

Problem Statement-

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

Introduction-

The master node serves as the overall system management server (SMS) and is provisioned with CentOS7.7 and is subsequently configured to provision the compute node with xCAT in a stateless configuration.

XCAT-

In VMWare Create 1 Machine namely-masterwith 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
```

```
# lsb_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-newworkboot loader

```
# lsdef cn00
```

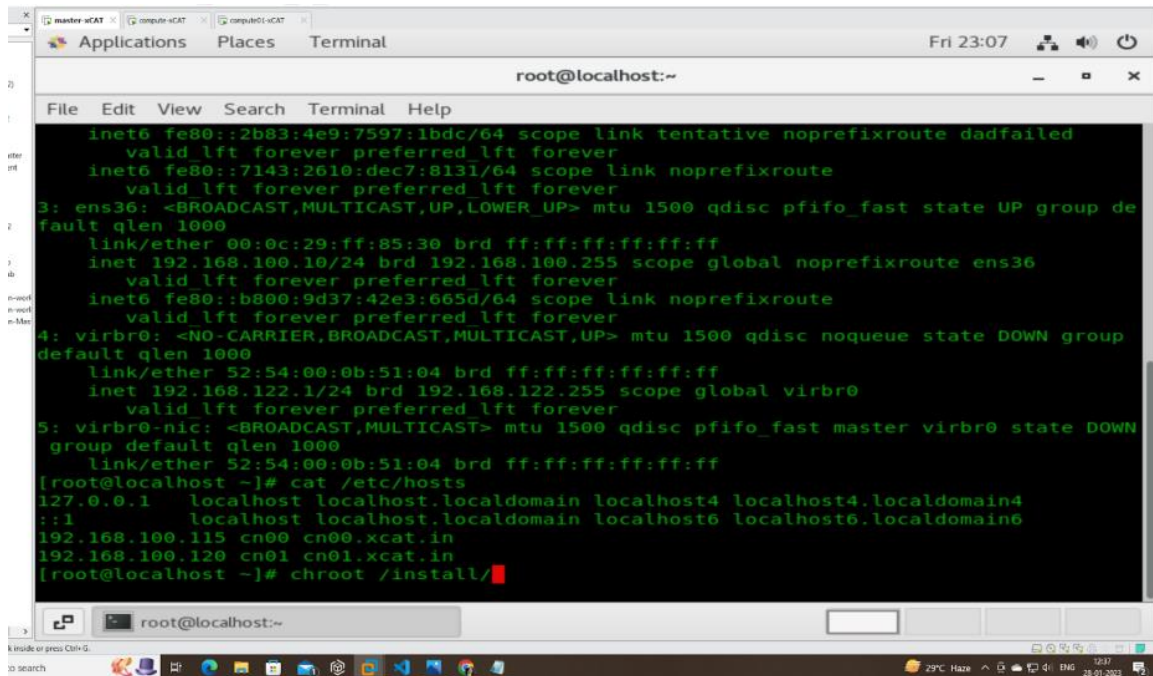
```
# chdef -t node node1 provmethod=centos7.9-x86_64-netboot-compute
```

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

```
# lsdef node1
```

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

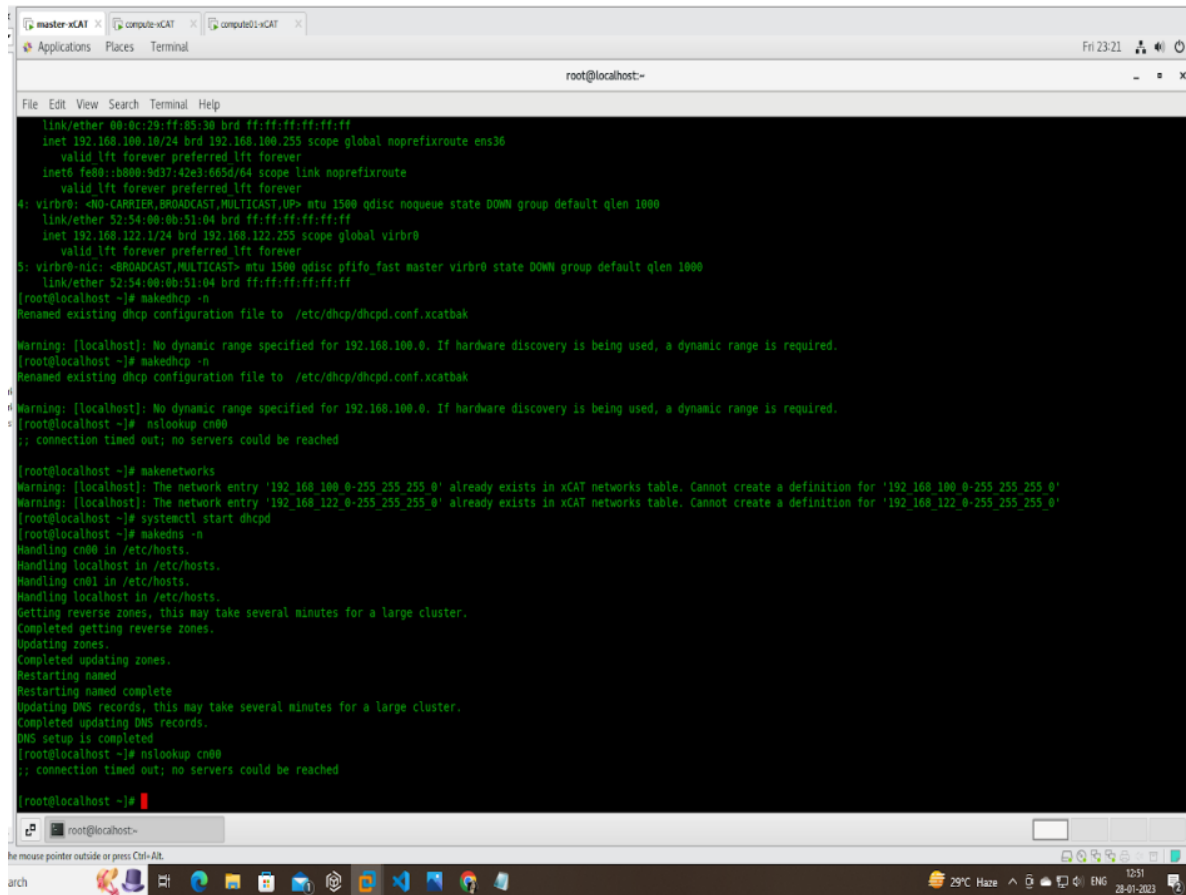
```
# cat /etc/hosts
```



The screenshot shows a terminal window titled 'root@localhost:~' with a menu bar (File, Edit, View, Search, Terminal, Help). The terminal output displays the configuration of network interfaces 'ens36' and 'virbr0'. For 'ens36', it shows IPv6 addresses, MTU, and state 'UP'. For 'virbr0', it shows state 'DOWN'. Below the interface details, the output of 'cat /etc/hosts' is shown, listing localhost entries. The prompt '[root@localhost ~]# chroot /install/' is visible at the bottom of the terminal output.

```
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:85:30 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::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
```

