

Parallel and Distributed Computing  
CSE4001  
Fall Semester 2020-21

Lab Assignment 7/ Lab CAT

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**Aim:**

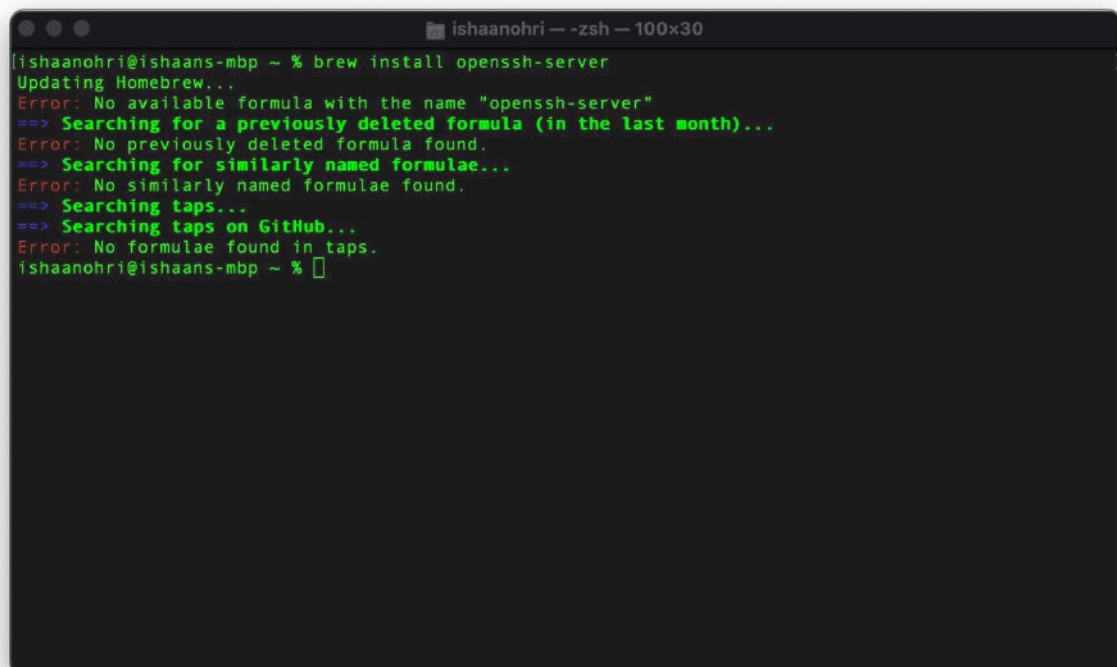
Setup computational cluster with MPI.

**Source Code/ Execution:**

**TRIED ON STAND ALONE MACHINE:**

Tried using Homebrew to install openssh-server, but throws error on MacOS.

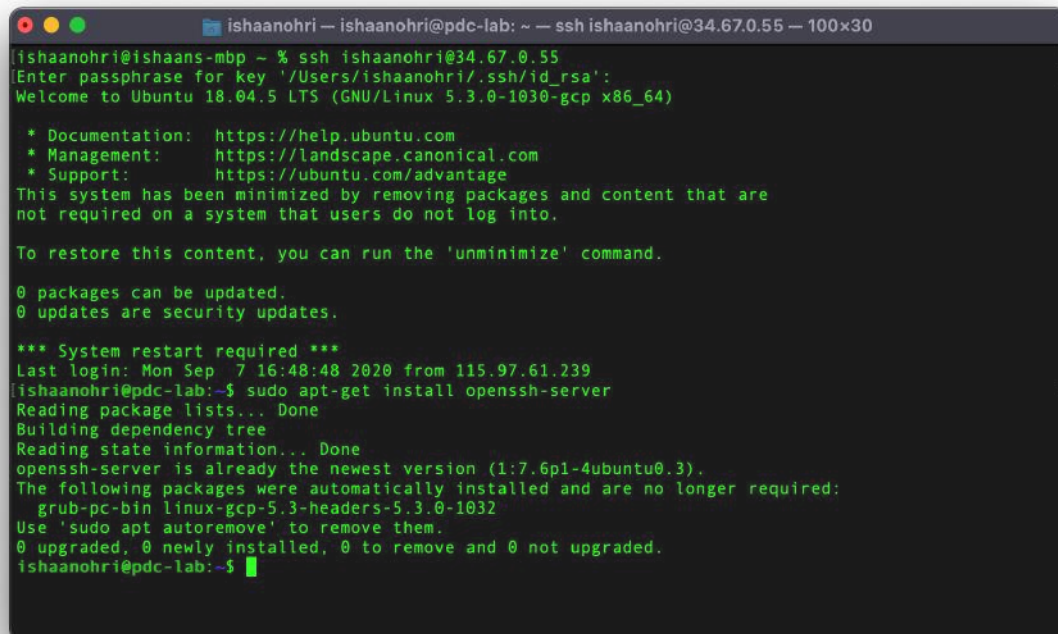
```
sudo apt-get install openssh-server
```

