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Roll No : 2023-BSE-073

Subject: Cloud Computing

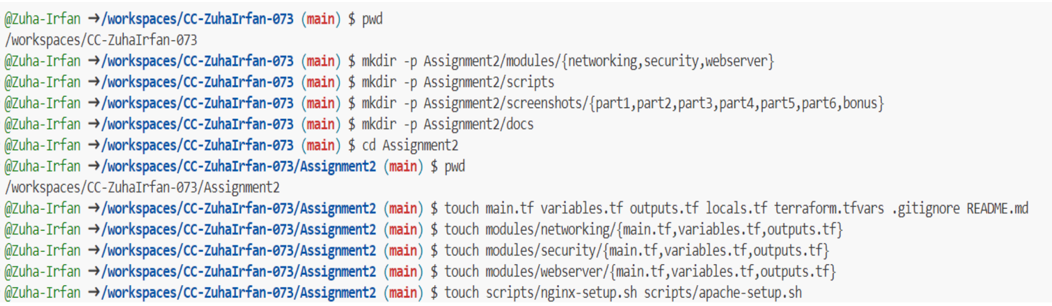
Semester & Section : V-B

Assignment 2 – Terraform & AWS Setup

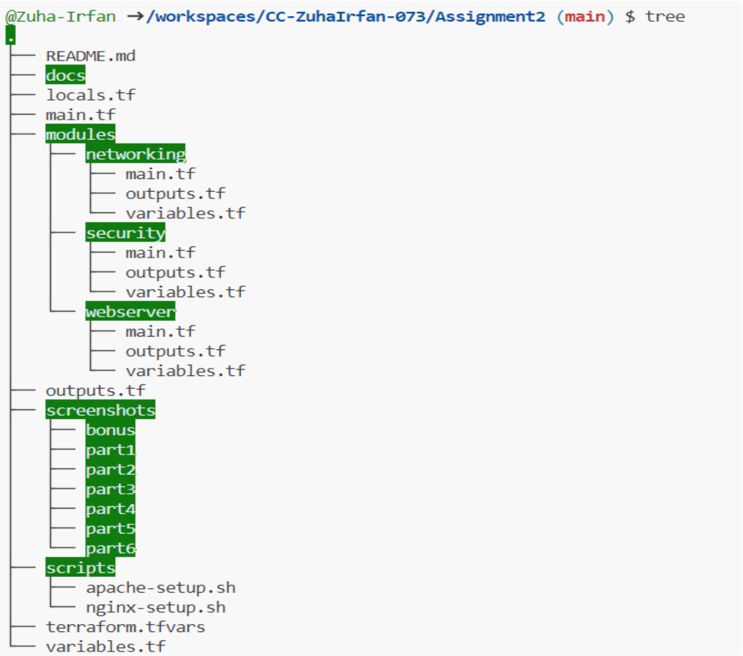
Phase 1: Infrastructure Setup

1.1 Create Project Structure

Screenshot: assignment_part1_project_structure.png → tree

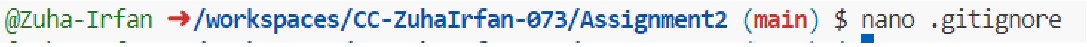


```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073 (main) $ pwd
/workspaces/CC-ZuhaIrfan-073
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073 (main) $ mkdir -p Assignment2/modules/{networking,security,webserver}
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073 (main) $ mkdir -p Assignment2/scripts
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073 (main) $ mkdir -p Assignment2/screenshots/{part1,part2,part3,part4,part5,part6,bonus}
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073 (main) $ mkdir -p Assignment2/docs
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073 (main) $ cd Assignment2
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ pwd
/workspaces/CC-ZuhaIrfan-073/Assignment2
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ touch main.tf variables.tf outputs.tf locals.tf terraform.tfvars .gitignore README.md
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ touch modules/networking/{main.tf,variables.tf,outputs.tf}
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ touch modules/security/{main.tf,variables.tf,outputs.tf}
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ touch modules/webserver/{main.tf,variables.tf,outputs.tf}
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ touch scripts/nginx-setup.sh scripts/apache-setup.sh
```

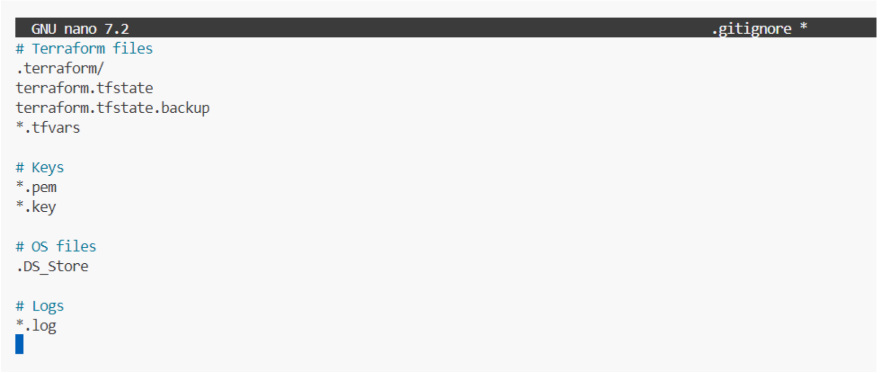


```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ tree
.
├── README.md
├── docs
├── locals.tf
├── main.tf
├── modules
│   ├── networking
│   │   ├── main.tf
│   │   ├── outputs.tf
│   │   └── variables.tf
│   ├── security
│   │   ├── main.tf
│   │   ├── outputs.tf
│   │   └── variables.tf
│   └── webserver
│       ├── main.tf
│       ├── outputs.tf
│       └── variables.tf
├── outputs.tf
├── screenshots
│   ├── bonus
│   ├── part1
│   ├── part2
│   ├── part3
│   ├── part4
│   ├── part5
│   └── part6
├── scripts
│   ├── apache-setup.sh
│   └── nginx-setup.sh
├── terraform.tfvars
└── variables.tf
```

Screenshot: assignment_part1_gitignore.png → .gitignore content



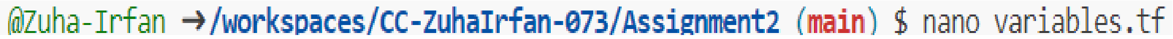
```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ nano .gitignore
```



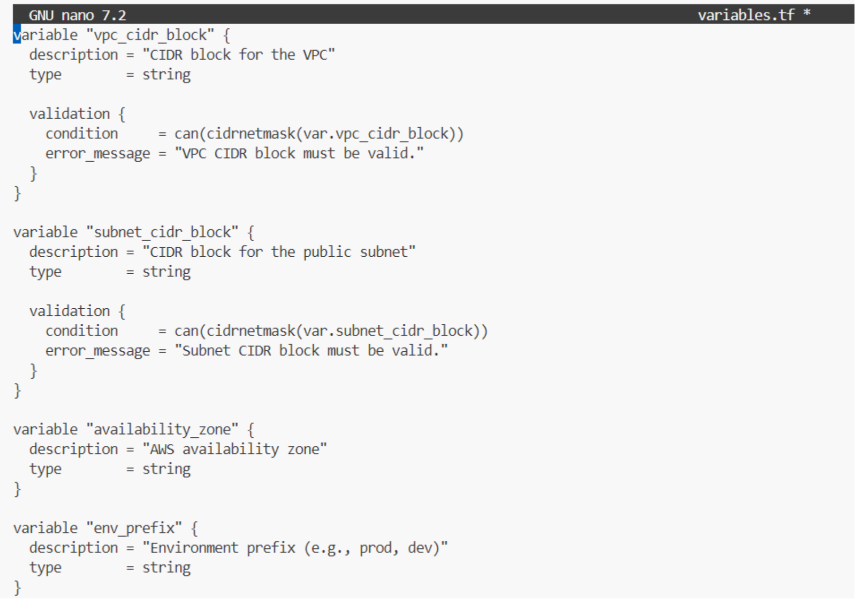
```
  GNU nano 7.2                                                      .gitignore *
# Terraform files
.terraform/
terraform.tfstate
terraform.tfstate.backup
*.tfvars

# Keys
*.pem
*.key

# OS files
.DS_Store

# Logs
*.log
```

1.2 Configure Variables

Screenshot: assignment_part1_variables_tf.png

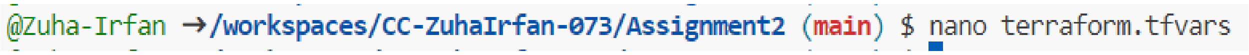


```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ nano variables.tf
```

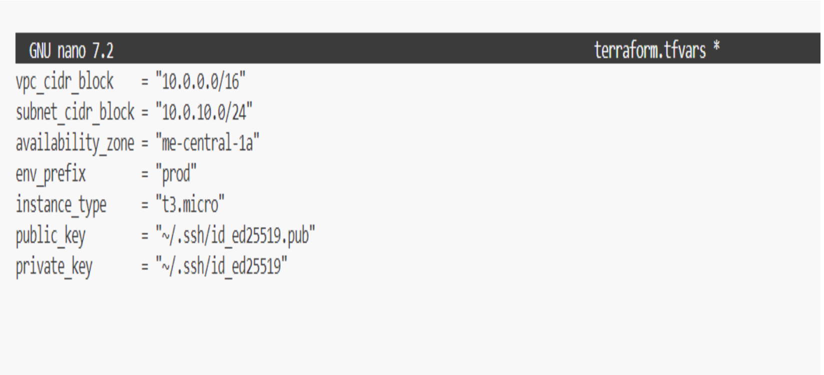


```
  GNU nano 7.2                                                      variables.tf *
variable "vpc_cidr_block" {
  description = "CIDR block for the VPC"
  type        = string

  validation {
    condition     = can(cidrnetmask(var.vpc_cidr_block))
    error_message = "VPC CIDR block must be valid."
  }
}

variable "subnet_cidr_block" {
  description = "CIDR block for the public subnet"
  type        = string

  validation {
    condition     = can(cidrnetmask(var.subnet_cidr_block))
    error_message = "Subnet CIDR block must be valid."
  }
}

variable "availability_zone" {
  description = "AWS availability zone"
  type        = string
}

variable "env_prefix" {
  description = "Environment prefix (e.g., prod, dev)"
  type        = string
}
```

Screenshot: assignment_part1_terraform_tfvars.png



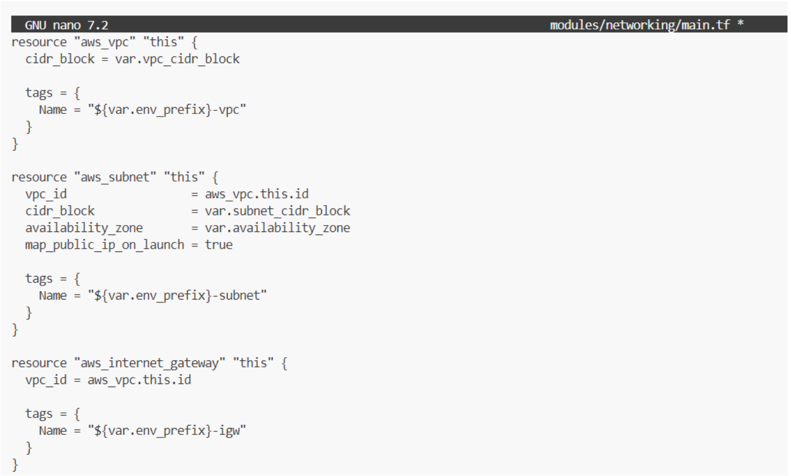
```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ nano terraform.tfvars
```



```
GNU nano 7.2                                        terraform.tfvars *
vpc_cidr_block    = "10.0.0.0/16"
subnet_cidr_block = "10.0.10.0/24"
availability_zone = "me-central-1a"
env_prefix        = "prod"
instance_type     = "t3.micro"
public_key        = "~/.ssh/id_ed25519.pub"
private_key       = "~/.ssh/id_ed25519"
```

