

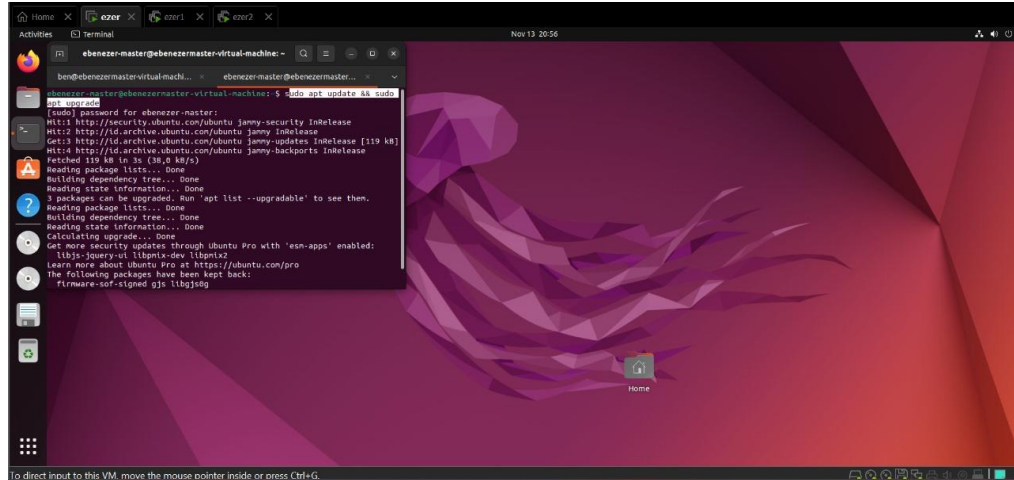
LAPORAN PEMROSESAN PARALEL BUBBLE SORT DENGAN MPI



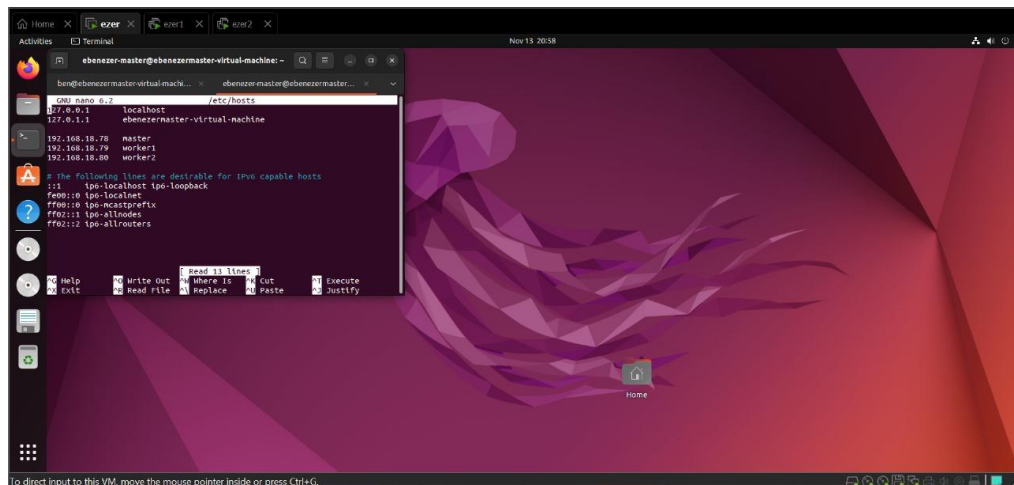
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Kelas : SK5B
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SISTEM KOMPUTER
FAKULTAS ILMU KOMPUTER
UNIVERSITAS SRIWIJAYA
2023

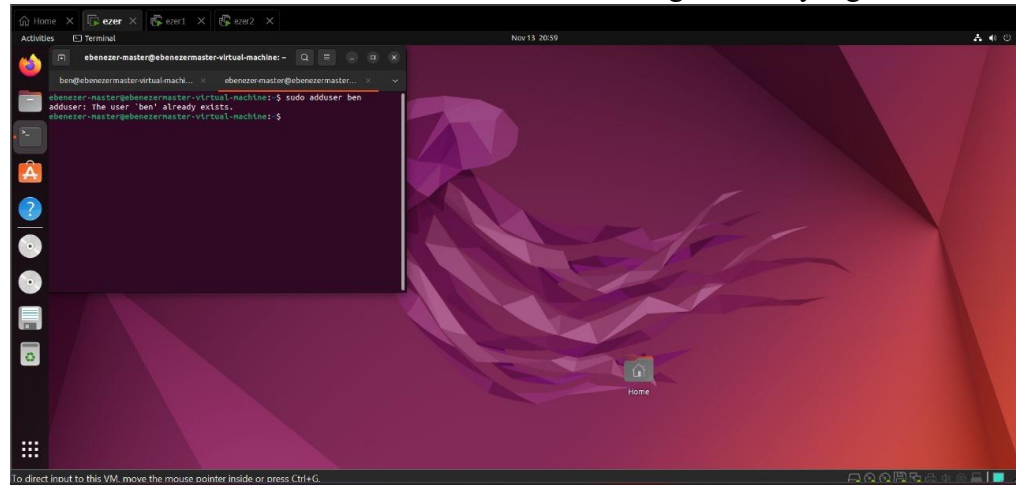
- Device dan Tools yang digunakan
 - 3 Virtual Machine (1 master dan 2 worker/slave)
 - MPI (Message Passing Interface)
 - SSH (Secure Shell)
 - Python
- Update dan Upgrade Ubuntu



