

LAPORAN RESMI
PRAKTIKUM ORGANISASI DAN ARSITEKTUR KOMPUTER



JUDUL:
Open MPI (Parallel Computing) Linux Ubuntu

Disusun Oleh :

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PROGRAM STUDI TEKNIK KOMPUTER
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Ini adalah tampilan hasil installasi untuk slave1

- Buka Ubuntu Dekstop ketik “*sudo apt update*”

```
zakitirta@zakitirta-VirtualBox:~$ sudo apt update
[sudo] password for zakitirta:
Hit:1 http://id.archive.ubuntu.com/ubuntu focal InRelease
Hit:2 http://id.archive.ubuntu.com/ubuntu focal-updates InRelease
Hit:3 http://id.archive.ubuntu.com/ubuntu focal-backports InRelease
Hit:4 http://security.ubuntu.com/ubuntu focal-security InRelease
Reading package lists... Done
Building dependency tree
Reading state information... Done
1 package can be upgraded. Run 'apt list --upgradable' to see it.
```

- Ketik “*ip a*” atau “*hostname -I*” untuk mengecek ip address

```
zakitirta@zakitirta-VirtualBox:~$ ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    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: enp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 08:00:27:68:d3:aa brd ff:ff:ff:ff:ff:ff
    inet 10.1.11.134/22 brd 10.1.11.255 scope global dynamic noprefixroute enp0s3
        valid_lft 113sec preferred_lft 113sec
    inet6 fe80::789b:fe77:efbc:e1a8/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
3: enp0s8: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 08:00:27:41:f8:f9 brd ff:ff:ff:ff:ff:ff
    inet 10.0.3.15/24 brd 10.0.3.255 scope global dynamic noprefixroute enp0s8
        valid_lft 86213sec preferred_lft 86213sec
    inet6 fe80::288a:de4d:707c:988f/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
```

```
zakitirta@zakitirta-VirtualBox:~$ hostname -I
10.1.11.134 10.0.3.15
```

- Ketik “*sudo adduser tony1*” buat password *1* setelah itu ketik *Y*
- Ketik “*sudo usermod -aG sudo tony1*”
- Ketik “*su - tony1*”

```
zakitirta@zakitirta-VirtualBox:~$ sudo adduser tony1
Adding user `tony1' ...
Adding new group `tony1' (1006) ...
Adding new user `tony1' (1006) with group `tony1' ...
Creating home directory `/home/tony1' ...
Copying files from `/etc/skel' ...
New password:
Retype new password:
passwd: password updated successfully
Changing the user information for tony1
Enter the new value, or press ENTER for the default
  Full Name []: tony
    Room Number []: 1
    Work Phone []: 1
    Home Phone []: 1
      Other []: 1
Is the information correct? [Y/n] y
zakitirta@zakitirta-VirtualBox:~$ sudo usermod -aG sudo tony1
zakitirta@zakitirta-VirtualBox:~$ su - tony1
Password:
To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.
```

- Ketik *“sudo apt update && sudo apt upgrade*

```

mpiuser@zakitirta-VirtualBox:~$ sudo apt update && sudo apt upgrade
[sudo] password for mpiuser:
Hit:1 http://id.archive.ubuntu.com/ubuntu focal InRelease
Hit:2 http://id.archive.ubuntu.com/ubuntu focal-updates InRelease
Hit:3 http://id.archive.ubuntu.com/ubuntu focal-backports InRelease
Hit:4 http://security.ubuntu.com/ubuntu focal-security InRelease
Reading package lists... Done
Building dependency tree
Reading state information... Done
1 package can be upgraded. Run 'apt list --upgradable' to see it.
Reading package lists... Done
Building dependency tree
Reading state information... Done
Calculating upgrade... Done
The following packages were automatically installed and are no longer required:
  linux-headers-5.15.0-67-generic linux-hwe-5.15-headers-5.15.0-67 linux-image-5.15.0-67-generic
  linux-modules-5.15.0-67-generic linux-modules-extra-5.15.0-67-generic
Use 'sudo apt autoremove' to remove them.
Get more security updates through Ubuntu Pro with 'esm-apps' enabled:
  libpython3.9-minimal libpython3.9-stdlib libpython3.9 python3.9
  python3.9-dev python3.9-minimal libpython3.9-dev python3.9-venv
Learn more about Ubuntu Pro at https://ubuntu.com/pro
The following packages will be upgraded:
  openvpn
1 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
Need to get 483 kB of archives.
After this operation, 7.168 B of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:1 http://id.archive.ubuntu.com/ubuntu focal-updates/main amd64 openvpn amd64 2.4.12-0ubuntu0.20.04.1 [483 kB]
Fetched 483 kB in 0s (2.269 kB/s)
Preconfiguring packages ...
(Reading database ... 227936 files and directories currently installed.)
Preparing to unpack .../openvpn_2.4.12-0ubuntu0.20.04.1_amd64.deb ...
Unpacking openvpn (2.4.12-0ubuntu0.20.04.1) over (2.4.7-1ubuntu2.20.04.4) ...
Setting up openvpn (2.4.12-0ubuntu0.20.04.1) ...
* Restarting virtual private network daemon.
Processing triggers for man-db (2.9.1-1) ...
Processing triggers for systemd (245.4-4ubuntu3.22) ...
[ OK ]

