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.

Group Members:

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REQUIREMENTS

Hardware requirements:

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

Software requirements:

- Vmware workstation
- Centos 7 iso

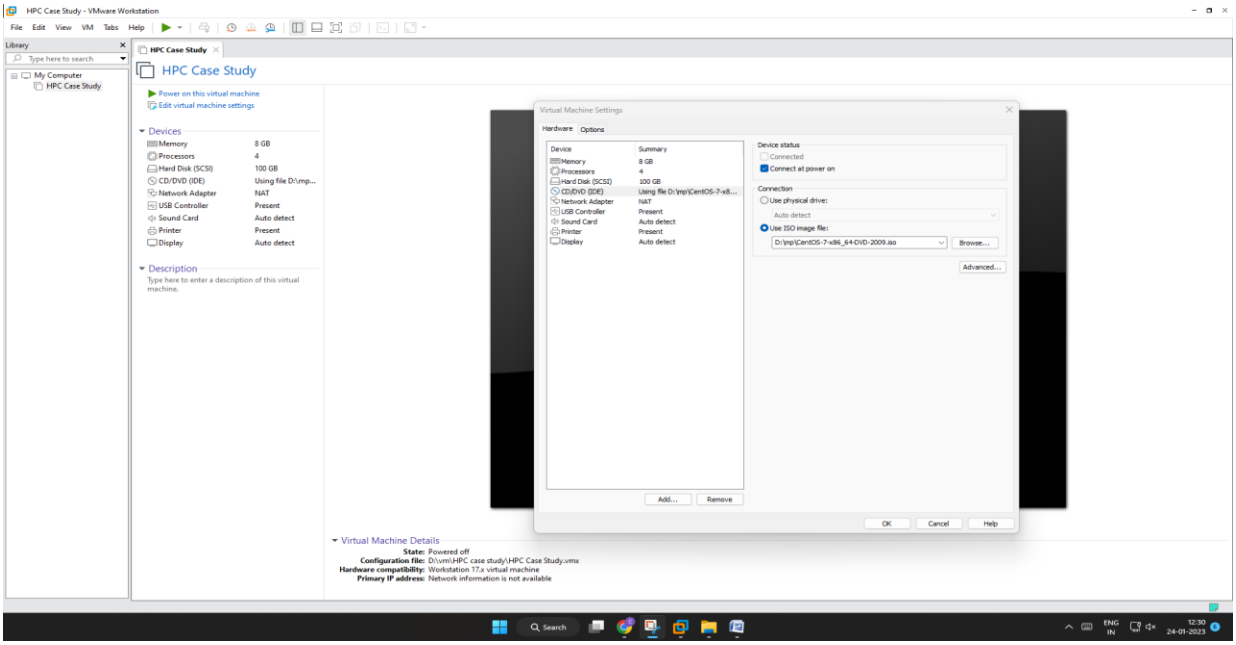
*Internet connectivity

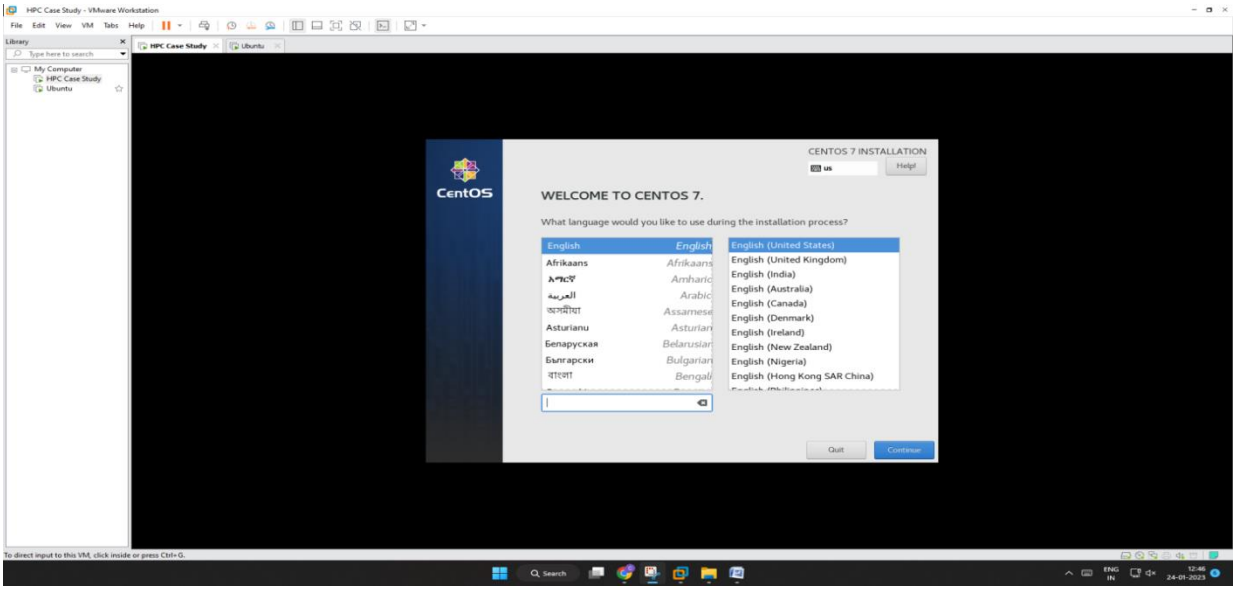
INSTALLATION

