

Creating a NFS File Server

A PROJECT REPORT

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Abstract

Unshared joy is an unlighted candle, says an old Spanish proverb. This applies even to the modern day world where one could find almost everything with the help of a search engine. But a few years ago, when this was still under construction and development, sharing wasn't an easy task. The Network File System(NFS) was used in those times as a means of sharing information between Linux/Unix Operating Systems. And we, as students who are still getting to know the basics of Operating Systems, we decided to create and explore how Network File Systems worked.

Introduction

NFS, or Network File System, was designed in 1984 by Sun Microsystems. This distributed file system protocol allows a user on a client computer to access files over a network in the same way they would access a local storage file. Because it is an open standard, anyone can implement the protocol.

NFS started in-system as an experiment but the second version was publicly released after the initial success.

To access data stored on another machine (i.e. a server) the server would implement NFS daemon processes to make data available to clients. The server administrator determines what to make available and ensures it can recognize validated clients. From the client's side, the machine requests access to exported data, typically by issuing a mount command. If successful, the client machine can then view and interact with the file systems within the decided parameters.

Project Description

The project involves creating a NFS Server and Client using CentOS and establishing a connection between them, and sharing the files in that system and verifying it.

Tools Used

2 CentOS machines used in Virtual Box

Sample Code

Setting up an internal network to mimic a DHCP connection

```
VBoxManage dhcpserver add --netname intnet --ip 10.0.1.1 --netmask 255.255.255.0 --lowerip 10.0.1.2 --upperip 10.0.1.200 --enable
```

On Command Prompt opened in Virtualbox Directory (./VBoxManage on Powershell)

On both machines, we set up the Internet Connection.

```
nmcli d  
enps08  
enps03
```

enps08 will be connected, but enps03 will be disconnected

```
vi /etc/sysconfig/network-scripts/ifcfg-enp0s3
```

We open this file and change onboot to yes

```
systemctl restart network
```

Now we check ip using ip addr show

```
CentOS-1: 10.0.1.2  
CentOS-2: 10.0.1.3
```

```
On CentOS-1: ping 10.0.1.3  
On CentOS-2: ping 10.0.1.2
```

We ping each other to make sure everything works correctly before we work on the NFS Server and client on CentOS 1 and 2 respectively

Setting up NFS Server: Machine #1

On CentOS-1, we'll install the utilities and libraries for an NFS server and start it using rpcbind

```
yum install nfs-utils nfs-utils-lib -y
systemctl start rpcbind nfs-server
systemctl enable rpcbind nfs-server
```

Now, we create a new empty folder that will be our shared folder.

```
mkdir /nfs
vi /etc/exports
```

We write the name of the shared folder and the IP addresses that we want the shared folder to be shared inside this file.

Shell

```
/nfs 10.0.1.3(rw,sync,no_root_squash,no_subtree_check)
```

```
/nfs
10.0.1.3(rw,sync,no_root_squash,no_subtr
ee_check)
```

```
exportfs -a
```

We have to change the firewall to allow NFS and complimenting services.

```
firewall-cmd --permanent --zone=public --add-service=nfs
firewall-cmd --permanent --zone=public --add-service=mountd
firewall-cmd --permanent --zone=public --add-service=rpc-bind
firewall-cmd --reload
systemctl restart nfs
```

Setting up NFS Client: Machine #2

```
yum install nfs-utils nfs-utils-lib -y
```

And we make the NFS folder where we mount the server

```
mkdir -p /nfs
```

Check if we can access the server properly

```
showmount -e 10.0.1.2
rpcinfo -p 10.0.1.2
mount 10.0.1.2:/nfs /nfs
```

With `df -h`, we see that `10.0.1.2:/nfs` mount has been created at the bottom.

