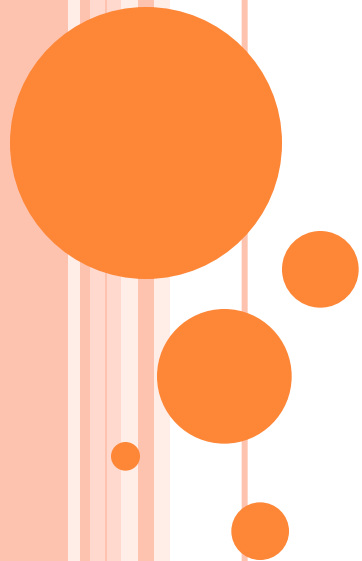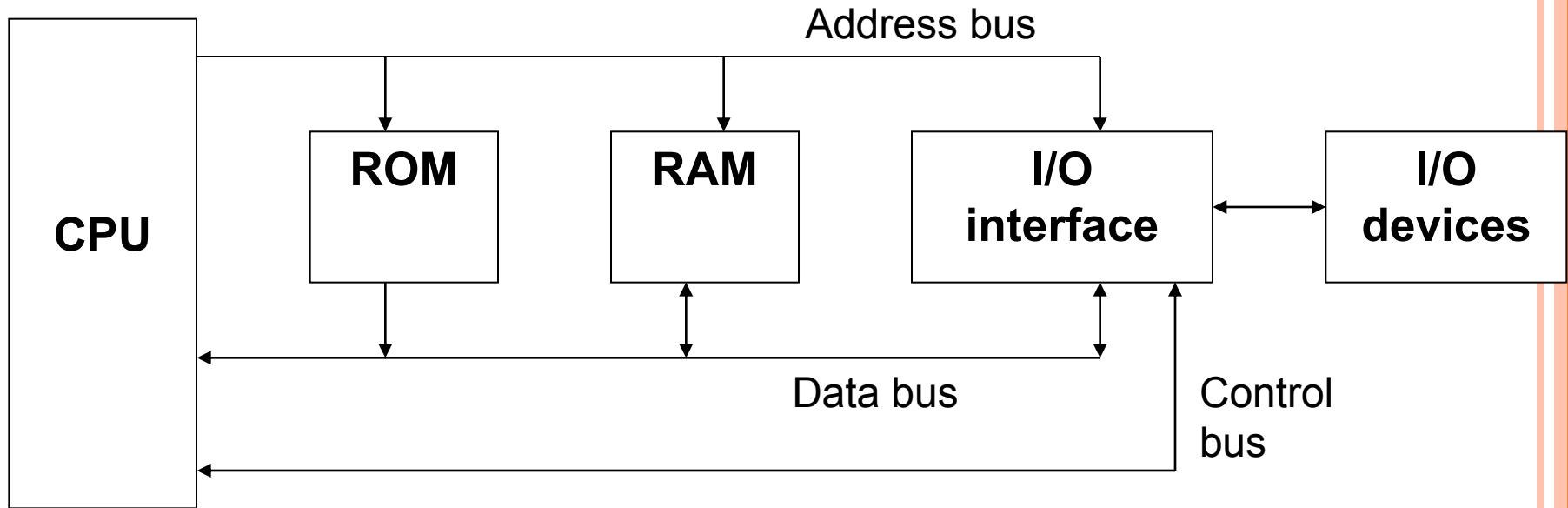# INTRODUCTION TO MICROPROCESSOR
UNIT 1
LECTURE 1

Microprocessor

- The **microprocessor** is a multipurpose, programmable device that accepts digital data as input, processes it according to instructions stored in its memory, and provides results as output. It is an example of sequential digital logic, as it has internal memory.

2

BLOCK DIAGRAM OF A BASIC COMPUTER SYSTEM

Basic computer system consist of a Central processing unit (CPU), memory (RAM and ROM), input/output (I/O) unit.

