CS-341 Lecture 10

March 6, 2001

Exam Topics

- Textbook Chapter 1, Appendices A and B
- Chapter 2: Section 2.1, 2.2.4, pg 93, 96-98, section 2.4.6
- Homework questions
- Lecture material
  - Units of measure
  - Time to execute a program
  - Information encoding
  - Quantization (sampling)
  - Compression
  - Bandwidth

Administriva

- Exam will be this Friday, the 9th
- Material from today's class will *not* be on this Friday's exam.

Memory Concepts

- Addresses, Data
- Addressable Data Units (bytes, words)
- Operations
  - Read / Load
  - Write / Store
- Access Time
  - The interval from the time a *read* operation is initiated to the time when the data are available.
  - For *write* operations, it's the time the processor has to wait after initiating one write until it can start the next one.

Memory Hierarchy

- Parameters
  - Speed (access time)
  - Cost per bit
  - Capacity
  - If it weren't for the cost factor, there would be no hierarchy: All of a computer's storage capacity would use the fastest technology.
- Levels
  - Registers
  - Cache
  - Main Memory
  - Disk ← **Non-volatile (magnetic or optical)**

Registers

- Implemented using *flip-flops*, which we will cover in Chapter 3
- Access times measured in nanoseconds, or even tens of picoseconds.
- 128 32-bit registers would be a lot.
- Volatile

Cache

- Section 2.2.5 of the textbook
- Concepts
  - Operation is transparent to the CPU
  - Cache lines are wider than memory words.
  - Effective access time is c * h + m * (1 - h)
    - Error in this formula on page 66 of the text.

Main Memory

- Read and Write Operations
- Memory Bus Connects CPU and memory
  - Address Wires
    - Always pass information from the CPU to memory
    - The address of the word to be read or written
  - Data Wires
    - Read: Information from memory to CPU
    - Write: Information from CPU to memory
  - Control Wires
    - Used by CPU to tell memory when to read or write
    - Used by memory to tell CPU when operation completes

Disk Memory

- Organization
  - Platters, heads, tracks/cylinders, sectors
- Access Time
  - Seek time
    - Time to move the read/write heads from the current track to the addressed track
    - It takes few milliseconds to go from one track to an adjacent one
  - Rotational Delay
    - Time for the required sector to rotate into position
    - Average value is half of one full rotation
      - 7200 RPM ⇒ ~4 msec
  - Transfer Time
    - Time to transfer the sector(s) between disk and memory
    - Depends on I/O bus speed as well as rotational speed
      - Some disks cache tracks; then it's just bus speed