

# 1. GCP Configurations

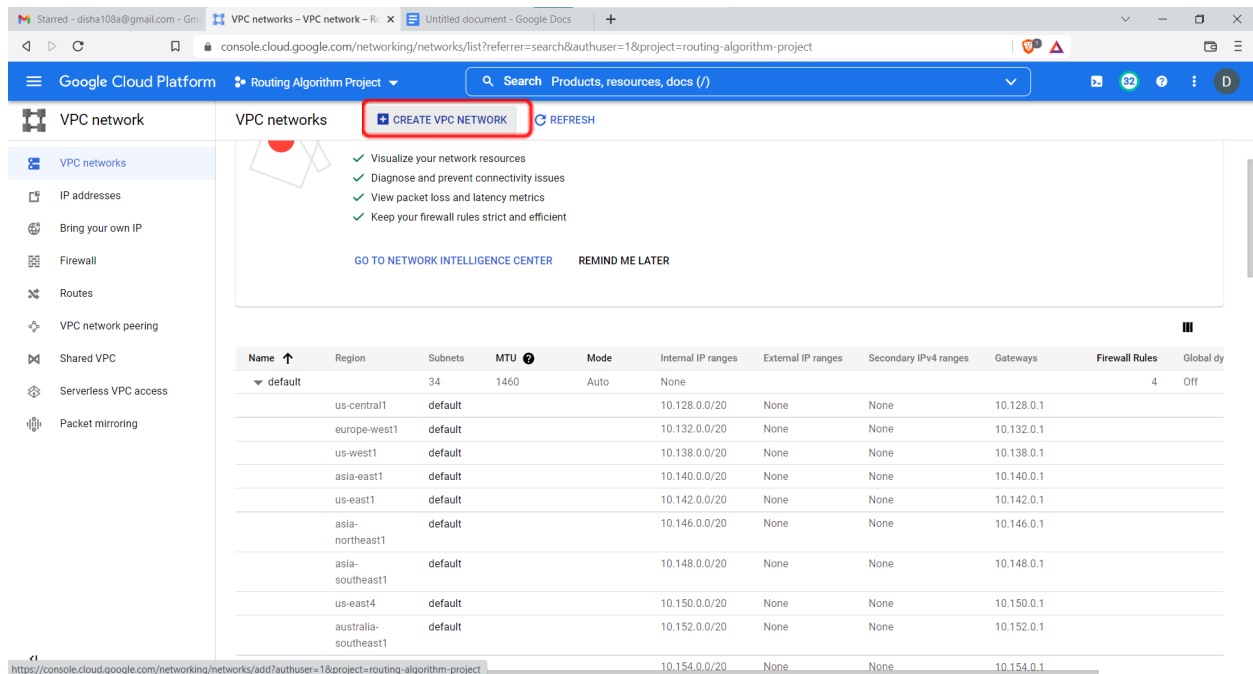
Our project is done in the Google Cloud Platform (GCP). We have mainly used two services provided by GCP:

## 1.1. VPC Setup

Google Cloud Platform provides us with a default VPC network called “default” as shown below:

Name ↑	Region	Subnets	MTU ⓘ	Mode	Internal IP ranges	External IP ranges	Secondary IPv4 ranges	Gateways	Firewall Rules	Global dy
▼ default		34	1460	Auto	None				4	Off
	us-central1	default			10.128.0.0/20	None	None	10.128.0.1		
	europa-west1	default			10.132.0.0/20	None	None	10.132.0.1		
	us-west1	default			10.138.0.0/20	None	None	10.138.0.1		

But we have used a different network of our own. To create a VPC network, we followed the below steps:



Name ↑	Region	Subnets	MTU ⓘ	Mode	Internal IP ranges	External IP ranges	Secondary IPv4 ranges	Gateways	Firewall Rules	Global dy
▼ default		34	1460	Auto	None				4	Off
	us-central1	default			10.128.0.0/20	None	None	10.128.0.1		
	europa-west1	default			10.132.0.0/20	None	None	10.132.0.1		
	us-west1	default			10.138.0.0/20	None	None	10.138.0.1		
	asia-east1	default			10.140.0.0/20	None	None	10.140.0.1		
	us-east1	default			10.142.0.0/20	None	None	10.142.0.1		
	asia-northeast1	default			10.146.0.0/20	None	None	10.146.0.1		
	asia-southeast1	default			10.148.0.0/20	None	None	10.148.0.1		
	us-east4	default			10.150.0.0/20	None	None	10.150.0.1		
	australia-southeast1	default			10.152.0.0/20	None	None	10.152.0.1		
					10.154.0.0/20	None	None	10.154.0.1		

### ← Create a VPC network

Name \*

internal



Lowercase letters, numbers, hyphens allowed

Description

Internal Network




Name of the VPC network should be unique.

The firewall rules associated with this VPC network are:

- allowing ssh
- allowing icmp
- allowing rdp connections
- allowing internal connections between virtual machines in the network

#### Firewall rules

Select any of the firewall rules below that you would like to apply to this VPC network. Once the VPC network is created, you can manage all firewall rules on the Firewall rules page.

IPV4 FIREWALL RULES		IPV6 FIREWALL RULES					
<input checked="" type="checkbox"/>	Name	Type	Targets	Filters	Protocols / ports	Action	Priority 
<input checked="" type="checkbox"/>	internal-allow-custom 	Ingress	Apply to all	IP ranges: 10.128.0.0/9	all	Allow	65,534
<input checked="" type="checkbox"/>	internal-allow-icmp 	Ingress	Apply to all	IP ranges: 0.0.0.0/0	icmp	Allow	65,534
<input checked="" type="checkbox"/>	internal-allow-rdp 	Ingress	Apply to all	IP ranges: 0.0.0.0/0	tcp:3389	Allow	65,534
<input checked="" type="checkbox"/>	internal-allow-ssh 	Ingress	Apply to all	IP ranges: 0.0.0.0/0	tcp:22	Allow	65,534
	internal-deny-all-ingress 	Ingress	Apply to all	IP ranges: 0.0.0.0/0	all	Deny	65,535
	internal-allow-all-egress 	Egress	Apply to all	IP ranges: 0.0.0.0/0	all	Allow	65,535


#### Dynamic routing mode

☒ Regional

Cloud Routers will learn routes only in the region in which they were created

☐ Global

Global routing lets you dynamically learn routes to and from all regions with a single VPN or interconnect and Cloud Router

 Enable DNS API to pick a DNS policy

ENABLE

Maximum transmission unit (MTU)

1460

CREATE

CANCEL

EQUIVALENT COMMAND LINE



After choosing these necessary configurations we can click on the “create” button, also we can generate the equivalent command line for this manual steps.

## 1.2. Compute Engine Setup

We have used GCP's Compute Engine to launch virtual machines (VMs) on demand. The specifications of each VM is as follows:

Name	Region	IP Address Range	Zone	Machine Type	Boot Disk Image	Boot Disk Size (GB)	Subnetwork	Primary Internal IP
node1	us-central1	10.128.0.0/20	us-central1-a	e2-micro	ubuntu-1804-lts	10	internal1	10.128.0.2
node2	us-central1	10.128.0.0/20	us-central1-a	e2-micro	ubuntu-1804-lts	10	internal1	10.128.0.3
node3	us-central1	10.128.0.0/20	us-central1-a	e2-micro	ubuntu-1804-lts	10	internal1	10.128.0.4
node4	us-central1	10.128.0.0/20	us-central1-a	e2-micro	ubuntu-1804-lts	10	internal1	10.128.0.5
node5	us-central1	10.128.0.0/20	us-central1-a	e2-micro	ubuntu-1804-lts	10	internal1	10.128.0.6
node6	us-central1	10.128.0.0/20	us-central1-a	e2-micro	ubuntu-1804-lts	10	internal1	10.128.0.7
node7	us-central1	10.128.0.0/20	us-central1-a	e2-micro	ubuntu-1804-lts	10	internal1	10.128.0.8

