

Assignment : 3

VCC

Name : Abhishek Yadav.

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 :

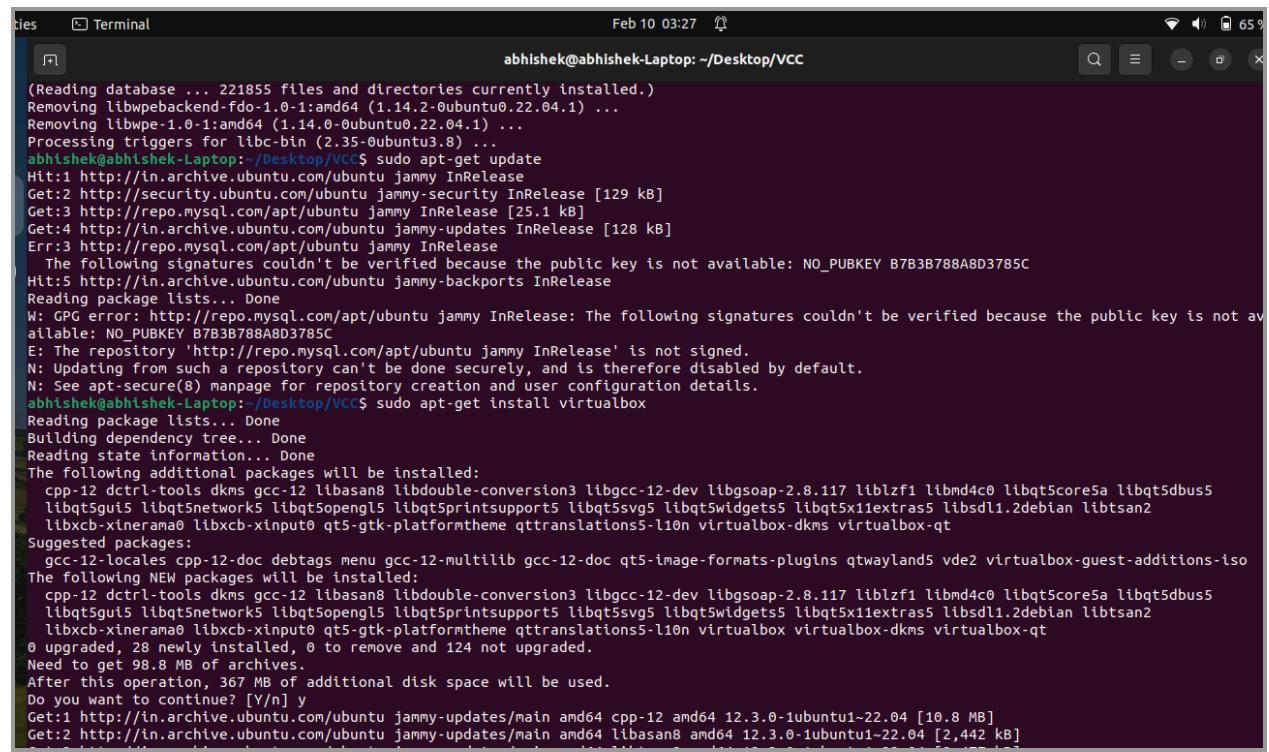
```
sudo apt-get update && sudo apt-get install virtualbox virtualbox-ext-pack
```

- 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
```



The screenshot shows a terminal window titled "Terminal" with the command "sudo apt-get install virtualbox" entered. The output of the command is displayed, showing the process of updating the package list and installing the VirtualBox package. The terminal window has a dark background and light-colored text. The title bar includes the date and time ("Feb 10 03:27") and battery status ("65%").

