

Computer Organization & Architecture

## 3-8 Secondary Storage

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# Contents of this lecture

- Magnetic Hard Disks
  - Mechanical Structure
  - Data Organization
- Accessing of Data on a Disk

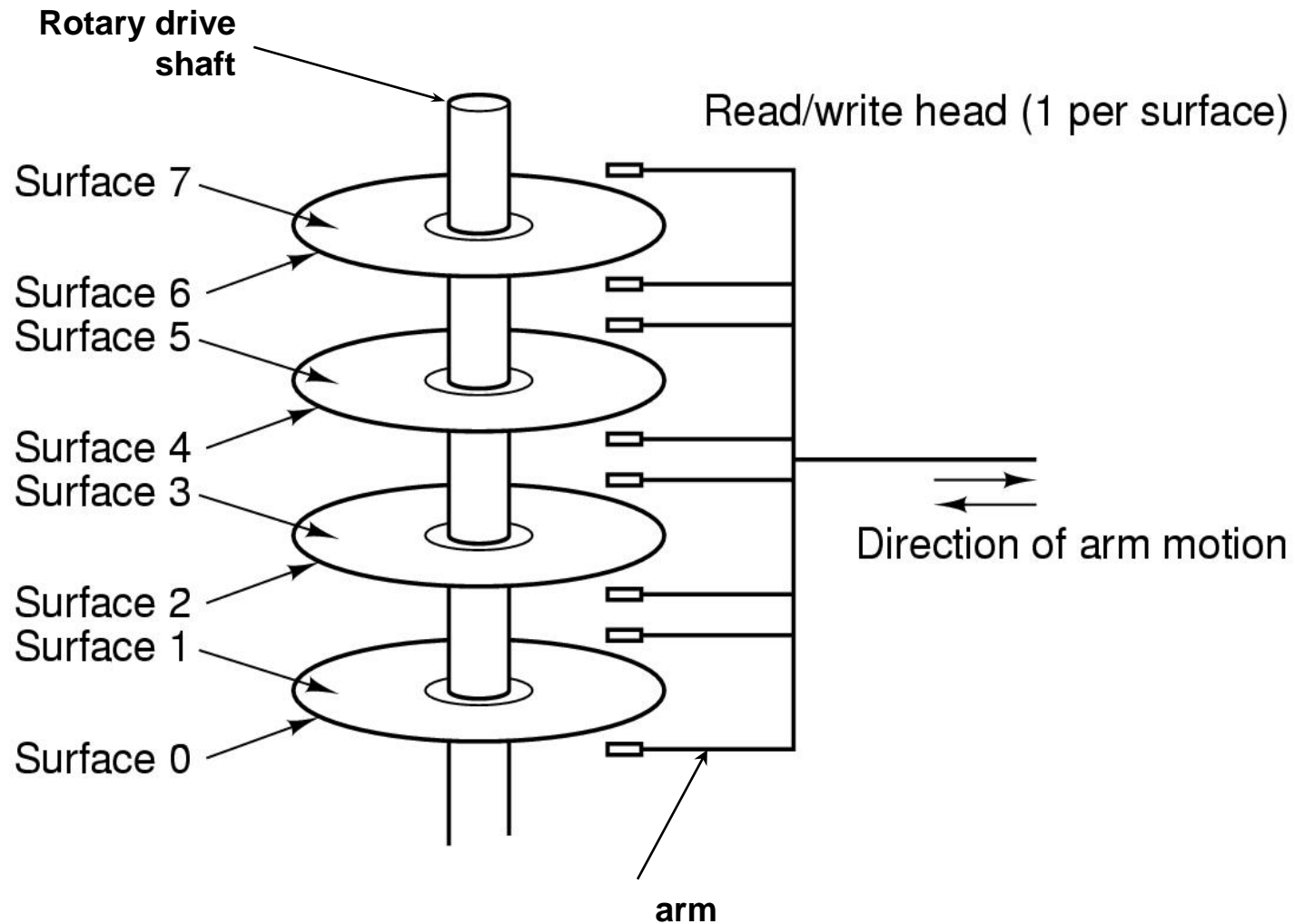
# Mechanical Structure (1)

- Storage Medium
  - One or more disks (double-sided/single-sided) mounted on a common spindle.
  - A disk is a circular platter constructed of metal or of plastic coated with a magnetizable material.
  - The disks are placed in a rotary drive and they rotate at a uniform speed.

