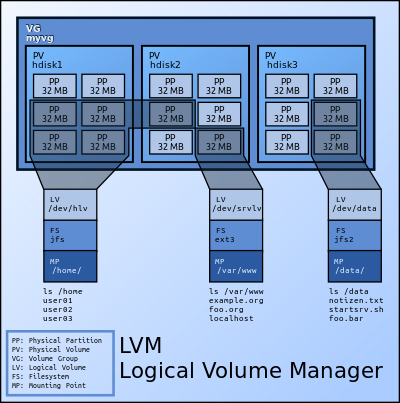
**LOGICAL VOLUME MANAGER (LVM)**

Logical Volume Manager (LVM) is a device mapper framework that provides logical volume management for the Linux kernel. Most modern Linux distributions are LVM-aware to the point of being able to have their root file systems on a logical volume.

**Uses:**

LVM is used for the following purposes:

* Creating single logical volumes of multiple physical volumes or entire hard disks, allowing for dynamic volume resizing.
* Managing large hard disk farms by allowing disks to be added and replaced without downtime or service disruption, in combination with hot swapping.
* On small systems, instead of having to estimate at installation time how big a partition might need to be, LVM allows filesystems to be easily resized as needed.
* Performing consistent backups by taking snapshots of the logical volumes.
* Encrypting multiple physical partitions with one password.



**Key Components:**

1. Physical Volumes (PV): These are the physical storage devices like hard drives or partitions. LVM combines one or more physical volumes into volume groups.
2. Volume Groups (VG): A Volume Group is a collection of physical volumes. Logical volumes are created within volume groups. You can add or remove physical volumes from a volume group dynamically.
3. Logical Volumes (LV): Logical volumes are similar to partitions but have more flexibility. They are created within volume groups and can be resized without requiring changes to the file system.
4. Extents: LVM divides physical volumes into small chunks called extents. Logical volumes are created using these extents. Extents provide a level of abstraction and flexibility when allocating and managing storage.

**LVM RAID 0:**

LVM RAID 0 (striping) is a method of combining multiple physical storage devices into a single logical volume with the goal of improving performance by distributing data across the devices.

**How LVM RAID 0 works:**

1. **Striping –** In RAID 0, data is divided into blocks, and these blocks are written across the multiple physical volumes (PVs) in a round-robin fashion. This striping of data across multiple disks allows for parallel read and write operations, potentially improving overall I/O performance.
2. **No Redundancy** – Unlike other RAID levels such as RAID 1 or RAID5, RAID 0 does not provide redundancy or fault tolerance. If one physical volume fails, the entire RAID 0 setup is compromised and data may be lost. As a result, RAID 0 is considered a high-performance but risky configuration.
3. **Capacity** – The total capacity of the RAID 0 logical volume is the sum of the capabilities of all the physical volumes involved.

**LVM RAID 1:**

LVM RAID 1 as mirroring is a method of creating a redundant storage setup by duplicating data across multiple physical storage devices. In RAID, if one drive fails, the data can still be retrieved from the mirrored copy on the other drive. This provides a level of fault tolerance and data protection.

**How LVM RAID 1 works:**

1. **Mirroring –** In RAID 1, data is duplicated on two or more physical volumes (PVs). Each block of data is written to both PVs, creating an identical copy on each. This redundancy ensures that if one PV fails, the data is still accessible from the mirror.
2. **Fault Tolerance –** RAID 1 provides a higher level of fault tolerance compared to RAID 0. If one drive fails, the system can continue to operate using the data from the remaining drive(s). Once the failed drive is replaced, the RAID array can be rebuilt.
3. **Capacity –** The total capacity of the RAID 1 logical volume is equal to the capacity of the smallest physical volume involved. This is because every piece of data is duplicated, so the usable space is effectively halved.

**Comparison:**

**Performance:**

* RAID 0 offers higher performance due to parallel I/O operations.
* RAID 1 may have slightly lower write performance but provides redundancy.

**Redundancy:**

* RAID 0 provides no redundancy; data loss occurs if any disk fails.
* RAID 1 provides redundancy; data remains accessible even if one disk fails.

**Capacity:**

* RAID 0 has a capacity equal to the sum of individual capacities.
* RAID 1 has a total capacity equal to the capacity of the smallest PV.

**Use case:**

* RAID 0 is suitable for scenarios prioritizing high performance with an acceptable risk of data loss.
* RAID 1 is suitable for scenarios where data integrity and availability are critical, and the cost of storage redundancy is justified.

**LVM RAID 5:**

RAID 5 consists of block-level striping with distributed parity. It requires that all drives but one be present to operate. Upon a failure of a single drive, subsequent reads can be calculated from the distributed parity such that no data is lost. RAID 5 requires at least three disks.

* RAID 5 uses block-level striping, similar to RAID 0, for distributing data across multiple drives.
* It also incorporates distributed parity, which means that parity information is distributed across all drives in the array.
* Parity is a mathematical function used for error checking and data recovery.
* Data is striped across multiple drives for improved performance
* Each block of data has its parity block distributed across all drives.

**LVM RAID 6:**

RAID 6 extends RAID 5 by adding another parity block; thus it uses block-level striping with two parity blocks distributed across all member disks. RAID 6 is a standard RAID level that provides a high level of fault tolerance by using double parity.

* RAID 6 uses block-level striping, similar to RAID 5, for distributing data across multiple drives.
* It employs double parity, meaning that two separate sets of parity information are used to provide fault tolerance.
* Like RAID 5, RAID 6 uses distributed parity with each block of data having its parity blocks spread across all drives.
* The total capacity of the RAID 6 logical volume is the sum of the capabilities of all but two of the physical volumes.
* Similar to RAID 5, RAID 6 may have slower write performance compared to RAID 0 or RAID 1 due to parity calculations.

**RAID 6 vs RAID 5:**

1. **Fault Tolerance:**

* RAID 6 provides higher fault tolerance than RAID 5, as it can withstand the failure of up to two drives.
* RAID 5 can only tolerate the failure of one drive.

1. **Capacity:**

* The usable capacity of RAID 6 is less than RAID 5 because two drives are dedicated to parity.
* RAID 5 has a higher usable capacity as it only requires one drive for parity.

1. **Performance:**

* Both RAID 5 and RAID may experience slower write performance compared to RAID 0 due to parity calculations.
* RAID 6 generally has slightly lower write performance than RAID 5 die to the additional parity information.

1. **Use Cases:**

* RAID 6 is suitable for scenarios where a high level of fault tolerance is required, and sacrificing some capacity and write performance is acceptable.
* RAID 5 is suitable for situations where fault tolerance is important but sacrificing some capacity for higher performance is acceptable.