

CS222 Computer Organization & Architecture

Somanath Tripathy
IIT Patna

CS222: Computer Organization & Architecture

- **Prerequisite:**
 - CS221 Digital Design,
 - CS101 Introduction to computing
- **Objective:**
 - To understand the computers' functional components, their characteristics and interconnections among themselves.
- **After completion**
 - A student will have clear understanding of the architecture
 - To help in **designing programs that runs efficiently in a real machine**

CS 222 COMPUTER ORGANIZATION AND ARCHITECTURE (3 0 0 6)

- **Pre-requisites:** CS221 (Digital Design)
- Course Instructor: Dr. Somanath Tripathy
Room: 407 @ Block III,
C.S.E. Departemnt, IIT Patna.
Ph: 3028036, Email: som@iitp.ac.in
-
- **Objective:** To understand the computers' functional components, their characteristics and interconnections among themselves. This will help in designing programs that runs efficiently in a real machine.
-
- **Syllabus:**
- Study of an existing CPU: architecture, instruction set and the addressing modes supported; assembly language programming. Control unit Design: instruction interpretation, hardwired and microprogrammed methods of design. RISC and CISC paradigms.
- Memory organization: hierarchical memory systems, cache memories, cache coherence, virtual memory. System buses: interconnection structures and bus interconnection. Arithmetic Logic Unit.
- I/O Transfer techniques: programmed, interrupt-driven and DMA; I/O processors and channels, mapping of I/O addresses. Advanced architectures: parallel and pipelined systems, dataflow, hypercubes, superscalar processors.

Course Outline

- CPU
- Control Units
- I/O
- Memory

- Advanced Architecture

Books

- Text :
 - D.A. Patterson and J.L. Hennessy: Computer Organization and Design, Morgan Kulfman Publisher
 - W. Stallings, *Computer Organization and Architecture: Designing for Performance*, 8th Ed, Pearson, 2010
- **References:**
 - **Relevant Materials to be placed in the course website**
 - Structured Computer Organization, By A. Tenenbaum, 5th Ed, Prentice-Hall of India, 2009.
 - Computer Architecture and Parallel Processing, K Hwang and F.A. Briggs, Mcgrahill pub. 2008

Evaluation Policy

- Before-Mid
 - Assessment (Assignments, Quizzes & etc.) : 10%
 - Mid-Sem: 40%
- After-Mid
 - Assessment & End-Sem: 50%
- NB: Class performance has major role in Grading
- Course Web: 172.16.1.3/~som/CS222

Computer Architecture Introduction



Before Start!!!

- Why do you study computer architecture?
 - Is it to design a new computer?
 - To know how the computer works
 - How to achieve the high performance
 - Using a high speed processor can the performance increased as desired?

Must a Programmer Care About Hardware?

- Must know how to reason about program performance and energy
- Memory management: if we understand how/where data is placed, we can help ensure that relevant data is nearby
- Thread management: if we understand how threads interact, we can write smarter multi-threaded programs
- → Why do we care about multi-threaded programs?

Building Architecture

- **Materials**

- Brick
- Cement
- Wood
- Glass

- **Goals**

- Function
- Cost
- Safety

- **Buildings**

- Houses
- Offices
- Computer center
- Laboratory
- Auditorim
- Apartment

Computer Architecture

- Technology
 - Logic Gates
 - SRAM
 - Circuit Techniques
 - Magnetic storage
 - Etc.

- Goals
 - operations
 - Performance
 - Reliability
 - Cost
 - Energy Efficiency

- Computer
 - Servers
 - Supercomputer
 - PCs
 - PDAs

Computer Architecture:

Art/ Science/ Technology ,that selects the hardware components and interconnects them with **optimized cost and performance**