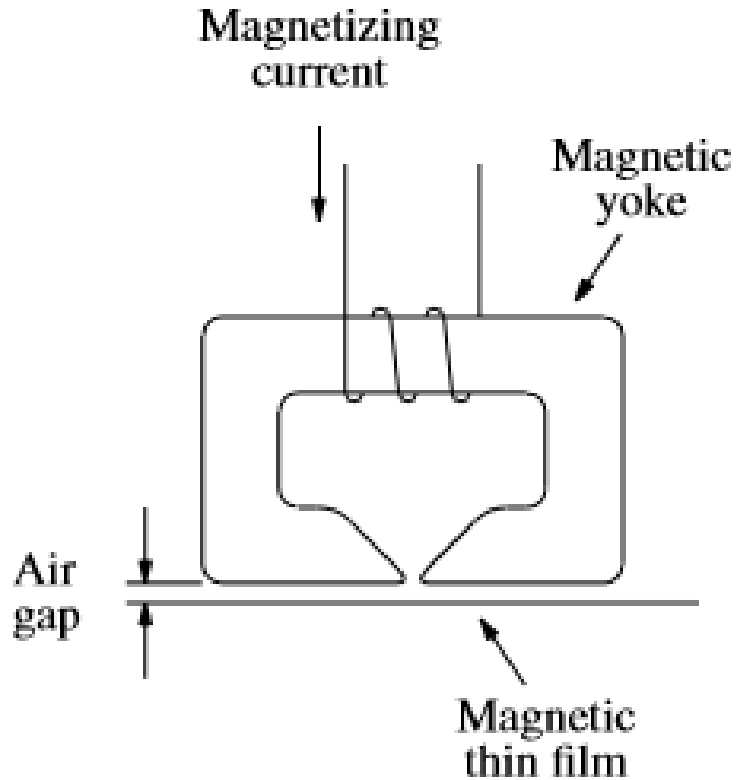
# Mechanical Structure (2)

- Read/Write Head
  - Fixed Head
    - One read-write head per track
    - Heads mounted on fixed ridged arm
  - Movable Head
    - One read-write head per surface
    - Heads mounted on a movable arm

# Mechanical Structure (3)



# Mechanical Structure (4)



- Read/Write Head
  - Each head consist of a magnetic yoke and a magnetizing coil.
  - Read/Write head must be maintained at a very small distance from the moving disk surfaces.

# Mechanical Structure (5)

- Storage Theory
  - Write: Digital information can be stored on the magnetic film by applying current pulses of suitable polarity to the magnetizing coil.
  - Read: Changes in the magnetic field in the vicinity of the head caused by the movement of the film relative to the yoke induce a voltage in the coil.

