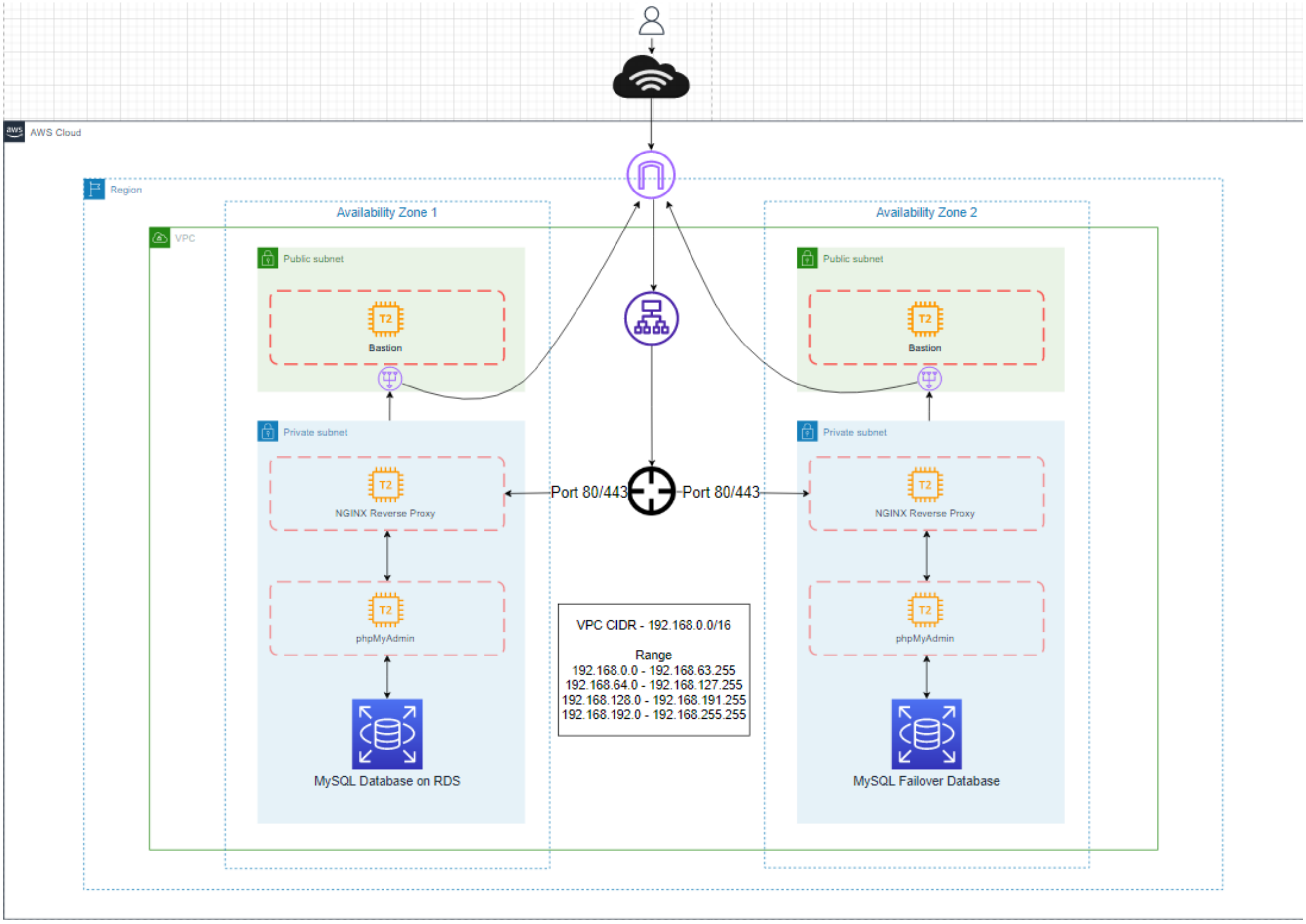
NGINX phpMyAdmin MySQL® CloudFormation

Three Tier Assignment



For this assignment, we automated the process of creating a 3 tier architecture utilizing CloudFormation which resulted in an elastic, reliable, and secure deployment.

A three-tier architecture consists of a presentation layer, an application layer, and a data layer. In this assignment, the presentation layer was an NGINX application that was configured to be a reverse proxy that served traffic on behalf of the backend application. The application layer was a phpMyAdmin application that talked to the RDS database and visualized the data. PhpMyAdmin handles the administration of MySQL databases over the web. This allows us to create, update, drop, alter, delete, import, and export MySQL database tables all through phpMyAdmin. Finally, the data layer is often called the database tier where the information processed by the application is stored and managed.

For this assignment, we created the majority of our AWS architecture using CloudFormation. All EC2 instances, security groups, subnets, and VPC were configured to minimize user error. The only services that need configuration are the load balancer and target group. Once everything was set up, we had to connect to the instances and install the required applications. The bastion EC2 instance is used as a jump host which will allow us to access our private resource only if we have access to the bastion EC2. This will add another layer of security to our architecture. For the database layer, we used MySQL RDS. We then had to configure the phpMyAdmin to connect to the RDS database. Once that was set up, we had to configure the NGINX application to be the reverse proxy. When everything is configured, you can access the application through the load balancer DNS name. Deleting the CloudFormation stack will tear down all the resources for us. We just had to delete the load balancer and target group. With the help of CloudFormation, we created an elastic, reliable, and secure deployment architecture.

Task 1

Create a VPC with a public subnet and a private subnet using CloudFormation

Create a YAML file called base.yaml
Paste the following inside the YAML file and save the file.

```
Description:
  This template deploys a VPC, with a pair of public and private subnets spread
  across two Availability Zones. It deploys an internet gateway, with a default
  route on the public subnets. It deploys a pair of NAT gateways (one in each AZ),
  and default routes for them in the private subnets.

Parameters:
  EnvironmentName:
    Description: An environment name that is prefixed to resource names
    Type: String

  VpcCIDR:
    Description: Please enter the IP range (CIDR notation) for this VPC
    Type: String
    Default: 192.168.0.0/16

  PublicSubnet1CIDR:
    Description: Please enter the IP range (CIDR notation) for the public subnet in the first Availability Zone
    Type: String
    Default: 192.168.0.0/18

  PublicSubnet2CIDR:
    Description: Please enter the IP range (CIDR notation) for the public subnet in the second Availability Zone
    Type: String
    Default: 192.168.64.0/18

  PrivateSubnet1CIDR:
    Description: Please enter the IP range (CIDR notation) for the private subnet in the first Availability Zone
    Type: String
    Default: 192.168.128.0/18

  PrivateSubnet2CIDR:
    Description: Please enter the IP range (CIDR notation) for the private subnet in the second Availability Zone
    Type: String
    Default: 192.168.192.0/18

  KeyName:
    Description: Name of an existing EC2 KeyPair to enable SSH access to the instance
    Type: AWS::EC2::KeyPair::KeyName

Resources:
  VPC:
    Type: AWS::EC2::VPC
    Properties:
      CidrBlock: !Ref VpcCIDR
      EnableDnsSupport: true
      EnableDnsHostnames: true
      Tags:
```

