Laporan Praktikum Eksekusi Program Bubble Sort Python Menggunakan MPI

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Langkah 1: Hostname

Buka terminal di sistem Ubuntu. Terminal adalah antarmuka teks ke komputer, yang akan digunakan untuk menjalankan semua perintah.

Pertama kita menuliskan hostname dikomputer master dan 3 komputer lainnya

```
root@aral-amd-lol:~# hostname -I
10.9.53.40 172.17.0.1
```

Lalu kita akan menjalankan comen "*sudo nano /etc/hosts*" untuk mengubah ip hosts. Dan output nya akan seperti ini:

```
  GNU nano 6.2                        /etc/hosts *
127.0.0.1 localhost
127.0.1.1 aral-amd-lol

10.8.143.99 aral-amd-lol

# 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
```

Yang akan kita ubah menjadi seperti dibawah sesuai dengan ip dan hostname keempat komputer

```
127.0.0.1 localhost
127.0.1.1 aral-amd-lol

10.8.143.99 aral-amd-lol
10.8.140.186 nanda
10.8.143.52 tiaraputri
10.8.141.132 pico556

# 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   M-U Undo
^X Exit       ^R Read File  ^\ Replace    ^U Paste      ^J Justify    ^/ Go To Line M-E Redo
```

Dan ini dijalankan oleh semua computer.

Langkah selanjutnya, pada komputer master menjalan kan command "ssh-copy-id tiaraptri@tiaraputri" untuk meminta izin akses ke user dan hostname tersebut. Command ini dijalankan untuk semua user secara bergantian dikomputer master, dengan mengubah user dan hostname nya.

 Berikut adalah beberapa dokumentasi permintaan izin akses ke user lainnya

```
aral@aral-amd-lol:~$ ssh-copy-id tiaraptri@tiaraputri
/usr/bin/ssh-copy-id: INFO: Source of key(s) to be installed: "/home/aral/.ssh/id_rsa.pub"
The authenticity of host 'tiaraputri (10.8.143.52)' can't be established.
ED25519 key fingerprint is SHA256:2u3aazKwKAyJs+OQjTq+zv7GRCFo+I+kNH97MTstfgI.
This key is not known by any other names
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
/usr/bin/ssh-copy-id: INFO: attempting to log in with the new key(s), to filter out any that are alr
eady installed
/usr/bin/ssh-copy-id: INFO: 1 key(s) remain to be installed -- if you are prompted now it is to inst
all the new keys
tiaraptri@tiaraputri's password:

Number of key(s) added: 1

Now try logging into the machine, with:   "ssh 'tiaraptri@tiaraputri'"
and check to make sure that only the key(s) you wanted were added.
```

```
aral@aral-amd-lol:~$ ssh-copy-id nanda@nanda
/usr/bin/ssh-copy-id: INFO: Source of key(s) to be installed: "/home/aral/.ssh/id_rsa.pub"
The authenticity of host 'nanda (10.9.55.166)' can't be established.
ED25519 key fingerprint is SHA256:UNav9rqck4cKqKBOO+d572EbO1Hbu18u9JxNAFZS89M.
This key is not known by any other names
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
/usr/bin/ssh-copy-id: INFO: attempting to log in with the new key(s), to filter out any that are alr
eady installed
/usr/bin/ssh-copy-id: INFO: 1 key(s) remain to be installed -- if you are prompted now it is to inst
all the new keys
nanda@nanda's password:
```

```
aral@aral-amd-lol:~$ ssh-copy-id pico556@pico556
/usr/bin/ssh-copy-id: INFO: Source of key(s) to be installed: "/home/aral/.ssh/id_rsa.pub"
The authenticity of host 'pico556 (10.8.141.132)' can't be established.
ED25519 key fingerprint is SHA256:3CSygfaqYFI1fQnF+P8XahK94Tm2JRS7knX7W+TLeyI.
This key is not known by any other names
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
/usr/bin/ssh-copy-id: INFO: attempting to log in with the new key(s), to filter out any that are alr
eady installed
/usr/bin/ssh-copy-id: INFO: 1 key(s) remain to be installed -- if you are prompted now it is to inst
all the new keys
pico556@pico556's password:

Number of key(s) added: 1

Now try logging into the machine, with:   "ssh 'pico556@pico556'"
and check to make sure that only the key(s) you wanted were added.
```