A terminal window titled 'ishaanohri -- zsh -- 100x30' showing the command 'brew install openssh-server' being executed. The output shows Homebrew updating and then failing to find the formula. It searches for previously deleted formulas, similarly named formulas, and taps, all without success.

```
ishaanohri@ishaans-mbp ~ % brew install openssh-server
Updating Homebrew...
Error: No available formula with the name "openssh-server"
==> Searching for a previously deleted formula (in the last month)...
Error: No previously deleted formula found.
==> Searching for similarly named formulae...
Error: No similarly named formulae found.
==> Searching taps...
==> Searching taps on GitHub...
Error: No formulae found in taps.
ishaanohri@ishaans-mbp ~ %
```

## TRIED ON VM ON GCP:

```
sudo apt-get install openssh-server
```



```
isshaanohri — isshaanohri@pdc-lab: ~ — ssh isshaanohri@34.67.0.55 — 100x30
[isshaanohri@ishaans-mbp ~ % ssh isshaanohri@34.67.0.55
Enter passphrase for key '/Users/ishaanohri/.ssh/id_rsa':
Welcome to Ubuntu 18.04.5 LTS (GNU/Linux 5.3.0-1030-gcp x86_64)

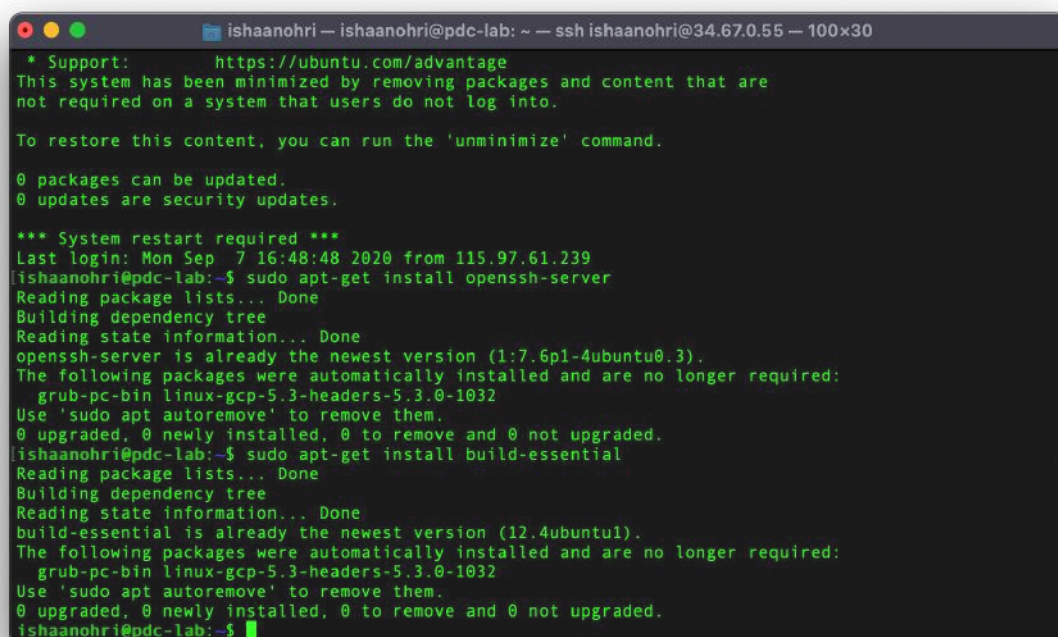
 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:       https://ubuntu.com/advantage
This system has been minimized by removing packages and content that are
not required on a system that users do not log into.

To restore this content, you can run the 'unminimize' command.

0 packages can be updated.
0 updates are security updates.

*** System restart required ***
Last login: Mon Sep  7 16:48:48 2020 from 115.97.61.239
[isshaanohri@pdc-lab:~$ sudo apt-get install openssh-server
Reading package lists... Done
Building dependency tree
Reading state information... Done