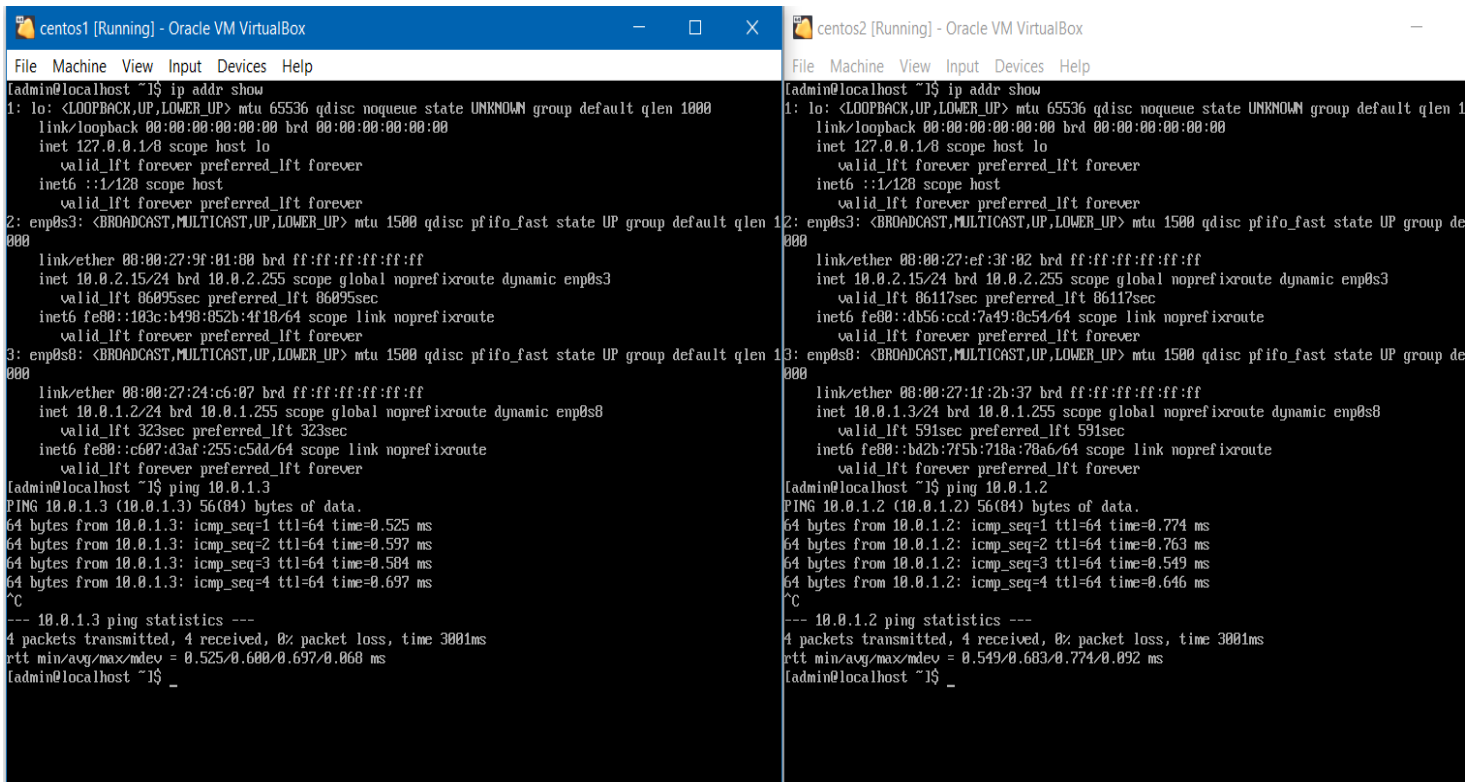
```
df -h
```

Now, we test that the shared folder actually works.

```
cd /nfs
```

Screenshots have the rest of the information.

