

<b>Name:</b> John Renzo L. Mendoza	<b>Date Performed:</b> December 14, 2023
<b>Course/Section:</b> CPE31S5	<b>Date Submitted:</b> December 15, 2023
<b>Instructor:</b> Engr. Roman Richard	<b>Semester and SY:</b> 1st Semester, 2023-2024
<b>Activity 15: OpenStack Installation (Neutron, Horizon, Cinder)</b>	
<b>1. Objectives</b>	
Create a workflow to install OpenStack using Ansible as your Infrastructure as Code (IaC).	
<b>2. Intended Learning Outcomes</b>	
<ol style="list-style-type: none"> <li>1. Analyze the advantages and disadvantages of cloud services</li> <li>2. Evaluate different Cloud deployment and service models</li> <li>3. Create a workflow to install and configure OpenStack base services using Ansible as documentation and execution.</li> </ol>	
<b>3. Resources</b>	
<p>Oracle VirtualBox (Hypervisor)</p> <p>1x Ubuntu VM or Centos VM</p>	
<b>4. Tasks</b>	
<ol style="list-style-type: none"> <li>1. Create a new repository for this activity.</li> <li>2. Create a playbook that converts the steps in the following items in <a href="https://docs.openstack.org/install-guide/">https://docs.openstack.org/install-guide/</a> <ol style="list-style-type: none"> <li>a. Neutron</li> <li>b. Horizon</li> <li>c. Cinder</li> <li>d. Create different plays in installing per server type (controller, compute etc.) and identify it as a group in the Inventory file.</li> <li>e. Add, commit and push it to your GitHub repo.</li> </ol> </li> </ol>	

## 5. Output (screenshots and explanations)

### 1. Create a new repository for this activity.

The screenshot shows a virtual machine environment titled "CPE31S5 Workstation\_Mendoza [Running] - Oracle VM VirtualBox". Inside the VM, a Firefox web browser is open to the GitHub "Create a new repository" page. The page shows the "Owner" as "MendozaJRL" and the "Repository name" as "PE232\_MendozaExperiment". A green message indicates "CPE232\_MendozaExperiment15 is available". The "Description" field is empty. The "Public" option is selected under the visibility settings.

Overlaid on the bottom right is the "DirectX Diagnostic Tool" window. It displays system information for a Windows 10 Pro 64-bit system. The "System" tab is active, showing details such as the current date/time, computer name, operating system, language, system manufacturer, system model, BIOS, processor, memory, page file, and DirectX version.

**System Information**

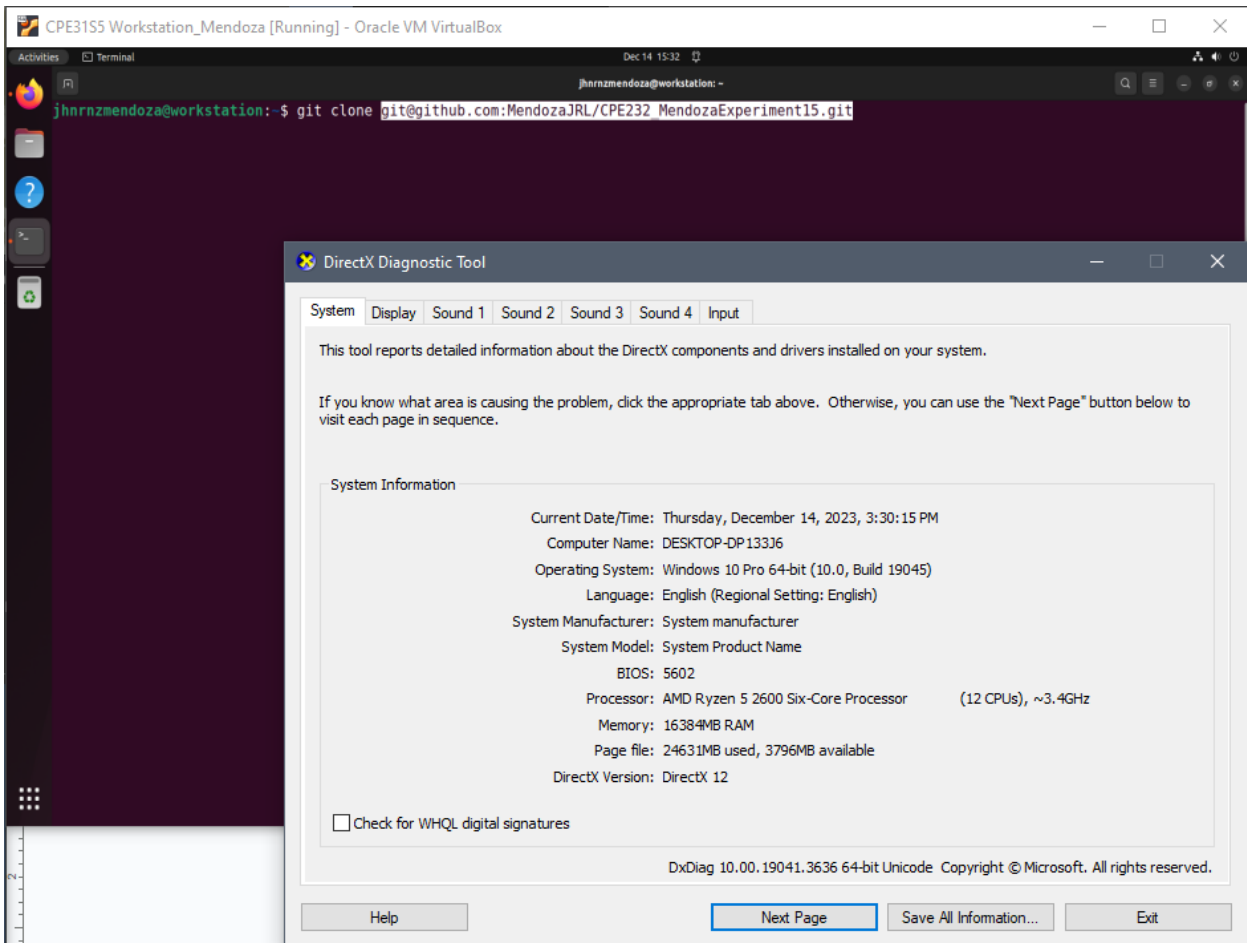
- Current Date/Time: Thursday, December 14, 2023, 3:30:15 PM
- Computer Name: DESKTOP-DP133J6
- Operating System: Windows 10 Pro 64-bit (10.0, Build 19045)
- Language: English (Regional Setting: English)
- System Manufacturer: System manufacturer
- System Model: System Product Name
- BIOS: 5602
- Processor: AMD Ryzen 5 2600 Six-Core Processor (12 CPUs), ~3.4GHz
- Memory: 16384MB RAM
- Page file: 24631MB used, 3796MB available
- DirectX Version: DirectX 12

☐ Check for WHQL digital signatures

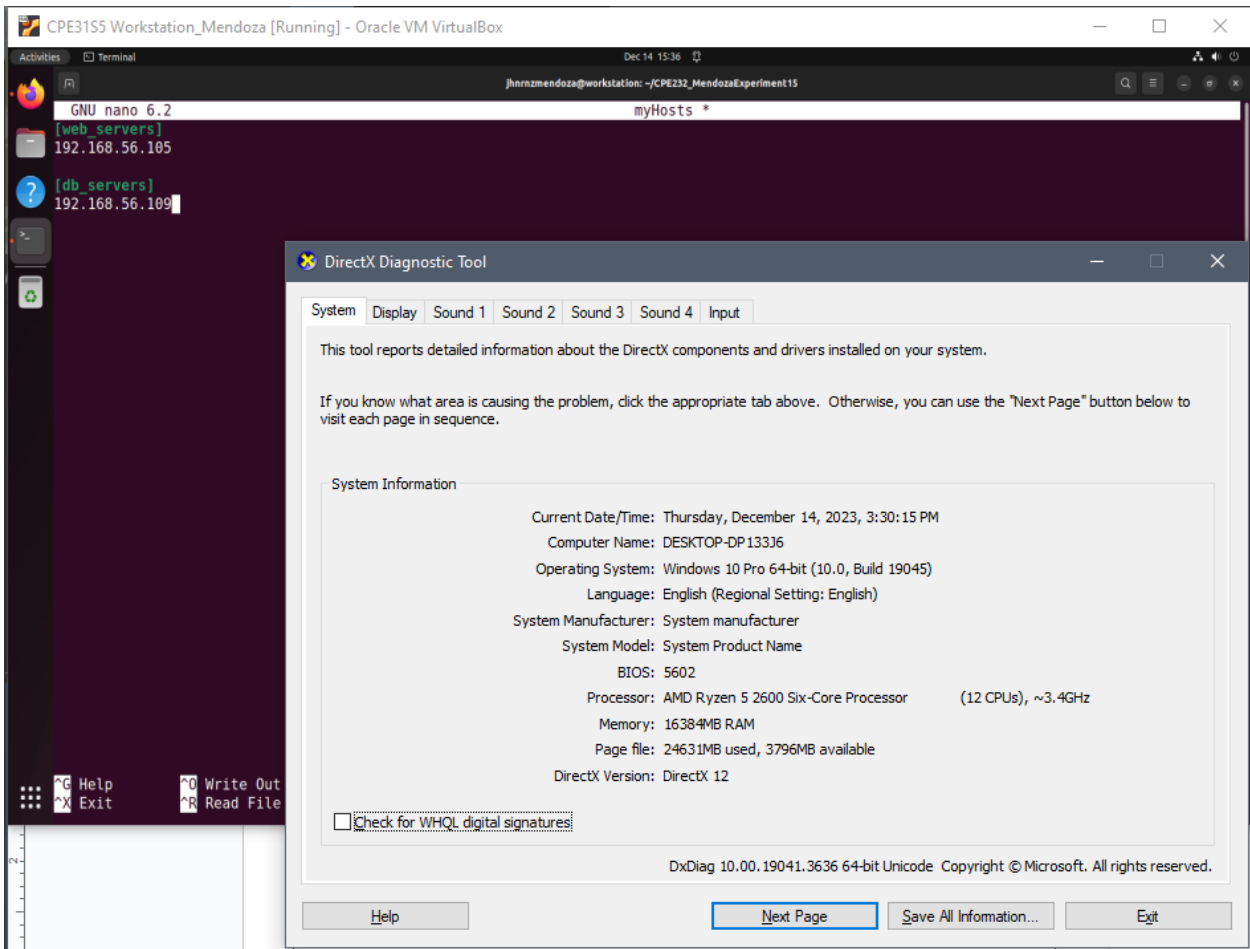
DxDiag 10.00.19041.3636 64-bit Unicode Copyright © Microsoft. All rights reserved.

