CS343 - Operating Systems

Module-5A

Secondary Storage Systems Management

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Disk Storage Systems Management

❖ Disk Organization & Structure

❖ Storage Characteristics

❖ Disk Management

❖ Disk Scheduling

❖ Disk Attachment

❖ RAID Structure

❖ Swap-Space Management

Objectives

❖ To describe the physical structure of secondary storage devices and its effects on the uses of the devices

❖ To explain the performance characteristics of mass-storage devices

❖ To evaluate disk scheduling algorithms

❖ To discuss operating-system services provided for mass storage, including RAID

❖ Systems today need to store many terabytes of data.

❖ Primary level of permanent storage is hard disk.

❖ Electromechanical

  ❖ Rotating disks

  ❖ Arm assembly

❖ Electronics

  ❖ Disk controller

  ❖ Cache

  ❖ Interface controller
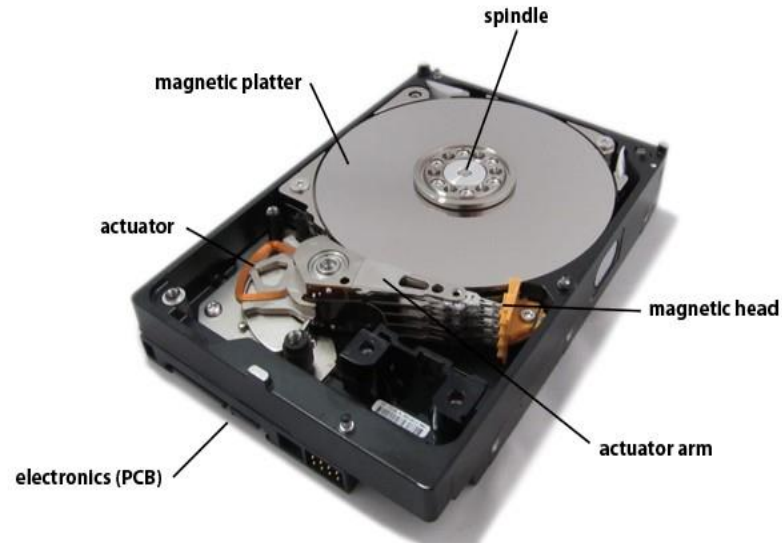
Hard Disk Drive Organization

❖ Hard disk drive consists of spinning disks with heads that move over the disks and store data in tracks and sectors.

❖ The heads read and write data in concentric rings called tracks.

❖ Tracks are divided into sectors, which normally store 512 bytes each.
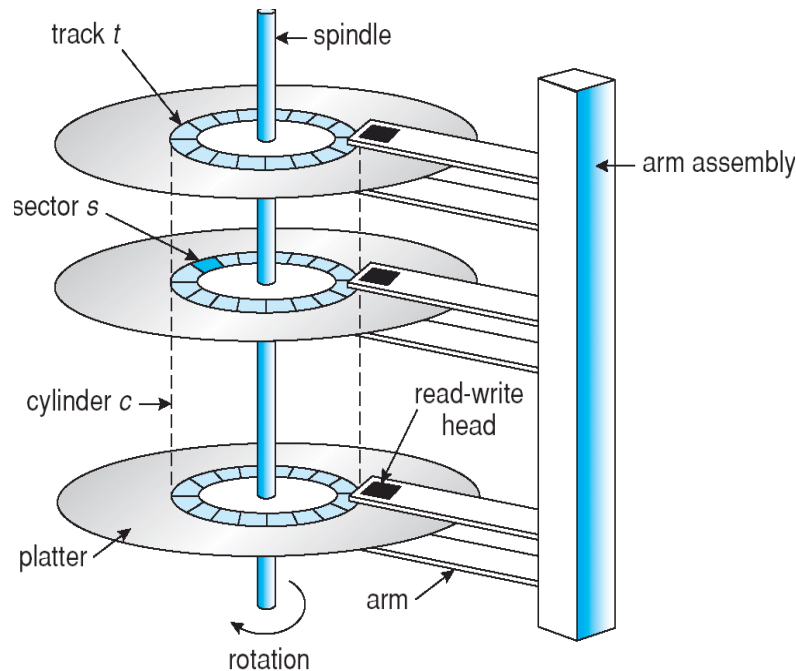
Hard Disk Drive Organization