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

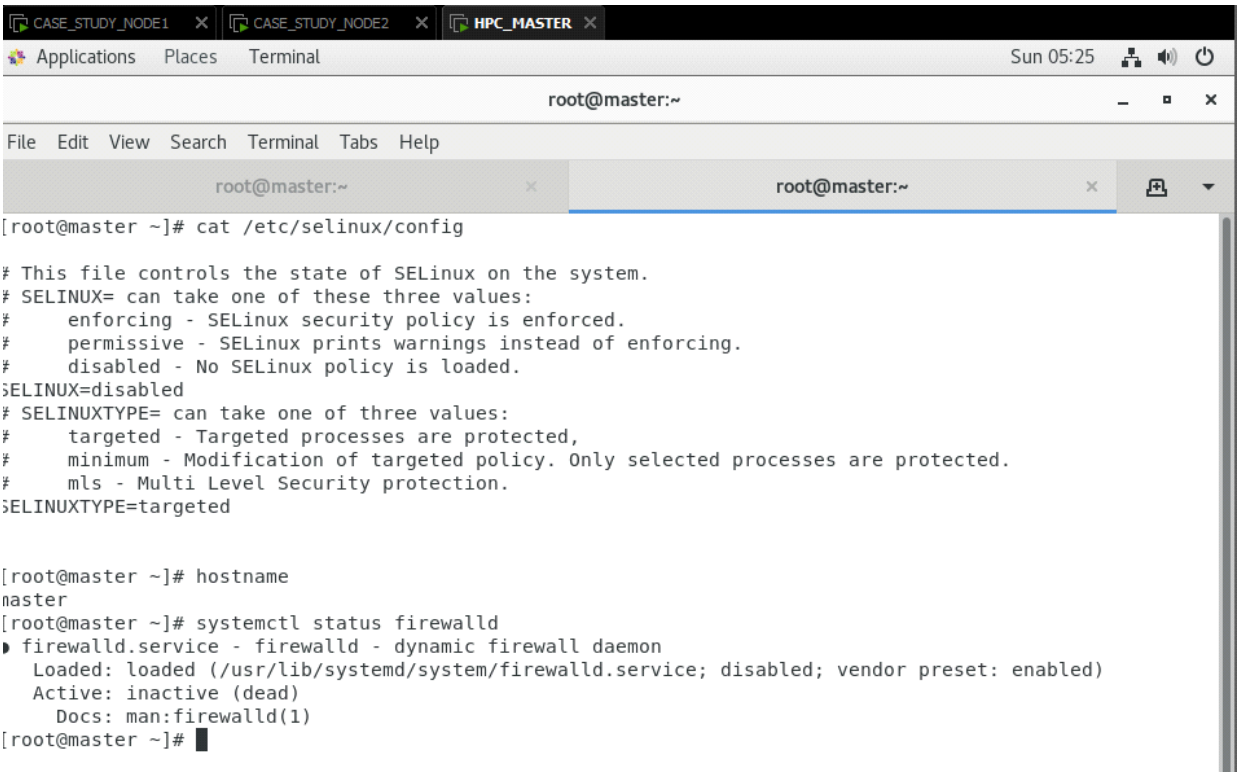
[root@master ~]#

systemctl stop firewalld

#systemctl disable firewalld

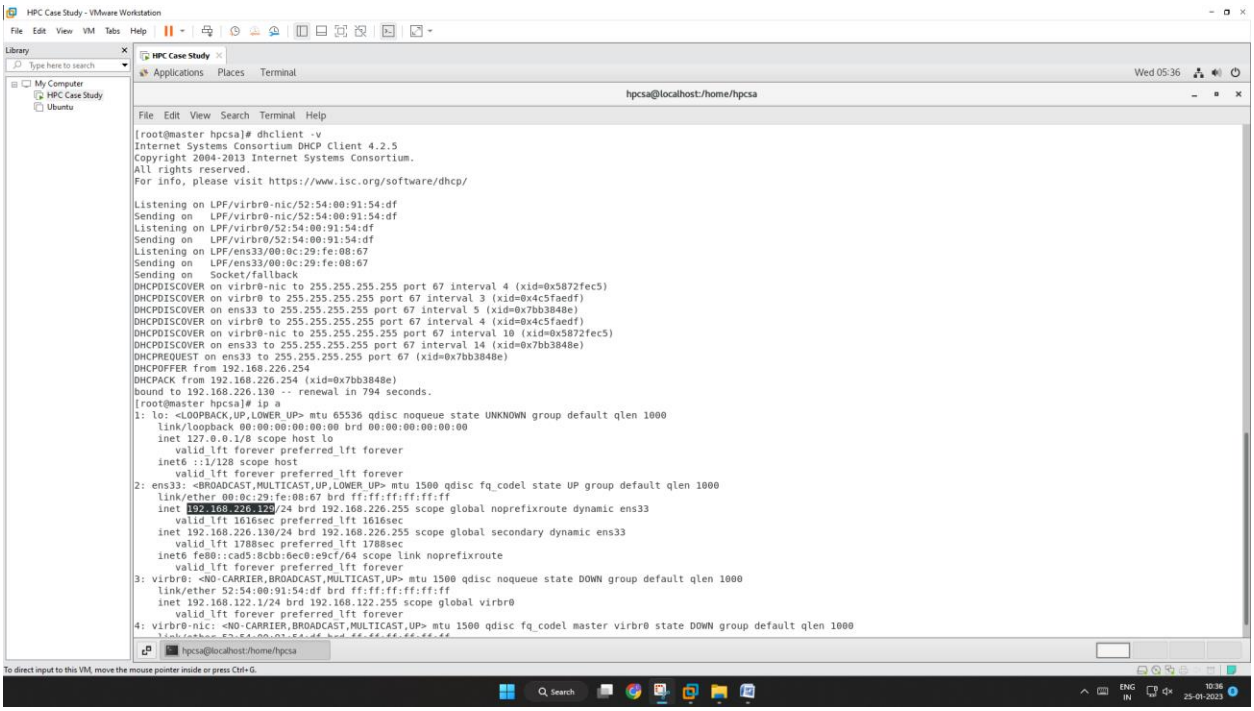
vi /etc/selinux/conf

- Change enforcing to disabled

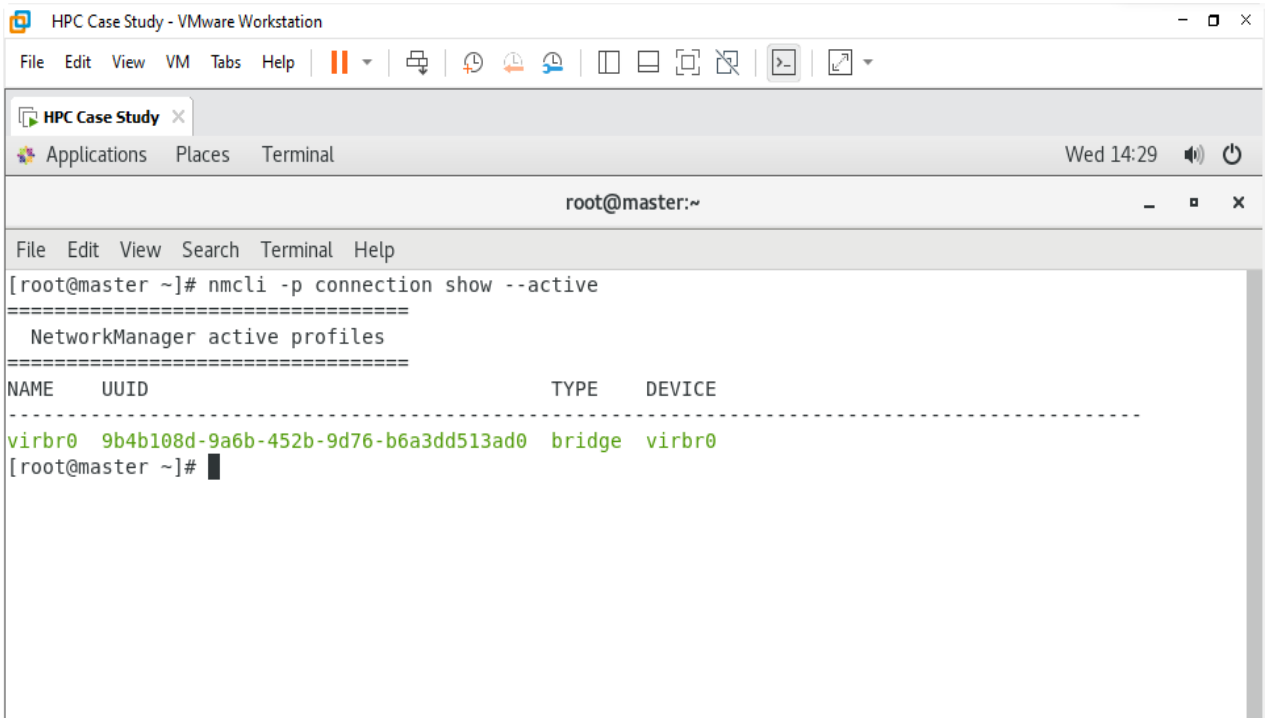


dhclient -v

ip a



nmcli -p connection show --active



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.

