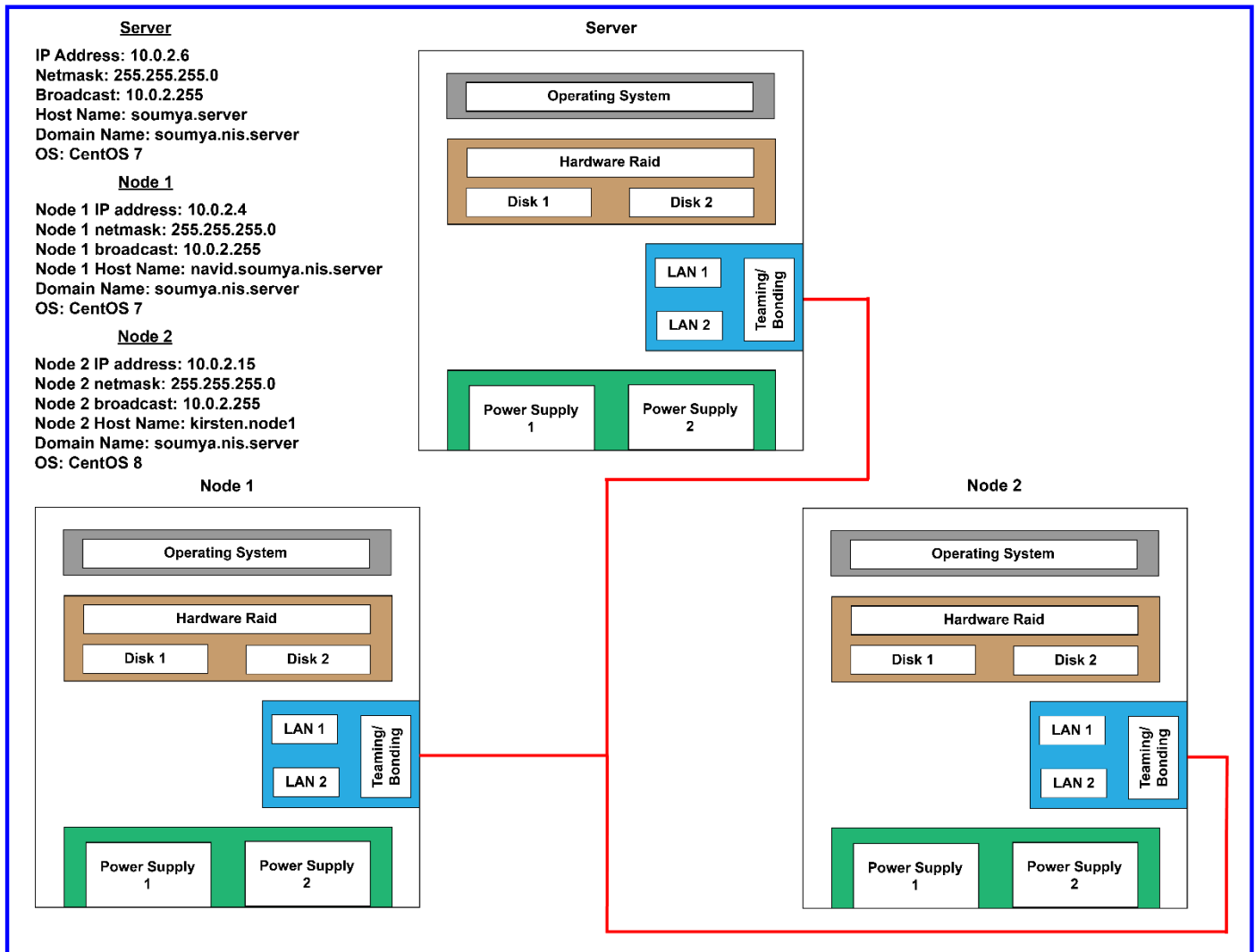


# Linux/Cluster System Administration

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## Server-Client Communication in VirtualBox Environment -- Linux System Administration



The virtual environment used in this manual is shown in the schematic above.

