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**Course: Cloud Computing Lab**

**Section: V-B**

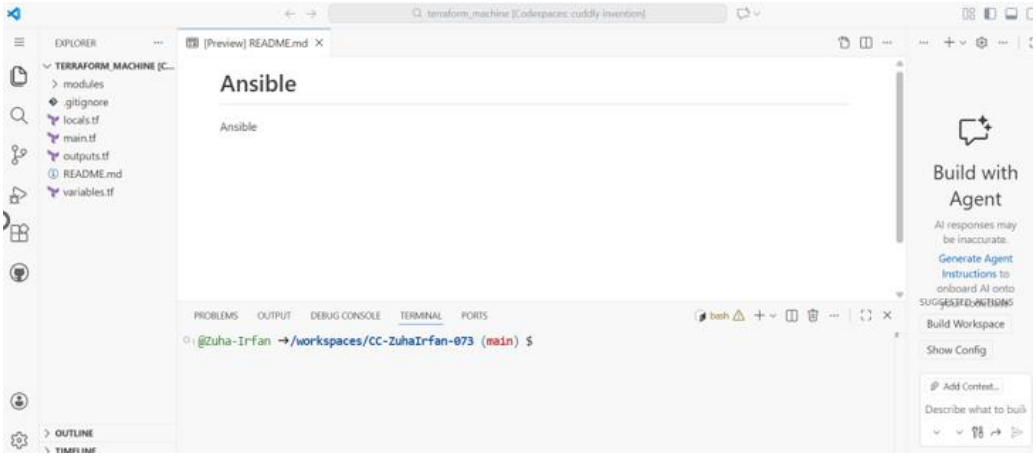
# LAB 14

**Terraform + Ansible: Dynamic Inventory, Roles & Automated Nginx/PHP & Docker Deployment**

## Task 0- Lab Setup(Codespace & GH CLI)

Fork the repo terraform_machine

1. Create/open Codespace on your GitHub account (from terraform_machine repo).




2. Inside the Codespace terminal, configure GH CLI (if needed) and verify:

aws --version

terraform --version

3. Ensure AWS CLI is configured with credentials that have permissions to create EC2, VPC, subnets, and security groups in region me-central-1:

aws sts get-caller-identity

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073 (main) $ aws sts get-caller-identity
{
    "UserId": "345343384808",
    "Account": "345343384808",
    "Arn": "arn:aws:iam::345343384808:root"
}
```

## Task 1 – Generate ssh key and Initial Terraform apply

You will start from an existing repository and prepare Terraform variables and SSH keys.

1. Check SSH directory & generate SSH key pair if not already present:

ls ~/.ssh

ssh-keygen -t ed25519 -f ~/.ssh/id_ed25519 -N ""

ls -la ~/.ssh

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073 (main) $ ls ~/.ssh
ls: cannot access '/home/codespace/.ssh': No such file or directory
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073 (main) $ ssh-keygen -t ed25519 -f ~/.ssh/id_ed25519 -N
""
Generating public/private ed25519 key pair.
Created directory '/home/codespace/.ssh'.
Your identification has been saved in /home/codespace/.ssh/id_ed25519
Your public key has been saved in /home/codespace/.ssh/id_ed25519.pub
The key fingerprint is:
SHA256:nIfZLetNaPApLzdMovoqtYLo3GV7575epdnqB0831Y8 codespace@codespaces-aad63a
The key's randomart image is:
+--[ED25519 256]--+
|                 |
|                 |
|                .|
|       . = .    o|
|        S + .. .o|
|    .   .+.*=.Eo.|
|.. . + ..+*+=.. .|
|+ + + o..*=o.o   |
|.o +o=o =B=+o    |
+----[SHA256]-----+
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073 (main) $ ls -la ~/.ssh
total 20
drwx------ 2 codespace codespace 4096 Jan  8 18:59 .
drwxr-x--- 1 codespace codespace 4096 Jan  8 18:59 ..
-rw------- 1 codespace codespace  419 Jan  8 18:59 id_ed25519
-rw-r--r-- 1 codespace codespace  109 Jan  8 18:59 id_ed25519.pub
```

2. Create terraform.tfvars in the repo root:

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073 (main) $ cd /workspaces/terraform_machine
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ touch terraform.tfvars
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ ls -la terraform.tfvars
```

Add the following content:

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim terraform.tfvars
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat 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 = "dev"
  instance_type = "t3.micro"
  public_key = "~/.ssh/id_ed25519.pub"
  private_key = "~/.ssh/id_ed25519"
```

3. Initialize Terraform:

terraform init

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ terraform init
Initializing the backend...
Initializing modules...
- myapp-subnet in modules/subnet
- myapp-webserver in modules/webserver
Initializing provider plugins...
- Finding latest version of hashicorp/http...
- Finding latest version of hashicorp/aws...
- Installing hashicorp/http v3.5.0...
- Installed hashicorp/http v3.5.0 (signed by HashiCorp)
- Installing hashicorp/aws v6.28.0...
- Installed hashicorp/aws v6.28.0 (signed by HashiCorp)
Terraform has created a lock file .terraform.lock.hcl to record the provider
selections it made above. Include this file in your version control repository
so that Terraform can guarantee to make the same selections by default when
you run "terraform init" in the future.

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.
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ terraform apply -auto-approve
```

4. Apply Terraform to create 2 EC2 instances (as defined in the existing Terraform code):

terraform apply -auto-approve

```
Apply complete! Resources: 10 added, 0 changed, 0 destroyed.

Outputs:

webserver_public_ips = [
  "158.252.81.245",
  "3.28.134.219",
]
```

5. Check outputs:

terraform output

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ terraform output
webserver_public_ips = [
  "158.252.81.245",
  "3.28.134.219",
]
```

## Task 2 – Static Ansible inventory with two EC2 instances

You will install Ansible (via pipx), create a static inventory, and verify connectivity.

1. Install Ansible (core) using pipx:

pipx install ansible-core

ansible –version


2. Obtain the two public IPs of your EC2 instances:

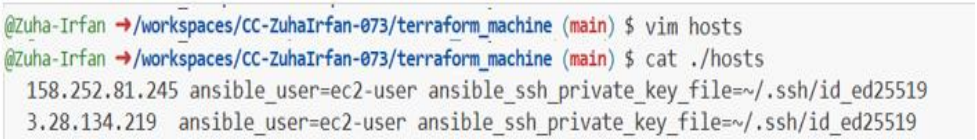
terraform output


3. Create Ansible inventory file hosts:

touch hosts

ls -la hosts


Add the following (replace <public-ip-ec2> with your 2 real IPs):f




4. Test connectivity:

ansible all -i hosts -m ping

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ -i hosts -m ping
[ERROR]: Task failed: Failed to connect to the host via ssh: Host key verification failed.
Origin: <adhoc 'ping' task>

{'action': 'ping', 'args': {}, 'timeout': 0, 'async_val': 0, 'poll': 15}

158.252.81.245 | UNREACHABLE! => {
    "changed": false,
    "msg": "Task failed: Failed to connect to the host via ssh: Host key verification failed.",
    "unreachable": true
}
3.28.134.219 | UNREACHABLE! => {
    "changed": false,
    "msg": "Task failed: Failed to connect to the host via ssh: Host key verification failed.",
    "unreachable": true
}
```

5. If it fails due to host key checking, add this to each line in hosts:

ansible_ssh_common_args='-o StrictHostKeyChecking=no'

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ ansible_ssh_common_args='-o StrictHostKeyChecking=no'
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim hosts
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat ./hosts
158.252.81.245 ansible_user=ec2-user ansible_ssh_private_key_file=~/.ssh/id_ed25519 ansible_ssh_common_args='-o StrictHostKeyChecking=no'
3.28.134.219  ansible_user=ec2-user ansible_ssh_private_key_file=~/.ssh/id_ed25519 ansible_ssh_common_args='-o StrictHostKeyChecking=no'
```

6. Retry:

ansible all -i hosts -m ping

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ ansible all -i hosts -m ping
[WARNING]: Host '3.28.134.219' is using the discovered Python interpreter at '/usr/bin/python3.9', but future installation of another Python interpreter could cause a different in
erpreter to be discovered. See https://docs.ansible.com/ansible-core/2.20/reference_appendices/interpreter_discovery.html for more information.
3.28.134.219 | SUCCESS => {
    "ansible_facts": {
        "discovered_interpreter_python": "/usr/bin/python3.9"
    },
    "changed": false,
    "ping": "pong"
}
[WARNING]: Host '158.252.81.245' is using the discovered Python interpreter at '/usr/bin/python3.9', but future installation of another Python interpreter could cause a different
nterpreter to be discovered. See https://docs.ansible.com/ansible-core/2.20/reference_appendices/interpreter_discovery.html for more information.
158.252.81.245 | SUCCESS => {
    "ansible_facts": {
        "discovered_interpreter_python": "/usr/bin/python3.9"
    },
    "changed": false,
    "ping": "pong"
}
```

## Task 3 - Scale to three instances & group-based inventory

You will expand to 3 web servers via Terraform's count and restructure your inventory into groups.

1. Update your Terraform module for webservers in main.tf to use count = 3:

```
module "myapp-webserver" {
  source = "./modules/webserver"
  env_prefix = var.env_prefix
  instance_type = var. instance_type
  availability_zone = var.availability_zone
  public_key = var.public_key
  my_ip = local.my_ip
  vpc_id = aws_vpc.myapp_vpc.id
  subnet_id = module.myapp-subnet.subnet.id

  # Loop count
  count             = 3
  # Use count.index to differentiate instances
  instance_suffix   = count.index
}
```

2. Apply Terraform to get 3 instances:

terraform apply -auto-approve

```
Apply complete! Resources: 3 added, 0 changed, 0 destroyed.

