Welcome!

Comp 411 Fall 2011

Computer Organization

Gary Bishop

Lecture 1

Topics for today

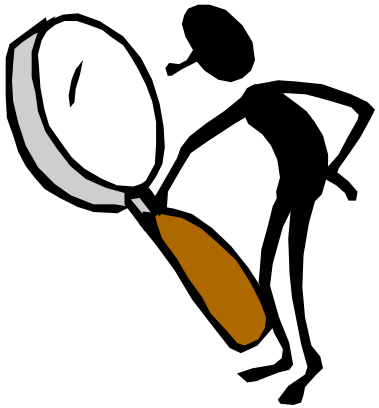
- Course Mechanics
- Course Objectives
- What is Information?
- Computer Abstractions

Credits

- Some of these slides were developed by Leonard McMillan and adapted by Gary Bishop and Montek Singh.

Course Mechanics

- Grading:
  - Problem sets: 25%
    - 5-7 problem sets
    - Lowest one will be dropped
  - In-Class Quizzes: 15%
  - Three Exams: 35%
  - Lab: 25%
    - Register for Comp 590-411 for 1 hour credit
    - Same grade as class
    - 9-10 lab assignments focused on assembly, C, and Linux
    - Friday 2pm



Course Mechanics

- Policies:
  - Problem Sets:
    - Will be distributed on the web. You will typically have 1 week to do them, but sometimes more or less time.
    - Late problem sets will not be accepted, but the lowest problem-set score will be dropped.
  - Honor Code:
    - The honor code is in effect for all homework, labs, exams etc. Please review the policy on the course website.
  - Lecture Notes:
    - I will attempt to make Lecture Slides, Problem Sets, and other course materials available on the web either before class, or soon after, on the day they are given.