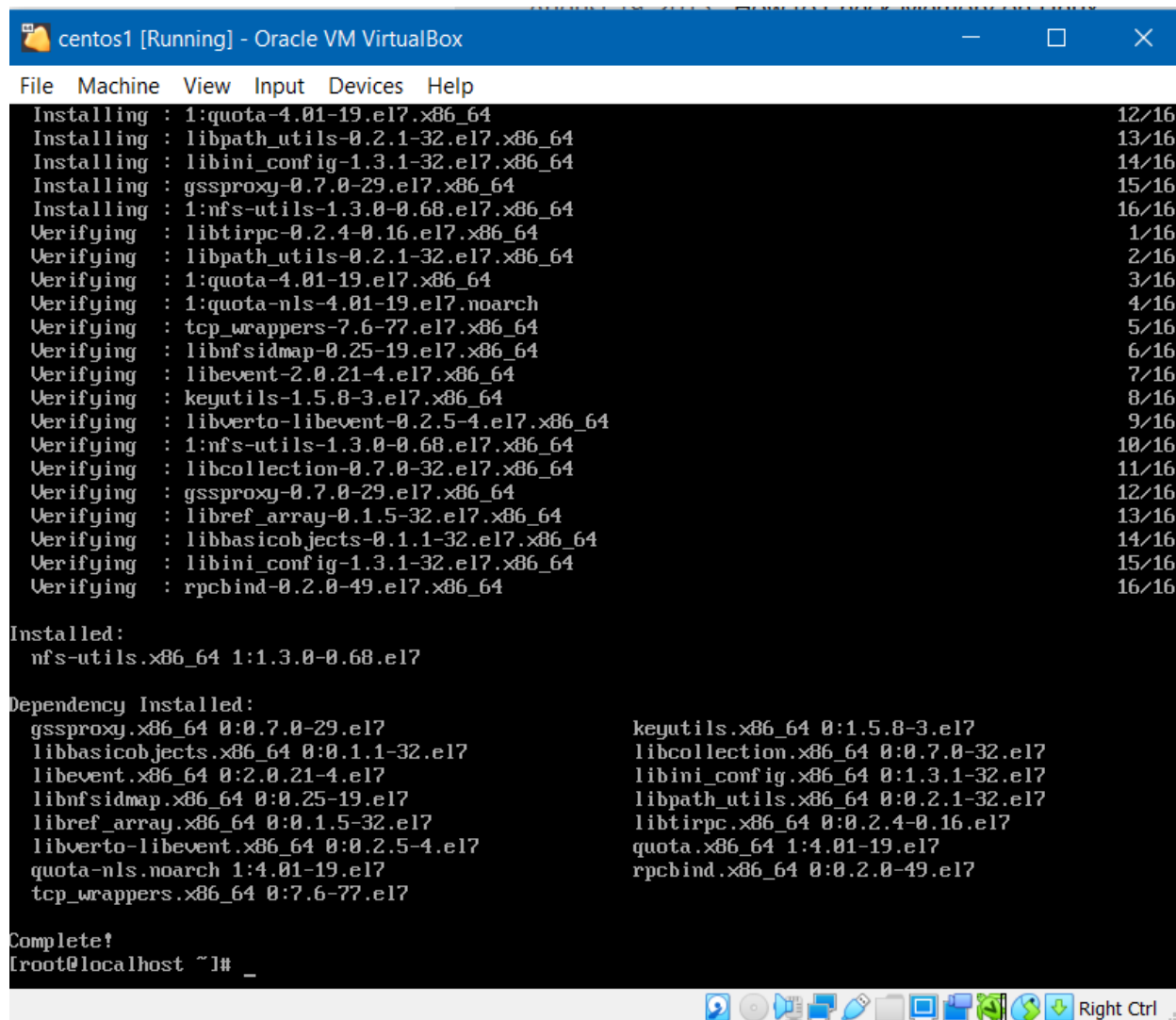
SCREEN SHOTS:



```
centos1 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
[admin@localhost ~]$ ip addr show
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
2: emp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:9f:01:00 brd ff:ff:ff:ff:ff:ff
    inet 10.0.2.15/24 brd 10.0.2.255 scope global noprefixroute dynamic emp0s3
        valid_lft 86095sec preferred_lft 86095sec
    inet6 fe80::103c:b498:852b:4f18/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
3: emp0s8: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:24:c6:07 brd ff:ff:ff:ff:ff:ff
    inet 10.0.1.2/24 brd 10.0.1.255 scope global noprefixroute dynamic emp0s8
        valid_lft 323sec preferred_lft 323sec
    inet6 fe80::c607:d3af:255:c5dd/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
[admin@localhost ~]$ ping 10.0.1.3
PING 10.0.1.3 (10.0.1.3) 56(84) bytes of data.
64 bytes from 10.0.1.3: icmp_seq=1 ttl=64 time=0.525 ms
64 bytes from 10.0.1.3: icmp_seq=2 ttl=64 time=0.597 ms
64 bytes from 10.0.1.3: icmp_seq=3 ttl=64 time=0.584 ms
64 bytes from 10.0.1.3: icmp_seq=4 ttl=64 time=0.697 ms
^C
--- 10.0.1.3 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3001ms
rtt min/avg/max/mdev = 0.525/0.600/0.697/0.060 ms
