IMPLEMENTATION OF VIRTUAL MACHINES

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1. Introduction

Virtualization is a core technology in modern computing that enables multiple operating systems to run simultaneously on a single physical machine. This is achieved by abstracting hardware resources such as CPU, memory, storage, and networking and presenting them as virtual environments called Virtual Machines (VMs). Each virtual machine operates as an independent computer with its own kernel, system libraries, and applications.

Unlike container-based virtualization, virtual machines rely on a hypervisor that emulates hardware and provides strong isolation between guest operating systems. This makes VMs highly secure and suitable for running different OS types on the same host system.

This experiment demonstrates the creation and execution of three types of virtual machines: Desktop Virtual Machine, Server Virtual Machine, and Cloud Virtual Machine. Using KVM/QEMU with Virtual Machine Manager on Kali Linux and AWS EC2 in the cloud, Ubuntu Desktop and Ubuntu Server operating systems are deployed. The experiment provides hands-on understanding of local and cloud virtualization environments.

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2. Aim

The aim of this experiment is to create and execute desktop, server, and cloud virtual machines using virtualization technologies and to understand their working principles, access methods, and real-world use cases.

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3. Objectives

- To understand the fundamentals of virtualization and hypervisors
- To install and configure local virtual machines using KVM/QEMU
- To create a GUI-based desktop virtual machine
- To create a headless server virtual machine and access it via SSH
- To launch a cloud virtual machine using AWS EC2
- To observe isolation and resource allocation in different VM types
- To compare local and cloud virtualization environments

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4. Software and System Requirements

Hardware Requirements

- Laptop/Desktop Computer
- Minimum 4 GB RAM
- Internet Connectivity

Software Requirements

- Host Operating System: Kali Linux
- Virtualization Tools: KVM / QEMU with Virtual Machine Manager (virt-manager)
- Cloud Platform: AWS EC2
- Guest Operating Systems:
    - Ubuntu Desktop 24.04 LTS
    - Ubuntu Server 22.04 LTS

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5. Virtual Machine Overview

A Virtual Machine (VM) is a software-based computer that emulates physical hardware and runs a complete operating system. Each VM has its own virtual CPU, memory, disk, and network interface.

Key characteristics of virtual machines include:

- Strong OS-level isolation
- Independent kernel per VM
- Enhanced security
- Ability to run multiple OS types
- Full hardware emulation using hypervisors

VMs differ from containers in that containers share the host kernel, whereas VMs run entirely separate operating systems.

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6. Virtualization Architecture

The virtualization stack consists of:

- Host Operating System (Kali Linux)
- Hypervisor (KVM/QEMU)
- Virtual Machine Manager (virt-manager)

- Guest Operating Systems (Ubuntu Desktop and Server)

For cloud virtualization:

- AWS Infrastructure
- EC2 Hypervisor
- Ubuntu Server AMI

Workflow:

Host System → Hypervisor → Virtual Machines → Guest OS → Applications

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7. Implementation Methodology

The implementation is carried out using three different approaches:

Method 1: Desktop Virtual Machine

Description

A desktop virtual machine provides a complete graphical user interface similar to a physical computer. Ubuntu Desktop 24.04 LTS is installed as the guest operating system using KVM/QEMU through virt-manager.

Procedure

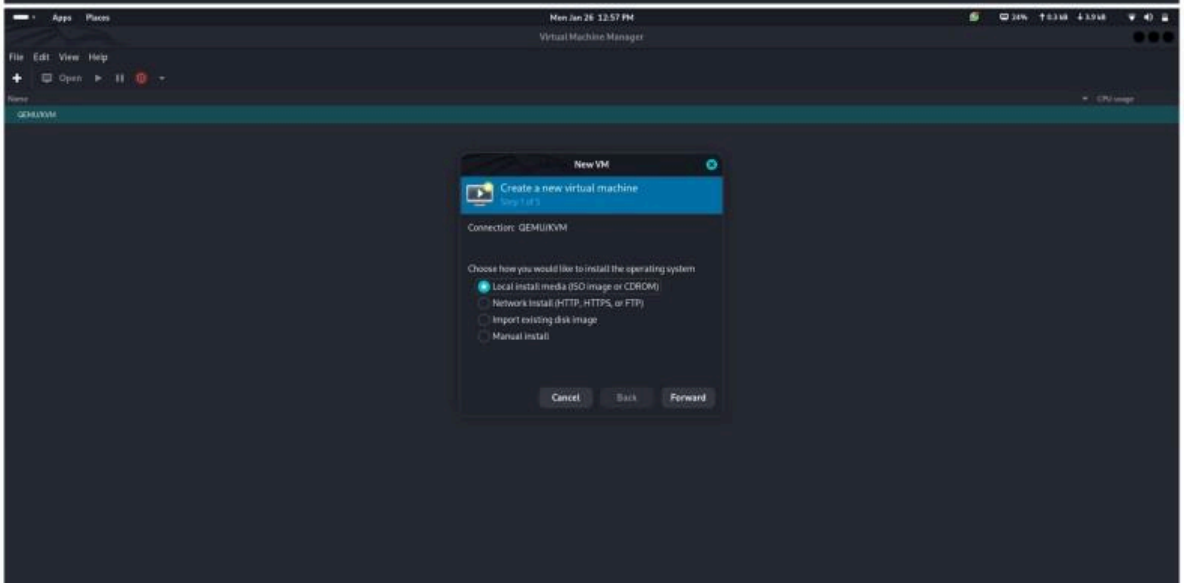
1. Virtual Machine Manager is launched using `virt-manager`.
2. A new virtual machine is created.
3. Local ISO installation media is selected.
4. Ubuntu Desktop 24.04 ISO file is chosen.
5. CPU cores, RAM, and disk storage are allocated.
6. Network is configured using default NAT.
7. Installation process is started.
8. Ubuntu installer steps are completed.
9. VM is restarted after installation.