Buttons: Help, Next Page, Save All Information..., Exit

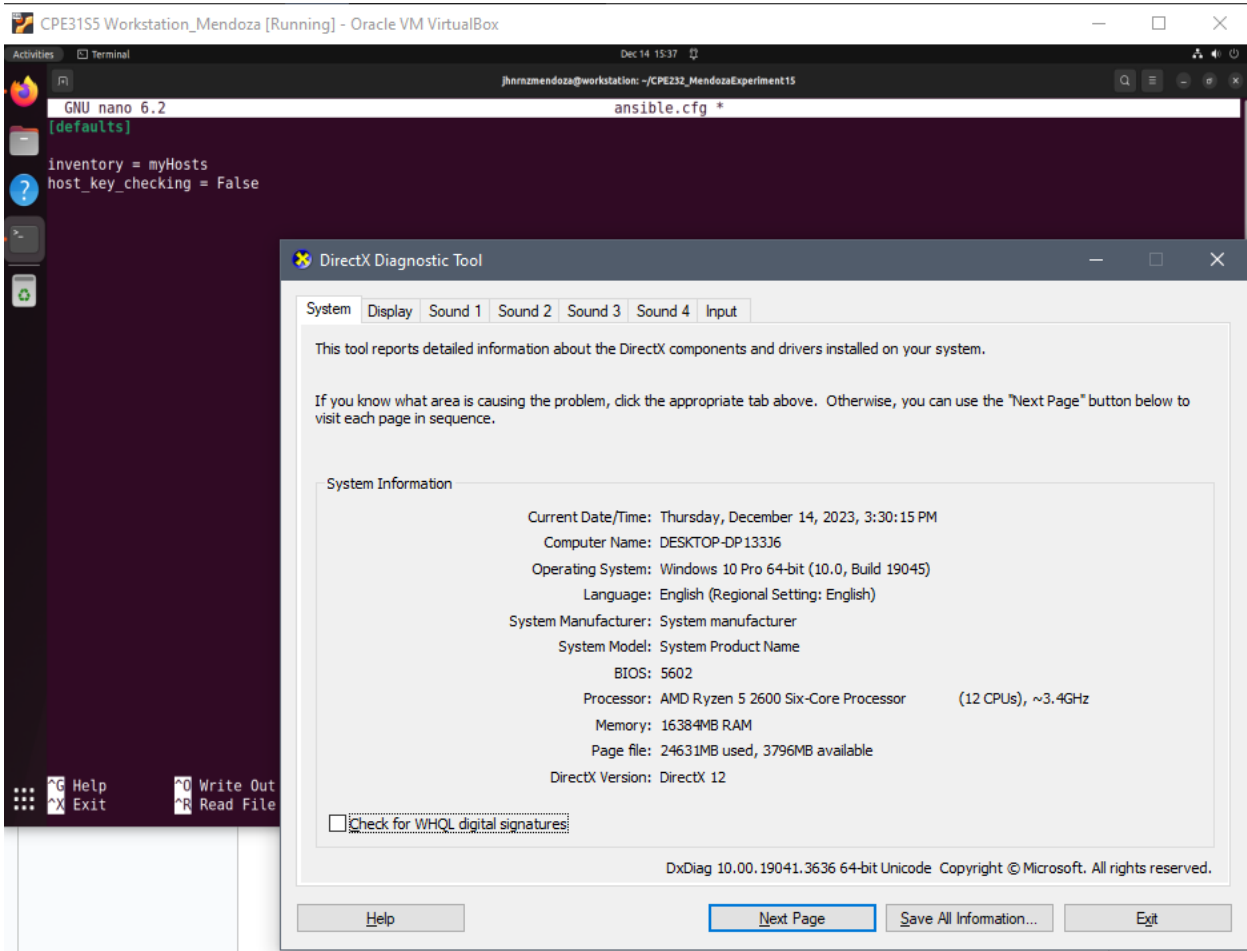
## Cloning the Repository to the Local Terminal of the Control Node



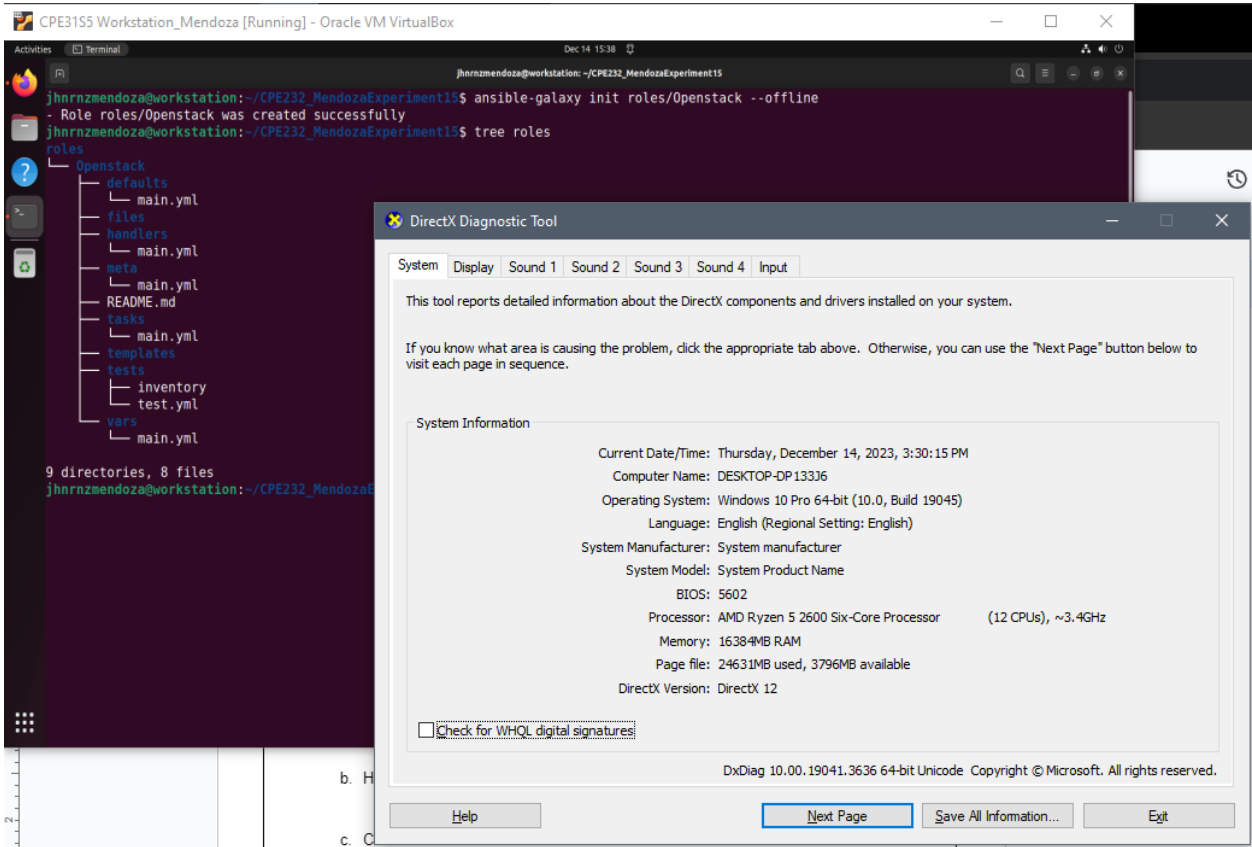
# Creation of the Ansible Configuration File.



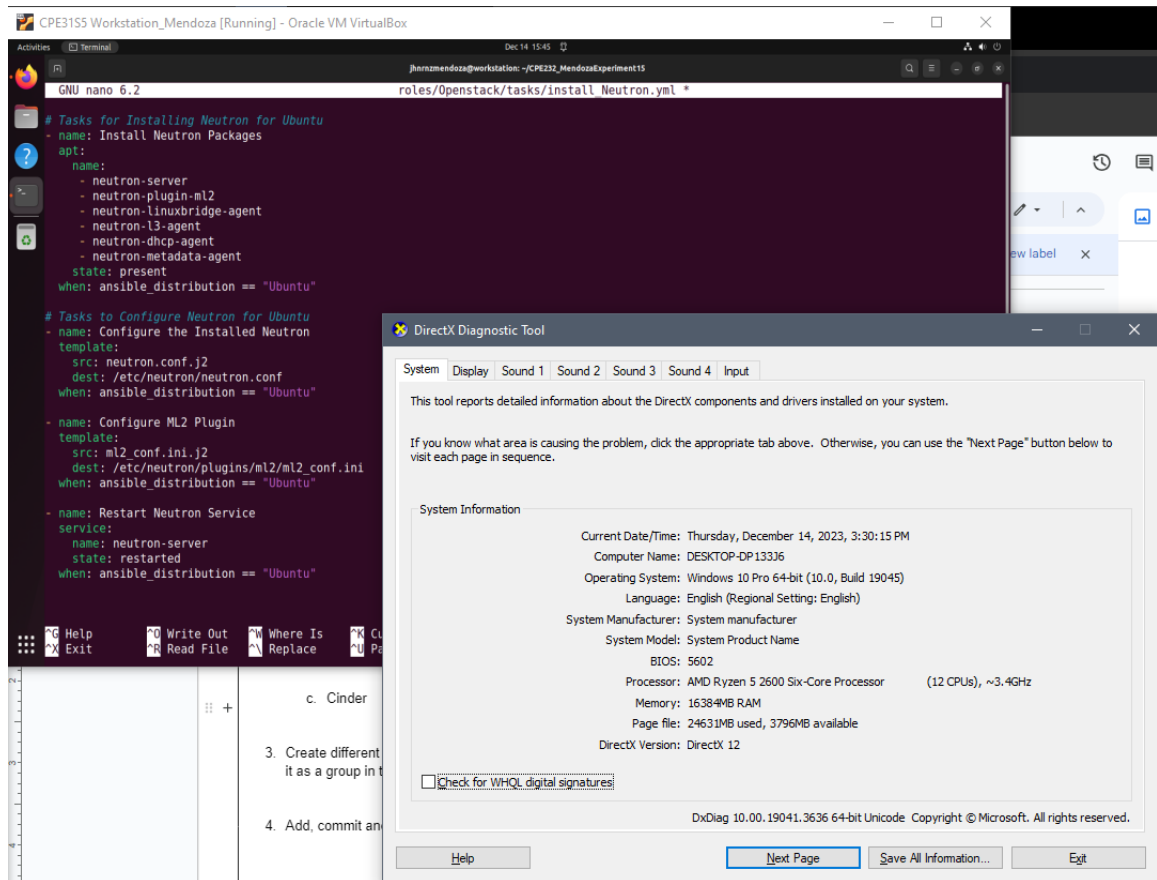
## Creation of the Inventory File which defines the Managed Nodes



