TELE6420 INFRASTRUCTURE AUTOMATION DESIGN AND TOOLS FINAL PROJECT

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CONTENTS:

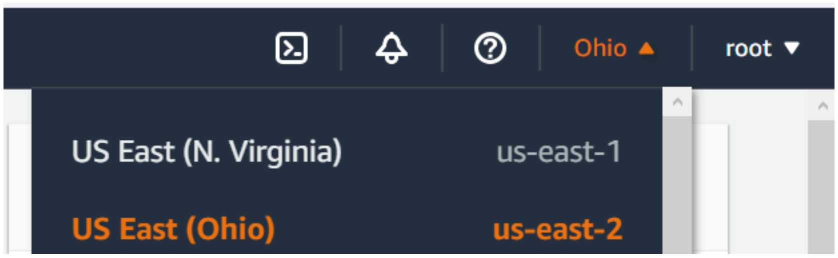
CREDENTIAL AND LINKS:

AWS login link: https://996278926886.signin.aws.amazon.com/console
Iam_user name: proj_prof
Password: Hihello123.
Access Key: AKIA6P5WZ7YTLNXIC7NZ
Shared Access Key: b0tNwe4SooiLswsuIxPPe44ZZWKvyVXxKMkeFU9D
Github: https://github.com/finalprojiadt/iadt
Dockerhub: https://hub.docker.com/repository/docker/projiadt/weeb/general

CODE EXPLANATION:

Region & AZ

```
provider "aws" {
  region = "us-east-2"
}
data "aws_availability_zones" "available" {
  state = "available"
}
```

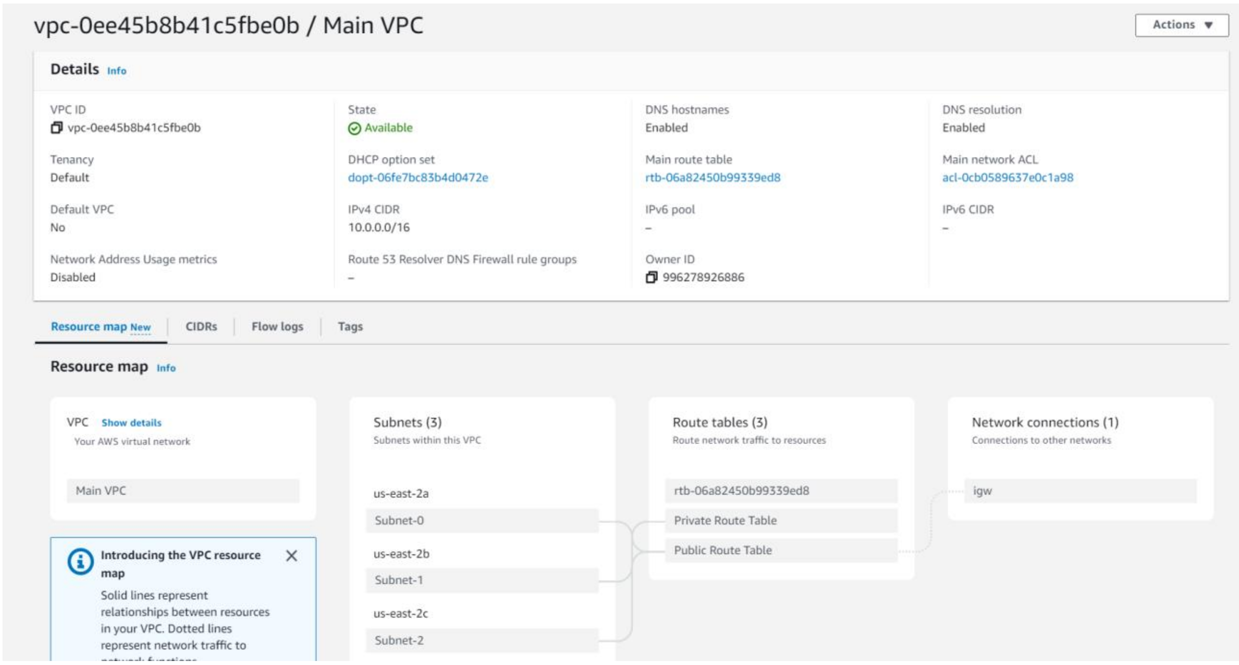


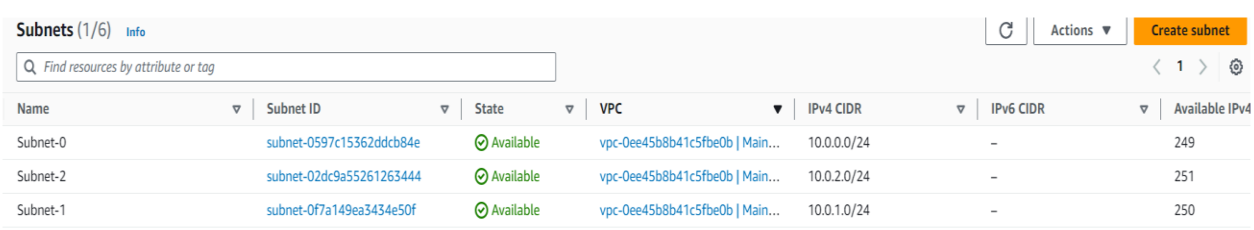
The AWS provider is set up with a specified region of us-east-2. Additionally, to ensure high availability, all the Availability Zones (Az) within that region is used for data retrieval.

VPC

```
# Create VPC
resource "aws_vpc" "main" {
  cidr_block           = "10.0.0.0/16"
  enable_dns_hostnames = true
  enable_dns_support   = true

  tags = {
    Name = "Main VPC"
  }
}
# Create 3 subnets in the VPC
resource "aws_subnet" "subnets" {
  count                   = 3
  vpc_id                  = aws_vpc.main.id
  cidr_block              = "10.0.${count.index}.0/24"
  availability_zone       = element(data.aws_availability_zones.available.names,
count.index)
  map_public_ip_on_launch = count.index < 2 ? true : false

  tags = {
    Name = "Subnet-${count.index}"
  }
}
```

A new VPC named "Main VPC" has been established with a CIDR block of 10.0.0.0/16. This VPC is further segmented into three subnets with CIDR blocks: 10.0.0.0/24, 10.0.1.0/24, and 10.0.2.0/24, distributed across all available zones in us-east-2. The first two subnets are designated as public, meaning they automatically assign public IPs to instances, while the third subnet is private.



