



OpenStack Labs

Lab 05: Customizing Instances

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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 use the **cloud-init** utility to customize OpenStack instances. This utility is used to perform actions from an instance upon creation. For example, it can be used to install a list of packages or change the message of the day displayed upon login to the instance.

Objectives

- Customize an instance with **cloud-init** with the *Horizon Dashboard*.
- Customize an instance with **cloud-init** with the *OpenStack Unified CLI*.
- Verify instance customization.

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 Setting Up the Environment

In this task, you will set up the OpenStack environment to support the customized external instances you will create in the following sections.

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

```
Ubuntu 18.04.6 LTS workstation tty1
workstation login: ubuntu
Password:
```

- 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 keystone credentials for the **admin** user.

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

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

- 1.4. In this lab, we will create our own router and external network. First, the default router and external network need to be deleted. List the routers to find the default router's name so it can be deleted.

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

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

Tip

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

- 1.5. Before the router can be deleted, it must be disconnected from all subnets. First, remove its external gateway.

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

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

- 1.6.** In previous labs, you disconnected routers from their subnets by using a **for** loop to iterate over interface IDs. In this lab, you will instead identify the connected subnets by name before disconnecting them. To begin, list the details of **router1** to see which subnets it is connected to.

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

Field	Value
admin_state_up	UP
availability_zone_hints	
availability_zones	
created_at	2024-02-09T19:58:10Z
description	
distributed	False
external_gateway_info	{"network_id": "32da4c25-b517-40c5-97e3-cea031467d13", "enable_snat": true, "external_fixed_ips": [{"subnet_id": "c7916655-8954-4bf4-913d-416702f35d1b", "ip_address": "172.24.4.73"}, {"subnet_id": "4fc6bf88-919c-49df-83c4-b09bd65776ad", "ip_address": "2001:db8::1"}]}
flavor_id	None
ha	False
id	07df5a07-8795-4d8e-accf-f9d7e4cbb4ee
interfaces_info	[{"subnet_id": "fa8a2545-5a8c-44a2-bacc-1b86c253b880", "ip_address": "10.0.0.1", "port_id": "a05f4e1c-4014-4d25-9538-64e8114197e1"}, {"subnet_id": "674205b6-1357-4727-a21a-94220492a57f", "ip_address": "fd96:731b:22b0::1", "port_id": "d369b706-db4a-4239-b715-721708931870"}]
name	router1
project_id	39e851b14f864573aad60582c35e40dc
revision_number	6
routes	
status	ACTIVE
tags	
updated_at	2024-02-09T19:58:27Z

- 1.7. List the subnets to see which names are mapped to the IDs from the previous step.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack subnet list
```

ID	Name	Network	Subnet
4fc6bf88-919c-49df-83c4-b09bd65776ad	ipv6-public-subnet	32da4c25-b517-40c5-97e3-cea03146	2001:db8::/64
674205b6-1357-4727-a21a-94220492a57f	ipv6-private-subnet	966ecb4f-4ff8-44ea-a476-2d2f1895	fd96:731b:22b0::/64
7e456257-76e5-4cfc-bf3f-b2a3876dba40	shared-subnet	9f23266f-d833-435085	192.168.233.0/24
c7916655-8954-4bf4-913d-416702f35d1b	public-subnet	32da4c25-b517-40c5-97e3-cea03146	172.24.4.0/24
fa8a2545-5a8c-44a2-bacc-1b86c253b880	private-subnet	966ecb4f-4ff8-44ea-a476-2d2f1895	10.0.0.0/26
		5085	

- 1.8. By matching the names and IDs, you can see that the router is connected to the **private-subnet** and **ipv6-private-subnet** subnets. Remove **private-subnet** from **router1**.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack router remove subnet \
> router1 \
> private-subnet
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack router remove subnet \
> router1 \
> private-subnet
[ubuntu@workstation (keystone-admin)]:~$
```

- 1.9. Now, remove **ipv6-private-subnet** from **router1**.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack router remove subnet \
> router1 \
> ipv6-private-subnet
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack router remove subnet \
> router1 \
> ipv6-private-subnet
[ubuntu@workstation (keystone-admin)]:~$
```

- 1.10. Now, the router can be deleted. Delete **router1**.

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

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

- 1.11. List the details of the available networks and find which one is external. The **-long** option adds several columns to the tabular output of the command, including the **Router Type** column, which shows whether the router is internal or external. We will limit the output to just the **Name** and **Route Type** columns.

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

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

Tip

In most terminal commands, arguments that contain spaces must be enclosed in quotation marks so that the shell treats them as a single value. In this case, “**Router Type**” must be quoted to be interpreted correctly.

- 1.12. The output of the previous step shows that **public** is the external network. Delete the **public** network.

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

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

- 1.13. Now, we will create our own resources. First, create an external network named **extern-net**. Set the network type to **flat** and the physical network to **public**. Set the network as shared and external.

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

