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RAID 6 Recovery Lab Report

1. Executive Summary

This lab involved the creation, failure simulation, and manual recovery of a RAID 6 array using five 10GB virtual disks in a Linux environment. The objective was to test the theoretical limits of RAID 6 (dual-drive failure tolerance) and practice advanced recovery techniques using mdadm.

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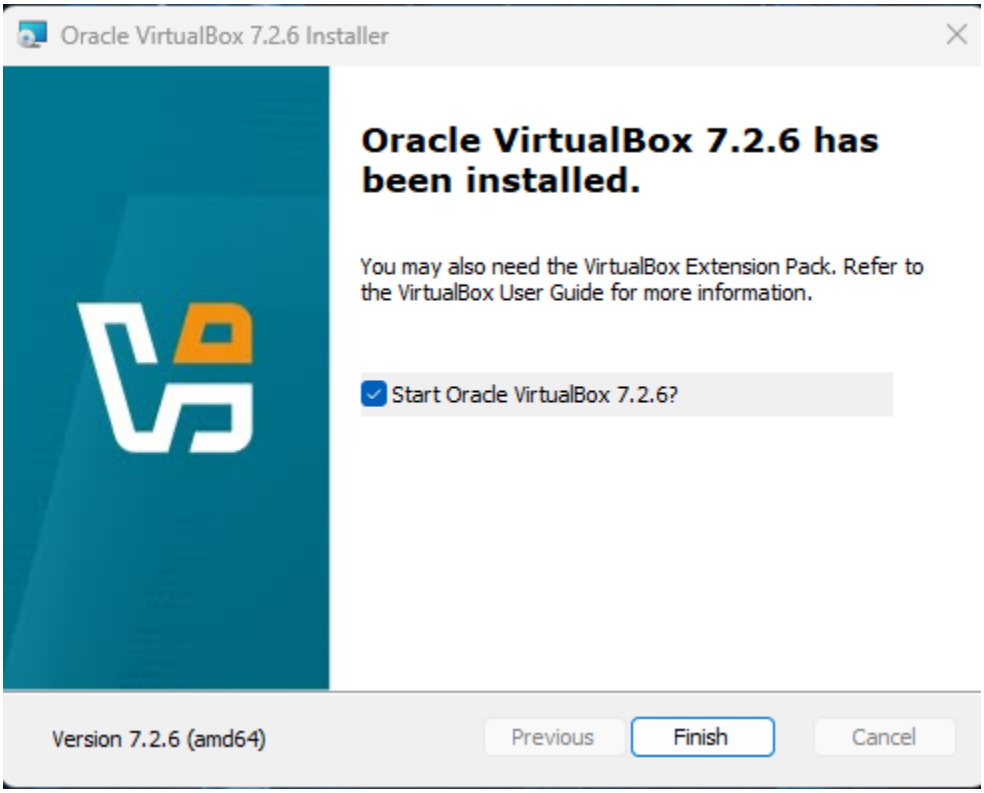
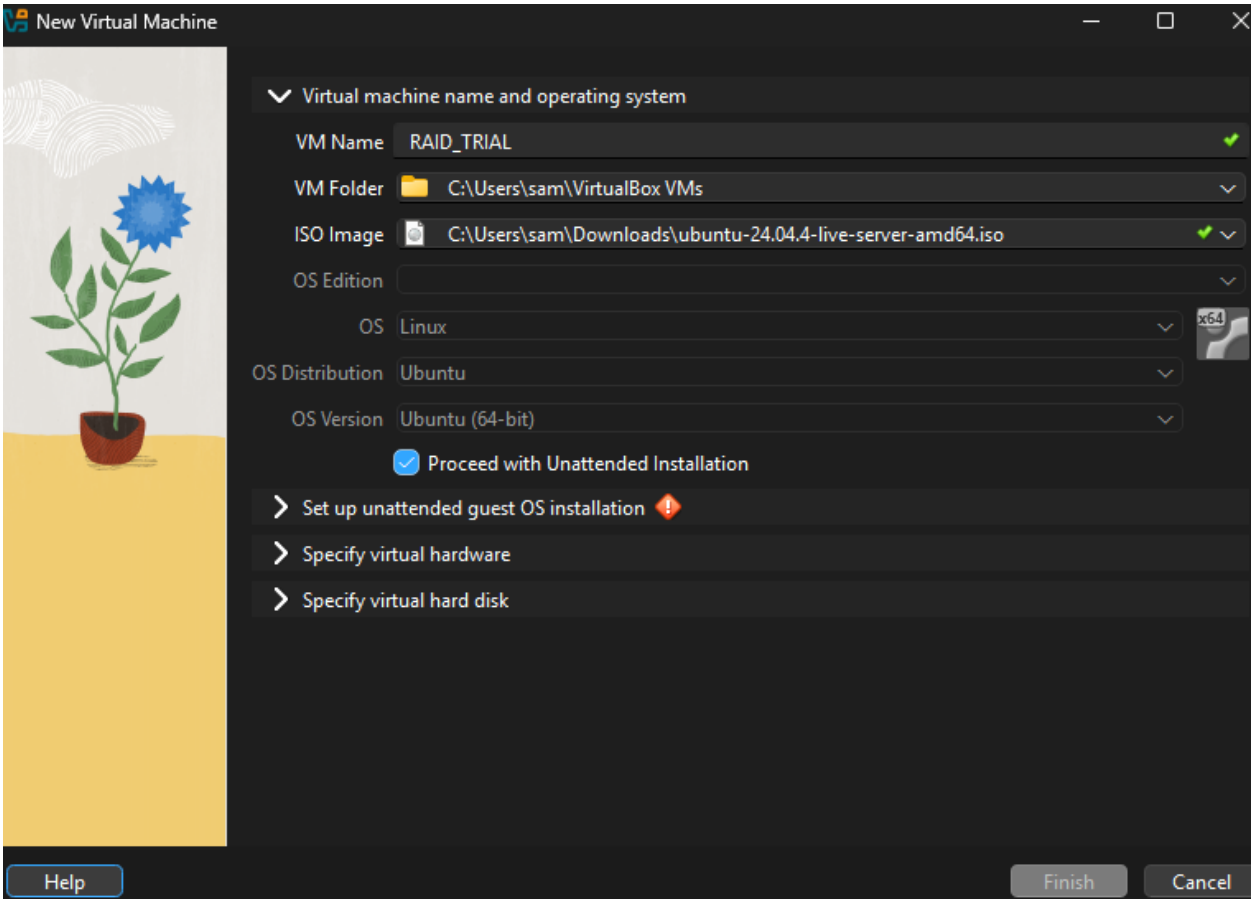
1. Installed VirtualBox

