

OpenStack Cloud Security

Lab 1

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Introduction to OpenStack

Learning Objectives

By the end of this lab, students will be able to:

- Understand what OpenStack is and its core components
- Identify the key services that make up an OpenStack cloud
- Navigate the OpenStack architecture and understand service relationships
- Access and use the OpenStack Horizon dashboard
- Create and manage basic cloud resources

Prerequisites

- Basic Linux command-line knowledge
 - Understanding of virtualization concepts
 - Access to a virtual machine or physical server with:
 - Ubuntu 22.04 LTS or later (recommended)
 - Minimum 8GB RAM, 40GB disk space
 - Network connectivity
 - DevStack Preinstalled ([Install Here](#))
-

Part 1: What is OpenStack?

OpenStack is an open-source cloud computing platform that provides Infrastructure as a Service (IaaS). It enables organizations to create and manage large networks of virtual machines and other resources through a web-based dashboard, command-line tools, or REST APIs.

Key Characteristics

- **Open Source:** Free and community-driven
- **Modular Architecture:** Composed of multiple interconnected services
- **Scalable:** Can manage thousands of compute nodes
- **Multi-tenant:** Supports multiple users and projects
- **API-driven:** Everything can be automated through APIs

OpenStack VS the Competition:

			
License Model	Open Source	pay as you go	licensing / subscription
Control	Full control	Limited. Aws managed	Strong control but limited to VMWare tools
Scalability	Very High, proven at hyperscale	Virtually unlimited	Good but high cost for enterprise scale
Flexibility	Highly modular using only the modules you need	Great but locked to AWS ecosystem	VMWare Ecosystem Only (NSX, vSAN)

OpenStack vs. Traditional IT

Traditional IT	OpenStack Cloud
Manual provisioning	Self-service provisioning
Fixed capacity	Elastic scaling
Hardware-specific	Hardware-agnostic
Siloed resources	Pooled resources
Manual management	Automated management

Part 2: OpenStack Architecture

- **Controller Node** – Runs central services (Keystone, Glance, Horizon, DB, MQ).
 - **Compute Node** – Hosts VM workloads.
 - **Storage Node** – Provides block/object storage.
 - **Networking Node** – Handles routing, VLANs, DHCP, NAT.
-

Part 3: Core OpenStack Services

OpenStack consists of several core services, each with a specific role:

Compute (Nova)

- **Purpose:** Manages virtual machine instances
- **Function:** Provisions, schedules, and manages VM lifecycle
- **Analogy:** The "brain" that decides where and how to run your applications

Networking (Neutron)

- **Purpose:** Provides network connectivity services
- **Function:** Creates virtual networks, subnets, routers, and security groups
- **Analogy:** The "highway system" connecting your resources

Storage Services

Block Storage (Cinder)

- **Purpose:** Provides persistent block storage volumes
- **Function:** Creates, attaches, and manages storage volumes for VMs
- **Analogy:** External hard drives that can be attached to any computer

Object Storage (Swift)

- **Purpose:** Stores and retrieves unstructured data objects
- **Function:** Handles files, images, backups through REST API

- **Analogy:** A massive filing cabinet accessible from anywhere

Image Service (Glance)

- **Purpose:** Manages virtual machine images
- **Function:** Stores, discovers, and retrieves VM templates
- **Analogy:** A library of operating system templates

Identity (Keystone)

- **Purpose:** Authentication and authorization service
- **Function:** Manages users, projects, roles, and service catalog
- **Analogy:** The "security guard" that controls access to everything

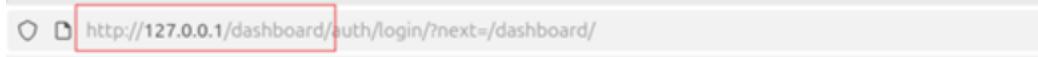
Dashboard (Horizon)

- **Purpose:** Web-based management interface
- **Function:** Provides graphical access to OpenStack services
- **Analogy:** The "control panel" for your cloud

Part 4: Hands-On OpenStack Introduction Lab

Section 1: Dashboard Overview

1. With DevStack installed on your computer, open your web browser and navigate to <http://127.0.0.1/dashboard/> to see the dashboard login for OpenStack.

