Computer Architecture
The Fundamental

Course Number : TTH2D3

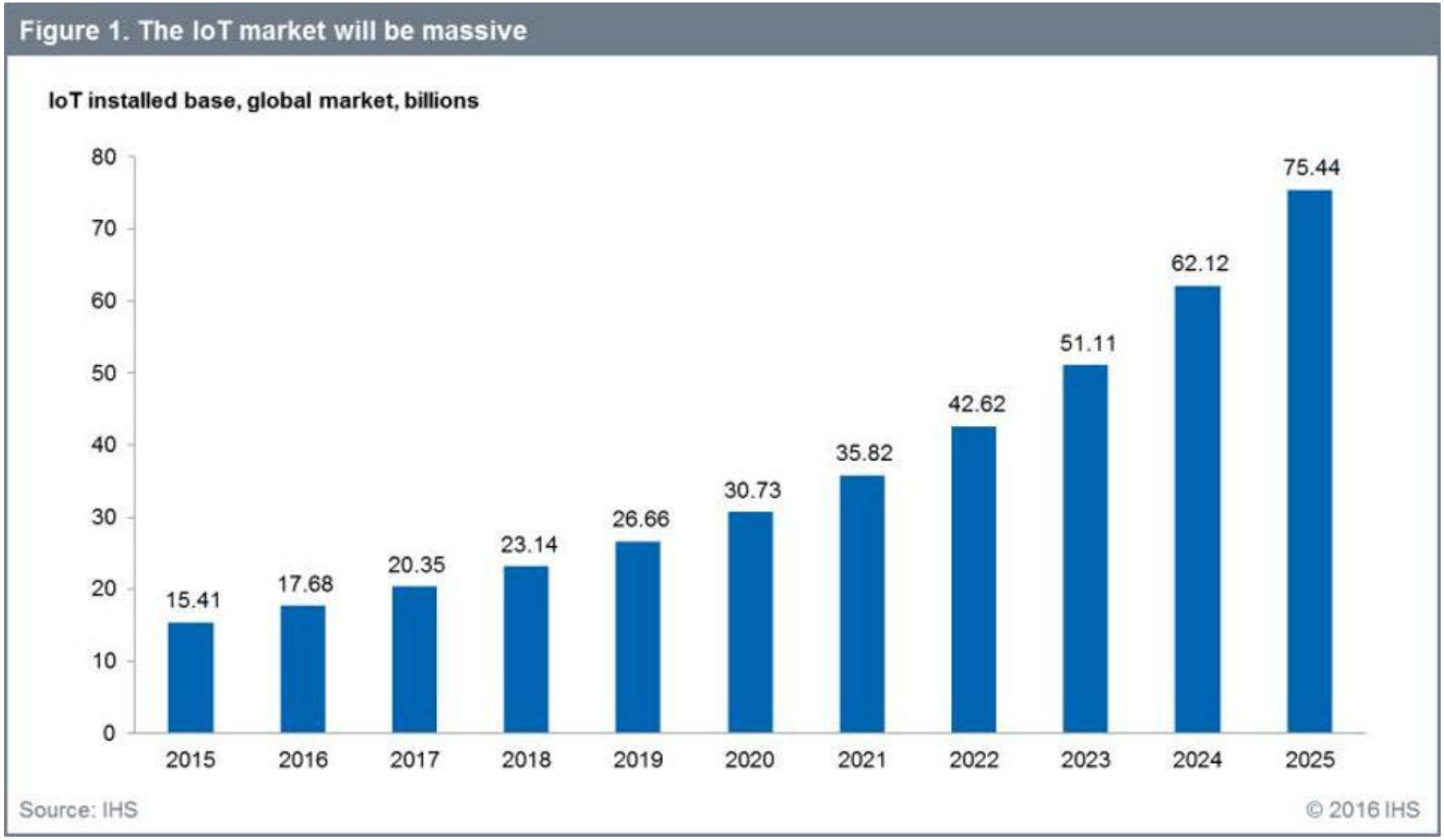
CLO : 1

Week : 1

CLO#1 Student have the knowledge to explain microprocessor system
[C2] Understand the history of microprocessor and microcontroller
[C2] Understand the architecture of computer system
[C2] Understand the design of minimum system for microcontroller

Why do we need to take this course?

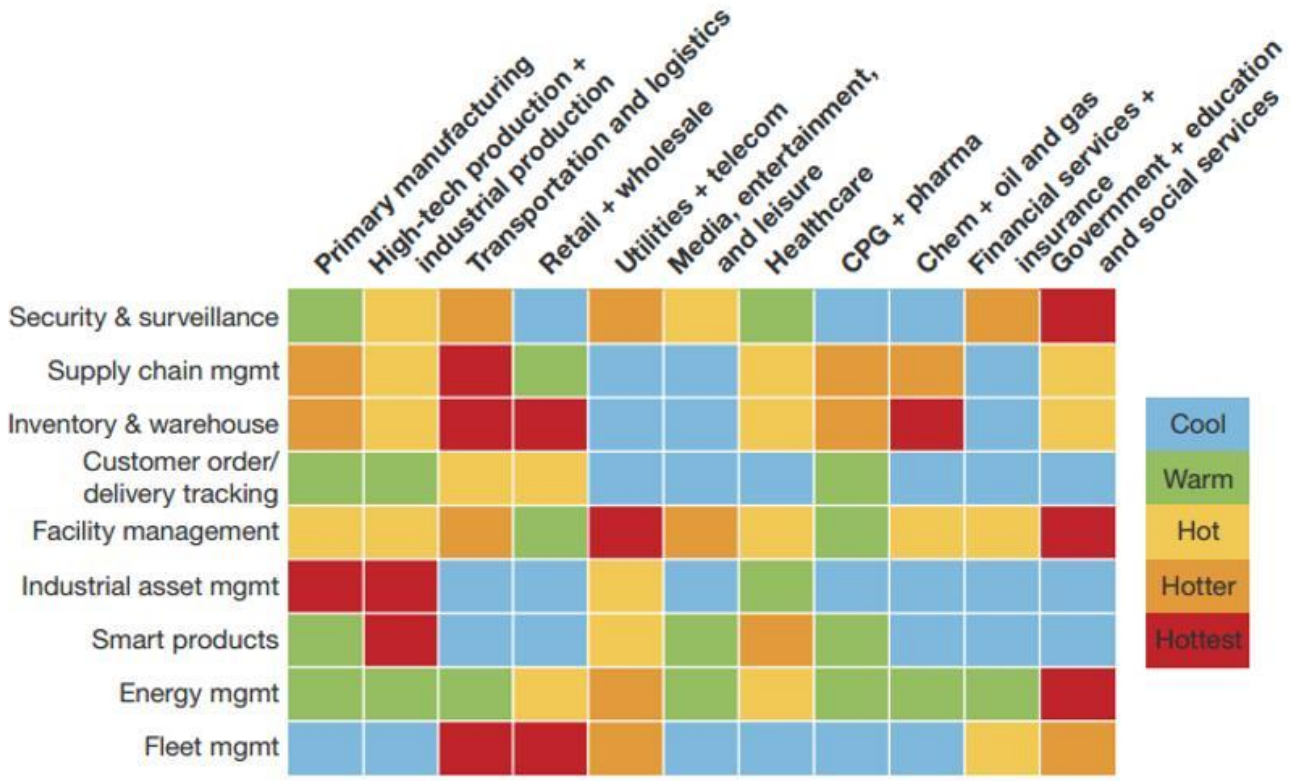
IoT Growth Rate



Source: Forbes

Heat Map of IoT by Industry and Application

FIGURE 6 Heat Map Of Key IoT Opportunities Varies By Industry And Application



Source: Forbes

Why do we need to take this course?

