OpenStack Labs

Lab 08: Deploying an FTP Server

Contents

About This Document

- This document was developed by a team at the University of Tennessee at Chattanooga led by Dr. Mengjun Xie (**mengjun-xie@utc.edu**).
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Introduction

In this lab, you will practice and demonstrate the knowledge and skills you acquired throughout the course by deploying an FTP server through OpenStack.

Objectives

- Launch an instance in your OpenStack environment and customize the instance to run an FTP server.
- Access the FTP server from the workstation to confirm the configuration.

Lab Settings

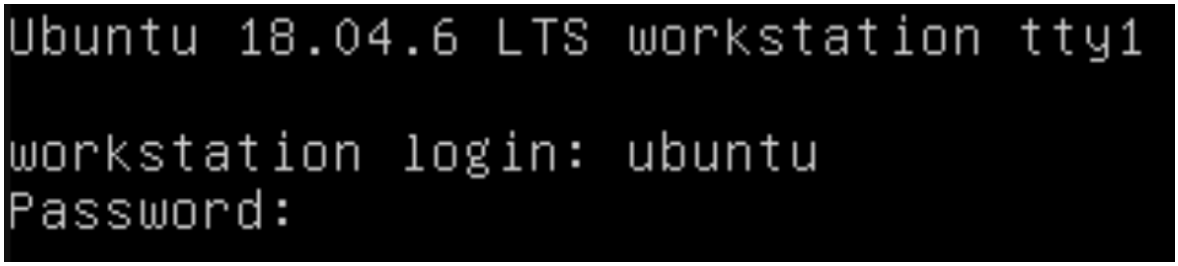
The information in the table below will be needed in order to complete the lab. The task sections below provide details on the use of this information.

Virtual Machine	IP Address	Account	Password
workstation	ens3: 192.168.1.21 ens4: 172.25.250.21	ubuntu	ubuntu
devstack	ens3: 192.168.20 ens4: 172.25.250.20	ubuntu	ubuntu

1 Creating an Environment

In this task, you will create all the resources necessary to create an external instance running an FTP server. The architecture will be composed of an external network and an internal network, a new project that includes a privileged user and a non-privileged user, and a set of new security rules to allow ICMP, SSH, and FTP access to the instance. A floating IP will be associated with the instance to permit external connectivity.

1.1. Log into the **workstation** machine as **ubuntu** with the password **ubuntu**.



1.2. Launch the graphical user interface.

```
ubuntu@workstation:~$ startx
```

```
Welcome to Ubuntu 18.04.6 LTS (GNU/Linux 4.15.0-213-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/advantage

  System information as of Fri Jun  7 21:01:55 UTC 2024

  System load:  0.6               Processes:           197
  Usage of /:   7.9% of 116.12GB  Users logged in:     0
  Memory usage: 13%               IP address for ens3: 192.168.1.21
  Swap usage:   0%                IP address for ens4: 172.25.250.21


Expanded Security Maintenance for Infrastructure is not enabled.

2 updates can be applied immediately.
To see these additional updates run: apt list --upgradable

146 additional security updates can be applied with ESM Infra.
Learn more about enabling ESM Infra service for Ubuntu 18.04 at
https://ubuntu.com/18-04


ubuntu@workstation:~$ startx_
```

1.3. Open a terminal window and source the ~/**keystonerc-admin** keystone credentials file.

```
ubuntu@workstation:~$ source ~/kesytonerc-admin
```

```
ubuntu@workstation:~$ source ~/keystonerc-admin
[ubuntu@workstation (keystone-admin)]:~$
```

1.4. In this lab, we will create our own project and set of users to simulate a more realistic working environment. First, create the **prod** project.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack project create \
> --domain default \
> prod
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack project create \
> --domain default \
> prod
+-------------+----------------------------------+
| Field       | Value                            |
+-------------+----------------------------------+
| description |                                  |
| domain_id   | default                          |
| enabled     | True                             |
| id          | 75b91313be3d4a709de4b615b5109127 |
| is_domain   | False                            |
| name        | prod                             |
| options     | {}                               |
| parent_id   | default                          |
| tags        | []                               |
+-------------+----------------------------------+
[ubuntu@workstation (keystone-admin)]:~$
```

Tip

When typing the command, make sure there is a space between **prod** and the \ character, and press **Enter** to get the > and continue typing the rest of the command.

1.5. Create a user named **superuser** with the password **secret** to the **prod** project.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack user create \
> --project prod \
> --password secret \
> superuser
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack user create \
> --project prod \
> --password secret \
> superuser
+---------------------+----------------------------------+
| Field               | Value                            |
+---------------------+----------------------------------+
| default_project_id  | c0f3e7114ea04faf9b714df14c54fc41 |
| domain_id           | default                          |
| enabled             | True                             |
| id                  | d64283cd29e44603b01b68579e41336d |
| name                | superuser                        |
| options             | {}                               |
| password_expires_at | None                             |
+---------------------+----------------------------------+
[ubuntu@workstation (keystone-admin)]:~$
```

1.6. Assign the **admin** role to the user **superuser**.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack role add \
> --project prod \
> --user superuser \
> admin
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack role add \
> --project prod \
> --user superuser \
> admin
[ubuntu@workstation (keystone-admin)]:~$
```

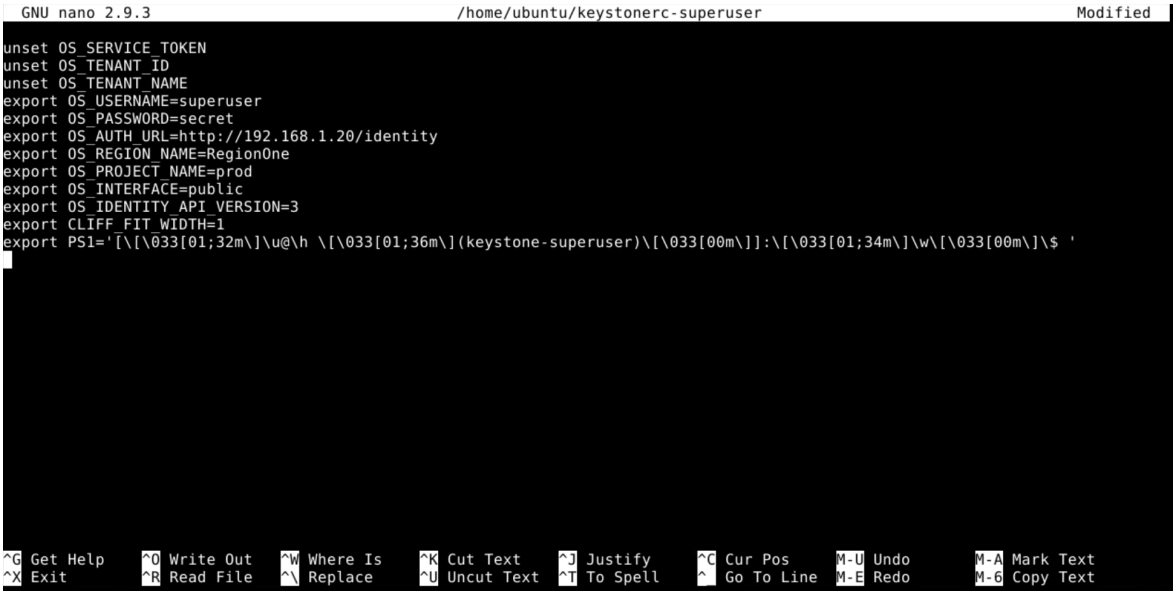
1.7. Copy the keystone credentials file **~/keystonerc-admin** to **~/keystonerc-superuser**.

```
[ubuntu@workstation (keystone-admin)]:~$ cp ~/keystonerc-admin \
> ~/keystonerc-superuser
```

```
[ubuntu@workstation (keystone-admin)]:~$ cp ~/keystonerc-admin \
> ~/keystonerc-superuser
[ubuntu@workstation (keystone-admin)]:~$
```

1.8. Use **nano** to edit the **~/keystonerc-superuser** file. Change the **OS_USERNAME** to **superuser**, and change the **OS_PROJECT_NAME** to **prod**. Finally, in the line beginning **export PS1=...**, replace **(keystone-admin)** with **(keystone-superuser)**. The file should match the contents shown below. Press **Ctrl+X** to exit the file, then press **Y** and then **Enter** to save the changes to the file.

```
[ubuntu@workstation (keystone-admin)]:~$ nano ~/keystonerc-superuser
```



1.9. Now, create a non-privileged user called **cloud-dev** with the password **secret**.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack user create \
> --project prod \
> --password secret \
> cloud-dev
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack user create \
> --project prod \
> --password secret \
> cloud-dev
+---------------------+----------------------------------+
| Field               | Value                            |
+---------------------+----------------------------------+
| default_project_id  | c0f3e7114ea04faf9b714df14c54fc41 |
| domain_id           | default                          |
| enabled             | True                             |
| id                  | 80c26eb4c7494a55a24e1cff505456df |
| name                | cloud-dev                        |
| options             | {}                               |
| password_expires_at | None                             |
+---------------------+----------------------------------+
[ubuntu@workstation (keystone-admin)]:~$
```

1.10. Assign **cloud-dev** the **member** role in the **prod** project so that it can perform actions in that project.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack role add \
> --project prod \
> --user cloud-dev \
> member
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack role add \
> --project prod \
> --user cloud-dev \
> member
[ubuntu@workstation (keystone-admin)]:~$
```

1.11. Copy the keystone credentials file ~/**keystonerc-superuser** to ~/**keystonerc-cloud-dev**.

