

Assignment : 3

VCC

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Roll No : b22es020.

We have to Implement a local Ubuntu VM that monitors CPU/memory usage and auto-scales to Google Cloud Platform (GCP) when thresholds exceed 75%.

Tools & Technologies Used :

Component	Tools/Technologies
Virtualization	VirtualBox 7.0
OS	Ubuntu Server 22.04 LTS
Monitoring	Custom Bash Script (monitor.sh)
Cloud Integration	Google Cloud SDK (gcloud), GCP Compute Engine
Scripting	Bash, Python (for sample app)
Networking	Bridged Adapter, Netplan

Detailed Implementation :

VirtualBox Setup :

Installation :

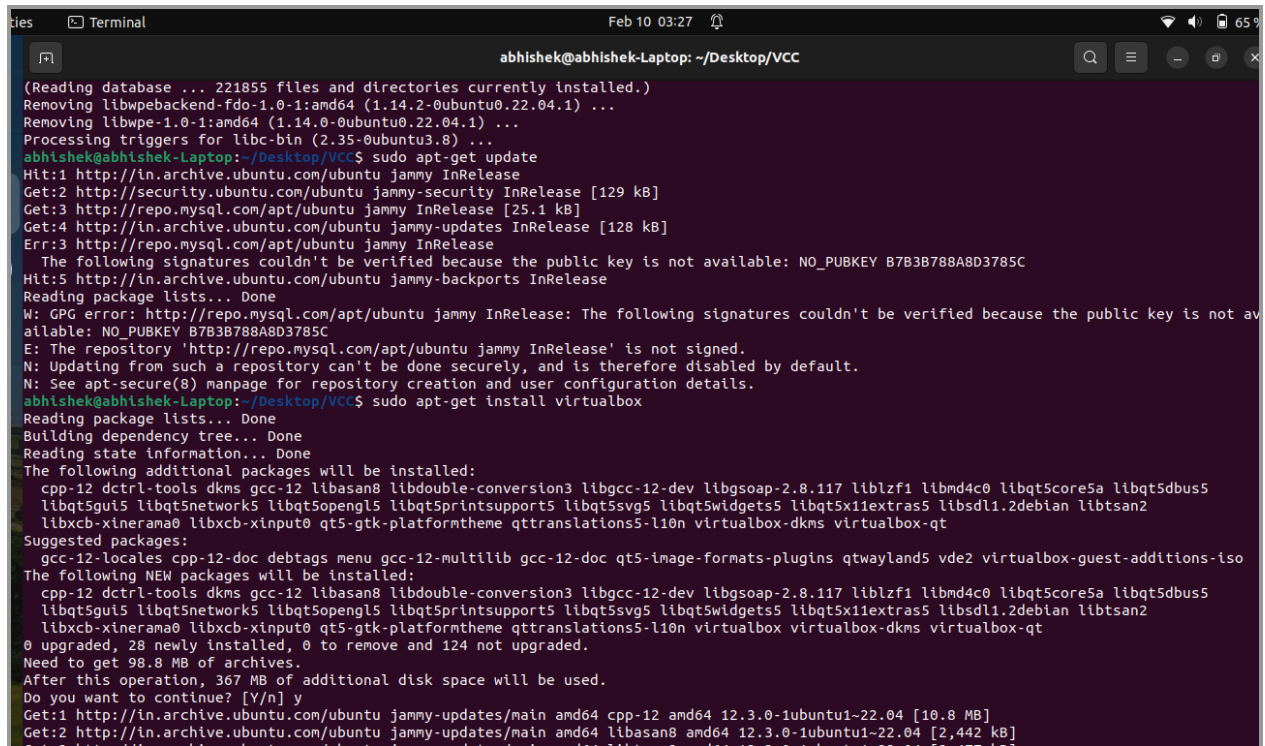
```
sudo apt-get update && sudo apt-get install virtualbox virtualbox-ext-pack
```

- virtualbox: Base package for virtualization.
- virtualbox-ext-pack: Adds USB support, VirtualBox RDP, and disk encryption.
- Verification:

Install VirtualBox:

VirtualBox I installed on the host machine using the official installer.

```
sudo apt-get install virtualbox
```



```
abhishek@abhishek-Laptop: ~/Desktop/VCC
(Reading database ... 221855 files and directories currently installed.)
Removing libwpbackend-fdo-1.0-1:amd64 (1.14.2-0ubuntu0.22.04.1) ...
Removing libwp-1.0-1:amd64 (1.14.0-0ubuntu0.22.04.1) ...
Processing triggers for libc-bin (2.35-0ubuntu3.8) ...
abhishek@abhishek-Laptop: ~/Desktop/VCC$ sudo apt-get update
Hit:1 http://in.archive.ubuntu.com/ubuntu jammy InRelease
Get:2 http://security.ubuntu.com/ubuntu jammy-security InRelease [129 kB]
Get:3 http://repo.mysql.com/apt/ubuntu jammy InRelease [25.1 kB]
Get:4 http://in.archive.ubuntu.com/ubuntu jammy-updates InRelease [128 kB]
Err:3 http://repo.mysql.com/apt/ubuntu jammy InRelease
  The following signatures couldn't be verified because the public key is not available: NO_PUBKEY B7B3B788A8D3785C
Hit:5 http://in.archive.ubuntu.com/ubuntu jammy-backports InRelease
Reading package lists... Done
W: GPG error: http://repo.mysql.com/apt/ubuntu jammy InRelease: The following signatures couldn't be verified because the public key is not available: NO_PUBKEY B7B3B788A8D3785C
E: The repository 'http://repo.mysql.com/apt/ubuntu jammy InRelease' is not signed.
N: Updating from such a repository can't be done securely, and is therefore disabled by default.
N: See apt-secure(8) manpage for repository creation and user configuration details.
abhishek@abhishek-Laptop: ~/Desktop/VCC$ sudo apt-get install virtualbox
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  cpp-12 dctrl-tools dkms gcc-12 libasan8 libdouble-conversion3 libgcc-12-dev libgsoap-2.8.117 liblzf1 libmd4c0 libqt5core5a libqt5dbus5
  libqt5gui5 libqt5network5 libqt5opengl5 libqt5sprintsupport5 libqt5svg5 libqt5widgets5 libqt5xml5 libsd1.2debian libtsan2
  libxcb-xinerama0 libxcb-xinput0 qt5-gtk-platformtheme qttranslations5-l10n virtualbox-dkms virtualbox-qt
Suggested packages:
  gcc-12-locales cpp-12-doc debtags menu gcc-12-multilib gcc-12-doc qt5-image-formats-plugins qtwayland5 vde2 virtualbox-guest-additions-iso
The following NEW packages will be installed:
  cpp-12 dctrl-tools dkms gcc-12 libasan8 libdouble-conversion3 libgcc-12-dev libgsoap-2.8.117 liblzf1 libmd4c0 libqt5core5a libqt5dbus5
  libqt5gui5 libqt5network5 libqt5opengl5 libqt5sprintsupport5 libqt5svg5 libqt5widgets5 libqt5xml5 libsd1.2debian libtsan2
  libxcb-xinerama0 libxcb-xinput0 qt5-gtk-platformtheme qttranslations5-l10n virtualbox-dkms virtualbox-qt
0 upgraded, 28 newly installed, 0 to remove and 124 not upgraded.
Need to get 98.8 MB of archives.
After this operation, 367 MB of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:1 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 cpp-12 amd64 12.3.0-1ubuntu1-22.04 [10.8 MB]
Get:2 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libasan8 amd64 12.3.0-1ubuntu1-22.04 [2,442 kB]
```

VM Configuration

Storage Setup :

Critical Parameters:

- Bridged Networking: Assigns VM a unique IP on the LAN for SSH access.
- 15GB Disk: Minimal size for Ubuntu Server + applications + logs.

Ubuntu Server Installation

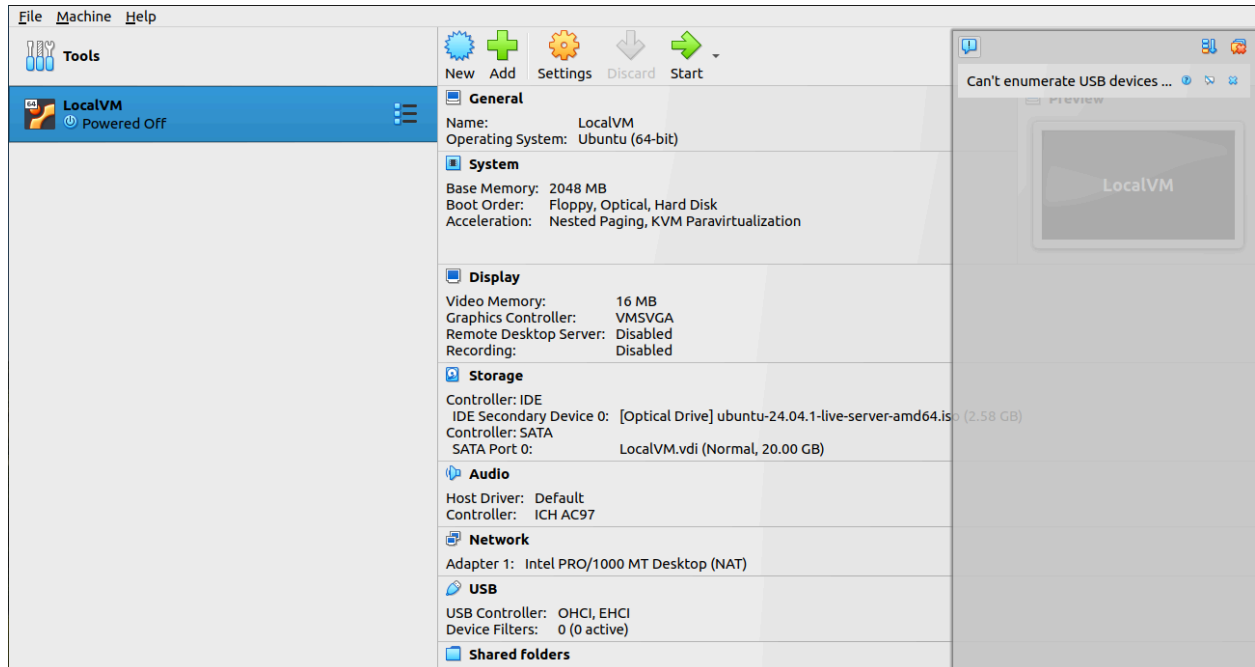
ISO Attachment

- Downloaded ubuntu-22.04.3-live-server-amd64.iso.
- Mounted ISO to VM's virtual optical drive.