Because everything will be connected through The Internet, and it starts with what you will learn in this course, i.e. microcontroller.

What is Organization and how it differ with Architecture?

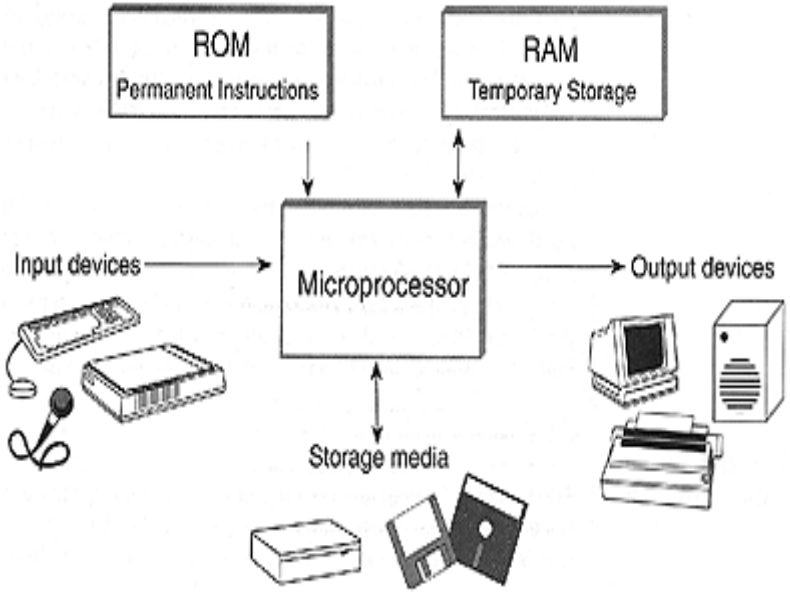
- Computer Organization

  describes each unit's functionality, like input, storage, process, and output.

- Computer Architecture

  describes the interconnection between units and how they work together, including hardware and software.

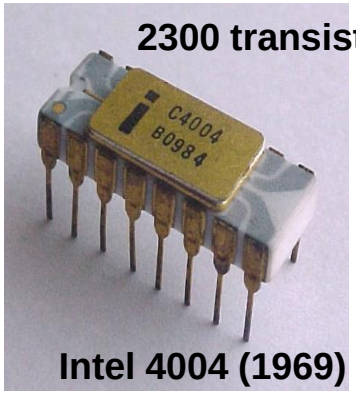
Computer System Hardware

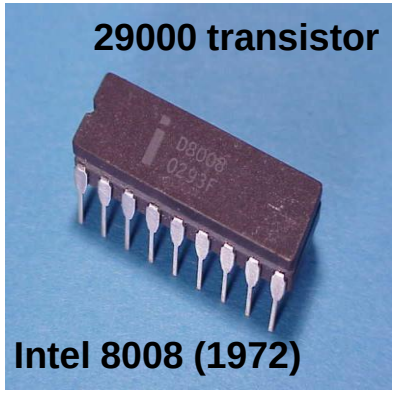


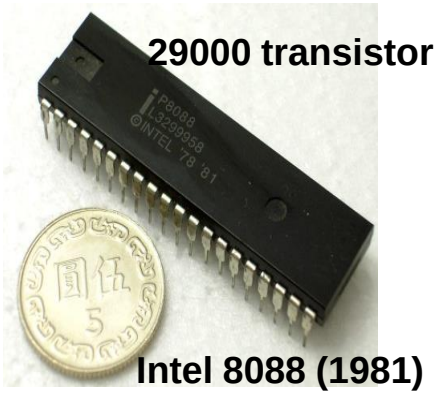
Microprocessor

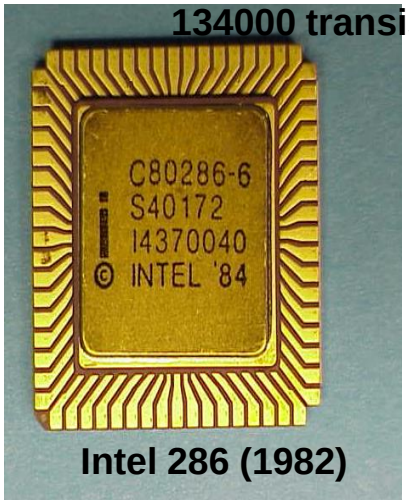
The Fundamental

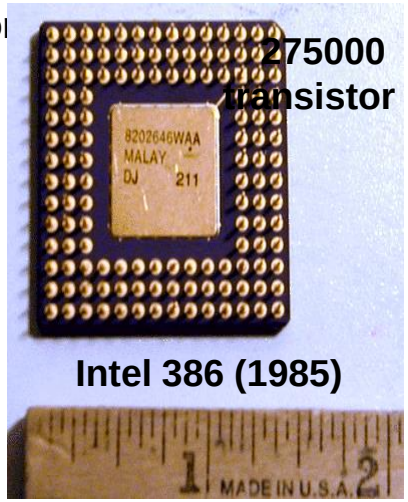
Microprocessor: Historical Review (1/3)

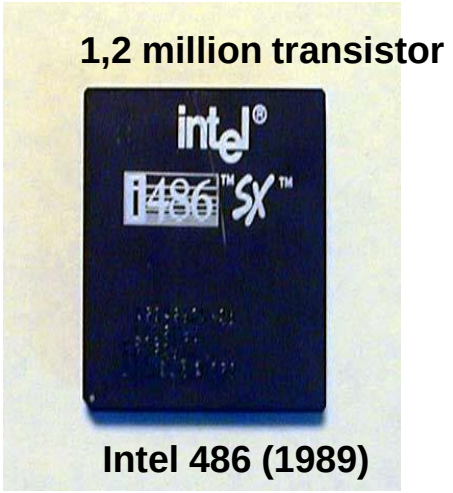




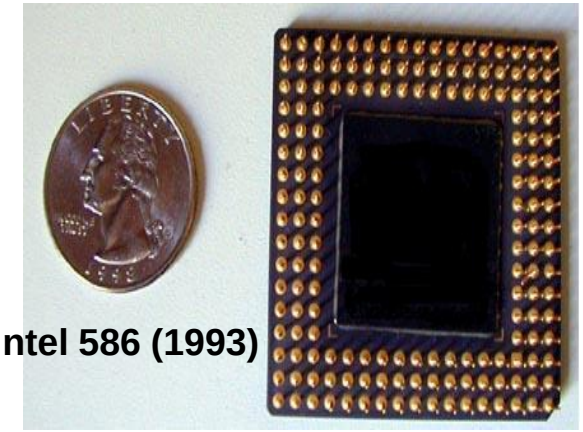




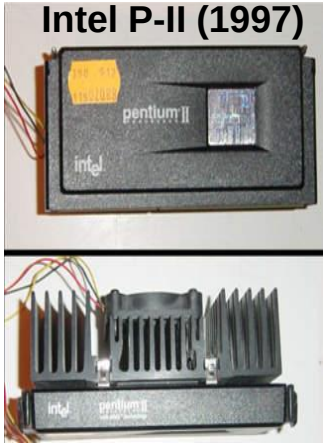




Microprocessor: Historical Review (2/3)

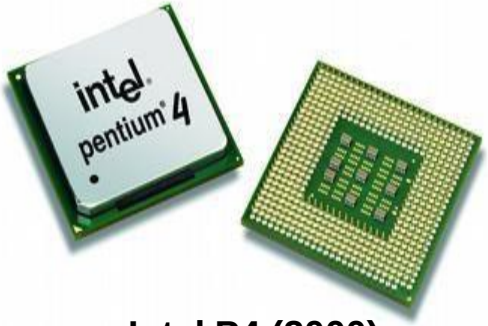


Intel 586 (1993)



Intel P-II (1997)

Intel P-III (1999)



