ACCRA TECHNICAL UNIVERSITY


FACULTY OF APPLIED SCIENCES

COMPUTER SCIENCE DEPARTMENT

# Computer Organization and Architecture
# BCP 203

## COMPUTER EVOLUTION AND PERFORMANCE

# Presentation Content



1. Organization and Architecture
2. Brief History of Computers
3. Designing for Performance
4. Evolution of Intel x86 Architecture
5. Embedded Systems and ARM

# 1. Organization and Architecture



- ***Architecture*** describes what the computer does, and ***Organization*** describes how it does it
- ***Computer Architecture*** refers to those attributes of a system visible to the programmer or put another way, those attributes that have a direct impact on the logical execution of a program.
- ***Computer Organization*** refers to the operational units and their interconnections that realize the architectural specifications. Organizational attributes include hardware details transparent to the programmer
- Architectural attributes include:
  - Instruction set
  - Number of bits used to represent various data types
  - I/O mechanisms
  - Techniques for addressing memory
- Organization attributes include:
  - Control signals
  - Interfaces between computer and peripherals
  - Memory technology used

# 1.1 Architecture-Organization Relationship



- In microcomputers the relationship between architecture and organization is very close
- Changes in technology not only affect organization but also results in introduction of more powerful and complex architecture
- Computer organization must be designed to implement a particular architectural specification
- Thorough treatment of organization required detailed examination of architecture

# 1.2 The Computer as a System

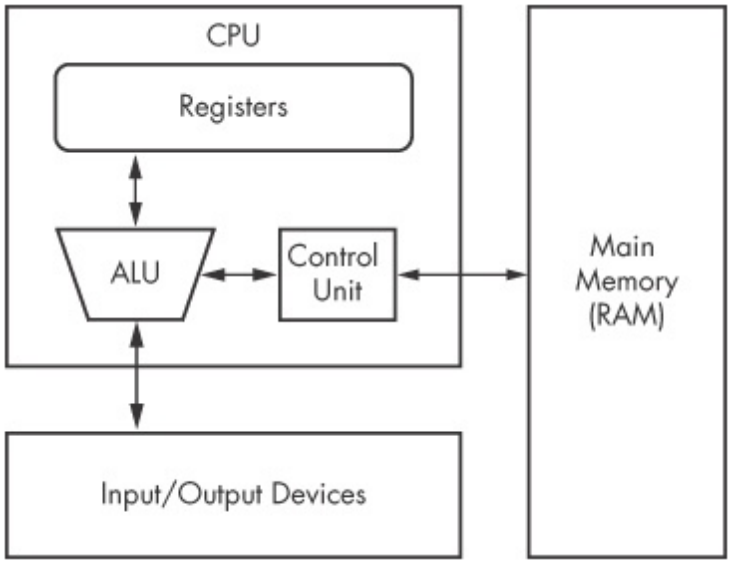


- A computer is complex system made up of interrelated subsystems.
- It is a hierarchical system which can be approached in two ways;
  1. Beginning with a top view and decomposing the system into its subparts
  2. Starting at the bottom and building up to a complete description
- In either case we are concerned with ***structure*** and ***function***
- ***Structure:*** The way in which the components are interrelated
- ***Function:*** The operation of each individual component as part of the structure

# 1.3 Function and Structure



- Functions: in general, there are four basic functions a computer can perform
  1. Data processing
  2. Data storage
  3. Data movement
  4. Control
- Structure: there are four main structural components
  1. Central processing unit
  2. Main memory
  3. I/O
  4. System interconnection



# 1.4 The Central Processing Unit



- The most complex subcomponent is the CPU.
- Its major components are as follows:
  1. Control Unit – controls the operation of the CPU and hence the computer
  2. Arithmetic and Logic Unit (ALU) – performs the computer's data processing function
  3. Registers – provide storage internal to the CPU
  4. CPU interconnection – some mechanism that provides for communication among the control unit, ALU and registers

# 2. Brief History of Computers



- How did it all begin?
- War efforts of the U.S. Army's Ballistics Research Laboratory (BRL) led to invention of ENIAC in 1945
- The Electronic Numerical Integrator And Computer
  1. Cost $486000
  2. Weighed 30 tons
  3. Occupied 1500 square feet of floor space
  4. Contained more than 18000 vacuum tubes
  5. Consumed 140 kilowatts of power
  6. Performed 5000 additions per second, 357 multiplications per second and 38 divisions per second
  7. Used the decimal number system
  8. Had no long-term storage and used accumulators for results

# 2.1 Von Neumann Machine



- Stored program concept - an idea proposed for EDVAC, is attributed to John Von Neumann, a consultant on the ENIAC project
- In 1946, Von Neumann and his colleagues made the IAS computer at the Princeton Institute of Advance Studies
- It consisted of:
  1. A main memory, which stored both data and instruction
  2. An arithmetic and logic unit that operated on binary data
  3. A control unit which interprets the instructions in memory and causes them to be executed
  4. Input and Output (I/O) equipment operated by the control unit
- Most of today's computers have this same general structure and functions and are referred to as Von Neumann Machines

# 2.1 Birth of the Microprocessor



- In 1969 Busicom, a Japanese company contacted Intel (short for Integrated Electronics) to manufacture chips for their programmable calculator
- Intel engineers studied the design and proposed programmable chips in place of chips that performed similar functions.
- The first microprocessor the 4004, containing all of the components of the CPU on a single chip, was born in 1971
- In 1972 the 8008, an 8-bit processor twice as powerful as the 4 bit 4004 was born.
- The 8080, was released in 1974
- The all powerful 16-bit 8086 processor was introduced in 1978
- Intel introduced a 32-bit processor 80386 in 1985

# 3. Designing for Performance



- Cost of computer systems continue to drop while performance and capacity of those systems rise dramatically
- In microprocessors the addition of new circuits, and the speed boost that comes from reducing the distances between them, has improved performance four or five-fold every three years since Intel launched its x86 family in 1978
- Raw speed of the processor will not achieve its potential unless it is fed a stream of work to do in the form of computer instructions. This is accomplished by:
    1. Branch prediction: predict what is next to process
    2. Data flow analysis: analyzes which instructions depend on other results or data
    3. Speculative execution: executing instructions ahead of time based on 1 and 2

# 4. Evolution of Intel x86 Architecture



- It is worthwhile to list some of the high lights of the evolution of the intel product line. The x86 is essentially a Complex Instruction Set Computer (CISC) with some Reduced Instruction Set Computer (RISC) features.
    1. 8086
    2. 80286
    3. 80386
    4. 80486
    5. Celeron
    6. Pentium, Pentium Pro, Pentium II, Pentium III, Pentium 4
    7. Core i3, i5, i7 & i9
    8. Core ultra processors
- Over 46 years of its introduction the x86 architecture continues to dominate the computer market outside of embedded systems

# 5. Embedded Systems and ARM



- ***Embedded system***: a combination of some computer hardware and software designed to perform a dedicated function.
- In many cases, embedded systems are part of a larger system or product
- Embedded systems far outnumber general purpose computer systems encompassing a broad range of applications
- ***ARM (Advanced RISC Machines***) is a family of RISC based micro processors and microcontrollers designed by ARM Inc., Cambridge, England that are used in embedded systems

# 5.1 ARM Processors



- ARM processors are of three main categories;
  1. Embedded real time systems: Systems for storage, automotive body and power-train, industrial, and networking applications

  2. Application platform : Devices running open operating systems, including Linux, Palm OS, Symbian OS, and Windows CE in wireless, Consumer entertainment and digital imaging applications

  3. Secure applications: Smart cards, SIM cards and payment terminals