A screenshot of the OpenStack dashboard login page. At the top center is the OpenStack logo, which consists of a red square icon above the word 'openstack.' Below the logo is the word 'Log in'. There are two input fields: 'User Name' and 'Password'. To the right of the 'Password' field is a small eye icon for password visibility. At the bottom right is a blue 'Sign In' button.

2. Login with the username: 'admin' and password that is in the '/opt/stack/devstack/local.conf' file. Then click 'Sign In'

openstack.

Log in

The screenshot shows a login form for the OpenStack interface. It has two input fields: 'User Name' containing 'admin' and 'Password' containing '*****'. Both fields have a red border. To the right of the password field is an 'eye' icon for password visibility. Below the fields is a blue 'Sign In' button with a white border.

3. You should see the Overview screen for the Compute section. On this page, an overview of the entire cloud network can be found that gives you information about the Compute, Volume, and Network sections of your cloud network.

Project ▾

Project / Compute / Overview

API Access

Compute ▾

Overview

[Overview](#)[Instances](#)

Limit Summary

Compute

[Key Pairs](#)[Server Groups](#)[Volumes](#) >Instances
Used 0 of 10vCPUs
Used 0 of 20[Network](#) >

Volume

Used 0 of 10

RAM
Used 0B of 50GB[Admin](#) >[Identity](#) >Volumes
Used 0 of 10Volume Snapshots
Used 0B of 1000GB

Network

Floating IPs
Allocated 1 of 50Security Groups
Used 2 of 10Security Group Rules
Used 7 of 100

4. Click on ‘Instances’ below the highlighted Overview section. This screen shows all instances that are set up to run on OpenStack. Right now, there should be no instances running on your virtual machine. This screen will later allow you to create, monitor, and manage your VMs.

The screenshot shows the OpenStack Compute interface. The top navigation bar includes 'Project', 'API Access', and 'Compute' dropdowns. Below the navigation is a breadcrumb path: Project / Compute / Instances. The main title is 'Instances'. A horizontal menu bar below the title has tabs for 'Overview' and 'Instances', with 'Instances' being the active tab and highlighted with a blue background. To the left of the main content area, there is a sidebar with links for 'Images', 'Key Pairs', 'Server Groups', 'Volumes', 'Network', 'Admin', and 'Identity'. The main content area displays a table with columns: Instance Name, Image Name, IP Address, Flavor, Key Pair, and Status. A message at the bottom of the table says 'No items to display.'

5. Next, click on ‘Images’ below the Instances section. Here you will find all the virtual machine images that can be set up to run on your version of OpenStack. Cirros is the default image installed with DevStack.

The screenshot shows the OpenStack Compute interface. The top navigation bar includes 'Project', 'API Access', and 'Compute' dropdowns. Below the navigation is a breadcrumb path: Project / Compute / Images. The main title is 'Images'. A horizontal menu bar below the title has tabs for 'Overview' and 'Images', with 'Images' being the active tab and highlighted with a blue background. To the left of the main content area, there is a sidebar with links for 'Instances', 'Key Pairs', 'Server Groups', 'Volumes', 'Network', 'Admin', and 'Identity'. The main content area displays a table with columns: Owner, Name, Type, Status, Visibility, and Protected. One item is listed: 'admin' with the name 'cirros-0.6.3-x86_64-disk', Type 'Image', Status 'Active', Visibility 'Public', and Protected 'No'. A search bar at the top of the table says 'Click here for filters or full text search.'