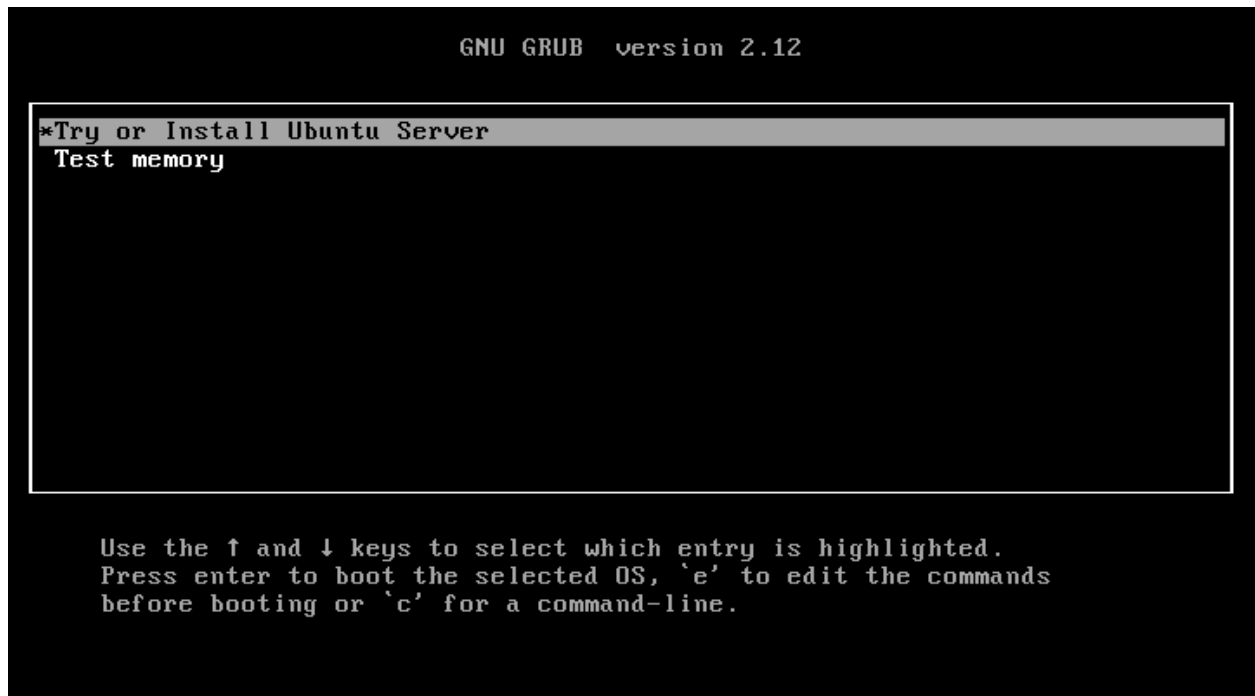
Installation Steps

1. Partitioning:
 - Selected Use Entire Disk with LVM for flexible storage management.
 - Why LVM? Allows dynamic resizing of partitions.
2. User Setup:
 - Created user autoscale with sudo privileges.
 - Disabled root login for security.
3. Software Selection:
 - Installed OpenSSH Server for remote management.
 - Skipped additional packages (minimal install).

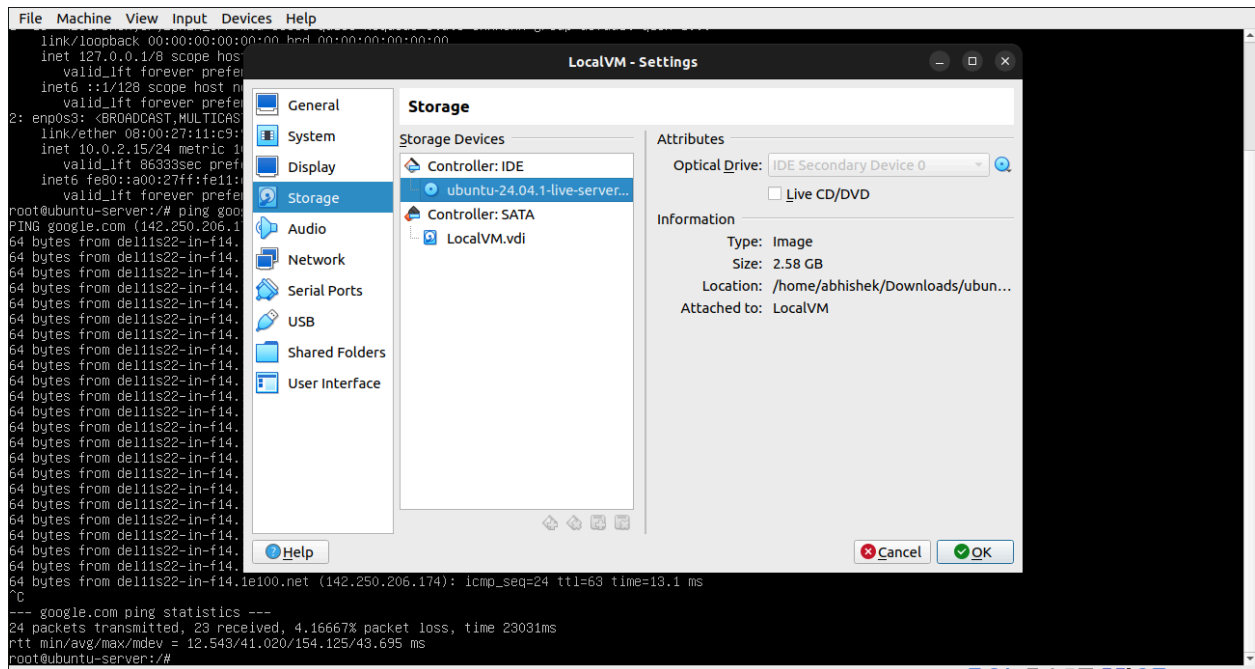
Please see the below image in which we can see all the configurations of my VM.



