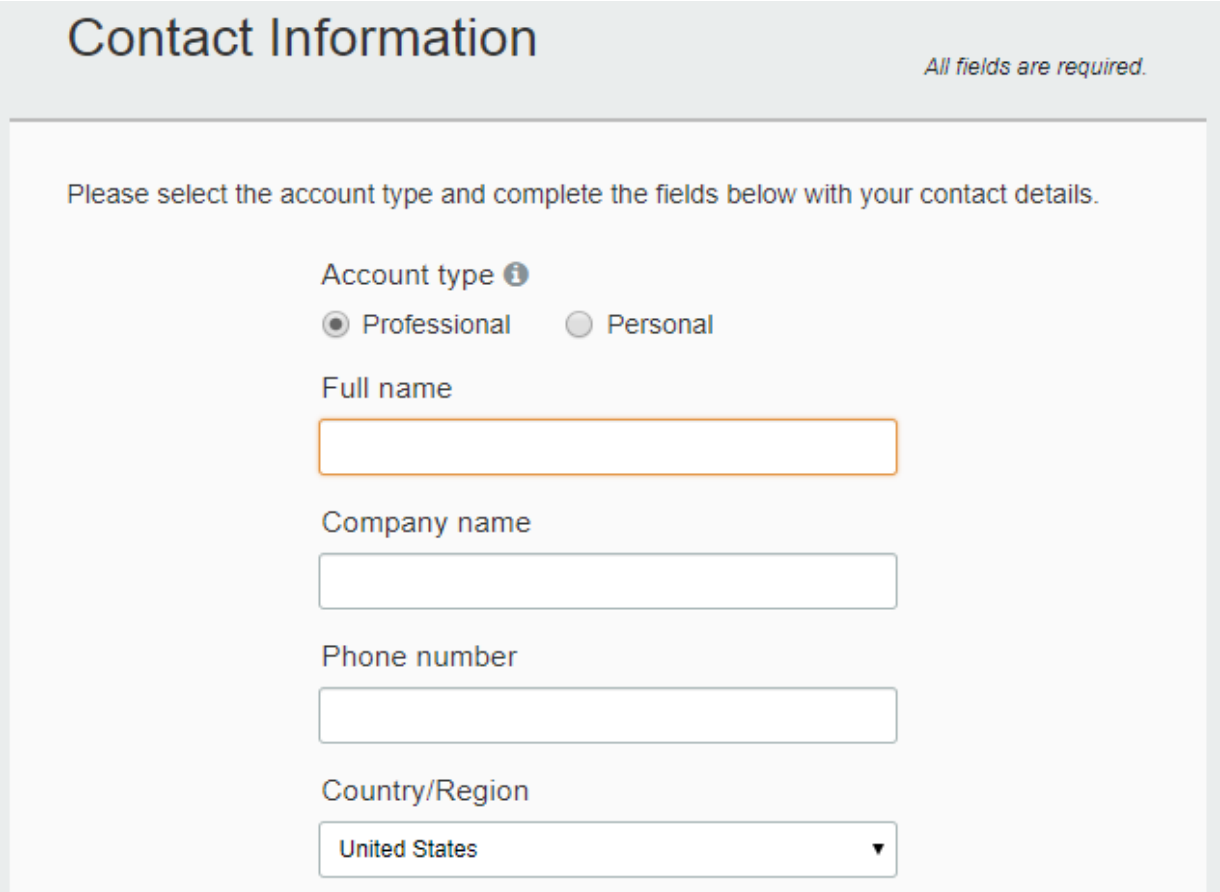
Go to https://aws.amazon.com/free/ and click on create free account. You can see the screenshot as given below:

Step 2
Click on **Create a Free Account** button and you will be redirected to the screen as shown below:



Now, fill in the details of email address, password and AWS account name as per your choice in this form shown above and click **Continue**.

Step 3
Now, you can find the screen as shown below:



Enter all the required details in this form.

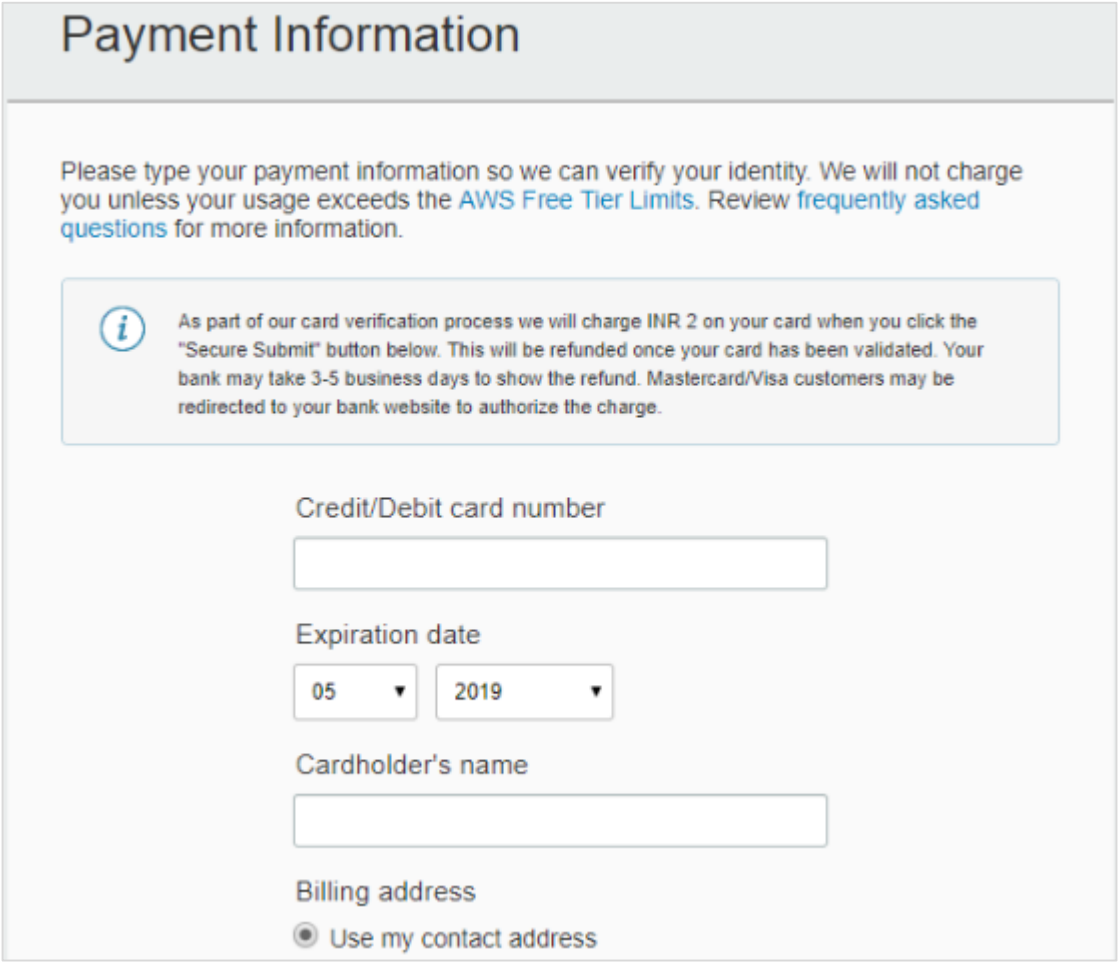
Note that there are minimum charges to be paid based on country selected. The same is refunded once the details entered are validated. You need credit or debit card details to create the free account. For Indian users **Rs 2/-** is deducted and for US **$1** is charged.The same is refunded to the respective card user once the user is validated.

Please note the account is free and there is limit to the usage of the services. If the usage exceeds the limit, the user will be charged for it.

Once the details are entered in the form shown above click **Create Account and Continue.**

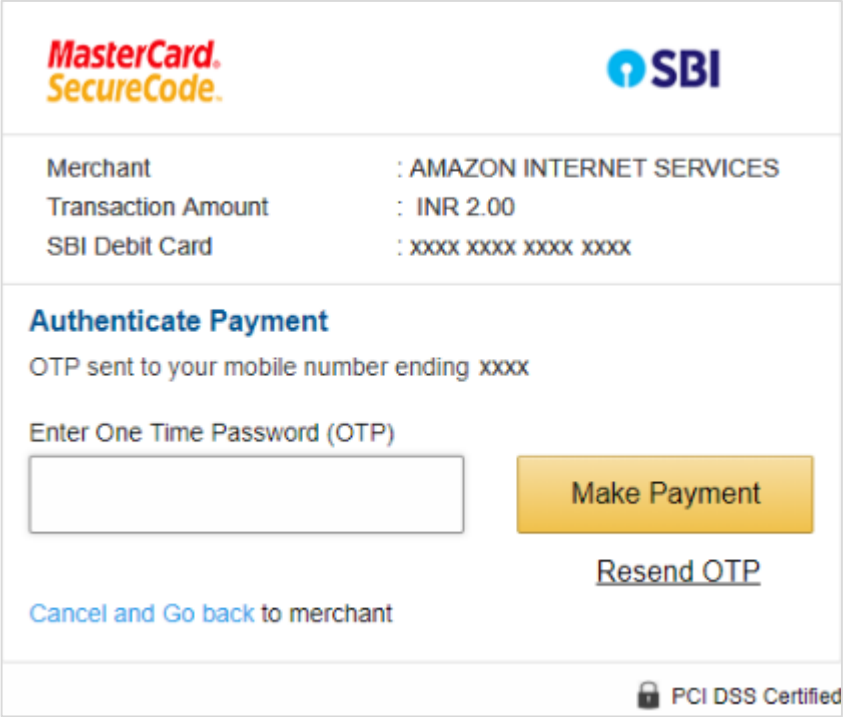
You will be redirected to the next screen as shown below.

Step 4
You need to enter the payment details, that is either credit card or debit card, along with its expiry date and the card holder's name as shown below:



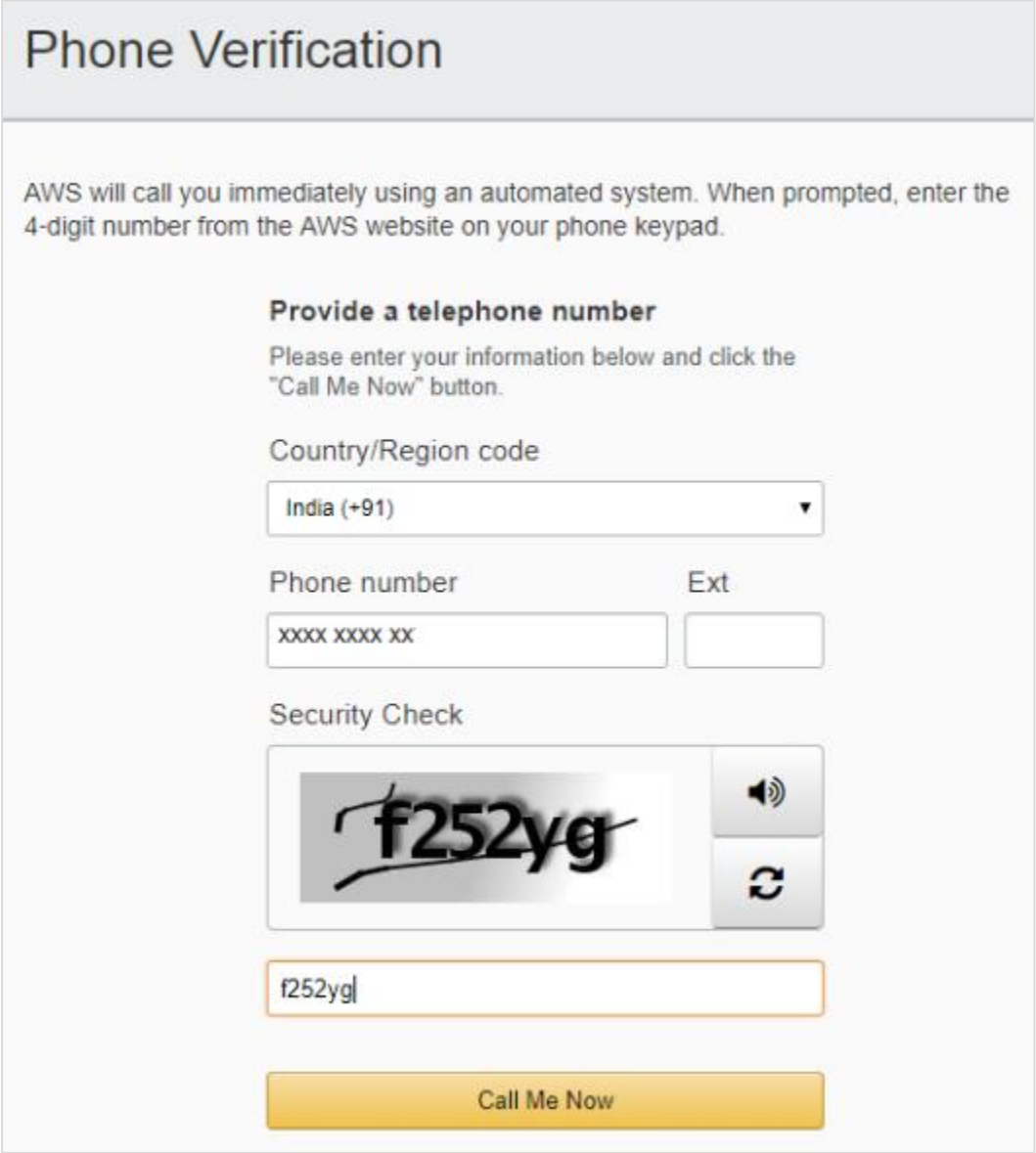
Step 5

Once all the details are entered, click **Secure Submit** and it will validate the card with the bank and will give you the **OTP** on your mobile which is linked with the card. You can find a window as shown below:



Now, enter the **OTP** details and click **Make Payment.**You are charged based on the country selected.

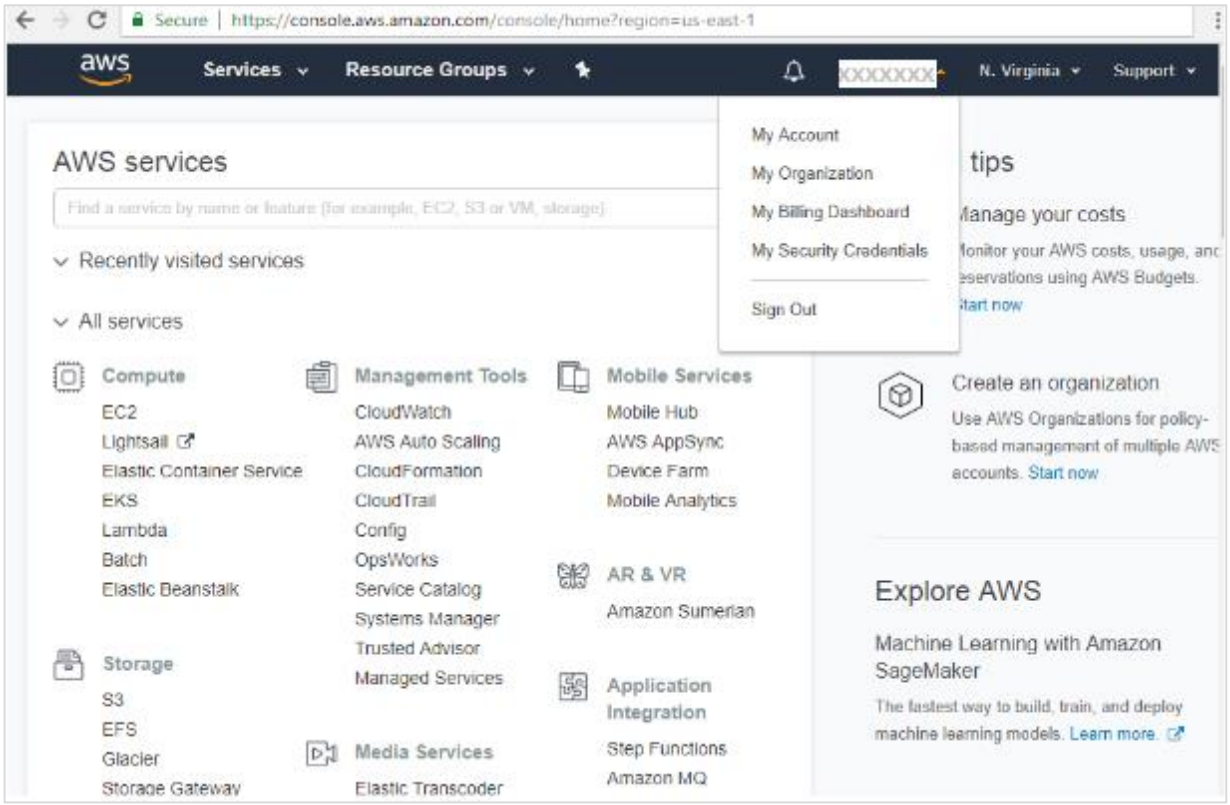
Step 6
Once the payment is done the next step is phone verification.You need to enter your mobile number as shown below:



Once details are filled click **Call Me Now**. AWS will call immediately using automated system. When prompted on call, enter the 4-digit number that will appear on your AWS site to your phone using your phone keypad. This will verify your number and you will get the mail activation in the mail id specified at the start while creating login.

Step 7

Click the mail link and enter the account name or email id and the password and login to you to the AWS services as shown below:

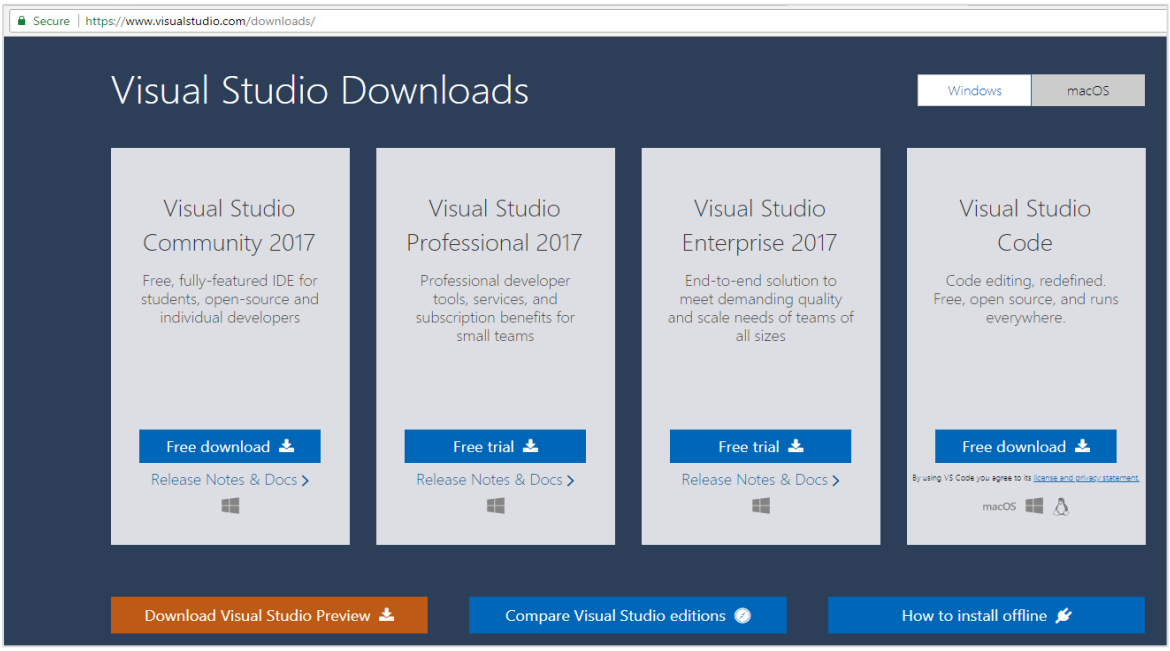


The account name is displayed at top right corner as shown above. You can now start using the AWS Lambda service. For AWS Lambda service the languages supported are NodeJS, Python, Java, C# and Go.

Installation of Visual Studio 2017

There are 2 IDEs compatible with AWS: **Visual Studio** and **Eclipse**. In this section, we will discuss installation of Visual studio 2017 on Windows, Linux Mac. Go to the official site of Visual Studio : https://www.visualstudio.com/downloads/. You can find the welcome screen as shown:

Download the community version ie **Visual Studio Community 2017** as its a free now for practice. Once installed, it will run you through the installation steps where you need to select packages to be used later. You can select **nodejs**, **python**, **c#** package for us to work later.

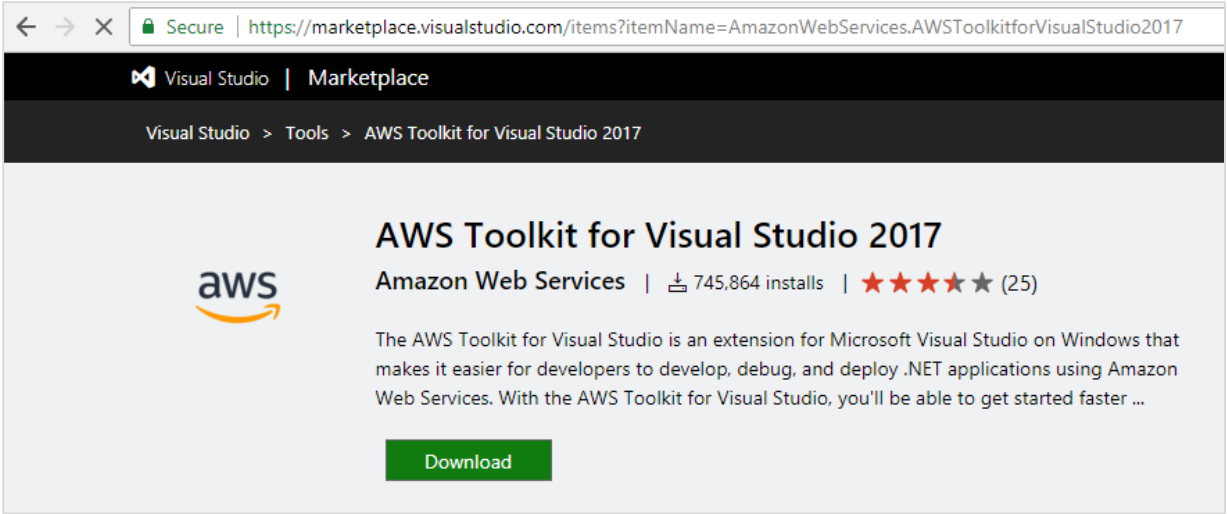


AWS Toolkit Support for Visual Studio 2017

Once you have Visual Studio 2017 installed, you will have to follow the given steps for installing AWS Toolkit support for Visual Studio 2017:

Step 1

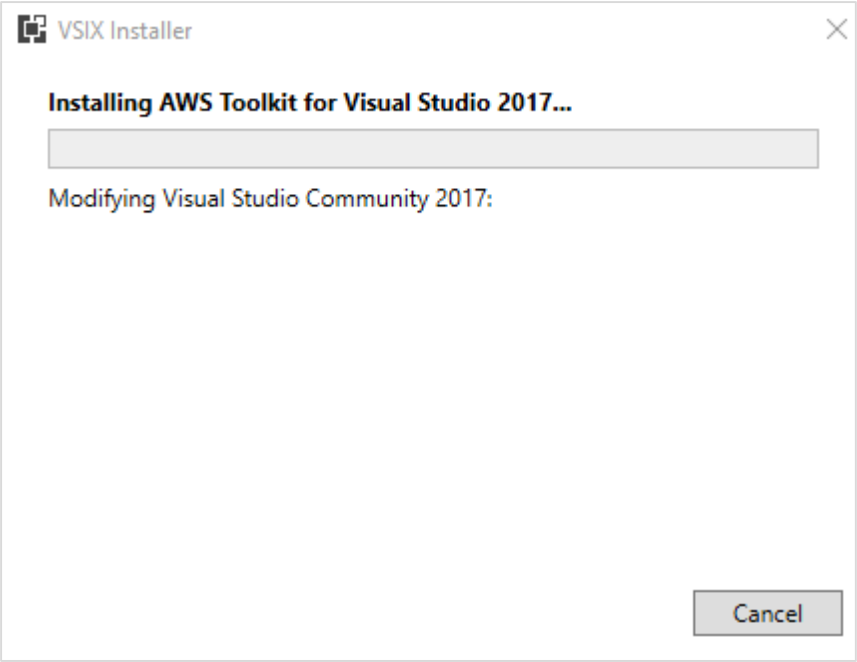
Go to https://aws.amazon.com/visualstudio/ and download the AWS toolkit for Visual Studio. The display is as shown below:



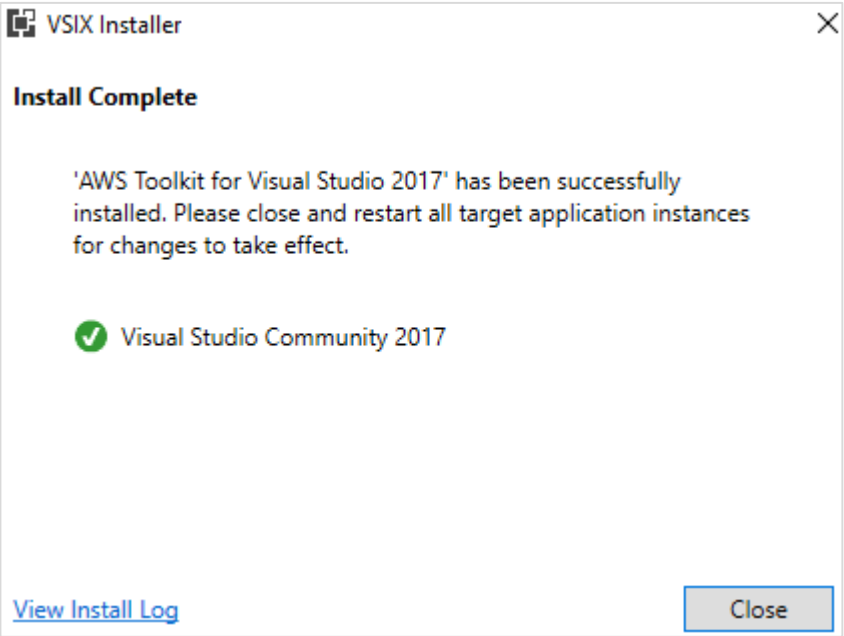
Note that the package downloaded for Visual Studio 2017 is **vsix** package. If your visual studio version is between 2013-2015, it will install a **msi** installer. Click the **Download** button as shown below.

Step 2

Now, double click the vsix package downloaded and it will run you through installation steps as shown below:

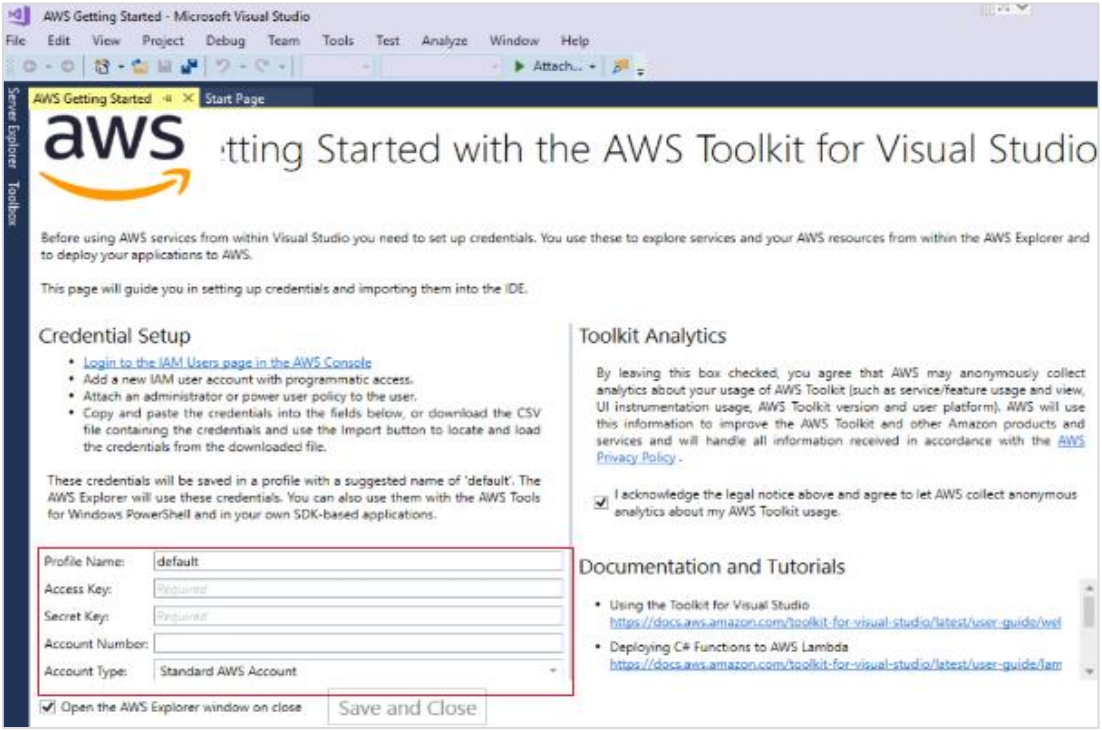


Once Visual Studio is successfully installed, you can see a window, as shown below:



Step 3

Now, open Visual Studio 2017 and you should see a welcome page from AWS as shown below:



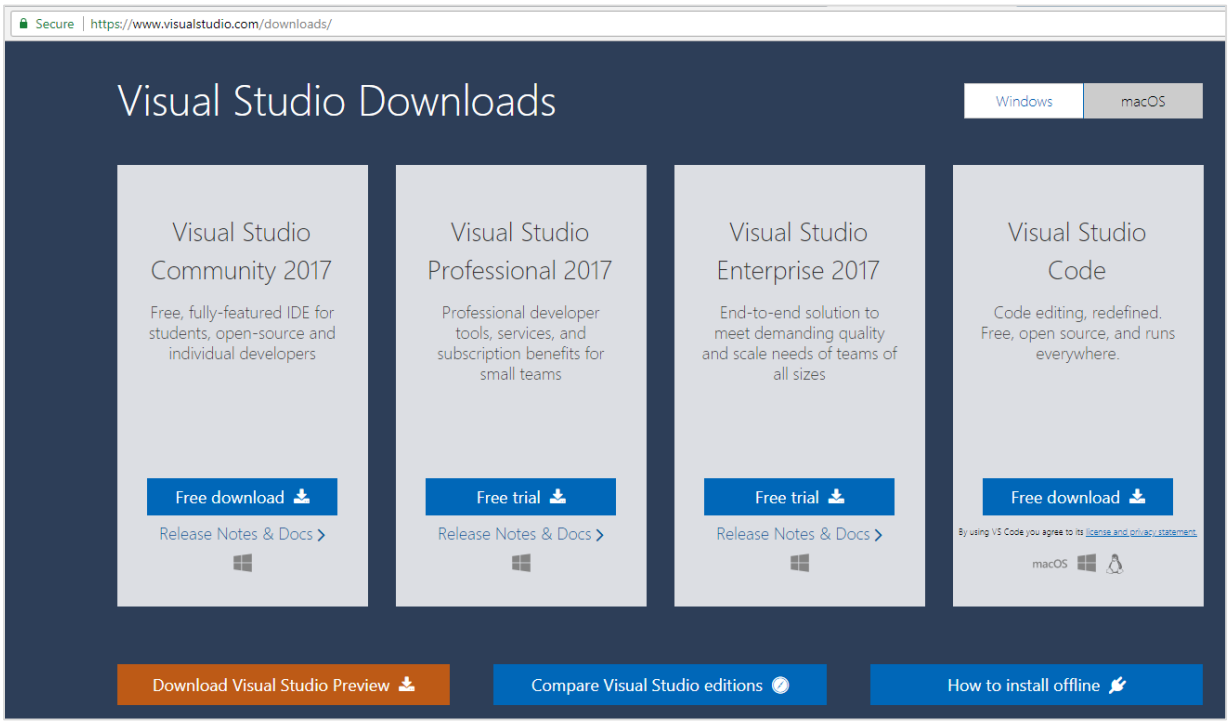
Note that you need to add the access key, secret key, account number to get started and use the AWS services from visual studio.s

AWS Lambda BoilerPlate for NodeJS

You can use it with **visual studio code** as shown below.

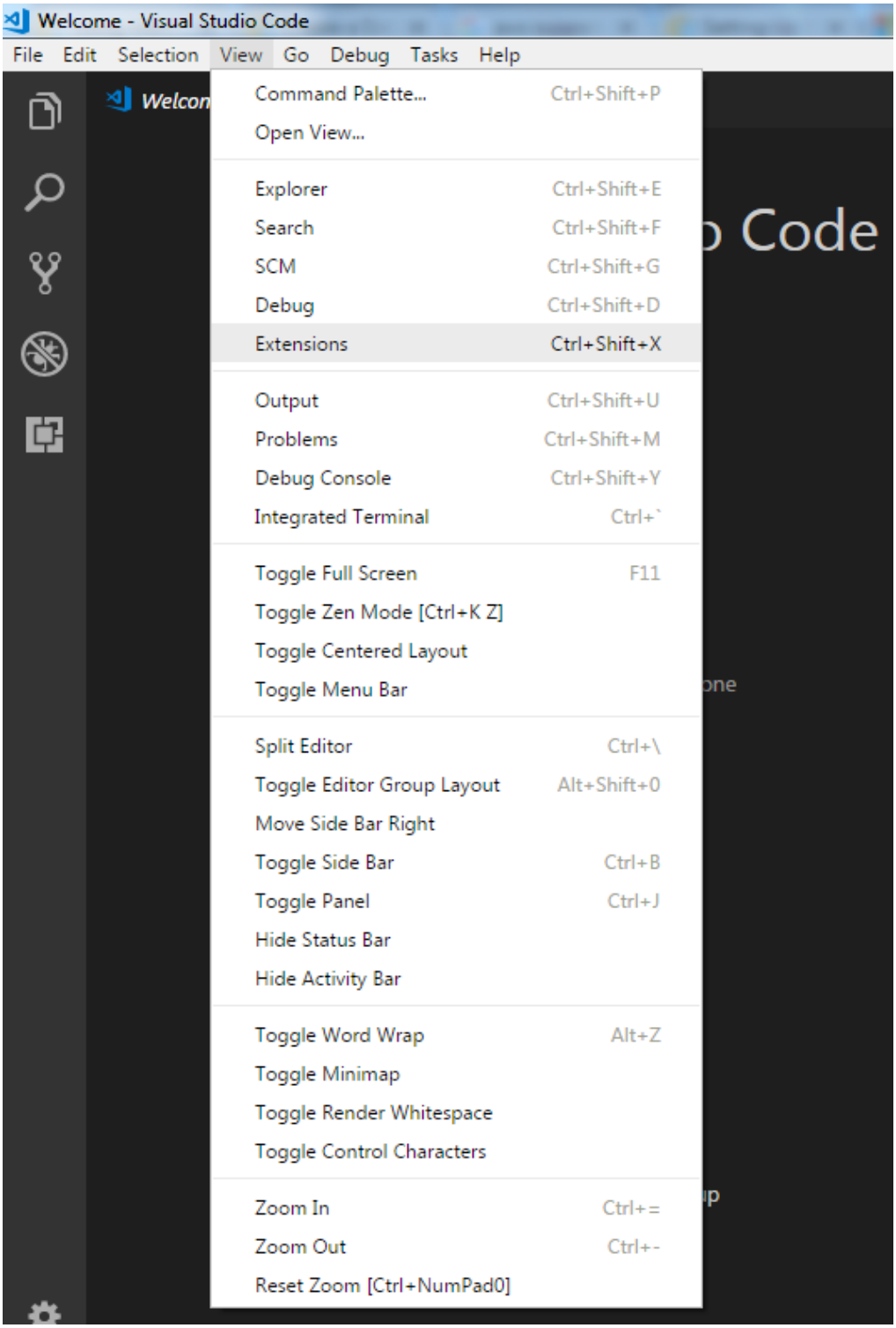
Step 1

You can download **Visual studio code** for free from the official website*:*https://www.visualstudio.com/downloads/. The home page of Visual Studio downloads looks like this:



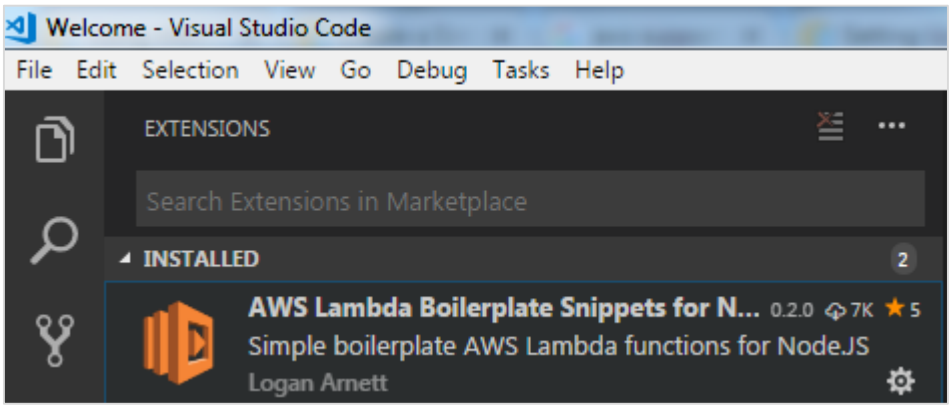
Step 2
Now, open Visual Studio code as shown below:

T



Step 3

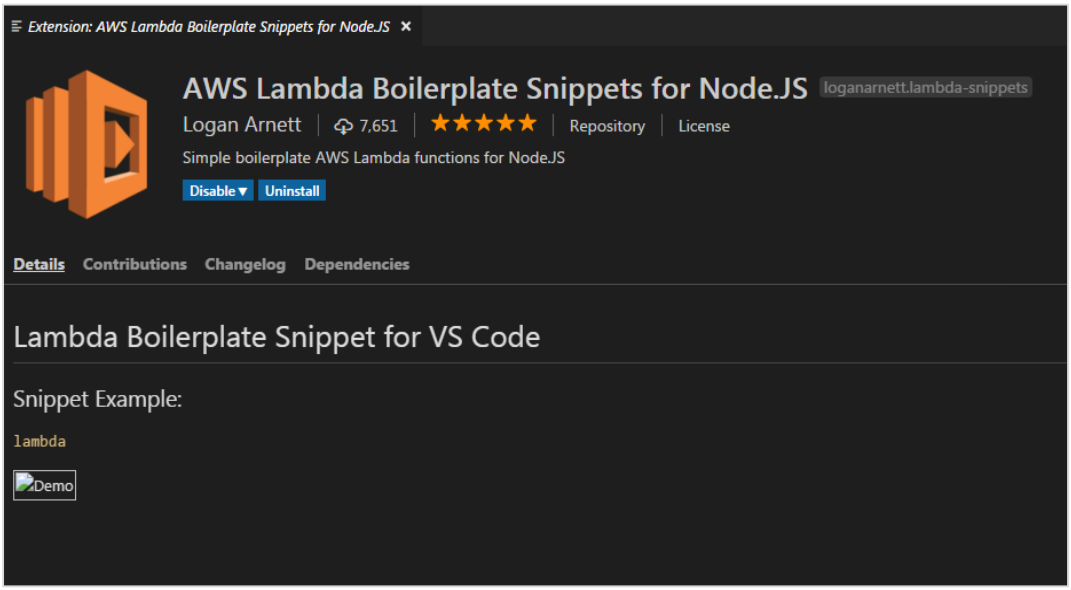
To install support for AWS, **support for nodejs** option is available inside



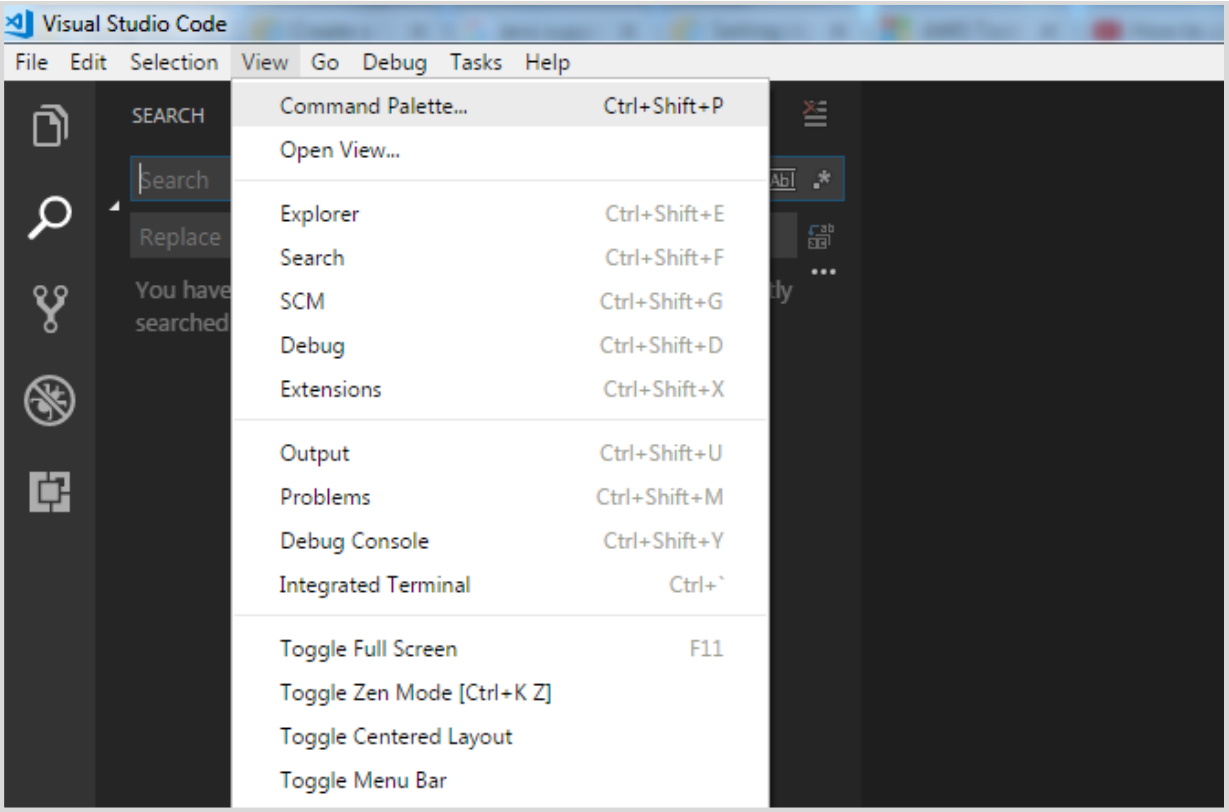
extensions. You can search for AWS and it will display the option as follows:

Step 4

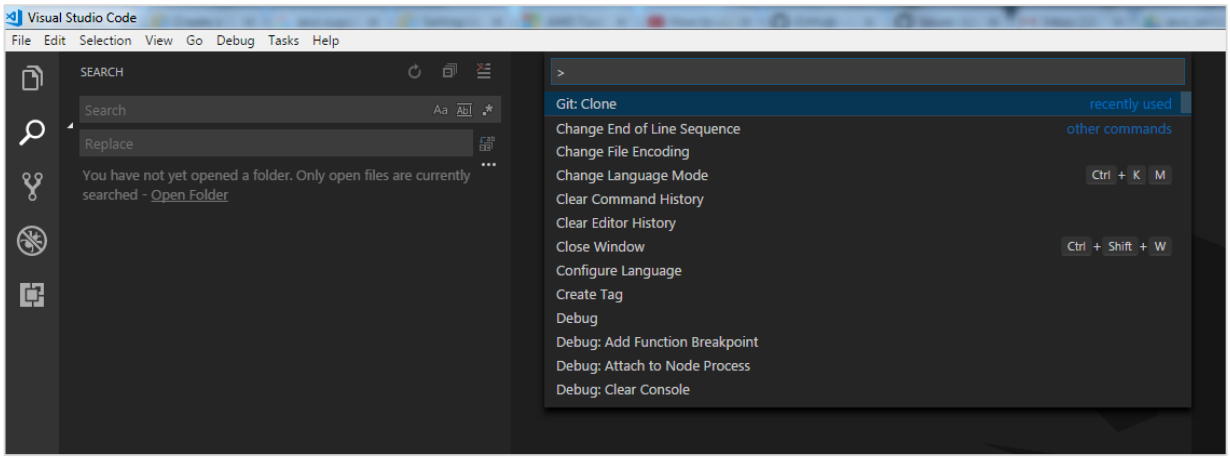
Now, install the boilerplate for AWS Lambda in **nodejs** as shown:



Step 5
Click the repository and clone it in Visual Studio to start writing the Lambda function in Visual Studio. It redirects you to this repository which we can clone in Visual Studio : https://github.com/loganarnett/vscode-lambda-snippets. Now, open command palette from **View** option in Visual Studio.

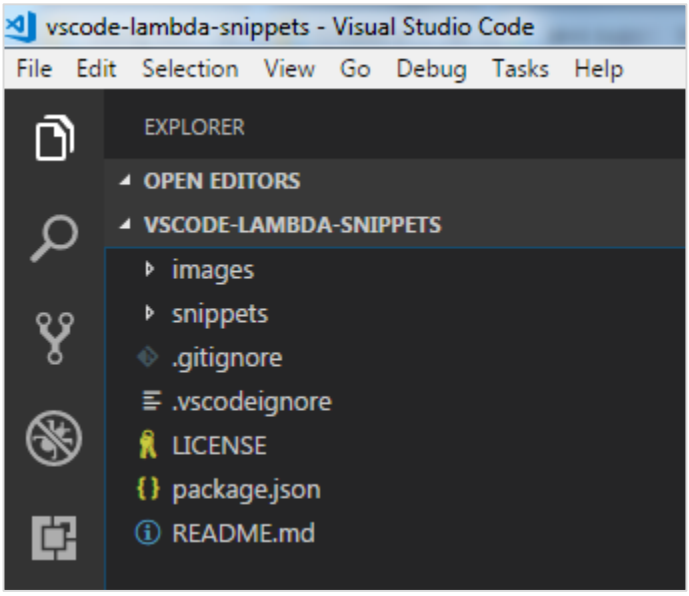


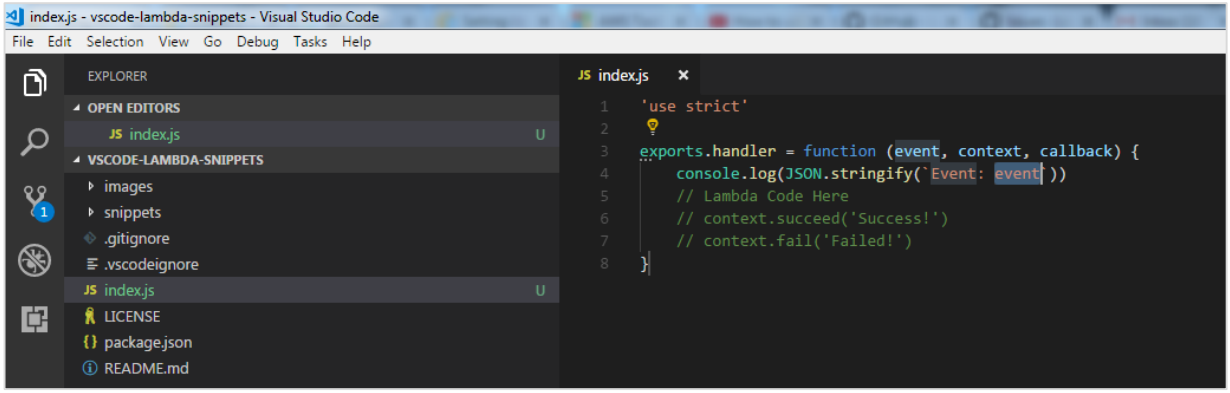
Step 6
Click on it and choose git clone as shown below:



Step 7

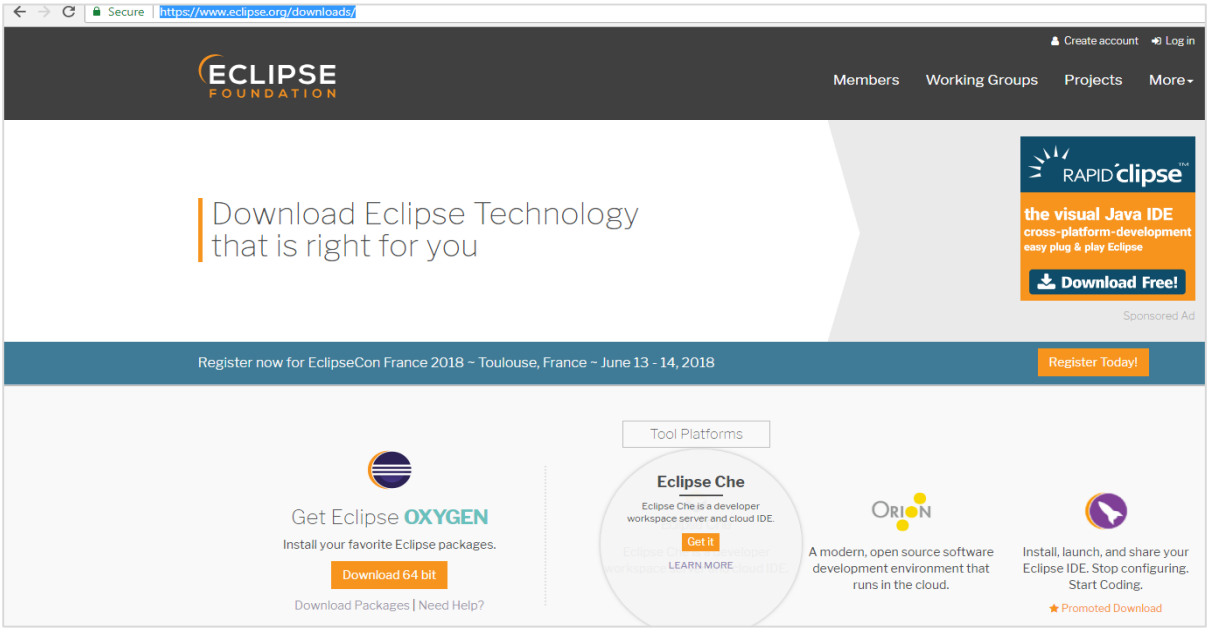
Enter the repository url and save it as per your choice locally. Create **index.js** file as shown below to work with lambda function:

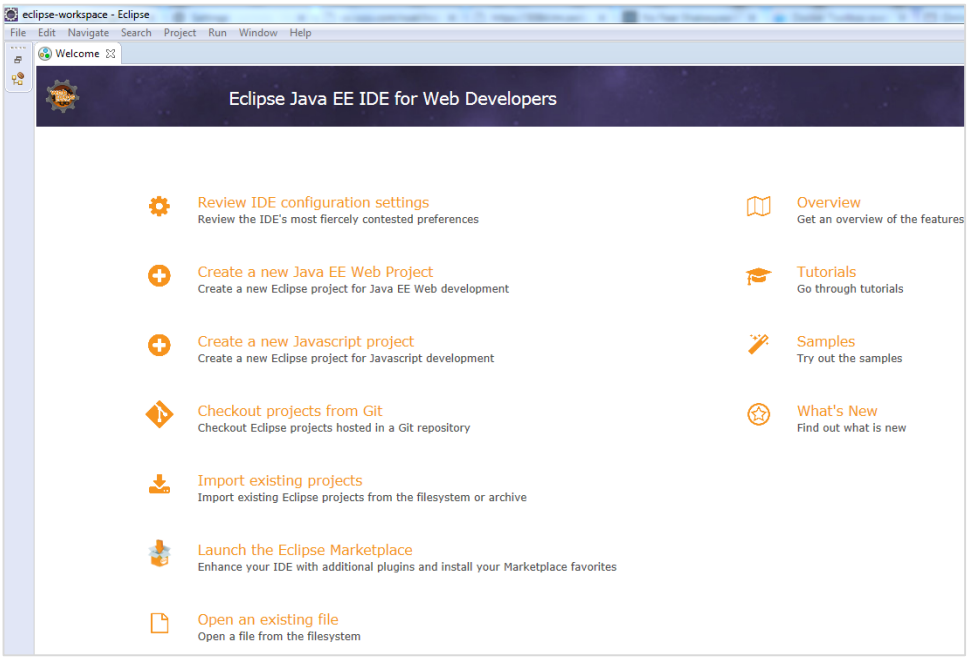



index.js - vscode-lambda-snippets - Visual Studio Code
File Edit Selection View Go Debug Tasks Help
EXPLORER
OPEN EDITORS
index.js U
VSCODE-LAMBDA-SNIPPETS
images
snippets
.gitignore
.vscodeignore
index.js U
LICENSE
package.json
README.md
index.js
'use strict'
exports.handler = function (event, context, callback) {
console.log(JSON.stringify(`Event: event`))
// Lambda Code Here
// context.succeed('Success!')
// context.fail('Failed!')
}

Installation of Eclipse IDE

Now, you will have to install latest eclipse Java EE IDE.You can download it from Eclipse official site: https://www.eclipse.org/downloads/





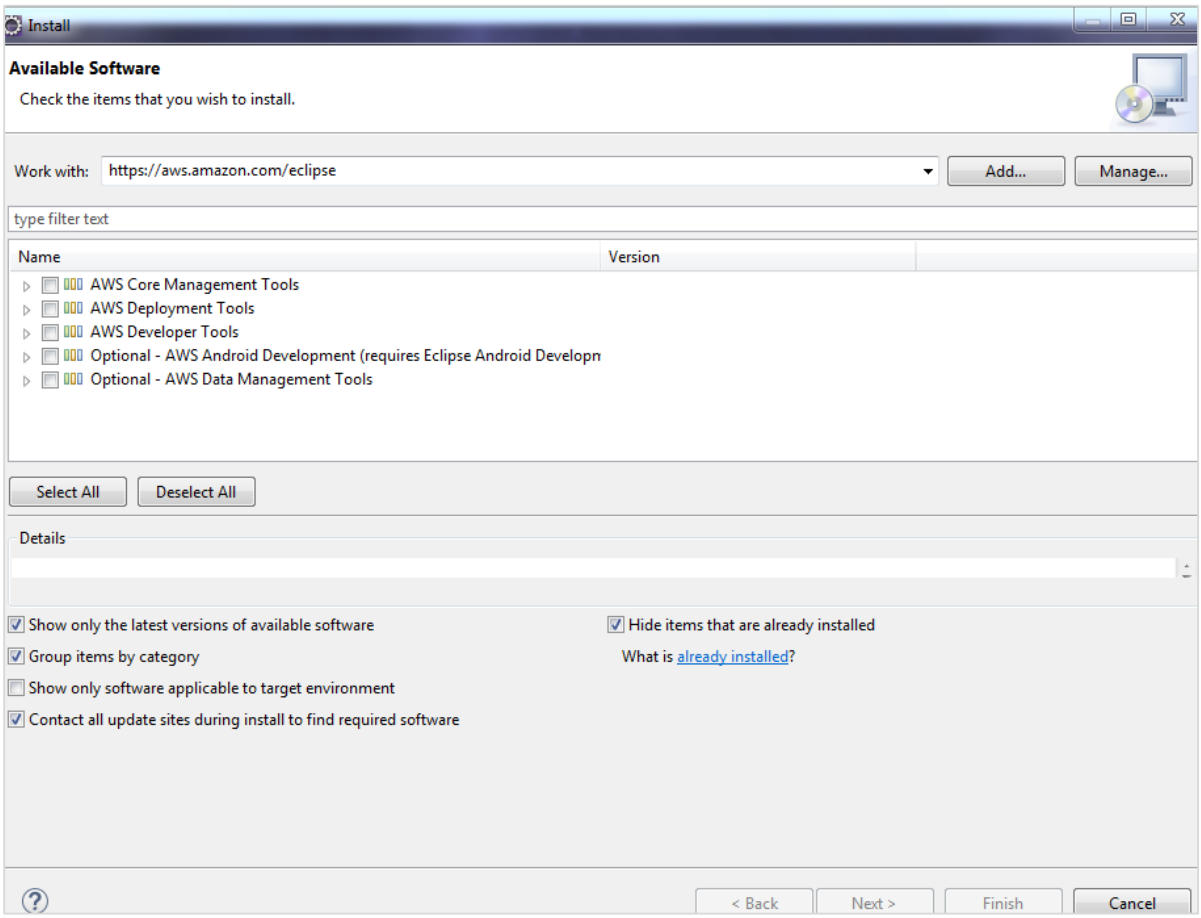
AWS Toolkit Support for Eclipse IDE

Once Eclipse is installed, perform the following steps:

Step 1
Go to help from the menu and click **Install New Software.**

Step 2
Enter https://aws.amazon.com/eclipse in the text box labeled **Work with** at the top of the dialog.

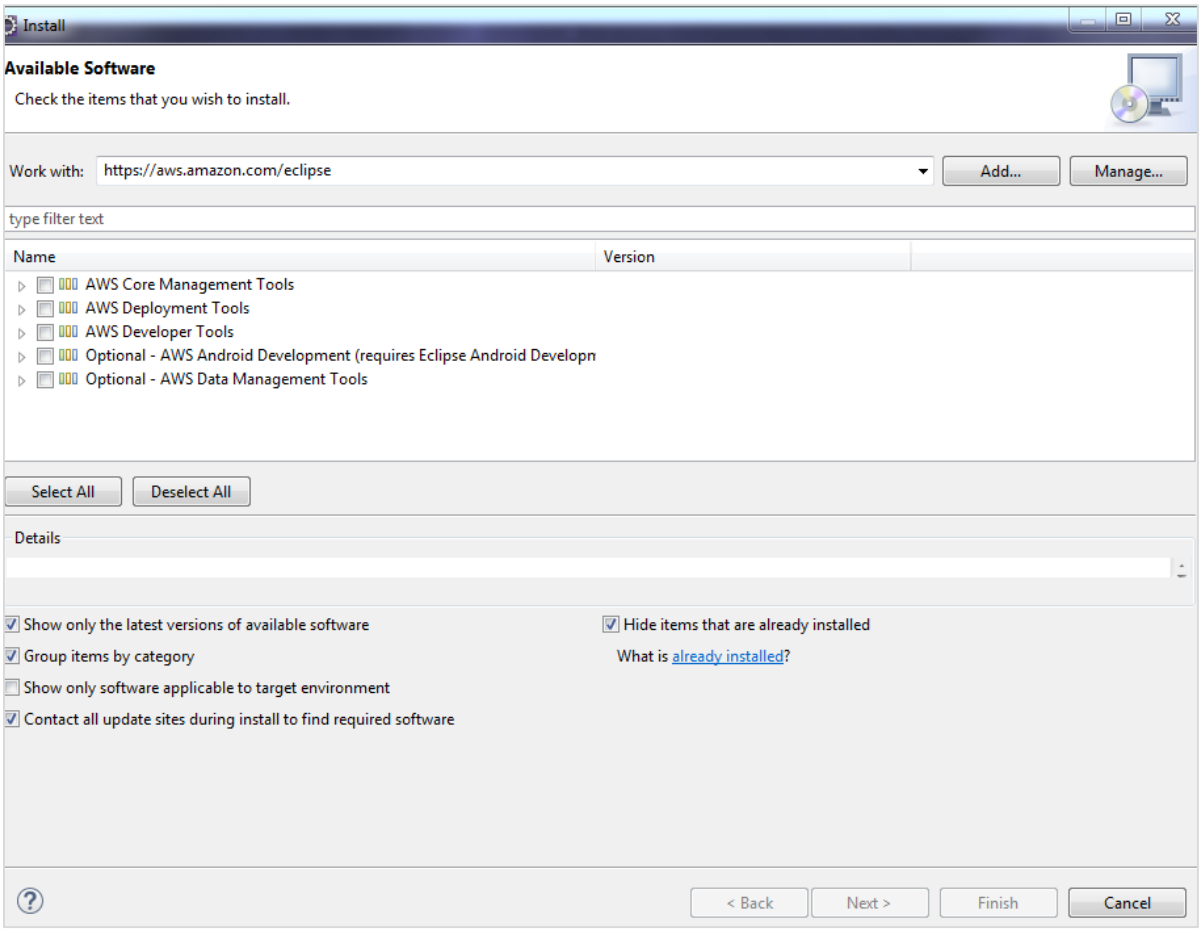
Step 3
Now, select the required **AWS Core Management Tools** and other optional items from the list shown below.



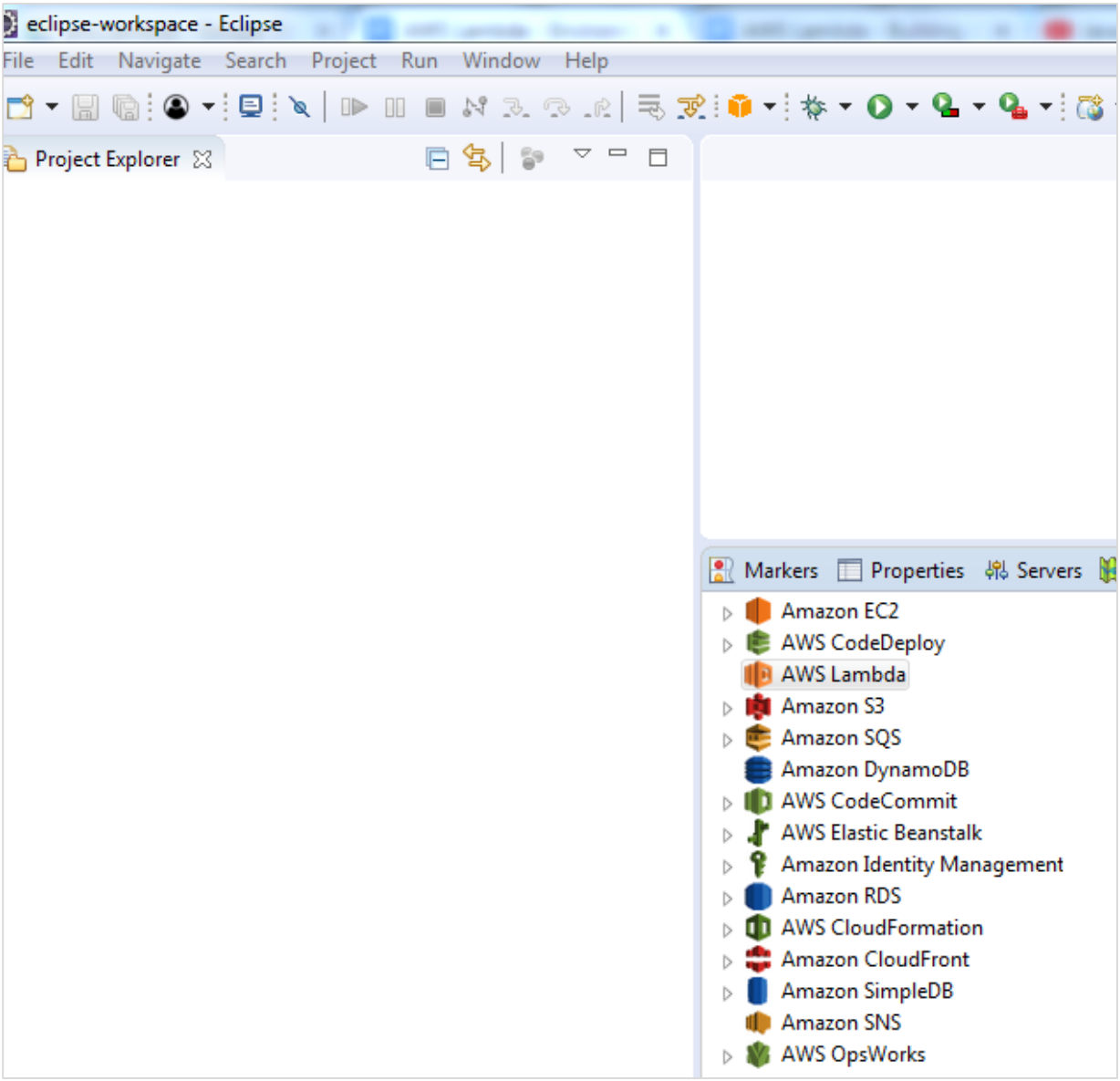
Step 4
Now, click **Next.** Eclipse will guide you through the remaining installation steps as given in the further steps given below.

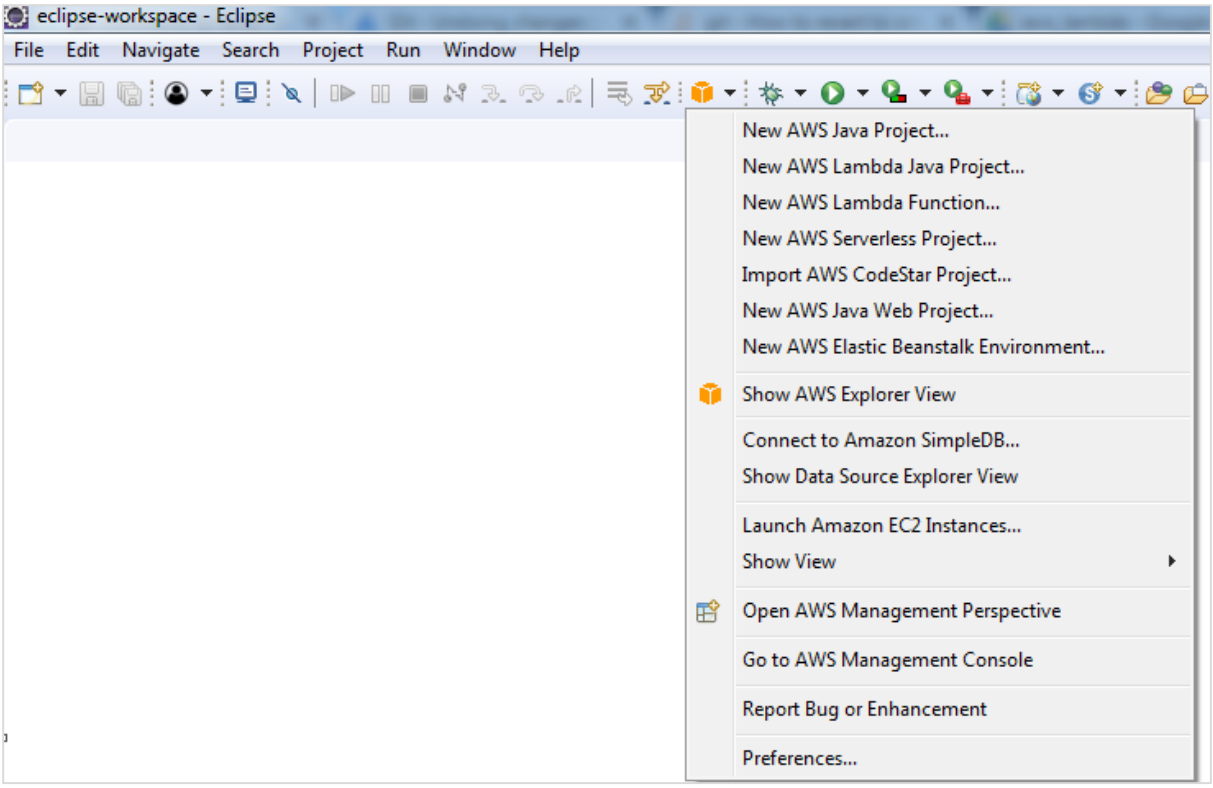
Step 5

The AWS core modules are displayed in the grid below as shown in the screenshot given below:

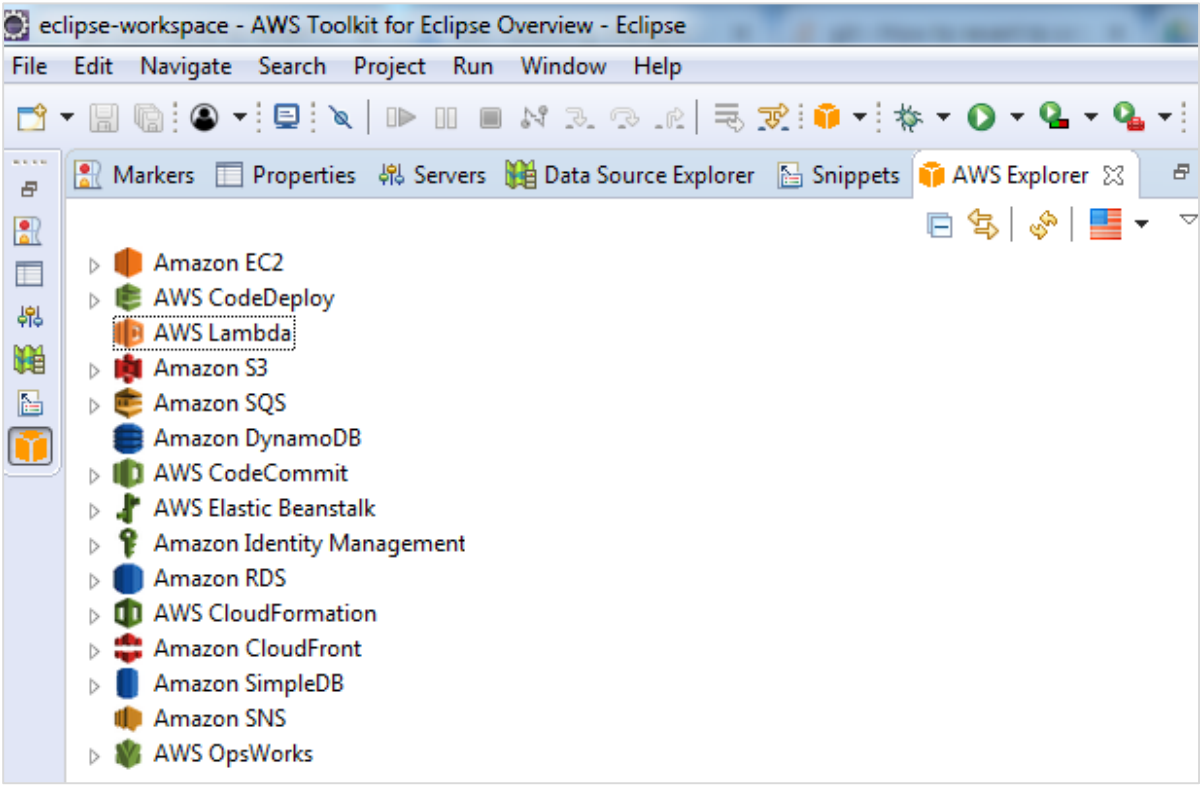


Step 6
Once installed the AWS tool will be available in Eclipse as shown below:




eclipse-workspace - Eclipse
File
Edit
Navigate
Search
Project
Run
Window
Help
New AWS Java Project...
New AWS Lambda Java Project...
New AWS Lambda Function...
New AWS Serverless Project...
Import AWS CodeStar Project...
New AWS Java Web Project...
New AWS Elastic Beanstalk Environment...
Show AWS Explorer View
Connect to Amazon SimpleDB...
Show Data Source Explorer View
Launch Amazon EC2 Instances...
Show View
Open AWS Management Perspective
Go to AWS Management Console
Report Bug or Enhancement
Preferences...

Step 7
You can see the following screen when you click on the Amazon service.



Now, click on AWS Explorer to see the services available. We shall discuss how to work with the installed IDE in upcoming chapters.

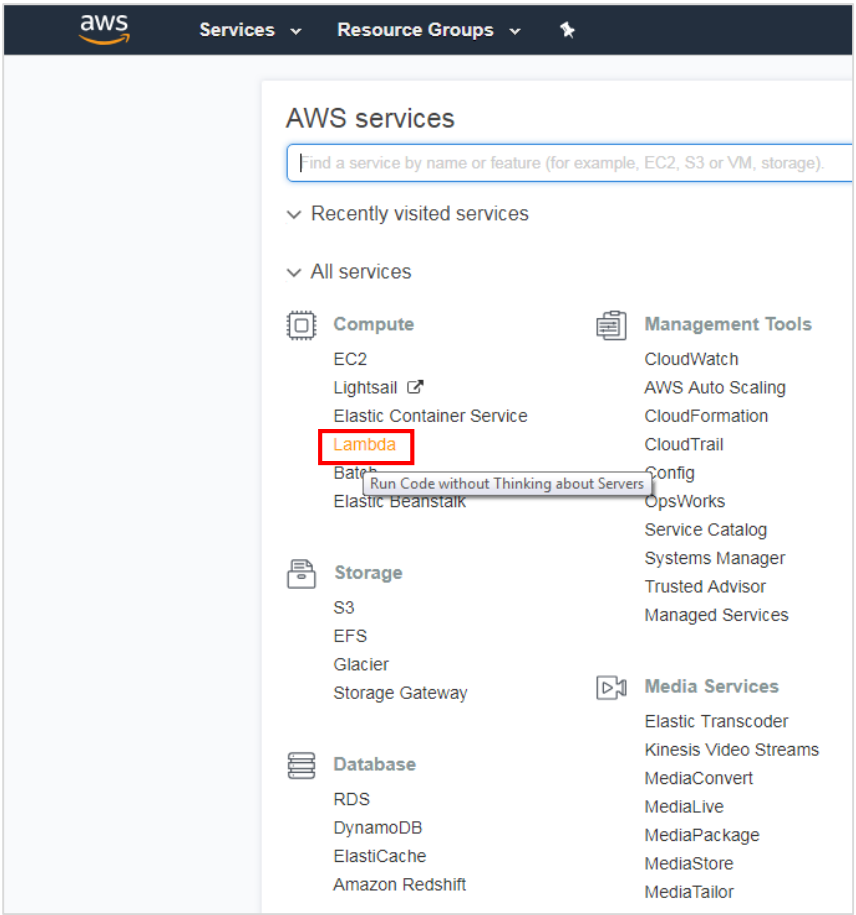
3. AWS Lambda — Introduction

AWS Lambda is a service which takes care of computing your code without any server. It is said to be serverless compute. The code is executed based on the response of events in AWS services like adding /removing files in S3 bucket, updating Amazon DynamoDB tables, HTTP request from Amazon Api gateway etc.

AWS Lambda code can be written in NodeJS, Java, C#, Python and Go. This chapter will talk in detail about creating AWS Lambda function in AWS console.

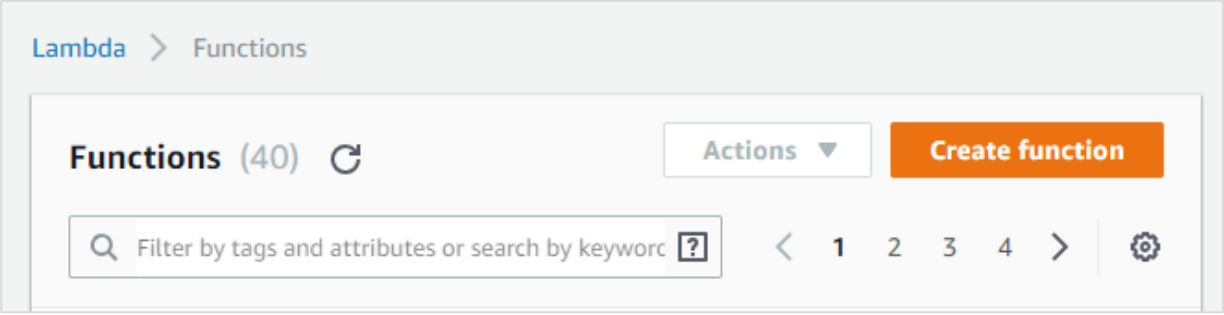
AWS Console

Login to AWS Console at the link **https://aws.amazon.com/console.**Once you login into it, it will redirect you to the screen where AWS services are displayed.

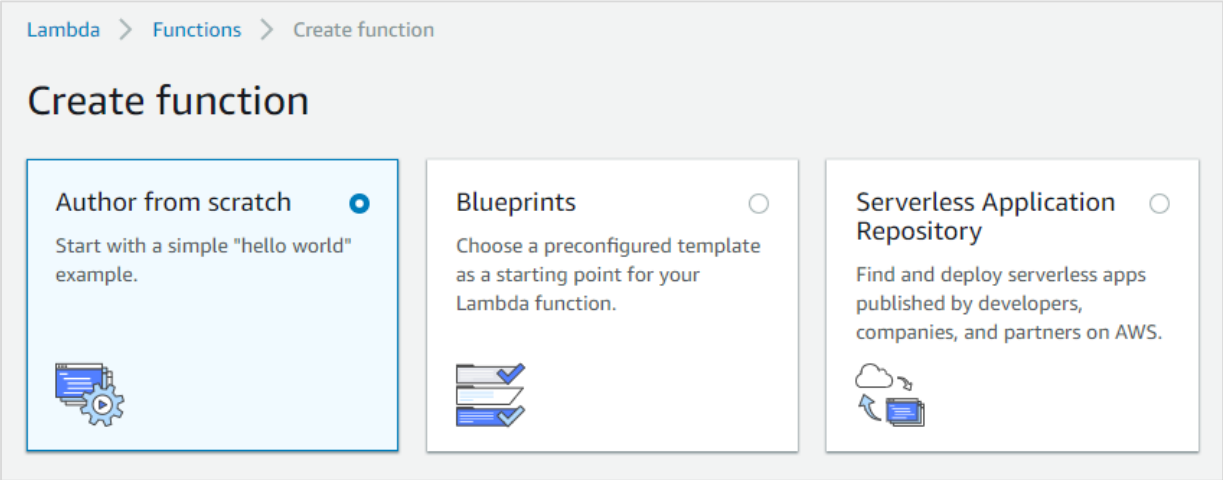


Example: Creating a Function

Let us understand the functionality of AWS Console with the help of an example. Click on Lambda (marked above), it will redirect to create function as shown below:

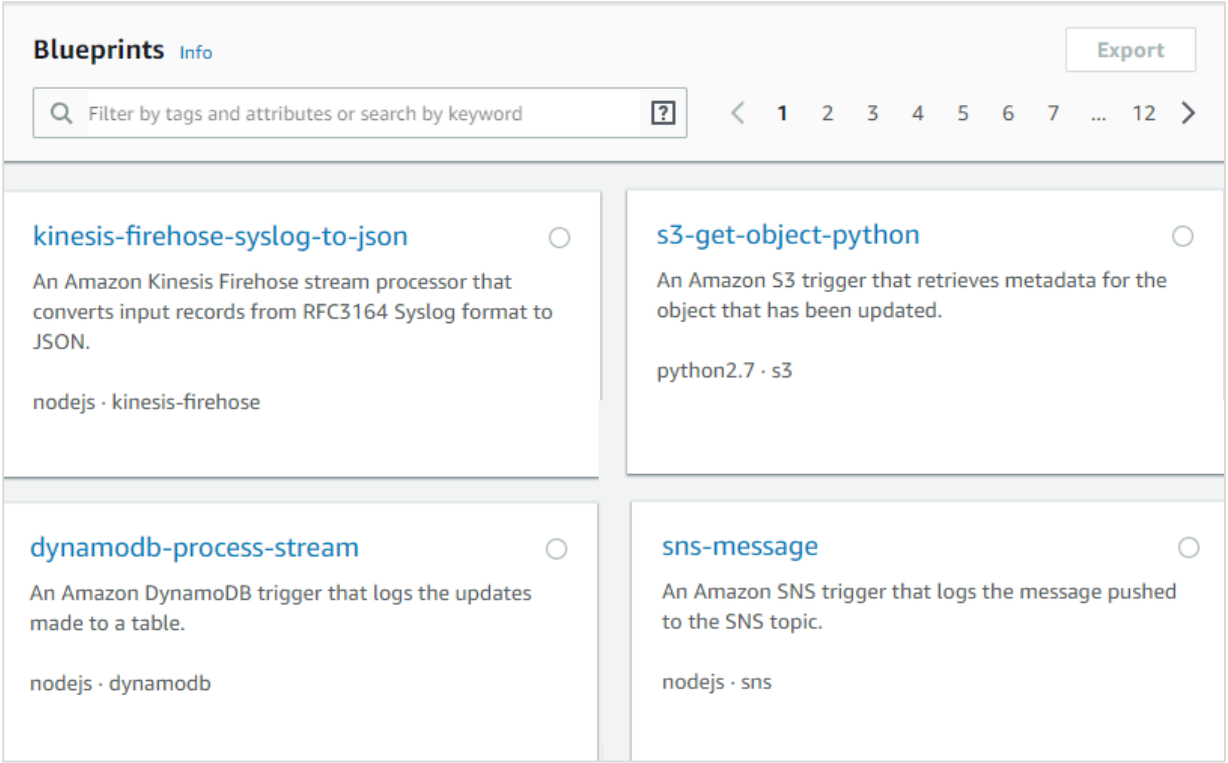


Click **Create function** button and the screen displays following details:



Note that, by default, the option is **Author from scratch.** This option lets you to write the Lambda code from scratch.It will just have a simple function with **helloworld** message.

The second option **Blueprints** has following details.



It gives details of code already written for some of the aws services in languages available with AWS Lambda. In case you need to write AWS Lambda code for any services you can check in **blueprints** and get started.

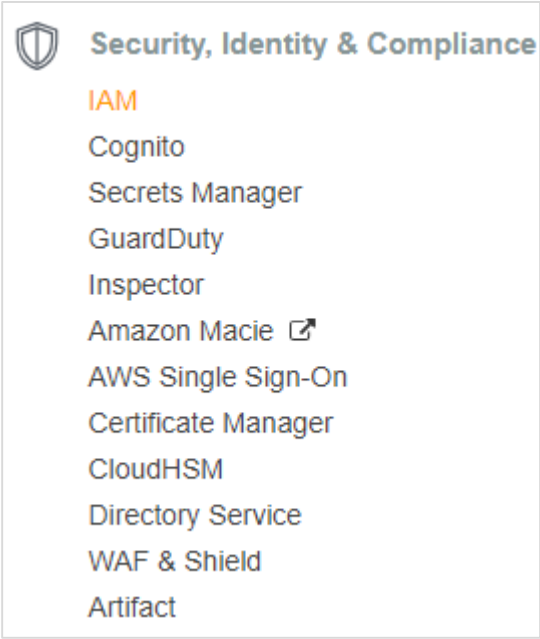
The third option **Serverless Application Repository** has the setup of serverless application which will help to deploy the AWS Lambda code.

In the discussion futher, we will work on the first option where we create the AWS lambda function using **Author from scratch.**

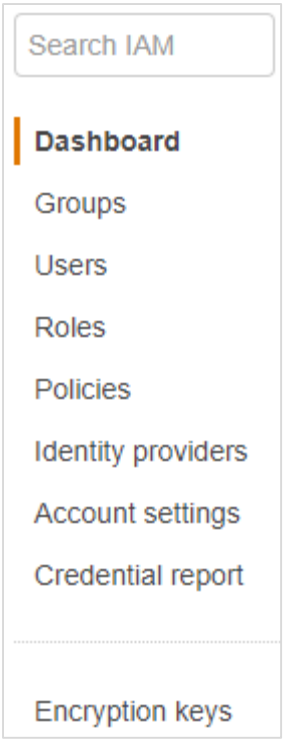
Before we create Lambda function, will need a role i.e, permission for working with AWS services and aws lambda. Later the Role has to be assigned to aws lambda function.

Role creation in AWS Console

For creating a role in AWS Console, go to AWS console services and click on IAM as shown below:

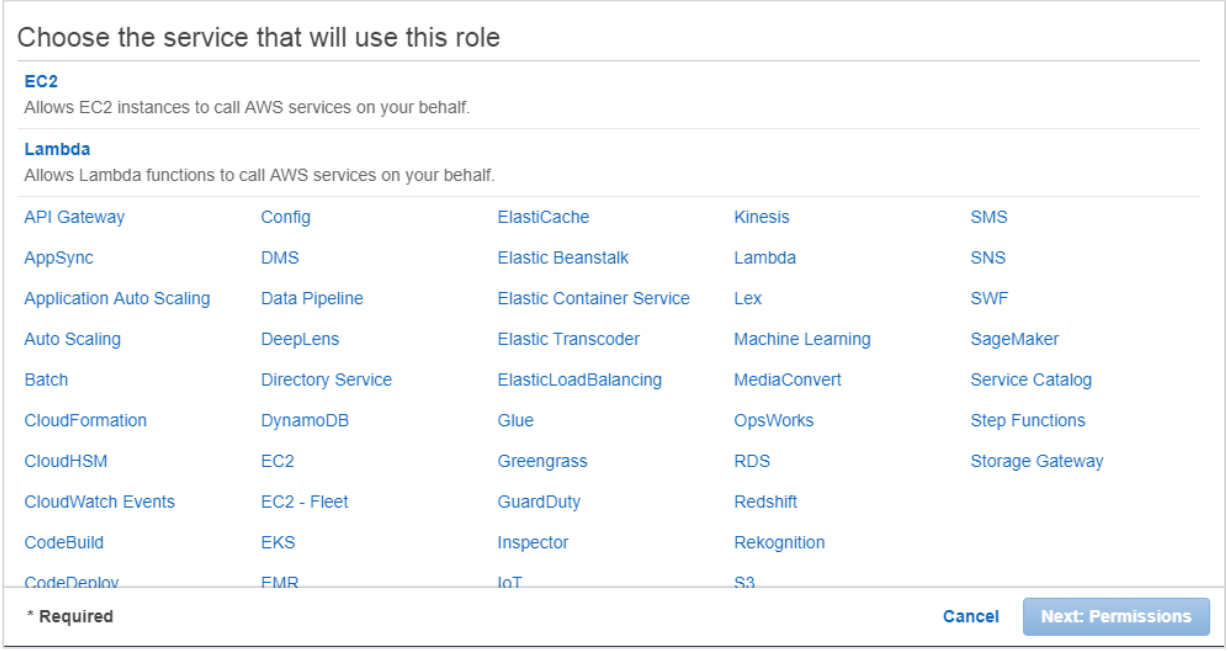


Now, if you click **IAM**, you will the screen as shown below:

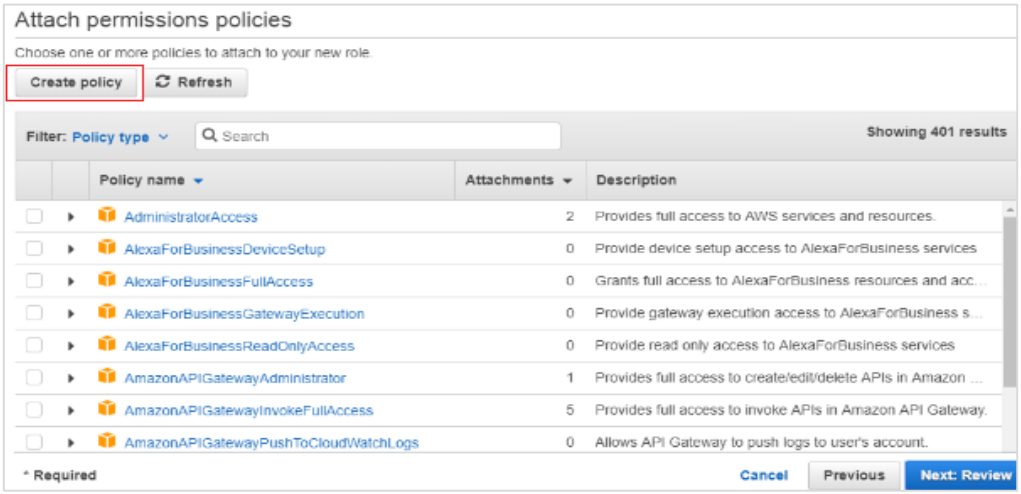


If you select **Roles,** you can see the following buttons on the screen:

Now, click **Create role.**It will ask you to choose the service where you need to use the role created.



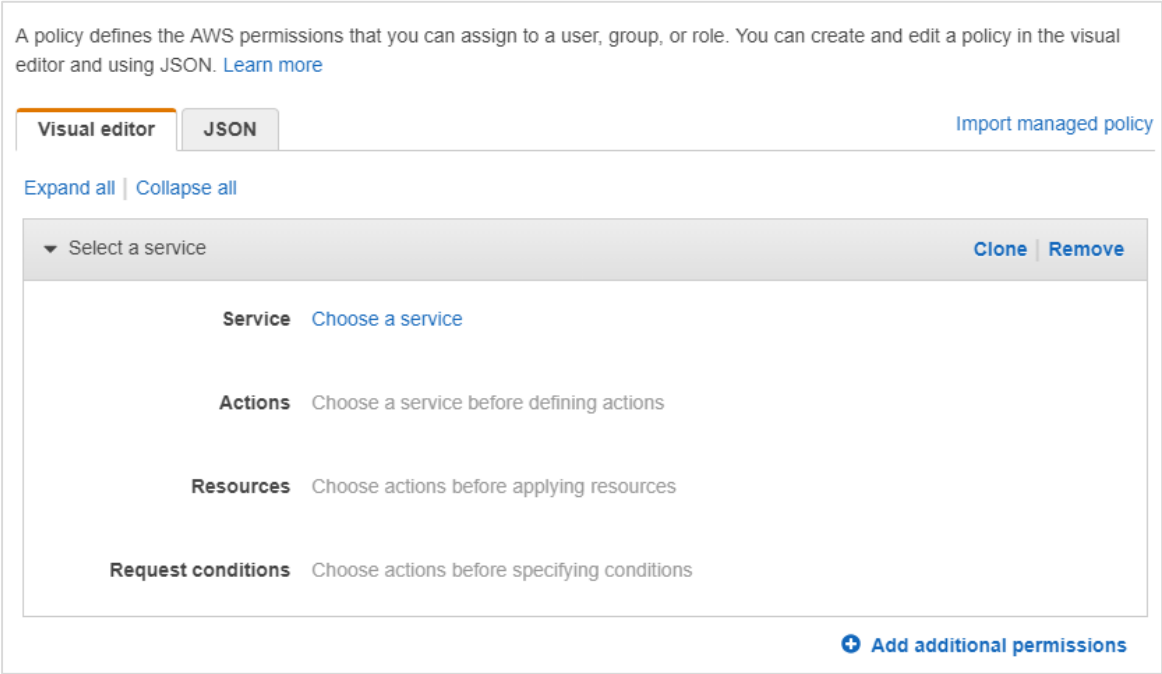
Since we need to use this role with AWS Lambda , select **Lambda** and click **Next:Permissions** button as shown above. The next screen displays the policy name which is available as per AWS services.You can select the policy from here:



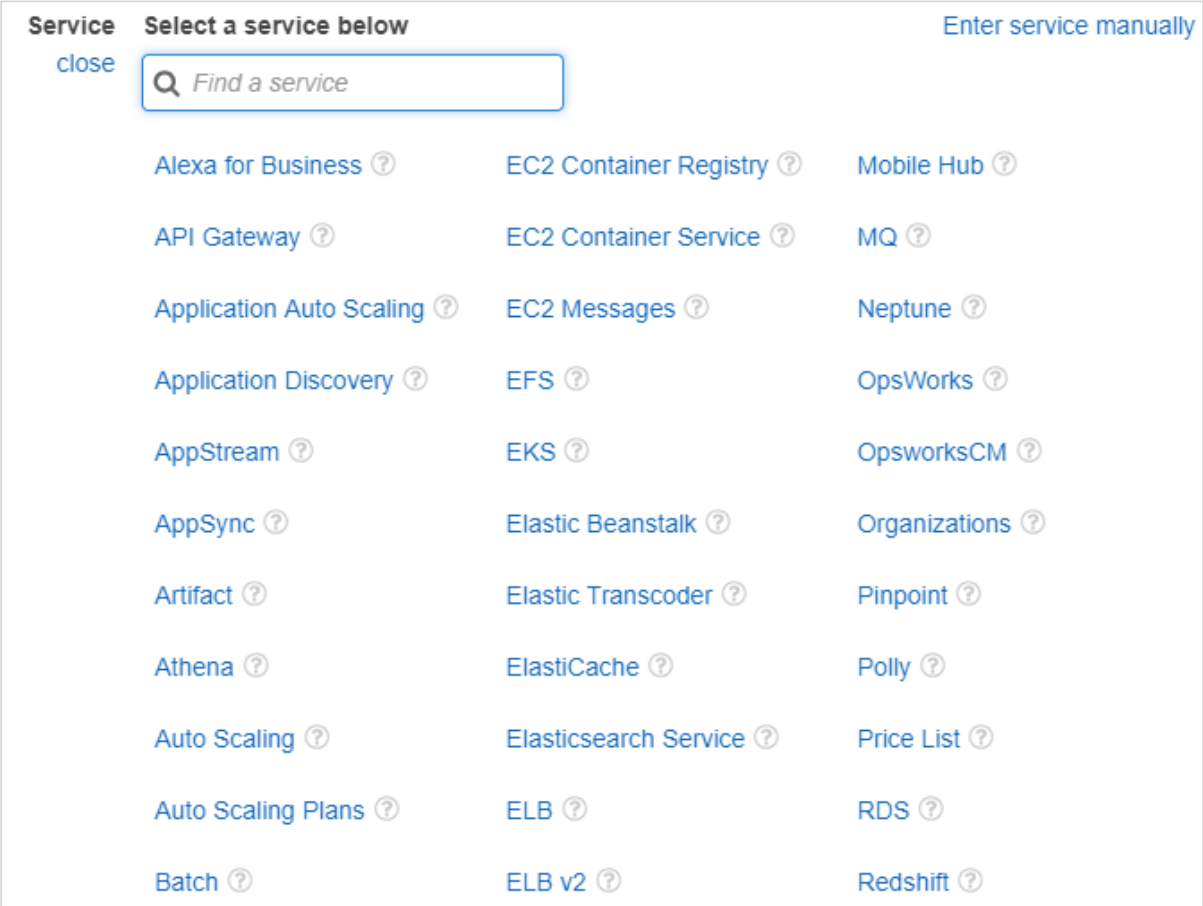
For example, if you want permission for AWS Lambda to work with S3 and DynamoDB, you need to select the policy. In the searchbox, enter the AWS service and click on the checkbox. You can select multiple policies and later click on **Next:Review.**

It is also possible to create policy of your own.For example, there is dynamodb table and you need to give permission only to that table, under such cases you can create policy.

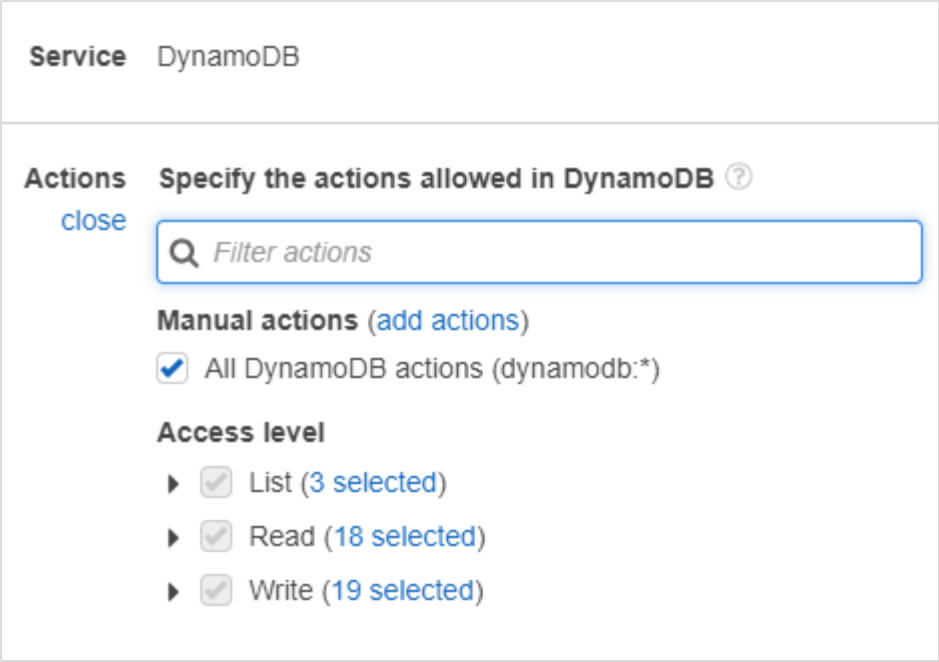
Click on **Create policy** button as shown in the screen above.Following are the details displayed on screen.



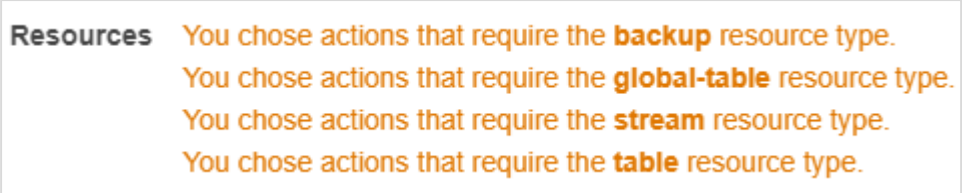
Choose a **Service** for which you are creating the policy. Later it will display data for **Actions**, **Resources** and **Request conditions.**



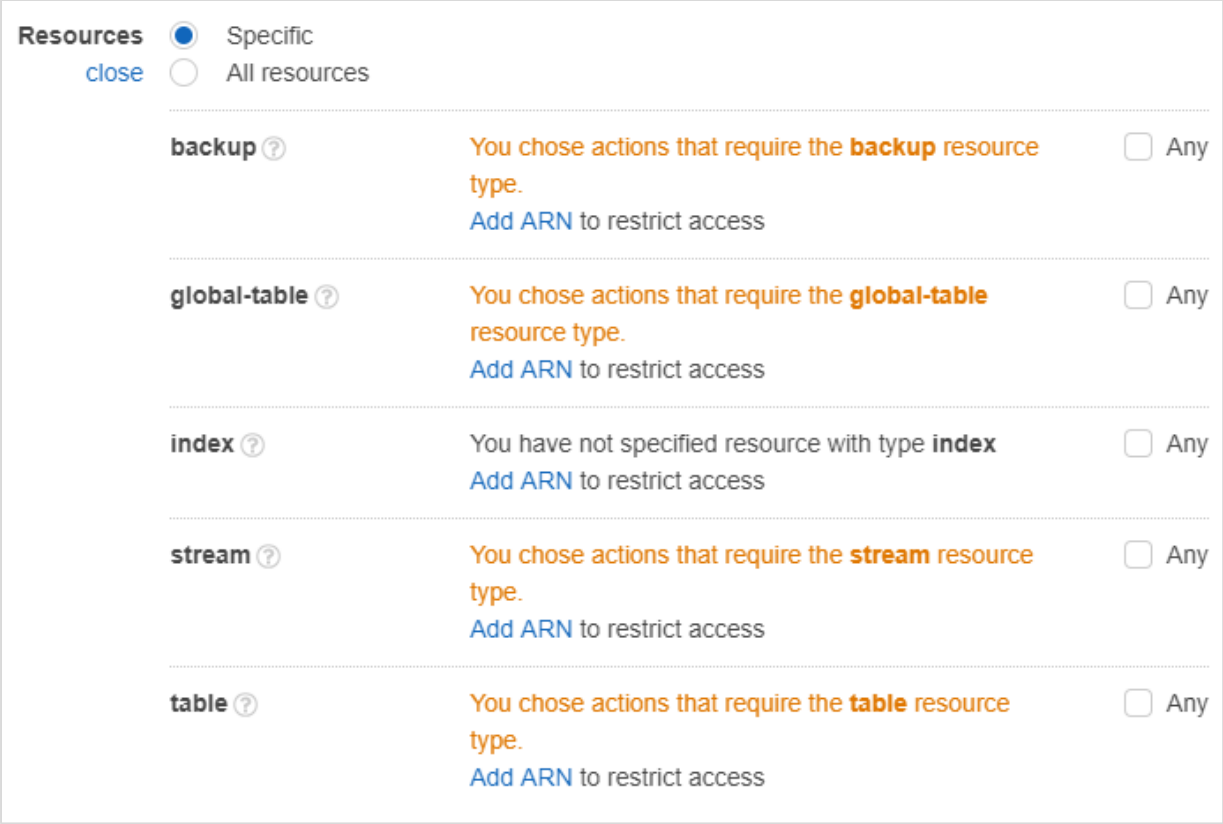
Now, we should choose the service. Let us select **AWS Dynamodb** from search. **Actions** has following details:



Now, enter the **Access level** you want to give to DynamoDB. Then, **Resources** will display the following details:

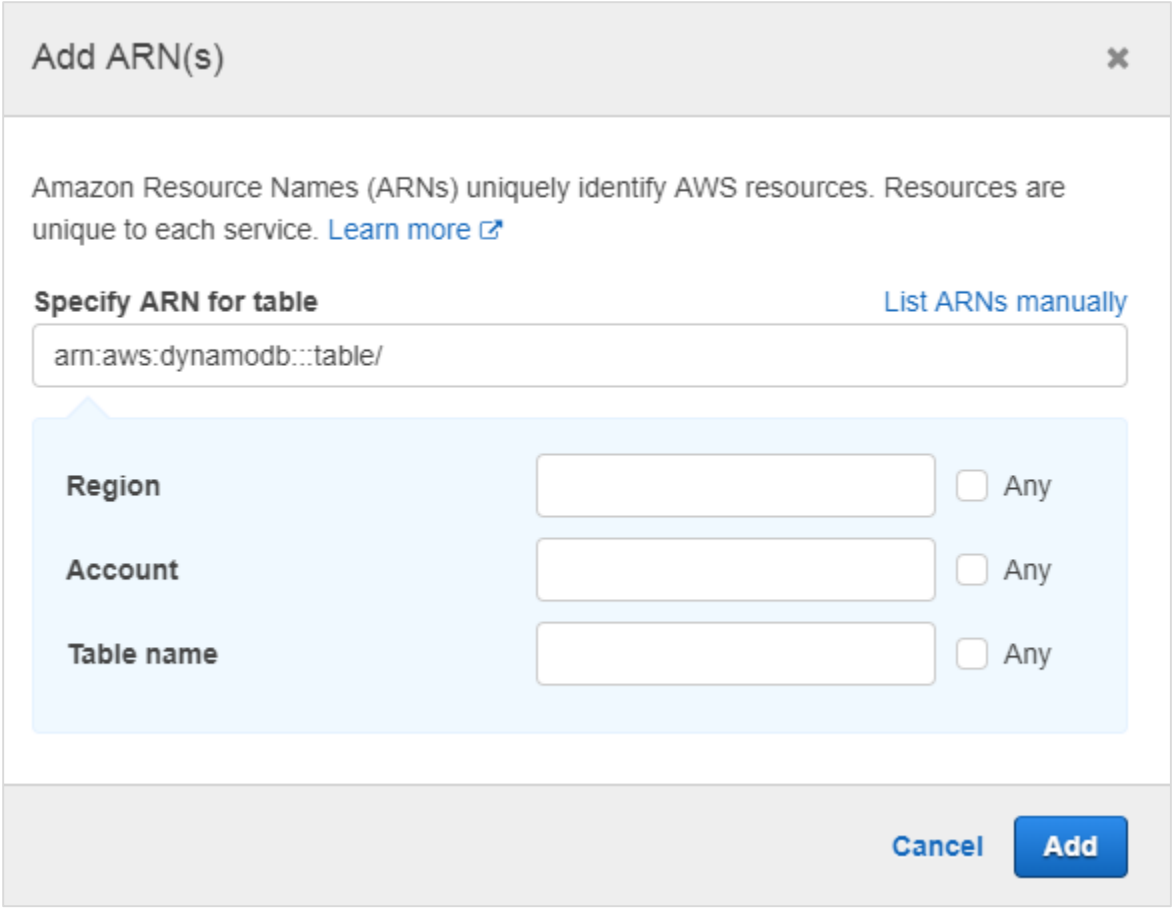


Now, select the table resource type. You can see the following output:

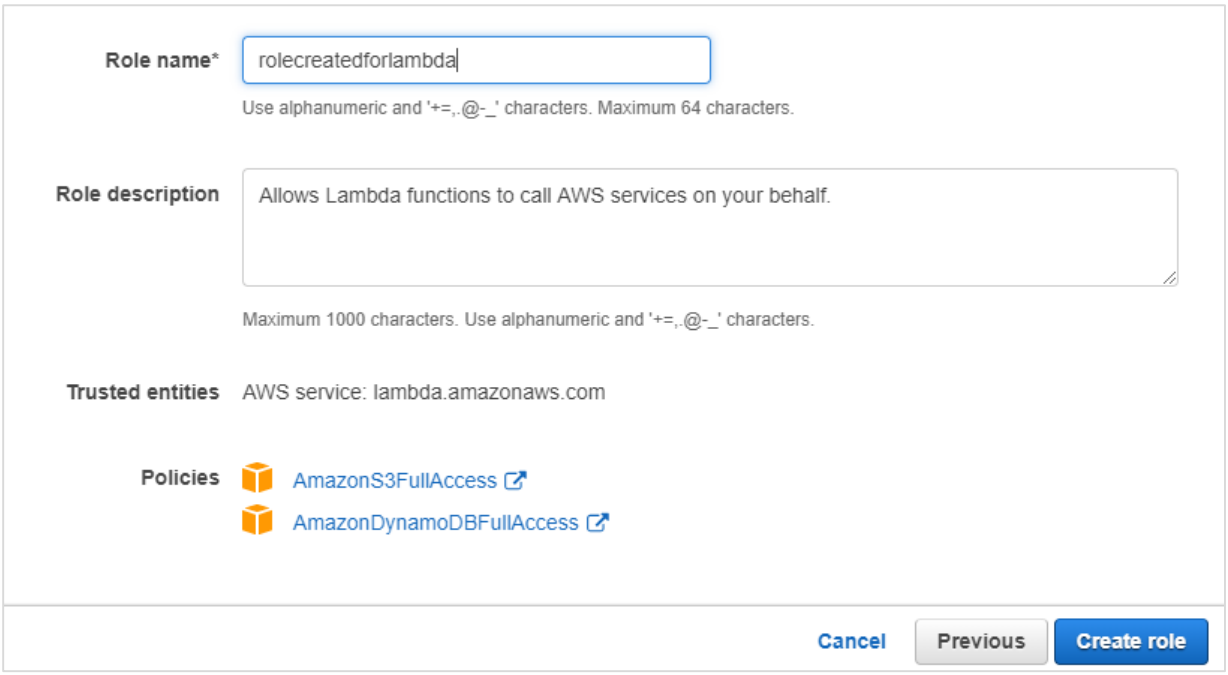


For permission on table, you need to **Add ARN**. ARN is the details which is unique to the table created in AWS DynamoDB. You will get the details when the table is created in dynamodb.

If you click **Add ARN** and it will display following details:



Now, if you enter the **ARN** and the **Region, Account** and **Table** name will get populated. You should click **Add** button to add the policy. Similarly, you can create policies for other services.

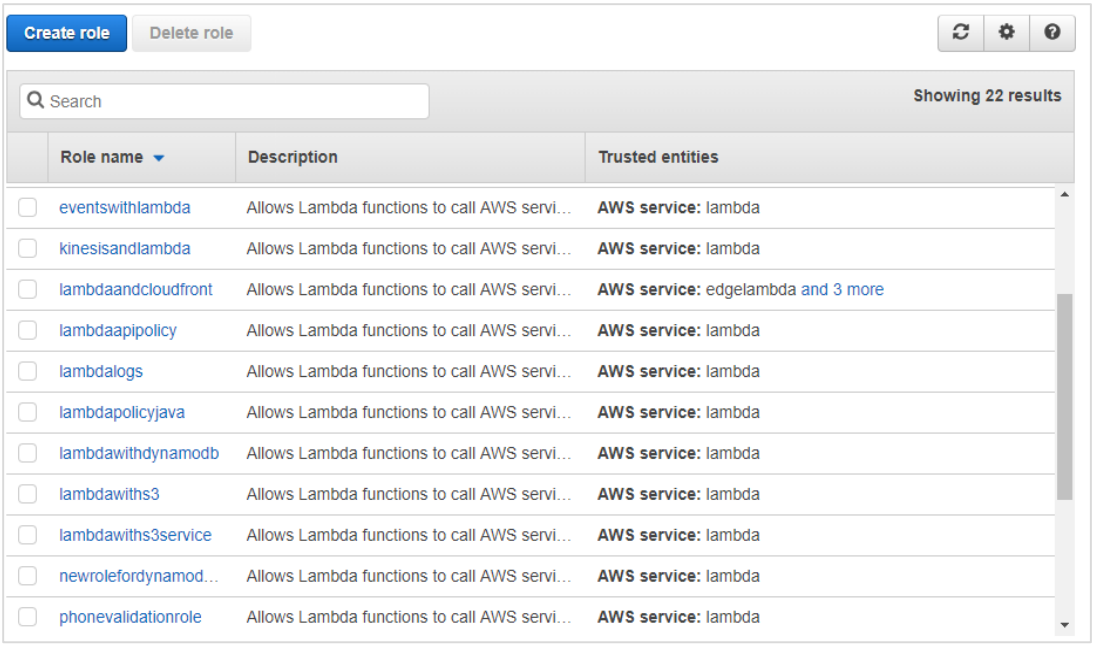


Here, we have selected two policies **AmazonS3FullAccess** and **AmazonDynamoDBFullACcess**.We have given full access to S3 and DynamoDB in that role. However, it is suggested that you give permission only to necessary buckets and tables.

You can follow the steps discussed earlier to create the policies using **ARN.**

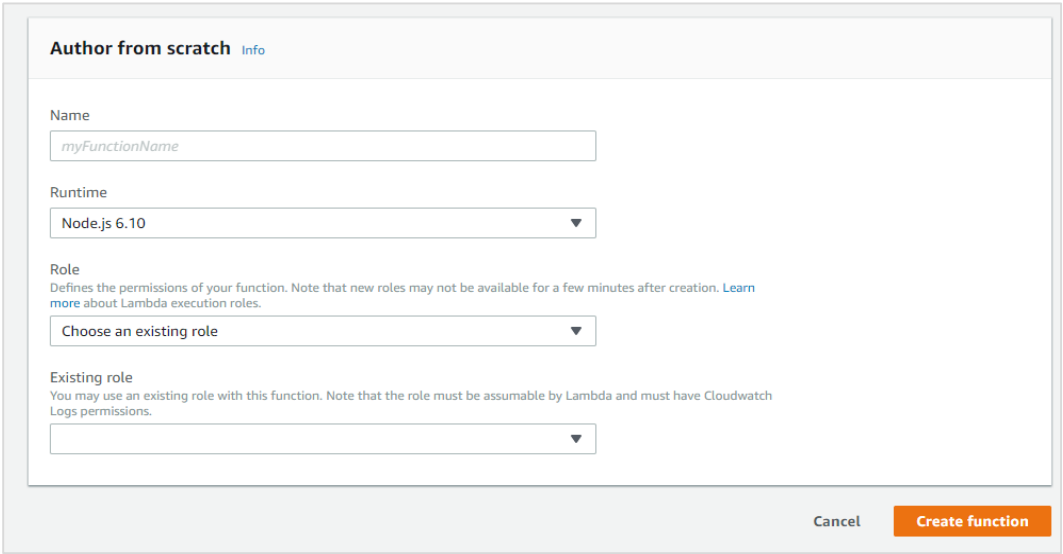
Step 1

Click **Create role** button to create the role. All the roles created are displayed as shown:



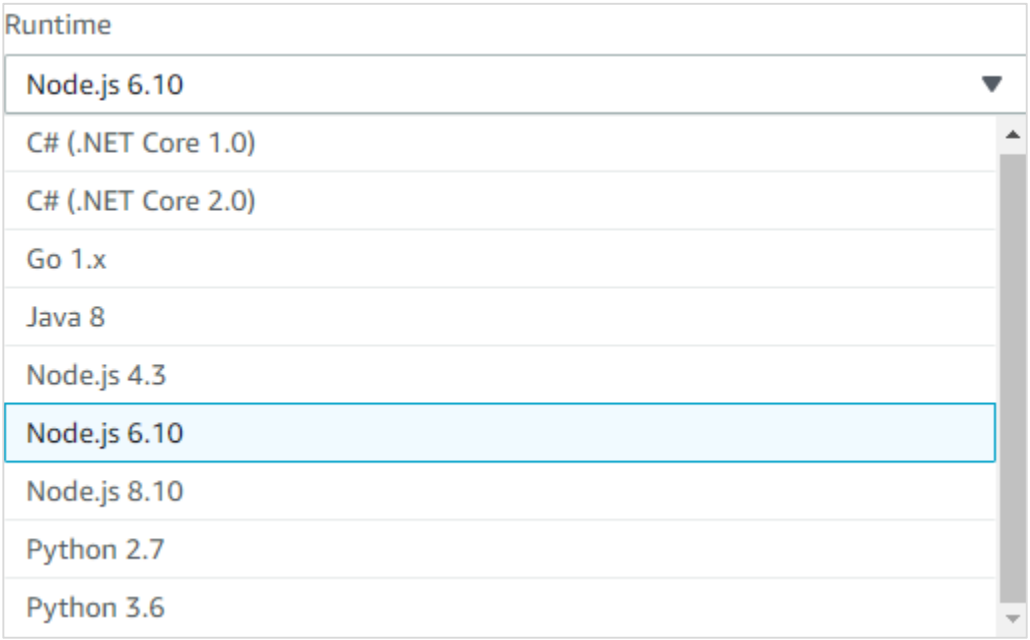
Step 2

Note that you can select the role you require incase you need any modification for the role created. If we select **Author from scratch** option, you have to enter **Name, Runtime and Role.**



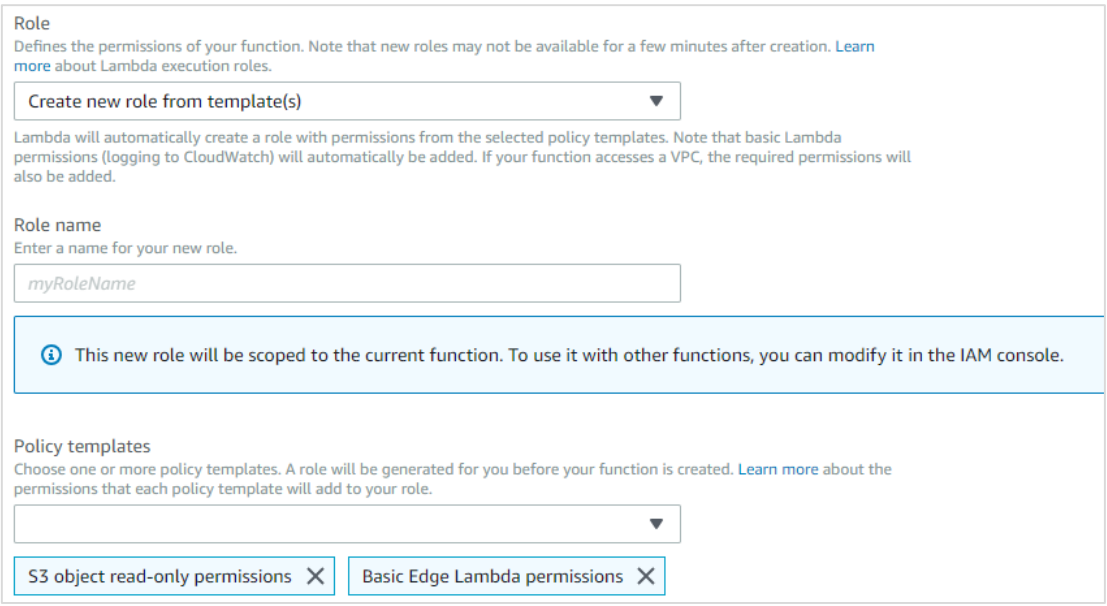
Step 3

You can observe the following details in **Runtime** dropdown:



Step 4

You can select the runtime of your choice and proceed as shown.

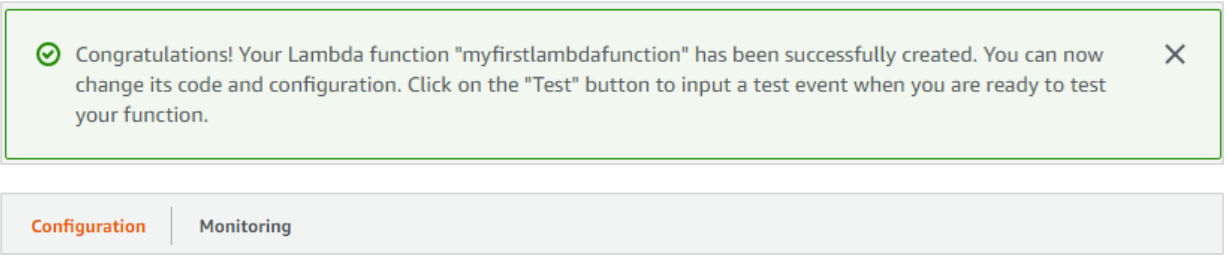


Role dropdown has following options:

- **Choose an existing role**: This will display all the roles created in the IAM roles.
- **Create new role from template(s)**: This will allow you to create role and will display permission to be selected for that role. Observe the scrrenshot for a better understanding.
- **Create a custom role**: This allows the user to create policies as we discussed earlier.

Step 5

Select the **runtime**, **role** and add the function. Click on **Create function** button to create the lambda function. The next screen displayed is as follows:



Parts of AWS Lambda Function

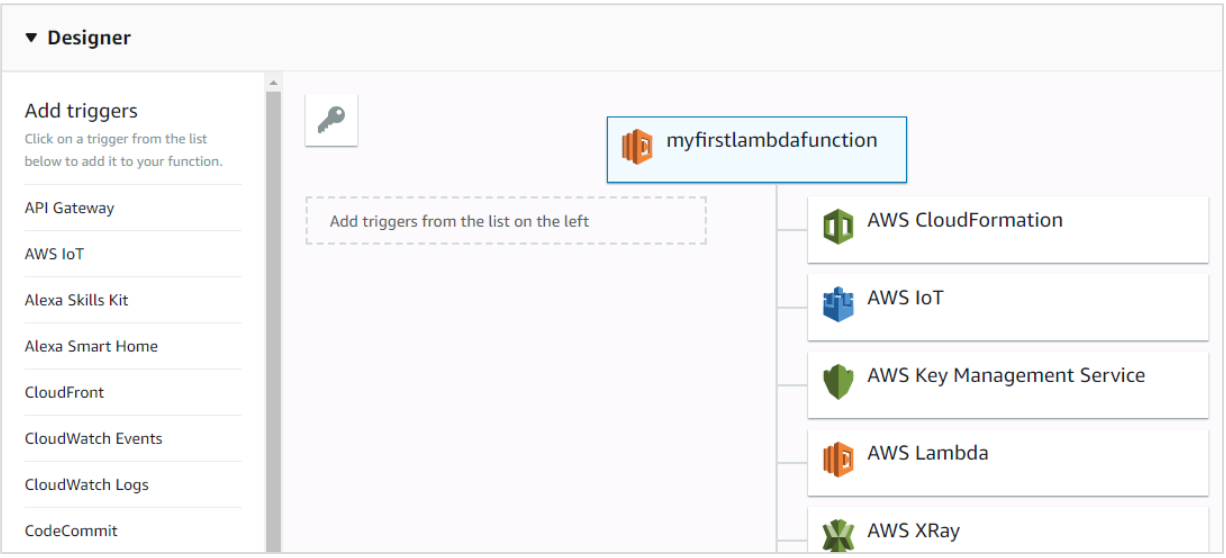
There are two parts for AWS Lambda function: **Configuration** and **Monitoring**. Let us discuss each in detail.

Configuration

The following functionalities are included in the Configuration.

Add Triggers

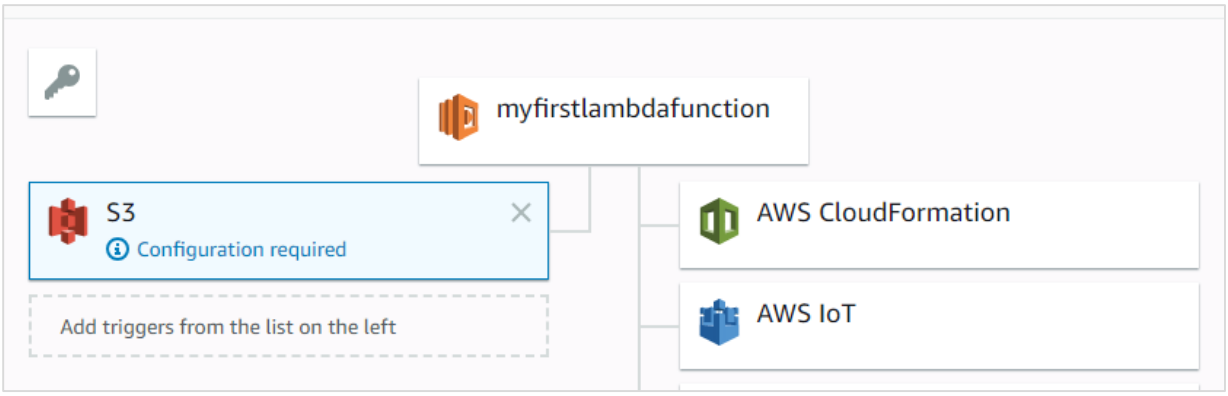
The triggers that are needed to added to AWS Lambda function are displayed as follows:



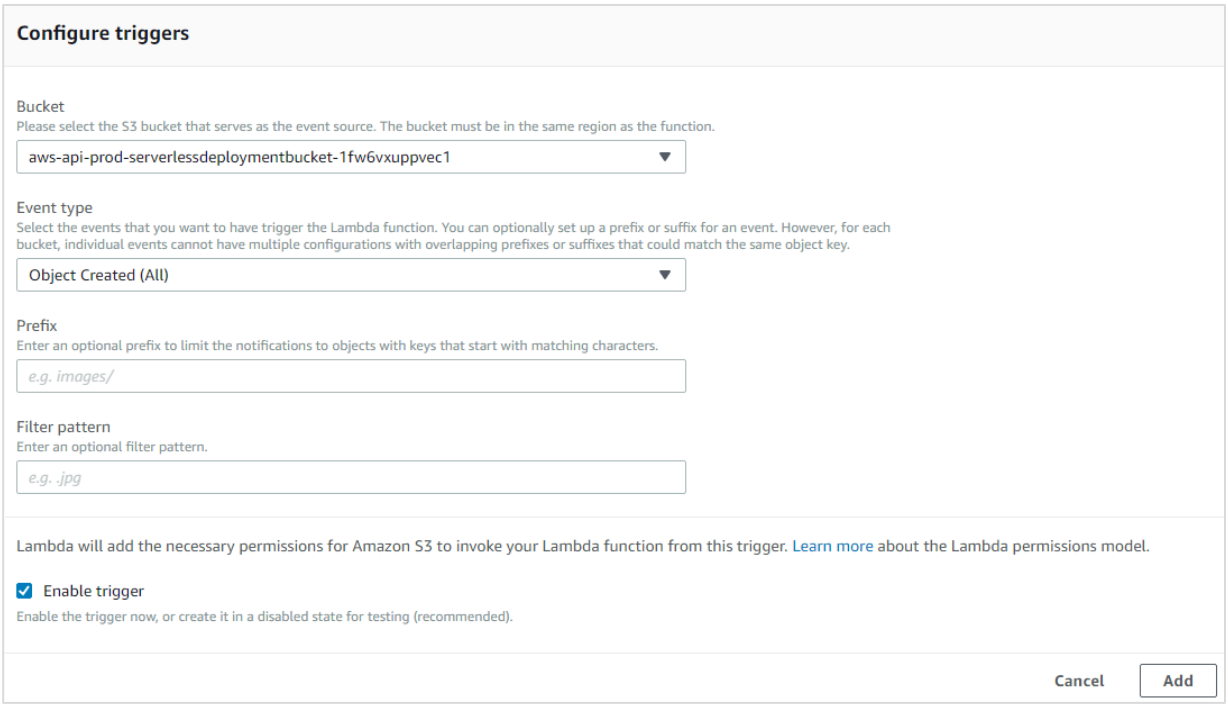
Note that when we select a trigger, we need to add the configuration details for that trigger.For example for S3 trigger, we need to select the bucket name; for Dynamodb trigger we need to select the table name .

Example

Let us see an example of configuration details for a S3 trigger:



Now, add configuration details for S3 trigger added:



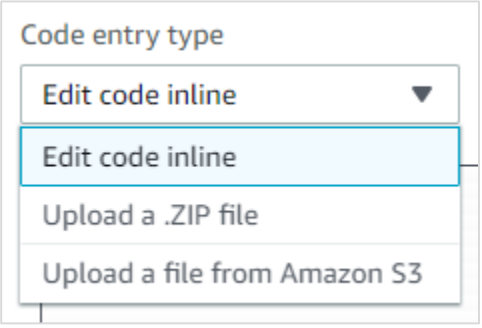
Here you need to select the **bucket name**, **event type** on which you want to trigger Lambda, prefix and filter pattern if any and **Add** the trigger.

Adding Code in Lambda

Now, we should focus on the Lambda code to be written.To add code in aws lambda there are three options:

- Using the inline editor
- Using .zip file
- Upload file from Amazon S3

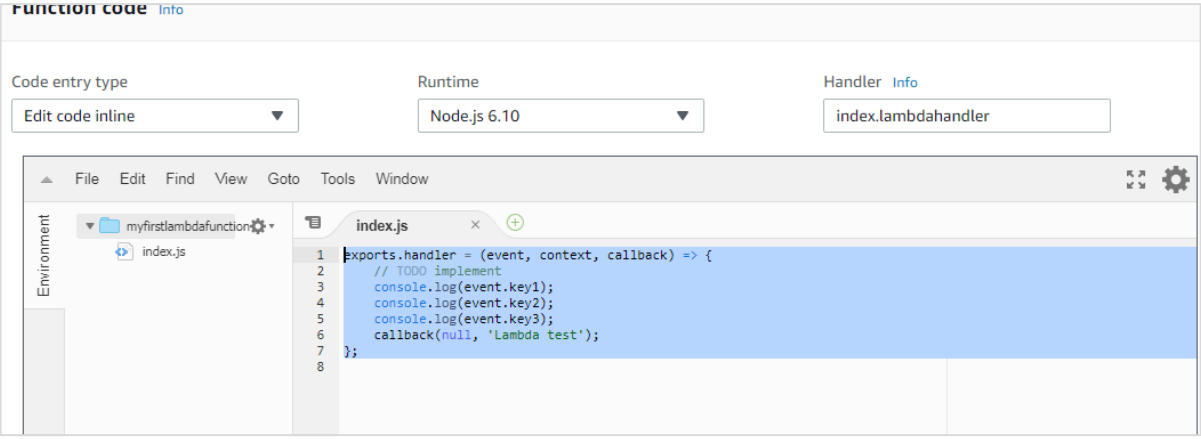
It is shown in the screenshot given below:



Let us discuss each of them in detail.

