



**OpenStack Labs**

## **Lab 02: Organizing People and Resources**

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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).
- The development of this document was supported by a National Centers of Academic Excellence in Cybersecurity Grant (#H98230-20-1-0351), housed at the National Security Agency.
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## Introduction

In this lab, you will manage projects, users, and roles.

## Objectives

- Create and delete projects using the *Horizon Dashboard*.
- Create and delete projects using the *OpenStack Unified CLI*.
- Manage users using the *Horizon Dashboard*

## 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 Create and Delete Projects Using the Horizon Dashboard

In this task, you will create and delete projects using the *Horizon Dashboard*.

- 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

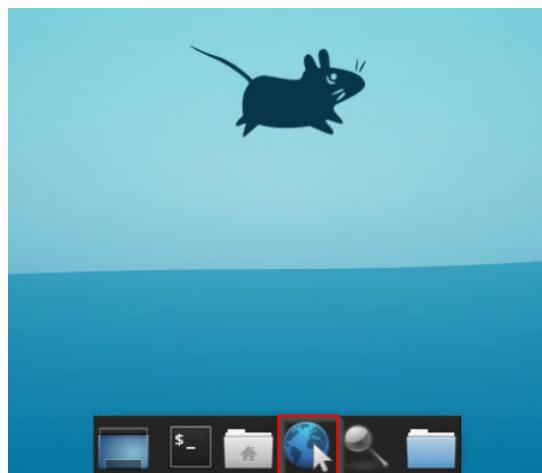
 Expanded Security Maintenance for Infrastructure is not enabled.

 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 the web browser.



- 1.4.** Enter the IP address of the **devstack** machine (**192.168.1.20**) into the address bar, and log into the OpenStack Horizon Dashboard. The username is **admin** and the password is **secret**.

The screenshot shows the OpenStack Horizon Dashboard login interface. At the top center is the OpenStack logo, which consists of a red square with four white horizontal bars inside. Below the logo, the word "openstack." is written in a large, dark gray sans-serif font. Underneath this, the word "LOG IN" is displayed in a smaller, dark gray font. The main form area begins with a "User Name" label and a text input field containing "admin". Below that is a "Password" label and a text input field containing ".....". To the right of the password field is a small eye icon with a "view" symbol. At the bottom right of the form is a blue "Sign In" button.

- 1.5.** Create a project named **dev**. First, navigate to **Identity > Projects**, then click on **Create Project**.

The screenshot shows the OpenStack Horizon interface under the 'Identity' section. The 'Projects' tab is selected. At the bottom right of the table, there is a red box around the '+ Create Project' button.

Name	Description	Project ID	Domain Name	Enabled	Actions
admin	Bootstrap project for initializing the cloud.	6328a8abcf994977b8c01140884a130c	Default	Yes	<input type="button" value="Manage Members"/>
service		64f81ae8ba4443aabec0228cd571fc	Default	Yes	<input type="button" value="Manage Members"/>
demo		a077ab0519ac4a588dfcb7d7c31085	Default	Yes	<input type="button" value="Manage Members"/>
invisible_to_admin		c1f778ac7718494ab7945e638662ac26	Default	Yes	<input type="button" value="Manage Members"/>
alt_demo		f50dc27796f649e3b383625da5c37d37	Default	Yes	<input type="button" value="Manage Members"/>

- 1.6.** Enter **dev** in the *Name* field and **Dev Project** in the *Description* field. Leave the **Enabled** check box selected, then click on **Create Project**.

### Create Project

Project Information \*  Project Members  Project Groups

Domain ID	default
Domain Name	Default
Name *	dev
Description	Dev Project
Enabled	<input checked="" type="checkbox"/>

#### Note

Notice the **dev** project now appears in the *Horizon Dashboard*.

- 1.7.** Suppose that the **alt\_demo** project is no longer needed and can be deleted. To delete this project, click the checkbox in the same row as **alt\_demo**, then click **Delete Projects**.

Name	Description	Project ID	Domain Name	Enabled	Actions
demo		39e851b14f864573aad60582c35e40dc	Default	Yes	<button>Manage Members</button>
<input checked="" type="checkbox"/> alt_demo		3d65ee93169c4e4fc87a7398e2e	Default	Yes	<button>Manage Members</button>
dev	Dev Project	710f8a9f6ded43189d6655e16cae77bc	Default	Yes	<button>Manage Members</button>
service		b66a24ad2cc49b79ca1e0c07b3b3258	Default	Yes	<button>Manage Members</button>
invisible_to_admin		bb23f57aff584133a0657ee0fc7fd3f	Default	Yes	<button>Manage Members</button>
admin	Bootstrap project for initializing the cloud.	eb2dc08d8ae46ffac3f16c3973ef61d	Default	Yes	<button>Manage Members</button>

### Tip

The above method allows selecting and deleting multiple projects at once. A single project can also be deleted by clicking the dropdown in the same row as the project in the **Actions** column and clicking **Delete Project**.

- 1.8. In the **Confirm Delete Projects** popup box, click **Delete Projects**.

### Confirm Delete Projects

You have selected: "alt\_demo". Please confirm your selection. This action cannot be undone.

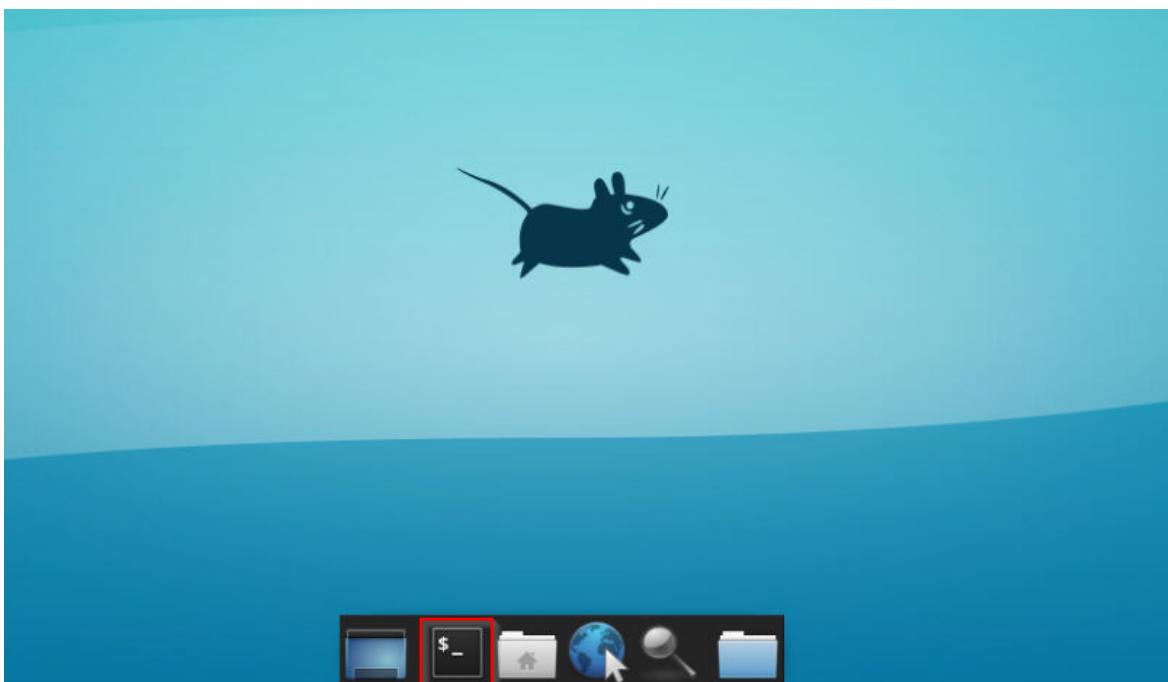
- 1.9. Log out of the Horizon Dashboard by clicking on admin at the top right and selecting **Sign Out**.