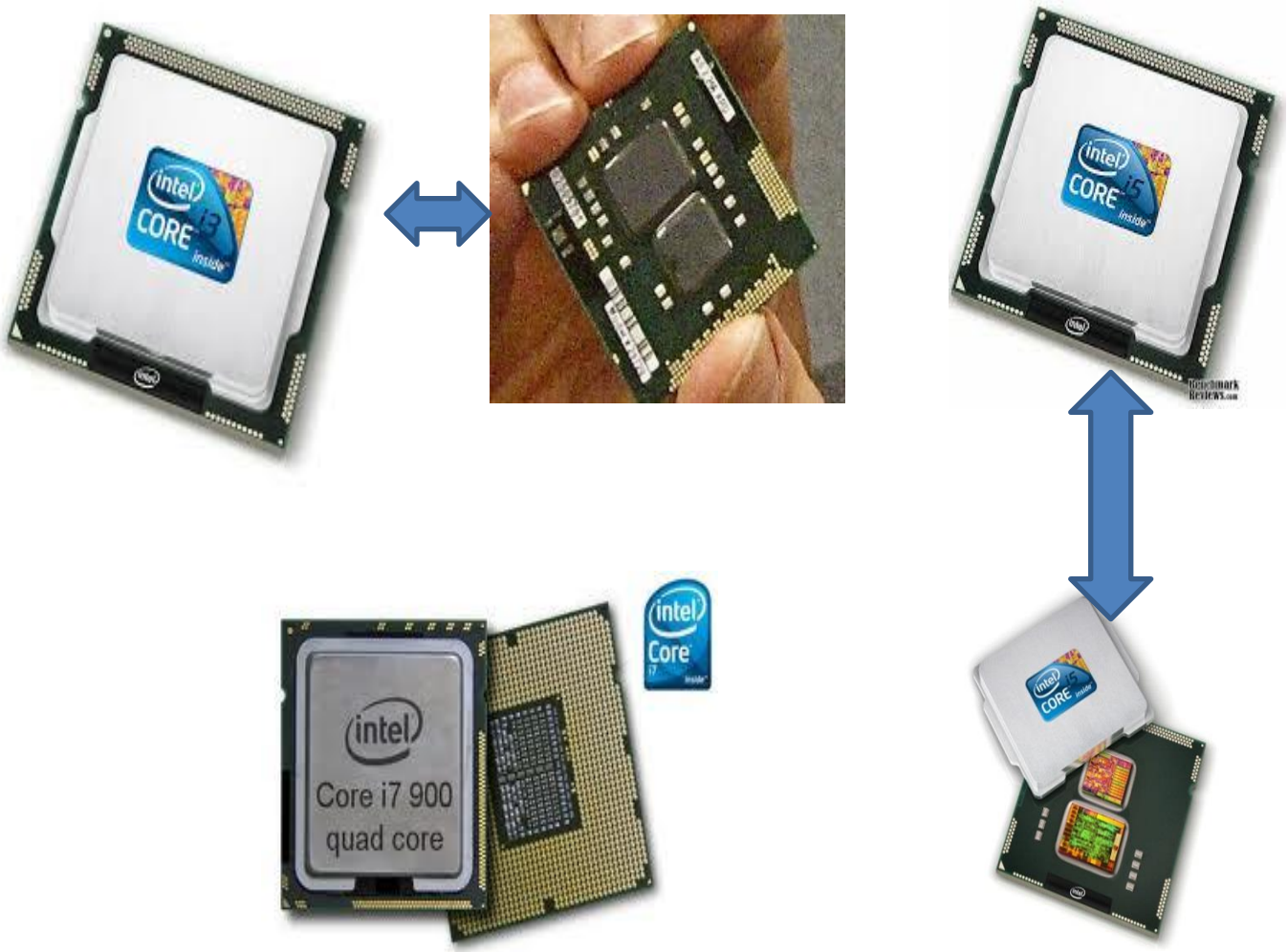
Intel P4 (2000)

Intel Pentium-M (2003)

Intel Pentium-D (2005)

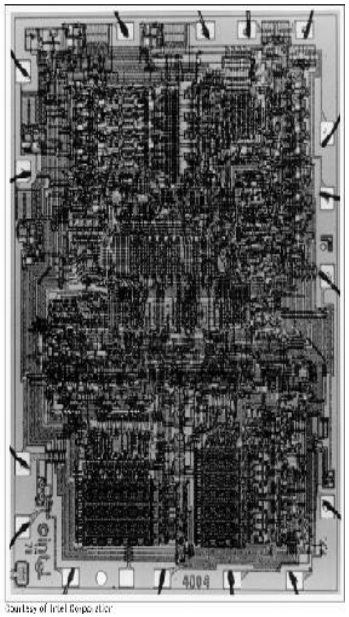
Intel Itanium (2006)

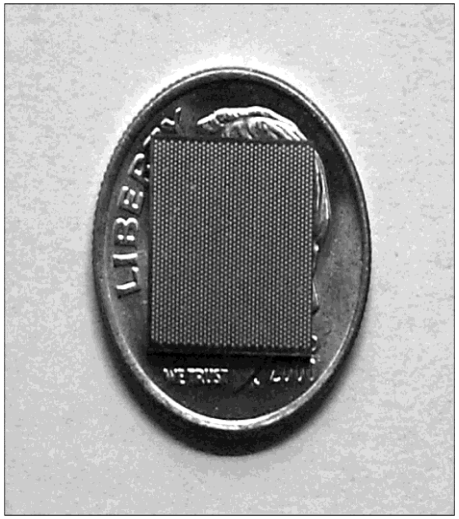
Microprocessor: Historical Review (3/3)



Microprocessor Complexity

- Intel 4004 with 2300 transistors (1969)
- Intel Itanium with 330 million transistors (2005)





Microprocessor Complexity (in Detail)

Microprocessor Type	Year	Speed	Word	Transistors	MIPS
4004	1969	108 kHz	4 bit	2300	0.06
8008	1972	200 kHz	8 bit	3500	0.06
8080	1974	2 MHz	8 bit	6000	0.64
8086	1978	4.47 MHz	16 bit	29000	0.66
8088	1981	4.47 MHz	16 bit	29000	0.75
80286	1982	12 MHz	16 bit	134000	2.66
80386	1985	16-33 MHz	32 bit	275000	4
80486 (i486)	1989	20-100 MHz	32 bit	1.2 million	70
80586 (Pentium)	1993	75-200 MHz	32 bit	3.3 million	126-203
Pentium Pro	1995	150-200 MHz	32 bit	5.5 million	300
Pentium MMX	1997	166-233 MHz	32 bit	4.5 million	
Pentium II	1997	233-450 MHz	32 bit	7.5 million	
Pentium III	1999	450-933 MHz	32 bit	9.5 million	
Itanium	2000	1 GHz	64 bit	15 million	1200

Intel i7

Name	Intel® Core™ i7-975 Processor Extreme Edition	Intel® Core™ i7-980X Processor Extreme Edition
Code Name	Bloomfield	Gulftown
# of Core	4	6
# of Thread	8	12
Clock Speed	3.33 GHz	3.33 GHz
Max Turbo Frequency	3.6 GHz	3.6 GHz
L3 Cache	8 MB	12 MB
Bus/Core Ratio	25	25
Bus Type	QPI	QPI
System Bus	6.4 GT/s	6.4 GT/s
Production Process	45 nm	32 nm
Max TDP	130 W	130 W
Memory Types	DDR3	DDR3
# of Memory Channels	3	3
Processing Die Size	263 mm2	248 mm2
# of Processing Die Transistors	731 million	1170 million
Processor Sockets	LGA1366	LGA1366
Intel® Turbo Boost Technology	Yes	Yes
Intel® Hyper-Threading Technology	Yes	Yes
AES New Instructions	No	Yes
Enhanced Intel® Speedstep Technology	Yes	Yes
Price	$999.00	$999.00

