

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

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

REQUIREMENTS

Hardware requirements:

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

Software requirements:

- Vmware workstation
- Centos 7 iso

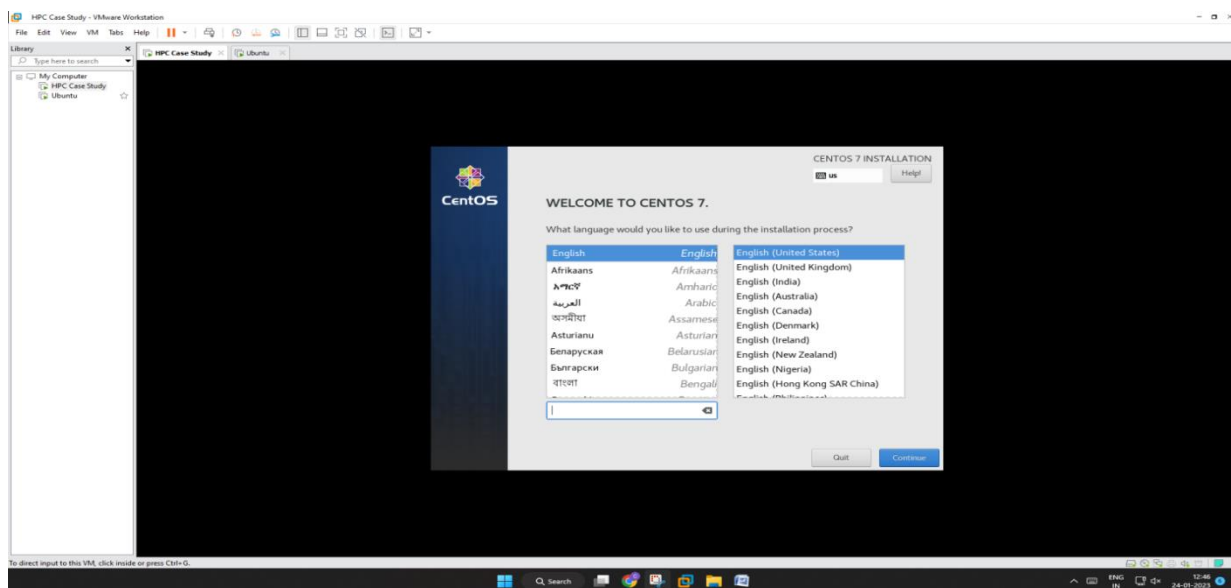
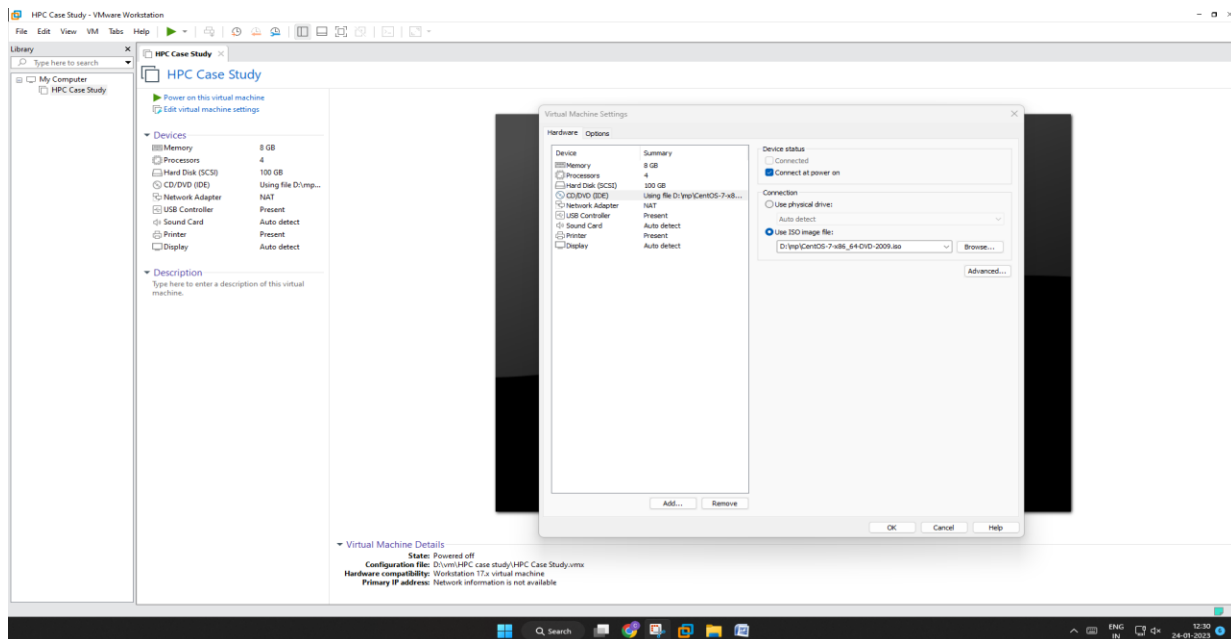
*Internet connectivity