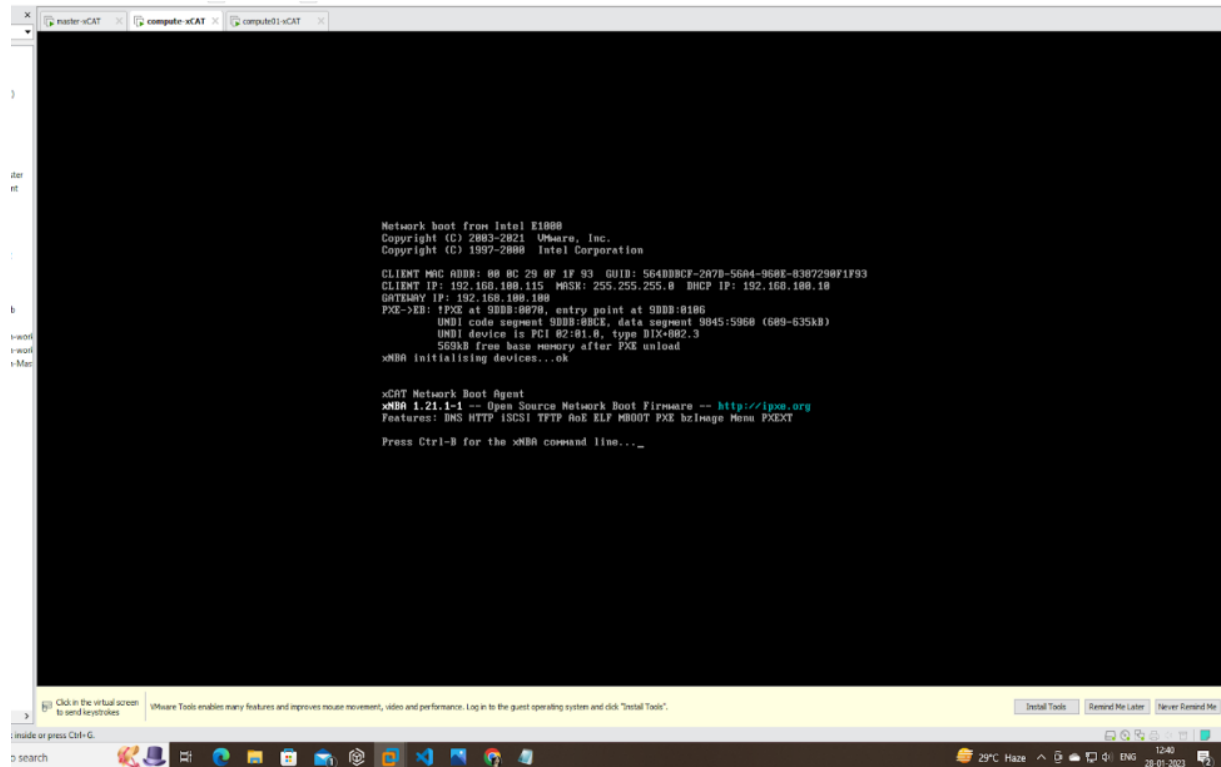
```
# nodeset compute osimage=centos7.9-x86_64-netboot-compute
```

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

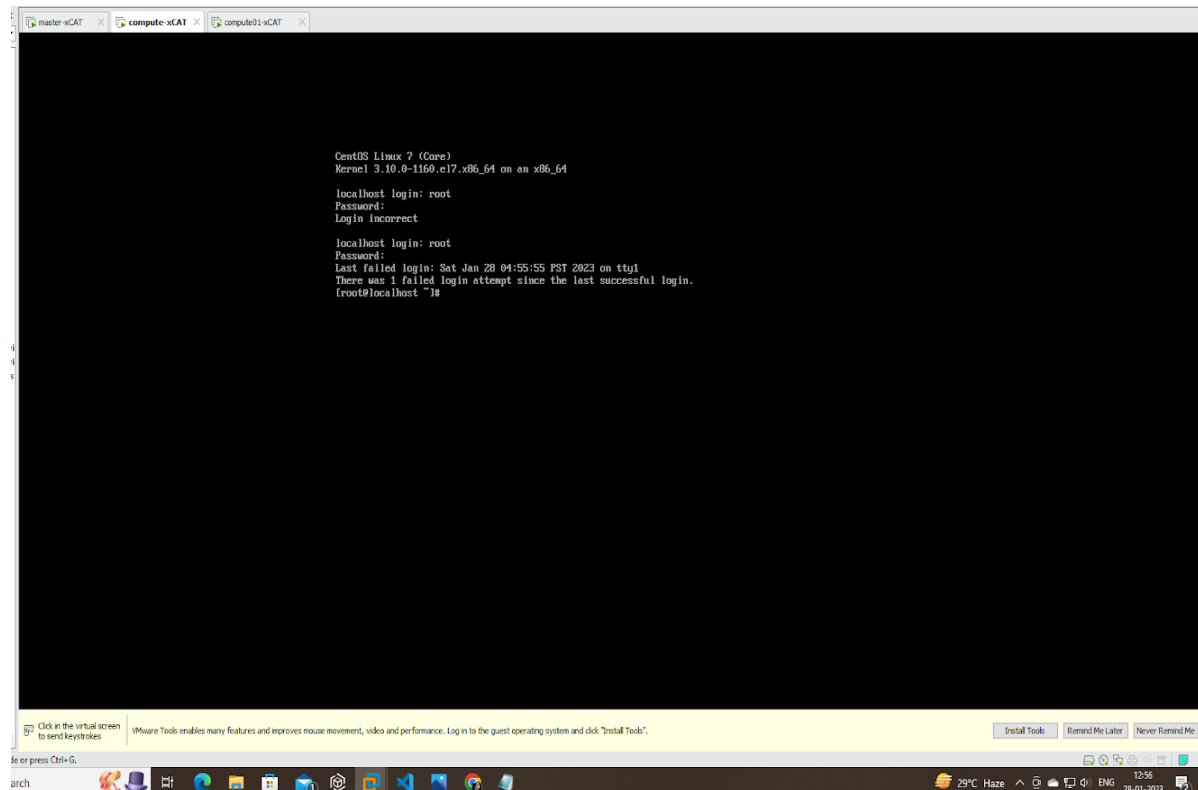
The screenshot displays the VMware Workstation interface. The top menu bar includes File, Edit, View, VM, Tools, Help, and icons for power, undo, redo, copy, paste, delete, and zoom. Below the menu is a toolbar with various icons. On the left, the Library pane shows a tree view of virtual machines under 'My Computer'. The main window has tabs for 'master-eCAT', 'CaseStudyMaster' (active), and 'CaseStudyNode1'. The active tab shows a terminal window titled 'root@localhost~' with the following commands and output:

```
File Edit View Search Terminal Help  
  
[root@localhost ~]# ip net 192.168.122.1/24 brd 192.168.122.255 scope global virbr0  
    valid lft forever preferred lft forever  
[root@localhost ~]# virbr0-nic <BRIDGECAST,MULTICAST> mtu 1500 qdisc pfifo_fast master virbr0 state DOWN group default qlen 1000  
Link/ether 52:54:00:b8:51:04 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 tmp var  
boot etc lib media opt root sbin sys usr xatpost  
[root@localhost ~]# exit  
exit  
[root@localhost ~]# chdef -t site dhcpinterfaces="ens36"  
Object definitions have been created or modified.  
[root@localhost ~]# chdef -t site master="192.168.88.128"  
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 09:03 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/passwd -> /etc/passwd  
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 ~]# chdef -t pxe model groups=compute,all ip=192.168.88.130 mac=08:0C:29:1C:5A:2F netboot=xnba  
Object definitions have been created or modified.  
[root@localhost ~]# lsdef model  
Object name: model  
groups=compute,all  
ip=192.168.88.130  
mac=08:0C:29:1C:5A:2F  
netboot=xnba  
postbootscripts=otherpkgs  
postscriptseasylog.remeteshell.sysfiles
```