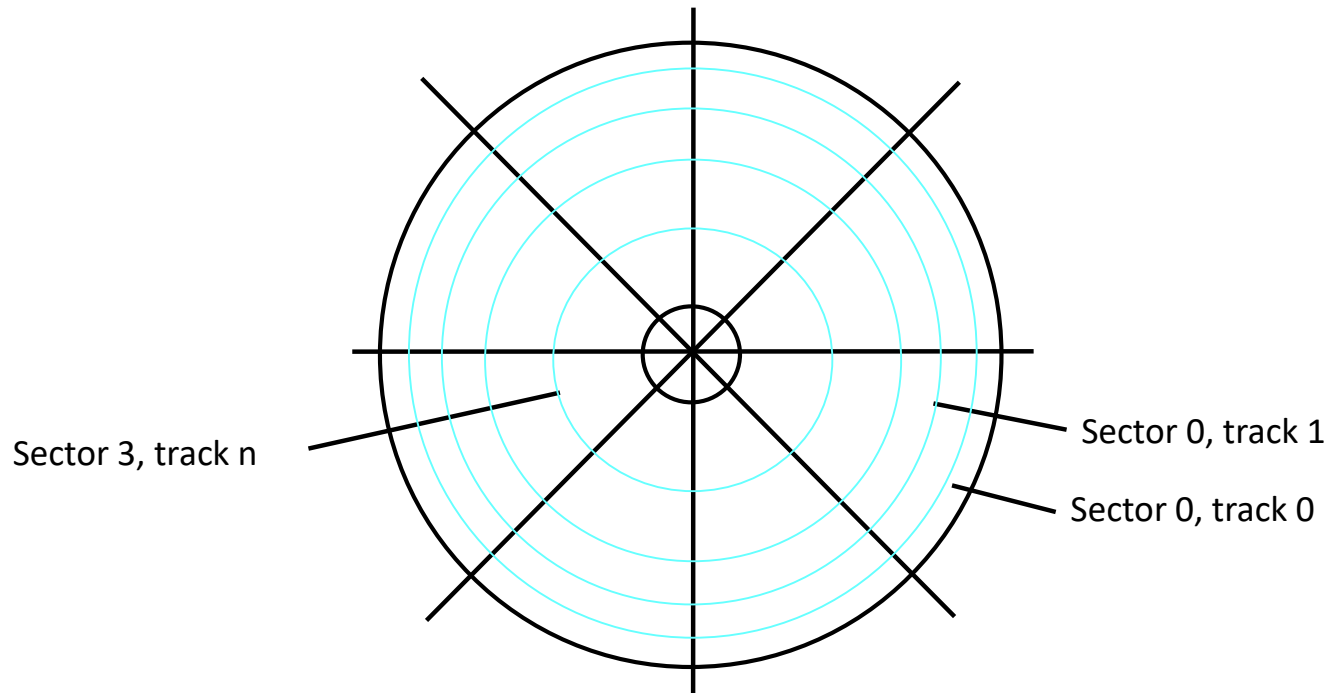
# Mechanical Structure (6)

- Winchester Hard Disk
  - Winchester Technology
    - Developed by IBM in 1968
  - Characteristics
    - The disks and the read/write heads are placed in a sealed, air-filtered enclosure.
    - The read/write heads can operate closer to the magnetized track surfaces.
  - Advantages
    - Data density tends to be greater.
    - Larger capacity for a given physical size compared to unsealed units be greater.



# Data Organization (1)

- Track and Sector
  - Each surface is divided into concentric tracks, and each track is divided into sectors.