openssh-server is already the newest version (1:7.6p1-4ubuntu0.3).
The following packages were automatically installed and are no longer required:
  grub-pc-bin linux-gcp-5.3-headers-5.3.0-1032
Use 'sudo apt autoremove' to remove them.
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
isshaanohri@pdc-lab:~$
```

```
sudo apt-get install build-essential
```



```
isshaanohri — isshaanohri@pdc-lab: ~ — ssh isshaanohri@34.67.0.55 — 100x30
 * Support:       https://ubuntu.com/advantage
This system has been minimized by removing packages and content that are
not required on a system that users do not log into.

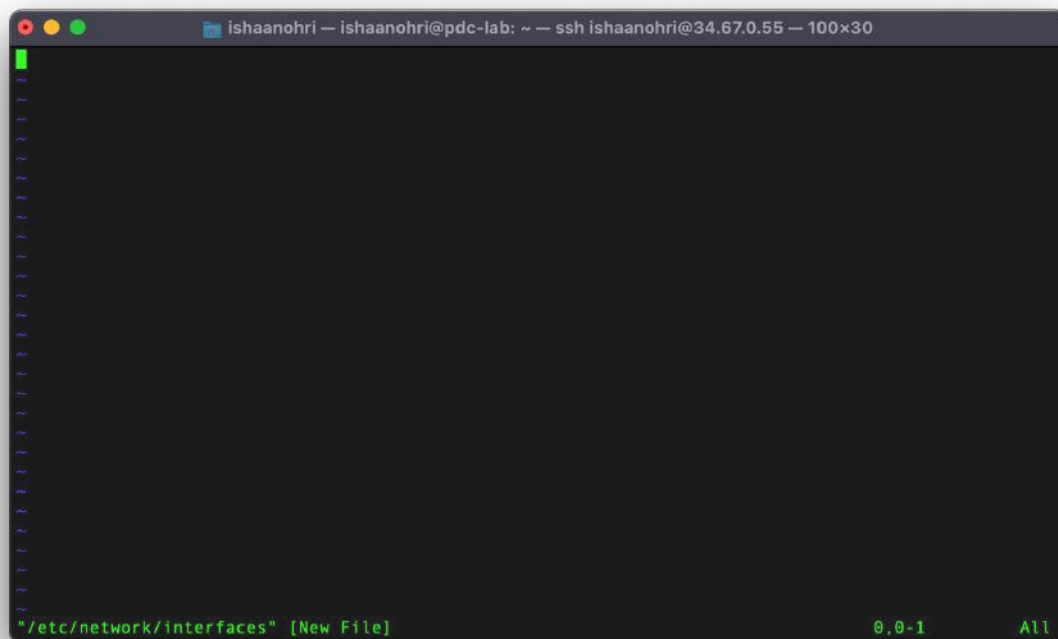
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*** System restart required ***
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[isshaanohri@pdc-lab:~$ sudo apt-get install openssh-server
Reading package lists... Done
Building dependency tree
Reading state information... Done
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The following packages were automatically installed and are no longer required:
  grub-pc-bin linux-gcp-5.3-headers-5.3.0-1032
Use 'sudo apt autoremove' to remove them.
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
[isshaanohri@pdc-lab:~$ sudo apt-get install build-essential
Reading package lists... Done
Building dependency tree
Reading state information... Done
build-essential is already the newest version (12.4ubuntu1).
The following packages were automatically installed and are no longer required:
  grub-pc-bin linux-gcp-5.3-headers-5.3.0-1032
Use 'sudo apt autoremove' to remove them.
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
isshaanohri@pdc-lab:~$
```

