README.md

Cloud Computing Project

Submitted by Group 25

Github Repository Link: https://github.com/vimrajesh/cc/

Group 25 Members

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Task

Build your own cloud management system using the libvirt API.

Introduction

The following is an implementation of an autoscaling system which scales and shifts the load from N virtual machines to N+1 virtual machines to ensure that performance can keep up with the increased incoming load.

We are generating random license numbers and sending it to virtual machine to hash and store safely. This set of computations is used to check the autoscaling component of our code.

Configuration

You need to setup the following to get started. We did the implementation on Ubuntu 20.04 LTS. You can use any other Linux distribution.

Initial Installation

Install the following packages:

```
sudo apt-get install virt-manager
```

Check whether KVM can be used by running the following command:

```
kvm-ok
```

If output is something similar, then we are good to go.

```
INFO: /dev/kvm exists
KVM acceleration can be used
```

Then install the rest of the requirements

```
sudo apt-get install qemu-kvm libvirt-daemon-system libvirt-clients bridge-utils
```

Helpful Commands

Check if virtual machines are running:

```
virsh list --all
```

Setting up VMs

- Open virtual machine manager and create a new virtual machine.

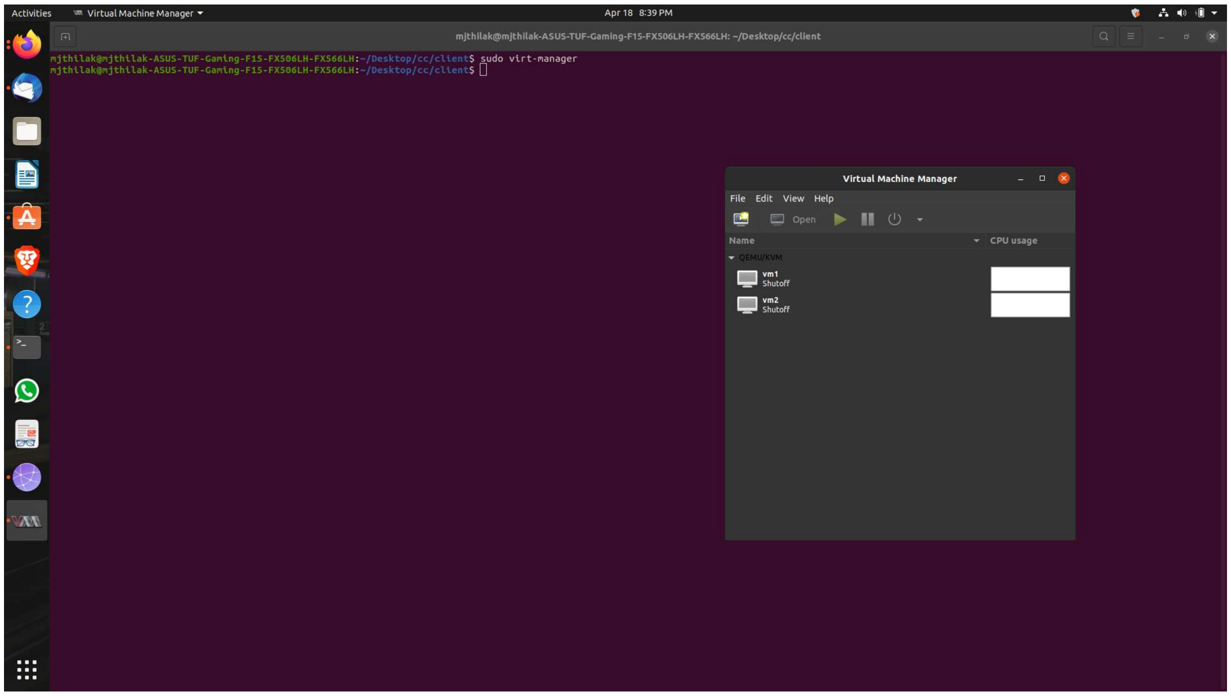
  ```
  virt-manager
  ```

- Set up a new VM with appropriate configurations of RAM and CPU.
- Name the VM as 'vm-1'.
- Clone the VM and remember to rename the hostname of the new VM to 'vm-2'.

  ```
  virsh domrename <old-name> <new-name>
  ```

Implementation

- Start virt-manager.



Activities
Virtual Machine Manager
Apr 18 8:39 PM
mjthilak@mjthilak-ASUS-TUF-Gaming-F15-FX506LH-FX566LH: ~/Desktop/cc/client

```
mjthilak@mjthilak-ASUS-TUF-Gaming-F15-FX506LH-FX566LH:~/Desktop/cc/client$ sudo virt-manager
mjthilak@mjthilak-ASUS-TUF-Gaming-F15-FX506LH-FX566LH:~/Desktop/cc/client$
```

vm1
Shutoff
vm2
Shutoff

Figure 1: Virtual Machines Setup Successfully

The following image above shows the two setup VMs.