```
[ubuntu@workstation (keystone-admin)]:~$ openstack network create \
> --external \
> --share \
> --provider-network-type flat \
> --provider-physical-network public \
> extern-net
+-----+-----+
| Field | Value |
+-----+-----+
| admin_state_up | UP |
| availability_zone_hints | |
| availability_zones | |
| created_at | 2025-07-06T20:17:03Z |
| description | |
| dns_domain | None |
| id | fcffb4d7-ee3e-4bd5-bb7b-8856f0e16ed2 |
| ipv4_address_scope | None |
| ipv6_address_scope | None |
| is_default | False |
| is_vlan_transparent | None |
| mtu | 1500 |
| name | extern-net |
| port_security_enabled | True |
| project_id | 39e851b14f864573aad60582c35e40dc |
| 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 | 2025-07-06T20:17:03Z |
+-----+
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 1.14.** Create a subnet named **extern-subnet** in the **extern-net** network. Give the subnet a range of **172.25.250.60** to **172.25.250.80**. Disable DHCP services for the subnet and use the address **172.25.250.254** as the gateway as well as the DNS name server.

```
[ubuntu@workstation (keystone-admin)]:~$ 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=172.25.250.60,end=172.25.250.80 \
> --network extern-net \
> extern-subnet
```

```
[ubuntu@workstation (keystone-admin)]:~$ 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=172.25.250.60,end=172.25.250.80 \
> --network extern-net \
> extern-subnet
+-----+-----+
| Field | Value |
+-----+-----+
| allocation_pools | 172.25.250.60-172.25.250.80 |
| cidr | 172.25.250.0/24 |
| created_at | 2025-07-06T20:18:44Z |
| description | |
| dns_nameservers | 172.25.250.254 |
| enable_dhcp | False |
| gateway_ip | 172.25.250.254 |
| host_routes | |
| id | fe15d8ef-d309-48fe-9b0a-e2cda8156983 |
| ip_version | 4 |
| ipv6_address_mode | None |
| ipv6_ra_mode | None |
| name | extern-subnet |
| network_id | fcffb4d7-ee3e-4bd5-bb7b-8856f0e16ed2 |
| project_id | 39e851b14f864573aad60582c35e40dc |
| revision_number | 0 |
| segment_id | None |
| service_types | |
| subnetpool_id | None |
| tags | |
| updated_at | 2025-07-06T20:18:44Z |
+-----+-----+
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 1.15. List the floating IPs to make sure none are already allocated. The list should be empty.

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

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

```
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 1.16. From the floating IP pool in the **extern-net** network, create a floating IP.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack floating ip create extern-net
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack floating ip create extern-net
+-----+-----+
| Field          | Value
+-----+-----+
| created_at     | 2025-07-07T16:31:25Z
| description    |
| fixed_ip_address | None
| floating_ip_address | 172.25.250.76
| floating_network_id | 84b47575-e146-4057-b793-c9fd4625540f
| id             | 3b60ab3d-68a5-408f-8950-642aacf93b71
| name           | 172.25.250.76
| port_id         | None
| project_id     | 39e851b14f864573aad60582c35e40dc
| qos_policy_id   | None
| revision_number | 0
| router_id       | None
| status          | DOWN
| subnet_id       | None
| updated_at      | 2025-07-07T16:31:25Z
+-----+-----+
[ubuntu@workstation (keystone-admin)]:~$ █
```

1.17. Create a router named `extern-router`.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack router create extern-router
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack router create extern-router
+-----+-----+
| Field | Value |
+-----+-----+
| admin_state_up | UP
| availability_zone_hints |
| availability_zones |
| created_at | 2024-06-20T00:40:08Z
| description |
| distributed | False
| external_gateway_info | None
| flavor_id | None
| ha | False
| id | c92e57ef-ba53-4081-92be-d4856d09ae1b
| name | extern-router
| project_id | 39e851b14f864573aad60582c35e40dc
| revision_number | 1
| routes |
| status | ACTIVE
| tags |
| updated_at | 2024-06-20T00:40:08Z
+-----+
[ubuntu@workstation (keystone-admin)]:~$ █
```

1.18. List the available subnets to see what the router can be connected to.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack subnet list
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack subnet list
+-----+-----+-----+-----+
| ID | Name | Network | Subnet |
+-----+-----+-----+-----+
| 674205b6-1357-472 | ipv6-private-subnet | 966ecb4f-4ff8-44e | fd96:731b:22b0::/64
| 7-a21a-94220492a57f | shared-subnet | a-a476-2d2f189550 | 85
| 7e456257-76e5-4fcf-b2a3876dba40 | private-subnet | 9f23266f-d833-433 | 192.168.233.0/24
| fa8a2545-5a8c-44a2-bacc-1b86c253b880 | extern-subnet | fcffb4d7-ee3e-4bd5-bb7b-8856f0e16ed2 | 172.25.250.0/24
| fe15d8ef-d309-e48fe-9b0a-e2cda8156983 |
+-----+-----+-----+-----+
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 1.19. Connect the router to the **shared-subnet** subnet.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack router add subnet \
> extern-router shared-subnet
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack router add subnet \
> extern-router shared-subnet
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 1.20. Set the **extern-net** network as the gateway for the router.

