

**Pemrosesan Paralel
“Message Passing Interface pada Ubuntu
Dekstop menggunakan
Bahasa Python”**



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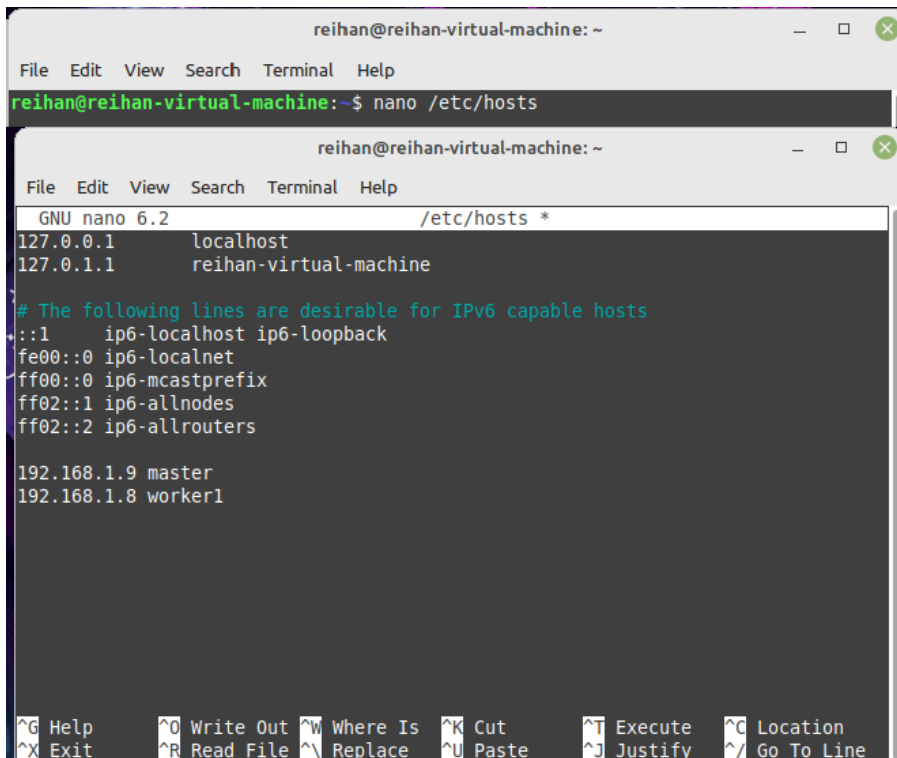
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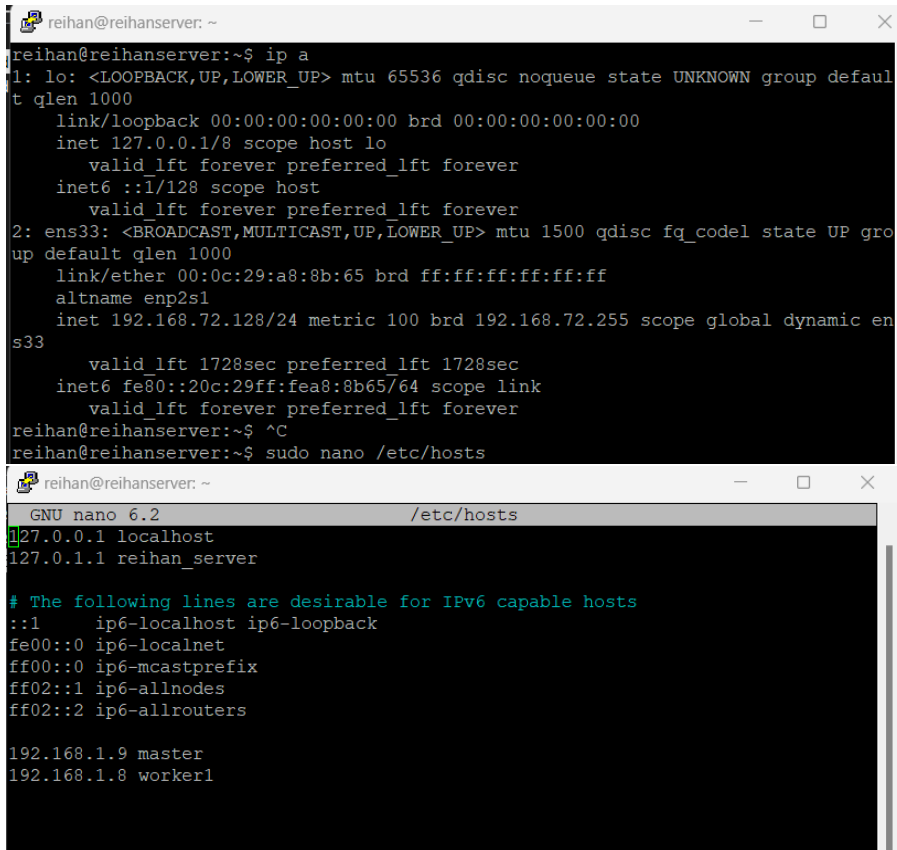
Message Passing Interface pada ubuntu dekstop menggunakan bahasa python