- Clone the code repository in the client.

```
git clone https://github.com/vimrajesh/cc/
```

- Clone the code repository in the individual VMs as well.
- Move the server.py code from server directory of the code base to the respective VMs from the server folder to the **'/home/<VM_name>'** directory of the VM.
- Move the rc.local file from **'server\<VM_name>\rc.local'** to the **'\etc'** directory.
- Execute the following commands in the directory.

```
sudo chown root rc.local
sudo chmod 777 rc.local
```

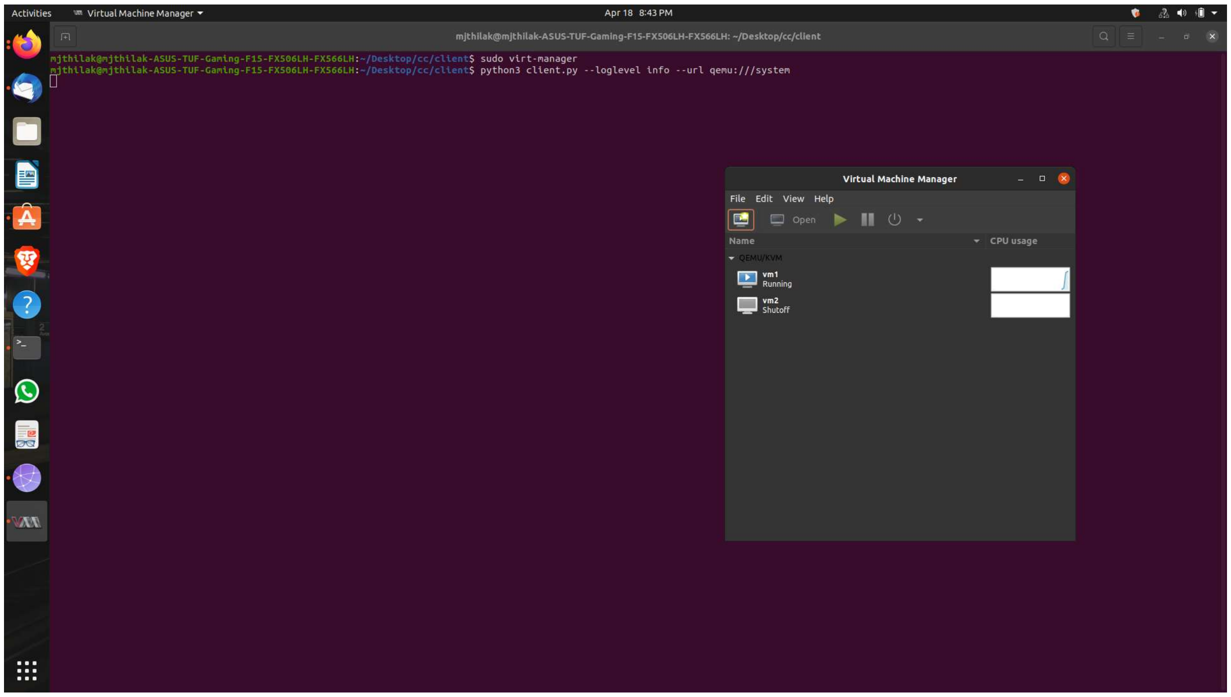
The above commands are to make sure that the rc.local file is executable. The rc.local file gets triggered on the boot of the VM instance. The rc.local files looks like this:

```
#!/bin/sh -e
# VM1 rc.local file
# rc.local
#
# This script is executed at the end of each multiuser runlevel.
# Make sure that the script will "exit 0" on success or any other
# value on error.
#
# In order to enable or disable this script just change the execution
# bits.
#
# By default this script does nothing.

/usr/bin/python3 /home/vm1/server.py &
exit 0
```

- Now you can shut down the VMs. And let us move to the client part of the code.
- Make sure you have libvirt port of python and numpy modules installed in client. You can navigate to **'client/'** directory and run the following command to start the client.

```
python3 client.py --loglevel info --url qemu:///system
```