Address bus

| CPU | ROM | RAM | I/O interface | I/O devices |

Data bus

Control bus

Block diagram of a basic computer system

3

Basic component of microcomputer

1. CPU - Central Processing Unit
   - the portion of a computer system that carries out the instructions of a computer program
   - the primary element carrying out the computer's functions. It is the unit that reads and executes program instructions.
   - The data in the instruction tells the processor what to do.
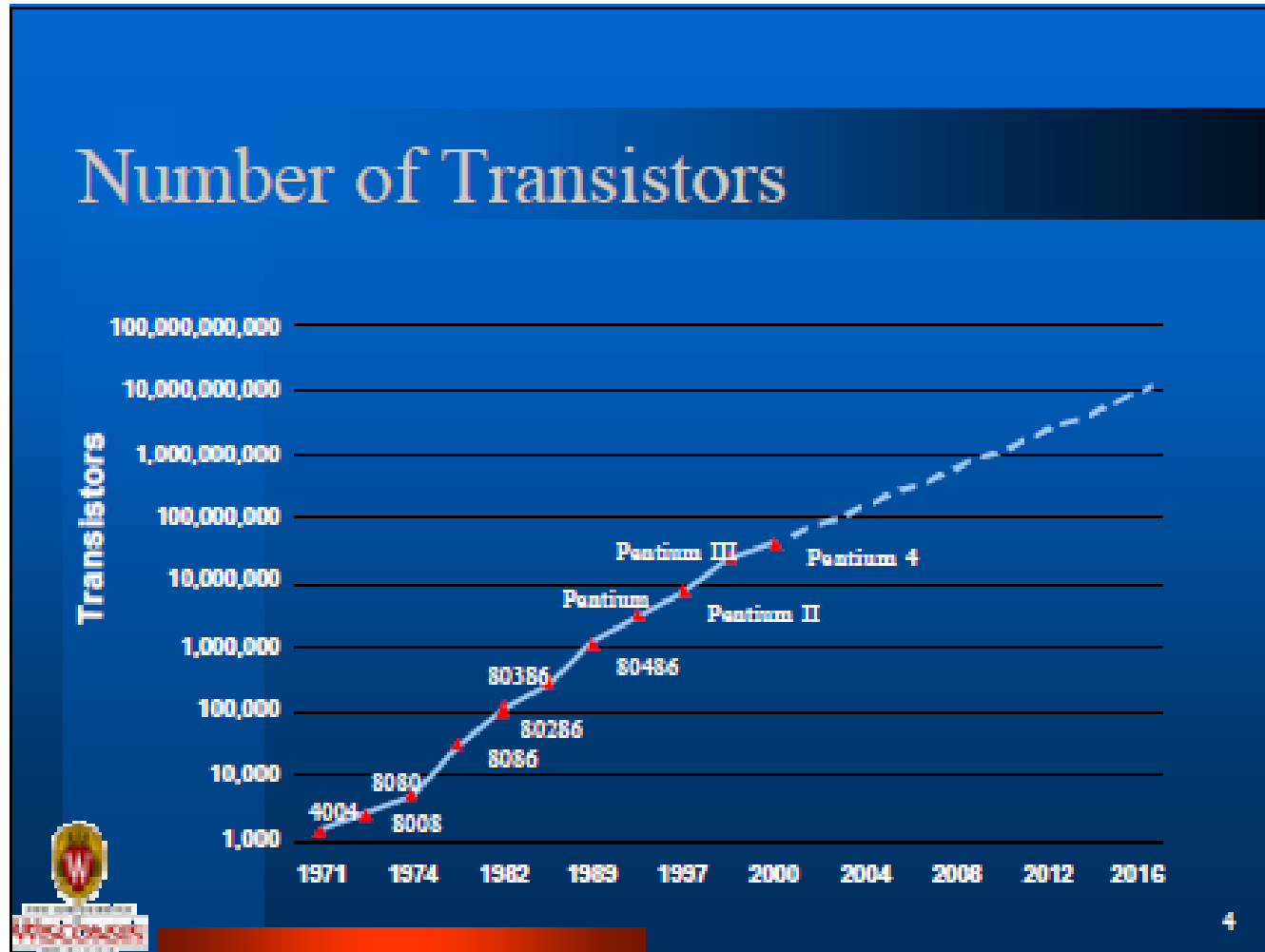
Pentium D dual core processors

2. Memory

- Physical devices used to store data or programs (sequences of instructions) on a temporary or permanent basis for use in an electronic digital computer.

- Computer main memory comes in two principal varieties: random access memory (RAM) and read only memory(ROM).

- RAM can be read and written to anytime the CPU commands it, but ROM is pre-loaded with data and software that never changes, so the CPU can only read from it.

- ROM is typically used to store the computer's initial start-up instructions.

- In general, the contents of RAM are erased when the power to the computer is turned off, but ROM retains its data indefinitely.