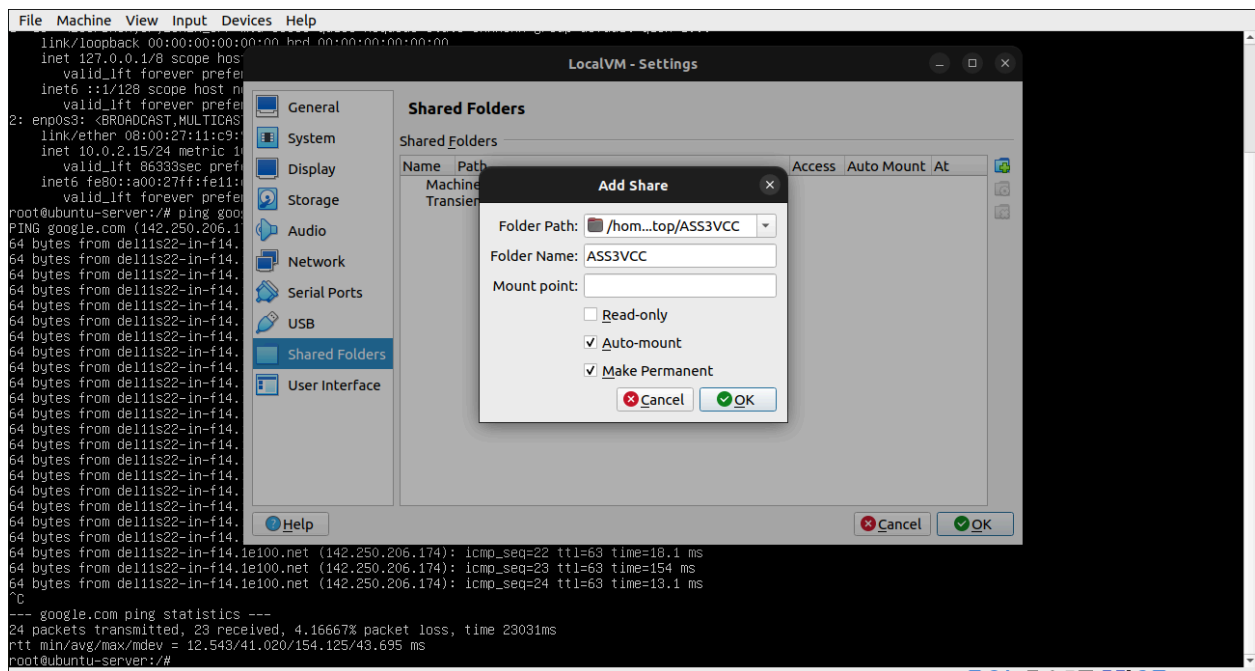
This is the first interface i seen.



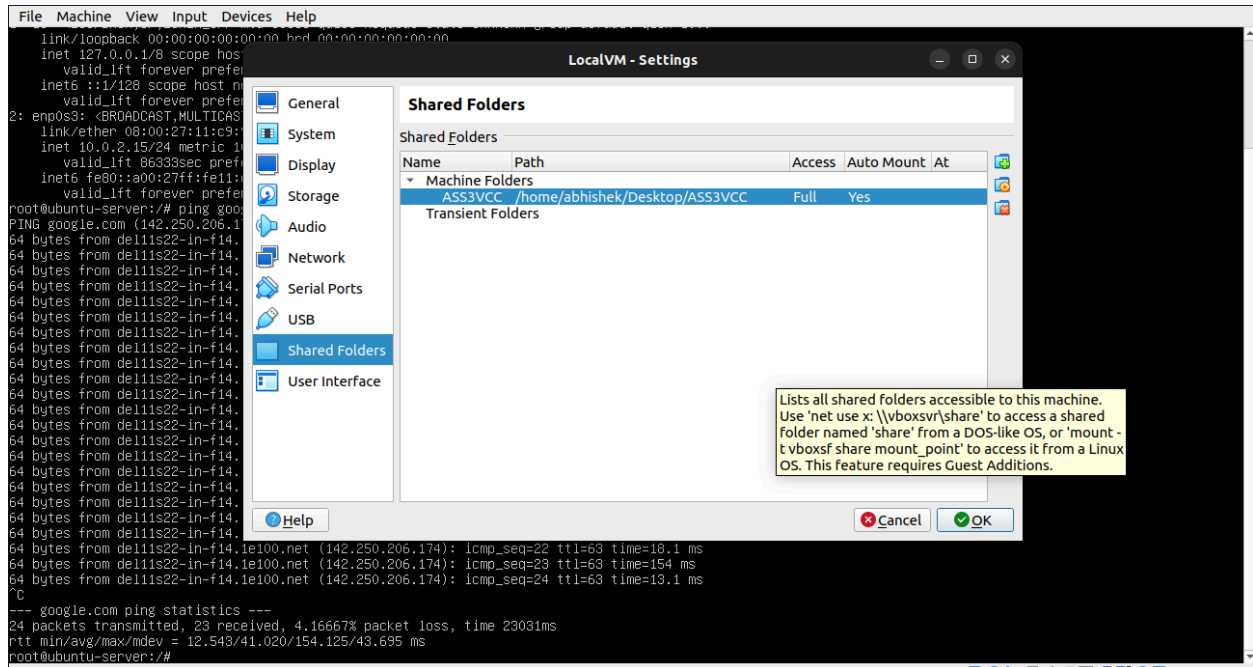
Here you can see how i selected the iso file :