```
[ubuntu@workstation (keystone-admin)]:~$ cp ~/keystonerc-superuser \
> ~/keystonerc-cloud-dev
```

```
[ubuntu@workstation (keystone-admin)]:~$ cp ~/keystonerc-superuser \
> ~/keystonerc-cloud-dev
[ubuntu@workstation (keystone-admin)]:~$
```

1.12. Use **nano** to edit the ~/**keystonerc-cloud-dev** file. Change the **OS_USERNAME** to **cloud-dev**. In the line beginning **export PS1=...**, replace **(keystone-superuser)** with **(keystone-cloud-dev)** The file should match the contents shown below. Press **Ctrl+X** to exit the file, then press **Y** and then **Enter** to save the changes to the file.

```
[ubuntu@workstation (keystone-admin)]:~$ nano ~/keystonerc-cloud-dev
```

```
 GNU nano 2.9.3                  /home/ubuntu/keystonerc-cloud-dev                  Modified

unset OS_SERVICE_TOKEN
unset OS_TENANT_ID
unset OS_TENANT_NAME
export OS_USERNAME=cloud-dev
export OS_PASSWORD=secret
export OS_AUTH_URL=http://192.168.1.20/identity
export OS_REGION_NAME=RegionOne
export OS_PROJECT_NAME=prod
export OS_INTERFACE=public
export OS_IDENTITY_API_VERSION=3
export CLIFF_FIT_WIDTH=1
export PS1='[\[\033[01;32m\]\u@\h \[\033[01;36m\](keystone-cloud-dev)\[\033[00m\]]:\[\033[01;34m\]\w\[\033[00m\]\$ '

^G Get Help  ^O Write Out  ^W Where Is  ^K Cut Text  ^J Justify  ^C Cur Pos  M-U Undo  M-A Mark Text
^X Exit      ^R Read File  ^\ Replace   ^U Uncut Text ^T To Spell ^_ Go To Line M-E Redo  M-6 Copy Text
```

1.13. Now, source the **keystonerc-superuser** keystone file to begin working with admin privileges in the **prod** project.

```
[ubuntu@workstation (keystone-admin)]:~$ source ~/keystonerc-superuser
```

```
[ubuntu@workstation (keystone-admin)]:~$ source ~/keystonerc-superuser
[ubuntu@workstation (keystone-superuser)]:~$
```

1.14. Before making an external network for the project, the existing router and external network need to be deleted. List the details of the available networks and find which one is external. From the output, it is clear that **public** is the external network.

```
[ubuntu@workstation (keystone-superuser)]:~$ openstack network list \
> --long \
> -c Name \
> -c "Router Type"
```

```
[ubuntu@workstation (keystone-superuser)]:~$ openstack network list \
> --long \
> -c Name \
> -c "Router Type"
+---------+-------------+
| Name    | Router Type |
+---------+-------------+
| public  | External    |
| private | Internal    |
| shared  | Internal    |
+---------+-------------+
[ubuntu@workstation (keystone-superuser)]:~$
```

1.15. List the routers to find the existing router's name.

```
[ubuntu@workstation (keystone-superuser)]:~$ openstack router list
```

```
[ubuntu@workstation (keystone-superuser)]:~$ openstack router list
+-------------+---------+--------+-------+-------------+-------+---------------+
| ID          | Name    | Status | State | Distributed | HA    | Project       |
+-------------+---------+--------+-------+-------------+-------+---------------+
| 07df5a07-87 | router1 | ACTIVE | UP    | False       | False | 39e851b14f864 |
| 95-4d8e-    |         |        |       |             |       | 573aad60582c3 |
| accf-f9d7e4 |         |        |       |             |       | 5e40dc        |
| cbb4ee      |         |        |       |             |       |               |
+-------------+---------+--------+-------+-------------+-------+---------------+
[ubuntu@workstation (keystone-superuser)]:~$
```

1.16. First, unset the external gateway from **router1**.

```
[ubuntu@workstation (keystone-superuser)]:~$ openstack router unset \
> --external-gateway \
> router1
```

```
[ubuntu@workstation (keystone-superuser)]:~$ openstack router unset \
> --external-gateway \
> router1
[ubuntu@workstation (keystone-superuser)]:~$
```

1.17. List the interface IDs of **router1**.

```
[ubuntu@workstation (keystone-superuser)]:~$ openstack port list \
> -c ID \
> -f value \
> --router router1
```

```
[ubuntu@workstation (keystone-superuser)]:~$ openstack port list \
> -c ID \
> -f value \
> --router router1
a05f4e1c-4014-4d25-9538-64e8114197e1
d369b706-db4a-4239-b715-721708931870
[ubuntu@workstation (keystone-superuser)]:~$
```

1.18. Capture the output of the previous command in to a variable called **ports**.

```
[ubuntu@workstation (keystone-superuser)]:~$ ports=$(!!)
```

```
[ubuntu@workstation (keystone-superuser)]:~$ ports=$(!!)
ports=$(openstack port list -c ID -f value --router router1)
[ubuntu@workstation (keystone-superuser)]:~$
```

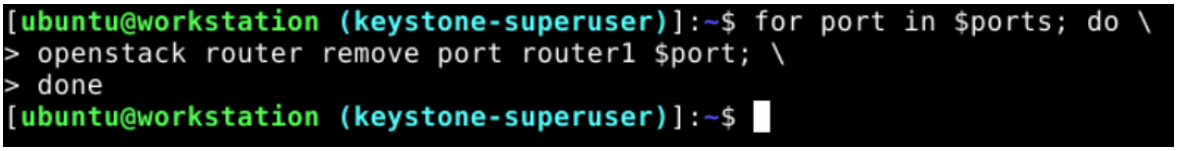
1.19. Ensure that **ports** contains the ID values as expected.

```
[ubuntu@workstation (keystone-superuser)]:~$ echo $ports
```

```
[ubuntu@workstation (keystone-superuser)]:~$ echo $ports
a05f4e1c-4014-4d25-9538-64e8114197e1 d369b706-db4a-4239-b715-721708931870
[ubuntu@workstation (keystone-superuser)]:~$
```

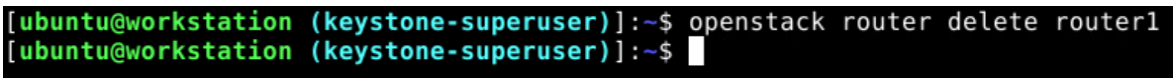
1.20. Use a **for** loop to delete the interfaces from **router1**.

```
[ubuntu@workstation (keystone-superuser)]:~$ for port in $ports; do \
> openstack router remove port router1 $port; \
> done
```



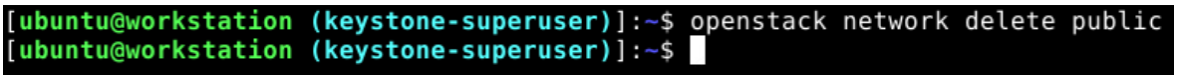
1.21. Delete **router1** now that its interfaces have been disconnected.

```
[ubuntu@workstation (keystone-superuser)]:~$ openstack router delete router1
```



1.22. Delete the **public** network.

```
[ubuntu@workstation (keystone-superuser)]:~$ openstack network delete public
```



1.23. Create an external, shared network called **external**.

```
[ubuntu@workstation (keystone-superuser)]:~$ openstack network create \
> --external \
> --share \
> --provider-network-type flat \
> --provider-physical-network public \
> external
```

```
[ubuntu@workstation (keystone-superuser)]:~$ openstack network create \
> --external \
> --share \
> --provider-network-type flat \
> --provider-physical-network public \
> external
+---------------------------+--------------------------------------+
| Field                     | Value                                |
+---------------------------+--------------------------------------+
| admin_state_up            | UP                                   |
| availability_zone_hints   |                                      |
| availability_zones        |                                      |
| created_at                | 2025-07-12T15:42:50Z                 |
| description               |                                      |
| dns_domain                | None                                 |
| id                        | 9d1d67d6-58bf-4642-86be-88df0c5bccc0 |
| ipv4_address_scope        | None                                 |
| ipv6_address_scope        | None                                 |
| is_default                | False                                |
| is_vlan_transparent       | None                                 |
| mtu                       | 1500                                 |
| name                      | external                             |
| port_security_enabled     | True                                 |
| project_id                | 0822d3c87bff4de09999a8b52ea06383     |
| provider:network_type     | flat                                 |
| provider:physical_network | public                               |
| provider:segmentation_id  | None                                 |
| qos_policy_id             | None                                 |
| revision_number           | 1                                    |
| router:external           | External                             |
| segments                  | None                                 |
| shared                    | True                                 |
| status                    | ACTIVE                               |
| subnets                   |                                      |
| tags                      |                                      |
| updated_at                | 2025-07-12T15:42:50Z                 |
+---------------------------+--------------------------------------+
[ubuntu@workstation (keystone-superuser)]:~$
```

1.24. Create the **external-subnet** subnet in the **172.25.250.0/24** range. Make the floating IP allocation pool range from **172.25.250.25** to **172.25.250.30**. Set both the gateway and DNS nameserver addresses to **172.25.250.254**. Since we will statically allocate any IPs on this subnet, it does not need DHCP.