1. Konfigurasi file /etc/hosts
Server



```
reihan@reihan-virtual-machine: ~  
File Edit View Search Terminal Help  
reihan@reihan-virtual-machine:~$ nano /etc/hosts  
  
GNU nano 6.2 /etc/hosts *  
127.0.0.1 localhost  
127.0.1.1 reihan-virtual-machine  
  
# The following lines are desirable for IPv6 capable hosts  
::1 ip6-localhost ip6-loopback  
fe00::0 ip6-localnet  
ff00::0 ip6-mcastprefix  
ff02::1 ip6-allnodes  
ff02::2 ip6-allrouters  
  
192.168.1.9 master  
192.168.1.8 worker1  
  
^G Help ^O Write Out ^W Where Is ^K Cut ^T Execute ^C Location  
^X Exit ^R Read File ^\ Replace ^U Paste ^J Justify ^_ Go To Line
```

Client



```
reihan@reihanserver: ~  
reihan@reihanserver:~$ ip a  
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default  
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00  
    inet 127.0.0.1/8 scope host lo  
        valid_lft forever preferred_lft forever  
    inet6 ::1/128 scope host  
        valid_lft forever preferred_lft forever  
2: ens33: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP gro  
    up default qlen 1000  
    link/ether 00:0c:29:a8:8b:65 brd ff:ff:ff:ff:ff:ff  
    altname enp2s1  
    inet 192.168.72.128/24 metric 100 brd 192.168.72.255 scope global dynamic en  
s33  
        valid_lft 1728sec preferred_lft 1728sec  
    inet6 fe80::20c:29ff:fea8:8b65/64 scope link  
        valid_lft forever preferred_lft forever  
reihan@reihanserver:~$ ^C  
reihan@reihanserver:~$ sudo nano /etc/hosts  
  
GNU nano 6.2 /etc/hosts  
127.0.0.1 localhost  
127.0.1.1 reihan_server  
  
# The following lines are desirable for IPv6 capable hosts  
::1 ip6-localhost ip6-loopback  
fe00::0 ip6-localnet  
ff00::0 ip6-mcastprefix  
ff02::1 ip6-allnodes  
ff02::2 ip6-allrouters  
  
192.168.1.9 master  
192.168.1.8 worker1
```

2. Menambahkan user Server

```
reihan@reihan-virtual-machine: ~  
File Edit View Search Terminal Help  
reihan@reihan-virtual-machine:~$ nano /etc/hosts  
reihan@reihan-virtual-machine:~$ sudo adduser kel6
```

Client

```
reihan@reihanserver:~$ sudo adduser kel6  
Adding user `kel6' ...  
Adding new group `kel6' (1001) ...  
Adding new user `kel6' (1001) with group `kel6' ...  
Creating home directory `/home/kel6' ...  
Copying files from `/etc/skel' ...  
New password:  
Retype new password:  
passwd: password updated successfully  
Changing the user information for kel6  
Enter the new value, or press ENTER for the default  
Full Name []: reihan  
Room Number []: 0  
Work Phone []: 0  
Home Phone []: 0  
Other []: 0  
Is the information correct? [Y/n] y  
reihan@reihanserver:~$
```

