

CS162 Spring 2009

03/18/2009 Wed

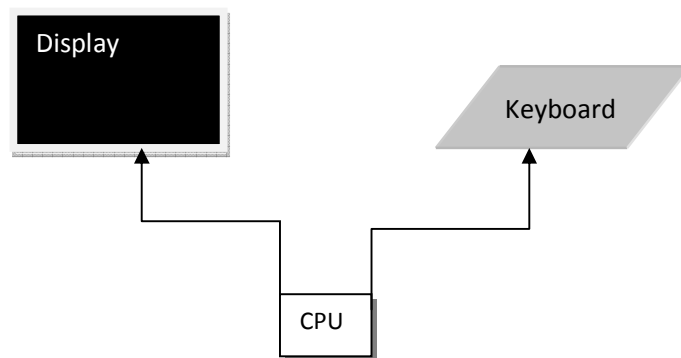
Lecture Notes (Taken by Guan Quan Liu)

Today's Topic:

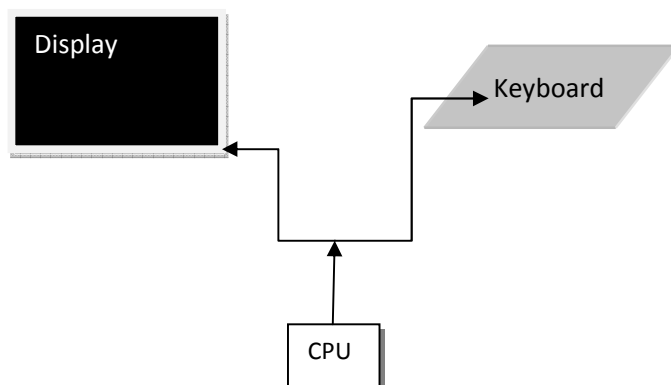
I/O Devices

- Terminal

- Capacity: one character sent at a time, for one interrupt (with DMA, I/O devices have its own controller to process characters)
- Speed: Baud Rate of 300 ~ 19200 (equivalent to 10 ~ 1900 character per second)
- Keyboard and Display: independent (full duplex)
 - Full Duplex: CPU can process output to display and input from keyboard at the same time.

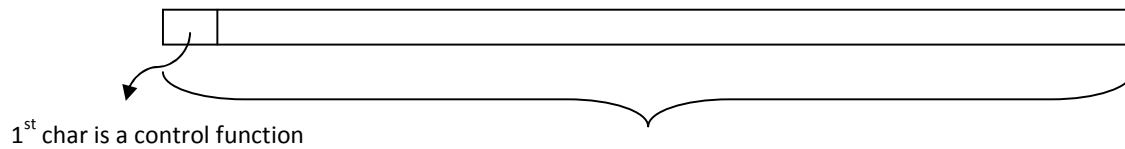


- Half Duplex: CPU can only process output or input once at a time.



- Line Printer

- A line of record



Fixed length: 132 printable characters

- Control function (1st character) can have stuff like “normal”, “skip to next page” and so on.
 - Speed: 2000 lines per minute. (this can vary) IBM has bigger machines, but cost much more.
 - Print methods: 1. print chain. A belt of letters goes by to be hammered for each field. 2. Drum. It rotates vertically with hammers behind, it hits characters as needed
 - Drawback: Frequent Paper Loading. Line printers can consume the box of paper in 10 minutes.
- Raster Printer : typically a laser or ink-jet printer
 - Pixel density on a page: typically 8 million pixels per page (each pixel can be made black or white)
 - Typical Painting Speed: 5 ~ 30 pages per minute
 - Laser printer: melt toner onto paper; the paper maker pass(es) around the imaging drum to pick up layer(s) of toner. 4 layers for color printer: cyan, magenta, yellow and black. Only 1 layer for B&W printer. Therefore B&W is 4 times quicker.
 - Ink-jet printer: ink drop can be produced by heat or by pressure on the cartridge
 - Challenge of printer technology: paper jam.
 - Displays
 - CRT: Cathode Ray Tube
 - The screen is phosphor coated. When electron beam hits it, it will glow.
 - Electron beam: generated by high voltage, controlled by magnetic field (deflecting the beam to specific pixels)
 - Q: How to obtain color?
 - A: Each color is a combination of different pixels. Beam shines to the desired sub-pixels.
 - LCD: Liquid Crystal Display
 - Each pixel is controlled by either passive or active matrix
 - Passive matrix: a column and row select; slower: 150ms response time.