```
[ubuntu@workstation (keystone-superuser)]:~$ openstack subnet create \
> --subnet-range 172.25.250.0/24 \
> --no-dhcp \
> --gateway 172.25.250.254 \
> --dns-nameserver 172.25.250.254 \
> --allocation-pool start=172.25.250.25,end=172.25.250.30 \
> --network external \
> external-subnet
```

```
[ubuntu@workstation (keystone-superuser)]:~$ openstack subnet create \
> --subnet-range 172.25.250.0/24 \
> --no-dhcp \
> --gateway 172.25.250.254 \
> --dns-nameserver 172.25.250.254 \
> --allocation-pool start=172.25.250.25,end=172.25.250.30 \
> --network external \
> external-subnet
+-------------------+--------------------------------------+
| Field             | Value                                |
+-------------------+--------------------------------------+
| allocation_pools  | 172.25.250.25-172.25.250.30          |
| cidr              | 172.25.250.0/24                      |
| created_at        | 2025-07-12T15:44:40Z                 |
| description       |                                      |
| dns_nameservers   | 172.25.250.254                       |
| enable_dhcp       | False                                |
| gateway_ip        | 172.25.250.254                       |
| host_routes       |                                      |
| id                | def5c6e4-25e6-4a29-b881-a02e6ef4dd17 |
| ip_version        | 4                                    |
| ipv6_address_mode | None                                 |
| ipv6_ra_mode      | None                                 |
| name              | external-subnet                      |
| network_id        | 9d1d67d6-58bf-4642-86be-88df0c5bccc0 |
| project_id        | 0822d3c87bff4de09999a8b52ea06383     |
| revision_number   | 0                                    |
| segment_id        | None                                 |
| service_types     |                                      |
| subnetpool_id     | None                                 |
| tags              |                                      |
| updated_at        | 2025-07-12T15:44:40Z                 |
+-------------------+--------------------------------------+
[ubuntu@workstation (keystone-superuser)]:~$
```

1.25. Source the **/keystonerc-cloud-dev** keystone credentials file.

```
[ubuntu@workstation (keystone-superuser)]:~$ source ~/keystonerc-cloud-dev
```

```
[ubuntu@workstation (keystone-superuser)]:~$ source ~/keystonerc-cloud-dev
[ubuntu@workstation (keystone-cloud-dev)]:~$
```

1.26. Create an internal network called **internal**.

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack network create internal
```

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack network create internal
+---------------------------+--------------------------------------+
| Field                     | Value                                |
+---------------------------+--------------------------------------+
| admin_state_up            | UP                                   |
| availability_zone_hints   |                                      |
| availability_zones        |                                      |
| created_at                | 2025-07-12T15:45:50Z                 |
| description               |                                      |
| dns_domain                | None                                 |
| id                        | 8491812a-219c-4f86-ace8-2a49a087a89a |
| ipv4_address_scope        | None                                 |
| ipv6_address_scope        | None                                 |
| is_default                | False                                |
| is_vlan_transparent       | None                                 |
| mtu                       | 1442                                 |
| name                      | internal                             |
| port_security_enabled     | True                                 |
| project_id                | 0822d3c87bff4de09999a8b52ea06383     |
| provider:network_type     | None                                 |
| provider:physical_network | None                                 |
| provider:segmentation_id  | None                                 |
| qos_policy_id             | None                                 |
| revision_number           | 1                                    |
| router:external           | Internal                             |
| segments                  | None                                 |
| shared                    | False                                |
| status                    | ACTIVE                               |
| subnets                   |                                      |
| tags                      |                                      |
| updated_at                | 2025-07-12T15:45:50Z                 |
+---------------------------+--------------------------------------+
[ubuntu@workstation (keystone-cloud-dev)]:~$
```

1.27. Create a subnet for the **internal** network called **internal-subnet** in the **192.168.0.0/24** range. Unlike the **external-subnet**, the **internal-subnet** does need DHCP services. Without them, the instance will be unreachable without additional configuration because it may not receive a valid IP address, subnet mask, default gateway, or DNS nameserver.

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack subnet create \
> --subnet-range 192.168.0.0/24 \
> --dhcp \
> --network internal \
> internal-subnet
```

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack subnet create \
> --subnet-range 192.168.0.0/24 \
> --dhcp \
> --network internal \
> internal-subnet
+-------------------+--------------------------------------+
| Field             | Value                                |
+-------------------+--------------------------------------+
| allocation_pools  | 192.168.0.2-192.168.0.254            |
| cidr              | 192.168.0.0/24                       |
| created_at        | 2025-07-12T15:47:02Z                 |
| description       |                                      |
| dns_nameservers   |                                      |
| enable_dhcp       | True                                 |
| gateway_ip        | 192.168.0.1                          |
| host_routes       |                                      |
| id                | 2cc66f9b-2cf2-47b2-a0ca-303277277eb4 |
| ip_version        | 4                                    |
| ipv6_address_mode | None                                 |
| ipv6_ra_mode      | None                                 |
| name              | internal-subnet                      |
| network_id        | 8491812a-219c-4f86-ace8-2a49a087a89a |
| project_id        | 0822d3c87bff4de09999a8b52ea06383     |
| revision_number   | 0                                    |
| segment_id        | None                                 |
| service_types     |                                      |
| subnetpool_id     | None                                 |
| tags              |                                      |
| updated_at        | 2025-07-12T15:47:02Z                 |
+-------------------+--------------------------------------+
[ubuntu@workstation (keystone-cloud-dev)]:~$
```

Note

The **–dhcp** option is default and is specified here for clarity.

1.28. Create a router named **router-external** so that the internal and external networks can be connected.

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack router create \
> router-external
```

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack router create \
> router-external
+-------------------------+--------------------------------------+
| Field                   | Value                                |
+-------------------------+--------------------------------------+
| admin_state_up          | UP                                   |
| availability_zone_hints |                                      |
| availability_zones      |                                      |
| created_at              | 2025-07-11T20:08:13Z                 |
| description             |                                      |
| distributed             | False                                |
| external_gateway_info   | None                                 |
| flavor_id               | None                                 |
| ha                      | False                                |
| id                      | e7b162aa-8b16-403a-beba-fb8b2326873f |
| name                    | router-external                      |
| project_id              | 4943b65e70da4dcab3bd3c7772fd4837     |
| revision_number         | 1                                    |
| routes                  |                                      |
| status                  | ACTIVE                               |
| tags                    |                                      |
| updated_at              | 2025-07-11T20:08:13Z                 |
+-------------------------+--------------------------------------+
[ubuntu@workstation (keystone-cloud-dev)]:~$
```

1.29. Add a port to the router for the internal network.

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack router add subnet \
> router-external \
> internal-subnet
```

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack router add subnet \
> router-external \
> internal-subnet
[ubuntu@workstation (keystone-cloud-dev)]:~$
```

1.30. Set the **external** network as the router's external gateway.

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack router set \
> --external-gateway external \
> router-external
```

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack router set \
> --external-gateway external \
> router-external
[ubuntu@workstation (keystone-cloud-dev)]:~$
```

1.31. We want to assign a specific floating IP address to the instance we will create. However, while a user with the **member** role can allocate a random floating IP address on a network, allocating a specific IP requires an **admin** role. Therefore, first source the credentials for the **superuser** user. Then, allocate the **127.25.250.25** floating IP address from the **external** network for the **prod** project.

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ source ~/keystonerc-superuser
[ubuntu@workstation (keystone-superuser)]:~$ openstack floating ip create \
> --floating-ip-address 172.25.250.25 \
> external
```

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ source ~/keystonerc-superuser
[ubuntu@workstation (keystone-superuser)]:~$ openstack floating ip create \
> --floating-ip-address 172.25.250.25 \
> external
+---------------------+--------------------------------------+
| Field               | Value                                |
+---------------------+--------------------------------------+
| created_at          | 2025-07-11T20:15:20Z                 |
| description         |                                      |
| fixed_ip_address    | None                                 |
| floating_ip_address | 172.25.250.25                        |
| floating_network_id | 2dcd93f3-e36d-4fc3-a052-89623127af08 |
| id                  | 75ae98c1-9ee5-449f-93d0-84fbb99fee2e |
| name                | 172.25.250.25                        |
| port_id             | None                                 |
| project_id          | 4943b65e70da4dcab3bd3c7772fd4837     |
| qos_policy_id       | None                                 |
| revision_number     | 0                                    |
| router_id           | None                                 |
| status              | DOWN                                 |
| subnet_id           | None                                 |
| updated_at          | 2025-07-11T20:15:20Z                 |
+---------------------+--------------------------------------+
[ubuntu@workstation (keystone-superuser)]:~$
```

1.32. We no longer need **admin** privileges, so switch back to the **cloud-dev** user. Generate a key pair named **ftp-key** for the **cloud-dev** user.