Outputs:

webserver_public_ips = [
  "158.252.81.245",
  "3.28.134.219",
  "51.112.229.190",
]
```

3. Check outputs:

terraform output

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ terraform output
webserver_public_ips = [
  "158.252.81.245",
  "3.28.134.219",
  "51.112.229.190",
]
```

4. Rewrite your hosts file using group definitions:

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim hosts
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat ./hosts
[ec2]
158.252.81.245
3.28.134.219

[ec2:vars]
ansible_user=ec2-user
ansible_ssh_private_key_file=~/.ssh/id_ed25519
ansible_ssh_common_args='-o StrictHostKeyChecking=no'

[droplet]
51.112.229.190

[droplet:vars]
ansible_user=ec2-user
ansible_ssh_private_key_file=~/.ssh/id_ed25519
ansible_ssh_common_args='-o StrictHostKeyChecking=no'
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ ansible ec2 -i hosts -m ping
```

5. Test group connectivity:

ansible ec2 -i hosts -m ping

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ ansible ec2 -i hosts -m ping
[WARNING]: Host '3.28.134.219' is using the discovered Python interpreter at '/usr/bin/python3.9', but future installa
tion of another Python interpreter could cause a different interpreter to be discovered. See https://docs.ansible.com/
ansible-core/2.20/reference_appendices/interpreter_discovery.html for more information.
3.28.134.219 | SUCCESS => {
    "ansible_facts": {
        "discovered_interpreter_python": "/usr/bin/python3.9"
    },
    "changed": false,
    "ping": "pong"
}
[WARNING]: Host '158.252.81.245' is using the discovered Python interpreter at '/usr/bin/python3.9', but future instal
lation of another Python interpreter could cause a different interpreter to be discovered. See https://docs.ansible.co
m/ansible-core/2.20/reference_appendices/interpreter_discovery.html for more information.
158.252.81.245 | SUCCESS => {
    "ansible_facts": {
        "discovered_interpreter_python": "/usr/bin/python3.9"
    },
    "changed": false,
    "ping": "pong"
}
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ ansible 51.112.229.190 -i hosts -m ping
```

6. Test single host by IP:

ansible <one-public-ip-from-ec2-group> -i hosts -m ping

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ ansible 158.252.81.245 -i hosts -m ping
[WARNING]: Host '158.252.81.245' is using the discovered Python interpreter at '/usr/bin/python3.9', but future instal
lation of another Python interpreter could cause a different interpreter to be discovered. See https://docs.ansible.co
m/ansible-core/2.20/reference_appendices/interpreter_discovery.html for more information.
158.252.81.245 | SUCCESS => {
    "ansible_facts": {
        "discovered_interpreter_python": "/usr/bin/python3.9"
    },
    "changed": false,
    "ping": "pong"
}
```

7. Test droplet group:

ansible droplet -i hosts -m ping

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ ansible droplet -i hosts -m ping
[WARNING]: Host '51.112.229.190' is using the discovered Python interpreter at '/usr/bin/python3.9', but future instal
lation of another Python interpreter could cause a different interpreter to be discovered. See https://docs.ansible.co
m/ansible-core/2.20/reference_appendices/interpreter_discovery.html for more information.
51.112.229.190 | SUCCESS => {
    "ansible_facts": {
        "discovered_interpreter_python": "/usr/bin/python3.9"
    },
    "changed": false,
    "ping": "pong"
}
```

8. Test all hosts:

ansible all -i hosts -m ping

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ ansible all -i hosts -m ping
[WARNING]: Host '51.112.229.190' is using the discovered Python interpreter at '/usr/bin/python3.9', but future inst
lation of another Python interpreter could cause a different interpreter to be discovered. See https://docs.ansible.
m/ansible-core/2.20/reference_appendices/interpreter_discovery.html for more information.
51.112.229.190 | SUCCESS => {
    "ansible_facts": {
        "discovered_interpreter_python": "/usr/bin/python3.9"
    },
    "changed": false,
    "ping": "pong"
}
[WARNING]: Host '3.28.134.219' is using the discovered Python interpreter at '/usr/bin/python3.9', but future instal
tion of another Python interpreter could cause a different interpreter to be discovered. See https://docs.ansible.co
ansible-core/2.20/reference_appendices/interpreter_discovery.html for more information.
3.28.134.219 | SUCCESS => {
    "ansible_facts": {
        "discovered_interpreter_python": "/usr/bin/python3.9"
    },
    "changed": false,
    "ping": "pong"
}
[WARNING]: Host '158.252.81.245' is using the discovered Python interpreter at '/usr/bin/python3.9', but future inst
lation of another Python interpreter could cause a different interpreter to be discovered. See https://docs.ansible.
m/ansible-core/2.20/reference_appendices/interpreter_discovery.html for more information.
158.252.81.245 | SUCCESS => {
    "ansible_facts": {
        "discovered_interpreter_python": "/usr/bin/python3.9"
    },
    "changed": false,
    "ping": "pong"
}
```

## Task 4 – Global ansible.cfg & first nginx playbook

You will configure a global Ansible configuration file, then create a basic playbook for nginx.

1. Create global Ansible configuration:

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim ~/.ansible.cfg
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat ~/.ansible.cfg
[default]
host_key_checking = False
interpreter_python = /usr/bin/python3
```

2. Remove ansible_ssh_common_args from hosts (delete from all groups).

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim hosts
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat hosts
[ec2]
158.252.81.245
3.28.134.219

[ec2:vars]
ansible_user=ec2-user
ansible_ssh_private_key_file=~/.ssh/id_ed25519

[droplet]
51.112.229.190

[droplet:vars]
ansible_user=ec2-user
ansible_ssh_private_key_file=~/.ssh/id_ed25519
```

3. Confirm connectivity:

ansible all -i hosts -m ping


4. Create my-playbook.yaml:

touch my-playbook.yaml

ls -la my-playbook.yaml

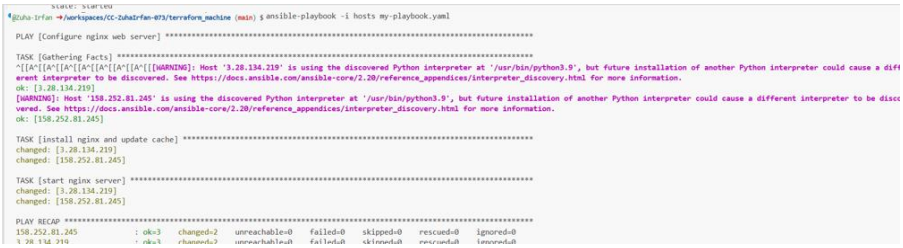
```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ touch my-playbook.yaml
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ ls -la my-playbook.yaml
-rw-rw-rw- 1 codespace codespace 0 Jan  8 20:09 my-playbook.yaml
```

Add:

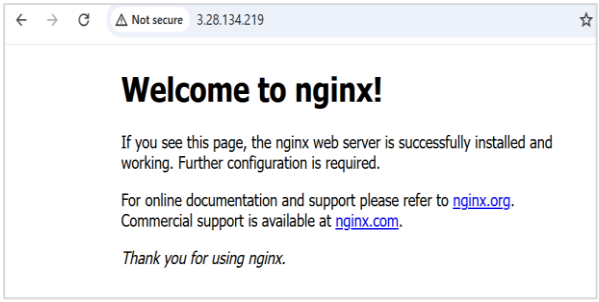
```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim my-playbook.yaml
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat my-playbook.yaml
---
- name: Configure nginx web server
  hosts: ec2
  become: true
  tasks:
    - name: install nginx and update cache
      yum:
        name: nginx
        state: present
        update_cache: yes

    - name: start nginx server
      service:
        name: nginx
        state: started
```

5. Run the playbook on [ec2] group:

ansible-playbook -i hosts my-playbook.yaml




6. Verify nginx default page on [ec2] servers by visiting http://<public-ip-ec2>.


7. Change target to droplet:

Edit my-playbook.yaml to:

hosts: droplet

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim my-playbook.yaml
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat ./my-playbook.yaml
---
- name: Configure nginx web server
  hosts: droplet
  become: true
  tasks:
    - name: install nginx and update cache
      yum:
        name: nginx
        state: present
        update_cache: yes

    - name: start nginx server
      service:
        name: nginx
        state: started
```

8. Re-run:

ansible-playbook -i hosts my-playbook.yaml

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ ansible-playbook -i hosts my-playbook.yaml

PLAY [Configure nginx web server] ***********************************************************************************

TASK [Gathering Facts] **********************************************************************************************
[WARNING]: Host '51.112.229.190' is using the discovered Python interpreter at '/usr/bin/python3.9', but future insta
lation of another Python interpreter could cause a different interpreter to be discovered. See https://docs.ansible.c
m/ansible-core/2.20/reference_appendices/interpreter_discovery.html for more information.
ok: [51.112.229.190]

TASK [install nginx and update cache] *******************************************************************************
changed: [51.112.229.190]

TASK [start nginx server] *******************************************************************************************
changed: [51.112.229.190]

PLAY RECAP **********************************************************************************************************
51.112.229.190             : ok=3    changed=2    unreachable=0    failed=0    skipped=0    rescued=0    ignored=0
```

9. Verify nginx default page on droplet:


## Task 5 – Single nginx target group & HTTPS prerequisites

You will prepare project-level Ansible configuration and adjust nginx installation scope.

1. Create project-level ansible.cfg in repo root:

touch ansible.cfg

ls -la ansible.cfg

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ touch ansible.cfg
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ ls -la ansible.cfg
-rw-rw-rw- 1 codespace codespace 0 Jan  8 20:26 ansible.cfg
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim ansible.cfg
```

Add:

[defaults]

host_key_checking=False

interpreter_python = /usr/bin/python3

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim ansible.cfg
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat ansible.cfg
[defaults]
host_key_checking=False
interpreter_python = /usr/bin/python3
```

2. Switch Terraform EC2 count back to 1:

In main.tf:

count = 1

```
module "myapp-webserver" {
  source = "./modules/webserver"
  env_prefix = var.env_prefix
  instance_type = var. instance_type
  availability_zone = var.availability_zone
  public_key = var.public_key
  my_ip = local.my_ip
  vpc_id = aws_vpc.myapp_vpc.id
  subnet_id = module.myapp-subnet.subnet.id

  # Loop count
  count            = 1
  # Use count.index to differentiate instances
  instance_suffix   = count.index
}
```

3. Apply:

terraform apply -auto-approve

```
Apply complete! Resources: 0 added, 0 changed, 6 destroyed.

Outputs:

webserver_public_ips = [
  "158.252.81.245",
]
```

4. Outputs:

terraform output

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ terraform output
webserver_public_ips = [
  "158.252.81.245",
]
```

5. Adjust hosts:

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim hosts
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat hosts
[nginx]
158.252.81.245

[nginx:vars]
ansible_ssh_private_key_file=~/.ssh/id_ed25519
ansible_user=ec2-user
```

6. Update my-playbook.yaml:

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim my-playbook.yaml
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat ./my-playbook.yaml
---
- name: Configure nginx web server
  hosts: nginx
  become: true
  tasks:
    - name: install nginx and update cache
      yum:
        name: nginx
        state: present
        update_cache: yes

    - name: install openssl
      yum:
        name: openssl
        state: present

    - name: start nginx server
      service:
        name: nginx
        state: started
        enabled: true
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ ansible-playbook -i hosts my-playbook.yaml
```

7. Run the playbook:

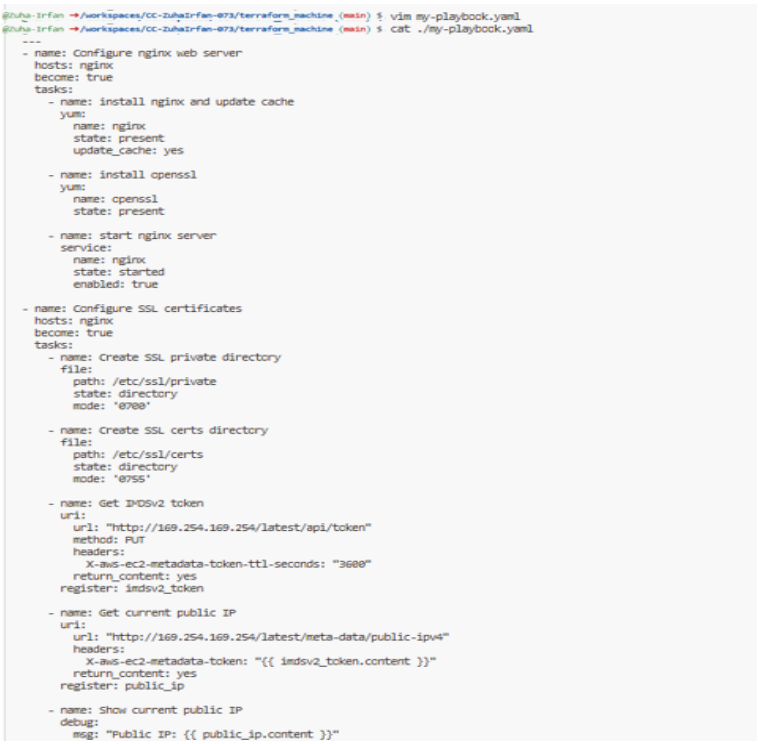
ansible-playbook -i hosts my-playbook.yaml


8. Verify nginx default page at http://<public-ip>.


## Task 6 - Ansible-managed SSL certificates

Extend your playbook to generate self-signed SSL certificates using dynamic public IP.

