CIS 314 : Computer Organization
Lecture 1 – Introduction

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www.cs.uoregon.edu/classes/cis314

What is this course all about?

Fundamental concepts about how a computer works

- The five basic components of a computer
- How everything boils down to 1’s and 0’s
- How a computer program is executed by the hardware
- Machine language: the basic language that a computer ‘understands’
- How the basic instructions in a machine language are carried out by the computer hardware

What is this course all about? (cont.)

Fundamental concepts about how a computer works

- A little about how a program in a high level language like C gets translated into machine language (this is really the topic of our compilers course)
- How to measure computer performance
- How the computer architecture is designed to maximize performance:
  - CPU design: Pipelining
  - Memory design: Caching

Skills acquired in 314

Assembly Language Programming in MIPS

- A side effect of understanding the key ideas (not the goal of this course)

Logic Design

- A little about how to design computer components from logic gates

Unix Basics

- Basic commands and tools

Textbook

Required: Computer Organization and Design: The Hardware/Software Interface, Third Edition, Patterson and Hennessy (P&H). The second edition is far inferior, and is not suggested.

- The book will be available in the bookstore end of this week/beginning of next week.
- We’ll use both the textbook and the CD included with it

Weekly Schedule

Lectures: MWF 10-10:50

??? Can we change this to MW ???

Principles and concepts

Discussion Sections:

W 3-3:50 or Th 4-4:50

Assignments

Unix/Lab Help: TBA
### Course Assignments

- **Programming Projects**
  - (6 assignments; due in lecture class, returned in discussion section)
  - You will use the SPIM simulator. Grading is based on how your program runs on the department machines. You will use automatic turnin software.
  - Get UNIX accounts before Wednesday
  - UNIX tutorials session in Room 100 this week!!

- **Homework and Quizzes**
  - (4 assignments with followup quizzes; due in lecture class.)
  - NO LATE ASSIGNMENTS ACCEPTED
  - We will DROP your lowest assignment grade.

### Two Course Exams

- **Midterm:** Friday Oct. 29
  - One sheet of notes allowed
  - Review session Oct. 27
- **Final:** Wed. Dec 8 @ 10:15 AM
  - One sheet of notes allowed
  - Review session Dec. 3

### GRADING

- 25% Assignments
- 15% Quizzes and Homeworks
- 30% Midterm
- 30% Final
+ Extra credit!!

### Extra Credit: EPA! (borrowed from Dan Garcia)

- **Effort**
  - Attending Ginnie’s and TA’s office hours, completing all assignments
- **Participation**
  - Attending lecture regularly
  - Asking thoughtful questions in discussion and lecture and making it more interactive
- **Altruism**
  - Helping others in lab without crossing the line
- EPA! extra credit points have the potential to bump students up to the top of the earned grade level (e.g., at most from B- to B+). Cannot cross grade level (e.g. from B+ to A-)

### Course Problems...Cheating

- **What is cheating?**
  - Studying together in groups is encouraged.
  - Turned-in work must be completely your own.
  - Common examples of cheating: running out of time on a assignment and then pick up output, take homework from box and copy, person asks to borrow solution “just to take a look”, copying an exam question, ...
  - Both “giver” and “receiver” are equally culpable
- **Cheating on homeworks:** negative points for that assignment (e.g., if it’s worth 10 pts, you get -10)
- **Cheating on projects / exams:** At least, negative points for that project / exam. In most cases, F in the course.
- **Every offense will be referred to the Office of Student Judicial Affairs** (http://darkwing.uoregon.edu/~7E conduc/)
**Powerpoint Lecture Slides**

- Credit to Dan Garcia, UC Berkeley Computer Science department for many of the slides for this course.
- I will try to make them available online in .ppt and .pdf before class (but no guarantees).

**What is Computer Organization?**

Where is the HW/SW Interface?

*Coordination of many levels (layers) of abstraction*

**Levels of Representation**

<table>
<thead>
<tr>
<th>High Level Language Program (e.g., C)</th>
<th>Compiler</th>
</tr>
</thead>
<tbody>
<tr>
<td>v[k] = v[k+1];</td>
<td>lw $t0, 0($2)</td>
</tr>
<tr>
<td>v[k+1] = temp;</td>
<td>lw $t1, 4($2)</td>
</tr>
<tr>
<td>temp = v[k];</td>
<td>sw $t0, 4($2)</td>
</tr>
<tr>
<td>lw $t1, 4($2)</td>
<td>sw $t1, 0($2)</td>
</tr>
</tbody>
</table>

**Overview of Physical Implementations**

*The hardware out of which we make systems.*

- Integrated Circuits (ICs)
  - Combinational logic circuits, memory elements, analog interfaces.
- Printed Circuits (PC) boards
  - substrate for ICs and interconnection, distribution of CLK, Vdd, and GND signals, heat dissipation.
- Power Supplies
  - Converts line AC voltage to regulated DC low voltage levels.
- Chassis (rack, card case, ...)
  - holds boards, power supply, provides physical interface to user or other systems.
- Connectors and Cables.