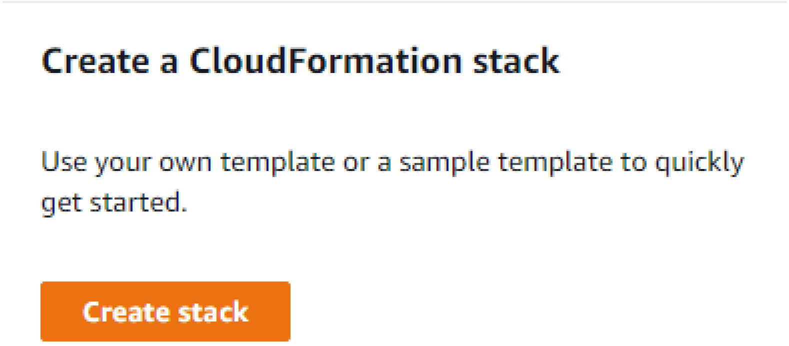
```
      - Key: Name
        Value: !Ref EnvironmentName

InternetGateway:
  Type: AWS::EC2::InternetGateway
  Properties:
    Tags:
      - Key: Name
        Value: !Ref EnvironmentName

InternetGatewayAttachment:
  Type: AWS::EC2::VPCGatewayAttachment
  Properties:
    InternetGatewayId: !Ref InternetGateway
    VpcId: !Ref VPC

PublicSubnet1:
  Type: AWS::EC2::Subnet
  Properties:
    VpcId: !Ref VPC
    AvailabilityZone: !Select [0, !GetAZs ""]
    CidrBlock: !Ref PublicSubnet1CIDR
    MapPublicIpOnLaunch: true
    Tags:
      - Key: Name
        Value: !Sub ${EnvironmentName} Public Subnet (AZ1)

PublicSubnet2:
  Type: AWS::EC2::Subnet
  Properties:
    VpcId: !Ref VPC
    AvailabilityZone: !Select [1, !GetAZs ""]
    CidrBlock: !Ref PublicSubnet2CIDR
    MapPublicIpOnLaunch: true
    Tags:
      - Key: Name
        Value: !Sub ${EnvironmentName} Public Subnet (AZ2)

PrivateSubnet1:
  Type: AWS::EC2::Subnet
  Properties:
    VpcId: !Ref VPC
    AvailabilityZone: !Select [0, !GetAZs ""]
    CidrBlock: !Ref PrivateSubnet1CIDR
    MapPublicIpOnLaunch: false
    Tags:
      - Key: Name
        Value: !Sub ${EnvironmentName} Private Subnet (AZ1)

PrivateSubnet2:
  Type: AWS::EC2::Subnet
  Properties:
    VpcId: !Ref VPC
    AvailabilityZone: !Select [1, !GetAZs ""]
    CidrBlock: !Ref PrivateSubnet2CIDR
    MapPublicIpOnLaunch: false
    Tags:
      - Key: Name
        Value: !Sub ${EnvironmentName} Private Subnet (AZ2)

NatGateway1EIP:
  Type: AWS::EC2::EIP
  DependsOn: InternetGatewayAttachment
  Properties:
    Domain: vpc

NatGateway2EIP:
  Type: AWS::EC2::EIP
  DependsOn: InternetGatewayAttachment
  Properties:
    Domain: vpc

NatGateway1:
  Type: AWS::EC2::NatGateway
  Properties:
    AllocationId: !GetAtt NatGateway1EIP.AllocationId
    SubnetId: !Ref PublicSubnet1

NatGateway2:
  Type: AWS::EC2::NatGateway
  Properties:
    AllocationId: !GetAtt NatGateway2EIP.AllocationId
    SubnetId: !Ref PublicSubnet2

PublicRouteTable:
  Type: AWS::EC2::RouteTable
  Properties:
    VpcId: !Ref VPC
    Tags:
      - Key: Name
        Value: !Sub ${EnvironmentName} Public Routes

DefaultPublicRoute:
  Type: AWS::EC2::Route
  DependsOn: InternetGatewayAttachment
  Properties:
    RouteTableId: !Ref PublicRouteTable
    DestinationCidrBlock: 0.0.0.0/0
```

```
      GatewayId: !Ref InternetGateway

  PublicSubnet1RouteTableAssociation:
    Type: AWS::EC2::SubnetRouteTableAssociation
    Properties:
      RouteTableId: !Ref PublicRouteTable
      SubnetId: !Ref PublicSubnet1

  PublicSubnet2RouteTableAssociation:
    Type: AWS::EC2::SubnetRouteTableAssociation
    Properties:
      RouteTableId: !Ref PublicRouteTable
      SubnetId: !Ref PublicSubnet2

  PrivateRouteTable1:
    Type: AWS::EC2::RouteTable
    Properties:
      VpcId: !Ref VPC
      Tags:
        - Key: Name
          Value: !Sub ${EnvironmentName} Private Routes (AZ1)

  DefaultPrivateRoute1:
    Type: AWS::EC2::Route
    Properties:
      RouteTableId: !Ref PrivateRouteTable1
      DestinationCidrBlock: 0.0.0.0/0
      NatGatewayId: !Ref NatGateway1

  PrivateSubnet1RouteTableAssociation:
    Type: AWS::EC2::SubnetRouteTableAssociation
    Properties:
      RouteTableId: !Ref PrivateRouteTable1
      SubnetId: !Ref PrivateSubnet1

  PrivateRouteTable2:
    Type: AWS::EC2::RouteTable
    Properties:
      VpcId: !Ref VPC
      Tags:
        - Key: Name
          Value: !Sub ${EnvironmentName} Private Routes (AZ2)

  DefaultPrivateRoute2:
    Type: AWS::EC2::Route
    Properties:
      RouteTableId: !Ref PrivateRouteTable2
      DestinationCidrBlock: 0.0.0.0/0
      NatGatewayId: !Ref NatGateway2

  PrivateSubnet2RouteTableAssociation:
    Type: AWS::EC2::SubnetRouteTableAssociation
    Properties:
      RouteTableId: !Ref PrivateRouteTable2
      SubnetId: !Ref PrivateSubnet2

  NoIngressSecurityGroup:
    Type: AWS::EC2::SecurityGroup
    Properties:
      GroupName: "no-ingress-sg"
      GroupDescription: "Security group with no ingress rule"
      VpcId: !Ref VPC

  BastionSecurityGroup:
    Type: AWS::EC2::SecurityGroup
    Properties:
      GroupDescription: "Security group that allows SSH from anywhere"
      GroupName: "Bastion"
      SecurityGroupIngress:
        - IpProtocol: tcp
          FromPort: 22
          ToPort: 22
          CidrIp: 0.0.0.0/0
      VpcId: !Ref VPC

  BastionEC2Instance:
    Type: AWS::EC2::Instance
    Properties:
      ImageId: ami-09e67e426f25ce0d7
      InstanceType: t2.micro
      SubnetId: !Ref PublicSubnet1
      KeyName: !Ref KeyName
      SecurityGroupIds:
        - !Ref BastionSecurityGroup
      Tags:
        - Key: "Name"
          Value: "Bastion"


  NginxSecurityGroup:
    Type: AWS::EC2::SecurityGroup
    Properties:
      GroupDescription: "Security group that allows SSH from bastion host only and allows client access on HTTP/HTTPS"
      GroupName: "Nginx"
      SecurityGroupIngress:
        - IpProtocol: tcp
          FromPort: 22
          ToPort: 22
          SourceSecurityGroupId:
            Fn::GetAtt:
            - BastionSecurityGroup
            - GroupId
        - IpProtocol: tcp
          FromPort: 80
          ToPort: 80
          CidrIp: 0.0.0.0/0
        - IpProtocol: tcp
          FromPort: 443
          ToPort: 443
          CidrIp: 0.0.0.0/0
      VpcId: !Ref VPC

  NginxEC2Instance:
    Type: AWS::EC2::Instance
    Properties:
      ImageId: ami-09e67e426f25ce0d7
      InstanceType: t2.micro
      SubnetId: !Ref PrivateSubnet1
      KeyName: !Ref KeyName
      SecurityGroupIds:
        - !Ref NginxSecurityGroup
      Tags:
        - Key: "Name"
          Value: "Nginx"

  phpMyAdminSecurityGroup:
    Type: AWS::EC2::SecurityGroup
    Properties:
      GroupDescription: "Security group that allows SSH from the bastion host only"
      GroupName: "phpMyAdmin"
      SecurityGroupIngress:
        - IpProtocol: tcp
          FromPort: 22
          ToPort: 22
          SourceSecurityGroupId:
            Fn::GetAtt:
            - BastionSecurityGroup
            - GroupId
        - IpProtocol: tcp
          FromPort: 80
          ToPort: 80
          SourceSecurityGroupId:
            Fn::GetAtt:
            - NginxSecurityGroup
            - GroupId
      VpcId: !Ref VPC

  phpMyAdminEC2Instance:
    Type: AWS::EC2::Instance
    Properties:
      ImageId: ami-09e67e426f25ce0d7
      InstanceType: t2.micro
      SubnetId: !Ref PrivateSubnet1
      KeyName: !Ref KeyName
      SecurityGroupIds:
        - !Ref phpMyAdminSecurityGroup
      Tags:
        - Key: "Name"
          Value: "phpMyAdmin"

  ThreeTierSecurityGroup:
    Type: AWS::EC2::SecurityGroup
    Properties:
      GroupDescription: "Security group that allows client access on HTTP/HTTPS for the Load Balancer"
      GroupName: "ThreeTier"
      SecurityGroupIngress:
        - IpProtocol: tcp
          FromPort: 80
          ToPort: 80
          CidrIp: 0.0.0.0/0
        - IpProtocol: tcp
          FromPort: 443
          ToPort: 443
          CidrIp: 0.0.0.0/0
      VpcId: !Ref VPC

  ThreeTierDBSecurityGroup:
    Type: AWS::EC2::SecurityGroup
    Properties:
      GroupDescription: "Security group for the RDS MySQL database that allows access from phpMyAdmin SG only"
      GroupName: "ThreeTierDB"
      SecurityGroupIngress:
        - IpProtocol: tcp
          FromPort: 3306
          ToPort: 3306
          SourceSecurityGroupId:
            Fn::GetAtt:
            - phpMyAdminSecurityGroup
            - GroupId
      VpcId: !Ref VPC

Outputs:
  VPC:
    Description: A reference to the created VPC
    Value: !Ref VPC
```

```
PublicSubnets:
  Description: A list of the public subnets
  Value: !Join [",", [!Ref PublicSubnet1, !Ref PublicSubnet2]]

PrivateSubnets:
  Description: A list of the private subnets
  Value: !Join [",", [!Ref PrivateSubnet1, !Ref PrivateSubnet2]]

PublicSubnet1:
  Description: A reference to the public subnet in the 1st Availability Zone
  Value: !Ref PublicSubnet1

PublicSubnet2:
  Description: A reference to the public subnet in the 2nd Availability Zone
  Value: !Ref PublicSubnet2

PrivateSubnet1:
  Description: A reference to the private subnet in the 1st Availability Zone
  Value: !Ref PrivateSubnet1

PrivateSubnet2:
  Description: A reference to the private subnet in the 2nd Availability Zone
  Value: !Ref PrivateSubnet2

NoIngressSecurityGroup:
  Description: Security group with no ingress rule
  Value: !Ref NoIngressSecurityGroup

BastionSecurityGroup:
  Description: Security group with SSH from anywhere ingress rule
  Value: !Ref BastionSecurityGroup

NginxSecurityGroup:
  Description: Security group with SSH from anywhere ingress rule
  Value: !Ref NginxSecurityGroup

NginxSecurityGroup:
  Description: Security group that allows SSH from bastion host only and allows client access on HTTP/HTTPS
  Value: !Ref NginxSecurityGroup

phpMyAdminSecurityGroup:
  Description: Security group with SSH from only the bastion SG ingress rule
  Value: !Ref phpMyAdminSecurityGroup

ThreeTierSecurityGroup:
  Description: Security group that allows client access on HTTP/HTTPS for the Load Balancer
  Value: !Ref ThreeTierSecurityGroup

ThreeTierDBSecurityGroup:
  Description: Security group for the RDS MySQL database that allows access from phpMyAdmin SG only
  Value: !Ref ThreeTierDBSecurityGroup
```

Once you have created that file. Save it and go To AWS CloudFormation

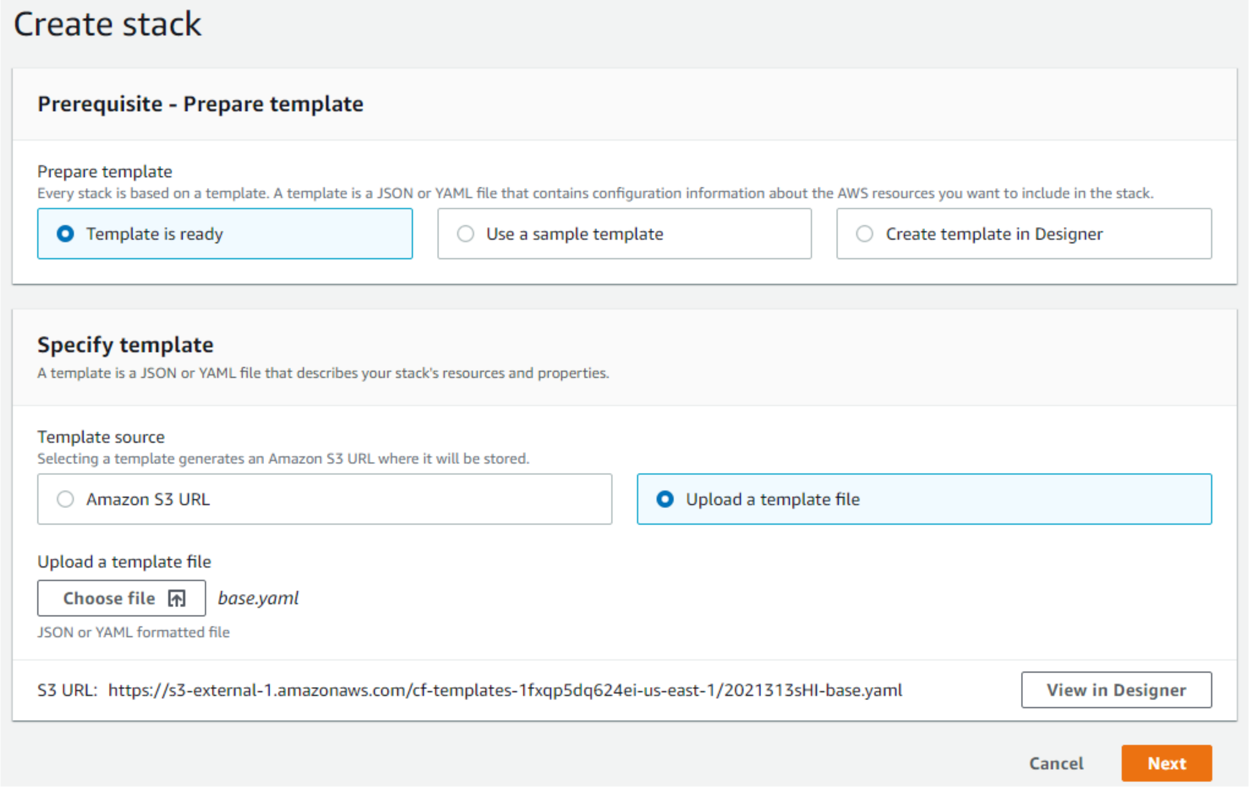
Select Create a Stack



Create a CloudFormation stack

Use your own template or a sample template to quickly get started.

Upload your YAML file that has your CloudFormation template.



Create stack

Prerequisite - Prepare template

Prepare template

Every stack is based on a template. A template is a JSON or YAML file that contains configuration information about the AWS resources you want to include in the stack.

● Template is ready ○ Use a sample template ○ Create template in Designer

Specify template

A template is a JSON or YAML file that describes your stack's resources and properties.

Template source

Selecting a template generates an Amazon S3 URL where it will be stored.

○ Amazon S3 URL ● Upload a template file

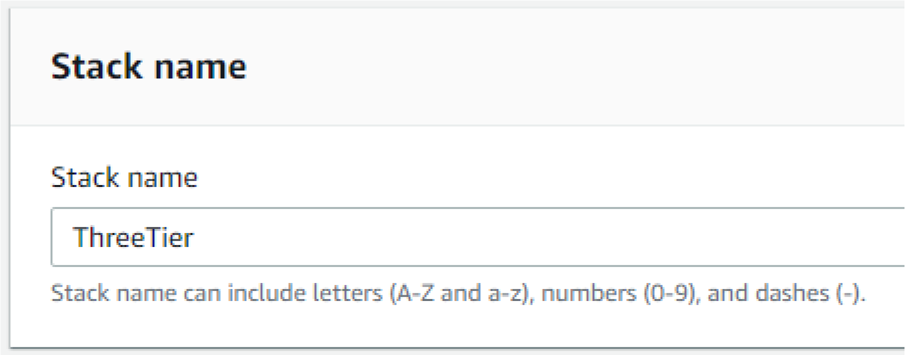
Upload a template file

Choose file *base.yaml*

JSON or YAML formatted file

S3 URL: https://s3-external-1.amazonaws.com/cf-templates-1fxqp5dq624ei-us-east-1/2021313sHI-base.yaml

Select a Stack Name



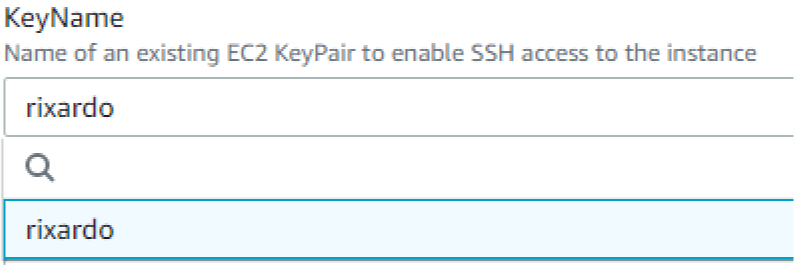
Stack name

Stack name

ThreeTier

Stack name can include letters (A-Z and a-z), numbers (0-9), and dashes (-).