❖ Platter diameters: 3.7", 3.3", 2.6"

❖ RPMs: 5400, 7200, 10000, 15000 [0.5 to 1%variation]

❖ Number of platters: 1-5

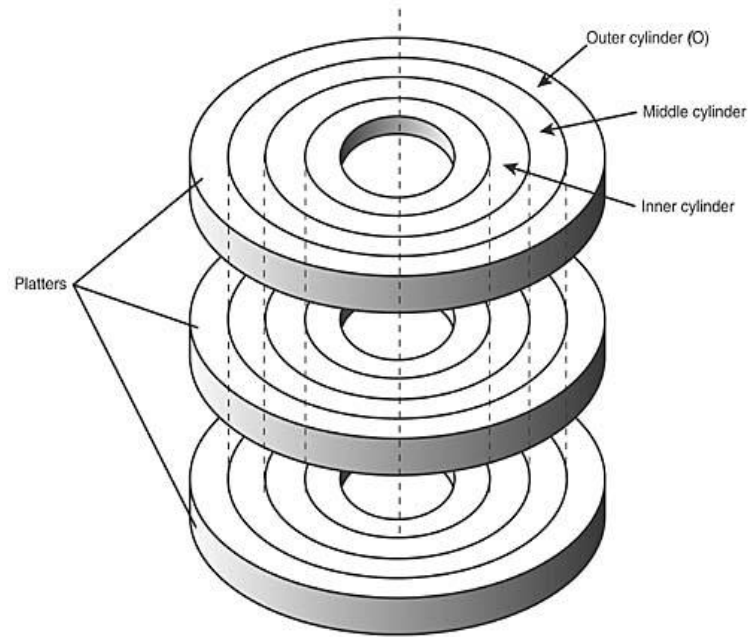❖ Power proportional to: $(Platters)*(RPM)^{2.8}(Diameter)^{4.6}$

❖ Read/write head
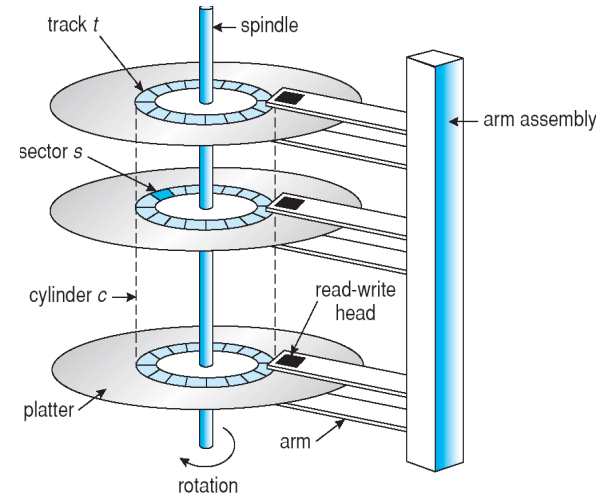
Hard Disk Drive Operation

❖ One side of a platter is called a head.

❖ HDD can have multiple platters, depending on their design and storage capacity.