```
Reading database ... 221855 files and directories currently installed.  
Removing libwpebackend-fdo-1.0-1:amd64 (1.14.2-0ubuntu0.22.04.1) ...  
Removing libwpe-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 [129 kB]  
Get:2 http://security.ubuntu.com/ubuntu jammy-security InRelease [25.1 kB]  
Get:3 http://repo.mysql.com/apt/ubuntu jammy 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-dcrtl-tools dkms gcc-12 libasan8 libdouble-conversion3 libgcc-12-dev libgsoap-2.8.117 liblzf1 libmd4c0 libqt5core5a libqt5dbus5  
  libqt5gui5 libqt5network5 libqt5opengl5 libqt5printsupport5 libqt5svg5 libqt5widgets5 libqt5x11extras5 libsdl1.2debian 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-dcrtl-tools dkms gcc-12 libasan8 libdouble-conversion3 libgcc-12-dev libgsoap-2.8.117 liblzf1 libmd4c0 libqt5core5a libqt5dbus5  
  libqt5gui5 libqt5network5 libqt5opengl5 libqt5printsupport5 libqt5svg5 libqt5widgets5 libqt5x11extras5 libsdl1.2debian libtsan2  
  libxcb-xinerama0 libxcb-xinput0 qt5-gtk-platformtheme qttranslations5-l10n virtualbox 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