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 BootfromtheCentOS*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
```

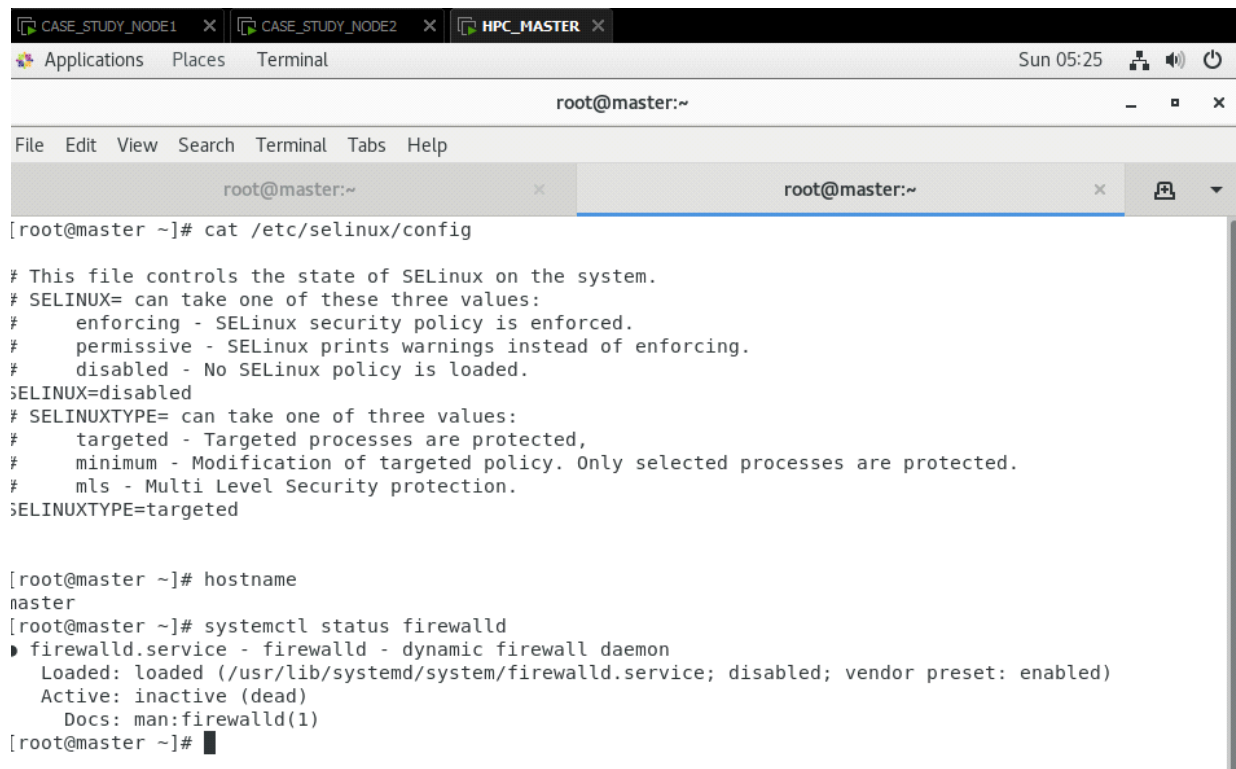
```
[root@master ~]#
```

```
# 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

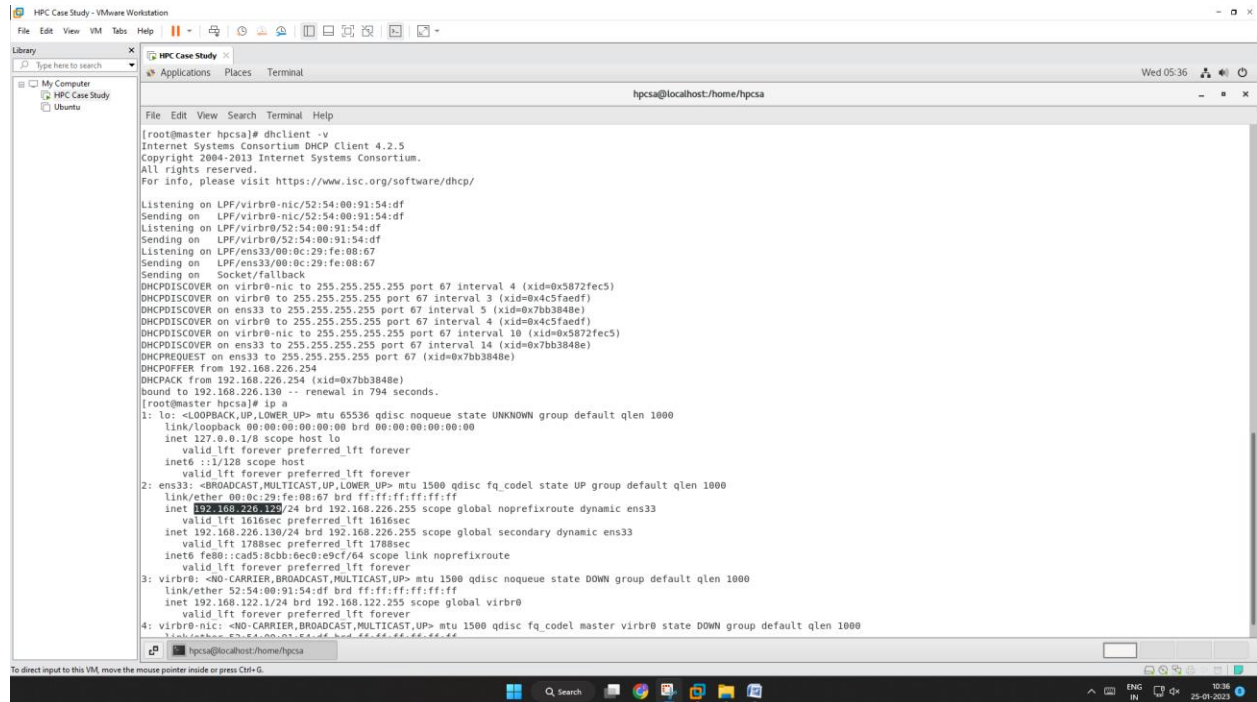
# This file controls the state of SELinux on the system.
# SELINUX= can take one of these three values:
#   enforcing - SELinux security policy is enforced.
#   permissive - SELinux prints warnings instead of enforcing.
#   disabled - No SELinux policy is loaded.
SELINUX=disabled
# SELINUXTYPE= can take 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
  Type here to search
  My Computer
  HPC Case Study
  Ubuntu

