SESSION 2 – BACKGROUND

Reading:
- Chapter 1 (1.1 – 1.3)
- Wikipedia: Semiconductor device fabrication

Session Objectives
- Understand principles of IC fabrication that affect system design
- Experience a brief tour of hardware components in a typical computer (become familiar with the terminology)
- Understand layers of abstraction
- Understand how the evolution of computers affects today’s computers

Plan on rereading Chapter 1 periodically during the semester
Typical Spec Sheet

• Is the device fast enough to run necessary programs?
• Is the device cost-effective?
• Will it be obsolete in 6 months?
• Will some applications run better on one device or another?
• Do you know the implications of different features and measures?
• Are you proficient enough in the terminology of the specifications to ask questions?

Computer Components

• A basic abstraction of a computer is that it is a device consisting of:
  • A processor to interpret and execute programs
  • A memory to store both data and programs
  • A mechanism for transferring data to and from the outside world.

What is your intuitive understanding of a processor, memory, and data transfer?
Views of Computer Hardware

- Computer organization (microarchitecture)
  - The way an instruction set is implemented on a computer
  - Encompasses all physical aspects of computer systems
  - E.g., circuit design, control signals, memory types
- Computer architecture
  - Some definitions include microarchitecture
  - Logical aspects of system implementation as seen by the programmer
  - E.g., instruction sets, instruction formats, data types, addressing modes

Equivalence

- Principle of Equivalence of HW and SW
  - Any task done by software can also be done using hardware, and any operation performed directly by hardware can be done using software

What are the implications of a HW implementation vs. a SW implementation of a function (e.g., 3-D animation)?
Integrated Circuit

- Integrated circuit (IC or chip) – manufactured by lithography
- Printed as a unit rather than built one transistor at a time
- Composed of overlapping layers
- Formed by the patterned diffusion of trace elements into the surface of a semiconductor material
- Continual reduction in feature size results in Enormous advantages in price and performance

VLSI ranges from hundreds of thousands of transistors to several billion transistors on an IC

Lithography

- A method for printing using a process that deposits an image on a surface
- Invented in 1796 for the production of artwork and print work
- Process applied to production of ICs
- Many improvements in the process allow reduction in IC feature size

Image courtesy of plyojump.com
Manufacturing Process

- Wafers contain multiple die (typically hundreds)
- As feature size gets smaller, fabrication costs increase

Semiconductor IC Fabrication

- Steps
  - Imaging – design of the IC
  - Deposition – transfer of a material on the semiconductor material
  - Etching – removal of material from the wafer
  - Fab plant construction well in excess of $1B
IC Packaging

- IC often is encased in a support that
  - Prevents physical damage and corrosion
  - Supports the electrical contacts required to assemble the integrated circuit into a system
- Considerations
  - I/O
  - Protection
  - Heat dissipation

IC Issues

- As feature size decreases, the purity of the manufacturing process becomes more important
  - Clean rooms
  - Testing
  - Redundancy
Implications of ICs

• Regularity of design vs. minimum number of transistors
• Finding useful functions for the large number of available transistors
• Large scale applications that justify the investment in fabrication
• Importance of market share

Example: difficulty in sustaining a good design such as the Power PC

Summary

• Throughout the remainder of the course you will:
  • See how these components work and
  • See how they interact with software to make complete computer systems.
Have You Satisfied the Objectives?

- Understand principles of IC fabrication that affect system design
- Experience a brief tour of hardware components in a typical computer (to get used to the terminology)
- Understand layers of abstraction
- Understand how the evolution of computers affects today’s computers