CCT College Dublin

Assessment Cover Page

Module Title:	Cloud Services
Assessment Title:	Designing and Implementing a Proof-of-Concept Cloud Solution Based on a Client's Needs
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TASK 1: Medi-Advice company (Needs | Solutions)

Convert client needs into a proposed technical solution.

Current Infrastructure and Its Flaws:

The current infrastructure is hosted in a data canter based in Dublin, Ireland, on Microsoft Windows servers. It consists of:

- Two web servers
- Two application servers
- One database server

Defined weaknesses:

- One Point of Failure
- Manual Scaling
- Performance Issues
- Lack of Disaster Recovery
- Non-elastic Infrastructure
- Issues in Content Delivery

Recommended AWS solution:

Availability Zones and AWS Regions Medi-Advice should leverage AWS regions and Availability Zones (AZs) to ensure disaster recovery, fault tolerance, and high availability.

Specifically:

- The production environment should be in the EU (Ireland) region.
- For the North American user base, the US-East (North Virginia) area should be used. Resources need to be spread across at least two Availability Zones within a location to ensure redundancy and high availability. Essential AWS Services Needed.

Architecture Design Proposal:

Web Tier:

- Elastic load balancer (ALB) distributes traffic across multiple EC2 instances in two regions, North Virginia and Ireland.
- Auto Scaling changes the count of EC2 instances based on real-time traffic.

Tier of Application:

- Application logic is hosted in EC2 instances, which are attached to the RDS database.
- Document processing operations that are initiated by uploads to S3 are automated via AWS Lambda.

Tier of the Database:

- Database availability is guaranteed across two availability zones when Amazon RDS is deployed using Multi-AZ.
- From North America, Read Replicas offer quick access to the database.

Level of Storage:

- Images and documents are stored on S3.
- S3 Glacier is utilized for long-term, reasonably priced storage.

Delivery of Content:

- It allows the enhancement of accessibility to brochures and other resources all over the world by caching static content at edge sites.

Disaster Recovery:

- The cross-region load balancing feature in Route 53 guarantees service continuity and failover between the US and EU.

(Dong et al., 2018).

Auto-Setup of Servers and Availability:

The EC2 instance auto-scaling groups guarantee that the infrastructure can adjust automatically to traffic, both during periods of high traffic and periods of low traffic.

CloudWatch Alarms immediately deploy new instances in order to save money or terminate unused ones based on the failure or heavy load of EC2 instances.

Cost Optimization:

EC2 Reserved Instances significantly reduce costs if used for the base load of database and application servers. S3 Intelligent-Tiering and S3 Glacier will automatically move infrequently accessed data to lower-cost storage, optimizing storage costs.

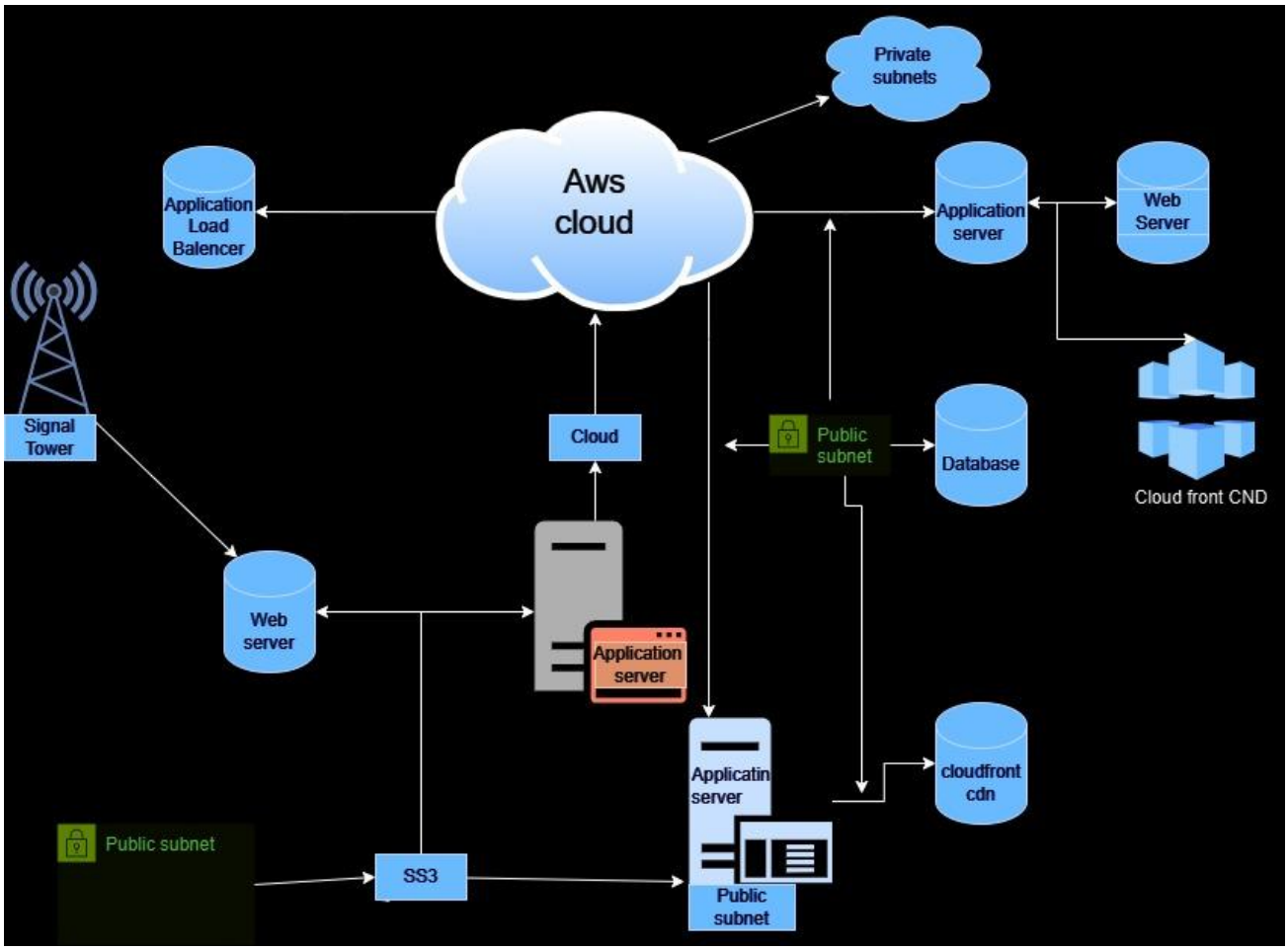
Conclusion:

The proposed AWS solution addresses all the requirements Medi-Advice has for a secure, scalable, and highly available infrastructure. We can ensure that the application runs well on a global scale, scales dynamically, and is resilient to regional failures by using AWS services such as EC2, RDS, CloudFront, and Lambda. Moreover, the implementation of a content distribution network and automation of document processing would greatly improve user experience and operational efficiency. Moreover, the architecture ensures that Medi-Advice can scale down to reduce costs and scale up in light of growing demand. In addition to addressing the client's needs, this solution positions Medi-Advice for eventual growth and expansion.

(elmoallistair, 2020).

TASK2: Architecture diagram (Solution Medi-Advice needs)

- The architecture ensures fault tolerance, high availability, and scalability, addressing Medi-Advice's challenges like single points of failure, manual scaling, and disaster recovery.
- It incorporates best practices by separating tiers (web, application, database) and isolating private resources.
- The inclusion of CloudFront addresses global accessibility issues for brochures and other static content.



- This diagram effectively meets the technical requirements stated in the assignment.

TASK 3a) Anti-patterns of Medi-Advice

While applied to the context of infrastructure design, anti-pattern has more negative connotations, denoting mere recurrent inefficient approaches that, in most cases, result in increased costs or diminished performance and complexity. Describe here two anti-patterns observed in Medi-Advice's current application structure and then explain, how the presented AWS solution eradicates them.

Some of the Anti-Patterns identified in Medi-Advice's current infrastructure are as follows;

1) Single Point of Failure (SPOF) in Database Architecture:

Problem (Anti-Pattern):

Medi-Advice currently relies on a single database server to manage their application data. This creates a single point of failure for the entire system. If the database server goes down, the entire application becomes unusable, resulting in significant service outages and downtime. This is an anti-pattern because it fails to provide the necessary fault tolerance and high availability for critical business operations.

Impacts:

- Doctors and patients cannot access records.
- Application downtime disrupts business continuity.
- Recovery from failure is slow and manual, increasing operational overhead.

(Amazon Web Services, 2018).

Solution:

In an attempt to overcome this problem, the proposed solution employs the use of Amazon RDS with Multi-AZ Deployment. This arrangement makes certain the database is mirrored across different Availability Zones (AZs) to give an instant failover in case of a problem in a particular zone.

High Availability:

Multi-AZ deployment means if for any reason, the primary database is not available, there will be a solution and the application will be served the replica without interruption.

2) Lack of Elasticity and Manual Scaling Issue:

Problem (Anti-Pattern):

At the present time Medi-Advice employs manual scaling to increase the number of machines that are used in response to the changing conditions. This is evidenced by delays, inefficiency and overprovisioning.

Impact:

- Slow response to sudden traffic increase that results in a poor performance like time out errors or slow page rendering.
- Over investing in certain regions at sometimes h increases infrastructure cost disproportionately.

(AWS, 2019).

Solution:

AWS Elastic Load Balancer known as ALB and AWS Auto Scaling are adopted in the proposed strategy.

Elasticity:

Due to auto scaling, infrastructure can easily scale in or out according to the intensity of traffic. It eliminates situations of under and over provision and ensures optimum use of resources.

Cost Efficiency:

Medi-Advice does not have to pay for more computing capability than is necessary because intelligent resource scaling reduces costs of those related.

TASK 3b) Six Pillars of the AWS Well-Architected Framework

An explanation of how each pillar can be used to maximize Medi-Advice's infrastructure is provided below:

1) Excellence in Operations:

Optimal Techniques:

Sustained the operations of recurring activities and monitor the state of the system. For continuous monitoring and alerting that we are assured that any issues will be detected and resolved on time, use Amazon CloudWatch.

Optimization:

Decrease the need for human intervention and the general operational cost by automatically managing volume with CloudWatch Alarms and using AWS Lambda for document processing.

2) Security:

Best Practices:

Implement least privilege through AWS IAM, and for critical assets, you should allow the Multi-Factor Authentication.

Optimization:

Run Security Hub to triage security policies every now and then and subsequently encrypt sensitive data that is stored in Amazon S3. AWS WAF and Shield should be adopted for web application security to protect application flow.

3) Dependability:

Best Practices:

Ensure systems availability and redundancy by following Failure Design thru Multi-AZ and Multi-Region configurations.

Optimization:

For availability zones contingency utilize Cross-Region Replication and for databases availability utilize Amazon RDS Multi-AZ. For web and application servers safe guard performance under different loads, you need to apply auto scaling. (New Relic, 2021).

4) Performance Efficiency:

Best Practices:

Select resources necessary for the task, monitor results and adjust resources if it's needed.

Optimization:

To increase performance at the international level, use CloudFront to help to cache and deliver content to the clients and obtain EC2 Auto Scaling to transform the capacity on the basis of requirement. For breaking the traffic, utilize an elastic load balancer (ALB).

5) Cost Optimization:

Best Practices:

Identify wastage in the usage of the resources, choose a right model of pricing and remove unnecessary resources.

Optimization:

For EC2, save money on the instance cost by subscribing to AWS RI or AWS Savings Plans to cut-on the long-term cost. For more cost-effective storage of the data and for data that is rarely accessed, use S3 Glacier. Minimize operation cost through auto scaling in order to ensure that servers are not over provisioned, yet provisioned enough to meet load demands.

(vsi_clear_admin, 2022).

6) Ecological Responsibility:

Best Practices:

Design services that will achieve highest service levels while demand the least input resources.

Optimization:

To reduce server supposedly hence the efficient use of serverless services like AWS Lambda for processing tasks. Choose the right EC2 instance types with the help of AWS Compute Optimizer.

TASK 4a) VPC & its components

A conceptually separate region of the AWS cloud where you can place AWS resources: A Virtual Private Cloud (VPC) enables you to launch AWS resources in a virtual network of your selection. It gives you full control of the network environment; specification of the subnets, route tables, IP address range, and security.

Public Subnets:

Subnets running on direct internet connection are referred to as public subnets. Resources placed in public subnets can start using the internet after connecting it via an Internet Gateway.

Private Subnets:

These subnets are for handling operational data such as user informations or back-end included databases and Application servers and does not have access to the public internet.

(Spiceworks, n.d.).

Blocks of CIDR:

The private IP addresses that you are allowed to select in your VPC are determined by CIDR blocks. An example is the CIDR block like 10.0.0.0/16, where we may be given an amount of range that could accommodate 65,536 IP numbers.

Every CIDR blocks helps in the division of the distribution of IP address in relation to the subnets in the VPC. (T, 2023).

Gateway to the Internet (IGW):

An Internet gateway provides access to the Internet for traffic originating from resources in public subnets. This makes it possible for the VPC and the internet to communicate with each other in both ways. The IGW provides the ability for any resource located on a public subnet, let it be a web server, to have access to the internet.

NAT Instances and NAT Gateways:

A managed service termed as NAT (Network Address Translation) gateway allow resources in the private subnets to send traffic out to the internet without letting incoming traffic get through to them.

NAT Instances:

An EC2 instance which has been configured to perform NAT duties. It works like the NAT Gateway but needs more attention since it is a self-serviced service.

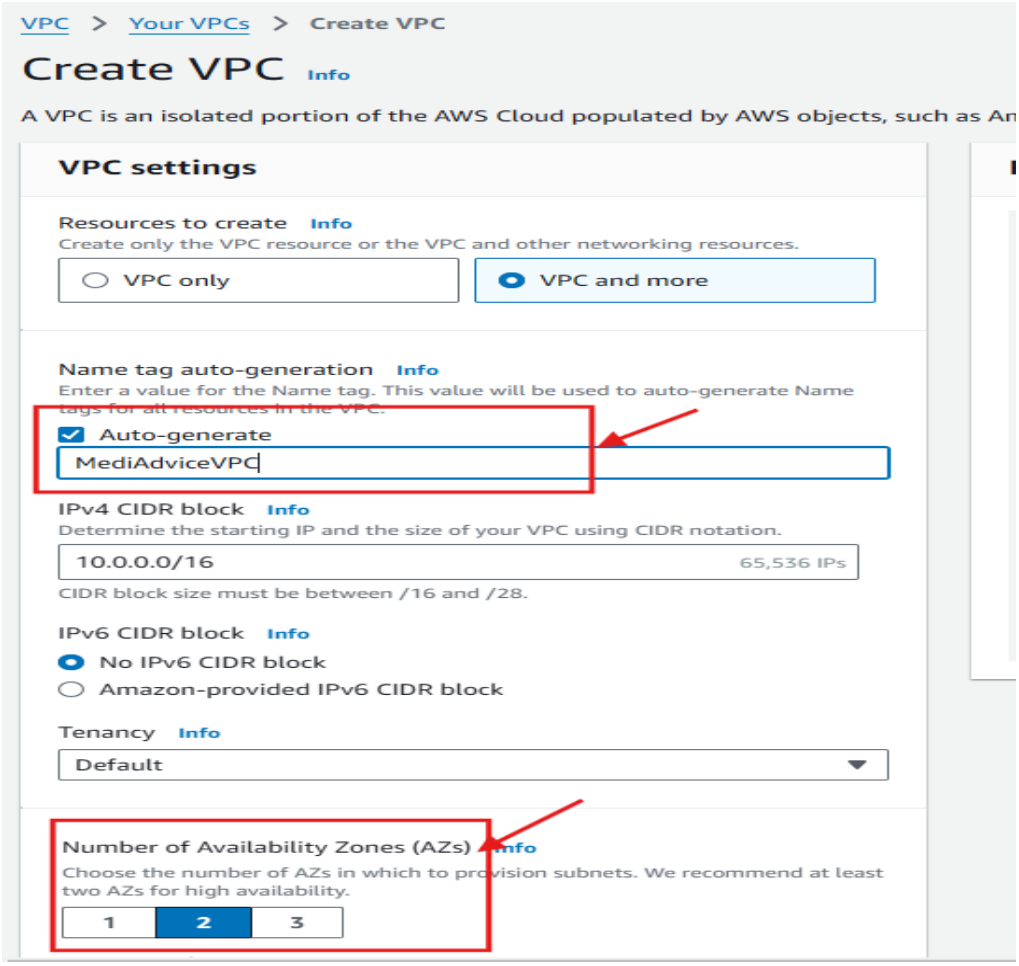
Security Groups:

Security Groups act in a manner that of instance-level security appliances that control traffic flow. Since instances are stateful, when letting incoming traffic to an instance, this also immediately allows outgoing traffic. Alternatively, they are used to control traffic flow in and out of the EC2 instances.

