University of East London

SCHOOL OF ARCHITECTURE, COMPUTING & ENGINEERING

INDIVIDUAL CW REPORT

on

Vertical Sector – SMART campus

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Module Code: CN7026

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1 Abstract

The development of digital infrastructure has happened at a devastating rate, but it lags in the goal of smart campus. The major problem was to change the development of infrastructure with the changing technology, to ensure connectivity need it to centralize the information, and lastly, but most importantly to provide a good user interface by developing a smart application. The reason is the absence of a suitable model or framework for effective transition into smart campus. This coursework designs the overall architecture of smart campus based on the cloud infrastructure. The cloud service provider I will be using – AWS (Amazon Web Services). By using cloud services, we can solve the above-mentioned problems by using pay-as-you-go model we ensure the elasticity of the system, it also provides centralized storage and highly secure and with low latency network to provide an enjoyable experience to the student and make their interaction with the application effortless. This will provide the true experience and transformation to the smart campus much easier and faster than before.

2 Introduction

Over the years, after the development of the internet it has become an inclusive part of society. This has caused involvement of Information technology across the diverse fields of industry, economy, and education. It brings the reality of Smart City closer. With the changing environment, education also needs to change. In recent years, particularly in the last decade, major changes have been seen in education which involves adopting media like Mooc, LMS etc., then the usage of Artificial Intelligence, Artificial Reality, Big Data, Cloud and Internet of Things, and recent evaluations in learning patterns and models. This involvement of big data on people's life has evolved the formation of Smart Campus from digital campus. Smart Campus consists of Big Data, IoT (Internet of Things), Cloud Services which comprise of big data sharing and exchange platform, unified identity management and authentication, one-stop personalized integrated management service system, mobile smart campus, and security design.[1]

Every university has tried to achieve the SMART campus to provide best educational experience to students, but due to reasons such as CAPEX investment in traditional hardware's, division into departments which leads to decentralized storage of data and less technical experience in developing a truly integrated smart application. In this coursework, I have developed the AWS based cloud architecture for creating an application for unified information access and identity access based on centralized database. This architecture developed by utilizing the requirements of current as well as future needs of the campuses. The various AWS services used involve Simple Storage Service and DynamoDB for storage, Identity and Access Management (IAM) policies for authentication and authorization, VPC and various other services.

[1] Cao, J., Li, Z., Luo, Q., Hao, Q. and Jiang, T. (2018). *Research on the Construction of Smart University Campus Based on Big Data and Cloud Computing*. [online] IEEE Xplore. Available at: https://ieeexplore.ieee.org/document/8530431 [Accessed 23 Apr. 2022].

3 Project Plan

(22 March 2022-8 May 2022)

7 WEEKS

Phases of Completion	Finish Time	finish/unfinish	Level of completion	Resource Used
Phase 1				
Collecting data about current functioning of various universities (Including University of East London)	Week 1	finish	100%	Source - https://www.uel.ac.uk/study/postgraduate/postgraduate-open-events?gclid=CjwKCAjwx46TBhBhEiwArA_DjDLOe2zj_8vwPa9adPuAmZCpXEtSE-n0-nKZcvWhBcV0-gplGcuq_RoCddsQAvD_BwE
Analyzing the information and figuring out the reason for divergence from ideal Smart Campus.	Week 2	finish	100%	IEEE Website, Uel Website, Harvard Website

FIG 1.1

Phases of Completion	Finish Time	finish/unfinish	Level of completion	Resource Used
Phase 2				
Figuring out the best Cloud service provider and best solution for smart campus	Week 3	finish	100%	IEEE papers, Google scholar, AWS documentation, Tier1 cloud service providers comparison articles
Selecting the most suitable AWS service	Week 4	finish	100%	AWS Documentation
Phase 3				
Figuring out the architecture	Week 5	finish	100%	AWS Documentation
Implementing the solution in AWS Academic lab	Week 6	finish	100%	AWS Documentation
Calculating the cost (TCO and monthly cost)	Week 7	Finish	100%	AWS Documentation

FIG 1.2

3 Requirements Gathering

3.1 Functional Requirements

Functional Requirements	Metric
Main Requirements for SMART Campus	Unification of Database, reduction in CAPEX cost to upgrade hardware, good application interface
Person managing and responsible for operation of the application	College and AWS cloud technicians
Private Information management	Result and personal information of students must be limited to college teachers and principal.
Central Database	Unique database for all sub-sections of the school
Management tasks	Regular update of the database
Real time updating	central location to update the information for all the
Encryption	Full Encrypted
Load Time	In single digit seconds
Recovery	Should be in 1 minute
Data Transfer	In single digit seconds

FIG 2

3.2 Non-Functional Requirements

Non-Functional	Measure
Authenticity	Automatic by Google, and Outlook API
Secured	Highly secured data transfer, authenticity for user and institution and treating of spam activities
Reliability	Exceptionally reliable with guarantee of AWS
Authorization	Different level access for institutions and student
Storage requirements	Managed with current and fully flexible to incorporate future needs
Scalability	Fully balanced to manage heavy traffic at any instance
elasticity	Fully adaptable to change
management	Fully managed to be run during working hours and update during non-working night hours

FIG 3

3.3 Key characteristics (e.g., risk) of the system

1.) Decentralized storage

2.) Inability to upgrade hardware with changing technology

3) Weak application with average user experience

3.4 cloud computing as a solution

3.4.1 Goal

Centralized Storage System, Rapid and Quick advancement and implementation with the change, and diverse and integrated collaboration by real-time processing,

also to frame architecture to reduce Capex and complexity in adaptation of new system

3.4.2 Result

Cloud computing is the unique solution to achieve the above goals.

4 Choice of cloud platform as solution for the problem domain and rationale for choice

4.1 Why Cloud?

1. can store substantial amounts of data at an individual location

2. pay-as-you-go i.e OPEX can try and utilize technologies in real-time

3 low latency network means more speed of data transfer and less load time

4. built-in data encryption, security, and upgradation

5. better connectivity with IoT, Big Data technologies with edge computing and large compute and storage

4.2 Why AWS?

After comparing 1 to 3 tiers of cloud service providers, AWS performs better in terms of number of services, reachability, and market capture. With the largest team of technical experts, AWS offers the best security, uptime guarantee and technical support.

5 Choice of data center and standards

5.1 Datacenter

I have selected AWS datacenter because they are present in over 24 regions with 84 availability zones and offer multiple layers of security at distinct levels from Physical Security to data and application layer.

5.2 Standards-

1 PCI-DSS

2 GDPR

3 FIPS 140-2

6 System Architecture

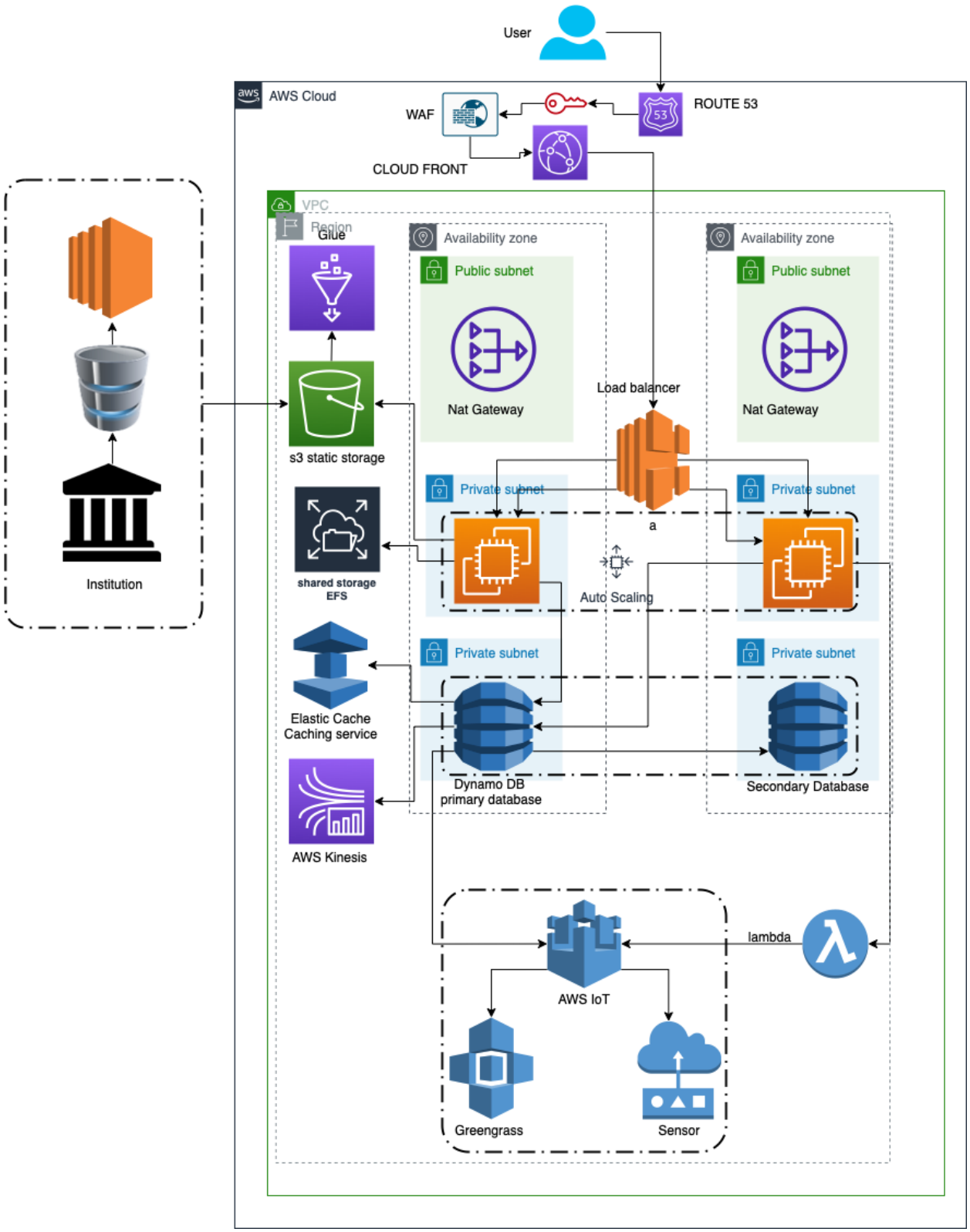

FIG 4

6.1 Description

I have started by considering two users' group one will be students, teachers and other will be institution administrators and higher authorities. Among these main users like students and teachers will get access to the application (EC2 instances) and institution will get access to the storage (S3). To provide secure access to the group one users, we are using Route 53, IAM policies, Web Application Firewall. Next, it will go via Cloud Front, Load Balancer where traffic will be diverted to one of the EC2 instances. EC2 instances are well connected with Dynamo DB, S3 which relates to glue, kinesis and IoT. Other applications connected with EC2 instances are Elastic File Storage, to store and lambda functions to trigger the IoT services as and when required. In IoT services I have selected AWS Green Grass and Sensor which are keen IoT services for our SMART campus architecture. Additionally, there are two public NAT Gateways to provide public internet access to the services.