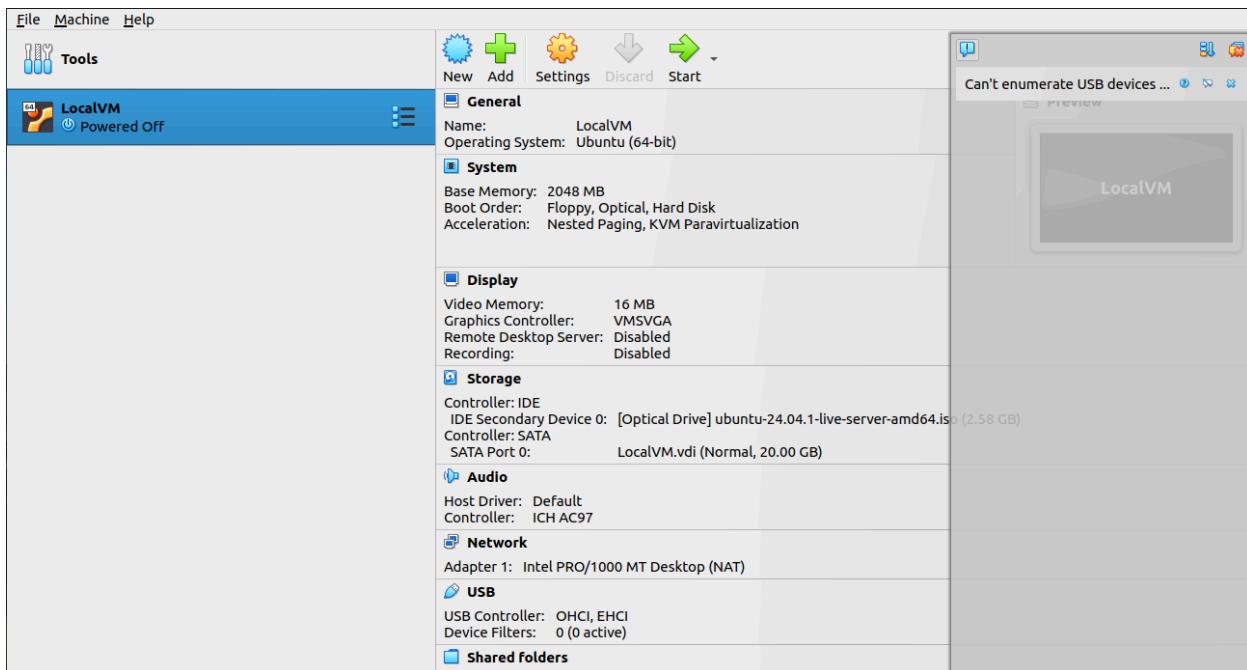
ISO Attachment

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

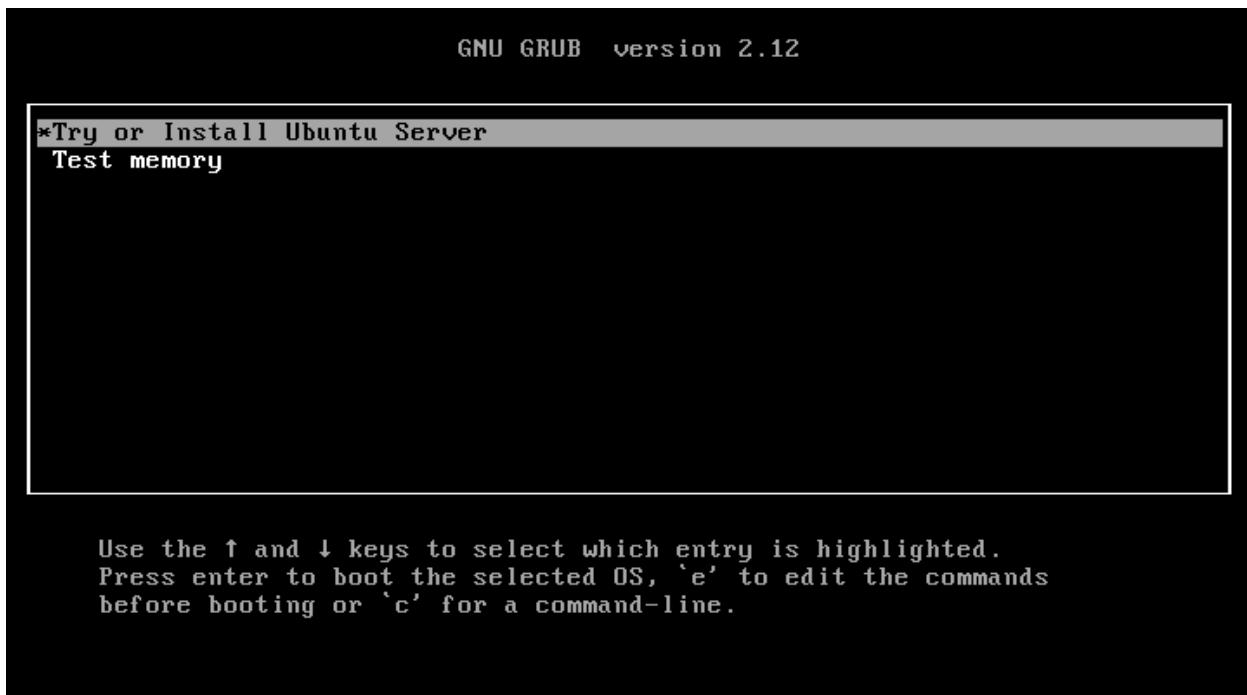
Installation Steps

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).

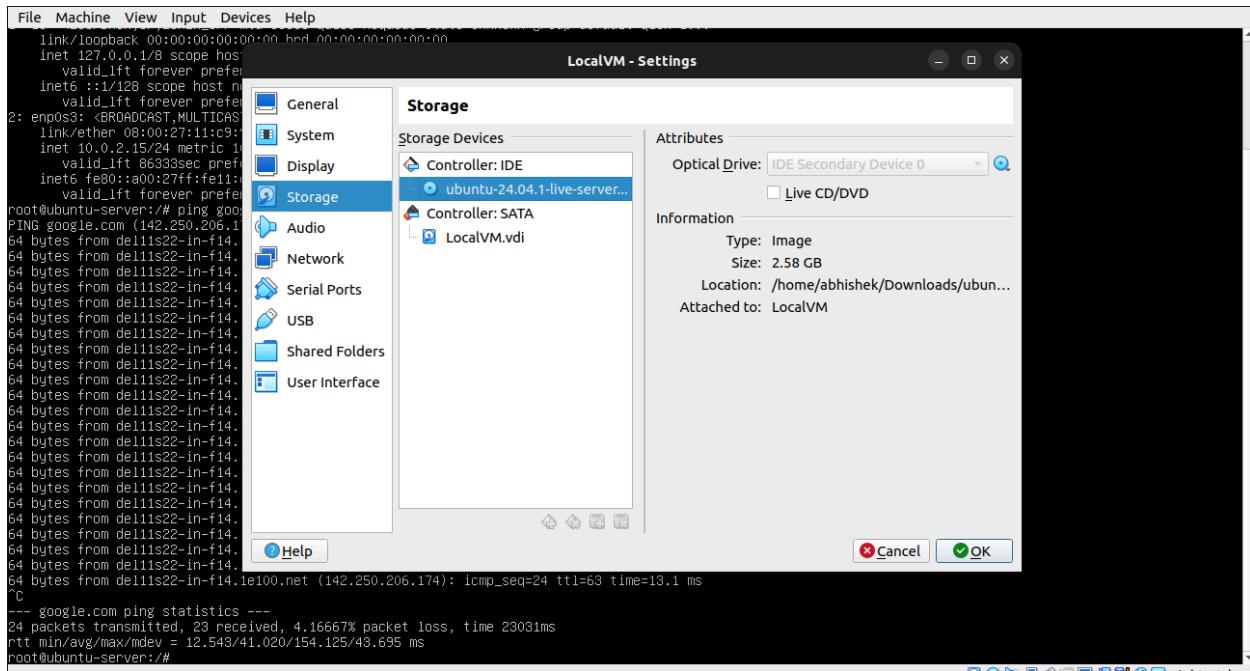
Please see the below image in which we can see all the configurations of my VM.