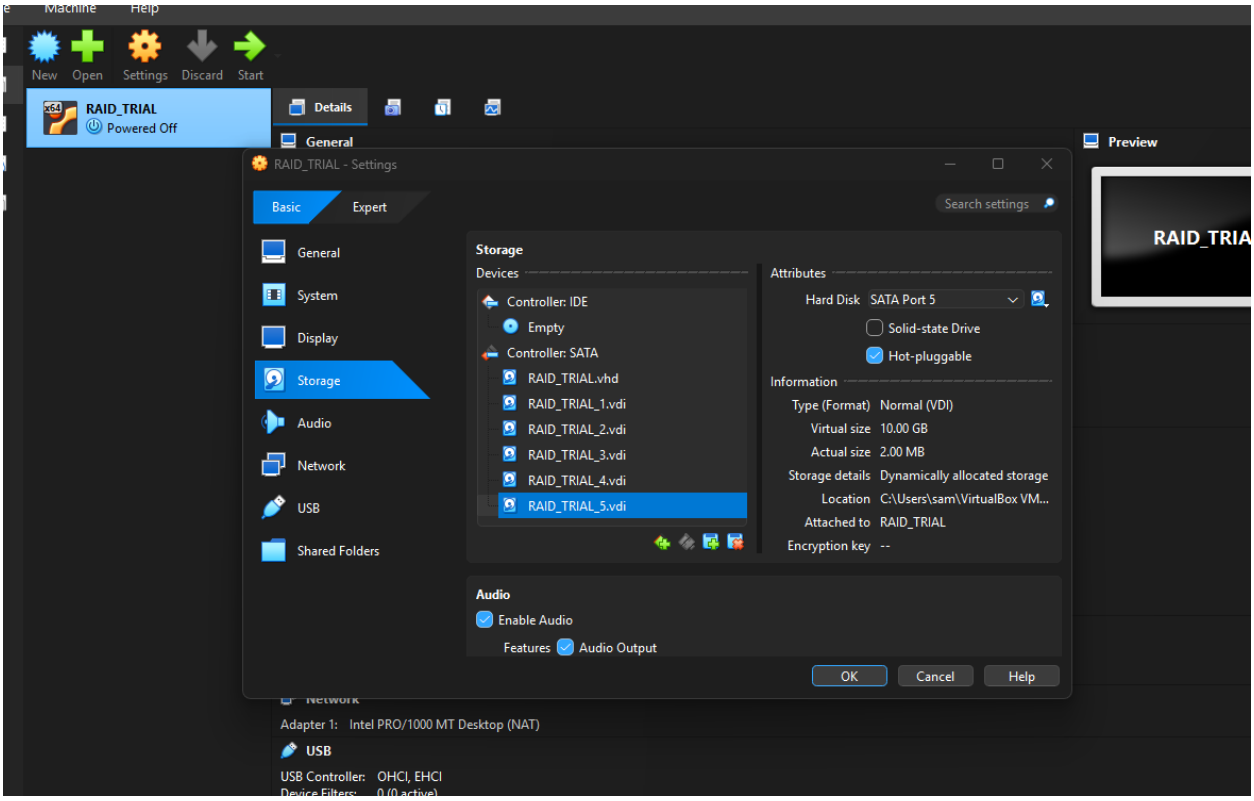


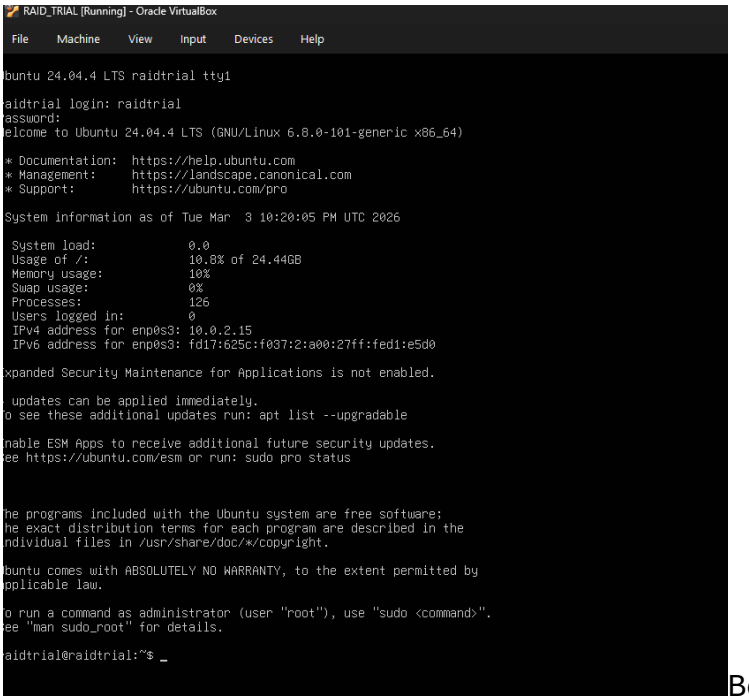
I've decided to go with Ubuntu as it is easier to run a trial project with as I tried doing this initially with ProxMox and wasn't able to solve GUI issues due to it not being a VM friendly OS. I do want to try it with a bare metal machine.

2. Downloaded Ubuntu Server from https://ubuntu.com/download/server



3. I created my 5x10GB hard disks to accompany the Ubuntu boot drive and to act as my RAID6 party





Booting onto the VM

4. I ran “lsblk” which lists information about all available block devices.

```
raidtrial@raidtrial:~$ lsblk
NAME   MAJ:MIN RM  SIZE RO TYPE MOUNTPOINTS
sda      8:0    0   25G  0 disk
├─sda1   8:1    0    1M  0 part
└─sda2   8:2    0   25G  0 part /
sdb      8:16   0   10G  0 disk
sdc      8:32   0   10G  0 disk
sdd      8:48   0   10G  0 disk
sde      8:64   0   10G  0 disk
sdf      8:80   0   10G  0 disk
sr0     11:0    1 1024M  0 rom
raidtrial@raidtrial:~$
```