- Booting Compute node through XCAT-



- Successfully booted via XCAT on node1



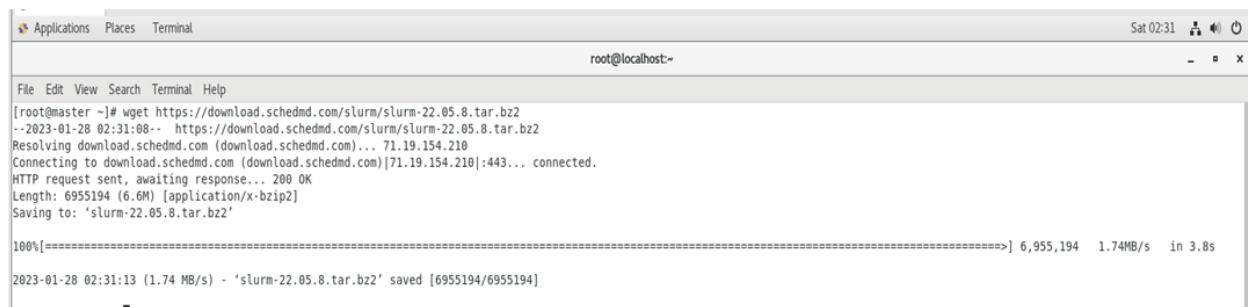
SLURM-

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/rooting/
```

```
# 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 'wget' command to download 'https://download.schedmd.com/slurm/slurm-22.05.8.tar.bz2'. The output indicates the file was successfully downloaded from 'download.schedmd.com' to the local path 'slurm-22.05.8.tar.bz2'. The download progress is shown as 100% complete, with a speed of 1.74 MB/s and a total size of 6,955,194 bytes. The terminal also shows the file was saved at 2023-01-28 02:31:13.

```
root@localhost~  
[root@master ~]# wget https://download.schedmd.com/slurm/slurm-22.05.8.tar.bz2  
--2023-01-28 02:31:08-- https://download.schedmd.com/slurm/slurm-22.05.8.tar.bz2  
Resolving download.schedmd.com (download.schedmd.com)... 71.19.154.218  
Connecting to download.schedmd.com (download.schedmd.com)|71.19.154.218|:443... connected.  
HTTP request sent, awaiting response... 200 OK  
Length: 6955194 (6.6M) [application/x-bzip2]  
Saving to: 'slurm-22.05.8.tar.bz2'  
  
100%[=====] 6,955,194 1.74MB/s in 3.8s  
  
2023-01-28 02:31:13 (1.74 MB/s) - 'slurm-22.05.8.tar.bz2' saved [6955194/6955194]
```

```
#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
```

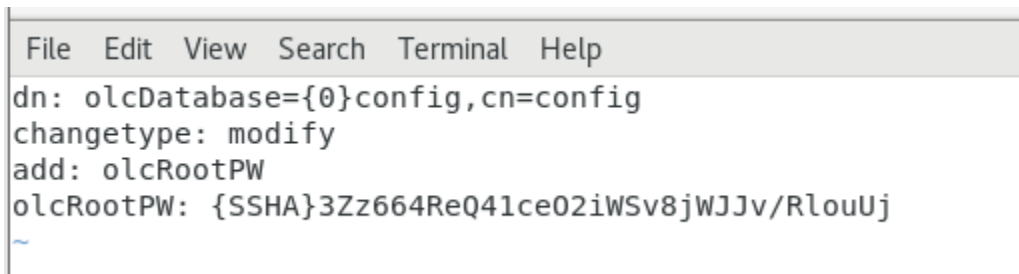
- Saving the password from below command for further authentication

```
# 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 LDAP configuration commands:

```
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}3Zz664ReQ41ce02iWSv8jWJJv/RlouUj
loginShell: /bin/bash
uidNumber: 1501
gidNumber: 1501
homeDirectory: /home/test1

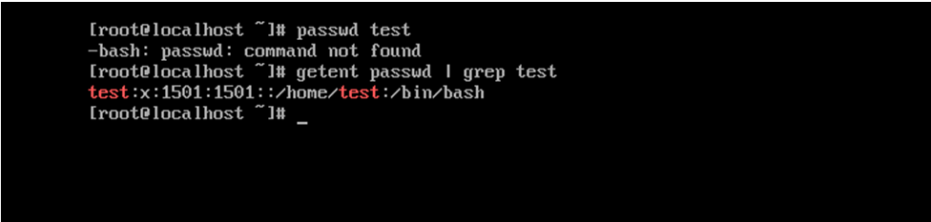
dn: cn=test1,ou=Group,dc=cdac,dc=in
objectClass: posixGroup
cn: test1
gidNumber: 1501
memberUid: test1
```