- In a PC, the ROM contains a specialized program called the BIOS that orchestrates loading the computer's operating system from the hard disk drive into RAM whenever the computer is turned on or reset.
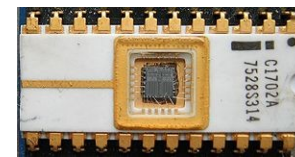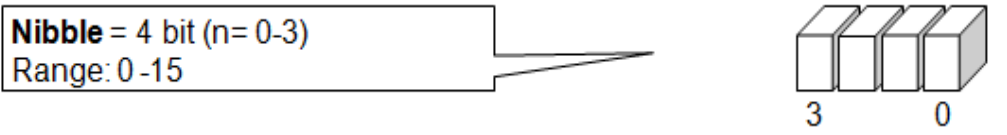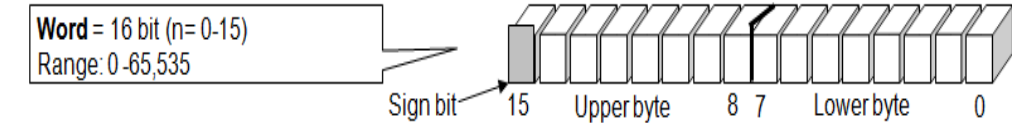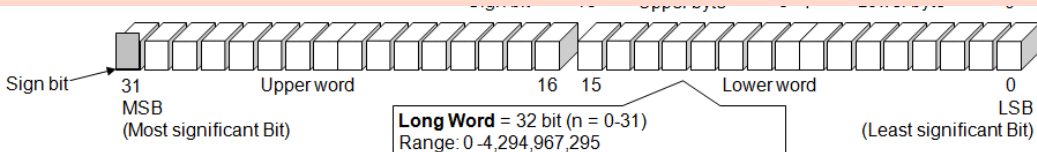
3. I/O Unit

- **Input/output (I/O)**, refers to the communication between an information processing system (such as a computer), and the outside world possibly a human, or another information processing system.

- Inputs are the signals or data received by the system, and Outputs are the signals or data sent from it

- Devices that provide input or output to the computer are called peripherals.

- On a typical personal computer , peripherals include input devices like the keyboard and mouse, and output devices such as the display and printer . Hard disk drives, floppy disk drives and optical disc drives serve as both input and output devices. Computer networking is another form of I/O.

Evolution of Microprocessor

DATA SIZE

Nibble	4 bit	
Byte	**8 bit**	
Word	**16 bit**	
Long word	**32 bit**	

Nibble = 4 bit (n= 0-3)
Range: 0 -15

3   0

Byte = 8 bit (n = 0-7)
Range: 0 -255

Sign bit   7   4 3   0
Upper   Lower Nibble
Nibble

Word = 16 bit (n= 0-15)
Range: 0 -65,535

Sign bit   15   Upper byte   8 7   Lower byte   0

Sign bit   31   Upper word   16 15   Lower word   0
MSB   LSB
(Most significant Bit)   (Least significant Bit)
Long Word = 32 bit (n = 0-31)
Range: 0 -4,294,967,295

