CHAPTER 6: OPTICAL STORAGE MEDIA

Multimedia Systems

Robinhood Khadka

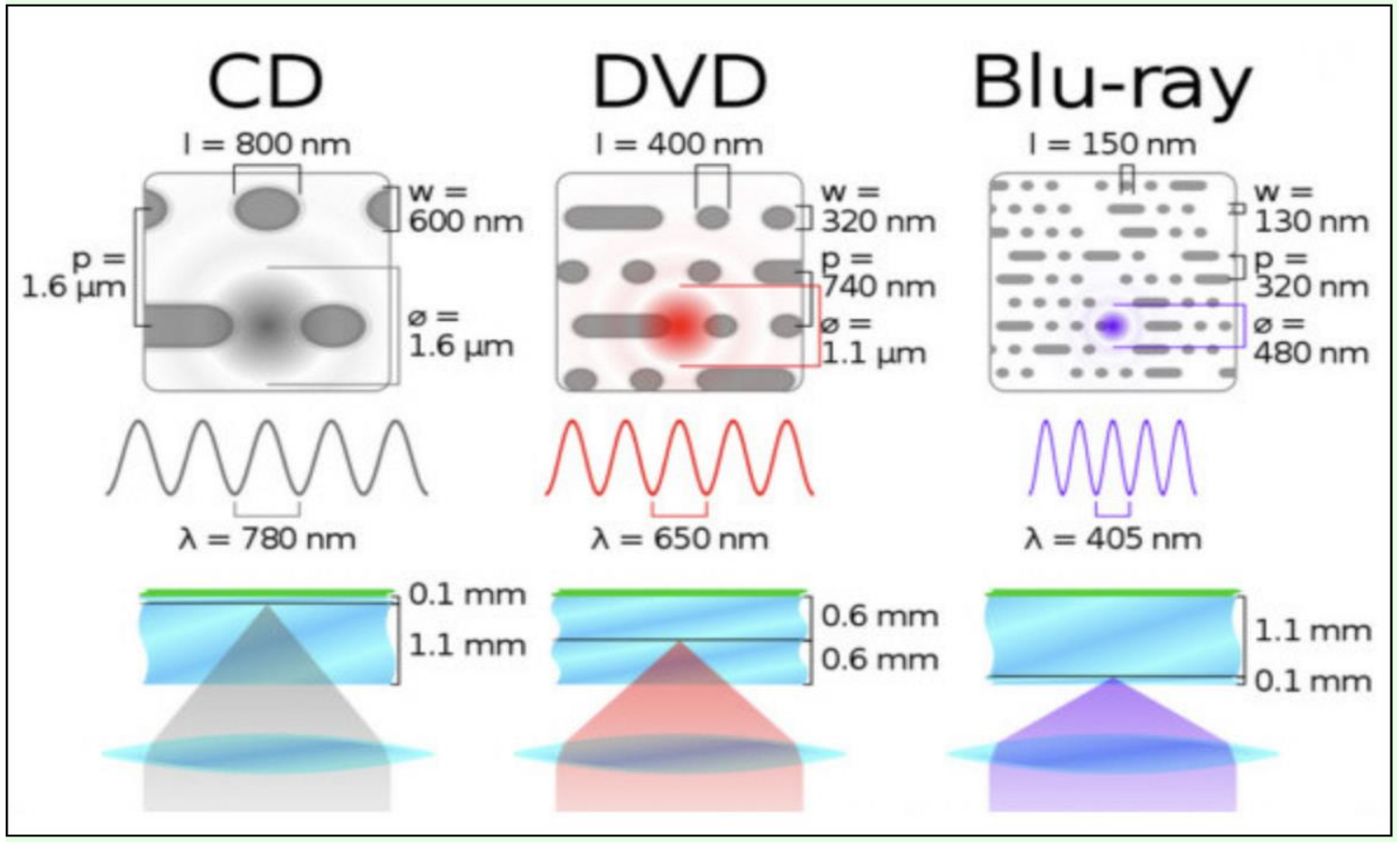
INTRODUCTION

- Optical storage is a type of digital storage that uses light from a laser to read and write data on a spinning disc
- Optical discs are a popular method for storing large amounts of data, as they have a high storage capacity and are quite durable
- This technology has been widely used for various purposes, including storing music, movies, games, and computer software.

