Developer Operations 2024 - Assignment 2

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Project URL: https://github.com/MartyRath/aws-web-app-autoscaling

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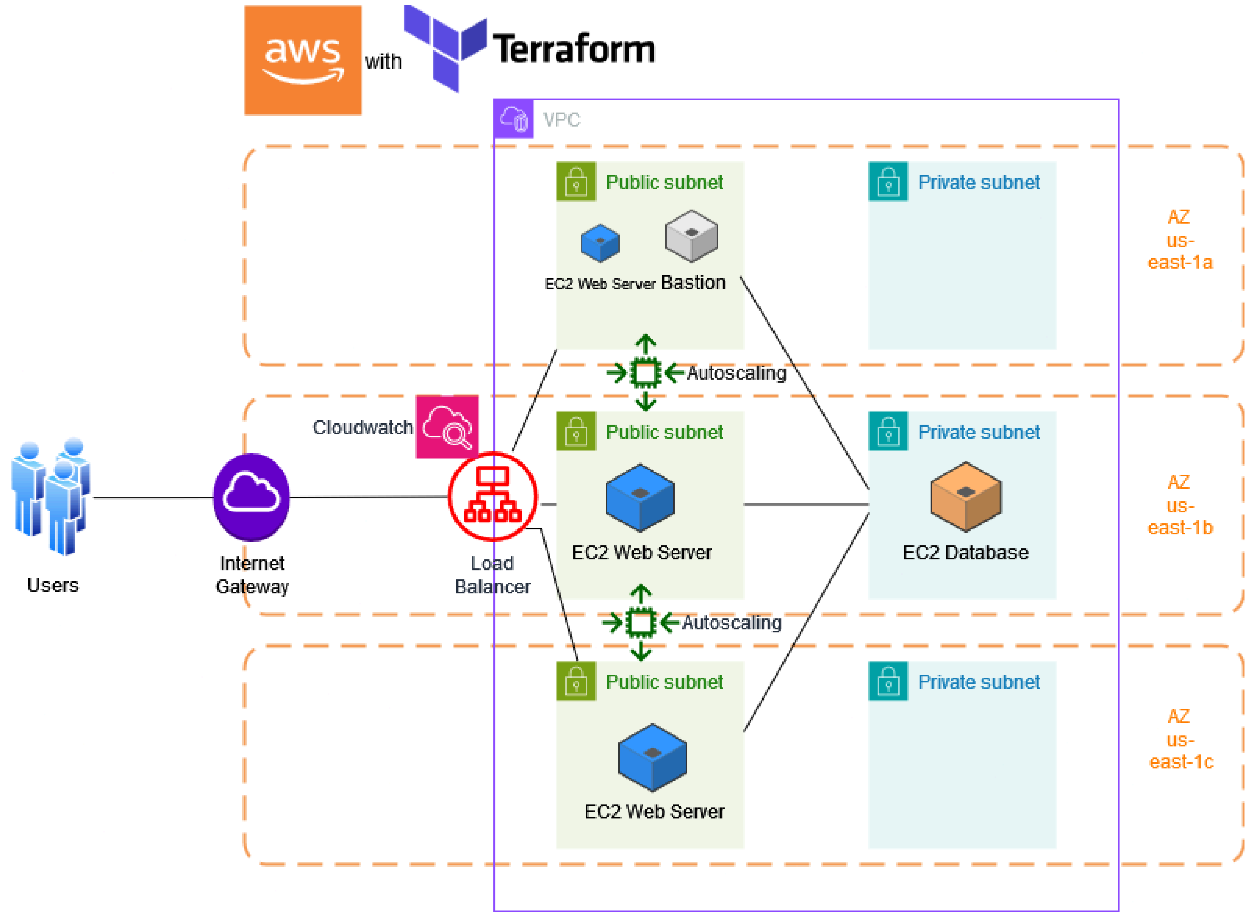
Architecture overview



The architecture is designed to ensure high availability, scalability and automated management of the web application running on the EC2 Web Servers.
Key points are:

- The web application. This was configured on a master instance, from which a custom Amazon Machine Image (AMI) was built. The custom AMI is the template for scaled instances.
- The Virtual Private Cloud (VPC) provides an isolated network environment for deploying the application. The web application runs on public subnets to enable internet accessibility via the Internet Gateway. The database instance is run on a private subnet for security.
- Traffic distribution across the web application instances is managed by the load balancer. This is to maintain high quality of service, dynamically scaling based on demand.
- Template instances of the web application from the custom AMI are dynamically launched or destroyed by the auto-scaling.
- CloudWatch alarms monitor instance metrics, informing the scaling policies to adjust instance count as needed, ensuring consistent performance.