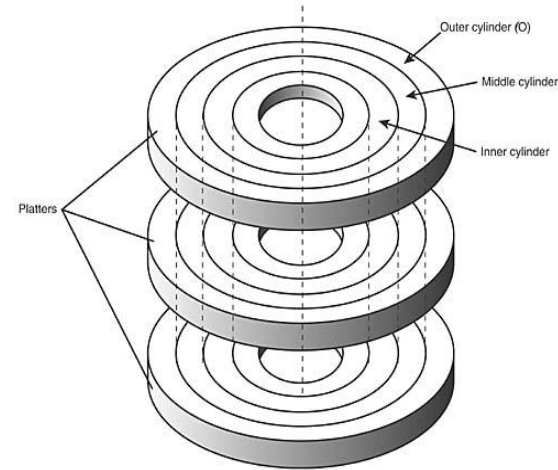❖ On the heads, there are concentric rings (tracks) and pieces of rings (sectors)
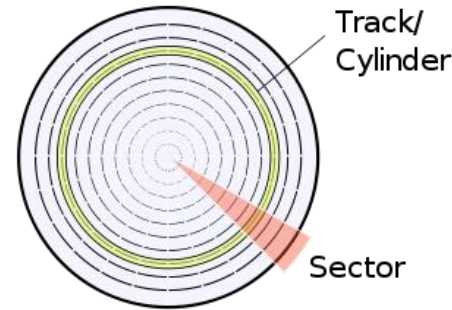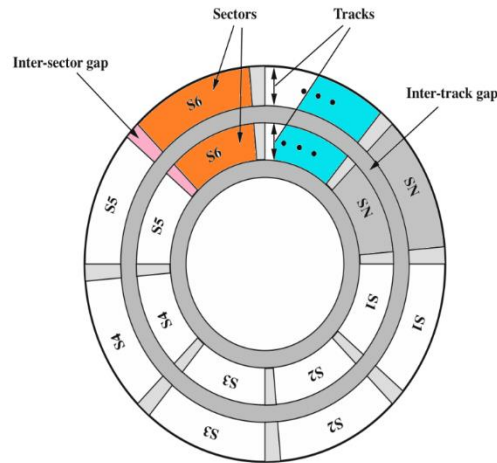
❖ Cylinder: 3D collection of track 'n' of each surface of all platters.

Disk Structure

❖ Disk drives are addressed as large 1-dimensional arrays of **logical blocks**, where the logical block is the smallest unit of transfer

    ❖ Low-level formatting creates **logical blocks** on physical media

❖ The 1-dimensional array of logical blocks is mapped into the sectors of the disk sequentially

    ❖ Sector 0 is the first sector of the first track on the outermost cylinder

    ❖ Mapping proceeds in order through that track, then the rest of the tracks in that cylinder, and then through the rest of the cylinders from outermost to innermost
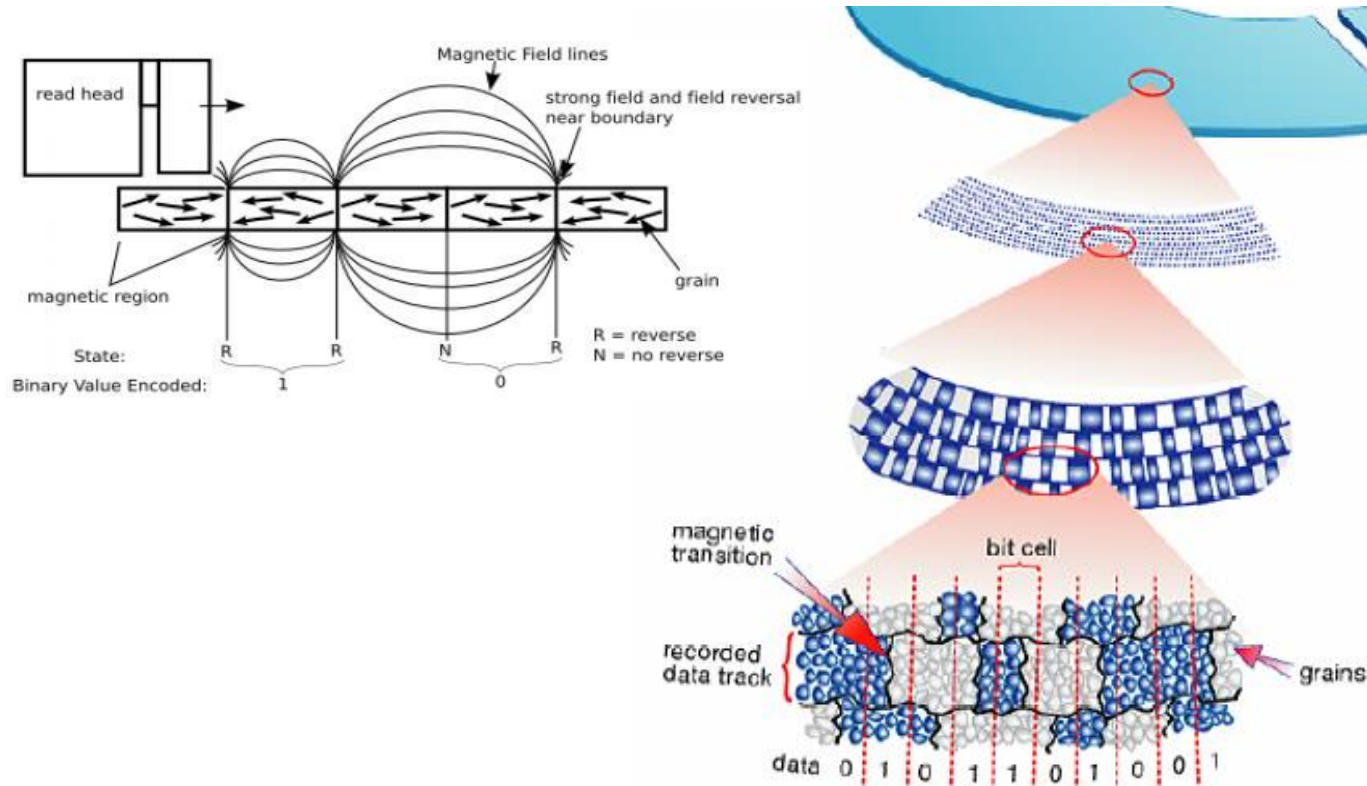
❖ Bit-cell composed of magnetic grains : 50-100 grains/bit

