Computer Organization and Architecture (EET 2211)

Lecture 24

OPTICAL MEMORY

- In 1983, one of the most successful consumer products of all time was introduced: the compact disc (CD) digital audio system.
- The CD is a non-erasable disk that can store more than 60 minutes of audio information on one side.
- The huge commercial success of CD enabled the development of low-cost optical disk storage technology that revolutionized computer data storage.

Table 6.6 Optical Disk Products

CD
Compact Disk. A nonerasable disk that stores digitized audio information. The standard system uses 12-cm disks and can record more than 60 minutes of uninterrupted playing time.

CD-ROM
Compact Disk Read-Only Memory. A nonerasable disk used for storing computer data. The standard system uses 12-cm disks and can hold more than 650 Mbytes.

CD-R
CD Recordable. Similar to a CD-ROM. The user can write to the disk only once.

CD-RW
CD Rewritable. Similar to a CD-ROM. The user can erase and rewrite to the disk multiple times.

DVD
Digital Versatile Disk. A technology for producing digitized, compressed representation of video information, as well as large volumes of other digital data. Both 8 and 12 cm diameters are used, with a double-sided capacity of up to 17 Gbytes. The basic DVD is read-only (DVD-ROM).

DVD-R
DVD Recordable. Similar to a DVD-ROM. The user can write to the disk only once. Only one-sided disks can be used.

DVD-RW
DVD Rewritable. Similar to a DVD-ROM. The user can erase and rewrite to the disk multiple times. Only one-sided disks can be used.

Blu-ray DVD
High-definition video disk. Provides considerably greater data storage density than DVD, using a 405-nm (blue-violet) laser. A single layer on a single side can store 25 Gbytes.

Compact Disk

CD-ROM

- Both the audio CD and the CD-ROM (compact disk read-only memory) share a similar technology.
- The main difference is that CD-ROM players are more rugged and have error correction devices to ensure the data are properly transferred from disk to computer.
- Digitally recorded information (either music or computer data) is imprinted as a series of microscopic pits on the surface of the polycarbonate.

- Information is retrieved from a CD or CD-ROM by a low-powered laser housed in an optical-disk player, or drive unit.
- The intensity of the reflected light of the laser changes as it encounters a **pit**.
- The areas between pits are called **lands**.
- The change between pits and lands is detected by a photosensor and converted into a digital signal.

