



DEPARTMENT OF SOFTWARE ENGINEERING

LAB#14

SUBMITTED TO:

ENGR. MUHAMMAD SHOAIB

ENGR. WAQAS SALEEM

SUBMITTED BY: NEHA AMJAD

REG NO: 2021-BSE-024

Task 0 – Lab Setup (Codespace & GH CLI)

task0_codespace_open.png

The screenshot shows two windows side-by-side. The left window is a GitHub repository page for 'terraform_machine' (Public). It displays basic repository stats (main branch, 1 branch, 0 tags), a message indicating it's up-to-date with the upstream branch, and a list of recent commits by 'WaqasSaleem97' (6 commits, last updated last week). The right window is a Microsoft Visual Studio Code interface showing the file structure of the 'TERRAFORM_MACHINE [CODESPACES]' folder. The Explorer sidebar lists files like 'modules', '.gitignore', 'locals.tf', 'main.tf', 'outputs.tf', 'README.md', and 'variables.tf'. The main workspace shows a large 'X' placeholder icon, and the bottom navigation bar has tabs for PROBLEMS, OUTPUT, TERMINAL, and PORTS.

task0_env_check.png

```
terraform --version
aws-cli/2.33.1 Python/3.13.11 Linux/6.8.0-1030-azure exe/x86_64.ubuntu.24
Terraform v1.14.3
on linux_amd64
```

task0_aws_config.png

```
{
  "UserId": "368002277745",
  "Account": "368002277745",
  "Arn": "arn:aws:iam::368002277745:root"
}
```

Task 1 – Generate ssh key and Initial Terraform apply

task1_ssh_keygen_before.png

```
total 20
drwx----- 2 codespace codespace 4096 Jan 16 14:44 .
drwxr-x--- 1 codespace codespace 4096 Jan 16 14:44 ..
-rw------- 1 codespace codespace 419 Jan 16 14:44 id_ed25519
-rw-r--r-- 1 codespace codespace 109 Jan 16 14:44 id_ed25519.pub
```

task1_ssh_keygen.png

```
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:
SHA256:8s9rB8zI0NsXrUJ+zlqenvDnbXjC35A7aPSN4K9BC+Y codespace@codespaces-feaa13
The key's randomart image is:
+ [ED25519 256] +
```

task1_ssh_keygen_after.png

```
total 20
drwx----- 2 codespace codespace 4096 Jan 16 14:44 .
drwxr-x--- 1 codespace codespace 4096 Jan 16 14:44 ..
-rw----- 1 codespace codespace 419 Jan 16 14:44 id_ed25519
-rw-r--r-- 1 codespace codespace 109 Jan 16 14:44 id_ed25519.pub
```

task1_terraform_tfvars_created.png

```
→/workspaces/terraform_machine (main) $ touch terraform.tfvars
→/workspaces/terraform_machine (main) $ []
```

task1_terraform_tfvars.png



```
terraform.tfvars
  terraform.tfvars
    1  vpc_cidr_block      = "10.0.0.0/16"
    2  subnet_cidr_block   = "10.0.10.0/24"
    3  availability_zone   = "me-central-1a"
    4  env_prefix          = "dev"
    5  instance_type        = "t3.micro"
    6  public_key           = "~/.ssh/id_ed25519.pub"
    7  private_key          = "~/.ssh/id_ed25519"
```

task1_terraform_init.png

```
Initializing the backend...
Initializing modules...
- myapp-subnet in modules/subnet
- myapp-webserver in modules/webserver
Initializing provider plugins...
- Finding latest version of hashicorp/aws...
- Finding latest version of hashicorp/http...
- Installing hashicorp/aws v6.28.0...
```

task1_terraform_apply_2_instances.png

```
module.myapp-webserver[0].aws_instance.myapp-server: Creation complete after 13s [id=i-0208ef0ce18a8ce67]

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

Outputs:

webserver_public_ips = [
    "51.112.228.98",
    "51.112.178.49",
]
```

task1_terraform_output_ips.png

```
webserver_public_ips = [
    "51.112.228.98",
    "51.112.178.49",
]
```

Task 2 – Static Ansible inventory with two EC2 instances

task2_ansible_install.png

```
ansible [core 2.20.1]
  config file = None
  configured module search path = ['/home/codespace/.ansible/plugins/modules', '/usr/share/ansible/plugins/modules']
  ansible python module location = /usr/local/py-utils/venvs/ansible-core/lib/python3.12/site-packages/ansible
  ansible collection location = /home/codespace/.ansible/collections:/usr/share/ansible/collections
  executable location = /usr/local/py-utils/bin/ansible
```

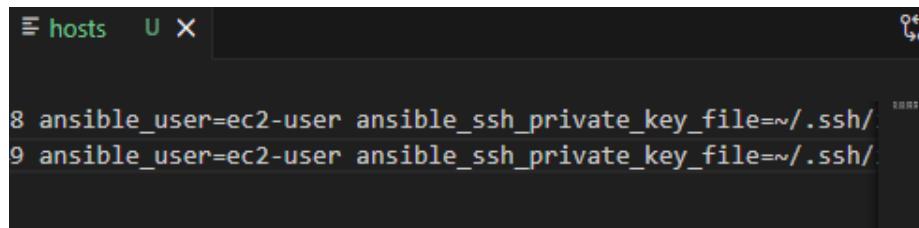
task2_terraform_output_ips.png

```
webserver_public_ips = [
    "51.112.228.98",
    "51.112.178.49",
]
```

task2_hosts_created.png

```
VER 3.8.0 (WITH LIBYAML V0.7.2.5)
→/workspaces/terraform_machine (main) $ touch hosts
→/workspaces/terraform_machine (main) $
```

task2_hosts_initial.png



A screenshot of a terminal window titled "hosts". The window contains two lines of text:

```
8 ansible_user=ec2-user ansible_ssh_private_key_file=~/.ssh/
9 ansible_user=ec2-user ansible_ssh_private_key_file=~/.ssh/
```

task2_ansible_ping_success.png

```
[WARNING]: Host '51.112.178.49' is using the discovered Python interpreter at '/usr/bin/python3.9',
, but future installation of another Python interpreter could cause a different interpreter to b
e discovered. See https://docs.ansible.com/ansible-core/2.20/reference_appendices/interpreter_dis
covery.html for more information.
51.112.178.49 | SUCCESS => {
    "ansible_facts": {
        "discovered_interpreter_python": "/usr/bin/python3.9"
    },
    "changed": false,
    "ping": "pong"
}
[WARNING]: Host '51.112.228.98' is using the discovered Python interpreter at '/usr/bin/python3.9'
```

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

task3_main_tf_count_3.png

```
main.tf
22
23 module "myapp-webserver" {
24   source = "./modules/webserver"
25   env_prefix = var.env_prefix
26   instance_type = var.instance_type
27   availability_zone = var.availability_zone
28   public_key = var.public_key
29   my_ip = local.my_ip
30   vpc_id = aws_vpc.myapp_vpc.id
31   subnet_id = module.myapp-subnet.subnet.id
32
33   # Loop count
34   count      = 3
35   # Use count.index to differentiate instances
36   instance_suffix = count.index
37
38 }
39
```

task3_terraform_apply_3_instances.png

```
836cdb5]
Apply complete! Resources: 3 added, 0 changed, 0 destroyed.
```

task3_terraform_output_3_ips.png

```
836cdb5]
Apply complete! Resources: 3 added, 0 changed, 0 destroyed.

Outputs:

webserver_public_ips = [
  "51.112.228.98",
  "51.112.178.49",
  "3.29.232.128",
]
```

task3_hosts_grouped.png

task3_ansible_ec2_ping.png

```
[WARNING]: Host '51.112.228.98' 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/2.20/reference_appendices/interpreter_discovery.html for more information.
51.112.228.98 | SUCCESS => {
    "ansible_facts": {
        "discovered_interpreter_python": "/usr/bin/python3.9"
    },
    "changed": false,
    "ping": "pong"
}
```

