

# High Performance Computing System Administrator



**CENTRE FOR DEVELOPMENT OF ADVANCED COMPUTING PUNE**

## **CASE STUDY**

**Submitted By:**

**Batch September 2022-23**

## AIM

Build a two node Disk-less HPC-Cluster using OpenHPC with warewulf, slurm, Nagios and do a HPL benchmark and document the result.

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## TABLE OF CONTENT

<b>Requirements .....</b>	<b>04</b>
<b>Hardware requirements.....</b>	
<b>Software requirements.....</b>	
<b>Installation .....</b>	<b>05</b>
<b>Pre-Configuration .....</b>	<b>06</b>
<b>OpenHPC with Warewulf.....</b>	<b>08</b>
<b>Slurm .....</b>	<b>12</b>
<b>Nagios .....</b>	<b>15</b>
<b>Ganglia .....</b>	<b>21</b>
<b>HPL Benchmarking .....</b>	<b>23</b>
<b>Commands History.....</b>	<b>29</b>

## REQUIREMENTS

### **Hardware requirements:**

- RAM : 32 GB
- PROCESSOR : i7 10 gen
- HDD : 200GB

### **Software requirements:**

- Vmware workstation
- Centos 7 iso

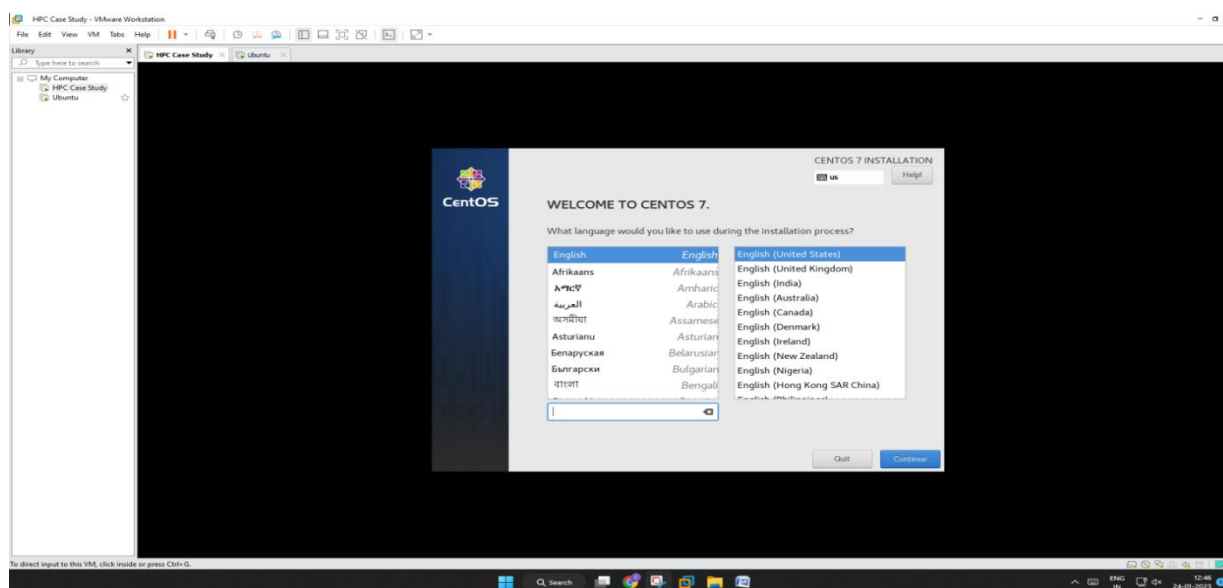
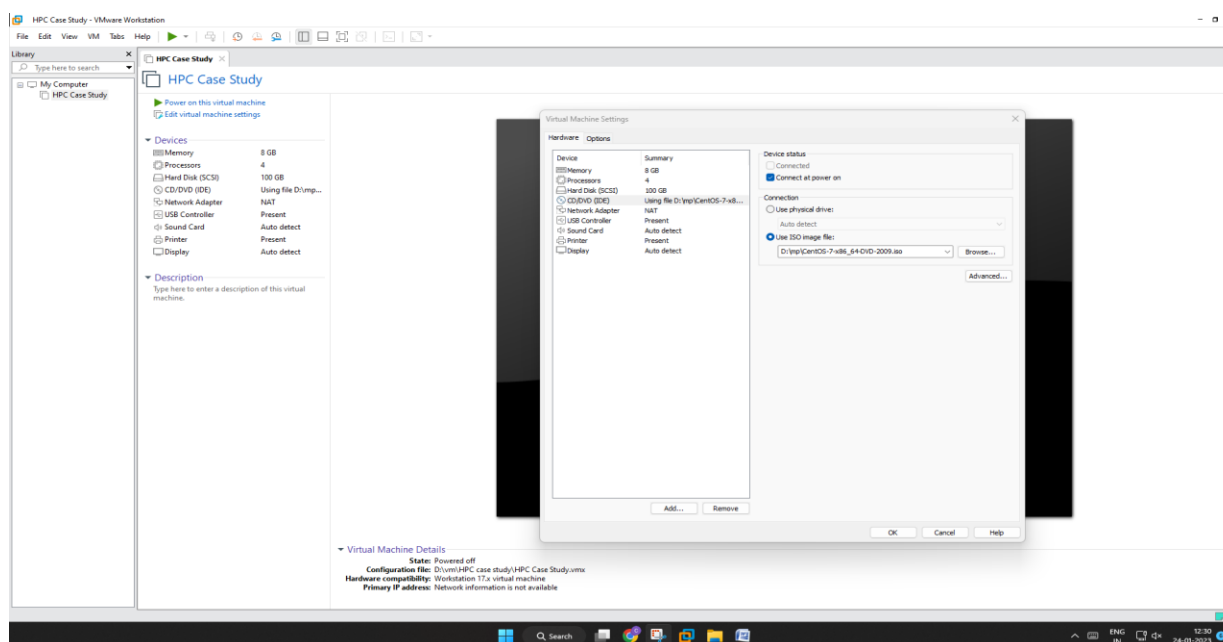
\*Internet connectivity

# INSTALLATION

The head node is configured as the primary node in the cluster and is setup to manage and install all compute nodes.

## Install the Base Operating System

Create new virtual machine and Boot from CentOS\*installmedia(DVD).



## Post-Install Configuration

After done to create virtual machine of Centos 7 with master configuration few must configuration are required

- 1) Setting hostname : master
- 2) Firewalld must be disabled
- 3) Selinux disable
- 4) Network configuration must be done

```
# hostnamectl set-hostname master
```

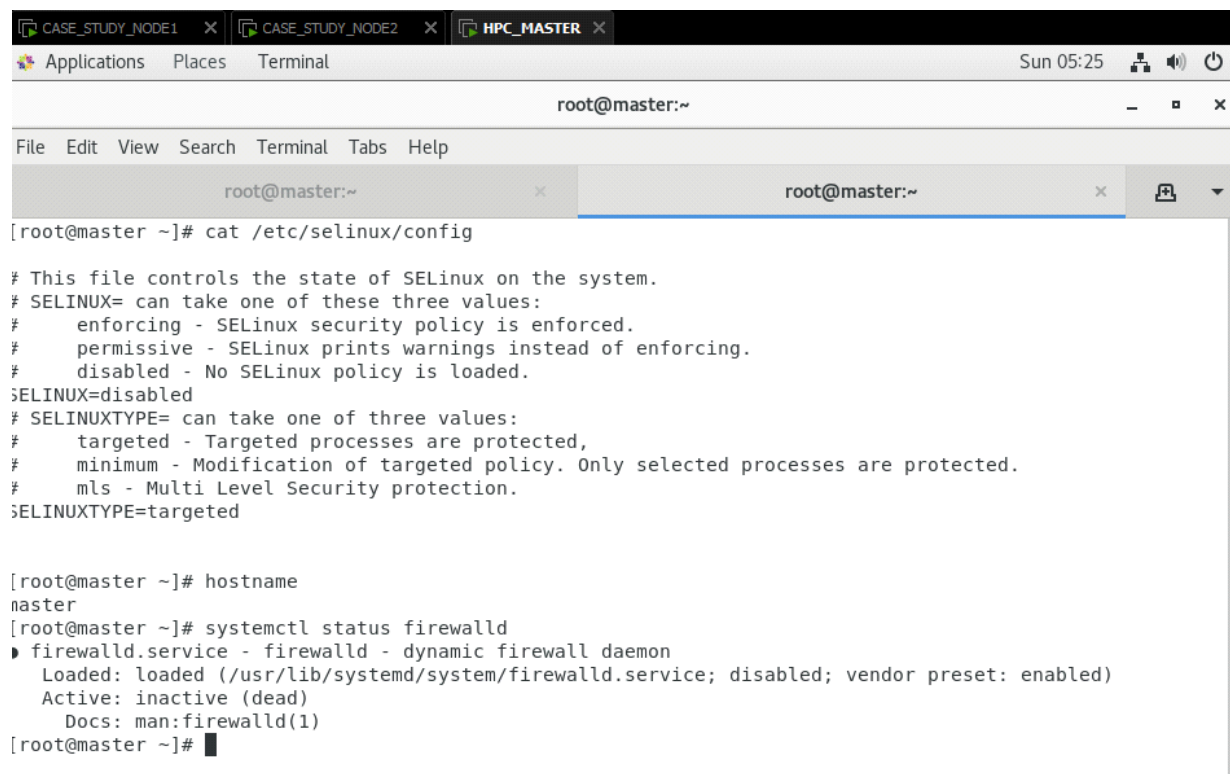
```
[root@master ~]#
```

```
# systemctl stop firewalld
```

```
#systemctl disable firewalld
```

```
# vi /etc/selinux/conf
```