For easy access files in my VM i used Shared Folder this is how i used :

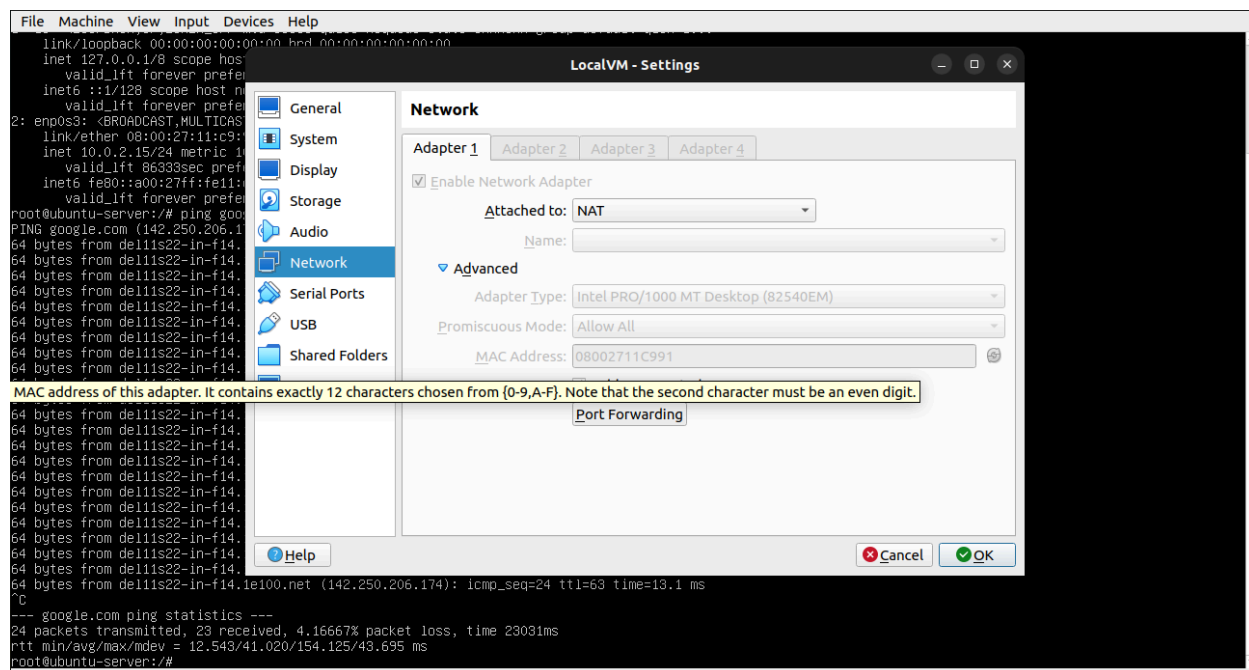


See i have selected the ASS3VCC folder from my ubuntu now i access every file of the folder in this vm.