Definition

Microprocessor is a:

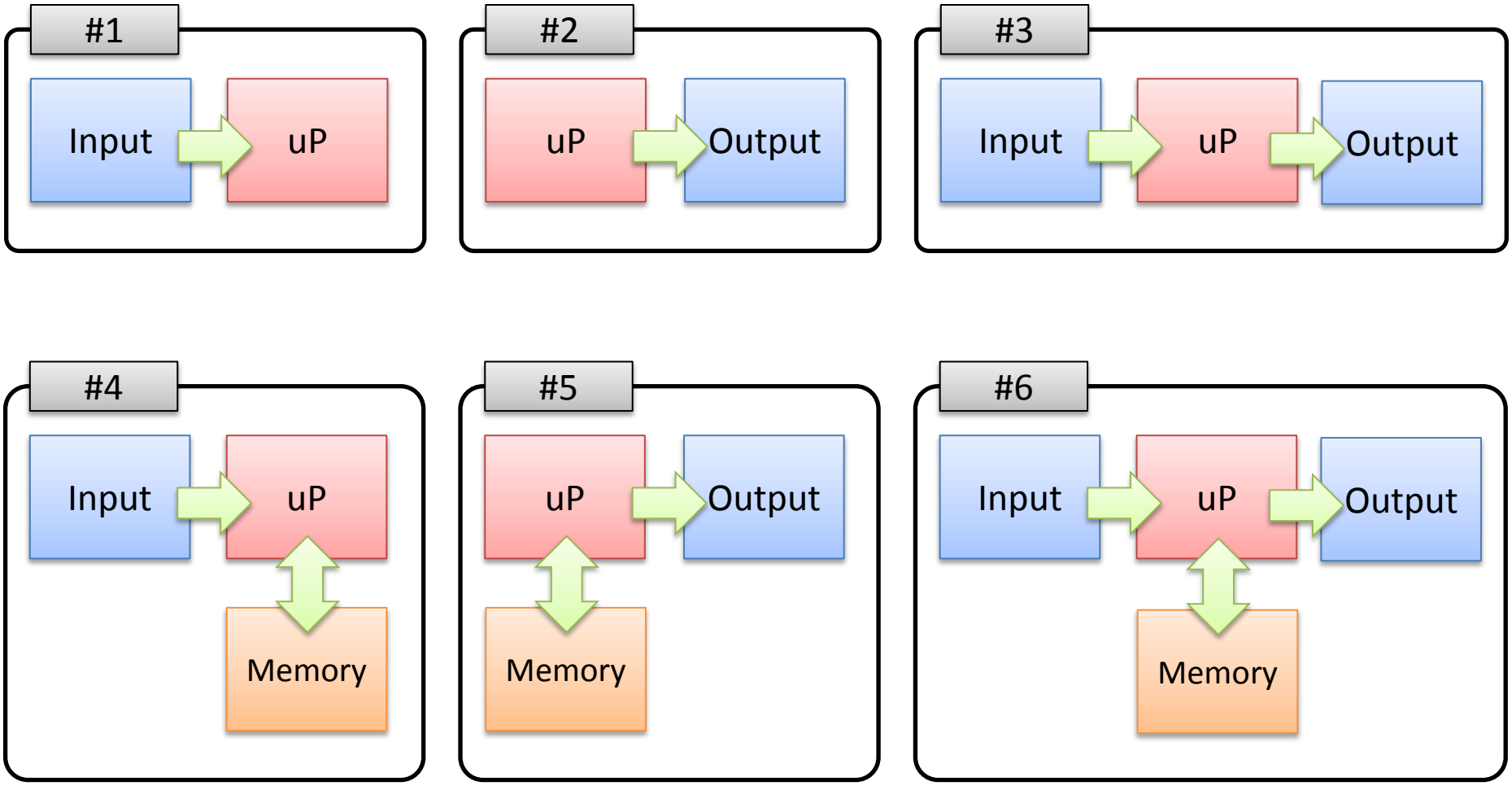
- LSI/VLSI (Very Large Scale Integration), designed to process information, any information.
- Multipurpose or General Purpose LSI/VLSI
- Sometimes (incorrectly) named CPU (Central Processing Unit)
- Fabricated on a die chip

Definition

Microprocessor System is a:

- System consists of at least 1 microprocessor and a support system
- Support system may include:
  - Memory unit
  - Input unit
  - Output unit