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

```
[ubuntu@workstation (keystone-admin)]:~$ openstack router set \
> --external-gateway extern-net \
> extern-router
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 1.21. List the current key pairs to make sure there are not any already allocated. The list should be empty.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack keypair list
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack keypair list
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 1.22. Create the key pair **dev-keypair** and save the private key to the file **~/Downloads/dev-keypair.pem**.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack keypair create \
> dev-keypair > ~/Downloads/dev-keypair.pem
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack keypair create \
> dev-keypair > ~/Downloads/dev-keypair.pem
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 1.23. View the permission of the **/Downloads/dev-keypair.pem** file. You can see that the **ubuntu** user has read and write privileges to the file, the **ubuntu** user group has read and write privileges to the file, and other users have read permissions to the file. However, this is a sensitive file, and only the **ubuntu** user should have any privileges to it.

```
[ubuntu@workstation (keystone-admin)]:~$ ls -l ~/Downloads/dev-keypair.pem
```

```
[ubuntu@workstation (keystone-admin)]:~$ ls -l ~/Downloads/dev-keypair.pem
-rw-rw-r-- 1 ubuntu ubuntu 1680 Jun 20 00:50 /home/ubuntu/Downloads/dev-keypair.pem
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 1.24.** Use the **chmod** command with a mode of **600** to make it so that the **ubuntu** user has read/write permissions on the file, and groups and other users have no permissions to the file.

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

```
[ubuntu@workstation (keystone-admin)]:~$ chmod 600 ~/Downloads/dev-keypair.pem
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 1.25.** List the permissions again to ensure that the change took effect.

```
[ubuntu@workstation (keystone-admin)]:~$ ls -l ~/Downloads/dev-keypair.pem
```

```
[ubuntu@workstation (keystone-admin)]:~$ ls -l ~/Downloads/dev-keypair.pem
-rw----- 1 ubuntu ubuntu 1680 Jun 20 00:50 /home/ubuntu/Downloads/dev-keypair.pem
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 1.26.** Create the **dev-secgroup** security group.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack security group create \
> dev-secgroup
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack security group create \
> dev-secgroup
+-----+-----+
| Field      | Value
+-----+-----+
| created_at | 2025-07-06T20:21:05Z
| description | dev-secgroup
| id          | 69c4fd3c-a78c-44b0-9c4b-03a7101d65c2
| name        | dev-secgroup
| project_id  | 39e851b14f864573aad60582c35e40dc
| revision_number | 1
| rules       | created_at='2025-07-06T20:21:05Z', direction='egress',
|               | ethertype='IPv4', id='3e3d08e8-2688-4354-a20a-
|               | 44f062537880', standard_attr_id='48',
|               | updated_at='2025-07-06T20:21:05Z'
|               | created_at='2025-07-06T20:21:05Z', direction='egress',
|               | ethertype='IPv6',
|               | id='4ba2c126-18ee-4739-9d23-477ff8677af1',
|               | standard_attr_id='47', updated_at='2025-07-06T20:21:05Z'
| updated_at   | 2025-07-06T20:21:05Z
+-----+-----+
[ubuntu@workstation (keystone-admin)]:~$ █
```

1.27. List the default security group rules.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack security group rule list \
> dev-secgroup
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack security group rule list \
> dev-secgroup
+-----+-----+-----+-----+-----+
| ID      | IP Protocol | IP Range | Port Range | Remote Security Group |
+-----+-----+-----+-----+
| 3e3d08e8-2688-4354 | None       | None     |             | None
| -a20a-44f062537880 | None       | None     |             | None
| 4ba2c126-18ee-4739 | None       | None     |             | None
| -9d23-477ff8677af1 |             |          |             |
+-----+-----+-----+-----+
[ubuntu@workstation (keystone-admin)]:~$ █
```

Tip

You can verify that the default rules allow any outgoing traffic over IPv4 or IPv6 with this command:

```
openstack security group rule show <rule-id>
```

1.28. Add a security rule in the **dev-secgroup** security group to allow remote ICMP traffic.

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

```
[ubuntu@workstation (keystone-admin)]:~$ openstack security group rule create \
> --protocol icmp \
> dev-secgroup
+-----+-----+
| Field      | Value           |
+-----+-----+
| created_at | 2025-07-06T20:23:12Z
| description |                 |
| direction   | ingress          |
| ether_type  | IPv4            |
| id          | b05d62d2-b94f-443c-92b8-1086bb59b88
| name        | None            |
| port_range_max | None          |
| port_range_min | None          |
| project_id  | 39e851b14f864573aad60582c35e40dc
| protocol    | icmp            |
| remote_group_id | None          |
| remote_ip_prefix | 0.0.0.0/0      |
| revision_number | 0              |
| security_group_id | 69c4fd3c-a78c-44b0-9c4b-03a7101d65c2
| updated_at   | 2025-07-06T20:23:12Z
+-----+
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 1.29.** Add another security rule to allow remote connection using SSH on the default port 22.

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