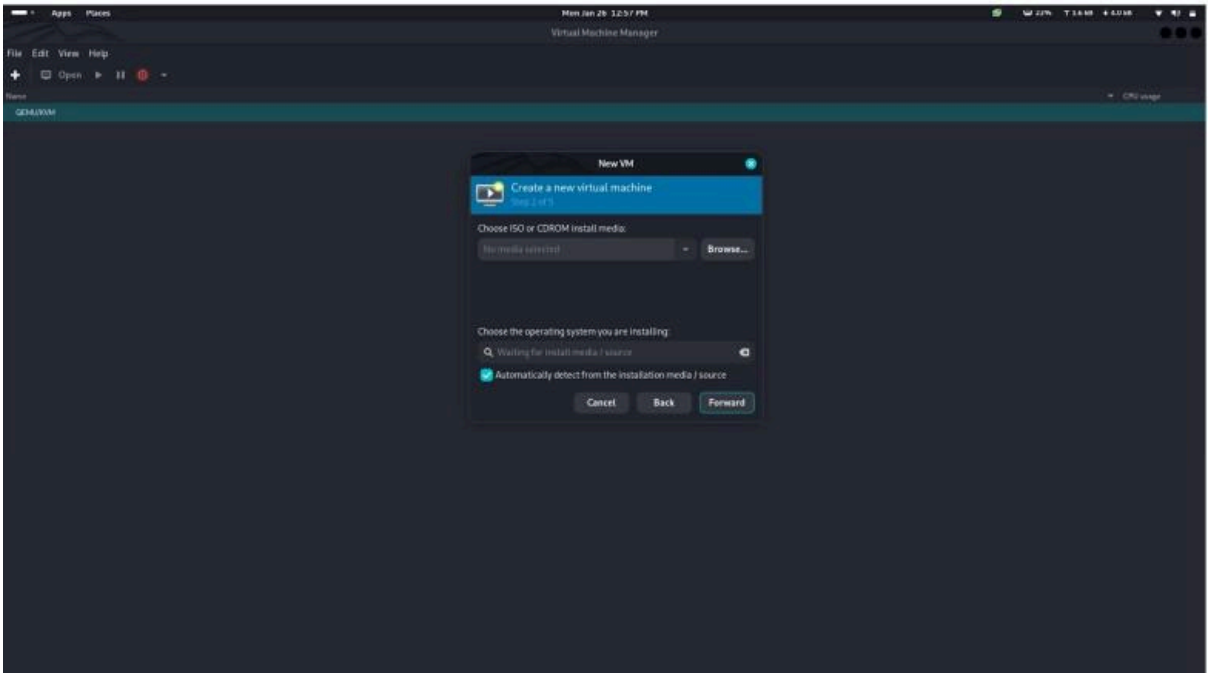
Observation

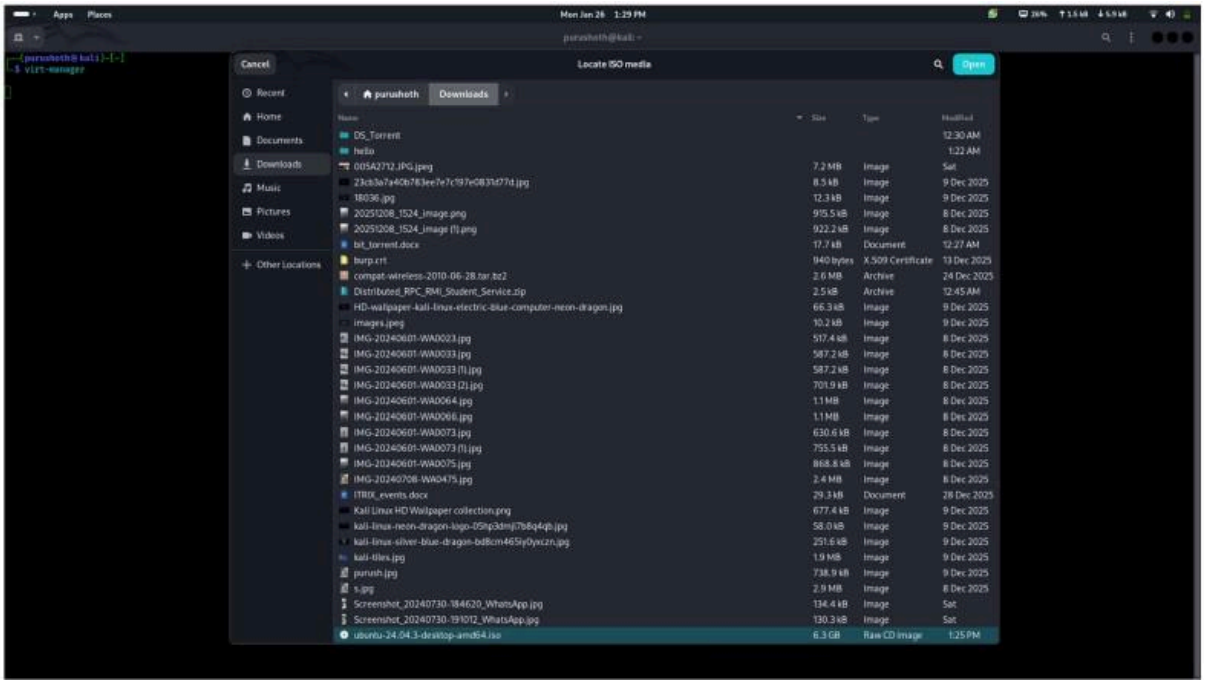
- Ubuntu Desktop graphical interface loaded successfully.
- Keyboard, mouse, and display worked normally.
- VM behaved like a physical desktop system.

This confirms successful deployment of a GUI-based desktop VM.


