Embedded System Getting Started

<Training Topic /Lesson Name>

Lesson Objectives

- *Understanding about the embedded system and its products in real world*
- *Understanding about the microcontroller: a microprocessor and common architectures nowadays.*

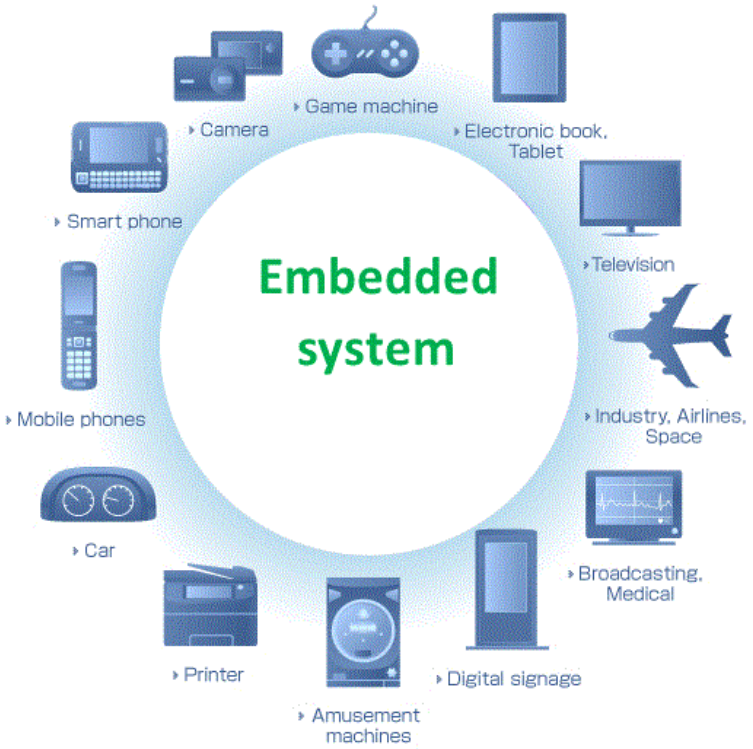
Section 1

Embedded system Introduction

Embedded system Introduction

- *Introduction*
- *What is embedded system?*
- *History of Embedded system*
- *Types of Embedded System*
- *Applications of Embedded Systems*

Introduction



What is embedded system?

- An embedded system is a computer system with a dedicated function within a larger mechanical or electrical system, often with real-time computing constraints. It is embedded as part of a complete device often including hardware and mechanical parts.

(wikipedia)

History of Embedded system

- In 1960: First embedded system was introduced by Charles Stark Draper.
- In 1965, Second embedded system was D-17B
- In 1968, First embedded system was released for vehicle
- In 1971, First microcontroller was developed by Texas Instruments.
- In 1987, First embedded operating system (VxWorks) was introduced by Wind River.
- In 1990, First embedded Linux system was introduced.

Characteristics of Embedded Systems

- Microcontroller or microprocessors are used to design embedded systems.
- All Embedded Systems are task specific.
- Embedded systems are created to perform the task within a certain time frame.
- They have minimal or no user interface (UI).
- Embedded systems are not always standalone devices.
- Embedded systems are built to achieve certain efficiency levels.
- Embedded systems must rank high on reliability and stability.

Types of Embedded System

- Base on Performance and Functional Requirement
  - ✓ Real Time Embedded Systems
  - ✓ Stand-Alone Embedded Systems
  - ✓ Networked Embedded Systems
  - ✓ Mobile Embedded Systems
- Base on Microcontroller Performance
  - ✓ Small Scale Embedded Systems
  - ✓ Medium Scale Embedded Systems
  - ✓ Sophisticated Embedded Systems

Applications of Embedded Systems

- Medical
- Manufacturing Industry
- Home Appliances
- Telecommunication
- Banking
- Automotive
- …