Computer System Architecture



Support System

- Memory

  Static RAM, Dynamic RAM, ROM, EPROM, Flash Disk, Hard Disk

- Input

  Keyboard, Mouse, Touch Pad, Scanner, ADC

- Output

  Monitor, Speaker, VR, Printer, DAC

Inside the Microprocessor

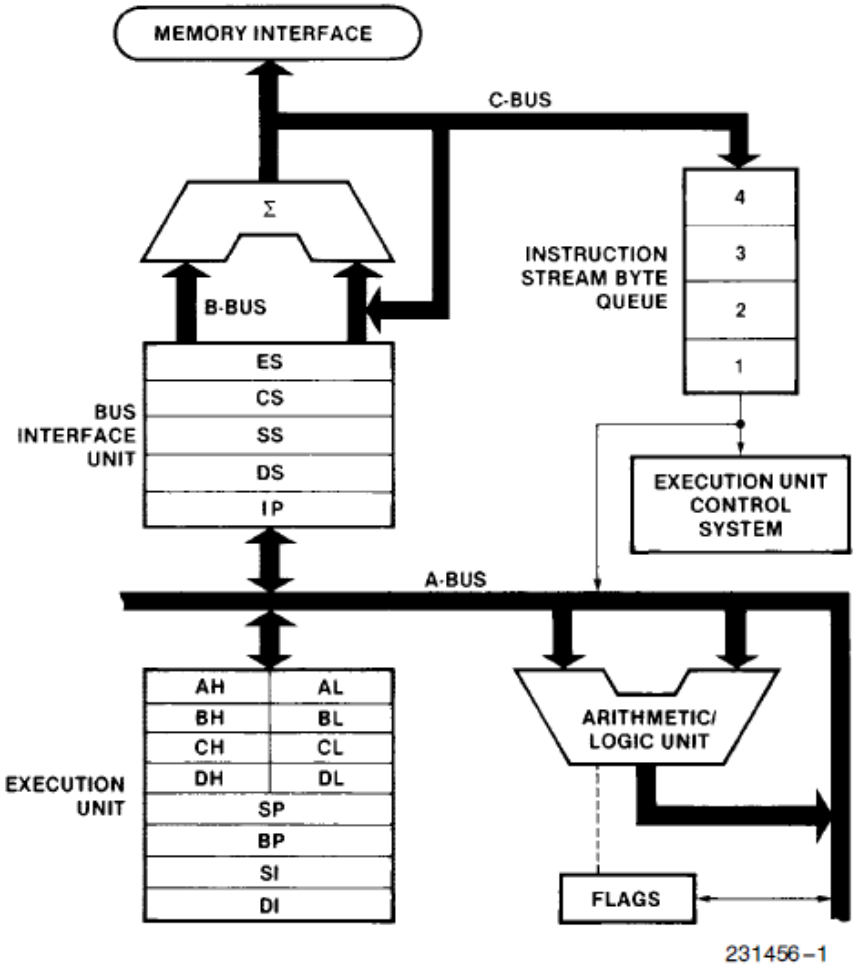


Figure 1. 8088 CPU Functional Block Diagram

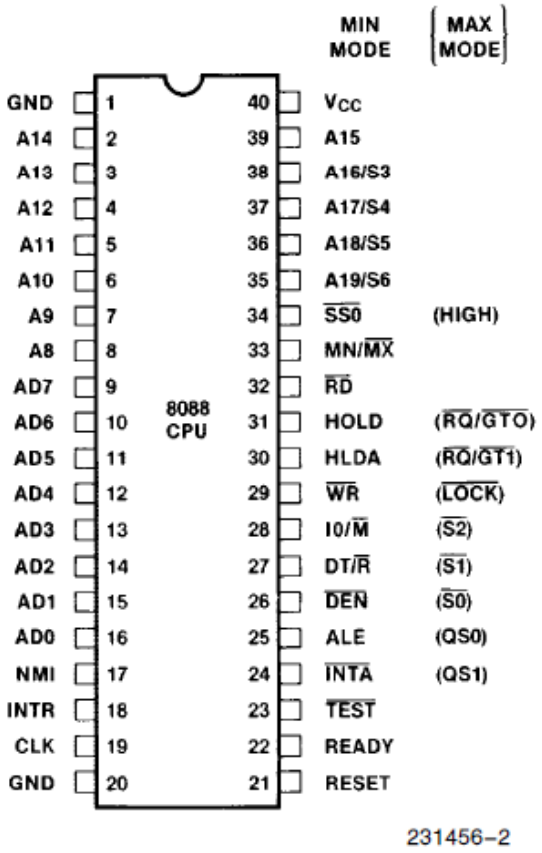


Figure 2. 8088 Pin Configuration

1. ALU
2. Register
3. Control Unit
4. Bus

Inside the Microprocessor

1. ALU, Arithmetic and Logic Unit
   responsible for calculation
2. Register, a special type (very fast) of memory
   responsible for storing instruction, data, address, and status
3. Control Unit
   responsible to control the works
4. Bus
   responsible for transferring
   signal (control, data, address)

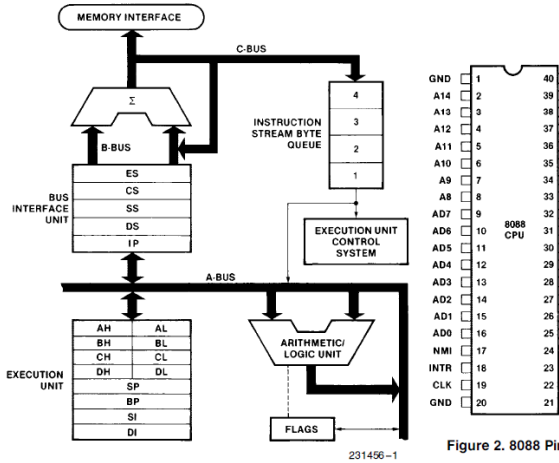
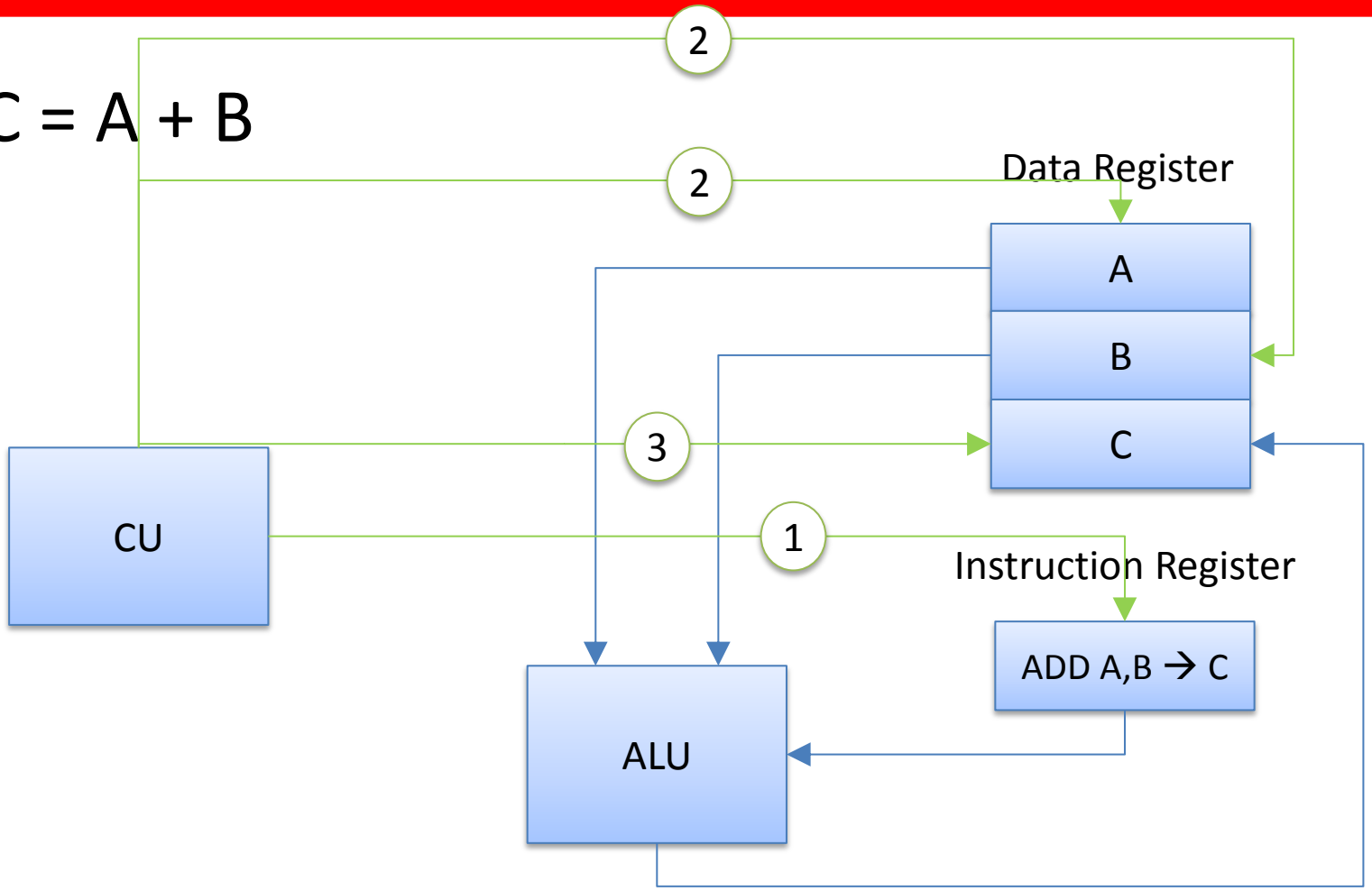


Figure 1. 8088 CPU Functional Block Diagram

Figure 2. 8088 Pin Configuration

How it Works?