6.2 AWS VPC

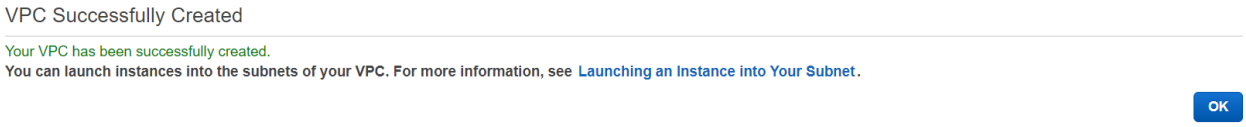

FIG 5 Virtual Private Cloud, private network to isolate from other public networks.

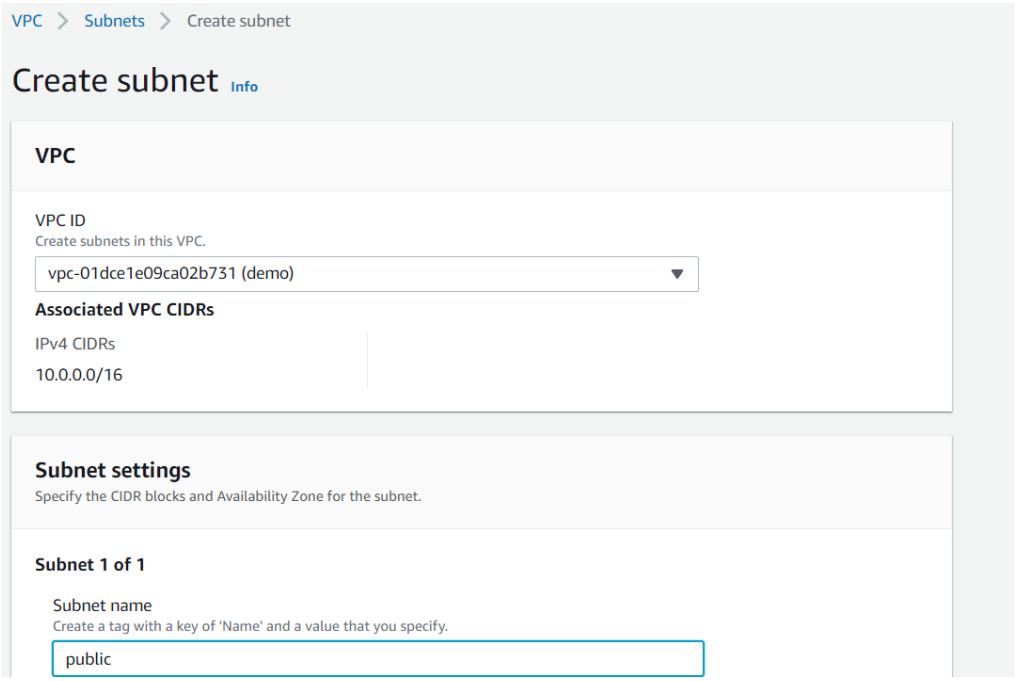

FIG 6 public subnets – division of IP addresses for access from outside VPC

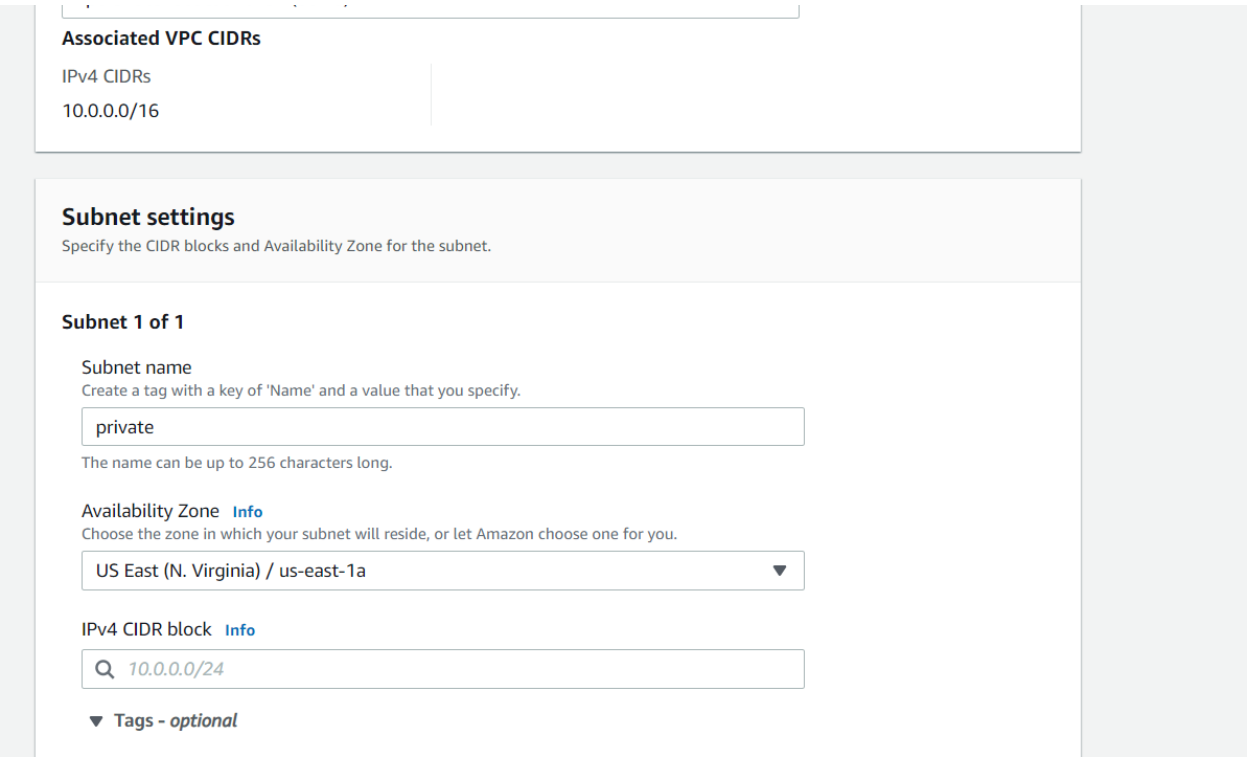

FIG 7 private subnets – division of IP addresses for access from outside VPC

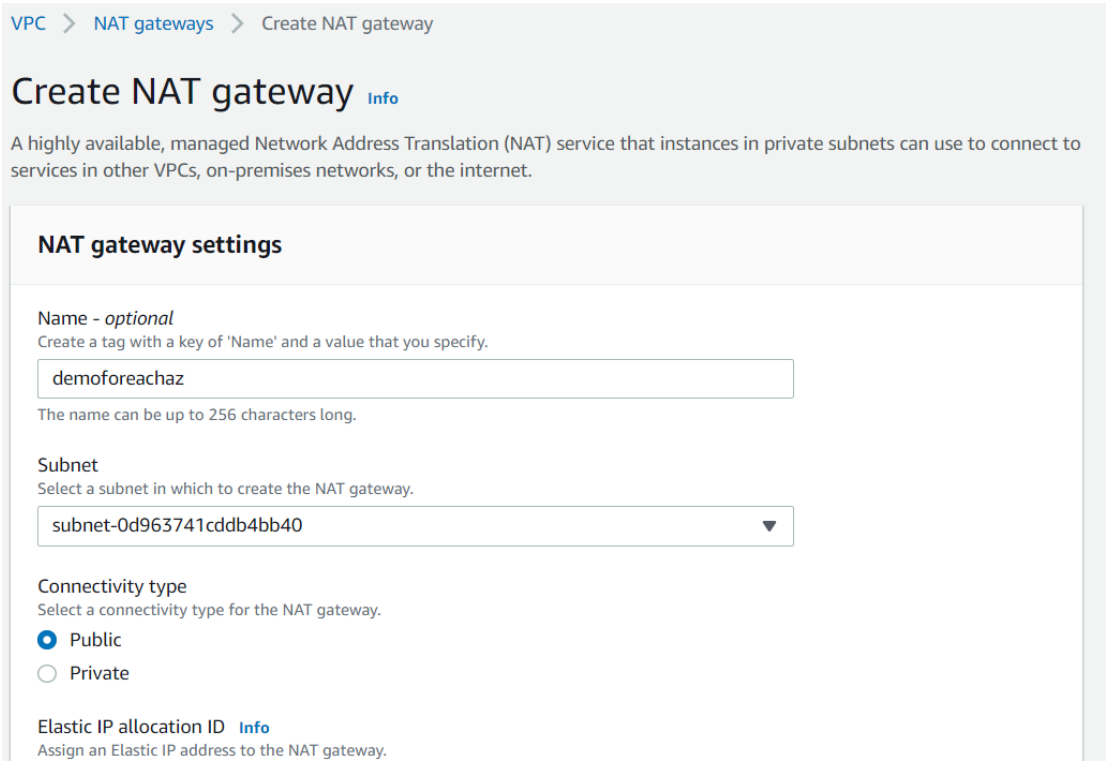

FIG 8 NAT gateway (1 for 1 AZ)- (Network Address Translation) for connection outside VPC

