In the next 4 yrs, time-lapse movies will show the construction of the new CITRIS building. Very cool.

Teaching Assistants
- Andy Carle [Head TA]
- Steven Kusalo
- Danny Krause
- Casey Ho

What are “Machine Structures”?
- Coordination of many levels (layers) of abstraction

61C Levels of Representation
- High Level Language Program (e.g., C)
- Compiler
- Assembly Language Program (e.g., MIPS)
- Machine Language Program (MIPS)
- Machine Interpretation
  - Logic Circuit Description
    - (e.g., Verilog Language)
    - Architecture Implementation
  - Machine Interpretation
    - Hardware Architecture Description
      - (e.g., Verilog Language)
      - Logic Circuit Description
        - (e.g., Verilog Language)

Anatomy: 5 components of any Computer
- Personal Computer
  - Processor
    - Control (“brain”)
    - Datapath (“brawn”)
  - Memory
    - (where programs, data live when running)
  - Devices
    - Input
    - Output
  - Keyboard, Mouse
  - Disk
    - (where programs, data live when not running)
  - Display, Printer

Technology Trends: Memory Capacity (Single-Chip DRAM)
- 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”

Technology Trends: Processor Performance

- Intel P4 2000 MHz (Fall 2001)
- DEC Alpha 21264/600
- DEC Alpha 5/500
- DEC Alpha 5/300
- DEC Alpha 4/266
- IBM POWER 100

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!

- We’ll see that Kilo, Mega, etc. are incorrect tomorrow!
- 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! Mega = (Kilo, Mega, Giga, Tera, Peta, Exa, Zetta, Yotta = 10^24)
  - Come up with a clever mnemonic, fame!

CS61C: So what’s in it for me?

- Learn some of the big ideas in CS & engineering:
  - 5 Classic components of a Computer
  - Data can be anything (integers, floating point, characters); a program determines what it is
  - Stored program concept: instructions just data
  - Principle of Locality, exploited via a memory hierarchy (cache)
  - Greater performance by exploiting parallelism
  - Principle of abstraction, used to build systems as layers
  - Compilation v. interpretation thru system layers
  - Principles/Pitfalls of Performance Measurement

Others Skills learned in 61C

- Learning C
  - If you know one, you should be able to learn another programming language largely on your own
  - Given that you know C++ or Java, should be easy to pick up their ancestor, C

- Assembly Language Programming
  - This is a skill you will pick up, as a side effect of understanding the Big Ideas

- Hardware design
  - We think of hardware at the abstract level, with only a little bit of physical logic to give things perspective
  - CS 150, 152 teach this
Course Lecture Outline

- Number representations
- C-Language (basics + pointers)
- Storage management
- Assembly Programming
- Floating Point
- make-ing an Executable
- Caches
- Virtual Memory
- Logic Design
- Introduction to Verilog (HDL)
- CPU organization
- Pipelining
- Performance
- I/O Interrupts
- Disks, Networks
- Advanced Topics

Texts

- Required: Computer Organization and Design: The Hardware/Software Interface, Third Edition, Patterson and Hennessy (COD). The second edition is far inferior, and is not suggested.
- Required: The C Programming Language, Kernighan and Ritchie (K&R), 2nd edition
- Reading assignments on web page

Tried-and-True Technique: Peer Instruction

- Increase real-time learning in lecture, test understanding of concepts vs. details
- As complete a “segment” ask multiple choice question
  - 1-2 minutes to decide yourself
  - 3 minutes in pairs/triples to reach consensus. Teach others!
  - 5-7 minute discussion of answers, questions, clarifications
- Buy PRS transmitters from ASUC student store or others

Peer Instruction

- Read textbook
  - Reduces examples have to do in class
  - Get more from lecture (also good advice)
- Fill out 3-question Web Form on reading (released mondays, due every Friday before lecture)
  - Graded for effort, not correctness...
  - This counts for “E”ffort in EPA score

Weekly Schedule

- We are having discussion, lab and office hours this week...

Homeworks, Labs and Projects

- Lab exercises (every wk; due in that lab session unless extension given by TA) – extra point if you finish in 1st hour!
- Homework exercises (~ every week; HW 0 out now, due in section next week)
- Projects (every 2 to 3 weeks)
- All exercises, reading, homeworks, projects on course web page
- We will DROP your lowest HW, Lab!
- Only one (HW, Project, Midterm) / week
2 Course Exams + 2 Faux Exams

- Midterm: Early 8th week, room TBA
  - Give 3 hours for 2 hour exam
  - One “review sheet” allowed
  - Review session Sun beforehand, time/place TBA
- Final: Sat 2005-05-14 @ 12:30-3:30pm (grp 5)
  - You can clobber your midterm grade!
  - (students last semester LOVED this…)

Your final grade

- Grading (could change before 1st midterm)
  - 15pts = 5% Labs
  - 30pts = 10% Homework
  - 45pts = 15% Projects
  - 75pts = 25% Midterm* [can be clobbered by Final]
  - 135pts = 45% Final
  - Extra credit for EPA. What’s EPA?

- Grade distributions
  - Similar to CS61B, in the absolute scale.
  - Perfect score is 300 points. 10-20-10 for A+, A, A-
  - Similar for Bs and Cs (40 pts per letter-grade)
  - … C+, C, C-, D, F (No D+ or D- distinction)
  - Differs: No F will be given if all-but-one {hw, lab}, all projects submitted and all exams taken
  - We’ll “ooch” grades up but never down

Extra Credit: EPA!

- Effort
  - Attending Dan’s and TA’s office hours, completing all assignments, turning in HW0, doing reading quizzes
- Participation
  - Attending lecture and voting using the PRS system
  - Asking great questions in discussion and lecture and making it more interactive
- Altruism
  - Helping others in lab or on the newsgroup
- EPA! extra credit points have the potential to bump students up to the next grade level! (but actual EPA! scores are internal)

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 an 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, …
  - You’re not allowed to work on homework/projects/exams with anyone (other than ask Qs walking out of lecture)
  - Both “giver” and “receiver” are equally culpable
- Cheating points: negative points for that assignment / project / exam (e.g., if it’s worth 10 pts, you get -10) in most cases, F in the course.
- Every offense will be referred to the Office of Student Judicial Affairs.

Student Learning Center (SLC)

- Cesar Chavez Center (on Lower Sproul)
  - The SLC will offer directed study groups for students CS 61C.
  - They will also offer Drop-in tutoring support for about 20 hours each week.
  - Most of these hours will be conducted by paid tutorial staff, but these will also be supplemented by students who are receiving academic credit for tutoring.

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 yra)
- 5 classic components of all computers
  - Control Datapath Memory Input Output

Processor