Master of Computer Applications

# CAPOL403R01: Computer Organization & Architecture

## Unit III: Lecture 5
## External Memory

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# Magnetic Disk

- Disk is a circular platter constructed of non-magnetic material (substrate)
- Aluminium, aluminium alloy and glass are used as substrate
- Advantages of glass substrate
  - Improvement in the uniformity of magnetic film surface (Disk reliability is increased)
  - Significant reduction in overall surface defects (Reduction in read-write errors)
  - Lower fly heights are supported
  - Better stiffness to reduce disc dynamics
  - Greater ability to withstand shock and damage
- Head
  - It is a conductive coil used to read and write data on magnetic disks
  - Many systems have separate read and write heads

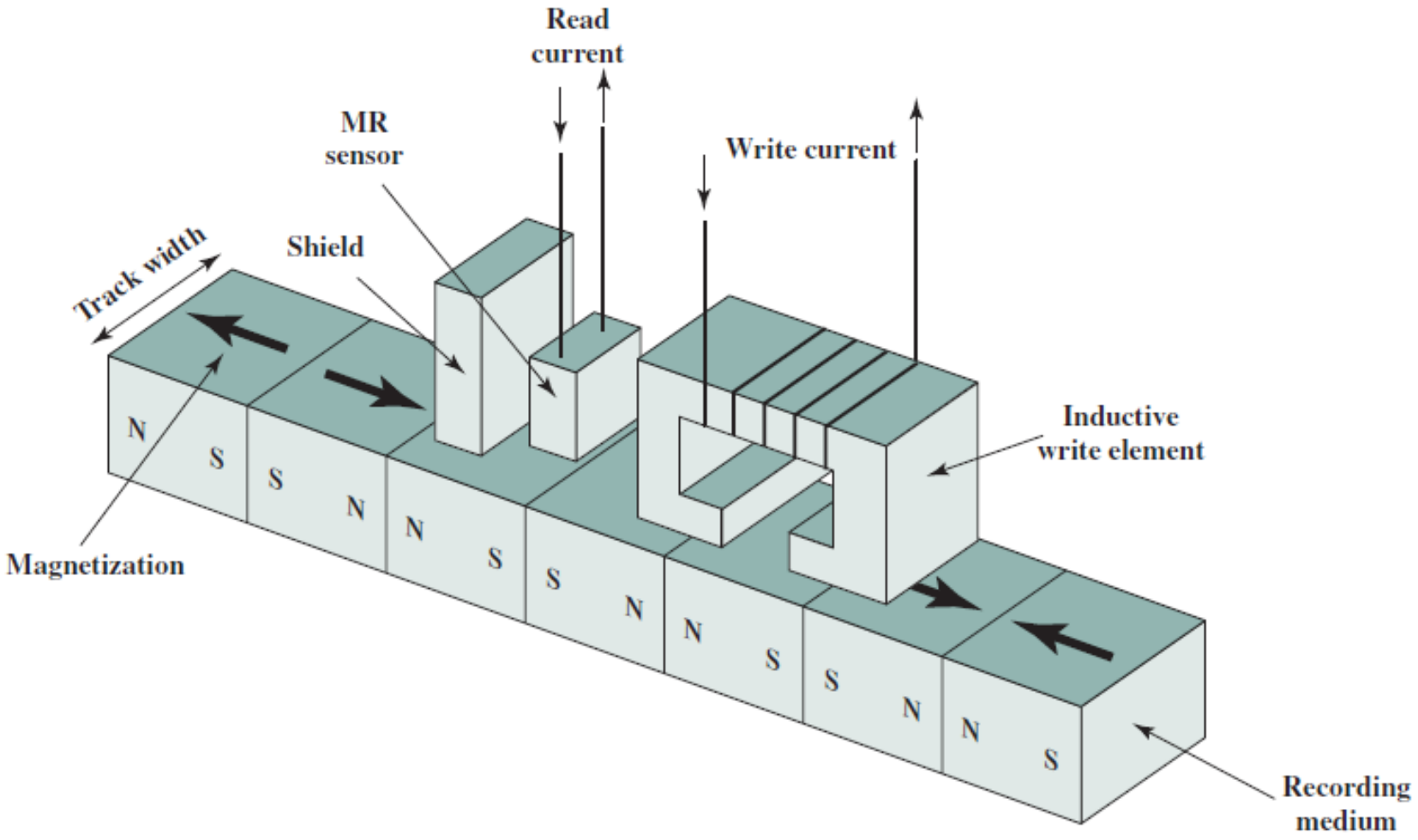
# Write mechanism

- Writing
  - Writing head is made of easily magnetisable material
  - At one end it has a gap and in the other end it has few turns of conducting wire
  - Electric pulses are sent to the writing head through this wire
  - It induces a magnetic field across the gap
  - This magnetic field magnetizes a small area of the recording medium under it
  - Different patterns are recorded for positive and negative currents

# Read mechanisms

- Reading
  - A moving magnetic field relative to a coil produces an electrical current in the coil
  - The produced current depends on the polarity of the magnetic field
  - In this way, the magnetic information is converted into a bit
- Reading in contemporary disks
  - Separate read head is available
  - It consists of a partially shielded magneto-resistive sensor (MR)
  - MR has an electrical resistance that depends on the magnetic polarity
  - By passing a current through MR, the resistance changes are detected as voltages
  - MR allows high frequency operation
  - MR equates greater storage densities and operating speeds