The remainder of this report will go into detail on how this architecture was achieved.

Step 1: Master instance

See 01-master-instance.tf

The Terraform resource aws_ami was used to retrieve the most recent Amazon Linux x86_64 AMI for the master instance. The AMI was searched for via aws_ami, with results filtered using globbing:

```
filter {
        name   = "name"
        values = ["al2023-ami-2023*x86_64"]
  }
```

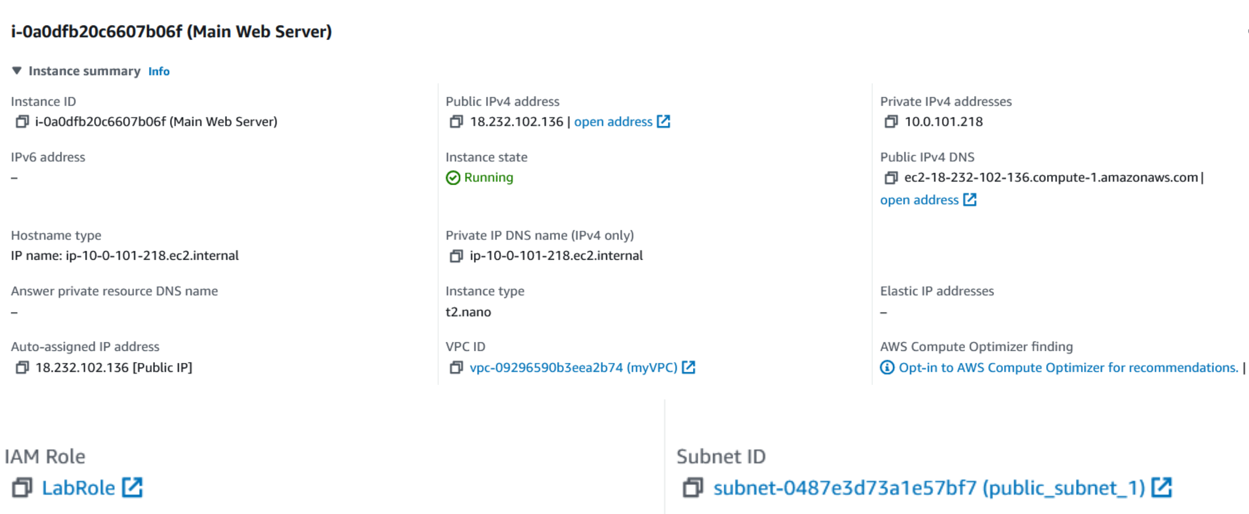
Aws_instance was used to create the master instance in a public subnet. Other configurations include, a web server security group (discussed Step 3b), a key pair for SSH access, and an IAM instance profile (LabInstanceProfile) in order to push custom metrics to CloudWatch.

User data included the script deploy_app.sh. In this script, it uploaded the start_app.sh script to install the Playtime web application onto the instance. The script also installed dependencies for the app and created a static web page with the EC2 ID at id.html.

In the end, the node app was installed, along with custom metrics pushed to CloudWatch via SSH when attempts to automate this through user_data scripts failed.

This was done to create a new custom AMI with the web app properly installed.