To launch a compute engine, we have to follow the below steps:

- Form the Compute Engine dashboard click on “CREATE INSTANCE”

The screenshot shows the Google Cloud Platform (GCP) console interface. The top navigation bar includes the Google Cloud Platform logo, the project name 'Routing Algorithm Project', a search bar, and various utility icons. The main content area is titled 'Compute Engine' and 'VM instances'. A red box highlights the 'CREATE INSTANCE' button. Below this, there are tabs for 'INSTANCES' and 'INSTANCE SCHEDULES'. The 'INSTANCES' tab is active, displaying a table of VM instances. The table has columns for Status, Name, Zone, Recommendations, In use by, Internal IP, Ex, and Connect. There are 7 instances listed, all with a status of 'Running' and a primary internal IP address. A sidebar on the left contains a navigation menu with options like 'Virtual machines', 'Instance templates', 'Sole-tenant nodes', 'Machine images', 'TPUs', 'Committed use discounts', 'Migrate for Compute Eng...', 'Storage', 'Disks', 'Snapshots', 'Images', 'Instance groups', 'Marketplace', and 'Release Notes'. On the right side, there is a 'Select an instance' panel with tabs for 'PERMISSIONS', 'LABELS', and 'MONITORING'. A message in this panel says 'Please select at least one resource.'

Status	Name	Zone	Recommendations	In use by	Internal IP	Ex	Connect
Running	node1	us-central1-a			10.128.0.2 (nic0)		SSH
Running	node2	us-central1-a			10.128.0.3 (nic0)		SSH
Running	node3	us-central1-a			10.128.0.4 (nic0)		SSH
Running	node4	us-central1-a			10.128.0.5 (nic0)		SSH
Running	node5	us-central1-a			10.128.0.6 (nic0)		SSH
Running	node6	us-central1-a			10.128.0.7 (nic0)		SSH
Running	node7	us-central1-a			10.128.0.8 (nic0)		SSH

- Provide the instance name, region, zone and machine type according to the requirements.

← Create an instance

HELP ASSISTANT

To create a VM instance, select one of the options:

New VM instance  
Create a single VM instance from scratch

New VM instance from template  
Create a single VM instance from an existing template

New VM instance from machine image  
Create a single VM instance from an existing machine image

Marketplace  
Deploy a ready-to-go solution onto a VM instance

Name \*  
instance-1

Labels  
+ ADD LABELS

Region \*  
us-central1 (Iowa)  
Region is permanent

Zone \*  
us-central1-a  
Zone is permanent


Machine configuration


Machine family  
GENERAL-PURPOSE COMPUTE-OPTIMIZED MEMORY-OPTIMIZED GPU

Machine types for common workloads, optimized for cost and flexibility

Series  
E2  
CPU platform selection based on availability

Machine type  
e2-micro (2 vCPU, 1 GB memory)

vCPU  
1 shared core

Memory  
1 GB


Monthly estimate  
\$7.11  
That's about \$0.01 hourly  
Pay for what you use: No upfront costs and per second billing

Item	Monthly estimate
2 vCPU + 1 GB memory	\$6.11
10 GB balanced persistent disk	\$1.00
Sustained use discount	-\$0.00
Total	\$7.11

[Compute Engine pricing](#)  
[^ LESS](#)

- Change the boot disc configurations

## Boot disk ?

Name	instance-1
Type	New balanced persistent disk
Size	10 GB
Image	 Debian GNU/Linux 11 (bullseye)

CHANGE

Google Cloud PlatformRouting Algorithm Project

Create an instance

To create a VM instance, select one of the options:

New VM instance  
Create a single VM instance from scratch

New VM instance from template  
Create a single VM instance from an existing template

New VM instance from machine image  
Create a single VM instance from an existing machine image

Marketplace  
Deploy a ready-to-go solution onto a VM instance

ENABLE

Container

Deploy a container image

DEPLOY CONTAINER

Boot disk

Name

Type

Size

Image

CHANGE

Identity and Access

Service accounts

Service account

Compute Engine default service account

Requires the Service Account to have the Compute Engine VM Instance Admin (roles/compute.instanceAdmin.v1) who want to access VM instances

