

Problem Statement-

Build a Two node Disk-less HPC-Cluster using OpenHPC with xCAT, OpenLDAP, Slurm, Ganglia, HPL benchmark and Document the result.

XCAT-

In VMWare Create 1 Machine namely-master with HDD 100GB, RAM 15GB, two Network 1. NAT 2. HostOnly.

Commands on master:

```
# systemctl status firewalld

# systemctl stop firewalld

# systemctl disable firewalld

• Disabling Selinux

# vi /etc/selinux/config

# getenforce

# setenforce 0

# getenforce

# vi /etc/selinux/config

# syslinux=disabled

# reboot

# getenforce

• Enable use of the public xCAT repository by adding it to the local list of available package repositories. This also requires network access from your master server to the internet, or alternatively, that the repository be mirrored locally

# yum install yum-utils

# cat /etc/yum.conf

# wget -P /etc/yum.repos.d https://xcat.org/files/xcat/repos/yum/latest/xcat-core/xcat-core.repo

# yum install xCAT

# yum update

# ll /etc/profile.d/xcat.sh

[root@master ~]# ll /etc/profile.d/xcat.sh
-rwxr-xr-x 1 root root 174 Dec 23 08:24 /etc/profile.d/xcat.sh

# . /etc/profile.d/xcat.sh

# echo $PATH

# lsxcatd -a
```

```
# lsxcatd -d
```

```
# lsxcatd -v
```

```
[root@master ~]# lsxcatd -a
Version 2.16.4 (git commit bb7a4bbbc8bde7e6613558d8d039fe43d49d2079, built Mon Jun 13 08:53:10 EDT 2022)
This is a Management Node
dbengine=SQLite
[root@master ~]# lsxcatd -d
dbengine=SQLite
[root@master ~]# lsxcatd -v
Version 2.16.4 (git commit bb7a4bbbc8bde7e6613558d8d039fe43d49d2079, built Mon Jun 13 08:53:10 EDT 2022)
```

```
# tabdump site
```

```
# chdef -t site dhcpinterfaces="ens36"
```

- Assigning host only IP to master

```
# chdef -t site master="192.168.100.10"
```

```
# tabdump site | grep master
```

```
# tabdump site | grep dhcpinterfaces
```

```
[root@master ~]# tabdump site | grep master
"master", "192.168.100.10", ,
[root@master ~]# tabdump site | grep dhcpinterfaces
"dhcpinterfaces", "ens36", ,
```

```
# lsblk
```

```
# ls_release
```

```
# cat /etc/os-release
```

```
# dd if=/dev/sr0 of=/root/CentOS7.iso
```

```
# ll -h
```

- Building a default image for use with xCAT. To begin, we will first need to have a local copy of the ISO image available for the underlying OS. The relevant ISO image is CentOS-7-x86 64-minimal.iso (available from the CentOS mirrors). We initialize the image creation process using the copycds command assuming that the necessary ISO image is available locally.

```
# copycds /root/CentOS7.iso
```

- Once completed, several OS images should be available for use within xCAT. These can be queried via:

```
# lsdef -t osimage
```

- we leverage the stateless (netboot) image for compute nodes and proceed by using genimage to initialize a chroot-based install. Note that the previous query highlights the existence of other provisioning images as well.

```
# genimage centos7.9-x86_64-netboot-compute
```

```
# mkdir -p /install/custom/netboot/
```

```
# lsdef -t osimage centos7.9-x86_64-netboot-compute
```

```
# chdef -t osimage centos7.9-x86_64-netboot-compute synclists="/install/custom/netboot/compute.synclist"
```

- Syncing users, groups and passwords

```
# echo "/etc/passwd -> /etc/passwd" >> /install/custom/netboot/compute.synclist
```

```
# echo "/etc/group -> /etc/group" >> /install/custom/netboot/compute.synclist
```

```
# echo "/etc/hosts -> /etc/hosts" >> /install/custom/netboot/compute.synclist
```

```
# echo "/etc/shadow -> /etc/shadow" >> /install/custom/netboot/compute.synclist
```

- To finalize the xCAT provisioning configuration, this section first highlights packing of the stateless image from the chroot environment followed by the registration of desired compute nodes. To assemble the final compute image use packimage as follows:

```
# packimage centos7.9-x86_64-netboot-compute
```

- Assigning IP in range of host only IP and mac address of newly created VM machine (compute node)

```
# mkdef -t node cn00 groups=compute,all ip=192.168.100.115 mac=00:0C:29:0F:1F:93 netboot=xnba
```

- xnba-neworkboot loader

```
# lsdef cn00
```

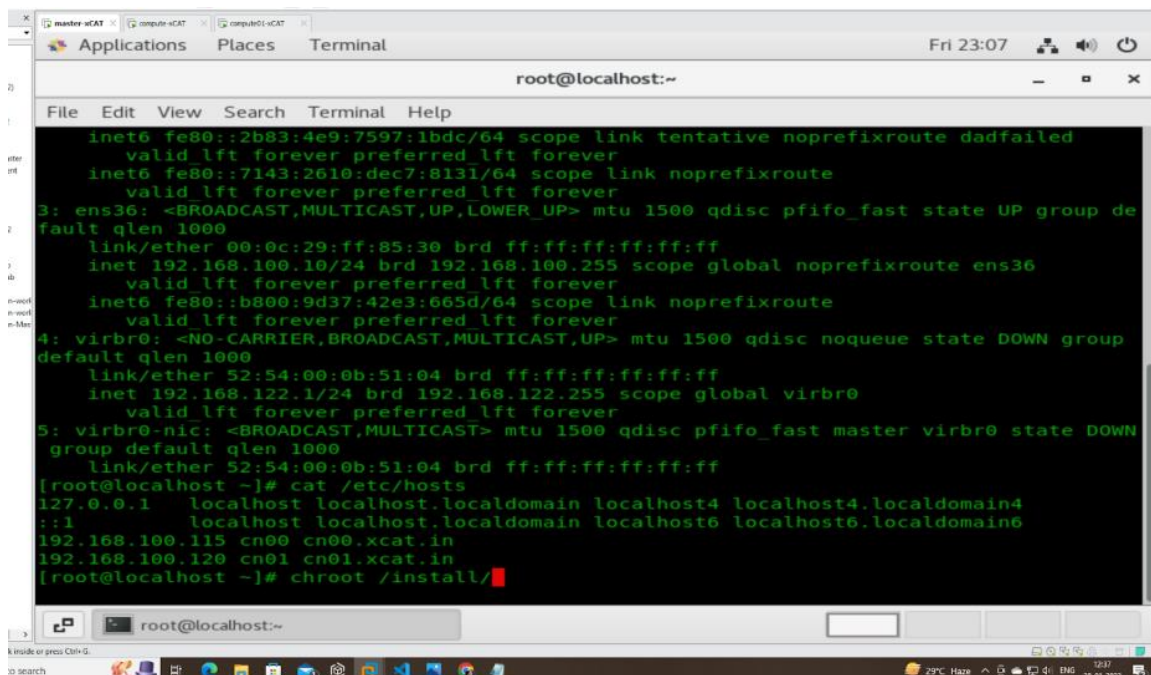
```
# chdef -t node node1 provmethod=centos7.9-x86_64-netboot-compute
```

```
# chdef -t group compute provmethod=centos7.9-x86_64-netboot-compute
```

```
# lsdef node1
```

```
# chdef -t site domain=xcat.in
```