□ Change enforcing to disabled



```

CASE_STUDY_NODE1 x CASE_STUDY_NODE2 x HPC_MASTER x
Applications Places Terminal Sun 05:25
root@master:~

File Edit View Search Terminal Tabs Help
root@master:~ root@master:~

[root@master ~]# cat /etc/selinux/config

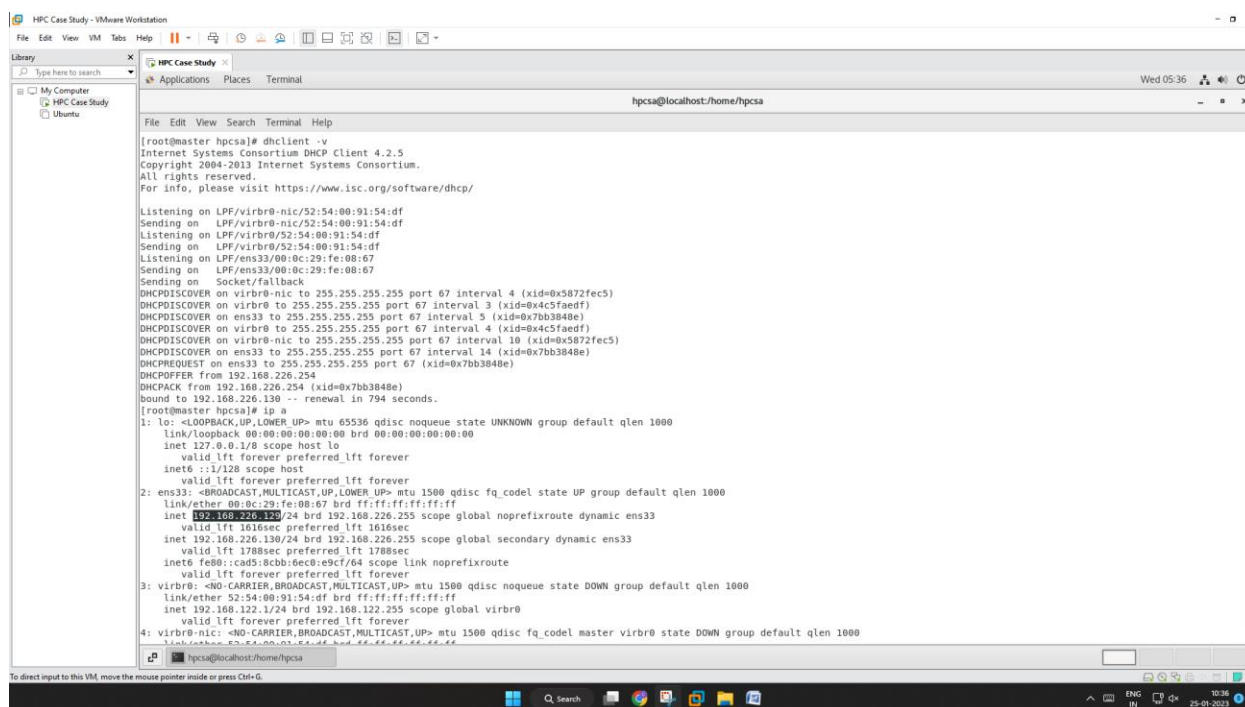
# This file controls the state of SELinux on the system.
# SELINUX= can take one of these three values:
#   enforcing - SELinux security policy is enforced.
#   permissive - SELinux prints warnings instead of enforcing.
#   disabled - No SELinux policy is loaded.
SELINUX=disabled
# SELINUXTYPE= can take one of three values:
#   targeted - Targeted processes are protected,
#   minimum - Modification of targeted policy. Only selected processes are protected.
#   mls - Multi Level Security protection.
SELINUXTYPE=targeted

[root@master ~]# hostname
master
[root@master ~]# systemctl status firewalld
● firewalld.service - firewalld - dynamic firewall daemon
   Loaded: loaded (/usr/lib/systemd/system/firewalld.service; disabled; vendor preset: enabled)
   Active: inactive (dead)
     Docs: man:firewalld(1)
[root@master ~]#

```

```
# dhclient -v
```

```
# ip a
```



```

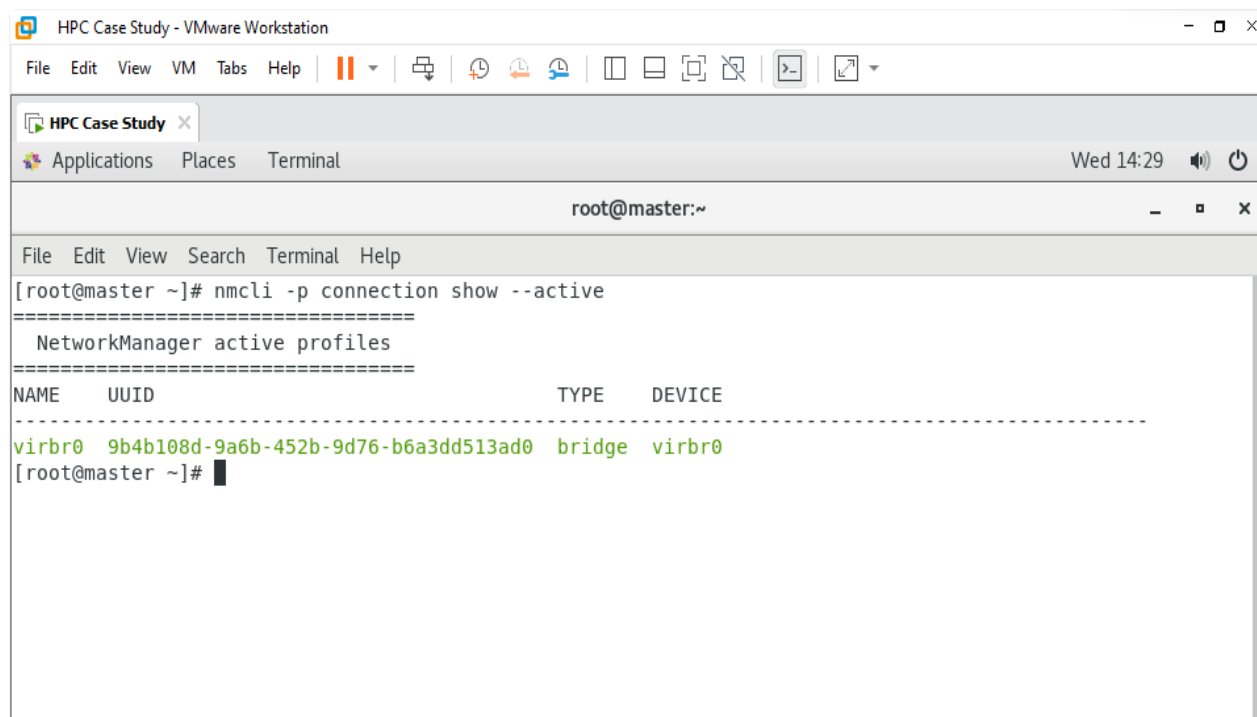
HPC Case Study - VMware Workstation
File Edit View VM Tabs Help
Library
HPC Case Study
Applications Places Terminal
hpcs@localhost/home/hpcs

[root@master hpcs]# dhclient -v
Internet Systems Consortium DHCP Client 4.2.5
Copyright 2004-2013 Internet Systems Consortium.
All rights reserved.
For info, please visit https://www.isc.org/software/dhcp/

Listening on LPP/virbr0-nic/52:54:00:91:54:df
Sending on   LPP/virbr0-nic/52:54:00:91:54:df
Listening on LPP/virbr0/52:54:00:91:54:df
Sending on   LPP/virbr0/52:54:00:91:54:df
Listening on LPP/ens33/00:0c:29:fe:08:67
Sending on   LPP/ens33/00:0c:29:fe:08:67
Sending on   Socket/fallback
DHCPDISCOVER on virbr0-nic to 255.255.255.255 port 67 interval 4 (xid=0x5872fec5)
DHCPDISCOVER on virbr0 to 255.255.255.255 port 67 interval 3 (xid=0x4c5faedf)
DHCPDISCOVER on ens33 to 255.255.255.255 port 67 interval 5 (xid=0x7bb3848e)
DHCPDISCOVER on virbr0 to 255.255.255.255 port 67 interval 4 (xid=0x4c5faedf)
DHCPDISCOVER on virbr0-nic to 255.255.255.255 port 67 interval 10 (xid=0x5872fec5)
DHCPDISCOVER on ens33 to 255.255.255.255 port 67 interval 14 (xid=0x7bb3848e)
DHCPREQUEST on ens33 to 255.255.255.255 port 67 (xid=0x7bb3848e)
DHCPOFFER from 192.168.226.254
DHCPACK from 192.168.226.254 (xid=0x7bb3848e)
bound to 192.168.226.130 -- renewal in 794 seconds.
[root@master hpcs]# 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: ens33: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 00:0c:29:fe:08:67 brd ff:ff:ff:ff:ff:ff
    inet 192.168.226.130/24 brd 192.168.226.255 scope global noprefixroute dynamic ens33
        valid lft 1616sec preferred lft 1616sec
    inet 192.168.226.130/24 brd 192.168.226.255 scope global secondary dynamic ens33
        valid lft 1788sec preferred lft 1788sec
    inet6 fe80::cad5:8cb:6ec8:e9cf/64 scope link noprefixroute
        valid lft forever preferred lft forever
3: virbr0: <NO-CARRIER,BROADCAST,MULTICAST,UP> mtu 1500 qdisc noqueue state DOWN group default qlen 1000
    link/ether 52:54:00:91:54:df brd ff:ff:ff:ff:ff:ff
    inet 192.168.122.1/24 brd 192.168.122.255 scope global virbr0
        valid lft forever preferred lft forever
4: virbr0-nic: <NO-CARRIER,BROADCAST,MULTICAST,UP> mtu 1500 qdisc fq_codel master virbr0 state DOWN group default qlen 1000
    link/ether 52:54:00:91:54:df brd ff:ff:ff:ff:ff:ff

```

```
# nmcli -p connection show --active
```



```

HPC Case Study - VMware Workstation
File Edit View VM Tabs Help
HPC Case Study
Applications Places Terminal
root@master:~

File Edit View Search Terminal Help
[root@master ~]# nmcli -p connection show --active
=====
NetworkManager active profiles
=====
NAME          UUID                                  TYPE      DEVICE
-----
virbr0        9b4b108d-9a6b-452b-9d76-b6a3dd513ad0  bridge   virbr0
[root@master ~]#

```

# openHPC with Warewulf

**OpenHPC** is a set of community-driven FOSS tools for Linux based HPC. OpenHPC does not have specific hardware requirements.

Warewulf is a **bare metal, stateless, cluster provisioning solution** to facilitate the **operating system deployment and management of large quantities of clustered hardware resources**. Extensible. Easy to change the default functionality, node images, and customize for any clustering use-case.

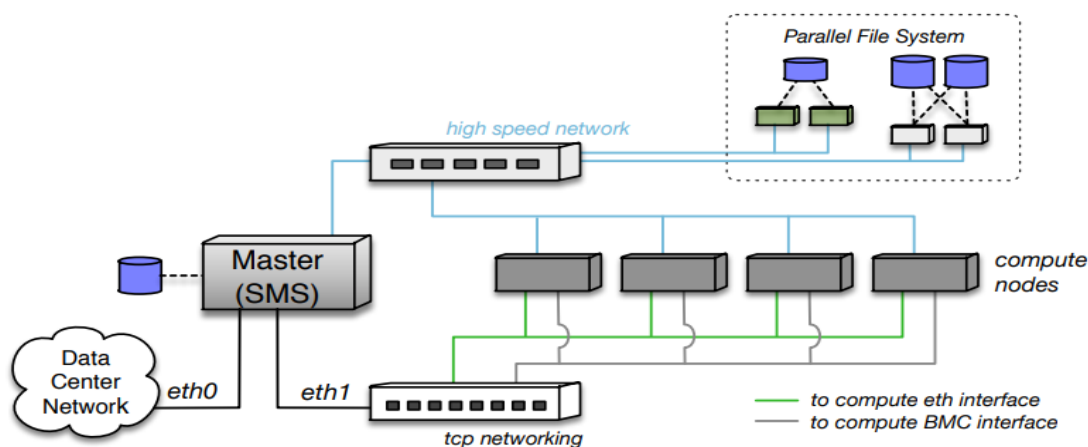


Figure 1: Overview of physical cluster architecture.

