

Configuration Manual

MSc Research Project
MSc in Cloud Computing

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1 Introduction

1.1 Purpose of the document

This Configuration Manual follows the specifications of the NCI Research project. In this document, we will discuss the software tools and settings that are required to provide efficient task scheduling in serverless platform using Ant Colony Optimization(ACO) Algorithm.

1.2 Document structure

Section	Purpose
General Information	This module describes how the serverless platform is set up and the project requirements.
Setup prerequisites	This module describes how to set up the development environment for the development and update of the solution.
Deployment procedure	A proposed model deployment procedure is described in this module
Validations	The purpose of this module is to provide an overview of the validation requirements for the deployment of the solution

2 General Information

2.1 Objective

The objective of this research work is to schedule a task efficiently using Ant Colony Optimization(ACO) algorithm. The ACO algorithm was written in Python 3.8 and utilizes boto3, redis and json library. The experimental simulation was conducted to check the memory and cost utilization by MapReduce application on serverless platform.

2.2 Architecture requirement

Here is a description of the AWS services required to build a Composite model.

2.2.1 AWS Virtual Private Cloud(VPC)

To access Lambda and Elastic Cache, the AWS VPC (Virtual Private Network) is created. The VPC contains subnets, security groups, route tables, and NAT gateways. ¹.

2.2.2 AWS Simple Storage Service(S3)

AWS S3 is used for storing input data for MapReduce application and storing output data from MapReduce application ².

2.2.3 AWS CloudWatch

AWS CloudWatch is used for monitoring MapReduce performance such as CPU utilization, execution time and many more with and without ACO algorithm. ³.

2.3 AWS Lambda

Creation of coordinator, mapper, and reducer functions with Python 3.8 is accomplished by using the Lambda compute service provided by Amazon ⁴.

2.4 AWS Elastic Cache

Using AWS Elastic Cache service, intermediate files are produced by map functions. This is used to additional power to our application⁵.

2.5 Required Skill

You will need to be familiar with Amazon Web Services before you start reading this guide. You will also need to be familiar with the Python language so that you can understand the code.

¹<https://aws.amazon.com/vpc/>

²<https://aws.amazon.com/s3/>

³<https://aws.amazon.com/cloudwatch/>

⁴<https://aws.amazon.com/lambda/>

⁵<https://aws.amazon.com/elasticache/>

3 Development Environment Requirement

3.1 Code Repository

Please refer to the zip file I have submitted in the ICT solution.

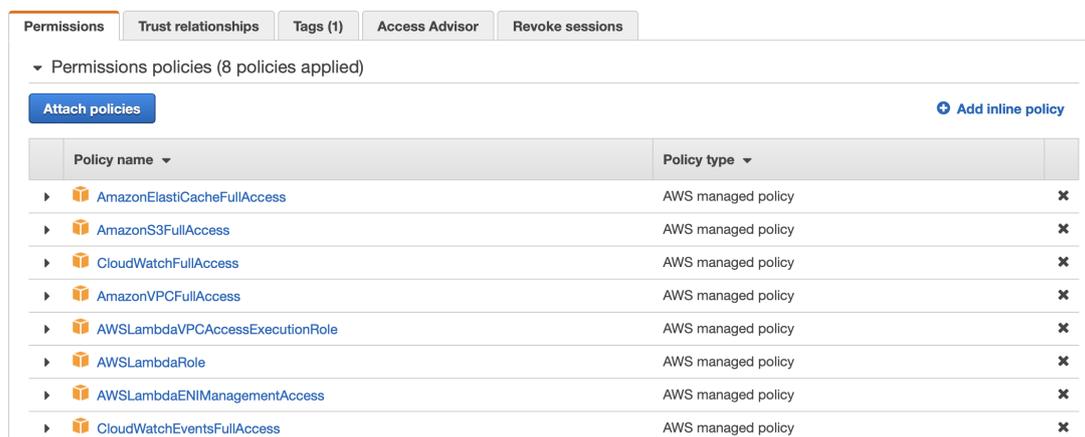
3.2 Programming language required

- Python Version 3.8
- Boto3
- Shell scripting

3.3 Configuring IAM role

It is necessary, before creating a Lambda function, to create an IAM role which has policy attached to it as shown in the figure 1. This facilitates the execution environment creation for the lambda function.