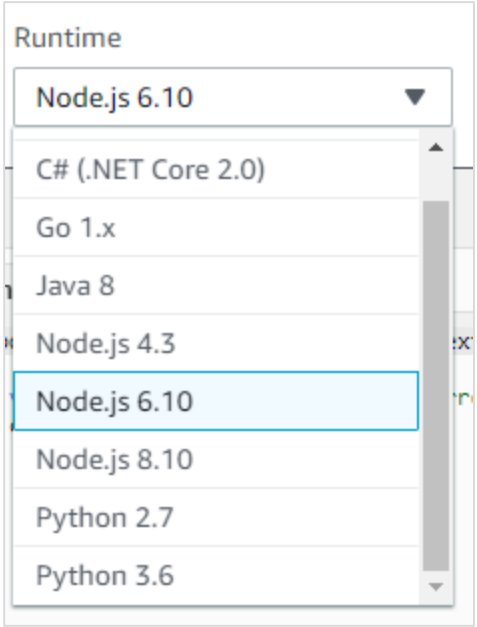
Using the inline editor

The inline code editor where you can write you code is as follows:



You can write your code by choosing the language of your choice. You are allowed to choose the runtime again here.

Observe the following screenshot for a better understanding:



The code has to be written **in index.js.Handler**. Details will differ based on runtime. For **nodejs,** it is **filename.exportfunction** which is right now **index.lambdahandler.**

Upload a .ZIP file

You can first write the code, zip it and upload the zip file by selecting **Upload a .ZIP file.**

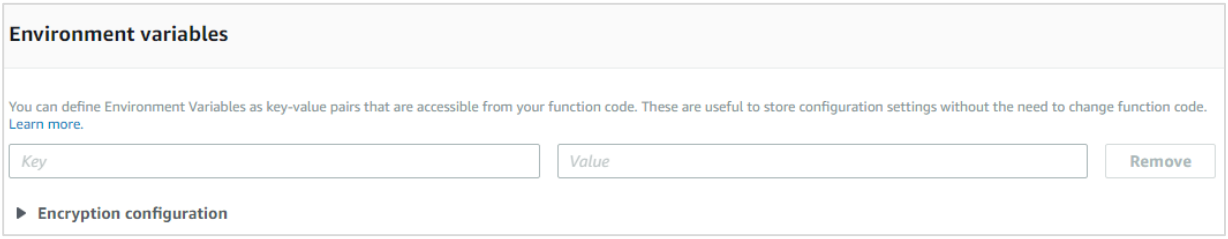
Upload a file from Amazon S3

You can upload the file in S3 bucket and choose the option **Upload a file from Amazon S3.**

Note that for ***.ZIP*** and ***S3*** it will not be possible to change the runtime.

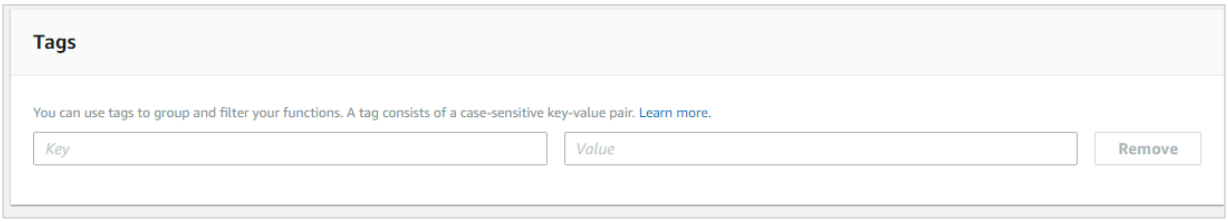
Environment variables

They take in key value pairs and share them with AWS Lambda code.We can use environment variables in AWS Lambda for storing the database connection details, file details as to store the output , log file details etc.



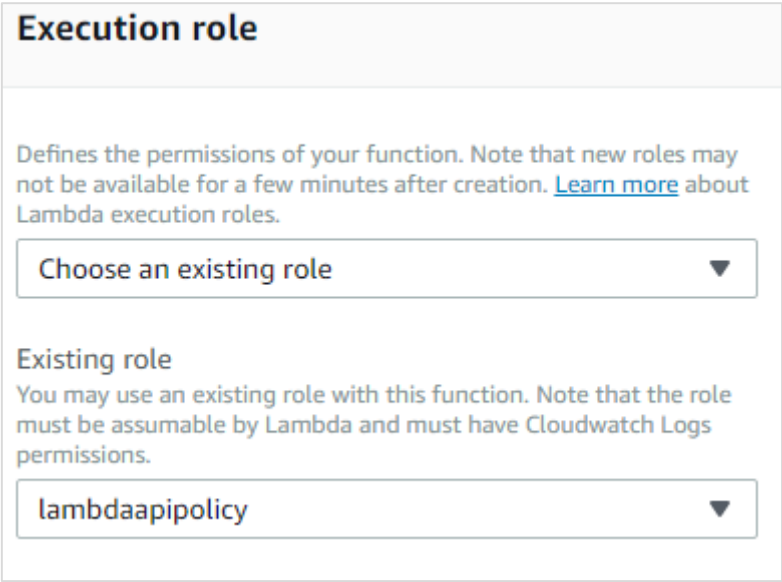
Tags

They are key-value pairs added to AWS Lambda for better organizing the function when used across different regions. For a simple use case, it is not required. When there are lot of Lambda functions created, the tagging helps in filtering and managing the Lambda functions.



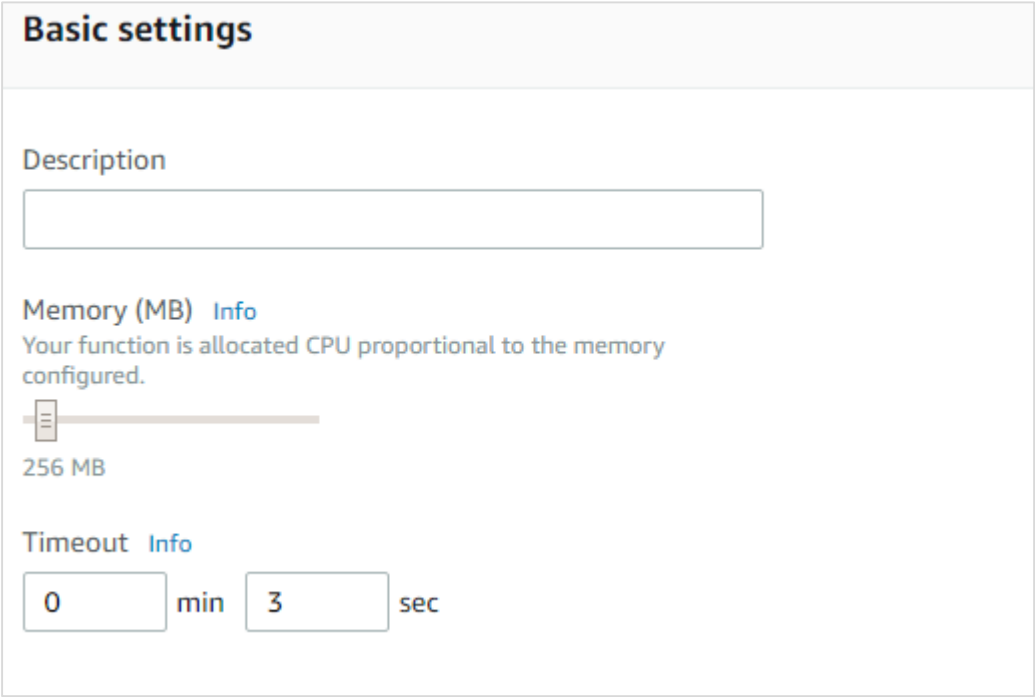
Execution role

You can change the role again here if not done properly at the start of creating Lambda function. You can update or create new role here. It provides same options which were displayed at the start of creating Lambda function.



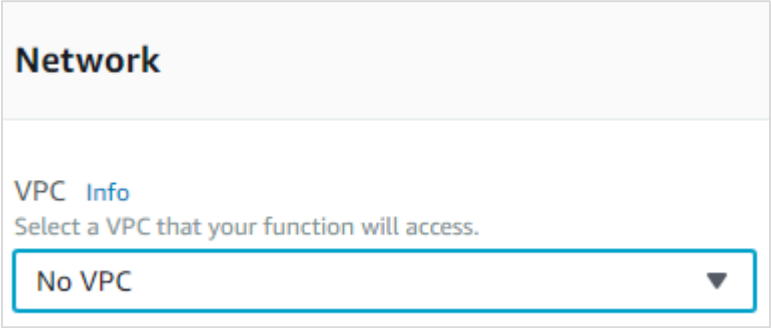
Basic Settings

Here you need to enter the short description of what your Lambda function is doing. Select the memory and timeout which are required for the Lambda function.



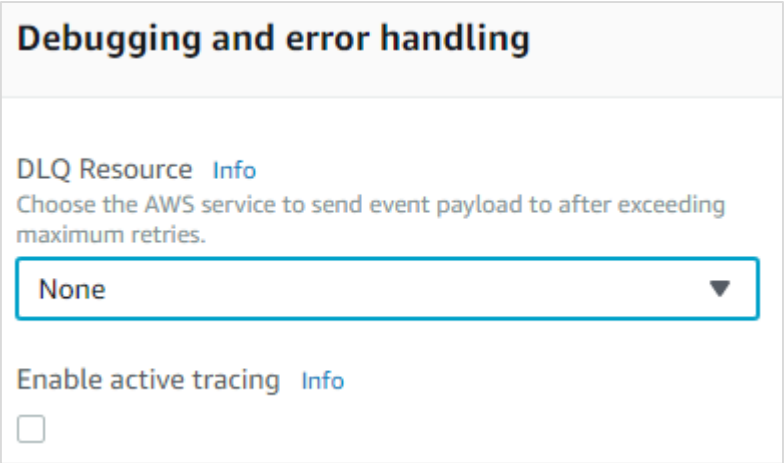
Network

This allows you to select the VPC which will allow you to access the Lambda function from the VPC. By default, no VPC is selected.



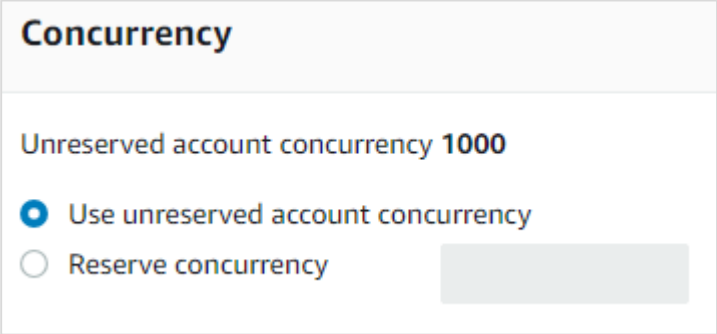
Debugging and Error Handling

For debugging and errors handling, you can select AWS service to send the details.The options available are **None, SNS** and **SQS**.



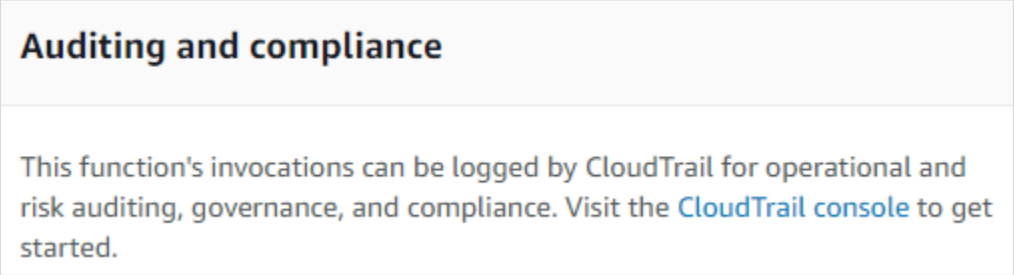
Concurrency

This allows you to allocate a specific limit of concurrent executions allowed for this function.

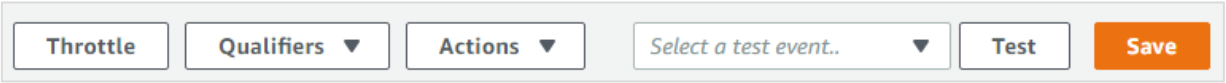


Auditing and Compliance

This contains logs which are managed with the help of AWS CloudTrail.

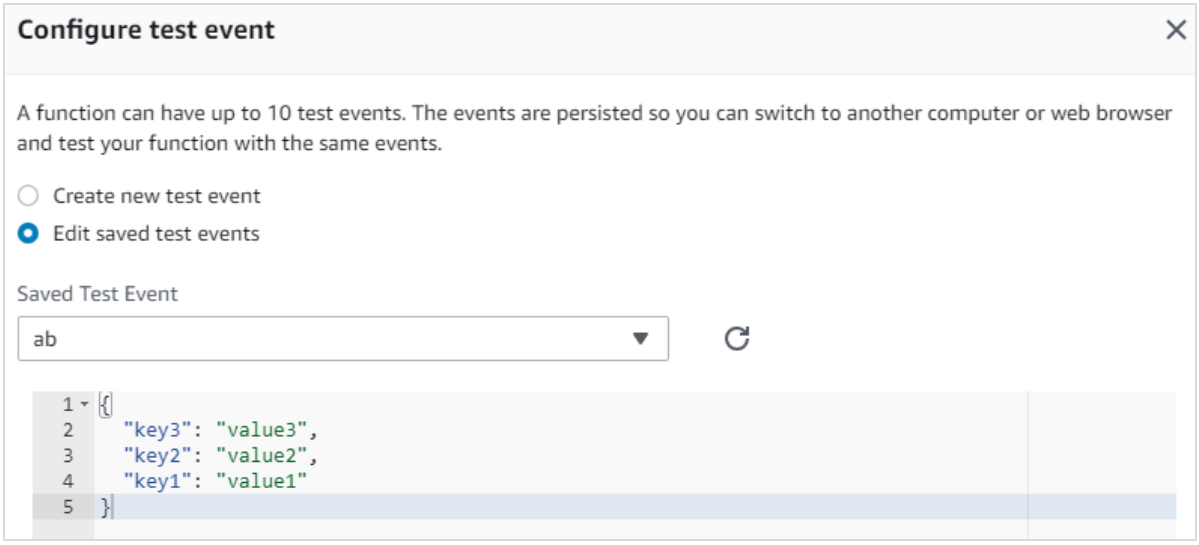


Once done you need to save the changes using the **Save** button as shown here:

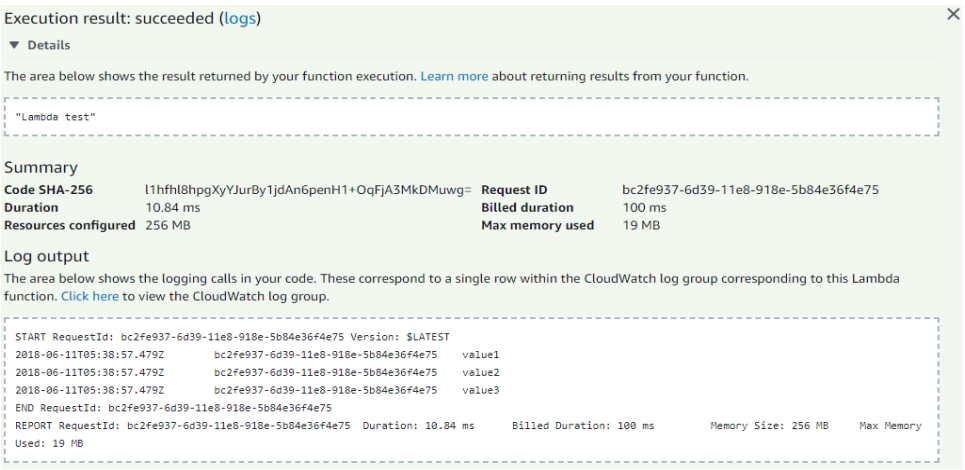


Now, if you click **Test** button, it will ask for a test event.You can pass a sample test event as follows:

The test event created is as shown here:



Now, save the test event and click the test button to see the execution of AWS Lambda function:



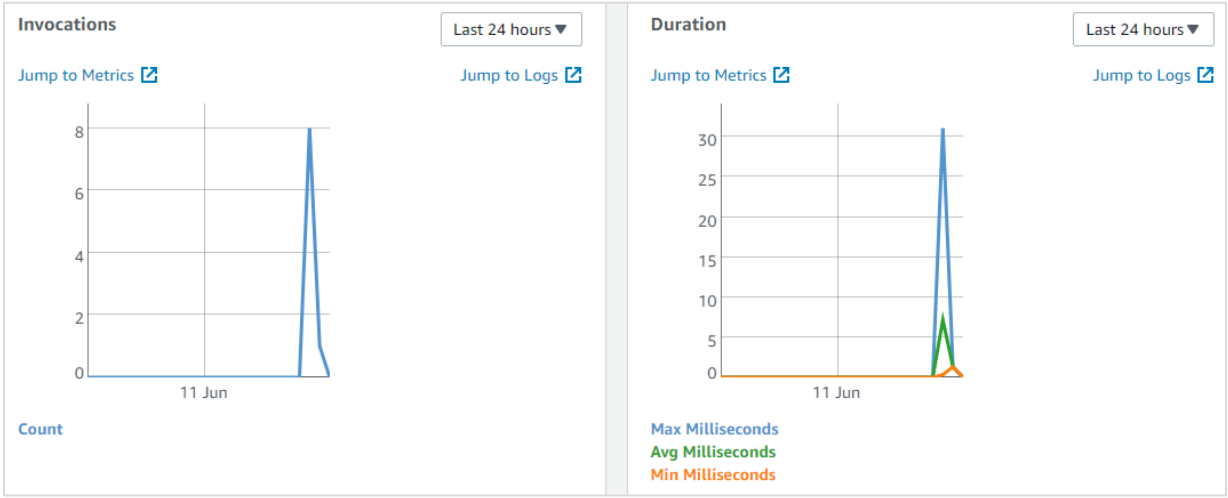
The code for **index.js** is as follows:

```
exports.lambdahandler = (event, context, callback) => {
    // TODO implement
    console.log(event.key1);
    console.log(event.key2);
    console.log(event.key3);
    callback(null, 'Lambda test');
};
```

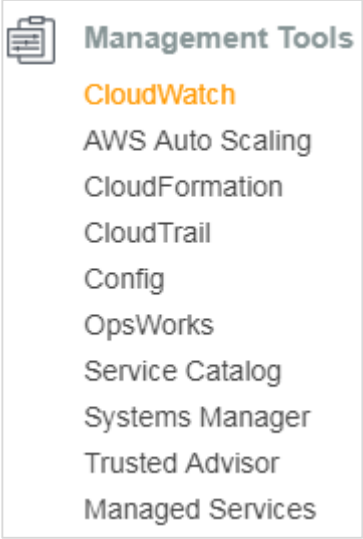
Note that callback function is called when there is error or success. If success, you can see **Lambda tes** will get displayed.

Monitoring

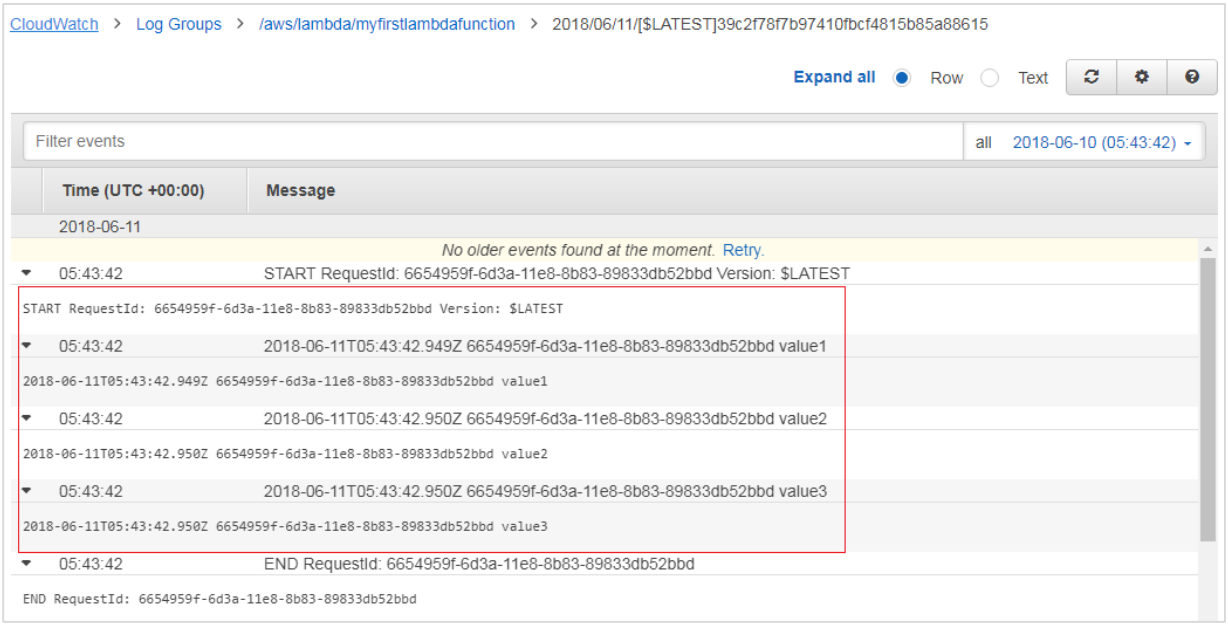
Select the monitoring tab to view the execution details of Lambda function. The graphs show the details of the execution time, errors occured etc.



You can also view the logs in Cloudwatch. For this, go to AWS services and select cloudwatch as shown:



Now, select logs from left side and enter your function name in the filter:



4. AWS Lambda — Building the Lambda function

AWS Lambda function executes a code when it is invoked. This chapter discusses all these steps involved in the life cycle of AWS Lambda function in detail.

Steps for Building a Lambda function

The lifecycle of Lambda function includes four necessary steps:

- Authoring
- Deploying
- Monitoring
- Troubleshooting

Authoring Lambda Code

AWS Lambda function code can be written in following languages:

- NodeJS
- Java,
- Python
- C#
- Go.

We can write code for AWS Lambda using the AWS console, AWS CLI, from Eclipse IDE, from Visual Studio IDE, serverless framework etc.

The following table shows a list of languages and the different tools and IDE that can be used to write the Lambda function:

Language	Tools and IDE for Authoring Lambda Code
NodeJS	AWS Lambda Console Visual Studio IDE
Java	Eclipse IDE
Python	AWS Lambda Console
C#	Visual Studio IDE .NET core
Go	AWS Lambda Console

Deploying Lambda Code

Once you decide the language you want to write the Lambda function, there are two ways to deploy the code:

- Directly write the code in AWS console
- Zip or jar the files with all the files and dependencies

However, remember that proper permission has to given to be given to the zip file .

Testing Lambda Code

Lambda Code can be tested for events inside the AWS Lambda console. It is also possible to test the Lambda function from the AWS cli and serverless cli. AWS console has also event data which can be used as sample events while testing AWS Lambda function.

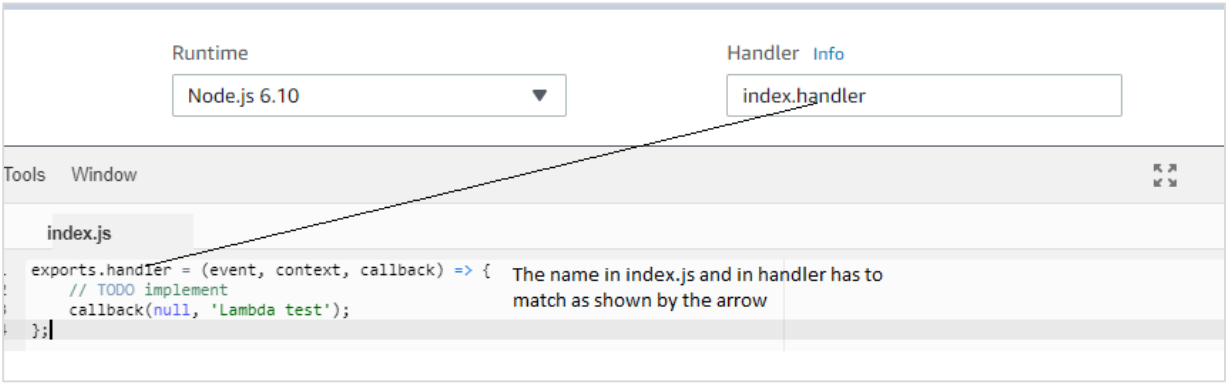
Monitoring Lambda function

Monitoring of Lambda function can be done using the AWS CloudWatch. We can add necessary log messages in languages we choose and see the same in AWS CloudWatch.

To start writing Lambda function, there is pattern to be followed. The following are the main core concepts to be followed for writing a Lambda function:

Handler

Handler is a name of the AWS lambda function from where the execution starts. It appears in AWS console as shown below:

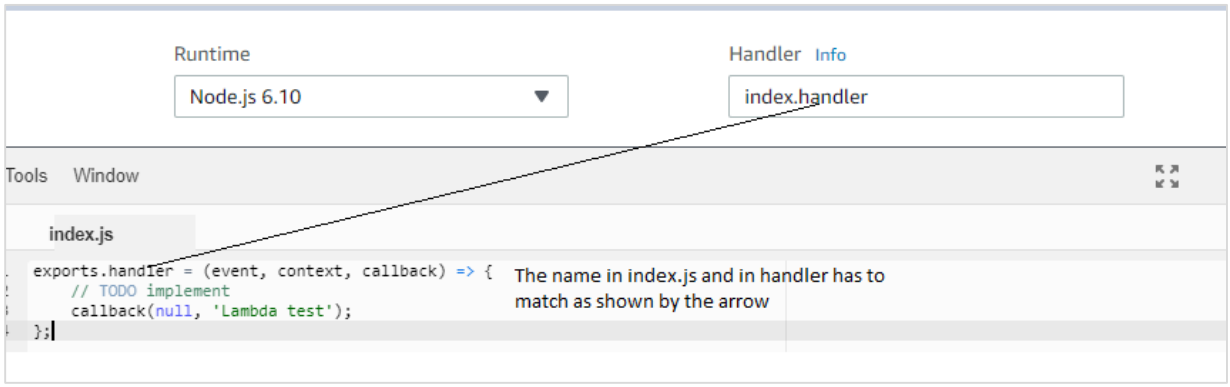


Notice that here we have changed the default handler to another name and updated the same in the Handler:

Note that the way a handler is called differs from the languages selected as runtime.

Params passed to handler

If you observe the handler function, the params passed are **event**, **context** and **callback function** as shown below:



Event parameter has all the details for the trigger used.

Context parameter basically takes care of runtime details for the Lambda function to execute. We can interact with the Lambda function using the **context** param. It has the details like the time left before AWS Lambda terminates a function i.e, timeout specified while creating Lambda function, name of the Lambda function, cloudwatch group name, arn details etc.

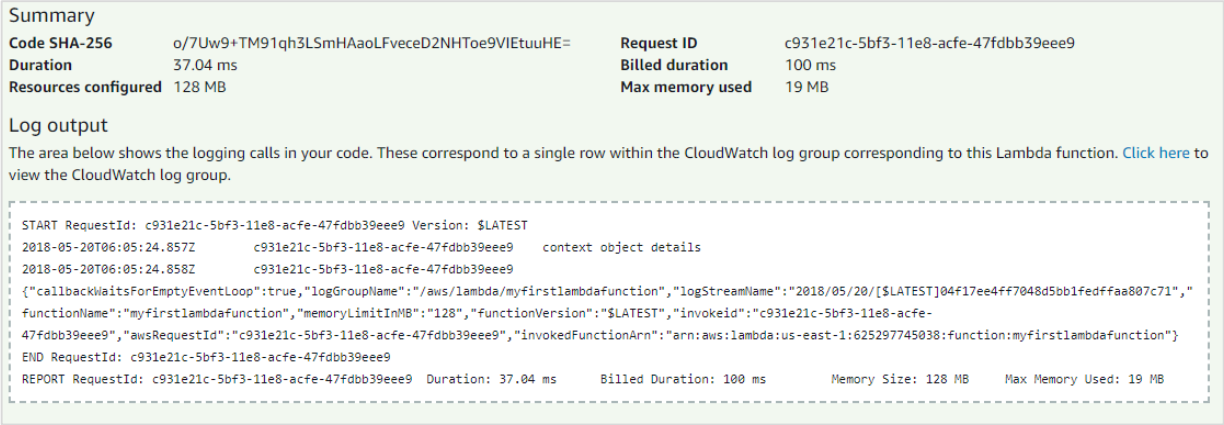
Example

Let us understand the details obtained from AWS Lambda context object with the help of an example:

```
exports.lambdahandler = (event, context, callback) => {
    // TODO implement
    console.log("context object details");
    console.log(JSON.stringify(context));
    callback(null, 'Lambda test');
};
```

When you execute the Lambda function shown above, you can see the following output:

Output



Summary

Code SHA-256	o/7Uw9+TM91qh3LSmHAaoLFveceD2NHToe9VIEtuuHE=	**Request ID**	c931e21c-5bf3-11e8-acfe-47fdbb39eee9
Duration	37.04 ms	**Billed duration**	100 ms
Resources configured	128 MB	**Max memory used**	19 MB

Log output

The area below shows the logging calls in your code. These correspond to a single row within the CloudWatch log group corresponding to this Lambda function. Click here to view the CloudWatch log group.

```
START RequestId: c931e21c-5bf3-11e8-acfe-47fdbb39eee9 Version: $LATEST
2018-05-20T06:05:24.857Z        c931e21c-5bf3-11e8-acfe-47fdbb39eee9    context object details
2018-05-20T06:05:24.858Z        c931e21c-5bf3-11e8-acfe-47fdbb39eee9
{"callbackWaitsForEmptyEventLoop":true,"logGroupName":"/aws/lambda/myfirstlambdafunction","logStreamName":"2018/05/20/[$LATEST]04f17ee4ff7048d5bb1fedffaa807c71","
functionName":"myfirstlambdafunction","memoryLimitInMB":"128","functionVersion":"$LATEST","invokeid":"c931e21c-5bf3-11e8-acfe-
47fdbb39eee9","awsRequestId":"c931e21c-5bf3-11e8-acfe-47fdbb39eee9","invokedFunctionArn":"arn:aws:lambda:us-east-1:625297745038:function:myfirstlambdafunction"}
END RequestId: c931e21c-5bf3-11e8-acfe-47fdbb39eee9
REPORT RequestId: c931e21c-5bf3-11e8-acfe-47fdbb39eee9  Duration: 37.04 ms      Billed Duration: 100 ms         Memory Size: 128 MB     Max Memory Used: 19 MB
```

The **context** details are given as follows:

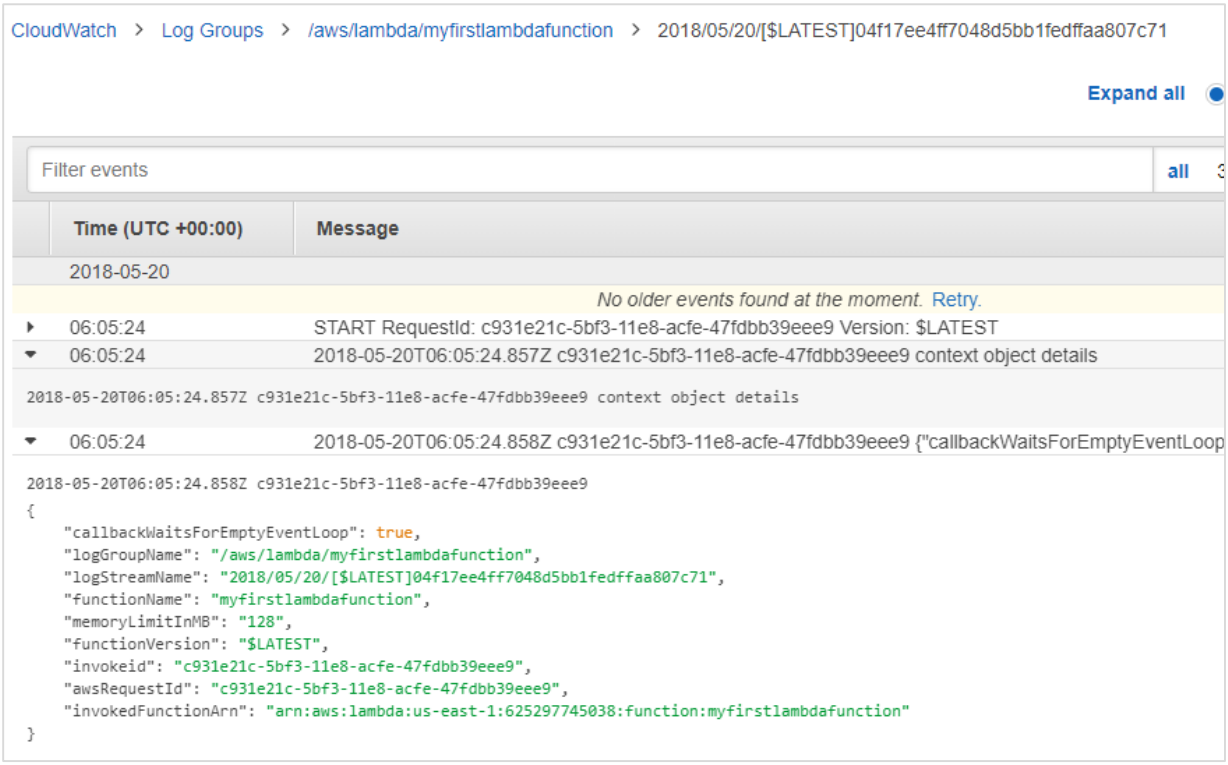
```
{"callbackWaitsForEmptyEventLoop":true,"logGroupName":"/aws/lambda/myfirstlambdafu
nction","logStreamName":"2018/05/20/[$LATEST]04f17ee4ff7048d5bb1fedffaa807c71","fu
nctionName":"myfirstlambdafunction","memoryLimitInMB":"128","functionVersion":"$LA
TEST","invokeid":"c931e21c-5bf3-11e8-acfe-47fdbb39eee9","awsRequestId":"c931e21c-
5bf3-11e8-acfe-47fdbb39eee9","invokedFunctionArn":"arn:aws:lambda:us-east-
1:625297745038:function:myfirstlambdafunction"}
```

Observe that it has details like functionName, memorylimit, requestId etc.

Logging

The logs added inside the Lambda function are displayed in AWS CloudWatch when the AWS function executes. The logs syntax will vary from the langauge selected. For example in **nodejs**, it is console.log.

This is the output you can see in AWS CloudWatch:



Error Handling

AWS Lambda function provides a callback function which is used to notify to the Lambda function that an error or success has happened. Note that here we have used **nodejs** as the runtime. The error handling will differ as per the language selected.

Observe the example given here for abetter understanding:

```
exports.lambdahandler = (event, context, callback) => {
    // TODO implement
   var error = new Error("There is error in code");
   callback(error);
};
```

Output

When you test the Lambda code, you can find the output as shown below:

Execution result: failed (logs)

▼ Details

The area below shows the result returned by your function execution. Learn more about returning results from your function.

```
{
  "errorMessage": "There is error in code",
  "errorType": "Error",
  "stackTrace": [
    "exports.lambdahandler (/var/task/index.js:3:16)"
  ]
}
```

The log details as follows:

Log output

The area below shows the logging calls in your code. These correspond to a single row within the CloudWatch log group corresponding to this Lambda function. Click here to view the CloudWatch log group.

```
START RequestId: 9d20010d-5bf7-11e8-872e-ad422717381f Version: $LATEST
2018-05-20T06:32:48.937Z        9d20010d-5bf7-11e8-872e-ad422717381f    {"errorMessage":"There is error in code","errorType":"Error","stackTrace":
["exports.lambdahandler (/var/task/index.js:3:16)"]}
END RequestId: 9d20010d-5bf7-11e8-872e-ad422717381f
REPORT RequestId: 9d20010d-5bf7-11e8-872e-ad422717381f  Duration: 106.00 ms     Billed Duration: 200 ms         Memory Size: 128 MB     Max Memory Used: 19 MB
```

5. AWS Lambda — Function in NODEJS

Nodejs is one of the languages that AWS Lambda function supports. The version supported with nodejs are v6.10 and v8.10. In this chapter, we will learn about various functionalities of AWS Lambda function in NODEJS in detail.

Handler in NodeJS

To write AWS Lambda function in nodejs, we should first declare a handler first. The handler in nodejs is name of the file and the name of the export function. For example, the name of the file is **index.js** and the export function name is **lambdahandler**, so its corresponding handler is **index.lambdahandler**

Observe a sample handler shown here:

```
exports.lambdahandler = function(event, context, callback) {   //code goes here}
```

Params to Handler

Handler is the main core for building Lambda function. The handler takes three params: **event**, **context** and **callback**.

Event Parameter

It has all the details of the event triggered. For example, if we are using Lambda function to be triggered on *S3*, the event will have details of the *S3* object.

Context Parameter

It has the details of the context such as the properties and configuration details of the Lambda function.

Callback Function

It helps in giving details back to the caller. The structure of callback looks as follows:

```
callback(error, result);
```

The parameters of callback function are explained given below:

Error: This will have details if any error has occurred during the execution of Lambda function. If the Lambda function succeeds, **null** can be passed as the first param for callback function.

Result: This will give the details of the successful execution of the lambda function. If an error occurrs, the result param is ignored.

Note: It is not mandatory to use the callback function in AWS Lambda. In case if there is no callback function, the handler will return it as null.

The valid callback signatures are given below:

```
callback();     // It will return success , but no indication to the caller
callback(null); // It will return success, but no indication to the caller
callback(null, "success");  // It will return the success indication to the caller
callback(error);    //  It will return the error indication to the caller
```

Whenever AWS Lambda gets executed the callback details such as error or success, are logged in AWS CloudWatch along with console messages, if any.

Working with AWS Lambda in Nodejs8.10

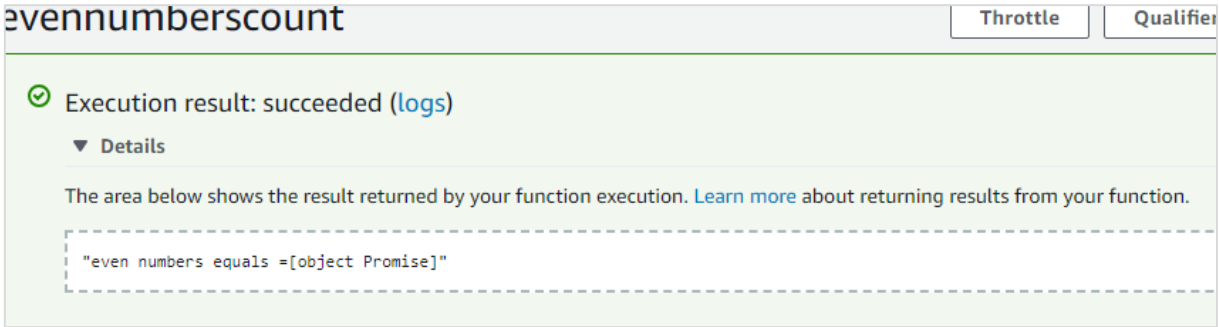
Let us understand how to work with AWS Lambda in **nodejs8.10** and invoke the function in sync and async way.

Invoking Lambda Function in Sync Way

The following example gives you an idea about invoking Lambda function in sync way:

```
exports.handler = function(event, context, callback) {
     let arrItems = [4,5,6,8,9,10,35,70,80,31];
         function countevennumbers (items) {
     return new Promise(resolve => {
            setTimeout(() => {
                let a = 0;
                  for (var i in items) {
                         if (items[i] % 2 == 0) {
                                a++;
                         }
                  }
                resolve(a);
            }, 2000);
     });
    }
     let evennumber = countevennumbers(arrItems);
     callback(null,'even numbers equals ='+evennumber);};
```

You can observe the following output after testing this code in AWS console:



Note that the output from the above code is a promise object. It does not give the count, as the count is incremented inside a setTimeout and the function call does not wait for the execution inside setTimeout and returns the promise object.

If we had **async/await** on the handler function will get exact output of from the lambda function.

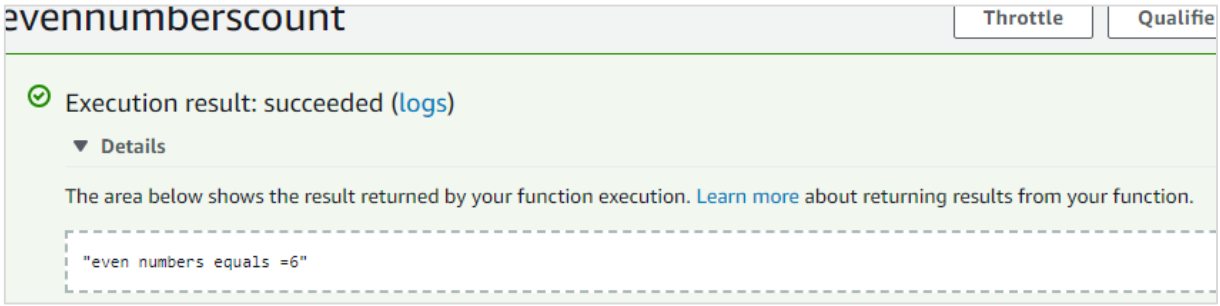
Invoking the Handler in an Async Way

The following example gives you an idea about invoking Lambda function in an async way:

```
exports.handler = async function(event, context, callback) {
     let arrItems = [4,5,6,8,9,10,35,70,80,31];
         function countevennumbers (items) {
     return new Promise(resolve => {
            setTimeout(() => {
                let a = 0;
                  for (var i in items) {
                         if (items[i] % 2 == 0) {
                                a++;
                         }
                  }
                resolve(a);
            }, 2000);
     });
    }
     let evennumber = await countevennumbers(arrItems);
     callback(null,'even numbers equals ='+evennumber);
};
```

We have added **async** and **await** in above code. When we use **await** beside the function call, the execution pauses till the promise inside the function gets resolved. Note that **await** is valid only for **async** functions.

You can observe the following output after testing this code in AWS console:



Context Details in NodeJS

Context object gives details such as the name of the Lambda function, time remaining in milliseconds, request id, cloudwatch group name, timeout details etc.

The following tables shows the list of methods and attributes available with context object:

Method available for context object

Method Name	Description
getRemainingTimeInMillis()	This method gives the remaining time in milliseconds until the Lambda function terminates the function

Attributes available for context object

Attribute name	Description
functionName	This gives AWS Lambda function name
functionVersion	This gives the version of AWS Lambda function executing
invokedFunctionArn	This will gives ARN details.
memoryLimitInMB	This shows the memory limit added while creating Lambda function

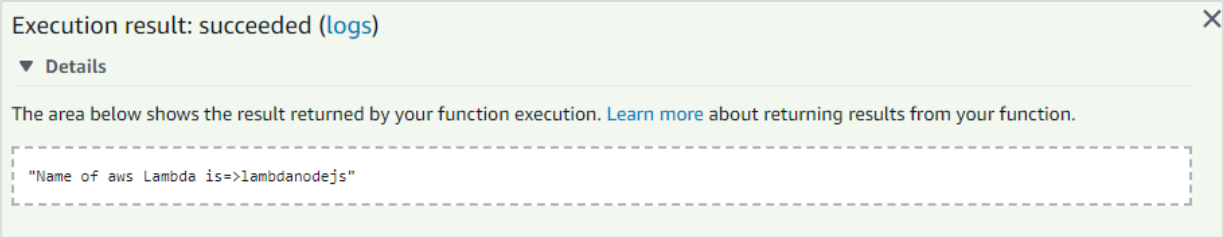
awsRequestId	This gives the AWS request id.
logGroupName	This will give the name of the cloudwatch group name
logStreamName	This will give the name of the cloudwatch log stream name where the logs are written.
identity	This will give details about amazon cognito identity provider when used with aws mobile sdk. Details given are as follows: identity.cognito_identity_id identity.cognito_identity_pool_id
clientContext	This will details of the client application when used with aws mobile sdk.The details given are as follows: client_context.client.installation_id client_context.client.app_title client_context.client.app_version_name client_context.client.app_version_code client_context.client.app_package_name client_context.custom - it has dict of custom values from the mobile client app client_context.env - it has environment details from the AWS Mobile SDK

Look at the following example to get a better idea about context object:

```
exports.handler = (event, context, callback) => {
    // TODO implement
    console.log('Remaining time =>', context.getRemainingTimeInMillis());
    console.log('functionName =>', context.functionName);
    console.log('AWSrequestID =>', context.awsRequestId);
    console.log('logGroupName =>', context.log_group_name);
    console.log('logStreamName =>', context.log_stream_name);
    console.log('clientContext =>', context.clientContext);
```

```
    callback(null, 'Name of aws Lambda is=>'+context.functionName);
};
```

You can observe the following output after testing this code in AWS console:



You can observe the following log output after testing this code in AWS console:

Logging in NodeJS

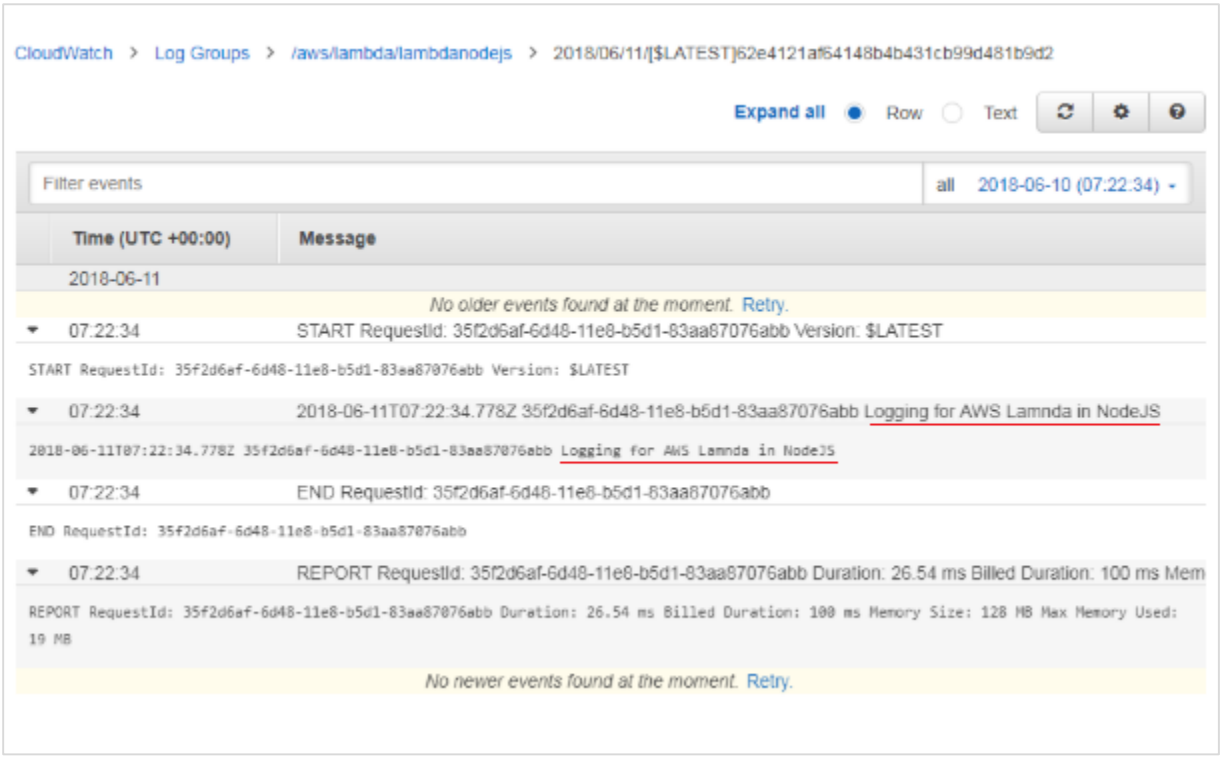
We can use console.log for logging in NodeJS.The log details can be fetched from CloudWatch service against the Lambda function.

Observe the following example for a better understanding:

```
exports.handler = (event, context, callback) => {
    // TODO implement
    console.log('Logging for AWS Lamnda in NodeJS');
    callback(null, 'Name of aws Lambda is=>'+context.functionName);
};
```

You can observe the following output after testing this code in AWS console:

You can observe the following screenshot from CloudWatch:



Error Handling in NodeJS

Let us understand how error notification is done in NodeJS. Observe the following code:

```
exports.handler = function(event, context, callback) {
    // This example code only throws error.
    var error = new Error("something is wrong");
    callback(error);
};
```

Execution result: failed (logs)

▼ Details

The area below shows the result returned by your function execution. Learn more about returning results from your function.

```
{
  "errorMessage": "something is wrong",
  "errorType": "Error",
  "stackTrace": [
    "exports.handler (/var/task/index.js:2:17)"
  ]
}
```

You can observe the following in the log output:

Log output

The area below shows the logging calls in your code. These correspond to a single row within the CloudWatch log group corresponding to this Lambda function. Click here to view the CloudWatch log group.

```
START RequestId: 1f98d5d9-6d49-11e8-9ef9-39413c6562cd Version: $LATEST
2018-06-11T07:29:06.838Z        1f98d5d9-6d49-11e8-9ef9-39413c6562cd    {"errorMessage":"something is
wrong","errorType":"Error","stackTrace":["exports.handler (/var/task/index.js:2:17)"]}
END RequestId: 1f98d5d9-6d49-11e8-9ef9-39413c6562cd
REPORT RequestId: 1f98d5d9-6d49-11e8-9ef9-39413c6562cd  Duration: 86.65 ms      Billed Duration: 100 ms         Memory Size: 128
MB      Max Memory Used: 19 MB
```

The error details are given in the callback as follows:

```
{
  "errorMessage": "something is wrong",
  "errorType": "Error",
  "stackTrace": [    "exports.handler (/var/task/index.js:2:17)"  ] }
```

6. AWS Lambda Function in Java

In this chapter, let us understand in detail how to create a simple AWS Lambda function in Java in detail.

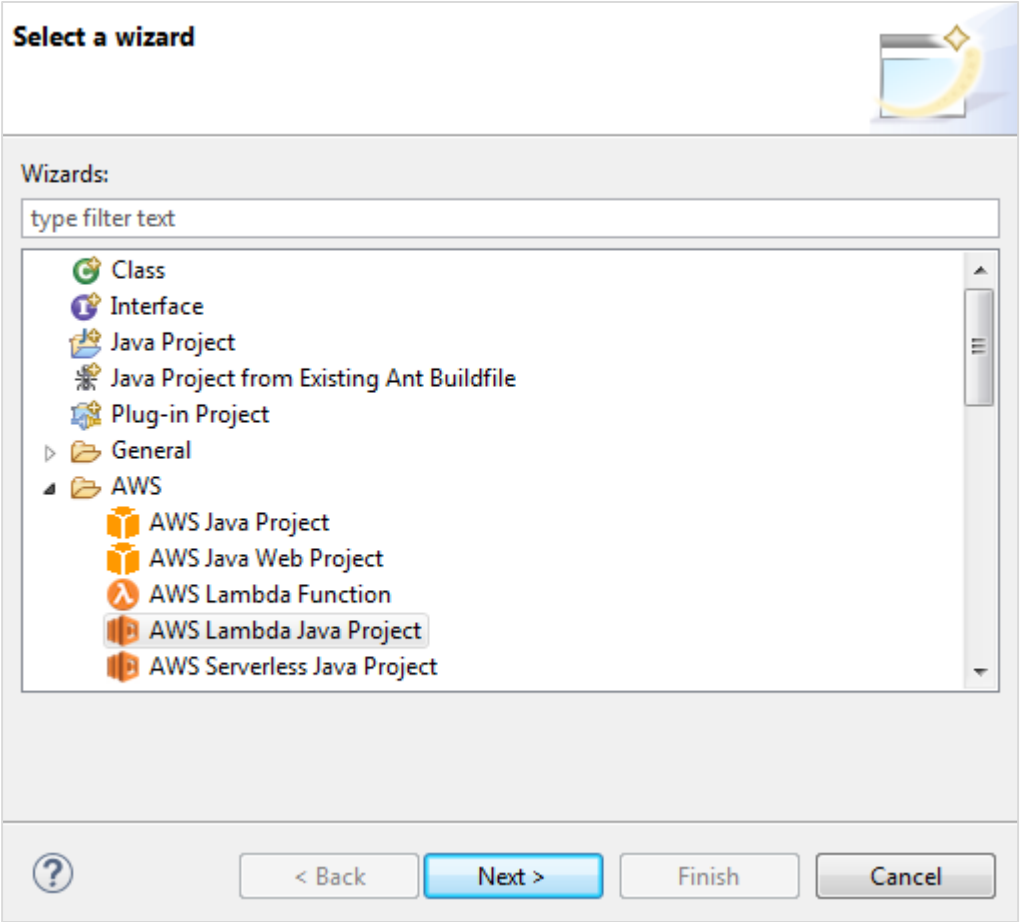
Creating JAR file in Eclipse

Before proceeding to work on creating a lambda function in AWS, we need AWS toolkit support for Eclipse. For any guidance on installation of the same, you can refer to the **Environment Setup** chapter in this tutorial.

Once you are done with installation, follow the steps given here:

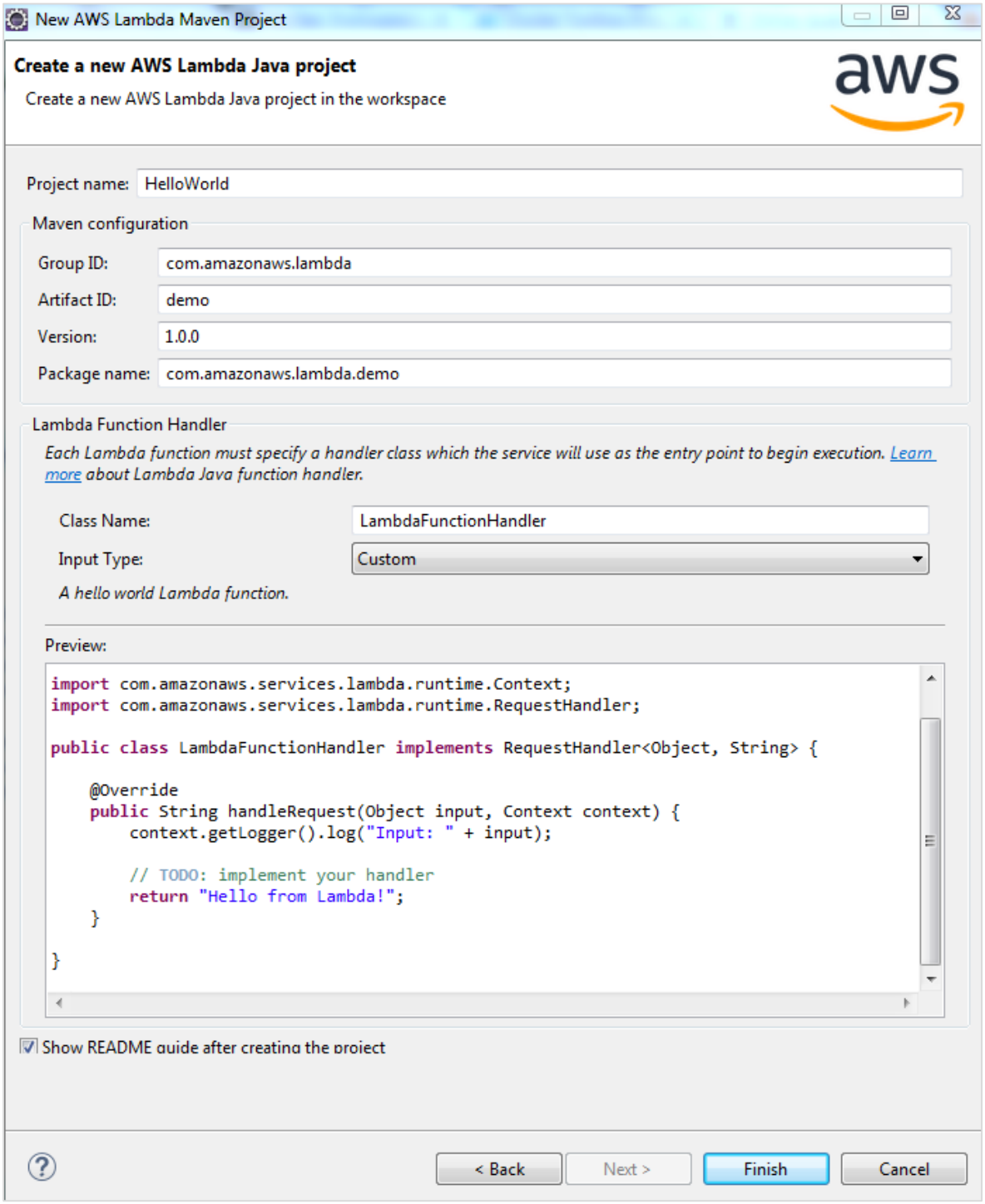
Step 1

Open Eclipse IDE and create a new project with **AWS Lambda Java Project**. Observe the screenshot given below for better understanding:



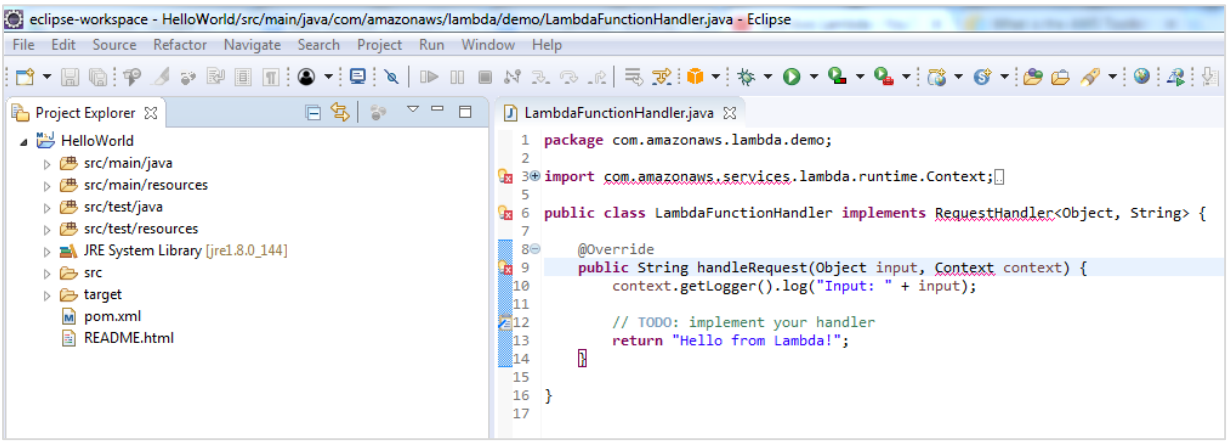
Step 2

Once you select **Next**, it will redirect you the screen shown below:



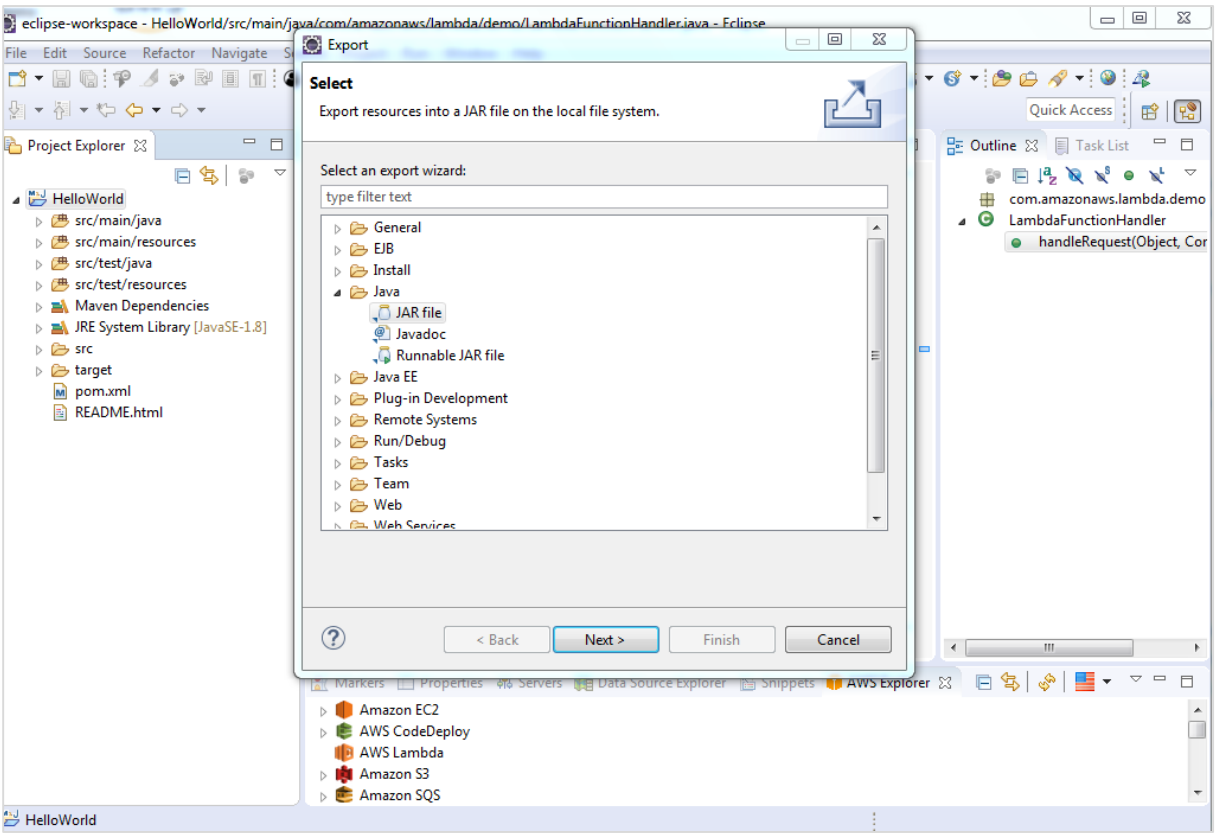
Step 3

Now, a default code is created for Input Type **Custom**. Once you click **Finish** button the project gets created as shown below:



Step 4

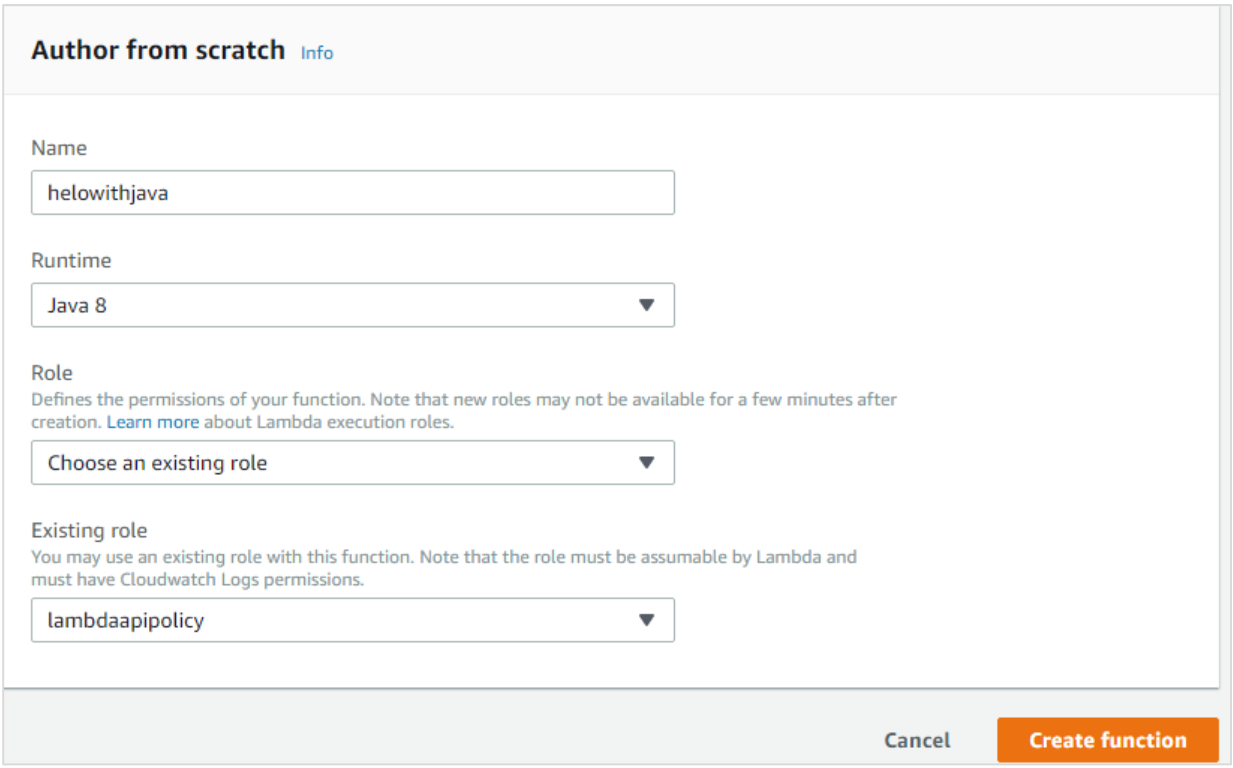
Now, right click your project and export it.Select **Java / JAR** file from the **Export** wizard and click **Next**.



Step 5

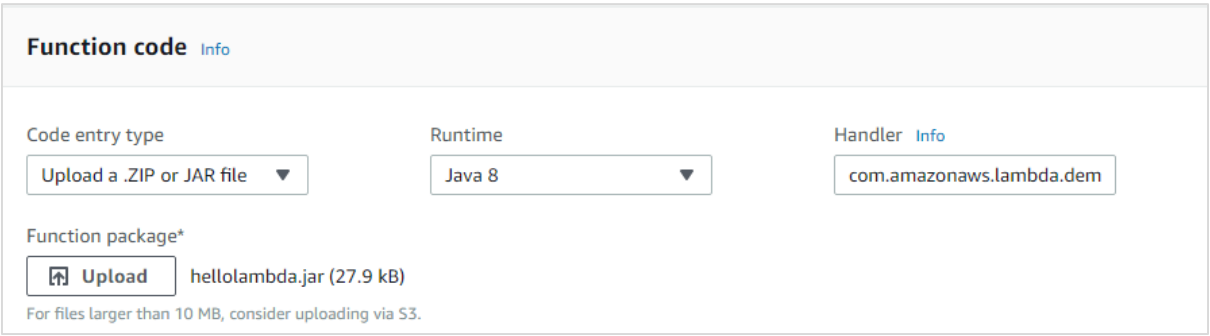
Now, if you click **Next,** you will be prompted save the file in the destination folder which will be asked when you click on next.

Once the file is saved, go back to AWS Console and create the AWS Lambda function for Java.



Step 6

Now, upload the **.jar** file that we created using the **Upload** button as shown in the screenshot given below:



Handler Details for Java

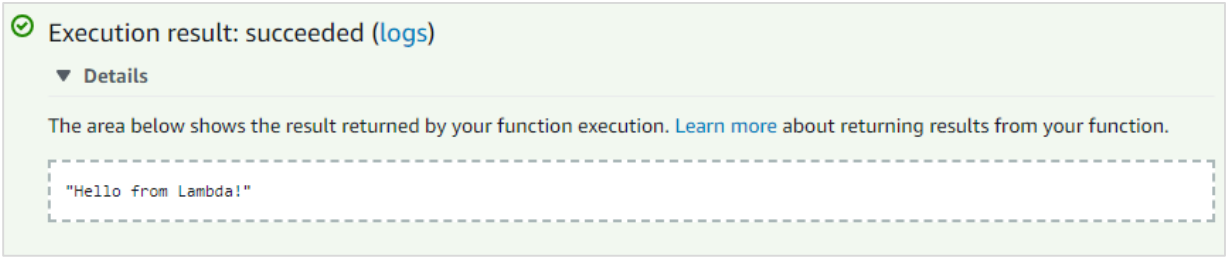
Handler is **package name** and **class name**. Look at the following example to understand **handler** in detail:

Example

```
package com.amazonaws.lambda.demo;


import com.amazonaws.services.lambda.runtime.Context;
import com.amazonaws.services.lambda.runtime.RequestHandler;
public class LambdaFunctionHandler implements RequestHandler<Object, String> {
    @Override
    public String handleRequest(Object input, Context context) {
        context.getLogger().log("Input: " + input);


        // TODO: implement your handler
        return "Hello from Lambda!";
    }
```

Observe that from the above code, the handler will be **com.amazonaws.lambda.demo.LambdaFunctionHandler**

Now, let us test the changes and see the output:



Context Object in Java

Interaction with AWS Lambda execution is done using the context. It provides following methods to be used inside Java:

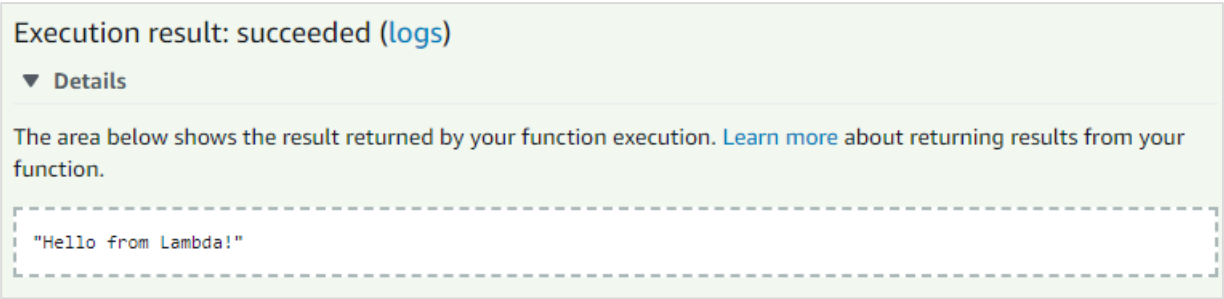
Context Methods	Description
getMemoryLimitInMB()	this will give the memory limit you specified while creating lambda function.
getFunctionName()	this will give the name of the lambda function.
getFunctionVersion()	this will give the version of the lambda function running.
getInvokedFunctionArn()	this will give the ARN used to invoke the function.
getAwsRequestId()	this will give the aws request id.This id gets created for the lambda function and it is unique.The id can be used with aws support incase if you face any issues.
getLogGroupName()	this will give the aws cloudwatch group name linked with aws lambda function created.It will be null if the iam user is not having permission for cloudwatch logging.
getClientContext()	this will give details about the app and device when used with aws mobile sdk .It will give details like version name and code, client id, title , app package name.It can be null.
getIdentity()	this will give details about the amazon cognito identity when used with aws mobile sdk.It can be null.
getRemainingTimeInMillis()	this will give the remaining time execution in milliseconds when the function is terminated after the specified timeout.

getLogger()	this will give the lambda logger linked with the context object.

Now, let us update the code given above and observe the output for some of the methods listed above. Observe the example code given below for a better understanding:

```
package com.amazonaws.lambda.demo;


import com.amazonaws.services.lambda.runtime.Context;

import com.amazonaws.services.lambda.runtime.RequestHandler;


public class LambdaFunctionHandler implements RequestHandler<Object, String> {


    @Override

    public String handleRequest(Object input, Context context) {

        context.getLogger().log("Input: " + input);

        System.out.println("AWS Lambda function name: " +
context.getFunctionName());

        System.out.println("Memory Allocated: " + context.getMemoryLimitInMB());

        System.out.println("Time remaining in milliseconds: " +
context.getRemainingTimeInMillis());

        System.out.println("Cloudwatch group name " + context.getLogGroupName());

        System.out.println("AWS Lambda Request Id " + context.getAwsRequestId());

        // TODO: implement your handler

        return "Hello from Lambda!";

    }

}
```

Once you run the code given above, you can find the output as given below:



Logs for context

You can observe the following output when you are viewing your log output:

Log output

The area below shows the logging calls in your code. These correspond to a single row within the CloudWatch log group corresponding to this Lambda function. Click here to view the CloudWatch log group.

```
START RequestId: 7518574f-5e3f-11e8-81cd-5f50a114f165 Version: $LATEST
Input: {key3=value3, key2=value2, key1=value1}AWS Lambda function name: helowithjava
Memory Allocated: 512
Time remaining in milliseconds: 24961
Cloudwatch group name /aws/lambda/helowithjava
AWS Lambda Request Id 7518574f-5e3f-11e8-81cd-5f50a114f165
END RequestId: 7518574f-5e3f-11e8-81cd-5f50a114f165
REPORT RequestId: 7518574f-5e3f-11e8-81cd-5f50a114f165  Duration: 54.80 ms      Billed Duration: 100 ms
Memory Size: 512 MB     Max Memory Used: 35 MB
```

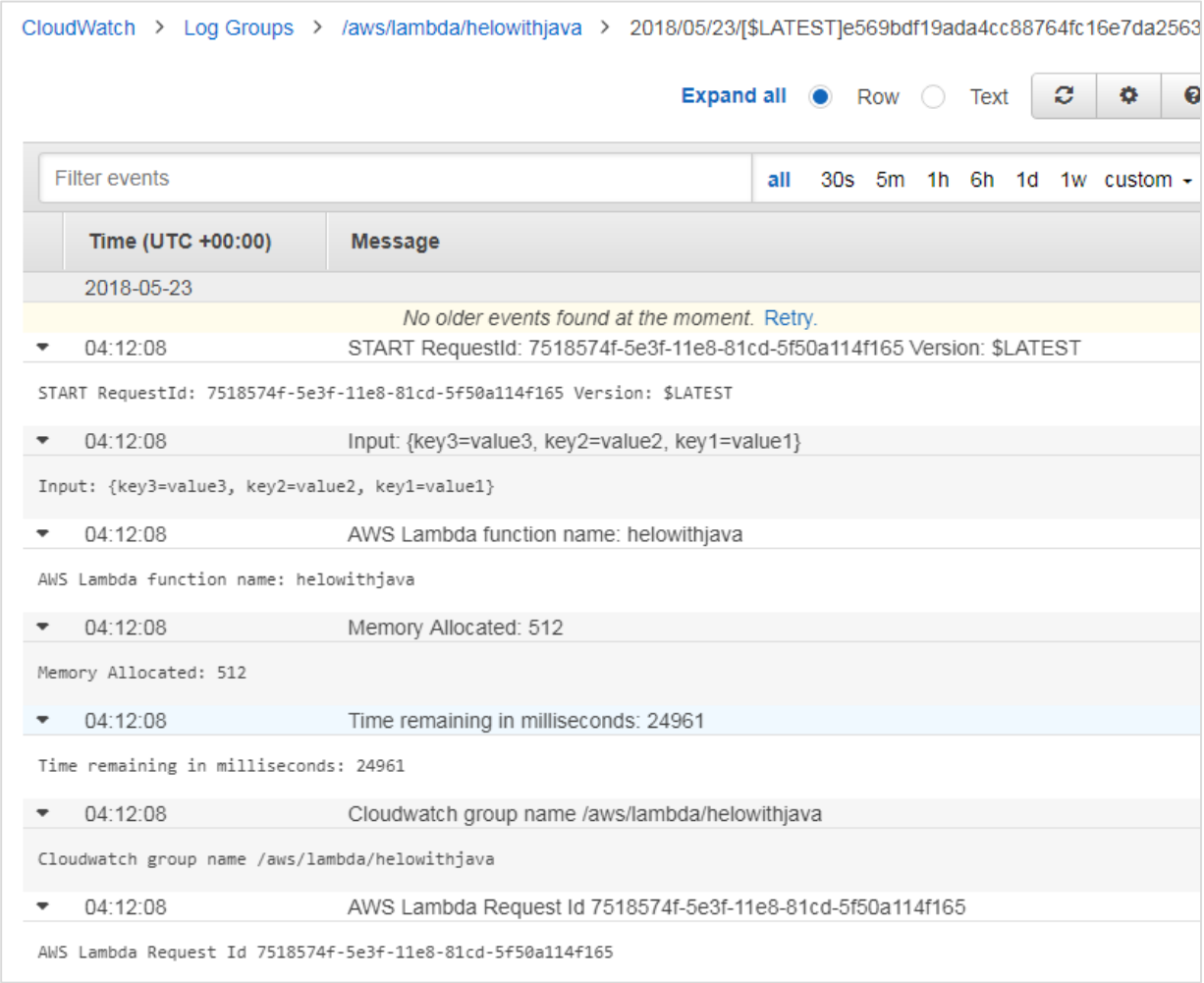
The memory allocated for the Lambda function is 512MB.The time allocated is 25 seconds. The time remaining as displayed above is 24961, which is in milliseconds. So 25000 - 24961 which equals to 39 milliseconds is used for the execution of the Lambda function. Note that Cloudwatch group name and request id are also displayed as shown above.

Note that we have used the following command to print logs in Java:

```
System.out.println ("log message")
```

The same is available in CloudWatch. For this ,go to AWS services, select **CloudWatch** services and click **Logs**.

Now, if you select the Lambda function, it will display the logs date wise as shown below:



Logging in Java

You can also use Lambdalogger in Java to log the data. Observe the following example that shows the same:

Example

```
package com.amazonaws.lambda.demo;

import com.amazonaws.services.lambda.runtime.Context;

import com.amazonaws.services.lambda.runtime.RequestHandler;

import com.amazonaws.services.lambda.runtime.LambdaLogger;

public class LambdaFunctionHandler implements RequestHandler<Object, String> {


    @Override
```

```
    public String handleRequest(Object input, Context context) {
     LambdaLogger logger = context.getLogger();
     logger.log("Input: " + input);
     logger.log("AWS Lambda function name: " + context.getFunctionName()+"\n");
     logger.log("Memory Allocated: " + context.getMemoryLimitInMB()+"\n");
     logger.log("Time remaining in milliseconds: " +
context.getRemainingTimeInMillis()+"\n");
     logger.log("Cloudwatch group name " + context.getLogGroupName()+"\n");
     logger.log("AWS Lambda Request Id " + context.getAwsRequestId()+"\n");
        // TODO: implement your handler
        return "Hello from Lambda!";
    }
```

The code shown above will give you the following output:

▼ **Details**

The area below shows the result returned by your function execution. Learn more about returning results from your function.

```
"Hello from Lambda!"
```

Summary

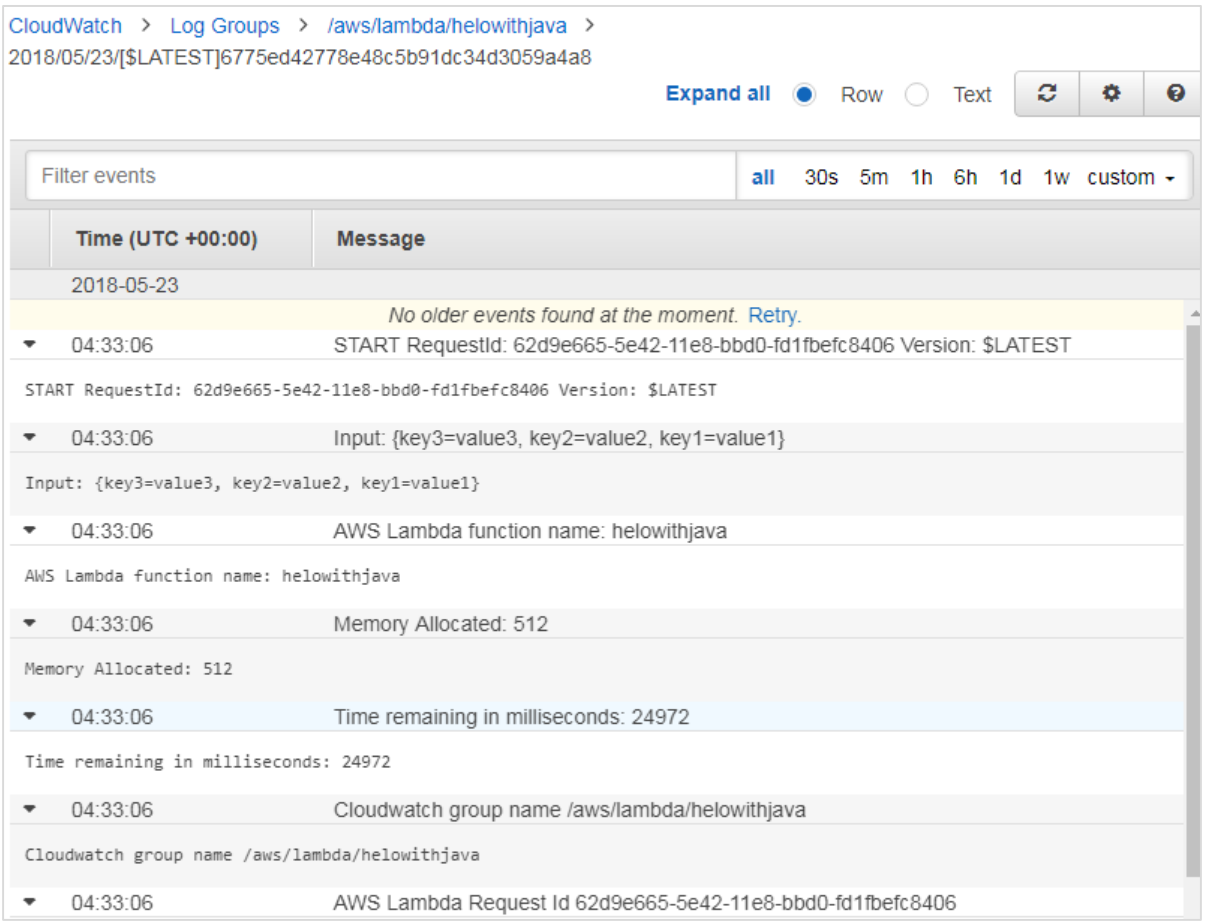
Code SHA-256	dmkplsnKUaiAb9/va73fRj+UmYV7r1[illegible]SZLSQ=	**Request ID**	62d9e665-5e42-11e8-bbd0-fd1fbefc8406
Duration	44.28 ms	**Billed duration**	100 ms
Resources configured	512 MB	**Max memory used**	34 MB

Log output

The area below shows the logging calls in your code. These correspond to a single row within the CloudWatch log group corresponding to this Lambda function. Click here to view the CloudWatch log group.

```
START RequestId: 62d9e665-5e42-11e8-bbd0-fd1fbefc8406 Version: $LATEST
Input: {key3=value3, key2=value2, key1=value1}AWS Lambda function name: helowithjava
Memory Allocated: 512
Time remaining in milliseconds: 24972
Cloudwatch group name /aws/lambda/helowithjava
AWS Lambda Request Id 62d9e665-5e42-11e8-bbd0-fd1fbefc8406
END RequestId: 62d9e665-5e42-11e8-bbd0-fd1fbefc8406
REPORT RequestId: 62d9e665-5e42-11e8-bbd0-fd1fbefc8406  Duration: 44.28 ms      Billed Duration: 100 ms
Memory Size: 512 MB     Max Memory Used: 34 MB
```

The output in CloudWatch will be as shown below:



Error handling in Java for Lambda Function

This section will explain how to handle errors in Java for Lambda function. Observe the following code that shows the same:

```
package com.amazonaws.lambda.errorhandling;
import com.amazonaws.services.lambda.runtime.Context;
import com.amazonaws.services.lambda.runtime.RequestHandler;
public class LambdaFunctionHandler implements RequestHandler<Object, String> {
    @Override
    public String handleRequest(Object input, Context context) {
     throw new RuntimeException("Error from aws lambda");
    } }
```

Note that the error details are displayed in **json** format with errorMessage **Error from AWS Lambda.** Also, the **ErrorType** and **stackTrace** gives more details about the error.

The output and the corresponding log output of the code given above will be as shownin the following screenshots given below:

Execution result: failed (logs)

▼ Details

The area below shows the result returned by your function execution. Learn more about returning results from your function.

```
{
  "errorMessage": "Error from aws lambda",
  "errorType": "java.lang.RuntimeException",
  "stackTrace": [
    "com.amazonaws.lambda.errorhandling.LambdaFunctionHandler.handleRequest(LambdaFunctionHandler.java:11)",
    "com.amazonaws.lambda.errorhandling.LambdaFunctionHandler.handleRequest(LambdaFunctionHandler.java:1)"
  ]
}
```

Log output

The area below shows the logging calls in your code. These correspond to a single row within the CloudWatch log group corresponding to this Lambda function. Click here to view the CloudWatch log group.

```
START RequestId: 85afa16d-6d6e-11e8-bb14-036c13ec7244 Version: $LATEST
Error from aws lambda: java.lang.RuntimeException
java.lang.RuntimeException: Error from aws lambda
        at com.amazonaws.lambda.errorhandling.LambdaFunctionHandler.handleRequest(LambdaFunctionHandler.java:11)
        at com.amazonaws.lambda.errorhandling.LambdaFunctionHandler.handleRequest(LambdaFunctionHandler.java:1)

END RequestId: 85afa16d-6d6e-11e8-bb14-036c13ec7244
REPORT RequestId: 85afa16d-6d6e-11e8-bb14-036c13ec7244  Duration: 651.61 ms     Billed Duration: 700 ms         Memory Size: 512
MB      Max Memory Used: 50 MB
```

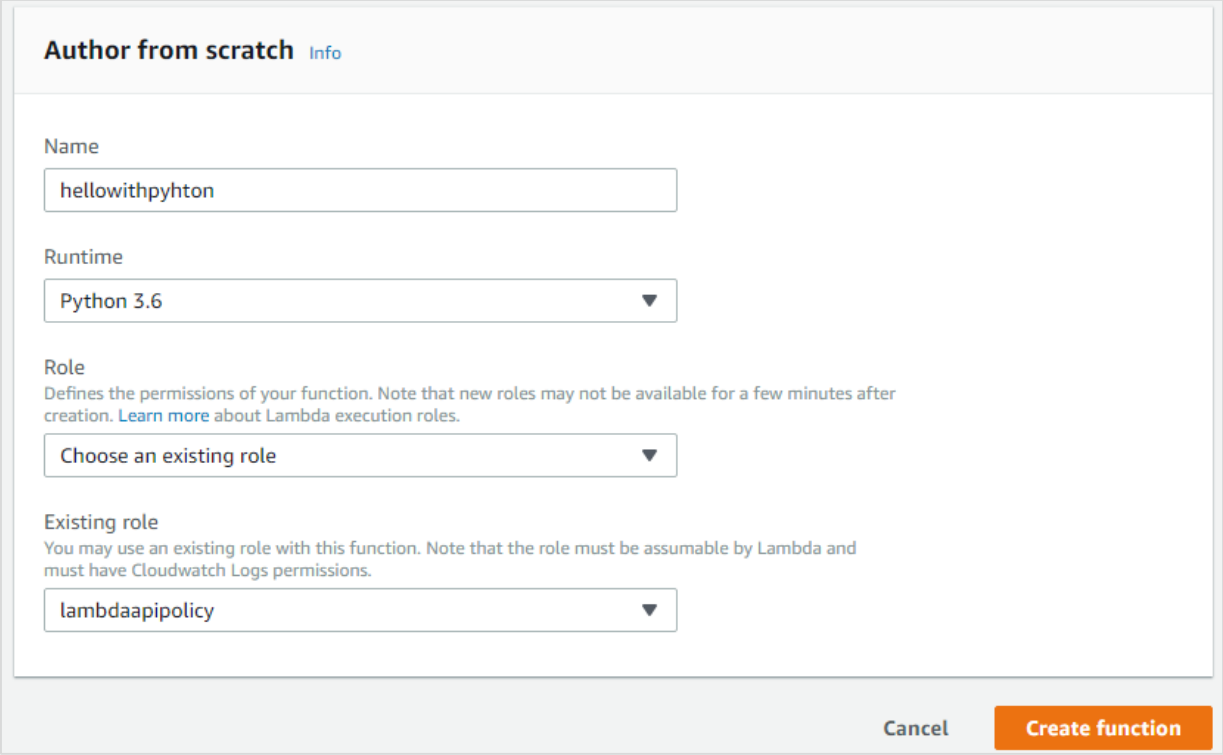
7. AWS Lambda — Function in Python

In this chapter, we will create a simple AWS Lambda function in Python and understand its working concepts following detail.

Before proceeding to work on creating a Lambda function in AWS, we need AWS toolkit support for Python. For this purpose, follow the steps given below and observe the corresponding screesnshots attached:

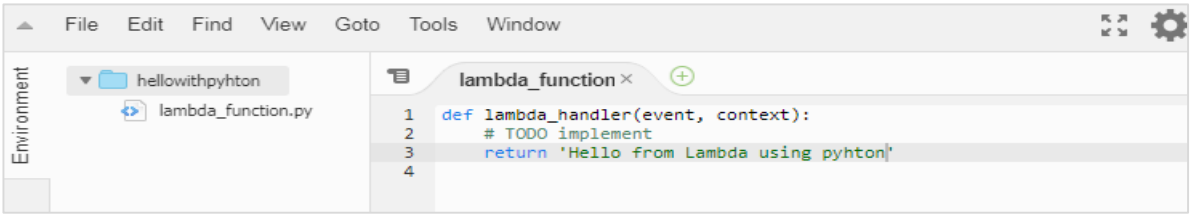
Step 1

Login to AWS console and create Lambda function and select the language as Python.



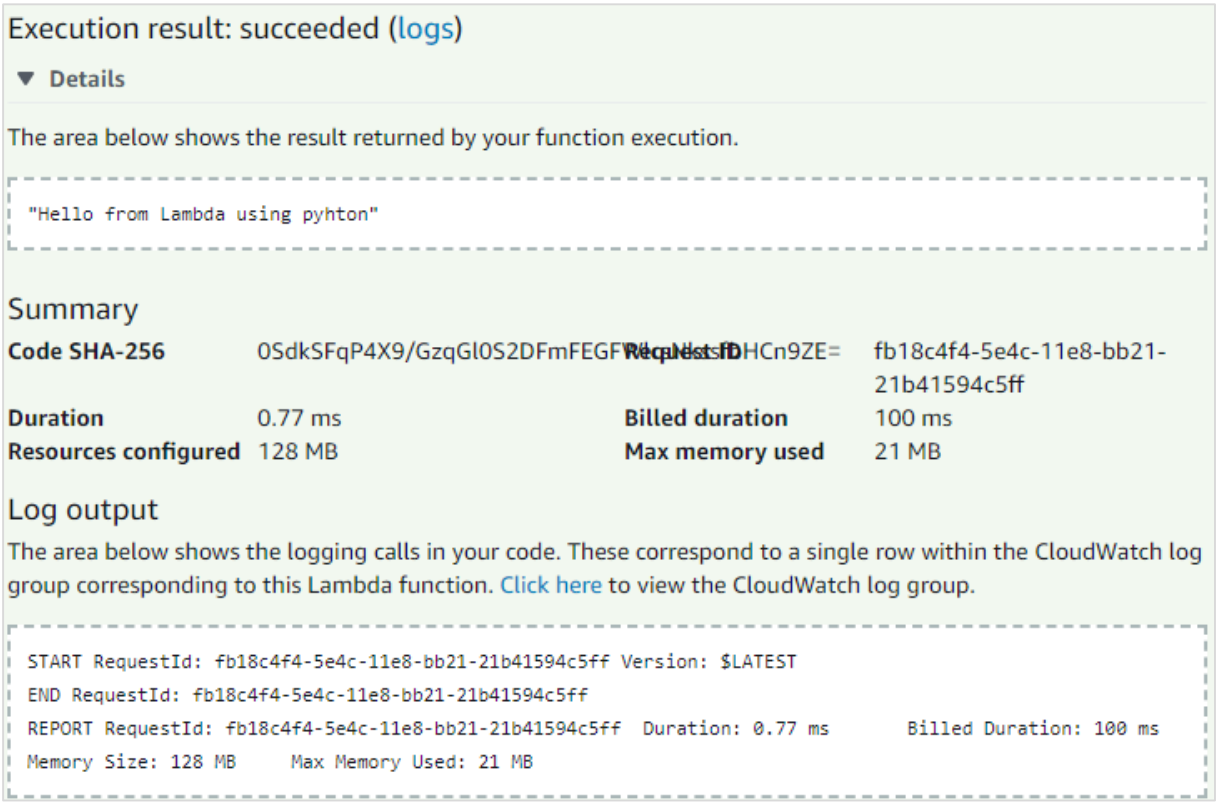
Step 2

Now, click **Create function** button and enter the details for creating a simple AWS Lambda in Python. This code returns the message **Hello from Lambda using Python** and looks as shown here:



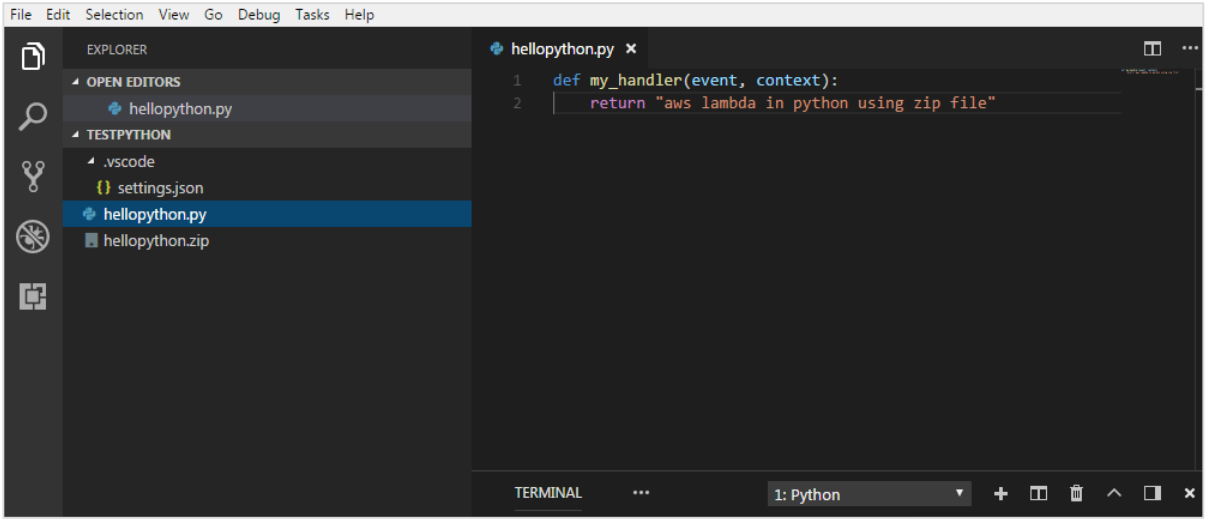
Step 3

Now, save the changes and the test the code to see the output. You should see the following output and logs when you test it in AWS console using the test button from the UI.



Step 4

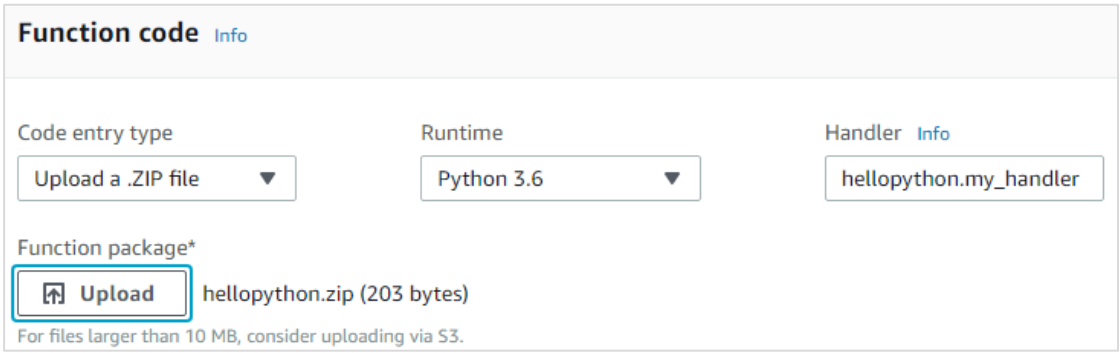
Now, you can write code inside any editor or an IDE for Python. Here, we are using visual studio code for writing the code. You should later zip the file and upload in AWS console.



Here, we have zipped the code and using it AWS console.

Step 5

Now, select **Upload a .ZIP file** option as shown below:



Handler Details for Python

Note that the handler has to be name of the file followed by name of the function. In the above case, our file name is **hellopython.py** and name of the function is **my_handler**; so the handler will be **hellopython.my_handler.**

Once the upload is done and changes are saved, it actually shows the details of the zip file in the online editor in AWS Lambda console. Now, let us test the code to see the output and logs.

Now, let us understand the details of the Lambda function using the following sample code:

```
def my_handler(event, context):
    return "aws lambda in python using zip file"
```

In the above code, the function name **my_handler** is having 2 params, **event** and **context**.

Context Object in Python

Context object gives details like the name of the Lambda function, time remaining in milliseconds, request id, cloudwatch group name, timeout details etc.

The methods and attributes available on context object are shown in the tables given below:

Method Name	Description
get_remaining_time_in_millis()	This method gives the remaining time in milliseconds until the lambda function terminates the function

Attribute name	Description
function_name	This gives aws lambda function name

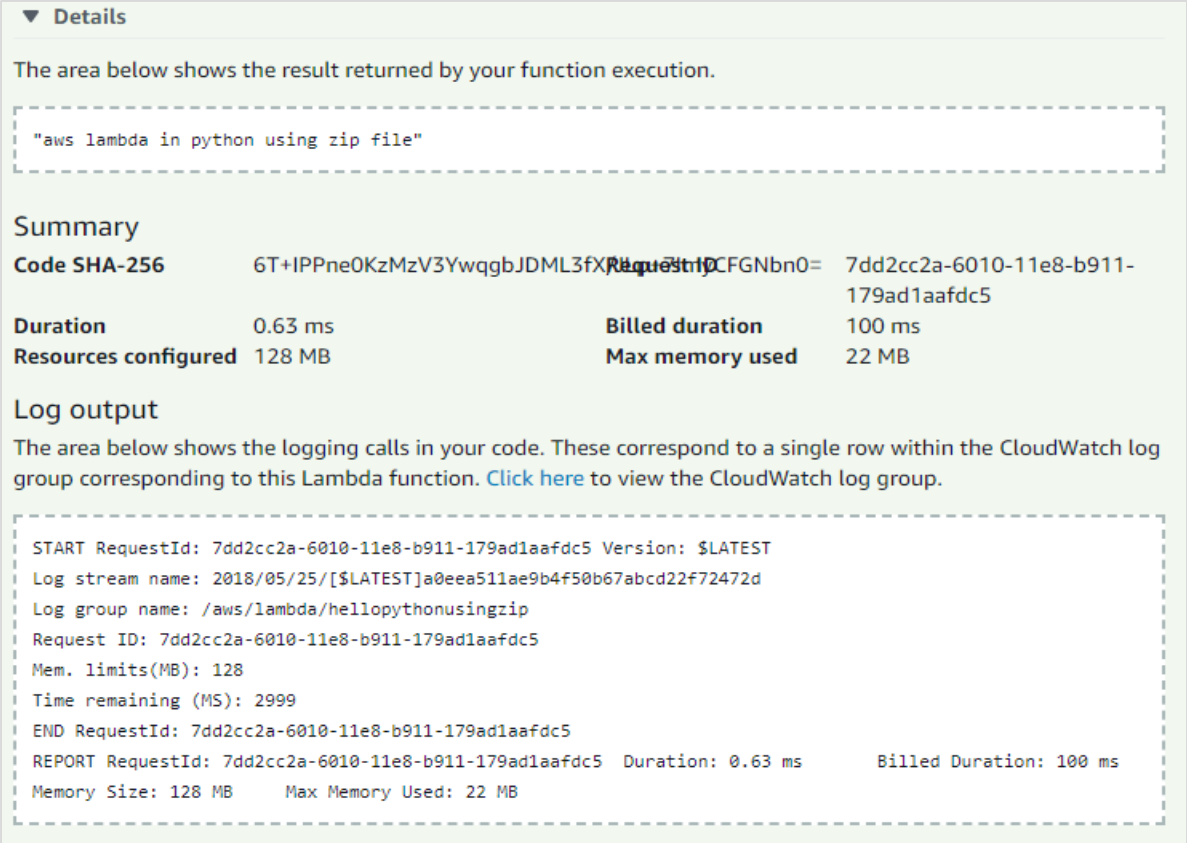
function_version	This gives the version of aws lambda function executing
invoked_function_arn	This will gives ARN details.
memory_limit_in_mb	This shows the memory limit added while creating lambda function
aws_request_id	This gives the aws request id.
log_group_name	This will give the name of the cloudwatch group name
log_stream_name	This will give the name of the cloudwatch log stream name where the logs are written.
identity	This will give details about amazon cognito identity provider when used with aws mobile sdk .Details given are as follows: identity.cognito_identity_id identity.cognito_identity_pool_id
client_context	This will details of the client application when used with aws mobile sdk. The details given are as follows: client_context.client.installation_id client_context.client.app_title client_context.client.app_version_name client_context.client.app_version_code client_context.client.app_package_name client_context.custom - it has dict of custom values from the mobile client app client_context.env - it has dict of environment details from the AWS Mobile SDK

Let us see a working example in Python which outputs the context details. Observe the code given below:

```
def my_handler(event, context):
```

```
    print("Log stream name:", context.log_stream_name)
    print("Log group name:",  context.log_group_name)
    print("Request ID:",context.aws_request_id)
    print("Mem. limits(MB):", context.memory_limit_in_mb)
    print("Time remaining (MS):", context.get_remaining_time_in_millis())
    return "aws lambda in python using zip file"
```

The corresponding output of the code shown above is given below:

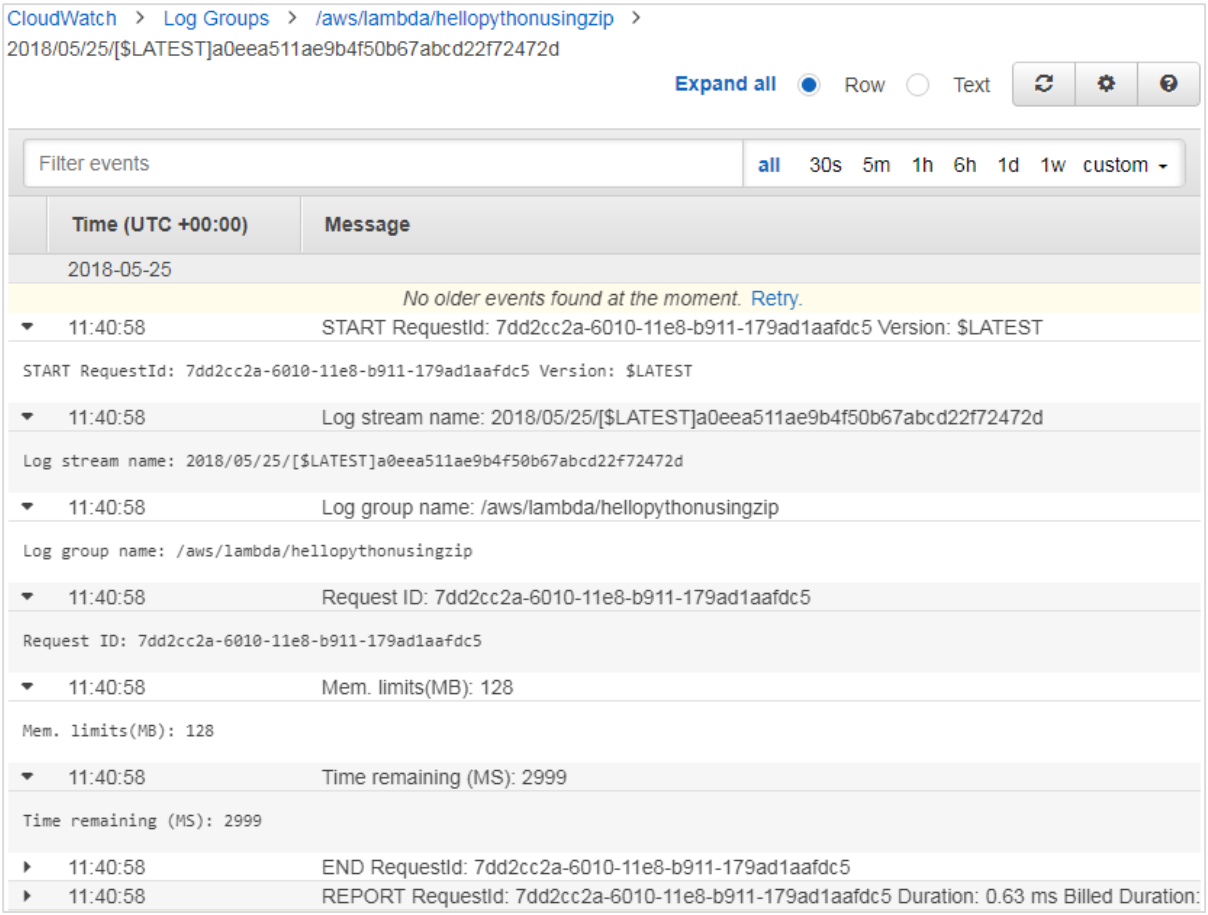


Logging using Python

To log info using Python, we can use print or logger function available. Let us use the above example of context and check in CloudWatch to see if the logs are printed. Observe the following code:

```
def my_handler(event, context):
    print("Log stream name:", context.log_stream_name)
    print("Log group name:",  context.log_group_name)
    print("Request ID:",context.aws_request_id)
    print("Mem. limits(MB):", context.memory_limit_in_mb)
    print("Time remaining (MS):", context.get_remaining_time_in_millis())
    return "aws lambda in python using zip file"
```

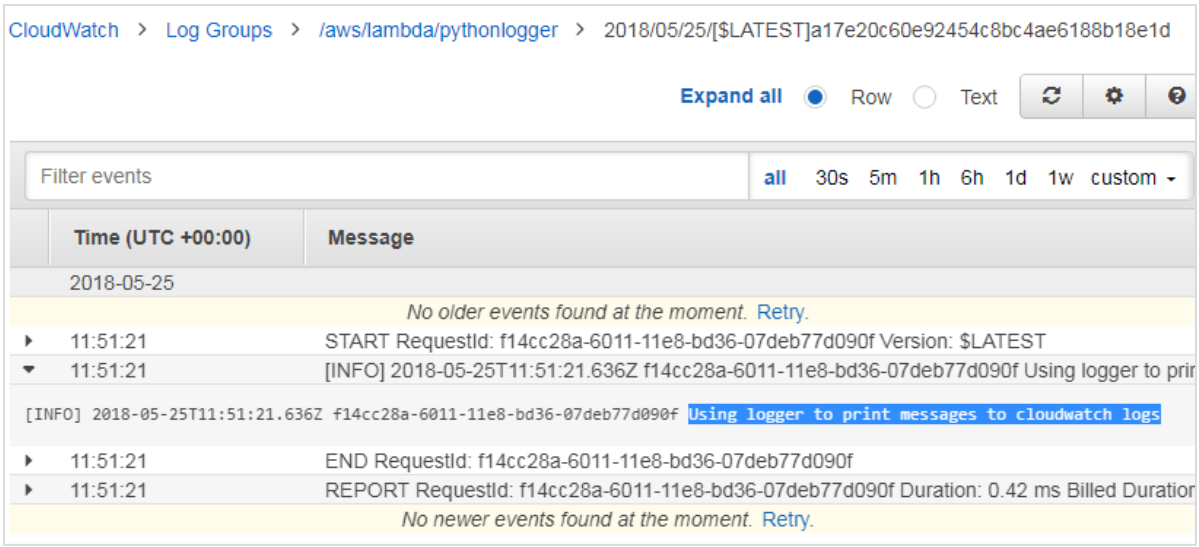
The output of this code in CloudWatch is as shown below:



\ Observe the following example to understand about using logger to print logs to CloudWatch:

```
import logging
logger = logging.getLogger()
logger.setLevel(logging.INFO)
def my_handler(event, context):
    logger.info('Using logger to print messages to cloudwatch logs')
    return "aws lambda in python using zip file"
```

The output for this will be as shown in the screenshot given below:



Error Handling in Python for Lambda function

In this section , let us see a working example which shows how to handler errors in Python. Observe the piece of code given here:

```
def error_handler(event, context):
    raise Exception('Error Occured!')
```

The log display is as shown in the image here:

Log output

The area below shows the logging calls in your code. These correspond to a single row within the CloudWatch log group corresponding to this Lambda function. Click here to view the CloudWatch log group.

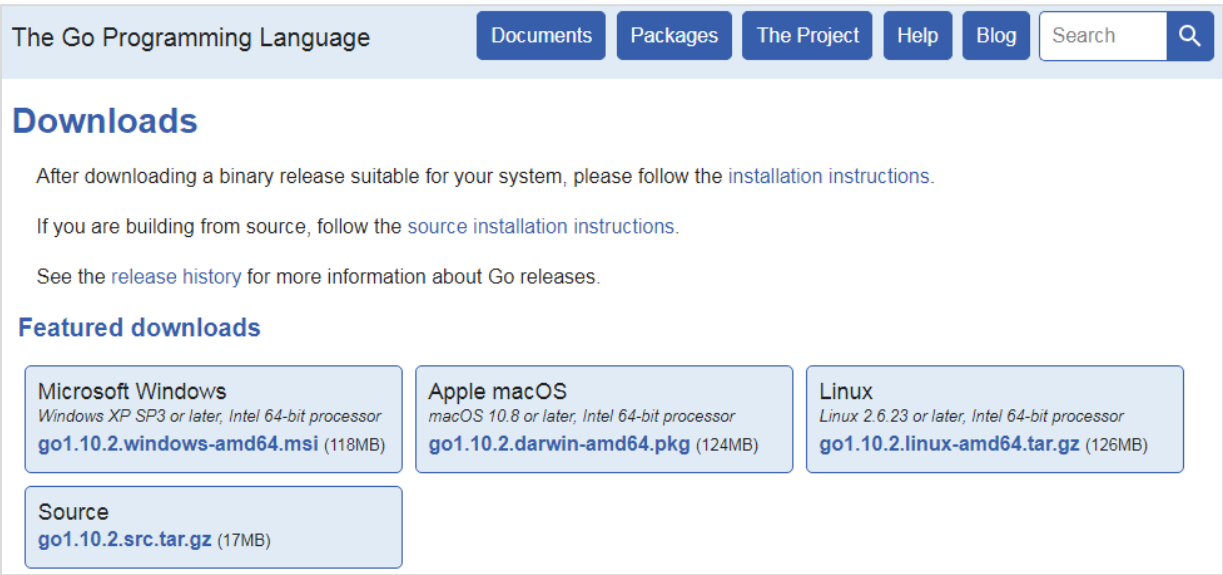
```
START RequestId: e030c3e9-6012-11e8-81e9-d52528b906a6 Version: $LATEST
Error Occured!: Exception
Traceback (most recent call last):
  File "/var/task/errorhandlingpython.py", line 2, in error_handler
    raise Exception('Error Occured!')
Exception: Error Occured!

END RequestId: e030c3e9-6012-11e8-81e9-d52528b906a6
REPORT RequestId: e030c3e9-6012-11e8-81e9-d52528b906a6  Duration: 1.01 ms       Billed Duration: 100 ms
Memory Size: 128 MB     Max Memory Used: 21 MB
```

8. AWS Lambda — Function in Go

Go Language support is a recent addition to AWS . To work with Go, you need to select the language from AWS console while creating the AWS Lambda function. In this chapter, let us learn in detail about AWS Lambda function in Go language.

Installing Go

To get started we need Go Language support. In this section, we will go through following details to start working with AWS Lambda in Go. This is the official site for Go download: https://golang.org/dl/

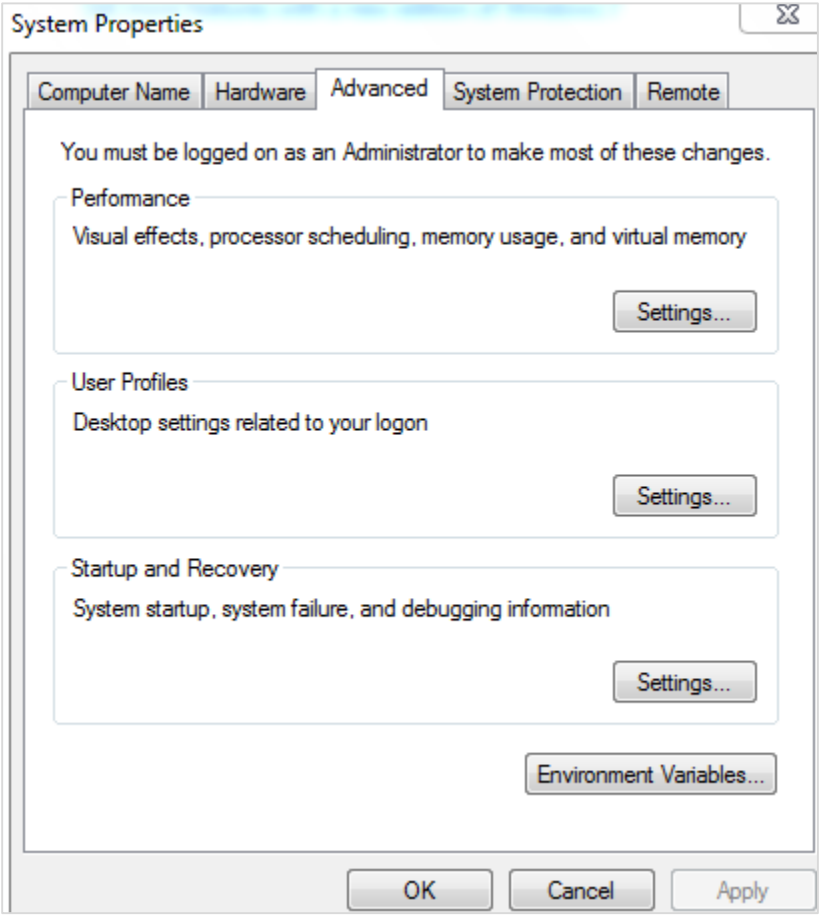


Now, download the package as per the operating system. Follow the procedure given here to install Go on the respective operating system.

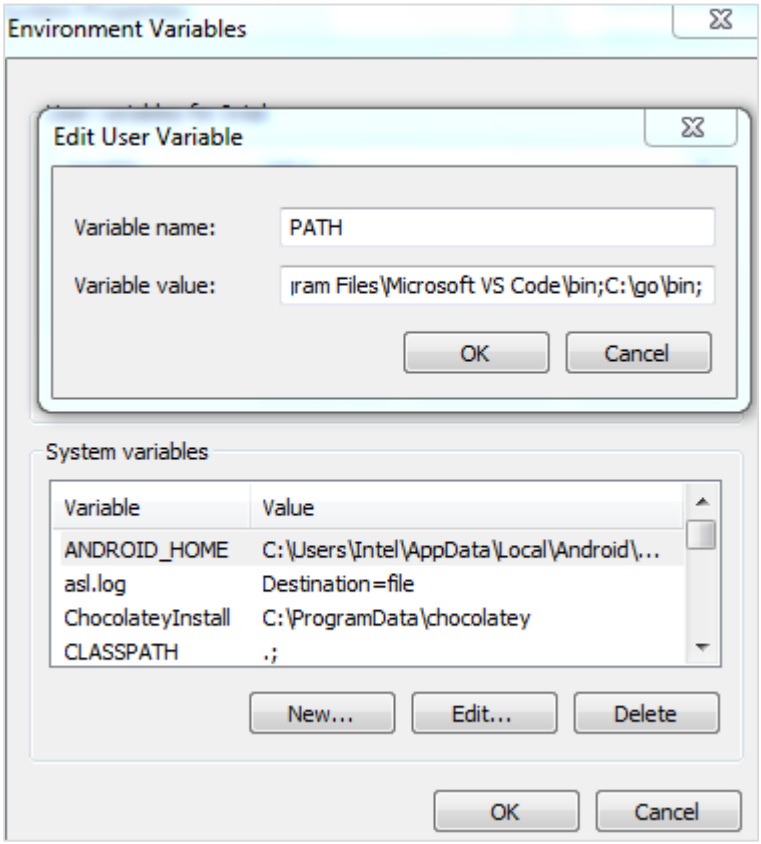
Installation on Windows

Observe that for Windows, there is 32-bit and 64-bit download available. Download the zip file and extract the contents and store it in a directory of your choice.

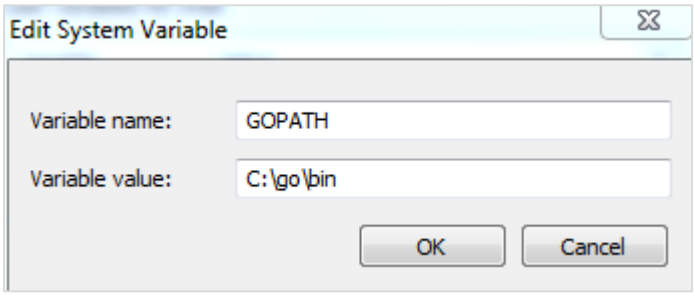
Add the environment variables available at **ControlPanel ---> System ---> Advanced system settings.**



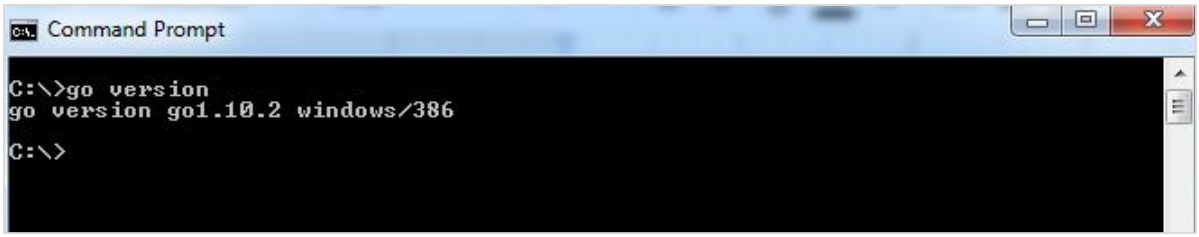
Now, click **Environment Variables** button and add the directory path as shown here:



You can also edit the sytem variable as shown here:



Once these steps are done, you should be able to start working with Go. Open command prompt and check the Go command for version. Observe the following screenshot for the same.



Installation for Linux and Mac OS

For installating packages on Linux and Mac OS, follow the instruction as shown below:

Unpack the packages and store it at the location **/usr/local/go**. Now, add **/usr/local/go/bin** to the PATH environment variable. It can be done using **/etc/profile** or **$HOME/.profile**.

For this purpose, you can use the following command

```
export PATH=$PATH:/usr/local/go/bin
```

To add AWS support to for Windows, Linux and mac, use the following in your git command line:

```
go.exe get -u github.com/aws/aws-lambda-go/lambda

go.exe get -u github.com/aws/aws-lambda-go/lambdacontext

go.exe get -u github.com/aws/aws-lambda-go/cmd/build-lambda-zip
```

To compile the code Windows/Linux/Mac, use the following commands:

```
GOOS=linux GOARCH=amd64 go build -o main main.go

%GOPATH%\bin\build-lambda-zip.exe -o main.zip main
```

AWS Lambda Function using GO

A program returned in Go when build gives an executable file. The following is a simple program in Go with AWS Lambda support. We need to import the **github.com/aws/aws-lambda-go/lambda**, as this has the Lambda programming functionality. Another important need for AWS Lambda is the handler.

Main.go

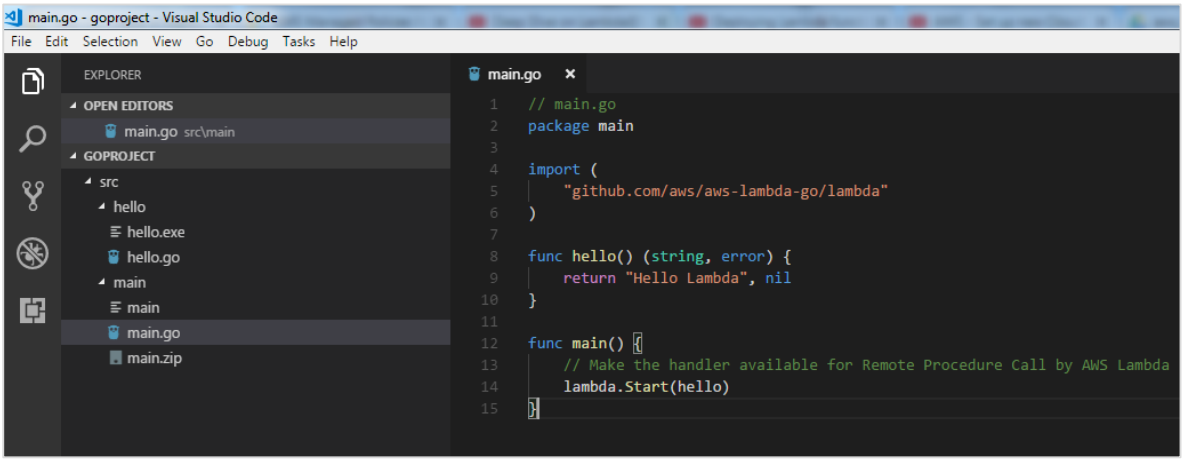
```
// main.go
package main

import (
	"github.com/aws/aws-lambda-go/lambda"
)

func hello() (string, error) {
	return "Hello Lambda", nil
}

func main() {
	// Make the handler available for Remote Procedure Call by AWS Lambda
	lambda.Start(hello)
}
```

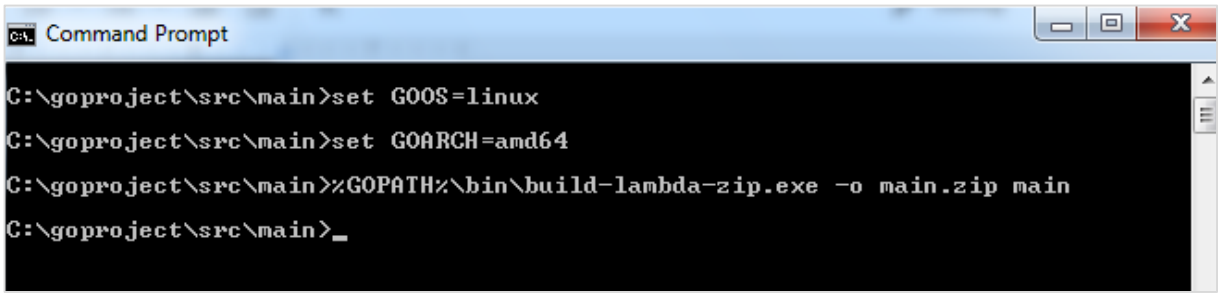
Note that the execution of the **Go** program starts from main where **lambda.start** is called with the handler function. Observe the code shown below:

```
func main() {
	// Make the handler available for Remote Procedure Call by AWS Lambda
	lambda.Start(hello)
}
```

Now, let us execute the above file using Go command and then zip the executable file.

The structure of the file we have been using is as shown here:



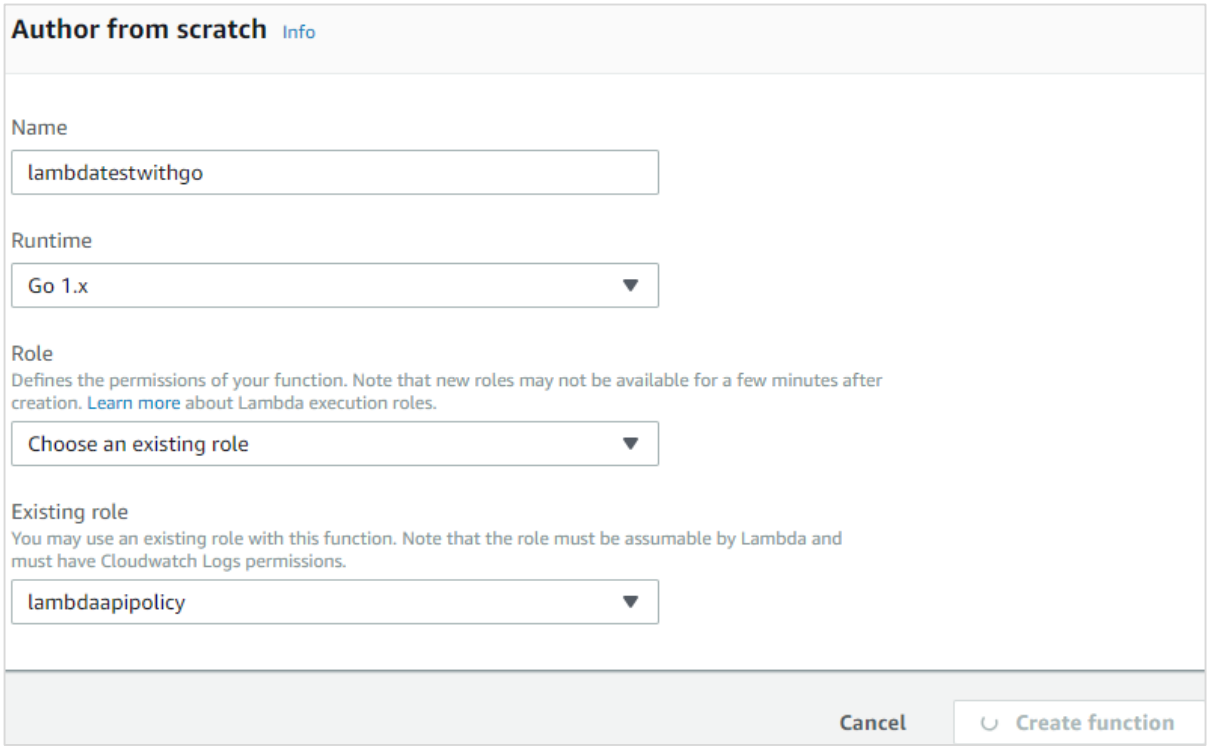


With **go build,** it creates an executable file called main.exe. To zip the file and upload it in AWS Lambda, you can use the following procedure:

To compile the code Windows/Linux/Mac, use the following commands:

```
GOOS=linux GOARCH=amd64 go build -o main main.go
%GOPATH%\bin\build-lambda-zip.exe -o main.zip main
```

Then, login into AWS console and create Lambda function using **Go** as runtime :



Once the function is created, upload the executable zip file created above.