```

- Ketik *“sudo apt install net-tools vim”*

```

mpiuser@zakitirta-VirtualBox:~$ sudo apt install net-tools vim
Reading package lists... Done
Building dependency tree
Reading state information... Done
net-tools is already the newest version (1.60+git20180626.aebd88e-1ubuntu1).
vim is already the newest version (2:8.1.2269-1ubuntu5.20).
The following packages were automatically installed and are no longer required:
  linux-headers-5.15.0-67-generic linux-hwe-5.15-headers-5.15.0-67 linux-image-5.15.0-67-generic
  linux-modules-5.15.0-67-generic linux-modules-extra-5.15.0-67-generic
Use 'sudo apt autoremove' to remove them.
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
mpiuser@zakitirta-VirtualBox:~$ hostname -I
10.1.11.134 10.0.3.15

```

- Ketik *“sudo apt install openssh-server”*
- Ketik *“ssh-keygen -t rsa”*
- Ketik *“cd .ssh”*

cat id_rsa.pub | ssh mpiuser@slave1 "mkdir .ssh; cat >> .ssh/authorized_keys"

```

mpiuser@zakitirta-VirtualBox:~$ sudo nano /etc/hosts
mpiuser@zakitirta-VirtualBox:~$ sudo nano /etc/hosts
mpiuser@zakitirta-VirtualBox:~$ sudo nano /etc/hosts
mpiuser@zakitirta-VirtualBox:~$ sudo apt install openssh-server
Reading package lists... Done
Building dependency tree
Reading state information... Done
openssh-server is already the newest version (1:8.2p1-4ubuntu0.9).
The following packages were automatically installed and are no longer required:
  linux-headers-5.15.0-67-generic linux-hwe-5.15-headers-5.15.0-67 linux-image-5.15.0-67-generic
  linux-modules-5.15.0-67-generic linux-modules-extra-5.15.0-67-generic
Use 'sudo apt autoremove' to remove them.
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
mpiuser@zakitirta-VirtualBox:~$

```

- Ketik “*sudo apt install openmpi-bin libopenmpi-dev*”
- Ketik “*sudo apt install python3-pip*”
- *pip install mpi4py*

```
tonyi@zakitirta-VirtualBox:~$ sudo apt install openmpi-bin libopenmpi-dev
Reading package lists... Done
Building dependency tree
Reading state information... Done
libopenmpi-dev is already the newest version (4.0.3-0ubuntu1).
openmpi-bin is already the newest version (4.0.3-0ubuntu1).
The following packages were automatically installed and are no longer required:
  linux-headers-5.15.0-67-generic linux-hwe-5.15-headers-5.15.0-67
  linux-image-5.15.0-67-generic linux-modules-5.15.0-67-generic
  linux-modules-extra-5.15.0-67-generic
Use 'sudo apt autoremove' to remove them.
0 upgraded, 0 newly installed, 0 to remove and 2 not upgraded.
tonyi@zakitirta-VirtualBox:~$ sudo apt install python3-pip
Reading package lists... Done
Building dependency tree
Reading state information... Done
python3-pip is already the newest version (20.0.2-5ubuntu1.10).
The following packages were automatically installed and are no longer required:
  linux-headers-5.15.0-67-generic linux-hwe-5.15-headers-5.15.0-67
  linux-image-5.15.0-67-generic linux-modules-5.15.0-67-generic
  linux-modules-extra-5.15.0-67-generic
Use 'sudo apt autoremove' to remove them.
0 upgraded, 0 newly installed, 0 to remove and 2 not upgraded.
tonyi@zakitirta-VirtualBox:~$ pip install mpi4py
Requirement already satisfied: mpi4py in ~/.local/lib/python3.8/site-packages (3.1.5)
tonyi@zakitirta-VirtualBox:~$
```