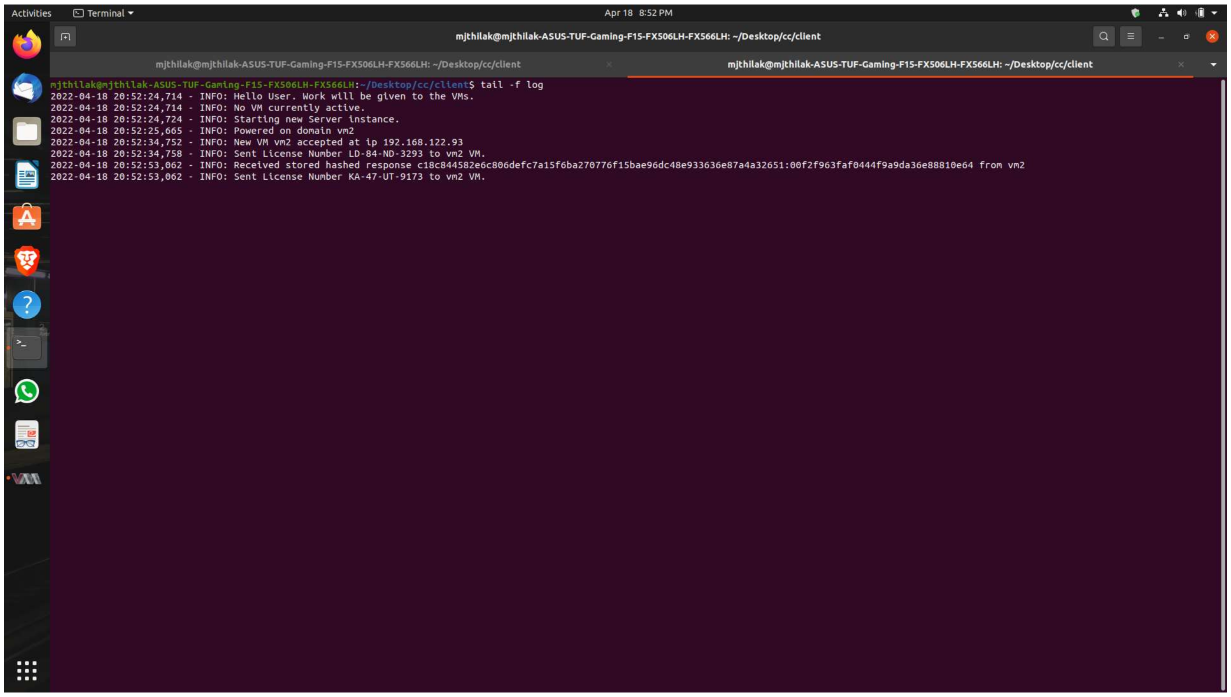


```
mjthilak@mjthilak-ASUS-TUF-Gaming-F15-FX506LH-FX566LH:~/Desktop/cc/client$ sudo virt-manager
mjthilak@mjthilak-ASUS-TUF-Gaming-F15-FX506LH-FX566LH:~/Desktop/cc/client$ python3 client.py --loglevel info --url qemu:///system
```

Figure 2: Running Client Code

- The delta has been set to 1. Delta signifies the inter request time.
- You can follow the log files of the execution in the client end using this command in the same directory.

```
tail -f log
```