Screenshot 1: Master instance



Step 2: Custom AMI

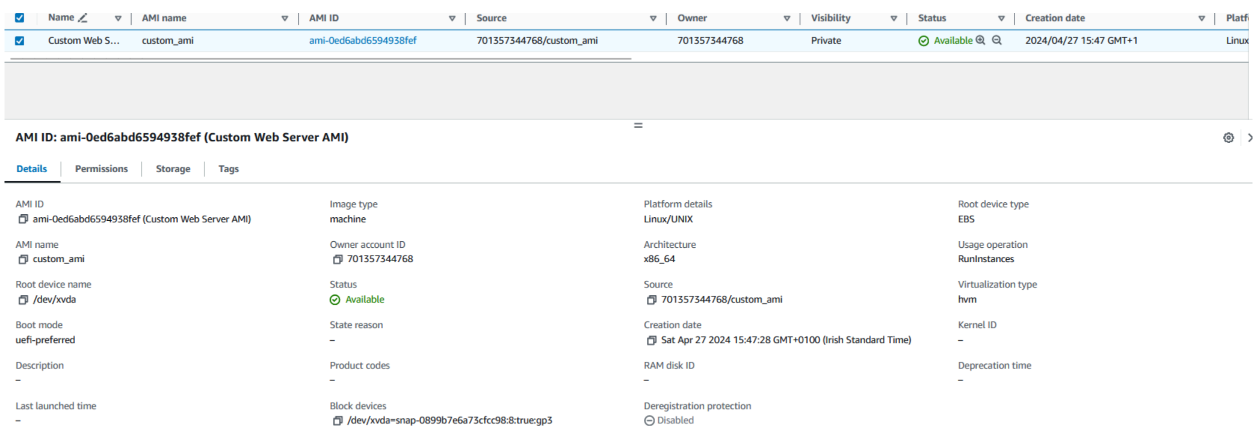
See 01-master-instance.tf

The custom AMI was based on the master instance, and so shared the configurations discussed above. This was achieved by using the Terraform resource: aws_ami_from_instance

The custom AMI is tagged as, “Custom Web Server AMI”.
The AMI is linked to the master instance via the instance id:

```
source_instance_id = aws_instance.main_web_server.id
```

Screenshot 2: Custom AMI



Step 3a: VPC and subnets

See 02-vpc-security-groups.tf

A Terraform module was used to create the VPC. The documentation can be found here:
https://registry.terraform.io/modules/terraform-aws-modules/vpc/aws/latest

Along with the VPC, it was specified to create three private and public subnets, in the availability zones: us-east-1a, us-east-1b, us-east-1c.

Screenshot 3a: Public/Private subnet AZ distribution

Name	Subn...	State	VPC	IPv4 CIDR	IPv6 ...	Avail...	Availability Zone
public_subnet_3	subnet-...	Available	vpc-092...	10.0.103.0/24	–	249	us-east-1c
public_subnet_2	subnet-...	Available	vpc-092...	10.0.102.0/24	–	250	us-east-1b
public_subnet_1	subnet-...	Available	vpc-092...	10.0.101.0/24	–	248	us-east-1a
private_subnet_3	subnet-...	Available	vpc-092...	10.0.3.0/24	–	251	us-east-1c
private_subnet_2	subnet-...	Available	vpc-092...	10.0.2.0/24	–	251	us-east-1b
private_subnet_1	subnet-...	Available	vpc-092...	10.0.1.0/24	–	250	us-east-1a

Other customisations to this module were to:
Auto-assign public IPv4 address for instances launched in public subnets

map_public_ip_on_launch = true

Enable a NAT gateway in just one availability zone for private subnets.

enable_nat_gateway = true
single_nat_gateway = true

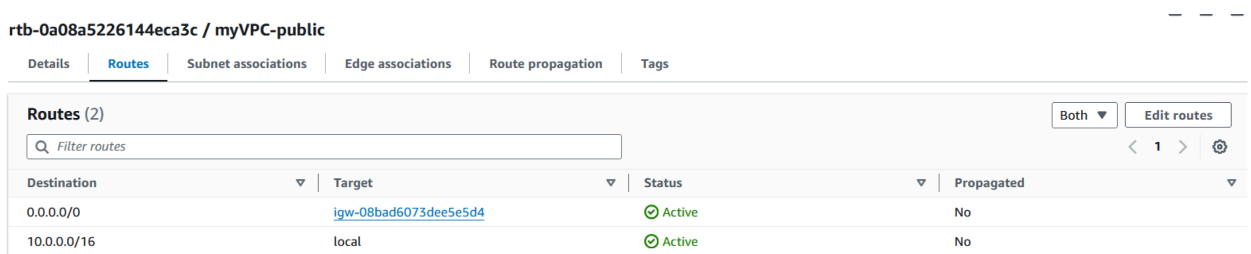
And to disable the creation of a default security group.