- Active matrix: thin-film, individual transistor; faster: 40ms response time.
- Backlight is a must. But it saves more power than CRT.
- Typical LCD power consumption: 2~5W.
- Q: How to obtain color?
- A: Using color filters and sub-pixels.

➤ OLED: Organic Light Emitting Diodes

- Current induces light emission.
- Advantages: bright; energy efficient; no back light required; no viewing angle limit.

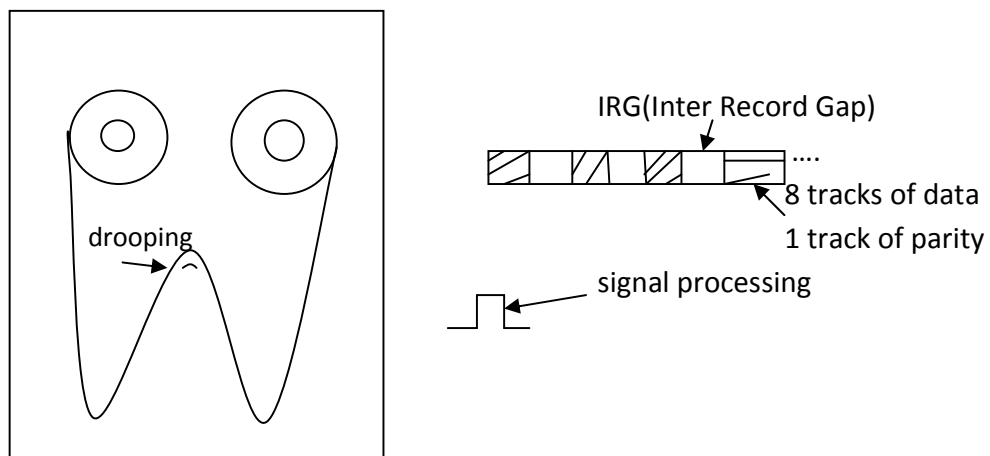
➤ Plasma: Radiation of Plasma causes phosphor emission.

- Advantage vs. LCD: Cheaper; display motion pictures better.
- Disadvantage vs. LCD: shorter life time; more power hungry.

➤ FED: Field Emitter Display. Electron gun controls each pixel.

➤ Touch Screen: Capacitive ones don't require much precision.

- Reel to Reel Tape: we need the tape to read fast, but the reels move too slow



- Typical specification: 9 Tracks, 0.5" wide by 2400 feet long.
- Disadvantage for tape: not addressable; new data can only be appended; read/write only in one direction
- material: iron oxide is history now
- newest disk has perpendicular domain
- Density: 800, 1600 or 6250 bytes per inch (dpi), which is less than calculated capacity of 180-200MB due to large interrecord gaps
- Speed: 125 inches/ second
- Newer IBM Cartridges:
 - Typical Specification: 220MB, 18 Tracks with the tape in 540'long, 1/2" wide