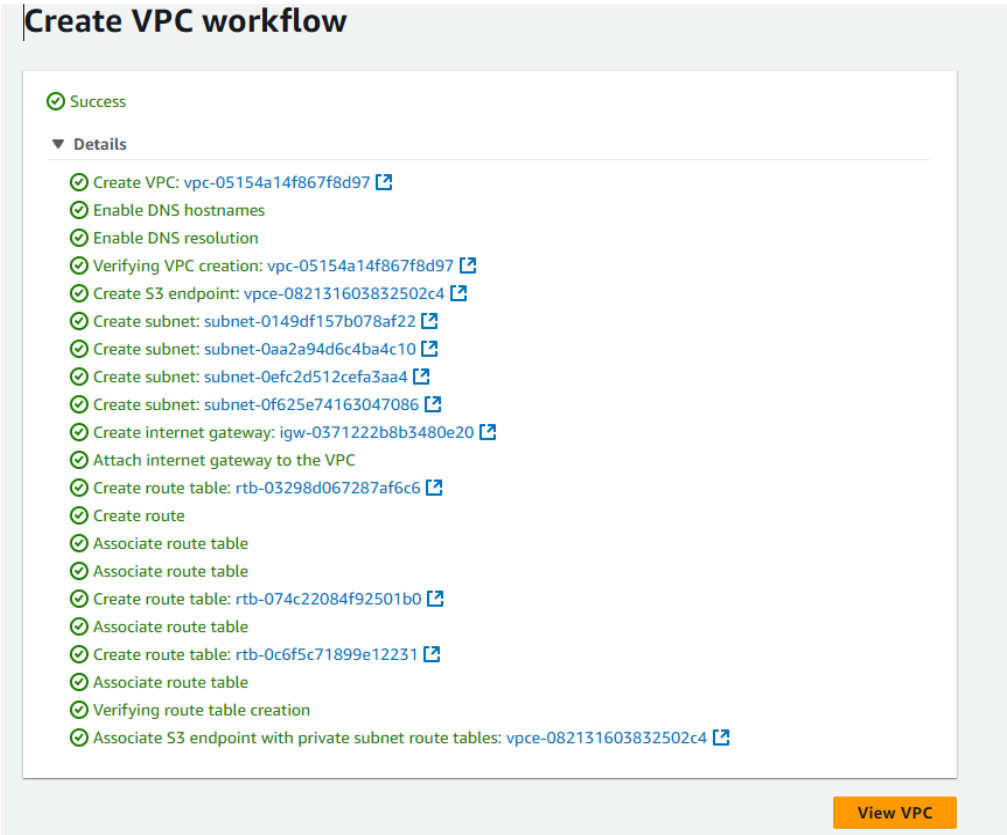
(Shalom, 2018).

TASK 4(b) Use of FileZilla, Linux Server & MediAdviceVPC

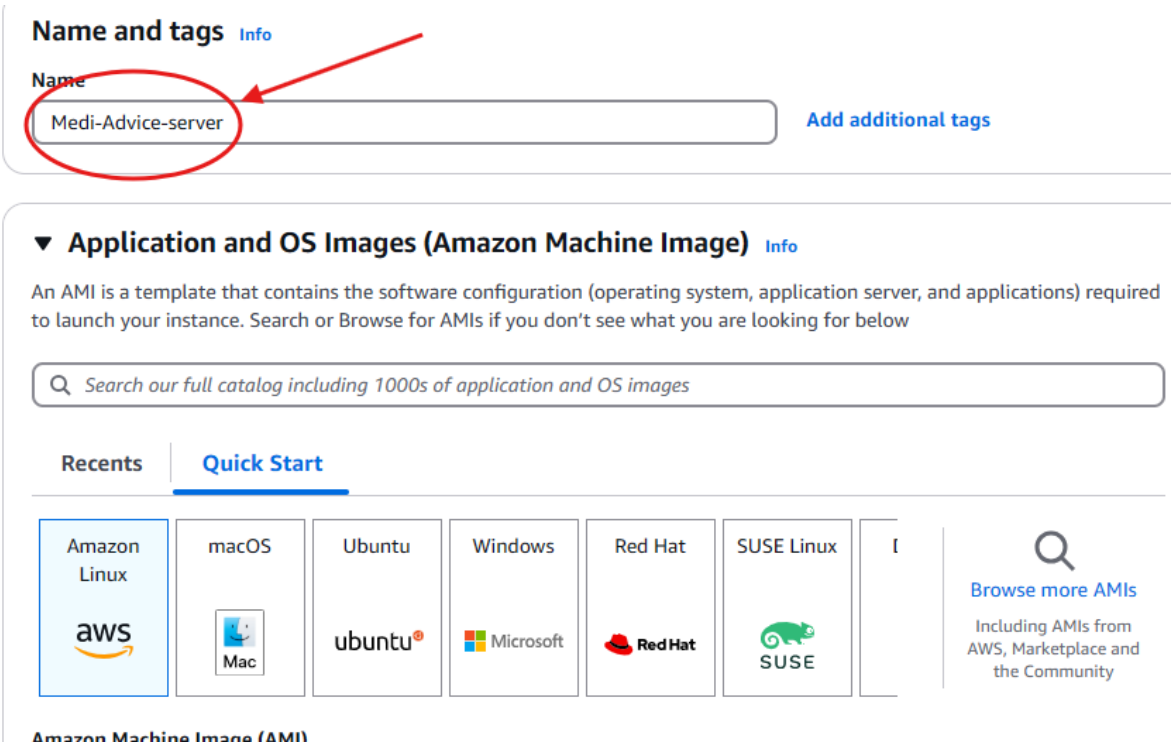
- Firstly, Set the name of new VPC as MediAdviceVPC.



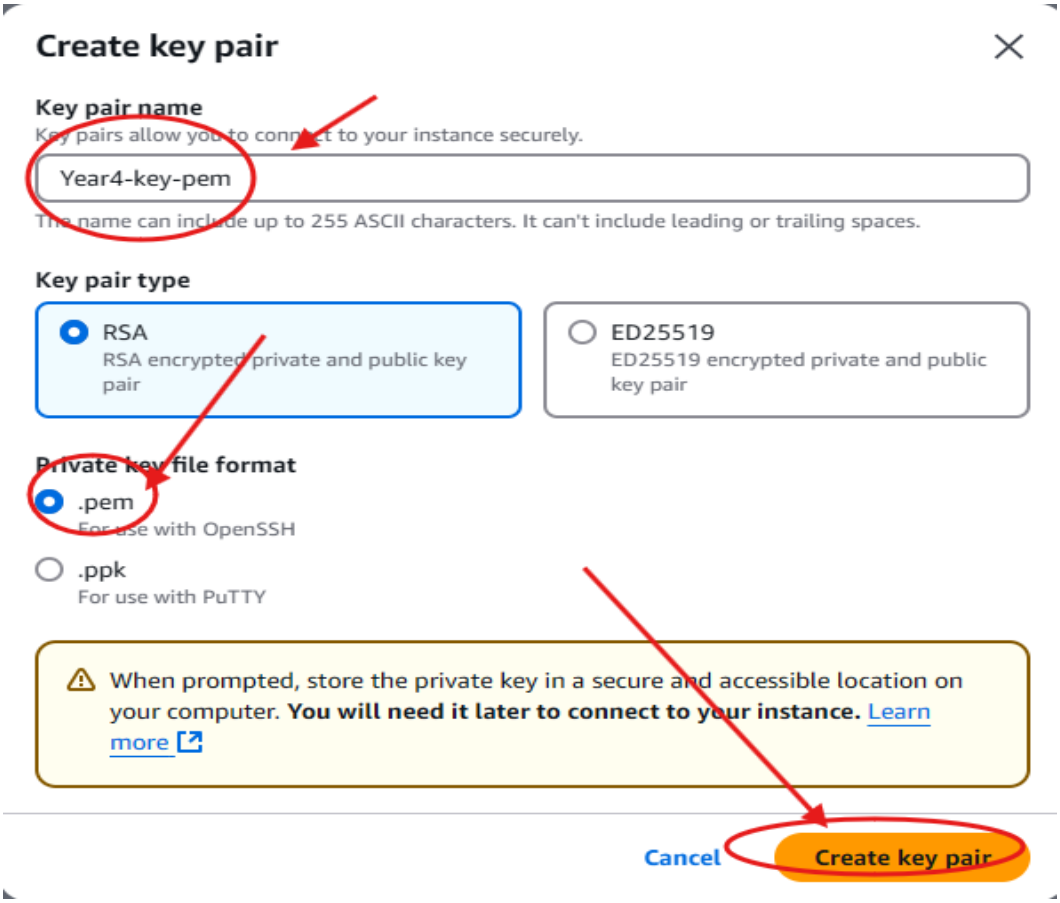
- VPC has created successfully.



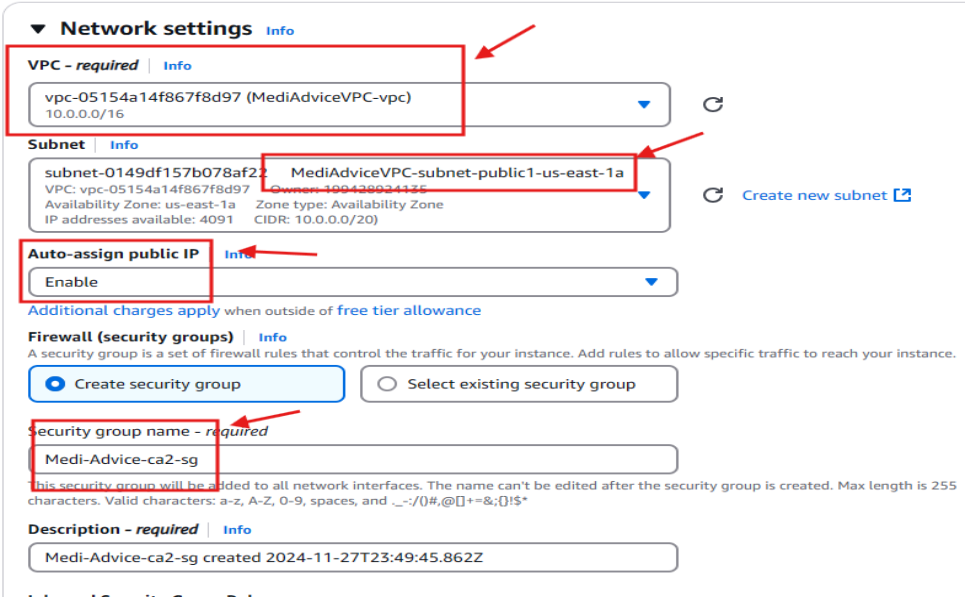
- Created new Linux instance with the name Medi-Advice-server.



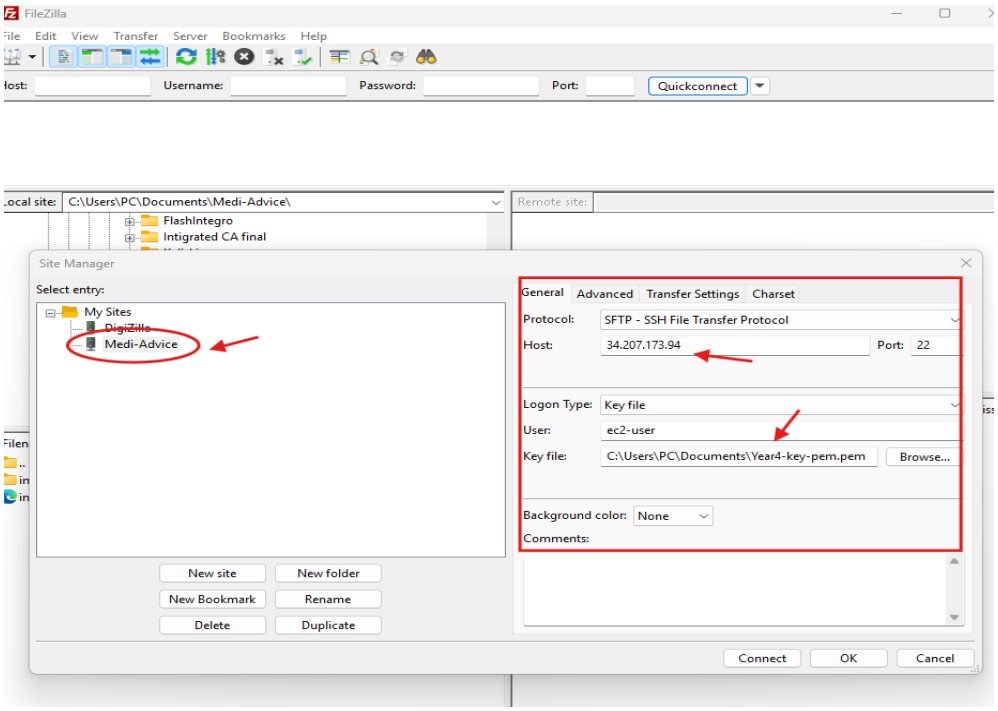
- Created new .pem key pair for this instance and named as Year4-key-pem.



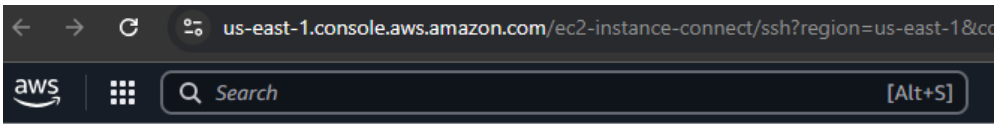
- In Network settings, selected the MediAdviceVPC which has created above with the public subnet.
- Also created new security group Medi-Advice-ca2-sg for this particular instance.

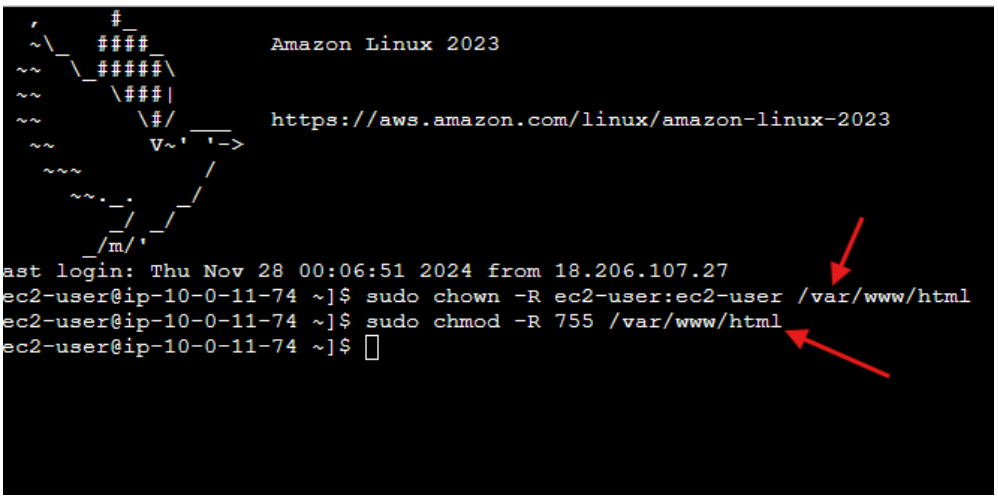


- Used FileZilla software to access the Medi-Advice Linux server created above.
- In FileZilla, go to file and navigate Site Manager.
- In Site Manager, selected SSH protocol with the public IP address of Linux instance as Host and used Port 22 for connection.
- Logged on the client site by using key file which is used to create the instance above.