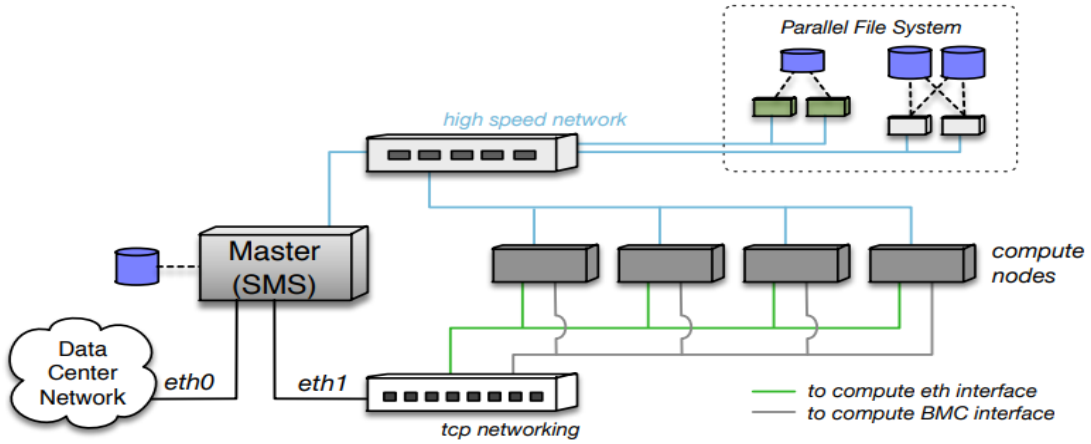
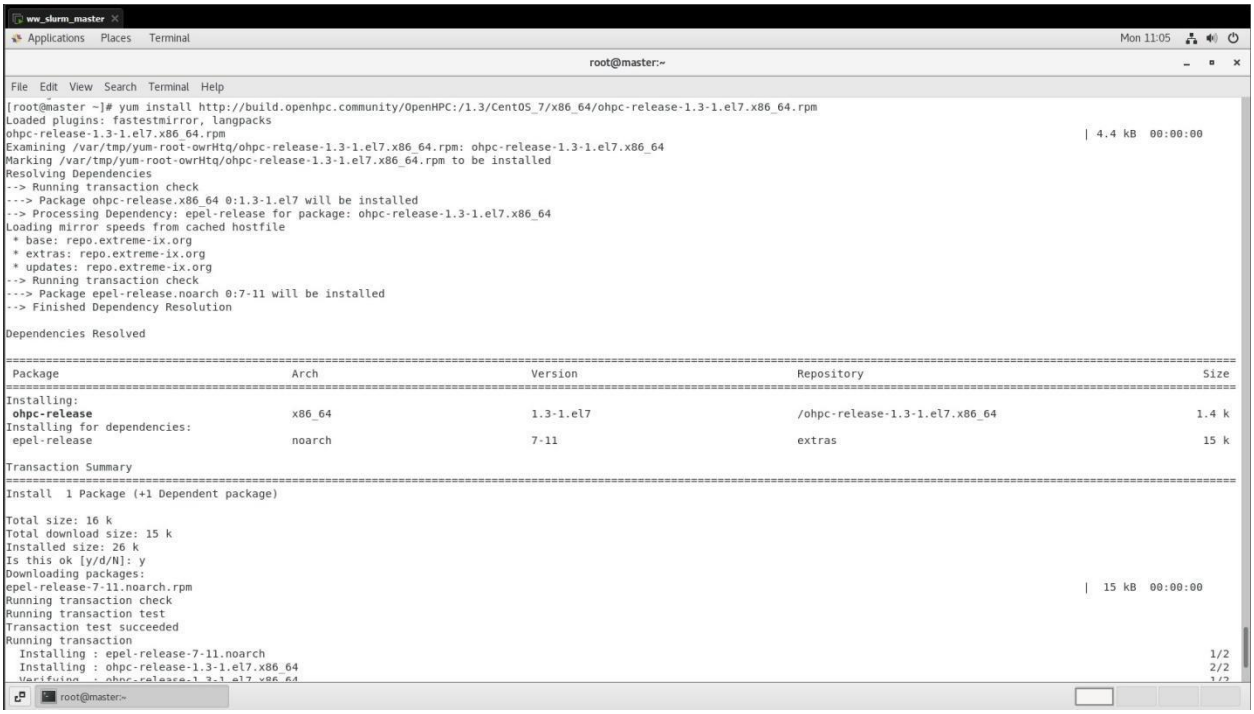
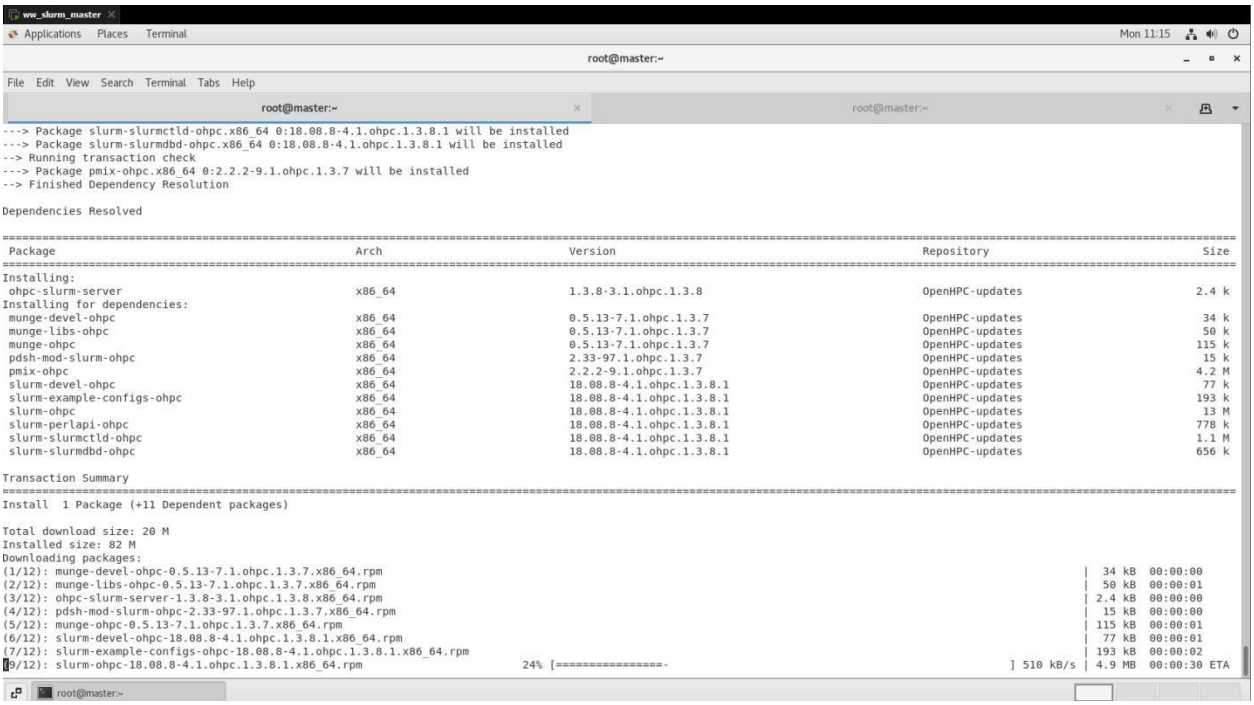


Figure 1: Overview of physical cluster architecture.

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

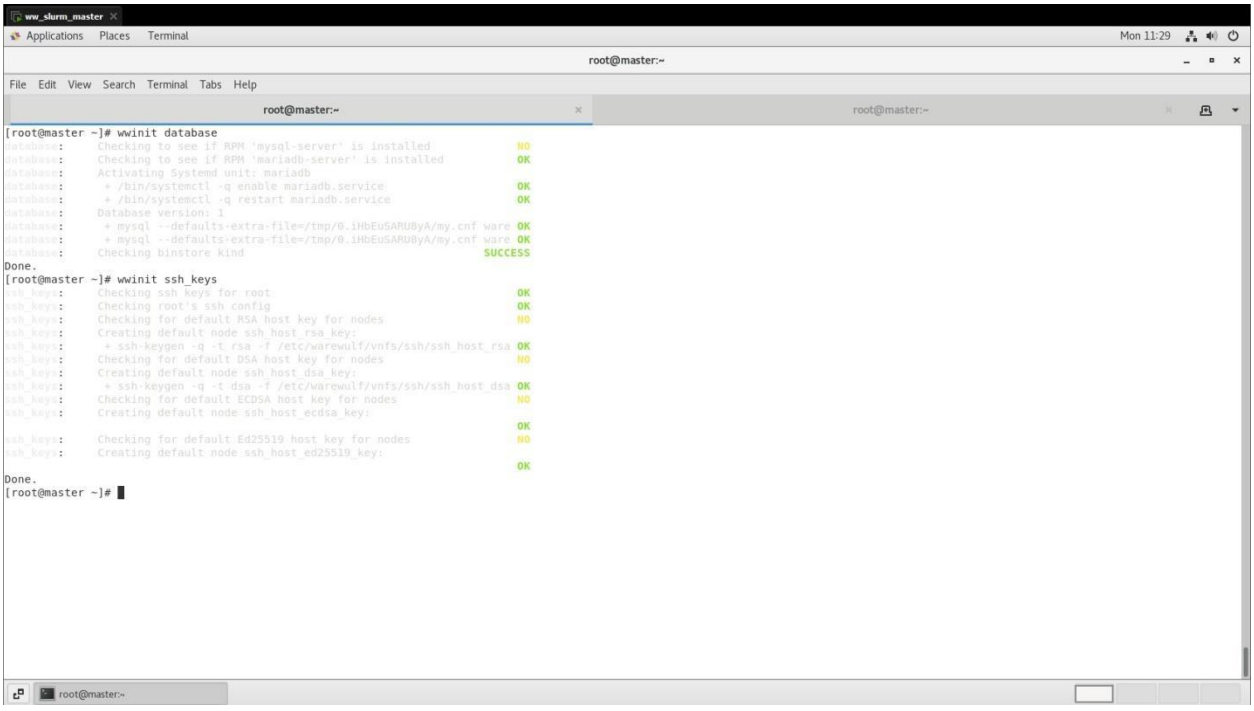
yum -y install ohpc-base


ww_slurm_master
Applications Places Terminal
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-owrHtq/ohpc-release-1.3-1.el7.x86_64.rpm: ohpc-release-1.3-1.el7.x86_64
Marking /var/tmp/yum-root-owrHtq/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
root@master:~



wwinit database

wwinit ssh_keys



df -hT | grep -v tmpfs

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

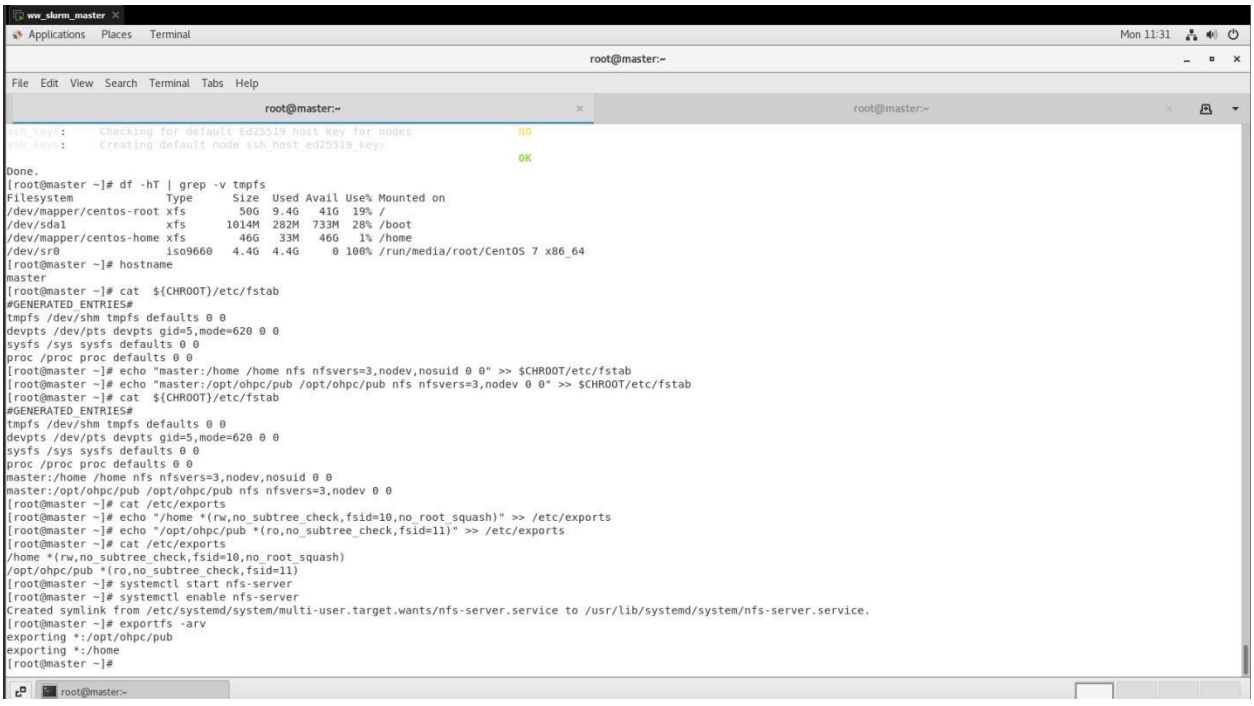
echo "master:/opt/ohpc/pub /opt/ohpc/pub nfs nfsvers=3,nodev 0 0" >> $CHROOT/etc/fstab

