LBSC 690 Session #1

Computers and Networks

Jimmy Lin
The iSchool
University of Maryland

Wednesday, September 3, 2008

History

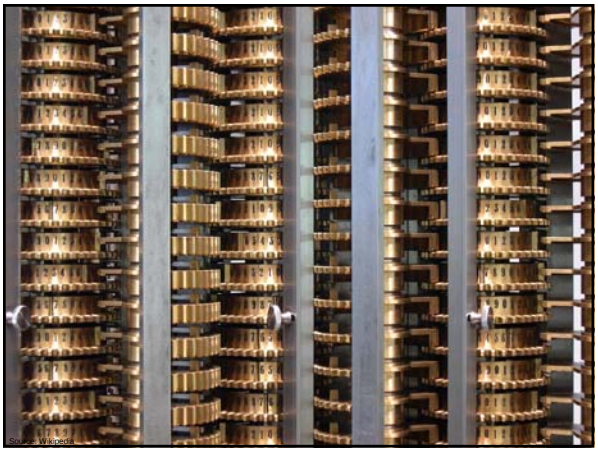
(how we got here in computing)

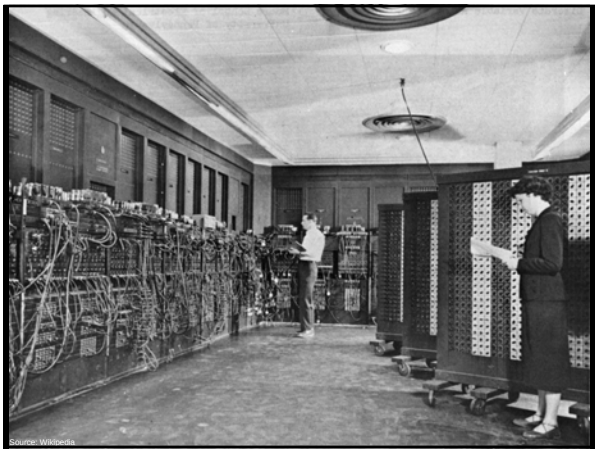
A COMPUTER WANTED.

WASHINGTON, May 1.—A civil service examination will be held May 18 in Washington, and, if necessary, in other cities, to secure eligibles for the position of computer in the Nautical Almanac Office, where two vacancies exist—one at $1,000, the other at $1,400.

The examination will include the subjects of algebra, geometry, trigonometry, and astronomy. Application blanks may be obtained of the United States Civil Service Commission.

The New York Times
Published: May 2, 1892
Copyright © The New York Times

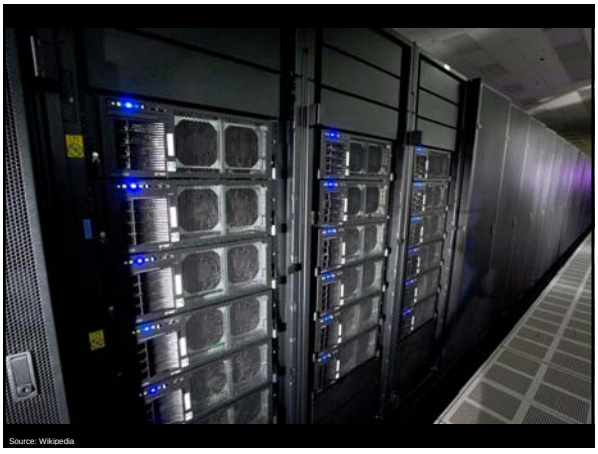




Source: Wikipedia

Source: Wikipedia

Source: Wikipedia



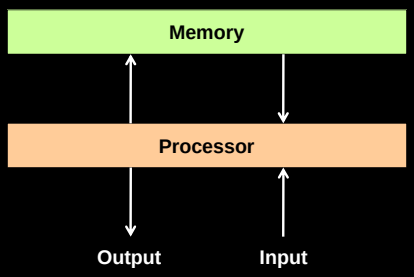
Source: Wikipedia

Introductions

(how you got to LBSC 690)

Computing

What is a computer?



The iSchool
University of Maryland

The Processing Cycle

- Input comes from somewhere
  - Keyboard, mouse, microphone, camera, …
  - Fetch data from memory
- The computer does something with it
  - Add, subtract, multiply, etc.
- Output goes somewhere
  - Monitor, speaker, printer, robot controls, …
  - Store data back into memory

The iSchool
University of Maryland

Source: Wikipedia

Source: Wikipedia

Source: Wikipedia

Networking

Why Networking?

- Sharing data
- Sharing hardware
- Sharing software
- Increasing robustness
- Facilitating communications
- Facilitating commerce

How did it all start?
How did it evolve?
How did we get here?

Packet vs. Circuit Networks

- Telephone system ("circuit-switched")
  - Fixed connection between caller and called
  - High network load results in busy signals
- Internet ("packet-switched")
  - Each transmission is broken up into pieces and routed separately
  - High network load results in long delays

Packet Switching

- Break long messages into short "packets"
  - Keeps one user from hogging a line
  - Each packet is tagged with where it's going
- Route each packet separately
  - Each packet often takes a different route
  - Packets often arrive out of order
  - Receiver must reconstruct original message
  - How do packet-switched networks deal with continuous data?
  - What happens when packets are lost?

