

Basic Bits – looking back and inwards

- Comments from the past
- BRIEF overview of history
 - New technology
 - Problems
 - Solutions
 - New technology ... repeat
- Moore's law
- Some observations

Questions

- 1940s: How many PCs needed?
- 1950s: Predicted future weight?
- When was the first computer?
- How long to reprogramme WWII computer?
- Cost of 1950s IBM computer?

	1 st PC	2 nd laptop
When		
Weight		
Cost		

Comments from the Past

- 1940s
 - "I think there is a world market for maybe five computers." Thomas Watson, *chairman of IBM, 1943*
 - "Where a calculator on the ENIAC is equipped with 18 000 vacuum tubes and weighs 30 tons, computers of the future may have only 1 000 vacuum tubes and perhaps weigh 1½ tons." — *Popular Mechanics, March 1949.*
- 1950s
 - "Computers in the future may weigh no more that 1.5 tons" – *Popular Mechanics*
 - "We'll have to think up bigger problems if we want to keep them busy" – Howard Aiken
- 1960s
 - "There is no reason anyone would want a computer in their home" – Ken Olson, Chairman DEC

History of Computing H/W

- Aim to make computer # faster, cheaper and store more data
- Changes every decade since 1940s
- Uses:
 - Computation, automation, communication, control, entertainment, education
- What was the initial computer?
- Early h/w
 - 4000 years ago: abacus
 - 1206: "Castle clock" – 1206 Al-Jazari (astronomer)
 - 1623: Digital mechanical calculator
 - 1801: punch card technology
 - 1820: arithmometer
 - 1830s: analytical machine - Charles Babbage
 - 1909: programmable mechanical calculator – Percy Ludgate, Dublin
 - 1900s: desktop calculators
 - Up to before World War II (WWII): Analog computers

Arrange these in chronological order?
What are they called?



150 AD(CE)
~1890?
1938
1948



Book music
Cambridge differential analyser
Curta calculator
Suanpan

Problems

- Reliability issues
- Mechanical – error prone
- Not at all flexible
- Functionality was limited
- Not readily available
- Something new was required

Digital Computers

- No one *definitive* date/computer
- Alan Turing (1936): Turing machine
 - Definition of universal computer
- John von Neumann: computer architecture
 - Memory: both programs and data
- 3 streams of computer development in WWII era
 - Zuse (1936), Germany – not generally known
 - Colossus, UK – used to decrypt German code during WWII – secret until 1970s
 - ENIAC (1945-1948), USA –
 - Electronic Numerical Integrator and Computer
 - first electronic general-purpose computer
 - 18,000 valves (vacuum tubes)

Problems

- Reliability issues
 - Vacuum tubes had technical issues
- Not at all flexible
 - e.g. to “re-programme” the ENIAC, it had to be manually reconfigured (could take up to 3 weeks)
 - Data was separate
- Functionality was limited
- Something new was required

Commercial Computers

- First generation: vacuum tube computers
- 1950s UNIVAC
 - First “mass produced” computer
 - 46 machines sold \$1 million (= \$8.2 million in 2009)
 - 5,200 vacuum tubes, 125kW of power
 - Storage: 1000 words of 11 decimal digits plus sign (72-bit words)
 - Used metal magnetic tape
- 1950s IBM
 - IBM 701 (part of 700/7000 series) – Fortran
 - IBM 650
 - Weight: 900kg, power supply 1350kg
 - Cabinets: 1.5m x 0.9m x 1.8m
 - Cost: \$0.5 million (~\$4 million in 2009), leased \$3,500 a month
 - Memory: 2,000 ten digit words

Old Hardware



Commercial Computers

- Second generation: transistor computers
- Transistors vs vacuum tubes
 - Smaller, need less power, give off less heat
 - More reliable, indefinite service life
 - Many binary logic circuits in compact space
 - Reduced computer size, initial cost and operating cost
- Example: IBM 1401
 - 100,000 installed (1960 – 1964)
- Improvements:
 - Improved CPU
 - Disk data storage units (not only fixed disk storage)
 - Second processor for peripheral device communications

Commercial Computers

- Third generation: integrated circuits
 - Development of microprocessor
- Example:
 - An Intel 8742, is an 8-bit microcontroller
 - a CPU running at 12 MHz
 - 128 bytes of RAM
 - 2048 bytes of EPROM (Erasable Programmable Read Only Memory)
 - Input/Output (I/O) in the same chip
- Microcomputers
 - Widely available in 1980s
- Advances
 - Fourth generation:
 - Very Large Scale Integration (VLSI)
 - ... and lots more

Sales

Semi-conductor Sales

'10	'09	Company	Country	Revenue	Mkt Share
1	1	Intel Corporation	USA	40 394	13.2%
2	2	Samsung Electronics	S. Korea	27 834	9.3%
3	3	Toshiba Semiconductor	Japan	13 010	4.3%
4	4	Texas Instruments	USA	12 944	4.3%
.....
12	8	Advanced Micro Devices	USA	6 355	2.1%
.....
Top 25				198 207	69.5%
All Other companies				92 667	30.5%
TOTAL				304 075	100.0%

Note: Revenue per employee down 2009 vs 2000

Ref: iSuppli Corporation supplied rankings for 2010

Global Microprocessor Revenue Share 2010

Company	Mkt Share '10	Mkt Share '09	% Change
Intel	81.0%	80.6%	0.4%
AMD	11.4%	12.2%	-0.8%
Others	7.5%	7.1	0.4%

Ref: IHS iSuppli 2010

Moore's Law (cont....)

- Cost to consumer goes down, cost to producer goes up
- Moore's second law:
 - The capital cost of a semiconductor fabrication plant (fab) also increases exponentially over time.
 - Research and Development (R&D)
 - Manufacturing
 - Test costs
 - Cost of polymers (based on petroleum), supply issues (supply, shortage risks?)

Moore's Law (cont....)

- Future trends?
 - silicon/germanium helium supercooled transistor (IBM/Georgia Tech)
 - deep-ultraviolet excimer laser photolithography (IBM, 2006)
 - Memristor (HP, 2008)
 - Junctionless transistor (Tyndall National Institute, Cork 2010)
 - single-electron transistor 1.5 nanometers in diameter made out of oxide based materials (University of Pittsburgh , 2011)

Moore's Law (cont....)

- Observations
 - It can't go on forever (Moore, 2005)
 - Speed of technical change
 - Transistor count vs computer performance
 - In multi-core CPU:
 - higher transistor density != faster applications
 - Why? ... software (s/w) not parallelised
 - Non-CPU bottlenecks
 - E.g. memory and disk performance speeds
 - Obsolescence
 - Hardware (h/w) and data security and survivability issues
 - Issues: limited resources, smooth, continuous operation

Lessons

- Size changes usually require new technology
 - First -> second -> third ... generation
- CPU improvements do not automatically imply performance improvements
 - Theoretical vs actual performance
 - Non-cpu, software issues
- Moore's law (observation, expectation, marketing)
- Technically possible size is different from what humans want
 - Smaller PCs -> laptops -> small netbooks (keyboard issues) -> bigger netbooks -> tablet PCs -> ?
- Others?

Other

- IBM
- Intel
 - "Intel inside"
 - Pentium flaw (no such thing as bad publicity?)
 - Slowing down of PC demand growth
 - Low-cost PCs
 - Microprocessor performance vs s/w demand
 - Naming issues
- AMD
 - 2nd largest supplier of microprocessors based on x86
 - Cross-licensing agreement with Intel