Access scopes

☒ Allow default access scopes

☐ Allow full access to all Cloud APIs

Boot disk

Select an image or snapshot to create a boot disk; or attach an existing disk. Can't find what you're looking for? Explore hundreds of VM solutions in [Marketplace](#)

PUBLIC IMAGESCUSTOM IMAGESSNAPSHOTSEXISTING DISKS

Operating system

Ubuntu

Version \*

Ubuntu 18.04 LTS

amd64 bionic image built on 2022-05-30, supports Shielded VM features

Boot disk type \*

Balanced persistent disk

Size (GB) \*

10

SHOW ADVANCED CONFIGURATION

SELECTCANCEL

Google Cloud PlatformRouting Algorithm Project

Create an instance

To create a VM instance, select one of the options:

New VM instance  
Create a single VM instance from scratch

New VM instance from template  
Create a single VM instance from an existing template

New VM instance from machine image  
Create a single VM instance from an existing machine image

Marketplace  
Deploy a ready-to-go solution onto a VM instance

ENABLE

Container

Deploy a container image

DEPLOY CONTAINER

Boot disk

Name

Type

Size

Image

Device name

CHANGE

Identity and Access

Service accounts

Service account

Compute Engine default service account

Requires the Service Account to have the Compute Engine VM Instance Admin (roles/compute.instanceAdmin.v1) who want to access VM instances

Access scopes

☒ Allow default access scopes

☐ Allow full access to all Cloud APIs

Boot disk

Deletion rule

When deleting instance

☐ Keep boot disk

☒ Delete boot disk

Encryption

Data is encrypted automatically. Select an encryption key management solution.

☒ Google-managed encryption key  
No configuration required

☐ Customer-managed encryption key (CMEK)  
Manage via Google Cloud Key Management Service

☐ Customer-supplied encryption key (CSEK)  
Manage outside of Google Cloud

Snapshot schedule

Use snapshot schedules to automate disk backups. [Learn more](#)

Select a snapshot schedule

Device name

Used to reference the device for mounting or resizing.

☒ Use a custom device name

Device name

instance-1

Custom

HIDE ADVANCED CONFIGURATION

SELECTCANCEL

Google Cloud PlatformRouting Algorithm Project

Create an instance

To create a VM instance, select one of the options:

New VM instance

Create a single VM instance from scratch

New VM instance from template

Create a single VM instance from an existing template

New VM instance from machine image

Create a single VM instance from an existing machine image

Marketplace

Deploy a ready-to-go solution onto a VM instance

ENABLE

Container

Deploy a container image

DEPLOY CONTAINER

Boot disk

Name

Type

Size

Image

Device name

CHANGE

Identity and Access

Service accounts

Compute Engine default service account

Requires the Service Account to have the Compute Engine default service account role who want to access VM instances

Access scopes

Allow default access

Boot disk

Deletion rule

When deleting instance

Keep boot disk

Delete boot disk

Encryption

Data is encrypted automatically. Select an encryption key management solution.

Google-managed encryption key

No configuration required

Customer-managed encryption key (CMEK)

Manage via Google Cloud Key Management Service

Customer-supplied encryption key (CSEK)

Manage outside of Google Cloud

Snapshot schedule

Use snapshot schedules to automate disk backups. [Learn more](#)

Select a snapshot schedule

Device name

Used to reference the device for mounting or resizing.

Use a custom device name

Device name

instance-1

Custom

HIDE ADVANCED CONFIGURATION

SELECT





CANCEL

- Now launch the instance in the VPC network we created in the prior step

The screenshot shows the 'Create an instance' page in the Google Cloud Platform console. The left sidebar lists options: 'New VM instance' (selected), 'New VM instance from template', 'New VM instance from machine image', and 'Marketplace'. The main content area shows configuration sections: 'Networking' (highlighted with a red box), 'Disks', 'Security', 'Management', and 'Sole-tenancy'. The 'Networking' section includes a dropdown for 'Hostname and network interfaces'. The right sidebar shows a 'Monthly estimate' of \$7.11, broken down by item: 2 vCPU + 1 GB memory (\$6.11), 10 GB balanced persistent disk (\$1.00), and Sustained use discount (-\$0.00). At the bottom, there are buttons for 'CREATE', 'CANCEL', and 'EQUIVALENT COMMAND LINE'.