HPC Case Study
Applications Places Terminal
hpcs@localhost/home/hpcs

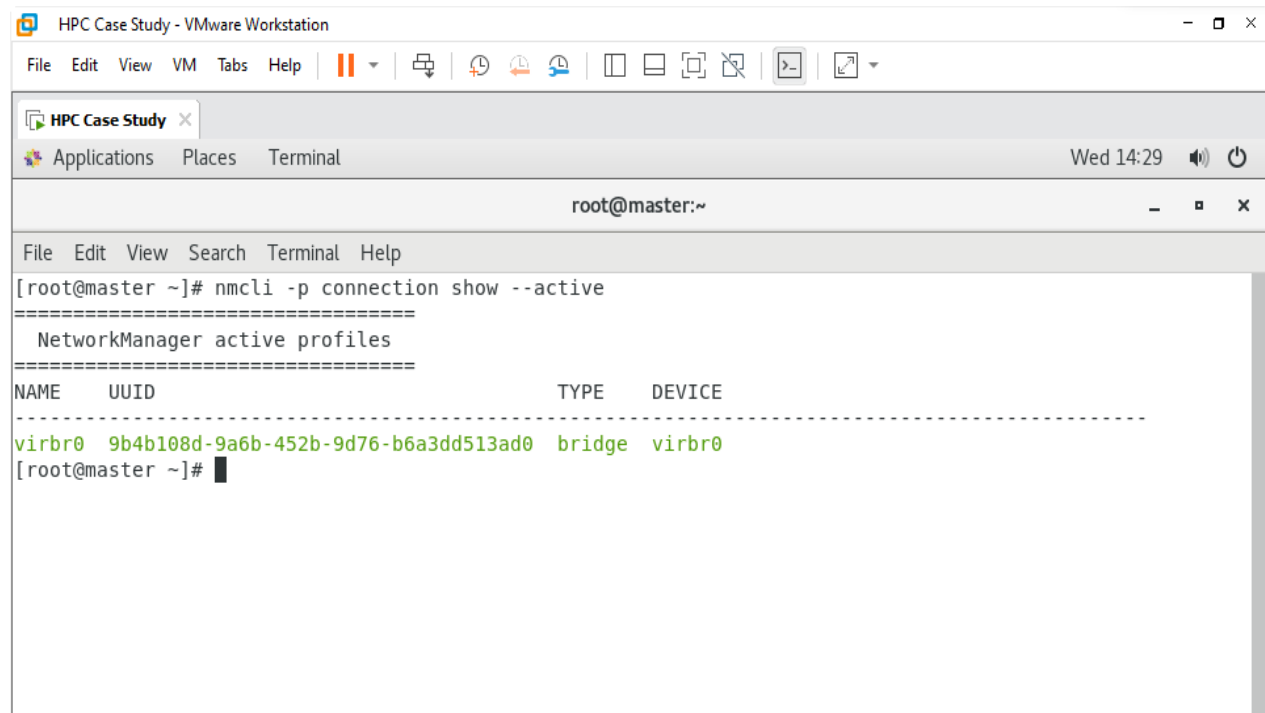
File Edit View Search Terminal Help

[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 LPF/virbr0-nic/52:54:00:91:54:df
Sending on LPF/virbr0-nic/52:54:00:91:54:df
Listening on LPF/virbr0/52:54:00:91:54:df
Sending on LPF/virbr0/52:54:00:91:54:df
Listening on LPF/ens33/00:0c:29:fe:00:07
Sending on LPF/ens33/00:0c:29:fe:00:07
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 (xid=0x7bb3848e)
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:00:07 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 1708sec preferred_lft 1708sec
    inet6 fe80::cad5:8cbb:6ec0: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
    inet 192.168.122.1/24 brd 192.168.122.255 scope global virbr0-nic
        valid_lft forever preferred_lft forever

```

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



```

HPC Case Study - VMware Workstation
File Edit View VM Tabs Help
Library
  Type here to search
  My Computer
  HPC Case Study
  Ubuntu

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.