```
[ubuntu@workstation (keystone-superuser)]:~$ source ~/keystonerc-cloud-dev
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack keypair create \
> ftp-key > ~/Downloads/ftp-key.pem
```

```
[ubuntu@workstation (keystone-superuser)]:~$ source ~/keystonerc-cloud-dev
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack keypair create \
> ftp-key > ~/Downloads/ftp-key.pem
[ubuntu@workstation (keystone-cloud-dev)]:~$
```

1.33. Change the permissions of the key pair file so that only the **ubuntu** user has read and write permissions.

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ chmod 600 ~/Downloads/ftp-key.pem
```

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ chmod 600 ~/Downloads/ftp-key.pem
[ubuntu@workstation (keystone-cloud-dev)]:~$
```

1.34. Create a security group named **ftp-secgroup** for the **prod** project.

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack security group create \
> --description "SSH, ICMP, and FTP" \
> ftp-secgroup
```

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack security group create \
> --description "SSH, ICMP, and FTP" \
> ftp-secgroup
+-----------------+-----------------------------------------------------------+
| Field           | Value                                                     |
+-----------------+-----------------------------------------------------------+
| created_at      | 2025-07-11T20:26:55Z                                      |
| description     | SSH, ICMP, and FTP                                        |
| id              | e0c2c937-f891-4a54-a8a4-3f0121dd5e4a                      |
| name            | ftp-secgroup                                              |
| project_id      | 4943b65e70da4dcab3bd3c7772fd4837                          |
| revision_number | 1                                                         |
| rules           | created_at='2025-07-11T20:26:55Z', direction='egress',    |
|                 | ethertype='IPv6', id='a82c39ef-1074-43a7-b21f-            |
|                 | b052217ccd8e', standard_attr_id='62',                     |
|                 | updated_at='2025-07-11T20:26:55Z'                         |
|                 | created_at='2025-07-11T20:26:56Z', direction='egress',    |
|                 | ethertype='IPv4', id='f0565e83-a0bf-456d-                 |
|                 | a6f9-5c5f961dcecb', standard_attr_id='63',                |
|                 | updated_at='2025-07-11T20:26:56Z'                         |
| updated_at      | 2025-07-11T20:26:56Z                                      |
+-----------------+-----------------------------------------------------------+
[ubuntu@workstation (keystone-cloud-dev)]:~$
```

1.35. Create a security group rule to allow **ICMP** traffic from any IP address.

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack security group \
> rule create \
> --proto icmp \
> ftp-secgroup
```

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack security group \
> rule create \
> --proto icmp \
> ftp-secgroup
+-------------------+--------------------------------------+
| Field             | Value                                |
+-------------------+--------------------------------------+
| created_at        | 2024-06-20T20:53:43Z                 |
| description       |                                      |
| direction         | ingress                              |
| ether_type        | IPv4                                 |
| id                | da090aea-462e-4ad6-bdca-40b894514af5 |
| name              | None                                 |
| port_range_max    | None                                 |
| port_range_min    | None                                 |
| project_id        | c0f3e7114ea04faf9b714df14c54fc41     |
| protocol          | icmp                                 |
| remote_group_id   | None                                 |
| remote_ip_prefix  | 0.0.0.0/0                            |
| revision_number   | 0                                    |
| security_group_id | d8f799be-7cc0-4d48-a845-7fdbd6839314 |
| updated_at        | 2024-06-20T20:53:43Z                 |
+-------------------+--------------------------------------+
[ubuntu@workstation (keystone-cloud-dev)]:~$
```

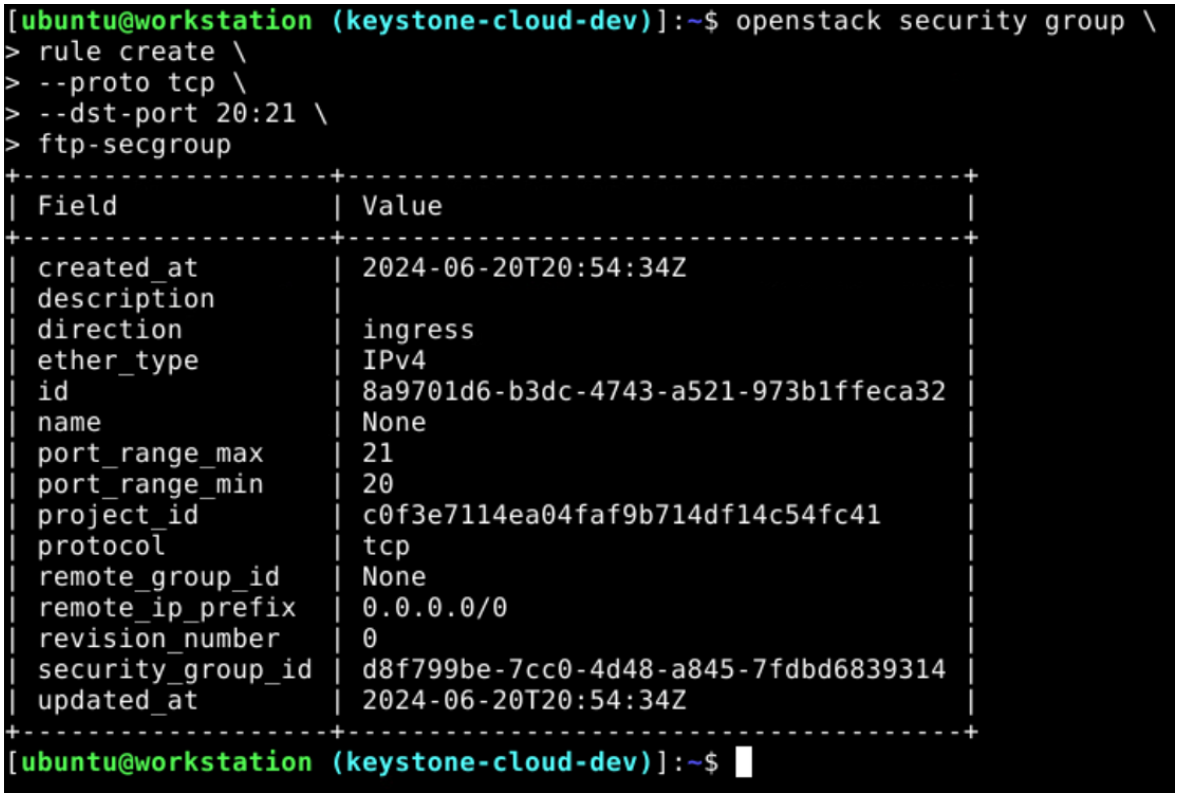
1.36. Create a security group rule to allow **SSH** traffic from any IP address on the default port 22.

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack security group \
> rule create \
> --proto tcp \
> --dst-port 22 \
> ftp-secgroup
```

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack security group \
> rule create \
> --proto tcp \
> --dst-port 22 \
> ftp-secgroup
+-------------------+--------------------------------------+
| Field             | Value                                |
+-------------------+--------------------------------------+
| created_at        | 2025-07-11T20:28:37Z                 |
| description       |                                      |
| direction         | ingress                              |
| ether_type        | IPv4                                 |
| id                | 3a2d144d-9286-467b-9767-fcc021edf63a |
| name              | None                                 |
| port_range_max    | 22                                   |
| port_range_min    | 22                                   |
| project_id        | 4943b65e70da4dcab3bd3c7772fd4837     |
| protocol          | tcp                                  |
| remote_group_id   | None                                 |
| remote_ip_prefix  | 0.0.0.0/0                            |
| revision_number   | 0                                    |
| security_group_id | e0c2c937-f891-4a54-a8a4-3f0121dd5e4a |
| updated_at        | 2025-07-11T20:28:37Z                 |
+-------------------+--------------------------------------+
[ubuntu@workstation (keystone-cloud-dev)]:~$
```

1.37. Create a security group rule to allow **FTP** traffic from any IP address. FTP uses the TCP protocol on port 20 (data channel) and port 21 (control channel).

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack security group \
> rule create \
> --proto tcp \
> --dst-port 20:21 \
> ftp-secgroup
```



1.38. Create an image named **ftp** with the file **~/Downloads/ftp.img**. This file comes preloaded on the **workstation** machine for the purpose of this lab.