1. Append this play after the nginx play in my-playbook.yaml:



```
@zuha-irfan →/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim my-playbook.yaml
@zuha-irfan →/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat ./my-playbook.yaml
---
- name: Configure nginx web server
  hosts: nginx
  become: true
  tasks:
    - name: install nginx and update cache
      yum:
        name: nginx
        state: present
        update_cache: yes

    - name: install openssl
      yum:
        name: openssl
        state: present

    - name: start nginx server
      service:
        name: nginx
        state: started
        enabled: true

- name: Configure SSL certificates
  hosts: nginx
  become: true
  tasks:
    - name: Create SSL private directory
      file:
        path: /etc/ssl/private
        state: directory
        mode: '0700'

    - name: Create SSL certs directory
      file:
        path: /etc/ssl/certs
        state: directory
        mode: '0755'

    - name: Get IMDSv2 token
      uri:
        url: "http://169.254.169.254/latest/api/token"
        method: PUT
        headers:
          X-aws-ec2-metadata-token-ttl-seconds: "3600"
        return_content: yes
      register: imdsv2_token

    - name: Get current public IP
      uri:
        url: "http://169.254.169.254/latest/meta-data/public-ipv4"
        headers:
          X-aws-ec2-metadata-token: "{{ imdsv2_token.content }}"
        return_content: yes
      register: public_ip

    - name: Show current public IP
      debug:
        msg: "Public IP: {{ public_ip.content }}"
```

2. Run:

ansible-playbook -i hosts my-playbook.yaml


3. SSH and verify:

ssh ec2-user@<public-ip> -i ~/.ssh/id_ed25519

sudo cat /etc/ssl/certs/selfsigned.crt

sudo cat /etc/ssl/private/selfsigned.key

exit


## Task 7 - PHP front-end deployment with templates

Deploy a PHP application and Nginx configuration using Ansible copy and template.

1. Create directories and files:

mkdir -p files templates

touch files/index.php

touch templates/nginx.conf.j2

ls -R

```
_elementtree.cpython-313-x86_64-linux-gnu.so      grp.cpython-313-x86_64-linux-gnu.so
_hashlib.cpython-313-x86_64-linux-gnu.so          math.cpython-313-x86_64-linux-gnu.so
_heapq.cpython-313-x86_64-linux-gnu.so            mmap.cpython-313-x86_64-linux-gnu.so
_json.cpython-313-x86_64-linux-gnu.so             pyexpat.cpython-313-x86_64-linux-gnu.so
_lzma.cpython-313-x86_64-linux-gnu.so             readline.cpython-313-x86_64-linux-gnu.so
_md5.cpython-313-x86_64-linux-gnu.so              resource.cpython-313-x86_64-linux-gnu.so
_multibytecodec.cpython-313-x86_64-linux-gnu.so   select.cpython-313-x86_64-linux-gnu.so
_multiprocessing.cpython-313-x86_64-linux-gnu.so  termios.cpython-313-x86_64-linux-gnu.so
_opcode.cpython-313-x86_64-linux-gnu.so           unicodedata.cpython-313-x86_64-linux-gnu.so
_pickle.cpython-313-x86_64-linux-gnu.so           zlib.cpython-313-x86_64-linux-gnu.so
_posixshmem.cpython-313-x86_64-linux-gnu.so

./aws/dist/prompt_toolkit-3.0.51.dist-info:
INSTALLER  METADATA  RECORD  WHEEL  licenses  top_level.txt

./aws/dist/prompt_toolkit-3.0.51.dist-info/licenses:
AUTHORS.rst  LICENSE

./aws/dist/wheel-0.45.1.dist-info:
INSTALLER  LICENSE.txt  METADATA  RECORD  REQUESTED  WHEEL  direct_url.json  entry_points.txt

./files:
index.php

./modules:
subnet  webserver

./modules/subnet:
main.tf  outputs.tf  variables.tf

./modules/webserver:
main.tf  outputs.tf  variables.tf

./templates:
nginx.conf.j2
```

2. Fill files/index.php with the following PHP metadata page:

```
        h1 {
            color: #fff;
            text-shadow: 2px 2px 4px rgba(0,0,0,0.3);
        }
        .info {
            margin: 15px 0;
            padding: 10px;
            background: rgba(255,255,255,0.2);
            border-radius: 5px;
        }
        .label {
            font-weight: bold;
            color: #ffd700;
        }
        .info a {
            color: white;          /* same as other values */
            text-decoration: none;  /* remove underline */
            font-weight: normal;
        }

        .info a:hover {
            text-decoration: underline; /* optional: underline on hover */
        }
    </style>
</head>
<body>
    <div class="container">
        <h1>🚀 Nginx Front End Web Server </h1>

        <div class="info"><span class="label">Hostname:</span> <?= htmlspecialchars($hostname) ?></div>
        <div class="info"><span class="label">Instance ID:</span> <?= htmlspecialchars($instance_id) ?></div>
        <div class="info"><span class="label">Private IP:</span> <?= htmlspecialchars($private_ip) ?></div>
        <div class="info"><span class="label">Public IP:</span> <?= htmlspecialchars($public_ip) ?></div>
        <div class="info"><span class="label">Public DNS:</span>
            <a href="https://<?= htmlspecialchars($public_dns) ?>" target="_blank">
            https://<?= htmlspecialchars($public_dns) ?></a>
        </div>
        <div class="info"><span class="label">Deployed:</span> <?= $deployed_date ?></div>
        <div class="info"><span class="label">Status:</span> ✅ Active and Running</div>
        <div class="info"><span class="label">Managed By:</span> Terraform + Ansible</div>
    </div>
</body>
</html>
```

3. Fill templates/nginx.conf.j2 with the following Nginx configuration template:

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim templates/nginx.conf.j2
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat templates/nginx.conf.j2
user nginx;
worker_processes auto;
error_log /var/log/nginx/error.log notice;
pid /run/nginx.pid;

events {
    worker_connections 1024;
}

http {
    log_format  main  '$remote_addr - $remote_user [$time_local] "$request"'
                      '$status $body_bytes_sent "$http_referer"'
                      '"$http_user_agent" "$http_x_forwarded_for"';

    access_log  /var/log/nginx/access.log  main;

    sendfile            on;
    tcp_nopush          on;
    keepalive_timeout   65;
    types_hash_max_size 4096;

    include             /etc/nginx/mime.types;
    default_type        application/octet-stream;

    upstream backend_servers {
        server 158.252.94.241:80;
        server 158.252.94.242:80 backup;
    }

    server {
        listen 443 ssl;
        server_name {{ server_public_ip }};
        ssl_certificate /etc/ssl/certs/selfsigned.crt;
        ssl_certificate_key /etc/ssl/private/selfsigned.key;

        location / {
            root /usr/share/nginx/html;
            index index.php index.html index.htm;
#           proxy_pass http://158.252.94.241:80;
#           proxy_pass http://backend_servers;

            # 🔴 This block is necessary for Php Website
            location ~ \.php$ {
                include fastcgi_params;
```

4. Add this play to my-playbook.yaml:

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim files/index.php
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat files/index.php
<?php
// Get hostname
$hostname = gethostname();

// Deployment date
$deployed_date = date("Y-m-d H:i:s");

// Metadata base URL
$metadata_base = "http://169.254.169.254/latest/";

// Function to get IMDSv2 token
function getImdsV2Token() {
    $ch = curl_init("http://169.254.169.254/latest/api/token");
    curl_setopt_array($ch, [
        CURLOPT_RETURNTRANSFER => true,
        CURLOPT_CUSTOMREQUEST  => "PUT",
        CURLOPT_HTTPHEADER     => [
            "X-aws-ec2-metadata-token-ttl-seconds: 21600"
        ],
        CURLOPT_TIMEOUT        => 2
    ]);

    $token = curl_exec($ch);
    curl_close($ch);

    return $token ?: null;
}

// Function to fetch metadata using token
function getMetadata($path, $token) {
    $url = "http://169.254.169.254/latest/meta-data/" . $path;

    $ch = curl_init($url);
    curl_setopt_array($ch, [
        CURLOPT_RETURNTRANSFER => true,
        CURLOPT_HTTPHEADER     => [
            "X-aws-ec2-metadata-token: $token"
        ],
        CURLOPT_TIMEOUT        => 2
    ]);

    $value = curl_exec($ch);
    curl_close($ch);

    return $value ?: "N/A";
}

// Fetch token
$token = getImdsV2Token();

// Fetch metadata only if token is available
$instance_id = $token ? getMetadata("instance-id", $token) : "N/A";
$private_ip  = $token ? getMetadata("local-ipv4", $token) : "N/A";
$public_ip   = $token ? getMetadata("public-ipv4", $token) : "N/A";
$public_dns  = $token ? getMetadata("public-hostname", $token) : "N/A";
```

5. Run the playbook:

ansible-playbook -i hosts my-playbook.yaml

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat my-playbook.yaml
- name: Deploy Nginx website and configuration files
  hosts: nginx
  become: true
  tasks:
    - name: install php-fpm and php-curl
      yum:
        name:
          - php-fpm
          - php-curl
        state: present

    - name: Copy website files
      copy:
        src: files/index.php
        dest: /usr/share/nginx/html/index.php
        owner: nginx
        group: nginx
        mode: '0644'

    - name: Copy nginx.conf template
      template:
        src: templates/nginx.conf.j2
        dest: /etc/nginx/nginx.conf
        owner: root
        group: root
        mode: '0644'

    - name: Restart nginx
      service:
        name: nginx
        state: restarted