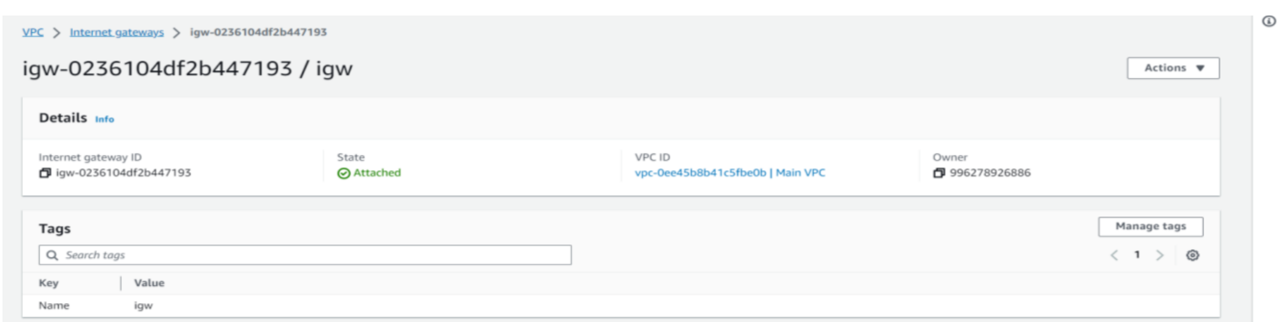


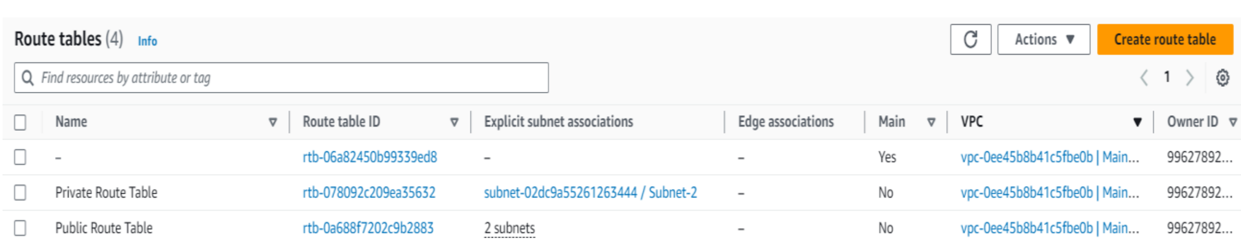
Internet gateway and route table

```
# Create Internet Gateway and attach to VPC
resource "aws_internet_gateway" "igw" {
  vpc_id = aws_vpc.main.id

  tags = {
    Name = "igw"
  }
}
# Create route table and add public route
resource "aws_route_table" "public" {
  vpc_id = aws_vpc.main.id

  route {
```

```
    cidr_block = "0.0.0.0/0"
    gateway_id = aws_internet_gateway.igw.id
  }
  tags = {
    Name = "Public Route Table"
  }
}
resource "aws_route_table" "private" {
  vpc_id = aws_vpc.main.id
  tags = {
    Name = "Private Route Table"
  }
}
resource "aws_route_table_association" "public" {
  count = 2

  subnet_id      = element(aws_subnet.subnets[*].id, count.index)
  route_table_id = aws_route_table.public.id
}
resource "aws_route_table_association" "private" {
  subnet_id      = aws_subnet.subnets[2].id
  route_table_id = aws_route_table.private.id
}
```

To enable instances to access the internet, an internet gateway and a public route table have been set up and associated with the first two subnets. Additionally, there's a private route table designed specifically for the private subnet, ensuring it's intended for internal network access only.

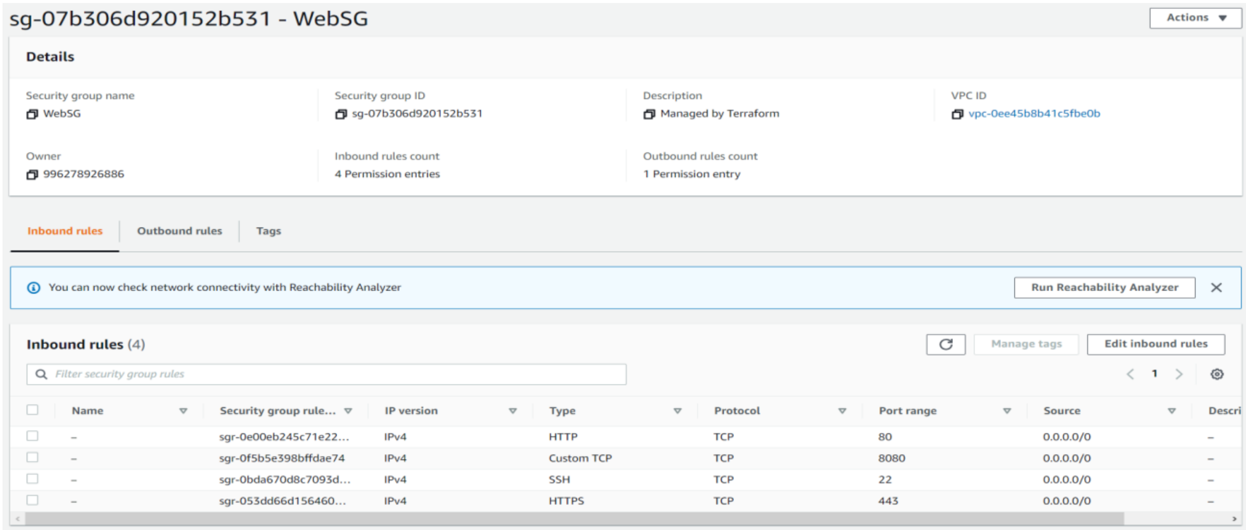




Security group

```
# Create security group for web traffic
resource "aws_security_group" "web" {
  name   = "WebSG"
  vpc_id = aws_vpc.main.id

  # Ingress rules for ports 22, 80, 443, 8080
  ingress {
    from_port   = 22
    to_port     = 22
    protocol    = "tcp"
    cidr_blocks = ["0.0.0.0/0"]
  }

  ingress {
    from_port   = 80
    to_port     = 80
    protocol    = "tcp"
    cidr_blocks = ["0.0.0.0/0"]
  }

  ingress {
    from_port   = 443
    to_port     = 443
    protocol    = "tcp"
    cidr_blocks = ["0.0.0.0/0"]
  }

  ingress {
    from_port   = 8080
    to_port     = 8080
    protocol    = "tcp"
    cidr_blocks = ["0.0.0.0/0"]
  }
   egress {
    from_port   = 0
    to_port     = 0
    protocol    = "-1"
    cidr_blocks = ["0.0.0.0/0"]
  }
}
```

A security group named "WebSG" has been created. This group permits incoming SSH, HTTP, HTTPS, and custom web traffic on port 8080 from any source. Since it's configured for a server that is not expected to initiate outbound traffic, it is set to allow all outgoing traffic by default

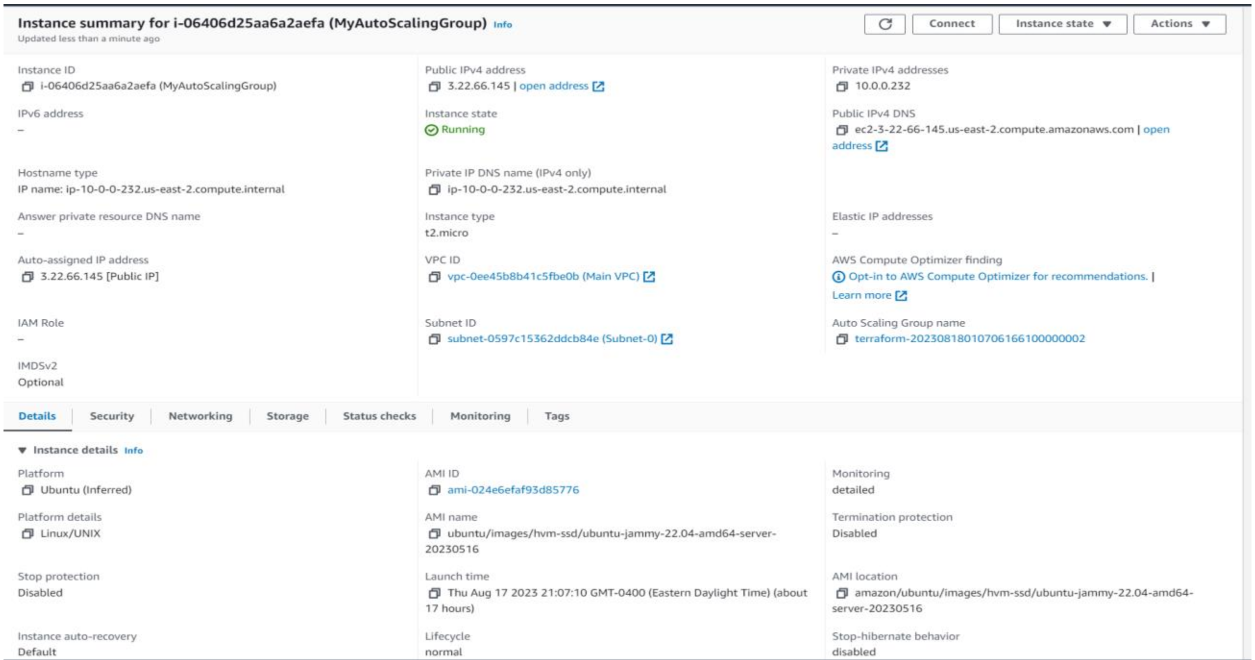


Launch configuration

```
# Create Launch Configuration
resource "aws_launch_configuration" "my_config" {
  name            = "MyLaunchConfig"
  image_id        = "ami-024e6efaf93d85776"
  instance_type = "t2.micro"
  security_groups = [aws_security_group.web.id]

  user_data = <<-EOT
                #!/bin/bash
                sudo snap install docker
                sudo apt install git
                sudo docker pull projiadt/weeb:final
                sudo docker run -d -p 8080:80 projiadt/weeb:final
                sudo docker exec my_container sed -i "/Rohit Wagh/a <p>IP
Address: $(hostname -i)</p>" /usr/src/app/index.html
                sudo wget
https://raw.githubusercontent.com/finalprojiadt/iadt/main/cpu.py
                sudo wget
https://raw.githubusercontent.com/finalprojiadt/iadt/main/mykey.pub
                sudo cat /mykey.pub >> /home/ubuntu/.ssh/authorized_keys
                EOT

  lifecycle {
    create_before_destroy = true
  }
}
```

An EC2 instance is provisioned using the Ubuntu 22.04 image with a "t2.micro" specification and is associated with the "WEBSG" security group. In EC2 user data(boot strap script), we have installed docker and pulled an imager from docker hub and subsequently run, mapping its internal port 80 to

the host's port 8080. Fetched both the CPU utilization code and the local host's public key. This key was then added to the instance's authorized keys, allowing SSH access from the local host. Furthermore, we enabled the create_before_destroy=true setting to ensure immutability."