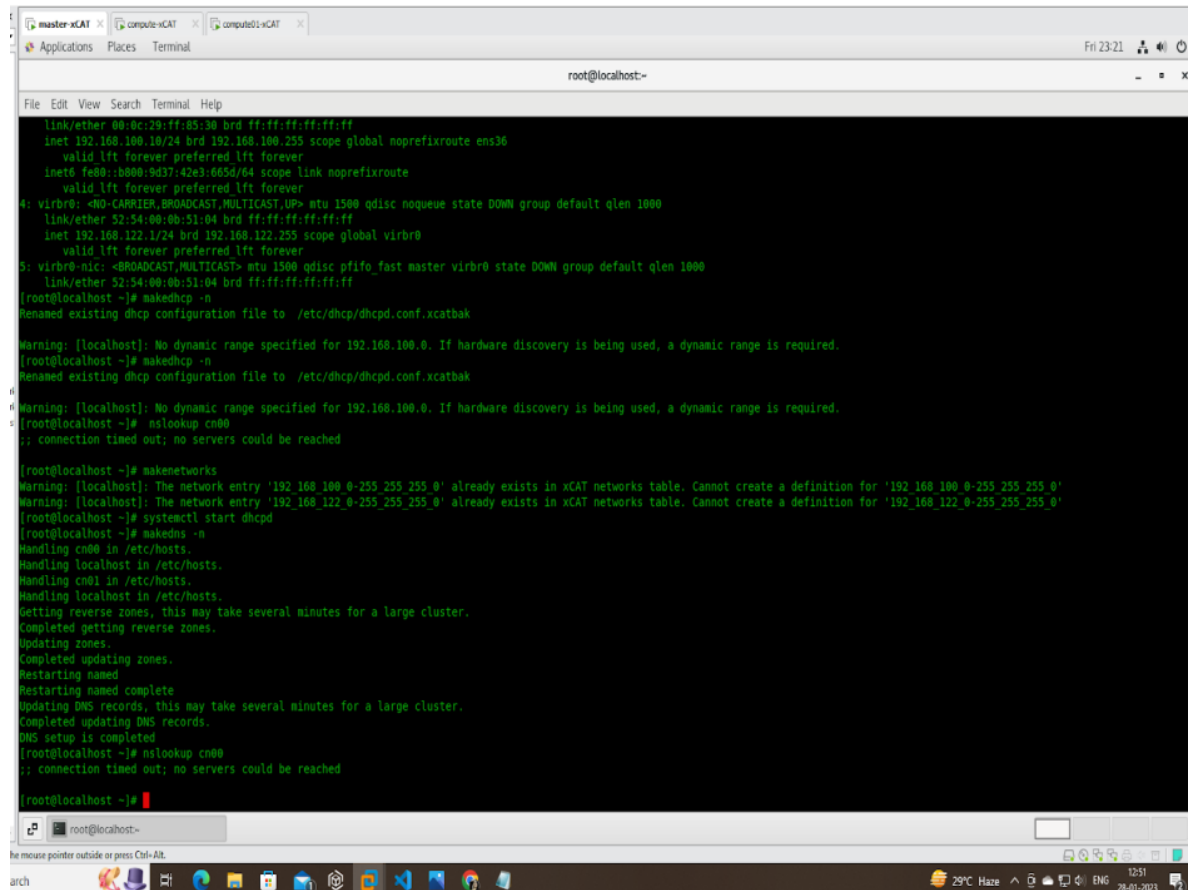
```
# cat /etc/hosts
```



The screenshot shows a terminal window titled "Terminal" with the prompt "root@localhost:~". The terminal output displays network configuration details for interfaces ens36, virbr0, and virbr0-nic, followed by the contents of the /etc/hosts file. The /etc/hosts file lists IP addresses 127.0.0.1, 192.168.100.115, and 192.168.100.120, mapping them to localhost and specific compute nodes (cn00, cn01). The terminal also shows the command "chroot /install/" being entered.

```
inet6 fe80::2b83:4e9:7597:1bdc/64 scope link tentative noprefixroute dadfailed
    valid lft forever preferred lft forever
inet6 fe80::7143:2610:dec7:8131/64 scope link noprefixroute
    valid lft forever preferred lft forever
3: ens36: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group de
fault qlen 1000
    link/ether 00:0c:29:ff:85:30 brd ff:ff:ff:ff:ff:ff
    inet 192.168.100.10/24 brd 192.168.100.255 scope global noprefixroute ens36
        valid lft forever preferred lft forever
    inet6 fe80::b800:9d37:42e3:665d/64 scope link noprefixroute
        valid lft forever preferred lft forever
4: virbr0: <NO-CARRIER,BROADCAST,MULTICAST,UP> mtu 1500 qdisc noqueue state DOWN group
default qlen 1000
    link/ether 52:54:00:0b:51:04 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
5: virbr0-nic: <BROADCAST,MULTICAST> mtu 1500 qdisc pfifo_fast master virbr0 state DOWN
group default qlen 1000
    link/ether 52:54:00:0b:51:04 brd ff:ff:ff:ff:ff:ff
[root@localhost ~]# cat /etc/hosts
127.0.0.1    localhost localhost.localdomain localhost4 localhost4.localdomain4
::1         localhost localhost.localdomain localhost6 localhost6.localdomain6
192.168.100.115 cn00 cn00.xcat.in
192.168.100.120 cn01 cn01.xcat.in
[root@localhost ~]# chroot /install/
```

```
# makehosts
# makenetworks
# makedhcp -n
# systemctl start dhcpd
# makedns -n
# yum install dhcp*
# makedhcp -n
# makedns
# nslookup cn00
# vi /etc/resolv.conf
# nslookup cn00
```



```
Link/ether 00:0c:29:ff:85:38 brd ff:ff:ff:ff:ff:ff
inet 192.168.100.10/24 brd 192.168.100.255 scope global noprefixroute ens36
    valid lft forever preferred lft forever
inets fe80::b080:9d37:42e3:665d/64 scope link noprefixroute
    valid lft forever preferred lft forever
4: virbr0: <NO-CARRIER,BROADCAST,MULTICAST,UP> mtu 1500 qdisc noqueue state DOWN group default qlen 1000
    link/ether 52:54:00:0b:51:04 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
5: virbr0-nic: <BROADCAST,MULTICAST> mtu 1500 qdisc pfifo_fast master virbr0 state DOWN group default qlen 1000
    link/ether 52:54:00:0b:51:04 brd ff:ff:ff:ff:ff:ff
[root@localhost ~]# makedhcp -n
Renamed existing dhcp configuration file to /etc/dhcp/dhcpd.conf.xcatbak
Warning: [localhost]: No dynamic range specified for 192.168.100.0. If hardware discovery is being used, a dynamic range is required.
[root@localhost ~]# makedhcp -n
Renamed existing dhcp configuration file to /etc/dhcp/dhcpd.conf.xcatbak
Warning: [localhost]: No dynamic range specified for 192.168.100.0. If hardware discovery is being used, a dynamic range is required.
[root@localhost ~]# nslookup cn00
;; connection timed out; no servers could be reached

[root@localhost ~]# makenetworks
Warning: [localhost]: The network entry '192.168.100.0-255.255.255.0' already exists in xCAT networks table. Cannot create a definition for '192.168.100.0-255.255.255.0'
Warning: [localhost]: The network entry '192.168.122.0-255.255.255.0' already exists in xCAT networks table. Cannot create a definition for '192.168.122.0-255.255.255.0'
[root@localhost ~]# systemctl start dhcpd
[root@localhost ~]# makedns -n
Handling cn00 in /etc/hosts.
Handling localhost in /etc/hosts.
Handling cn01 in /etc/hosts.
Handling localhost in /etc/hosts.
Getting reverse zones, this may take several minutes for a large cluster.
Completed getting reverse zones.
Updating zones.
Completed updating zones.
Restarting named
Restarting named complete
Updating DNS records, this may take several minutes for a large cluster.
Completed updating DNS records.
DNS setup is completed
[root@localhost ~]# nslookup cn00
;; connection timed out; no servers could be reached

[root@localhost ~]#
```

```
# vi /etc/resolv.conf
```

Generated by NetworkManager

search localdomain xcat.in

nameserver 192.168.100.10

nameserver 192.168.207.2

lsdef -t osimagewe

nodeset compute osimage=centos7.9-x86_64-netboot-compute

systemctl restart dhcpd

systemctl start dhcpd

makedhcp -n

nodeset compute osimage=centos7.9-x86_64-netboot-compute

makedhcp cn00

systemctl status dhcpd

systemctl restart dhcpd

systemctl status dhcpd

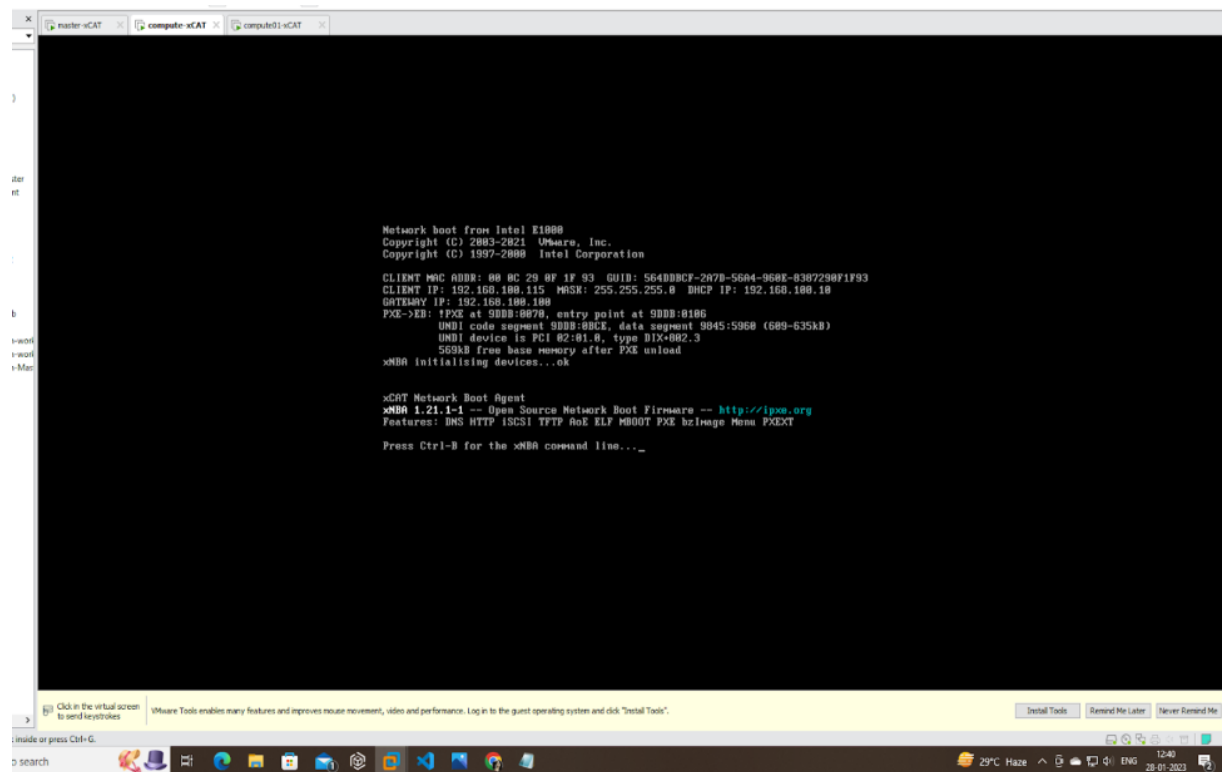
chdef -t osimage -o centos7.9-x86_64-netboot-compute synclists="/install/custom/netboot/compute.synclist"

```
root@localhost:~# ifconfig eth0 192.168.122.1/24 brd 192.168.122.255 scope global virbr0
    valid_lft forever preferred_lft forever
5: virbr0-nic: <BROADCAST,MULTICAST> mtu 1500 qdisc pfifo_fast master virbr0 state DOWN group default qlen 1000
    link/ether 52:54:00:0e:51:0e brd ff:ff:ff:ff:ff:ff
[root@localhost ~]# chroot /install/netboot/centos7.9/x86_64/compute/
chroot: failed to run command '/bin/bash': No such file or directory
[root@localhost ~]# chroot /install/netboot/centos7.9/x86_64/compute/rooting
[root@localhost ~]# ls
bin  dev  home  lib64  mnt  proc  run  srv  var
boot  etc  lib  media  opt  root  sbin  sys  usr  xcatpost
[root@localhost ~]# exit
exit
[root@localhost ~]# chdef -t site dhcpinterfaces="ens36"
1 object definitions have been created or modified.
[root@localhost ~]# chdef -t site master="192.168.88.128"
1 object definitions have been created or modified.
[root@localhost ~]# tabdump site | grep dhcpinterfaces
dhcpinterfaces, "ens36",
[root@localhost ~]# ll -h
total 4.4K
-rw-r--r-- 1 root root 3.8K Nov 27 20:06 anaconda-ks.cfg
-rw-r--r-- 1 root root 4.4K Dec 23 09:43 Centos7.iso
-rw-r--r-- 1 root root 2.1K Nov 27 20:06 original-ks.cfg
[root@localhost ~]# cat /install/custom/netboot/compute.synclist

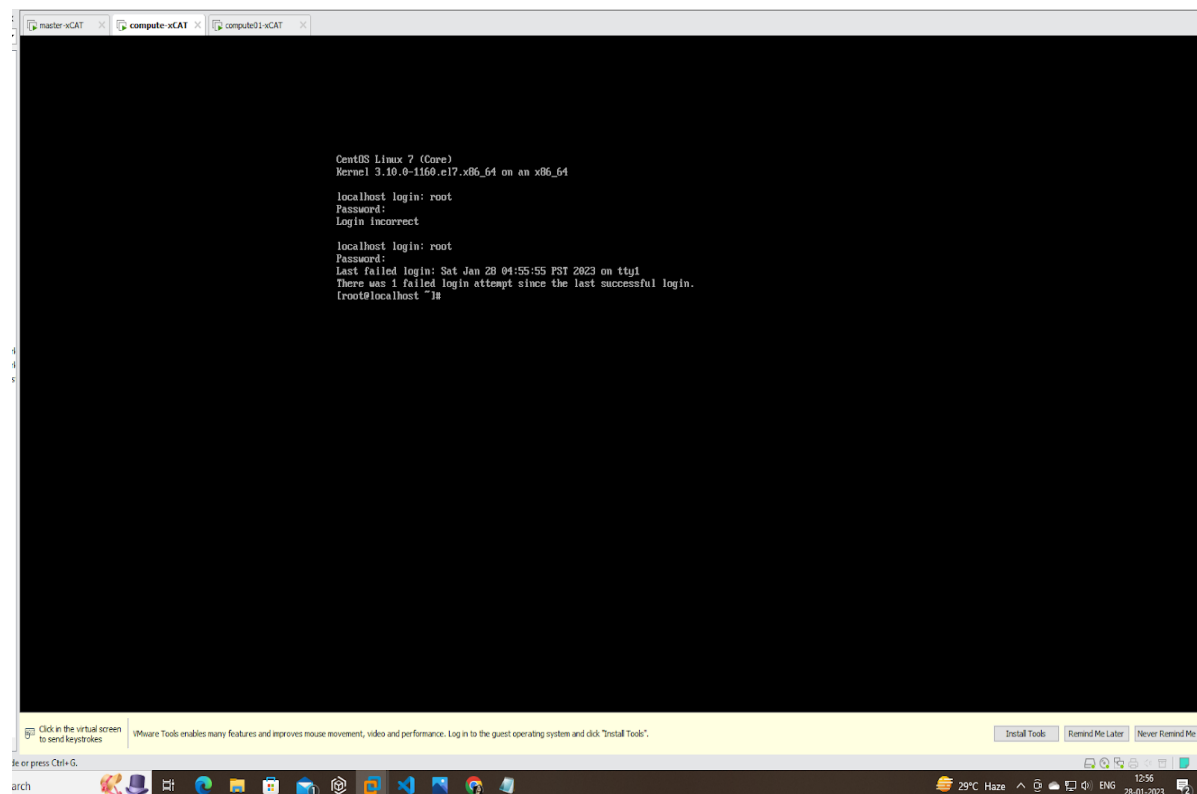
/etc/group -> /etc/group
/etc/hosts -> /etc/hosts
/etc/shadow -> /etc/shadow
/etc/passwd -> /etc/passwd
[root@localhost ~]# packimage centos7.9-x86_64-netboot-compute
Packing contents of /install/netboot/centos7.9/x86_64/compute/rooting
archive method:cpio
compress method:gzip

[root@localhost ~]# skdef -t node node1 groups=compute,all ip=192.168.88.130 mac=08:0C:29:1C:5A:2F netboot=xnba
1 object definitions have been created or modified.
[root@localhost ~]# lsdef node1
Object name: node1
  groups=compute,all
  ip=192.168.88.130
  mac=08:0C:29:1C:5A:2F
  netboot=xnba
  postbootscripts=otherpkgs
  postscripts=sylog,remoteshell,synclists
```