# Creation of Ansible Role “OpenStack” to Organize the Playbook Tasks.



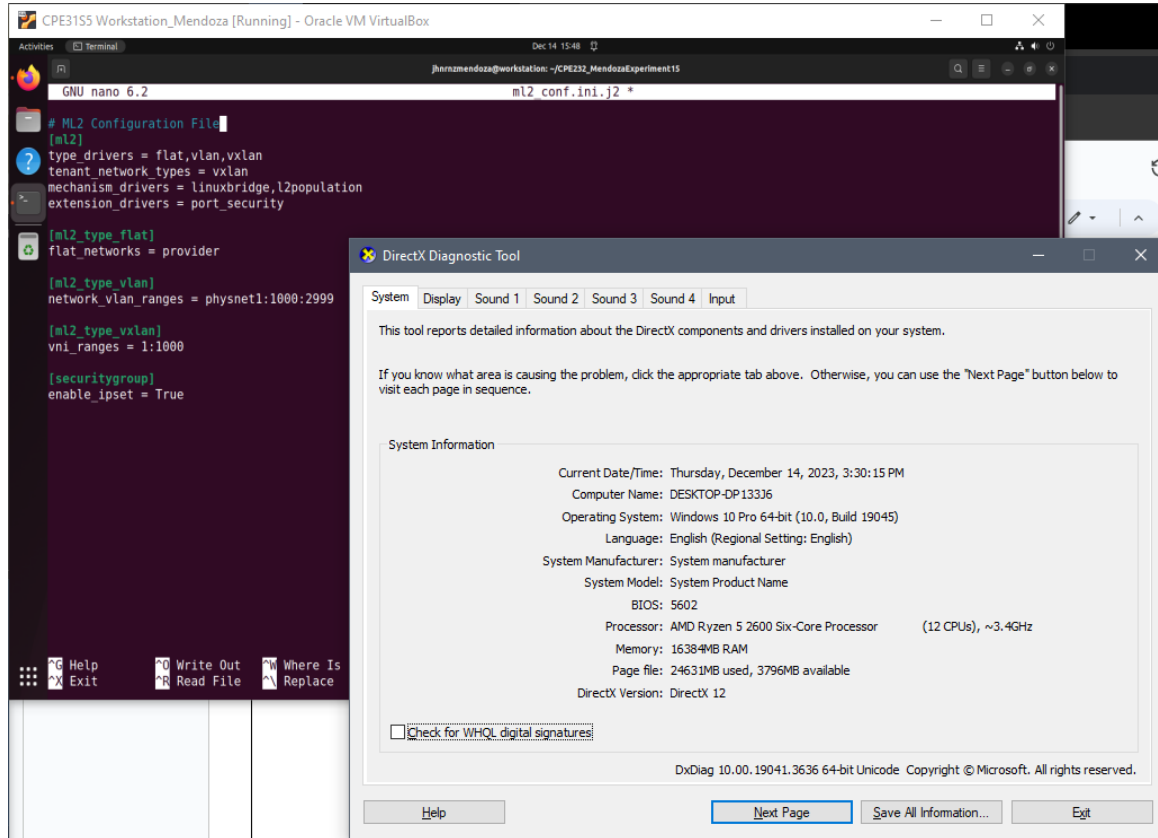
2. Create a playbook that converts the steps in the following items in [OpenStack Installation Guide](#).
  - a. Neutron



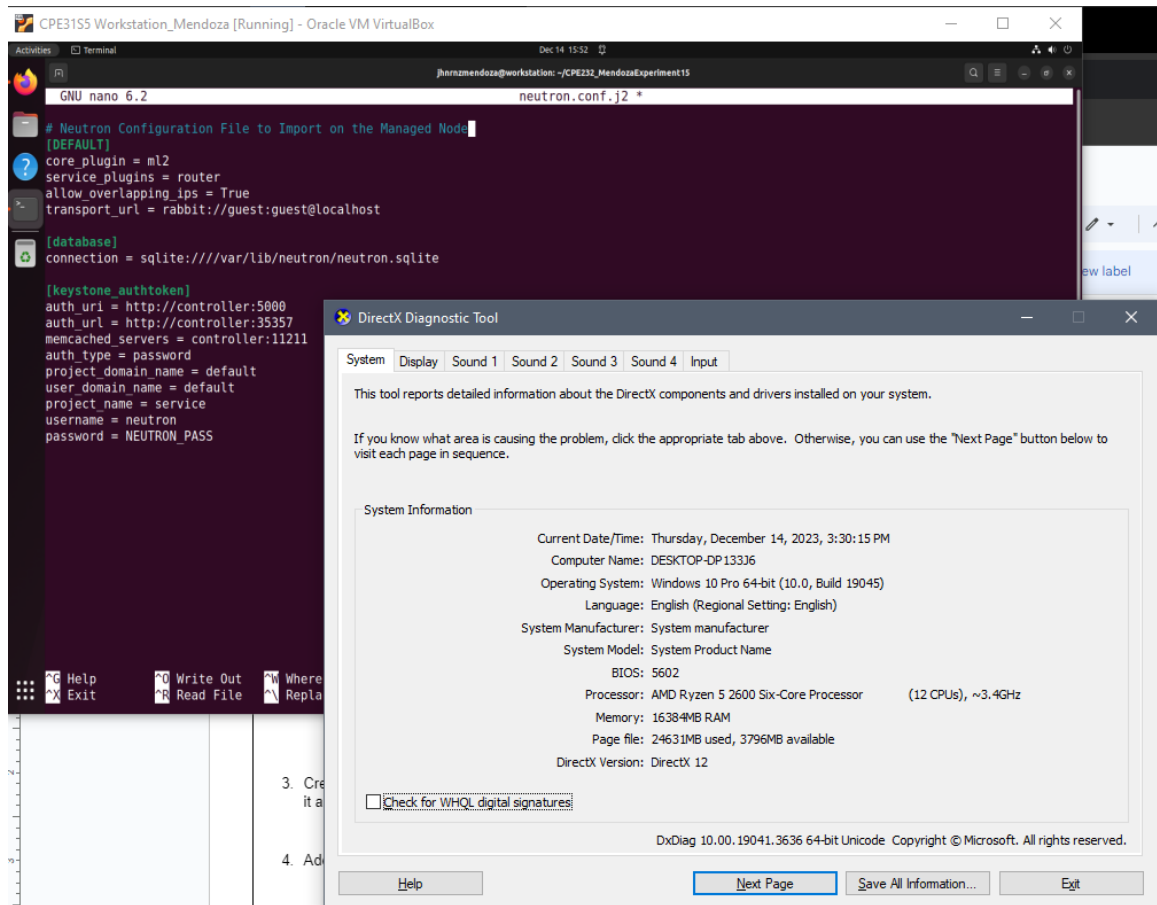
Observation:

- These tasks are on the yml file install\_Neutron.yml. It will initially install packages related to Neutron service. Then, it will load the configuration file defined on a separate .j2 file which contains the defaults for the installed package.

## Files to Import to the Managed Node



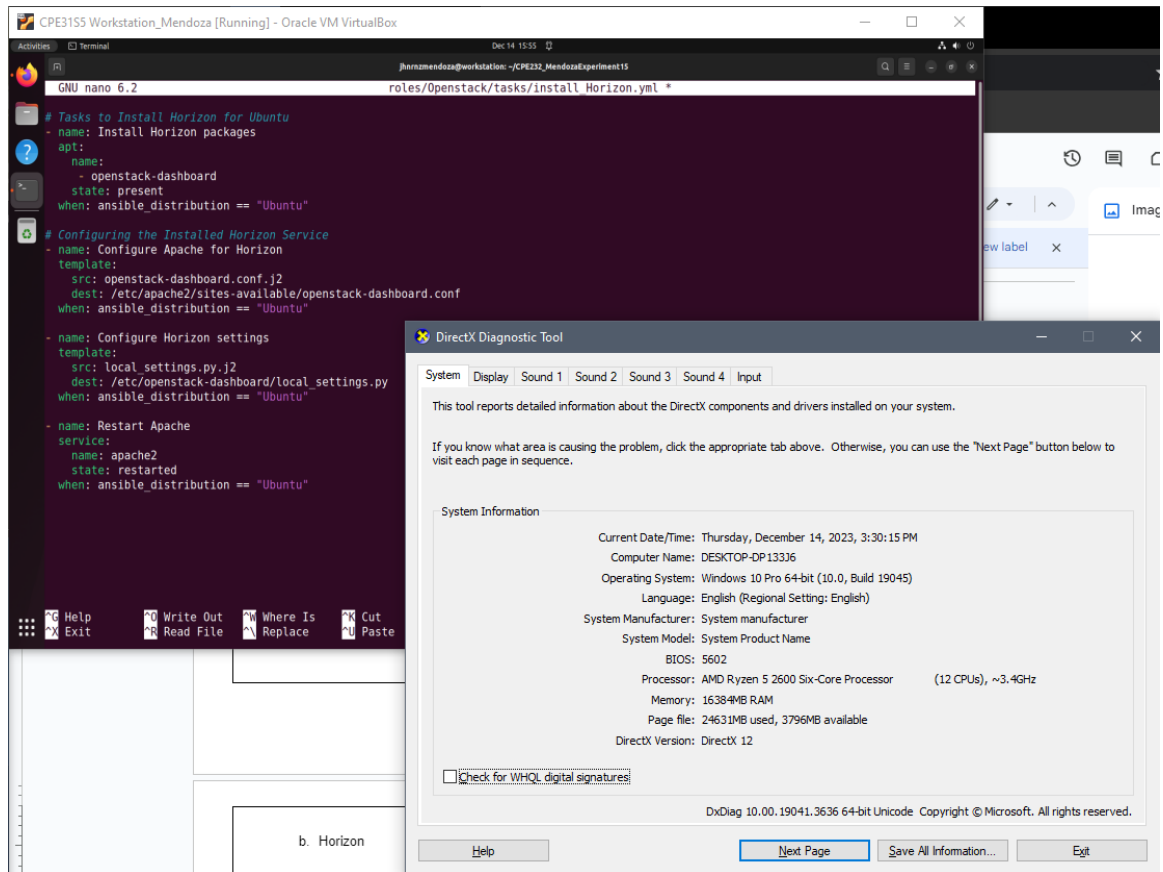




### Observation:

- In this Jinja template file, it contains the configurations that will be used by the playbook so that the task would import these configuration data to the remote managed node.