```
# 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 --ldapsrvdn="dc=cdac,dc=in" --enablemkhomedir --update
```

```
# systemctl restart nslcd
```

```
# ldapsearch -x
```

```
root@master:~# rpm -q --queryformat '%{NAME} %{VERSION} %{ARCH} %{SIZE} %{INSTALLDATE} %{INSTALLSIZE} %{INSTALLTIME} \n' --whatprovides epel-release
base: repo.extreme-ix.org
epel: mirrors.thghost.com
extras: repo.extreme-ix.org
updates: repo.extreme-ix.org

base                | 3.6 kB    00:00
epel                 | 4.7 kB    00:00
extras              | 2.9 kB    00:00
updates             | 2.9 kB    00:00
xcat-core            | 2.9 kB    00:00
xcat-dep             | 2.9 kB    00:00
(1/2): epel/x86_64/updateinfo | 1.0 MB    00:03
(2/2): epel/x86_64/primary.db | 7.0 MB    00:16
Package openldap-servers-2.4.44-25.el7_9.x86_64 already installed and latest version
Package openldap-clients-2.4.44-25.el7_9.x86_64 already installed and latest version
Nothing to do
[root@master ~]# cp /usr/share/openldap-servers/DB_CONFIG.example /var/lib/ldap/DB_CONFIG
cp: overwrite '/var/lib/ldap/DB_CONFIG'?
[root@master ~]# chown ldap:/var/lib/ldap/DB_CONFIG
[root@master ~]# systemctl start slapd
[root@master ~]# systemctl enable slapd
[root@master ~]# slapasswd
New password:
Re-enter new password:
(SSHA)u6xEFgydWodmCAQPHt4Ll97JbmgIegJ3
[root@master ~]# vi chrootpw.ldif
[root@master ~]# ldapadd -Y EXTERNAL -H ldapi:/// -f chrootpw.ldif
SASL/EXTERNAL authentication started
SASL username: gidNumber=0+uidNumber=0,cn=peercred,cn=external,cn=auth
SASL SSF: 0
modifying entry "olcDatabase={0}config,cn=config"
ldap_modify: inappropriate matching (18)
    additional info: modify/add: olcRootPW: no equality matching rule

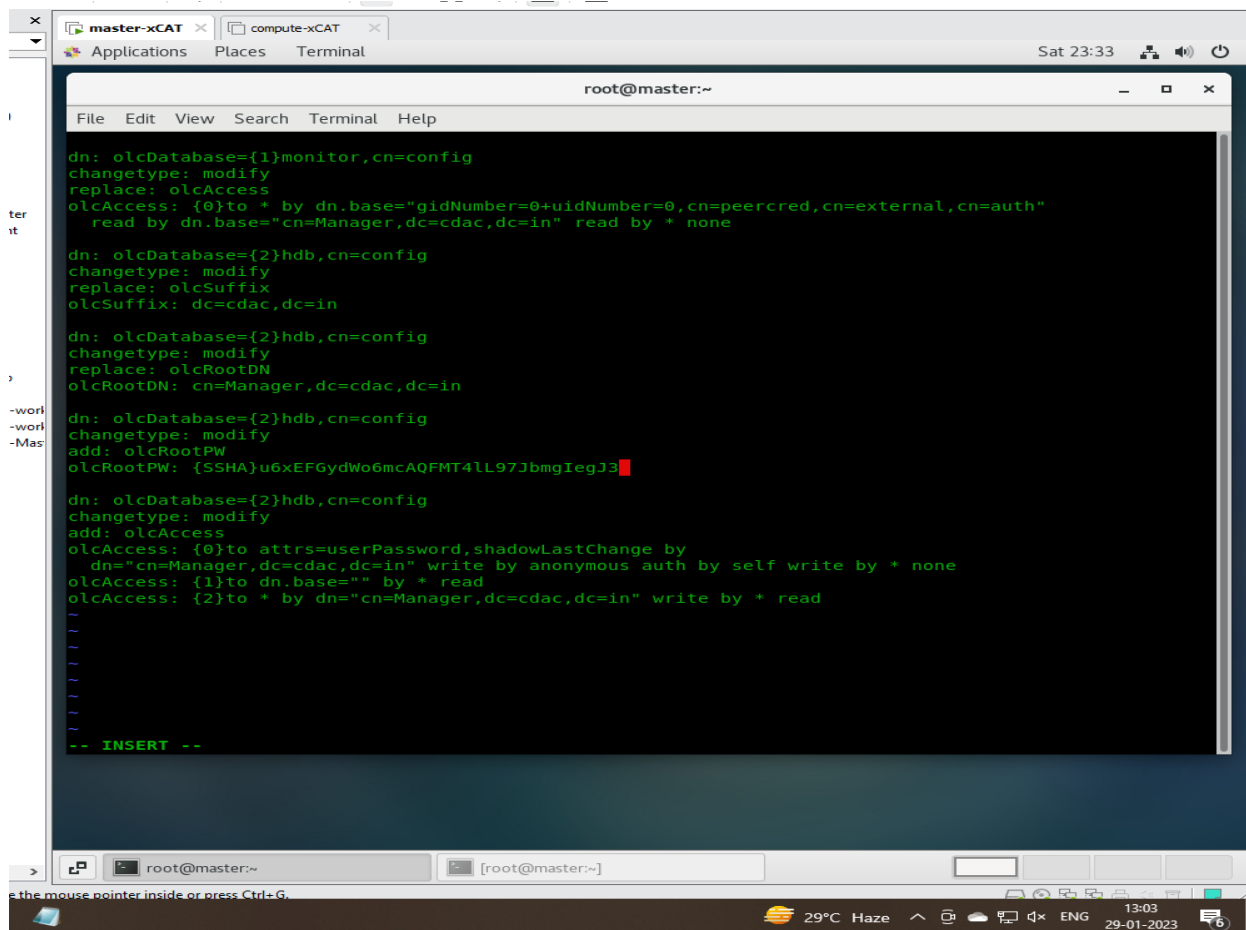
[root@master ~]# vi chrootpw.ldif
[root@master ~]# ldapadd -Y EXTERNAL -H ldapi:/// -f /etc/openldap/schema/cosine.ldif
SASL/EXTERNAL authentication started
```