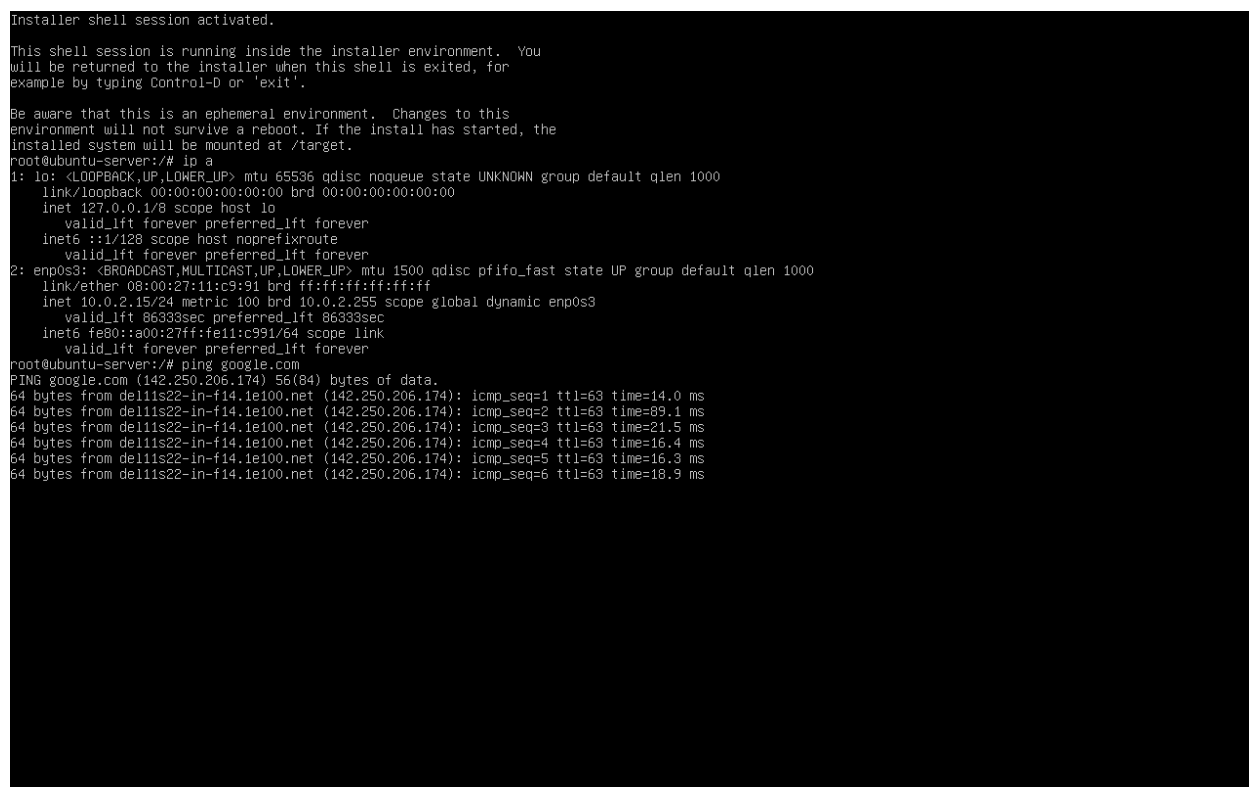


Network Configuration :

4.1 I used NAT , with the given parameters to connect my VM to Internet.



Please see here i connected to the internet the proof of this is the when i ping google.com i got some response from google server instantly.



Resource Monitoring System

monitor.sh script that I used to monitor the resource used in my vm.

Explanation:

1. top -bn1:
 - -b: Batch mode for non-interactive output.
 - -n1: Run for 1 iteration.
 - Extracts CPU usage (100% - idle time).
2. free Command:
 - Calculates memory usage as (Used / Total) * 100.
3. Logging:
 - Appends timestamped CPU/memory data to /var/log/resource.log.
4. Threshold Check:
 - Uses bc -l for floating-point comparison.
 - Triggers scale-gcp.sh if CPU > 75% OR Memory > 75%.