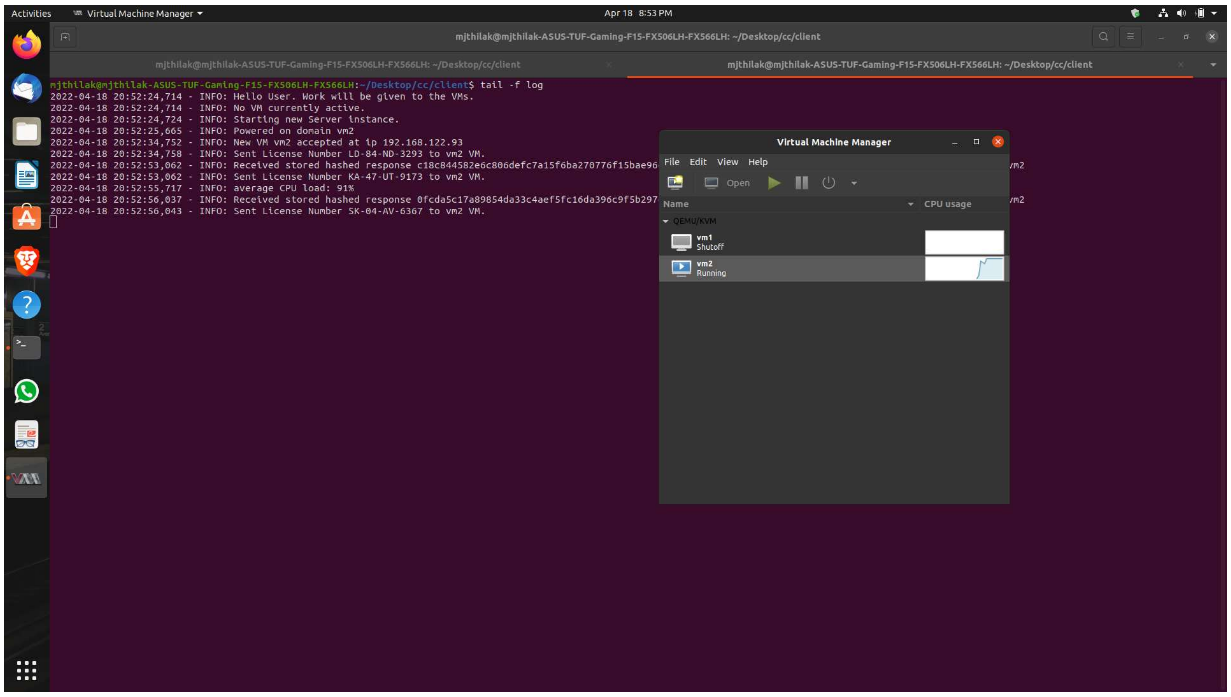


Activities
Terminal
Apr 18 8:52 PM
mjthilak@mjthilak-ASUS-TUF-Gaming-F15-FX506LH-FX566LH: ~/Desktop/cc/client

```
mjthilak@mjthilak-ASUS-TUF-Gaming-F15-FX506LH-FX566LH:~/Desktop/cc/client$ tail -f log
2022-04-18 20:52:24,714 - INFO: Hello User. Work will be given to the VMs.
2022-04-18 20:52:24,714 - INFO: No VM currently active.
2022-04-18 20:52:24,724 - INFO: Starting new Server instance.
2022-04-18 20:52:25,665 - INFO: Powered on domain vm2
2022-04-18 20:52:34,752 - INFO: New VM vm2 accepted at ip 192.168.122.93
2022-04-18 20:52:34,758 - INFO: Sent License Number LD-84-ND-3293 to vm2 VM.
2022-04-18 20:52:53,062 - INFO: Received stored hashed response c18c844582e6c806defc7a15f6ba270776f15bae96dc48e933636e87a4a32651:00f2f963faf0444f9a9da36e88810e64 from vm2
2022-04-18 20:52:53,062 - INFO: Sent License Number KA-47-UT-9173 to vm2 VM.
```

Figure 3: Client End Execution Log

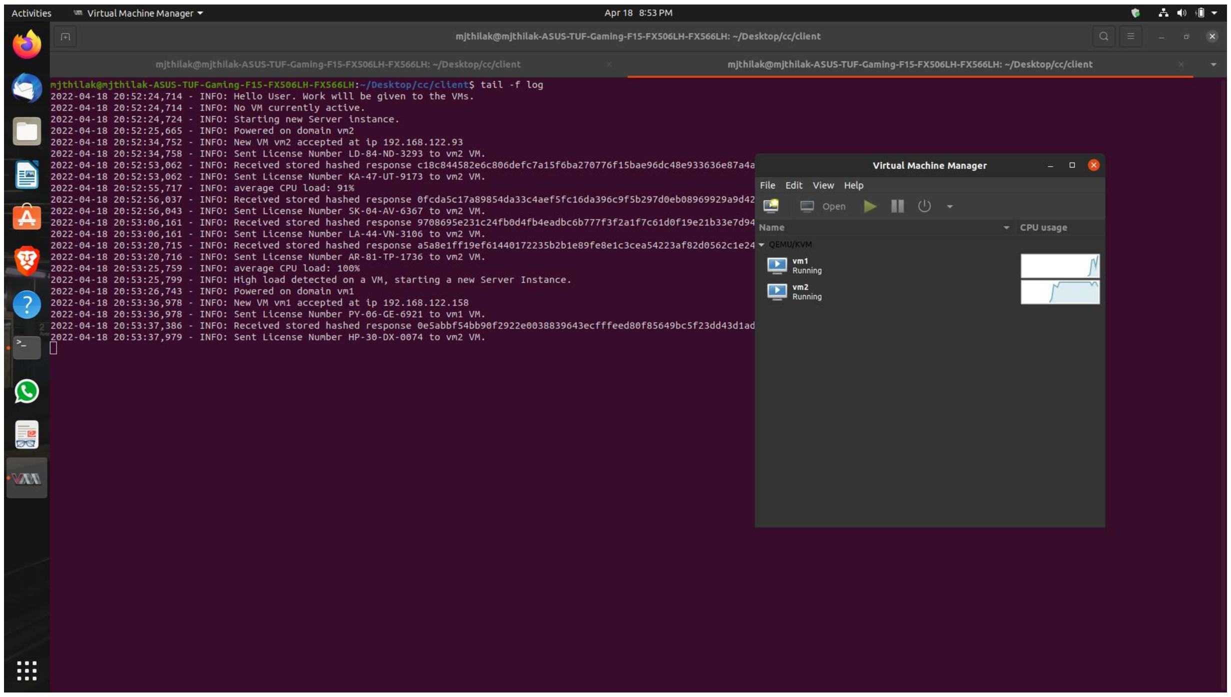