Apps
Places
Mon Jan 26 12:56 PM
Virtual Machine Manager
File Edit View Help
Open
QEMU/KVM


Apps
Places
Mon Jan 26 12:57 PM
Virtual Machine Manager
File Edit View Help
Open
QEMU/KVM
New VM
Create a new virtual machine
Step 1 of 5
Connection: QEMU/KVM
Choose how you would like to install the operating system
Local install media (ISO image or CDROM)
Network Install (HTTP, HTTPS, or FTP)
Import existing disk image
Manual install
Cancel
Back
Forward


Apps
Places
Mon Jan 26 12:57 PM
Virtual Machine Manager
File Edit View Help
Open
QEMU/KVM
New VM
Create a new virtual machine
Step 2 of 5
Choose ISO or CDROM install media:
No media selected
Browse...
Choose the operating system you are installing:
Waiting for install media / source
Automatically detect from the installation media / source
Cancel
Back
Forward


Apps
Places
Mon Jan 26 1:29 PM
purushoth@kali: ~
┌──(purushoth㉿kali)-[~]
└─$ virt-manager
Cancel
Locate ISO media
Open
Recent
Home
Documents
Downloads
Music
Pictures
Videos
Other Locations
purushoth
Downloads
Name
Size
Type
Modified
DS_Torrent
12:30 AM
hello
1:22 AM
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8.5 kB
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12.3 kB
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20251208_1524_image.png
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17.7 kB
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940 bytes
X.509 Certificate
13 Dec 2025
compat-wireless-2010-06-28.tar.bz2
2.6 MB
Archive
24 Dec 2025