Setelah meminta izin akses, maka kita akan mengakses ssh dengan command "*ssh tiaraptri@tiaraputri*".

```
aral@aral-amd-lol:~$ ssh tiaraptri@tiaraputri
Welcome to Ubuntu 22.04.3 LTS (GNU/Linux 5.15.0-87-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/advantage

  System information as of Thu Nov  2 06:52:33 AM UTC 2023

  System load:  0.0              Processes:             111
  Usage of /:   67.9% of 11.21GB  Users logged in:       1
  Memory usage: 30%              IPv4 address for enp0s3: 10.8.143.52
  Swap usage:   0%

 * Strictly confined Kubernetes makes edge and IoT secure. Learn how MicroK8s
   just raised the bar for easy, resilient and secure K8s cluster deployment.

   https://ubuntu.com/engage/secure-kubernetes-at-the-edge

Expanded Security Maintenance for Applications is not enabled.

38 updates can be applied immediately.
5 of these updates are standard security updates.
To see these additional updates run: apt list --upgradable

Enable ESM Apps to receive additional future security updates.
See https://ubuntu.com/esm or run: sudo pro status


Last login: Thu Nov  2 06:20:30 2023
```

Command ini juga dijalankan sesuai kebutuhan ingin menggunakan user dan hostname yang mana, jika kita ingin menggunakan user nanda maka command yang digunakan adalah "nanda@nanda".

Langkah 2 Generate Keygen

Kita akan menjalankan command di server "*ssh-keygen -t rsa*" nanti akan ada beberapa input kita lewatkan saja semua. Seharusnya ketika sudah menjalankan command akan ada folder ".ssh"

Langkah 3 Copy Key Public Client

Kita lakukan di server "*cd .ssh*" berpindah ke folder ssh nya. Lalu kita akan menjalankan "*cat id_rsa.pub | ssh kel7@nanda "mkdir .ssh; cat >> .ssh/authorized_keys*". Lalu dilakukan ke semua client yang ada dalam kasus ini memiki tiga client.

Langkah 4 Konfigurasi NFS

Mula mula kita membuat folder dengan nama yang bebas, kali ini kita membuat folder dengan nama kel7 dengan command "*mkdir kel7*". Lalu kita akan menginstall NFS dengan command "*sudo apt install nfs-kernel-server* ".

```
kel7@aral-amd-lol:~$ sudo apt install nfs-kernel-server
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following packages were automatically installed and are no longer require
d:
  libcgi-fast-perl libcgi-pm-perl libclone-perl libencode-locale-perl
  libfcgi-bin libfcgi-perl libfcgi0ldbl libhtml-parser-perl
  libhtml-tagset-perl libhtml-template-perl libhttp-date-perl
  libhttp-message-perl libio-html-perl liblwp-mediatypes-perl libmecab2
  libprotobuf-lite23 libtimedate-perl liburi-perl mecab-ipadic
  mecab-ipadic-utf8 mecab-utils
Use 'sudo apt autoremove' to remove them.
The following additional packages will be installed:
  keyutils libnfsidmap1 nfs-common rpcbind
Suggested packages:
  watchdog
The following NEW packages will be installed:
  keyutils libnfsidmap1 nfs-common nfs-kernel-server rpcbind
0 upgraded, 5 newly installed, 0 to remove and 0 not upgraded.
```

Jika sudah terinstall maka kita memulai kembali atau merestart NFS server dengan perintah

"*sudo exportfs -a*"

" *sudo systemctl restart nfs-kernel-server*"

Selanjutnya kita akan mengkonfigurasikan file /etc/exports. Lakukan kepada semua klient.

