Centre for Development of Advanced Computing

*Pune, Maharashtra*

### ****TITLE****

**Build a two node Disk-less HPC-cluster using OpenHPC with Warewulf, Slurm, Nagios, and Ganglia and do a HPL benchmarking**

Submitted by:

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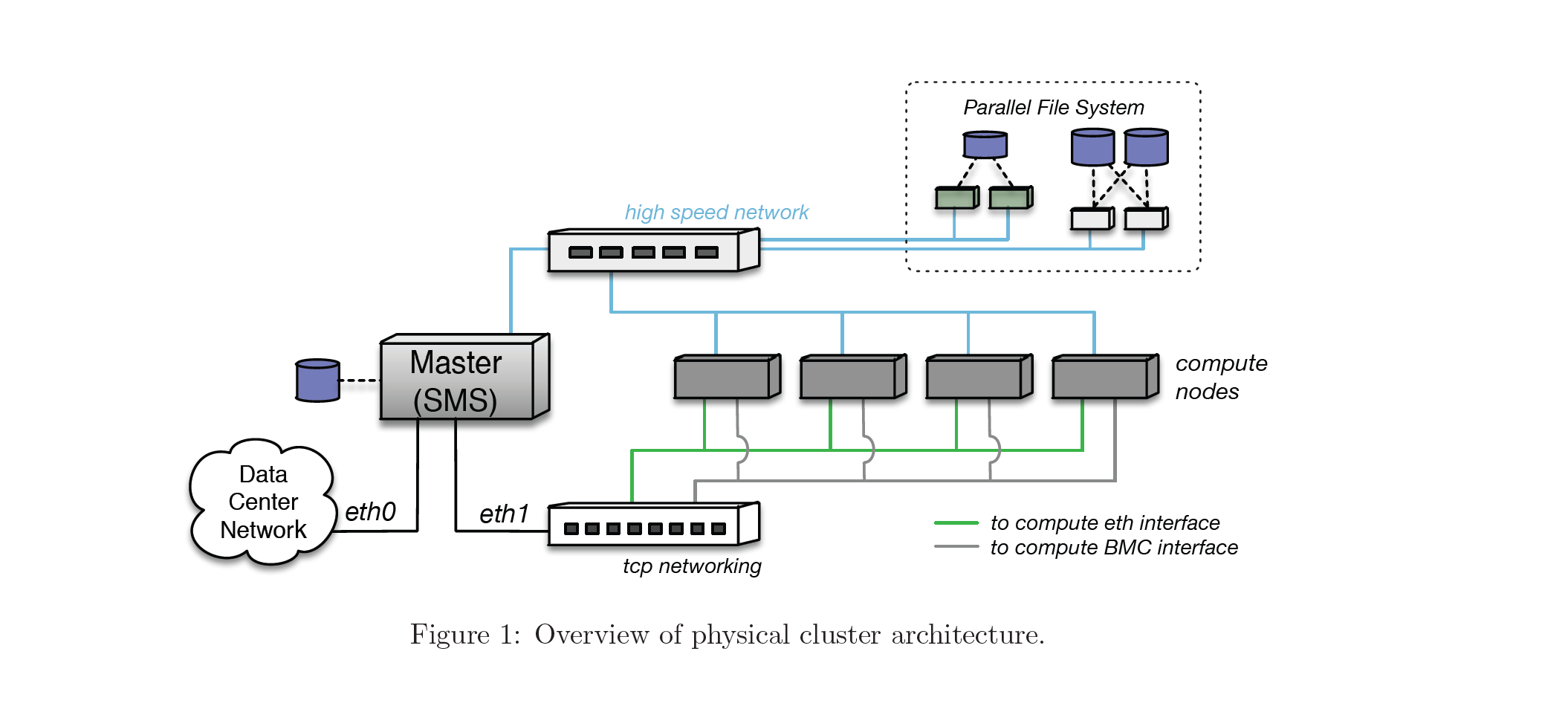
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Requirements

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

 For file systems, the master server will host an NFS file system that is made available to the compute nodes.

# VMware Require :

* One Master Vm with Two Network Adapters
  + ens33 (NAT)
  + ens34 (Host-only)
* Processor : 4
* Ram : 8 GB
* Storage : 100 GB

CONTANT



**Warewulf** - Operating System provisioning platform for Linux



**Slurm** - Open-Source Workload Manager/Scheduler



**Nagios** - Open Source Infrastructure Monitoring Package



**Ganglia** - Scalable Distributed System Monitoring Tool

**HPL-Benchmark** - High-Performance Linpack benchmark implementation

***INSTALLATION***

Pre-requisite:

We have to stop and disable firewall and disable selinux

* systemctl stop firewalld
* systemctl disable firewalld
* vi /etc/selinnux/conf

# 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 ens34

Output -> ens34:192.168.150.128

* vi /etc/hosts

-> edit ->192.168.149.147 master

* yum -y install yum-utils

***Install OpenHPC Components***

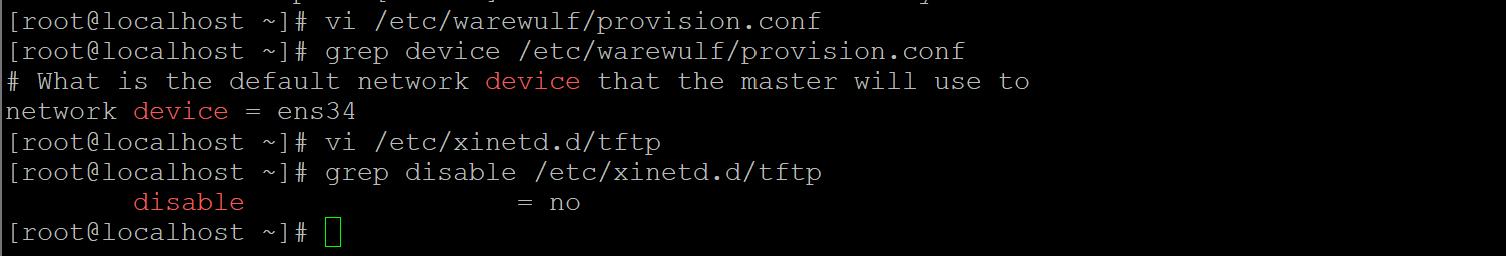
* yum install http://build.openhpc.community/OpenHPC:/1.3/CentOS\_7/x86\_64/ohpc-release-1.3-1.el7.x86\_64.rpm
* yum repolist
* yum -y install ohpc-base
* yum -y install ohpc-warewulf
* yum -y install chrony
* vi /etc/chrony.conf
  + Edit this Conf. file -> server 192.168.149.147iburst
  + allow 192.168.149.0/24 (uncomment and edit network address)
  + local stratum 10 (uncomment)
  + SAVE and Exit
* systemctl start chronyd
* systemctl enable chronyd
* yum install ntpdate
* ntpdate -q 192.168.149.147
* vi /etc/warewulf/provision.conf

edit -> change network device = ens34

* grep device /etc/warewulf/provision.conf
* vi /etc/xinetd.d/tftp

edit -> disable = no

* grep disable /etc/xinetd.d/tftp

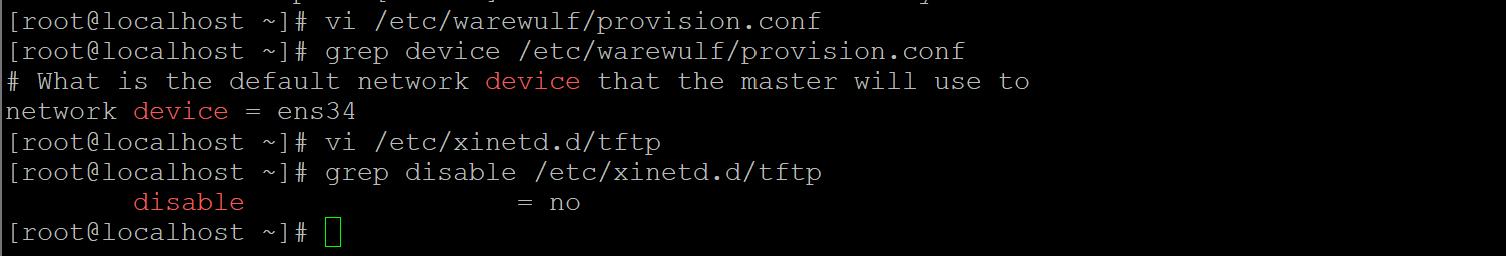


**Add Slurm services on master node**

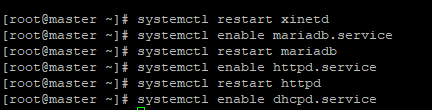
* yum -y install ohpc-slurm-server
* yum -y install slurm-sview-ohpc slurm-torque-ohpc
* vi /etc/slurm/slurm.conf

edit -> ClusterName=pearl

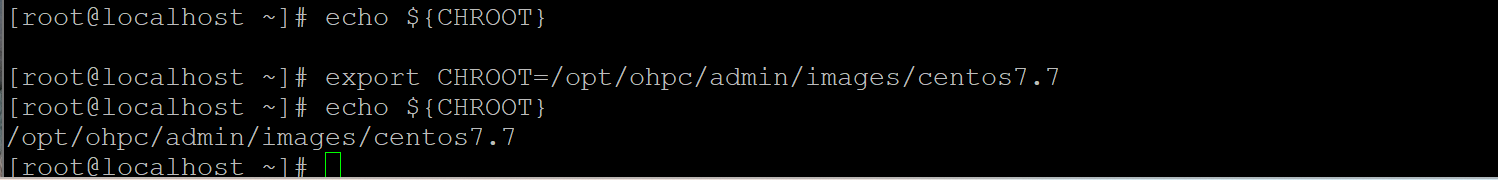
* + ControlMachine=master
  + NodeName=c[1-2]
  + Nodes=c[1-2] --> This is my nodename
* grep NodeName= /etc/slurm/slurm.conf