3. Memberikan akses root kepada user Server

```
reihan@reihan-virtual-machine: ~  
File Edit View Search Terminal Help  
reihan@reihan-virtual-machine:~$ sudo usermod -aG sudo kel6  
reihan@reihan-virtual-machine:~$
```

Client

```
reihan@reihanserver:~$ sudo usermod -aG sudo kel6  
reihan@reihanserver:~$
```

4. Melakukan login akun user Server

```
kel6@reihan-virtual-machine: ~  
File Edit View Search Terminal Help  
reihan@reihan-virtual-machine:~$ sudo usermod -aG sudo kel6  
reihan@reihan-virtual-machine:~$ su - kel6  
Password:  
kel6@reihan-virtual-machine:~$
```

Client

```
reihan@reihanserver:~$ sudo usermod -aG sudo kel6  
reihan@reihanserver:~$ su - kel6  
Password:  
To run a command as administrator (user "root"), use "sudo <command>".  
See "man sudo_root" for details.  
kel6@reihanserver:~$
```

5. Instalasi paket openssh-server Server

```
kel6@reihan-virtual-machine: ~  
File Edit View Search Terminal Help  
reihan@reihan-virtual-machine:~$ sudo usermod -aG sudo kel6  
reihan@reihan-virtual-machine:~$ su - kel6  
Password:  
kel6@reihan-virtual-machine:~$ sudo apt install openssh-server  
[sudo] password for kel6:  
Reading package lists... Done  
Building dependency tree... Done  
Reading state information... Done  
openssh-server is already the newest version (1:8.9p1-3ubuntu0.4).  
The following packages were automatically installed and are no longer required:  
  gssapi-common guile-3.0-libs libgsasl7 libntlm0 libpq5 mailutils-common  
Use 'sudo apt autoremove' to remove them.  
0 upgraded, 0 newly installed, 0 to remove and 48 not upgraded.  
kel6@reihan-virtual-machine:~$
```

Client

```
kel6@reihanserver:~$ sudo apt install openssh-server  
[sudo] password for kel6:  
Reading package lists... Done  
Building dependency tree... Done  
Reading state information... Done  
openssh-server is already the newest version (1:8.9p1-3ubuntu0.4).  
The following packages were automatically installed and are no longer required:  
  libevent-pthreads-2.1-7 libmecab2 libprotobuf-lite23 mecab-ipadic  
  mecab-ipadic-utf8 mecab-utils  
Use 'sudo apt autoremove' to remove them.  
0 upgraded, 0 newly installed, 0 to remove and 5 not upgraded.  
kel6@reihanserver:~$
```

6. Pengecekan ssh

Server

```
kel6@reihan-virtual-machine: ~/.ssh  
File Edit View Search Terminal Help  
kel6@reihan-virtual-machine:~$ ssh kel6@master  
"Anda telah berhasil melakukan login user"  
Last login: Mon Nov 6 11:57:41 2023 from 192.168.150.246
```

Client

```
kel6@reihanserver:~$ ssh kel6@worker1  
The authenticity of host 'worker1 (192.168.72.128)' can't be established.  
ED25519 key fingerprint is SHA256:7iFG63BZ+9fgTrMA6jFqJoLWWqpX2ZynHv2G9Cpc2LA.  
This key is not known by any other names  
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes  
Warning: Permanently added 'worker1' (ED25519) to the list of known hosts.  
kel6@worker1's password:  
Connection closed by 192.168.72.128 port 22  
kel6@reihanserver:~$
```