- 1.10. Close the web browser and continue to the next task.

## 2 Create and Delete Projects Using the OpenStack Unified CLI

In this task, you will use the *OpenStack Unified CLI* to create and delete a project from the command line.

- 2.1. Open a terminal, either by right-clicking the desktop and selecting **Open Terminal Here**, by clicking the terminal icon in the icon bar at the bottom of the screen, or by selecting **Applications** at the top left of the screen, then selecting **Terminal Emulator**.



- 2.2. Use the **source** command with the **keystonerc-admin** argument to access OpenStack as the admin.

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

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

- 2.3. List the existing OpenStack projects.

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

```
[ubuntu@workstation (keystone-admin)]:~$ openstack project list
+-----+-----+
| ID      | Name   |
+-----+-----+
| 39e851b14f864573aad60582c35e40dc | demo   |
| 710f8a9f6ded43189d6655e16cae77bc | dev    |
| b66a24ad2cc49b79cale0c07b3b3258 | service |
| bb23f57aff584133a0657ee0fc7ffd3f | invisible_to_admin |
| eb2dcd08d8ae46ffac3f16c3973ef61d | admin   |
+-----+-----+
[ubuntu@workstation (keystone-admin)]:~$ █
```

#### 2.4. Create a project named **testing**.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack project create \
> --description testing \
> --enable testing
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack project create \
> --description testing \
> --enable testing
+-----+-----+
| Field      | Value   |
+-----+-----+
| description | testing |
| domain_id  | default |
| enabled     | True    |
| id          | 012e3f171c4a47be8019a612656a2df9 |
| is_domain   | False   |
| name        | testing |
| options     | {}      |
| parent_id   | default |
| tags        | []     |
+-----+-----+
[ubuntu@workstation (keystone-admin)]:~$ █
```

#### Tip

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

#### 2.5. Verify the project has been created.

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

```
[ubuntu@workstation (keystone-admin)]:~$ openstack project list
+-----+-----+
| ID      | Name   |
+-----+-----+
| 012e3f171c4a47be8019a612656a2df9 | testing
| 39e851b14f864573aad60582c35e40dc | demo
| 710f8a9f6ded43189d6655e16cae77bc | dev
| b66a24ad2cccd49b79cale0c07b3b3258 | service
| bb23f57aff584133a0657ee0fc7ffd3f | invisible_to_admin
| eb2dcd08d8ae46ffac3f16c3973ef61d | admin
+-----+-----+
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 2.6. The **dev** project from the previous step will be used throughout the remainder of the lab. The **testing** project was only created for demonstration and can be safely deleted. Delete the **testing** project.

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

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

- 2.7. Verify the **testing** project has been deleted by listing the projects again and noting that **testing** no longer appears.

