



Announcements

- Chapter 9 for today
- Guest speaker on Monday
 - Ian King from the Living Computer Museum



Announcements

- Project 1A due tonight at 10pm
 - 1-1-1 rule: Monday at 10pm



Announcements

- Clicker scoring
 - 2 points for correct answers
 - 1 point for incorrect answers



Announcements

- How does that work when there are 5 points possible per day?
 - Random number of questions each day
 1. Total your score
 - 12 correct out of 15
 2. Find the percentage correct
 - .80
 3. Multiply the percentage by 5
 - $.80 \times 5 = 4$
 4. Record your score
 - 4 points



Copyright

- Copyleft
- Creative Commons
- Fair Use Doctrine
- Public domain
 - Copyright has expired (28 yrs x 2 + 50)
 - Created by a government agency
- Copyright not listed anywhere
 - Copyright because someone made it
 - Be sure to check the fine print at bottom of Web page



Announcements

- Guest speaker on Monday and Friday
 - Ian King, Curator of the Living Computer Museum
 - Paul Allen's computer museum
 - History of computers and the various breakthroughs
 - Next week's schedule on the calendar has been re-arranged



Vocabulary for Monday

- No reading is required
- Vocabulary and definitions for Monday
 - See the GoPost under Vocabulary
 - I'll add more terms this afternoon
 - Study the terms for Monday and the terms for Chapter 11



Announcements

- Wednesday
 - Project 1B
 - Algorithms
 - High- and low-level programming languages



Computer Basics

*How exactly does a
computer work?*

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Integrated Circuits

Integrated circuits (ICs) are the power source of the information revolution

- When computers were made of discrete parts, wires of every transistor (3), capacitor (2), resistor (2), etc. had to be hand-connected
- Labor intensive, expensive, error prone, unreliable, cumbersome, ... even with robots!
- Integrated circuits solved that by 2 ideas
 - Integration—circuits built as a unit from like parts
 - Photolithography—printing process to make chips