Select your Key Pair that you will use to SSH into the ec2 instances.



KeyName

Name of an existing EC2 KeyPair to enable SSH access to the instance

rixardo

rixardo

Once you have done that, just proceed with default Stack configuration.

We can SSH into the Bastion EC2 instance to make sure everything is working (The publicIPv4 is from the Bastion EC2)

```
ssh -i key.pem ubuntu@publicIPv4
sudo apt-get update && sudo apt-get upgrade -y
```

Once inside that instance, you will need to create a private key that has your key pair that will allow you to SSH into the other instance.

```
nano key.pem
```

Paste the key value inside the file and save it. We will then need to change the permissions of the file

```
chmod 400 key.pem
```

We can SSH into the NGINX EC2 instance to make sure everything is working (The privateIPv4 is from the NGINX EC2)

```
ssh -i key.pem ubuntu@privateIPv4
sudo apt-get update && sudo apt-get upgrade -y
```

Once this EC2 has updated, we can exit it and SSH into the next EC2

```
exit
```

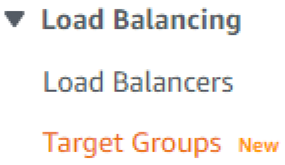
We can SSH into the phpMyAdmin EC2 instance to make sure everything is working (The privateIPv4 is from the phpMyAdmin EC2)

```
ssh -i key.pem ubuntu@privateIPv4
sudo apt-get update && sudo apt-get upgrade -y
```

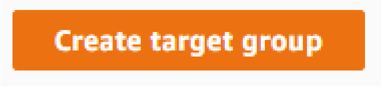
Task 2

Create an AWS Application Load Balancer to connect to your reverse proxy.

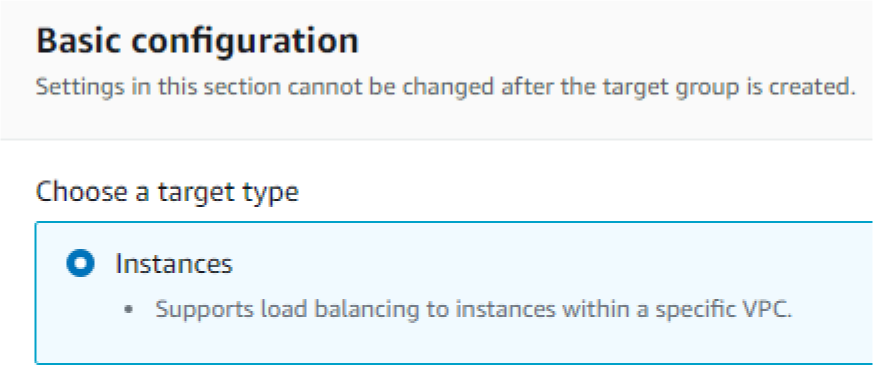
First, we will need to create a Target Group,



Create a target group



For configuration, we will need choose the Instance for target type



Basic configuration

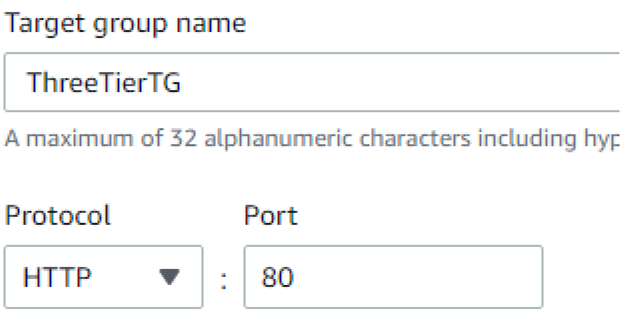
Settings in this section cannot be changed after the target group is created.

Choose a target type

● Instances

- Supports load balancing to instances within a specific VPC.

We then need to name the target group and choose HTTP protocol



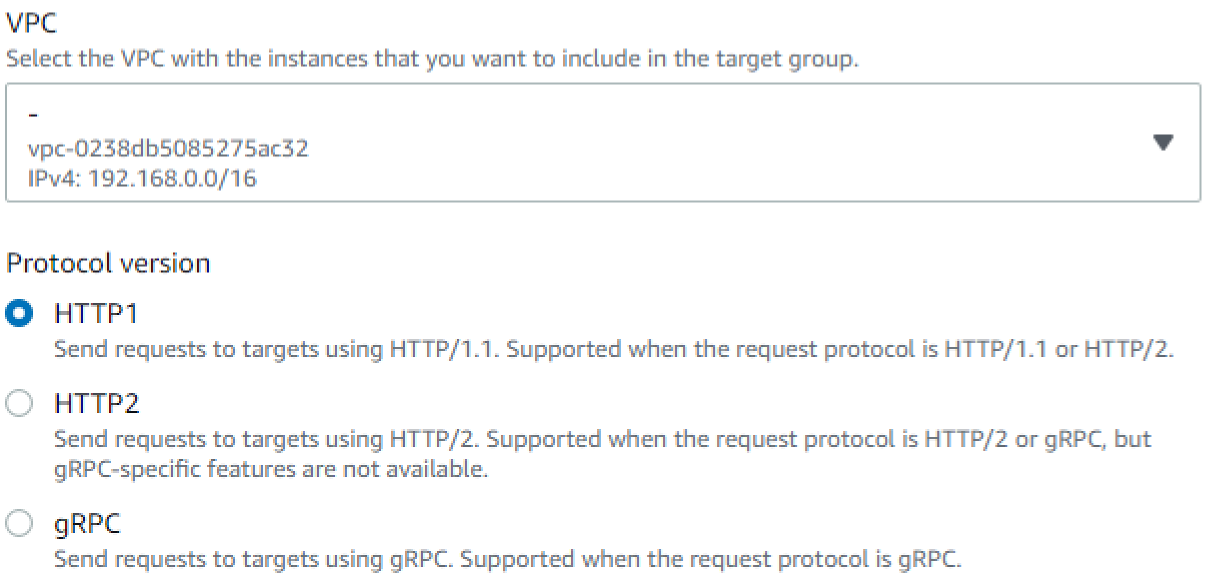
Target group name

ThreeTierTG

A maximum of 32 alphanumeric characters including hyp

Protocol: HTTP ▼ : Port: 80

When we select the VPC, make sure you select the one we created (starts in 192)



VPC

Select the VPC with the instances that you want to include in the target group.

-
vpc-0238db5085275ac32
IPv4: 192.168.0.0/16

Protocol version

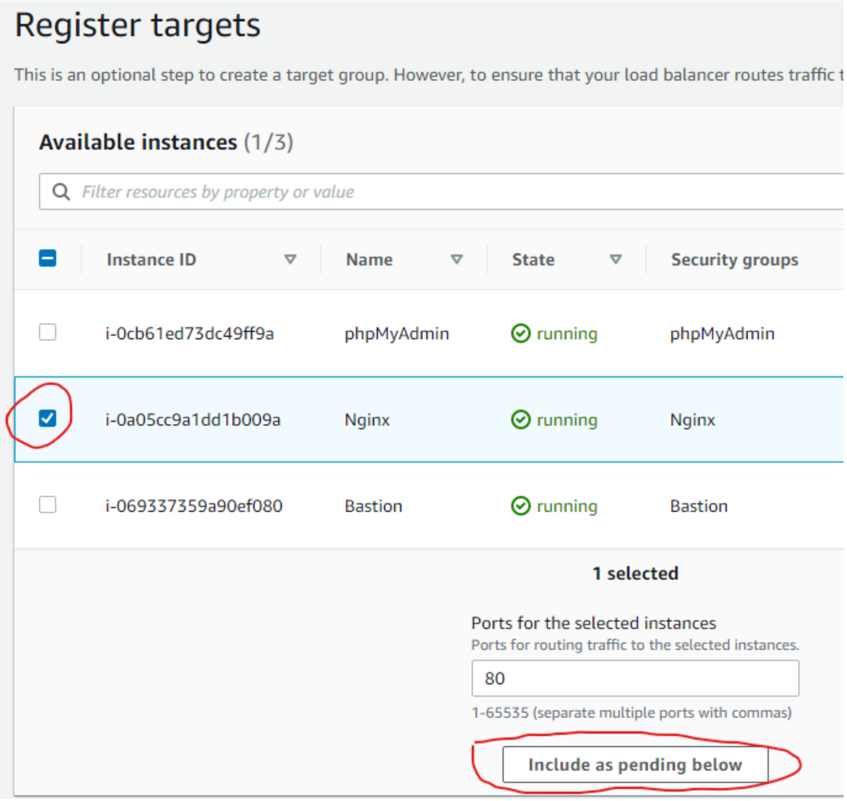
● HTTP1
Send requests to targets using HTTP/1.1. Supported when the request protocol is HTTP/1.1 or HTTP/2.

○ HTTP2
Send requests to targets using HTTP/2. Supported when the request protocol is HTTP/2 or gRPC, but gRPC-specific features are not available.

○ gRPC
Send requests to targets using gRPC. Supported when the request protocol is gRPC.

Leave the defaults and go to the next step.

In the next step, we will need to select the EC2 instance we want to target. This will be the NGINX EC2 that will be our reverse proxy. Once selected, choose include as pending below.



Register targets

This is an optional step to create a target group. However, to ensure that your load balancer routes traffic t

Available instances (1/3)

Filter resources by property or value

⊟	Instance ID	Name	State	Security groups
☐	i-0cb61ed73dc49ff9a	phpMyAdmin	✓ running	phpMyAdmin
☑	i-0a05cc9a1dd1b009a	Nginx	✓ running	Nginx
☐	i-069337359a90ef080	Bastion	✓ running	Bastion

1 selected

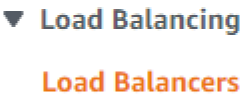
Ports for the selected instances
Ports for routing traffic to the selected instances.

80

1-65535 (separate multiple ports with commas)

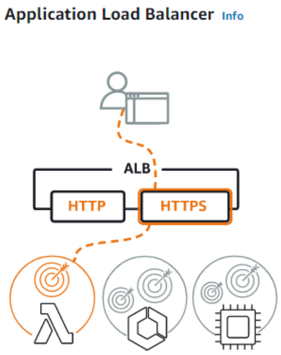
We can then create the target group

We will now need to configure a Load Balancer. Go to Load Balancing

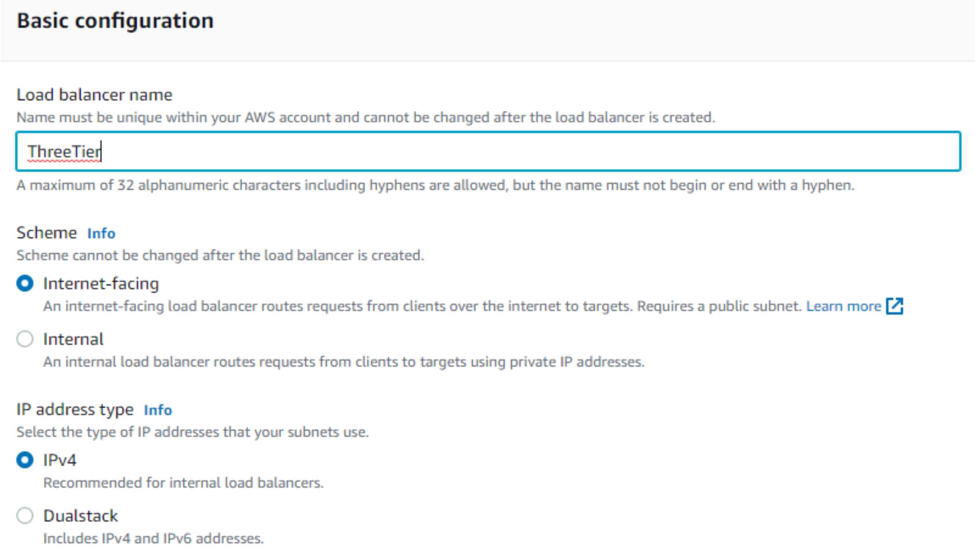


Create a Load Balancer

Select an Application Load Balancer



Name the Load balancer, select Internet facing, and IPv4 as address type.