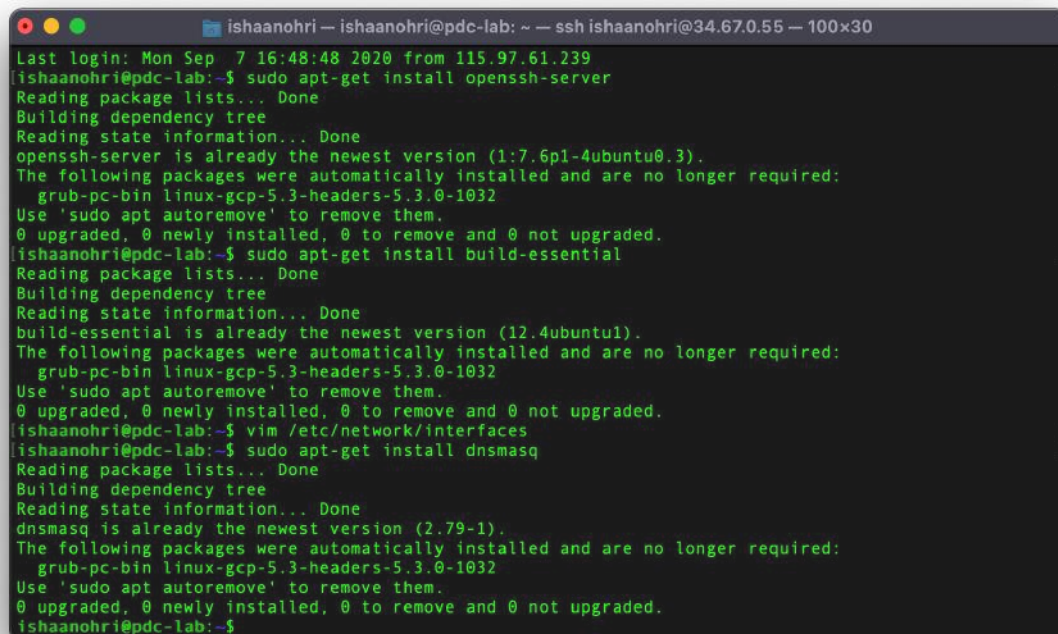
```
vim /etc/network/interfaces
```

The file is empty



A terminal window titled "ishaanohri — ishaanohri@pdc-lab: ~ — ssh ishaanohri@34.67.0.55 — 100x30". The terminal shows a vim editor interface with a dark background. The status bar at the bottom indicates the file is "/etc/network/interfaces" [New File] at line 0, column 1, with no changes (All).

```
sudo apt-get install dnsmasq
```