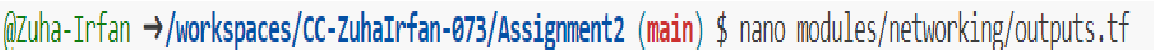
1.3 Networking Module

Screenshot: assignment_part1_networking_module_main.png

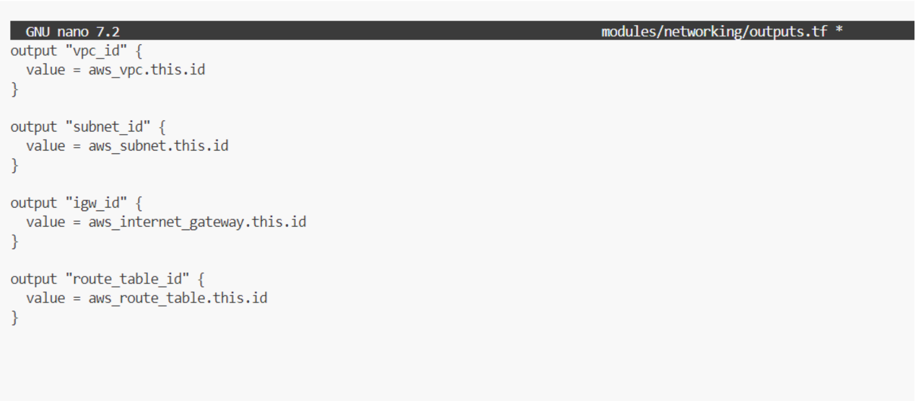


```
GNU nano 7.2                                        modules/networking/main.tf *
resource "aws_vpc" "this" {
  cidr_block = var.vpc_cidr_block

  tags = {
    Name = "${var.env_prefix}-vpc"
  }
}

resource "aws_subnet" "this" {
  vpc_id                  = aws_vpc.this.id
  cidr_block              = var.subnet_cidr_block
  availability_zone       = var.availability_zone
  map_public_ip_on_launch = true

  tags = {
    Name = "${var.env_prefix}-subnet"
  }
}

resource "aws_internet_gateway" "this" {
  vpc_id = aws_vpc.this.id

  tags = {
    Name = "${var.env_prefix}-igw"
  }
}
```

Screenshot: assignment_part1_networking_module_ outputs.png



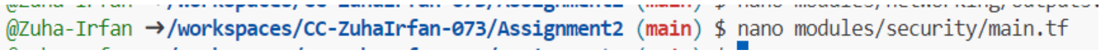
```
@Zuha-Irfan ➜ /workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ nano modules/networking/outputs.tf
```



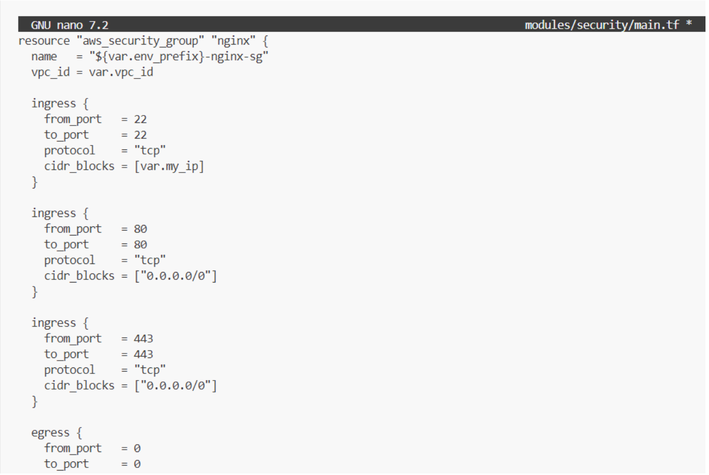
```
GNU nano 7.2                                        modules/networking/outputs.tf *
output "vpc_id" {
  value = aws_vpc.this.id
}

output "subnet_id" {
  value = aws_subnet.this.id
}

output "igw_id" {
  value = aws_internet_gateway.this.id
}

output "route_table_id" {
  value = aws_route_table.this.id
}
```

1.4 Security Module

Screenshot: assignment_part1_security_module.png

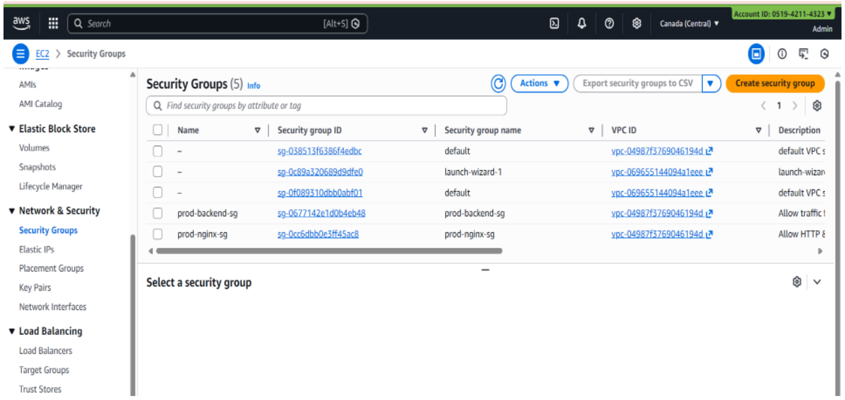


```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ nano modules/security/main.tf
```



```
  GNU nano 7.2                                              modules/security/main.tf *
resource "aws_security_group" "nginx" {
  name   = "${var.env_prefix}-nginx-sg"
  vpc_id = var.vpc_id

  ingress {
    from_port   = 22
    to_port     = 22
    protocol    = "tcp"
    cidr_blocks = [var.my_ip]
  }

  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"]
  }

  egress {
    from_port   = 0
    to_port     = 0
```

Screenshot: assignment_part1_security_groups_console.png



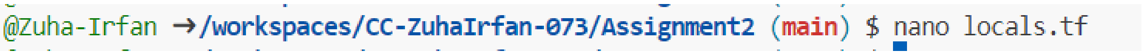
Security Groups (5) Info

□	Name	Security group ID	Security group name	VPC ID	Description
□	–	sg-038513f6386f4edbc	default	vpc-04987f3769046194d	default VPC s
□	–	sg-0c89a320689d9dfe0	launch-wizard-1	vpc-069655144094a1eee	launch-wizar
□	–	sg-0f089310dbb0abf01	default	vpc-069655144094a1eee	default VPC s
□	prod-backend-sg	sg-0677142e1d0b4eb48	prod-backend-sg	vpc-04987f3769046194d	Allow traffic f
□	prod-nginx-sg	sg-0cc6dbb0e3ff45ac8	prod-nginx-sg	vpc-04987f3769046194d	Allow HTTP &

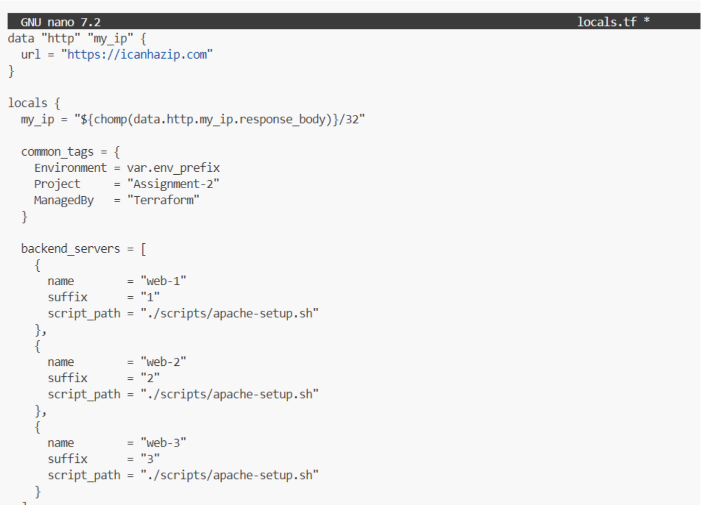
Select a security group

1.5 Local Configuration

Screenshot: assignment_part1_locals_tf.png



```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ nano locals.tf
```

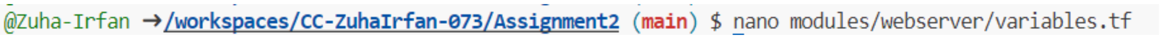


```
  GNU nano 7.2                                                         locals.tf *
data "http" "my_ip" {
  url = "https://icanhazip.com"
}

locals {
  my_ip = "${chomp(data.http.my_ip.response_body)}/32"

  common_tags = {
    Environment = var.env_prefix
    Project     = "Assignment-2"
    ManagedBy   = "Terraform"
  }

  backend_servers = [
    {
      name        = "web-1"
      suffix      = "1"
      script_path = "./scripts/apache-setup.sh"
    },
    {
      name        = "web-2"
      suffix      = "2"
      script_path = "./scripts/apache-setup.sh"
    },
    {
      name        = "web-3"
      suffix      = "3"
      script_path = "./scripts/apache-setup.sh"
    }
```

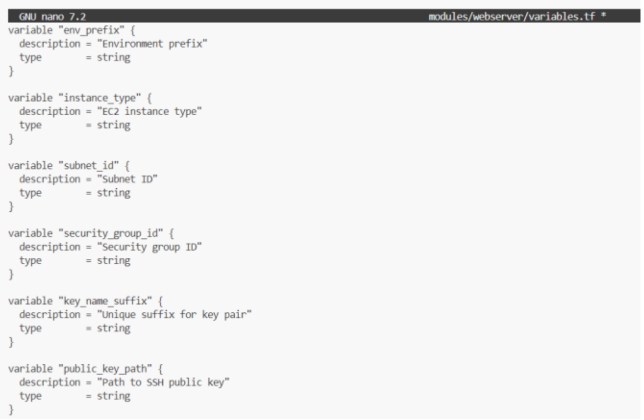
Phase 2: Webserver Module

21.Generate Webserver Module

Screenshot: assignment_part2_webserver_module_variables.png

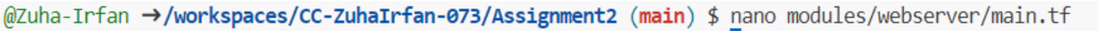


```
@Zuha-Irfan ➜ /workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ nano modules/webserver/variables.tf
```

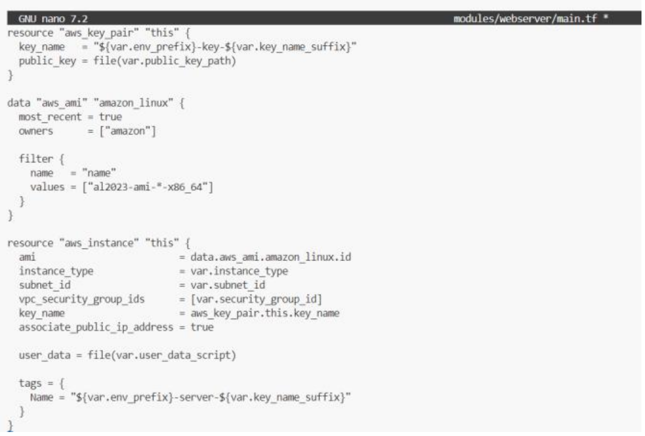


```
  GNU nano 7.2                                     modules/webserver/variables.tf *
variable "env_prefix" {
  description = "Environment prefix"
  type        = string
}

variable "instance_type" {
  description = "EC2 instance type"
  type        = string
}

variable "subnet_id" {
  description = "Subnet ID"
  type        = string
}

variable "security_group_id" {
  description = "Security group ID"
  type        = string
}

variable "key_name_suffix" {
  description = "Unique suffix for key pair"
  type        = string
}

variable "public_key_path" {
  description = "Path to SSH public key"
  type        = string
}
```

Screenshot: assignment_part2_webserver_module_ main.png

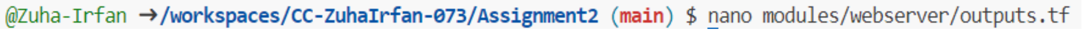


```
@Zuha-Irfan ➜ /workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ nano modules/webserver/main.tf
```

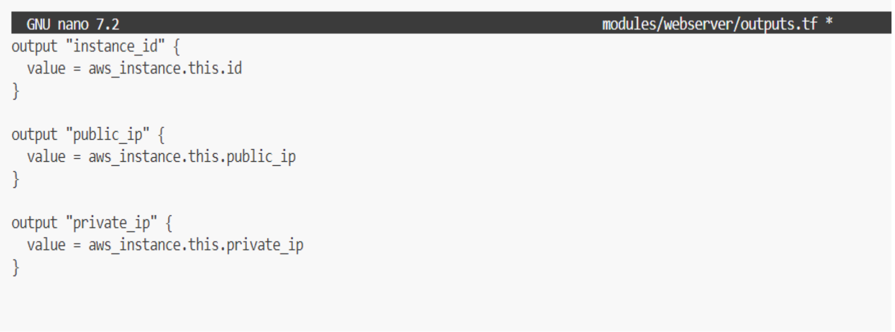


```
 GNU nano 7.2                                                    modules/webserver/main.tf *
resource "aws_key_pair" "this" {
  key_name   = "${var.env_prefix}-key-${var.key_name_suffix}"
  public_key = file(var.public_key_path)
}

data "aws_ami" "amazon_linux" {
  most_recent = true
  owners      = ["amazon"]

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

resource "aws_instance" "this" {
  ami                         = data.aws_ami.amazon_linux.id
  instance_type               = var.instance_type
  subnet_id                   = var.subnet_id
  vpc_security_group_ids      = [var.security_group_id]
  key_name                    = aws_key_pair.this.key_name
  associate_public_ip_address = true

  user_data = file(var.user_data_script)

  tags = {
    Name = "${var.env_prefix}-server-${var.key_name_suffix}"
  }
}
```