Distributed_RPC_RMI_Student_Service.zip
2.5 kB
Archive
12:45 AM
HD-wallpaper-kali-linux-electric-blue-computer-neon-dragon.jpg
66.3 kB
Image
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images.jpeg
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Document
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purush.jpg
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8 Dec 2025
Screenshot_20240730-184620_WhatsApp.jpg
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Image
Sat
Screenshot_20240730-191012_WhatsApp.jpg
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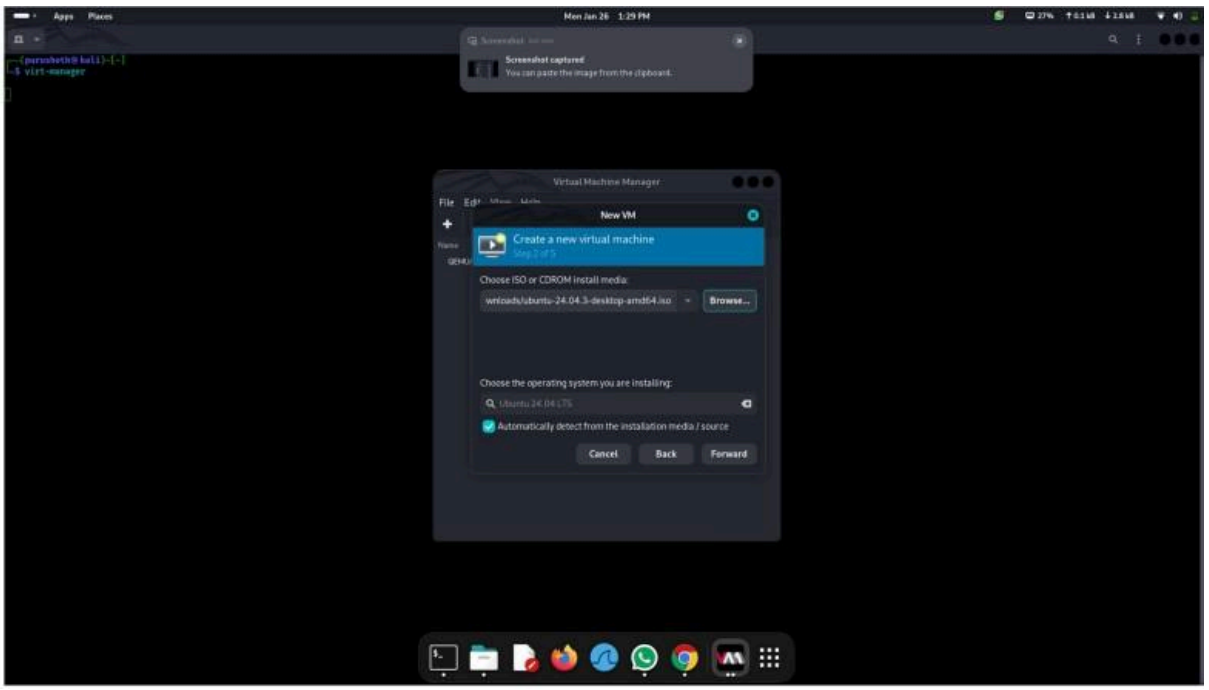
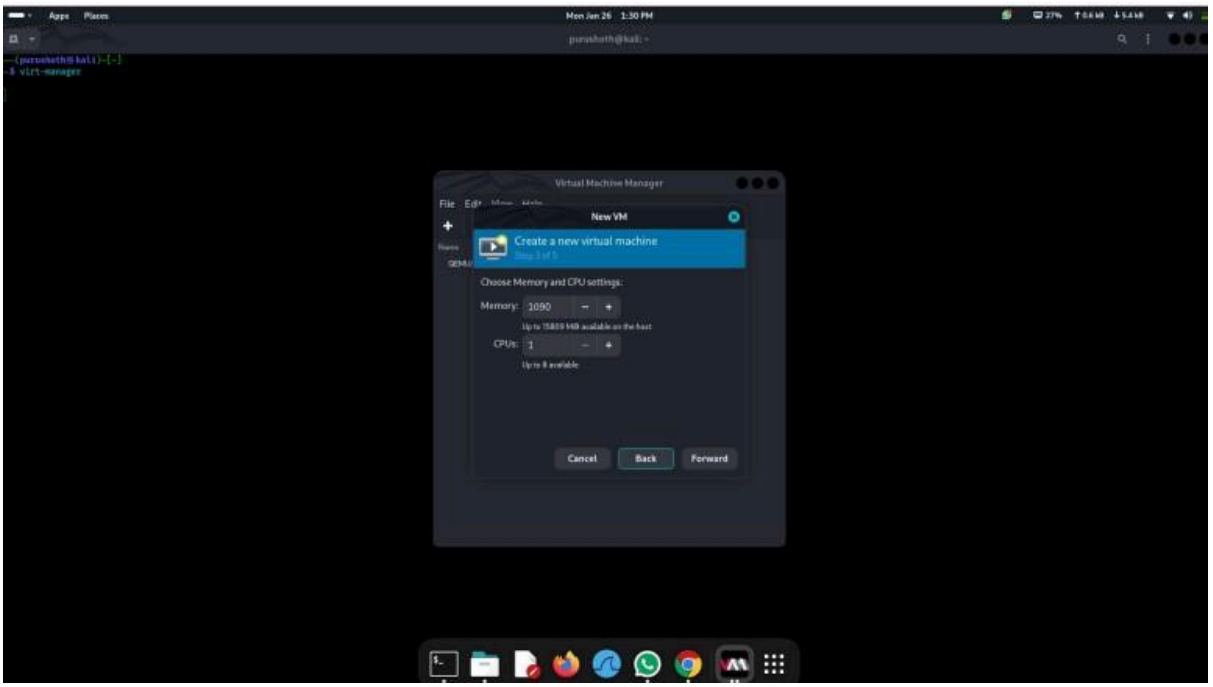
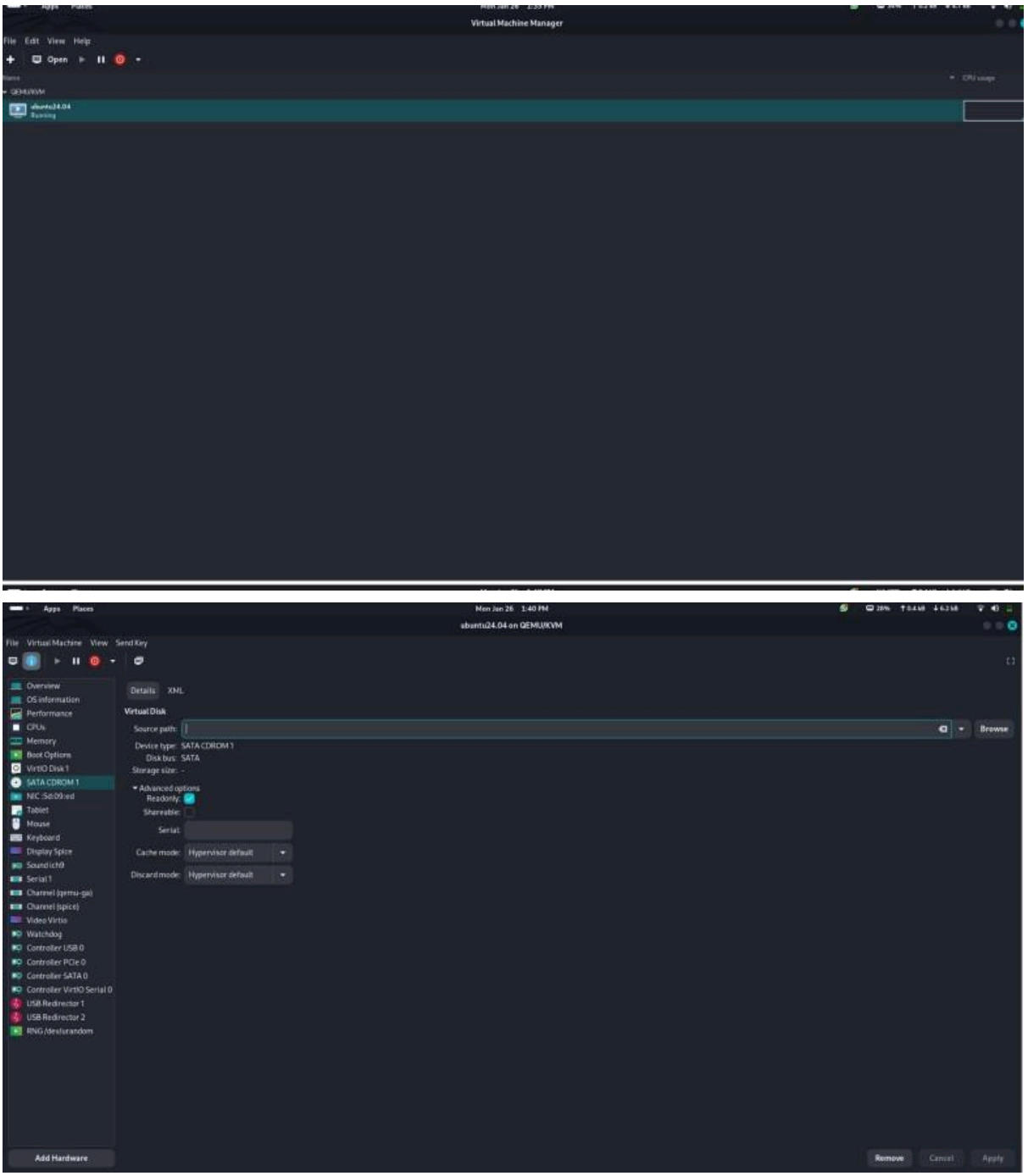
Image
Sat
ubuntu-24.04.3-desktop-amd64.iso
6.3 GB
Raw CD image
1:25 PM


Apps
Places
Mon Jan 26 1:29 PM
Screenshot captured
You can paste the image from the clipboard.
Virtual Machine Manager
File
New VM
Create a new virtual machine
Choose ISO or CDROM install media:
Browse...
Choose the operating system you are installing:
Automatically detect from the installation media / source
Cancel
Back
Forward


Apps
Places
Mon Jan 26 1:30 PM
Virtual Machine Manager
File
New VM
Create a new virtual machine
Choose Memory and CPU settings:
Memory:
1090
CPUs:
1
Cancel
Back
Forward



Method 2: Server Virtual Machine (Headless VM)

Description

A server virtual machine runs without a graphical interface and is accessed remotely via SSH. Ubuntu Server 22.04 LTS is used as the guest OS.