- The following client code would trigger the **server.py** execution at the server end as specified in the **rc.local** file. The following can be verified using the CPU graph in the virt manager.



```
mjthilak@mjthilak-ASUS-TUF-Gaming-F15-FX506LH-FX566LH:~/Desktop/cc/client$ tail -f log
2022-04-18 20:52:24,714 - INFO: Hello User. Work will be given to the VMs.
2022-04-18 20:52:24,714 - INFO: No VM currently active.
2022-04-18 20:52:24,724 - INFO: Starting new Server instance.
2022-04-18 20:52:25,665 - INFO: Powered on domain vm2
2022-04-18 20:52:34,752 - INFO: New VM vm2 accepted at ip 192.168.122.93
2022-04-18 20:52:34,758 - INFO: Sent License Number LD-84-ND-3293 to vm2 VM.
2022-04-18 20:52:53,062 - INFO: Received stored hashed response c18c844582e6c806defc7a15f6ba270776f15bae96
2022-04-18 20:52:53,062 - INFO: Sent License Number KA-47-UT-9173 to vm2 VM.
2022-04-18 20:52:55,717 - INFO: average CPU load: 91%
2022-04-18 20:52:56,037 - INFO: Received stored hashed response 0fcda5c17a89854da33c4aef5fc16da396c9f5b297
2022-04-18 20:52:56,043 - INFO: Sent License Number SK-04-AV-6367 to vm2 VM.
```