Screenshot: assignment_part2_webserver_module_ outputs.png



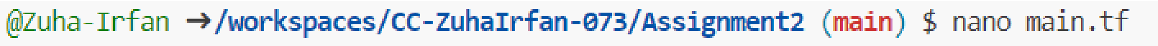
```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ nano modules/webserver/outputs.tf
```



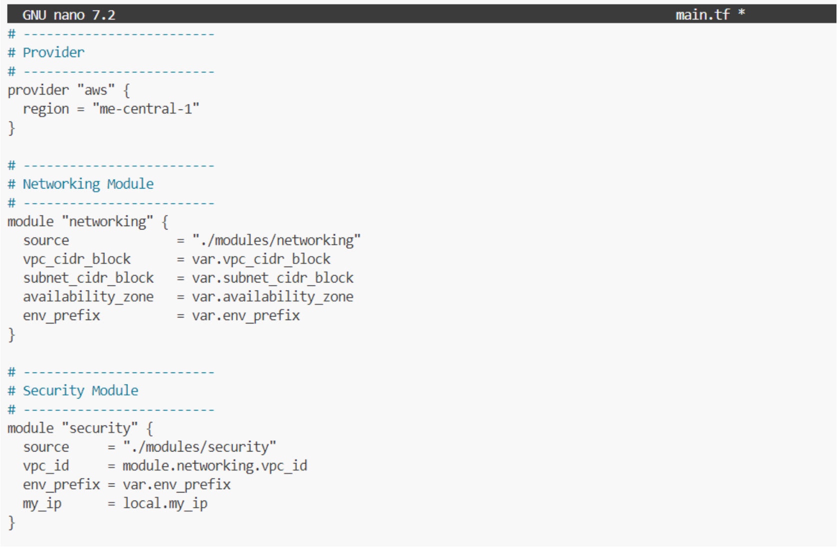
```
 GNU nano 7.2                                          modules/webserver/outputs.tf *
output "instance_id" {
  value = aws_instance.this.id
}

output "public_ip" {
  value = aws_instance.this.public_ip
}

output "private_ip" {
  value = aws_instance.this.private_ip
}
```

2.2 Use Module in Root main.tf

Screenshot: assignment_part2_main_tf_modules.png



```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ nano main.tf
```

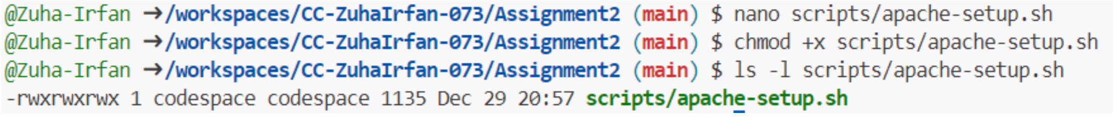


```
 GNU nano 7.2                                                      main.tf *
# ------------------------
# Provider
# ------------------------
provider "aws" {
  region = "me-central-1"
}

# ------------------------
# Networking Module
# ------------------------
module "networking" {
  source             = "./modules/networking"
  vpc_cidr_block     = var.vpc_cidr_block
  subnet_cidr_block  = var.subnet_cidr_block
  availability_zone  = var.availability_zone
  env_prefix         = var.env_prefix
}

# ------------------------
# Security Module
# ------------------------
module "security" {
  source     = "./modules/security"
  vpc_id     = module.networking.vpc_id
  env_prefix = var.env_prefix
  my_ip      = local.my_ip
}
```

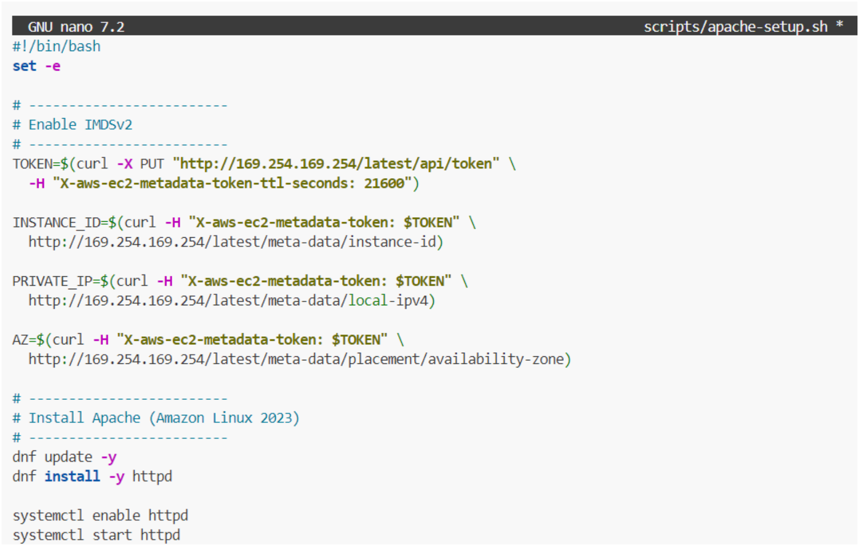
Phase 3: Server Configuration Scripts

3.1 Apache Script

Screenshot: assignment_part3_apache_script.png

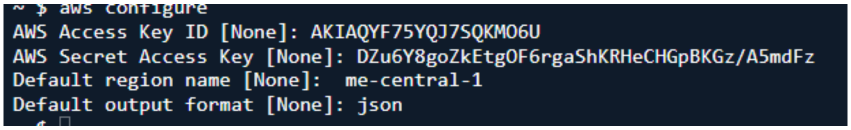


```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ nano scripts/apache-setup.sh
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ chmod +x scripts/apache-setup.sh
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ ls -l scripts/apache-setup.sh
-rwxrwxrwx 1 codespace codespace 1135 Dec 29 20:57 scripts/apache-setup.sh
```

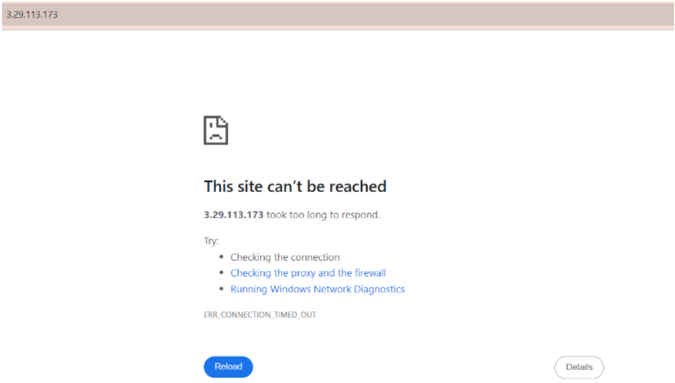


```
  GNU nano 7.2                                                 scripts/apache-setup.sh *
#!/bin/bash
set -e

# ------------------------
# Enable IMDSv2
# ------------------------
TOKEN=$(curl -X PUT "http://169.254.169.254/latest/api/token" \
  -H "X-aws-ec2-metadata-token-ttl-seconds: 21600")

INSTANCE_ID=$(curl -H "X-aws-ec2-metadata-token: $TOKEN" \
  http://169.254.169.254/latest/meta-data/instance-id)

PRIVATE_IP=$(curl -H "X-aws-ec2-metadata-token: $TOKEN" \
  http://169.254.169.254/latest/meta-data/local-ipv4)

AZ=$(curl -H "X-aws-ec2-metadata-token: $TOKEN" \
  http://169.254.169.254/latest/meta-data/placement/availability-zone)

# ------------------------
# Install Apache (Amazon Linux 2023)
# ------------------------
dnf update -y
dnf install -y httpd

systemctl enable httpd
systemctl start httpd
```

Screenshot: assignment_part3_backend_webpage.png



```
~ $ aws configure
AWS Access Key ID [None]: AKIAQYF75YQJ7SQKMO6U
AWS Secret Access Key [None]: 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
Default region name [None]:  me-central-1
Default output format [None]: json
```



3.29.113.173

This site can’t be reached

3.29.113.173 took too long to respond.

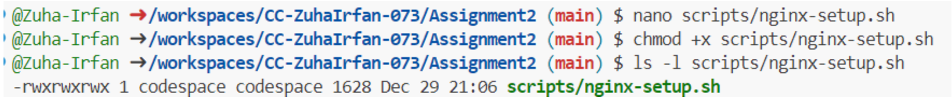
Try:

- Checking the connection
- Checking the proxy and the firewall
- Running Windows Network Diagnostics

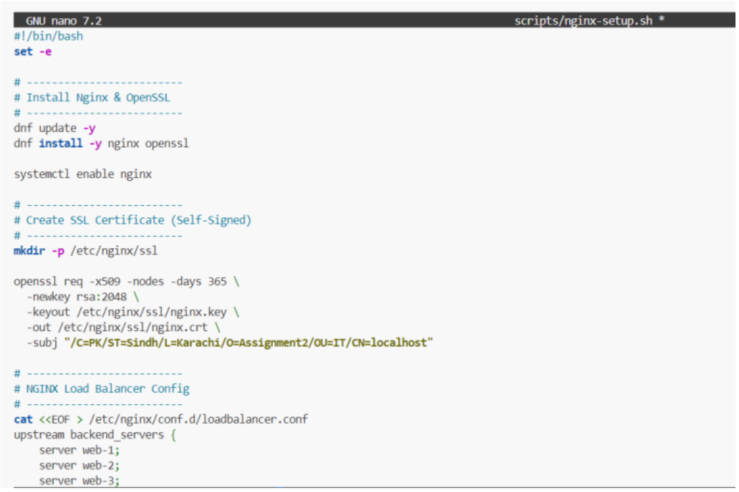
ERR_CONNECTION_TIMED_OUT

3.2 Nginx Script

Screenshot: assignment_part3_nginx_script.png



```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ nano scripts/nginx-setup.sh
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ chmod +x scripts/nginx-setup.sh
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ ls -l scripts/nginx-setup.sh
-rwxrwxrwx 1 codespace codespace 1628 Dec 29 21:06 scripts/nginx-setup.sh
```

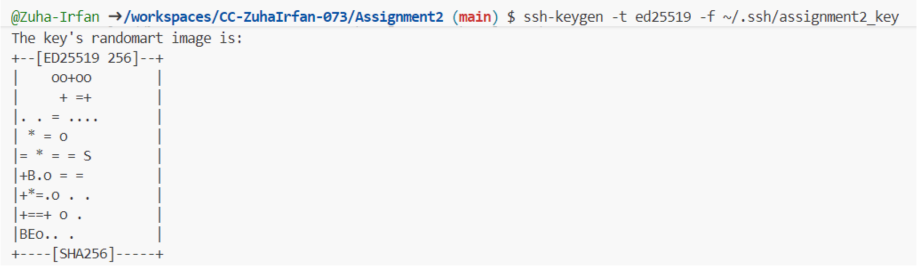


```
GNU nano 7.2                                          scripts/nginx-setup.sh *
#!/bin/bash
set -e

# ------------------------
# Install Nginx & OpenSSL
# ------------------------
dnf update -y
dnf install -y nginx openssl

systemctl enable nginx

# ------------------------
# Create SSL Certificate (Self-Signed)
# ------------------------
mkdir -p /etc/nginx/ssl

openssl req -x509 -nodes -days 365 \
  -newkey rsa:2048 \
  -keyout /etc/nginx/ssl/nginx.key \
  -out /etc/nginx/ssl/nginx.crt \
  -subj "/C=PK/ST=Sindh/L=Karachi/O=Assignment2/OU=IT/CN=localhost"

# ------------------------
# NGINX Load Balancer Config
# ------------------------
cat <<EOF > /etc/nginx/conf.d/loadbalancer.conf
upstream backend_servers {
    server web-1;
    server web-2;
    server web-3;
```

