Overview of Computer Organization

Irvine Edition IV : Section 1.2 and Section 2.4

Fundamentals Of Computer Organization and Design, Dandamudi, Chapter 1

SYSC-3006 Objective

- Our key objective : To Understand computers at **machine level**

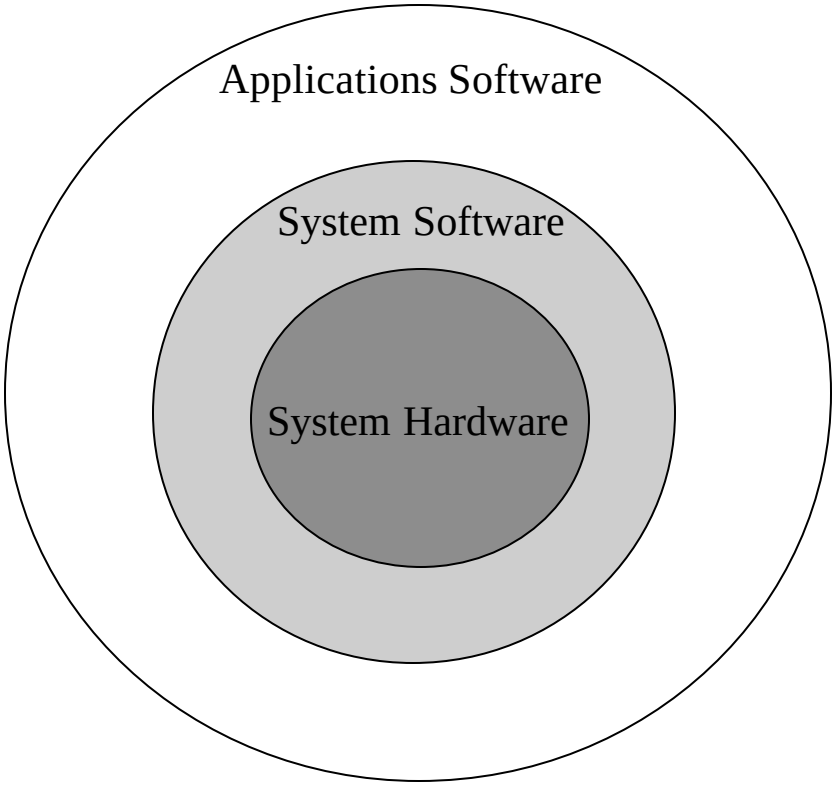

Figure 1.1
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Understanding Computer Organization: basic terms

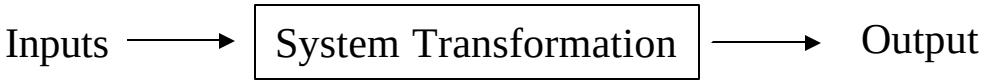
- Computer Architecture: describes **structure** and basic **functional** parts of a computer system *at a logical level… from the **programmer's point of view***.
  - Key component: Instruction Set

- Computer Organization: describes how hardware components **operate** to meet the architecture.
  - **Behaviour** : How the parts work

- Computer Programming: expression of a program in a language that the **computer can understand**.
  - High-level languages: Close to human expression and needs
  - Low-level languages: Close to the computer architecture with lots of low-level details.

Systems and Models

- System: set of components that interact to accomplish an objective



- Models used in all areas of life to manage complexity in systems
  - Management hierarchies in large corporations
  - Architectural plans
  - Telecommunication systems
- Abstract models emphasize the important details/attributes
  - Ignore nonessential details
- Abstract Models are WIDELY used in engineering!
  - Have you done this in other courses?

Computers are Complex Systems

- Problem
  - How can we understand programming at a machine level ?
    - How do the millions of transistors in a computer support a program ?

- Solution: The Programmer's Model
  - Abstract model appropriate for explaining software at the machine level
    - No transistor details! ☺
    - Widely used in practice ☺
    - Models computer as a state-based system (Later)

Abstract models of a Computer System

- Abstract models of a computer depends on the **level** of the language being used.