    - name: Start and enable php-fpm
      service:
        name: php-fpm
        state: started
```

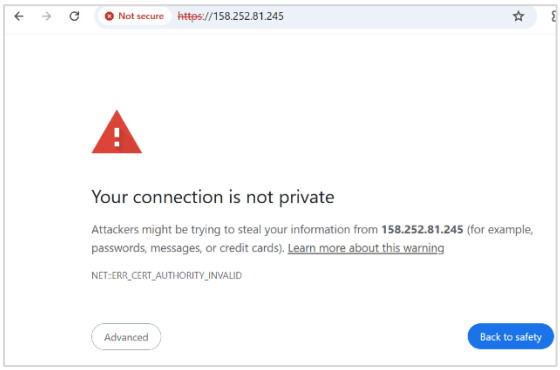
```
TASK [Copy website files] ******************************************************************************************************************************
changed: [158.252.81.245]

TASK [Copy nginx.conf template] ************************************************************************************************************************
[ERROR]: Task failed: 'server_public_ip' is undefined

Task failed.
Origin: /workspaces/terraform_machine/my-playbook.yaml:93:7

91        mode: '0644'
92
93    - name: Copy nginx.conf template
          ^ column 7

<<< caused by >>>

'server_public_ip' is undefined
Origin: /workspaces/terraform_machine/templates/nginx.conf.j2

fatal: [158.252.81.245]: FAILED! => {"changed": false, "msg": "Task failed: 'server_public_ip' is undefined"}

PLAY RECAP *********************************************************************************************************************************************
158.252.81.245             : ok=14   changed=2    unreachable=0    failed=1    skipped=0    rescued=0    ignored=0

@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim my-playbook.yaml
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat my-playbook.yaml
---
```

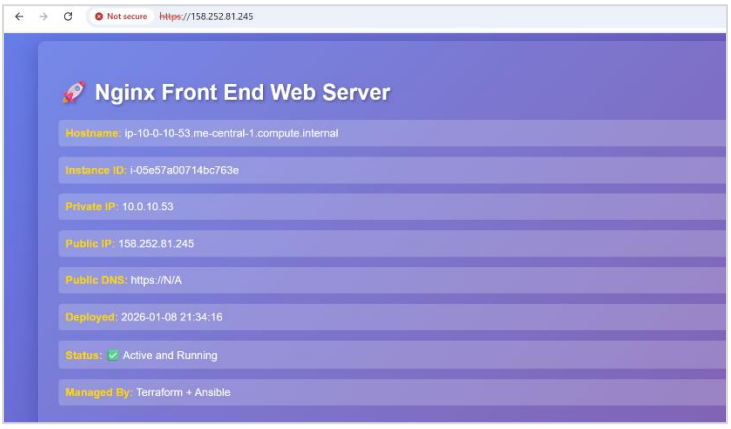
```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ ansible-playbook -i hosts my-playbook.yaml
[WARNING]: Ansible is being run in a world writable directory (/workspaces/terraform_machine), ignoring it as an ansible.cfg source. For more information see https://docs.ansible.com/ansible/devel/reference_appendices/config.html#cfg-in-world-writable-dir

PLAY [Configure nginx web server] **********************************************

TASK [Gathering Facts] *********************************************************
[WARNING]: Host '158.252.81.245' is using the discovered Python interpreter at '/usr/bin/python3.9', but future installation of another Python interpreter could cause a different interpreter to be discovered. See https://docs.ansible.com/ansible-core/2.16/reference_appendices/interpreter_discovery.html for more information.
ok: [158.252.81.245]

TASK [Install nginx and update cache] ******************************************
ok: [158.252.81.245]

TASK [Install openssl] *********************************************************
ok: [158.252.81.245]

TASK [Start nginx server] ******************************************************
ok: [158.252.81.245]

PLAY [Configure SSL certificates] **********************************************

TASK [Gathering Facts] *********************************************************
ok: [158.252.81.245]

TASK [Create SSL private directory] *********************************************
ok: [158.252.81.245]

TASK [Create SSL certs directory] **********************************************
ok: [158.252.81.245]

TASK [Get IMDSv2 token] ********************************************************
ok: [158.252.81.245]

TASK [Get current public IP] ***************************************************
ok: [158.252.81.245]

TASK [Show current public IP] **************************************************
ok: [158.252.81.245] => {
    "msg": "Public IP: 158.252.81.245"
}

TASK [Save public IP as fact] **************************************************
ok: [158.252.81.245]

TASK [Generate self-signed SSL certificate] ************************************
ok: [158.252.81.245]

PLAY [Deploy Nginx website and configuration files] ****************************

TASK [Gathering Facts] *********************************************************
ok: [158.252.81.245]

TASK [Install php-fpm and php-curl] ********************************************
ok: [158.252.81.245]

TASK [Copy website files] ******************************************************
ok: [158.252.81.245]

TASK [Copy nginx.conf template] ************************************************
changed: [158.252.81.245]

TASK [Restart nginx] ***********************************************************
changed: [158.252.81.245]

TASK [Start and enable php-fpm] ************************************************
changed: [158.252.81.245]

PLAY RECAP *********************************************************************
158.252.81.245             : ok=13   changed=3    unreachable=0    failed=0    skipped=0    rescued=0    ignored=0
```

6. Visit https://<public-ip>:

   Accept SSL warning.

   Verify the PHP page content.




## Task 8 – Docker & Docker Compose provisioning via Ansible

Deploy Docker and Docker Compose on a new EC2 instance.

1. Destroy old infrastructure:

terraform destroy -auto-approve

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ terraform destroy -auto-approve
  module.myapp-webserver[0].aws_instance.myapp-server: Destroying... [id=i-05e57a00714bc763e]
  module.myapp-subnet.aws_default_route_table.main_rt: Destruction complete after 0s
  module.myapp-subnet.aws_internet_gateway.myapp_igw: Destroying... [id=igw-0c3425f766430d8dc]
  module.myapp-webserver[0].aws_instance.myapp-server: Still destroying... [id=i-05e57a00714bc763e, 00m10s
  elapsed]
  module.myapp-subnet.aws_internet_gateway.myapp_igw: Still destroying... [id=igw-0c3425f766430d8dc, 00m10s
   elapsed]
  module.myapp-webserver[0].aws_instance.myapp-server: Still destroying... [id=i-05e57a00714bc763e, 00m20s
  elapsed]
  module.myapp-subnet.aws_internet_gateway.myapp_igw: Still destroying... [id=igw-0c3425f766430d8dc, 00m20s
   elapsed]
  module.myapp-webserver[0].aws_instance.myapp-server: Still destroying... [id=i-05e57a00714bc763e, 00m30s
  elapsed]
  module.myapp-subnet.aws_internet_gateway.myapp_igw: Still destroying... [id=igw-0c3425f766430d8dc, 00m30s
   elapsed]
  module.myapp-subnet.aws_internet_gateway.myapp_igw: Destruction complete after 37s
  module.myapp-webserver[0].aws_instance.myapp-server: Still destroying... [id=i-05e57a00714bc763e, 00m40s
  elapsed]
  module.myapp-webserver[0].aws_instance.myapp-server: Destruction complete after 40s
  module.myapp-subnet.aws_subnet.myapp_subnet_1: Destroying... [id=subnet-074649248c91c4526]
  module.myapp-webserver[0].aws_key_pair.ssh-key: Destroying... [id=dev-serverkey-0]
  module.myapp-webserver[0].aws_security_group.web_sg: Destroying... [id=sg-074fc3e1f709e084e]
  module.myapp-webserver[0].aws_key_pair.ssh-key: Destruction complete after 0s
  module.myapp-subnet.aws_subnet.myapp_subnet_1: Destruction complete after 1s
  module.myapp-webserver[0].aws_security_group.web_sg: Destruction complete after 1s
  aws_vpc.myapp_vpc: Destroying... [id=vpc-0b6418f8143b0ffaf]
  aws_vpc.myapp_vpc: Destruction complete after 1s

  Destroy complete! Resources: 7 destroyed.
```

2. Recreate fresh infrastructure (1 instance):

terraform apply -auto-approve

terraform output

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ terraform apply -auto-approve
module.myapp-webserver[0].aws_key_pair.ssh-key: Creating...
aws_vpc.myapp_vpc: Creating...
module.myapp-webserver[0].aws_key_pair.ssh-key: Creation complete after 1s [id=dev-serverkey-0]
aws_vpc.myapp_vpc: Creation complete after 2s [id=vpc-051f2f19b879b12a8]
module.myapp-subnet.aws_internet_gateway.myapp_igw: Creating...
module.myapp-subnet.aws_subnet.myapp_subnet_1: Creating...
module.myapp-webserver[0].aws_security_group.web_sg: Creating...
module.myapp-subnet.aws_internet_gateway.myapp_igw: Creation complete after 0s [id=igw-07a66f23c5b03f7a8]
module.myapp-subnet.aws_default_route_table.main_rt: Creating...
module.myapp-subnet.aws_default_route_table.main_rt: Creation complete after 1s [id=rtb-0de8e7c2f6e2a21ed
]
module.myapp-webserver[0].aws_security_group.web_sg: Creation complete after 3s [id=sg-0f742f005673765ad]
module.myapp-subnet.aws_subnet.myapp_subnet_1: Still creating... [00m10s elapsed]
module.myapp-subnet.aws_subnet.myapp_subnet_1: Creation complete after 11s [id=subnet-05e79b898e70ece6e]
module.myapp-webserver[0].aws_instance.myapp-server: Creating...
module.myapp-webserver[0].aws_instance.myapp-server: Still creating... [00m10s elapsed]
module.myapp-webserver[0].aws_instance.myapp-server: Creation complete after 12s [id=i-08faa252eebf7bde9]

Apply complete! Resources: 7 added, 0 changed, 0 destroyed.