❖ Size of grains is order of 10 nm.

❖ **'0'** Region of grains of uniform magnetic polarity

❖ **'1'** Boundary between regions of opposite magnetization

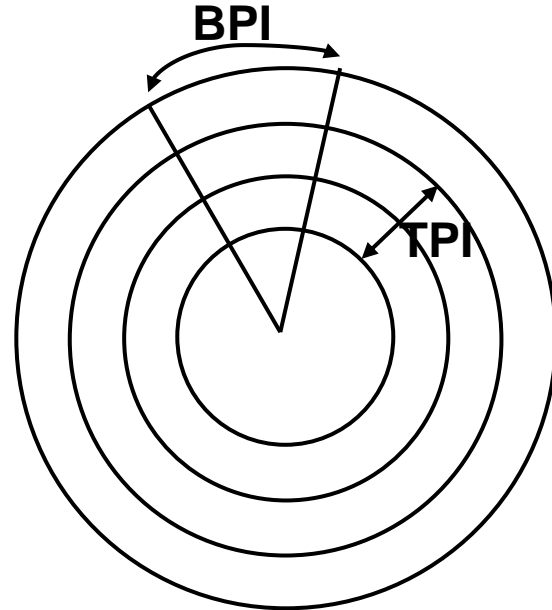❖ The read-and-write head is used to detect and modify the magnetization of the material immediately under it.
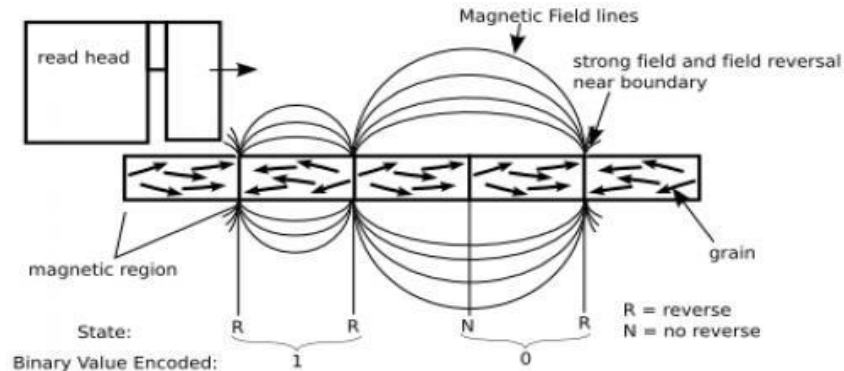
Logic Storage in Hard Disk Drive

Storage Density

❖ Determines both capacity and performance

❖ Density Metrics

    ❖ Linear density (Bits/inch or BPI)

   ❖ Track density (Tracks/inch or TPI)