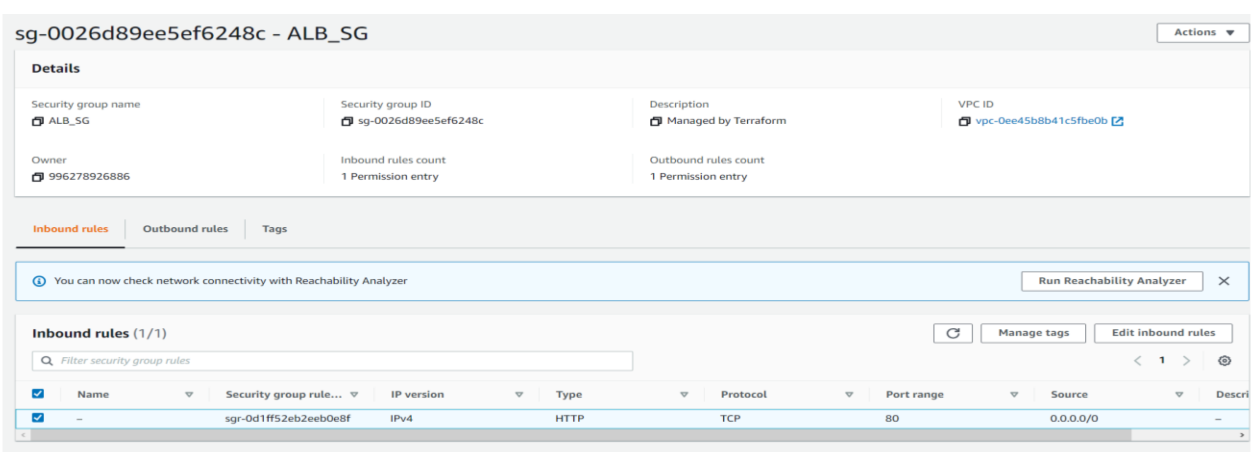


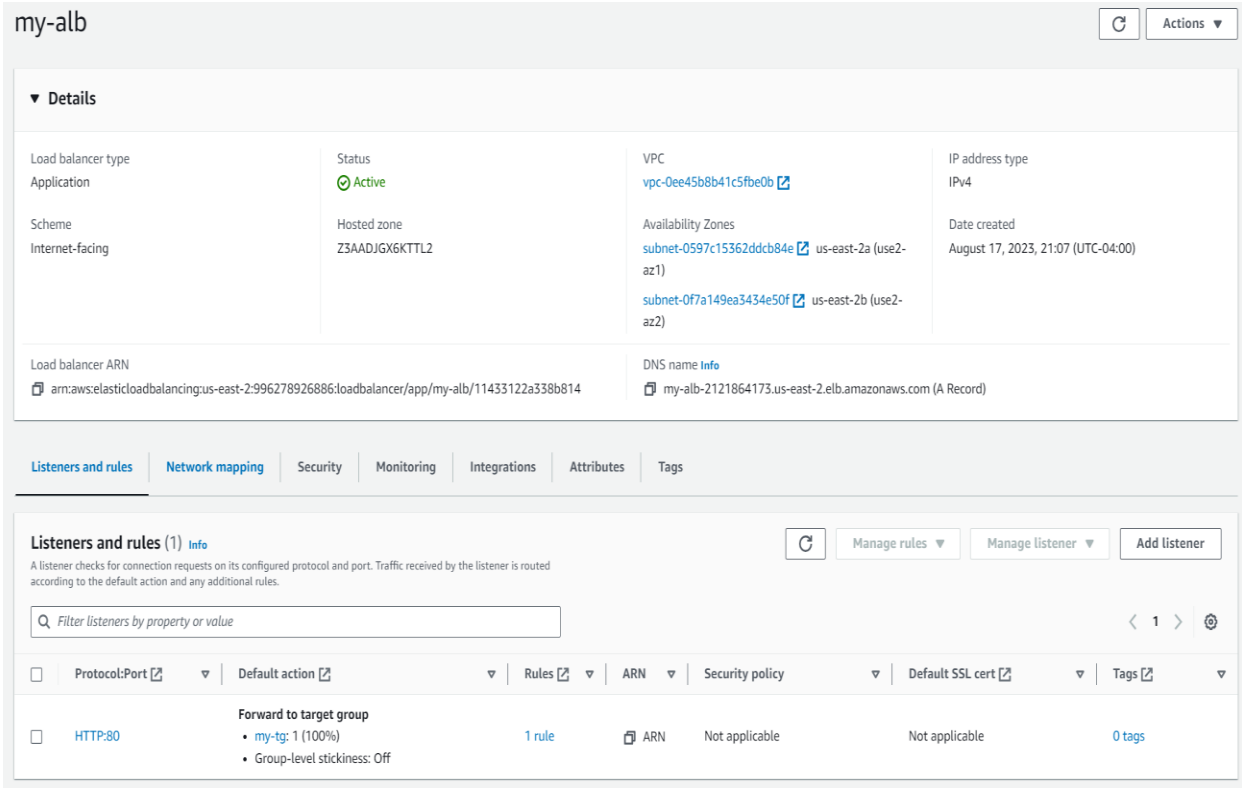
Application Load Balancer

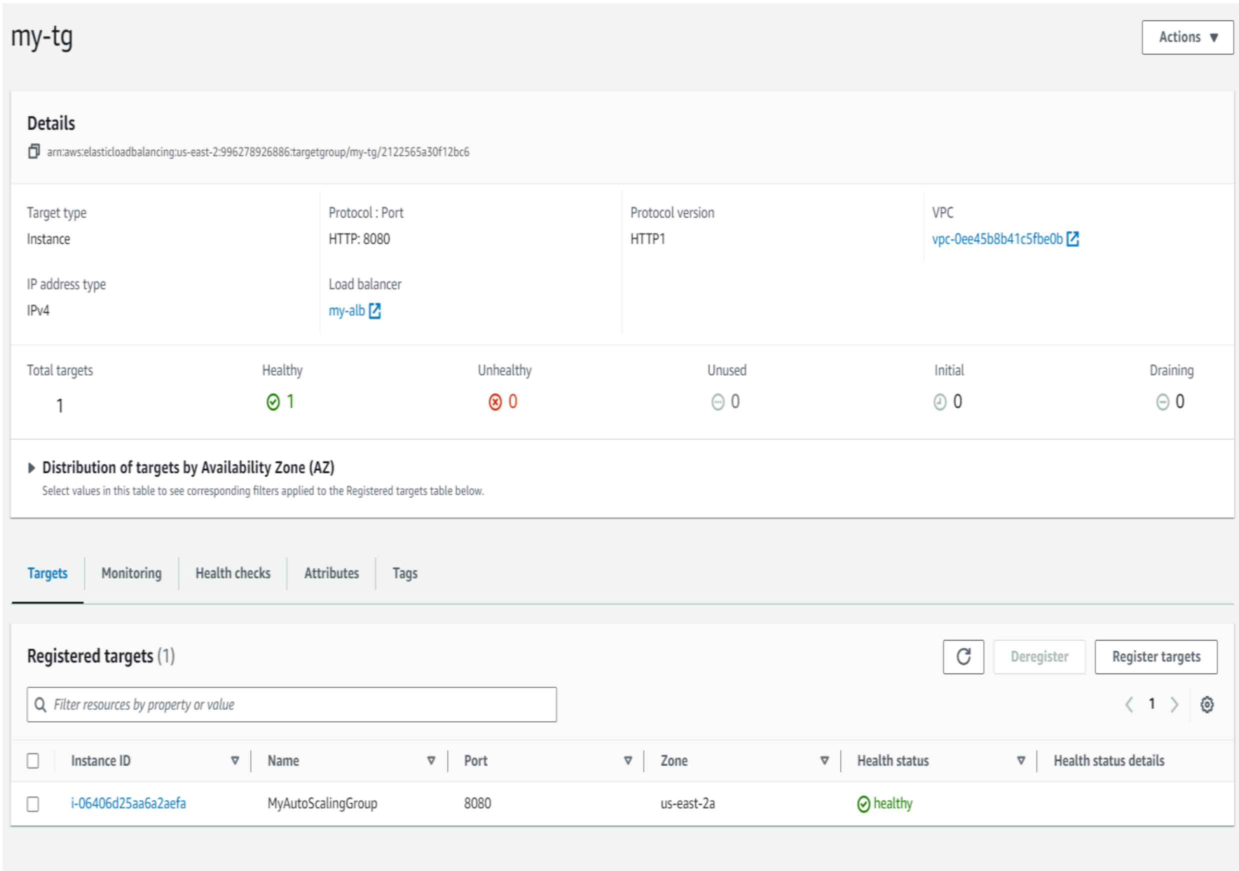
```
# ALB Security Group
resource "aws_security_group" "alb_sg" {
  name   = "ALB_SG"
  vpc_id = aws_vpc.main.id

  ingress {
    from_port   = 80
    to_port     = 80
    protocol    = "tcp"
    cidr_blocks = ["0.0.0.0/0"]
  }

  egress {
    from_port   = 0
    to_port     = 0
    protocol    = "-1"
    cidr_blocks = ["0.0.0.0/0"]
  }
}
```

```
resource "aws_lb" "my_alb" {
  name               = "my-alb"
  internal           = false
  load_balancer_type = "application"
  security_groups    = [aws_security_group.alb_sg.id]
  subnets            = [aws_subnet.subnets[0].id, aws_subnet.subnets[1].id]

  enable_deletion_protection          = false
  enable_cross_zone_load_balancing    = true
}

resource "aws_lb_listener" "front_end" {
  load_balancer_arn = aws_lb.my_alb.arn
  port              = "80"
  protocol          = "HTTP"

  default_action {
    type             = "forward"
    target_group_arn = aws_lb_target_group.my_tg.arn
  }
}

resource "aws_lb_target_group" "my_tg" {
  name     = "my-tg"
  port     = 8080
  protocol = "HTTP"
  vpc_id   = aws_vpc.main.id
}
```

Another security group “aws_security_group”. This group is associated with Application Load Balancer(ALB) which only permits incoming traffic on port 80 and unrestricted outgoing traffic(Least Privilege principle) and configured to operate across two subnets. The ALB listens on port 80 for HTTP traffic and forwards it to a target group named 'my-tg', which expects traffic on port 8080.

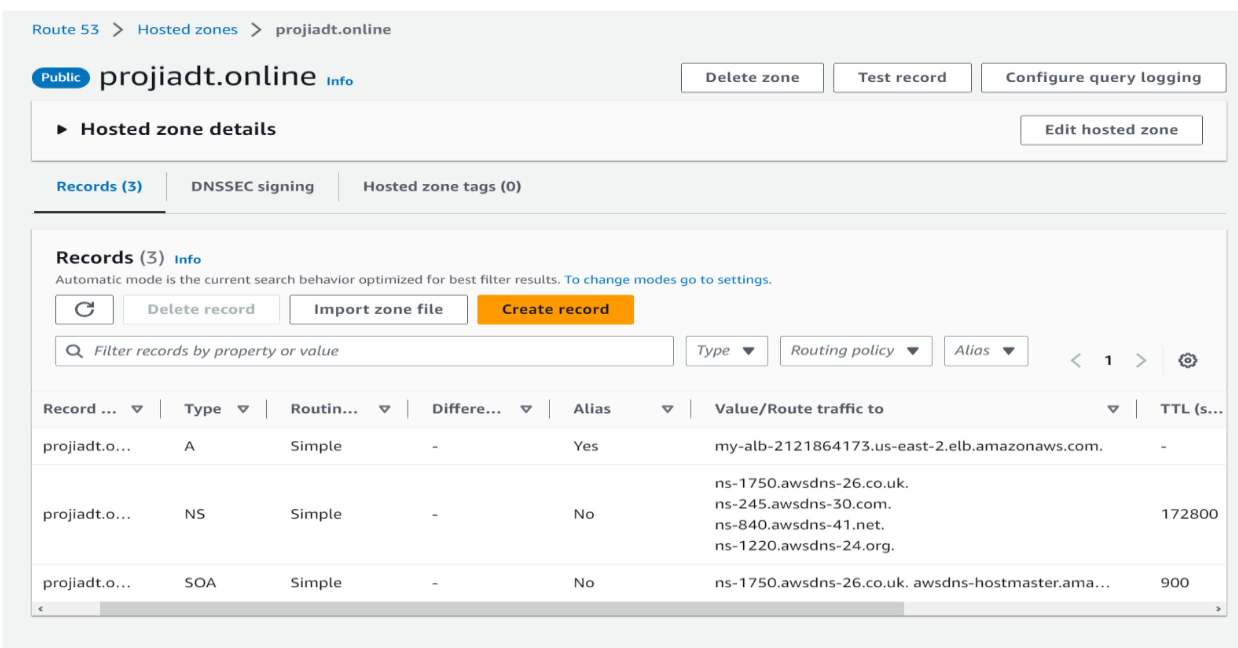



my-alb
Actions
Details
Load balancer type
Application
Status
Active
VPC