- AmazonLambdaRole
- AmazonS3FullAccess
- AmazonVPCFullAccess
- Amazon ElasticCacheFullAccess
- AmazonCloudWatchFullAccess



The screenshot shows the AWS IAM console interface for an IAM role. The 'Permissions' tab is active, displaying a list of 8 attached policies. The table below summarizes the policies shown in the screenshot.

Policy name	Policy type	Remove
AmazonElastiCacheFullAccess	AWS managed policy	✕
AmazonS3FullAccess	AWS managed policy	✕
CloudWatchFullAccess	AWS managed policy	✕
AmazonVPCFullAccess	AWS managed policy	✕
AWSLambdaVPCAccessExecutionRole	AWS managed policy	✕
AWSLambdaRole	AWS managed policy	✕
AWSLambdaENIManagementAccess	AWS managed policy	✕
CloudWatchEventsFullAccess	AWS managed policy	✕

Figure 1: Required IAM policies

3.4 Configuring a VPC

The VPC (server virtual private network) is configured with the 192.168.0.0/16 CIDR block in figure 2

- Use 192.168.10.0/24 v4 CIDR blocks for the public subnet as shown in figure4.
- A public subnet is created by an internet gateway that is assigned to the subnet shown in figure 3
- In figure 5, you can see how to create a private subnet with 192.168.20.0/24 CIDR addresses
- Create a NAT gateway for assigning a private subnet as depicted in the figure6.
- Add public subnet and internet gateway to public route table as shown in figure 7
- Set up private route tables and assign private subnets to them along with their respective NAT gateways and virtual private connections, as shown in figure8.
- Create the VPC endpoint as depicted in figure ??
- As a virtual firewall, create the security group that allows both inbound and out-bound traffic. This security group uses HTTP, HTTPS, SSH, and Custom TCP to allow any traffic from anywhere to Redis and other services as shown in figure 10.

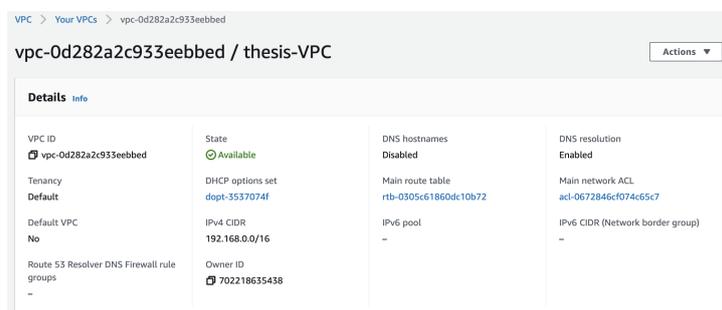


Figure 2: VPC creation

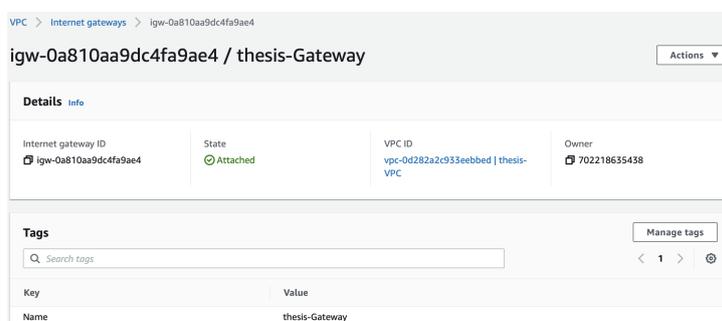


Figure 3: Internet Gateway creation

Name	Subnet ID	State	VPC	IPv4 CIDR	IPv6 CIDR
-	subnet-a083f8c6	Available	vpc-25db4c58	172.31.0.0/20	-
-	subnet-ce704cc0	Available	vpc-25db4c58	172.31.64.0/20	-
-	subnet-ba29689b	Available	vpc-25db4c58	172.31.80.0/20	-
-	subnet-bbc9478a	Available	vpc-25db4c58	172.31.48.0/20	-
thesis-subnet-private	subnet-0c84ef513c19f5d82	Available	vpc-0d282a2c933eebbd the...	192.168.20.0/24	-
-	subnet-b8c581e7	Available	vpc-25db4c58	172.31.32.0/20	-
-	subnet-1e676d53	Available	vpc-25db4c58	172.31.16.0/20	-
thesis-subnet-public	subnet-04dd6cca48f919210	Available	vpc-0d282a2c933eebbd the...	192.168.10.0/24	-