7. Membuat keygen

Server

```
kel6@reihan-virtual-machine: ~  
File Edit View Search Terminal Help  
kel6@reihan-virtual-machine:~$ ssh-keygen -t rsa  
Generating public/private rsa key pair.  
Enter file in which to save the key (/home/kel6/.ssh/id_rsa):  
/home/kel6/.ssh/id_rsa already exists.  
Overwrite (y/n)? y  
Enter passphrase (empty for no passphrase):  
Enter same passphrase again:  
Your identification has been saved in /home/kel6/.ssh/id_rsa  
Your public key has been saved in /home/kel6/.ssh/id_rsa.pub  
The key fingerprint is:  
SHA256:60wT8crID7ekFPgNnSbkmls+a0S+KQggRULJPkUStU kel6@reihan-virtual-machine  
The key's randomart image is:  
+---[RSA 3072]-----+  
|. +* = 0 |  
|ooo. E |  
|o+ . . |  
|o . + . + |  
|o . = S . |  
|+.o. * O + |  
|o+=.+ * X |  
|..oo o X o |  
|.o.o = |  
+----[SHA256]-----+  
kel6@reihan-virtual-machine:~$
```

8. Menyalin keygen ke Server dan Client

Server

```
kel6@reihan-virtual-machine:~/.ssh$ cat id_rsa.pub | ssh kel6@worker1 "mkdir .ssh  
; cat >> .ssh/authorized_keys"  
mkdir: cannot create directory '.ssh': File exists  
kel6@reihan-virtual-machine:~/.ssh$ cat id_rsa.pub | ssh kel6@master "mkdir .ssh  
; cat >> .ssh/authorized_keys"  
mkdir: cannot create directory '.ssh': File exists  
kel6@reihan-virtual-machine:~/.ssh$
```

9. Membuat sharing file

Server

```
kel6@reihan-virtual-machine: ~  
File Edit View Search Terminal Help  
kel6@reihan-virtual-machine:~$ mkdir cloud  
mkdir: cannot create directory 'cloud': File exists  
kel6@reihan-virtual-machine:~$ ls  
cloud  
kel6@reihan-virtual-machine:~$
```

Client

```
kel6@reihanserver: ~  
kel6@reihanserver:~$ mkdir cloud  
kel6@reihanserver:~$ ls  
cloud
```

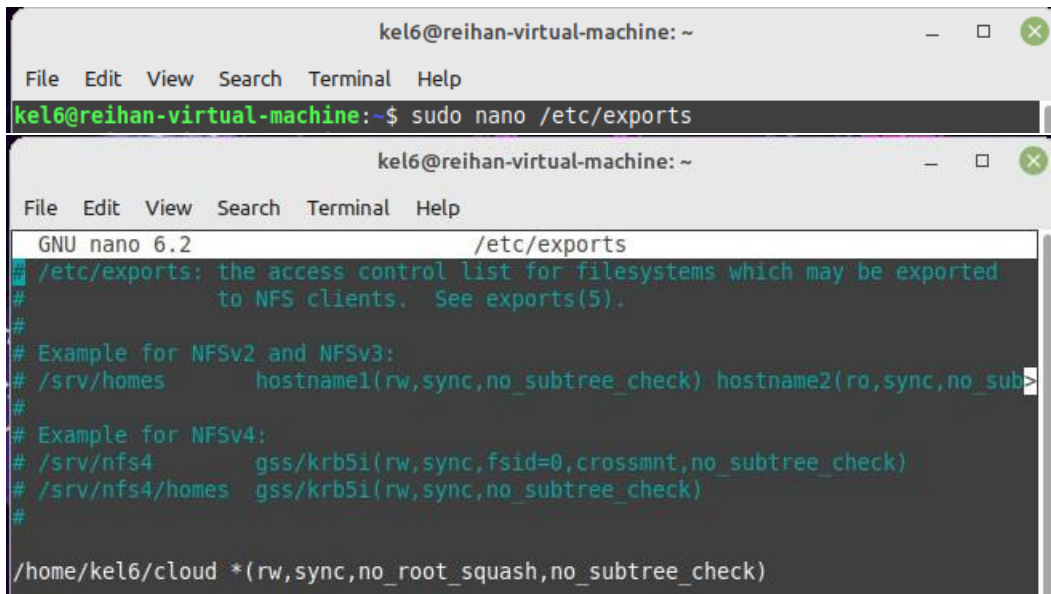
10. Instalasi nfs server

Server

```
kel6@reihan-virtual-machine:~$ sudo apt install nfs-kernel-server
[sudo] password for kel6:
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
nfs-kernel-server is already the newest version (1:2.6.1-1ubuntu1.2).
The following packages were automatically installed and are no longer required:
  gssapi-common guile-3.0-lib libgssapi7 libntlm0 libpq5 mailutils-common
Use 'sudo apt autoremove' to remove them.
0 upgraded, 0 newly installed, 0 to remove and 48 not upgraded.
kel6@reihan-virtual-machine:~$
```