## A. Creating instances in the VirtualBox

### 1. Preparing VirtualBox instance to install operating system

- Download the iso file for the Red Hat Enterprise Linux (RHEL, CentOS) 7/8
- Download and install VirtualBox
- Click "Machine > New" to create a new virtual machine (VirtualBox instance),
- Give instance a name (like CentOS 8: Node 2), specify the Machine Folder (use default), Type (Linux), Version (Red Hat (64 bit))
- Memory size: select the amount of RAM allocated to the virtual machine (4 GB recommended)
- Hard disk: select "Create a virtual hard disk now"
- Hard disk file type: select "VDI (VirtualBox Disk Image)"
- Storage on physical hard disk: select "Dynamically allocated"
- File location and size: choose 15 GB (recommended)
- Click "create". It will create a new virtual machine inside the VirtualBox

## 2. Install operating system <sup>1</sup>

- Load OS for the instance
- Select the instance > settings > storage > controller: IDE
- Click on “Empty” > next to the optical drive, click on the disk icon > select the iso file for the OS > click OK (if this is the first time reading from the iso, make it IDE *Primary Master*)
- Click on “start” to start installing the OS
- If the booting goes in a loop or tries to restart installation configuration again, power off the instance and go to “System > Boot Order”: change the order to Hard Disk, Optical, Floppy. Pointing Device: USB Tablet, Chipset: PIIX3, and leave everything else in the system section as it is (default setting).
- License information: click on “I accept” then “Done”, “Finish Configuration”

## 3. Configuring full-screen mode

- Power off the machine
- Display > Video Memory: 128 MB
- Check “Enable 3D Acceleration”
- Power on the machine
- Open the terminal as root (**su root**)
- **yum update**
- **reboot**
- **yum -y install gcc**
- **yum install make perl**
- **yum install kernel-devel**
- **yum install elfutils-libelf-devel**
- Exit terminal window
- Click on Activities > Files > eject ALL the mounted drives
- Click on Devices > Insert Guest Additions CD image. Click on “Run” when prompted. Enter user’s password for authentication. (wait until the VirtualBox Guest Additions are installed)
- Restart the machine and go to View > Full Screen

## B. Network Information Services (NIS) installation and configuration

NIS protocol is used in a computer network to maintain and distribute a central directory of user and group information, hostnames, e-mail aliases, and other text-based tables of information.

Installing NIS server locally on a network under CentOS 7 environment as an administrator. Server installation for CentOS 7 and 8 are very similar; more information for CentOS can be found in this [link](https://www.server-world.info/en/note?os=CentOS_8&p=nis&f=1). [https://www.server-world.info/en/note?os=CentOS\_8&p=nis&f=1]

### 1.i. Server: Creating NIS user’s account

- Create a master directory under the root partition within which we will keep all the user’s home directories  
**mkdir /soumya**
- Now we will add two network users who will use this server. We will create their home directories and give them usernames and passwords  
**useradd -d /soumya/kirsten kirsten**  
**useradd -d /soumya/navid navid**  
**passwd kirsten**  
[type the password and verify]  
**passwd navid**  
[type the password and verify]

---

<sup>1</sup> NOTE 1: There are different ways to configure the interaction between the guest and the host OS, such as copy-paste and file transfer. A simple Google search can resolve such issues.

NOTE 2: By default, the network adapter is set to *NAT*. We need to change it to *NAT Network* so that different machines in the VirtualBox can talk to each other.

### 1.ii. Server: Provide domain and host name

- Provide a NIS domain name to the server  
`nisdomainname soumya.nis.server`  
`echo "NISDOMAIN=soumya.nis.server" >> /etc/sysconfig/network`
- Change default host name to the desired host name  
`hostnamectl set-hostname soumya.server`
- Modify the network setting to give the server a host name and enable networking  
`vi /etc/sysconfig/network`  
`NETWORKING=yes`  
`HOSTNAME=soumya.server`  
`DOMAINNAME=soumya.nis.server`  
`YPSEV_ARGS="-p 834"`

### 1.iii. Server: Install and enable NIS services

- Install all nis (yp) packages on the server  
`yum install yp* -y`
- Start and enable the following nis packages: ypserv  
`systemctl start ypserv`  
`systemctl enable ypserv`