- C = A + B

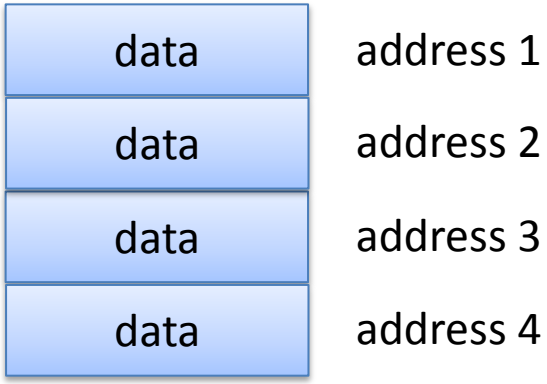


Microprocessor: Basic functionalities

- Able to locate where the instruction and data resides
- Able to fetch the instruction and data from memory
- Able to store instruction and data in register
- Able to decode and understand the instruction
- Able to execute the instruction
- Able to manage all process in a proper sequence

Memory

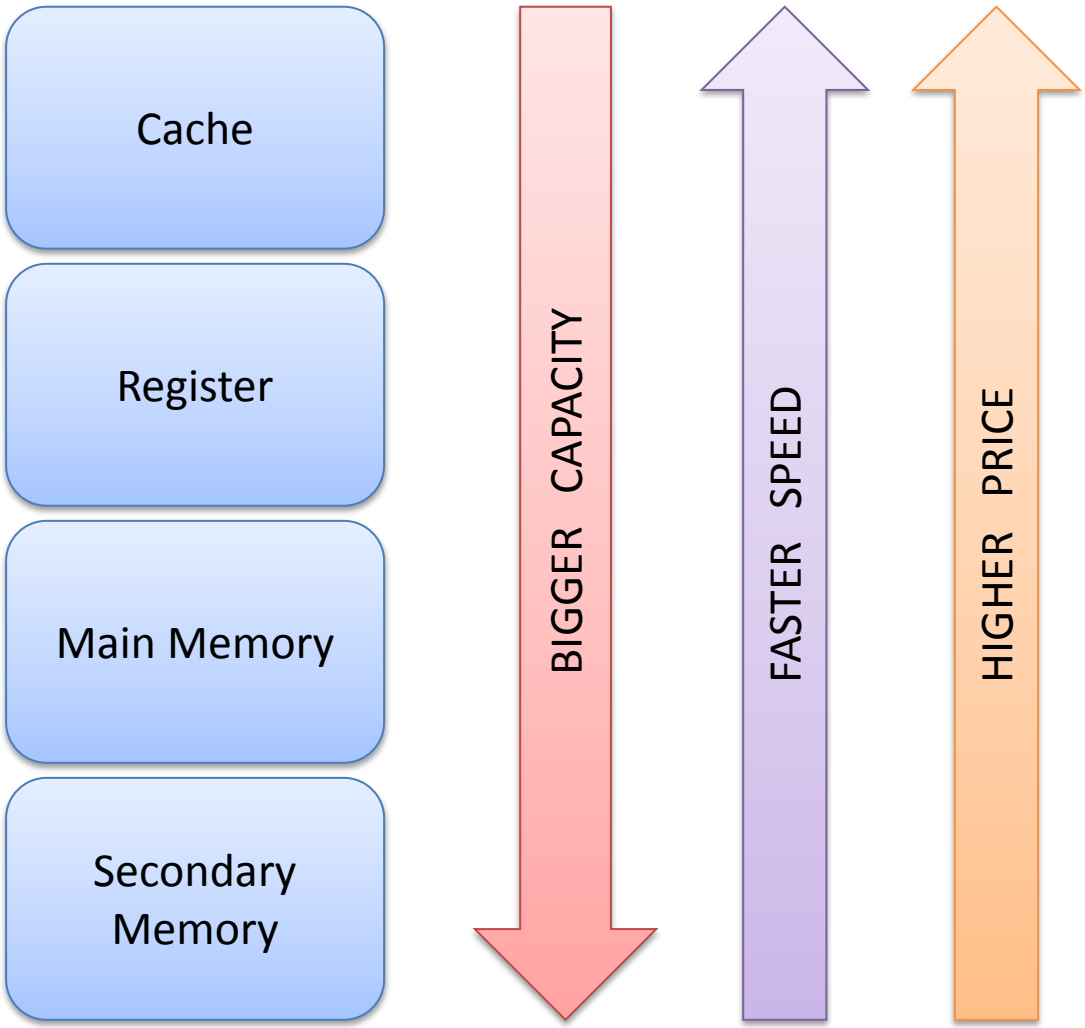
- Why do we need memory?
  to store data and instruction



- What is memory hierarchy?
  a hierarchy of memory types

- What are memory types?
  internal vs. external, accessibility, media

Hierarchy Memory



is a way to balance capacity, speed, and price

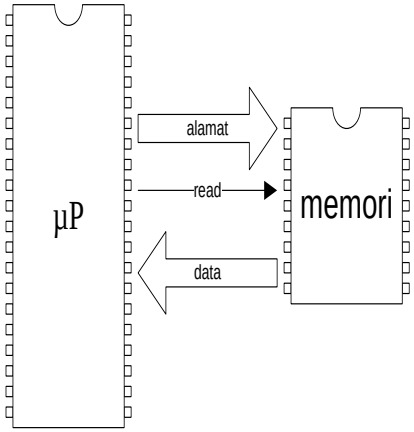
Memory Types

- Internal vs. External
  - Register, RAM, Hard Disk, CD/DVD
- Accessibility
  - ROM (Read Only Memory), PROM (Programmable ROM), EPROM (Erasable PROM), EEPROM (Electrically EPROM)
  - RAM (Random Access Memory), SRAM (Static RAM), DRAM (Dynamic RAM)
- Media
  - Electric charge, Optic, Magnetic

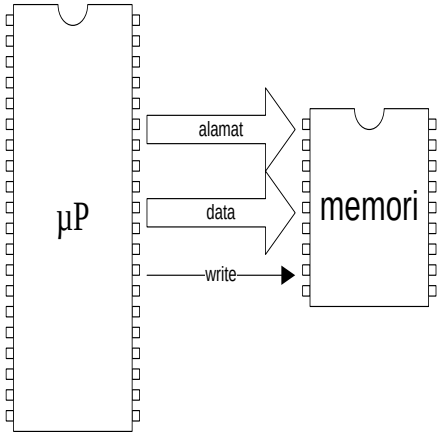
Interaction between Microprocessor and Memory

There are 2 types of interaction:

1. READ operation (retrieve), where microprocessor retrieves data from memory

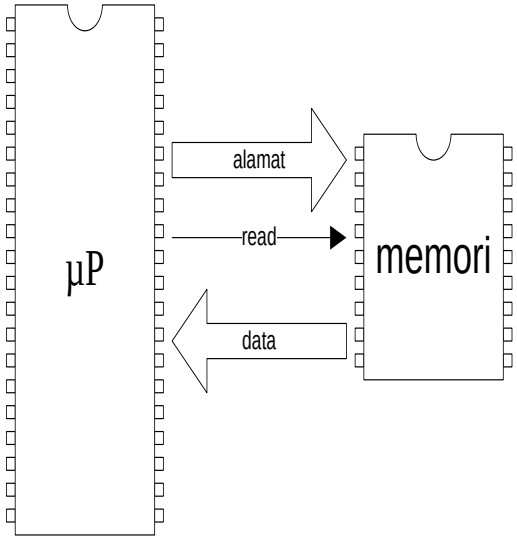


2. WRITE operation (store), where microprocessor stores data into memory



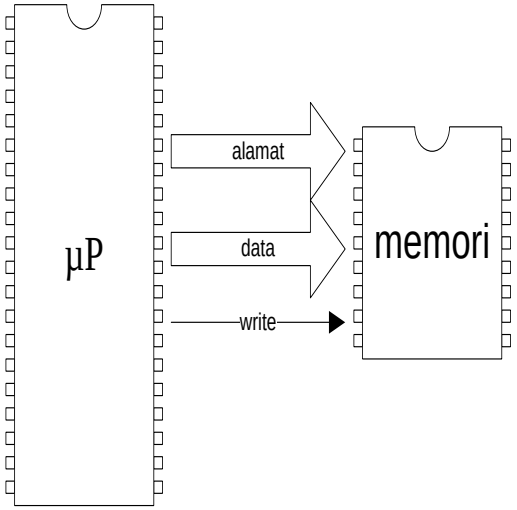
How Microprocessor READs from Memory?

