

CSCI322 Lab Exercises

Lab 5

Objective

You will explore the RAID array and create network shares using NFS.

Do not start VMs now.

1. Adding disks to the server VM

- Select the *server* VM in the VirtualBox manager main window and click at the **Storage** section from the **Details** pane;
- Under the **Storage Devices**, click at Controller: SATA. Then click at the **Add Hard Disk** button (the green plus sign) and select Create new disk. Choose the followings:
 - Hard disk file type: VDI (default)
 - Storage on physical hard disk: Dynamically allocated (default)
 - File location and size: myDisk1 and 1.0 GB
- Repeat the above to create another two disks called: myDisk2 and myDisk3 with the same 1.0 GB.

2. Install RAID

The RAID software included with Ubuntu Linux is based on the `mdadm` driver.

- Now start the *server* VM;
- Identify the newly created disks

```
lsblk -o NAME,SIZE,FSTYPE,TYPE,MOUNTPOINT
```

You will have the output like the following:

```
NAME      SIZE FSTYPE  TYPE MOUNTPOINT
loop0    86.9M squashfs loop  /snap/core/4917
loop1    87.9M squashfs loop  /snap/core/5328
loop2     87M squashfs loop  /snap/core/5145
sda       10G                disk
├─sda1     1M                part
└─sda2    10G ext4           part /
sdb       1G                disk
sdc       1G                disk
sdd       1G                disk
sr0      1024M                rom
```

As you can see above, the `sdb`, `sdc`, and `sdd` are the newly created disks without a filesystem, each 1G in size. These will be the raw disks we use to build a RAID5 array.

- Create the RAID5 array

Watch out: Do not use `sda` !

```
sudo mdadm --create --verbose /dev/md0 --level=5 --raid-devices=3 /dev/sdb /dev/sdc
/dev/sdd
```

The `mdadm` tool will configure the array. You can check the status of the array.

```
cat /proc/mdstat
```

```
Personalities : [linear] [multipath] [raid0] [raid1] [raid6] [raid5] [raid4] [raid10]
md0 : active raid5 sdd[3] sdc[1] sdb[0]
      2093056 blocks super 1.2 level 5, 512k chunk, algorithm 2 [3/3] [UUU]

unused devices: <none>
```

You will see the device `md0` has been created in the RAID5 using `sdb`, `sdc`, and `sdd` disks.

- Create and mount the filesystem

```
sudo mkfs.ext4 /dev/md0
```

- Create a mount point to attach the new filesystem

```
sudo mkdir /mnt/md0
```

- Mount the filesystem

```
sudo mount /dev/md0 /mnt/md0
```

You can check the new space by typing:

```
df -h
```

You will see:

Filesystem	Size	Used	Avail	Use%	Mounted on
/dev/md0	2.0G	6.0M	1.9G	1%	/mnt/md0

- Check the disks again

```
lsblk -o NAME,SIZE,FSTYPE,TYPE,MOUNTPOINT
```

You will see that the three disks in the RAID array mounted at `/mnt/md0` have the `linux_raid_member` type for the disks and `ext4` filesystem on the partition `md0` as the `raid5` type. Note that the RAID 5 array has a capacity of 2GB instead of the total capacity of 3GB of all three disks.

```
sdb      1G linux_raid_member disk
└─md0    2G ext4          raid5 /mnt/md0
sdc      1G linux_raid_member disk
└─md0    2G ext4          raid5 /mnt/md0
sdd      1G linux_raid_member disk
└─md0    2G ext4          raid5 /mnt/md0
```

- Save the RAID array layout for automatic assembling and mounting at boot
 - To make sure that the array is reassembled automatically at boot, append the array configuration to `/etc/mdadm/mdadm.conf`

```
sudo mdadm --detail --scan | sudo tee -a /etc/mdadm/mdadm.conf
sudo update-initramfs -u
```

- Add the new filesystem mount options to the `/etc/fstab` file for automatic mounting at boot

```
echo '/dev/md0 /mnt/md0 ext4 defaults,nofail,discard 0 0' | sudo tee -a /etc/fstab
```

- Create a file in the storage space

```
cd /mnt/md0
sudo pico readme.txt
```

enter the text: "This is my storage on RAID5.", save and exit.

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You will see the file `readme.txt` is created.

3. Create a Network File System (NFS) share

Continue work on your server VM.