Figure 4: Public subnet creation

Name	Subnet ID	State	VPC	IPv4 CIDR	IPv6 CIDR
-	subnet-a083f8c6	Available	vpc-25db4c58	172.31.0.0/20	-
-	subnet-ce704cc0	Available	vpc-25db4c58	172.31.64.0/20	-
-	subnet-ba29689b	Available	vpc-25db4c58	172.31.80.0/20	-
-	subnet-bbc9478a	Available	vpc-25db4c58	172.31.48.0/20	-
thesis-subnet-private	subnet-0c84ef513c19f5d82	Available	vpc-0d282a2c933eebbd the...	192.168.20.0/24	-
-	subnet-b8c581e7	Available	vpc-25db4c58	172.31.32.0/20	-
-	subnet-1e676d53	Available	vpc-25db4c58	172.31.16.0/20	-
thesis-subnet-public	subnet-04dd6cca48f919210	Available	vpc-0d282a2c933eebbd the...	192.168.10.0/24	-

Figure 5: Private subnet creation

nat-08e7ef8caf8b924b6 / thesis-NAT

Field	Value
NAT gateway ID	nat-08e7ef8caf8b924b6
Connectivity type	Private
Elastic IP address	-
Subnet	subnet-0c84ef513c19f5d82 / thesis-subnet-private
Private IP address	192.168.20.96
Created	2021/07/25 18:28 GMT+1
State	Available
Network Interface ID	eni-0eb71a2d8aae6275a
Deleted	-
State message	-
VPC	vpc-0d282a2c933eebbd / thesis-VPC

Figure 6: Nat Gateway creation

Name	Route table ID	Explicit subnet associat...	Edge associations	Main	VPC
thesis-route-table-private	rtb-01cf28fb0129da384	subnet-0c84ef513c19f5...	-	No	vpc-0d282a2c933eebbd
-	rtb-0305c61860dc10b72	-	-	Yes	vpc-0d282a2c933eebbd
thesis-route-table-public	rtb-0ca682027746b84b3	subnet-04dd6cca48f91...	igw-0a810aa9dc4...	No	vpc-0d282a2c933eebbd
-	rtb-c12133bf	-	-	Yes	vpc-25db4c58

Figure 7: Public routing table creation

Name	Route table ID	Explicit subnet associat...	Edge associations	Main	VPC
thesis-route-table-private	rtb-01cf28fb0129da384	subnet-0c84ef513c19f5...	-	No	vpc-0d282a2c933eebbd
-	rtb-0305c61860dc10b72	-	-	Yes	vpc-0d282a2c933eebbd
thesis-route-table-public	rtb-0ca682027746b84b3	subnet-04dd6cca48f91...	igw-0a810aa9dc4...	No	vpc-0d282a2c933eebbd
-	rtb-c12133bf	-	-	Yes	vpc-25db4c58