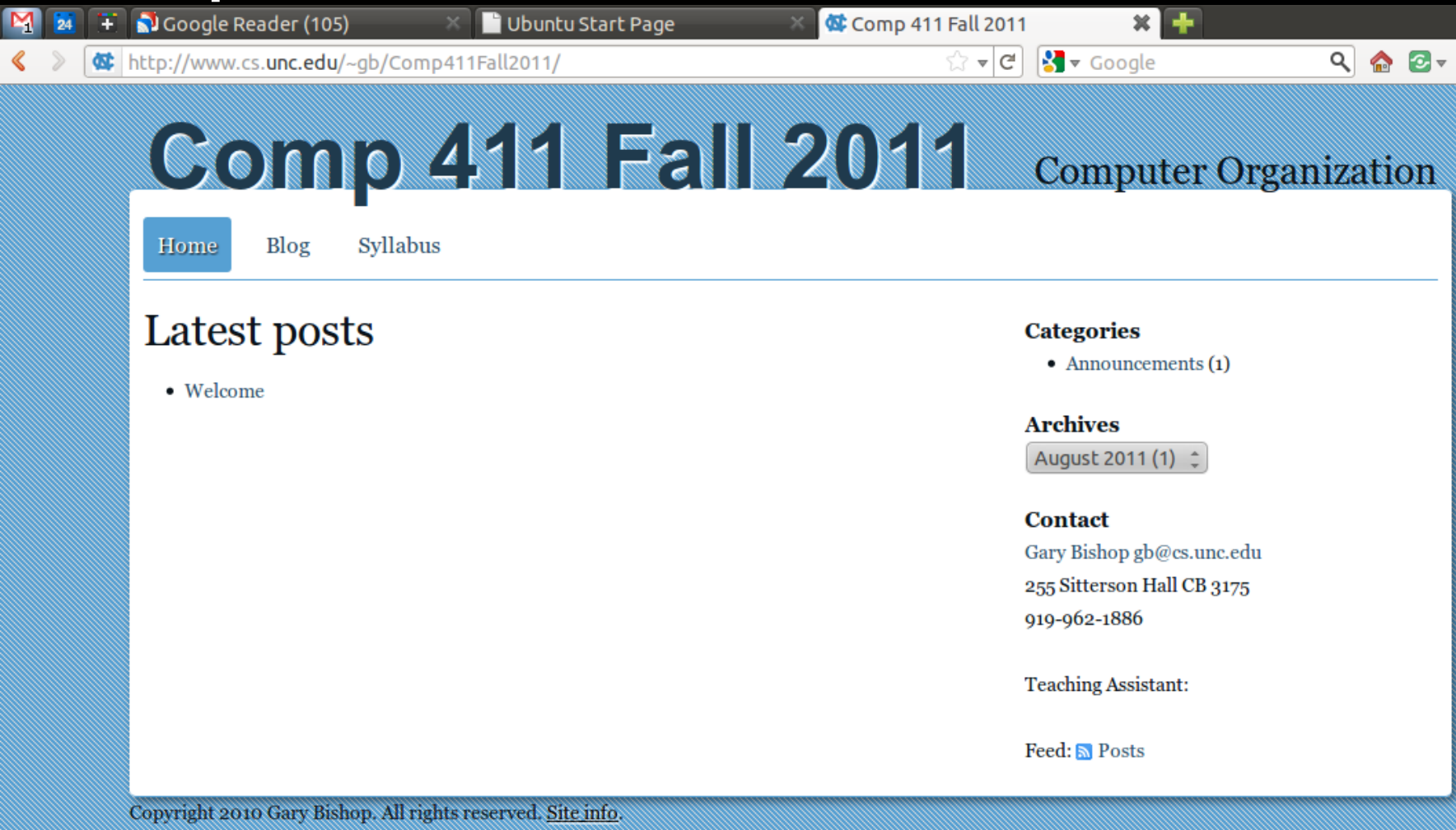
Prerequisites

- COMP401: Foundations of Programming
  - This is a hard prerequisite
- You must know at least the following concepts:
  - basic data types: integers, characters, Boolean, etc.
  - basic arithmetic operators and expressions
  - "if-then-else" constructs, and "while"/"for" loops
  - function and procedure calls
  - basic Boolean operators (AND, OR, XOR, etc.)

How to do well in this course

- Attend lectures (stay awake!)
- Read the book!
  - Big mistake = only reviewing lecture slides
- Do all homework
  - Start early. Many problem sets are too hard to attempt the night before.
- Ask questions in class
- Discuss with other students
  - But all work handed must be your own (see Honor Code)
- Use all materials from this semester only
  - Much of the material (lecture slides, homework) has changed
  - Looking up solutions from earlier semesters = cheating. Not worth it.

Comp 411: Course Website



Who I am

Google Reader (105) | Ubuntu Start Page | Gary Bishop

http://www.cs.unc.edu/~gb/

Gary Bishop

Geeks making the world a bit better.

About | Blog | Calendar | Important | Publications | Research | Students | Teaching

About

I am a Professor of Computer Science at the University of North Carolina at Chapel Hill. My students and I develop software designed to enable people with disabilities to participate fully in education, literacy and play.

Quick Links

- Check out Tar Heel Reader, our site with books for beginning readers.
- Hark the Sound, our **online** collection of games for kids who are blind or visually impaired.
- Comp 411
- UNC Open Web Project
- Accessible YouTube choose and play YouTube videos using only 2 keys.
- Download the older, windows only, Hark the Sound, sound games for kids who are blind or visually impaired.
- Read about our work on enabling technology
- Look for ideas for enabling technology projects
- Check my calendar to find an open time we could meet

Search... Search

Contact

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Who are you?

* Name
* Major
* Why are you here?
* One thing we might not know about you?

Goal 1: Demystify Computers

- Strangely, most people (even some computer scientists) are afraid of computers.

- We are only afraid of things we do not understand!
  - I do not fear computers. I fear the lack of them.

    - Isaac Asimov (1920 - 1992)

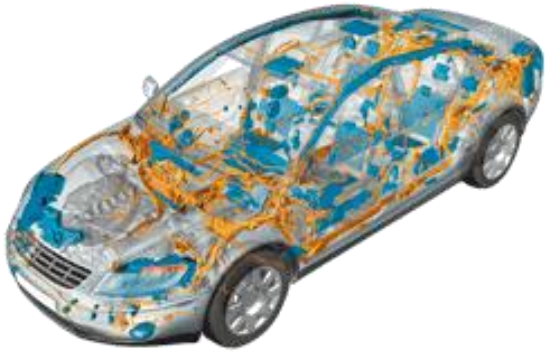
  - Fear is the main source of superstition, and one of the main sources of cruelty. To conquer fear is the beginning of wisdom.

    - Bertrand Russell (1872 – 1970)

Computers Everywhere

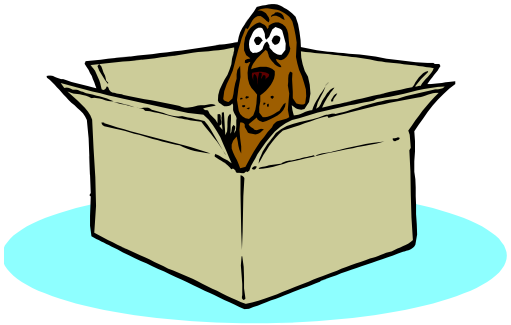
- The computers we are used to
  - Desktops
  - Laptops

  - Embedded processors
    - Cars
    - Mobile phones
    - Toasters, irons, wristwatches, happy-meal toys



Goal 2: Power of Abstraction

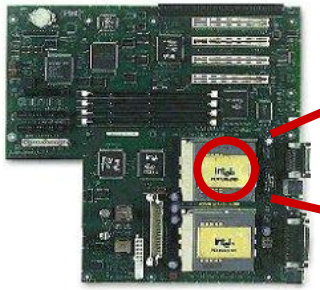
* What is *abstraction?*
  - Define a function, develop a robust implementation, and then put a box around it.