task3_ansible_single_ip_ping.png

```
[WARNING]: Host '51.112.178.49' 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/2.20/reference_appendices/interpreter_discovery.html for more information.
51.112.178.49 | SUCCESS => {
    "ansible_facts": {
        "discovered_interpreter_python": "/usr/bin/python3.9"
    },
    "changed": false,
    "ping": "pong"
}
```

task3_ansible_droplet_ping.png

```
[WARNING]: Host '3.29.232.128' 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/2.20/reference_appendices/interpreter_discovery.html for more information.
3.29.232.128 | SUCCESS => {
    "ansible_facts": {
        "discovered_interpreter_python": "/usr/bin/python3.9"
    },
    "changed": false,
    "ping": "pong"
}
```

task3_ansible_all_ping.png

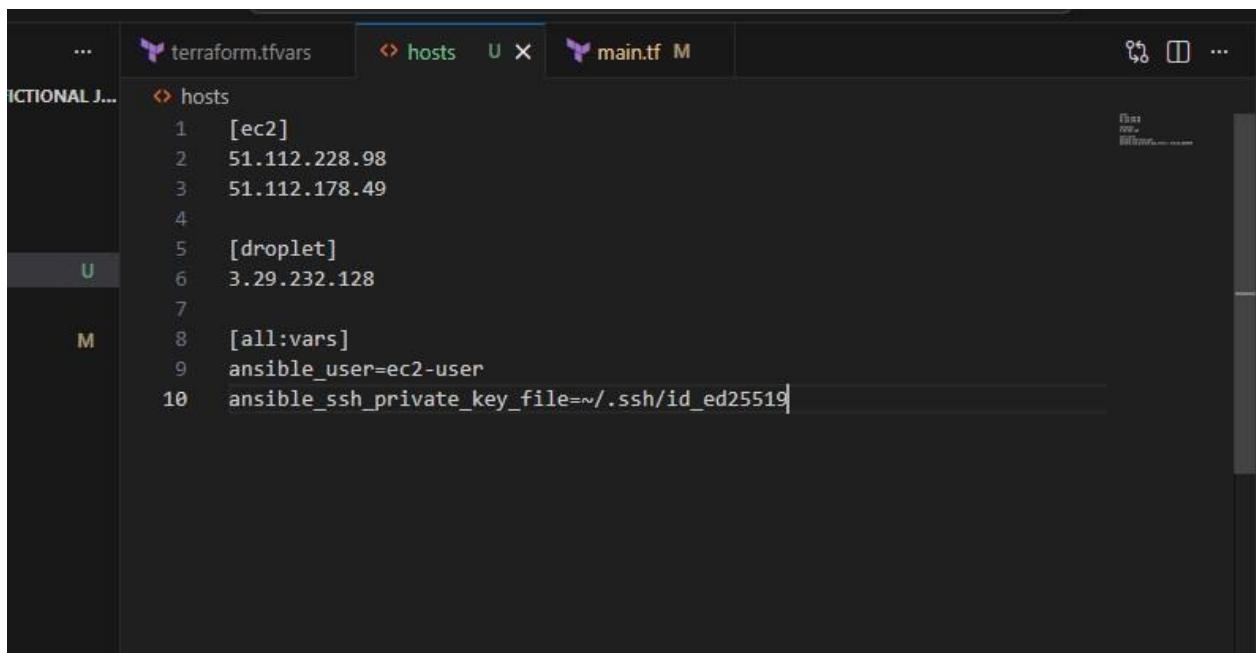
```
[WARNING]: Host '51.112.228.98' is using the discovered Python interpreter at '/usr/bin/python3.9', but future installation of another Python interpreter could cause a different interpreter to be discovered. See https://docs.ansible.com/ansible-core/2.20/reference_appendices/interpreter_discovery.html for more information.  
51.112.228.98 | SUCCESS => {  
    "ansible_facts": {  
        "discovered_interpreter_python": "/usr/bin/python3.9"  
    },  
    "changed": false,  
    "ping": "pong"  
}
```

Task 4 – Global ansible.cfg & first nginx playbook

task4_global_ansible_cfg.png

```
": "pong"  
→/workspaces/terraform_machine (main) $ vim ~/.ansible.cfg  
→/workspaces/terraform_machine (main) $ |  
Ln
```

task4_hosts_without_common_args.png



A screenshot of a terminal window titled 'hosts'. The content of the file is as follows:

```
1 [ec2]  
2 51.112.228.98  
3 51.112.178.49  
4  
5 [droplet]  
6 3.29.232.128  
7  
8 [all:vars]  
9 ansible_user=ec2-user  
10 ansible_ssh_private_key_file=~/.ssh/id_ed25519
```

task4_ansible_ping_after_cfg.png

```
3.29.232.128 | SUCCESS => {
    "changed": false,
    "ping": "pong"
}
51.112.228.98 | SUCCESS => {
    "changed": false,
    "ping": "pong"
}
51.112.178.49 | SUCCESS => {
    "changed": false,
    "ping": "pong"
}
```

task4_my_playbook_created.png

```
→/workspaces/terraform_machine (main) $ touch my-playbook.yaml
playbook.yaml
· 1 codespace codespace 0 Jan 16 15:37 my-playbook.yaml
→/workspaces/terraform_machine (main) $
```

task4_my_playbook_ec2.png

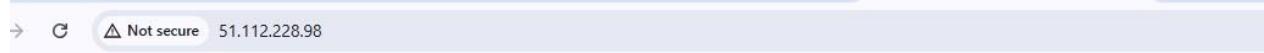
```
! my-playbook.yaml
1  ---
2  - name: Configure nginx web server
3    hosts: ec2
4    become: true
5    tasks:
6      - name: install nginx and update cache
7        yum:
8          name: nginx
9          state: present
10         update_cache: yes
11
12      - name: start nginx server
13        service:
14          name: nginx
15          state: started
```