# Inductive read-write head

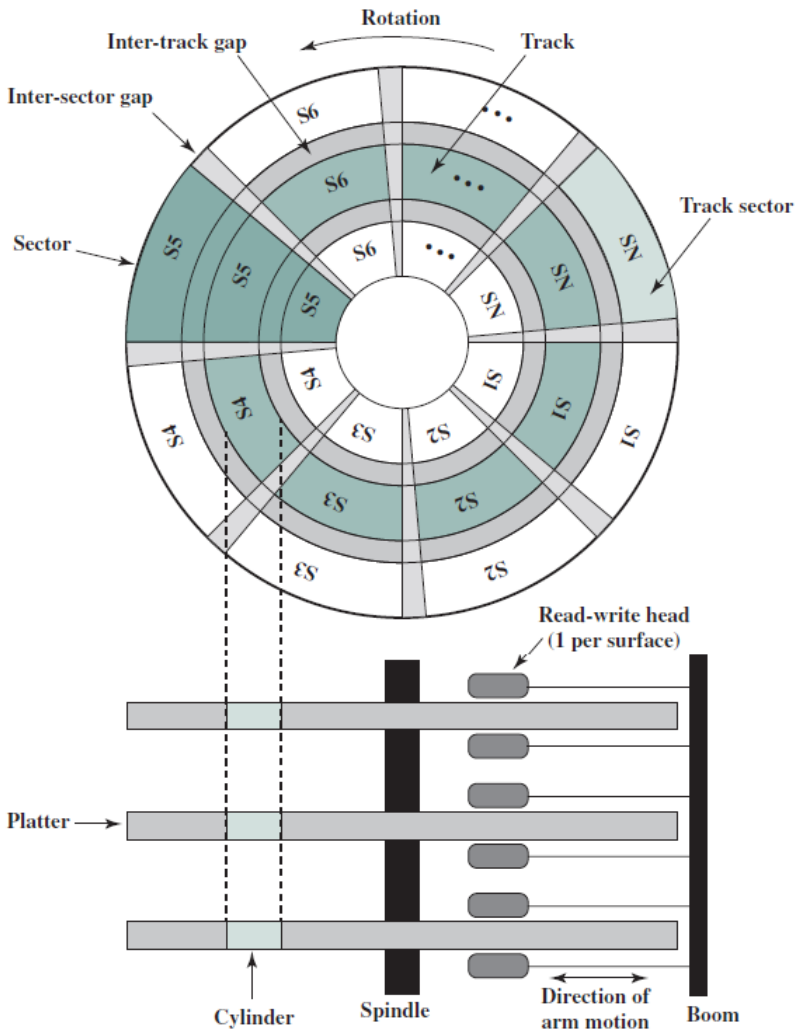


# Data organization and formatting

- Tracks
  - Concentric rings on the platter
  - Each track is the same width as the head
  - Adjacent tracks are separated by “inter-track gaps”
    - It minimizes errors due to misalignment of the head / interference of magnetic fields
- Sectors
  - Tracks are divided into many sectors – either with fixed or variable length
  - Data are transferred to and from the disc in sectors
  - Adjacent sectors are separated by “inter-sector gaps”

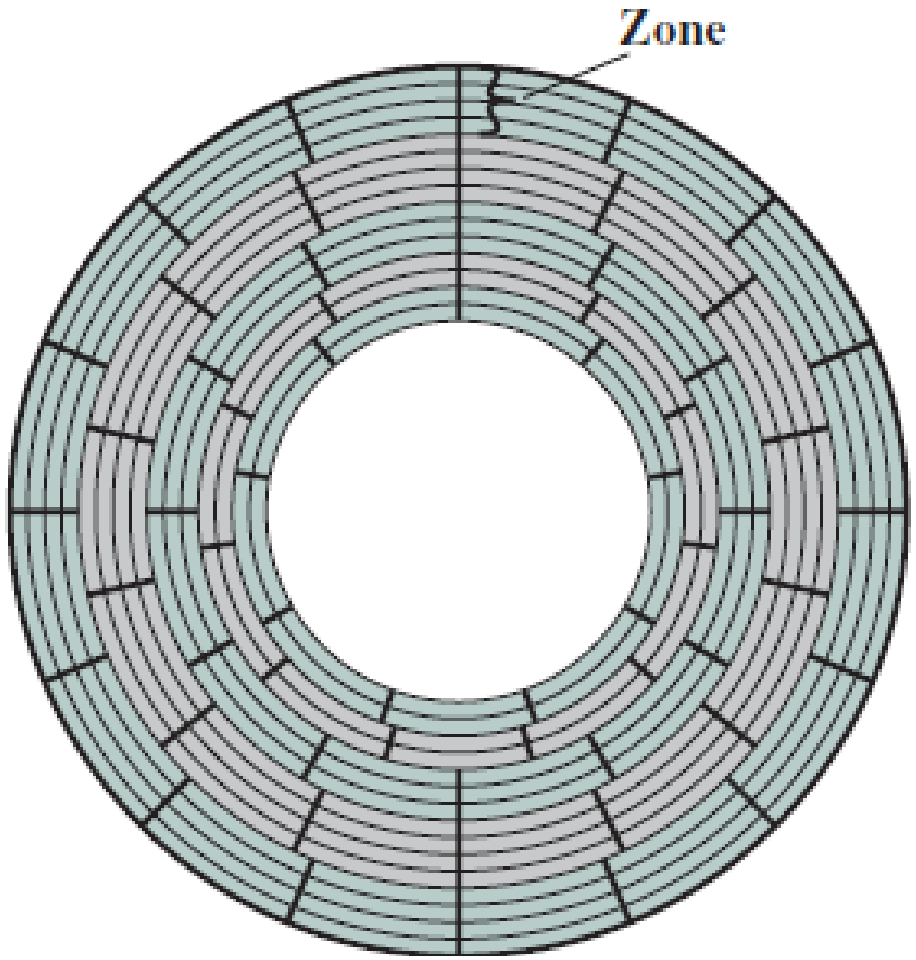
# Disk data layout - CAV

- A bit near the center of the rotating disk travels past a fixed point slower than a bit on the outside
- But the head has to read all bits in a constant speed
- It is achieved by providing variable spacing between the bits of information
- Outermost track has the largest space and innermost track has the smallest space between the bits
- In this organization, the information from all tracks are scanned by rotating the disk at a fixed speed
- This is called as “constant angular velocity (CAV)”
- Drawback: wastage of disk space