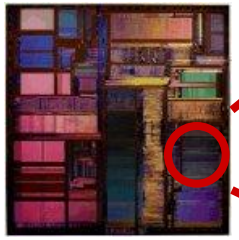
* Why is abstraction useful?
  - enables us to create unfathomable machines called computers
  - imagine a billion --- 1,000,000,000

Abstraction is key to building systems with >1G components

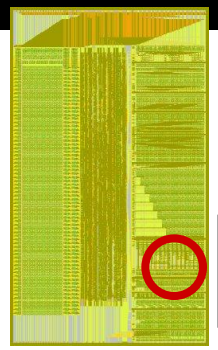
Personal Computer:
Hardware & Software



Circuit Board:
≈8 / system
1-2G devices

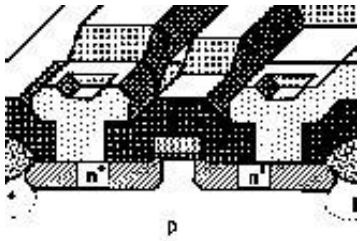


Integrated Circuit:
≈8-16 / PCB
0.25M-16M devices

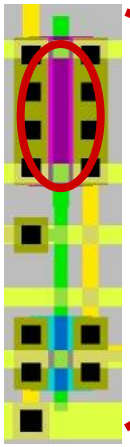


Module:
≈8-16 / IC
100K devices

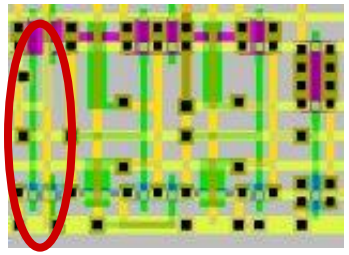
MOSFET
="transistor"
="device"



Scheme for
representing
information



Gate:
≈2-8 / Cell
8 devices

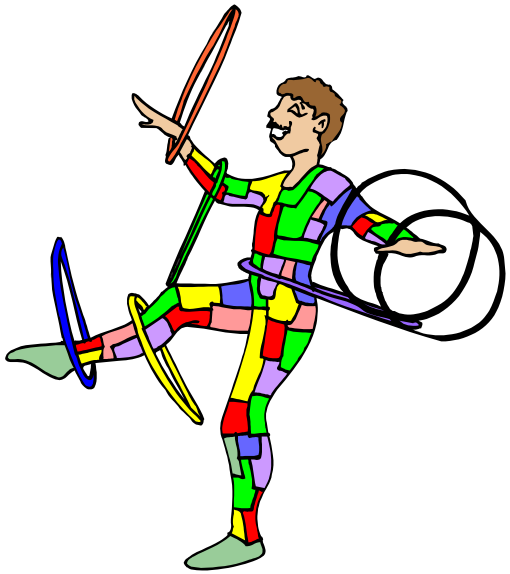


Cell:
≈1K-10K / Module
16-64 devices

Our Plan of Attack...

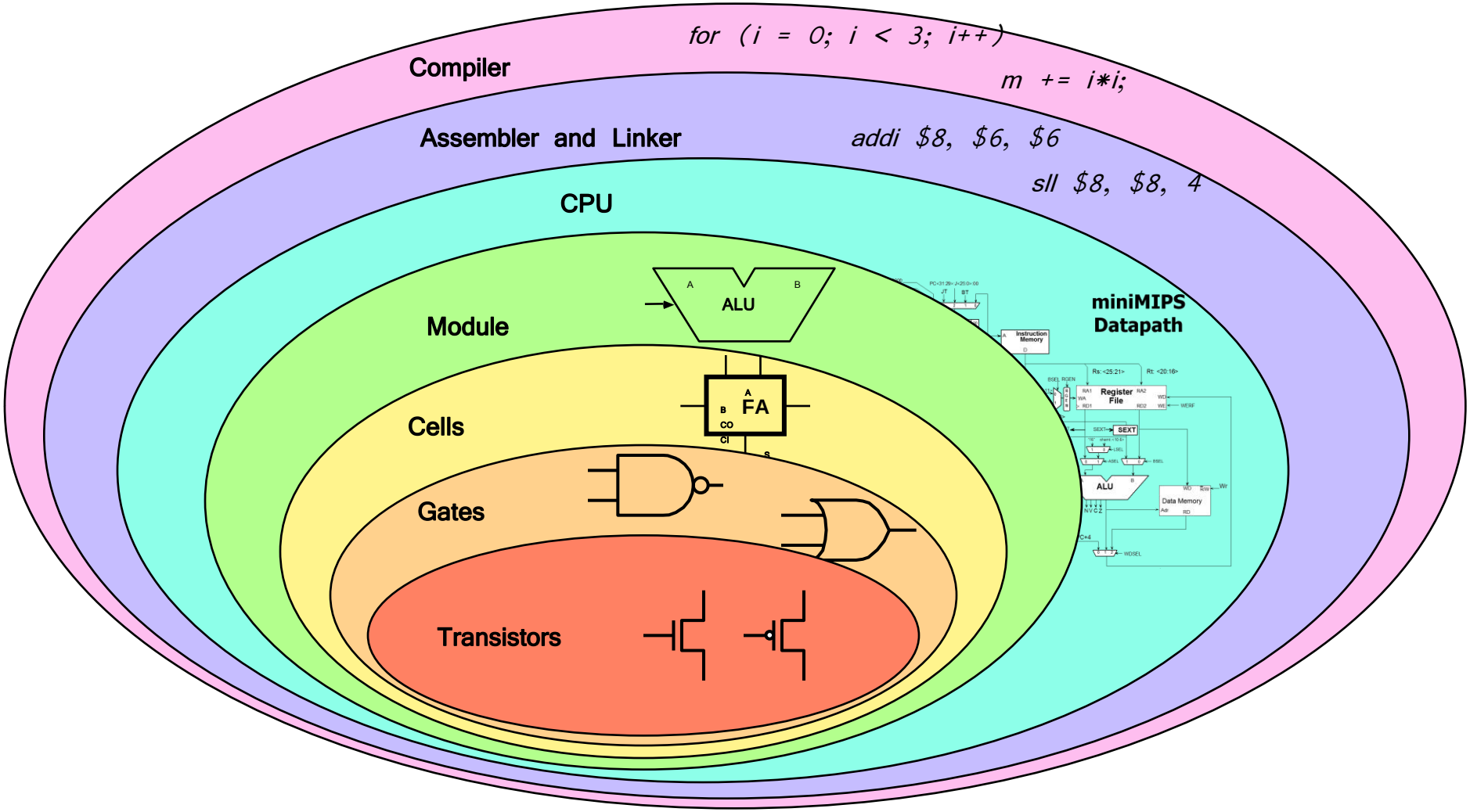
- Understand how things work, by alternating between low-level (*bottom-up*) and high level (*top-down*) concepts
- Encapsulate our understanding using appropriate abstractions
- Study organizational principles: abstractions, interfaces, APIs.