Figure 8: Private route table creation

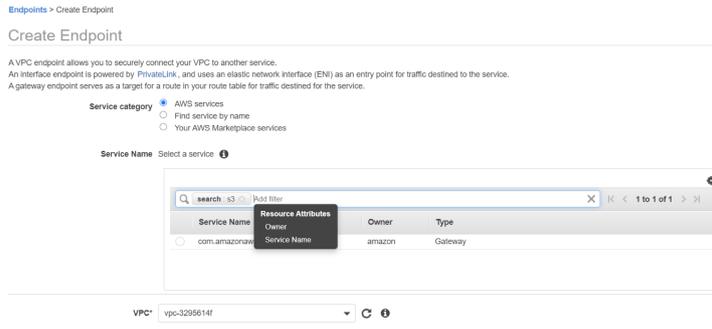


Figure 9: Endpoint creation

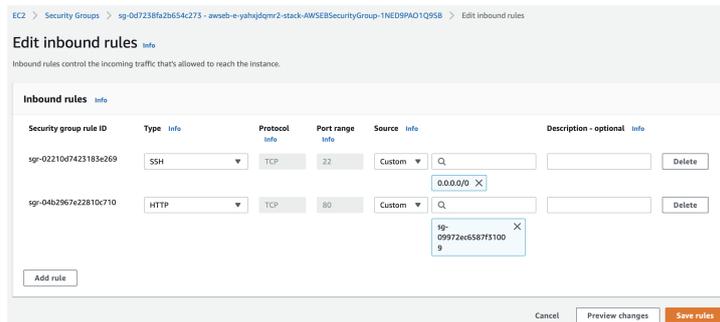


Figure 10: Security group creation

3.5 AWS S3 creation

To store incoming data, create the S3 bucket as shown in figure ??

3.6 Creation of AWS Lambda function

Once you create the IAM role, create the lambdas for mapper, coordinator, and reducer.

- The AWS lambda function can be created by going to Lambda and clicking Create a Function as shown in figure 12.
- Click the blueprint button once you've selected the create function as shown in figure 13
- As shown in figure 14, select the basic information section with the function name, run-time language, and permissions – a permissions role with everything required.
- You need to edit the vpc section after creating the lambda function in the project. As illustrated in figure 16, add the network configuration
- Whenever input data is entered into the bucket, it should be notified to the lambda function. To do this, we must set a trigger event on the bucket in the lambda function ??