Different Networks Types

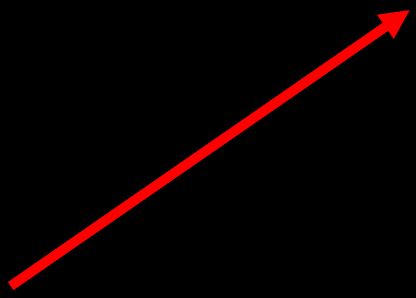
- Local Area Networks (LANs)
  - Connections within a building or a small area
  - Wireless or wired
- Metropolitan Area Networks (MANs)
  - Connections across a city or a larger geographic area
- Wide Area Networks (WANs)
  - Connections between multiple LANs/MANs
  - May cover thousands of square miles
- The Internet
  - Collection of WANs across multiple organizations

The Internet

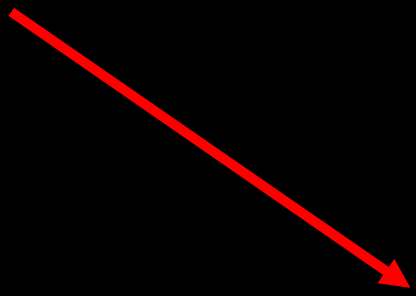
- Global collection of public networks
  - Private networks are often called "intranets"
- Use of shared protocols
  - TCP/IP (Transmission Control Protocol/Internet Protocol): basis for communication
  - DNS (Domain Name Service): basis for naming computers on the network
  - HTTP (HyperText Transfer Protocol): World Wide Web
- Next week: how does all of this work?

How Big?
How Fast?

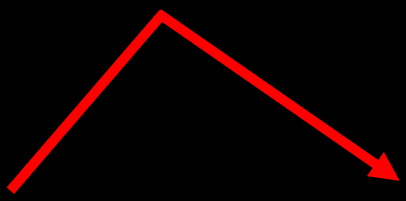
Trends in Computing: #1



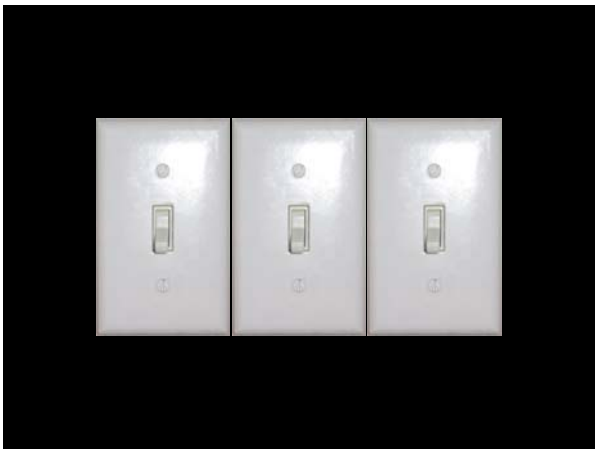
Trends in Computing: #2



Trends in Computing: #3

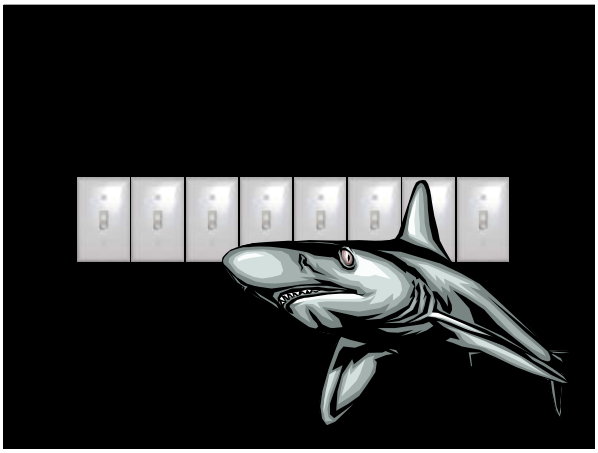


How Big?



How many states can *n* bits represent?
(or the story of 18,446,744,073,709,551,615 grains of rice)

How do you count?
In binary?
Octal?
Hexadecimal?