5. I then installed mdadm which is the tool that manages RAID for this lab.

```
raidtrial@raidtrial:~$ sudo apt update && sudo apt install mdadm -y
Hit:1 http://us.archive.ubuntu.com/ubuntu noble InRelease
Hit:2 http://us.archive.ubuntu.com/ubuntu noble-updates InRelease
Hit:3 http://us.archive.ubuntu.com/ubuntu noble-backports InRelease
Hit:4 http://security.ubuntu.com/ubuntu noble-security InRelease
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
4 packages can be upgraded. Run 'apt list --upgradable' to see them.
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
mdadm is already the newest version (4.3-1ubuntu2.1).
mdadm set to manually installed.
0 upgraded, 0 newly installed, 0 to remove and 4 not upgraded.
```

6. I then created the a new device called /dev/md0 using the level 6 RAID with my 5 disks.

```
raidtrial@raidtrial:~$ sudo mdadm --create --verbose /dev/md0 --level=6 --raid-devices=5 /dev/sdb /dev/sdc /dev/sdd /dev/sde /dev/sdf
mdadm: layout defaults to left-symmetric
mdadm: layout defaults to left-symmetric
mdadm: chunk size defaults to 512K
mdadm: size set to 10476544K
mdadm: Defaulting to version 1.2 metadata
mdadm: array /dev/md0 started.
```

7. I am now viewing the RAID setup

```
raidtrial@raidtrial:~$ cat /proc/mdstat
Personalities : [raid0] [raid1] [raid6] [raid5] [raid4] [raid10]
md0 : active raid6 sdf[4] sde[3] sdd[2] sdc[1] sdb[0]
      31429632 blocks super 1.2 level 6, 512k chunk, algorithm 2 [5/5] [UUUUU]
      [======>.............]  resync = 32.7% (3435100/10476544) finish=0.7min speed=163576K/sec

unused devices: <none>
raidtrial@raidtrial:~$
```

8. I forgot to show a step, but first I formatted the drive with “sudo mkfs.ext4 /dev/md0”
9. Then I made a directory /mnt/raid_lab and mounted that onto the raid steup

```
raidtrial@raidtrial:~$ sudo mkdir /mnt/raid_lab
raidtrial@raidtrial:~$ sudo mount /dev/md0 /mnt/raid_lab
raidtrial@raidtrial:~$ df -h /mnt/raid_lab
Filesystem      Size  Used Avail Use% Mounted on
/dev/md0         30G   24K   28G   1% /mnt/raid_lab
raidtrial@raidtrial:~$
```

10. Now, I created data on the actual directory which is just a plain text file with the following “This data is protected by RAID 6”

```
raidtrial@raidtrial:~$ echo "This data is protected by RAID 6" | sudo tee /mnt/raid_lab/secret.txt
This data is protected by RAID 6
```

11. Now it’s time to make a drive fail to simulate a real-world scenario, I do that then I check if the data is still preserved, which it is.

```
raidtrial@raidtrial:~$ sudo mdadm /dev/md0 --fail /dev/sdb
[  570.528748] md/raid:md0: Disk failure on sdb, disabling device.
[  570.528889] md/raid:md0: Operation continuing on 4 devices.
mdadm: set /dev/sdb faulty in /dev/md0
raidtrial@raidtrial:~$
raidtrial@raidtrial:~$ cat /proc/mdstat
Personalities : [raid0] [raid1] [raid6] [raid5] [raid4] [raid10]
md0 : active raid6 sdf[4] sde[3] sdd[2] sdc[1] sdb[0](F)
      31429632 blocks super 1.2 level 6, 512k chunk, algorithm 2 [5/4] [_UUUU]

unused devices: <none>
raidtrial@raidtrial:~$ cat /mnt/raid_lab/secret.txt
This data is protected by RAID 6
raidtrial@raidtrial:~$
```