Figure 4: CPU Load of VM1

- Now when the computational load is expensive, and above a certain threshold for a sustained period of time (mean is taken), then the load is shifted to other VM as well. VM2 which was previously shut down is booted and the load is shifted to it.

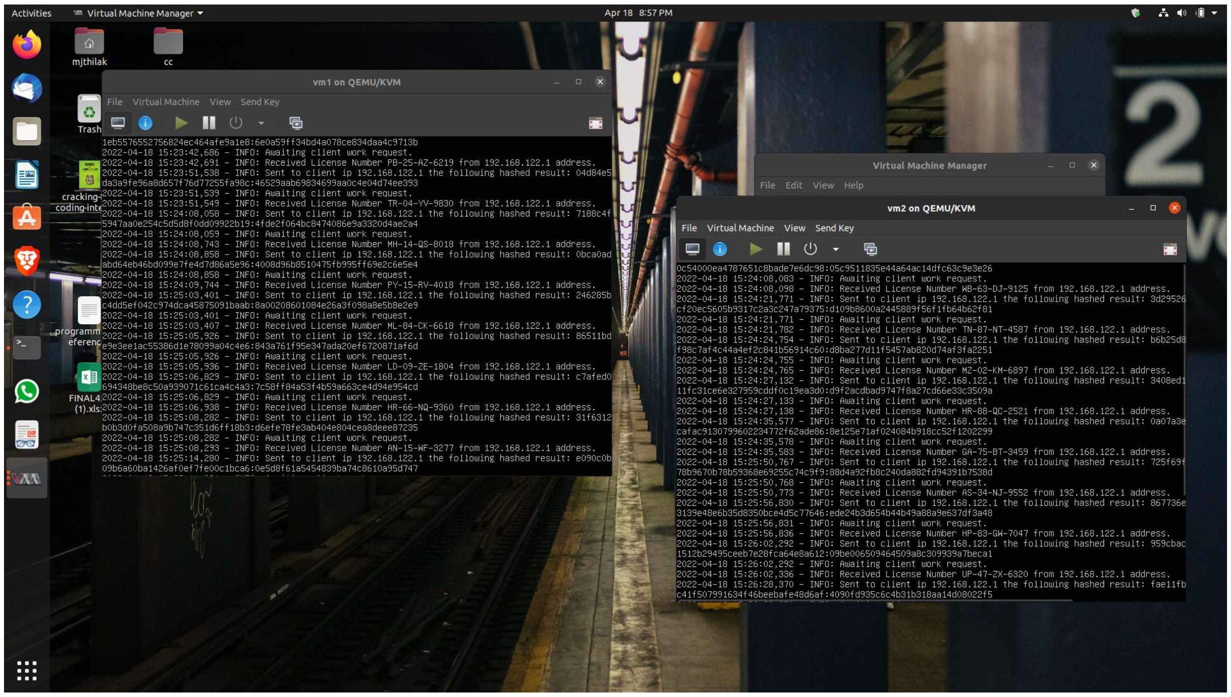


```
mjthilak@mjthilak-ASUS-TUF-Gaming-F15-FX506LH-FX566LH:~/Desktop/cc/client$ tail -f log
2022-04-18 20:52:24,714 - INFO: Hello User. Work will be given to the VMs.
2022-04-18 20:52:24,714 - INFO: No VM currently active.
2022-04-18 20:52:24,724 - INFO: Starting new Server instance.
2022-04-18 20:52:25,665 - INFO: Powered on domain vm2
2022-04-18 20:52:34,752 - INFO: New VM vm2 accepted at ip 192.168.122.93
2022-04-18 20:52:34,758 - INFO: Sent License Number LD-84-ND-3293 to vm2 VM.
2022-04-18 20:52:53,062 - INFO: Received stored hashed response c18c844582e6c806defc7a15f6ba270776f15bae96dc48e933636e87a4a
2022-04-18 20:52:53,062 - INFO: Sent License Number KA-47-UT-9173 to vm2 VM.
2022-04-18 20:52:55,717 - INFO: average CPU load: 91%
2022-04-18 20:52:56,037 - INFO: Received stored hashed response 0fcda5c17a89854da33c4aef5fc16da396c9f5b297d0eb08969929a9d42
2022-04-18 20:52:56,043 - INFO: Sent License Number SK-04-AV-6367 to vm2 VM.
2022-04-18 20:53:06,161 - INFO: Received stored hashed response 9708695e231c24fb0d4fb4eadbc6b777f3f2a1f7c61d0f19e21b33e7d94
2022-04-18 20:53:06,161 - INFO: Sent License Number LA-44-VN-3106 to vm2 VM.
2022-04-18 20:53:20,715 - INFO: Received stored hashed response a5a8e1ff19ef61440172235b2b1e89fe8e1c3cea54223af82d0562c1e24
2022-04-18 20:53:20,716 - INFO: Sent License Number AR-81-TP-1736 to vm2 VM.
2022-04-18 20:53:25,759 - INFO: average CPU load: 100%
2022-04-18 20:53:25,799 - INFO: High load detected on a VM, starting a new Server Instance.
2022-04-18 20:53:26,743 - INFO: Powered on domain vm1
2022-04-18 20:53:36,978 - INFO: New VM vm1 accepted at ip 192.168.122.158
2022-04-18 20:53:36,978 - INFO: Sent License Number PY-06-GE-6921 to vm1 VM.
2022-04-18 20:53:37,386 - INFO: Received stored hashed response 0e5abbf54bb90f2922e0038839643ecfffeed80f85649bc5f23dd43d1ad
2022-04-18 20:53:37,979 - INFO: Sent License Number HP-30-DX-0074 to vm2 VM.
```

Figure 5 Shifting load to available VM instance

- You can also verify the operations at server end by checking the log files at server end. It usually should be in the root directory. You can check them using the following command.

```
tail -f log
```