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

```
[ubuntu@workstation (keystone-admin)]:~$ openstack project list
+-----+-----+
| ID      | Name   |
+-----+-----+
| 39e851b14f864573aad60582c35e40dc | demo
| 710f8a9f6ded43189d6655e16cae77bc | dev
| b66a24ad2cccd49b79cale0c07b3b3258 | service
| bb23f57aff584133a0657ee0fc7ffd3f | invisible_to_admin
| eb2dcd08d8ae46ffac3f16c3973ef61d | admin
+-----+-----+
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 2.8. Leave the terminal window open and continue to the next task.

### 3 Managing Users Using the Horizon Dashboard

In this task, you will use the *Horizon Dashboard* to manage users.

- 3.1. Open the web browser, navigate to the OpenStack login page at <http://192.168.1.20>, and log in with username **admin** and password **secret** as before. In the following steps, you will create users named **cloud-dev**, **cloud-test1**, and **cloud-test2**; set all of these account passwords to **secret**; and add these accounts to the **dev** project.
- 3.2. First, navigate to **Identity > Users** and click on **Create User**.

User Name	Description	Email	User ID	Enabled	Domain Name	Actions
admin	-		14f5376f00c04e90b7103dd8d4263040	Yes	Default	<button>Edit</button>
demo	-	demo@example.com	603b42080bb549d7ad3217eb456e7a55	Yes	Default	<button>Edit</button>

- 3.3. In the *Create User* dialog box, enter **cloud-dev** in the *User Name* field, and **secret** in the *Password* and *Confirm Password* fields.

## Create User

**Domain ID**

default

**Domain Name**

Default

**User Name \***

cloud-dev

**Description:**

Create a new user and set related properties including the Primary Project and Role.

**Description****Email****Password \*** **Confirm Password \*** **Tip**

You may need to use the scroll bar on the right side of the dialog box to see the rest of the fields.

- 3.4.** After scrolling down if necessary, select the **dev** project from the *Primary Project* drop down. Leave the *Role* set to **member**, and leave the **Enabled** check box selected. Click on **Create User**.

Primary Project

Role

Enabled

Lock password

**3.5.** Repeat steps 2 through 4 to create the **cloud-test1** and **cloud-test2** user accounts.

**3.6.** Delete the **cloud-test1** user account. On the *Users* tab, select the **cloud-test1** user account checkbox and click on **Delete Users** and then confirm the deletion in the popup box that follows.

User Name	Description	Email	User ID	Enabled	Domain Name	Actions
admin	-		d20b6567672412b891563feeb6b2d	Yes	Default	<input type="button" value="Edit"/>
demo	-	demo@example.com	b227be89207469389f4db402850fb	Yes	Default	<input type="button" value="Edit"/>
demo_reader	-	demo_reader@example.com	630755a2181043d9b319a11c1c06b8073	Yes	Default	<input type="button" value="Edit"/>
alt_demo	-	alt_demo@example.com	8849a02a203043100010000cd79a603	Yes	Default	<input type="button" value="Edit"/>
alt_demo_member	-	alt_demo_member@example.com	faa47953aa5942688895871e9938ac57	Yes	Default	<input type="button" value="Edit"/>
alt_demo_reader	-	alt_demo_reader@example.com	83026a36010948fb12464020264a537	Yes	Default	<input type="button" value="Edit"/>
system_member	-	system_member@example.com	90a437a73289447d882205049a8d3d	Yes	Default	<input type="button" value="Edit"/>
system_reader	-	system_reader@example.com	7d305ca820a0400b8f79e017b2548	Yes	Default	<input type="button" value="Edit"/>
nova	-		f1acd1f11d94aa8a9d54eeb598f3696	Yes	Default	<input type="button" value="Edit"/>
glance	-		5b044ec057e949995967e95055225	Yes	Default	<input type="button" value="Edit"/>
cinder	-		0e377dea2a0e44803b0cd8a49143d7ee	Yes	Default	<input type="button" value="Edit"/>
neutron	-		4396031965f420509522978842058	Yes	Default	<input type="button" value="Edit"/>
placement	-		c07a5174209abaa85c5a5b7449d12b	Yes	Default	<input type="button" value="Edit"/>
cloud-dev	-		a7388c19f17457265191fa3b7af872	Yes	Default	<input type="button" value="Edit"/>
<input checked="" type="checkbox"/> cloud-test1	-		20da499ce4244235b77071c0bd5d30	Yes	Default	<input type="button" value="Delete User"/>

**3.7.** Disable the **cloud-test2** user account. On the *Users* tab, select **Disable User** under the *Actions* column for the **cloud-test2** user account entry.

## Users

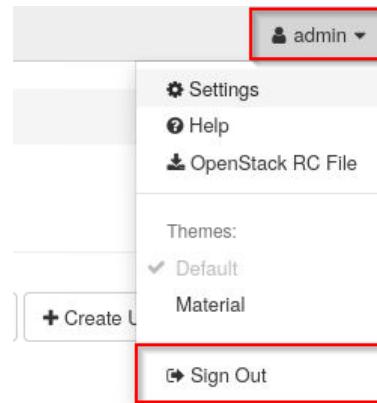
Displaying 15 items

User Name	Description	Email	User ID	Enabled	Domain Name	Actions
admin	-	demo@example.com	d200615676724f12b91563fe0b2d	Yes	Default	<a href="#">Edit</a>
demo	-	demo_read@example.com	b227ae892074a939094045ba40285cfb	Yes	Default	<a href="#">Edit</a>
demo_reader	-	demo_reader@example.com	636759218104208019a1c1c068b73	Yes	Default	<a href="#">Edit</a>
alt_demo	-	alt_demo@example.com	8849522a8304831a0001693c7f9a503	Yes	Default	<a href="#">Edit</a>
alt_demo_member	-	alt_demo_member@example.com	faa47953aa5428a8885871a8938ac57	Yes	Default	<a href="#">Edit</a>
alt_demo_reader	-	alt_demo_reader@example.com	839264369494851246402026457	Yes	Default	<a href="#">Edit</a>
system_member	-	system_member@example.com	90a437a73289427db8226504ca8b3	Yes	Default	<a href="#">Edit</a>
system_reader	-	system_reader@example.com	7d305ca20a4020e97f9e917c2b88	Yes	Default	<a href="#">Edit</a>
nova	-		f1acd1011d94a7e9a546e5b598f3f996	Yes	Default	<a href="#">Edit</a>
glance	-		586cd6cc07949999b67e95b05225	Yes	Default	<a href="#">Edit</a>
cinder	-		0e777de250e403bc0cc845914507ee	Yes	Default	<a href="#">Edit</a>
neutron	-		4366001a6f9420890229178a4265a8	Yes	Default	<a href="#">Edit</a>
placement	-		c07a5470429b40aa05fc5d744bd12b	Yes	Default	<a href="#">Edit</a>
cloud-dev	-		a7386c191f7457205191fa3b7a9f2	Yes	Default	<a href="#">Edit</a>
cloud-test2	-		85c98701468b4a1918596da78450a2	Yes	Default	<a href="#">Edit</a>

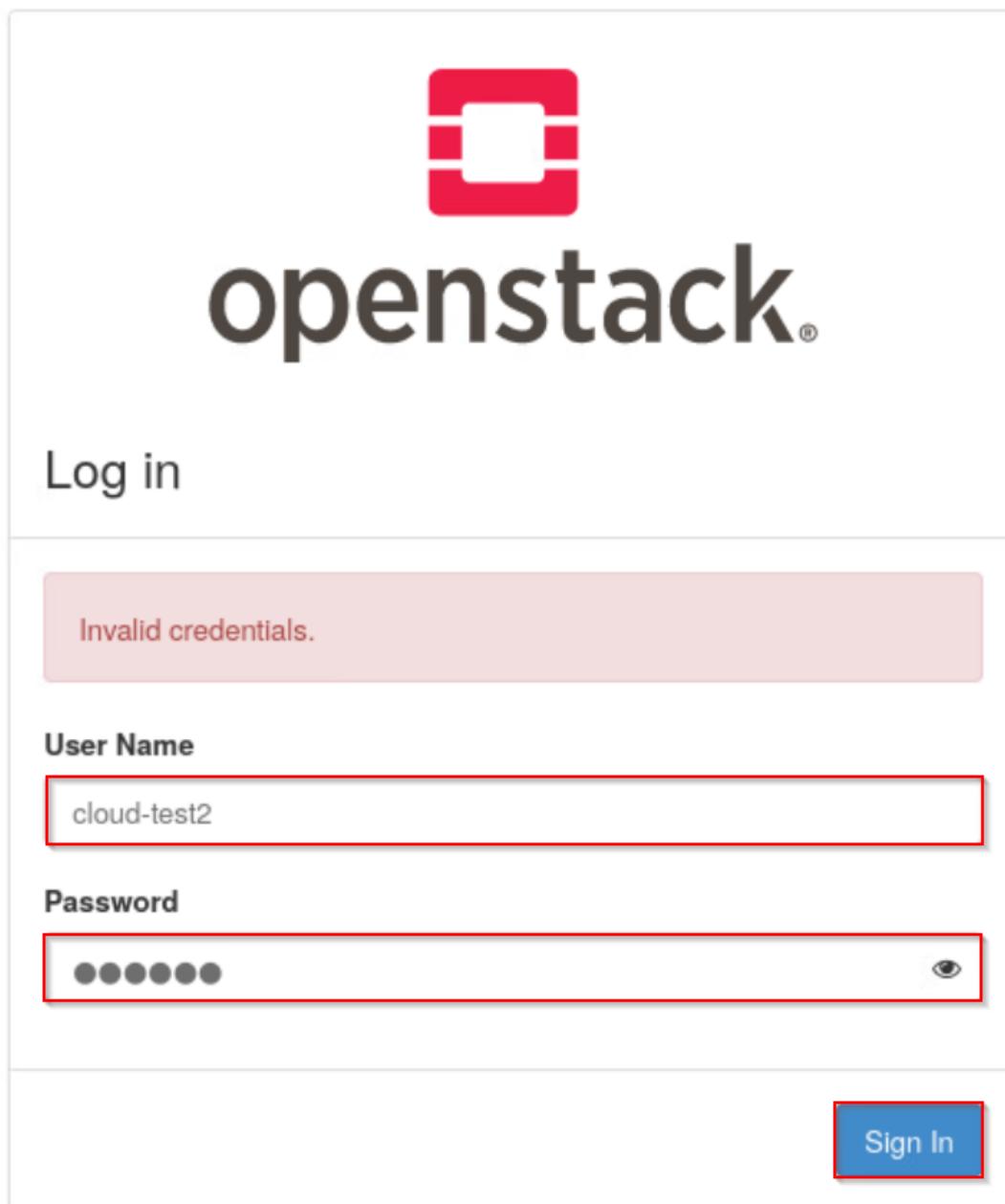
Displaying 15 items

[Change Password](#) | 
[Disable User](#) | 
[Delete User](#)

- 3.8.** Log out of the dashboard as **admin**. Select the **admin** dropdown at the top right and click on **Sign Out**.



- 3.9.** At the Horizon Dashboard screen, attempt to log in as **cloud-test2** with the password **secret**.

**Note**

Notice the user account is disabled as intended.