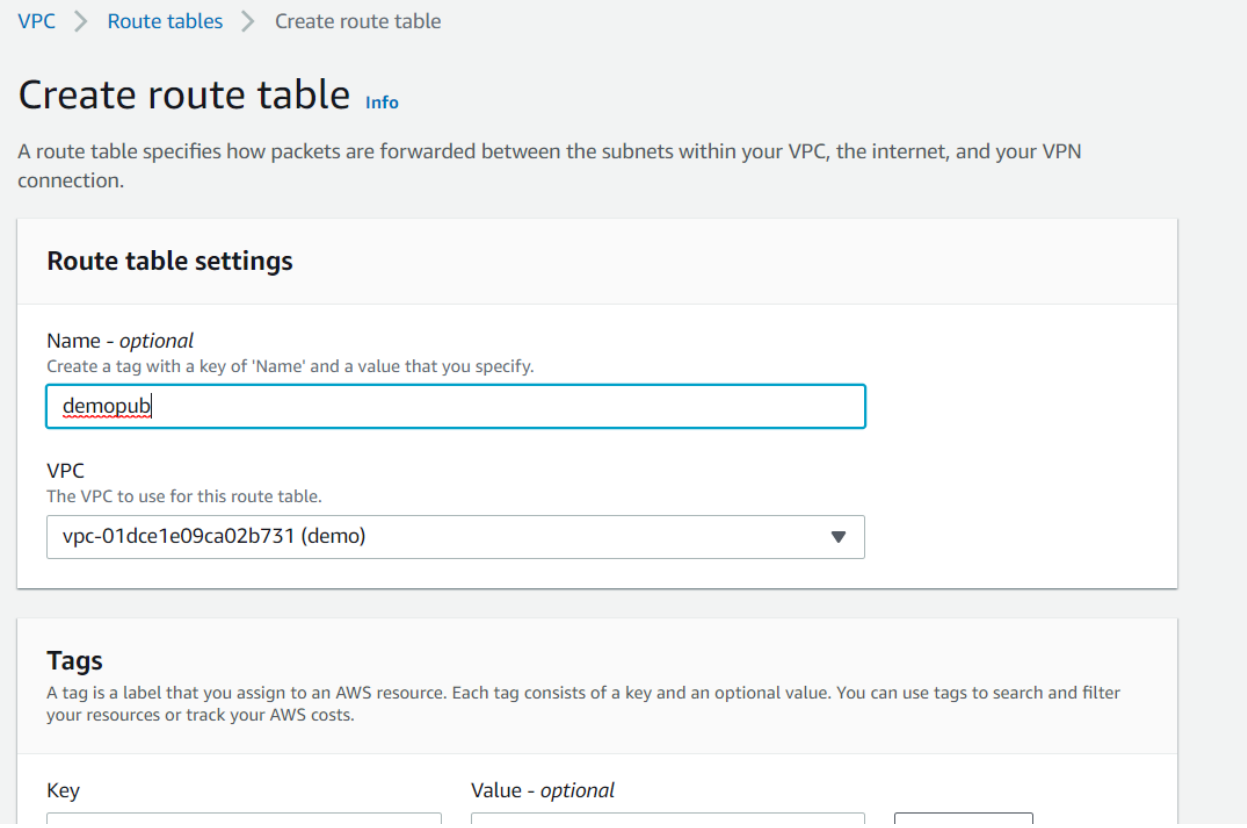

FIG 9 Route Tables – rules for direction of traffic

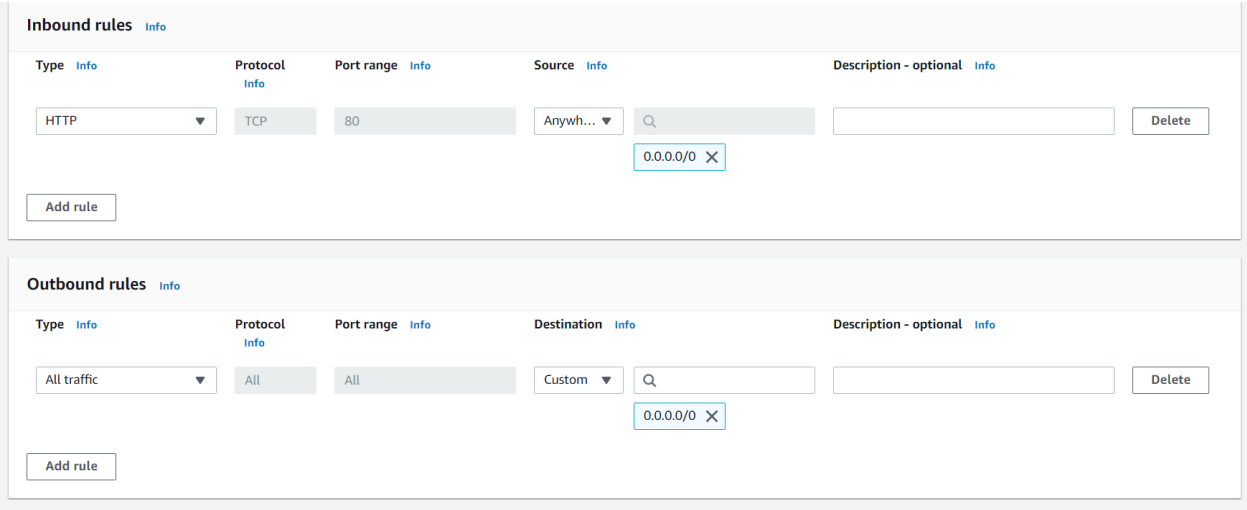

FIG 10 AWS Security group (for controlling the traffic in/out)

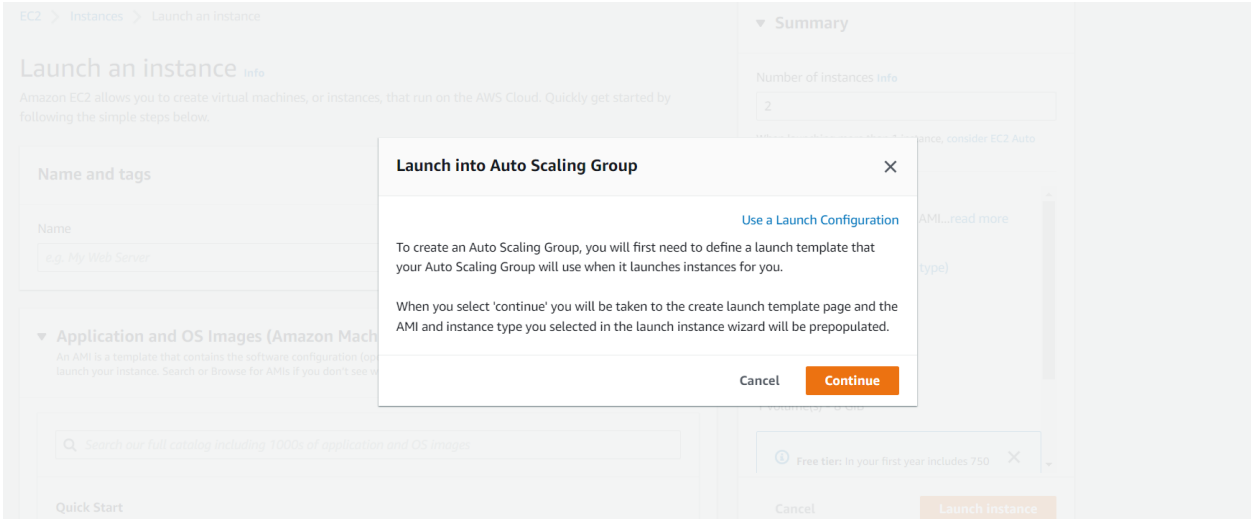

FIG 11 Auto Scaling group for ec2 instance

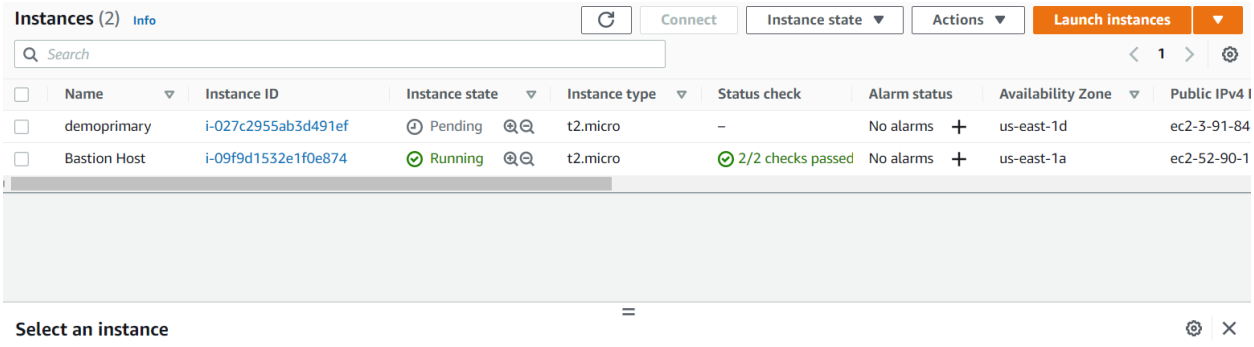

FIG 12 Launched first EC2 instance – primary for computation and application hosting