The screenshot shows the 'Create an instance' page in the Google Cloud Platform console, specifically the 'Network performance configuration' section. The 'Network interfaces' section is highlighted with a red box. It shows a table with columns 'Network interface card' and 'Network bandwidth'. The 'Network interface card' dropdown is set to 'default default (10.128.0.0/20)'. The 'Network bandwidth' section has a checkbox for 'Increase total egress bandwidth' which is unchecked. The right sidebar shows the same 'Monthly estimate' of \$7.11. At the bottom, there are buttons for 'CREATE', 'CANCEL', and 'EQUIVALENT COMMAND LINE'.

To create a VM instance, select one of the options:

-  **New VM instance**  
Create a single VM instance from scratch
-  **New VM instance from template**  
Create a single VM instance from an existing template
-  **New VM instance from machine image**  
Create a single VM instance from an existing machine image
-  **Marketplace**  
Deploy a ready-to-go solution onto a VM instance

#### Network bandwidth

- ☐ Increase total egress bandwidth  
Maximum outbound network bandwidth: 1Gbps

#### Network interfaces

Network interface is permanent

##### Edit network interface

Network \*  
default

Subnetwork \*  
default IPv4 (10.128.0.0/20)

**i** To use IPv6, you need an IPv6 subnet range. [LEARN MORE](#)

##### IP stack type

- ☒ IPv4 (single-stack)
- ☐ IPv4 and IPv6 (dual-stack)

Primary internal IP  
Ephemeral (Automatic)

##### Alias IP ranges

[+ ADD IP RANGE](#)

External IPv4 address

#### Monthly estimate

**\$7.11**

That's about \$0.01 hourly

Pay for what you use: No upfront costs and per second billing

Item	Monthly estimate
2 vCPU + 1 GB memory	\$6.11
10 GB balanced persistent disk	\$1.00
Sustained use discount	-\$0.00
Total	\$7.11

[Compute Engine pricing](#)

[LESS](#)



To create a VM instance, select one of the options:

- New VM instance**  
Create a single VM instance from scratch
- New VM instance from template**  
Create a single VM instance from an existing template
- New VM instance from machine image**  
Create a single VM instance from an existing machine image
- Marketplace**  
Deploy a ready-to-go solution onto a VM instance

**Network bandwidth**  
☐ Increase total egress bandwidth  
Maximum outbound network bandwidth: 1Gbps

### Network interfaces

Network interface is permanent

#### Edit network interface

Network + ?

Filter [Type to filter]

default ?

internal

**IP stack type**  
☒ IPv4 (single-stack)  
☐ IPv4 and IPv6 (dual-stack)

**Primary internal IP**  
Ephemeral (Automatic)

**Alias IP ranges**

+ ADD IP RANGE

**External IPv4 address**

#### Monthly estimate

**\$7.11**

That's about \$0.01 hourly

Pay for what you use: No upfront costs and per second billing

Item	Monthly estimate
2 vCPU + 1 GB memory	\$6.11
10 GB balanced persistent disk	\$1.00
Sustained use discount	-\$0.00
Total	\$7.11

[Compute Engine pricing](#)

[LESS](#)

To create a VM instance, select one of the options:

- New VM instance**  
Create a single VM instance from scratch
- New VM instance from template**  
Create a single VM instance from an existing template
- New VM instance from machine image**  
Create a single VM instance from an existing machine image
- Marketplace**  
Deploy a ready-to-go solution onto a VM instance

DONE

ADD NETWORK INTERFACE

### Disks

Additional disks

### Security

Shielded VM and SSH keys

### Management

Description, deletion protection, reservations, automation, and availability policies