[admin@localhost ~]$ _

centos2 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
[admin@localhost ~]$ ip addr show
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
2: emp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:ef:3f:02 brd ff:ff:ff:ff:ff:ff
    inet 10.0.2.15/24 brd 10.0.2.255 scope global noprefixroute dynamic emp0s3
        valid_lft 86117sec preferred_lft 86117sec
    inet6 fe80::db56:ccd:7a49:8c54/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
3: emp0s8: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:1f:2b:37 brd ff:ff:ff:ff:ff:ff
    inet 10.0.1.3/24 brd 10.0.1.255 scope global noprefixroute dynamic emp0s8
        valid_lft 591sec preferred_lft 591sec
    inet6 fe80::bd2b:7f5b:718a:78a6/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
[admin@localhost ~]$ ping 10.0.1.2
PING 10.0.1.2 (10.0.1.2) 56(84) bytes of data.
64 bytes from 10.0.1.2: icmp_seq=1 ttl=64 time=0.774 ms
64 bytes from 10.0.1.2: icmp_seq=2 ttl=64 time=0.763 ms
64 bytes from 10.0.1.2: icmp_seq=3 ttl=64 time=0.549 ms
64 bytes from 10.0.1.2: icmp_seq=4 ttl=64 time=0.646 ms
^C
--- 10.0.1.2 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3001ms
rtt min/avg/max/mdev = 0.549/0.603/0.774/0.092 ms
[admin@localhost ~]$ _
```