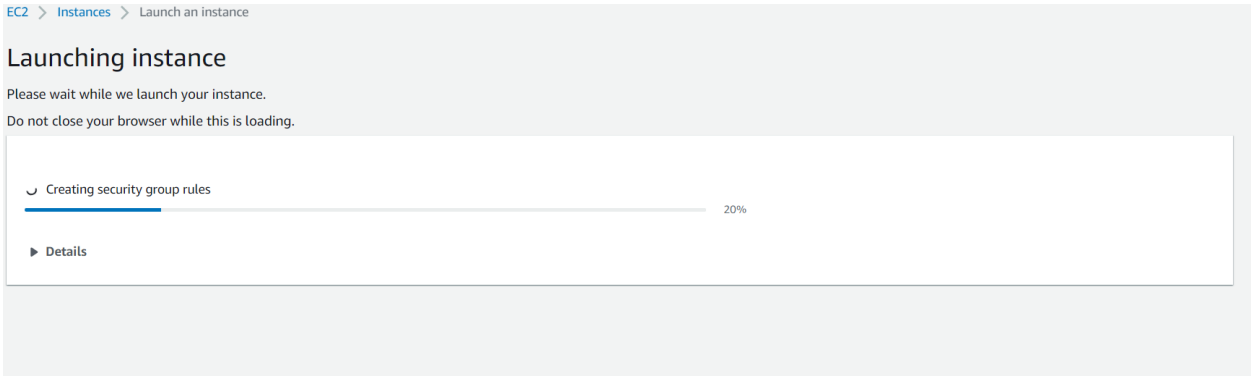

FIG 13 Launching Second EC2 instance – secondary EC2 to support primary

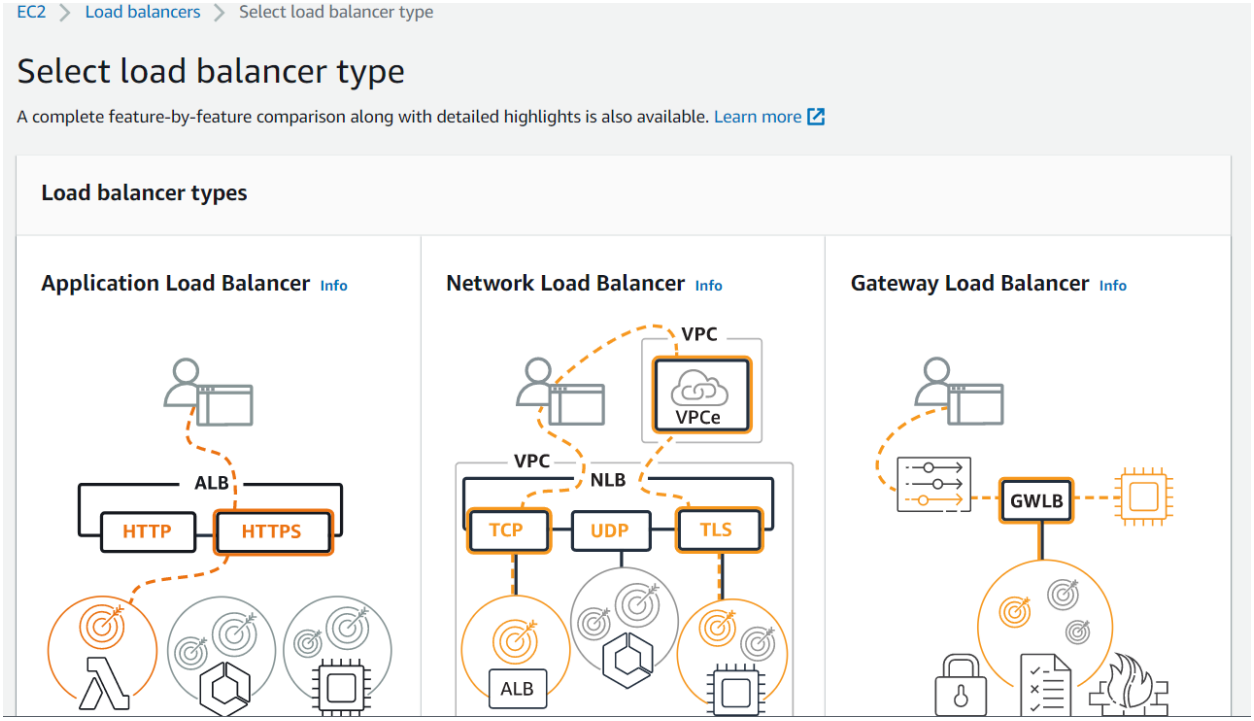

FIG 14 Load Balancer – automatic distribution of traffic across ec2

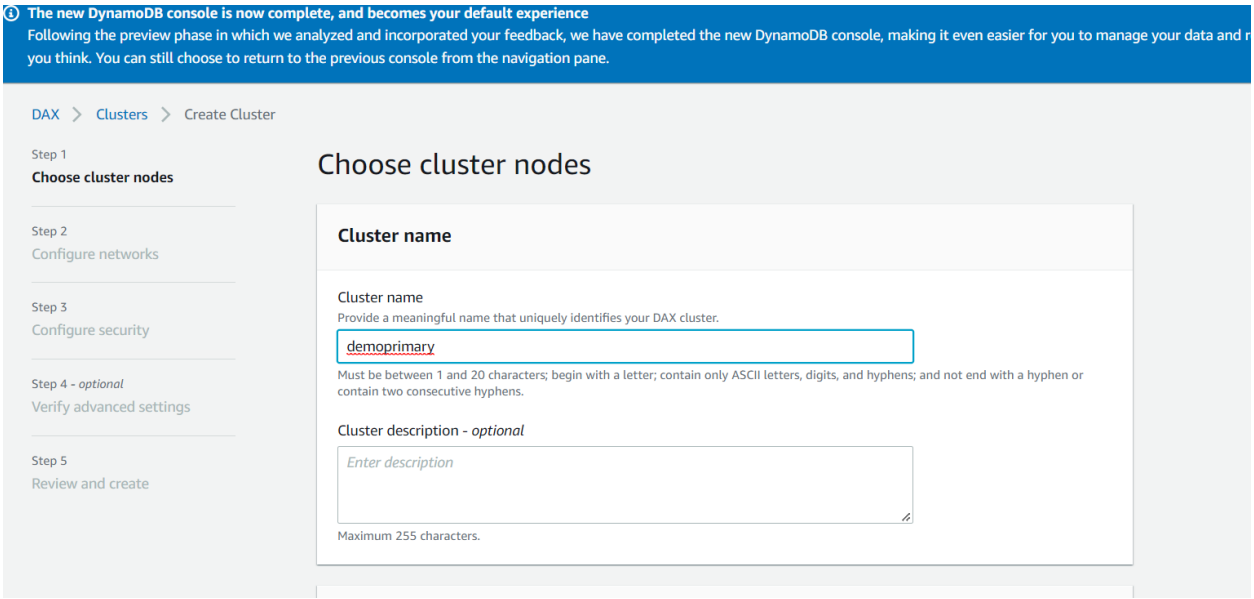

FIG 15 Launching DB1 – primary Dynamo DB (non-relational database)