### 1.iv. Server: Disable firewalld (not recommended)<sup>2</sup>

- Stop and disable the firewalld service  
`systemctl stop firewalld.service`  
`systemctl disable firewalld.service`

### 1.v. Server: Update NIS database

- update the server database (it should show the hostname of the server, "soumya.server")  
`/usr/lib64/yp/ypinit -m`
- There are some nis databases under the /var/yp/ directory. We need to update them as well  
`cd /var/yp`  
`make`

### 1.vi. Server: Share user's directory (using NFS service)

- Now, we need to share the master directory ("/soumya"), that contains the home directories of all the network users, using the nfs server  
`yum install nfs* -y`
- Then edit the exports file under etc directory as follows to share the master directory with all the users with read-write and sync permissions  
`vi /etc/exports`  
`/soumya *(rw,sync)`  
  
`start the nfs service`  
`systemctl start nfs-server`  
`systemctl enable nfs-server`

reboot

## 2.i. Client: Provide authentication to users

### CentOS 7

- Check if the server is responsive. we can ping the server with the server's IP address  
`ping 10.0.2.5`
- Install two nis packages, ypbind and yp-tools  
`yum install ypbind yp-tools -y`
- We will provide the domain membership to this client by this command  
`authconfig-tui`  
`(select) "Use NIS"`  
`(select) "Use MD5 Passwords"`  
`(select) "Use Shadow Passwords"`

---

<sup>2</sup> Instead of disabling the firewalld service, it is recommended to add the NIS and NFS services to the firewalld

(select) "Use Fingerprint reader"  
(select) "Local authorization is sufficient"  
(next)

- Provide the name of the domain in which we want this machine to join: **soumya.nis.server**  
the IP address of the nis server: **10.0.2.5**

Now, this machine is a part of the domain!!!

## CentOS 8

- Install the following services: ypbinding, rpcbind, oddjob-mkhomedir  
**dnf -y install ypbinding yp-tools rpcbind oddjob-mkhomedir**
- Give a domain name and stick the domain name to the network configuration for future use  
**ypdomainname soumya.nis.server**  
**echo "NISDOMAIN= soumya.nis.server" >> /etc/sysconfig/network**
- Add the following to the NIS configuration  
**vi /etc/yp.conf**  
**domain soumya.nis.server server 10.0.2.5 [server IP address]**  
**authselect select nis --force**

## 2.ii. Client: Create home directory upon first login

### CentOS 7

- Install authconfig-gtk package to create local home directory on the client's machine of the user upon signing in  
**yum install authconfig-gtk -y**
- **system-config-authentication** -- > this will open a console. verify the network information. go to the advance option and check the "create home directories on the first login". this is to automatically create home directory of the user.
- Final step is to disable the selinux service on the user's machine  
**vi /etc/sysconfig/selinux/**  
**SELINUX=disabled**

### CentOS 8

- Set if you need (create home directory when initial login)  
**authselect enable-feature with-mkhomedir**  
**systemctl enable --now rpcbind ypbinding nis-domainname oddjobd**

**ssh [username]@[server IP address or hostname (if the server is already associated to its IP address in the host configuration)]**  
**[login password]**

After login in, the user goes to their home directory. If the user *kirsten* log in, she will log in to */soumya/kirsten*.

## C. Network File System (NFS) installation and configuration<sup>3</sup>

NFS protocol allows an user on a client's computer to access files over a computer network. This is a centralized file storage and distribution system.

### 1.i. Server: Install the NFS services

**yum install nfs\* -y**

### 1.ii. Server: Determine what to share, with whom to share, and with what permission

- Specify the directory path (*/soumya/kirsten*) to be exported and shared by the NFS server among all the users. Give the users read-write and sync permission (*\*(rw,sync,no\_root\_squash)*). We assumed that the domain name has already been specified for the server.  
**vi /etc/exports**  
**/soumya/kirsten \*(rw,sync,no\_root\_squash)**
- Give access of the shared directory/file to the end user  
**chmod -R 755 /soumya/kirsten**

---

<sup>3</sup> NOTE 1: The installation and sharing NFS service is the same for CentOS 7 and 8.