Outputs:

webserver_public_ips = [
  "40.172.187.29",
]
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ terraform output
webserver_public_ips = [
  "40.172.187.29",
]
```

3. Update hosts:

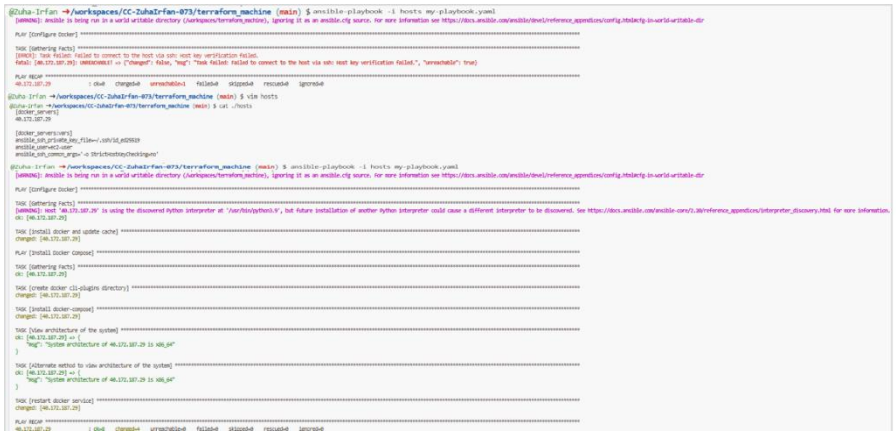
```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim hosts
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat ./hosts
[docker_servers]
40.172.187.29

[docker_servers:vars]
ansible_ssh_private_key_file=~/.ssh/id_ed25519
ansible_user=ec2-user
```

4. Replace my-playbook.yaml content with:

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim my-playbook.yaml
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat my-playbook.yaml
---
- name: Configure Docker
  hosts: all
  become: true
  tasks:
    - name: install docker and update cache
      yum:
        name: docker
        state: present
        update_cache: yes

- name: Install Docker Compose
  hosts: all
  become: true
  gather_facts: true
  tasks:
    - name: create docker cli-plugins directory
      file:
        path: /usr/local/lib/docker/cli-plugins
        state: directory
        mode: '0755'

    - name: install docker-compose
      get_url:
        url: https://github.com/docker/compose/releases/latest/download/docker-compose-linux-{{ lookup('pipe', 'uname -m') }}
        dest: /usr/local/lib/docker/cli-plugins/docker-compose
        mode: +x

    - name: View architecture of the system
      debug:
        msg: "System architecture of {{ inventory_hostname }} is {{ ansible_facts['architecture'] }}"

    - name: Alternate method to view architecture of the system
      debug:
        msg: "System architecture of {{inventory_hostname}} is {{ lookup('pipe', 'uname -m') }}"

    - name: restart docker service
      service:
        name: docker
        state: restarted
```

5. Run the play:

ansible-playbook -i hosts my-playbook.yaml



6. Verify Docker:

ssh ec2-user@<public-ip> -i ~/.ssh/id_ed25519

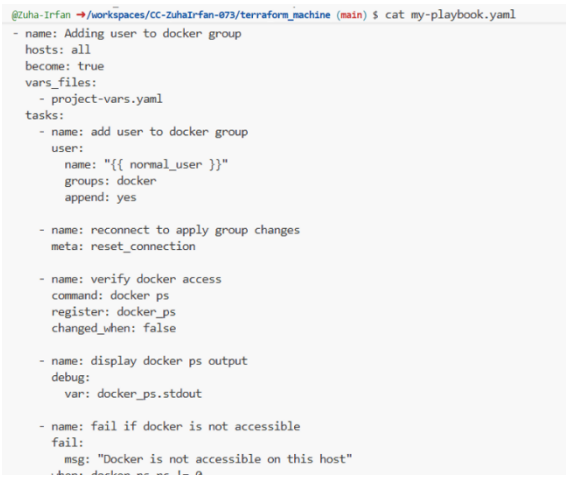
sudo docker ps

exit


## Task 9 – Gitea Docker stack via Ansible + Terraform security group update

Run containers for Gitea + Postgres and open port 3000 in the security group.

1. Extend my-playbook.yaml by appending:



2. Create project-vars.yaml:

touch project-vars.yaml

Add:

normal_user: ec2-user

docker_compose_file_location: <location-of-file>

```
@Zuha-Irfan ➜ /workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ touch project-vars.yaml
@Zuha-Irfan ➜ /workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim project-vars.yaml
@Zuha-Irfan ➜ /workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat ./project-vars.yaml
normal_user: ec2-user
docker_compose_file_location: /workspaces/terraform_machine
```

3. Add the deploy containers play:

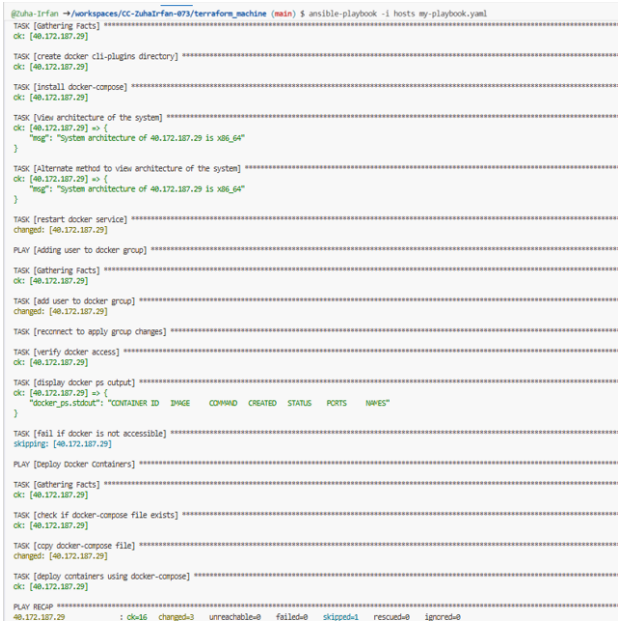
```
@Zuha-Irfan ➜ /workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat my-playbook.yaml
      fail:
        msg: "Docker is not accessible on this host"
      when: docker_ps.rc != 0

- name: Deploy Docker Containers
  hosts: all
  become: true
  user: "{{ normal_user }}"
  vars_files:
    - project-vars.yaml
  tasks:
    - name: check if docker-compose file exists
      stat:
        path: /home/{{ normal_user }}/compose.yaml
      register: compose_file

    - name: copy docker-compose file
      copy:
        src: "{{ docker_compose_file_location }}/compose.yaml"
        dest: /home/{{ normal_user }}/compose.yaml
        mode: '0644'
      when: not compose_file.stat.exists

    - name: deploy containers using docker-compose
      command: docker compose up -d
      register: compose_result
      changed_when: "'Creating' in compose_result.stdout or 'Recreating' in compose_result.stdout"
```

4. Create compose.yaml in repo root:

```
@Zuha-Irfan ➜ /workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ touch compose.yaml
@Zuha-Irfan ➜ /workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim compose.yaml
@Zuha-Irfan ➜ /workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat compose.yaml
services:
  gitea:
    image: gitea/gitea:latest
    container_name: gitea
    environment:
      - DB_TYPE=postgres
      - DB_HOST=db:5432
      - DB_NAME=gitea
      - DB_USER=gitea
      - DB_PASSWD=gitea
    restart: always
    volumes:
      - gitea:/data
    ports:
      - 3000:3000
    extra_hosts:
      - "www.jenkins.com:host-gateway"
    networks:
      - webnet
  db:
    image: postgres:alpine
    container_name: gitea_db
    environment:
      - POSTGRES_USER=gitea
      - POSTGRES_PASSWORD=gitea
      - POSTGRES_DB=gitea
    restart: always
    volumes:
      - gitea_postgres:/var/lib/postgresql/data
    expose:
      - 5432
    networks:
      - webnet

volumes:
  gitea_postgres:
    name: gitea_postgres
  gitea:
    name: gitea

networks:
  webnet:
    name: webnet
```

5. Run playbook and visit the public-ip on your browser but webpage will not be shown due to permission issue:

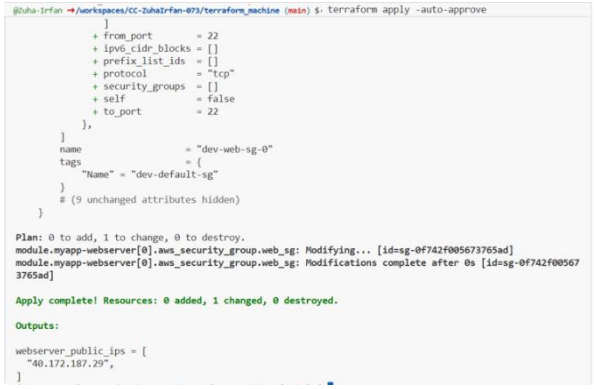
ansible-playbook -i hosts my-playbook.yaml




6. Update security group in modules/webserver/main.tf to add port 3000:

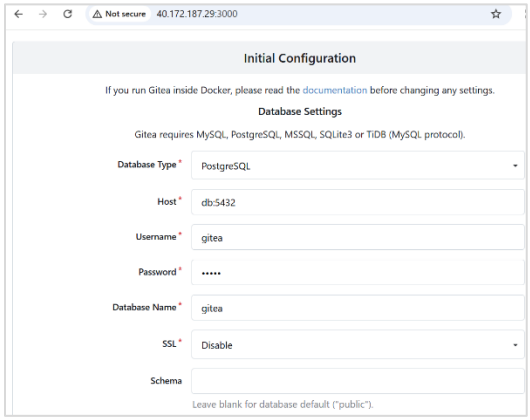

7. Apply:

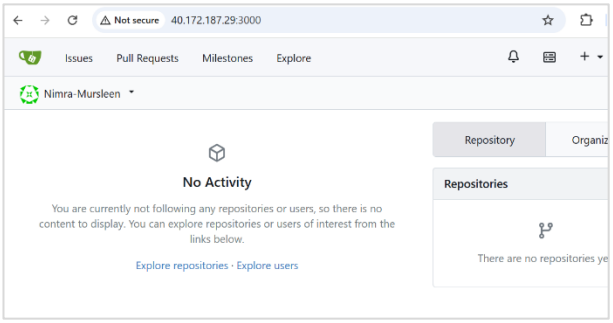
terraform apply -auto-approve



8. Access Gitea:

Visit http://<public-ip>:3000.




## Task 10 – Automating Ansible with Terraform (null_resource)

Have Terraform trigger Ansible automatically after EC2 creation.

1. Add null_resource to main.tf:

```
@Zuha-Irfan ➜ /workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat main.tf
resource "null_resource" "configure_server" {
  triggers = {
    webserver_public_ips_for_ansible = join(",", [for i in module.myapp-webserver : i.aws_instance.publ
ic_ip])
  }

  depends_on = [module.myapp-webserver]

  provisioner "local-exec" {
    command = <<-EOT
      ansible-playbook -i ${self.triggers.webserver_public_ips_for_ansible}, \
      --private-key "${var.private_key}" --user ec2-user \
      my-playbook.yaml
    EOT
  }
}
```

2. Destroy and recreate infrastructure:

terraform init

terraform destroy -auto-approve

terraform apply -auto-approve

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ terraform destroy -auto-approve
    - webserver_public_ips = [
        - "40.172.187.29",
      ] -> null
module.myapp-subnet.aws_default_route_table.main_rt: Destroying... [id=rtb-0de8e7c2f6e2a21ed]
module.myapp-subnet.aws_default_route_table.main_rt: Destruction complete after 0s
module.myapp-webserver[0].aws_instance.myapp-server: Destroying... [id=i-08faa252eebf7bde9]
module.myapp-subnet.aws_internet_gateway.myapp_igw: Destroying... [id=igw-07a66f23c5b03f7a8]
module.myapp-webserver[0].aws_instance.myapp-server: Still destroying... [id=i-08faa252eebf7bde9, 00m10
s elapsed]
module.myapp-subnet.aws_internet_gateway.myapp_igw: Still destroying... [id=igw-07a66f23c5b03f7a8, 00m1
0s elapsed]
module.myapp-webserver[0].aws_instance.myapp-server: Still destroying... [id=i-08faa252eebf7bde9, 00m20
s elapsed]
module.myapp-subnet.aws_internet_gateway.myapp_igw: Still destroying... [id=igw-07a66f23c5b03f7a8, 00m2
0s elapsed]
module.myapp-subnet.aws_internet_gateway.myapp_igw: Destruction complete after 27s
module.myapp-webserver[0].aws_instance.myapp-server: Still destroying... [id=i-08faa252eebf7bde9, 00m30
s elapsed]
module.myapp-webserver[0].aws_instance.myapp-server: Destruction complete after 30s
module.myapp-webserver[0].aws_key_pair.ssh-key: Destroying... [id=dev-serverkey-0]
module.myapp-subnet.aws_subnet.myapp_subnet_1: Destroying... [id=subnet-05e79b898e70ece6e]
module.myapp-webserver[0].aws_security_group.web_sg: Destroying... [id=sg-0f742f005673765ad]
module.myapp-webserver[0].aws_key_pair.ssh-key: Destruction complete after 0s
module.myapp-subnet.aws_subnet.myapp_subnet_1: Destruction complete after 0s
module.myapp-webserver[0].aws_security_group.web_sg: Destruction complete after 1s
aws_vpc.myapp_vpc: Destroying... [id=vpc-051f2f19b879b12a8]
aws_vpc.myapp_vpc: Destruction complete after 0s

