

Steps to Implement RAID 5 with Hot Spare Disks

1. Ensure mdadm is installed:

```
sudo apt-get update
```

```
sudo apt-get install mdadm
```

2. Create RAID 5 Array

```
sudo mdadm --create --verbose /dev/md127 --level=5 --raid-devices=3 /dev/sdb /dev/sdc /dev/sdd --  
spare-devices=2 /dev/sde /dev/sdf
```

- `--create`: Initializes a new RAID array.
- `--level=5`: Configures RAID 5 (striping with parity).
- `--raid-devices=3`: Three active disks.
- `--spare-devices=2`: Two hot spare disks.

3. Verify RAID Creation

```
sudo mdadm --detail /dev/md127
```

```
lsblk
```

- Check RAID status and disk structure. Look for three active disks and two spare disks.

4. Format and Mount the RAID

```
sudo mkfs.ext4 /dev/md127
```

```
sudo mkdir /mnt/raid5
```

```
sudo mount /dev/md127 /mnt/raid5
```

```
df -h | grep /mnt/raid5
```

- Format with ext4 and mount at /mnt/raid5.
- Verify using df -h.

5. Simulate Disk Failure

```
sudo mdadm /dev/md127 --remove /dev/sdb
```

- Simulates failure of /dev/sdb, marking it as failed.
- Use sudo mdadm --detail /dev/md127 to verify RAID's degraded state.

6. Monitor Hot Spare Activation

```
watch cat /proc/mdstat
```

```
sudo mdadm --detail /dev/md127
```

- Hot spare disks automatically replace failed drives.
- Use watch to monitor the rebuild process in real time.

7. Re-Add Removed Disk (Optional)

```
sudo mdadm /dev/md127 --add /dev/sdb
```

- Re-add the failed disk after rebuild completion to restore it as a hot spare.

8. Persist RAID Configuration

- Save the RAID configuration to make it persistent across reboots:

```
sudo mdadm --detail --scan >> /etc/mdadm/mdadm.conf
```

```
sudo update-initramfs -u
```

9. Final Verification

```
sudo mdadm --detail /dev/md127
```

```
cat /mnt/raid5/testfile.txt
```

- Confirm RAID is in a "clean" state.
- Ensure the test file remains intact and accessible.

-----Screenshots-----

1.

```
[suraj@vbox ~]$ su
Password:
su: Authentication failure
[suraj@vbox ~]$ su
Password:
su: Authentication failure
[suraj@vbox ~]$ su root
Password:
[root@vbox suraj]#
[root@vbox suraj]# lsblk
NAME                MAJ:MIN RM  SIZE RO TYPE MOUNTPOINTS
sda                  8:0      0   20G  0 disk
├─sda1                8:1      0    1G  0 part /boot
├─sda2                8:2      0   19G  0 part
│   └─cs_vbox-root    253:0     0    17G  0 lvm  /
└─cs_vbox-swap        253:1     0     2G  0 lvm  [SWAP]
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

[root@vbox suraj]# mdam --version
bash: mdam: command not found...
[root@vbox suraj]# madam --version
bash: madam: command not found...
[root@vbox suraj]# mdadam --version
bash: mdadam: command not found...
[root@vbox suraj]# yuminstall mdadm
bash: yuminstall: command not found...
[root@vbox suraj]# yum install mdadm
Last metadata expiration check: 0:30:58 ago on Thu 05 Dec 2024 12:23:11 IST.
Package mdadm-4.3-4.el9.x86_64 is already installed.
Dependencies resolved.
Nothing to do.
Complete!
[root@vbox suraj]# mdadam --version
bash: mdadam: command not found...
```

2.

```
[root@vbox suraj]# mdadm --version
bash: mdadm: command not found...
[root@vbox suraj]# mdadm -v
Usage: mdadm --help
      for help
[root@vbox suraj]# mdadm --version
mdadm - v4.3 - 2024-02-15 - 4
[root@vbox suraj]# mdadm --create --verbose /dev/md0 --level=5 --raid-devices=3 /dev/sdb /dev/sdc /dev/sdd --spare-devices=2 /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.
[root@vbox suraj]# mdadm --detail /dev/md0
/dev/md0:
    Version : 1.2
  Creation Time : Thu Dec  5 12:54:50 2024
    Raid Level : raid5
    Array Size : 20953088 (19.98 GiB 21.46 GB)
  Used Dev Size : 10476544 (9.99 GiB 10.73 GB)
    Raid Devices : 3
  Total Devices : 5
 Persistence : Superblock is persistent

    Update Time : Thu Dec  5 12:55:23 2024
      State : clean, degraded, recovering
 Active Devices : 2
Working Devices : 5
Failed Devices : 0
Spare Devices : 3

    Layout : left-symmetric
   Chunk Size : 512K

Consistency Policy : resync
```