## #Yum install

[http://build.openhpc.community/OpenHPC:/1.3/CentOS\\_7/aarch64/ohpc-release-1.3-1.el7.aarch64.rpm](http://build.openhpc.community/OpenHPC:/1.3/CentOS_7/aarch64/ohpc-release-1.3-1.el7.aarch64.rpm)

```
# yum -y install ohpc-base
```



```
ww_slurm_master x
Applications Places Terminal
Mon 11:05
root@master:~

File Edit View Search Terminal Help
[root@master ~]# yum install http://build.openhpc.community/OpenHPC::1.3/CentOS_7/x86_64/ohpc-release-1.3-1.el7.x86_64.rpm
Loaded plugins: fastestmirror, langpacks
ohpc-release-1.3-1.el7.x86_64.rpm | 4.4 kB 00:00:00
Examining /var/tmp/yum-root-0wrHtq/ohpc-release-1.3-1.el7.x86_64.rpm: ohpc-release-1.3-1.el7.x86_64
Marking /var/tmp/yum-root-0wrHtq/ohpc-release-1.3-1.el7.x86_64.rpm to be installed
Resolving Dependencies
--> Running transaction check
--> Package ohpc-release.x86_64 0:1.3-1.el7 will be installed
--> Processing Dependency: epel-release for package: ohpc-release-1.3-1.el7.x86_64
Loading mirror speeds from cached hostfile
* base: repo.extreme-ix.org
* extras: repo.extreme-ix.org
* updates: repo.extreme-ix.org
--> Running transaction check
--> Package epel-release.noarch 0:7-11 will be installed
--> Finished Dependency Resolution

Dependencies Resolved

=====
Package Arch Version Repository Size
=====
Installing:
ohpc-release x86_64 1.3-1.el7 /ohpc-release-1.3-1.el7.x86_64 1.4 k
Installing for dependencies:
epel-release noarch 7-11 extras 15 k
=====
Transaction Summary
=====
Install 1 Package (+1 Dependent package)

Total size: 16 k
Total download size: 15 k
Installed size: 26 k
Is this ok [y/d/N]: y
Downloading packages:
epel-release-7-11.noarch.rpm | 15 kB 00:00:00
Running transaction check
Running transaction test
Transaction test succeeded
Running transaction
Installing : epel-release-7-11.noarch 1/2
Installing : ohpc-release-1.3-1.el7.x86_64 2/2
Verifying : ohpc-release-1.3-1.el7.x86_64 1/2
root@master:~
```

```

root@master:~
File Edit View Search Terminal Tabs Help

root@master:~
root@master:~

--> Package slurm-slurmctld-ohpc.x86_64 0:18.08.8-4.1.ohpc.1.3.8.1 will be installed
--> Package slurm-slurmd-ohpc.x86_64 0:18.08.8-4.1.ohpc.1.3.8.1 will be installed
--> Running transaction check
--> Package pmix-ohpc.x86_64 0:2.2.2-9.1.ohpc.1.3.7 will be installed
--> Finished Dependency Resolution

Dependencies Resolved

=====
Package                               Arch             Version                               Repository          Size
=====
Installing:
ohpc-slurm-server                     x86_64            1.3.8-3.1.ohpc.1.3.8                 OpenHPC-updates     2.4 k
Installing for dependencies:
munge-devel-ohpc                     x86_64            0.5.13-7.1.ohpc.1.3.7                 OpenHPC-updates     34 k
munge-libs-ohpc                      x86_64            0.5.13-7.1.ohpc.1.3.7                 OpenHPC-updates     50 k
munge-ohpc                           x86_64            0.5.13-7.1.ohpc.1.3.7                 OpenHPC-updates    115 k
pdsh-mod-slurm-ohpc                  x86_64            2.33-97.1.ohpc.1.3.7                 OpenHPC-updates     15 k
pmix-ohpc                            x86_64            2.2.2-9.1.ohpc.1.3.7                 OpenHPC-updates     4.2 M
slurm-devel-ohpc                     x86_64            18.08.8-4.1.ohpc.1.3.8.1             OpenHPC-updates     77 k
slurm-example-configs-ohpc           x86_64            18.08.8-4.1.ohpc.1.3.8.1             OpenHPC-updates    193 k
slurm-ohpc                           x86_64            18.08.8-4.1.ohpc.1.3.8.1             OpenHPC-updates    13 M
slurm-perlapl-ohpc                   x86_64            18.08.8-4.1.ohpc.1.3.8.1             OpenHPC-updates    778 k
slurm-slurmctld-ohpc                 x86_64            18.08.8-4.1.ohpc.1.3.8.1             OpenHPC-updates     1.1 M
slurm-slurmd-ohpc                    x86_64            18.08.8-4.1.ohpc.1.3.8.1             OpenHPC-updates     650 k
=====

Transaction Summary
-----
Install 1 Package (+11 Dependent packages)

Total download size: 20 M
Installed size: 82 M
Downloading packages:
(1/12): munge-devel-ohpc-0.5.13-7.1.ohpc.1.3.7.x86_64.rpm | 34 kB 00:00:00
(2/12): munge-libs-ohpc-0.5.13-7.1.ohpc.1.3.7.x86_64.rpm | 50 kB 00:00:01
(3/12): ohpc-slurm-server-1.3.8-3.1.ohpc.1.3.8.x86_64.rpm | 2.4 kB 00:00:00
(4/12): pdsh-mod-slurm-ohpc-2.33-97.1.ohpc.1.3.7.x86_64.rpm | 15 kB 00:00:00
(5/12): munge-ohpc-0.5.13-7.1.ohpc.1.3.7.x86_64.rpm | 115 kB 00:00:01
(6/12): slurm-devel-ohpc-18.08.8-4.1.ohpc.1.3.8.1.x86_64.rpm | 77 kB 00:00:01
(7/12): slurm-example-configs-ohpc-18.08.8-4.1.ohpc.1.3.8.1.x86_64.rpm | 193 kB 00:00:02
(8/12): slurm-ohpc-18.08.8-4.1.ohpc.1.3.8.1.x86_64.rpm | 1.1 MB 00:00:02
[9/12]: slurm-ohpc-18.08.8-4.1.ohpc.1.3.8.1.x86_64.rpm 24% [=====] | 510 kB/s | 4.9 MB 00:00:30 ETA
root@master:~

```

# wwininit database

# wwininit ssh\_keys

```

root@master:~
File Edit View Search Terminal Tabs Help

root@master:~
root@master:~

[root@master ~]# wwininit database
database: Checking to see if RPM 'mysql-server' is installed NO
database: Checking to see if RPM 'mariadb-server' is installed OK
database: Activating Systemd unit: mariadb OK
database: + /bin/systemctl -q enable mariadb.service OK
database: + /bin/systemctl -q restart mariadb.service OK
database: Database version: 1
database: + mysql --defaults-extra-file=/tmp/0.1HBEuSARUbyA/my.cnf ware OK
database: + mysql --defaults-extra-file=/tmp/0.1HBEuSARUbyA/my.cnf ware OK
database: Checking Binstore kind SUCCESS
Done.
[root@master ~]# wwininit ssh_keys
ssh_keys: Checking ssh keys for root OK
ssh_keys: Checking root's ssh config OK
ssh_keys: Checking for default RSA host key for nodes NO
ssh_keys: Creating default node ssh host rsa key: NO
ssh_keys: + ssh-keygen -q -t rsa -f /etc/warewulf/vnfs/ssh/ssh_host_rsa OK
ssh_keys: Checking for default DSA host key for nodes NO
ssh_keys: Creating default node ssh host dsa key: NO
ssh_keys: + ssh-keygen -q -t dsa -f /etc/warewulf/vnfs/ssh/ssh_host_dsa OK
ssh_keys: Checking for default ECDSA host key for nodes NO
ssh_keys: Creating default node ssh host ecdsa key: NO
ssh_keys: + ssh-keygen -q -t ecdsa -f /etc/warewulf/vnfs/ssh/ssh_host_ecdsa OK
ssh_keys: Checking for default Ed25519 host key for nodes NO
ssh_keys: Creating default node ssh host ed25519 key: NO
Done.
[root@master ~]#

```

```
# df -hT | grep -v tmpfs
```

```
# echo "master:/home /home nfs nfsvers=3,nodev,nosuid 0 0" >>
$CHROOT/etc/fstab
```

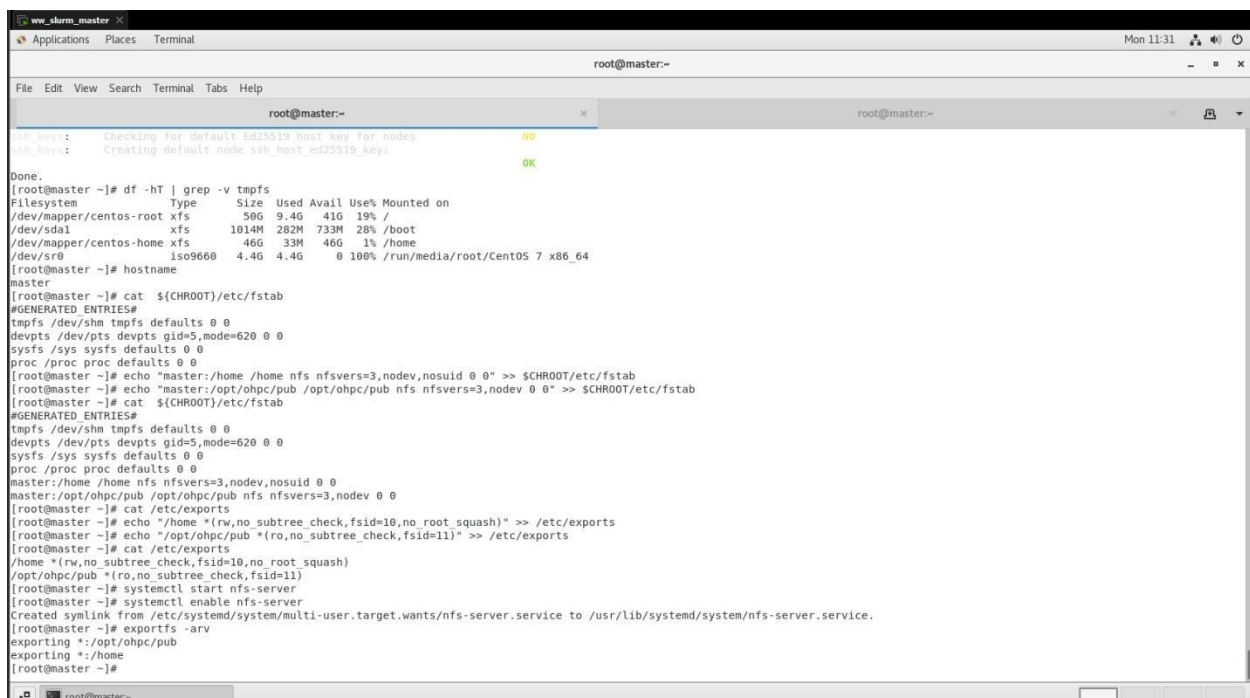
```
# echo "master:/opt/ohpc/pub /opt/ohpc/pub nfs nfsvers=3,nodev 0 0" >>
$CHROOT/etc/fstab
```

```
# cat ${CHROOT}/etc/fstab
```

```
# cat /etc/exports
```

```
# echo "/home *(rw,no_subtree_check,fsid=10,no_root_squash)" >> /etc/exports
```

```
# echo "/opt/ohpc/pub *(ro,no_subtree_check,fsid=11)" >> /etc/exports
```



```

root@master:~# df -hT | grep -v tmpfs
Filesystem      Type      Size      Used      Avail     Use%      Mounted on
/dev/mapper/centos-root xfs        50G       9.4G       41G       19%      /
/dev/sda1        xfs       1014M     282M      733M       28%      /boot
/dev/mapper/centos-home xfs         46G       33M       46G        1%      /home
/dev/sr0         iso9660    4.4G      4.4G        0 100% /run/media/root/CentOS 7 x86_64

root@master:~# hostname
master

root@master:~# cat ${CHROOT}/etc/fstab
#GENERATED ENTRIES#
tmpfs /dev/shm tmpfs defaults 0 0
devpts /dev/pts devpts gid=5,mode=620 0 0
sysfs /sys sysfs defaults 0 0
proc /proc proc defaults 0 0
root@master:~# cat ${CHROOT}/etc/fstab
#GENERATED ENTRIES#
tmpfs /dev/shm tmpfs defaults 0 0
devpts /dev/pts devpts gid=5,mode=620 0 0
sysfs /sys sysfs defaults 0 0
proc /proc proc defaults 0 0
master:/home /home nfs nfsvers=3,nodev,nosuid 0 0
master:/opt/ohpc/pub /opt/ohpc/pub nfs nfsvers=3,nodev 0 0
root@master:~# cat /etc/exports
#GENERATED ENTRIES#
tmpfs /dev/shm tmpfs defaults 0 0
devpts /dev/pts devpts gid=5,mode=620 0 0
sysfs /sys sysfs defaults 0 0
proc /proc proc defaults 0 0
master:/home /home nfs nfsvers=3,nodev,nosuid 0 0
master:/opt/ohpc/pub /opt/ohpc/pub nfs nfsvers=3,nodev 0 0
root@master:~# cat /etc/exports
/home *(rw,no_subtree_check,fsid=10,no_root_squash)
/opt/ohpc/pub *(ro,no_subtree_check,fsid=11)
root@master:~# systemctl start nfs-server
Created symlink from /etc/systemd/system/multi-user.target.wants/nfs-server.service to /usr/lib/systemd/system/nfs-server.service.
root@master:~# systemctl enable nfs-server
Created symlink from /etc/systemd/system/multi-user.target.wants/nfs-server.service to /usr/lib/systemd/system/nfs-server.service.
root@master:~#
```

```
# systemctl start nfs-server
```

```
# systemctl enable nfs-server
```