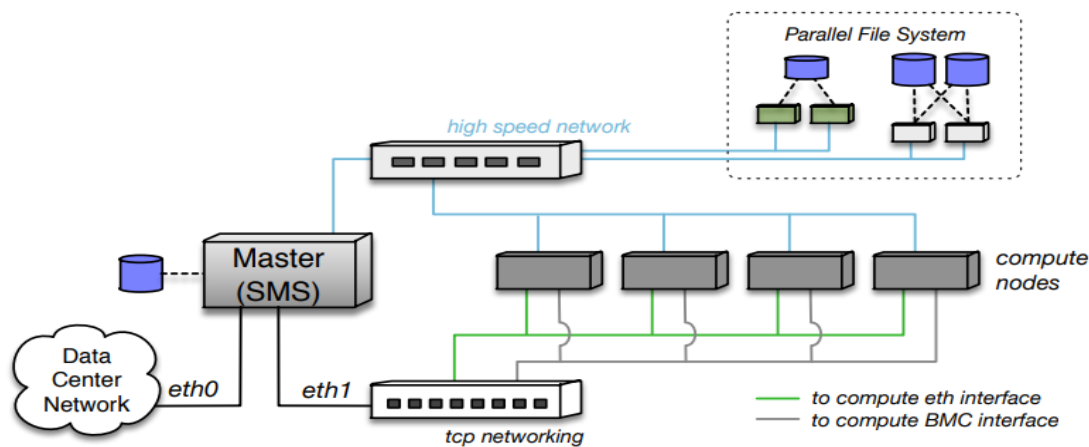


Figure 1: Overview of physical cluster architecture.

#Yum install

http://build.openhpc.community/OpenHPC:/1.3/CentOS_7/aarch64/ohpc-release-1.3-1.el7.aarch64.rpm

yum -y install ohpc-base


```

[ww_slurm_master]
Applications Places Terminal
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

```

```

ww_slurm_master
Applications Places Terminal
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-slurmdbd-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-perlapi-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-slurmdbd-ohpc                   x86_64            18.08.8-4.1.ohpc.1.3.8.1            OpenHPC-updates    656 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 | 510 kB/s | 4.9 MB 00:00:30 ETA
[9/12]: slurm-slurmctld-ohpc-18.08.8-4.1.ohpc.1.3.8.1.x86_64.rpm 24% [=====]

root@master:~

```

wwininit database

wwininit ssh_keys

```

ww_slurm_master
Applications Places Terminal
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 OK
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 OK
Database: + mysql --defaults-extra-file=/tmp/0.iHbEUSARUByk/my.cnf ware OK
Database: + mysql --defaults-extra-file=/tmp/0.iHbEUSARUByk/my.cnf ware OK
Database: Checking binstore kind SUCCESS
Done.
[root@master ~]# wwininit ssh_keys
ssh_key: Checking ssh Keys for root OK
ssh_key: Checking root's ssh config OK
ssh_key: Checking for default RSA host key for nodes OK
ssh_key: Creating default node ssh host rsa key: OK
ssh_key: + ssh-keygen -q -t rsa -f /etc/warewolf/vnfs/ssh/ssh_host_rsa OK
ssh_key: Checking for default DSA host key for nodes OK
ssh_key: Creating default node ssh host dsa key: OK
ssh_key: + ssh-keygen -q -t dsa -f /etc/warewolf/vnfs/ssh/ssh_host_dsa OK
ssh_key: Checking for default ECDSA host key for nodes OK
ssh_key: Creating default node ssh host ecdsa key: OK
ssh_key: Checking for default Ed25519 host key for nodes OK
ssh_key: Creating default node ssh host ed25519 key: OK
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 ~# echo "master:/home /home nfs nfsvers=3,nodev,nosuid 0 0" >> $CHROOT/etc/fstab
root@master ~# echo "master:/opt/ohpc/pub /opt/ohpc/pub nfs nfsvers=3,nodev 0 0" >> $CHROOT/etc/fstab
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
root@master ~# echo "/home *(rw,no_subtree_check,fsid=10,no_root_squash)" >> /etc/exports
root@master ~# echo "/opt/ohpc/pub *(ro,no_subtree_check,fsid=11)" >> /etc/exports
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
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 ~# exportfs -arv
exporting *: /opt/ohpc/pub
exporting *: /home
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: 5640D81C-C8BD-0A0D-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
        UND code segment 9000:0000, data segment 9045:5960 (609-635kB)
        UND device is PCI 02:01:0, type DIX-082.3
        609kB free base memory after PXE unload
IPXE initialising devices...ok

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

net0: 00:0c:29:ec:16:c2 using undionly on 0000:02:01:0 (open)
[Linkup, TX:0 TXE:1 RX:0 PXE: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: whci-hcd ehci-hcd ehci-hcd whci-hcd ispi16x-hcd ispi362-hcd xhc OK
l-hcd s1011-hcd sd-mmc-ahci-nvme OK
Detecting hardware: ata_piix ata_piix mptspi e1000 OK
Bringing up local loopback network: OK
Checking for network device: 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 HW 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
* mountimg / 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.

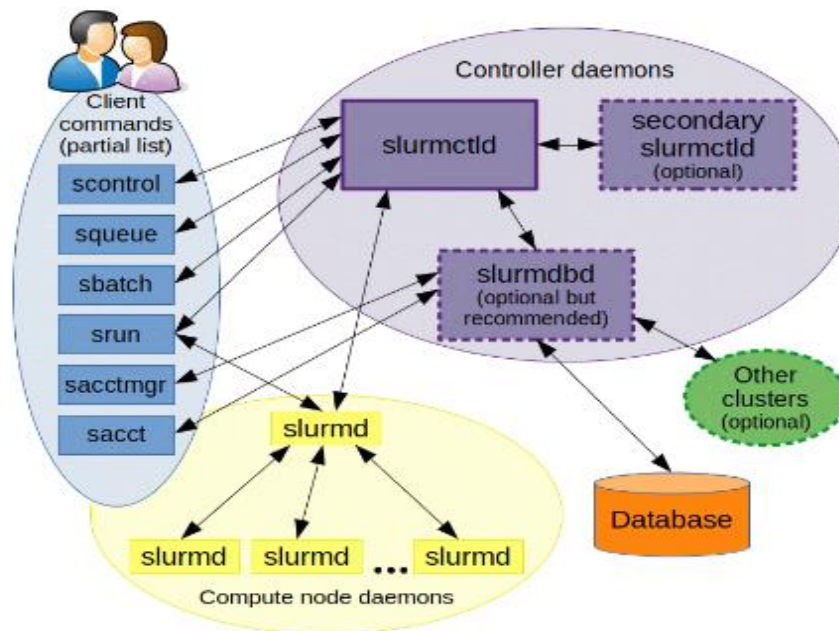


Figure 1. Slurm components