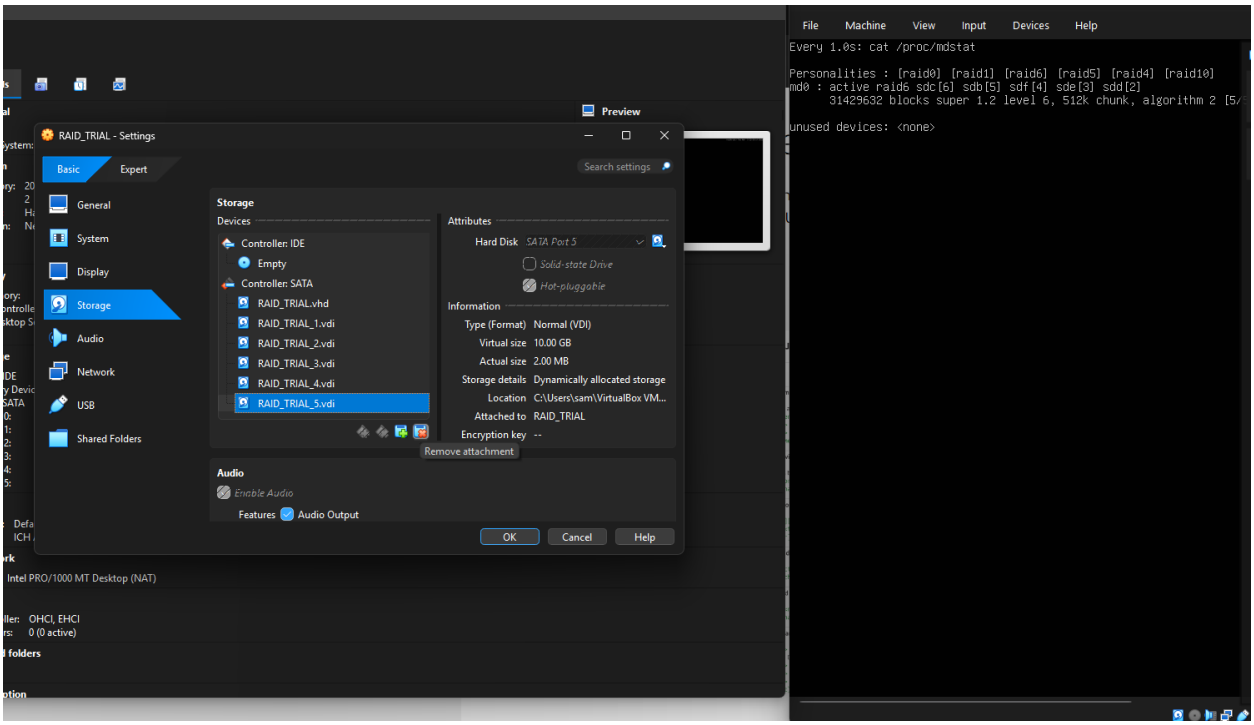
12. Now, I go a step further which a RAID5 setup would fail in this case, but with RAID6, we can do it. So I failed another drive, now running 3/5. We still have the data!

```
raidtrial@raidtrial:~$ sudo mdadm /dev/md0 --fail /dev/sdc
[  691.724218] md/raid:md0: Disk failure on sdc, disabling device.
[  691.724357] md/raid:md0: Operation continuing on 3 devices.
mdadm: set /dev/sdc faulty in /dev/md0
raidtrial@raidtrial:~$ cat /proc/mdstat
Personalities : [raid0] [raid1] [raid6] [raid5] [raid4] [raid10]
md0 : active raid6 sdf[4] sde[3] sdd[2] sdc[1](F) sdb[0](F)
      31429632 blocks super 1.2 level 6, 512k chunk, algorithm 2 [5/3] [__UUU]

unused devices: <none>
raidtrial@raidtrial:~$ cat /mnt/raid_lab/secret.txt
This data is protected by RAID 6
raidtrial@raidtrial:~$
```

13. Now let’s recover what a technician would do. So, to fix it, I would remove the physical disks in a real-world event, and run the following commands to tell RAID6 that they are no longer in the configuration. Then I would “add” new disks and let mdadm know that.