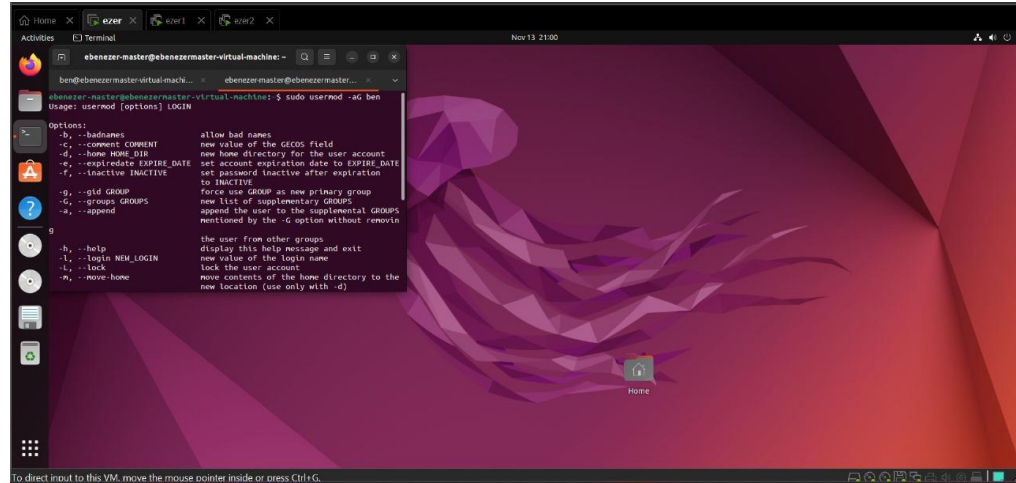
- Konfigurasi MPI
 - Lakukan Konfigurasi `/etc/hosts` di master dan slave dengan mengisi ip dari master dan slave



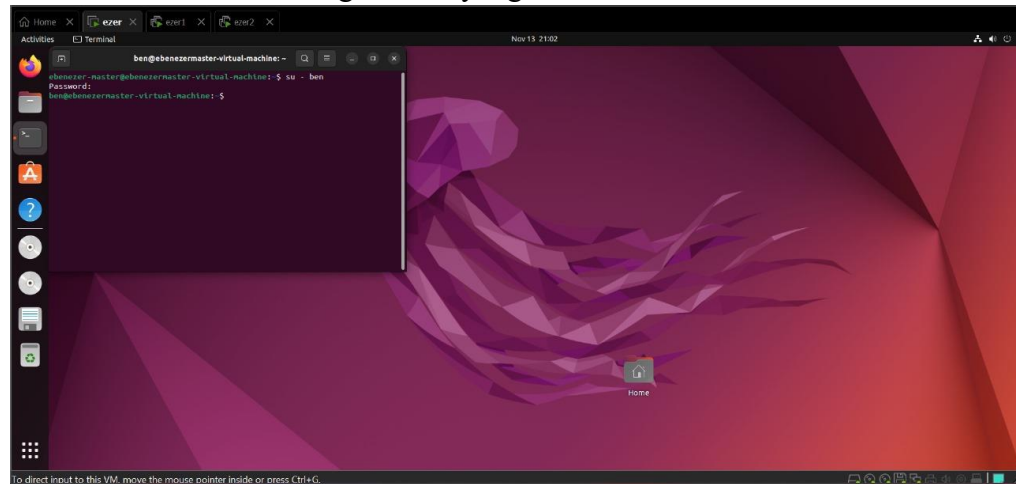
- Buat user baru di master, worker1 dan worker2 dengan nama yang sama