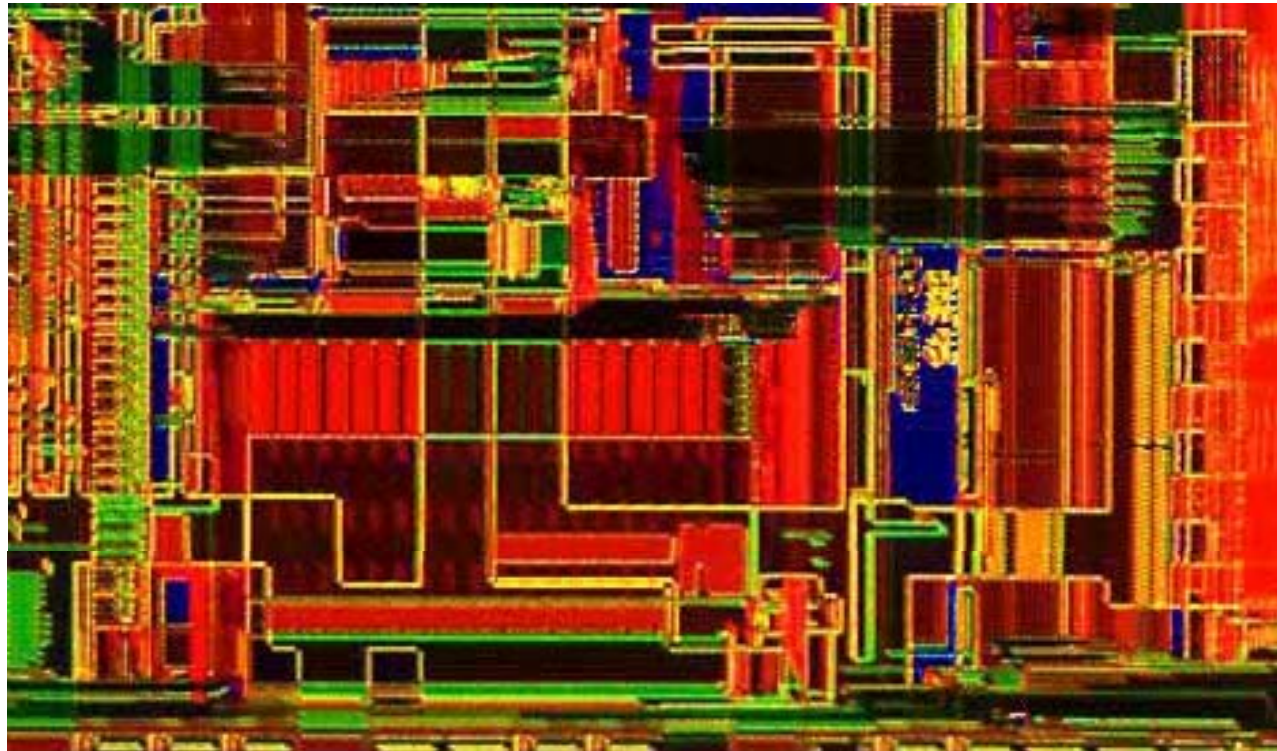


Videos—How they're made

- Integrated Circuits (5:21)
- Microprocessor (6:48)
- Printed Circuit Boards (5:26)