- 3.10.** Log back into the dashboard as **admin** using the password **secret** and re-enable the **cloud-test2** user. Navigate to **Identity > Users**. Click on the dropdown in the *Actions* column in the row for **cloud-test2** and select **Enable User**.

## Users

User Name	Description	Email	User ID	Enabled	Domain Name	Actions
admin	-	demo@example.com	d20fb6567672412b891563fe6b2fd	Yes	Default	<input type="button" value="Edit"/>
demo	-	demo_reader@example.com	b227ae892074493890448ba40285cfb	Yes	Default	<input type="button" value="Edit"/>
demo_reader	-	demo_reader@example.com	63675a211043b03019a11c19d8673	Yes	Default	<input type="button" value="Edit"/>
alt_demo	-	alt_demo@example.com	88449c32a304831a0001039d79a503	Yes	Default	<input type="button" value="Edit"/>
alt_demo_member	-	alt_demo_member@example.com	faa47983ea5d4268885871e8938a57	Yes	Default	<input type="button" value="Edit"/>
alt_demo_reader	-	alt_demo_reader@example.com	83926a369948b1246b029e6437	Yes	Default	<input type="button" value="Edit"/>
system_member	-	system_member@example.com	90a437e73289a47d8822050498fb3	Yes	Default	<input type="button" value="Edit"/>
system_reader	-	system_reader@example.com	7d305ca820a4009bf79e2e17b2b88	Yes	Default	<input type="button" value="Edit"/>
nova	-		f1cc0f1611df94a9a95c5ab7e9b3695	Yes	Default	<input type="button" value="Edit"/>
glance	-		58c04ec0b7e48999b6795b65225	Yes	Default	<input type="button" value="Edit"/>
cinder	-		0e3771ea20a4009b03cc0854914307ee	Yes	Default	<input type="button" value="Edit"/>
neutron	-		4366031a68f4269322917884268	Yes	Default	<input type="button" value="Edit"/>
placement	-		c07a547e429b4aa8a95c5ab744db612b	Yes	Default	<input type="button" value="Edit"/>
cloud-dev	-		e7386c191174572b5191aa3b7a972	Yes	Default	<input type="button" value="Edit"/>
cloud-test2	-		85c9870146864c4198569a7a8509e2	No	Default	<input type="button" value="Edit"/> <input type="button" value="Change Password"/> <input type="button" value="Disable User"/> <input type="button" value="Delete User"/>

### 3.11. Select the same dropdown, but this time click on **Change Password**.

User Name	Description	Email	User ID	Enabled	Domain Name	Actions
admin	-	demo@example.com	d20fb6567672412b891563fe6b2fd	Yes	Default	<input type="button" value="Edit"/>
demo	-	demo_reader@example.com	b227ae892074493890448ba40285cfb	Yes	Default	<input type="button" value="Edit"/>
demo_reader	-	demo_reader@example.com	63675a211043b03019a11c19d8673	Yes	Default	<input type="button" value="Edit"/>
alt_demo	-	alt_demo@example.com	88449c32a304831a0001039d79a503	Yes	Default	<input type="button" value="Edit"/>
alt_demo_member	-	alt_demo_member@example.com	faa47983ea5d4268885871e8938a57	Yes	Default	<input type="button" value="Edit"/>
alt_demo_reader	-	alt_demo_reader@example.com	83926a369948b1246b029e6437	Yes	Default	<input type="button" value="Edit"/>
system_member	-	system_member@example.com	90a437e73289a47d8822050498fb3	Yes	Default	<input type="button" value="Edit"/>
system_reader	-	system_reader@example.com	7d305ca820a4009bf79e2e17b2b88	Yes	Default	<input type="button" value="Edit"/>
nova	-		f1cc0f1611df94a9a95c5ab7e9b3695	Yes	Default	<input type="button" value="Edit"/>
glance	-		58c04ec0b7e48999b6795b65225	Yes	Default	<input type="button" value="Edit"/>
cinder	-		0e3771ea20a4009b03cc0854914307ee	Yes	Default	<input type="button" value="Edit"/>
neutron	-		4366031a68f4269322917884268	Yes	Default	<input type="button" value="Edit"/>
placement	-		c07a547e429b4aa8a95c5ab744db612b	Yes	Default	<input type="button" value="Edit"/>
cloud-dev	-		e7386c191174572b5191aa3b7a972	Yes	Default	<input type="button" value="Edit"/>
cloud-test2	-		85c9870146864c4198569a7a8509e2	Yes	Default	<input type="button" value="Edit"/> <input type="button" value="Change Password"/> <input type="button" value="Disable User"/> <input type="button" value="Delete User"/>

### 3.12. Change the password for **cloud-test2** to **password**. Enter **password** into the **Password** and **Confirm Password** fields, then click on **Save**.

## Change Password



Password \*

Confirm Password \*

User Name

## Description:

Change user's password. We highly recommend you create a strong one.

Cancel

Save

**3.13.** Log out of the dashboard and log back in as **cloud-test2** with the password **password** to verify the password has been changed.

**3.14.** Log out of the dashboard and close the web browser. Continue to the next task.

## 4 Managing Users Using the OpenStack Unified CLI

In this task, you will manage users using the *OpenStack Unified CLI*.

- 4.1. Open a terminal if you do not already have one running, and navigate to the home directory.
- 4.2. Source the credential for **admin** using the **keystonerc-admin** file.

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

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

- 4.3. List the existing OpenStack users.

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

ID	Name
14f5376f00c04e90b7103dd8d4263040	admin
603b42080bb549d7ad3217eb456e7a55	demo
a7cee45b0f484fc8980c71e2243d2e1	demo_reader
8d21de784ae2493aa5c8cc73a82be6b3	alt_demo
7e7596f02f1c45afad1fcd09de331781	alt_demo_member
44ffe37cf07948c88958066614ef5d74	alt_demo_reader
899fc9a9b17445b4aac553e4f5f192ec	system_member
604adb2150514649a41eaee6273ceb2a	system_reader
ab546669b1cd44b3aa2305c303363425	nova
82142039d42341718fb126134266ec80	glance
0c5d50f813184b588f3bc0c91250c7d7	cinder
efc593f762a447dba12bf2fe870f1310	neutron
c79e26f993fb45ab939e7d0bbe12c263	placement
192dd28050c0422a8fee1654e0be8a83	cloud-dev
848a0e0496cb401bb0f1e561b7019f9e	cloud-test2

- 4.4. Create the **cloud-test3** user on the **dev** project with a password of **secret**.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack user create \
> --project dev \
> --password secret \
> --enable cloud-test3
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack user create \
> --project dev \
> --password secret \
> --enable cloud-test3
+-----+-----+
| Field | Value |
+-----+-----+
| default_project_id | 710f8a9f6ded43189d6655e16cae77bc |
| domain_id | default |
| enabled | True |
| id | f14a1c4573414b0ea93d3c13cb3ca05d |
| name | cloud-test3 |
| options | {} |
| password_expires_at | None |
+-----+-----+
[ubuntu@workstation (keystone-admin)]:~$ █
```