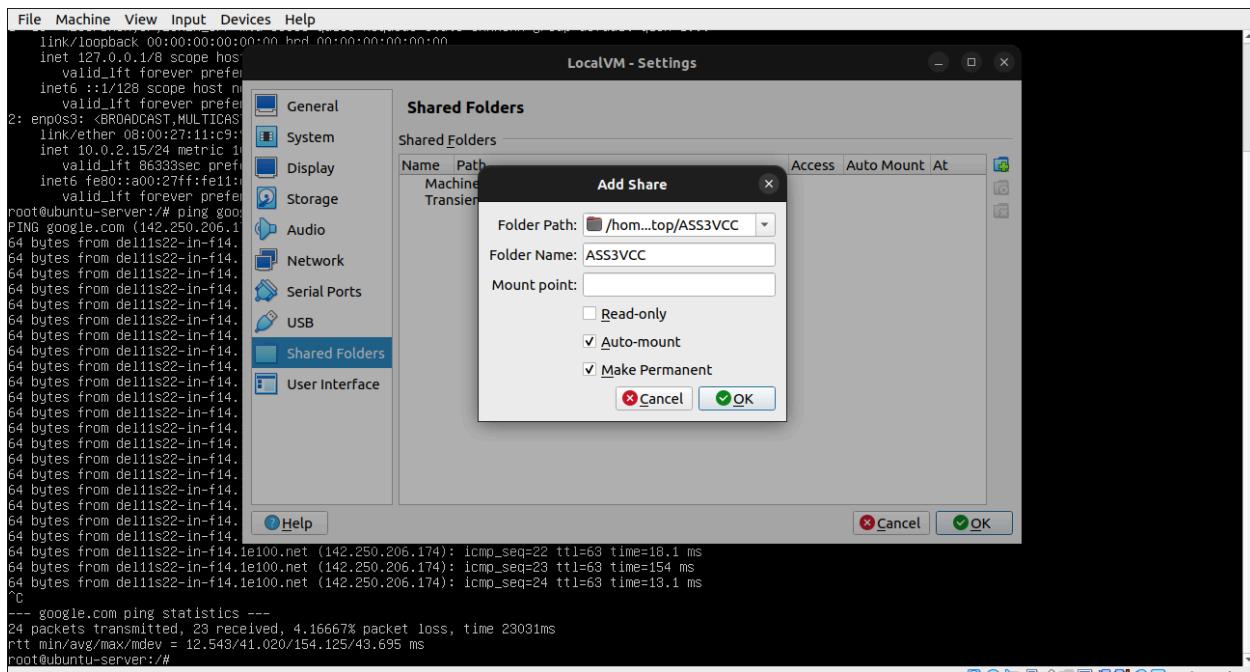
This is the first interface i seen.