11. Konfigurasi file /etc/exports

Server



```
kel6@reihan-virtual-machine: ~
File Edit View Search Terminal Help
kel6@reihan-virtual-machine:~$ sudo nano /etc/exports

kel6@reihan-virtual-machine: ~
File Edit View Search Terminal Help
GNU nano 6.2 /etc/exports
# /etc/exports: the access control list for filesystems which may be exported
# to NFS clients. See exports(5).
#
# Example for NFSv2 and NFSv3:
# /srv/homes hostname1(rw,sync,no_subtree_check) hostname2(ro,sync,no_subtree_check)
#
# Example for NFSv4:
# /srv/nfs4 gss/krb5i(rw,sync,fsid=0,crossmnt,no_subtree_check)
# /srv/nfs4/homes gss/krb5i(rw,sync,no_subtree_check)
#
/home/kel6/cloud *(rw,sync,no_root_squash,no_subtree_check)
```

12. Simpan dan restart nfs-kernel-server

Server

```
kel6@reihan-virtual-machine:~$ sudo nano /etc/exports
kel6@reihan-virtual-machine:~$ sudo exportfs -a
kel6@reihan-virtual-machine:~$ sudo systemctl restart nfs-kernel-server
kel6@reihan-virtual-machine:~$
```

13. Instalasi nfs client

Client

```
kel6@reihanserver:~$ sudo apt install nfs-common
[sudo] password for kel6:
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following packages were automatically installed and are no longer required:
  libevent-pthreads-2.1-7 libmecab2 libprotobuf-lite23 mecab-ipadic
  mecab-ipadic-utf8 mecab-utils
Use 'sudo apt autoremove' to remove them.
The following additional packages will be installed:
  keyutils libnfsidmap1 rpcbind
Suggested packages:
  watchdog
The following NEW packages will be installed:
  keyutils libnfsidmap1 nfs-common rpcbind
0 upgraded, 4 newly installed, 0 to remove and 5 not upgraded.
```


14. Mounting sharing file pada Client
Client

```
kel6@reihanserver: ~  
kel6@reihanserver:~$ sudo mount master:/home/kel6/cloud /home/kel6/cloud  
[sudo] password for kel6:
```

15. Instalasi python3 dan mpi
Server

```
kel6@reihan-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).  
The following packages were automatically installed and are no longer required:  
  gssasl-common guile-3.0-libs libgssasl7 libntlm0 libpq5 mailutils-common  
Use 'sudo apt autoremove' to remove them.  
0 upgraded, 0 newly installed, 0 to remove and 48 not upgraded.  
kel6@reihan-virtual-machine:~$
```

Client

```
kel6@reihanserver:~$ sudo apt install openmpi-bin libopenmpi-dev  
Reading package lists... Done  
Building dependency tree... Done  
Reading state information... Done  
The following packages were automatically installed and are no longer required:  
  libmecab2 libprotobuf-lite23 mecab-ipadic mecab-ipadic-utf8 mecab-utils  
Use 'sudo apt autoremove' to remove them.  
The following additional packages will be installed:  
  autoconf automake autotools-dev cpp cpp-11 gcc gcc-11 gcc-11-base gfortran  
  gfortran-11 ibverbs-providers javascript-common libasan6 libatomic1  
  libc-dev-bin libc-devtools libc6-dev libcaf-openmpi-3 libcc1-0  
  libcoarrays-dev libcoarrays-openmpi-dev libcrypt-dev libevent-dev  
  libevent-extra-2.1-7 libevent-openssl-2.1-7 libfabric1 libgcc-11-dev  
  libgfortran-11-dev libgfortran5 libhwloc-dev libhwloc-plugins libhwloc15  
  libibverbs-dev libibverbs1 libisl23 libitm1 libjs-jquery libjs-jquery-ui  
  liblsan0 libltdl-dev libltdl7 libmpc3 libnl-3-dev libnl-route-3-200  
  libnl-route-3-dev libnsl-dev libnuma-dev libopenmpi3 libpmix-dev libpmix2  
  libpsm-infinipath1 libpsm2-2 libquadmath0 librdmacm1 libtirpc-dev libtool  
  libtsan0 libubsan1 libucx0 libxnvctrl0 linux-libc-dev m4 manpages-dev  
  ocl-icd-libopencl1 openmpi-common rpcsvc-proto zlib1g-dev  
Suggested packages:
```