vpc-0ee45b8b41c5fbe0b
IP address type
IPv4
Scheme
Internet-facing
Hosted zone
Z3AADJGX6KTTL2
Availability Zones
subnet-0597c15362ddcb84e us-east-2a (use2-az1)
subnet-0f7a149ea3434e50f us-east-2b (use2-az2)
Date created
August 17, 2023, 21:07 (UTC-04:00)
Load balancer ARN
arn:aws:elasticloadbalancing:us-east-2:996278926886:loadbalancer/app/my-alb/11433122a338b814
DNS name Info
my-alb-2121864173.us-east-2.elb.amazonaws.com (A Record)
Listeners and rules
Network mapping
Security
Monitoring
Integrations
Attributes
Tags
Listeners and rules (1) Info
A listener checks for connection requests on its configured protocol and port. Traffic received by the listener is routed according to the default action and any additional rules.
Manage rules
Manage listener
Add listener
Filter listeners by property or value
1
Protocol:Port
Default action
Rules
ARN
Security policy
Default SSL cert
Tags
HTTP:80
Forward to target group
my-tg: 1 (100%)
Group-level stickiness: Off
1 rule
ARN
Not applicable
Not applicable
0 tags



my-tg
Actions
Details
arn:aws:elasticloadbalancing:us-east-2:996278926886:targetgroup/my-tg/2122565a30f12bc6
Target type
Instance
Protocol : Port
HTTP: 8080
Protocol version
HTTP1
VPC
vpc-0ee45b8b41c5fbe0b
IP address type
IPv4
Load balancer
my-alb
Total targets
1
Healthy
1
Unhealthy
0
Unused
0
Initial
0
Draining
0
Distribution of targets by Availability Zone (AZ)
Select values in this table to see corresponding filters applied to the Registered targets table below.
Targets
Monitoring
Health checks
Attributes
Tags
Registered targets (1)
Deregister
Register targets
Filter resources by property or value
Instance ID
Name
Port
Zone
Health status
Health status details
i-06406d25aa6a2aefa
MyAutoScalingGroup
8080
us-east-2a
healthy