manage_default_security_group = false

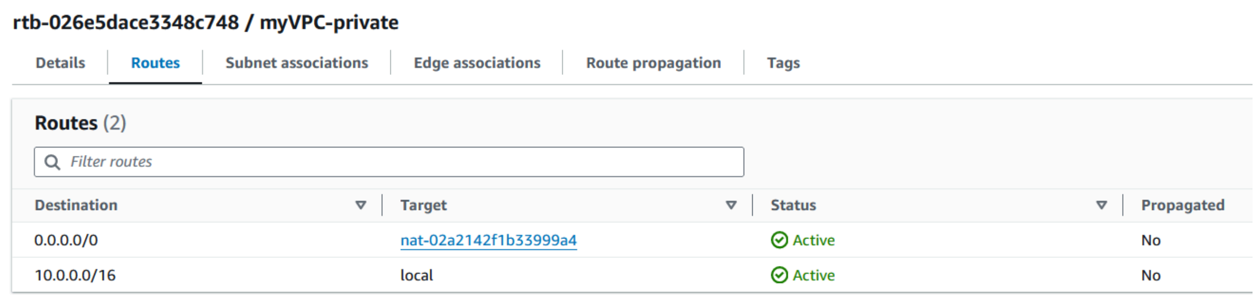
By default, this module sets up custom route tables, an internet gateway for the public subnets, and a network access control list.

The default network ACL allows traffic from any source, but the security groups (step 3b) take precedence over this rule.

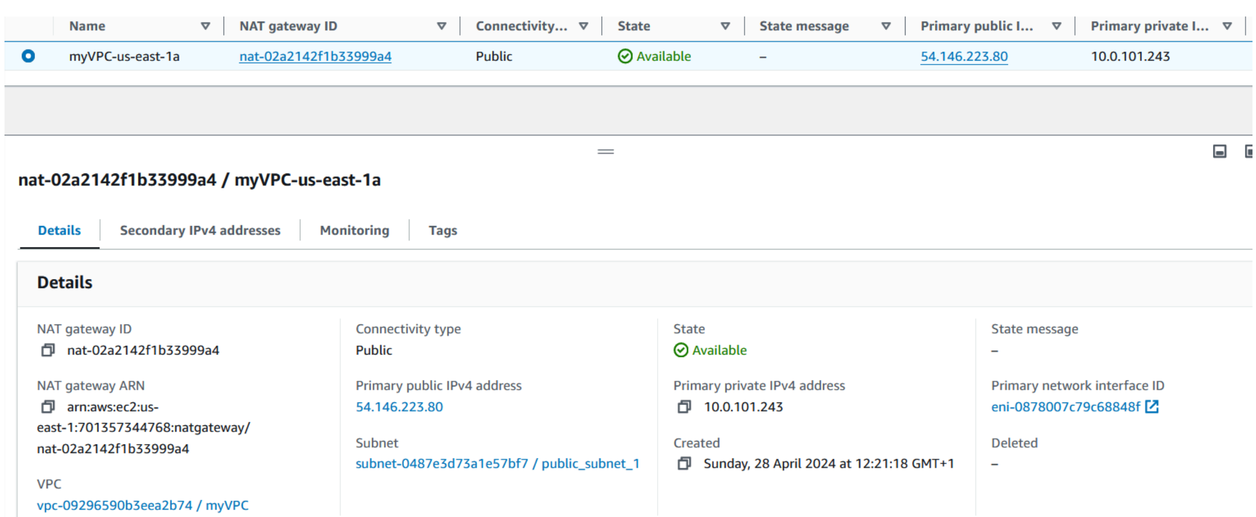
Screenshot 3a - 1: Public route table using IGW



Screenshot 3a - 2: Private route table using Nat gateway



Screenshot 3a -3: Nat gateway



Step 3b: Security groups (rules listed)

See 02-vpc-security-groups.tf

I used a Terraform resource to create multiple security groups.

Web server security group:
Ingress rules to allow:

- SSH traffic from any IP
- HTTP traffic from any IP
- HTTPS traffic from any IP
- Custom TCP traffic from any IP

Egress rule:

- All outbound traffic from anywhere

Bastion Security Group
Ingress rules to allow:

- SSH traffic from any IP
- HTTP traffic from any IP
- HTTPS traffic from any IP
- Custom TCP traffic from any IP

Mongo Security Group
Ingress rules to allow:

- SSH traffic from the Bastion
- TCP traffic from the web server/node app.