```
[ubuntu@workstation (keystone-admin)]:~$ openstack security group rule create \
> --protocol tcp \
> --dst-port 22 \
> dev-secgroup
+-----+
| Field      | Value
+-----+
| created_at | 2025-07-06T20:23:48Z
| description |
| direction   | ingress
| ether_type  | IPv4
| id          | 2bed3edf-798f-4d2e-8701-113b2d38c320
| name        | None
| port_range_max | 22
| port_range_min | 22
| project_id  | 39e851b14f864573aad60582c35e40dc
| protocol    | tcp
| remote_group_id |
| remote_ip_prefix | 0.0.0.0/0
| revision_number | 0
| security_group_id | 69c4fd3c-a78c-44b0-9c4b-03a7101d65c2
| updated_at   | 2025-07-06T20:23:48Z
+-----+
[ubuntu@workstation (keystone-admin)]:~$
```

- 1.30.** List the security group rules again to see that the new rules have taken effect.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack security group rule list \
> dev-secgroup
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack security group rule list \
> dev-secgroup
+-----+-----+-----+-----+-----+
| ID      | IP Protocol | IP Range | Port Range | Remote Security Group |
+-----+-----+-----+-----+
| 2bed3edf-798f-4d2e-8701-113b2d38c320 | tcp       | 0.0.0.0/0 | 22:22      | None
| 3e3d08e8-2688-4354-a20a-44f062537880 | None     | None     | None       | None
| 4ba2c126-18ee-4739-9d23-477ff8677af1 | None     | None     | None       | None
| b05d62d2-b94f-443c-92b8-1086bbd59b88 | icmp     | 0.0.0.0/0 | None       | None
+-----+-----+-----+-----+
[ubuntu@workstation (keystone-admin)]:~$
```

- 1.31.** Close the terminal window, and continue to the next task.

2 Creating a Customized Instance with the Horizon Dashboard

In this task, you will create a customized instance with the Horizon Dashboard and log into the instance to verify that the customization took effect.

- 2.1. Open the web browser and navigate to **192.168.1.20**. Log into the dashboard as **admin** with the password **secret**.
- 2.2. Make sure the **demo** project is selected. Navigate to **Project > Compute > Instances**, and click **Launch Instance**.

Instance Name	Image Name	IP Address	Flavor	Key Pair	Status	Availability Zone	Task	Power State	Age	Actions
No items to display.										

- 2.3. In the *Details* tab, enter **instance1** in the *Instance Name* field and click **Next**.

Please provide the initial hostname for the instance, the availability zone where it will be deployed, and the instance count. Increase the Count to create multiple instances with the same settings.

Project Name: demo

Instance Name: **instance1**

Description: (empty)

Availability Zone: nova

Count: 1

Total Instances (10 Max): 10% (0 Current Usage, 1 Added, 9 Remaining)

Next >

- 2.4.** In the *Source* tab, make sure **Image** is selected in the *Select Boot Source* dropdown and click **No** under *Create New Volume*. Select the **ubuntu** image by clicking the **↑** symbol in the same row. Click **Next**.

Launch Instance

Details

Source *

Flavor *

Networks *

Network Ports

Security Groups

Key Pair

Configuration

Server Groups

Scheduler Hints

Metadata

Allocated

Displaying 0 items

Select Boot Source

Image

Create New Volume

Yes No

Available 2

Select one

Click here for filters or full text search.

Name	Updated	Size	Format	Visibility	
cirros-0.6.2-x86_64-disk	11/8/23 9:23 PM	20.44 MB	QCOW2	Public	↑
ubuntu	11/8/23 10:23 PM	642.75 MB	QCOW2	Public	↑

Displaying 2 items

Cancel Back Next Launch Instance

Stop

Before proceeding to the next step, confirm that **ubuntu** appears underneath the *Allocated* section.

2.5. In the *Flavor* tab, click the ↑ symbol in the same row as **m1.small**. Click **Next**.

Launch Instance

Details

Allocated

Source

Flavor *

Networks *

Network Ports

Security Groups

Key Pair

Configuration

Server Groups

Scheduler Hints

Metadata

Name	VCPUS	RAM	Total Disk	Root Disk	Ephemeral Disk	Public	
▶ m1.nano	1	128 MB	1 GB	1 GB	0 GB	Yes	↑
▶ m1.micro	1	192 MB	1 GB	1 GB	0 GB	Yes	↑
▶ cirros256	1	256 MB	1 GB	1 GB	0 GB	Yes	↑
▶ m1.tiny	1	512 MB	1 GB	1 GB	0 GB	Yes	↑
▶ ds512M	1	512 MB	5 GB	5 GB	0 GB	Yes	↑
▶ ds1G	1	1 GB	10 GB	10 GB	0 GB	Yes	↑
▶ m1.small	1	2 GB	20 GB	20 GB	0 GB	Yes	↑
▶ ds2G	2	2 GB	10 GB	10 GB	0 GB	Yes	↑
▶ m1.medium	2	4 GB	40 GB	40 GB	0 GB	Yes	↑
▶ ds4G	4	4 GB	20 GB	20 GB	0 GB	Yes	↑
▶ m1.large	4	8 GB	80 GB	80 GB	0 GB	Yes	↑
▶ m1.xlarge	8	16 GB	160 GB	160 GB	0 GB	Yes	↑

Displaying 12 items

< Back **Next >** Launch Instance

Stop

Before proceeding to the next step, confirm that **m1.small** appears underneath the *Allocated* section.