- Berikan akses root ke user baru yang dibuat di master, worker1 dan worker2



- Kemudian masuklah sebagai “user yang telah dibuat” di master dan kedua worker



- Kemudian install openssh di master, worker1 dan worker2

```
ben@ebenezer-master-virtual-machine: ~$ sudo apt install openssh-server
[sudo] password for ebenezer-master:
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
openssh-server is already the newest version (1:8.9p1-3ubuntu4.4).
0 upgraded, 0 newly installed, 0 to remove and 3 not upgraded.
ebenezer-master@ebenezer-master-virtual-machine: ~$
```

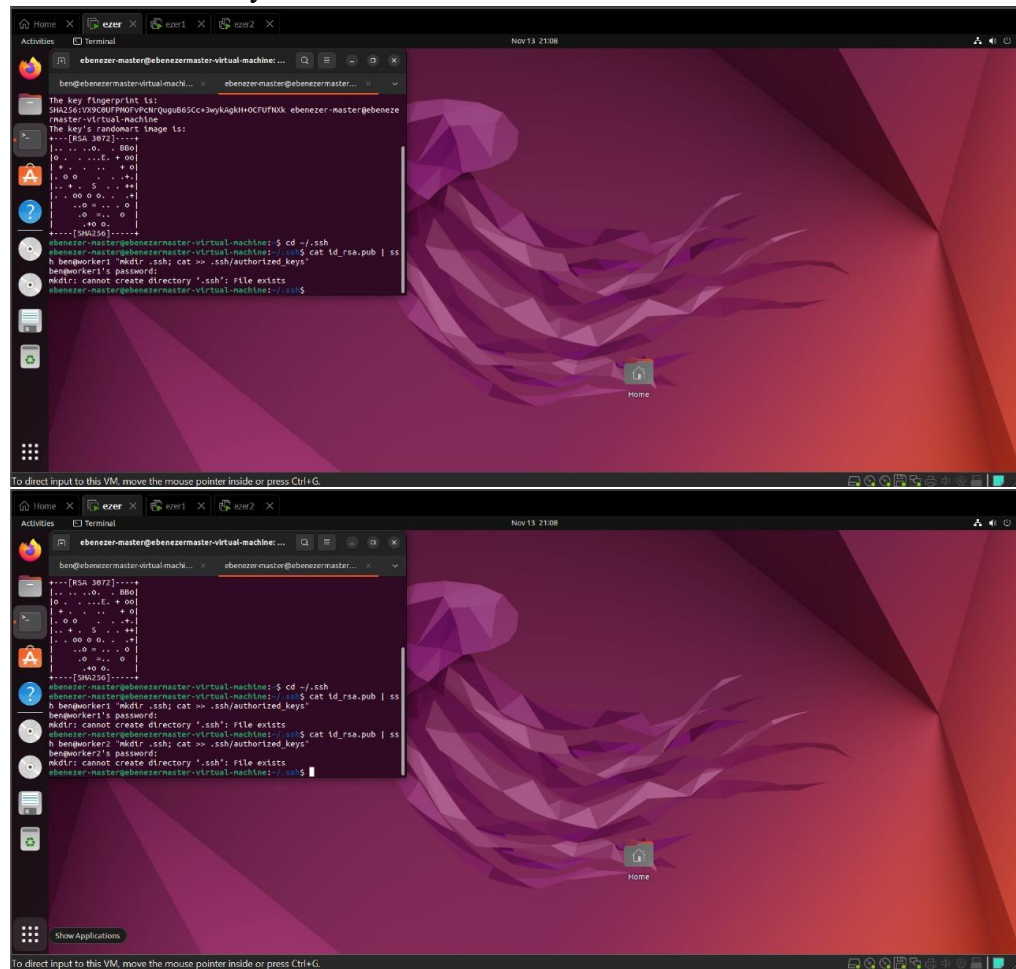
- Kemudian buatlah key ssh di master

```
ben@ebenezer-master-virtual-machine: ~$ ssh-keygen -t rsa
Generating public/private rsa key pair.
Enter file in which to save the key (/home/ebenezer-master/.ssh/id_rsa):
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /home/ebenezer-master/.ssh/id_rsa
Your public key has been saved in /home/ebenezer-master/.ssh/id_rsa.pub
The key fingerprint is:
SHA256:V9SC0UFP0FVPC8U9qub65Cc3JyKAgkshOCUFN0K ebenezer-master@ebenezer-master-virtual-machine
The key's randomart image is:
+--[RSA 3072]--+
|.. ..o. .BB=|
|o . . . .L. + oo|
|+ . . . . . + o|
|.. o . . . . + +|
|.. + . 5 . . + +|
|.oo o o . . + |
|.o = . . . o |
|.o = . . . o |
|.o o . . . |
+-----+
-----[SHA256]-----
ebenezer-master@ebenezer-master-virtual-machine: ~$ cd ~/.ssh
ebenezer-master@ebenezer-master-virtual-machine: ~$ ls
id_rsa  id_rsa.pub
```