task4_ansible_play_ec2.png

```
TASK [start nginx server] ****
changed: [51.112.178.49]
changed: [51.112.228.98]

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

task4_nginx_browser_ec2.png



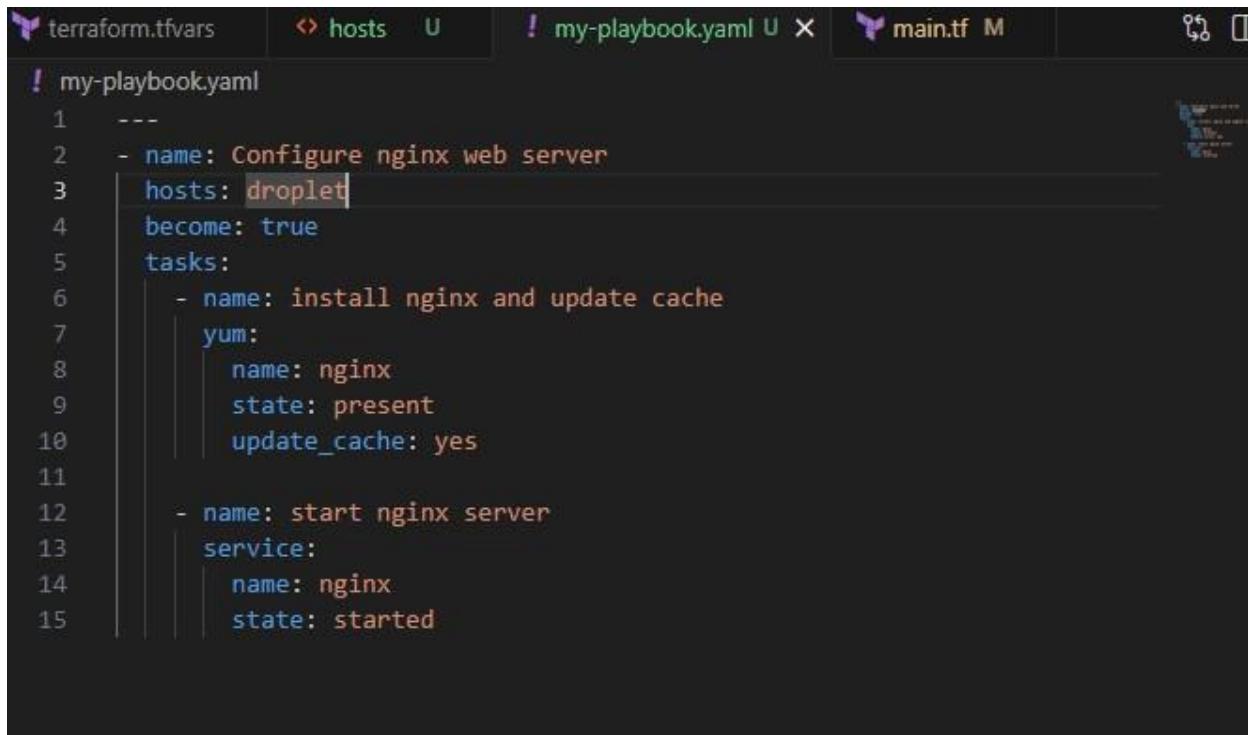
Welcome to nginx!

If you see this page, the nginx web server is successfully installed and working. Further configuration is required.

For online documentation and support please refer to nginx.org.
Commercial support is available at nginx.com.

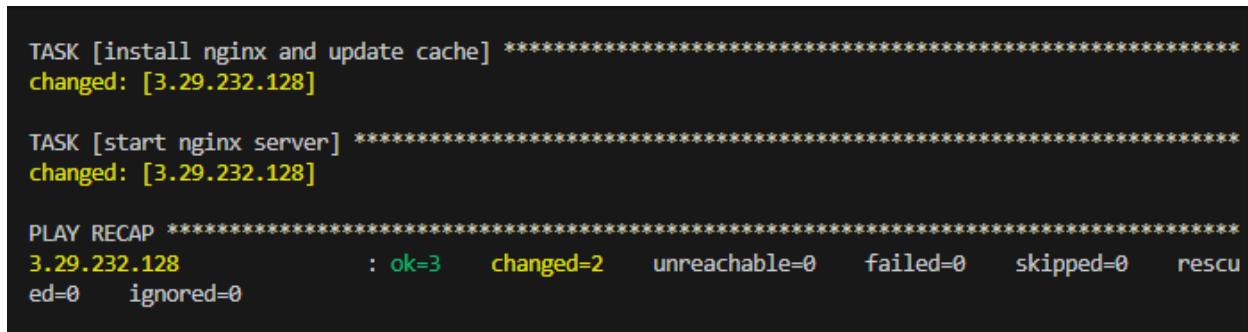
Thank you for using nginx.

task4_my_playbook_droplet.png



```
! my-playbook.yaml
1  ---
2  - name: Configure nginx web server
3    hosts: droplet
4    become: true
5    tasks:
6      - name: install nginx and update cache
7        yum:
8          name: nginx
9          state: present
10         update_cache: yes
11
12      - name: start nginx server
13        service:
14          name: nginx
15          state: started
```

task4_ansible_play_droplet.png



```
TASK [install nginx and update cache] ****
changed: [3.29.232.128]

TASK [start nginx server] ****
changed: [3.29.232.128]

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

task4_nginx_browser_droplet.png

⚠ Not secure 3.29.232.128

Welcome to nginx!

If you see this page, the nginx web server is successfully installed and working. Further configuration is required.

For online documentation and support please refer to nginx.org.
Commercial support is available at nginx.com.

Thank you for using nginx.

Task 5 – Single nginx target group & HTTPS prerequisites

task5_project_ansible_cfg_created.png

```
→/workspaces/terraform_machine (main) $ cd /workspaces/terraform_machine
ible.cfg
sible.cfg
- 1 codespace codespace 0 Jan 16 15:45 ansible.cfg
→/workspaces/terraform_machine (main) $ |
```

task5_project_ansible_cfg.png

```
→/workspaces/terraform_machine (main) $ vim ~/.ansible.cfg
→/workspaces/terraform_machine (main) $ |
```

task5_main_tf_count_1.png

```
main.tf
22
23 module "myapp-webserver" {
24   source = "./modules/webserver"
25   env_prefix = var.env_prefix
26   instance_type = var.instance_type
27   availability_zone = var.availability_zone
28   public_key = var.public_key
29   my_ip = local.my_ip
30   vpc_id = aws_vpc.myapp_vpc.id
31   subnet_id = module.myapp-subnet.subnet.id
32
33   # Loop count
34   count          = 1
35   # Use count.index to differentiate instances
36   instance_suffix = count.index
37
38 }
39
```

task5_terraform_apply_one_instance.png

differences, so no changes are needed.

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

Outputs:

```
webserver_public_ips = [
  "51.112.228.98",
  "51.112.178.49",
  "3.29.232.128",
]
```

task5_terraform_output_single_ip.png

```
webserver_public_ips = [
  "51.112.228.98",
```

task5_hosts_nginx_group.png

A screenshot of a terminal window with three tabs open:

- hosts**: Contains the following configuration:

```
1 [nginx]
2 51.112.178.49
3
4 [nginx:vars]
5 ansible_ssh_private_key_file=~/ssh/id_ed25519
6 ansible_user=ec2-user
```
- my-playbook.yaml**: Contains the Ansible playbook configuration:

```
1 ---
2 - name: Configure nginx web server
3   hosts: nginx
4   become: true
5   tasks:
6     - name: install nginx and update cache
7       yum:
8         name: nginx
9         state: present
10        update_cache: yes
11
12     - name: install openssl
13       yum:
14         name: openssl
15         state: present
16
17     - name: start nginx server
18       service:
```
- main.tf**: Contains Terraform configuration.

task5_my_playbook_nginx_group.png

A screenshot of a terminal window showing the output of an Ansible playbook run:

```
! my-playbook.yaml
1 ---
2 - name: Configure nginx web server
3   hosts: nginx
4   become: true
5   tasks:
6     - name: install nginx and update cache
7       yum:
8         name: nginx
9         state: present
10        update_cache: yes
11
12     - name: install openssl
13       yum:
14         name: openssl
15         state: present
16
17     - name: start nginx server
18       service:
```

task5_ansible_play_nginx_group.png

A screenshot of a terminal window showing the output of an Ansible playbook run:

```
TASK [install openssl] *****
ok: [51.112.178.49]

TASK [start nginx server] *****
changed: [51.112.178.49]

PLAY RECAP *****
51.112.178.49 : ok=4    changed=1    unreachable=0    failed=0    skipped=0    rescued=0    ignored=0
```

task5_nginx_browser_single.png

Welcome to nginx!