6. Skip further down and click on the ‘Volumes’ drop-down and then ‘Volumes’ again. Volumes in OpenStack are like virtual hard drives you can attach to instances, providing persistent storage for your VMs.

openstack. admin

Project API Access Compute > Volumes

Volumes Snapshots Groups Group Snapshots Network > Admin > Identity >

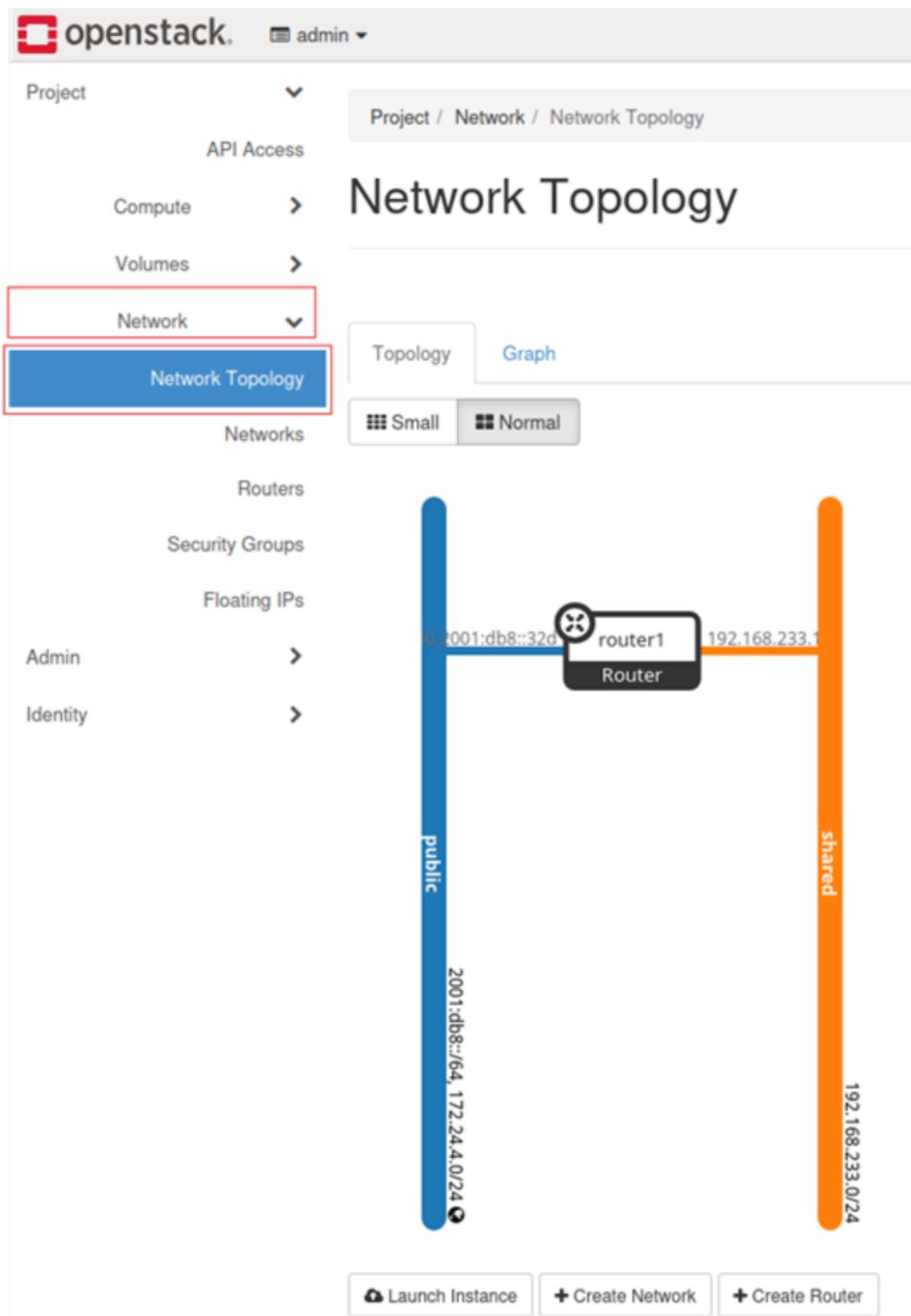
Project / Volumes / Volumes

Volumes

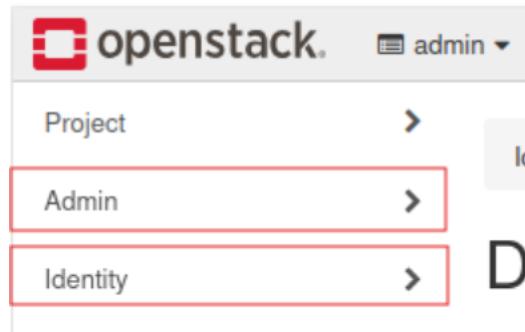
Filter

Name	Description	Size	Status	Group	Type	Attached To	Availability Zone
No items to display.							

7. Click on the ‘Network’ drop-down and then click on ‘Network Topology’. Virtual networks can be set up on OpenStack that connect instances with one another and to external networks. This page shows a visual map of your virtual networks. As an example, in the picture below, a router is set up that connects the shared subnet to the public external network.



8. Below the Project drop-down there are two sections labeled ‘Admin’ and ‘Identity’. These sections provide many useful tools for administrators to control their OpenStack deployment. However, these sections are out of scope for the current lab. This concludes section 1 of the hand-on lab.



Section 2: Setting Up Your First Virtual Machine Instance

9. Navigate to the ‘Project > Compute > Instances’ page in your OpenStack Dashboard. You should see ‘No items to display.’ under Status.

A screenshot of the OpenStack dashboard. The left sidebar has 'Project' selected in the dropdown. Under 'Compute', the 'Instances' option is highlighted with a blue box. The main content area shows a table titled 'Instances' with columns: Instance Name, Image Name, IP Address, Flavor, Key Pair, and Status. A message at the bottom of the table says 'No items to display.' The sidebar also includes links for 'Images', 'Key Pairs', 'Server Groups', 'Volumes', 'Network', 'Admin', and 'Identity'.

