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
    (More what than how. The how 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


° The book will be available in the bookstore. (Not sure when.)

° We’ll use both the textbook and the CD included with it
Weekly Schedule

° Lectures - Principles and concepts
  MWF 10-10:50

° Discussion Sessions - Assignments
  F 13:00 – 13:50
  F 16:00 – 16:50

° First Discussion Session will be held in Room 100.

  Unix Tutorial

° Class Schedule may change slightly.
Course Assignments

- 4 assignments; due in lecture class, returned in discussion section
  - NO LATE ASSIGNMENTS ACCEPTED
  - We will DROP your lowest assignment grade.

- 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 CS UNIX accounts before Wednesday

- 2 Quizzes
Two Course Exams

• **Midterm: Monday Oct. 31**
  - One sheet of notes allowed
  - Review session Oct. 28

• **Final: Wed. Dec 7 @ 10:10 AM**
  - One sheet of notes allowed
  - Review session Dec. 2
GRADING

25% Homework Assignments
15% Quizzes
30% Midterm
30% Final
+ Extra credit !!
Extra Credit: EPA!  (from Dan Garcia)

° **Effort**
  - Attending Juan’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: saving somebody else’s work to a floppy/remote site, 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/%7Econduct/)
Powerpoint Lecture Slides

° Credit to Dan Garcia, UC Berkeley Computer Science department, for many of the slides for this course

° Credit to Ginnie Lo, UO Computer Science department, for a lot of material she lent me

° Slides are available on-line in .ppt and .pdf formats
What is Computer Organization?
Where is the HW/SW Interface?

* Coordination of many

levels (layers) of abstraction
Levels of Representation

High Level Language Program (e.g., C)

Compiler

Assembly Language Program (e.g., MIPS)

Assembler

Machine Language Program (MIPS)

Machine Interpretation

Hardware Architecture Description (e.g., Verilog Language)

Architecture Implementation

Logic Circuit Description (Verilog Language)

temp = v[k];
v[k] = v[k+1];
v[k+1] = temp;

lw $t0, 0($2)
lw $t1, 4($2)
sw $t1, 0($2)
sw $t0, 4($2)

0000 1001 1100 0110 1010 1111 0101 1000
1010 1111 0101 1000 0000 1001 1100 0110
1100 0110 1010 1111 0101 1000 0000 1001
0101 1000 0000 1001 1100 0110 1010 1111

wire [31:0] dataBus;
regFile registers (databus);
ALU ALUBlock (inA, inB, databus);
wire w0;
XOR (w0, a, b);
AND (s, w0, a);
Anatomy:
5 components of any Computer

- **Processor**
  - Control ("brain")
  - Datapath ("brawn")
- **Memory**
  (where programs, data live when running)
- **Devices**
  - Input
  - Output

**Personal Computer**

- **Input**
- **Output**
- **Disk**
- **Display, Printer**
- **Keyboard, Mouse**
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 $\sim 0.13\mu m = 0.13 \times 10^{-6}$ 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>
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<th>Year</th>
<th>Size (Mbit)</th>
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<tbody>
<tr>
<td>1980</td>
<td>0.0625</td>
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<tr>
<td>1983</td>
<td>0.25</td>
</tr>
<tr>
<td>1986</td>
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<td>1989</td>
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<td>128</td>
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<td>2000</td>
<td>256</td>
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<tr>
<td>2002</td>
<td>512</td>
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- Now 1.4X/yr, or 2X every 2 years.
- 8000X since 1980!
Technology Trends: Microprocessor Complexity

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 4 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

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.
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 for the future!

(Kilo, Mega, Giga, Tera, Peta, Exa, Zetta, Yotta = 10^{24})
Technology in the News

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

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