Phase 4: Infrastructure Deployment

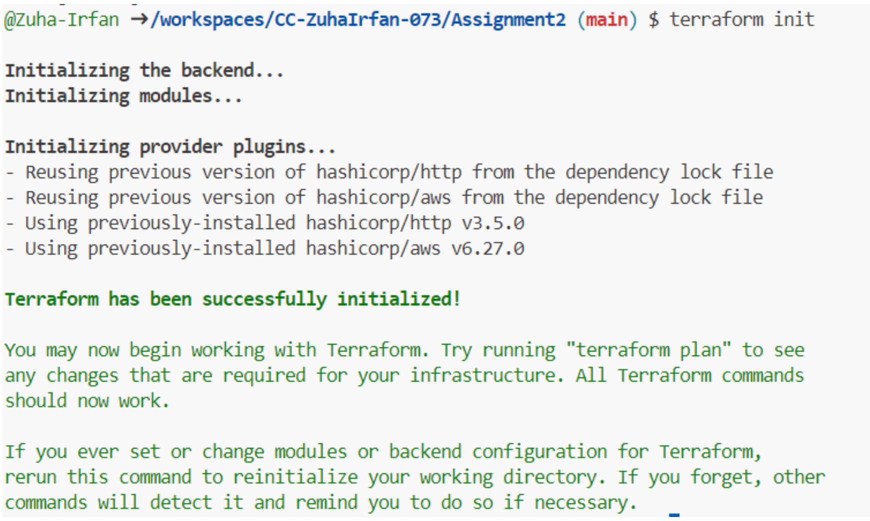
4.1 Terraform Commands

Screenshot: assignment_part4_ssh_keygen.png



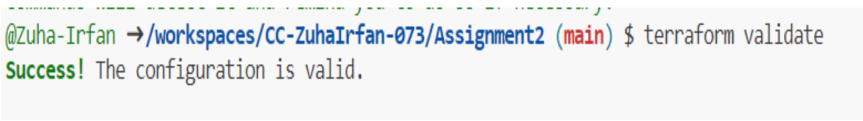
```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ ssh-keygen -t ed25519 -f ~/.ssh/assignment2_key
The key's randomart image is:
+--[ED25519 256]--+
|    oo+oo        |
|     + =+        |
|. . = ....       |
| * = o           |
|= * = = S        |
|+B.o = =         |
|+*=.o . .        |
|+==+ o .         |
|BEo.. .          |
+----[SHA256]-----+
```

Screenshot: assignment_part4_terraform_init.png



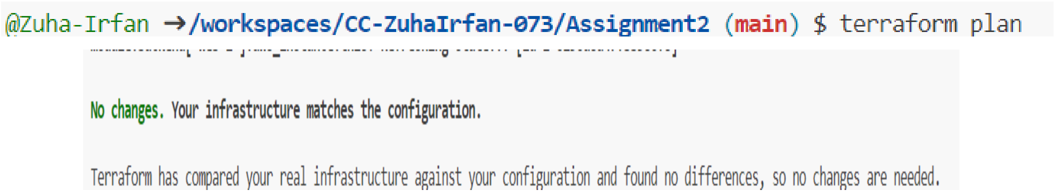
```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ terraform init

Initializing the backend...
Initializing modules...

Initializing provider plugins...
- Reusing previous version of hashicorp/http from the dependency lock file
- Reusing previous version of hashicorp/aws from the dependency lock file
- Using previously-installed hashicorp/http v3.5.0
- Using previously-installed hashicorp/aws v6.27.0

Terraform has been successfully initialized!

You may now begin working with Terraform. Try running "terraform plan" to see
any changes that are required for your infrastructure. All Terraform commands
should now work.

If you ever set or change modules or backend configuration for Terraform,
rerun this command to reinitialize your working directory. If you forget, other
commands will detect it and remind you to do so if necessary.
```

Screenshot: assignment_part4_terraform_validate.png



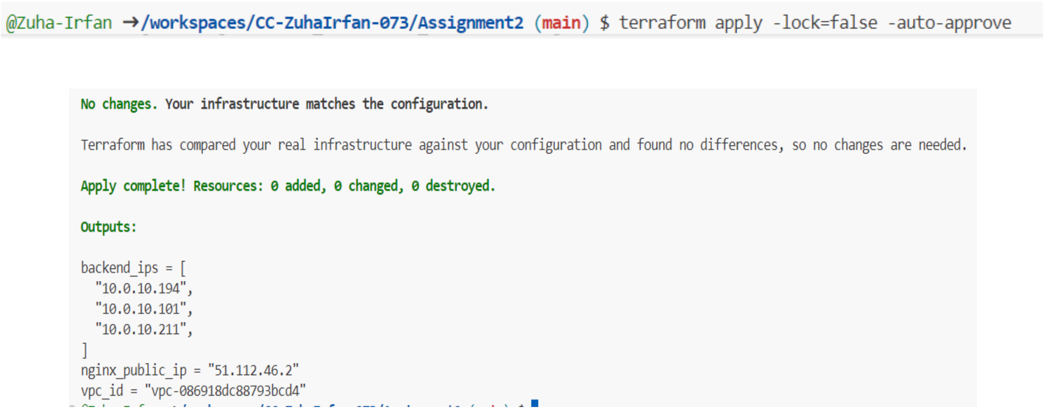
```
commands will detect it and remind you to do so if necessary.
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ terraform validate
Success! The configuration is valid.
```

Screenshot: assignment_part4_terraform_plan.png



```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ terraform plan

No changes. Your infrastructure matches the configuration.

Terraform has compared your real infrastructure against your configuration and found no differences, so no changes are needed.
```

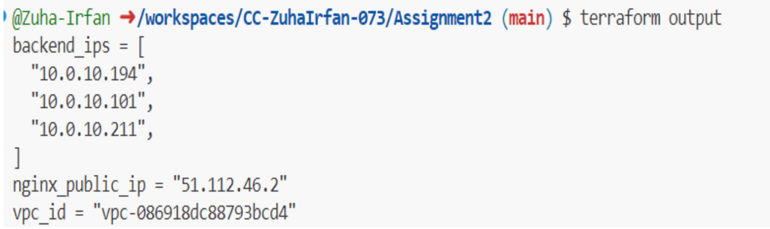
Screenshot: assignment_part4_terraform_apply.png



```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ terraform apply -lock=false -auto-approve

No changes. Your infrastructure matches the configuration.

Terraform has compared your real infrastructure against your configuration and found no differences, so no changes are needed.

Apply complete! Resources: 0 added, 0 changed, 0 destroyed.

Outputs:

backend_ips = [
  "10.0.10.194",
  "10.0.10.101",
  "10.0.10.211",
]
nginx_public_ip = "51.112.46.2"
vpc_id = "vpc-086918dc88793bcd4"
```

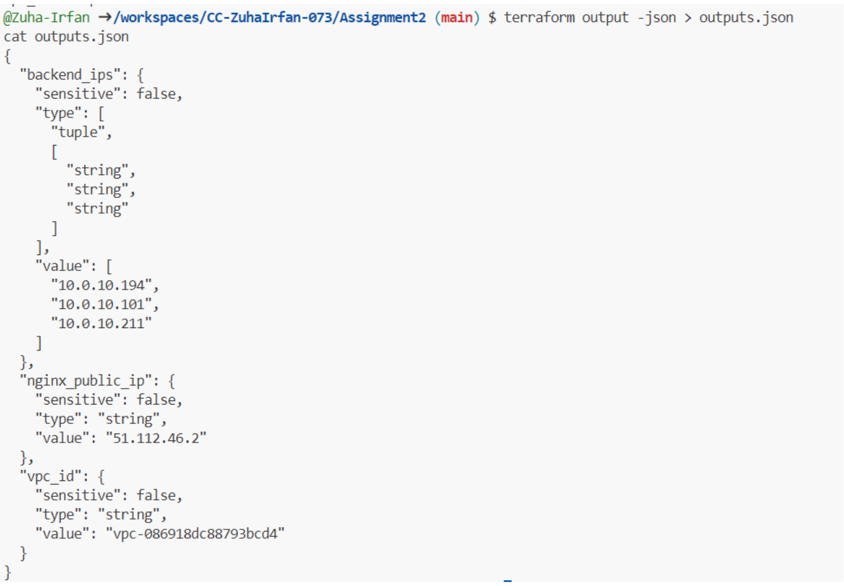
4.2 Outputs

Screenshot: assignment_part4_terraform_output.png



```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ terraform output
backend_ips = [
  "10.0.10.194",
  "10.0.10.101",
  "10.0.10.211",
]
nginx_public_ip = "51.112.46.2"
vpc_id = "vpc-086918dc88793bcd4"
```

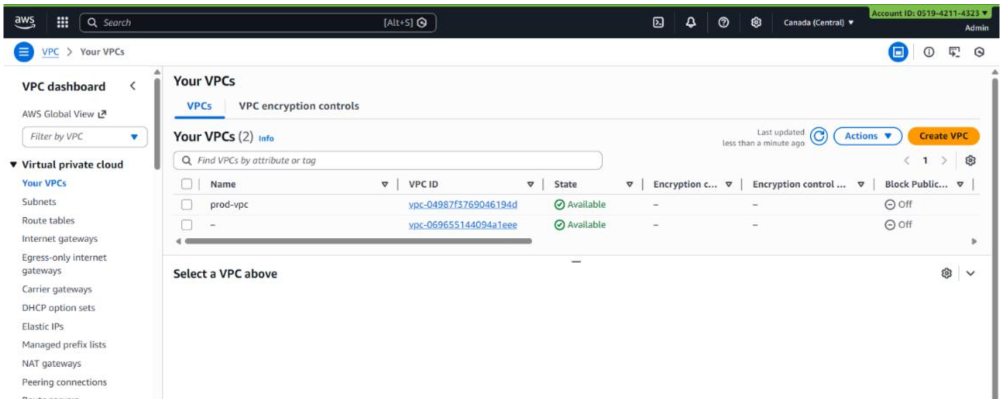
Screenshot: assignment_part4_outputs_json.png



```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ terraform output -json > outputs.json
cat outputs.json
{
  "backend_ips": {
    "sensitive": false,
    "type": [
      "tuple",
      [
        "string",
        "string",
        "string"
      ]
    ],
    "value": [
      "10.0.10.194",
      "10.0.10.101",
      "10.0.10.211"
    ]
  },
  "nginx_public_ip": {
    "sensitive": false,
    "type": "string",
    "value": "51.112.46.2"
  },
  "vpc_id": {
    "sensitive": false,
    "type": "string",
    "value": "vpc-086918dc88793bcd4"
  }
}
```

4.3 AWS Console Verification

Screenshot: assignment_part4_aws_vpc.png



Your VPCs

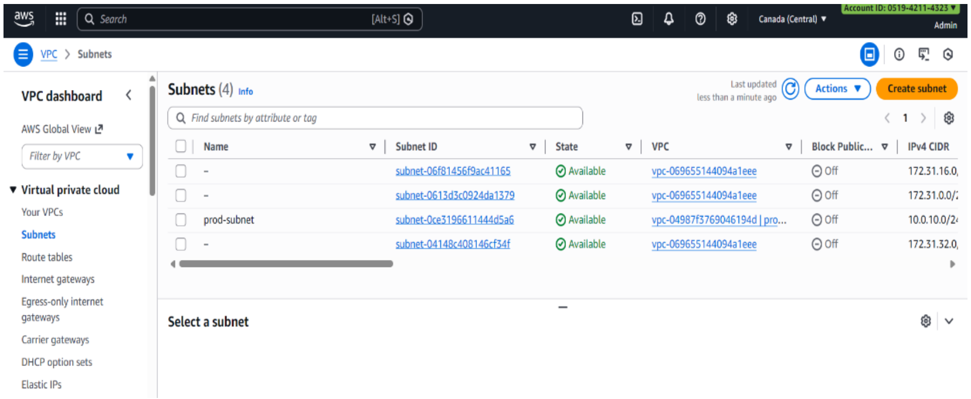
Your VPCs (2) Info

Last updated less than a minute ago

□	Name	VPC ID	State	Encryption c...	Encryption control ...	Block Public...
□	prod-vpc	vpc-04987f3769046194d	✓ Available	–	–	Off
□	–	vpc-069655144094a1eee	✓ Available	–	–	Off

Select a VPC above

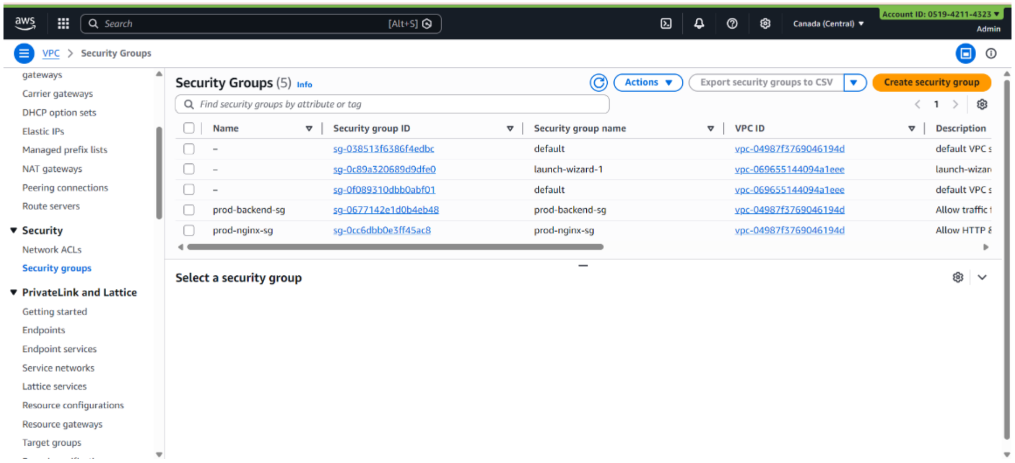
Screenshot: assignment_part4_aws_subnet.png