ROUTE 53



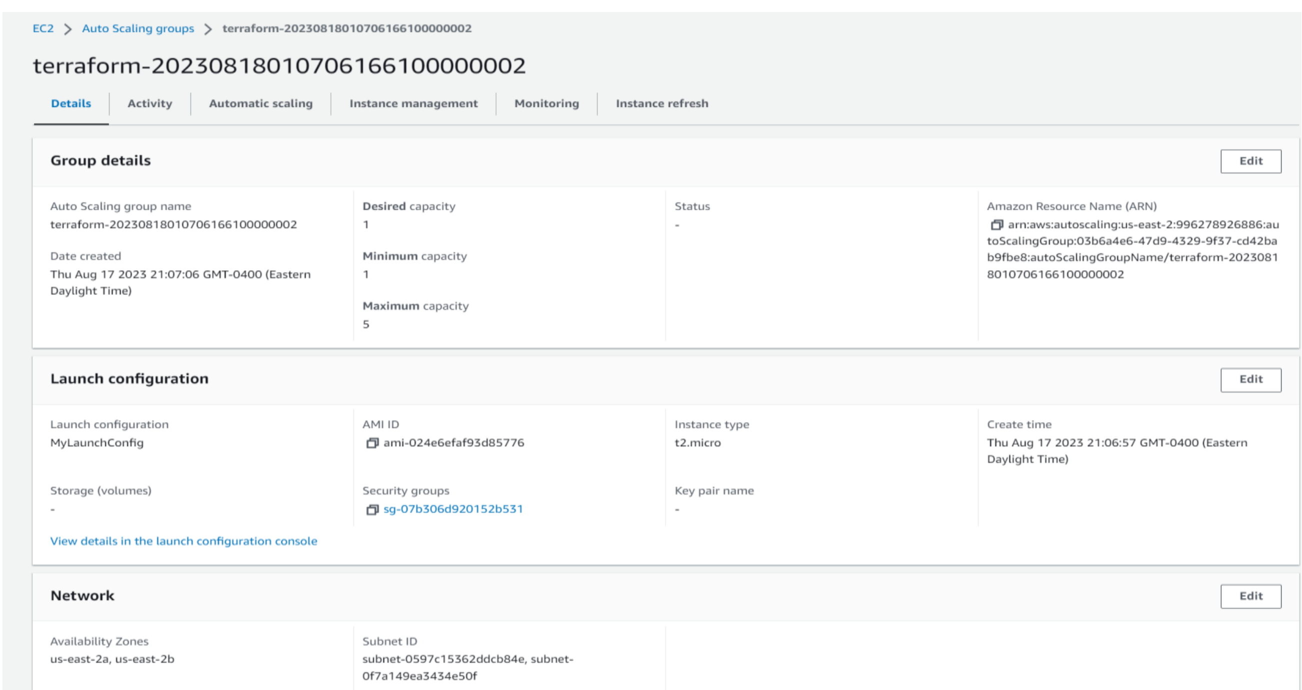
Route 53 > Hosted zones > projiadt.online
Public
projiadt.online
Info
Delete zone
Test record
Configure query logging
Hosted zone details
Edit hosted zone
Records (3)
DNSSEC signing
Hosted zone tags (0)
Records (3) Info
Automatic mode is the current search behavior optimized for best filter results. To change modes go to settings.
Delete record
Import zone file
Create record
Filter records by property or value
Type
Routing policy
Alias
Record ...
Type
Routin...
Differe...
Alias
Value/Route traffic to
TTL (s...
projiadt.o...
A
Simple
-
Yes
my-alb-2121864173.us-east-2.elb.amazonaws.com.
-
projiadt.o...
NS
Simple
-
No
ns-1750.awsdns-26.co.uk.
ns-245.awsdns-30.com.
ns-840.awsdns-41.net.
ns-1220.awsdns-24.org.
172800
projiadt.o...
SOA
Simple
-
No
ns-1750.awsdns-26.co.uk. awsdns-hostmaster.ama...
900

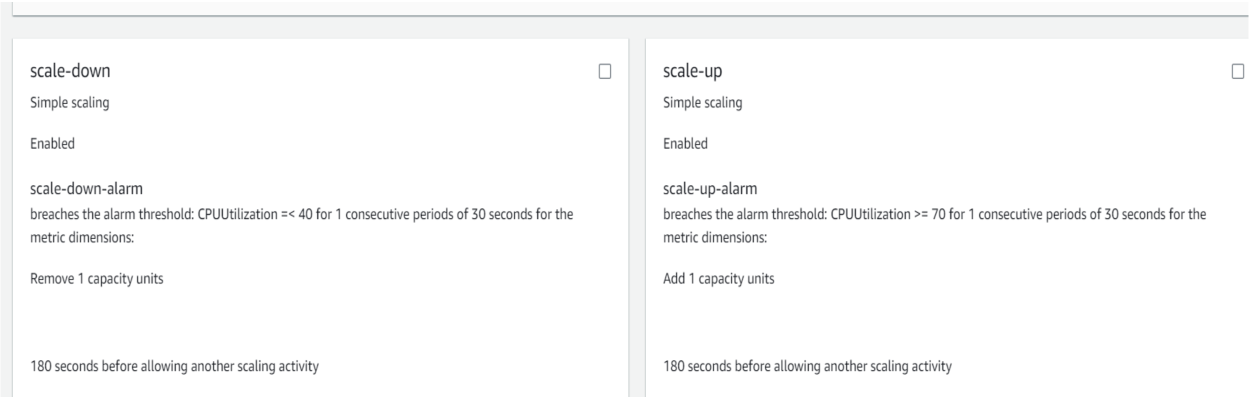
AUTO SCALING

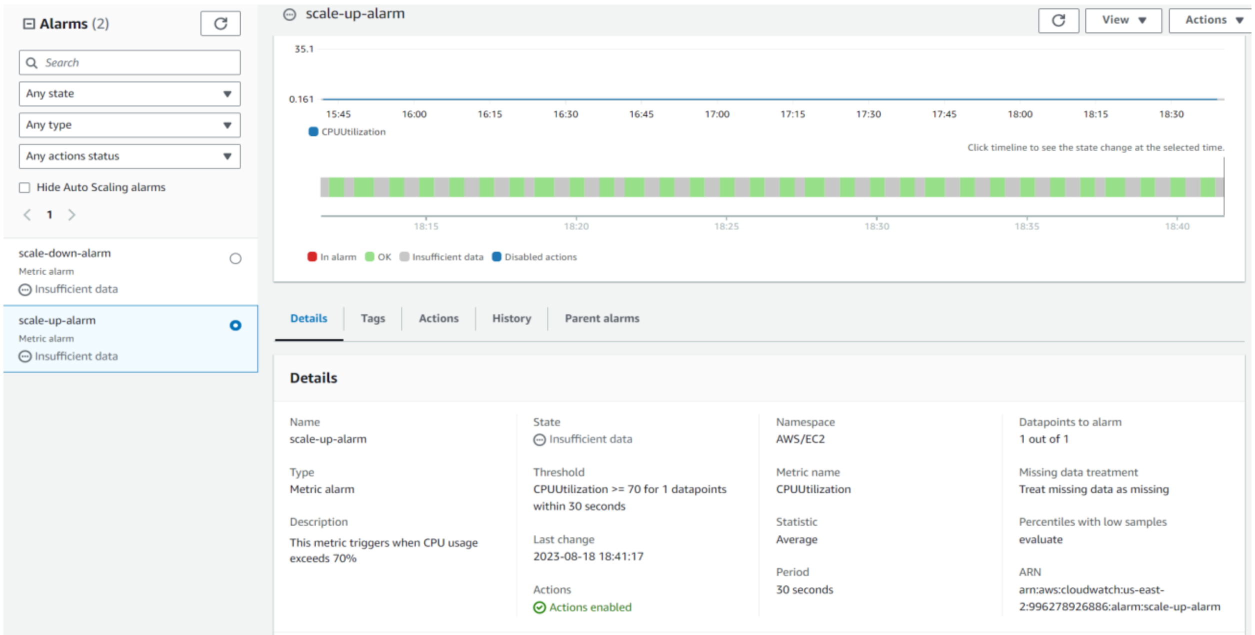
```
# Create AutoScaling Group

resource "aws_autoscaling_group" "my_asg" {
  launch_configuration = aws_launch_configuration.my_config.name
  min_size             = 1
  max_size             = 5
  desired_capacity     = 1
  vpc_zone_identifier  = [aws_subnet.subnets[0].id, aws_subnet.subnets[1].id]
  target_group_arns = [aws_lb_target_group.my_tg.arn]

  tag {
    key                 = "Name"
    value               = "MyAutoScalingGroup"
    propagate_at_launch = true
  }
}

# Scale up policy
resource "aws_autoscaling_policy" "scale_up" {
  name                   = "scale-up"
  scaling_adjustment     = 1
  adjustment_type        = "ChangeInCapacity"
  cooldown               = 180
  autoscaling_group_name = aws_autoscaling_group.my_asg.name
}

# Scale down policy
resource "aws_autoscaling_policy" "scale_down" {
  name                   = "scale-down"
  scaling_adjustment     = -1
  adjustment_type        = "ChangeInCapacity"
  cooldown               = 180
  autoscaling_group_name = aws_autoscaling_group.my_asg.name
}

# CloudWatch Alarm to scale up
resource "aws_cloudwatch_metric_alarm" "scale_up_alarm" {
  alarm_name          = "scale-up-alarm"
  comparison_operator = "GreaterThanOrEqualToThreshold"
  evaluation_periods  = "1"
  metric_name         = "CPUUtilization"
  namespace           = "AWS/EC2"
  period              = "30"
```