CONTINUE..

- Compact Disc (CD): Introduced in the 1980s, CDs can store up to 700MB of data.
- Digital Versatile Disc (DVD): Developed in the late 1990s, DVDs can store between 4.7GB and 17.1GB depending on the type.
- Blu-ray Disc (BD): Launched in the mid-2000s, BDs can store between 25GB and 128GB.
- A CD player cannot natively play Blu-ray discs because CDs and Blu-ray discs use different technologies for data storage and reading. However, Blu-ray players are designed to play both Blu-ray discs and CDs (as well as DVDs).
- Optical storage media differ in terms of their capacity, data transfer rate, and compatibility with devices.

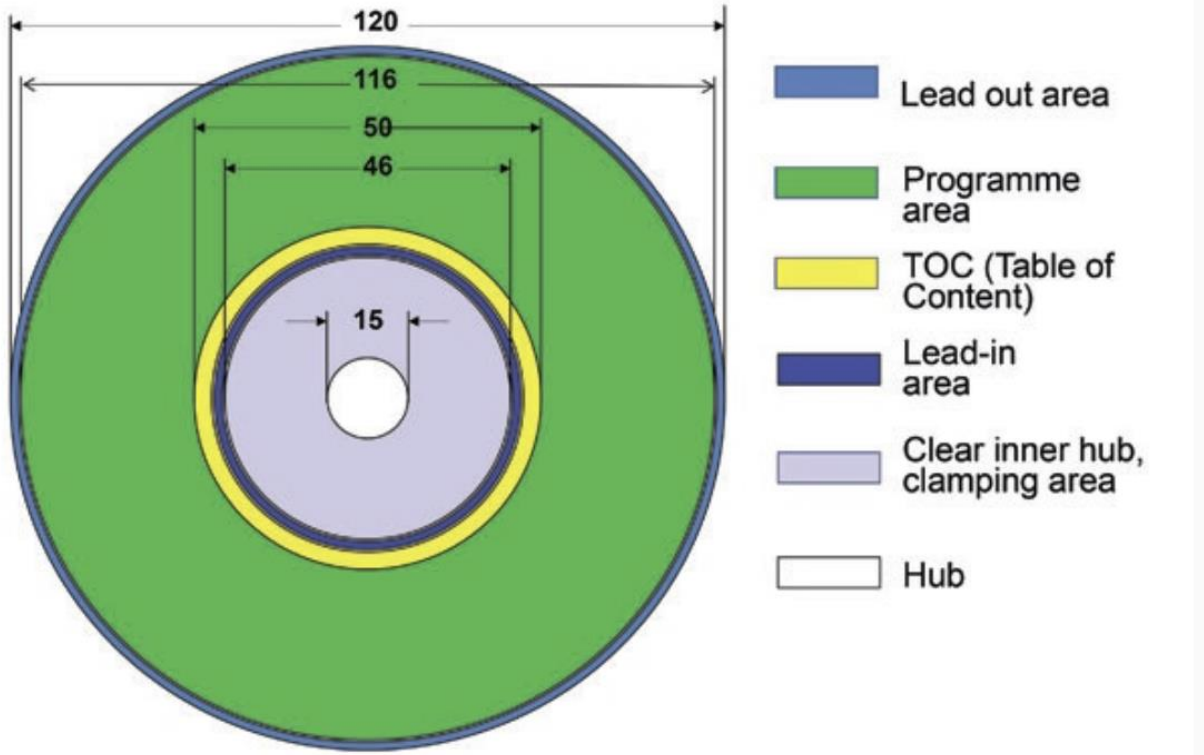
CD, DVD AND BLU-RAY LASERS



Infrared laser for CDs.
Red laser for DVDs.
Blue-violet laser for Blu-ray.