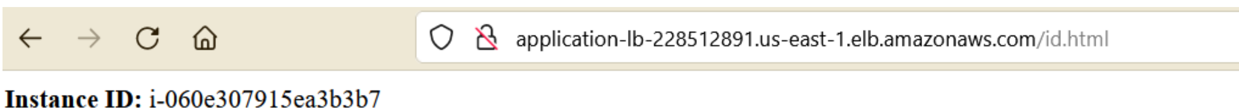
Step 4a: Load balancer

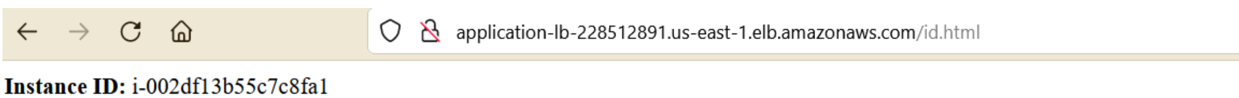
See 03-load-balancer.tf

An application Load Balancer (ALB) along with a target group and listeners for handling HTTP traffic using Terraform.

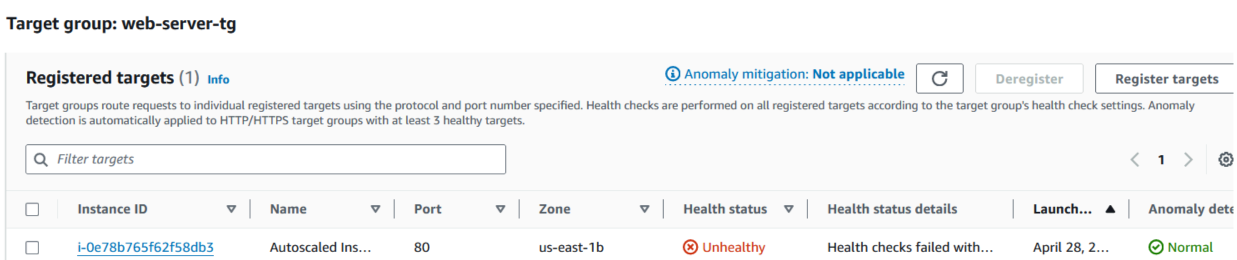
The ALB distributes incoming requests to the instances registered with the target group based on the configured listeners and routing rules.

Screenshot 4a: Load Balancer (round robin)





Screenshot 4a - 1: Target group


Target group: web-server-tg

Registered targets (1) Info

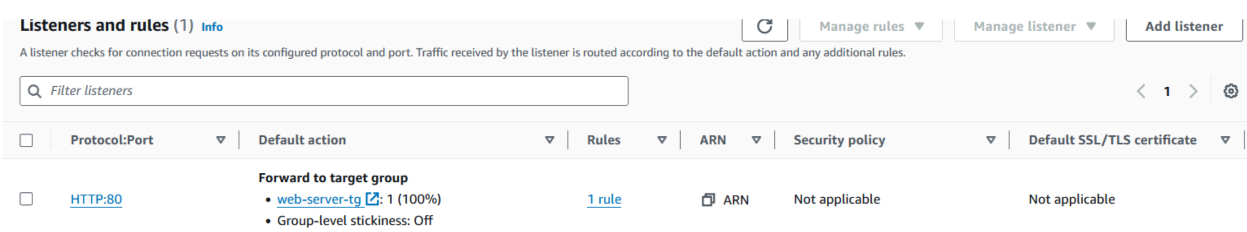
Anomaly mitigation: Not applicable | Deregister | Register targets

Target groups route requests to individual registered targets using the protocol and port number specified. Health checks are performed on all registered targets according to the target group's health check settings. Anomaly detection is automatically applied to HTTP/HTTPS target groups with at least 3 healthy targets.

Filter targets

Instance ID	Name	Port	Zone	Health status	Health status details	Launch...	Anomaly dete
i-0e78b765f62f58db3	Autoscaled Ins...	80	us-east-1b	Unhealthy	Health checks failed with...	April 28, 2...	Normal

Screenshot 4a - 2: Listener


Listeners and rules (1) Info

Manage rules | Manage listener | Add listener

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.