- Roll up our sleeves and design at each level of hierarchy
- Learn engineering tricks at each level



A Computer System

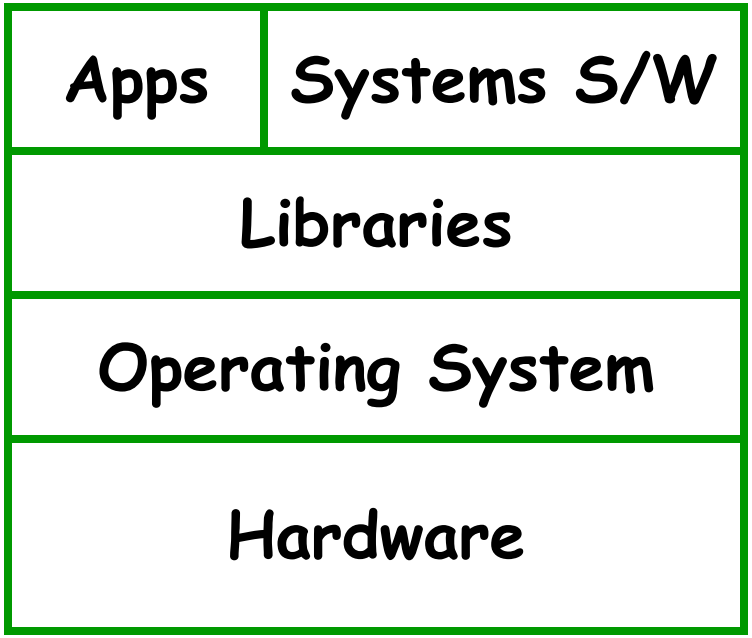
- What is a computer system?
- Where does it start?
- Where does it end?