- Speed: 3MB/sec
 - Sealed which facilitates auto loading by robots in large tape libraries
 - Expensive.
- DEC Tape (obsolete now):
 - Pros: Allows random reads and writes. Cheap. Addressable.
 - Cons: Slow.
- DAT Tape:
 - Typical Specification: 4mm tape. 2GB Large. Allows random reading and writing
 - Speed: (1993) 183 KB/sec
 - A little history:
 - DAT are good as an audio format; however, the recording industry killed the format because of potential piracy issue.
 - DAT tapes were more sophisticated than reel to reel tapes. Originally they contained only 7 tracks which only stored data bits; later on they evolved to 9 tracks with both data and ECC bits.
 - Tape speed is comparable to reel to reel speeds. Speed is limited by stretching and tearing of tape. However, DAT tapes are read with diagonal scan method. Head rotate as it reads allowing for higher bit rates.
 - Tapes offer cheap dense storage. However, they are not reliable as permanent storage. Tapes will eventually lose their magnetic information. ECC can only correct for only so much errors. Tapes are not invulnerable to physical damage.
- DLT Tape:
 - Feature: Linear Tape System; Tracks to in both direction of tape:
 - Typical Specification: <300GB big. Tape in 2000' long, 1/2" wide; Lifetime: 30 years, <10% due to demagnetization, 1 million passes over data; Errors: 1 bit in 1e17 correctable errors, 1 bit in 1e27 permanent errors
 - Speed: 36MB/sec (burst speed 200MB/sec)
 - Tapes are often used in automated backups in case data is lost. However, often times when data is needed, the data is not there due to failed backups: either the backup program never worked or backup operator didn't happen to show up that night.
- Tape conclusion:
 - Tapes are a cheap way to store data. But it is slow and will deteriorate over time.

- Tapes have incompatible formats. If you need to recover data from a tape after the original manufacturer has gone, you may never be able to recover your data.
- In the past, tapes were the cheapest way to store data: LBL uses tapes to transport the terabytes data to their supercomputers. Today, cheaper disks and high bandwidth fiber optics may succeed the tape.

- **Hard Drives (HDD):**

- Terminology:
 - Track: circular path traced by a stationary head as platter spins.
 - Cylinder: the set of vertical aligned tracks
 - Record: logical block of data and extra bits containing ECC and location data such as track, cylinder, and block #.
 - Cylinders are divided into sectors. Sectors are physical data blocks of fixed size with inter record gaps. Size is traditionally set to 512 bytes. Note: A Record is a logical piece of information. A Sector is a physical storage on a disk
- Highlights: Data is stored on hard flat aluminum platters coated with a thin magnetic coating. This coating used to be iron oxide, but is now aluminum nickel cobalt. Heads are located on either side of each platter (3 platters->6 heads). All of the platters are connected to the same spindle and all heads are connected so they all move at one. A drive with 3 platters can read 6 tracks at a time without moving the head.
- Progression:
 - Old drives used to use absolute positioning to find a track. Today, with drives containing over 10k cylinders, heads use feedback to find the tracks. As they move toward the desired track, they read the track info as they go to determine how much further it needs to move until it actually finds the track.
- Difference vs. Floppy:
 - Unlike floppies, drive heads float over the platter like a glider. The spinning platter generates a vortex and the head rides on this vortex of air. This gap is generally in the order of micrometers. If the drive is jolted, the head may crash into the platter and may result in the loss of data.
- Drawback: Even though drives have N heads, typically only 1 track is read at a time.
- Storage: Drives are sealed to prevent contamination such as dust which will cause the head to crash.
- IBM Count Key Data (CKD) Drives
 - In the past, IBM made high end CKD formatted drives. Data blocks of variable size that contains CKD data.
 - Terminology:

C-count: block id#, track, cylinder, ECC

K-key used by IBM Channel searches

D-data

- Between every block there is a inter-record block. Max block size is about 32KB, the bigger the block used, the more efficient the disk.

- **Other Drives:**

- Zip Drive (100MB) and Jazz Drive (2GB), very expensive.
 - Drawback: Very hard to do because of precision required. Any disk inserted into the drive must precisely align the head up with the tracks.
- Floppies have a capacity of 1.44MB. They are cheap per disk but too small in capacity and too slow.