Subnets (4)

Name	Subnet ID	State	VPC	Block Public...	IPv4 CIDR
-	subnet-06f81456f9ac41165	Available	vpc-069655144094a1eee	Off	172.31.16.0,
-	subnet-0613d3c0924da1379	Available	vpc-069655144094a1eee	Off	172.31.0.0/:
prod-subnet	subnet-0ce3196611444d5a6	Available	vpc-04987f3769046194d | pro...	Off	10.0.10.0/2
-	subnet-04148c408146cf34f	Available	vpc-069655144094a1eee	Off	172.31.32.0,

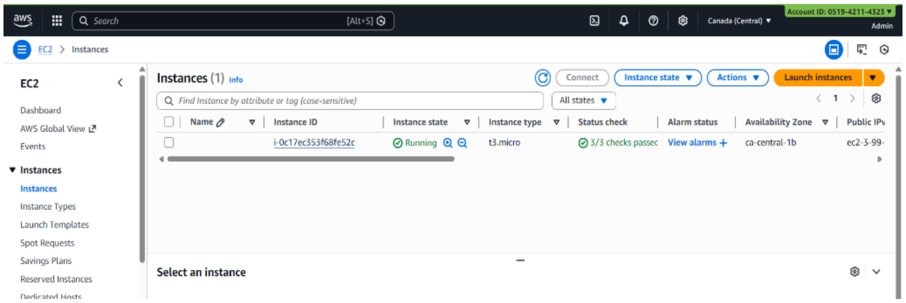
Screenshot: assignment_part4_aws_security_groups.png



Security Groups (5)

Name	Security group ID	Security group name	VPC ID	Description
-	sg-038513f6386f4edbc	default	vpc-04987f3769046194d	default VPC s
-	sg-0c89a320689d9dfe0	launch-wizard-1	vpc-069655144094a1eee	launch-wizar
-	sg-0f089310dbb0abf01	default	vpc-069655144094a1eee	default VPC s
prod-backend-sg	sg-0677142e1d0b4eb48	prod-backend-sg	vpc-04987f3769046194d	Allow traffic t
prod-nginx-sg	sg-0cc6dbb0e3ff45ac8	prod-nginx-sg	vpc-04987f3769046194d	Allow HTTP &

Screenshot: assignment_part4_aws_instances.png



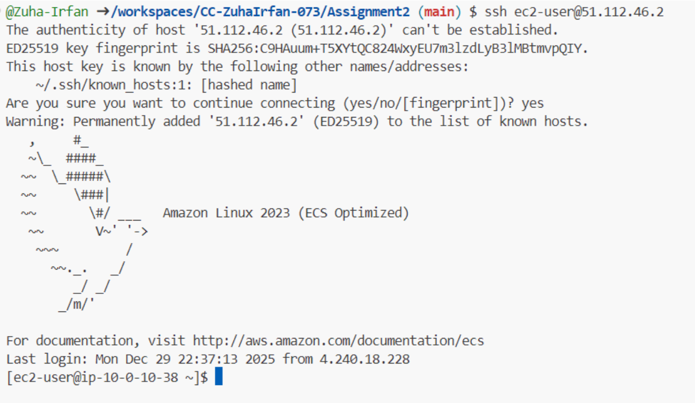
Instances (1)

Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Availability Zone	Public IPv
	i-0c17ec353f68fe52c	Running	t3.micro	3/3 checks passec	View alarms +	ca-central-1b	ec2-3-99-

Phase 5: Nginx Configuration

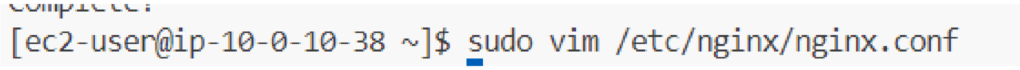
5.1 Update Backend IPs

Screenshot: assignment_part5_ssh_nginx.png

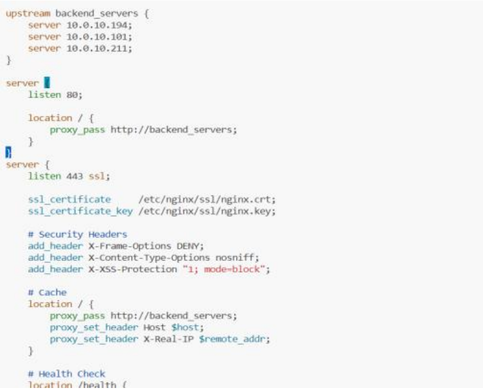


```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ ssh ec2-user@51.112.46.2
The authenticity of host '51.112.46.2 (51.112.46.2)' can't be established.
ED25519 key fingerprint is SHA256:C9HAuum+T5XYtQC824WxyEU7m3lzdLyB3lMBtmvpQIY.
This host key is known by the following other names/addresses:
    ~/.ssh/known_hosts:1: [hashed name]
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '51.112.46.2' (ED25519) to the list of known hosts.
   ,     #_
   ~\_  ####_
  ~~  \_#####\
  ~~     \###|
  ~~       \#/ ___   Amazon Linux 2023 (ECS Optimized)
   ~~       V~' '->
    ~~~         /
      ~~._.   _/
         _/ _/
       _/m/'

For documentation, visit http://aws.amazon.com/documentation/ecs
Last login: Mon Dec 29 22:37:13 2025 from 4.240.18.228
[ec2-user@ip-10-0-10-38 ~]$
```

Screenshot: assignment_part5_nginx_conf_updated.png

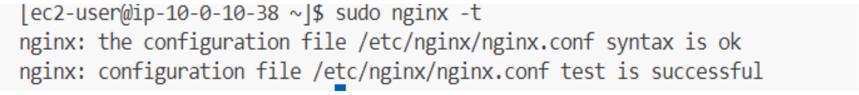


```
complete!
[ec2-user@ip-10-0-10-38 ~]$ sudo vim /etc/nginx/nginx.conf
```



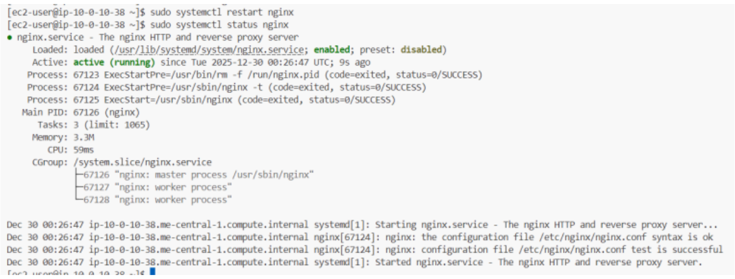
```
upstream backend_servers {
    server 10.0.10.194;
    server 10.0.10.101;
    server 10.0.10.211;
}

server {
    listen 80;

    location / {
        proxy_pass http://backend_servers;
    }
}
server {
    listen 443 ssl;

    ssl_certificate     /etc/nginx/ssl/nginx.crt;
    ssl_certificate_key /etc/nginx/ssl/nginx.key;

    # Security Headers
    add_header X-Frame-Options DENY;
    add_header X-Content-Type-Options nosniff;
    add_header X-XSS-Protection "1; mode=block";

    # Cache
    location / {
        proxy_pass http://backend_servers;
        proxy_set_header Host $host;
        proxy_set_header X-Real-IP $remote_addr;
    }

    # Health Check
    location /health {
```

Screenshot: assignment_part5_nginx_test.png



```
[ec2-user@ip-10-0-10-38 ~]$ sudo nginx -t
nginx: the configuration file /etc/nginx/nginx.conf syntax is ok
nginx: configuration file /etc/nginx/nginx.conf test is successful
```

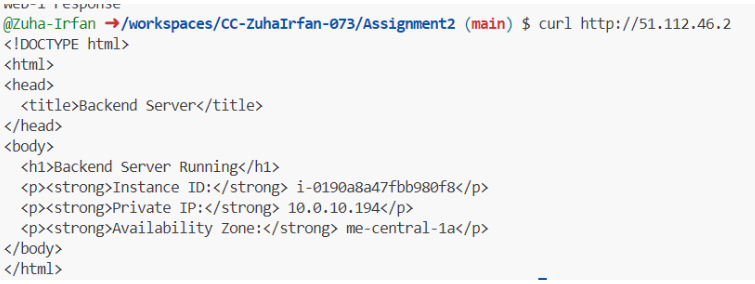
Screenshot: assignment_part5_nginx_restart.png



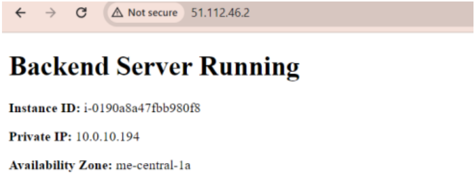
```
[ec2-user@ip-10-0-10-38 ~]$ sudo systemctl restart nginx
[ec2-user@ip-10-0-10-38 ~]$ sudo systemctl status nginx
● nginx.service - The nginx HTTP and reverse proxy server
     Loaded: loaded (/usr/lib/systemd/system/nginx.service; enabled; preset: disabled)
     Active: active (running) since Tue 2025-12-30 00:26:47 UTC; 9s ago
    Process: 67123 ExecStartPre=/usr/bin/rm -f /run/nginx.pid (code=exited, status=0/SUCCESS)
    Process: 67124 ExecStartPre=/usr/sbin/nginx -t (code=exited, status=0/SUCCESS)
    Process: 67125 ExecStart=/usr/sbin/nginx (code=exited, status=0/SUCCESS)
   Main PID: 67126 (nginx)
      Tasks: 3 (limit: 1065)
     Memory: 3.3M
        CPU: 59ms
     CGroup: /system.slice/nginx.service
             ├─67126 "nginx: master process /usr/sbin/nginx"
             ├─67127 "nginx: worker process"
             └─67128 "nginx: worker process"

Dec 30 00:26:47 ip-10-0-10-38.me-central-1.compute.internal systemd[1]: Starting nginx.service - The nginx HTTP and reverse proxy server...
Dec 30 00:26:47 ip-10-0-10-38.me-central-1.compute.internal nginx[67124]: nginx: the configuration file /etc/nginx/nginx.conf syntax is ok
Dec 30 00:26:47 ip-10-0-10-38.me-central-1.compute.internal nginx[67124]: nginx: configuration file /etc/nginx/nginx.conf test is successful
Dec 30 00:26:47 ip-10-0-10-38.me-central-1.compute.internal systemd[1]: Started nginx.service - The nginx HTTP and reverse proxy server.
[ec2-user@ip-10-0-10-38 ~]$
```

5.2 Load Balancing Test

Screenshot: SSL warning



```
web-1 response
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ curl http://51.112.46.2
<!DOCTYPE html>
<html>
<head>
  <title>Backend Server</title>
</head>
<body>
  <h1>Backend Server Running</h1>
  <p><strong>Instance ID:</strong> i-0190a8a47fbb980f8</p>
  <p><strong>Private IP:</strong> 10.0.10.194</p>
  <p><strong>Availability Zone:</strong> me-central-1a</p>
</body>
</html>
```