cat ${CHROOT}/etc/fstab

cat /etc/exports

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

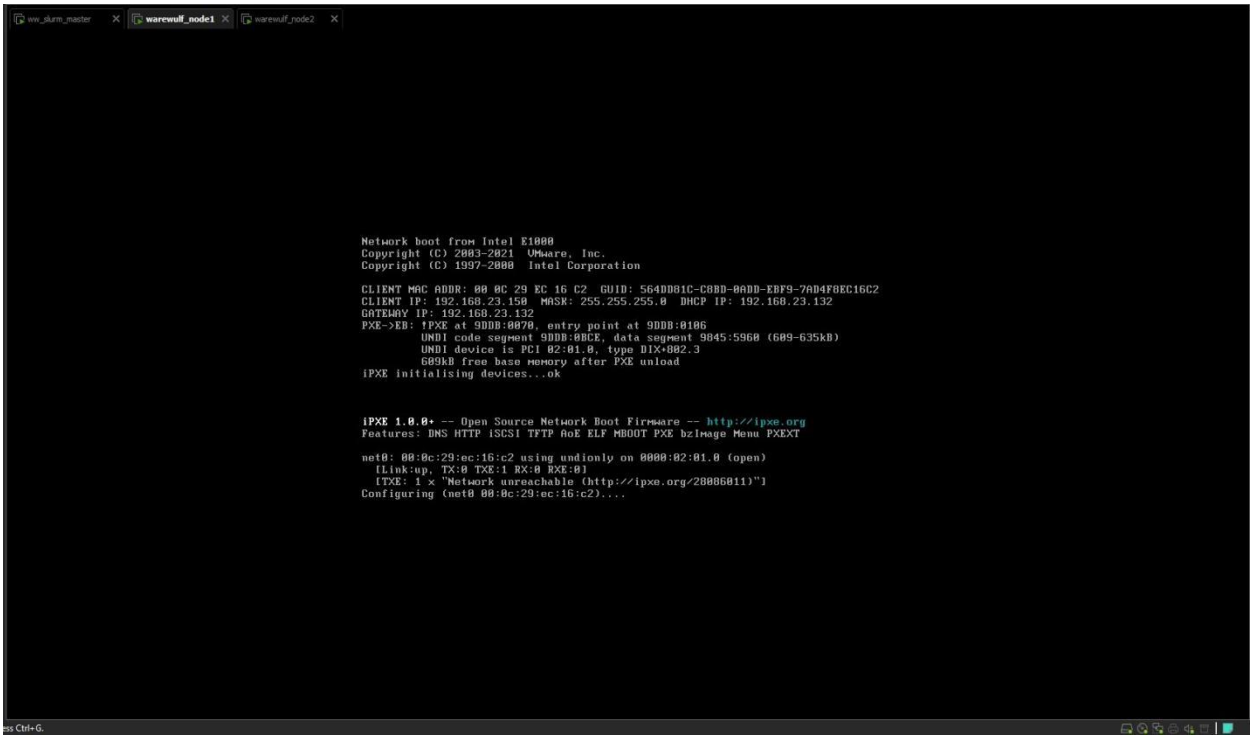
echo "/opt/ohpc/pub *(ro,no_subtree_check,fsid=11)" >> /etc/exports

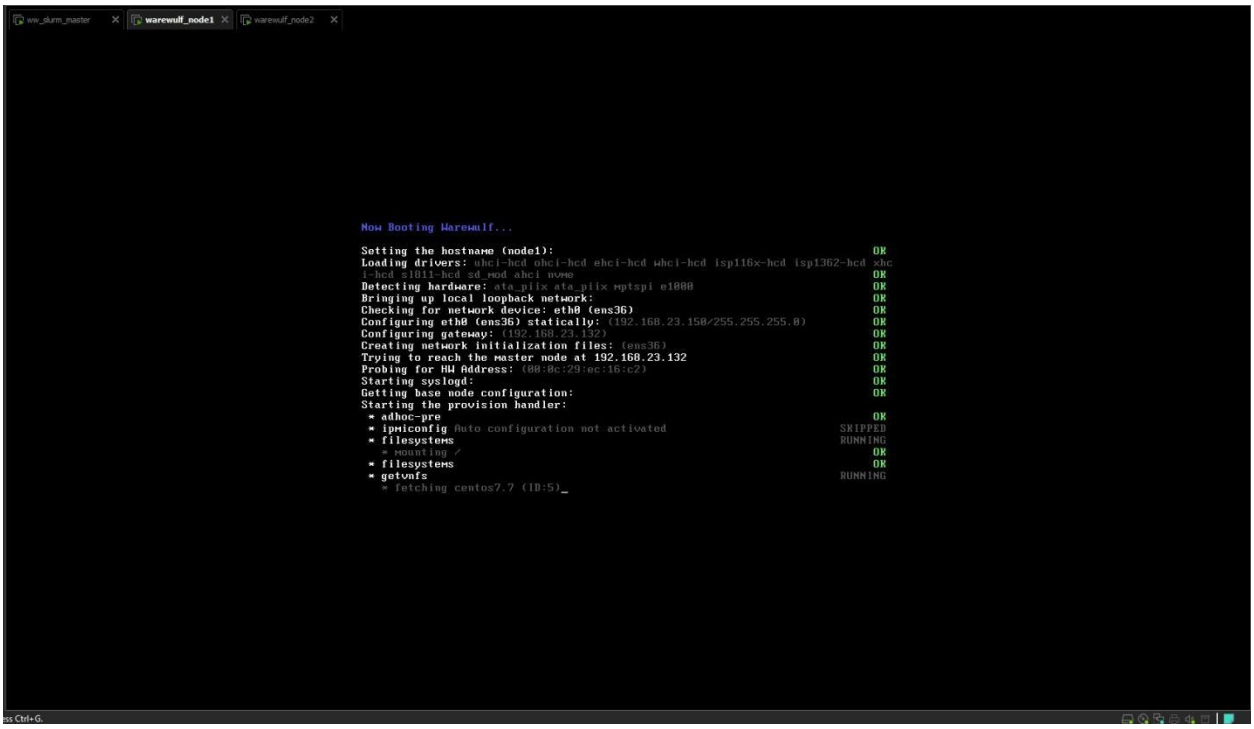


systemctl start nfs-server

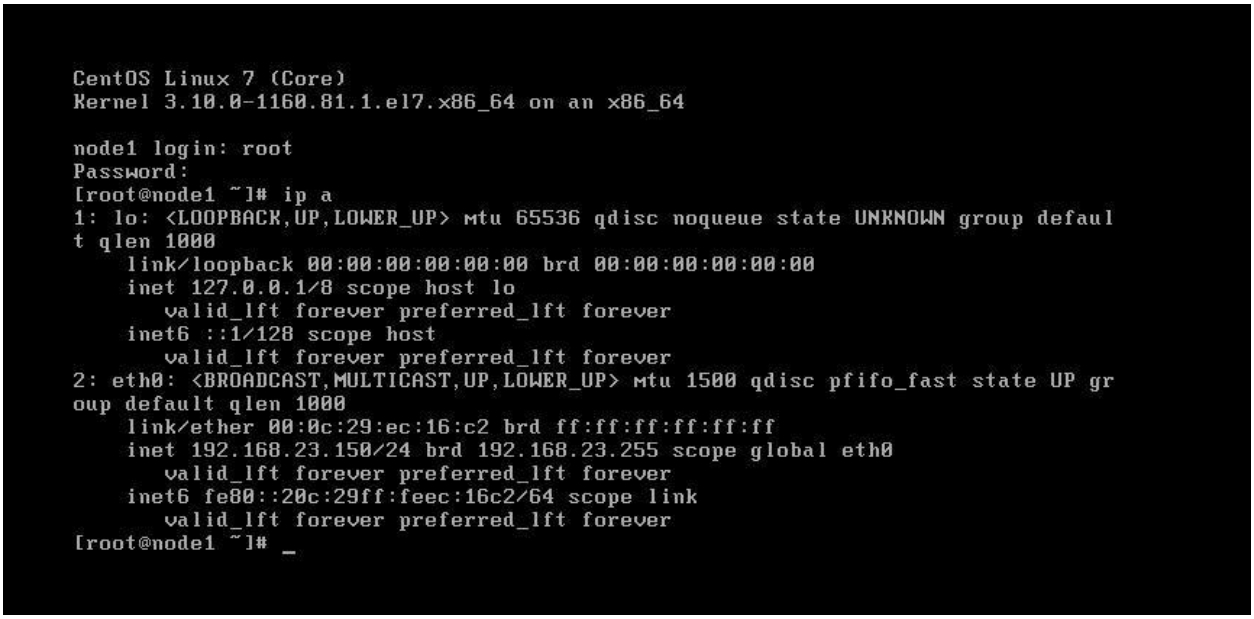
systemctl enable nfs-server

Booting Disk-less Node





ip a (Booted node)



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.