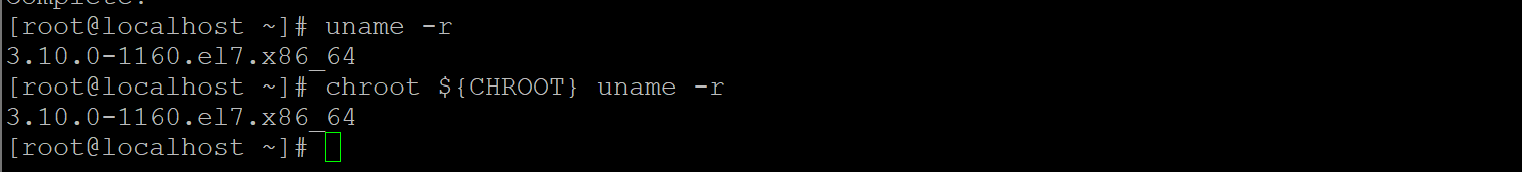
* echo ens34
* ifconfig ens34
* systemctl restart xinetd
* systemctl enable mariadb.service
* systemctl restart mariadb
* systemctl enable httpd.service
* systemctl restart httpd
* systemctl enable dhcpd.service



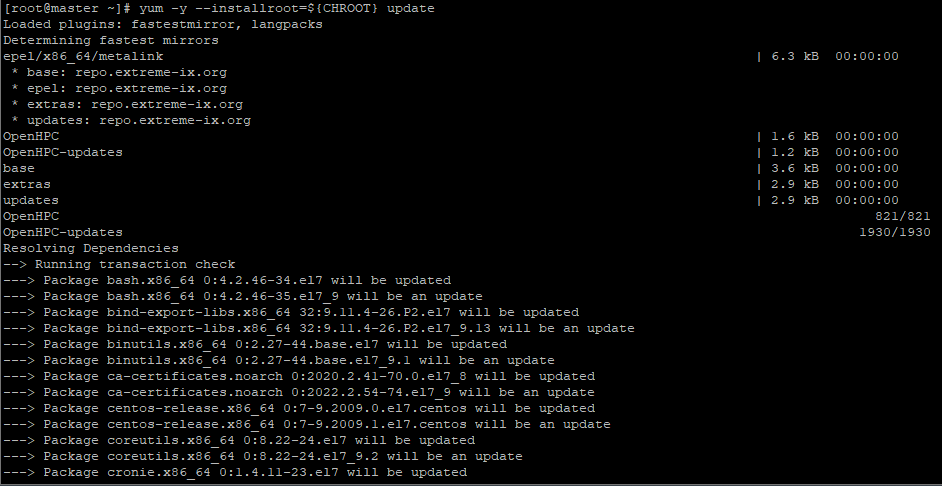
* echo ${CHROOT}
* export CHROOT=/opt/ohpc/admin/images/centos7.7
* echo ${CHROOT}



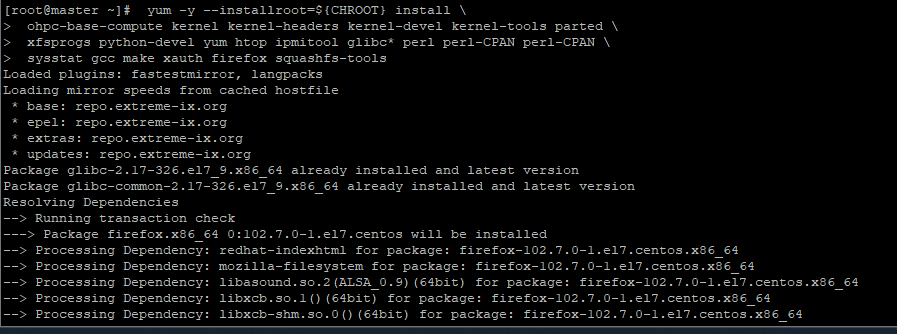
* wwmkchroot centos-7 $CHROOT -> Building initial BOS image
* uname -r
* chroot ${CHROOT} uname -r



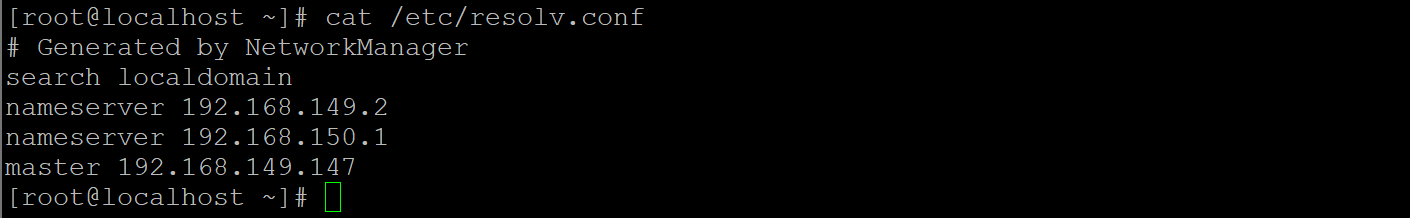
* yum -y --installroot=${CHROOT} update



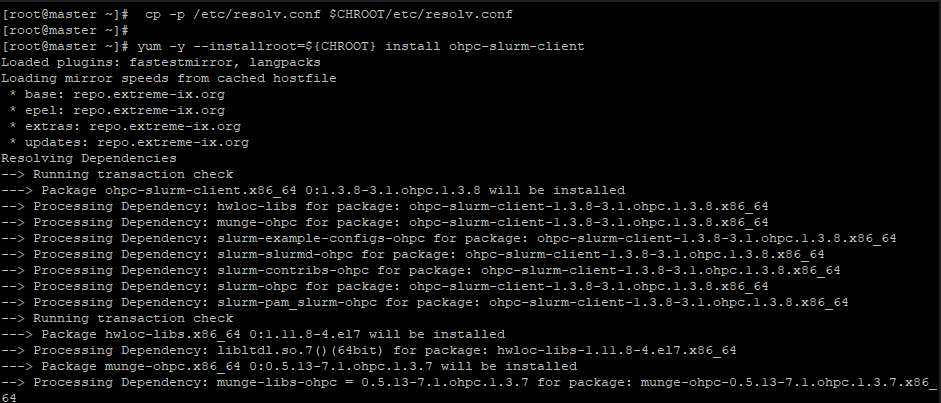
* yum -y --installroot=${CHROOT} install \



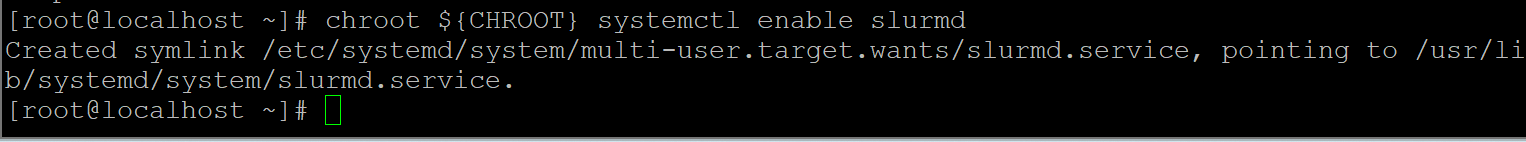
* ohpc-base-compute kernel kernel-headers kernel-devel kernel-tools parted \
* xfsprogs python-devel yum htop ipmitool glibc\* perl perl-CPAN perl-CPAN \
* sysstat gcc make xauth firefox squashfs-tools
* cat /etc/resolv.conf
* vi /etc/resolv.conf

add -> master 192.168.149.147

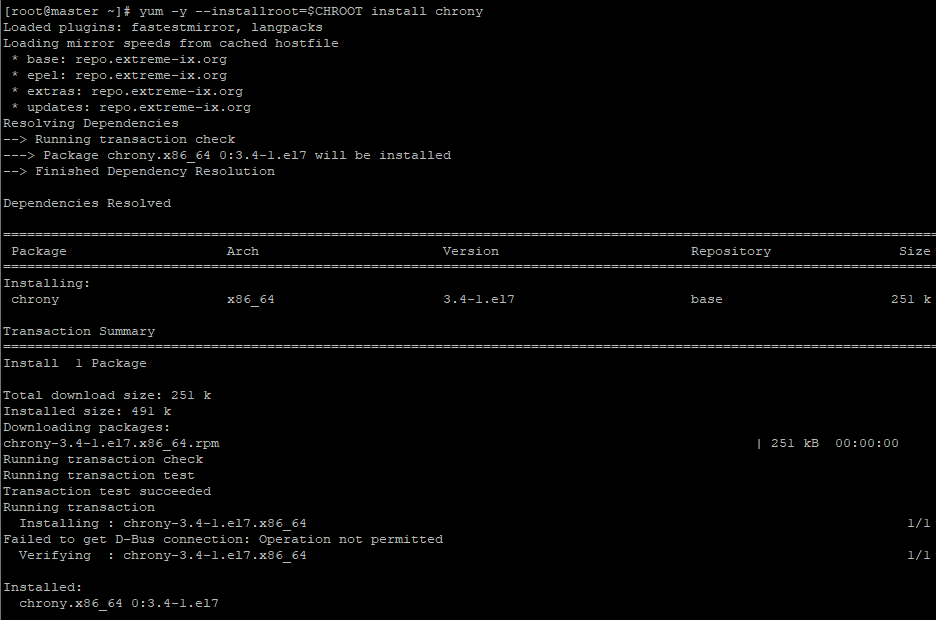
* cp -p /etc/resolv.conf $CHROOT/etc/resolv.conf
* yum -y --installroot=${CHROOT} install ohpc-slurm-client