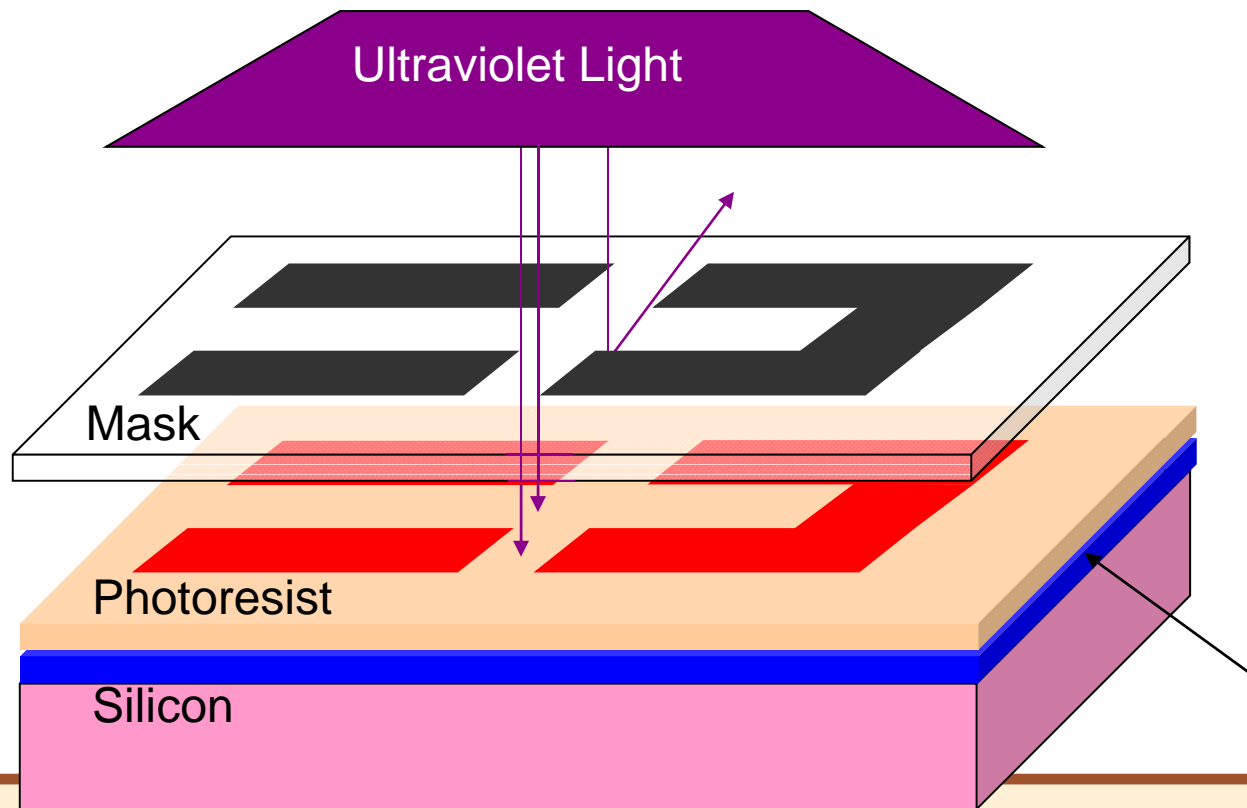
Intel Pentium Processor





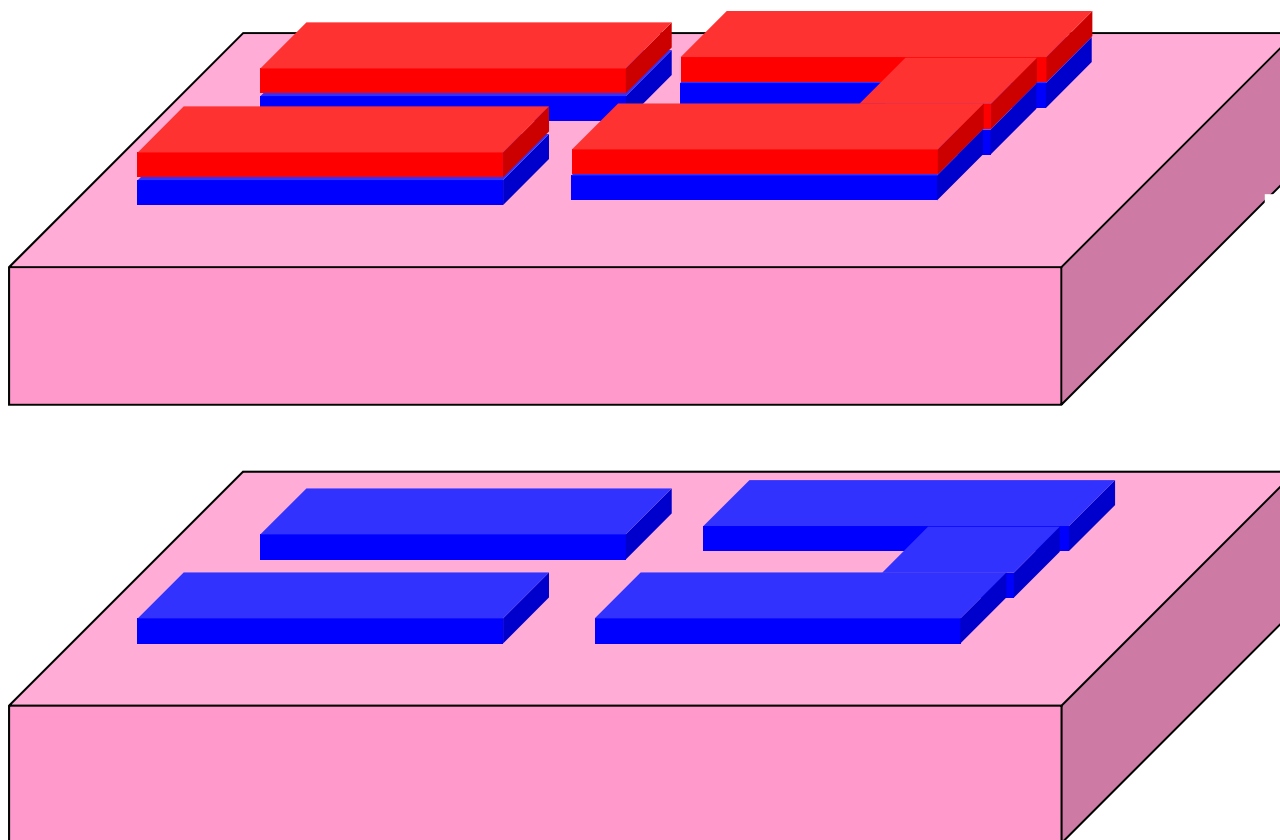
Photolithography

Consider process for depositing wires





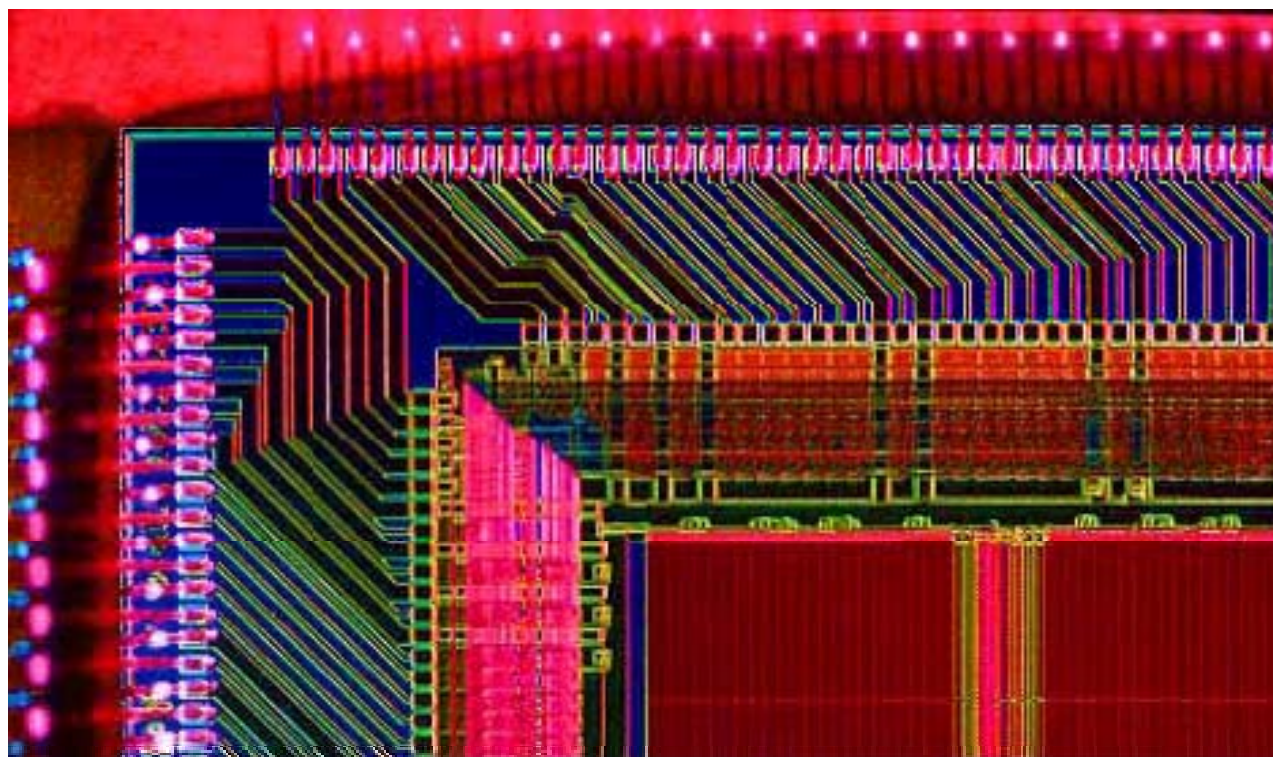
Remove Resist



The cost of the circuit is not related to complexity



R4400 NEC/MIPS Processor





Semiconductors

Silicon, a semiconductor -- sometimes it conducts and sometimes it doesn't

- It's possible to control when semiconductors do and don't conduct

Compute by controlling conducting

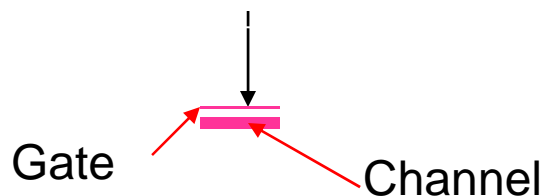
Ex.: Use control to test **Mars AND rover**

Send "yes" signal on wire

Detect presence/absence of "yes"