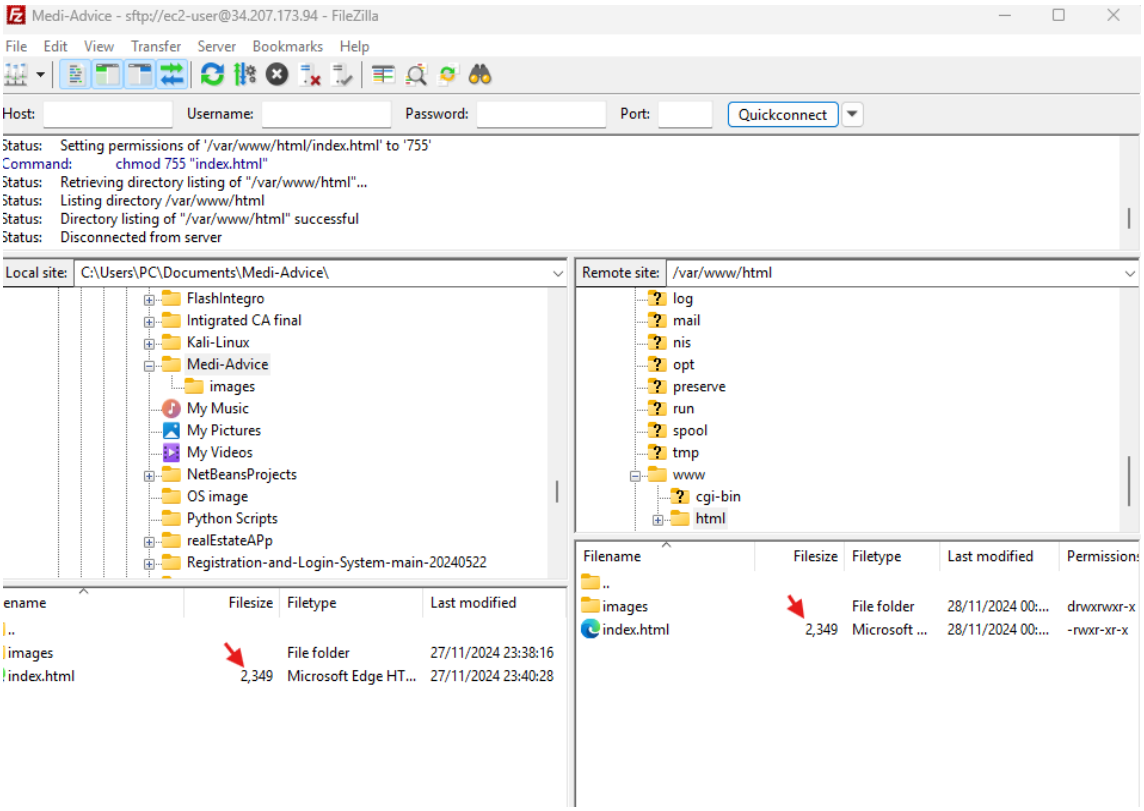


- Connect the Linux instance with EC2 connect and applied the permission commands for the FileZilla to allowed the uploading of Medi-Advice website in Linux server.

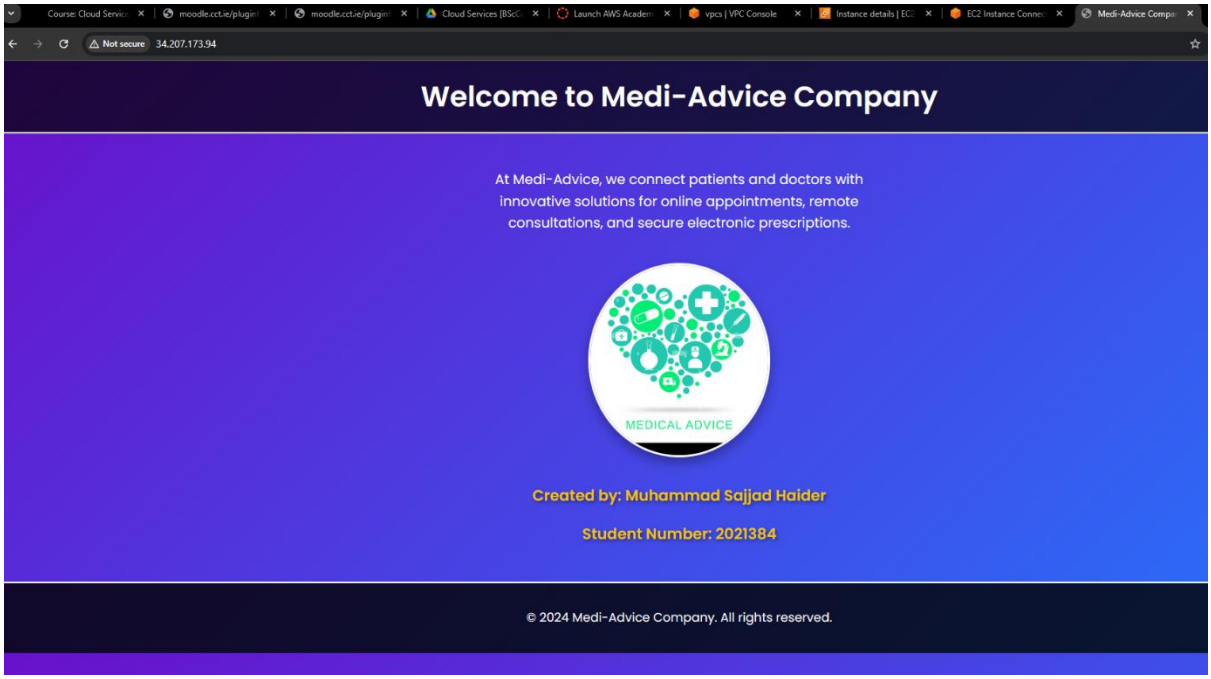




- The Medi-Advice website has uploaded on the Linux server successfully.



- Copied and pasted the public IP address of Medi-Advice Linux server in browser and searched, Medi-Advice website worked success.



TASK 5: Content Delivery Network (CDN)

Utilizing Guide on AWS CloudFront CDN to Enhance Availability of Sales Brochures.

In order to enhance the rapid dissemination for their global clients, Medi-Advice's new sales brochure may be cached and distributed to many edge locations around the globe through AWS CloudFront, a CDN. CloudFront reduces client laten cinder and imp roves content deliver y by serving material from the nearest edge location to the end user.

The Functionalist Approach to Understanding How Content Delivery Is Accelerated by AWS CloudFront CDN.

(Google Cloud, n.d.).

1)Essential System element is the usage of Edge Sites for Worldwide Distribution:

CloudFront has an enhanced expansive worldwide network location; such locations are well placed. When a customer wants to download the sales brochure, the material is fed from the nearest edge location possibly an EC2 instance or AWS S3 rather than directly from the source. (Ioriver.io, 2024).

2) Caching of Content:

The material is only cached at the edge location for the first time after a particular user request for the sales brochure. While the first time a user might request the brochure could involve having to go to a remote server or origin, later requests by other users in the area will require retrieving from this cached content which of course takes much less time for the retrieval process.

3) Decreased Latency:

Since the data between the user and the server takes less time in round-trip, using edge locations of CloudFront is beneficial. For example, to reduce latency by nearly all possible extent, a customer from North America will be served content by CDN edge server from United States rather than the origin server located in Ireland.

4) Enhanced Scalability:

Actually, dealing with such high levels of traffic loads is achieved quite transparently via CloudFront. CloudFront will distribute the load amongst the several edge locations in case there is high traffic demand for the brochure and this will ensure that the server is never overburden and at the same time the brochure will always be availed to the customers.

(www.harperdb.io, n.d.).

5) Enhanced Delivery of Content:

To ensure that content delivery is both fast and secure, CloudFront is implemented with additional features to support such as SSL and compression.

Benefit of Medi-Advice CloudFront CDN Use.

Quicker loading times:

Faster loading is a gain for users when the sales brochure is served from the nearest edge point this benefit the user constantly. Foreign customers possibly located far from the main server should take extra precautions in this respect.

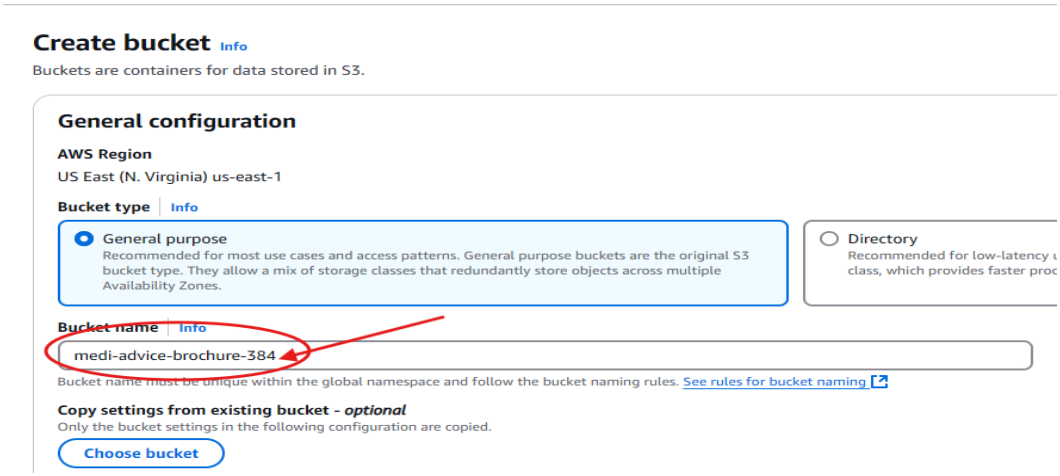
Economic Effectiveness:

- Technique EXPERIMENT
- Reliability and approachability
- High and increased availability
- Delivery Scalability

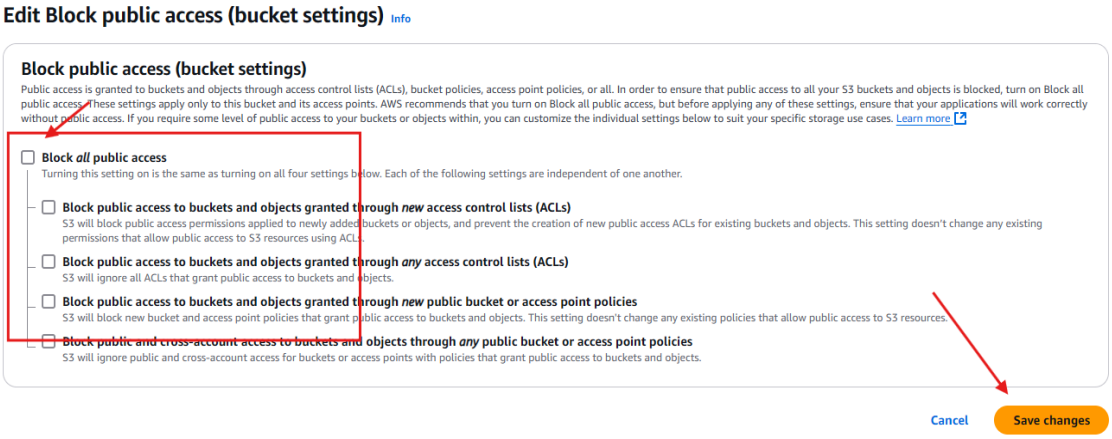
(STL Partners, 2024).

CH-TASK 1: Edge Location content caching of the Medi-Advice brochures

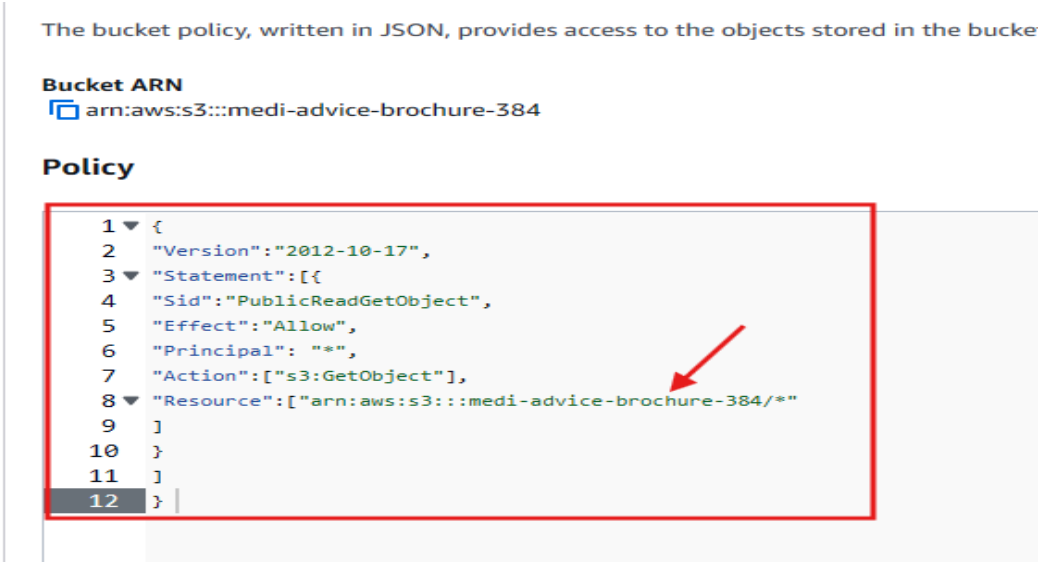
- Firstly, created S3 bucket with name medi-advice-brochure-384.



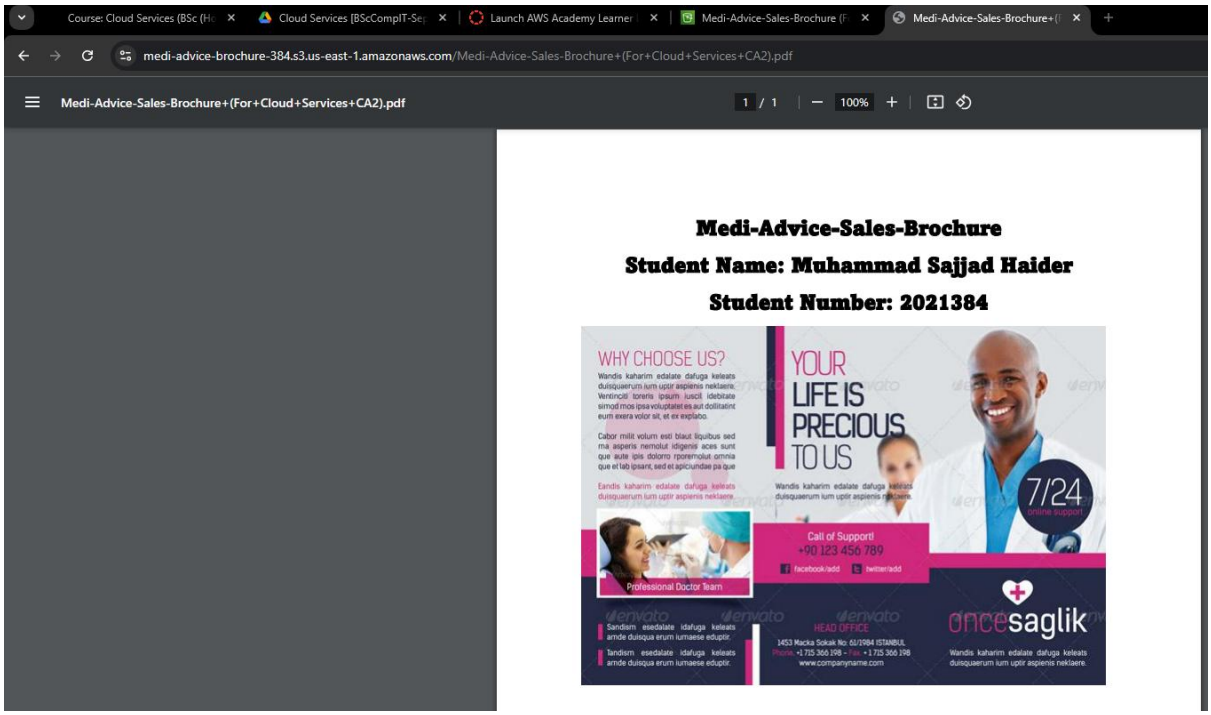
- Unblock the all-public access in bucket setting.