Computer Layer Cake

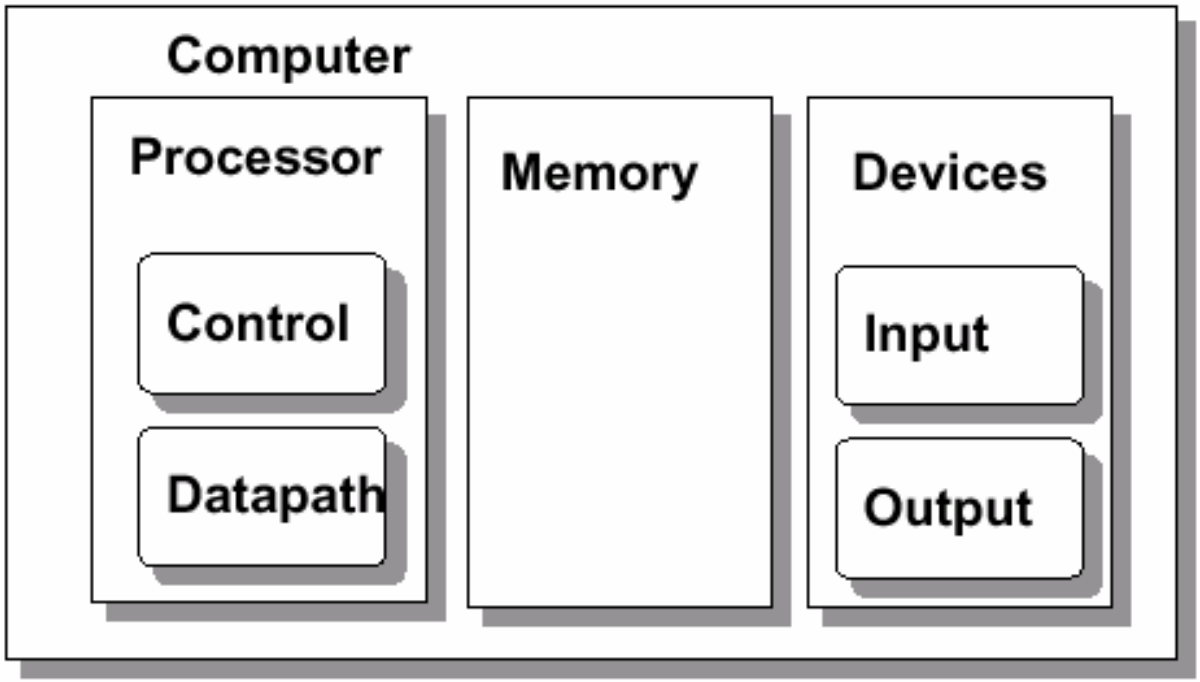
- Applications
- Systems software
- Shared libraries
- Operating System
- Hardware – the bare metal

Computers are digital Chameleons



Under the Covers

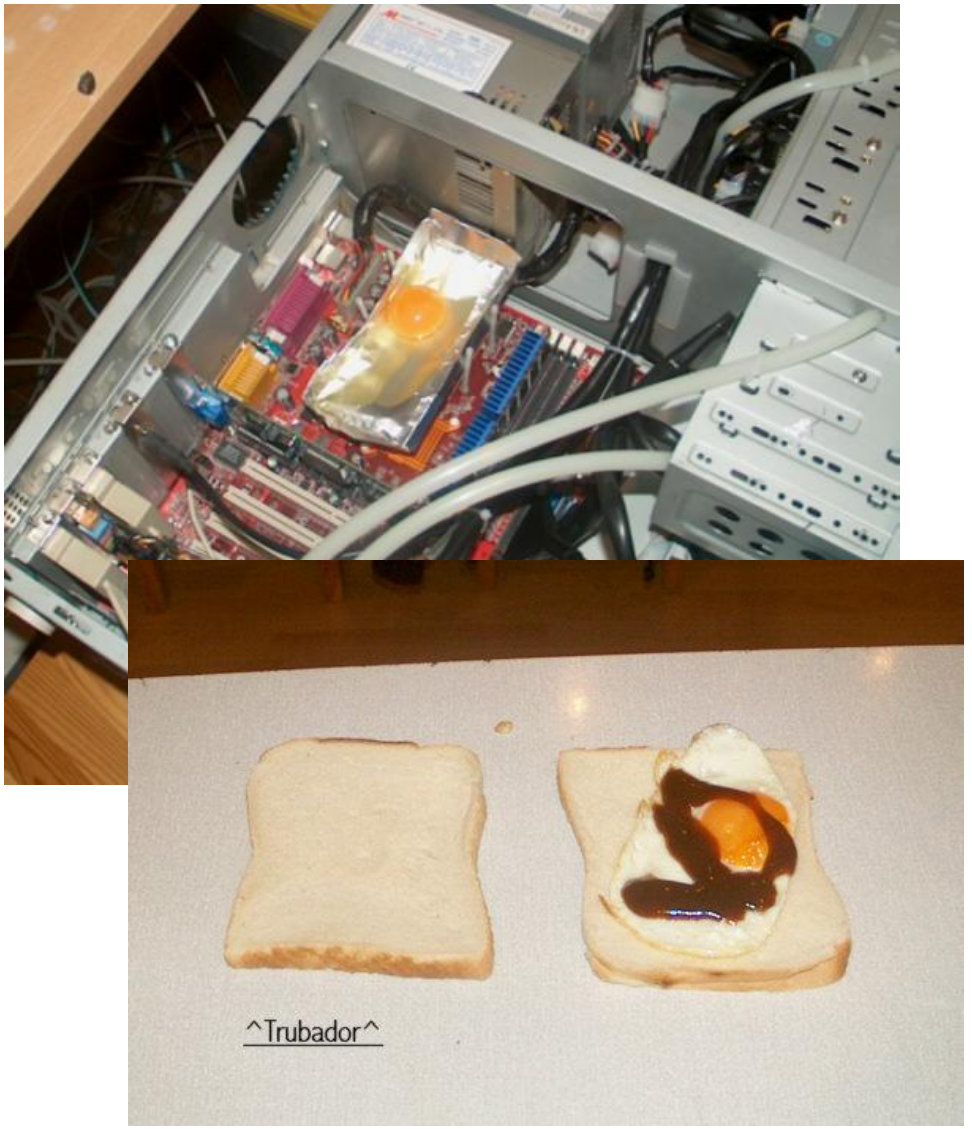
- Input
- Output
- Storage
- Processing
  - Datapath
  - Control