Basic configuration

Load balancer name

Name must be unique within your AWS account and cannot be changed after the load balancer is created.

ThreeTier

A maximum of 32 alphanumeric characters including hyphens are allowed, but the name must not begin or end with a hyphen.

Scheme Info

Scheme cannot be changed after the load balancer is created.

● Internet-facing
An internet-facing load balancer routes requests from clients over the internet to targets. Requires a public subnet. Learn more

○ Internal
An internal load balancer routes requests from clients to targets using private IP addresses.

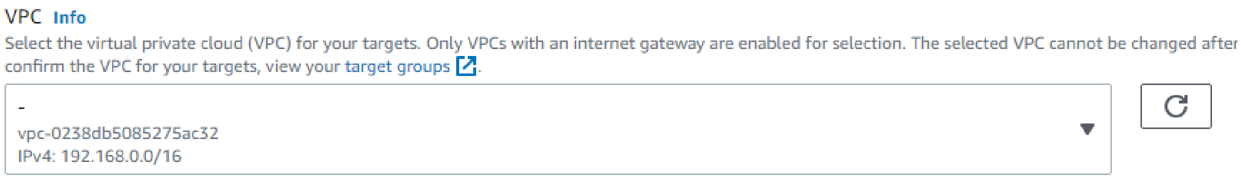
IP address type Info

Select the type of IP addresses that your subnets use.

● IPv4
Recommended for internal load balancers.

○ Dualstack
Includes IPv4 and IPv6 addresses.

For Network mapping, select the VPC that we created (the IPv4 should start with 192)

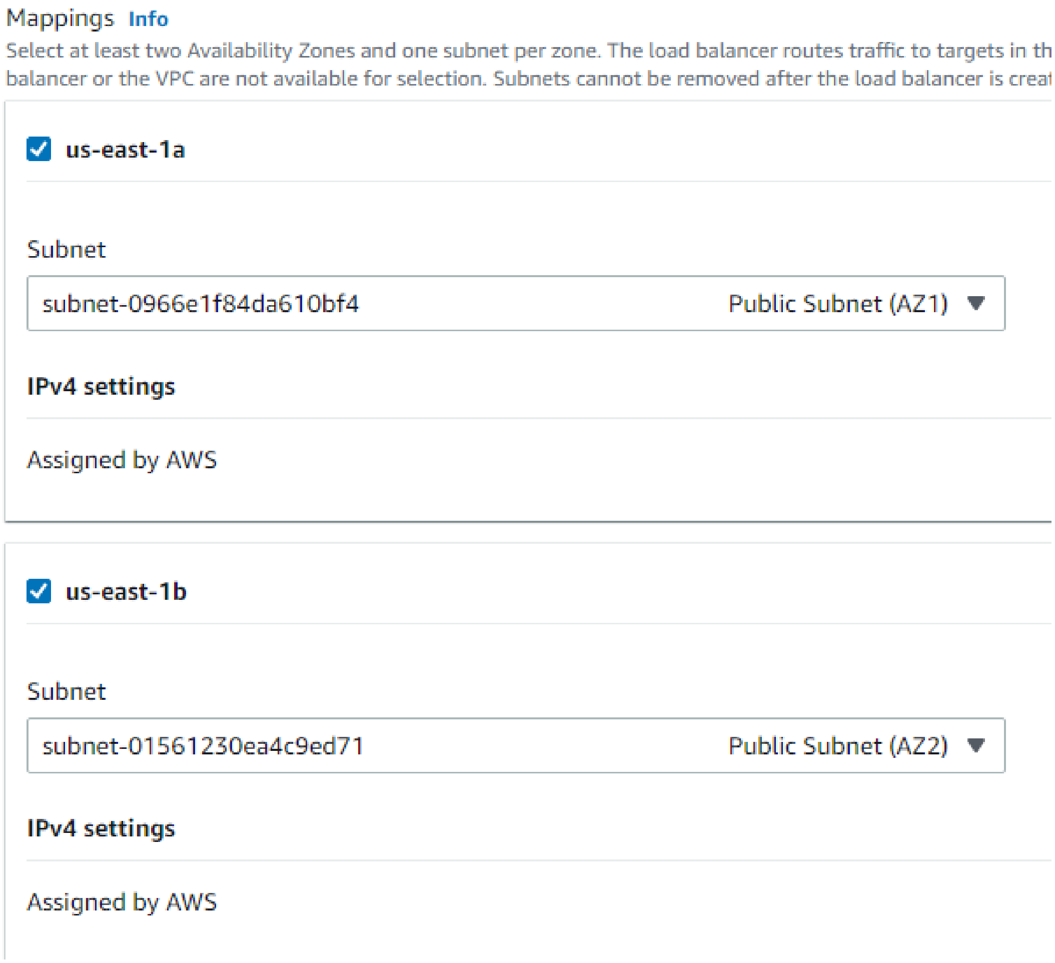


VPC Info

Select the virtual private cloud (VPC) for your targets. Only VPCs with an internet gateway are enabled for selection. The selected VPC cannot be changed after confirm the VPC for your targets, view your target groups.

-
vpc-0238db5085275ac32
IPv4: 192.168.0.0/16

We then need to select two public subnets for the Mapping…



Mappings Info

Select at least two Availability Zones and one subnet per zone. The load balancer routes traffic to targets in th balancer or the VPC are not available for selection. Subnets cannot be removed after the load balancer is creat

☑ us-east-1a

Subnet

subnet-0966e1f84da610bf4 Public Subnet (AZ1)

IPv4 settings

Assigned by AWS

☑ us-east-1b

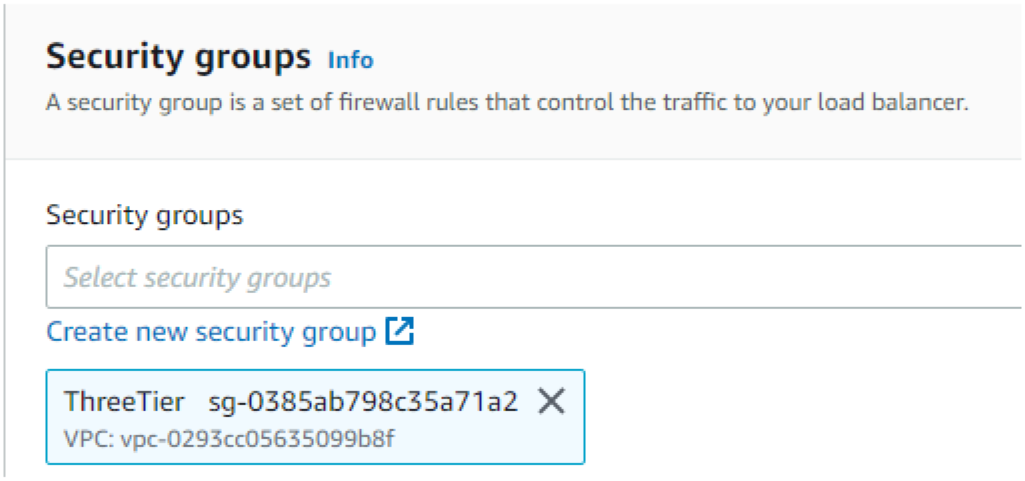
Subnet

subnet-01561230ea4c9ed71 Public Subnet (AZ2)

IPv4 settings

Assigned by AWS

We will need to select the security group that allows HTTP and HTTPS . This was created during the CloudFormation stack creation. It's called "ThreeTier"



Security groups Info

A security group is a set of firewall rules that control the traffic to your load balancer.

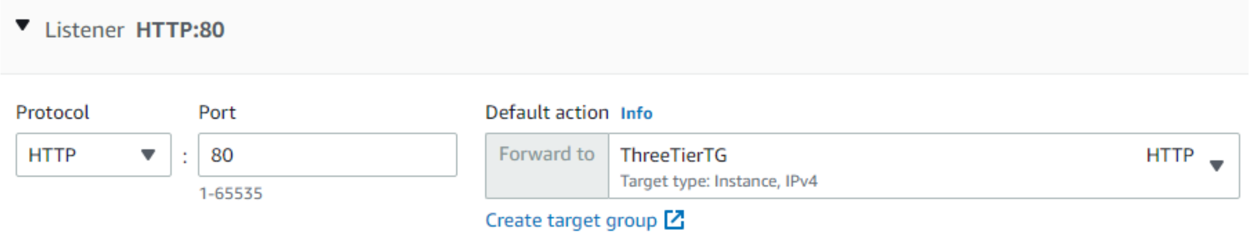
Security groups

Select security groups

Create new security group

ThreeTier sg-0385ab798c35a71a2 ×
VPC: vpc-0293cc05635099b8f

For Listeners and routing, we need to Forward traffic to our Target Group



▼ Listener **HTTP:80**

Protocol: HTTP ▼ : Port: 80
1-65535

Default action Info

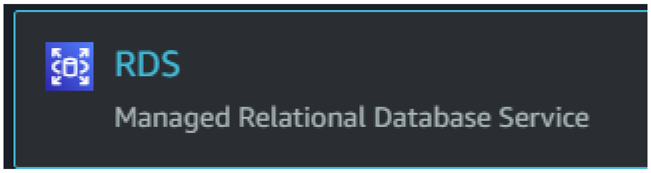
Forward to: ThreeTierTG HTTP ▼
Target type: Instance, IPv4

Create target group

We can then create out load balancer

Task 3

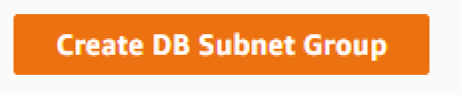
We will now need to create a MYSQL database
Go to AWS RDS



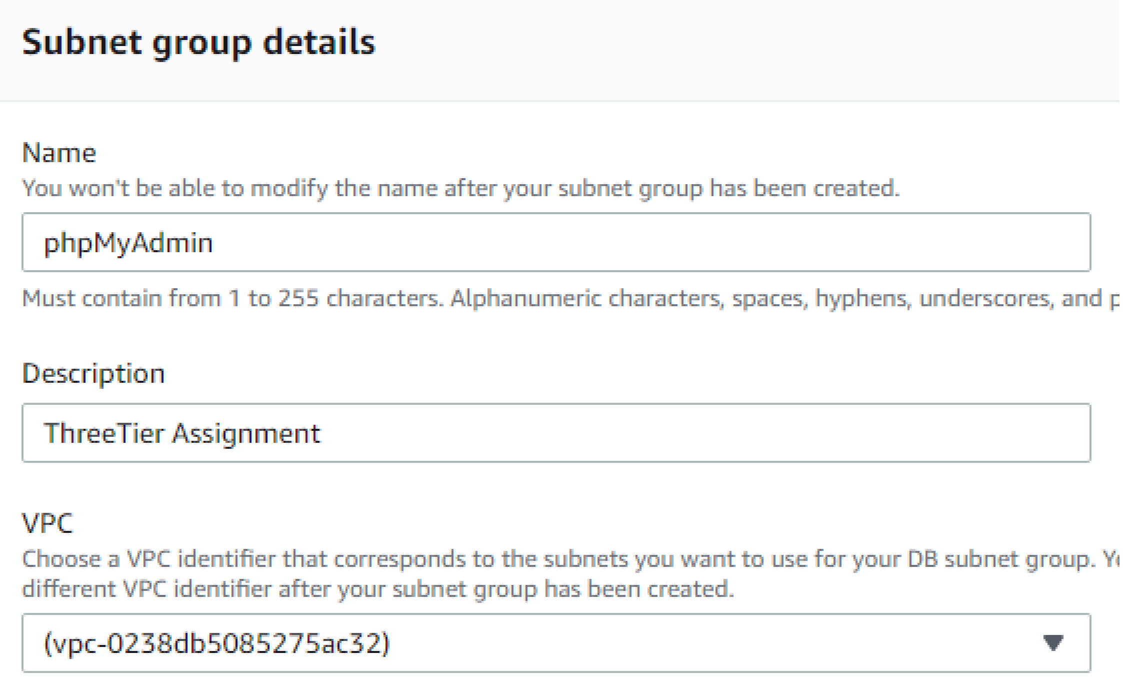
We will need to create a subnet group

Select Subnet Groups in the left

Create a DB Subnet Group



When configuring the Subnet Group, make sure to select the correct VPC that we created. We also need to put a brief name and description



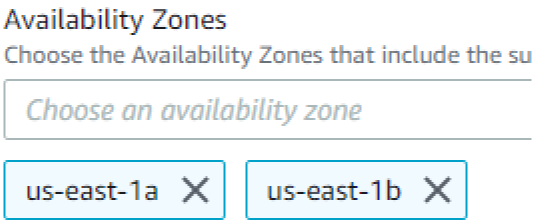
Subnet group details

Name
You won't be able to modify the name after your subnet group has been created.
phpMyAdmin
Must contain from 1 to 255 characters. Alphanumeric characters, spaces, hyphens, underscores, and p

Description
ThreeTier Assignment

VPC
Choose a VPC identifier that corresponds to the subnets you want to use for your DB subnet group. Y
different VPC identifier after your subnet group has been created.
(vpc-0238db5085275ac32)

For the next step, we will need to add subnets. Select 2 availability zones us-east-1a, and us-east-1b.