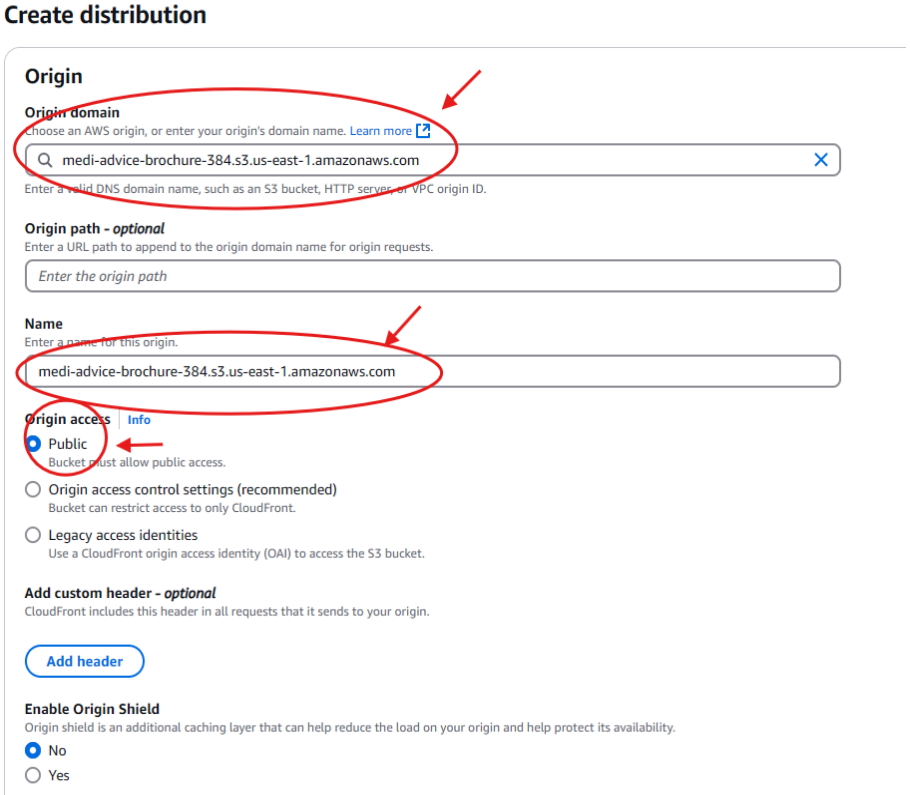
- Gave scrip in bucket policy for public access to read the bucket object with the bucket ARN.



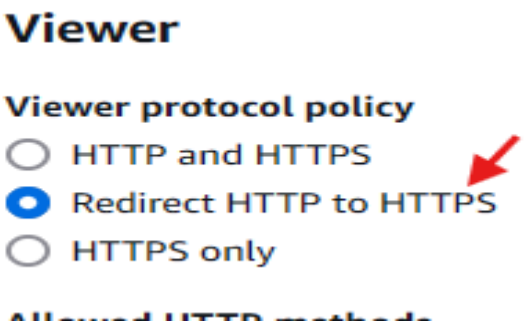
- Copy and pasted the DNS name of medi-advice-brochure-384 bucket in browser and searched it, showed the Medi-Advice-Sales-Brochure with my name and student number.



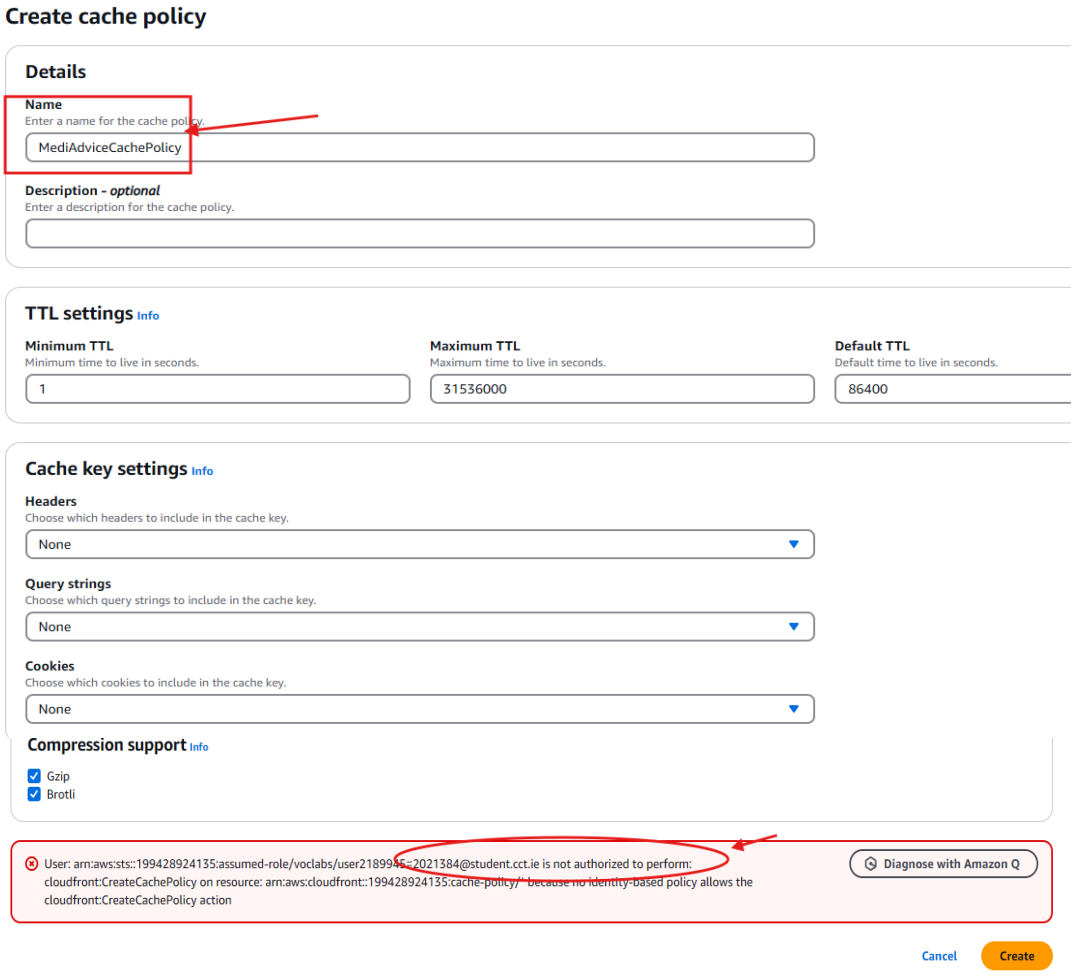
- In the AWS services, search for CloudFront.
- Click Create Distribution.
- Under Origin domain, paste the S3 bucket URL for the brochure.

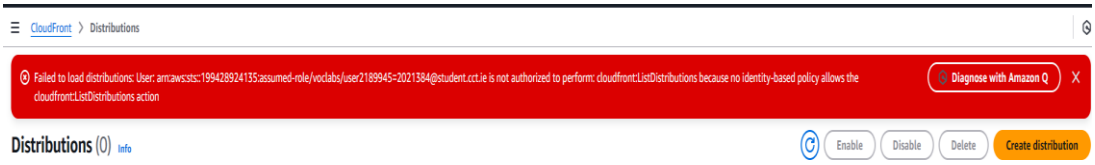


- Set the Viewer Protocol Policy to "Redirect HTTP to HTTPS."



- For Cache Policy, tried to create new cache policy.
- Set name as MediAdviceCachePolicy and hit create.
- Unfortunately, I got error as a student, I wasn't authorized for this to perform as seen in shots below:



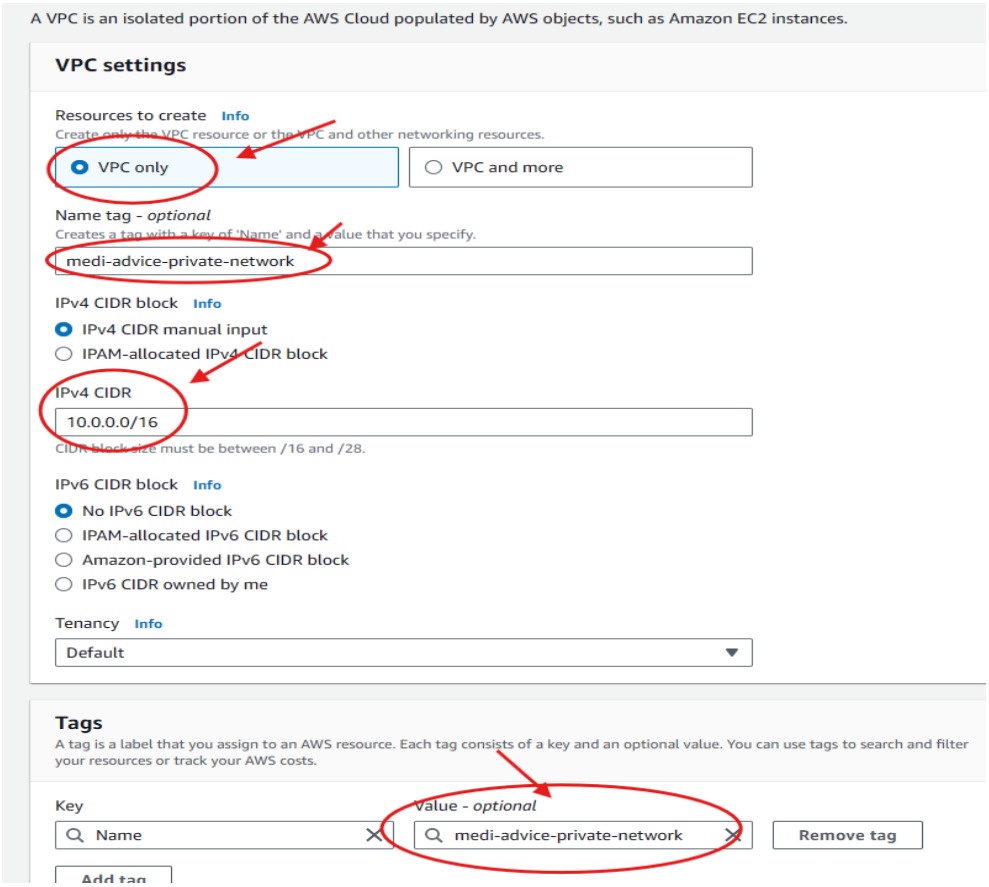


- But I studied the whole procedure of its deployment as stated below:
- Leave other settings as default and click Create Distribution
- It might take a few minutes for the distribution to deploy.
- Once completed, you'll see a domain name.
- Copy and paste the CloudFront domain name in browser and searched it.
- The brochure should be displayed from the CloudFront edge location.

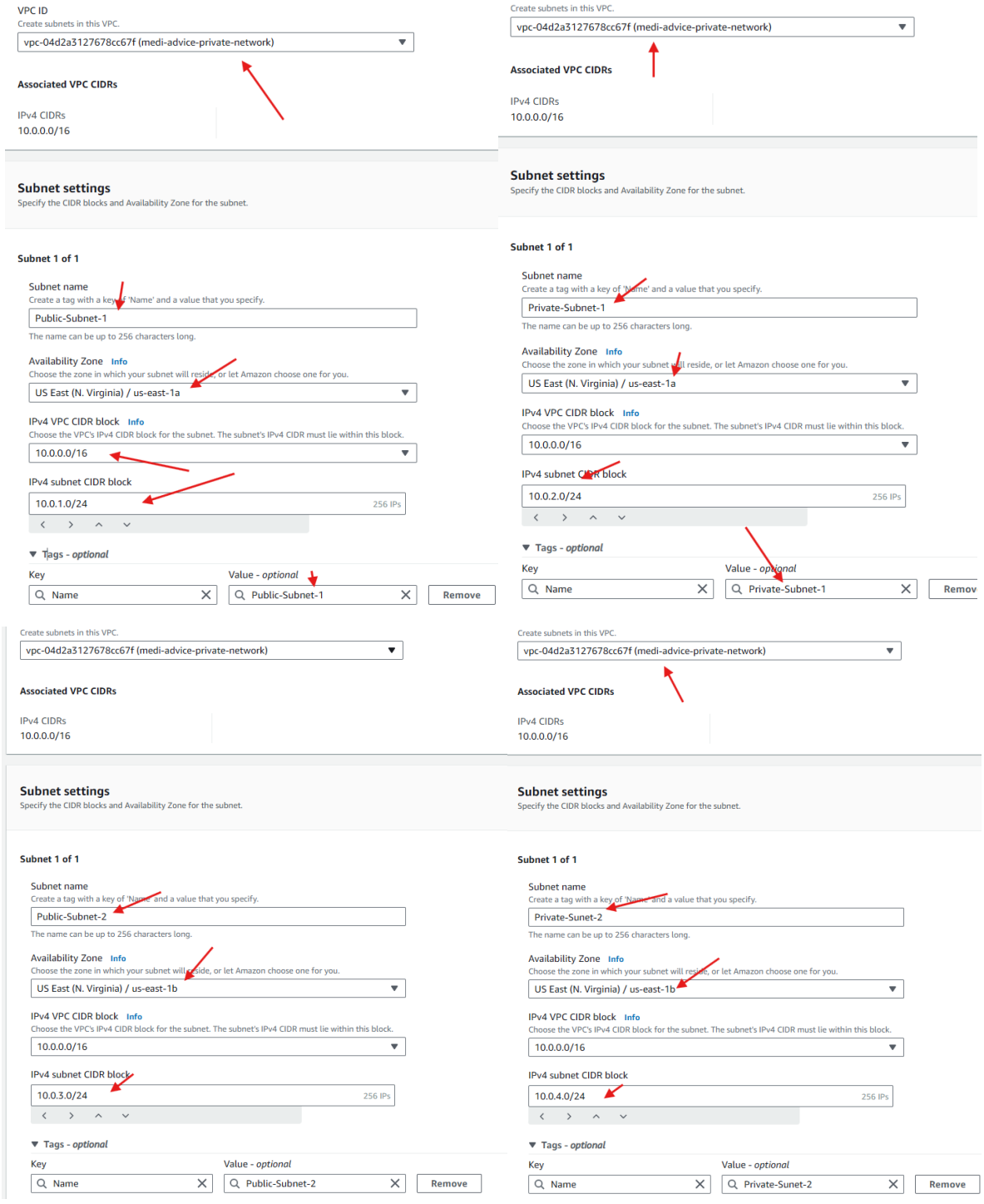
CH-TASK 2: Medi-advice-private-network (VPC), ALB with ASG:

Practical Work:

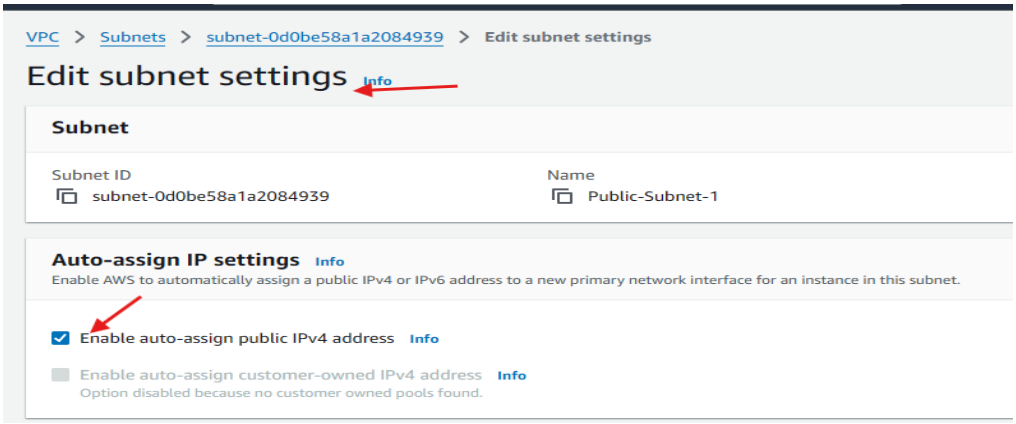
- Created VPC by using VPC only option.
- Set name as medi-advice-private-network.