Issues for Modern Computers

- GHz clock speeds
- Multiple instructions per clock cycle
- Multi-core
- Memory wall
- I/O bottlenecks
- Power dissipation
- Implementation tech changes

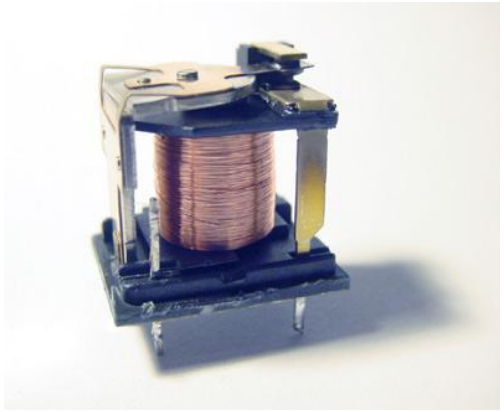
http://www.hotchips.org/

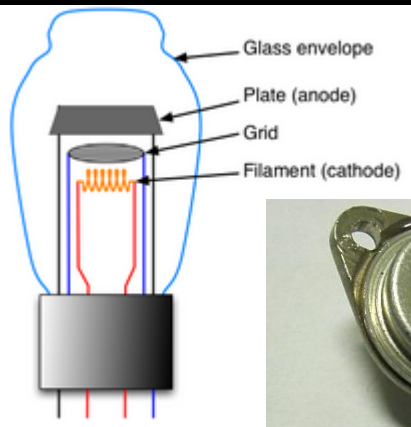


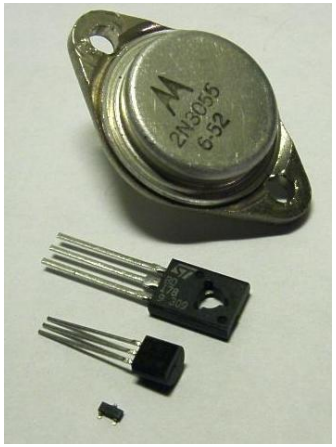
Courtesy Troubador

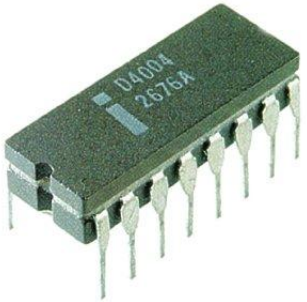
Implementation Technology

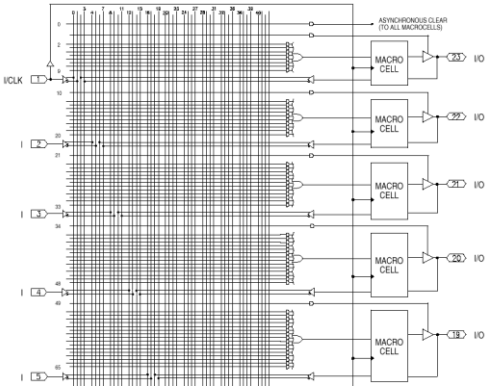
- Relays
- Vacuum Tubes
- Transistors
- Integrated Circuits
  - Gate-level integration
  - Medium Scale Integration (PALs)
  - Large Scale Integration (Processing unit on a chip)
  - Today (Multiple CPUs on a chip)
- Nanotubes?
- Quantum-Effect Devices?
- DNA?





