Introduction to Computer Engineering
CS/ECE 252, Spring 2008
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Notes adapted from Mark D. Hill’s notes

Computer as a tool

- Hammer
  - Arguably the most useful tool in human history
  - Pounds, prises, and useful as weapon
- Computer
  - Arguably supplanting the hammer as most useful tool

Computers!

- Engineers and scientists of all disciplines rely on computers for many aspects of their work
  - Not just word processing, spreadsheets, CAD, etc.
  - Computational methods, data mining, analysis/synthesis are fundamental to advances in many fields
- Many of the advanced techniques used in today’s microprocessors were invented right here at UW
- Some of the most renowned computer design researchers in the world are on our faculty
- There is a near-100% likelihood that a Wisconsin graduate helped design the computer or processor that you own

Technology

- Technology advances at astounding rate
  - 19th century: attempts to build mechanical computers
  - Early 20th century: mechanical counting systems (cash registers, etc.)
  - Mid 20th century: vacuum tubes as switches
  - Since: transistors, integrated circuits
- 1965: Moore’s law [Gordon Moore]
  - Predicted doubling of capacity every 18 months
  - Has held and will continue to hold
- Drives functionality, performance, cost
  - Exponential improvement for 40 years
Some History

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1947</td>
<td>1st transistor</td>
<td>Bell Labs</td>
</tr>
<tr>
<td>1958</td>
<td>1st IC</td>
<td>Jack Kilby (MSEE '50) @TI Winner of 2000 Nobel prize</td>
</tr>
<tr>
<td>1971</td>
<td>1st microprocessor</td>
<td>Intel (calculator market)</td>
</tr>
<tr>
<td>1974</td>
<td>Intel 4004</td>
<td>2300 transistors</td>
</tr>
<tr>
<td>1978</td>
<td>Intel 8086</td>
<td>29K transistors</td>
</tr>
<tr>
<td>1989</td>
<td>Intel 80486</td>
<td>1M transistors</td>
</tr>
<tr>
<td>1995</td>
<td>Intel Pentium Pro</td>
<td>5.5M transistors</td>
</tr>
<tr>
<td>2006</td>
<td>Intel Montecito</td>
<td>1.7B transistors</td>
</tr>
</tbody>
</table>

Applications

- Corollary to Moore’s Law:
  - Cost halves every two years
  - In a decade you can buy a computer for less than its sales tax today. —Jim Gray
- Computers cost-effective for
  - National security – weapons design
  - Enterprise computing – banking, Amazon.com
  - Web Search – Google & Yahoo!
  - Departmental computing – computer-aided design
  - Personal computer – word processing, email, web
  - Pervasive computing – iPhone
- Countless industries revolutionized

Place on Desk

- 7MB Disk Pack
- 6’ Disk
- IPod (30GB)
- (30GB/7MB = 4,000x)
- 32KB PDP-11 memory board
- 512MB DIMM
- Computer useful & then 10,000x better!

$16 base; 60% growth

<table>
<thead>
<tr>
<th>Year</th>
<th>Salary</th>
<th>Comments</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>$16</td>
<td>Base</td>
</tr>
<tr>
<td>3</td>
<td>$64</td>
<td>Still live at home</td>
</tr>
<tr>
<td>15</td>
<td>$16K</td>
<td>Buy car</td>
</tr>
<tr>
<td>24</td>
<td>$100K</td>
<td>Buy house</td>
</tr>
<tr>
<td>36</td>
<td>$300M</td>
<td>Need fundamentally new ways to spend money</td>
</tr>
</tbody>
</table>
Performance Growth

Unmatched by any other industry!
[John Crawford, Intel]

• Doubling every 18 months (1982-1996): 800x
  – Cars travel at 44,000 mph and get 16,000 mpg
  – Air travel: LA to NY in 22 seconds (MACH 800)
  – Wheat yield: 80,000 bushels per acre

• Doubling every 24 months (1971-1996): 9,000x
  – Cars travel at 600,000 mph, get 150,000 mpg
  – Air travel: LA to NY in 2 seconds (MACH 9,000)
  – Wheat yield: 900,000 bushels per acre

Place On Desk

• iPod
• Laptop
• Treo
• Etc.

• All Computers
• Software/Hardware separation key

This Course

This course will:
• Help you understand the significance and pervasiveness of computers in today’s society and economy
• Teach you how computers really operate and how they are designed
• Introduce you to concepts that students in the Computer Sciences and Computer Engineering degree program learn in depth over four years
• Prepare and motivate you for study in this degree program
• Will count towards GCR introduction to engineering requirement

Course Outline

• Prerequisite – none
• Major topics in course
  – Introduction to computers and computing
  – Information representation and manipulation
  – Logic elements and combinational Logic
  – Sequential Logic and Memory
  – Simple computer organization, design and operation
  – Machine language and instruction set architecture
  – Assembly language
  – Programming constructs
Abstraction and Complexity

- Abstraction helps us manage complexity
- Complex interfaces
  - Specify what to do
  - Hide details of how
- Goal: Use abstractions yet still understand details

Go Over Web Page

http://www.cs.wisc.edu/~david/courses/cs252/Spring2008/
Instructor & TAs
Textbook
Lecture Notes
Schedule
LC-3 Simulator
Grading
Exams
Homework

Advice

- **Textbook** — read BEFORE corresponding lecture
- **Lecture** — attend!
  - book does NOT have all the material
- **Homework** — best completed in **study groups**
  - Will reinforce in-class coverage
  - Will help you prepare for midterm exams
- **Study Groups**
  - Groups of 2-3
  - Should meet weekly, learn from each other
  - Review material & discuss homework assignments
  - Each student should submit his/her own homework

Computer As a Tool

- Many computers today are embedded
  - Fixed functionality
  - Appliance-like
  - Not really programmable by end user
- **Not the focus of this course!**
  - Instead, programmable computers
  - Learn to think of computer as a tool
- **Program?**
  - Algorithm or set of steps that computer follows
  - Human brains wired to work this way