**Integrated Circuits (2003 state-of-the-art)**

- Primarily Crystalline Silicon
  - 1mm - 25mm on a side
  - 2003 - feature size ~ 0.13µm = 0.13 x 10^-6 m
  - 100 - 400M transistors
  - 25 - 100M “logic gates”
  - 3 - 10 conductive layers
  - “CMOS” (complementary metal oxide semiconductor) - most common.

- Package provides:
  - spreading of chip-level signal paths to board-level
  - heat dissipation
  - Ceramic or plastic with gold wires.
Printed Circuit Boards

- fiberglass or ceramic
- 1-20 conductive layers
- 1-20 in on a side
- IC packages are soldered down.

Technology Trends: Memory Capacity (Single-Chip DRAM)

<table>
<thead>
<tr>
<th>Year</th>
<th>size (Mbit)</th>
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<tbody>
<tr>
<td>1980</td>
<td>0.0625</td>
</tr>
<tr>
<td>1983</td>
<td>0.25</td>
</tr>
<tr>
<td>1986</td>
<td>1</td>
</tr>
<tr>
<td>1989</td>
<td>4</td>
</tr>
<tr>
<td>1992</td>
<td>16</td>
</tr>
<tr>
<td>1996</td>
<td>64</td>
</tr>
<tr>
<td>1998</td>
<td>128</td>
</tr>
<tr>
<td>2000</td>
<td>256</td>
</tr>
<tr>
<td>2002</td>
<td>512</td>
</tr>
</tbody>
</table>

- Now 1.4X/yr, or 2X every 2 years.
- 8000X since 1980!

Technology Trends: Microprocessor Complexity

<table>
<thead>
<tr>
<th>Year</th>
<th>Transistors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>1000</td>
</tr>
<tr>
<td>1975</td>
<td>10000</td>
</tr>
<tr>
<td>1980</td>
<td>100000</td>
</tr>
<tr>
<td>1985</td>
<td>1000000</td>
</tr>
<tr>
<td>1990</td>
<td>10000000</td>
</tr>
<tr>
<td>1995</td>
<td>100000000</td>
</tr>
<tr>
<td>2000</td>
<td>1000000000</td>
</tr>
</tbody>
</table>

- Itanium 2: 410 Million
- Athlon (K7): 22 Million
- Alpha 21264: 15 million
- Pentium Pro: 5.5 million
- PowerPC 620: 6.9 million
- Alpha 21164: 9.3 million
- Sparc Ultra 5.2 million

- 2X transistors/Chip Every 1.5 years
- Called "Moore's Law"

Moore's Law

- Gordon Moore - co-founder of Intel observed and predicted a trend:
  - Density of data on a chip would double every year
  - (Specifically density of transistors on an integrated circuit)
  - True for 40 decades. Has slowed a little to double every 18 months. Expected to continue for at least two more decades.
  - Implications: increased performance, decreased cost

Technology Trends: Processor Performance

- Intel P4 2000 MHz (Fall 2001)
- DEC Alpha 21264/600
- DEC Alpha A2000
- DEC Alpha 5/500
- DEC Alpha 5/300
- IBM POWER 100

We'll talk about processor performance later on...

Computer Technology - Dramatic Change!

- Memory
  - DRAM capacity: 2x / 2 years (since '96); 64x size improvement in last decade.

- Processor
  - Speed 2x / 1.5 years (since '85); 100X performance in last decade.

- Disk
  - Capacity: 2x / 1 year (since '97) 250X size in last decade.
Computer Technology - Dramatic Change!

° State-of-the-art PC when you graduate: (at least...)
  • Processor clock speed: 5000 MegaHertz (5.0 GigaHertz)
  • Memory capacity: 4000 MegaBytes (4.0 GigaBytes)
  • Disk capacity: 2000 GigaBytes (2.0 TeraBytes)
  • New units needed:

(Kilo, Mega, Giga, Tera, Peta, Exa, Zetta, Yotta = \(10^{24}\))

Technology in the News

° BIG
  • LaCie the first to offer consumer-level 1.6 Tera-byte disk!
  • $2,200
  • Weighs 11 pounds!
  • 5 1/4" form-factor

° SMALL
  • Pretec is soon offering a 12GB CompactFlash card
  • Size of a silver dollar
  • Cost?

Summary

° Continued rapid improvement in computing
  • 2X every 2.0 years in memory size;
    every 1.5 years in processor speed;
    every 1.0 year in disk capacity;

  • Moore’s Law enables processor
    (2X transistors/chip ~1.5 yrs)

° 5 classic components of all computers
  Control   Datapath   Memory   Input   Output

  Processor   I/O

CIS 314 MUG SHOTS

I need your pictures so I can learn your names.
Come up to the front in groups of 3 or 4. Write your name on the board and SMILE !!!