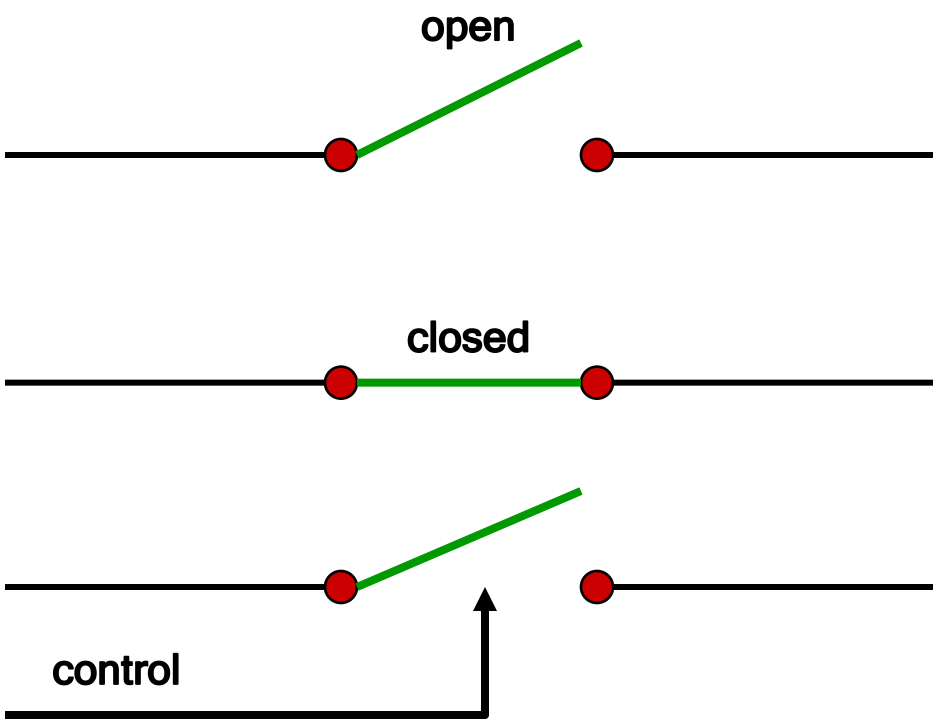






Implementation Technology

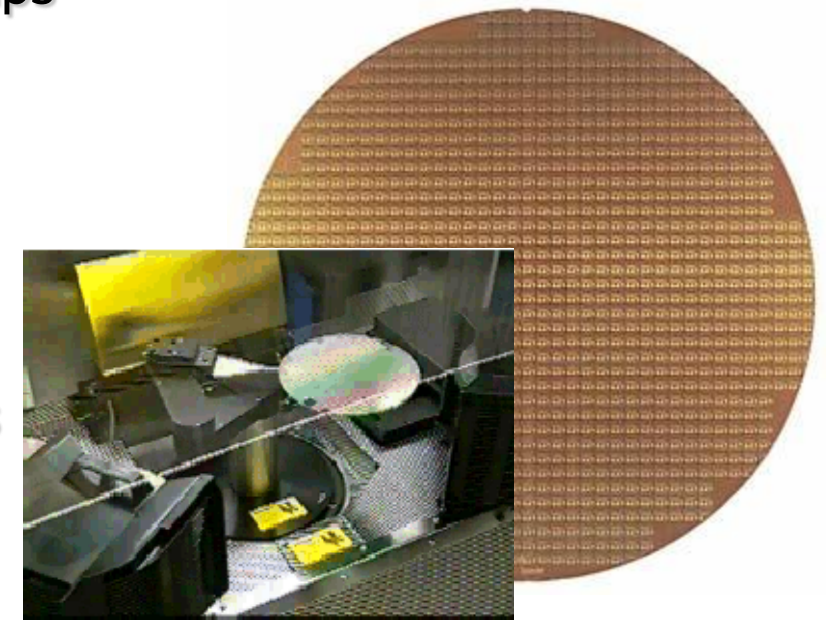
- Common Links?
  - A controllable switch
- Computers are wires and switches



Chips

Silicon Wafers

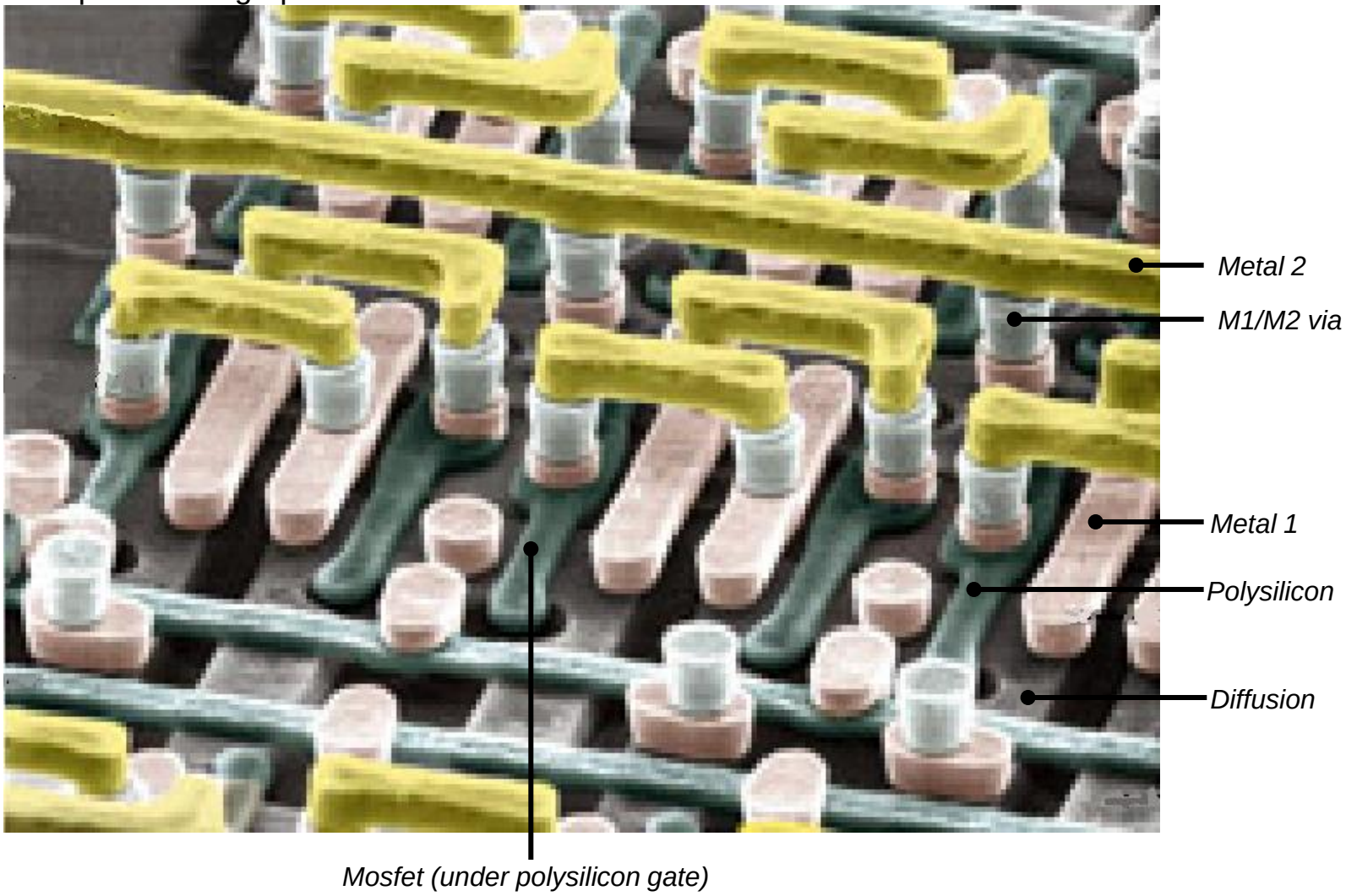
- Chip manufactures build many copies of the same circuit onto a single wafer.
  - Only a percentage of the chips will work; those that work will run at different speeds. The yield decreases as the size of the chips increases and the feature size decreases.
- Wafers are processed by automated fabrication lines.
  - To minimize the chance of contaminants ruining a process step, great care is taken to maintain a meticulously clean environment.