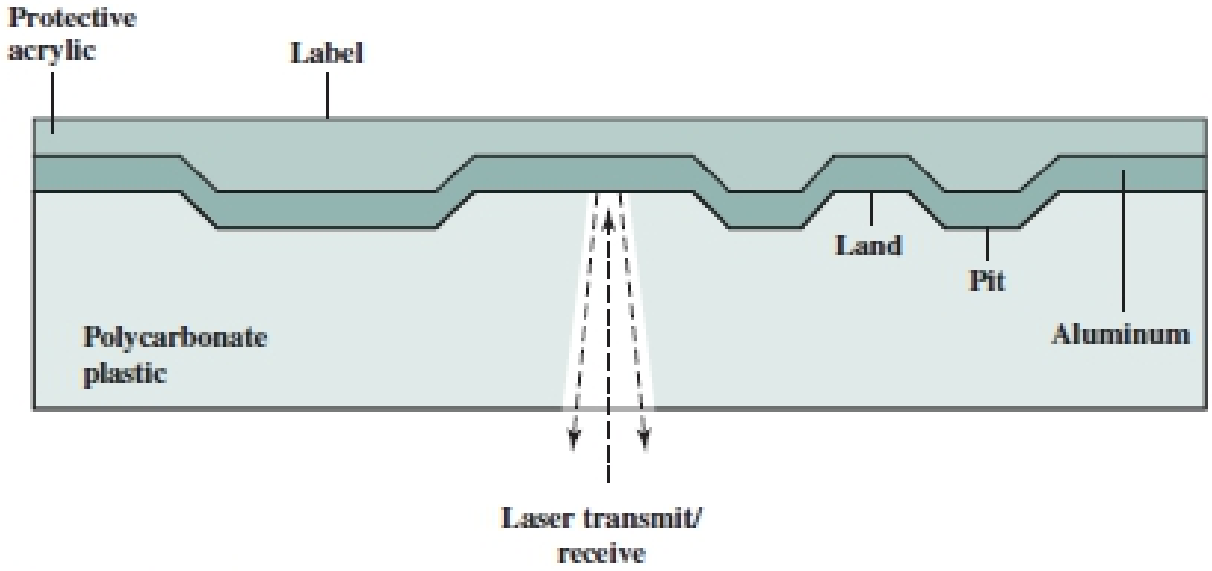


Figure 6.9 CD Operation

- To achieve greater capacity, CDs and CD-ROMs do not organize information on concentric tracks.
- Instead, the disk contains a single spiral track, beginning near the center and spiraling out to the outer edge of the disk.
- Sectors near the outside of the disk are the same length as those near the inside.
- The pits are read by the laser at a **constant linear velocity (CLV)**.
- The data capacity for a CD-ROM is about 680 MB.

Data on the CD-ROM are organized as a sequence of blocks.

It consists of the following fields:

- **Sync:** The Sync field identifies the beginning of a block. It consists of a byte of all 0s, 10 bytes of all 1s, and a byte of all 0s.
- **Header:** The header contains the block address and the mode byte. **Mode 0** specifies a blank data field; **mode 1** specifies the use of an error-correcting code and 2048 bytes of data; **mode 2** specifies 2336 bytes of user data with no error-correcting code.
- **Data:** User data.
- **Auxiliary:** Additional user data in mode 2. In mode 1, this is a 288-byte error-correcting code.

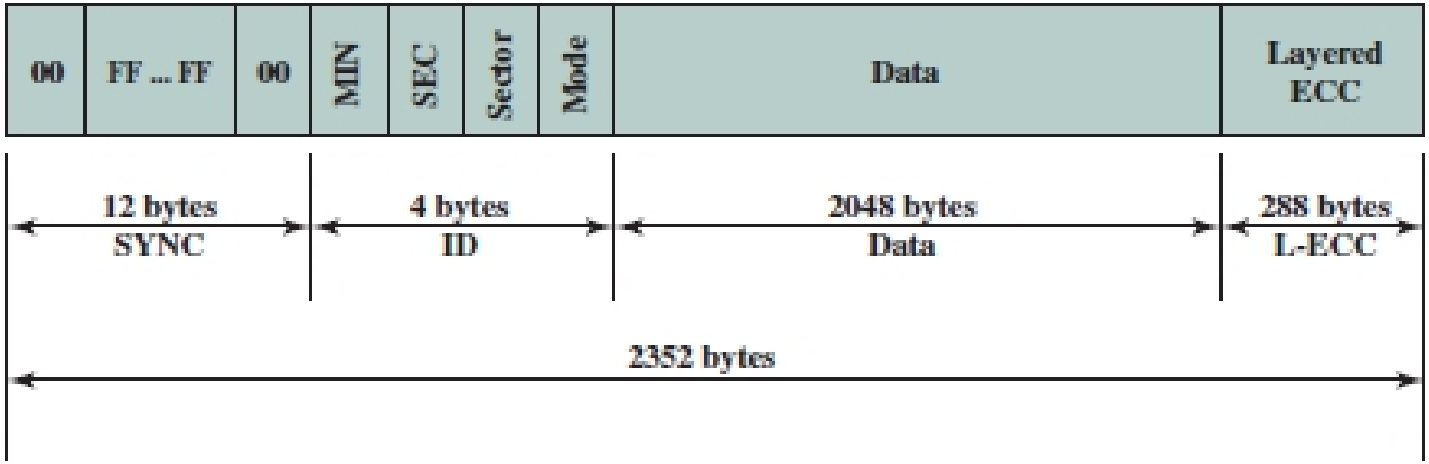


Figure 6.10 CD-ROM Block Format

- With the use of CLV, random access becomes more difficult.
- CD-ROM is appropriate for the distribution of large amounts of data to a large number of users.
- Because of the expense of the initial writing process, it is not appropriate for individualized applications.

