

**Tugas Laporan
Pemrosesan Paralel
“Message Passing Interface pada Ubuntu
Desktop menggunakan
Bahasa Python”**



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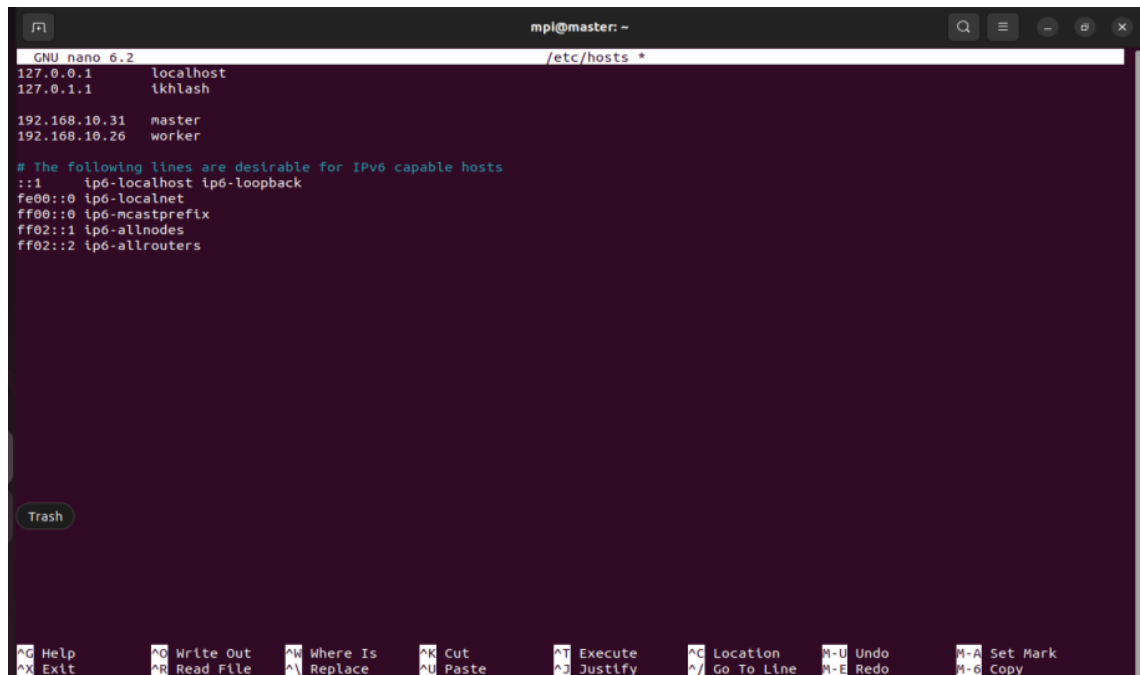
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Message Passing Interface pada ubuntu dekstop menggunakan bahasa python

1. Konfigurasi file /etc/hosts

Server



```
GNU nano 6.2 /etc/hosts *
127.0.0.1 localhost
127.0.1.1 ikhlash

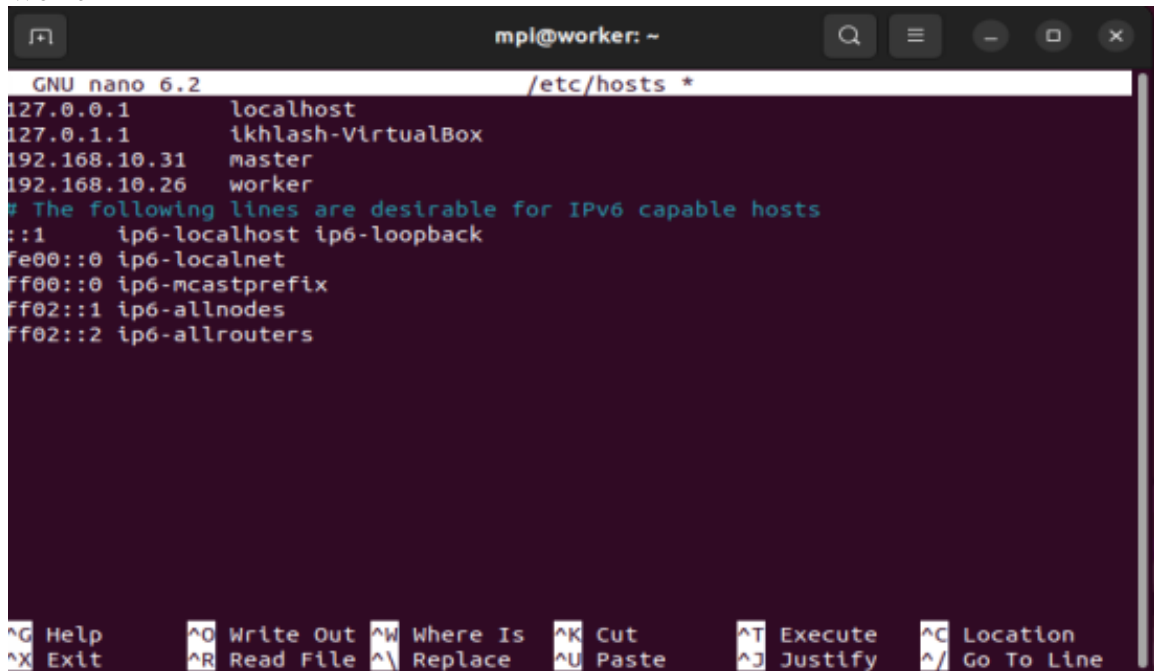
192.168.10.31 master
192.168.10.26 worker

# 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

Trash

^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
^U Undo      ^E Redo      ^- Set Mark
^M Copy
```