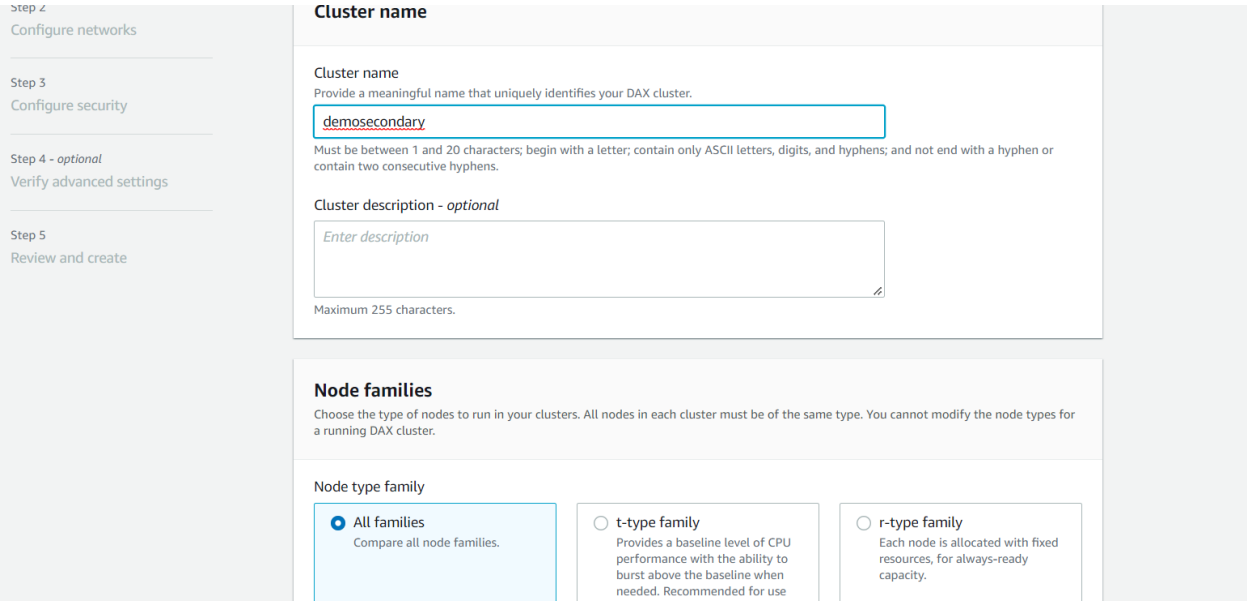

FIG 16 Launching DB2 secondary dynamo DB to support primary DB

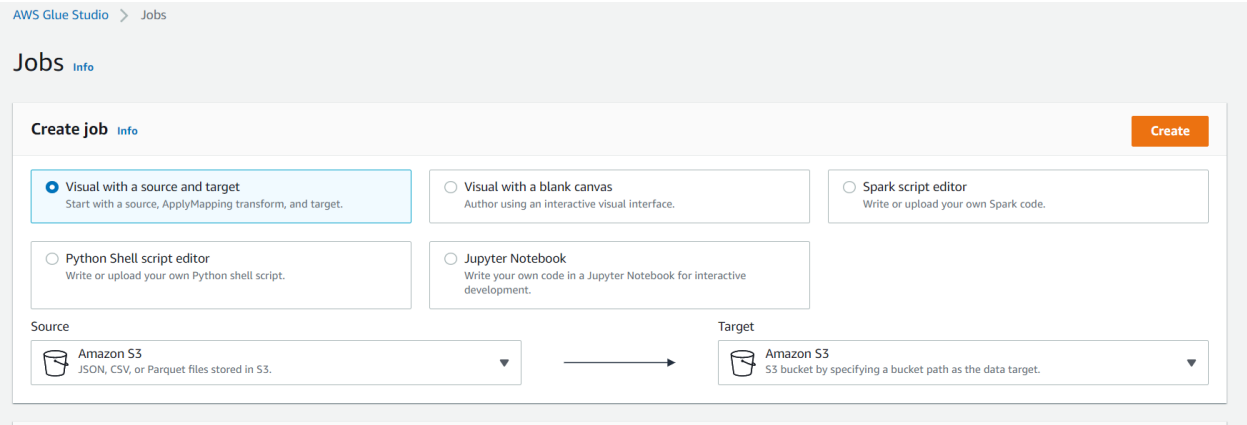

FIG 17 AWS Glue (discovering, preparing, and enriching data)

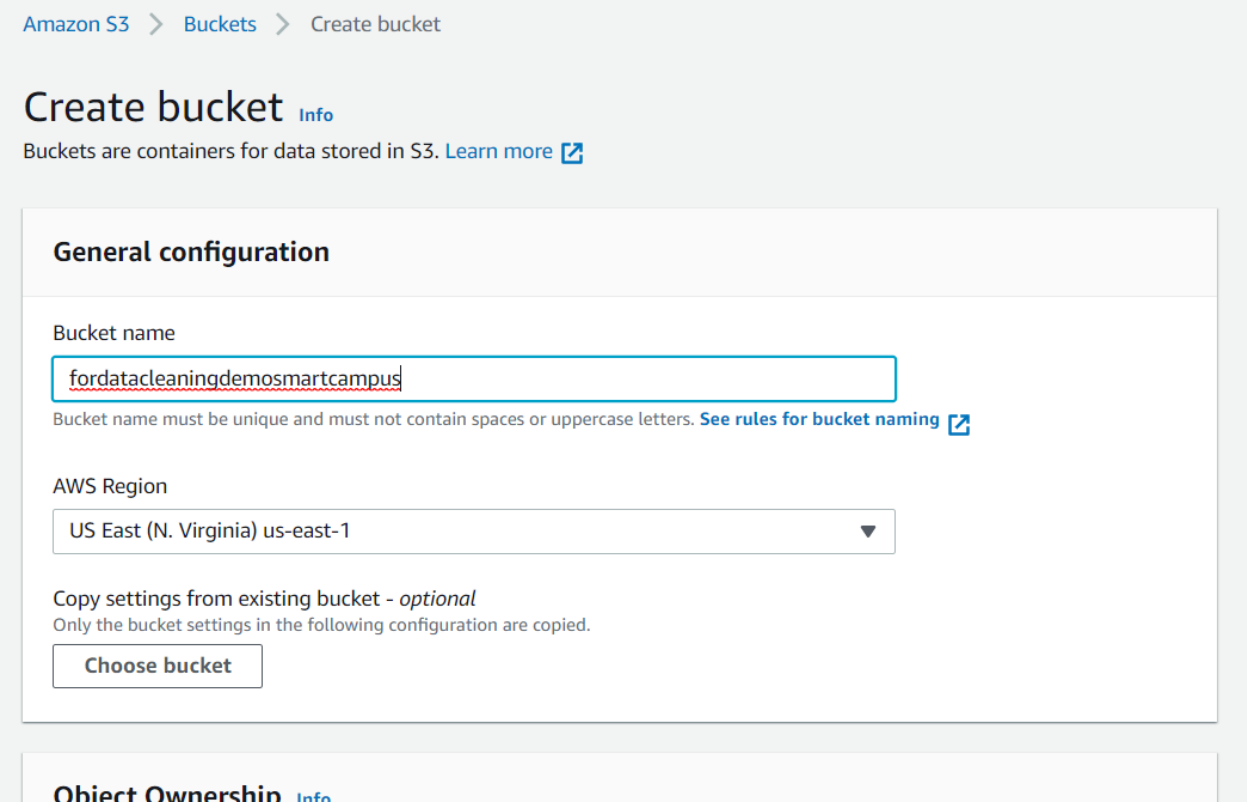

FIG 18 S3 bucket (All storing purpose)

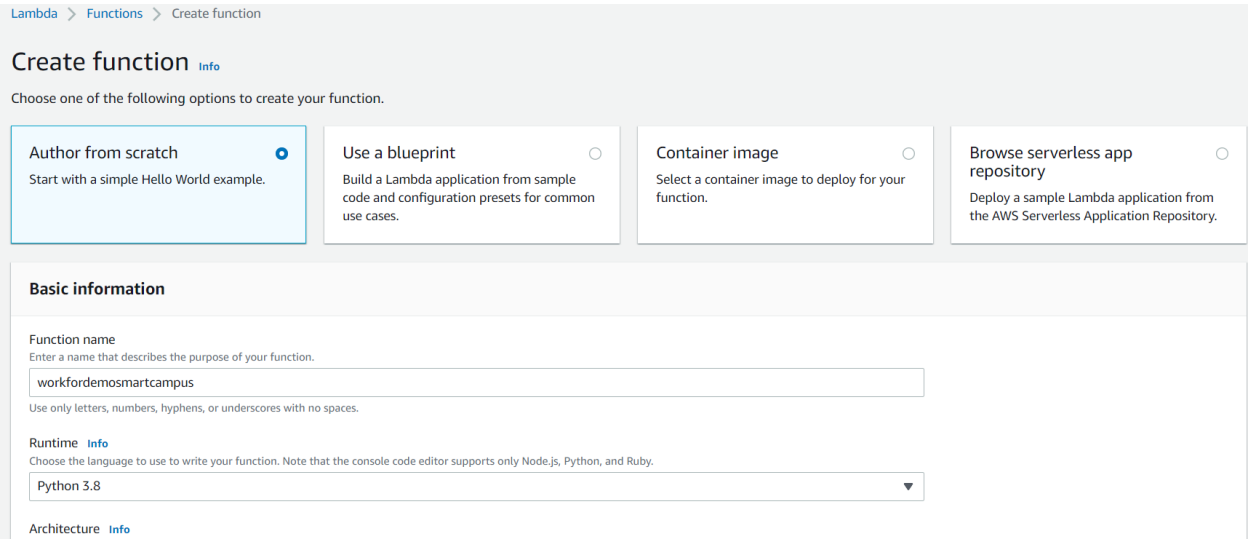

FIG 19 Lambda (running code based on EC2 activity)

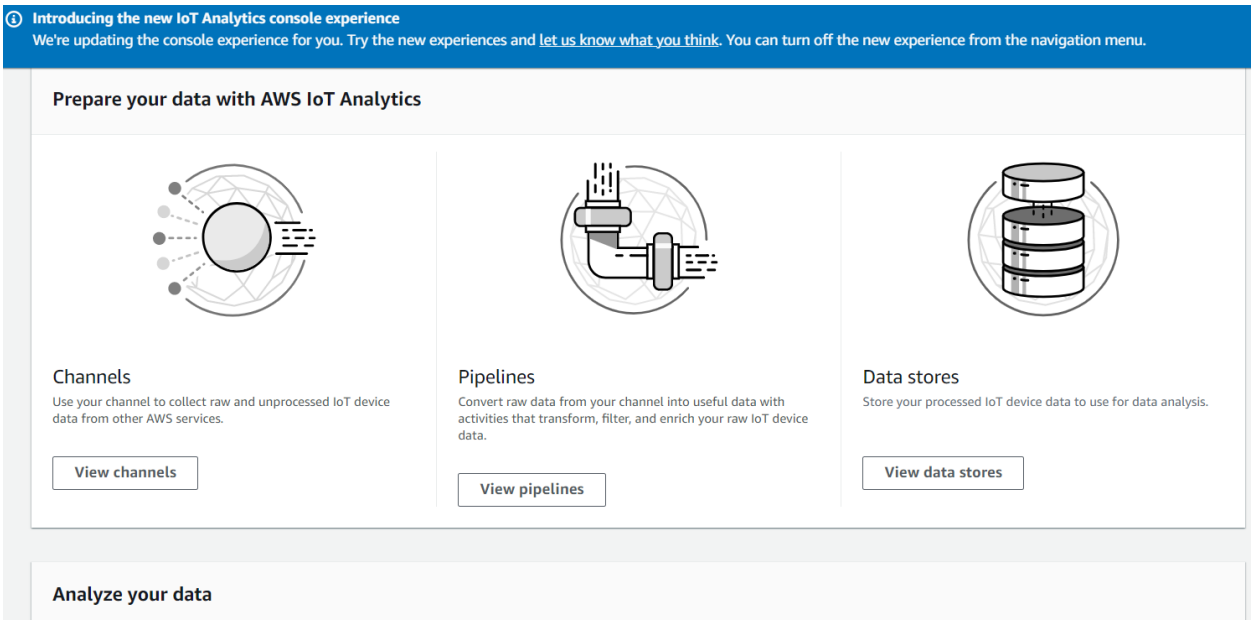

FIG 20 AWS IoT (Each and every task of IoT)