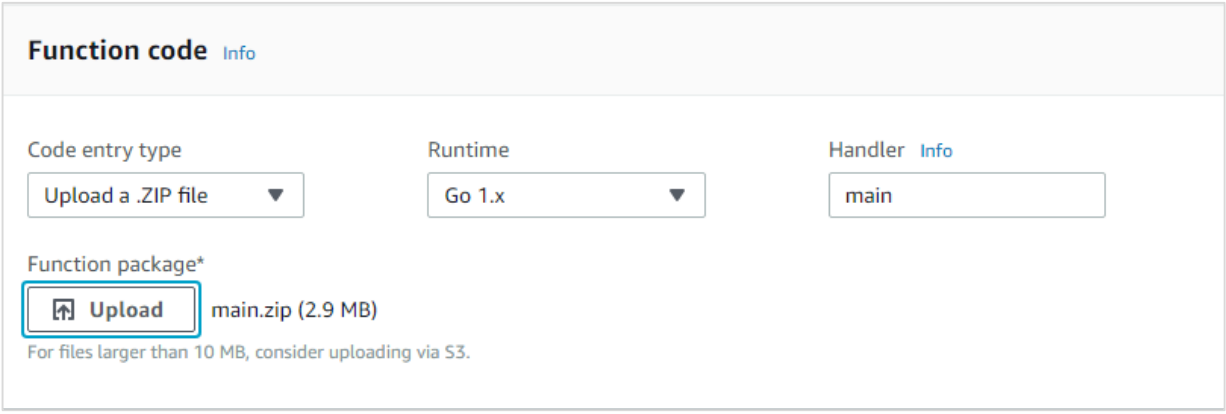
Lambda function handler with Go

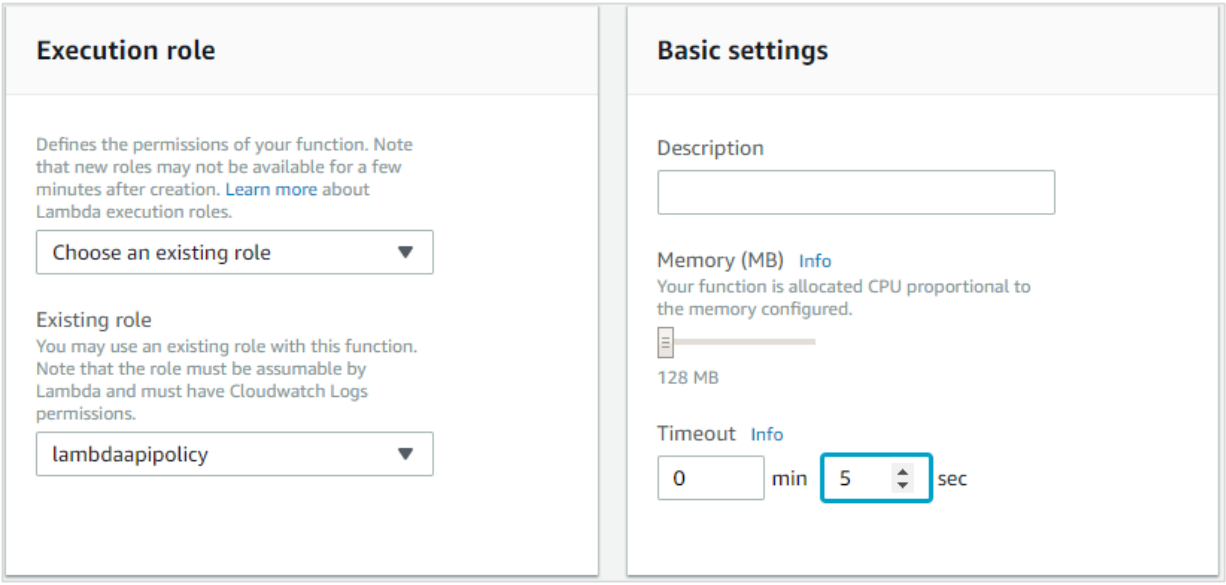
Handler is where the execution of the Go program starts. From main call to **lambda.start,** execution is called with the handler function. Note that the handler to be added will be **main.**

Observe the code here for an understanding:

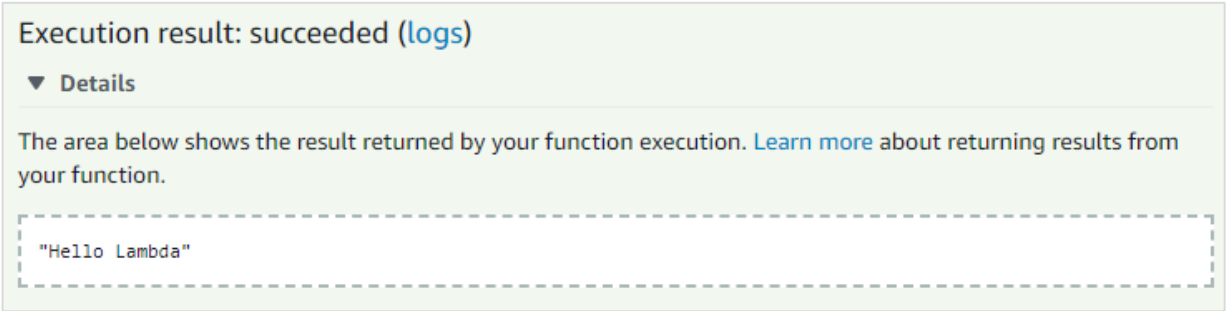
```
func main() {
     // Make the handler available for Remote Procedure Call by AWS Lambda
     lambda.Start(hello)
}
```

Follow as per the screenshots given below:





Now, save the function and test it. You can see the execution result as shown here.



The corresponding log output will be as shown here:

Log output

The area below shows the logging calls in your code. These correspond to a single row within the CloudWatch log group corresponding to this Lambda function. Click here to view the CloudWatch log group.

```
START RequestId: b7b133b6-6a0e-11e8-ad05-f9a913806046 Version: $LATEST
END RequestId: b7b133b6-6a0e-11e8-ad05-f9a913806046
REPORT RequestId: b7b133b6-6a0e-11e8-ad05-f9a913806046  Duration: 0.94 ms       Billed Duration: 100 ms
Memory Size: 704 MB     Max Memory Used: 26 MB
```

Context object with Go

AWS Lambda in Go gives following global variables and properties for context.

- MemoryLimitInMB: Memory limit, in MB that is configured in aws lambda.
- FunctionName: name of aws lambda function.
- FunctionVersion: the version of aws lambda function executing.
- LogStreamName: cloudwatch logstream name.
- LogGroupName: cloudwatch group name

The properties available on context are given as under:

AwsRequestID

This is AWS request id which you get when AWS Lambda function is invoked.

ClientContext

This contains details about the client application and device when invoked through the AWS Mobile SDK. It can be null. Client context provides details like client ID, application title, version name, version code, and the application package name.

InvokedFunctionArn

The ARN of the function invoked. An unqualified ARN executes the $LATEST version and aliases execute the function version it is pointing to.

Identity

It gives details about the Amazon Cognito identity provider when used with AWS mobile SDK.

The changes added to **main.go** to print context details:

```
// main.go
package main

import (
	"context"
	"log"
	"github.com/aws/aws-lambda-go/lambda"
	"github.com/aws/aws-lambda-go/lambdacontext"
)

func hello(ctx context.Context) (string, error) {
	lc, _ := lambdacontext.FromContext(ctx);
	log.Print(lc);
	log.Print(lc.AwsRequestID);
	log.Print(lc.InvokedFunctionArn);

	return "Hello Lambda", nil
}

func main() {
	// Make the handler available for Remote Procedure Call by AWS Lambda
	lambda.Start(hello)
}
```

We need to import the **log** and **lambdacontext** to use it with Go. The context details are as follows:

```
func hello(ctx context.Context) (string, error) {
      lc, _ := lambdacontext.FromContext(ctx);
      log.Print(lc);
      log.Print(lc.AwsRequestID);
      log.Print(lc.InvokedFunctionArn);
      return "Hello Lambda", nil
}
```

You can observe the following output on testing the above code:

Execution result: succeeded (logs)

▼ Details

The area below shows the result returned by your function execution. Learn more about returning results from your function.

```
"Hello Lambda"
```

Summary

Code SHA-256	IQTrx5wJEfp2tkSkHG4q0lJDUTzpIu[illegible]UuEU=	**Request ID**	e75e1dd2-6a21-11e8-ac34-1de2b4c1b027
Duration	0.79 ms	**Billed duration**	100 ms
Resources configured	704 MB	**Max memory used**	26 MB

Log output

The area below shows the logging calls in your code. These correspond to a single row within the CloudWatch log group corresponding to this Lambda function. Click here to view the CloudWatch log group.

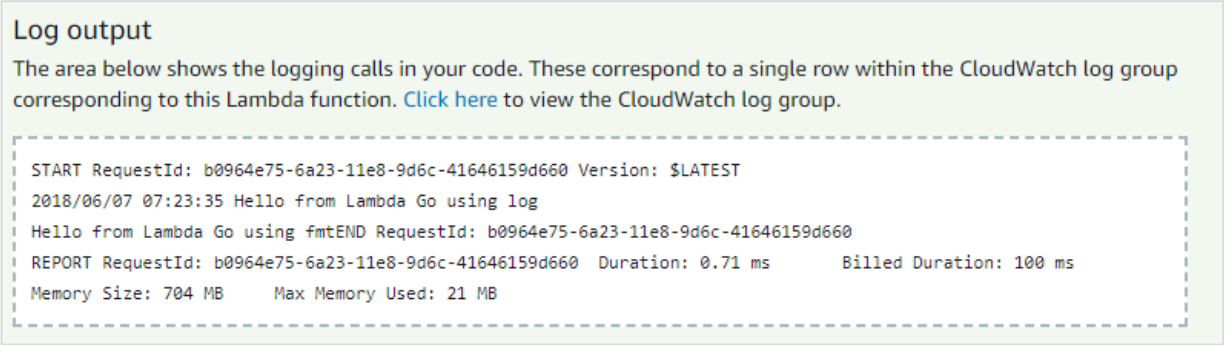
```
START RequestId: e75e1dd2-6a21-11e8-ac34-1de2b4c1b027 Version: $LATEST
2018/06/07 07:10:48 &{e75e1dd2-6a21-11e8-ac34-1de2b4c1b027 arn:aws:lambda:us-east-
1:625297745038:function:lambdatestwithgo { } {{   } map[] map[]}}
2018/06/07 07:10:48 e75e1dd2-6a21-11e8-ac34-1de2b4c1b027
2018/06/07 07:10:48 arn:aws:lambda:us-east-1:625297745038:function:lambdatestwithgo
END RequestId: e75e1dd2-6a21-11e8-ac34-1de2b4c1b027
REPORT RequestId: e75e1dd2-6a21-11e8-ac34-1de2b4c1b027  Duration: 0.79 ms       Billed Duration: 100 ms
Memory Size: 704 MB     Max Memory Used: 26 MB
```

Logging data

With **Go** you can log data using the log or fmt module as shown below:

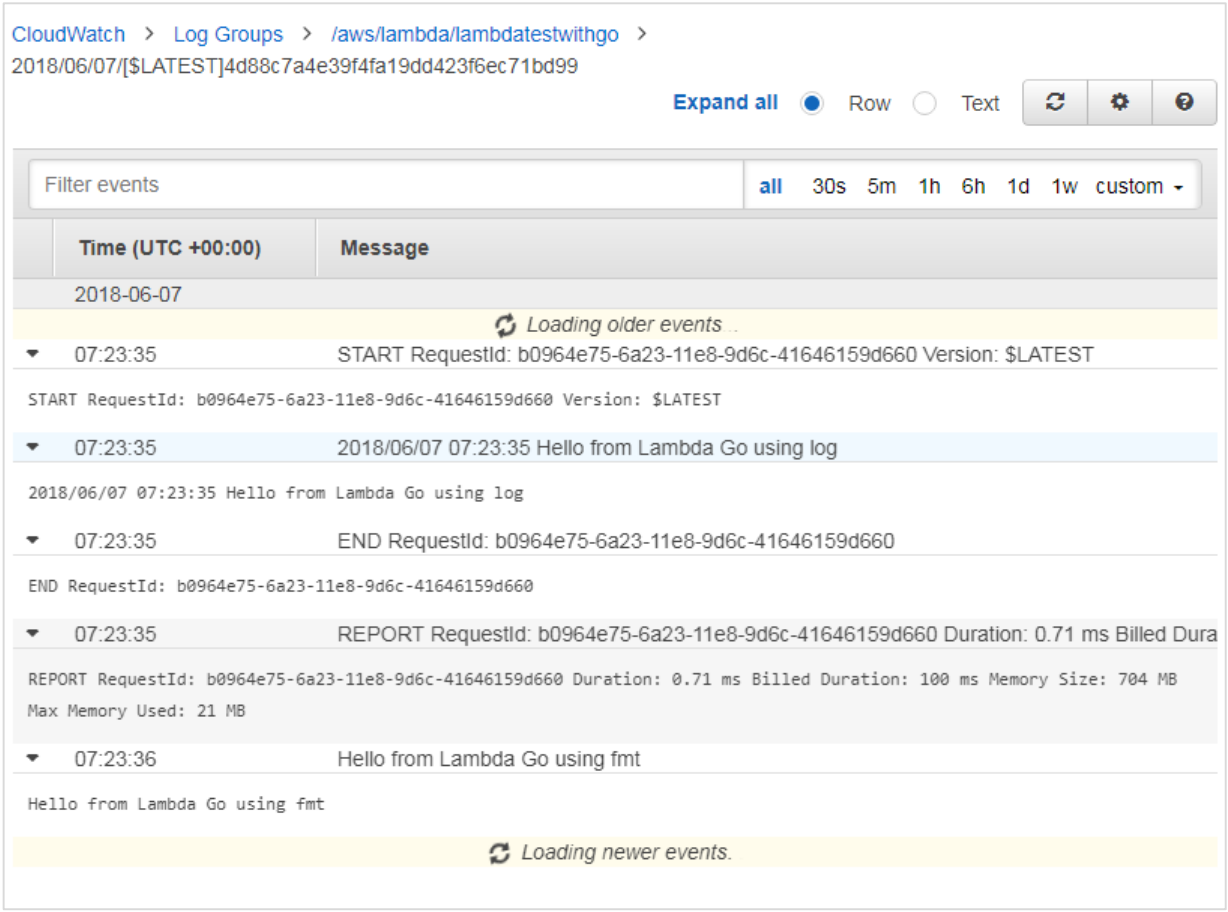
```
// main.go
package main

import (
	"log"
	"fmt"
	"github.com/aws/aws-lambda-go/lambda"
)

func hello() (string, error) {
	log.Print("Hello from Lambda Go using log");
	fmt.Print("Hello from Lambda Go using fmt");
	return "Hello Lambda", nil
}

func main() {
	// Make the handler available for Remote Procedure Call by AWS Lambda
	lambda.Start(hello)
}
```

The output for same is as shown below:



Checking Logs in CloudWatch

You can see the logs in CloudWatch also. For this, go to AWS service and select cloudwatch and click **Logs** on left side. Now, search for Lambda function in the list to see the logs:



Function Errors

You can create custom error handling in AWS Lambda using the errors module as shown in the code below:

```
// main.go
package main

import (
	"errors"
	"github.com/aws/aws-lambda-go/lambda"
)

func hello() error  {
	return errors.New("There is an error in the code!")
}

func main() {
	// Make the handler available for Remote Procedure Call by AWS Lambda
	lambda.Start(hello)
}
```

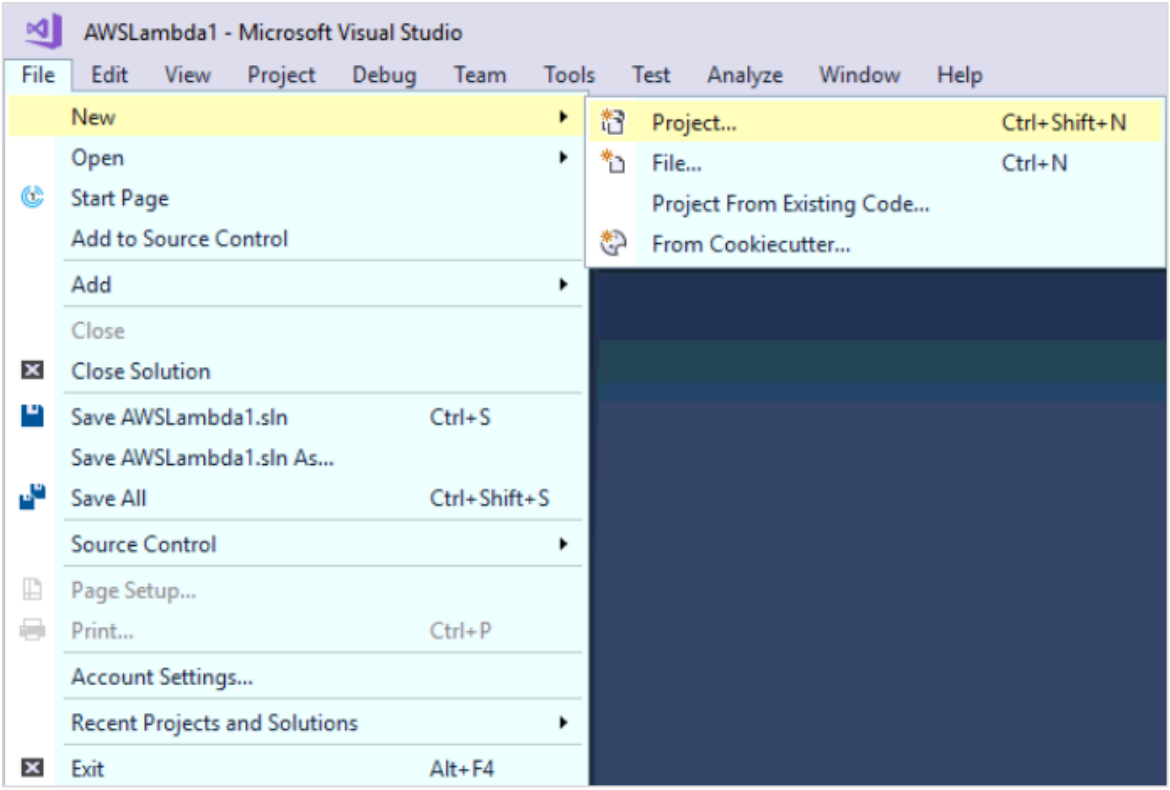
The output for the code shown above is as given below:

9. AWS Lambda — Function in C#

This chapter will explain you how to work with AWS Lambda function in C# in detail. Here, we are going to use visual studio to write and deploy the code to AWS Lambda. For any information and help regarding installation of Visual studio and adding AWS toolkit to Visual Studio, please refer to the **Introduction** chapter in this tutorial. Once you are done with installation of Visual Studio, please follow the steps given below.Refer to the respective screenshots for a better understanding:

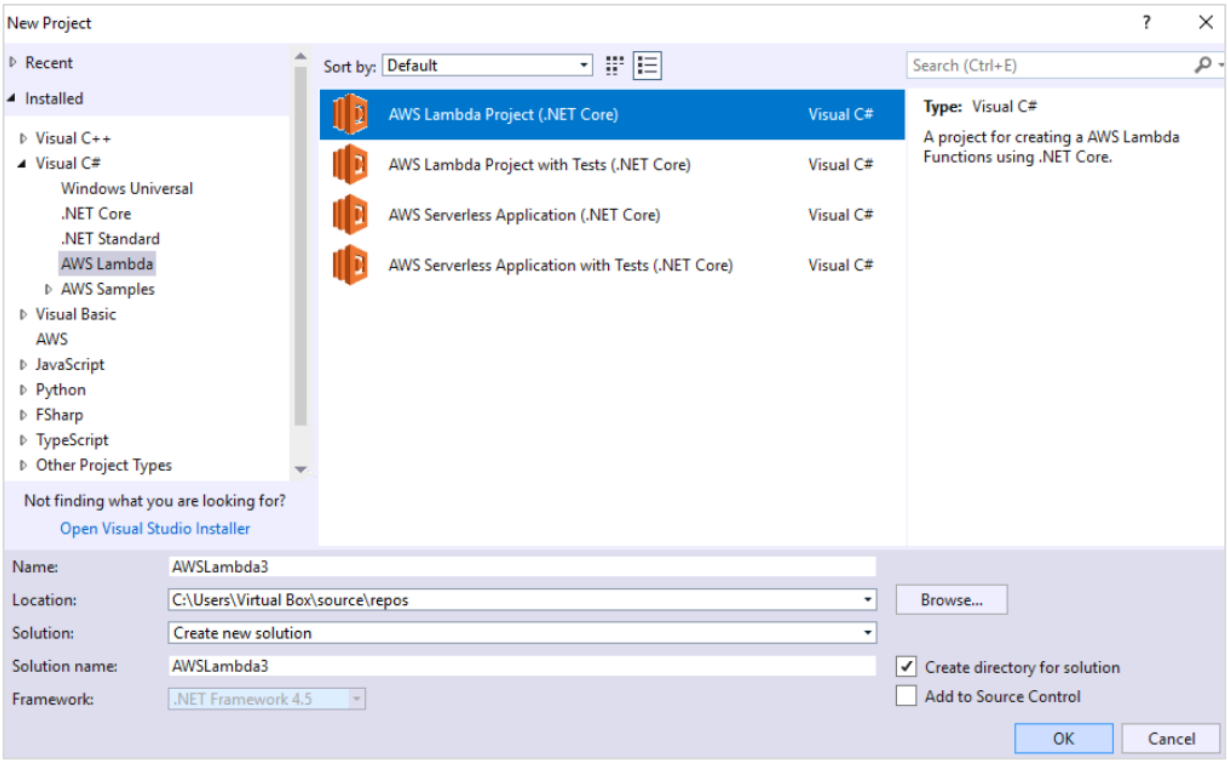
Step 1

Open your Visual Studio and follow the steps to create new project. Click on **File -> New -> Project.**



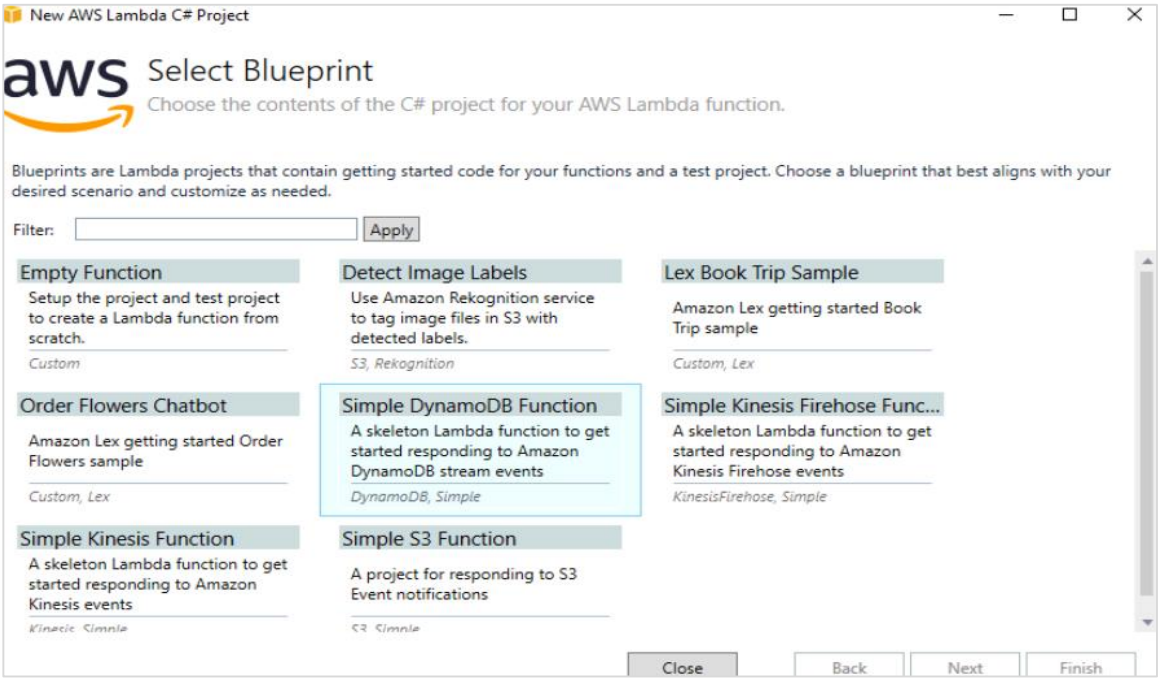
Step 2

Now, the following screen is displayed wherein you select **AWS Lambda for Visual C#.** Select **AWS Lambda Project (.NET Core).**

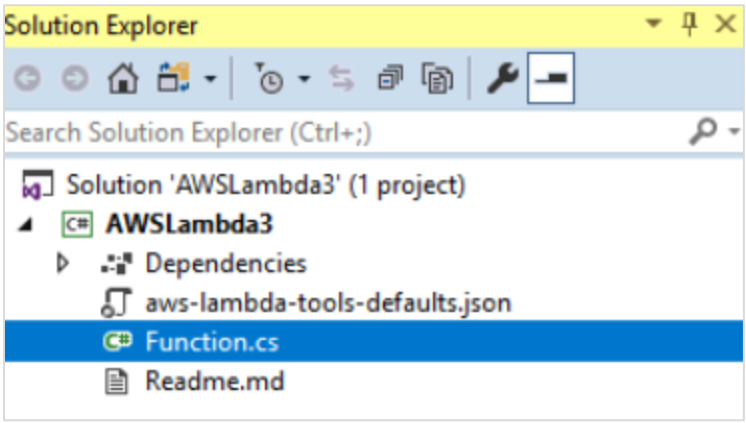


You can change the name if required, will keep here the default name. Click **OK** to continue.

The next step will ask you to select a **Blueprint.**



Select **Empty function** for this example and click **Finish**. It will create a new project structure as shown below:



Now, select **Function.cs** which is the main file where the handler with event and context is created for AWS Lambda.

The display of the file **Functions.cs** is as follows:

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;

using Amazon.Lambda.Core;

// Assembly attribute to enable the Lambda function's JSON input to be converted into a .NET class
[assembly: LambdaSerializer(typeof(Amazon.Lambda.Serialization.Json.JsonSerializer))]

namespace AWSLambda3
{
    public class Function
    {

        /// <summary>
        /// A simple function that takes a string and does a ToUpper
        /// </summary>
        /// <param name="input"></param>
        /// <param name="context"></param>
        /// <returns></returns>
        public string FunctionHandler(string input, ILambdaContext context)
        {
            return input?.ToUpper();
        }
    }
}
```

You can use the command given below to serialize the input and output parameters to AWS Lambda function.

```
[assembly:
LambdaSerializer(typeof(Amazon.Lambda.Serialization.Json.JsonSerializer))]
```

Handler Details for C#

The handler is displayed as follows:

```
public string FunctionHandler(string input, ILambdaContext context)
      {
            return input?.ToUpper();
      }
}
```

Various components of the above code are explained below:

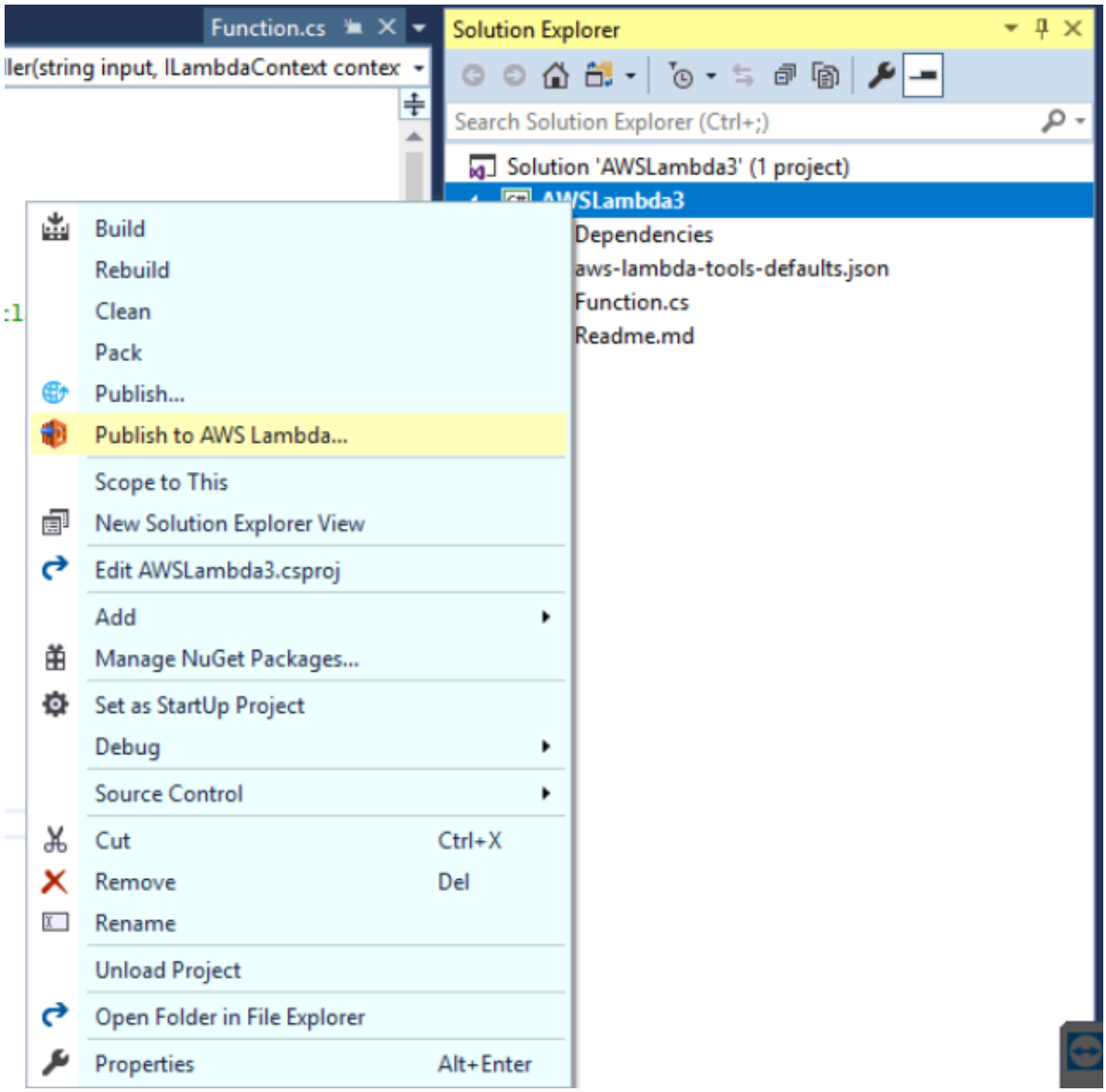
FunctionHandler: This is the starting point of the C# AWS Lambda function.

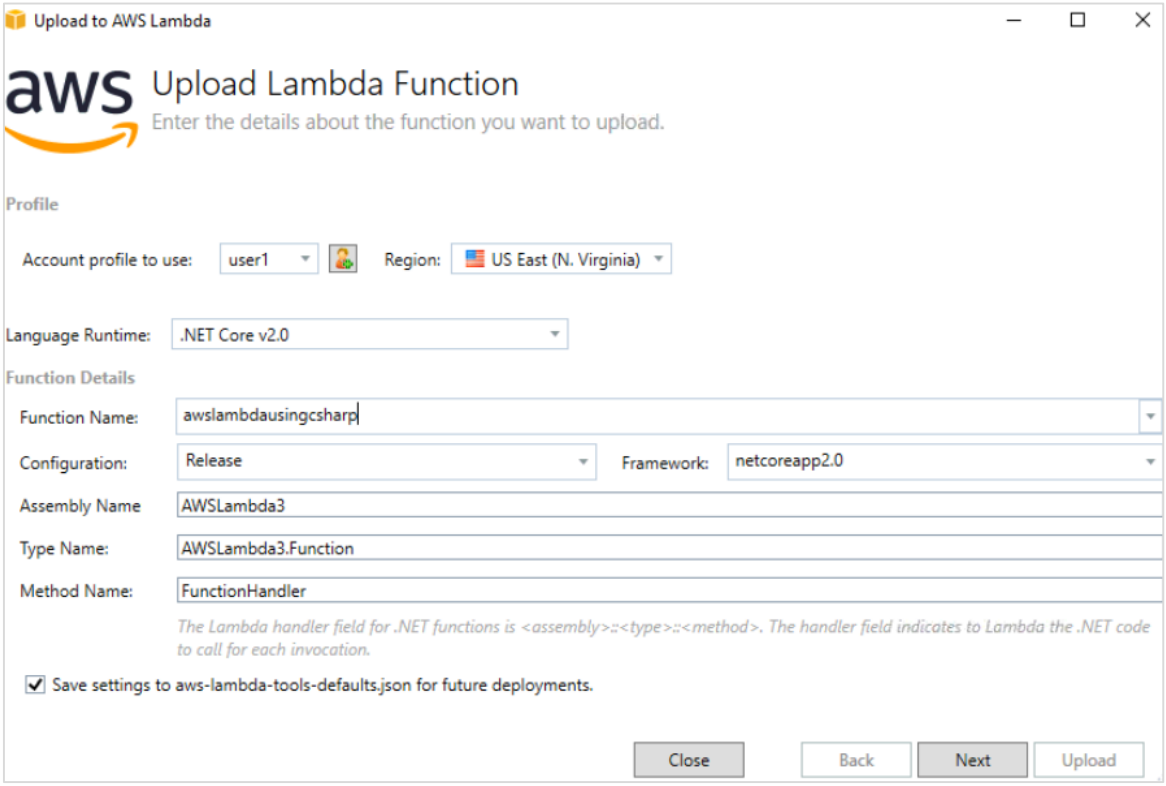
String input: The parameters to the handler **string input** has all the event data such as S3 object, API gateway details etc.

ILambdaContext context: ILamdaContext is an interface which has context details.It has details like lambda function name , memory details, timeout details etc.

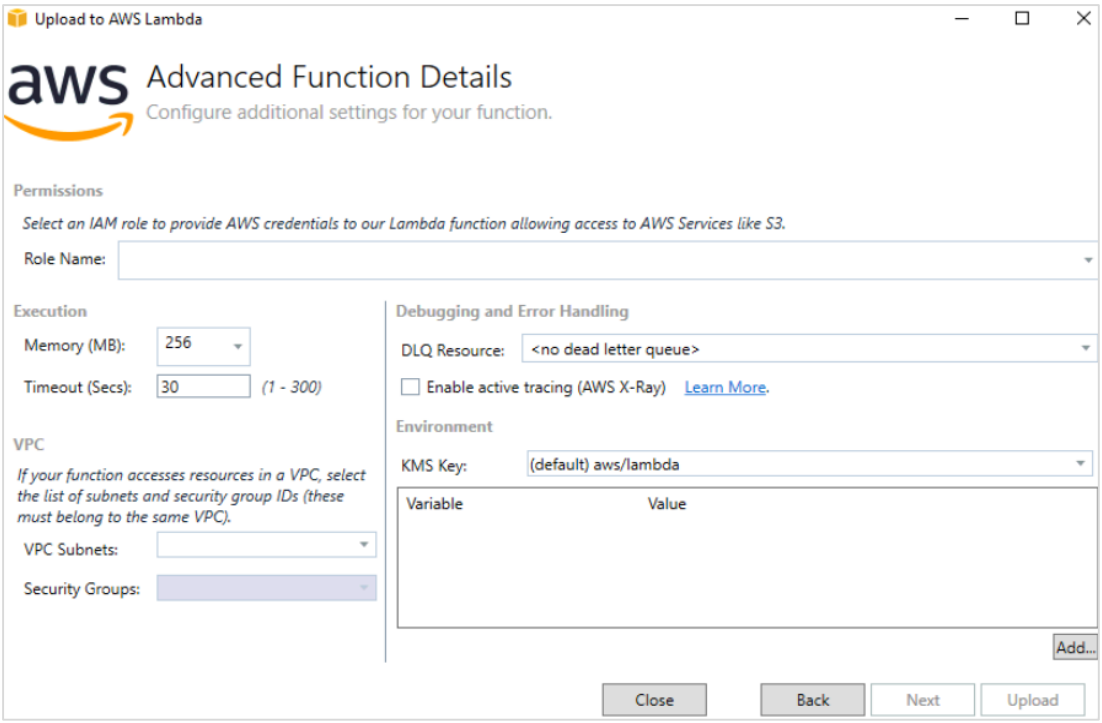
The Lambda handler can be invoked in sync and async way. If invoked in a sync way as shown above you can have the return type. If async than the return type has to be void.

Now, let us deploy the AWS Lambda C# and test the same. Right click the project and click **Publish to AWS Lambda** as shown below:

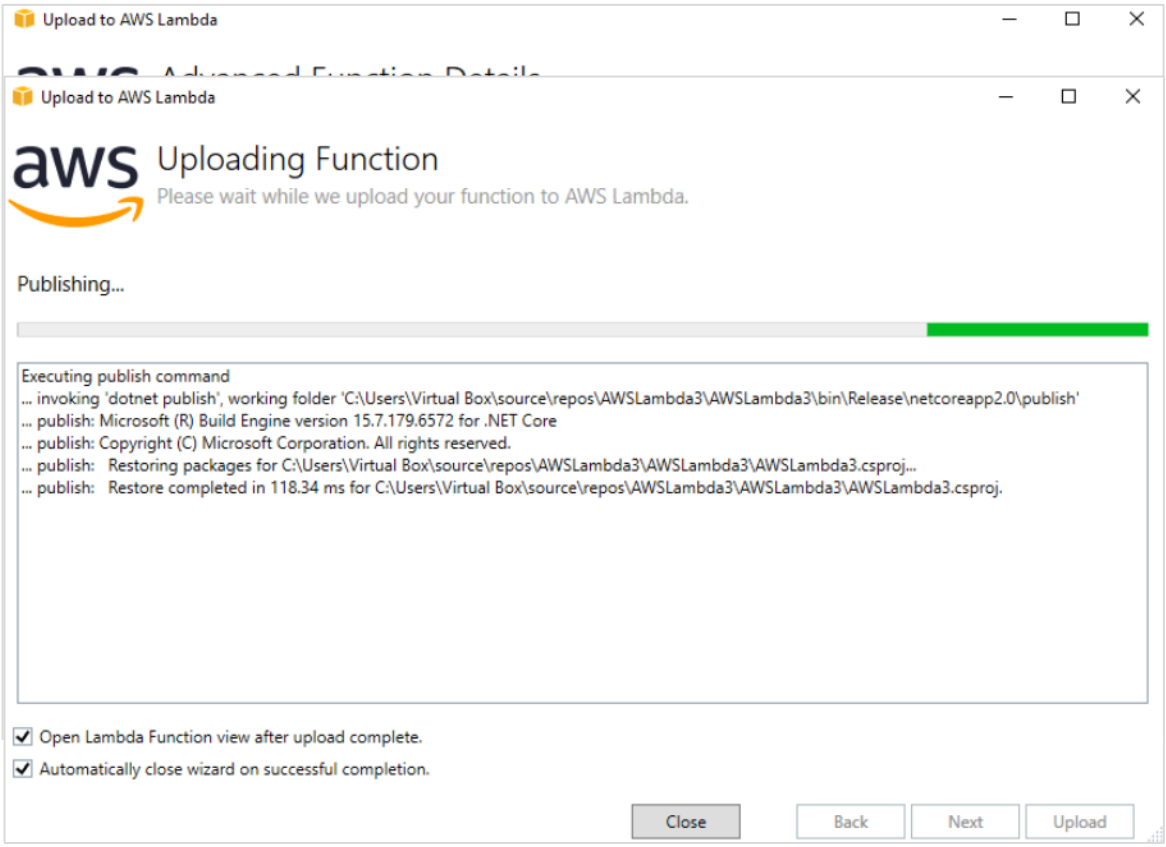




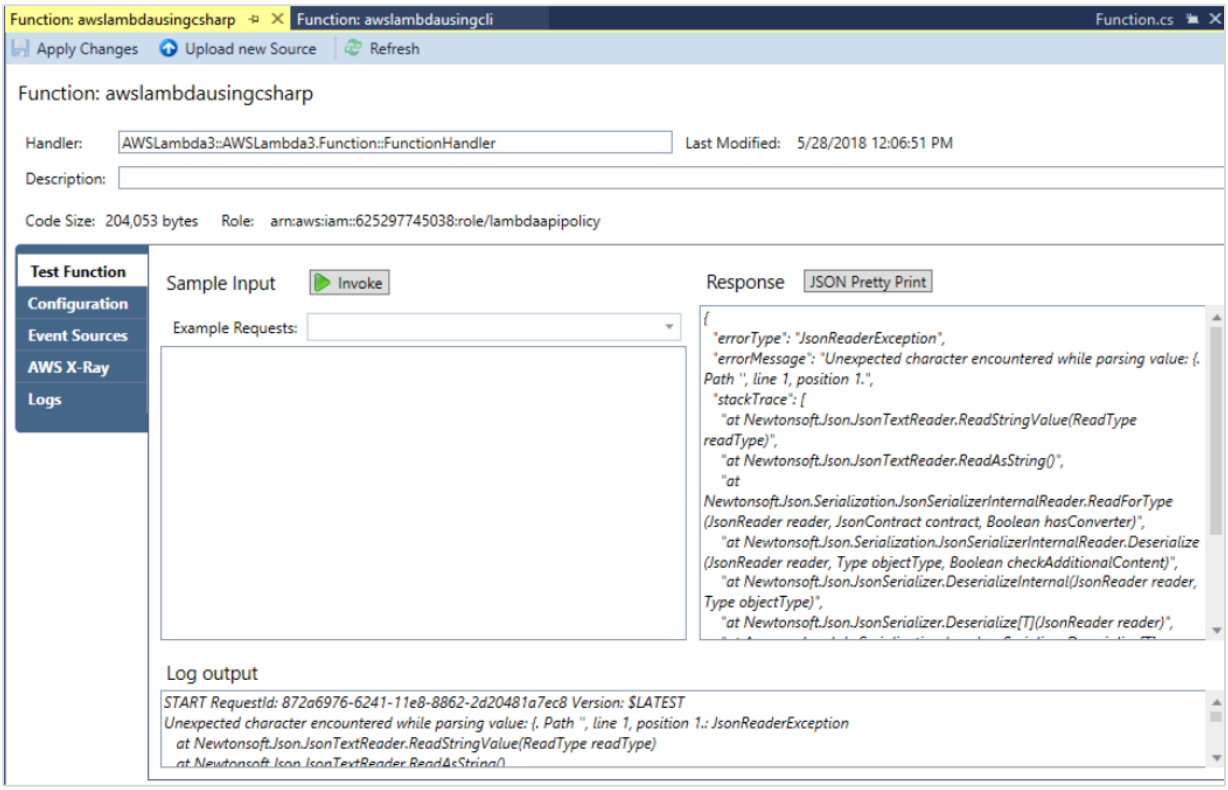
Fill up the **Function Name** and click on **Next**. The next screen displayed is the **Advanced Function Details** as shown:



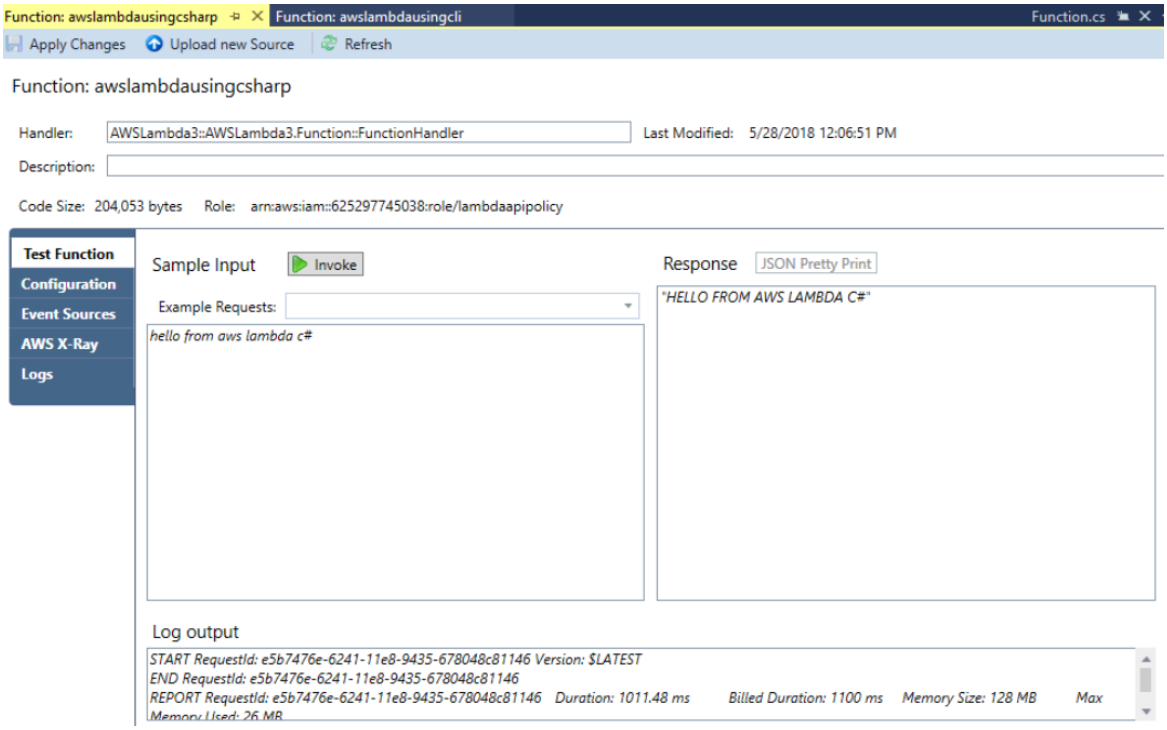
Enter the **Role Name**, **Memory** and **Timeout** details. Note that here we have selected the existing role created and used memory as 128MB and timeout as 10 seconds. Once done click **Upload** to publish to AWS Lambda console.



You can see the following screen once AWS Lambda function is uploaded. Click **Invoke** to execute the AWS Lambda function created. At present, it shows error as it needs some input as per the code written.



Now, let us enter some sample input and **Invoke** it again. Note that here we have entered some text in the input box and the same on clicking **invoke** is displayed in uppercase in the response section.The log output is displayed below:



Now, let us also check AWS console to see if the function is created as we have deployed the function from Visual Studio.

The Lambda function created above is **awslambdausingcsharp** and the same is displayed in AWS console as shown in the screenshots given below:

Functions (17)

Actions | Create function

Filter by tags and attributes or search by keyword

1 2

Function name	Description	Runtime	Code size	Last Modified
awslambdausingcsharp		C# (.NET Core 2.0)	199.3 kB	5 minutes ago
displaydate		Node.js 6.10	221 bytes	16 days ago
helowithjava		Java 8	28.2 kB	5 days ago
displaydate1		Node.js 6.10	206 bytes	16 days ago
awslambdausingcli		C# (.NET Core 2.0)	199.3 kB	23 minutes ago
lambdatestwithgo		Go 1.x	1.3 MB	2 days ago
myfirstlambdafunction		Node.js 6.10	235 bytes	yesterday

Function code Info

Code entry type: Upload a .ZIP file

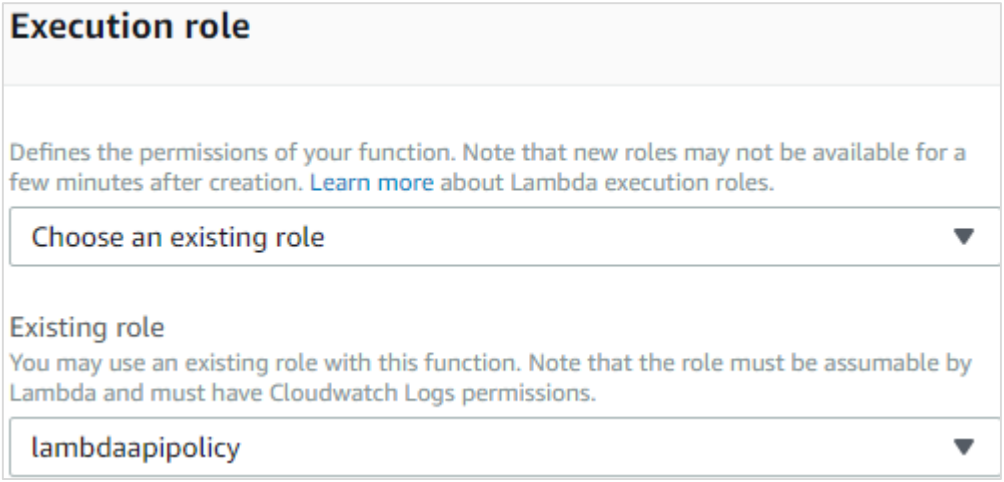
Runtime: C# (.NET Core 2.0)

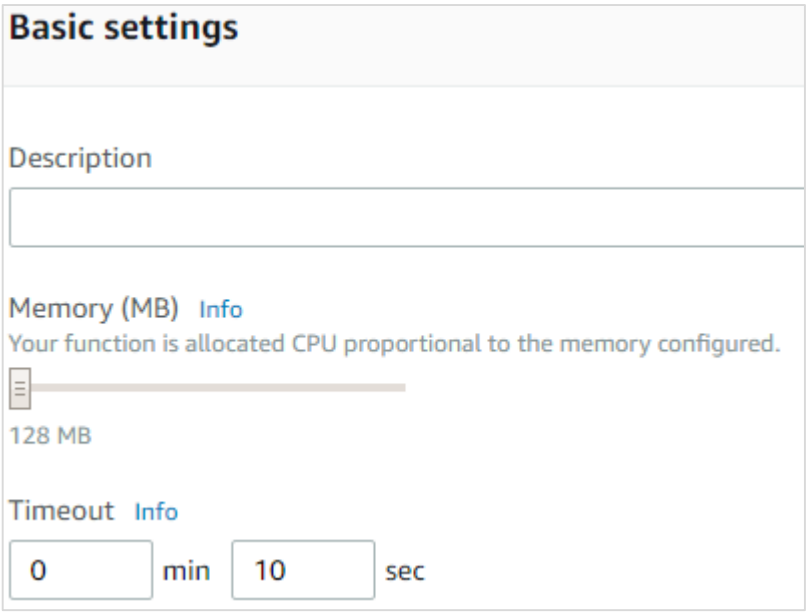
Handler Info: AWSLambda3::AWSLambda3.Function

Function package*

Upload

For files larger than 10 MB, consider uploading via S3.





Handler Signature

Handler is start point for AWS to execute. The name of the handler should be defined as:

```
ASSEMBLY::TYPE::METHOD
```

The details of the signature are explained as below:

ASSEMBLY:This is the name of the .NET assembly for the application created. It is basically the name of the folder from where the project is created.

TYPE: This is the name of the handler.It is basically the namespace.classname.

METHOD: This is the name of the function handler.

The code for handler signature is as shown below:

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;

using Amazon.Lambda.Core;

// Assembly attribute to enable the Lambda function's JSON input to be converted
into a .NET class.
[assembly:
LambdaSerializer(typeof(Amazon.Lambda.Serialization.Json.JsonSerializer))]

namespace AWSLambda3
{
    public class Function
    {

        /// <summary>
        /// A simple function that takes a string and does a ToUpper
        /// </summary>
        /// <param name="input"></param>
        /// <param name="context"></param>
        /// <returns></returns>
        public string FunctionHandler(string input, ILambdaContext context)
        {
            return input?.ToUpper();
        }
    }}
```

Note that here the assembly is **AWSLamda3,** Type is namespace.classname which is **AWSLambda3.Function** and Method is **FunctionHandler.** Thus, the handler signature is **AWSLamda3::AWSLambda3.Function::FunctionHandler**

Context object in C#

Context Object gives useful information about the runtime in AWS environment. The properties available in the context object are as shown in the following table:

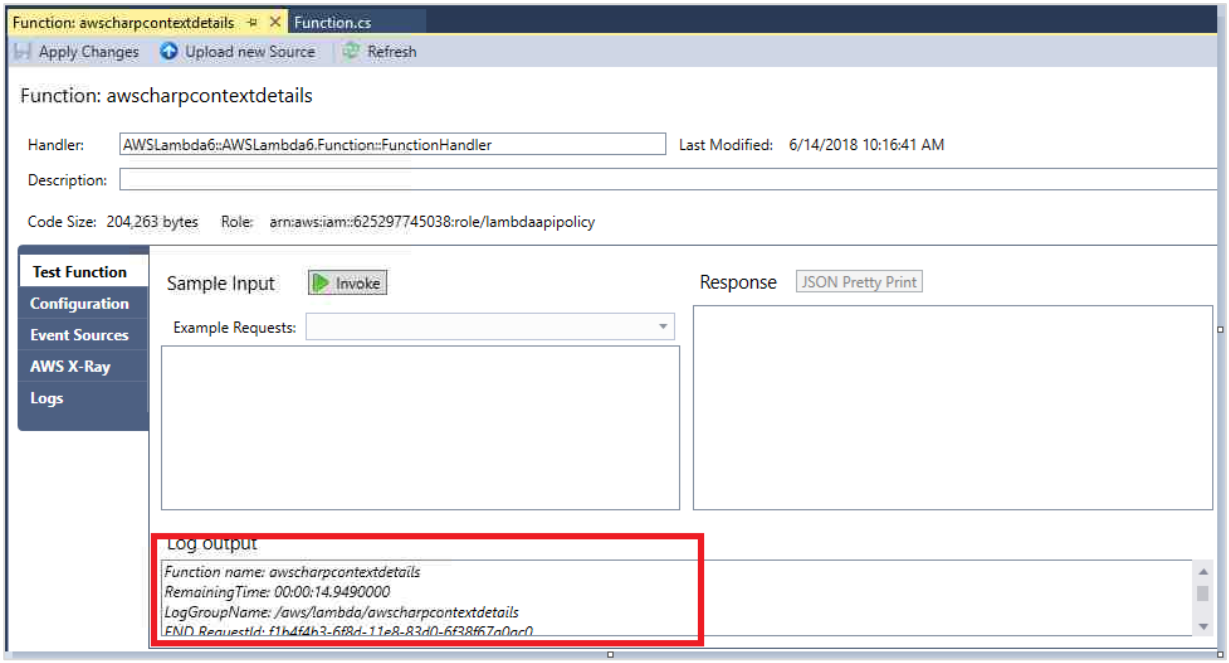
Properties	Description
MemoryLimitInMB	This will give details of the memory configured for AWS Lambda function
FunctionName	Name of AWS Lambda function
FunctionVersion	Version of AWS Lambda function
InvokedFunctionArn	ARN used to invoke this function.
AwsRequestId	AWS request id for the AWS function created
LogStreamName	Cloudwatch log stream name
LogGroupName	Cloudwatch group name
ClientContext	Information about the client application and device when used with AWS mobile SDK
Identity	Information about the amazon cogbnito identity when used with AWS mobile SDK
RemainingTime	Remaining execution time till the function will be terminated
Logger	The logger associated with the context

Example

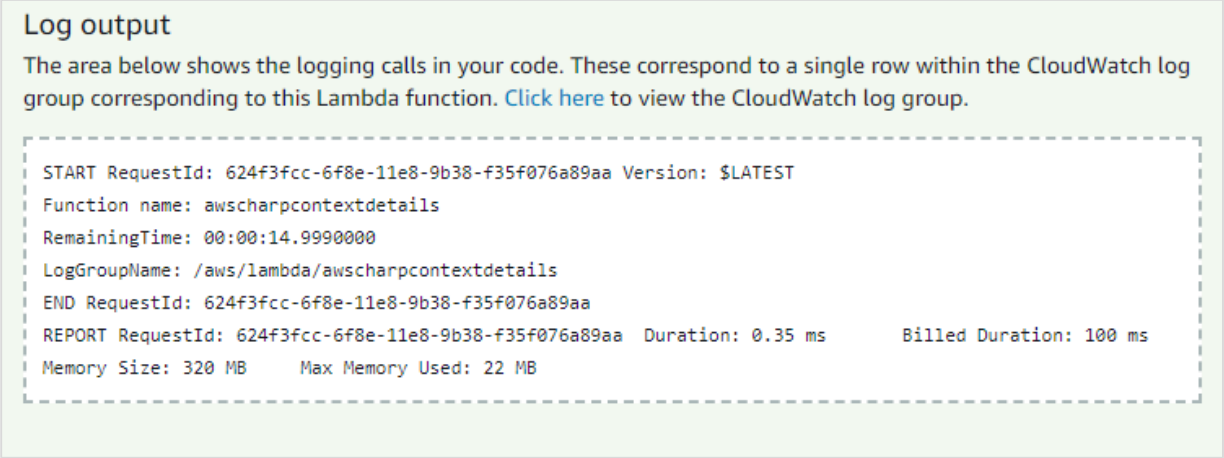
In this section, let us test some of the above properties in AWS Lambda in C#. Observe the sample code given below:

```
using System;

using System.Collections.Generic;

using System.Linq;

using System.Threading.Tasks;

using Amazon.Lambda.Core;

// Assembly attribute to enable the Lambda function's JSON input to be converted
into a .NET class.

[assembly:
LambdaSerializer(typeof(Amazon.Lambda.Serialization.Json.JsonSerializer))]


namespace AWSLambda6

{

    public class Function

    {


        /// <summary>

        /// </summary>

        /// <param name="input"></param>

        /// <param name="context"></param>

        /// <returns></returns>

        public void FunctionHandler(ILambdaContext context)

        {


            LambdaLogger.Log("Function name: " + context.FunctionName+"\n");

            context.Logger.Log("RemainingTime: " + context.RemainingTime+"\n");

            LambdaLogger.Log("LogGroupName: " + context.LogGroupName+"\n");

        }

    }

}
```

The related output that you can observe when you invoke the above code in **C#** is as shown below:



The related output that you can observe when you invoke the above code in **AWS Console** is as shown below:



Logging using C#

For logging, you can use two functions:

- **context.Logger.Log**
- **LambdaLogger.Log**

Observe the following example shown here:

```
public void FunctionHandler(ILambdaContext context)
        {

            LambdaLogger.Log("Function name: " + context.FunctionName+"\n");
            context.Logger.Log("RemainingTime: " + context.RemainingTime+"\n");
            LambdaLogger.Log("LogGroupName: " + context.LogGroupName+"\n");
        }
```

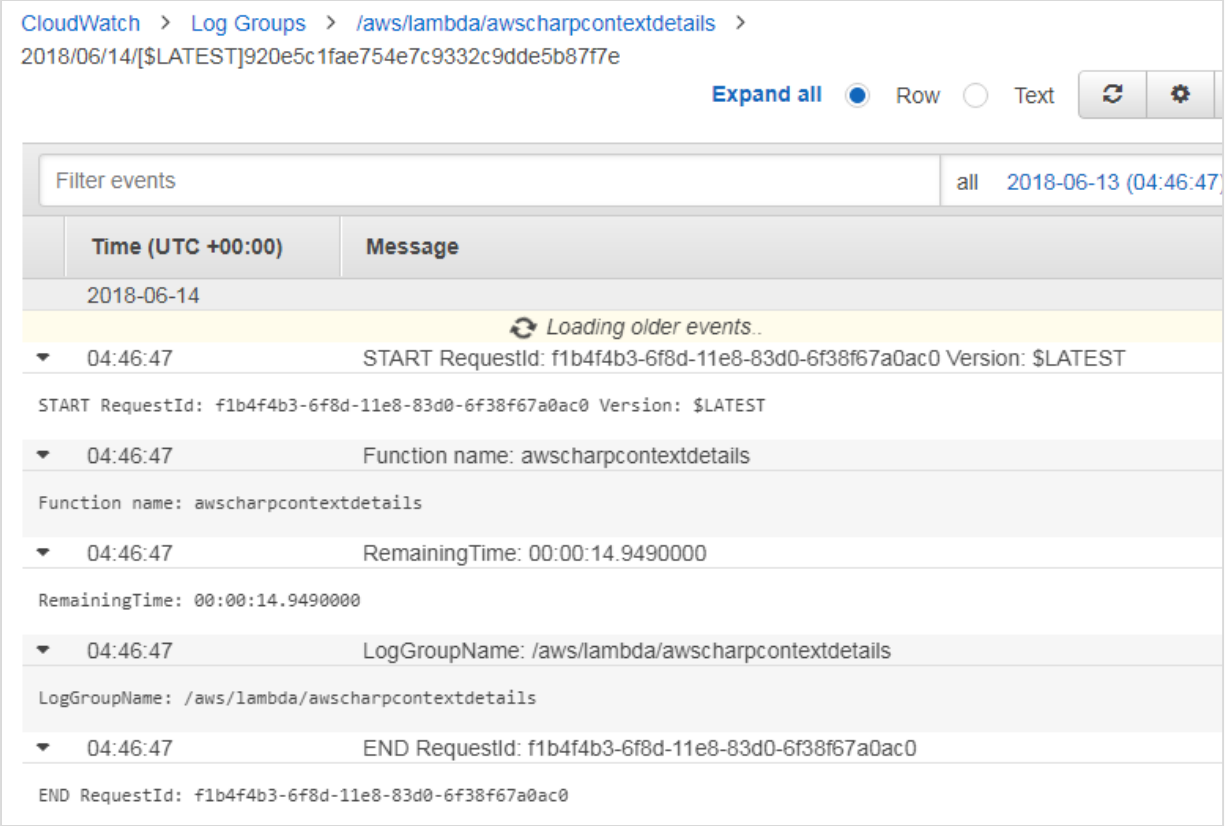
The corresponding output fo the code given above is shown here:

Log output

The area below shows the logging calls in your code. These correspond to a single row within the CloudWatch log group corresponding to this Lambda function. Click here to view the CloudWatch log group.

```
START RequestId: 624f3fcc-6f8e-11e8-9b38-f35f076a89aa Version: $LATEST
Function name: awscharpcontextdetails
RemainingTime: 00:00:14.9990000
LogGroupName: /aws/lambda/awscharpcontextdetails
END RequestId: 624f3fcc-6f8e-11e8-9b38-f35f076a89aa
REPORT RequestId: 624f3fcc-6f8e-11e8-9b38-f35f076a89aa  Duration: 0.35 ms       Billed Duration: 100 ms
Memory Size: 320 MB     Max Memory Used: 22 MB
```

You can get the logs from CloudWatch as shown below:



Error Handling in C# for Lambda Function

This section discusses about error handling in C#. For error handling, **Exception** class has to be extended as shown in the example shown below:

Example

```
namespace Example {
   public class AccountAlreadyExistsException : Exception {
      public AccountAlreadyExistsException(String message) :
         base(message) {
      }
   }
}

namespace Example {
   public class Handler {
```

```
      public static void CreateAccount() {
        throw new AccountAlreadyExistsException("Error in AWS Lambda!");
      }
    }
}
```

The corresponding output for the code given above is as given below:

```
{
  "errorType": "LambdaException",
  "errorMessage": "Error in AWS Lambda!"
}
```

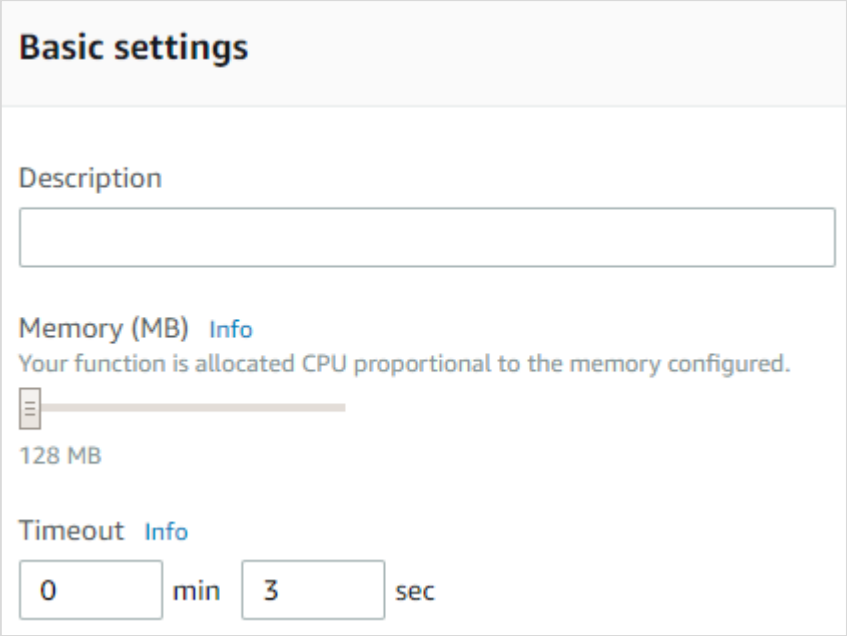
10. AWS Lambda — Configuring Lambda Function

In the previous chapters, we have learnt how to create AWS Lambda function in AWS console. However, there are other parameters for creating a Lambda function. These include memory allocation, timeout etc.

In this chapter, let us understand in detail about the following configuration properties for AWS Lambda**.**

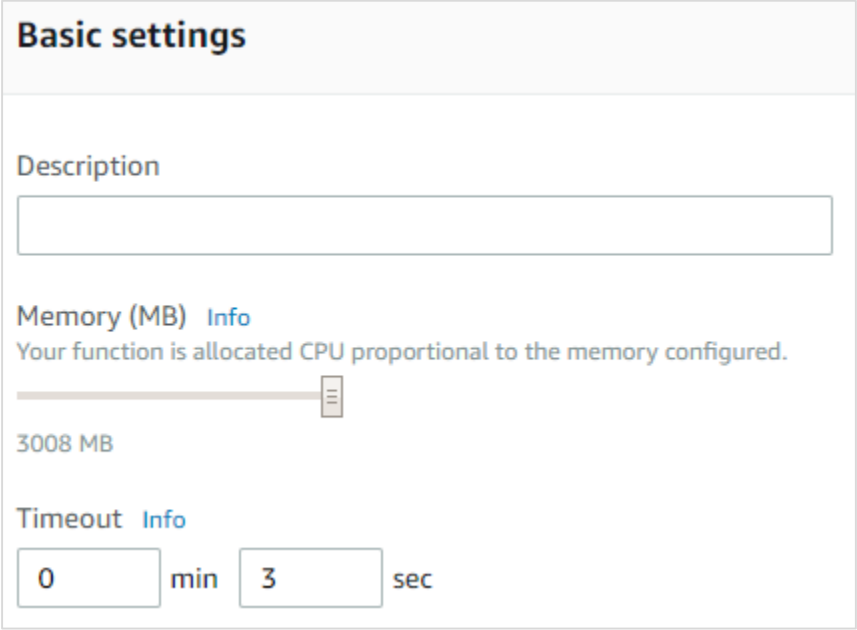
Memory Allocation

Login to AWS console and create or select the existing lambda function. Click the **Configuration** tab to get the details of the memory allocated. Look at the screenshot shown below:



Note that by default the memory allocated is **128MB**. If you want to increase the memory you can click the slider.

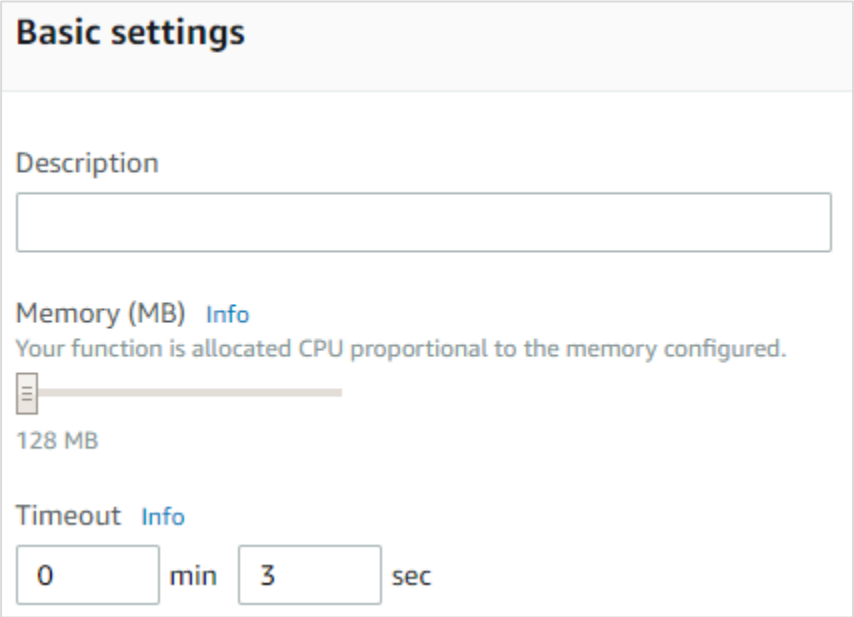
The memory will get incremented to **64MB** as you move the slider. Observe that the maximum memory available is **3008MB.** Look at the screenshot shown below:



You can also use **aws cli** from command prompt to increase the memory limit. You will have to give the memory in increments of 64MB.

Now, let us increase the memory limit of AWS Lambda with name :**myfirstlambdafunction**.

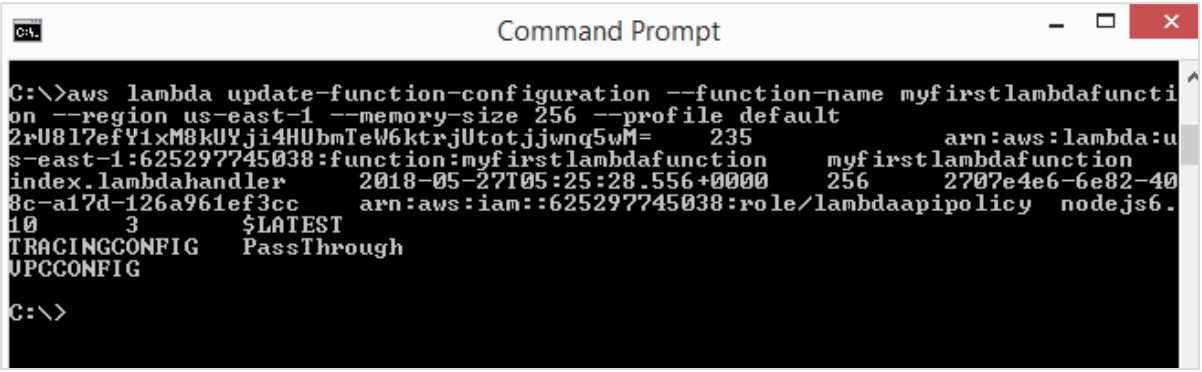
The memory details of the function are shown in the screenshot given below:



The command used to change the memory using **aws cli** is as follows:

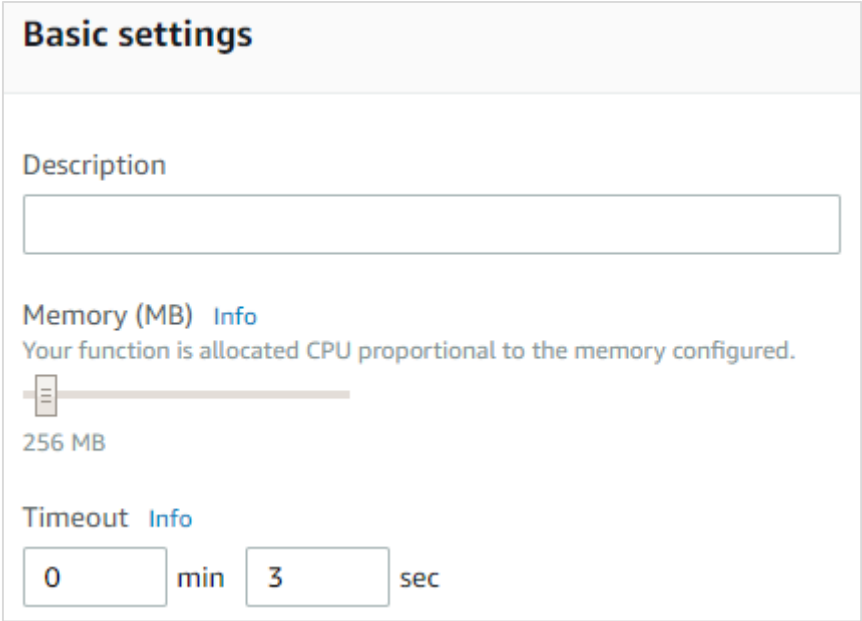
```
aws lambda update-function-configuration --function-name your function name --
region region where your function resides --memory-size memory amount --profile
adminuser
```

The corresponding output of AWS Lambda function **myfirstlambdafunction** in AWS console is shown here. Observe that the memory is changed from 128MB to 256MB.



Maximum Execution Time

Timeout is the time allotted to AWS Lambda function to terminate if the timeout happens. AWS Lambda function will either run within the allocated time or terminate if it exceeds the timeout given.You need to evaluate the time required for the function to execute and accordingly select the time in **Configuration** tab in AWS console as shown below:



IAM Role

When creating AWS Lambda function, the role or the permission needs to be assigned. Incase you need AWS Lambda for S3 or dynamoDB, permission with regard to the services of lambda needs to be assigned. Based on the role assigned, AWS Lambda will decide the steps to be taken. For example if you give full access of dynamodb, you can add, update and delete the rows from the dynamodb table .

Handler Name

This is the start of execution of the AWS Lambda function. Handler function has the details of the event triggered, context object and the callback which has to send back on **success** or **error** of AWS Lambda.

The format of the handler function in nodejs is shown here:

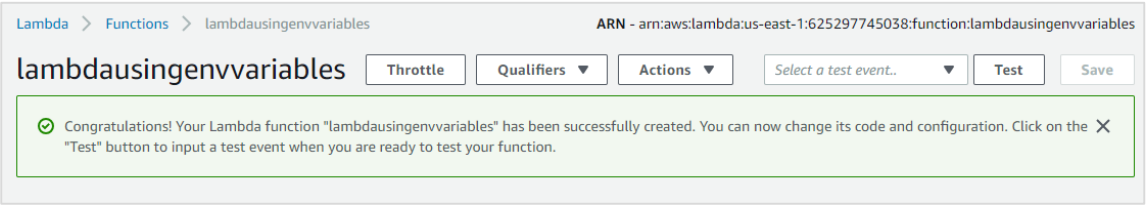
```
exports.handler = (event, context, callback) => {
    callback(null, "hello from lambda");
};
```

Lambda Function using Environment Variables

In this section , we will create a simple Lambda function using environment variables added in the configuration section. For this purpose, follow the steps given below and refer the respective screenshots:

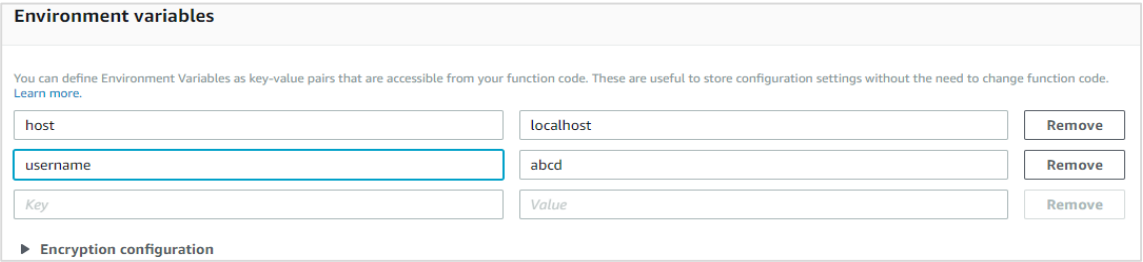
Step 1

Go to AWS console and create a function in Lambda as shown.



Step 2

Now, add the environment variables as shown:



Step 3

Now, let us fetch the same in Lambda code as follows:

```
exports.handler = (event, context, callback) => {
    var hostName = process.env.host;
    var userName = process.env.username;
    callback(null, "Environment Variables =>"+hostName+" and "+userName);
};
```

Step 4

To get the details from environment variables we need to use **process.env** as shown. Note that this syntax is for **NodeJS** runtime.

```
var hostName = process.env.host;
 var userName = process.env.username;
```

Step 5

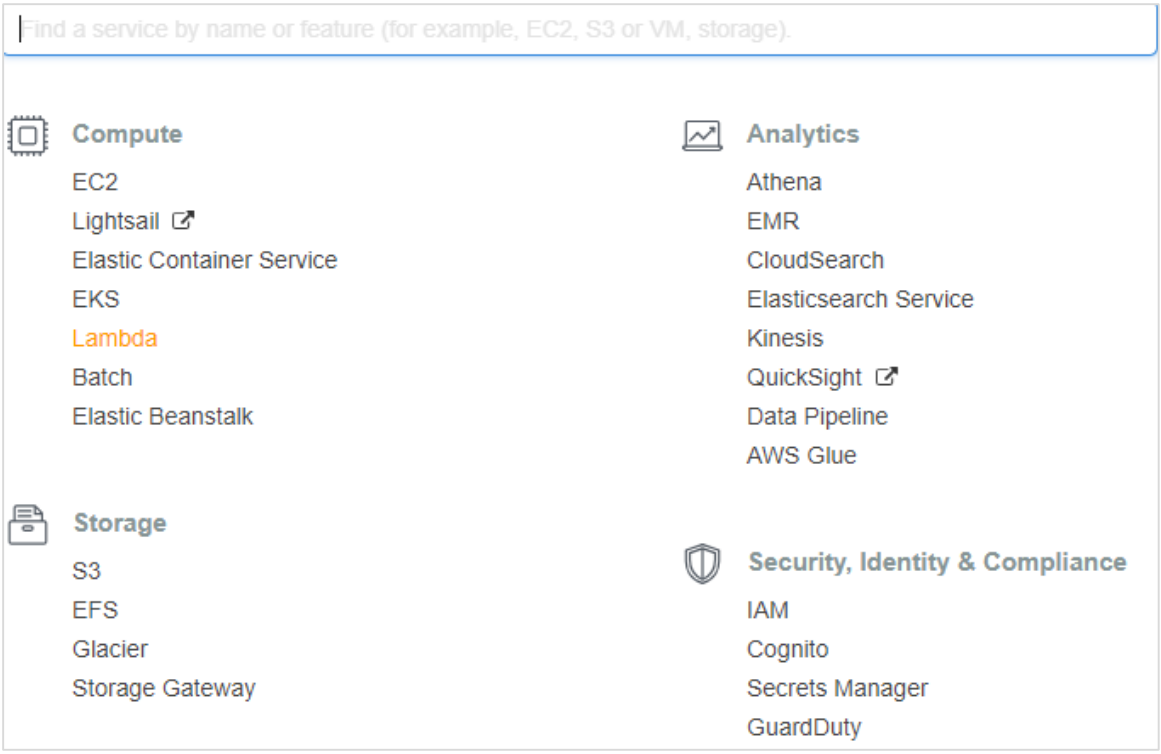
The output for the Lambda function on execution will be as shown:

11. AWS Lambda — Creating and Deploying using AWS Console

We can create Lambda function and test the same in AWS console. This chapter discusses this in detail. Forthis purpose, you will have to follow the steps given here and observe the respective screenshots given:

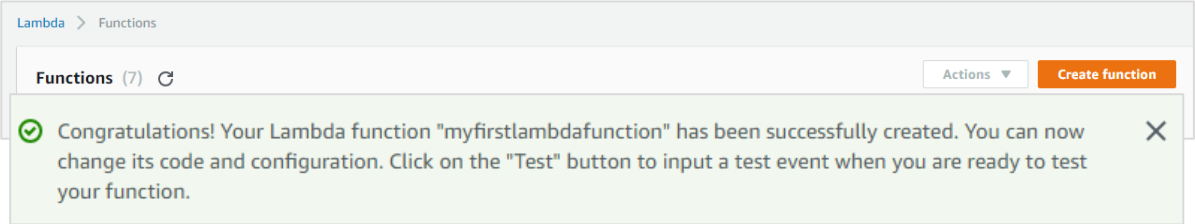
Step 1

Login to AWS Console https://aws.amazon.com/console/. Now, you will be redirected to the screen where the AWS services are displayed.

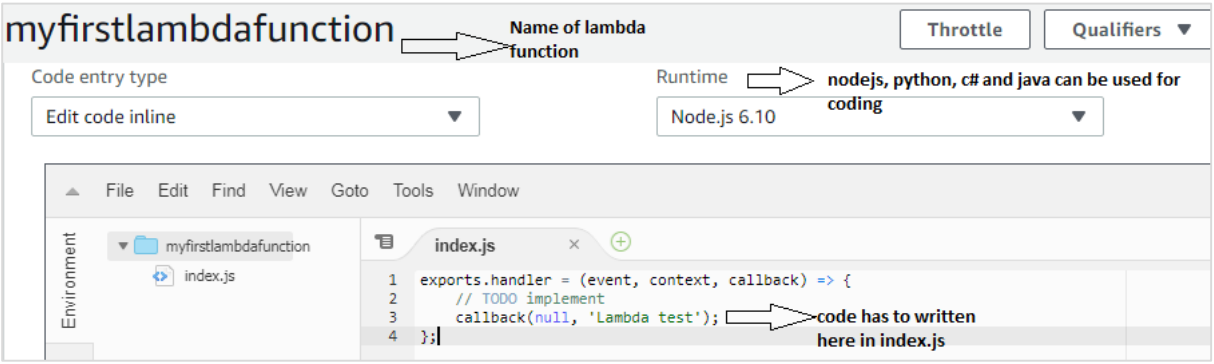


Step 2

Now, click on **Lambda** service as highlighted above. This will redirect to create function as shown below:



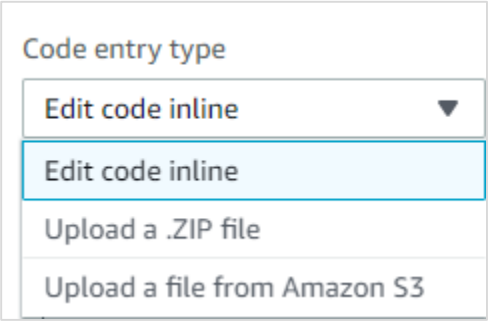
Step 3 Now, click **Create function** and enter the details of the function. Then you can see a



screen as shown below:

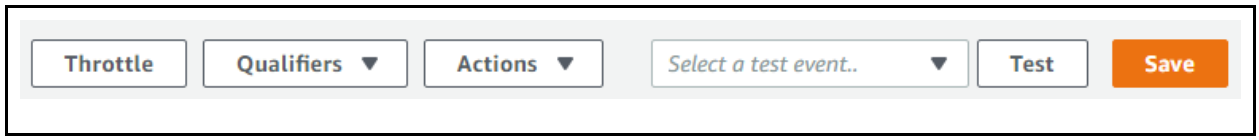
Step 4

You can write your code by choosing the language of your choice. The code has to be written in editor if the option selected is edit code inline. The other options available are as follows:



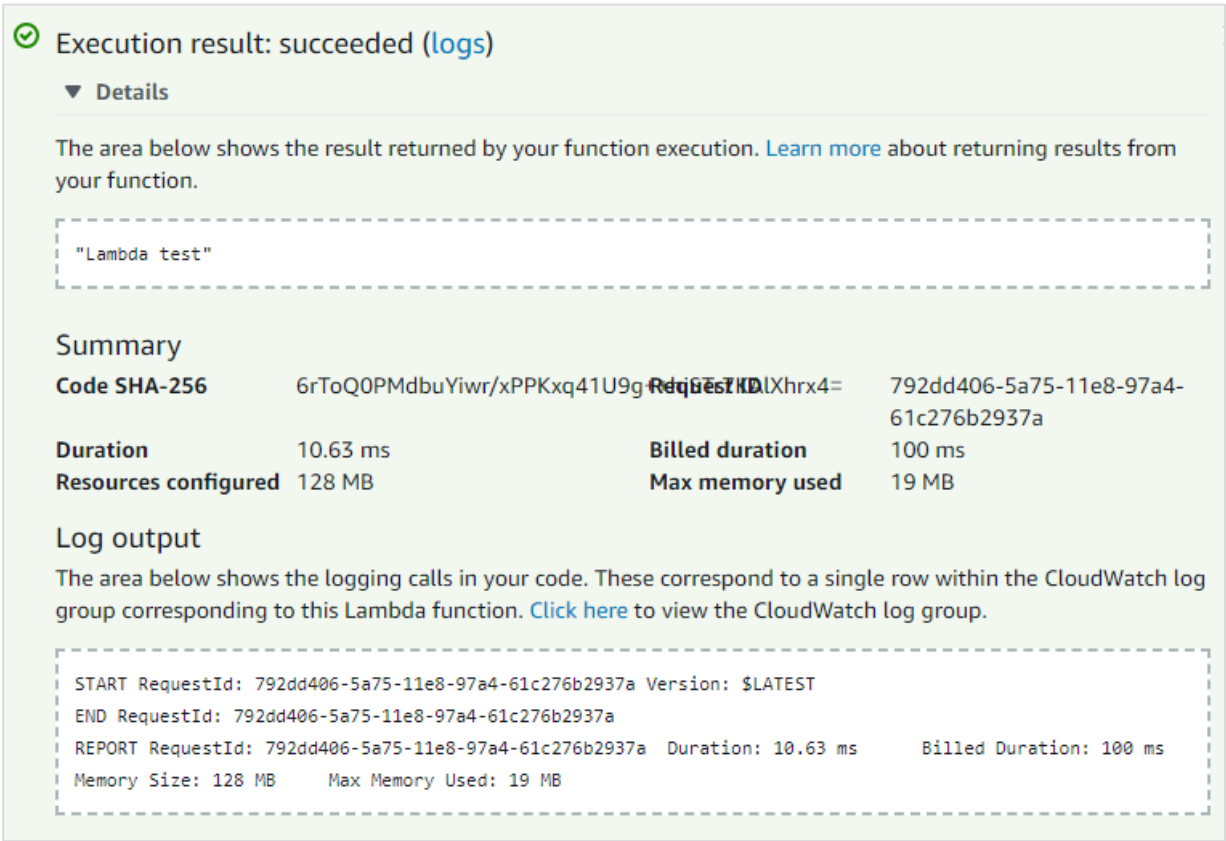
Step 5

Once done you need to save the changes for which the button is given at the top right corner as shown below:



Step 6

Now, click **Test** button. This gives all details of the execution of the Lambda function as shown below:



Step 7

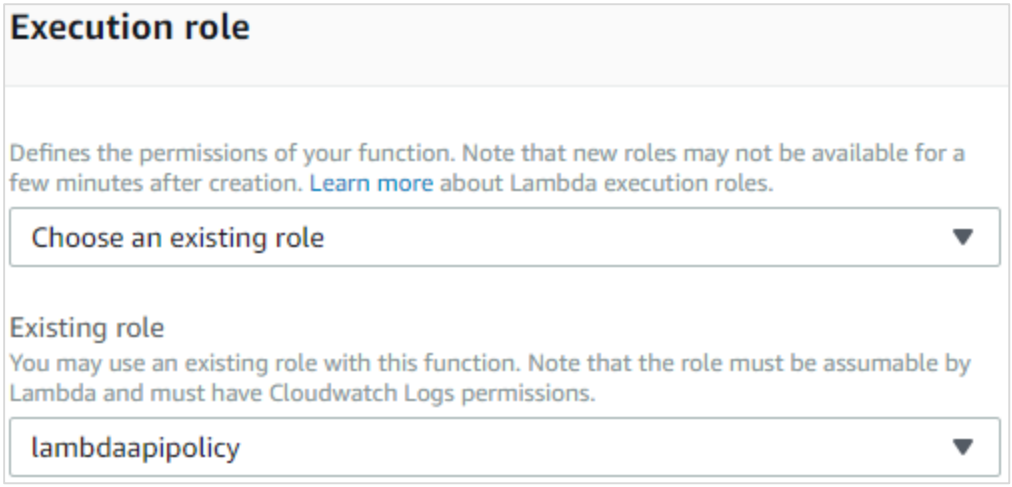
The code for **index.js** is as follows:

```
exports.handler = (event, context, callback) => {
    // TODO implement
    callback(null, 'Lambda test');
};
```

This will call the **Callback function** and the result can be error or success. On success you will see a **Lambda test** message; if error it will pass null.

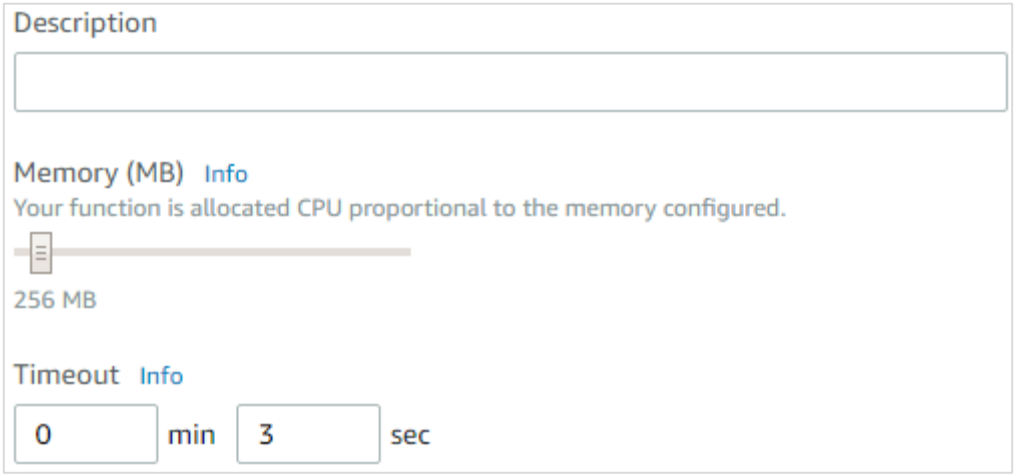
Step 8

The **Role** details for Lambda function is a part of the configuration and is displayed as shown below:



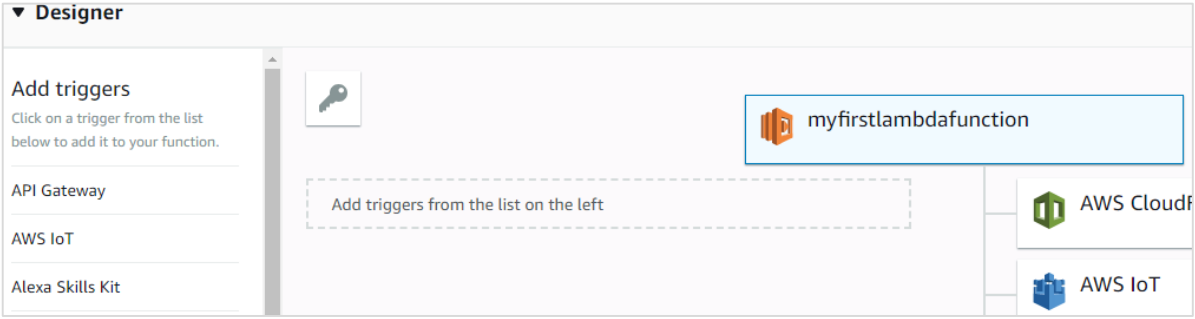
Step 9

Now, you can update the role if required and save the Lambda function. Then, the memory and timeout details for lambda function are displayed as shown below:



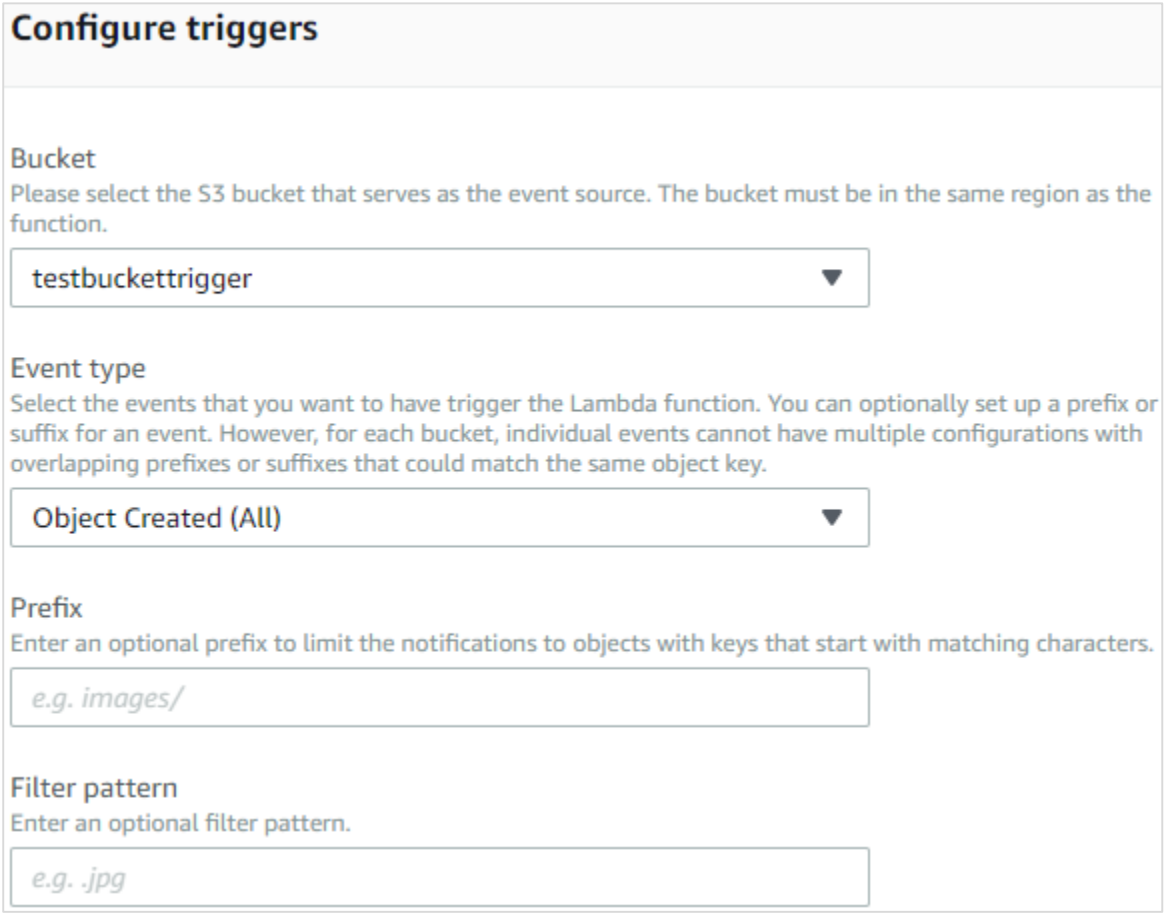
Step 10

Now, we need to add trigger to the Lambda function so that it executes when the event occurs. The trigger details are displayed at the start of the AWS Lambda function screen as shown below:



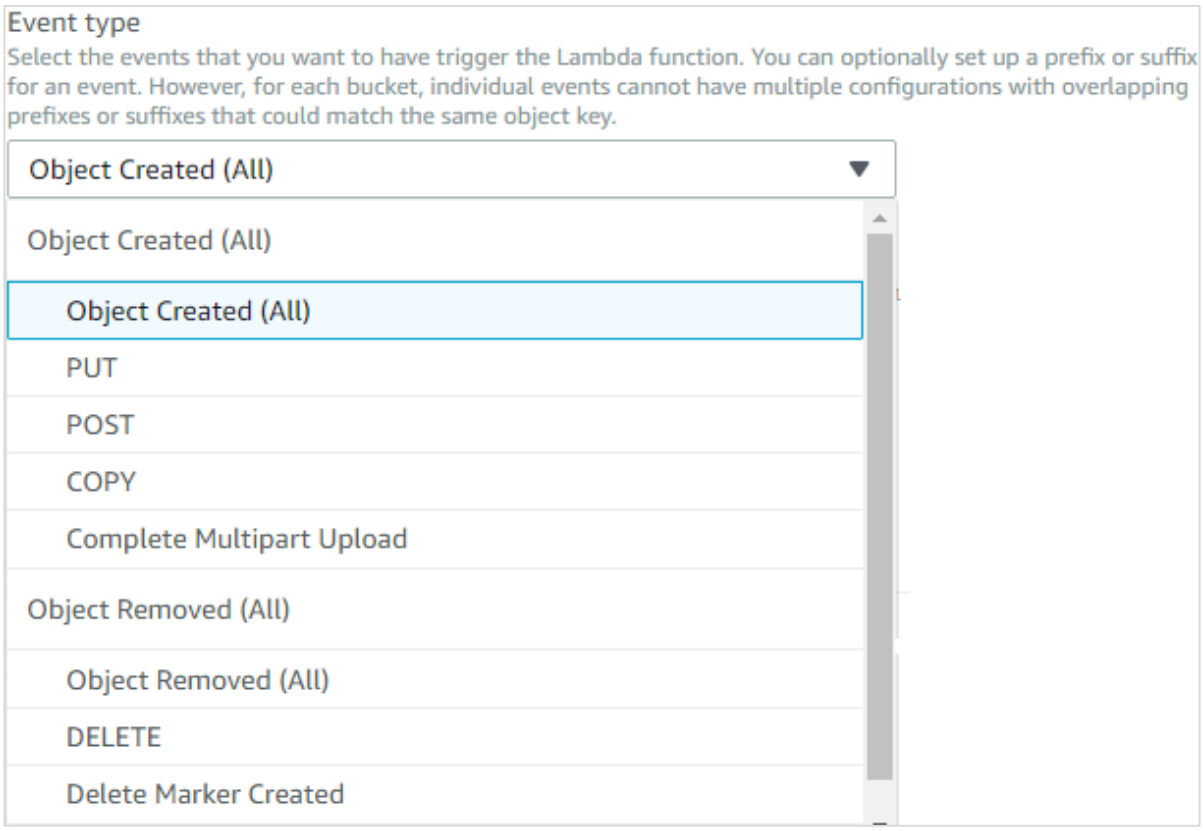
From this, you can select the trigger you want your Lambda function to get triggered. When you select the trigger, the config details for the trigger has to be added.

For example, for trigger on **S3** the config details to be added are as follows:



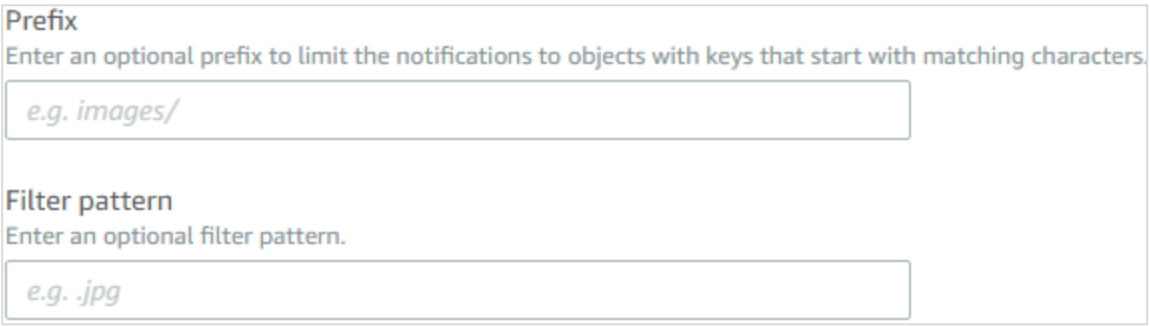
Step 11

Now, select the bucket you want the trigger on. The event type has the following details:



Step 11

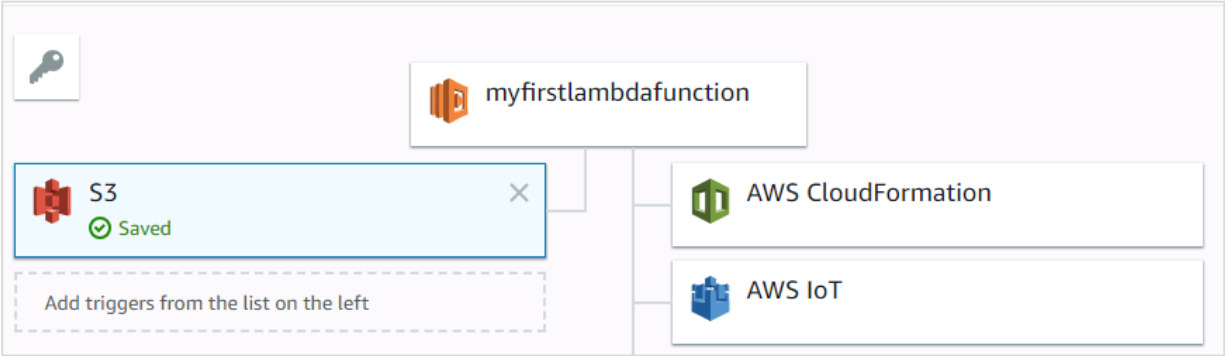
For the trigger, you can also mention the prefix type files or file pattern, the Lambda has to be trigger. The details are as shown:



Step 12

Now, fill up the required details for the trigger and click **Add** button .Save the Lambda function for the trigger to get added. Saving the function deploys the details, and from now onwards anytime files are added to the S3 bucket, the Lambda will get triggered.

Observe the following screenshot which shows S3 trigger added to AWS Lambda:



Step 13

Now, let us use **S3** sample event to test the Lambda function. The code for the same is shown here:

Amazon S3 Put Sample Event

```
{
  "Records": [
    {
      "eventVersion": "2.0",
      "eventTime": "1970-01-01T00:00:00.000Z",
      "requestParameters": {
        "sourceIPAddress": "127.0.0.1"
      },
      "s3": {
        "configurationId": "testConfigRule",
        "object": {
          "eTag": "0123456789abcdef0123456789abcdef",
          "sequencer": "0A1B2C3D4E5F678901",
          "key": "HappyFace.jpg",
          "size": 1024
        },
        "bucket": {
          "arn": bucketarn,
```

```
          "name": "sourcebucket",
          "ownerIdentity": {
            "principalId": "EXAMPLE"
          }
        },
        "s3SchemaVersion": "1.0"
      },
      "responseElements": {
        "x-amz-id-2":
"EXAMPLE123/5678abcdefghijklambdaisawesome/mnopqrstuvwxyzABCDEFGH",
        "x-amz-request-id": "EXAMPLE123456789"
      },
      "awsRegion": "us-east-1",
      "eventName": "ObjectCreated:Put",
      "userIdentity": {
        "principalId": "EXAMPLE"
      },
      "eventSource": "aws:s3"
    }
  ]
}
```

You will have to use the following command to get the details of file uploaded from the S3 put event:

```
event.Records[0].s3.object.key                        //will display the name of
the file
```

You will have to use the following command to get the bucket name :

```
event.Records[0].s3.bucket.name             //will give the name of the bucket.
```

You will have to use the following command to get the EventName:

```
event.Records[0].eventName  // will display the eventname
```

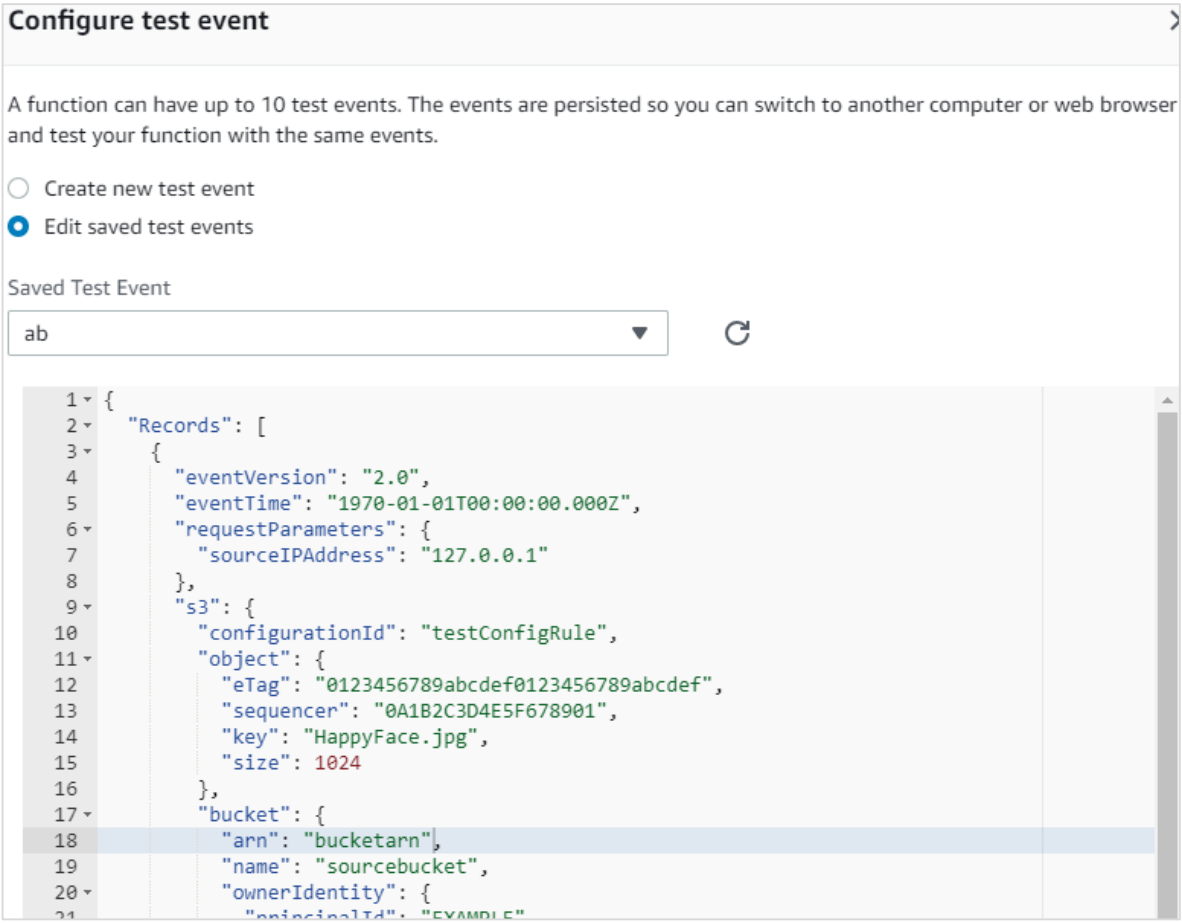
Step 14

Now, let us update AWS Lambda code to print the S3 details as shown below:

```
exports.lambdahandler = (event, context, callback) => {

    callback(null, "Bucket name: "+event.Records[0].s3.bucket.name+"  File
name:"+event.Records[0].s3.object.key );

};
```

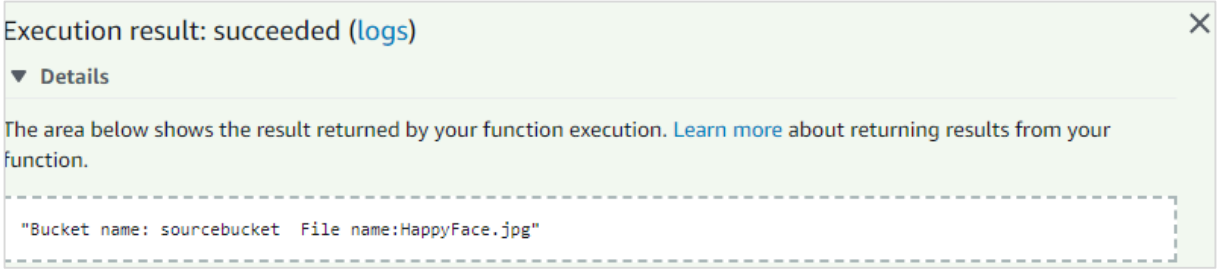
Step 15

Save the changes. Click **Test** and enter the S3 sample event:



Step 16

Now click **Test** and you can see the output as shown:



Step 17

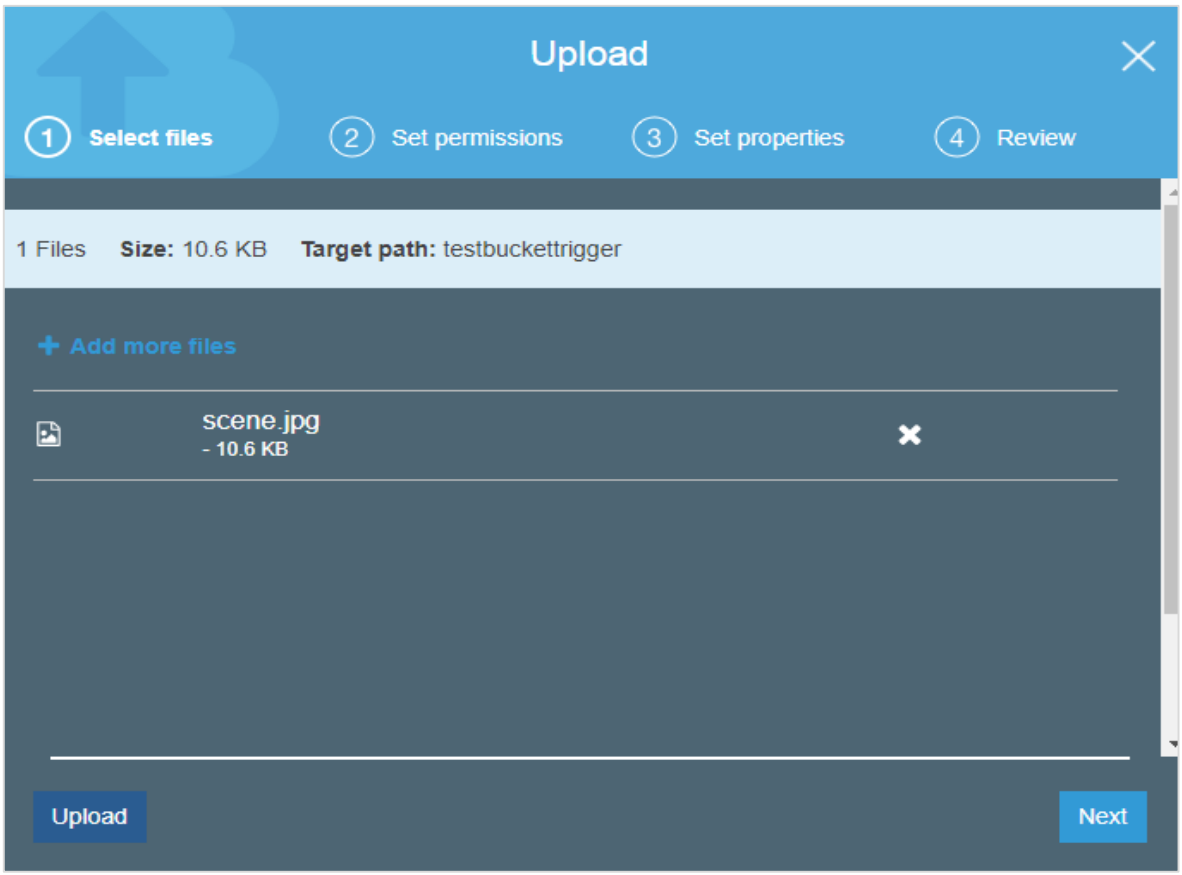
To test the trigger on S3 using S3 AWS service, upload a file in S3 bucket: **testbuckettrigger.** Update the role used with Lambda to take S3 and SES policy (to send mail) for permissions. This will update AWS Lambda code to send mail to see the trigger working:

The updated AWS Lambda code is as shown:

```
var aws = require('aws-sdk');
var ses = new aws.SES({
    region: 'us-east-1'
});
exports.lambdahandler = function(event, context, callback) {
    var eParams = {
        Destination: {
            ToAddresses: ["coxxxxxxx@gmail.com"]
        },
        Message: {
            Body: {
                Text: {
                    Data: "Bucket name: "+event.Records[0].s3.bucket.name+"  File
name:"+event.Records[0].s3.object.key
                }
            },
            Subject: {
                Data: "S3 and AWS Lambda"
            }
        },
        Source: "coxxxxxx@gmail.com"
    };
```

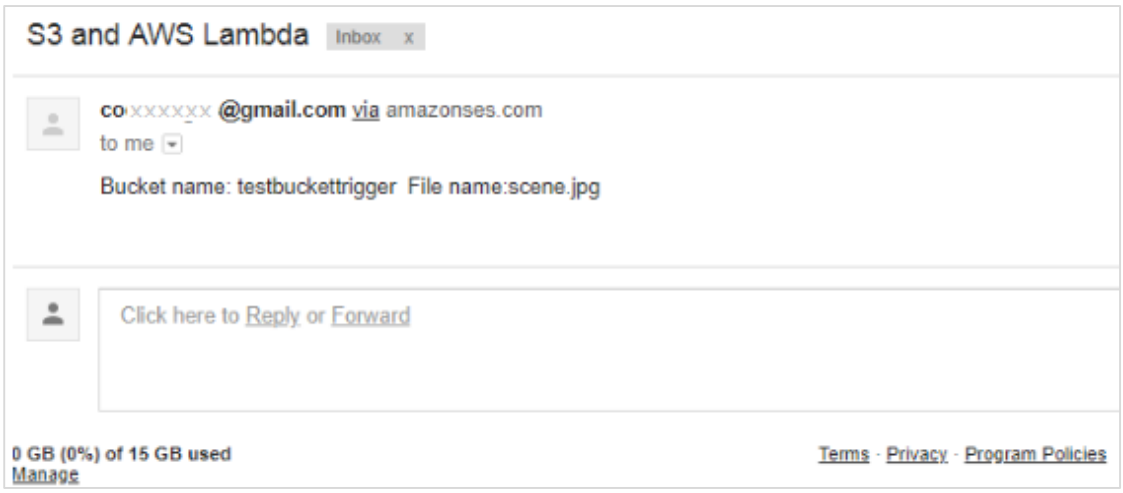
```
    console.log('===SENDING EMAIL===');
    var email = ses.sendEmail(eParams, function(err, data) {
        if (err) console.log(err);
        else {
            console.log("===EMAIL SENT===");
            console.log("EMAIL CODE END");
            console.log('EMAIL: ', email);
            context.succeed(event);
     callback(null, "email is send");
        }
    });
};
```

The corresponding screenshot is as shown here:



Step 18

Now, upload the file and check the mail id provided in AWS Lambda code:



12. AWS Lambda — Creating and Deploying using AWS CLI

AWS CLI is a command line tool which helps to work with AWS services.We can use it to create, update, delete, invoke aws lambda function. In this chapter, you will discuss about installation and usage of AWS CLI in detail.

Installation of AWS CLI

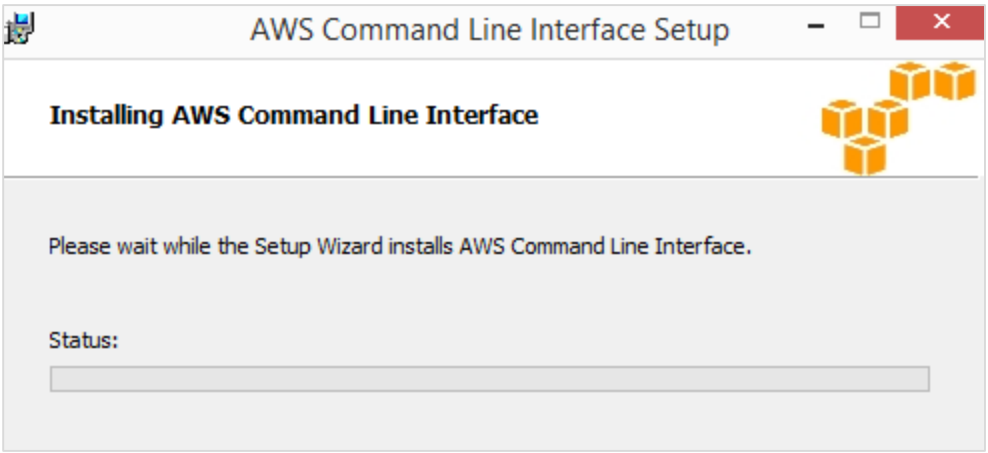
This section will guide you through the installation of AWS CLI on various operating systems. Follow the steps given and observe corresponding screenshots wherever attached.

For Windows

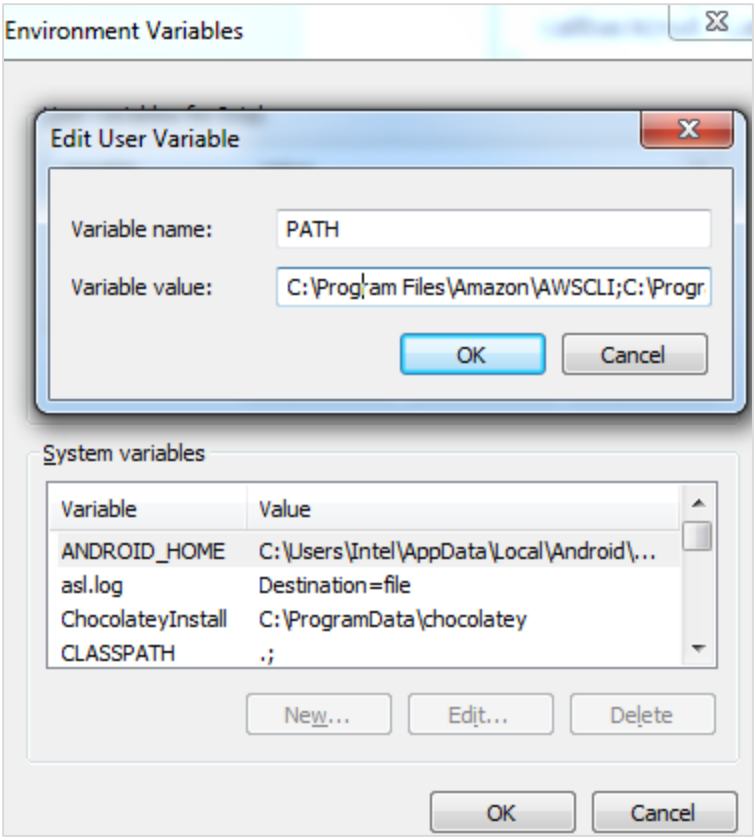
Check your Windows configuration and choose one of the following links for installing AWS CLI MSI:

- For Windows 64 bit: AWS CLI MSI installl for windows (64bit)
- For Windows 32 bit: AWS CLI MSI installl for windows (32bit)

Once you choose corresponding link and click it, you can find a Window as shown here:



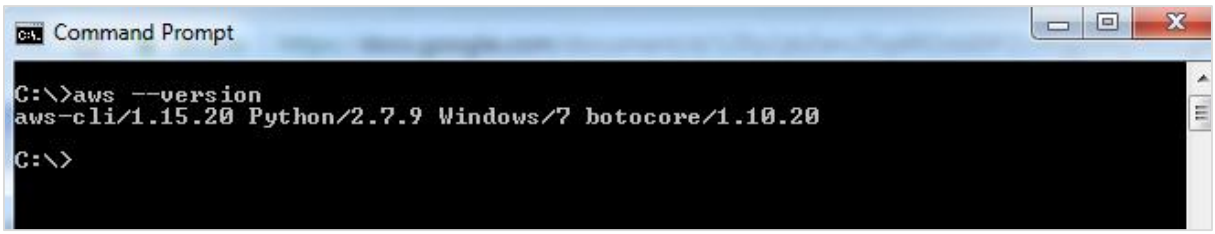
Next, set the **Environment path in windows** as shown in the screenshots below:



Once done, you can use the following command on the command prompt, to see if **aws cli** is installed:

```
aws --version
```

It displays the details of aws-cli version as shown in the following screenshot:



For Linux / Mac

For installing on Linux and Mac, you need Python 2.6.3 or higher verison of it. Then, use following commands for further installation processes:

```
$ 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
```

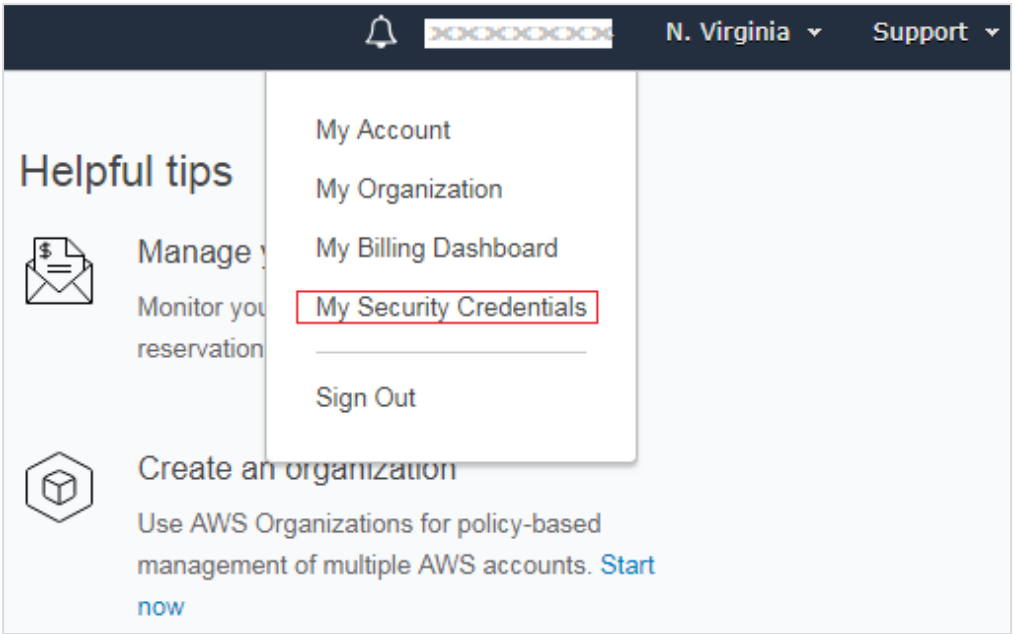
Now, we need to configure AWS settings. You can use the following command for this purpose:

```
aws configure
```

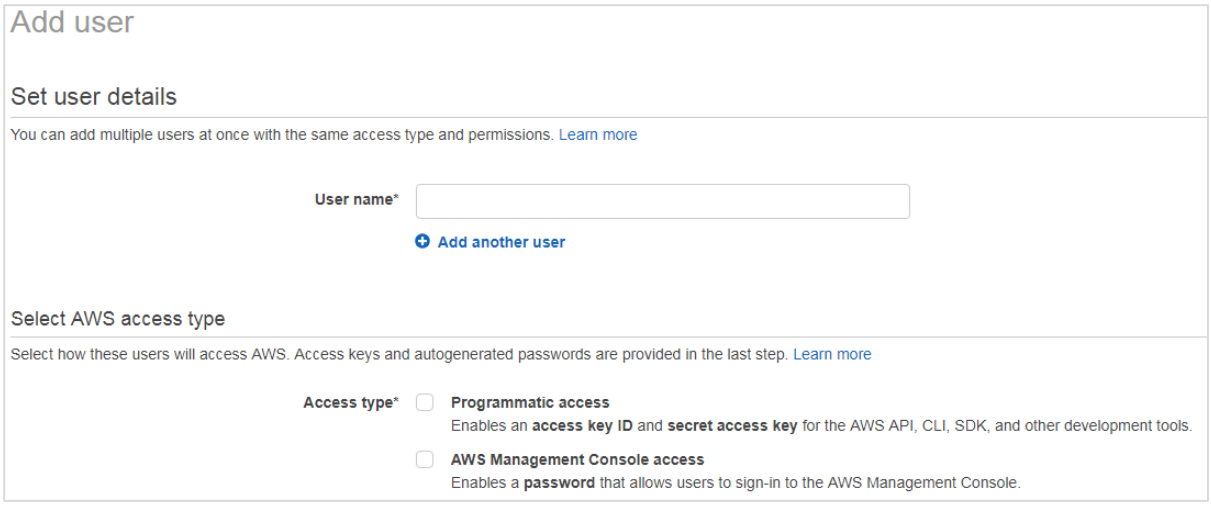
For this purpose, it requires details such as:

- AWS Access Key ID
- AWS Secret Access Key
- Default region name
- Default output from format

You can obtain these details from your aws console. Go to you Account name at top right corner as shown:



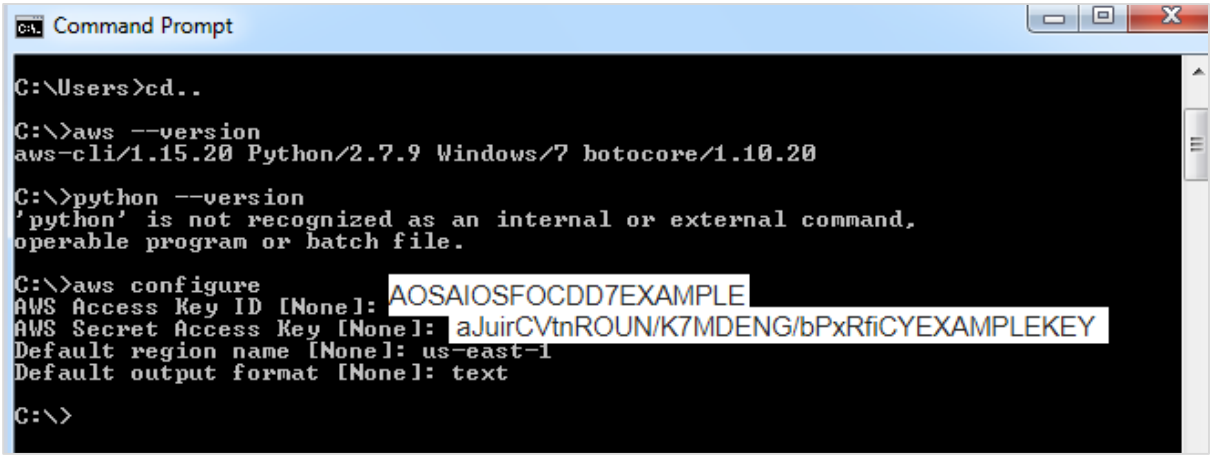
Now, click **My Security Credentials** and select users from left side.Add user with details as asked.