16. Menjalankan program bubble sort pada file bubble.py secara multi computing
Server

```
kel6@reihan-virtual-machine: ~/cloud  
File Edit View Search Terminal Help  
kel6@reihan-virtual-machine:~$ cd cloud  
kel6@reihan-virtual-machine:~/cloud$ mpirun -np 1 -host master python3 bubble.py  
Authorization required, but no authorization protocol specified  
Authorization required, but no authorization protocol specified  
Sorted array is: [2, 3, 4, 4, 5, 7, 9, 11, 11, 12, 12, 12, 14, 15, 16, 16, 16, 17, 19, 20]  
Lama Proses: 0.0006468296051025391 detik
```

Kodingan :

```
from mpi4py import MPI  
import random  
import time
```

```

start_time = time.time()
def bubbleSort(arr):
    n = len(arr)
    swapped = False
    for i in range(n - 1):
        for j in range(0, n - i - 1):
            if arr[j] > arr[j + 1]:
                swapped = True
                arr[j], arr[j + 1] = arr[j + 1], arr[j]

        if not swapped:
            return

if __name__ == '__main__':
    comm = MPI.COMM_WORLD
    size = comm.Get_size()
    rank = comm.Get_rank()

    n = 20 # Jumlah elemen dalam array
    max_number = 20 # Rentang angka acak
    local_data = []

    # Setiap proses mendapatkan data yang berbeda
    for i in range(n):
        local_data.append(random.randint(1, max_number))

    local_data = comm.gather(local_data, root=0)

    if rank == 0:
        sorted_data = [item for sublist in local_data for item in sublist]
        bubbleSort(sorted_data)
        print("Sorted array is:", sorted_data)

# Waktu selesai
end_time = time.time()

# Hitung lama eksekusi
execution_time = end_time - start_time

print(f"Lama Proses: {execution_time} detik")

```

17. Menjalankan program numeric pada file numerik.py secara multi computing

Server

```

kel6@reihan-virtual-machine:~/cloud$ mpirun -np 1 -host master python3 numerik.py
Authorization required, but no authorization protocol specified
Authorization required, but no authorization protocol specified
Total sum: 55
Lama Proses: 0.0007097721099853516 detik
kel6@reihan-virtual-machine:~/cloud$

```

Kodingan :

```

from mpi4py import MPI
import numpy as np
import time

start_time = time.time()

```



```

def parallel_sum(data):
    comm = MPI.COMM_WORLD
    rank = comm.Get_rank()
    size = comm.Get_size()

    # Bagi data di antara proses
    local_data = np.array_split(data, size)[rank]

    # Hitung jumlah lokal
    local_sum = np.sum(local_data)

    # Gather hasil dari setiap proses
    total_sum = comm.reduce(local_sum, op=MPI.SUM, root=0)

    if rank == 0:
        print("Total sum:", total_sum)

if __name__ == '__main__':
    # Data numerik (gunakan data sesuai kebutuhan Anda)
    data = np.array([1, 2, 3, 4, 5, 6, 7, 8, 9, 10])

    # Panggil fungsi untuk menjalankan program secara paralel
    parallel_sum(data)

    # Waktu selesai
    end_time = time.time()

    # Hitung lama eksekusi
    execution_time = end_time - start_time

    print(f"Lama Proses: {execution_time} detik")

```