#### 4.5. Verify the user was created.

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

```
[ubuntu@workstation (keystone-admin)]:~$ openstack user list
+-----+-----+
| ID | Name |
+-----+-----+
| 14f5376f00c04e90b7103dd8d4263040 | admin |
| 603b42080bb549d7ad3217eb456e7a55 | demo |
| a7cee45b0f484fc8980c71e2243d2e1 | demo_reader |
| 8d21de784ae2493aa5c8cc73a82be6b3 | alt_demo |
| 7e7596f02f1c45afad1fc09de331781 | alt_demo_member |
| 44ffe37cf07948c88958066614ef5d74 | alt_demo_reader |
| 899fc9a9b17445b4aac553e4f5f192ec | system_member |
| 604adb2150514649a41eaee6273ceb2a | system_reader |
| ab546669b1cd44b3aa2305c303363425 | nova |
| 82142039d42341718fb126134266ec80 | glance |
| 0c5d50f813184b588f3bc0c91250c7d7 | cinder |
| efc593f762a447dba12bf2fe870f1310 | neutron |
| c79e26f993fb45ab939e7d0bbe12c263 | placement |
| 192dd28050c0422a8fee1654e0be8a83 | cloud-dev |
| 848a0e0496cb401bb0f1e561b7019f9e | cloud-test2 |
| f14a1c4573414b0ea93d3c13cb3ca05d | cloud-test3 |
+-----+-----+
[ubuntu@workstation (keystone-admin)]:~$ █
```

#### 4.6. The **cloud-test3** user will also need to be assigned a role to a project before being able to perform any actions. List the available roles to choose an appropriate one.

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

```
[ubuntu@workstation (keystone-admin)]:~$ openstack role list
+-----+-----+
| ID | Name |
+-----+-----+
| 06a95c82ba3d4100a1d0f60bb905103c | reader |
| 2c3b8113b193450aae853366edde59cf | member |
| 3e87224510c64534ab79f89dale4bc30 | service |
| 7fead54bd7254e19953681eff51bb8d7 | manager |
| 8dcf33f6eba64391b67ef08c5fae8c80 | ResellerAdmin |
| 8ecccc9d106748ba9c3f69a594a035ee | admin |
| c885d097a99c4311842278b3c65e54ce | anotherrole |
+-----+-----+
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 4.7. Assign **cloud-test3** the **member** role on the **dev** project.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack role add \
> --project dev \
> --user cloud-test3 \
> member
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack role add \
> --project dev \
> --user cloud-test3 \
> member
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 4.8. Copy the existing **~/keystonerc-admin** file to **~/keystonerc-cloud-dev**.

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

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

- 4.9. Edit the **~/keystonerc-cloud-dev** file and change the **OS\_USERNAME** from **admin** to **cloud-dev** and the **OS\_PROJECT\_NAME** from **demo** to **dev** using the **nano** command. Additionally, change the line beginning with **export PS1=...** so that **(keystone-admin)** becomes **(keystone-cloud-dev)**. Modify the file so the content matches below. When you are finished, press **CTRL+X**, then **Y** to accept the file changes. Press **Enter** to save and exit **nano**.

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

```
GNU nano 2.9.3                               /home/ubuntu/keystonerc-cloud-dev
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=dev
export OS_INTERFACE=public
export OS_IDENTITY_API_VERSION=3
export PS1=[\[\033[01;32m\]\u@\h \[\033[01;36m\](keystone-cloud-dev)\[\033[00m\]]:\[\033[01;34m\]\w\[\033[00m\]\$ '
```

- 4.10.** Repeat steps 8 and 9, this time for user **cloud-test3**.

- 4.11.** Disable the **cloud-test3** account.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack user set \
> --disable cloud-test3
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack user set \
> --disable cloud-test3
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 4.12.** To verify that the **cloud-test3** account is disabled, first source the `~/keystonerc-cloud-test3` keystone credentials file for the **cloud-test3** user.

```
[ubuntu@workstation (keystone-admin)]:~$ source ~/keystonerc-cloud-test3
```

```
[ubuntu@workstation (keystone-admin)]:~$ source ~/keystonerc-cloud-test3
[ubuntu@workstation (keystone-cloud-test3)]:~$ █
```

- 4.13.** Now try listing the available flavors and notice that the **cloud-test3** user is not authenticated.

```
[ubuntu@workstation (keystone-cloud-test3)]:~$ openstack flavor list
```

```
[ubuntu@workstation (keystone-cloud-test3)]:~$ openstack flavor list
The request you have made requires authentication. (HTTP 401) (Request-ID: req-2
dcb249f-a5fa-433d-acd4-c4a519f498c0)
[ubuntu@workstation (keystone-cloud-test3)]:~$ █
```

- 4.14.** Source the keystone credentials using the **admin** user keystone file so that further changes can be made to the accounts.

