

# **RAID 5:**

## **What is RAID 5 (Striping with Distributed Parity)?**

- **Definition:** RAID 5 Splits(Stripes) data across three or more disks with **parity information** distributed among the disks. Parity allows data recovery if one disk fails.
- **Purpose:** Offers a **balance of performance, storage efficiency, and fault tolerance**.
- **Tradeoff:** Can only tolerate **one disk failure**. Rebuild time can be long, and write performance is slightly lower than RAID 0 due to parity calculation.

## **Why RAID 5?**

- **Efficient Redundancy:** Unlike RAID 1, you get usable capacity of  $(N - 1)$  disks (e.g., **3x1TB = 2TB usable**), while still protecting against a single disk failure.
- **Balanced Performance:**
  - **Reads:** Fast, like RAID 0 – data is striped.
  - **Writes:** Slightly slower than RAID 0 – parity must be calculated and written.
- **Fault Tolerance:**
  - If **one disk fails**, the array can still operate.
  - **Parity data** allows full recovery of the lost disk's data.
- **Cost-Effective:** More storage efficiency than mirroring, ideal for file servers and read-intensive systems.

To configure **RAID 5 (Striping with Distributed Parity)** on Linux:

1. LVM (Logical Volume Manager)
2. MDADM (Multiple Device Administration)

## **RAID 5 Striping with Parity using LVM – Full Workflow**

### **Step 1: Add New Disks & Initialize as PVs**

After attaching your disks (e.g., `/dev/sdb`, `/dev/sdc`, `/dev/sdd`), convert them into **LVM Physical Volumes**.

**Command:** `pvcreate /dev/sdb /dev/sdc /dev/sdd`

```
root@localhost:~  
[root@localhost ~]# lsblk | grep -E 'sdb|sdc|sdd'  
sdb      8:16    0     3G  0 disk  
sdc      8:32    0     3G  0 disk  
sdd      8:48    0     3G  0 disk  
[root@localhost ~]#  
[root@localhost ~]# pvcreate /dev/sdb /dev/sdc /dev/sdd  
Physical volume "/dev/sdb" successfully created.  
Physical volume "/dev/sdc" successfully created.  
Physical volume "/dev/sdd" successfully created.  
[root@localhost ~]#
```

### **Explanation:**

This command initializes the raw disks and marks them as **LVM-compatible physical volumes (PVs)**. LVM cannot use disks unless they are first converted to PVs. This is the foundation for building a volume group.

Check with:


 root@localhost:~

```
[root@localhost ~]# pvs
  PV          VG   Fmt  Attr  PSize  PFree
  /dev/sda3   rhel lvm2  a--   18.41g    0
  /dev/sdb           lvm2  ---    3.00g   3.00g
  /dev/sdc           lvm2  ---    3.00g   3.00g
  /dev/sdd           lvm2  ---    3.00g   3.00g
[root@localhost ~]# █
```

## Step 2: Create a Volume Group (VG)

Create a **Volume Group (VG)** that includes the three physical volumes

**Command:** `vgcreate raidvg /dev/sdb /dev/sdc /dev/sdd`

 root@localhost:~

```
[root@localhost ~]# vgcreate raidvg /dev/sdb /dev/sdc /dev/sdd
Volume group "raidvg" successfully created
[root@localhost ~]#
[root@localhost ~]# vgs raidvg
  VG      #PV #LV #SN Attr   VSize  VFree
  raidvg   3   0   0 wz--n- <8.99g <8.99g
[root@localhost ~]# █
```

## Explanation:

This creates a Volume Group named **raidvg** using the three physical volumes

## Step 3: Create a RAID 5 Logical Volume

To stripe across the 3 PVs:

**Command:** `lvcreate -L 5G --type raid5 -i 2 -n raidlv raidvg`

```

root@localhost:~
[root@localhost ~]# lvcreate -L 5G --type raid5 -i 2 -n raidlv raidvg
Using default stripesize 64.00 KiB.
Logical volume "raidlv" created.
[root@localhost ~]#
[root@localhost ~]# lvdisplay /dev/raidvg/raidlv
--- Logical volume ---
LV Path                /dev/raidvg/raidlv
LV Name                raidlv
VG Name                raidvg
LV UUID                eykvvR-jHGt-S8ef-7et6-8y19-z8Zb-EqKUQs
LV Write Access        read/write
LV Creation host, time localhost.localdomain, 2025-07-08 14:18:00 +0530
LV Status              available
# open                 0
LV Size                5.00 GiB
Current LE             1280
Segments               1
Allocation             inherit
Read ahead sectors     auto
- currently set to    8192
Block device           253:8

[root@localhost ~]#

```

- **lvcreate**  
This is the LVM command used to create a new logical volume.
- **-L 5G**  
This specifies the size of the logical volume you want to create — in this case, 5 gigabytes
- **--type raid5**
  - You're telling LVM to create the logical volume using a **RAID 5 layout**.
  - RAID 5 uses **striping with distributed parity**, meaning it splits data across multiple disks and adds parity for fault tolerance.
  - RAID 5 can tolerate **one disk failure**
- **-i 2**
  - **-i** stands for number of data stripes.
  - In RAID 5, the total number of disks used = **data stripes (-i) + 1 (for parity)**.
  - So **-i 2** → 2 data devices + 1 parity device = **3 physical volumes**
  - If you had 4 disks, you could use **-i 3** (3 data + 1 parity)

- **raidvg**
  - This is the name of the **Volume Group (VG)** in which the logical volume will be created.
  - This VG should be created from **3 physical volumes (disks)**, each at least 3 GB in size

Check with:

Command:

**lvs raidvg/raidlv**

**lvs -a -o +devices**

**lvs -a -o +segtype,devices raidvg/raidlv**

**lvs -a -o lv\_name,vg\_name,devices raidvg/raidlv**

**lvs --segment -o+segtype,stripes,devices raidvg/raidlv**

**lvdisplay -m /dev/raidvg/raidlv**

```

root@localhost:~# lvs raidvg/raidlv
LV      VG      Attr      LSize Pool Origin Data%  Meta%  Move Log Cpy%Sync Convert
raidlv  raidvg  rwi-a-r--- 5.00g                               100.00
root@localhost:~#
root@localhost:~# lvs -a -o +segtype,devices raidvg/raidlv
LV      VG      Attr      LSize Pool Origin Data%  Meta%  Move Log Cpy%Sync Convert Type  Devices
raidlv  raidvg  rwi-a-r--- 5.00g                               100.00                               raid5 raidlv_rimage_0(0),raidlv_r
image_1(0),raidlv_rimage_2(0)
root@localhost:~#
root@localhost:~# lvs -a -o lv_name,vg_name,devices raidvg/raidlv
LV      VG      Devices
raidlv  raidvg  raidlv_rimage_0(0),raidlv_rimage_1(0),raidlv_rimage_2(0)
root@localhost:~#
root@localhost:~# lvs --segment -o+segtype,stripes,devices raidvg/raidlv
LV      VG      Attr      #Str Type  SSize Type  #Str Devices
raidlv  raidvg  rwi-a-r---   3 raid5 5.00g raid5   3 raidlv_rimage_0(0),raidlv_rimage_1(0),raidlv_rimage_2(0)
root@localhost:~#

```

- **lvs**: Shows info about your Logical Volumes (LVs).
- **-a**: Includes all parts—like hidden mirror segments—not just the main logical volume.
- **-o lv\_name,vg\_name,devices**: Only shows these three pieces of info:

- **lv\_name**: The volume's name (e.g., **raidlv**)
- **vg\_name**: The group it belongs to (e.g., **raidvg**)
- **devices**: The actual disk parts storing the LV (like the mirrored copies)
- created a RAID 5 logical volume (**raidlv**) with **-i 2** (2 data stripes), which means 3 devices total: 2 data, 1 parity
- LVM creates **internal sub-volumes**:
  - **rimage\_0** → data stripe 1
  - **rimage\_1** → data stripe 2
  - **rimage\_2** → parity stripe
- The **(0)** indicates each is ACTIVE and online.