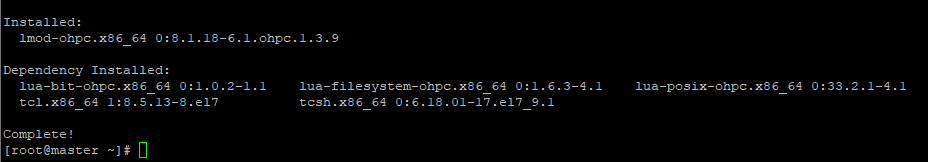
* chroot ${CHROOT} systemctl enable slurmd



* yum -y --installroot=$CHROOT install chrony

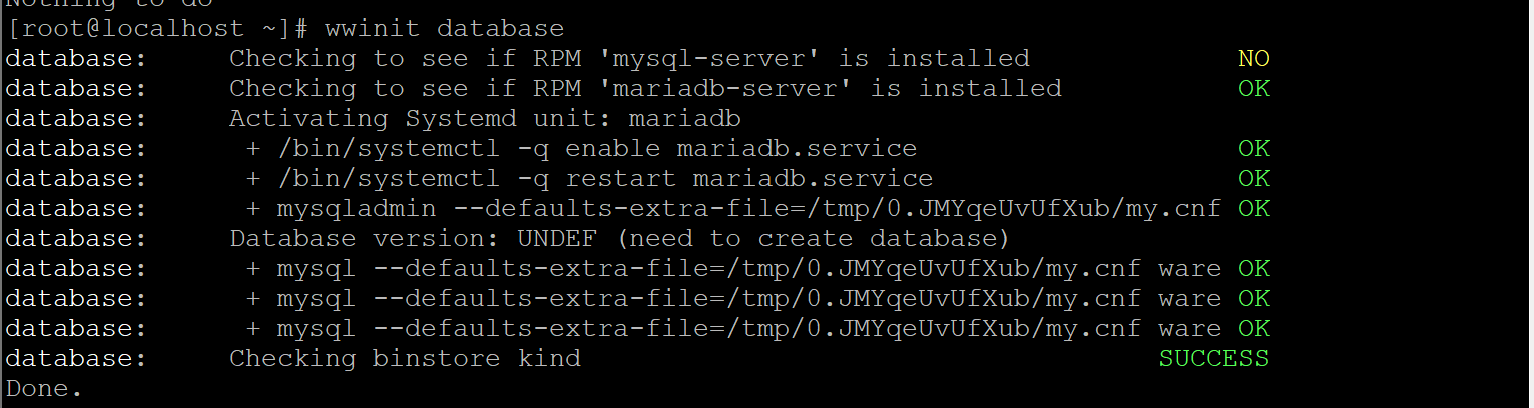


* yum -y --installroot=$CHROOT install kernel lmod-ohpc

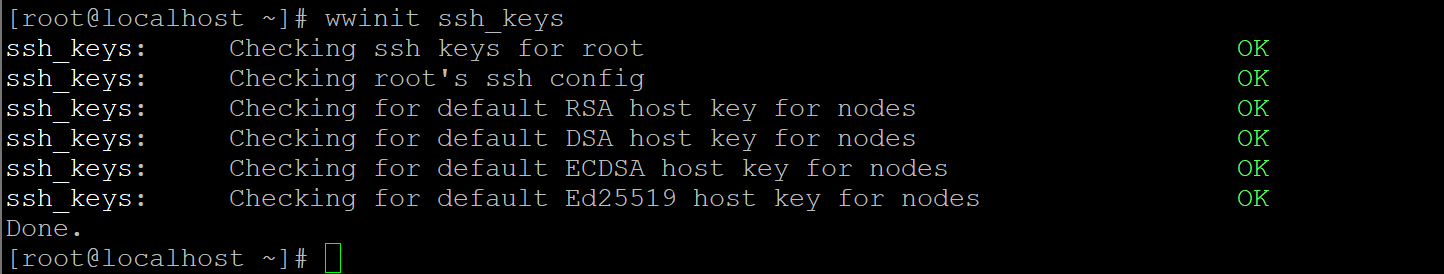


# Initialize warewulf database and ssh\_keys

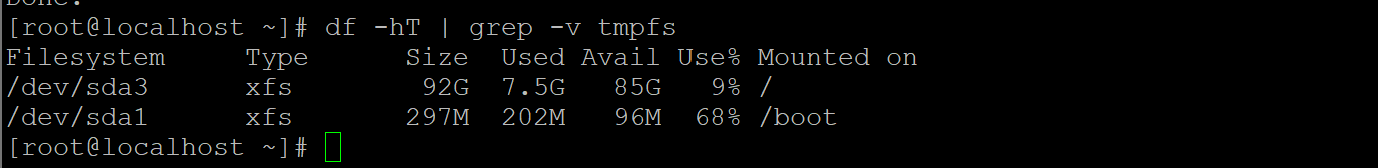
* wwinit database



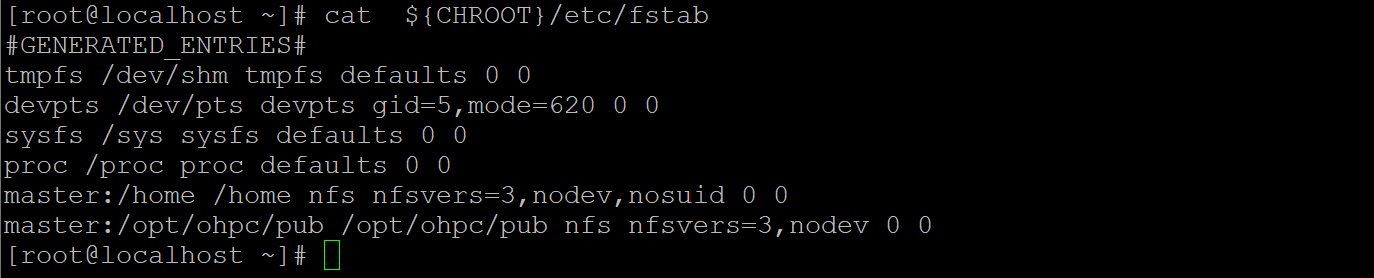
* wwinit ssh\_keys



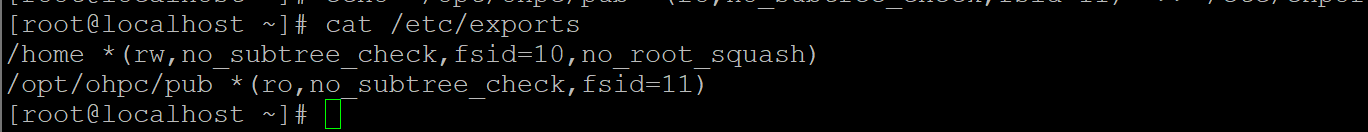
* df -hT | grep -v tmpfs



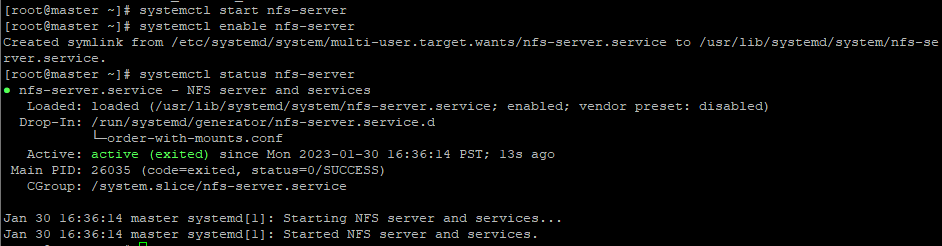
* cat ${CHROOT}/etc/fstab
* echo "master:/home /home nfs nfsvers=3,nodev,nosuid 0 0" >> $CHROOT/etc/fstab
* echo "master:/opt/ohpc/pub /opt/ohpc/pub nfs nfsvers=3,nodev 0 0" >> $CHROOT/etc/fstab
* cat ${CHROOT}/etc/fstab