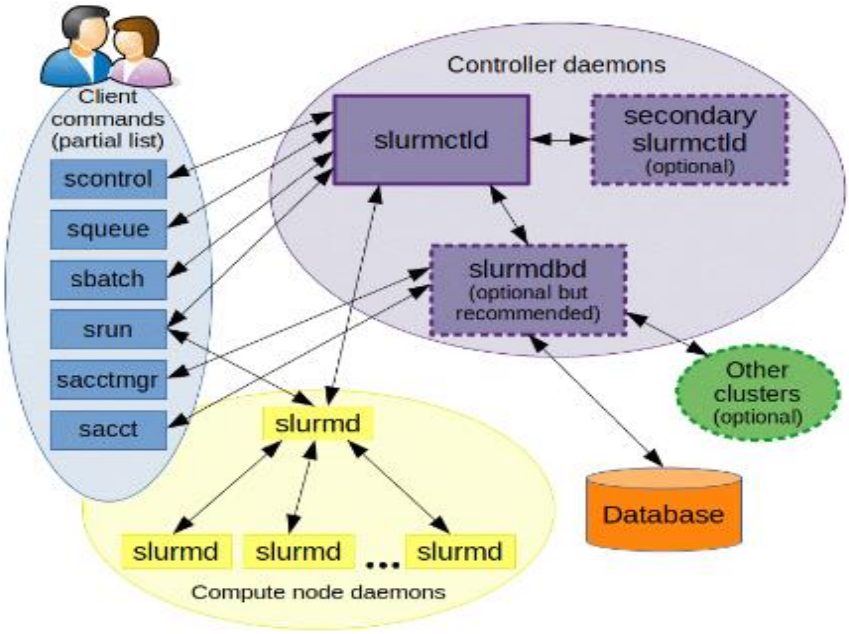


Figure 1. Slurm components

yum -y install ohpc-slurm-server

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

vi /etc/slurm/slurm.conf

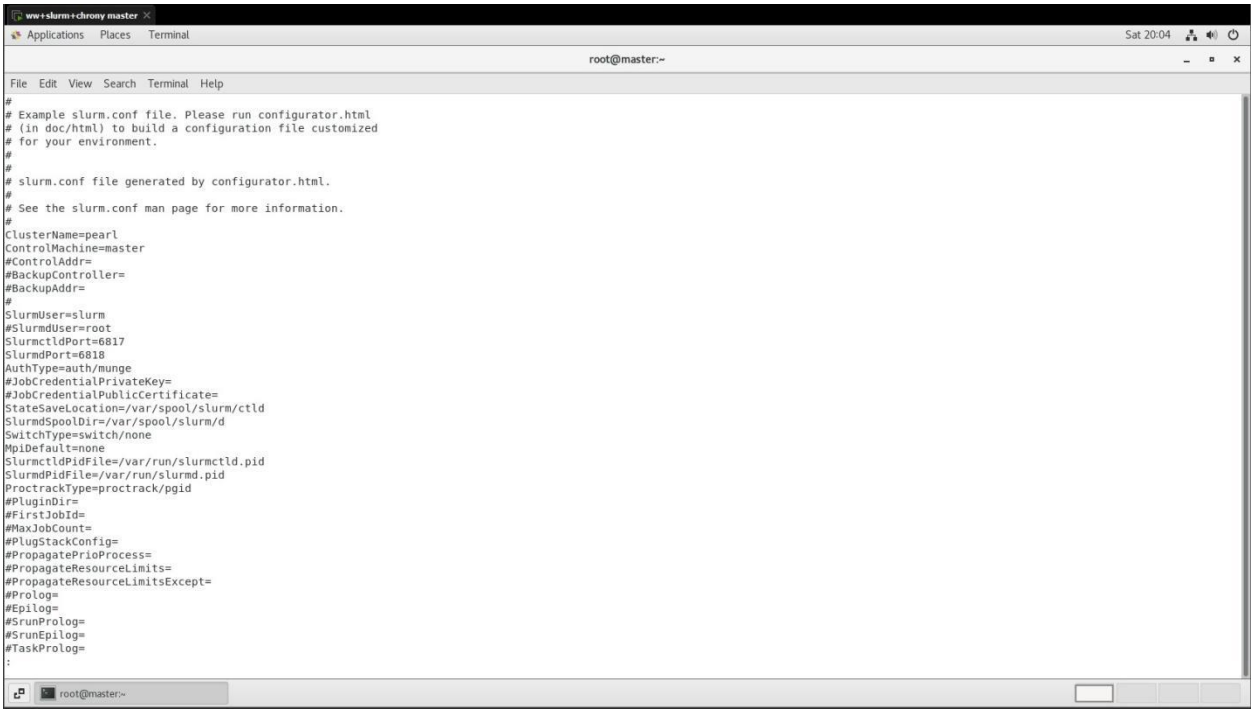
edit -> ClusterName=pearl

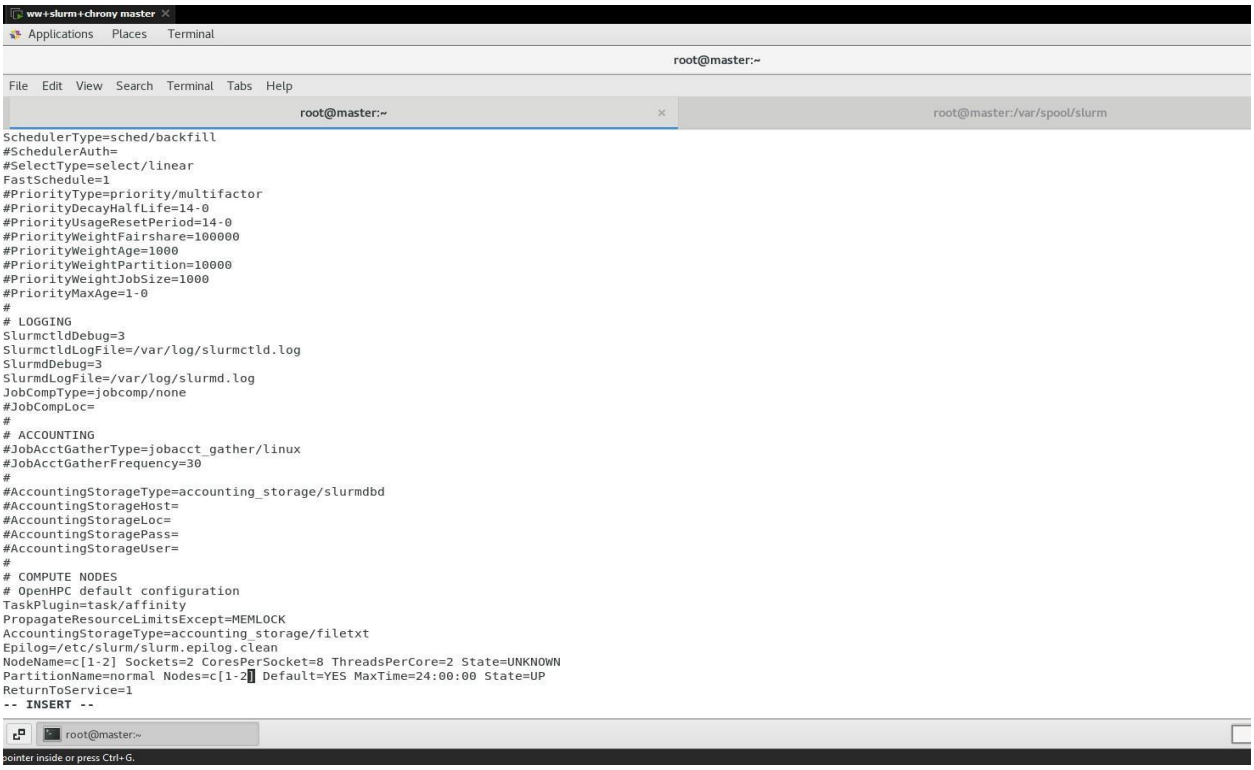
-> ControlMachine=master

-> 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 htop ipmitool glibc* perl perl-CPAN perl-CPAN \