Worker



```
GNU nano 6.2 /etc/hosts *
127.0.0.1 localhost
127.0.1.1 ikhlash-VirtualBox

192.168.10.31 master
192.168.10.26 worker

# 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

^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
^U Undo      ^E Redo      ^- Set Mark
^M Copy
```

2. Menambahkan user

Server

```
mpl@master: ~  
mpl@master:~$ sudo adduser mpl  
adduser: The user 'mpl' already exists.  
mpl@master:~$
```

Client

```
mpl@worker: ~  
mpl@worker:~$ sudo adduser mpl  
adduser: The user 'mpl' already exists.  
mpl@worker:~$
```

3. Memberikan akses root kepada user

Server

```
mpl@master: ~  
mpl@master:~$ sudo usermod -aG sudo mpl  
mpl@master:~$
```

Client

```
mpl@worker: ~  
mpl@worker:~$ sudo usermod -aG sudo mpl  
mpl@worker:~$
```

4. Melakukan login akun user

Server

```
mpl@master: ~  
mpl@master:~$ sudo usermod -aG sudo mpl  
mpl@master:~$ su - mpl  
Password:  
mpl@master:~$
```

Client

```
mpl@worker: ~  
mpl@worker:~$ sudo usermod -aG sudo mpl  
mpl@worker:~$ su - mpl  
Password:  
mpl@worker:~$
```

5. Instalai paket openssh-server
Server

```
mpl@master: ~  
mpl@master:~$ sudo usermod -aG sudo mpl  
mpl@master:~$ su - mpl  
Password:  
mpl@master:~$ sudo apt install openssh-server  
Reading package lists... Done  
Building dependency tree... Done  
Reading state information... Done  
openssh-server is already the newest version (1:8.9p1-3ubuntu0.4).  
0 upgraded, 0 newly installed, 0 to remove and 2 not upgraded.  
mpl@master:~$
```

6. Pengecekan ssh
Server

```
mpl@worker: ~  
Reading package lists... Done  
Building dependency tree... Done  
Reading state information... Done  
openssh-server is already the newest version (1:8.9p1-3ubuntu0.4).  
0 upgraded, 0 newly installed, 0 to remove and 2 not upgraded.  
mpl@master:~$ ssh mpl@master  
mpl@master's password:  
Welcome to Ubuntu 22.04.3 LTS (GNU/Linux 6.2.0-36-generic x86_64)  
  
 * Documentation:  https://help.ubuntu.com  
 * Management:    https://landscape.canonical.com  
 * Support:       https://ubuntu.com/advantage  
  
Expanded Security Maintenance for Applications is not enabled.  
  
0 updates can be applied immediately.  
  
3 additional security updates can be applied with ESM Apps.  
Learn more about enabling ESM Apps service at https://ubuntu.com/esm  
  
The list of available updates is more than a week old.  
To check for new updates run: sudo apt update  
Last login: Mon Nov 13 11:29:06 2023 from 192.168.15.207  
mpl@master:~$ ssh mpl@worker  
Welcome to Ubuntu 22.04.3 LTS (GNU/Linux 6.2.0-36-generic x86_64)  
  
 * Documentation:  https://help.ubuntu.com  
 * Management:    https://landscape.canonical.com  
 * Support:       https://ubuntu.com/advantage  
  
Expanded Security Maintenance for Applications is not enabled.  
  
0 updates can be applied immediately.  
  
3 additional security updates can be applied with ESM Apps.  
Learn more about enabling ESM Apps service at https://ubuntu.com/esm  
  
Last login: Mon Nov 13 10:04:23 2023 from 192.168.15.114  
mpl@worker:~$
```