Architecture & Organization

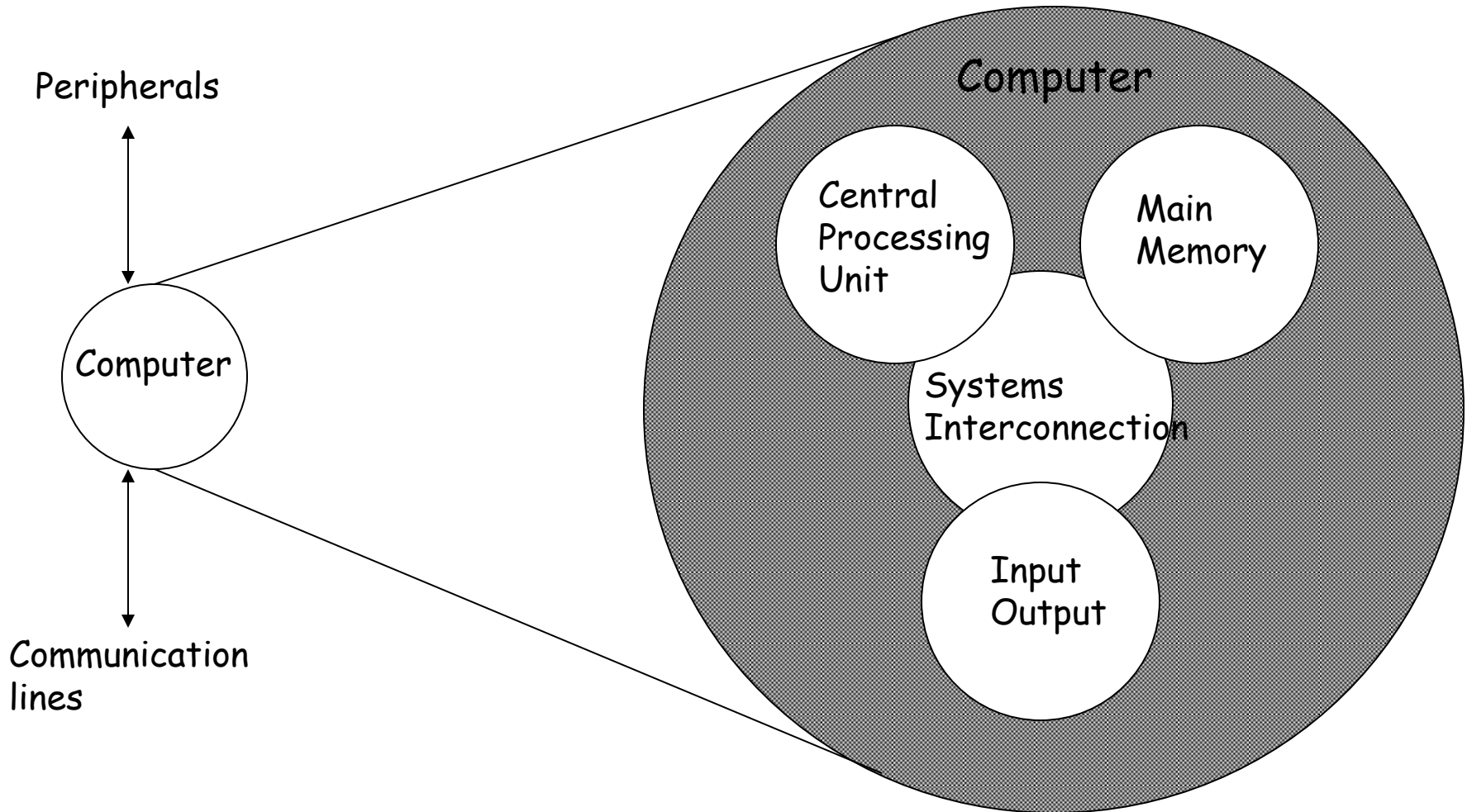
Architecture & Organization

- Architecture is those attributes visible to the programmer
 - Instruction set, number of bits used for data representation, I/O mechanisms, addressing techniques.
- e.g. Is there a multiply instruction?
- Organization is how features are implemented
 - Control signals, interfaces, memory technology.
- e.g. Is there a hardware multiply unit or is it done by repeated addition?
- Distinguishing computer Architecture and organization is vague