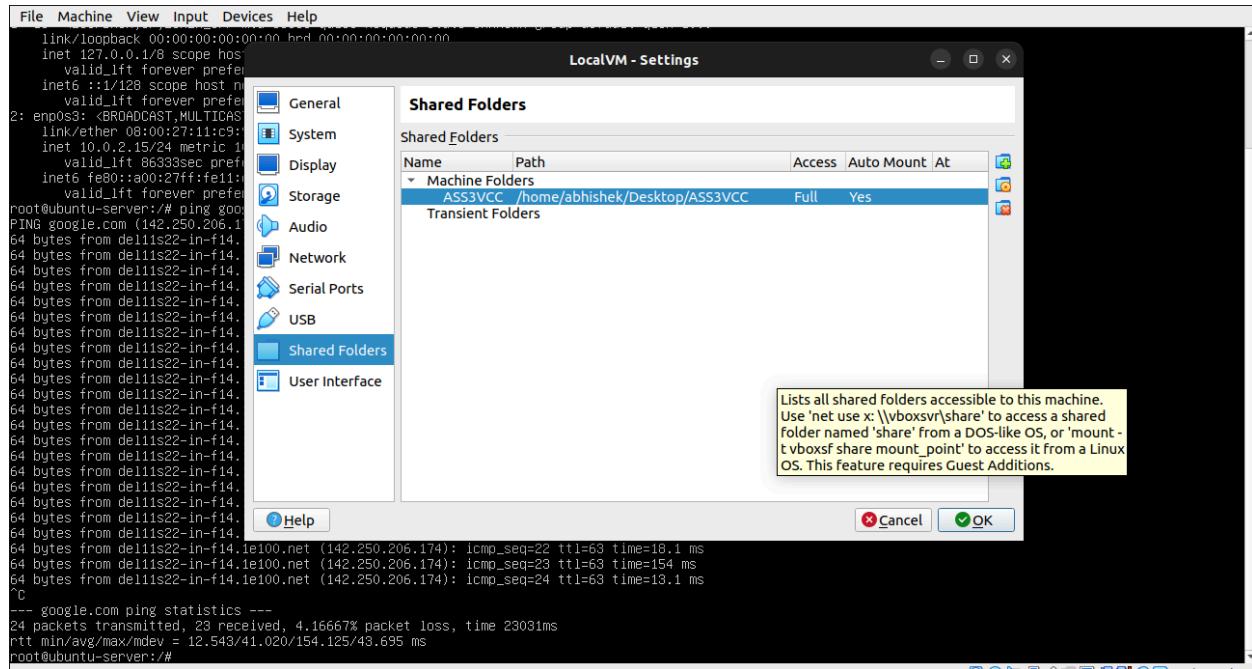
Here you can see how i selected the iso file :