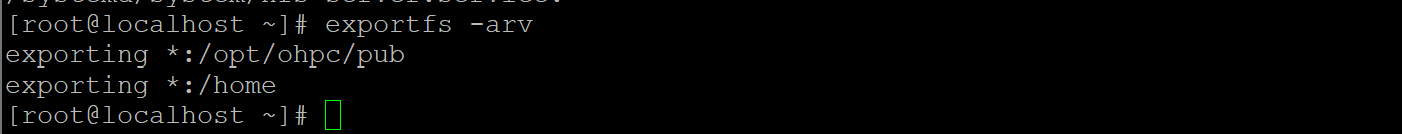
* cat /etc/exports
* echo "/home \*(rw,no\_subtree\_check,fsid=10,no\_root\_squash)" >> /etc/exports
* echo "/opt/ohpc/pub \*(ro,no\_subtree\_check,fsid=11)" >> /etc/exports
* cat /etc/exports



* systemctl start nfs-server
* systemctl status nfs-server



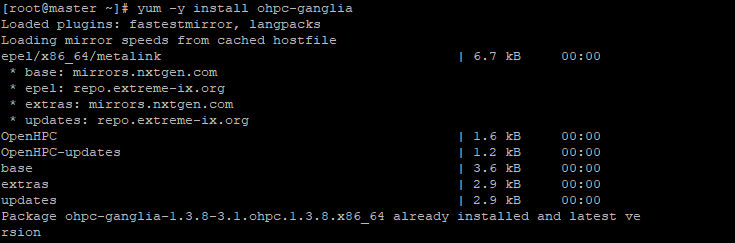
* systemctl enable nfs-server
* exportfs -arv

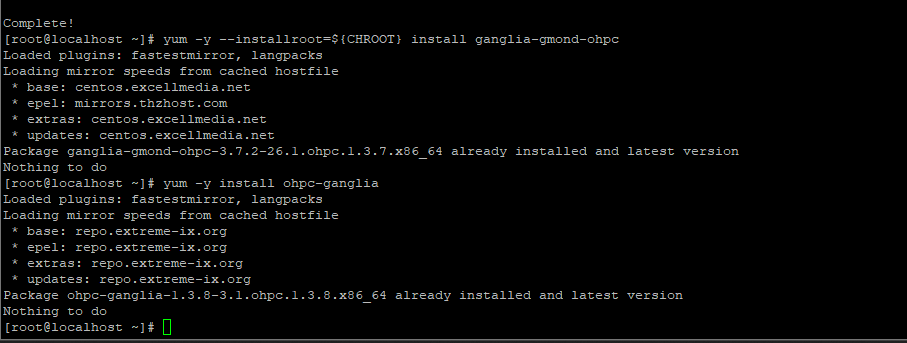


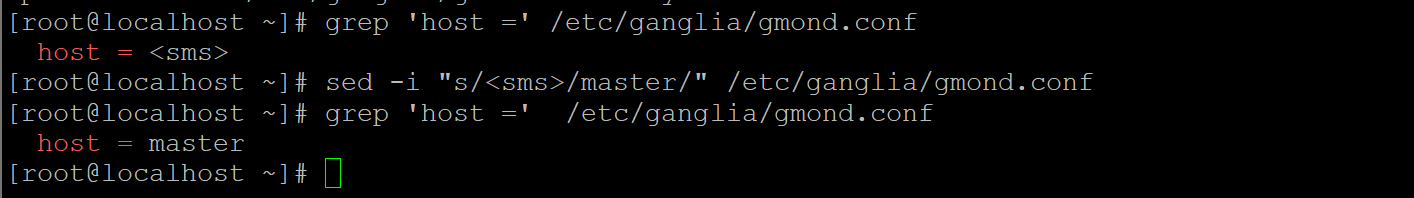
* chroot $CHROOT systemctl enable chronyd
* echo "server 192.168.149.147 iburst" >> $CHROOT/etc/chrony.conf

**Add Ganglia monitoring**

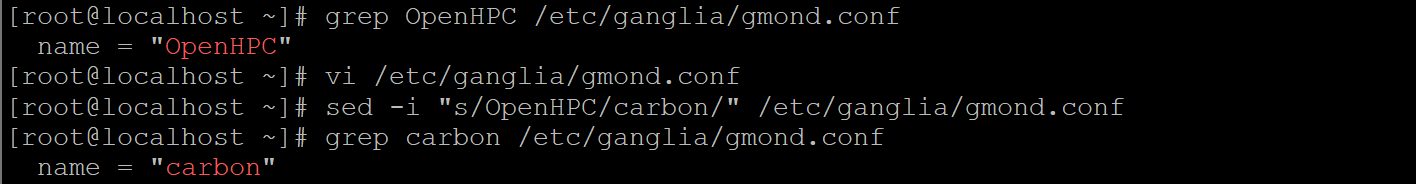
* yum -y install ohpc-ganglia -> # Install Ganglia meta-package on master



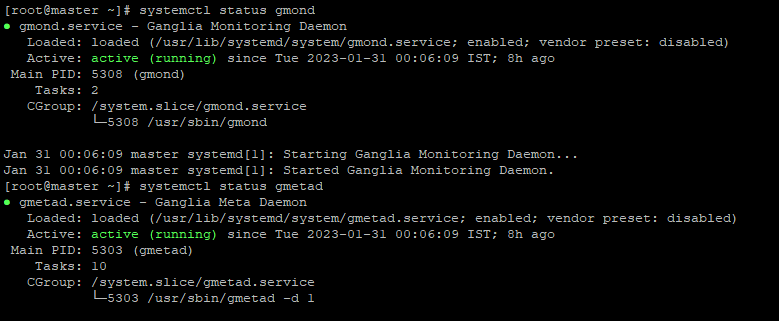
* yum -y --installroot=${CHROOT} install ganglia-gmond-ohpc -> Install Ganglia compute node daemon
* 
* Use example configuration script to enable unicast receiver on master host
* cp /opt/ohpc/pub/examples/ganglia/gmond.conf /etc/ganglia/gmond.conf -> yes
* grep 'host =' /etc/ganglia/gmond.conf
* sed -i "s/<sms>/master/" /etc/ganglia/gmond.conf
* grep 'host =' /etc/ganglia/gmond.conf



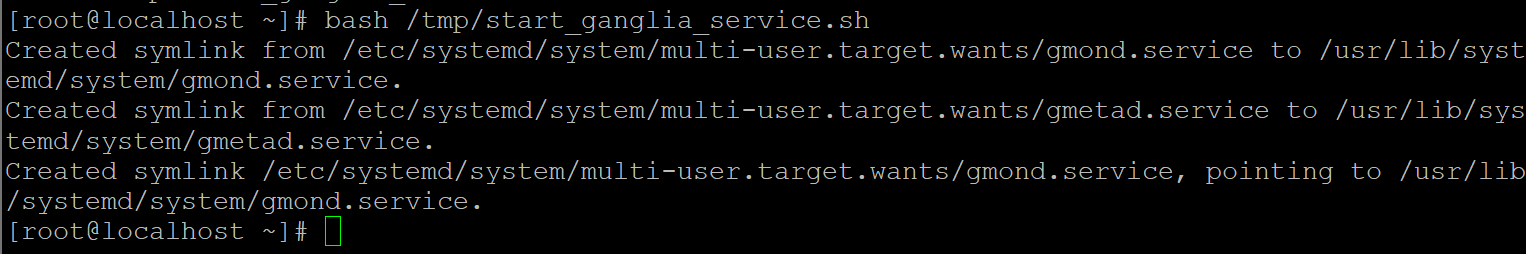
* grep OpenHPC /etc/ganglia/gmond.conf
* sed -i "s/OpenHPC/carbon/" /etc/ganglia/gmond.conf
* grep carbon /etc/ganglia/gmond.conf



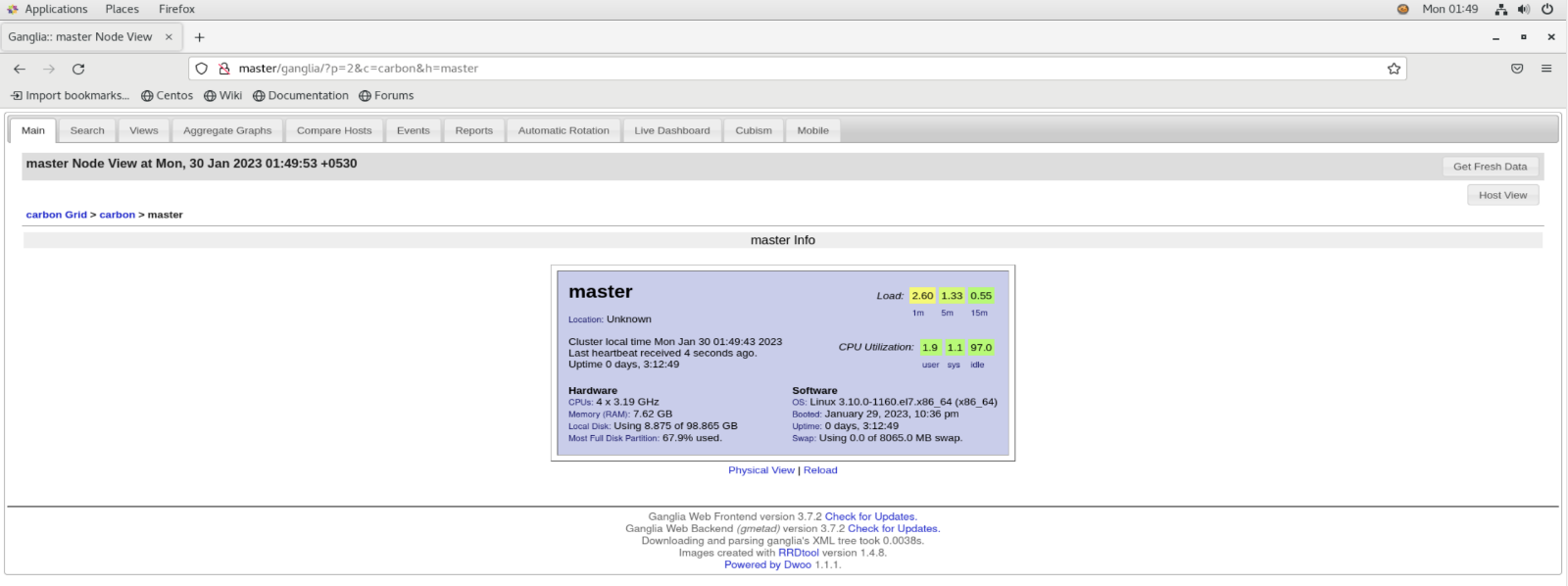
* cp /etc/ganglia/gmond.conf $CHROOT/etc/ganglia/gmond.conf -> yes
* echo "gridname carbon" >> /etc/ganglia/gmetad.conf
* grep gridname /etc/ganglia/gmetad.conf
* echo "systemctl enable gmond
* systemctl enable gmetad
* systemctl start gmond
* systemctl status gmetad