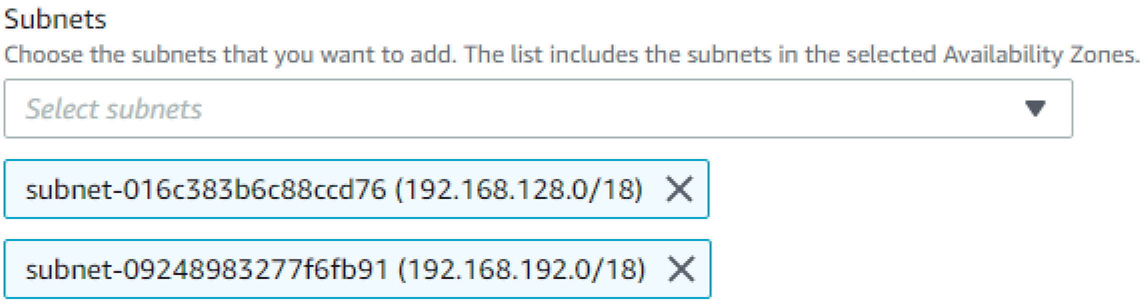
Availability Zones

Choose the Availability Zones that include the su

Choose an availability zone

us-east-1a ✕ us-east-1b ✕

We then need to select two PRIVATE Subnets (You can find the private subnet IP ranges inside AWS VPC service -> Subnet Association)



Subnets

Choose the subnets that you want to add. The list includes the subnets in the selected Availability Zones.

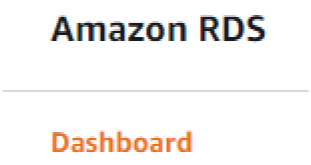
Select subnets ▼

subnet-016c383b6c88ccd76 (192.168.128.0/18) ✕

subnet-09248983277f6fb91 (192.168.192.0/18) ✕

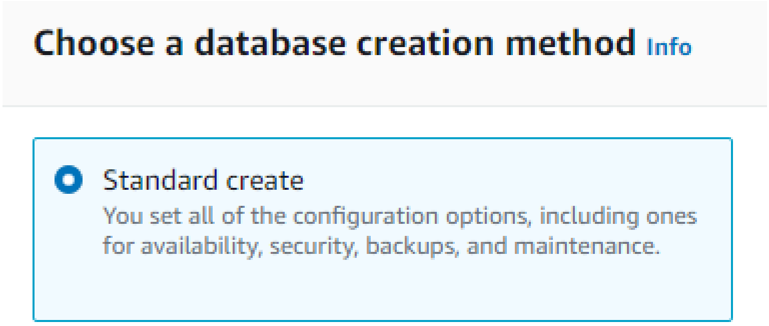
Once we configured the Subnet Group, we can create it.

We can now create our database. Go back to the Dashboard



Create a database

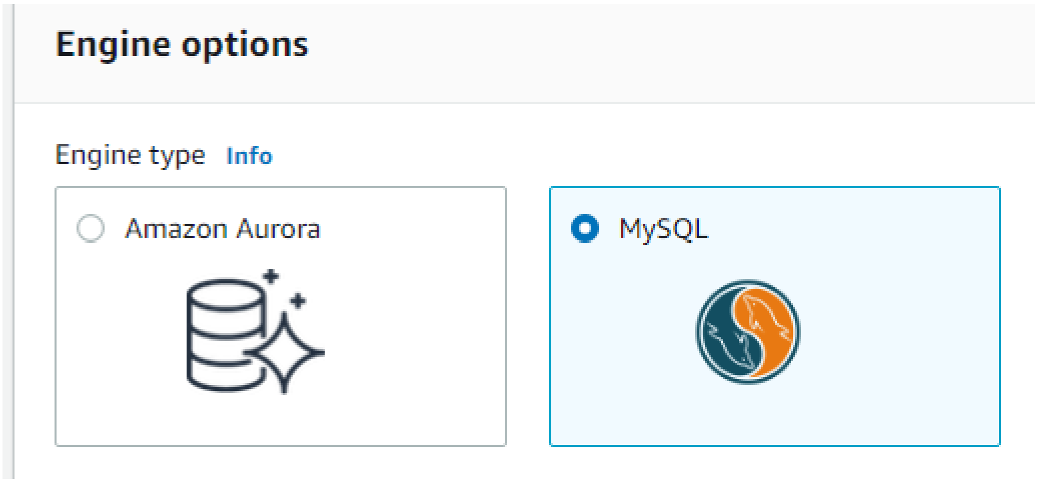
The creation method should be standard



Choose a database creation method Info

● Standard create
You set all of the configuration options, including ones for availability, security, backups, and maintenance.

We will select MySQL as the Engine type



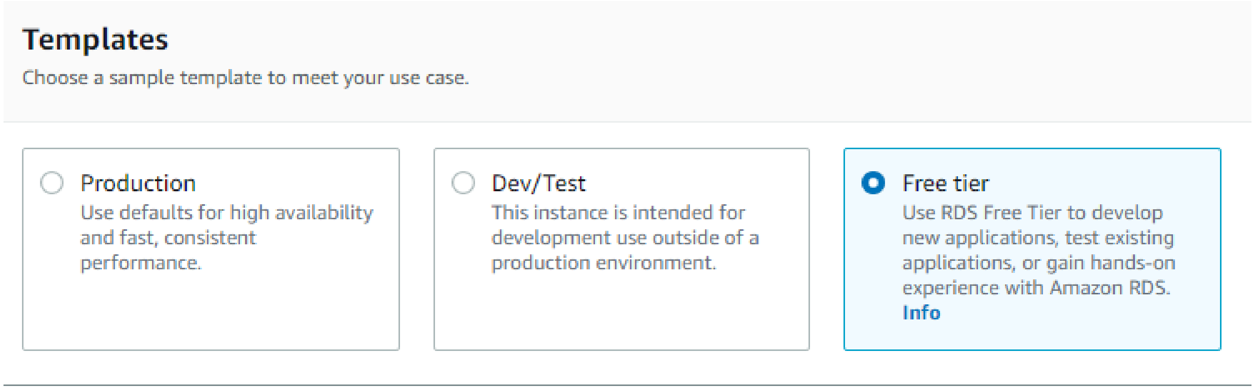
Engine options

Engine type Info

○ Amazon Aurora

● MySQL

It is important to select Free Tier



Templates

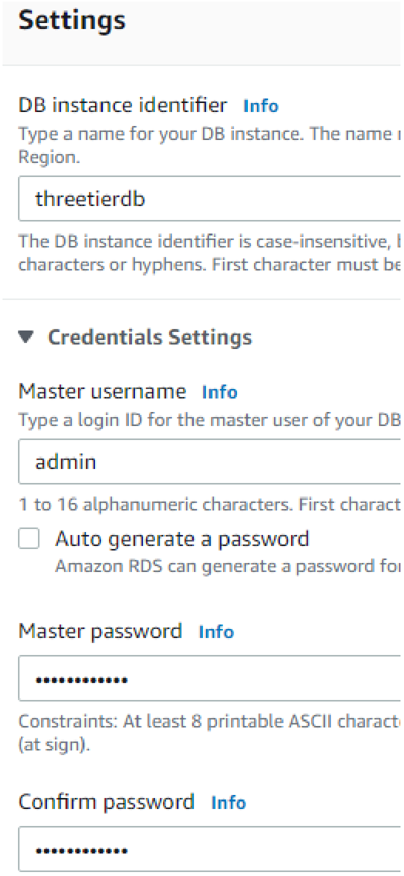
Choose a sample template to meet your use case.

○ Production
Use defaults for high availability and fast, consistent performance.

○ Dev/Test
This instance is intended for development use outside of a production environment.

● Free tier
Use RDS Free Tier to develop new applications, test existing applications, or gain hands-on experience with Amazon RDS.
Info

When configuring the database, it is important to write down the password. We can name it and leave the username as admin.



Settings

DB instance identifier Info

Type a name for your DB instance. The name i
Region.

threetierdb

The DB instance identifier is case-insensitive, l
characters or hyphens. First character must be

▼ Credentials Settings

Master username Info

Type a login ID for the master user of your DB

admin

1 to 16 alphanumeric characters. First charact

□ Auto generate a password
Amazon RDS can generate a password for

Master password Info

••••••••••••

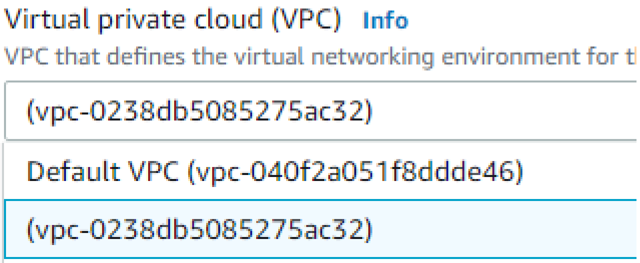
Constraints: At least 8 printable ASCII charact
(at sign).

Confirm password Info

••••••••••••

Password: KuraLabs123$

Scroll down to Connectivity and select the VPC that we created



Virtual private cloud (VPC) Info

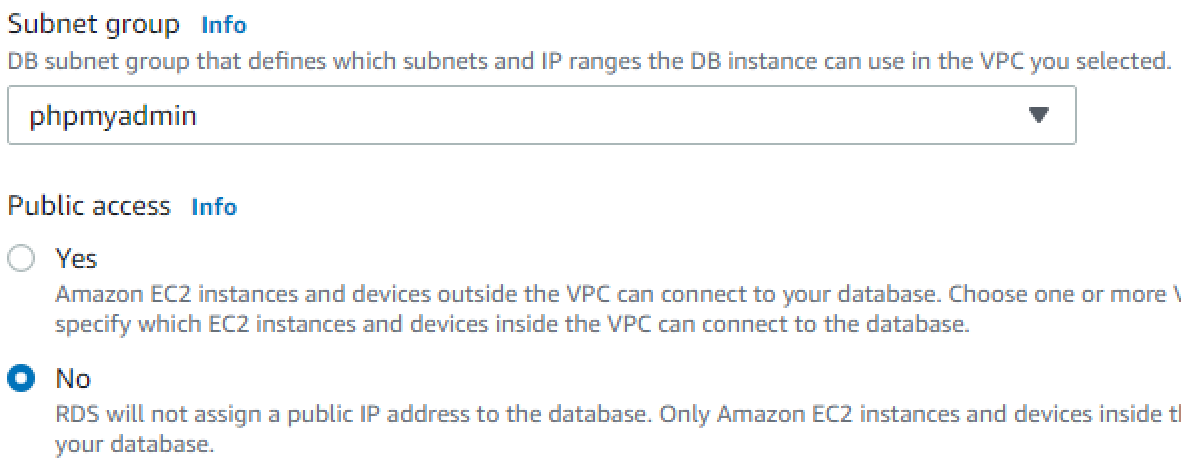
VPC that defines the virtual networking environment for t

(vpc-0238db5085275ac32)

Default VPC (vpc-040f2a051f8ddde46)

(vpc-0238db5085275ac32)

Select the Subnet Group that we created



Subnet group Info

DB subnet group that defines which subnets and IP ranges the DB instance can use in the VPC you selected.

phpmyadmin ▼

Public access Info

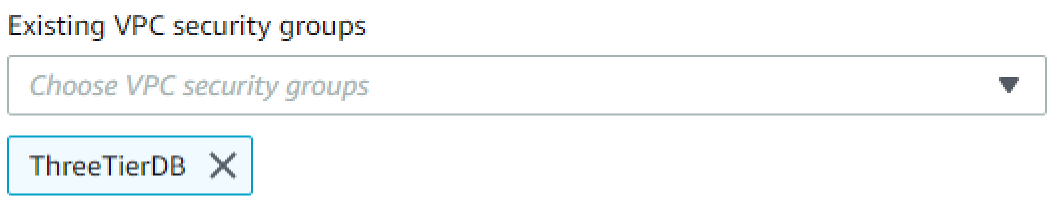
○ Yes

Amazon EC2 instances and devices outside the VPC can connect to your database. Choose one or more \ specify which EC2 instances and devices inside the VPC can connect to the database.