Compared with traditional magnetic disks, the CD-ROM has two **advantages**:

- The optical disk together with the information stored on it can be mass replicated inexpensively – unlike a magnetic disk.
- The optical disk is removable, allowing the disk itself to be used for archival storage.

The **disadvantages** of CD-ROM are as follows:

- It is read-only and can not be updated.
- It has an access time much longer than that of a magnetic disk drive, as much as half a second.

CD RECORDABLE:

- To accommodate applications in which only one or a small number of copies of a set of data is needed, the write-once read-many CD, known as **CD recordable (CD-R)**, has been developed.
- For CD-R, a disk is prepared in such a way that it can be subsequently written once with a laser beam of modest-intensity.
- The CD-R medium is similar to but not identical to that of a CD or CD-ROM.
- For a CD-R, the medium includes a dye layer.
- The CD-R optical disk is attractive for archival storage of documents and files.

CD REWRITABLE:

- The **CD-RW** optical disk can be repeatedly written and overwritten, as with a magnetic disk.
- The **phase change** disk uses a material that has two significantly different reflectivities in two different phase states.
- There is an amorphous state, in which the molecules exhibit a random orientation that reflects light poorly; and a crystalline state, which has a smooth surface that reflects light well.
- A beam of laser light can change the material from one phase to the other.

The primary **disadvantages** is:

- In the phase change optical disks, the material eventually and permanently loses its desirable properties.

The **advantages** of CD-RW over CD-ROM and CD-R are as follows:

- It can be rewritten and thus used as a true secondary storage.

Digital Versatile Disk:

- With the capacious **Digital Versatile Disk (DVD),** the electronics industry has at last found an acceptable replacement for the analog VHS(Video Home System) video tape.

- The DVD takes video into the digital age.

- Vast volumes of data can be crammed onto the disk, currently seven times as much as a CD-ROM.

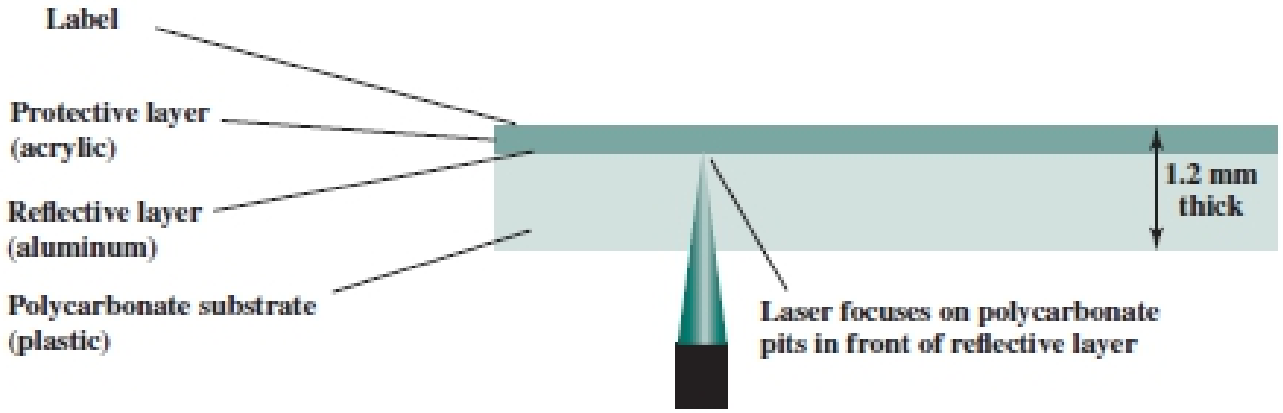
The DVD's greater capacity is due to three differences from CDs

1. Bits are packed more closely on a DVD. The spacing between loops of a spiral on a CD is 1.6μm and the minimum distance between pits along the spiral is 0.834μm.