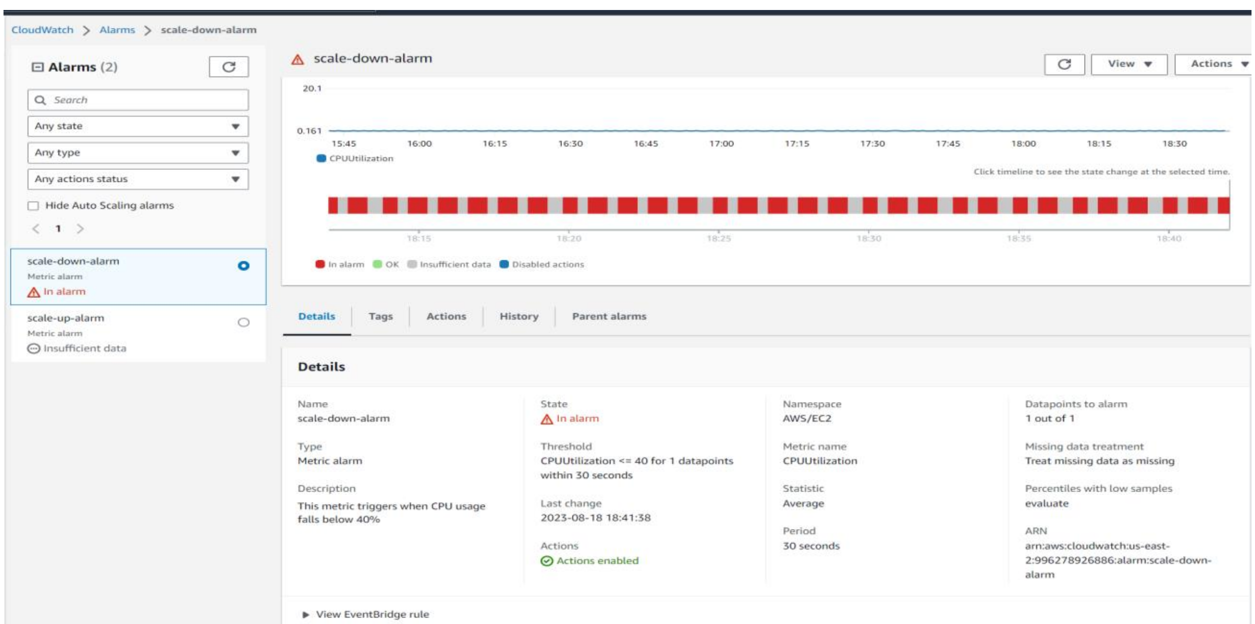
```
  statistic           = "Average"
  threshold           = "70"
  alarm_description   = "This metric triggers when CPU usage exceeds 70%"
  alarm_actions       = [aws_autoscaling_policy.scale_up.arn]
}

# CloudWatch Alarm to scale down
resource "aws_cloudwatch_metric_alarm" "scale_down_alarm" {
  alarm_name          = "scale-down-alarm"
  comparison_operator = "LessThanOrEqualToThreshold"
  evaluation_periods  = "1"
  metric_name         = "CPUUtilization"
  namespace           = "AWS/EC2"
  period              = "30"
  statistic           = "Average"
  threshold           = "40"
  alarm_description   = "This metric triggers when CPU usage falls below 40%"
  alarm_actions       = [aws_autoscaling_policy.scale_down.arn]
}
```

Established an AWS Auto Scaling Group "my_asg" that dynamically adjusts instance counts between 1 and 5 based on CPU usage. It monitor the CPU usage of all the instance that is running and If CPU exceeds 70%(average), it scales up by one instance, and if it drops below 40%(average), it scales down by one. These decisions are monitored and triggered by CloudWatch Alarms.




scale-down
Simple scaling
Enabled
scale-down-alarm
breaches the alarm threshold: CPUUtilization =< 40 for 1 consecutive periods of 30 seconds for the metric dimensions:
Remove 1 capacity units
180 seconds before allowing another scaling activity
scale-up
Simple scaling
Enabled
scale-up-alarm
breaches the alarm threshold: CPUUtilization >= 70 for 1 consecutive periods of 30 seconds for the metric dimensions:
Add 1 capacity units
180 seconds before allowing another scaling activity


Alarms (2)
Search
Any state
Any type
Any actions status
Hide Auto Scaling alarms
scale-down-alarm
Metric alarm
Insufficient data
scale-up-alarm
Metric alarm
Insufficient data
scale-up-alarm
View
Actions
35.1
0.161
15:45 16:00 16:15 16:30 16:45 17:00 17:15 17:30 17:45 18:00 18:15 18:30
CPUUtilization
Click timeline to see the state change at the selected time.
18:15 18:20 18:25 18:30 18:35 18:40
In alarm OK Insufficient data Disabled actions
Details Tags Actions History Parent alarms
Details
Name
scale-up-alarm
Type
Metric alarm
Description
This metric triggers when CPU usage exceeds 70%
State
Insufficient data
Threshold
CPUUtilization >= 70 for 1 datapoints within 30 seconds
Last change
2023-08-18 18:41:17
Actions
Actions enabled
Namespace
AWS/EC2
Metric name
CPUUtilization
Statistic
Average
Period
30 seconds
Datapoints to alarm
1 out of 1
Missing data treatment
Treat missing data as missing
Percentiles with low samples
evaluate
ARN
arn:aws:cloudwatch:us-east-2:996278926886:alarm:scale-up-alarm


CloudWatch > Alarms > scale-down-alarm
Alarms (2)
Search
Any state
Any type
Any actions status
Hide Auto Scaling alarms
scale-down-alarm
Metric alarm
In alarm
scale-up-alarm
Metric alarm
Insufficient data
scale-down-alarm
View
Actions
20.1
0.161
15:45 16:00 16:15 16:30 16:45 17:00 17:15 17:30 17:45 18:00 18:15 18:30
CPUUtilization
Click timeline to see the state change at the selected time.
18:15 18:20 18:25 18:30 18:35 18:40
In alarm OK Insufficient data Disabled actions
Details Tags Actions History Parent alarms
Details
Name
scale-down-alarm
Type
Metric alarm
Description
This metric triggers when CPU usage falls below 40%
State
In alarm
Threshold
CPUUtilization <= 40 for 1 datapoints within 30 seconds
Last change
2023-08-18 18:41:38
Actions
Actions enabled
Namespace
AWS/EC2
Metric name
CPUUtilization
Statistic
Average
Period
30 seconds
Datapoints to alarm
1 out of 1
Missing data treatment
Treat missing data as missing
Percentiles with low samples
evaluate
ARN
arn:aws:cloudwatch:us-east-2:996278926886:alarm:scale-down-alarm
View EventBridge rule