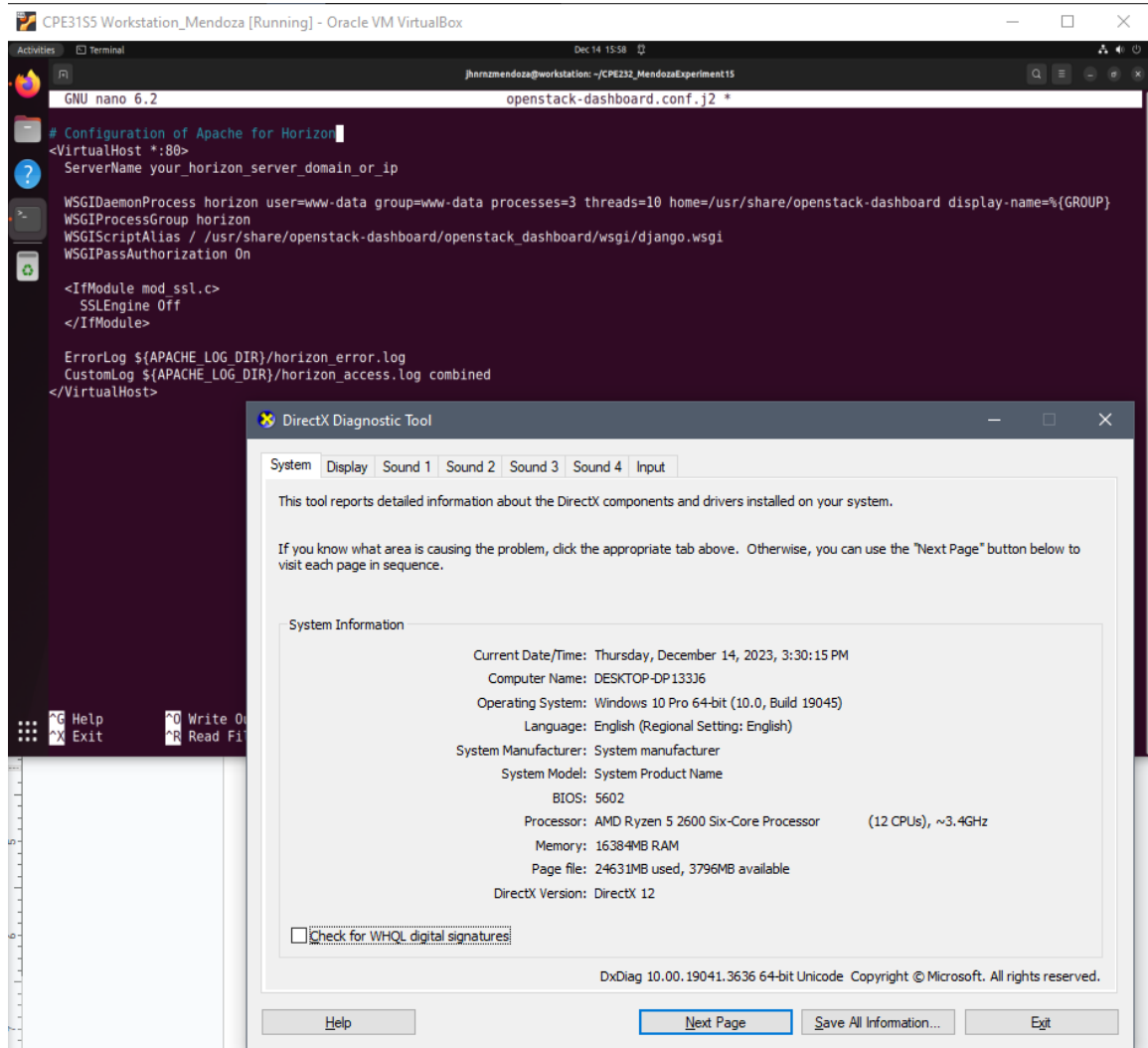
## b. Horizon

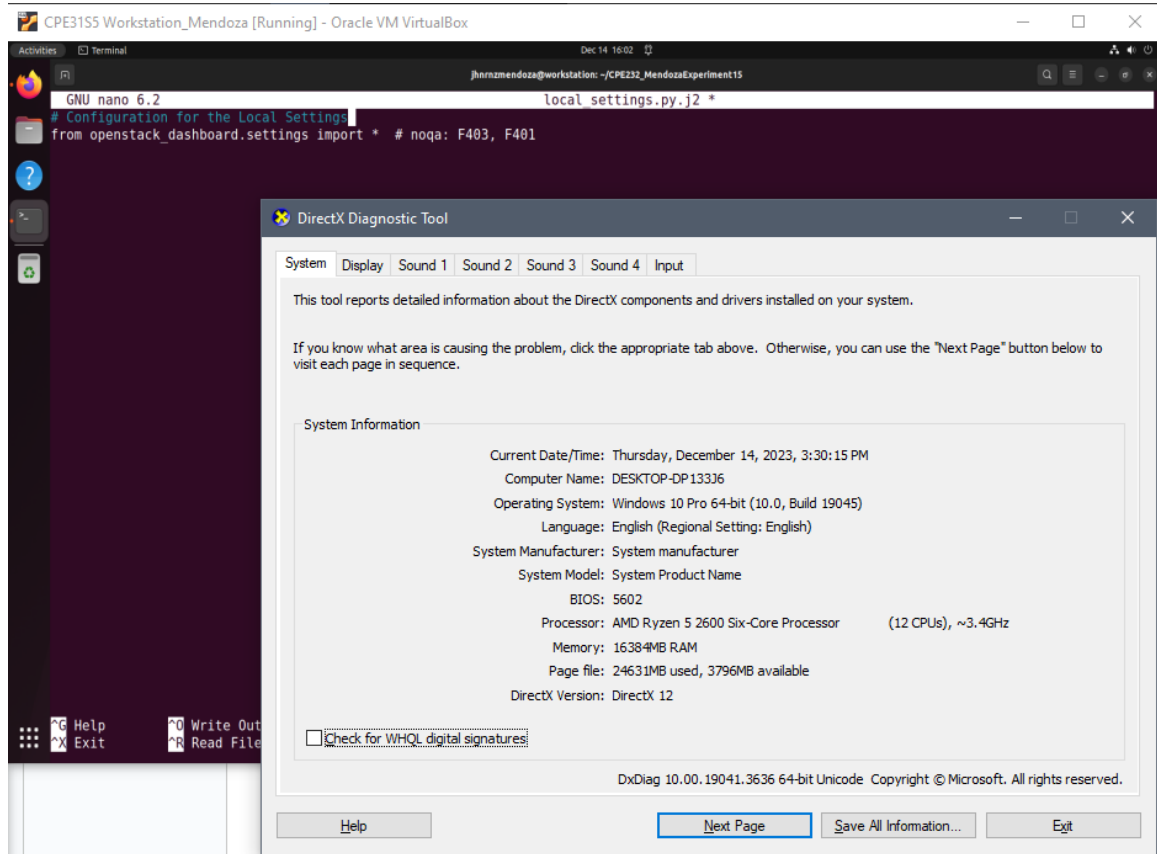


### Observation:

- These tasks are on the yml file `install_Horizon.yml`. It will initially install packages related to Horizon service. Then, it will load the configuration file defined on a separate `.j2` file which contains the defaults for the installed package.

## Files to Import to the Managed Node

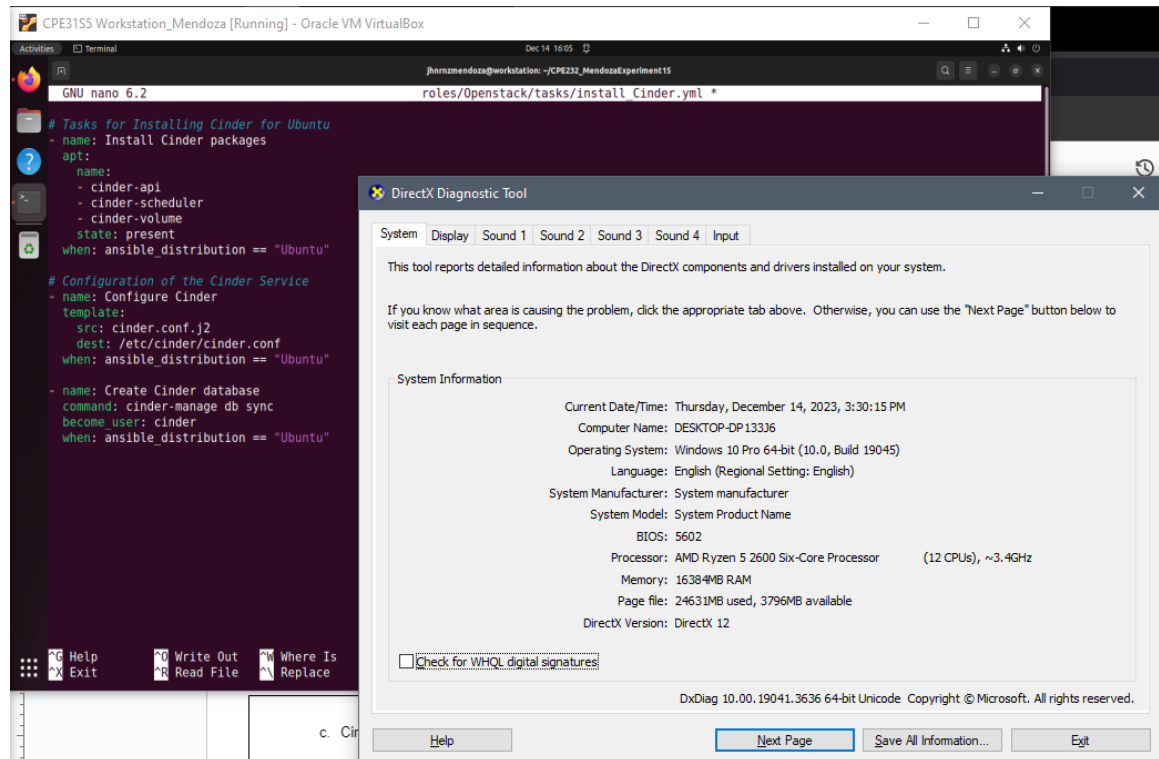




#### Observation:

- In this Jinja template file, it contains the configurations that will be used by the playbook so that the task would import these configuration data to the remote managed node.