NOTE 2: To share it with only a specific user with IP address **10.0.2.10:/soumya/kirsten 10.0.2.10(rw,sync,no\_root\_squash)**

NOTE 3: To verify the exporting: **exportfs -avr**. We can see the shared directory path and the identity of the user with whom we shared the directory.

NOTE 4: If the firewall is running, we need to add the nfs service and rpcbind services to the firewall

### 1.iii. Start and enable the NFS service

```
systemctl start nfs-service
systemctl enable nfs-service
```

### 2.i. Client: Install NFS packages

```
yum install nfs* -y
```

### 2.ii. Client: Mount shared directory<sup>4</sup>

- To mount the directory (/soumya) from the server using the server's IP address (10.0.2.6) to the client's machine with a given mounting path (/home) on the client's machine  
**mount -t nfs -o sync 10.0.2.6:/soumya /home**
- To verify the mount  
**df -h**

Now, any file/directory created on the client's machine inside the /home directory will automatically be synchronized to the server machine in the /soumya directory.

## D. Dynamic Host Configuration Protocol (DHCP) installation and configuration

DHCP server assigns IP address to its clients dynamically (default). Except it few cases, most of the clients lease the IP address for a given amount of time so that the server can recycle IP addresses from expired clients. The server also gives static/fixed IP address to special clients in the network, such as printer, another server, etc.

### 1.i. Server: Install service packages

```
yum -y install dhcp
```

### 1.ii. Server: Configure DHCP server

- Find the IP address, netmask, and broadcast information of the server: **ifconfig -a**. In this case, IP address is **10.0.2.6**, netmask is **255.255.255.0**, broadcast is **10.0.2.255**
- Modify the DHCP configuration file (**vi /etc/dhcp/dhcpd.conf**) by copy and replace the example from the file specified in the dhcpd.conf file and modify it as needed  
**cp /usr/share/doc/dhcp\*/dhcp.conf.example /etc/dhcp/dhcpd.conf**
- Comment out everything except the section shown below

```
# dhcpd.conf
#
# Sample configuration file for ISC dhcpd
#
##### If we have a DNS server, we can give a domain name. Otherwise comment this section out.
## option definitions common to all supported networks...
# option domain-name "example.org";
# option domain-name-servers ns1.example.org, ns2.example.org;
```

```
default-lease-time 600;
max-lease-time 7200;
```

```
# Use this to enable / disable dynamic dns updates globally.
#ddns-update-style none;
```

```
# If this DHCP server is the official DHCP server for the local
# network, the authoritative directive should be uncommented.
authoritative;

# Use this to send dhcp log messages to a different log file (you also
# have to hack syslog.conf to complete the redirection).
log-facility local7;
```

```
# No service will be given on this subnet, but declaring it helps the
# DHCP server to understand the network topology.
```

```
# subnet 10.152.187.0 netmask 255.255.255.0 {
# }
```

```
# This is a very basic subnet declaration.
```

```
# subnet 10.254.239.0 netmask 255.255.255.224 {
#   range 10.254.239.10 10.254.239.20;
#   option routers rtr-239-0-1.example.org, rtr-239-0-2.example.org;
# }
```

<sup>4</sup> NOTE 1: Configure NFS mounting on fstab to mount it when the system boots

```
vi /etc/fstab
```

```
10.0.2.6:/soumya/kirsten /home/kirsten/nfs_shared    nfs    defaults    0 0
```