## Booting Disk-less Node

```

Network boot from Intel E1000
Copyright (C) 2003-2021  VMware, Inc.
Copyright (C) 1997-2000  Intel Corporation

CLIENT MAC ADDR: 00:0C:29:EC:16:C2  GUID: 5640081C-C8BD-BADD-EBF9-7AD4F8EC16C2
CLIENT IP: 192.168.23.150  MASK: 255.255.255.0  DHCP IP: 192.168.23.132
GATEWAY IP: 192.168.23.132
PXE->EB: IPXE at 9000:0070, entry point at 9000:0106
UNDI code segment 9000:00CE, data segment 9045:5960 (609-635kB)
UNDI device is PCI 02:01:0, type D1X+002.3
609kB free base memory after PXE unload
IPXE initializing devices...ok

IPXE 1.0.0* -- Open Source Network Boot Firmware -- http://ipxe.org
Features: DNS HTTP iSCSI TFTP AoE ELF MDDUT PXE bzImage Menu PXEXT

net0: 00:0c:29:ec:16:c2 using undionly on 0000:02:01:0 (open)
(Link-up, TX:0 TXE:1 RX:0 RXE:0)
[IPXE: 1 x "Network unreachable (http://ipxe.org/20006011)"]
Configuring (net0 00:0c:29:ec:16:c2)....

```

```

Now Booting Warewulf...

Setting the hostname (node1): OK
Loading drivers: uhci-hcd ehci-hcd ehci-hcd uhci-hcd ispl16x-hcd ispl362-hcd xhc OK
i-hcd e1000-hcd ed-rom ehci-rom OK
Detecting hardware: ata_piix ata_piix mptspi e1000 OK
Bringing up local loopback network: OK
Checking for network devices: eth0 (ens36) OK
Configuring eth0 (ens36) statically: 192.168.23.150/255.255.255.0 OK
Configuring gateway: (192.168.23.132) OK
Creating network initialization files: (ens36) OK
Trying to reach the master node at 192.168.23.132 OK
Probing for HLU Address: (00:0c:29:ec:16:c2) OK
Starting syslogd: OK
Getting base node configuration: OK
Starting the provision handler:
  * adhoc-pre OK
  * ipmiconfig Auto configuration not activated SKIPPED
  * filesystems RUNNING
  * mounting / OK
  * filesystems OK
  * getvnfs RUNNING
    * fetching centos7.7 (ID:5)_

```

## # ip a (Booted node)

```
CentOS Linux 7 (Core)
Kernel 3.10.0-1160.81.1.el7.x86_64 on an x86_64

node1 login: root
Password:
[root@node1 ~]# 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: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 00:0c:29:ec:16:c2 brd ff:ff:ff:ff:ff:ff
    inet 192.168.23.150/24 brd 192.168.23.255 scope global eth0
        valid_lft forever preferred_lft forever
    inet6 fe80::20c:29ff:feec:16c2/64 scope link
        valid_lft forever preferred_lft forever
[root@node1 ~]# _
```

## SLURM

The Slurm Workload Manager, formerly known as Simple Linux Utility for Resource Management (SLURM), or simply Slurm, is a free and open-source job scheduler for Linux and Unix-like kernels, used by many of the world's supercomputers and computer clusters.

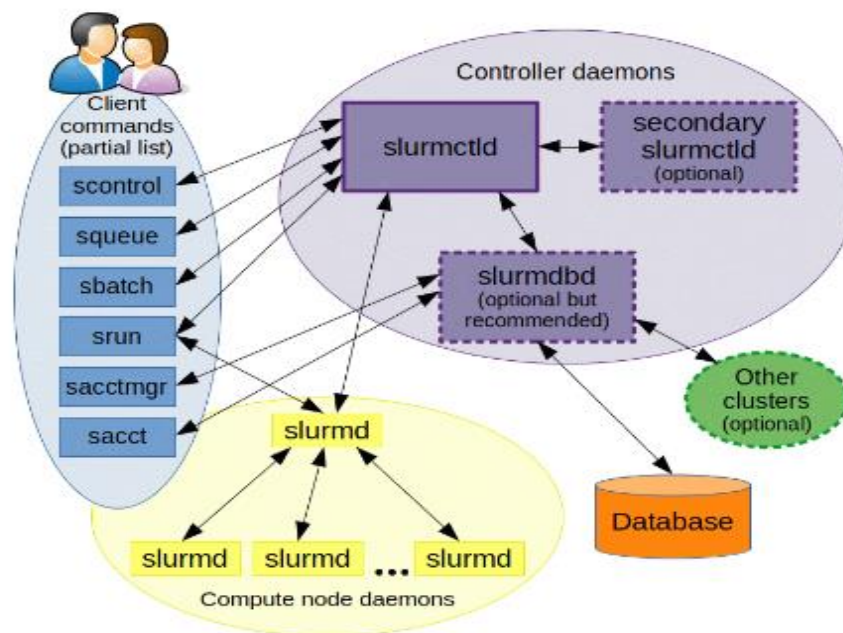


Figure 1. Slurm components

```
# yum -y install ohpc-slurm-server
```

```
# yum -y install slurm-sview-ohpc slurm-torque-ohpc
```

```
# vi /etc/slurm/slurm.conf
```

```
edit -> ClusterName=pearl
```

```
-> ControlMachine=master
```

```
-> NodeName=node[1-2]
```

```
# export CHROOT=/opt/ohpc/admin/images/centos7.7

# wwmkchroot centos-7 $CHROOT

# chroot ${CHROOT} uname -r

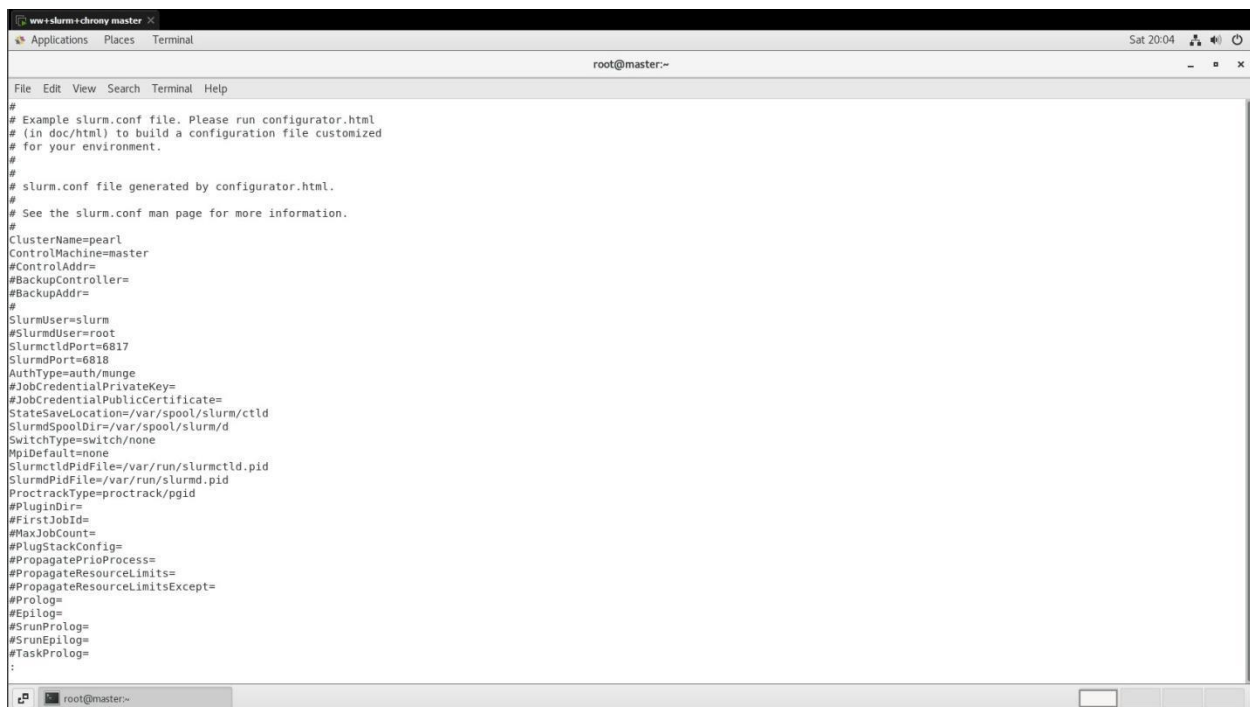
# yum -y --installroot=${CHROOT} install \

ohpc-base-compute kernel kernel-headers kernel-devel kernel-tools parted \

xfsprogs python-devel yum httpd ipmitool glibc* perl perl-CPAN perl-CPAN \

sysstat gcc make xauth firefox squashfs-tools
```