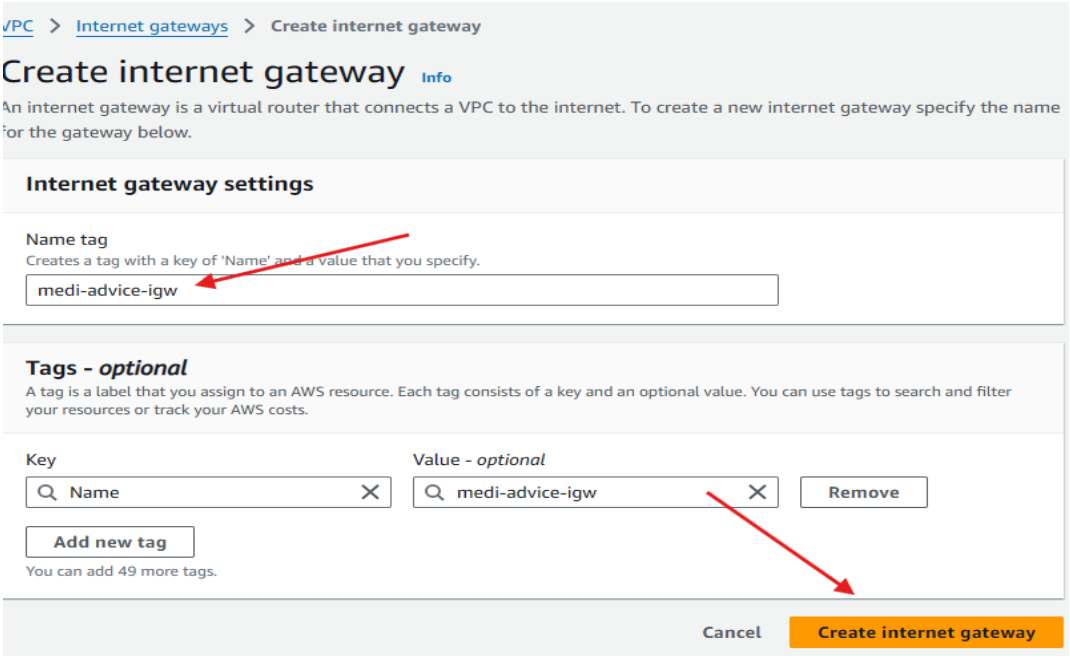
- Created two new public and two new private subnets manually in this VPC.
- Set in US East (N. Virginia) / us-east-1a and us-east-1b two availability zone with network 10.0.0.0/16.



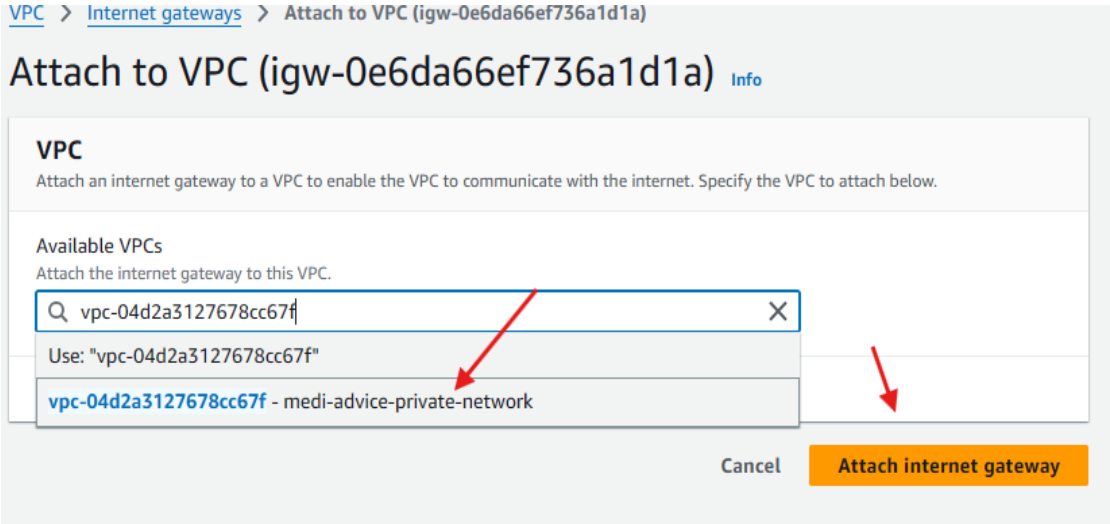
- Enable auto-assign public IPv4 addresses for public subnets in setting.



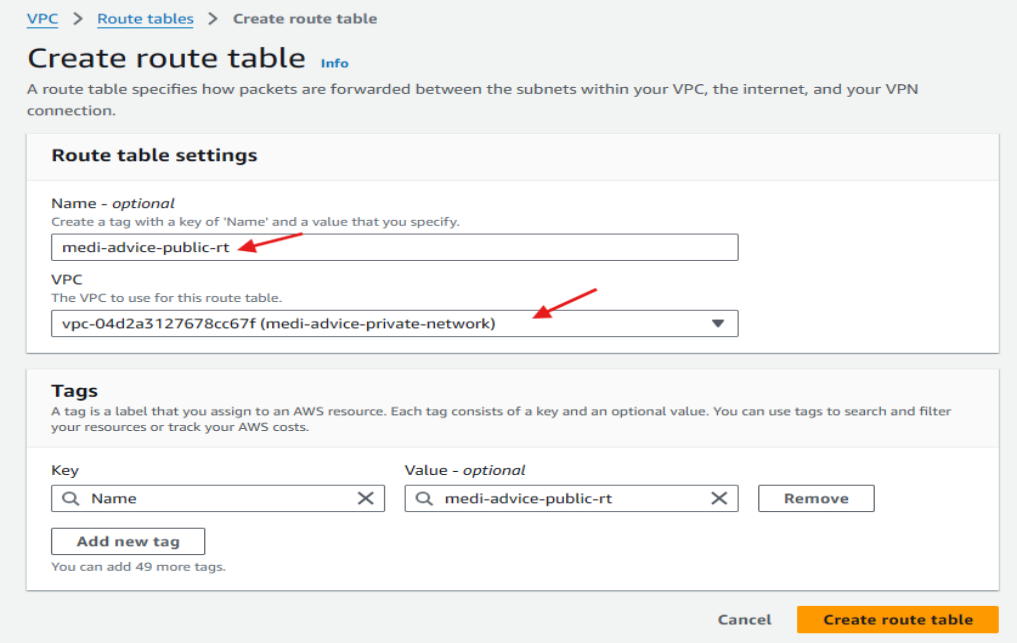
- Created New Internet Gateway with name medi-advice-igw.



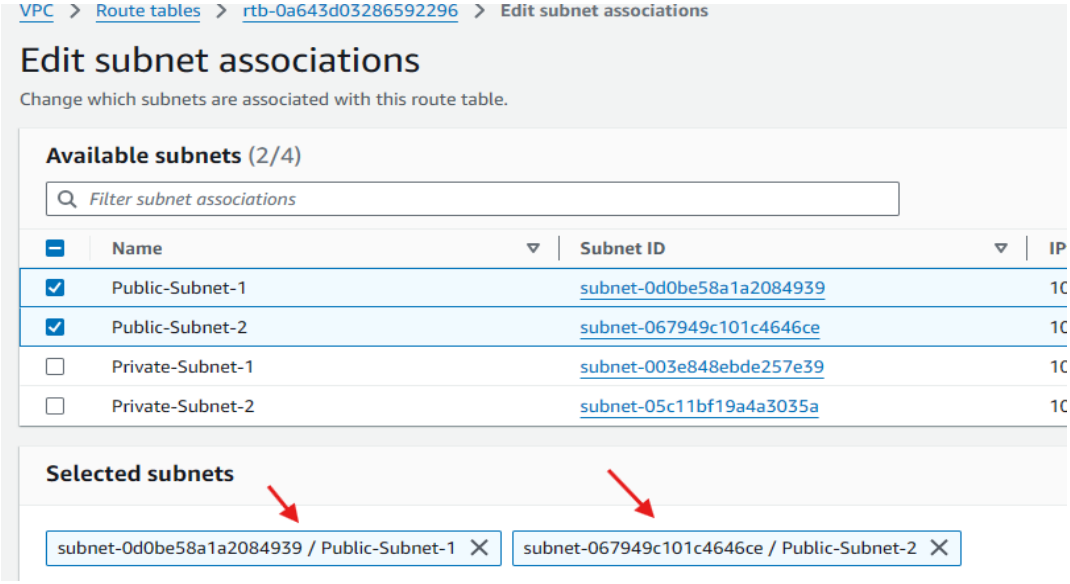
- Attached Internet Gateway with medi-advice-private-network VPC.



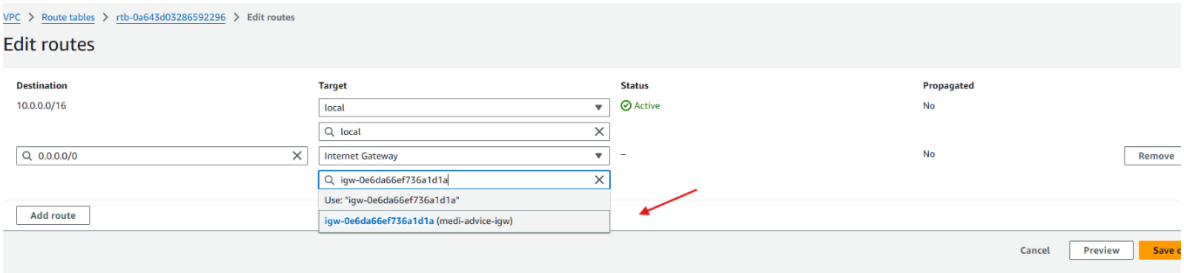
- Navigate route tables in VPC, created a public route with name medi-advice-public-rt and attached the medi-advice-private-network VPC.



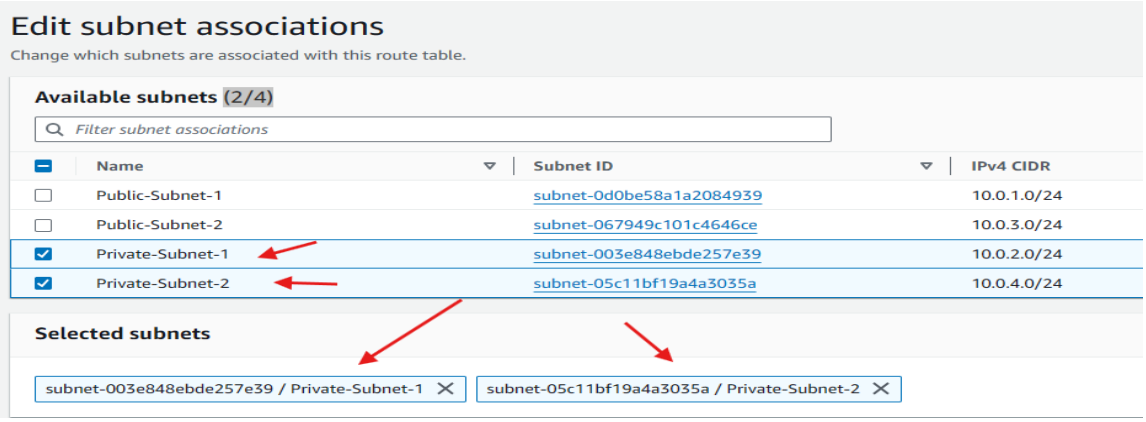
- Associated the public subnets only with this route table.



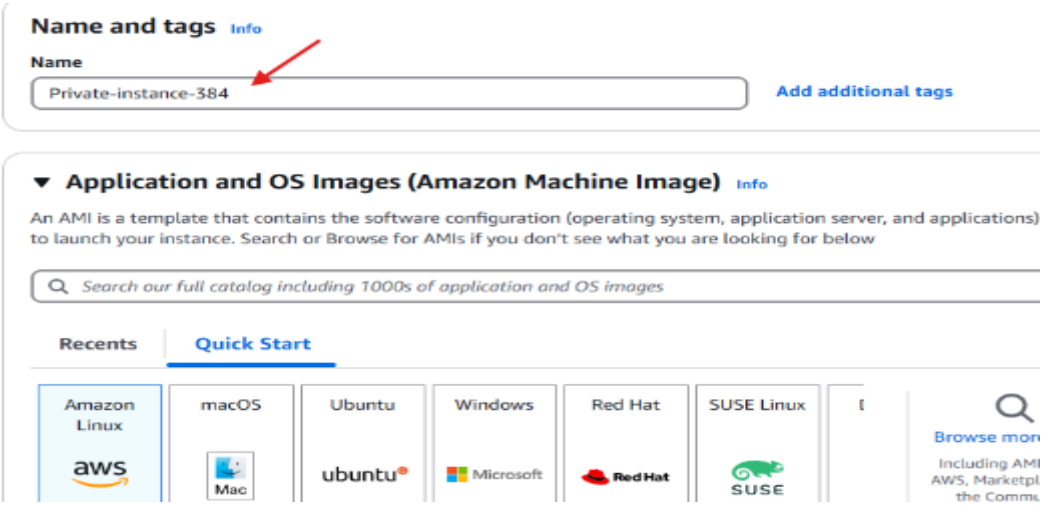
- Add route in edit routes setting, routed it with medi-advice-igw Internet gateway.



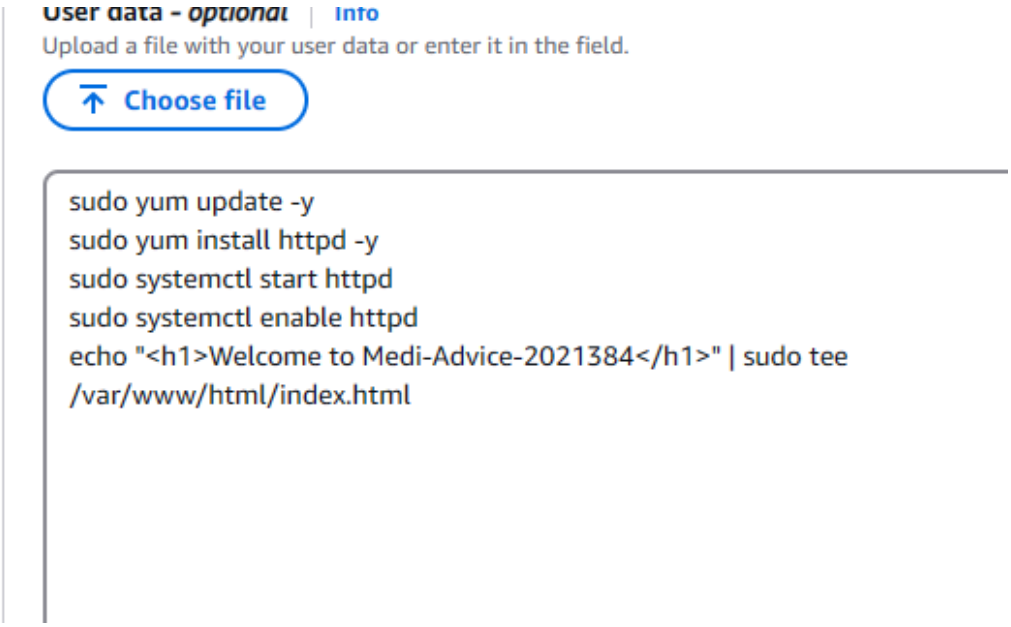
- Created a private route table with name medi-advice-private-rt and attached the medi-advice-private-network VPC as did above for public route.
- Associated the private subnets only with this route table.



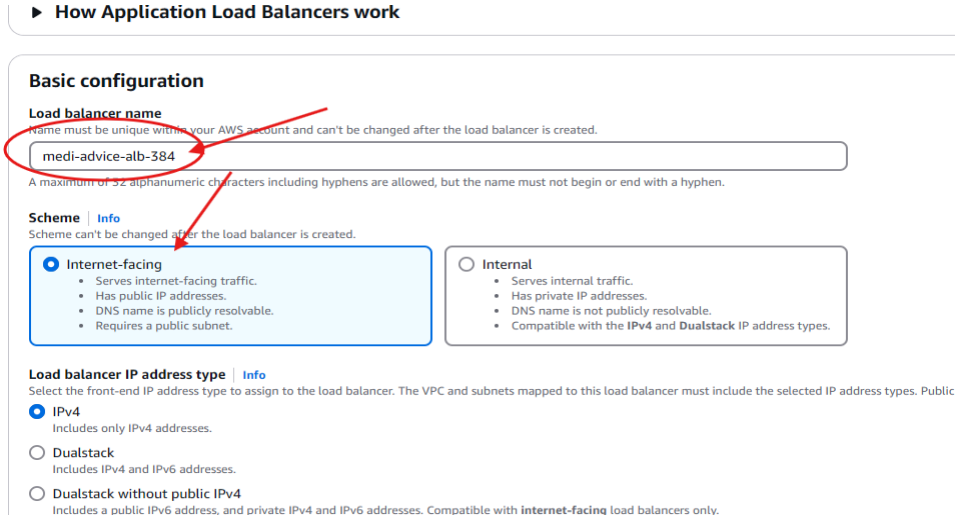
- Created new Linux-instance with name Private-instance-384.