```
# 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

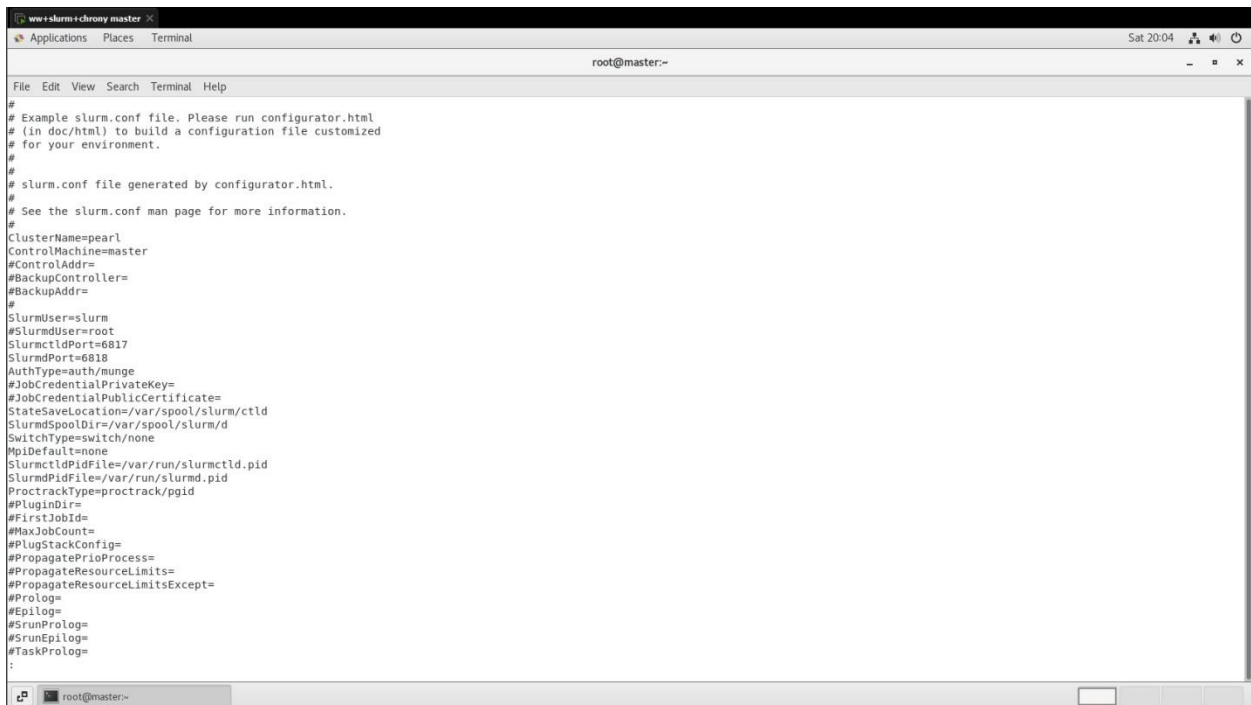
# yum -y --installroot=${CHROOT} install \