- Booting Compute node through XCAT-



- Successfully booted via XCAT on node1



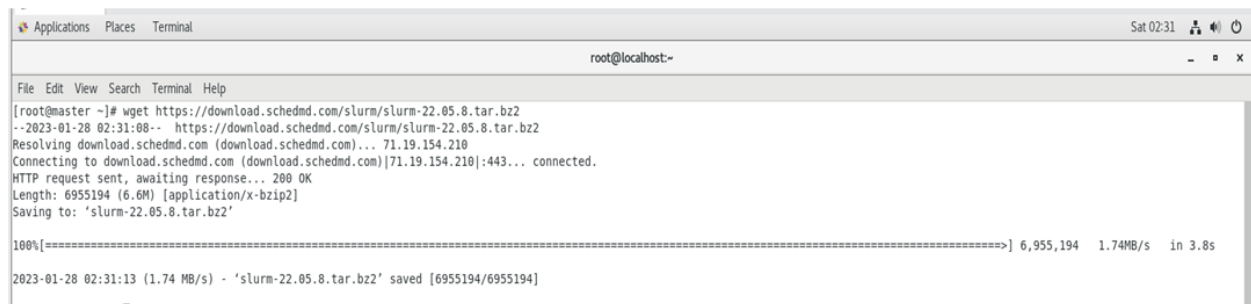
SLURM-

Installing Slurm via XCAT is a process of configuring the Slurm workload manager to run on a cluster managed by XCAT. It involves setting up XCAT as the frontend node and the compute nodes, configuring the Slurm daemons (such as slurmd and slurmctld), and defining the Slurm partition and nodes.

Commands for master

```
# export CHROOT=/install/netboot/centos7.9/x86_64/compute/rootimg/
```

```
# wget https://download.schedmd.com/slurm/slurm-22.05.8.tar.bz2
```

A screenshot of a terminal window titled 'root@localhost~'. The terminal shows the execution of the command 'wget https://download.schedmd.com/slurm/slurm-22.05.8.tar.bz2'. The output indicates the file is being resolved, connected to the server, and downloaded. A progress bar shows 100% completion. The file size is 6,955,194 bytes, downloaded at 1.74 MB/s in 3.8 seconds. The terminal also shows the file being saved as 'slurm-22.05.8.tar.bz2'.

```
#yum install mariadb-server mariadb-devel -y
```

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

```
#yum --installroot=$CHROOT install epel-release
```

```
# yum install munge munge-libs munge-devel -y
```

```
# yum --installroot=$CHROOT install munge munge-libs munge-devel -y
```

```
# yum install rpm-build
```

```
# yum install python3 readline-devel pam-devel
```

```
# rpmbuild -ta slurm-22.05.8.tar.bz2
```

```
# yum install gcc
```

- Creating munge key

```
# /usr/sbin/create-munge-key -r
```

```
[root@master ~]# /usr/sbin/create-munge-key -r
Please type on the keyboard, echo move your mouse,
utilize the disks. This gives the random number generator
a better chance to gain enough entropy.
Generating a pseudo-random key using /dev/random completed.
[root@master ~]#
```

- Copying munge.key to node

```
# scp /etc/munge/munge.key $CHROOT/etc/munge
```

```
#ls -l
```

```
[root@master munge]# ls -l
total 4
-r----- 1 munge munge 1024 Jan 28 02:44 munge.key
[root@master munge]#
```

- Changing permission and ownership of the munge.key on both nodes

```
# chown -R munge:munge /etc/munge/
```

```
# chroot $CHROOT chown -R munge:munge /etc/munge/
```

```
# chroot $CHROOT chmod 400 /etc/munge/munge.key
```

```
# systemctl start munge
```

```
# systemctl enable munge
```

```
# systemctl status munge
```

```
[root@master munge]# systemctl start munge
[root@master munge]# systemctl enable munge
Created symlink from /etc/systemd/system/multi-user.target.wants/munge.service to /usr/lib/systemd/system/munge.service.
[root@master munge]# systemctl status munge
● munge.service - MUNGE authentication service
   Loaded: loaded (/usr/lib/systemd/system/munge.service; enabled; vendor preset: disabled)
   Active: active (running) since Sat 2023-01-28 02:52:58 PST; 32s ago
     Docs: man:munged(8)
   Main PID: 61391 (munged)
   CGroup: /system.slice/munge.service
           └─61391 /usr/sbin/munged

Jan 28 02:52:48 master systemd[1]: Starting MUNGE authentication service...
Jan 28 02:52:58 master systemd[1]: Started MUNGE authentication service.
```

- On master

```
# scp -r /root/rpmbuild/RPMS/x86_64/ $CHROOT/home
```

```
# chroot $CHROOT
```

```
# cd /home/x86_64
```

- Removing Slurmctld service from compute node

```
# rm -rf slurm-slurmctld-22.05.8-1.el7.x86_64.rpm
```

```
# yum --installroot=$CHROOT install slurm*
```

- On both nodes-

```
# export SLURMUSER=1500
```

```
# groupadd -g $SLURMUSER slurm
```



```
# useradd -m -c "SLURM workload manager" -d /var/lib/slurm -u $SLURMUSER -g slurm -s /bin/bash slurm
```

```
# cp /etc/slurm/slurm.conf.example /etc/slurm.conf
```

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

```
# 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.
# Put this file on all nodes of your cluster.
# See the slurm.conf man page for more information.
#
ClusterName=Diamond
SlurmctldHost=master
```

```
#RebootProgram=
ReturnToService=1
SlurmctldPidFile=/var/run/slurmctld.pid
SlurmctldPort=6817
SlurmdPidFile=/var/run/slurmd.pid
SlurmdPort=6818
SlurmdSpoolDir=/var/share/slurm/d
SlurmUser=slurm
#SlurmdUser=root
#SrunEpilog=
#SrunProlog=
StateSaveLocation=/var/share/slurm/ctld
SwitchType=switch/none
#TaskEpilog=
```

```
#
#
# COMPUTE NODES
#NodeName=linux[1-32] CPUs=1 State=UNKNOWN
NodeName=localhost CPUs=12 Boards=1 SocketsPerBoard=4 CoresPerSocket=3 ThreadsPerCore=1 RealMemory=7802
PartitionName=debug Nodes=ALL Default=YES MaxTime=INFINITE State=UP
```

```
# mkdir -p /var/share/slurm/ctld
```

```
# chown -R slurm:slurm /var/share/slurm
```

```
# touch /var/log/slurmctld.log
```

```
# systemctl start slurmd
```

```
# systemctl enable slurmd
```

```
# systemctl start slurmctld
```

```
# systemctl enable slurmctld
```

```
# chroot $CHROOT mkdir -p /var/share/slurm/d
# chroot $CHROOT chown -R slurm:slurm /var/share/slurm
# chroot $CHROOT touch /var/log/slurmd.log
# cp /etc/slurm/cgroup.conf.example /etc/slurm/cgroup.conf
# scp /etc/slurm/cgroup.conf $CHROOT/etc/slurm
# systemctl start slurmctld
# systemctl enable slurmctld
# systemctl start munge
# systemctl enable munge
# chroot $CHROOT systemctl enable slurmctld
# chroot $CHROOT systemctl enable munge
```

