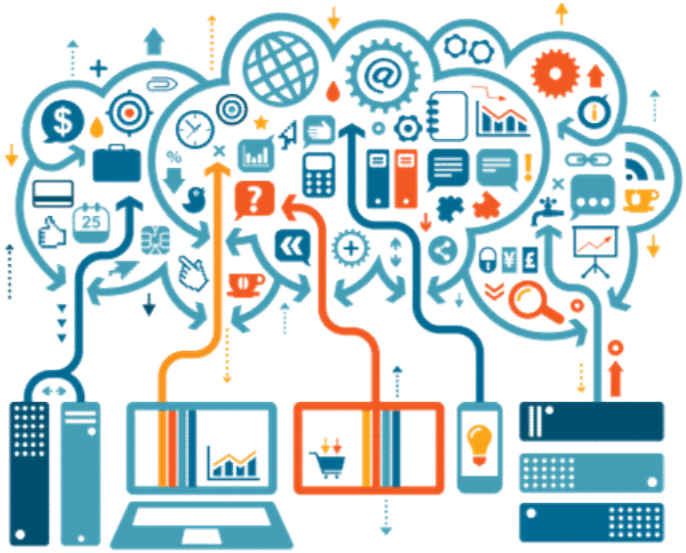
Big Data Storage and Management

(CDS502)



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Assignment

Course Title & Code: Big Data Storage and Management (CDS502)

Big Data Storage and Management

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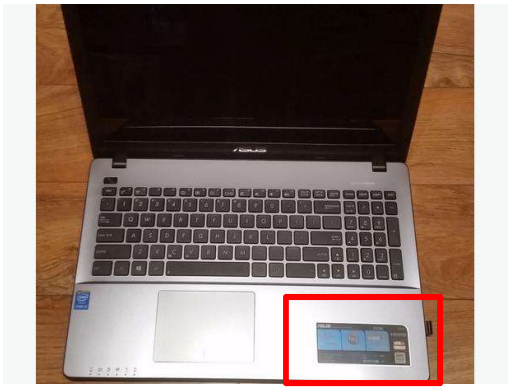
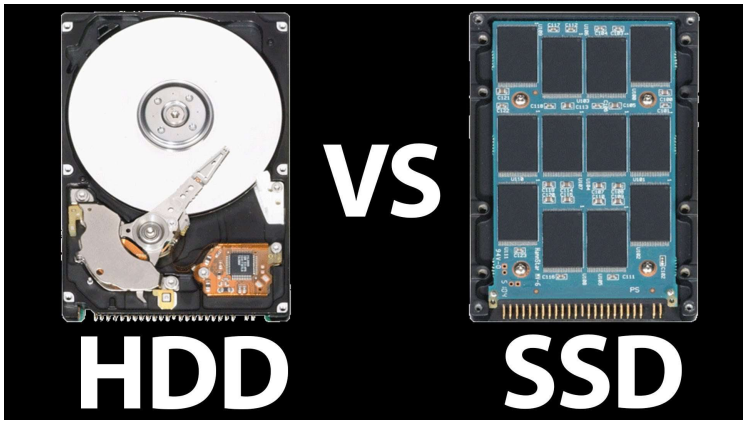
Conventional Storage

- Storage is a core component in a data center.
- A storage device uses magnetic, optic, or solid state media.
- Disks, tapes, and diskettes use magnetic media for storage.
- CD/DVD uses optical media for storage.
- Removable Flash memory or Flash drives are examples of solid state media.





Tapes

In the past, **tapes** were the most popular storage option for backups because of their low cost. However, tapes have various limitations:

- Data is stored on the tape linearly along the length of the tape. Search and retrieval of data are done sequentially, and it invariably takes several seconds to access the data. As a result, random data access is **slow** and **time-consuming**.

- In a shared computing environment, data stored on tape cannot be accessed by multiple applications simultaneously, **restricting** its use to **one** application at a time.

- On a tape drive, the read/write head touches the tape surface, so the tape **degrades** or **wears out** after repeated use.

Due to these limitations and availability of low-cost disk drives, tapes are **no longer** a preferred choice as a backup destination for enterprise-class data centers.

Optical Disc Storage

- Optical disc storage is popular in **small**, **single-user** computing environments.
- It is used as a **distribution medium** for small applications, such as games, or as a means to transfer small amounts of data from one computer system to another.
- Optical discs have **limited** capacity and speed, which limit the use of optical media as a business data storage solution.
- Optical discs, to some degree, guarantee that the content has not been altered. It can be used as a **low-cost** alternative for **long-term** storage of relatively small amounts of fixed content that do not change after it is created.

Optical Disc Storage

- The capability to write once and read many (**WORM**) is one advantage of optical disc storage. A CD-ROM is an example of a WORM device.

- Write once read many (WORM) describes a data storage device in which information, once written, cannot be modified. This write protection affords the assurance that the data cannot be tampered (damage) with once it is written to the device.