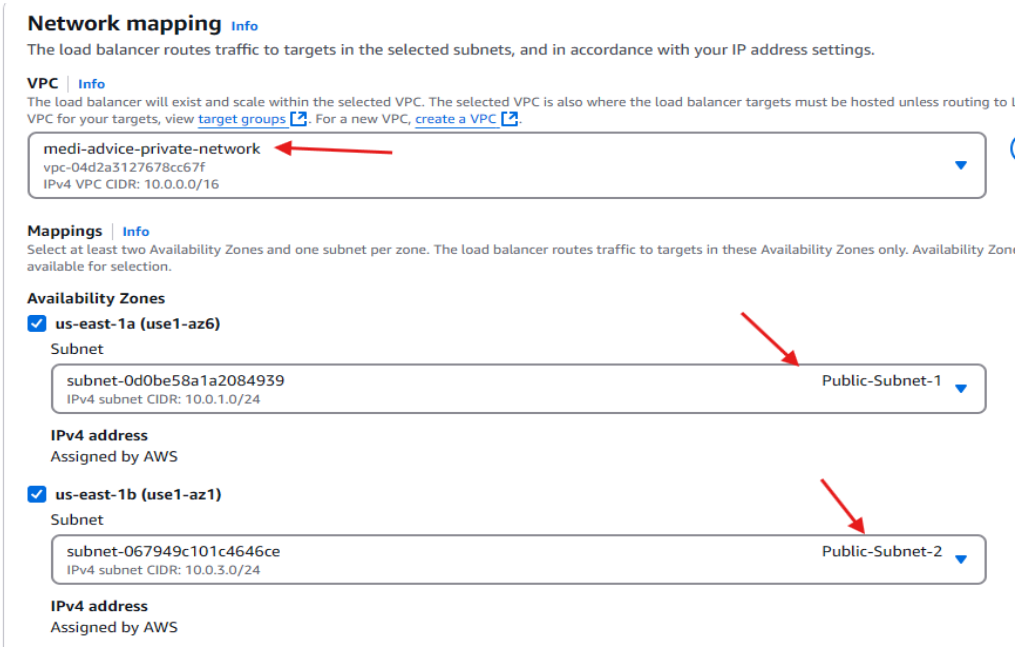
- User data will display Welcome page with my student number 2021384.



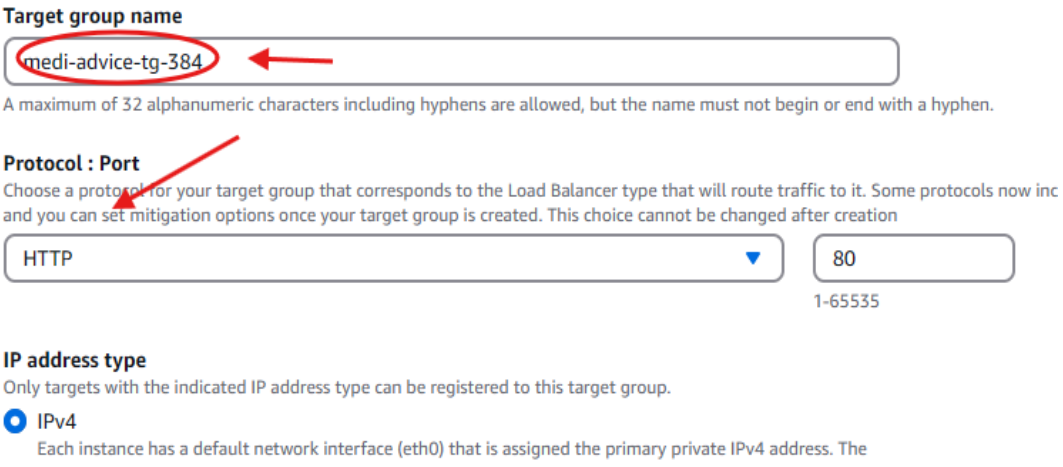
- Created new Application Load Balancer with name medi-advice-alb-384.



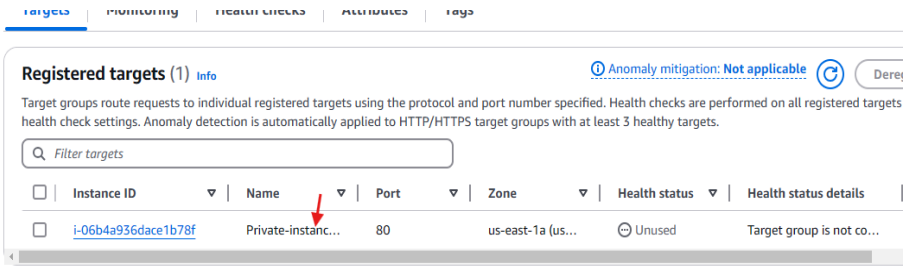
- Selected medi-advice-private-network VPC with public subnets in Network.



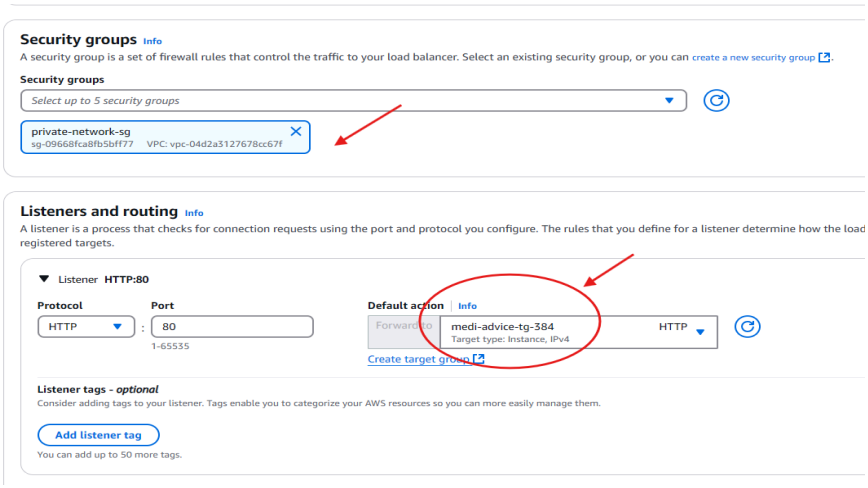
- Created a new target group with name medi-advice-tg-384 with HTTP 80.



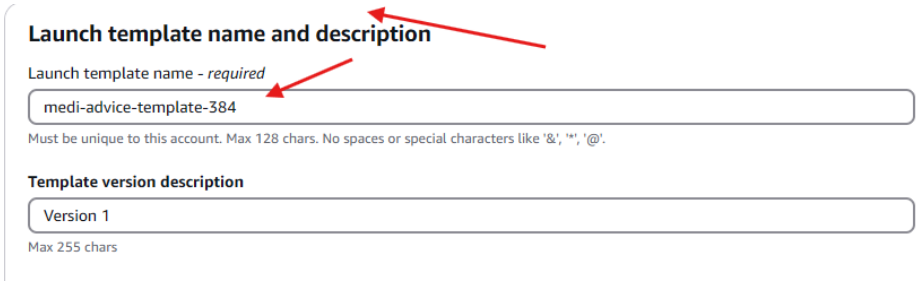
- Add private-instance-384 Linux server as registered in target group.



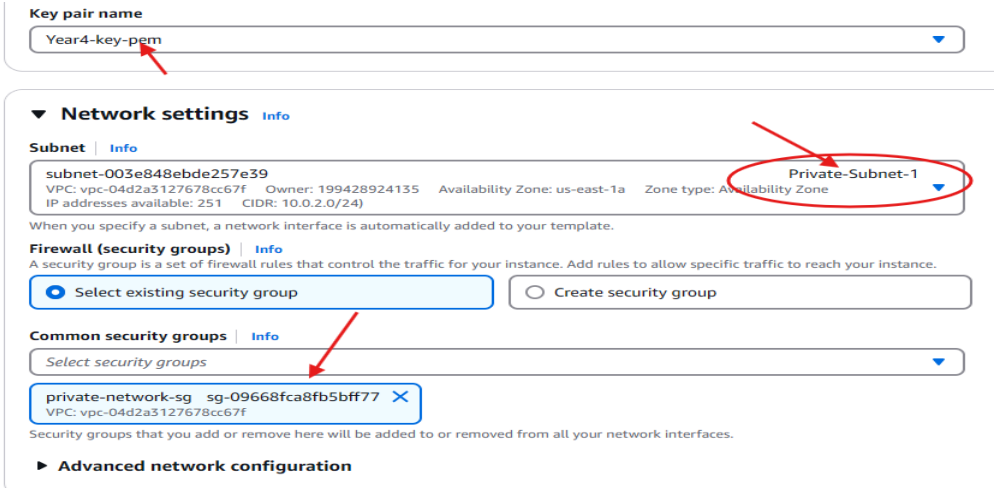
- Go back in ALB, Attached the newly created security group (private-network-sg) and target group (medi-advice-tg-384) by editing.



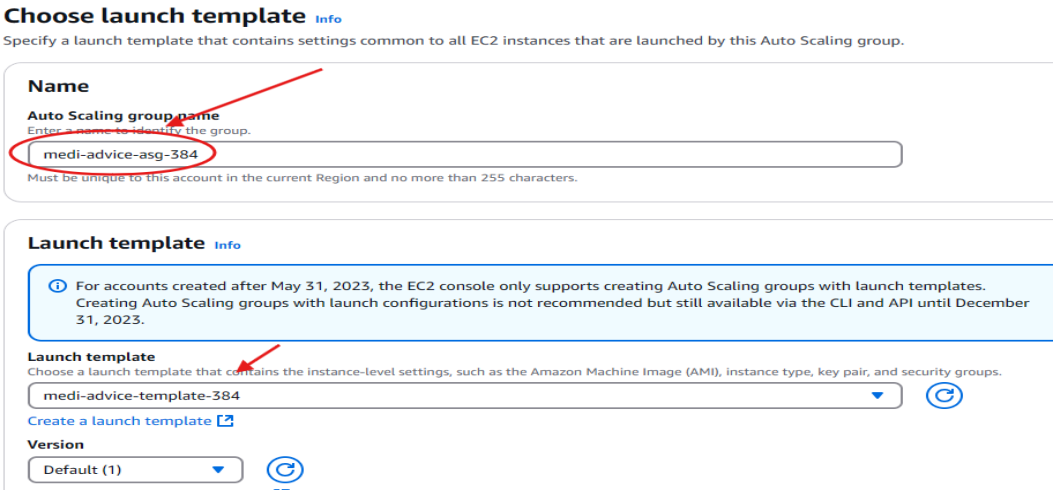
- Created Launch template with name medi-advice-template-384.



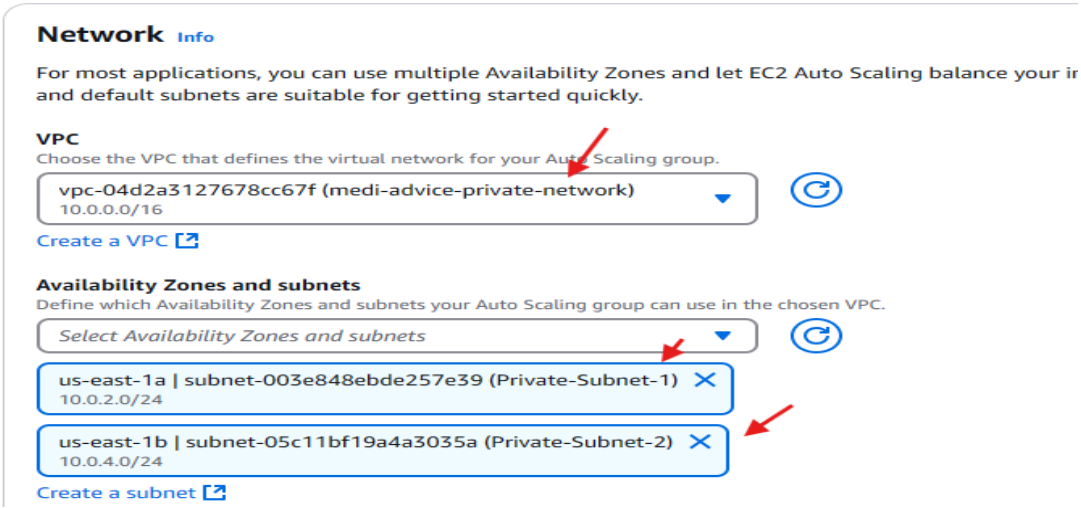
- Selected Private-Subnet-1 for Launch template with private-network-sg.



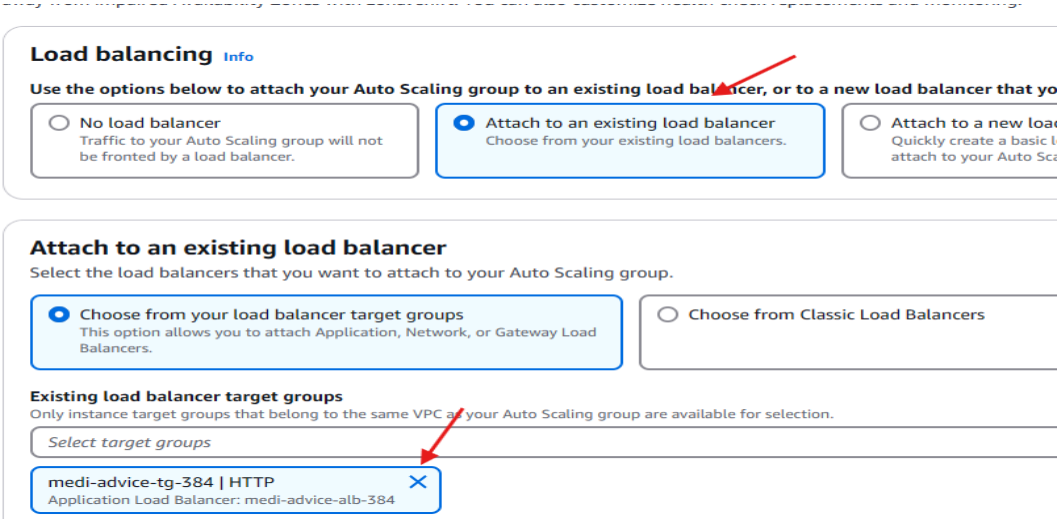
- Created Auto scaling group with name medi-advice-asg-384.
- Attached above created medi-advice-template-384.



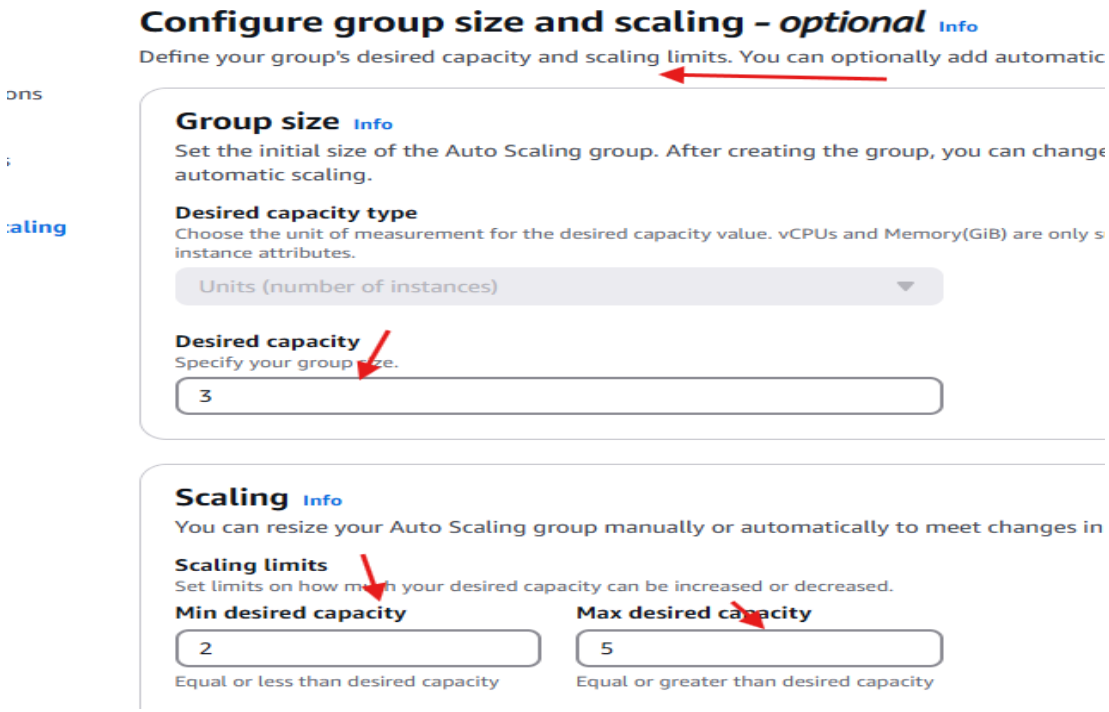
- Attached medi-advice-private-network VPC with Private subnets only.