Charged objects are familiar -- use a nylon comb on a dry day

- A charged field can control whether a semiconductor conducts or not



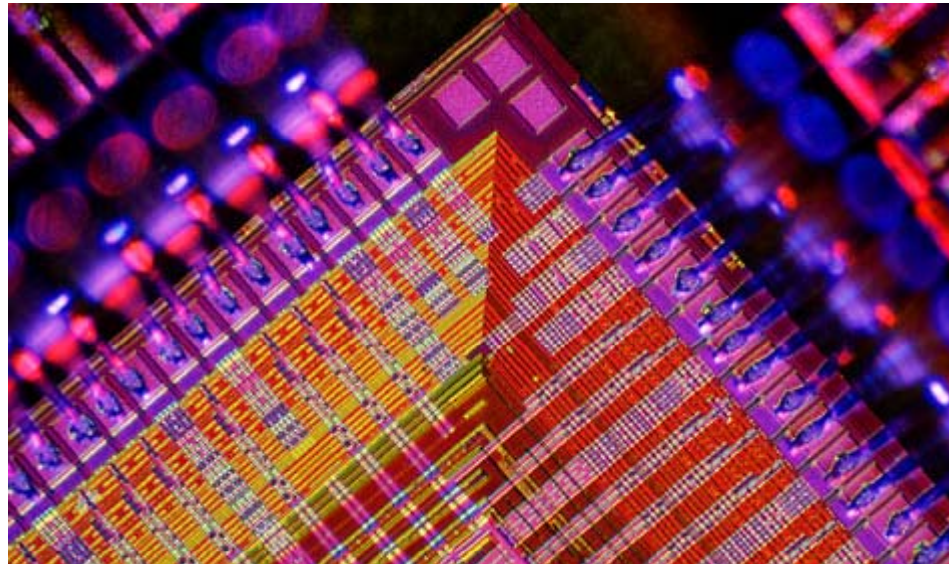
A transistor has
3 wires

The charge of the control wire (gate) is key

- Neutral gate, channel doesn't conduct
- Charged gate, channel conducts



MIPS R10000 Processor

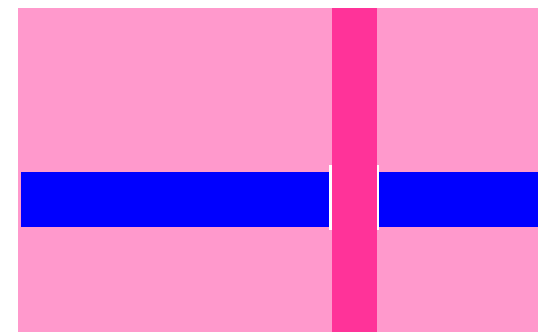
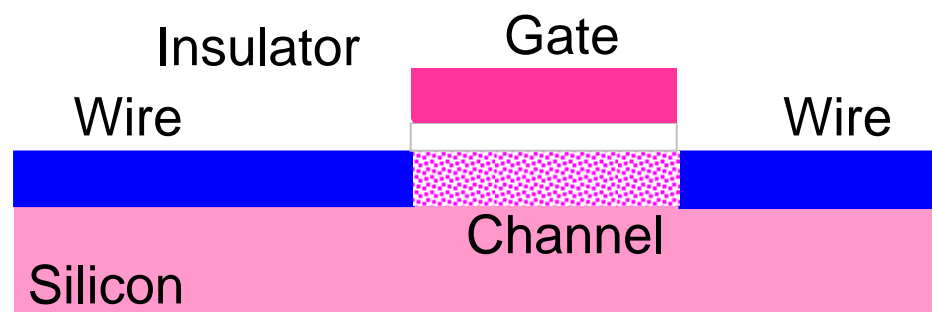


Notice that wires cross over other wires ...



MOS Transistors

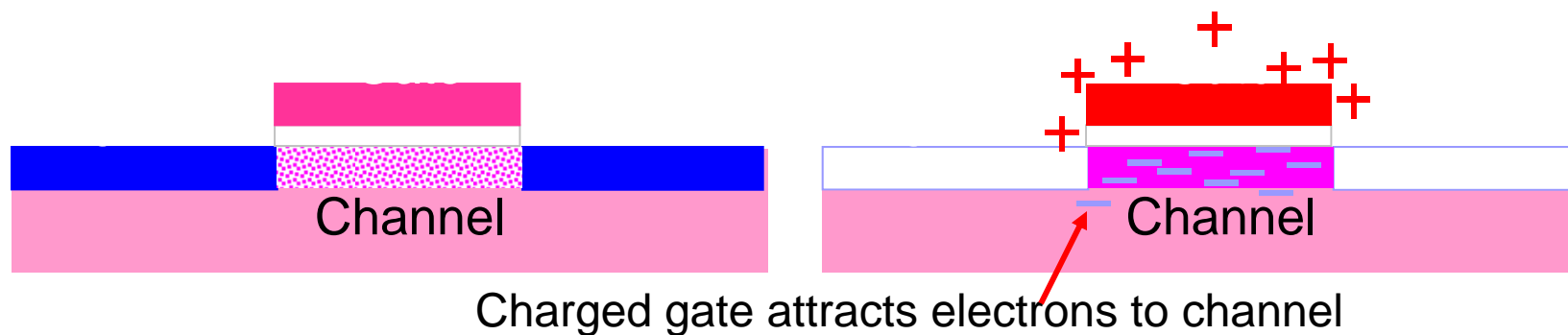
The field effect idea is implemented in metal-oxide-semiconductor transistors





Operation

The two cases: the gate is neutral or the gate is charged





Computers ...