```
root@master:~# cp: overwrite '/var/lib/ldap/DB_CONFIG'?
[root@master ~]# chown ldap:/var/lib/ldap/DB_CONFIG
[root@master ~]# systemctl start slapd
[root@master ~]# systemctl enable slapd
[root@master ~]# slapasswd
New password:
Re-enter new password:
(SSHA)u6xEFgydWodmCAQPHt4Ll97JbmgIegJ3
[root@master ~]# vi chrootpw.ldif
[root@master ~]# ldapadd -Y EXTERNAL -H ldapi:/// -f chrootpw.ldif
SASL/EXTERNAL authentication started
SASL username: gidNumber=0+uidNumber=0,cn=peercred,cn=external,cn=auth
SASL SSF: 0
modifying entry "olcDatabase={0}config,cn=config"
ldap_modify: inappropriate matching (18)
    additional info: modify/add: olcRootPW: no equality matching rule

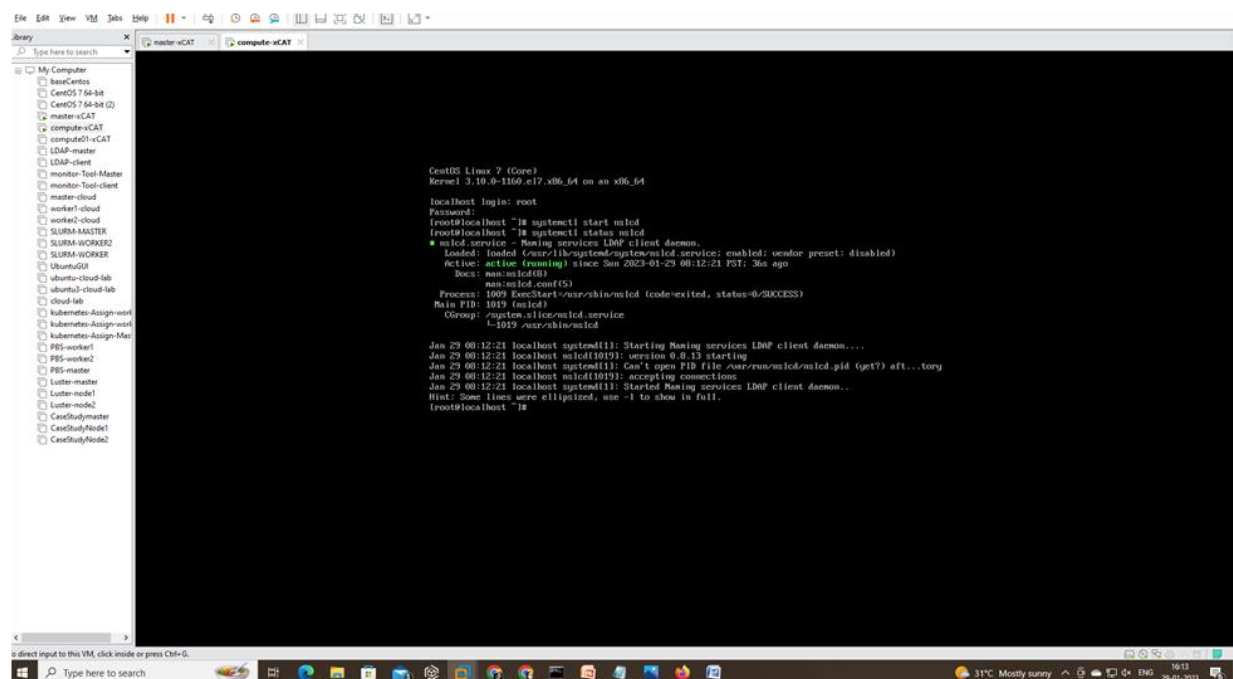
[root@master ~]# vi chrootpw.ldif
[root@master ~]# ldapadd -Y EXTERNAL -H ldapi:/// -f /etc/openldap/schema/cosine.ldif
SASL/EXTERNAL authentication started
SASL username: gidNumber=0+uidNumber=0,cn=peercred,cn=external,cn=auth
SASL SSF: 0
adding new entry "cn=c cosine,cn=schema,cn=config"
ldap_add: Other (e.g., implementation specific) error (80)
    additional info: olcAttributeTypes: Duplicate attributeType: "0.9.2342.19200300.100.1.2"

[root@master ~]# ldapadd -Y EXTERNAL -H ldapi:/// -f /etc/openldap/schema/nis.ldif
SASL/EXTERNAL authentication started
SASL username: gidNumber=0+uidNumber=0,cn=peercred,cn=external,cn=auth
SASL SSF: 0
adding new entry "cn=nis,cn=schema,cn=config"
ldap_add: Other (e.g., implementation specific) error (80)
    additional info: olcAttributeTypes: Duplicate attributeType: "1.3.6.1.1.1.1.2"

[root@master ~]#
```



Service started successfully on node —

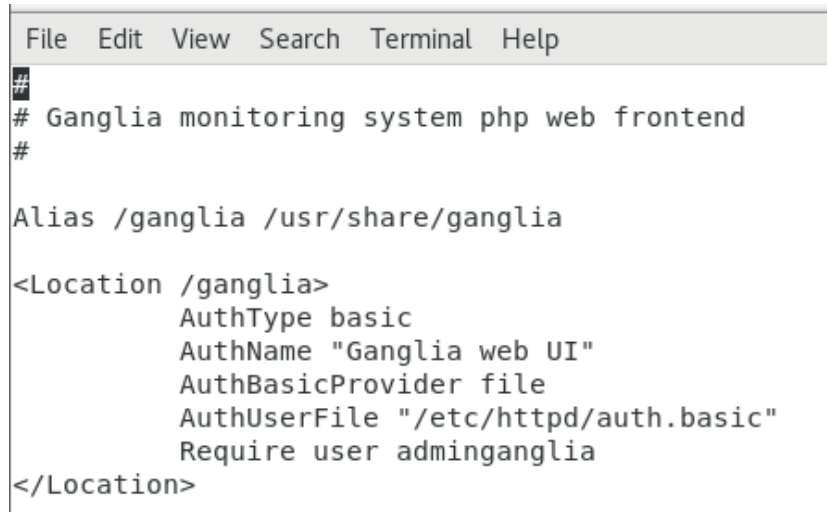


GANGLIA