Filter listeners

Protocol:Port	Default action	Rules	ARN	Security policy	Default SSL/TLS certificate
HTTP:80	Forward to target group • web-server-tg: 1 (100%) • Group-level stickiness: Off	1 rule	ARN	Not applicable	Not applicable

Step 4b: Launch template

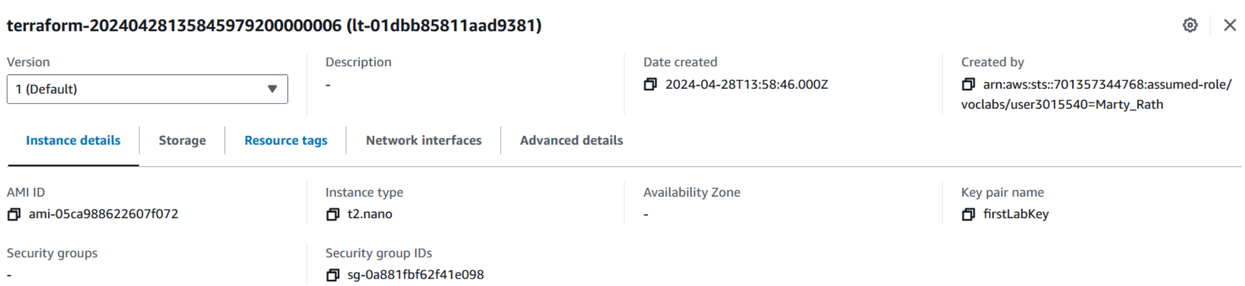
See 04-autoscaling.tf

The launch template is created from the custom AMI created called localMongo. It has the web server security group and a key pair for SSH access.
As custom metrics will be run every minute, it also enables detailed monitoring, and for permissions to push custom metrics to CloudWatch has the IAM instance profile, LabInstanceProfile.

Then, its user data was used to start the node app with:

```
su - ec2-user -c 'cd playtime; npm run start'
```

Screenshot 4b: Launch Template



Step 4c: Auto-scaling group

See 04-autoscaling.tf

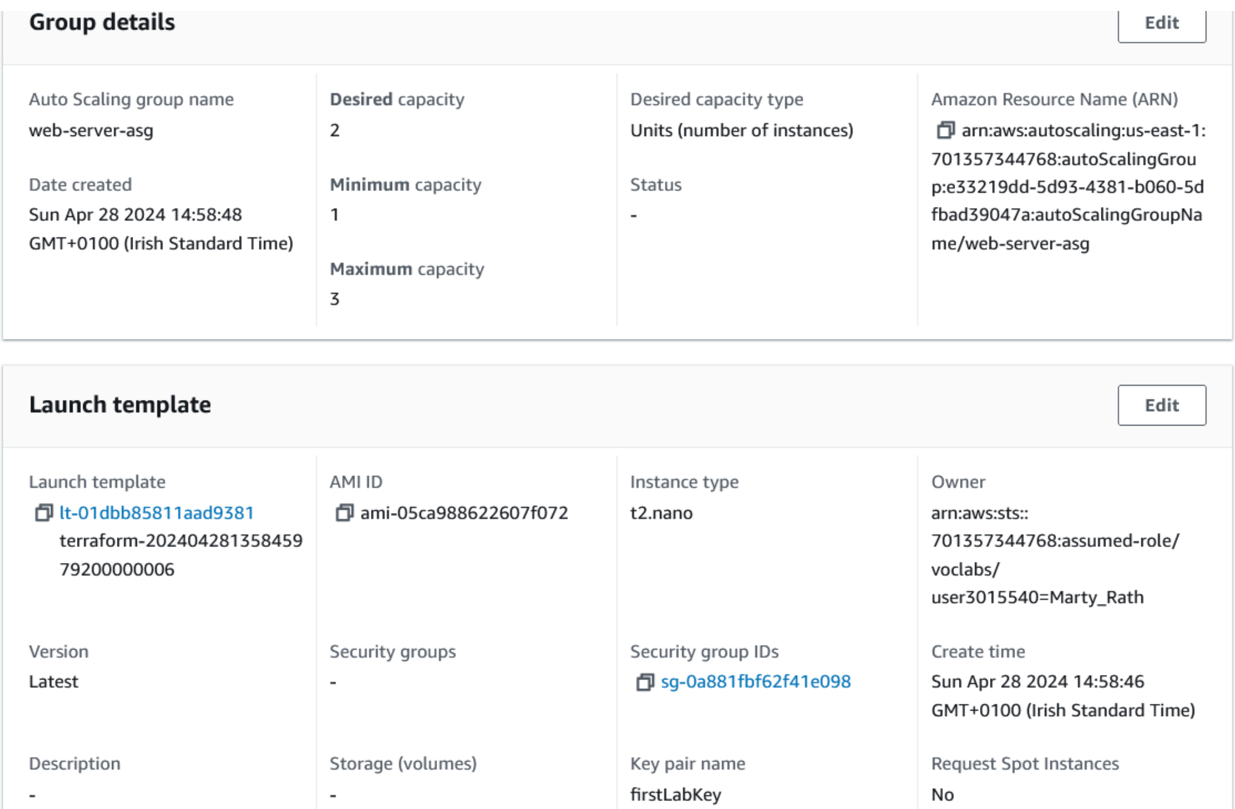
The web server auto-scaling group (ASG) uses the launch template and is linked to the load balancer.