FUNDAMENTALS

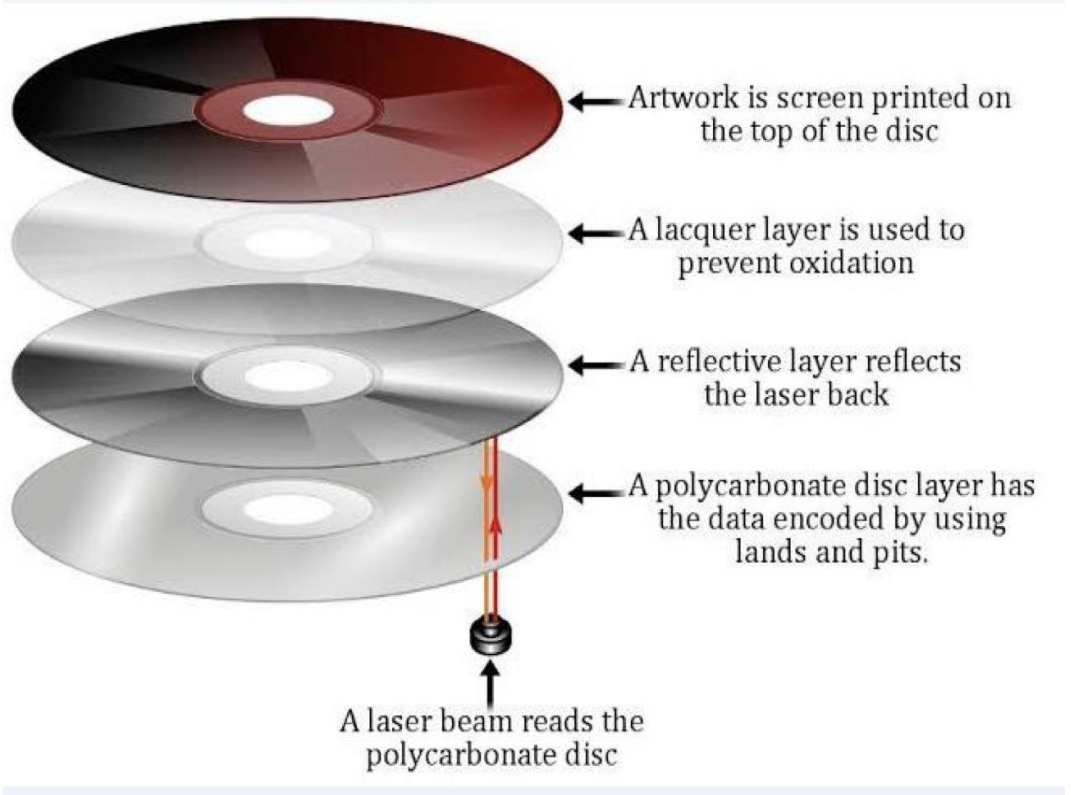
- In optical storage technology, data is written and read by a laser diode in the optical storage drive.
- Recording and reproducing data involves several steps:
- 1. Encoding: Transforming data into a binary format to be stored on a disc.
- 2. Writing: Storing data on a disc by either burning pits or modifying its reflective properties.
- 3.Reading: Retrieving data from the disc using a laser that detects changes in light reflection
- 4.Decoding: Converting the binary information back into the original data.