# Multiple zone recording (MZR)

- The surface is divided into a number of concentric zones (typical value is 16)
- Each zone has a number of contiguous tracks (typically thousands)
- Within a zone, the number of bits per track is equal
- Zones farther from the center have more bits than the zones which are closer to the center
- The read-write timing will be different from zone to zone



# Physical characteristics

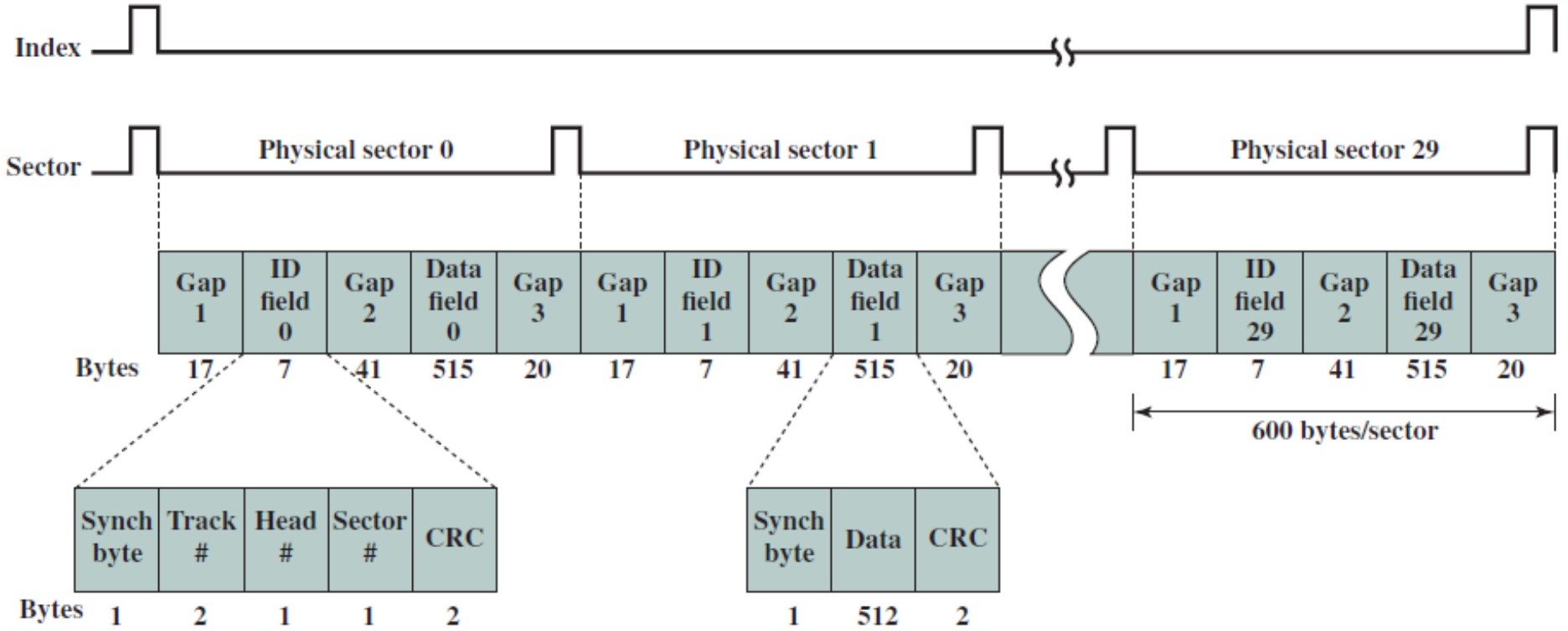
| | |
|---|---|
| **Head Motion** | **Fixed Head (one per track)** |
| | **Movable Head (one per surface)** |
| **Disk portability** | **Non-removable (eg: Hard disk)** |
| | **Removable (eg: Floppy disk)** |
| **Sides** | **Single sided** |
| | **Double sided** |
| **Platters** | **Single platter** |
| | **Multiple platter** |
| **Head mechanism** | **Contact (eg: Floppy)** |
| | **Fixed gap** |
| | **Aerodynamic gap (Winchester)** |