The ASG ensures that the number of instances dynamically scales based on demand, with a maximum size of 3 instances, a minimum size of 1 instance, and a desired capacity of 1 instance.

The ASG is configured to use 1-minute granularity for metrics within CloudWatch, allowing for precise monitoring and scaling actions.

Additionally, each autoscaled instance is tagged with a timestamp for identification.

Screenshot 4c: Auto-scaling Group (shows Launch Template, subnet AZs, load balancer)



Network

Edit

Availability Zones	Subnet ID
us-east-1a, us-east-1b, us-east-1c	subnet-093453e05f92b3ebe, subnet-08507d23034124a12, subnet-05f2509e216652e69

Load balancing

Edit

Load balancer target groups	Classic Load Balancers
web-server-tg	-

Health checks

Edit

Health check type	Health check grace period
EC2	30

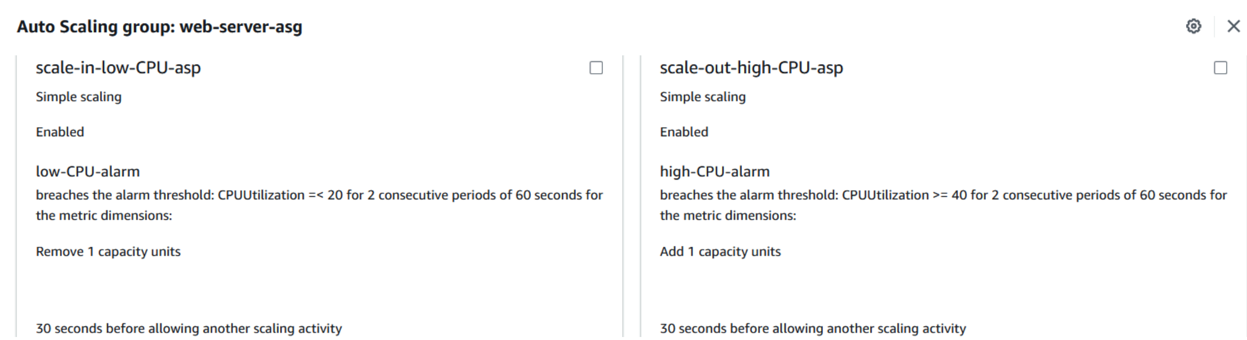
Step 5: Scaling Policies, CloudWatch Alarms

See 04-autoscaling.tf

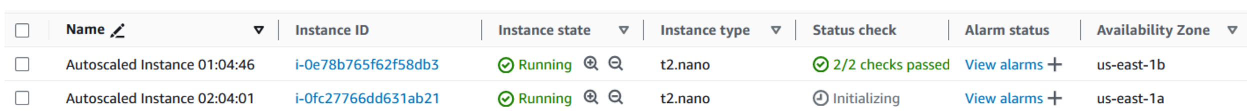
There are two autoscaling policies in place, designed to scale out on high CPU, and scale in on low CPU.

These policies are linked to the high_CPU_alarm and low_CPU_alarm CloudWatch alarms. These alarms are configured to notify the autoscaling policies of high/low CPU after two consequent checks of CPU utilisation , which are done every minute.
The high_CPU_alarm is triggered when CPU utilisation is on average above 40%, and the low_CPU_alarm is triggered when CPU utilisation is on average below 20%.