CONSTRUCTION

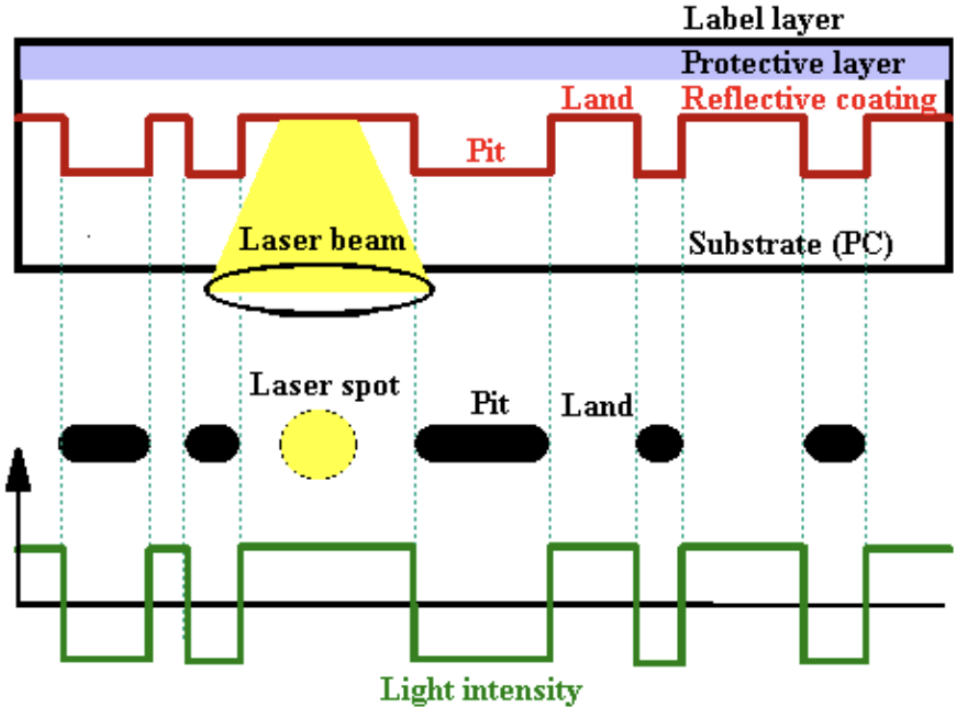
- A CD is flat, round, portable metal disc, made of clear polycarbonate plastic, coated with a reflective metal, and a protective coat of clear lacquer.
- Data placed on the CD-ROM in the form of small pits recorded in a spiral track starting at the center of the CD-ROM and working to the outer edge.
- If the data track of a CD-ROM could be stretched out it would be about 4.5km long.
- Three type of reflective metals are typically used for this layer: aluminum, gold, and silver or silver alloy.

1. Label: An optional layer that can have printed text or images.
2. Polycarbonate layer: A transparent layer that houses the actual data (pits and lands).
3. Reflective layer: A thin layer of material that reflects the laser light back towards the laser diode.
4. Protective layer: A clear layer that protects the reflective layer from damage.



READING/WRITING OF CD

- When reading a CD-ROM, a low power laser beam is focused on the rotating CD- ROM and its reflection is viewed by the read head.
- When the beam reflects back from the CD-ROM, its intensity changes as it moves from "land" to "pits".
- CD- ROMs rotate at a constant linear velocity (CLV) This requires that the driver's servo mechanism makes the CD-ROM turn slower as the read head moves to the outer edge of the disc.
- During the writing process, a laser diode emits a focused beam of light onto the spinning disc. When the laser hits the disc's surface, it burns a series of tiny pits into the polycarbonate layer. These pits represent 0s and the unburned areas (lands) represent 1s, creating a binary code.



EIGHT TO FOURTEEN MODULATION(EFM)

- Eight-to-Fourteen Modulation (EFM) is a data encoding technique used primarily in Compact Discs (CDs) to efficiently store digital information.
- It converts 8-bit data into a 14-bit sequence, ensuring the presence of sufficient transitions in the data stream to maintain synchronization between the reading devices and CDs using a predefined lookup conversion table.
- The codewords are carefully chosen to satisfy the minimum transition rule (at least 2 and at most 10 consecutive 0s between 1s).
- This method helps reduce the chances of errors during data retrieval.
- EFM helps to minimize errors caused by scratches, dust, or imperfections.