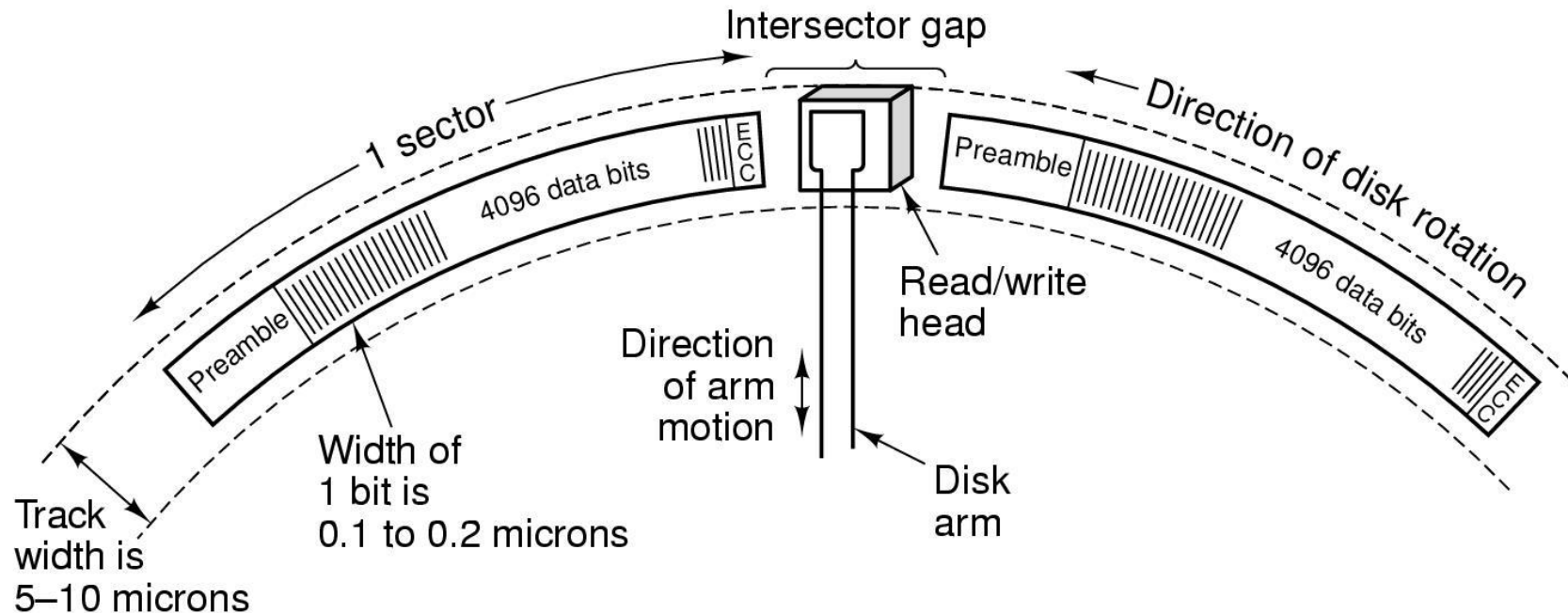


# Data Organization (2)

- Track and Sector
  - Each track has the same number of sectors
  - Outer tracks have more sectors. (Applied in large disks)
  - Tracks: 500 ~ 2000 tracks per surface
  - 10 ~ 100 sectors per track
  - Sectors: Typically 512 bytes
  - Disk address: (surface number, track number, sector number)

# Data Organization (3)

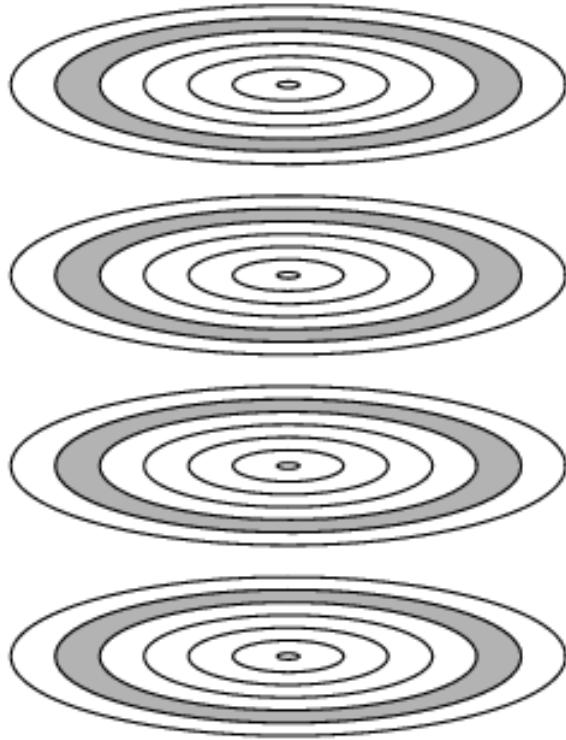
- The Organization of Track and Sector
  - Inter-sector Gap: Distinguish between two consecutive sectors easily.



# Data Organization (4)

- The Organization of Track and Sector
  - Sector Header (Preamble): Contains identification (addressing) information used to find the desired sector on the selected track.
  - ECC (Error-correcting Code) bits: Detect and correct errors that may have occurred in writing or reading of the 512 data bytes.

# Data Organization (5)



- Cylinder
  - The set of tracks on all surfaces at a given radius of a disk pack forms a logical cylinder.
  - The data on all tracks of a cylinder can be accessed without moving the read/write heads.