FETCHING & EXECUTION CYCLES

- **Fetching Cycles**
  - The fetch cycle takes the instruction required from memory, stores it in the instruction register, and
  - moves the program counter on one so that it points to the next instruction.
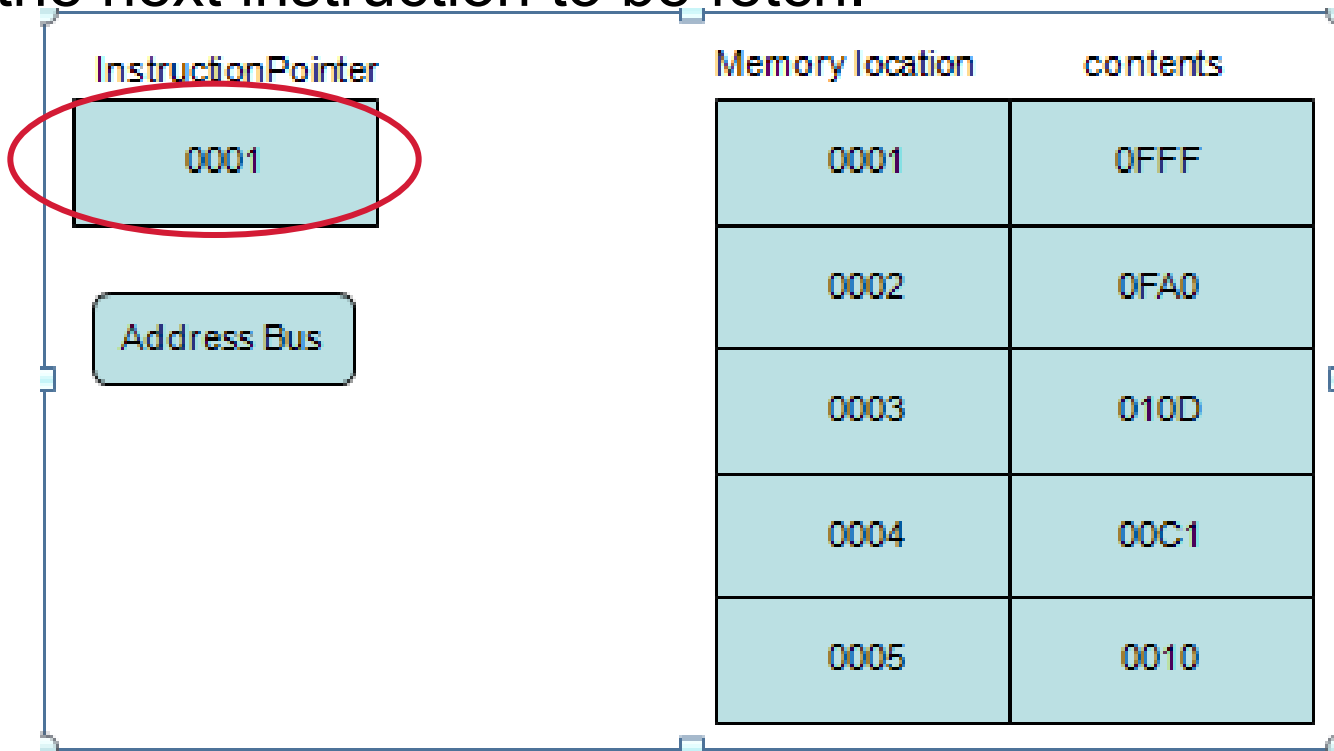- **Execute cycle**
  - The actual actions which occur during the execute cycle of an instruction.
  - depend on both the instruction itself and the addressing mode specified to be used to access the data that may be required.

FETCHING AN INSTRUCTION

○ **Step 1**

Instruction pointer (program counter) hold the address of the next instruction to be fetch.

InstructionPointer	Memory location	contents
0001	0001	0FFF
Address Bus	0002	0FA0
	0003	010D
	0004	00C1
	0005	0010

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FETCHING AN INSTRUCTION (cont.)

- **Step 2**
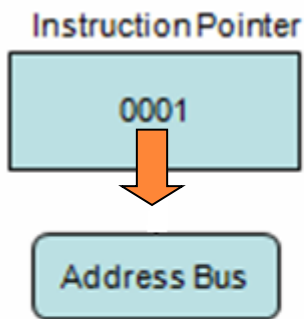
Instruction Pointer	Memory location	contents
0001	0001	0FFF
	0002	0FA0
Address Bus	0003	010D
	0004	00C1
Contents of the Program Counter are passed across the Address Bus	0005	0010

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FETCHING AN INSTRUCTION (cont.)

- **Step 3**

Instruction Pointer		Memory location	contents
0001	The address moves over the address bus to the Memory Access Register	0001	0FFF
Address Bus		0002	0FA0
0001		0003	010D
Memory Access Register		0004	00C1
		0005	0010

FETCHING AN INSTRUCTION (cont.)

- **Step 4**

The memory location of the next instruction is located.