**Cylinder: The set of all tracks in the same relative position on the platter**

**The aerodynamic foil rests lightly on the surface when the disk is not rotating**

**The air produced by the rotation to make the foil rise above the surface**

# Winchester disk format



# Disk performance parameters

- Seek time
  - On a fixed-head system, it is the time to select one head electronically
  - On a movable- head system, it is the time it takes to position the head at the track
- Rotational delay (rotational latency)
  - The time to bring the beginning of the correct sector under the head by rotating the disk
- Access time
  - It is the sum of seek time and rotational delay
- Transfer time
  - The time to transfer the data after the head is on the correct track and the beginning of the sector
  - T=b/(rN)
    - where T, b, r and N are transfer time, number of bytes to be transferred, rotation speed in revolutions per second and the number of bytes on a track respectively
- Average read/write time $T_{total} = T_S + (1/(2r)) + (b/(rN))$

# Numerical examples

- Consider a disk with an advertised average seek time of 4 ms, rotation speed of 15,000 rpm, and 512-byte sectors with 500 sectors per track. Suppose that we wish to read a file consisting of 2500 sectors for a total of 1.28 Mbytes
- Scenario 1: (best time) – All sectors are placed in all sectors of 5 adjacent tracks. So, there is no need for seek time for the 2$^{nd}$ track onwards
  - Ts = 4 ms; r= 2ms; Read 500 sectors = 4 ms; T
  - Time to read the first track data = (4+2+4) = 10 ms
  - Time to read the remaining 4 tracks = 4 * 6 = 24 ms
  - Total time to read the file = 34 ms (or) 0.034 seconds
  - Scenario 2: (worst time) – All sectors are placed in different random sectors

# Numerical examples

- Consider a disk with an advertised average seek time of 4 ms, rotation speed of 15,000 rpm, and 512-byte sectors with 500 sectors per track. Suppose that we wish to read a file consisting of 2500 sectors for a total of 1.28 Mbytes
- Scenario 2: (worst time) – All sectors are placed in different random sectors
  - Average seek time = 4 ms
  - Average rotational delay = 2 ms
  - Average data transfer time of 1 sector = 1/((15000/60)*500)=0.008 ms
  - Average read time for 1 sector = 6.008 ms
  - Average read time for 2500 sectors = 2500 * 6.008 ms = 15.02 seconds

# Optical memory

| | |
|---|---|
| CD | Compact Disk. Non-erasable. Stores digitized audio information. Records more than 60 minutes of audio data |
| CD ROM | CD – Read only memory. Non-erasable. Used to store computer data of more than 650 Mbytes |
| CD R | CD-Recordable. Similar to CD ROM. The user can write the disk only once |
| CD RW | CD- Rewritable. Similar to CDROM. The user can erase and rewrite the disk multiple times |
| DVD | Digital Versatile Disk. DVD ROM. It is a technology for producing digitized, compressed representation of video information (or large volumes of other digital data). When both sides are used, 17GB data can be stored |
| DVD R | DVD Recordable – User can write the disk once. Only one sided disks are used |
| DVD RW | DVD Rewritable. Similar to DVD ROM. User can erase and write multiple times. Only one side is used |
| Blu-ray DVD | High definition video disk. Provides greater data density than DVD. A single layer on single side can store 25 GB. |