2.6. In the *Networks* tab, click the ↑ symbol in the same row as **shared**. Click **Next**.

Launch Instance

Details Networks provide the communication channels for instances in the cloud. You can select ports instead of networks or a mix of both. [?](#)

Source **Allocated** Displaying 0 items

Flavor

Networks * [?](#)

Network	Subnets Associated	Shared	Admin State	Status
Select one or more networks from the available networks below.				

Network Ports Displaying 0 items

Security Groups **Available** [?](#) Select one or more

Key Pair Click here for filters or full text search. [X](#)

Configuration Displaying 3 items

Server Groups

Network	Subnets Associated	Shared	Admin State	Status
shared	shared-subnet	Yes	Up	Active ↑
extern-net	extern-subnet	Yes	Up	Active ↑
private	ipv6-private-subnet private-subnet	No	Up	Active ↑

Scheduler Hints Displaying 3 items

Metadata

[Cancel](#) [Back](#) [Next >](#) [Launch Instance](#)

Stop

Before proceeding to the next step, confirm that **shared** appears underneath the *Allocated* section.

2.7. In the *Network Ports* tab, click **Next**.

Launch Instance

Details Ports provide extra communication channels to your instances. You can select ports instead of networks or a mix of both.

Source ▼ Allocated Displaying 0 items

Flavor Name IP Admin State Status

Select one or more ports from the available ports below.

Networks Networks Displaying 0 items

Network Ports Security Groups Key Pair Configuration Server Groups Scheduler Hints Metadata

Available 0 Select one or more

Click here for filters or full text search.

Displaying 0 items

Name IP Admin State Status

No items to display.

Displaying 0 items

Cancel < Back Next > Launch Instance

2.8. In the *Security Groups* tab, click the ↓ symbol in the same row as **default**, and click the ↑ symbol in the same row as **dev-secgroup**. Click **Next**.

Launch Instance

Details Select the security groups to launch the instance in.

Source ▼ Allocated 1

Flavor Name Description

Networks > default Default security group

Network Ports Displaying 1 item

Security Groups Available 1 Select one or more

Key Pair Click here for filters or full text search.

Configuration Displaying 1 item

Server Groups Name Description

Scheduler Hints > dev-secgroup dev-secgroup

Metadata Displaying 1 item

Cancel < Back Next > Launch Instance

Stop

Before proceeding to the next step, confirm that only **dev-secgroup** appears underneath the *Allocated* section.

- 2.9.** In the *Key Pair* tab, ensure that the key pair **dev-keypair** has been selected and is underneath the *Allocated* section. Click **Next**.

Launch Instance

Details A key pair allows you to SSH into your newly created instance. You may select an existing key pair, import a key pair, or generate a new key pair. ?

Source [+ Create Key Pair](#) [Import Key Pair](#)

Flavor Allocated
Displaying 1 item

Name	Type	Fingerprint
dev-keypair	ssh	bc:c6:93:d6:a8:71:08:bc:9d:e1:74:6e:e8:8f:b5:2b

Networks Networks Displaying 1 item

Network Ports Security Groups Key Pair Configuration Server Groups Scheduler Hints Metadata

Available 0 Select one

[Click here for filters or full text search.](#)

Available 0 items Name Type Fingerprint

No items to display.

Displaying 0 items

< Back Next > Launch Instance

- 2.10.** In the *Configuration* tab, populate the **Customization Script** field with the content below. Once finished, click **Launch Instance**.

```
#!/bin/bash
echo 'Hello, world!' > /root/hello.txt
```

Launch Instance

[Details](#)

You can customize your instance after it has launched using the options available here. "Customization Script" is analogous to "User Data" in other systems.

[Source](#)

Load Customization Script from a file
 No file selected.

[Flavor](#)

Customization Script (Modified) Content size: 50 bytes of 16.00 KB

```
#!/bin/bash
echo 'Hello, world!' > /root/hello.txt
```

[Networks](#)

[Network Ports](#)

[Security Groups](#)

[Key Pair](#)

Configuration

[Disk Partition](#)

Automatic

Configuration Drive

[Metadata](#)

Tip

A customization script can be used to perform many commands automatically upon instance creation, such as installing packages, configuring a host name, etc. The simple script above is just an example.

- 2.11.** Once the status for **instance1** is **Active**, attach a floating IP address to it. Select **Associate Floating IP** from the dropdown menu next to **Create Snapshot** in the row for the instance.