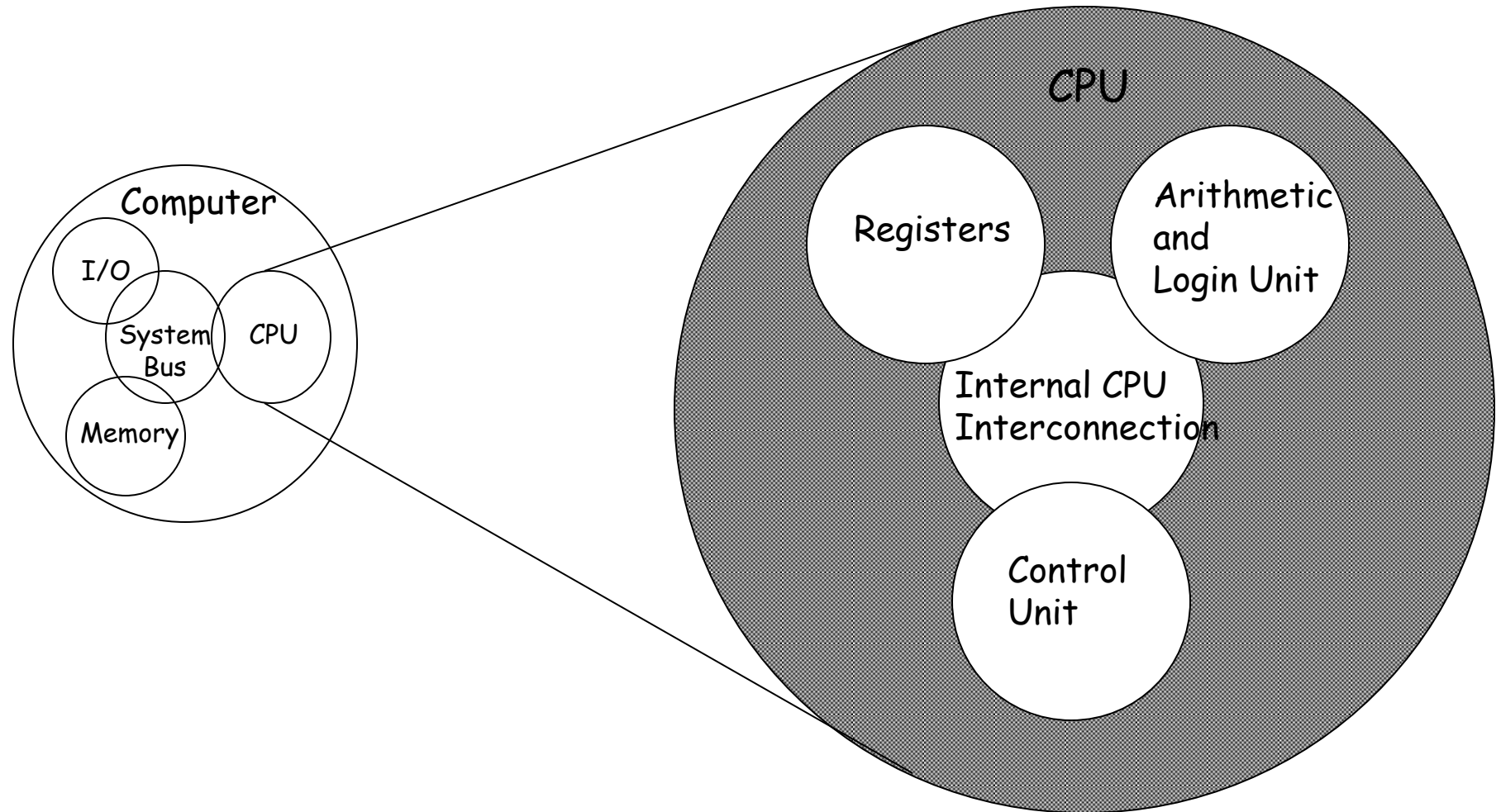
Top-down Approach

- Hierarchical view
 - At each level designer is concerned with function and structure
 - Function is the operation of individual components
 - Structure is the way in which components relate to each other
- All computer functions are:
 - Data processing
 - Data storage
 - Data movement
 - Control