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

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

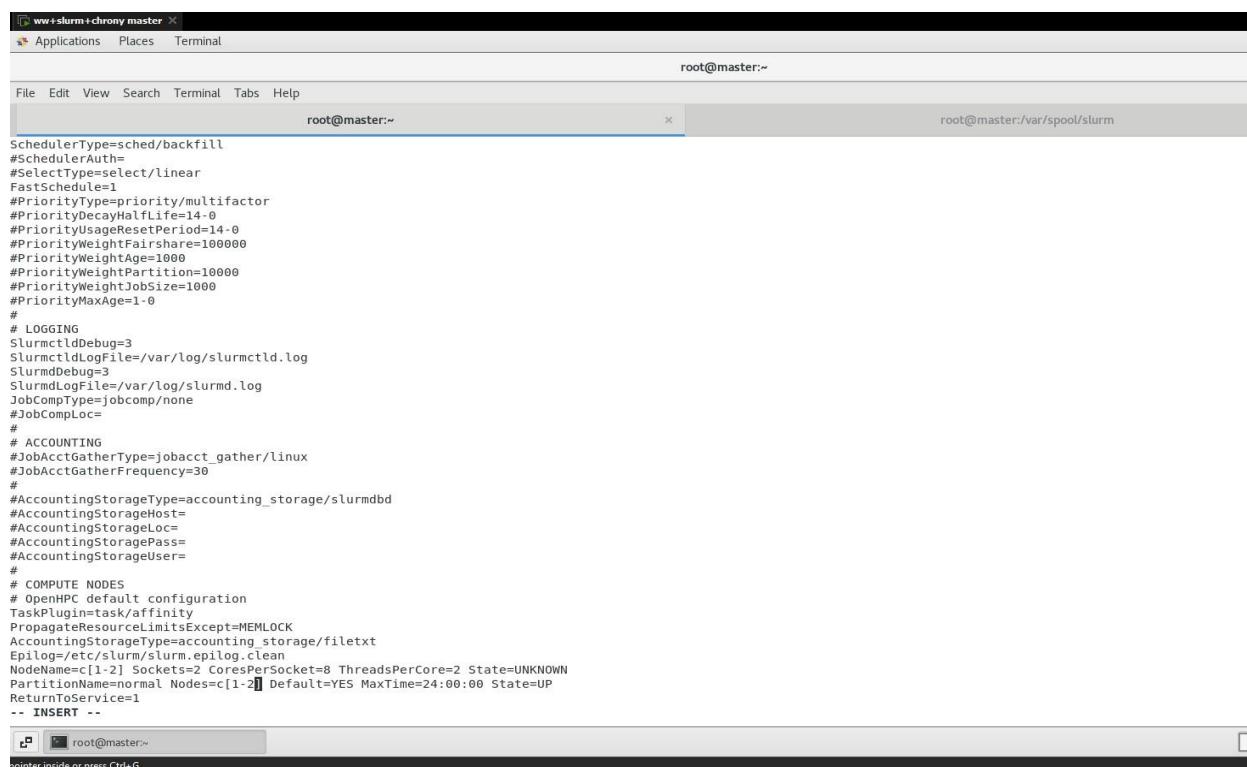
sysstat gcc make xauth firefox squashfs-tools
```

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
SlurmctlPort=6817
SlurmPort=6818
AuthType=auth/munge
#JobCredentialPrivateKey=
#JobCredentialPublicKey=
StateSaveLocation=/var/spool/slurm/ctld
SlurmSpoolDir=/var/spool/slurm/d
SwitchType=switch/none
MpiDefault=none
SlurmctlPidFile=/var/run/slurmctl.pid
SlurmPidFile=/var/run/slurmd.pid
ProctrackType=proctrack/pgid
#PluginDir=
#FirstJobId=
#MaxJobCount=
#PlugStackConfig=
#PropagatePriorProcess=
#PropagateResourceLimits=
#PropagateResourceLimitsExcept=
#Prolog=
#Epilog=
#SrunProlog=
#SrunEpilog=
#TaskProlog=
:
```



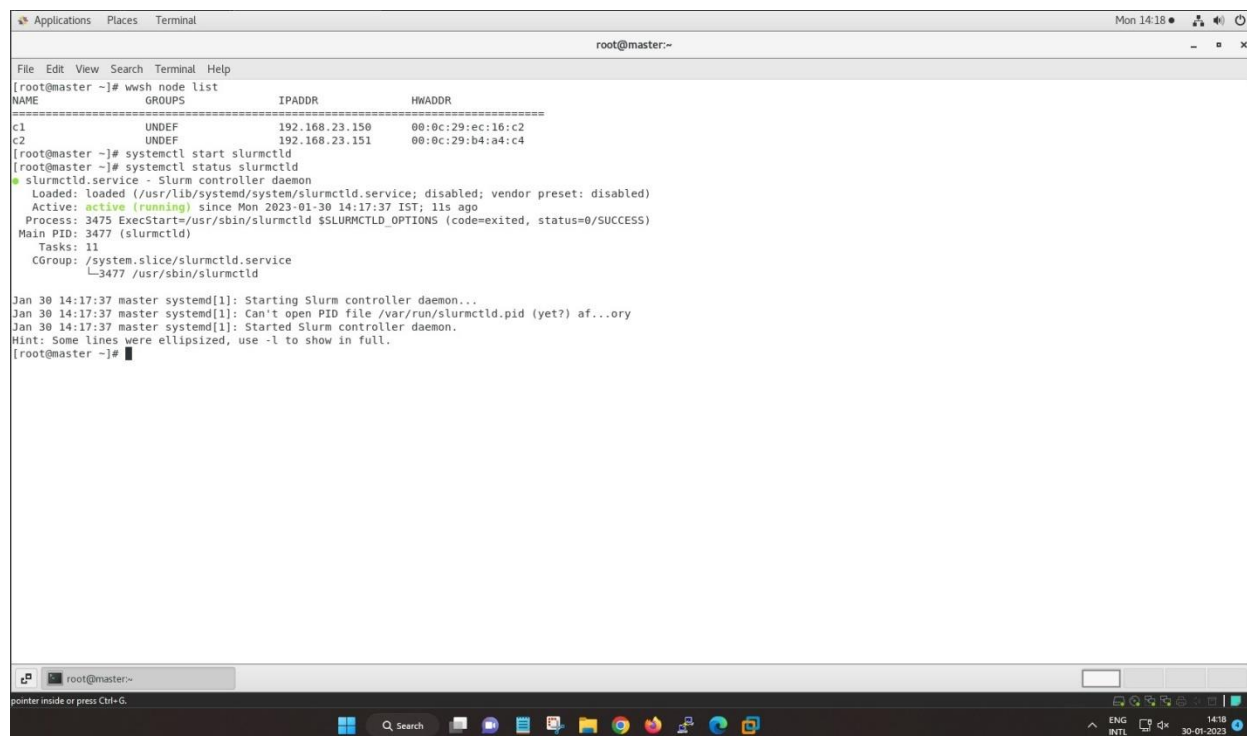
```

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=c1:2 Sockets=2 CoresPerSocket=8 State=UNKNOWN
PartitionName=normal Nodes=c1:2 Default=YES MaxTime=24:00:00 State=UP
ReturnToService=1
-- INSERT --