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack image create \
> --disk-format qcow2 \
> --file ~/Downloads/ftp.img \
> ftp
```

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack image create \
> --disk-format qcow2 \
> --file ~/Downloads/ftp.img \
> ftp
+------------------+------------------------------------------------------+
| Field            | Value                                                |
+------------------+------------------------------------------------------+
| checksum         | 92a592a8619d0d7834d7aaddaf4187dd                     |
| container_format | bare                                                 |
| created_at       | 2025-07-11T20:30:12Z                                 |
| disk_format      | qcow2                                                |
| file             | /v2/images/38a48c99-3471-42da-998d-1a5986176704/file |
| id               | 38a48c99-3471-42da-998d-1a5986176704                 |
| min_disk         | 0                                                    |
| min_ram          | 0                                                    |
| name             | ftp                                                  |
| owner            | 4943b65e70da4dcab3bd3c7772fd4837                     |
| properties       | os_hash_algo='sha512', os_hash_value='b3a52e18efb12dd965d |
|                  | 3f674ce7465fa46bf354336b9b58b2769a150eee2af9e5787d8a0fcfe |
|                  | 7f402f32434c090234c92fff66947c9beb42c2e46ad6c706e597',    |
|                  | os_hidden='False'                                    |
| protected        | False                                                |
| schema           | /v2/schemas/image                                    |
| size             | 2155479040                                           |
| status           | active                                               |
| tags             |                                                      |
| updated_at       | 2025-07-11T20:30:24Z                                 |
| virtual_size     | 21474836480                                          |
| visibility       | shared                                               |
+------------------+------------------------------------------------------+
[ubuntu@workstation (keystone-cloud-dev)]:~$
```

1.39. Finally, we will create a custom flavor for the instance based on one of the existing flavors. The **ftp** image requires at least 20 GB of disk. If we list the available flavors, we can see that **m1.small** is close to what we need, so we will create a similar flavor with a small amount of ephemeral and swap disk.

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack flavor list
```

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack flavor list
+----+-----------+-------+------+-----------+-------+-----------+
| ID | Name      |   RAM | Disk | Ephemeral | VCPUs | Is Public |
+----+-----------+-------+------+-----------+-------+-----------+
| 1  | m1.tiny   |   512 |    1 |         0 |     1 | True      |
| 2  | m1.small  |  2048 |   20 |         0 |     1 | True      |
| 3  | m1.medium |  4096 |   40 |         0 |     2 | True      |
| 4  | m1.large  |  8192 |   80 |         0 |     4 | True      |
| 42 | m1.nano   |   128 |    1 |         0 |     1 | True      |
| 5  | m1.xlarge | 16384 |  160 |         0 |     8 | True      |
| 84 | m1.micro  |   192 |    1 |         0 |     1 | True      |
| c1 | cirros256 |   256 |    1 |         0 |     1 | True      |
| d1 | ds512M    |   512 |    5 |         0 |     1 | True      |
| d2 | ds1G      |  1024 |   10 |         0 |     1 | True      |
| d3 | ds2G      |  2048 |   10 |         0 |     2 | True      |
| d4 | ds4G      |  4096 |   20 |         0 |     4 | True      |
+----+-----------+-------+------+-----------+-------+-----------+
[ubuntu@workstation (keystone-cloud-dev)]:~$
```

1.40. Creating a flavor is another action that requires **admin** privileges, so first source the credentials of the **superuser** user. Then, define a flavor called **ftp** with **1 VCPU**, **2048 MB** of RAM, a **10 GB** root disk, a **2 GB** ephemeral disk, and a **1024 MB** swap disk.

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ source ~/keystonerc-superuser
[ubuntu@workstation (keystone-superuser)]:~$ openstack flavor create \
> --vcpus 1 \
> --ram 2048 \
> --disk 20 \
> --ephemeral 2 \
> --swap 1024 \
> ftp
```

```
[ubuntu@workstation (keystone-superuser)]:~$ source ~/keystonerc-superuser
[ubuntu@workstation (keystone-superuser)]:~$ openstack flavor create \
> --vcpus 1 \
> --ram 2048 \
> --disk 20 \
> --ephemeral 2 \
> --swap 1024 \
> ftp
+----------------------------+--------------------------------------+
| Field                      | Value                                |
+----------------------------+--------------------------------------+
| OS-FLV-DISABLED:disabled   | False                                |
| OS-FLV-EXT-DATA:ephemeral  | 2                                    |
| disk                       | 20                                   |
| id                         | e1e64350-8bd4-4f7c-ae1f-5d8ba5f1ce83 |
| name                       | ftp                                  |
| os-flavor-access:is_public | True                                 |
| properties                 |                                      |
| ram                        | 2048                                 |
| rxtx_factor                | 1.0                                  |
| swap                       | 1024                                 |
| vcpus                      | 1                                    |
+----------------------------+--------------------------------------+
[ubuntu@workstation (keystone-superuser)]:~$
```

1.41. Switch back to the **cloud-dev** user.

```
[ubuntu@workstation (keystone-supuser)]:~$ source ~/keystonerc-cloud-dev
```

```
[ubuntu@workstation (keystone-superuser)]:~$ source ~/keystonerc-cloud-dev
[ubuntu@workstation (keystone-cloud-dev)]:~$
```

1.42. The FTP server instance is almost ready to be launched. First, use **nano** to create a file named **ftp-init** in the home directory. Be sure it has the correct indentation and matches the contents shown below. Press **Ctrl+X** to exit the file, then press **Y** and then **Enter** to save the changes to the file.

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ nano ~/ftp-init
```

```
#cloud-config
runcmd:
 - echo "This instance has been customized by cloud-init" > /etc/motd
 - echo "127.0.1.1 ftp-server" >> /etc/hosts
```

Note

This **cloud-init** script writes to the "message of the day" file, whose contents will be displayed upon a successful login. It also appends **127.0.1.1 ftp-server** to the **/etc/hosts** file to suppress an "unable to resolve host" warning that would otherwise occur when running commands with `sudo`.

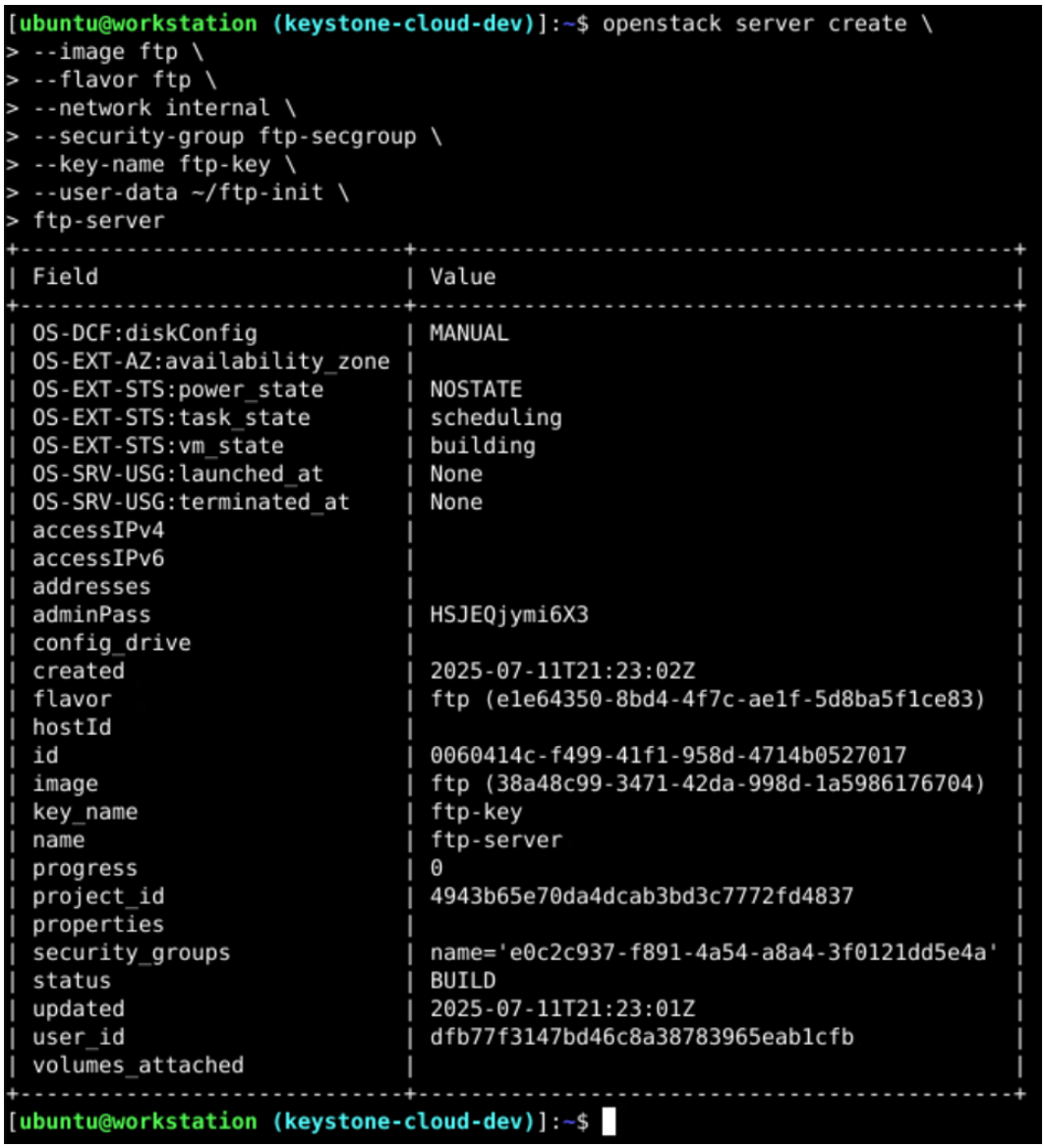
1.43. Leave the terminal window open and continue to the next task.