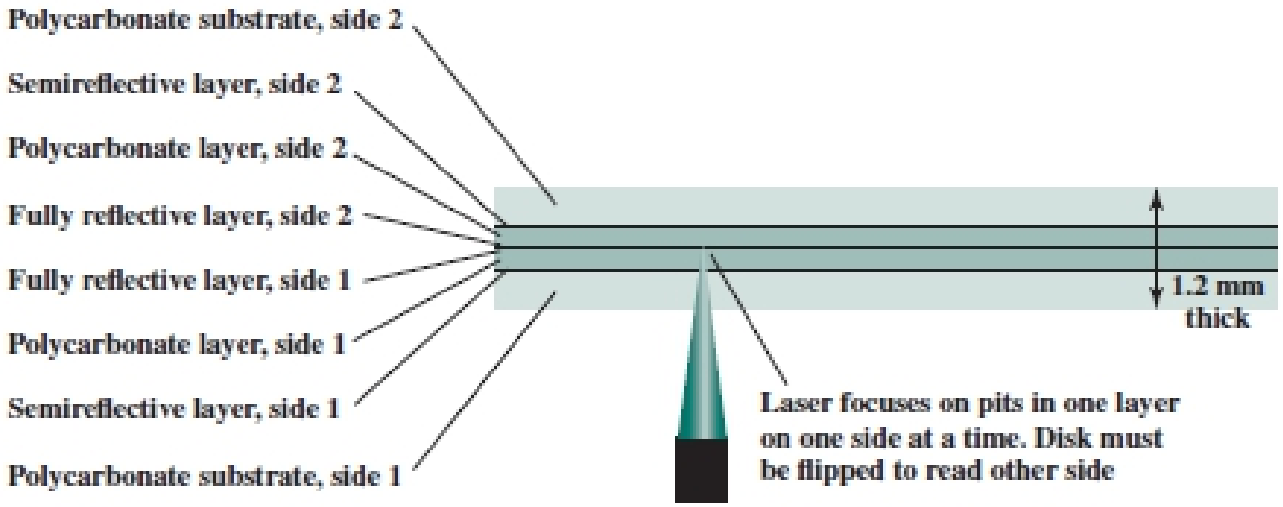
   The DVD uses a laser with shorter wavelength and achieves a loop spacing of 0.74μm and a minimum distance between pits of 0.4μm. The result of these two improvements is about a seven-fold increase in capacity to about 4.7GB.

2. The DVD employs a second layer of pits and lands on top of the first layer. A dual-layer DVD has semi reflective layer, and by adjusting focus, the lasers in DVD drives can read each layer separately.

3. The DVD-ROM can be two sided, whereas data are [redacted] one side of a CD. This brings total capacity [redacted] GB.



(a) CD-ROM–Capacity 682 MB



(b) DVD-ROM, double-sided, dual-layer–Capacity 17 GB

Figure 6.11 CD-ROM and DVD-ROM

High-Definition Optical Disk:

- High-definition optical disks are designed to store high-definition videos and to provide significantly greater storage capacity compared to DVDs.
- The higher bit density is achieved by using a laser with a shorter wavelength, in the blue-violet range.
- Two competing disk formats and technologies initially competed for market acceptance: HD DVD and Blu-ray DVD.
- The HD DVD scheme can store 15 GB on a single layer on a single side.
- Blu-ray positions the data layer on the disk closer to the laser. This enables a tighter focus and less distortion and thus smaller pits and tracks.
- Blu-ray can store 25GB on a single layer.

available: read only ((Blue ray Disc)BD-ROM), once (BD-R), and rerecordable (BD-RE).