```
# 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
}

```

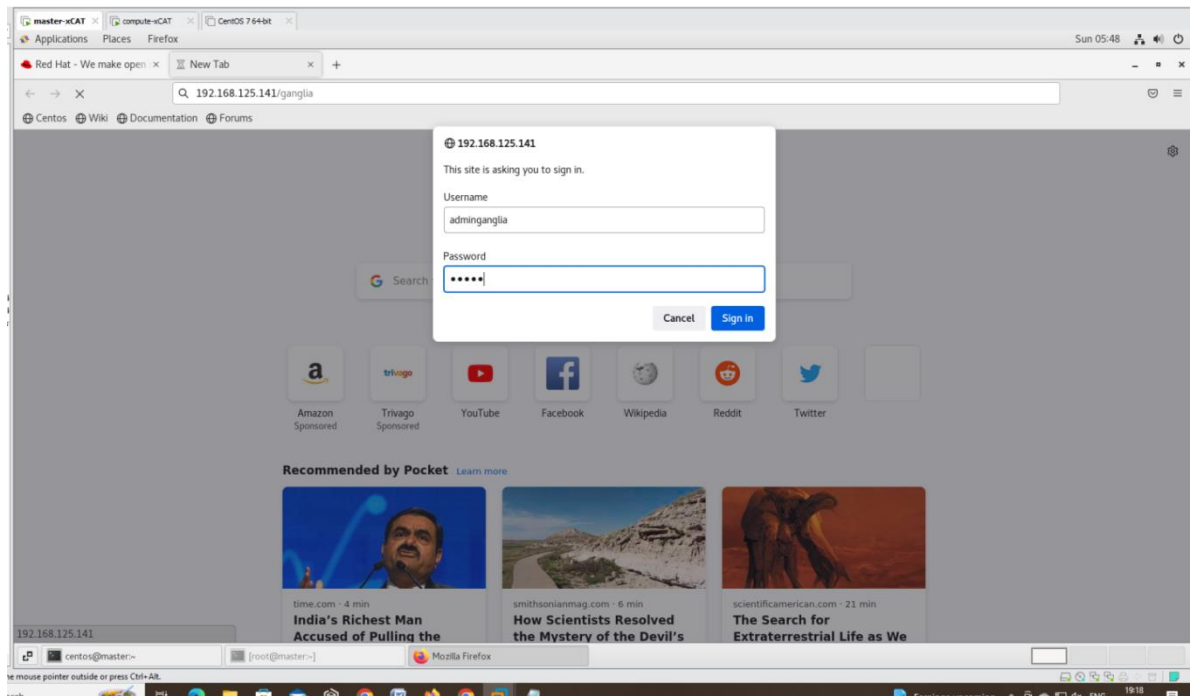
setsebool -P httpd_can_network_connect 1

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
}
```

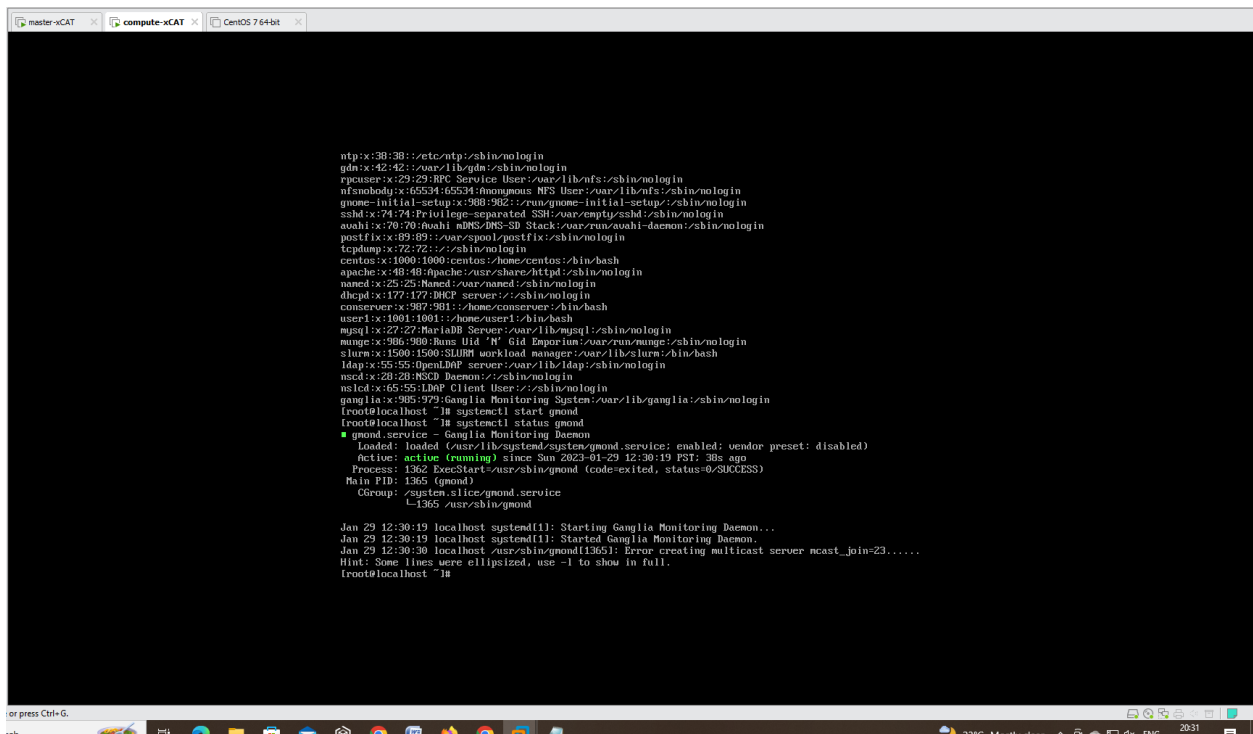
```
# chroot $CHROOT

# systemctl enable gmond

# systemctl restart httpd gmetad gmond

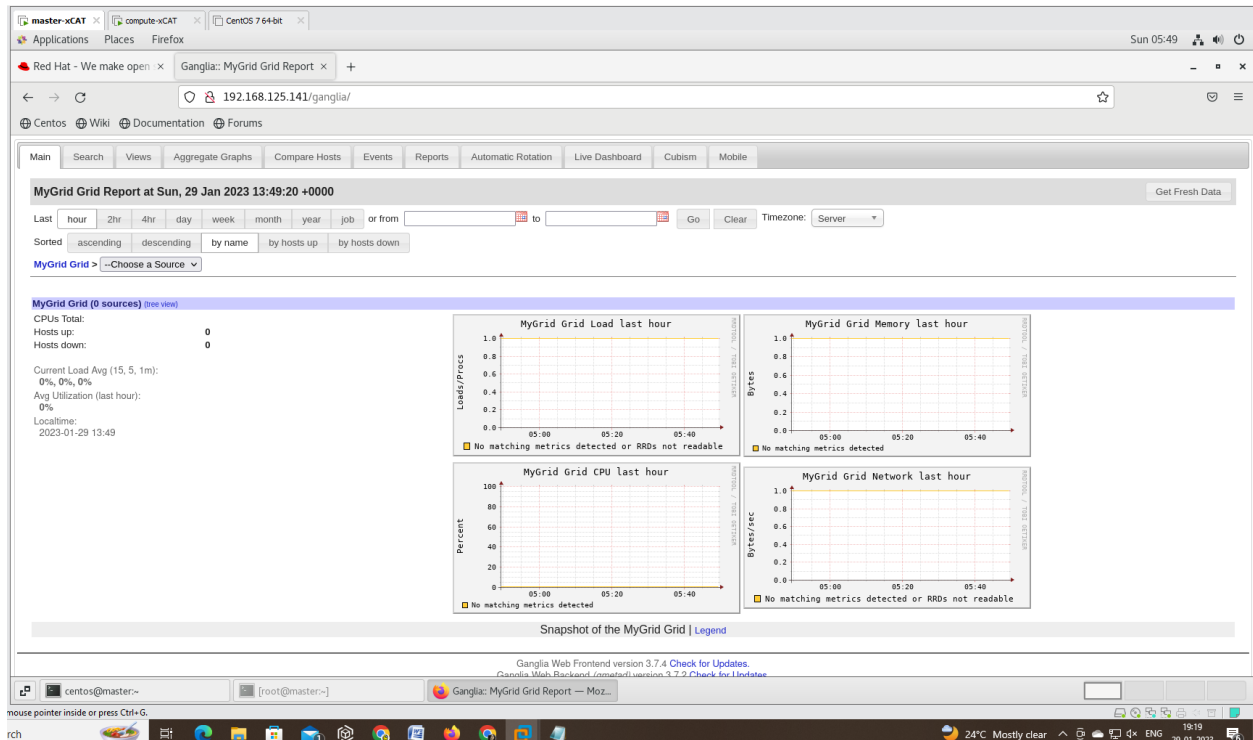
# systemctl enable httpd gmetad httpd

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

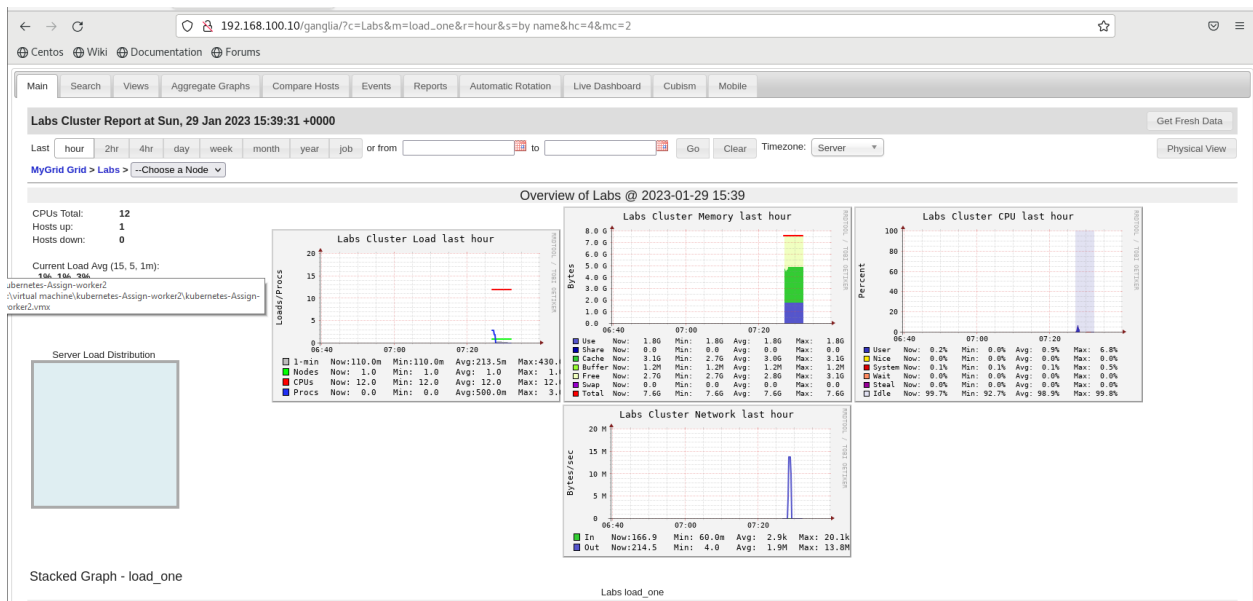