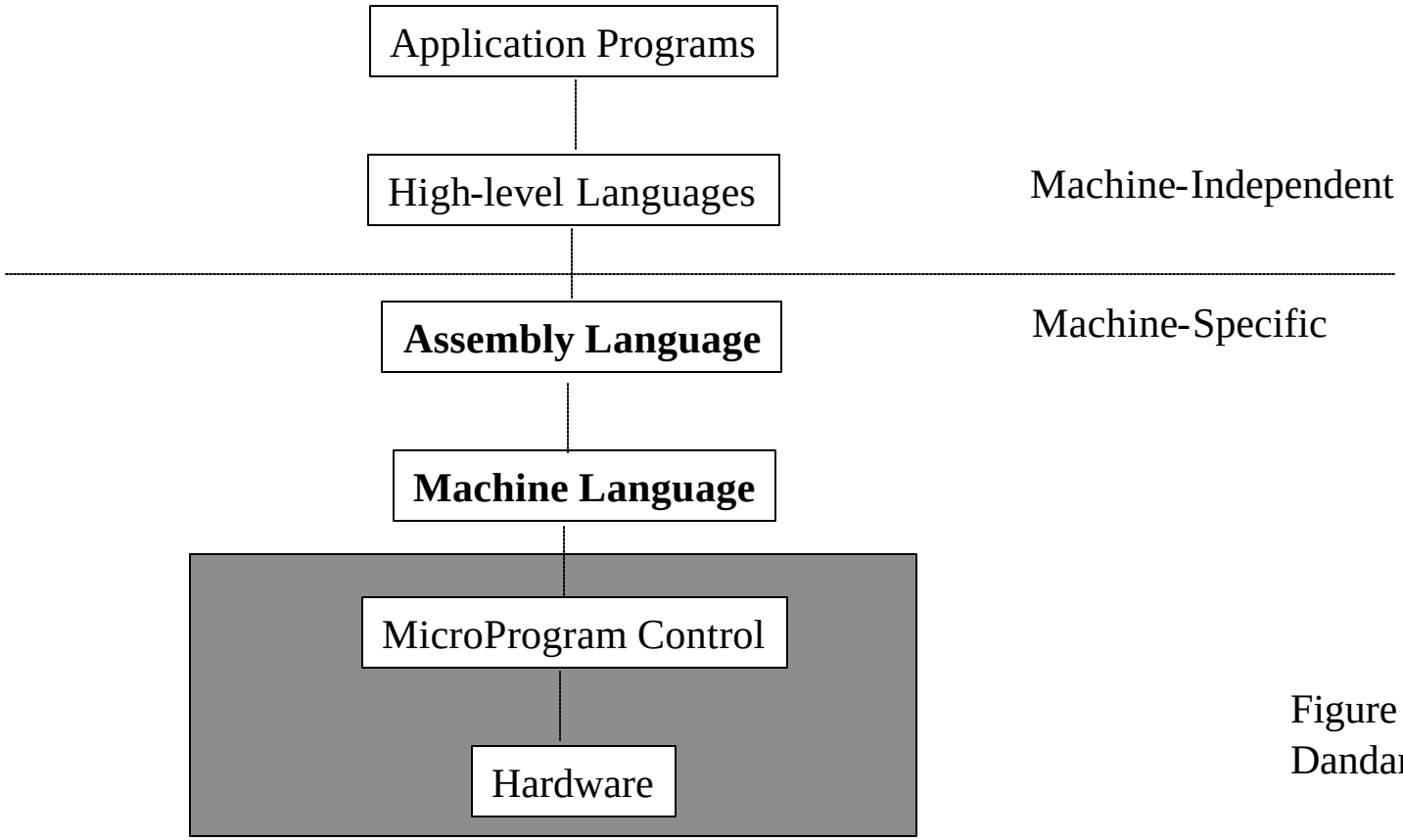


Figure 1.2
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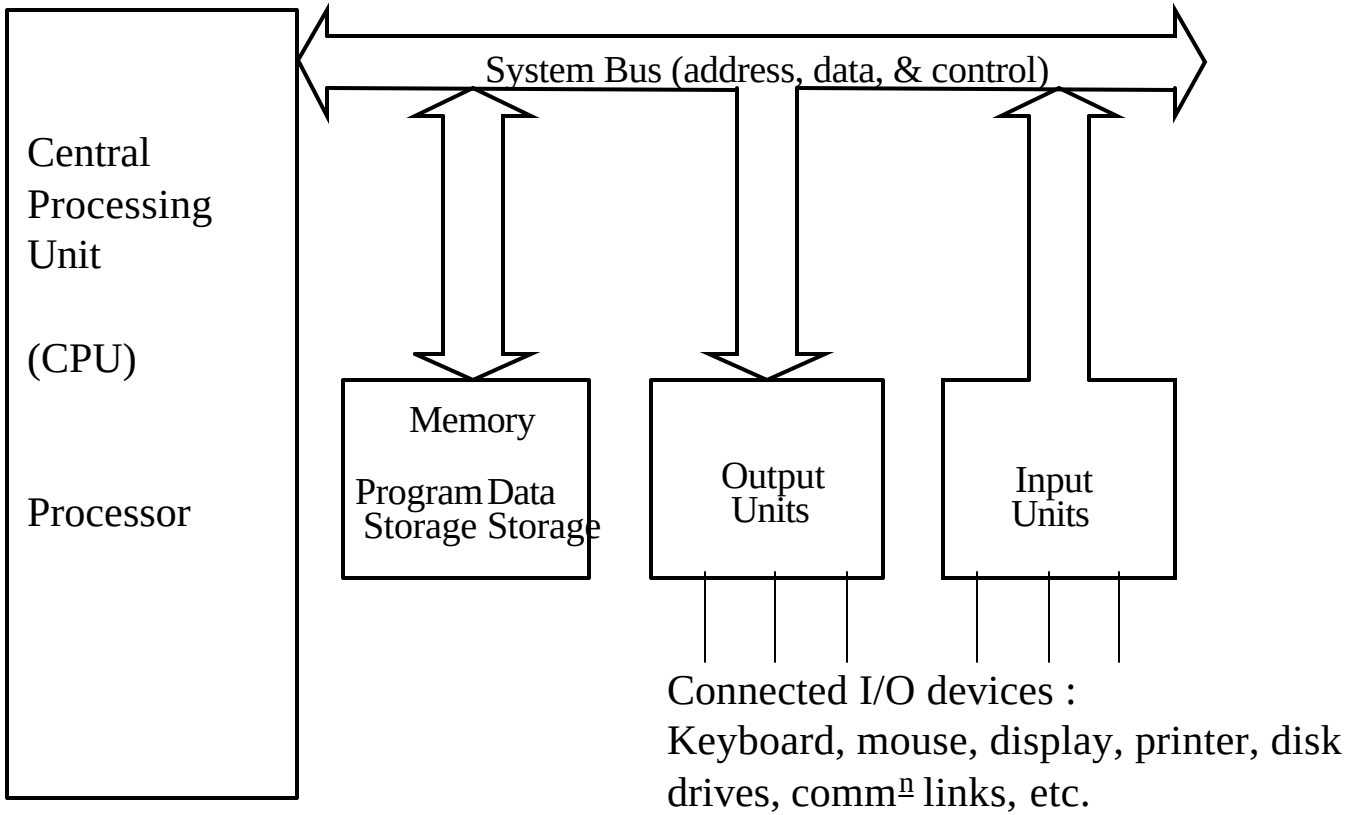
Organization of a Simple Computer System

- A Simple Computer System is comprised of three major components – (**processor, memory, I/O**) – that interact indirectly through the bus.
  - The objective of the system is associated with attached devices



System Components

- Processor **manipulates** information (located in processor, memory, I/O) by executing instructions
  - Information in processor is held in registers
  - Processors are characterized by: (more later)
    1. register set
    2. instruction set – includes addressing modes
    3. interrupt mechanism – lets other components notify processor when "events" happen
- Memory **holds** information in cells (or "locations")
  - A cell has an address (name that identifies cell) and contents (information "value" held in cell)
  - Memory supports 2 operations: read and write
- Input/Output supports the information **exchange** between computer and connected devices
  - Independent I/O components associated with each connected device
  - Ports: exchange information between bus and I/O components

Information in computer systems

- Observation: information plays key role in all components of the computer system

- How does information exist in a computer system?

- At the application level, what sort of information needs encoding?
  - **Numerical** information: counting numbers, integers, reals, fractions, complex, irrational
  - **Text** information: characters, strings
  - **Graphical** information
  - **Composite** information: date = “day, month, year”
  - …

Information in computer systems

- Hardware limitations of a computer in storing information:

1. Single transistor switched between two states
   - on / off ; high / low ; **0 / 1**

– Information information must be encoded in **2-state values**!

– BInary digiT = bit = one 2-state value of either 0 or 1

2. Registers, cells ports built using fixed numbers of transistors
   - Byte = values that are 8-bits wide
   - Information encoded in **fixed number of bits**; finite limitation of the range of values.
   - n-bit width → $\mathbf{2^n}$ different value

Information Encoding Problem

- How to represent information as fixed length binary values ?
- Information is **abstract**. It is invented by people
- Computers **do not "know"** about information
  - Computer deals with binary values in fixed width registers, cells and ports.
- Computers: use binary values (**chosen by people**) to represent information.