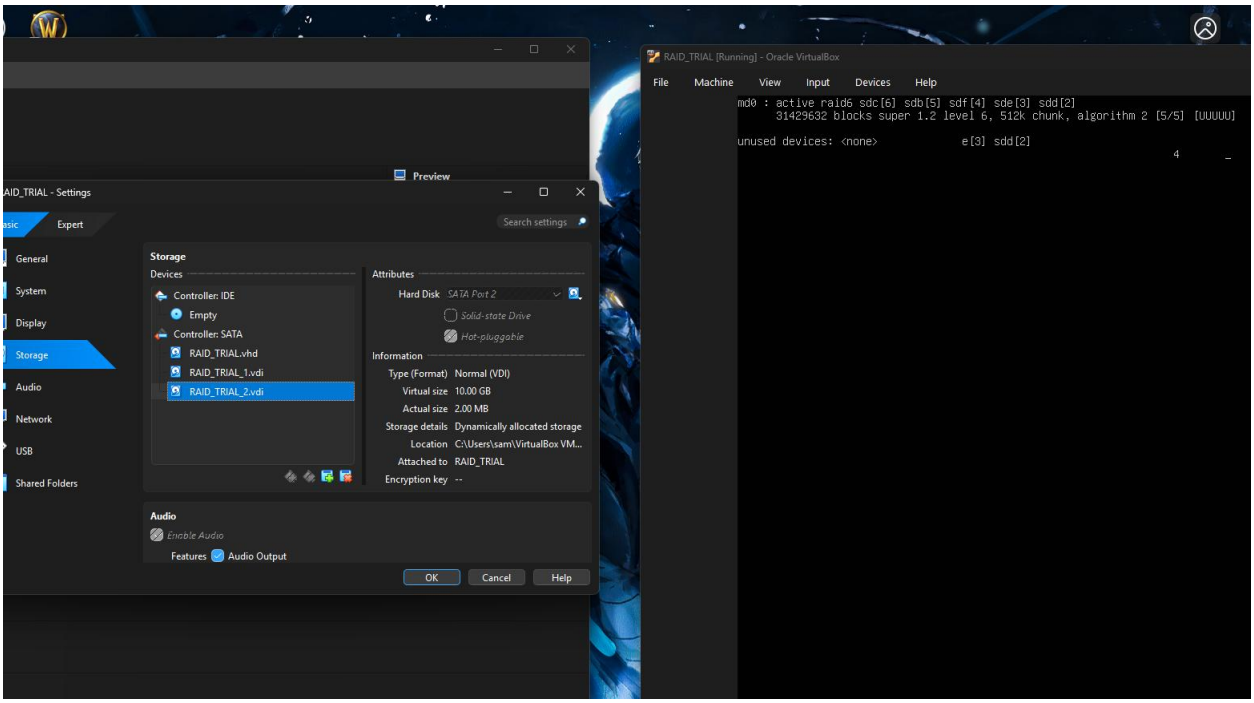
```
raidtrial@raidtrial:~$ sudo mdadm /dev/md0 --remove /dev/sdb /dev/sdc
mdadm: hot removed /dev/sdb from /dev/md0
mdadm: hot removed /dev/sdc from /dev/md0
raidtrial@raidtrial:~$ sudo mdadm /dev/md0 --add /dev/sdb /dev/sdc
mdadm: added /dev/sdb
mdadm: added /dev/sdc
raidtrial@raidtrial:~$ cat /proc/mdstat
Personalities : [raid0] [raid1] [raid6] [raid5] [raid4] [raid10]
md0 : active raid6 sdc[6] sdb[5] sdf[4] sde[3] sdd[2]
      31429632 blocks super 1.2 level 6, 512k chunk, algorithm 2 [5/3] [__UUU]
      [==>..................]  recovery = 13.8% (1453660/10476544) finish=0.9min speed=161517K/sec

unused devices: <none>
raidtrial@raidtrial:~$
```

14. Now I want to simulate a different kind of failure, where we delete a drive completely while running, so I use the command “watch -n 1 cat /proc/mdstat” which refreshes the status and I remove a drive.