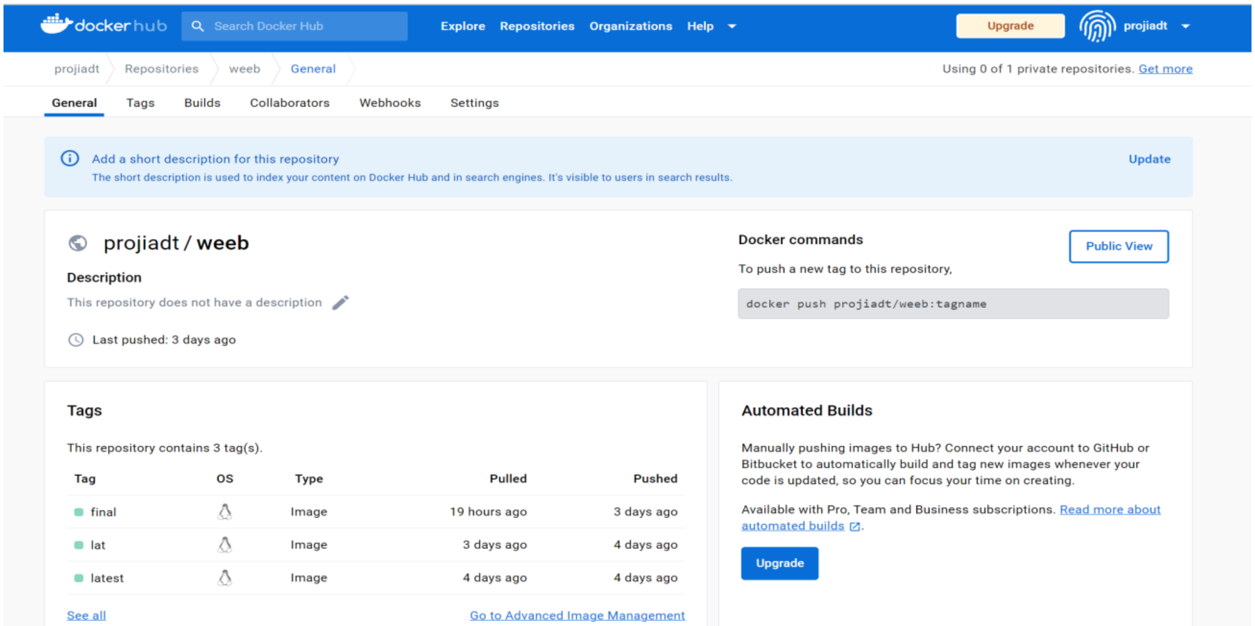
CPU LOAD

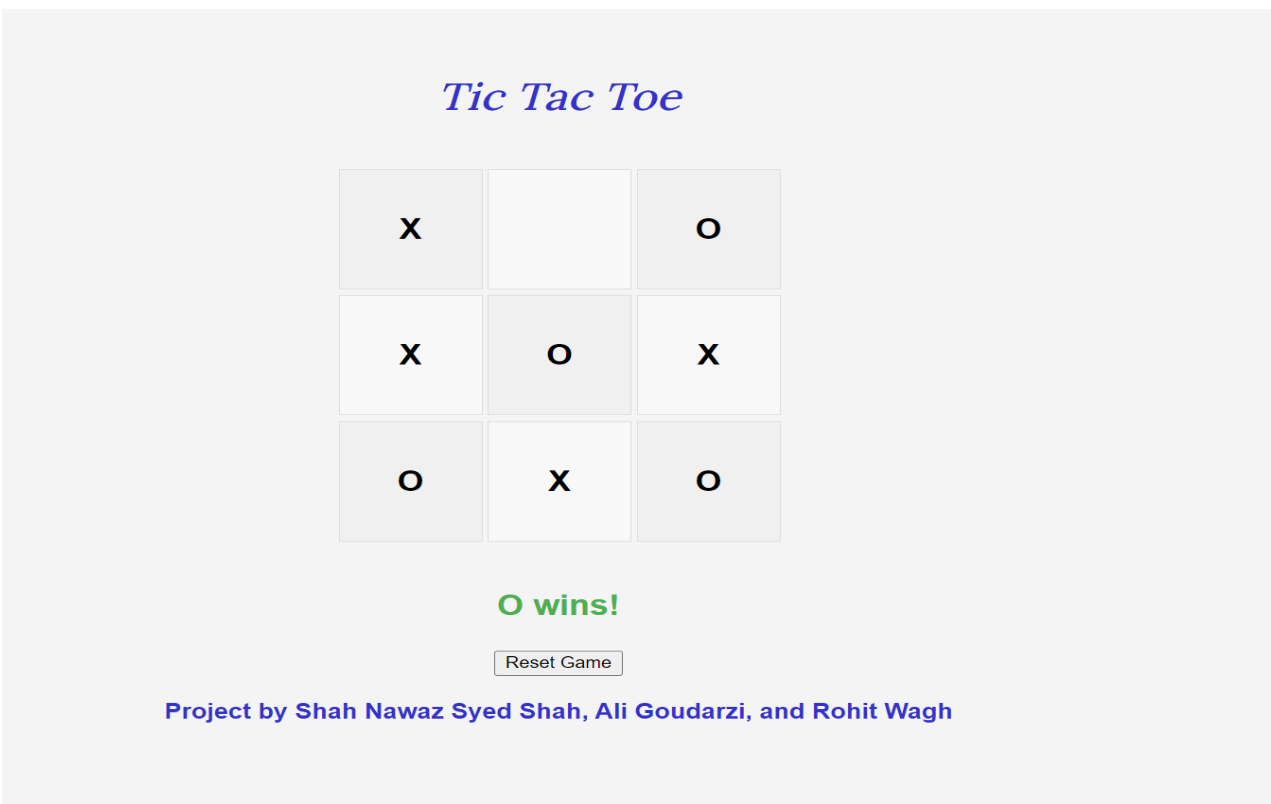
```python
import multiprocessing
import time

def load_cpu(load_percentage, interval):
    """
    A function that generates a specific load on the CPU.
    """
    work_time = interval * load_percentage
    sleep_time = interval - work_time

    while True:
        end_time = time.time() + work_time
        while time.time() < end_time:
            x = (0.00001*3.14*3.14) / 2.34
        time.sleep(sleep_time)

NUM_PROCESSES = 1
LOAD_PERCENTAGE = 0.80  # 80% load
INTERVAL = 1.0  # interval in seconds

if __name__ == "__main__":
    processes = []

    for _ in range(NUM_PROCESSES):
        process = multiprocessing.Process(target=load_cpu, args=(LOAD_PERCENTAGE, 
INTERVAL))
        processes.append(process)
        process.start()

    try:
        while True:
            time.sleep(1)  # Keep the script running
    except KeyboardInterrupt:
        for process in processes:
            process.terminate()
```

This code generates CPU load by running a computational task in parallel processes. It uses the multiprocessing module to spawn number of processes, each applying an 80% load on the CPU over 1-second intervals. This is achieved by performing calculations for 80% of the time and resting for the remaining 20%. The main script keeps running indefinitely, and upon manual interruption, all active processes are terminated.

Web Application

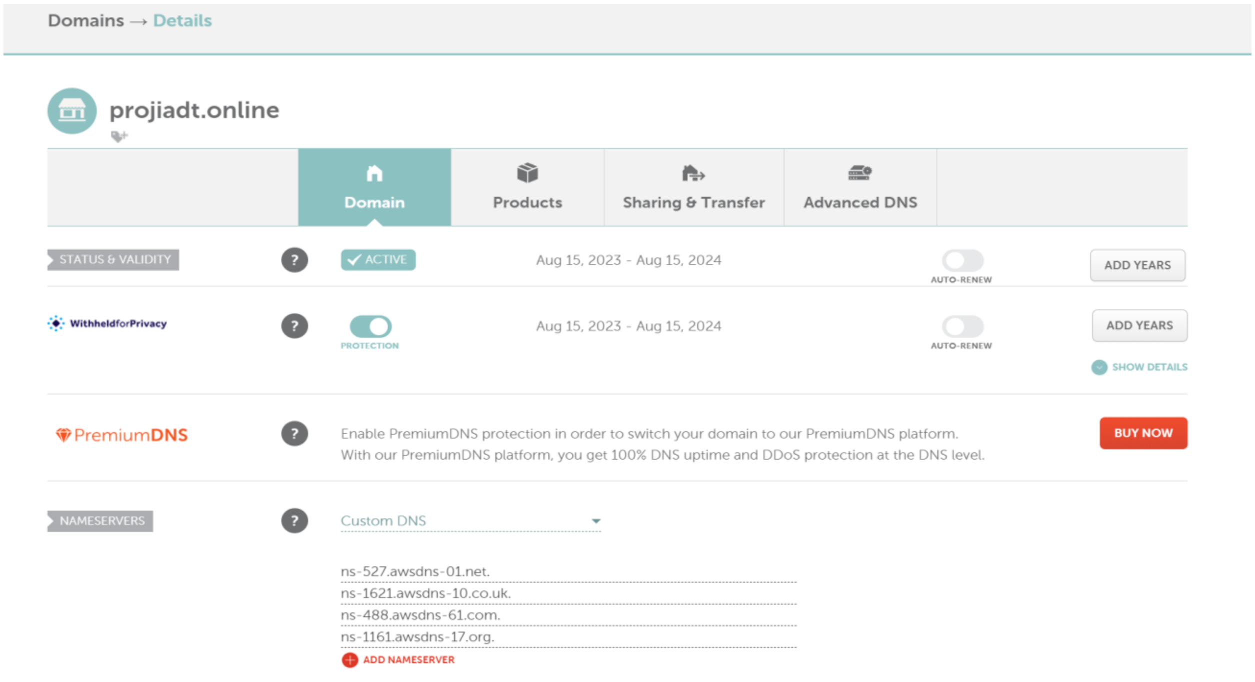
Developed a Tic Tac Toe game using HTML and then packaged it into a container. This containerized version was then uploaded to Docker Hub (https://hub.docker.com/repository/docker/projiadt/weeb/general)