3.

```
[root@vbox suraj]# mdadm --version
mdadm - v4.3 - 2024-02-15 - 4
[root@vbox suraj]# mdadm --create --verbose /dev/md0 --level=5 --raid-devices=3 /dev/sdb /dev/sdc /dev/sdd --spare-devices=2 /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.
[root@vbox suraj]# mdadm --detail /dev/md0
/dev/md0:
  Version : 1.2
  Creation Time : Thu Dec 5 12:54:50 2024
  Raid Level : raid5
  Array Size : 20953088 (19.98 GiB 21.46 GB)
  Used Dev Size : 10476544 (9.99 GiB 10.73 GB)
  Raid Devices : 3
  Total Devices : 5
  Persistence : Superblock is persistent

  Update Time : Thu Dec 5 12:55:23 2024
  State : clean, degraded, recovering
  Active Devices : 2
  Working Devices : 5
  Failed Devices : 0
  Spare Devices : 3

  Layout : left-symmetric
  Chunk Size : 512K

Consistency Policy : resync

Rebuild Status : 65% complete

    Name : vbox:0 (local to host vbox)
    UUID : f4bf5bf6:5f5cae3b:7bd4220c:04229575
    Events : 11

Number Major Minor RaidDevice State
  0       8      16        0 active sync  /dev/sdb
  1       8      32        1 active sync  /dev/sdc
  5       8      48        2 spare rebuilding /dev/sdd

  3       8      64        - spare /dev/sde
  4       8      80        - spare /dev/sdf
[root@vbox suraj]#
```

4.

```
Layout : left-symmetric
Chunk Size : 512K

Consistency Policy : resync

Rebuild Status : 65% complete

Name : vbox:0 (local to host vbox)
UUID : f4bf5bf6:5f5cae3b:7bd4220c:04229575
Events : 11

Number Major Minor RaidDevice State
0 8 16 0 active sync /dev/sdb
1 8 32 1 active sync /dev/sdc
5 8 48 2 spare rebuilding /dev/sdd

3 8 64 - spare /dev/sde
4 8 80 - spare /dev/sdf

[root@vbox suraj]# lsblk
NAME MAJ:MIN RM SIZE RO TYPE MOUNTPOINTS
sda 8:0 0 20G 0 disk
├─sda1 8:1 0 1G 0 part /boot
├─sda2 8:2 0 19G 0 part
│ └─cs_vbox-root 253:0 0 17G 0 lvm /
│ └─cs_vbox-swap 253:1 0 2G 0 lvm [SWAP]
sdb 8:16 0 10G 0 disk
└─md0 9:0 0 20G 0 raid5
sdc 8:32 0 10G 0 disk
└─md0 9:0 0 20G 0 raid5
sdd 8:48 0 10G 0 disk
└─md0 9:0 0 20G 0 raid5
sde 8:64 0 10G 0 disk
└─md0 9:0 0 20G 0 raid5
sdf 8:80 0 10G 0 disk
└─md0 9:0 0 20G 0 raid5
sr0 11:0 1 1024M 0 rom
```

5.

```
sdf                8:80    0   10G   0 disk
└─md0              9:0     0   20G   0 raid5
sr0               11:0     1 1024M   0 rom
[root@vbox suraj]# mdadm --detail /dev/md0
/dev/md0:
    Version : 1.2
  Creation Time : Thu Dec  5 12:54:50 2024
    Raid Level : raid5
    Array Size : 20953088 (19.98 GiB 21.46 GB)
  Used Dev Size : 10476544 (9.99 GiB 10.73 GB)
    Raid Devices : 3
    Total Devices : 5
 Persistence : Superblock is persistent

    Update Time : Thu Dec  5 12:55:43 2024
      State : clean
    Active Devices : 3
    Working Devices : 5
    Failed Devices : 0
    Spare Devices : 2

    Layout : left-symmetric
    Chunk Size : 512K

Consistency Policy : resync

    Name : vbox:0 (local to host vbox)
    UUID : f4bf5bf6:5f5cae3b:7bd4220c:04229575
    Events : 18

   Number   Major   Minor   RaidDevice State
    0         8       16         0     active sync  /dev/sdb
    1         8       32         1     active sync  /dev/sdc
    5         8       48         2     active sync  /dev/sdd

    3         8       64         -     spare  /dev/sde
    4         8       80         -     spare  /dev/sdf
[root@vbox suraj]#
```

