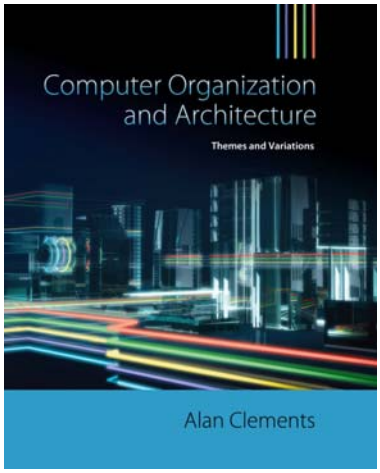
CHAPTER 1

Computer Systems Architecture



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CENGAGE Learning

Structure of the Book (5 Parts)

Part I ***The Beginning***

introduces the concepts, history and underlying technology of digital computers.

1. ***Computer Systems Architecture***
2. ***Computer Arithmetic and Digital Logic***

Part II ***Instruction Set Architectures (ISAs)***

looks at the ***programming model*** of a computer and introduces the *register model* of a computer, its *instruction types*, and the *addressing modes* of a typical microprocessor.

3. ***Architecture and Organization***
4. ***Instruction Set Architectures - Breadth and Depth***
5. Computer Architecture and Multimedia

Part III ***Organization and Efficiency***

describes how we measure the performance of computers.

6. ***Performance - Meaning and Metrics***
7. Processor Control
8. Beyond RISC: Superscalar, VLIW, and Itanium

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Structure of the Book

Part IV ***The System***

covers the other parts of a computer required to ***convert the microprocessor chip into a complete system***; for example, *peripheral subsystems* and the wide range of *memory systems*, *storage devices*, and *buses* available to the computer systems' designer.

9. Cache Memory and Virtual Memory
10. Main Memory
11. Secondary Storage
12. Input/Output

Part V ***Processor-Level Parallelism***

goes beyond the single-processor computer and introduces the notion of ***computers with multiple processors***.

13. Processor-Level Parallelism

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Computer Architecture

- A computer is characterized by its *instruction set architecture* (***ISA***)
- An ***ISA*** is an *abstract entity* because it does not consider the specific design or implementation of a computer
- An ***ISA*** is concerned with the computer's *register set*, *instruction set*, and *addressing modes*
- An ***ISA*** defines the model of a computer *from the programmer view point*
  - traditional sequential computer model (*von Neumann model*)
  - parallel computer model (reflecting different ways of processors interconnection --- based on shared memory, distributed memory with message passing, or a hybrid of the two)
- The computer's assembly language embodies its ***ISA***

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Computer Organization

- Computer *organization* is concerned with the implementation of an ISA
- Any given ISA can have many different organizations
  - Examples
- Computer manufacturers regularly *modify the organization* of a processor while *keeping its ISA essentially constant*
- Today, a computer's organization is often referred to as its *microarchitecture*
- In **theory**, ***architecture*** and ***organization*** are orthogonal; that is, they are entirely independent
- You could say that
  - ***architecture*** tells you ***what*** a computer does and
  - ***organization*** tells you ***how*** it does it

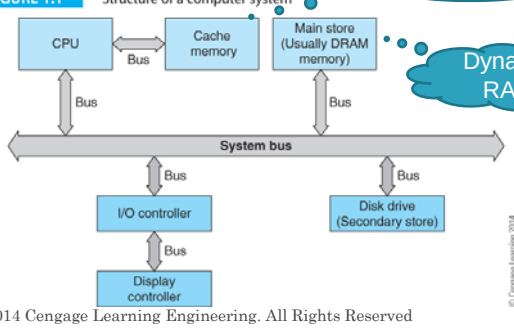
Should be "*organization*", not "*architecture*", as in the original slide.

Computer Structure

- Figure 1.1 describes the structure of a computer.
- The term computer describes the entire system.
- The CPU is the *Central Processing Unit* that reads instructions and executes them.
- The CPU is often synonymous with microprocessor.
- Modern microprocessors usually include cache (high-speed) memory on-chip.
- A key component of computers is the bus (or family of busses) that moves information around the computer between different functional units (data highway).

Static RAM (faster and more expensive than DRAM)

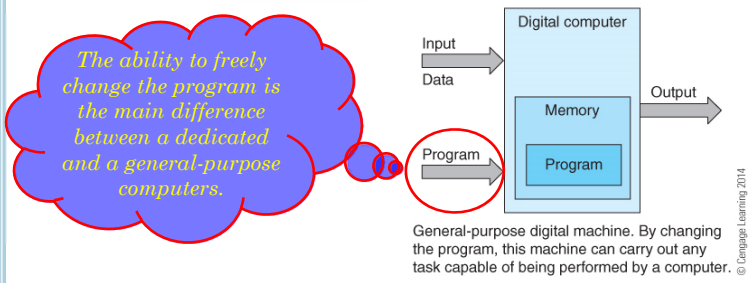
FIGURE 1.1 Structure of a computer system



Computer Types

- Computers are either dedicated or general-purpose.
  - A dedicated computer solves only one class of problems (e.g., a computer in a calculator, a cruise speed control, or washing machine).
  - A general-purpose computer can be programmed to solve any problem.
- Figure 1.2 describes the structure of a general-purpose computer.
- A key feature of the general-purpose computer is that *the program* and *its data* are held in the same memory.
- Such a computer is called a **von Neumann machine**.

FIGURE 1.2 The general-purpose computer



General-purpose digital machine. By changing the program, this machine can carry out any task capable of being performed by a computer.

The Register

- A register is a memory element that holds a single unit data (a word of data).
- A register is specified in terms of the number of bits it holds, which is typically, 8, 16, 32, or 64.
  - Currently, most of computers either have 32-bit or 64-bit-wide registers.
- There is no fundamental difference between
  - a register and
  - a word in memory.
- The practical difference is that registers are located within the CPU
  - can be accessed more rapidly than other memories.