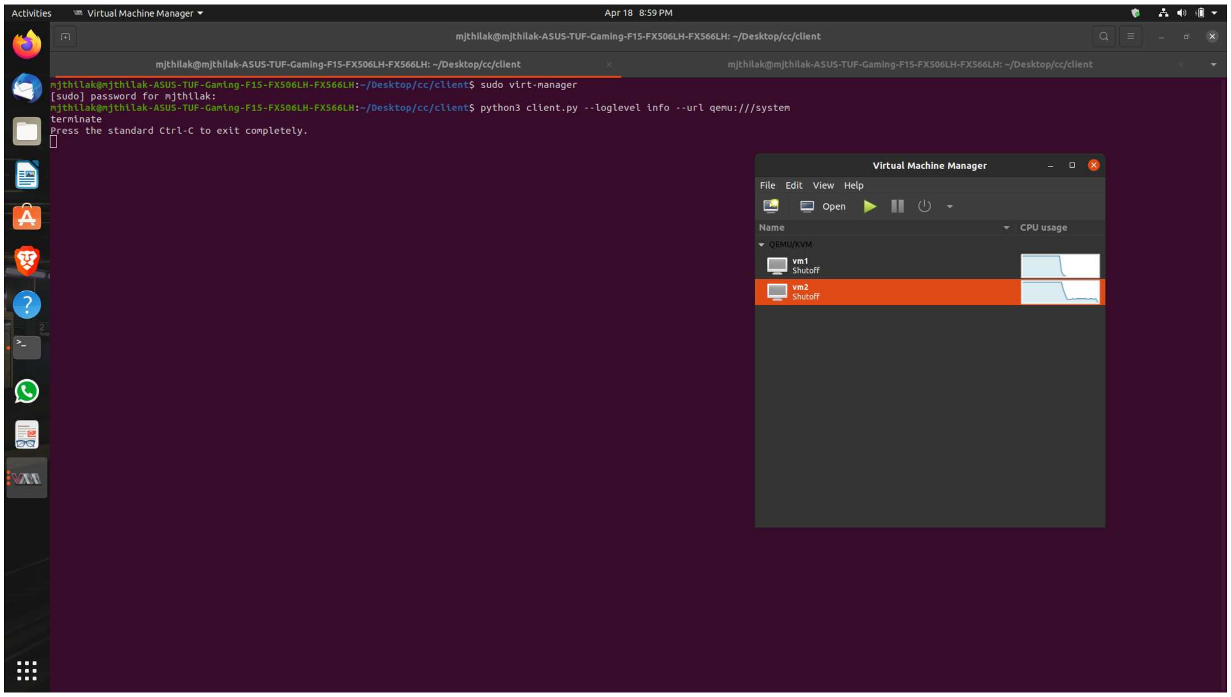


```
1eb5576552756824ec464afe9a1e8:6e0a59ff34bd4a078ce834daa4c9713b
2022-04-18 15:23:42,686 - INFO: Awaiting client work request.
2022-04-18 15:23:42,691 - INFO: Received License Number PB-25-AZ-6219 from 192.168.122.1 address.
2022-04-18 15:23:51,538 - INFO: Sent to client ip 192.168.122.1 the following hashed result: 04d84e5
da3a9fe96a8d657f76d77255fa98c:46529aab69834699aa0c4e04d74ee393
2022-04-18 15:23:51,539 - INFO: Awaiting client work request.
2022-04-18 15:23:51,549 - INFO: Received License Number TR-04-YV-9830 from 192.168.122.1 address.
2022-04-18 15:24:08,058 - INFO: Sent to client ip 192.168.122.1 the following hashed result: 7188c4f
5947aa0e254c5d5d8f0dd09922b19:4fde2f064bc8474086e9a3320d4ae2a4
2022-04-18 15:24:08,059 - INFO: Awaiting client work request.
2022-04-18 15:24:08,743 - INFO: Received License Number MH-14-QS-8018 from 192.168.122.1 address.
2022-04-18 15:24:08,858 - INFO: Sent to client ip 192.168.122.1 the following hashed result: 0bca0ad
abd64eb46bd099e7fe4d7d86a5e96:4008d96b8510475fb995ff69e2c6e5e4
2022-04-18 15:24:08,858 - INFO: Awaiting client work request.
2022-04-18 15:24:09,744 - INFO: Received License Number PY-15-RV-4018 from 192.168.122.1 address.
2022-04-18 15:25:03,401 - INFO: Sent to client ip 192.168.122.1 the following hashed result: 246285b
c4dd5ef042c974dca45875091baab:8a00208601084e26a3f098a8e5b8e2e9
2022-04-18 15:25:03,401 - INFO: Awaiting client work request.
2022-04-18 15:25:03,407 - INFO: Received License Number ML-84-CK-6618 from 192.168.122.1 address.
2022-04-18 15:25:05,926 - INFO: Sent to client ip 192.168.122.1 the following hashed result: 86511bd
e9e3ee1ac55386d1e78099a04c4e6:843a761f95e347ada20ef6720871af6d
2022-04-18 15:25:05,926 - INFO: Awaiting client work request.
2022-04-18 15:25:05,936 - INFO: Received License Number LD-09-ZE-1804 from 192.168.122.1 address.
2022-04-18 15:25:06,829 - INFO: Sent to client ip 192.168.122.1 the following hashed result: c7afed0
694348be8c50a939071c61ca4c4a3:7c58ff84a53f4b59a663ce4d94e954cd
2022-04-18 15:25:06,829 - INFO: Awaiting client work request.
2022-04-18 15:25:06,938 - INFO: Received License Number HR-66-NQ-9360 from 192.168.122.1 address.
2022-04-18 15:25:08,282 - INFO: Sent to client ip 192.168.122.1 the following hashed result: 31f6312
b0b3d0fa508a9b747c351d6ff18b3:d6efe78fe3ab404e804cea8deee87235
2022-04-18 15:25:08,282 - INFO: Awaiting client work request.
2022-04-18 15:25:08,293 - INFO: Received License Number AN-15-WF-3277 from 192.168.122.1 address.
2022-04-18 15:25:14,280 - INFO: Sent to client ip 192.168.122.1 the following hashed result: e090c0b
09b6a60ba1426af0ef7fe00c1bca6:0e5d8f61a5454839ba74c8610a95d747
```

```
0c54000ea4787651c8bade7e6dc98:05c9511835e44a64ac14dfc63c9e3e26
2022-04-18 15:24:08,083 - INFO: Awaiting client work request.
2022-04-18 15:24:08,098 - INFO: Received License Number WB-63-DJ-9125 from 192.168.122.1 address.
2022-04-18 15:24:21,771 - INFO: Sent to client ip 192.168.122.1 the following hashed result: 3d29526
cf20ec5605b9317c2a3c247a79375:d109b8600a2445889f56f1fb64b62f81