Procedure

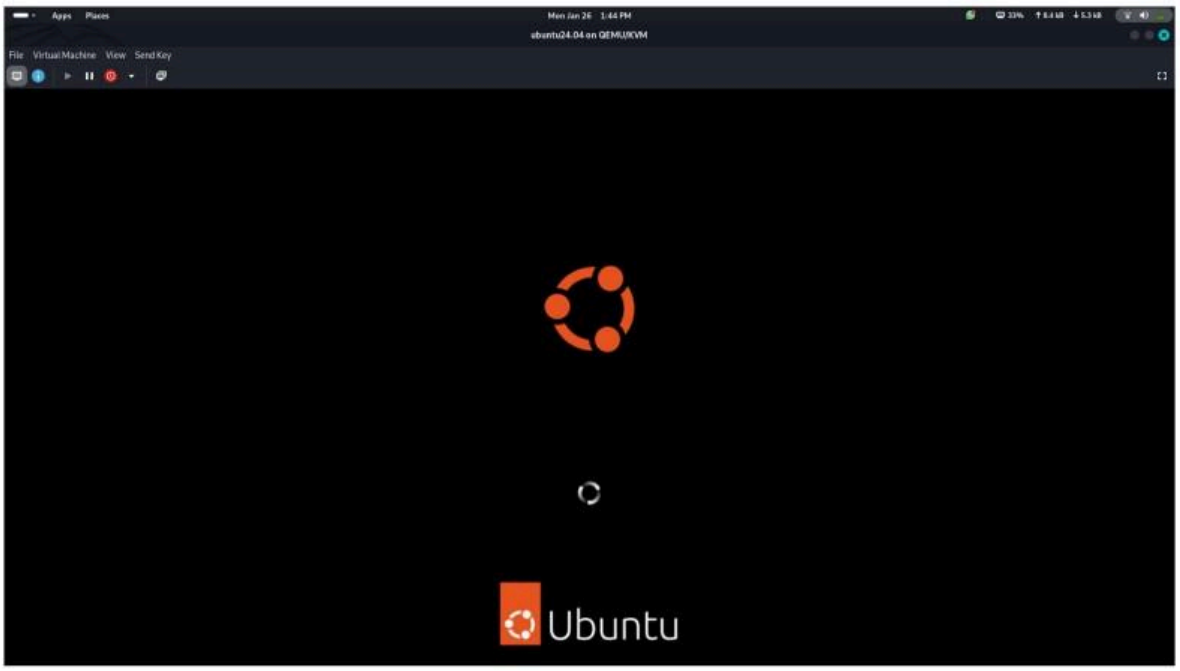
1. New VM is created in virt-manager.
2. Ubuntu Server ISO is selected.
3. CPU, RAM, and storage are assigned.
4. Text-based installation is completed.
5. Username and password are configured.
6. OpenSSH Server is enabled during installation.
7. VM is rebooted.
8. Server IP address is obtained using `ip a`.
9. SSH access is established from host:

ssh username@<server-ip>

Observation

- Ubuntu Server installed successfully.
- SSH connection established without errors.
- Server operated efficiently without GUI.

This demonstrates remote management of headless server VMs.



Method 3: Cloud Virtual Machine

Description

A cloud virtual machine is deployed on AWS EC2 and accessed over the internet. Ubuntu Server 22.04 LTS is used with key-based authentication.

Procedure

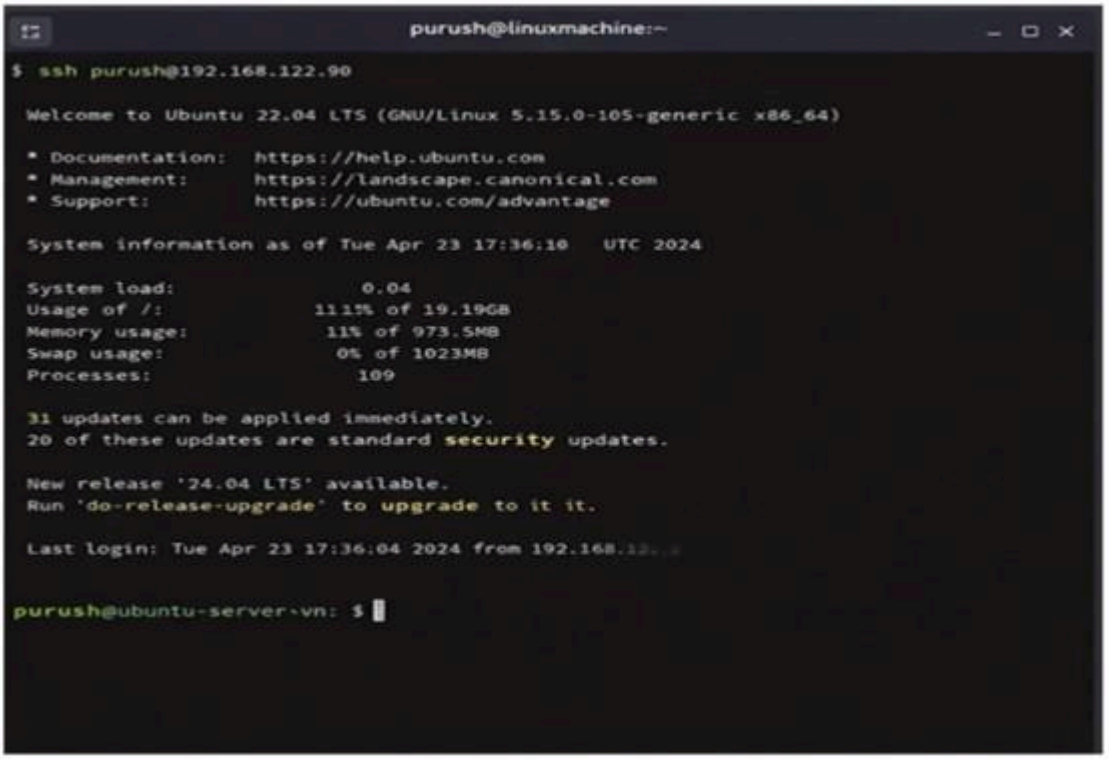
1. AWS Management Console is opened.
2. EC2 Dashboard is accessed.
3. New EC2 instance is launched.
4. Ubuntu Server 22.04 AMI is selected.
5. Instance type t2.micro is chosen.
6. SSH key pair is created or selected.
7. Security group allows SSH (port 22).
8. Instance is launched.
9. Public IP address is copied.
10. SSH connection established:

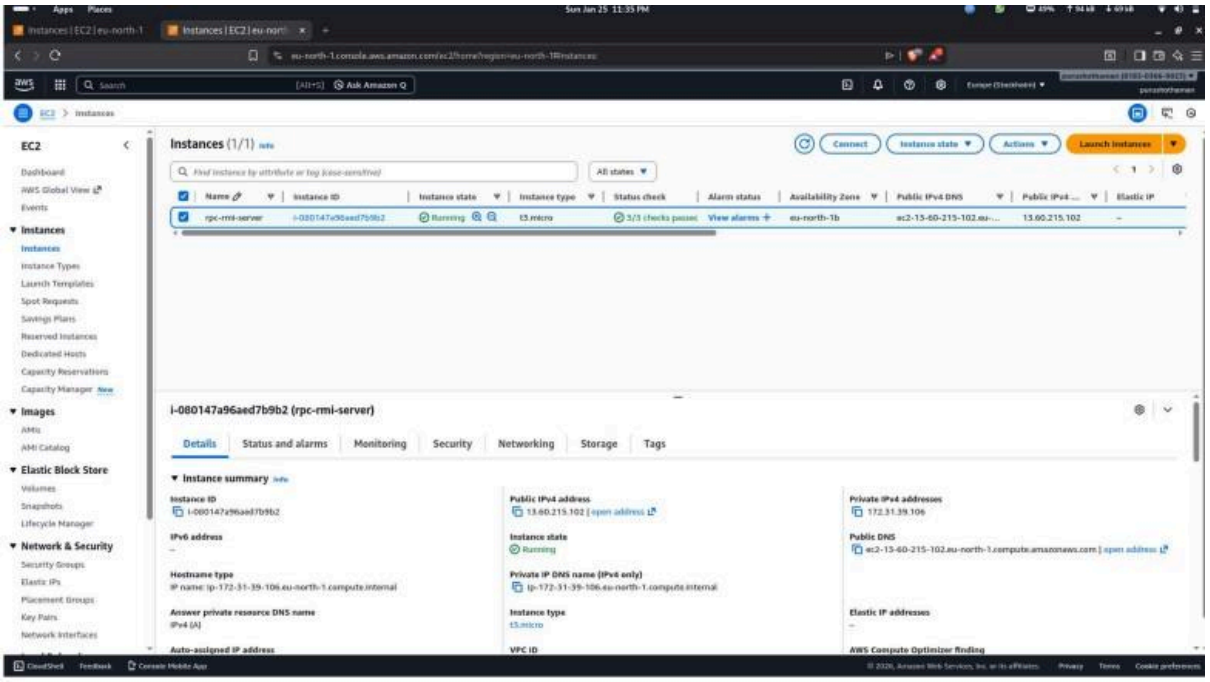
ssh -i key.pem ubuntu@<public-ip>

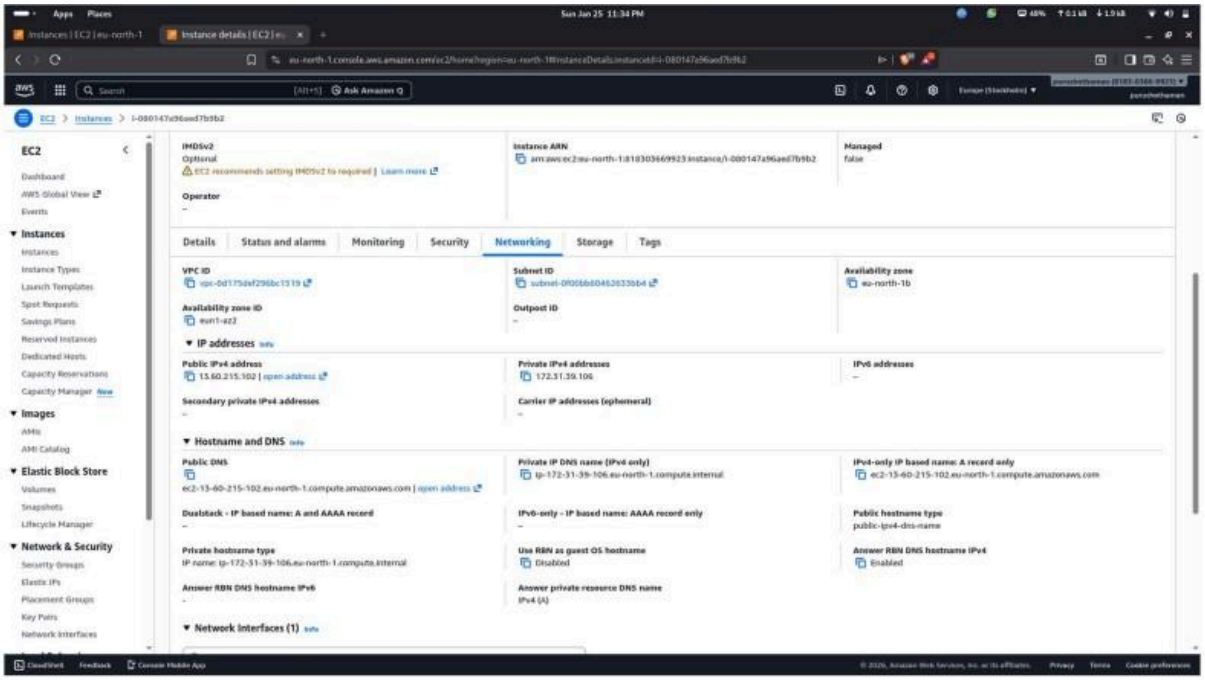
Observation

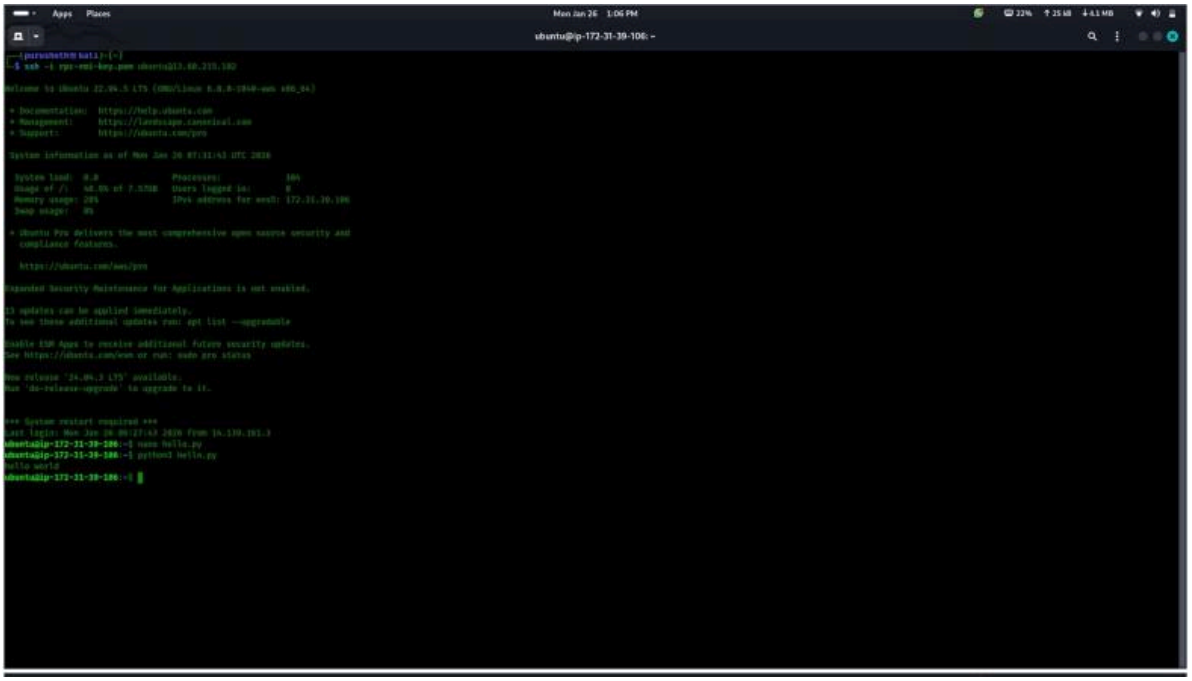
- EC2 instance launched successfully.