Section 2

Microcontroller & Microprocessor

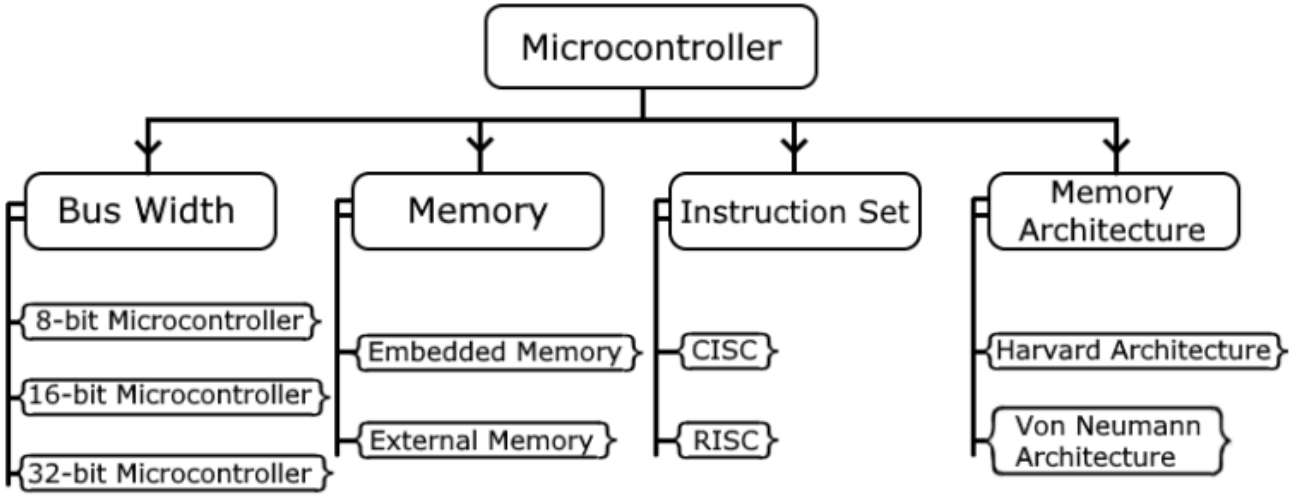
Microcontroller & Microprocessor

- *Definition*
- *Types*
- *History*
- *Architecture*
- *Features*
- *Applications*
- *Key between Microcontroller and Microprocessor*

Definition

- A **microcontroller** is a compact integrated circuit designed to govern a specific operation in an embedded system.
- A **microprocessor** is a controlling unit of a micro-computer wrapped inside a small chip. It performs Arithmetic Logical Unit (ALU) operations and communicates with the other devices connected with it.