- Collections of optical discs in an array, called a **jukebox**, used as a fixed-content storage solution.

Disk Drives

- Disk drives are the most popular storage medium used in modern computers for storing and accessing data for performance-intensive, online applications.
- Disks support rapid access to random data locations. This means that data can be written or retrieved quickly for a large number of simultaneous users or applications.
- Disks have a large capacity.
- Disk storage arrays are configured with multiple disks to provide increased capacity and enhanced performance.

Disk Drive Components: Platters

- A hard drive contains a series of rotating platters within a sealed case. The sealed case is known as **H**ead **D**isk **A**ssembly (HDA).

- A **platter** has the following attributes:

  - It is a rigid, round disk which is coated with magnetically sensitive material.

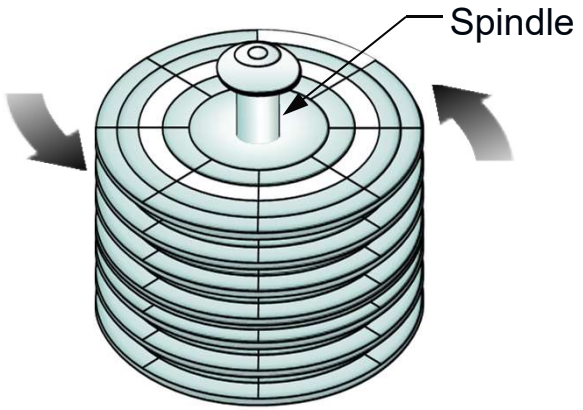
  - Data is stored in binary code (0s and 1s). It is encoded by polarizing magnetic areas, or domains, on the disk surface.

  - Data can be written to and read from both surfaces of a platter.

  - A platter's storage capacity varies across drives. There is an industry trend toward higher capacity as technology improves.

Disk Drive Components: Spindle

- Multiple platters are connected by a **spindle**.
  - The spindle is connected to a motor which rotates at a constant speed.
  - The spindle rotates continuously until power is removed from the spindle motor.
  - Many hard drive failures occur when the spindle motor fails.
- Disk platters spin at speeds of several thousand revolutions per minute. These speeds increase as technologies improve.