## Slurm Configuration



```
File Edit View Search Terminal Help
root@master:~

#
# Example slurm.conf file. Please run configurator.html
# (in doc/html) to build a configuration file customized
# for your environment.
#
# slurm.conf file generated by configurator.html.
#
# See the slurm.conf man page for more information.
#
ClusterName=pearl
ControlMachine=master
#ControlAddr=
#BackupController=
#BackupAddr=
#
SlurmUser=slurm
#SlurmUser=root
SlurmctldPort=6817
SlurmdPort=6818
AuthType=auth/munge
#JobCredentialPrivateKey=
#JobCredentialPublicCertificate=
StateSaveLocation=/var/spool/slurm/ctld
SlurmdSpoolDir=/var/spool/slurm/d
SwitchType=switch/none
MpiDefault=none
SlurmctldPidFile=/var/run/slurmctld.pid
SlurmdPidFile=/var/run/slurmd.pid
ProctrackType=proctrack/pgid
#PluginDir=
#FirstJobId=
#MaxJobCount=
#PlugStackConfig=
#PropagatePriorProcess=
#PropagateResourceLimits=
#PropagateResourceLimitsExcept=
#Prolog=
#Epilog=
#SrunProlog=
#SrunEpilog=
#TaskProlog=
:
```

```

root@master:~
File Edit View Search Terminal Tabs Help

root@master:~
root@master:/var/spool/slurm

SchedulerType=sched/backfill
#SchedulerAuth=
#SelectType=select/linear
FastSchedule=1
#PriorityType=priority/multifactor
#PriorityDecayHalfLife=14-0
#PriorityUsageResetPeriod=14-0
#PriorityWeightFairshare=100000
#PriorityWeightAge=1000
#PriorityWeightPartition=10000
#PriorityWeightJobSize=1000
#PriorityMaxAge=1-0
#
# LOGGING
SlurmctldDebug=3
SlurmctldLogFile=/var/log/slurmctld.log
SlurmdDebug=3
SlurmdLogFile=/var/log/slurmd.log
JobCompType=jobcomp/none
#JobCompLoc=
#
# ACCOUNTING
#JobAcctGatherType=jobacct_gather/linux
#JobAcctGatherFrequency=30
#
#AccountingStorageType=accounting_storage/slurddb
#AccountingStorageHost=
#AccountingStorageLoc=
#AccountingStoragePass=
#AccountingStorageUser=
#
# COMPUTE NODES
# OpenHPC default configuration
TaskPlugin=task/affinity
PropagateResourceLimitsExcept=MEMLOCK
AccountingStorageType=accounting_storage/filetxt
EpiLog=/etc/slurm/slurm.epilog.clean
NodeName=c[1-2] Sockets=2 CoresPerSocket=8 ThreadsPerCore=2 State=UNKNOWN
PartitionName=normal Nodes=c[1-2] Default=YES MaxTime=24:00:00 State=UP
ReturnToService=1
-- INSERT --

```

# systemctl status slurmctld

## Slurm status on master

```

root@master:~
File Edit View Search Terminal Help

root@master ~# wvsh node list
=====
NAME          GROUPS          IPADDR          HWADDR
=====
c1             UNDEF          192.168.23.150  00:0c:29:ec:16:c2
c2             UNDEF          192.168.23.151  00:0c:29:b4:a4:c4
=====

root@master ~# systemctl start slurmctld
root@master ~# systemctl status slurmctld
● slurmctld.service - Slurm controller daemon
   Loaded: loaded (/usr/lib/systemd/system/slurmctld.service; disabled; vendor preset: disabled)
   Active: active (running) since Mon 2023-01-30 14:17:37 IST; 11s ago
     Process: 3475 ExecStart=/usr/sbin/slurmctld $SLURMCTLD_OPTIONS (code=exited, status=0/SUCCESS)
    Main PID: 3477 (slurmctld)
      Tasks: 11
     CGroup: /system.slice/slurmctld.service
             └─3477 /usr/sbin/slurmctld

Jan 30 14:17:37 master systemd[1]: Starting Slurm controller daemon...
Jan 30 14:17:37 master systemd[1]: Can't open PID file /var/run/slurmctld.pid (yet?) af...ory
Jan 30 14:17:37 master systemd[1]: Started Slurm controller daemon.
Hint: Some lines were ellipsized, use -l to show in full.
root@master ~#

```



```
# systemctl status slurmd
```

## Slurm status on node

```
Kernel 3.10.0-1160.81.1.el7.x86_64 on an x86_64

c1 login: root
Password:
[root@c1 ~]# systemctl start slurmd
[root@c1 ~]# systemctl status slurmd
■ slurmd.service - Slurm node daemon
   Loaded: loaded (/usr/lib/systemd/system/slurmd.service; enabled; vendor prese
   t: disabled)
   Active: active (running) since Mon 2023-01-30 14:17:19 IST; 42s ago
     Process: 1182 ExecStart=/usr/sbin/slurmd $SLURMD_OPTIONS (code=exited, status=
0/SUCCESS)
    Main PID: 1219 (slurmd)
       Tasks: 2
      Memory: 1.1M
    CGroup: /system.slice/slurmd.service
            └─1219 /usr/sbin/slurmd

Jan 30 14:16:59 c1 systemd[1]: Starting Slurm node daemon...
Jan 30 14:17:19 c1 systemd[1]: Can't open PID file /var/run/slurmd.pid (yet...ry
Jan 30 14:17:19 c1 systemd[1]: Started Slurm node daemon.
Hint: Some lines were ellipsized, use -l to show in full.
[root@c1 ~]# date
Mon Jan 30 14:20:13 IST 2023
[root@c1 ~]#
```

# NAGIOS

Nagios is **an open source monitoring system for computer systems**. It was designed to run on the Linux operating system and can monitor devices running Linux, Windows and Unix operating systems (OSes). Nagios software runs periodic checks on critical parameters of application, network and server resources.

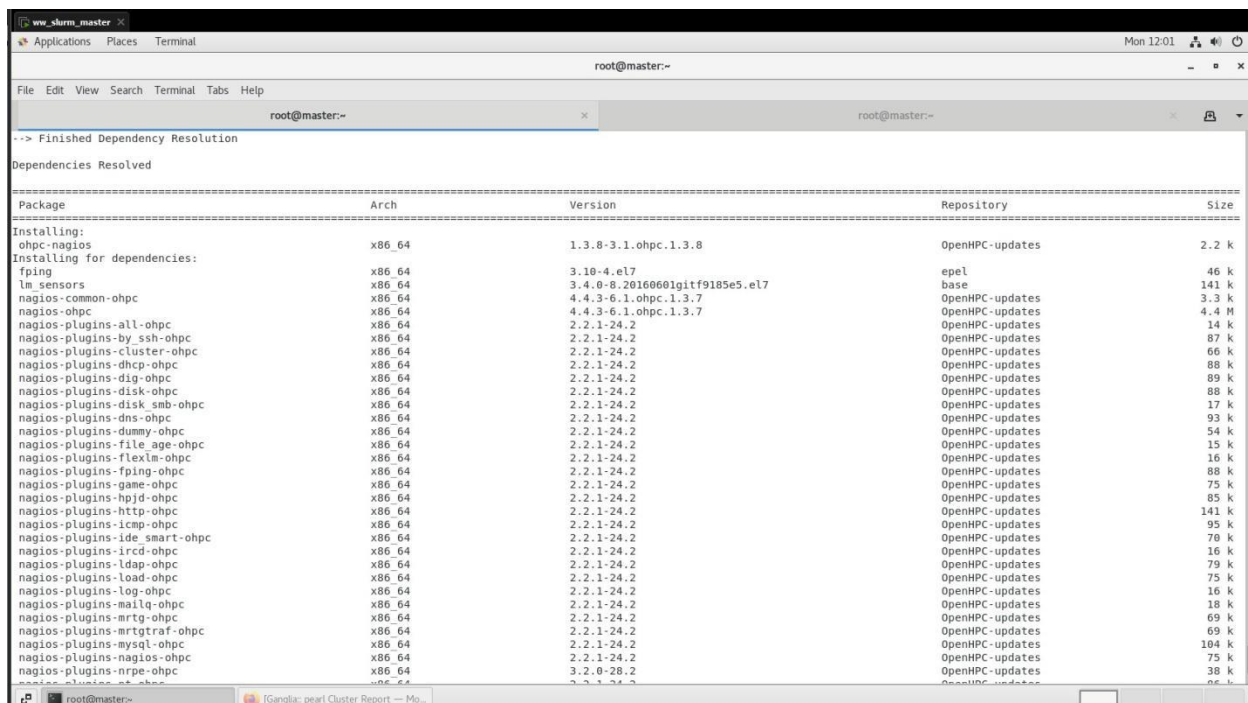
```
# yum -y install ohpc-nagios -> Install Nagios meta-package on master host
```

```
# yum -y --installroot=$CHROOT install nagios-plugins-all-ohpc nrpe-ohpc
```

```
# vi $CHROOT/etc/nagios/nrpe.cfg
```

```
# vi $CHROOT/etc/hosts.allow
```

Nagios Packages:



```
--> Finished Dependency Resolution
```

Dependencies Resolved

Package	Arch	Version	Repository	Size
Installing:				
ohpc-nagios	x86_64	1.3.8-3.1.ohpc.1.3.8	OpenHPC-updates	2.2 k
Installing for dependencies:				
base	x86_64	3.10-4.el7	epel	46 k
lm_sensors	x86_64	3.4.0-8.20160601gitf9185e5.el7	base	141 k
nagios-common-ohpc	x86_64	4.4.3-6.1.ohpc.1.3.7	OpenHPC-updates	3.3 k
nagios-ohpc	x86_64	4.4.3-6.1.ohpc.1.3.7	OpenHPC-updates	4.4 M
nagios-plugins-all-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	14 k
nagios-plugins-by_ssh-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	87 k
nagios-plugins-cluster-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	66 k
nagios-plugins-dhcp-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	88 k
nagios-plugins-dig-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	89 k
nagios-plugins-disk-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	88 k
nagios-plugins-disk_smb-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	17 k
nagios-plugins-dns-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	93 k
nagios-plugins-dummy-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	54 k
nagios-plugins-file_age-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	15 k
nagios-plugins-flexlm-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	16 k
nagios-plugins-fping-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	88 k
nagios-plugins-gane-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	75 k
nagios-plugins-hpjd-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	85 k
nagios-plugins-http-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	141 k
nagios-plugins-icmp-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	95 k
nagios-plugins-ide_smart-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	70 k
nagios-plugins-ircd-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	16 k
nagios-plugins-ldap-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	79 k
nagios-plugins-load-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	75 k
nagios-plugins-log-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	16 k
nagios-plugins-mailq-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	18 k
nagios-plugins-mrtg-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	69 k
nagios-plugins-mrtgtraf-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	69 k
nagios-plugins-mysql-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	104 k
nagios-plugins-nagios-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	75 k
nagios-plugins-nrpe-ohpc	x86_64	3.2.0-28.2	OpenHPC-updates	38 k
nagios-plugins-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	86 k

## Nagios Configuration file:

```

Applications  Places  Terminal
Sat 23:53

root@master:~

File Edit View Search Terminal Help
## Linux Host Template ##
define host{
    name linux-box ; Name of this template
    use generic-host ; Inherit default values
    check_period 24x7
    check_interval 5
    retry_interval 1
    max_check_attempts 10
    check_command check-host-alive
    notification_period 24x7
    notification_interval 30
    notification_options d,r
    contact_groups admins
    register 0 ; DONT REGISTER THIS - ITS A TEMPLATE
}

define hostgroup {
    hostgroup name compute
    alias compute nodes
    members c1,c2
}

# example configuration of 4 remote linux systems
define host{
    use linux-box ; Inherit default values from a template
    host_name c1 ; The name we're giving to this server
    alias c1 ; A longer name for the server
    address 192.168.23.150 ; IP address of Remote Linux host
}

define host{
    use linux-box ; Inherit default values from a template
    host_name c2 ; The name we're giving to this server
    alias c2 ; A longer name for the server
    address 192.168.23.151 ; IP address of Remote Linux host
}

-- INSERT --