Screenshot 5: Scaling policies



Screenshot 5 - 1: Auto-scaled instances



Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Availability Zone
Autoscaled Instance 01:04:46	i-0e78b765f62f58db3	Running	t2.nano	2/2 checks passed	View alarms	us-east-1b
Autoscaled Instance 02:04:01	i-0fc27766dd631ab21	Running	t2.nano	Initializing	View alarms	us-east-1a

Step 6: Test Traffic

See generate_test_traffic.sh

Test traffic was generated to the load balancer via a script which prompts the user for the DNS name of the load balancer. The traffic is generated using curl to send 100 HTTP requests to the load balancer using a loop.

Screenshot 6: Test traffic generation script

```
# Prompt user to enter the DNS name of the load balancer
read -p "Enter the DNS name of the load balancer: " LB_DNS_NAME

# Loop to send requests with different URLs, supressing output
for i in {1..100}; do
    curl -s "http://$LB_DNS_NAME/$i" > /dev/null &
done
```

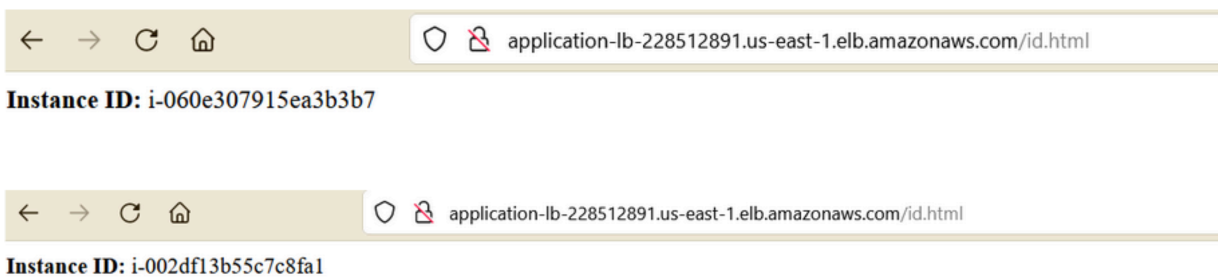
Step 7: Load Distribution

See load_logs.sh

This script is to be used after generating test traffic to the load balancer. It prompts the user for the ip address of the auto-scaled instance, then shows the Apache access log.

Due to lack of time, here is the browser load distribution.

Screenshot 7: Load Distribution (browser)



Step 8: Custom metrics

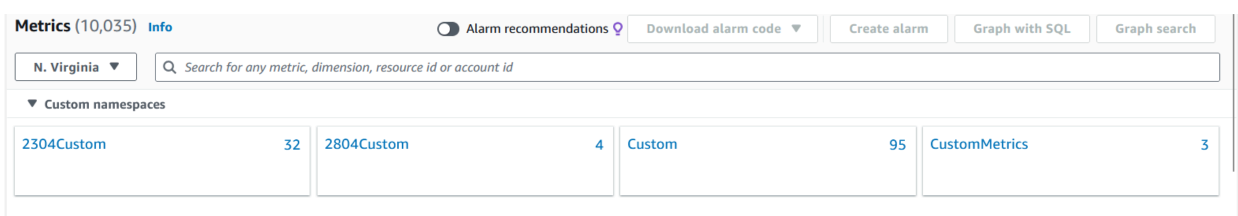
See push_metrics.sh

This script is added to the user data of the launch template for auto-scaled instances. The script collects performance and health metrics on those instances, and then pushes those metrics to CloudWatch every minute using a cron job. This script failed and I used SSH to add custom metrics.

The metrics collected are:

1. **Used Memory**: This metric ensures an instance has sufficient memory to efficiently handle its workload.
2. **TCP Connections**: It measures the total number of TCP connections to the instance, reflecting network activity. High TCP connections indicate increased traffic.
3. **TCP Connections from Port 80**: Specifically tracks incoming HTTP traffic.
4. **IO Wait Time**: This represents the percentage of time the CPU spends waiting for I/O operations to complete.
5. **Process Count**: It counts the total number of processes running on the instance, reflecting system activity.

Screenshot 8: Custom metrics in CloudWatch



Additional Functionality

- Capture your configuration using your own customised Terraform script: https://github.com/MartyRath/aws-web-app-autoscaling
- Screenshot: HTTPS set up:

- Failed attempt for web app communicates with database in private subnet via Bastion.
- Failed attempt - Deploying app via user_data script. See deploy_app.sh