● No

RDS will not assign a public IP address to the database. Only Amazon EC2 instances and devices inside tl your database.

We will need to select the Security Group for the database that was created in CloudFormation.

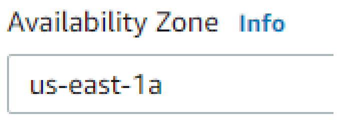


Existing VPC security groups

Choose VPC security groups ▼

ThreeTierDB ✕

We then need to select an Availability Zone



Availability Zone Info

us-east-1a

We can leave everything else default and create the database

This will take a couple of minutes to create, you can move on to the next task

Task 4

We will need to set up phpMyAdmin on our EC2 and connect to our MySQL database

Connect to your phpMyAdmin EC2 instance
ssh into the bastion EC2 -> ssh into the phpMyAdmin EC2

Run the following command

```
sudo apt-get update && sudo apt-get upgrade -y
```

Download apache2

```
sudo apt-get install apache2 -y
```

Install PHP and module that will have php connect with apache and php connect to mysql server.

```
sudo apt install php libapache2-mod-php php-mysql -y
```

We will need to check that our PHP is working
We need to change directory to where apache host web pages

```
cd /var/www/html
```

Create a PHP file

```
sudo nano test.php
```

Paste the following into the file and save it

```
<?php phpinfo();
```

Install MySQL server

```
sudo apt install mysql-server -y
```

Run the basic MYSQL installation

```
sudo mysql_secure_installation
Y
1
Password for root user mysql: same as rds database KuraLabs123$
Y
<ENTERKEY>
<ENTERKEY>
<ENTERKEY>
<ENTERKEY>
```

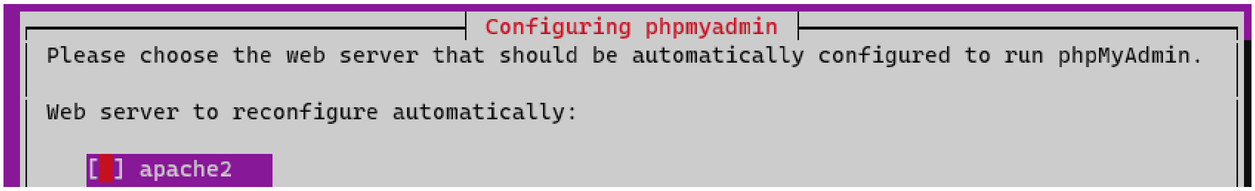
Enter into the interactive shell of mysql to check if installation was successful.
sudo mysql

Enter the following command inside the interactive shell
show databases;

Exit the interactive shell
exit

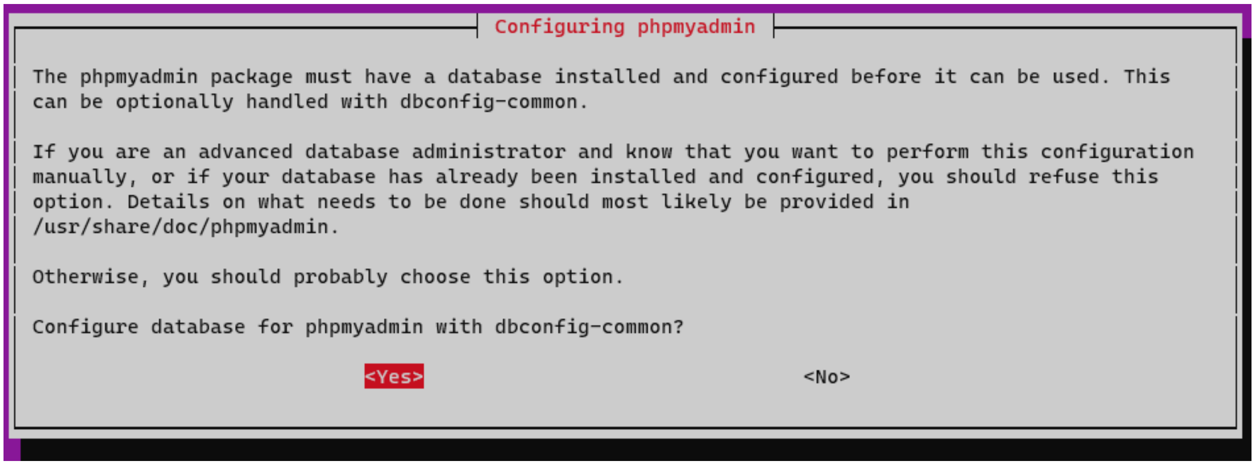
We will need to download some other necessary packages
sudo apt install phpmyadmin php-mbstring php-zip php-gd php-json php-curl -y

When a prompt comes up, select apache2



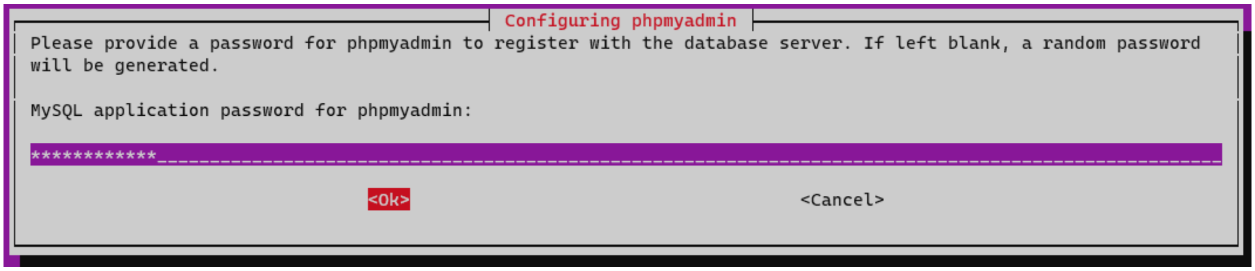
```
Configuring phpmyadmin
Please choose the web server that should be automatically configured to run phpMyAdmin.

Web server to reconfigure automatically:

    [ ] apache2
```

When the next prompt comes up, select yes



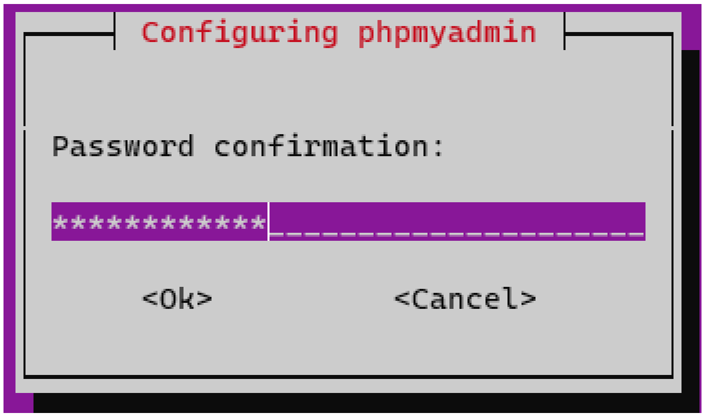
```
Configuring phpmyadmin

The phpmyadmin package must have a database installed and configured before it can be used. This
can be optionally handled with dbconfig-common.

If you are an advanced database administrator and know that you want to perform this configuration
manually, or if your database has already been installed and configured, you should refuse this
option. Details on what needs to be done should most likely be provided in
/usr/share/doc/phpmyadmin.

Otherwise, you should probably choose this option.

Configure database for phpmyadmin with dbconfig-common?

                  <Yes>                              <No>
```

When the next prompt comes, we will have to enter a password. We can use KuraLabs123$ from the database we created



```
Configuring phpmyadmin
Please provide a password for phpmyadmin to register with the database server. If left blank, a random password
will be generated.

MySQL application password for phpmyadmin:

************_____________________________________________________________________________________________________

                        <Ok>                                      <Cancel>
```

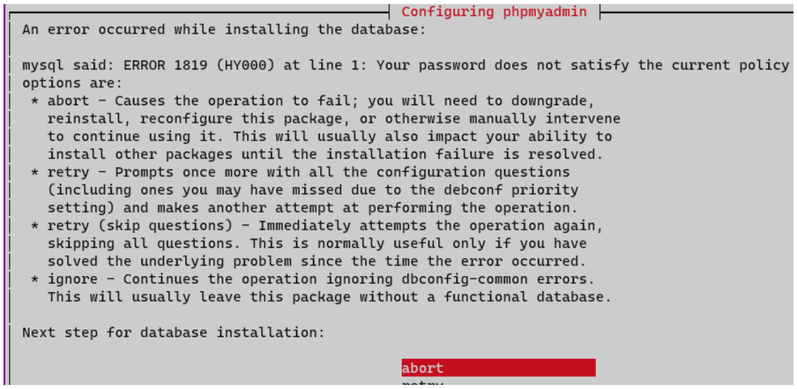
Re-enter the same password



Password confirmation:

****

When the next prompt comes up select ok then choose abort.


```
                                          ┤ Configuring phpmyadmin ├
 An error occurred while installing the database:

 mysql said: ERROR 1819 (HY000) at line 1: Your password does not satisfy the current policy
 options are:
  * abort - Causes the operation to fail; you will need to downgrade,
    reinstall, reconfigure this package, or otherwise manually intervene
    to continue using it. This will usually also impact your ability to
    install other packages until the installation failure is resolved.
  * retry - Prompts once more with all the configuration questions
    (including ones you may have missed due to the debconf priority
    setting) and makes another attempt at performing the operation.
  * retry (skip questions) - Immediately attempts the operation again,
    skipping all questions. This is normally useful only if you have
    solved the underlying problem since the time the error occurred.
  * ignore - Continues the operation ignoring dbconfig-common errors.
    This will usually leave this package without a functional database.

 Next step for database installation:

                                          abort
                                          retry
```

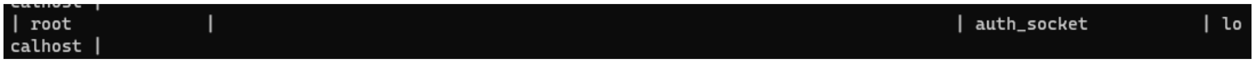
Log back into mysql

sudo mysql

Paste the following inside the MySQL interactive shell

SELECT user,authentication_string,plugin,host FROM mysql.user;

Inside the table, the root should be empty


```
calhost |
| root             |                                                                                | auth_socket           | lo
calhost |
```

Run the following command inside the MySQL interactive shell

UNINSTALL COMPONENT "file://component_validate_password";

We can then run the next command inside the MySQL interactive shell and exit

INSTALL COMPONENT "file://component_validate_password";

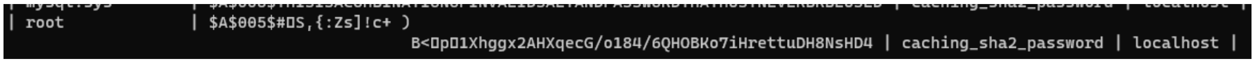
exit

Install the following packages
sudo phpenmod mbstring

Go back into the MySQL
sudo mysql

We can use the following command which will use a hashing algorithm to encrypt our password and store it into the root localhost field.
ALTER USER 'root'@'localhost' IDENTIFIED WITH caching_sha2_password BY 'KuraLabs123$';

We can check if the changes were made using the following command
SELECT user,authentication_string,plugin,host FROM mysql.user;



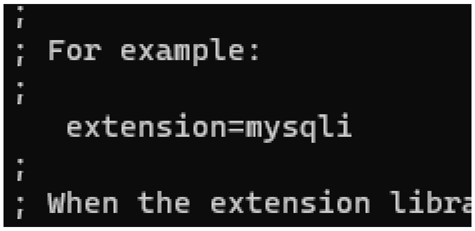
```
| mysql.sys        | $A$005$THISISACOMBINATIONOFINVALIDSALTANDPASSWORDTHATMUSTNEVERBRBEUSED | caching_sha2_password | localhost |
| root             | $A$005$#□S,{:Zs]!c+ )
                                              B<□p□1Xhggx2AHXqecG/o184/6QHOBKo7iHrettuDH8NsHD4 | caching_sha2_password | localhost |
```

Exit the MySQL interactive shell
exit

Change directory to the following
cd /etc/php/7.4/apache2/

We will need to edit a file…
sudo nano php.ini

Inside Nano select ALT + G. This will allow us to go to a line. Go to line 895 and remove the semicolon ;



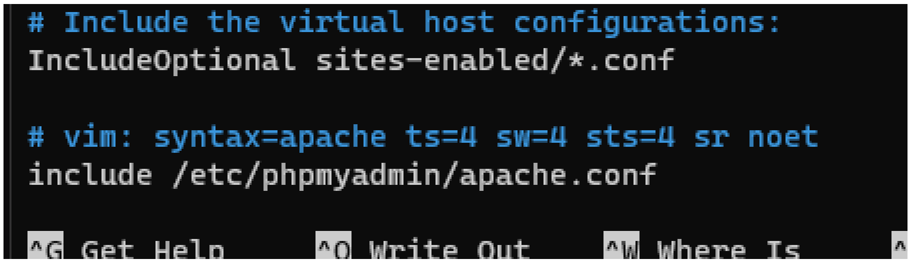
```
;
; For example:
;
   extension=mysqli
;
; When the extension libra
```

Save the file and exit it
CTRL + O
CTRL + X

We will edit the apache2 config file
sudo nano /etc/apache2/apache2.conf

Scroll all the way to the bottom and paste the following

include /etc/phpmyadmin/apache.conf



```
# Include the virtual host configurations:
IncludeOptional sites-enabled/*.conf

# vim: syntax=apache ts=4 sw=4 sts=4 sr noet
include /etc/phpmyadmin/apache.conf
```

Save the file and exit it

CTRL + O

CTRL + X

We will need to restart apache

sudo systemctl restart apache2

The PHP application is the PHMyAdmin that lets us interact with the database.