```

```

ww_slurm_master
Applications  Places  Terminal
Mon 12:17

root@master:~

File Edit View Search Terminal Tabs Help

root@master:~
root@master:~

[root@master ~]# vi /etc/nagios/conf.d/hosts.cfg
[root@master ~]# vi $CHROOT/etc/nagios/nrpe.cfg
[root@master ~]# echo command[check_ssh]=usr/lib64/nagios/plugins/check_ssh master >> $CHROOT/etc/nagios/nrpe.cfg
[root@master ~]# htpasswd -bc /etc/nagios/passwd nagiosadmin nagios
Adding password for user nagiosadmin
[root@master ~]# chkconfig nagios on
Note: Forwarding request to 'systemctl enable nagios.service'.
Created symlink from /etc/systemd/system/multi-user.target.wants/nagios.service to /usr/lib/systemd/system/nagios.service.
[root@master ~]# vi /etc/nagios/conf.d/hosts.cfg
[root@master ~]# systemctl start nagios
[root@master ~]# systemctl status nagios
● nagios.service - Nagios Network Monitoring
   Loaded: loaded (/usr/lib/systemd/system/nagios.service; enabled; vendor preset: disabled)
   Active: active (running) since Mon 2023-01-30 12:14:45 IST; 9s ago
     Docs: https://www.nagios.org/documentation/
   Process: 126363 ExecStartPre=/usr/sbin/nagios -d /etc/nagios/nagios.cfg (code=exited, status=0/SUCCESS)
   Process: 126361 ExecStartPre=/usr/sbin/nagios -v /etc/nagios/nagios.cfg (code=exited, status=0/SUCCESS)
   Main PID: 126365 (nagios)
      Tasks: 8
     CGroup: /system.slice/nagios.service
            └─126365 /usr/sbin/nagios -d /etc/nagios/nagios.cfg
              └─126366 /usr/sbin/nagios --worker /var/log/nagios/nagios.qh
                └─126367 /usr/sbin/nagios --worker /var/log/nagios/nagios.qh
                  └─126368 /usr/sbin/nagios --worker /var/log/nagios/nagios.qh
                    └─126369 /usr/sbin/nagios --worker /var/log/nagios/nagios.qh
                      └─126370 /usr/sbin/nagios --worker /var/log/nagios/nagios.qh
                        └─126371 /usr/sbin/nagios --worker /var/log/nagios/nagios.qh
                          └─126378 /usr/sbin/nagios -d /etc/nagios/nagios.cfg

Jan 30 12:14:45 master nagios[126365]: qh: echo service query handler registered
Jan 30 12:14:45 master nagios[126365]: qh: help for the query handler registered
Jan 30 12:14:45 master nagios[126365]: wproc: Successfully registered manager as @wproc with query handler
Jan 30 12:14:45 master nagios[126365]: wproc: Registry request: name=Core Worker 126368;pid=126368
Jan 30 12:14:45 master nagios[126365]: wproc: Registry request: name=Core Worker 126370;pid=126370
Jan 30 12:14:45 master nagios[126365]: wproc: Registry request: name=Core Worker 126366;pid=126366
Jan 30 12:14:45 master nagios[126365]: wproc: Registry request: name=Core Worker 126369;pid=126369
Jan 30 12:14:45 master nagios[126365]: wproc: Registry request: name=Core Worker 126371;pid=126371
Jan 30 12:14:45 master nagios[126365]: wproc: Registry request: name=Core Worker 126367;pid=126367
Jan 30 12:14:46 master nagios[126365]: Successfully launched command file worker with pid 126378
[root@master ~]# chmod u+s `which ping`
[root@master ~]#

```

## Nagios result on browser:

**Nagios**

**Current Network Status**  
 Last Updated: Sun Jan 29 04:50:19 PST 2023  
 Updated every 90 seconds  
 Nagios® Core™ 4.4.3 - www.nagios.org  
 Logged in as nagiosadmin

**Host Status Totals**

Up	Down	Unreachable	Pending
3	0	0	0

**Service Status Totals**

OK	Warning	Unknown	Critical	Pending
6	2	0	30	0

**Host Status Details For All Host Groups**

Limit Results: 100

Host	Status	Last Check	Duration	Status Information
localhost	UP	01-29-2023 04:47:42	0d 0h 21m 29s	PING OK - Packet loss = 0%, RTA = 0.22 ms
node1	UP	01-29-2023 04:49:58	0d 0h 5m 21s	PING OK - Packet loss = 0%, RTA = 0.57 ms
node2	UP	01-29-2023 04:46:39	0d 0h 3m 40s	PING OK - Packet loss = 0%, RTA = 0.48 ms

Results 1 - 3 of 3 Matching Hosts

Node1 & Node2 showed

## GANGLIA

Ganglia is **an open-source scalable distributed monitoring system for high-performance computing systems such as clusters and Grids**. It is carefully engineered to achieve very low per-node overheads and high concurrency.

```
# yum -y install ohpc-ganglia
# yum -y --installroot=${CHROOT} install ganglia-gmond-ohpc
# cp /opt/ohpc/pub/examples/ganglia/gmond.conf /etc/ganglia/gmond.conf
# sed -i "s/<sms>/master/" /etc/ganglia/gmond.conf
# sed -i "s/OpenHPC/pearl/" /etc/ganglia/gmond.conf
# cp /etc/ganglia/gmond.conf $CHROOT/etc/ganglia/gmond.conf
# echo "gridname pearl" >> /etc/ganglia/gmetad.conf
# echo "

systemctl enable gmond
systemctl enable gmetad
systemctl start gmond
systemctl start gmetad
chroot ${CHROOT} systemctl enable gmond
" > /tmp/start_ganglia_service.sh
```

```
# bash /tmp/start_ganglia_service.sh

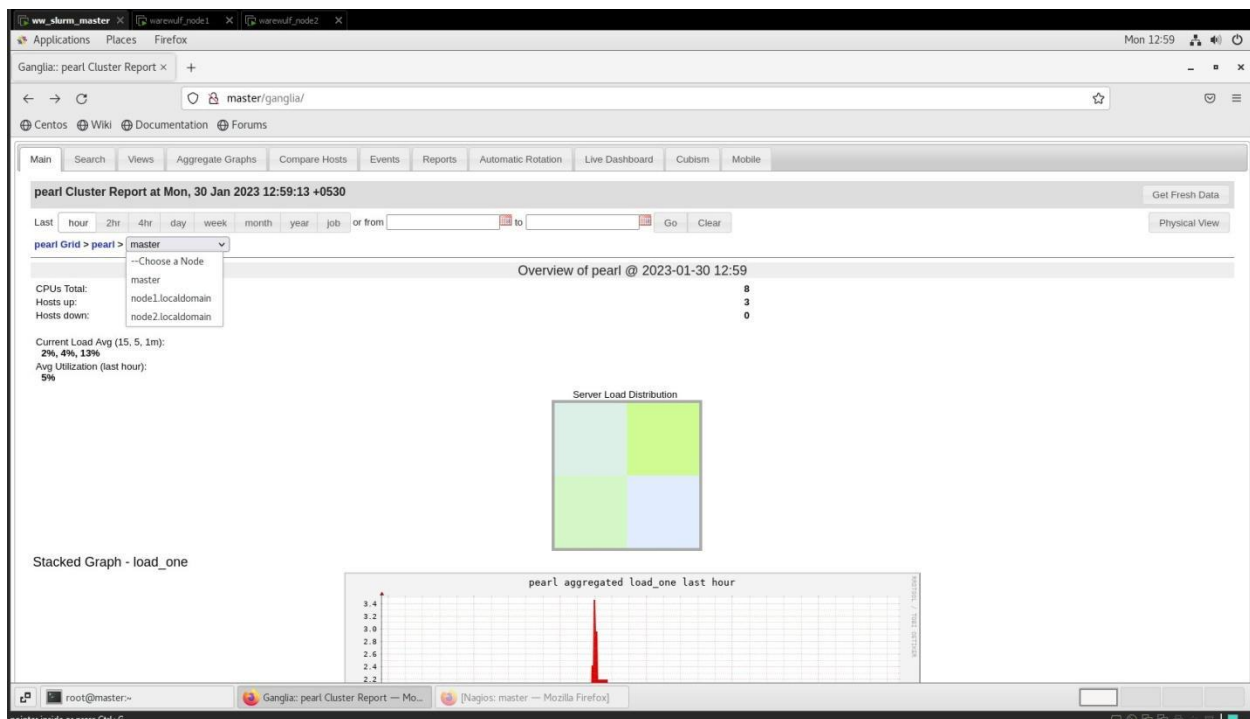
# grep "^date.timezone =" /etc/php.ini

# echo "date.timezone = Asia/Kolkata" >> /etc/php.ini

# grep "^date.timezone =" /etc/php.ini

# systemctl try-restart httpd
```

Go to browser : <http://master/ganglia>



# HPL Benchmarking

HPL is a **High-Performance Linpack benchmark implementation**. The code solves a uniformly random system of linear equations and reports time and floating-point execution rate using a standard formula for operation count.

```
# yum install atlas -y
```

```
# wget https://netlib.org/benchmark/hpl/hpl-2.3.tar.gz
```

```
# wget https://download.open-mpi.org/release/open-mpi/v4.1/openmpi-4.1.4.tar.gz
```

```

root@master hpl-2.3]# rpm -ql atlas
/etc/ld.so.conf.d/atlas-x86_64.conf
/usr/lib64/atlas
/usr/lib64/atlas/libsatlas.so.3
/usr/lib64/atlas/libsatlas.so.3.10
/usr/lib64/atlas/libtatlas.so.3
/usr/lib64/atlas/libtatlas.so.3.10
/usr/share/doc/atlas-3.10.1
/usr/share/doc/atlas-3.10.1/README.dist
[root@master hpl-2.3]#

```

```
# vim Make.Linux_PII_CBLAS
```

```
>> edit  # -----

# - HPL Directory Structure / HPL library -----

# -----

      TOPdir    = /root/Downloads/hpl-2.

# -----

# - Message Passing library (MPI) -----

# -----

      MPdir     = /opt/openmpi-4.1.

      MPLib     = $(MPdir)/lib/libmpi.so

# -----

      # - Compilers / linkers - Optimization flags -----

# -----

# CC          = /usr/bin/gcc

      LINKER    = /usr/bin/gcc

# -----

# - Linear Algebra library (BLAS or VSIPL) -----

# -----

      LAlib     = $(LAdir)/libsatlas.so.3
      $(LAdir)/libtatlas.so.3

>> <Escape Key> : wq
```



```
# cd /root/Downloads/hpl-2.3/bin/Linux_PII_CBLAS/
```

```
# vi HPL.dat
```

```
HPLinpack benchmark input file
Innovative Computing Laboratory, University of Tennessee
HPL.out      output file name (if any)
6            device out (6=stdout,7=stderr,file)
4            # of problems sizes (N)
29 30 34 35 Ns
4            # of NBs
1 2 3 4      NBs
0            PMAP process mapping (0=Row-,1=Column-major)
3            # of process grids (P x Q)
2 1 4        Ps
2 4 1        Qs
16.0         threshold
3            # of panel fact
0 1 2        PFACTS (0=left, 1=Crout, 2=Right)
2            # of recursive stopping criterium
2 4          NEMINS (>= 1)
1            # of panels in recursion
2            NDIVs
3            # of recursive panel fact.
0 1 2        RFACTS (0=left, 1=Crout, 2=Right)
1            # of broadcast
0            BCASTS (0=lrg,1=lrm,2=rgr,3=rrM,4=Lng,5=LnM)
1            # of lookahead depth
0            DEPTHS (>=0)
2            SWAP (0=bin-exch,1=long,2=mix)
64           swapping threshold
0            L1 in (0=transposed,1=no-transposed) form
0            U in (0=transposed,1=no-transposed) form
1            Equilibration (0=no,1=yes)
8            memory alignment in double (> 0)
```