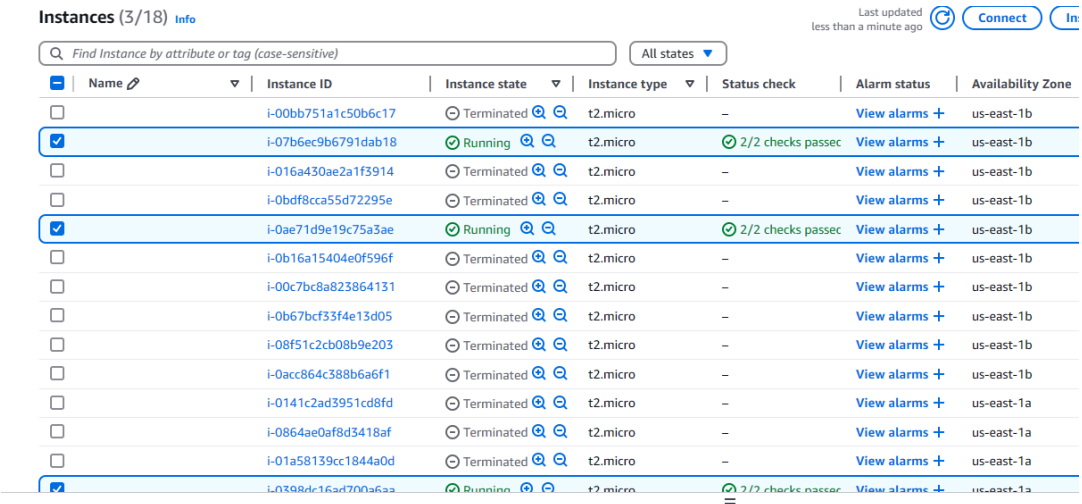
- Attached ALB, configured above with target group (medi-advice-tg-384).



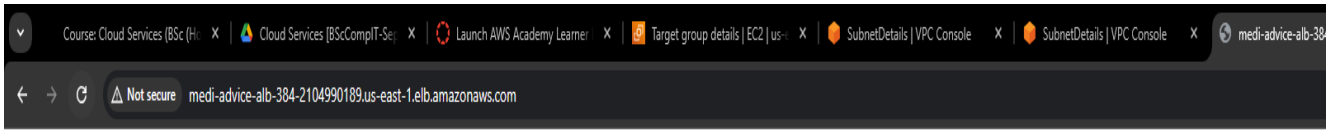
- Set scaling capacities, desired 3, min 2 and max 5.



- Instances are automatically launching again after termination, indicating the successful working of auto scaling group.



- Copy the DNS name of ALB and searched on browser.
- Showed the Welcome page with my student number 2021384.
- It distributed the traffic through instances by refreshing again and again.



Welcome to Medi-Advice 2021384 ip-10-0-1-230.ec2.internal

Load-Balancer integration with Auto-scaler benefits:

For a healthcare company like Medi-Advice, merging an Auto Scaling Group together with a Load Balancer brings a lot of anticipated benefits in terms of application's availability, performance, and use of resources in a cost-effective manner.

Improved Availability and Reliability:

A Load Balancer ensures that the expected traffic is satisfactorily served and, in the case of a server losing connectivity, it intelligently routes traffic to other available servers - ever helping to keep the desired application up and running. This is very crucial in the context of health services in which the existence of the application is critical to patients.

Cost effectiveness and system growth:

When there is a drop in traffic Auto Scaling reduces the number of servers, whereas, during peak traffic it increases the number of servers. In this manner, application performance is maintained while the number of servers is increased whenever it is required or minimized when usage is lower, resulting in decreased expenses. In this way, Medi-Advice will be able to use the required resources within a specified time and no more which is economically sound.

Prevention of Information Leakage and Compliance:

Encryption can be made much stronger through the addition of Load Balancers because they perform SSL/TLS, so fewer certificates need to be processed and back-end servers require less computation power. This is very important in the healthcare industry since patients' personal information must be safeguarded.

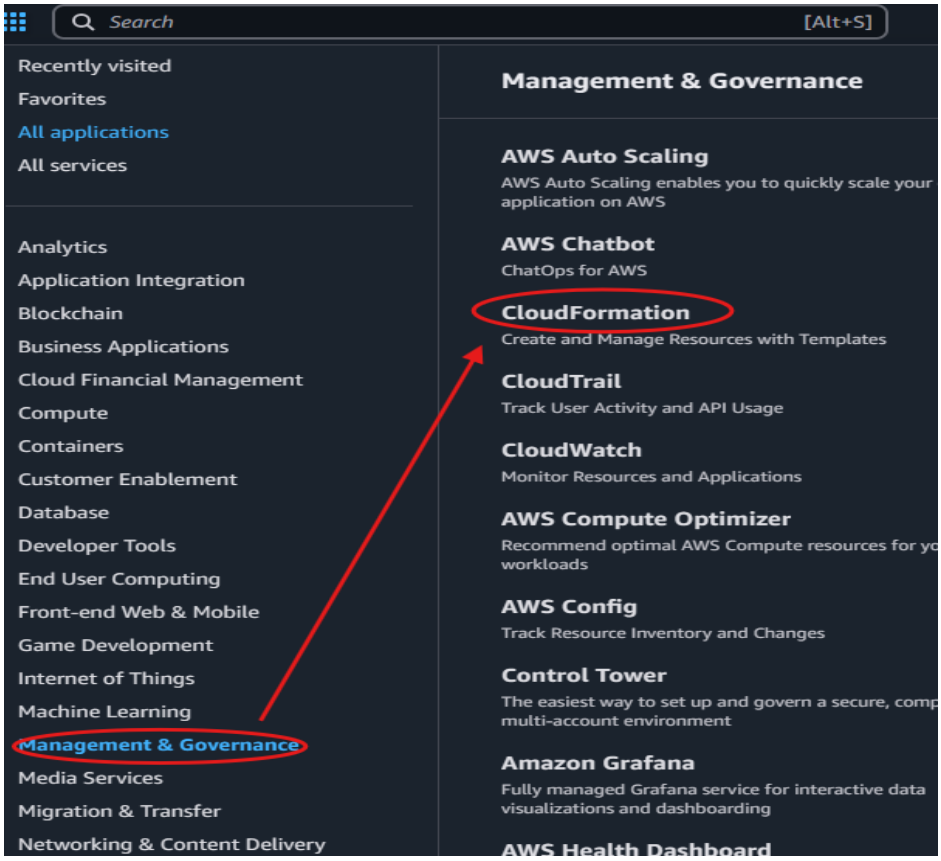
Reduced Manual Efforts:

Combining Load Balancers with Auto Scaling lessens human supervision and inputs. Instead, it streamlines the maintenance of the desired volume of servers and traffic distribution, allowing IT staff to focus on strategic initiatives rather than routine maintenance.

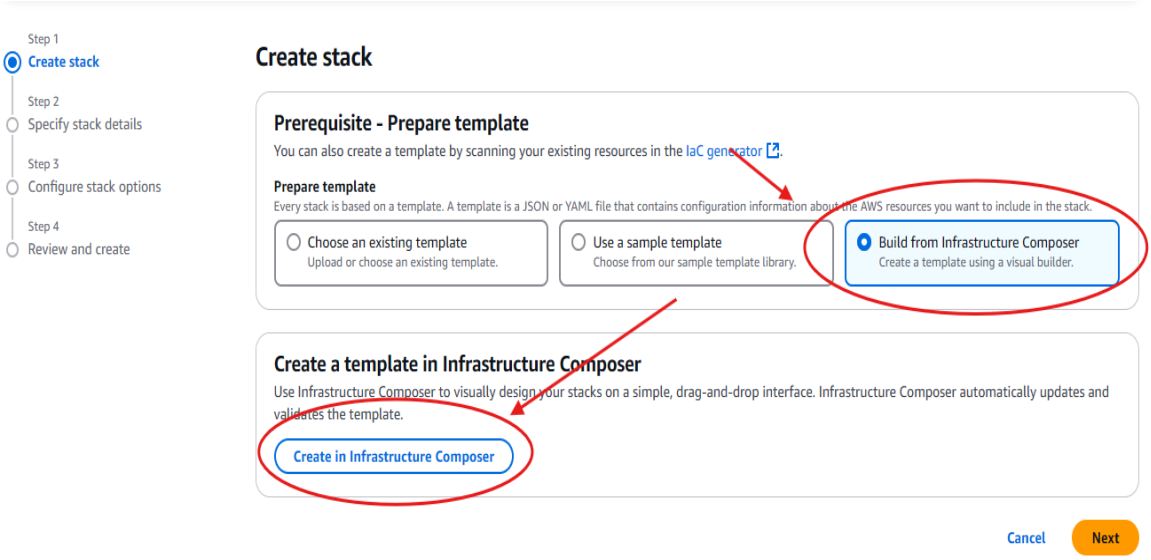
CH-TASK 3: AWS Cloud Formation (Infrastructure as code)

A1: Deployment of VPC using AWS CloudFormation template:

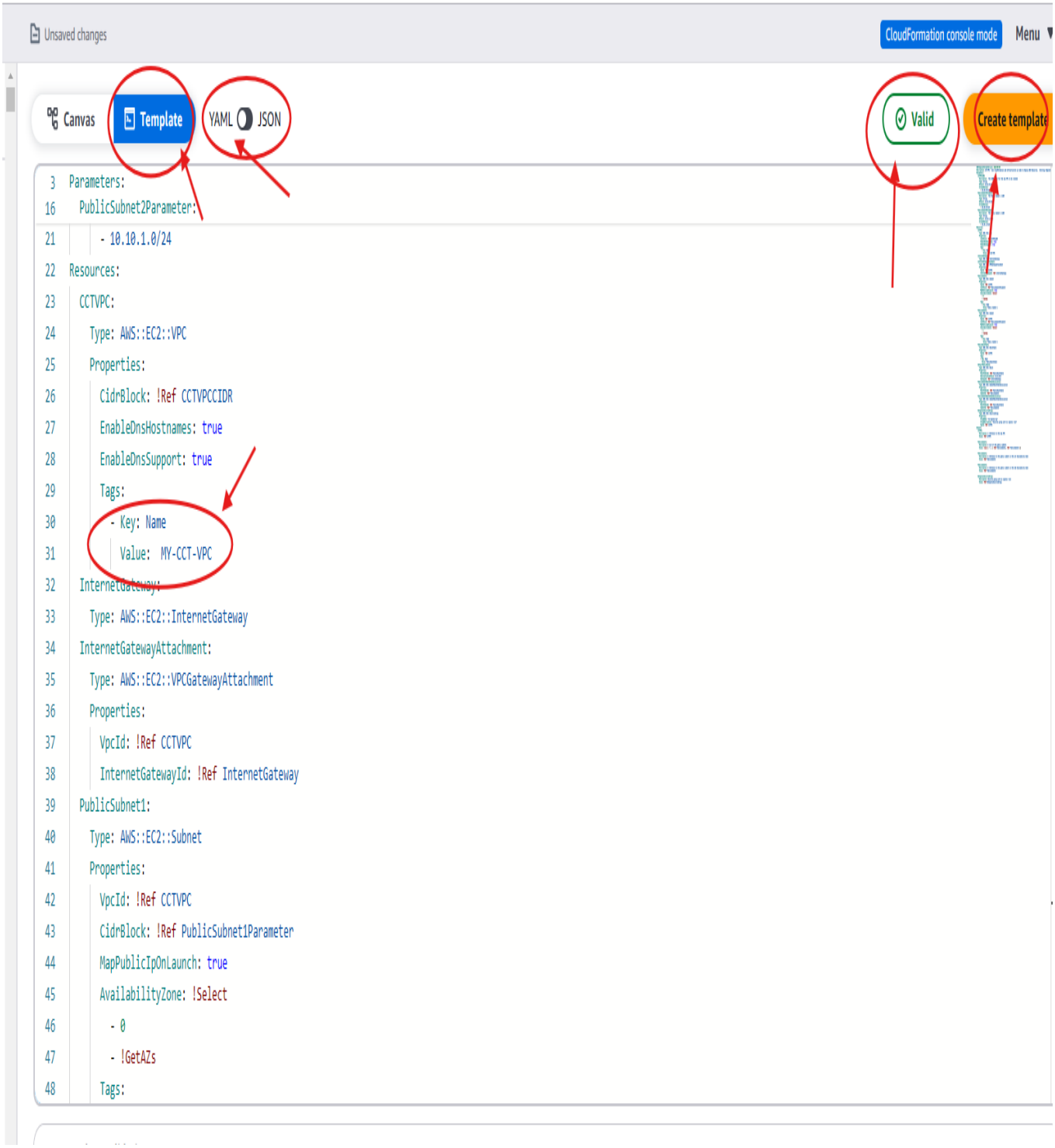
- Navigate CloudFormation from Management & Governance services.



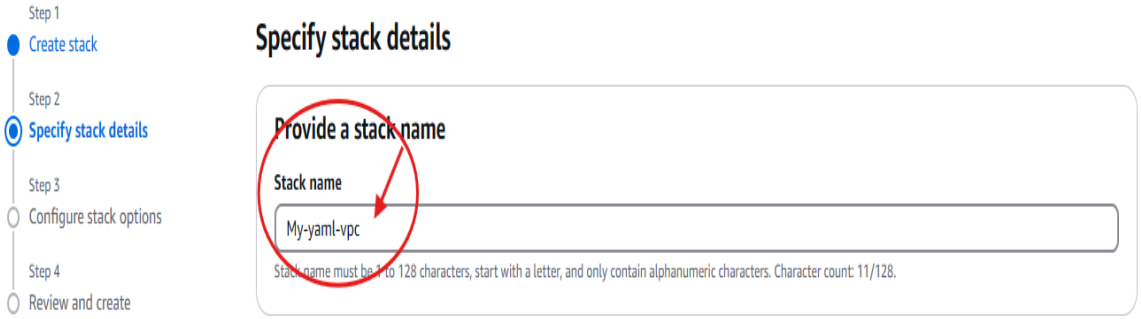
- Create stack, selected ‘Build from Infrastructure Composer’ option.
- Open blue highlighted below option of create as shown in shot below with red circle.



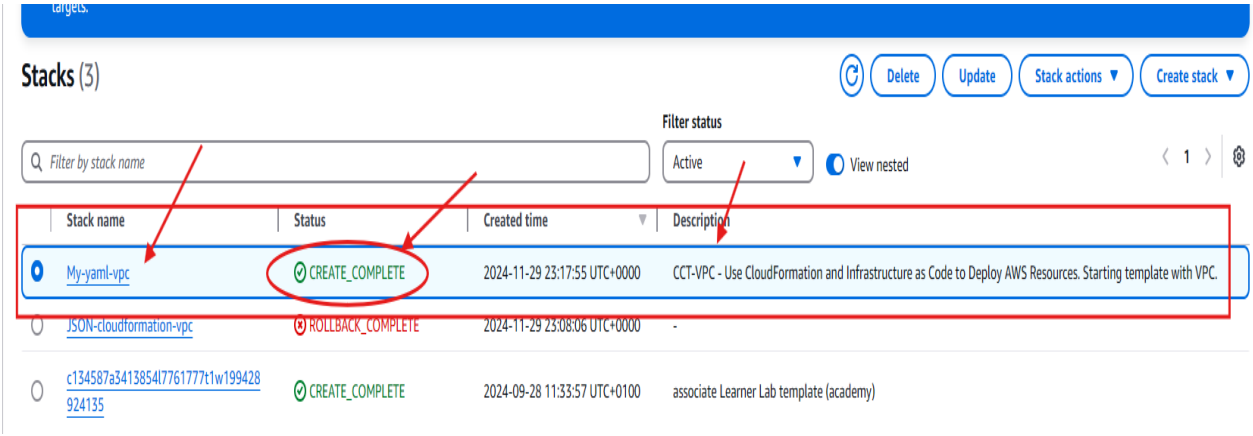
- Selected Template option with YAML code.
- Gave YAML code for creating the new VPC with name MY-CCT-VPC.
- Checked Validity of code and hit create template.