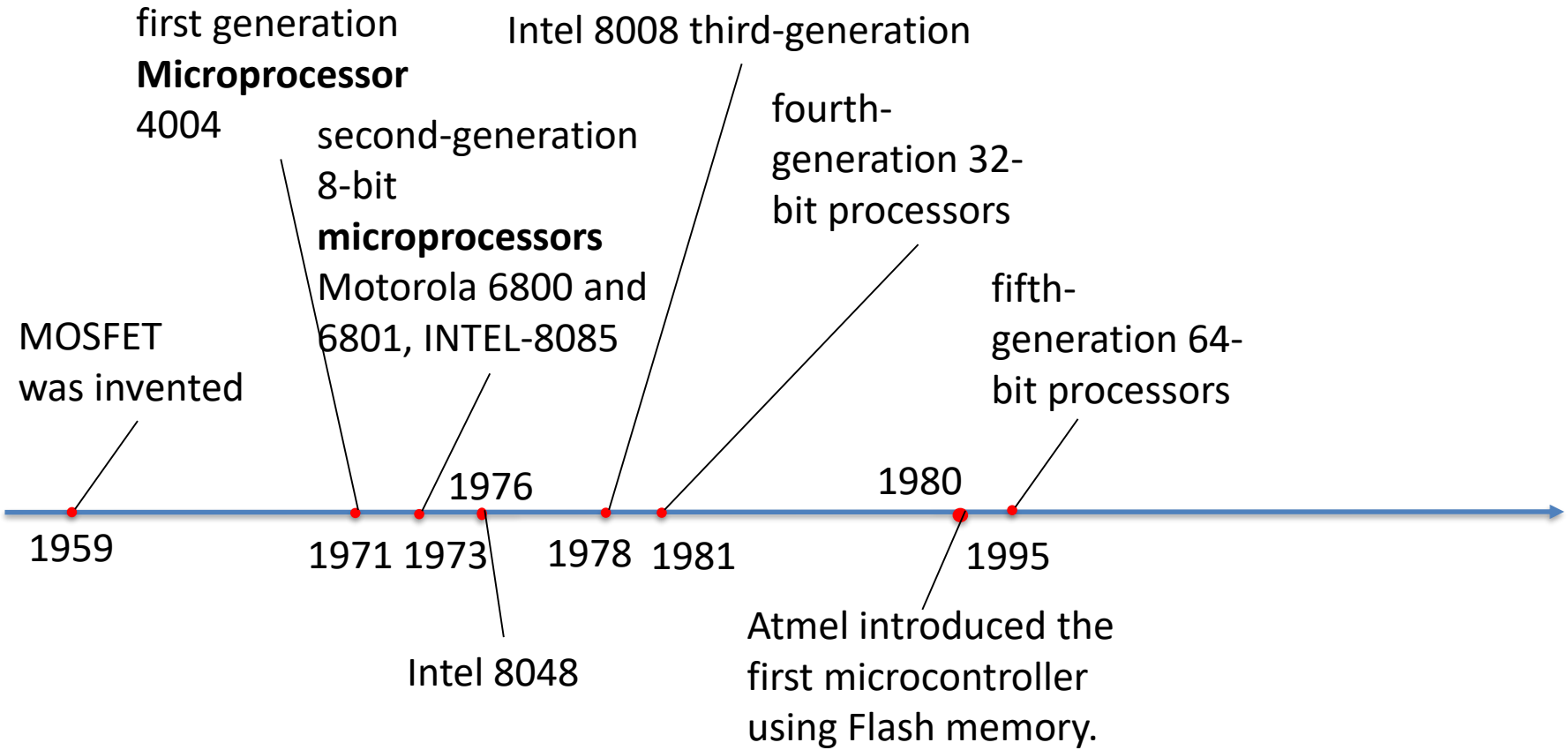
- **Types of Microcontroller**



Types

- **Types of Microprocessor**
  - ✓ Scalar and Superscalar Processors
  - ✓ Vector Processors
  - ✓ Array processor
  - ✓ Digital Signal Processors
  - ✓ RISC Processors
  - ✓ CISC Processors
  - ✓ ASIC Processors

History

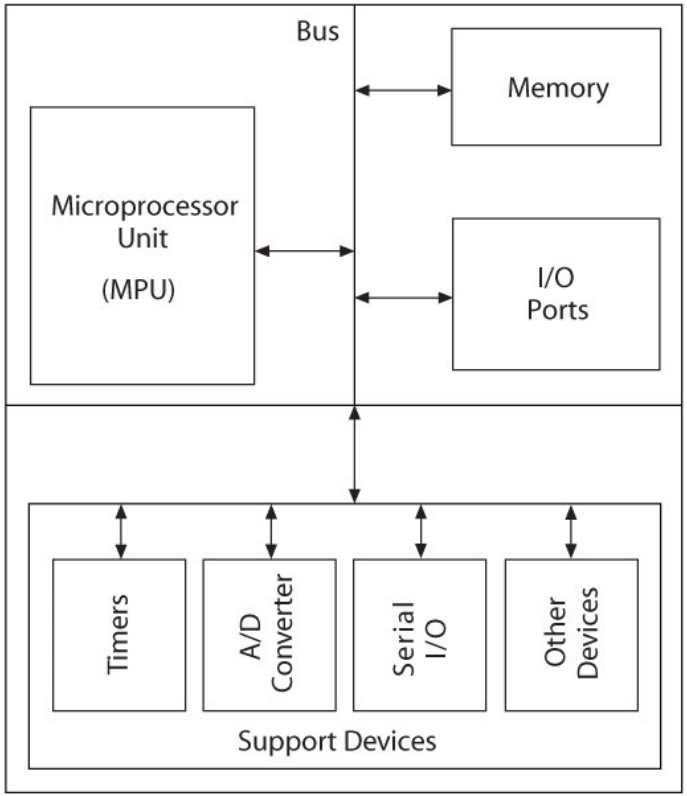

first generation
Microprocessor
4004
second-generation
8-bit
microprocessors
Motorola 6800 and
6801, INTEL-8085
Intel 8008 third-generation
fourth-
generation 32-
bit processors
fifth-
generation 64-
bit processors
MOSFET
was invented
1959
1971
1973
1976
Intel 8048
1978
1981
1980
1995
Atmel introduced the
first microcontroller
using Flash memory.

Structure

- **Structure of Microcontroller**

  MCU is integrated electronic computing device that includes three major components on a single chip:

  - Microprocessor
  - Memory
  - I/O ports

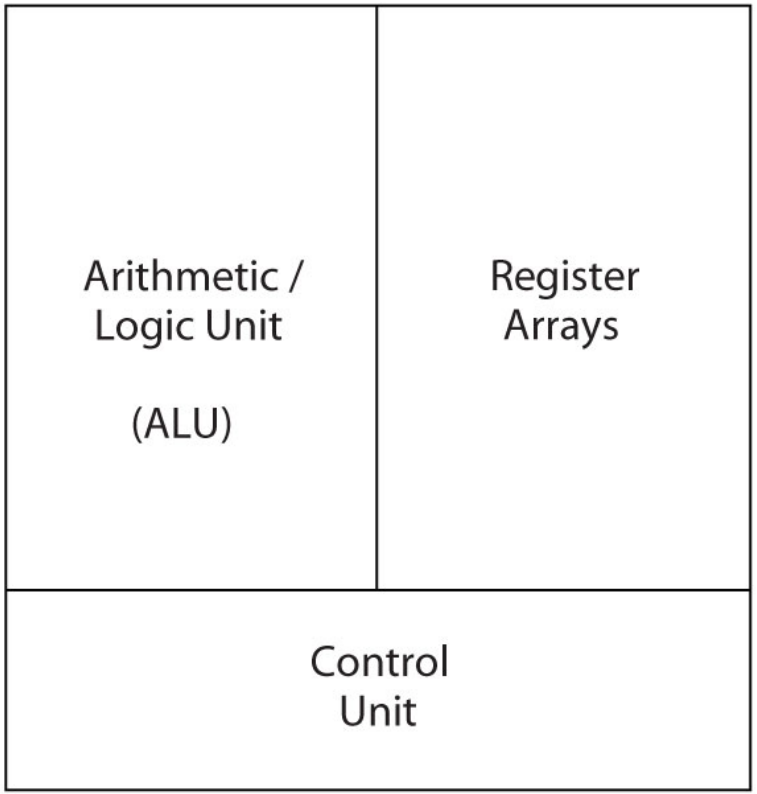


Structure

- **Structure of Microprocessor**

  Microprocessor includes three major components:

  - Arithmetic Logic Unit (ALU)
  - Register Arrays
  - Control Unit



Features

- **Feature of Microprocessor**
  - ✓ Offers built-in monitor/debugger program with interrupt capability
  - ✓ Large amount of instructions each carrying out a different variation of the same operation
  - ✓ Offers Parallel I/O
  - ✓ Instruction cycle timer
  - ✓ External memory interface

Features

- **Feature of Microcontroller**
  - ✓ Central processing unit – ranging from small and simple 4-bit processors to complex 32-bit or 64-bit processors
  - ✓ RAM for data storage
  - ✓ ROM, EPROM, EEPROM or Flash memory for program and operating parameter storage
  - ✓ I/O pins
  - ✓ Serial input/output such as serial ports (UARTs)
  - ✓ serial communications interfaces like I^2C,..
  - ✓ Timers, event counters, PWM generators, and watchdog
  - ✓ Analog-to-digital converters, digital-to-analog converters
  - ✓ In-circuit programming and in-circuit debugging support

- **Applications of Microprocessor**
  - ✓ Accounting system
  - ✓ Games machine
  - ✓ Complex industrial controllers
  - ✓ Traffic light
  - ✓ Control data
  - ✓ Military applications
  - ✓ Defense systems
  - ✓ Computation systems

- **Applications of Microcontroller**
  - ✓ Mobile phones
  - ✓ Automobiles
  - ✓ CD/DVD playersCameras
  - ✓ Security alarms
  - ✓ Keyboard controllers
  - ✓ Microwave oven
  - ✓ Watches
  - ✓ …

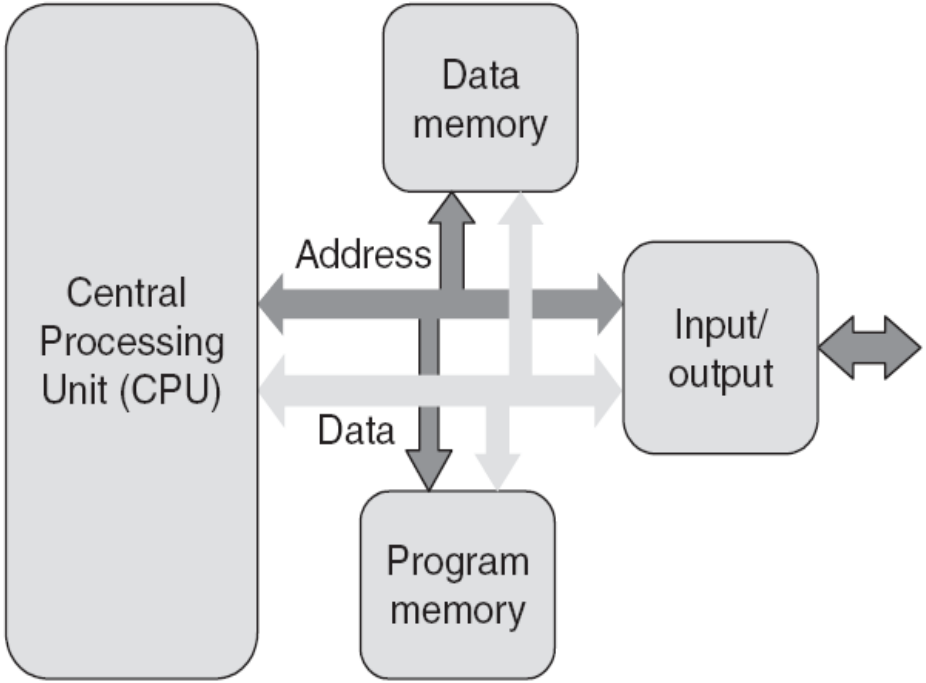
Key between Microcontroller and Microprocessor

