

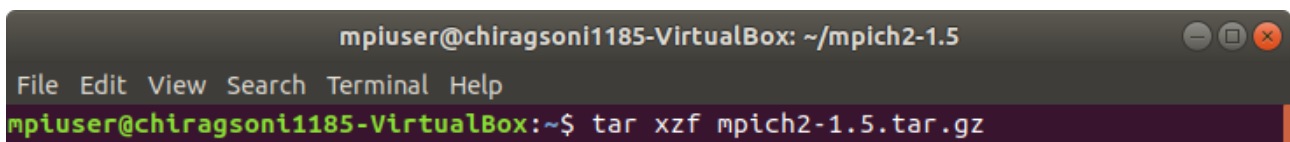
MPI CLUSTER ON A LAN (MPICH2)

PREREQUISITE:

- a) You should be able to **ping between your devices**(laptops/PC's).
- b) If working on Virtual Machines, then select **Bridged Network Adapter** under network settings.

1)INSTALLING MPICH2:

- a) Download the latest version of mpich2 from “mpich.org”.
- b) Unpack the tar file using the following command:

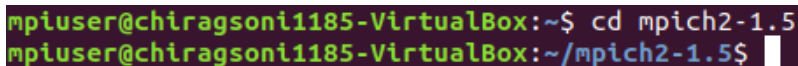


```
mpiuser@chiragsoni1185-VirtualBox: ~/mpich2-1.5
File Edit View Search Terminal Help
mpiuser@chiragsoni1185-VirtualBox:~$ tar xzf mpich2-1.5.tar.gz
```

NOTE: If your tar doesn't accept the z option, use:

```
gunzip mpich2-1.5.tar.gz
tar xf mpich2-1.5.tar
```

- c) Move to the toplevel directory after unpacking the files:
- d) Choose an installation directory, say /home/<USERNAME>/mpich2-install, which is assumed to non-existent or empty. It will be most convenient if this directory is shared by all of the machines where you

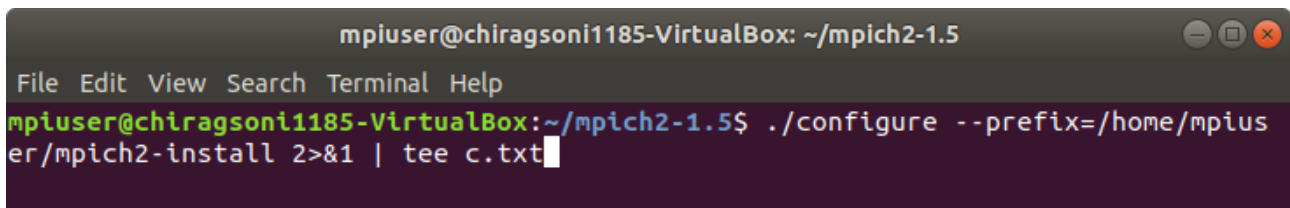


```
mpiuser@chiragsoni1185-VirtualBox:~$ cd mpich2-1.5
mpiuser@chiragsoni1185-VirtualBox:~/mpich2-1.5$
```

intend to run processes. If not, you will have to duplicate it on the other machines after installation.

- e) Configure the MPICH2 specifying the installation directory:

(**NOTE:** If “FORTRAN” is not installed in your machine then either install it or diable it in this step.)



```
mpiuser@chiragsoni1185-VirtualBox: ~/mpich2-1.5
File Edit View Search Terminal Help
mpiuser@chiragsoni1185-VirtualBox:~/mpich2-1.5$ ./configure --prefix=/home/mpiuser/mpich2-install 2>&1 | tee c.txt
```

f) Build MPICH2:

```
mpiuser@chiragsoni1185-VirtualBox: ~/mpich2-1.5
File Edit View Search Terminal Help
mpiuser@chiragsoni1185-VirtualBox:~/mpich2-1.5$ make 2>&1 | tee m.txt
```

g) Install the MPICH2 commands:

```
mpiuser@chiragsoni1185-VirtualBox: ~/mpich2-1.5
File Edit View Search Terminal Help
mpiuser@chiragsoni1185-VirtualBox:~/mpich2-1.5$ make install 2>&1 | mi.txt
```

h) Add the bin subdirectory of the installation directory to your path in your startup script:

```
mpiuser@chiragsoni1185-VirtualBox:~/mpich2-1.5$ PATH=/home/mpiuser/mpich2-install/bin:$PATH ; export PATH
mpiuser@chiragsoni1185-VirtualBox:~/mpich2-1.5$
```

IMPORTANT NOTE: The install directory has to be visible at exactly the same path on all machines you want to run your applications on. This is typically achieved by installing MPICH2 on a shared NFS file-system. If you do not have a shared NFS directory, you will need to manually copy the install directory to all machines at exactly the same location.