Add the user and to get the access key and secret key. To see the new access key, choose **Show**. Your credentials will look like as shown below:

Access key ID: AOSAIOSFOCDD7EXAMPLE

Secret access key: aJuirCVtnROUN/K7MDENG/bPxRfiCYEXAMPLEKEY



Reference Commands for AWS CLIS

The following table will give command references available to work with **aws cli**.

Name of aws cli command	Command reference
create-function	create-function --function-name <value> --runtime <value> --role <value> --handler <value> [--code <value>] [--description <value>] [--timeout <value>] [--memory-size <value>] [--environment <value>] [--kms-key-arn <value>] [--tags <value>] [--zip-file <value>] [--cli-input-json <value>]
list-functions	list-functions [--master-region <value>] [--function-version <value>] [--max-items <value>] [--cli-input-json <value>] [--starting-token <value>] [--page-size <value>] [--generate-cli-skeleton <value>]
get-function	get-function --function-name <value> [--qualifier <value>] [--cli-input-json <value>] [--generate-cli-skeleton <value>]
get-function-configuration	get-function-configuration --function-name <value> [--qualifier <value>] [--cli-input-json <value>] [--generate-cli-skeleton <value>]
get-account-settings	get-account-settings [--cli-input-json <value>] [--generate-cli-skeleton <value>]
update-function-configuration	update-function-configuration --function-name <value> [--role <value>] [--handler <value>] [--description <value>] [--timeout <value>] [--memory-size <value>] [--vpc-config <value>] [--environment <value>] [--runtime <value>] [--dead-letter-config <value>] [--kms-key-arn <value>] [--tracing-config <value>] [--revision-id <value>] [--cli-input-json <value>] [--generate-cli-skeleton <value>]
update-function-code	update-function-code --function-name <value> [--zip-file <value>] [--s3-bucket

	<value>] [--s3-key <value>] [--s3-object-version <value>] [--publish | --no-publish] [--dry-run | --no-dry-run] [--revision-id <value>][--cli-input-json <value>][--generate-cli-skeleton <value>]
delete-function	delete-function --function-name <value> [--qualifier <value>] [--cli-input-json <value>] [--generate-cli-skeleton <value>]

Now, let us discuss these commands one by one in detail.

create-function

This api will create a new lambda function. The code needs to be given in zip format. If the function to be created already exists, the api will fail. Note that the function name is case-sensitive.

Commands Included

The list of commands that you can use with create-function is given here:

```
create-function
--function-name <value>
--runtime <value>
--role <value>
--handler <value>
[--code <value>]
[--description <value>]
[--timeout <value>]
[--memory-size <value>]
[--environment <value>]
[--kms-key-arn <value>]
[--tags <value>]
[--zip-file <value>]
[--cli-input-json <value>]
```

Options Included

Various options that you can use with the functions above are as follows:

--function-name (string): This takes the name of the function.The name can be 64-bit characters.

--runtime(string): Here you need to specify the runtime environment ie the language selection. The details of the runtime are as given below:

Options available	runtime
Python v3.6	python3.6
Python v2.7	python2.7
NodeJS v6.10	nodejs6.10
NodeJS v8.10	nodejs8.10
Java	java8
C# 1	dotnetcore1.0
C# 2	dotnetcore2.0
Go	go1.x

--role(string): This will be the name of the lambda policy ie the role to be given to the lambda function for accessing other services.It will have the permission as per the role specified.

--handler (string): This is the name of the handler where the lambda code execution will start.

For nodejs, handler name is the module name that we export.

For java, it is package.classname :: handler or package.classname

For python, handler is nameofthefile.functionname

--code (structure): AWS Lambda code

--description (string): description for the AWS Lambda function

--timeout (integer): timeout will have the time at which the lambda function has to terminate execution.The default is 3s.

--memory-size (integer): This is the memory given to the aws lambda function.AWS will allocate the amount of CPU and memory allocation based on the memory given.

--environment (structure): its a object with environment details required in the aws lambda function.

e.g : Variables={Name1=string,Name2=string}

--kms-key-arn (string): this is amazon resource name (ARN) used to encrypt the environment variables.If not provided it will take the default settings to encrypt.

--zip-file (blob): path of the zip file which has the details of the code.

--cli-input-json (string) : Performs service operation based on the JSON string provided. The JSON string follows the format provided by --generate-cli-skeleton. If other arguments are provided on the command line, the CLI values will override the JSON-provided values.

Now, let us create a simple AWS Lambda function using runtime as **nodejs** and add some console.logs to be printed.

Consider a sample code for understanding the same:

```
exports.handler = async (event) => {
    console.log("Using aws cli");
    return 'Hello from Lambda from aws cli!'
};
```

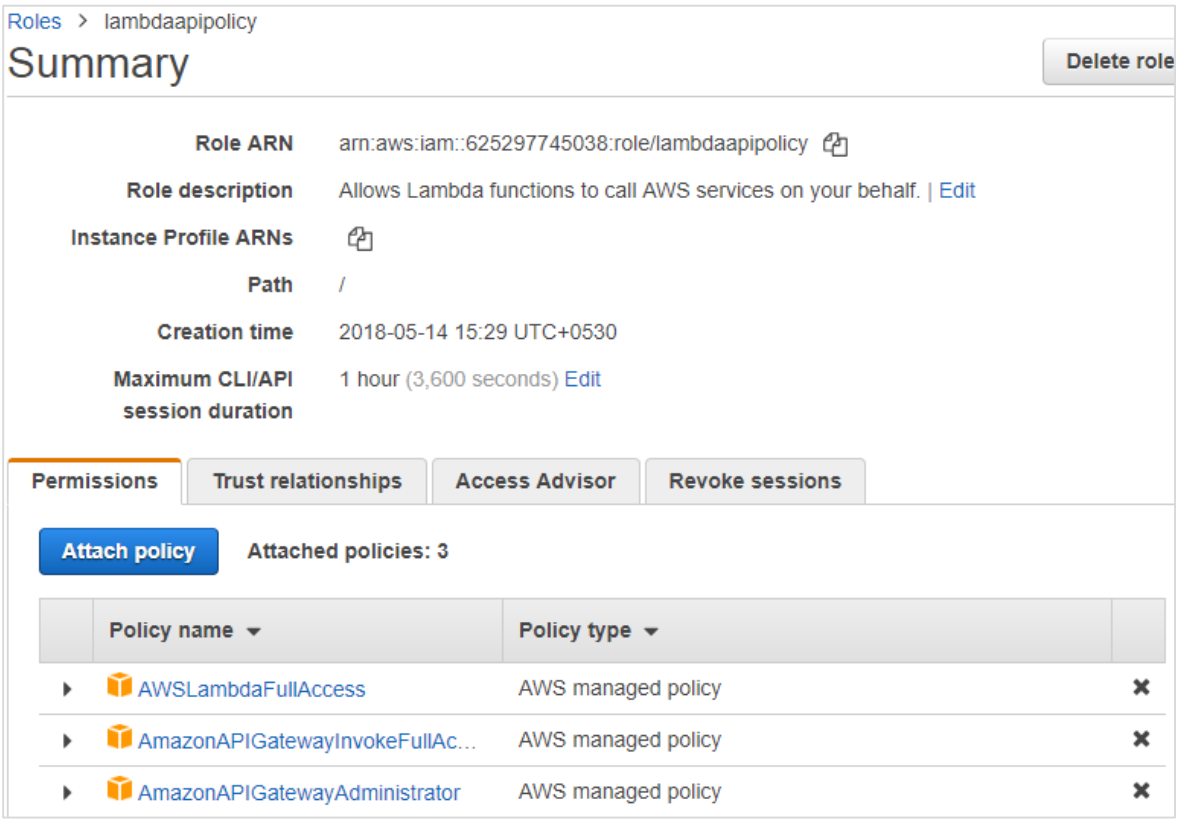
Now, zip the file and store it as **awscli.zip.**

Getting ARN

For the role, let us use the **arn** from the existing role we have created. To get the ARN, you will have to follow the steps as shown here. Observe the respective screenshots wherever attached:

Step 1

Go to IAM and select the role you want from **Roles**. The ARN details for the role are displayed as shown below. Use ***Role ARN*** with **create-function** in **aws cli**.



Observe here that the role arn is : arn:aws:iam::625297745038:role/lambdaapipolicy

The command with values for **create-function** is as follows:

```
aws lambda create-function
--function-name "awslambdausingcli"
--runtime "nodejs8.10"
--role "arn:aws:iam::625297745038:role/lambdaapipolicy"
--handler "awscli.handler"
--timeout 5
--memory-size 256
--zip-file "fileb://awscli.zip"
```

Now, if you run the command in aws cli, you can find an output as shown below:

```
Command Prompt

C:\>aws lambda create-function --function-name "awslambdausingcli" --runtime "no
dejs8.10" --role "arn:aws:iam::625297745038:role/lambdaapipolicy" --handler "aws
cli.handler"  --timeout 5  --memory-size 256 --zip-file "fileb://awscli.zip"
mCaUTGzXfS34zmN8lim0UYqYu9D48AUBtPCwbL792JM=    260             arn:aws:lambda:u
s-east-1:625297745038:function:awslambdausingcli        awslambdausingcli
awscli.handler  2018-05-27T10:30:31.702+0000    256     0527d034-e15b-4c10-9a45-
1d925f644c2c    arn:aws:iam::625297745038:role/lambdaapipolicy  nodejs8.10
5       $LATEST
TRACINGCONFIG   PassThrough

C:\>
```

In AWS console, the Lambda function is displayed as shown below:

Functions (16) Actions Create function

Filter by tags and attributes or search by keyword 1 2

Function name	Description	Runtime	Code size	Last Modified
displaydate		Node.js 6.10	221 bytes	15 days ago
helowithjava		Java 8	28.2 kB	4 days ago
displaydate1		Node.js 6.10	206 bytes	15 days ago
awslambdausingcli		Node.js 8.10	260 bytes	1 minute ago
lambdatestwithgo		Go 1.x	1.3 MB	18 hours ago
myfirstlambdafunction		Node.js 6.10	235 bytes	5 hours ago
errorhandlingpython		Python 3.6	213 bytes	2 days ago
directapigateway		Node.js 6.10	231 bytes	11 days ago
hellopythonusingzip		Python 3.6	325 bytes	2 days ago

The details of the functions are as shown here:

Function code Info

Code entry type: Upload a .ZIP file

Runtime: Node.js 8.10

Handler Info: awscli/awscli.handler

Function package*

Upload

For files larger than 10 MB, consider uploading via S3.

The details of the configuration are as given below:

Execution role

Defines the permissions of your function. Note that new roles may not be available for a few minutes after creation. Learn more about Lambda execution roles.

Choose an existing role

Existing role

You may use an existing role with this function. Note that the role must be assumable by Lambda and must have Cloudwatch Logs permissions.

lambdaapipolicy

Basic settings

Description

Memory (MB) Info

Your function is allocated CPU proportional to the memory configured.

256 MB

Timeout Info

0 min 5 sec

You can test the function and check the output as shown:

Execution result: succeeded (logs)

Details

The area below shows the result returned by your function execution. Learn more about returning results from your function.

```
"Hello from Lambda from aws cli!"
```

The corresponding Log output is shown here:

Log output

The area below shows the logging calls in your code. These correspond to a single row within the CloudWatch log group corresponding to this Lambda function. Click here to view the CloudWatch log group.

```
START RequestId: 3321e588-6199-11e8-9dcf-c58c5846b14d Version: $LATEST
2018-05-27T10:32:05.260Z        3321e588-6199-11e8-9dcf-c58c5846b14d    Using aws cli
END RequestId: 3321e588-6199-11e8-9dcf-c58c5846b14d
REPORT RequestId: 3321e588-6199-11e8-9dcf-c58c5846b14d  Duration: 2.77 ms       Billed Duration: 100 ms
Memory Size: 256 MB     Max Memory Used: 20 MB
```

list-functions

This api gives the list of functions created so far in AWS Lambda.

Commands Included

The following are the commands asscociated with this API:

```
list-functions
[--master-region <value>]
[--function-version <value>]
[--max-items <value>]
[--cli-input-json <value>]
```

Options under list-functions

The following are various options you can use under this list-functions api:

--master-region(string): optional. The region from which the functions needs to be displayed.

--function-version(string): optional. This will give the function version.

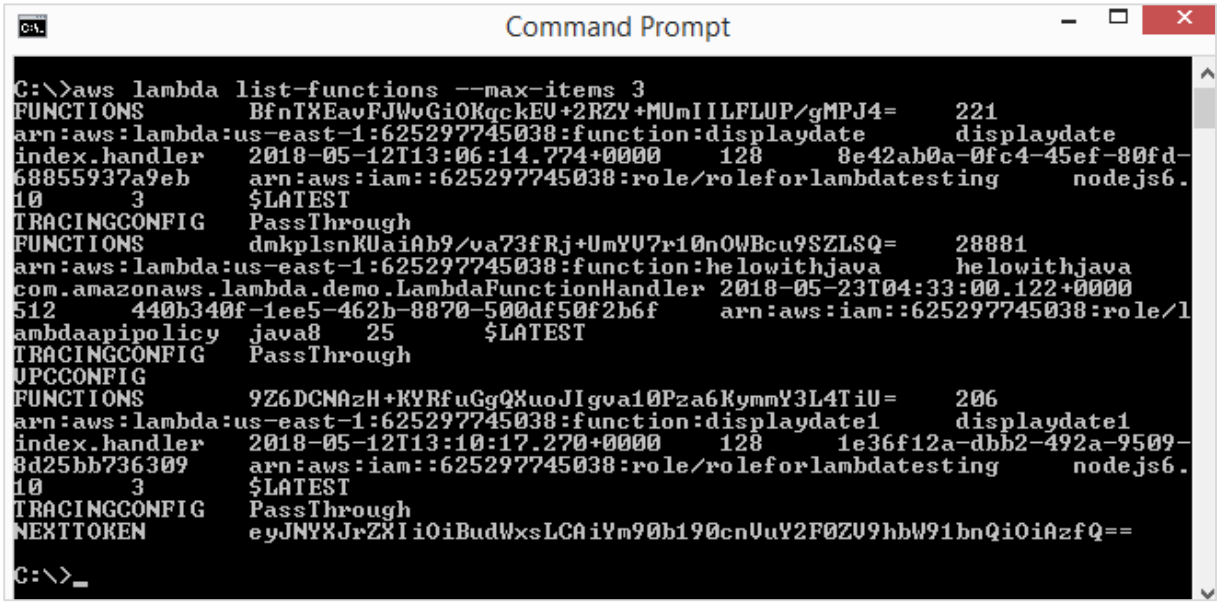
--max-items(integer): optional.This will give the items as the per the value specified.

--cli-input-json(string): optional.Will perform operation based on the json file provided.

The command with values **list-functions** is as follows:

```
aws lambda list-functions --max-items 3
```

The command displays details as follows:



get-function

This api will give details of the functions and also a url link which has zip file uploaded using create-function. The url with zip details will be valid only for 10 mins.

Commands Included

The following are the commands associated with this api:

```
get-function

--function-name <value>

[--qualifier <value>]

[--cli-input-json <value>]

[--generate-cli-skeleton <value>]
```

Options Included

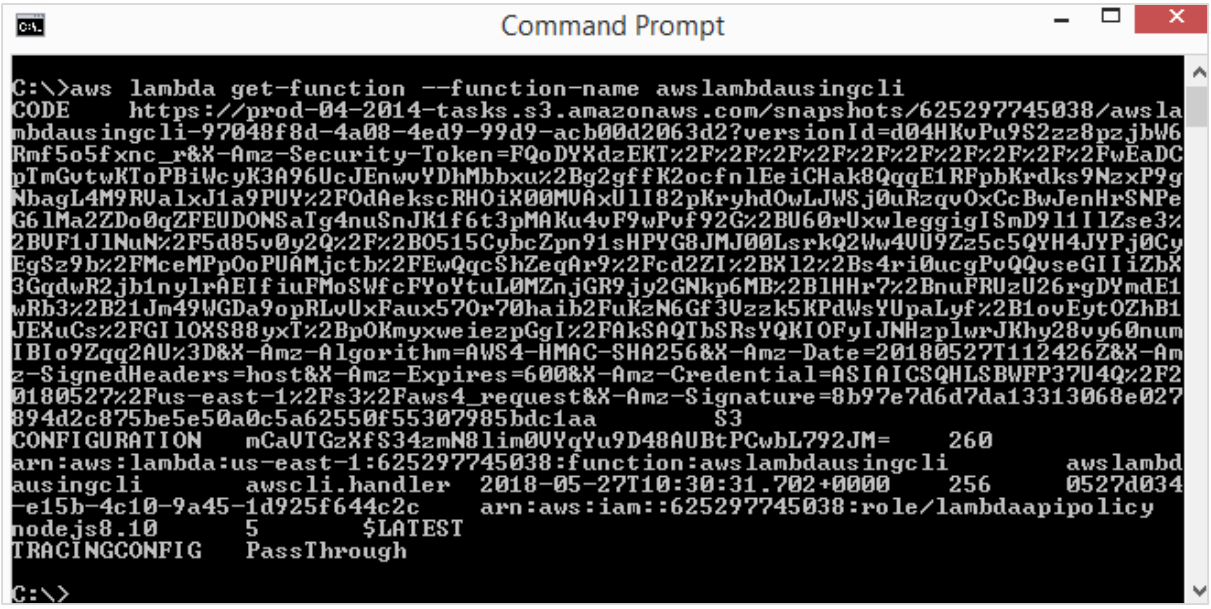
--function-name: Name of the AWS Lambda function. You can also specify Amazon Resource Name of the function.

--qualifier(string): Optional. Function version can be used to get the details of the function.

The command with values to get-function are:

```
aws lambda get-function --function-name awslambdausingcli
```

The command display details are as follows:



It gives the url which has the zip code uploaded. In the above case the url is:

```
https://prod-04-2014-
tasks.s3.amazonaws.com/snapshots/625297745038/awslambdausingcli-97048f8d-4a08-
4ed9-99d9-acb00d2063d2?versionId=d04HKvPu9S2zz8pzjbW6Rmf5o5fxnc_r&X-Amz-Security-
Token=FQoDYXdzEKT%2F%2F%2F%2F%2F%2F%2F%2F%2F%2FwEaDCpTmGvtwKToPBiWcyK3A96UcJEnwvYD
hMbbxu%2Bg2gffK2ocfnlEeiCHak8QqqE1RFpbKrdks9NzxP9gNbagL4M9RValxJ1a9PUY%2FOdAekscRH
OiX00MVAxUlI82pKryhdOwLJWSj0uRzqvOxCcBwJenHrSNPeG6lMa2ZDo0qZFEUDONSaTg4nuSnJK1f6t3
pMAKu4vF9wPvf92G%2BU60rUxwleggigISmD9l1IlZse3%2BVF1JlNuN%2F5d85v0y2Q%2F%2BO515Cybc
Zpn91sHPYG8JMJ00LsrkQ2Ww4VU9Zz5c5QYH4JYPj0CyEgSz9b%2FMceMPpOoPUAMjctb%2FEwQqcShZeq
Ar9%2Fcd2ZI%2BXl2%2Bs4ri0ucgPvQQvseGIIiZbX3GqdwR2jb1nylrAEIfiuFMoSWfcFYoYtuL0MZnjG
R9jy2GNkp6MB%2BlHHr7%2BnuFRUzU26rgDYmdE1wRb3%2B21Jm49WGDa9opRLvUxFaux57Or70haib2Fu
KzN6Gf3Vzzk5KPdWsYUpaLyf%2B1ovEytOZhB1JEXuCs%2FGIlOXS88yxT%2BpOKmyxweiezpGgI%2FAkS
AQTbSRsYQKIOFyIJNHzplwrJKhy28vy60numIBIo9Zqq2AU%3D&X-Amz-Algorithm=AWS4-HMAC-
SHA256&X-Amz-Date=20180527T112426Z&X-Amz-SignedHeaders=host&X-Amz-Expires=600&X-
Amz-Credential=ASIAICSQHLSBWFP37U4Q%2F20180527%2Fus-east-1%2Fs3%2Faws4_request&X-
Amz-Signature=8b97e7d6d7da13313068e027894d2c875be5e50a0c5a62550f55307985bdc1aa
```

get-function-configuration

This will give the configuration details of the AWS Lambda function.

The following are the commands used along with this api:

```
get-function-configuration

--function-name <value>

[--qualifier <value>]
```

The following are the options used with

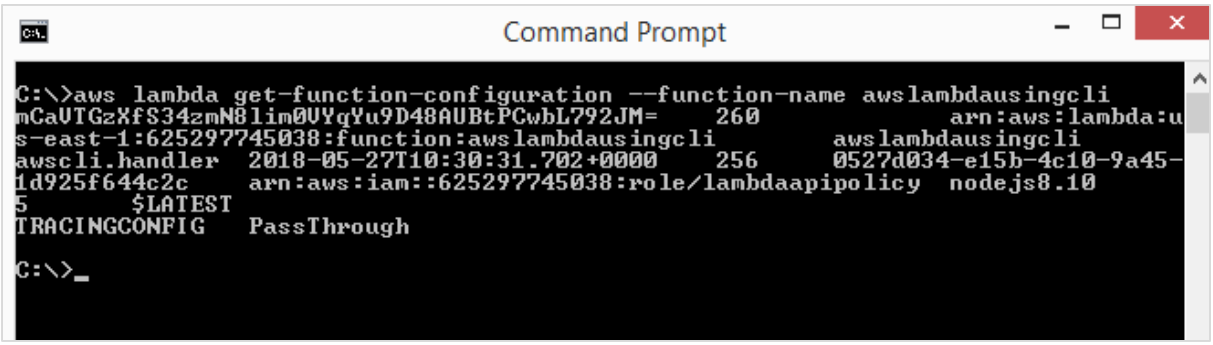
--function-name (string): name of the aws lambda function.You can also specify Amazon Resource Name of the function.

--qualifier(string): Optional. Function version can be used to get the details of the function.

The command with values to get-function are:

```
aws lambda get-function-configuration --function-name awslambdausingcli
```

The command displays details as follows:



get-account-settings

This api gives the accounts settings.

Commands Involved

The command that you can use with this api are:

```
get-account-settings

[--cli-input-json <value>]

[--generate-cli-skeleton <value>]
```

Options Involved

You can use the following options with this api:

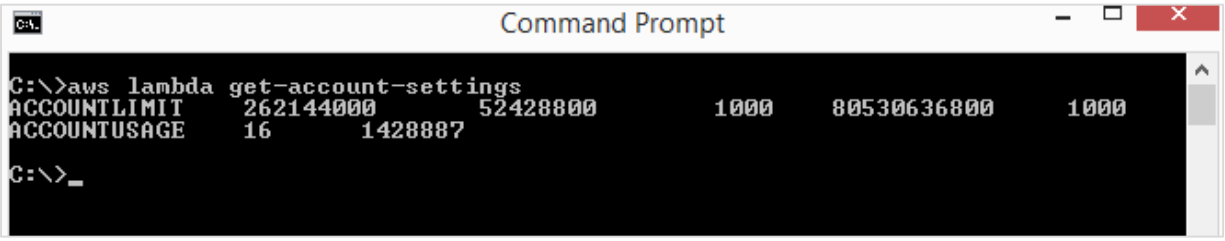
--cli-input-json(string): Performs the service based on the json string provided.

--generate-cli-skeleton(string): It prints json output without sending the API request.

You can use the following command for get-account-settings:

```
aws lambda get-account-settings
```

You can see the following output when you execute the command given above:



update-function-configuration

This api helps to update the configuration details for AWS Lambda function created. You can change the memory, timeout, handler, role, runtime, description etc.

Commands Involved

The following are the commands involved in the update-function-configuration api:

```
update-function-configuration
--function-name <value>
[--role <value>]
[--handler <value>]
[--description <value>]
[--timeout <value>]
[--memory-size <value>]
[--environment <value>]
[--runtime <value>]
[--cli-input-json <value>]
[--generate-cli-skeleton <value>]
```

Options Involved

The following are the options involved in update-function-configuration api:

--function-name: name of the aws lambda function

--role (string): optional.The ARN of role is needed to be updated.

--handler (string): optional.The handler details of aws lambda function.

--description(string): optional.Description for the function.

--timeout(integer): optional.Time required so that aws lambda function can terminate.

--memory-size(integer): optional.This is the memory given to the aws lambda function.AWS will allocate the amount of CPU and memory allocation based on the memory given.

--environment (structure): optional. It is an object with environment details required in the aws lambda function.

e.g: Variables={Name1=string,Name2=string}

--runtime(string): Here you need to specify the runtime environment ie the language selection.

The details of the runtime are shown in the table given below:

Options available	**runtime**
Python v3.6	python3.6
Python v2.7	python2.7
NodeJS v6.10	nodejs6.10
NodeJS v8.10	nodejs8.10
Java	java8
C# 1	dotnetcore1.0
C# 2	dotnetcore2.0
Go	go1.x

--cli-input-json (string): optional.This will perform the operation on the api as specified in the json string provided.

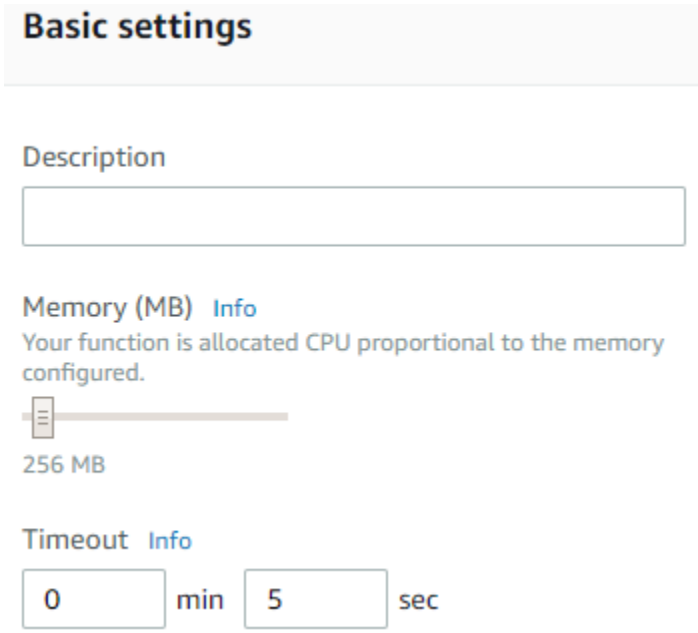
--generate-cli-skeleton (string): optional. This will output the JSON skeleton of all details

without executing the api. The output can be used as a input to **--cli-input-json**.

Now, let us chage the memory and timeout of AWS Lambda function that we have created earlier. Follow the steps given below and observe the corresponding screenshots attached for this purpose:

Step 1

The memory and timeout before the change occurred is as follows:



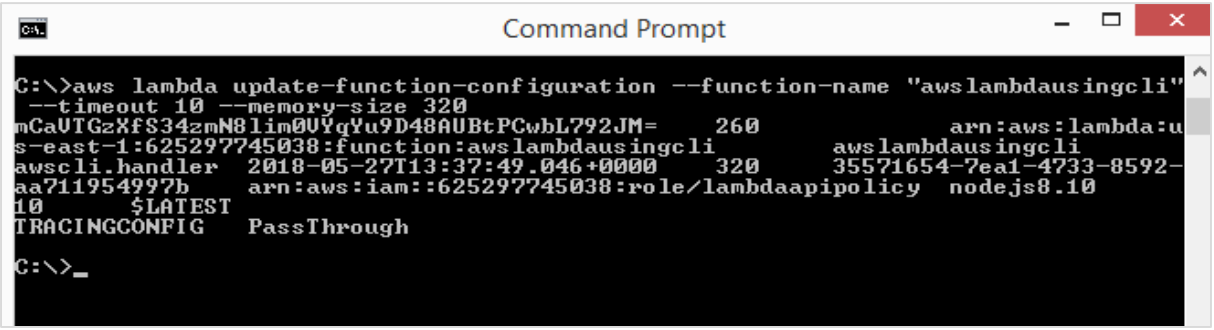
Step 2

Now, with **update-function-configuration**, let us change the memory and timeout to 320MB and timeout to 10s. For this purpose, use the following command with values:

```
aws lambda update-function-configuration --function-name “awslambdusingcli” --
timeout 10 --memory-size 320
```

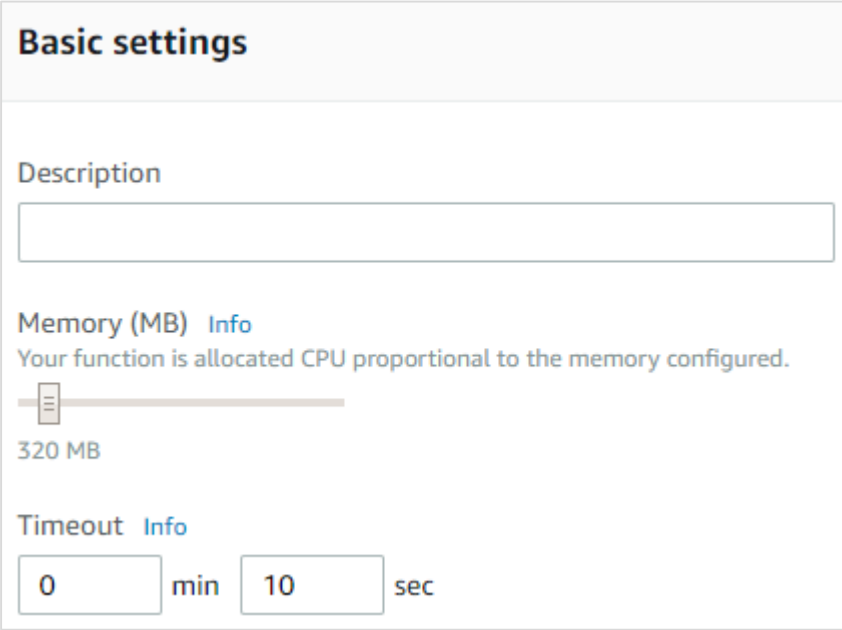
Step 3

Then you can see the following output as the display:



Step 4

The display in AWS console after using **update-function-configuration** is as follows:



Update-function-code

This api will update the code for an existing AWS Lambda function.

Commands Involved

```
update-function-code
--function-name <value>
[--zip-file <value>]
[--s3-bucket <value>]
[--s3-key <value>]
[--s3-object-version <value>]
[--cli-input-json <value>]
[--generate-cli-skeleton <value>]
```

Options Involved

The following are the options involved with the update-function-code api:

--function-name(string): name of aws lambda function

--zip-file (blob): optional . Path of the zip file which has the code to be updated.

--s3-bucket(string): optional.S3 bucket name which has the zip file with code uploaded.

--s3-key(string): optional.AWS s3 object key name which has to be uploaded.

--s3-object-version (string): optional .AWS s3 object version.

--cli-input-json (string): optional.This will perform the operation on the api as specified in the json string provided.

--generate-cli-skeleton (string): optional. This will output the JSON skeleton of all details without executing the api. The output can be used as a input to --cli-input-json.

The updated code is as shown below:

```
exports.handler = async (event,context) => {

    console.log("Using aws cli");

    console.log()

    return 'Hello from Lambda from aws cli!'

};
```

You can use the following **command with values for this purpose:**

```
aws lambda update-function-code --function-name "awslambdausingcli" --zip-file
"fileb://awscli.zip"
```

The corresponding output is as shown here:

The display from AWS console is as shown here:

Execution result: succeeded (logs)

▼ Details

The area below shows the result returned by your function execution. Learn more about returning results from your function.

```
"Hello from Lambda from aws cli!"
```

The corresponding log output is as shown below:

Log output

The area below shows the logging calls in your code. These correspond to a single row within the CloudWatch log group corresponding to this Lambda function. Click here to view the CloudWatch log group.

```
START RequestId: bfc3b8b5-61b5-11e8-a37c-bf94c68025d9 Version: $LATEST
2018-05-27T13:56:27.381Z        bfc3b8b5-61b5-11e8-a37c-bf94c68025d9    Using aws cli
2018-05-27T13:56:27.382Z        bfc3b8b5-61b5-11e8-a37c-bf94c68025d9    remaining time = 9997
2018-05-27T13:56:27.382Z        bfc3b8b5-61b5-11e8-a37c-bf94c68025d9    functionName = awslambdausingcli
2018-05-27T13:56:27.382Z        bfc3b8b5-61b5-11e8-a37c-bf94c68025d9    AWSrequestID = bfc3b8b5-61b5-11e8-a37c-bf94c68025d9
2018-05-27T13:56:27.382Z        bfc3b8b5-61b5-11e8-a37c-bf94c68025d9    logGroupName = undefined
2018-05-27T13:56:27.382Z        bfc3b8b5-61b5-11e8-a37c-bf94c68025d9    logStreamName = undefined
2018-05-27T13:56:27.382Z        bfc3b8b5-61b5-11e8-a37c-bf94c68025d9    clientContext = undefined
END RequestId: bfc3b8b5-61b5-11e8-a37c-bf94c68025d9
REPORT RequestId: bfc3b8b5-61b5-11e8-a37c-bf94c68025d9  Duration: 4.37 ms       Billed Duration: 100 ms         Memory Size: 320 MB
Max Memory Used: 46 MB
```

delete-function

The **delete** aws cli api will delete the function given.

Commands Included

The command details for the same are given here:

```
delete-function
--function-name <value>
[--qualifier <value>]
[--cli-input-json <value>]
```

```
[--generate-cli-skeleton <value>]
```

Options Included

The options included in this api are as given below:

--function-name(string): this will take the lambda function name or the arn of the aws lambda function.

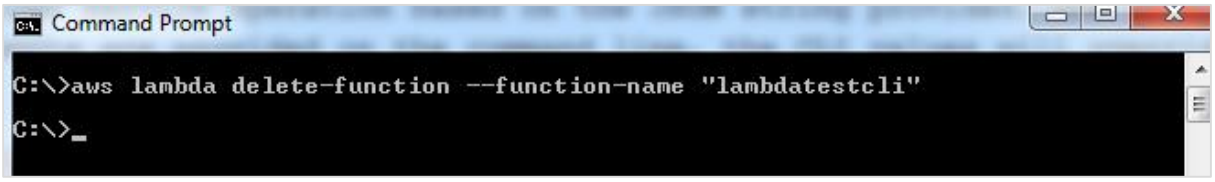
--qualifier (string): This is optional.Here you can specify the version of aws lambda that needs to be deleted.

-- cli-input-json(string): Performs service operation based on the JSON string provided. The JSON string follows the format provided by --generate-cli-skeleton. If other arguments are provided on the command line, the CLI values will override the JSON-provided values.

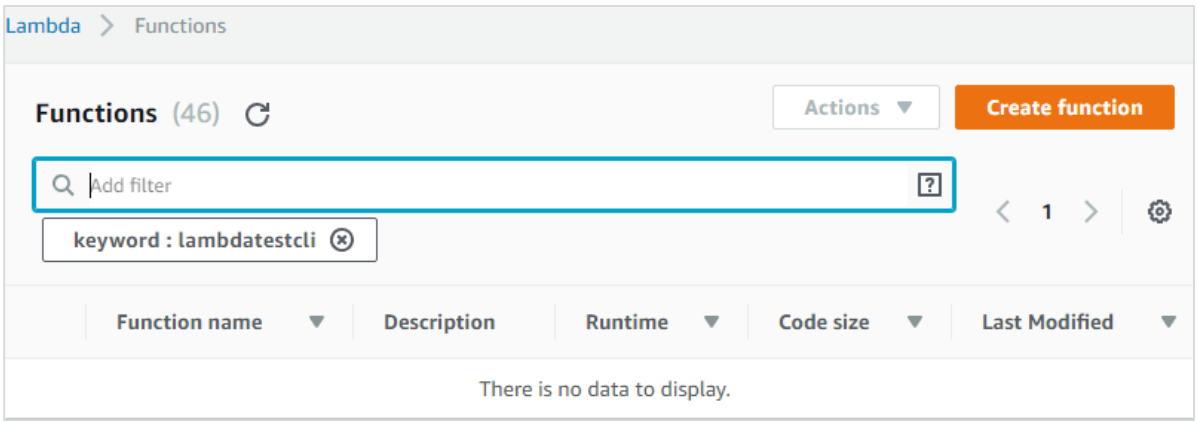
--generate-cli-skeleton(string) : it prints json skeleton to standard output without sending the API request.

You can use the following command with values for this purpose:

```
aws lambda delete-function --function-name "lambdatestcli"
```



Now, observe that the function will not be seen in AWS Lambda function list:



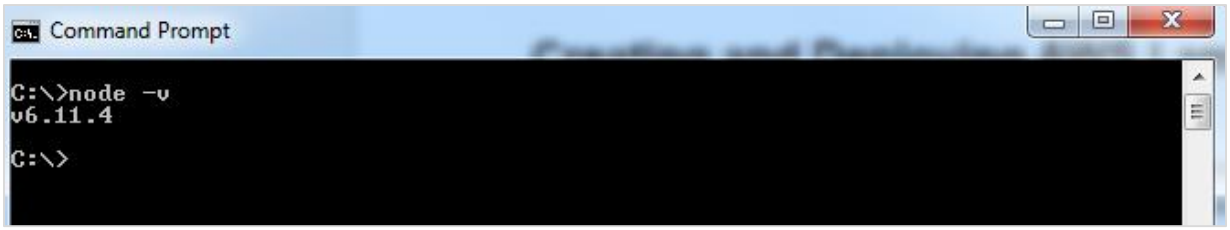
13. AWS Lambda — Creating and Deploying using Serverless Framework

AWS Lambda can be created and deployed using serverless framework. It allows you to create AWS Lambda triggers and also deploy the same by creating the required roles. Serverless framework allows to handle big projects in an easier way.The events and resources required are written in one place and just a few commands helps in deploying the full functionality on AWS console.

In this chapter, you will learn in detail how to get started with AWS serverless framework.

Install Serverless Framework using npm install

To begin with, you need to first install **nodejs**. You can check for nodejs as follows:



You will have to use the following command to install serverless using npm package:

```
npm install -g serverless
```

Once npm is done, execute serverless command which shows the list of command to be used to create and deploy AWS Lambda function. Observe the screenshots given below:

```
Command Prompt

C:\>serverless

Commands
* You can run commands with "serverless" or the shortcut "sls"
* Pass "--verbose" to this command to get in-depth plugin info
* Pass "--no-color" to disable CLI colors
* Pass "--help" after any <command> for contextual help

Framework
* Documentation: https://serverless.com/framework/docs/

config ......................... Configure Serverless
config credentials ............ Configures a new provider profile for the Server
less Framework
create ......................... Create new Serverless service
deploy ......................... Deploy a Serverless service
deploy function ............... Deploy a single function from the service
deploy list ................... List deployed version of your Serverless Service

deploy list functions ......... List all the deployed functions and their versio
ns
info ........................... Display information about the service
install ........................ Install a Serverless service from GitHub or a pl
ugin from the Serverless registry
```

```
Command Prompt

deploy list functions ......... List all the deployed functions and their versio
ns
info ........................... Display information about the service
install ........................ Install a Serverless service from GitHub or a pl
ugin from the Serverless registry
invoke ......................... Invoke a deployed function
invoke local ................... Invoke function locally
logs ........................... Output the logs of a deployed function
metrics ........................ Show metrics for a specific function
package ........................ Packages a Serverless service
plugin ......................... Plugin management for Serverless
plugin install ................. Install and add a plugin to your service
plugin uninstall ............... Uninstall and remove a plugin from your service
plugin list .................... Lists all available plugins
plugin search .................. Search for plugins
print .......................... Print your compiled and resolved config file
remove ......................... Remove Serverless service and all resources
rollback ....................... Rollback the Serverless service to a specific de
ployment
rollback function .............. Rollback the function to the previous version
slstats ........................ Enable or disable stats

Platform (Beta)
* The Serverless Platform is currently in experimental beta. Follow the docs bel
ow to get started.
```

You can also use **sls** instead of servesless. **sls** is the shorthand command for serverless.

```
C:\>sls

Commands
* You can run commands with "serverless" or the shortcut "sls"
* Pass "--verbose" to this command to get in-depth plugin info
* Pass "--no-color" to disable CLI colors
* Pass "--help" after any <command> for contextual help

Framework
* Documentation: https://serverless.com/framework/docs/

config ......................... Configure Serverless
config credentials ............ Configures a new provider profile for the Server
less Framework
create ......................... Create new Serverless service
deploy ......................... Deploy a Serverless service
deploy function ................ Deploy a single function from the service
deploy list .................... List deployed version of your Serverless Service

deploy list functions .......... List all the deployed functions and their versio
ns
info ........................... Display information about the service
install ........................ Install a Serverless service from GitHub or a pl
ugin from the Serverless registry
```

In case you need help on the command **sls,** you can use the following command:

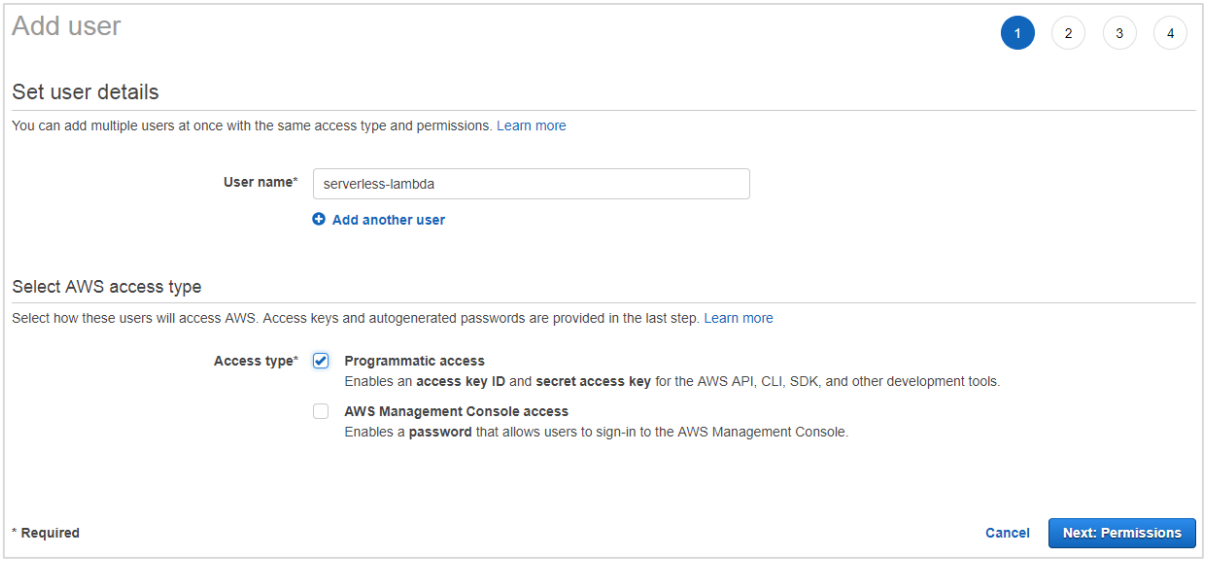
```
sls create --help
```

```
C:\>sls create --help
Plugin: Create
create ......................... Create new Serverless service
    --template / -t ...................... Template for the service. Available tem
plates: "aws-nodejs", "aws-nodejs-typescript", "aws-nodejs-ecma-script", "aws-py
thon", "aws-python3", "aws-groovy-gradle", "aws-java-maven", "aws-java-gradle",
"aws-kotlin-jvm-maven", "aws-kotlin-jvm-gradle", "aws-kotlin-nodejs-gradle", "aw
s-scala-sbt", "aws-csharp", "aws-fsharp", "aws-go", "aws-go-dep", "azure-nodejs"
, "fn-nodejs", "fn-go", "google-nodejs", "kubeless-python", "kubeless-nodejs", "
openwhisk-java-maven", "openwhisk-nodejs", "openwhisk-php", "openwhisk-python",
"openwhisk-swift", "spotinst-nodejs", "spotinst-python", "spotinst-ruby", "spoti
nst-java8", "webtasks-nodejs", "plugin" and "hello-world"
    --template-url / -u .................. Template URL for the service. Supports:
 GitHub, BitBucket
    --template-path ...................... Template local path for the service.
    --path / -p .......................... The path where the service should be cr
eated (e.g. --path my-service)
    --name / -n .......................... Name for the service. Overwrites the de
fault name of the created service.


C:\>
```

For creating a serverless framework, you have to follow the steps given below:

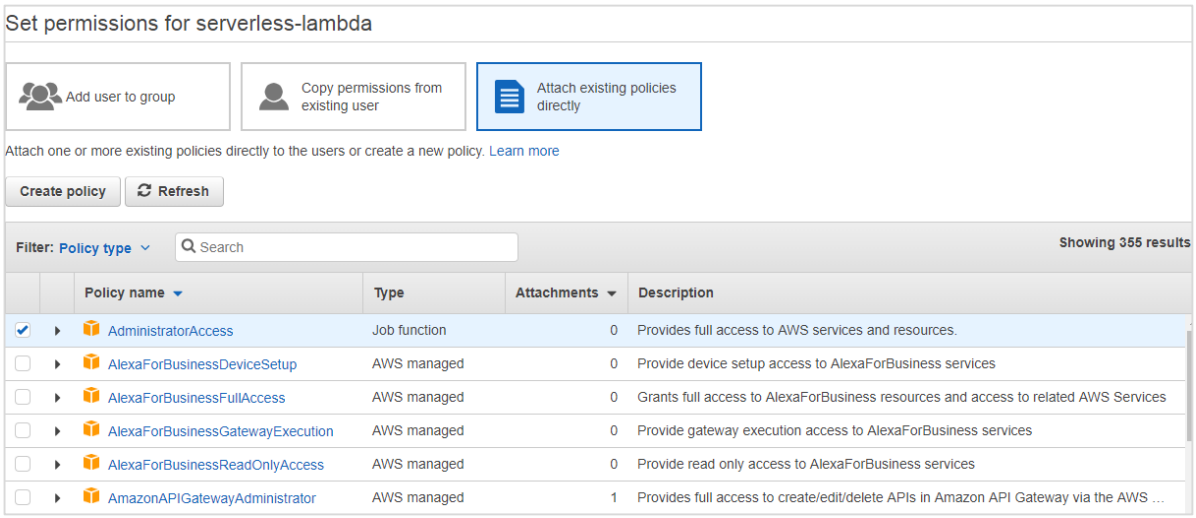
Step 1

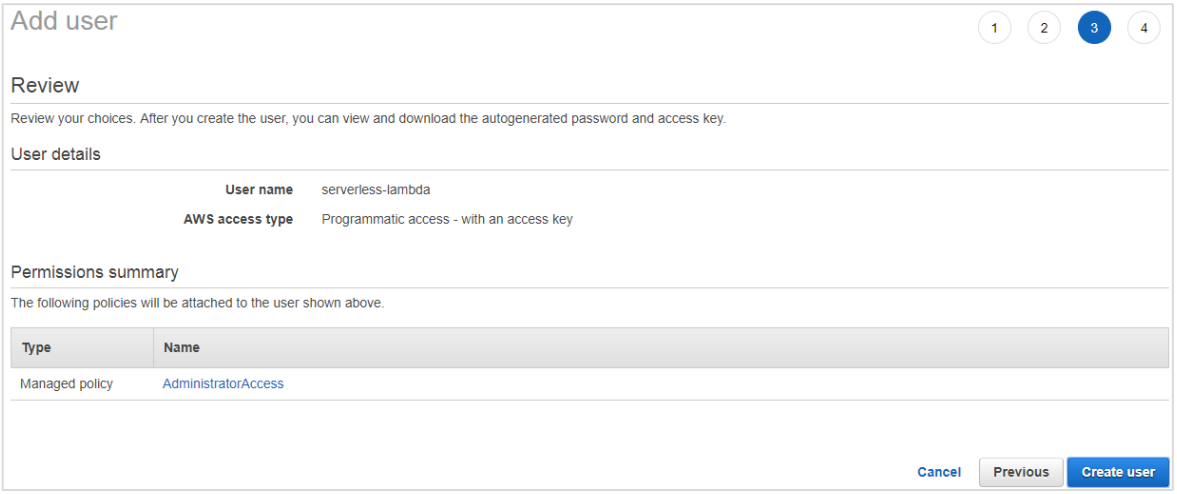
To start using serverless framework, we need to add the credentials. By this, you can the user first in AWS console as follows:



Step 2

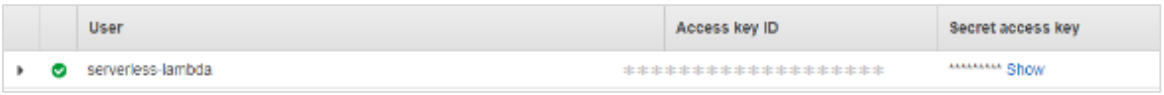
Click on **Next:Permissions** button to add permissions. You will have to attach the existing policies or Administrator Access to this user.





Step 3

Click **Create User** to add the user. It will display the access key and secret key which we need to configure the serverless framework:



Configure AWS Serverless Framework

Let us see how to configure AWS serverless framework. You can use the following command for this purpose:

```
sls config credentials --provider aws --key accesskey --secret secretkey
```

Note that the details of credentials entered, that is the **access key** and **secret key** are stored in the **file /aws/credentials**.

First, create a folder where you want your project files to be stored.

```
Command Prompt

C:\>sls config credentials --provider aws --key AKIAJTJRDSPLBUH6VV5A --secret p0
I3KIDKBO+Dxzpo24J3dcM/CYAF7ac4kOwA2qi3
Serverless: Setting up AWS...
Serverless: Saving your AWS profile in "~/.aws/credentials"...
Serverless: Success! Your AWS access keys were stored under the "default" profil
e.

C:\>mkdir aws-serverless

C:\>cd aws-serverless

C:\aws-serverless>
```

Next, we will start the work in **aws-serverless** folder.

Create AWS Lambda using Serverless Framework

Now, let us create a Lambda function with the serverless framework using the steps given below:

Step 1

Following are the details for serverless **create** command:

```
Command Prompt

C:\aws-serverless>sls create --help
Plugin: Create
create ......................... Create new Serverless service
    --template / -t ..................... Template for the service. Available tem
plates: "aws-nodejs", "aws-nodejs-typescript", "aws-nodejs-ecma-script", "aws-py
thon", "aws-python3", "aws-groovy-gradle", "aws-java-maven", "aws-java-gradle",
"aws-kotlin-jvm-maven", "aws-kotlin-jvm-gradle", "aws-kotlin-nodejs-gradle", "aw
s-scala-sbt", "aws-csharp", "aws-fsharp", "aws-go", "aws-go-dep", "azure-nodejs"
, "fn-nodejs", "fn-go", "google-nodejs", "kubeless-python", "kubeless-nodejs", "
openwhisk-java-maven", "openwhisk-nodejs", "openwhisk-php", "openwhisk-python",
"openwhisk-swift", "spotinst-nodejs", "spotinst-python", "spotinst-ruby", "spoti
nst-java8", "webtasks-nodejs", "plugin" and "hello-world"
    --template-url / -u ................. Template URL for the service. Supports:
 GitHub, BitBucket
    --template-path ..................... Template local path for the service.
    --path / -p ......................... The path where the service should be cr
eated (e.g. --path my-service)
    --name / -n ......................... Name for the service. Overwrites the de
fault name of the created service.


C:\aws-serverless>_
```

Step 2

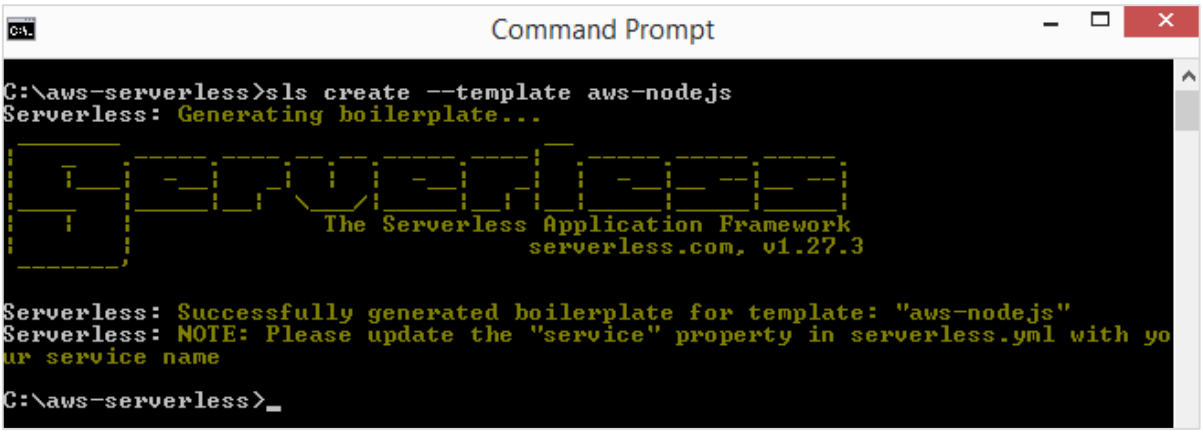
Now, we need to assign the template which are as follows:

Aws-nodejs, aws-nodejs-typescript, aws-nodejs-ecma-script, aws-python, aws-python3, aws-groovy-gradle etc.

Step 3

We shall make use of **aws-nodejs** template to create our first project using serverless framework. The command for the same purpose is as shown here:

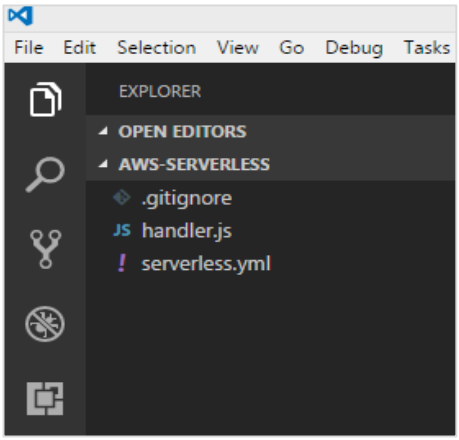
```
sls create --template aws-nodejs
```



Note that this command creates a boilerplate for template **aws-nodejs**.

Step 4

Now, open the folder created in an IDE. Here we are using Visual Studio code and the folder structure is as follows:



Step 5

There are 2 files created: **handler.js** and **Serverless.yml**

The AWS Lambda basic function details are shown in **handler.js** as follows:

```
'use strict';


module.exports.hello = (event, context, callback) => {
  const response = {
    statusCode: 200,
    body: JSON.stringify({
      message: 'Go Serverless v1.0! Your function executed successfully!',
      input: event,
    }),
  };


  callback(null, response);


  // Use this code if you don't use the http event with the LAMBDA-PROXY
integration
  // callback(null, { message: 'Go Serverless v1.0! Your function executed
successfully!', event });
};
```

Thie file **Serverless.yml** has the configuration details of the serverless framework as shown below:

```
# Welcome to Serverless!
#
# This file is the main config file for your service.
# It's very minimal at this point and uses default values.
# You can always add more config options for more control.
# We've included some commented out config examples here.
# Just uncomment any of them to get that config option.
#
# For full config options, check the docs:
#    docs.serverless.com
```

```
#
# Happy Coding!

service: aws-nodejs # NOTE: update this with your service name

# You can pin your service to only deploy with a specific Serverless version
# Check out our docs for more details
# frameworkVersion: "=X.X.X"

provider:
 name: aws
 runtime: nodejs6.10

# you can overwrite defaults here
#  stage: dev
#  region: us-east-1

# you can add statements to the Lambda function's IAM Role here
#  iamRoleStatements:
#    - Effect: "Allow"
#      Action:
#        - "s3:ListBucket"
#      Resource: { "Fn::Join" : ["", ["arn:aws:s3:::", { "Ref" :
"ServerlessDeploymentBucket" } ] ]  }
#    - Effect: "Allow"
#      Action:
#        - "s3:PutObject"
#      Resource:
#        Fn::Join:
#          - ""
#          - - "arn:aws:s3:::"
#            - "Ref" : "ServerlessDeploymentBucket"
#            - "/*"

# you can define service wide environment variables here
```

```
#  environment:
#    variable1: value1

# you can add packaging information here
#package:
#  include:
#    - include-me.js
#    - include-me-dir/**
#  exclude:
#    - exclude-me.js
#    - exclude-me-dir/**

functions:
 hello:
   handler: handler.hello

#    The following are a few example events you can configure
#    NOTE: Please make sure to change your handler code to work with those events
#    Check the event documentation for details
#    events:
#      - http:
#          path: users/create
#          method: get
#      - s3: ${env:BUCKET}
#      - schedule: rate(10 minutes)
#      - sns: greeter-topic
#      - stream: arn:aws:dynamodb:region:XXXXXX:table/foo/stream/1970-01-
01T00:00:00.000
#      - alexaSkill: amzn1.ask.skill.xx-xx-xx-xx
#      - alexaSmartHome: amzn1.ask.skill.xx-xx-xx-xx
#      - iot:
#          sql: "SELECT * FROM 'some_topic'"
#      - cloudwatchEvent:
#          event:
#            source:
```

```
#              - "aws.ec2"
#            detail-type:
#              - "EC2 Instance State-change Notification"
#            detail:
#              state:
#                - pending
#      - cloudwatchLog: '/aws/lambda/hello'
#      - cognitoUserPool:
#          pool: MyUserPool
#          trigger: PreSignUp

#    Define function environment variables here
#    environment:
#      variable2: value2

# you can add CloudFormation resource templates here
#resources:
#  Resources:
#    NewResource:
#      Type: AWS::S3::Bucket
#      Properties:
#        BucketName: my-new-bucket
#  Outputs:
#     NewOutput:
#       Description: "Description for the output"
#       Value: "Some output value"
```

Now, we need to add changes in serverless.yml file as per our requirements. You can use the commands as given below:

You can use the following command for **Service:**

```
service: aws-nodejs # NOTE: update this with your service name
```

Now, change the service here and add the name given to our folder as shown:

```
service: aws-serverless # NOTE: update this with your service name
```

The provider details are as shown:

```
provider:
 name: aws
 runtime: nodejs6.10
```

The provider is **aws** and runtime is **nodejs6.10**. We need to add the **region** in which we will be working and the **stage**, that is **dev *or* prod** environment for the project. So here are the updated details of provider:provider:

```
 name: aws
 runtime: nodejs6.10
# you can overwrite defaults here
 stage: prod
 region: us-east-1
```

IAM Role

The **iam role**, that is, the code for permission to work with Lambda is shown here in the **.yml** file:

```
#  iamRoleStatements:
#    - Effect: "Allow"
#      Action:
#        - "s3:ListBucket"
#      Resource: { "Fn::Join" : ["", ["arn:aws:s3:::", { "Ref" :
"ServerlessDeploymentBucket" } ] ]  }
#    - Effect: "Allow"
#      Action:
#        - "s3:PutObject"
#      Resource:
#        Fn::Join:
```

```
#          - ""
#          - - "arn:aws:s3:::"
#            - "Ref" : "ServerlessDeploymentBucket"
#            - "/*"
```

Note that we need to give the details of the role, that is the permission required with other AWS services, in the above section.

AWS Lambda Handler Details

The name of the export function in **handler.js** is hello. So the handler is name of the file followed by export name.

```
functions:
 hello:
   handler: handler.hello
```

The resource details about the s3 service added as shown below here:

```
# you can add CloudFormation resource templates here
#resources:
#  Resources:
#    NewResource:
#      Type: AWS::S3::Bucket
#      Properties:
#        BucketName: my-new-bucket
#  Outputs:
#     NewOutput:
#       Description: "Description for the output"
#       Value: "Some output value"
```

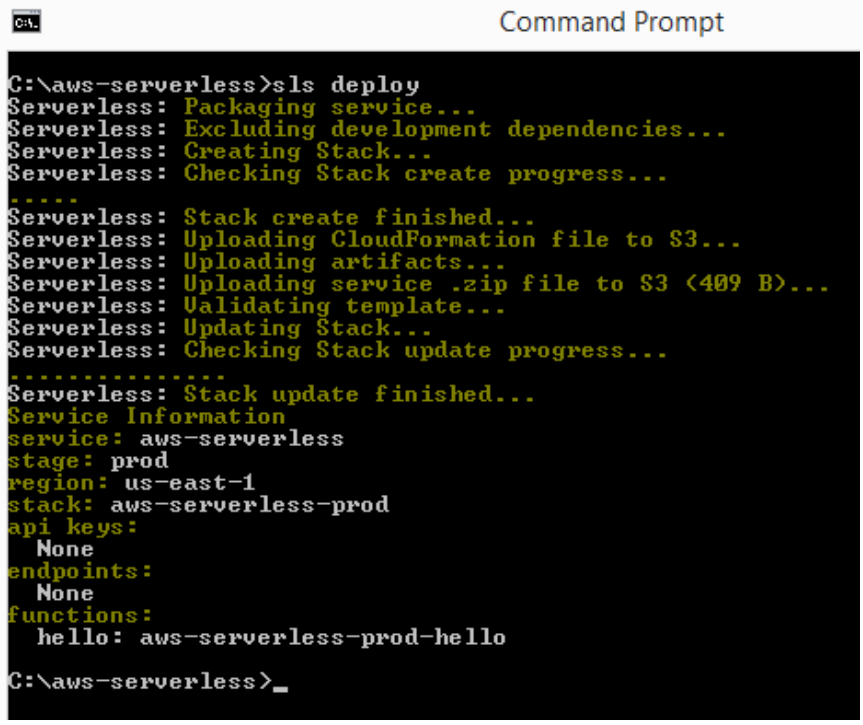
Deploy AWS Lambda using Serverless Framework

Let us deploy the above lambda function to AWS console. You can use the following steps for this purpose:

Step 1

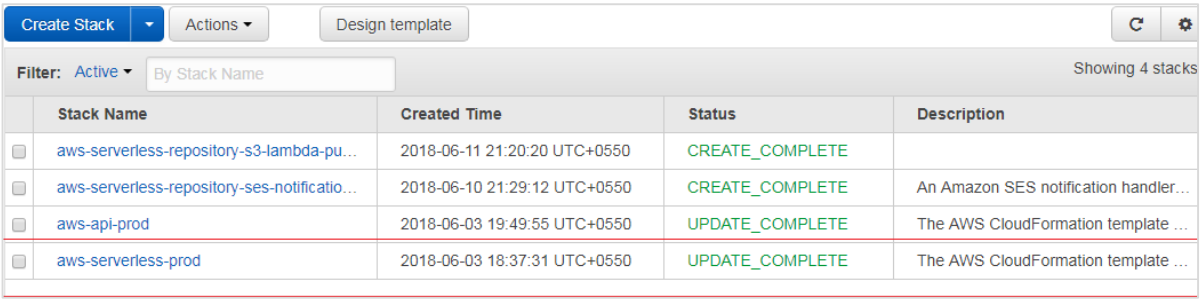
First, you will have to use the following command:

```
sls deploy
```



Step 2

Now, you should see the function in AWS console now as shown. The details of serverless AWS are logged in AWS cloudformation. For this purpose, go to AWS service and select **CloudFormation**.The details of the AWS Lambda are displayed as follows:



Observe that the name given is project name followed by the stage used.

Resources

Logical ID	Physical ID	Type	Status	Status Reason
HelloLambdaFunc...	aws-serverless-prod-hello	AWS::Lambda::Function	CREATE_COMPL...	
HelloLambdaVersi...	arn:aws:lambda:us-east-1:625297745038:function:aws-serverless-prod-hello:1	AWS::Lambda::Version	CREATE_COMPL...	
HelloLogGroup	/aws/lambda/aws-serverless-prod-hello	AWS::Logs::LogGroup	CREATE_COMPL...	
IamRoleLambdaE...	aws-serverless-prod-us-east-1-lambdaRole	AWS::IAM::Role	CREATE_COMPL...	
ServerlessDeploy...	aws-serverless-prod-serverlessdeploymentbucket-1weyz6w8aftk0	AWS::S3::Bucket	CREATE_COMPL...	

Step 3

It creates the **iam** role for AWS Lambda and log group for AWS cloudwatch. S3 bucket is created which has the code details stored and the configuration details.

This is created by the command **sls deploy**. You need not specify the iam role, instead it is created by default during the **deploy** stage.

aws-serverless-prod

Stack name:	aws-serverless-prod
Stack ID:	arn:aws:cloudformation:us-east-1:625297745038:stack/aws-serverless-prod/12b92ed0-672f-11e8-9851-50fae97e0835
Status:	UPDATE_COMPLETE
Status reason:	
Termination protection:	Disabled
IAM role:	
Description	The AWS CloudFormation template for this Serverless application

Step 4

The detailed flow of events is displayed below in the cloudformation service.

Events

Filter by: Status Search events

2018-06-03	Status	Type	Logical ID	Status Reason
18:38:33 UTC+0550	UPDATE_COMPLETE	AWS::CloudFormation::Stack	aws-serverless-prod	
18:38:32 UTC+0550	UPDATE_COMPLETE_CLEANUP_IN_PROGRESS	AWS::CloudFormation::Stack	aws-serverless-prod	
18:38:30 UTC+0550	CREATE_COMPLETE	AWS::Lambda::Version	HelloLambdaVersionrNq8rGPHmBE0OwhLE3iRSwslxAz8rEdbccZBPpLc8	
18:38:30 UTC+0550	CREATE_IN_PROGRESS	AWS::Lambda::Version	HelloLambdaVersionrNq8rGPHmBE0OwhLE3iRSwslxAz8rEdbccZBPpLc8	Resource creation Initiated
18:38:29 UTC+0550	CREATE_IN_PROGRESS	AWS::Lambda::Version	HelloLambdaVersionrNq8rGPHmBE0OwhLE3iRSwslxAz8rEdbccZBPpLc8	
18:38:27 UTC+0550	CREATE_COMPLETE	AWS::Lambda::Function	HelloLambdaFunction	
18:38:27 UTC+0550	CREATE_IN_PROGRESS	AWS::Lambda::Function	HelloLambdaFunction	Resource creation Initiated
18:38:26 UTC+0550	CREATE_IN_PROGRESS	AWS::Lambda::Function	HelloLambdaFunction	
18:38:24 UTC+0550	CREATE_COMPLETE	AWS::IAM::Role	IamRoleLambdaExecution	
18:38:15 UTC+0550	CREATE_COMPLETE	AWS::Logs::LogGroup	HelloLogGroup	
18:38:14 UTC+0550	CREATE_IN_PROGRESS	AWS::Logs::LogGroup	HelloLogGroup	Resource creation Initiated
18:38:14 UTC+0550	CREATE_IN_PROGRESS	AWS::IAM::Role	IamRoleLambdaExecution	Resource creation Initiated
18:38:14 UTC+0550	CREATE_IN_PROGRESS	AWS::Logs::LogGroup	HelloLogGroup	
18:38:14 UTC+0550	CREATE_IN_PROGRESS	AWS::IAM::Role	IamRoleLambdaExecution	
18:38:11 UTC+0550	UPDATE_IN_PROGRESS	AWS::CloudFormation::Stack	aws-serverless-prod	User Initiated

Lambda > Functions > aws-serverless-prod-hello

ARN - arn:aws:lambda:us-east-1:625297745038:function:aws-serverless-prod-hello

aws-serverless-prod-hello

Throttle | Qualifiers | Actions | Select a test event.. | Test | Save

This function belongs to the CloudFormation stack **aws-serverless-prod**. Visit the CloudFormation console to manage this stack.

AWS Lambda Code

The AWS Lambda code and its execution settings are shown in the screenshot given below:

Code entry type: Edit code inline

Runtime: Node.js 6.10

Handler Info: handler.hello

File Edit Find View Goto Tools Window

Environment

aws-serverless-prod-hello

handler.js

handler.js

```
'use strict';

module.exports.hello = (event, context, callback) => {
  const response = {
    statusCode: 200,
    body: JSON.stringify({
      message: 'Go Serverless v1.0! Your function executed successfully!',
      input: event,
    }),
  };

  callback(null, response);

  // Use this code if you don't use the http event with the LAMBDA-PROXY integration
  // callback(null, { message: 'Go Serverless v1.0! Your function executed successfully!', even
};
```

When you test the Lambda function, you can find the following output:

Execution result: succeeded (logs)

▼ Details

The area below shows the result returned by your function execution. Learn more about returning results from your function.

```
{
  "statusCode": 200,
  "body": "{\"message\":\"Go Serverless v1.0! Your function executed successfully!\",\"input\":
{\"key3\":\"value3\",\"key2\":\"value2\",\"key1\":\"value1\"}}"
}
```

Execution role

Defines the permissions of your function. Note that new roles may not be available for a few minutes after creation. Learn more about Lambda execution roles.

Choose an existing role

Existing role

You may use an existing role with this function. Note that the role must be assumable by Lambda and must have Cloudwatch Logs permissions.

aws-serverless-prod-us-east-1-lambdaRole

Basic settings

Description

Memory (MB) Info

Your function is allocated CPU proportional to the memory configured.

1024 MB

Timeout Info

0 min 6 sec

The Log output for the above function is shown here:

Log output

The area below shows the logging calls in your code. These correspond to a single row within the CloudWatch log group corresponding to this Lambda function. Click here to view the CloudWatch log group.

```
START RequestId: dcb47d2c-672f-11e8-b560-ff62a0440aea Version: $LATEST
END RequestId: dcb47d2c-672f-11e8-b560-ff62a0440aea
REPORT RequestId: dcb47d2c-672f-11e8-b560-ff62a0440aea  Duration: 2.28 ms      Billed Duration: 100 ms        Memory Size: 1024
MB      Max Memory Used: 20 MB
```

We can also test the AWS Lambda function using the serverless command as shown below:

```
sls invoke --function hello
```

```
Command Prompt

C:\aws-serverless>sls deploy
Serverless: Packaging service...
Serverless: Excluding development dependencies...
Serverless: Creating Stack...
Serverless: Checking Stack create progress...
.....
Serverless: Stack create finished...
Serverless: Uploading CloudFormation file to S3...
Serverless: Uploading artifacts...
Serverless: Uploading service .zip file to S3 (409 B)...
Serverless: Validating template...
Serverless: Updating Stack...
Serverless: Checking Stack update progress...
.............
Serverless: Stack update finished...
Service Information
service: aws-serverless
stage: prod
region: us-east-1
stack: aws-serverless-prod
api keys:
  None
endpoints:
  None
functions:
  hello: aws-serverless-prod-hello

C:\aws-serverless>sls invoke --function hello_
```

The syntax of the invoke command is shown here:

```
sls invoke --function hello
```

This invoke command triggers the AWS Lambda function and displays the output in the command prompt as shown below:

```
Command Prompt
Serverless: Packaging service...
Serverless: Excluding development dependencies...
Serverless: Creating Stack...
Serverless: Checking Stack create progress...
.....
Serverless: Stack create finished...
Serverless: Uploading CloudFormation file to S3...
Serverless: Uploading artifacts...
Serverless: Uploading service .zip file to S3 (409 B)...
Serverless: Validating template...
Serverless: Updating Stack...
Serverless: Checking Stack update progress...
...............
Serverless: Stack update finished...
Service Information
service: aws-serverless
stage: prod
region: us-east-1
stack: aws-serverless-prod
api keys:
  None
endpoints:
  None
functions:
  hello: aws-serverless-prod-hello

C:\aws-serverless>sls invoke --function hello
{
    "statusCode": 200,
    "body": "{\"message\":\"Go Serverless v1.0! Your function executed successfu
lly!\",\"input\":{}}"
}

C:\aws-serverless>
```

You can also test the Lambda function before deploying and the command for same using the following command :

```
sls invoke local --function hello
```

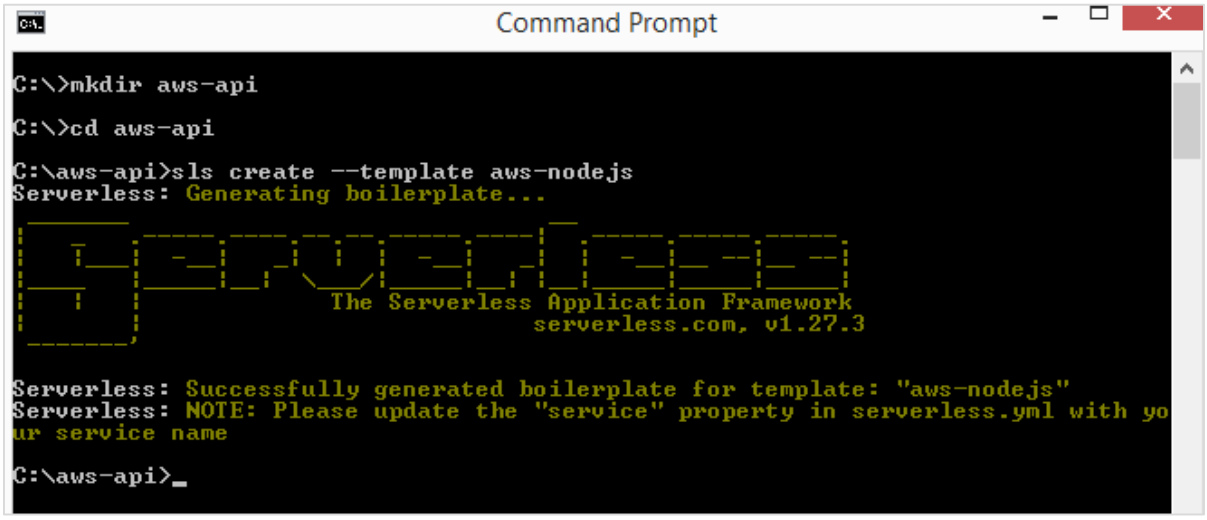
Please note that it is not always possible to test locally as the resources like S3 and DynanoDB cannot be simulated on the local environment. Only the basic function calls can be tested locally.

```
Command Prompt - sls  invoke local --function hello

C:\aws-serverless>sls invoke local --function hello
{
    "statusCode": 200,
    "body": "{\"message\":\"Go Serverless v1.0! Your function executed successfu
lly!\",\"input\":\"\"}"
}

C:\aws-serverless>
```

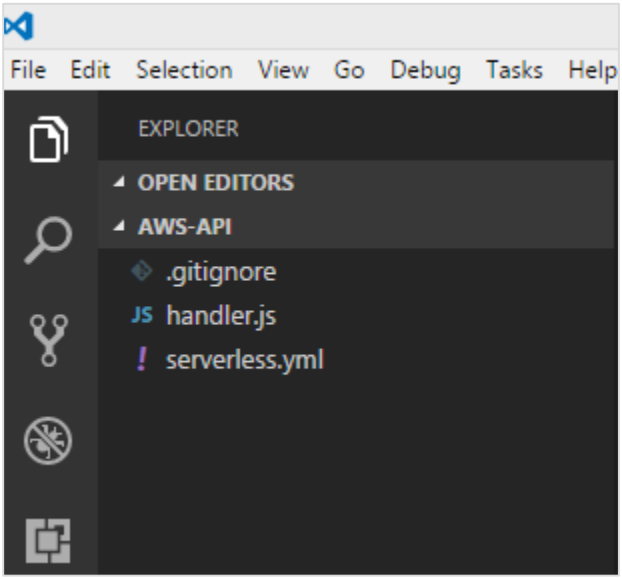
Using API Gateway and AWS Lambda with Serverless Framework

Let us see how to create new project to work with Lambda and api gateway.You can use the following command for this purpose:

```
sls create --template aws-nodejs
```



Now, open **aws-api** project in visual code. You can see that the **handler.js** and **serverless.yml** files created. Let us do the changes in that for addition of api gateway.



You will have to do the following changes in **serverless.yml**:

```yaml
service: aws-api # NOTE: update this with your service name

# You can pin your service to only deploy with a specific Serverless version
# Check out our docs for more details
# frameworkVersion: "=X.X.X"

provider:
  name: aws
  runtime: nodejs6.10

# you can overwrite defaults here
  stage: prod
  region: us-east-1
```

Now, the events details added for api gateway activation with AWS Lambda:

```yaml
functions:
  hello:
    handler: handler.hello
    events:
      - http:
          path: first-api
          method: GET
```

There is a new thing added here called **events**. We have specified the event as **http**, along with its path and method.

The path is the end-point which we will use when the api gateway path is created and method used is GET.

Observe that the handler is **handler.hello**, and **hello** is the export name from handler.js.

```
'use strict';

module.exports.hello = (event, context, callback) => {
  const response = {
    statusCode: 200,
    body: JSON.stringify({
      message: 'Go Serverless v1.0! Your function executed successfully!',
      input: event,
    }),
  };

  callback(null, response);

  // Use this code if you don't use the http event with the LAMBDA-PROXY integration
  // callback(null, { message: 'Go Serverless v1.0! Your function executed successfully!', event });
};
```

Note that you do not have to deploy the api gateway here, as the serverless framework will perform it.

Now, we will run the **sls deploy** command to create AWS Lambda function with trigger as **api gateway**.

```
sls deploy
```

```
Command Prompt

C:\aws-api>sls deploy
Serverless: Packaging service...
Serverless: Excluding development dependencies...
Serverless: Creating Stack...
Serverless: Checking Stack create progress...
.....
Serverless: Stack create finished...
Serverless: Uploading CloudFormation file to S3...
Serverless: Uploading artifacts...
Serverless: Uploading service .zip file to S3 (409 B)...
Serverless: Validating template...
Serverless: Updating Stack...
Serverless: Checking Stack update progress...
.............................
Serverless: Stack update finished...
Service Information
service: aws-api
stage: prod
region: us-east-1
stack: aws-api-prod
api keys:
  None
endpoints:
  GET - https://nvbhfdojfg.execute-api.us-east-1.amazonaws.com/prod/first-api
functions:
  hello: aws-api-prod-hello

C:\aws-api>_
```

Observe that the deploy details are listed above. It gives the **Get** url with the end-point as the path details. The stage is **prod** so same is used in the url. The name of the function is **aws-api-prod-hello**.

Let us hit the url and see the output. You can see the followings the response we get from the api-gateway get url:


```
{"message":"Go Serverless v1.0! Your function executed
successfully!","input":{"resource":"/first-api","path":"/first-
api","httpMethod":"GET","headers":{"Accept":"text/html,application/xhtml+xml,appli
cation/xml;q=0.9,image/webp,image/apng,*/*;q=0.8","Accept-Encoding":"gzip,
deflate, br","Accept-Language":"en-US,en;q=0.9","CloudFront-Forwarded-
Proto":"https","CloudFront-Is-Desktop-Viewer":"true","CloudFront-Is-Mobile-
Viewer":"false","CloudFront-Is-SmartTV-Viewer":"false","CloudFront-Is-Tablet-
Viewer":"false","CloudFront-Viewer-Country":"IN","Host":"nvbhfdojfg.execute-
api.us-east-1.amazonaws.com","upgrade-insecure-requests":"1","User-
Agent":"Mozilla/5.0 (Windows NT 6.3; Win64; x64) AppleWebKit/537.36 (KHTML, like
Gecko) Chrome/66.0.3359.181 Safari/537.36","Via":"2.0
707912794802dbb4825c79b7d8626a5d.cloudfront.net (CloudFront)","X-Amz-Cf-
Id":"j70MMqkWFp6kmvuauzp_nvTbI-WwKIQmm2Jl5hzSoN6gkdvX11hh-g==","X-Amzn-Trace-
Id":"Root=1-5b13f9ef-5b012e36b7f40b5013a326fc","X-Forwarded-For":"157.33.133.217,
54.182.242.73","X-Forwarded-Port":"443","X-Forwarded-
Proto":"https"},"queryStringParameters":null,"pathParameters":null,"stageVariables
":null,"requestContext":{"resourceId":"pes5sy","resourcePath":"/first-
api","httpMethod":"GET","extendedRequestId":"H6P9fE-
MoAMFdIg=","requestTime":"03/Jun/2018:14:23:43 +0000","path":"/prod/first-
api","accountId":"625297745038","protocol":"HTTP/1.1","stage":"prod","requestTimeE
poch":1528035823928,"requestId":"b865dbd6-6739-11e8-b135-
a30269a8ec58","identity":{"cognitoIdentityPoolId":null,"accountId":null,"cognitoId
entityId":null,"caller":null,"sourceIp":"157.33.133.217","accessKey":null,"cognito
AuthenticationType":null,"cognitoAuthenticationProvider":null,"userArn":null,"user
Agent":"Mozilla/5.0 (Windows NT 6.3; Win64; x64) AppleWebKit/537.36 (KHTML, like
Gecko) Chrome/66.0.3359.181
Safari/537.36","user":null},"apiId":"nvbhfdojfg"},"body":null,"isBase64Encoded":fa
lse}}
```

The event details are also available in the output when you hit the url. The httpMethod is GET and the queryStringParameters are null as there is nothing passed in the query string. The event details are given to **input** which we have specified in the AWS Lambda handler:

```
'use strict';

module.exports.hello = (event, context, callback) => {
  const response = {
    statusCode: 200,
    body: JSON.stringify({
      message: 'Go Serverless v1.0! Your function executed successfully!',
      input: event,
    }),
  };

  callback(null, response);

  // Use this code if you don't use the http event with the LAMBDA-PROXY integration
  // callback(null, { message: 'Go Serverless v1.0! Your function executed successfully!', event });
};
```

The output we get from api gateway are only the **body** details such as **message** and **input**. The response is totally controlled by the api gateway and how to display it as output.

Now, let us pass inputs to the GET url in query string and see the display:

Secure | https://nvbhfdojfg.execute-api.us-east-1.amazonaws.com/prod/first-api?displaymessage=Hello


```
{"message":"Go Serverless v1.0! Your function executed successfully!","input":{"resource":"/first-api","path":"/first-
api","httpMethod":"GET","headers":
{"Accept":"text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,image/apng,*/*;q=0.8","Accept-Encoding":"gzip,
deflate, br","Accept-Language":"en-US,en;q=0.9","CloudFront-Forwarded-Proto":"https","CloudFront-Is-Desktop-
Viewer":"true","CloudFront-Is-Mobile-Viewer":"false","CloudFront-Is-SmartTV-Viewer":"false","CloudFront-Is-Tablet-
Viewer":"false","CloudFront-Viewer-Country":"IN","Host":"nvbhfdojfg.execute-api.us-east-1.amazonaws.com","upgrade-insecure-
requests":"1","User-Agent":"Mozilla/5.0 (Windows NT 6.3; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko)
Chrome/66.0.3359.181 Safari/537.36","Via":"2.0 8b1d3263c2fbd0a2c270b174d7aa3d61.cloudfront.net (CloudFront)","X-Amz-Cf-
Id":"JIBZw3I-blKbnpHP8LYXPVolCgdW5KmEukZS4at9mi4vrWBMI-UKNw==","X-Amzn-Trace-Id":"Root=1-5b13ff90-
7d6e38d4c0e4a5d4e6184f30","X-Forwarded-For":"157.33.133.217, 54.182.242.127","X-Forwarded-Port":"443","X-Forwarded-
Proto":"https"},"queryStringParameters":
{"displaymessage":"Hello"},"pathParameters":null,"stageVariables":null,"requestContext":
{"resourceId":"pes5sy","resourcePath":"/first-
api","httpMethod":"GET","extendedRequestId":"H6TeiG34oAMFguA=","requestTime":"03/Jun/2018:14:47:44
+0000","path":"/prod/first-
api","accountId":"625297745038","protocol":"HTTP/1.1","stage":"prod","requestTimeEpoch":1528037264252,"requestId":"12e5dca3
-673d-11e8-8966-69fcf43bd4db","identity":
{"cognitoIdentityPoolId":null,"accountId":null,"cognitoIdentityId":null,"caller":null,"sourceIp":"157.33.133.217","accessKe
y":null,"cognitoAuthenticationType":null,"cognitoAuthenticationProvider":null,"userArn":null,"userAgent":"Mozilla/5.0
(Windows NT 6.3; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/66.0.3359.181
Safari/537.36","user":null},"apiId":"nvbhfdojfg"},"body":null,"isBase64Encoded":false}}
```

Then you can see the output of querystring as shown below:

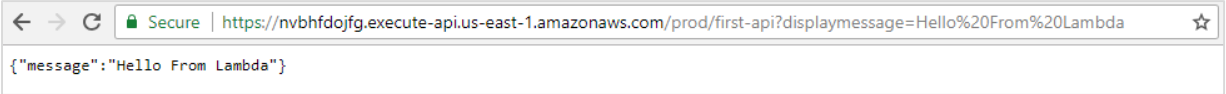

```
{"message":"Go Serverless v1.0! Your function executed
successfully!","input":{"resource":"/first-api","path":"/first-
api","httpMethod":"GET","headers":{"Accept":"text/html,application/xhtml+xml,appli
cation/xml;q=0.9,image/webp,image/apng,*/*;q=0.8","Accept-Encoding":"gzip,
deflate, br","Accept-Language":"en-US,en;q=0.9","CloudFront-Forwarded-
Proto":"https","CloudFront-Is-Desktop-Viewer":"true","CloudFront-Is-Mobile-
Viewer":"false","CloudFront-Is-SmartTV-Viewer":"false","CloudFront-Is-Tablet-
Viewer":"false","CloudFront-Viewer-Country":"IN","Host":"nvbhfdojfg.execute-
api.us-east-1.amazonaws.com","upgrade-insecure-requests":"1","User-
Agent":"Mozilla/5.0 (Windows NT 6.3; Win64; x64) AppleWebKit/537.36 (KHTML, like
Gecko) Chrome/66.0.3359.181 Safari/537.36","Via":"2.0
8b1d3263c2fbd0a2c270b174d7aa3d61.cloudfront.net (CloudFront)","X-Amz-Cf-
Id":"JIBZw3I-blKbnpHP8LYXPVolCgdW5KmEukZS4at9mi4vrWBMI-UKNw==","X-Amzn-Trace-
Id":"Root=1-5b13ff90-7d6e38d4c0e4a5d4e6184f30","X-Forwarded-For":"157.33.133.217,
54.182.242.127","X-Forwarded-Port":"443","X-Forwarded-
Proto":"https"},"queryStringParameters":{"displaymessage":"Hello"},"pathParameters
":null,"stageVariables":null,"requestContext":{"resourceId":"pes5sy","resourcePath
":"/first-
api","httpMethod":"GET","extendedRequestId":"H6TeiG34oAMFguA=","requestTime":"03/J
un/2018:14:47:44 +0000","path":"/prod/first-
api","accountId":"625297745038","protocol":"HTTP/1.1","stage":"prod","requestTimeE
poch":1528037264252,"requestId":"12e5dca3-673d-11e8-8966-
69fcf43bd4db","identity":{"cognitoIdentityPoolId":null,"accountId":null,"cognitoId
entityId":null,"caller":null,"sourceIp":"157.33.133.217","accessKey":null,"cognito
AuthenticationType":null,"cognitoAuthenticationProvider":null,"userArn":null,"user
Agent":"Mozilla/5.0 (Windows NT 6.3; Win64; x64) AppleWebKit/537.36 (KHTML, like
Gecko) Chrome/66.0.3359.181
Safari/537.36","user":null},"apiId":"nvbhfdojfg"},"body":null,"isBase64Encoded":fa
lse}}
```


Let us change the AWS Lambda function to just display the querystring details as shown below:

```
'use strict';

module.exports.hello = (event, context, callback) => {

  const response = {

    statusCode: 200,

    body: JSON.stringify({

        message:(event.queryStringParameters &&
event.queryStringParameters.displaymessage!="") ?
event.queryStringParameters.displaymessage : 'Go Serverless v1.0! Your function
executed successfully!'

    }),
```

```
  };


  callback(null, response);

  // Use this code if you don't use the http event with the LAMBDA-PROXY
integration

  // callback(null, { message: 'Go Serverless v1.0! Your function executed
successfully!', event });

};
```

Observe that we have changed the message based on the querystring **displaymessage**. This will deploy the the function again and check the output.It displays the details present in query string variable displaymessage as shown below.



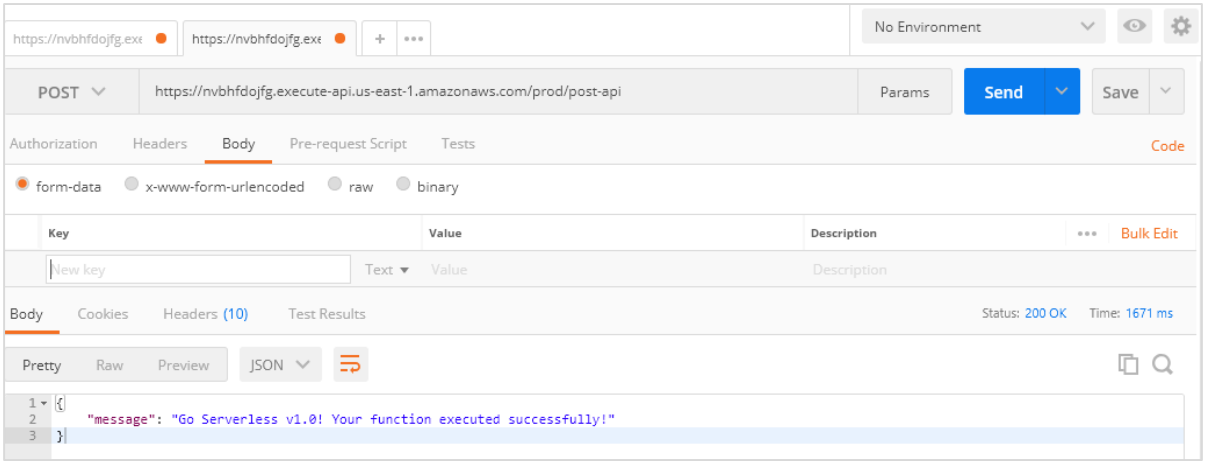
Let us now add **post** method to the events created as shown below:

Now, deploy the changes made and you can see the following output from the deploy command:

```
C:\aws-api>sls deploy
Serverless: Packaging service...
Serverless: Excluding development dependencies...
Serverless: Uploading CloudFormation file to S3...
Serverless: Uploading artifacts...
Serverless: Uploading service .zip file to S3 (448 B)...
Serverless: Validating template...
Serverless: Updating Stack...
Serverless: Checking Stack update progress...
..............
Serverless: Stack update finished...
Service Information
service: aws-api
stage: prod
region: us-east-1
stack: aws-api-prod
api keys:
  None
endpoints:
  GET - https://nvbhfdojfg.execute-api.us-east-1.amazonaws.com/prod/first-api
  POST - https://nvbhfdojfg.execute-api.us-east-1.amazonaws.com/prod/post-api
functions:
  hello: aws-api-prod-hello

C:\aws-api>_
```

Note that testing post url in browser directly will not give the details. You should test the post url in **postman**.

To get postman go to https://www.getpostman.com/apps. Download the app as per your OS. Once installed, you should be able to test your post url as shown below:



This displays the message we have added in the Lambda function.

14. AWS Lambda — Executing and Invoking Lambda Function

This chapter will explain in detail about process of executing and invoking Lambda function and the steps involved in it.

AWS Lambda Execution Model

AWS execution depends on the configuration details added for AWS Lambda Function. When the function is created, there is a **memory** and **time allotted,** which is used for the execution of AWS Lambda function.

With the help of the configuration details, AWS Lambda creates an execution context. Execution context is a temporary runtime environment which is made ready with any external dependencies such as database connection, http endpoints, third party libraries etc., if any.

When AWS Lambda function is invoked for the very first time or if the lambda function is updated, there is little latency added because of the execution context setup. However, the subsequent calls are faster in comparison to the first one. AWS Lambda tries to reuse the execution context again if the Lambda function is invoked taking lesser time.

The reuse of execution context has the following implications:

- If there is any database connection done for the execution of Lambda, the connection is maintained for reuse. So the Lambda code has to be such that the connection has to be checked first- if exists and reused; otherwise we shall have to make fresh new connection.

- Execution context maintains a disk space of 500MB in **/tmp** directory. The data required is cached in this directory. You can have additional check in the code to see if the data exists.

- If the callbacks or some background processes if the are not complete when the Lambda function was invoked, the execution will start when the lambda function is invoked again. Incase you do not need such thing to happen make sure your processes are all ended properly, when the function execution is complete.

You should use of the execution context and the data stored in tmp directory. You will have to add necessary checks in the code to see if the required data exists before creating fresh new ones.This will save the time during execution and make it more faster.

Invoking AWS Lambda function

We can invoke AWS manually using **aws cli**. We have already seen how to create and deploy AWS Lambda using **cli**. Here, we will first create a function using **aws cli** and invoke the same.

Creating AWS Lambda Function using AWS CLI

You can use the following commands for creating AWS Lambda function using **aws cli:**

Commands

```
create-function
--function-name <value>
--runtime <value>
--role <value>
--handler <value>
[--code <value>]
[--description <value>]
[--timeout <value>]
[--memory-size <value>]
[--environment <value>]
[--kms-key-arn <value>]
[--tags <value>]
[--zip-file <value>]
[--cli-input-json <value>]
```

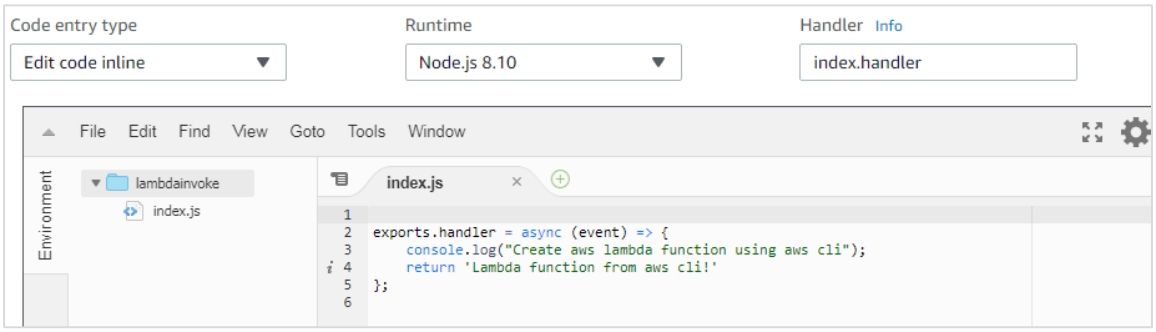
Command with values

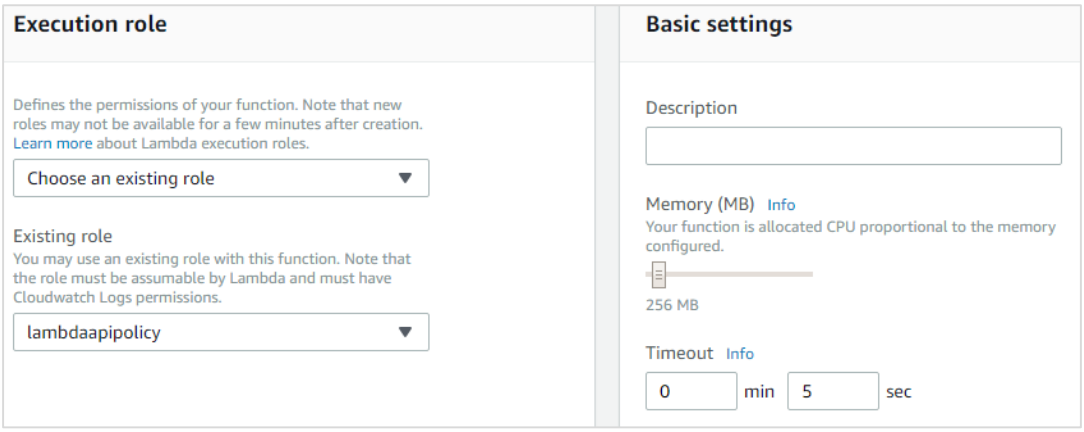
```
aws lambda create-function
--function-name "lambdainvoke"
--runtime "nodejs8.10"
--role "arn:aws:iam::625297745038:role/lambdaapipolicy"
--handler "index.handler"
--timeout 5
--memory-size 256
--zip-file "fileb://C:\nodeproject\index.zip"
```

The output is as shown below:

```
Command Prompt
C:\>aws lambda create-function --function-name "lambdainvoke" --runtime "nodejs8
.10" --role "arn:aws:iam::625297745038:role/lambdaapipolicy" --handler "index.ha
ndler" --timeout 5 --memory-size 256 --zip-file "fileb://C:\nodeproject\index.zi
p"
Jb/OVnhUrpcre7N2rgkcQwNbenRKltW28D4qcSXXbFw=     233              arn:aws:lambda:u
s-east-1:625297745038:function:lambdainvoke      lambdainvoke     index.handler
2018-06-08T06:19:35.645+0000     256      65708a27-3295-487e-bf01-30302585ee23
arn:aws:iam::625297745038:role/lambdaapipolicy  nodejs8.10       5        $LATEST
TRACINGCONFIG    PassThrough

C:\>_
```

The function created in AWS console is as shown below:





Now, you can invoke the function using the command: **invoke**

```
--function-name <value>
[--invocation-type <value>]
[--log-type <value>]
[--client-context <value>]
[--payload <value>]
[--qualifier <value>]
outfile <value>
```

Options

--function-name: Specify the name of the function you want to invoke.

--invocation-type(string): by default the invokation-type is **requestresponse**. The values available to be used with invokation-type is **RequestResponse** , **Event** and **DryRun**.

- Event invocation-type is to be used for async response.
- DryRun is to be used when you want to verify the Lambda function without need of executing it.

--log-type: It will be **Tail** if the invocation type is RequestResponse.It gives the last 4KB base64-encoded log data. Possible values are **Tail** and **None**.

--client-context: You can pass client specific details to the Lambda function.The clientcontext has to be in json format and base64-encoded. Maximum file size is 3583 bytes.

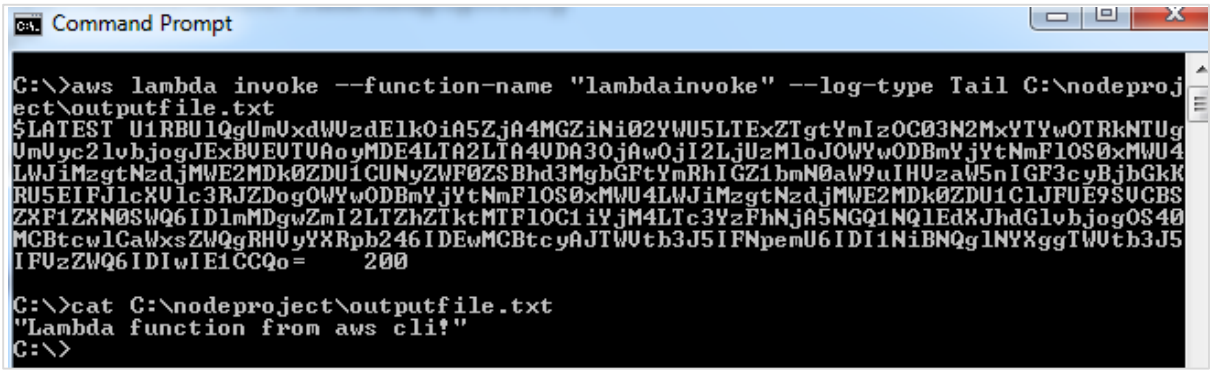
--payload: json format input to you lambda function.

--qualifier: You can specify Lambda function version or alias name.If you pass the function version than the api will use qualified function arn to invoke the Lambda function.If you specify alias name, the api uses alias ARN to invoke Lambda function.

outfile: This is the filename where the content will be saved.

Command with values

```
aws lambda invoke --function-name "lambdainvoke" --log-type Tail
C:\nodeproject\outputfile.txt
```



You can use payload option to send dummy event to the lambda function in json format as shown below.

The related AWS Lambda code is as follows:

```
exports.handler = async (event, callback) => {
    console.log("Hello => "+ event.name);
    console.log("Address =>"+ event.addr);
    callback(null, 'Hello '+event.name +" and address is "+ event.addr);
};
```

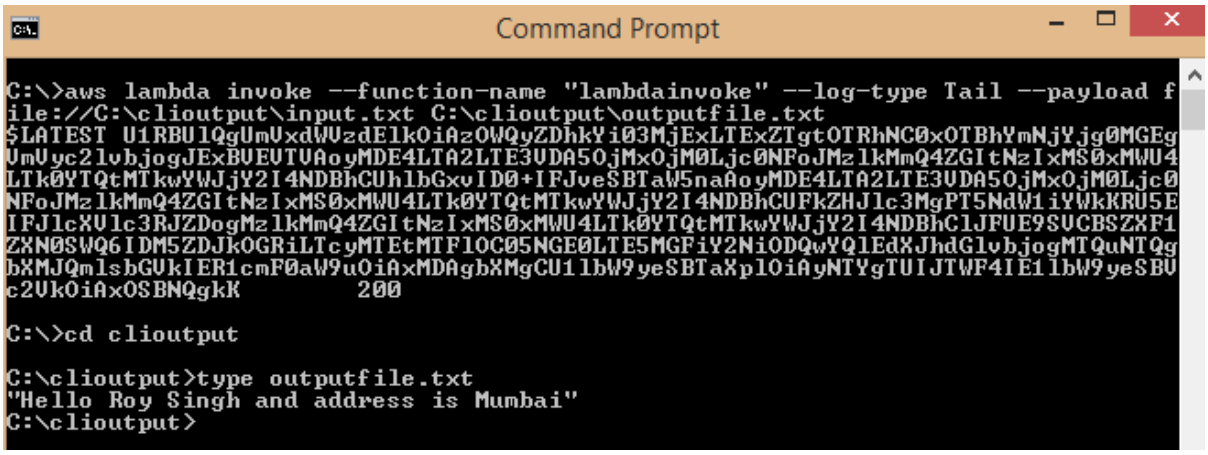
Observe that in the code, we have console **event.name** and **event.addr**. Now, let us use payload option in aws cli to send the event with name and address as follows:

```
aws lambda invoke --function-name "lambdainvoke" --log-type Tail --payload
file://C:\clioutput\input.txt C:\clioutput\outputfile.txt
```

Thenpayload takes input as a filepath which has json input as shown:

```
{"name":"Roy Singh", "addr":"Mumbai"}
```

The corresponding output is as shown below:



The output is stored in the file **C:\clioutput\outputfile.txt** as follows:

```
"Hello Roy Singh and address is Mumbai"
```

Sample Events

You can test AWS Lambda function by passing a sample event. This section gives some sample events for AWS Services. You can use the **invoke** command to test the output when triggered with any of the services. Observe the codes given for corresponding sample events below:

Amazon S3 Put Sample Event

```
{
  "Records": [
    {
      "eventVersion": "2.0",
      "eventTime": "1970-01-01T00:00:00.000Z",
      "requestParameters": {
        "sourceIPAddress": "127.0.0.1"
      },
      "s3": {
        "configurationId": "testConfigRule",
        "object": {
          "eTag": "0123456789abcdef0123456789abcdef",
          "sequencer": "0A1B2C3D4E5F678901",
```

```
          "key": "HappyFace.jpg",
          "size": 1024
        },
        "bucket": {
          "arn": bucketarn,
          "name": "sourcebucket",
          "ownerIdentity": {
            "principalId": "EXAMPLE"
          }
        },
        "s3SchemaVersion": "1.0"
      },
      "responseElements": {
        "x-amz-id-2":
"EXAMPLE123/5678abcdefghijklambdaisawesome/mnopqrstuvwxyzABCDEFGH",
        "x-amz-request-id": "EXAMPLE123456789"
      },
      "awsRegion": "us-east-1",
      "eventName": "ObjectCreated:Put",
      "userIdentity": {
        "principalId": "EXAMPLE"
      },
      "eventSource": "aws:s3"
    }
  ]
}
```


To get the **details of the file from the s3 put event**, you can use the following command:

```
event.Records[0].s3.object.key                        //will display the name of
the file
```

To **get the bucket name**, you can use the following command:

```
event.Records[0].s3.bucket.name            //will give the name of the bucket.
```

To **see the EventName,** you can use the following command:

```
event.Records[0].eventName  // will display the eventname
```

Amazon S3 Delete Sample Event


```
{
  "Records": [
    {
      "eventVersion": "2.0",
      "eventTime": "1970-01-01T00:00:00.000Z",
      "requestParameters": {
        "sourceIPAddress": "127.0.0.1"
      },
      "s3": {
        "configurationId": "testConfigRule",
        "object": {
          "sequencer": "0A1B2C3D4E5F678901",
          "key": "HappyFace.jpg"
        },
        "bucket": {
          "arn": bucketarn,
          "name": "sourcebucket",
          "ownerIdentity": {
            "principalId": "EXAMPLE"
          }
        },
        "s3SchemaVersion": "1.0"
      },
      "responseElements": {
        "x-amz-id-2":
"EXAMPLE123/5678abcdefghijklambdaisawesome/mnopqrstuvwxyzABCDEFGH",
        "x-amz-request-id": "EXAMPLE123456789"
      },
      "awsRegion": "us-east-1",
      "eventName": "ObjectRemoved:Delete",
      "userIdentity": {
```

```
        "principalId": "EXAMPLE"
      },
      "eventSource": "aws:s3"
    }
  ]
}
```

Amazon DynamoDB

Amazon DynamoDB can be an event on AWS Lambda when changes are made on DynamoDB table. We can perform operation like add entry, update and delete records from the DynamodDB table.

A sample event for DynamoDB add, insert and delete event is shown here:

```
{
  "Records": [
    {
      "eventID": "1",
      "eventVersion": "1.0",
      "dynamodb": {
        "Keys": {
          "Id": {
            "N": "101"
          }
        },
        "NewImage": {
          "Message": {
            "S": "New item!"
          },
          "Id": {
            "N": "101"
          }
        },
        "StreamViewType": "NEW_AND_OLD_IMAGES",
        "SequenceNumber": "111",
        "SizeBytes": 26
```

```
      },
      "awsRegion": "us-west-2",
      "eventName": "INSERT",
      "eventSourceARN": eventsourcearn,
      "eventSource": "aws:dynamodb"
    },
    {
      "eventID": "2",
      "eventVersion": "1.0",
      "dynamodb": {
        "OldImage": {
          "Message": {
            "S": "New item!"
          },
          "Id": {
            "N": "101"
          }
        },
        "SequenceNumber": "222",
        "Keys": {
          "Id": {
            "N": "101"
          }
        },
        "SizeBytes": 59,
        "NewImage": {
          "Message": {
            "S": "This item has changed"
          },
          "Id": {            "N": "101"
          }
        },
        "StreamViewType": "NEW_AND_OLD_IMAGES"
      },
```

```
      "awsRegion": "us-west-2",
      "eventName": "MODIFY",
      "eventSourceARN": sourcearn,
      "eventSource": "aws:dynamodb"
    },
    {      "eventID": "3",
      "eventVersion": "1.0",
      "dynamodb": {
        "Keys": {
          "Id": {
            "N": "101"
          }
        },
        "SizeBytes": 38,
        "SequenceNumber": "333",
        "OldImage": {
          "Message": {
            "S": "This item has changed"
          },
          "Id": {
            "N": "101"
          }
        },
        "StreamViewType": "NEW_AND_OLD_IMAGES"
      },      "awsRegion": "us-west-2",
      "eventName": "REMOVE",
      "eventSourceARN": sourcearn,
      "eventSource": "aws:dynamodb"    }
  ]
}
```


Amazon Simple Notification Service

AWS Lambda can be helpful to process the notification created in **Simple Notification Service (SNS)**. Whenever there is message published in SNS, the Lambda function can be

triggered with a SNS event, which has details of the messages. This messages can be processed inside Lambda function and can be sent further to other services as per the requirement.

Once the message is entered, SNS will trigger the Lambda function. If any error tries to invoke the Lambda function, SNS will retry to call the lambda function upto three times.

Amazon SNS Sample Event

A sample event that has all the details available in AWS Lambda function to carry out the further process is shown below:

```
{
  "Records": [
    {
      "EventVersion": "1.0",
      "EventSubscriptionArn": eventsubscriptionarn,
      "EventSource": "aws:sns",
      "Sns": {
        "SignatureVersion": "1",
        "Timestamp": "1970-01-01T00:00:00.000Z",
        "Signature": "EXAMPLE",
        "SigningCertUrl": "EXAMPLE",
        "MessageId": "95df01b4-ee98-5cb9-9903-4c221d41eb5e",
        "Message": "Hello from SNS!",
        "MessageAttributes": {
          "Test": {
            "Type": "String",
            "Value": "TestString"
          },
          "TestBinary": {
            "Type": "Binary",
            "Value": "TestBinary"
          }
        },
        "Type": "Notification",
        "UnsubscribeUrl": "EXAMPLE",
        "TopicArn": topicarn,
        "Subject": "TestInvoke"
```

```
      }
    }
  ]
}
```

Amazon Simple Mail Service

Amazon Simple Mail Service can be used to send messages and also to receive messages. The AWS Lambda function can be called on Simple Mail Service when the message is received.

Amazon SES Email Receiving Sample Event

The details of SES event when used inside AWS Lambda is shown below:

```
{
  "Records": [
    {
      "eventVersion": "1.0",
      "ses": {
        "mail": {
          "commonHeaders": {
            "from": [
              "Jane Doe <janedoe@example.com>"
            ],
            "to": [
              "johndoe@example.com"
            ],
            "returnPath": "janedoe@example.com",
            "messageId": "<0123456789example.com>",
            "date": "Wed, 7 Oct 2015 12:34:56 -0700",
            "subject": "Test Subject"
          },
          "source": "janedoe@example.com",
          "timestamp": "1970-01-01T00:00:00.000Z",
          "destination": [
            "johndoe@example.com"
          ],
```

```
          "headers": [
            {
              "name": "Return-Path",
              "value": "<janedoe@example.com>"
            },
            {
              "name": "Received",
              "value": "from mailer.example.com (mailer.example.com [203.0.113.1])
by inbound-smtp.us-west-2.amazonaws.com with SMTP id o3vrnil0e2ic for
johndoe@example.com; Wed, 07 Oct 2015 12:34:56 +0000 (UTC)"
            },
            {
              "name": "DKIM-Signature",
              "value": "v=1; a=rsa-sha256; c=relaxed/relaxed; d=example.com;
s=example; h=mime-version:from:date:message-id:subject:to:content-type;
bh=jX3F0bCAI7sIbkHyy3mLYO28ieDQz2R0P8HwQkklFj4=;
b=sQwJ+LMe9RjkesGu+vqU56asvMhrLRRYrWCbV"
            },
            {
              "name": "MIME-Version",
              "value": "1.0"
            },
            {
              "name": "From",
              "value": "Jane Doe <janedoe@example.com>"
            },
            {
              "name": "Date",
              "value": "Wed, 7 Oct 2015 12:34:56 -0700"
            },
            {
              "name": "Message-ID",
              "value": "<0123456789example.com>"
            },
            {
              "name": "Subject",
```

```
              "value": "Test Subject"
            },
            {
              "name": "To",
              "value": "johndoe@example.com"
            },
            {
              "name": "Content-Type",
              "value": "text/plain; charset=UTF-8"
            }
          ],
          "headersTruncated": false,
          "messageId": "o3vrnil0e2ic28tr"
        },
        "receipt": {
          "recipients": [
            "johndoe@example.com"
          ],
          "timestamp": "1970-01-01T00:00:00.000Z",
          "spamVerdict": {
            "status": "PASS"
          },
          "dkimVerdict": {
            "status": "PASS"
          },
          "processingTimeMillis": 574,
          "action": {
            "type": "Lambda",
            "invocationType": "Event",
            "functionArn": "arn:aws:lambda:us-west-
2:012345678912:function:Example"
          },
          "spfVerdict": {
            "status": "PASS"
          },
```

```
          "virusVerdict": {
            "status": "PASS"
          }
        }
      },
      "eventSource": "aws:ses"
    }
  ]
}
```

Amazon Cloudwatch Logs

AWS Lambda can be triggered from Amazon CloudWatch Logs using the **CloudWatch Logs Subscriptions**. CloudWatch Logs subscriptions has data real-time data about the logs which can be processed and analyzed inside AWS Lambda or could be used to load to other systems.

Amazon CloudWatch Logs Sample Event

```
{
 "awslogs": {
 "data":
"H4sIAAAAAAAAAHWPwQqCQBCGX0Xm7EFtK+smZBEUgXoLCdMhFtKV3akI8d0bLYmibvPPN3wz00CJxmQnT
O41whwWQRIctmEcB6sQbFC3CjW3XW8kxpOpP+OC22d1Wml1qZkQGtoMsScxaczKN3plG8zlaHIta5KqWso
zoTYw3/djzwhpLwivWFGHGpAFe7DL68JlBUk+l7KSN7tCOEJ4M3/qOI49vMHj+zCKdlFqLaU2ZHV2a4Ct/
an0/ivdX8oYc1UVX860fQDQiMdxRQEAAA=="
 }  }
```

Amazon API Gateway

AWS Lambda function can be invoked on **https** url. IT can be done on **GET, POST, PUT**. When the https url is invoked, the AWS Lambda function is also triggered and the data passed to https using get/post can be made available inside AWS Lambda to be used to insert in DynamoDB or to send mail etc.

API Gateway Proxy Request Event

```
{
  "path": "/test/hello",
  "headers": {
```

```
    "Accept":
"text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,*/*;q=0.8",
    "Accept-Encoding": "gzip, deflate, lzma, sdch, br",
    "Accept-Language": "en-US,en;q=0.8",
    "CloudFront-Forwarded-Proto": "https",
    "CloudFront-Is-Desktop-Viewer": "true",
    "CloudFront-Is-Mobile-Viewer": "false",
    "CloudFront-Is-SmartTV-Viewer": "false",
    "CloudFront-Is-Tablet-Viewer": "false",
    "CloudFront-Viewer-Country": "US",
    "Host": "wt6mne2s9k.execute-api.us-west-2.amazonaws.com",
    "Upgrade-Insecure-Requests": "1",
    "User-Agent": "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_11_6)
AppleWebKit/537.36 (KHTML, like Gecko) Chrome/52.0.2743.82 Safari/537.36
OPR/39.0.2256.48",
    "Via": "1.1 fb7cca60f0ecd82ce07790c9c5eef16c.cloudfront.net (CloudFront)",
    "X-Amz-Cf-Id": "nBsWBOrSHMgnaROZJK1wGCZ9PcRcSpq_oSXZNQwQ10OTZL4cimZo3g==",
    "X-Forwarded-For": "192.168.100.1, 192.168.1.1",
    "X-Forwarded-Port": "443",
    "X-Forwarded-Proto": "https"
  },
  "pathParameters": {
    "proxy": "hello"
  },
  "requestContext": {
    "accountId": "123456789012",
    "resourceId": "us4z18",
    "stage": "test",
    "requestId": "41b45ea3-70b5-11e6-b7bd-69b5aaebc7d9",
    "identity": {
      "cognitoIdentityPoolId": "",
      "accountId": "",
      "cognitoIdentityId": "",
      "caller": "",
      "apiKey": "",
```

```
      "sourceIp": "192.168.100.1",
      "cognitoAuthenticationType": "",
      "cognitoAuthenticationProvider": "",
      "userArn": "",
      "userAgent": "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_11_6)
AppleWebKit/537.36 (KHTML, like Gecko) Chrome/52.0.2743.82 Safari/537.36
OPR/39.0.2256.48",
      "user": ""
    },
    "resourcePath": "/{proxy+}",
    "httpMethod": "GET",
    "apiId": "wt6mne2s9k"
  },
  "resource": "/{proxy+}",
  "httpMethod": "GET",
  "queryStringParameters": {
    "name": "me"
  },
  "stageVariables": {
    "stageVarName": "stageVarValue"
  }
}
```

API Gateway Proxy Response Event

```
{
  "statusCode": 200,
  "headers": {
    "Accept":
"text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,*/*;q=0.8",
    "Accept-Encoding": "gzip, deflate, lzma, sdch, br",
    "Accept-Language": "en-US,en;q=0.8",
    "CloudFront-Forwarded-Proto": "https",
    "CloudFront-Is-Desktop-Viewer": "true",
```

```
    "CloudFront-Is-Mobile-Viewer": "false",
    "CloudFront-Is-SmartTV-Viewer": "false",
    "CloudFront-Is-Tablet-Viewer": "false",
    "CloudFront-Viewer-Country": "US",
    "Host": "wt6mne2s9k.execute-api.us-west-2.amazonaws.com",
    "Upgrade-Insecure-Requests": "1",
    "User-Agent": "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_11_6)
AppleWebKit/537.36 (KHTML, like Gecko) Chrome/52.0.2743.82 Safari/537.36
OPR/39.0.2256.48",
    "Via": "1.1 fb7cca60f0ecd82ce07790c9c5eef16c.cloudfront.net (CloudFront)",
    "X-Amz-Cf-Id": "nBsWBOrSHMgnaROZJK1wGCZ9PcRcSpq_oSXZNQwQ10OTZL4cimZo3g==",
    "X-Forwarded-For": "192.168.100.1, 192.168.1.1",
    "X-Forwarded-Port": "443",
    "X-Forwarded-Proto": "https"
  },
  "body": "Hello World"
}
```

15. AWS Lambda — Deleting Lambda Function

Deleting AWS Lambda function will remove the AWS Lambda from the AWS console. There are 2 ways to delete AWS Lambda function.

- Using AWS console.
- Using AWS CLI command

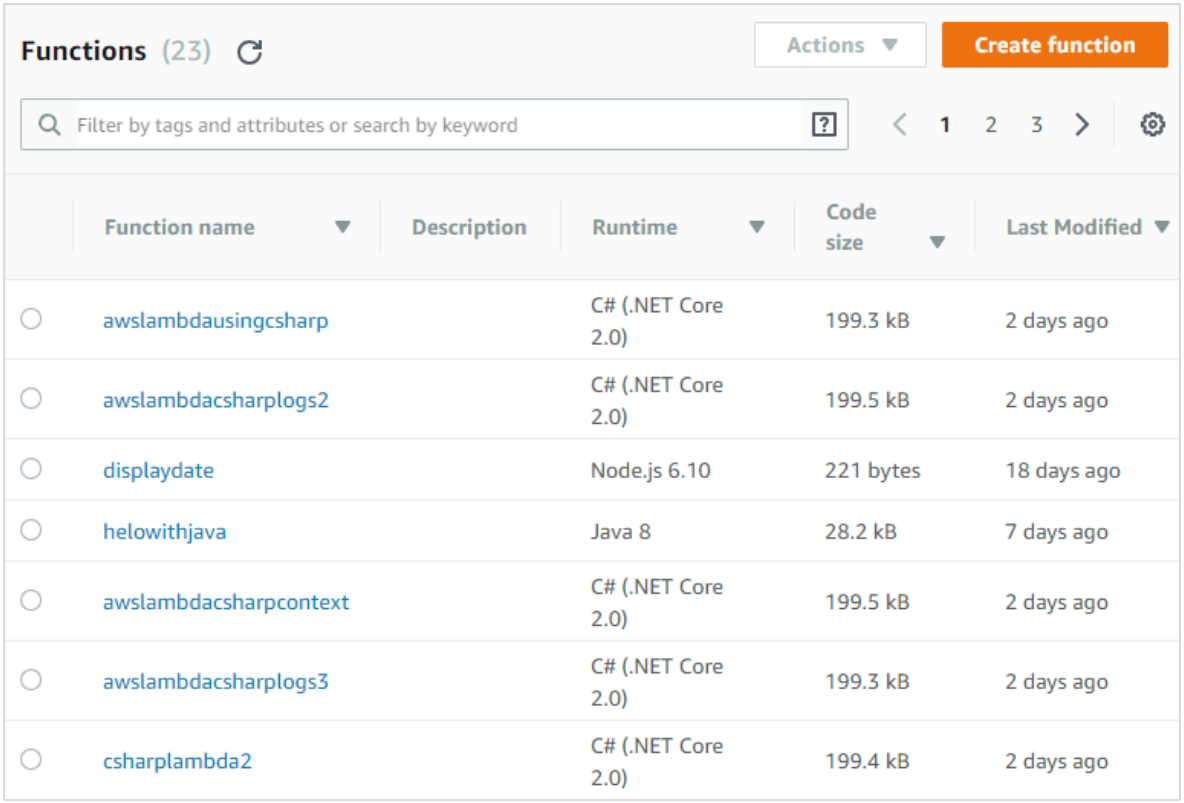
This chapter discusses these two ways in detail.

Using AWS Console

For deleting a Lambda function using AWS console, follow the steps given below:

Step 1

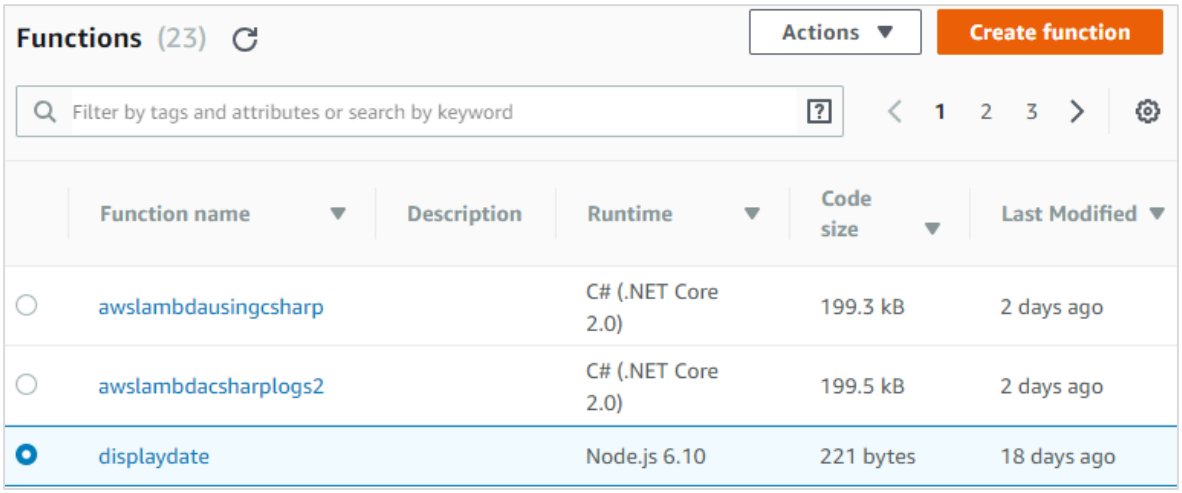
Login to AWS console and go to AWS Lambda service. You can find that AWS lambda functions created so far are listed in AWS console as shown below:



The list shows that there are 23 AWS Lambda functions created so far. You can view them using the pagination provided on the top or search the AWS Lambda by using the search box.

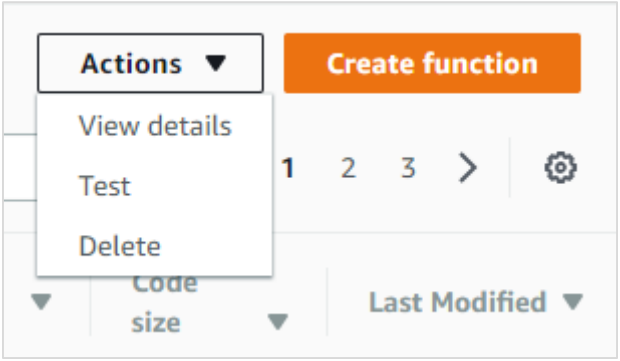
Step 2

Observe that there is a radio button across each of the AWS Lambda function. Select the function you want to delete. Observe the screenshot shown below:

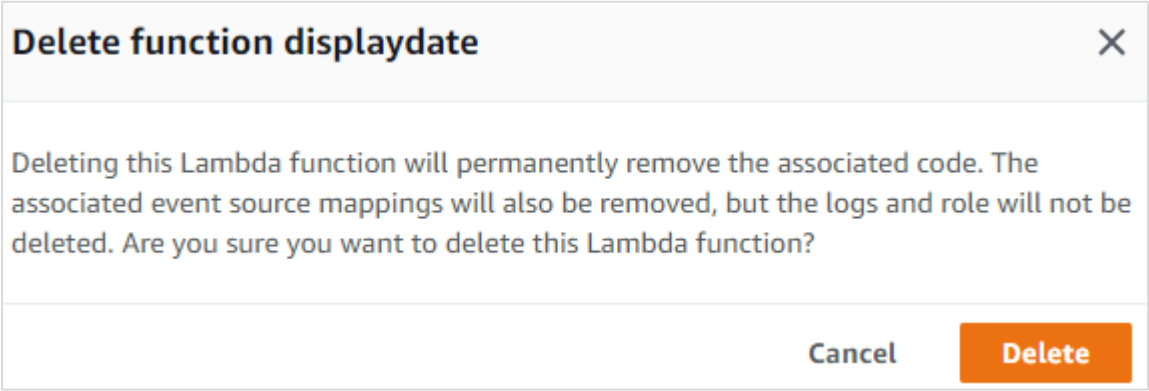


Step 3

Once you select the AWS Lambda function, the **Action** dropdown which was earlier grayed out is highlighted now. Now, open the combo box and it will display options as shown:



Step 4 Select the **Delete** button to delete the AWS Lambda function. Once you click **Delete,** it displays the message as follows:



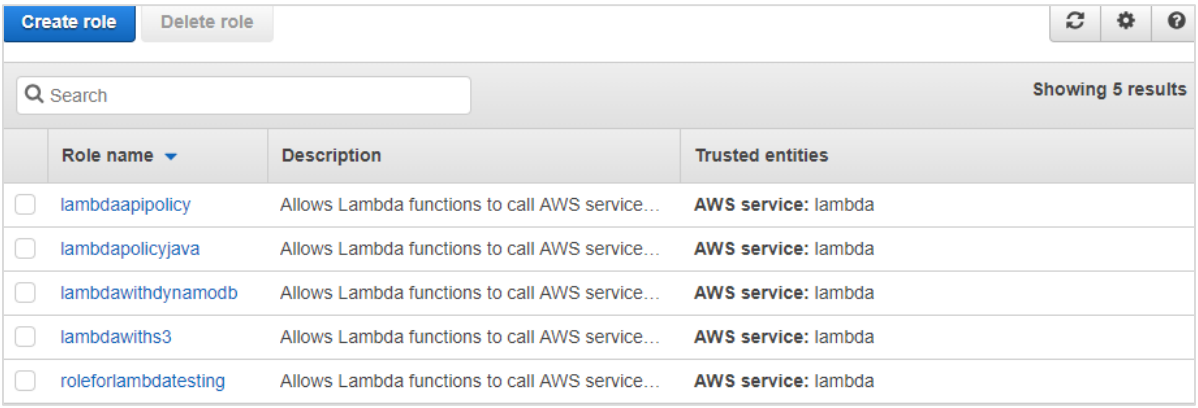
Step 5

Read the message carefully and later click **Delete** button to remove the AWS lambda function permanently.