Slurm configuration done successfully-

Packaging the image –

```
# packimage centos7.9-x86_64-netboot-compute
```

```
[root@master ~]# packimage centos7.9-x86_64-netboot-compute
Packing contents of /install/netboot/centos7.9/x86_64/compute/rootimg
archive method:cpio
compress method:gzip
```

LDAP

- Install OpenLDAP on master

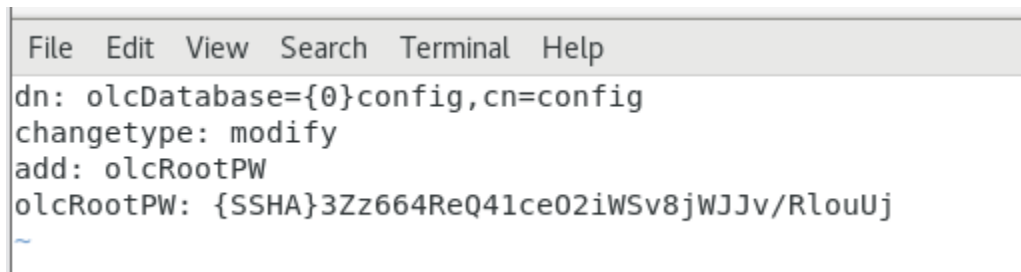
```
# yum -y install openldap-servers openldap-clients  
  
# cp /usr/share/openldap-servers/DB_CONFIG.example /var/lib/ldap/DB_CONFIG  
  
# chown ldap. /var/lib/ldap/DB_CONFIG  
  
# systemctl start slapd  
  
# systemctl enable slapd
```

```
# generate encrypted password
```

- Saving the password from below command for further authentication

```
# slappasswd  
  
    {SSHA}3Zz664ReQ41ceO2iWSv8jWJJv/RlouUj  
  
# vi chrootpw.ldif
```

- Adding the above generated password in below file

A screenshot of a terminal window with a menu bar at the top containing 'File', 'Edit', 'View', 'Search', 'Terminal', and 'Help'. The terminal displays the following text:

```
dn: olcDatabase={0}config,cn=config  
changetype: modify  
add: olcRootPW  
olcRootPW: {SSHA}3Zz664ReQ41ceO2iWSv8jWJJv/RlouUj
```

```
# ldapadd -Y EXTERNAL -H ldapi:/// -f chrootpw.ldif  
  
# ldapadd -Y EXTERNAL -H ldapi:/// -f /etc/openldap/schema/cosine.ldif  
  
# ldapadd -Y EXTERNAL -H ldapi:/// -f /etc/openldap/schema/nis.ldif  
  
# ldapadd -Y EXTERNAL -H ldapi:/// -f /etc/openldap/schema/inetorgperson.ldif
```

- Generate directory manager's password

```
# vi chdomain.ldif
```

- replace to your own domain name for "dc=***,dc=***" section
- specify the password generated above for "olcRootPW" section

```
File Edit View Search Terminal Help
dn: olcDatabase={1}monitor,cn=config
changetype: modify
replace: olcAccess
olcAccess: {0}to * by dn.base="gidNumber=0+uidNumber=0,cn=peercred,cn=external,cn=auth"
  read by dn.base="cn=Manager,dc=cdac,dc=in" read by * none

dn: olcDatabase={2}hdb,cn=config
changetype: modify
replace: olcSuffix
olcSuffix: dc=cdac,dc=in

dn: olcDatabase={2}hdb,cn=config
changetype: modify
replace: olcRootDN
olcRootDN: cn=Manager,dc=cdac,dc=in

dn: olcDatabase={2}hdb,cn=config
changetype: modify
add: olcRootPW
olcRootPW: {SSHA}3Zz664ReQ41ce02iWSv8jWJJv/RlouUj

dn: olcDatabase={2}hdb,cn=config
changetype: modify
add: olcAccess
olcAccess: {0}to attrs=userPassword,shadowLastChange by
  dn="cn=Manager,dc=cdac,dc=in" write by anonymous auth by self write by * none
olcAccess: {1}to dn.base="" by * read
olcAccess: {2}to * by dn="cn=Manager,dc=cdac,dc=in" write by * read
~
```

```
# ldapmodify -Y EXTERNAL -H ldapi:/// -f chdomain.ldif
```

```
# vi basedomain.ldif
```

- replace to your own domain name for "dc=***,dc=***" section

```
File Edit View Search Terminal Help
dn: dc=cdac,dc=in
objectClass: top
objectClass: dcObject
objectClass: organization
o: cdac in
dc: cdac

dn: cn=Manager,dc=cdac,dc=in
objectClass: organizationalRole
cn: Manager
description: Directory Manager

dn: ou=People,dc=cdac,dc=in
objectClass: organizationalUnit
ou: People

dn: ou=Group,dc=cdac,dc=in
objectClass: organizationalUnit
ou: Group
```

```
# ldapadd -x -D cn=Manager,dc=cdac,dc=in -W -f basedomain.ldif
```

- Adding user account

```
# vi ldapuser.ldif
```

- create new
- replace to your own domain name for "dc=***,dc=***" section

```
File Edit View Search Terminal Help
dn: uid=test1,ou=People,dc=cdac,dc=in
objectClass: inetOrgPerson
objectClass: posixAccount
objectClass: shadowAccount
cn: test1
sn: Linux
userPassword: {SSHA}3Zz664ReQ4lce02iWSv8jWJJv/RlouUj
loginShell: /bin/bash
uidNumber: 1501
gidNumber: 1501
homeDirectory: /home/test1

dn: cn=test1,ou=Group,dc=cdac,dc=in
objectClass: posixGroup
cn: test1
gidNumber: 1501
memberUid: test1
```

```
# ldapadd -x -D cn=Manager,dc=cdac,dc=in -W -f ldapuser.ldif
```

- If you'd like to delete LDAP User or Group, Do as below.

```
# ldapdelete -x -W -D 'cn=Manager,dc=cdac,dc=in' "uid=test,ou=People,dc=cdac,dc=in"
```

```
[root@localhost ~]# passwd test
-bash: passwd: command not found
[root@localhost ~]# getent passwd | grep test
test:x:1501:1501::/home/test:/bin/bash
[root@localhost ~]# _
```

- Install OpenLDAP Client.

```
# yum --installroot=/install/netboot/centos7.9/x86_64/compute/rootimg install openldap-clients
```

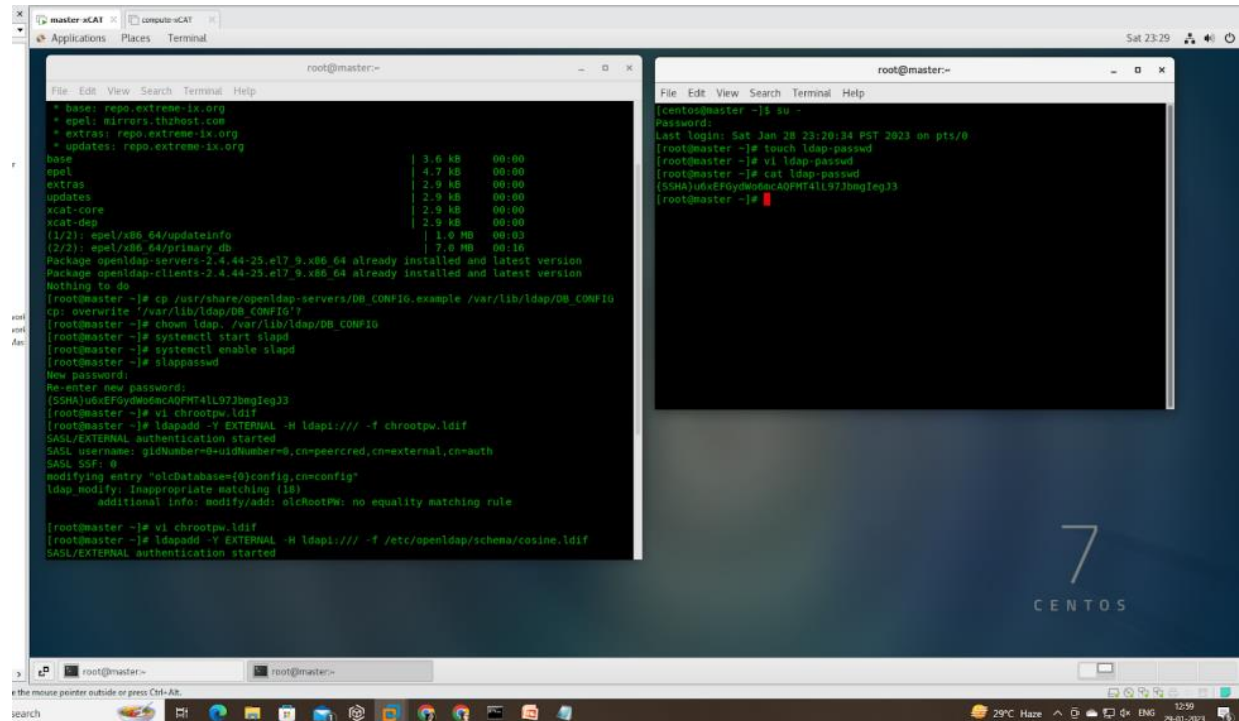
```
# exports CHROOT=/install/netboot/centos7.9/x86_64/compute/rootimg
```

```
# chroot $CHROOT
```