Langkah 5 Eksekusi Program MPI

Pertama kita install MPI dengan menggunakan command *"sudo apt install openmpi-bin libopenmpi-dev "*.


```
aral@aral-amd-lol:/home$ python3 pemparr.py
List sorted with bubble sort in ascending order:  [1, 2, 3, 4, 5]
aral@aral-amd-lol:/home$ mpiexec -oversubscribe -n 4 python3 pemparr.py
List sorted with bubble sort in ascending order:  [1, 2, 3, 4, 5]
List sorted with bubble sort in ascending order:  [1, 2, 3, 4, 5]
List sorted with bubble sort in ascending order:  [1, 2, 3, 4, 5]
List sorted with bubble sort in ascending order:  [1, 2, 3, 4, 5]
aral@aral-amd-lol:/home$ 
```

```
aral@aral-amd-lol:~$ sudo apt install openmpi-bin openmpi-common libopenmpi-d
ev
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
openmpi-bin is already the newest version (4.1.2-2ubuntu1).
openmpi-common is already the newest version (4.1.2-2ubuntu1).
openmpi-common set to manually installed.
The following additional packages will be installed:
  autoconf automake autotools-dev gfortran gfortran-11 libcaf-openmpi-3
  libcoarrays-dev libcoarrays-openmpi-dev libevent-2.1-7 libevent-dev
  libevent-extra-2.1-7 libevent-openssl-2.1-7 libgfortran-11-dev
  libgfortran5 libhwloc-dev libibverbs-dev libjs-jquery-ui libltdl-dev
  libnl-3-dev libnl-route-3-dev libnuma-dev libpmix-dev libtool m4
Suggested packages:
  autoconf-archive gnu-standards autoconf-doc gettext gfortran-multilib
  gfortran-doc gfortran-11-multilib gfortran-11-doc libjs-jquery-ui-docs
  libtool-doc openmpi-doc gcj-jdk m4-doc
The following NEW packages will be installed:
  autoconf automake autotools-dev gfortran gfortran-11 libcaf-openmpi-3
  libcoarrays-dev libcoarrays-openmpi-dev libevent-2.1-7 libevent-dev
  libevent-extra-2.1-7 libevent-openssl-2.1-7 libgfortran-11-dev
  libgfortran5 libhwloc-dev libibverbs-dev libjs-jquery-ui libltdl-dev
  libnl-3-dev libnl-route-3-dev libnuma-dev libopenmpi-dev libpmix-dev
  libtool m4
0 upgraded, 25 newly installed, 0 to remove and 10 not upgraded.
Need to get 18,6 MB of archives.
After this operation, 77,3 MB of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:1 http://id.archive.ubuntu.com/ubuntu jammy/main amd64 m4 amd64 1.4.18-5u
buntu2 [199 kB]
Get:2 http://id.archive.ubuntu.com/ubuntu jammy/main amd64 autoconf all 2.71-
2 [338 kB]
Get:3 http://id.archive.ubuntu.com/ubuntu jammy/main amd64 autotools-dev all
20220109.1 [44,9 kB]
Get:4 http://id.archive.ubuntu.com/ubuntu jammy/main amd64 automake all 1:1.1
6.5-1.3 [558 kB]
Get:5 http://id.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libgfortra
n5 amd64 12.3.0-1ubuntu1~22.04 [879 kB]
Get:6 http://id.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libgfortra
n-11-dev amd64 11.4.0-1ubuntu1~22.04 [842 kB]
Get:7 http://id.archive.ubuntu.com/ubuntu jammy-updates/main amd64 gfortran-1
1 amd64 11.4.0-1ubuntu1~22.04 [11,2 MB]
```

Setelah MPI terinstall ke semua client selanjutnya kita akan membuat user baru dengan command " *sudo adduser kel7*" disini kami membuat user dengan nama "kel7" :

```
mpiuser@aral-amd-lol:~$ sudo adduser kel7
Adding user `kel7' ...
Adding new group `kel7' (1003) ...
Adding new user `kel7' (1003) with group `kel7' ...
Creating home directory `/home/kel7' ...
Copying files from `/etc/skel' ...
New password:
Retype new password:
passwd: password updated successfully
Changing the user information for kel7
Enter the new value, or press ENTER for the default
        Full Name []: a
        Room Number []: a
        Work Phone []: a
        Home Phone []: a
        Other []: a
Is the information correct? [Y/n] y
mpiuser@aral-amd-lol:~$ sudo usermod -aG sudo kel7
mpiuser@aral-amd-lol:~$ su - kel7
Password:
To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

kel7@aral-amd-lol:~$ sudo su - kel7
```

LANGKAH 7 EKSEKUSI PROGRAM

Setelah membuat user selanjutnya kita akan membuat file baru yang akan mengeksekusi program mpi bubble sort , dengan menggunakan command "*sudo touch kalu.py* " .

```
kel7@aral-amd-lol:~/.ssh$ sudo nano  kalu.py
```

Setelah file berhasil dibuat di direktori ."ssh", edit file tersebut dengan cara "*sudo nano kalu.py*" dan menyalin program mpi bubble sort nya.

```
  GNU nano 6.2                              kalu.py
def bubble_sort(x):
    for i in range(len(x) - 1, 0, -1):
        for j in range(i):
            if x[j] > x[j + 1]:
                temp = x[j]
                x[j] = x[j + 1]
                x[j + 1] = temp

angka = [3, 1, 4, 2, 8]
bubble_sort(angka)
print(angka)
```

Lakukan cara tadi ke semua client .

LANGKAH 8 MENJALANKAN KODINGAN PYTHON

Setelah codingan tersebut sudah di edit ke semua client selanjutnya kita akan menjalankanya di hostmaster dengan menggunakan command "*mpirun -np 4 -host aral-amd-lol,nanda,pico556,tiaraputri python3 kalu.py*" sesuai kan command dengan banyak jumlah client dan *hostname* mereka .

```
kel7@aral-amd-lol:~/.ssh$ mpirun -np 4 -host aral-amd-lol,tiaraputri,pico556,
nanda python3 kalu.py
[1, 2, 3, 4, 8]
[1, 2, 3, 4, 8]
[1, 2, 3, 4, 8]
[1, 2, 3, 4, 8]
```

Program mpi bubble sort berhasil dijalankan