### Sole-tenancy

Node affinity labels and CPU overcommit

[SHOW LESS](#)

Your free trial credit will be used for this VM instance. [GCP Free Tier](#)

CREATE

CANCEL

EQUIVALENT COMMAND LINE

#### Monthly estimate

**\$7.11**

That's about \$0.01 hourly

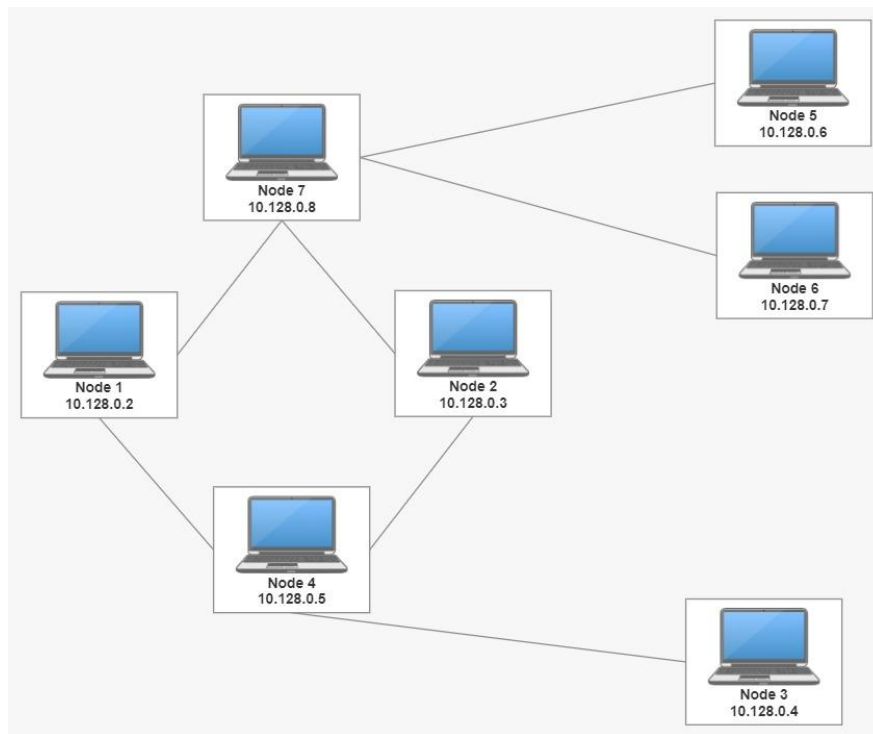
Pay for what you use: No upfront costs and per second billing

Item	Monthly estimate
2 vCPU + 1 GB memory	\$6.11
10 GB balanced persistent disk	\$1.00
Sustained use discount	-\$0.00
Total	\$7.11

[Compute Engine pricing](#)

[LESS](#)

- Following the above steps create instance for each of the nodes in the below network:



## 2. Coding & Implementation

### 2.1. Accessing the VMs

To access the vms, we need to first **start** the vm and then **ssh** to the vms.

Status	Name	Zone	Recommendations	In use by	Internal IP	Ex	Connect
<input type="checkbox"/>	node1	us-central1-a			10.128.0.2 (nic0)		SSH <span style="border: 1px solid red; padding: 2px;">⋮</span>
<input type="checkbox"/>	node2	us-central1-a			10.128.0.3 (nic0)		SSH <span style="border: 1px solid red; padding: 2px;">⋮</span>
<input type="checkbox"/>	node3	us-central1-a			10.128.0.4 (nic0)		SSH <span style="border: 1px solid red; padding: 2px;">⋮</span>
<input type="checkbox"/>	node4	us-central1-a			10.128.0.5 (nic0)		SSH <span style="border: 1px solid red; padding: 2px;">⋮</span>
<input type="checkbox"/>	node5	us-central1-a			10.128.0.6 (nic0)		SSH <span style="border: 1px solid red; padding: 2px;">⋮</span>
<input type="checkbox"/>	node6	us-central1-a			10.128.0.7 (nic0)		SSH <span style="border: 1px solid red; padding: 2px;">⋮</span>
<input type="checkbox"/>	node7	us-central1-a			10.128.0.8 (nic0)		SSH <span style="border: 1px solid red; padding: 2px;">⋮</span>