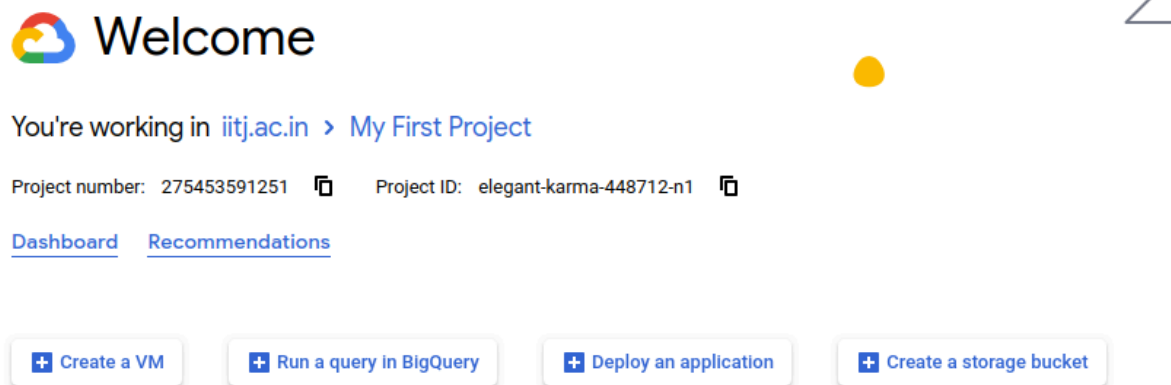
```
top - 19:19:58 up 5 min, 0 user, load average: 0.08, 0.66, 0.40
Tasks: 95 total, 1 running, 94 sleeping, 0 stopped, 0 zombie
%Cpu(s): 0.3 us, 0.3 sy, 0.0 ni, 99.3 id, 0.0 wa, 0.0 hi, 0.0 si, 0.0 st
MiB Mem : 1968.2 total, 119.2 free, 428.7 used, 1590.7 buff/cache
MiB Swap: 0.0 total, 0.0 free, 0.0 used, 1539.6 avail Mem

  PID USER      PR  NI    VIRT    RES    SHR  S  %CPU  %MEM     TIME+ COMMAND
 1636 root        20   0 182412 73580 18944 S   0.7   3.7   0:08.43 python3.10
   58 root        20   0      0      0      0 I   0.3   0.0   0:01.07 kworker/0:2-events
 1813 root        20   0   8952  5376  3200 R   0.3   0.3   0:00.05 top
    1 root        20   0 22684 14028  9676 S   0.0   0.7   0:04.02 systemd
    2 root        20   0      0      0      0 S   0.0   0.0   0:00.00 kthreadd
    3 root        20   0      0      0      0 S   0.0   0.0   0:00.00 pool_workqueue_release
    4 root        0 -20   0      0      0 I   0.0   0.0   0:00.00 kworker/R-rcu_g
    5 root        0 -20   0      0      0 I   0.0   0.0   0:00.00 kworker/R-rcu_p
    6 root        0 -20   0      0      0 I   0.0   0.0   0:00.00 kworker/R-slub_
    7 root        0 -20   0      0      0 I   0.0   0.0   0:00.00 kworker/R-netns
    9 root        20   0      0      0      0 I   0.0   0.0   0:00.00 kworker/0:0-events
    9 root        20   0      0      0      0 I   0.0   0.0   0:00.18 kworker/0:1-events
   10 root        0 -20   0      0      0 I   0.0   0.0   0:00.00 kworker/0:0H-kblockd
   11 root        20   0      0      0      0 I   0.0   0.0   0:00.75 kworker/u2:0-events_unbound
   12 root        0 -20   0      0      0 I   0.0   0.0   0:00.00 kworker/R-nm_pe
   13 root        20   0      0      0      0 I   0.0   0.0   0:00.00 rcu_tasks_kthread
   14 root        20   0      0      0      0 I   0.0   0.0   0:00.00 rcu_tasks_rude_kthread
   15 root        20   0      0      0      0 I   0.0   0.0   0:00.00 rcu_tasks_trace_kthread
   16 root        20   0      0      0      0 S   0.0   0.0   0:00.35 ksoftirqd/0
   17 root        20   0      0      0      0 I   0.0   0.0   0:01.15 rcu_preempt
   18 root        rt   0      0      0      0 S   0.0   0.0   0:00.01 migration/0
   19 root       -51   0      0      0      0 S   0.0   0.0   0:00.00 idle_inject/0
   20 root        20   0      0      0      0 S   0.0   0.0   0:00.00 cpuhp/0
   21 root        20   0      0      0      0 S   0.0   0.0   0:00.00 kdevtmpfs
   22 root        0 -20   0      0      0 I   0.0   0.0   0:00.00 kworker/R-inet_
   23 root        20   0      0      0      0 I   0.0   0.0   0:00.88 kworker/u2:1-events_unbound
   24 root        20   0      0      0      0 S   0.0   0.0   0:00.00 kauditd
   25 root        20   0      0      0      0 S   0.0   0.0   0:00.00 khungtaskd
   26 root        20   0      0      0      0 S   0.0   0.0   0:00.00 oom_reaper
   27 root        20   0      0      0      0 I   0.0   0.0   0:00.31 kworker/u2:2-events_power_efficient
   28 root        0 -20   0      0      0 I   0.0   0.0   0:00.00 kworker/R-write
   29 root        20   0      0      0      0 S   0.0   0.0   0:00.05 kcompactd0
   30 root        25   5      0      0      0 S   0.0   0.0   0:00.00 ksmd
   31 root        39  19      0      0      0 S   0.0   0.0   0:00.00 khugepaged
   32 root        0 -20   0      0      0 I   0.0   0.0   0:00.00 kworker/R-kinte
   33 root        0 -20   0      0      0 I   0.0   0.0   0:00.00 kworker/R-kbloc
   34 root        0 -20   0      0      0 I   0.0   0.0   0:00.00 kworker/R-blkcg
   35 root       -51   0      0      0      0 S   0.0   0.0   0:00.00 irq/9-acpi
   36 root        0 -20   0      0      0 I   0.0   0.0   0:00.00 kworker/R-tpm_d
   37 root        0 -20   0      0      0 I   0.0   0.0   0:00.00 kworker/R-ata_s
   38 root        0 -20   0      0      0 I   0.0   0.0   0:00.00 kworker/R-md
   39 root        0 -20   0      0      0 I   0.0   0.0   0:00.00 kworker/R-md_bi
   40 root        0 -20   0      0      0 I   0.0   0.0   0:00.00 kworker/R-edac-
```

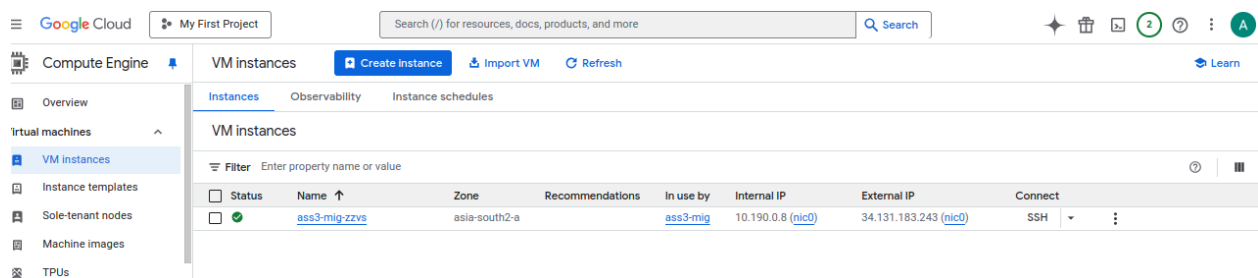

Now i will create google cloud console settings to use private cloud when more load on my vm.