10. Click the ‘Launch Instance’ button on the right side of the dashboard. This will open up a menu that allows you to configure a new instance.

The screenshot shows a user interface for managing cloud instances. At the top right, there is a user profile icon labeled 'admin'. Below it is a search bar with placeholder text 'Instance ID = ▾' and a 'Filter' button. To the right of these is a prominent red-bordered 'Launch Instance' button with a cloud icon. The main area contains a table with columns: 'Key Pair', 'Status', 'Availability Zone', 'Task', 'Power State', 'Age', and 'Actions'. A message below the table says 'No items to display.'

11. You should see the screen below open up in your dashboard. Type a name into the ‘Instance Name’ text box and click ‘Next’.

The screenshot shows the 'Launch Instance' configuration dialog. On the left, a sidebar lists options: Details (selected), Source*, Flavor*, Networks*, Network Ports, Security Groups, Key Pair, Configuration, Server Groups, Scheduler Hints, and Metadata. The 'Details' section contains fields for 'Project Name' (set to 'admin'), 'Instance Name*' (set to 'test instance', highlighted with a red border), 'Description' (empty), 'Availability Zone' (set to 'nova'), and 'Count*' (set to '1'). To the right, there is a circular progress indicator showing '10%' completion and a legend indicating '0 Current Usage', '1 Added', and '9 Remaining' instances. At the bottom, there are buttons for 'Cancel', '< Back', 'Next >', and 'Launch Instance' (which is also red-bordered).

12. On the Source screen, click on the up arrow to the right of the cirros image. This will add it to the section titled ‘Allocated’. If you wanted to use a previously created volume, you could change the ‘Create New Volume’ setting. You can also set up the volume to delete when the instance is deleted by changing the ‘Delete Volume on Instance Delete’ setting. However, for this lab, continue with the default settings by clicking ‘Next’ at the bottom right corner.