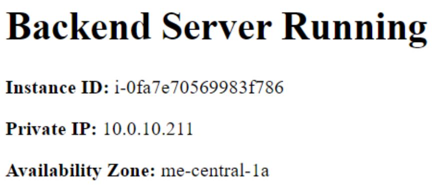
Backend Server Running

Instance ID: i-0190a8a47fbb980f8

Private IP: 10.0.10.194

Availability Zone: me-central-1a

Screenshot: web-1 response



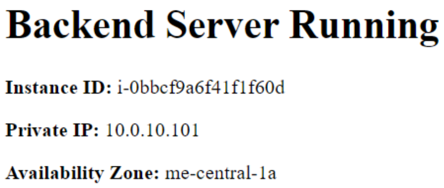
Backend Server Running

Instance ID: i-0fa7e70569983f786

Private IP: 10.0.10.211

Availability Zone: me-central-1a

Screenshot: web-2 response



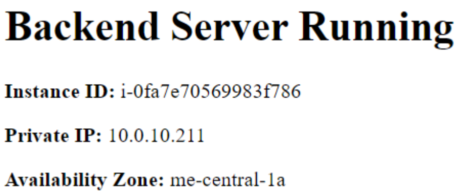
Backend Server Running

Instance ID: i-0bbcf9a6f41f1f60d

Private IP: 10.0.10.101

Availability Zone: me-central-1a

Screenshot: load balancing proof



Backend Server Running

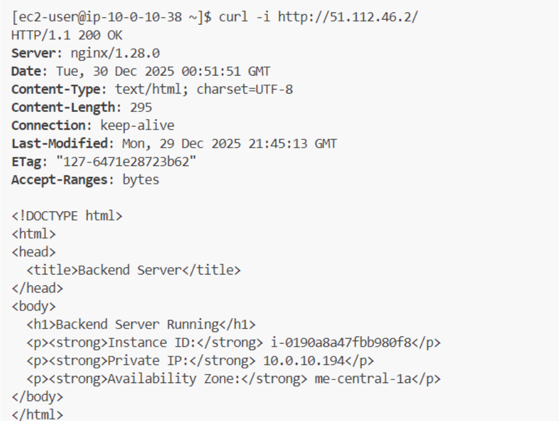
Instance ID: i-0fa7e70569983f786

Private IP: 10.0.10.211

Availability Zone: me-central-1a

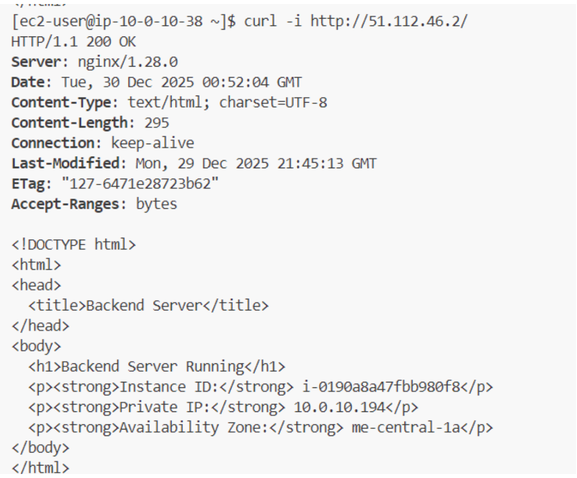
5.3 Cache Test

Screenshot: Cache MISS



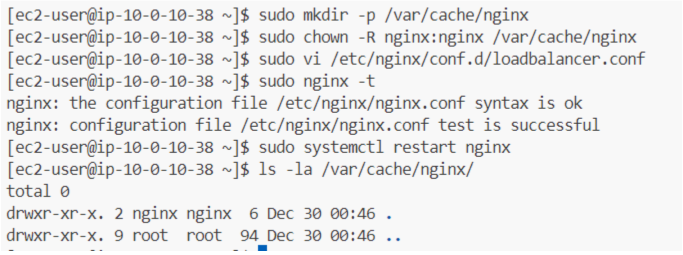
```
[ec2-user@ip-10-0-10-38 ~]$ curl -i http://51.112.46.2/
HTTP/1.1 200 OK
Server: nginx/1.28.0
Date: Tue, 30 Dec 2025 00:51:51 GMT
Content-Type: text/html; charset=UTF-8
Content-Length: 295
Connection: keep-alive
Last-Modified: Mon, 29 Dec 2025 21:45:13 GMT
ETag: "127-6471e28723b62"
Accept-Ranges: bytes

<!DOCTYPE html>
<html>
<head>
  <title>Backend Server</title>
</head>
<body>
  <h1>Backend Server Running</h1>
  <p><strong>Instance ID:</strong> i-0190a8a47fbb980f8</p>
  <p><strong>Private IP:</strong> 10.0.10.194</p>
  <p><strong>Availability Zone:</strong> me-central-1a</p>
</body>
</html>
```

Screenshot: Cache HIT



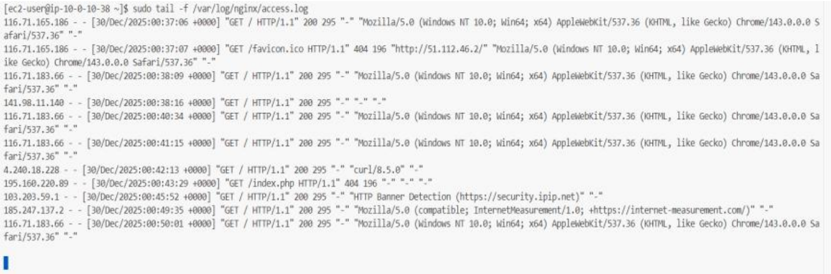
```
[ec2-user@ip-10-0-10-38 ~]$ curl -i http://51.112.46.2/
HTTP/1.1 200 OK
Server: nginx/1.28.0
Date: Tue, 30 Dec 2025 00:52:04 GMT
Content-Type: text/html; charset=UTF-8
Content-Length: 295
Connection: keep-alive
Last-Modified: Mon, 29 Dec 2025 21:45:13 GMT
ETag: "127-6471e28723b62"
Accept-Ranges: bytes

<!DOCTYPE html>
<html>
<head>
  <title>Backend Server</title>
</head>
<body>
  <h1>Backend Server Running</h1>
  <p><strong>Instance ID:</strong> i-0190a8a47fbb980f8</p>
  <p><strong>Private IP:</strong> 10.0.10.194</p>
  <p><strong>Availability Zone:</strong> me-central-1a</p>
</body>
</html>
```

Screenshot: Cache directory



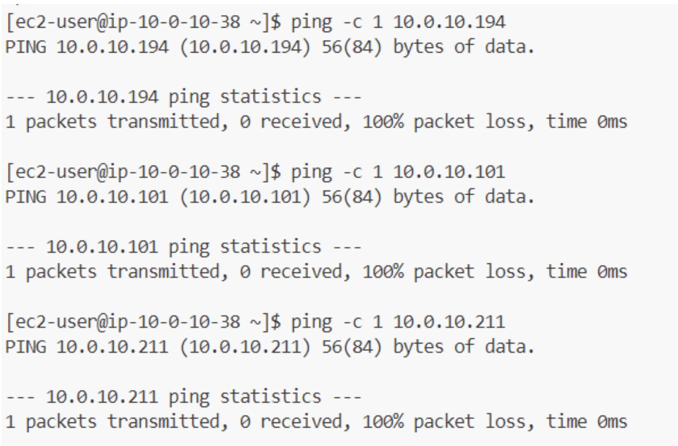
```
[ec2-user@ip-10-0-10-38 ~]$ sudo mkdir -p /var/cache/nginx
[ec2-user@ip-10-0-10-38 ~]$ sudo chown -R nginx:nginx /var/cache/nginx
[ec2-user@ip-10-0-10-38 ~]$ sudo vi /etc/nginx/conf.d/loadbalancer.conf
[ec2-user@ip-10-0-10-38 ~]$ sudo nginx -t
nginx: the configuration file /etc/nginx/nginx.conf syntax is ok
nginx: configuration file /etc/nginx/nginx.conf test is successful
[ec2-user@ip-10-0-10-38 ~]$ sudo systemctl restart nginx
[ec2-user@ip-10-0-10-38 ~]$ ls -la /var/cache/nginx/
total 0
drwxr-xr-x. 2 nginx nginx  6 Dec 30 00:46 .
drwxr-xr-x. 9 root  root  94 Dec 30 00:46 ..
```

Screenshot: Access log



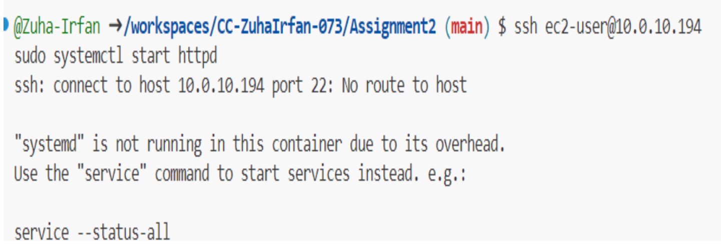
```
[ec2-user@ip-10-0-10-38 ~]$ sudo tail -f /var/log/nginx/access.log
116.71.165.186 - - [30/Dec/2025:00:37:06 +0000] "GET / HTTP/1.1" 200 295 "-" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/143.0.0.0 S
afari/537.36" "-"
116.71.165.186 - - [30/Dec/2025:00:37:07 +0000] "GET /favicon.ico HTTP/1.1" 404 196 "http://51.112.46.2/" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, l
ike Gecko) Chrome/143.0.0.0 Safari/537.36" "-"
116.71.183.66 - - [30/Dec/2025:00:38:09 +0000] "GET / HTTP/1.1" 200 295 "-" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/143.0.0.0 Sa
fari/537.36" "-"
141.98.11.140 - - [30/Dec/2025:00:38:16 +0000] "GET / HTTP/1.1" 200 295 "-" "-" "-"
116.71.183.66 - - [30/Dec/2025:00:40:34 +0000] "GET / HTTP/1.1" 200 295 "-" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/143.0.0.0 Sa
fari/537.36" "-"
116.71.183.66 - - [30/Dec/2025:00:41:15 +0000] "GET / HTTP/1.1" 200 295 "-" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/143.0.0.0 Sa
fari/537.36" "-"
4.240.18.228 - - [30/Dec/2025:00:42:13 +0000] "GET / HTTP/1.1" 200 295 "-" "curl/8.5.0" "-"
195.160.220.89 - - [30/Dec/2025:00:43:29 +0000] "GET /index.php HTTP/1.1" 404 196 "-" "-" "-"
103.203.59.1 - - [30/Dec/2025:00:45:52 +0000] "GET / HTTP/1.1" 200 295 "-" "HTTP Banner Detection (https://security.ipip.net)" "-"
185.247.137.2 - - [30/Dec/2025:00:49:35 +0000] "GET / HTTP/1.1" 200 295 "-" "Mozilla/5.0 (compatible; InternetMeasurement/1.0; +https://internet-measurement.com/)" "-"
116.71.183.66 - - [30/Dec/2025:00:50:01 +0000] "GET / HTTP/1.1" 200 295 "-" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/143.0.0.0 Sa
fari/537.36" "-"
```

5.4 High Availability Test



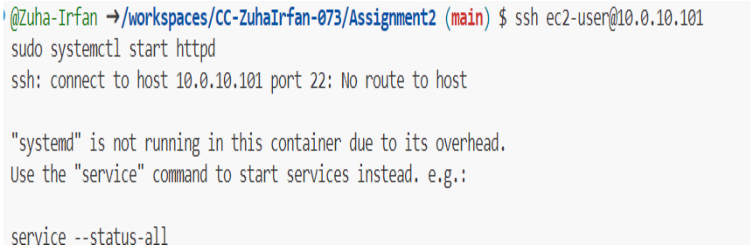
```
[ec2-user@ip-10-0-10-38 ~]$ ping -c 1 10.0.10.194
PING 10.0.10.194 (10.0.10.194) 56(84) bytes of data.

--- 10.0.10.194 ping statistics ---
1 packets transmitted, 0 received, 100% packet loss, time 0ms

[ec2-user@ip-10-0-10-38 ~]$ ping -c 1 10.0.10.101
PING 10.0.10.101 (10.0.10.101) 56(84) bytes of data.

--- 10.0.10.101 ping statistics ---
1 packets transmitted, 0 received, 100% packet loss, time 0ms

[ec2-user@ip-10-0-10-38 ~]$ ping -c 1 10.0.10.211
PING 10.0.10.211 (10.0.10.211) 56(84) bytes of data.

--- 10.0.10.211 ping statistics ---
1 packets transmitted, 0 received, 100% packet loss, time 0ms
```

Screenshot: web-1 stopped



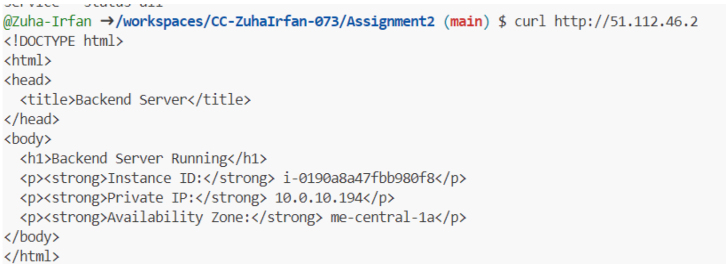
```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ ssh ec2-user@10.0.10.194
sudo systemctl start httpd
ssh: connect to host 10.0.10.194 port 22: No route to host

"systemd" is not running in this container due to its overhead.
Use the "service" command to start services instead. e.g.:

service --status-all
```

Screenshot: web-2 stopped



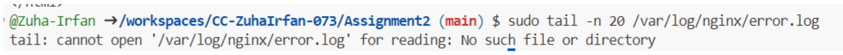
```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ ssh ec2-user@10.0.10.101
sudo systemctl start httpd
ssh: connect to host 10.0.10.101 port 22: No route to host

"systemd" is not running in this container due to its overhead.
Use the "service" command to start services instead. e.g.:

service --status-all
```