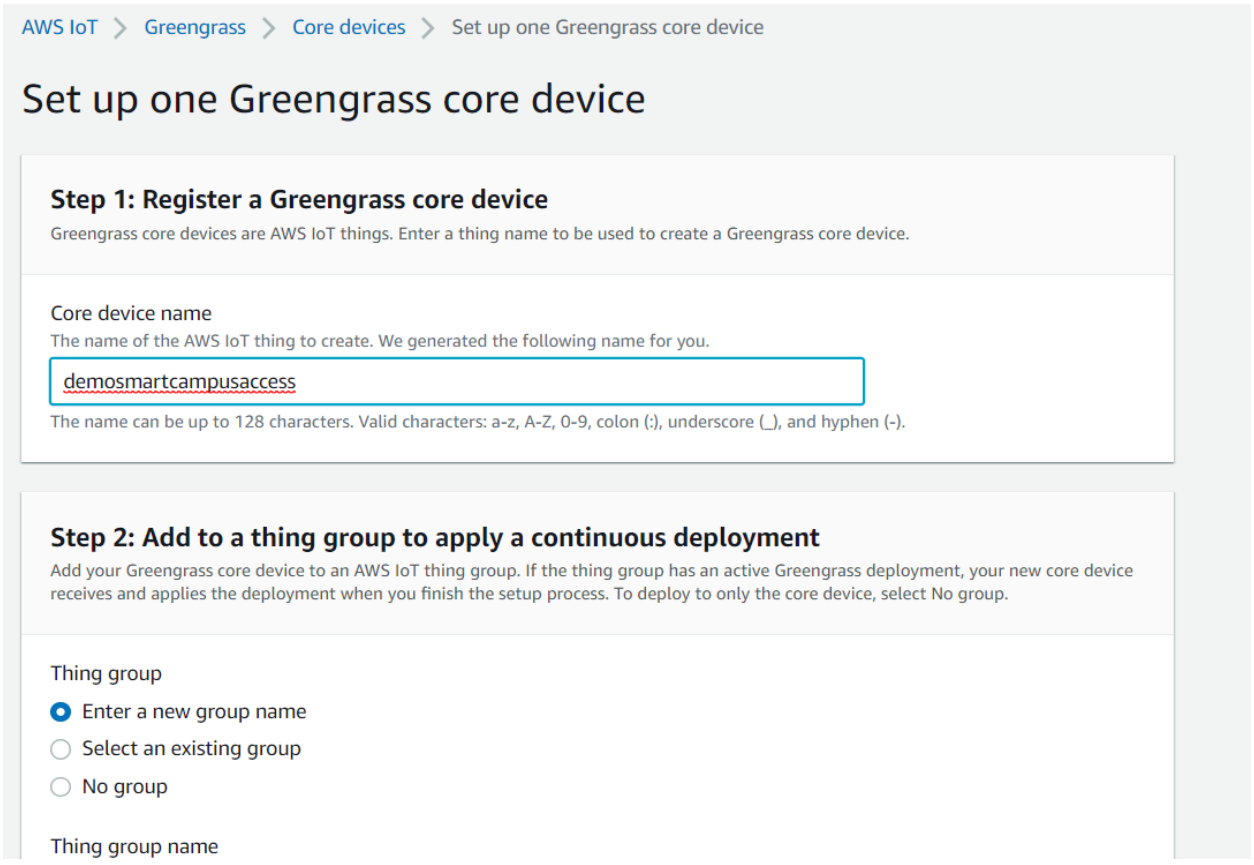

FIG 21 AWS Green grass

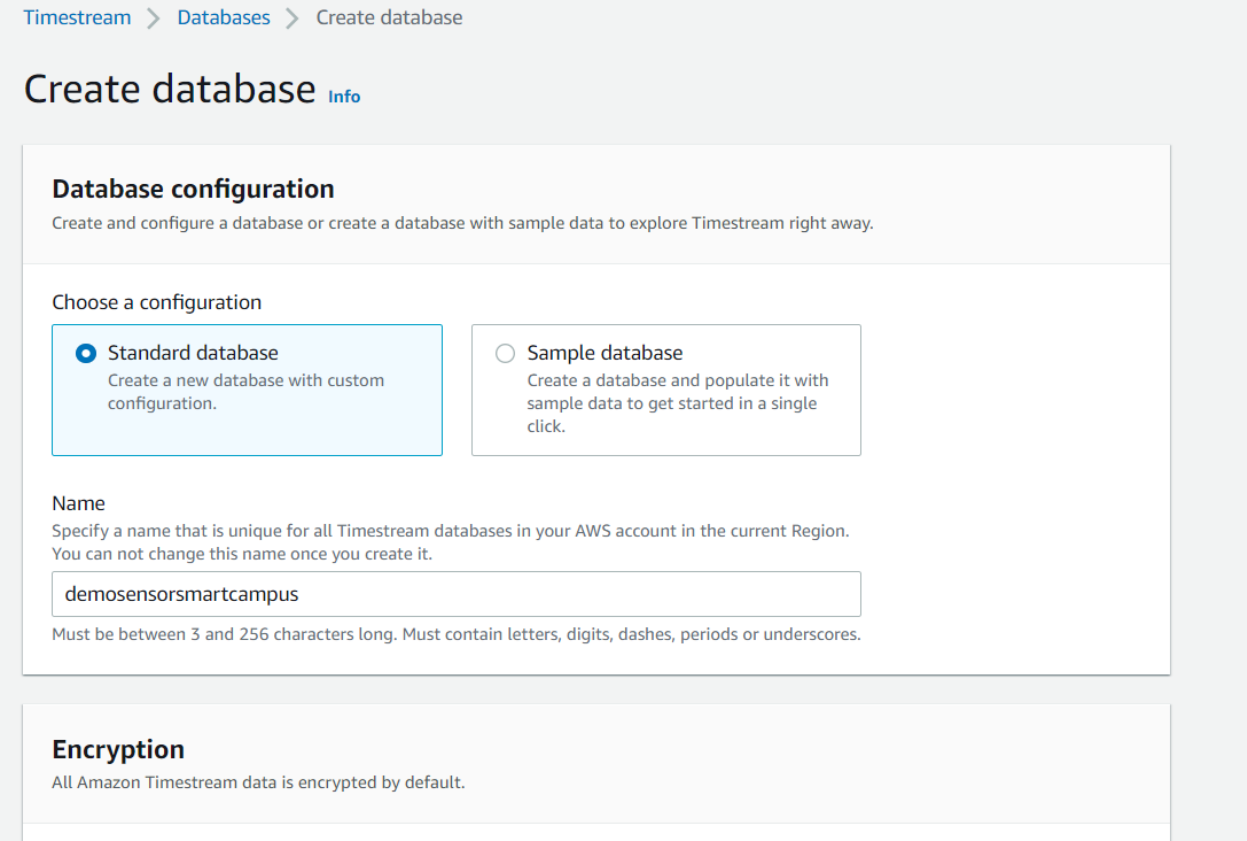

FIG 22 AWS Timestream (for Sensor)

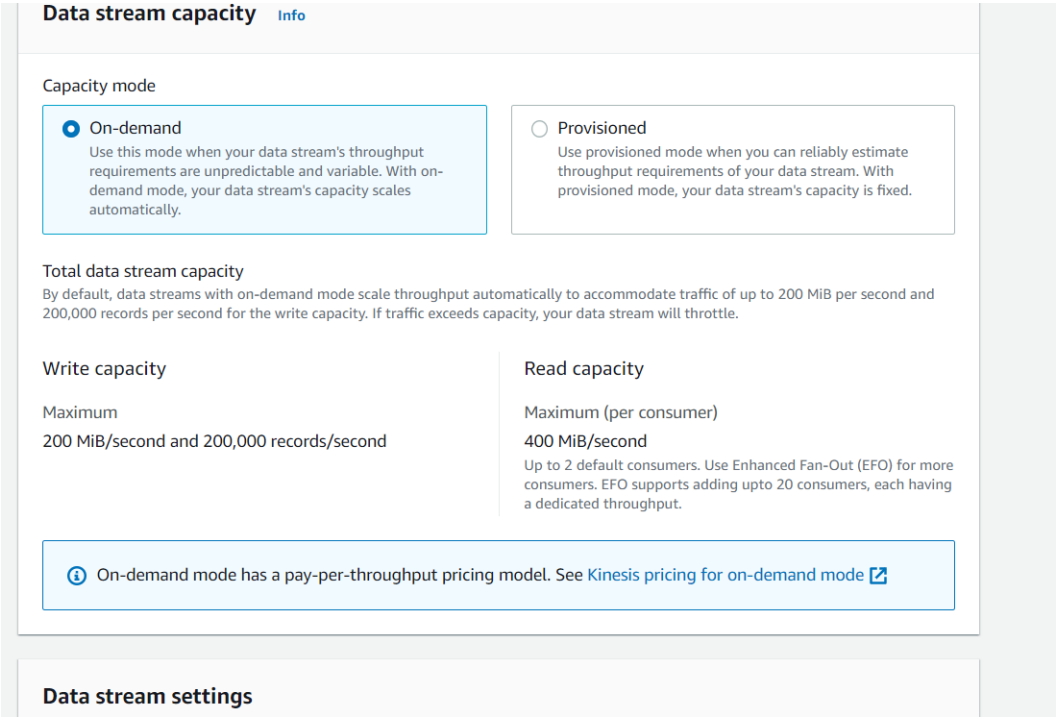

FIG 23 AWS Kinesis (Realtime Analysis of data)