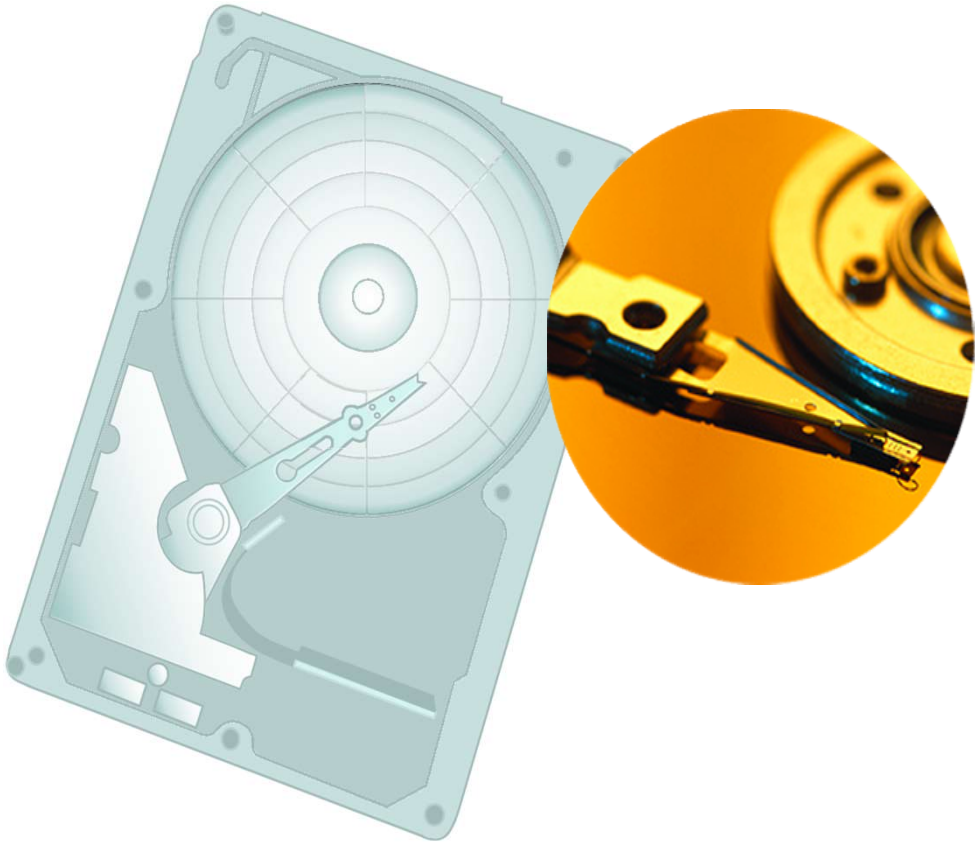


Platters

Disk Drive Components: Read/Write Heads

- Data is read and written by **read/write heads** (R/W heads). Most drives have two R/W heads per platter, one for each surface of the platter.
  - ❖ When reading data, they detect magnetic polarization on the platter surface.
  - ❖ When writing data, they change the magnetic polarization on the platter surface.
- Reading and writing data is a magnetic process, the R/W heads never actually touch the surface of the platter. There is a microscopic air gap between the read/write heads and the platter. This is known as the head **flying height**.
- When the spindle rotation has stopped, the air gap is removed and the R/W heads rest on the surface of the platter in a special area near the spindle called a **landing zone**.
- If the drive malfunctions and a read/write head accidentally touches the surface of the platter outside of the landing zone, it is called a **head crash**. A head crash generally results in data loss.

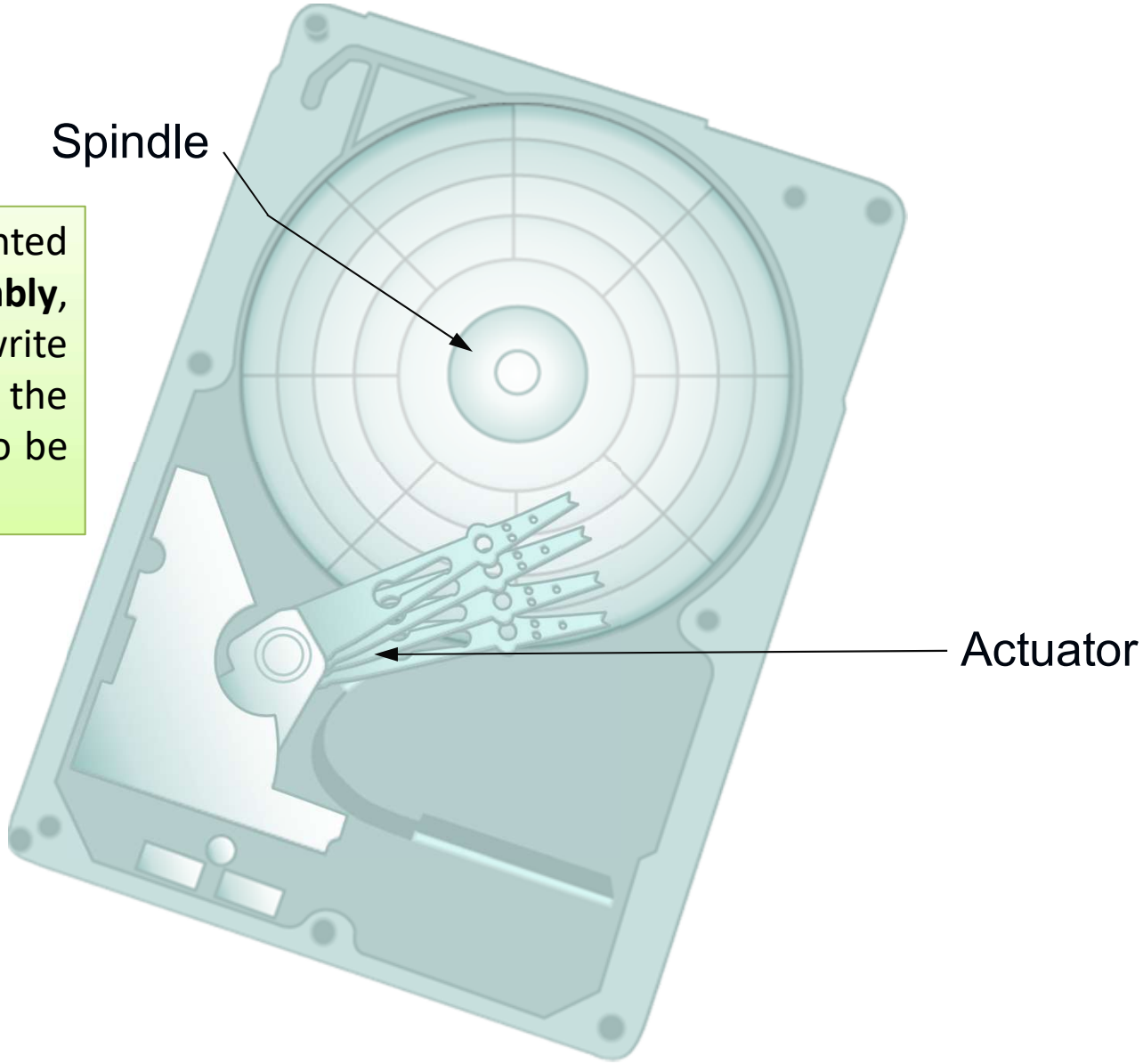
Disk Drive Components: Read/Write Heads



The landing zone is coated with a lubricant to reduce head/platter friction. Logic on the disk drive ensures that the heads are moved to the landing zone before they touch the surface.