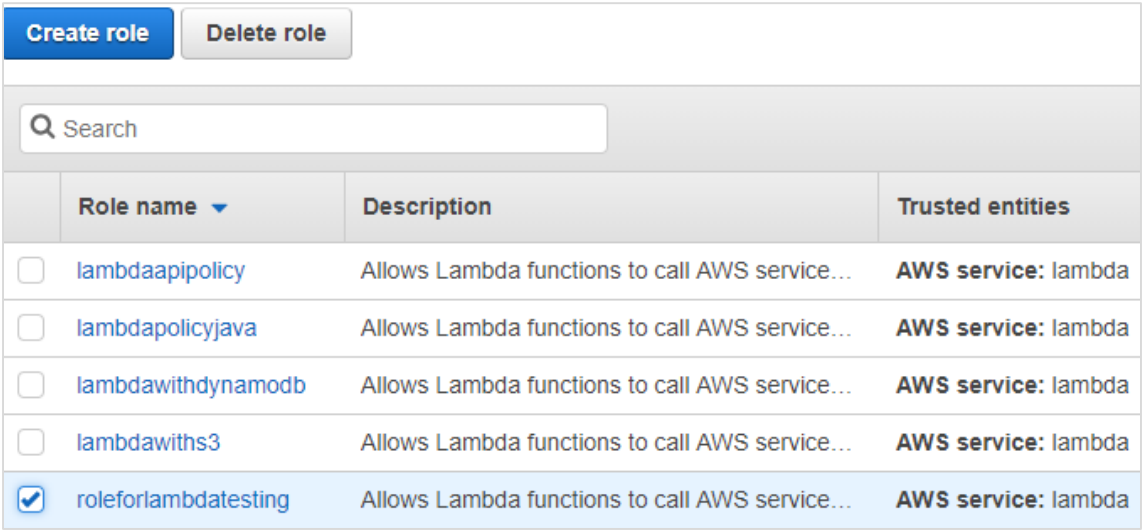
Note: Deleting aws lambda will not delete the role linked. To remove the role, you need to go to IAM and remove the role.

Step 6

The list of roles created so far is shown below. Observe that there is a **Create role** button and **Delete role** button.

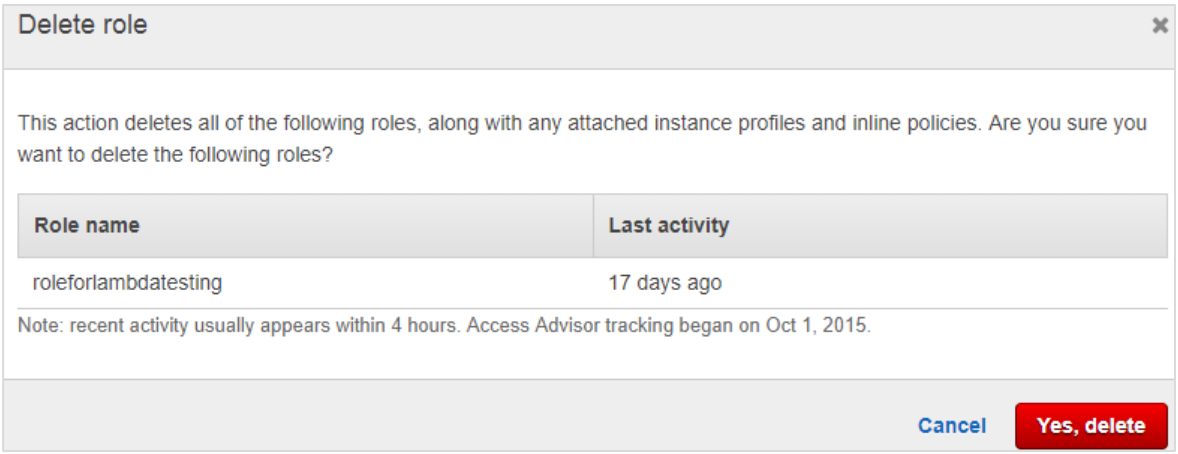


Click the checkbox across the role you want to delete. You can also select multiple roles to delete at a time.



Step 7

You will see a confirmation message as shown below once you click Delete button:



Now, read the details mentioned carefully and later click **Yes, delete** button.

Using AWS CLI command

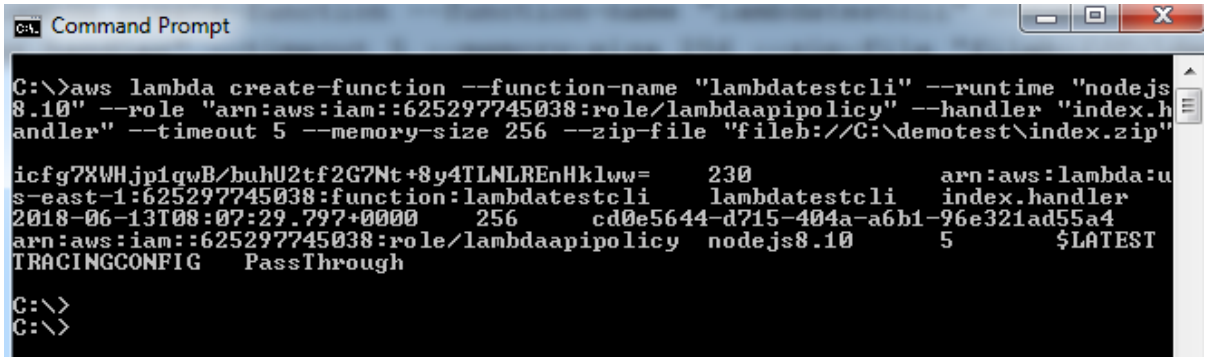
Let us first create a Lambda function using aws cli and delete the same using the same command. Follow the steps given below for this purpose:

Step 1

The command with values for create-function is as follows:

```
aws lambda create-function
--function-name "lambdatestcli"
--runtime "nodejs8.10"
--role "arn:aws:iam::625297745038:role/lambdaapipolicy"
--handler "index.handler"
--timeout 5
--memory-size 256
--zip-file "fileb://C:\demotest\index.zip"
```

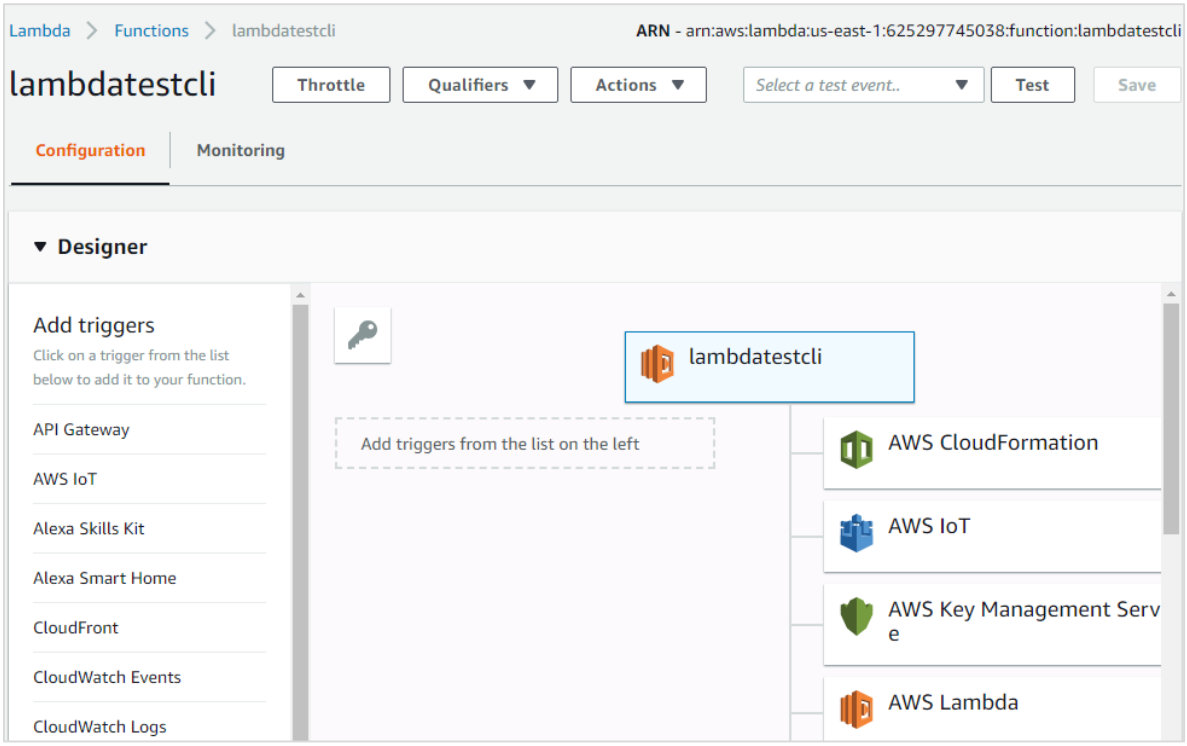
The corresponding output is shown here:



Step 2

The AWS Lambda function created is **lambdatestcli**. We have used existing role arn to create the lambda function.

Then you can find this function displayed in AWS console as shown below:

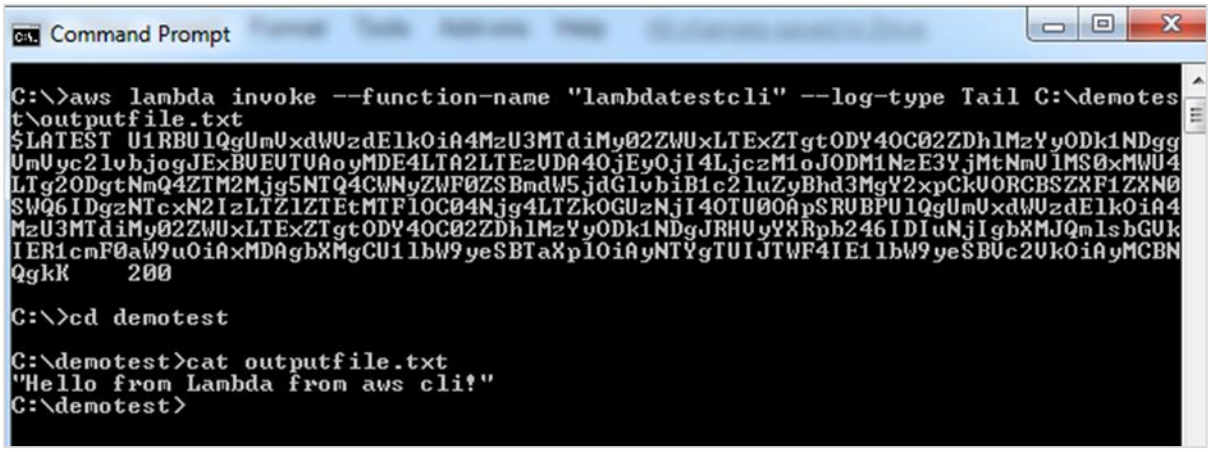


Step 3

Now, let us invoke the function to test the output using the command shown:

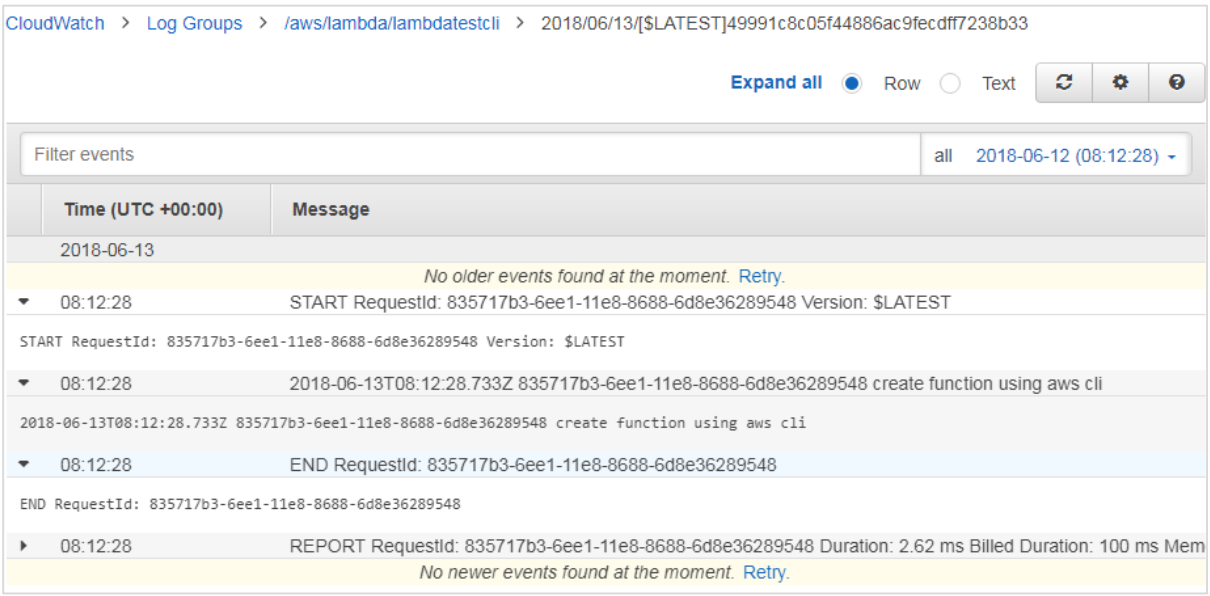
```
aws lambda invoke --function-name "lambdatestcli" --log-type Tail
C:\demotest\outputfile.txt
```

This command will give you the output as shown:



Step 4

You can observe logs from cloudwatch for lambda function ***lambdatestcli***



Step 5

Now, let us come to the actual part of deleting the AWS function. **Delete aws cli api** will delete the function given. The details of command used for this purpose is given below:

Command

```
delete-function
--function-name <value>
[--qualifier <value>]
[--cli-input-json <value>]
[--generate-cli-skeleton <value>]
```

Options

--function-name(string): This will take the Lambda function name or the arn of the AWS Lambda function.

--qualifier (string): This is optional. Here you can specify the version of AWS Lambda that needs to be deleted.

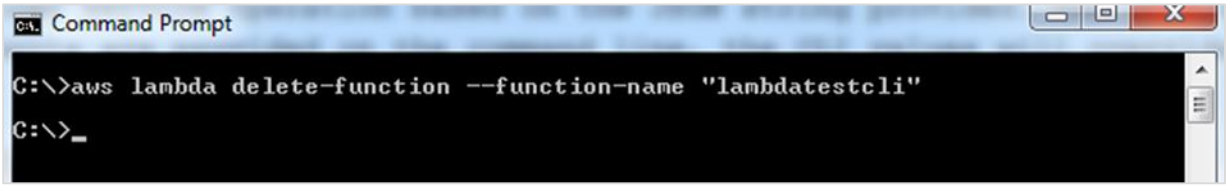
-- cli-input-json(string): Performs service operation based on the JSON string provided. The JSON string follows the format provided **by --generate-cli-skeleton**. If other arguments are provided on the command line, the CLI values will override the JSON-provided values.

--generate-cli-skeleton(string): it prints json skeleton to standard output without sending the API request.

Command with values

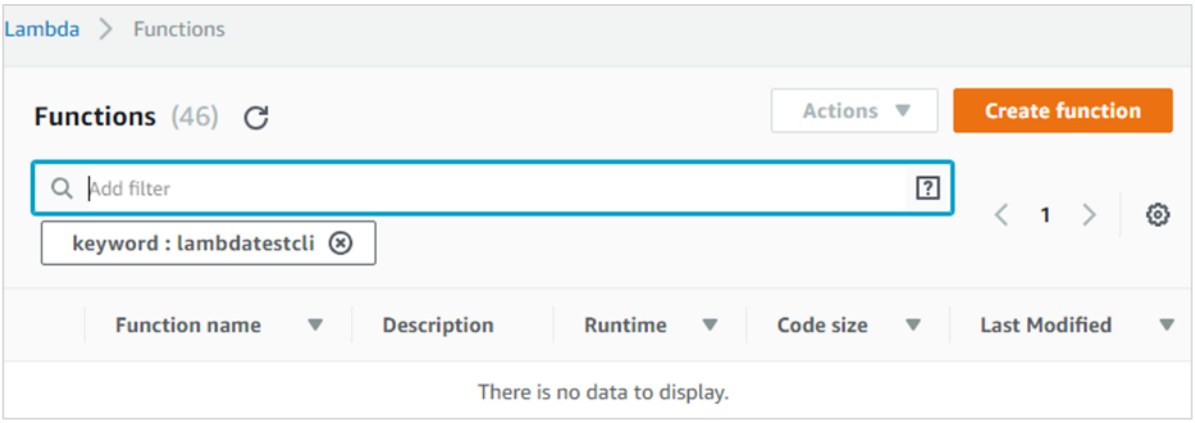
```
aws lambda delete-function --function-name "lambdatestcli"
```

The corresponding output is shown below:



Step 6

If you check now, you can observe that the function will not be seen in AWS Lambda function list as shown in the screenshot given below:



16. AWS Lambda — Working with Amazon API Gateway

AWS Lambda function can be invoked on **HTTPS** url. It can be done on GET, POST, PUT. When the HTTPS url is invoked, the AWS Lambda function can also triggered and the data passed to HTTPS using **get/post** can be made available inside AWS Lambda to be used to insert in DynamoDB or to send mail etc.

This chapter discusses in detail about various processes involved in workin with AWS lambda and API Gateway.

Processes involved

The following are the processes involved in working with AWS lambda and API Gateway:

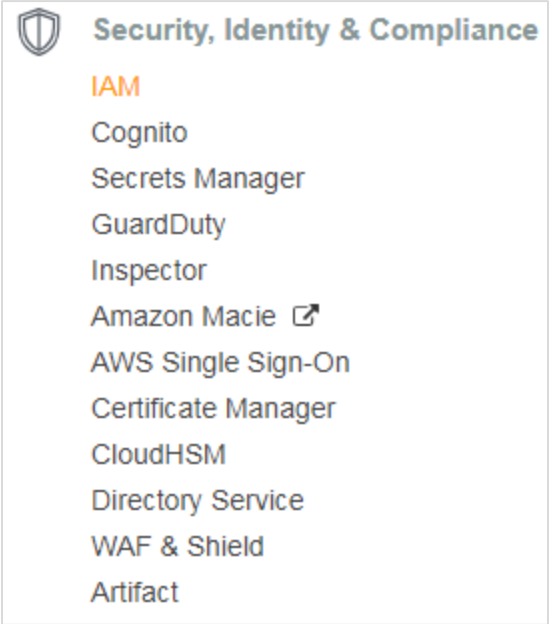
- Create IAM role for permission
- Create AWS lambda function
- Create API Gateway
- Link lambda function to api gateway
- Passing data to api gateway

A basic diagram that explains the working of API gateway and AWS Lambda is given here:

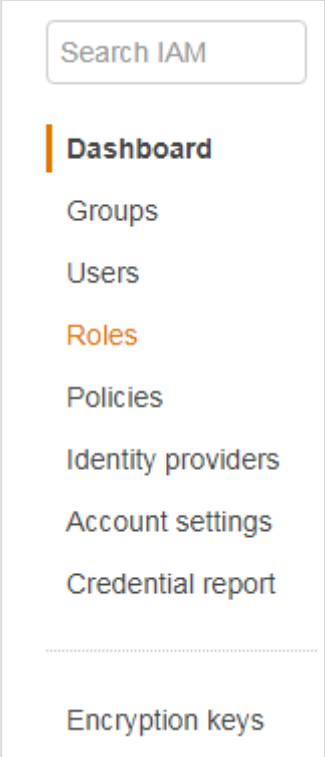
These processes are explained in detail further in this chapter with relevant screenshots.

Create IAM role for permission

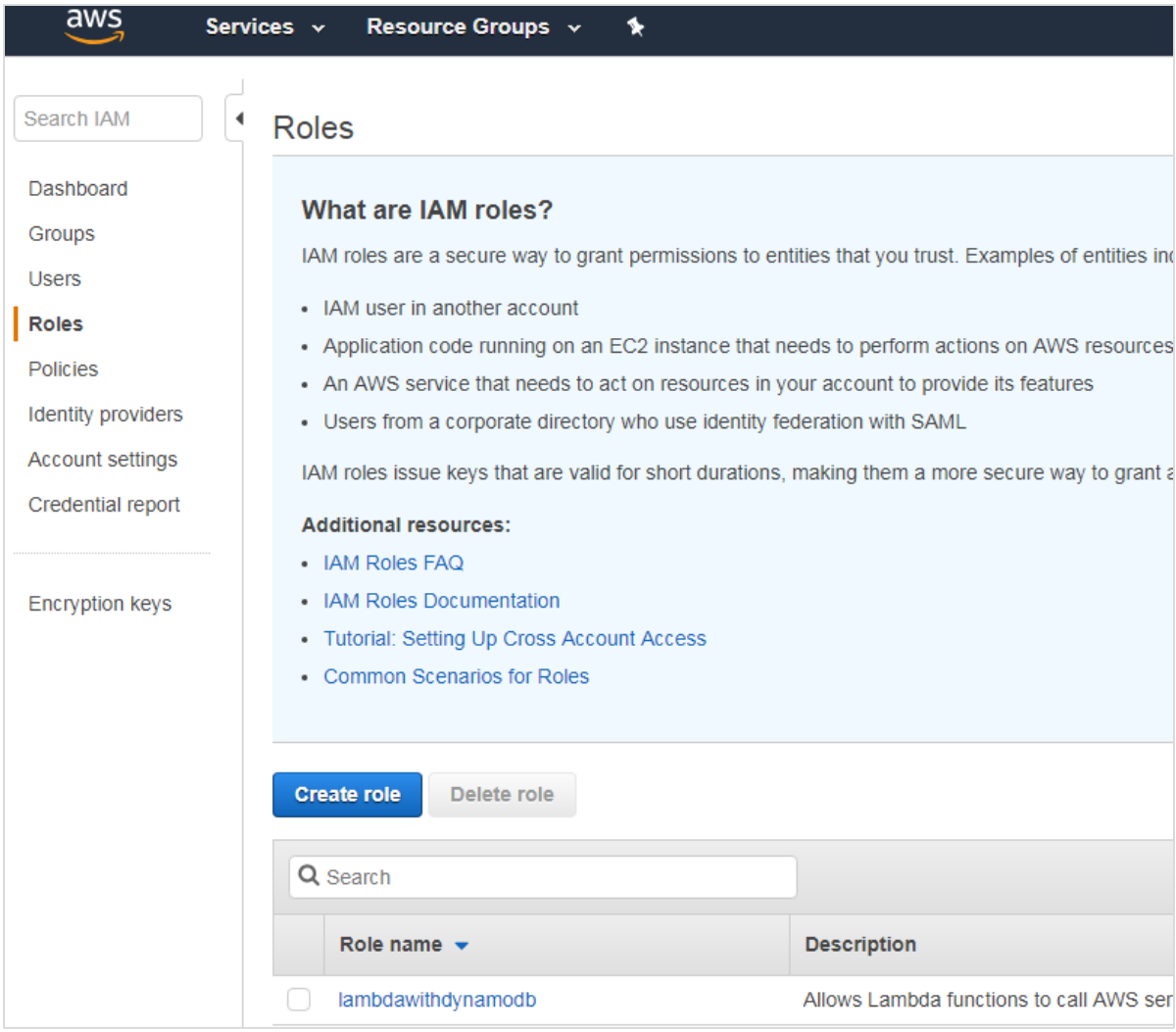
From Amazon services as shown below, select IAM for creating roles to be used by Lambda function.



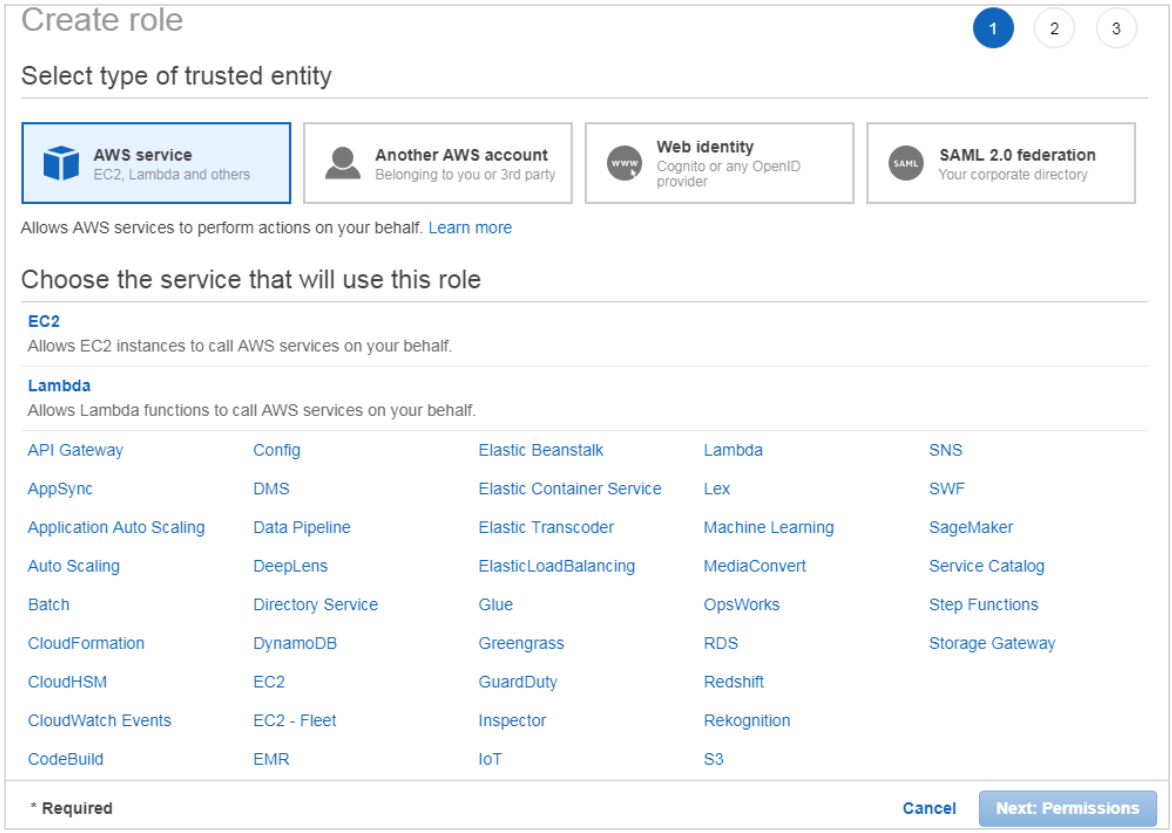
Go to IAM and select **Roles** from left side section as shown below:



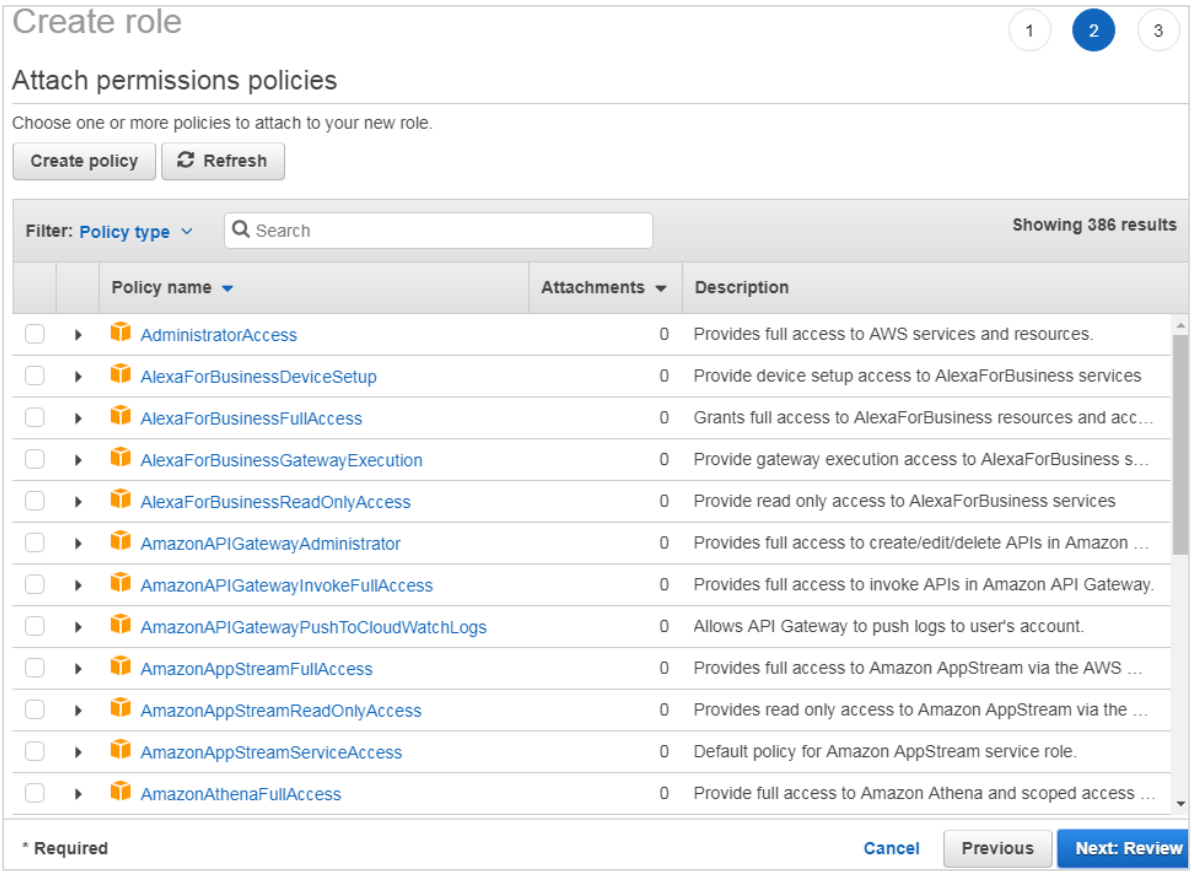
Click **Create role** for Lambda function.



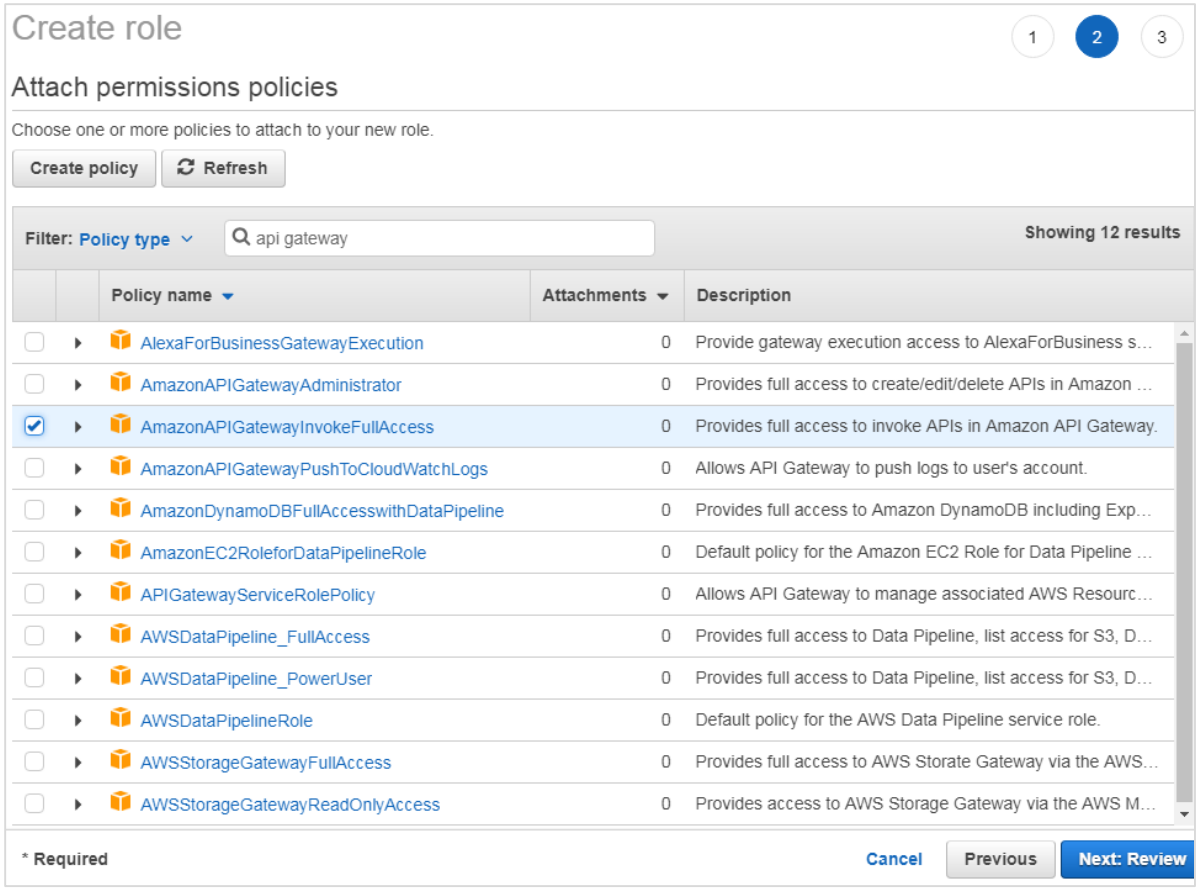
Select Lambda and click **Permissions** at the bottom. Select the permission required for the API Gateway and Lambda.



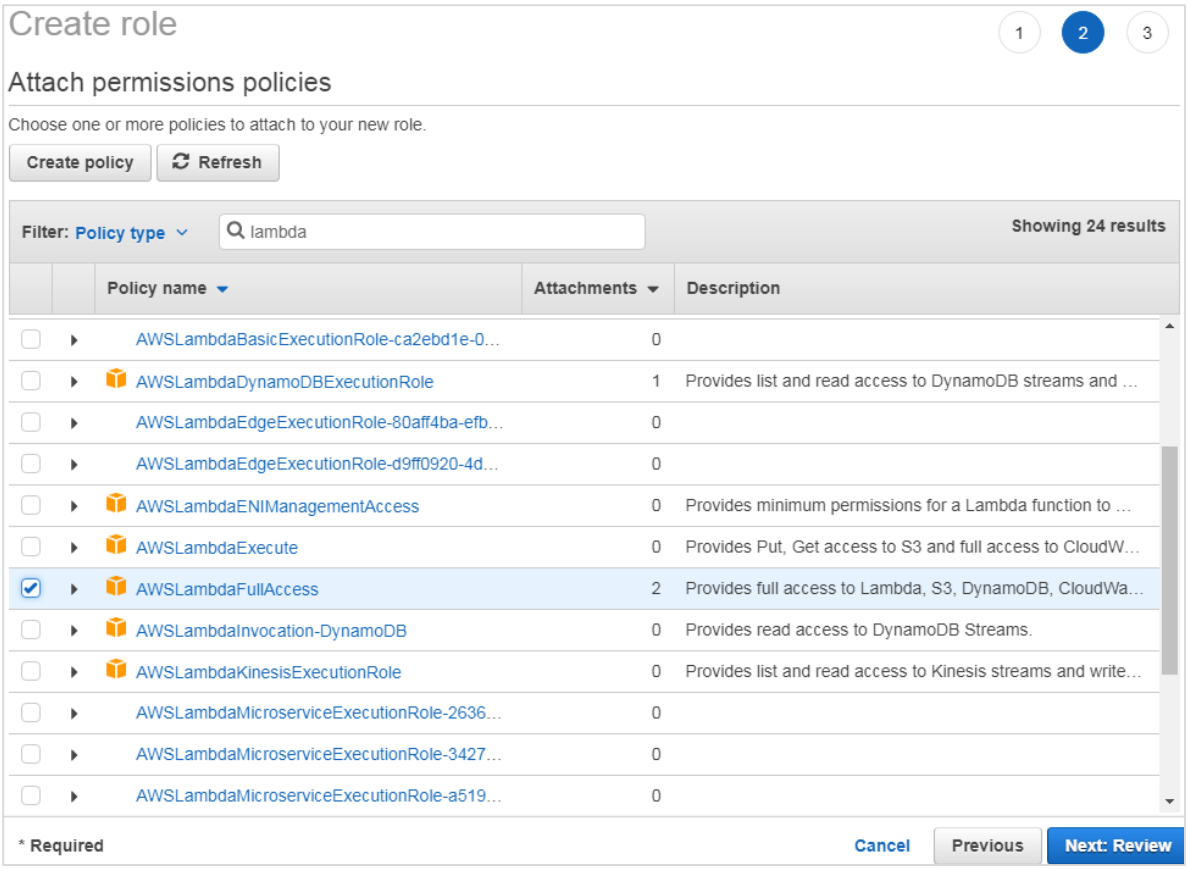
Search for API gateway in the search and it will list you all the related permissions. Here we have chosen full access to API gateway as shown below:



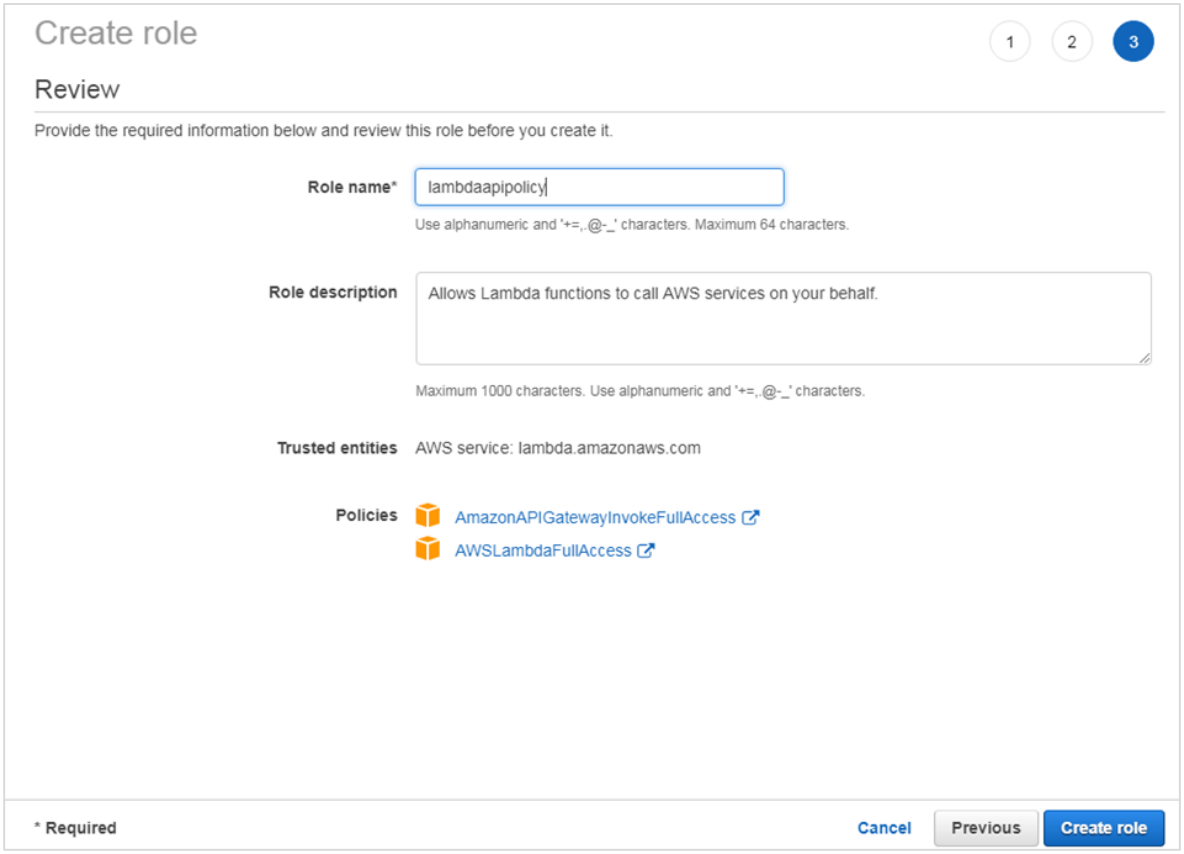
Now, search for API gateway and it will list you all the related permissions. Here we have chosen full access to API gateway as shown below:



You have to repeat the same process for Policies also.



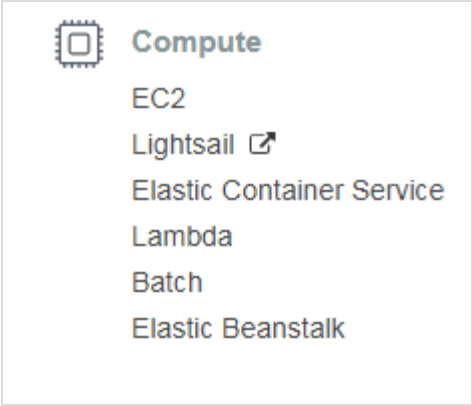
Once you are done choosing the necessary policies, click **Review** for the next step. Enter the name of the role as per your choice as shown below:



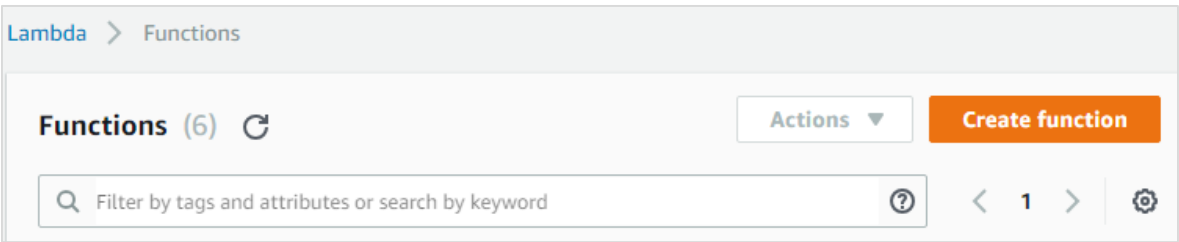
It displays the policies attached to the role. Click **Create role** and we are done with the role creation and can proceed with the lambda function.

Create AWS Lambda Function

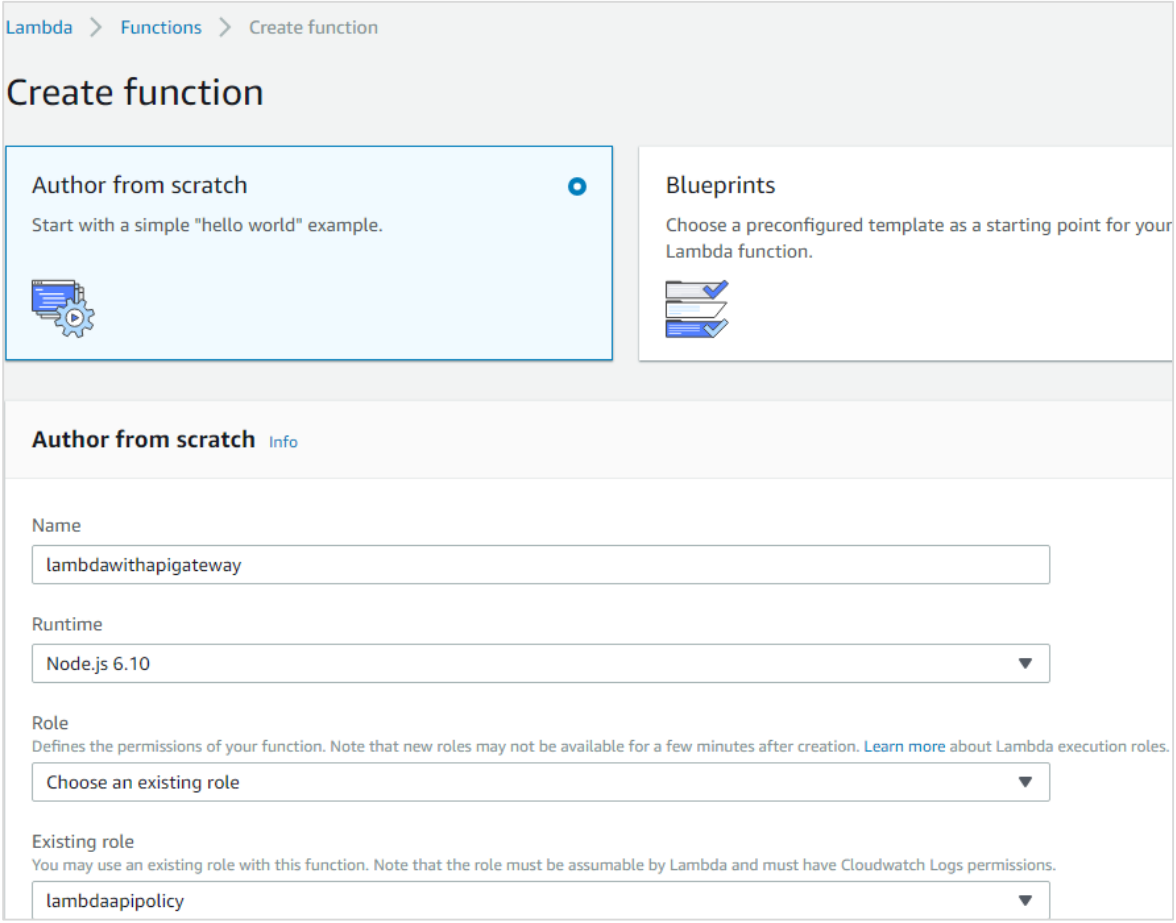
Go to AWS services and click on lambda service to create a function for connecting it with api gateway.



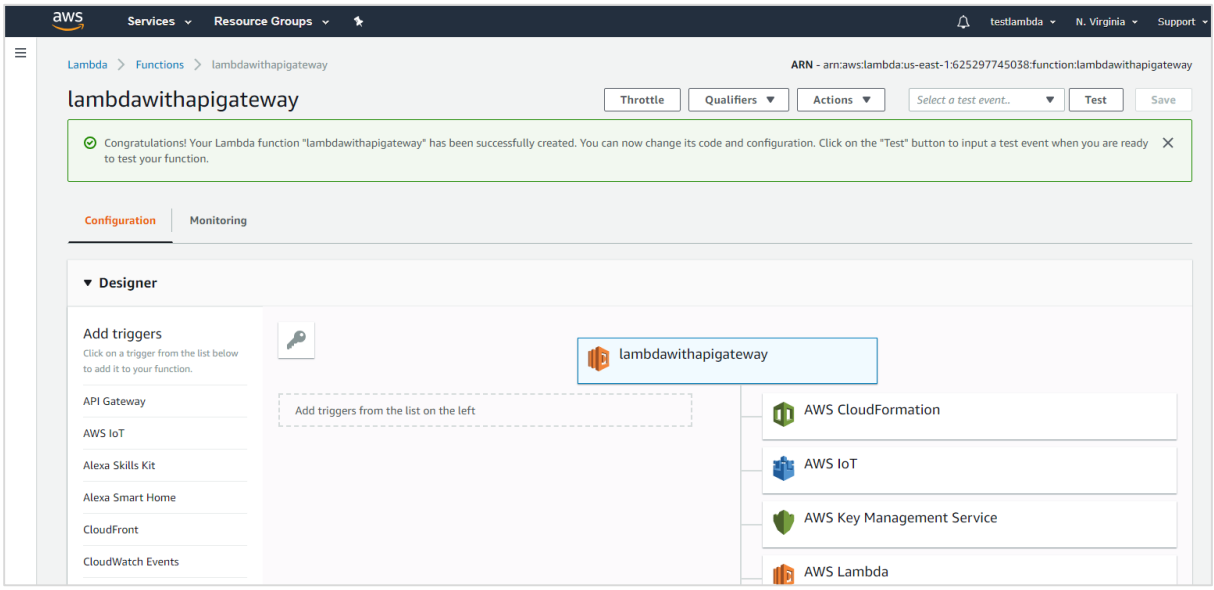
The UI screen for Lambda function is shown below. Click **Create function** button to proceed with creation of Lambda function.



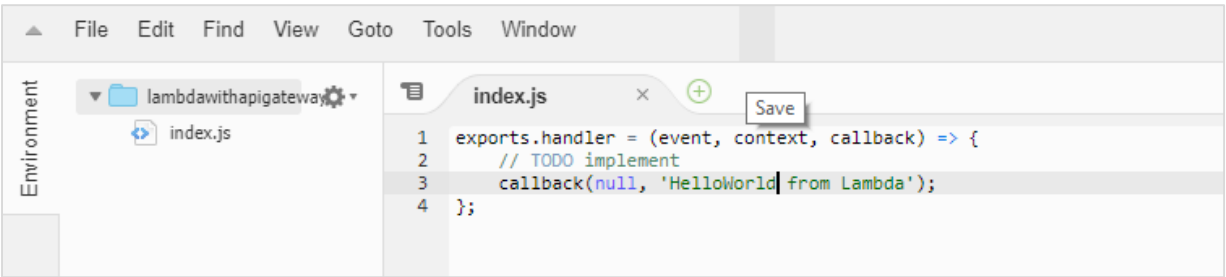
Enter the name of the function and choose the existing role which we have created above.



It flashes a message that the function with the name **lambdawithapigateway** is created successfully.



Note that here we will use **nodejs** runtime to write the code.The AWS code with **helloworld** message is as shown below:



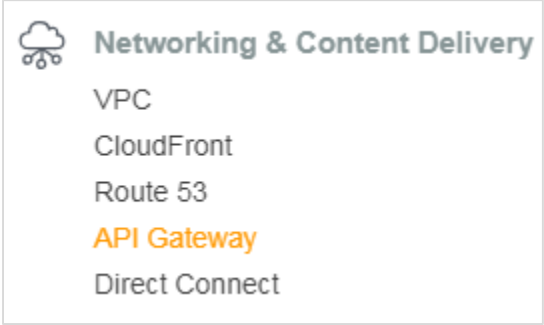
AWS Lambda code is present in **index.js** file. The function called handler has the params namely **events, context** and **callback**.

Callback function basically has the error and the success message. Note that here we do not have any error related code, so null is passed and the success message is **HelloWorld from lambda**.

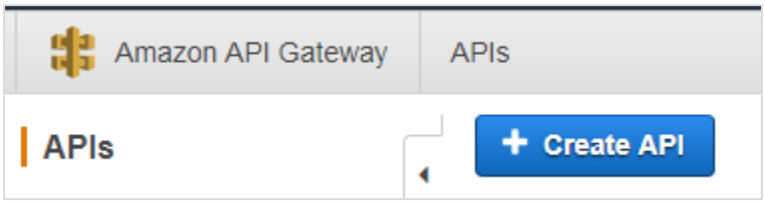
Lastly, save the changes added and let us proceed to add the Lambda function to the API gateway.

Create API Gateway

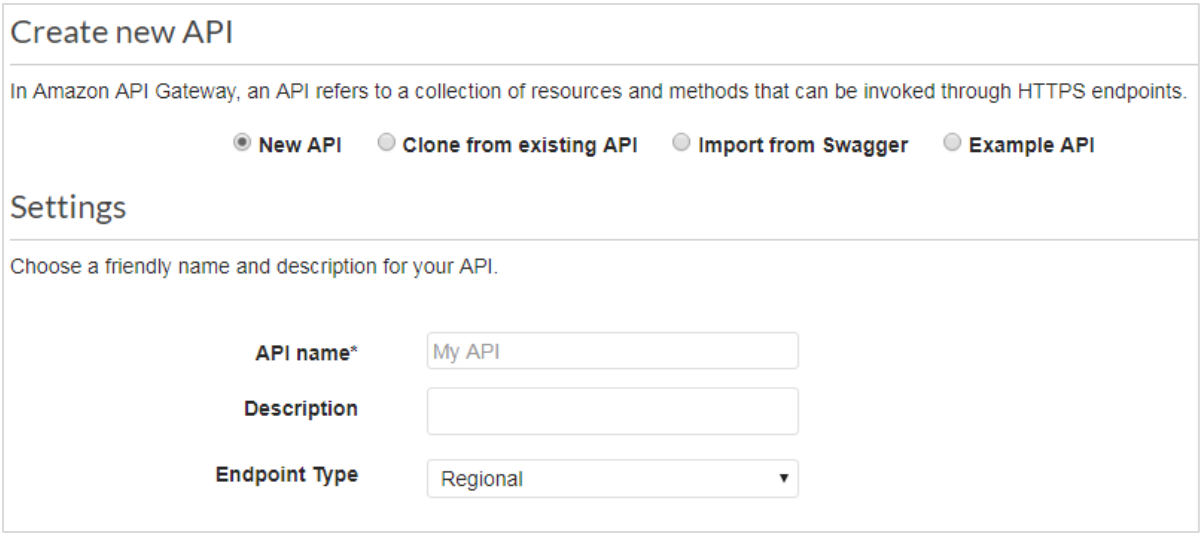
Login to your AWS account and open API Gateway as shown below:



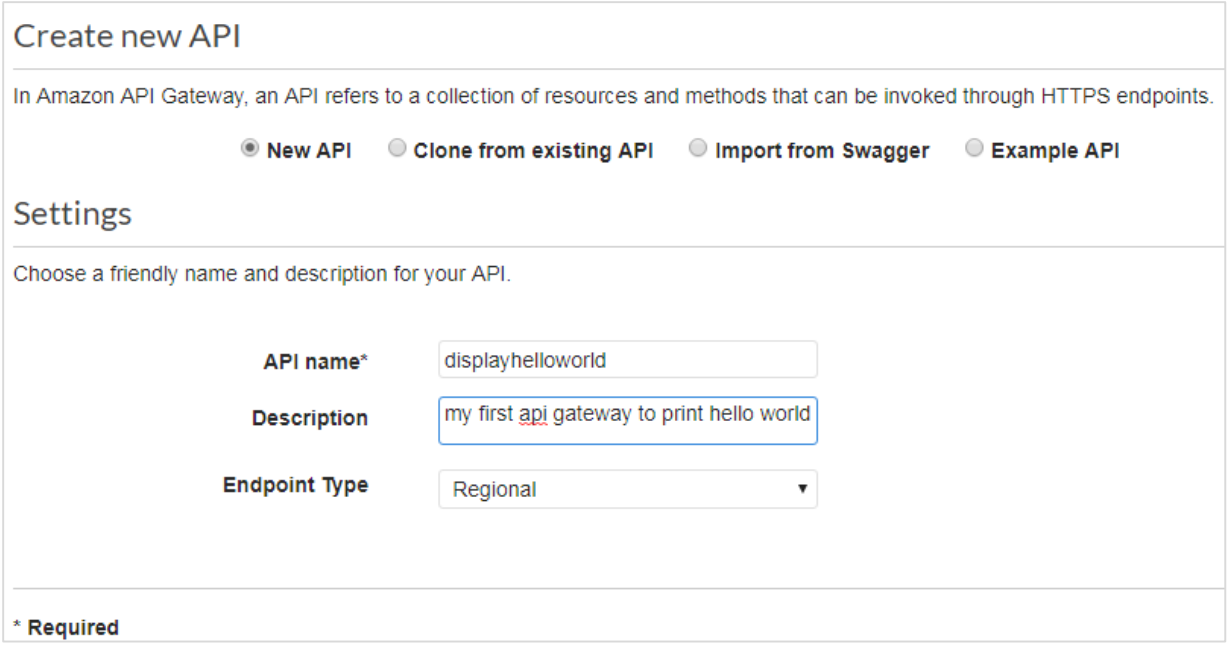
Click API Gateway and it will lead you to the screen where new API gateway can be created.



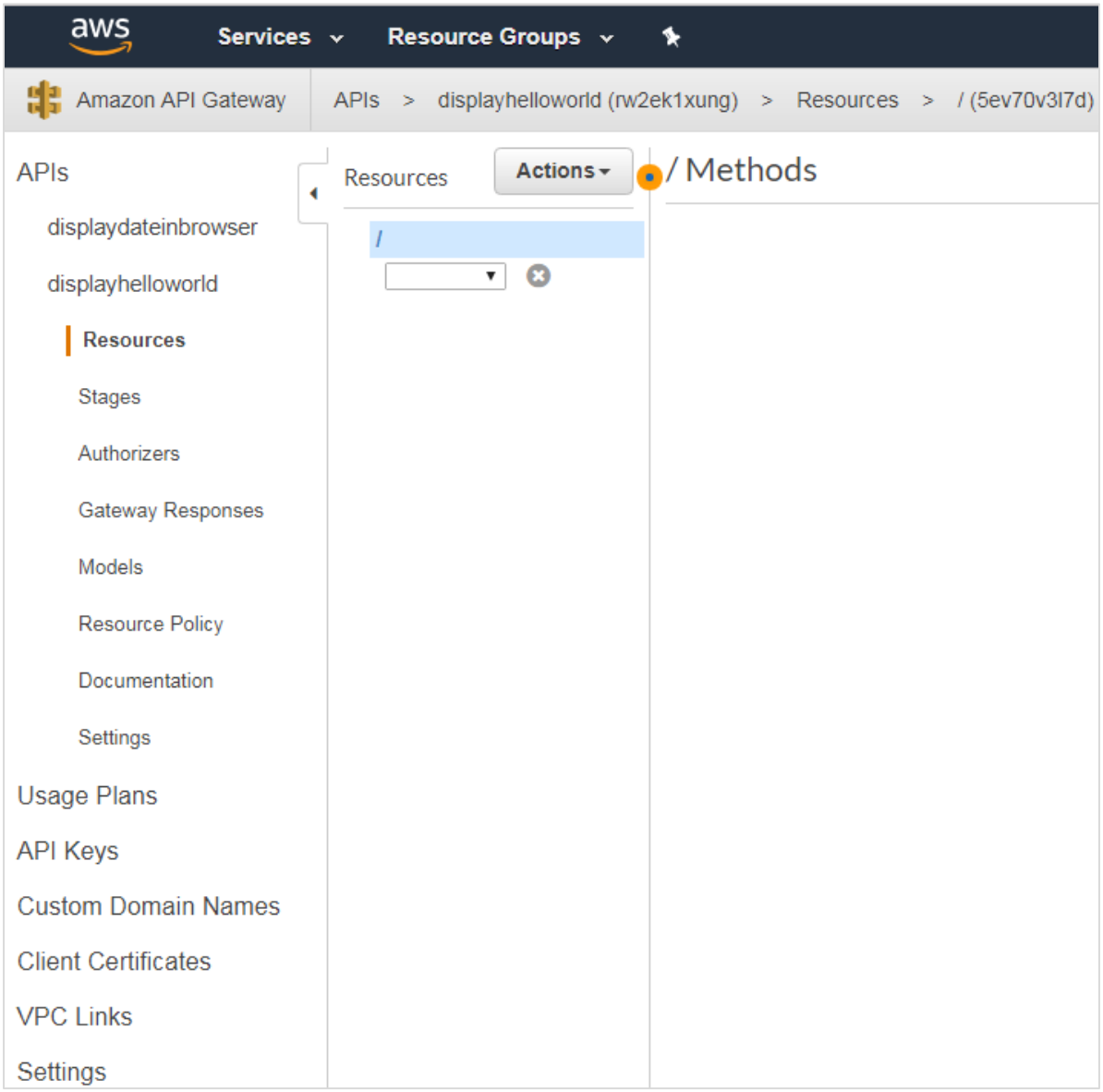
Click **Create API** and add details as shown below:



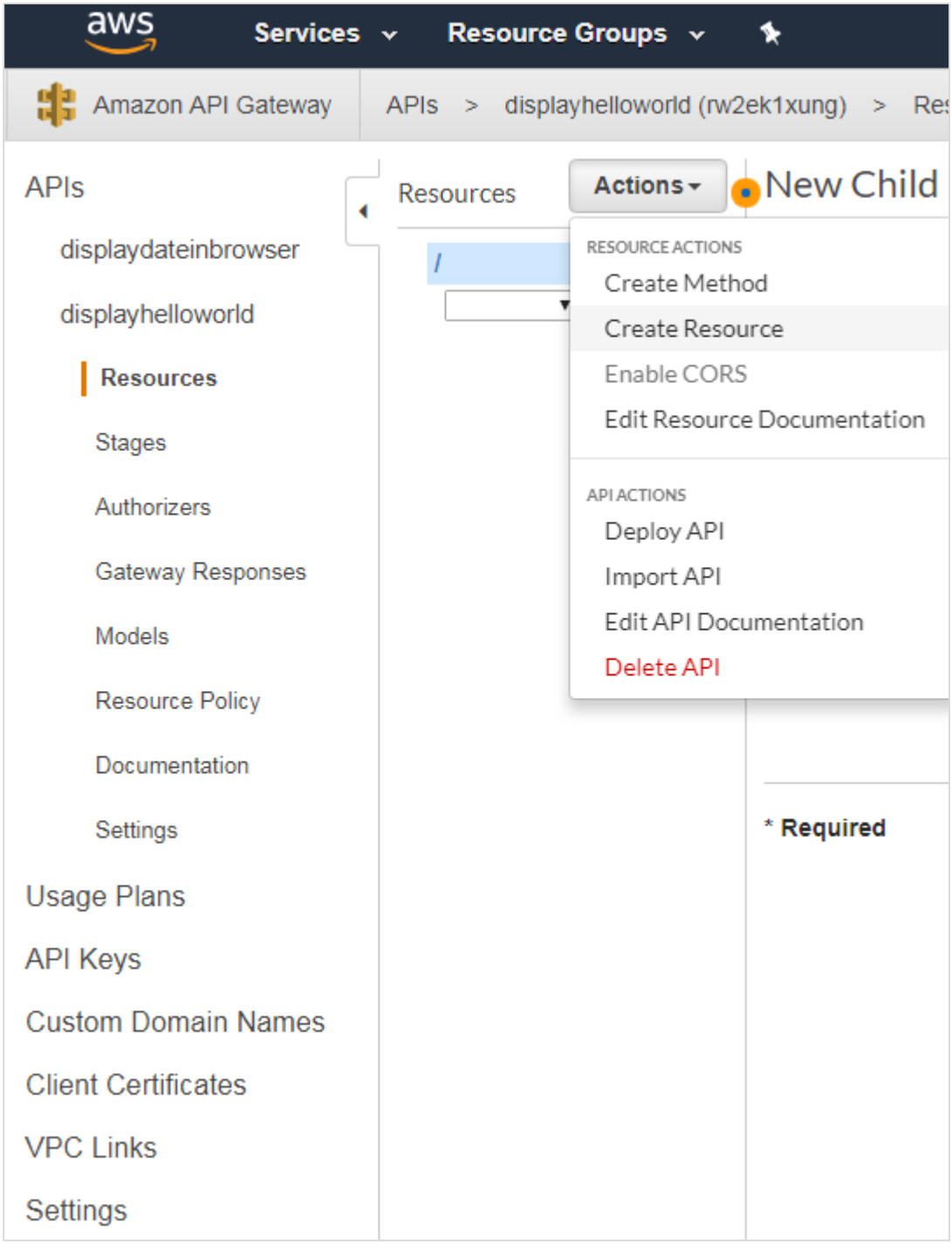
Click the **Create API** button on right side of the screen. This will display the newly created API on to left side of the screen.



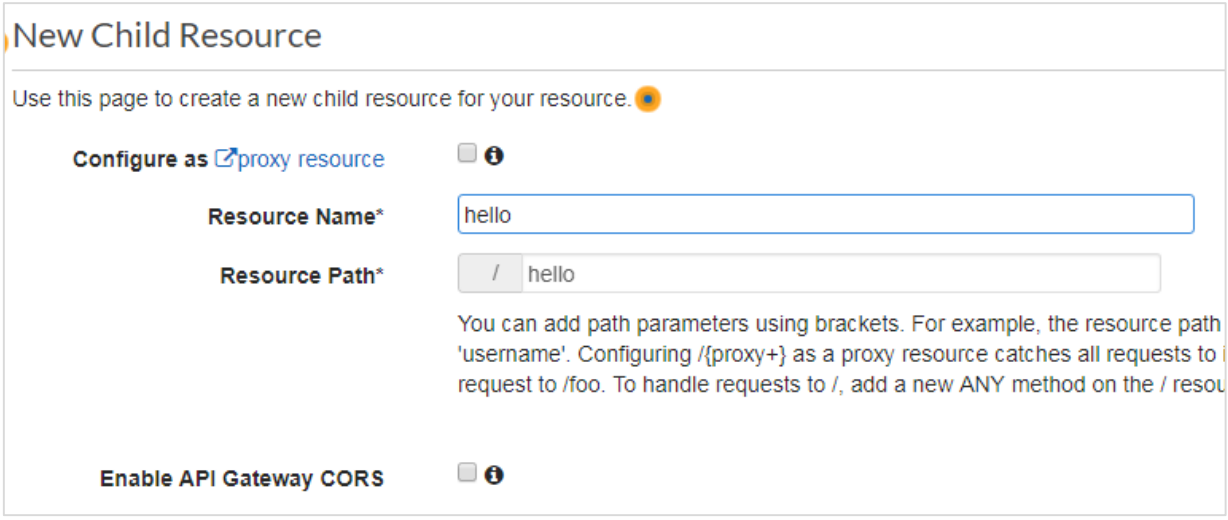
Click the **Actions** dropdown to create a new resource for the API.

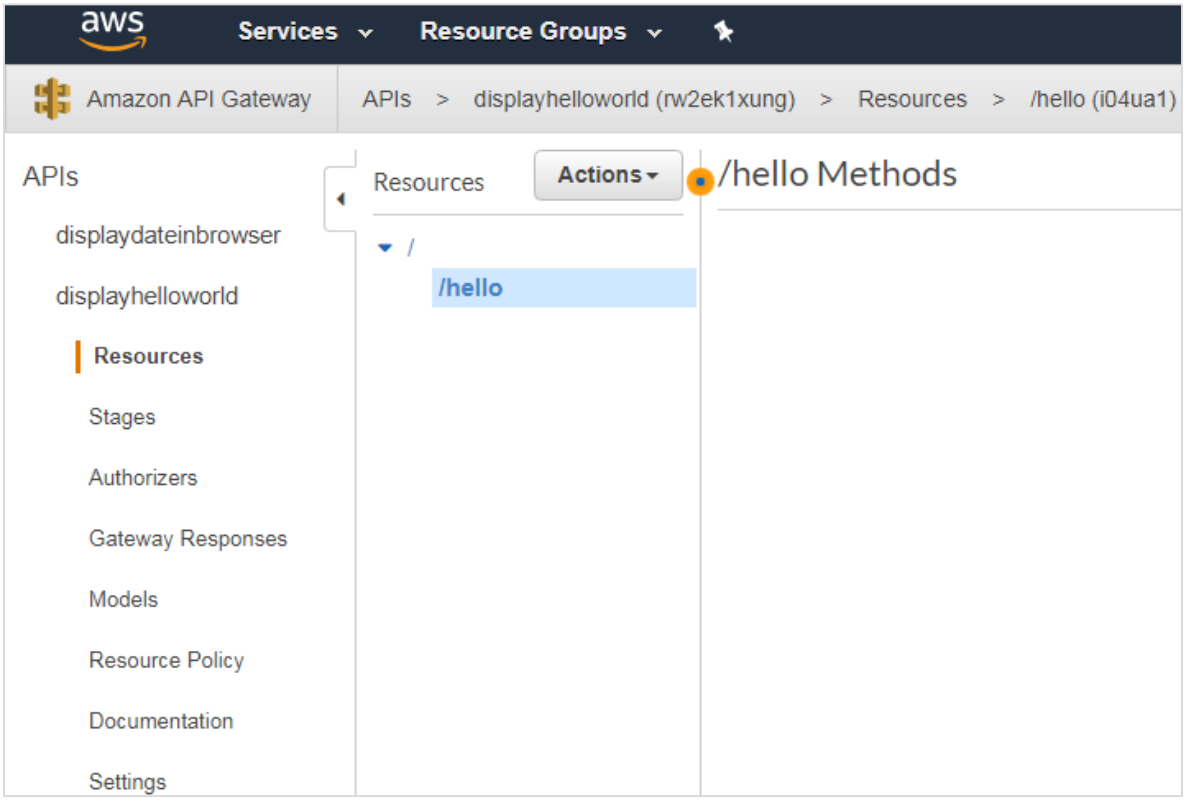


Now, create a new resource as shown below:

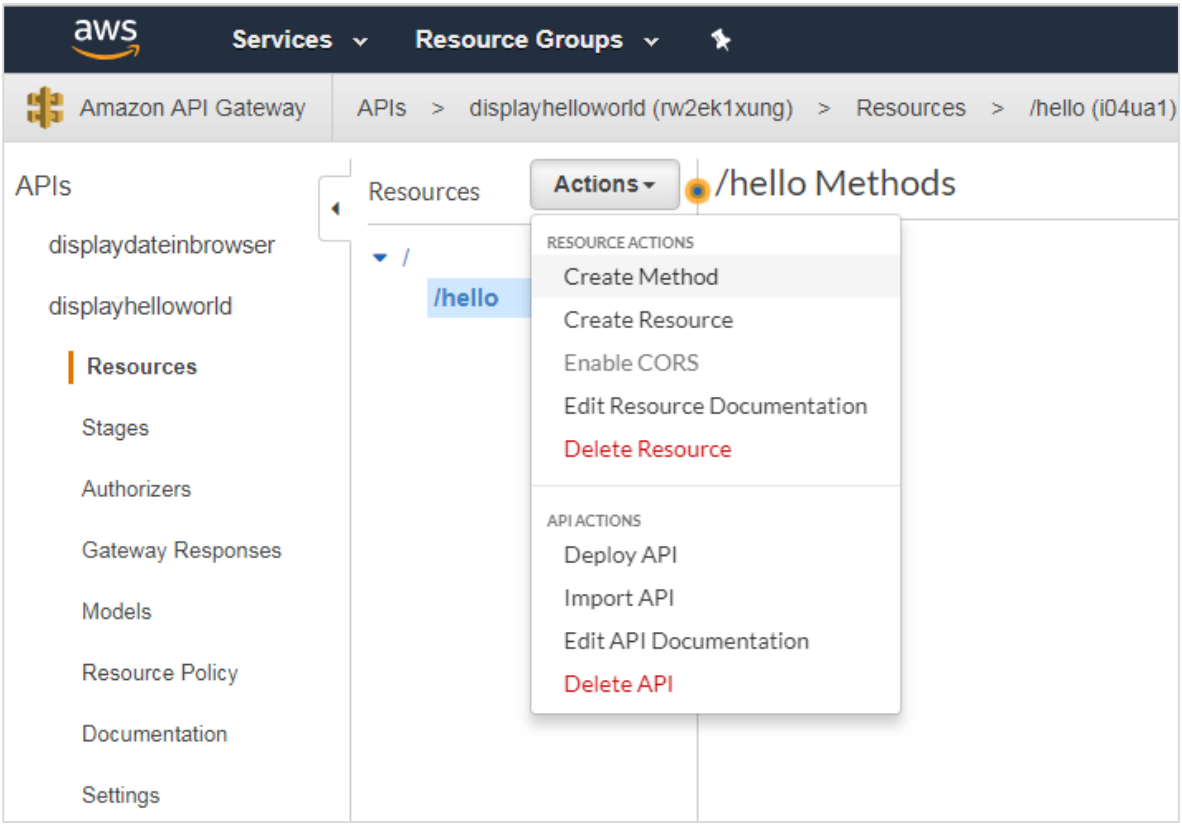


Enter the **Resource Name** as shown below.You will see the name of the resource entered in the url created at the end.Click **Create Resource** and you will see it on the screen as follows:

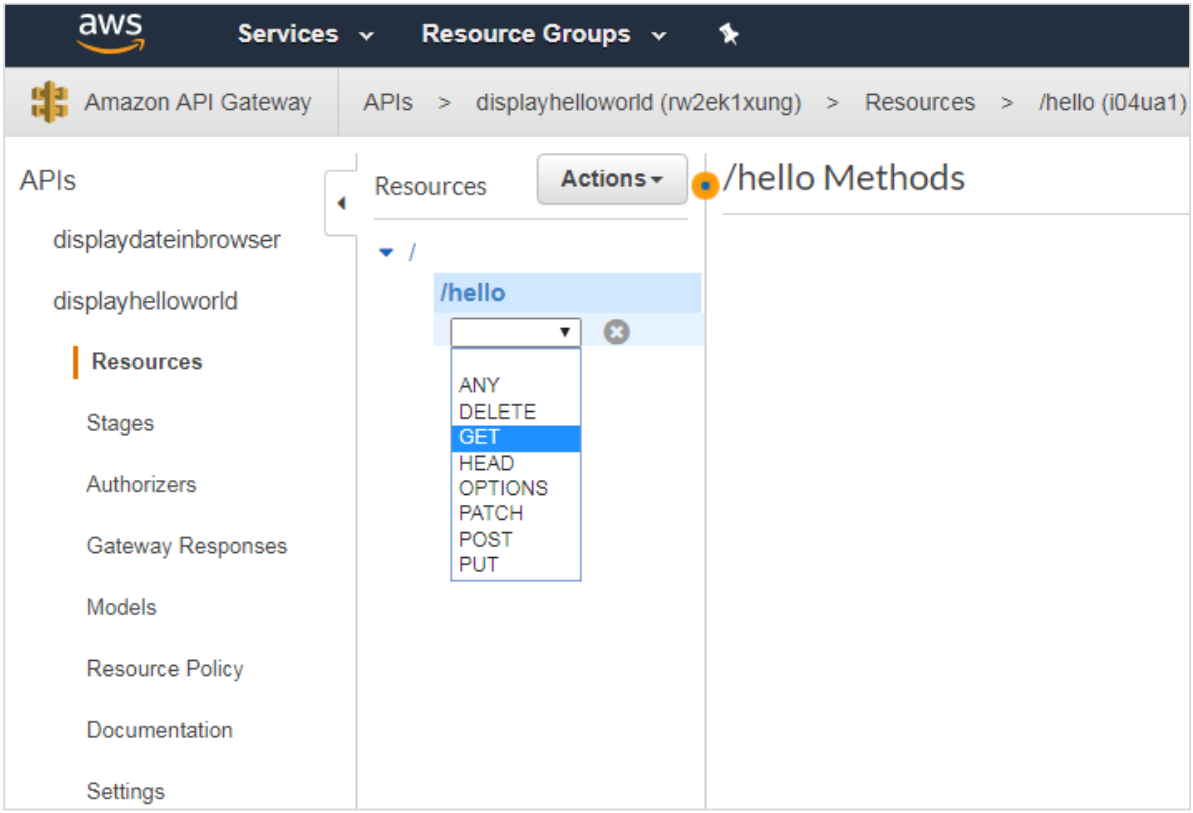




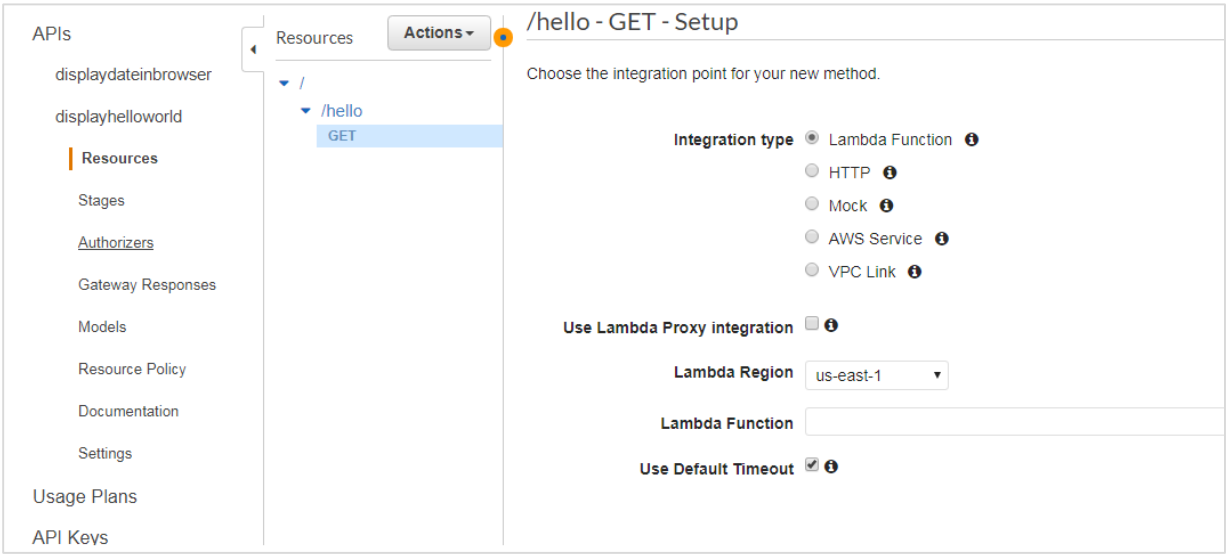
Add **GET/POST** methods to the resource created as shown below. Select the method from **Actions** dropdown.



Click the **GET** method to add the method to the API.

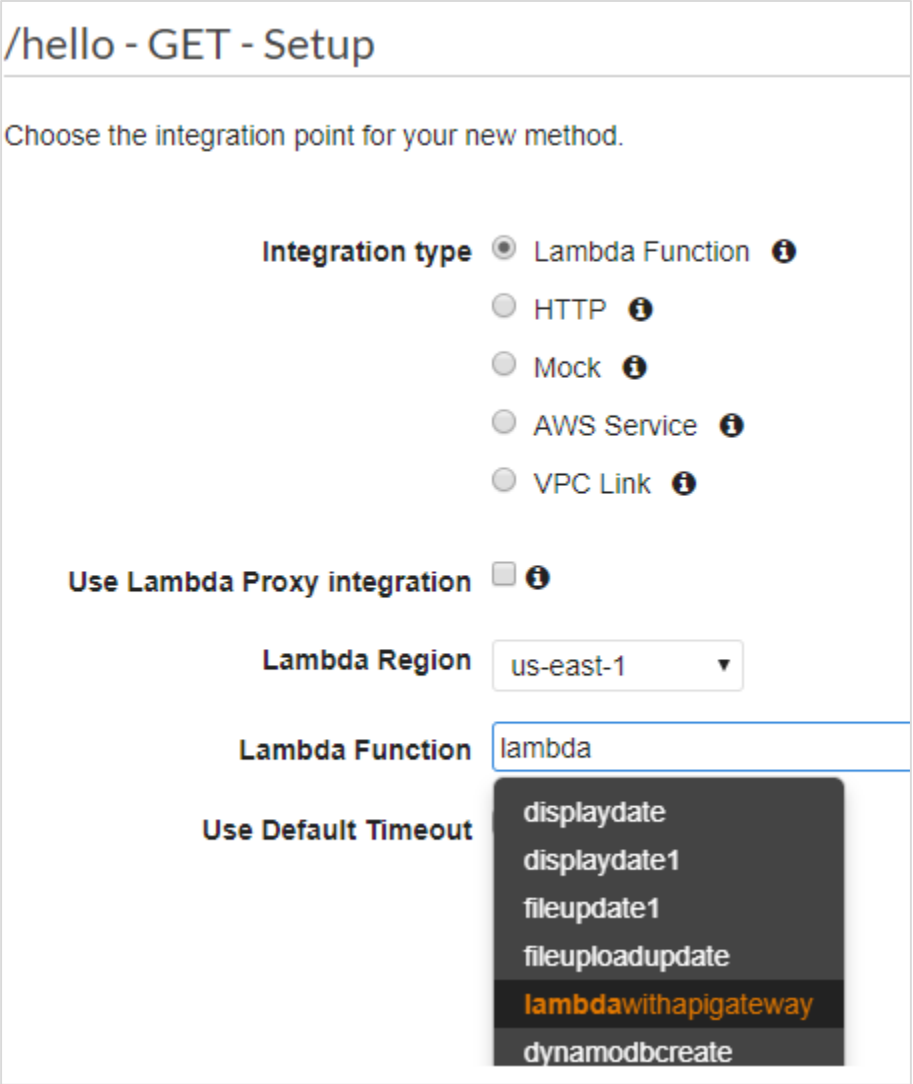


Next step is the integration which will integrate it with Lambda function. Now add the Lambda function to it as shown below:

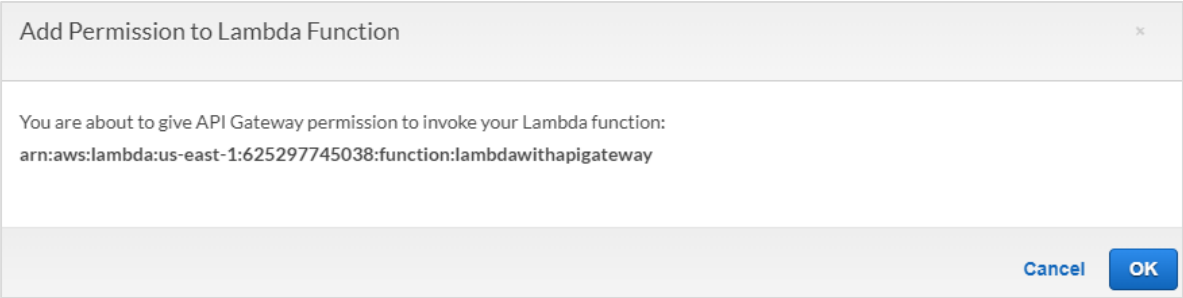


Link Lambda Function to API Gateway

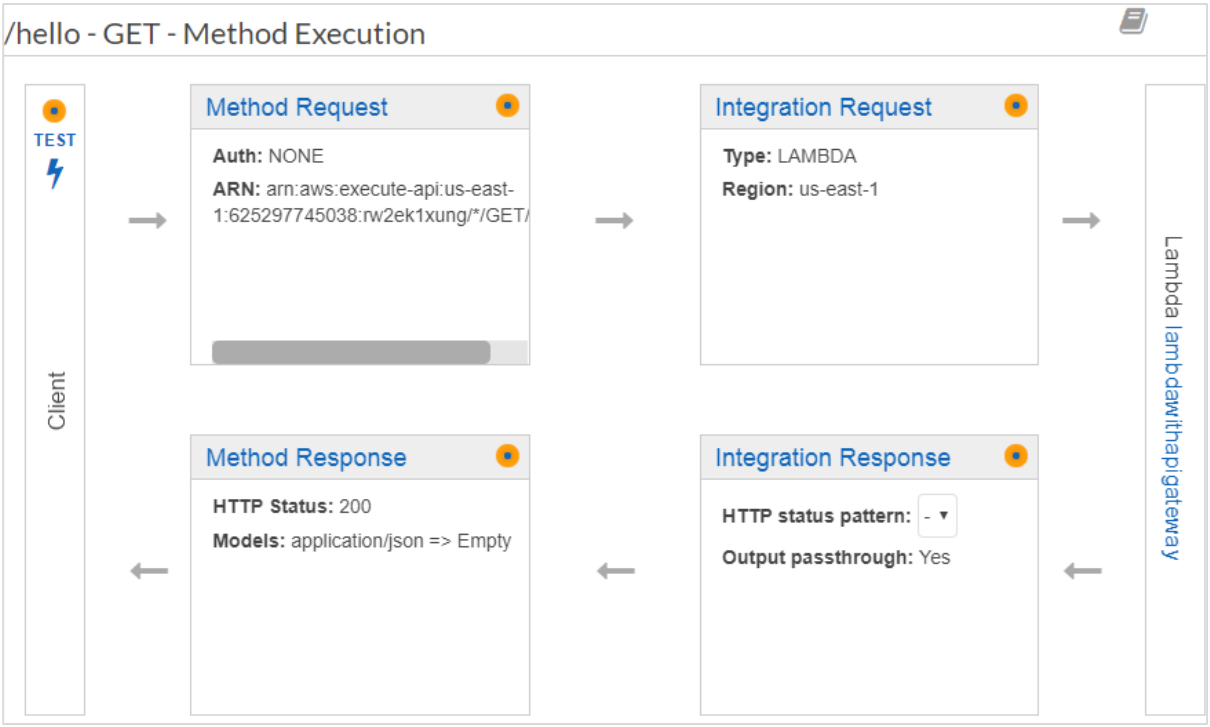
Select the lambda function created earlier.



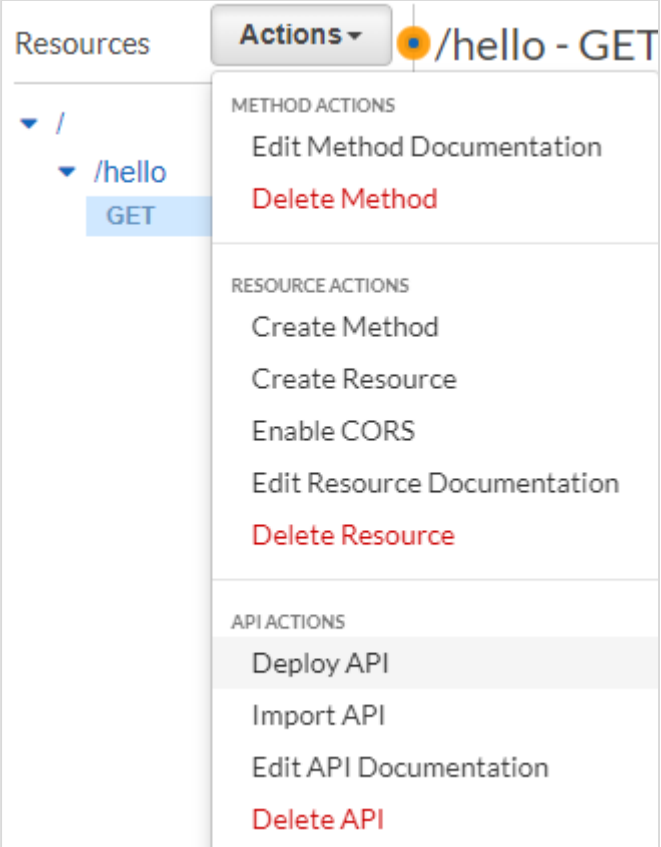
Save the changes and you can see a dialog box asking for permission as shown below:



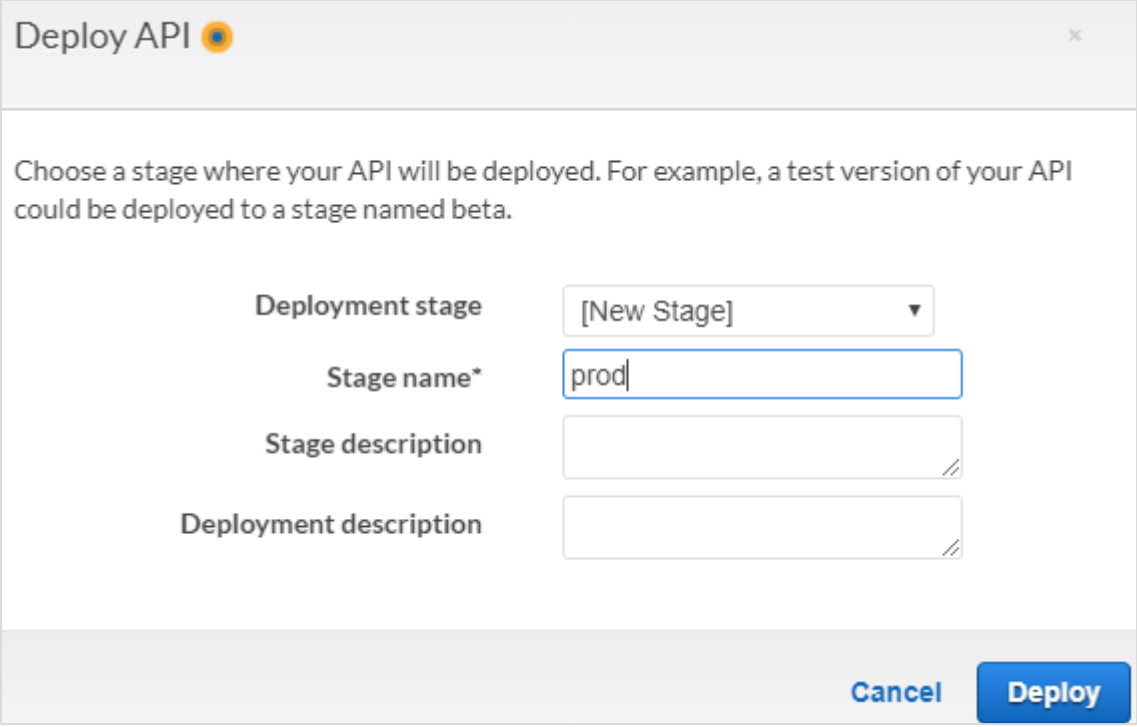
Click **OK** for the permission. This is the execution details between the API gateway HTTP request and the Lambda function:



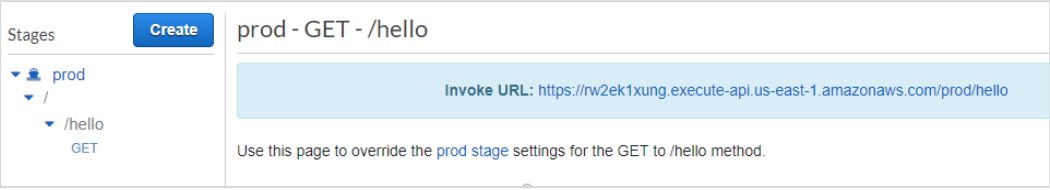
Now, let us deploy the API gateway changes. For this purpose, we need to select the **Deploy API** from **Actions** dropdown as shown below:



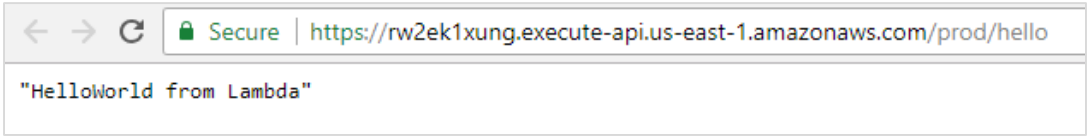
Select **Deploy API**. It will ask for the deployment state. Select **New Stage** from Deployment stage dropdown and add the stage name as **Production**.



Click **Deploy** button and it will redirect you to the url as shown below:



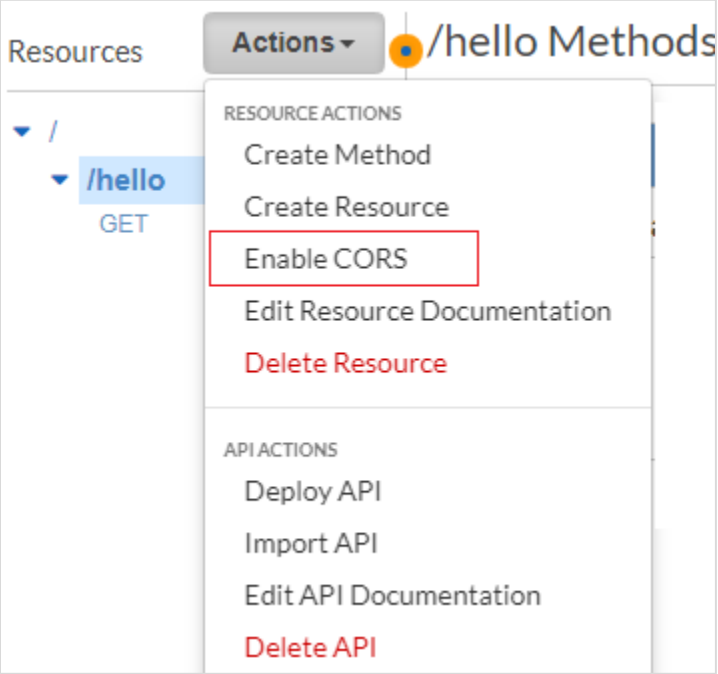
Select the **GET** method from left side to get the url. Open the url in a new tab to see the message from Lambda function.



This is a basic example of working with AWS Lambda and AWS API Gateway.In the above example, we have hardcoded the message in Lambda function.

Now, let us take the message details from the API Gateway. Incase if the HTTPS call has to be called from a different domain, for example AJAX call to the API, we need to enable CORS for the API gateway created.

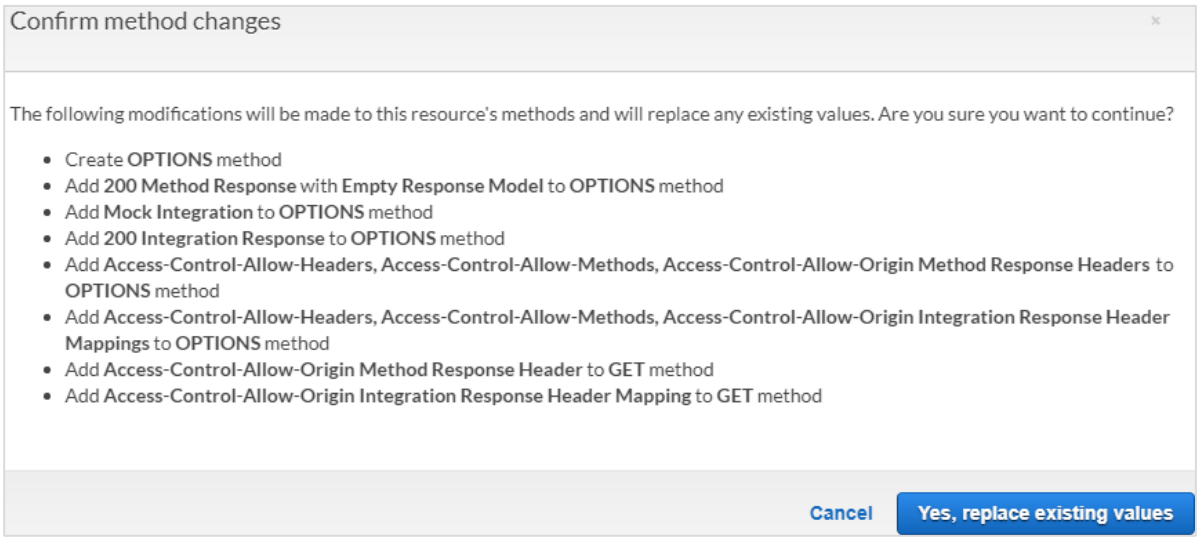
Select the resource created for the API and click **Actions** dropdown:



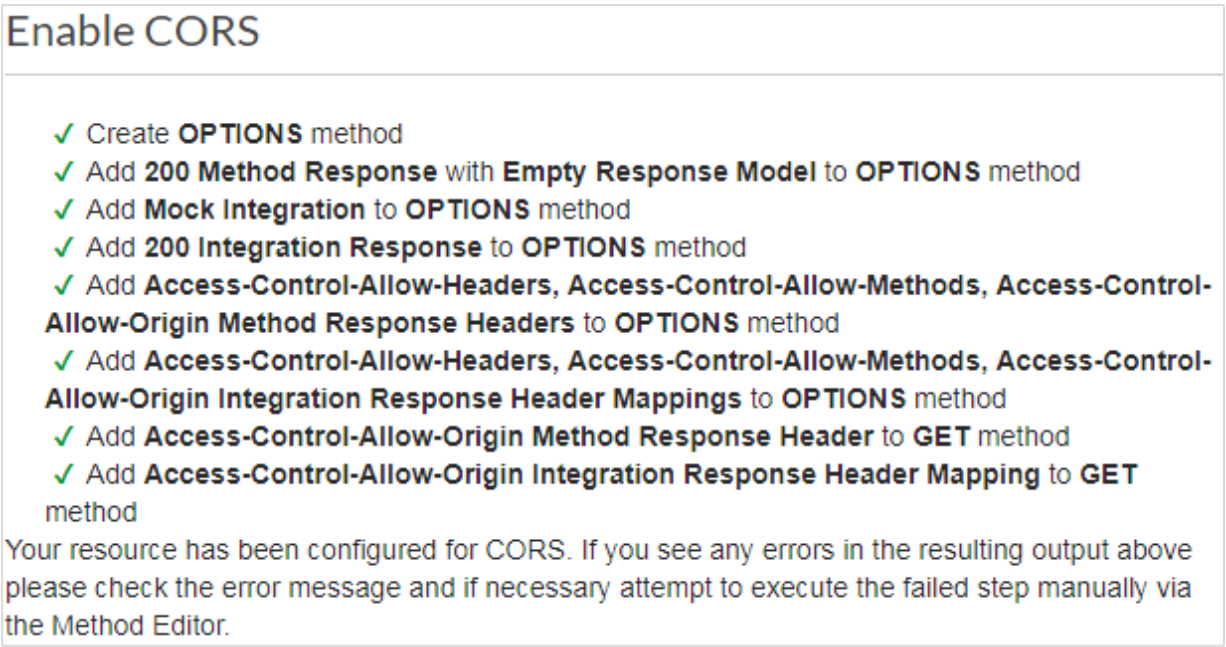
Now, **Enable CORS** will open up the following screen:

You can use few methods to ENABLE CORS. **Access-Control-Allow-Origin** is marked as * which means it will allow to get contents from API gateway from any domain.

You can also specify the domain name you want to work with the API. Click **Enable CORS and replace existing CORS headers** button and it will display confirmation message as shown below:

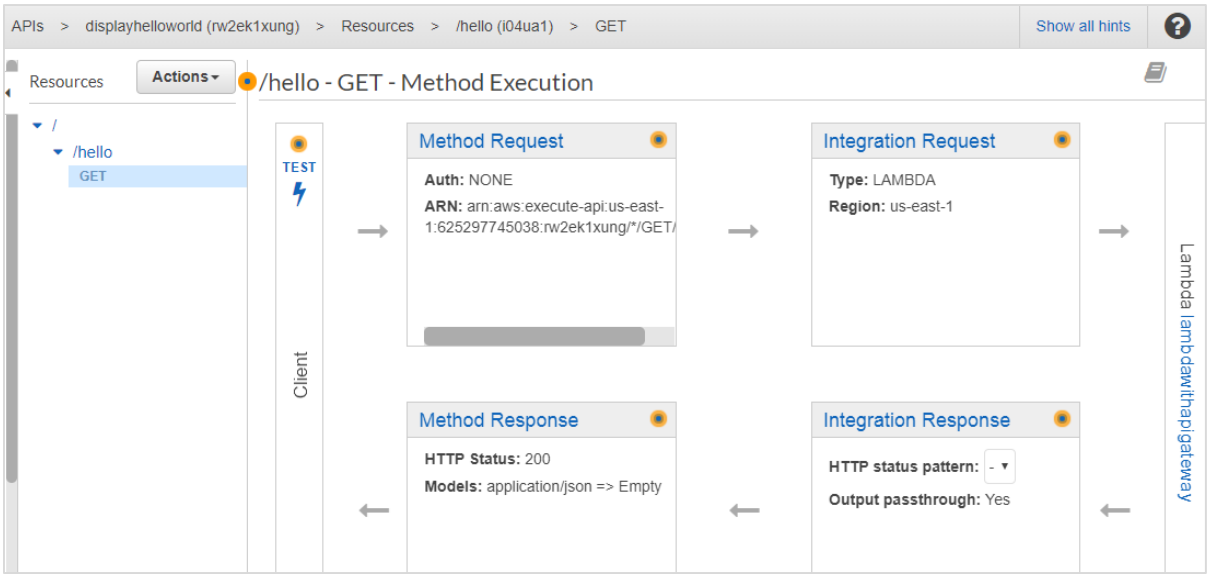


Click **Yes, replace existing values** button to enable it. The **Enable CORS** screen looks as shown below:

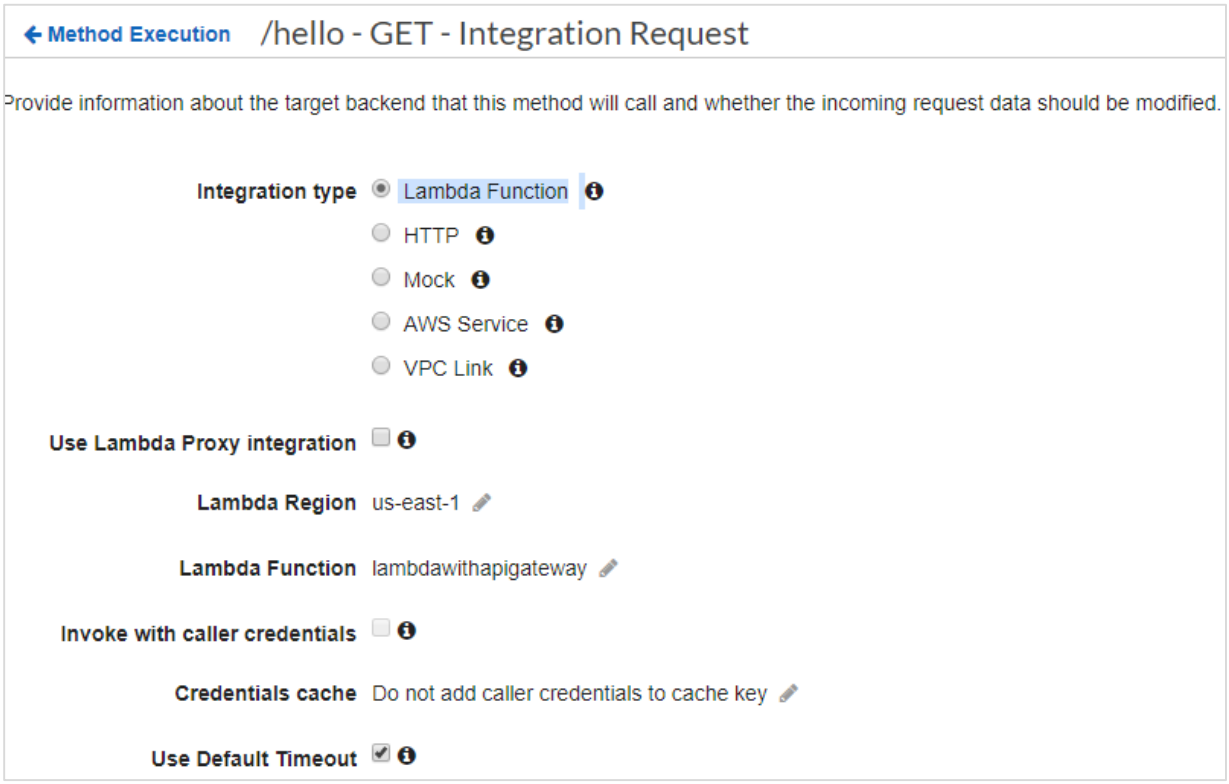


Passing Data to API Gateway

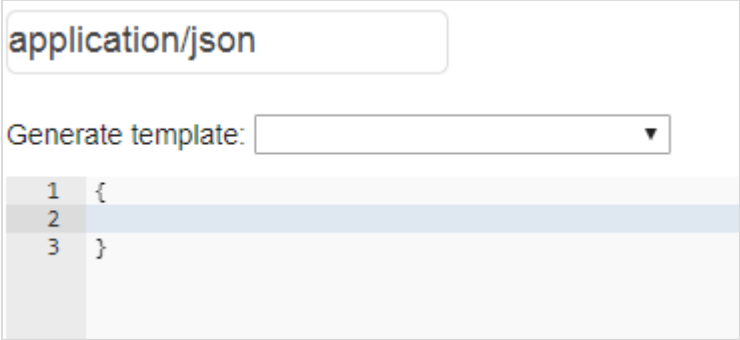
Open the API created in API Gateway **displayhelloworld** as shown below:



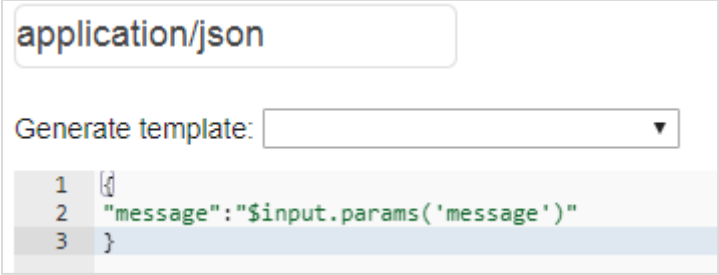
Click **Integration Request** to send data as shown below:



Choose **Body Mapping Templates** and add the **Content-Type** for this example as **application/json**. Click on the content type added add the details as follows:



Now, add the template in JSON format as shown below:

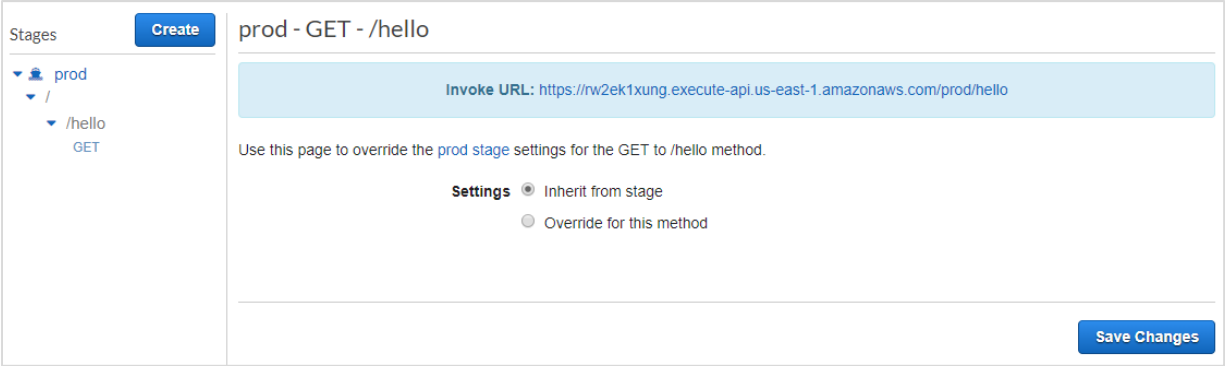


Observe that we have taken the message as the parameter to get data from API Gateway and share it with AWS Lambda.The syntax to get the details is as shown above.

Now, deploy the API to make the changes available on the API Gateway URL. For this, we need to change Lambda function to display the data based on the API Gateway URL. The code for Lambda function is givn below. Note that we are taking the message from the event and passing to callback.

```
exports.handler = (event, context, callback) => {
    let message = event.message;
    callback(null, message);
};
```

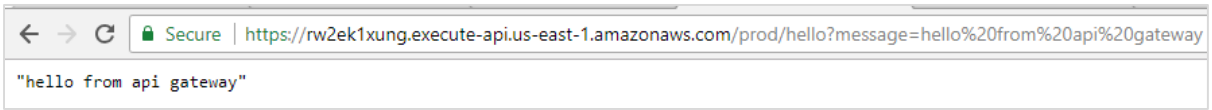
Now, save the changes in Lambda and hit the URL to see the changes. Observe the screenshot given below:



Click the URL as shown below:

```
https://rw2ek1xung.execute-api.us-east-
1.amazonaws.com/prod/hello?message=hello%20from%20api%20gateway
```

Observe that here we are passing message as query string to the GET url. Then you can observe the output as shown below:



It reads the details sent to message from the URL and displays the same in the browser.

17. AWS Lambda — Using Lambda Function with Amazon S3

Amazon S3 service is used for file storage, where you can upload or remove files. We can trigger AWS Lambda on S3 when there are any file uploads in S3 buckets. AWS Lambda has a handler function which acts as a start point for AWS Lambda function.The handler has the details of the events. In this chapter, let us see how to use AWS S3 to trigger AWS Lambda function when we upload files in S3 bucket.

Steps for Using AWS Lambda Function with Amazon S3

To start using AWS Lambda with Amazon S3, we need the following:

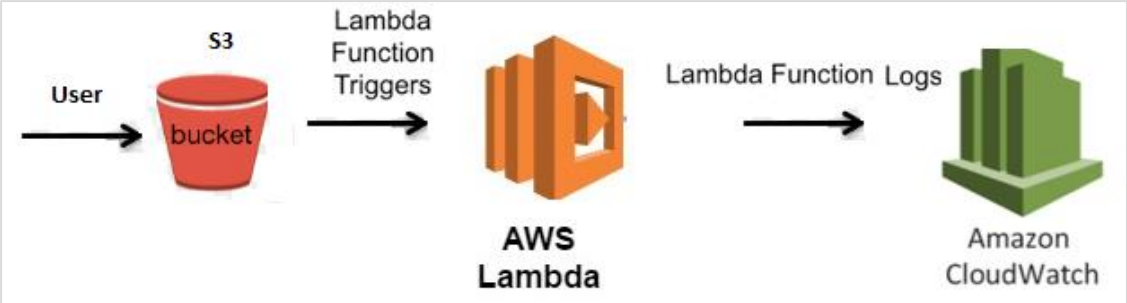
- Create S3 Bucket
- Create role which has permission to work with s3 and lambda
- Create lambda function and add s3 as the trigger.

Example

Let us see these steps with the help of an example which shows the basic interaction between Amazon S3 and AWS Lambda.

- User will upload a file in Amazon S3 bucket
- Once the file is uploaded, it will trigger AWS Lambda function in the background which will display an output in the form of a console message that the file is uploaded.
- The user will be able to see the message in Cloudwatch logs once the file is uploaded.

The block diagram that explains the flow of the example is shown here:

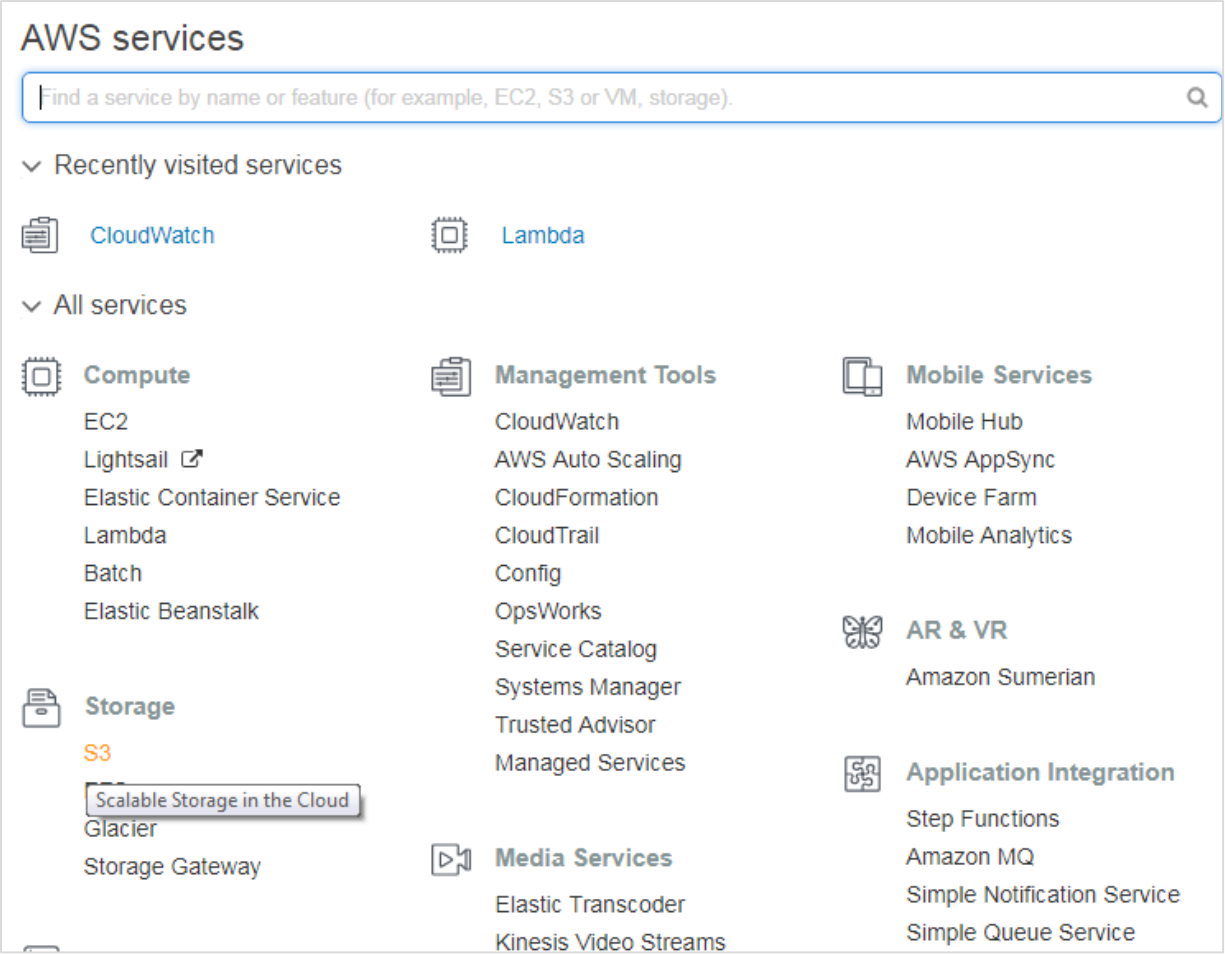


Creating S3 Bucket

Let us start first by creating a s3 bucket in AWS console using the steps given below:

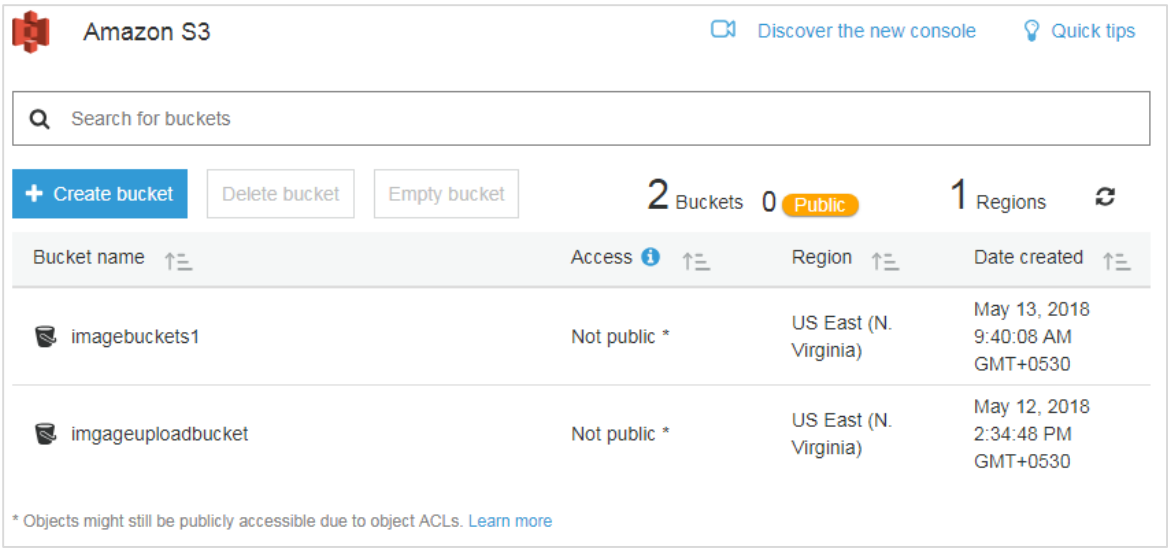
Step 1

Go to Amazon services and click **S3** in storage section as highlighted in the image given below:



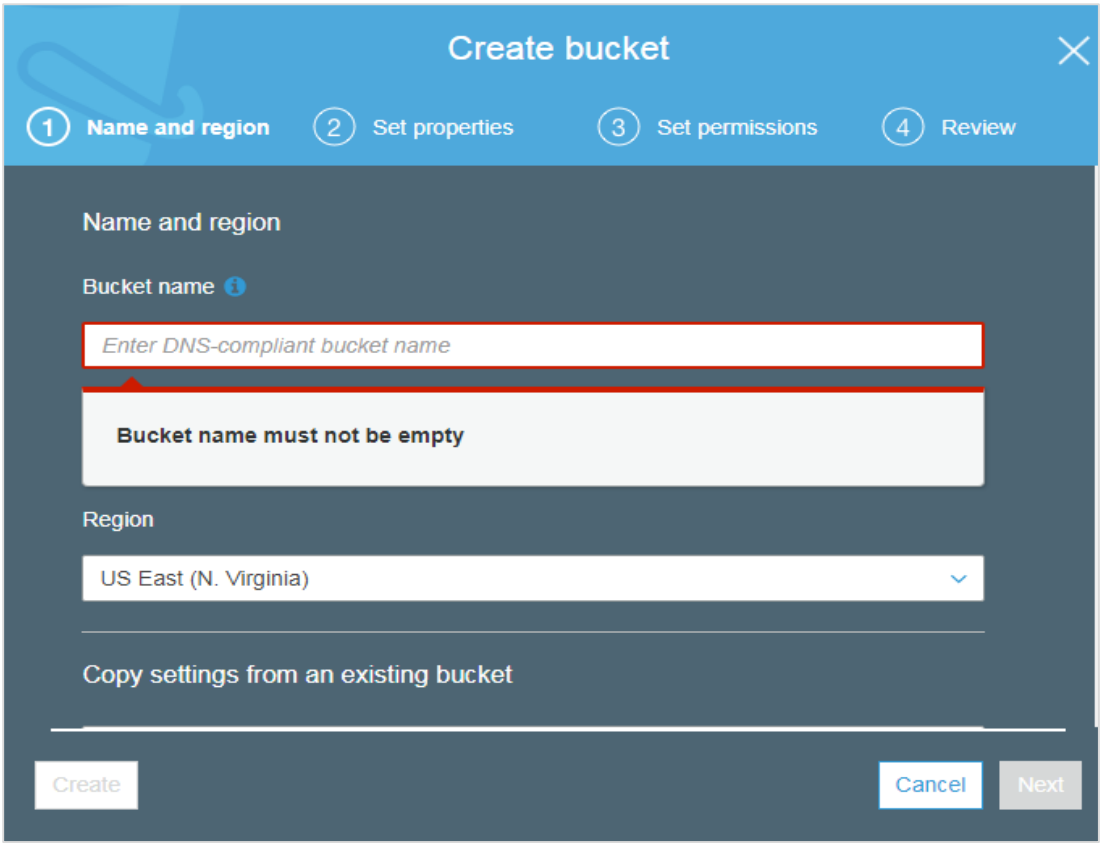
Step 2

Click S3 storage and **Create bucket** which will store the files uploaded.



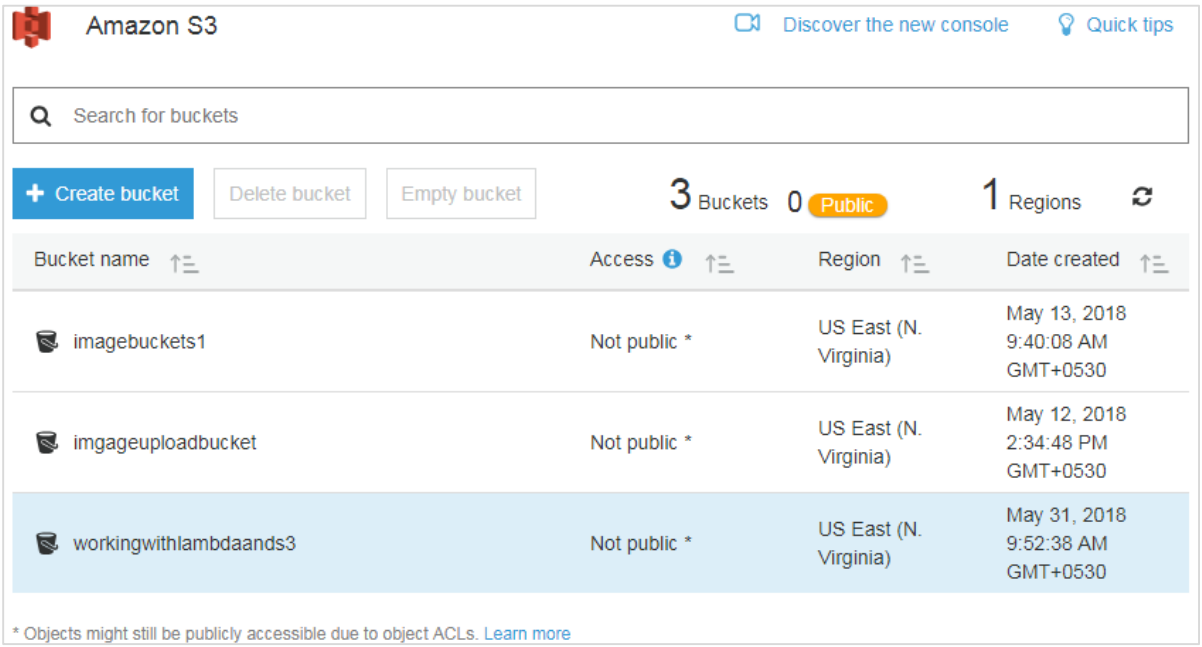
Step 3

Once you click **Create bucket** button, you can see a screen as follows:



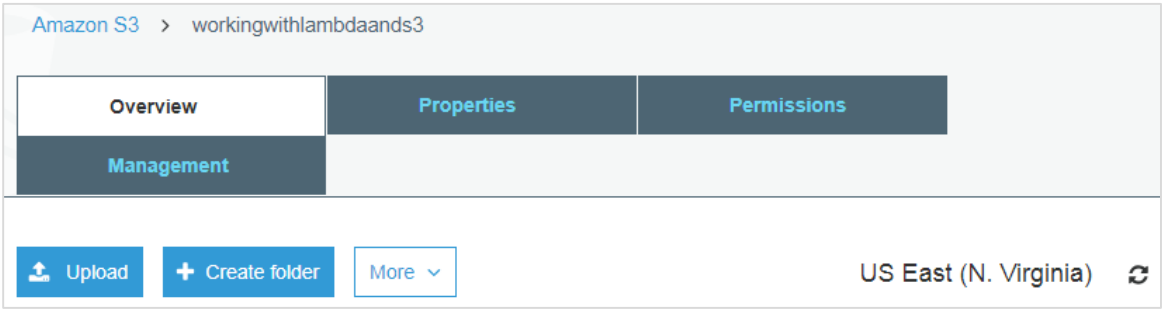
Step 4

Enter the details **Bucket name, Select the Region** and click **Create** button at the bottom left side. Thus, we have created bucket with name : **workingwithlambdaands3**.



Step 5

Now, click the bucket name and it will ask you to upload files as shown below:



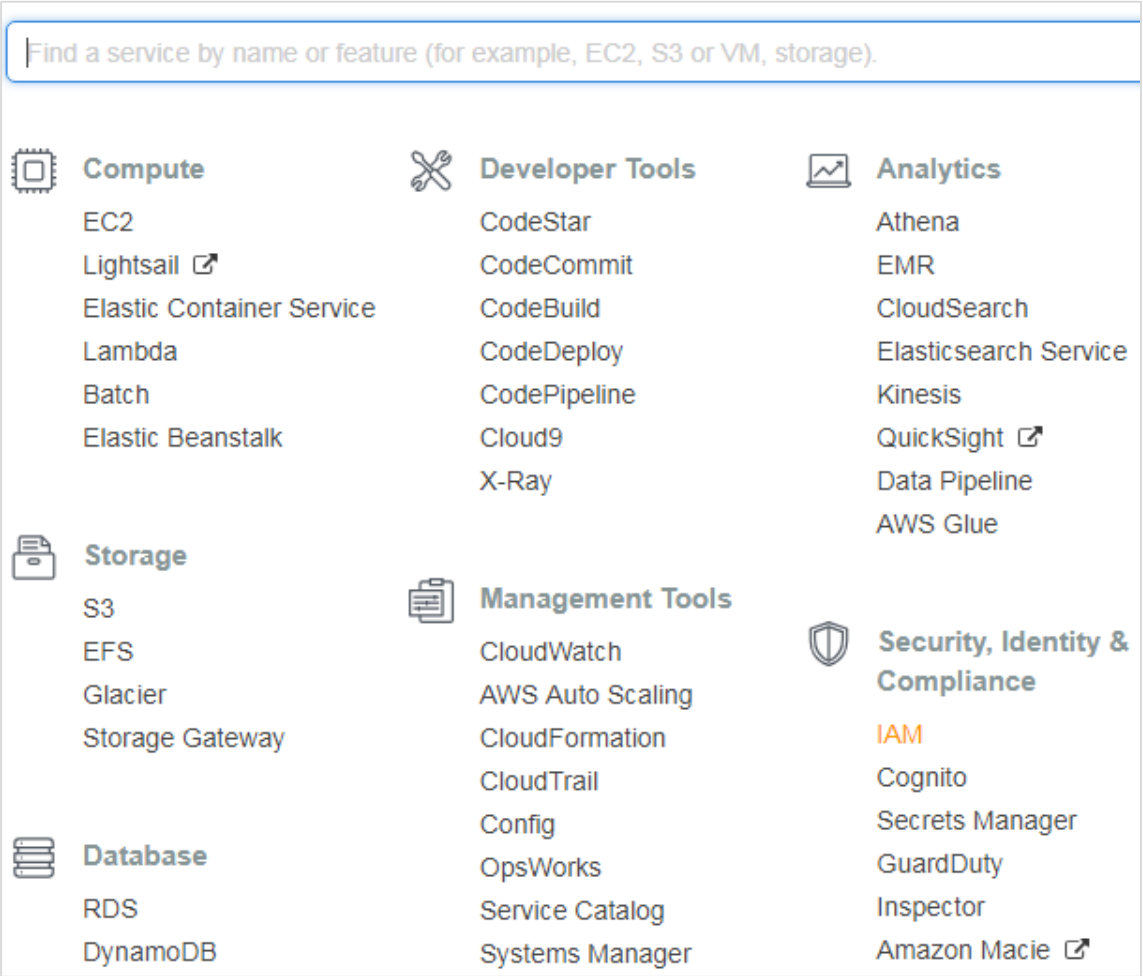
Thus, we are done with bucket creation in S3.