## Step 4: Format & Mount the LV

Commands:

**mkfs.xfs /dev/raidvg/raidlv**

**mkdir /data3**

**mount /dev/raidvg/raidlv /data2**

**df -h /data3**

root@localhost:~

```
[root@localhost ~]# mkfs.xfs /dev/raidvg/raidlv
meta-data=/dev/raidvg/raidlv      isize=512    agcount=8, agsize=163824 blks
      =                               sectsz=512    attr=2, projid32bit=1
      =                               crc=1        finobt=1, sparse=1, rmapbt=0
      =                               reflink=1     bigtime=1 inobtcount=1 nrext64=0
data      =                               bsize=4096   blocks=1310592, imaxpct=25
      =                               sunit=16     swidth=32 blks
naming    =version 2                 bsize=4096   ascii-ci=0, ftype=1
log        =internal log             bsize=4096   blocks=16384, version=2
      =                               sectsz=512    sunit=16 blks, lazy-count=1
realtime  =none                      extsz=4096   blocks=0, rtextents=0
[root@localhost ~]#
[root@localhost ~]# blkid /dev/raidvg/raidlv
/dev/raidvg/raidlv: UUID="87527f08-ae5b-48b8-bf3f-8d25884ca38d" TYPE="xfs"
[root@localhost ~]#
```

root@localhost:~

```
[root@localhost ~]# mkdir /data3
[root@localhost ~]# mount /dev/raidvg/raidlv /data3
[root@localhost ~]# df -h /data3
Filesystem                Size      Used Avail Use% Mounted on
/dev/mapper/raidvg-raidlv  5.0G      68M    4.9G   2% /data3
[root@localhost ~]#
```

## Step 5: Persist the Mount in /etc/fstab

Ensure it auto-mounts after reboot:

Command:

**vi /etc/fstab**

**cat /etc/fstab | grep -i /data3**

**mount | grep /data3**

root@localhost:~

```
[root@localhost ~]# vi /etc/fstab
[root@localhost ~]# cat /etc/fstab | grep -i /data3
/dev/raidvg/raidlv      /data3  xfs     defaults      0 0
[root@localhost ~]# mount | grep /data3
/dev/mapper/raidvg-raidlv on /data3 type xfs (rw,relatime,seclabel,attr2,inode64,logbufs=8,logbsize=64k,sunit=128,swid
th=256,noquota)
[root@localhost ~]#
```

```
[root@localhost ~]# lsblk /dev/sdb /dev/sdc /dev/sdd
NAME                                MAJ:MIN RM  SIZE RO TYPE MOUNTPOINTS
sdb                                8:16   0    3G  0 disk
├─raidvg-raidlv_rmeta_0            253:2   0    4M  0 lvm
│ └─raidvg-raidlv                  253:8   0    5G  0 lvm  /data3
└─raidvg-raidlv_rimage_0           253:3   0   2.5G  0 lvm
   └─raidvg-raidlv                  253:8   0    5G  0 lvm  /data3
sdc                                8:32   0    3G  0 disk
├─raidvg-raidlv_rmeta_1            253:4   0    4M  0 lvm
│ └─raidvg-raidlv                  253:8   0    5G  0 lvm  /data3
└─raidvg-raidlv_rimage_1           253:5   0   2.5G  0 lvm
   └─raidvg-raidlv                  253:8   0    5G  0 lvm  /data3
sdd                                8:48   0    3G  0 disk
├─raidvg-raidlv_rmeta_2            253:6   0    4M  0 lvm
│ └─raidvg-raidlv                  253:8   0    5G  0 lvm  /data3
└─raidvg-raidlv_rimage_2           253:7   0   2.5G  0 lvm
   └─raidvg-raidlv                  253:8   0    5G  0 lvm  /data3
```

## **Final Notes:**

- **RAID 5 with LVM provides data redundancy and performance without sacrificing too much usable space.**
- **It can tolerate one disk failure and still function.**
- **Write speed is slightly reduced due to parity calculation, but read speed is good.**
- **It's a flexible and modern approach, combining LVM's manageability with RAID's reliability.**