Operating Systems

Course Code: **71203002004**

Physical File System

by -

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Physical File System View

- Refers to how data is actually stored on storage devices (disk, tape, SSD).
- Deals with the physical organization of bytes, blocks, and sectors.
- Defines record formats, how records are arranged, and storage allocation.

- **Key Characteristics:**
  - Occupies real memory/disk space.
  - Contains the actual data.
  - One record format per physical file.
  - Can exist without a logical file.
  - Uses commands like CRTPF (on IBM systems).

Example: A physical file storing employee records, each record containing fields like ID, name, and salary.

Physical View vs Logical View

Aspect	Physical File	Logical File
Storage	Occupies actual disk/memory	No storage; contains no data
Content	Original data	View/description of physical data
Record Format	Single	Multiple (up to 32)
Existence	Independent	Depends on physical file
Deletion	Physical file cannot be deleted if logical file exists	Logical file can be deleted without deleting physical file
Purpose	Store data	Provide flexible views/access paths

Physical File System

Definition:

The **physical file system** is the lowest layer of a file system that directly manages how data is stored and retrieved on physical storage devices like HDDs, SSDs, or CDs.

Role:

- It communicates with the hardware (disk controllers, storage media).
- Divides the disk into **sectors, blocks, and clusters** for storing files.
- Maps higher-level logical file system operations (like opening or saving a file) into low-level read/write commands to the hardware.
- Ensures data is placed efficiently on the disk and manages space allocation and retrieval.