```
[ubuntu@workstation (keystone-cloud-test3)]:~$ source ~/keystonerc-admin
```

```
[ubuntu@workstation (keystone-cloud-test3)]:~$ source ~/keystonerc-admin
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 4.15.** Enable the **cloud-test3** user account and change the password to **password**.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack user set \
> --password password \
> --enable cloud-test3
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack user set \
> --password password \
> --enable cloud-test3
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 4.16.** Set the password, **password** in the keystone credential file for **cloud-test3**. Modify the file so the content matches below. When you are finished, press **CTRL+X**, then **Y** to accept the file changes. Press **Enter** to save and exit **nano**.

```
[ubuntu@workstation (keystone-admin)]:~$ nano ~/keystonerc-cloud-test3
```

```
GNU nano 2.9.3                               /home/ubuntu/keystonerc-cloud-test3                         Modified
unset OS_SERVICE_TOKEN
unset OS_TENANT_ID
unset OS_TENANT_NAME
export OS_USERNAME=cloud-test3
export OS_PASSWORD=password
export OS_AUTH_URL=http://192.168.1.20/identity
export OS_REGION_NAME=RegionOne
export OS_PROJECT_NAME=dev
export OS_INTERFACE=public
export OS_IDENTITY_API_VERSION=3
export PS1='[\[\033[01;32m\]\u@\h \[\033[01;36m\](keystone-cloud-test3)\[\033[00m\]]:\[\033[01;34m\]\w\[\033[00m\]]\$ '
```

- 4.17.** Source the **~/keystonerc-cloud-test3** keystone credentials file for the **cloud-test3** user.

```
[ubuntu@workstation (keystone-admin)]:~$ source ~/keystonerc-cloud-test3
```

```
[ubuntu@workstation (keystone-admin)]:~$ source ~/keystonerc-cloud-test3
[ubuntu@workstation (keystone-cloud-test3)]:~$ █
```

- 4.18.** Now that the **cloud-test3** user has been enabled, verify that the **openstack flavor list** command returns a list of available flavors.

```
[ubuntu@workstation (keystone-cloud-test3)]:~$ openstack flavor list
```

```
[ubuntu@workstation (keystone-cloud-test3)]:~$ 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-test3)]:~$ █
```

- 4.19.** Source the keystone credentials file for the **admin** user.

```
[ubuntu@workstation (keystone-cloud-test3)]:~$ source ~/keystonerc-admin
```

```
[ubuntu@workstation (keystone-cloud-test3)]:~$ source ~/keystonerc-admin
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 4.20.** Delete the **cloud-test2** and **cloud-test3** user accounts since they are no longer needed.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack user delete cloud-test2
[ubuntu@workstation (keystone-admin)]:~$ openstack user delete cloud-test3
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack user delete cloud-test2
[ubuntu@workstation (keystone-admin)]:~$ openstack user delete cloud-test3
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 4.21.** Verify that the users have been deleted.

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

```
[ubuntu@workstation (keystone-admin)]:~$ openstack user list
+-----+-----+
| ID          | Name      |
+-----+-----+
| 14f5376f00c04e90b7103dd8d4263040 | admin     |
| 603b42080bb549d7ad3217eb456e7a55 | demo      |
| a7cee45b0f484fc8980c71e2243d2e1 | demo_reader |
| 8d21de784ae2493aa5c8cc73a82be6b3 | alt_demo   |
| 7e7596f02f1c45afad1fc09de331781 | alt_demo_member |
| 44ffe37cf07948c88958066614ef5d74 | alt_demo_reader |
| 899fc9a9b17445b4aac553e4f5f192ec | system_member |
| 604adb2150514649a41eaee6273ceb2a | system_reader |
| ab546669b1cd44b3aa2305c303363425 | nova      |
| 82142039d42341718fb126134266ec80 | glance    |
| 0c5d50f813184b588f3bc0c91250c7d7 | cinder    |
| efc593f762a447dba12bf2fe870f1310 | neutron   |
| c79e26f993fb45ab939e7d0bbe12c263 | placement |
| 192dd28050c0422a8fee1654e0be8a83 | cloud-dev |
+-----+-----+
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 4.22. Leave the terminal window open and continue on to the next task.

## 5 Assigning User Roles and Privileges Using the Horizon Dashboard

In this task, you will assign user roles privileges using the *Horizon Dashboard*.

- 5.1. Open the web browser, navigate to the OpenStack login page at <http://192.168.1.20>, and log in with username **admin** and password **secret** as before.
- 5.2. Navigate to **Identity > Users** and click on the **Create User** button.

User Name	Description	Email	User ID	Enabled	Domain Name	Actions
admin	-		be70ca5c1a9e46eb8be7b25a6cd18ba	Yes	Default	Edit

- 5.3. Create the **cloud-admin** user with **admin** privileges. In the dialog box, enter **cloud-admin** in the *User Name* field, and enter **secret** in the *Password* and *Confirm Password* fields. Select the **dev** project from the *Primary Project* dropdown, and select **admin** in the *Role* dropdown. Finally, leave the **Enabled** checkbox selected and click the **Create User** button.

## Create User

**Domain ID**

default

**Domain Name**

Default

**User Name \***

cloud-admin

**Description:**

Create a new user and set related properties including the Primary Project and Role.

**Description****Email****Password \*****Confirm Password \*****Primary Project****Role** **Enabled** **Lock password**[Cancel](#)[Create User](#)**Tip**

You may need to use the scroll bar on the right of the dialog to scroll down to see the projects and roles.

- 5.4. Log out of the dashboard by clicking the **admin** dropdown in the top right corner, then clicking **Sign Out**, and log back into the dashboard as the newly created **cloud-admin** user with password **secret**.
- 5.5. Verify that the **cloud-admin** user has **admin** privileges by creating a user named **cloud-user1**. Navigate to **Identity > Users** and click on the **Create User** button as before. In the dialog box, enter **cloud-user1** in the *User Name* field and **secret** in the *Password* and *Confirm Password* fields. Select the **dev** project from the *Primary Project* dropdown, leave the *Role* set to **member**, and leave the **Enabled** checkbox selected. Click the **Create User** button.

## Create User

**Domain ID**

default

**Domain Name**

Default

**User Name \***

cloud-user1

**Description:**

Create a new user and set related properties including the Primary Project and Role.