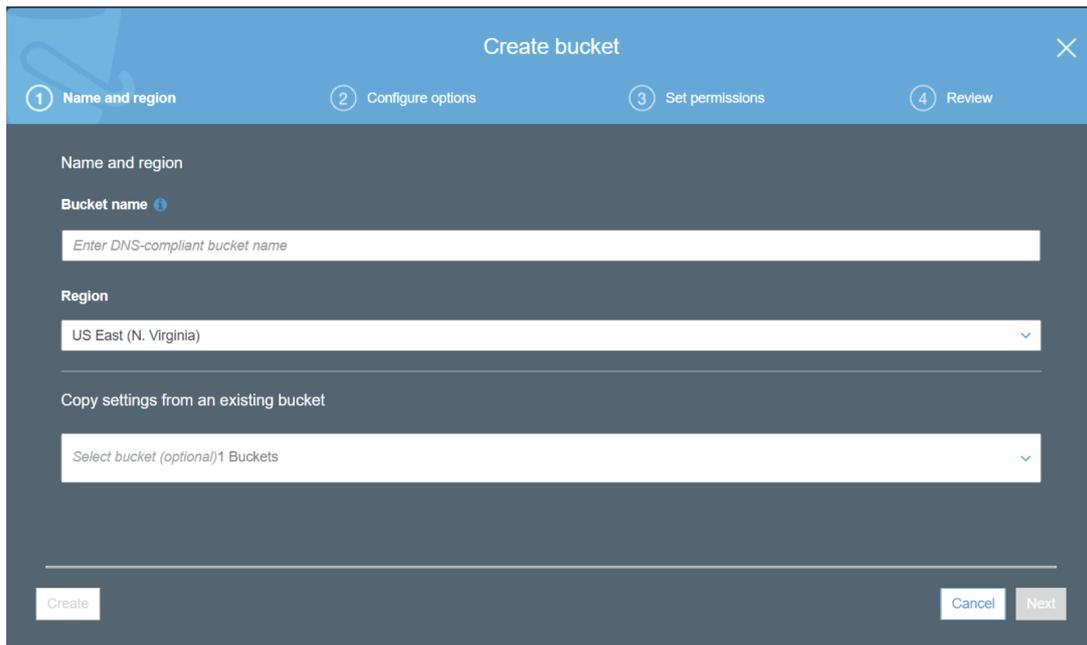


Figure 11: AWS S3 bucket interface

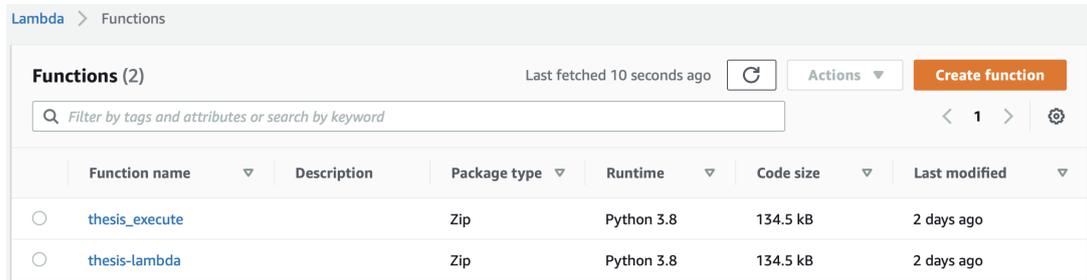


Figure 12: Function Creation

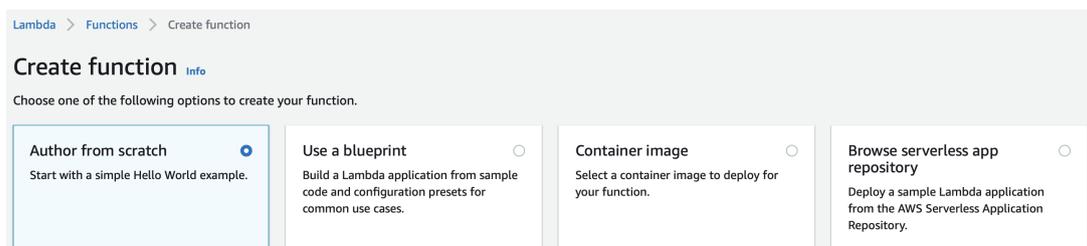


Figure 13: Blueprint Selection

Basic information

Function name
Enter a name that describes the purpose of your function.

Use only letters, numbers, hyphens, or underscores with no spaces.

Runtime [Info](#)
Choose the language to use to write your function. Note that the console code editor supports only Node.js, Python, and Ruby.

Node.js 14.x ▼

Permissions [Info](#)
By default, Lambda will create an execution role with permissions to upload logs to Amazon CloudWatch Logs. You can customize this default role later when adding triggers.

▶ [Change default execution role](#)

Figure 14: Configuration details

▼ Advanced settings

Code signing

Code signing configuration - optional [Info](#)
To enable code signing, choose a configuration that defines the signature validation policy and the signing profiles that are permitted to sign code.

Choose a code signing configuration ARN
▼
↻

Network

To provide network access for your Lambda function, specify a virtual private cloud (VPC), VPC subnets, and VPC security groups. VPC configuration is optional unless your user permissions require you to configure a VPC.

VPC - optional [Info](#)
Choose a VPC for your function to access.

vpc-0d282a2c933eebbed (192.168.0.0/16)
▼
↻

Subnets
Select the VPC subnets for Lambda to use to set up your VPC configuration.

Choose subnets
▼
↻

subnet-0c84ef513c19f5d82 (192.168.20.0/24) us-east-1c ✕
Name: thesis-subnet-private

subnet-04dd6cca48f919210 (192.168.10.0/24) us-east-1c ✕
Name: thesis-subnet-public

Security groups
Choose the VPC security groups for Lambda to use to set up your VPC configuration. The table below shows the inbound and outbound rules for the security groups that you choose.