NOTE 2: We can auto mount the shared directory/file as well.

```
# This declaration allows BOOTP clients to get dynamic addresses,
# which we don't really recommend.
```

```
# subnet 10.254.239.32 netmask 255.255.255.224 {
#   range dynamic-bootp 10.254.239.40 10.254.239.60;
#   option broadcast-address 10.254.239.31;
#   option routers rtr-239-32-1.example.org;
# }
```

```
# A slightly different configuration for an internal subnet.
subnet 10.0.2.0 netmask 255.255.255.0 {
    range 10.0.2.2 10.0.2.10;

    # Give the IP address of the DNS server for "ns1.internal.example.org"
    # option domain-name-servers ns1.internal.example.org;
    # Give the domain name of the DNS server
    # option domain-name "internal.example.org";

    # Routers are basically the gateways
    # option routers 10.0.2.1;

    option broadcast-address 10.0.2.255;

    default-lease-time 600;
    max-lease-time 7200;
}
```

```
# Hosts which require special configuration options can be listed in
# host statements. If no address is specified, the address will be
# allocated dynamically (if possible), but the host-specific information
# will still come from the host declaration.
```

```
# host passacaglia {
#   hardware ethernet 0:0:c0:5d:bd:95;
#   filename "vmunix.passacaglia";
#   server-name "toccata.fugue.com";
# }
```

```
# Fixed IP addresses can also be specified for hosts. These addresses
# should not also be listed as being available for dynamic assignment.
# Hosts for which fixed IP addresses have been specified can boot using
# BOOTP or DHCP. Hosts for which no fixed address is specified can only
# be booted with DHCP, unless there is an address range on the subnet
# to which a BOOTP client is connected which has the dynamic-bootp flag
# set.
```

```
#host fantasia {
#   hardware ethernet 08:00:07:26:c0:a5;
#   fixed-address fantasia.fugue.com;
#}
```

```
# You can declare a class of clients and then do address allocation
# based on that. The example below shows a case where all clients
# in a certain class get addresses on the 10.17.224/24 subnet, and all
# other clients get addresses on the 10.0.29/24 subnet.
```

```
#class "foo" {
#   match if substring (option vendor-class-identifier, 0, 4) = "SUNW";
#}
#
#shared-network 224-29 {
#   subnet 10.17.224.0 netmask 255.255.255.0 {
#       option routers rtr-224.example.org;
#   }
#   subnet 10.0.29.0 netmask 255.255.255.0 {
#       option routers rtr-29.example.org;
#   }
#   pool {
#       allow members of "foo";
#       range 10.17.224.10 10.17.224.250;
#   }
#   pool {
#       deny members of "foo";
#       range 10.0.29.10 10.0.29.230;
#   }
# }
```

### 1.iii. Server: Start and enable DHCP service<sup>5</sup>

```
systemctl start dhcpd
systemctl enable dhcpd
```

<sup>5</sup> If a DHCP client needs a fixed IP address # Fixed IP addresses can also be specified for hosts. These addresses

- # should not also be listed as being available for dynamic assignment.
- # Hosts for which fixed IP addresses have been specified can boot using
- # BOOTP or DHCP. Hosts for which no fixed address is specified can only
- # be booted with DHCP, unless there is an address range on the subnet
- # to which a BOOTP client is connected which has the dynamic-bootp flag set

```
host fantasia {
    hardware ethernet 08:00:07:26:c0:a5; <<<< find the MAC/Physical address of the user
    fixed-address 10.0.2.9; <<<< provide the fixed IP address for the user
}
```

## 2. Client: Configure Network setting using GUI

On the Client's machine, make sure the IP address method is Automatic/DHCP. On CentOS we can do it by,  
**Wired Setting > Network > Wired > [click on the setting icon] > IPv4 > Set "IPv4 Method" to "Automatic (DHCP)"**

## E. Domain Name Service (DNS) installation and configuration

DNS acts like a phonebook. For example, when we want to search for a website, DNS resolve the name of the website to its IP address to establish connection. In general, the DNS server should have a static IP address (10.0.2.6) and Static hostname (server.soumya.local). The domain name in this case is "soumya.local" (**ifconfig -a** and **hostnamectl**).

### 1.i. Server: Install service packages

```
yum install -y bind bind-utils
```

### 1.ii. Server: Configure bind service

- Configure the service  
`vi /etc/named.conf`

```
options {  
    listen-on port 53 { 127.0.0.1; 10.0.2.6; }; # <----- static IP of the DNS server  
    listen-on-v6 port 53 { ::1; };  
    directory "/var/named";  
    dump-file "/var/named/data/cache_dump.db";  
    statistics-file "/var/named/data/named_stats.txt";  
    memstatistics-file "/var/named/data/named_mem_stats.txt";  
    recursing-file "/var/named/data/named.recursing";  
    secroots-file "/var/named/data/named.secroots";  
    allow-query { localhost; any; };  
};
```
- Start the service  

```
systemctl start named  
systemctl enable named
```