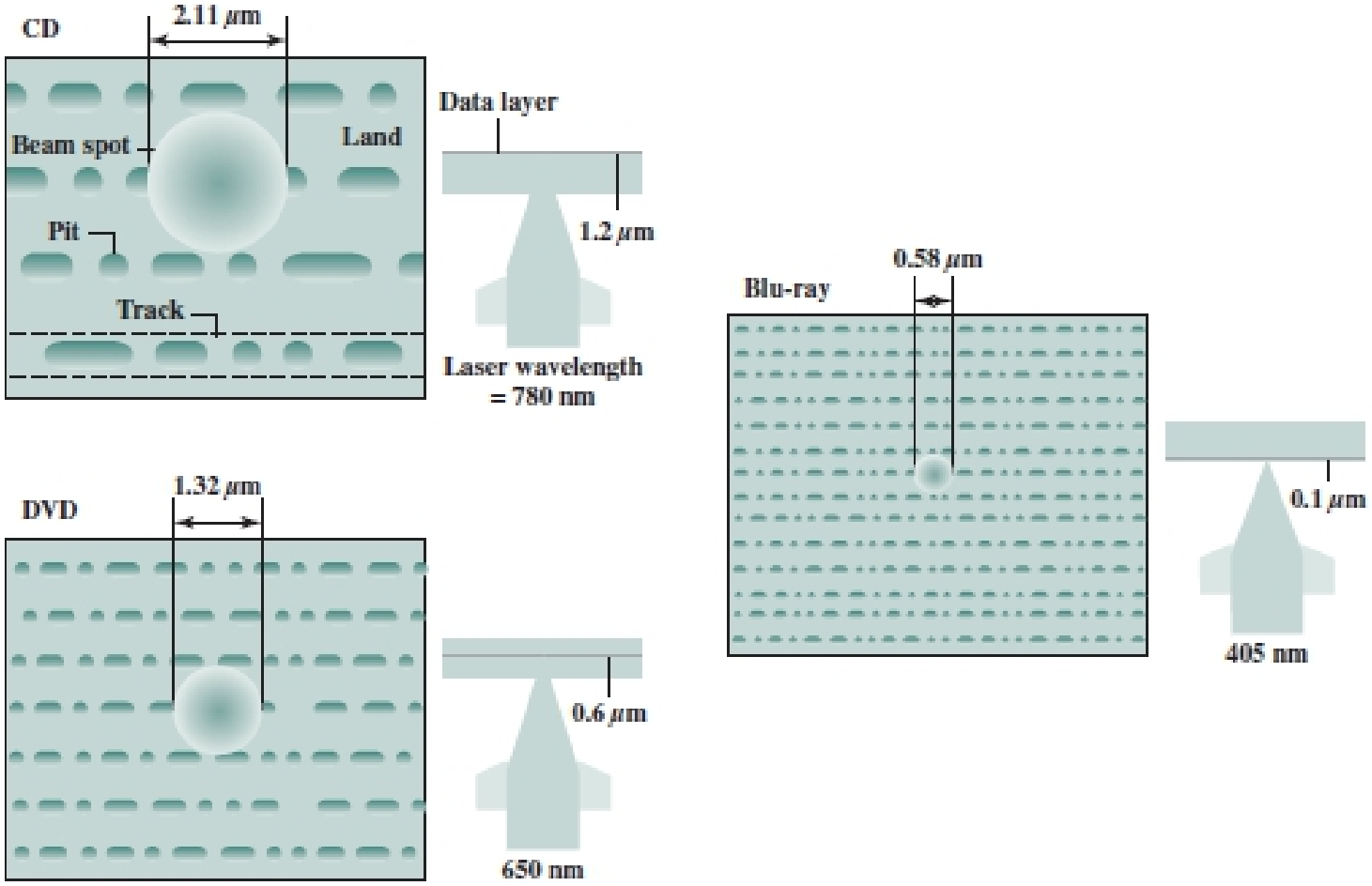


Figure 6.12 Optical Memory Characteristics