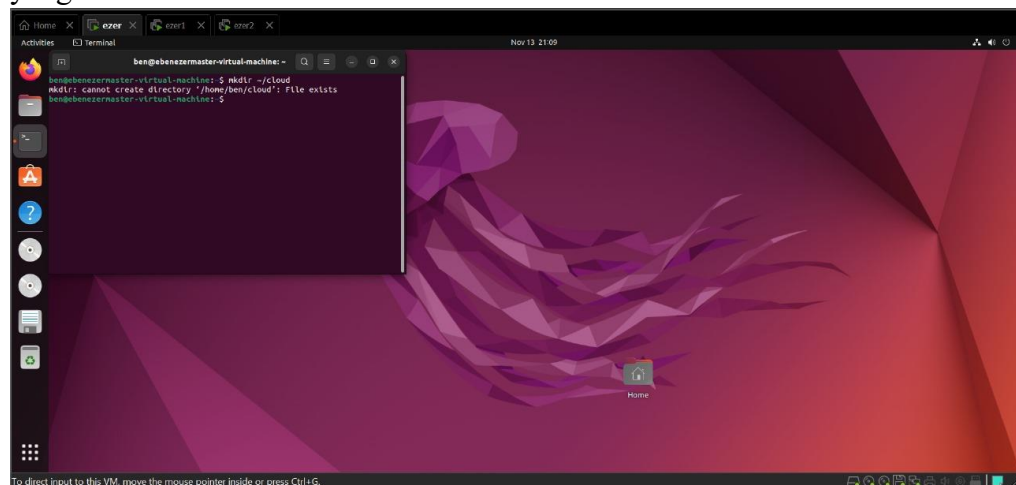
- Kemudian pindah direktori

```
ben@ebenezer-master-virtual-machine: ~$ cd ~/.ssh
ebenezer-master@ebenezer-master-virtual-machine: ~$ ls
id_rsa  id_rsa.pub
```

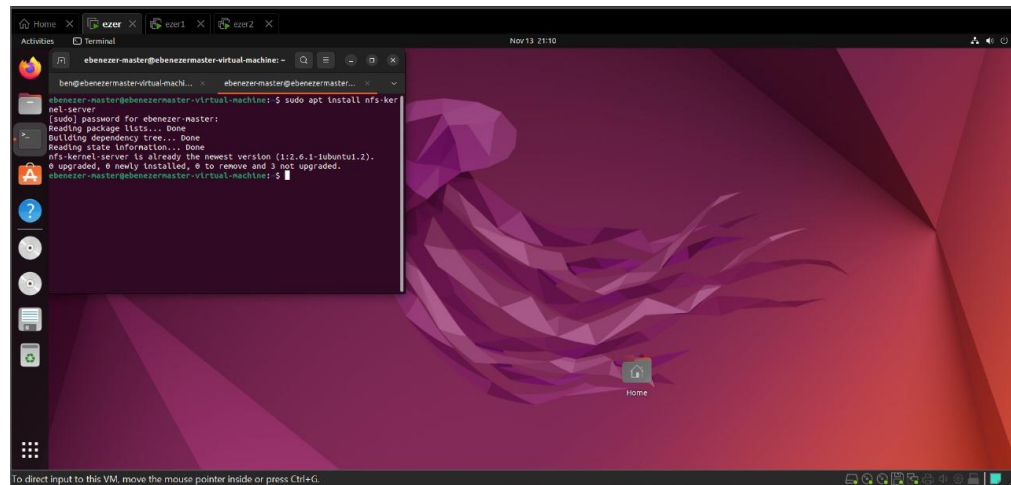
- Kemudian salin key master ke worker 1 dan worker 2