Create Role that Works with S3 and Lambda

To create role that works with S3 and Lambda, please follow the steps given below:

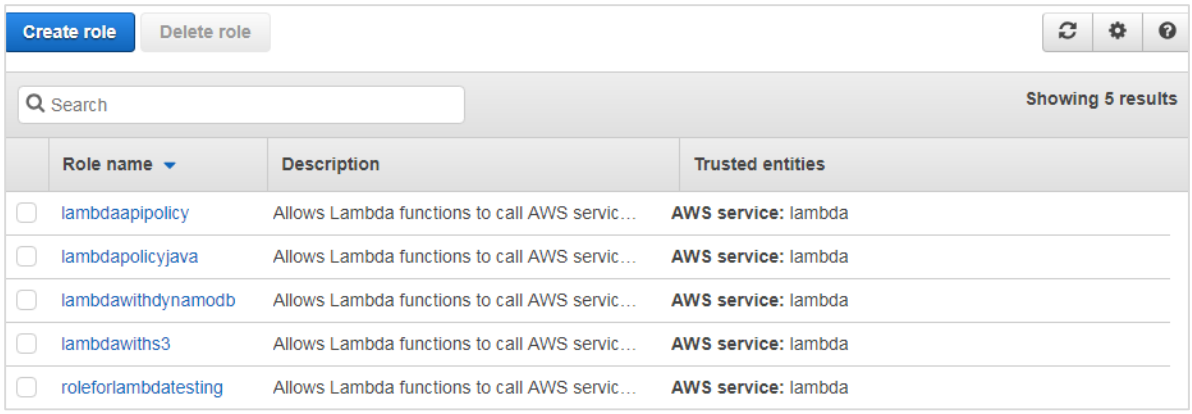
Step 1

Go to AWS services and select IAM as shown below:



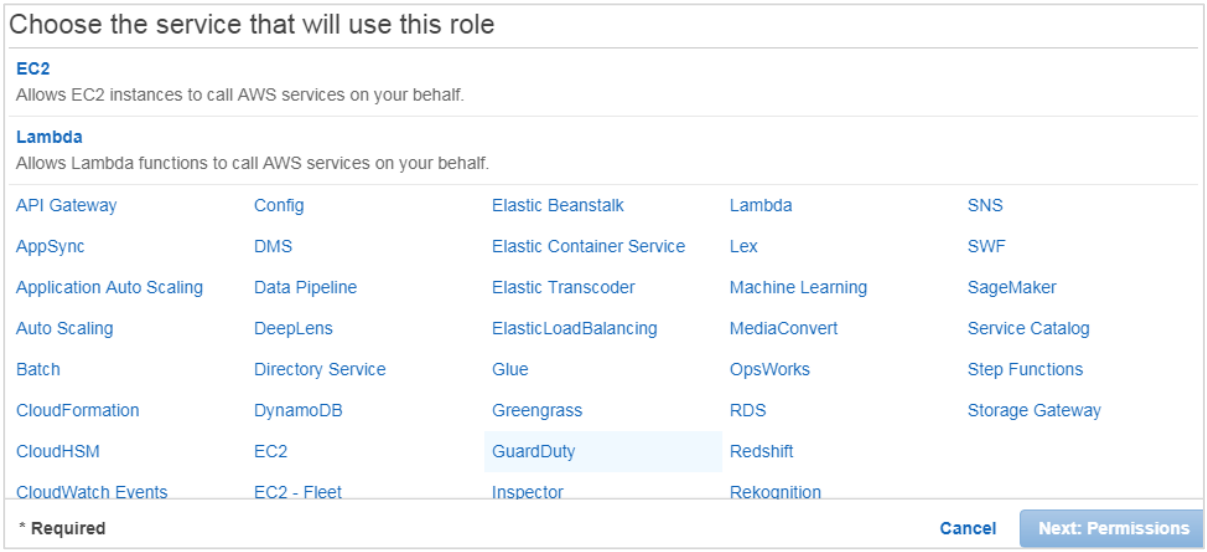
Step 2

Now, click **IAM -> Roles** as shown below:



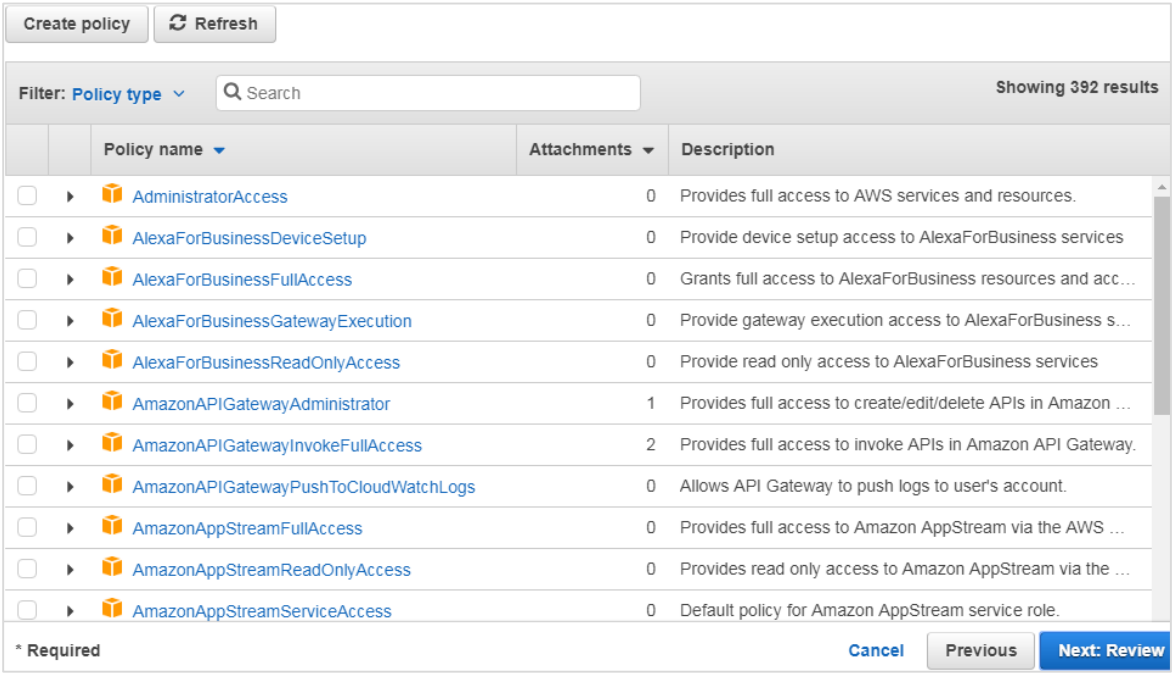
Step 3

Now, click **Create role** and choose the services that will use this role. Select Lambda and click **Permission** button.



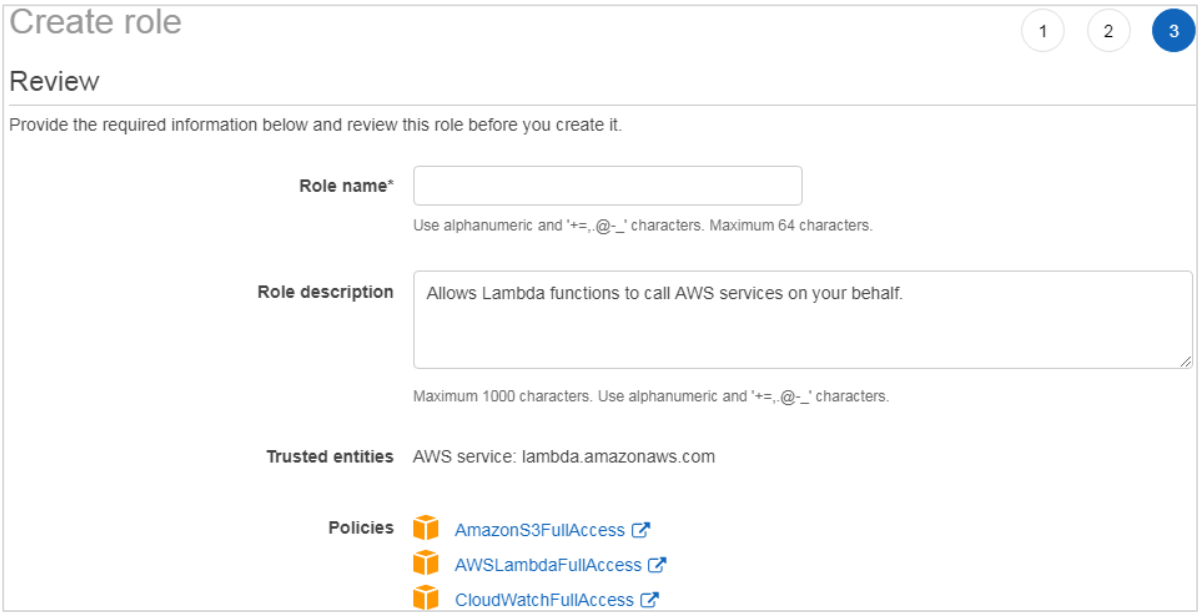
Step 4

Add the permission from below and click **Review**.



Step 5

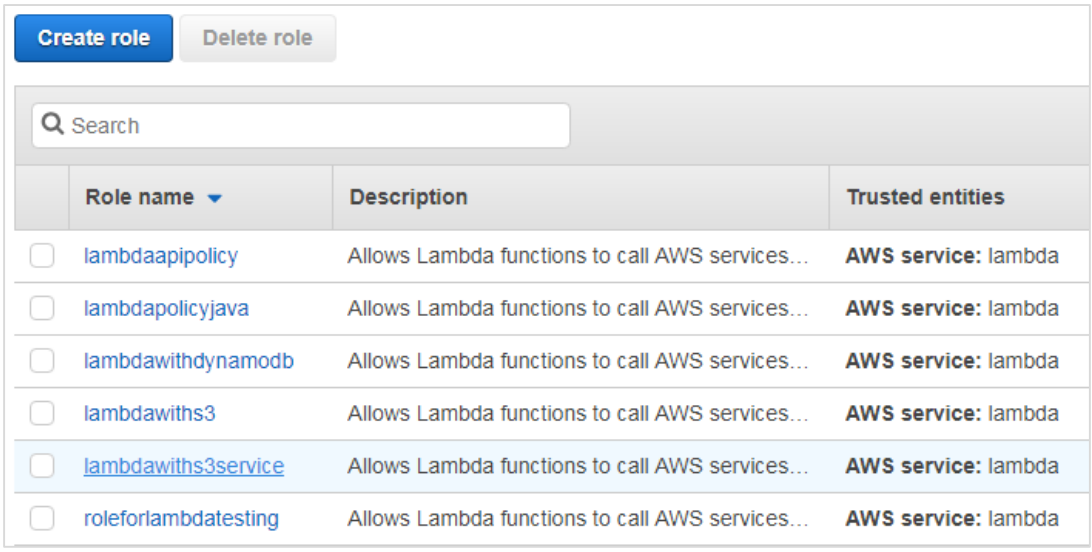
Observe that we have chosen the following permissions:



Observe that the Policies that we have selected are **AmazonS3FullAccess, AWSLambdaFullAccess** and **CloudWatchFullAccess.**

Step 6

Now, enter the Role name, Role description and click ***Create Role*** button at the bottom.



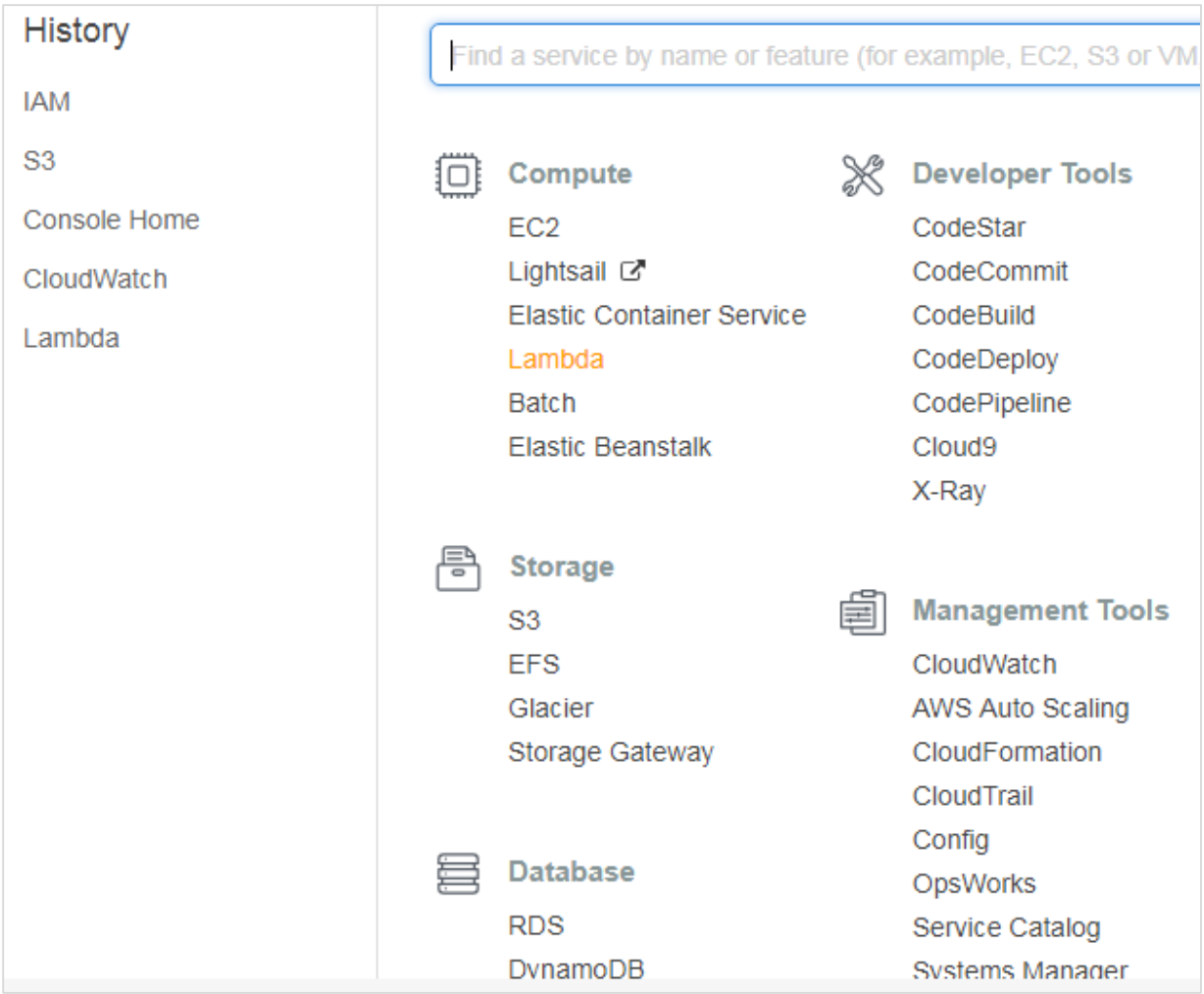
Thus, our role named **lambdawiths3service** is created.

Create Lambda function and Add S3 Trigger

In this section, let us see how to create a Lambda function and add a S3 trigger to it. For this purpose, you will have to follow th steps given below:

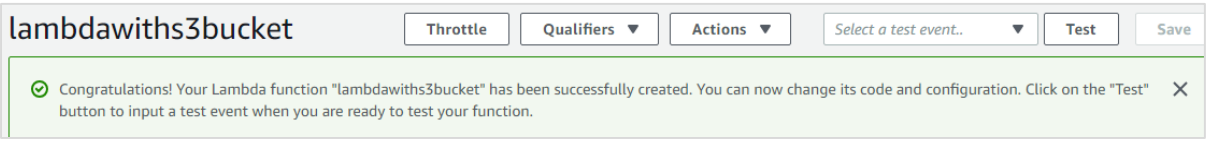
Step 1

Go to AWS Services and select Lambda as shown below:



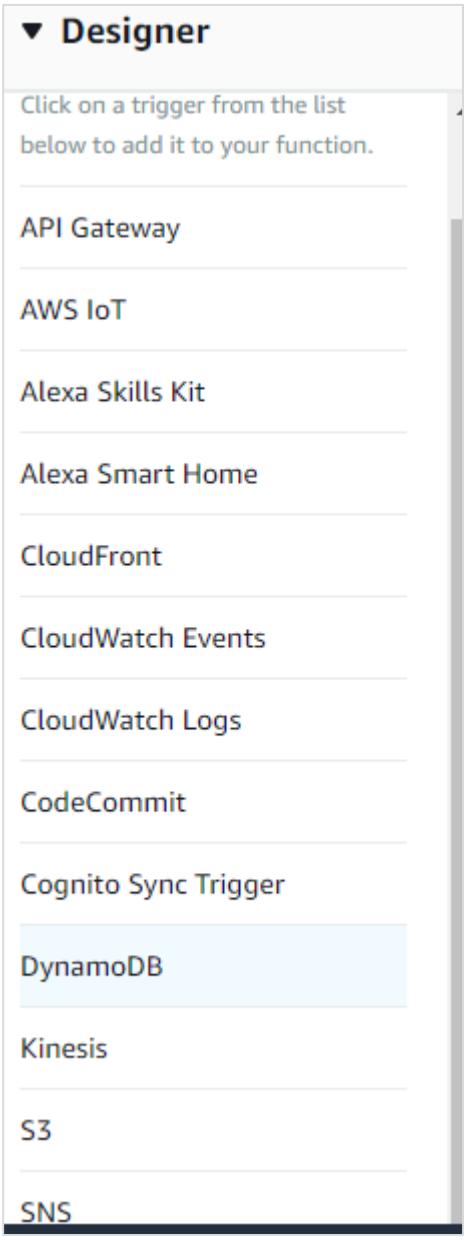
Step 2

Click **Lambda** and follow the process for adding **Name**. Choose the **Runtime**, **Role** etc. and create the function. The Lambda function that we have created is shown in the screenshot below:



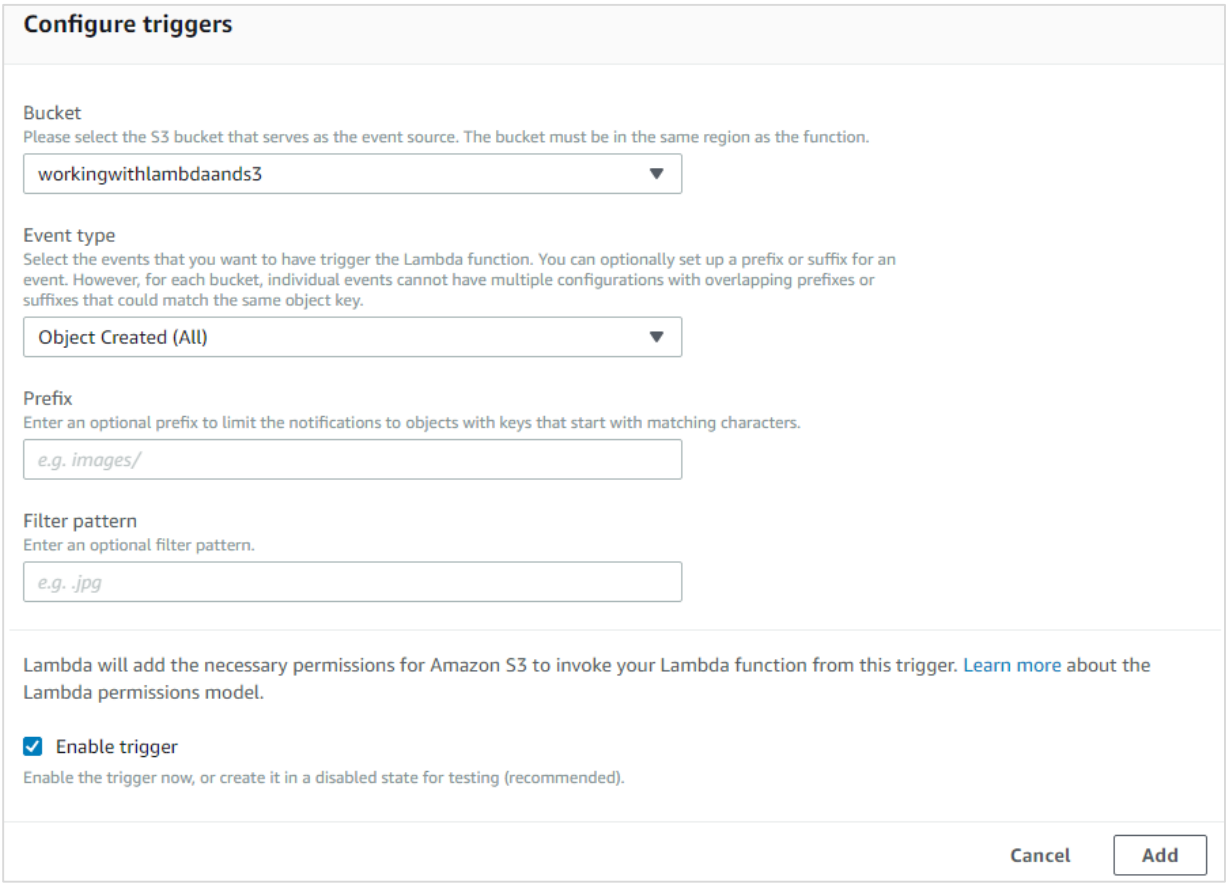
Step 3

Now let us add the S3 trigger.



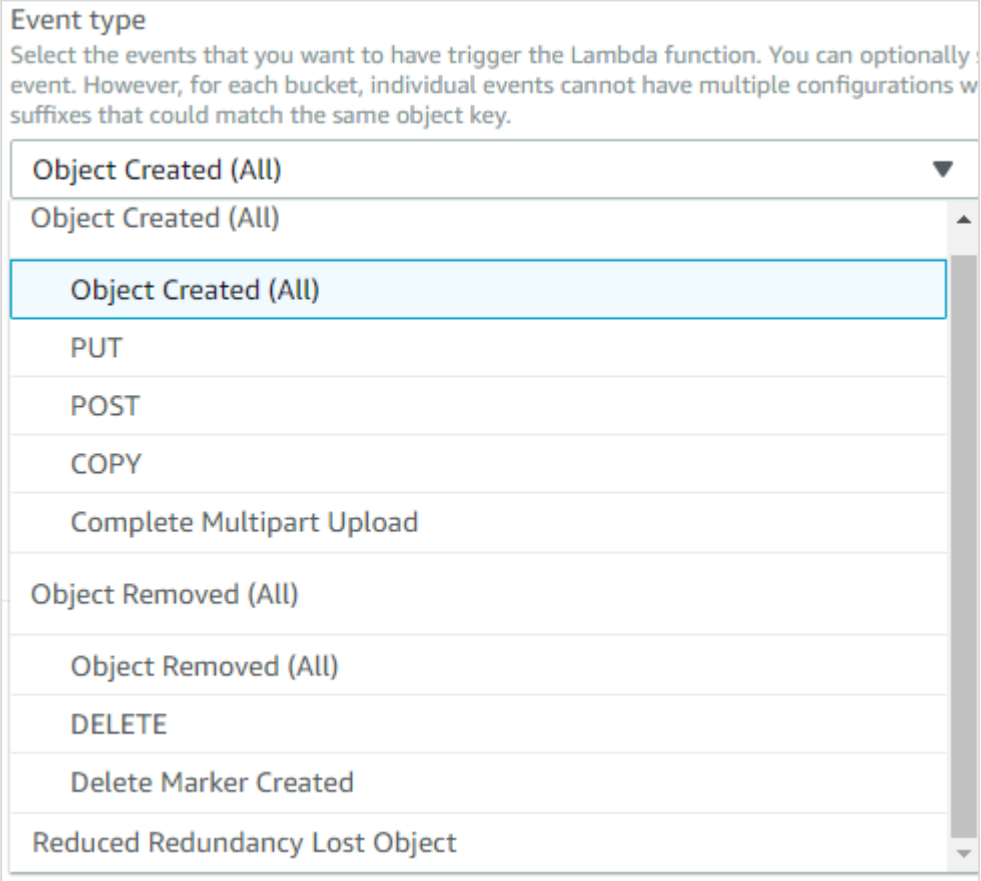
Step 4

Choose the trigger from above and add the details as shown below:



Step 5

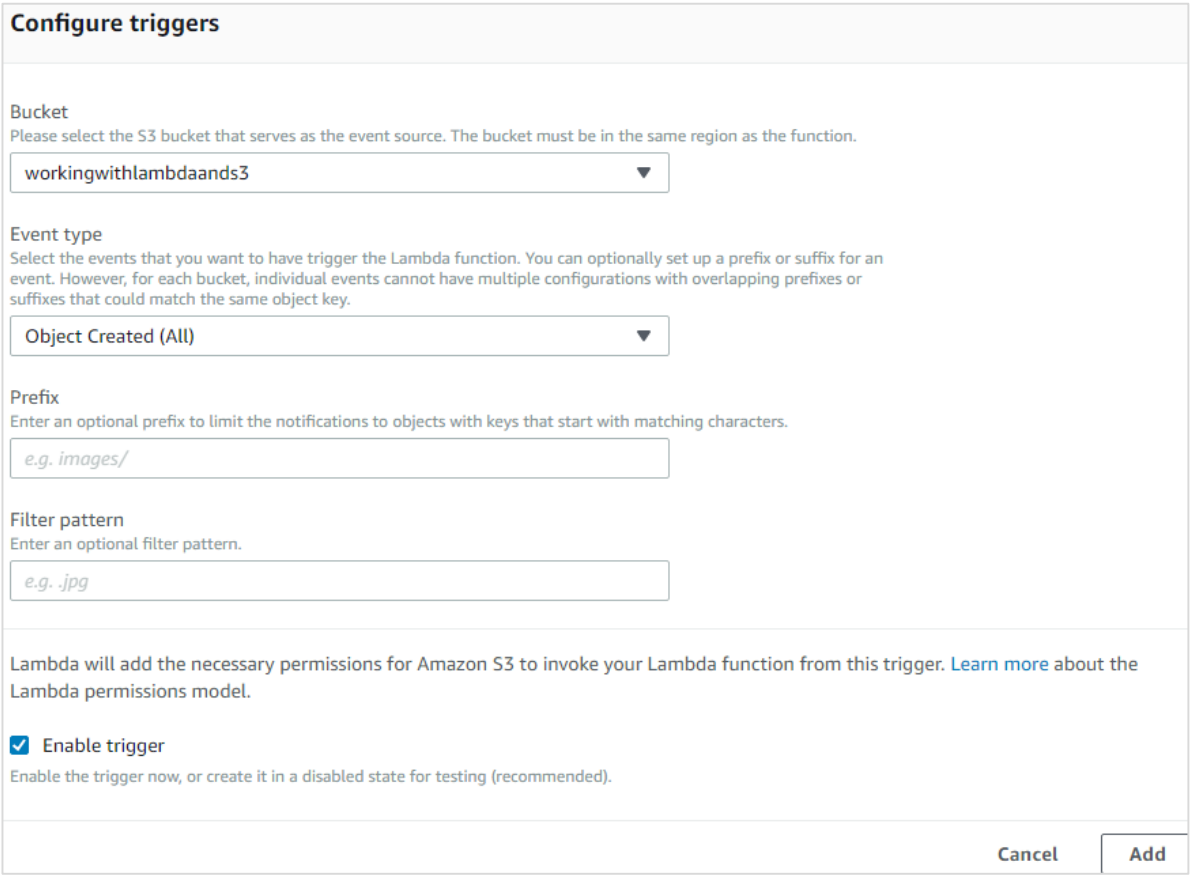
Select the bucket created from bucket dropdown. The event type has following details:



Select **Object Created (All),** as we need AWS Lambda trigger when file is uploaded, removed etc.

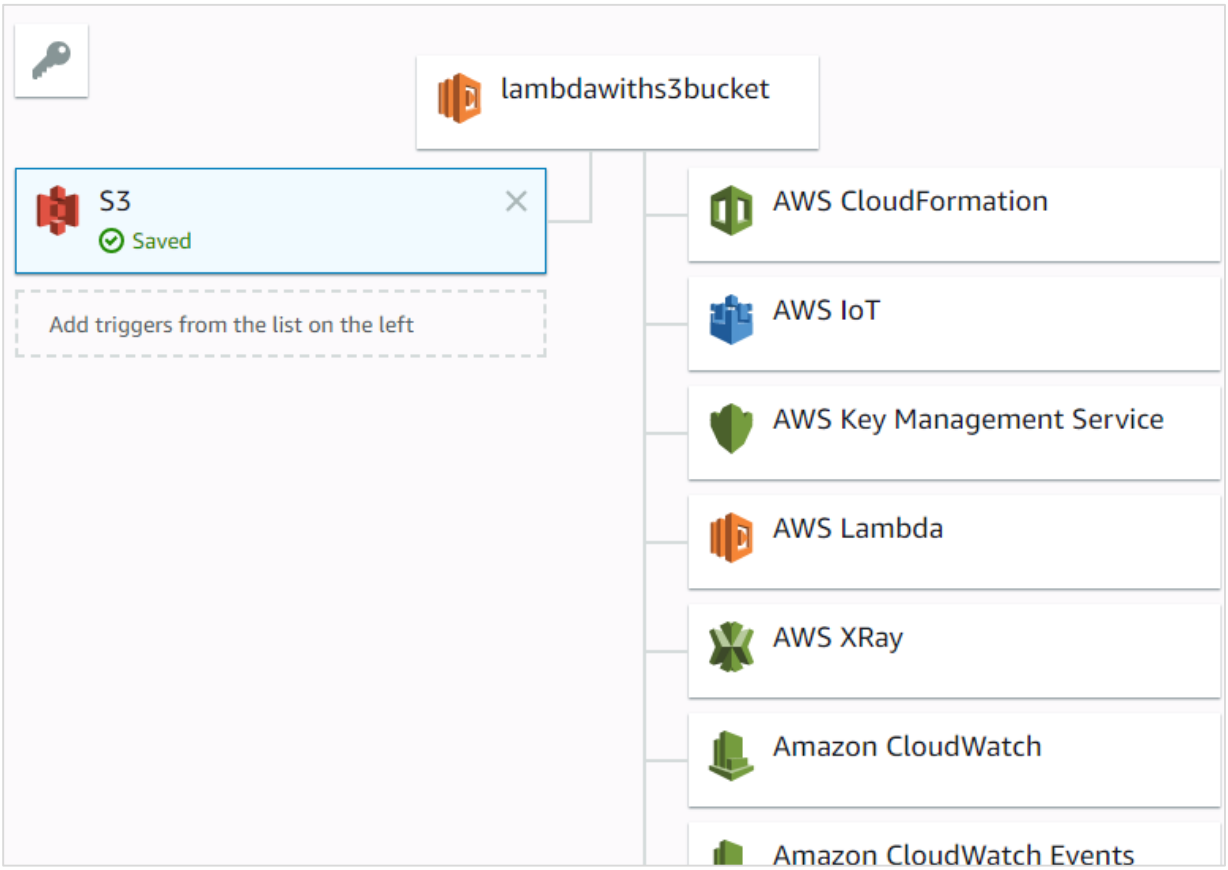
Step 7

You can add Prefix and File pattern which are used to filter the files added. For example, to trigger lambda only for .jpg images. Let us keep it blank for now as we need to trigger Lambda for all files uploaded. Click **Add** button to add the trigger.



Step 8

You can find the the trigger display for the Lambda function as shown below:



Let's add the details for the aws lambda function. Here, we will use the online editor to add our code and use *nodejs* as the runtime environment.

Step 9

To trigger S3 with AWS Lambda, we will have to use S3 event in the code as shown below:

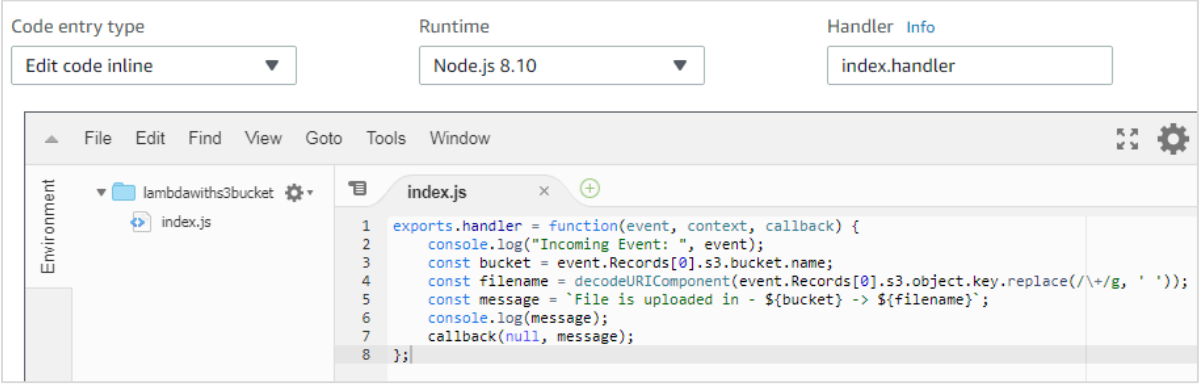
```
exports.handler = function(event, context, callback) {
    console.log("Incoming Event: ", event);
    const bucket = event.Records[0].s3.bucket.name;
    const filename =
decodeURIComponent(event.Records[0].s3.object.key.replace(/\+/g, ' '));
    const message = `File is uploaded in - ${bucket} -> ${filename}`;
    console.log(message);
    callback(null, message);
```

```
};
```

Note that the event param has the details of the S3 event. We have consoled the bucket name and the file name which will get logged when you upload image in S3 bucket.

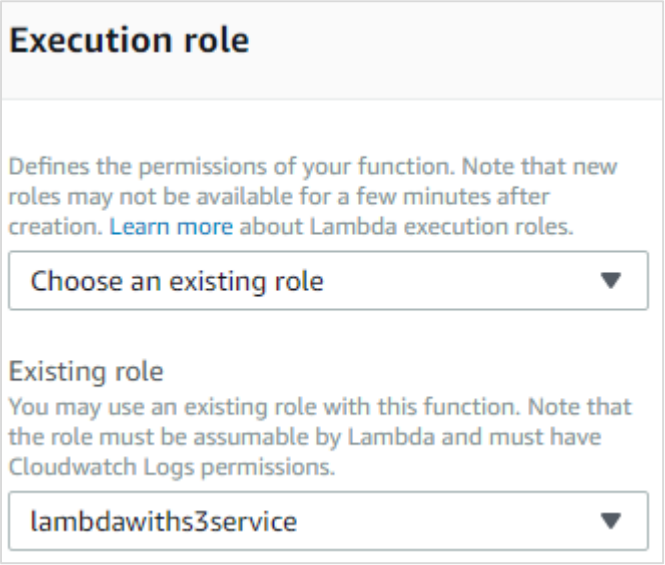
Step 10

Now, let us save the changes and test the lambda function with S3 upload. The following are the code details added in AWS Lambda:



Step 11

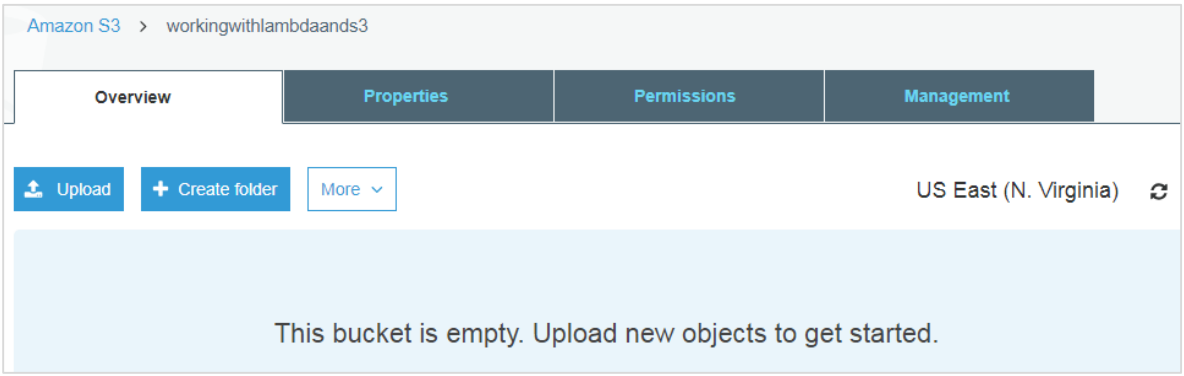
Now, let us add the role, memory and timeout.



Step 12

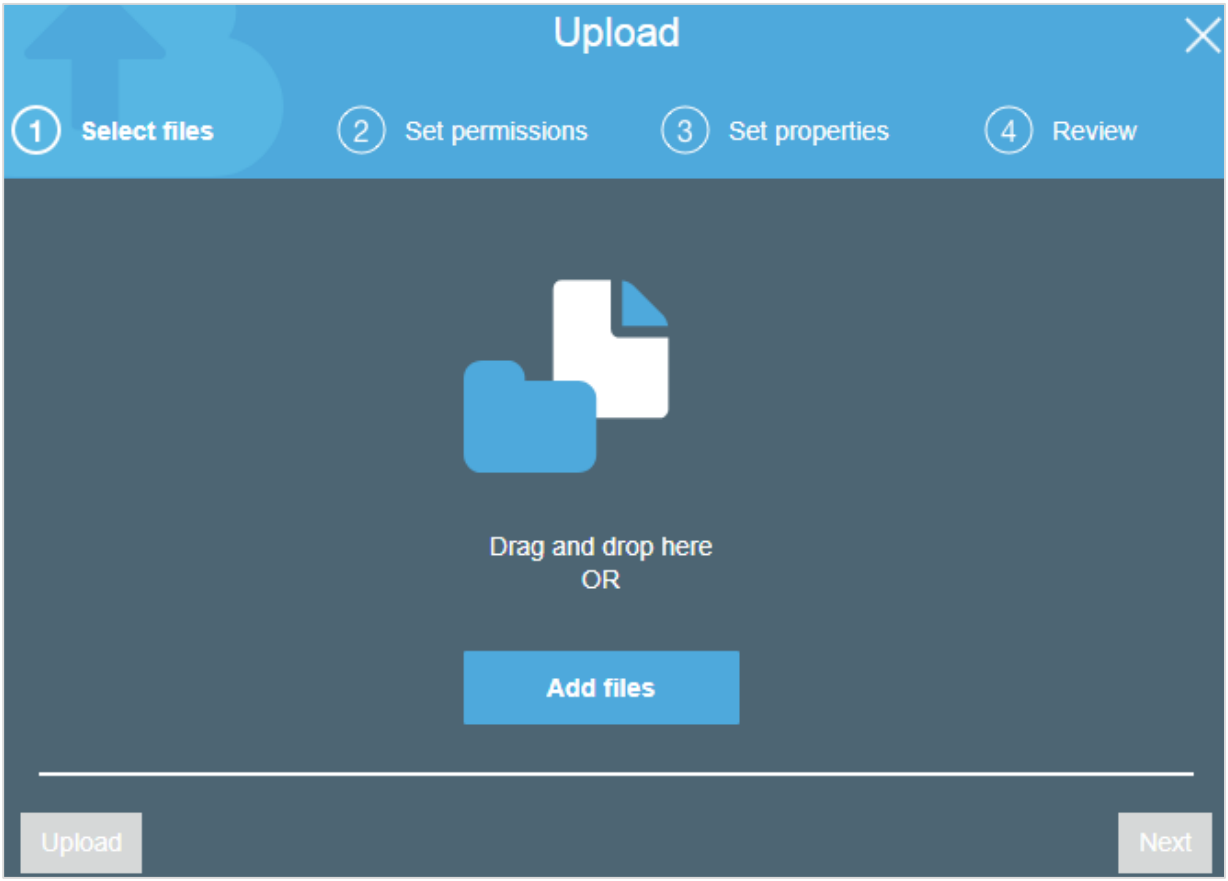
Now, save the Lambda function. Open S3 from Amazon services and open the bucket we created earlier namely **workingwithlambdaands3.**

Upload the image in it as shown below:



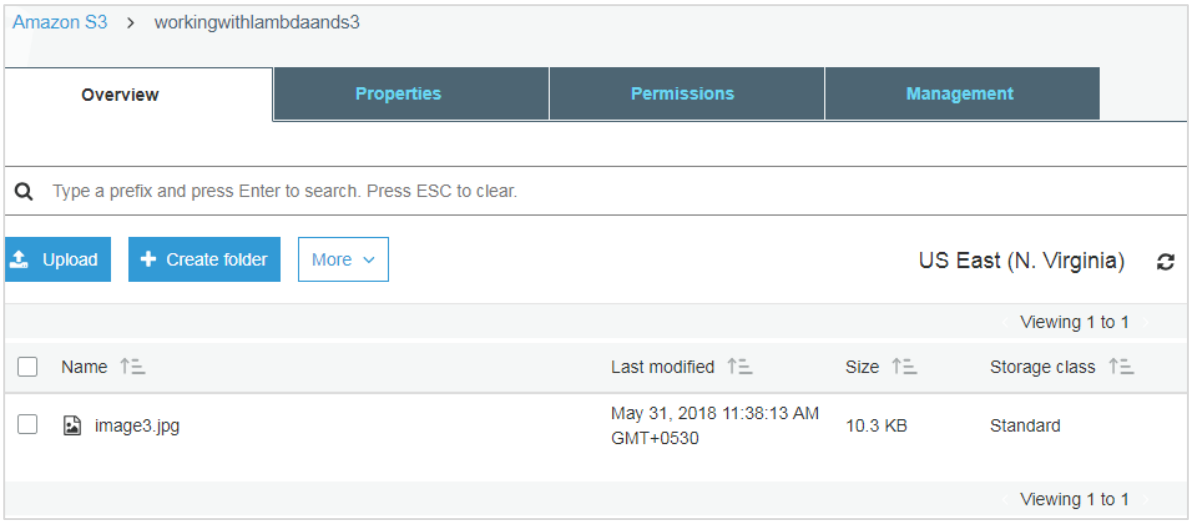
Step 13

Click **Upload** button to add files as shown:



Step 14

Click **Add files** to add files. You can also drag and drop the files. Now, click **Upload** button.



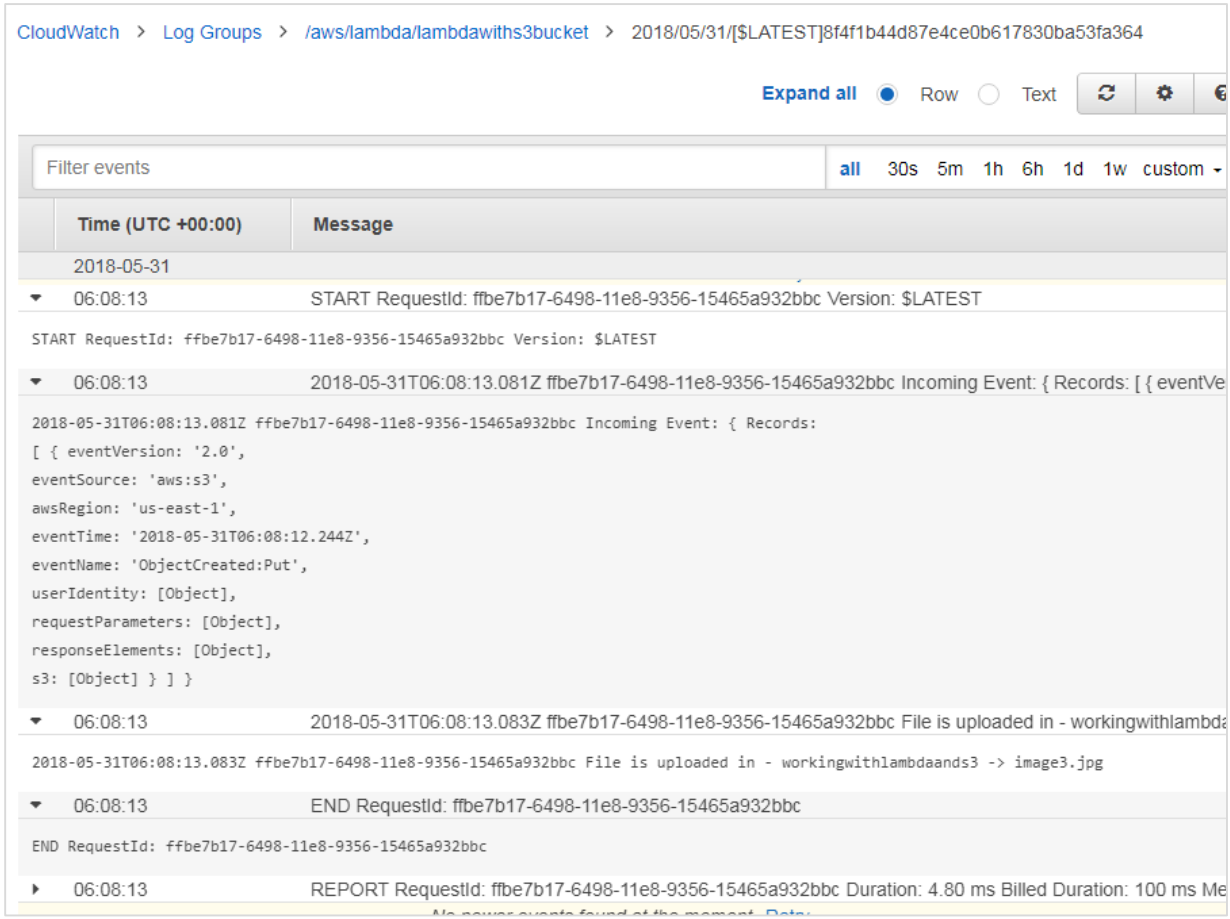
Thus, we have uploaded one image in our S3 bucket.

Step 15

To see the trigger details, go to AWS service and select **CloudWatch**. Open the logs for the Lambda function and use the following code:

```
exports.handler = function(event, context, callback) {
    console.log("Incoming Event: ", event);
    const bucket = event.Records[0].s3.bucket.name;
    const filename =
decodeURIComponent(event.Records[0].s3.object.key.replace(/\+/g, ' '));
    const message = `File is uploaded in - ${bucket} -> ${filename}`;
    console.log(message);
    callback(null, message);
};
```

The output you can observe in Cloutwatch is as shown:



AWS Lambda function gets triggered when file is uploaded in S3 bucket and the details are logged in Cloudwatch as shown below:

```
2018-05-31T06:08:13.081Z ffbe7b17-6498-11e8-9356-15465a932bbc Incoming Event: { Records:
[ { eventVersion: '2.0',
eventSource: 'aws:s3',
awsRegion: 'us-east-1',
eventTime: '2018-05-31T06:08:12.244Z',
eventName: 'ObjectCreated:Put',
userIdentity: [Object],
requestParameters: [Object],
responseElements: [Object],
s3: [Object] } ] }
2018-05-31T06:08:13.083Z   ffbe7b17-6498-11e8-9356-15465a932bbc    File is uploaded in
- workingwithlambdaands3 -> image3.jpg
```

18. AWS Lambda — Using Lambda Function with Amazon DynamoDB

DynamoDB can trigger AWS Lambda when the data in added to the tables, updated or deleted. In this chapter, we will work on a simple example that will add items to the DynamoDB table and AWS Lambda which will read the data and send mail with the data added.

Requisites

To use Amazon DB and AWS Lambda, we need to follow the steps as shown below:

- Create a table in DynamoDB with primary key
- Create a role which will have permission to work with DynamoDB and AWS Lambda.
- Create function in AWS Lambda
- AWS Lambda Trigger to send mail
- Add data in DynamoDB

Let us discuss each of this step in detail.

Example

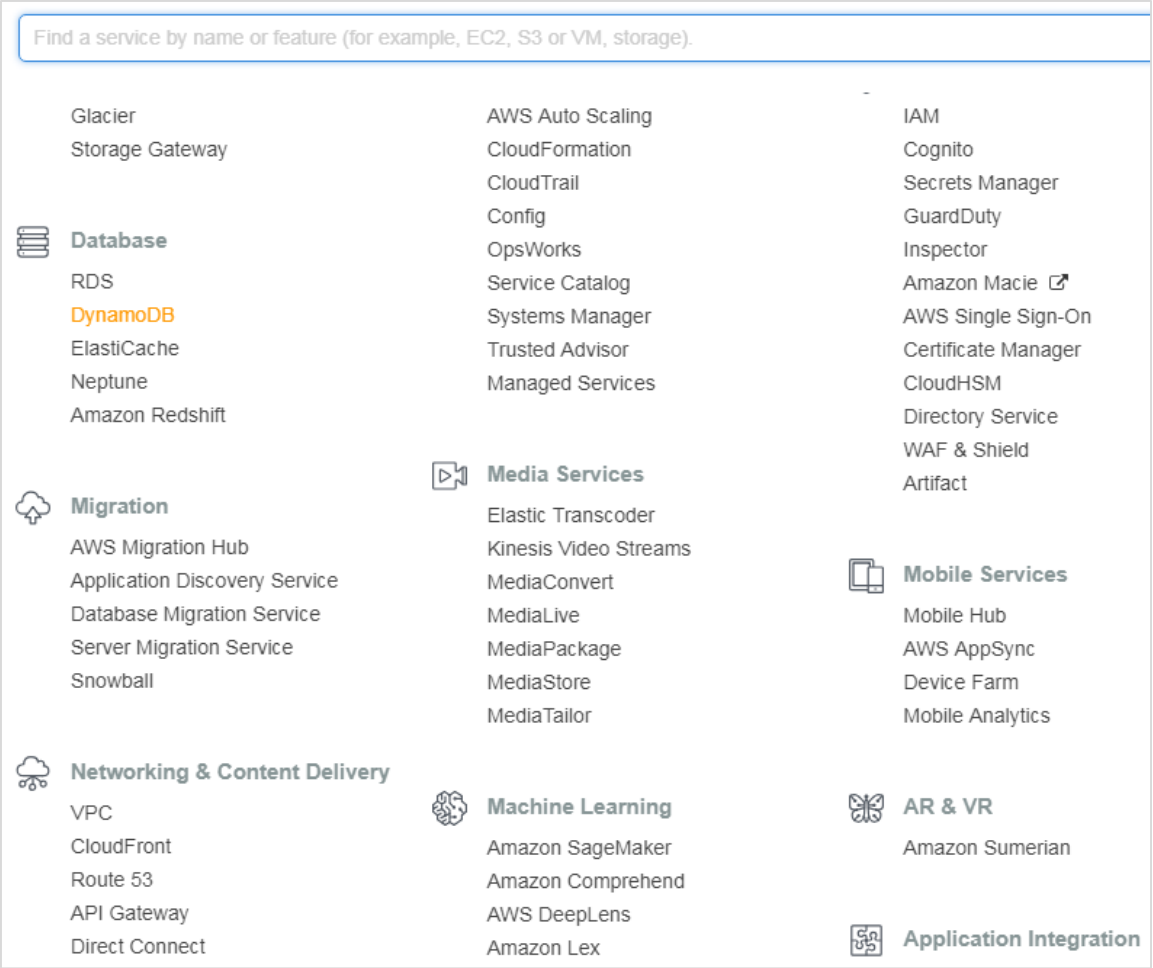
We are going to work out on following example which shows the basic interaction between DynamoDB and AWS Lambda. This example will help you to understand the following operations:

- Creating a table called customer in Dynamodb table and how to enter data in that table.
- Triggering AWS Lambda function once the data is entered and sending mail using Amazon SES service.

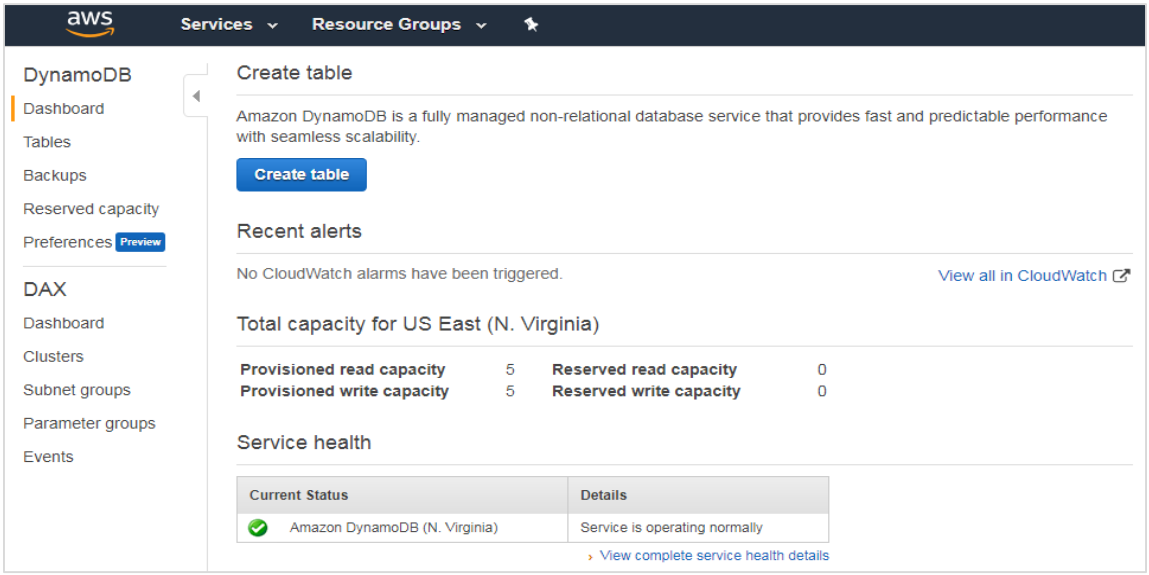
The basic block diagram that explains the flow of the example is as shown below:

Create Table in DynamoDB with Primary Key

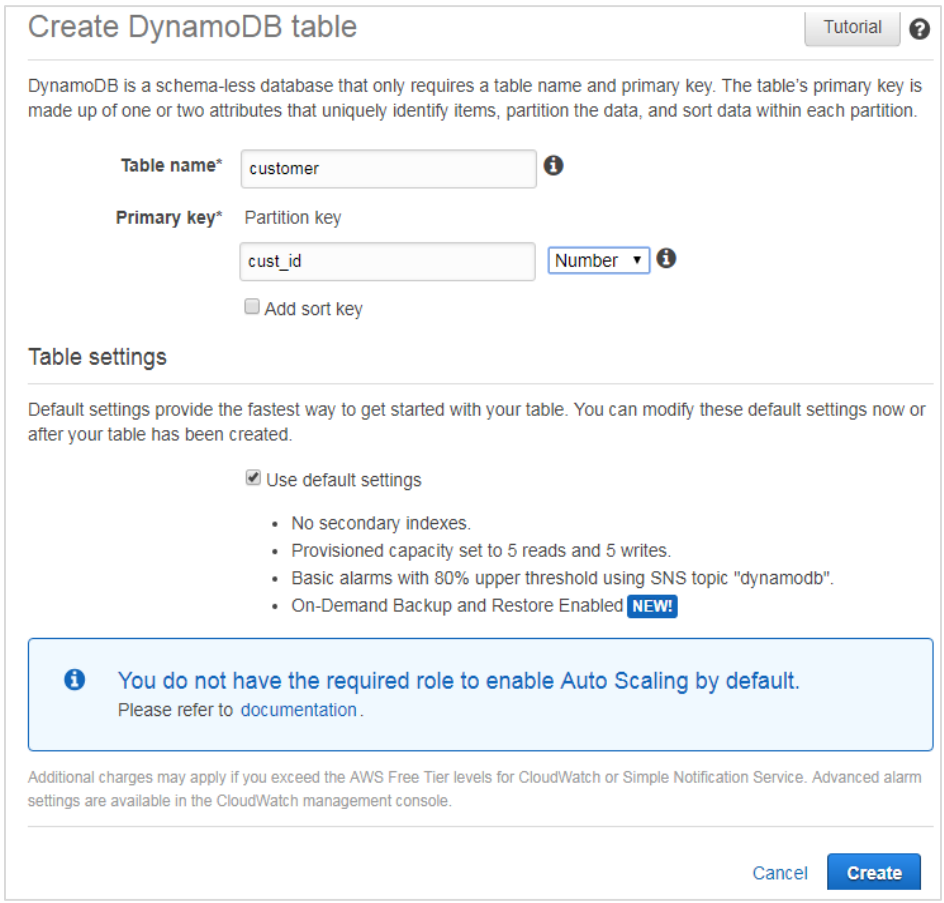
Log in to AWS console. Go to AWS Services and select DynamoDB as shown below. Select DynamoDB.



DynamoDB shows the options as shown below:



Now, click **Create table** to create the table as shown. We have named the table as **customer** with primary key for that table as **cust_id**. Click on ***Create*** button to add the table to dynamodb.



The table created is as shown below:

Table details

Table name	customer
Primary partition key	cust_id (Number)
Primary sort key	-
Point-in-time recovery	DISABLED **Enable**
Encryption	DISABLED
Time to live attribute	DISABLED **Manage TTL**
Table status	Active
Creation date	May 31, 2018 at 1:48:07 PM UTC+5:30
Provisioned read capacity units	5 (Auto Scaling Disabled)
Provisioned write capacity units	5 (Auto Scaling Disabled)
Last decrease time	-
Last increase time	-
Storage size (in bytes)	0 bytes
Item count	0
Region	US East (N. Virginia)
Amazon Resource Name (ARN)	arn:aws:dynamodb:us-east-1:625297745038:table/customer

We can add items to the table created as follows:

customer Close

Overview | Items | Metrics | Alarms | Capacity | Indexes | Global Tables | More

Recent alerts

No CloudWatch alarms have been triggered for this table.

Stream details

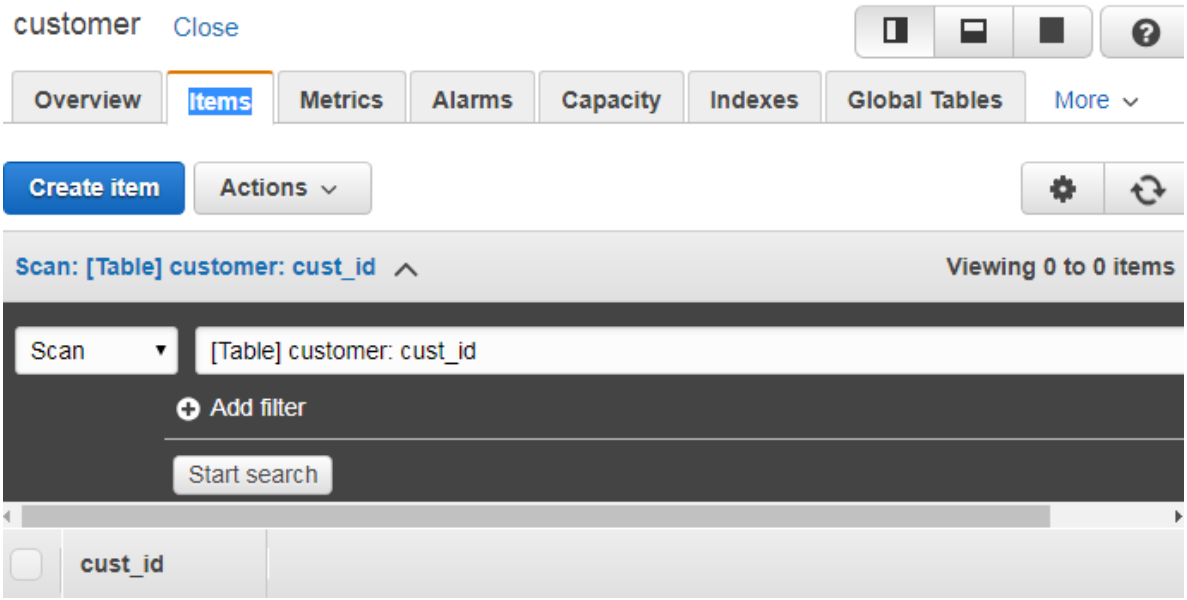
Stream enabled	No
View type	-
Latest stream ARN	-

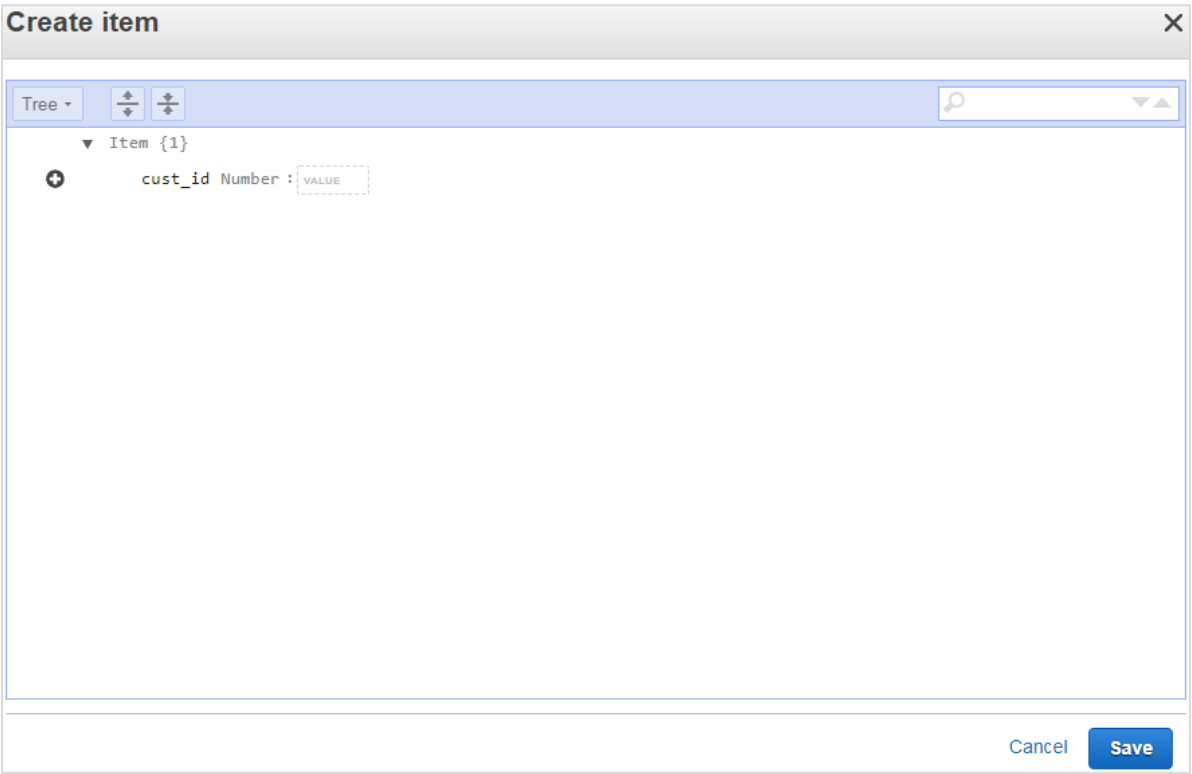
Manage Stream

Table details

Table name	customer
Primary partition key	cust_id (Number)
Primary sort key	-
Point-in-time recovery	DISABLED **Enable**
Encryption	DISABLED
Time to live attribute	DISABLED **Manage TTL**
Table status	Active
Creation date	May 31, 2018 at 1:48:07 PM UTC+5:30
Provisioned read capacity units	5 (Auto Scaling Disabled)
Provisioned write capacity units	5 (Auto Scaling Disabled)
Last decrease time	-
Last increase time	-

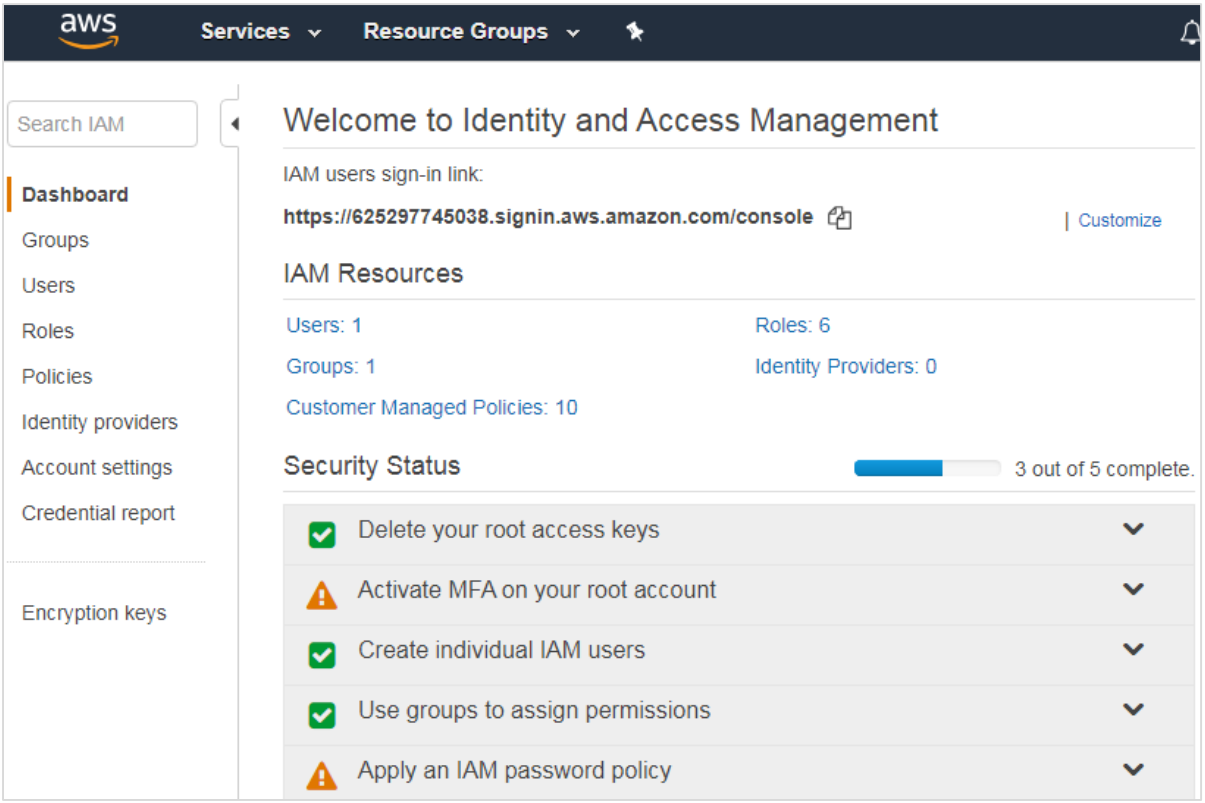
Click **Items** and click **Create item** button as shown:



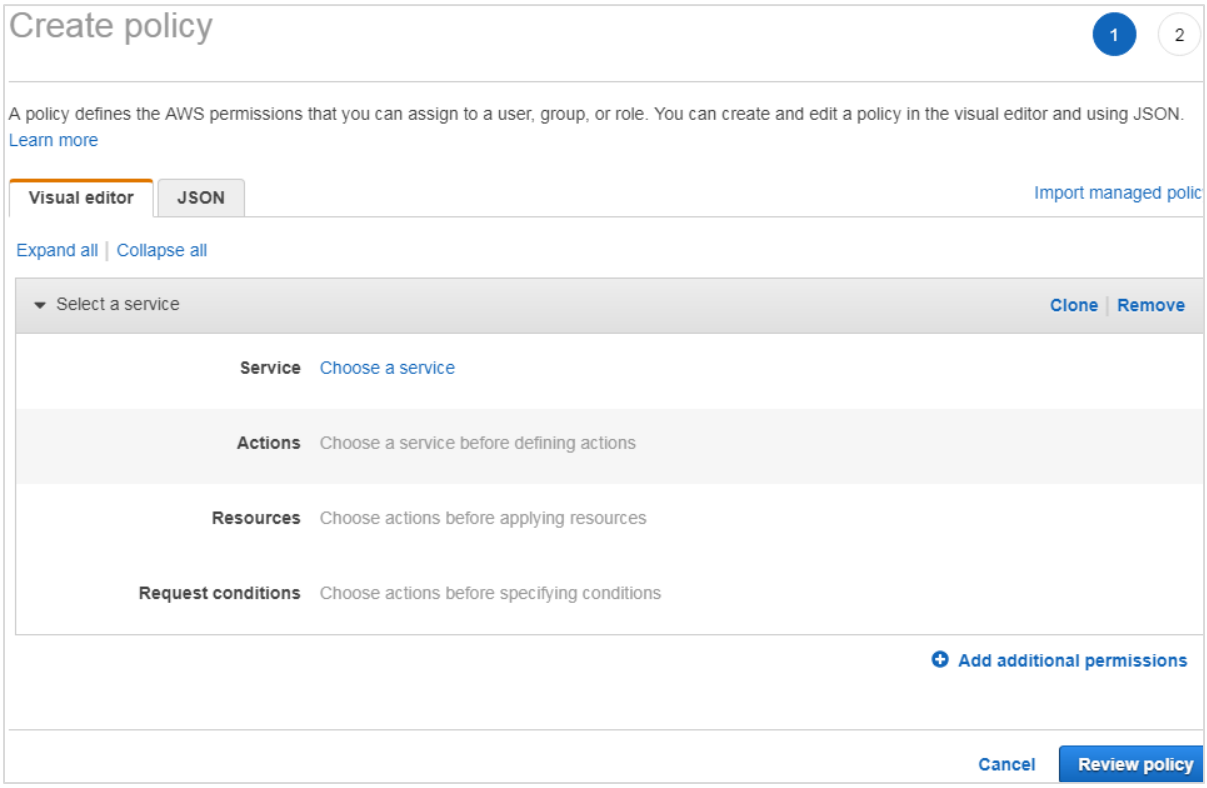


Creating Role with Permissions to Work with DynamoDB and AWS Lambda

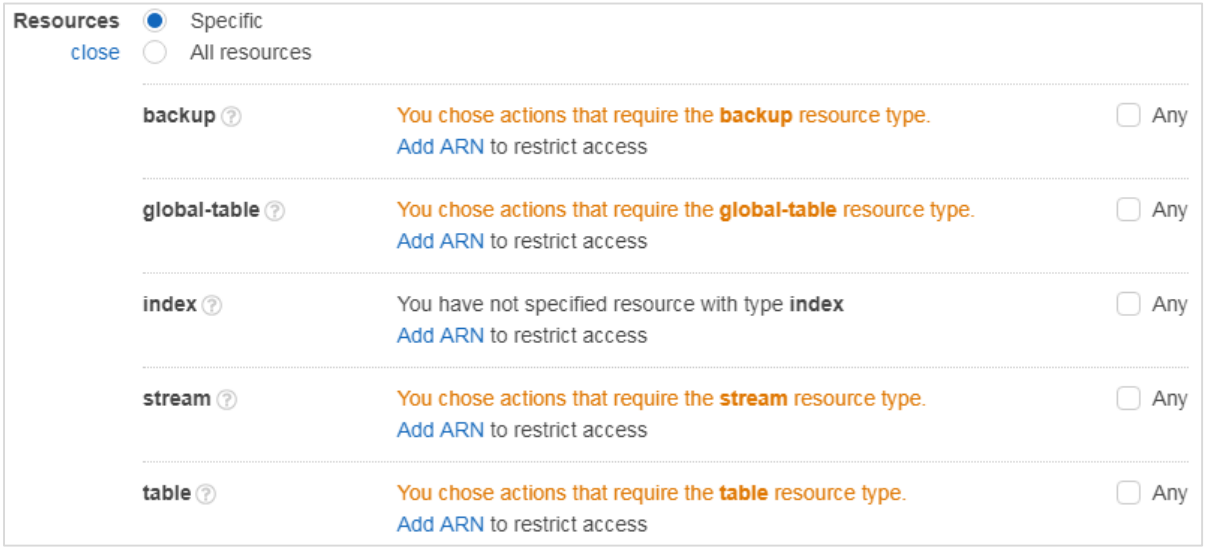
To create role, Go to AWS services and click IAM.



Let us create a policy to be used only for the DynamoDB table created earlier:



Now, choose a **Service**. Observe that the service we have selected is **DynamoDB.** For **Actions** we have taken all **Dynamodb** actions ie access to list, read and write. For **Resources,** we will select the table resource type actions. When you click it, you can see a screen as follows:

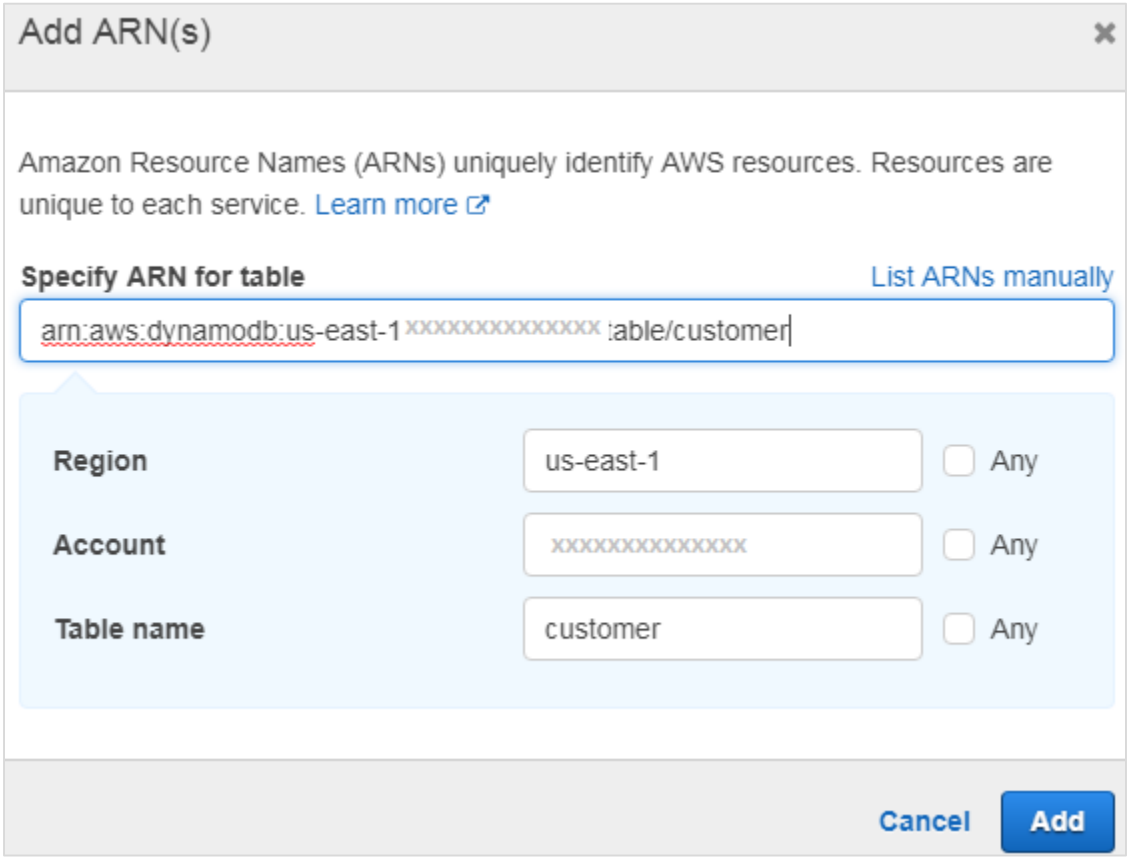


Now, select **table** and **Add ARN** to it as shown. We will get **ARN** details from **customer table** created as shown below:

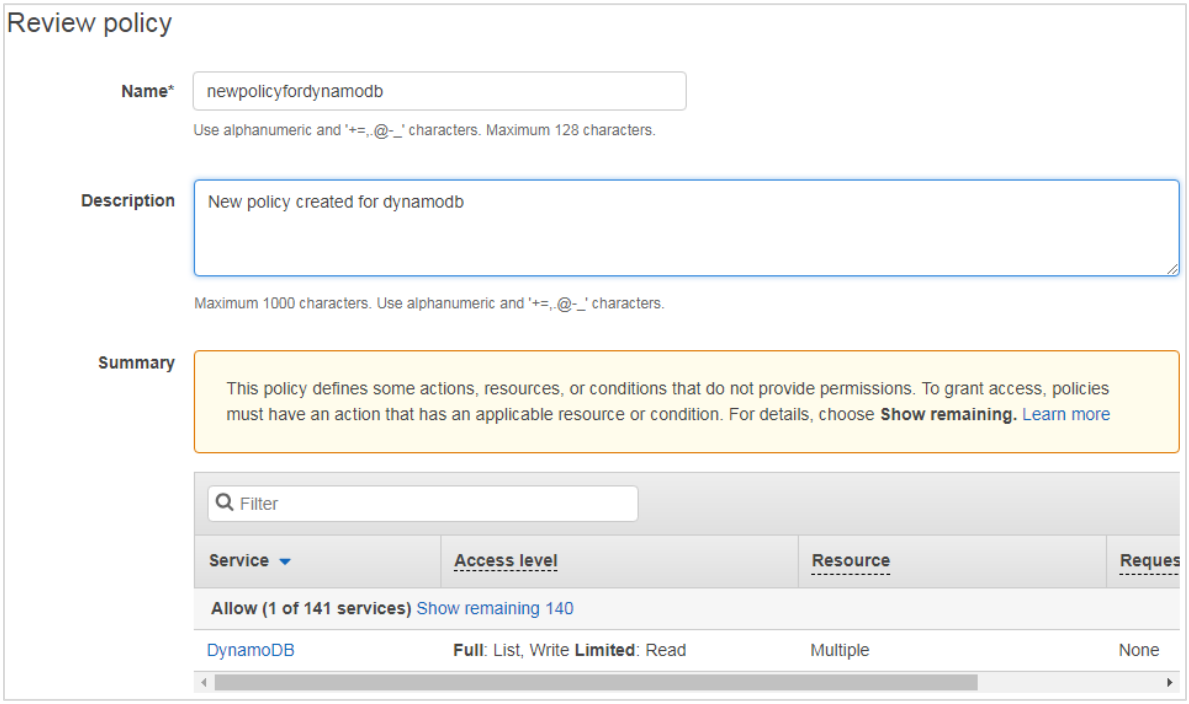
Table details

Table name	customer
Primary partition key	cust_id (String)
Primary sort key	-
Point-in-time recovery	DISABLED **Enable**
Encryption	DISABLED
Time to live attribute	DISABLED **Manage TTL**
Table status	Active
Creation date	May 31, 2018 at 2:11:43 PM UTC+5:30
Provisioned read capacity units	5 (Auto Scaling Disabled)
Provisioned write capacity units	5 (Auto Scaling Disabled)
Last decrease time	-
Last increase time	-
Storage size (in bytes)	0 bytes
Item count	0
Region	US East (N. Virginia)
Amazon Resource Name (ARN)	arn:aws:dynamodb:us-east-1:625297745038:table/customer

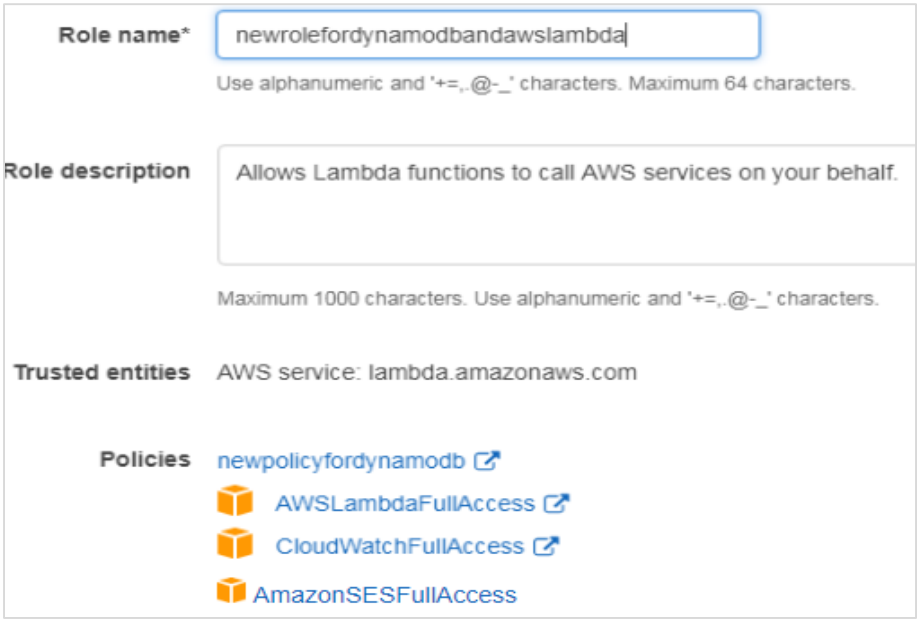
Enter **arn** details here:



Click **Add** button to save the changes.Once done **Click on Review policy.** Enter the name of the policy, description etc as shown below:



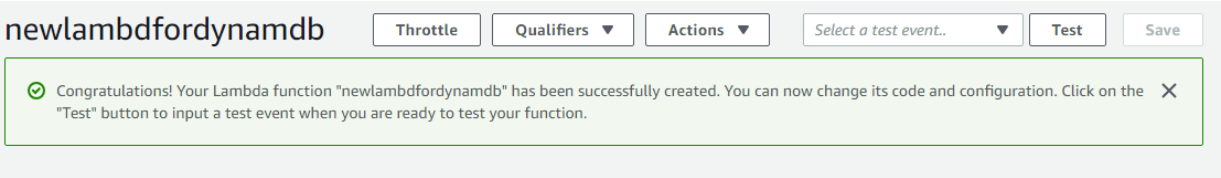
Click on **create policy** to save it. Add the policy to the role to be created. Select **Role** from left side and enter the details.



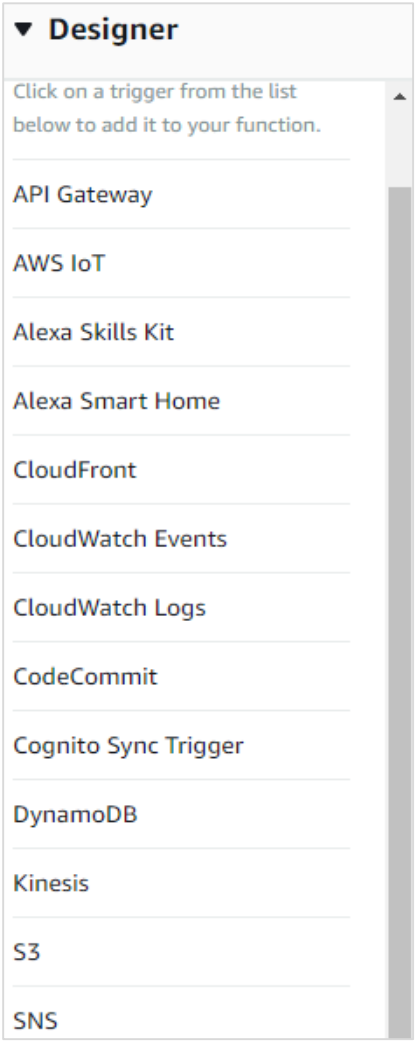
Observe that the policies added are **newpolicyfordynamdb, awslambdafullaccess ,cloudwatchfullaccess** and **amazonsesfullaccess**. Add the role and will use it while creating AWS Lambda function.

Create Function in AWS Lambda

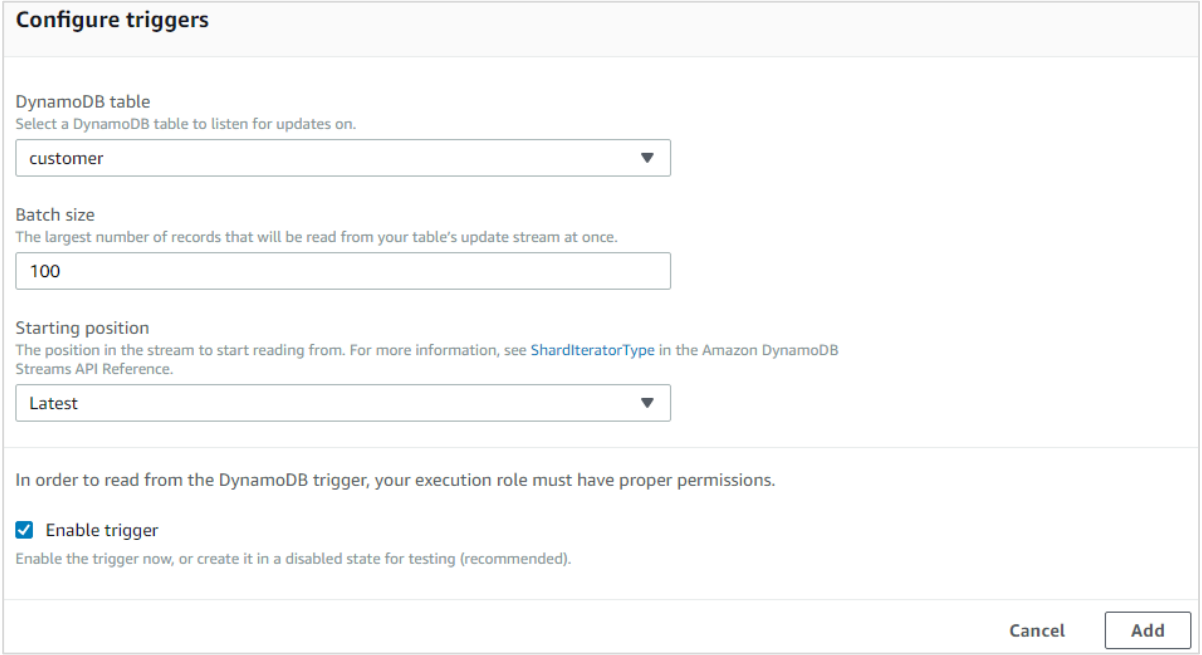
Thus, we have created Lambda function called **newlambdafordynamodb** as shown.



Now, let us add DynamodDB trigger to the AWS Lambda created. The runtime we shall use is Node.js.



You can find the following details in Dynamodb trigger that are to be configured for AWS Lambda:



Now, simply click **Add** to add the trigger to AWS Lambda.

AWS Lambda Trigger to Send Mail

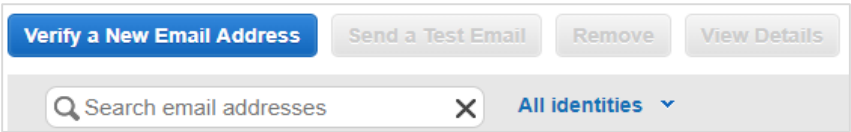
AWS Lambda will get triggered when data is inserted into AWS Lambda. The event parameter will have the dynamodb data inserted. This will read the data from the event and send email.

Sending an email

To send email, you need to follow the steps given below:

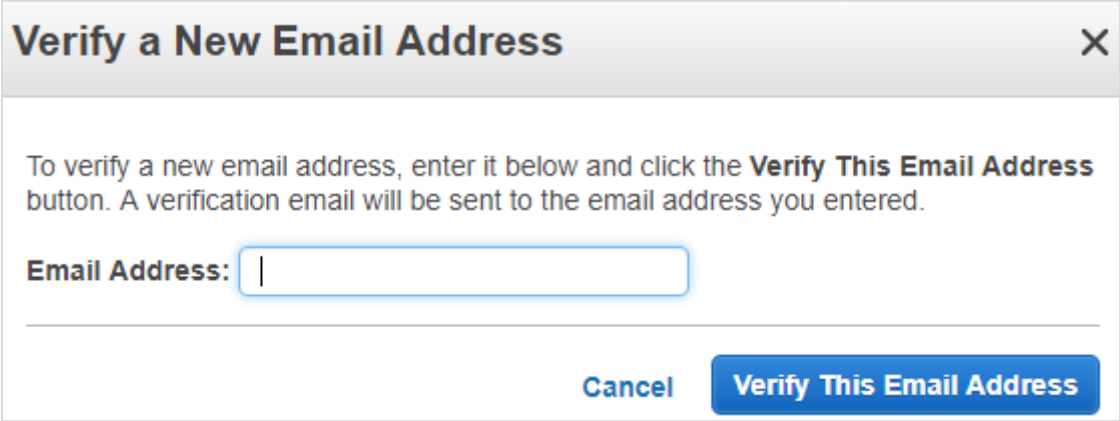
Step 1

Go to AWS service and select SES (simple email service). Validate the email to which we need to send an email as shown:



Step 2

Click the button **Verify a New Email Addres** to add the email address.



Step 3

Enter an email address to verify it. The email address will receive and activation mail from Amazon which needs to be clicked. Once the activation is done, the email id is verified and can be used with AWS services.

Step 4

The AWS Lambda code which reads data from the event and sends email is given below:

```
var aws = require('aws-sdk');
var ses = new aws.SES({
    region: 'us-east-1'
});
exports.handler = function(event, context, callback) {
     console.log(event);
     let tabledetails = JSON.parse(JSON.stringify(event.Records[0].dynamodb));
     console.log(tabledetails.NewImage.address.S);
     let customerid = tabledetails.NewImage.cust_id.S;
     let name = tabledetails.NewImage.name.S;
     let address = tabledetails.NewImage.address.S;

      var eParams = {
        Destination: {
            ToAddresses: ["xxxxx@gmail.com"]
        },
        Message: {
```

```
            Body: {
                Text: {
                    Data: "The data added is as follows:\n
CustomerId:"+customerid+"\n Name:"+name+"\nAddress:"+address
                }
            },
            Subject: {
                Data: "Data Inserted in Dynamodb table customer"
            }
        },
        Source: "xxxxx@gmail.com"
    };
    console.log('===SENDING EMAIL===');
    var email = ses.sendEmail(eParams, function(err, data) {
        if (err) console.log(err);
        else {
            console.log("===EMAIL SENT===");
            console.log("EMAIL CODE END");
            console.log('EMAIL: ', email);
            context.succeed(event);
     callback(null, "email is send");
        }
    });
}
```

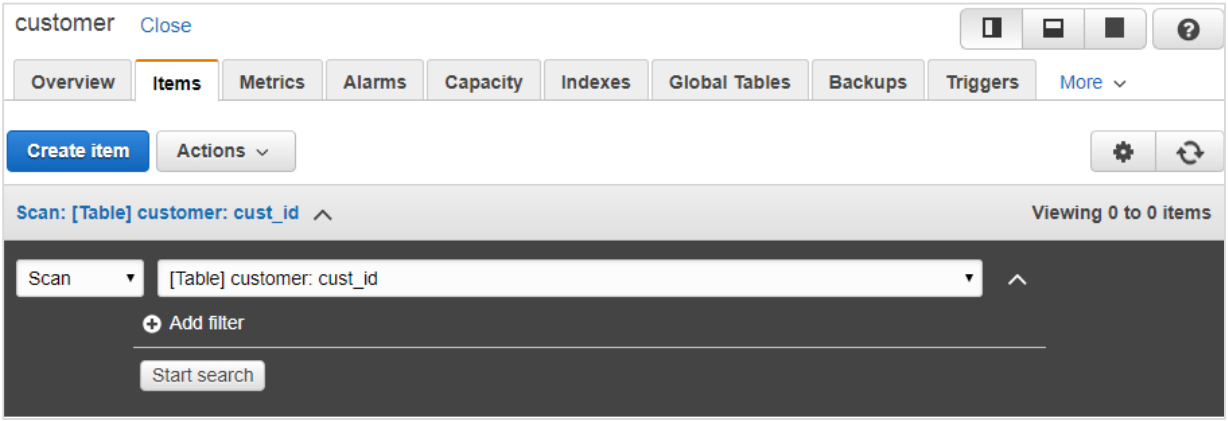
Now, save the Lambda function and data in DynamoDB table.

Add Data in DynamoDB

Use the following sequence to add data in DynamoDB.

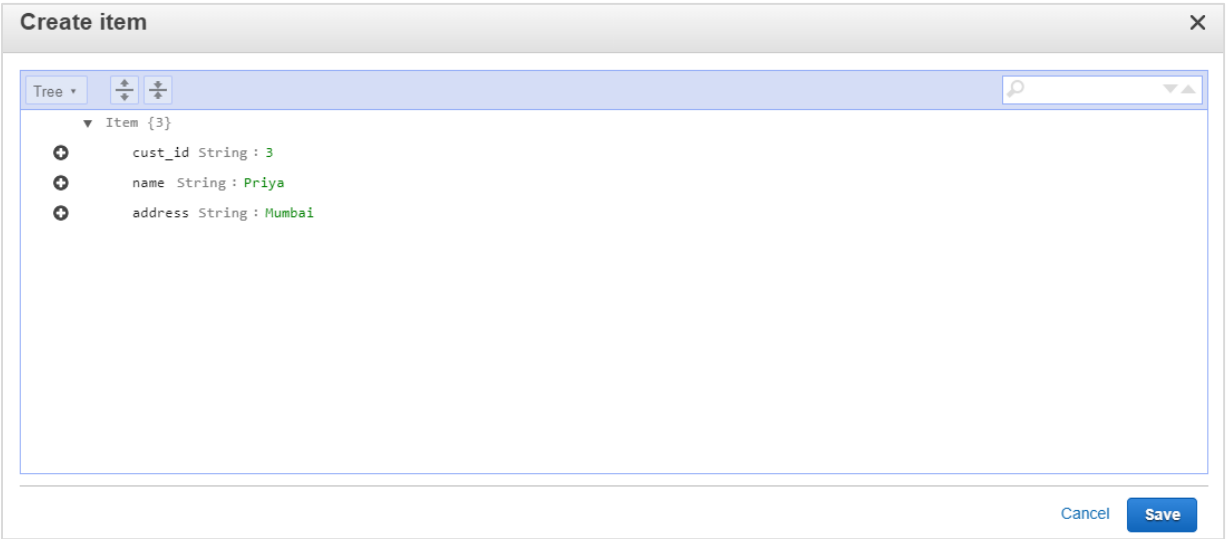
Step 1

Go to the table **customer** created in Dynamodb.



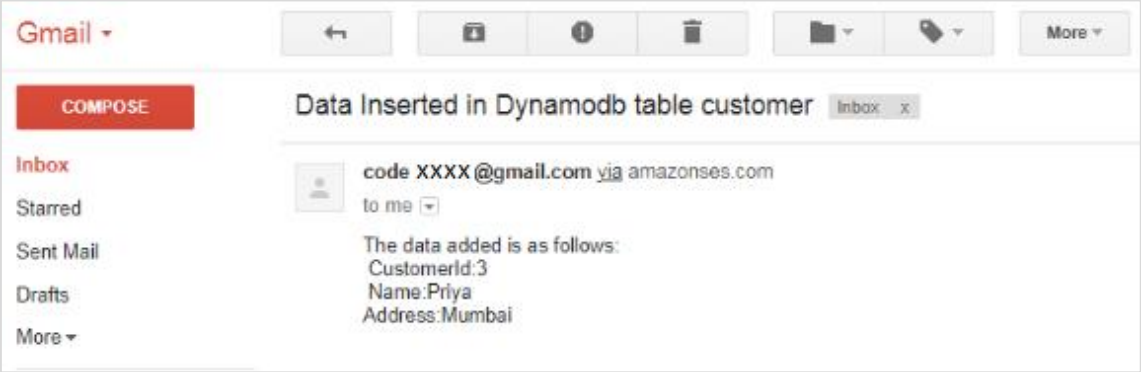
Step 2

Click **Create item.**



Step 3

Click **Save** button and check the email id provided in AWS Lambda to see if the mail has been sent by AWS Lambda.



19. AWS Lambda — Using Lambda Function with Scheduled Events

Scheduled events are suppose to happen at regular intervals based on a rule set. Scheduled events are used to execute Lambda function after an interval which is defined in cloudwatch services. They are best used for working on cron jobs along with AWS Lambda. This chapter will explain with simple example how to send mail after every 5 minutes using scheduled events and AWS Lambda.

Requisites

The requirements for using Lambda function with Scheduled events are as follows:

- Verify email id using AWS SES
- Create Role to use AWS SES, Cloudwatch and AWS Lambda
- Create Lambda Function to send email
- Add rule for scheduled events from AWS CloudWatch

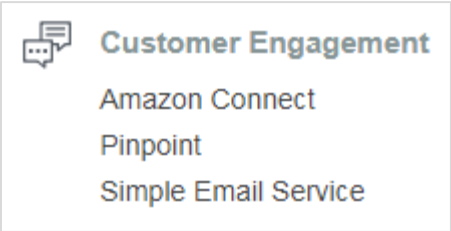
Example

The example that we are going to consider will add CloudWatch event to the AWS Lambda function. Cloudwatch will trigger AWS Lambda based on the time pattern attached to it. For example, in the example below we have used 5 minutes as the trigger. It means for every 5 minutes, AWS Lambda will be triggered and AWS Lambda will send mail whenever triggered.

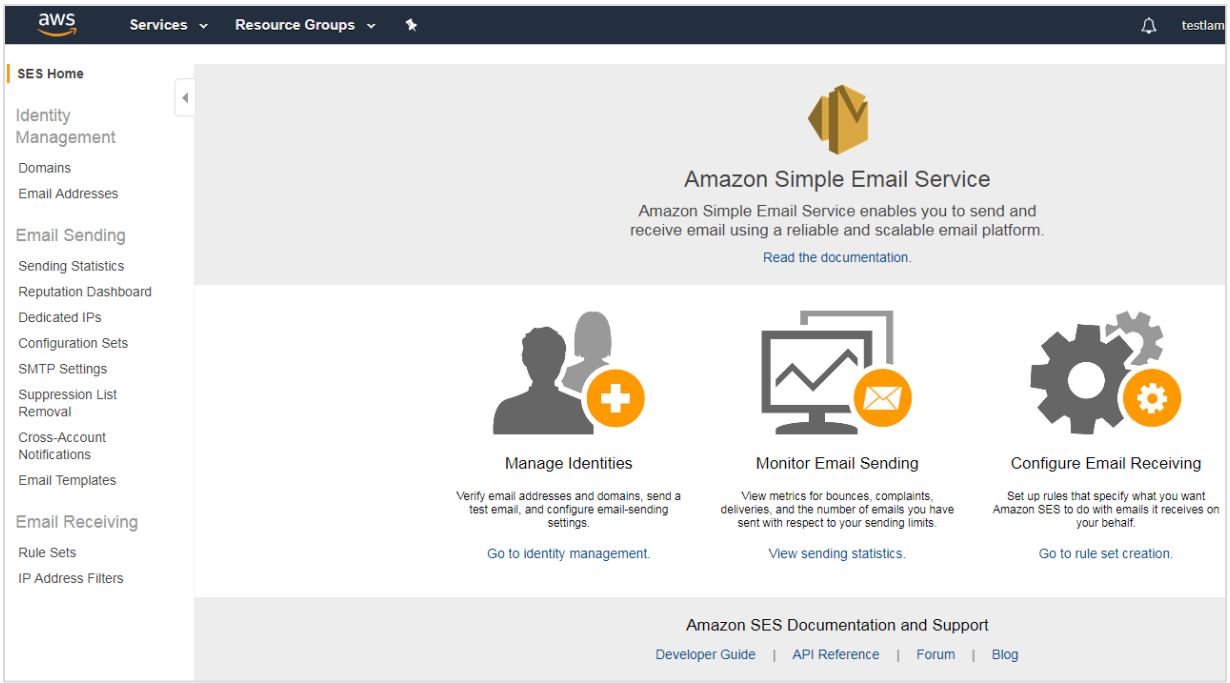
The basic block diagram for the same is shown below:

Verify Email ID using AWS SES

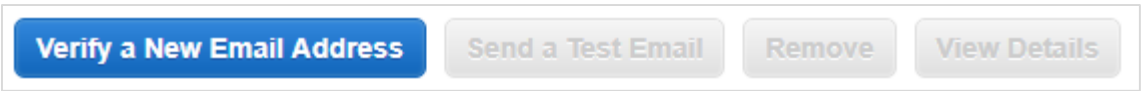
Log in to AWS and go to AWS SES service as shown below:



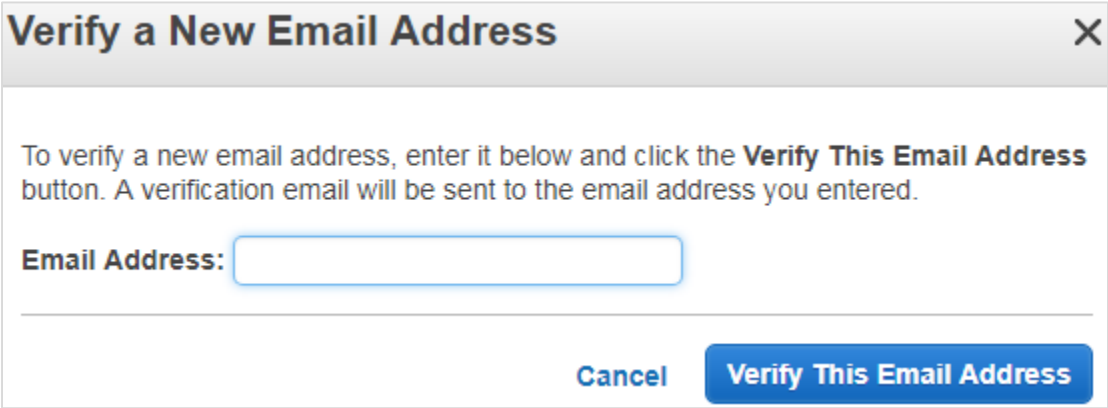
Now, click **Simple Email Service** as shown:



Click **Email Addresses** on left side as shown:

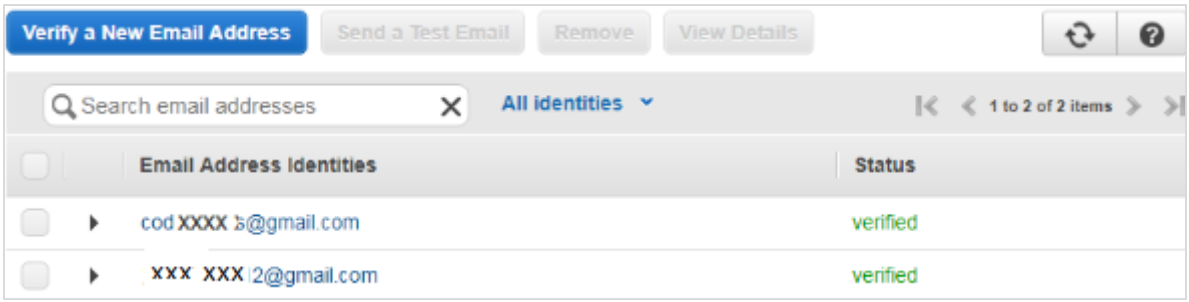


It displays a button **Verify a New Email Address.** Click it.



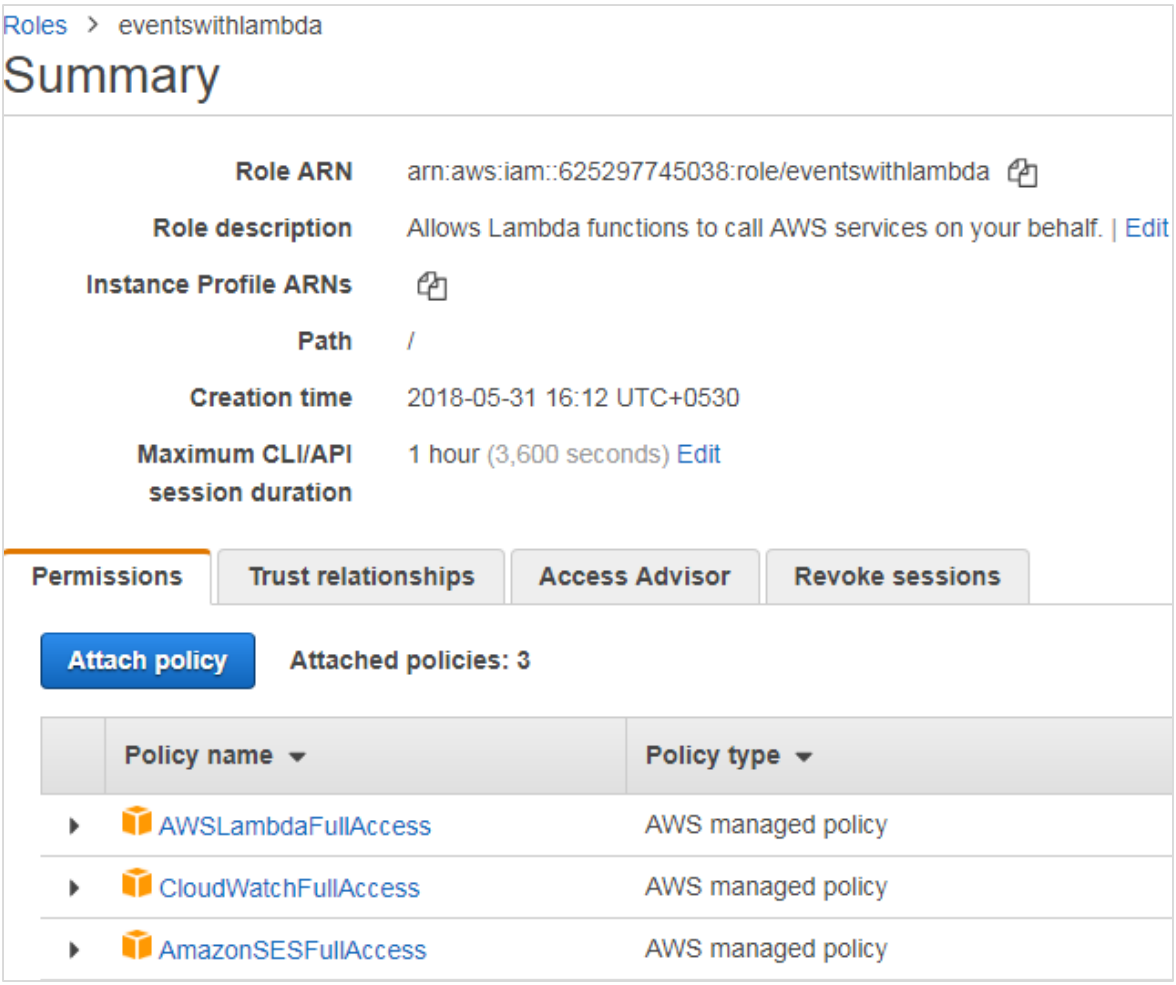
Enter **Email Address** you want to verify. Click **Verify This Email Addres*s*** button. You will receive mail from AWS on that email id with email subject: `Amazon Web Services – Email Address Verification Request in region US East (N. Virginia)`

Click the link given in the mail to verify email address. Once verified, it will display the email id as follows:



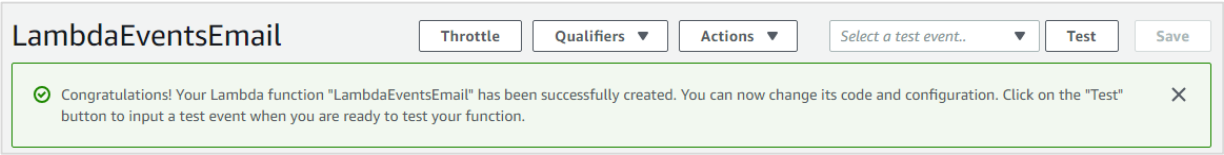
Create Role to use AWS SES, Cloudwatch and AWS Lambda

You can also create a role which gives permission to use the services. For this, go to IAM and select Role. Add the required policies and create the role. Observe that the role created here is **eventswithlambda**.

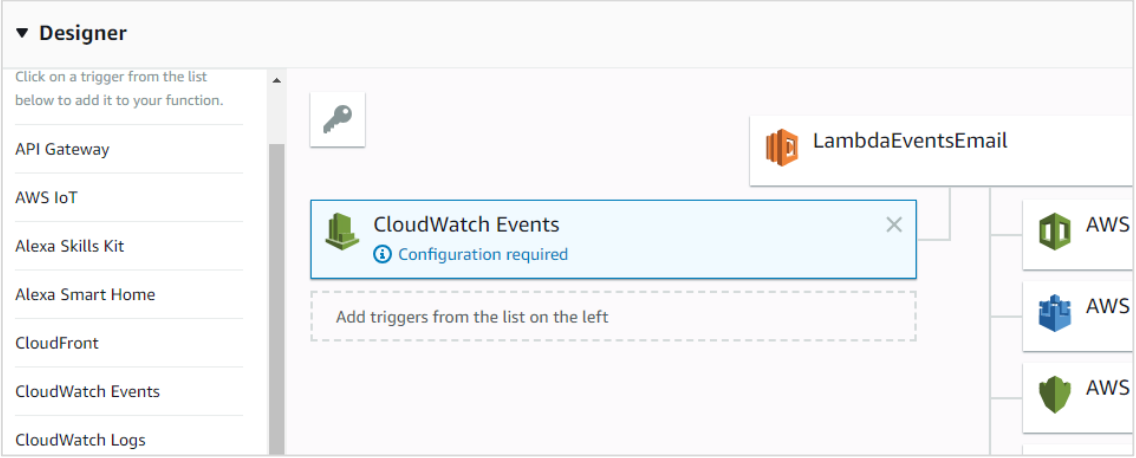


Create Lambda Function to Send Email

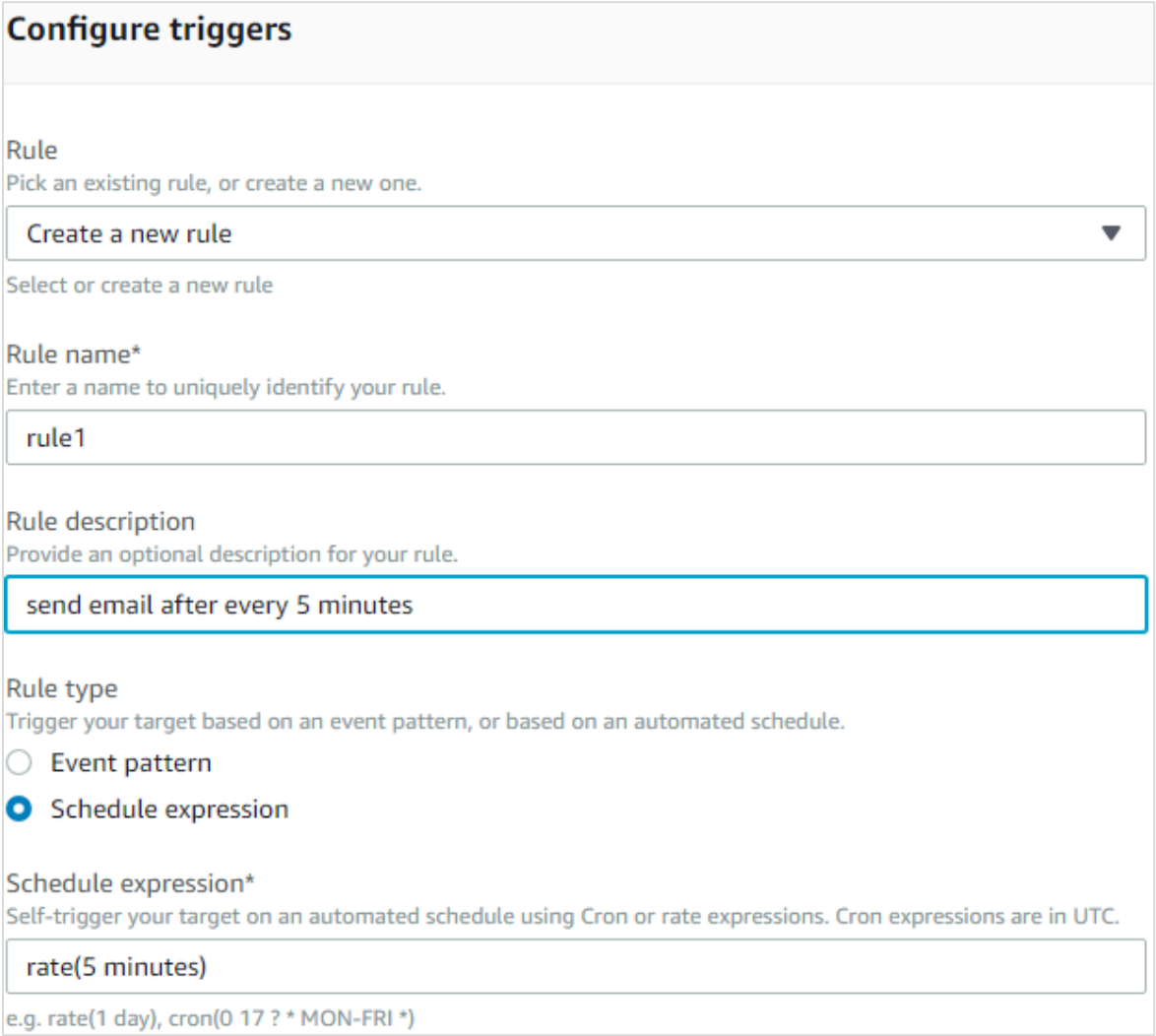
You will have to follow the steps to create Lambda function using runtime as nodejs.



Now, add trigger to Lambda as shown:



Add details to C**loudWatch Events Trigger** as shown below:



Note that the event will be triggered after every 5 minutes as per the rule trigger created.

The Lambda code for sending an email is given below:

```
var aws = require('aws-sdk');
var ses = new aws.SES({
    region: 'us-east-1'
});
exports.handler = function(event, context, callback) {
    var eParams = {
        Destination: {
            ToAddresses: ["xxxxxxxt12@gmail.com"]
```

```
        },
        Message: {
            Body: {
                Text: {
                    Data: "this mail comes from aws lambda event scheduling"
                }
            },
            Subject: {
                Data: "Event scheduling from aws lambda"
            }
        },
        Source: "coxxxxxx@gmail.com"
    };
    console.log('===SENDING EMAIL===');
    var email = ses.sendEmail(eParams, function(err, data) {
        if (err) console.log(err);
        else {
            console.log("===EMAIL SENT===");
            console.log("EMAIL CODE END");
            console.log('EMAIL: ', email);
            context.succeed(event);
                  callback(null, "email is send");
        }
    });
};
```

Now, we need the AWS SES service. You can add this using the code shown as follows:

```
var aws = require('aws-sdk');
var ses = new aws.SES({
    region: 'us-east-1'
});
```

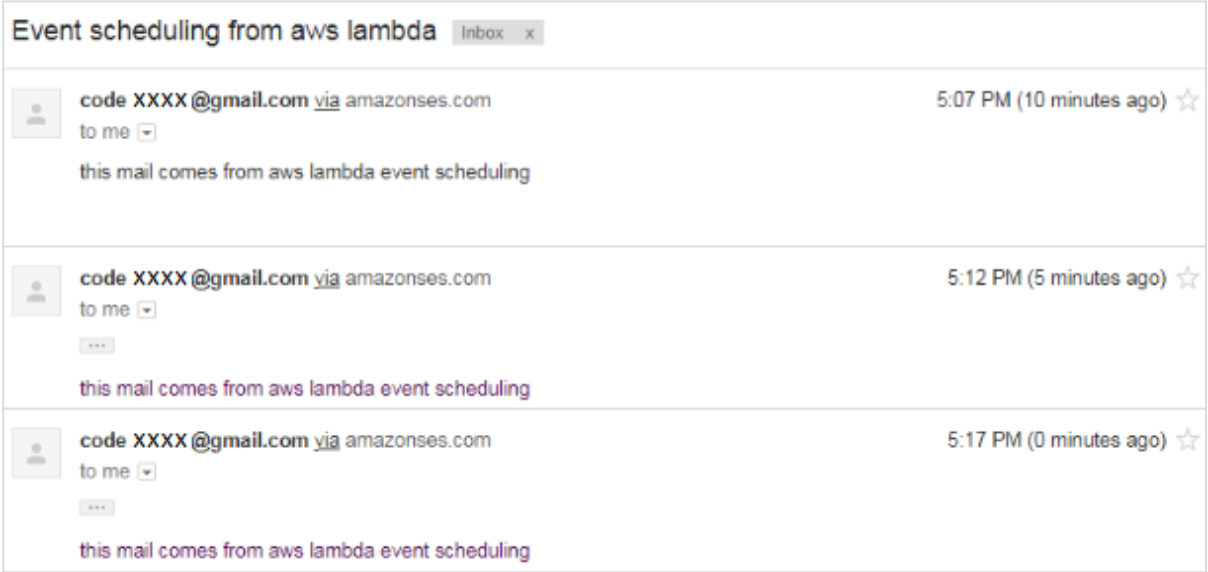
To send mail from **nodejs,** we have created **eParams** object which has details like the **source mail, to mail id** and **the body with message** as follows:

```
var eParams = {
        Destination: {
            ToAddresses: ["xxxxxxxx12@gmail.com"]
        },
        Message: {
            Body: {
                Text: {
                    Data: "this mail comes from aws lambda event scheduling"
                }
            },
            Subject: {
                Data: "Event scheduling from aws lambda"
            }
        },
        Source: "coxxxxxx@gmail.com"
    };
```

The Lambda code to send email is as follows:

```
var email = ses.sendEmail(eParams, function(err, data) {
        if (err) console.log(err);
        else {
            console.log("===EMAIL SENT===");
            console.log("EMAIL CODE END");
            console.log('EMAIL: ', email);
            context.succeed(event);
                  callback(null, "email is send");
        }
    });
```

Now, let us save this Lambda function and check the email id for mails. The screenshot shown below shows that the mail is sent from AWS Lambda after every 5 minutes.



20. AWS Lambda — Using Lambda Function with Amazon SNS

Amazon SNS is a service used for push notification. In this chapter, we will explain working of AWS Lambda and Amazon SNS with the help of an example where will perform the following actions:

- Create Topic in SNS Service and use AWS Lambda Add Topics to CloudWatch
- Send SNS text message on phone number given.

Requisites

To create Topic in SNS Service and use AWS Lambda Add Topics to CloudWatch, we need ot follow the steps given below:

- Create Topic in SNS
- Create Role for permission in IAM
- Create AWS Lambda Function
- Publish to topic to activate trigger
- Check the message details in CloudWatch service.

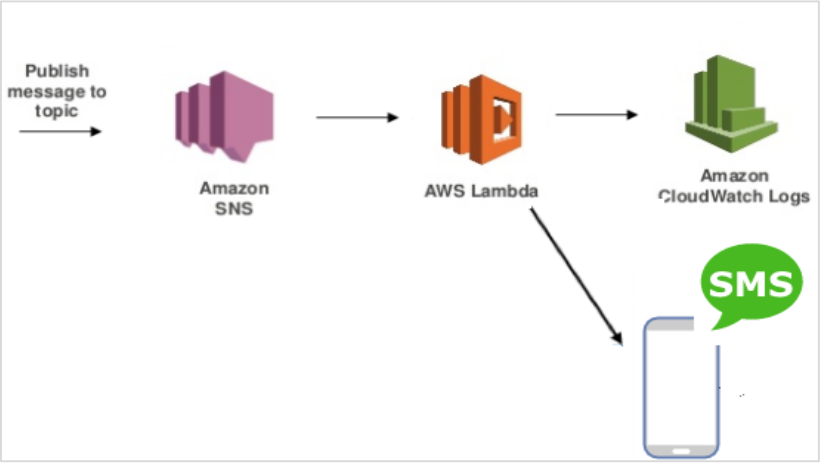
To send SNS text message on phone number given, we need to do the following:

- Add code in AWS Lambda to send message to your phone.

Example

In this example, we will create a topic in SNS. When details are entered in the topic to publish, AWS Lambda is triggered. The topic details are logged in CloudWatch and a message is sent on phone by AWS Lambda.

Hers is a basic block diagram which explains the same:

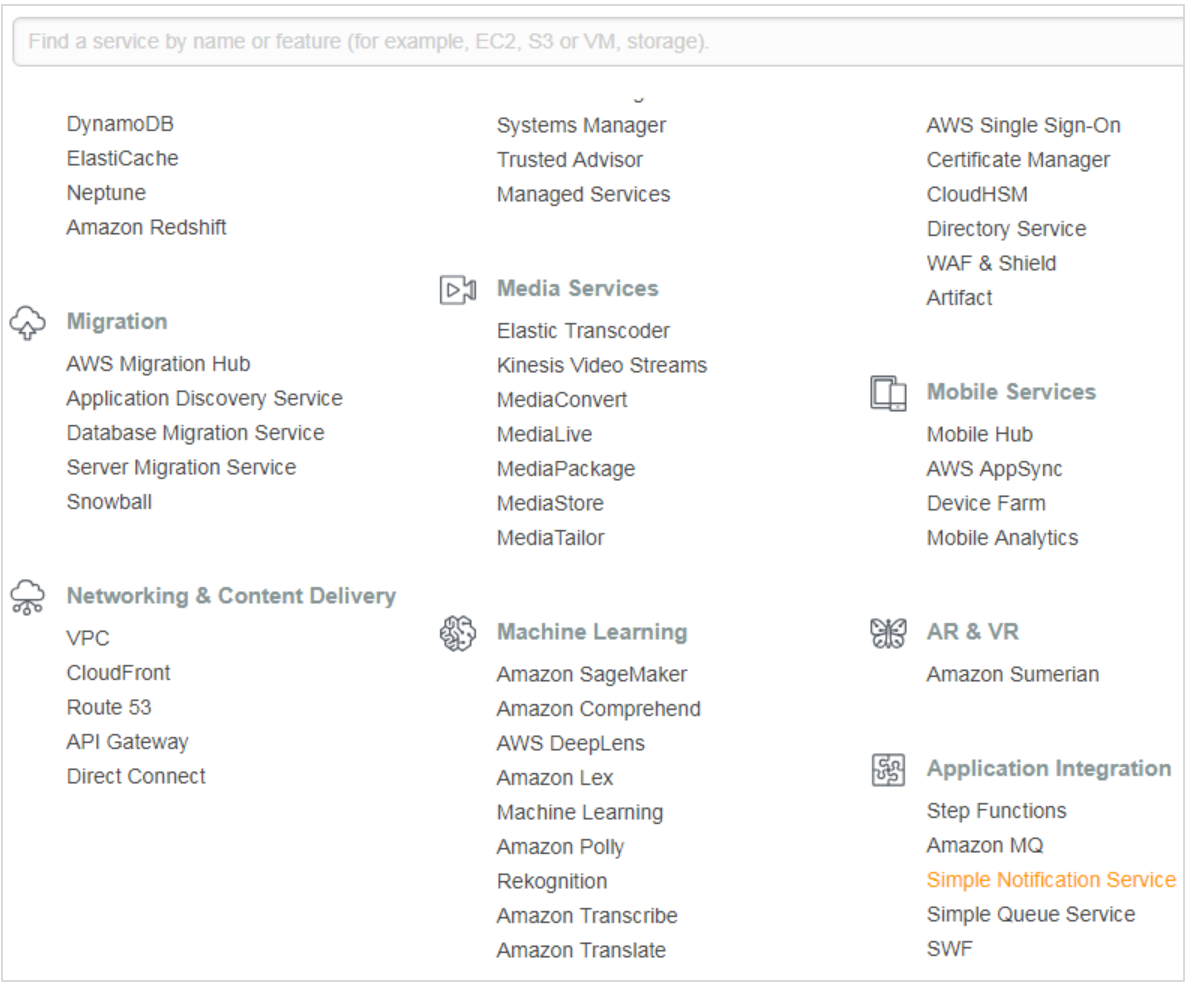


Create Topic in SNS

You will have to follow the steps given below to create topic in SNS:

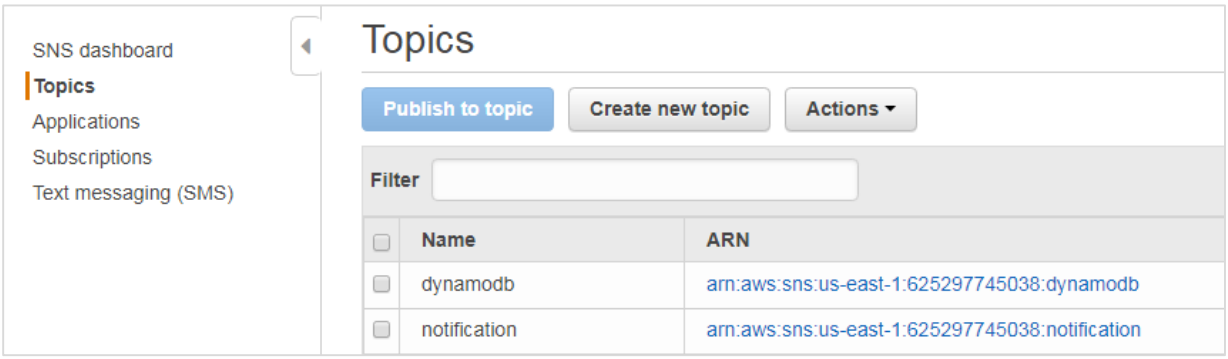
Step 1

Login to AWS Console and go to SNS service in Amazon as shown below:



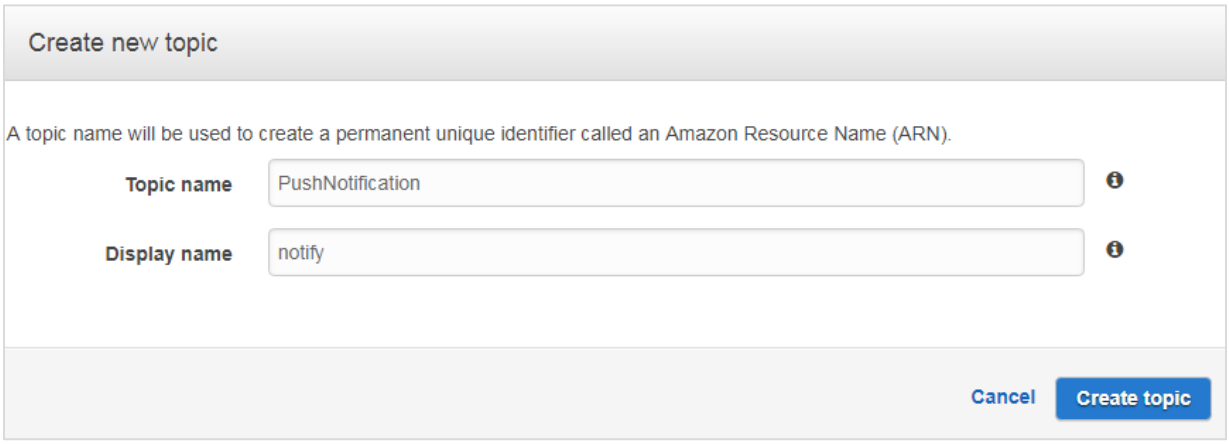
Step 2

Click **Simple Notification Service** and **Create topic** in it.