    ❖ Areal Density = BPI x TPI

HDD- Bit Density

❖ Reduce bit density per track for outer layers. Constant Linear Velocity.
❖ Have more sectors per track on the outer layers, and increase rotational speed when reading from outer tracks. Constant Angular Velocity.
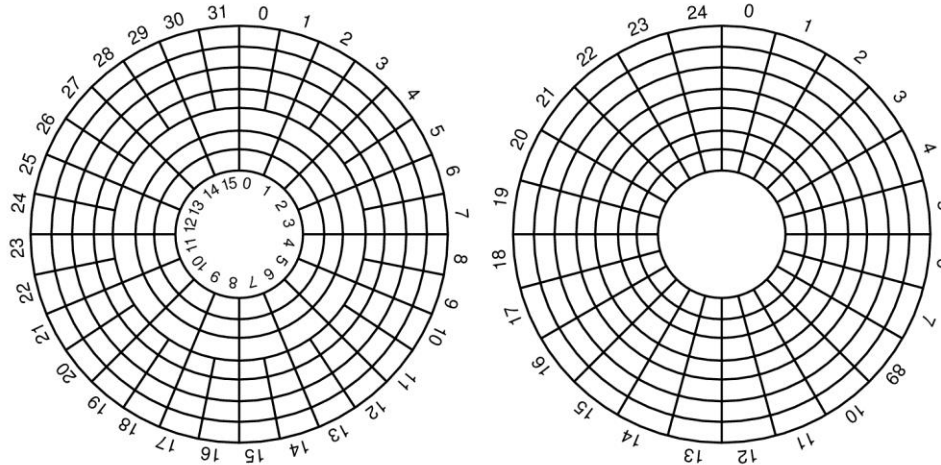
Disk Access Time

❖ To read from disk, we must specify:

    ❖ cylinder #, surface #, sector #, size, memory address

❖ Transfer time includes:

    ❖ Seek time: to get to the track

    ❖ Rotational Latency: to get to the sector

    ❖ Transfer time: get bits off the disk

Track
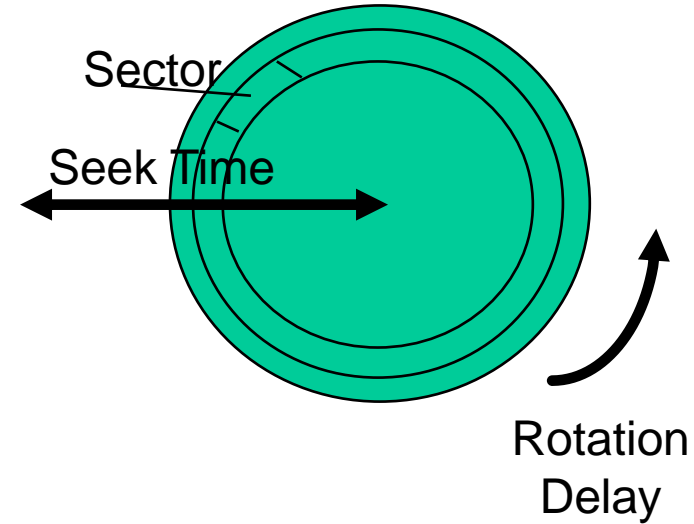
Sector

Seek Time
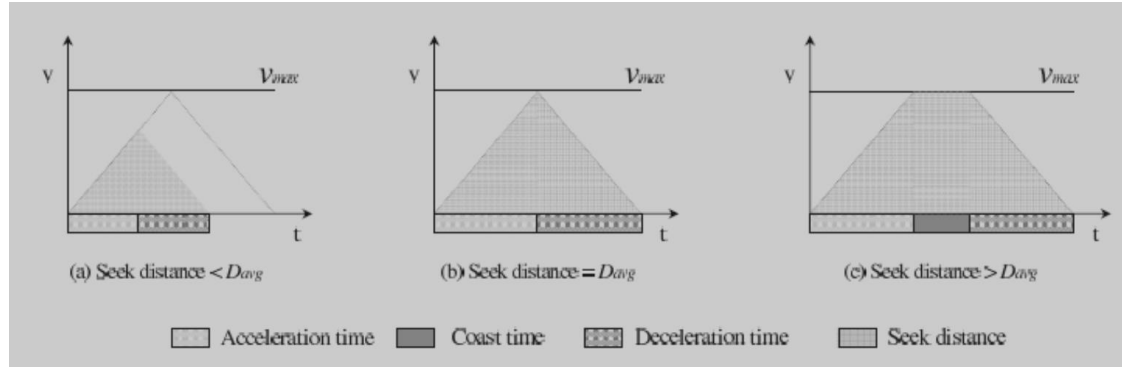
Rotation
Delay
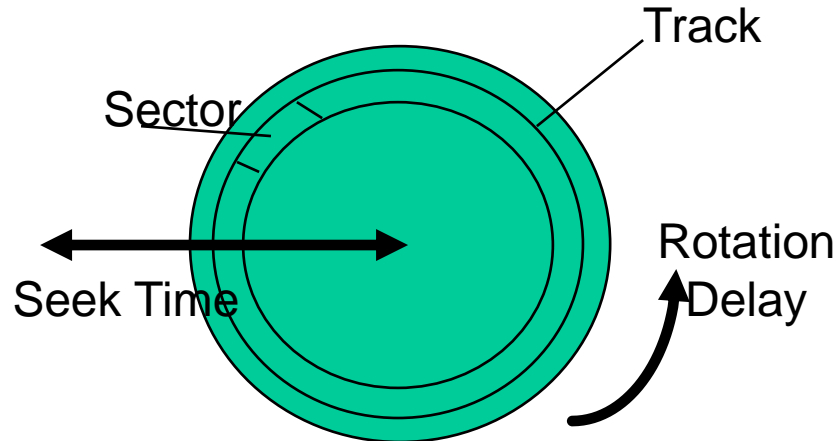
Seek Time

❖ **Seek time depends on:**

 ❖ Inertial power of the arm actuator motor

 ❖ Distance between outer-disk recording radius and inner-disk recording radius (data-band)

 ❖ Depends on platter-size

❖ **Components of a seek:**

 ❖ Speedup: Arm accelerates

 ❖ Coast: Arm moving at maximum velocity (long seeks)

 ❖ Slowdown: Arm brought to rest near desired track

 ❖ Settle: Head is adjusted to reach the access the desired location

Sector

Seek Time

Rotation Delay

Variations in Seek Time

(a) Seek distance $< D_{avg}$ (b) Seek distance $= D_{avg}$ (c) Seek distance $> D_{avg}$

Acceleration time   Coast time   Deceleration time   Seek distance

❖ Very short seeks (2-4 cylinders)
  ❖ Settle-time dominates
❖ Short seeks (100-200 cylinders)
  ❖ Speedup/Slowdown-time dominates
❖ Longer seeks (> 200 cylinders)
  ❖ Coast-time dominates
❖ With smaller platter-sizes and higher TPI
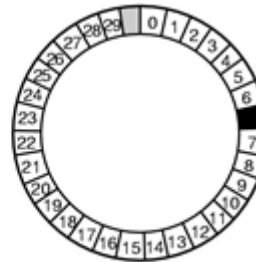 ❖ Settle-time becoming more important

Disk Formatting

❖ **Low-Level Formatting (LLF)** is the process of outlining the positions of the tracks and sectors on the hard disk, and writing the control structures that define where the tracks and sectors. Latest hard disks are LLF at factory.

❖ **High-Level Formatting (HLF)** is the process of initializing portions of the hard disk and creates the file system structures on the disk, such as the master boot record and the file allocation tables. High-level formatting is typically done to erase the hard disk and reinstall the operating system back onto the disk drive.

Bad sector management in disks

❖ **Bad sector** is a sector on disk that is either inaccessible or un-writeable due to permanent damage.

❖ Bad sectors are usually detected by LLF or HLF or by utility software such as CHKDSK or SCANDISK .

❖ The sectors unusable are not used for storage.

❖ If a file uses a sector which is marked as bad then the bad sector of the file is remapped to a free sector.
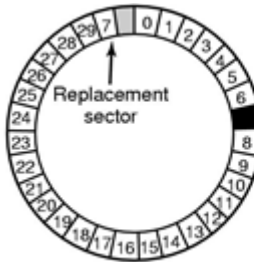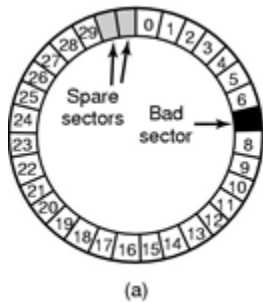
Sector forwarding   Sector slipping

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