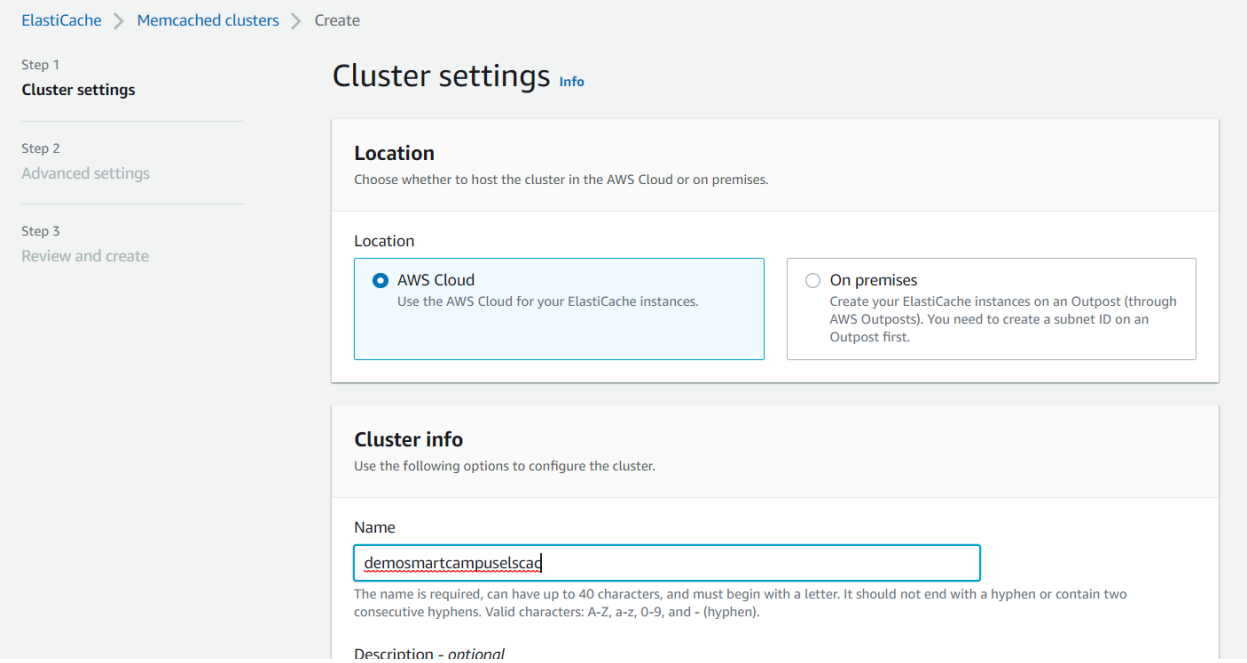

FIG 24 AWS Elasticache (for storing cache and support analysis)

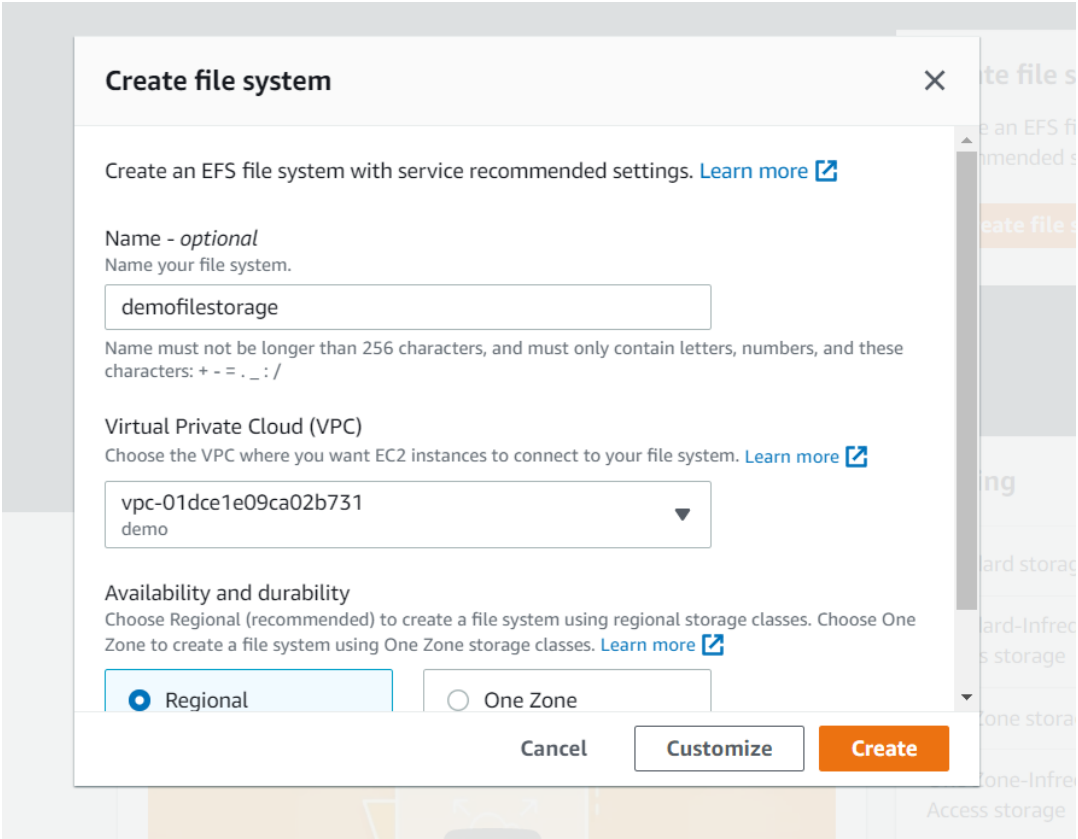

FIG 25 AWS EFS (Elastic File System)