Destroy complete! Resources: 7 destroyed.
```

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ terraform apply -auto-approve

  Error: local-exec provisioner error

    with null_resource.configure_server,
    on main.tf line 44, in resource "null_resource" "configure_server":
    44:   provisioner "local-exec" {

  Error running command 'ansible-playbook -i 51.112.47.121, \
  --private-key "~/.ssh/id_ed25519" --user ec2-user \
  my-playbook.yaml
  ': exit status 127. Output: [WARNING]: Ansible is being run in a world writable directory
  (/workspaces/terraform_machine), ignoring it as an ansible.cfg source. For more information see
  https://docs.ansible.com/ansible/devel/reference_appendices/config.html#cfg-in-world-writable-dir
 could not be foundbook:
  /bin/sh: 2: --private-key: not found
: not found3: my-playbook.yaml

@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim main.tf
```

3. If Ansible fails due to readiness, add a wait play at the top of my-playbook.yaml:

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat ./my-playbook.yaml
- name: Wait for some time to ensure system readiness
  hosts: all
  tasks:
    - name: Wait 300 seconds for port 22 to become open and contain "OpenSSH"
      wait_for:
        port: 22
        host: "{{ inventory_hostname }}"
        delay: 10
        timeout: 300
      delegate_to: localhost
```

```
resource "null_resource" "configure_server" {
  depends_on = [module.myapp-webserver]

  triggers = {
    webserver_public_ips_for_ansible = join(",", [
      for i in module.myapp-webserver : i.aws_instance.public_ip
    ])
  }

  provisioner "local-exec" {
    command = "ANSIBLE_HOST_KEY_CHECKING=False ansible-playbook -i ${self.triggers.webserver_public_ips_f
or_ansible}, --private-key ${var.private_key} --user ec2-user ${path.module}/my-playbook.yaml"
  }
}
```

4. Destroy and apply again:

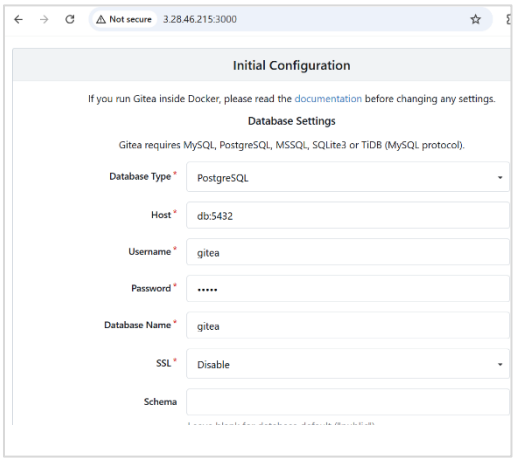
terraform destroy -auto-approve

terraform apply -auto-approve

```
module.myapp-subnet.aws_subnet.myapp_subnet_1: Destruction complete after 1s
module.myapp-webserver[0].aws_security_group.web_sg: Destruction complete after 1s
aws_vpc.myapp_vpc: Destroying... [id=vpc-0b616feb867897322]
aws_vpc.myapp_vpc: Destruction complete after 1s

Destroy complete! Resources: 8 destroyed.
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ terraform apply -auto-approve
```

```
Apply complete! Resources: 8 added, 0 changed, 0 destroyed.

Outputs:

webserver_public_ips = [
  "3.28.46.215",
]
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $
```

5. Verify Gitea / Nginx application is reachable at the appropriate URL.




## Task 11 – Dynamic inventory with aws_ec2 plugin

Let Ansible discover EC2 instances dynamically via the aws_ec2 inventory plugin.

1. Update ansible.cfg:

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim ansible.cfg
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat ./ansible.cfg
[defaults]
host_key_checking=False
interpreter_python = /usr/bin/python3

[defaults]
host_key_checking=False
interpreter_python = /usr/bin/python3
deprecation_warnings = False

enable_plugins = aws_ec2
private_key_file = ~/.ssh/id_ed25519
```

2. Create inventory_aws_ec2.yaml:

touch inventory_aws_ec2.yaml

ls -la inventory_aws_ec2.yaml

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ touch inventory_aws_ec2.yaml
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ ls -la inventory_aws_ec2.yaml
  -rw-rw-rw- 1 codespace codespace 0 Jan  8 22:59 inventory_aws_ec2.yaml
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim inventory_aws_ec2.yaml
```

Add initial content:

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim inventory_aws_ec2.yaml
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat ./inventory_aws_ec2.yaml
---
plugin: aws_ec2
regions:
  - me-central-1
```

3. Ensure Terraform code includes both dev and prod webservers in main.tf:

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat ./main.tf
}

module "myapp-webserver-prod" {
  source = "./modules/webserver"
  env_prefix = "prod"
  instance_type = "t3.nano"
  availability_zone = var.availability_zone
  public_key = var.public_key
  my_ip = local.my_ip
  vpc_id = aws_vpc.myapp_vpc.id
  subnet_id = module.myapp-subnet.subnet.id

  # Loop count
  count             = 1
  # Use count.index to differentiate instances
  instance_suffix   = count.index
}

resource "null_resource" "configure_server" {
  depends_on = [module.myapp-webserver]

  triggers = {
```

4. Add outputs in outputs.tf:

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim outputs.tf
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat ./outputs.tf
  #output "webserver_public_ips" {
   # value = [for i in module.myapp-webserver : i.aws_instance.public_ip]
  #}

  output "webserver_public_ips" {
    value = [for i in module.myapp-webserver : i.aws_instance.public_ip]
  }

  output "prod-webserver_public_ips" {
    value = [for i in module.myapp-webserver-prod : i.aws_instance.public_ip]
  }
```

5. Rebuild infra:

terraform init

terraform apply -auto-approve

terraform output

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ terraform apply -auto-approve
  aws_vpc.myapp_vpc: Modifying... [id=vpc-0fcce9ae3aefac3a1]
  module.myapp-webserver-prod[0].aws_key_pair.ssh-key: Creation complete after 1s [id=prod-serverkey-0]
  aws_vpc.myapp_vpc: Still modifying... [id=vpc-0fcce9ae3aefac3a1, 00m10s elapsed]
  aws_vpc.myapp_vpc: Modifications complete after 12s [id=vpc-0fcce9ae3aefac3a1]
  module.myapp-webserver-prod[0].aws_security_group.web_sg: Creating...
  module.myapp-webserver-prod[0].aws_security_group.web_sg: Creation complete after 2s [id=sg-0dd75b6dd32bd
  7be5]
  module.myapp-webserver-prod[0].aws_instance.myapp-server: Creating...
  module.myapp-webserver-prod[0].aws_instance.myapp-server: Still creating... [00m10s elapsed]
  module.myapp-webserver-prod[0].aws_instance.myapp-server: Creation complete after 13s [id=i-07b57e378b054
  8659]

  Apply complete! Resources: 3 added, 1 changed, 0 destroyed.

  Outputs:

  prod-webserver_public_ips = [
    "3.28.40.241",
  ]
  webserver_public_ips = [
    "3.28.46.215",
  ]
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ terraform output
  prod-webserver_public_ips = [
    "3.28.40.241",
  ]
  webserver_public_ips = [
    "3.28.46.215",
  ]
```

6. Install boto3 and botocore:

$(which python) -m pip install boto3 botocore

- Verify the version

$(which python) -c "import boto3, botocore; print(boto3.__version__)"

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ $(which python) -m pip install boto3 botocore
Collecting boto3
  Downloading boto3-1.42.24-py3-none-any.whl.metadata (6.8 kB)
Collecting botocore
  Downloading botocore-1.42.24-py3-none-any.whl.metadata (5.9 kB)
Collecting jmespath<2.0.0,>=0.7.1 (from boto3)
  Downloading jmespath-1.0.1-py3-none-any.whl.metadata (7.6 kB)
Collecting s3transfer<0.17.0,>=0.16.0 (from boto3)
  Downloading s3transfer-0.16.0-py3-none-any.whl.metadata (1.7 kB)
Requirement already satisfied: python-dateutil<3.0.0,>=2.1 in /home/codespace/.local/lib/python3.12/site-packages (from botoco
re) (2.9.0.post0)
Requirement already satisfied: urllib3!=2.2.0,<3,>=1.25.4 in /home/codespace/.local/lib/python3.12/site-packages (from botocor
e) (2.5.0)
Requirement already satisfied: six>=1.5 in /home/codespace/.local/lib/python3.12/site-packages (from python-dateutil<3.0.0,>=2
.1->botocore) (1.17.0)
Downloading boto3-1.42.24-py3-none-any.whl (140 kB)
Downloading botocore-1.42.24-py3-none-any.whl (14.6 MB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 14.6/14.6 MB 28.3 MB/s  0:00:00
Downloading jmespath-1.0.1-py3-none-any.whl (20 kB)
Downloading s3transfer-0.16.0-py3-none-any.whl (86 kB)
Installing collected packages: jmespath, botocore, s3transfer, boto3
Successfully installed boto3-1.42.24 botocore-1.42.24 jmespath-1.0.1 s3transfer-0.16.0
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ $(which python) -c "import boto3, botocore; print(boto3.__version__)"
1.42.24
```

