Computer Organization and Assembly Language

August 21, 2000

CSC201 Section 002
Fall, 2000
Plans for Today

• Some Important Definitions
• Discussion of Course Structure
• Handouts and handins
The Software Translation Process

• We will study these parts in CSC201
The Software Execution Process

- Operating System is running on the CPU
- Operating System copies Application Program Executable from disk into memory
- Operating System transfers control to the Application Program Executable
- Application Program is running on the CPU
- Application Program completes, halts execution

- We will study these parts in CSC201
Computer Architecture

- The set of instructions implemented directly by the hardware, and available to the assembly language programmer
- Example: the add instruction

- We will study this (in depth) in CSC201
Computer Organization

• The major parts or components of the computer, and what their function is
• Example: The arithmetic-logic unit (ALU)

• We will study this (somewhat) in CSC201
Computer Design

- The detailed implementation (in logic gates) of all of the parts of the computer
- Example: an adder circuit

- We will not study this in CSC201
Some Important Milestones

• The invention of the mechanical calculator (Pascal and Leibniz, 1600’s)
• The design of the Differential Engine for computing logarithms, polynomials, trigonometric functions (Babbage, 1820’s)
• The design of the Analytical Engine, the first real computer (Babbage, 1830’s)
Milestones (cont.)

- The invention of electro-mechanical and electrical (vacuum-tube based) computers (1930-1960)
- The invention of the "stored-program" computer (late 1940's)
- The invention of cheap, fast "core" memory (1950's)
- The invention of caches (and the memory hierarchy) (1950's)
- The invention of pipelined instruction execution (1950's)
- The invention of floating point number representations and arithmetic (1940's to 1950's)
Milestones (cont.)

• The invention of the transistor (late 1940’s, early 1950’s)
• The invention of integrated circuits (late 1950’s, early 1960's)
• The invention of the microprocessor (1970's)
• The invention of optimized instruction sets and superscalar processors (1980’s and 1990's)
Some Technology Trends

• Microprocessor performance has been improving 50-60% per year since the mid-80’s!

• Memory prices (per MB) have dropped by a factor of 5,000x in 24 years!

• Disk prices (per MB) have dropped by a factor of 20,000x in 18 years!
## The Intel x86 Microprocessor Family

<table>
<thead>
<tr>
<th>Chip</th>
<th>Date</th>
<th>MHz</th>
<th>Transistors</th>
<th>Memory</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4004</td>
<td>1971</td>
<td>.1</td>
<td>2,300</td>
<td>640</td>
<td>First microprocessor on a chip</td>
</tr>
<tr>
<td>8008</td>
<td>1972</td>
<td>.1</td>
<td>3,500</td>
<td>16KB</td>
<td>First 8-bit microprocessor</td>
</tr>
<tr>
<td>8080</td>
<td>1974</td>
<td>2</td>
<td>6,000</td>
<td>64KB</td>
<td>First general-purpose CPU on a chip</td>
</tr>
<tr>
<td>8086</td>
<td>1978</td>
<td>5-10</td>
<td>29,000</td>
<td>1MB</td>
<td>First 16-bit CPU on a chip</td>
</tr>
<tr>
<td>8088</td>
<td>1979</td>
<td>5-8</td>
<td>29,000</td>
<td>1MB</td>
<td>Used in IBM PC</td>
</tr>
<tr>
<td>80286</td>
<td>1982</td>
<td>8-12</td>
<td>134,000</td>
<td>16MB</td>
<td>Memory protection present</td>
</tr>
<tr>
<td>80386</td>
<td>1989</td>
<td>16-33</td>
<td>275,000</td>
<td>4GB</td>
<td>First 32-bit CPU</td>
</tr>
<tr>
<td>80486</td>
<td>1989</td>
<td>25-100</td>
<td>1.2M</td>
<td>4GB</td>
<td>Built-in cache memory</td>
</tr>
<tr>
<td>Pentium</td>
<td>1993</td>
<td>60-233</td>
<td>3.1M</td>
<td>4GB</td>
<td>Two pipelines</td>
</tr>
<tr>
<td>Pentium Pro</td>
<td>1995</td>
<td>150-200</td>
<td>5.5M</td>
<td>4GB</td>
<td>Two levels of cache built-in</td>
</tr>
<tr>
<td>Pentium II</td>
<td>1997</td>
<td>233-400</td>
<td>7.5M</td>
<td>4GB</td>
<td>MMX instructions introduced</td>
</tr>
</tbody>
</table>
Why Study the Intel Architecture?