2022-04-18 15:24:21,771 - INFO: Awaiting client work request.
2022-04-18 15:24:21,782 - INFO: Received License Number TN-87-NT-4587 from 192.168.122.1 address.
2022-04-18 15:24:24,754 - INFO: Sent to client ip 192.168.122.1 the following hashed result: b6b25d8
f98c7af4c44a4ef2c841b56914c60:d8ba277d11f5457ab820d74af3fa2251
2022-04-18 15:24:24,755 - INFO: Awaiting client work request.
2022-04-18 15:24:24,765 - INFO: Received License Number MZ-02-KM-6897 from 192.168.122.1 address.
2022-04-18 15:24:27,132 - INFO: Sent to client ip 192.168.122.1 the following hashed result: 3408ed1
11fc31ce6e327959cddf0c19ea3d0:d9f2acdbad9747f8a27cd66e33c3509a
2022-04-18 15:24:27,133 - INFO: Awaiting client work request.
2022-04-18 15:24:27,138 - INFO: Received License Number HR-88-QC-2521 from 192.168.122.1 address.
2022-04-18 15:24:35,577 - INFO: Sent to client ip 192.168.122.1 the following hashed result: 0a07a3e
cafac913079960223477 2f62ade86:8e125e71af024084b918cc52f1202299
2022-04-18 15:24:35,578 - INFO: Awaiting client work request.
2022-04-18 15:24:35,583 - INFO: Received License Number GA-75-BT-3459 from 192.168.122.1 address.
2022-04-18 15:25:50,767 - INFO: Sent to client ip 192.168.122.1 the following hashed result: 725f69f
78b9670b78b59368e69255c74c9f9:88d4a92fb8c240da882fd94391b7538d
2022-04-18 15:25:50,768 - INFO: Awaiting client work request.
2022-04-18 15:25:50,773 - INFO: Received License Number AS-34-NJ-9552 from 192.168.122.1 address.
2022-04-18 15:25:56,830 - INFO: Sent to client ip 192.168.122.1 the following hashed result: 867736e
3139e48e6b35d8350bce4d5c77646:ede24b3d654b44b49a88a9e637df3a48
2022-04-18 15:25:56,831 - INFO: Awaiting client work request.
2022-04-18 15:25:56,836 - INFO: Received License Number HP-83-GW-7047 from 192.168.122.1 address.
2022-04-18 15:26:02,292 - INFO: Sent to client ip 192.168.122.1 the following hashed result: 959cbac
1512b29495ceeb7e28fca64e8a612:09be006509464509a8c309939a7beca1
2022-04-18 15:26:02,292 - INFO: Awaiting client work request.
2022-04-18 15:26:02,336 - INFO: Received License Number UP-47-ZX-6320 from 192.168.122.1 address.
2022-04-18 15:26:28,370 - INFO: Sent to client ip 192.168.122.1 the following hashed result: fae11fb
c41f507991634f46beebafe48d6af:4090fd935c6c4b31b318aa14d08022f5
```

Figure 6: Server End Execution Log

- You can finally end the execution by typing out **terminate** in the client console. It will terminate the execution of the client and shut down the VMs.



```
mjthilak@mjthilak-ASUS-TUF-Gaming-F15-FX506LH-FX566LH:~/Desktop/cc/client$ sudo virt-manager
[sudo] password for mjthilak:
mjthilak@mjthilak-ASUS-TUF-Gaming-F15-FX506LH-FX566LH:~/Desktop/cc/client$ python3 client.py --loglevel info --url qemu:///system
terminate
Press the standard Ctrl-C to exit completely.
```

Figure 7: Terminating Client Code Execution

Conclusion

As you can see, the client code is able to scale up and down the number of VMs. This is a very simple implementation of the autoscaling system which scales and shifts the load from N virtual machines to N+1 virtual machines to ensure that performance can keep up with the increased incoming load.