7. Check inventory graph:

ansible-inventory -i inventory_aws_ec2.yaml --graph

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ /usr/local/py-utils/venvs/ansible-core/bin/python -m pip install boto
3 botocore
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ ansible-inventory -i inventory_aws_ec2.yaml --graph
[WARNING]: Ansible is being run in a world writable directory (/workspaces/terraform_machine), ignoring it as an ansible.cfg s
ource. For more information see https://docs.ansible.com/ansible/devel/reference_appendices/config.html#cfg-in-world-writable-
dir
[WARNING]: Deprecation warnings can be disabled by setting `deprecation_warnings=False` in ansible.cfg.
[DEPRECATION WARNING]: Importing 'to_text' from 'ansible.module_utils._text' is deprecated. This feature will be removed from
ansible-core version 2.24. Use ansible.module_utils.common.text.converters instead.
[DEPRECATION WARNING]: Importing 'to_native' from 'ansible.module_utils._text' is deprecated. This feature will be removed fro
m ansible-core version 2.24. Use ansible.module_utils.common.text.converters instead.
[DEPRECATION WARNING]: Passing `disable_lookups` to `template` is deprecated. This feature will be removed from ansible-core v
ersion 2.23.
@all:
  |--@ungrouped:
  |--@aws_ec2:
  |  |--ec2-3-28-46-215.me-central-1.compute.amazonaws.com
  |  |--ec2-3-28-40-241.me-central-1.compute.amazonaws.com
```

## Task 12 – Filtering EC2 instances by tags & instance type

Augment the inventory plugin to group by tags and instance type, then limit plays to specific groups.

1. Modify inventory_aws_ec2.yaml to add tag-based grouping:

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim inventory_aws_ec2.yaml
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat ./inventory_aws_ec2.yaml
---
plugin: aws_ec2
regions:
  - me-central-1

keyed_groups:
  - key: tags
    prefix: tag
    separator: "_"
```

Check graph:

ansible-inventory -i inventory_aws_ec2.yaml –graph

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ ansible-inventory -i inventory_aws_ec2.yaml --graph
[WARNING]: Ansible is being run in a world writable directory (/workspaces/terraform_machine), ignoring it as an ansible.cfg s
ource. For more information see https://docs.ansible.com/ansible/devel/reference_appendices/config.html#cfg-in-world-writable-
dir
[WARNING]: Deprecation warnings can be disabled by setting `deprecation_warnings=False` in ansible.cfg.
[DEPRECATION WARNING]: Importing 'to_text' from 'ansible.module_utils._text' is deprecated. This feature will be removed from
ansible-core version 2.24. Use ansible.module_utils.common.text.converters instead.
[DEPRECATION WARNING]: Importing 'to_native' from 'ansible.module_utils._text' is deprecated. This feature will be removed fro
m ansible-core version 2.24. Use ansible.module_utils.common.text.converters instead.
[DEPRECATION WARNING]: Passing `disable_lookups` to `template` is deprecated. This feature will be removed from ansible-core v
ersion 2.23.
@all:
  |--@ungrouped:
  |--@aws_ec2:
  |  |--ec2-3-28-46-215.me-central-1.compute.amazonaws.com
  |  |--ec2-3-28-40-241.me-central-1.compute.amazonaws.com
  |--@tag_Name_dev_ec2_instance_0:
  |  |--ec2-3-28-46-215.me-central-1.compute.amazonaws.com
  |--@tag_Name_prod_ec2_instance_0:
  |  |--ec2-3-28-40-241.me-central-1.compute.amazonaws.com
```

2. Extend to group by instance type as well:

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ vim inventory_aws_ec2.yaml
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat ./inventory_aws_ec2.yaml
---
plugin: aws_ec2
regions:
  - me-central-1

keyed_groups:
  - key: tags
    prefix: tag
    separator: "_"

  - key: instance_type
    prefix: instance_type
    separator: "_"
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $
```

Check graph again:

ansible-inventory -i inventory_aws_ec2.yaml –graph

```
@Zuha-Irfan ➜ /workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ ansible-inventory -i inventory_aws_ec2.yaml --graph
[WARNING]: Ansible is being run in a world writable directory (/workspaces/terraform_machine), ignoring it as an ansible.cfg so
For more information see https://docs.ansible.com/ansible/devel/reference_appendices/config.html#cfg-in-world-writable-dir
[WARNING]: Deprecation warnings can be disabled by setting `deprecation_warnings=False` in ansible.cfg.
[DEPRECATION WARNING]: Importing 'to_text' from 'ansible.module_utils._text' is deprecated. This feature will be removed from a
-core version 2.24. Use ansible.module_utils.common.text.converters instead.
[DEPRECATION WARNING]: Importing 'to_native' from 'ansible.module_utils._text' is deprecated. This feature will be removed from
le-core version 2.24. Use ansible.module_utils.common.text.converters instead.
[DEPRECATION WARNING]: Passing `disable_lookups` to `template` is deprecated. This feature will be removed from ansible-core ve
2.23.
@all:
|--@ungrouped:
|--@aws_ec2:
|  |--ec2-3-28-46-215.me-central-1.compute.amazonaws.com
|  |--ec2-3-28-40-241.me-central-1.compute.amazonaws.com
|--@tag_Name_dev_ec2_instance_0:
|  |--ec2-3-28-46-215.me-central-1.compute.amazonaws.com
|--@instance_type_t3_micro:
|  |--ec2-3-28-46-215.me-central-1.compute.amazonaws.com
|--@tag_Name_prod_ec2_instance_0:
|  |--ec2-3-28-40-241.me-central-1.compute.amazonaws.com
|--@instance_type_t3_nano:
|  |--ec2-3-28-40-241.me-central-1.compute.amazonaws.com
```

3. Prepare my-playbook.yaml for nginx+SSL+PHP on hosts: all:
4. Run on all instances:

ansible-playbook -i inventory_aws_ec2.yaml my-playbook.yaml

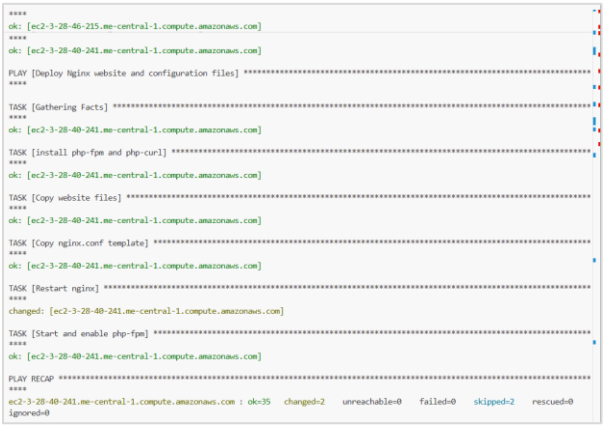
```
@Zuha-Irfan ➜ /workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ ansible-playbook -i inventory_aws_ec2.yaml my-playbook.yaml

TASK [Generate self-signed SSL certificate] ************************************************************************************
ok: [ec2-3-28-40-241.me-central-1.compute.amazonaws.com]
ok: [ec2-3-28-46-215.me-central-1.compute.amazonaws.com]

PLAY [Deploy Nginx website and configuration files] ****************************************************************************

TASK [Gathering Facts] *********************************************************************************************************
ok: [ec2-3-28-46-215.me-central-1.compute.amazonaws.com]
ok: [ec2-3-28-40-241.me-central-1.compute.amazonaws.com]

TASK [install php-fpm and php-curl] ********************************************************************************************
ok: [ec2-3-28-46-215.me-central-1.compute.amazonaws.com]
ok: [ec2-3-28-40-241.me-central-1.compute.amazonaws.com]

TASK [Copy website files] ******************************************************************************************************
ok: [ec2-3-28-46-215.me-central-1.compute.amazonaws.com]
ok: [ec2-3-28-40-241.me-central-1.compute.amazonaws.com]

TASK [Copy nginx.conf template] ************************************************************************************************
ok: [ec2-3-28-46-215.me-central-1.compute.amazonaws.com]
ok: [ec2-3-28-40-241.me-central-1.compute.amazonaws.com]

TASK [Restart nginx] ***********************************************************************************************************
changed: [ec2-3-28-46-215.me-central-1.compute.amazonaws.com]
changed: [ec2-3-28-40-241.me-central-1.compute.amazonaws.com]

TASK [Start and enable php-fpm] ************************************************************************************************
ok: [ec2-3-28-46-215.me-central-1.compute.amazonaws.com]
ok: [ec2-3-28-40-241.me-central-1.compute.amazonaws.com]

PLAY RECAP *********************************************************************************************************************
ec2-3-28-40-241.me-central-1.compute.amazonaws.com : ok=35   changed=2    unreachable=0    failed=0    skipped=2    rescued=0    igno
red=0
ec2-3-28-46-215.me-central-1.compute.amazonaws.com : ok=35   changed=2    unreachable=0    failed=0    skipped=2    rescued=0    igno
red=0
```

5. Run only on dev instances:

ansible-playbook -i inventory_aws_ec2.yaml -l tag_Name_dev_* my-playbook.yaml


6. Run only on prod instances:

ansible-playbook -i inventory_aws_ec2.yaml -l tag_Name_prod_* my-playbook.yaml




7. Run only on t3.micro instances:

ansible-playbook -i inventory_aws_ec2.yaml -l instance_type_t3_micro my-playbook.yaml

8. Run only on t3.nano instances:

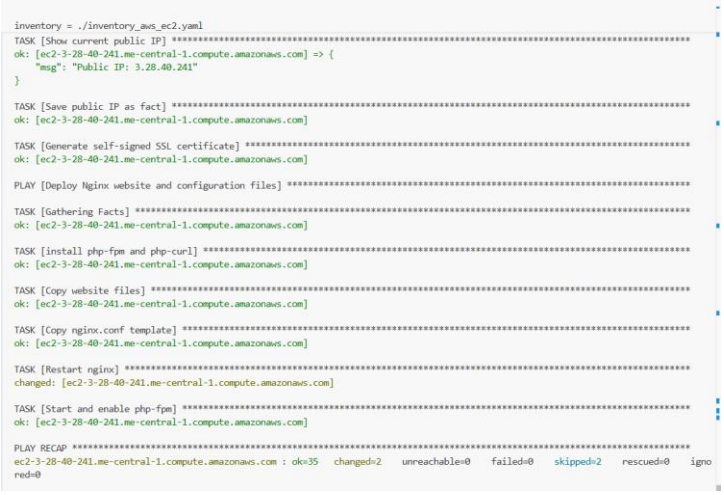
ansible-playbook -i inventory_aws_ec2.yaml -l instance_type_t3_nano my-playbook.yaml


9. Update ansible.cfg to use inventory by default:

inventory = ./inventory_aws_ec2.yaml


10. Now you can simply run:

ansible-playbook -l instance_type_t3_nano my-playbook.yaml



**Task 13 – Ansible roles: nginx, ssl, webapp**

Reorganize your configuration into roles.