2 Launching an FTP Server Instance

In this task, you will deploy an FTP server in your environment and verify its external connectivity and functionality.

2.1. Create an instance named **ftp-server** using all our custom resources.

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack server create \
> --image ftp \
> --flavor ftp \
> --network internal \
> --security-group ftp-secgroup \
> --key-name ftp-key \
> --user-data ~/ftp-init \
> ftp-server
```



```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack server create \
> --image ftp \
> --flavor ftp \
> --network internal \
> --security-group ftp-secgroup \
> --key-name ftp-key \
> --user-data ~/ftp-init \
> ftp-server
+-----------------------------+----------------------------------------------+
| Field                       | Value                                        |
+-----------------------------+----------------------------------------------+
| OS-DCF:diskConfig           | MANUAL                                       |
| OS-EXT-AZ:availability_zone |                                              |
| OS-EXT-STS:power_state      | NOSTATE                                      |
| OS-EXT-STS:task_state       | scheduling                                   |
| OS-EXT-STS:vm_state         | building                                     |
| OS-SRV-USG:launched_at      | None                                         |
| OS-SRV-USG:terminated_at    | None                                         |
| accessIPv4                  |                                              |
| accessIPv6                  |                                              |
| addresses                   |                                              |
| adminPass                   | HSJEQjymi6X3                                 |
| config_drive                |                                              |
| created                     | 2025-07-11T21:23:02Z                         |
| flavor                      | ftp (e1e64350-8bd4-4f7c-ae1f-5d8ba5f1ce83)   |
| hostId                      |                                              |
| id                          | 0060414c-f499-41f1-958d-4714b0527017         |
| image                       | ftp (38a48c99-3471-42da-998d-1a5986176704)   |
| key_name                    | ftp-key                                      |
| name                        | ftp-server                                   |
| progress                    | 0                                            |
| project_id                  | 4943b65e70da4dcab3bd3c7772fd4837             |
| properties                  |                                              |
| security_groups             | name='e0c2c937-f891-4a54-a8a4-3f0121dd5e4a'  |
| status                      | BUILD                                        |
| updated                     | 2025-07-11T21:23:01Z                         |
| user_id                     | dfb77f3147bd46c8a38783965eab1cfb             |
| volumes_attached            |                                              |
+-----------------------------+----------------------------------------------+
[ubuntu@workstation (keystone-cloud-dev)]:~$
```

2.2. Ensure that the instance state is **ACTIVE**.

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack server list
```

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack server list
+--------------------+------------+--------+--------------------+-------+--------+
| ID                 | Name       | Status | Networks           | Image | Flavor |
+--------------------+------------+--------+--------------------+-------+--------+
| 0060414c-f499-41f  | ftp-server | ACTIVE | internal=192.168.  | ftp   | ftp    |
| 1-958d-            |            |        | 0.253              |       |        |
| 4714b0527017       |            |        |                    |       |        |
+--------------------+------------+--------+--------------------+-------+--------+
[ubuntu@workstation (keystone-cloud-dev)]:~$
```

2.3. List the available floating IP addresses.

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack floating ip list
```

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack floating ip list
+------------+---------------------+------------------+------+------------------+--------------+
| ID         | Floating IP Address | Fixed IP Address | Port | Floating Network | Project      |
+------------+---------------------+------------------+------+------------------+--------------+
| 75ae98c1-9e | 172.25.250.25       | None             | None | 2dcd93f3-e36d-4f | 4943b65e70da4 |
| e5-449f-93d |                     |                  |      | c3-a052-89623127 | dcab3bd3c7772 |
| 0-84fbb99fe |                     |                  |      | af08             | fd4837       |
| e2e         |                     |                  |      |                  |              |
+------------+---------------------+------------------+------+------------------+--------------+
[ubuntu@workstation (keystone-cloud-dev)]:~$
```

2.4. Associate an open floating IP address to the instance.

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack server add floating ip \
> ftp-server 172.25.250.25
```

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack server add floating ip \
> ftp-server 172.25.250.25
[ubuntu@workstation (keystone-cloud-dev)]:~$
```

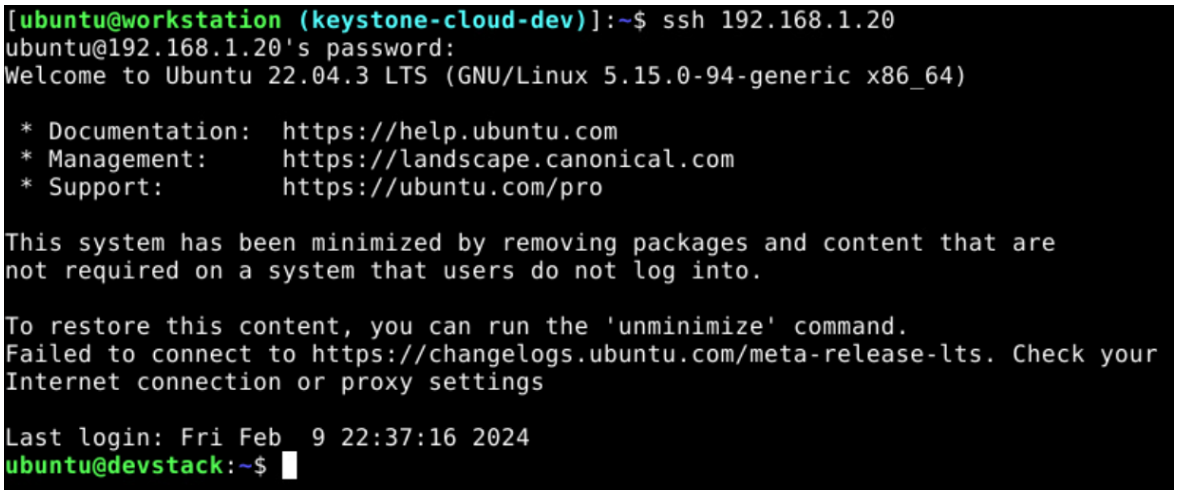
2.5. Use the **scp** command to copy the ~**/Downloads/ftp-key.pem** file to the **devstack** machine. When prompted to enter the password for **ubuntu@192.168.1.20**, enter **ubuntu**.

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ scp ~/Downloads/ftp-key.pem \
> 192.168.1.20:~/ftp-key.pem
```

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ scp ~/Downloads/ftp-key.pem \
> 192.168.1.20:~/ftp-key.pem
ubuntu@192.168.1.20's password:
ftp-key.pem                                   100% 1676     1.2MB/s   00:00
[ubuntu@workstation (keystone-cloud-dev)]:~$
```

2.6. SSH into the **devstack** machine. Enter **ubuntu** when prompted for a password.

```
[ubuntu@workstation (keystone-cloud-dev)]:~$ ssh 192.168.1.20
```



2.7. SSH into the **ftp-server** instance with the **ftp-key** private key. Enter **yes** when asked if you want to continue connecting. Notice that the message of the day uploaded with the **cloud-init** script appears near the bottom of the output.

```
ubuntu@devstack:~$ ssh -i ~/ftp-key.pem 172.25.250.25
```

```
ubuntu@devstack:~$ ssh -i ~/ftp-key.pem 172.25.250.25
The authenticity of host '172.25.250.25 (172.25.250.25)' can't be established.
ED25519 key fingerprint is SHA256:5jU8aBe9N9Fwx2cpwNijmPJ9oX8RnqYDZivSxJ4mNWo.
This key is not known by any other names
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '172.25.250.25' (ED25519) to the list of known hosts.
Welcome to Ubuntu 22.04.3 LTS (GNU/Linux 5.15.0-91-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/pro

  System information as of Tue Jan 23 16:41:33 UTC 2024

  System load:  0.7685546875      Processes:             90
  Usage of /:   7.3% of 19.20GB   Users logged in:       0
  Memory usage: 9%                IPv4 address for ens3: 192.168.1.57
  Swap usage:   0%                IPv4 address for ens4: 172.25.250.153


Expanded Security Maintenance for Applications is not enabled.

0 updates can be applied immediately.

Enable ESM Apps to receive additional future security updates.
See https://ubuntu.com/esm or run: sudo pro status


The list of available updates is more than a week old.
To check for new updates run: sudo apt update


The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

This instance has been customized by cloud-init
To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

ubuntu@ftp-server:~$
```

> **Note**
>
> It may take several minutes for the instance to fully boot and be available for an SSH connection. Until then, the connection will be refused.

2.8. Verify that the **/etc/hosts** file was updated properly.