- Update the system

It is a good practice to update your system each time before you install a package.

```
sudo apt update
sudo apt upgrade
```

- Install NFS server

```
sudo apt install nfs-kernel-server
```

- Configure the exports

Add the following line in the file `/etc/exports` using `pico`.

```
/mnt/md0 *(rw, sync, no_root_squash)
```

- Start the NFS server

```
sudo systemctl start nfs-kernel-server.service
```

- Reboot the server VM

```
sudo reboot
```

4. Connect the NFS share from the *desktop* VM

You can connect to the NFS server to browse and use files on the server as if they were on the local computer.

Now start the *desktop* VM.

- Install the NFS client from the Terminal
 - Update the system

```
sudo apt update
sudo apt upgrade
```

- Install the NFS client

```
sudo apt install nfs-common
```

- Check the list of shares on the server

```
showmount -e server.csci322.test
```

You will see that the share /mnt/md0 is listed.

- Mount the NFS share
 - Create a mount point

```
sudo mkdir -p /share/md0
```

- Mount the NFS share

```
sudo mount -t nfs server.csci322.test:/mnt/md0 /share/md0
```

- List the files on the share

```
ll /share/md0
```

You will see the readme.txt file you created on the server. Display the content of it.

```
cat /share/md0/readme.txt
```

- Create a file in the new filesystem

```
sudo pico /share/md0/fromdesktop.txt
```

enter the text: "This is from desktop VM", save and exit.

```
ll
```

You will see the file fromdesktop.txt is created.

- Access the file from the *server* VM

On the server,

```
ll /mnt/md0
```

You will see the file fromdesktop.txt listed. Display the content of it.

```
cat /mnt/md0/fromdesktop.txt
```

- Mount the NFS share at boot

Add the following line to the end of the /etc/fstab file (on the server or desktop?):

```
server.csci322.test:/mnt/md0 /share/md0 nfs defaults,user,exec 0 0
```

5. Simulate a disk failure in the RAID array on the server VM

- View the status

To view the status of an array:

```
sudo mdadm -D /dev/md0
```

To view the status of a disk in an array:

```
sudo mdadm -E /dev/sdd
```

- Simulate a disk failure in the RAID array
 - Shutdown the *server* VM (not power off but ACPI shutdown by sending shutdown signal).
 - Select the *server* VM in the VirtualBox manager main window and click at the **Storage** section from the **Details** pane;
 - Under the **Storage Devices**, click *myDisk2.vdi* and press the Remove selected storage attachment button (a disc with red minus sign).;
 - Start the *server* VM again;
 - Reassemble the array with a disk failure

```
sudo mdadm --stop /dev/md0
sudo mdadm --assemble --force /dev/md0
```

- View the status of the array again:

```
sudo mdadm -D /dev/md0
```

Now, there are only 2 **Active** devices with the array **state** as clean, degraded.

- Display the file on the RAID5 array with a disk missing

```
cd /mnt/md0
ll
cat readme.txt
```

The files are intact and accessible.

- Add a new disk to replace the failed disk in the RAID array
 - Shutdown the *server* VM and follow the steps in the Section 1 to add new disk called *myDisk4* to the *server* VM;
 - Start the *server* VM;
 - Identify the new disk:

```
lsblk
```

The new disk is likely */dev/sdc*.

- Add a new disk to the array

```
sudo mdadm --add /dev/md0 /dev/sdc
```

This will cause the drive to re-sync with the array. It will normally take a considerable time to complete. you can use the command `cat /proc/mdstat` to check the progress. In our case, it completes instantly as the disk is only 1GB in size.

- View the status of the array:

```
sudo mdadm -D /dev/md0
```

Now, there should be 3 **Active** devices with the array **state** as clean.

Submission and mark

Show your work to the lab tutor.

Of 3 marks, you can get

- 0.5 mark for showing the content of `/etc/mdadm/mdadm.conf` on the server VM;
- 1 mark for showing the content of `/etc/fstab` on the server VM;
- 1 mark for listing the files in the directory `/share/md0` on the desktop VM;
- 0.5 for showing the new disk called `myDisk4.vdi` for the server VM in the VirtualBox manager.

You should be ready to answer any questions to demonstrate that all work is done by yourself otherwise you may receive 0 mark.

IMPORTANT NOTE: You will need to document all of your lab work in CSCI322 in your wiki.