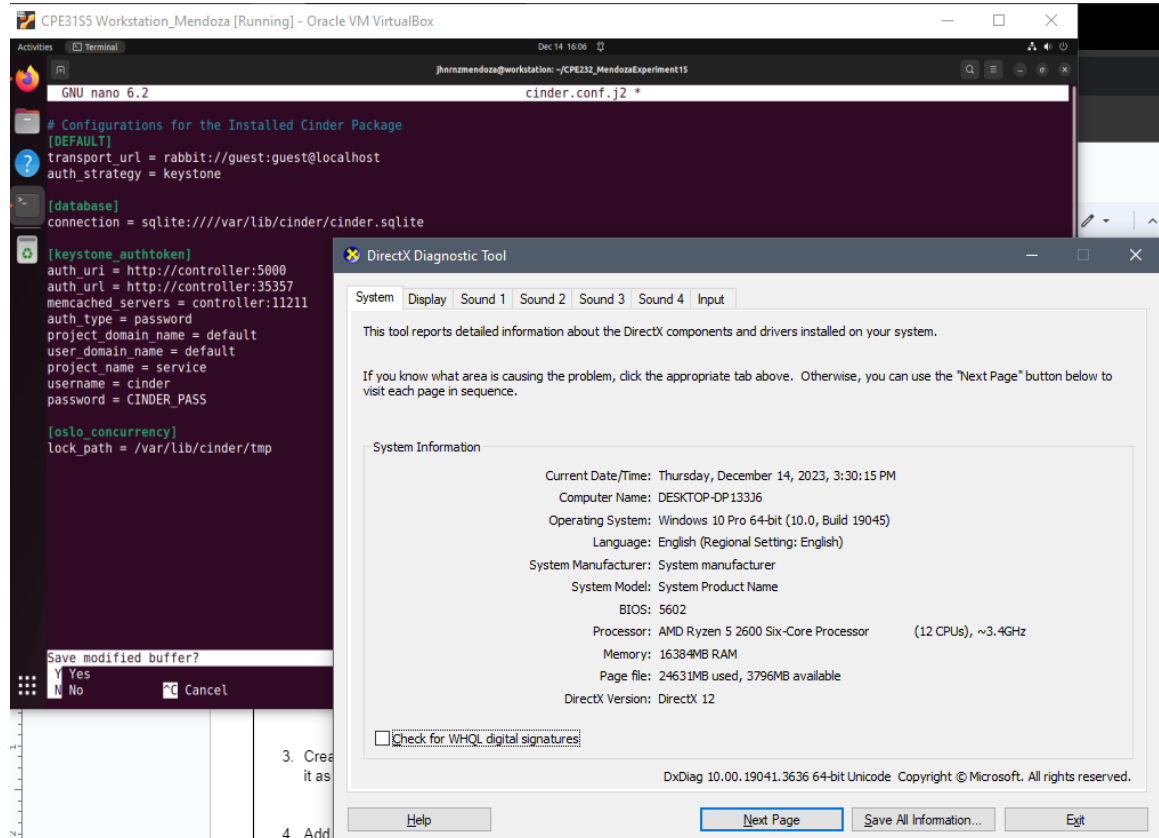
### c. Cinder



#### Observation:

- These tasks are on the yml file install\_Cinder.yml. It will initially install packages related to Cinder service. Then, it will load the configuration file defined on a separate .j2 file which contains the defaults for the installed package.

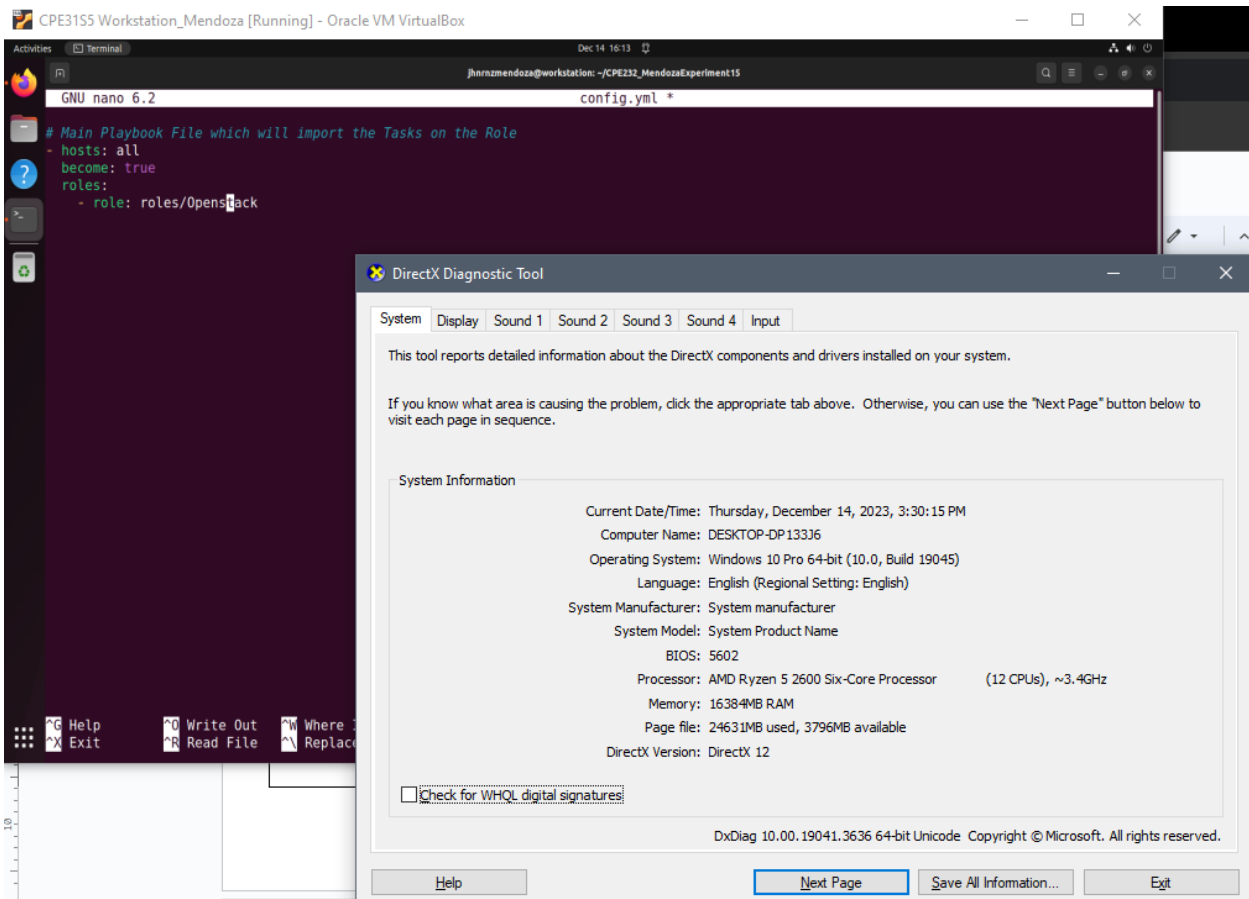
## Files to Import to the Managed Node

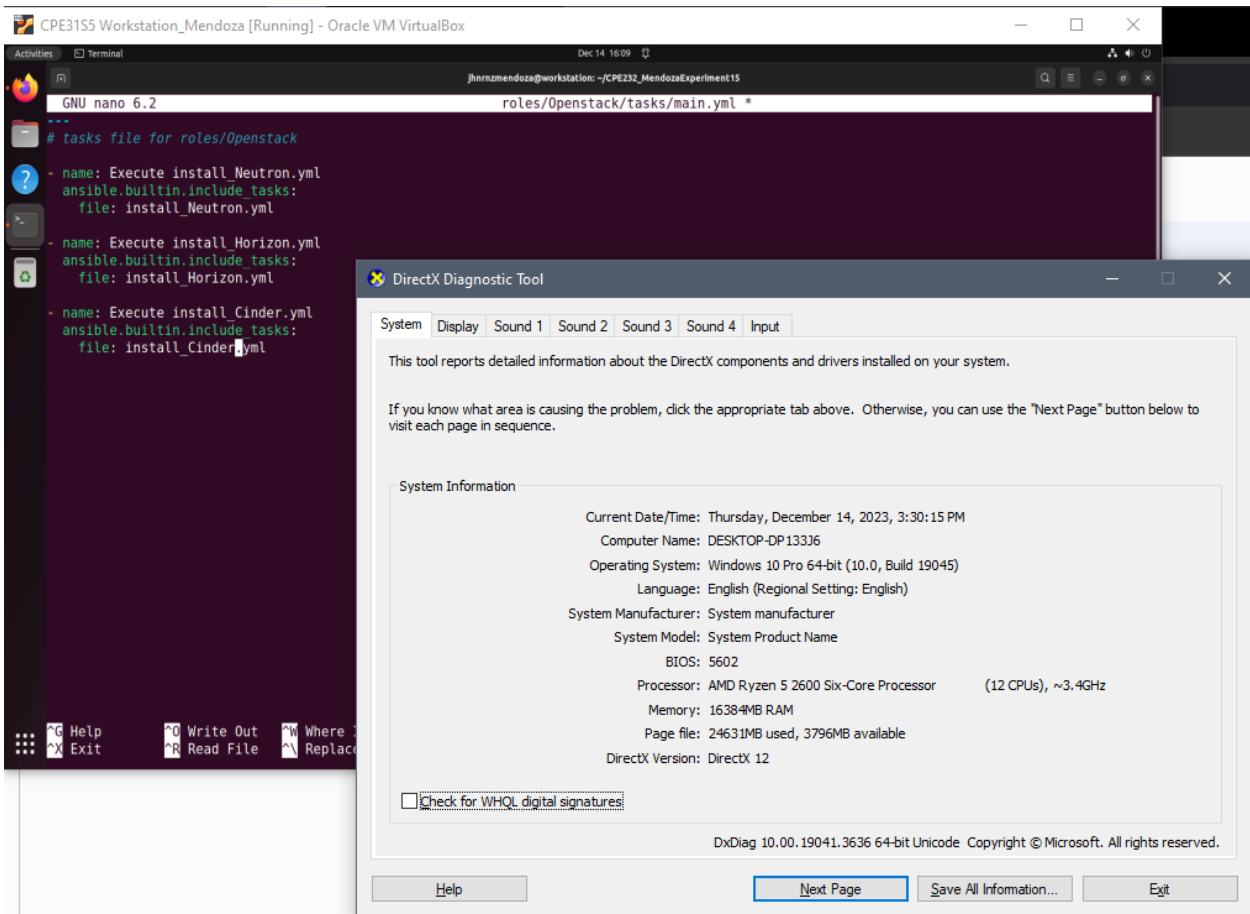


### Observation:

- In this Jinja template file, it contains the configurations that will be used by the playbook so that the task would import these configuration data to the remote managed node.

3. Create different plays in installing per server type (controller, compute etc.) and identify it as a group in the Inventory file.





### Observation:

- In this main.yml file defined on the roles/Openstack/tasks/ directory, the tasks required to install the services Neutron, Horizon, and Cinder are listed. This is made so that the installation is much organized and just importing the tasks if needed.