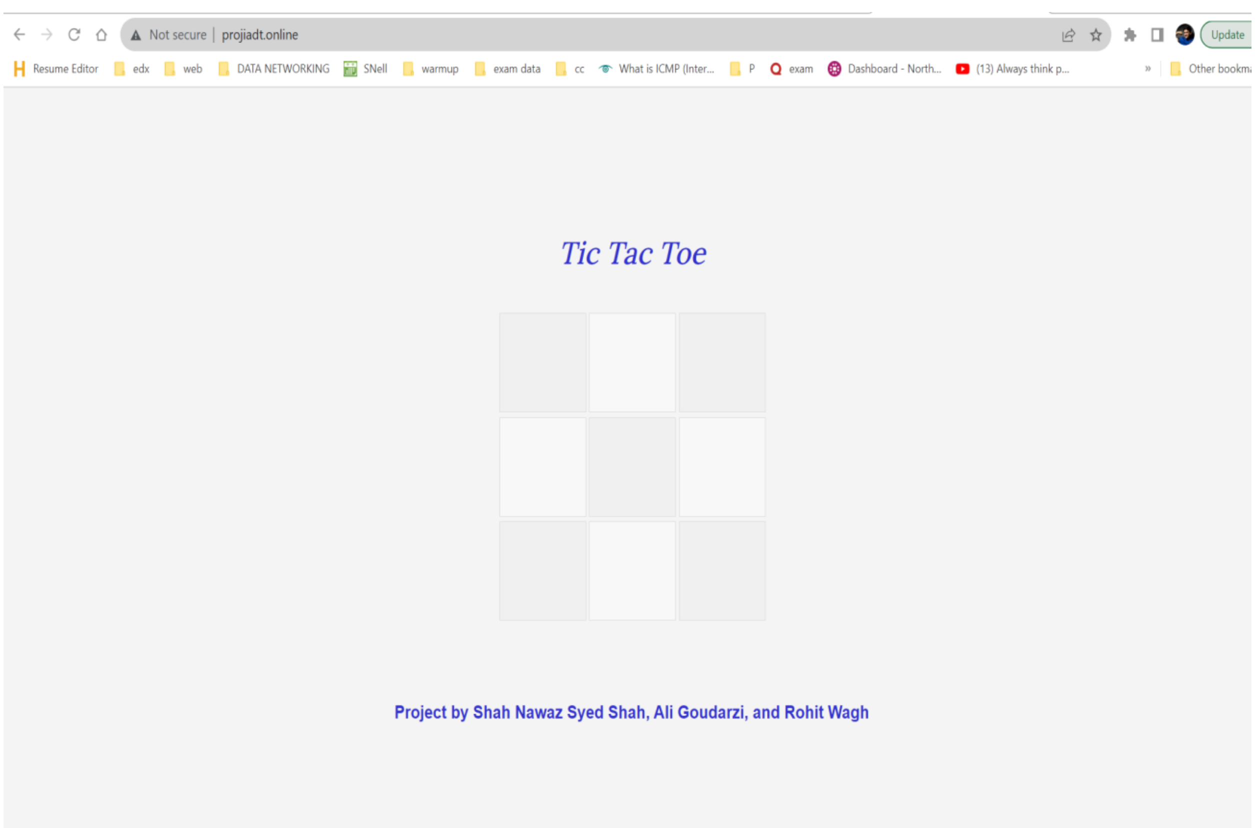




Code link : https://github.com/finalprojiadt/iadt/blob/main/dummy.html

Domain Name:


Domains → Details
projiadt.online
Domain
Products
Sharing & Transfer
Advanced DNS
STATUS & VALIDITY
ACTIVE
Aug 15, 2023 - Aug 15, 2024
AUTO-RENEW
ADD YEARS
WithheldforPrivacy
PROTECTION
Aug 15, 2023 - Aug 15, 2024
AUTO-RENEW
ADD YEARS
SHOW DETAILS
PremiumDNS
Enable PremiumDNS protection in order to switch your domain to our PremiumDNS platform.
With our PremiumDNS platform, you get 100% DNS uptime and DDoS protection at the DNS level.
BUY NOW
NAMESERVERS
Custom DNS
ns-527.awsdns-01.net.
ns-1621.awsdns-10.co.uk.
ns-488.awsdns-61.com.
ns-1161.awsdns-17.org.
ADD NAMESERVER


Not secure | projiadt.online
Update
Resume Editor
edx
web
DATA NETWORKING
SNell
warmup
exam data
cc
What is ICMP (Inter...
P
exam
Dashboard - North...
(13) Always think p...
Other bookma
Tic Tac Toe
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DIFFICULTIES:

1. **SSH into each instance to increase the CPU load**
   Though we developed the script to increase the CPU load and tested it, for each ec2 instance which is being automatically created using Auto Scaling Group, we were not able to SSH into them.
   In order to Overcome this problem, we generated a SSH key and pushed that public key into each instance using EC2 boot strap script. After accomplishing this, we were able to increase the CPU load.
2. **Auto Scaling**
   Initially we had the auto scaling to scale up when any one of the CPU increases above the 70%. But, on a longer run we realized that load will be distributed and average CPU load has to be calculated. So later we changed, the measuring criteria from Maximum to Average.
3. **Route 53**
   Initially, we employed Terraform for DNS automation. However, the challenge we encountered was that every time we executed terraform apply, a new elastic load balancer and Route53 instance were generated. As a result, we consistently had to update the settings on namecheap.com, leading to a 24-48 hour delay for projiadt.online to become active.

BONUS:

1. **Immutability**
   Immutability means not updating/ modifying the resource once they have been deployed. Rather replacing the older one with a new one. This prevents configuration drift
   In our project by using the
   "create_before_destroy=true", we ensure that new version of the instance is created before the old version is destroyed and this ensures that there is no downtime.
2. **Elastic Load Balancer**
   We employed an Application Load Balancer to evenly distribute incoming traffic across our web servers. As it's internet-facing, it guarantees high availability, ensuring the application remains accessible even if one of the instances fails.
3. **Container**
   We've encapsulated our web application within a container, streamlining its deployment.

Future Scope:

1. RDS & NAT instance/ NAT Gateway
   We can utilize RDS to record the game's winners and also keep track of IP address of each container and place the RDS within a private subnet. This ensures that only instances within our network can interact with it. If we need to provide internet access to this RDS, we can do so using a NAT instance (using Bastion Host) or a NAT Gateway.
2. NACL

Though we have security group which prevents malicious activity, being stateful, if server presses by mistake it will allow the traffic in without checking. By having NACL and its stateful as well, network will have additional security.

3. Custom AMI
   Using the current Terraform script, every deployment involves setting up software packages and other resources, leading to longer boot-up times for the EC2 instances. If we instead use a customized AMI with Docker and other required software pre-installed, the instances would launch faster. The more commands and data you have in EC2's user data, the longer it takes for the instance to become operational. Leveraging a pre-configured AMI can optimize this process.
4. Ansible Dynamic Inventory
   Instead of executing scripts to manually increase the CPU load on each instance, we can utilize Dynamic Inventory. This approach allows for more efficient provisioning and monitoring of each EC2 instance.