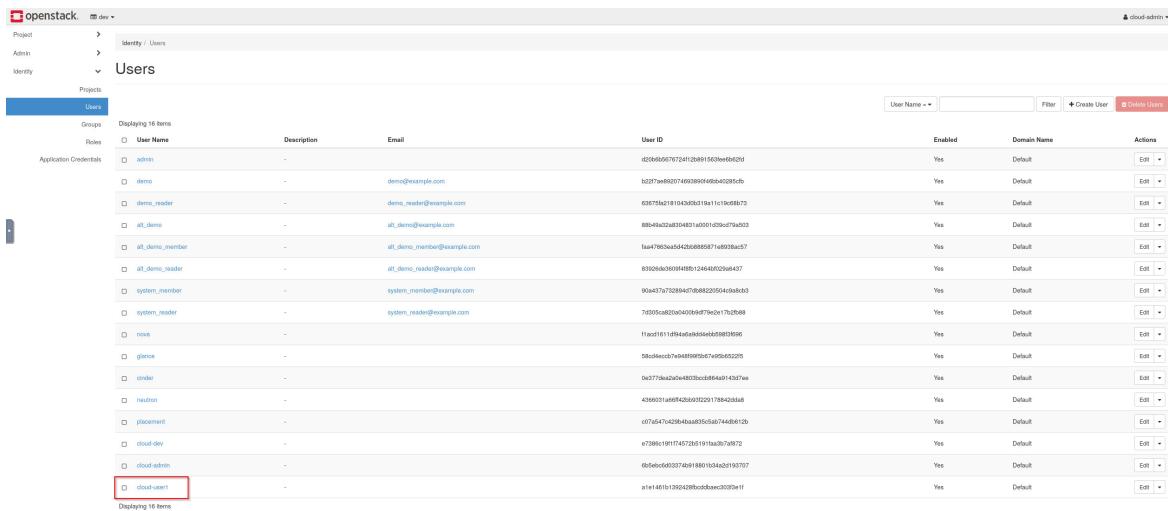
**Description****Email****Password \*****Confirm Password \*****Primary Project****Role** Enabled Lock password

Cancel

**Create User****Tip**

You may need to use the scroll bar on the right of the dialog to scroll down to see the projects and roles.

- 5.6.** Verify that the **cloud-user1** account appears in the user list.



User ID	Enabled	Domain Name	Actions
d29fb6b5676742f1398915639eb62d2f	Yes	Default	<a href="#">Edit</a>
b237ae89207469989916bb40283fcfb	Yes	Default	<a href="#">Edit</a>
037595d181043d0319a1c19d9737	Yes	Default	<a href="#">Edit</a>
88649a02a81a481a001cd20e07fa505	Yes	Default	<a href="#">Edit</a>
faa1765aa5425a6885771a03ba57	Yes	Default	<a href="#">Edit</a>
839264a36094ff8b1246480729a47	Yes	Default	<a href="#">Edit</a>
90a437a722994d7288023004a0a8b3	Yes	Default	<a href="#">Edit</a>
76705c5a020a400a9d7e977e0a77b288	Yes	Default	<a href="#">Edit</a>
1faed1811954a6a9d5eebd8d802060	Yes	Default	<a href="#">Edit</a>
5b6ec5e57e404995957474956523	Yes	Default	<a href="#">Edit</a>
0a3773ea261e48070cc8b64a9143f7ee	Yes	Default	<a href="#">Edit</a>
4390031a6ef42b60352201784243648	Yes	Default	<a href="#">Edit</a>
c076547c429404a83fcfaab744b812b	Yes	Default	<a href="#">Edit</a>
e798619917457265191aa307a972	Yes	Default	<a href="#">Edit</a>
659ebc6033749f1880104a26193707	Yes	Default	<a href="#">Edit</a>
a1e1461b1392429f00dbbae20202e11	Yes	Default	<a href="#">Edit</a>

**5.7.** Log out of the dashboard, close the web browser, and continue to the next task.

## 6 Assigning User Roles and Privileges Using the OpenStack Unified CLI

In this task, you will assign user roles and privileges using the *OpenStack Unified CLI*.

- 6.1. Open a terminal window if one is not already running.
- 6.2. Source the `~/keystonerc-admin` keystone credentials file for the **admin** user.

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

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

- 6.3. Create the user **cloud-admin2** with the password **secret**, and make it a member of the **dev** project.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack user create \
> --password secret \
> --project dev \
> cloud-admin2
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack user create \
> --password secret \
> --project dev \
> cloud-admin2
+-----+-----+
| Field | Value |
+-----+-----+
| default_project_id | 710f8a9f6ded43189d6655e16cae77bc |
| domain_id | default |
| enabled | True |
| id | c7668a3ea7bb4793ab50fbcc7392799c8 |
| name | cloud-admin2 |
| options | {} |
| password_expires_at | None |
+-----+-----+
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 6.4. The user **cloud-admin2** is not assigned a role by default and must be assigned one. Assign the **admin** user role to the **cloud-admin2** user.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack role add \
> --user cloud-admin2 \
> --project dev \
> admin
```

```
[ubuntu@workstation (keystone-admin)]:~$ openstack role add \
> --user cloud-admin2 \
> --project dev \
> admin
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 6.5. Verify that the **cloud-admin2** is in the **admin** user role for the **dev** project.

```
[ubuntu@workstation (keystone-admin)]:~$ openstack role assignment list \
> --user cloud-admin2 \
> --project dev \
> --names
```

Role	User	Group	Project	Domain	Inherited
admin	cloud-admin2@Default		dev@Default		False

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

- 6.6. Next, the admin role for **cloud-admin2** will be used to perform an admin action. In particular, the admin privileges of **cloud-admin2** will be used to delete another user. First, follow steps 8 and 9 from Section 4 to create the `~/keystonerc-cloud-admin2` keystone credentials file for the **cloud-admin2** user.
- 6.7. Source the `~/keystonerc-cloud-admin2` keystone credentials file for the **cloud-admin2** user.

```
[ubuntu@workstation (keystone-admin)]:~$ source ~/keystonerc-cloud-admin2
```

```
[ubuntu@workstation (keystone-admin)]:~$ source ~/keystonerc-cloud-admin2
[ubuntu@workstation (keystone-cloud-admin2)]:~$ █
```