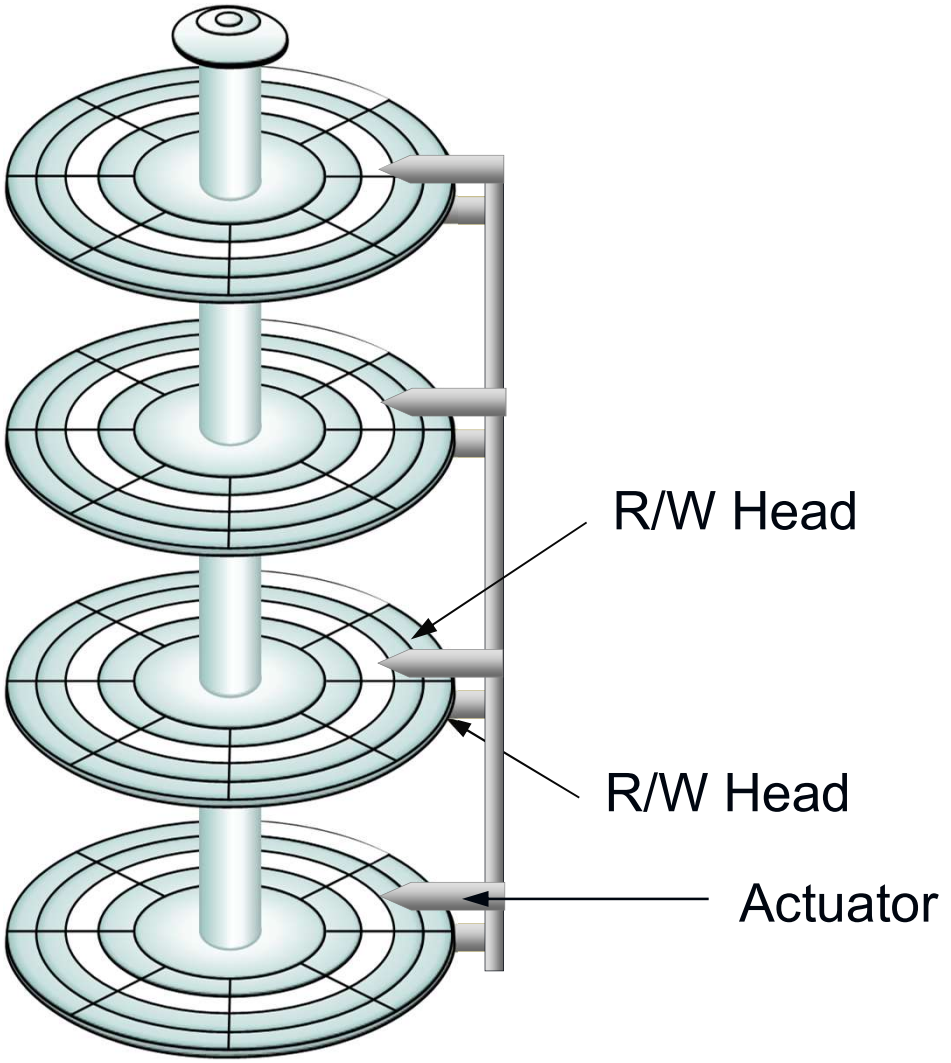
Disk Drive Components: Actuator

Read/write heads are mounted on the **actuator arm assembly**, which positions the read/write head at the location on the platter where data needs to be written or read.



Physical Disk Structures: Actuator Arm Assembly

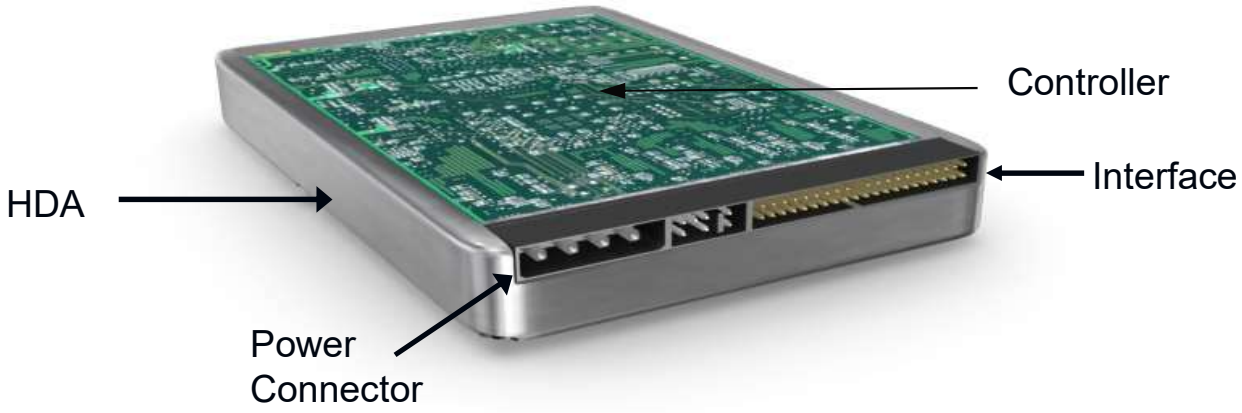
- The read/write heads for all of the platters in a drive are attached to one actuator arm assembly and move across the platter simultaneously.
- Notice there are two read/write heads per platter, one for each surface.