• It's worth studying one real assembly language, to see typical capabilities and complexities

• The Intel architecture isn't the best, but it's the most successful (and available to us)
What is SASM?

• A "higher-level" assembly language
• No registers; all operands are in memory
• Relies on Microsoft compiler, and macro definitions, to do a lot
Why Use SASM + High-Level Programming Tools?

• Real assembly languages are quite complex
  - 300+ instruction types, 10+ addressing modes, effect on condition codes, constraints on operand lengths, exceptions to every rule, ...

• Real I/O is quite complex
  - conversions, interface to interrupt routines, details of device control, ...

• SASM hides the details so we can concentrate on important concepts

• Later, we'll also look at some of the details
The Syllabus

• How to contact me
  - Before and after class
  - 1:15-2:15pm, Withers 220 (phone 515-7479)
  - E-mail: reeves@eos.ncsu.edu
  - My “home” office: EGRC 450 (phone 515-2044)

• The textbook

• Course is for CSC majors

• CSC210 is a prerequisite

• The Windows NT lab
Syllabus (cont.)

• Grading
  - 25% Homeworks
  - 40% Exams
  - 30% Final
  - 5% in-class

• Homeworks

• Exams

• Excused absences and late work

• Academic integrity
## The Calendar

### CALENDAR

<table>
<thead>
<tr>
<th>Week</th>
<th>Monday</th>
<th>Wednesday</th>
<th>Friday</th>
<th>Readings in Textbook</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 21-25</td>
<td></td>
<td></td>
<td></td>
<td>Chapter 1, Chapter 2</td>
</tr>
<tr>
<td>August 28-September 01</td>
<td></td>
<td></td>
<td></td>
<td>Chapter 3</td>
</tr>
<tr>
<td>September 04-08</td>
<td></td>
<td>Labor Day (no class)</td>
<td></td>
<td>Chapter 4 (except Approximate Values)</td>
</tr>
<tr>
<td>September 11-15</td>
<td>Homework #1 Due</td>
<td></td>
<td></td>
<td>Chapter 5 (except 1’s complement, biased representation, some of 5.4, all of 5.5)</td>
</tr>
<tr>
<td>September 18-22</td>
<td>Exam #1</td>
<td></td>
<td></td>
<td>Chapter 6, Chapter 7 (except binary representation)</td>
</tr>
<tr>
<td>September 25-29</td>
<td></td>
<td></td>
<td></td>
<td>Chapter 9 (plus some of Chapter 8)</td>
</tr>
<tr>
<td>October 02-06</td>
<td>Homework #2 Due</td>
<td></td>
<td></td>
<td>Chapter 10</td>
</tr>
<tr>
<td>October 09-13</td>
<td>Exam #2</td>
<td></td>
<td></td>
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<tr>
<td>October 16-20</td>
<td>Fall Break (no class)</td>
<td></td>
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<tr>
<td>October 23-27</td>
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<td>Homework #3 Due</td>
<td></td>
<td>Chapter 11</td>
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<tr>
<td>October 30-November 03</td>
<td></td>
<td>Exam #3</td>
<td></td>
<td>Chapter 12</td>
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<tr>
<td>November 06-10</td>
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<tr>
<td>November 13-17</td>
<td>Homework #4 Due</td>
<td></td>
<td></td>
<td>Chapter 14</td>
</tr>
<tr>
<td>November 20-24</td>
<td>Exam #4</td>
<td></td>
<td>Thanksgiving Break (no class)</td>
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<tr>
<td>November 27-December 01</td>
<td></td>
<td></td>
<td></td>
<td>Chapter 13</td>
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<tr>
<td>December 04-08</td>
<td></td>
<td>Homework #5 Due</td>
<td></td>
<td>TBD</td>
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<tr>
<td>December 19 (Tuesday)</td>
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<tr>
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<td>Final Exam!</td>
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CSC201 Section 002 Fall 2000
Get Acquainted
Some Information