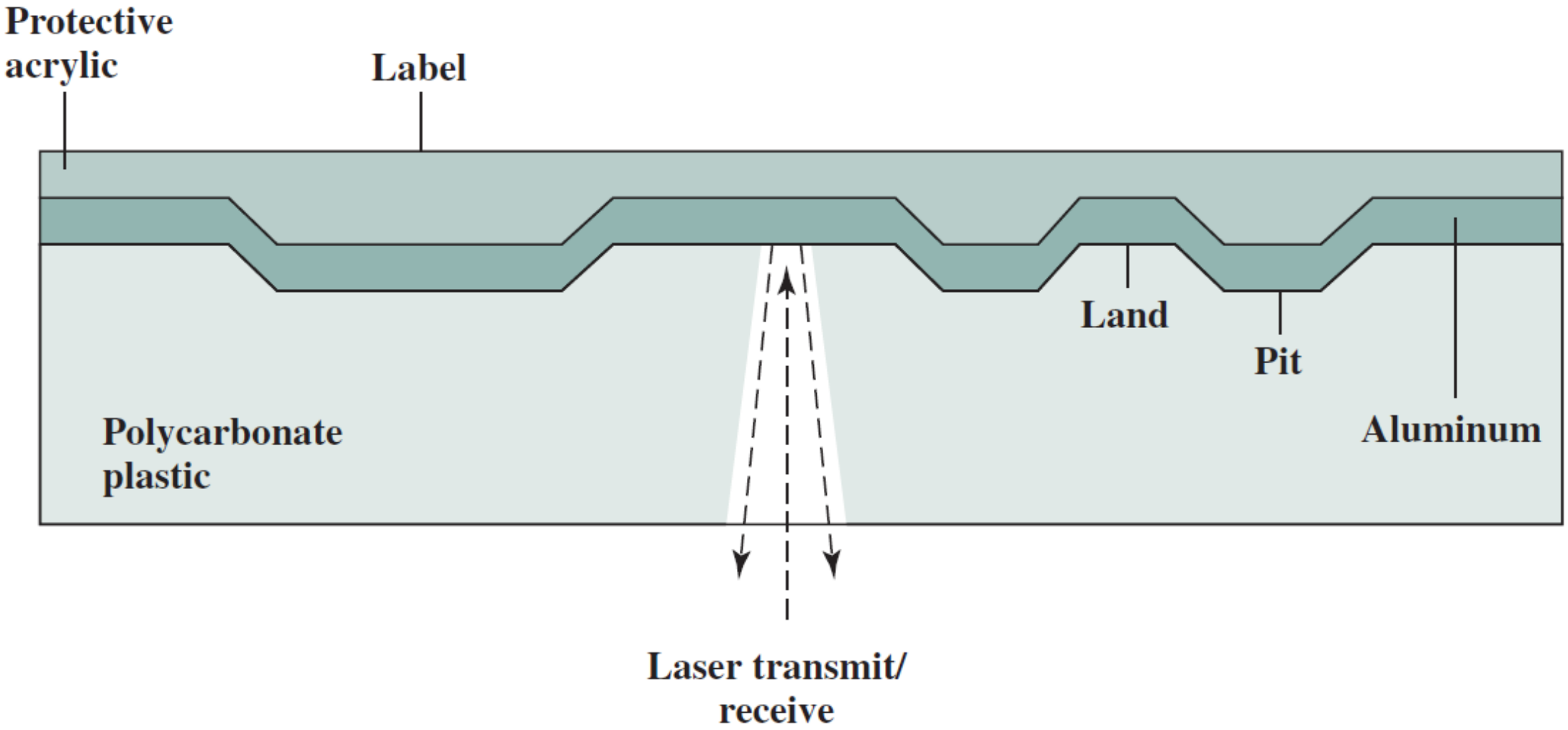
# Compact disk

- Digitally recorded information is imprinted as a series of microscopic pits on the surface of the polycarbonate
- It is done with a finely focussed high-intensity laser to create a master disk
- The master is used to make a die to stamp out copies onto polycarbonate
- The pitted surface is coated with a highly reflective surface
  - Usually Aluminium or gold is used as the reflective surface
- This is protected against dust and scratches by a top coat of clear acrylic
- Finally a label can be silkscreened onto the acrylic