"HPL.dat" 31L, 1133C

```
# mpirun --allow-run-as-root -np 4 ./xhpl HPL.dat
```

root@master:~/Downloads/hpl-2.3/bin/Linux\_PII\_CBLAS

```
=====
||Ax-b||_oo/(eps*(||A||_oo*||x||_oo+||b||_oo)*N)= 1.81558863e-02 ..... PASSED
=====
```

T/V	N	NB	P	Q	Time	Gflops
-----	---	----	---	---	------	--------

WR00R2L4	30	1	4	1	0.00	3.0368e-01
----------	----	---	---	---	------	------------

HPL\_pdgesv() start time Sun Jan 29 19:32:49 2023

HPL\_pdgesv() end time Sun Jan 29 19:32:49 2023

```
=====
||Ax-b||_oo/(eps*(||A||_oo*||x||_oo+||b||_oo)*N)= 1.81558863e-02 ..... PASSED
=====
```

T/V	N	NB	P	Q	Time	Gflops
-----	---	----	---	---	------	--------

WR00R2C2	30	1	4	1	0.00	2.9527e-01
----------	----	---	---	---	------	------------

HPL\_pdgesv() start time Sun Jan 29 19:32:49 2023

HPL\_pdgesv() end time Sun Jan 29 19:32:49 2023

```
=====
||Ax-b||_oo/(eps*(||A||_oo*||x||_oo+||b||_oo)*N)= 1.81558863e-02 ..... PASSED
=====
```

T/V	N	NB	P	Q	Time	Gflops
-----	---	----	---	---	------	--------

WR00R2C4	30	1	4	1	0.00	3.0281e-01
----------	----	---	---	---	------	------------

HPL\_pdgesv() start time Sun Jan 29 19:32:49 2023

HPL\_pdgesv() end time Sun Jan 29 19:32:49 2023

```
=====
||Ax-b||_oo/(eps*(||A||_oo*||x||_oo+||b||_oo)*N)= 1.81558863e-02 ..... PASSED
=====
```

T/V	N	NB	P	Q	Time	Gflops
-----	---	----	---	---	------	--------

WR00R2R2	30	1	4	1	0.00	3.0077e-01
----------	----	---	---	---	------	------------

HPL\_pdgesv() start time Sun Jan 29 19:32:49 2023

HPL\_pdgesv() end time Sun Jan 29 19:32:49 2023

```
=====
||Ax-b||_oo/(eps*(||A||_oo*||x||_oo+||b||_oo)*N)= 1.81558863e-02 ..... PASSED
=====
```

T/V	N	NB	P	Q	Time	Gflops
-----	---	----	---	---	------	--------

WR00R2R4	30	1	4	1	0.00	2.7510e-01
----------	----	---	---	---	------	------------

HPL\_pdgesv() start time Sun Jan 29 19:32:49 2023

HPL\_pdgesv() end time Sun Jan 29 19:32:49 2023

```
=====
||Ax-b||_oo/(eps*(||A||_oo*||x||_oo+||b||_oo)*N)= 1.81558863e-02 ..... PASSED
=====
```

T/V	N	NB	P	Q	Time	Gflops
-----	---	----	---	---	------	--------

WR00L2L2	30	2	4	1	0.00	2.4171e-01
----------	----	---	---	---	------	------------

HPL\_pdgesv() start time Sun Jan 29 19:32:49 2023

HPL\_pdgesv() end time Sun Jan 29 19:32:49 2023

```
=====
||Ax-b||_oo/(eps*(||A||_oo*||x||_oo+||b||_oo)*N)= 2.65355261e-02 ..... PASSED
=====
```

root@master:~/Downloads/hpl-2.3/bin/Linux\_PII\_CBLAS

```

=====
||Ax-b||_oo/(eps*(||A||_oo*||x||_oo+||b||_oo)*N)= 2.07165390e-02 ..... PASSED
=====
T/V          N    NB    P    Q          Time          Gflops
=====
WR00L2L4      35    4    4    1          0.00          5.6846e-01
HPL_pdgesv() start time Sun Jan 29 19:32:49 2023

HPL_pdgesv() end time   Sun Jan 29 19:32:49 2023

=====
||Ax-b||_oo/(eps*(||A||_oo*||x||_oo+||b||_oo)*N)= 2.17523660e-02 ..... PASSED
=====
T/V          N    NB    P    Q          Time          Gflops
=====
WR00L2C2      35    4    4    1          0.00          5.8055e-01
HPL_pdgesv() start time Sun Jan 29 19:32:49 2023

HPL_pdgesv() end time   Sun Jan 29 19:32:49 2023

=====
||Ax-b||_oo/(eps*(||A||_oo*||x||_oo+||b||_oo)*N)= 2.07165390e-02 ..... PASSED
=====
T/V          N    NB    P    Q          Time          Gflops
=====
WR00L2C4      35    4    4    1          0.00          6.0286e-01
HPL_pdgesv() start time Sun Jan 29 19:32:49 2023

HPL_pdgesv() end time   Sun Jan 29 19:32:49 2023

=====
||Ax-b||_oo/(eps*(||A||_oo*||x||_oo+||b||_oo)*N)= 3.57360298e-02 ..... PASSED
=====
T/V          N    NB    P    Q          Time          Gflops
=====
WR00L2R2      35    4    4    1          0.00          5.9891e-01
HPL_pdgesv() start time Sun Jan 29 19:32:49 2023

HPL_pdgesv() end time   Sun Jan 29 19:32:49 2023

=====
||Ax-b||_oo/(eps*(||A||_oo*||x||_oo+||b||_oo)*N)= 2.07165390e-02 ..... PASSED
=====
T/V          N    NB    P    Q          Time          Gflops
=====
WR00L2R4      35    4    4    1          0.00          6.3178e-01
HPL_pdgesv() start time Sun Jan 29 19:32:49 2023

HPL_pdgesv() end time   Sun Jan 29 19:32:49 2023

=====
||Ax-b||_oo/(eps*(||A||_oo*||x||_oo+||b||_oo)*N)= 2.07165390e-02 ..... PASSED
=====
T/V          N    NB    P    Q          Time          Gflops
=====
WR00C2L2      35    4    4    1          0.00          4.6802e-01
HPL_pdgesv() start time Sun Jan 29 19:32:49 2023

HPL_pdgesv() end time   Sun Jan 29 19:32:49 2023

=====
||Ax-b||_oo/(eps*(||A||_oo*||x||_oo+||b||_oo)*N)= 2.07165390e-02 ..... PASSED
=====

```

root@master:~/Downloads/hpl-2.3/bin/Linux\_PII\_CBLAS

```
=====
||Ax-b||_oo/(eps*(||A||_oo*||x||_oo+||b||_oo)*N)= 2.07165390e-02 ..... PASSED
=====
```

T/V	N	NB	P	Q	Time	Gflops
-----	---	----	---	---	------	--------

WR00R2C4	35	4	4	1	0.00	6.1972e-01
----------	----	---	---	---	------	------------

HPL\_pdgesv() start time Sun Jan 29 19:32:49 2023

HPL\_pdgesv() end time Sun Jan 29 19:32:49 2023

```
=====
||Ax-b||_oo/(eps*(||A||_oo*||x||_oo+||b||_oo)*N)= 3.57360298e-02 ..... PASSED
=====
```

T/V	N	NB	P	Q	Time	Gflops
-----	---	----	---	---	------	--------

WR00R2R2	35	4	4	1	0.00	6.0979e-01
----------	----	---	---	---	------	------------

HPL\_pdgesv() start time Sun Jan 29 19:32:49 2023

HPL\_pdgesv() end time Sun Jan 29 19:32:49 2023

```
=====
||Ax-b||_oo/(eps*(||A||_oo*||x||_oo+||b||_oo)*N)= 2.07165390e-02 ..... PASSED
=====
```

T/V	N	NB	P	Q	Time	Gflops
-----	---	----	---	---	------	--------

WR00R2R4	35	4	4	1	0.00	6.2135e-01
----------	----	---	---	---	------	------------

HPL\_pdgesv() start time Sun Jan 29 19:32:49 2023

HPL\_pdgesv() end time Sun Jan 29 19:32:49 2023

```
=====
||Ax-b||_oo/(eps*(||A||_oo*||x||_oo+||b||_oo)*N)= 2.07165390e-02 ..... PASSED
=====
```

```
Finished      864 tests with the following results:
              864 tests completed and passed residual checks,
                0 tests completed and failed residual checks,
                0 tests skipped because of illegal input values.
```

End of Tests.

```
=====
[root@master Linux_PII_CBLAS]# mpirun --allow-run-as-root -np 4 ./xhpl HPL.dat
```

## Commands Used

### Warewulf installation (Network Boot in HPC Cluster) Centos-7

---

#### Pre-requisite:

---

We have to stop and disable firewall and disable selinux

sethostname of machine as master

```
# hostnamectl set-hostname master
```

---

Check for the file of ens36 (if not there use #nmtui command and edit Wired Connection 1 to ens36)

```
# cat /etc/sysconfig/network-scripts/ifcfg-ens36
```

```
# ifconfig ens36
```

```
# vi /etc/hosts
```

```
-> edit -> <ip.address> master
```

```
# yum -y install yum-utils
```

```
# yum install
```

```
http://build.openhpc.community/OpenHPC:/1.3/CentOS_7/x86_64/ohpc-  
release-1.3-1.el7.x86_64.rpm
```

```
# yum repolist
```

```
# yum -y install ohpc-base
```

```
# yum -y install ohpc-warewulf
```

```
# yum -y install chrony
```

```
# vi /etc/chrony.conf
```

```
-> Edit this Conf. file -> server 192.168.23. iburst
```

```
-> allow 192.168.23.0/24 (uncomment and edit  
network address)
```

```
-> local stratum 10 (uncomment)
```

```
-> SAVE and Exit
```

```
# systemctl start chronyd
```

```
# systemctl enable chronyd
```

```
# yum install ntpdate
```

```
# ntpdate -q 192.168.23.130
```

```
# vi /etc/warewulf/provision.conf
```

```
edit -> change network device = ens36
```

```
# grep device /etc/warewulf/provision.conf
```

```
# vi /etc/xinetd.d/tftp
```

```
edit -> disable = no
```

```
# grep disable /etc/xinetd.d/tftp
```

```
*****
```

## Resource Manager Installation

---

```
# yum -y install ohpc-slurm-server
# yum -y install slurm-sview-ohpc slurm-torque-ohpc
# vi /etc/slurm/slurm.conf

    edit -> ClusterName=pearl
    -> ControlMachine=master
    -> NodeName=c[1-2]
    -> Nodes=c[1-2]           --> This is my nodename
```

```
# grep NodeName= /etc/slurm/slurm.conf
```

```
# echo ens36
```

```
# ifconfig ens36
```

```
# systemctl restart xinetd
```

```
# systemctl enable mariadb.service
```

```
# systemctl restart mariadb
```

```
# systemctl enable httpd.service
```

```
# systemctl restart httpd
```

```
# systemctl enable dhcpd.service
```

```
*****
```

```
# echo ${CHROOT}
```

```
# export CHROOT=/opt/ohpc/admin/images/centos7.7
```

```
# echo ${CHROOT}
```