Project / Compute / Instances

Instances

Instance ID = ▾ Filter Launch Instance Delete Instances More Actions ▾

Displaying 1 item

Instance Name	Image Name	IP Address	Flavor	Key Pair	Status	Availability Zone	Task	Power State	Age	Actions
instance1	ubuntu	192.168.233.7	m1.small	dev-keypair	Active	nova	None	Running	0 minutes	<input style="border: 1px solid #ccc; padding: 2px 10px; margin-right: 5px;" type="button" value="Create Snapshot"/> Associate Floating IP <input type="button" value="Attach Interface"/> <input type="button" value="Detach Interface"/> <input type="button" value="Edit Instance"/>

Displaying 1 item

- 2.12.** Select any one of the IP addresses from the *IP Address* dropdown and select **instance1: 192.168.233.XYZ** as the *Port to be associated*. Click **Associate**.

Manage Floating IP Associations

IP Address *

172.25.250.76 +

Select the IP address you wish to associate with the selected instance or port.

Port to be associated *

instance1: 192.168.233.7

Cancel Associate

- 2.13.** To verify that the customization script worked, first click **instance1** under the *Instance Name* column, then navigate to the *Console* tab if you are not directed there automatically. Click the **Click here to show only the console** link. Log into the instance as **root** with the password **secret**.

```
Connected to QEMU (instance-00000009)

Ubuntu 22.04.3 LTS instance1 tty1

instance1 login: root
Password:
Welcome to Ubuntu 22.04.3 LTS (GNU/Linux 5.15.0-87-generic x86_64)

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

 System information as of Thu Nov 30 17:42:55 UTC 2023

 System load: 0.0927734375 Processes: 81
 Usage of /: 15.0% of 9.51GB Users logged in: 0
 Memory usage: 17% IPv4 address for ens3: 192.168.233.250
 Swap usage: 0%

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
Failed to connect to https://changelogs.ubuntu.com/meta-release-its. Check your Internet connection or proxy settings

Last login: Wed Nov 29 22:05:32 UTC 2023 on tty1
root@instance1:~#
```

Note

Be patient for the login prompt. Even if OpenStack reports the instance to be active, it may still take several minutes to fully launch and present the login prompt.

- 2.14.** Check **/var/log/cloud-init.log** to confirm that **cloud-init** ran. Use the **tail** command to print the last 10 lines of the log.

```
root@instance1:~# sudo tail /var/log/cloud-init.log
```

```
Connected to QEMU (instance-00000009)

root@instance1:~# sudo tail /var/log/cloud-init.log
sudo: unable to resolve host instance1: Temporary failure in name resolution
2023-11-30 17:32:30,843 - util.py[DEBUG]: Writing to /var/lib/cloud/instance/boot-finished - wb: [644] 70 bytes
2023-11-30 17:32:30,852 - handlers.py[DEBUG]: finish: modules-final/config-final_message: SUCCESS: config-final_message ran successfully
2023-11-30 17:32:30,853 - main.py[DEBUG]: Ran 11 modules with 0 failures
2023-11-30 17:32:30,860 - atomic_helper.py[DEBUG]: Atomically writing to file /var/lib/cloud/data/status.json (via temporary file /var/lib/cloud/data/tmpppufi16z_) - w: [644] 590 bytes/chars
2023-11-30 17:32:30,867 - atomic_helper.py[DEBUG]: Atomically writing to file /var/lib/cloud/data/result.json (via temporary file /var/lib/cloud/data/tmpwymnsadmy) - w: [644] 87 bytes/chars
2023-11-30 17:32:30,870 - util.py[DEBUG]: Creating symbolic link from '/run/cloud-init/result.json' => '../../../../../var/lib/cloud/data/result.json'
2023-11-30 17:32:30,872 - util.py[DEBUG]: Reading from /proc/uptime (quiet=False)
2023-11-30 17:32:30,875 - util.py[DEBUG]: Read 12 bytes from /proc/uptime
2023-11-30 17:32:30,877 - util.py[DEBUG]: cloud-init mode 'modules' took 3.172 seconds (3.17)
2023-11-30 17:32:30,878 - handlers.py[DEBUG]: finish: modules-final: SUCCESS: running modules for final
root@instance1:~# _
```

- 2.15.** Ensure that the `/root/hello.txt` file exists and has the correct content.

```
root@instance1:~# cat /root/hello.txt
```

```
Connected to QEMU (Instance-0000000b)

root@instance1:~# cat /root/hello.txt
Hello, world!
root@instance1:~# _
```

- 2.16.** Close the tab with the terminal window and navigate back to **Project > Compute > Instances** if you are not already on that page. We are finished with this instance and will create another one in the next section. Select the checkbox next to **instance1** and click **Delete Instances**.

Instance Name	Image Name	IP Address	Flavor	Key Pair	Status	Availability Zone	Task	Power State	Age	Actions
<input checked="" type="checkbox"/> instance1	ubuntu	192.168.233.7, 172.25.250.76	m1.small	dev-keypair	Active	nova	None	Running	8 minutes	<button>Create Snapshot</button>

- 2.17.** Log out of the *Horizon Dashboard* and close the web browser.