6.

```
Consistency Policy : resync

      Name : vbox:0 (local to host vbox)
      UUID : f4bf5bf6:5f5cae3b:7bd4220c:04229575
      Events : 18

    Number  Major  Minor  RaidDevice State
      0       8     16        0  active sync  /dev/sdb
      1       8     32        1  active sync  /dev/sdc
      5       8     48        2  active sync  /dev/sdd

      3       8     64        -  spare      /dev/sde
      4       8     80        -  spare      /dev/sdf
[root@vbox suraj]# mkfs.ext4 /dev/md0
mke2fs 1.46.5 (30-Dec-2021)
Creating filesystem with 5238272 4k blocks and 1310720 inodes
Filesystem UUID: 0e83a98a-d9e5-4e09-b84b-b24cf16af152
Superblock backups stored on blocks:
    32768, 98304, 163840, 229376, 294912, 819200, 884736, 1605632, 2654208,
    4096000

Allocating group tables: done
Writing inode tables: done
Creating journal (32768 blocks): done
Writing superblocks and filesystem accounting information: done

[root@vbox suraj]# mkdir /mnt/raid5
[root@vbox suraj]# mount /dev/md0 /mnt/raid5
[root@vbox suraj]# df -h
Filesystem              Size  Used Avail Use% Mounted on
devtmpfs                 4.0M   0    4.0M   0% /dev
tmpfs                    2.2G   0    2.2G   0% /dev/shm
tmpfs                    884M   9.2M  875M   2% /run
/dev/mapper/cs_vbox-root 17G   5.7G   12G  34% /
/dev/sda1                960M  456M  505M  48% /boot
tmpfs                    442M  900K  442M   1% /run/user/1000
/dev/md0                 20G   24K   19G   1% /mnt/raid5
[root@vbox suraj]#
```


7.

```
[root@vbox suraj]# mdadm /dev/md0 --remove /dev/sdb1
mdadm: stat failed for /dev/sdb1: No such file or directory
[root@vbox suraj]# mdadm /dev/md0 --remove -f /dev/sdb
[root@vbox suraj]# lsblk
NAME                MAJ:MIN RM  SIZE RO TYPE  MOUNTPOINTS
sda                  8:0      0   20G  0 disk
├─sda1               8:1      0    1G  0 part  /boot
├─sda2               8:2      0   19G  0 part
│   └─cs_vbox-root 253:0      0   17G  0 lvm    /
│   └─cs_vbox-swap 253:1      0    2G  0 lvm    [SWAP]
sdb                  8:16     0   10G  0 disk
├─md0               9:0      0   20G  0 raid5 /mnt/raid5
sdc                  8:32     0   10G  0 disk
├─md0               9:0      0   20G  0 raid5 /mnt/raid5
sdd                  8:48     0   10G  0 disk
├─md0               9:0      0   20G  0 raid5 /mnt/raid5
sde                  8:64     0   10G  0 disk
├─md0               9:0      0   20G  0 raid5 /mnt/raid5
sdf                  8:80     0   10G  0 disk
├─md0               9:0      0   20G  0 raid5 /mnt/raid5
sr0                  11:0     1 1024M  0 rom

[root@vbox suraj]# mdadm --detail /dev/md0
/dev/md0:
    Version : 1.2
  Creation Time : Thu Dec  5 12:54:50 2024
    Raid Level : raid5
    Array Size : 20953088 (19.98 GiB 21.46 GB)
  Used Dev Size : 10476544 (9.99 GiB 10.73 GB)
    Raid Devices : 3
    Total Devices : 5
 Persistence : Superblock is persistent

    Update Time : Thu Dec  5 13:15:57 2024
      State : clean, degraded, recovering
    Active Devices : 2
    Working Devices : 4
    Failed Devices : 1
    Spare Devices : 2
```

8.

```
sr0          11:0      1 1024M  0 rom
[root@vbox suraj]# mdadm --detail /dev/md0
/dev/md0:
    Version : 1.2
  Creation Time : Thu Dec  5 12:54:50 2024
    Raid Level : raid5
    Array Size : 20953088 (19.98 GiB 21.46 GB)
  Used Dev Size : 10476544 (9.99 GiB 10.73 GB)
    Raid Devices : 3
    Total Devices : 5
 Persistence : Superblock is persistent

    Update Time : Thu Dec  5 13:15:57 2024
      State : clean, degraded, recovering
  Active Devices : 2
 Working Devices : 4
 Failed Devices : 1
  Spare Devices : 2

    Layout : left-symmetric
    Chunk Size : 512K

Consistency Policy : resync

    Rebuild Status : 95% complete

        Name : vbox:0 (local to host vbox)
        UUID : f4bf5bf6:5f5cae3b:7bd4220c:04229575
        Events : 35

   Number  Major   Minor   RaidDevice State
     4         8       80           0  spare rebuilding   /dev/sdf
     1         8       32           1  active sync        /dev/sdc
     5         8       48           2  active sync        /dev/sdd

     0         8       16           -  faulty             /dev/sdb
     3         8       64           -  spare              /dev/sde
[root@vbox suraj]#
```