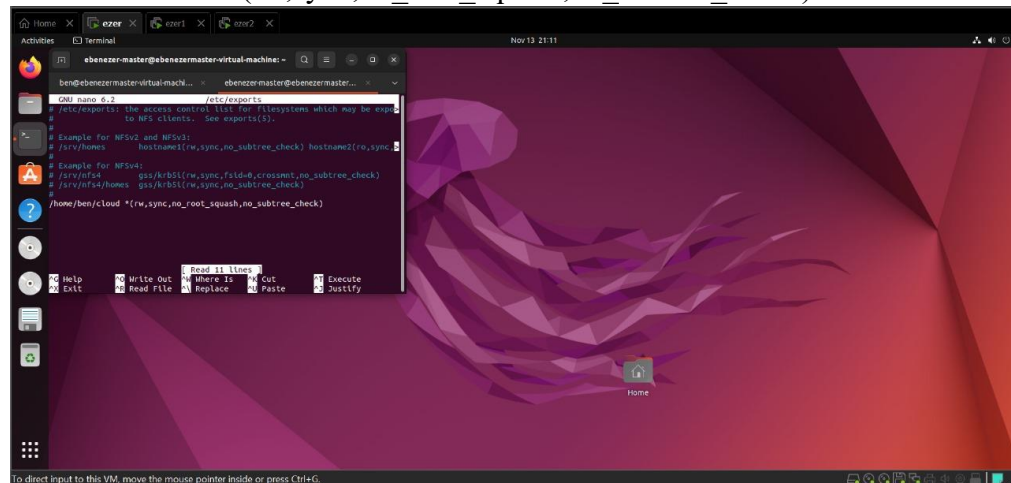
- Buatlah direktori Bernama cloud di semua virtual machine, lakukan ini di user yang dibuat tadi



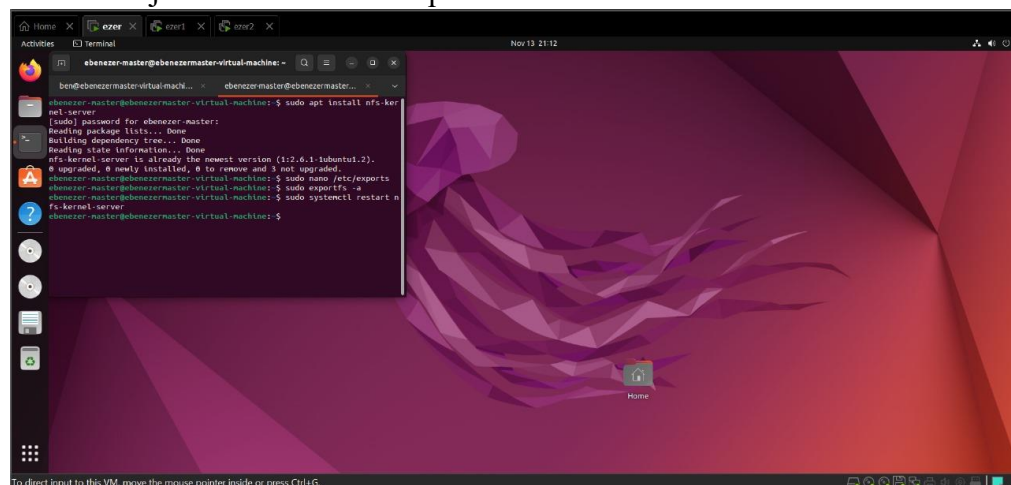
- Setelah itu kemudian install lah nfs di master



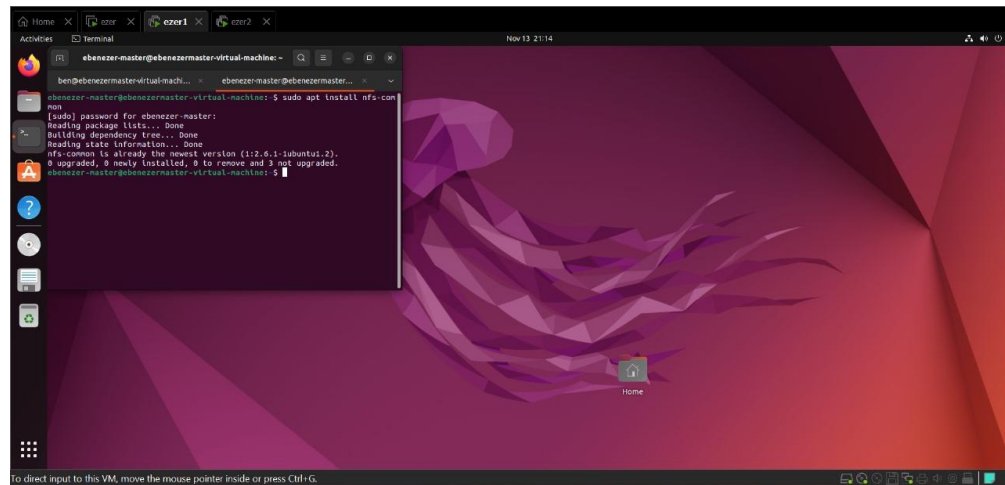
- edit file exports dan tambahkan `/home/ben/cloud*(rw,sync,no_root_squash,no_subtree_check)`