Chips

⁕ Silicon Wafers

IBM photomicrograph



What is "Computation"?

- Computation is about "processing information"
  - Transforming information from one form to another
  - Deriving new information from old
  - Finding information associated with a given input
- "Computation" describes the motion of information through time
- "Communication" describes the motion of information through space

What is "Information"?

information, *n.* Knowledge communicated or received *concerning a particular fact or circumstance.*

A Computer Scientist's Definition:

Information resolves uncertainty. Information is simply that which cannot be predicted.

The less predictable a message is, the more information it conveys!

Real-World Information

Why do *unexpected* messages get allocated the biggest headlines?


The New York Times

At 14, a Liberian War Veteran Dreams of Finding a Way Home

U.S. TO SEND IRAQIS TO SITE IN HUNGARY FOR POLICE COURSE

4 MILITANTS KILLED IN ISRAELI ATTACK

Plan to Preserve Sept. 11 Remains Leaves Open Future Identification

Technology and Brain Power Used to Tame an Aging Grid

Finding Comfort in Strangers With an Online Diet Journal

Old ID Card Gives New Status to Mexicans in U.S.


TITANIC SINKS


Wisconsin State Journal

ON THE MOON!

And It's One Giant Leap for Mankind

Americans First to Walk on Dead Lunar Surface


The Milwaukee Leader

HOME EDITION

BILLIONS LOST IN NEW STOCK CRASH

TRUNK PLANT FIRE DAMAGE IS $75,000

May Punish Senator for Aiding Tariff Lobbyists

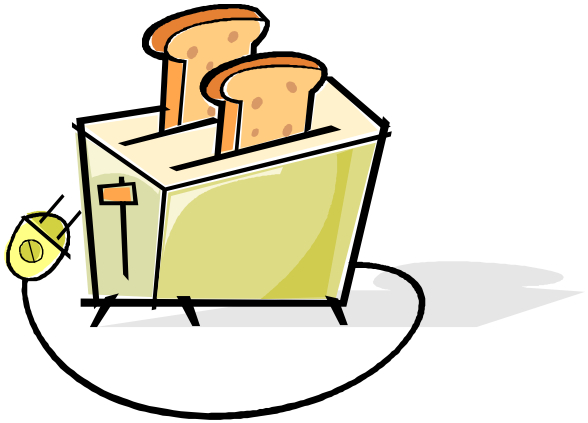
BANKERS' AID FAILS TO END SELLING WAVE

BINGHAM SAYS IT'S FRAME-UP, IS CRITICISED

… because they carry the *most information*.

What Does A Computer Process?

- A Toaster processes bread and bagels
- A Blender processes smoothies and margaritas
- What does a computer process?
  - Information
  - Bits
- What is the mapping from information to bits?



Next Lecture

- Computer Representations
- How do computers represent:
  - Text?
  - Numbers?
  - Everything else?