Microprocessor	Microcontroller
It is only a processor, so memory and I/O components need to be connected externally	Micro Controller has a processor along with internal memory and I/O components.
It has no RAM, ROM, Input-Output units, timers, and other peripherals on the chip.	It has a CPU along with RAM, ROM, and other peripherals embedded on a single chip.
Microprocessor has a smaller number of registers	Microcontroller has more register
Microprocessors are based on Von Neumann model	Micro controllers are based on Harvard architecture

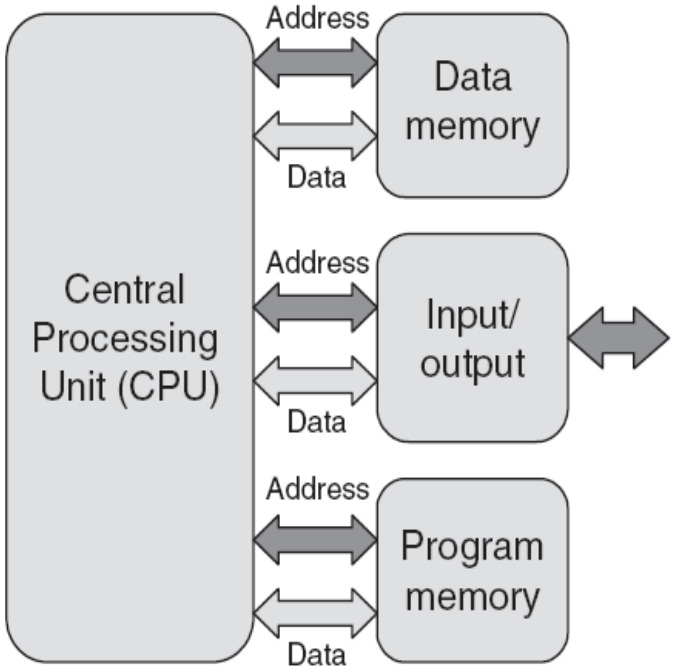
Section 3

Von Neumann and Harvard Architecture

Von Neumann and Harvard Architecture



Von Neumann



Harvard

Section 4

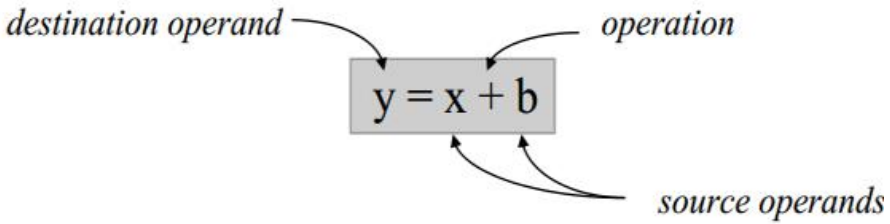
Instruction Set Architecture

Overview

- In computer science, an instruction set architecture (ISA) is an abstract model of a computer.
- The Instruction Set Architecture (ISA) is the part of the processor that is visible to the programmer or compiler writer. The ISA serves as the boundary between software and hardware.

Overview

- The 3 most common types of ISAs are:
  - ✓ **Stack** - The operands are implicitly on top of the stack.
  - ✓ **Accumulator** - One operand is implicitly the accumulator.
  - ✓ **General Purpose Register (GPR)** - All operands are explicitely mentioned, they are either registers or memory locations.



Stack	Accumulator	GPR
PUSH x	LOAD x	LOAD R1,x
PUSH b	ADD b	ADD R1,b
ADD	STORE y	STORE R1,y
POP y		

Classification of ISAs

CISC

- Fewer instructions to execute a given task than RISC
- Programs for CISC take less storage space than programs for RISC
- Arithmetic or other instructions may read their operand from memory and could write the result in memory

RISC

- Simpler instructions, faster execution speeds per instruction
- Cheaper to implement
- Load/Store architecture – only load and store are used to access the external memory

Lesson Summary

- *An embedded system is a product that has one or more computers embedded within it.*
- *The embedded computer is usually a microcontroller: a microprocessor adapted for embedded control applications.*
- *There are two kinds of microprocessor architectures: Harvard & Von Neumann*
- *The ISA serves as the boundary between software and hardware*

Thank you