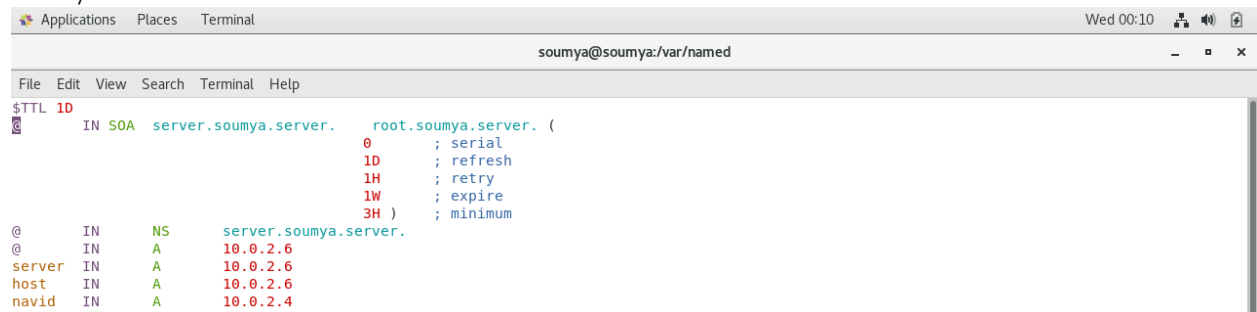
### 1.iii. Server: Create and configure zones

- For Zone # 1, add this at the end of the *etc/named.conf* file, just before the *include* statements. Name of the domain is soumya.nis.server, IN is for the internet, the type of the dns server is master.  
`vi /etc/named.conf`

```
zone "soumya.nis.server" IN {  
    type master;  
    file "forward.soumya.nis.server";  
    allow-update { none; };  
};
```
- We defined one file in the zone called forward.soumya.nis.server. Now, we need to create these files in /var/named. Check the contain of the directory with "ll" command. We can copy the named.localhost file to create the forward.soumya.nis.server.

```
cp named.localhost forward.soumya.nis.server
```

Modify the file to make it look like this



```
$TTL 1D  
IN SOA server.soumya.server. root.soumya.server. (  
    0 ; serial  
    1D ; refresh  
    1H ; retry  
    1W ; expire  
    3H ) ; minimum  
  
@ IN NS server.soumya.server.  
@ IN A 10.0.2.6  
server IN A 10.0.2.6  
host IN A 10.0.2.6  
navid IN A 10.0.2.4
```

Syntax: SOA server.[Host name]. root.[Host name].

SOA = start of authority

Host name = soumya.server

NS = name server

A = IP address



- We create three host names (server, host, and navid) and resolved them with the IP address (10.0.2.6, 10.0.2.6, and 10.0.2.4). If there are 10 clients (like navid), we need to use the host name for each client and resolve it with the IP address.
- Change the default ownership of the from root to named  
**chown root:named forward.soumya.nis.server**

#### 1.iv. Server: Start and enable service

- Check if the configuration is right  
**named-checkconf -z /etc/named.conf**
- Check the forward.soumya.nis.server is right  
**named-checkzone forward /var/named/forward.soumya.nis.server**
- Restart the service  
**systemctl restart named**

#### 2.i. Client: Provide DNS membership

- The client has host name “**navid.soumya.nis.server**”. Making the client a member of the dns or name server  
**vim /etc/resolv.conf**  
**search soumya.nis.server**  
**nameserver 10.0.2.6 <<<< add this part with the dns server IP address**

#### 2.ii. Client: Ping server

- Ping one of the hosts defined in the forward.soumya.nis.server file  
**ping server**

---

### Useful commands and information

1. Check the configuration of the server, such as IP address, netmask, broadcast etc: **ifconfig**
2. Check the host name: **hostname**
3. Check domain name: **domainname**
4. Check the configuration of the yum server after installation of the yum server: **yum repolist**
5. Check if the master directory is been shared successfully: **exportfs -v**
6. Check the port numbers for the running services: **rpcinfo -p**
7. We can restart the demon of any service (e.g. yperv) using the following command: **systemctl restart ypserv**
8. Finding out in which machine the nis server is install within the network: **ypwhich**