Client

```
mpl@master: ~  
mpl@worker:~$ sudo usermod -aG sudo mpl  
mpl@worker:~$ su - mpl  
Password:  
mpl@worker:~$ ssh mpl@master  
mpl@master's password:  
Welcome to Ubuntu 22.04.3 LTS (GNU/Linux 6.2.0-36-generic x86_64)  
  
 * Documentation:  https://help.ubuntu.com  
 * Management:    https://landscape.canonical.com  
 * Support:       https://ubuntu.com/advantage  
Rhythmbox  
Expanded Security Maintenance for Applications is not enabled.  
  
0 updates can be applied immediately.  
  
3 additional security updates can be applied with ESM Apps.  
Learn more about enabling ESM Apps service at https://ubuntu.com/esm  
  
The list of available updates is more than a week old.  
To check for new updates run: sudo apt update  
Last login: Mon Nov 13 22:33:36 2023 from 192.168.10.31  
mpl@master:~$
```

7. Membuat keygen

Server

```
mpi@master:~$ ssh-keygen -t rsa
Generating public/private rsa key pair.
Enter file in which to save the key (/home/mpi/.ssh/id_rsa):
/home/mpi/.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/mpi/.ssh/id_rsa
Your public key has been saved in /home/mpi/.ssh/id_rsa.pub
The key fingerprint is:
SHA256:lIt8/Nh1eq9NynUiNWdLZV/0lqiBJBkfpX/z84r8Nbc mpi@master
The key's randomart image is:
+---[RSA 3072]-----+
|      ooo . . . = |
|      .+. = . . * |
|      o+ + . . * |
|      . + . . * o. |
|      o S  o.o+ o |
|      . + . +o+ |
|      . o o o+= |
|      . .+oB= |
|      o.o+Eo |
+-----[SHA256]-----+
mpi@master:~$
```

8. Menyalin keygen ke Server dan Client

Server

```
mpi@master:~$ cd .ssh
mpi@master:~/.ssh$ cat id_rsa.pub | ssh mpi@worker "mkdir .ssh; cat >> .ssh/authorized_key"
mpi@worker's password:
mkdir: cannot create directory '.ssh': File exists
mpi@master:~/.ssh$
```

9. Membuat sharing file

Server

```
mpi@master:~$ mkdir cloud
mkdir: cannot create directory 'cloud': File exists
mpi@master:~$ ls
cloud Desktop Documents Downloads Music Pictures Public snap Templates Videos
mpi@master:~$
```

Client

```
mpi@worker:~$ mkdir cloud
mkdir: cannot create directory 'cloud': File exists
mpi@worker:~$ ls
cloud Desktop Documents Downloads Music Pictures Public snap Templates Videos
mpi@worker:~$
```

10. Instalasi nfs server

Server

```
mpi@master: ~  
mpi@master:~$ sudo apt install nfs-kernel-server  
[sudo] password for mpi:  
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).  
0 upgraded, 0 newly installed, 0 to remove and 2 not upgraded.  
mpi@master:~$
```

cl

11. Konfigurasi file /etc/exports

Server

```
mpi@master:~$ sudo nano /etc/exports  
mpi@master:~$  
mpi@master: ~  
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/mpl/cloud *(rw,sync,no_root_squash,no_subtree_check)
```

12. Simpan dan restart nfs-kernel-server

Server

```
mpi@master:~$ sudo nano /etc/exports  
mpi@master:~$ sudo exportfs -a  
mpi@master:~$ sudo systemctl restart nfs-kernel-server  
mpi@master:~$
```