- Ketik “*touch /home/mpiuser/bubble/bubble.py*”
- Ketik “*cd /home/tonyi/bubble*”

Nano bubble.py

Lalu buatlah code Bubble Sort Python. Simpan dengan menekan CTRL + X. bubble.py

```
tonyi@zakitirta-VirtualBox:~$ sudo nano /etc/hosts
tonyi@zakitirta-VirtualBox:~$ touch /home/tonyi/bubble/bubble.py
tonyi@zakitirta-VirtualBox:~$ cd /home/tonyi/bubble
tonyi@zakitirta-VirtualBox:~/bubble$ nano bubble.py
```

```
GNU nano 4.8 bubble.py
from mpi4py import MPI

def parallel_bubble_sort(arr):
    comm = MPI.COMM_WORLD
    rank = comm.Get_rank()
    size = comm.Get_size()

    local_arr = arr[rank::size]

    for i in range(len(local_arr)):
        for j in range(0, len(local_arr) - i - 1):
            if local_arr[j] > local_arr[j + 1]:
                local_arr[j], local_arr[j + 1] = local_arr[j + 1], local_arr[j]

    sorted_arr = comm.gather(local_arr, root=0)

    if rank == 0:
        combined_arr = [item for sublist in sorted_arr for item in sublist]
        combined_arr.sort()
        for i in range(len(arr)):
            arr[i] = combined_arr[i]

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

    if rank == 0:
        arr = [5, 3, 4, 1, 2]
    else:
        arr = None

    arr = comm.bcast(arr, root=0) # Broadcast the arr from rank 0 to all nodes

    comm.barrier()

    parallel_bubble_sort(arr)

    if rank == 0:
        print(f"List sorted with bubble sort in ascending order: {arr}")
```

- Jalankan code “`mpirun -np 4 -host master,slave1,slave2,slave3 python3 bubble.py`”

```

3 (3.1.3)
tony1@tony-VirtualBox:~/.ssh$ touch /home/tony1/bubble/bubble.py
tony1@tony-VirtualBox:~/.ssh$ cd /home/tony1/bubble
tony1@tony-VirtualBox:~/bubble$ nano bubble.py
tony1@tony-VirtualBox:~/bubble$ sudo mount master:/home/tony1/bubble /home/tony1/bubble
^C
tony1@tony-VirtualBox:~/bubble$ mpirun -np 4 -host master,slave1,slave2,slave3 python3
bubble.py

```

```

tony1@tony-VirtualBox:~/bubble$ mpirun -np 1 -host slave3 python3 bubble.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
List sorted with bubble sort in ascending order: [1, 2, 3, 4, 5]
tony1@tony-VirtualBox:~/bubble$ mpirun -np 1 -host slave1 python3 bubble.py
List sorted with bubble sort in ascending order: [1, 2, 3, 4, 5]

```

- Selesai

Kesimpulan

Tujuan Open MPI dalam Linux Ubuntu adalah menyediakan platform komputasi paralel yang efisien dan fleksibel. Open MPI didesain untuk mendukung model pemrograman paralel dengan penekanan pada manajemen tugas, fleksibilitas pemrograman, dan peningkatan kinerja. Dengan optimalisasi penggunaan sumber daya, Open MPI bertujuan untuk meningkatkan kecepatan dan efisiensi pelaksanaan tugas paralel di lingkungan Linux Ubuntu. Keberagaman dan fleksibilitas platform ini diperkuat oleh berbagai kasus penggunaan yang mendemonstrasikan aplikabilitasnya di berbagai bidang. Sebagai hasilnya, implementasi Open MPI di Linux Ubuntu dianggap sebagai pilihan yang sangat layak untuk proyek-proyek yang memerlukan pemrosesan data besar dan tugas-tugas komputasi intensif, berpotensi mendorong evolusi dalam paradigma komputasi paralel.