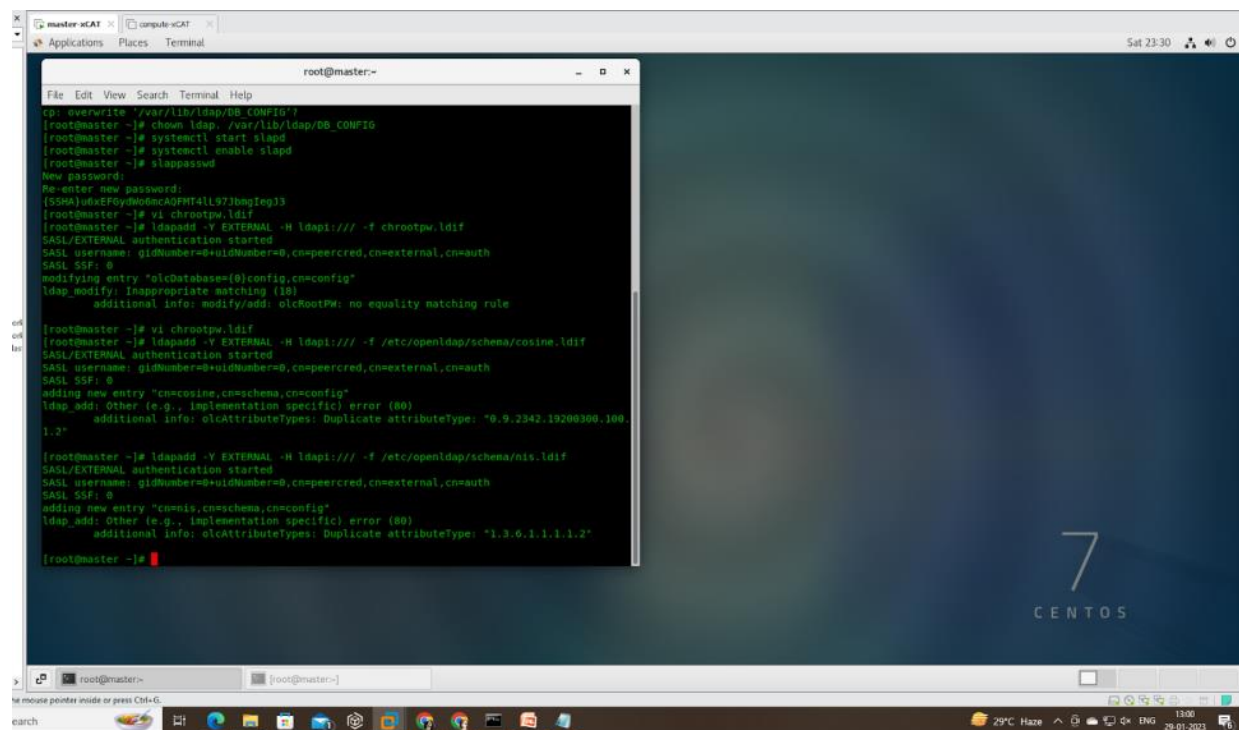
```
# authconfig --enableldap --enableldapauth --ldapsrv=master --ldapbasedn="dc=cdac,dc=in" --enablemkhomedir
--update
```

systemctl restart nsld

ldapsearch -x



```
root@master:~# rpm -q --queryformat '%{NAME} %{VERSION} %{ARCH} %{SIZE} %{INSTALLDATE} %{INSTALLTIME} %{INSTALLFROM}\n' --whatprovides epel\nbase\nepel\nextras\nupdates\nxcat-core\nxcat-dap\n(1/2): epel/x86_64/updateinfo\n(2/2): epel/x86_64/primary.db\nPackage openldap-servers-2.4.44-25.el7_9.x86_64 already installed and latest version\nPackage openldap-clients-2.4.44-25.el7_9.x86_64 already installed and latest version\nNothing to do\n\n[root@master ~]# cp /usr/share/openldap-servers/DB_CONFIG.example /var/lib/ldap/DB_CONFIG\n[root@master ~]# cp /usr/share/openldap-servers/DB_CONFIG.example /var/lib/ldap/DB_CONFIG\n[root@master ~]# systemctl start slapd\n[root@master ~]# systemctl enable slapd\n[root@master ~]# slapasswd\nNew password:\nRe-enter new password:\n(SSHA)u0xEF0yDw0mcA0PHT4LL97JbngIegJ3\n[root@master ~]# vi chrootpw.ldif\n[root@master ~]# ldapadd -Y EXTERNAL -H ldapi:/// -f chrootpw.ldif\nSASL/EXTERNAL authentication started\nSASL username: gidNumber=0+uidNumber=0,cn=peercred,cn=external,cn=auth\nSASL SSF: 0\nmodifying entry \"olcDatabase={0}config,cn=config\"\nldap_modify: Inappropriate matching (18)\nadditional info: modify/add: olcRootPW: no equality matching rule\n\n[root@master ~]# vi chrootpw.ldif\n[root@master ~]# ldapadd -Y EXTERNAL -H ldapi:/// -f /etc/openldap/schema/cosine.ldif\nSASL/EXTERNAL authentication started\nSASL username: gidNumber=0+uidNumber=0,cn=peercred,cn=external,cn=auth\nSASL SSF: 0\nadding new entry \"cn=c cosine,cn=schema,cn=config\"\nldap_add: Other (e.g., implementation specific) error (80)\nadditional info: olcAttributeTypes: Duplicate attributeType: \"0.9.2342.19200300.100.1.2\"
```



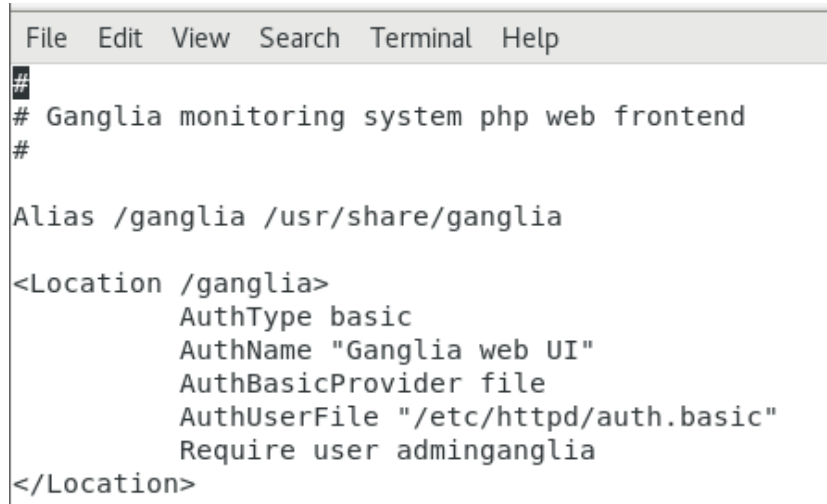
```
root@master:~# rpm -q --queryformat '%{NAME} %{VERSION} %{ARCH} %{SIZE} %{INSTALLDATE} %{INSTALLTIME} %{INSTALLFROM}\n' --whatprovides epel\nbase\nepel\nextras\nupdates\nxcat-core\nxcat-dap\n(1/2): epel/x86_64/updateinfo\n(2/2): epel/x86_64/primary.db\nPackage openldap-servers-2.4.44-25.el7_9.x86_64 already installed and latest version\nPackage openldap-clients-2.4.44-25.el7_9.x86_64 already installed and latest version\nNothing to do\n\n[root@master ~]# cp /usr/share/openldap-servers/DB_CONFIG.example /var/lib/ldap/DB_CONFIG\n[root@master ~]# cp /usr/share/openldap-servers/DB_CONFIG.example /var/lib/ldap/DB_CONFIG\n[root@master ~]# systemctl start slapd\n[root@master ~]# systemctl enable slapd\n[root@master ~]# slapasswd\nNew password:\nRe-enter new password:\n(SSHA)u0xEF0yDw0mcA0PHT4LL97JbngIegJ3\n[root@master ~]# vi chrootpw.ldif\n[root@master ~]# ldapadd -Y EXTERNAL -H ldapi:/// -f chrootpw.ldif\nSASL/EXTERNAL authentication started\nSASL username: gidNumber=0+uidNumber=0,cn=peercred,cn=external,cn=auth\nSASL SSF: 0\nmodifying entry \"olcDatabase={0}config,cn=config\"\nldap_modify: Inappropriate matching (18)\nadditional info: modify/add: olcRootPW: no equality matching rule\n\n[root@master ~]# vi chrootpw.ldif\n[root@master ~]# ldapadd -Y EXTERNAL -H ldapi:/// -f /etc/openldap/schema/cosine.ldif\nSASL/EXTERNAL authentication started\nSASL username: gidNumber=0+uidNumber=0,cn=peercred,cn=external,cn=auth\nSASL SSF: 0\nadding new entry \"cn=c cosine,cn=schema,cn=config\"\nldap_add: Other (e.g., implementation specific) error (80)\nadditional info: olcAttributeTypes: Duplicate attributeType: \"0.9.2342.19200300.100.1.2\"
```