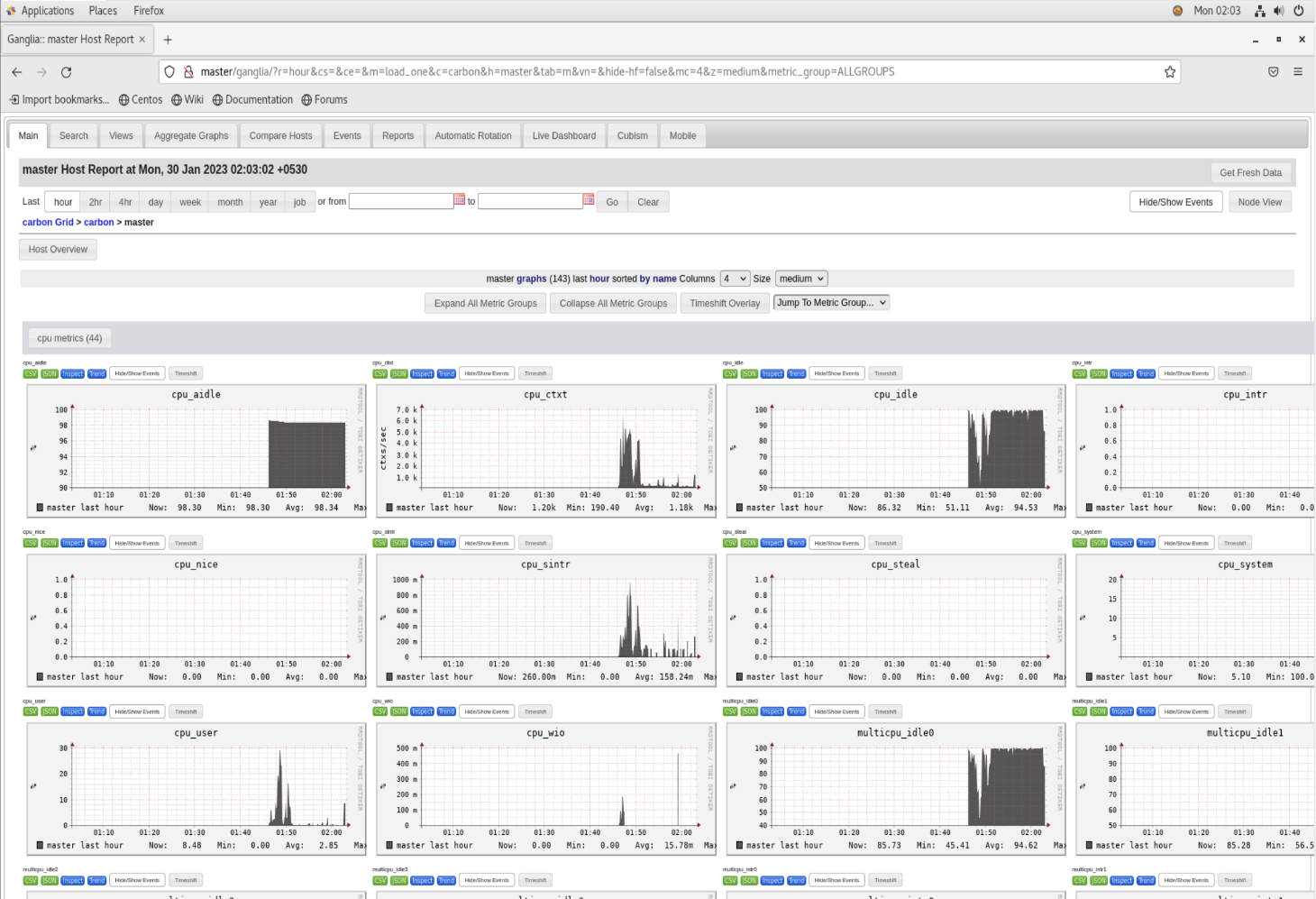


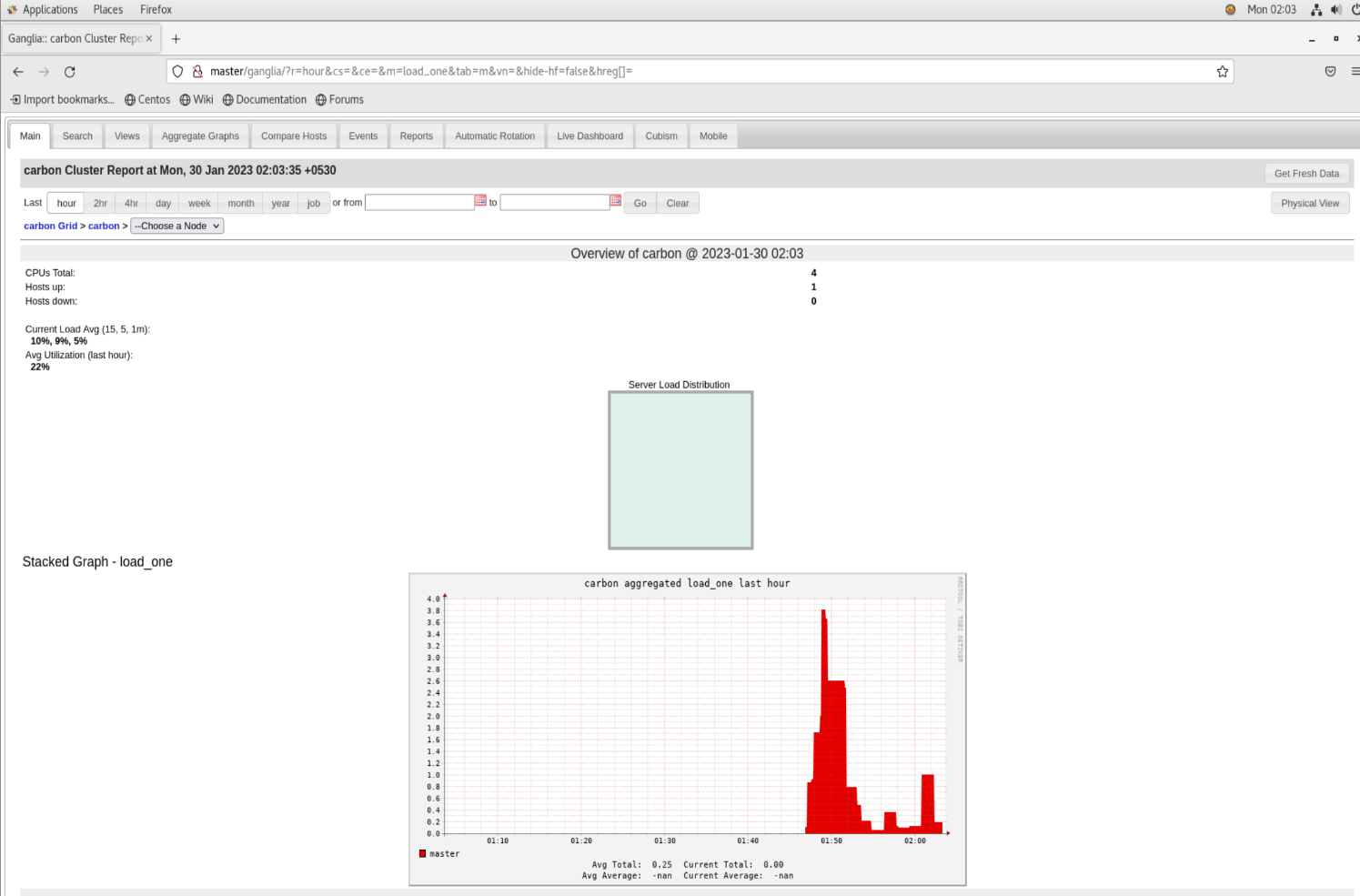
* chroot ${CHROOT} systemctl enable gmond
* " > /tmp/start\_ganglia\_service.sh
* bash /tmp/start\_ganglia\_service.sh