i) At this point we check whether everything is in order by executing the following commands:

```
mpiuser@chiragsoni1185-VirtualBox:~/mpich2-1.5$ which mpicc
/home/mpiuser/mpich2-install/bin/mpicc
mpiuser@chiragsoni1185-VirtualBox:~/mpich2-1.5$ which mpiexec
/home/mpiuser/mpich2-install/bin/mpiexec
mpiuser@chiragsoni1185-VirtualBox:~/mpich2-1.5$
```

ii) Executing the example program provided in the mpich2 package:

```
mpiuser@chiragsoni1185-VirtualBox:~/mpich2-1.5$ mpiexec -n 1 ./examples/cpi
Process 0 of 1 is on chiragsoni1185-VirtualBox
pi is approximately 3.1415926544231341, Error is 0.0000000008333410
wall clock time = 0.000235
```

2) EDIT THE “/etc/hosts” FILE:

Edit the above mentioned file so that there is no need to remember the ip-addresses of every client every time. We can assign aliases to the ip-addresses so that we can refer the client using the aliases.

```
mpiuser@chiragsoni1185-VirtualBox: ~  
File Edit View Search Terminal Help  
mpiuser@chiragsoni1185-VirtualBox:~$ vim /etc/hosts  
mpiuser@chiragsoni1185-VirtualBox:~$
```

```
mpiuser@chiragsoni1185-VirtualBox: ~  
File Edit View Search Terminal Help  
127.0.0.1      localhost  
127.0.1.1      chiragsoni1185-VirtualBox  
  
# 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  
~  
# MPI CLUSTER ADDRESSES  
192.168.43.211 M0  
192.168.43.80  M1  
~  
~  
~
```

Here M0,M1 are aliases for the master and client machines respectively.

3) ADD ANOTHER USER

We add another user , here named “mpiuser” , such that we can have a common user in all the nodes to keep things simple.

```
mpiuser@chiragsoni1185-VirtualBox: ~  
File Edit View Search Terminal Help  
mpiuser@chiragsoni1185-VirtualBox:~$ sudo adduser mpiuser
```

PS: Do not use “useradd” instead of “adduser” as it does not create a separate home for different users.

4) SETTING UP SSH:

The machines are going to talk over the ssh.

```
mpiuser@chiragsoni1185-VirtualBox: ~  
File Edit View Search Terminal Help  
mpiuser@chiragsoni1185-VirtualBox:~$ sudo apt-get install openssh-server
```

5) SWITCH TO THE NEWLY CREATED USER

```
mpiuser@chiragsoni1185-VirtualBox: ~  
File Edit View Search Terminal Help  
chiragsoni1185@chiragsoni1185-VirtualBox:~$ su - mpiuser  
Password:  
mpiuser@chiragsoni1185-VirtualBox:~$
```

Since the ssh server is already installed, you must be able to login to other machines by ssh username@hostname, at which you will be prompted to enter the password of the username. To enable more easier login, we generate keys and copy them to other machines' list of authorized_keys.

6) PASSWORDLESS LOGIN:

a) Generate a pair of authentication rsa keys using the ssh:

```
mpiuser@chiragsoni1185-VirtualBox: ~  
File Edit View Search Terminal Help  
mpiuser@chiragsoni1185-VirtualBox:~$ ssh-keygen -t rsa
```

b) Use ssh to create a directory ~/.ssh as user on any Client(here M0) .
(**Note:** The directory may already exist, which is fine):

```
mpiuser@chiragsoni1185-VirtualBox: ~  
File Edit View Search Terminal Help  
mpiuser@chiragsoni1185-VirtualBox:~$ ssh M0 mkdir -p .ssh
```

c) Append Master's new public key to user@Client:~/.ssh/authorized_keys and enter users's password one last time:

```
mpiuser@chiragsoni1185-VirtualBox: ~  
File Edit View Search Terminal Help  
mpiuser@chiragsoni1185-VirtualBox:~$ cat .ssh/id_rsa.pub | ssh M0 'cat >> .ssh/authorized_keys'
```

d) The next login to the client will be passwordless.

```
mpiuser@chiragsoni1185-VirtualBox: ~  
File Edit View Search Terminal Help  
mpiuser@chiragsoni1185-VirtualBox:~$ ssh M0
```

7) INSTALLING NFS-SERVER:

You share a directory via NFS in **master** which the **client** mounts to exchange data.

a) Install the required packages:

```
mpiuser@chiragsoni1185-VirtualBox: ~  
File Edit View Search Terminal Help  
mpiuser@chiragsoni1185-VirtualBox:~$ sudo apt-get install nfs-kernel-server
```

b) Create a common folder(here cloud) which we will share across the network.

```
mpiuser@chiragsoni1185-VirtualBox: ~  
File Edit View Search Terminal Help  
mpiuser@chiragsoni1185-VirtualBox:~$ mkdir cloud
```

c) To export the cloud directory, we will have to create an entry in the /etc/exports file.

```
mpiuser@chiragsoni1185-VirtualBox: ~  
File Edit View Search Terminal Help  
mpiuser@chiragsoni1185-VirtualBox:~$ vim /etc/exports
```