```

systemctl status slurmctld

Slurm status on master



```

[root@master ~]# wssh 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.

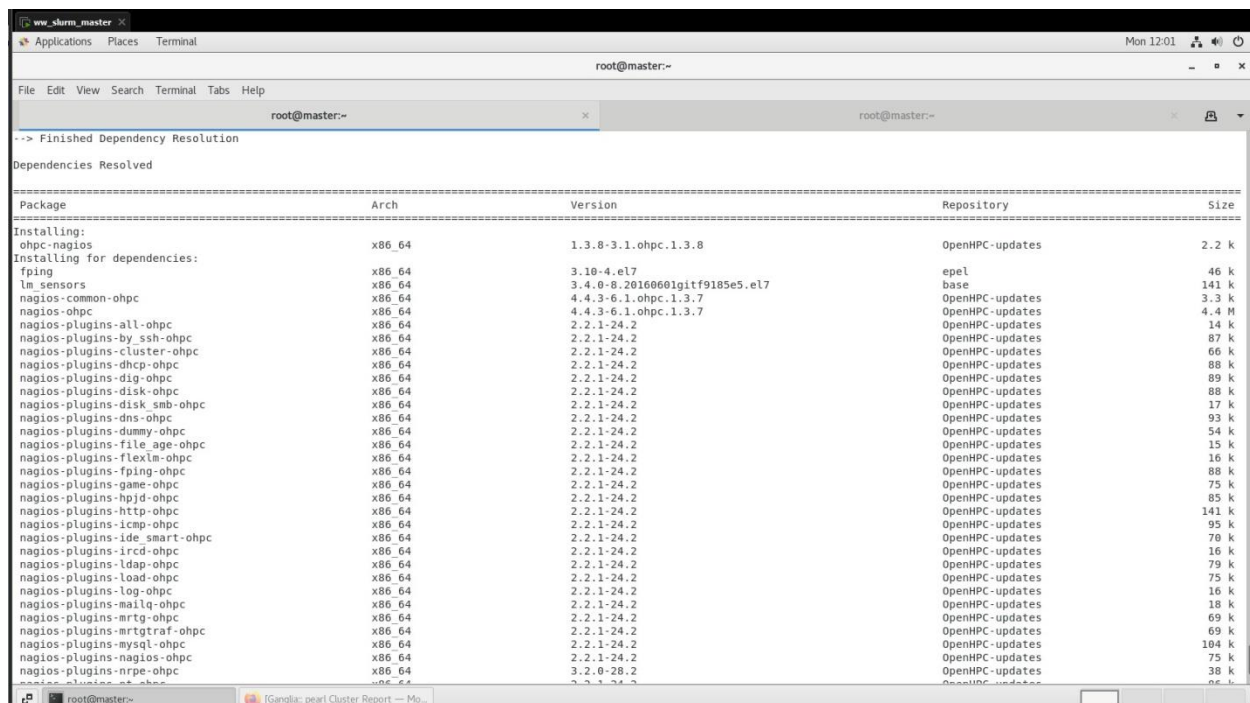
```
# yum -y install ohpc-nagios -> Install Nagios meta-package on master host
```

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

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

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

Nagios Packages:



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:				
rpm	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-game-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-ntfs-ohpc	x86_64	2.2.1-24.2	OpenHPC-updates	86 k

Nagios Configuration file:

```

Applications Places Terminal
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 --

```

```

www_slurm_master
Applications Places Terminal
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 $CHR00T/etc/nagios/nrpe.cfg
[root@master ~]# echo command[check_ssh]=usr/lib64/nagios/plugins/check_ssh master >> $CHR00T/etc/nagios/nrpe.cfg
[root@master ~]# httpasswd -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 ExecStart=/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: Mon Jan 30 12:16:01 IST 2023
Updated every 30 seconds
Nagios® Core™ 4.4.3 - www.nagios.org
Logged in as nagiosadmin

Host Status Totals
Up Down Unreachable Pending
1 0 0 2
All Problems: All Types
0 3

Service Status Totals
Ok Warning Unknown Critical Pending
0 0 0 0 18
All Problems: All Types
0 18

Host Status Details For All Host Groups

Limit Results: 100

Host	Status	Last Check	Duration	Status Information
localhost	UP	01-30-2023 12:14:46	0d 0h 1m 16s+	PING OK - Packet loss = 0%, RTA = 0.09 ms
node1	PENDING	N/A	0d 0h 1m 16s+	Host check scheduled for Mon Jan 30 12:16:25 IST 2023
node2	PENDING	N/A	0d 0h 1m 16s+	Host check scheduled for Mon Jan 30 12:16:05 IST 2023