* 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>

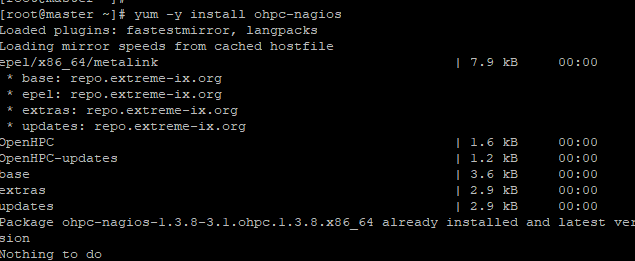




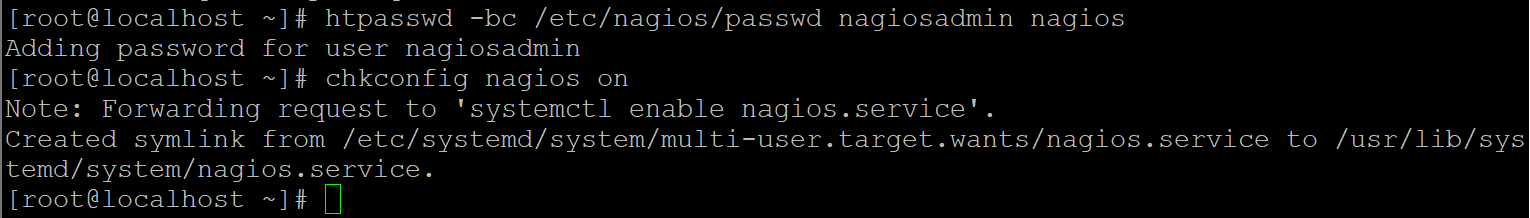
Add Nagios moni

**Add Nagios monitoring**

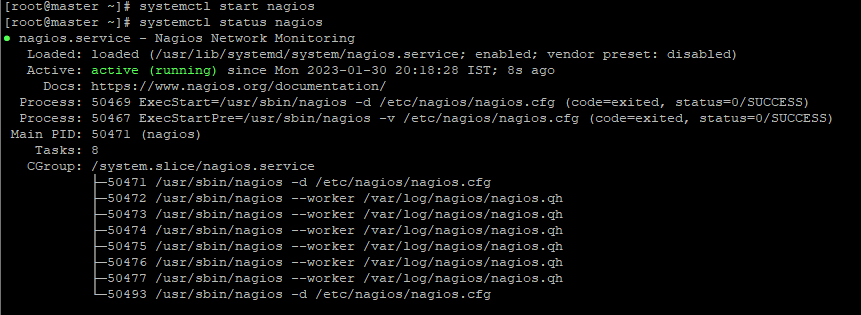
* yum -y install ohpc-nagios -> Install Nagios meta-package on master host



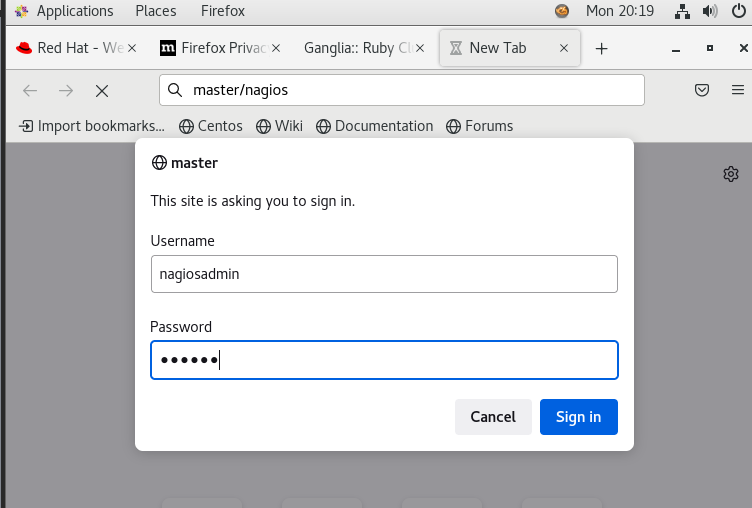
* yum -y --installroot=$CHROOT install nagios-plugins-all-ohpc nrpe-ohpc -> Install plugins into compute node image
* chroot $CHROOT systemctl enable nrpe
* perl -pi -e "s/^allowed\_hosts=/# allowed\_hosts=/" $CHROOT/etc/nagios/nrpe.cfg
* echo "nrpe 5666/tcp # NRPE" >> $CHROOT/etc/services
* echo "nrpe : 192.168.149.147 : 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