Internet connection within the internal network works perfectly, allowing us to ping both servers



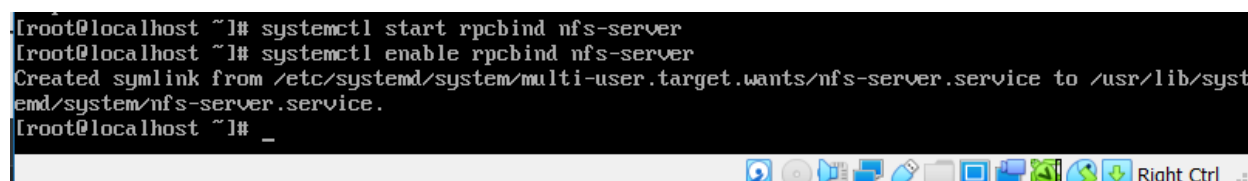
```
centos1 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Installing : 1:quota-4.01-19.el7.x86_64 12/16
Installing : libpath_utils-0.2.1-32.el7.x86_64 13/16
Installing : libini_config-1.3.1-32.el7.x86_64 14/16
Installing : gssproxy-0.7.0-29.el7.x86_64 15/16
Installing : 1:nfs-utils-1.3.0-0.68.el7.x86_64 16/16
Verifying : libtirpc-0.2.4-0.16.el7.x86_64 1/16
Verifying : libpath_utils-0.2.1-32.el7.x86_64 2/16
Verifying : 1:quota-4.01-19.el7.x86_64 3/16
Verifying : 1:quota-nls-4.01-19.el7.noarch 4/16
Verifying : tcp_wrappers-7.6-77.el7.x86_64 5/16
Verifying : libnfsidmap-0.25-19.el7.x86_64 6/16
Verifying : libevent-2.0.21-4.el7.x86_64 7/16
Verifying : keyutils-1.5.8-3.el7.x86_64 8/16
Verifying : libverto-libevent-0.2.5-4.el7.x86_64 9/16
Verifying : 1:nfs-utils-1.3.0-0.68.el7.x86_64 10/16
Verifying : libcollection-0.7.0-32.el7.x86_64 11/16
Verifying : gssproxy-0.7.0-29.el7.x86_64 12/16
Verifying : libref_array-0.1.5-32.el7.x86_64 13/16
Verifying : libbasicobjects-0.1.1-32.el7.x86_64 14/16
Verifying : libini_config-1.3.1-32.el7.x86_64 15/16
Verifying : rpcbind-0.2.0-49.el7.x86_64 16/16

Installed:
nfs-utils.x86_64 1:1.3.0-0.68.el7

Dependency Installed:
gssproxy.x86_64 0:0.7.0-29.el7
libbasicobjects.x86_64 0:0.1.1-32.el7
libevent.x86_64 0:2.0.21-4.el7
libnfsidmap.x86_64 0:0.25-19.el7
libref_array.x86_64 0:0.1.5-32.el7
libverto-libevent.x86_64 0:0.2.5-4.el7
quota-nls.noarch 1:4.01-19.el7
tcp_wrappers.x86_64 0:7.6-77.el7
keyutils.x86_64 0:1.5.8-3.el7
libcollection.x86_64 0:0.7.0-32.el7
libini_config.x86_64 0:1.3.1-32.el7
libpath_utils.x86_64 0:0.2.1-32.el7
libtirpc.x86_64 0:0.2.4-0.16.el7
quota.x86_64 1:4.01-19.el7
rpcbind.x86_64 0:0.2.0-49.el7

Complete!
[root@localhost ~]# _
```

Installing the NFS utilities on CentOS 1



```
[root@localhost ~]# systemctl start rpcbind nfs-server
[root@localhost ~]# systemctl enable rpcbind nfs-server
Created symlink from /etc/systemd/system/multi-user.target.wants/nfs-server.service to /usr/lib/systemd/system/nfs-server.service.
[root@localhost ~]# _
```

Enabling the server using a remote procedure call

```
centos1 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
[root@localhost ~]# sudo firewall-cmd --permanent --zone=public --add-service=nfs
success
[root@localhost ~]# sudo firewall-cmd --permanent --zone=public --add-service=mountd
success
[root@localhost ~]# sudo firewall-cmd --permanent --zone=public --add-service=rpc-bind
success
[root@localhost ~]# sudo firewall-cmd --reload
success
[root@localhost ~]# systemctl restart nfs
[root@localhost ~]# _
```