```
ubuntu@ftp-server:~$ cat /etc/hosts
```

```
ubuntu@ftp-server:~$ cat /etc/hosts
127.0.0.1 localhost

# The following lines are desirable for IPv6 capable hosts
::1 ip6-localhost ip6-loopback
fe00::0 ip6-localnet
ff00::0 ip6-mcastprefix
ff02::1 ip6-allnodes
ff02::2 ip6-allrouters
ff02::3 ip6-allhosts
127.0.1.1 ftp-server
ubuntu@ftp-server:~$
```

2.9. Verify that the **vsftpd** package is installed.

```
ubuntu@ftp-server:~$ apt list --installed | grep vsftpd
```

```
ubuntu@ftp-server:~$ apt list --installed | grep vsftpd

WARNING: apt does not have a stable CLI interface. Use with caution in scripts.

vsftpd/now 3.0.5-0ubuntu1 amd64 [installed,local]
ubuntu@ftp-server:~$
```

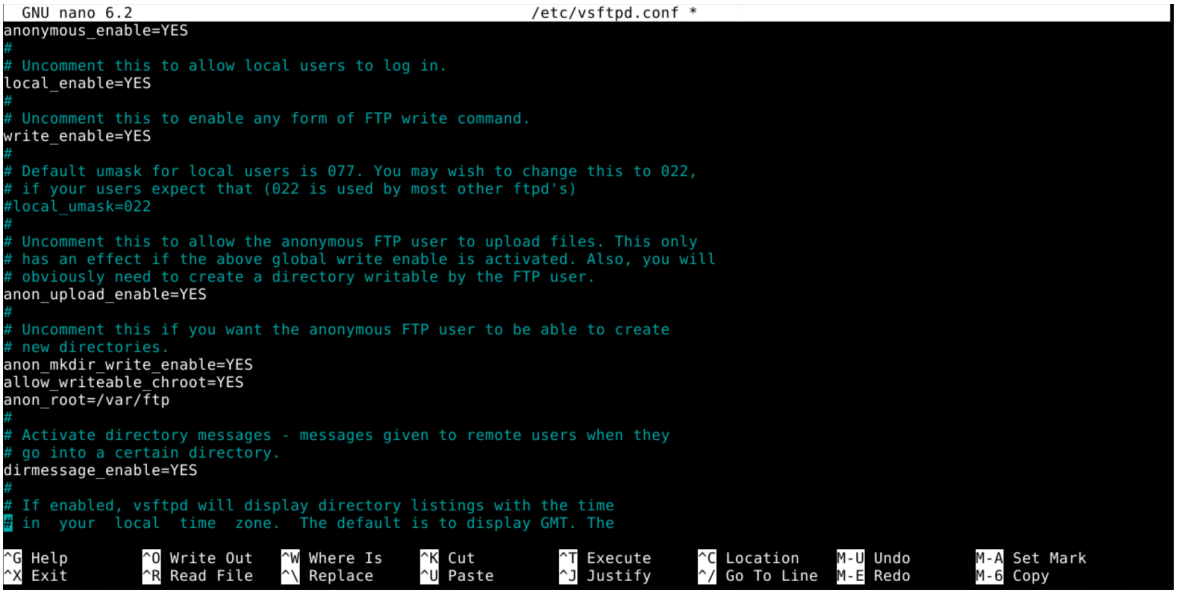
2.10. Use **nano** to edit the **/etc/vsftpd.conf** configuration file and uncomment the variables **anonymous_enable**, **write_enable**, **anon_upload_enable**, and **anon_mkdir_write_enable** by deleting the "**#**" character that comes before them. For the variable **anonymous_enable**, change the **NO** to **YES**. Then, append the following lines:

```
allow_writeable_chroot=YES
anon_root=/var/ftp
```

The content of the file should resemble the output given below.

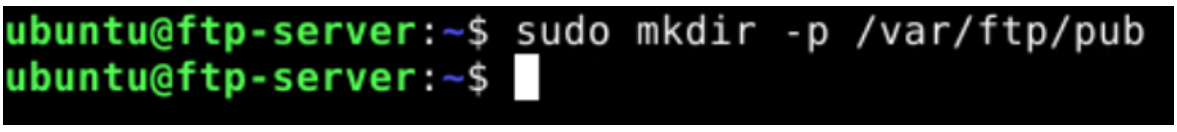
```
ubuntu@ftp-server:~$ sudo nano /etc/vsftpd.conf
```

```
anonymous_enable=YES
write_enable=YES
anon_upload_enable=YES
anon_mkdir_write_enable=YES
allow_writeable_chroot=YES
anon_root=/var/ftp
```



2.11. Create a directory for anonymous FTP users.

```
ubuntu@ftp-server:~$ sudo mkdir -p /var/ftp/pub
```

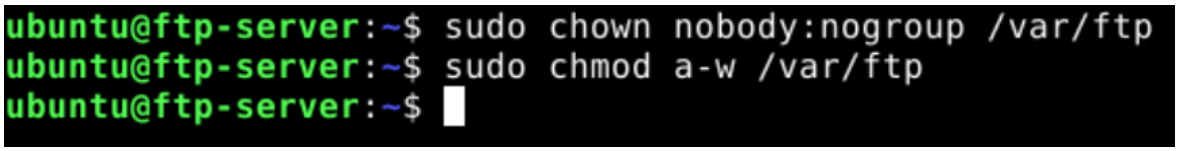


Note

The **-p** option creates parent directories as necessary.

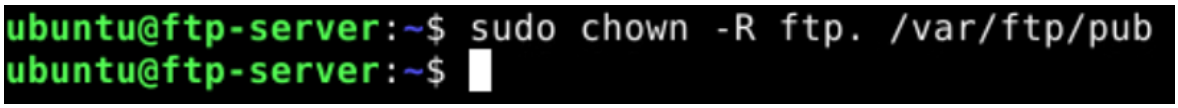
2.12. Remove all ownership and write permissions from the root FTP directory.

```
ubuntu@ftp-server:~$ sudo chown nobody:nogroup /var/ftp
ubuntu@ftp-server:~$ sudo chmod a-w /var/ftp
```



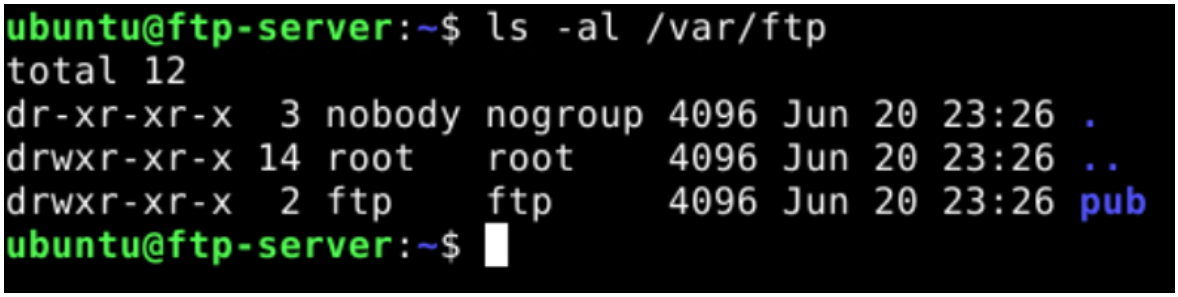
2.13. Change the ownership of the **/var/ftp/pub** directory so that the **ftp** user and group owns everything within this directory.

```
ubuntu@ftp-server:~$ sudo chown -R ftp. /var/ftp/pub
```



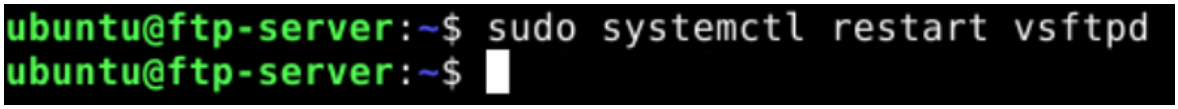
2.14. View the permissions of the **/var/ftp** directory. Ensure that no users or groups have ownership or write privileges for the **/var/ftp** directory and that the **ftp** user and group owns the **/var/ftp/pub** directory and its contents.

```
ubuntu@ftp-server:~$ ls -al /var/ftp
```



2.15. Restart the **vsftpd** service so that the changes will take effect.

```
ubuntu@ftp-server:~$ sudo systemctl restart vsftpd
```



2.16. View the status of the **vsftpd** service. If all changes were made correctly, it should report that the service is active. If it reports that the service has failed, there is mostly likely a mistake in the **/var/vsftpd.conf** file. Press **Q** to regain control of the command prompt.

```
ubuntu@ftp-server:~$ sudo systemctl status vsftpd
```

```
ubuntu@ftp-server:~$ sudo systemctl status vsftpd
● vsftpd.service - vsftpd FTP server
     Loaded: loaded (/lib/systemd/system/vsftpd.service; enabled; vendor preset>
     Active: active (running) since Fri 2024-06-21 00:07:04 UTC; 25s ago
    Process: 1214 ExecStartPre=/bin/mkdir -p /var/run/vsftpd/empty (code=exited>
   Main PID: 1215 (vsftpd)
      Tasks: 1 (limit: 2309)
     Memory: 856.0K
        CPU: 163ms
     CGroup: /system.slice/vsftpd.service
             └─1215 /usr/sbin/vsftpd /etc/vsftpd.conf

Jun 21 00:07:04 ftp-server systemd[1]: Starting vsftpd FTP server...
Jun 21 00:07:04 ftp-server systemd[1]: Started vsftpd FTP server.
ubuntu@ftp-server:~$
```

2.17. Exit from the **ftp-server** instance.