Disk Drive Components: Controller

The controller is a printed circuit board, mounted at the bottom of the disk drive. It contains a microprocessor (as well as some internal memory, circuitry, and firmware) that controls:

- power to the spindle motor and control of motor speed
- how the drive communicates with the host CPU
- reads/writes by moving the actuator arm, and switching between R/W heads
- optimization of data access



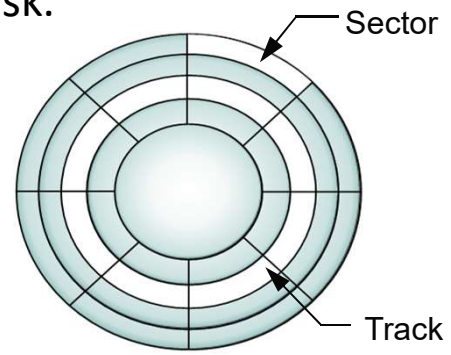
Bottom View of Disk Drive

Physical Disk Structures: Sectors and Tracks

- Data is recorded in **tracks**. A track is a concentric ring around the spindle which contains data.
  - A track can hold a large amount of data. **Track density** describes how tightly packed the tracks are on a platter.
  - Tracks are numbered from the outer edge of the platter, starting at track zero.
  - A track is divided into **sectors.** A sector is the smallest individually-addressable unit of storage.
  - Sectors typically hold 512 bytes of user data. Some disks can be formatted with larger sectors.

- Each sector stores user data as well as other information, including its sector number, head number (or platter number) and track number. This information aids the controller in locating data on the drive, but it also takes up space on the disk.

- The first PC hard disks typically held 17 sectors per track. Today's hard disks can have a much larger number of sectors in a single track. There can be thousands of tracks on a platter, depending on the size of the drive.



Platter

Platter Geometry and Zoned-Bit Recording

- A platter is made up of concentric tracks, the outer tracks can hold more data than the inner ones because they are physically longer than the inner tracks. However, in older disk drives, the outer tracks had the same number of sectors as the inner tracks, which means that the data density was very low on the outer tracks. This was an inefficient use of the available space.

- **Zoned-bit recording** uses the disk more efficiently. It groups tracks into zones that are based upon their distance from the center of the disk. Each zone is assigned an appropriate number of sectors per track. This means that a zone near the center of the platter has fewer sectors per track than a zone on the outer edge.

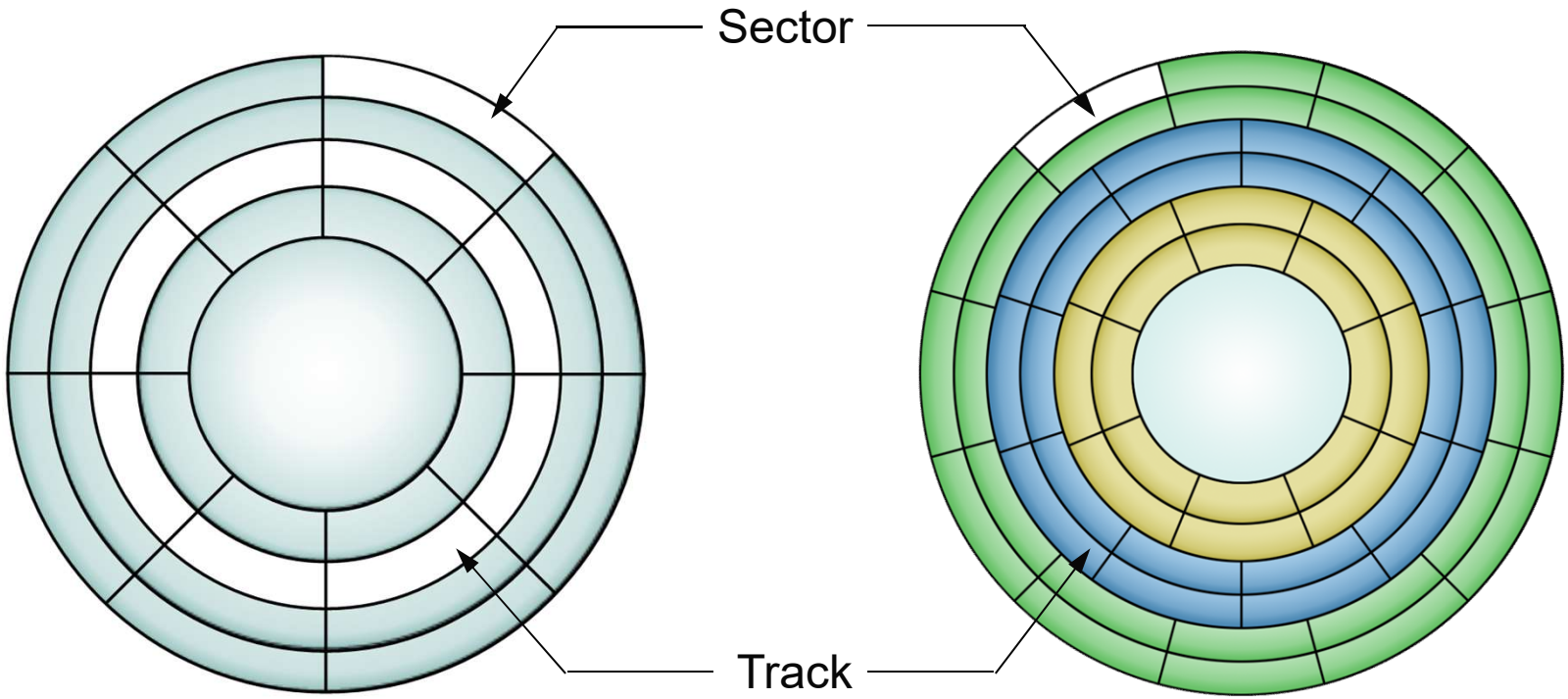
- In zoned-bit recording:

  - outside tracks have more sectors than inside tracks

  - zones are numbered, with the outermost zone being Zone 0

  - tracks within a given zone have the same number of sectors

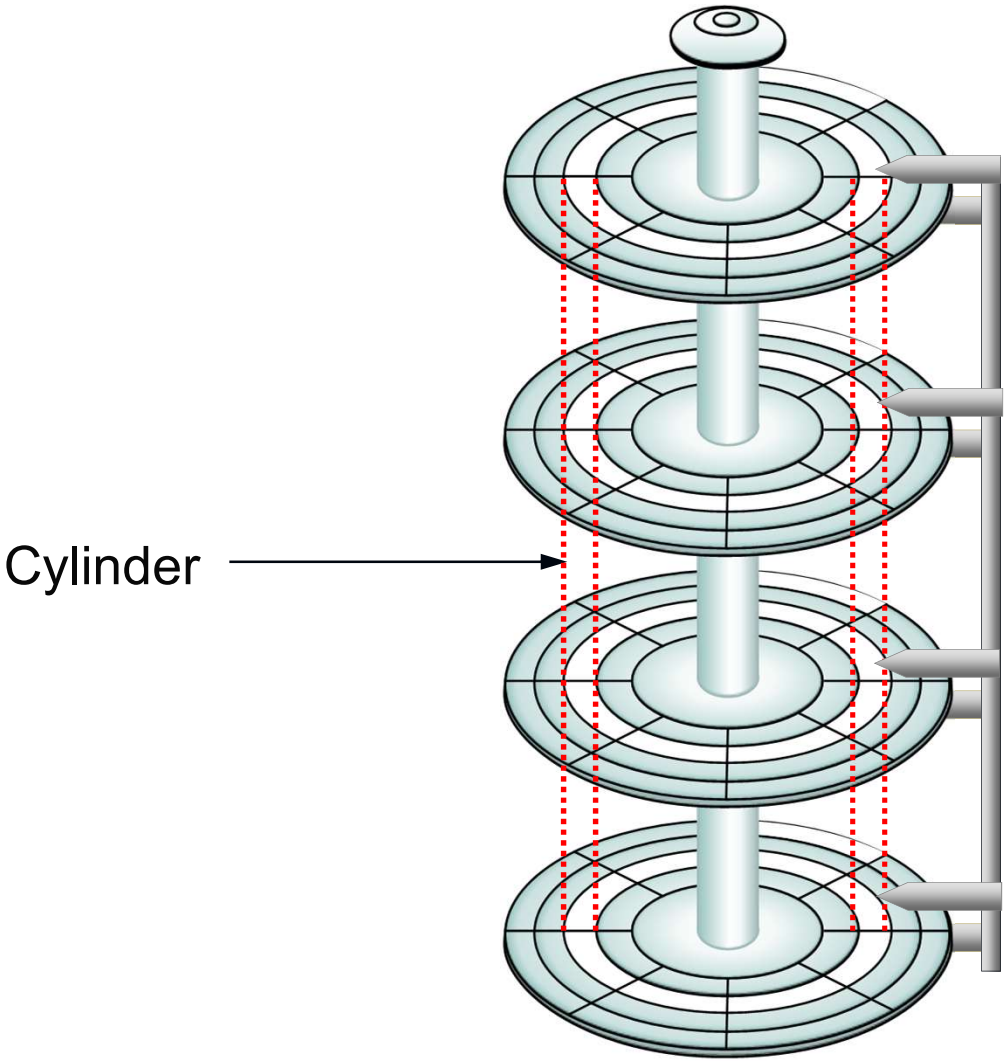
Platter Geometry and Zoned-Bit Recording