# Playbook Output

CPE31S5 Workstation\_Mendoza [Running] - Oracle VM VirtualBox

Dec 14 17:23

ActivitiesTerminal

jhnrmendoza@workstation: ~/CPE232\_MendozaExperiment15

jhnrmendoza@workstation:~/CPE232\_MendozaExperiment15\$ ansible-playbook --ask-become-pass config.yml

BECOME password:

PLAY [all]

TASK [Gathering Facts]

ok: [192.168.56.105]

ok: [192.168.56.109]

TASK [roles/Openstack : Execute install\_Neutron.yml]

included: /home/jhnrmendoza/CPE232\_MendozaExperiment15/roles/Openstack/tasks/install\_Neutron.yml for 192.168.56.105, 192.168.56.109

TASK [roles/Openstack : Install Neutron Packages]

changed: [192.168.56.105]

changed: [192.168.56.109]

TASK [roles/Openstack : Configure the Installed Neutron]

changed: [192.168.56.109]

changed: [192.168.56.105]

TASK [roles/Openstack : Configure ML2 Plugin]

changed: [192.168.56.105]

changed: [192.168.56.109]

TASK [roles/Openstack : Restart Neutron Service]

changed: [192.168.56.109]

changed: [192.168.56.105]

TASK [roles/Openstack : Exe

included: /home/jhnrmendoza

TASK [roles/Openstack : Ins

changed: [192.168.56.105]

changed: [192.168.56.109]

TASK [roles/Openstack : Con

changed: [192.168.56.105]

changed: [192.168.56.109]

DirectX Diagnostic Tool

SystemDisplaySound 1Sound 2Sound 3Sound 4Input

This tool reports detailed information about the DirectX components and drivers installed on your system.

If you know what area is causing the problem, click the appropriate tab above. Otherwise, you can use the "Next Page" button below to visit each page in sequence.

System Information

Current Date/Time: Thursday, December 14, 2023, 3:30:15 PM

Computer Name: DESKTOP-DP133J6

Operating System: Windows 10 Pro 64-bit (10.0, Build 19045)

Language: English (Regional Setting: English)

System Manufacturer: System manufacturer

System Model: System Product Name

BIOS: 5602

Processor: AMD Ryzen 5 2600 Six-Core Processor (12 CPUs), ~3.4GHz

Memory: 16384MB RAM

Page file: 24631MB used, 3796MB available

DirectX Version: DirectX 12

☐ Check for WHQL digital signatures

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HelpNext PageSave All Information...Exit

Activities Terminal Dec 14 17:24 jhnrnmendoza@workstation: ~/CPE232\_MendozaExperiment15

```
TASK [roles/Openstack : Execute install_Horizon.yml] *****
included: /home/jhnrnmendoza/CPE232_MendozaExperiment15/roles/Openstack/tasks/install_Horizon.yml for 192.168.56.105, 192.168.56.109

TASK [roles/Openstack : Install Horizon packages] *****
changed: [192.168.56.105]
changed: [192.168.56.109]

TASK [roles/Openstack : Configure Apache for Horizon] *****
changed: [192.168.56.105]
changed: [192.168.56.109]

TASK [roles/Openstack : Configure Horizon settings] *****
changed: [192.168.56.105]
changed: [192.168.56.109]

TASK [roles/Openstack : Restart Apache] *****
changed: [192.168.56.105]
changed: [192.168.56.109]

TASK [roles/Openstack : Execute install_Cinder.yml] *****
included: /home/jhnrnmendoza/CPE232_MendozaExperiment15/roles/Openstack/tasks/install_Cinder.yml for 192.168.56.105, 192.168.56.109

TASK [roles/Openstack : Install Cinder packages] *****
changed: [192.168.56.105]
changed: [192.168.56.109]

TASK [roles/Openstack : Configure Cinder] *****
changed: [192.168.56.109]
changed: [192.168.56.105]

TASK [roles/Openstack : Create Cinder database] *****
[WARNING]: Module remote_t
running as another user. T
changed: [192.168.56.105]
changed: [192.168.56.109]

PLAY RECAP *****
192.168.56.105
192.168.56.109
```

DirectX Diagnostic Tool

System Display Sound 1 Sound 2 Sound 3 Sound 4 Input

This tool reports detailed information about the DirectX components and drivers installed on your system.

If you know what area is causing the problem, click the appropriate tab above. Otherwise, you can use the "Next Page" button below to visit each page in sequence.

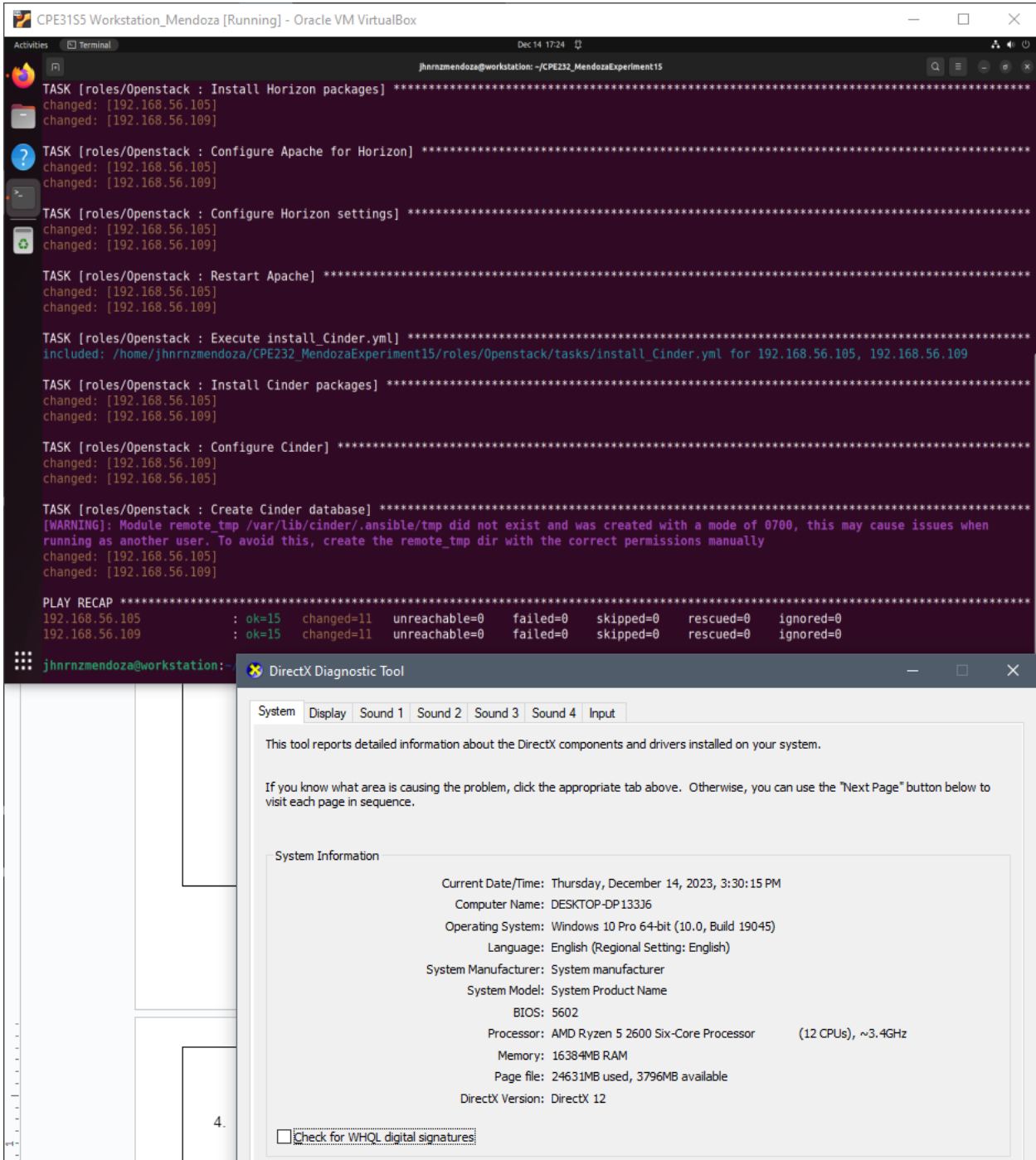
System Information

Current Date/Time: Thursday, December 14, 2023, 3:30:15 PM  
Computer Name: DESKTOP-DP13336  
Operating System: Windows 10 Pro 64-bit (10.0, Build 19045)  
Language: English (Regional Setting: English)  
System Manufacturer: System manufacturer  
System Model: System Product Name  
BIOS: 5602  
Processor: AMD Ryzen 5 2600 Six-Core Processor (12 CPUs), ~3.4GHz  
Memory: 16384MB RAM  
Page file: 24631MB used, 3796MB available  
DirectX Version: DirectX 12

☐ Check for WHQL digital signatures

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Help Next Page Save All Information... Exit



#### Observation:

- In running the ansible playbook, it has successfully run the tasks from the three sub-playbooks defined under the Openstack role. As observed, both of the servers have been changed and installed the services.

# Verification: Installed OpenStack Services on Remote Server 1

```
jhnrmendoza@Server1:~$ sudo systemctl status cinder-scheduler.service
● cinder-scheduler.service - OpenStack Cinder Scheduler
   Loaded: loaded (/lib/systemd/system/cinder-scheduler.service; enabled; vendor preset: enabled)
   Active: active (running) since Thu 2023-12-14 20:33:36 +08; 3min 25s ago
     Docs: man:cinder-scheduler(1)
    Main PID: 22175 (cinder-scheduler)
      Tasks: 1 (limit: 4602)
     Memory: 107.1M
        CPU: 2.542s
    CGroup: /system.slice/cinder-scheduler.service
            └─22175 /usr/bin/python3 /usr/bin/cinder-scheduler --config-file=/etc/cinder/cinder.conf --log-file=/var/log/cinder/ci

Dec 14 20:33:36 Server1 systemd[1]: Started OpenStack Cinder Scheduler.
Dec 14 20:33:39 Server1 cinder-scheduler[22175]: /usr/lib/python3/dist-packages/cinder/db/sqlalchemy/models.py:152: SAWarning: impl
Dec 14 20:33:39 Server1 cinder-scheduler[22175]: last_heartbeat = column_property(
Dec 14 20:33:39 Server1 cinder-scheduler[22175]: /usr/lib/python3/dist-packages/cinder/db/sqlalchemy/models.py:160: SAWarning: impl
Dec 14 20:33:39 Server1 cinder-scheduler[22175]: num_hosts = column_property(
Dec 14 20:33:39 Server1 cinder-scheduler[22175]: /usr/lib/python3/dist-packages/cinder/db/sqlalchemy/models.py:169: SAWarning: impl
Dec 14 20:33:39 Server1 cinder-scheduler[22175]: num_down_hosts = column_property(
jhnrmendoza@Server1:~$ dpkg -l | grep horizon
ii python3-django-horizon 4:22.1.1-0ubuntu1 all Django module providing web base
d interaction with OpenStack (Python 3)
jhnrmendoza@Server1:~$ sudo systemctl status neutron-server.service
● neutron-server.service - OpenStack Neutron Server
   Loaded: loaded (/lib/systemd/system/neutron-server.service; enabled; vendor preset: enabled)
   Active: active (running) since Thu 2023-12-14 20:37:12 +08; 3s ago
     Docs: man:neutron-server(1)
    Main PID: 24105 (neutron-server)
      Tasks: 1 (limit: 4602)
     Memory: 100.4M
        CPU: 2.360s
    CGroup: /system.slice/neutron-server.service
            └─24105 /usr/bin/python3 /usr/bin/neutron-server --config-file=/etc/neutron/neutron.conf --config-file=/etc/neutron/p

Dec 14 20:37:12 Server1 systemd[1]: Started OpenStack Neutron Server.
jhnrmendoza@Server1:~$
```

1.