Launch Instance

Details

Source *

Flavor *

Networks *

Network Ports

Security Groups

Key Pair

Configuration

Server Groups

Scheduler Hints

Metadata

Allocated

Displaying 0 items

Name	Updated	Size	Format	Visibility
Select an item from Available items below				

▼ Available ⓘ Select one

Click here for filters or full text search.

Displaying 1 item

Name	Updated	Size	Format	Visibility
cirros-0.6.3-x86_64-disk	9/15/25 1:02 AM	20.69 MB	QCOW2	Public

Displaying 1 item

Cancel

Back

Next >

Launch Instance

13. Next, you will see a long list of Flavors. These allow you to allocate virtual CPUs, RAM, and disk space for your instance. Click the arrow to the right of the ‘m1.tiny’ flavor to select it. Then click ‘Next’ at the bottom right.

Security Groups

Key Pair

Configuration

Server Groups

Scheduler Hints

Metadata

Available 12 Select one

Click here for filters or full text search.

Name	vCPUs	RAM	Total Disk	Root Disk	Ephemeral Disk	Public	Action
m1.nano	1	192 MB	1 GB	1 GB	0 GB	Yes	▲
m1.micro	1	256 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	▲ (highlighted)
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

14. In the Network menu, click the up arrow to the right of the ‘shared’ network. This will put your VM instance in a private shared subnet on your cloud network. The public network can be used with other settings to allow your instance to connect to the internet. For now, continue with the ‘shared’ network selected and click the ‘Launch Instance’ button.

The screenshot shows the 'Launch Instance' dialog box. The 'Networks' tab is selected, displaying a table with columns: Network, Subnets Associated, Shared, Admin State, and Status. Two networks are listed: 'shared' (associated with 'shared-subnet', status: No, Up, Active) and 'public' (associated with 'ipv6-public-subnet' and 'public-subnet', status: No, Up, Active). An upward arrow icon is next to the 'shared' row, indicating it was moved from the 'Allocated' list. The 'Available' tab shows the 'public' network with its own upward arrow icon. Other tabs like Details, Source, Flavor, and Security Groups are visible but not selected.

15. You should see your instance starting up on the Instances page. Wait until it says None under the Task menu and Running is listed under the Power State section. Now click the name of your instance under ‘Instance Name’.

Instances

The screenshot shows the Instances page with one item displayed. The table columns are: Instance ID (dropdown), Instance Name, Image Name, IP Address, Flavor, Key Pair, Status, Availability Zone, Task, Power State, Age, and Actions. The 'test 1' instance is listed with the following details: Image Name - m1.tiny, Flavor - m1.tiny, Key Pair - - (empty), Status - Build, Availability Zone - nova, Task - Networking, Power State - No State, Age - 0 minutes, and Actions - Associate Floating IP. The 'test 1' link in the first column is highlighted with a red box, and the 'Associate Floating IP' button in the Actions column is also highlighted with a red box.

16. Here you will see information about the instance you created. To access your virtual machine instance, click ‘Console’ to the right of the Overview section.

test 1

Overview	Interfaces	Log	Console	Action Log
Name	test 1			
ID	4715831e-8869-424c-8f60-14f01ebeef08			
Description	-			
Project ID	262375dcfe024207911ef954eb472d88			
Status	Active			
Locked	False			
Availability Zone	nova			
Created	Sept. 20, 2025, 5:35 p.m.			
Age	5 minutes			
Host	ubuntu			
Instance Name	instance-00000004			
Reservation ID	r-esa1zd74			
Launch Index	-			
Hostname	test-1			
Kernel ID	-			
Ramdisk ID	-			
Device Name	/dev/vda			
User Data	-			

17. When you scroll down, you will see the console for your virtual machine. You can login with the default user and password listed in the console window.