Screenshot: backup activated



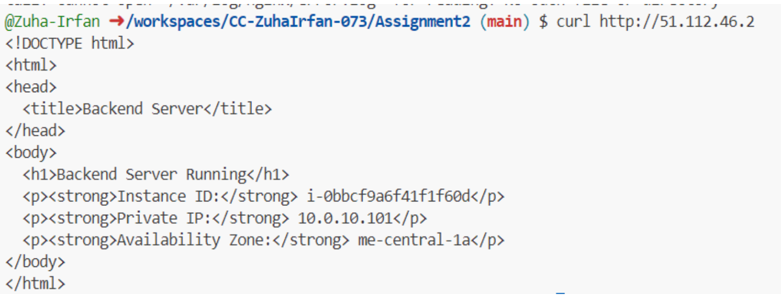
```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ curl http://51.112.46.2
<!DOCTYPE html>
<html>
<head>
  <title>Backend Server</title>
</head>
<body>
  <h1>Backend Server Running</h1>
  <p><strong>Instance ID:</strong> i-0190a8a47fbb980f8</p>
  <p><strong>Private IP:</strong> 10.0.10.194</p>
  <p><strong>Availability Zone:</strong> me-central-1a</p>
</body>
</html>
```

Screenshot: nginx error log



```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ sudo tail -n 20 /var/log/nginx/error.log
tail: cannot open '/var/log/nginx/error.log' for reading: No such file or directory
```

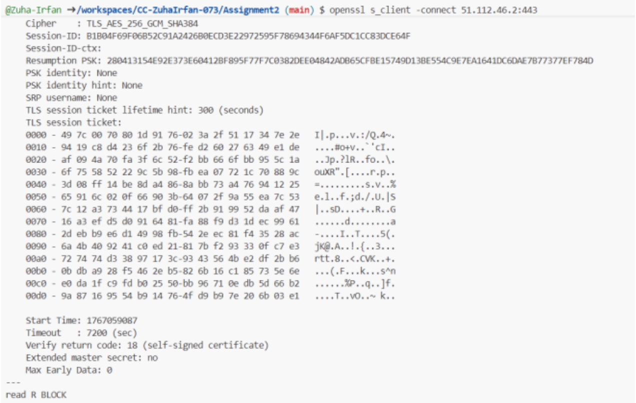
Screenshot: services restored



```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ curl http://51.112.46.2
<!DOCTYPE html>
<html>
<head>
  <title>Backend Server</title>
</head>
<body>
  <h1>Backend Server Running</h1>
  <p><strong>Instance ID:</strong> i-0bbcf9a6f41f1f60d</p>
  <p><strong>Private IP:</strong> 10.0.10.101</p>
  <p><strong>Availability Zone:</strong> me-central-1a</p>
</body>
</html>
```

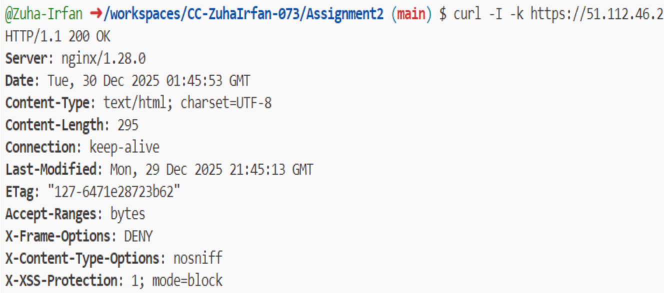
5.5 Security & Performance

Screenshot: SSL cert



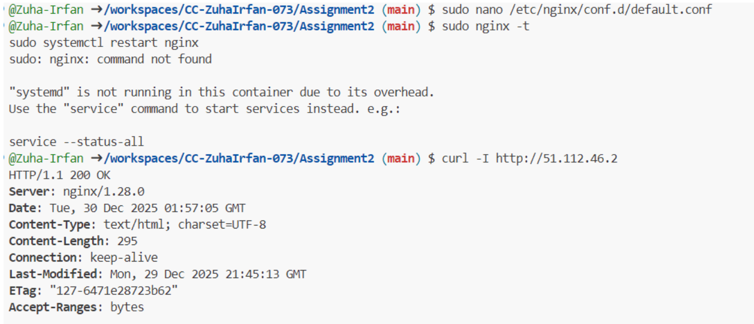
```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ openssl s_client -connect 51.112.46.2:443
    Cipher    : TLS_AES_256_GCM_SHA384
    Session-ID: B1B04F69F06B52C91A2426B0ECD3E22972595F78694344F6AF5DC1CC83DCE64F
    Session-ID-ctx:
    Resumption PSK: 280413154E92E373E60412BF895F77F7C0382DEE04842ADB65CFBE15749D13BE554C9E7EA1641DC6DAE7B77377EF784D
    PSK identity: None
    PSK identity hint: None
    SRP username: None
    TLS session ticket lifetime hint: 300 (seconds)
    TLS session ticket:
    0000 - 49 7c 00 70 80 1d 91 76-02 3a 2f 51 17 34 7e 2e   I|.p...v.:/Q.4~.
    0010 - 94 19 c8 d4 23 6f 2b 76-fe d2 60 27 63 49 e1 de   ....#o+v..`'cI..
    0020 - af 09 4a 70 fa 3f 6c 52-f2 bb 66 6f bb 95 5c 1a   ..Jp.?lR..fo..\.
    0030 - 6f 75 58 52 22 9c 5b 98-fb ea 07 72 1c 70 88 9c   ouXR".[....r.p..
    0040 - 3d 08 ff 14 be 8d a4 86-8a bb 73 a4 76 94 12 25   =.........s.v..%
    0050 - 65 91 6c 02 0f 66 90 3b-64 07 2f 9a 55 ea 7c 53   e.l..f.;d./.U.|S
    0060 - 7c 12 a3 73 44 17 bf d0-ff 2b 91 99 52 da af 47   |..sD....+..R..G
    0070 - 16 a3 ef d5 d0 91 64 81-fa 88 f9 d3 1d ec 99 61   ......d........a
    0080 - 2d eb b9 e6 d1 49 98 fb-54 2e ec 81 f4 35 28 ac   -....I..T....5(.
    0090 - 6a 4b 40 92 41 c0 ed 21-81 7b f2 93 33 0f c7 e3   jK@.A..!.{..3...
    00a0 - 72 74 74 d3 38 97 17 3c-93 43 56 4b e2 df 2b b6   rtt.8..<.CVK..+.
    00b0 - 0b db a9 28 f5 46 2e b5-82 6b 16 c1 85 73 5e 6e   ...(.F...k...s^n
    00c0 - e0 da 1f c9 fd b0 25 50-bb 96 71 0e db 5d 66 b2   ......%P..q..]f.
    00d0 - 9a 87 16 95 54 b9 14 76-4f d9 b9 7e 20 6b 03 e1   ....T..vO..~ k..

    Start Time: 1767059087
    Timeout   : 7200 (sec)
    Verify return code: 18 (self-signed certificate)
    Extended master secret: no
    Max Early Data: 0
---
read R BLOCK
```

Screenshot: Security headers



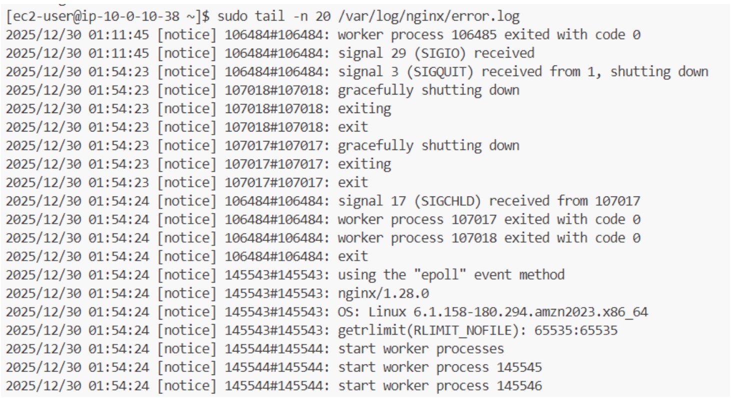
```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ curl -I -k https://51.112.46.2
HTTP/1.1 200 OK
Server: nginx/1.28.0
Date: Tue, 30 Dec 2025 01:45:53 GMT
Content-Type: text/html; charset=UTF-8
Content-Length: 295
Connection: keep-alive
Last-Modified: Mon, 29 Dec 2025 21:45:13 GMT
ETag: "127-6471e28723b62"
Accept-Ranges: bytes
X-Frame-Options: DENY
X-Content-Type-Options: nosniff
X-XSS-Protection: 1; mode=block
```

Screenshot: HTTP redirect



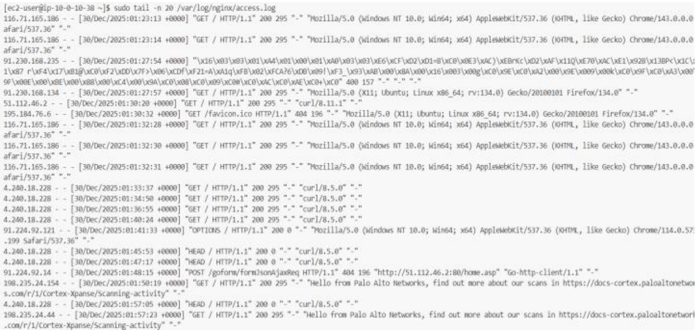
```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ sudo nano /etc/nginx/conf.d/default.conf
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ sudo nginx -t
sudo systemctl restart nginx
sudo: nginx: command not found

"systemd" is not running in this container due to its overhead.
Use the "service" command to start services instead. e.g.:

service --status-all
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ curl -I http://51.112.46.2
HTTP/1.1 200 OK
Server: nginx/1.28.0
Date: Tue, 30 Dec 2025 01:57:05 GMT
Content-Type: text/html; charset=UTF-8
Content-Length: 295
Connection: keep-alive
Last-Modified: Mon, 29 Dec 2025 21:45:13 GMT
ETag: "127-6471e28723b62"
Accept-Ranges: bytes
```

Screenshot: Error log



```
[ec2-user@ip-10-0-10-38 ~]$ sudo tail -n 20 /var/log/nginx/error.log
2025/12/30 01:11:45 [notice] 106484#106484: worker process 106485 exited with code 0
2025/12/30 01:11:45 [notice] 106484#106484: signal 29 (SIGIO) received
2025/12/30 01:54:23 [notice] 106484#106484: signal 3 (SIGQUIT) received from 1, shutting down
2025/12/30 01:54:23 [notice] 107018#107018: gracefully shutting down
2025/12/30 01:54:23 [notice] 107018#107018: exiting
2025/12/30 01:54:23 [notice] 107018#107018: exit
2025/12/30 01:54:23 [notice] 107017#107017: gracefully shutting down
2025/12/30 01:54:23 [notice] 107017#107017: exiting
2025/12/30 01:54:23 [notice] 107017#107017: exit
2025/12/30 01:54:24 [notice] 106484#106484: signal 17 (SIGCHLD) received from 107017
2025/12/30 01:54:24 [notice] 106484#106484: worker process 107017 exited with code 0
2025/12/30 01:54:24 [notice] 106484#106484: worker process 107018 exited with code 0
2025/12/30 01:54:24 [notice] 106484#106484: exit
2025/12/30 01:54:24 [notice] 145543#145543: using the "epoll" event method
2025/12/30 01:54:24 [notice] 145543#145543: nginx/1.28.0
2025/12/30 01:54:24 [notice] 145543#145543: OS: Linux 6.1.158-180.294.amzn2023.x86_64
2025/12/30 01:54:24 [notice] 145543#145543: getrlimit(RLIMIT_NOFILE): 65535:65535
2025/12/30 01:54:24 [notice] 145544#145544: start worker processes
2025/12/30 01:54:24 [notice] 145544#145544: start worker process 145545
2025/12/30 01:54:24 [notice] 145544#145544: start worker process 145546
```