Choose security groups
▼
↻

sg-07aa111c7783ded77 (thesis-security-group) ✕
thesis SG

Figure 15: Configuring network

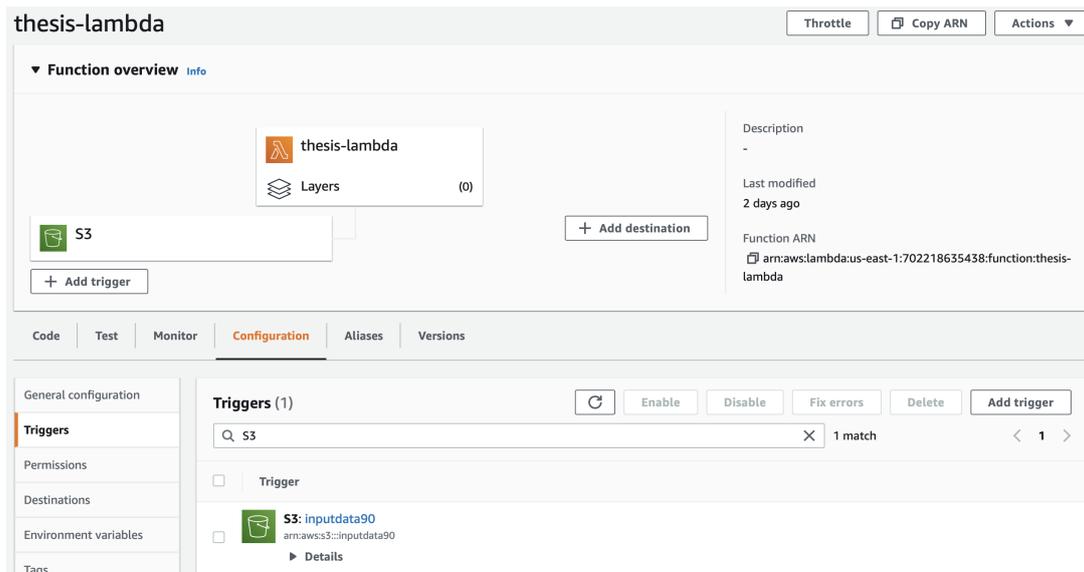


Figure 16: Configuring network

3.7 AWS Elastic Cache Creation

To store intermediate data generated from mapper functions, create an elastic cache memory for redis.

- The cluster engine should be selected as redis and we will configure the redis setting in which we will select engine version, port, node type, and the number of replicas as shown in figure 17
- There are a number of advance settings that need to be selected, including subnet group, security group, backup and maintenance windows as shown in figure 18.

Cluster engine

- Redis**
In-memory data structure store used as database, cache and message broker. ElastiCache for Redis offers Multi-AZ with Auto-Failover and enhanced robustness.
 - Cluster Mode enabled**
- Memcached**
High-performance, distributed memory object caching system, intended for use in speeding up dynamic web applications.

Location

Choose a location

- Amazon Cloud**
Use Amazon's cloud for your ElastiCache instances
- On-Premises**
Create your ElastiCache instances on AWS Outposts. You need to create a subnet ID on an Outpost first.

Redis settings

Ensure you have reviewed the five workload characteristics to consider when right sizing Amazon ElastiCache Redis clusters. [Learn more](#)

Name ⓘ

Description ⓘ

Engine version compatibility ⓘ

Figure 17: Redis configuration

▼ Advanced Redis settings

Advanced settings have common defaults set to give you the fastest way to get started. You can modify these now or after your cluster has been created.

Slots and keyspaces ⓘ

Availability zones placement ⓘ

	Slots/Keyspaces	Primary	Replica 1	Replica 2
Shard 1	Equal distribution	No preference	No preference	No preference
Shard 2	Equal distribution	No preference	No preference	No preference
Shard 3	Equal distribution	No preference	No preference	No preference

Security

Security groups ⓘ

Encryption at-rest ⓘ

Encryption in-transit ⓘ

Logs

Slow log ⓘ

Figure 18: Additional Redis settings

4 Validation

Prepare the code and upload the files using the upload zip file option. now create a lambda function and inside that function, set up a mapper, a coordinator, and a reducer. After creating all the services in the VPC section, you should now configure the network. The configuration is tested in two ways as shown below:

- An alternative way is to create tests within functions, as shown in the figure 19. Run the tests, and then view the results displayed in the figure 20. When the configuration is incorrect, an error will be thrown.
- As shown in figure 21, the second way involves adding input to the S3 bucket so that whenever there is input at the bucket, a S3 event trigger is triggered. Figure 22 shows the output in the cloud watch service when there is a correct connection between the trigger event in S3 and lambda function.

