# 1. What is RAID

RAID (Redundant Array of Independent/Inexpensive Disks) is a data storage virtualization technology that combines multiple physical hard drives or SSDs into a single logical unit to improve performance, redundancy, or both. Even though multiple drives are used, the operating system sees them as one logical drive.

# 2. Software and Hardware RAID

RAID (Redundant Array of Independent Disks) can be implemented using either software or hardware. Software RAID is managed by the operating system without additional hardware, making it cost-effective but slightly slower. Hardware RAID, on the other hand, uses a dedicated RAID controller for better performance and reliability.

Both methods support common RAID levels like RAID 0, RAID 1, RAID 5, and RAID 10, but hardware RAID is preferred for enterprise and high-performance applications due to its efficiency and advanced features like hot-swapping (The ability to replace or add hard drives **without shutting down** the system, no downtime) and battery-backed cache.

# 3. Types of RAIDs

## 3.1. RAID 0 (Stripping) – High Speed, No Redundancy

**Purpose**: Improves performance by splitting (striping) data across multiple drives.

**Minimum Drives**: 2

**Performance**: Fastest because data is split across disks.

**Fault Tolerance**: None – If one drive fails, all data is lost.

**Best For**: Gaming, video editing, and applications needing high speed but no redundancy.

**Example**:

If you have two 1TB drives in RAID 0, your system sees 2TB of total space, but if one drive fails, everything is lost.

If you save "**HELLO RAID**", and the system breaks it into 4-character stripes, it would be stored like this:

"__" (underscores represent empty space to align data)

| **Drive 1** | **Drive 2** |
|---|---|
| H E L | L O |
| R A I | D _ |

## 3.2. RAID 1 (Mirroring) – Data Safety, No Speed Boost

**Purpose**: Provides data redundancy by keeping identical copies of data on two drives.
**Minimum Drives**: 2
**Performance**: Read speed improves, but write speed is the same as a single drive.
**Fault Tolerance**: High – If one drive fails, data is safe on the other.
**Best For**: Critical data storage (e.g., accounting, databases, and backups).
**Example**:
If you have two 1TB drives in RAID 1, your system sees only 1TB of usable space (the second drive is a mirror copy).

| Drive 1 | Drive 2 (Mirror of Drive 1) |
|---|---|
| H E L | H E L |
| L O | L O |
| R A I | R A I |
| D _ | D _ |

## 3.3. RAID 5 (Striping with Parity) – Balanced Speed and Redundancy

**Purpose**: Provides both performance and redundancy by striping data across drives and adding parity (error correction).
**Minimum Drives**: 3
**Performance**: Good read speed, slower write speed due to parity calculations
**Fault Tolerance**: Can survive one drive failure.
**Best For**: Business storage, file servers, and general-purpose storage.
**Example**:
With three 1TB drives in RAID 5, you get 2TB of usable space (1TB is used for parity). If one drive fails, the system can rebuild the lost data.

| Drive 1 | Drive 2 | Drive 3 (Parity) |
|---|---|---|
| H E _ | L O _ | H ⊕ L (Parity) |
| R A _ | I D _ | R ⊕ I (Parity) |

### 3.4. RAID 10 (1+0, Mirroring + Striping) – Best Performance + Redundancy

**Purpose**: Combines RAID 1 (mirroring) and RAID 0 (striping) for both speed and fault tolerance.

**Minimum Drives**: 4

**Performance**: Fast read/write speeds and high redundancy.

**Fault Tolerance**: Can survive multiple drive failures (as long as one drive from each mirrored pair is working).

**Best For**: High-performance applications (e.g., databases, web servers).

**Example**:

With four 1TB drives in RAID 10, your system sees 2TB of usable space (because half is used for mirroring).

If you save "**HELLO RAID**", and the system breaks it into 4-character stripes, it would be stored like this:

| **Drive 1** (Mirror A) | **Drive 2** (Mirror A, Copy of Drive 1) | **Drive 3** (Mirror B) | **Drive 4** (Mirror B, Copy of Drive 3) |
|---|---|---|---|
| HELL | HELL | O RA | O RA |
| ID__ | ID__ | (Next data) | (Next data) |