Google Cloud Platform - Routing Algorithm Project

Compute Engine - VM instances

INSTANCES

VM instances are highly configurable virtual machines for running workloads on Google infrastructure. [Learn more](#)

Filter: Enter property name or value

Status	Name	Zone	Recommendations	In use by	Internal IP	Ex	Connect
<input checked="" type="checkbox"/>	node1	us-central1-a			10.128.0.2 (nic0)	SSH	⋮
<input type="checkbox"/>	node2	us-central1-a			10.128.0.3 (nic0)	SSH	⋮
<input type="checkbox"/>	node3	us-central1-a			10.128.0.4 (nic0)	SSH	⋮
<input type="checkbox"/>	node4	us-central1-a			10.128.0.5 (nic0)	SSH	⋮
<input type="checkbox"/>	node5	us-central1-a			10.128.0.6 (nic0)	SSH	⋮
<input type="checkbox"/>	node6	us-central1-a			10.128.0.7 (nic0)	SSH	⋮
<input type="checkbox"/>	node7	us-central1-a			10.128.0.8 (nic0)	SSH	⋮

Select an instance

PERMISSIONS LABELS MONITORING

Please select at least one resource.

Start / Resume

Stop

Suspend

Reset

Delete

View network details

Create new machine image

View logs

View monitoring

Google Cloud Platform - Routing Algorithm Project

Compute Engine - VM instances

INSTANCES

VM instances are highly configurable virtual machines for running workloads on Google infrastructure. [Learn more](#)

Filter: Enter property name or value

Status	Name	Zone	Recommendations	In use by	Internal IP	Ex	Connect
<input checked="" type="checkbox"/>	node1	us-central1-a			10.128.0.2 (nic0)	SSH	⋮
<input type="checkbox"/>	node2	us-central1-a			10.128.0.3 (nic0)	SSH	⋮
<input type="checkbox"/>	node3	us-central1-a			10.128.0.4 (nic0)	SSH	⋮
<input type="checkbox"/>	node4	us-central1-a			10.128.0.5 (nic0)	SSH	⋮
<input type="checkbox"/>	node5	us-central1-a			10.128.0.6 (nic0)	SSH	⋮
<input type="checkbox"/>	node6	us-central1-a			10.128.0.7 (nic0)	SSH	⋮
<input type="checkbox"/>	node7	us-central1-a			10.128.0.8 (nic0)	SSH	⋮

Select an instance

PERMISSIONS LABELS MONITORING

Please select at least one resource.

Instance started

SSH-in-browser

Welcome to Ubuntu 18.04.4 LTS (GNU/Linux 5.4.0-1078-gcp x86\_64)

\* Documentation: <https://help.ubuntu.com>  
\* Management: <https://landscape.canonical.com>  
\* Support: <https://ubuntu.com/advantage>

System information as of Sun Jun 12 17:43:08 UTC 2022

System load: 0.92 Processes: 123  
Usage of /: 43.64 of 9.50GB Users logged in: 0  
Memory usage: 50% IP address for ens3: 10.128.0.2  
Swap usage: 0%

\* Super-optimized for small spaces - read how we shrank the memory footprint of MicroK8s to make it the smallest full K8s around.  
<https://ubuntu.com/blog/microk8s-memory-optimisation>

18 updates can be applied immediately.  
To see these additional updates run: apt list --upgradable

Last login: Sat Jun 11 11:34:59 2022 from 35.235.240.4  
disha@ubuntu:~\$

Select an instance

PERMISSIONS LABELS MONITORING

Please select at least one resource.

