Introduction to Computer Engineering
ECE/CS 252, Fall 2008
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Department of Electrical and Computer Engineering
University of Wisconsin – Madison

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

1987 vs. 2008

<table>
<thead>
<tr>
<th>Year</th>
<th>1987</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>$2000</td>
<td>$699 (MSRP)</td>
</tr>
<tr>
<td>Form factor</td>
<td>½ desktop</td>
<td>Pocket</td>
</tr>
<tr>
<td>CPU</td>
<td>12 MHz 80286</td>
<td>333MHz ARM</td>
</tr>
<tr>
<td>Memory</td>
<td>512KB</td>
<td>128MB</td>
</tr>
<tr>
<td>Storage</td>
<td>20MB hard disk, 1.2MB floppy</td>
<td>8+ GB</td>
</tr>
<tr>
<td>Display</td>
<td>80x25 monochrome text</td>
<td>320x240 pixel color</td>
</tr>
<tr>
<td>Peripherals</td>
<td>Keyboard</td>
<td>Camera, phone, web</td>
</tr>
<tr>
<td>Connectivity</td>
<td>1200 baud dialup modem</td>
<td>3G, WiFi</td>
</tr>
</tbody>
</table>

$10 base; 60% growth

<table>
<thead>
<tr>
<th>Year</th>
<th>Salary</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$10</td>
<td>Base</td>
</tr>
<tr>
<td>3</td>
<td>$40</td>
<td>Still live at home</td>
</tr>
<tr>
<td>16</td>
<td>$18K</td>
<td>Buy car</td>
</tr>
<tr>
<td>21</td>
<td>$193K</td>
<td>Buy median house in Madison</td>
</tr>
<tr>
<td>36</td>
<td>$223M</td>
<td>Need fundamentally new ways to spend money</td>
</tr>
<tr>
<td>51</td>
<td>$2.5T</td>
<td>Replace US Federal Government</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
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 Engineering and Computer Science degree programs learn in depth over four years
• Prepare and motivate you for study in these degree programs (CMPE, EE, CS)
• Counts towards GCR introduction to engineering requirement

Go Over Web Page

http://ece252.ece.wisc.edu
Instructor & TAs
Textbook
Lecture Notes
Schedule
LC-3 Simulator
Grading
Exams
Homework

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

Advice

• Textbook – read BEFORE corresponding lecture
• Homework – completed in study groups
  – Will reinforce in-class coverage
  – Will help you prepare for midterm exams
• Study Groups
  – Groups of 3, should meet weekly, learn from each other
  – Review material, complete homework assignments
  – Each submitted homework should include consensus-based statement of work

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

Applications

• Corollary to Moore’s Law:
  Cost halves every two years
• Computers cost-effective for
  – National security – weapons design
  – Enterprise computing – banking
  – Departmental computing – computer-aided design
  – Personal computer – spreadsheets, email, web
  – Smartphone – camera, calendar, email, web, games
  – Pervasive computing – computers everywhere
• Countless industries revolutionized
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</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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>
<tr>
<td>201x</td>
<td>IBM</td>
<td>50B transistors</td>
</tr>
</tbody>
</table>

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

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
    - Embedded/appliance computers still programmed!
    - Learn to think of computer as a tool
- Program?
  - Algorithm or set of steps that computer follows
  - Human brains wired to work this way

Additional Information

- Resources for Special Help
  - McBurney Center – alternative testing or other arrangements
  - Course problem consultation: Prof. Lipasti
  - Broader problem consultation: advisor or counselor
- Academic Misconduct
  - We really don’t expect it to happen
  - Please don’t disappoint us
  - Serious repercussions
    - Academic record, dismissal from university
    - Only hurting yourself and your future

Wrapping Up

- Readings
  - Chapter 1: Welcome Aboard
- Homework 1
  - Due Friday 9/12 in class (next week)
- Room changes, starting Friday:
  - Lec 001 (11am) meets in CS1240
  - Lec 002 (8:50am) unchanged (EH1227)
  - Lec 003 (1:20pm) meets in CS1221