Eight to fourteen modulation (EFM) encoding table:

Decimal Value	Original Bits	Translated Bits
0	00000000	01001000100000
1	00000001	10000100000000
2	00000010	10010000100000
3	00000011	10001000100000
4	00000100	01000100000000
5	00000101	00000100010000
6	00000110	00010000100000
7	00000111	00100100000000
8	00001000	01001001000000

ERROR HANDLING

- Error handling in Compact Discs (CDs) is achieved through a combination of error detection, error correction, and concealment techniques. These methods ensure reliable playback and data retrieval even in the presence of scratches, dust, or physical imperfections on the disc.
- Cross-Interleaved Reed-Solomon Code (CIRC).CIRC is the primary error correction mechanism in CDs. It involves two main components:
- 1. Reed-Solomon Error Correction
- The data is encoded with parity symbols using the Reed-Solomon algorithm.
- These parity symbols add redundancy, enabling the correction of up to 2,000 consecutive bits.
- 2. Interleaving
- Data is interleaved (shuffled) before being written to the CD.
- This spreads the data over a larger area, so localized damage (scratch) affects less critical parts of the data stream.
- During playback, the interleaved data is de-interleaved to reconstruct the original order, mitigating the impact of damage.

CD-ROM

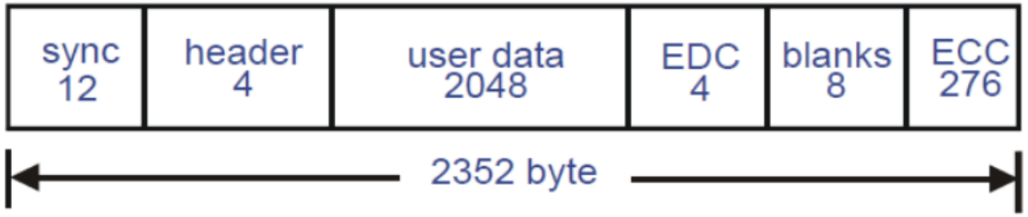
- CD-ROM is a type of Compact Disc (CD) that is designed to store data in a read-only format.
- The data on a CD-ROM is written during manufacturing and cannot be altered or erased by the user.
- Data is physically stamped into the disc during production, making it resistant to accidental erasure or overwriting.
- It is widely used for distributing software, games, multimedia content, and large datasets. Unlike audio CDs, CD-ROMs are optimized for storing digital data rather than sound.
- A CD-ROM may contain audio and data. In such mixed form, the data tracks are usually at the beginning followed by the audio tracks. Hence they are also called mixed mode disc.
- Has two modes that are used to hold uncompressed datas:
  - **MODE 1 & MODE 2**

<The main difference between the two modes lies in how much error correction and overhead data is applied to the stored data>

CD-ROM-MODES

MODE 1

- Mode 1 is the standard format for CD-ROMs and is the most commonly used format for storing data.
- Data is stored in 2048-byte sectors. Each sector contains the actual data plus additional error correction information.
- Uses Cross-Interleaved Reed-Solomon Code (CIRC) for error correction.
- Has a relatively higher level of error correction, making it suitable for applications where data integrity is important



MODE 2

- Mode 2 is often used for audio-visual and multimedia applications where higher data throughput is required, but some error correction can be sacrificed.
- Mode 2 stores data in 2336-byte sectors. The larger sector size allows more user data to be stored but here is less room for error correction data.

DIFFERENCE: MODE 1 & MODE 2

Aspect	Mode 1	Mode 2
Primary Use	General data storage	Multimedia data
Error Correction	Includes EDC/ECC	No error correction
User Data per Sector	2,048 bytes	2,336 bytes
Reliability	High data integrity	Lower integrity, higher capacity
Applications	Software, documents, text-based data	Audio, video, and games

CD-ROM/XA (EXTENDED ARCH.)