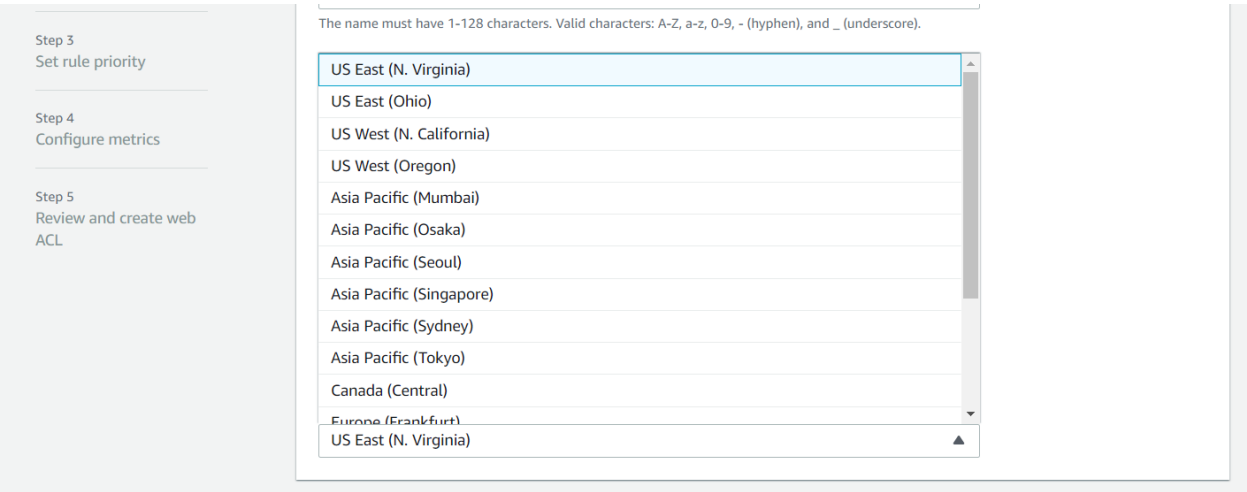

FIG 26 Web ACL(WAF) Web Application Firewall for additional security

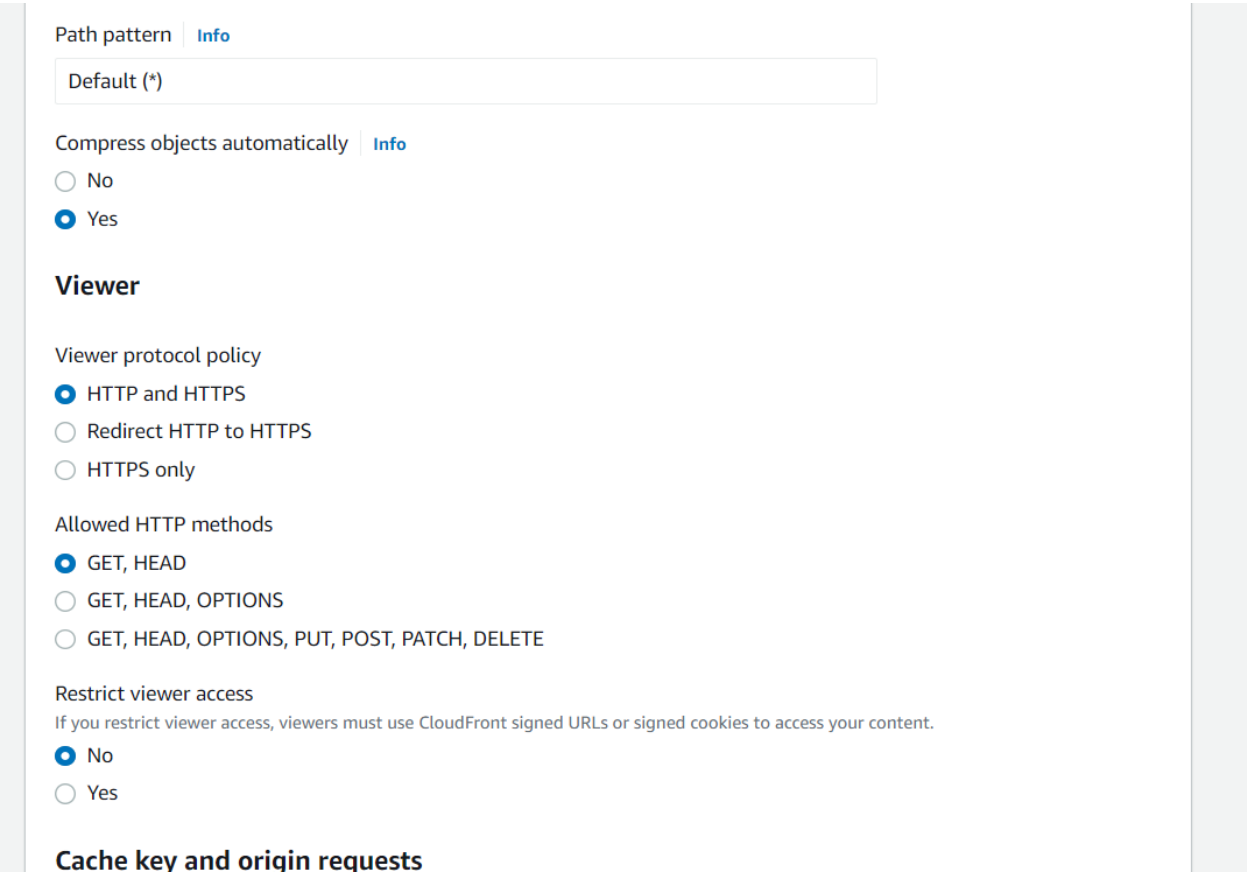

FIG 27 CloudFront (for content distribution)

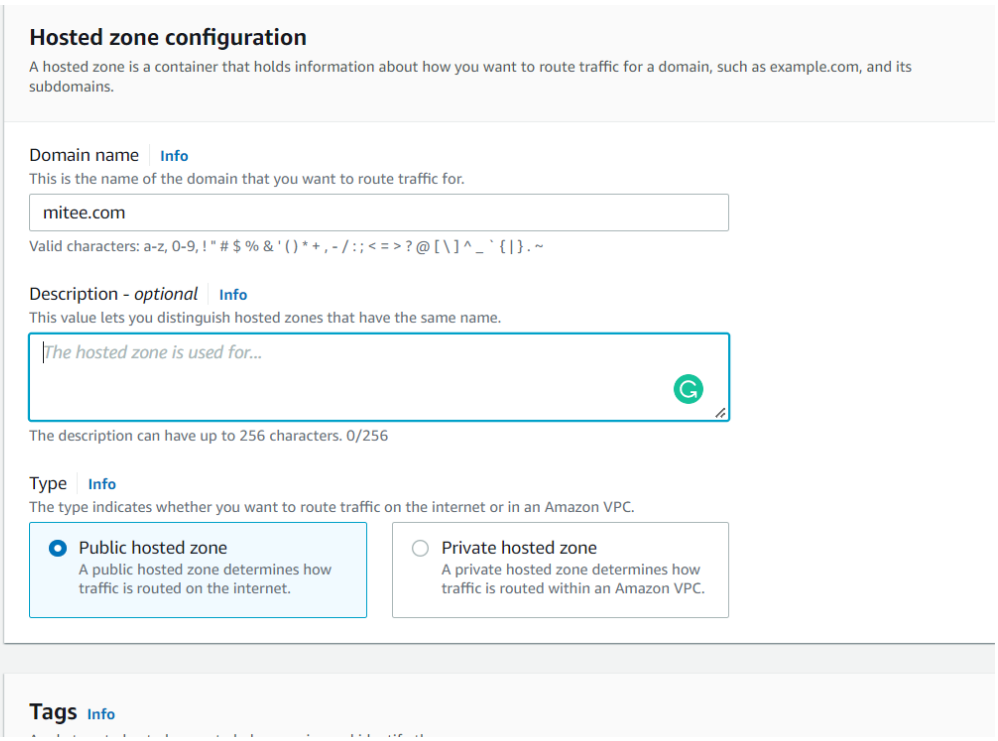

FIG 28 Route 53 (for connecting domain name)

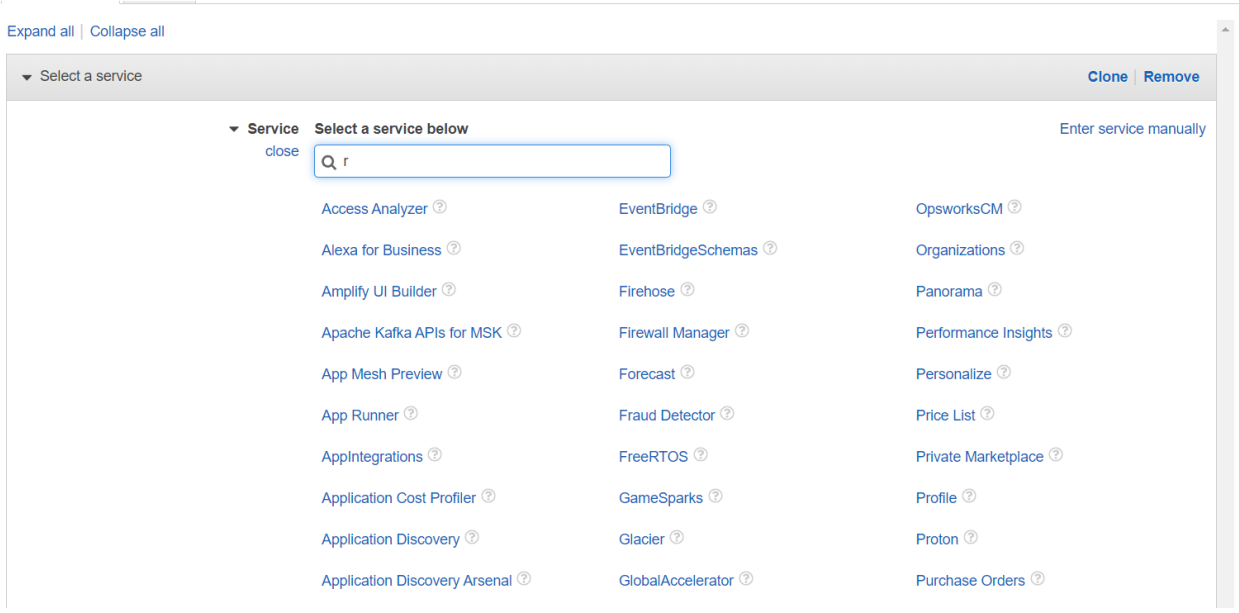

FIG 29 IAM Policies (authorization and authentication)

7 Analysis and Reflection

7.1 AWS Monthly cost

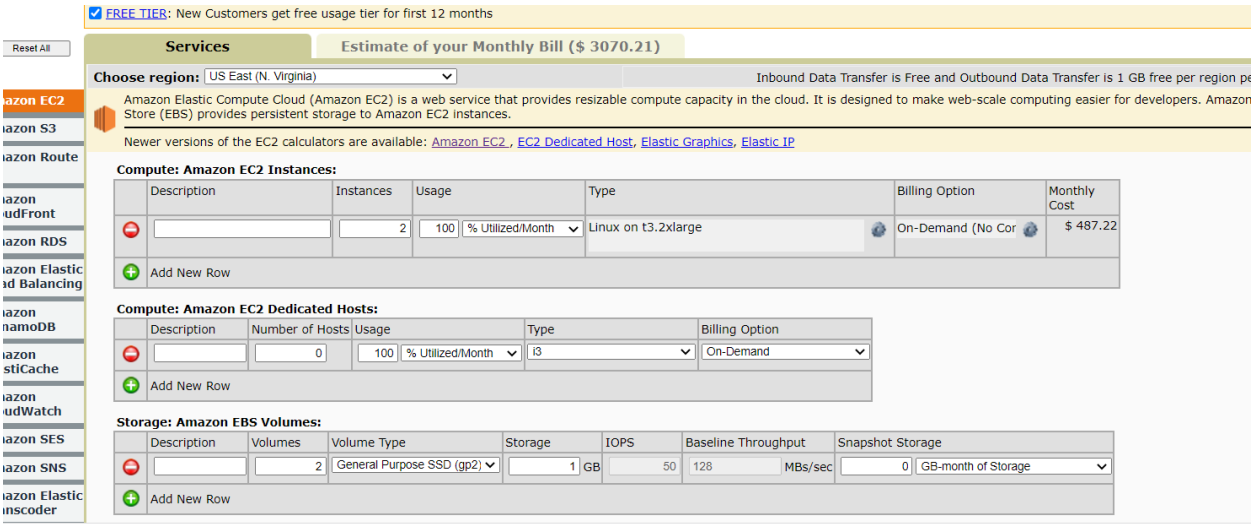

FIG 30

- cost for operating essential services for running - 3070.21$
- equivalent to 2494.50-pound approximately 2500pound (including price conversion rate).

7.2 Analysis and Reflection

AWS graviton application, which makes launching vast range of services on mouse click makes it my first choice. These services are highly advanced and expandable for future needs. As a result, the architecture I designed comes out to be perfect and priced. Thus, it can be used to fulfill SMART Campus needs.

8 References

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