We will need to connect our MySQL database hosted on AWS to our phpmyadmin

Edit the config file

sudo nano /etc/phpmyadmin/config.inc.php

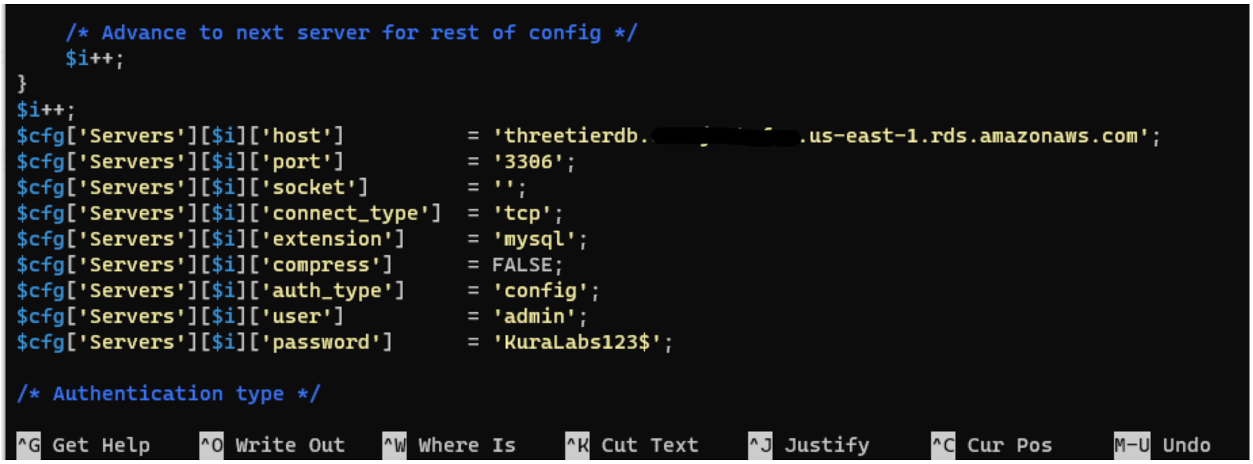
Inside nano select ALT + G. This will allow us to go to a line. Go to line 102 and paste the following below

```
$i++;
$cfg['Servers'][$i]['host']          = '__FILL_IN_DETAILS__';
$cfg['Servers'][$i]['port']          = '3306';
$cfg['Servers'][$i]['socket']        = '';
$cfg['Servers'][$i]['connect_type']  = 'tcp';
$cfg['Servers'][$i]['extension']     = 'mysql';
$cfg['Servers'][$i]['compress']      = FALSE;
$cfg['Servers'][$i]['auth_type']     = 'config';
$cfg['Servers'][$i]['user']          = '__FILL_IN_DETAILS__';
$cfg['Servers'][$i]['password']      = '__FILL_IN_DETAILS__';
```

We will have to enter our information in the lines that read __FILL_IN_DETAILS__

Host is the endpoint URL found on the AWS RDS database we created

Enter the username and password in the user and password line of the code



```
    /* Advance to next server for rest of config */
    $i++;
}
$i++;
$cfg['Servers'][$i]['host']          = 'threetierdb.[redacted].us-east-1.rds.amazonaws.com';
$cfg['Servers'][$i]['port']          = '3306';
$cfg['Servers'][$i]['socket']        = '';
$cfg['Servers'][$i]['connect_type']  = 'tcp';
$cfg['Servers'][$i]['extension']     = 'mysql';
$cfg['Servers'][$i]['compress']      = FALSE;
$cfg['Servers'][$i]['auth_type']     = 'config';
$cfg['Servers'][$i]['user']          = 'admin';
$cfg['Servers'][$i]['password']      = 'KuraLabs123$';

/* Authentication type */
```

We can now test our connection to the new database. We should be able to log into your AWS RDS
curl localhost:80/phpmyadmin/

Restart nginx
sudo systemctl restart apache2

We can now configure the NGINX Proxy. Exit the phpMyAdmin EC2
exit

Connect to your NGINX EC2 instance

ssh into the bastion EC2 -> ssh into the NGINX EC2

Run the following command

sudo apt-get update && sudo apt-get upgrade -y

Install NGINX
sudo apt-get install nginx -y

Change directories to Sites available
sites-available are conf files that tell NGINX where to look for.
cd /etc/nginx/sites-available/

We need to unlink the default sites-enabled file
sudo unlink /etc/nginx/sites-enabled/default
sudo unlink /etc/nginx/sites-enabled/reverse-proxy.conf

Unlinking the reverse-proxy.conf will say there is no file. We need to create a configuration file for the reverse proxy

```
sudo nano reverse-proxy.conf
```

Paste the following inside the reverse-proxy configuration file (The proxy_pass IP is the phpMyAdmin private IPv4)

```
server {
    listen 80;
    location / {
        proxy_pass http://192.168.163.173;
    }
}
```

Save the file and exit it

```
CTRL + O
CTRL + X
```

Check if the following directory is empty

```
ls /etc/nginx/sites-enabled/
```

We will link reverse-proxy to sites enabled so that apache can read it and use it. (ONE LINE COMMAND)

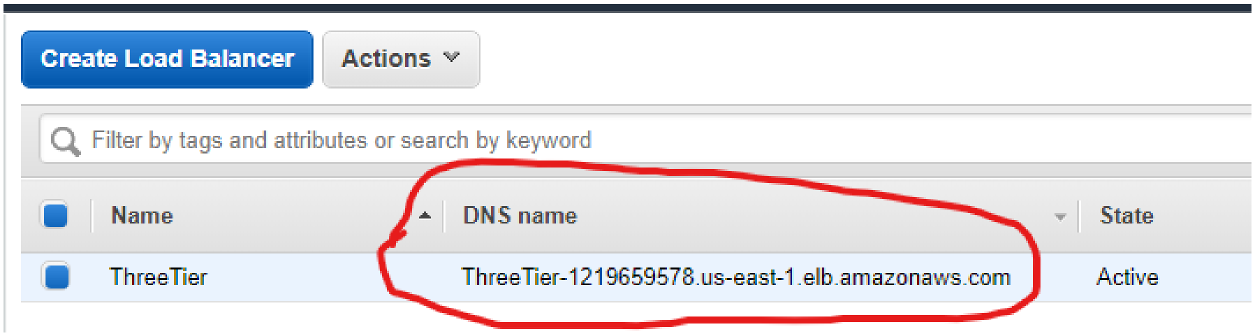
```
sudo ln -s /etc/nginx/sites-available/reverse-proxy.conf /etc/nginx/sites-enabled/reverse-proxy.conf
```

We will need to restart NGINX

```
sudo systemctl restart nginx
```

Task 5

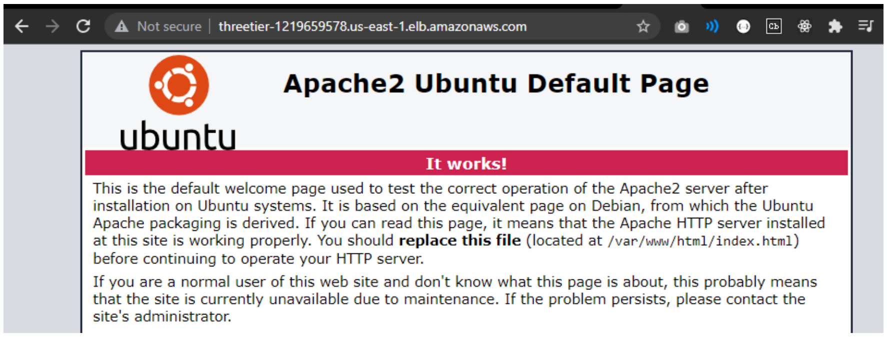
Access your application. Go back to the Load balancer on AWS



Name	DNS name	State
ThreeTier	ThreeTier-1219659578.us-east-1.elb.amazonaws.com	Active

Select the DNS name and paste it into your browser.

You should see an apache2 default page



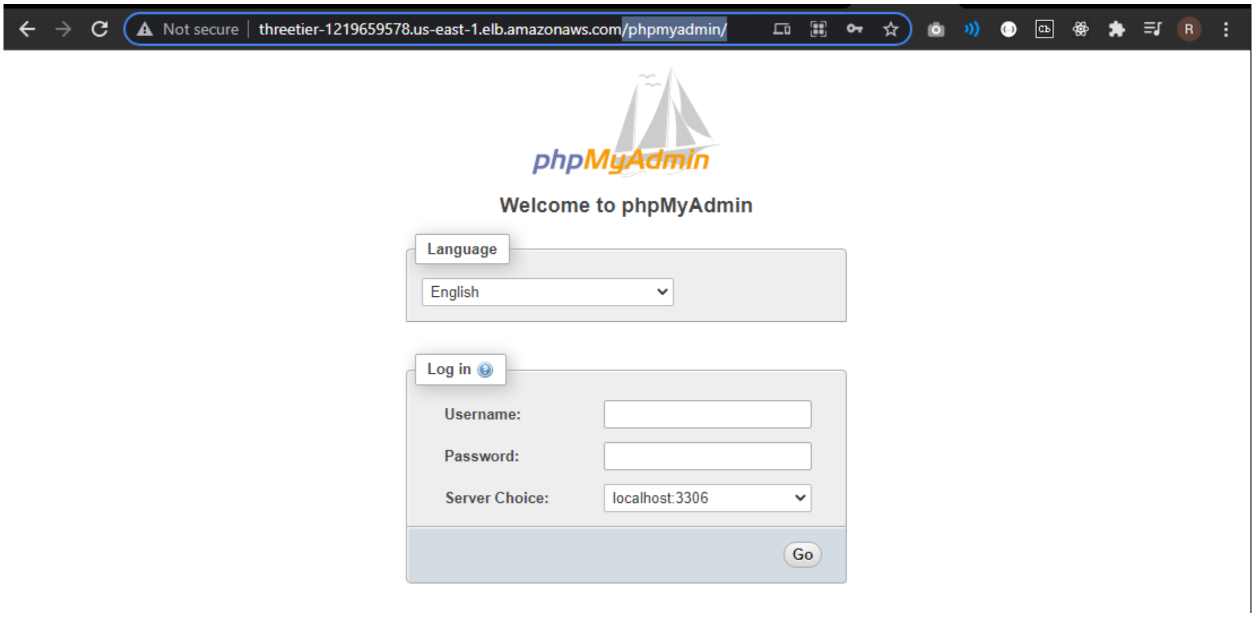
Apache2 Ubuntu Default Page

It works!

This is the default welcome page used to test the correct operation of the Apache2 server after installation on Ubuntu systems. It is based on the equivalent page on Debian, from which the Ubuntu Apache packaging is derived. If you can read this page, it means that the Apache HTTP server installed at this site is working properly. You should **replace this file** (located at `/var/www/html/index.html`) before continuing to operate your HTTP server.