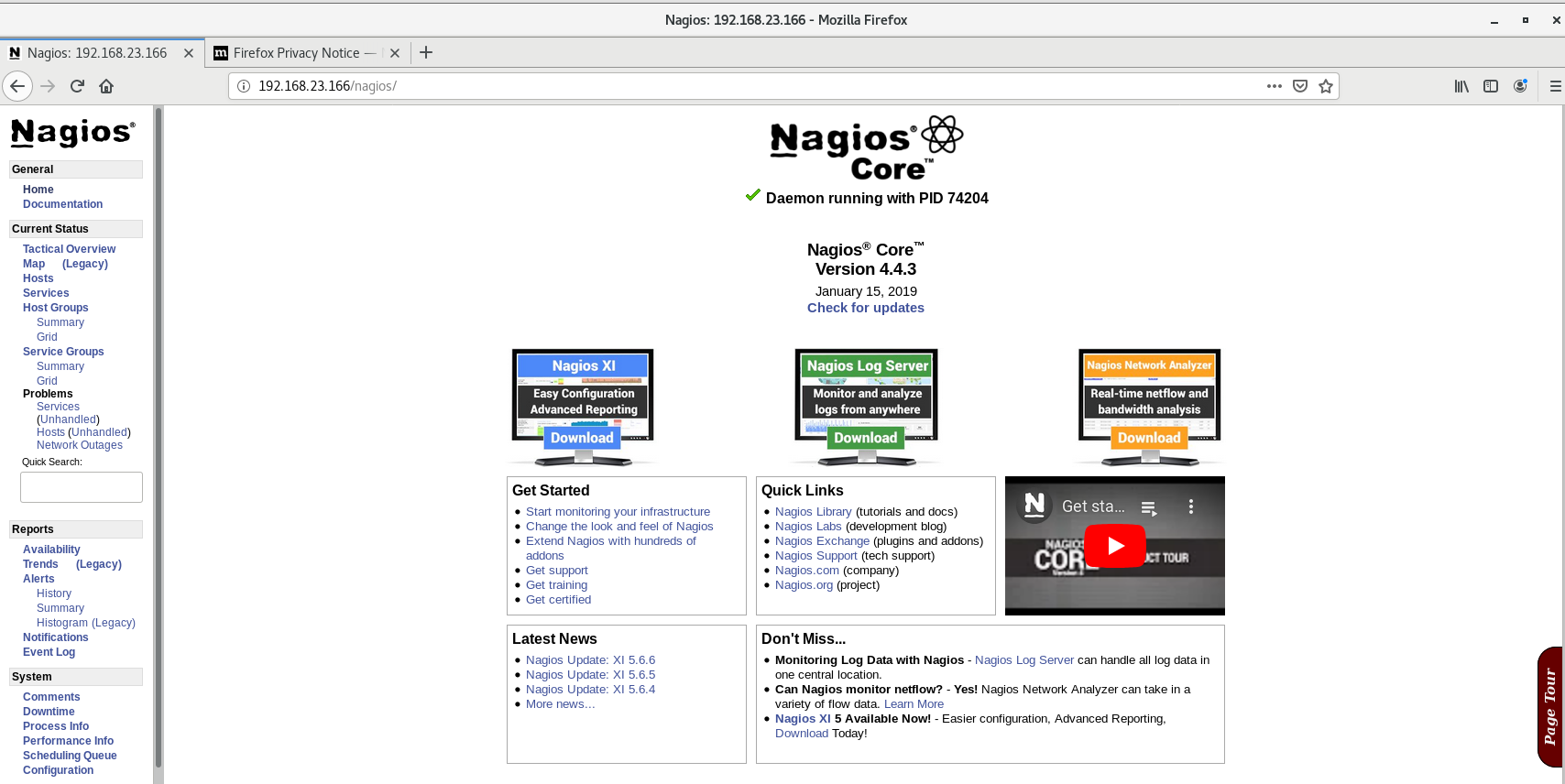


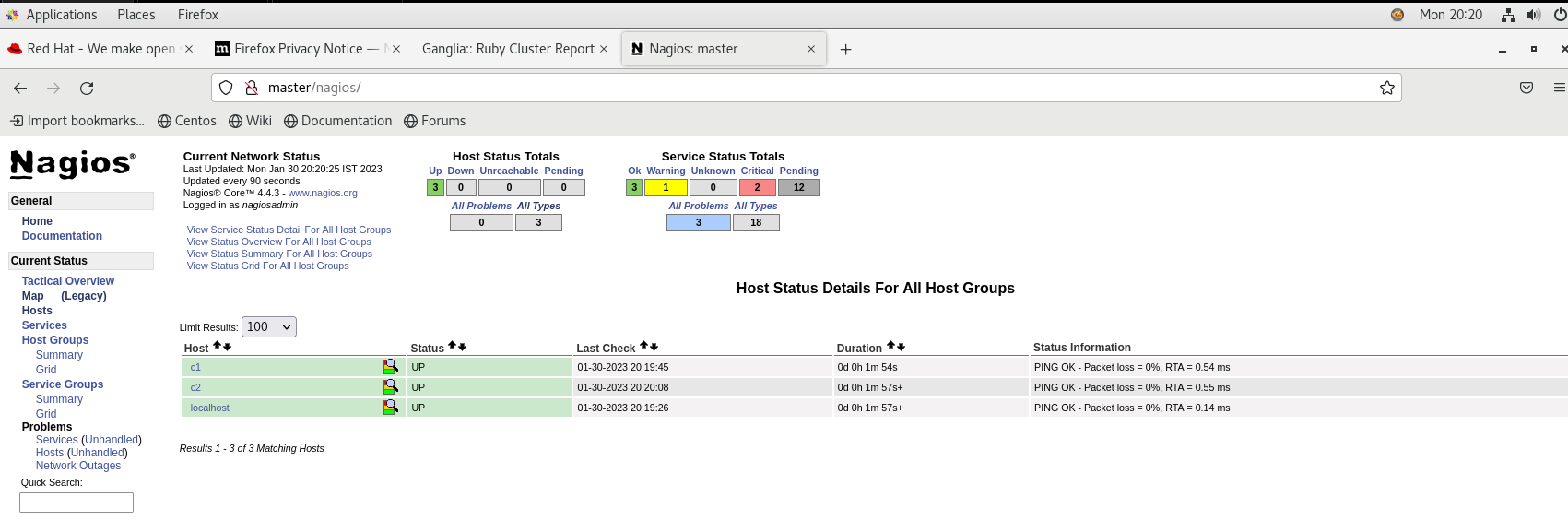
* chkconfig nagios on
* vi /etc/nagios/conf.d/hosts.cfg -> Add clients and hostname
* systemctl start nagios
* systemctl status nagios

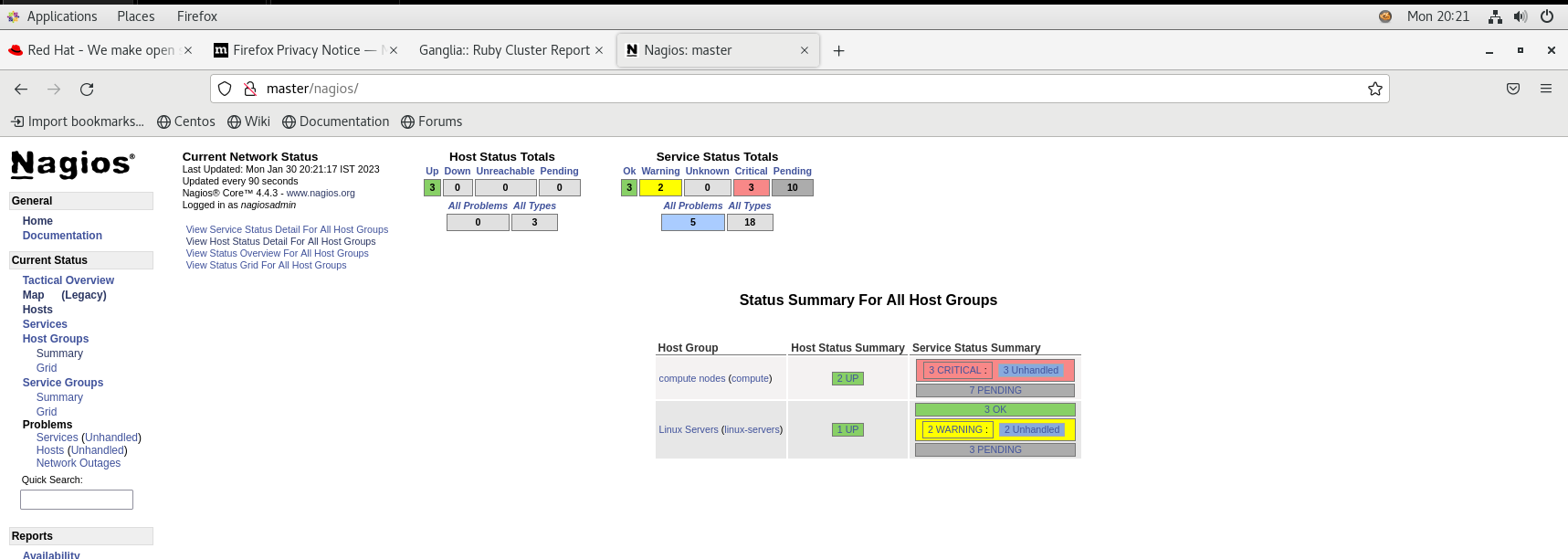


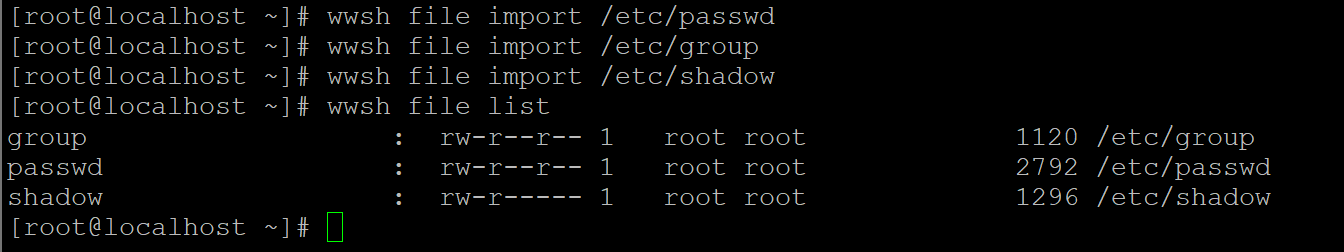
* chmod u+s `which ping`
* Go to browser : http://master/nagios
  + username : nagiosadmin
  + password : nagios

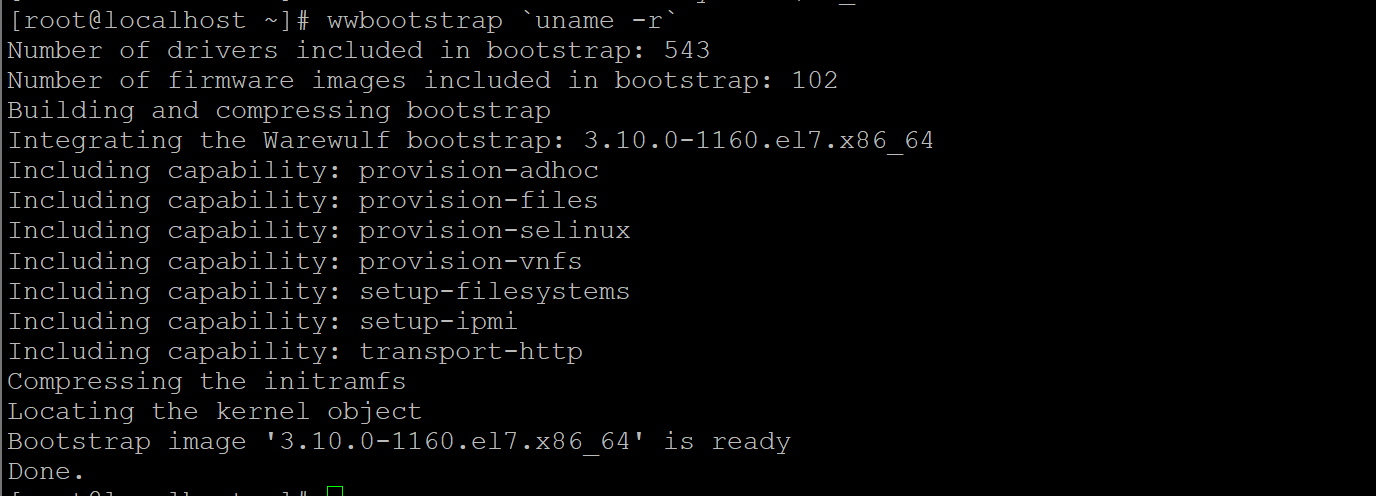


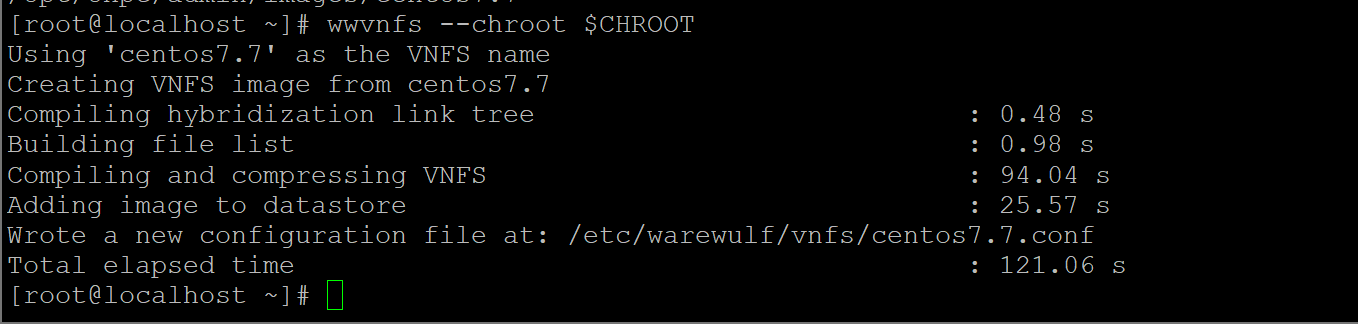






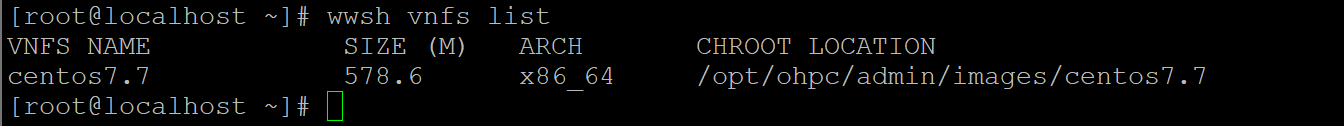
* wwsh file list
* wwsh file import /etc/passwd
* wwsh file import /etc/group
* wwsh file import /etc/shadow
* wwsh file list
* export WW\_CONF=/etc/warewulf/bootstrap.conf
* echo "drivers += updates/kernel/" >> $WW\_CONF
* echo "modprobe += ahci, nvme" >> $WW\_CONF
* echo "drivers += overlay" >> $WW\_CONF



