# Digital Systems: Data Storage

Session 9d for
"Digital Systems: Computers and Communications"
A Fairfield University E-Course
Powered by LearnLinc

# Module: Digital Systems (in two parts)

- Texts:
  - "Computers," Capron, Benjamin Cummings, 1996, ISBN 0-8053-0662-5
  - "Telecommunications," Blyth, McGraw-Hill, 1990, ISBN 0-02-680841-2
  - "Understanding Telephone Electronics," Bigelow, Newnes, 1997, ISBN 0-7506-9944
- References:
  - Electronics Tutorial (Thanks to Alex Pounds)
  - Electronics Tutorial (Thanks to Mark Sokos)
- Part 9 – Computers
  - 5 on-line sessions plus one lab
- Part 10 – Digital Communications
  - 5 on-line sessions plus one lab
- Mastery Test part 5 follows this Module

# Digital Systems: Topics

- Computer Architecture
  - Memory: ROM, RAM, Cache, Error Checking
  - CPU and Program Control
  - Secondary Storage: Floppy, Hard Drive, CD / DVD
  - I/O (Human: Video, Keyboard, & Pointer)
- Digital I/O: Serial, Parallel, IDE, USB. FireWire, SCSI

Part 9

---

- Serial I/O: RS232
- Modems
  - Telephone: Modulation and Data compression
  - Cable and DSL
- Telephony Digital Transmission
- Packet Transmission
- Fiber Optics: SONET

Part 10

# Section 9 Schedule

| | | | |
|---|---|---|---|
| Session 9a<br>(5/26 – Holiday) | 05/21 | Introduction: Computer Overview | Capron: Ch 1;<br>Notes |
| Session 9b | 06/02 | The CPU (Central Processing Unit) | Capron: Ch 2; |
| Session 9c | 06/04 | I/O | Capron: Ch 3; |
| **Session 9d** | **06/09** | **Data Storage** | **Capron: Ch 4;** |
| Session 9e<br>(Lab - 06/14, Sat.) | 06/11 | Digital I/O: Serial, Parallel, IDE, SCSI, USB, and Firewire | Bigelow: pp. 285-288, 301-305; Notes |
| Session 9f<br>Quiz 9 due 06/22) | 06/16 | Review for Quiz 9 | |
| Session 9g<br>(6/18 – no class) | 06/23 | Quiz Results | |

# Input/Output System Review

## Human I/O

- Input
  - Keyboard
  - Mouse
  - Video
  - Audio
- Output
  - Video
  - Audio

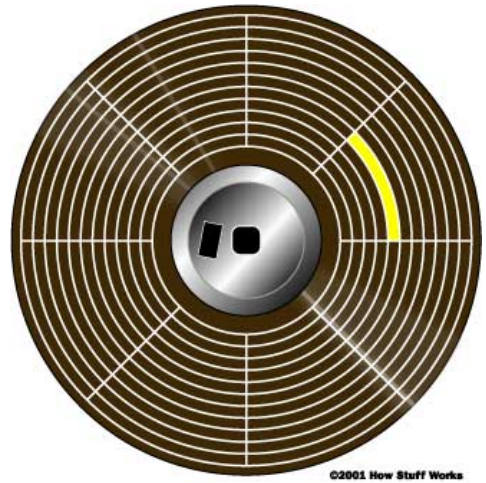
## Machine I/O

- Data
  - LAN
  - Serial
  - Modems
- Printers:
  - Impact
  - Laser
  - Ink Jet
- Memory
  - Floppy
  - CD / DVD
  - Other
  - Memory Modules
- Image Scanner
- Optical Character Recognition (OCR)
- Bar Codes
- Digital Still Camera
- Digital VCR

# Data Storage

- Magnetic Disks:
  - Characteristics: Fast, Dense storage
  - Types: Floppies, Hard Disks
- Optical Disks
  - Characteristics: Dense, Inexpensive, Archival
  - Types: CD, DVD, Magneto-Optical
- Tape
  - Characteristics: Sequential, Extreme density
  - Types: Reels, Cartridge