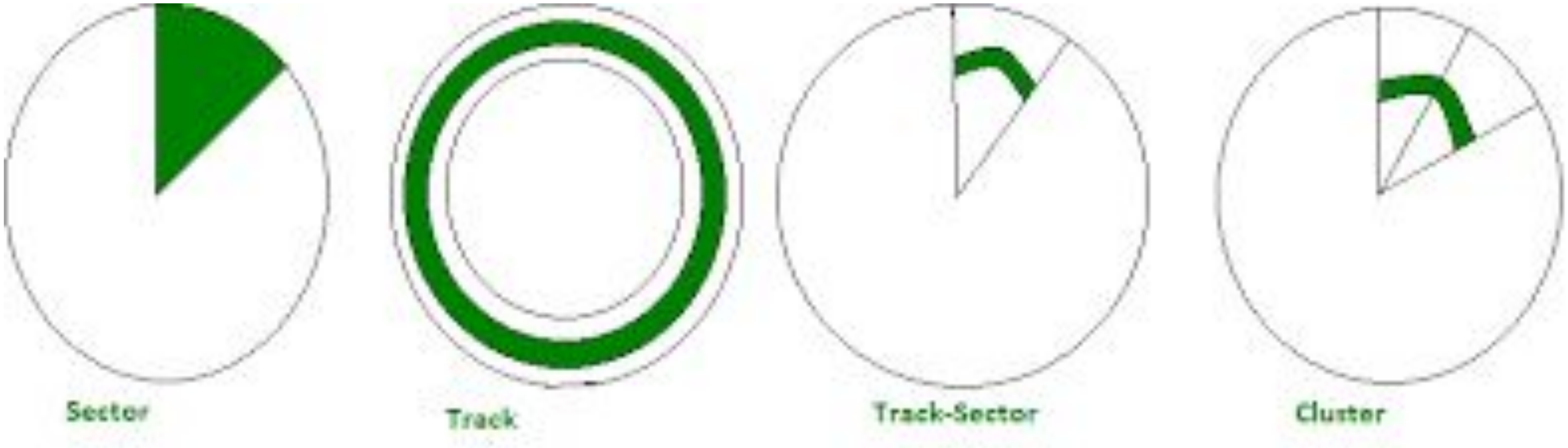
Blocks, Sectors, and Clusters

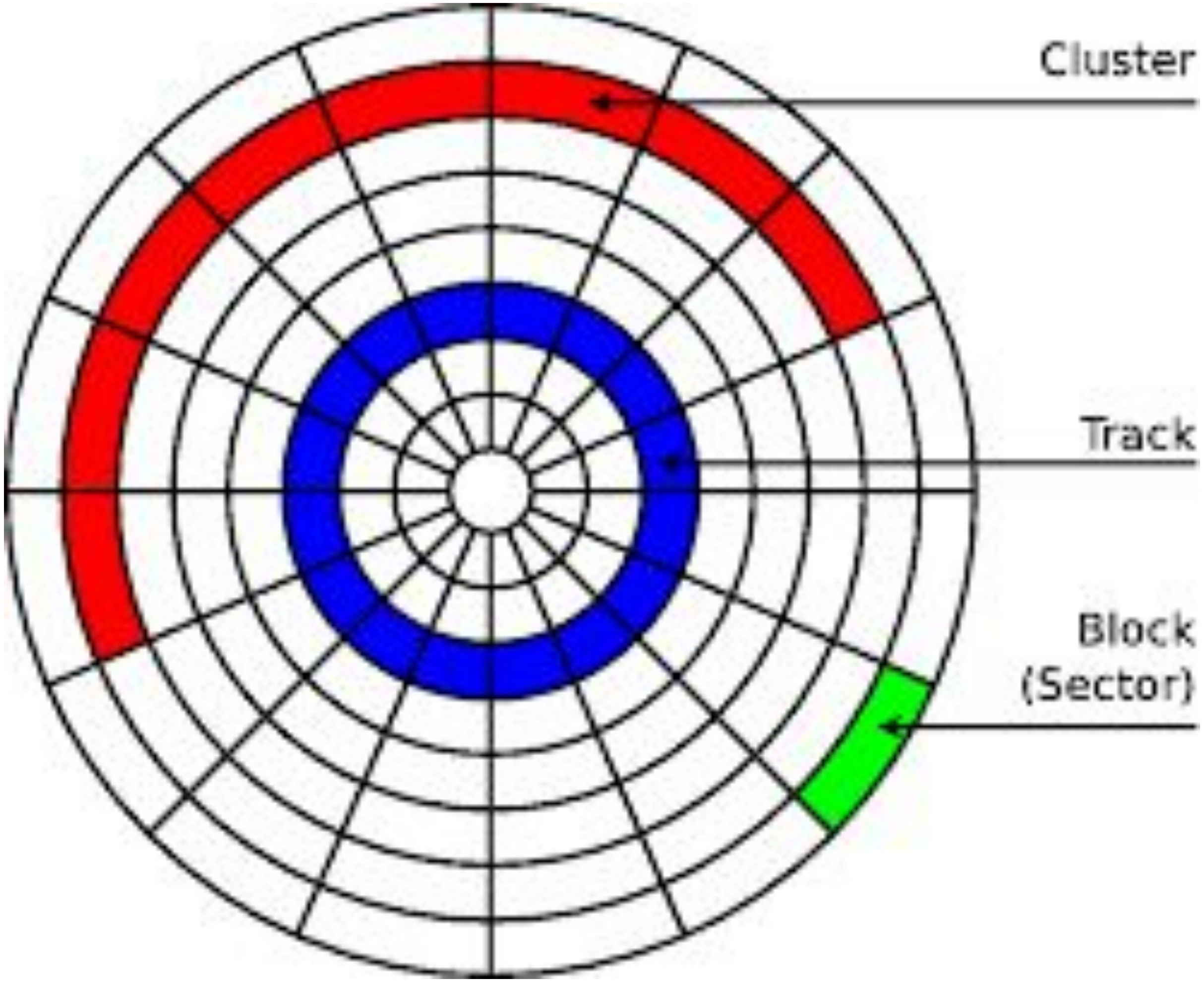
Sector

- The smallest unit of storage on a disk.
- Typically **512 bytes or 4096 bytes** in size.
- It’s the physical division created on the disk surface.

Block

- A logical unit of storage used by the operating system.
- Formed by grouping one or more sectors together.
- The OS reads/writes data in blocks instead of single sectors for efficiency.


Sector
Track
Track-Sector
Cluster


Cluster
Track
Block
(Sector)

Blocks, Sectors, and Clusters…

Cluster

- A group of contiguous blocks treated as a single unit by the file system.
- Used to reduce overhead and speed up access.
- Example: If a cluster is 4 KB and a file is 6 KB, it will occupy 2 clusters (8 KB total).

Summary:

- **Sector** = physical smallest unit.
- **Block** = logical unit OS uses.
- **Cluster** = group of blocks for efficient file storage.

File System Layers & Logical → Physical Mapping

Layered File System:
A file system is organized in **layers**, each handling specific tasks, which allows the operating system to translate user requests into actual disk operations.

Key Layers:

1. **Application/User Layer** – Where programs request file operations (open, read, write).
2. **Logical File System (LFS) Layer** – Manages file metadata, directories, and file access permissions.
3. **Physical File System (PFS) Layer** – Converts logical file operations into low-level commands for the hardware.
4. **Storage Device Layer** – Actual physical devices (HDD, SSD) perform the read/write operations.

File System Layers & Logical → Physical Mapping…

Logical → Physical Mapping:

- The system takes a logical file address (like a filename or block in a file) and translates it into a physical location on the disk (sector, block, cluster).
- Example: User requests file.txt → read block 3 → OS maps it to Cylinder 5, Sector 12 on HDD.
- This ensures abstraction, so users don’t need to know the underlying hardware details.

Key Layers of a File System

- **Application Layer (User Interface)** – User or application interacts with the file system using commands like open(), read(), write().
- **Logical File System (Metadata Management)** – Manages file names, directories, permissions, timestamps, and enforces access control.
- **File Organization Module (Logical Block Mapping)** – Converts files into logical blocks and allocates disk space efficiently (contiguous, linked, or indexed).
- **Basic File System (Storage Interface)** – Bridges logical operations to physical storage; manages block-level I/O and caching.
- **I/O Control Layer (Device Driver)** – Converts generic block commands into device-specific instructions; interacts with drivers for optimization.
- **Physical Storage Layer (Hardware)** – Actual storage devices (HDD, SSD, USB) with disk controllers, flash cells, or platters; handles error correction and recovery.

Key Layers of a File System

Logical → Physical Mapping:

- Each higher-level layer abstracts complexity for the layer above.
- User sees logical files; the OS maps these into **blocks** → **sectors** → **physical addresses** on the storage device.
- Example: Reading file.txt → Logical block 2 → Physical sector 18 on HDD.

DISCUSSION & REVISION

1. What is the smallest unit of storage on a disk?
2. Which file provides a view or description of physical data?
3. Which unit is formed by grouping one or more sectors?
4. Which file type actually occupies disk/memory?
5. What is a group of contiguous blocks called?

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