0001

Memory Access Register

Memory location	contents
0001	0FFF
0002	0FA0
0003	010D
0004	00C1
0005	0010
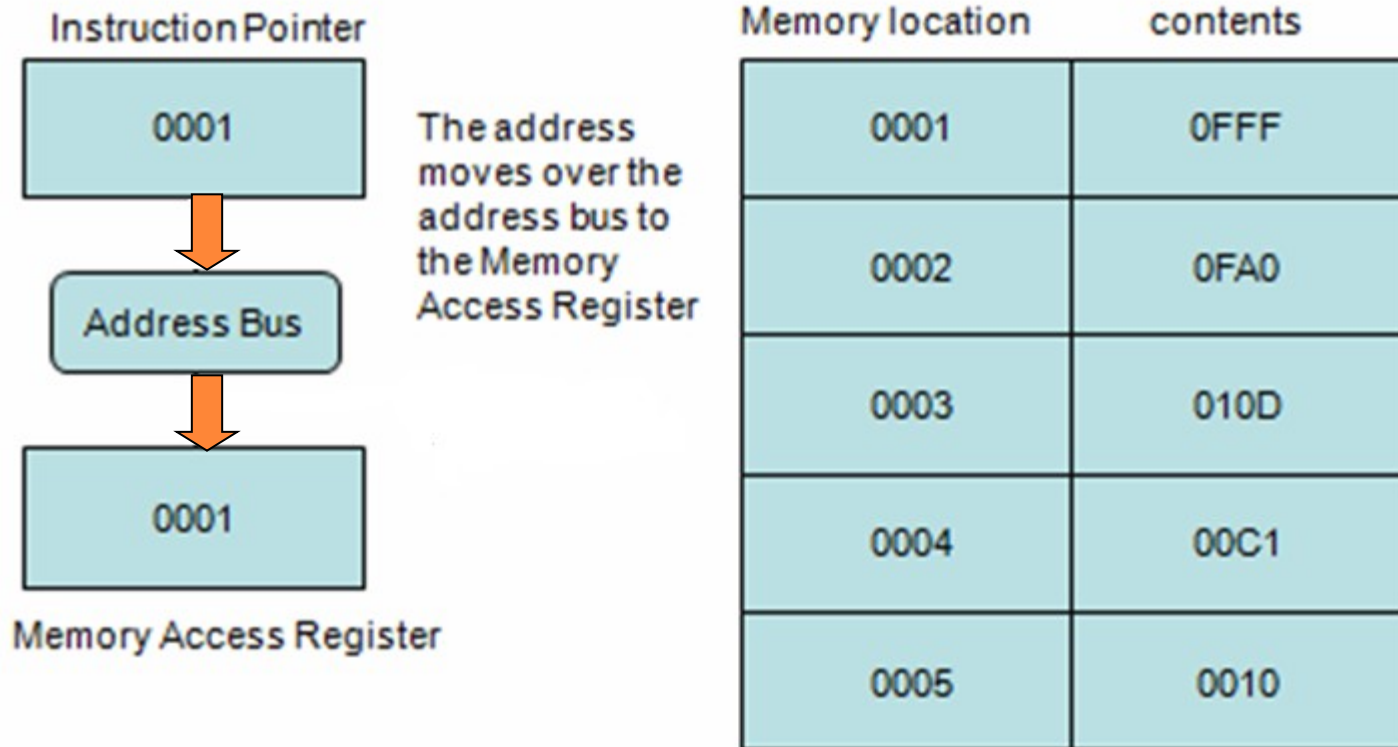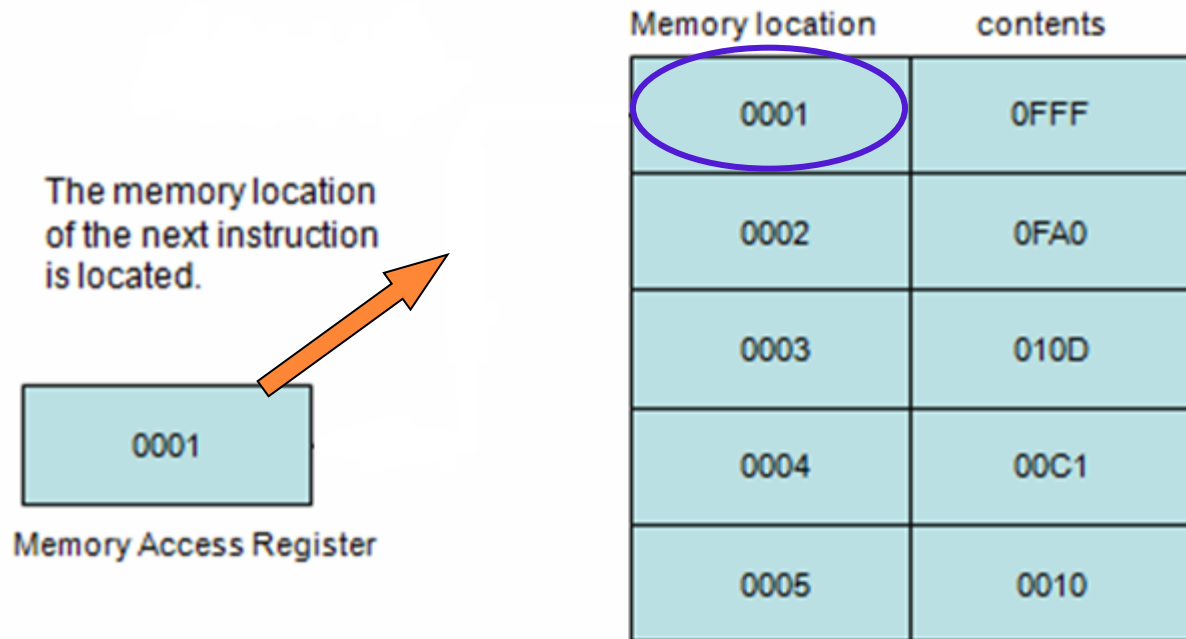
FETCHING AN INSTRUCTION (cont.)