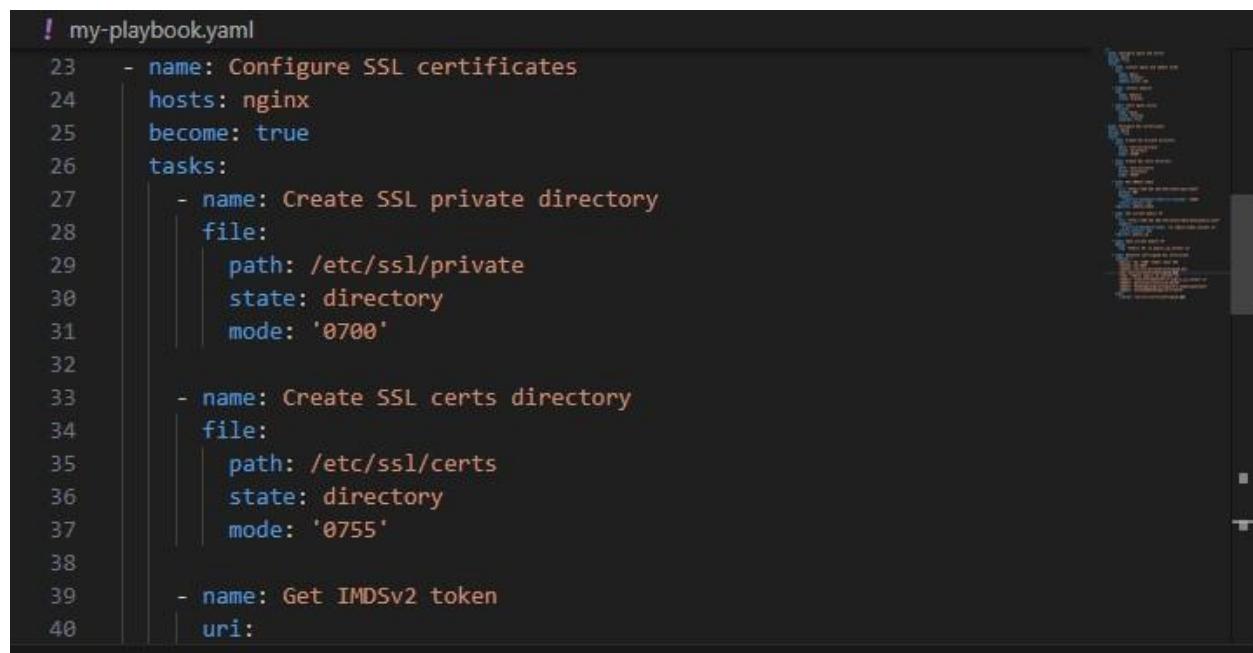
If you see this page, the nginx web server is successfully installed and working. Further configuration is required.

For online documentation and support please refer to nginx.org.
Commercial support is available at nginx.com.

Thank you for using nginx.

Task 6 – Ansible-managed SSL certificates

task6_my_playbook_ssl_section.png



```
! my-playbook.yaml
23 - name: Configure SSL certificates
24   hosts: nginx
25   become: true
26   tasks:
27     - name: Create SSL private directory
28       file:
29         path: /etc/ssl/private
30         state: directory
31         mode: '0700'
32
33     - name: Create SSL certs directory
34       file:
35         path: /etc/ssl/certs
36         state: directory
37         mode: '0755'
38
39     - name: Get IMDSv2 token
40       uri:
```

task6_ansible_play_ssl.png

```
ok: [51.112.178.49] => {
    "msg": "Public IP: 51.112.178.49"
}

TASK [Generate self-signed SSL certificate] ****
changed: [51.112.178.49]

PLAY RECAP ****
51.112.178.49 : ok=11    changed=3    unreachable=0    failed=0    skipped=0    rescued=0    ignored=0
```

task6_ssl_cert_file.png

```
ssh ec2-user@51.112.178.49 -i ~/.ssh/id_ed25519
,      #
~\_ #####_      Amazon Linux 2023
~~ \#####\
~~  \###|
~~   \#/ ___ https://aws.amazon.com/linux/amazon-linux-2023
~~   V~' '-->
~~   /
~~ ._. / /
~~ /m/'
```



```
_m/
Last login: Fri Jan 16 16:08:13 2026 from 4.240.18.226
[ec2-user@ip-10-0-10-81 ~]$ █
```

task6_ssl_key_file.png

```
Last login: Fri Jan 16 16:08:13 2026 from 4.240.18.226
[ec2-user@ip-10-0-10-81 ~]$ sudo cat /etc/ssl/certs/selfsigned.crt
-----BEGIN CERTIFICATE-----
MIIDPzCCAiegAwIBAgIUC70z6RNpwdTI2DdobdVjpm9k/u4wDQYJKoZIhvcNAQEL
BQAwGDEwMBQGA1UEAwNNTEmTEyLjE3OC40TAeFw0yNjAxMTYxNjA4MTNaFw0y
NzAxMTYxNjA4MTNaMBgxFjAUBgNVBAMMDUxLjExMi4xNzguNDkwggEiMA0GCSqG
SIb3DQEBAQUAA4IBDwAwggEKAoIBAQDUq9w1wKjURrI97cpP9I802vPAXTxQeVl
+WL4WaBn9CbeVXct5TTK6Anw1XNRJH8R8wnG/cWDFwPkFDjwtnTK6OCNH0jM1dk0
W/X9fCTOInZsM4FY5vfPEN4ysPKM/OrChKZ9e7MY2XeZenikmrTi+Iu4PnXqCNbm
WYegIQ85iWFz3AeviWmM1ytfn7wMIaMmnxBMzGNgGrKbPuk34AmEs/E0pesZc2Hp
Rm08igs+;iI1YVji4ecwI4+8/uXGTHvPXLxK+y04C+B1E3lyuRGOMuiuF5Fx+bEl
IJerT7V1njq7q0pAGMGU0ju86Rp0B4iGH6W+hmg8ejFNtsjxahDAGMBAAGjgYA
FjAdBgNVHQ4EFgQUNi5kfxRhVZ01szwdp1oIY7pa+hEwHwYDVR0jBBgwFoAUNi5k
fxRhVZ01szwdp1oIY7pa+hEwDwYDVR0RBAGwBocEM3CyMTAJBgNVHRMEAjAAMAsG
A1UdDwQEAvIFoDATBgNVHSUEDDAKBgggrBgfEFBQcDATANBgkqhkiG9w0BAQsFAAO
AQEAKp8TiUAjsXxKC7aA9hbDoP9dMtk4pnT8KObuAqDFkAoR3RsquiaFux+DV15
0fmZJrw9FEHbywvQIUaq3zkFd0C1VgqQjosRLygdIp5SpwB7kRC3wPsp9gtNr55
Lk7wc/iiiv/0h1p4RD9JSJSdtAZKm21t5rISsdB6ETUrXTyUDpvHR/4P2pEh9DRV
f1N5Xx5MRyRx78c4pM5yNHx6gkJJemA3PvIPTg4AA1wRtmqcDFU0jYy2rMCulsd
jMm/Q6U0XkrduuitMqdkQY4TrJBjTH18w1jAYkDjQA/Dq1eMm1D4uTZVH6puXPw6
SyUthNGS8Y4dUjjyDN1DG4MT+w==
-----END CERTIFICATE-----
[ec2-user@ip-10-0-10-81 ~]$
```

```
[ec2-user@ip-10-0-10-81 ~]$ sudo cat /etc/ssl/private/selfsigned.key
-----BEGIN PRIVATE KEY-----
MIIEvQIBADANBgkqhkiG9w0BAQEFAASCBKcwgSjAgEAAoIBAQDUq9w1wKjURrI9
7cpP9I802vPAXTxfQeV1+WL4WaBn9CbevXct5TTK6Anlw1XNRJH8R8wnG/cwDFwPk
FDjwttmTK60CNH0jm1dk0W/X9fCT0InZsM4FY5vfPEN4ysPKM/OrChKZ9e7MY2XeZ
enikmrTi+Iu4PnXqCNbmIWYegIQ85iWfz3AeviWmM1ytfn7wMIaMmnxBMzGNgGrKb
Puk34AmEs/E0pesZc2HpRm08igsv+iI1YVji4ecwI4+8/uXGTHvPXLxK+y04C+B1
E3lyuRGOMuiuF5Fx+bEWIJerT7Vl1njq7q0pAGMGU0ju86Rp0B4iGH6W+hmg8ejF
NtsjxahDAGMBAAEoggEAGkK4d+i40DGEm/ILa9ESgy6VL7kz1b2g0nU3e9wxlwTC
gezQwSe0281Qb9stGXRxQkaOXinLxbXk6fNmiejjYyxAawNxMFZQpUnbGwSbWPD
BLxdaeYj8G0wSskfwjo0eQMpPdBy/owH4StGz2iNEoPHWPJZhBMgwRPA35hj2SH
BLRddkjh86jfRd4LnLDapTYBm3ug8a8X9qVx0Gv4bkuMdaCDE5kSemSVtW04QmgP
VeuoTHaHSNzY1PnkCnXktozJXoJwEUuZKjXHjDoJ8uEBr9MkcI3A/XAqfASPsvJv
BFxC5iTkl5mFa9VdEB2sleOYaJK1NuOAS92EinMkVQKBgQDzhRSKP7TEycTXFDpE
FdQAyk8vNFbE7pY7pj1BBaca6eseT3SoAI8LY1LQA32raLbs/8wmDvBoK/FOIkB
ZOdDTSDnRxzXnSw4bwEvbxkREsclrGSBHPAXZMtoQFqJ74pwiD05ZeV6Me3D8JHT
R9Rj5wUcujmSQFWGqbBMZDv/LwKBgQDFkg4brq1MiGVKy4qcKnVzegMDi6nxuf11
jr6xKG02AZ+YpWH/5B+rYNO9hK3tMWHY0ib2Prw6831IJ2n4nsf0A0s1cprEIw4
671sUxNZvZ3yhs507hwClfLKfmnsw0Zs7CP8R1SdnpygLA2L7vs/IwkUcrJU1X7x
FSg+PXFDLQKBgEzpnFop0tNQks4Hgnu9bictvqK/GiSq4mJG1pphyayTcwIowES
LoKJNJYuzfo6TzSq/g+AFlweLc9iLiaIaf3zHMHw7lp1288+CpnOpGjatQp7gewHY
fPA2kpQDt1Txhk7cR9Hnn/nfKSR4p+YeSr0ecTgIjURm81xL3fxStqxbAoGBAJRd
9Qbh8RftHgt6kE36z18HBaEAupM0fbxL0rj2uNU8vPGsj2qmFW6HIoBoRRus1711
ZeYnJLakZMs9zeJwJo0dQYDpFx/eJ3B03wrIRvszHvKoC5nN4sDEig8auMjq/n2i
aG8urVC8xex1z7ehrRLENvgkgBCfq+2/rHvUN8xAoGAXFkmUpuApezcCDyaS6KH
/sAHjZJ20Ma4kSLIuwE9E5p7pYk/bwIeCDUaLmfqUV115XE25mLDBWM8uAjzy9fy
pQvvZRzJj4QswoTC1QkiRUMrYyt3NYIeBkB//WF57uX0Q4qXP8e9Gb+v5KS0dzk2
gme7yyVKRO5I+rjqYX1kFBA=
-----END PRIVATE KEY-----
[ec2-user@ip-10-0-10-81 ~]$
```