GANGLIA

```
# yum install ganglia rrdtool ganglia-gmetad ganglia-gmond ganglia-web
```

```
# htpasswd -c /etc/httpd/auth.basic adminganglia
```

```
# vi /etc/httpd/conf.d/ganglia.conf
```



```
File Edit View Search Terminal Help
# Ganglia monitoring system php web frontend
#
Alias /ganglia /usr/share/ganglia

<Location /ganglia>
    AuthType basic
    AuthName "Ganglia web UI"
    AuthBasicProvider file
    AuthUserFile "/etc/httpd/auth.basic"
    Require user adminganglia
</Location>
```

```
# vi /etc/ganglia/gmetad.conf
```

```
data_source "my cluster" localhost
gridname "MyGrid"

data_source "Labs" 60 192.168.100.10 # Master node
data_source "Labs" 60 192.168.100.115 # Monitored node
```

```
# vi /etc/ganglia/gmond.conf
```



```

/*
 * The cluster attributes specified will be used as part of the <CLUSTER>
 * tag that will wrap all hosts collected by this instance.
 */
cluster {
    name = "Labs"
    owner = "unspecified"
    latlong = "unspecified"
    url = "unspecified"
}

/* The host section describes attributes of the host, like the location */
host {
    location = "unspecified"
}

/* Feel free to specify as many udp_send_channels as you like. Gmond
   used to only support having a single channel */
udp_send_channel {
    #bind_hostname = yes # Highly recommended, soon to be default.
                        # This option tells gmond to use a source address
                        # that resolves to the machine's hostname. Without
                        # this, the metrics may appear to come from any
                        # interface and the DNS names associated with
                        # those IPs will be used to create the RRDs.

    #mcast_join = 239.2.11.71
    host = node
    port = 8649
    ttl = 1
}

/* You can specify as many udp_rcv_channels as you like as well. */
udp_rcv_channel {
    # mcast_join = 239.2.11.71
    port = 8649
    bind = 239.2.11.71
    #retry_bind = true
    #Size of the UDP buffer. If you are handling lots of metrics you really
    #should bump it up to e.g. 10MB or even higher.
    #buffer = 10485760
}

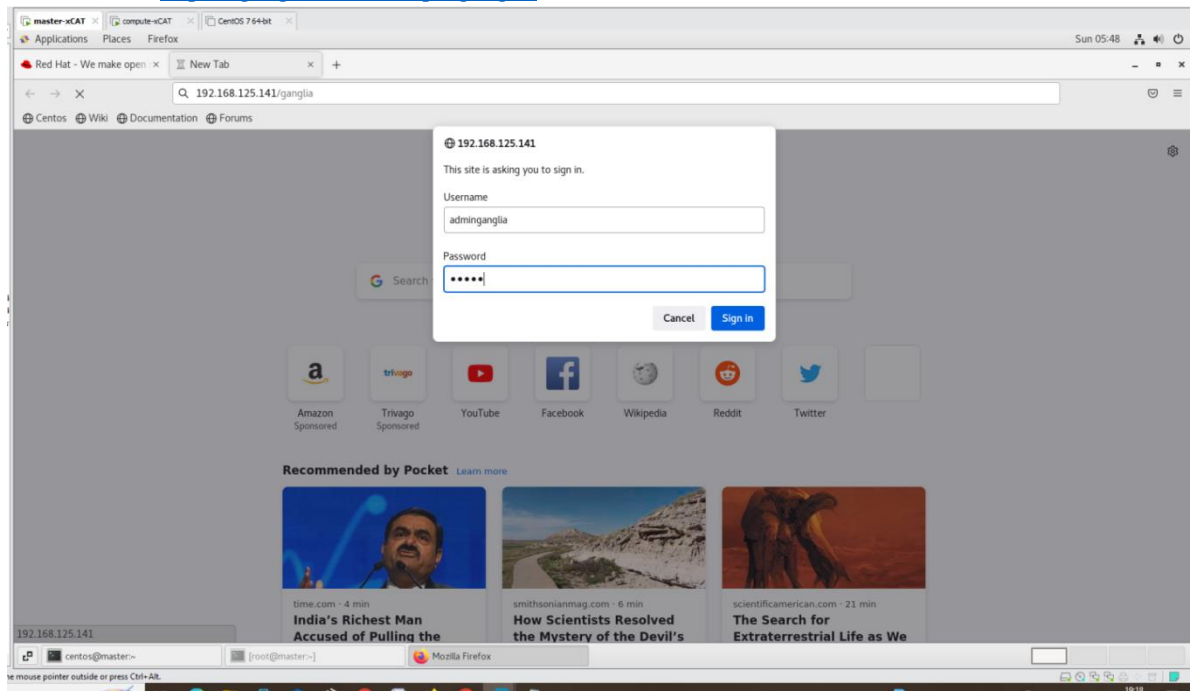
```

```

# setsebool -P httpd_can_network_connect 1
# systemctl restart httpd gmetad gmond
# systemctl enable httpd gmetad httpd
# ip a

```

- Browser-----> http://<ganglia_master_ip>/ganglia



```
# yum --installroot=$CHROOT install ganglia-rrdtool ganglia-gmetad ganglia-gmond ganglia-web
# vi /etc/ganglia/gmond.conf
```

```
/*
cluster {
    name = "Labs"
    owner = "unspecified"
    latlong = "unspecified"
    url = "unspecified"
}

/* The host section describes attributes of the host, like the location */
host {
    location = "unspecified"
}

/* Feel free to specify as many udp_send channels as you like. Gmond
used to only support having a single channel */
udp_send_channel {
    #bind_hostname = yes # Highly recommended, soon to be default.
    # This option tells gmond to use a source address
    # that resolves to the machine's hostname. Without
    # this, the metrics may appear to come from any
    # interface and the DNS names associated with
    # those IPs will be used to create the RRDs.

    mcast_join = 239.2.11.71
    host = localhost
    port = 8649
    ttl = 1
}

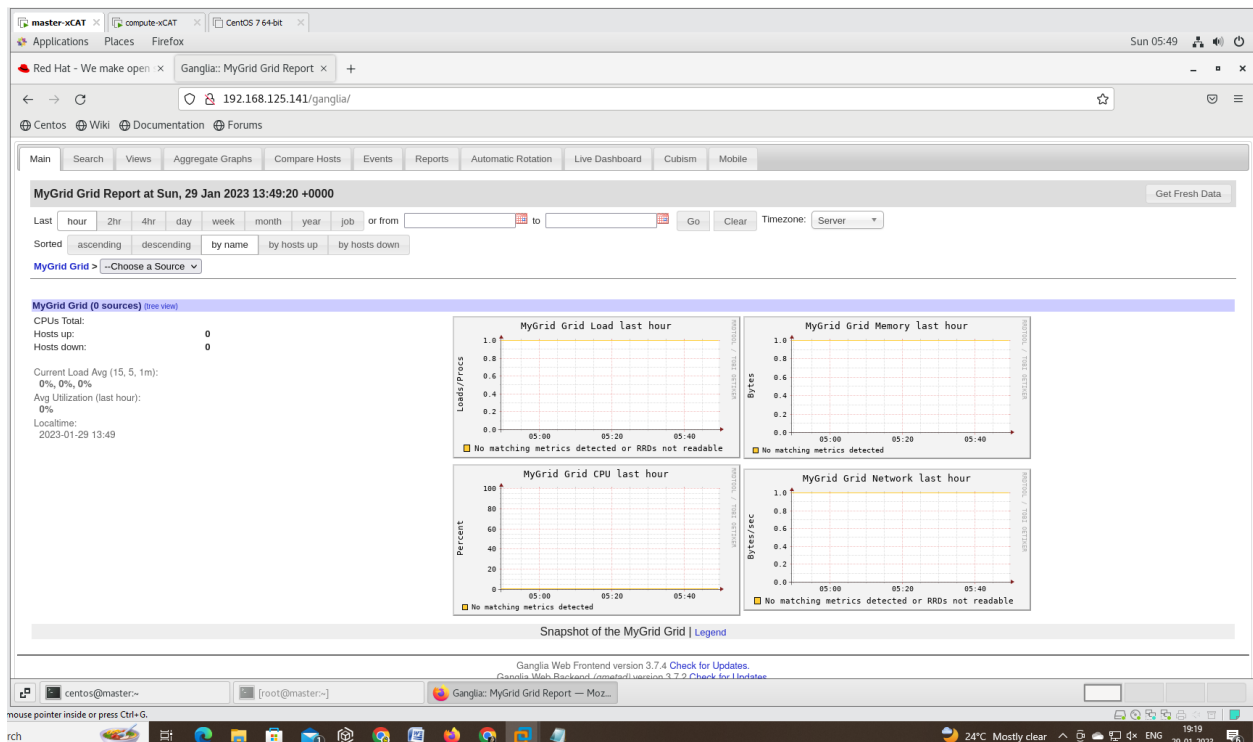
/* You can specify as many udp_rcv_channels as you like as well. */
udp_rcv_channel {
    mcast_join = 239.2.11.71
    port = 8649
    bind = 239.2.11.71
    # retry_bind = true
    # Size of the UDP buffer. If you are handling lots of metrics you really
    # should bump it up to e.g. 10MB or even higher.
    # buffer = 10485760
}
}
```

```
# chroot $CHROOT
# systemctl enable gmond
# systemctl restart httpd gmetad gmond
# systemctl enable httpd gmetad gmond
# packimage centos7.9-x86_64-netboot-compute
```