- **Step 5**

Data Bus

The contents of memory at the given location are moved across the data bus

Memory location	contents
0001	0FFF
0002	0FA0
0003	010D
0004	00C1
0005	0010

FETCHING AN INSTRUCTION (cont.)

- Step 6

Memory location	contents
0001	0FFF
0002	0FA0
0003	010D
0004	00C1
0005	0010

Data Bus

Into the instruction register (IR)

OFFF

Instruction Register
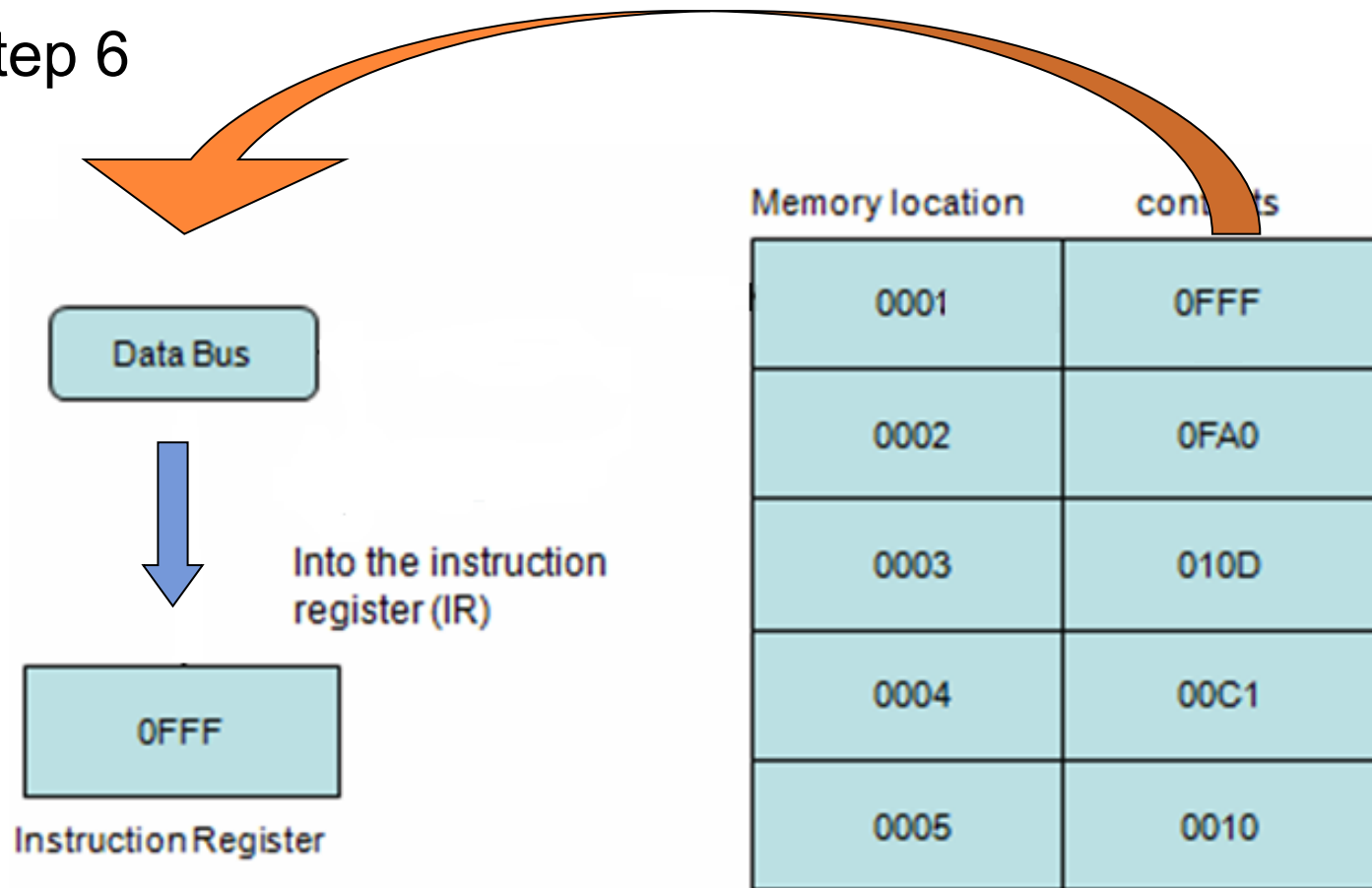
INTERNAL STRUCTURE AND BASIC OPERATION OF MICROPROCESSOR