1. Update main.tf for a simple dev environment with 1 instance (as shown previously).

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cat main.tf
    default_route_table_id = aws_vpc.myapp_vpc.default_route_table_id
  }

  module "myapp-webserver" {
    source = "./modules/webserver"
    env_prefix = var.env_prefix
    instance_type = var.instance_type
    availability_zone = var.availability_zone
    public_key = var.public_key
    my_ip = local.my_ip
    vpc_id = aws_vpc.myapp_vpc.id
    subnet_id = module.myapp-subnet.subnet.id

    # Loop count
    count             = 1
    # Use count.index to differentiate instances
    instance_suffix   = count.index
```

2. Create /ansible structure: mkdir -p ansible
   cd ansible
   mkdir inventory roles
   touch ansible.cfg my-playbook.yaml

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ mkdir -p ansible
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine (main) $ cd ansible
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $ mkdir inventory roles
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $ touch ansible.cfg my-playbook.yaml
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $ ls -R
.:
ansible.cfg  inventory  my-playbook.yaml  roles

./inventory:

./roles:
```

3. ansible/ansible.cfg:

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform machine/ansible (main) $ vim ansible.cfg
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $ cat ansible.cfg
[defaults]
host_key_checking=False
interpreter_python = /usr/bin/python3
```

4. ansible/inventory/hosts:

```
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $ vim inventory/hosts
@Zuha-Irfan ➜/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $ cat inventory/hosts
[nginx]
51.112.49.120

[nginx:vars]
ansible_ssh_private_key_file=~/.ssh/id_ed25519
ansible user=ec2-user
```

5. Create roles:

```
@Zuha-Irfan →.../CC-ZuhaIrfan-073/terraform_machine/ansible/roles (main) $  ansible-galaxy role init nginx
- Role nginx was created successfully
@Zuha-Irfan →.../CC-ZuhaIrfan-073/terraform_machine/ansible/roles (main) $  ansible-galaxy role init ssl
- Role ssl was created successfully
@Zuha-Irfan →.../CC-ZuhaIrfan-073/terraform_machine/ansible/roles (main) $  ansible-galaxy role init webapp
- Role webapp was created successfully
@Zuha-Irfan →.../CC-ZuhaIrfan-073/terraform_machine/ansible/roles (main) $  cd ..
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $ ls -R
.:
ansible.cfg  inventory  my-playbook.yaml  roles

./inventory:
hosts

./roles:
nginx  ssl  webapp

./roles/nginx:
README.md  defaults  files  handlers  meta  tasks  templates  tests  vars
```

6. Role: nginx

- ansible/roles/nginx/handlers/main.yml:

```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $  vim roles/nginx/handlers/main.yml
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $  cat roles/nginx/handlers/main.yml
#SPDX-License-Identifier: MIT-0
---
# handlers file for nginx
- name: Restart nginx
  service:
    name: nginx
    state: restarted
```

- ansible/roles/nginx/tasks/main.yml:

```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $  vim roles/nginx/tasks/main.yml
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $ cat roles/nginx/tasks/main.yml
#SPDX-License-Identifier: MIT-0
---
# tasks file for nginx
- name: Install nginx
  yum:
    name: nginx
    state: present
    update_cache: yes
  notify: Restart nginx

- name: Install openssl
  yum:
    name: openssl
    state: present

- name: Start and enable nginx
  service:
    name: nginx
    state: started
    enabled: true
```

7. First role-based playbook ansible/my-playbook.yaml:

```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $  vim my-playbook.yaml
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $  cat my-playbook.yaml
---
- name: Deploy NGINX Web Stack with SSL and PHP
  hosts: nginx
  become: true
  roles:
    - nginx
```

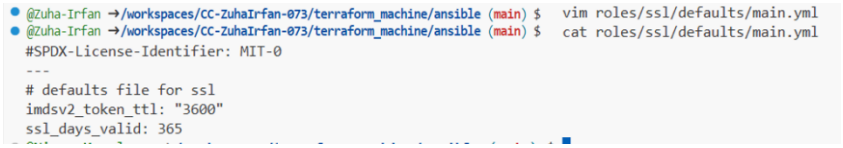
Run:

chmod 755 $(pwd)

ansible-playbook -i inventory/hosts my-playbook.yaml


8. Role: ssl

- ansible/roles/ssl/defaults/main.yml:




9. Role: webapp

- ansible/roles/webapp/defaults/main.yml:


- ansible/roles/webapp/files/index.php – PHP metadata page.

```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $   vim roles/webapp/defaults/main.yml
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $   cat roles/webapp/defaults/main.yml
#SPDX-License-Identifier: MIT-0
---
# defaults file for webapp
nginx_user: nginx
nginx_worker_processes: auto
nginx_worker_connections: 1024
nginx_error_log_level: notice

# Webapp settings
web_root: /usr/share/nginx/html
web_index_file: index.php
```

- ansible/roles/webapp/tasks/main.yml:

```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $  cat roles/webapp/files/index.php
            font-family: Arial, sans-serif;
            margin: 50px;
            background: linear-gradient(135deg, #667eea 0%, #764ba2 100%);
            color: white;
        }
        .container {
            background: rgba(255, 255, 255, 0.1);
            padding: 30px;
            border-radius: 10px;
            box-shadow: 0 8px 32px rgba(31, 38, 135, 0.37);
        }
        h1 {
            color: #fff;
            text-shadow: 2px 2px 4px rgba(0,0,0,0.3);
        }
        .info {
            margin: 15px 0;
            padding: 10px;
            background: rgba(255,255,255,0.2);
            border-radius: 5px;
        }
        .label {
            font-weight: bold;
            color: #ffd700;
        }
        .info a {
            color: white;          /* same as other values */
            text-decoration: none;  /* remove underline */
            font-weight: normal;
        }

        .info a:hover {
            text-decoration: underline; /* optional: underline on hover */
        }
    </style>
</head>
<body>
    <div class="container">
        <h1>🚀 Nginx Front End Web Server </h1>

        <div class="info"><span class="label">Hostname:</span> <?= htmlspecialchars($hostname) ?></div>
        <div class="info"><span class="label">Instance ID:</span> <?= htmlspecialchars($instance_id) ?></div>
        <div class="info"><span class="label">Private IP:</span> <?= htmlspecialchars($private_ip) ?></div>
        <div class="info"><span class="label">Public IP:</span> <?= htmlspecialchars($public_ip) ?></div>
        <div class="info"><span class="label">Public DNS:</span>
            <a href="https://<?= htmlspecialchars($public_dns) ?>" target="_blank">
```

10. Final role-based playbook ansible/my-playbook.yaml:

- ansible/roles/webapp/tasks/main.yml:

```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $  cat roles/webapp/templates/nginx.conf.j2

    server {
        listen 443 ssl;
        server_name {{ server_public_ip }};

        ssl_certificate /etc/ssl/certs/selfsigned.crt;
        ssl_certificate_key /etc/ssl/private/selfsigned.key;

        location / {
            root {{ web_root }};
            index {{ web_index_file }} index.html index.htm;
    #       proxy_pass http://158.252.94.241:80;
    #       proxy_pass http://backend_servers;

            location / {
                try_files $uri $uri/ =404;
            }

            # 🔴 This block is necessary for Php Website
            location ~ \.php$ {
                include fastcgi_params;
                fastcgi_pass unix:/run/php-fpm/www.sock;
                fastcgi_index index.php;
                fastcgi_param SCRIPT_FILENAME $document_root$fastcgi_script_name;
            }
        }
    }

    server {
        listen 80;
        server_name _;
        return 301 https://$host$request_uri;
    }
}
```

10. Final role-based playbook ansible/my-playbook.yaml:

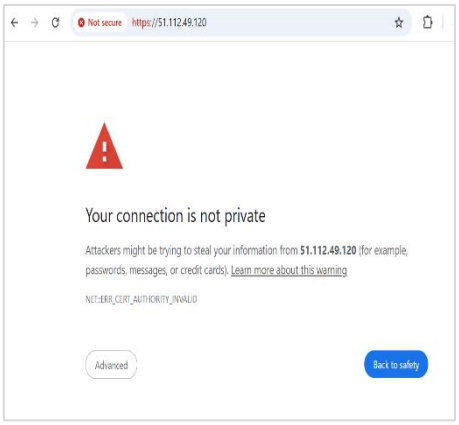
```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $  ansible-playbook -i inventory/hosts my-playbook.yaml

TASK [ssl : Create SSL certs directory] ****************************************************************************
ok: [51.112.49.120]

TASK [ssl : Get IMDSv2 token] **************************************************************************************
ok: [51.112.49.120]

TASK [ssl : Get public IP] *****************************************************************************************
ok: [51.112.49.120]

TASK [ssl : Save public IP as fact] ********************************************************************************
ok: [51.112.49.120]

TASK [ssl : Generate self-signed certificate] **********************************************************************
ok: [51.112.49.120]

TASK [webapp : Install PHP packages] *******************************************************************************
ok: [51.112.49.120]

TASK [webapp : Copy PHP website] ***********************************************************************************
changed: [51.112.49.120]

TASK [webapp : Deploy nginx config] ********************************************************************************
changed: [51.112.49.120]

TASK [webapp : Start and enable php-fpm] ***************************************************************************
ok: [51.112.49.120]

RUNNING HANDLER [webapp : Restart nginx] ***************************************************************************
changed: [51.112.49.120]

PLAY RECAP *********************************************************************************************************
51.112.49.120              : ok=15   changed=3    unreachable=0    failed=0    skipped=0    rescued=0    ignored=0
```

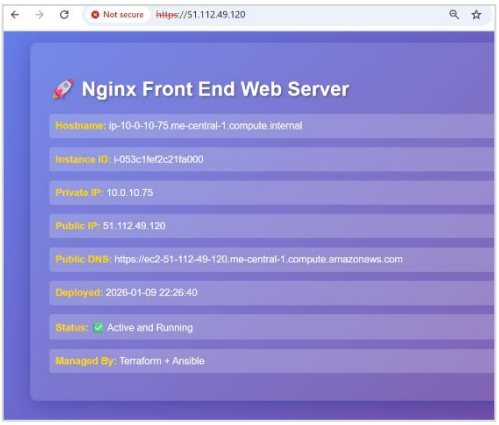
11. Run:

```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $  vim roles/webapp/tasks/main.yml
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $  cat roles/webapp/tasks/main.yml
#SPDX-License-Identifier: MIT-0
---
# tasks file for webapp
- name: Install PHP packages
  yum:
    name:
      - php-fpm
      - php-curl
    state: present
  notify: Restart php-fpm

- name: Copy PHP website
  copy:
    src: index.php
    dest: "{{ web_root }}/{{ web_index_file }}"
    owner: nginx
    group: nginx
    mode: '0644'
  notify: Restart nginx

- name: Deploy nginx config
  template:
    src: nginx.conf.j2
    dest: /etc/nginx/nginx.conf
  notify: Restart nginx

- name: Start and enable php-fpm
  service:
    name: php-fpm
    state: started
    enabled: true
```

```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $   vim my-playbook.yaml
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $   cat my-playbook.yaml
---
- name: Deploy NGINX Web Stack with SSL and PHP
  hosts: nginx
  become: true
  roles:
    - nginx
    - ssl
    - webapp
```

Visit https://<public-ip> and verify the PHP page with metadata.




## Cleanup

1. From the Terraform root:

terraform destroy -auto-approve

```
Destroy complete! Resources: 11 destroyed.
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $  terraform destroy -auto-approve

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.
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $  cat terraform.tfstate
```

2. Verify state:

cat terraform.tfstate

```
@Zuha-Irfan →/workspaces/CC-ZuhaIrfan-073/terraform_machine/ansible (main) $  cat terraform.tfstate
{
  "version": 4,
  "terraform_version": "1.14.3",
  "serial": 209,
  "lineage": "34978037-947f-49bd-9fd6-644456e744b7",
  "outputs": {},
  "resources": [],
  "check_results": null
}
```

3. Confirm that no EC2 instances remain in AWS console.