```
ubuntu@ftp-server:~$ exit
```

```
ubuntu@ftp-server:~$ exit
logout
Connection to 172.25.250.25 closed.
ubuntu@devstack:~$
```

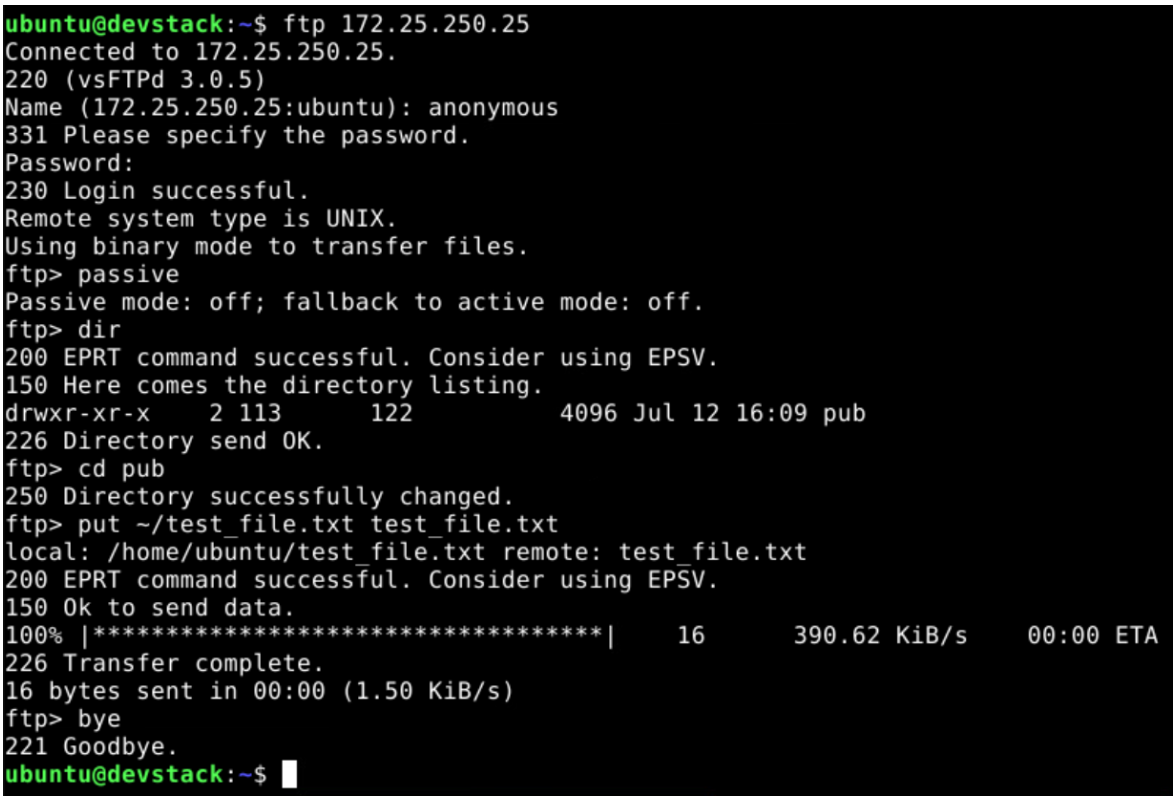
2.18. From **workstation**, create a text file named **test_file.txt** containing the string "This is my file".

```
ubuntu@devstack:~$ echo "This is my file" > ~/test_file.txt
```

```
ubuntu@devstack:~$ echo "This is my file" > ~/test_file.txt
ubuntu@devstack:~$
```

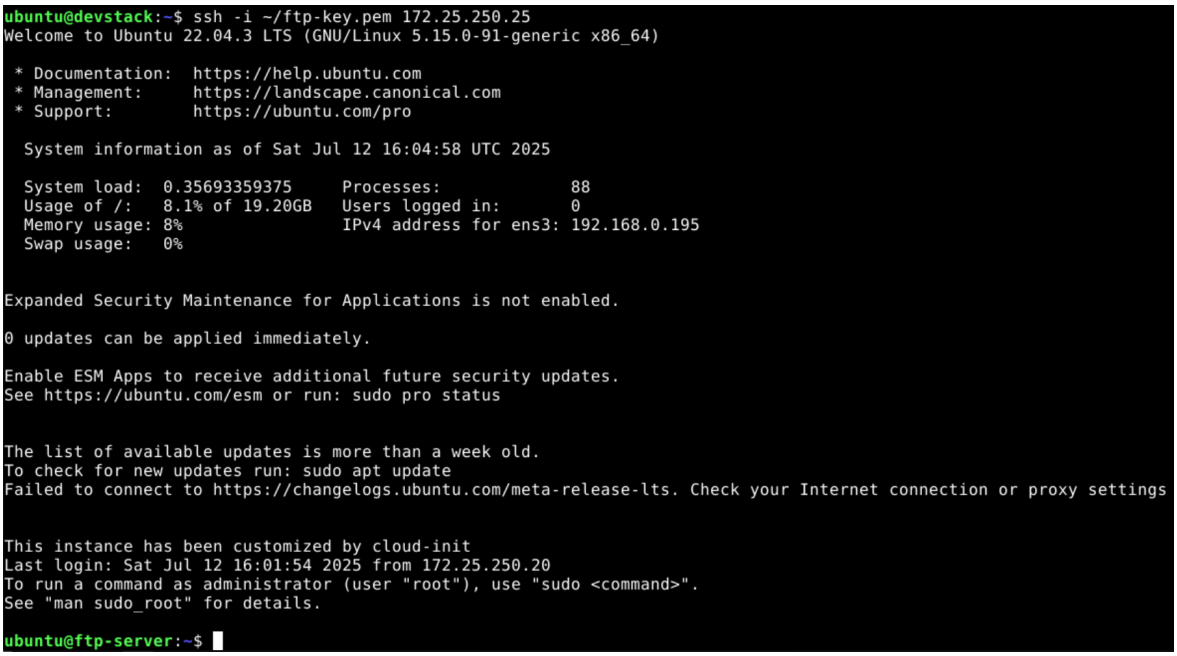
2.19. Open an FTP session to the FTP server and upload the **test_file.txt** file; then, log out. Use **anonymous** as the user and when prompted for the password, press the **Enter** key for no password input. Follow the instructions from the example and summary below.

```
ubuntu@devstack:~$ ftp 172.25.250.25
Name (172.25.250.25:ubuntu): anonymous
Password:
ftp> passive
ftp> dir
ftp> cd pub
ftp> put ~/test_file.txt test_file.txt
ftp> bye
```



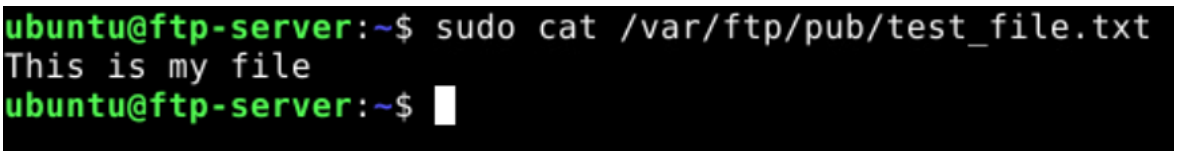
2.20. SSH into the **ftp-server** instance.

```
ubuntu@devstack:~$ ssh -i ~/ftp-key.pem 172.25.250.25
```



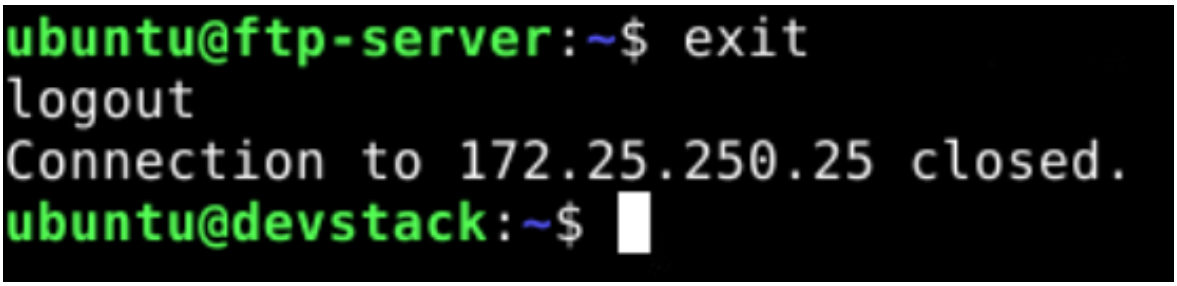
2.21. Verify the file uploaded successfully.

```
ubuntu@ftp-server:~$ sudo cat /var/ftp/pub/test_file.txt
```



2.22. Exit from the **ftp-server** instance.

```
ubuntu@ftp-server:~$ exit
```



2.23. The lab is now complete.