 sysstat gcc make xauth firefox squashfs-tools
```

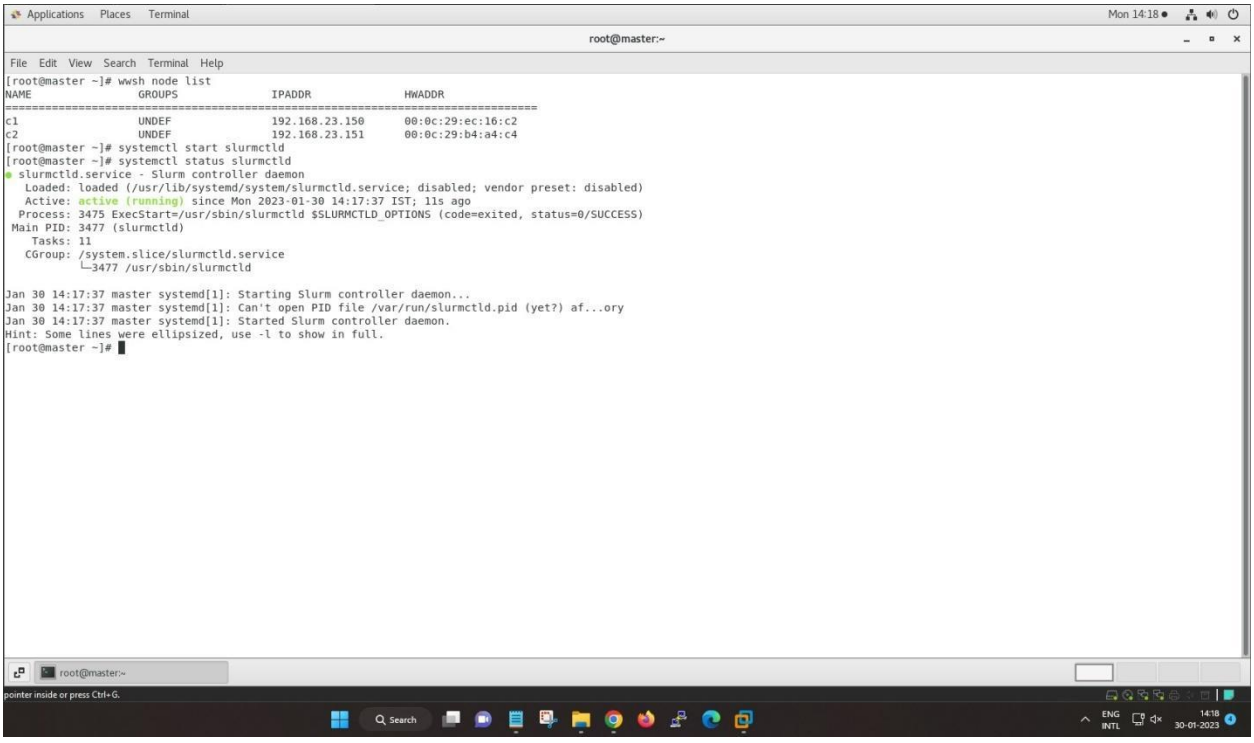
Slurm Configuration





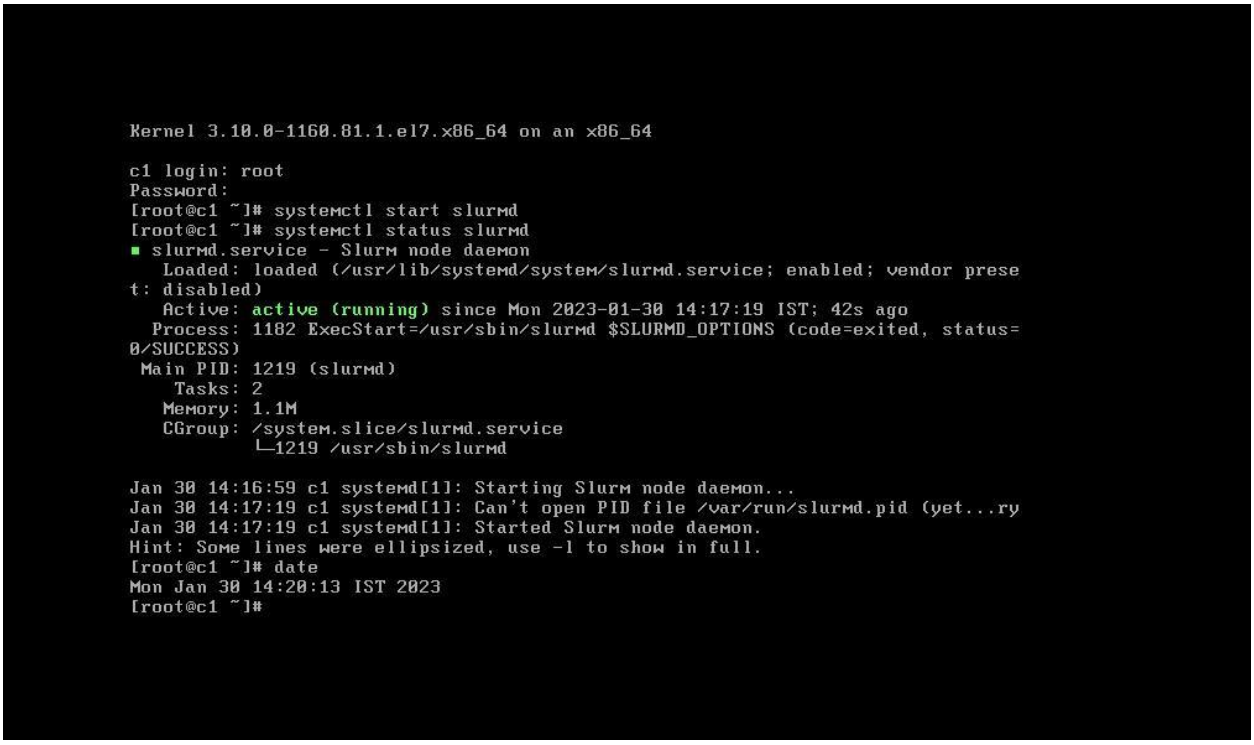
systemctl status slurmctld

Slurm status on master



systemctl status slurmd

Slurm status on node



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.

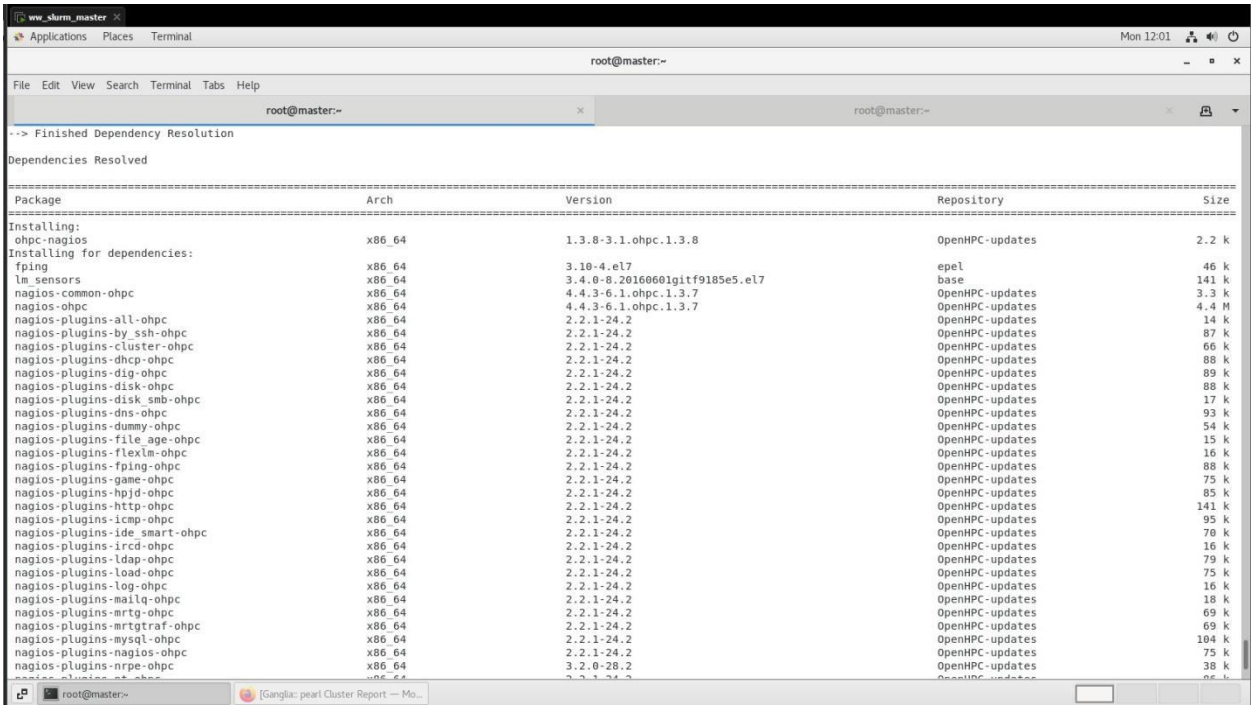