- Secure SSH login established using key authentication.
- Cloud VM accessible remotely via internet.

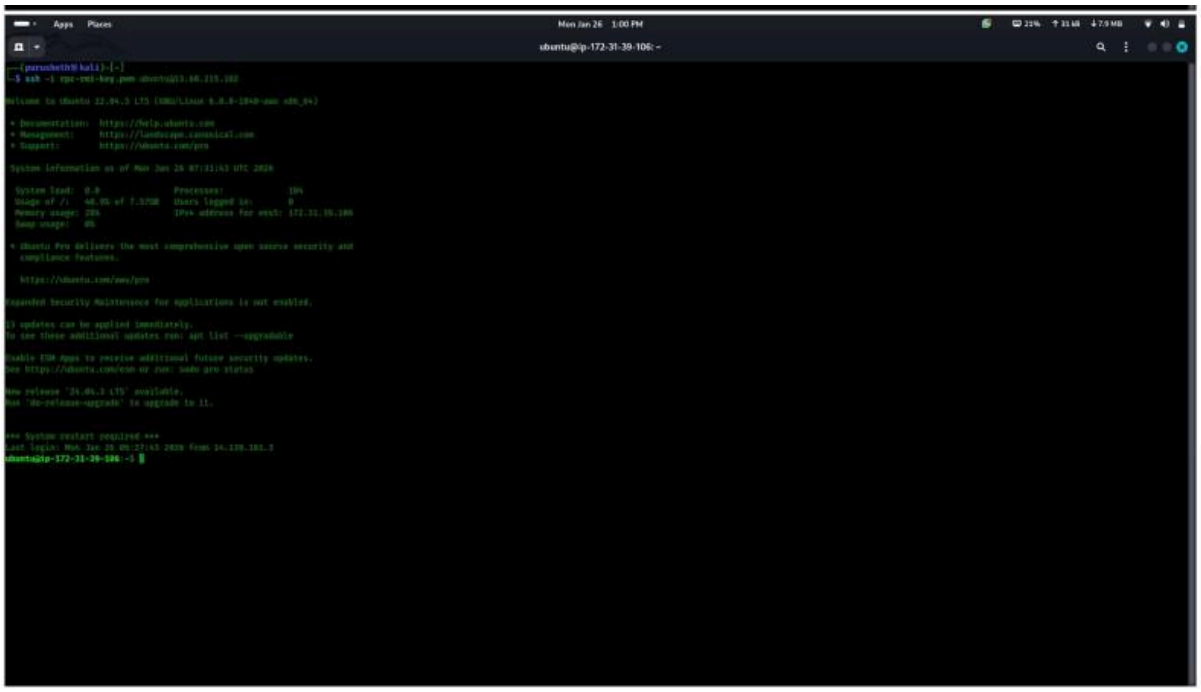
This validates cloud-based virtualization.