Task 7 – PHP front-end deployment with templates

task7_files_templates_created.png

```
touch files/index.php
touch templates/nginx.conf.j2
ls -R
.:
README.md    hosts      modules      templates      terraform.tfvars
ansible.cfg   locals.tf  my-playbook.yaml  terraform.tfstate  variables.tf
files        main.tf    outputs.tf    terraform.tfstate.backup

./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
```

task7_index_php_content.png

```
<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>
```

task7_nginx_conf_template.png

```
templates >  nginx.conf.j2
 1 user nginx;
 2 worker_processes auto;
 3 error_log /var/log/nginx/error.log notice;
 4 pid /run/nginx.pid;
 5
 6 events {
 7     worker_connections 1024;
 8 }
 9
10 http {
11     log_format main '$remote_addr - $remote_user [$time_local] "$request"
12                         '$status $body_bytes_sent "$http_referer"
13                         '"$http_user_agent" "$http_x_forwarded_for"';
14
15     access_log /var/log/nginx/access.log main;
16
17     sendfile on;
18     tcp_nopush on;
```

task7_my_playbook_web_deploy.png

```
! my-playbook.yaml
23   - name: Configure SSL certificates
73
74   - name: Deploy Nginx website and configuration files
75     hosts: nginx
76     become: true
77     tasks:
78       - name: install php-fpm and php-curl
79         yum:
80           name:
81             - php-fpm
82             - php-curl
83           state: present
84
85       - name: Copy website files
86         copy:
87           src: files/index.php
88           dest: /usr/share/nginx/html/index.php
89           owner: nginx
```

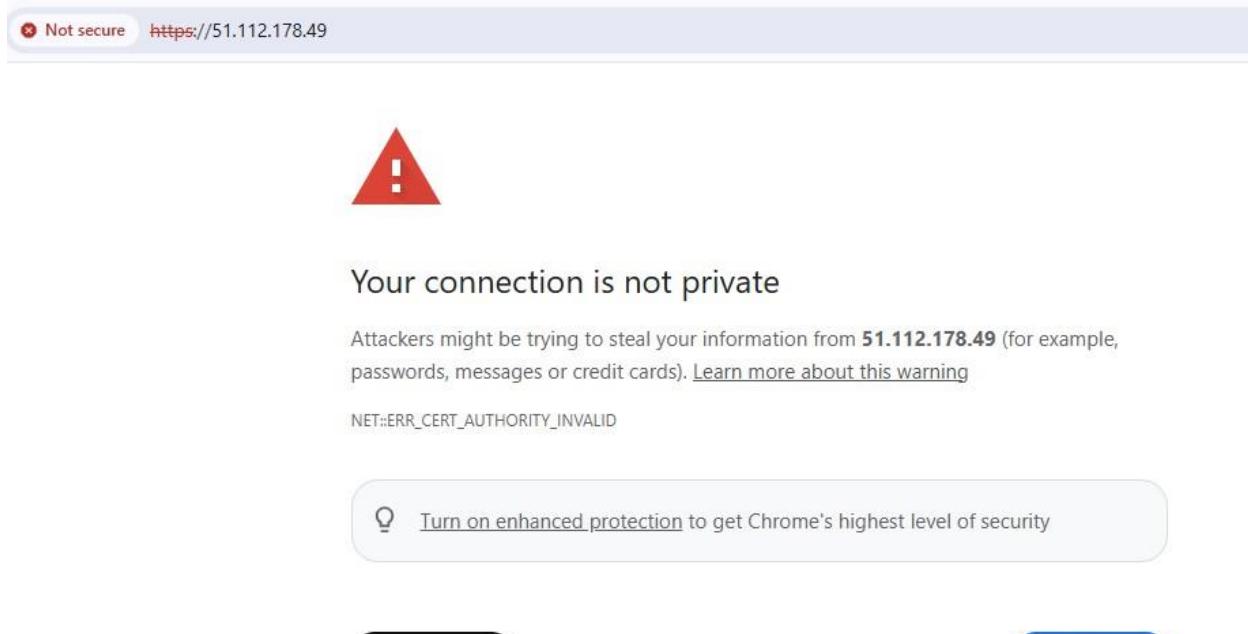
task7_ansible_play_web_deploy.png

```
TASK [Restart nginx] *****
changed: [51.112.178.49]

TASK [Start and enable php-fpm] *****
changed: [51.112.178.49]

PLAY RECAP *****
51.112.178.49          : ok=16   changed=3    unreachable=0    failed=0    skipped=0    rescued=0   ignored=0
```

task7_php_https_browser.png



Task 8 – Docker & Docker Compose provisioning via Ansible

task8_terraform_destroy_old.png

```
module.myapp-webserver[0].aws_instance.myapp-server: Destruction complete after 31s
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-0ecd1cb1aba9b8eb2]
module.myapp-webserver[1].aws_key_pair.ssh-key: Destruction complete after 1s
module.myapp-webserver[0].aws_key_pair.ssh-key: Destruction complete after 0s
module.myapp-webserver[1].aws_security_group.web_sg: Destruction complete after 1s
module.myapp-webserver[0].aws_security_group.web_sg: Destruction complete after 0s
module.myapp-webserver[2].aws_instance.myapp-server: Still destroying... [id=i-0cf6ca868d836cdb5,
 00m40s elapsed]
module.myapp-subnet.aws_internet_gateway.myapp_igw: Still destroying... [id=igw-036e2fb927ea9ba06
, 00m40s elapsed]
```