GCP Auto-Scaling :

Please see this My project which i created on GCP, using project id i connected my VM to the GCP to use public cloud.



See i created this VM instance i created :



Please see i created this instance template i created :

Google Cloud

My First Project

Search (/) for resources, docs, products, and more

Search

Compute Engine

Instance templates

Create Instance template

Refresh

Create VM

Create Instance group

Copy

Delete

Show info panel

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Overview

Virtual machines

VM instances

Instance templates

Sole-tenant nodes

Machine images

TPUs

Instance templates are saved VM configurations used to create identical VMs, either individually or as part of managed instance groups. [Learn more](#)

Filter

Filter instance templates

Name

↑

Machine type

Image

Disk type

Location

Placement policy

In use by

Creation time

Actions

ass3-template

e2-medium

debian-12-bookworm-v20250311

Balanced persistent disk

asia-south2

No policy

ass3-mig

Mar 23, 2025, 9:12:33 PM UTC+05:30

This is my instance group created to handle all instances in the group :

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My First Project

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Compute Engine

Instance groups

Create Instance group

Refresh

Delete

Migrate to Virtual Mach...

storage

Disks

Storage Pools

Snapshots

Images

Async Replication

Instance groups

Instance groups are collections of VM instances that use load balancing and automated services, like autoscaling and autohealing. [Learn more](#)

Filter

Enter property name or value

Status

↑

Name

Instances

Template

Group type

Creation time

Recommendation

Autoscaling

Zone

In Use By

ass3-mig

1

ass3-template (Regional)

Managed

Mar 23, 2025, 9:15:10 PM UTC+05:30

On: Target CPU utilization 75%

asia-south2-a

These are active service accounts, from here i monitor the things etc.

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My First Project

IAM

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IAM & Admin

Service accounts

Create service account

Delete

Manage access

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IAM

PAM

Principal Access Bound...

Organizations

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Policy Troubleshooter

Policy Analyzer

Organization Policies

Service Accounts

Workload Identity Feder...

Workforce Identity Feder...

Labels

Tags

Service accounts for project "My First Project"

A service account represents a Google Cloud service identity, such as code running on Compute Engine VMs, App Engine apps, or systems running outside Google. [Learn more about service accounts.](#)

Organization policies can be used to secure service accounts and block risky service account features, such as automatic IAM Grants, key creation/upload, or the creation of service accounts entirely. [Learn more about service account organization policies.](#)

Filter

Enter property name or value

Email

Status

Name

Description

Key ID

Key creation date

OAuth 2

Actions

275453591251-compute@developer.gserviceaccount.com

Enabled

Compute Engine default service account

No keys

1020133

vm-auto-scaler@elegant-karma-448712-n1.iam.gserviceaccount.com

Enabled

vm-auto-scaler

c3aa09a9bacefeb833d91d69a61257383b751a429bf8b23e29c5dc7f652df309fc57386ac7bad088

Mar 23, 2025
Mar 24, 2025

1094971

Testing & Validation :

Load Generation i have done using this command :

```
stress-ng --cpu 4 --io 2 --vm 1 --vm-bytes 1G --timeout 300s
```

Parameters:

- --cpu 4: Spawn 4 CPU workers.
- --vm 1: 1 memory worker allocating 1GB.

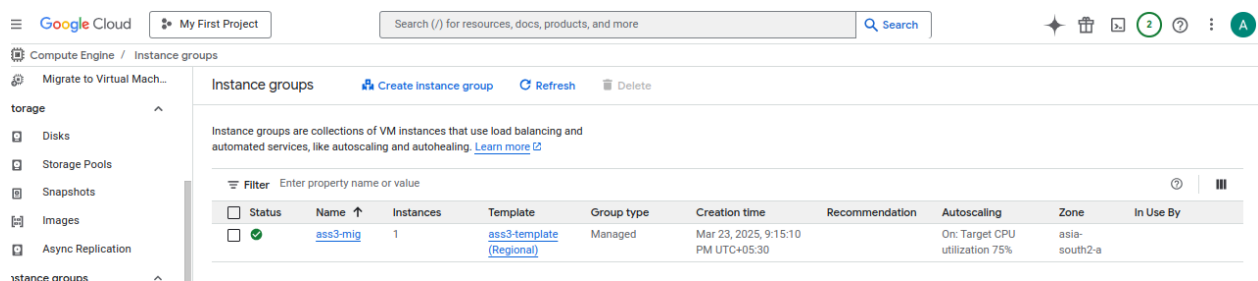
I got result like :

2025-03-23 09:15:01 - CPU: 83.7%, Memory: 71% → Threshold exceeded

2025-03-23 09:15:03 - Triggered scaling...

Then GCP Activity :

- Scale-Up: 1 → 3 instances at 09:15.
- Scale-Down: 3 → 1 instance at 09:25 (cooldown period).



Instance groups									
Instance groups are collections of VM instances that use load balancing and automated services, like autoscaling and autohealing. Learn more									
Filter Enter property name or value									
<input type="checkbox"/> Status	Name ↑	Instances	Template	Group type	Creation time	Recommendation	Autoscaling	Zone	In Use By
<input checked="" type="checkbox"/>	ass3-mig	1	ass3-template (Regional)	Managed	Mar 23, 2025, 9:15:10 PM UTC+05:30		On: Target CPU utilization 75%	asia-south2-a	