```
ntp:x:38:38::etc:/etc:/sbin/nologin
gdm:x:42:42::/var/lib/gdm:/sbin/nologin
rpcuser:x:29:29:RPC Service User:/var/lib/dfs:/sbin/nologin
nfsnobody:x:65534:65534:Anonymous NFS User:/var/lib/dfs:/sbin/nologin
gnome-initial-setup:x:988:982::/run/gnome-initial-setup:/sbin/nologin
sshd:x:74:74:Privilege-separated SSH:/var/empty/ssh:/sbin/nologin
sushi:x:70:70:Booth nfsS-DPS-SD Stack:/var/run/sushi-daemon:/sbin/nologin
postfix:x:99:99::/var/spool/postfix:/sbin/nologin
tcpdump:x:72:72::/sbin/nologin
centos:x:1000:1000:centos:/home/centos:/bin/bash
apache:x:48:48:Apache:/var/share/httpd:/sbin/nologin
named:x:25:25:Named:/var/named:/sbin/nologin
dhcpd:x:177:177:DHCP server:/sbin/nologin
consrver:x:989:981::/home/consrver:/bin/bash
user1:x:1001:1001::/home/user1:/bin/bash
mysql:x:27:27:MySQL Server:/var/lib/mysql:/sbin/nologin
munge:x:986:980:Runs Uid 'N' Gid Exporium:/var/run/munge:/sbin/nologin
slurm:x:1500:1500:SLURM workload manager:/var/lib/slurm:/bin/bash
ldap:x:55:55:OpenLDAP server:/var/lib/ldap:/sbin/nologin
nscd:x:28:28:NSCD Daemon:/sbin/nologin
nslcd:x:65:55:LDAP Client User:/sbin/nologin
ganglia:x:985:979:Ganglia Monitoring System:/var/lib/ganglia:/sbin/nologin
[root@localhost ~]# systemctl start gmond
[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)
      Group: systemd-lices/gmond.service
            └─1365 /usr/sbin/gmond