- 6.8. List the current OpenStack users to see the list of users that can be deleted.

```
[ubuntu@workstation (keystone-cloud-admin2)]:~$ openstack user list
```

```
[ubuntu@workstation (keystone-cloud-admin2)]:~$ openstack user list
+-----+-----+
| ID      | Name   |
+-----+-----+
| 14f5376f00c04e90b7103dd8d4263040 | admin   |
| 603b42080bb549d7ad3217eb456e7a55 | demo    |
| a7cee45b0f484fc8980c71e2243d2e1 | demo_reader |
| 8d21de784ae2493aa5c8cc73a82be6b3 | alt_demo |
| 7e7596f02f1c45afad1fc09de331781 | alt_demo_member |
| 44ffe37cf07948c88958066614ef5d74 | alt_demo_reader |
| 899fc9a9b17445b4aac553e4f5f192ec | system_member |
| 604adb2150514649a41eaee6273ceb2a | system_reader |
| ab546669b1cd44b3aa2305c303363425 | nova    |
| 82142039d42341718fb126134266ec80 | glance   |
| 0c5d50f813184b588f3bc0c91250c7d7 | cinder   |
| efc593f762a447dba12bf2fe870f1310 | neutron  |
| c79e26f993fb45ab939e7d0bbe12c263 | placement |
| 192dd28050c0422a8fee1654e0be8a83 | cloud-dev |
| e19cbad000444ba59b5539febfb1ada | cloud-admin |
| 39191f97f7434de0870655c964ec3d12 | cloud-user1 |
| c7668a3ea7bb4793ab50fb7392799c8 | cloud-admin2 |
+-----+-----+
[ubuntu@workstation (keystone-cloud-admin2)]:~$ █
```

#### 6.9. Delete the **cloud-user1** user.

```
[ubuntu@workstation (keystone-cloud-admin2)]:~$ openstack user delete cloud-user1
```

```
[ubuntu@workstation (keystone-cloud-admin2)]:~$ openstack user delete \
> cloud-user1
[ubuntu@workstation (keystone-cloud-admin2)]:~$ █
```

#### 6.10. List the users again to confirm that **cloud-user1** was deleted.

```
[ubuntu@workstation (keystone-cloud-admin2)]:~$ openstack user list
```

```
[ubuntu@workstation (keystone-cloud-admin2)]:~$ openstack user list
+-----+-----+
| ID      | Name   |
+-----+-----+
| 14f5376f00c04e90b7103dd8d4263040 | admin   |
| 603b42080bb549d7ad3217eb456e7a55 | demo    |
| a7cee45b0f484fc8980c71e2243d2e1 | demo_reader |
| 8d21de784ae2493aa5c8cc73a82be6b3 | alt_demo |
| 7e7596f02f1c45afad1fc09de331781 | alt_demo_member |
| 44ffe37cf07948c88958066614ef5d74 | alt_demo_reader |
| 899fc9a9b17445b4aac553e4f5f192ec | system_member |
| 604adb2150514649a41eaee6273ceb2a | system_reader |
| ab546669b1cd44b3aa2305c303363425 | nova    |
| 82142039d42341718fb126134266ec80 | glance   |
| 0c5d50f813184b588f3bc0c91250c7d7 | cinder   |
| efc593f762a447dba12bf2fe870f1310 | neutron  |
| c79e26f993fb45ab939e7d0bbe12c263 | placement |
| 192dd28050c0422a8fee1654e0be8a83 | cloud-dev |
| e19cbad000444ba59b5539feb2b1ada | cloud-admin |
| c7668a3ea7bb4793ab50fb7392799c8 | cloud-admin2 |
+-----+-----+
[ubuntu@workstation (keystone-cloud-admin2)]:~$ ]
```

- 6.11.** Delete the **cloud-admin2** user. This will delete the current user whose keystone credentials are being used.

```
[ubuntu@workstation (keystone-cloud-admin2)]:~$ openstack user delete \
> cloud-admin2
```

```
[ubuntu@workstation (keystone-cloud-admin2)]:~$ openstack user delete \
> cloud-admin2
[ubuntu@workstation (keystone-cloud-admin2)]:~$ ]
```

- 6.12.** Since the **cloud-admin2** user has been deleted, the keystone credentials no longer authenticate the user. You can verify this by attempting to list OpenStack users.

```
[ubuntu@workstation (keystone-cloud-admin2)]:~$ openstack user list
```

```
[ubuntu@workstation (keystone-cloud-admin2)]:~$ openstack user list
The request you have made requires authentication. (HTTP 401) (Request-ID: req-e
a9fa44b-1745-495f-87ba-86cff65c8f56)
[ubuntu@workstation (keystone-cloud-admin2)]:~$ ]
```

- 6.13.** Source the `~/keystonerc-admin` keystone credentials file for the **cloud-admin** user.

```
[ubuntu@workstation (keystone-cloud-admin2)]:~$ source ~/keystonerc-admin
```

```
[ubuntu@workstation (keystone-cloud-admin2)]:~$ source ~/keystonerc-admin
[ubuntu@workstation (keystone-admin)]:~$ ]
```

- 6.14. Verify that the **cloud-admin2** user has been deleted.

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

```
[ubuntu@workstation (keystone-admin)]:~$ openstack user list
+-----+-----+
| ID          | Name      |
+-----+-----+
| 14f5376f00c04e90b7103dd8d4263040 | admin      |
| 603b42080bb549d7ad3217eb456e7a55 | demo       |
| a7cee45b0f484fca8980c71e2243d2e1 | demo_reader |
| 8d21de784ae2493aa5c8cc73a82be6b3 | alt_demo   |
| 7e7596f02f1c45afad1fc09de331781 | alt_demo_member |
| 44ffe37cf07948c88958066614ef5d74 | alt_demo_reader |
| 899fc9a9b17445b4aac553e4f5f192ec | system_member |
| 604adb2150514649a41eaee6273ceb2a | system_reader |
| ab546669b1cd44b3aa2305c303363425 | nova       |
| 82142039d42341718fb126134266ec80 | glance     |
| 0c5d50f813184b588f3bc0c91250c7d7 | cinder     |
| efc593f762a447dba12bf2fe870f1310 | neutron    |
| c79e26f993fb45ab939e7d0bbe12c263 | placement  |
| 192dd28050c0422a8fee1654e0be8a83 | cloud-dev  |
| e19cbad000444ba59b5539febfb1ada | cloud-admin |
+-----+-----+
[ubuntu@workstation (keystone-admin)]:~$ █
```

- 6.15. Source the `~/keystonerc-cloud-dev` keystone credentials for the **cloud-dev** user and attempt to list the users. Notice the error displayed when a non-privileged user runs a command that requires administrator privileges.

```
[ubuntu@workstation (keystone-admin)]:~$ source ~/keystonerc-cloud-dev
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack user list
```

```
[ubuntu@workstation (keystone-admin)]:~$ source ~/keystonerc-cloud-dev
[ubuntu@workstation (keystone-cloud-dev)]:~$ openstack user list
You are not authorized to perform the requested action: identity:list_users. (HTTP 403) (Request-ID: req-73bab0be-afb7-4bc1-b4ff-8d05d0ce7c26)
[ubuntu@workstation (keystone-cloud-dev)]:~$ █
```

- 6.16. The lab is now complete.