2.

System

Display

Sound 1

Sound 2

Sound 3

Sound 4

Input

This tool reports detailed information about the DirectX components and drivers installed on your system.

If you know what area is causing the problem, click the appropriate tab above. Otherwise, you can use the "Next Page" button below to visit each page in sequence.

System Information

Current Date/Time: Thursday, December 14, 2023, 3:30:15 PM

Computer Name: DESKTOP-DP133J6

Operating System: Windows 10 Pro 64-bit (10.0, Build 19045)

Language: English (Regional Setting: English)

System Manufacturer: System manufacturer

System Model: System Product Name

BIOS: 5602

Processor: AMD Ryzen 5 2600 Six-Core Processor (12 CPUs), ~3.4GHz

Memory: 16384MB RAM

Page file: 24631MB used, 3796MB available

DirectX Version: DirectX 12

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## Verification: Installed OpenStack Services on Remote Server 2

CPE31S5 Server1 - Mendoza [Running] - Oracle VM VirtualBox

Activities Terminal

Dec 14 20:43

jhrnzmendoza@Server2: ~

jhrnzmendoza@Server2:~\$ sudo systemctl status neutron-server.service

[sudo] password for jhrnzmendoza:

● neutron-server.service - OpenStack Neutron Server

Loaded: loaded (/lib/systemd/system/neutron-server.service; enabled; vendor preset: enabled)

Active: active (running) since Thu 2023-12-14 20:42:43 +08; 2s ago

Docs: man:neutron-server(1)

Main PID: 3614 (neutron-server)

Tasks: 1 (limit: 4596)

Memory: 67.1M

CPU: 1.519s

CGroup: /system.slice/neutron-server.service

└─3614 /usr/bin/python3 /usr/bin/neutron-server --config-file=/etc/neutron/neutron.conf --config-file=/etc/neutron/plu

Dec 14 20:42:43 Server2 systemd[1]: Started OpenStack Neutron Server.

jhrnzmendoza@Server2:~\$ dpkg -l | grep horizon

ii python3-django-horizon 4:22.1.1-0ubuntu1 all Django module providing web base

d interaction with OpenStack (Python 3)

jhrnzmendoza@Server2:~\$ sudo systemctl status cinder-scheduler.service

● cinder-scheduler.service - OpenStack Cinder Scheduler

Loaded: loaded (/lib/systemd/system/cinder-scheduler.service; enabled; vendor preset: enabled)

Active: active (running) since Thu 2023-12-14 20:39:33 +08; 3min 29s ago

Docs: man:cinder-scheduler(1)

Main PID: 794 (cinder-schedule)

Tasks: 1 (limit: 4596)

Memory: 141.0M

CPU: 2.832s

CGroup: /system.slice/cinder-scheduler.service

└─794 /usr/bin/python3 /usr/bin/cinder-scheduler --config-file=/etc/cinder/cinder.conf --log-file=/var/log/cinder/cind

Dec 14 20:39:33 Server2 systemd[1]: Started OpenStack Cinder Scheduler.

Dec 14 20:39:55 Server2 cinder-scheduler[794]: /usr/lib/python3/dist-packages/cinder/db/sqlalchemy/models.py:152: SAWarning: implic

Dec 14 20:39:55 Server2 cinder-scheduler[794]: last\_heartbeat = column\_property(

Dec 14 20:39:55 Server2 cinder-scheduler[794]: /usr/lib/python3/dist-packages/cinder/db/sqlalchemy/models.py:160: SAWarning: implic

Dec 14 20:39:55 Server2 cinder-scheduler[794]: num\_hosts = column\_property(

Dec 14 20:39:55 Server2 cinder-scheduler[794]: /usr/lib/python3/dist-packages/cinder/db/sqlalchemy/models.py:169: SAWarning: implic

jhrnzmendoza@Server2:~\$

DirectX Diagnostic Tool

System Display Sound 1 Sound 2 Sound 3 Sound 4 Input

This tool reports detailed information about the DirectX components and drivers installed on your system.

If you know what area is causing the problem, click the appropriate tab above. Otherwise, you can use the "Next Page" button below to visit each page in sequence.

System Information

Current Date/Time: Thursday, December 14, 2023, 3:30:15 PM

Computer Name: DESKTOP-DP133J6

Operating System: Windows 10 Pro 64-bit (10.0, Build 19045)

Language: English (Regional Setting: English)

System Manufacturer: System manufacturer

System Model: System Product Name

BIOS: 5602

Processor: AMD Ryzen 5 2600 Six-Core Processor (12 CPUs), ~3.4GHz

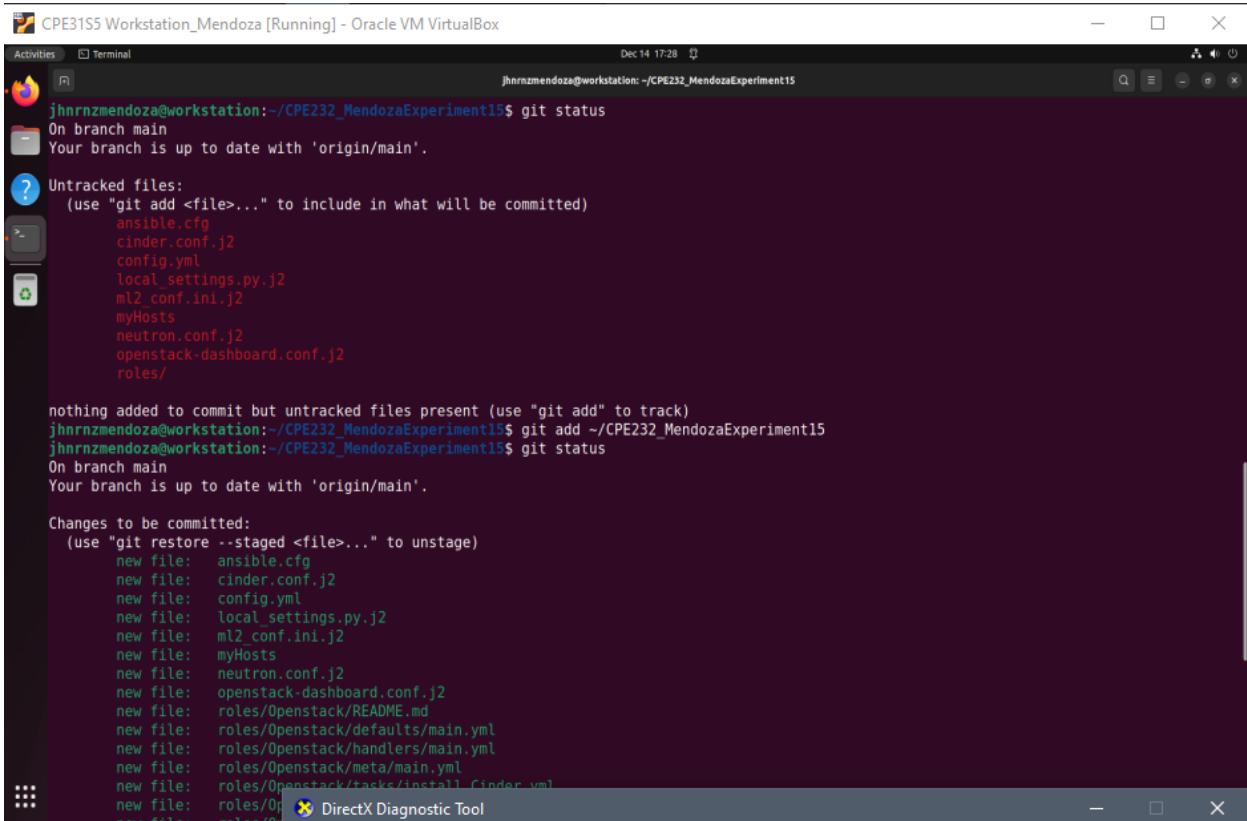
Memory: 16384MB RAM

Page file: 24631MB used, 3796MB available

DirectX Version: DirectX 12

Check for Windows digital signatures

#### 4. Add, commit and push it to your GitHub repository.



```
CPE3155 Workstation_Mendoza [Running] - Oracle VM VirtualBox
Dec 14 17:28
jhrnmendoza@workstation: ~/CPE232_MendozaExperiment15
jhrnmendoza@workstation:~/CPE232_MendozaExperiment15$ git status
On branch main
Your branch is up to date with 'origin/main'.

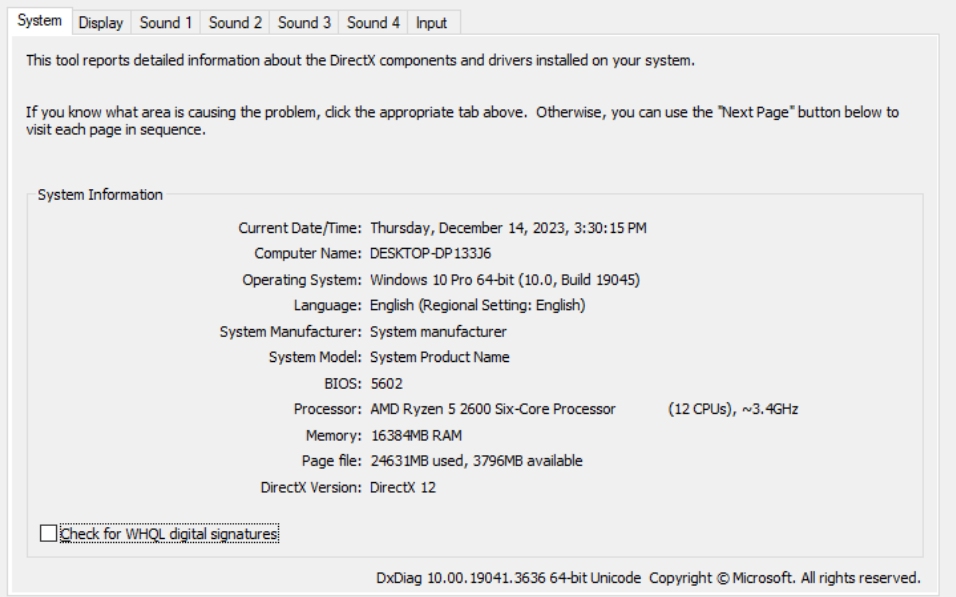
Untracked files:
  (use "git add <file>..." to include in what will be committed)
        ansible.cfg
        cinder.conf.j2
        config.yml
        local_settings.py.j2
        ml2_conf.ini.j2
        myHosts
        neutron.conf.j2
        openstack-dashboard.conf.j2
        roles/

nothing added to commit but untracked files present (use "git add" to track)
jhrnmendoza@workstation:~/CPE232_MendozaExperiment15$ git add ~/CPE232_MendozaExperiment15
jhrnmendoza@workstation:~/CPE232_MendozaExperiment15$ git status
On branch main
Your branch is up to date with 'origin/main'.

Changes to be committed:
  (use "git restore --staged <file>..." to unstage)
        new file:   ansible.cfg
        new file:   cinder.conf.j2
        new file:   config.yml
        new file:   local_settings.py.j2
        new file:   ml2_conf.ini.j2
        new file:   myHosts
        new file:   neutron.conf.j2
        new file:   openstack-dashboard.conf.j2
        new file:   roles/Openstack/README.md
        new file:   roles/Openstack/defaults/main.yml
        new file:   roles/Openstack/handlers/main.yml
        new file:   roles/Openstack/meta/main.yml
        new file:   roles/Openstack/tasks/install_cinder.yml
        new file:   roles/Openstack/tasks/install_neutron.yml
```