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

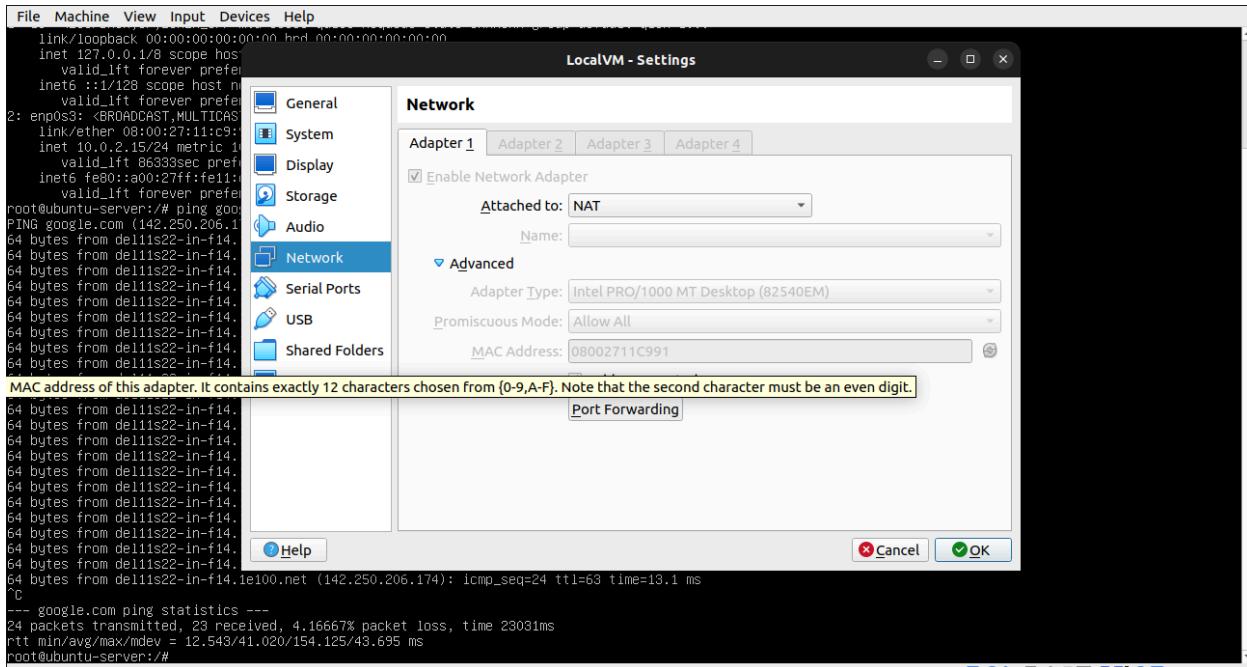


See i have selected the ASS3VCC folder from my ubuntu now i access every file of the folder in this vm.

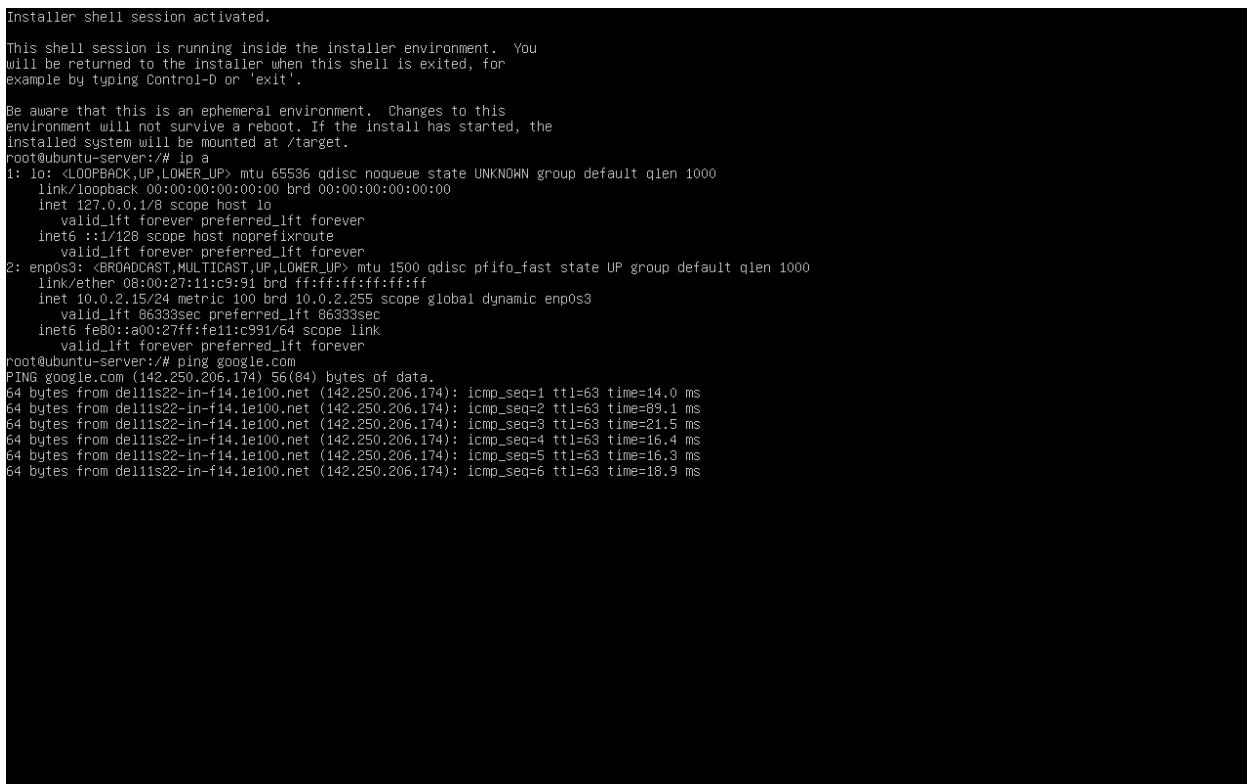


Network Configuration :

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:

- o -b: Batch mode for non-interactive output.
- o -n1: Run for 1 iteration.
- o Extracts CPU usage (100% - idle time).