- Kemudian jalankan command seperti dibawah

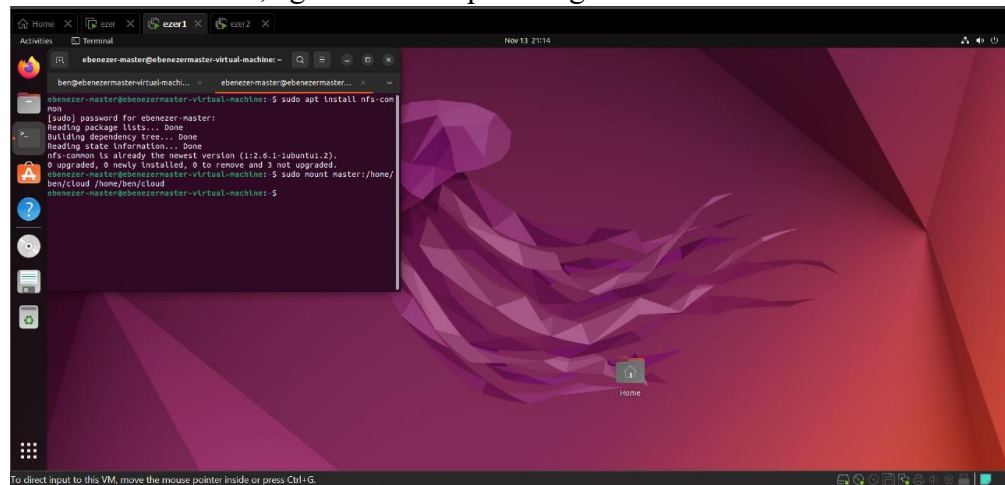


- Kemudian install nfs-common di worker1 dan worker2



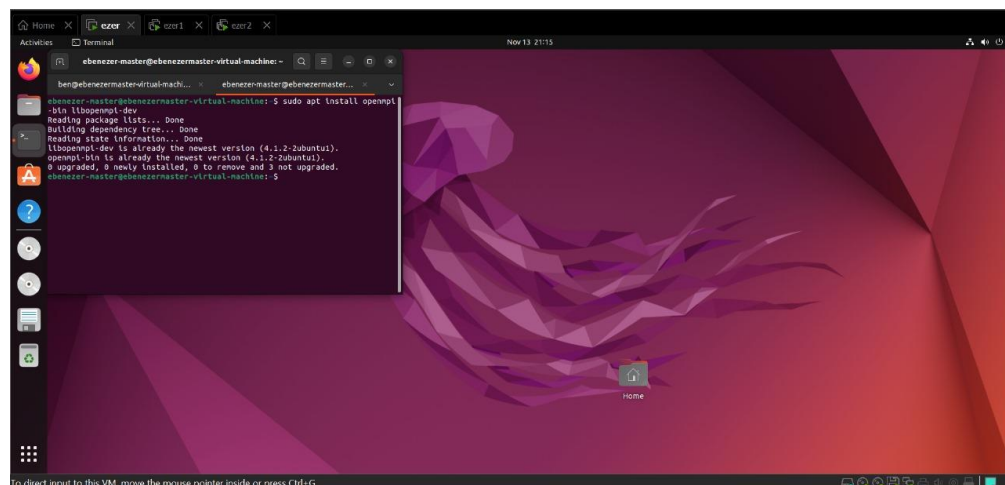
```
ben@ebenezer-master-virtual-machine: ~$ sudo apt install nfs-com
[sudo] password for ebenezer-master:
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
nfs-common is already the newest version (1:2.6.1-1ubuntu1.2).
0 upgraded, 0 newly installed, 0 to remove and 3 not upgraded.
ebenezer-master@ebenezer-master-virtual-machine: ~$
```

- Kemudian lakukan lah mount direktori cloud yang dibuat tadi, lakukan command ini di kedua worker, agar worker dapat mengakses direktori