Overview Interfaces Log **Console** Action Log

Instance Console

If console is not responding to keyboard input: click the grey status bar below. [Click here to show only console](#)
To exit the fullscreen mode, click the browser's back button.

Connected to QEMU (Instance-00000004)

```
[ 9.845570] evm: security.SMACK64
[ 9.845924] evm: security.SMACK64EXEC
[ 9.846244] evm: security.SMACK64TRANSMUTE
[ 9.846652] evm: security.SMACK64MMAP
[ 9.847007] evm: security.apparmor
[ 9.847610] evm: security.ima
[ 9.847908] evm: security.capability
[ 9.848303] evm: HMAC attrs: 0x1
[ 9.856261] PM: Magic number: 9:458:694
[ 9.865697] RAS: Correctable Errors collector initialized.
[ 9.869528] clk: Disabling unused clocks
[ 9.901233] Freeing unused decrypted memory: 2036K
[ 10.065009] Freeing unused kernel image (initmem) memory: 3368K
[ 10.066756] Write protecting the kernel read-only data: 30720K
[ 10.073574] Freeing unused kernel image (text/rodata gap) memory: 2036K
[ 10.079140] Freeing unused kernel image (rodata/data gap) memory: 1328K
[ 10.536743] x86/mm: Checked W+X mappings: passed, no W+X pages found.
[ 10.539630] x86/mm: Checking user space page tables
[ 10.971136] x86/mm: Checked W+X mappings: passed, no W+X pages found.
[ 10.982868] Run /init as init process

further output written to /dev/ttyS0
[ 13.281592] virtio_blk virtio2: [vdal] 2097152 512-byte logical blocks (1.07 G
B/1.00 GiB)
[ 13.729796] virtio_gpu virtio0: [drm] drm_plane_enable_fb_damage_clips() not called
[ 13.806798] random: crng init done

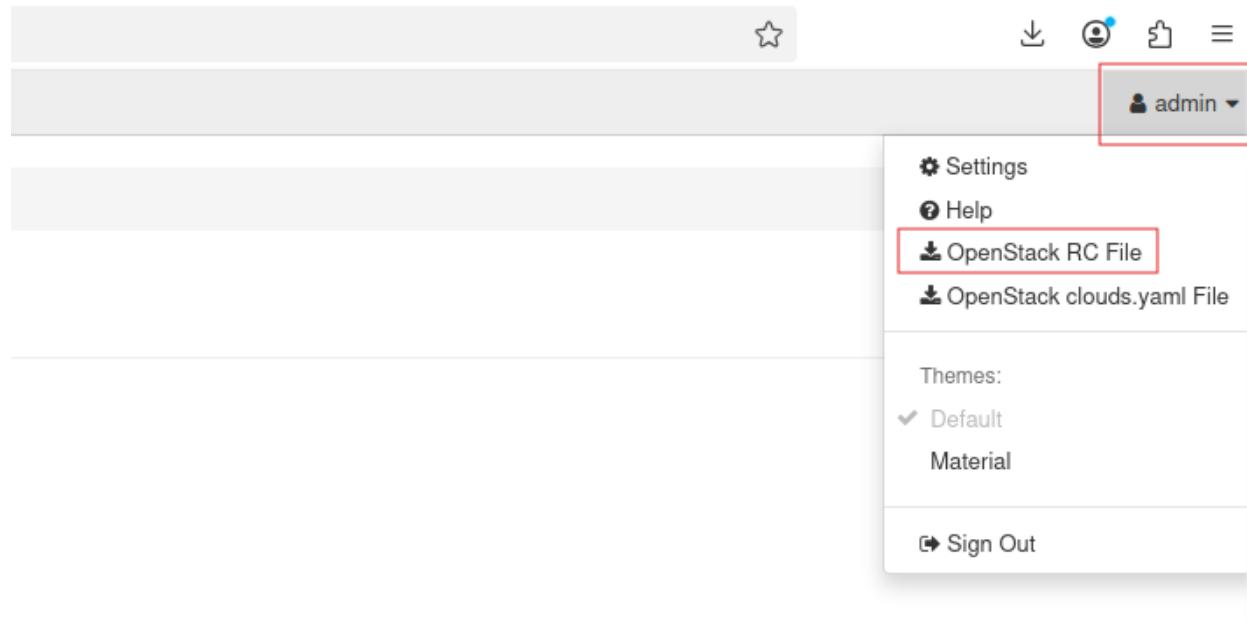
login as 'cirros' user. default password: 'gocubsgo'. use 'sudo' for root.
test-1 login:
```