If you are a normal user of this web site and don't know what this page is about, this probably means that the site is currently unavailable due to maintenance. If the problem persists, please contact the site's administrator.

To access our phpMyAdmin application, we will have to put a route in the URL. The format will be http://url/phpmyadmin/.


Not secure
threetier-1219659578.us-east-1.elb.amazonaws.com/phpmyadmin/
phpMyAdmin
Go

Welcome to phpMyAdmin

Language

English

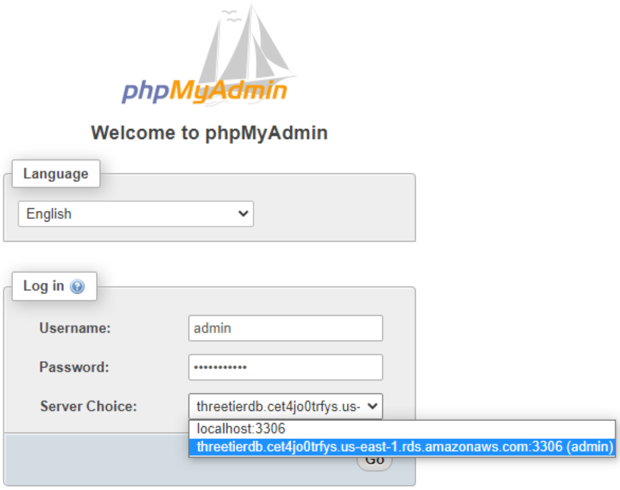
Log in

Username:

Password:

Server Choice: localhost:3306

You will see the RDS has been configured in the server choice.



Welcome to phpMyAdmin

Language: English

Log in

Username: admin

Password: •••••••••••

Server Choice: threetierdb.cet4jo0trfys.us-

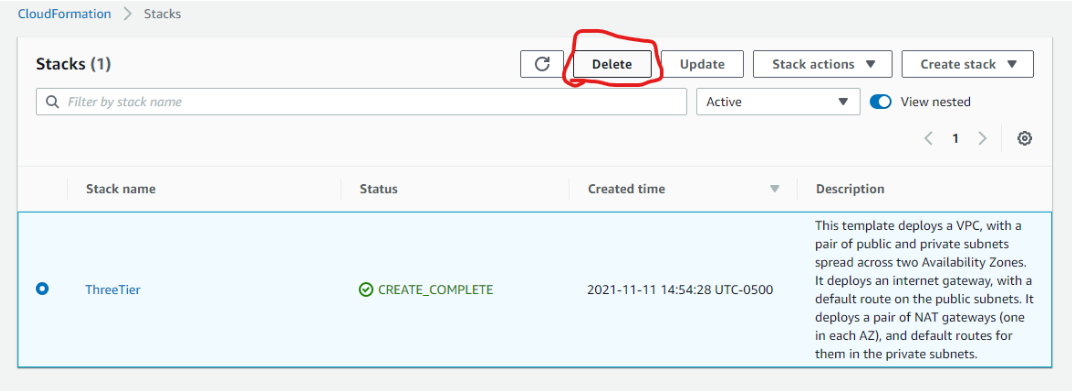
localhost:3306

threetierdb.cet4jo0trfys.us-east-1.rds.amazonaws.com:3306 (admin)

Once you logged into the database and can access it. You have completed the assignment!

Tear Down Time!

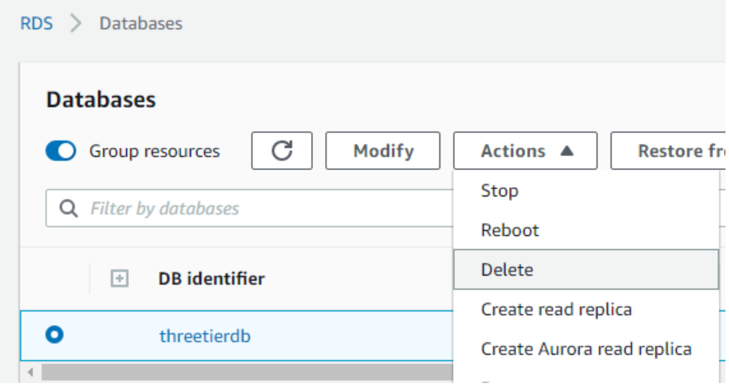
Go back into AWS CloudFormation. Select your Stack and delete it



Stack name	Status	Created time	Description
ThreeTier	CREATE_COMPLETE	2021-11-11 14:54:28 UTC-0500	This template deploys a VPC, with a pair of public and private subnets spread across two Availability Zones. It deploys an internet gateway, with a default route on the public subnets. It deploys a pair of NAT gateways (one in each AZ), and default routes for them in the private subnets.

Delete your Target Group and Load Balancer

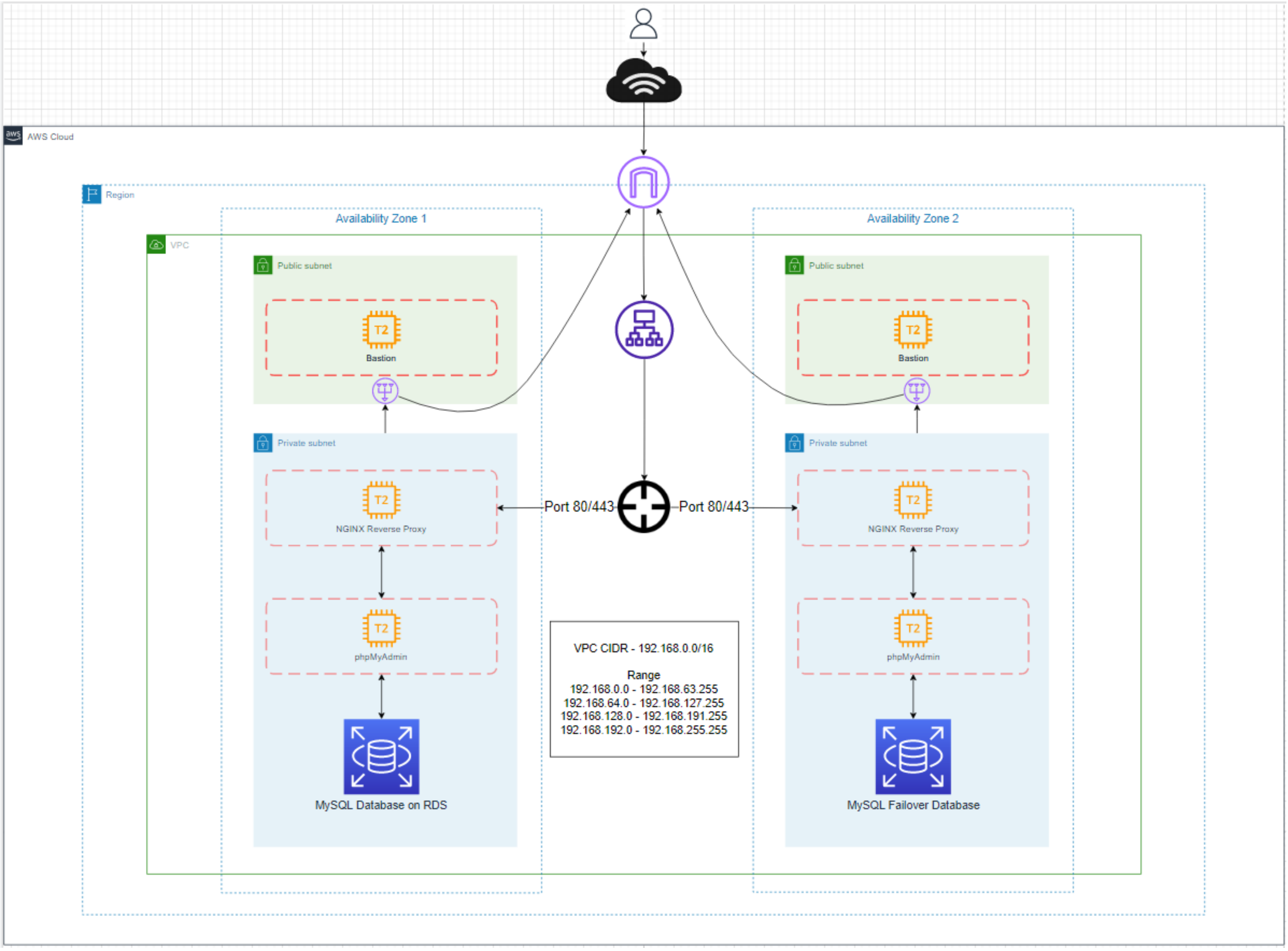
Go into AWS RDS and delete the database that we created (threetierdb)



We can also delete the Subnet Group, phpMyAdmin, that we created once the Database has been deleted.

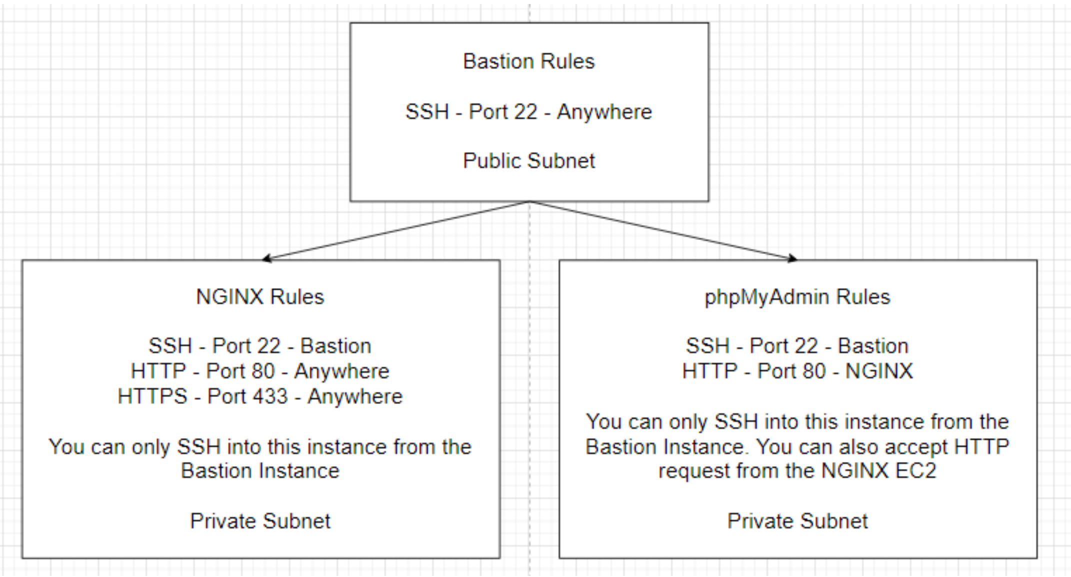
Make sure to check if the CloudFormation stack was deleted after 10minutes.

Topology



VPC CIDR - 192.168.0.0/16

Range
192.168.0.0 - 192.168.63.255
192.168.64.0 - 192.168.127.255
192.168.128.0 - 192.168.191.255
192.168.192.0 - 192.168.255.255


Bastion Rules
SSH - Port 22 - Anywhere
Public Subnet
NGINX Rules
SSH - Port 22 - Bastion
HTTP - Port 80 - Anywhere
HTTPS - Port 433 - Anywhere
You can only SSH into this instance from the Bastion Instance
Private Subnet
phpMyAdmin Rules
SSH - Port 22 - Bastion
HTTP - Port 80 - NGINX
You can only SSH into this instance from the Bastion Instance. You can also accept HTTP request from the NGINX EC2
Private Subnet

The bastion host allows us to get access to a private network from an external network. Bastion hosts are used to mitigate the risk of allowing SSH connections to our main application. This will minimize the chance of penetrating our main application. We can also use monitoring tools to see who accesses our bastion host.

Traffic is then sent through an internet gateway which is then sent to an application load balancer. The load balancer has a target group that will tell where specifically the traffic should be sent. In this case, traffic is sent to the NGINX ec2 Instance. This instance has a reverse proxy which talks to the phpMyAdmin EC2 which has a phpMyAdmin application. The phpMyAdmin application talks to the RDS MySQL database through port 3306 and connection details that were configured.

The NGINX server and phpMyAdmin server reach out to the internet gateway to get updates such as security and application updates. Our architecture needs to be configured using NAT gateways in the public subnets. NAT Gateways allows our instances to access the internet without exposing the instances to incoming connections. If our applications are not updated, the server will be left vulnerable.

Whenever the private subnet instances need to access the internet, it goes to the NAT Gateway which is inside the public subnet. The request is then sent to the internet gateway which accesses the internet.