yum -y install ohpc-nagios -> Install Nagios meta-package on master host

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

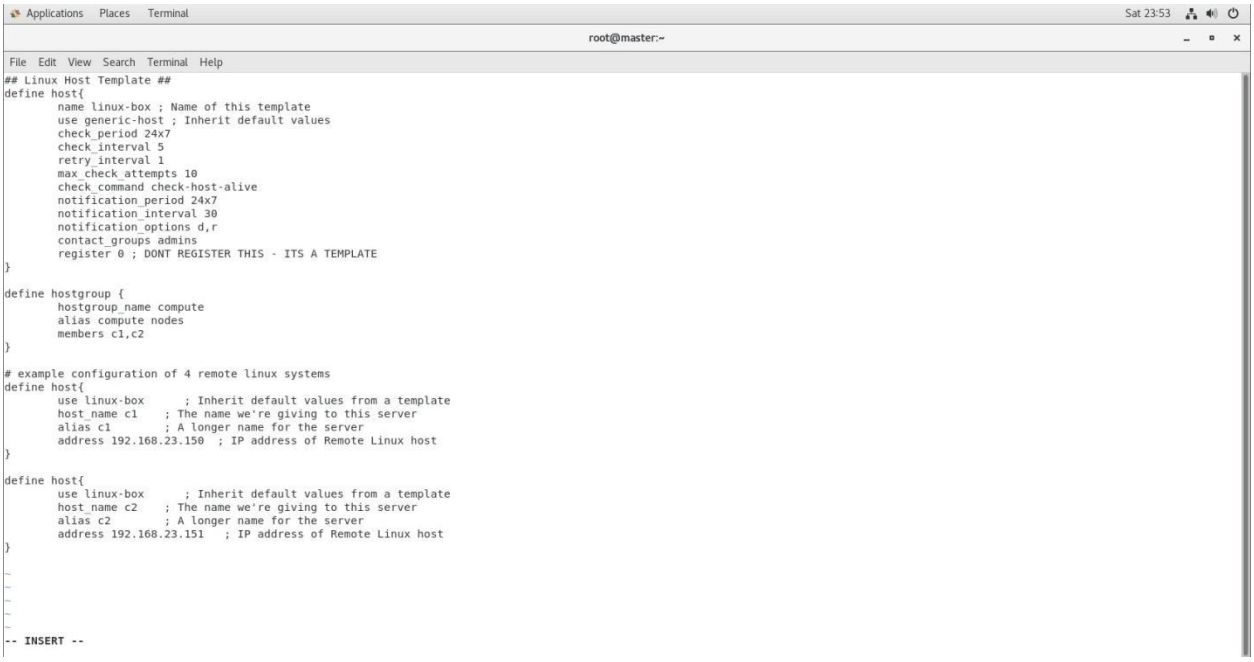
vi $CHROOT/etc/nagios/nrpe.cfg

vi $CHROOT/etc/hosts.allow

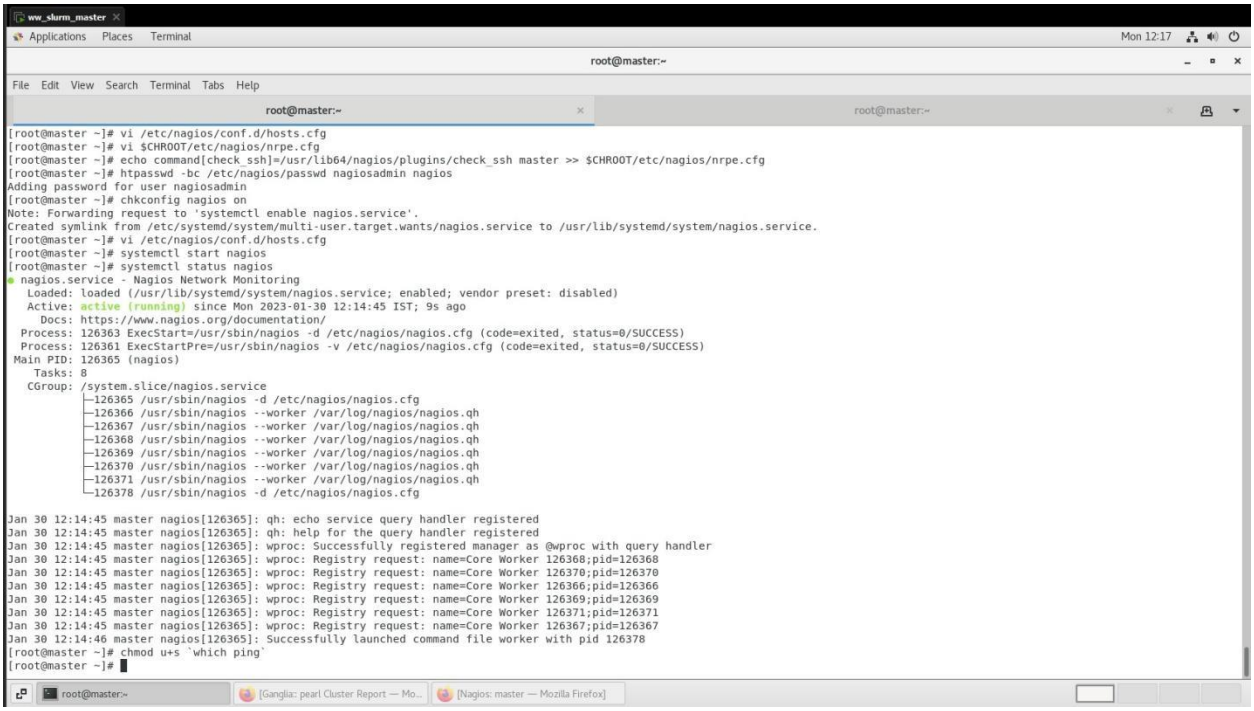
Nagios Packages:



Nagios Configuration file:

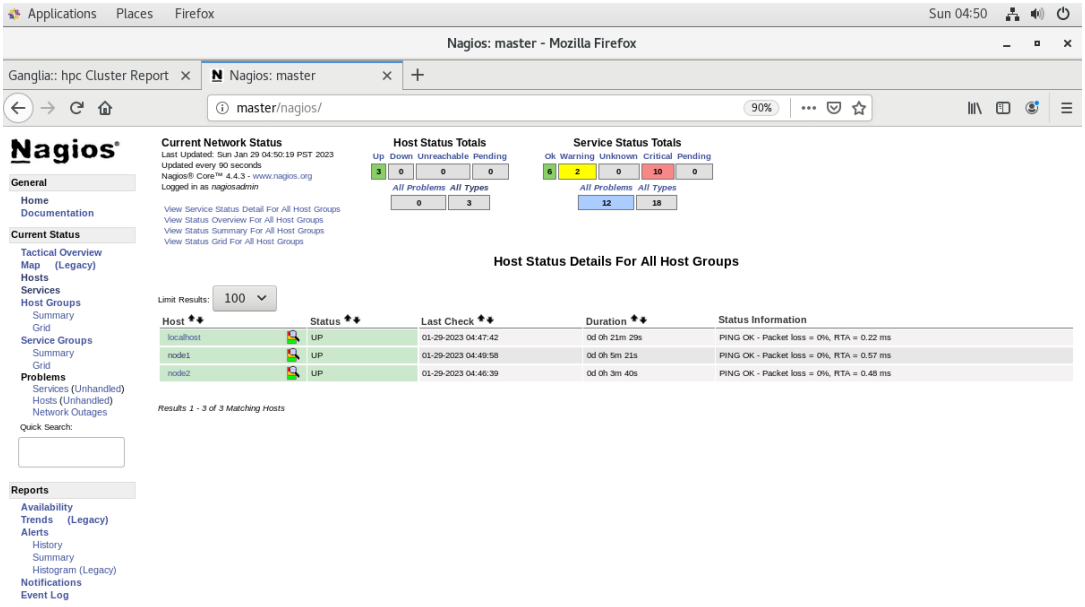