# Compact disk…

- A low powered laser is housed in an optical disk player – or drive unit
- The laser shines through the clear polycarbonate while a motor spins the disk past it
- Pit has rough surface and the land (area in between pits) has  smooth surface
- When the laser beam falls on a pit the light scatters and a low intensity is reflected back to the source.
- When the laser beam falls on a land a high intensity is reflected back to the source
- The change between pits and lands is detected by a photosensor and converted into a digital signal
- The sensor tests the surface at regular intervals
  - The beginning or end of a pit represents a 1
  - When no change in elevation occurs between intervals, a 0 is recorded.

# Compact disk…

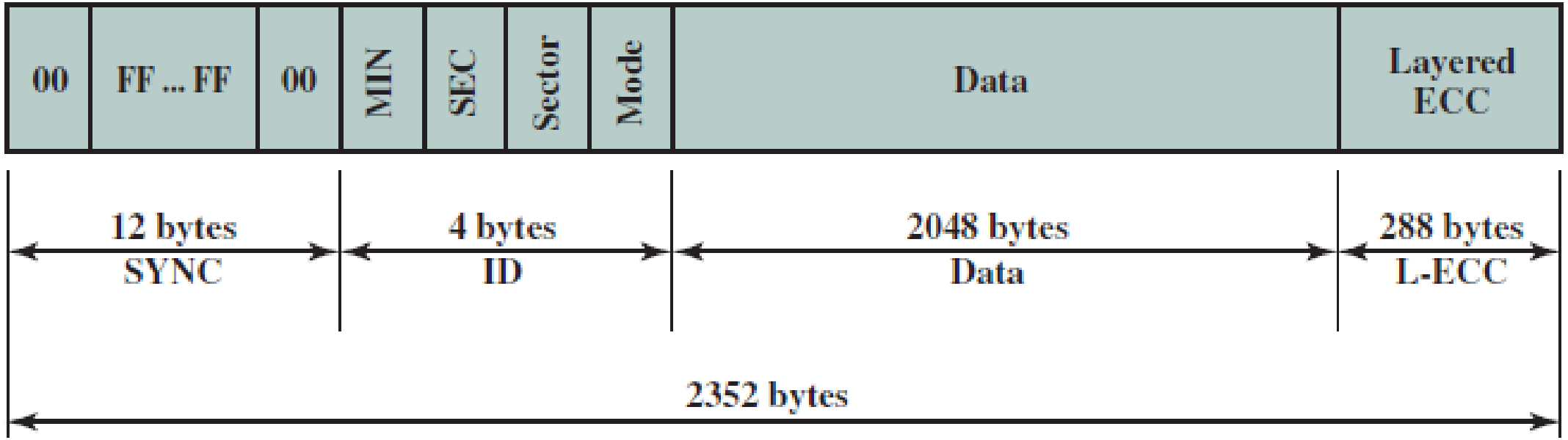


# Compact disk…

- CD uses “constant linear velocity (CLV)” to store more bits
- The data are saved in a single spiral track which begins near the center and spiralling out to the outer edge of the disk
- Sectors near the outside of the disk are the same length as those near the inside
  - So, information is packed evenly across the disk in segments of the same size
  - These are scanned at the same rate by rotating the disk at a variable speed.
  - The pits are read by the laser at constant linear velocity
  - The disk rotates more slowly for accesses near the outer edge than for those near the center