## 2.2. Prerequisites

We have implemented the above discussed routing algorithm using python socket programming. For the successful running of the program we need to install some libraries as prerequisites. Those are as follows:

- **Install pip3**

- **Step-1 Update System:** `sudo apt-get update`
- **Step-2 Install pip3:** `sudo apt-get -y install python3-pip`
- **Step-3 Verification:** `pip3 --version`

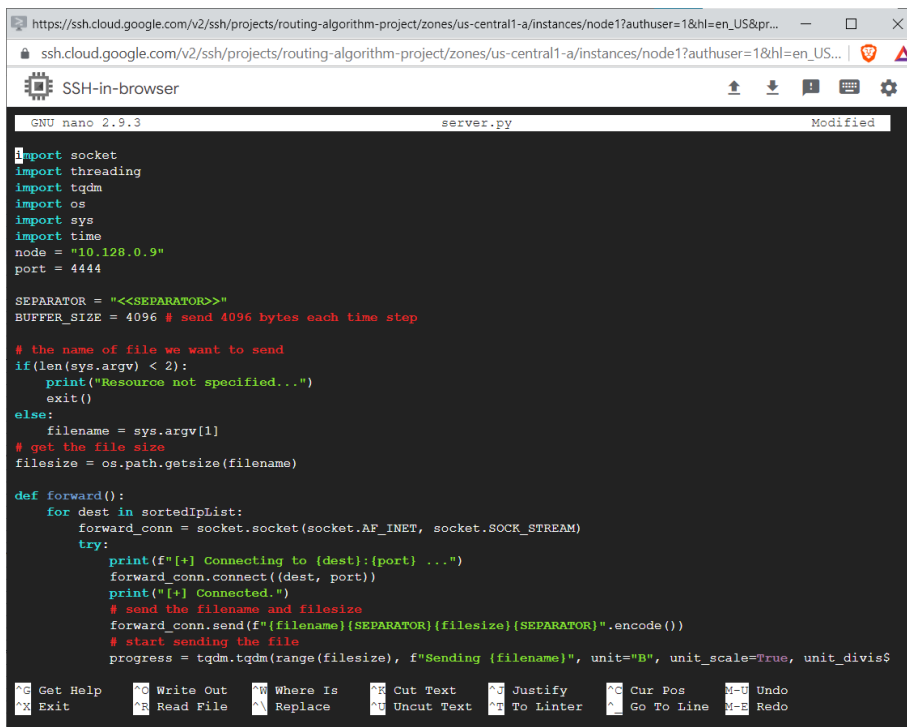
- **Install the tqdm library**

The command to install tqdm library: `pip3 install tqdm`

## 2.3. Writing the Code

- For writing the code, we will use the **nano editor**.

```
Last login: Sat Jun 11 11:34:59 2022 from 35.235.240.4
dishassabv@node1:~$ cd workspace/
dishassabv@node1:~/workspace$ nano server.py
```



```
GNU nano 2.9.3 server.py Modified

import socket
import threading
import tqdm
import os
import sys
import time
node = "10.128.0.9"
port = 4444

SEPARATOR = "<<SEPARATOR>>"
BUFFER_SIZE = 4096 # send 4096 bytes each time step

# the name of file we want to send
if (len(sys.argv) < 2):
    print("Resource not specified...")
    exit()
else:
    filename = sys.argv[1]
# get the file size
filesize = os.path.getsize(filename)

def forward():
    for dest in sortedIplist:
        forward_conn = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
        try:
            print(f"[+] Connecting to {dest}:{port} ...")
            forward_conn.connect((dest, port))
            print(f"[+] Connected.")
            # send the filename and filesize
            forward_conn.send(f"{filename}{SEPARATOR}{filesize}{SEPARATOR}".encode())
            # start sending the file
            progress = tqdm.tqdm(range(filesize), f"Sending {filename}", unit="B", unit_scale=True, unit_divisS

^G Get Help      ^O Write Out    ^W Where Is    ^R Cut Text    ^J Justify    ^C Cur Pos    M-U Undo
^X Exit          ^R Read File    ^\ Replace     ^U Uncut Text  ^T To Linter  ^_ Go To Line  M-E Redo
```

- For saving the code : `ctrl+o` followed by `enter`
- To exit nano editor: `ctrl+x`