Results 1 - 3 of 3 Matching Hosts

Page Tour

Nagios®

Current Network Status
Last Updated: Mon Jan 30 12:59:53 IST 2023
Updated every 30 seconds
Nagios® Core™ 4.4.3 - www.nagios.org
Logged in as nagiosadmin

Host Status Totals
Up Down Unreachable Pending
1 2 0 0
All Problems: All Types
2 3

Service Status Totals
Ok Warning Unknown Critical Pending
6 2 0 10 0
All Problems: All Types
12 18

Host Status Details For All Host Groups

Limit Results: 100

Host	Status	Last Check	Duration	Status Information
localhost	UP	01-30-2023 12:58:38	0d 0h 45m 7s	PING OK - Packet loss = 0%, RTA = 0.08 ms
node1	DOWN	01-30-2023 12:55:54	0d 0h 43m 28s	CRITICAL - Host Unreachable (192.168.23.150)
node2	DOWN	01-30-2023 12:57:41	0d 0h 41m 48s	CRITICAL - Host Unreachable (192.168.23.151)

Results 1 - 3 of 3 Matching Hosts

Page Tour

Node1 & Node2 showed

GANGLIA

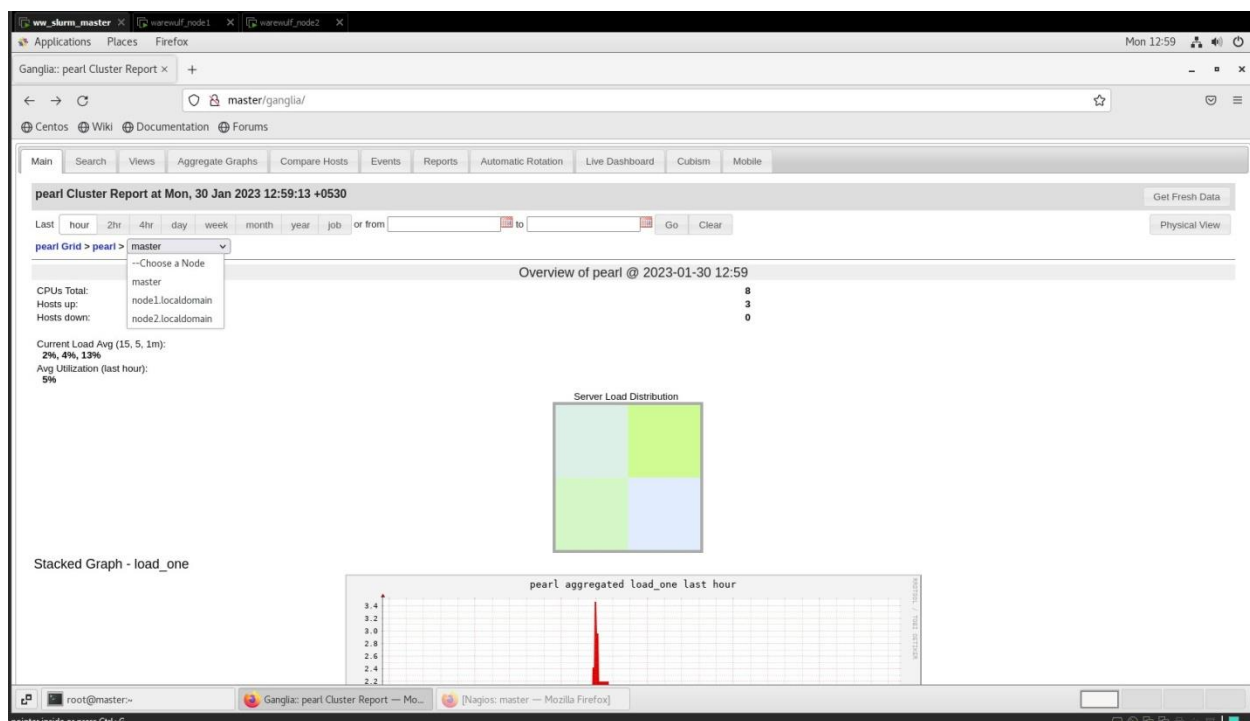
Ganglia is **an open-source scalable distributed monitoring system for high-performance computing systems such as clusters and Grids**. It is carefully engineered to achieve very low per-node overheads and high concurrency.

```
# 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
```

```
commit-frame-pointer -O3 -funit-100ps -O /root/Downloads/hpl-2.3/bin/Linux_PII_CBLAS
t.o /root/Downloads/hpl-2.3/lib/Linux_PII_CBLAS/libhpl.a /usr/lib64/atlas/libcblas.
mpi.so
gcc: error: /usr/lib64/atlas/libcblas.so.3: No such file or directory
gcc: error: /usr/lib64/atlas/libatlas.so.3: No such file or directory
make[2]: *** [dexe.grd] Error 1
make[2]: Leaving directory `/root/Downloads/hpl-2.3/testing/ptest/Linux_PII_CBLAS'
make[1]: *** [build_tst] Error 2
make[1]: Leaving directory `/root/Downloads/hpl-2.3'
make: *** [build] Error 2
[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
```


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
```

Cammands History

Work-Flow Commands:

Configuring Warewulf, Slurm, Nagios, Ganglia

Link1: [ohpc-warewulf-slurm-nagios-ganglia.txt](#)

Configuring HPL Benchmarking

Link2: [hpl benchmarking.txt](#)