9.

```
└md127      9:127 0 20G 0 raid5
sdd          8:48 0 10G 0 disk
└md127      9:127 0 20G 0 raid5
sde          8:64 0 10G 0 disk
└md127      9:127 0 20G 0 raid5
sdf          8:80 0 10G 0 disk
└md127      9:127 0 20G 0 raid5
sr0          11:0 1 1024M 0 rom
[root@vbox suraj]# mdadm --detail /dev/md0
mdadm: cannot open /dev/md0: No such file or directory
[root@vbox suraj]# mdadm --detail /dev/md127
mdadm: cannot open /dev/md127: No such file or directory
[root@vbox suraj]# mdadm --detail /dev/md127
/dev/md127:
    Version : 1.2
  Creation Time : Thu Dec 5 12:54:50 2024
    Raid Level : raid5
    Array Size : 20953088 (19.98 GiB 21.46 GB)
  Used Dev Size : 10476544 (9.99 GiB 10.73 GB)
    Raid Devices : 3
    Total Devices : 4
  Persistence : Superblock is persistent

    Update Time : Thu Dec 5 13:17:02 2024
      State : clean
    Active Devices : 3
    Working Devices : 4
    Failed Devices : 0
    Spare Devices : 1


    Layout : left-symmetric
    Chunk Size : 512K

Consistency Policy : resync

    Name : vbox:0 (local to host vbox)
    UUID : f4bf5bf6:5f5cae3b:7bd4220c:04229575
    Events : 38

   Number   Major   Minor   RaidDevice State
     4         8       80         0   active sync   /dev/sdf
     1         8       32         1   active sync   /dev/sdc
     5         8       48         2   active sync   /dev/sdd
           3         8       64         -    spare       /dev/sde
[root@vbox suraj]#
```

10.

```
Activities Terminal 5 D
suraj@vbox:/home/suraj
mdadm: cannot open /dev/md127: No such file or directory
[root@vbox suraj]# mdadm --detail /dev/md127
/dev/md127:
    Version : 1.2
    Creation Time : Thu Dec  5 12:54:50 2024
    Raid Level : raid5
    Array Size : 20953088 (19.98 GiB 21.46 GB)
    Used Dev Size : 10476544 (9.99 GiB 10.73 GB)
    Raid Devices : 3
    Total Devices : 4
    Persistence : Superblock is persistent

    Update Time : Thu Dec  5 13:17:02 2024
    State : clean
    Active Devices : 3
    Working Devices : 4
    Failed Devices : 0
    Spare Devices : 1

    Layout : left-symmetric
    Chunk Size : 512K

Consistency Policy : resync

    Name : vbox:0 (local to host vbox)
    UUID : f4bf5bf6:5f5cae3b:7bd4220c:04229575
    Events : 38

    Number Major Minor RaidDevice State
       4      8     80        0  active sync  /dev/sdf
       1      8     32        1  active sync  /dev/sdc
       5      8     48        2  active sync  /dev/sdd

       3      8     64        -    spare  /dev/sde
[root@vbox suraj]# mdadm /dev/md127 --add /dev/sdb
mdadm: added /dev/sdb
[root@vbox suraj]#
[root@vbox suraj]#
[root@vbox suraj]#
[root@vbox suraj]#
[root@vbox suraj]#
[root@vbox suraj]#
```

11.

```
Activities Terminal 5 Dec
suraj@vbox:/home/suraj
[root@vbox suraj]#
[root@vbox suraj]#
[root@vbox suraj]#
[root@vbox suraj]#
[root@vbox suraj]#
[root@vbox suraj]#
[root@vbox suraj]#
[root@vbox suraj]# mdadm --detail /dev/md127
/dev/md127:
    Version : 1.2
    Creation Time : Thu Dec  5 12:54:50 2024
    Raid Level : raid5
    Array Size : 20953088 (19.98 GiB 21.46 GB)
    Used Dev Size : 10476544 (9.99 GiB 10.73 GB)
    Raid Devices : 3
    Total Devices : 5
    Persistence : Superblock is persistent

    Update Time : Thu Dec  5 13:23:20 2024
    State : clean
    Active Devices : 3
    Working Devices : 5
    Failed Devices : 0
    Spare Devices : 2

    Layout : left-symmetric
    Chunk Size : 512K

Consistency Policy : resync

    Name : vbox:0 (local to host vbox)
    UUID : f4bf5bf6:5f5cae3b:7bd4220c:04229575
    Events : 39

    Number Major Minor RaidDevice State
    4      8     80        0    active sync  /dev/sdf
    1      8     32        1    active sync  /dev/sdc
    5      8     48        2    active sync  /dev/sdd

    3      8     64        -    spare      /dev/sde
    6      8     16        -    spare      /dev/sdb
[root@vbox suraj]#
```