purush@linuxmachine:~
$ ssh purush@192.168.122.90
Welcome to Ubuntu 22.04 LTS (GNU/Linux 5.15.0-105-generic x86_64)
* Documentation: https://help.ubuntu.com
* Management: https://landscape.canonical.com
* Support: https://ubuntu.com/advantage
System information as of Tue Apr 23 17:36:10 UTC 2024
System load: 0.04
Usage of /: 1111% of 19.19GB
Memory usage: 11% of 973.5MB
Swap usage: 0% of 1023MB
Processes: 109
31 updates can be applied immediately.
20 of these updates are standard security updates.
New release '24.04 LTS' available.
Run 'do-release-upgrade' to upgrade to it it.
Last login: Tue Apr 23 17:36:04 2024 from 192.168.
purush@ubuntu-server-vn: $


EC2
Instances (1/1)
rpc-rmi-server
i-080147a96aed7b9b2
Running
t3.micro
eu-north-1b
13.60.215.102
i-080147a96aed7b9b2 (rpc-rmi-server)
Details
Status and alarms
Monitoring
Security
Networking
Storage
Tags
Instance summary


Apps Places
Sun Jan 25 11:34 PM
Instances | EC2 | eu-north-1
Instance details | EC2 | eu-
eu-north-1.console.aws.amazon.com/ec2/home?region=eu-north-1#InstanceDetails:instanceId=i-080147a96aed7b9b2
Search
[Alt+S]
Ask Amazon Q
Europe (Stockholm)
EC2 > Instances > i-080147a96aed7b9b2
EC2
Dashboard
AWS Global View
Events
Instances
Instances
Instance Types
Launch Templates
Spot Requests
Savings Plans
Reserved Instances
Dedicated Hosts
Capacity Reservations
Capacity Manager New
Images
AMIs
AMI Catalog
Elastic Block Store
Volumes
Snapshots
Lifecycle Manager
Network & Security
Security Groups
Elastic IPs
Placement Groups
Key Pairs
Network Interfaces
IMDSv2
Optional
EC2 recommends setting IMDSv2 to required | Learn more
Operator
-
Instance ARN
arn:aws:ec2:eu-north-1:818303669923:instance/i-080147a96aed7b9b2
Managed
false
Details
Status and alarms
Monitoring
Security
Networking
Storage
Tags
VPC ID
vpc-0d1750ef296bc1519
Subnet ID
subnet-0f06bb6046203366d
Availability zone
eu-north-1b
Availability zone ID
eun1-az2
Outpost ID
-
IP addresses Info
Public IPv4 address
13.60.215.102 | open address
Private IPv4 addresses
172.31.39.106
IPv6 addresses
-
Secondary private IPv4 addresses
-
Carrier IP addresses (ephemeral)
-
Hostname and DNS Info
Public DNS
ec2-13-60-215-102.eu-north-1.compute.amazonaws.com | open address
Private IP DNS name (IPv4 only)
ip-172-31-39-106.eu-north-1.compute.internal
IPv4-only IP based name: A record only
ec2-13-60-215-102.eu-north-1.compute.amazonaws.com
Dualstack - IP based name: A and AAAA record
-
IPv6-only - IP based name: AAAA record only
-
Public hostname type
public-ipv4-dns-name
Private hostname type
IP name: ip-172-31-39-106.eu-north-1.compute.internal
Use RBN as guest OS hostname
Disabled
Answer RBN DNS hostname IPv4
Enabled
Answer RBN DNS hostname IPv6
-
Answer private resource DNS name
IPv4 (A)
Network interfaces (1) Info
CloudShell
Feedback
Console Mobile App
Privacy
Terms
Cookie preferences





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8. Output

- Desktop VM with GUI executed successfully
- Server VM accessed remotely using SSH
- Cloud VM accessed securely through AWS EC2
- Multiple virtual environments created and managed

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9. Advantages of Virtual Machines

- Strong isolation between systems
- High security
- Ability to run multiple operating systems
- Suitable for servers and cloud hosting
- Complete hardware abstraction
- Supports legacy applications

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10. Applications

- Desktop virtualization
- Enterprise server deployment
- Cloud computing infrastructure
- Software testing environments
- Cybersecurity labs
- Data center virtualization

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11. Result

Successfully implemented and executed:

- Desktop Virtual Machine
- Server (Headless) Virtual Machine
- Cloud Virtual Machine

Each VM operated independently, confirming effective virtualization.

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12. Conclusion

This experiment successfully demonstrated virtualization using desktop, server, and cloud virtual machines. Unlike containers, virtual machines provide complete operating system isolation through hypervisors, making them highly secure and flexible. Although virtual machines consume more system resources, they remain essential for cloud infrastructure, enterprise deployments, and multi-OS environments. The experiment highlights the importance of virtualization as a foundation for modern computing systems.