13. Instalasi nfs client

Client

```
mpi@worker:~$ sudo apt install nfs-common  
[sudo] password for mpi:  
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 2 not upgraded.  
mpi@worker:~$
```

14. Mounting sharing file pada Client

Client

```
mpi@worker: ~  
mpi@worker:~$ sudo mount master:/home/mpi/cloud /home/mpi/cloud  
mpi@worker:~$
```

15. Instalasi python3 dan mpi

Server

```
mpi@master: ~  
mpi@master:~$ 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 2 not upgraded.  
mpi@master:~$
```

Client

```
mpi@worker: ~  
mpi@worker:~$ 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 2 not upgraded.  
mpi@worker:~$
```

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

Server

```
mpi@master: ~/cloud  
mpi@master:~/cloud$ mpirun -np 2 -host master,worker python3 bubblesort.py  
Waktu dikerjakan 0.017549991607666016  
Sorted Data: [1, 1, 2, 2, 5, 5, 5, 5, 6, 6, 9, 9]  
Waktu dikerjakan 0.01981496810913086  
mpi@master:~/cloud$
```

Kodingan :

from mpi4py import MPI

def bubble_sort_parallel(data):

 comm = MPI.COMM_WORLD

 rank = comm.Get_rank()

 size = comm.Get_size()

 local_data = data[rank::size]

 local_data.sort()

 for step in range(1, size):

 if rank % 2 == 0:

 if rank < size - 1:

 comm.send(local_data, dest=rank+1)

 received_data = comm.recv(source=rank+1)

 local_data = merge(local_data, received_data)

 else:

 comm.send(local_data, dest=rank-1)

 received_data = comm.recv(source=rank-1)

 local_data = merge(local_data, received_data)

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

 if rank == 0:

 sorted_data = merge_sorted_arrays(sorted_data)

```

        return sorted_data
    else:
        return None

def merge(arr1, arr2):
    merged_array = []
    i = j = 0
    while i < len(arr1) and j < len(arr2):
        if arr1[i] < arr2[j]:
            merged_array.append(arr1[i])
            i += 1
        else:
            merged_array.append(arr2[j])
            j += 1
    merged_array.extend(arr1[i:])
    merged_array.extend(arr2[j:])
    return merged_array

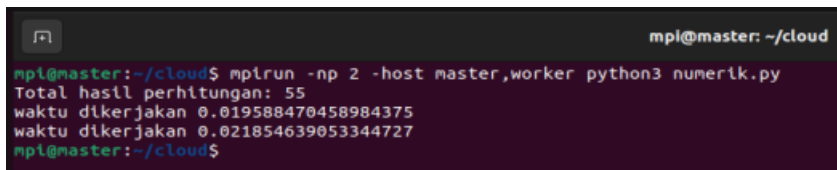
def merge_sorted_arrays(arrays):
    merged_array = []
    for array in arrays:
        merged_array = merge(merged_array, array)
    return merged_array

if __name__ == "__main__":
    data = [5, 2, 9, 1, 5, 6]
    comm = MPI.COMM_WORLD
    rank = comm.Get_rank()

    if rank == 0:
        sorted_data = bubble_sort_parallel(data)
        print("Sorted Data:", sorted_data)
    else:
        bubble_sort_parallel(data)

```

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



```

mpi@master: ~/cloud
mpi@master:~/cloud$ mpirun -np 2 -host master,worker python3 numerik.py
Total hasil perhitungan: 55
waktu dikerjakan 0.019588470458984375
waktu dikerjakan 0.021854639053344727
mpi@master:~/cloud$

```

Kodingan :

```
from mpi4py import MPI
```

```
import time
```

```
start = time.time()
```

```
def main():
```

```
    comm = MPI.COMM_WORLD
```

```
    rank = comm.Get_rank()
```

```
    size = comm.Get_size()
```



```

# Data yang akan dihitung
data = [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]

# Bagi data di antara proses
chunk_size = len(data) // size
start = rank * chunk_size
end = (rank + 1) * chunk_size

if rank == size - 1:
    # Pastikan semua data terhitung jika
panjang data tidak habis dibagi oleh jumlah
proses
    end = len(data)

local_sum = sum(data[start:end])

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

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

if __name__ == '__main__':
    main()
end = time.time()
print("waktu dikerjakan", end-start)

```