A terminal window titled "ishaanohri — ishaanohri@pdc-lab: ~ — ssh ishaanohri@34.67.0.55 — 100x30". The terminal shows the output of several commands:   
1. `sudo apt-get install openssh-server`: Shows that openssh-server is already the newest version (1:7.6p1-4ubuntu0.3) and lists packages to be removed.   
2. `sudo apt-get install build-essential`: Shows that build-essential is already the newest version (12.4ubuntu1) and lists packages to be removed.   
3. `vim /etc/network/interfaces`: Shows the vim editor interface.   
4. `sudo apt-get install dnsmasq`: Shows that dnsmasq is already the newest version (2.79-1) and lists packages to be removed.   
The terminal ends with the prompt `ishaanohri@pdc-lab:~$`.

```
vim /etc/dnsmasq.conf
```

```
ishaanohri — ishaanohri@pdc-lab: ~ — ssh ishaanohri@34.67.0.55 — 100x30

# If you want dnsmasq to listen for DHCP and DNS requests only on
# specified interfaces (and the loopback) give the name of the
# interface (eg eth0) here.
# Repeat the line for more than one interface.
interface=eth1
# Or you can specify which interface _not_ to listen on
#except-interface=
# Or which to listen on by address (remember to include 127.0.0.1 if
# you use this.)
listen-address=127.0.0.1
# If you want dnsmasq to provide only DNS service on an interface,
# configure it as shown above, and then use the following line to
# disable DHCP and TFTP on it.
no-dhcp-interface=eth0

# On systems which support it, dnsmasq binds the wildcard address,
# even when it is listening on only some interfaces. It then discards
# requests that it shouldn't reply to. This has the advantage of
# working even when interfaces come and go and change address. If you
# want dnsmasq to really bind only the interfaces it is listening on,
# uncomment this option. About the only time you may need this is when
# running another nameserver on the same machine.
#bind-interfaces

# If you don't want dnsmasq to read /etc/hosts, uncomment the
# following line.
#no-hosts
# or if you want it to read another file, as well as /etc/hosts, use
106,1 15%
```

```
ishaanohri — ishaanohri@pdc-lab: ~ — ssh ishaanohri@34.67.0.55 — 100x30

#domain=reserved.thekelleys.org.uk,192.68.3.100,192.168.3.200

# Uncomment this to enable the integrated DHCP server, you need
# to supply the range of addresses available for lease and optionally
# a lease time. If you have more than one network, you will need to
# repeat this for each network on which you want to supply DHCP
# service.
dhcp-range=192.168.0.50,192.168.0.150,12h

# This is an example of a DHCP range where the netmask is given. This
# is needed for networks we reach the dnsmasq DHCP server via a relay
# agent. If you don't know what a DHCP relay agent is, you probably
# don't need to worry about this.
#dhcp-range=192.168.0.50,192.168.0.150,255.255.255.0,12h

# This is an example of a DHCP range which sets a tag, so that
# some DHCP options may be set only for this network.
#dhcp-range=set:red,192.168.0.50,192.168.0.150

# Use this DHCP range only when the tag "green" is set.
#dhcp-range=tag:green,192.168.0.50,192.168.0.150,12h

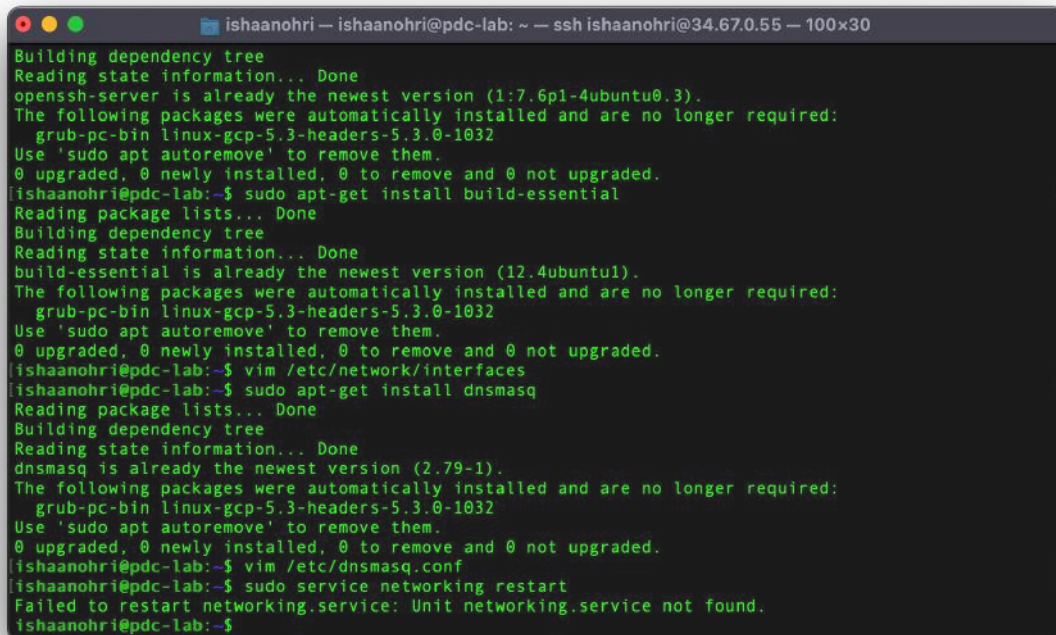
# Specify a subnet which can't be used for dynamic address allocation,
# is available for hosts with matching --dhcp-host lines. Note that
# dhcp-host declarations will be ignored unless there is a dhcp-range
# of some type for the subnet in question.
# In this case the netmask is implied (it comes from the network
# configuration on the machine running dnsmasq) it is possible to give
# an explicit netmask instead.
155,1 23%
```



```
sudo service networking restart
```

Error on last line.