**# wwmkchroot centos-7 \$CHROOT -> Building initial BIOS image**

**# uname -r**

**# chroot \${CHROOT} uname -r**

**\*\*\*\*\***

**# yum -y --installroot=\${CHROOT} update**

**# yum -y --installroot=\${CHROOT} install \**

**ohpc-base-compute kernel kernel-headers kernel-devel kernel-tools parted \**

**xfsprogs python-devel yum htop ipmitool glibc\* perl perl-CPAN perl-CPAN \**

**sysstat gcc make xauth firefox squashfs-tools**

**# cat /etc/resolv.conf**

**# vi /etc/resolv.conf**

**add -> master 192.168.23.130**

**# cp -p /etc/resolv.conf \$CHROOT/etc/resolv.conf**

**# yum -y --installroot=\${CHROOT} install ohpc-slurm-client**

**# chroot \${CHROOT} systemctl enable slurmd**

**# yum -y --installroot=\${CHROOT} install chrony**

**# yum -y --installroot=\${CHROOT} install kernel lmod-ohpc**

**\*\*\*\*\***

**# # Initialize warewulf database and ssh\_keys**

---

**# wwinit database**



```
# wwininit ssh_keys
# df -hT | grep -v tmpfs
# hostname
# cat ${CHROOT}/etc/fstab
# echo "master:/home /home nfs nfsvers=3,nodev,nosuid 0 0" >>
$CHROOT/etc/fstab
# echo "master:/opt/ohpc/pub /opt/ohpc/pub nfs nfsvers=3,nodev 0 0" >>
$CHROOT/etc/fstab
# cat ${CHROOT}/etc/fstab
# cat /etc/exports
# echo "/home *(rw,no_subtree_check,fsid=10,no_root_squash)" >>
/etc/exports
# echo "/opt/ohpc/pub *(ro,no_subtree_check,fsid=11)" >> /etc/exports
# cat /etc/exports
# systemctl start nfs-server
# systemctl status nfs-server
# systemctl enable nfs-server
# exportfs -arv
# chroot $CHROOT systemctl enable chronyd
# echo "server 192.168.23.130 iburst" >> $CHROOT/etc/chrony.conf
```

\*\*\*\*\*

## Add Ganglia monitoring

---

```
# yum -y install ohpc-ganglia -> # Install Ganglia meta-package on master
# yum -y --installroot=${CHROOT} install ganglia-gmond-ohpc
    -> Install Ganglia compute node daemon

# Use example configuration script to enable unicast receiver on master host
-----

# cp /opt/ohpc/pub/examples/ganglia/gmond.conf /etc/ganglia/gmond.conf ->
yes

# grep 'host =' /etc/ganglia/gmond.conf

# sed -i "s/<sms>/master/" /etc/ganglia/gmond.conf

# grep 'host =' /etc/ganglia/gmond.conf

# grep OpenHPC /etc/ganglia/gmond.conf

# sed -i "s/OpenHPC/pearl/" /etc/ganglia/gmond.conf

# grep pearl /etc/ganglia/gmond.conf

# cp /etc/ganglia/gmond.conf $CHROOT/etc/ganglia/gmond.conf -> yes

# echo "gridname pearl" >> /etc/ganglia/gmetad.conf

# grep gridname /etc/ganglia/gmetad.conf

# echo "

systemctl enable gmond

systemctl enable gmetad

systemctl start gmond

systemctl start gmetad

chroot ${CHROOT} systemctl enable gmond

" > /tmp/start_ganglia_service.sh
```

```
# bash /tmp/start_ganglia_service.sh
# grep "^date.timezone =" /etc/php.ini
# echo "date.timezone = Asia/Kolkata" >> /etc/php.ini
# grep "^date.timezone =" /etc/php.ini
# systemctl try-restart httpd
```

Go to browser : <http://master/ganglia>

\*\*\*\*\*

### Add Nagios monitoring

---

```
# yum -y install ohpc-nagios -> Install Nagios meta-package on master host
# yum -y --installroot=$CHROOT install nagios-plugins-all-ohpc nrpe-ohpc
-> Install plugins into compute node image
# chroot $CHROOT systemctl enable nrpe
# touch /var/log/nagios/nrpe.pid
# chown -R nrpe:nrpe /var/log/nagios/nrpe.pid
# perl -pi -e "s/^allowed_hosts=/# allowed_hosts=/"
$CHROOT/etc/nagios/nrpe.cfg
# echo "nrpe 5666/tcp # NRPE" >> $CHROOT/etc/services
# echo "nrpe : 192.168.23.130 : ALLOW" >> $CHROOT/etc/hosts.allow
# echo "nrpe : ALL : DENY" >> $CHROOT/etc/hosts.allow
# chroot $CHROOT /usr/sbin/useradd -c "NRPE user for the NRPE service"
-d /var/run/nrpe \
-r -g nrpe -s /sbin/nologin nrpe
```

```
# chroot $CHROOT /usr/sbin/groupadd -r nrpe
```

```
****
```

```
# # Configure remote services to test on compute nodes
```

```
-----
```

```
# mv /etc/nagios/conf.d/services.cfg.example /etc/nagios/conf.d/services.cfg
```

```
# mv /etc/nagios/conf.d/hosts.cfg.example /etc/nagios/conf.d/hosts.cfg
```

```
# for ((i=0; i<2; i++)) ; do perl -pi -e "s/HOSTNAME$((i+1))/${c[i]}/ ||  
s/HOST$((i+1))_IP/${c_ip[i]}/" /etc/nagios/conf.d/hosts.cfg; done
```

```
# perl -pi -e "s/ \bin\mail/ \usr\bin\mailx/g"  
/etc/nagios/objects/commands.cfg
```

```
# perl -pi -e "s/nagios\@localhost/root\@master/"  
/etc/nagios/objects/contacts.cfg
```

```
# echo command[check_ssh]=/usr/lib64/nagios/plugins/check_ssh localhost >>  
$CHROOT/etc/nagios/nrpe.cfg
```

```
# htpasswd -bc /etc/nagios/passwd nagiosadmin nagios    -> username :  
nagiosadmin | password: nagios
```

```
# chkconfig nagios on
```

```
# vi /etc/nagios/conf.d/hosts.cfg -> Add clients and hostname
```

```
# systemctl start nagios
```

```
# chmod u+s `which ping`
```

**Go to browser : <http://master/nagios>**

**username : nagiosadmin**

**password : nagios**

\*\*\*\*\*

**# wwsh file list**

**# wwsh file import /etc/passwd**

**# wwsh file import /etc/group**

**# wwsh file import /etc/shadow**

**# wwsh file list**

**# export WW\_CONF=/etc/warewulf/bootstrap.conf**

**# echo "drivers += updates/kernel/" >> \$WW\_CONF**

**# echo "modprobe += ahci, nvme" >> \$WW\_CONF**

**# echo "drivers += overlay" >> \$WW\_CONF**

**# wwbootstrap `uname -r`**

**# echo \${CHROOT}**

**# wwvnfs --chroot \$CHROOT**

**or**

**# wwvnfs --chroot /opt/ohpc/admin/images/centos7.7**

**# wwsh vnfs list**

\*\*\*\*\*

```
# echo "GATEWAYDEV=ens36" > /tmp/network.wwsh
# wwsh -y file import /tmp/network.wwsh --name network
# wwsh -y file set network --path /etc/sysconfig/network --mode=0644 --uid=0
# wwsh node new c1
# wwsh node set c1 --netdev ens36 --ipaddr=192.168.23.150 --
hwaddr=00:0C:29:EC:16:C2 --netmask=255.255.255.0 --gateway
192.168.23.130
# wwsh node new c2
# wwsh node set c2 --netdev ens36 --ipaddr=192.168.23.151 --
hwaddr=00:0C:29:B4:A4:C4 --netmask=255.255.255.0 --gateway
192.168.23.130
```

---

```
# wwsh node list
# wwsh -y provision set c1 --vnfs=centos7.7 --bootstrap=`uname -r` --
files=dynamic_hosts,passwd,group,shadow,network
# wwsh -y provision set c2 --vnfs=centos7.7 --bootstrap=`uname -r` --
files=dynamic_hosts,passwd,group,shadow,network
# systemctl restart dhcpd && wwsh pxe update
```

**Script : For Restart/enable relevant services to support provisioning**

```
-----
echo "
systemctl enable dhcpd
```

```
systemctl restart xinetd
```

```
systemctl enable mariadb
```

```
systemctl restart mariadb
```

```
systemctl enable httpd
```

```
systemctl restart httpd
```

```
" > /tmp/provisioning_service_run.sh
```

```
bash /tmp/provisioning_service_run.sh
```

```
*****
```

## **Installation of HPL Benchmarking (HPC-Cluster)**

```
*****
```

```
# yum install epel-release -y
```

```
# yum install atlas -y
```

```
# rpm -ql atlas
```

```
# wget https://netlib.org/benchmark/hpl/hpl-2.3.tar.gz
```

```
# mv hpl-2.3.tar.gz /root/Downloads/
```

```
# cd /root/Downloads
```

```
# tar -zxvf hpl-2.3.tar.gz
```

```
# ls
```

```
# cd hpl-2.3/
```

```
# ls
```

```
# cd setup

# vim Make.Linux_Intel64

# wget https://download.open-mpi.org/release/open-mpi/v4.1/openmpi-
4.1.4.tar.gz

# mv openmpi-4.1.4.tar.gz /root/Downloads/

# tar -xvf openmpi-4.1.4.tar.gz

# ls

# cd openmpi-4.1.4/

# ./configure --prefix=/opt/openmpi-4.1.4 --enable-orterun-prefix-by-default

# make -j 8

# make install

# echo $PATH

# export PATH=/opt/openmpi-4.1.4/bin:$PATH

# mp <Press TAB KEY>

# export LD_LIBRARY_PATH=/opt/openmpi-
4.1.4/bin:$LD_LIBRARY_PATH

# echo $LD_LIBRARY_PATH

# cd ~/Downloads/hpl-2.3/setup

# cp Make.Linux_PII_CBLAS /root/Downloads/hpl-2.3

# cd /root/Downloads/hpl-2.3/

# ls

# rpm -ql atlas

# vim Make.Linux_PII_CBLAS

    >> edit    # -----
```



**# - HPL Directory Structure / HPL library**

# -----

**TOPdir      = /root/Downloads/hpl-2.3**

# -----

**# - Message Passing library (MPI)**

# -----

**MPdir        = /opt/openmpi-4.1.4****MPlib        = \$(MPdir)/lib/libmpi.so**

# -----

**# - Compilers / linkers - Optimization flags**

# -----

#

**CC            = /usr/bin/gcc****LINKER       = /usr/bin/gcc**

#

# -----

**# - Linear Algebra library (BLAS or VSIPL)**

# -----

---

```
        LAlib      = $(LAdir)/libsatlas.so.3
$(LAdir)/libtatlas.so.3
```

```
>> <Escape Key> : wq
```

```
# make arch=Linux_PII_CBLAS
```

```
# cd /root/Downloads/hpl-2.3/bin/Linux_PII_CBLAS/
```

```
# ls
```

```
# vi HPL.dat
```

```
# mpirun --allow-run-as-root -np 4 ./xhpl HPL.dat
```