1 push it to your GitHub repository

horizon and Cinder services



System | Display | Sound 1 | Sound 2 | Sound 3 | Sound 4 | Input

This tool reports detailed information about the DirectX components and drivers installed on your system.

If you know what area is causing the problem, click the appropriate tab above. Otherwise, you can use the "Next Page" button below to visit each page in sequence.

System Information

Current Date/Time: Thursday, December 14, 2023, 3:30:15 PM	
Computer Name: DESKTOP-DP13336	
Operating System: Windows 10 Pro 64-bit (10.0, Build 19045)	
Language: English (Regional Setting: English)	
System Manufacturer: System manufacturer	
System Model: System Product Name	
BIOS: 5602	
Processor: AMD Ryzen 5 2600 Six-Core Processor	(12 CPUs), ~3.4GHz
Memory: 16384MB RAM	
Page file: 24631MB used, 3796MB available	
DirectX Version: DirectX 12	

☐ Check for WHQL digital signatures

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```
Activities Terminal Dec 14 17:29 jhnrzmendoza@workstation: ~/CPE232_MendozaExperiment15

[main 660e1da] Experiment 15
19 files changed, 295 insertions(+)
create mode 100644 ansible.cfg
create mode 100644 cinder.conf.j2
create mode 100644 config.yml
create mode 100644 local_settings.py.j2
create mode 100644 ml2_conf.ini.j2
create mode 100644 myHosts
create mode 100644 neutron.conf.j2
create mode 100644 openstack-dashboard.conf.j2
create mode 100644 roles/Openstack/README.md
create mode 100644 roles/Openstack/defaults/main.yml
create mode 100644 roles/Openstack/handlers/main.yml
create mode 100644 roles/Openstack/meta/main.yml
create mode 100644 roles/Openstack/tasks/install_Cinder.yml
create mode 100644 roles/Openstack/tasks/install_Horizon.yml
create mode 100644 roles/Openstack/tasks/install_Neutron.yml
create mode 100644 roles/Openstack/tasks/main.yml
create mode 100644 roles/Openstack/tests/inventory
create mode 100644 roles/Openstack/tests/test.yml
create mode 100644 roles/Openstack/vars/main.yml
jhnrzmendoza@workstation:~/CPE232_MendozaExperiment15$ git push origin main
ssh: Could not resolve hostname github.com: Temporary failure in name resolution
fatal: Could not read from remote repository.

Please make sure you have the correct access rights
and the repository exists.
jhnrzmendoza@workstation:~/CPE232_MendozaExperiment15$ git push origin main
Enumerating objects: 30, done.
Counting objects: 100% (30/30), done.
Delta compression using up to 2 threads
Compressing objects: 100% (20/20), done.
Writing objects: 100% (29/29), 5.14 KiB | 876.00 KiB/s, done.
Total 29 (delta 1), reused 0 (delta 0), pack-reused 0
remote: Resolving deltas: 100% (1/1), done.
To github.com:MendozaJRL/CPE232_MendozaExperiment15.git
1f1afd8..660e1da main -> main
jhnrzmendoza@workstation:~/CPE232_MendozaExperiment15$
```

DirectX Diagnostic Tool

System Display Sound 1 Sound 2 Sound 3 Sound 4 Input

This tool reports detailed information about the DirectX components and drivers installed on your system.

If you know what area is causing the problem, click the appropriate tab above. Otherwise, you can use the "Next Page" button below to visit each page in sequence.

System Information

Current Date/Time: Thursday, December 14, 2023, 3:30:15 PM

Computer Name: DESKTOP-DP133J6

Operating System: Windows 10 Pro 64-bit (10.0, Build 19045)

Language: English (Regional Setting: English)

System Manufacturer: System manufacturer

System Model: System Product Name

BIOS: 5602

Processor: AMD Ryzen 5 2600 Six-Core Processor (12 CPUs), ~3.4GHz

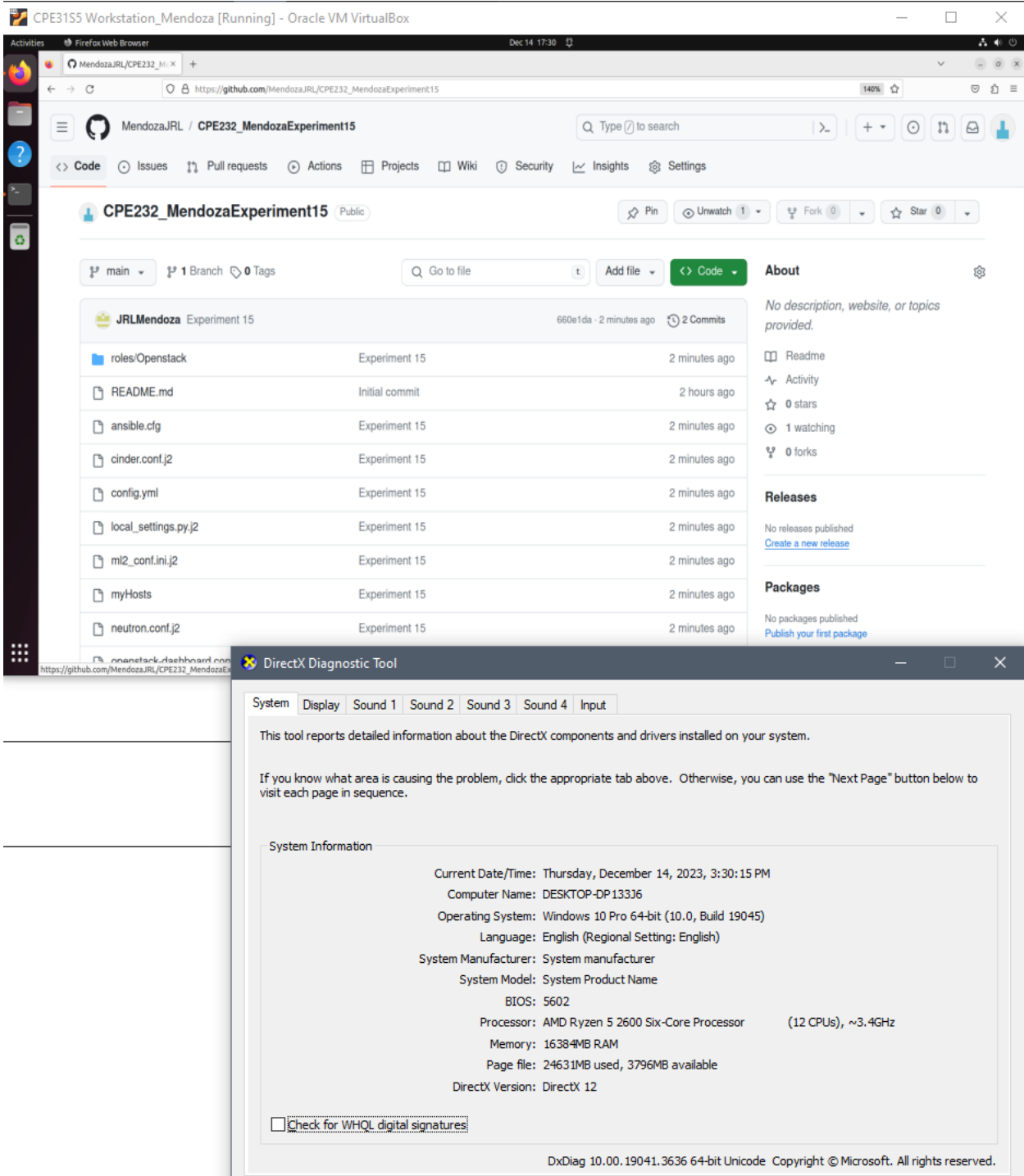
Memory: 16384MB RAM

Page file: 24631MB used, 3796MB available

DirectX Version: DirectX 12

horizon and Cinder services





#### Observation:

- Using Git commands, the changes on the local repository are added, committed, and has been pushed to the GitHub cloud repository. As observed, we can now access the changes made through the cloud platform.

GitHub Link: [https://github.com/MendozaJRL/CPE232\\_MendozaExperiment15.git](https://github.com/MendozaJRL/CPE232_MendozaExperiment15.git)



**Reflections:**

Answer the following:

1. Describe Neutron, Horizon and Cinder services

Neutron is an OpenStack feature which is responsible for network connections and topologies. For instance, it can help the user set-up a Virtual LAN to its network. Horizon is also an OpenStack feature which is similar to Nova that is responsible for a web-based user interface which offers support on APIs and interfaces. Cinder is an OpenStack feature which is responsible for handling block storages. It essentially controls the data storages of the device or server.

**Conclusions:**

In this activity, the students are introduced with the concepts of more OpenStack features such as Neutron, Horizon, and Cinder. As explained on the reflection part, Neutron is for network connections, Horizon is for APIs and interfaces, while cinder is for handling block storages. These three features may or may not be related to one another when used on the server environment as it may have different scope.

In addition, the students have successfully installed and implemented the OpenStack features from the installation guide as an Ansible code. The students have used previously learned topics such as creating Ansible Roles to further organize the playbook run. By organizing the tasks and importing them, the system administrator may just import the tasks anytime, if needed. Furthermore, the students may use and implement these learned concepts about OpenStack features on the future activities or projects which may require or may take advantage of these services.