Deterministically execute instructions to process information

“Deterministically” means that when a computer chooses the next instruction to perform it is required by its construction to execute a specific instruction based only on the program and input it is given

Computers have no free will and they are not cruel



Fetch/Execute Cycle

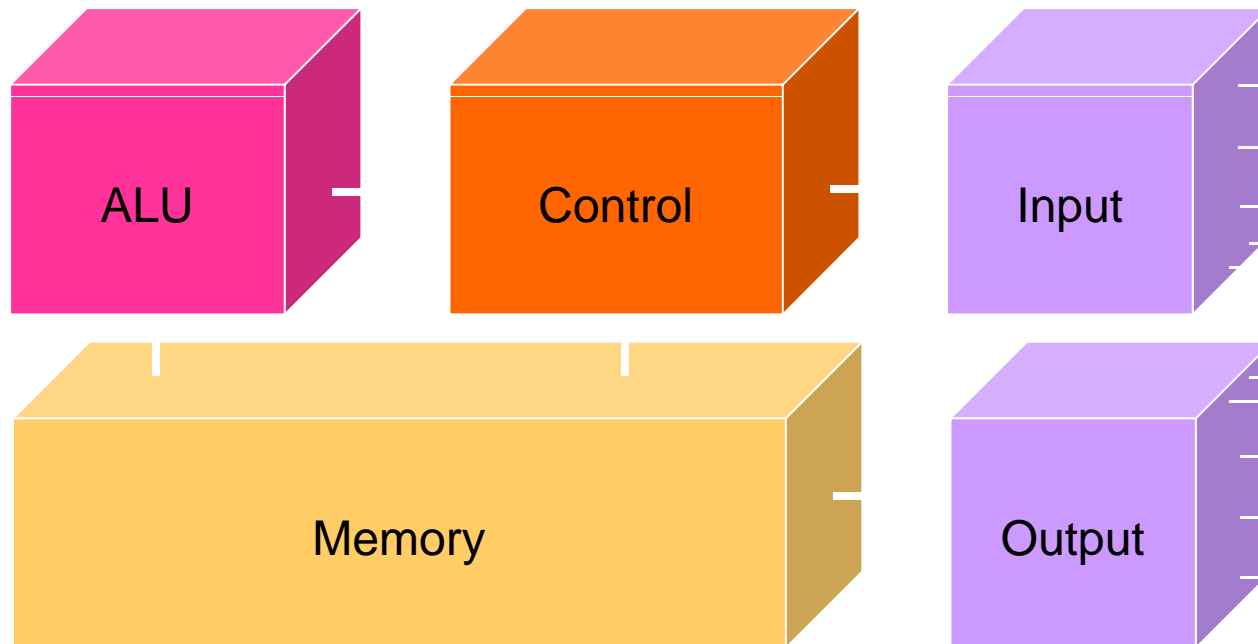
Computer = instruction execution engine

- The fetch/execute cycle is the process that executes instructions





Anatomy of a Computer

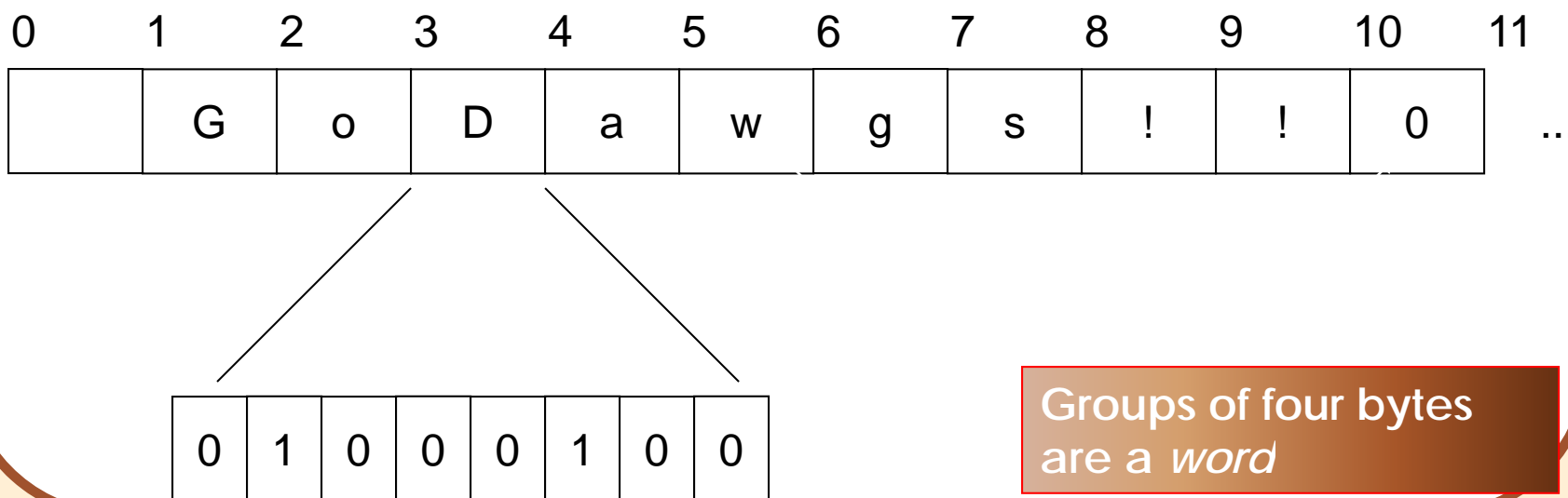


The Hard Disk is the α -device



Memory ...

Programs and their data must be in the memory while they are running

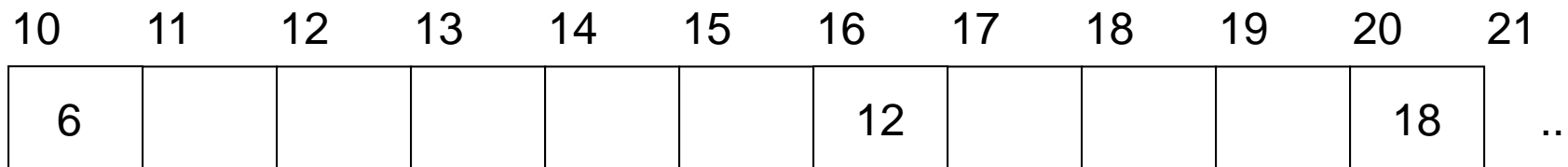


Groups of four bytes are a *word*



Control

The Fetch/Execute cycle is hardwired into the computer's control, i.e., it is the actual "engine"



Put in memory location 20 the contents of memory location 10 + contents of memory location 16



Indirect Data Reference

Instructions tell *where* the data is, not *what* the data is ... contents change

10	11	12	13	14	15	16	17	18	19	20	21	...
8						7				15		...

10	11	12	13	14	15	16	17	18	19	20	21	...
60						-55				5		...



ALU

The Arithmetic/Logic Unit does the actual computation

Most computers have only about 100-150 hard-wired instructions