Data is represented via an encoding

American Standard Code for Information Interchange (ASCII)
= standard byte encoding used in PC's

01000001 = A	01100001 = a
01000010 = B	01100010 = b
01000011 = C	01100011 = c
01000100 = D	01100100 = d
01000101 = E	01100101 = e
01000110 = F	01100110 = f
01000111 = G	01100111 = g
01001000 = H	01101000 = h
01001001 = I	01101001 = i
01001010 = J	01101010 = j
01001011 = K	01101011 = k
01001100 = L	01101100 = l
01001101 = M	01101101 = m
01001110 = N	01101110 = n
01001111 = O	01101111 = o
01010000 = P	01110000 = p
01010001 = Q	01110001 = q
…	…

The iSchool
University of Maryland

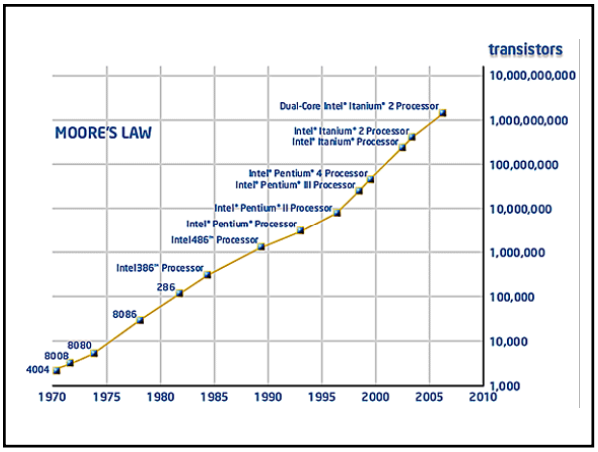
Units of Size

Unit	Abbreviation	Size (bytes)
bit	b	1/8
byte	B	1
kilobyte	KB	2^{10} = 1,024
megabyte	MB	2^{20} = 1,048,576
gigabyte	GB	2^{30} = 1,073,741,824
terabyte	TB	2^{40} = 1,099,511,627,776
petabyte	PB	2^{50} = 1,125,899,906,842,624

How Fast?

Moore's Law

- What is it?
  - Gordon E. Moore, co-founder of Intel: number of components on an integrated circuit will double every 18 months (1965)
- Why is it important?



Thinking About Speed

- Speed can be expressed in two ways:
  - How many things can you do in one second?
  - How long to do something once?
- Convenient units are typically used
  - 1 GHz instead of 1,000,000,000 Hz
  - 10 microseconds rather than 0.00001 seconds
  - When comparing mesurements, convert units first!

Units of Frequency

Unit	Abbreviation	Cycles per second
hertz	Hz	1
kilohertz	KHz	10^3 = 1,000
megahertz	MHz	10^6 = 1,000,000
gigahertz	GHz	10^9 = 1,000,000,000

What's that?

Who's faster?

- Intel Pentium 4 (2004): 3.80 GHz
- Intel Core 2 Duo (2008): 2.6 GHz

Wait, didn't you tell me that computers were getting fasters?

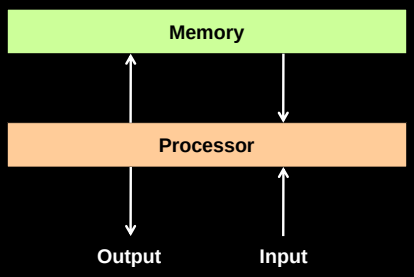
More cores!

Units of Time

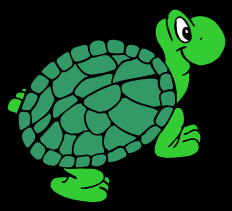
Unit	Abbreviation	Duration (seconds)
second	sec/s	1
millisecond	ms	10^{-3} = 1/1,000
microsecond	µs	10^{-6} = 1/1,000,000
nanosecond	ns	10^{-9} = 1/1,000,000,000
picosecond	ps	10^{-12} = 1/1,000,000,000,000
femtosecond	fs	10^{-15} = 1/1,000,000,000,000,000

How far does light travel in one nanosecond? 0.3048 m

What is a computer?



RAM: small, expensive, fast



Hard drives: big, cheap, slow

Best of both worlds? cheap, fast, and big

Think about your bookshelf and the library…

Caching

- **Idea:** move data you're going to use from slow memory into fast memory
  - Slow memory is cheap so you can buy lots of it
  - Caching gives you the illusion of having lots of fast memory
- How do we know what data to cache?
  - Spatial locality: If the system fetched *x*, it is likely to fetch data located near *x* (Why?)
  - Temporal locality: If the system fetched *x*, it is likely to fetch *x* again (Why?)

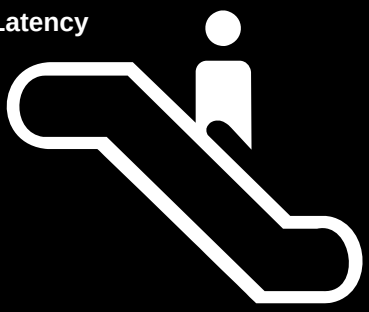
The iSchool
University of Maryland

The Complete Picture

- Two parts of moving data from here to there:
  - Getting the first bit there
  - Getting everything there
- Fundamentally, there's no difference:
  - Moving data from the processor to RAM
  - Saving a file to disk
  - Downloading pirated music from a server in China

The iSchool
University of Maryland

Latency



Bandwidth

Discussion Point

- What's more important: latency or bandwidth?
  - Streaming audio (e.g., NPR broadcast over Web)
  - Streaming video (e.g., CNN broadcast over Web)
  - Audio chat
  - Video conferencing

Now you know....

- History of computing
- Computers and networks
- Concepts of Space (how big?) and Time (how fast?)