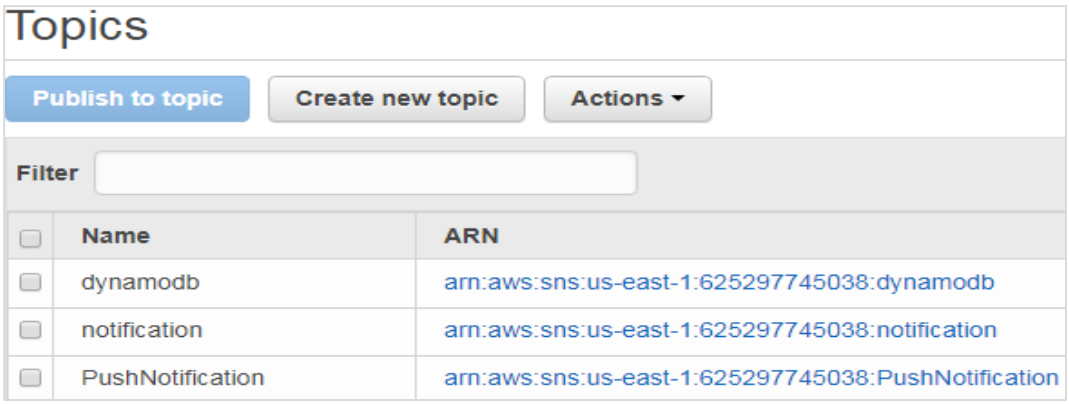
Step 3

Then, you have to click **Create new topic** button as shown:



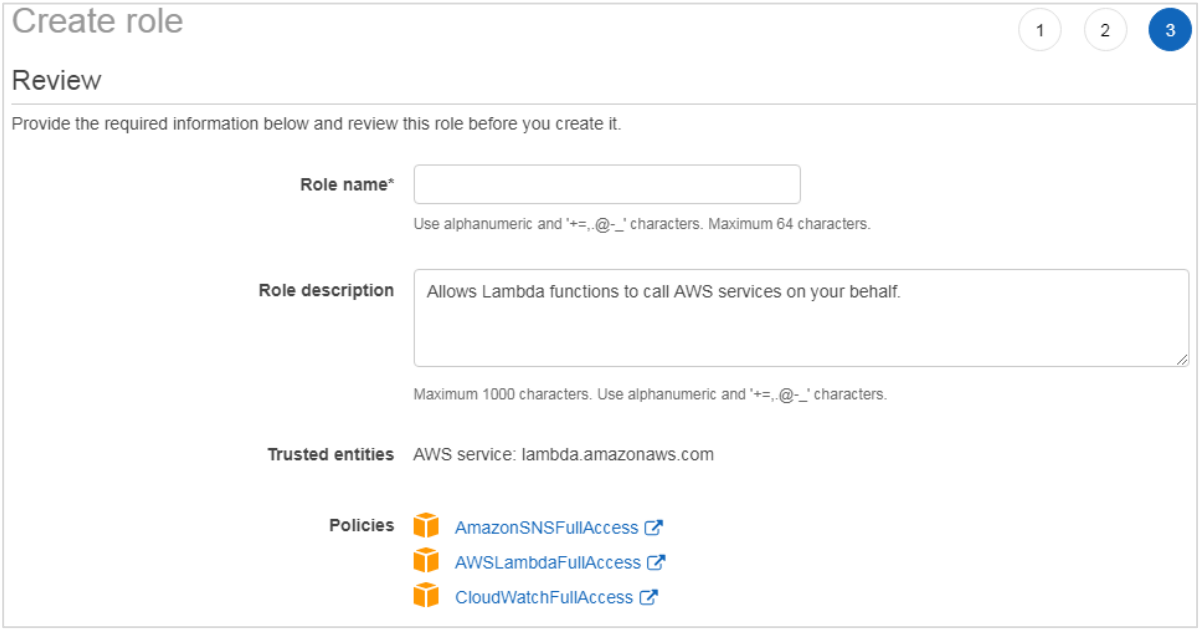
Step 4

Enter the **Topic name** and **Display name** and click on **Create topic.** You should see the topic name in the display as follows:

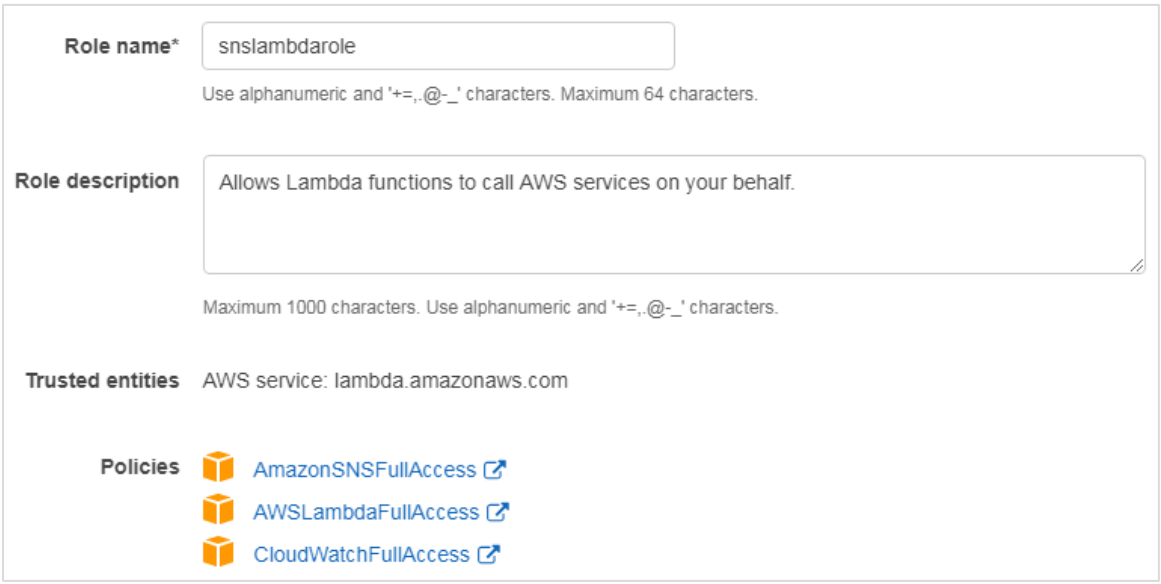


Create Role for Permission in IAM

To create a Role to work with AWS Lambda and SNS service, we need to login to AWS console. Then, select IAM from Amazon services and click role from left side as shown below.



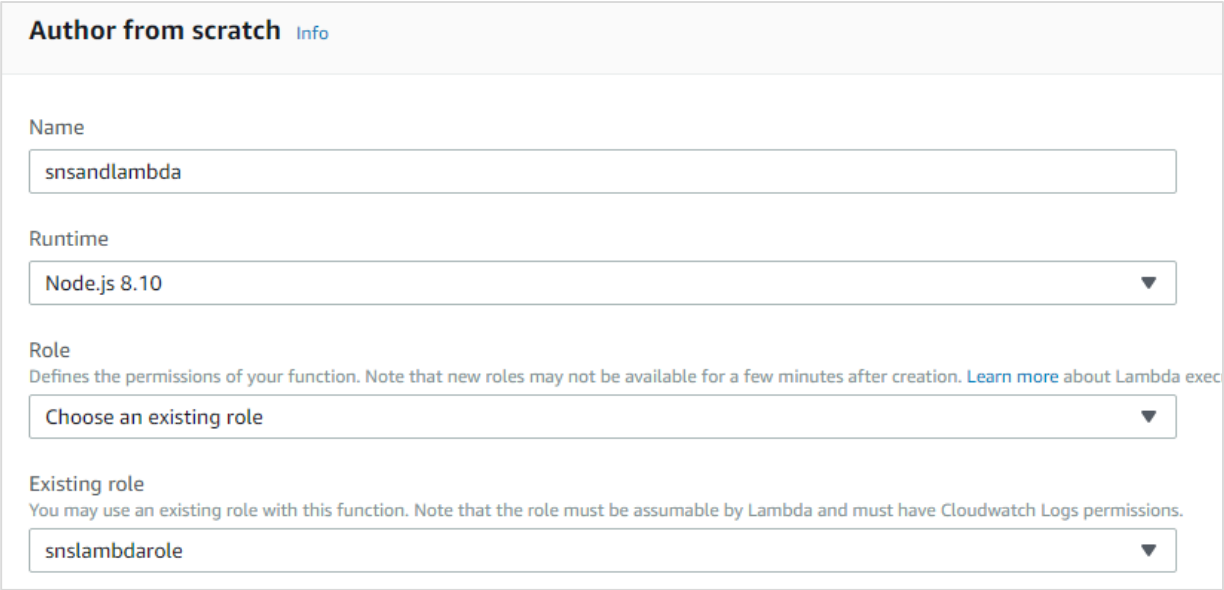
Observe that we have added policies for SNS, Lambda and CloudWatch. Add rolename and click Create role button to complete the process of role creation.



Create AWS Lambda Function

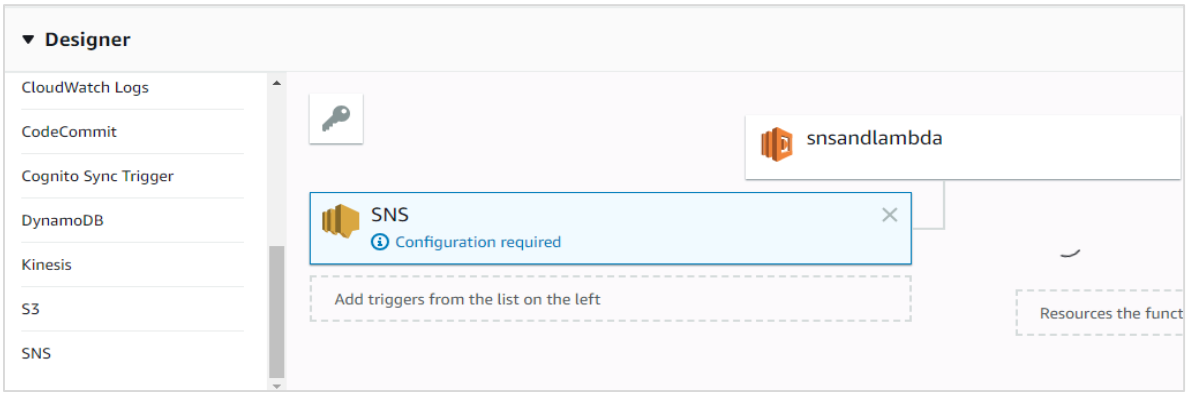
In this section, let us understand how to create AWS Lambda function using nodejs as the runtime.

For this purpose, login to AWS console and choose AWS Lambda from AWS services. Add the function name, role details etc and create the AWS Lambda function as shown.

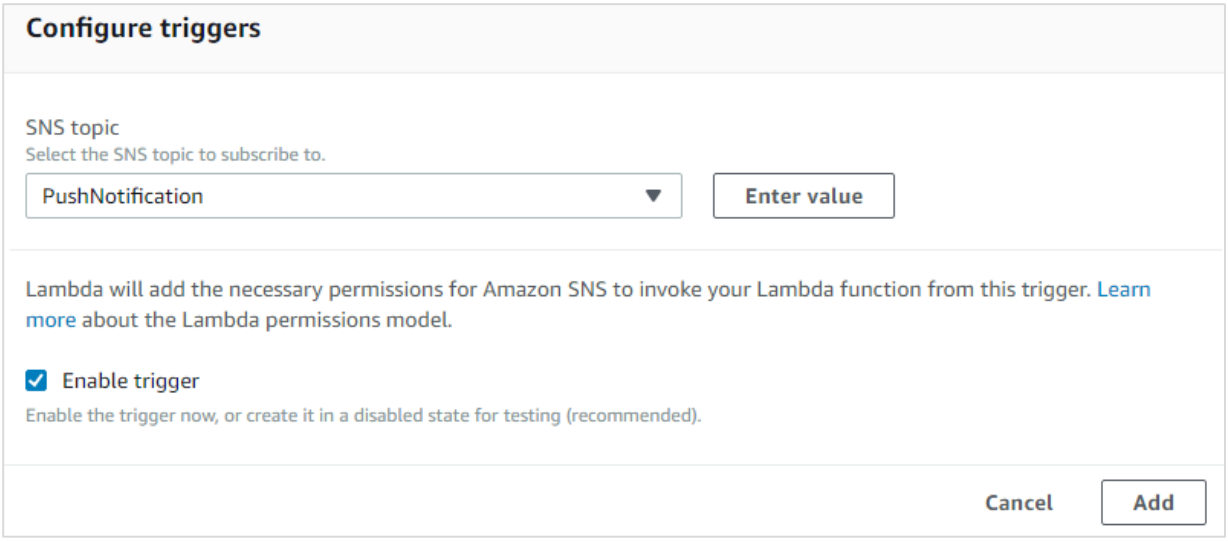


Add SNS Trigger

To add SNS trigger, enter SNS configuration details as shown:



Then , select **SNS topic** and **Add** the trigger to AWS Lambda function as shown:



Then , add AWS lambda code given below:

```
exports.handler = function(event, context, callback) {
    console.log("AWS lambda and SNS trigger ");
    console.log(event);
    const sns = event.Records[0].Sns.Message;
    console.log(sns)
    callback(null, sns);
};
```

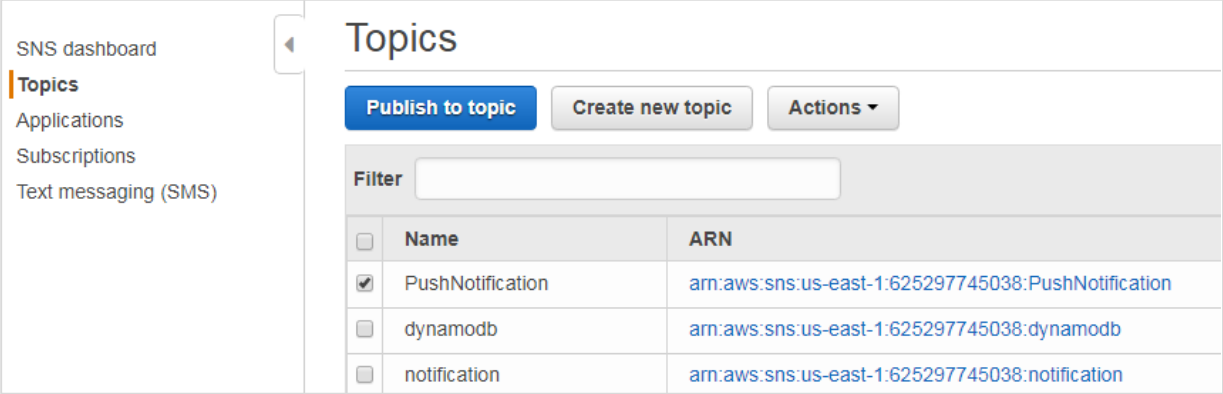
In the above code, **event.Records[0].Sns.Message** gives the message details added. We have added console logs to see them in CloudWatch. Now, save the Lambda function with required memory and time allocation.

Publish to Topic to Activate Trigger

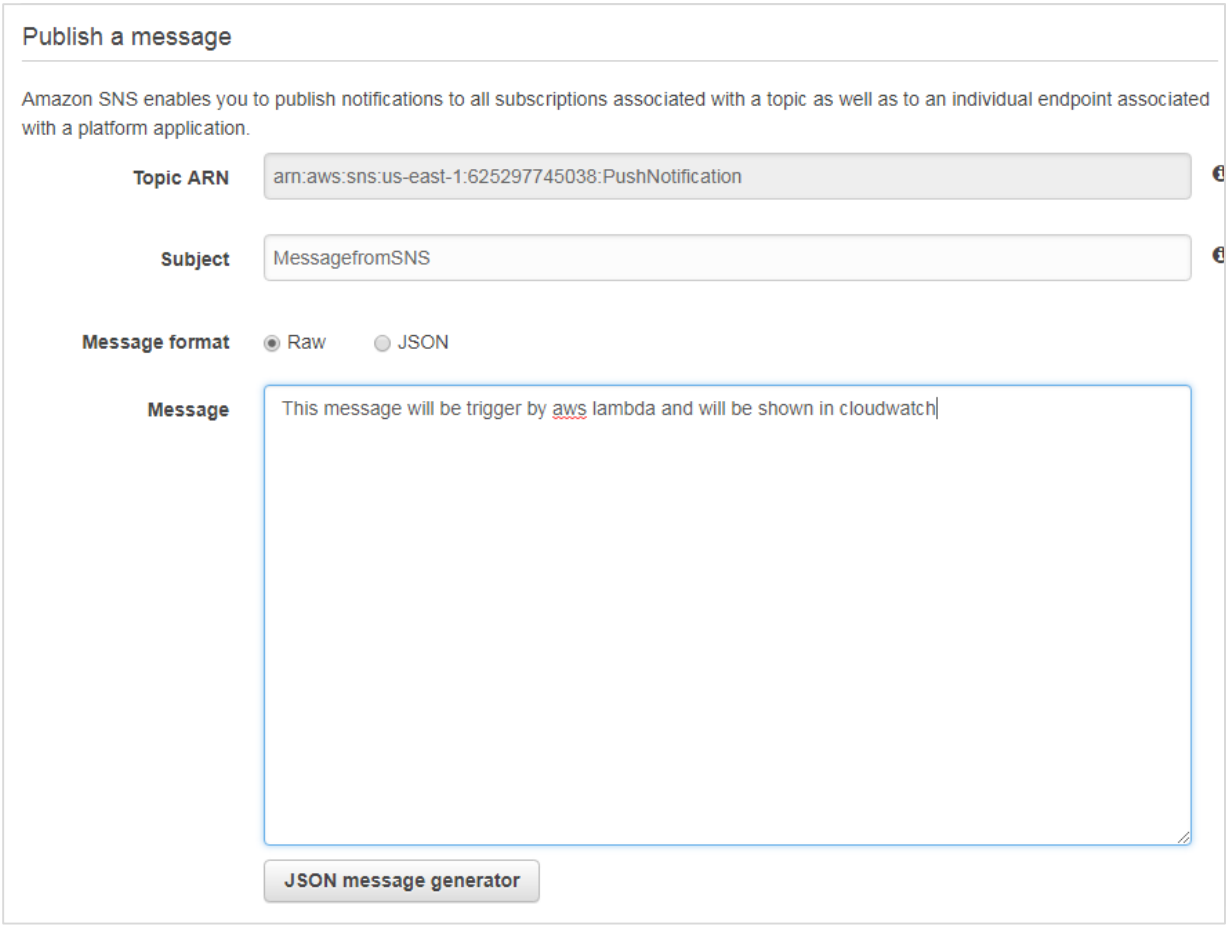
Recall that we have already created topic in SNS in step 1. We will now publish in the topic and see the details in CloudWatch which will be triggered by AWS Lambda:

Publish to Topic

First Select name of the topic you want to publish. Click on **Publish to topic** button:



Enter the **Subject** and **Message** details as shown below:



You can also select **JSON** message format to send in **JSON** style. Click **Publish the message** button at the end of the screen.

Check Message Details in CloudWatch Service

Log into AWS console and open CloudWatch service. Click on logs on left side and select the logs for AWS Lambda function created. You can find the following display for the logs with messages created as shown above:

Add Code in AWS Lambda to Send Message to your Phone

Here will use SNS Text messaging to send message on the phone using AWS Lambda. You can use the following code to update AWS Lambda code as follows:

```
const aws =  require("aws-sdk");
const sns = new aws.SNS({
region:'us-east-1'
});

exports.handler = function(event, context, callback) {
    console.log("AWS lambda and SNS trigger ");
    console.log(event);
    const snsmessage = event.Records[0].Sns.Message;
    console.log(snsmessage);
    sns.publish({
         Message: snsmessage,
         PhoneNumber: '+911212121212'
    }, function (err, data) {
     if (err) {
         console.log(err);
            callback(err, null);
     } else {
         console.log(data);
            callback(null, data);
     }
    });
```

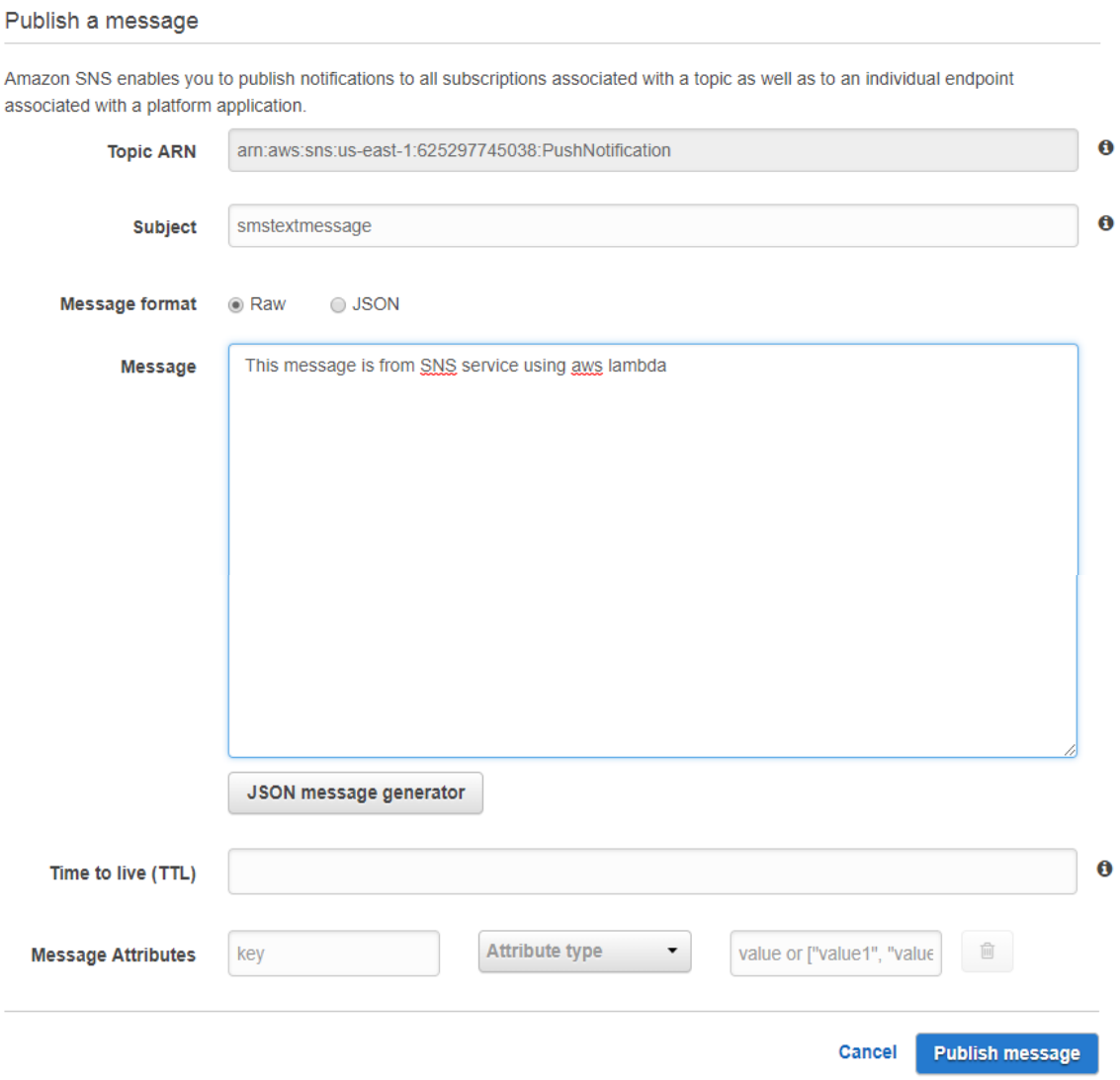
```
};
```

We have added AWS SDK and the SNS service to use to send message. The message from the event coming from SNS is send as text message on the phone numbe given.

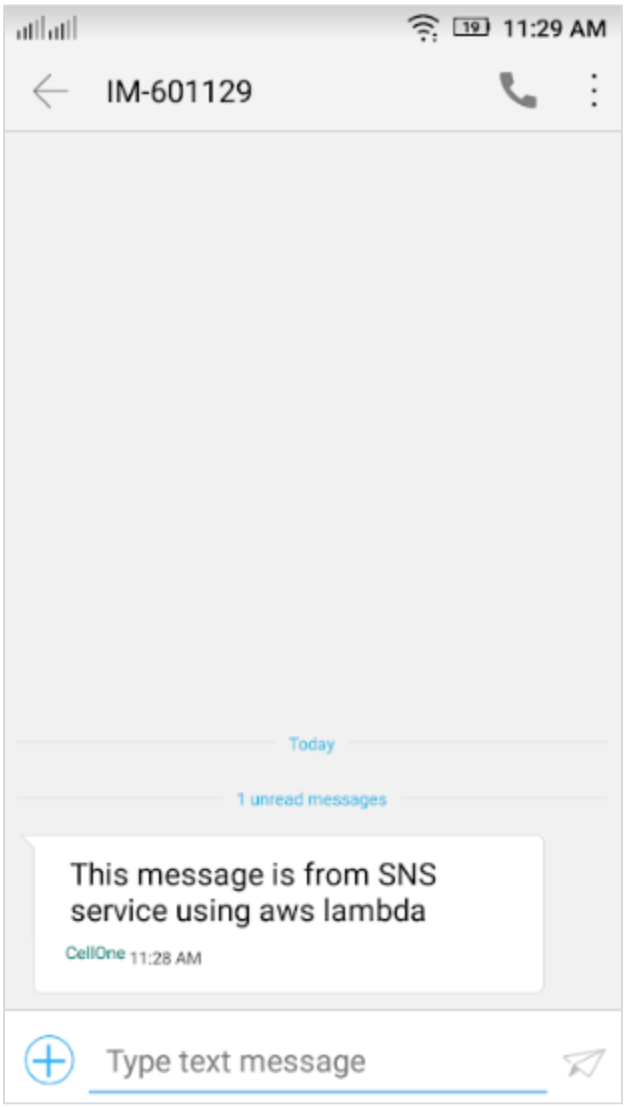
Observe the following code for example:

```
sns.publish({
         Message: snsmessage,
         PhoneNumber: '+911212121212'
 }, function (err, data) {
     if (err) {
         console.log(err);
            callback(err, null);
     } else {
         console.log(data);
            callback(null, data);
     }
  });
```

Enter the topic now to see the message in cloudwatch and the phone number given above.



Click **Publish message** to publish the message. You see a message on the phone number given as follows:



21. AWS Lambda — Using Lambda Function with CloudTrail

AWS CloudTrail is a service available with Amazon, which helps to logs all the activities done inside AWS console. It logs all the API calls and stores the history, which can be used later for debugging purpose. Note that we cannot trigger Lambda from CloudTrail. Instead, CloudTrail stores all the history in the form of logs in S3 bucket and we can trigger AWS Lambda from S3. Once any logs are to be processed, AWS Lambda will get triggered whenever any logs are added to S3 bucket.

Requisites

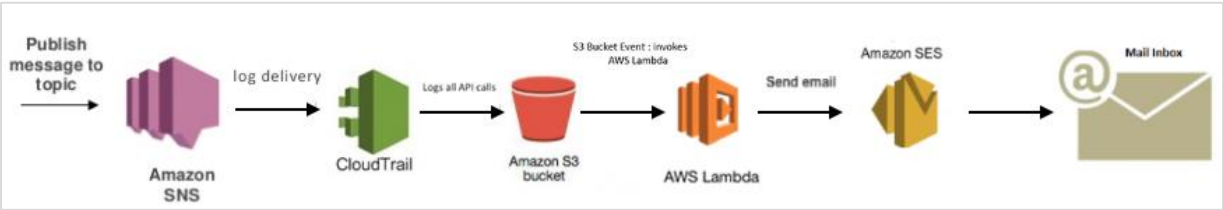
Before you start to work with AWS CloudTrail, S3 and AWS Lambda, you need to perform the following:

- Create S3 bucket to store CloudTrail logs
- Create SNS service
- Create a trail in CloudTrail and assign the S3 bucket and SNS service
- Create IAM role with permission.
- Create aws lambda function
- AWS Lambda configuration

Example

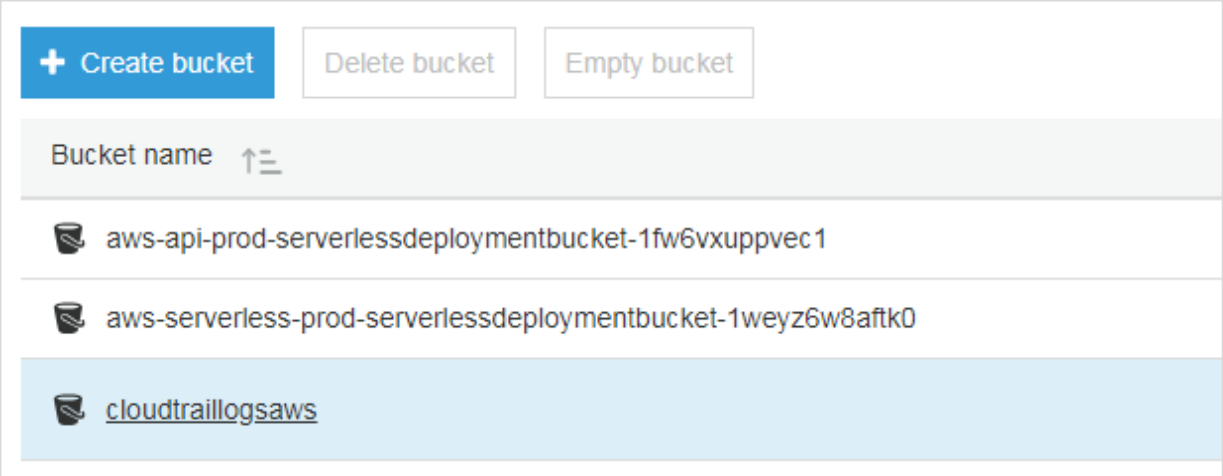
Let s consider an example which shows the working of AWS CloudTrail, S3 and AWS Lambda. Here, we will create a bucket in S3 which will store all the logs for any interaction done in AWS console. Let us create SNS topic and publish it. For this action, the logs will be entered as a file in S3. AWS lambda will get triggered which will send mail using Amazon SES service.

The block diagram for explaining this process is as shown below:



Create S3 Bucket to Store CloudTrail logs

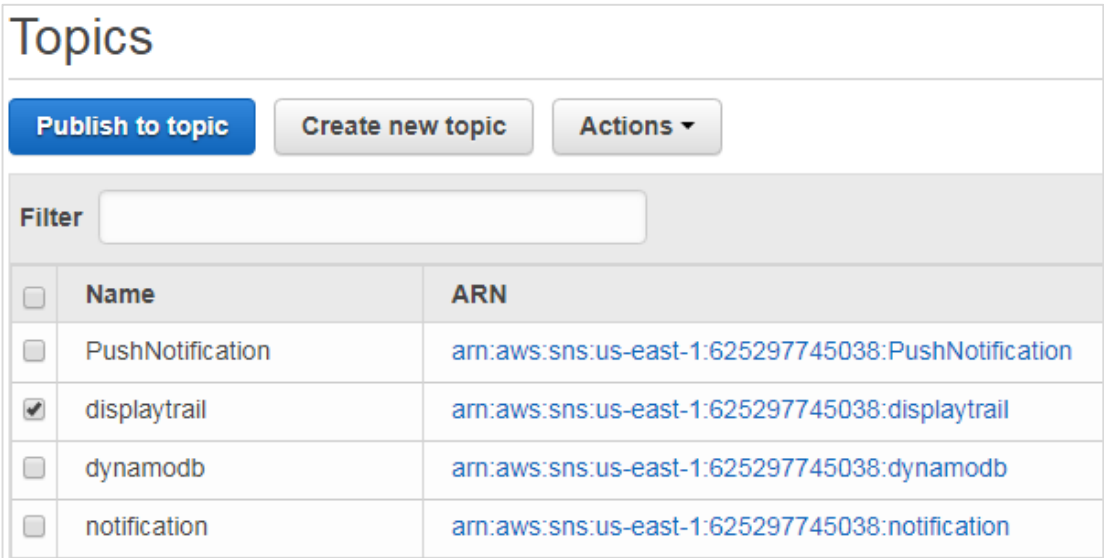
Go to AWS console and click S3 service. Click **Create bucket** and enter the name of the bucket you want to store cloudtrail logs as shown:



Observe that here we have created a S3 bucket **cloudtraillogsaws** for storing the logs.

Create SNS Service

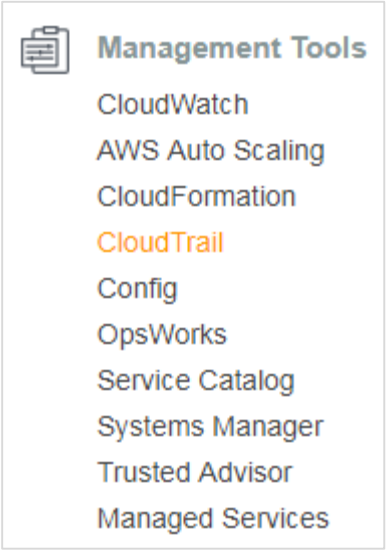
Go to AWS console and click **Simple notification Service**. Select topics from left side and click Create new topic button.



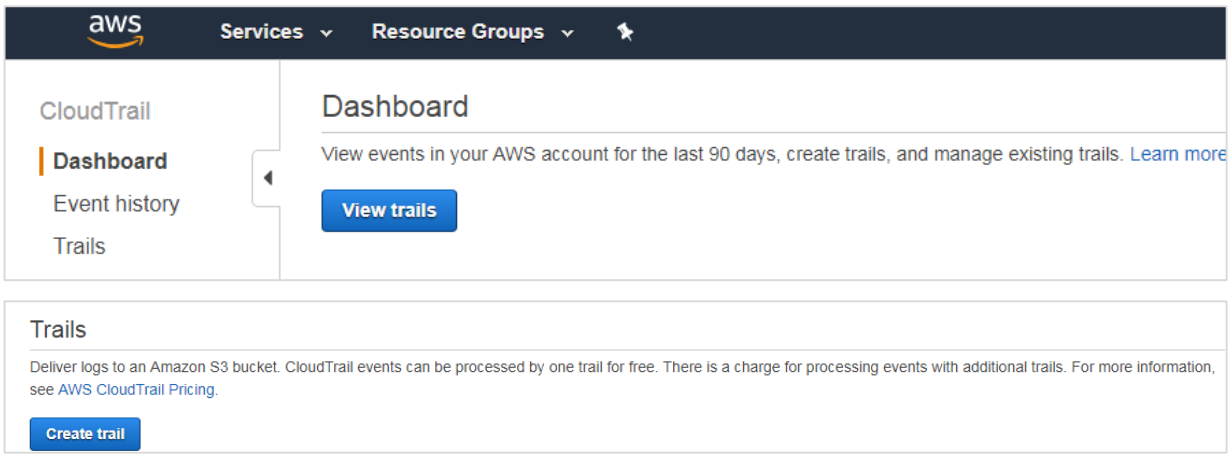
We have created topic called **displaytrail** to publish a topic. Its details will get stored in S3 bucket that is created above.

Create a Trail in Cloudtrail and Assign the S3 bucket and SNS service

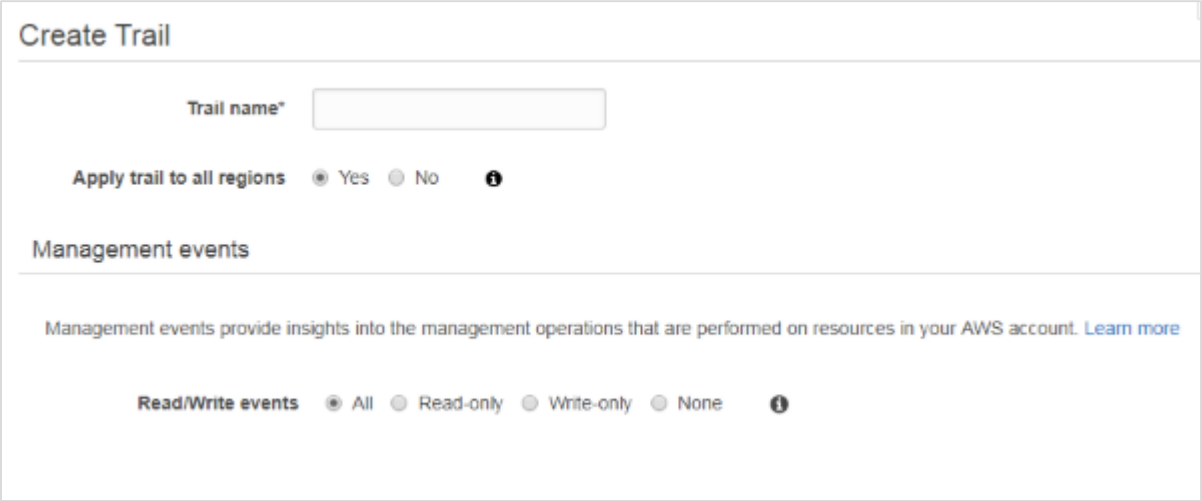
Go to AWS console and click **CloudTrail** service from Management tools as shown:



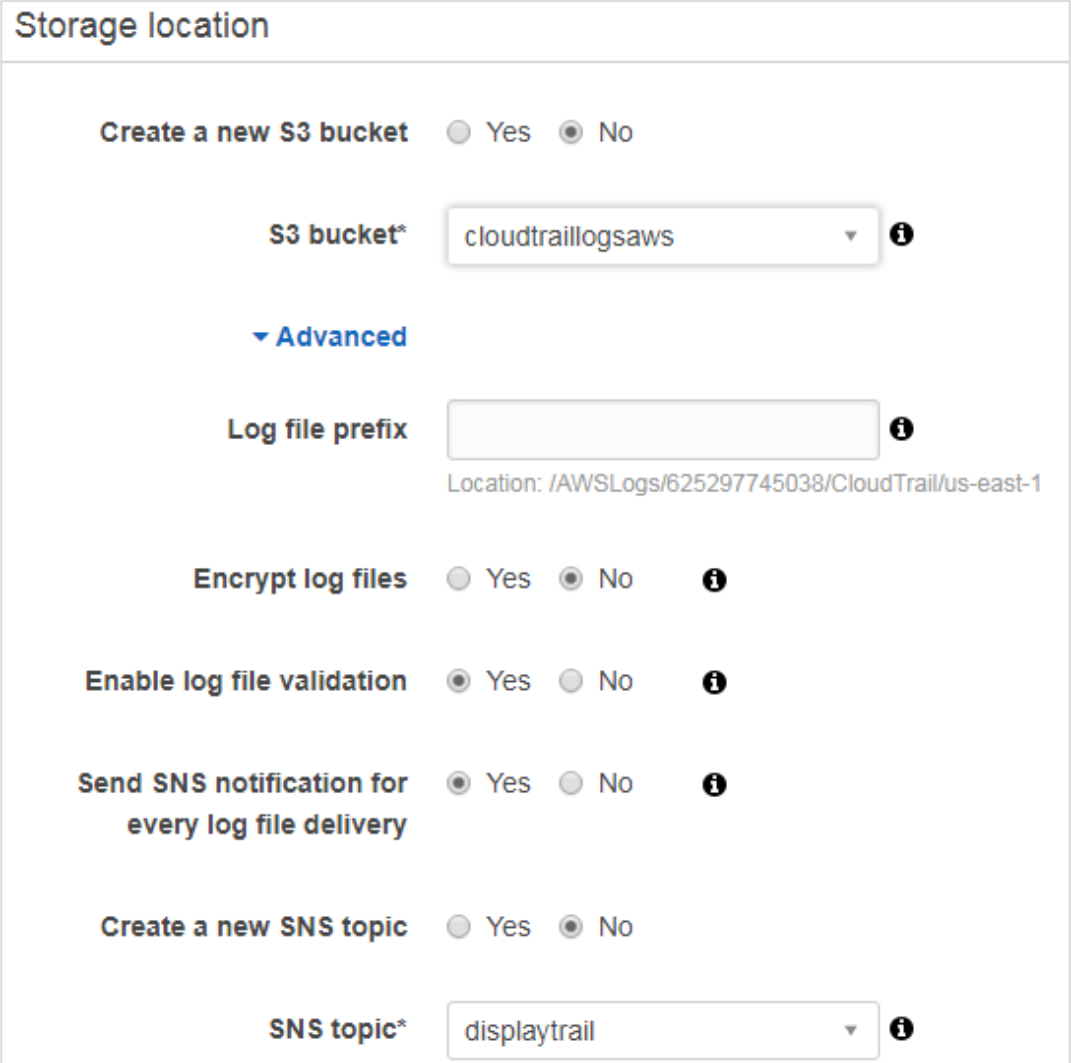
Click **Trails** from the left side as shown below:



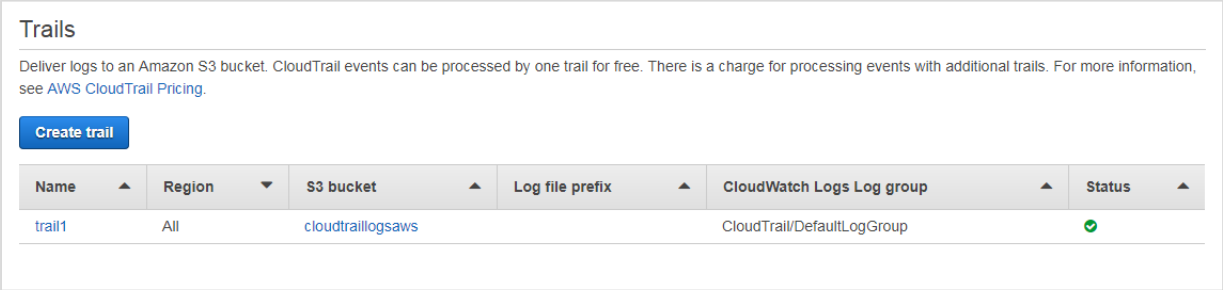
Click **Create Trail** button. Enter the **Trail name, Apply trail to all regions** and choose **Yes**. Then So the logs will be applied for all the region.



For **Read/Write events,** choose **All.** Add the **S3 bucket** and **SNS topic** details as shown below. You can create a new one here or add an existing one.

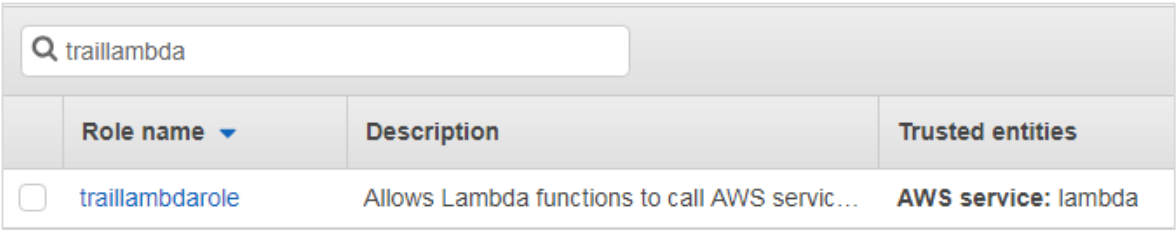


Note that there are options available to **encrypt log files**, **enable log file validation** , **send sns notification for every log file delivery** etc. I have used the default values here.You can allow file encryption and it will ask for encryption key. Click on **Create Trail** button once the details are added.



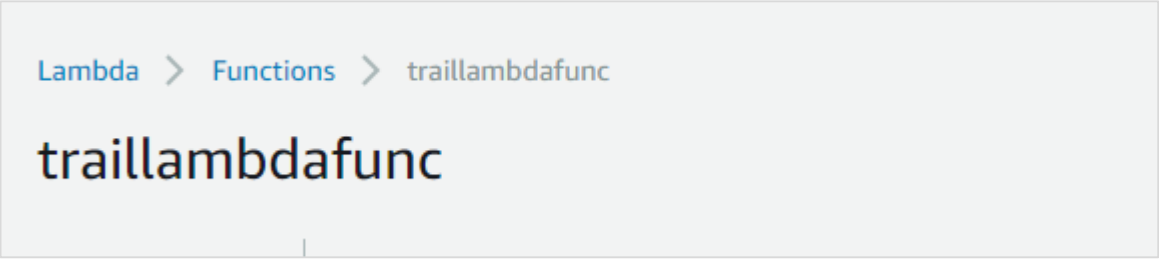
Create IAM Role with Permission

Go to AWS console and select IAM. Create a role with permission for S3, Lambda, CloudTrail and SES for sending email.The role created is as shown below:



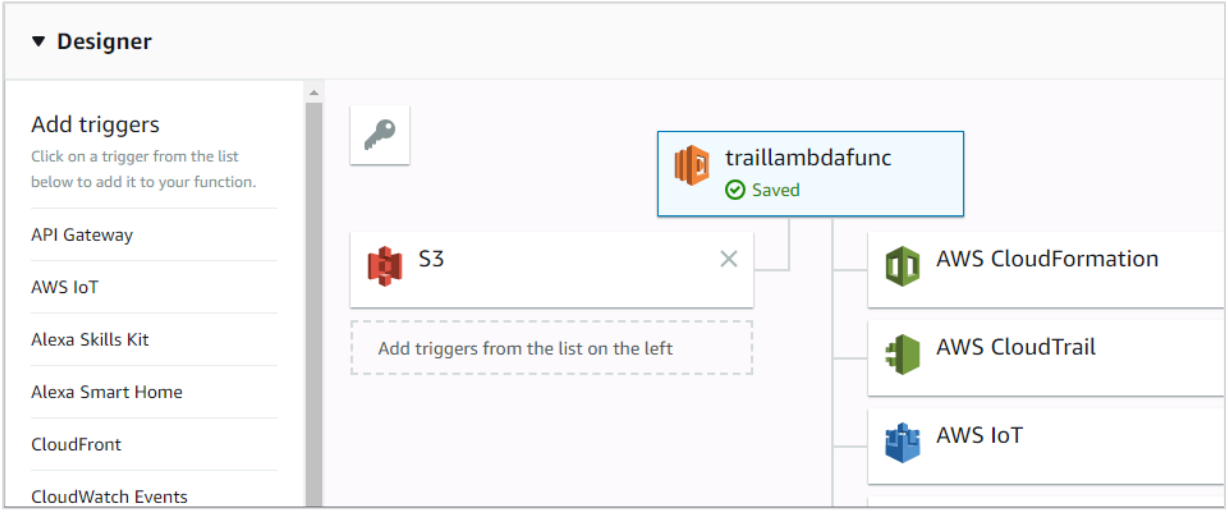
Create AWS Lambda Function

Go to AWS service and click **Lambda** service. Add the function name, select runtime as **nodejs**, and select the role created for the lambda function.Following is the lambda function created.



AWS Lambda Configuration

Next, we need to add S3 as the trigger for AWS lambda created.



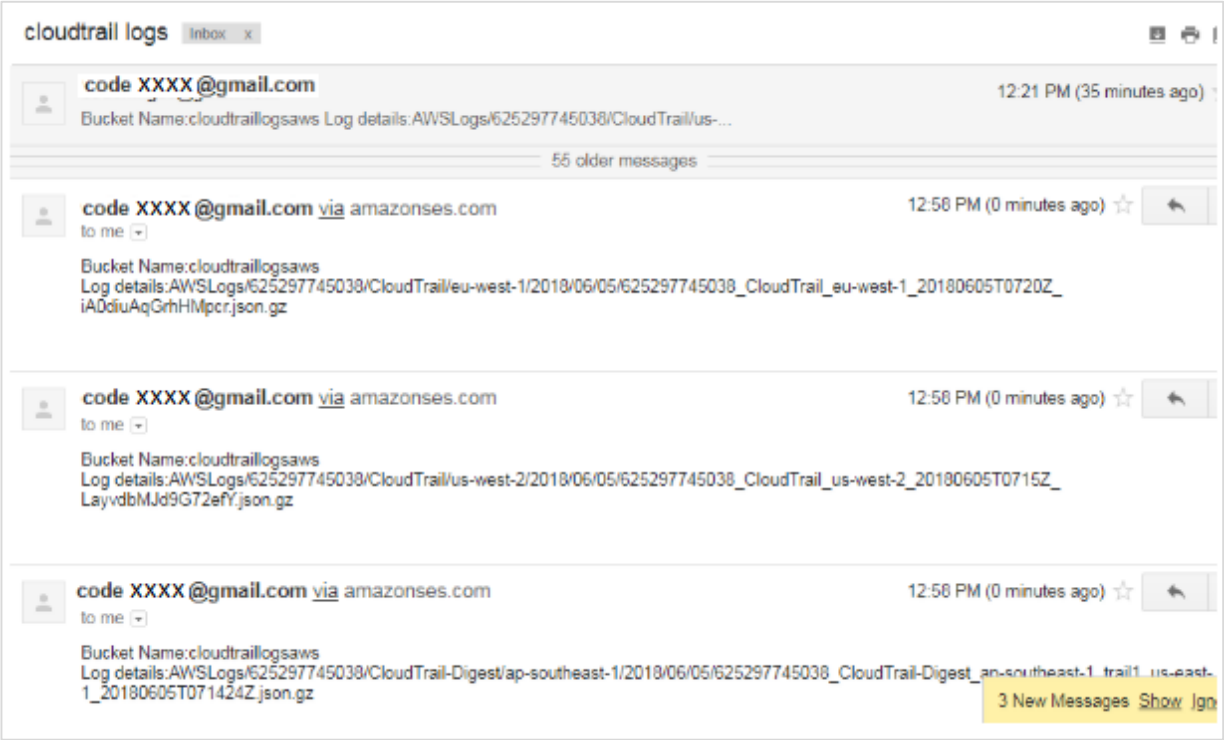
Add the S3 bucket details to add the trigger and add the following AWS Lambda code:

```
const aws =  require("aws-sdk");
const sns = new aws.SNS({
region:'us-east-1'
});
var ses = new aws.SES({
    region: 'us-east-1'
});
exports.handler = function(event, context, callback) {
    console.log("AWS lambda and SNS trigger ");
    console.log(event);
    const s3message = "Bucket Name:"+event.Records[0].s3.bucket.name+"\nLog
details:"+event.Records[0].s3.object.key;
    console.log(s3message);
    var eParams = {
        Destination: {
            ToAddresses: ["xxxxxxxxx12@gmail.com"]
        },
        Message: {
            Body: {
```

```
                Text: {
                    Data:s3message
                }
            },
            Subject: {
                Data: "cloudtrail logs"
            }
        },
        Source: "coxxxxxx@gmail.com"
    };

    var email = ses.sendEmail(eParams, function(err, data) {
        if (err) console.log(err);
        else {
            console.log("===EMAIL SENT===");
            console.log("EMAIL CODE END");
            console.log('EMAIL: ', email);
            context.succeed(event);
     callback(null, "email is send");
        }
    });
};
```

Note that we are taking the S3 bucket and log details from the event and sending mail using SES service as shown above.

Whenever any activity takes place in AWS console, the logs will be sent to S3 bucket and at the same time, AWS lambda will get triggered and the mail will be send to the email id mentioned in the code.



Note that you can process the logs as per your needs in AWS Lambda.

22. AWS Lambda — Using Lambda Function with Amazon Kinesis

AWS Kinesis service is used to capture/store real time tracking data coming from website clicks, logs, social media feeds. We can trigger AWS Lambda to perform additional processing on this logs.

Requisites

The basic requirements to get started with Kinesis and AWS Lambda are as shown:

- Create role with required permissions
- Create data stream in Kinesis
- Create AWS Lambda function.
- Add code to AWS Lambda
- Add data to Kinesis data stream

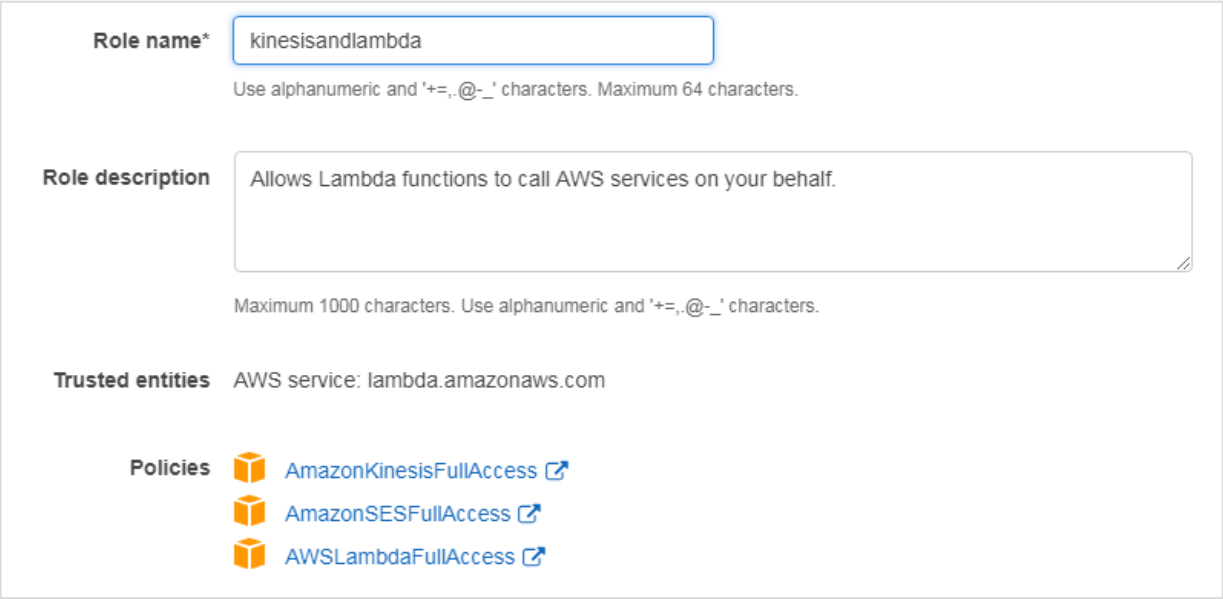
Example

Let us work on an example wherein we will trigger AWS Lambda for processing the data stream from Kinesis and send mail with the data received.

A simple block diagram for explaining the process is shown below:

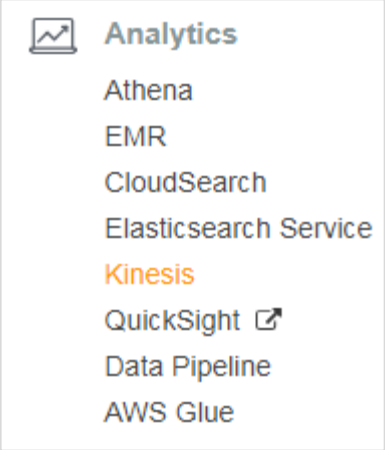
Create Role with Required Permissions

Go to AWS console and create a role.

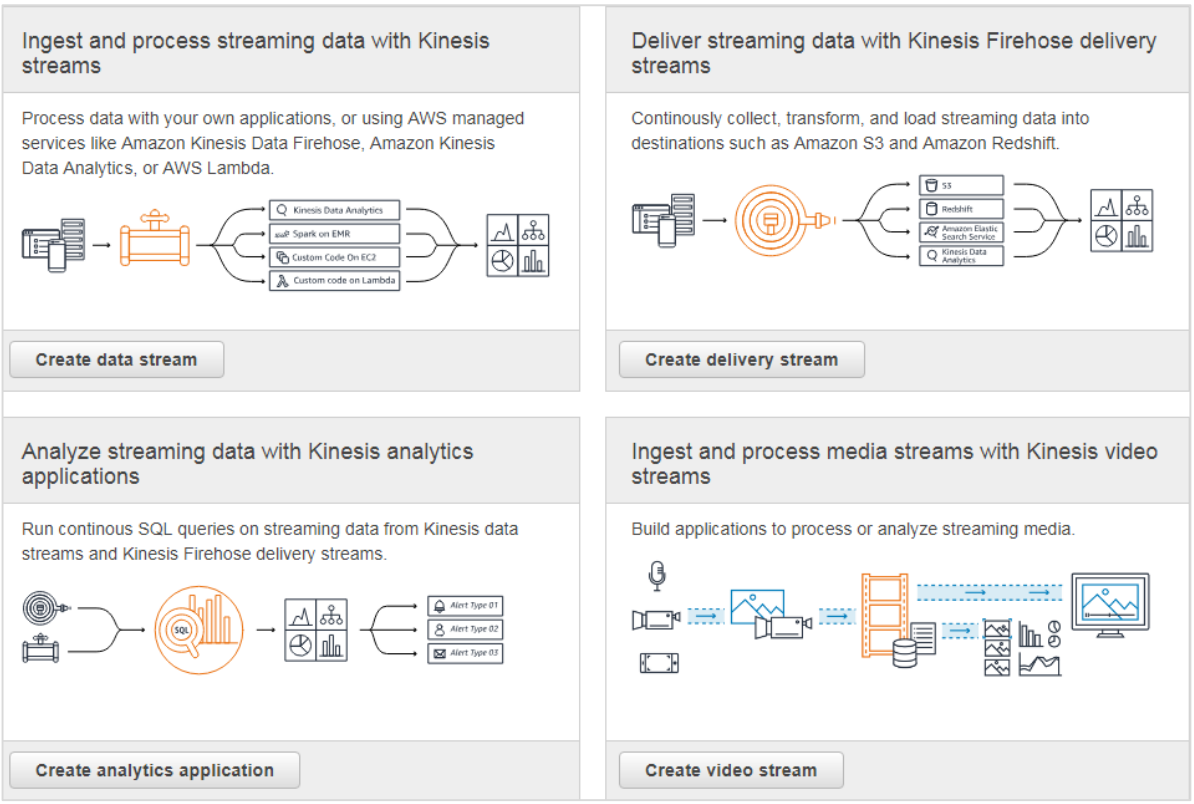


Create Data Stream in Kinesis

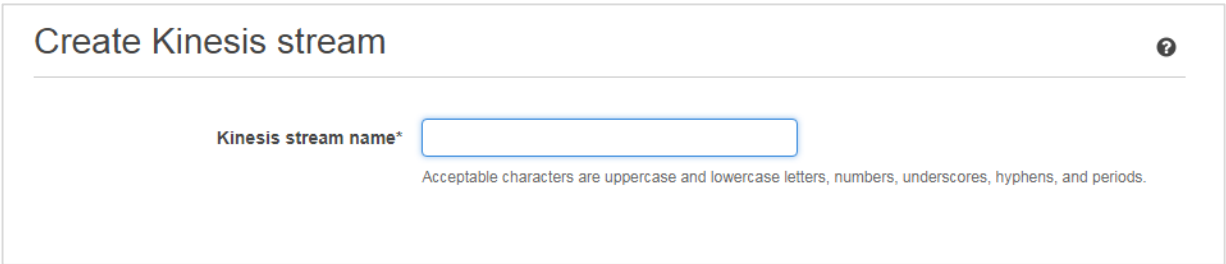
Go to AWS console and create data stream in kinesis.



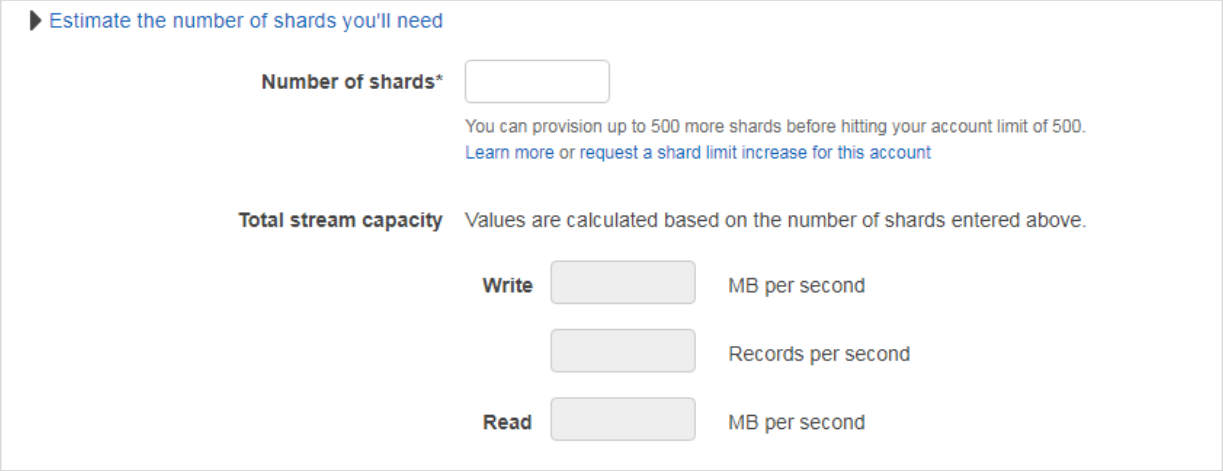
There are 4 options as shown. We will work on Create data stream in this example.



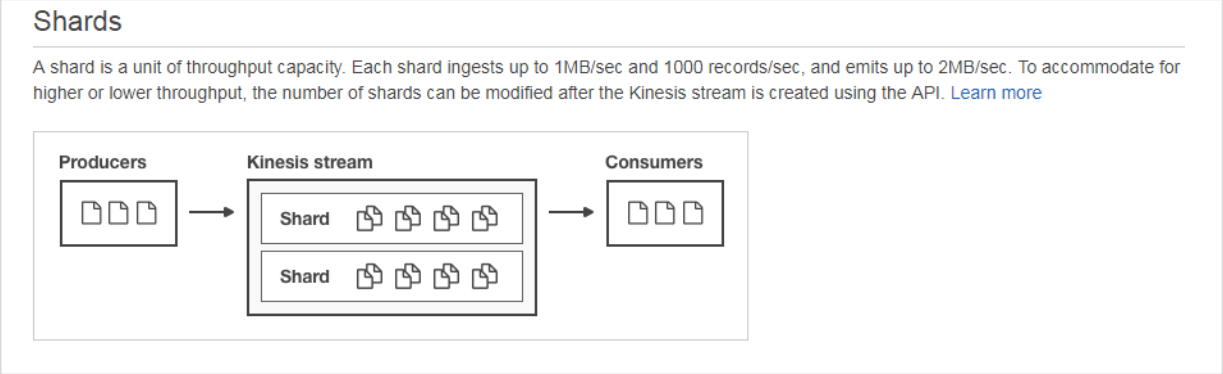
Click **Create data stream.** Enter the name in Kinesis stream name given below.



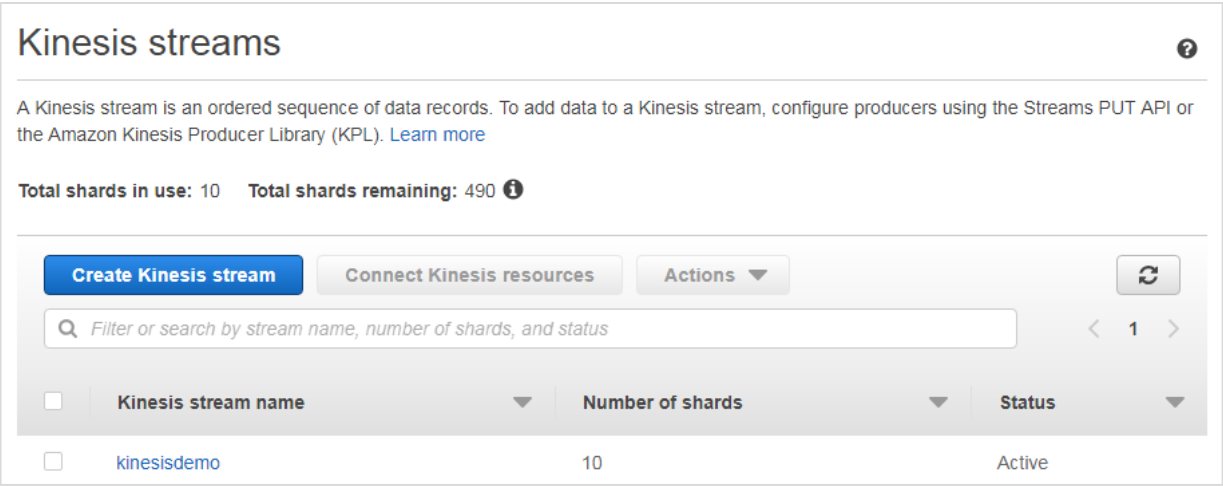
Enter number of shards for the data stream.



The details of Shards are as shown below:



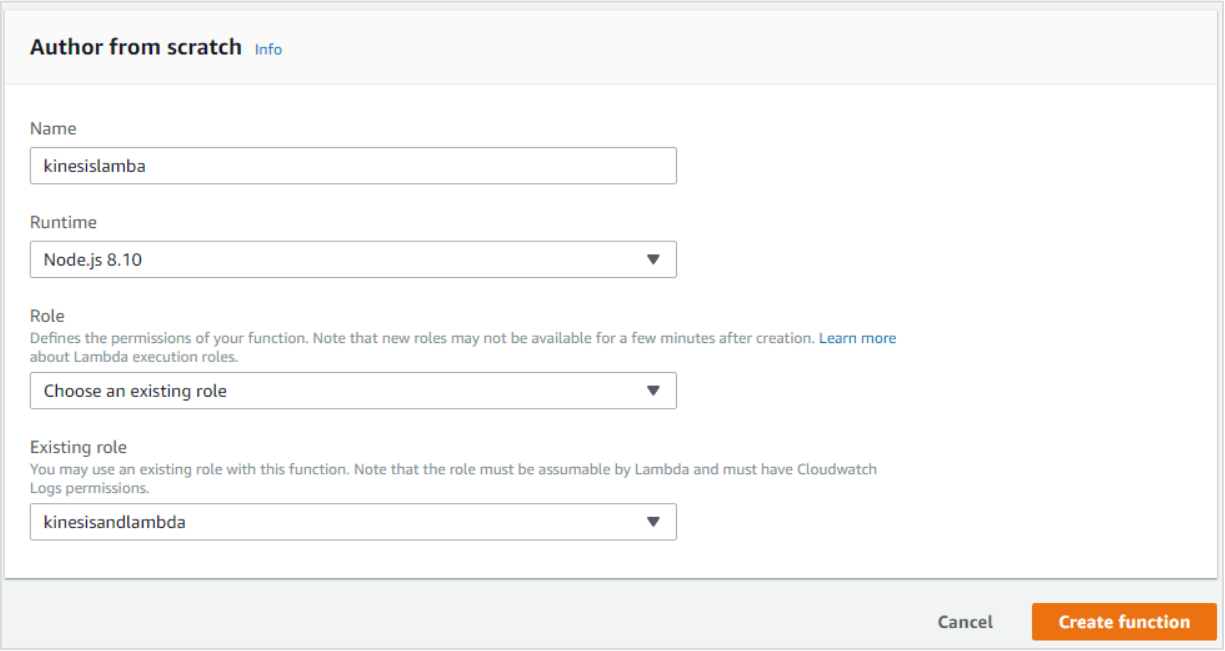
Enter the name and click the **Create Kinesis stream** button at the bottom.



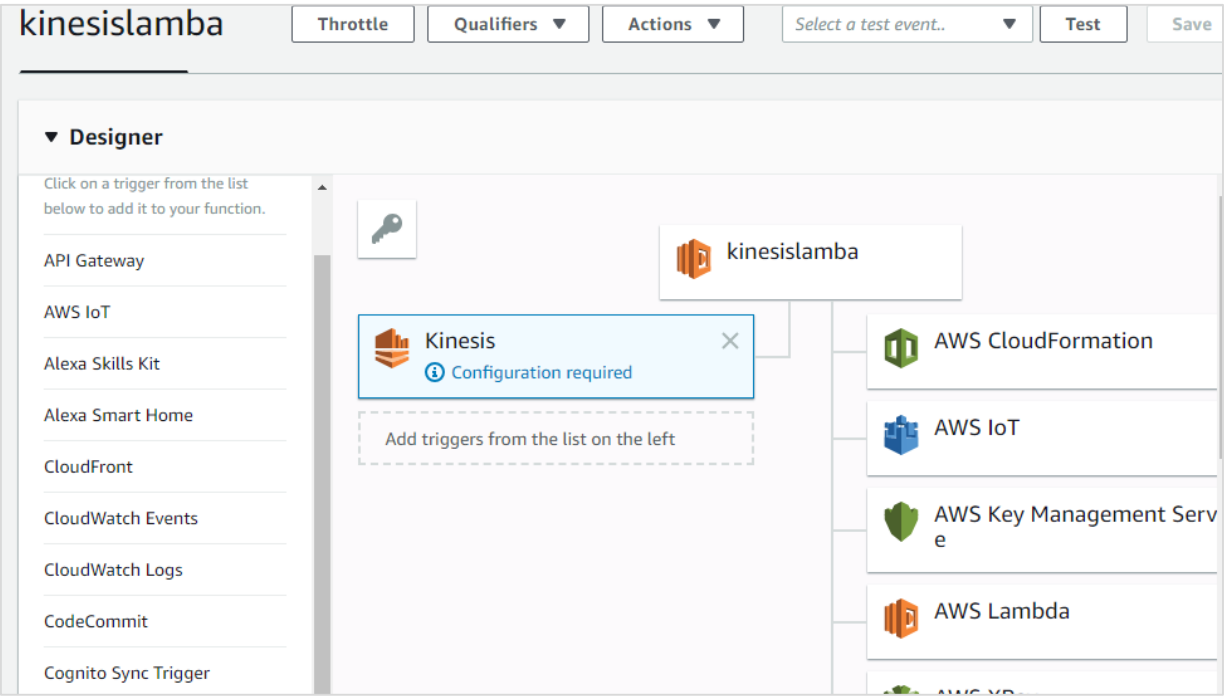
Note that it takes certain time for the stream to go active.

Create AWS Lambda Function

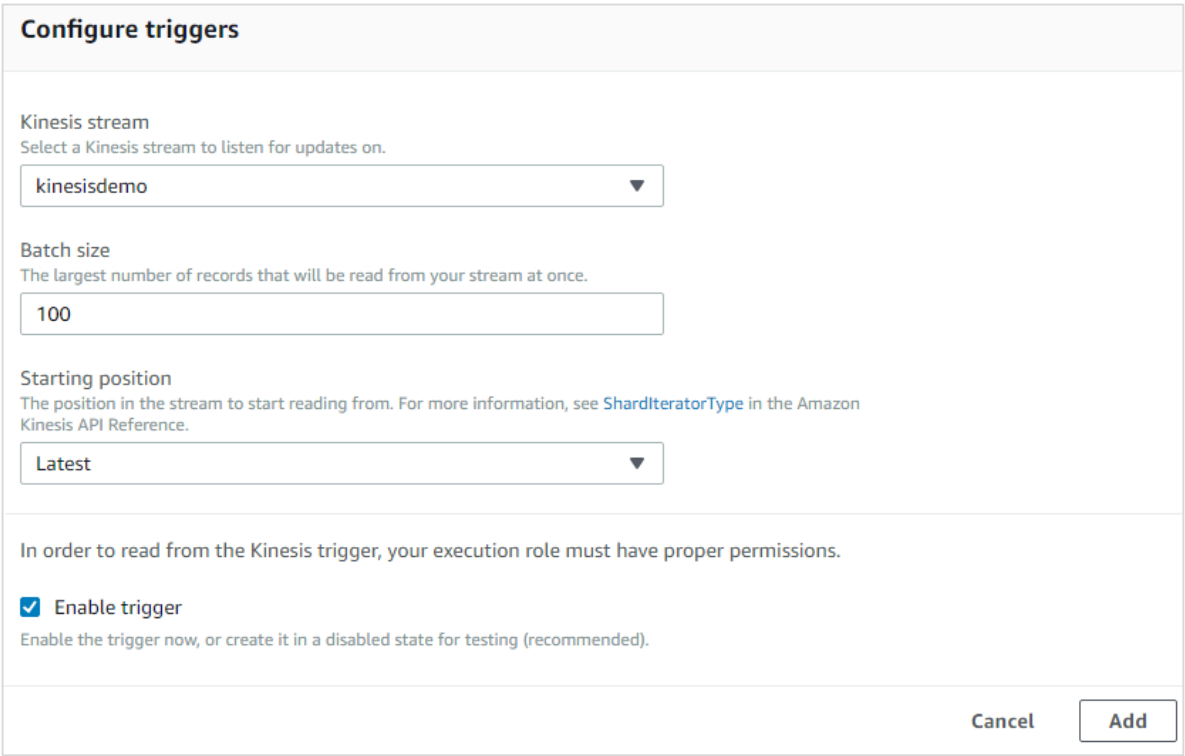
Go to AWS console and click Lambda. Create AWS Lambda function as shown:



Click **Create function** button at the end of the screen. Add Kinesis as the trigger to AWS Lambda.



Add configuration details to the Kinesis trigger:



Add the trigger and now add code to AWS Lambda.

Adding Code to AWS Lambda

For this purpose, we will use nodejs as the run-time. We will send mail once AWS Lambda is triggered with kinesis data stream.

```
const aws =  require("aws-sdk");
var ses = new aws.SES({
    region: 'us-east-1'
});
exports.handler = function(event, context, callback) {
    let payload = "";
    event.Records.forEach(function(record) {
        // Kinesis data is base64 encoded so decode here
        payload = new Buffer(record.kinesis.data, 'base64').toString('ascii');
```

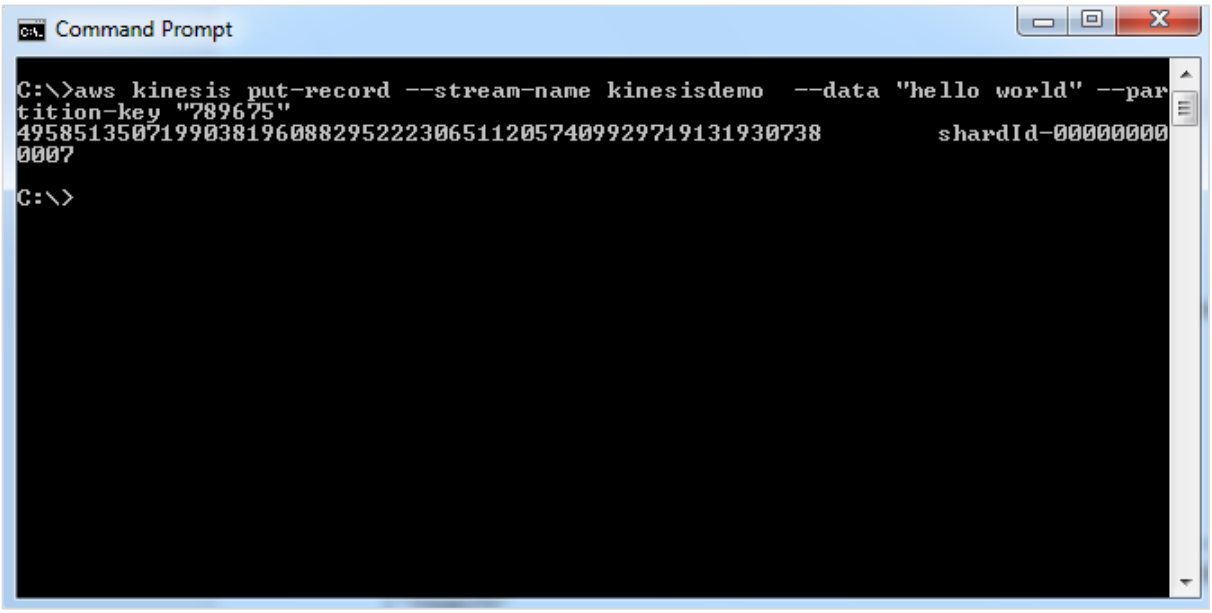
```
        console.log('Decoded payload:', payload);
    });
    var eParams = {
        Destination: {
            ToAddresses: ["xxxxxxx@gmail.com"]
        },
        Message: {
            Body: {
                Text: {
                    Data:payload
                }
            },
            Subject: {
                Data: "Kinesis data stream"
            }
        },
        Source: "cxxxxxxxxx@gmail.com"
    };

    var email = ses.sendEmail(eParams, function(err, data) {
        if (err) console.log(err);
        else {
            console.log("===EMAIL SENT===");
            console.log("EMAIL CODE END");
            console.log('EMAIL: ', email);
            context.succeed(event);
     callback(null, "email is send");
        }
    });
};
```

The event param has the data entered in kinesis data stream. The above aws lambda code will get activated once data is entered in kinesis data stream.

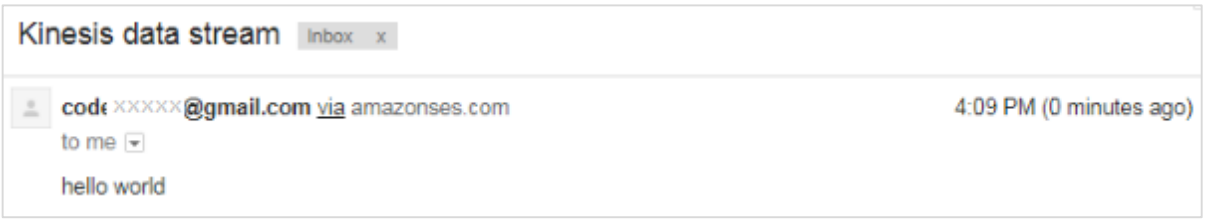
Add Data to Kinesis Data Stream

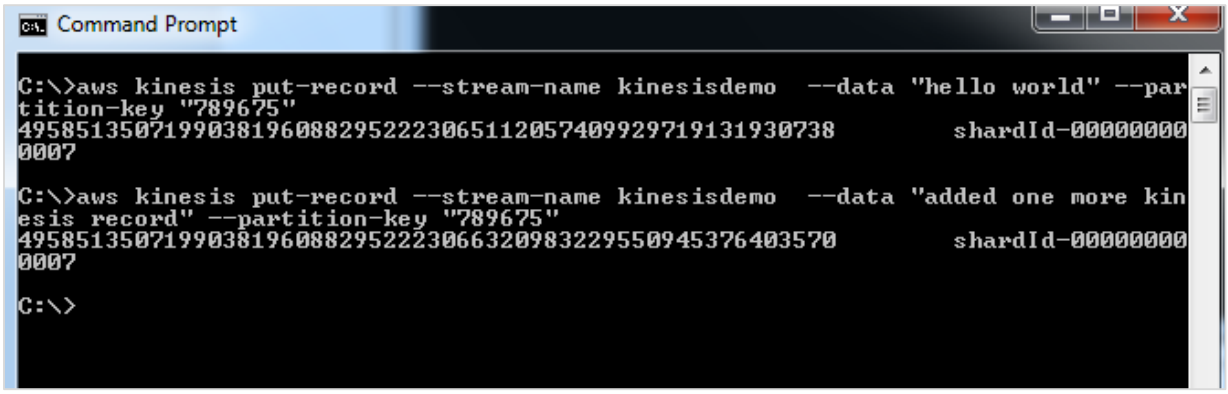
Here we will use AWS CLI to add data kinesis data stream as shown below. For this purpose, we can use the following command:

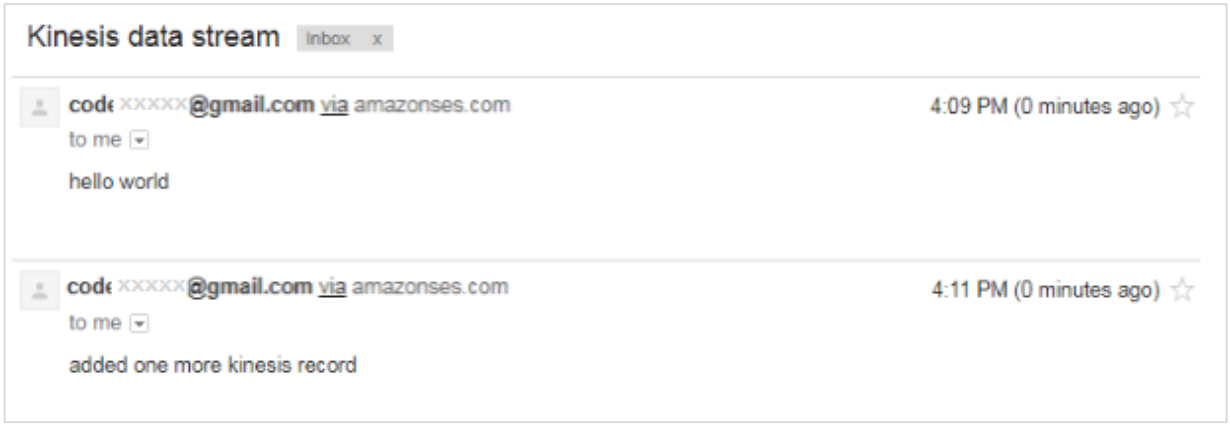
```
aws kinesis put-record --stream-name kinesisdemo  --data "hello world" --
partition-key "789675"
```



Then, AWS Lambda is activated and the mail is sent.






Kinesis data stream
Inbox x
code xxxxx@gmail.com via amazonses.com
4:09 PM (0 minutes ago)
to me
hello world
code xxxxx@gmail.com via amazonses.com
4:11 PM (0 minutes ago)
to me
added one more kinesis record

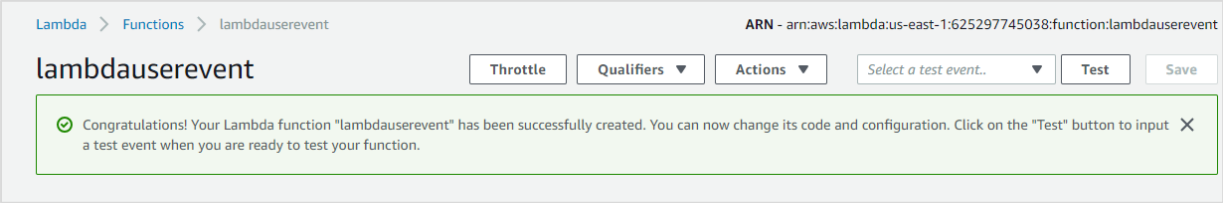
23. AWS Lambda — Using Lambda Function with Custom User Applications

We can use AWS lambda function to process using generated events by user application in the following two ways:

- Using AWS Console
- Using AWS CLI

Using AWS Console

From AWS console, we will work with events and AWS Lambda. For this purpose, go to AWS console and create a lambda function.

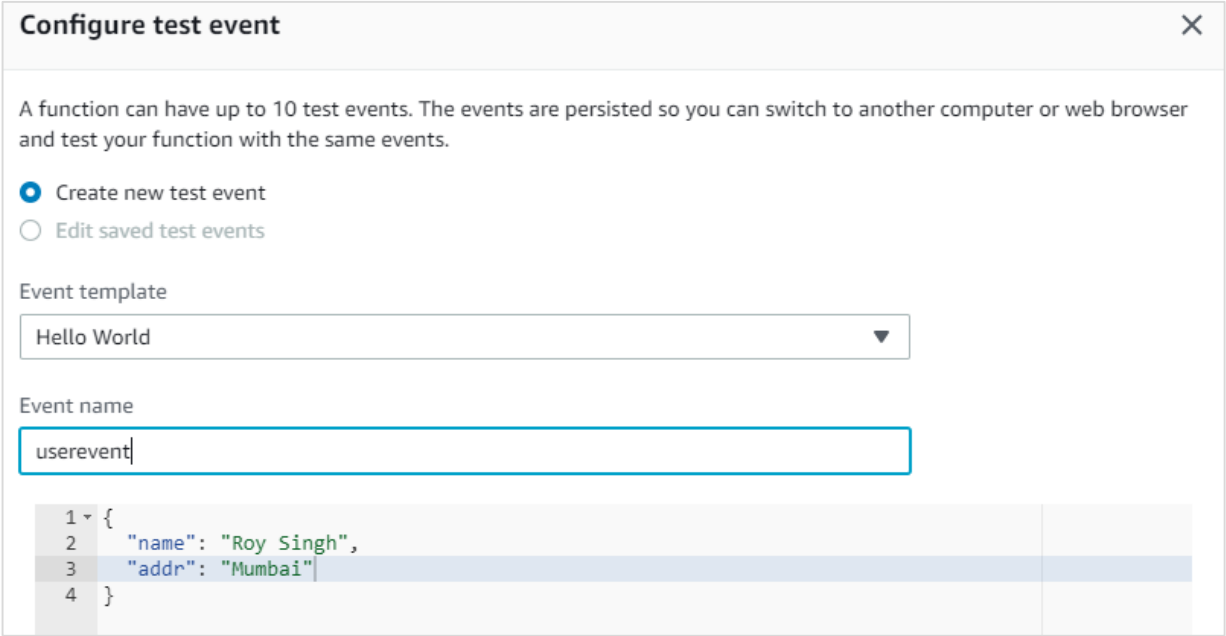


Next, let us add the code for AWS Lambda:

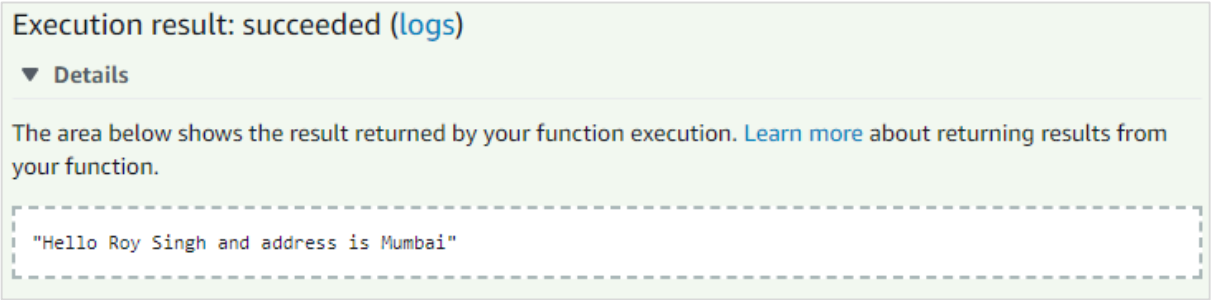
```
exports.handler = (event, context, callback) => {
    // TODO implement
    console.log("Hello => "+ event.name);
    console.log("Address =>"+ event.addr);
    callback(null, 'Hello '+event.name +" and address is "+ event.addr);
};
```

Note that in the above code, we are printing name and address using event.

The details to the event will be given using the test event created as follows:



Now, save the event and test it.



The corresponding log output is as shown here:

Using AWS CLI

We can invoke the above function using AWS CLI as follows:

```
aws lambda invoke --function-name "lambdauserevent" --log-type Tail --payload
file://C:\clioutput\input.txt C:\clioutput\outputfile.txt
```

The event details are given to payload and the output is stored at **C:\clioutput\outputfile.txt**. as follows:

input.txt

```
{"name":"Roy Singh", "addr":"Mumbai"}
```

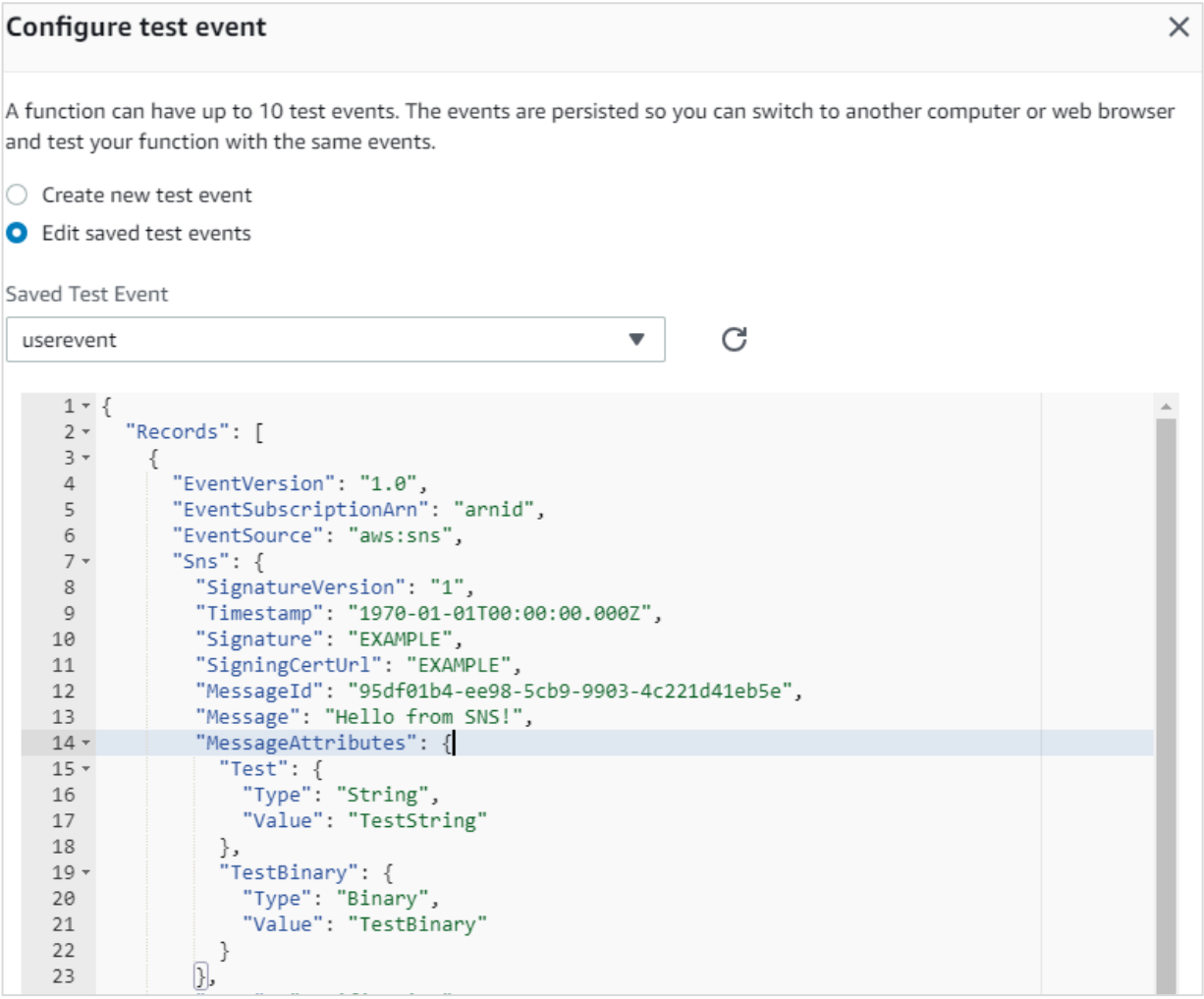
On invoking the Lambda using AWS CLI, you can see the output is as follows:

Similarly, in case you want to test AWS Lambda for any other AWS service, you can do so using the test event in AWS console and AWS CLI. A sample event for SNS service is shown below:

```
{
  "Records": [
    {
      "EventVersion": "1.0",
      "EventSubscriptionArn": "arnid",
      "EventSource": "aws:sns",
      "Sns": {
        "SignatureVersion": "1",
```

```
        "Timestamp": "1970-01-01T00:00:00.000Z",
        "Signature": "EXAMPLE",
        "SigningCertUrl": "EXAMPLE",
        "MessageId": "95df01b4-ee98-5cb9-9903-4c221d41eb5e",
        "Message": "Hello from SNS!",
        "MessageAttributes": {
          "Test": {
            "Type": "String",
            "Value": "TestString"
          },
          "TestBinary": {
            "Type": "Binary",
            "Value": "TestBinary"
          }
        },
        "Type": "Notification",
        "UnsubscribeUrl": "EXAMPLE",
        "TopicArn": "topicarn",
        "Subject": "TestInvoke"
      }
    }
  ]
}
```

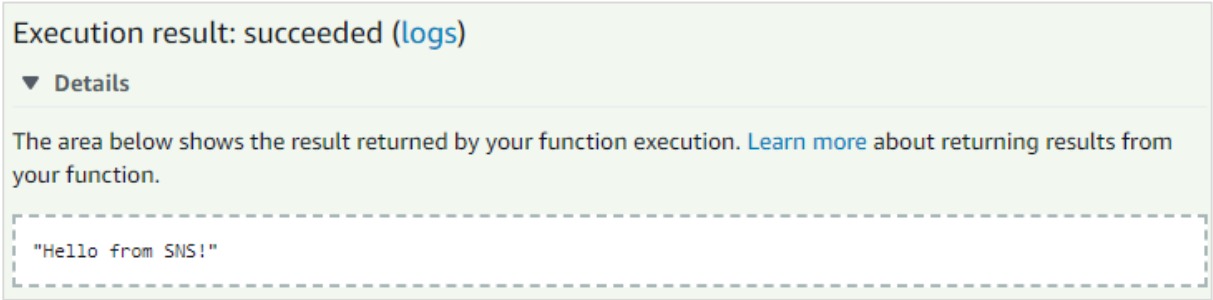
Let us add the sample event shown above and test it as shown:



In AWS Lambda, code will print the SNS message as shown in the example given below:

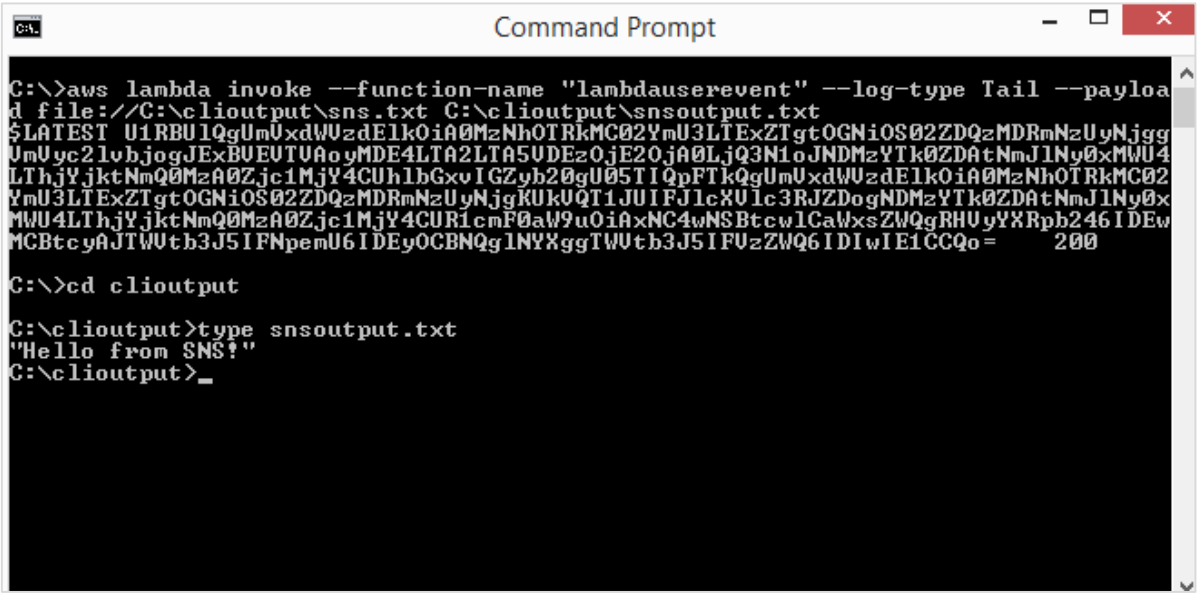
```
exports.handler = (event, context, callback) => {
    // TODO implement
    console.log(event.Records[0].Sns.Message);
```

```
    callback(null, event.Records[0].Sns.Message);};
```



Let us invoke the same using AWS CLI. Let us save the event in a file and use that for payload using the command shown:

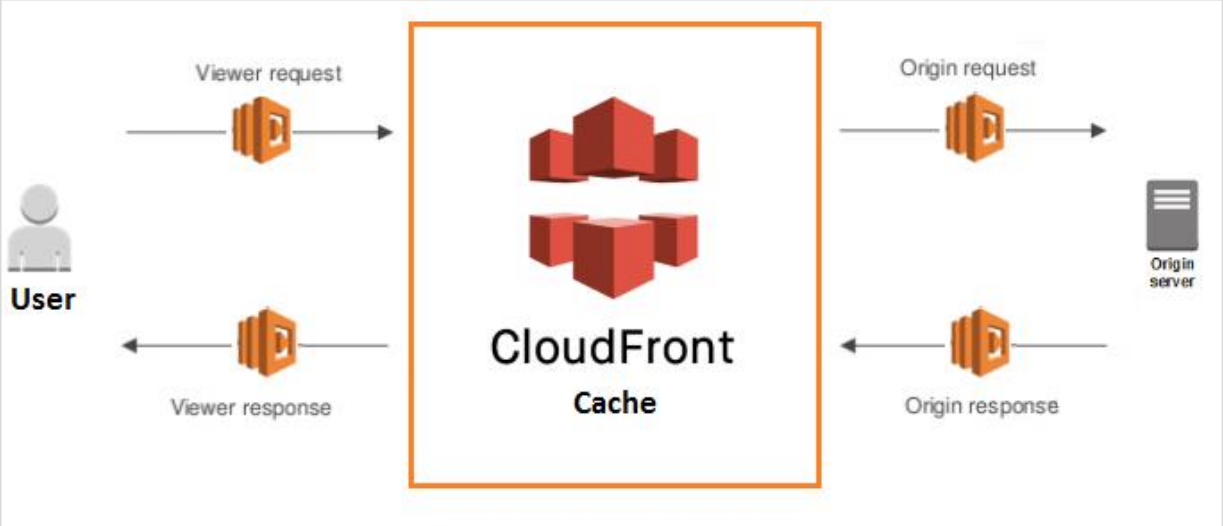
```
aws lambda invoke --function-name "lambdauserevent" --log-type Tail --payload
file://C:\clioutput\sns.txt C:\clioutput\snsoutput.txt
```



24. AWS Lambda — Using AWS Lambda@Edge with CloudFront

Lambda@Edge is an addition to the AWS Lambda compute service which is used to customize the content that cloudfront delivers.

The block diagram which shows the working of AWS Lambda with cloudfront from AWS is shown below:



There are four ways in which AWS Lambda can be used:

- **Viewer Request:** End user makes the request called Viewer Request to CloudFront
- **Origin Request:** CloudFront forwards the request to the origin
- **Origin Response:** CloudFront receives the response from the origin
- **Viewer Response:** CloudFront send the response to the viewer

We can use Lambda@Edge for the following purposes:

- To change the headers at the request and response time.
- Add cookies details to the headers. Carry out AB testing based on the request and response.
- Redirect the URL to another site, based on the header details.
- We can fetch the user-agent from the headers and find out the details of the browser, OS, etc.

Requisites

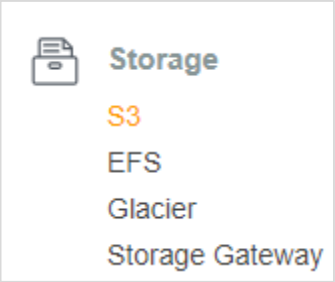
To start with working on CloudFront and Lambda@Edge, we need the following:

- Create S3 storage bucket with file details
- Create role which will allow permission to work with CloudFront and Lambda@Edge
- Create CloudFront distribution
- Create lambda function
- Add lambda function details to cloudfront
- Check the cloudfront url in browser

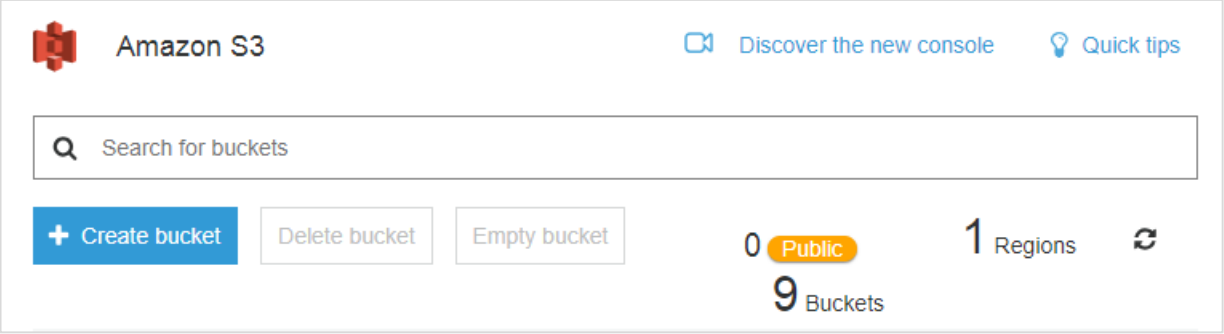
We will work on an example with CloudFront and Lambda@Egde, wherein we will host the page and change the response when detected as desktop and devices.

Create S3 Storage Bucket with File Details

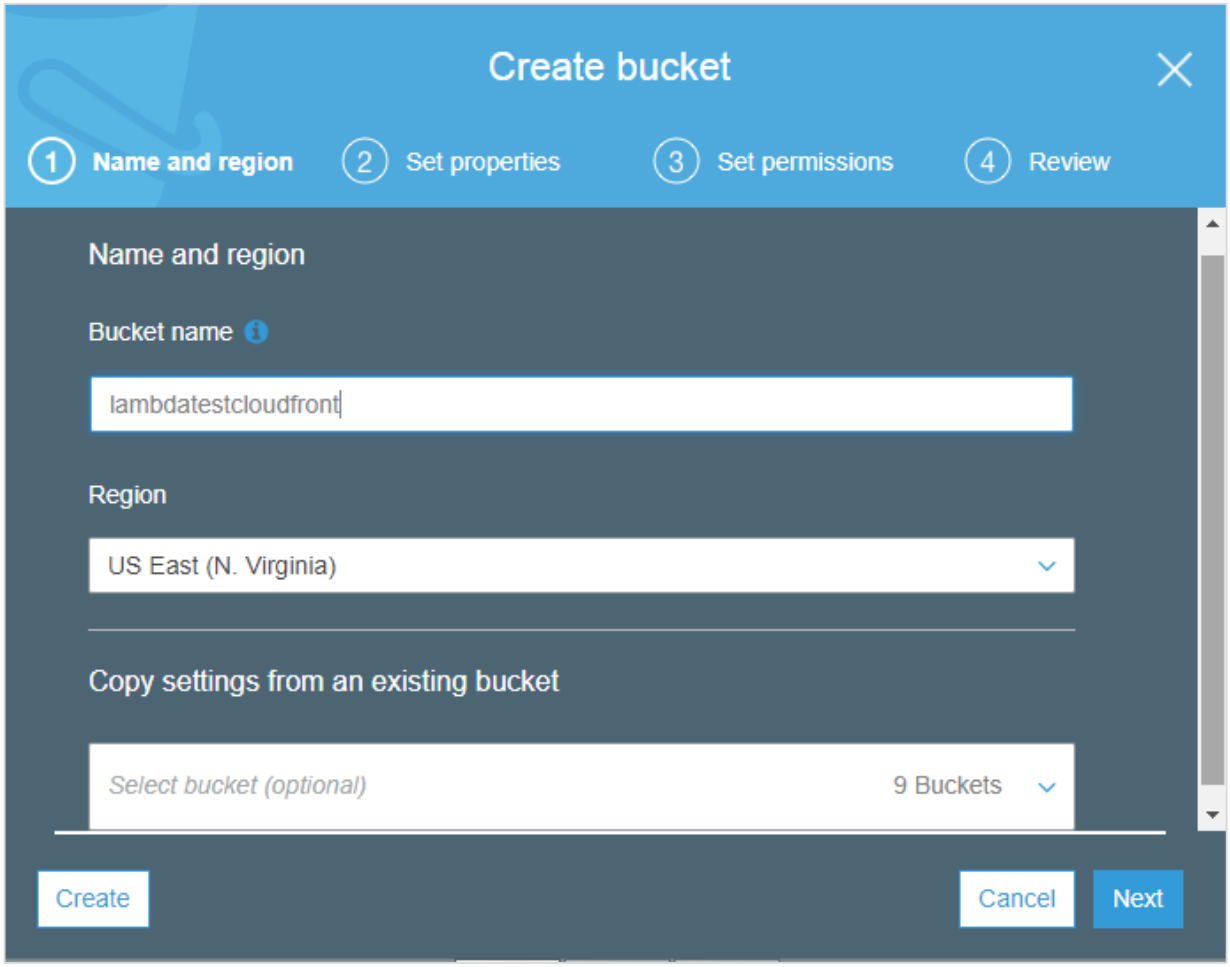
Login to AWS console and create a bucket in S3 and add the **.html** file which you want to display.



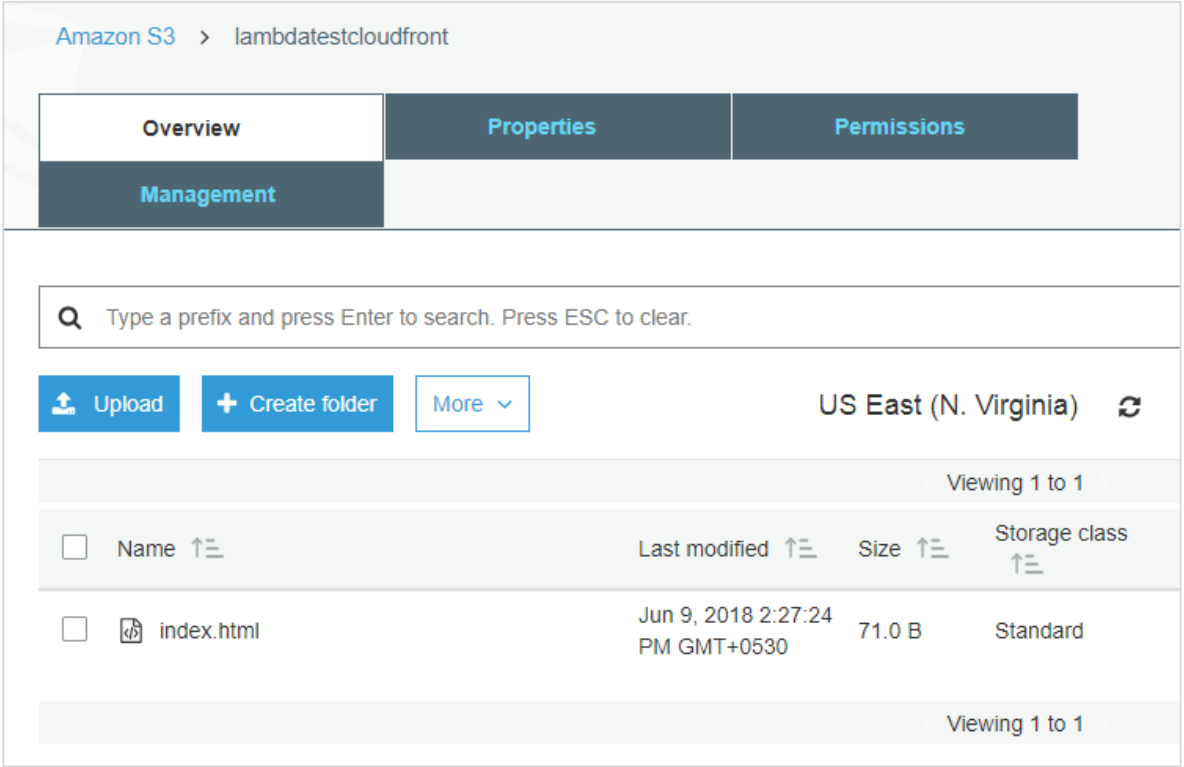
Click on **S3** and **Create bucket** as shown below:



Now, click **Create bucket** button and add the details of the bucket as shown below:



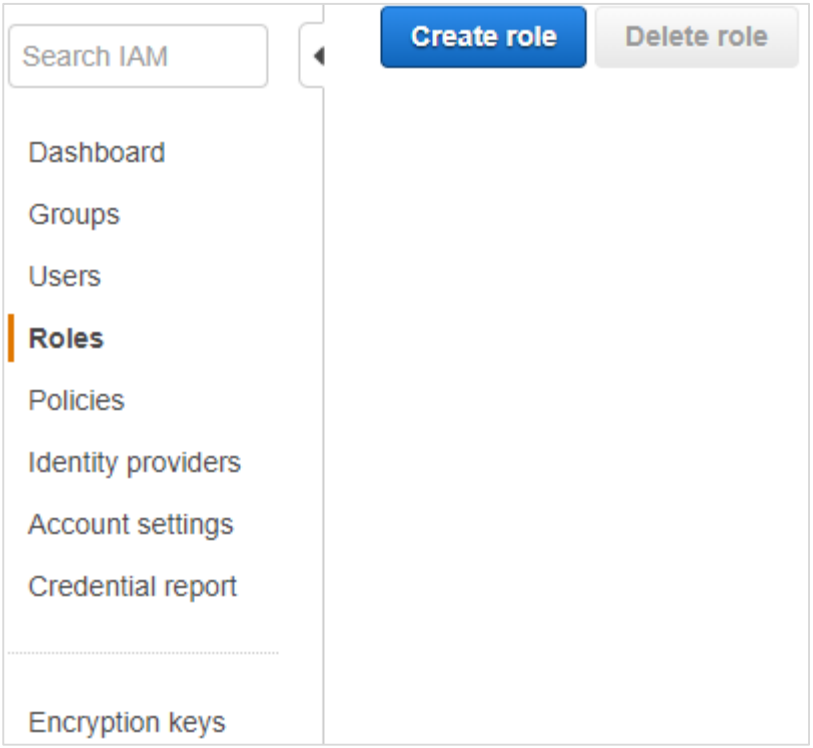
Click on **Create** button and upload the .html in it.



Create Role

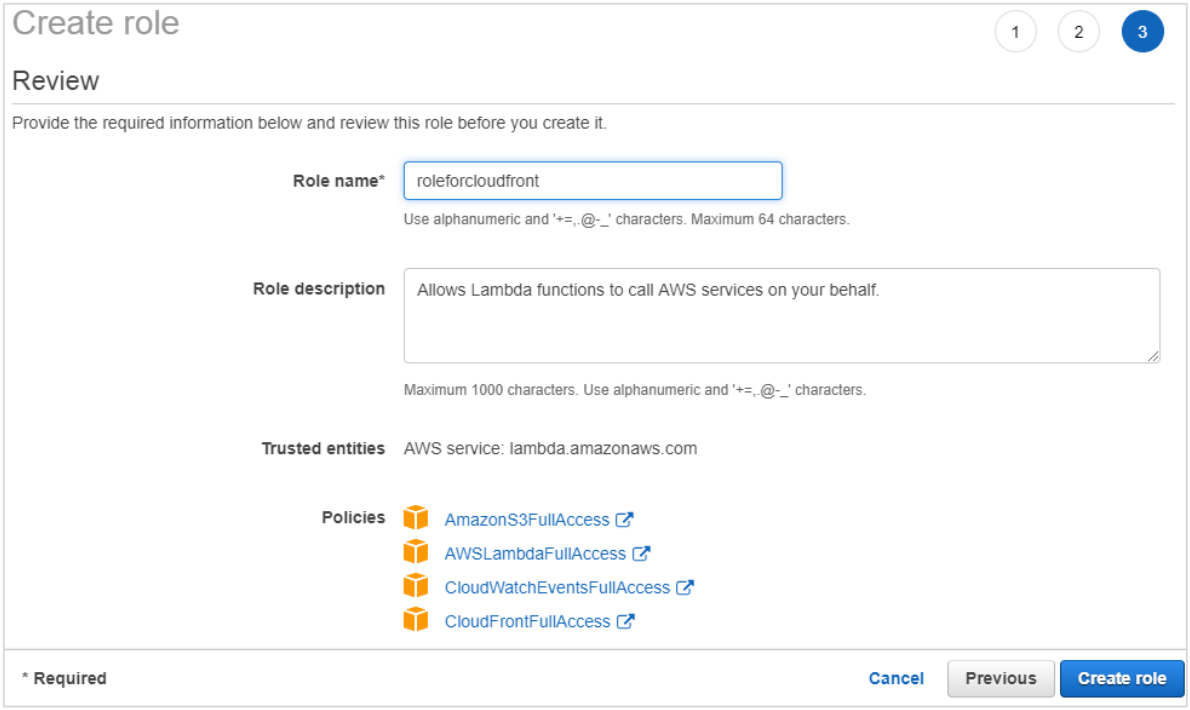
Go to AWS console and click **IAM.**

Now, click **Roles -> Create role** button as shown:

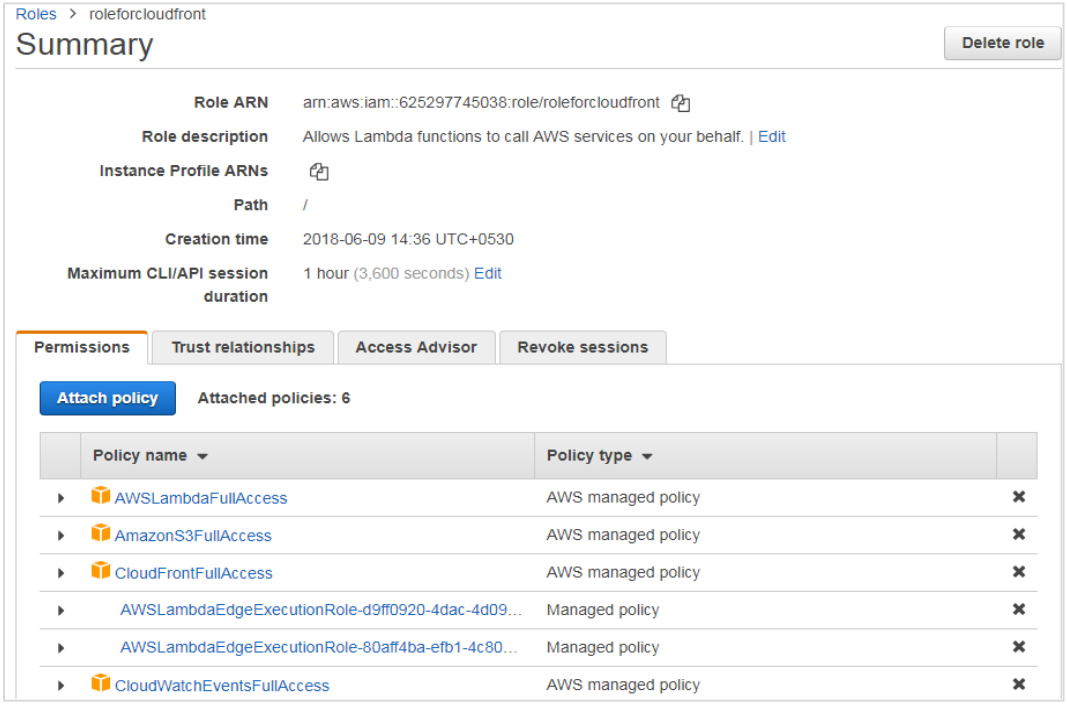


Choose the permission for **S3, Lambda** and **Cloudfront**. It is a good practice to create the policy giving permission to only the required function, storage by using the ARN details.

In the example discussed below, we are showing the **Full Access** permission. Policies for the

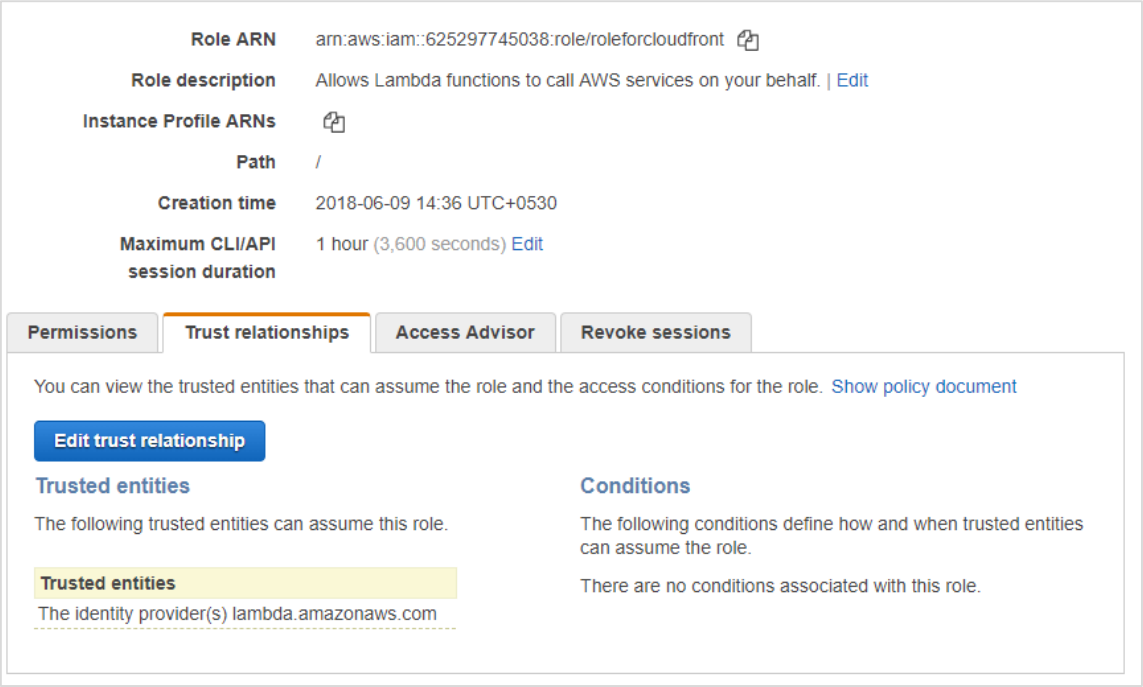


role name **roleforcloudfront** is added as shown above. Click on **Create role.**

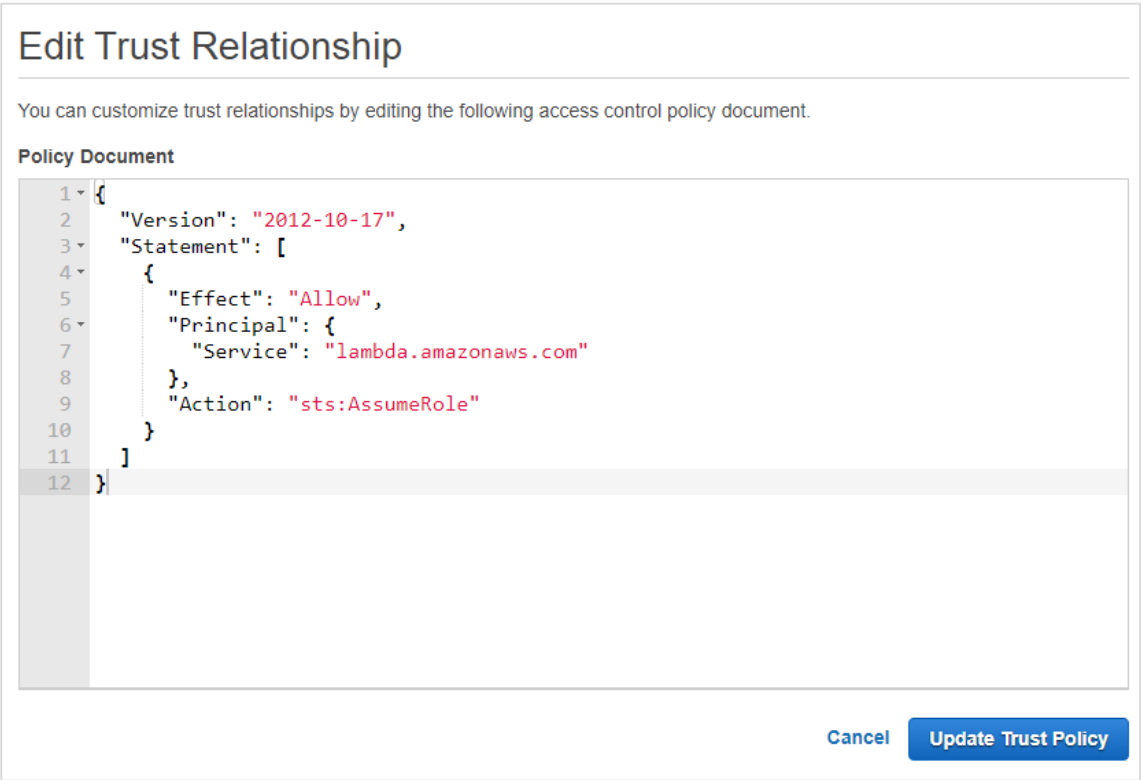


All the policy required for lambda@edge and cloudfront are as shown above. There is a additional step to be done here since incase of cloudfront the url will be available across region and it needs a trust relationship between the services we are using.

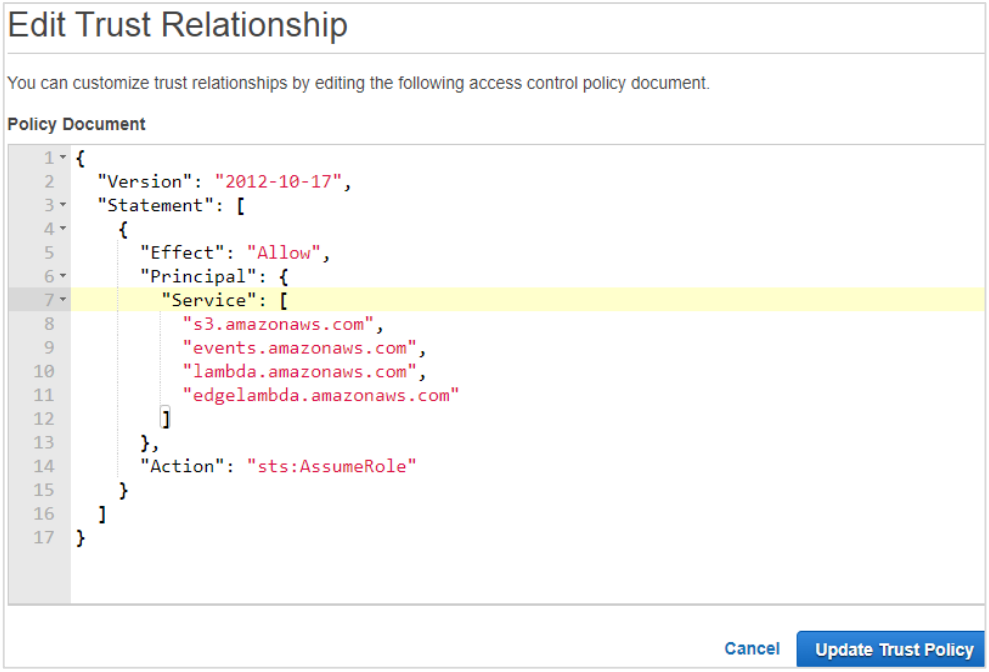
Now, for the role created, click on **Trust relationships** tab as shown:



Click on **Edit Trust Relationship** as shown below:



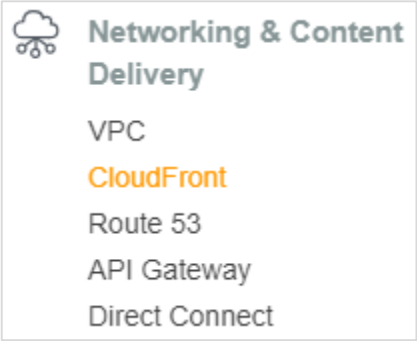
It displays a policy document. We need to add the other services in the **Principal -> Service** which we are planning to use. The final trust relationship policy document is as shown below:



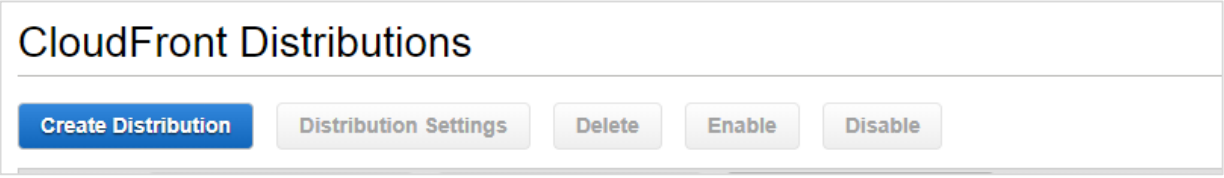
Click **Update Trust Policy** button to save the changes.