# Data Organization (6)

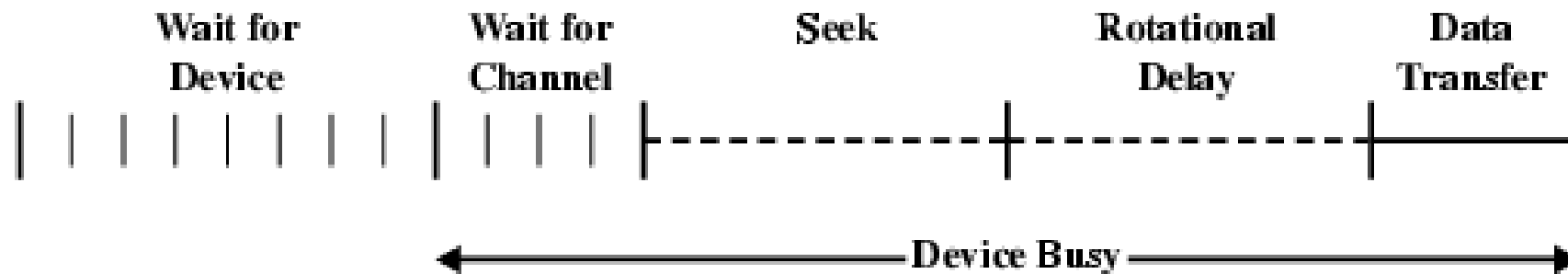
- Disk Format
  - Divide the disk into tracks and sectors.
  - The formatting process may discover some defective sectors or even whole tracks.
  - The formatting information (sector headers, ECC bits, and inter-sector gaps) accounts for about 15 percent of the total information that can be stored on a disk.

# Accessing of Data on a Disk (1)

- Disk Access Time
  - Access Time = Seek Time + Rotational Time
  - Seek Time
    - The time required to move the read/write head to the proper track.
    - Average value : 5ms ~ 8ms.
  - Rotational Time (Latency Time)
    - The amount of time that elapses after the head is positioned over the correct track until the starting position of the addressed sector passes under the read/write head.
    - Average value: the time for half a rotation of the disk.

# Accessing of Data on a Disk (2)

- **Transfer Rate**
  - The ratio of data transferring once the read/write head is positioned over the data.
  - **Transfer Time:** The time it takes to transfer data.





# Quiz (1)

1. The data of all tracks of a \_\_\_\_\_ can be accessed without moving the read-write head.

A. surface      B. platter      C. sector      D. cylinder

访问同一柱面上的所有磁道都不需要移动磁头

2. According to the specifications of a particular hard disk, a seek takes 3ms between adjacent tracks. If the disk has 100 cylinders, how long will it take for the head to move from the innermost cylinder to the outermost cylinder?

A. 3ms    B. 30ms      C. 300ms      D. 3000ms

## Quiz (2)

3. A hard disk with 5 double-sided platters has 2048 tracks/platter, how many movable heads does it have?

- A. 5                      B. 10                      C.  $2048 \times 5$                       D.  $2048 \times 10$

每个盘面有一个磁头，5个双面的盘片有10个盘面，所以有10个磁头

4. When we read a block of data from a disk into memory, the seek time refers to \_\_\_\_.

- A. the time required to move the read-write head to the proper track  
B. the time required to position the read-write head and transfer the data block  
C. the time required to rotate the correct sector under the head  
D. none of the above

## Quiz (3)

5. The amount of time required to read a block of data from a disk into memory is composed of seek time, rotational latency, and transfer time. Rotational latency refers to \_\_\_\_.
- A. the time it takes for the platter to make a full rotation
  - B. the time it takes for the read-write head to move into position over the appropriate track
  - C. the time it takes for the platter to rotate the correct sector under the head
  - D. none of the above

## Quiz (4)

6. A hard disk with 5 platters has 2048 tracks/platter, 1024 sectors/track (fixed number of sectors per track), and 512 byte sectors. What is its total capacity?
- A. 5G                      B. 10G                      C. 15G                      D. 20G

$$2048 * 5 * 1024 * 512 \text{B} = 5 \text{GB}$$

# Homework

- 8.2
- 8.3
- 8.8
- 8.10
- 8.11
- 8.12
- 8.13
- 8.22