Input/Output

Input units bring data to memory from outside world; output units send data to outside world from memory

- Most peripheral devices are “dumb” meaning that the processor assists in their operation
- Disks are *memory* devices because they can output information and input it back again

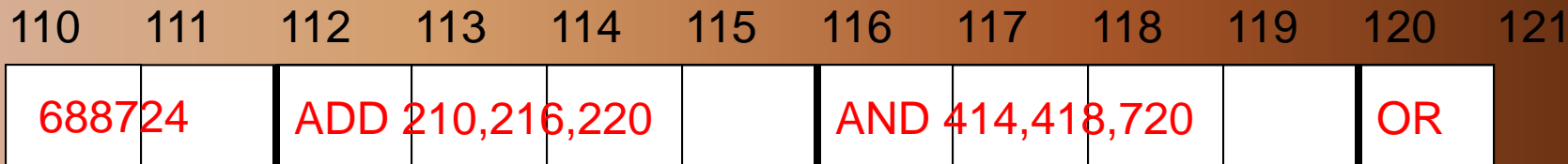


The PC's PC

The program counter (PC) tells where the next instruction comes from

- Instructions are a *word* long
 - Recall that 4 bytes is a word
- Add 4 to the PC to find the next instruction

Program Counter: 112





Clocks Run The Engine

The rate a computer “spins around” the Fetch/Execute cycle is controlled by its clock

- Current clocks run 2-3 GHz
- In principle, the computer should do one instruction per cycle, but often it fails to
- Modern processors try to do more than one instruction per cycle, and often succeed

Clock rate is not a good indicator of speed



Animation

- Fetch-Execute Cycle



Summary

Semiconductors made Info Revolution

- Semiconductor properties ...
 - Fields control when semiconductor conducts
 - On/off of conductors allows us to compute

Fetch/execute cycle runs instructions

- 5 steps to interpret machine instructions
- Programs must be in the memory
- Data is moved in and out of memory



Quiz topics



Monday