Screenshot: Access log

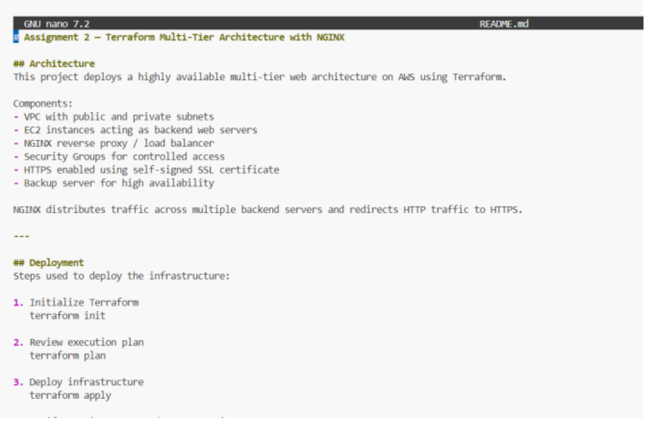


```
[ec2-user@ip-10-0-10-38 ~]$ sudo tail -n 20 /var/log/nginx/access.log
116.71.165.186 - - [30/Dec/2025:01:23:13 +0000] "GET / HTTP/1.1" 200 295 "-" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/143.0.0.0
afari/537.36" "-"
116.71.165.186 - - [30/Dec/2025:01:23:14 +0000] "GET / HTTP/1.1" 200 295 "-" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/143.0.0.0
afari/537.36" "-"
91.230.168.235 - - [30/Dec/2025:01:27:54 +0000] "\x16\x03\x03\x01\xA4\x01\x00\x01\xA0\x03\x03\xE6\xCF\xD2\xD1=B\xC0\x0E3\xAC)\xEBrKc\xD2\xAF\x11Q\xE70\xAC\xE1\x92B\x13BP<\x1C\
1\x87 r\xF4\x17\xB1@\xC0\xF2\xDD\x7F>\x06\xCDf\xF21=A\xA1q\xFB\x02\xFCA?6\xD0\x09!\xF3_\x93\xAB\x00\xBA\x00\x16\x003\x00g\xC0\x9E\xC0\xA2\x00\x9E\x009\x00k\xC0\x9F\xC0\xA3\x00
9F\x00E\x00\xBE\x00\x88\x00\xC4\x00\x9A\xC0\x08\xC0\x09\xC0#\xC0\xAC\xC0\xAE\xC0+\xC0" 400 157 "-" "-" "-"
91.230.168.134 - - [30/Dec/2025:01:27:57 +0000] "GET / HTTP/1.1" 200 295 "-" "Mozilla/5.0 (X11; Ubuntu; Linux x86_64; rv:134.0) Gecko/20100101 Firefox/134.0" "-"
51.112.46.2 - - [30/Dec/2025:01:30:20 +0000] "GET / HTTP/1.1" 200 295 "-" "curl/8.11.1" "-"
195.184.76.6 - - [30/Dec/2025:01:30:32 +0000] "GET /favicon.ico HTTP/1.1" 404 196 "-" "Mozilla/5.0 (X11; Ubuntu; Linux x86_64; rv:134.0) Gecko/20100101 Firefox/134.0" "-"
116.71.165.186 - - [30/Dec/2025:01:32:28 +0000] "GET / HTTP/1.1" 200 295 "-" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/143.0.0.0
afari/537.36" "-"
116.71.165.186 - - [30/Dec/2025:01:32:30 +0000] "GET / HTTP/1.1" 200 295 "-" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/143.0.0.0
afari/537.36" "-"
116.71.165.186 - - [30/Dec/2025:01:32:31 +0000] "GET / HTTP/1.1" 200 295 "-" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/143.0.0.0
afari/537.36" "-"
4.240.18.228 - - [30/Dec/2025:01:33:37 +0000] "GET / HTTP/1.1" 200 295 "-" "curl/8.5.0" "-"
4.240.18.228 - - [30/Dec/2025:01:34:50 +0000] "GET / HTTP/1.1" 200 295 "-" "curl/8.5.0" "-"
4.240.18.228 - - [30/Dec/2025:01:36:55 +0000] "GET / HTTP/1.1" 200 295 "-" "curl/8.5.0" "-"
4.240.18.228 - - [30/Dec/2025:01:40:24 +0000] "GET / HTTP/1.1" 200 295 "-" "curl/8.5.0" "-"
91.224.92.121 - - [30/Dec/2025:01:41:33 +0000] "OPTIONS / HTTP/1.1" 200 0 "-" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/114.0.57
.199 Safari/537.36" "-"
4.240.18.228 - - [30/Dec/2025:01:45:53 +0000] "HEAD / HTTP/1.1" 200 0 "-" "curl/8.5.0" "-"
4.240.18.228 - - [30/Dec/2025:01:47:17 +0000] "HEAD / HTTP/1.1" 200 0 "-" "curl/8.5.0" "-"
91.224.92.14 - - [30/Dec/2025:01:48:15 +0000] "POST /goform/formJsonAjaxReq HTTP/1.1" 404 196 "http://51.112.46.2:80/home.asp" "Go-http-client/1.1" "-"
198.235.24.154 - - [30/Dec/2025:01:50:19 +0000] "GET / HTTP/1.1" 200 295 "-" "Hello from Palo Alto Networks, find out more about our scans in https://docs-cortex.paloaltonetwo
s.com/r/1/Cortex-Xpanse/Scanning-activity" "-"
4.240.18.228 - - [30/Dec/2025:01:57:05 +0000] "HEAD / HTTP/1.1" 200 0 "-" "curl/8.5.0" "-"
198.235.24.44 - - [30/Dec/2025:01:57:23 +0000] "GET / HTTP/1.1" 200 295 "-" "Hello from Palo Alto Networks, find out more about our scans in https://docs-cortex.paloaltonetwork
.com/r/1/Cortex-Xpanse/Scanning-activity" "-"
```

Phase 6: Documentation & Cleanup

6.1 README.md

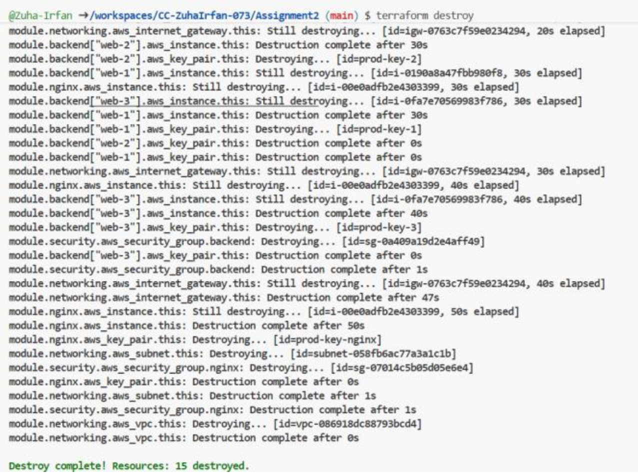
Screenshot: assignment_part6_readme.png



```
GNU nano 7.2                                                    README.md
# Assignment 2 – Terraform Multi-Tier Architecture with NGINX

## Architecture
This project deploys a highly available multi-tier web architecture on AWS using Terraform.

Components:
- VPC with public and private subnets
- EC2 instances acting as backend web servers
- NGINX reverse proxy / load balancer
- Security Groups for controlled access
- HTTPS enabled using self-signed SSL certificate
- Backup server for high availability

NGINX distributes traffic across multiple backend servers and redirects HTTP traffic to HTTPS.

---

## Deployment
Steps used to deploy the infrastructure:

1. Initialize Terraform
   terraform init

2. Review execution plan
   terraform plan

3. Deploy infrastructure
   terraform apply
```

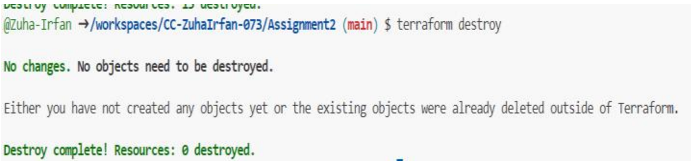
6.2 Destroy Infrastructure

Screenshot: Destroy prompt



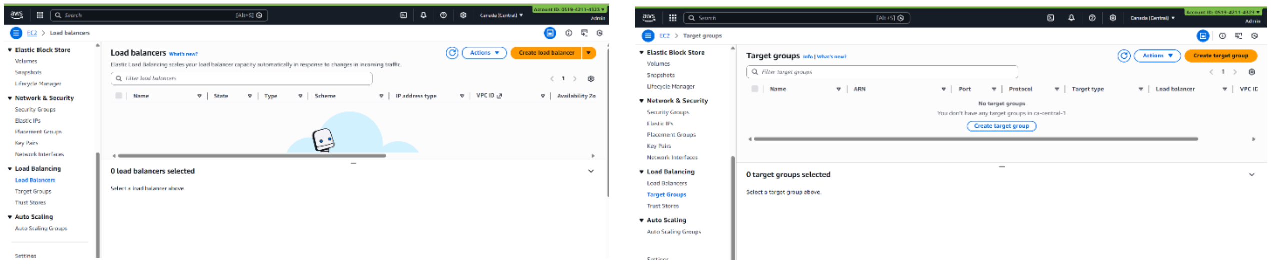
```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ terraform destroy
module.networking.aws_internet_gateway.this: Still destroying... [id=igw-0763c7f59e0234294, 20s elapsed]
module.backend["web-2"].aws_instance.this: Destruction complete after 30s
module.backend["web-2"].aws_key_pair.this: Destroying... [id=prod-key-2]
module.backend["web-1"].aws_instance.this: Still destroying... [id=i-0190a8a47fbb980f8, 30s elapsed]
module.nginx.aws_instance.this: Still destroying... [id=i-00e0adfb2e4303399, 30s elapsed]
module.backend["web-3"].aws_instance.this: Still destroying... [id=i-0fa7e70569983f786, 30s elapsed]
module.backend["web-1"].aws_instance.this: Destruction complete after 30s
module.backend["web-1"].aws_key_pair.this: Destroying... [id=prod-key-1]
module.backend["web-2"].aws_key_pair.this: Destruction complete after 0s
module.backend["web-1"].aws_key_pair.this: Destruction complete after 0s
module.networking.aws_internet_gateway.this: Still destroying... [id=igw-0763c7f59e0234294, 30s elapsed]
module.nginx.aws_instance.this: Still destroying... [id=i-00e0adfb2e4303399, 40s elapsed]
module.backend["web-3"].aws_instance.this: Still destroying... [id=i-0fa7e70569983f786, 40s elapsed]
module.backend["web-3"].aws_instance.this: Destruction complete after 40s
module.backend["web-3"].aws_key_pair.this: Destroying... [id=prod-key-3]
module.security.aws_security_group.backend: Destroying... [id=sg-0a409a19d2e4aff49]
module.backend["web-3"].aws_key_pair.this: Destruction complete after 0s
module.security.aws_security_group.backend: Destruction complete after 1s
module.networking.aws_internet_gateway.this: Still destroying... [id=igw-0763c7f59e0234294, 40s elapsed]
module.networking.aws_internet_gateway.this: Destruction complete after 47s
module.nginx.aws_instance.this: Still destroying... [id=i-00e0adfb2e4303399, 50s elapsed]
module.nginx.aws_instance.this: Destruction complete after 50s
module.nginx.aws_key_pair.this: Destroying... [id=prod-key-nginx]
module.networking.aws_subnet.this: Destroying... [id=subnet-058fb6ac77a3a1c1b]
module.security.aws_security_group.nginx: Destroying... [id=sg-07014c5b05d05e6e4]
module.nginx.aws_key_pair.this: Destruction complete after 0s
module.networking.aws_subnet.this: Destruction complete after 1s
module.security.aws_security_group.nginx: Destruction complete after 1s
module.networking.aws_vpc.this: Destroying... [id=vpc-086918dc88793bcd4]
module.networking.aws_vpc.this: Destruction complete after 0s

Destroy complete! Resources: 15 destroyed.
```

Screenshot: Destroy complete



```
Destroy complete! Resources: 15 destroyed.
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ terraform destroy

No changes. No objects need to be destroyed.

Either you have not created any objects yet or the existing objects were already deleted outside of Terraform.

Destroy complete! Resources: 0 destroyed.
```

Screenshot: AWS console empty



Load balancers

Elastic Load Balancing scales your load balancer capacity automatically in response to changes in incoming traffic.

0 load balancers selected

Select a load balancer above.

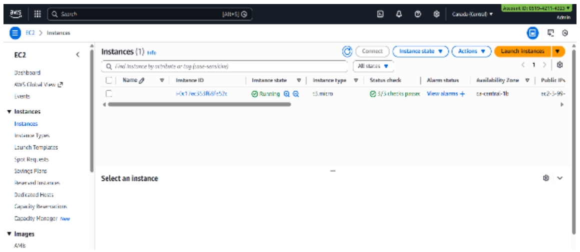
Target groups

No target groups

You don't have any target groups in ca-central-1

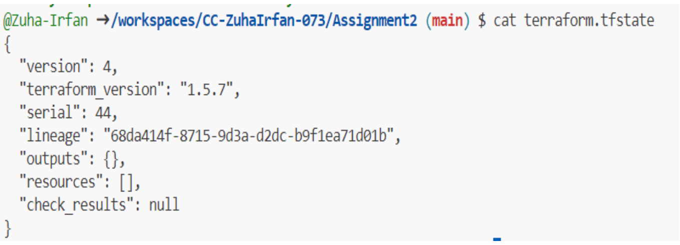
0 target groups selected

Select a target group above.



Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Availability Zone	Public IPv
	i-0c17ec353f68fe52c	Running	t3.micro	3/3 checks passed	View alarms +	ca-central-1b	ec2-3-99-

Screenshot: Empty tfstate



```
@Zuha-Irfan ➜ /workspaces/CC-ZuhaIrfan-073/Assignment2 (main) $ cat terraform.tfstate
{
  "version": 4,
  "terraform_version": "1.5.7",
  "serial": 44,
  "lineage": "68da414f-8715-9d3a-d2dc-b9f1ea71d01b",
  "outputs": {},
  "resources": [],
  "check_results": null
}
```