Providing access to the server through the System Firewall

```
centos2 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Installing : libpath_utils-0.2.1-32.el7.x86_64 13/16
Installing : libini_config-1.3.1-32.el7.x86_64 14/16
Installing : gssproxy-0.7.0-29.el7.x86_64 15/16
Installing : 1:nfs-utils-1.3.0-0.68.el7.x86_64 16/16
Verifying : libtirpc-0.2.4-0.16.el7.x86_64 1/16
Verifying : libpath_utils-0.2.1-32.el7.x86_64 2/16
Verifying : 1:quota-4.01-19.el7.x86_64 3/16
Verifying : 1:quota-nls-4.01-19.el7.noarch 4/16
Verifying : tcp_wrappers-7.6-77.el7.x86_64 5/16
Verifying : libnfsidmap-0.25-19.el7.x86_64 6/16
Verifying : libevent-2.0.21-4.el7.x86_64 7/16
Verifying : keyutils-1.5.8-3.el7.x86_64 8/16
Verifying : libverto-libevent-0.2.5-4.el7.x86_64 9/16
Verifying : 1:nfs-utils-1.3.0-0.68.el7.x86_64 10/16
Verifying : libcollection-0.7.0-32.el7.x86_64 11/16
Verifying : gssproxy-0.7.0-29.el7.x86_64 12/16
Verifying : libref_array-0.1.5-32.el7.x86_64 13/16
Verifying : libbasicobjects-0.1.1-32.el7.x86_64 14/16
Verifying : libini_config-1.3.1-32.el7.x86_64 15/16
Verifying : rpcbind-0.2.0-49.el7.x86_64 16/16

Installed:
  nfs-utils.x86_64 1:1.3.0-0.68.el7

Dependency Installed:
  gssproxy.x86_64 0:0.7.0-29.el7          keyutils.x86_64 0:1.5.8-3.el7
  libbasicobjects.x86_64 0:0.1.1-32.el7    libcollection.x86_64 0:0.7.0-32.el7
  libevent.x86_64 0:2.0.21-4.el7          libini_config.x86_64 0:1.3.1-32.el7
  libnfsidmap.x86_64 0:0.25-19.el7        libpath_utils.x86_64 0:0.2.1-32.el7
  libref_array.x86_64 0:0.1.5-32.el7      libtirpc.x86_64 0:0.2.4-0.16.el7
  libverto-libevent.x86_64 0:0.2.5-4.el7  quota.x86_64 1:4.01-19.el7
  quota-nls.noarch 1:4.01-19.el7         rpcbind.x86_64 0:0.2.0-49.el7
  tcp_wrappers.x86_64 0:7.6-77.el7

Complete!
[root@localhost ~]# mkdir -p /nfs
[root@localhost ~]# _
```

Setting up the client machine and making the connected directory

```

[root@localhost ~]# mount 10.0.1.2:/nfs /nfs
[root@localhost ~]# df -h

```

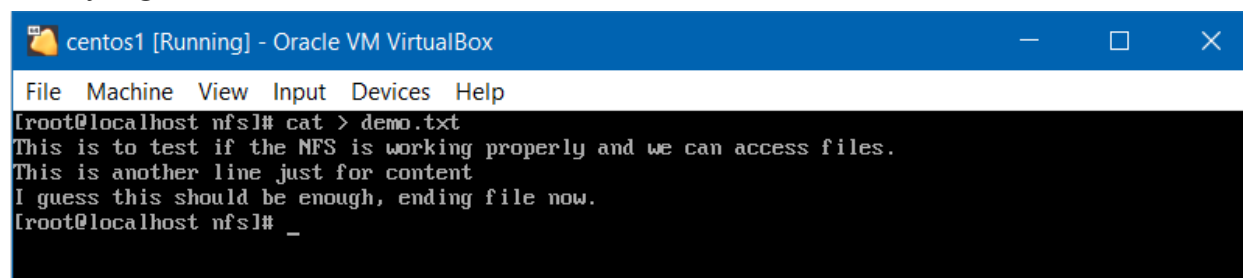
Filesystem	Size	Used	Avail	Use%	Mounted on
devtmpfs	232M	0	232M	0%	/dev
tmpfs	244M	0	244M	0%	/dev/shm
tmpfs	244M	4.6M	239M	2%	/run
tmpfs	244M	0	244M	0%	/sys/fs/cgroup
/dev/mapper/centos-root	6.2G	1.4G	4.9G	22%	/
/dev/sda1	1014M	137M	877M	14%	/boot
tmpfs	49M	0	49M	0%	/run/user/0
10.0.1.2:/nfs	6.2G	1.4G	4.9G	22%	/nfs

```

[root@localhost ~]# cd /nfs
[root@localhost nfs]#

```

Verifying that the connection is stable



```

centos1 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
[root@localhost nfs]# cat > demo.txt
This is to test if the NFS is working properly and we can access files.
This is another line just for content
I guess this should be enough, ending file now.
[root@localhost nfs]# _

```

Writing into a demo.txt file using vi in server machine

```

[root@localhost ~]# mount 10.0.1.2:/nfs /nfs
[root@localhost ~]# df -h