task8_terraform_apply_docker_instance.png

task8_terraform_output_new_ip.png

```
module.myapp-webserver[0].aws_instance.myapp-server: Still creating... [00m10s elapsed]
module.e0477: ● @areej-10 →/workspaces/terraform_machine (main) $ terraform output :d827
  webserver_public_ips = [
    "158.252.72.51",
  ]
Apply
Output
Output @areej-10 →/workspaces/terraform_machine (main) $ 
webserver_public_ips = [
  "158.252.72.51",
]
```

task8_hosts_docker_servers.png

```
hosts
  [docker_servers]
  158.252.72.51
  ...
  [docker_servers:vars]
  ansible_ssh_private_key_file=~/ssh/id_ed25519
  ansible_user=ec2-user
```

task8_my_playbook_docker.png

```
! my-playbook.yaml
1  ---
2  - name: Configure Docker
3    hosts: all
4    become: true
5    tasks:
6      - name: install docker and update cache
7        yum:
8          name: docker
9          state: present
10         update_cache: yes
11
12 - name: Install Docker Compose
13   hosts: all
14   become: true
15   gather_facts: true
16   tasks:
17     - name: create docker cli-plugins directory
18       file:
```

task8_ansible_play_docker.png

```
/workspaces/terraform_machine (main) $ terraform output
/workspaces/terraform_machine (main) $ ansible-playbook -i hosts my-playbook.yaml

PLAY [Configure Docker] ****
TASK [Gathering Facts] ****
ok: [158.252.72.51]

TASK [install docker and update cache] ****
```

task8_docker_ps_remote.png

```
9
sudo docker ps
~~ \_#####
~~ \|##|
~~ \#/ ___ https://aws.amazon.com/linux/amazon-linux-2023
~~ V~' '-->
~~ . /
~~ . / /
~~ /m/
Last login: Fri Jan 16 17:01:37 2026 from 4.240.18.226
[ec2-user@ip-10-0-10-35 ~]$
```

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

task9_my_playbook_add_user_to_docker.png

```
! my-playbook.yaml
41   - name: Adding user to docker group
42     hosts: all
43     become: true
44     vars_files:
45       - project-vars.yaml
46     tasks:
47       - name: add user to docker group
48         user:
49           name: "{{ normal_user }}"
50           groups: docker
51           append: yes
52
53       - name: reconnect to apply group changes
54         meta: reset_connection
55
56       - name: verify docker access
57         command: docker ps
58         register: docker_ps
```

task9_project_vars.png

```
! project-vars.yaml
1   normal_user: ec2-user
2   docker_compose_file_location: ".."
```

task9_my_playbook_deploy_containers.png

```
59      - name: Deploy Docker Containers
60    hosts: all
61    become: true
62    user: "{{ normal_user }}"
63    vars_files:
64      - project-vars.yaml
65    tasks:
66      - name: check if docker-compose file exists
67        stat:
68          path: /home/{{ normal_user }}/compose.yaml
69          register: compose_file
70
71      - name: copy docker-compose file
72        copy:
73          src: "{{ docker_compose_file_location }}/compose.yaml"
74          dest: /home/{{ normal_user }}/compose.yaml
75          mode: '0644'
76
77      when: not compose_file.stat.exists
```

task9_compose_yaml.png

```
compose.yaml
1 services:
2   gitea:
3     image: gitea/gitea:latest
4     container_name: gitea
5     environment:
6       - DB_TYPE=postgres
7       - DB_HOST=db:5432
8       - DB_NAME=gitea
9       - DB_USER=gitea
10      - DB_PASSWD=gitea
11     restart: always
12     volumes:
13       - gitea:/data
14     ports:
15       - 3000:3000
16     extra_hosts:
17       - "www.jenkins.com:host-gateway"
18     networks:
```

task9_ansible_play_gitea.png

```
TASK [copy docker-compose file] *****
skipping: [158.252.72.51]

TASK [deploy containers using docker-compose] *****
ok: [158.252.72.51]

PLAY RECAP *****
158.252.72.51 : ok=5    changed=0    unreachable=0    failed=0    skipped=1    rescued=0    ignored=0
```

task9_sg_ingress_3000.png

```
    }
    ingress {
        from_port    = 3000
        to_port      = 3000
        protocol     = "tcp"
        cidr_blocks  = ["0.0.0.0/0"]
    }
}
```

task9_terraform_apply_sg_3000.png

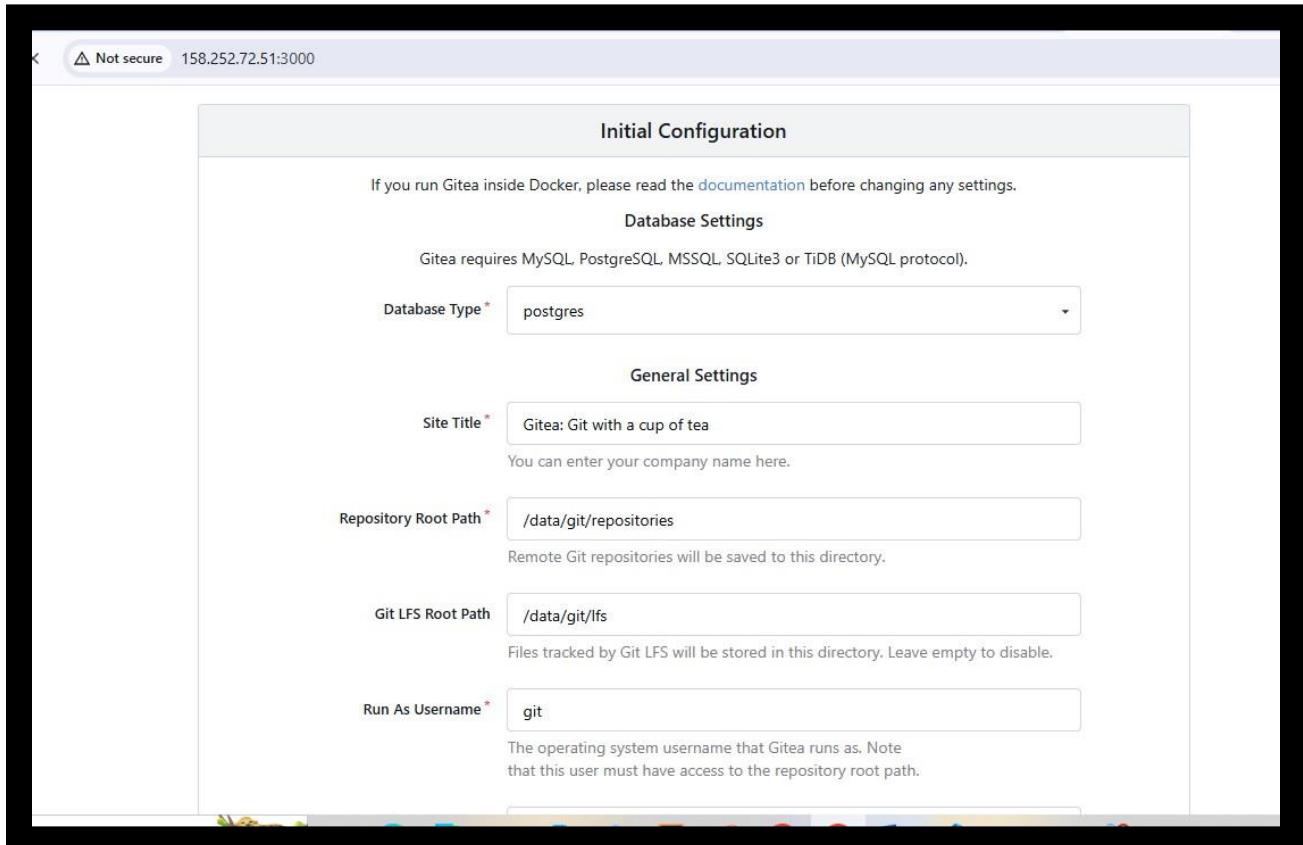
```
module.myapp-webserver[0].aws_security_group.web_sg: Modifying... [id=sg-04563a7d2eb42fa67]
module.myapp-webserver[0].aws_security_group.web_sg: Modifications complete after 2s [id=sg-04563a7d2eb42fa67]
```