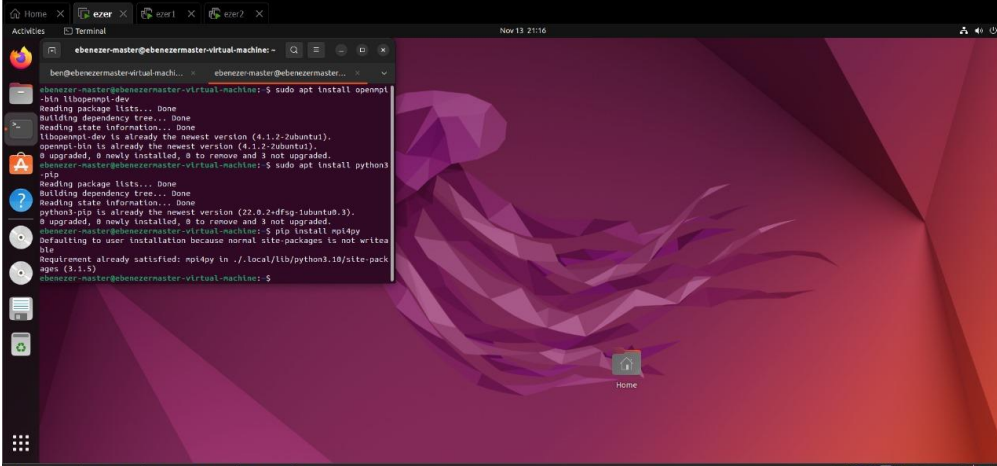
```
ebenezer-master@ebenezer-master-virtual-machine: ~$ sudo apt install nfs-com
[sudo] password for ebenezer-master:
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
nfs-common is already the newest version (1:2.6.1-1ubuntu1.2).
0 upgraded, 0 newly installed, 0 to remove and 3 not upgraded.
ebenezer-master@ebenezer-master-virtual-machine: ~$ sudo mount master:/home/
ben:/cloud /home/ben/cloud
ebenezer-master@ebenezer-master-virtual-machine: ~$
```

- Kemudian install lah MPI di semua virtual machine



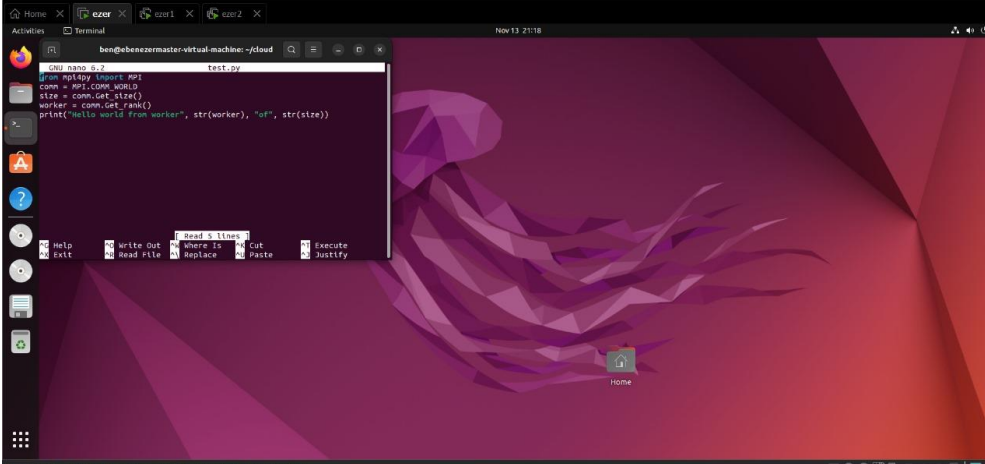
```
ebenezer-master@ebenezer-master-virtual-machine: ~$ sudo apt install openmpi
-bin libopenmpi-dev
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
libopenmpi-dev is already the newest version (4.1.2-2ubuntu1).
openmpi-bin is already the newest version (4.1.2-2ubuntu1).
0 upgraded, 0 newly installed, 0 to remove and 3 not upgraded.
ebenezer-master@ebenezer-master-virtual-machine: ~$
```

- Setelah terinstall, kemudian lanjutkan dengan menginstall librarynya di semua virtual machine



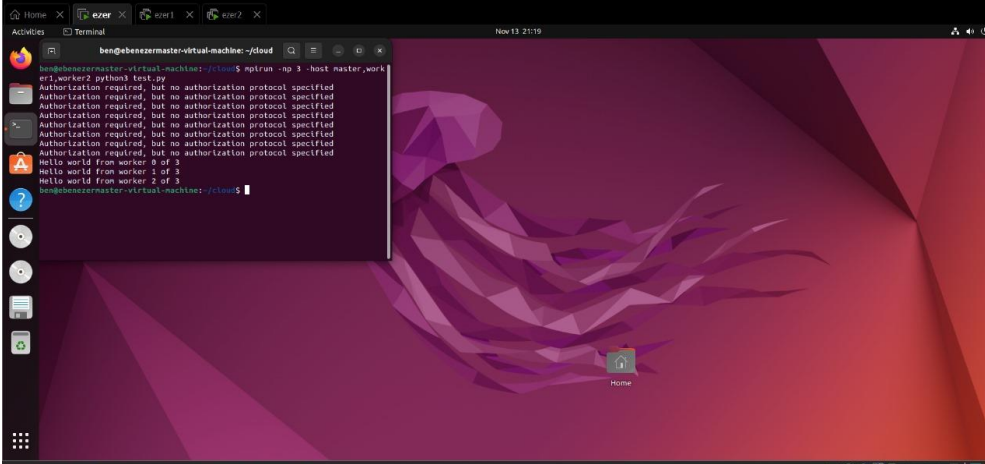
```
ben@ebenezermaster-virtual-machine:~$ sudo apt install openmpi
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
openmpi-bin is already the newest version (4.1.2-2ubuntu1).
openmpi-dev is already the newest version (4.1.2-2ubuntu1).
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
ben@ebenezermaster-virtual-machine:~$ sudo apt install python3
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
python3-pip is already the newest version (22.0.2dfsg-1ubuntu1.3).
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
ben@ebenezermaster-virtual-machine:~$ pip install mpi4py
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: mpi4py in ./local/lib/python3.10/site-packages (3.1.3)
```