- 2.18.** Continue to the next task.

3 Creating a Customized Instance with the OpenStack Unified CLI

In this task, you will verify that **cloud-init** has correctly customized the two instances created in the previous section.

- If a terminal window is not already open, open one and source the admin credentials from the `~/keystonerc-admin` file.

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

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

- Another instance will be created and customized with the *OpenStack Unified CLI*. First, create a **user-data** script that will be attached to the instance at creation. Create a script called `~/hello` that matches the content shown below. When the instance runs this script, it will create the file `/root/hello.txt` with the contents **Hello, world!**, and it will append the line **127.0.1.1 instance2** to the `/etc/hosts` file. This simply suppresses a warning when issuing a command with root privileges (i.e., `sudo ...`). Press **CTRL+X**, then **Y** to accept the file changes. Press **Enter** to confirm and exit back to the terminal.

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

```
#!/bin/bash
echo 'Hello, world!' > /root/hello.txt
echo '127.0.1.1 instance2' >> /etc/hosts
```

```
GNU nano 2.9.3                               hello                                Modified
#!/bin/bash
echo 'Hello, world!' > /root/hello.txt
echo '127.0.1.1 instance2' >> /etc/hosts
█

^G Get Help  ^O Write Out  ^W Where Is  ^K Cut Text  ^J Justify  ^C Cur Pos
^X Exit      ^R Read File  ^\ Replace   ^U Uncut Text ^T To Spell  ^  Go To Line
```

- 3.3. Launch an instance with the **user-data** option with the previously created script to perform the customization. Use the **ubuntu** image, the **m1.small** flavor, the **shared** network, the **dev-secgroup** security group, and the **dev-keypair** key pair.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack server create \
> --image ubuntu \
> --flavor m1.small \
> --network shared \
> --security-group dev-secgroup \
> --key-name dev-keypair \
> --user-data ~/hello \
> instance2
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack server create \
> --image ubuntu \
> --flavor m1.small \
> --network shared \
> --security-group dev-secgroup \
> --key-name dev-keypair \
> --user-data ~/hello \
> instance2
+-----+-----+
| Field | Value |
+-----+-----+
| OS-DCF:diskConfig | MANUAL |
| OS-EXT-AZ:availability_zone | None |
| OS-EXT-SRV-ATTR:host | None |
| OS-EXT-SRV-ATTR:hypervisor_hostname | None |
| OS-EXT-SRV-ATTR:instance_name | instance2 |
| 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 | kjQayg4tCXV6 |
| config_drive | |
| created | 2025-07-07T16:26:06Z |
| flavor | m1.small (2) |
| hostId | |
| id | ccd1fecd-537a-43ad-8a9e-592ec33078e6 |
| image | ubuntu (329d361e-f6dc-4b72-b200-3de0ec230e65) |
| key_name | dev-keypair |
| name | instance2 |
| progress | 0 |
| project_id | 39e851b14f864573aad60582c35e40dc |
| properties | |
| security_groups | name='381cc27c-6434-42d2-b10c-78c228a4c976' |
| status | BUILD |
| updated | 2025-07-07T16:26:05Z |
| user_id | 14f5376f00c04e90b7103dd8d4263040 |
| volumes_attached | |
+-----+-----+
[ubuntu@workstation (keystone-admin)]:~$
```

3.4. Verify that the status of the **instance2** instance is **ACTIVE**.

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

```
[ubuntu@workstation (keystone-admin)]:~$ openstack server list
+-----+-----+-----+-----+-----+
| ID      | Name    | Status | Networks      | Image   | Flavor  |
+-----+-----+-----+-----+-----+
| 352cc7e5-8e0a-4bc7-946e-aac5da0bb683 | instance2 | ACTIVE | shared=192.168.233.16 | ubuntu | m1.small |
+-----+-----+-----+-----+-----+
[ubuntu@workstation (keystone-admin)]:~$
```

3.5. List the floating IPs to see the free address, which was disassociated from the previous instance when the instance was deleted.

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

```
[ubuntu@workstation (keystone-admin)]:~$ openstack floating ip list
+-----+-----+-----+-----+-----+
| ID      | Floating IP Address | Fixed IP Address | Port | Floating Network | Project  |
+-----+-----+-----+-----+-----+
| 9c8804cd-23 | 172.25.250.76 | None           | None | 8f37949a-cf0a- | 39e851b14f864 |
| 18-405b-ac4 |                   |                 |       | 4df1-86fd-     | 573aad60582c3 |
| 5-fc89e0b7a |                   |                 |       | 8581a36a573a  | 5e40dc   |
| 509        |                   |                 |       |               |          |
+-----+-----+-----+-----+-----+
[ubuntu@workstation (keystone-admin)]:~$
```

3.6. Assign the floating IP to **instance2**.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack server add floating ip \
instance2 172.25.250.76
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack server add floating ip \
> instance2 172.25.250.76
[ubuntu@workstation (keystone-admin)]:~$
```