Platter Without Zones

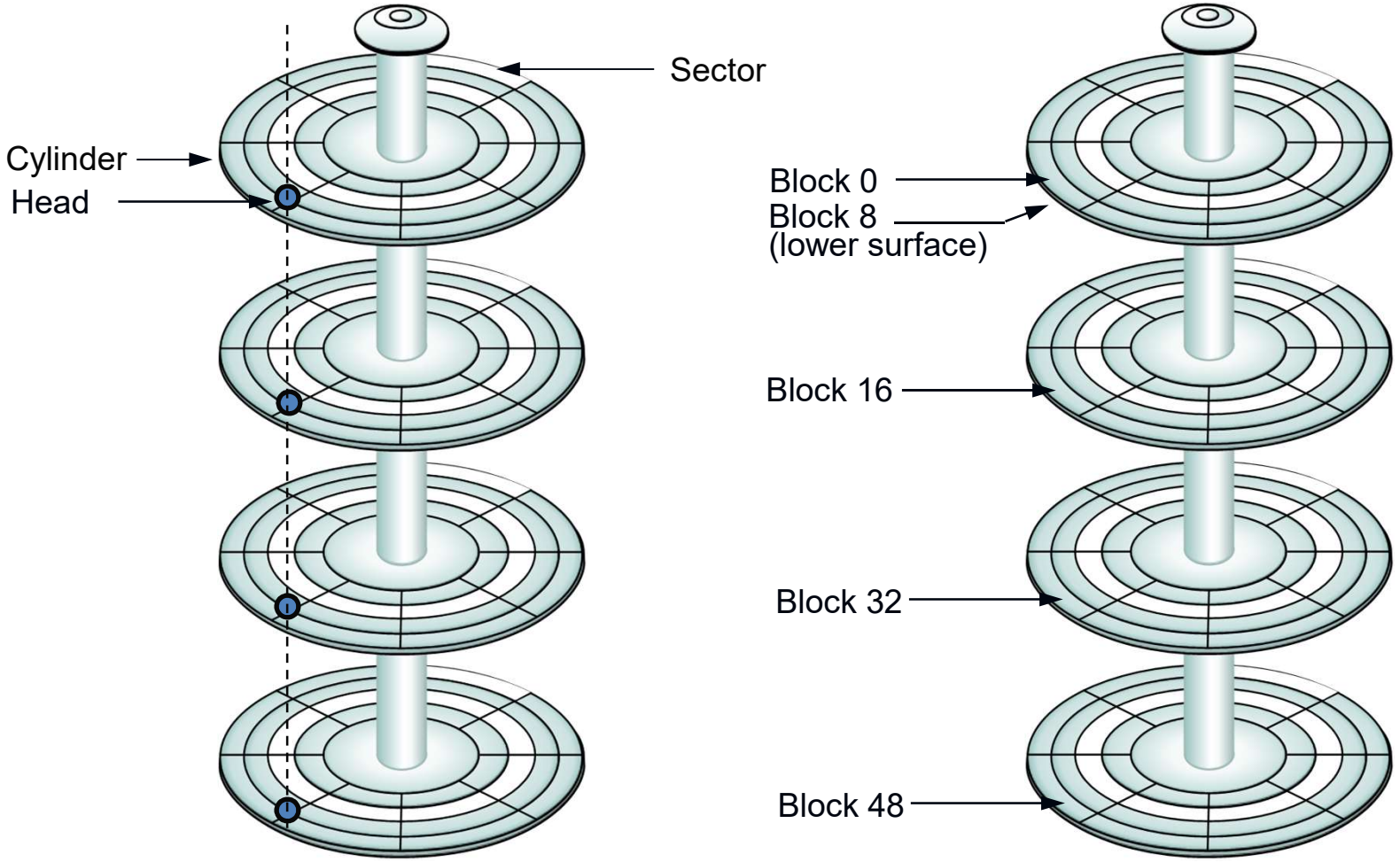
Platter With Zones

Physical Disk Structures: Cylinders



A **cylinder** is the set of identical tracks on both surfaces of each of the drive's platters. Often the location of drive heads are referred to by cylinder number rather than by track number.