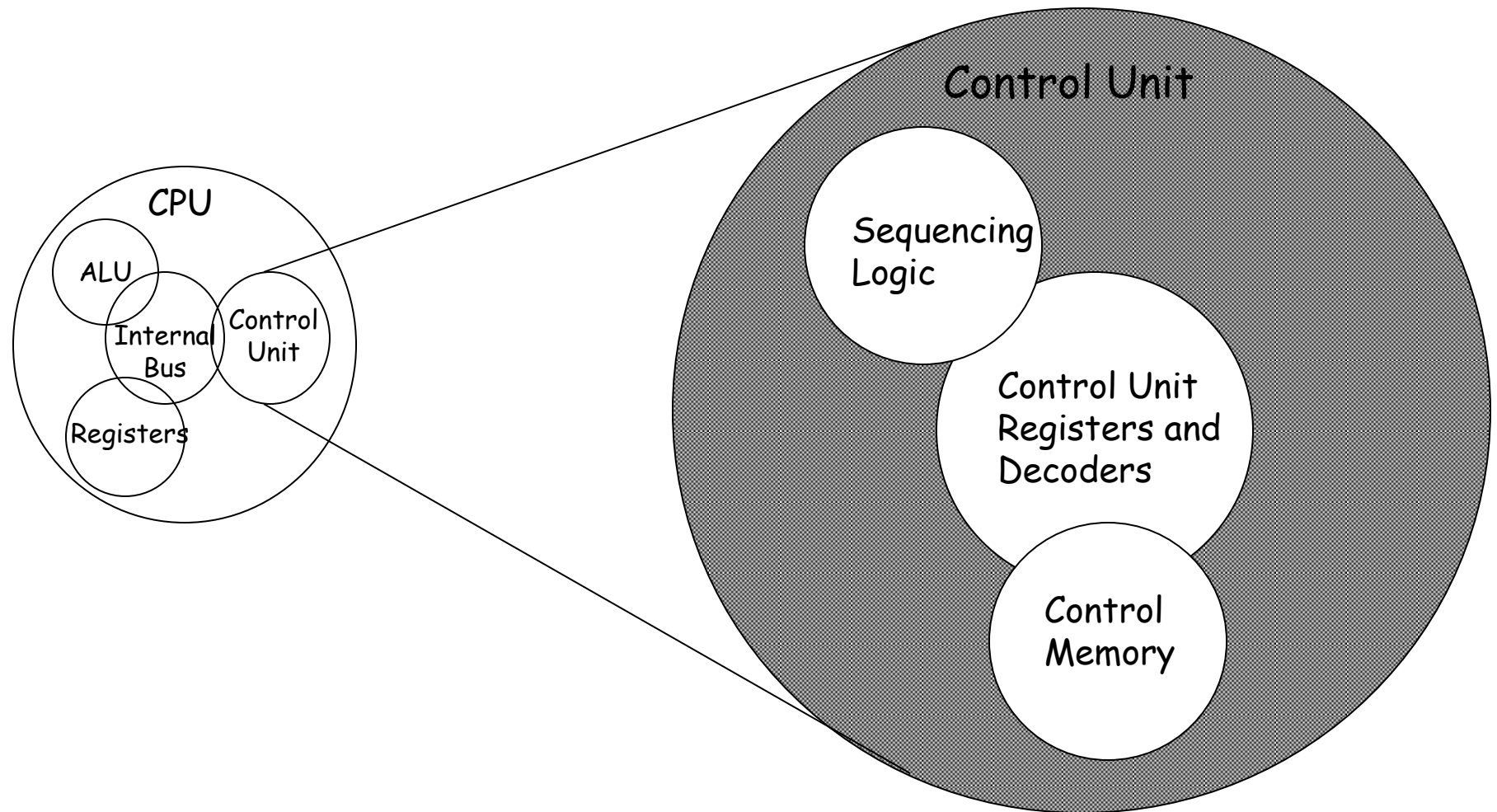
Structure - Top Level



Structure - The CPU



Structure - The Control Unit



Computer Designing Goals

- Reliable
 - Continue to perform correctly?
- High performance
 - Speed, throughput
- Low power
 - Energy (battery life)
- Low cost
 - Per unit manufacturing cost
- Balancing all these goals is constantly changing

Topics to be covered

- Performance issues
- A specific instruction set architecture
- Arithmetic and how to build an ALU
- Constructing a processor to execute instructions
- Pipelining to improve performance
- Memory: caches and virtual memory
- Input / output

- Thanks