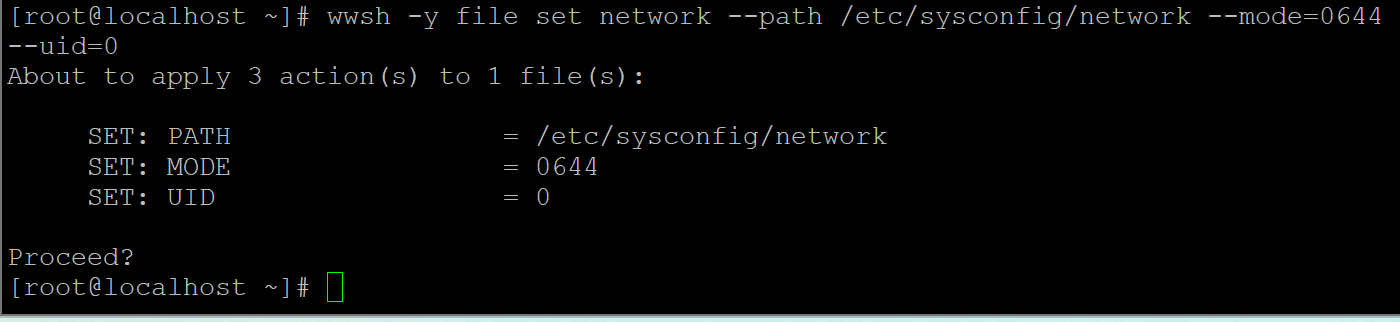
* wwbootstrap `uname -r`
* echo ${CHROOT}
* wwvnfs --chroot $CHROOT

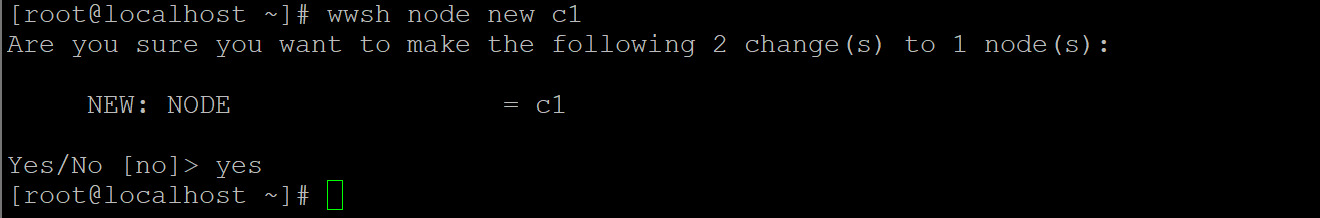
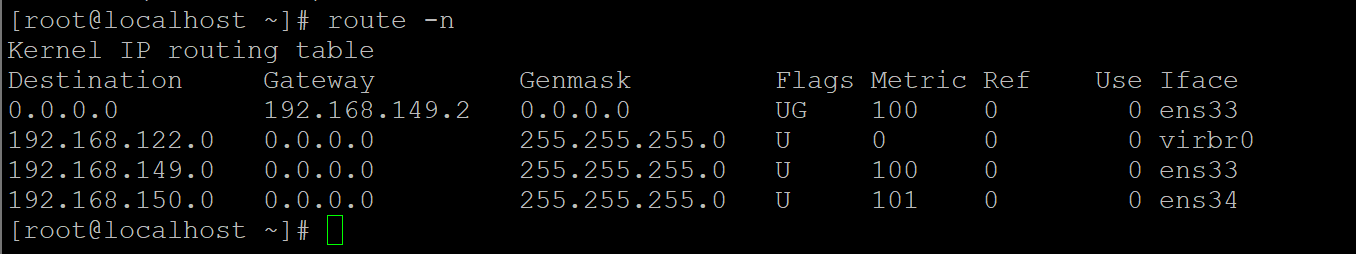
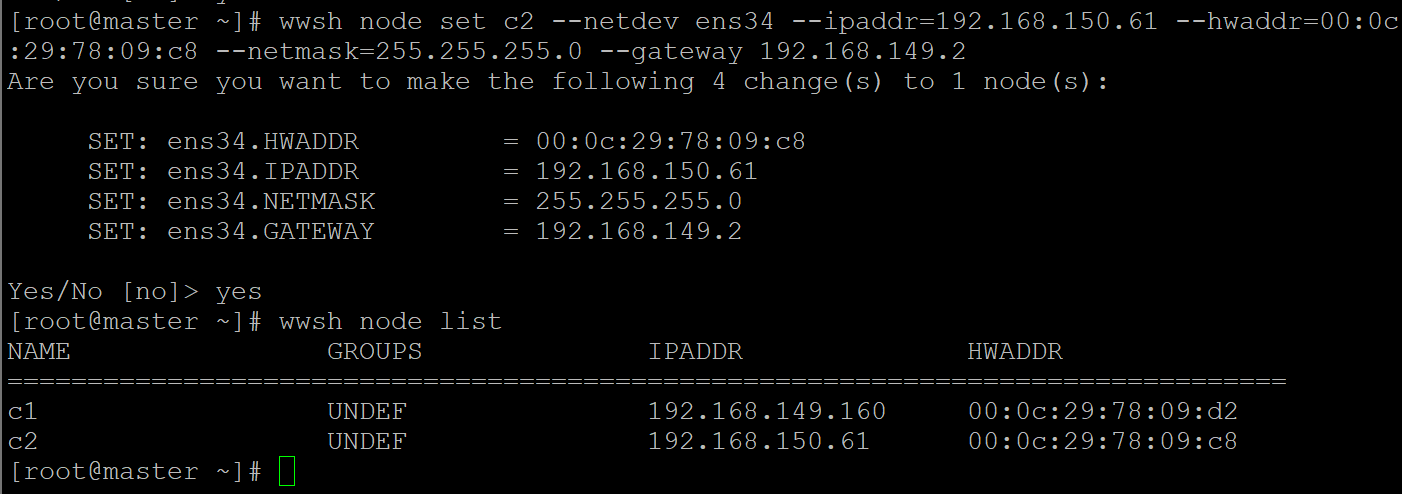
or

* 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
* route -n
* wwsh node set c1 --netdev ens34 --ipaddr=192.168.150.60 --hwaddr=00:0C:29:EC:16:C2 --netmask=255.255.255.0 --gateway 192.168.149.2
* wwsh node new c2
* wwsh node set c2 --netdev ens34 --ipaddr=192.168.150.61 --hwaddr=00:0c:29:78:09:c8 --netmask=255.255.255.0 --gateway 192.168.149.2
* 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

**HPL-Benchmark**

|  |
| --- |
|  |
|  | * 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 |
|  | * cd hpl-2.3/ |
|  | * 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 |
|  | * 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   C:\Users\dhpcsap\Desktop\warewulf\hpl_benchmarking\exportpath.png |
|  | * mp <Press TAB KEY> |
|  | * export LD\_LIBRARY\_PATH=/opt/openmpi-4.1.4/bin:$LD\_LIBRARY\_PATH |
|  | * echo $LD\_LIBRARY\_PATH   C:\Users\dhpcsap\Desktop\warewulf\hpl_benchmarking\LD_library.png |
|  | * cd ~/Downloads/hpl-2.3/setup |
|  | * cp Make.Linux\_PII\_CBLAS /root/Downloads/hpl-2.3 |
|  | * cd /root/Downloads/hpl-2.3/ |
|  | * 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  C:\Users\dhpcsap\Desktop\warewulf\hpl_benchmarking\MPI nad blas changes.png    C:\Users\dhpcsap\Desktop\warewulf\hpl_benchmarking\openmpi_configuration.png |
|  | * make arch=Linux\_PII\_CBLAS |
|  | * cd /root/Downloads/hpl-2.3/bin/Linux\_PII\_CBLAS/ |
|  | * vi HPL.dat |
|  | * mpirun --allow-run-as-root -np 4 ./xhpl HPL.dat * C:\Users\dhpcsap\Desktop\warewulf\hpl_benchmarking\HPL-benchmark  parameter.png |