```
Applications  Places  Terminal                                                Sat 23:53
root@master:~
File  Edit  View  Search  Terminal  Help
## Linux Host Template ##
define host{
        name linux-box ; Name of this template
        use generic-host ; Inherit default values
        check_period 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 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 ~]#
root@master:~   [Ganglia: pearl Cluster Report — Mo...   [Nagios: master — Mozilla Firefox]
```

Nagios result on browser:



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

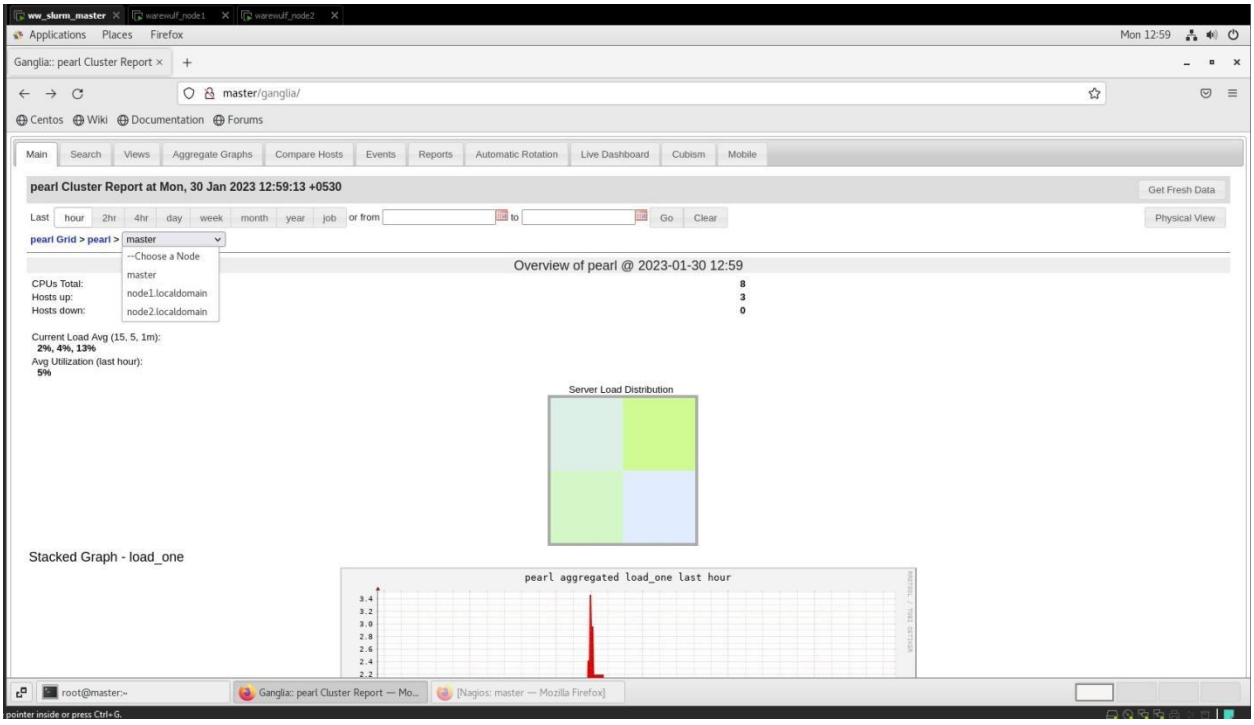
grep "^date.timezone =" /etc/php.ini

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

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

systemctl try-restart httpd

Go to browser : http://master/ganglia



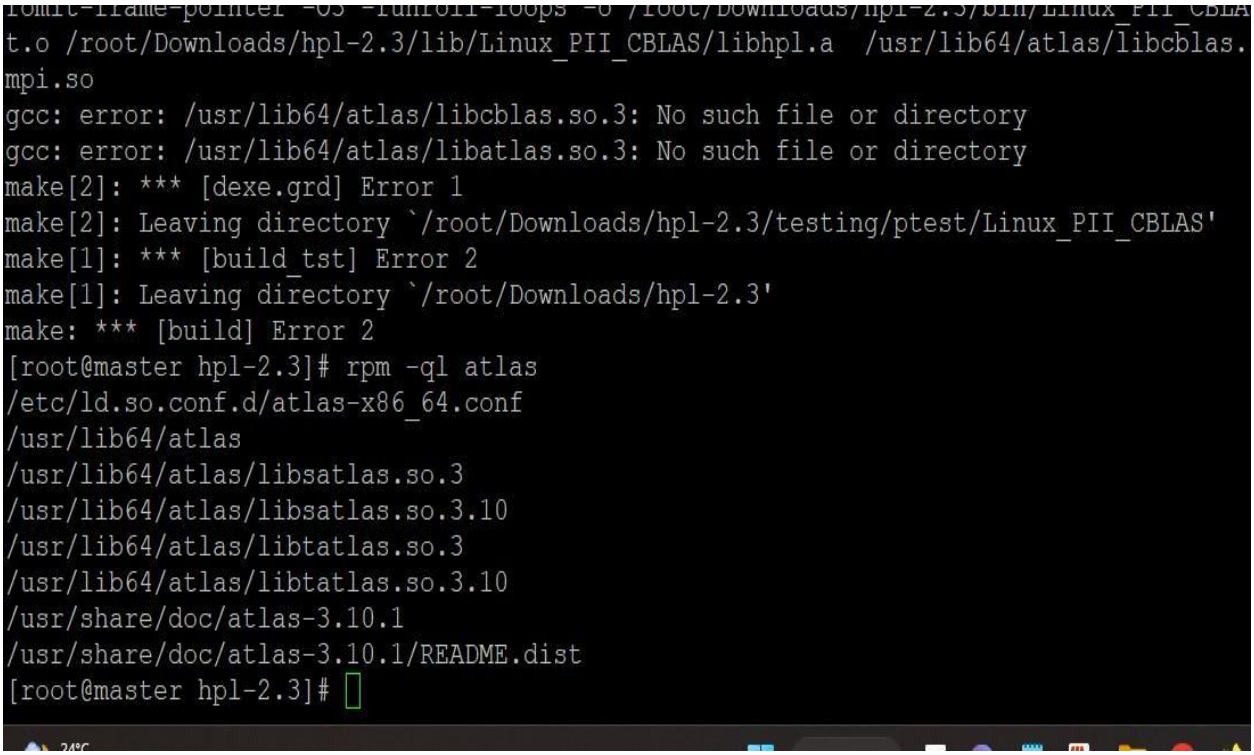
HPL Benchmarking

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



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) ---------------------

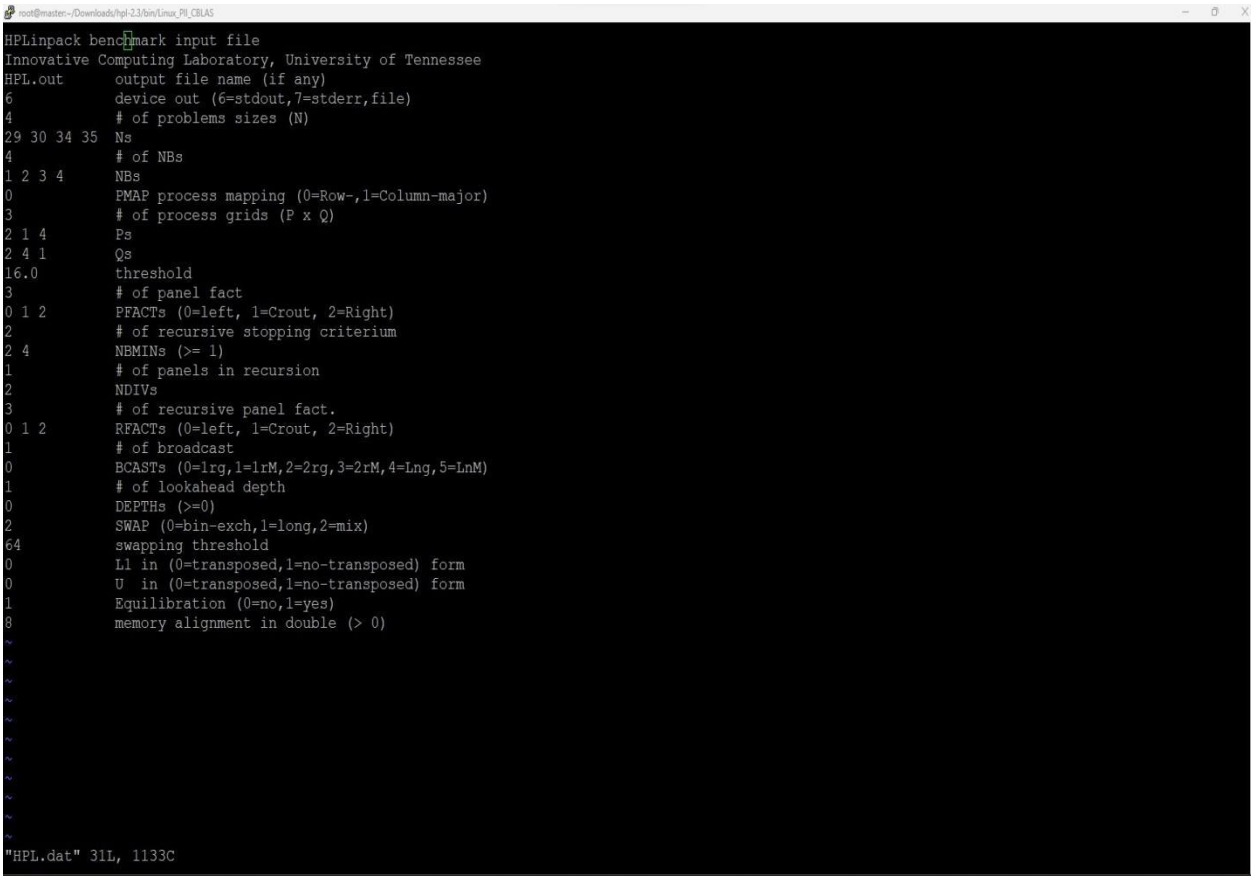
--

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



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

 # wwinit 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