15. As expected, there is a disk failure detected and disabling device.

16. Now I want to ruin the data, so I delete two more disks and put it into failure mode.



17. So 3/5 failed, and the data still works…so after some research it appears that it is coming from the “Page Cache” which is the RAM and because it’s not even a KB of data. (Not a real-world scenario!) So I clear the linux cache and now the data is gone.

```
raidtrial@raidtrial:~$ [  997.183379] md/raid:md0: Disk failure on sde, disabling device.
[  997.183434] md/raid:md0: Operation continuing on 3 devices.
[  997.183603] md: super_written gets error=-5
[  997.183643] md/raid:md0: Disk failure on sdd, disabling device.
[  997.183680] md/raid:md0: Cannot continue operation (3/5 failed).
cat /mnt/raid_lab/secret.txt
This data is protected by RAID 6
raidtrial@raidtrial:~$ sudo blockdev --flushbufs /dev/md0
raidtrial@raidtrial:~$ cat /mnt/raid_lab/secret.txt
This data is protected by RAID 6
raidtrial@raidtrial:~$
raidtrial@raidtrial:~$ lsblk
NAME   MAJ:MIN RM  SIZE RO TYPE  MOUNTPOINTS
sda      8:0    0   25G  0 disk
├─sda1   8:1    0    1M  0 part
└─sda2   8:2    0   25G  0 part  /
sdb      8:16   0   10G  0 disk
└─md0    9:0    0   30G  0 raid6 /mnt/raid_lab
sdc      8:32   0   10G  0 disk
└─md0    9:0    0   30G  0 raid6 /mnt/raid_lab
sr0     11:0    1 1024M  0 rom
raidtrial@raidtrial:~$ sudo sync && echo 3 | sudo tee /proc/sys/vm/drop_caches
3
raidtrial@raidtrial:~$ cat /mnt/raid_lab/secret.txt
[ 1131.262241] EXT4-fs error (device md0): __ext4_find_entry:1683: inode #2: comm cat: reading directory lblock 0
cat: /mnt/raid_lab/secret.txt: Input/output error
raidtrial@raidtrial:~$ [ 1137.151781] Aborting journal on device md0-8.
[ 1137.151903] Buffer I/O error on dev md0, logical block 3702784, lost sync page write
[ 1137.151992] JBD2: I/O error when updating journal superblock for md0-8.
```

18. I check the RAID controller state, and as you can see 3/5 are removed

```
sudo mdadm --detail /dev/md0
/dev/md0:
           Version : 1.2
     Creation Time : Tue Mar  3 22:24:02 2026
        Raid Level : raid6
        Array Size : 31429632 (29.97 GiB 32.18 GB)
     Used Dev Size : 10476544 (9.99 GiB 10.73 GB)
      Raid Devices : 5
     Total Devices : 2
       Persistence : Superblock is persistent

       Update Time : Tue Mar  3 22:35:04 2026
             State : clean, FAILED
    Active Devices : 2
   Working Devices : 2
    Failed Devices : 0
     Spare Devices : 0

            Layout : left-symmetric
        Chunk Size : 512K

Consistency Policy : resync

              Name : raidtrial:0  (local to host raidtrial)
              UUID : a0f47071:50fd594f:82822dc5:00f04d58
            Events : 56

    Number   Major   Minor   RaidDevice State
       6       8       32        0      active sync   /dev/sdc
       5       8       16        1      active sync   /dev/sdb
       -       0        0        2      removed
       -       0        0        3      removed
       -       0        0        4      removed
raidtrial@raidtrial:~$
```

19. I then unmount the folder and stop the raid controller

```
raidtrial@raidtrial:~$ sudo umount -l /mnt/raid_lab
[ 1348.231375] Buffer I/O error on dev md0, logical block 0, lost sync page write
[ 1348.231501] EXT4-fs (md0): I/O error while writing superblock
raidtrial@raidtrial:~$ sudo mdadm --stop /dev/md0
mdadm: stopped /dev/md0
raidtrial@raidtrial:~$
```

20. Now after re-attaching the hardware, I do a force assemble and it appears that 4/5 disks are active, which is a problem. So I stop it, retry it again, same problem, so I just end up manually adding the drive and that resolves the issue.