2. free Command:

- o Calculates memory usage as (Used / Total) * 100.

3. Logging:

- o Appends timestamped CPU/memory data to /var/log/resource.log.

4. Threshold Check:

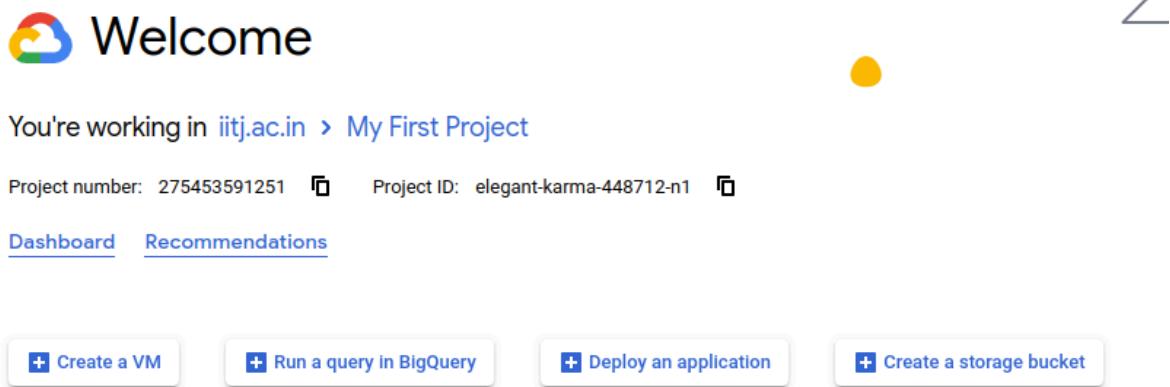
- o Uses bc -l for floating-point comparison.
- o Triggers scale-gcp.sh if CPU > 75% OR Memory > 75%.

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
1818	root	20	0	8952	5376	3200	R	0.9	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
8	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/0:0-kblockd
11	root	20	0	0	0	0	I	0.0	0.0	0:00.75	kworker/0:0-events_unbound
12	root	0	-20	0	0	0	I	0.0	0.0	0:00.00	kworker/R-mm_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	cpung/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/0:1-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/0:2-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	ksm
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-kblc
34	root	0	-20	0	0	0	I	0.0	0.0	0:00.00	kworker/R-blkg
35	root	-51	0	0	0	0	S	0.0	0.0	0:00.00	irq/3-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 :

The image shows the Google Cloud Compute Engine VM Instances page. The sidebar on the left is titled "Compute Engine" and includes sections for Overview, Virtual machines (with "VM instances" selected), Instance templates, Sole-tenant nodes, Machine images, and TPUs. The main content area is titled "VM instances" and shows a table with one row. The table columns are: Status, Name (sorted by Name), Zone, Recommendations, In use by, Internal IP, External IP, and Connect. The single instance listed is named "ass3-mig-zzvs", located in the "asia-south2-a" zone, and is connected to "ass3-mig".

Please see i created this instance template i created :

The screenshot shows the Google Cloud Compute Engine Instance templates page. The left sidebar has 'Compute Engine' selected under 'Virtual machines'. The main area displays a table of instance templates. One entry is visible:

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 :

The screenshot shows the Google Cloud Compute Engine Instance groups page. The left sidebar has 'Compute Engine' selected under 'Virtual machines'. The main area displays a table of instance groups. One entry is visible:

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.

The screenshot shows the Google Cloud IAM & Admin / Service accounts page. The left sidebar has 'Service Accounts' selected under 'IAM'. The main area displays a table of service accounts. Two entries are visible:

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	c3aa09a9bacfeb833d91d69a61257383b751a42 9bf8b23e29c5dc7f652df309fc57386ac7bad088	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).

The screenshot shows the Google Cloud Platform interface for managing instance groups. The left sidebar has a 'Compute Engine' section with 'Instance groups' selected. The main area displays the 'Instance groups' page with a single entry:

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	