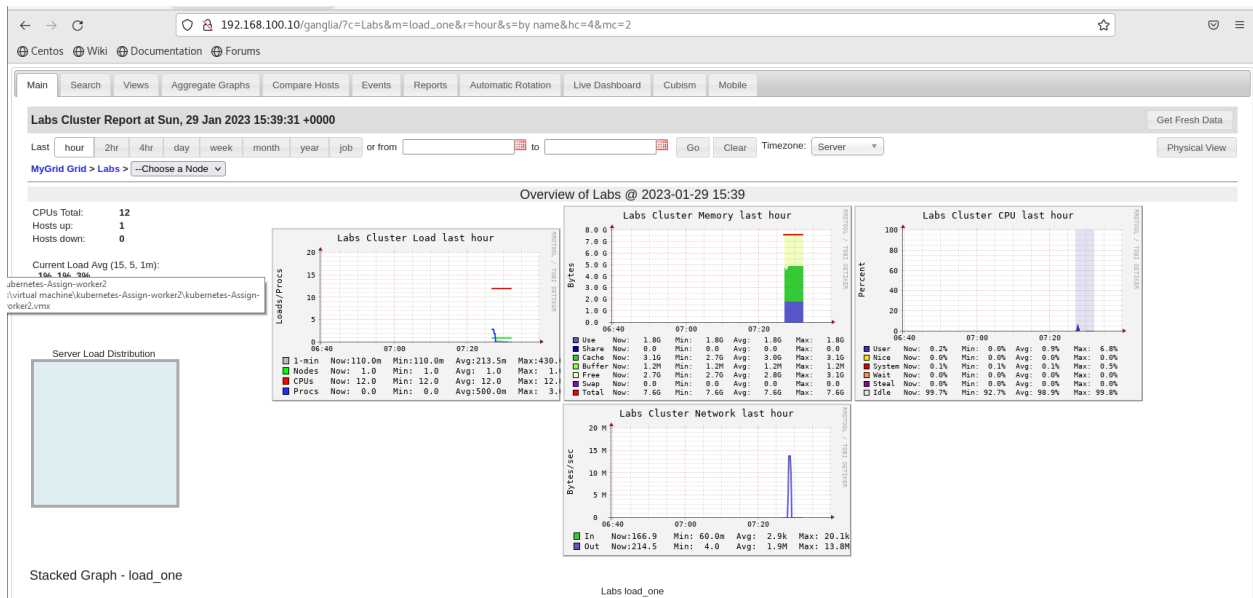
```

ntp:x:30:30::etc/ntp:/sbin/nologin
gdm:x:42:42:/usr/lib/gdm:/sbin/nologin
rpcuser:x:29:29:RPC Service User:/usr/lib/rpc:/sbin/nologin
nfsnobody:x:65534:65534:Anonymous NFS User:/usr/lib/nfs:/sbin/nologin
gnome-initial-setup:x:908:902:/run/gnome-initial-setup:/sbin/nologin
sbl:x:74:74:Privilege-separated SSH:/usr/empty:/sbin/nologin
sshd:x:70:70:ssh:/usr/sbin/sshd:/sbin/nologin
postfix:x:39:39:/usr/spool/postfix:/sbin/nologin
tepdm:x:32:32:/sbin/nologin
centos:x:1000:1000:centos:/home/centos:/bin/bash
apache:x:48:48:Apache:/usr/share/httpd:/sbin/nologin
nssd:x:25:25:Nssd:/usr/nssd:/sbin/nologin
dhcpd:x:177:177:dhcp_server:/sbin/nologin
conserver:x:907:901:/home/conserver:/bin/bash
user:x:1001:1001:/home/user:/bin/bash
nmap:x:27:27:Nmap Server:/usr/lib/nmap:/sbin/nologin
nmapge:x:906:900:Runs Uid "N" Gid Export:/usr/run/nmapge:/sbin/nologin
share:x:1500:1500:SLURM workload manager:/usr/lib/slurm:/bin/bash
lmap:x:55:55:lmapdmp_server:/usr/lib/lmap:/sbin/nologin
nsd:x:28:28:NSD Daemon:/sbin/nologin
niced:x:65:65:Linux Client User:/sbin/nologin
ganglia:x:905:979:Ganglia Monitoring System:/usr/lib/ganglia:/sbin/nologin
[root@localhost ~]# systemctl status gmond
gmond.service - Ganglia Monitoring Daemon
   Loaded: loaded (/usr/lib/systemd/system/gmond.service; enabled; vendor preset: disabled)
   Active: active (running) since Sun 2023-01-29 12:30:19 PST; 38s ago
     Process: 1362 ExecStart=/usr/sbin/gmond (code=exited, status=0/SUCCESS)
    Main PID: 1365 (gmond)
      CGroup: /system.slice/gmond.service
              └─1365 /usr/sbin/gmond

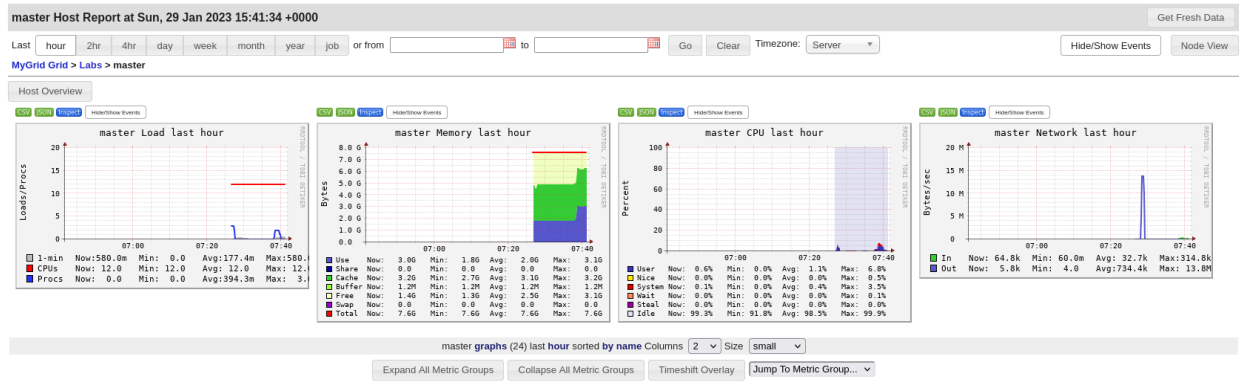
Jan 29 12:30:19 localhost systemd[1]: Starting Ganglia Monitoring Daemon...
Jan 29 12:30:19 localhost systemd[1]: Started Ganglia Monitoring Daemon.
Jan 29 12:30:30 localhost /usr/sbin/gmond[1365]: Error creating multicast server mcast_join=239.2.11.71
Hint: Some lines were ellipsized, use -l to show in full.
[root@localhost ~]#
```



- Cluster labs-



- Master-



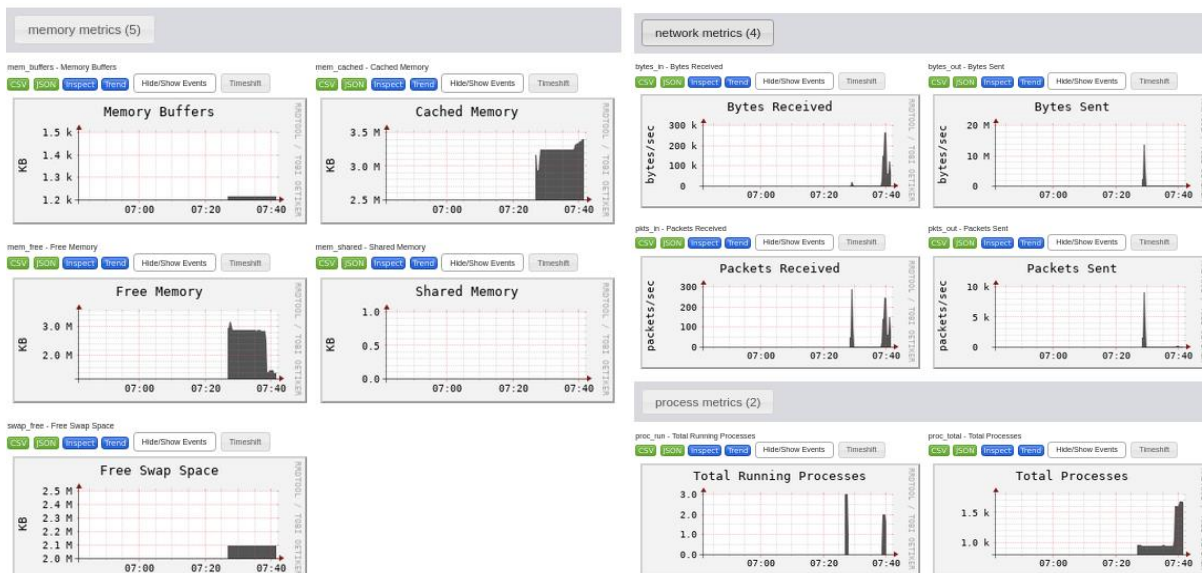
- CPU metrics of master-



- Disk and Load metrics of master



- Memory and network metrics of the master-



HPL BENCHMARKING

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

```
# yum install atlas
```

- Download below file from ->google->hpl netlib->hpl-2.3.tar.gz save in /etc/yum.repos.d

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

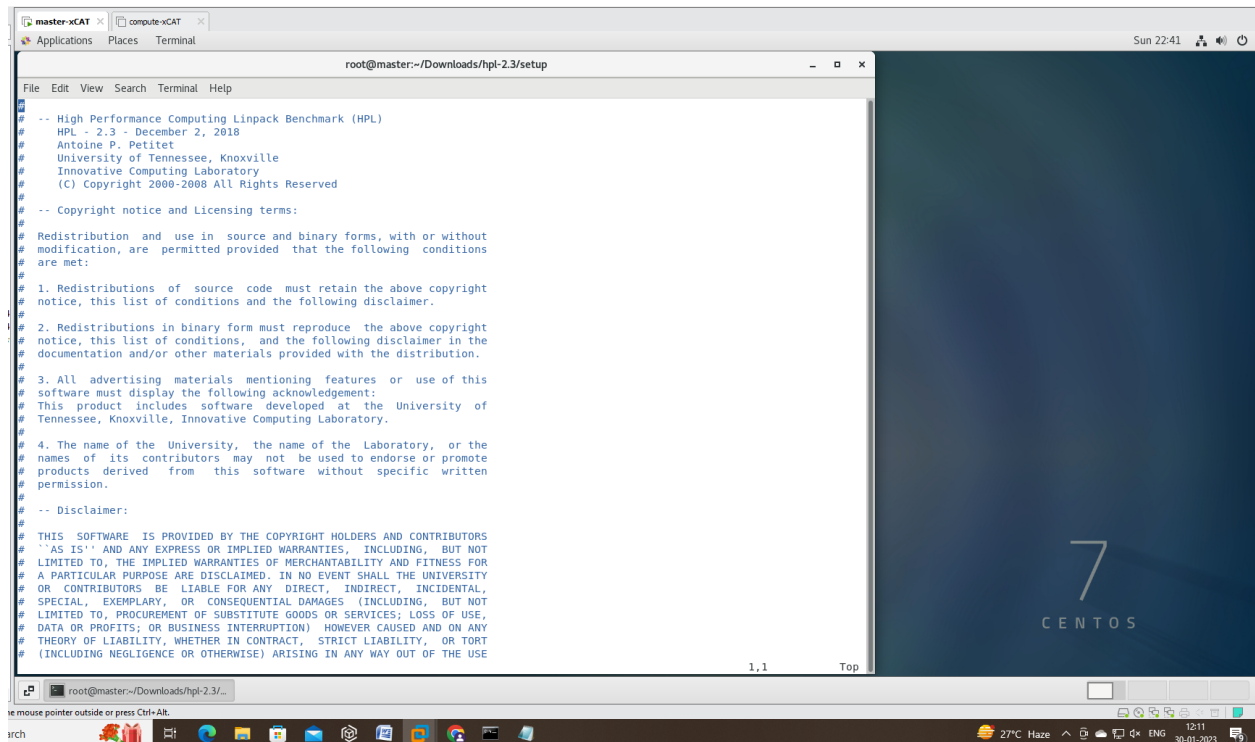
```
# tar -xf /hpl-2.3.tar.gz
```

```
# ls /hpl-2.3
```

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

```
# ls
```

```
# cat Make.Linux_Intel64
```



```
# cp /root/Downloads/hpl-2.3/setup/Make.Linux_Intel64 /root/Downloads/hpl-2.3
```

```
# rpm -ql
```

```
# rpm -ql atlas
```

- Download below file from ->google->Open MPI: Version 4.1 -> openmpi-4.1.4.tar.gz save in /etc/yum.repos.d

```
# tar -xf openmpi-4.1.4.tar.gz
```

```
# ls
```