1. Microprocessor prepares and outputs the address of data that need to be retrieved for processing
2. Microprocessor sends a READ signal to memory
3. After receiving a READ signal, memory locate the data based on given address
4. Memory provides the data into data bus



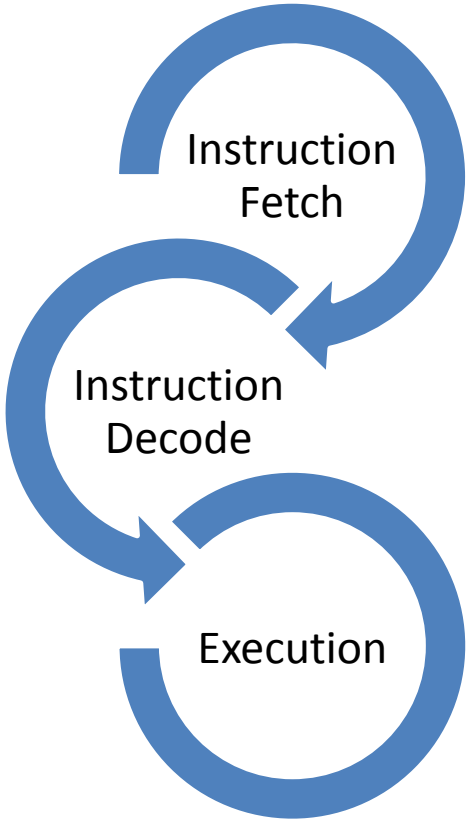
How Microprocessor WRITEs into Memory?

1. Microprocessor prepares and outputs the address of data that need to be stored in memory
2. Microprocessor provides data into data bus
3. Microprocessor sends a WRITE signal to memory
4. After receiving a WRITE signal, memory read the data bus and stores the data using given address



How Microprocessor RUNS an instruction?

1. Instruction Fetch (IF) is where microprocessor fetch the instruction from memory
2. Instruction Decode (DE) is where the microprocessor decode the instruction to understand what needs to be done
3. Execution (EX) is where te microprocessor execute the instruction



Input and Output

- Is an interface unit to communicate with outside the system's world
- Input unit receives data and in many cases also transforms signal from outside world (example, ADC Analog to Digital Converter)
- Output unit delivers data and in many cases also transforms the data into specific signal (example, DAC Digital to Analog Converter)

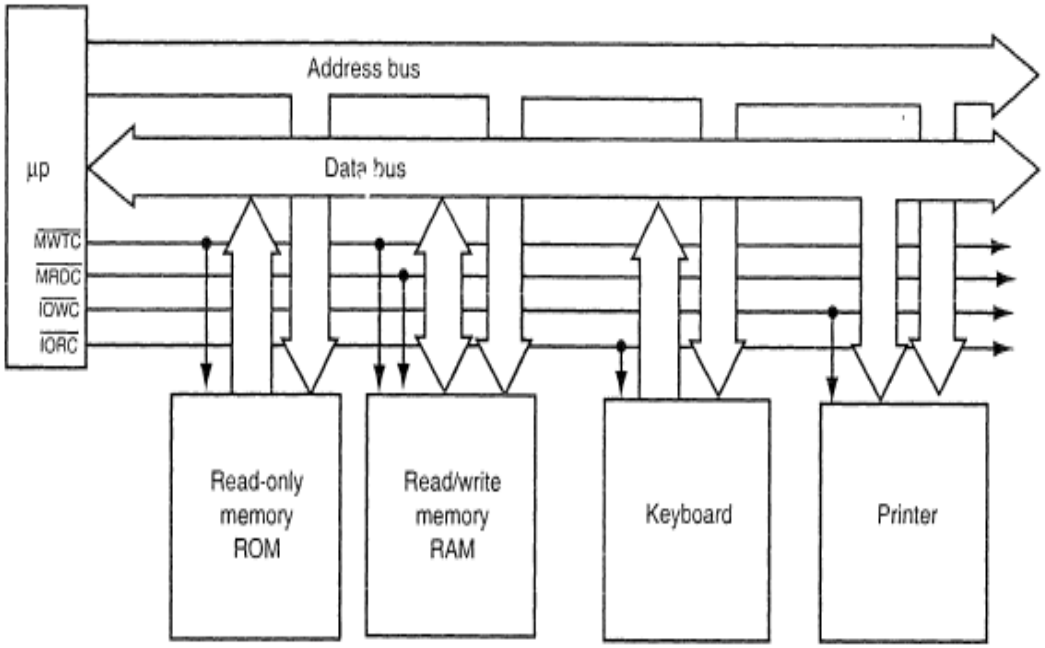
Clock

- Clock: is a digital periodic and independent signal, delivered to all units for synchronization
- Clock is generated using crystal oscillator with specific frequency

Bus System

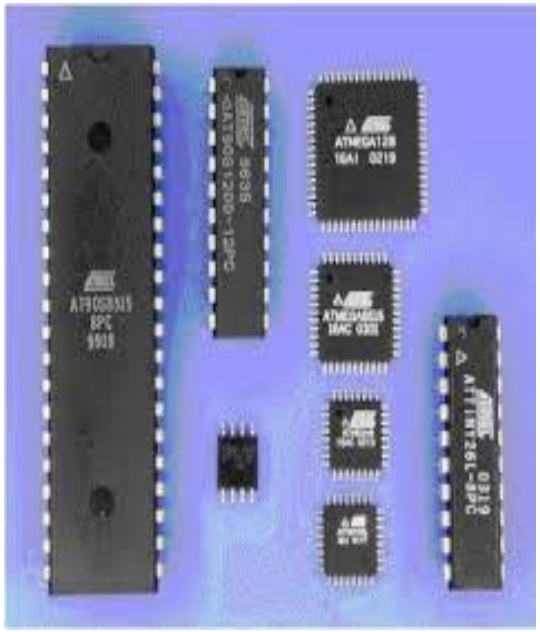
There are 3 types of bus:

- Data bus
- Address bus
- Control bus



Microcontroller

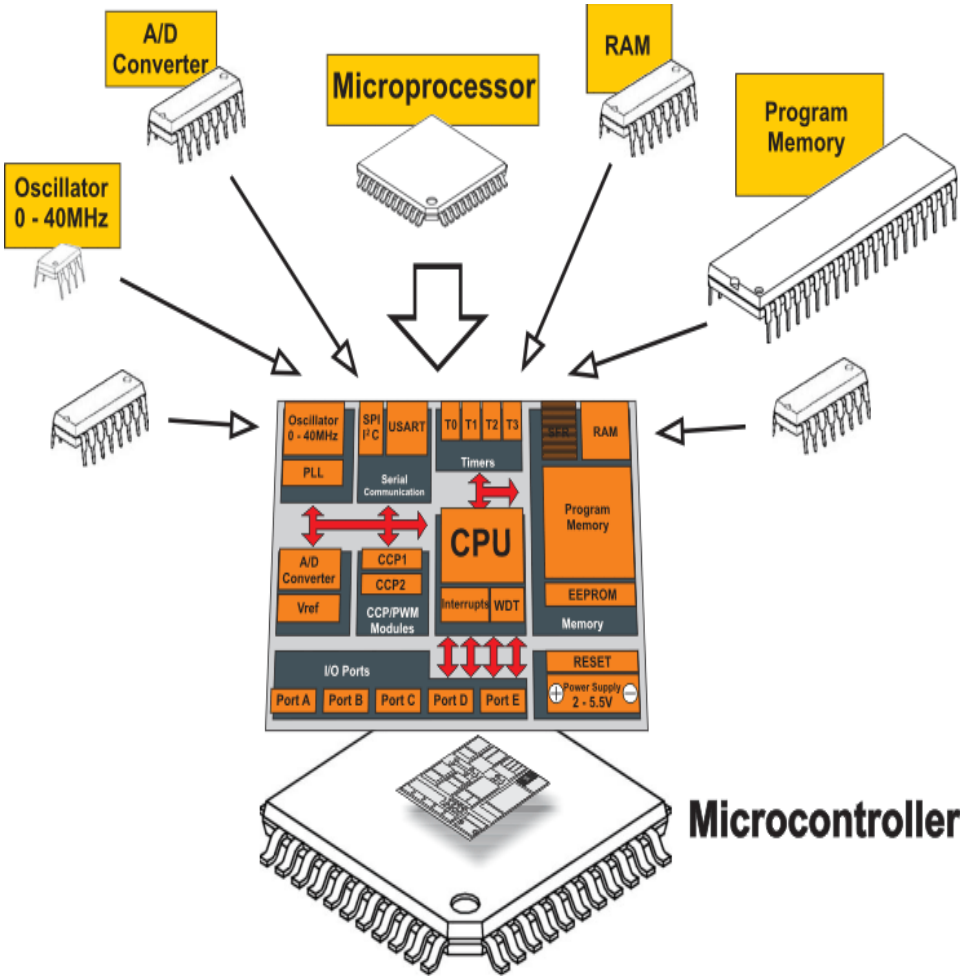
The Fundamental



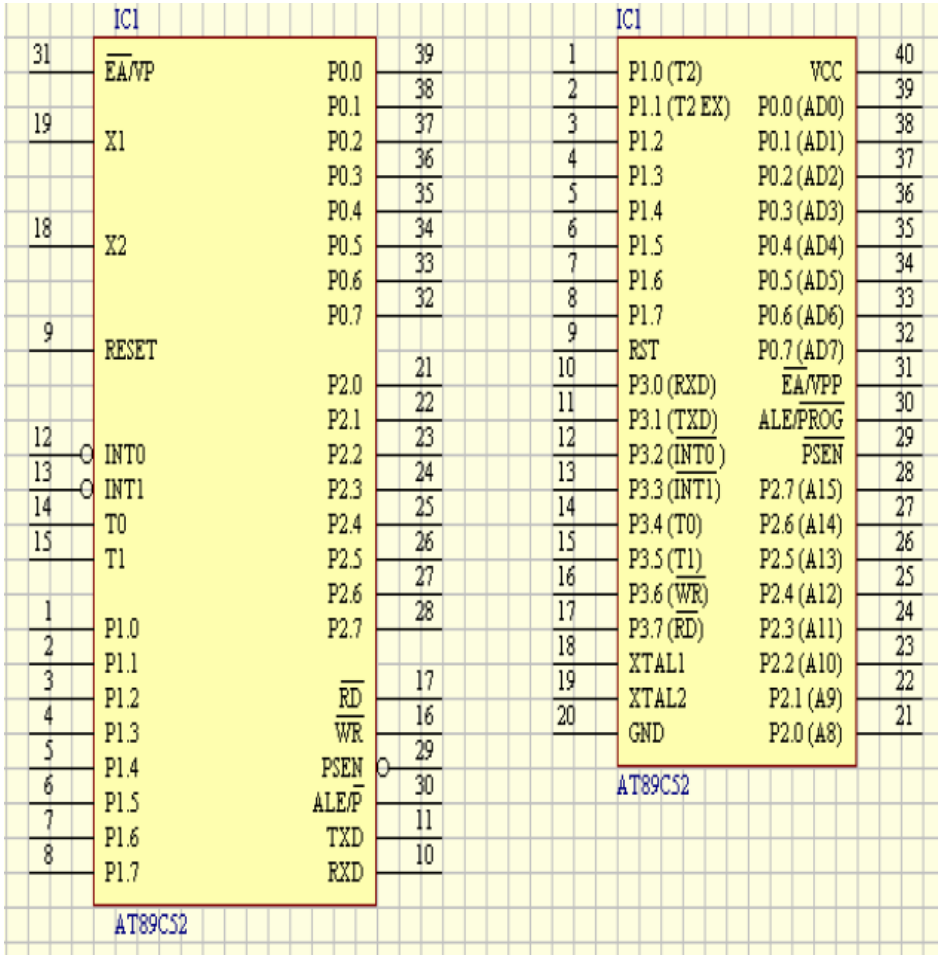
What is the difference between Microprocessor and Microcontroller?

- Microcontroller is a single chip CPU that already consists of:
  - Processor (ALU + Unit Control)
  - Internal Memory RAM
  - Input / Output
  - Timer
  - Interrupt Control
- Microcontroller is designed for a specific purpose, which makes it only applicable for 1 domain

Microcontroller

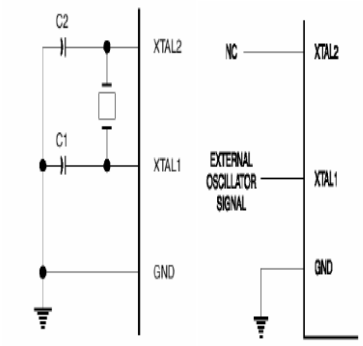


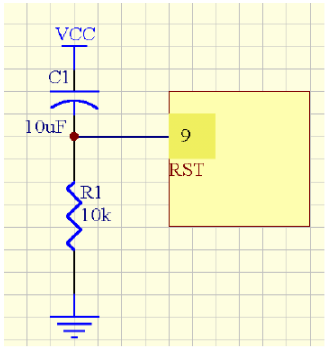
Atmel Microcontroller



To be fully functional, a microcontroller needs:

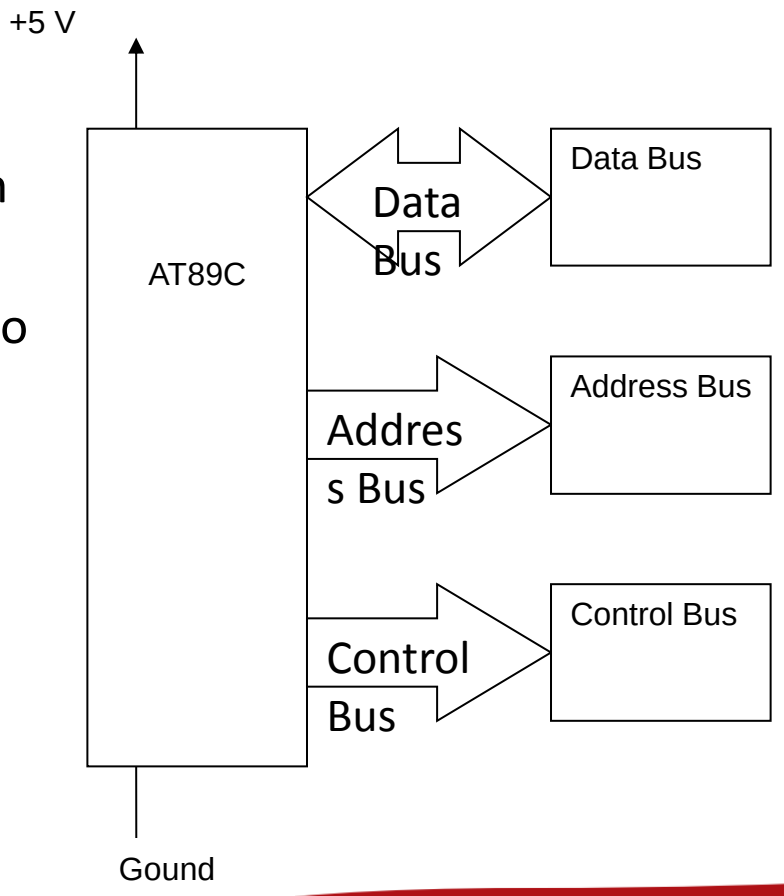
- Power suply
- Clock generator
- Power Reset





AT89CXX

- Data Bus (8 bit) for transferring data from or to AT89CXX
- Address Bus (16 bit) for:
  - indicating the address of data in memory
  - indicating which I/O that want to be connected
- Control Bus for delivering signal to other peripherals, such as memory and I/O



Telkom University

See you on next class