# Data organization

- Available fields
  - Sync
  - Header
  - Data
  - Auxiliary



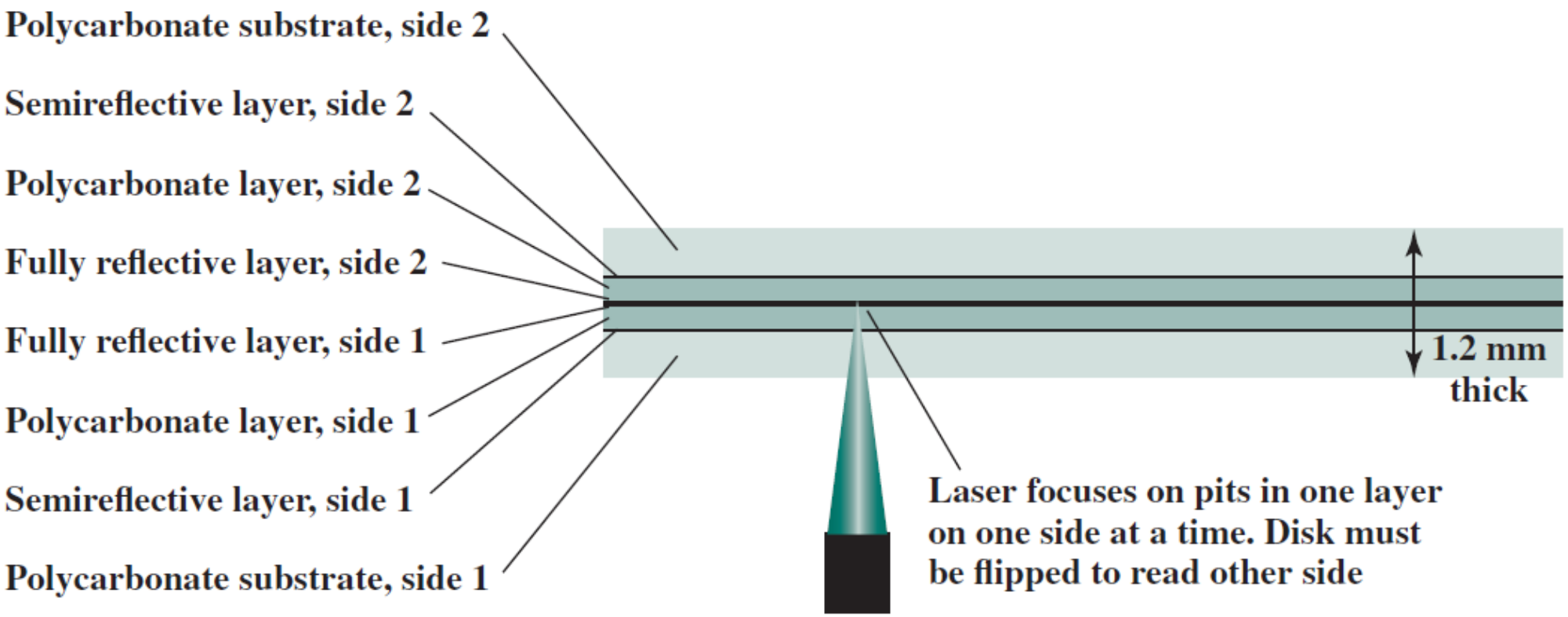
# CD Rewritable

- Phase Change
  - The phase change disk uses a material that has two significantly different reflectivities in two different phase states
  - Amorphous state - The molecules exhibit a random orientation that reflects light poorly
  - crystalline state - smooth surface that reflects light well
  - A beam of laser light can change the material from one phase to the other
  - Current materials can be used for between 500,000 and 1,000,000 erase cycles

# Digital Versatile Disk

- Bits are packed more closely on a DVD than CD
- The minimum spacing between loops and pits are less compared to CD
  - Hence DVD can store 4.7 GB of data
- The DVD employs a second layer of pits and lands on top of the first layer
  - A dual-layer DVD has a semi reflective layer on top of the reflective layer
  - By adjusting focus, the lasers in DVD drives can read each layer separately
  - This technique almost doubles the capacity of the disk, to about 8.5 GB
  - The lower reflectivity of the second layer limits its storage capacity so that a full doubling is not achieved.
- The DVD-ROM can be two sided
  - This brings total capacity up to 17 GB.

# Digital Versatile Disk…



*Thank you*