- if not execute install gcc yum install gcc

```
# yum install gcc-c++
```

```
# ./configure --prefix=/opt/openmpi4.1.4 --enable-orterun-prefix-by-default
```

```
# make -43j 8
```

```
# make install
```

```
# echo $PATH
```

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

```
[root@master openmpi-4.1.4]# export PATH=/opt/openmpi-4.1.4/bin:$PATH
[root@master openmpi-4.1.4]# mp
mpartition      mpic++      mpicxx      mpif90      mpls_dump
mpathconf       mpicc      mpiexec      mpifort      mpris-proxy
mpathpersist    mpiCC      mpif77      mpirun      mpstat
[root@master openmpi-4.1.4]# mp
aclocal.m4      Doxyfile      ompi/
AUTHORS         examples/     opal/
autogen.pl      INSTALL      orte/
config/         libtool      oshmem/
config.log      LICENSE      README
config.lt       Makefile     README.JAVA.txt
config.status   Makefile.am  test/
configure       Makefile.in  VERSION
configure.ac    Makefile.omp
contrib/        NEWS
-
```

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

```
[root@master hpl-2.3]# ls
acinclude.m4  config.guess  depcomp      Makefile.am      missing  THANKS
aclocal.m4   config.sub    HISTORY      Makefile.in      NEWS     TODO
AUTHORS      configure     include      Make.Linux_PII_CBLAS  README  TUNING
BUGS         configure.ac  INSTALL      makes             setup   www
ChangeLog    COPYING      install-sh   Make.top          src
compile      COPYRIGHT    Makefile     man               testing
```

```
[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
```

```
#vi Make.Linux_PII_CBLAS
```

```
# -----
```

```

# - shell -----
# -----
#
SHELL      = /bin/bash
# -----
# - HPL Directory Structure / HPL library -----
# -----
#
TOPdir     = /root/Downloads/hpl-2.3
# -----
# - Message Passing library (MPI) -----
# -----
#
MPdir      = /opt/openmpi4.1.4
MPlib      = $(MPdir)/lib/libmpi.so.40
#
# -----
# - Compilers / linkers - Optimization flags -----
# -----
#
CC         = /usr/bin/gcc
#
LINKER     = /usr/bin/gcc
#
# -----
# - Linear Algebra library (BLAS or VSIP) -----
# -----
#
LAdir      = /usr/lib64/atlas
LAlib      = $(LAdir)/libsatlas.so.3 $(LAdir)/libtatlas.so.3.10
#

```

```
# make arch=Linux_PII_CBLAS
```

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

```

[root@master hpl-2.3]# cd /root/Downloads/hpl-2.3/bin/Linux_PII_CBLAS/
[root@master Linux_PII_CBLAS]# ls
HPL.dat  xhpl
[root@master 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)
4 2          Ps
2 4          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          NBMINs (>= 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=1rg,1=1rM,2=2rg,3=2rM,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)
~
~

```

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

```
master-xCAT x compute-xCAT
Applications Places Terminal
root@master:~/Downloads/hpl-2.3/bin/Linux_PII_CBLAS

File Edit View Search Terminal Tabs Help
root@master:~/Downloads/hpl-2.3/bin/Linux_PII_CBLAS
root@master:~

mpirun has detected an attempt to run as root.

Running as root is *strongly* discouraged as any mistake (e.g., in
defining THPDIR) or bug can result in catastrophic damage to the OS
file system, leaving your system in an unusable state.

We strongly suggest that you run mpirun as a non-root user.

You can override this protection by adding the --allow-run-as-root option
to the cmd line or by setting two environment variables in the following way:
the variable OMPI_ALLOW_RUN_AS_ROOT=1 to indicate the desire to override this
protection, and OMPI_ALLOW_RUN_AS_ROOT_CONFIRM=1 to confirm the choice and
add one more layer of certainty that you want to do so.
We reiterate our advice against doing so - please proceed at your own risk.
-----
[root@master Linux_PII_CBLAS]# mpirun --allow-run-as-root -np 4 ./xhpl HPL.dat
=====
HPLinpack 2.3 -- High-Performance Linpack benchmark -- December 2, 2018
Written by A. Petitet and R. Clint Whaley, Innovative Computing Laboratory, UTK
Modified by Piotr Luszczek, Innovative Computing Laboratory, UTK
Modified by Julien Langou, University of Colorado Denver
=====

An explanation of the input/output parameters follows:
T/V : Wall time / encoded variant.
N : The order of the coefficient matrix A.
NB : The partitioning blocking factor.
P : The number of process rows.
Q : The number of process columns.
Time : Time in seconds to solve the linear system.
Gflops : Rate of execution for solving the linear system.

The following parameter values will be used:

N : 29 30 34 35
NB : 1 2 3 4
PMAP : Row-major process mapping
P : 2 1 2 4
Q : 2 4 1
PFACT : Left Crout Right
NBMIN : 2 4
NDIV : 2

root@master:~/Downloads/hpl-2.3/...
or press Ctrl+G.
```

```
master-xCAT x compute-xCAT
Applications Places Terminal
root@master:~/Downloads/hpl-2.3/bin/Linux_PII_CBLAS
root@master:~/Downloads/hpl-2.3

File Edit View Search Terminal Tabs Help
root@master:~/Downloads/hpl-2.3/bin/Linux_PII_CBLAS
root@master:~/Downloads/hpl-2.3

top - 02:56:48 up 52 min, 3 users, load average: 0.00, 0.02, 0.13
Tasks: 319 total, 1 running, 317 sleeping, 1 stopped, 0 zombie
%Cpu(s): 0.3 us, 0.1 sy, 0.0 ni, 99.7 id, 0.0 wa, 0.0 hi, 0.0 si, 0.0 st
KiB Mem : 7989848 total, 5202688 free, 1189332 used, 1597828 buff/cache
KiB Swap: 2098172 total, 2098172 free, 0 used, 6477096 avail Mem

  PID USER PR NI VIRT RES SHR S %CPU %MEM    TIME+    COMMAND
2668 root  20  0 4352144 210028 77412 S  6.3  2.6   3:03.83  gnome-shell
2041 root  20  0 461784 86724 45112 S  3.3  1.1   1:08.62 X
3122 root  20  0 683908 30724 17656 S  1.3  0.4   0:26.66  gnome-terminal-
2950 root  20  0 689148 26248 18924 S  1.0  0.3   0:10.03  vmtoolsd
778 root  20  0 295380 5196 3968 S  0.7  0.1   0:10.32  vmtoolsd
9 root  20  0 0 0 0 S  0.3  0.0   0:04.39  rcu_sched
386 root  20  0 0 0 0 S  0.3  0.0   0:05.51  xf86-video-sda3
1448 slurm 20  0 689312 6220 2980 S  0.3  0.1   0:05.50  slurmctld
1 root  20  0 191808 4812 2628 S  0.0  0.1   0:04.07  systemd
2 root  20  0 0 0 0 S  0.0  0.0   0:00.02  kthreadd
4 root  0 -20 0 0 0 S  0.0  0.0   0:00.00  kworker/0:0H
6 root  20  0 0 0 0 S  0.0  0.0   0:00.46  ksoftirqd/0
7 root  rt  0 0 0 S  0.0  0.0   0:00.16  migration/0
8 root  20  0 0 0 0 S  0.0  0.0   0:00.00  rcu_bh
10 root  0 -20 0 0 0 S  0.0  0.0   0:00.00  lru-add-drain
11 root  rt  0 0 0 S  0.0  0.0   0:00.11  watchdog/0
12 root  rt  0 0 0 S  0.0  0.0   0:00.11  watchdog/1
13 root  rt  0 0 0 S  0.0  0.0   0:00.52  migration/1
14 root  20  0 0 0 0 S  0.0  0.0   0:00.17  ksoftirqd/1
15 root  20  0 0 0 0 S  0.0  0.0   0:02.26  kworker/1:0
16 root  0 -20 0 0 0 S  0.0  0.0   0:00.00  kworker/1:0H
17 root  rt  0 0 0 S  0.0  0.0   0:00.08  watchdog/2
18 root  rt  0 0 0 S  0.0  0.0   0:00.17  migration/2
19 root  20  0 0 0 0 S  0.0  0.0   0:00.09  ksoftirqd/2
21 root  0 -20 0 0 0 S  0.0  0.0   0:00.00  kworker/2:0H
22 root  rt  0 0 0 S  0.0  0.0   0:00.08  watchdog/3
23 root  rt  0 0 0 S  0.0  0.0   0:00.14  migration/3
24 root  20  0 0 0 0 S  0.0  0.0   0:00.06  ksoftirqd/3
26 root  0 -20 0 0 0 S  0.0  0.0   0:00.00  kworker/3:0H
27 root  rt  0 0 0 S  0.0  0.0   0:00.09  watchdog/4
28 root  rt  0 0 0 S  0.0  0.0   0:00.53  migration/4
29 root  20  0 0 0 0 S  0.0  0.0   0:00.15  ksoftirqd/4
31 root  0 -20 0 0 0 S  0.0  0.0   0:00.00  kworker/4:0H
32 root  rt  0 0 0 S  0.0  0.0   0:00.07  watchdog/5

root@master:~/Downloads/hpl-2.3/...
ie mouse pointer outside or press Ctrl+Alt.
```

- Final Result of Benchmarking

```

root@master-xCAT x compute-xCAT
Applications Places Terminal
root@master:~/Downloads/hpl-2.3/bin/Linux_PII_CBLAS
File Edit View Search Terminal Tabs Help
root@master:~/Downloads/hpl-2.3/bin/Linux_PII_CBLAS
=====
T/V      N  NB  P  Q      Time      Gflops
-----
WR00R2C4  35   4   4   1      0.00      4.1664e-01
HPL_pdgesv() start time Mon Jan 30 02:46:52 2023
HPL_pdgesv() end time  Mon Jan 30 02:46:52 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      5.4725e-01
HPL_pdgesv() start time Mon Jan 30 02:46:52 2023
HPL_pdgesv() end time  Mon Jan 30 02:46:52 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      6.1113e-01
HPL_pdgesv() start time Mon Jan 30 02:46:52 2023
HPL_pdgesv() end time  Mon Jan 30 02:46:52 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]#

```

Conclusion-

We have successfully booted our Compute node via network using XCAT. We further, configured LDAP for user authentication supported by creation of a new user. Furthermore, added Slurm in our cluster for performing job scheduling. Added, Ganglia for monitoring of both the nodes. And finally, checked the efficiency of our cluster through HPL Benchmarking.