Secondary Storage Devices: CD-ROM

Last Time : Magnetic Tapes

Today

- Complete discussion of magnetic tapes from last class
- Physical Organization of CD-ROM
- CD-ROM Strengths and Weaknesses

Reference: Folk, Zoellick and Riccardi. Sections 3.5 and 3.6.

Physical Organization of CD-ROM

Compact Disc - read only memory (write once)

- Data is encoded and read optically with a laser
- Can store around 600 MB data

Digital data is represented as a series of **Pits** and **Lands**.

Pit = a little depression, forming a lower level in the track
Land = the flat part between pits, or the upper levels in the track

Reading a CD is done by shining a laser at the disc and detecting changing reflections patterns.

1 = change in height (land to pit or pit to land)
0 = a “fixed” amount of time between 1’s

```
       LAND        PIT        LAND        PIT   LAND
... ------------+     +-------------+       +---- ...
                |_____|             |_______|

... 0 0 0 0 0 0 1 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 0 ...
```

Changes in height in the track are detected as changes of intensity of th reflected light.

Note: We cannot have two 1's in a row!

Indeed, because of other limitations there must be at least two and at most ten 0's between two 1's.

Therefore, each of the 256 bytes must be encoded into a sequence of bits that has every pair of 1's separated by at least two zeros. There tare exactly 267 binary words of length 14 that satisfy this property; 256 of them were chosen to represent every possible byte in the so-called eight to fourteen modulation. We could not encode bytes using 13 bits since there are only 188 words of length 13 having the desired property.

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
...	...	...

Note that: Since 0's are represented by the **length of time** between transitions, we must travel at **constant linear velocity** on the tracks.

Comparing CD-ROM with magnetic disks:

CR-ROM	**Magnetic Disks**
CLV = Constant Linear Velocity	CAV = Constant Angular Velocity
Sectors organized along a spiral	Sectors organized in concentric track
Sectors have same linear length (data packed at its maximum density permitted)	Sectors have same angular length (data written less densely in the outer tracks)
Advantage: takes advantage of all storage space available	Advantage: operates on constant speed, timing marks to delimit tracks
Disadvantage: has to change rotational speed when seeking (slower towards the outside)	Disadvantage: it doesn't use up all storage available

Addressing

1 second of play time is divided up into 75 **sectors**.

Each sector holds 2KB.

60 Min CD :
60 min x 60 sec/min x 75 sectors/sec = 270,000 sectors = 540,000 KB $\sim$ 540 MB

A **sector** is addressed by :
Minute : Second : Sector
16:22:34
16 min, 22 sec, 34th sector

Difficulty in Seeking

- To read address of a sector it must be at the correct speed
- But knowing the correct speed depends on the ability to read the address info!

The **drive control mechanism** solves this problem by trial-and-error.
This slows down the performance!

CD-ROM Strength and Weaknesses

- Seek performance ($\sim$ 500 msecs) - Slow
  Our old analogy :
  20 secs (RAM)
  58 days (Magnetic Disks)
  2.5 years (CD-ROM)
- Data transfer rate - 150 KB/sec - Slow (while $\sim$ 3,000 KB/sec for magnetic disks)
- Storage capacity $\sim$ 600 MB
- Read-only access (publishing medium)

Things changed nowadays :

- Most drives use CAV or combination of CAV and CLV
- Other types of compact discs :
  - CD-R = compact disc-recordable
  - CD-RW = compact disc-rewritable
  They use different technologies which simulates the effect of Pits and Lands.