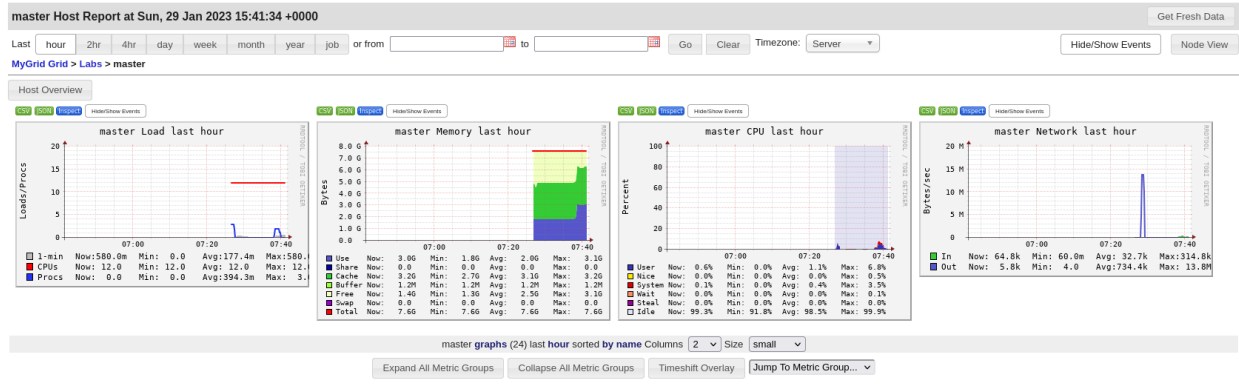
Jan 29 12:30:19 localhost systemd[1]: Starting Ganglia Monitoring Daemon...
Jan 29 12:30:19 localhost systemd[1]: Started Ganglia Monitoring Daemon.
Jan 29 12:30:30 localhost /usr/sbin/gmond[1365]: Error creating multicast server ncast_join=23.....
Hint: Some lines were ellipsized, use -l to show in 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
```

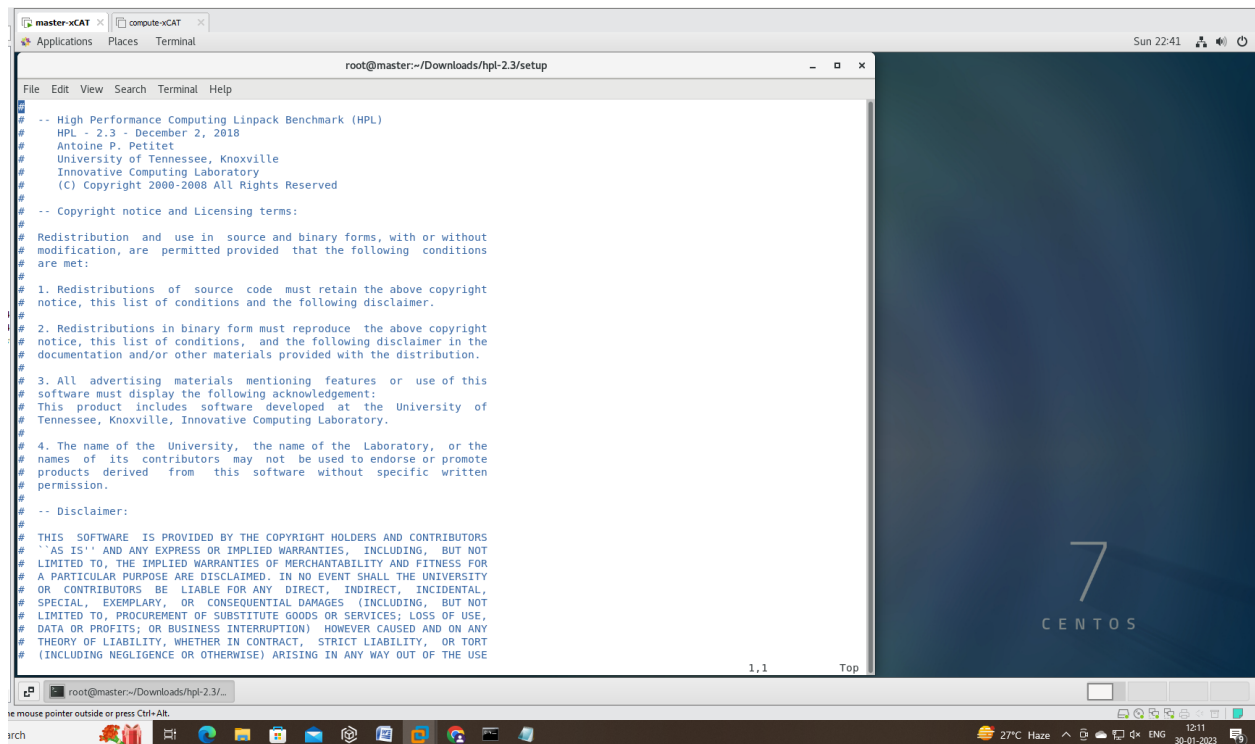
```
# tar -xf /hpl-2.3.tar.gz
```

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

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

```
# ls
```

```
# cat Make.Linux_Intel64
```



```
root@master:~/Downloads/hpl-2.3/setup
-- High Performance Computing Linpack Benchmark (HPL)
HPL - 2.3 - December 2, 2018
Antoine P. Petitet
University of Tennessee, Knoxville
Innovative Computing Laboratory
(C) Copyright 2000-2008 All Rights Reserved

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SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT
LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE,
DATA OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY
THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT
(INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE
```

```
# 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 -j 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
mpathconf  mpicc      mpicxx      mpif90      mpls_dump
mpathpersist  mpiCC      mpiexec      mpifort      mpris-proxy
mpathpersist  mpiCC      mpif77      mpirun      mpstat
[root@master openmpi-4.1.4]# mp
aclocal.m4      Doxyfile      omp/
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-rules
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      testing
compile      COPYRIGHT    Makefile     man
```

```
[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 VSIBL) -----
```

```
# -----
#
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:~/Downloads/hpl-2.3/bin/Linux_PII_CBLAS
mpirun has detected an attempt to run as root.

Running as root is *strongly* discouraged as any mistake (e.g., in
defining TMPDIR) 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. Petit et 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 4
Q : 2 4 1
PFACT : Left Crout Right
NBMIN : 2 4
NDIV : 2

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

```
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:~/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 609148 26248 18924 S  1.0  0.3   0:18.03 vmtoolsd
 778 root    20  0 295300 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 xfswild/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 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 0 S  0.0  0.0   0:00.11 watchdog/0
   12 root    rt  0 0 0 0 S  0.0  0.0   0:00.11 watchdog/1
   13 root    rt  0 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 0 S  0.0  0.0   0:00.08 watchdog/2
   18 root    rt  0 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 0 S  0.0  0.0   0:00.08 watchdog/3
   23 root    rt  0 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 0 S  0.0  0.0   0:00.09 watchdog/4
   28 root    rt  0 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 0 S  0.0  0.0   0:00.07 watchdog/5

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

- Final Result of Benchmarking

```

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.