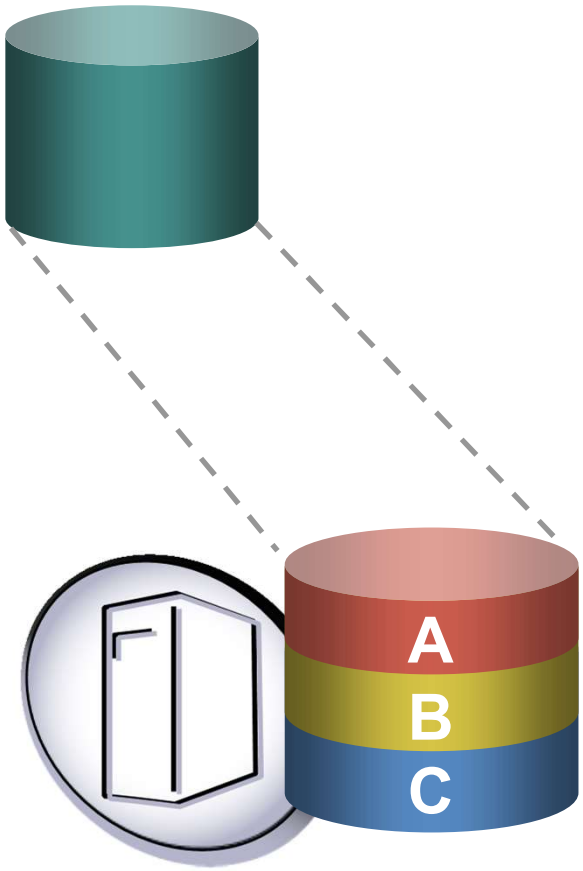
Logical Block Addressing



Physical Address = CHS

Logical Block Address = Block #

Drive Partitioning



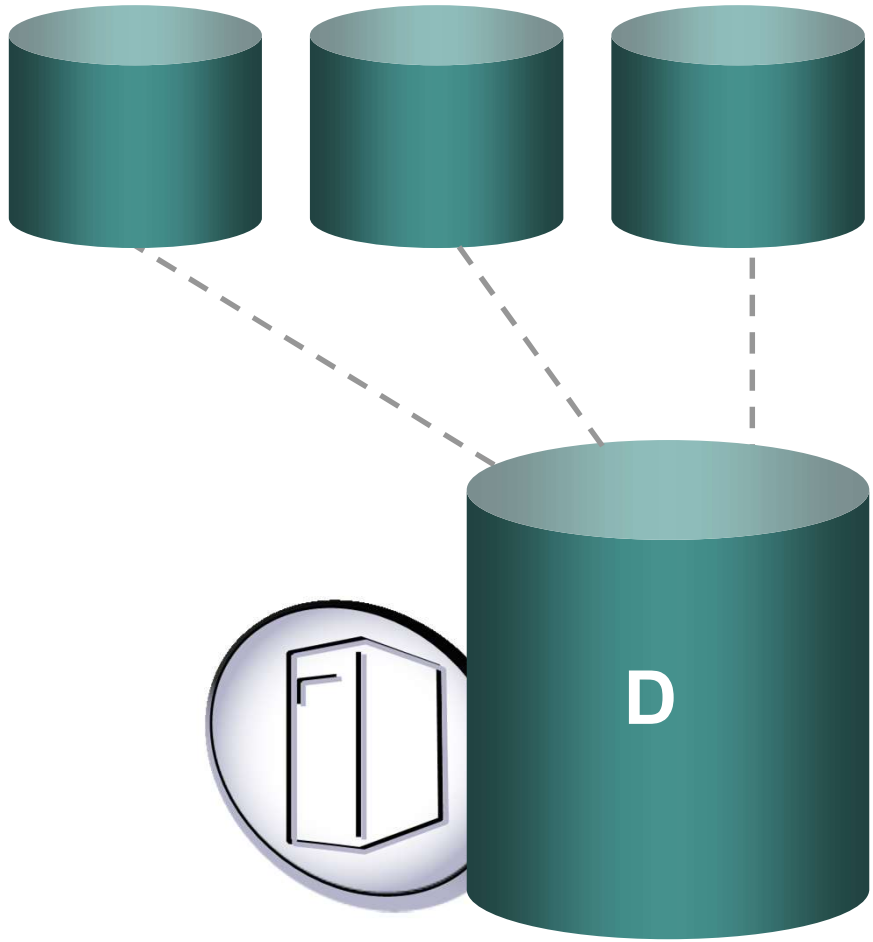
Partitioning - Multiple Logical Volumes

Partitioning divides the disk into logical containers (known as volumes), each of which can be used for a particular purpose.

- Partitions are created from groups of contiguous cylinders.
- A large physical drive could be partitioned into multiple Logical Volumes (LV) of smaller capacity.
- Because partitions define the disk layout, they are generally created when the hard disk is initially set up on the host.
- Partition size impacts disk space utilization.
- The host file system accesses partitions, with no knowledge of the physical structure.

Drive Concatenation

- **Concatenation** groups several smaller physical drives and presents them collectively as one large logical drive to the host.
- This is typically done using the Logical Volume Manager on the host.



Concatenation - One Logical Volume

Thank You

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