18. Congratulations! You have now created and logged into a simple virtual machine instance on your OpenStack deployment. Once you login, you can try some simple Linux commands, such as cd, ls, or echo. This concludes Section 2 of the hands-on lab.

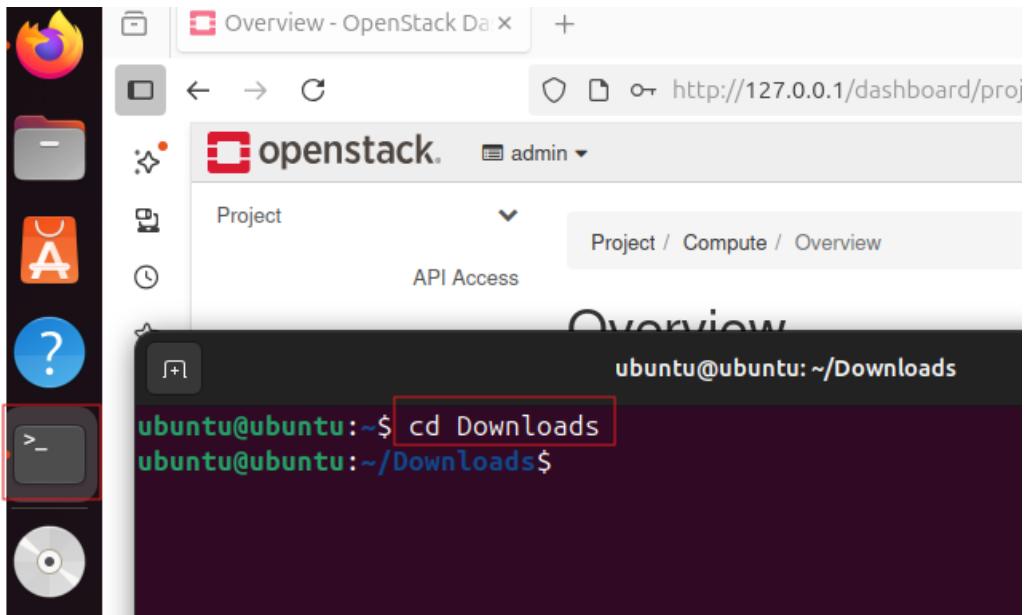
```
login as 'cirros' user. default password: 'gocubsgo'. use 'sudo' for root.
test-1 login: cirros
Password:
$ echo 'hello'
hello
$ ls
$ cd ..
$ ls
cirros
$ cd ..
$ ls
bin      dev      home      initrd.img  lib64     lost+found  mnt       opt       root
boot    etc      init      lib          linuxrc   media      old-root   proc
$ -
```