```

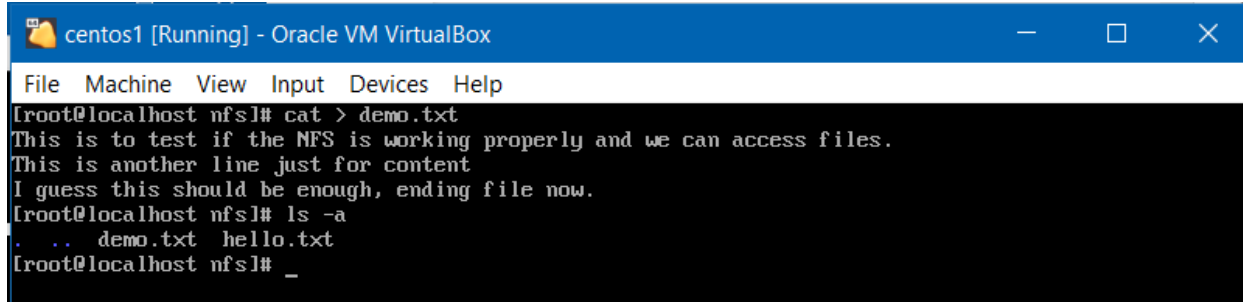
Filesystem	Size	Used	Avail	Use%	Mounted on
devtmpfs	232M	0	232M	0%	/dev
tmpfs	244M	0	244M	0%	/dev/shm
tmpfs	244M	4.6M	239M	2%	/run
tmpfs	244M	0	244M	0%	/sys/fs/cgroup
/dev/mapper/centos-root	6.2G	1.4G	4.9G	22%	/
/dev/sda1	1014M	137M	877M	14%	/boot
tmpfs	49M	0	49M	0%	/run/user/0
10.0.1.2:/nfs	6.2G	1.4G	4.9G	22%	/nfs

```

[root@localhost ~]# cd /nfs
[root@localhost nfs]# touch demo.txt
[root@localhost nfs]# touch hello.txt
[root@localhost nfs]# _

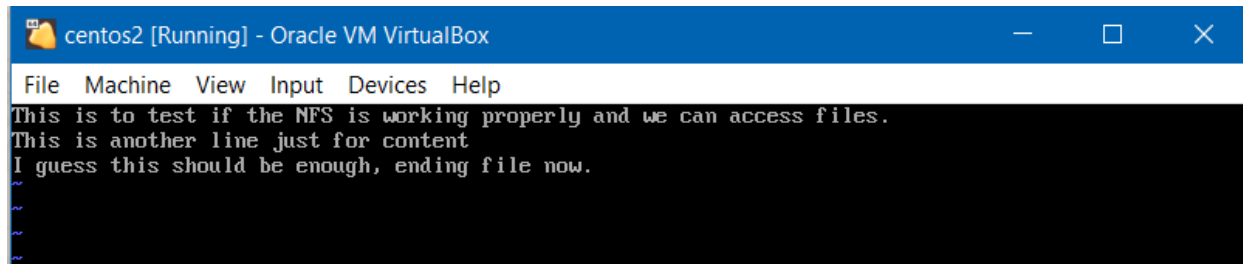
```

Creating another file on the client machine to verify bidirectional file transmission on the NFS



```
centos1 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
[root@localhost nfs1]# cat > demo.txt
This is to test if the NFS is working properly and we can access files.
This is another line just for content
I guess this should be enough, ending file now.
[root@localhost nfs1]# ls -a
. .. demo.txt hello.txt
[root@localhost nfs1]#
```

Verified that the file exists in server machine



```
centos2 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
This is to test if the NFS is working properly and we can access files.
This is another line just for content
I guess this should be enough, ending file now.
~
~
~
~
```

Verifying that the edited file exists in client machine

CONCLUSION

The NFS was created successfully and the files could be shared in it between the servers and clients as well.

REFERENCES

- [1]<https://www.cs.cornell.edu/courses/cs6411/2018sp/papers/nfs.pdf>
- [2]<https://dl.acm.org/doi/abs/10.1145/502034.502052>