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

Outputs:

```
webserver_public_ips = [
  "158.252.72.51",
]
```

task9_gitea_browser.png



Task 10 – Automating Ansible with Terraform (null_resource)

task10_null_resource_main_tf.png

```
main.tf
2/
38 }
39 resource "null_resource" "configure_server" {
40   triggers = [
41     webserver_public_ips_for_ansible = join(",", [for i in module.myapp-
42   ]
43
44   depends_on = [module.myapp-webserver]
45
46   provisioner "local-exec" {
47     command = <<-EOT
48       ansible-playbook -i ${self.triggers.webserver_public_ips_for_ansib
49       --private-key "${var.private_key}" --user ec2-user \
50       my-playbook.yaml
51     EOT
52   }
53 }
```

task10_terraform_destroy_before_null.png

```
module.myapp-webserver[0].aws_instance.myapp-server: Destruction complete after 30s
module.myapp-subnet.aws_subnet.myapp_subnet_1: Destroying... [id=subnet-094eafdd3b8c854ce]
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-04563a7d2eb42fa67]
module.myapp-webserver[0].aws_key_pair.ssh-key: Destruction complete after 1s
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-0999dcc606103fb9a]
aws_vpc.myapp_vpc: Destruction complete after 1s
```

```
Destroy complete! Resources: 7 destroyed.
```

task10_terraform_apply_with_local_exec.png

```
Error: local-exec provisioner error

with null_resource.configure_server,
on main.tf line 46, in resource "null_resource" "configure_server":
46:   provisioner "local-exec" {

Error running command 'ansible-playbook -i 3.28.39.62, \
--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
```

task10_my_playbook_wait_for_ssh.png

```
my-playbook.yaml
1  ---
2  - name: Wait for some time to ensure system readiness
3    hosts: all
4    tasks:
5      - name: Wait 300 seconds for port 22 to become open and contain "Ope
6        wait_for:
7          port: 22
8          host: "{{ inventory_hostname }}"
9          delay: 10
10         timeout: 300
11         delegate_to: localhost
12
13 - name: Configure Docker
14   hosts: all
15   become: true
16   tasks:
17     - name: install docker and update cache
18       yum:
```

task10_terraform_apply_after_wait.png

```
terraform apply -auto-approve

null_resource.configure_server: Creation complete after 1m56s [id=7563915408642739819]

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

Outputs:

webserver_public_ips = [
  "3.28.253.131",
]
```

task10_app_browser_post_null_resource.png

The screenshot shows a web browser window with the URL `3.28.253.131:3000`. The page title is "Initial Configuration". It contains instructions for running Gitea inside Docker and a "Database Settings" section. The "Database Type" is set to "PostgreSQL", "Host" is "db:5432", "Username" is "gitea", "Password" is ".....", "Database Name" is "gitea", "SSL" is "Disable", and "Schema" is left blank. A note at the bottom says "Leave blank for database default ("public")."

If you run Gitea inside Docker, please read the [documentation](#) before changing any settings.

Database Settings

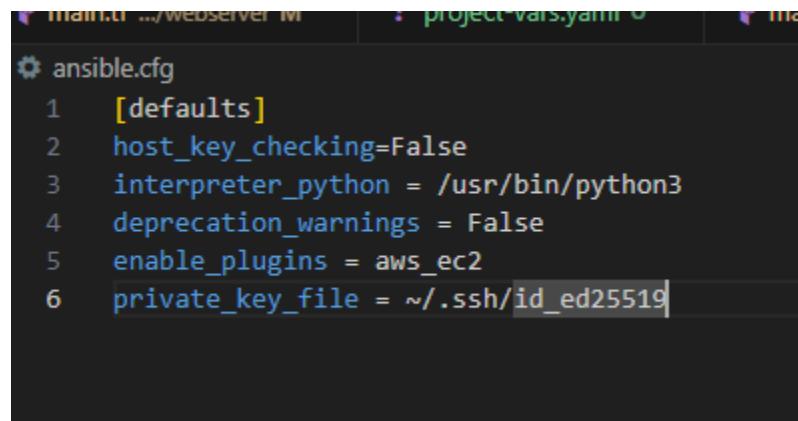
Gitea requires MySQL, PostgreSQL, MSSQL, SQLite3 or TiDB (MySQL protocol).

Database Type *	PostgreSQL
Host *	db:5432
Username *	gitea
Password *
Database Name *	gitea
SSL *	Disable
Schema	Leave blank for database default ("public").

General Settings

Task 11 – Dynamic inventory with aws_ec2 plugin

task11_ansible_cfg_aws_ec2.png

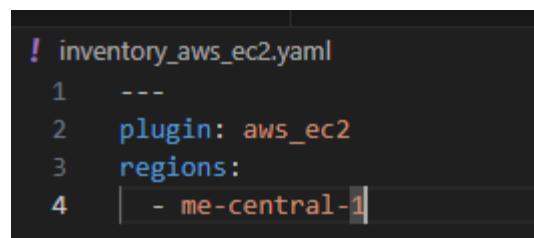


```
ansible.cfg
1 [defaults]
2 host_key_checking=False
3 interpreter_python = /usr/bin/python3
4 deprecation_warnings = False
5 enable_plugins = aws_ec2
6 private_key_file = ~/.ssh/id_ed25519
```

task11_inventory_aws_ec2_created.png

task11_inventory_aws_ec2_initial.png

```
ls -la inventory_aws_ec2.yaml
-rw-rw-rw- 1 codespace codespace 0 Jan 16 18:24 inventory_aws_ec2.yaml
```



```
! inventory_aws_ec2.yaml
1 ---
2 plugin: aws_ec2
3 regions:
4   - me-central-1
```

task11_main_tf_dev_prod_modules.png

```
# PROD Webserver Module
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

  count          = 1
  instance_suffix = count.index
}
```

task11_outputs_tf_dev_prod_ips.png



A screenshot of a code editor displaying a Terraform configuration file named `outputs.tf`. The file contains two `output` blocks. The first block, labeled `webserver_public_ips`, uses a `for` loop to iterate over instances in the `myapp-webserver` module and collect their `public_ip` values. The second block, labeled `prod-webserver_public_ips`, uses a similar `for` loop to iterate over instances in the `myapp-webserver-prod` module and collect their `public_ip` values.

```
outputs.tf
1  output "webserver_public_ips" {
2    value = [for i in module.myapp-webserver : i.public_ip]
3  }
4
5  output "prod-webserver_public_ips" [
6    value = [for i in module.myapp-webserver-prod : i.public_ip]
7  ]
8
```

task11_terraform_apply_dynamic_setup.png

```
terraform apply -auto-approve
terraform output

    + private_dns_name_options (known after apply)
    + root_block_device (known after apply)
}

Plan: 1 to add, 0 to change, 0 to destroy.

Changes to Outputs:
+ prod-webserver_public_ips = [
    + (known after apply),
]
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-07850
df62776850ec]

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

Outputs:

prod-webserver_public_ips = [
    "3.28.185.24",
]
webserver_public_ips = [
    "3.28.253.131",
]
prod-webserver_public_ips = [
    "3.28.185.24",
]
webserver_public_ips = [
    "3.28.253.131",
]
```