3.7. Verify that the instance was assigned the floating IP address.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack server list \
> -c Name \
> -c Networks
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack server list \
> -c Name \
> -c Networks
+-----+-----+
| Name      | Networks          |
+-----+-----+
| instance2 | shared=192.168.233.16, 172.25.250.76 |
+-----+-----+
[ubuntu@workstation (keystone-admin)]:~$
```

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

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

```
[ubuntu@workstation (keystone-admin)]:~$ scp ~/Downloads/dev-keypair.pem \
> 192.168.1.20:~/dev-keypair.pem
ubuntu@192.168.1.20's password:
dev-keypair.pem                                100% 1676      2.6MB/s   00:00
[ubuntu@workstation (keystone-admin)]:~$ █
```

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

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

```
[ubuntu@workstation (keystone-admin)]:~$ ssh 192.168.1.20
ubuntu@192.168.1.20's password:
Welcome to Ubuntu 22.04.3 LTS (GNU/Linux 5.15.0-94-generic x86_64)

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

This system has been minimized by removing packages and content that are
not required on a system that users do not log into.

To restore this content, you can run the 'unminimize' command.
Failed to connect to https://changelogs.ubuntu.com/meta-release-lts. Check your
Internet connection or proxy settings

Last login: Fri Feb  9 22:37:16 2024
ubuntu@devstack:~$ █
```

3.10. SSH into **instance2** with the **dev-keypair** private key.

```
ubuntu@devstack:~$ ssh -i ~/dev-keypair.pem 172.25.250.76
```

```
ubuntu@devstack:~$ ssh -i ~/dev-keypair.pem 172.25.250.76
The authenticity of host '172.25.250.76 (172.25.250.76)' can't be established.
ED25519 key fingerprint is SHA256:rl4Akqw7dM+Hv79JX5xvY2Nj3pxV9eR4ZIYZRT1ZPww.
This key is not known by any other names
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '172.25.250.76' (ED25519) to the list of known hosts.
Welcome to Ubuntu 22.04.3 LTS (GNU/Linux 5.15.0-92-generic x86_64)

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

 System information as of Thu Jun 20 14:46:06 UTC 2024

 System load:  0.5302734375      Processes:          85
 Usage of /:   7.4% of 19.20GB   Users logged in:    0
 Memory usage: 8%                  IPv4 address for ens3: 192.168.233.16
 Swap usage:   0%

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.

To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

ubuntu@instance2:~$
```

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.

- 3.11. Check **/var/log/cloud-init.log** to confirm that the **cloud-init** script ran.

```
ubuntu@instance2:~$ sudo tail /var/log/cloud-init.log
```

```
ubuntu@instance2:~$ sudo tail /var/log/cloud-init.log
2025-07-07 16:33:07,291 - util.py[DEBUG]: Writing to /var/lib/cloud/instance/boot-finished - wb: [644] 70 bytes
2025-07-07 16:33:07,302 - handlers.py[DEBUG]: finish: modules-final/config-final_message: SUCCESS: config-final_message ran successfully
2025-07-07 16:33:07,304 - main.py[DEBUG]: Ran 11 modules with 0 failures
2025-07-07 16:33:07,310 - atomic_helper.py[DEBUG]: Atomically writing to file /var/lib/cloud/data/status.json (via temporary file /var/lib/cloud/data/tmpjqk3qwy6) - w: [644] 592 bytes/chars
2025-07-07 16:33:07,316 - atomic_helper.py[DEBUG]: Atomically writing to file /var/lib/cloud/data/result.json (via temporary file /var/lib/cloud/data/tmptn_pm9_k) - w: [644] 87 bytes/chars
2025-07-07 16:33:07,319 - util.py[DEBUG]: Creating symbolic link from '/run/cloud-init/result.json' => '../..../var/lib/cloud/data/result.json'
2025-07-07 16:33:07,321 - util.py[DEBUG]: Reading from /proc/uptime (quiet=False)
2025-07-07 16:33:07,323 - util.py[DEBUG]: Read 13 bytes from /proc/uptime
2025-07-07 16:33:07,325 - util.py[DEBUG]: cloud-init mode 'modules' took 4.088 seconds (4.09)
2025-07-07 16:33:07,326 - handlers.py[DEBUG]: finish: modules-final: SUCCESS: running modules for final
ubuntu@instance2:~$ █
```

- 3.12. View the **/etc/hosts** file to ensure that the hostname was appended correctly.

```
ubuntu@instance2:~$ cat /etc/hosts
```

```
ubuntu@instance2:~$ 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 instance2
ubuntu@instance2:~$ █
```

- 3.13. Ensure that the **/root/hello.txt** file exists and has the correct content.

```
ubuntu@instance2:~$ sudo cat /root/hello.txt
```

```
ubuntu@instance2:~$ sudo cat /root/hello.txt
Hello, world!
ubuntu@instance2:~$ █
```

3.14. The lab is now complete.