Create CloudFront Distribution

Go to CloudFront service as shown below:



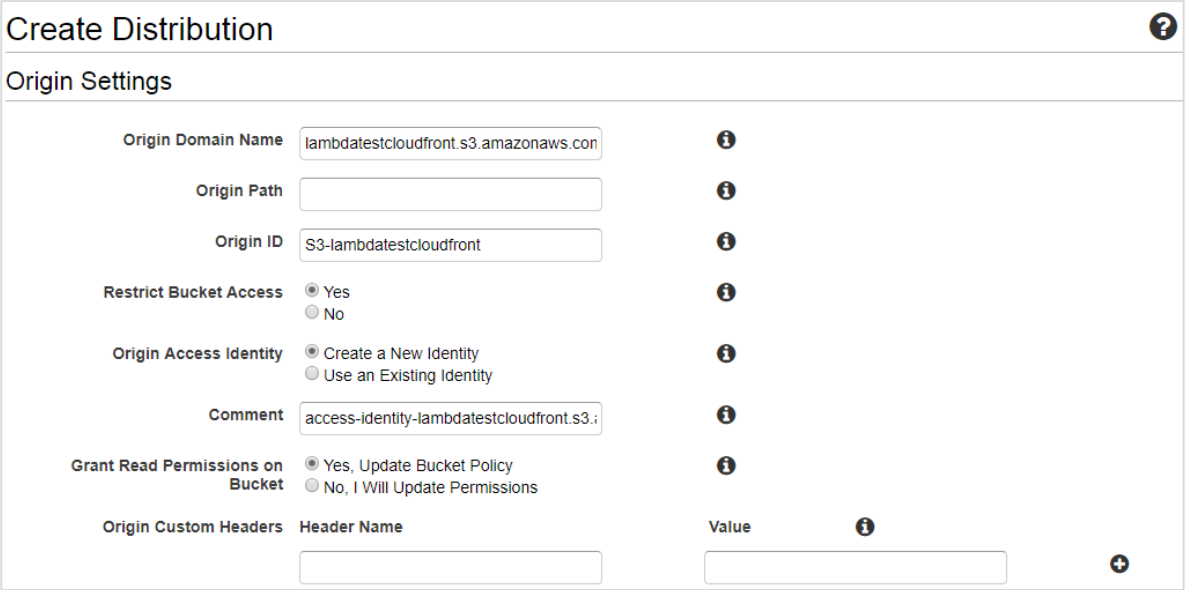
Click on CloudFront service and click on **Create Distribution:**



Origin Settings, Behaviour Settings and Distribution settings

Let us look into these settings one by one:

Origin Settings



Various parameters of Origin settings are explained as below:

Origin Domain Name: This is the name of the *S3* bucket where we have stored the html files. We can also store images, if any, in the S3 bucket by creating folders of our choice.

Origin Path: Here you need to enter the name of the folder where the files are stored. At present, we do not have this folder, so we will keep it blank for now.

Origin ID: It gets populated when the origin domain name is selected. You can change the id as per your choice.

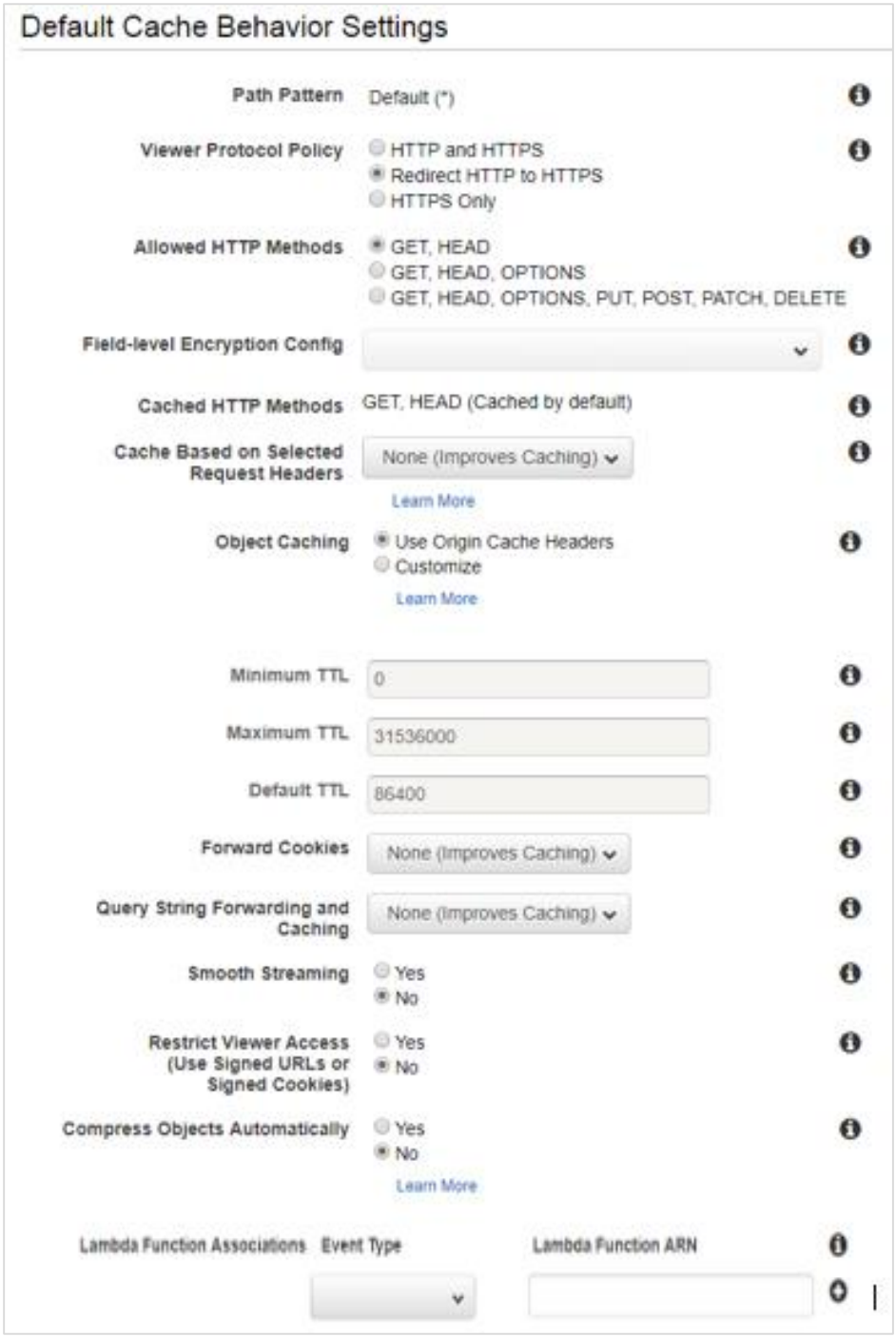
Restrict Bucket Access: In this, we will choose the option **yes**. Here we need security for the S3 bucket so that no one has the access to the S3 bucket. For this option there are some more options populated like **Origin Access Identity, Comment and Grant Read Permission on Bucket.**

Origin Access Identity: We have used create a new identity option.You can also choose the existing identity. This creates a new identity which is used by CloudFront to read the details from S3 bucket.

Grand Read Permission on Bucket: For this, choose the option **Yes**.

Origin Custom Headers: We will keep the headers blank here, as we do not need the details right now.

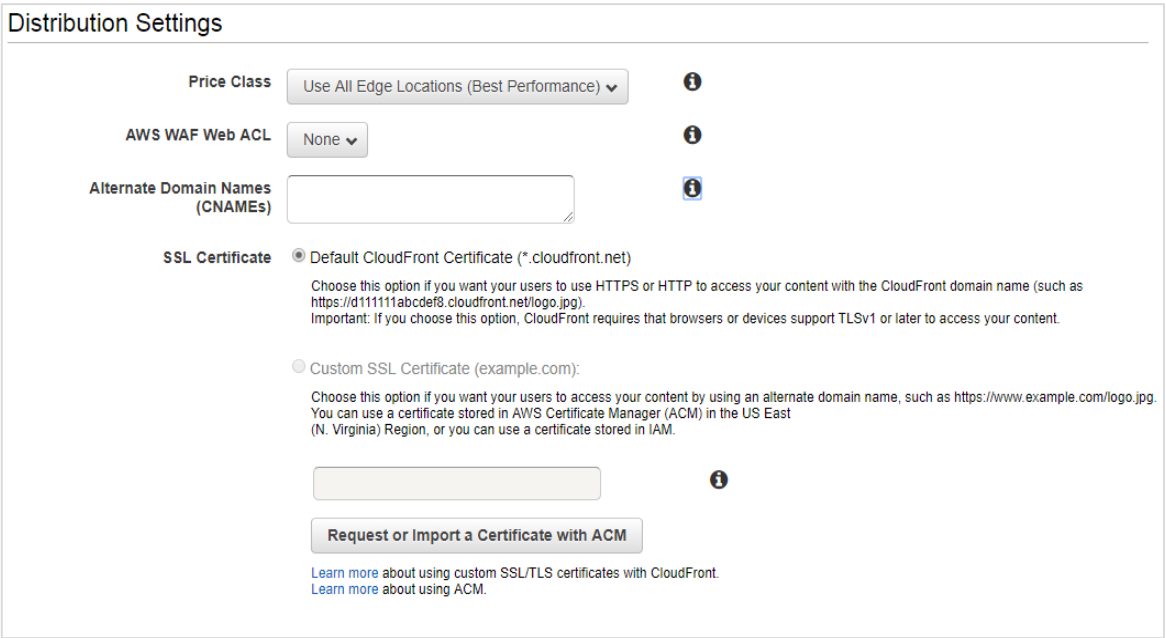
Next, let us discuss and fill up the **Behaviour Settings** for Cloudront distribution:



Now, select the protocol – https or http, and the caching option. Note that the default caching is 86400 or 24 hrs. You can change this value as per the requirement.

Click **Object Caching** (customize option) to change the caching. You can use **smooth streaming** in case if there any videos on your page. Here, we are keeping the default option available. Once the lambda function is created, its details will be added.

The details for distribution settings are shown below:



Various parameters of distribution settings are explained below:

Price class: It has details like the origin of users traffic. Note that here we have selected the default one - **Use All Edge Locations**.

AWS WAF Web ACL: This is for web application firewall selection. Here, it has option as **None**. First, we need to create the firewall in AWS. It provides security to the site.

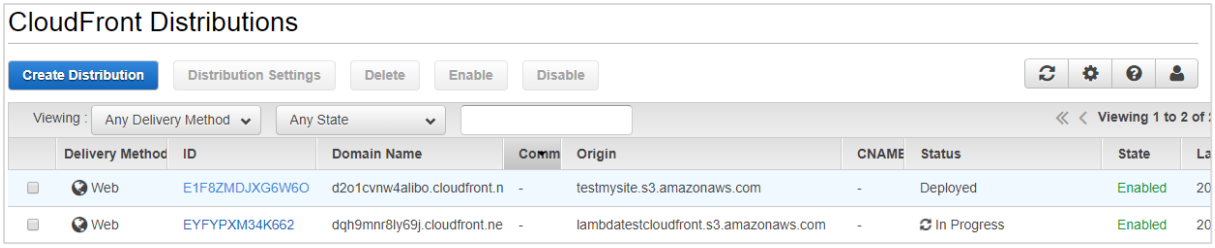
Alternate Domain Names: Here you can specify the domain name if you have.

SSL Certificate: This has all the details to be selected for SSL certificate. We will keep the default ones.

Default Root Object: Here we will specify the filename which we have uploaded in S3. For this, we need the content from the .html to be displayed by default.

For the rest, we will keep the default setting.

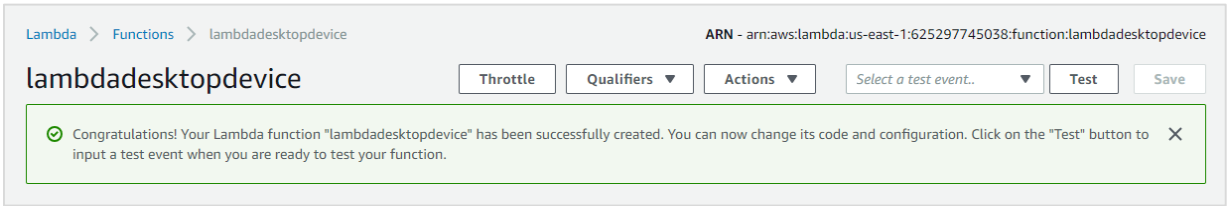
Click **Create Distribution** button to add the distribution.



Note that the distribution will take some time to show the status as deployed.

Create AWS Lambda Function

Go to AWS console and create Lambda function.



In AWS Lambda code, we will take the request headers and check the user-agent. If the user-agent is from desktop, we will change the response to display message as **"DESKTOP : Welcome to AWS Lambda with Cloudfront!"** and if device the message will be **"MOBILE DEVICES : Hello from Lambda@Edge!"**

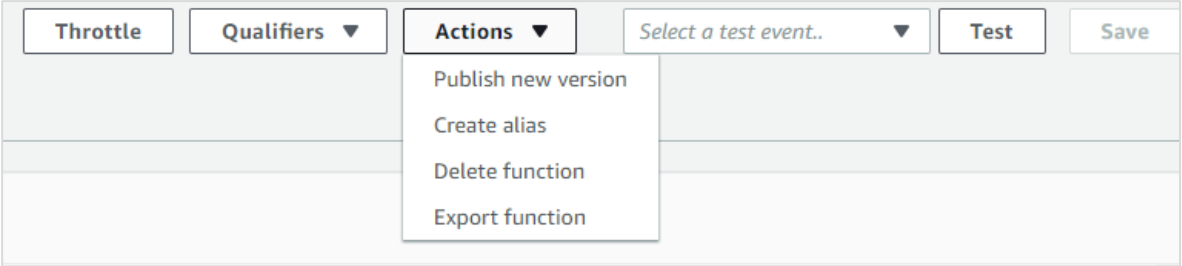
The corresponding AWS Lambda code is as shown below:

```
let content = `
<\!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="utf-8">
    <title>Simple Lambda@Edge Static Content Response</title>
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
  </head>
  <body>
    <h1>MOBILE DEVICES : Hello from Lambda@Edge!</h1>
  </body>
```

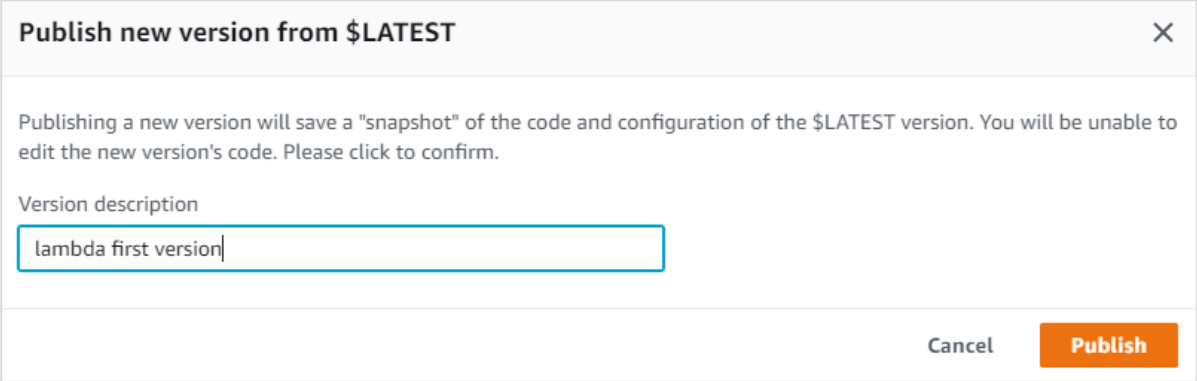
```
</html>
`;
let content1 = `
<\!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="utf-8">
    <title>Simple Lambda@Edge Static Content Response</title>
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
  </head>
  <body>
    <h1>DESKTOP : Welcome to AWS Lambda with Cloudfront!</h1>
  </body>
</html>
`;
exports.handler = (event, context, callback) => {
     let request = event.Records[0].cf.request;
     let finalrequest = JSON.stringify(request);
     let headers = request.headers;
     let useragent = JSON.stringify(headers["user-agent"][0].value);
     let str = "";
     if(/Android|webOS|iPhone|iPad|iPod|BlackBerry|IEMobile|Opera
Mini|Mobile|mobile|CriOS/i.test(useragent)) {
            str = content;
     } else {
            str = content1;
     }
    const response = {
        status: '200',
        statusDescription: 'OK',
        body: str+useragent,
    };
    callback(null, response);
};
```

Now, save the Lambda function. Note that we need to publish the Lambda function so that it can be used with all regions. To publish, we need to do the following:

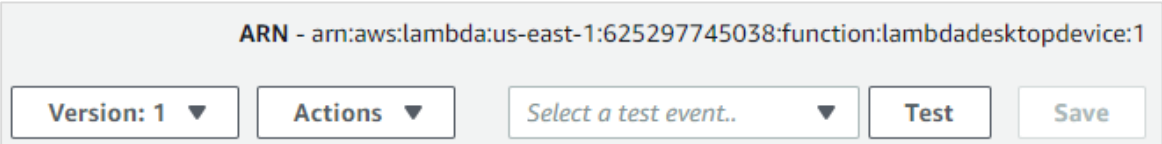
From Actions dropdown, select **Publish new version** as shown below:



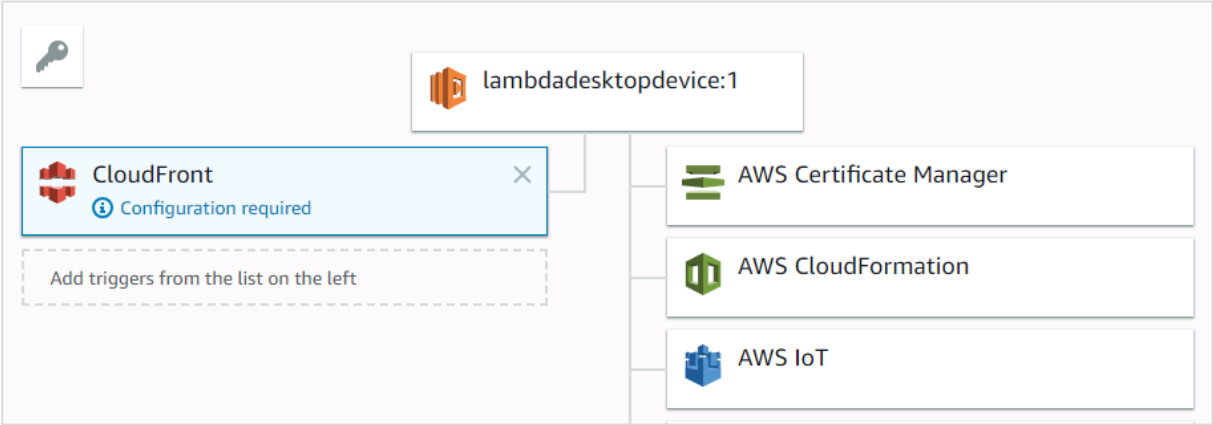
If you , click **Publish new version,** it displays the following screen:



Now, enter the Version description and click **Publish**.The ARN will display the version of the AWS Lambda function created as shown below:

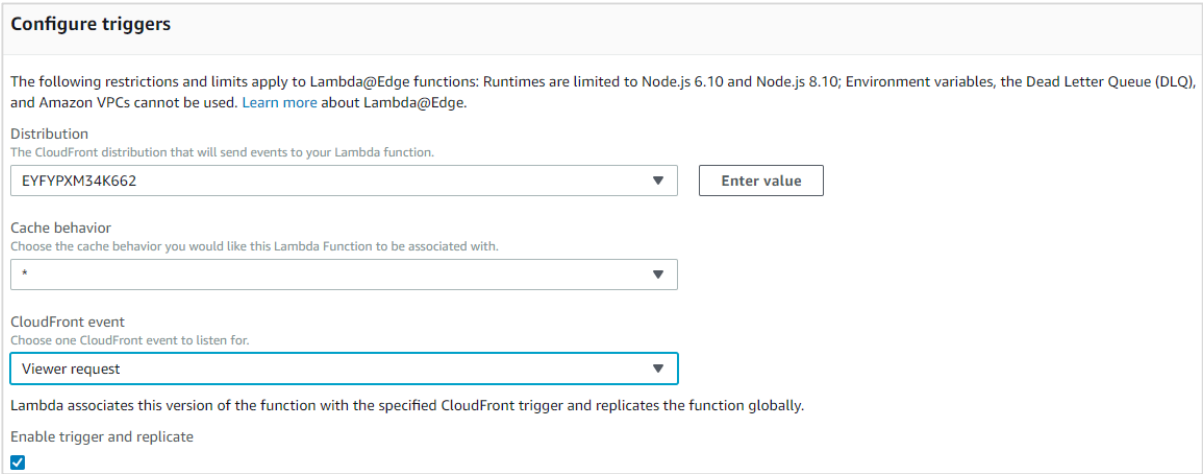


Add CloudFront trigger to the new version created as shown below:

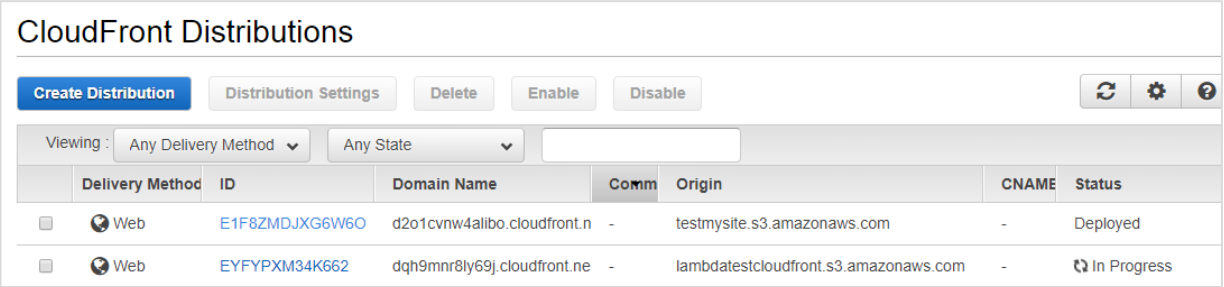


Now, add the configuration details for CloudFront .The CloudFront event has option for **Viewer request, Origin request, Origin response,** and **Viewer response.**

Next, choose the CloudFront distribution created earlier. From **events,** we will select **Viewer request**. Based on the viewer request, the desktop/device from user-agent will be decided and the response will be changed. Next, add the trigger details.



Once the trigger is added, we need to wait for the distribution from CloudFront to be deployed.



Once the status is changed to **Deployed**, we can test the CloudFront url and check the domain name in browser.

The display in desktop browser is as shown below. Here we have printed the user-agent from the viewer-request event.

This is the display in mobile device.

Thus, in the above example, we have used Lambda@Edge to change response on desktop and mobile device.

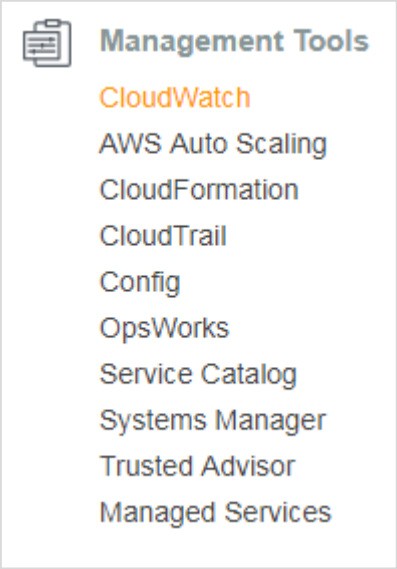
25. AWS Lambda — Monitoring and TroubleShooting using Cloudwatch

Functions created in AWS Lambda are monitored by Amazon CloudWatch. It helps in logging all the requests made to the Lambda function when it is triggered.

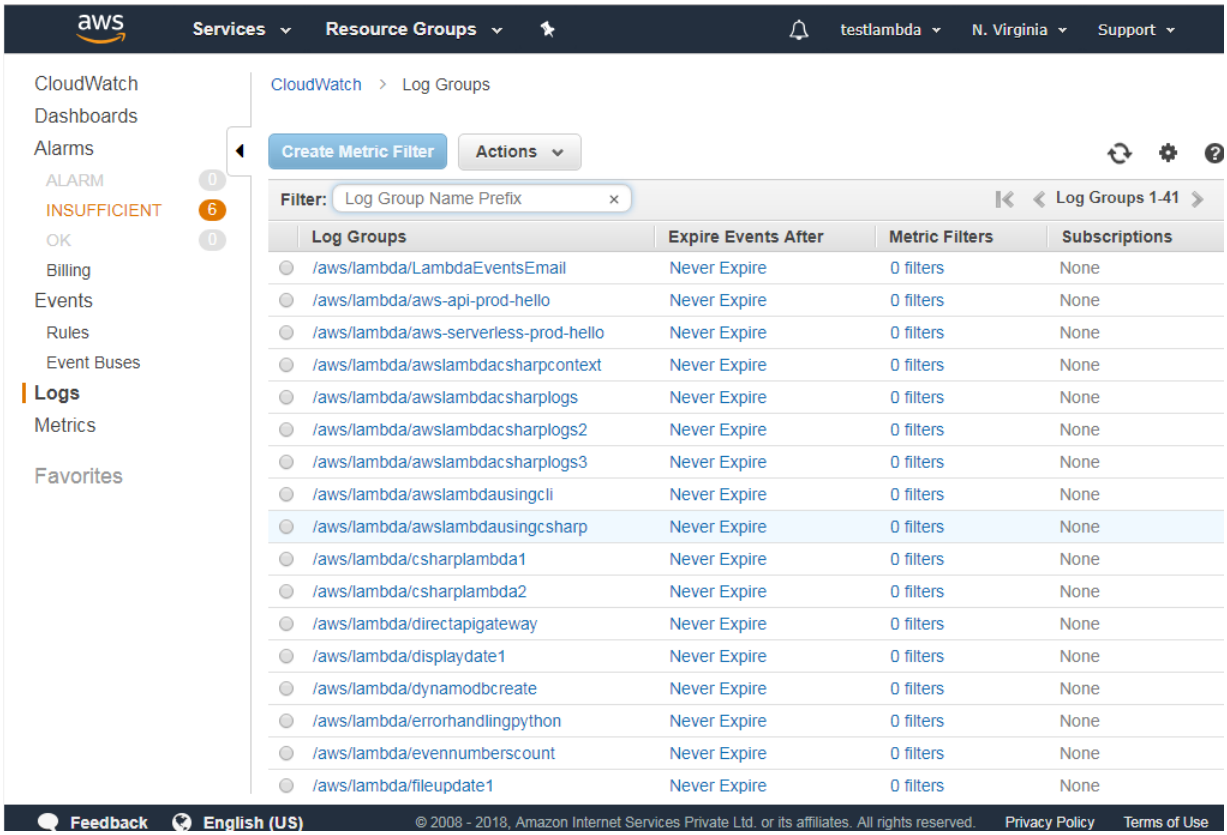
Consider that the following code is uploaded in AWS Lambda with function name as **lambdaandcloudwatch**.

```
exports.handler = (event, context, callback) => {
    // TODO implement
    console.log("Lambda monitoring using amazon cloudwatch");
    callback(null, 'Hello from Lambda');
};
```

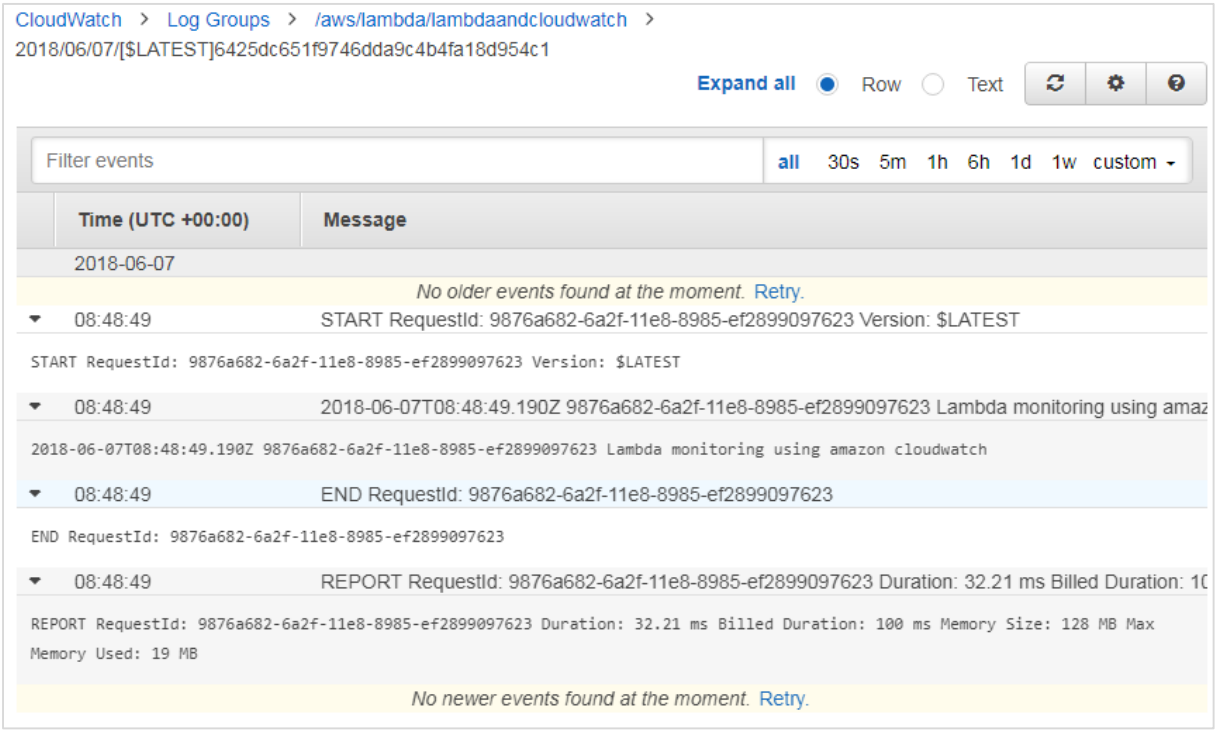
When the function is tested or triggered, you should see an entry in Cloudwatch. For this purpose, go to AWS services and click CloudWatch.



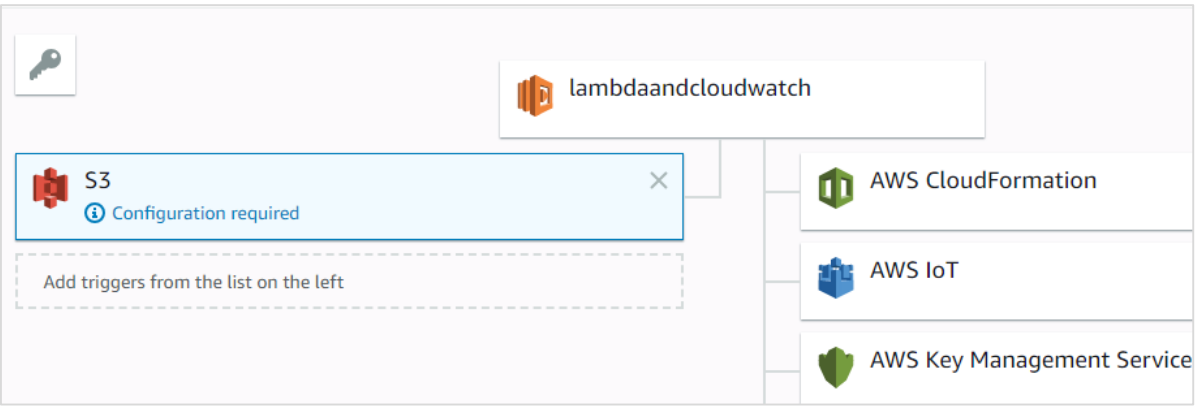
Select logs from left side.



When you click **Logs,** it has the **Log Groups** of AWS Lambda function created in your account. Select any AWS Lambda function and check the details. Here, we are referring to Lambda function with name:**lambdaandcloudwatch.** The logs added to the Lambda function are displayed here as shown below:



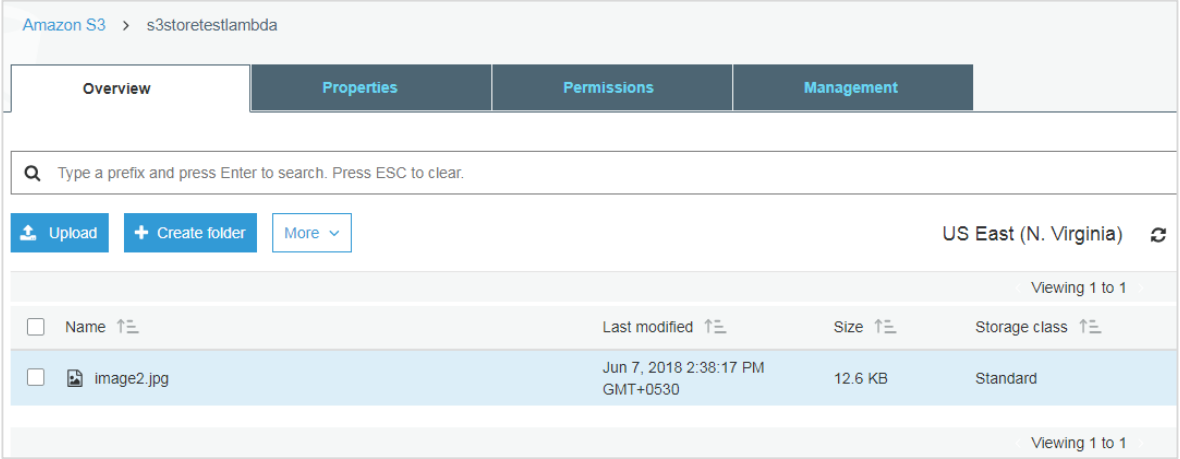
Now, let us add S3 trigger to the Lambda function and see the logs details in CloudWatch as shown below:



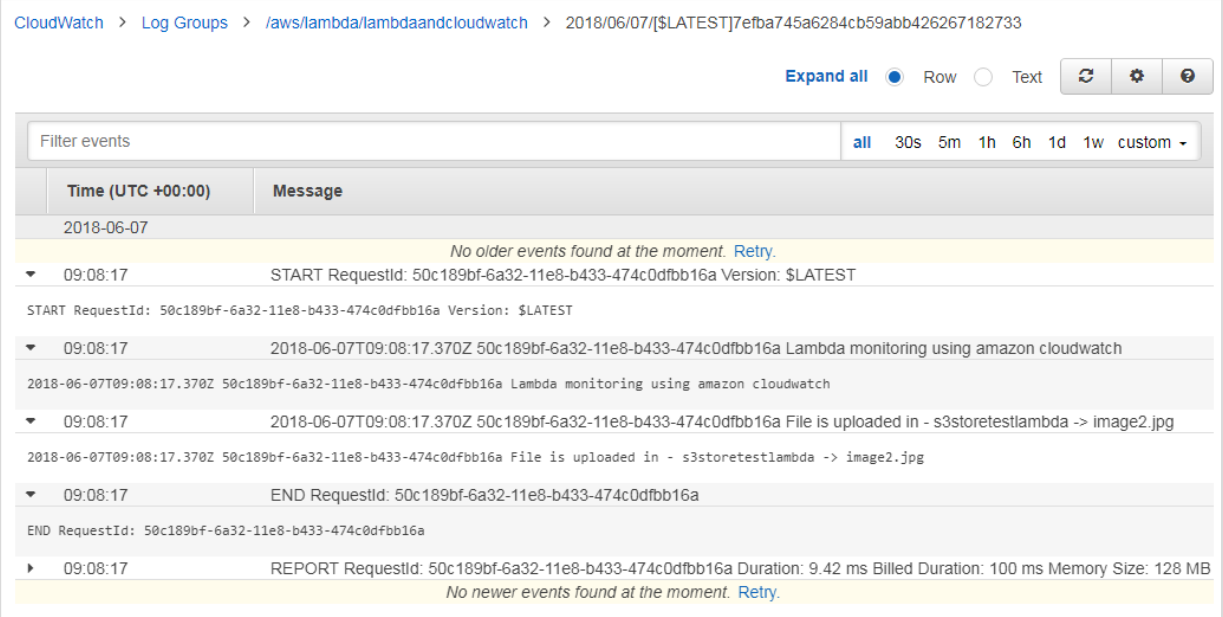
Let us update AWS Lambda code to display the file uploaded and bucket name as shown in the code given below:

```
exports.handler = (event, context, callback) => {
    // TODO implement
    console.log("Lambda monitoring using amazon cloudwatch");
    const bucket = event.Records[0].s3.bucket.name;
    const filename = event.Records[0].s3.object.key;
    const message = `File is uploaded in - ${bucket} -> ${filename}`;
    console.log(message);
    callback(null, 'Hello from Lambda');
};
```

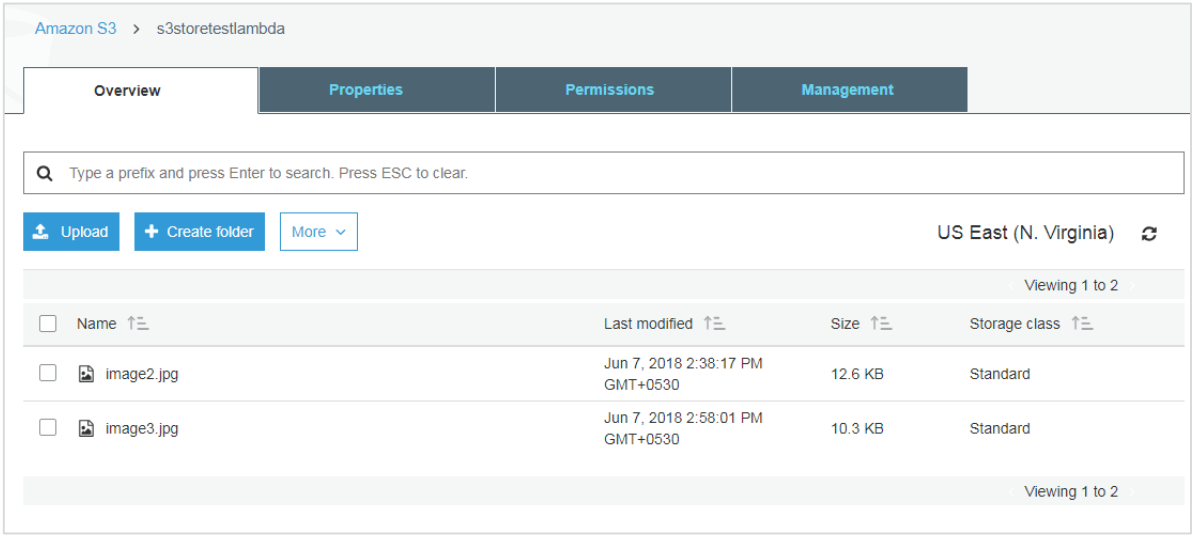
Now, add file in **s3storetestlambdaEvent** bucket as shown:



When the file is uploaded, AWS Lambda functions will get triggered and the console log messages from Lambda code are displayed in CloudWatch as shown below:



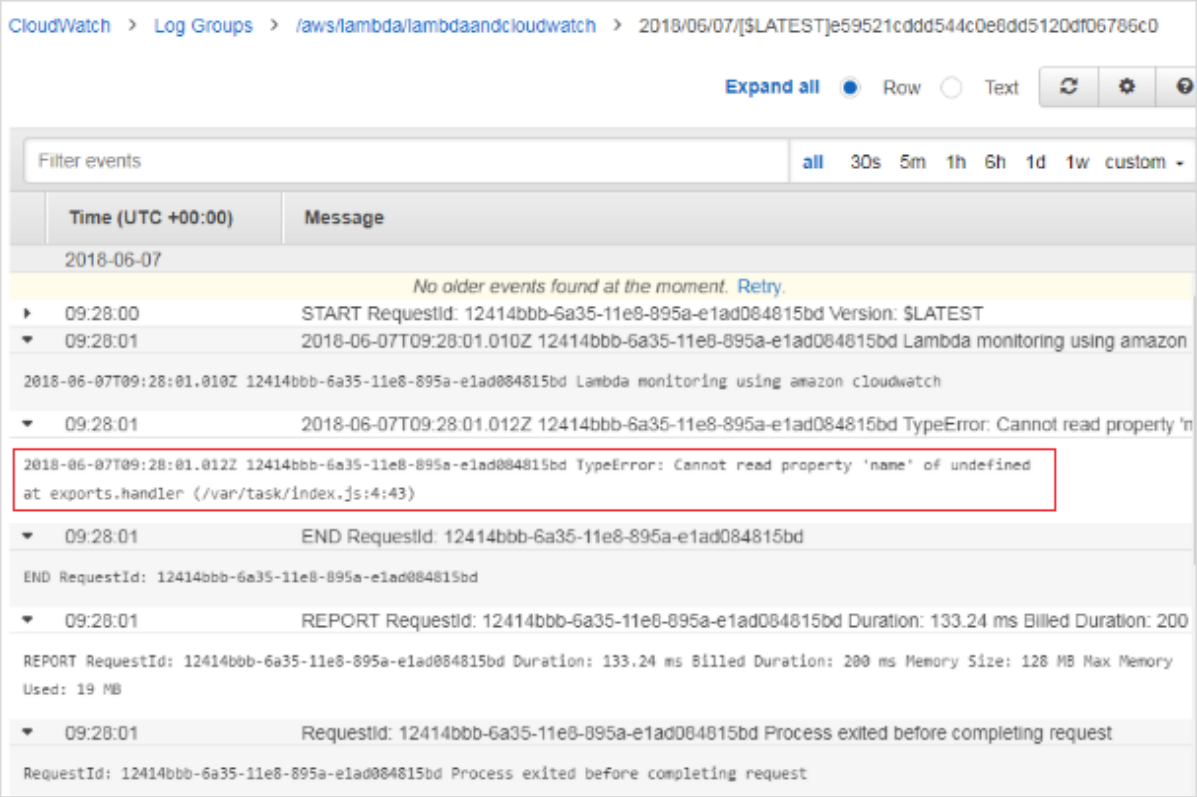
If there is any error, CloudWatch gives the error details as shown below:



Note that we have referred to the bucket name wrongly in AWS Lambda code as shown:

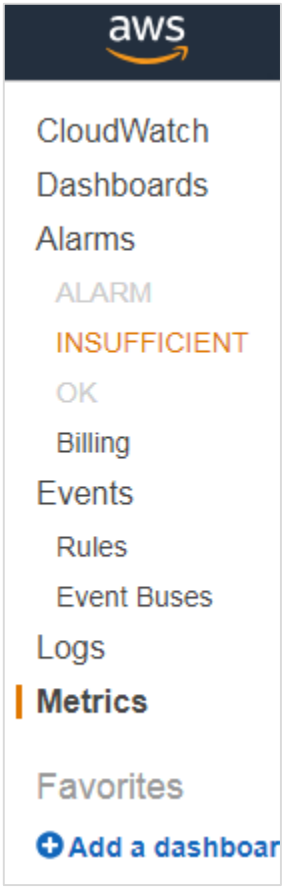
```
exports.handler = (event, context, callback) => {
    // TODO implement
    console.log("Lambda monitoring using amazon cloudwatch");
    const bucket = event.Records[0].bucket.name;
    const filename = event.Records[0].s3.object.key;
    const message = `File is uploaded in - ${bucket} -> ${filename}`;
    console.log(message);
    callback(null, 'Hello from Lambda');
};
```

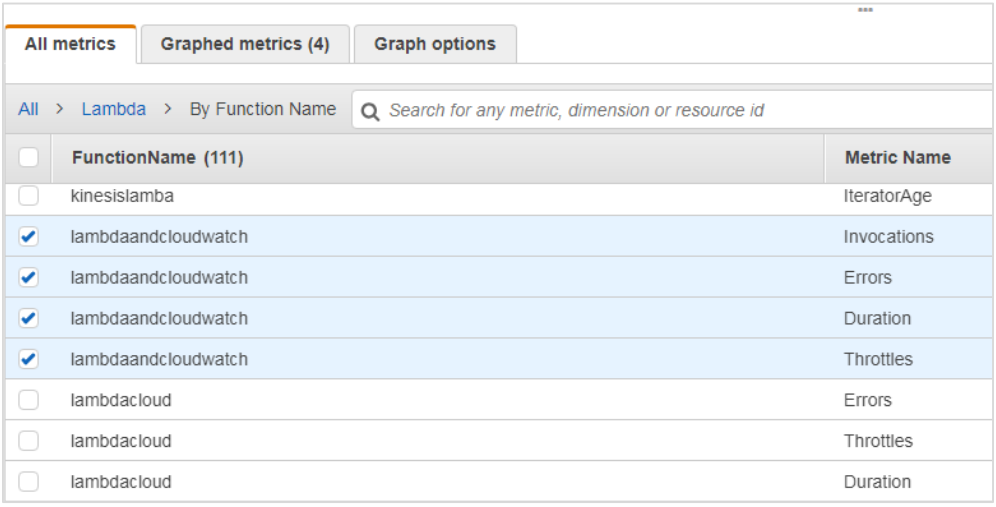
The bucket name reference from the event is wrong. Thus, we should see an error displayed in CloudWatch as shown below:



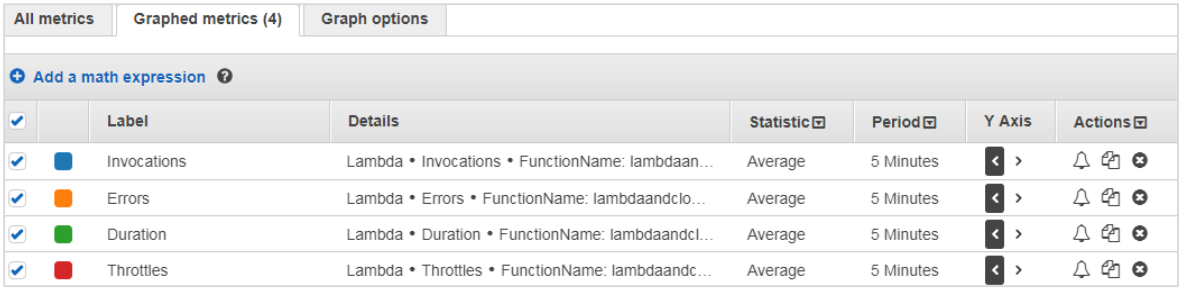
CloudWatch Metrics

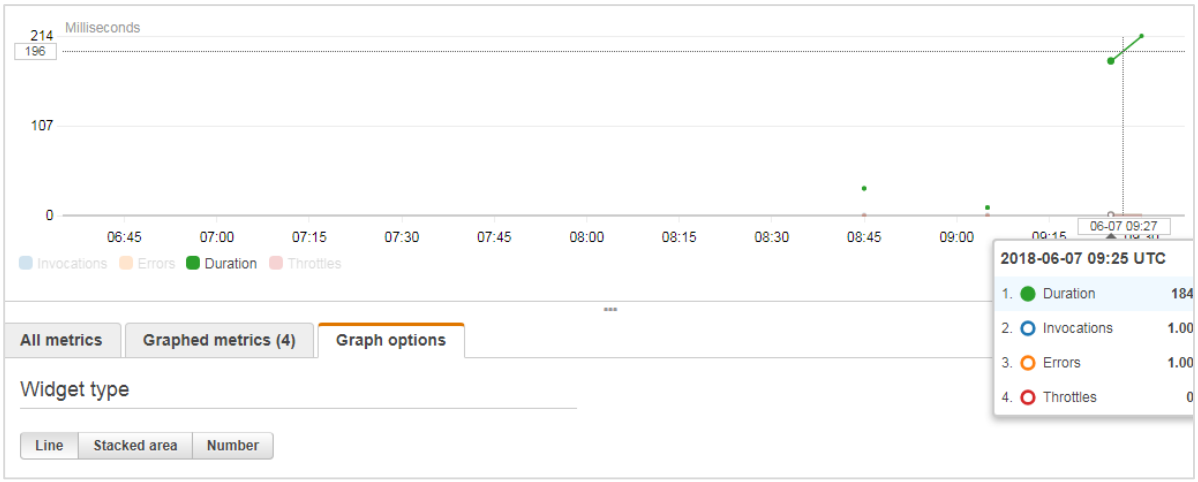
The details of the Lambda function execution can be seen in the metrics. Click **Metrics** displayed in the left side.

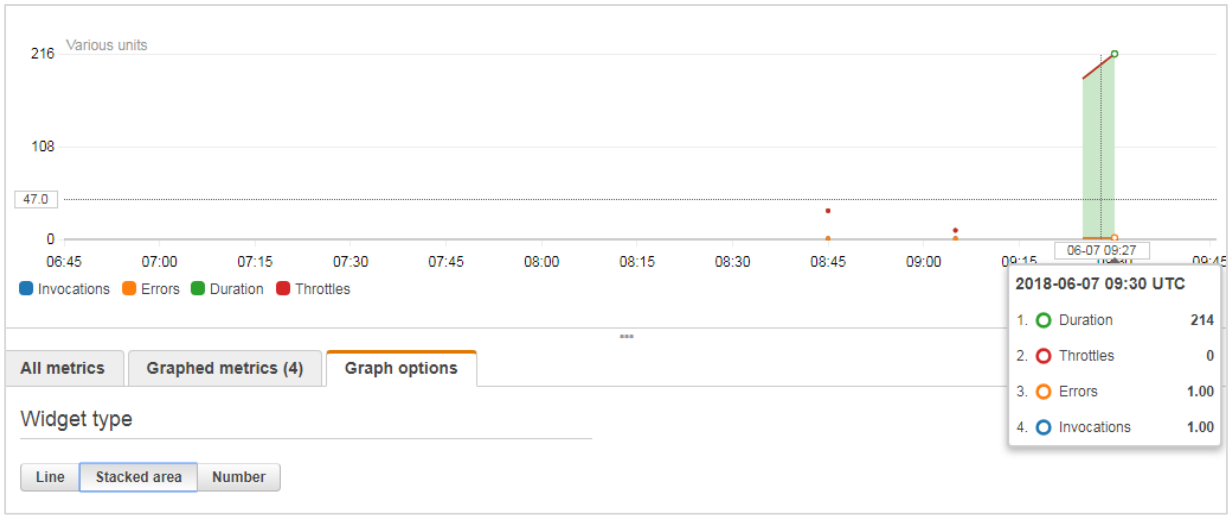




The graph details for the lambda function **lambdaandcloudwatch** are as shown below:







It gives details such as the duration for which the Lambda function is executed, number of times it is invoked and the errors from the Lambda function.

26. AWS Lambda —Additional Example

Till now, we have seen working of AWS Lambda with AWS services. Based on that knowledge, let us create a simple user registration form and post the data using API gateway to AWS Lambda. AWS Lambda will get the data from the event or the API gateway trigger and will add those details to DynamoDB table.

Example

Let us consider an example and perform the following functionalities on it:

- Create DynamoDB Table
- Create Form for User Registration
- Create AWS Lambda and API gateway to send message to Phone using AWS SNS service
- Create AWS Lambda and API gateway to POST form data and insert in DynamoDb table
- Create AWS Lambda and API gateway to read data from Dynamodb table
- Final Working of the User Registration Form

Create DynamoDB Table

The data entered will be stored in DynamodDB table. We will use API gateway to share data entered with AWS Lambda and later AWS Lambda will add the details in DynamoDB.

You can use the following details to create DynamodDB table in AWS console. First, go to AWS Service and click **DynamoDB**. Click **Table** to create the table as shown below:

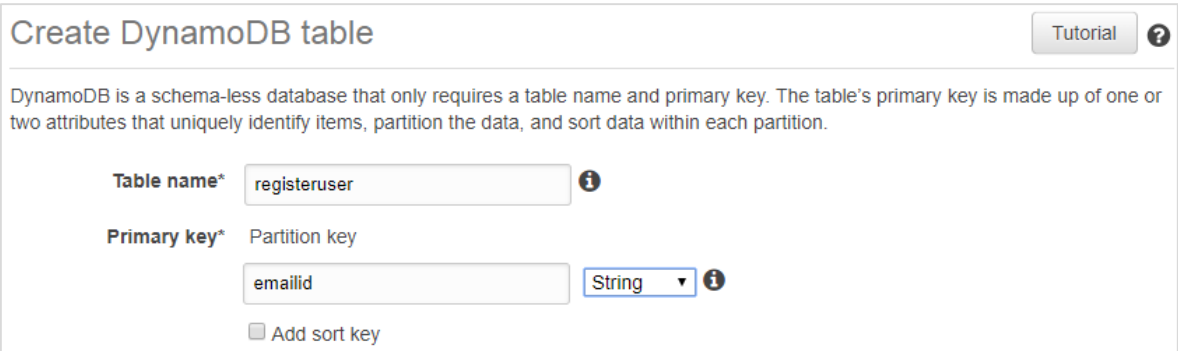


Table details

Table name	registeruser
Primary partition key	emailid (String)
Primary sort key	-
Point-in-time recovery	DISABLED **Enable**
Encryption	DISABLED
Time to live attribute	DISABLED **Manage TTL**
Table status	Active
Creation date	June 2, 2018 at 5:01:19 PM UTC+5:30
Provisioned read capacity units	5 (Auto Scaling Disabled)
Provisioned write capacity units	5 (Auto Scaling Disabled)
Last decrease time	-
Last increase time	-
Storage size (in bytes)	0 bytes
Item count	0
Region	US East (N. Virginia)
Amazon Resource Name (ARN)	arn:aws:dynamodb:us-east-1:625297745038:table/registeruser

You can use the ARN to create policy for the DynamoDB to be used with AWS Lambda.

Go to IAM and select **Policies**. Click **Create policy**, choose service as DynamodDB as shown below:

Service DynamoDB

Actions close

Specify the actions allowed in DynamoDB

Filter actions

Manual actions (add actions)

All DynamoDB actions (dynamodb:*)

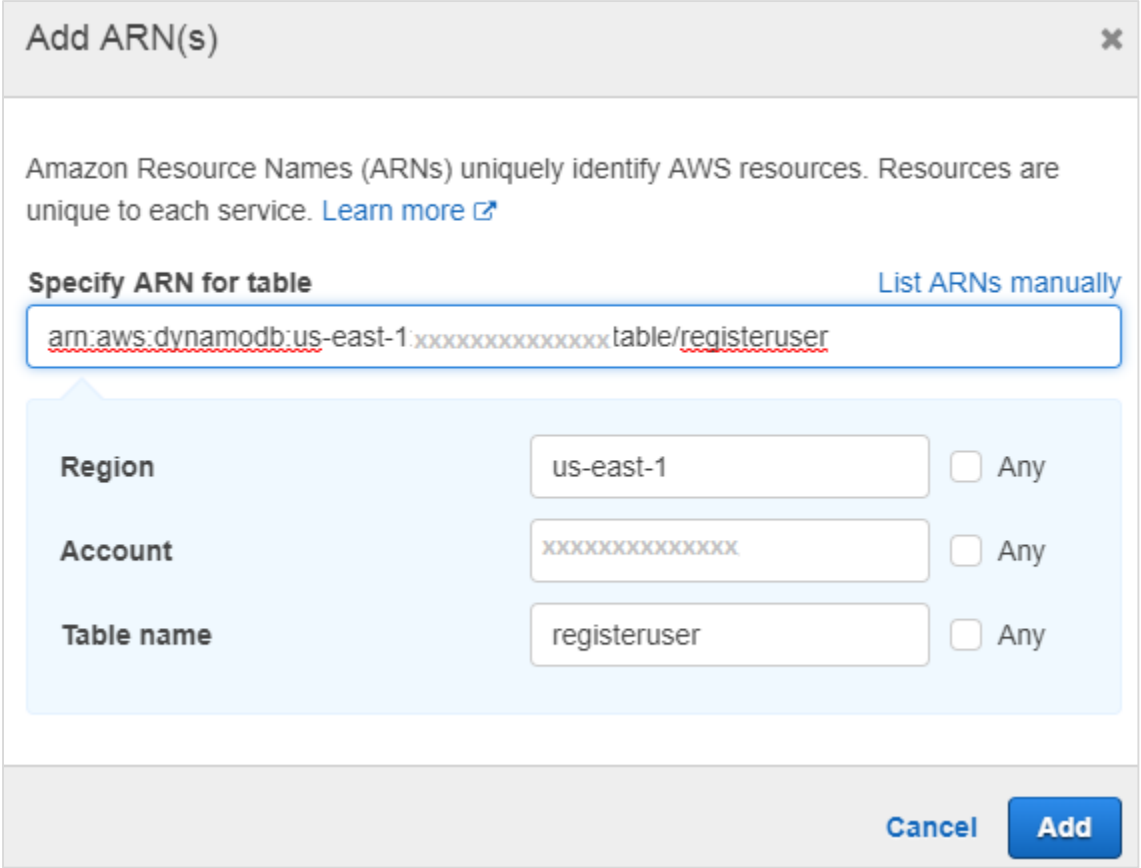
Access level

List (3 selected)

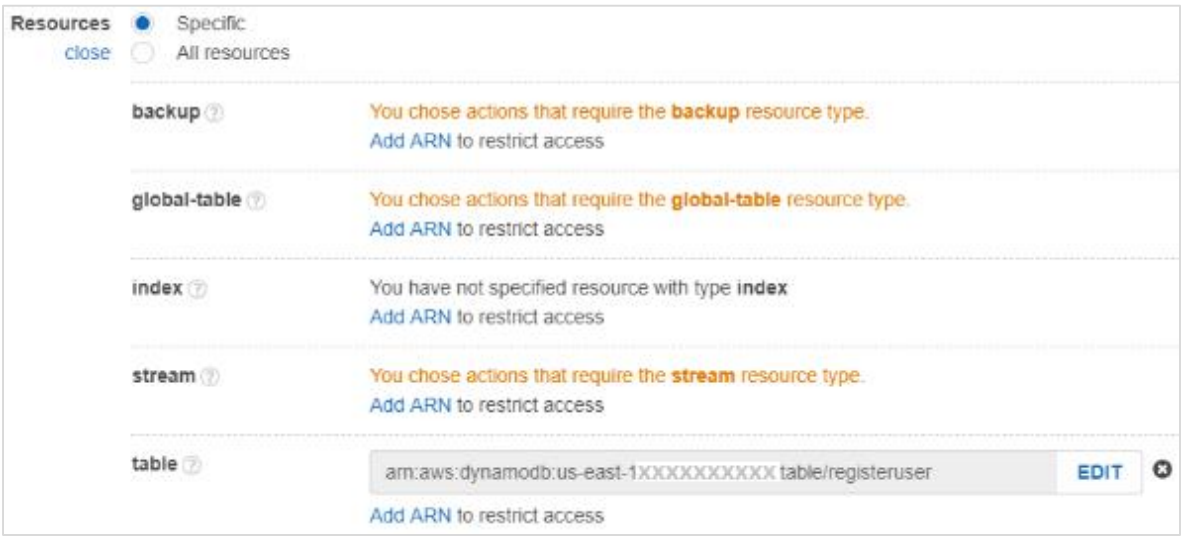
Read (18 selected)

Write (19 selected)

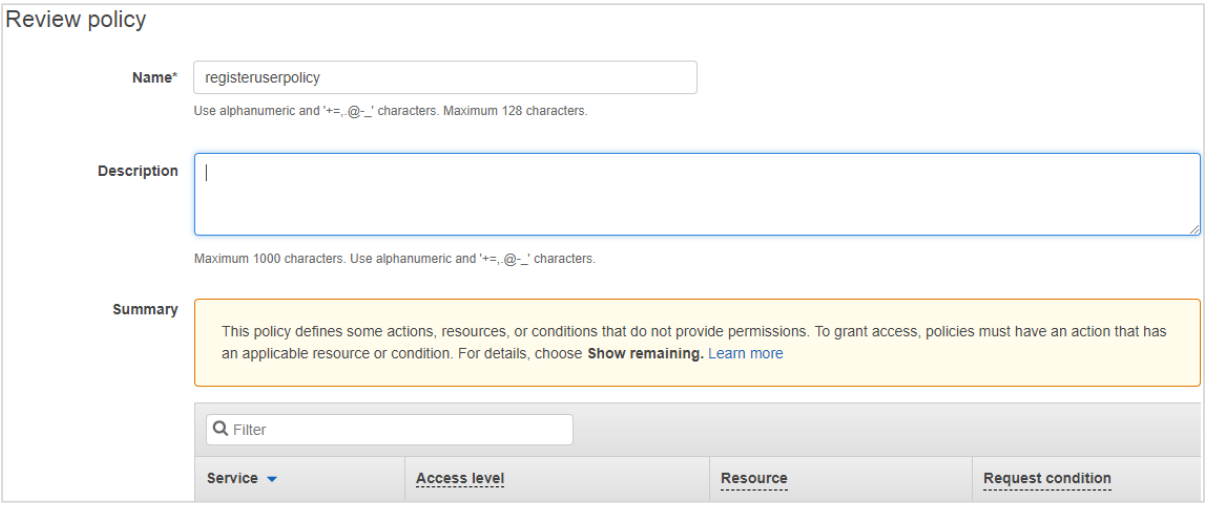
Click **All DynamoDB** actions as shown above. Choose resource and enter the ARN for table as shown below:



Now, click **Add** as shown below**.**

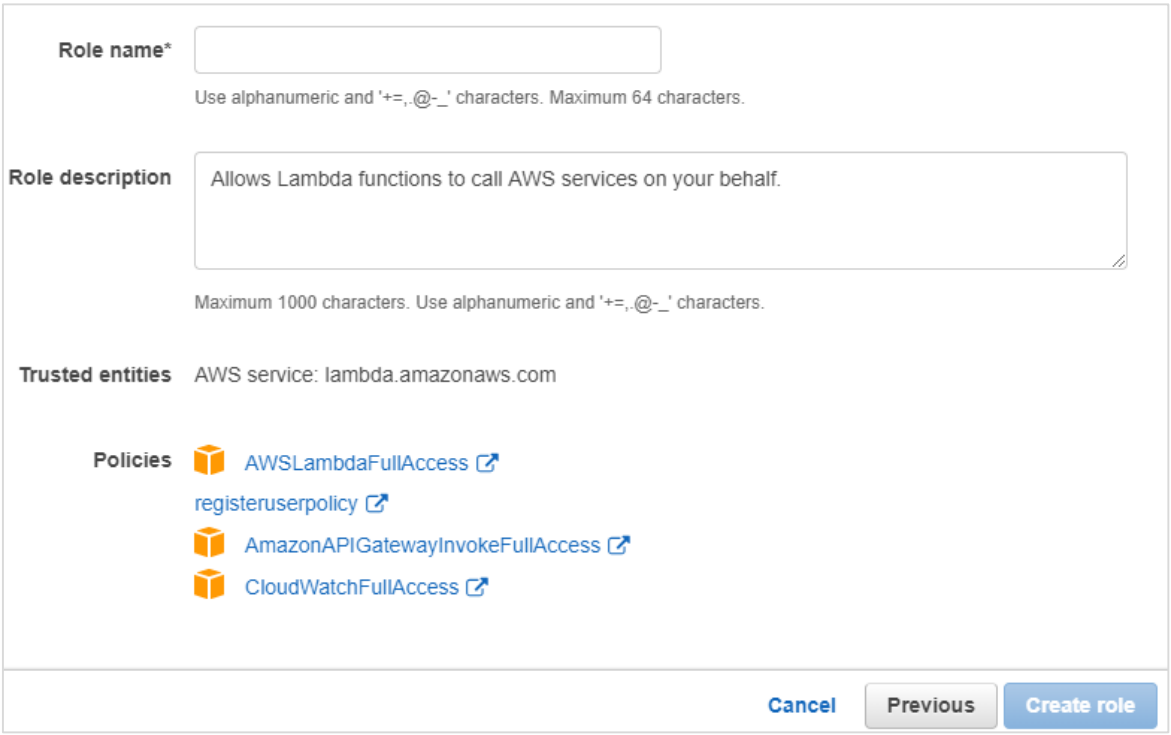


If you click **Review policy** button at the end of the screen, you can see the following window:



Enter name of the policy and click **Create policy** button at the end of the page. Now, we need to create role to be used with Lambda. We need permissions for DynamoDB, API Gateway and Lambda.

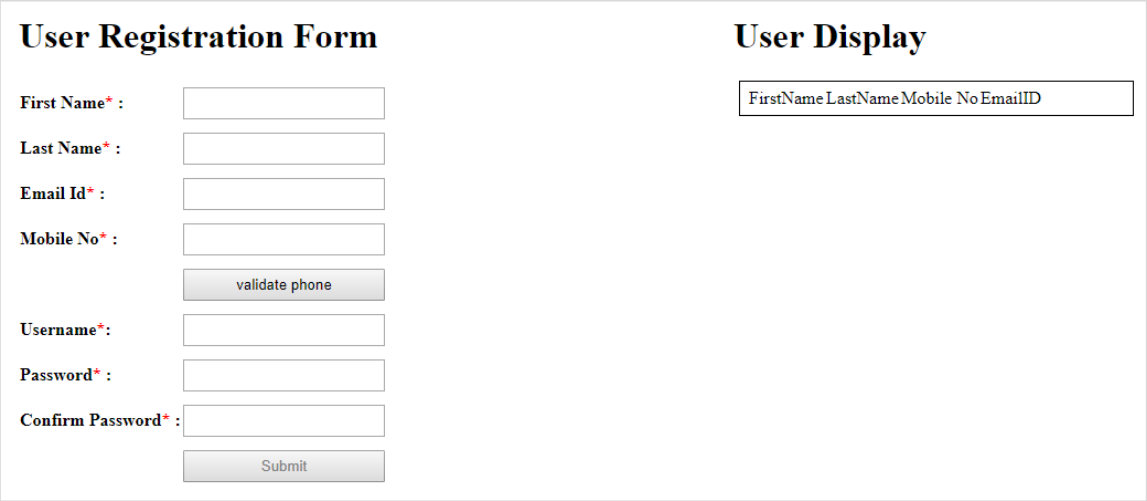
Go to AWS services and select IAM. Select Roles from left side and add the required roles.



Enter the role name and click **Create role**. The role created is **roleforlambdaexample**.

Create Form for User Registration

Here is the display of the user registration form to enter and to read the data from the dynamodb table.



Create AWS Lambda and API Gateway to Send OTP Message to Phone using SNS service

If you see the user registration form, there is a button **validate phone**. User is suppose to enter phone number and click on **validate phone** button to validate the phone number.

For this purpose:

When a user clicks this button, the API gateway post method which contains the phone details is called and internally AWS Lambda is triggered.

Then, AWS Lambda sends OTP to the phone number entered using AWS SNS service.

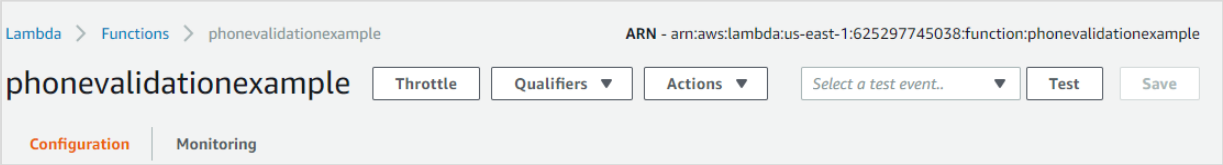
The user receives the OTP and has to enter this OTP number.

The textbox to enter OTP will appear when the phone number is entered and **validate phone** button is clicked.

The OTP received from AWS Lambda and the OTP entered by the user has to match,to allow the user to submit the user registration form.

A simple block diagram that explains the working of phone validation is shown here:

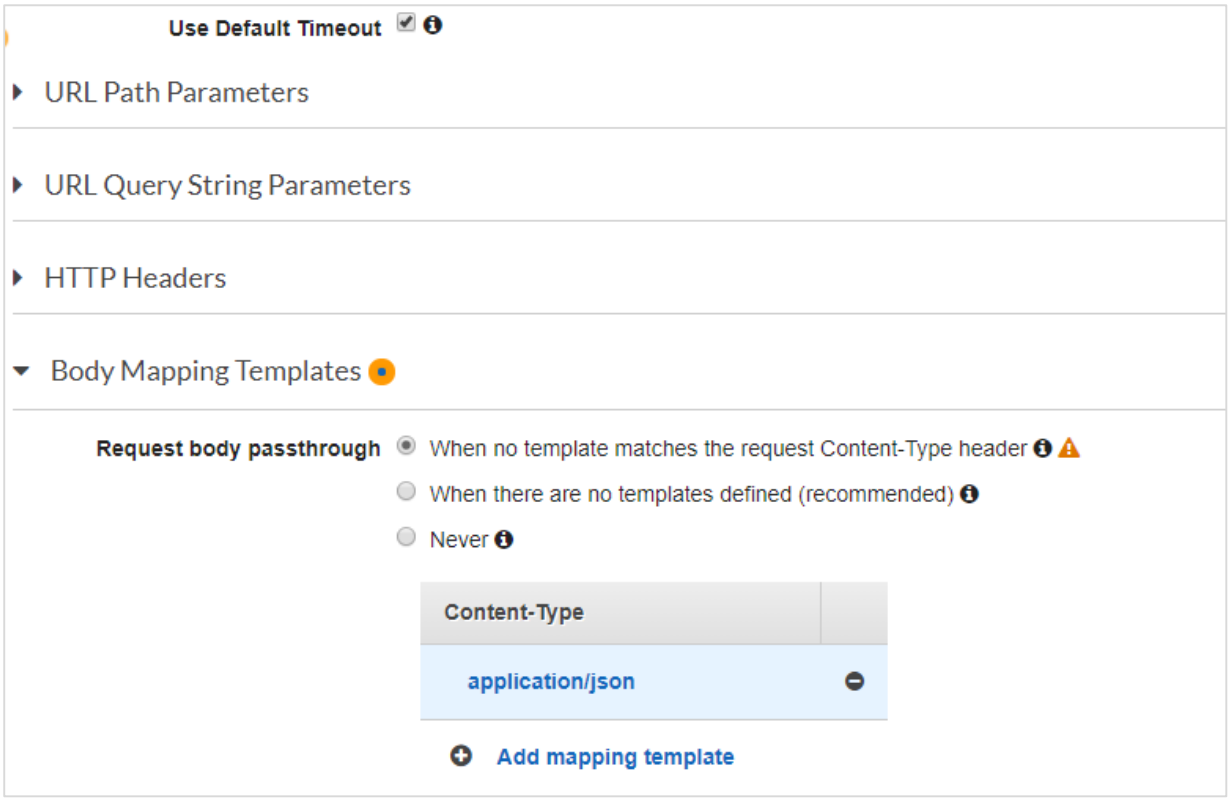
The AWS Lambda function created is as shown here:



The corresponding AWS Lambda code is as given below:

```
const aws =  require("aws-sdk");
const sns = new aws.SNS({
region:'us-east-1'
});
exports.handler = function(event, context, callback) {
    let phoneno = event.mphone;
    let otp = Math.floor(100000 + Math.random() * 900000);
    let snsmessage = "Your otp is : "+otp;
    sns.publish({
         Message: snsmessage,
         PhoneNumber: "+91"+phoneno
    }, function (err, data) {
     if (err) {
         console.log(err);
            callback(err, null);
     } else {
         console.log(data);
            callback(null, otp);
     }
    });
};
```

Note that we are using SNS service to send the OTP code. This code is used to validate the mobile number entered by the user in the user registration form. The API gateway created for above phone validation is as follows:

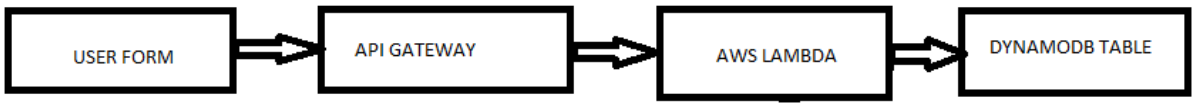


The Lambda function given is **phonevalidationexample.** We are taking the mobile phone details here to be used inside AWS Lambda. Then, AWS Lambda will send the OTP code to the given mobile number.

Create AWS Lambda and API Gateway to POST Form Data and Insert in DynamoDB Table

For user registration form, all the fields are mandatory. There is an AJAX call made wherein the data entered in the form is posted to the API Gateway URL.

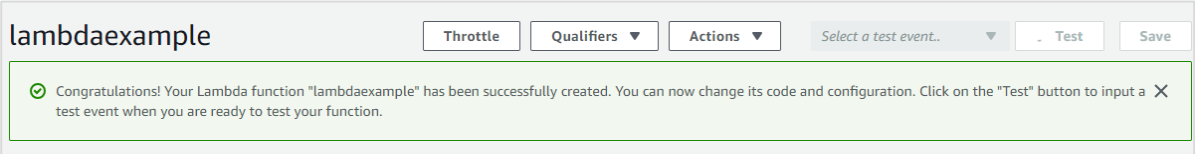
A simple block diagram which explains the working of the **submit** button is shown here:



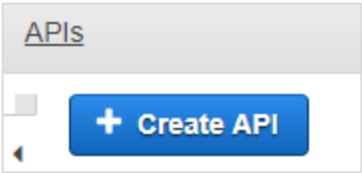
Once the form is filled, the submit button will call the API gateway which will trigger AWS Lambda. AWS Lambda will get the details of the form from event or the API Gateway and the data will be inserted in the DynamodDB table.

Let us understand the creation of API Gateway and AWS Lambda.

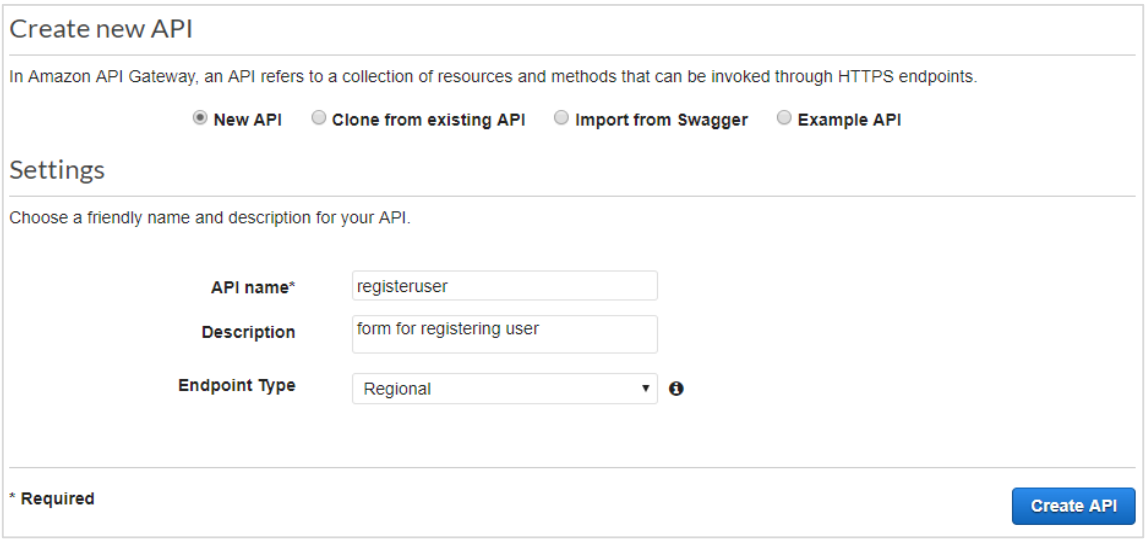
First, go to AWS services and click Lambda. The Lambda function created is as shown here:



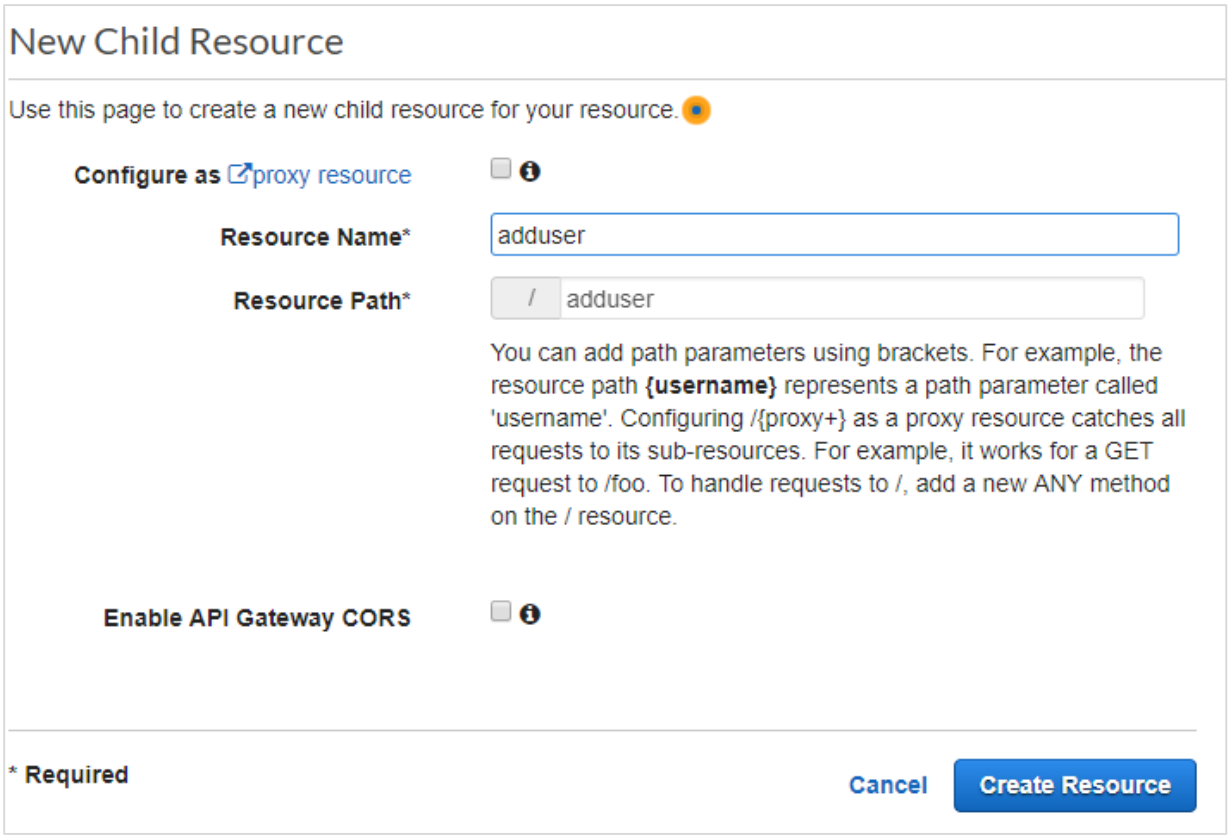
Now, to create an API gateway, go to AWS service and select **API Gateway**. Click on **Create API** button shown below.



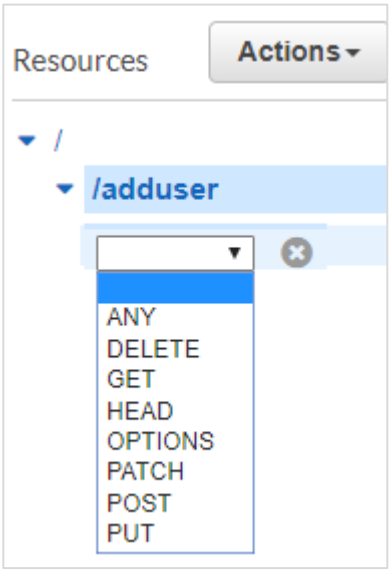
Enter the **API name** and click on **Create API** button to add the API.



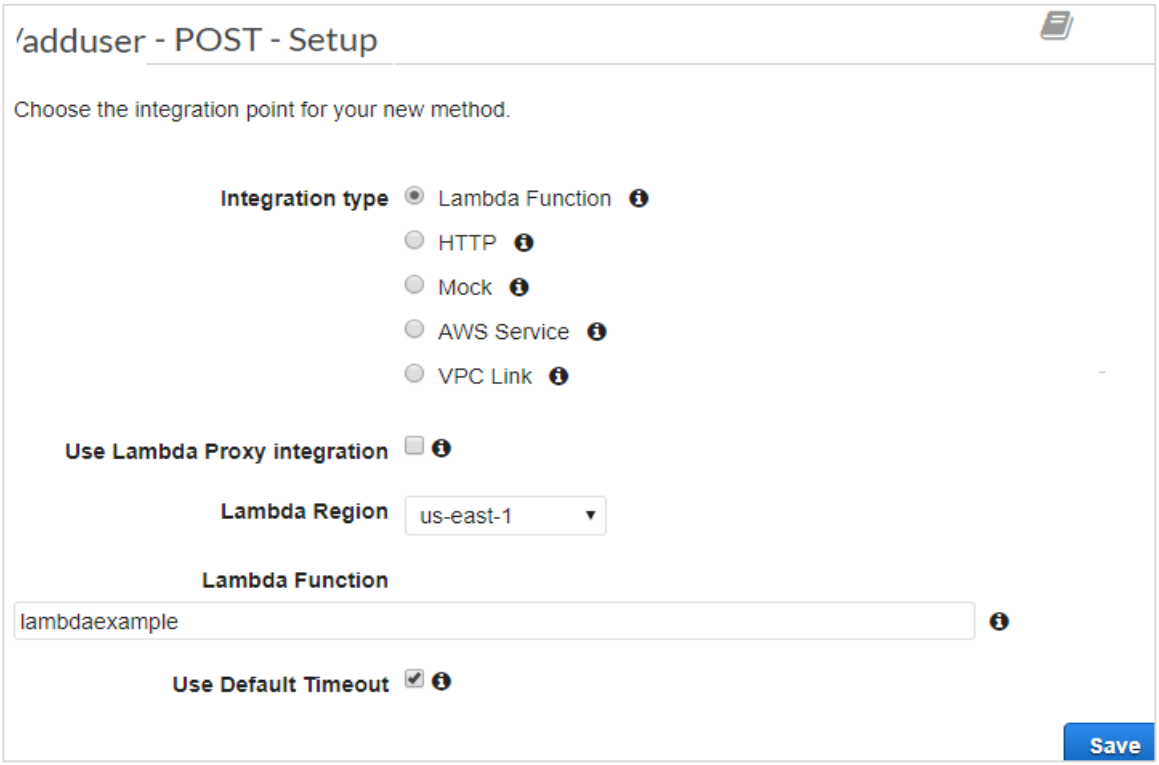
Now, an API is created called as **registeruser**. Select the API and click **Actions** dropdown to create **Resource.**



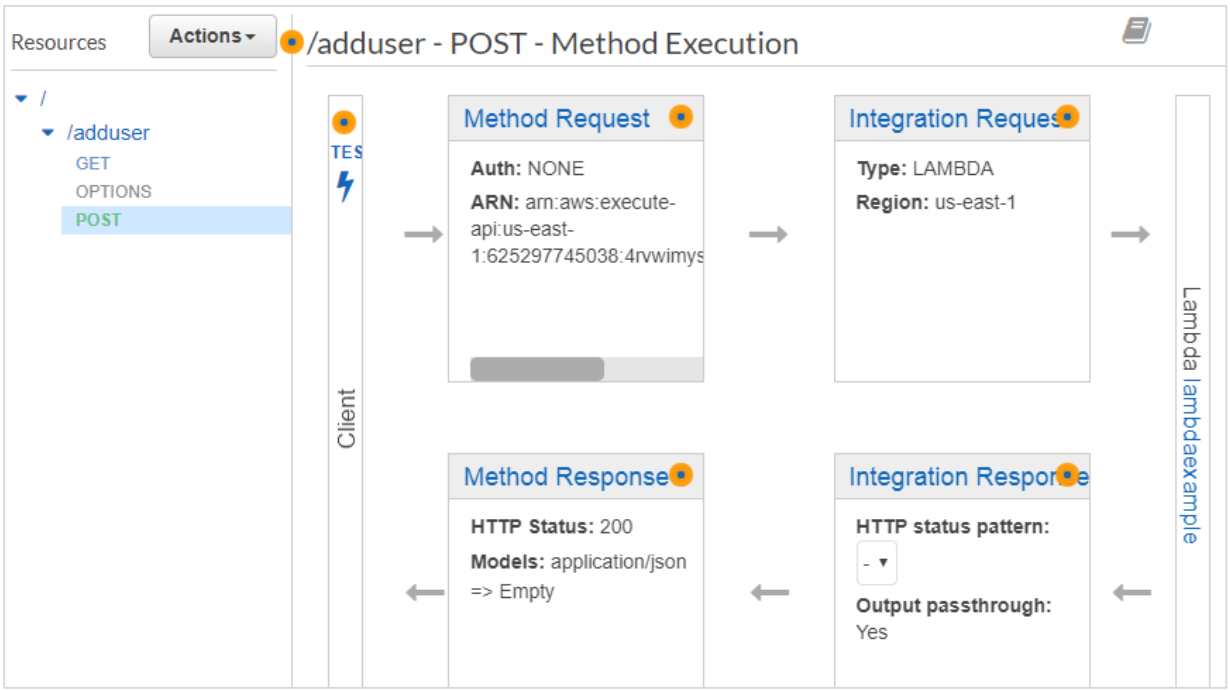
Click **Create Resource.** Now, let us add the **POST** method. For this, click on Resources created on left side and from **Actions** dropdown select **create method**. This will display dropdown as shown below:



Select the POST method and add the Lambda function that we created above.

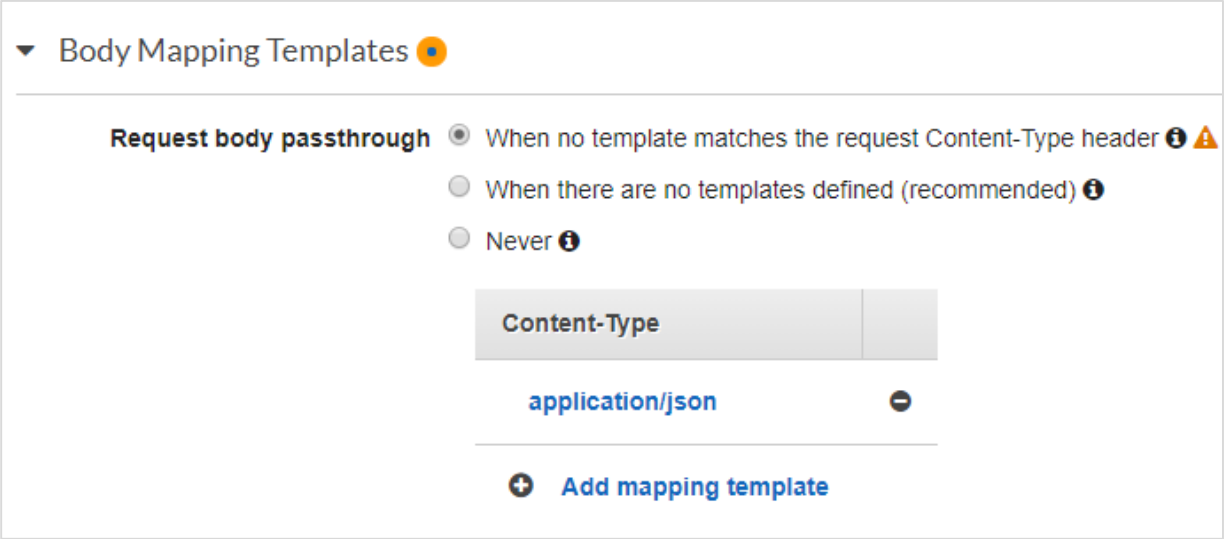


Click **Save** button to add the method. To send the form details to Lambda function **lambdaexample** we need to add the **Integration Request** as shown below:

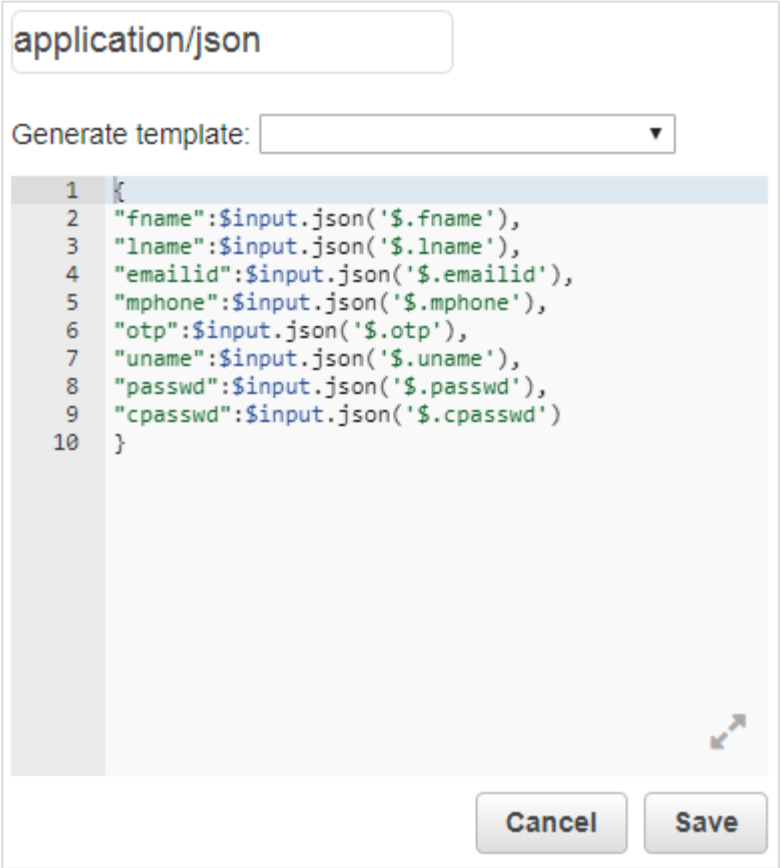


To post the form details, you will have to click **Integration Request.** It will display below details.

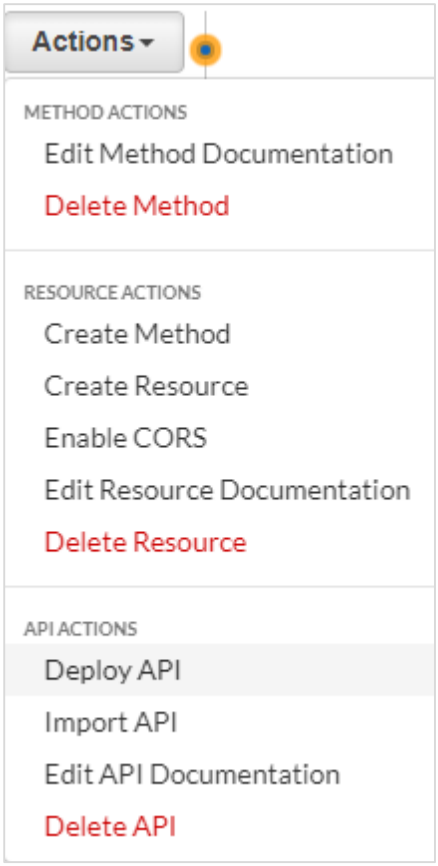
Click **Body Mapping Templates** to add the form fields to be posted.



Next, click **Add mapping template** and enter the content type. Here, we have added **application/json** as the content type. Click it and here you need to enter the field in json format as shown below:

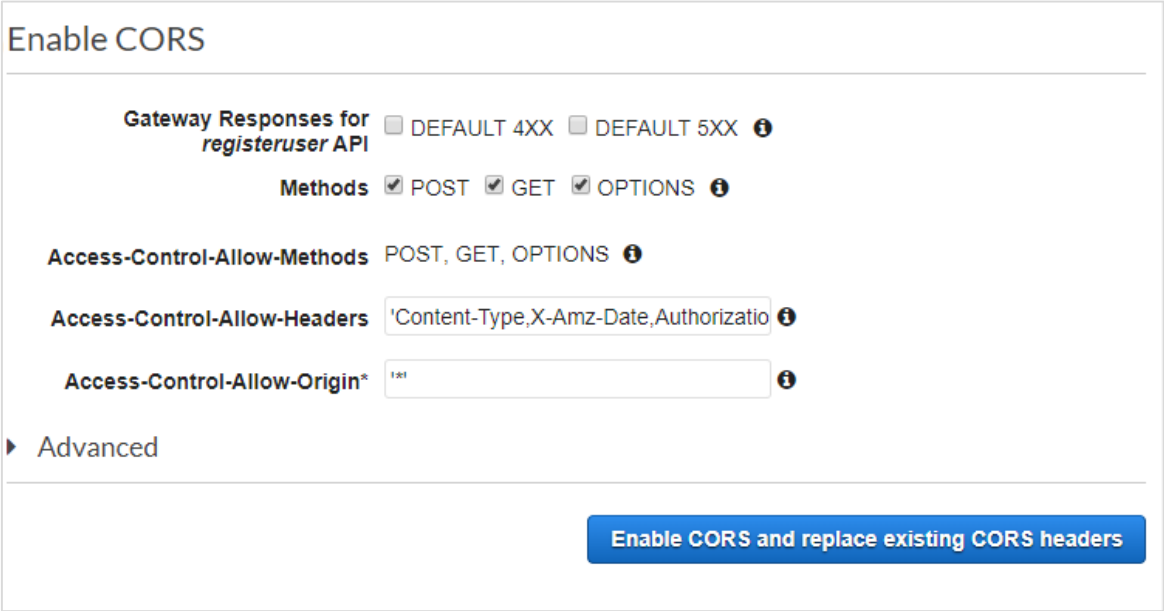


Now, click the **Save** button and deploy the API as shown below:

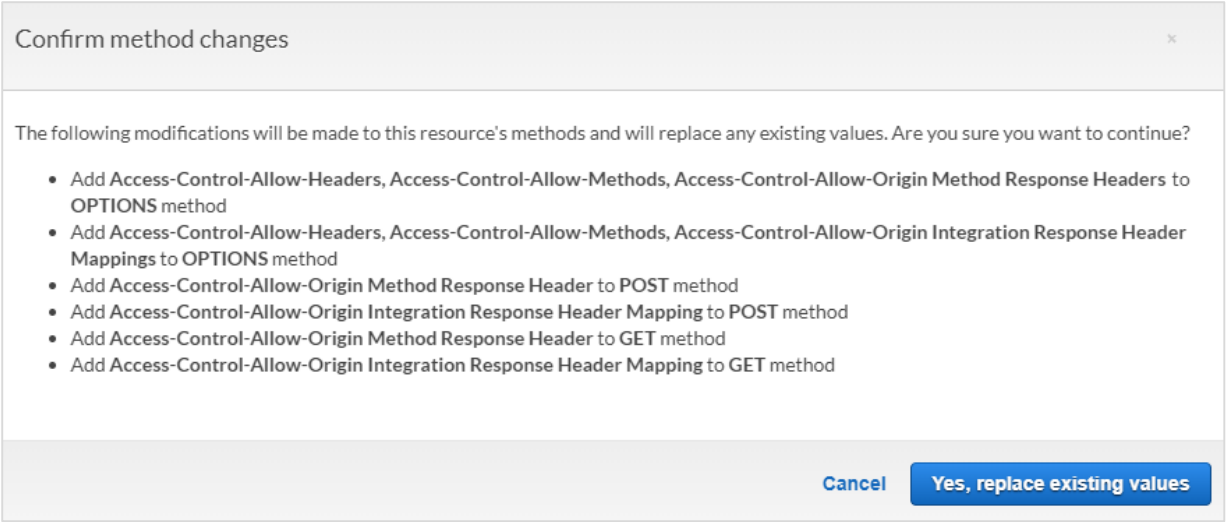


Here is the API created for POST which will use inside our .html file.Please note we need to Enable CORS for the resource created.Will use the api gateway url to make ajax call so the CORS has to enabled.

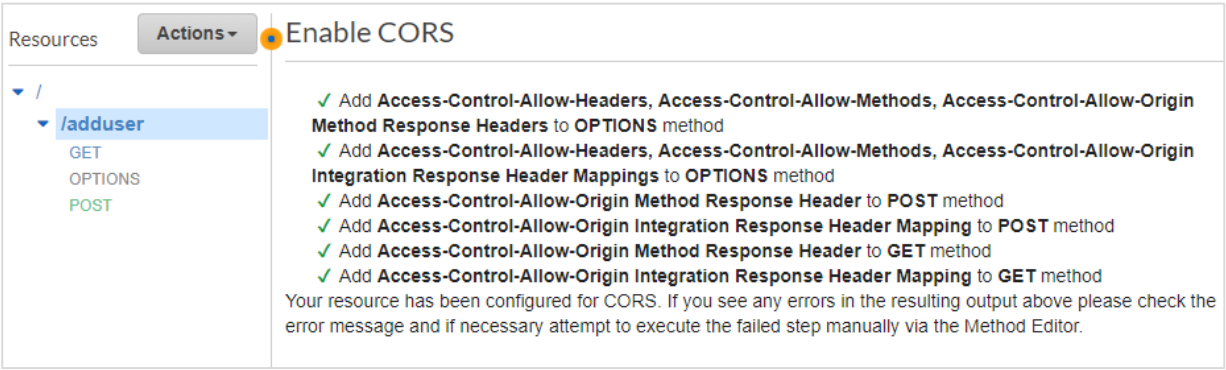
Select the Methods on which you want to enable the CORS.Click on **Enable CORS and replace existing CORS headers.**



It displays the confirmation screen as follows:



Click **Yes, replace existing values** to enable CORS.



The AWS Lambda code for POST API Gateway is as shown here*:*

```
const aws =  require("aws-sdk");
const docClient = new aws.DynamoDB.DocumentClient({
region:'us-east-1'
});
exports.handler = function(event, context, callback) {
    console.log(event);
    console.log("Entering Data");
     var data = {
            TableName : "registeruser",
            Item : {
```

```
                  first_name:event.fname,
                  last_name:event.lname,
               emailid:event.emailid,
               mobile_no : event.mphone,
                  otp:event.otp,
                  username:event.uname,
                  password:event.passwd,
                  confirm_password:event.cpasswd
            }
     }
     docClient.put(data,function(err, value){
            if (err) {
               console.log("Error");
                  callback(err, null);
            } else {
               console.log("data added successfully");
                  callback(null, value);
            }
     });
}
```

The event parameter in AWS Lambda handler will have all the details which are added earlier in POST integration request. The details from event are added to the DynamodDB table as shown in the code.

Now, we need to get the service details from AWS-SDK as shown below:

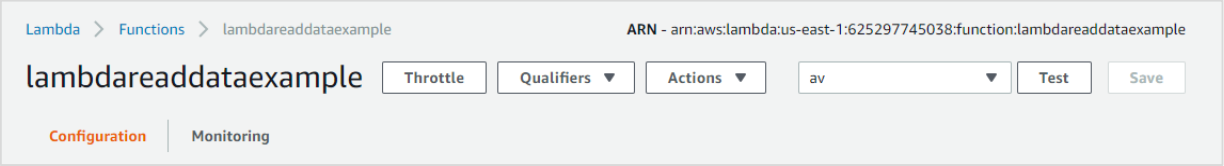
```
const aws =  require("aws-sdk");
const docClient = new aws.DynamoDB.DocumentClient({
region:'us-east-1'
});
var data = {
            TableName : "registeruser",
            Item : {
                  first_name:event.fname,
                  last_name:event.lname,
                              emailid:event.emailid,
```

```
                        mobile_no : event.mphone,
                  otp:event.otp,
                  username:event.uname,
                  password:event.passwd,
                  confirm_password:event.cpasswd
            }
      }
      docClient.put(data,function(err, value){
            if (err) {
                console.log("Error");
                  callback(err, null);
            } else {
                console.log("data added successfully");
                  callback(null, value);
            }
      });
```

Create AWS Lambda and API Gateway to Read Data from DynamodDB Table

Now, we will create AWS Lambda function to read data from DynamoDB table. We will trigger API Gateway to the AWS Lambda function which will send data to the html form.

The AWS Lambda function created is as shown below:

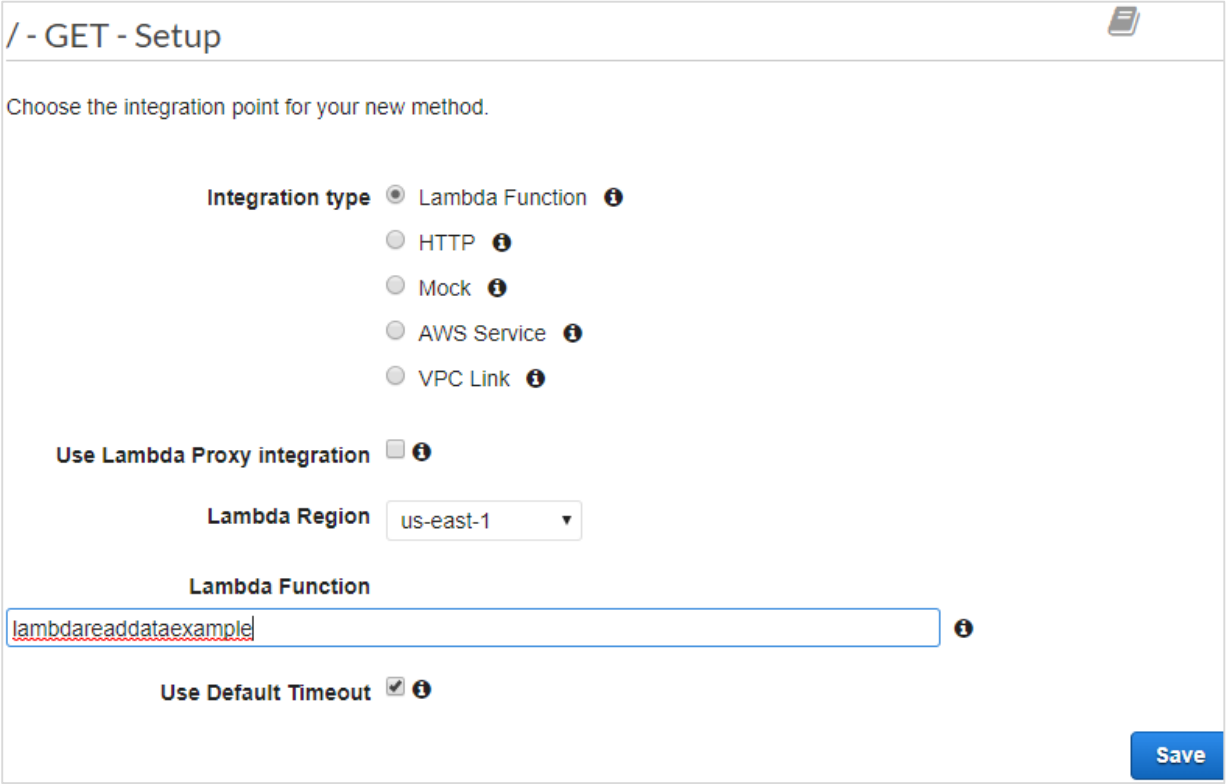


The corresponding AWS Lambda code is as follows:

```
const aws =  require("aws-sdk");
const docClient = new aws.DynamoDB.DocumentClient({
region:'us-east-1'
});
exports.handler = function(event, context, callback) {
     var readdata = {
            TableName : "registeruser",
            Limit : 10
     }
     docClient.scan(readdata,function(err, data){
            if (err) {
                console.log("Error");
                   callback(err, null);
            } else {
                console.log("Data is " + data);
                   callback(null, data);
            }
     });
}
```

Here the data is read from the DynamoDB table and given to the callback. Now, we will create API Gateway and add AWS Lambda function as the trigger.

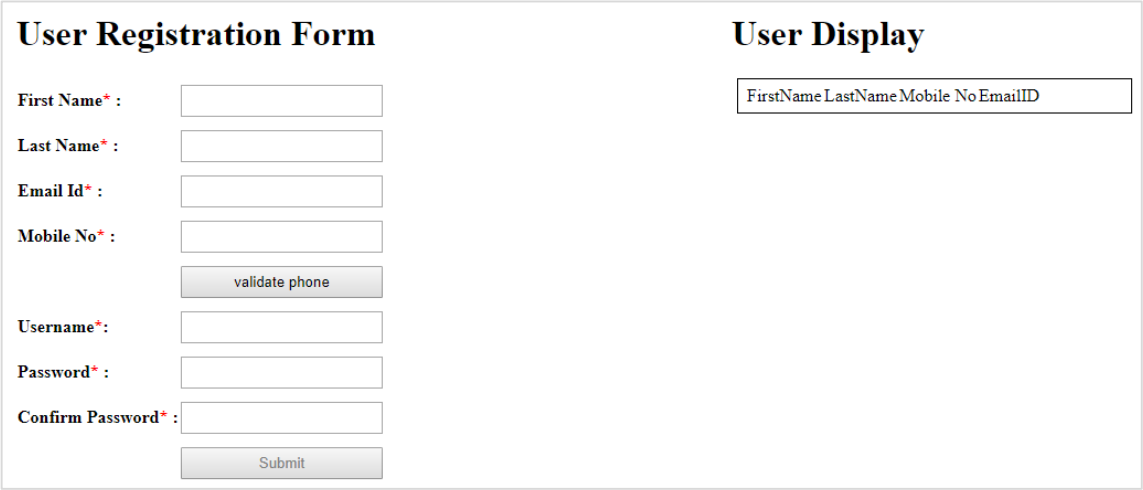
We will add get method to the API created earlier.



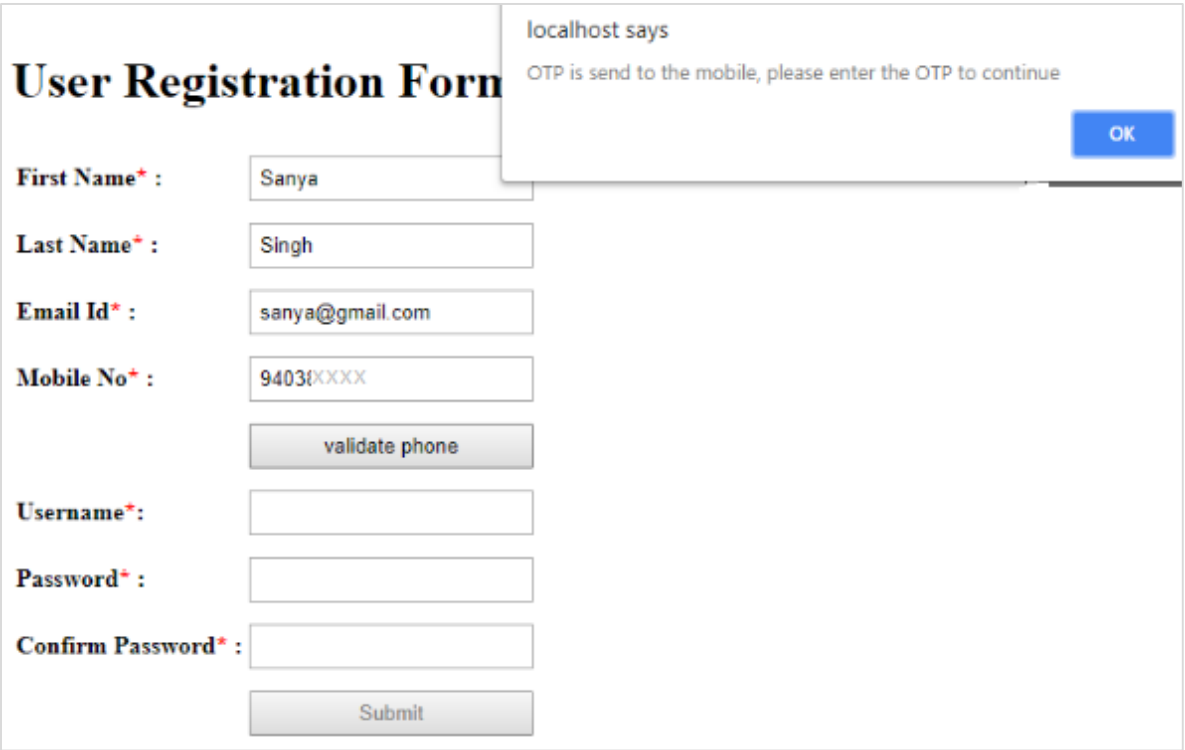
Lambda function added is **lambdareaddataexample.** Click **Save** to save the method and deploy the api.

Final Working of the User Registration Form

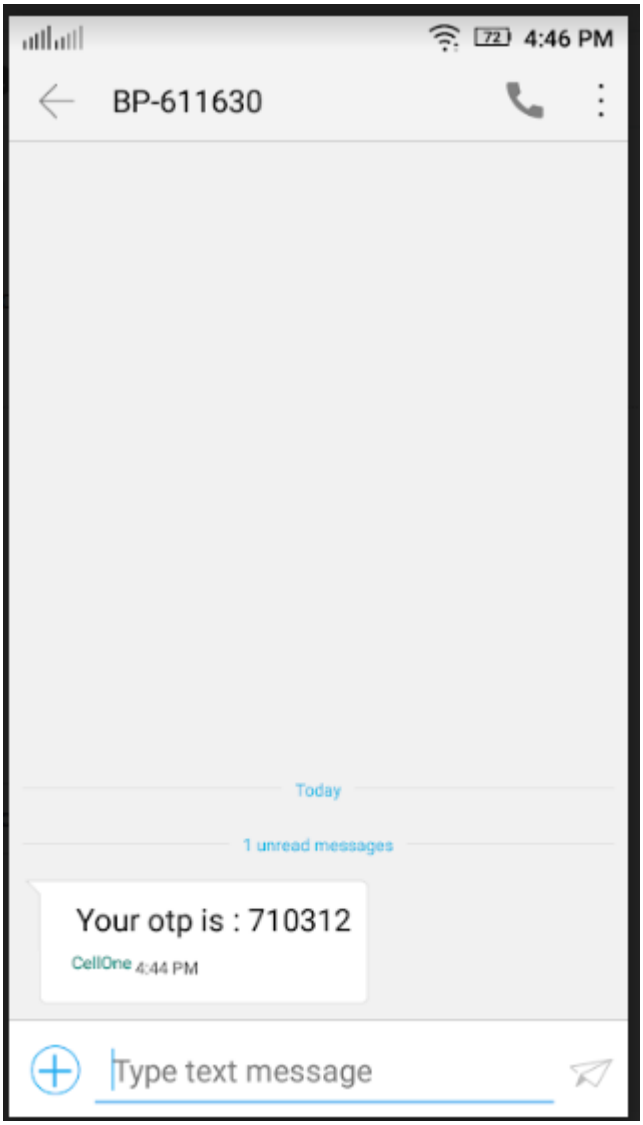
The final display of the form is as shown below:



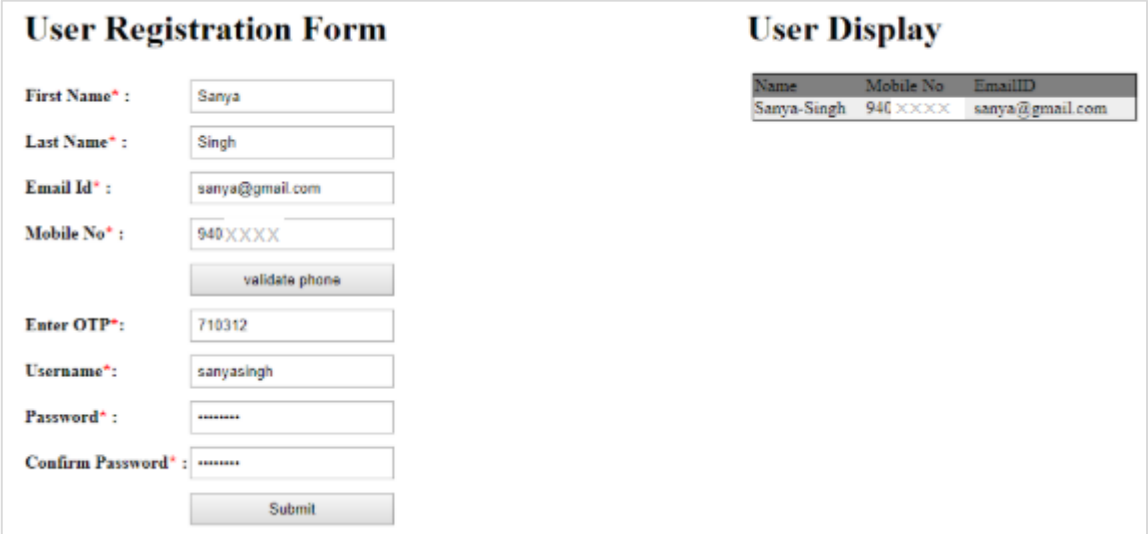
Now, enter the details as shown above. Note that the submit button is disabled. It will be enabled only when all the details are entered as shown:



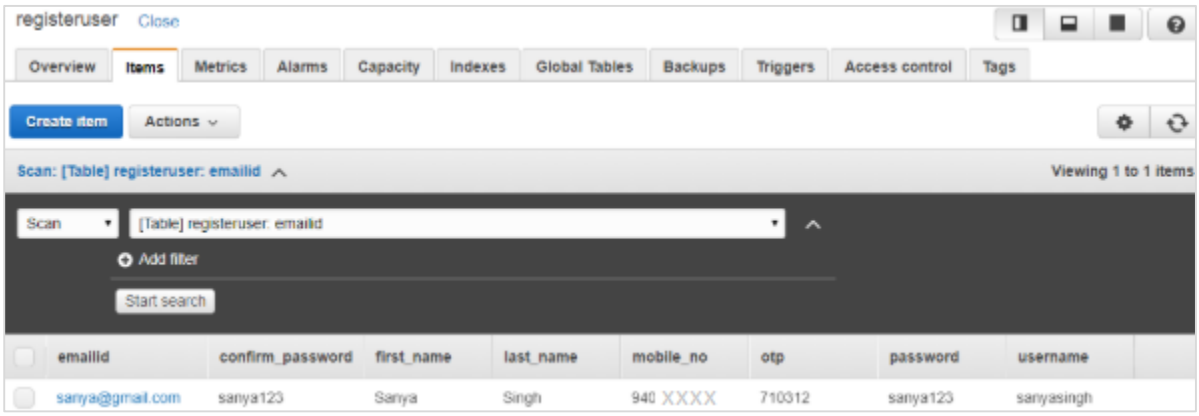
Now, enter the mobile number and click **validate phone** button. It will display the alert message saying *"***OTP is send to the mobile, please enter the OTP to continue***".* OTP sent to the mobile number is as follows:



Enter the OTP and remaining details and submit the form.



The data in DynamoDB **registeruser** table after submit is as shown here:



The code details are as given below:

example1.html

```
<html>
<head>
<script
src="https://ajax.googleapis.com/ajax/libs/jquery/3.3.1/jquery.min.js"></script>
<script type="text/javascript" src="formdet.js"></script>
<style>
     input[type=text],input[type=password],button {
    width: 100%;
    padding: 5px 5px;
    margin: 5px 0;
    box-sizing: border-box;
}

#maincontainer {
    width: 80%;
    margin: auto;
    padding: 10px;
}
div#userregistration {
    width: 60%;
    float: left;
}
div#userdisplay {
    margin-left: 60%;
}
</style>
</head>
<body>
<div id="maincontainer">
<div id="userregistration">
<h1>User Registration Form</h1>
<table border="0">
```

```
<tr>

     <td><b>First Name<span style="color:red;">*</span> : </b></td><td><input
type="text" value="" name="fname" id="fname" /></td>

     <td id="tdfname" style="display:none;"><span style="color:red;">Enter First
Name</span></td>

</tr>

<tr>

<td><b>Last Name<span style="color:red;">*</span> : </b></td><td><input
type="text" value="" name="lname" id="lname" /> </td>

<td id="tdlname" style="display:none;"><span style="color:red;">Enter Last
Name</span></td>

</tr>

<tr>

<td><b>Email Id<span style="color:red;">*</span> : </b></td><td><input type="text"
value="" name="emailid" id="emailid" /> </td>

<td id="tdemailid" style="display:none;"><span style="color:red;">Enter
Email</span></td>

</tr>

<tr>

<td><b>Mobile No<span style="color:red;">*</span> : </b></td><td><input
type="text" name="mphone" id="mphone"/></td>

<td id="tdmphone" style="display:none;"><span style="color:red;">Enter Mobile
Number</span></td>

</tr>

<tr>

     <td></td>

     <td><button id="validatephone">validate phone</button></td>

     <td></td>

</tr>

<tr  id="otpdiv" style="display:none;">

 <td><b>Enter OTP<span style="color:red;">*</span>:</b> </td><td><input
type="text" value="" name="otp" id="otp" /></td>

 <td id="tdotp" style="display:none;"><span style="color:red;">Enter
OTP</span></td>

</tr>

<tr>

<td><b>Username<span style="color:red;">*</span>: </b></td><td><input type="text"
value="" name="uname" id="uname"/></td>
```

```
<td id="tduname" style="display:none;"><span style="color:red;">Enter
Username</span></td>

</tr>

<tr><td><b>Password<span style="color:red;">*</span> :</b></td><td><input
type="password" value="" name="passwd" id="passwd"/></td>

     <td id="tdpasswd" style="display:none;"><span style="color:red;">Enter
Password</span></td>

</tr>

<tr><td><b>Confirm Password<span style="color:red;">*</span> :</b> </td><td><input
type="password" value="" name="cpasswd" id="cpasswd"/></td>

     <td id="tdcpasswd" style="display:none;"><span style="color:red;">Enter
Confirm Password</span></td>

</tr>

<tr>

     <td></td>

     <td><button name="submit" id="submit" style="display:;"
disabled="true">Submit</button></td>

     <td></td>

</tr>

</table>

</div>

<div id="userdisplay">

            <h1>User Display</h1>

<table id="displaydetails" style="display:block;width:80%;padding:5px;margin:5px;
border: 1px solid black;">

<tr>

     <td></td>

     <td>FirstName</td>

     <td>LastName</td>

     <td>Mobile No</td>

     <td>EmailID</td>

</tr>

</table>

</div>

</div>

</body>
```

```
</html>
```

formdet.js

```
function validateform() {
    var sError="";
    if ($("#fname").val() === "") {
        $("#tdfname").css("display","");
        sError++;
    }
    if ($("#lname").val() === "") {
        $("#tdlname").css("display","");
        sError++;
    }
    if ($("#emailid").val() === "") {
        $("#tdemailid").css("display","");
        sError++;
    }
    if ($("#mphone").val() === "") {
        $("#tdmphone").css("display","");
        sError++;
    }
    if ($("#otp").val() === "") {
        $("#tdotp").css("display","");
        sError++;
    }
    if ($("#uname").val() === "") {
        $("#tduname").css("display","");
        sError++;
    }
    if ($("#passwd").val() === "") {
        $("#tdpasswd").css("display","");
        sError++;
    }
    if ($("#cpasswd").val() === "") {
```

```
        $("#tdcpasswd").css("display","");
        sError++;
    }
    if (sError === "") {
        return true;
    } else {
        return false;
    }
}

$("#fname").change(function(){
    if ($("#fname").val() !== "") {
        $("#tdfname").css("display","none");
    } else {
        $("#tdfname").css("display","");
    }
});
$("#lname").change(function(){
    if ($("#lname").val() !== "") {
        $("#tdlname").css("display","none");
    } else {
        $("#tdlname").css("display","");
    }
});
$("#emailid").change(function(){
    if ($("#emailid").val() !== "") {
        $("#tdemailid").css("display","none");
    } else {
        $("#tdemailid").css("display","");
    }
});
$("#mphone").change(function(){
    if ($("#mphone").val() !== "") {
        $("#tdmphone").css("display","none");
```

```
    } else {
        $("#tdmphone").css("display","");
    }
});

$("#otp").change(function(){
    if ($("#otp").val() !== "") {
        $("#tdotp").css("display","none");
    } else {
        $("#tdotp").css("display","");
    }
});

$("#uname").change(function(){
    if ($("#uname").val() !== "") {
        $("#tduname").css("display","none");
    } else {
        $("#tduname").css("display","");
    }
});

$("#passwd").change(function(){
    if ($("#passwd").val() !== "") {
        $("#tdpasswd").css("display","none");
    } else {
        $("#tdpasswd").css("display","");
    }
});

$("#cpasswd").change(function(){
    if ($("#cpasswd").val() !== "") {
        $("#tdcpasswd").css("display","none");
    } else {
        $("#tdcpasswd").css("display","");
```

```
    }
});


var posturl = "https://4rvwimysc1.execute-api.us-east-
1.amazonaws.com/prod/adduser";
var phonevalidationurl = "https://wnvt01y6nc.execute-api.us-east-
1.amazonaws.com/prod/validate";
var otpsend = "";
function getdata() {
    var a =0;
    $.ajax({
            type:'GET',
            url:posturl,
            success: function(data){
                $("#displaydetails").html('');
                $("#displaydetails").css("display", "");
                console.log(data);
                $("#displaydetails").append('<tr
style="padding:5px;margin:5px;background-color:gray;"><td>Name</td><td>Mobile
No</td><td>EmailID</td></tr>');
                data.Items.forEach(function(registeruser){
                    var clr = (a%2 === 0) ? "#eee": "white";
                    a++;
                    $("#displaydetails").append('<tr
style="padding:5px;margin:5px;background-
color:'+clr+'"><td>'+registeruser.first_name+'-
'+registeruser.last_name+'</td><td>'+registeruser.mobile_no+'</td><td>'+registerus
er.emailid+'</td></tr>');
                });
            },
            error: function(err) {
                console.log(err);
            }
    });
}


$(document).ready(function(){
```

```
    $("#otp").on("change", function(){
        var otpentered = $("#otp").val();
        if (otpsend == otpentered) {
            document.getElementById("submit").disabled = false;
        } else {
            alert("OTP is not valid.Please enter the valid one or validate phone
again to continue!");
            document.getElementById("submit").disabled = true;
        }
    });

    $("#validatephone").on("click",function(){
        $.ajax({
            type:'POST',
            url:phonevalidationurl,
            data:JSON.stringify({
                "mphone":$("#mphone").val()
            }),
            success: function(data){
                $("#otpdiv").css("display", "");
                alert("OTP is send to the mobile, please enter to continue");
                console.log(data);
                otpsend = data;
            },
            error : function(err) {
                $("#otpdiv").css("display", "none");
                alert("Invalid mobile no.");
            }
        });
    });
    $("#submit").on("click",function(){
          if (validateform()){
            $.ajax({
                type:'POST',
                url:posturl,
```

```
                data:JSON.stringify({
                    "fname": $("#fname").val(),
                    "lname": $("#lname").val(),
                    "emailid":$("#emailid").val(),
                    "mphone":$("#mphone").val(),
                    "otp":$("#otp").val(),
                    "uname":$("#uname").val(),
                    "passwd":$("#passwd").val(),
                    "cpasswd":$("#cpasswd").val()
                },
                success: function(data){
                    alert("Data added successfully");
                    console.log(data);
                    getdata();
                }
            });
        }
    });
    getdata();
});
```

Till now, we have done AJAX call to the API created and posted the data as shown above.

The AJAX call to add the data to the table is as follows:

```
var posturl = "https://4rvwimysc1.execute-api.us-east-
1.amazonaws.com/prod/adduser";

$(document).ready(function(){
```

```
$("#submit").on("click",function(){
          if (validateform()){
            $.ajax({
                type:'POST',
                url:posturl,
                data:JSON.stringify({
                    "fname": $("#fname").val(),
                    "lname": $("#lname").val(),
                    "emailid":$("#emailid").val(),
                    "mphone":$("#mphone").val(),
                    "otp":$("#otp").val(),
                    "uname":$("#uname").val(),
                    "passwd":$("#passwd").val(),
                    "cpasswd":$("#cpasswd").val()
                },
                success: function(data){
                    alert("Data added successfully");
                    console.log(data);
                    getdata();
                }
            });
        }
 });
});
```

Note that to read the data, a function is called, whose code is given below:

```
function getdata() {
    var a =0;
```

```
    $.ajax({
            type:'GET',
            url:posturl,
            success: function(data){
                $("#displaydetails").html('');
                $("#displaydetails").css("display", "");
                console.log(data);
                $("#displaydetails").append('<tr
style="padding:5px;margin:5px;background-color:gray;"><td>Name</td><td>Mobile
No</td><td>EmailID</td></tr>');
                data.Items.forEach(function(registeruser){
                    var clr = (a%2 === 0) ? "#eee": "white";
                    a++;
                    $("#displaydetails").append('<tr
style="padding:5px;margin:5px;background-
color:'+clr+'"><td>'+registeruser.first_name+'-
'+registeruser.last_name+'</td><td>'+registeruser.mobile_no+'</td><td>'+registerus
er.emailid+'</td></tr>');
                });
            },
            error: function(err) {
                console.log(err);
            }
    });
}
```

When you click mobile number validate button, the following code is called and sends the mobile number:

```
var phonevalidationurl = "https://wnvt01y6nc.execute-api.us-east-1.amazonaws.com/prod/validate";
var otpsend = "";
 $("#validatephone").on("click",function(){
        $.ajax({
            type:'POST',
            url:phonevalidationurl,
            data:JSON.stringify({
                "mphone":$("#mphone").val()
            }),
            success: function(data){
                $("#otpdiv").css("display", "");
                alert("OTP is send to the mobile, please enter the OTP to continue");
                console.log(data);
                otpsend = data;
            },
            error : function(err) {
                $("#otpdiv").css("display", "none");
                alert("Invalid mobile no.");
            }
        });
    });
//Validate otp
$("#otp").on("change", function(){
        var otpentered = $("#otp").val();
        if (otpsend == otpentered) {
            document.getElementById("submit").disabled = false;
        } else {
            alert("OTP is not valid.Please enter the valid one or validate phone again to continue!");
            document.getElementById("submit").disabled = true;
```