task11_terraform_output_dynamic_ips.png

```
terraform apply -auto-approve
terraform output

    + private_dns_name_options (known after apply)
    + root_block_device (known after apply)
}

Plan: 1 to add, 0 to change, 0 to destroy.

Changes to Outputs:
+ prod-webserver_public_ips = [
  + (known after apply),
]
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-07850
df62776850ec]

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

Outputs:

prod-webserver_public_ips = [
  "3.28.185.24",
]
webserver_public_ips = [
  "3.28.253.131",
]
prod-webserver_public_ips = [
  "3.28.185.24",
]
webserver_public_ips = [
  "3.28.253.131",
]
```

task11_boto_install.png

```
Collecting boto3
  Downloading boto3-1.42.29-py3-none-any.whl.metadata (6.8 kB)
Collecting botocore
  Downloading botocore-1.42.29-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 botocore) (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 botocore) (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 boto3-1.42.29-py3-none-any.whl (140 kB)
Downloading botocore-1.42.29-py3-none-any.whl (14.6 MB)
  14.6/14.6 MB 27.7 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 boto3-1.42.29 botocore-1.42.29 jmespath-1.0.1 s3transfer-0.16.0
```

task11_boto_version.png

```
→ /workspaces/terraform machine (main) $ $(which python) -c "import boto3, botocore; print(int(boto3.__version__))"
1.42.29
```

task11_ansible_inventory_graph_initial.png

```
<<< caused by >>>

inventory config '/workspaces/terraform_machine/inventory_aws_ec2.yaml' specifies unknown plugin
'aws_ec2'
Origin: <inventory plugin 'auto' with source '/workspaces/terraform_machine/inventory_aws_ec2.yaml'>

[WARNING]: Failed to parse inventory with 'yaml' plugin: Plugin configuration YAML file, not YAML
inventory

Failed to parse inventory with 'yaml' plugin.

<<< caused by >>>

Plugin configuration YAML file, not YAML inventory
Origin: <inventory plugin 'yaml' with source '/workspaces/terraform_machine/inventory_aws_ec2.yaml'>

[WARNING]: Failed to parse inventory with 'ini' plugin: Failed to parse inventory: Invalid host p
attern '---' supplied, '---' is normally a sign this is a YAML file.

Failed to parse inventory with 'ini' plugin.

<<< caused by >>>

Failed to parse inventory: Invalid host pattern '---' supplied, '---' is normally a sign this is
a YAML file.
Origin: /workspaces/terraform_machine/inventory_aws_ec2.yaml

[WARNING]: Unable to parse /workspaces/terraform_machine/inventory_aws_ec2.yaml as an inventory s
ource
[WARNING]: No inventory was parsed, only implicit localhost is available
@all:
  |--@ungrouped:
```

Task 12 – Filtering EC2 instances by tags & instance type

[task12_inventory_aws_ec2_tag_groups.png](#)

```
! inventory_aws_ec2.yaml
1  ---
2  plugin: aws_ec2
3  regions:
4  |  - me-central-1
5  keyed_groups:
6  |  - key: tags
7  |    prefix: tag
8  |    separator: "_"
```

task12_inventory_graph_tag_groups.png

```
graph

Failed to parse inventory: Invalid host pattern '---' supplied, '---' is normally a sign this is
a YAML file.
Origin: /workspaces/terraform_machine/inventory_aws_ec2.yaml

[WARNING]: Unable to parse /workspaces/terraform_machine/inventory_aws_ec2.yaml as an inventory s
ource
[WARNING]: No inventory was parsed, only implicit localhost is available
@all:
|--@ungrouped:
```

task12_inventory_aws_ec2_instance_type_groups.png

```
! inventory_aws_ec2.yaml
1  ---
2  plugin: aws_ec2
3  regions:
4    - me-central-1
5  keyed_groups:
6    - key: tags
7      prefix: tag
8      separator: "_"
9    - key: instance_type
10   prefix: instance_type
11   separator: "_"
```

task12_inventory_graph_full.png

```
graph

Failed to parse inventory: Invalid host pattern '---' supplied, '---' is normally a sign this is
a YAML file.
Origin: /workspaces/terraform_machine/inventory_aws_ec2.yaml

[WARNING]: Unable to parse /workspaces/terraform_machine/inventory_aws_ec2.yaml as an inventory s
ource
[WARNING]: No inventory was parsed, only implicit localhost is available
@all:
  |--@ungrouped:
```

task12_my_playbook_all_hosts.png

```
! my-playbook.yaml U X ⚡ compose.yaml U 🐄 main.tf .../webserver M ! project-vars
! my-playbook.yaml
1  ---
2  - name: Configure nginx web server
3    hosts: all
4    become: true
5    tasks:
6      - name: install nginx and update cache
7        yum:
8          name: nginx
9          state: present
10         update_cache: yes
11
12      - name: install openssl
13        yum:
14          name: openssl
15          state: present
16
17      - name: start nginx server
18        command: service nginx start
```

task12_ansible_play_all.png

```
playbook.yaml
skipping: no hosts matched

PLAY [Configure SSL certificates] ****
skipping: no hosts matched

PLAY [Deploy Nginx website and configuration files] ****
skipping: no hosts matched

PLAY RECAP ****
```

task12_ansible_play_dev_only.png

```
tag_Name_dev_* my-playbook.yaml
skipping: no hosts matched

PLAY [Configure SSL certificates] ****
skipping: no hosts matched

PLAY [Deploy Nginx website and configuration files] ****
skipping: no hosts matched

PLAY RECAP ****
```

task12_ansible_play_prod_only.png

task12_ansible_play_t3_micro.png

```
tag_Name_prod_* my-playbook.yaml
skipping: no hosts matched
tag_Name_prod_* my-playbook.yaml
skipping: no hosts matched

PLAY [Configure SSL certificates] ****
skipping: no hosts matched

PLAY [Deploy Nginx website and configuration files] ****
skipping: no hosts matched

PLAY RECAP ****
```

task12_ansible_play_t3.nano.png

```
tag Name_prod_* my-playbook.yaml
skipping: no hosts matched

PLAY [Configure SSL certificates] ****
skipping: no hosts matched

PLAY [Deploy Nginx website and configuration files] ****
skipping: no hosts matched

PLAY RECAP ****
```

task12_ansible_cfg_inventory_default.png

```
playbook.yaml
skipping: no hosts matched

PLAY [Configure SSL certificates] ****
skipping: no hosts matched

PLAY [Deploy Nginx website and configuration files] ****
skipping: no hosts matched

PLAY RECAP ****
```

Task 13 – Ansible roles: nginx, ssl, webapp

task13_main_tf_single_dev.png

```
main.tf
provider "aws" {
  shared_config_files      = ["~/.aws/config"]
  shared_credentials_files = ["~/.aws/credentials"]
}

resource "aws_vpc" "myapp_vpc" {
  cidr_block = var.vpc_cidr_block
  enable_dns_hostnames = true
  tags = {
    Name = "${var.env_prefix}-vpc"
  }
}

module "myapp-subnet" {
  source = "./modules/subnet"
  vpc_id = aws_vpc.myapp_vpc.id
  subnet_cidr_block = var.subnet_cidr_block
  availability_zone = var.availability_zone
```

task13_ansible_structure_created.png

task13_ansible_cfg_project.png

```
mkdir inventory roles
touch ansible.cfg my-playbook.yaml
ls -R
.:
ansible.cfg  inventory  my-playbook.yaml  roles

./inventory:
```

```
ansible.cfg
[defaults]
host_key_checking = False
interpreter_python = /usr/bin/python3
```

task13_webapp_tasks_main.png

task13_php_https_browser_roles.png



Welcome to nginx!

If you see this page, the nginx web server is successfully installed and working. Further configuration is required.

For online documentation and support please refer to nginx.org.
Commercial support is available at nginx.com.

Thank you for using nginx.

Cleanup

cleanup_terraform_destroy.png

```
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.
```

cleanup_tfstate.png

cleanup_aws_console.png