# Disk Storage




- Data: stored as tiny magnetized regions of a Ferro-Magnetic coating on a spinning disk
- Tracks: a set of concentric rings on which data is stored
- Sector: a small block of data bits (shown in yellow).
- Total capacity
  = heads*sectors * tracks * bytes/sector
  (one head per disk surface)
- Read/Write Heads: Tiny magnetic coils on a moving arm (often float above the disk surface on a cushion of air)
- Speed:
  - Access time: milliseconds
  - Rotation Rate: 5k, 7.5k, 10k determines read/write speed

# Disk Storage (2)

- File Storage
  - Large disk file requires multiple sectors
  - The “FAT” (File Access Table) is a special area of the disk that records the sectors that hold each file.
  - Deleting a file only deletes its entry in the FAT, The data is still on the disk until its sectors are reused to store another file.
- Fragmentation: files stored in sectors are scattered over the whole disk surface causing slow access
- Partitioning: Making a disk look like multiple smaller disks

# Floppy Disks

- Disk: Mylar with magnetic coating
- Low Density, removable storage
  - 5.25 inch: 360 Kbytes, 1.2 Mbytes
  - 3.5 inch: 1.44 Mbytes (also 2.88 but rare)
- Temporary storage
  - 5 to 10 years if stored properly
  - Keep away from magnetic fields

# Hard Drives

- Fast, Dense Temporary Storage
  - Up to 160 Mbytes/sec transfer rates
  - 120 Gigabyte disks now common (~$200)
  - Disks can lose data
    - Hardware failures
    - Software errors (Virus)
    - Human error
    - special equipment can be used to recover much of the data (at a price)
    - Always back up your data (store in more than one place)

# Data Compression

- Most data has built in patterns and redundancy (what letter follow q in English?)
- Lossless Compression
  - "squish" the file such that you can exactly recover the original
  - Text: can be compressed to 5% of the original size
  - Binary: can be compressed about 50%
- Lossy Compression: allow some approximation
  - JPEG, MPEG

# CD ROM

- Data stored as on a magnetic disk, but as variations in reflectivity
- Data illuminated by a laser and read by a photo sensor
- Storage
  - 660 Mbytes – 72 minute disk (standard length)
  - 700 Mbytes – 80 minute disk
- Speed: originally ~1 Mbit/sec (1x), now 48x
- Read-only, Write once, Read/Write variants

# DVD
## Digital Video (versatile) Disk

- 4.7 Mbytes of data (about 4x CD speed standard)
- Variants
  - DVD ROM: 2 sided, Multi-layer
  - DVD – R (+R): write once, compatible with most DVD video players
  - DVD –RW (+RW): Read/Write: compatibility issues
- DVD Writers: great backup/archival facilities at a reasonable cost (~$250 now)

# Magnetic Tape

- Sequential Data Storage (Inconvenient)
- Half inch, 9-track reels
- Tape cartridges
  - Mini-Data (QIC-40, QIC-80)
  - Travan (TR-1, TR-2, TR-3 …)
  - DAT (Digital Audio Tape)

# Section 9 Schedule

| | | | |
|---|---|---|---|
| Session 9a<br>(5/26 – Holiday) | 05/21 | Introduction: Computer Overview | Capron: Ch 1;<br>Notes |
| Session 9b | 06/02 | The CPU (Central Processing Unit) | Capron: Ch 2; |
| Session 9c | 06/04 | I/O | Capron: Ch 3; |
| Session 9d | 06/09 | Data Storage | Capron: Ch 4; |
| **Session 9e<br>(Lab - 06/14, Sat.)** | **06/11** | **Digital I/O: Serial, Parallel, IDE, SCSI, USB, and Firewire** | **Bigelow: pp. 285-288, 301-305; Notes** |
| Session 9f<br>Quiz 9 due 06/22) | 06/16 | Review for Quiz 9 | |
| Session 9g<br>(6/18 – no class) | 06/23 | Quiz Results | |