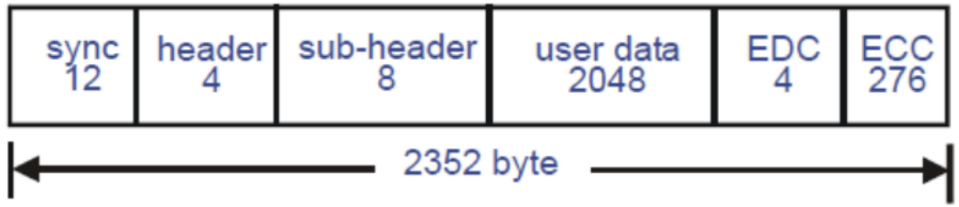
- The CD-ROM Extended Architecture (XA) is an extension of the standard CD-ROM format, introduced to support multimedia applications like video, audio, and interactive content.
- XA was developed to overcome the limitations of the original CD-ROM by enabling the storage of both data and audio/video content on the same CD, while maintaining compatibility with standard CD players and drives.
- It allows audio and video to be synchronized with data, enabling more interactive applications, like video games and multimedia presentations. This means Audio and video data are interleaved with regular data files.
- While it enhanced the capability of the traditional CD, the format was eventually superseded by newer technologies, such as DVD-ROM and Blu-ray, which offer higher storage capacities and more advanced multimedia support.
- There are two formats used to organize the data on the disc: **Form 1 & Form 2.**

<The main difference is in how they handle data interleaving and error correction>

CD-ROM/XA

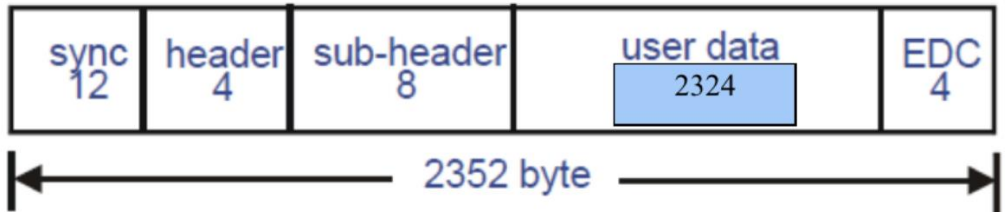
Form 1

- Form 1 is primarily designed for data + audio interleaving.
- Form 1 interleaves audio with regular data files, making it possible to access multimedia content along with program data.
- The unused 8 bytes of mode 1 are used as sub-headers
- Standard Reed-Solomon with interleaving for error correction



Form 2

- Form 2 allows for more complex multimedia content, including video.
- Form 2 is optimized for storing video data along with audio and other data.
- Enables synchronized video playback while other data is being accessed.
- Standard Reed-Solomon algorithm for multimedia content
- 13% more data space, at loss of error handling.



CD-WO(WRITE ONCE)

- CD-WO (Compact Disc Write Once) is a type of optical disc technology that allows data to be written once but not erased or rewritten.
- The key feature of CD-WO is that once data is written onto the disc, it becomes permanent and cannot be modified or deleted.
- CD-WO is used in various applications, including archival storage, data distribution, and for applications that require write-once media.
- They are also called WORM disc (Write Once Read Many)
- CD-WO discs are relatively inexpensive compared to other forms of writable media like hard drives or optical discs that are rewritable.
- CD-WO discs are generally compatible with most standard CD players and drives that support CD-R and CD-ROM formats.

CD-MO(MAGNETO OPTICAL)

- CD-MO discs use a magneto-optical (MO) recording process, which incorporates both laser light and magnetic fields to write and read data.
- The technology allows data to be written, erased, and rewritten on the disc many times, similar to a hard drive or floppy disk, but using optical technology for reading and writing.
- A magneto-optical layer is applied on the disc. This layer consists of a material that has magnetic properties but can also be altered by a laser beam.
- When writing data, a laser beam heats the magneto-optical material to a temperature above its Curie point (>150 degrees)(the temperature at which the material loses its magnetic properties).
- They are not compatible with standard CD-ROM drives. The magneto-optical mechanism in CD-MO requires special drives that are equipped with both the optical laser and the magnetic head.

END OF CHAPER 6