- Batlah program test, untuk menguji apakah mpi sudah dapat dijalankan



```
ben@ebenezermaster-virtual-machine:~/cloud$ nano test.py
#GNU nano 2.9.3 test.py
from mpi4py import MPI
comm = MPI.COMM_WORLD
size = comm.Get_size()
worker = comm.Get_rank()
print("Hello world from worker", str(worker), "of", str(size))
```

- Kemudian jalankan program tersebut



```
ben@ebenezermaster-virtual-machine:~/cloud$ mpirun -np 3 -host master,worker1,worker2 python3 test.py
Authorization required, but no authorization protocol specified
Authorization required, but no authorization protocol specified
Authorization required, but no authorization protocol specified
Authorization required, but no authorization protocol specified
Authorization required, but no authorization protocol specified
Authorization required, but no authorization protocol specified
Hello world from worker 0 of 3
Hello world from worker 1 of 3
Hello world from worker 2 of 3
ben@ebenezermaster-virtual-machine:~/cloud$
```


- Setelah berhasil, kemudian lakukanlah program bubble sort yang berjalan dengan mpi

```

ben@benbenmaster-virtual-machine: ~/cloud
benbenmaster-virtual-machine:~$ sudo pip3 install numpy==1.26.2
Successfully installed numpy-1.26.2
benbenmaster-virtual-machine:~$ nano bubblesort.py
benbenmaster-virtual-machine:~$ nano bubblesort.py
benbenmaster-virtual-machine:~$ mpiexec -np 3 -host master,work
er1,worker2 python3 bubblesort.py
Authorization required, but no authorization protocol specified
Authorization required, but no authorization protocol specified
Authorization required, but no authorization protocol specified
Authorization required, but no authorization protocol specified
Authorization required, but no authorization protocol specified
Authorization required, but no authorization protocol specified
Master memulai pengurutan...
Worker2 menerima data: [12 22 11 99]
Worker2 mengirim data yang sudah diurutkan: [11 12 22 99]
Worker1 menerima data: [54 34 25]
Worker1 mengirim data yang sudah diurutkan: [25 34 54]
Data setelah diurutkan: [11 12 22 25 34 54 99]
Waktu eksekusi: 0.135779939018104 detik
benbenmaster-virtual-machine:~$
  
```

- Berikut adalah perbandingan waktu bubble sort dengan python menggunakan 1 pc dan 3 pc secara parallel, dapat dilihat bahwa waktu yang diperlukan bubble sort menggunakan mpi lebih sedikit karena dilakukan secara parallel processing

```

ben@benbenmaster-virtual-machine: ~/cloud
benbenmaster-virtual-machine:~$ python3 bubblesortblasa.py
Array yang diurutkan adalah:
11 12 22 25 34 54 99
Waktu eksekusi: 2.8848648071289902e-05 detik
benbenmaster-virtual-machine:~$ mpiexec -np 3 -host master,work
er1,worker2 python3 bubblesort.py
Authorization required, but no authorization protocol specified
Authorization required, but no authorization protocol specified
Authorization required, but no authorization protocol specified
Authorization required, but no authorization protocol specified
Authorization required, but no authorization protocol specified
Authorization required, but no authorization protocol specified
Master memulai pengurutan...
Worker1 menerima data: [54 34 25]
Worker1 mengirim data yang sudah diurutkan: [25 34 54]
Worker2 menerima data: [12 22 11 99]
Worker2 mengirim data yang sudah diurutkan: [11 12 22 99]
Data setelah diurutkan: [11 12 22 25 34 54 99]
Waktu eksekusi: 0.1446544281631855 detik
benbenmaster-virtual-machine:~$
  
```