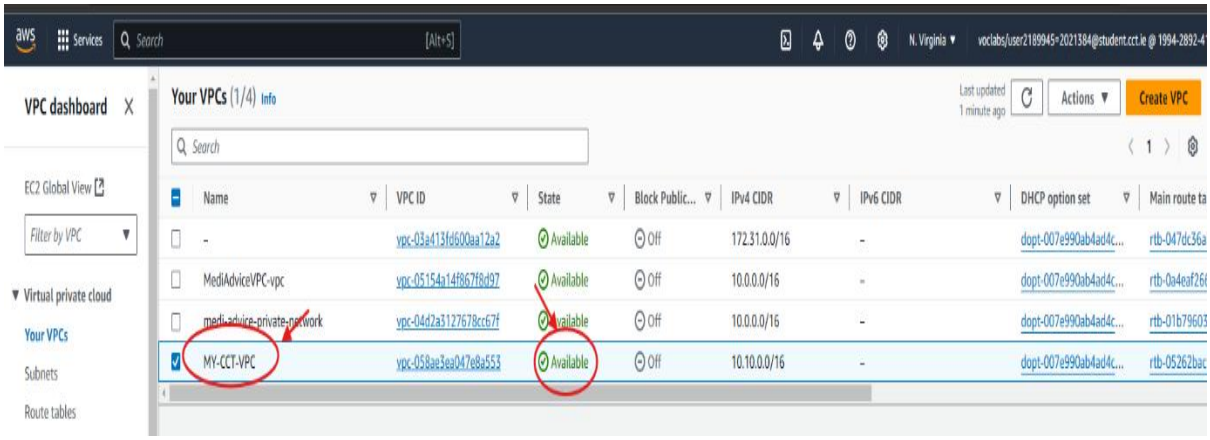
- Set stack name as My-yaml-vpc.
- Left the other settings default, review and create.



- It can be seen that My-yaml-vpc stack is successfully created.



- Navigate VPC from services and verified that the new MY-CCT-VPC has successfully created and showed.



Code Explanation:

Parameters:

- CCTVPCCIDR is CIDR block for the VPC.
- PublicSubnet1Parameter and PublicSubnet2Parameter are CIDR blocks for public subnets.

Resources:

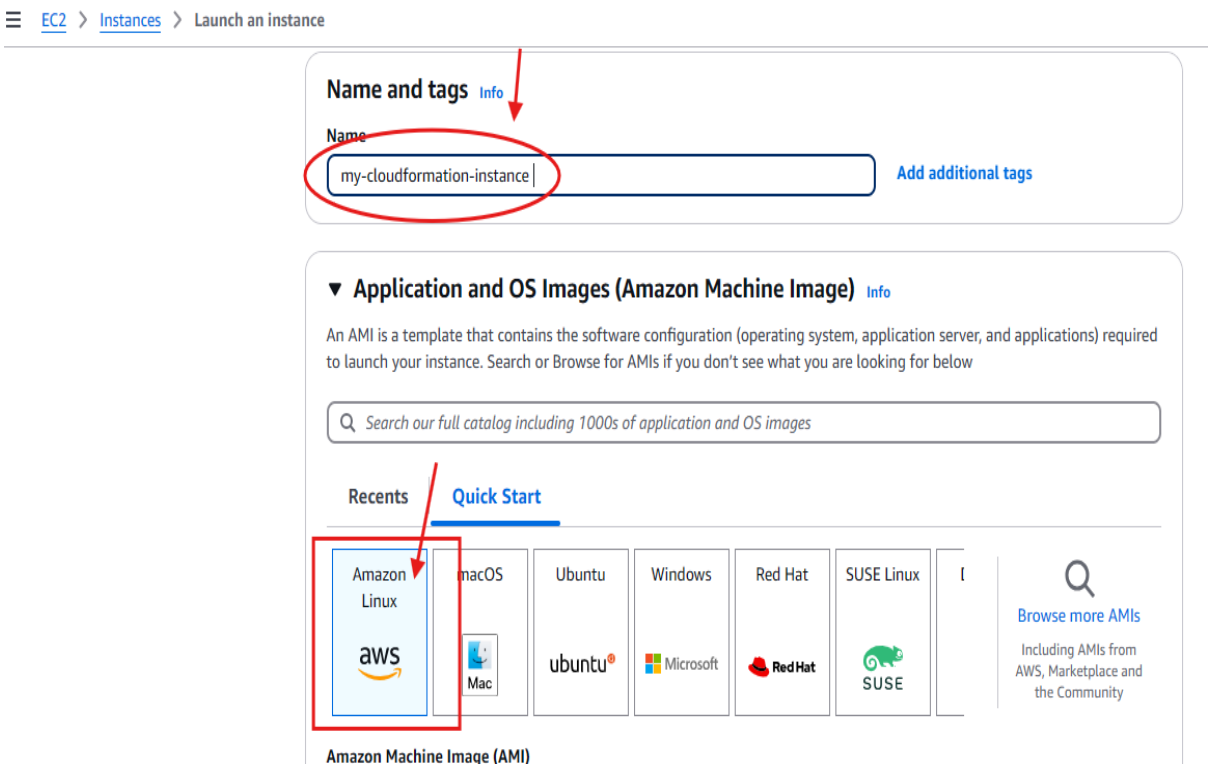
- VPC (CCTVPC) with the specified CIDR block.
- Internet Gateway for internet access.
- InternetGatewayAttachment to attach the Internet Gateway with VPC.
- Creates two public subnets across different Availability Zones with public IP mapping enabled.
- Creates a route table for the public subnets.
- Adds a default route to the Internet Gateway in the route table.
- Associates each public subnet with the public route table.
- Creates a security group with no ingress rules.

Outputs:

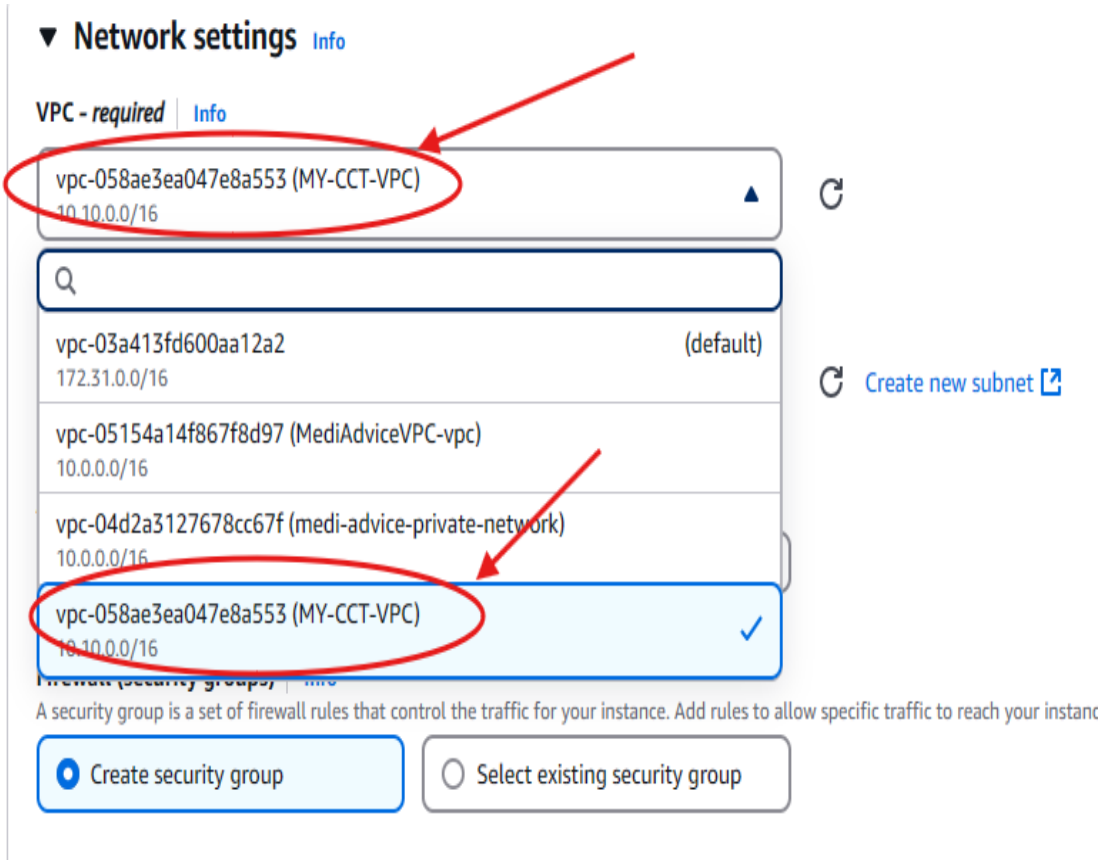
- References to the created VPC, public subnets, and the security group.
- Outputs are helpful for accessing resource IDs after stack creation.

A2: Linux EC2 instance in new VPC:

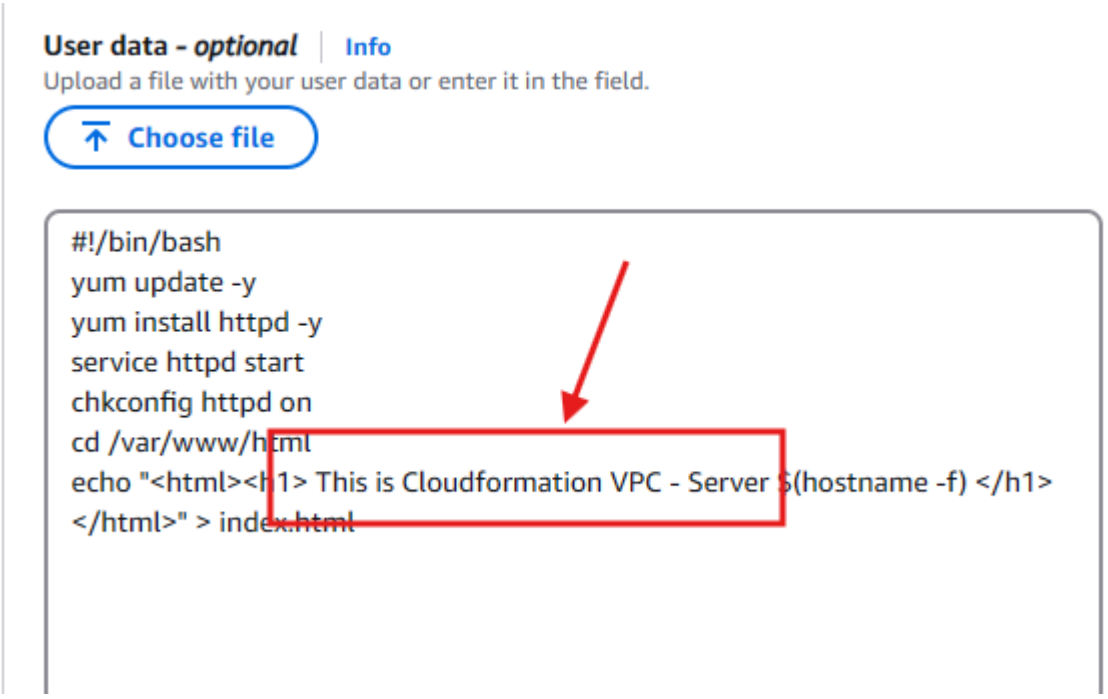
- Created a new Linux-instance with name my-cloudformation-instance.



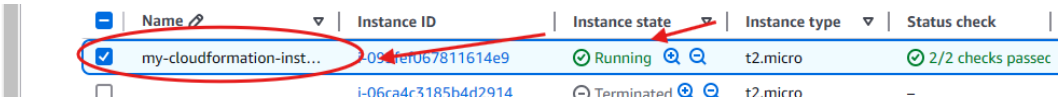
- Selected MY-CCT-VPC which is created above through CloudFormation.



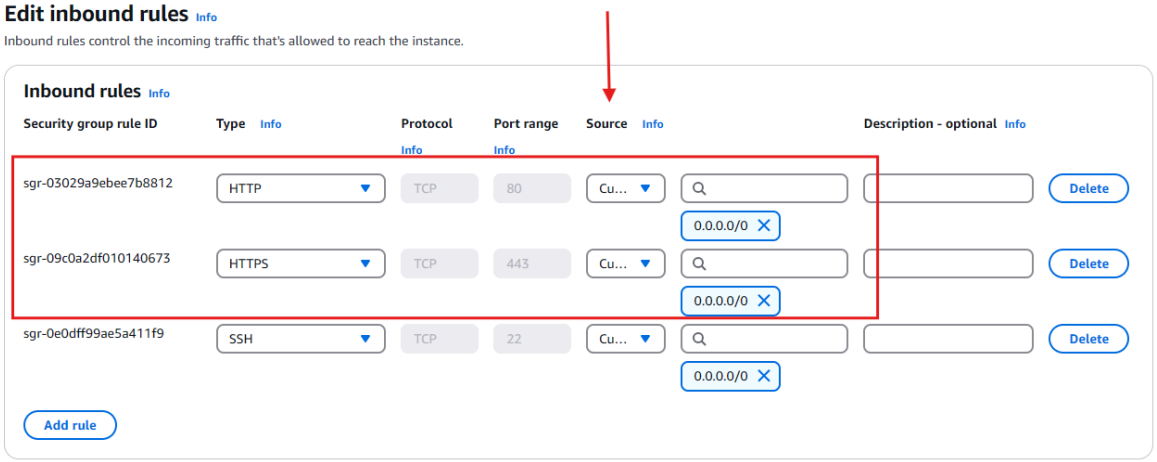
- User data to display html page.



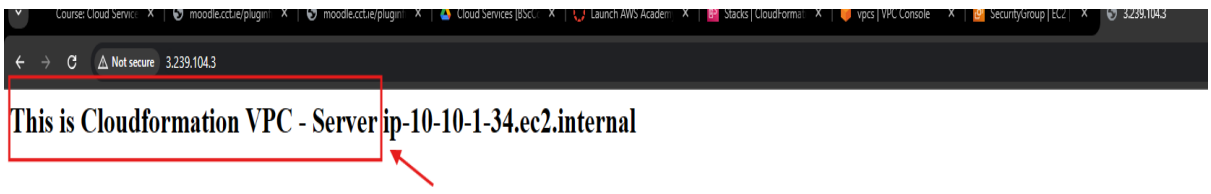
- New instance has created successfully inside MY-CCT-VPC.



- Added HTTP and HTTPS rule in security group which used for instance.



- Linux-server is running successfully.



B1: Advantage of using CloudFormation to create VPC:

Well, there are a number of benefits that come available through setting up a custom VPC using AWS CloudFormation: In terms of automation and repeatability, namely.

In code, define your infrastructure, and CloudFormation makes it even easier for you to deploy, manage, and maintain a standardized VPC across your different environments. A similar configuration in many AWS accounts or regions in a twinkle of an eye without typing the settings manually again after as soon as you define them in a CloudFormation template JSON or YAML format. By adopting this method, the assurance of deploying the infrastructure in the right manner every time is achieved while in the process reducing the time and effort required to put up this infrastructure and also reducing the impact that human element would have on the entire process. Version control is also accomplished easily, and the changes in infrastructure can be monitored and administered more effectively over a given period.

(Reliability Pillar AWS Well-Architected Framework, n.d.)

B2: Supporting Example for CloudFormation:

Suppose one of the production environments of a total production system of a company really fails critically. Using CloudFormation, if this tool were not there, it would mean going through a recovery procedure whereby even the VPC and subnets, EC2 instances, security groups and so on were all configured from the scratch by way of a very time-consuming process. It may take longer time and may be rife with a number of errors and non-re-usable.

However, CloudFormation holds all of the definitions in a single template of as-code infrastructure. Failure to the same can be easily rectified as the CloudFormation template is just used to load the same infrastructure again in just a few minutes. This reduces recover time and offers highly replicative and consistent environment for the deployment.

(Amazon Web Services, n.d.)

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