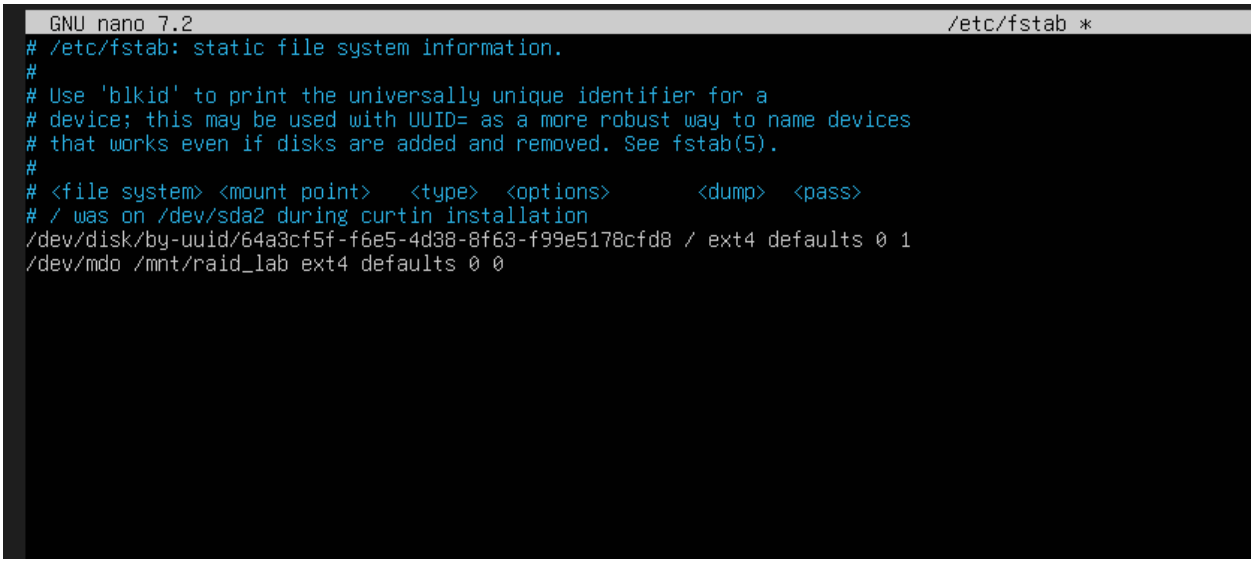
```
raidtrial@raidtrial:~$ sudo mdadm --assemble --force --verbose /dev/md0 /dev/sdb /dev/sdc /dev/sdd /dev/sde /dev/sdf
mdadm: looking for devices for /dev/md0
mdadm: /dev/sdb is identified as a member of /dev/md0, slot 1.
mdadm: /dev/sdc is identified as a member of /dev/md0, slot 0.
mdadm: /dev/sdd is identified as a member of /dev/md0, slot 2.
mdadm: /dev/sde is identified as a member of /dev/md0, slot 3.
mdadm: /dev/sdf is identified as a member of /dev/md0, slot 4.
mdadm: added /dev/sdb to /dev/md0 as 1
mdadm: added /dev/sdd to /dev/md0 as 2
mdadm: added /dev/sde to /dev/md0 as 3
mdadm: added /dev/sdf to /dev/md0 as 4 (possibly out of date)
mdadm: added /dev/sdc to /dev/md0 as 0
mdadm: /dev/md0 has been started with 4 drives (out of 5).
raidtrial@raidtrial:~$ sudo mdadm --stop /dev/md0
mdadm: stopped /dev/md0
raidtrial@raidtrial:~$ sudo mdadm --assemble --force /dev/md0 /dev/sdb /dev/sdc /dev/sdd /dev/sde /dev/sdf
mdadm: /dev/md0 has been started with 4 drives (out of 5).
raidtrial@raidtrial:~$ cat /proc/mdstat
Personalities : [raid0] [raid1] [raid6] [raid5] [raid4] [raid10]
md0 : active raid6 sdc[6] sde[3] sdd[2] sdb[5]
      31429632 blocks super 1.2 level 6, 512k chunk, algorithm 2 [5/4] [UUUU_]

unused devices: <none>
raidtrial@raidtrial:~$ sudo mdadm --manage /dev/md0 --add /dev/sdf
mdadm: added /dev/sdf
```

21. Now everything is running, I try to read my data that was long gone, and it appears it doesn't work because I wasn't mounted into the directory, so I do that, and we're back!

```
unused devices: <none>
raidtrial@raidtrial:~$ cat /mnt/raid_lab/secret.txt
cat: /mnt/raid_lab/secret.txt: No such file or directory
raidtrial@raidtrial:~$ sudo mount /dev/md0 /mnt/raid_lab
raidtrial@raidtrial:~$ cat /mnt/raid_lab/secret.txt
This data is protected by RAID 6
```

22. Now I want to make the RAID permanenty, so I do the following:

- Saving the raid CONFIG
- Ran sudo mdadm --detail --scan | sudo tee -a /etc/mdadm/mdadm.conf
- Updating the boot sequence: sudo update-initramfs -u
- Sudo nano /etc/fstab



Conclusion

- I built a RAID 6 array from scratch on a VM
- Simulated drive failures
- Handled an “inactive” array and out-of-date metadata
- Resurrected a collapsed system

In the future, I can configure the RAID setup for additional drives to simulate upgrading! This was a fun project to do that took me about an hour.