**Failed to restart networking.service: Unit networking.service not found.**

A terminal window titled 'ishaanohri — ishaanohri@pdc-lab: ~ — ssh ishaanohri@34.67.0.55 — 100x30'. The terminal shows the following commands and output:

```
Building dependency tree
Reading state information... Done
openssh-server is already the newest version (1:7.6p1-4ubuntu0.3).
The following packages were automatically installed and are no longer required:
  grub-pc-bin linux-gcp-5.3-headers-5.3.0-1032
Use 'sudo apt autoremove' to remove them.
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
ishaanohri@pdc-lab:~$ sudo apt-get install build-essential
Reading package lists... Done
Building dependency tree
Reading state information... Done
build-essential is already the newest version (12.4ubuntu1).
The following packages were automatically installed and are no longer required:
  grub-pc-bin linux-gcp-5.3-headers-5.3.0-1032
Use 'sudo apt autoremove' to remove them.
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
ishaanohri@pdc-lab:~$ vim /etc/network/interfaces
ishaanohri@pdc-lab:~$ sudo apt-get install dnsmasq
Reading package lists... Done
Building dependency tree
Reading state information... Done
dnsmasq is already the newest version (2.79-1).
The following packages were automatically installed and are no longer required:
  grub-pc-bin linux-gcp-5.3-headers-5.3.0-1032
Use 'sudo apt autoremove' to remove them.
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
ishaanohri@pdc-lab:~$ vim /etc/dnsmasq.conf
ishaanohri@pdc-lab:~$ sudo service networking restart
Failed to restart networking.service: Unit networking.service not found.
ishaanohri@pdc-lab:~$
```

## Result:

After executing on the two devices, I understood that on MacOS, a user cannot interact with the network card or other such modules because of Firewall restrictions because of security restrictions.

While on the GCP machine, as it is a virtual machine, it does not have a network card or such modules and therefore such commands cannot be executed.

Network card only exists on a stand-alone machine.

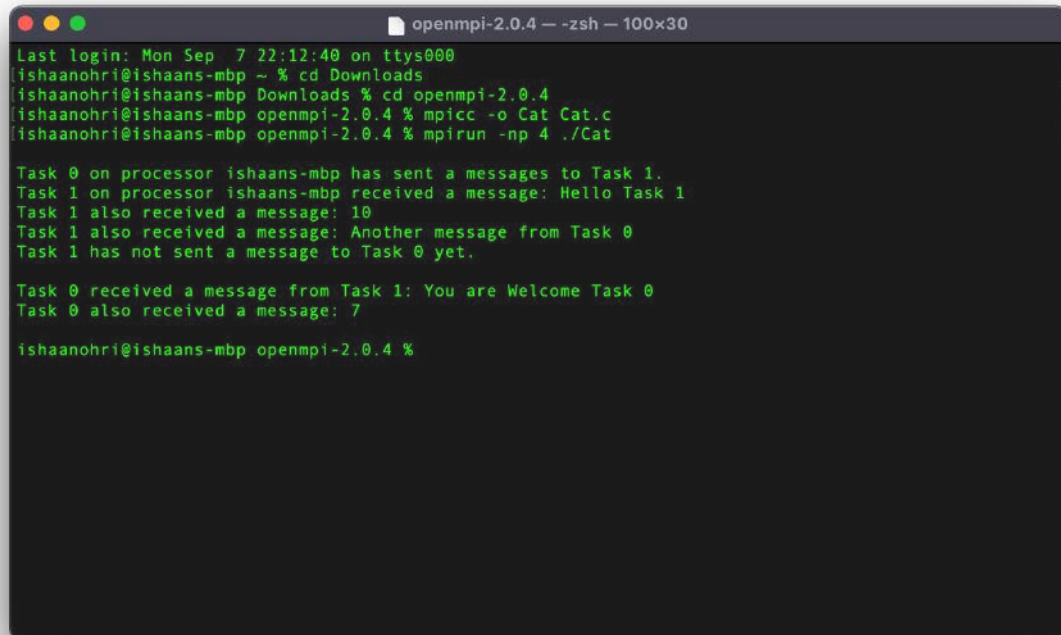
The question on VTop also mentions MPI\_Send() and MPI\_Recv() for Assignment 7, therefore I have attached the code below:

### Code:

```
openmpi-2.0.4 — vim ./Cat.c — 108x48
#include "mpi.h"
#include <stdio.h>
#include <string.h>

int main ( int argc , char *argv []) {
    int numtasks , rank , dest , source , rc , count , len ;
    char inmsg[30], inmsg1 [30], outmsg0 []= "Hello Task 1" , outmsg1 []= "You are Welcome Task 0" , outmsg
2 []= "Another message from Task 0" ;
    int nummsg1 = 10 , nummsg2 = 7 , nummsg3 ;
    int Tag_char = 27 , Tag_int = 15 ;
    char name [MPI_MAX_PROCESSOR_NAME];
    MPI_Init (&argc ,&argv );
    MPI_Comm_size ( MPI_COMM_WORLD , &numtasks );
    MPI_Comm_rank ( MPI_COMM_WORLD , &rank );
    MPI_Get_processor_name ( name , &len );
    if (rank==0) {
        dest = 1 ;
        source = 1 ;
        MPI_Send (&outmsg0 , strlen ( outmsg0 ) , MPI_CHAR , dest , Tag_char ,MPI_COMM_WORLD );
        MPI_Send (&nummsg1 , 1 , MPI_INT , dest , Tag_int , MPI_COMM_WORLD );
        MPI_Send (&outmsg2 , strlen ( outmsg2 ) , MPI_CHAR , dest , Tag_char ,MPI_COMM_WORLD );
        printf( "\nTask 0 on processor %s has sent a messages to Task 1. \n" , name );
        MPI_Recv (&nummsg3 , 1 , MPI_INT , source , Tag_int , MPI_COMM_WORLD,MPI_STATUS_IGNORE );
        memset(inmsg, 0, 30);
        MPI_Recv(&inmsg , 30 , MPI_CHAR , source , Tag_char , MPI_COMM_WORLD ,MPI_STATUS_IGNORE );
        printf( "Task 0 received a message from Task 1: %s\n" , inmsg );
        printf( "Task 0 also received a message: %i\n\n" , nummsg3 );
    } else if( rank == 1 ) {
        dest = 0 ;
        source = 0 ;
        memset(inmsg, 0, 30);
        MPI_Recv (&inmsg , 30 , MPI_CHAR , source , Tag_char , MPI_COMM_WORLD , MPI_STATUS_IGNORE );
        MPI_Recv (&nummsg3 , 1 , MPI_INT , source , Tag_int , MPI_COMM_WORLD , MPI_STATUS_IGNORE );
        printf ( "Task 1 on processor %s received a message: %s\n" , name , inmsg );
        memset(inmsg1, 0, 30);
        MPI_Recv (&inmsg1 , 30 , MPI_CHAR , source , Tag_char , MPI_COMM_WORLD , MPI_STATUS_IGNORE );
        printf ( "Task 1 also received a message: %i\n" , nummsg3 );
        printf ( "Task 1 also received a message: %s\n" , inmsg1 );
        printf ( "Task 1 has not sent a message to Task 0 yet.\n\n" );
        MPI_Send (&outmsg1 , strlen (outmsg1), MPI_CHAR , dest , Tag_char , MPI_COMM_WORLD );
        MPI_Send (&nummsg2 , 1 , MPI_INT , dest , Tag_int , MPI_COMM_WORLD );
    }
    MPI_Finalize ();
}
```

## Execution:

A terminal window titled 'openmpi-2.0.4 --zsh-- 100x30' showing the execution of an OpenMPI program. The user 'ishaanohri' is at the 'ishaans-mbp' machine. The terminal shows the user navigating to the 'Downloads' directory, compiling a program 'Cat.c' with 'mpicc', and running it with 'mpirun -np 4 ./Cat'. The output shows two tasks (Task 0 and Task 1) communicating. Task 0 sends a message to Task 1, which receives it and prints 'Hello Task 1'. Task 1 also receives a message '10' and prints 'Another message from Task 0'. Task 1 has not sent a message to Task 0 yet. Task 0 receives a message from Task 1: 'You are Welcome Task 0'. Task 0 also receives a message '7'. The prompt 'ishaanohri@ishaans-mbp openmpi-2.0.4 %' is shown at the bottom.

```
openmpi-2.0.4 --zsh-- 100x30
Last login: Mon Sep  7 22:12:40 on ttys000
ishaanohri@ishaans-mbp ~ % cd Downloads
ishaanohri@ishaans-mbp Downloads % cd openmpi-2.0.4
ishaanohri@ishaans-mbp openmpi-2.0.4 % mpicc -o Cat Cat.c
ishaanohri@ishaans-mbp openmpi-2.0.4 % mpirun -np 4 ./Cat

Task 0 on processor ishaans-mbp has sent a messages to Task 1.
Task 1 on processor ishaans-mbp received a message: Hello Task 1
Task 1 also received a message: 10
Task 1 also received a message: Another message from Task 0
Task 1 has not sent a message to Task 0 yet.

Task 0 received a message from Task 1: You are Welcome Task 0
Task 0 also received a message: 7

ishaanohri@ishaans-mbp openmpi-2.0.4 %
```