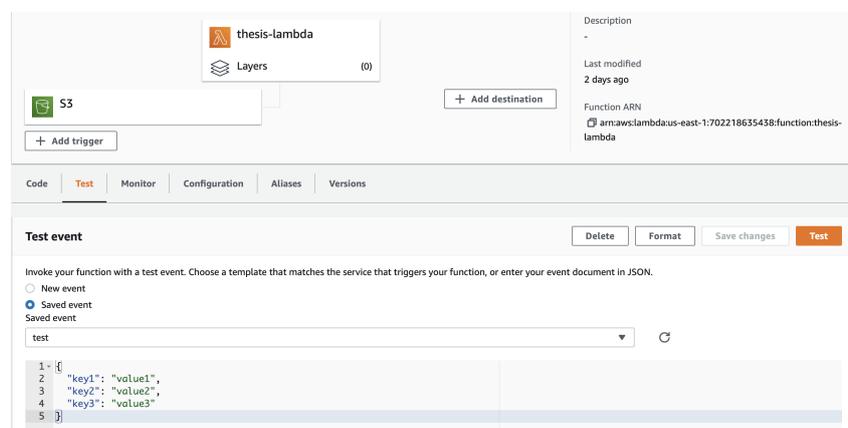


Figure 19: MapReduce application execution test case creation

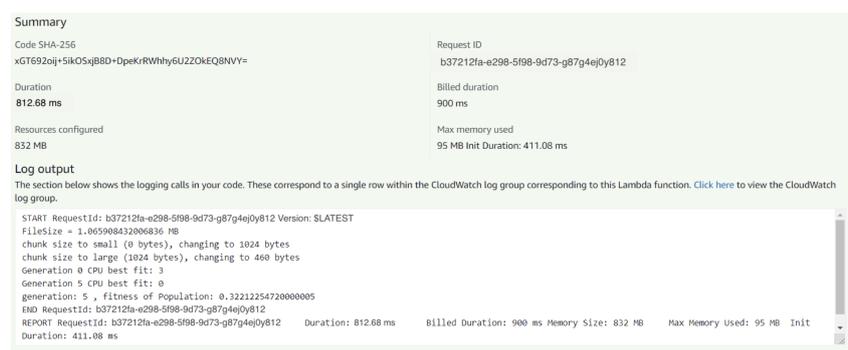


Figure 20: Execution result of MapReduce application

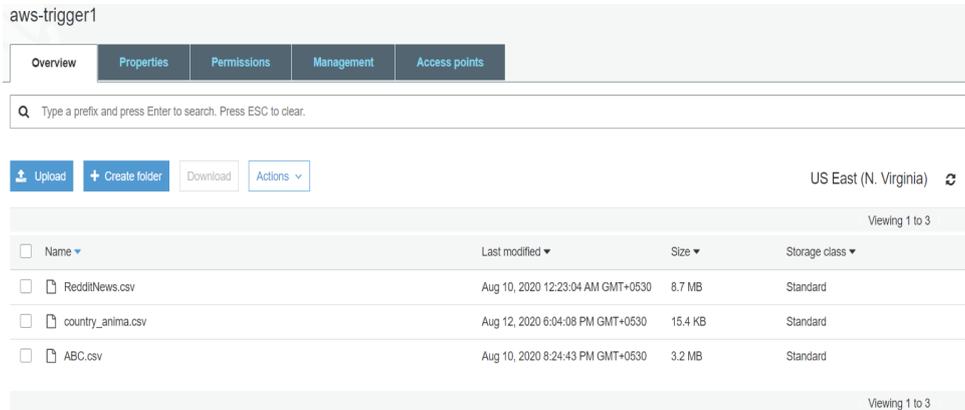


Figure 21: Event trigger for AWS S3

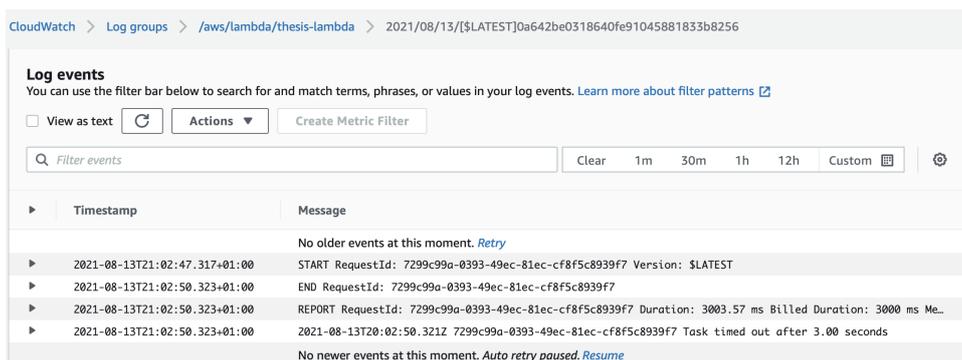


Figure 22: Execution logs provided by AWS Cloud Watch