Section 3: Setting Up OpenStack CLI

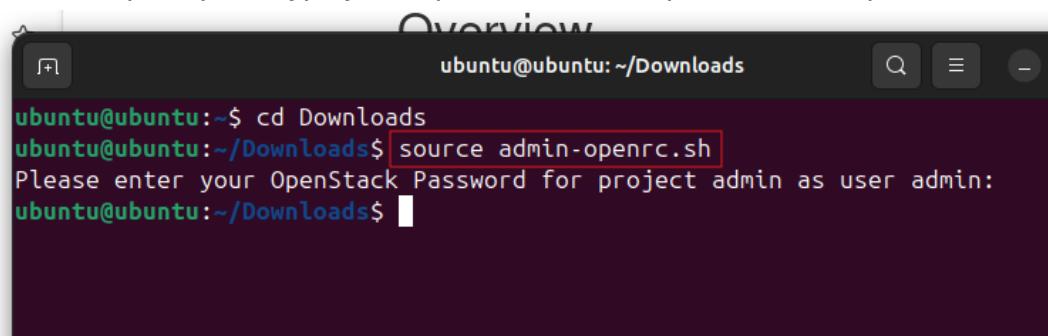
1. From the dashboard, click the admin drop-down on the top-right corner of the screen. Then click ‘OpenStack RC File’ to download the shell script.



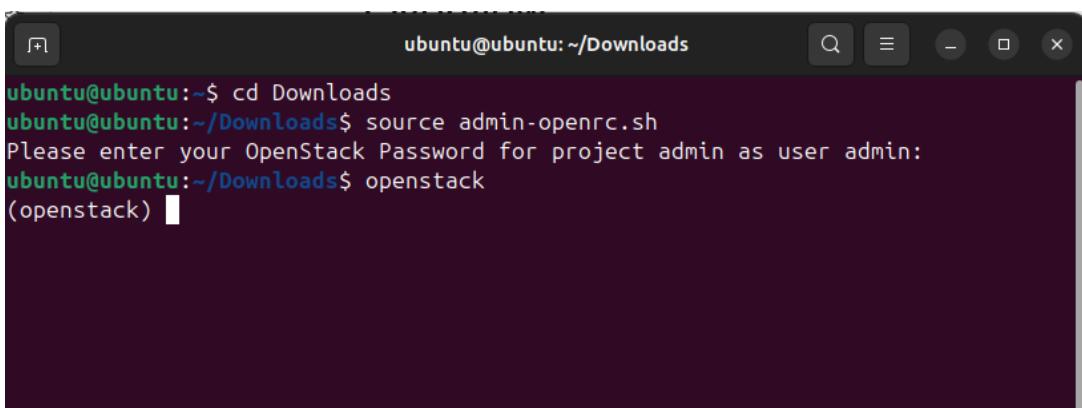
2. Open a terminal window, type ‘cd Downloads’, and press Enter to change to the directory where the downloaded admin-openrc.sh file is located.



3. In the terminal, type ‘source admin-openrc.sh’ from the Downloads directory and press Enter. When prompted, type your OpenStack admin password and press Enter.



4. You should be returned back to the shell prompt. Next, type ‘openstack’ and press Enter. This will open a new prompt with the text ‘(openstack)’. You can now enter OpenStack commands in the terminal window.



5. In the (openstack) prompt, type ‘service list’ and press Enter to see a list of all running OpenStack services.

```
(openstack) service list
+-----+-----+-----+
| ID          | Name      | Type     |
+-----+-----+-----+
| 3b26b0a0fdf74fdcaa07fa51978d027ba | cinder    | block-storage |
| 3d795027dcc648d4861214211ea85594 | glance    | image      |
| 55f8b99073084b4dab0016a5998d6289 | neutron   | network    |
| b40afb4df4a44060bd23c55464d8b084 | nova_legacy | compute_legacy |
| c66f3e50c0bf40828a8059c39417bd6f | nova      | compute    |
| d75ad13f19d34f99b3589aea8d80ba99 | placement | placement |
| e3886521e1d141189152417c5a8a7264 | keystone  | identity  |
+-----+-----+-----+
(openstack) █
```

6. Other interesting CLI commands can be found in the official OpenStack documentation. [Click this link](#) to see a quick cheat sheet with some useful commands to experiment with. This concludes Section 3 of the hands-on lab.

Part 5: References

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