[illegible]

PS: Here instead of * in the entry in the file you can add specific ip addresses

d) After making the entry in the `/etc/exports` file, we need to export the file system using **exportfs -a**

```
mpiuser@chiragsoni1185-VirtualBox: ~  
File Edit View Search Terminal Help  
mpiuser@chiragsoni1185-VirtualBox:~$ sudo exportfs -a
```

e) After exporting the file system , restart the nfs server.

```
mpluser@chiragsoni1185-VirtualBox: ~  
File Edit View Search Terminal Help  
mpluser@chiragsoni1185-VirtualBox:~$ sudo service nfs-kernel-server restart
```

8) NFS-CLIENT:

a) Install the required packages:

```
mpiuser@mohit-VirtualBox: ~  
File Edit View Search Terminal Help  
mpiuser@mohit-VirtualBox:~$ sudo apt-get install nfs-common
```

b) Now, we need to create a directory with the same name as the directory created in the previous step in the client's machine. Therefore we first login to the client's system.

```
mpiuser@mohit-VirtualBox: ~  
File Edit View Search Terminal Help  
mpiuser@mohit-VirtualBox:~$ ssh M1
```

c) Create the directory:

```
mpiuser@chiragsoni1185-VirtualBox: ~  
File Edit View Search Terminal Help  
mpiuser@chiragsoni1185-VirtualBox:~$ mkdir cloud
```

d) Mounting the shared directory:

```
mpiuser@chiragsoni1185-VirtualBox: ~  
File Edit View Search Terminal Help  
mpiuser@chiragsoni1185-VirtualBox:~$ sudo mount -t nfs M0:/home/mpiuser/cloud -/  
cloud
```

e) Checking the mounted directories:

```
mpiuser@chiragsoni1185-VirtualBox: ~  
File Edit View Search Terminal Help  
mpiuser@chiragsoni1185-VirtualBox:~$ df -h
```

/dev/loop16	141M	141M	0	100%	/snap/gnome-3-26-1604/92
/dev/loop17	15M	15M	0	100%	/snap/gnome-characters/296
/dev/loop14	150M	150M	0	100%	/snap/gnome-3-28-1804/71
M0:/home/mpiuser/cloud	20G	8.4G	11G	45%	/home/mpiuser/cloud
tmpfs	455M	28K	455M	1%	/run/user/1000
tmpfs	455M	40K	455M	1%	/run/user/1002

f) To make the mount permanent so you don't have to manually mount the shared directory everytime you do a system reboot, you can create an entry in your file systems table - i.e., /etc/fstab file like this:

```
mpiuser@chiragsoni1185-VirtualBox: ~  
File Edit View Search Terminal Help  
mpiuser@chiragsoni1185-VirtualBox:~$ cat /etc/fstab  
# /etc/fstab: static file system information.  
#  
# Use 'blkid' to print the universally unique identifier for a  
# device; this may be used with UUID= as a more robust way to name devices  
# that works even if disks are added and removed. See fstab(5).  
#  
# <file system> <mount point> <type> <options> <dump> <pass>  
# / was on /dev/sda1 during installation  
#MPI CLUSTER SETUP  
M0:/home/mpiuser/cloud /home/mpiuser/cloud nfs  
UUID=22185d6f-ef73-4f9a-ac4f-c17fd0970de1 / ext4 errors=remount  
-ro 0 1  
/swapfile none swap sw  
0 0  
mpiuser@chiragsoni1185-VirtualBox:~$
```

9) RUNNING THE MPI PROGRAMS:

We will just run the sample program provided in the MPICH2 installation for now.

a) Running it on your own machine:

```
mpiuser@chiragsoni1185-VirtualBox: ~  
File Edit View Search Terminal Help  
mpiuser@chiragsoni1185-VirtualBox:~$ mpirun -np 1 mpich2-1.5/examples/cpi  
Process 0 of 1 is on chiragsoni1185-VirtualBox  
pi is approximately 3.1415926544231341, Error is 0.0000000008333410  
wall clock time = 0.000235  
mpiuser@chiragsoni1185-VirtualBox:~$
```

b) Running it on the master's machine:

```
mpiuser@chiragsoni1185-VirtualBox: ~  
File Edit View Search Terminal Help  
mpiuser@chiragsoni1185-VirtualBox:~$ mpirun -np 1 -host M0 mpich2-1.5/examples/c  
pi  
Process 0 of 1 is on mohit-VirtualBox  
pi is approximately 3.1415926544231341, Error is 0.0000000008333410  
wall clock time = 0.000237  
mpiuser@chiragsoni1185-VirtualBox:~$
```

References:

<https://mpitutorial.com/tutorials/running-an-mpi-cluster-within-a-lan/>

<https://www.mpich.org/>

<https://www.linode.com/docs/security/authentication/use-public-key-authentication-with-ssh/>