ALU	Register Section
Control and timing section	

Address bus

Data bus

Control bus
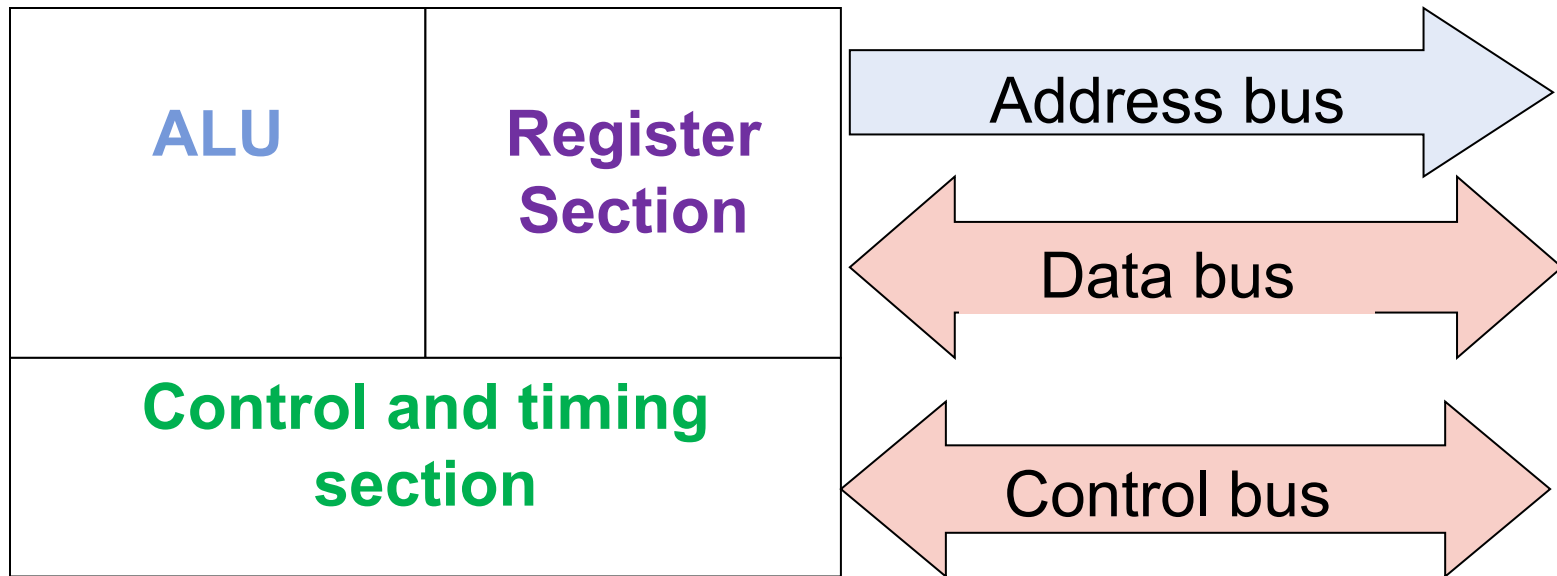
Block diagram of a microprocessor

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CONTROL UNIT

- The circuitry that controls the flow of information through the processor, and coordinates the activities of the other units within it.

- In a way, it is the "brain within the brain", as it controls what happens inside the processor, which in turn controls the rest of the PC.

- On a regular processor, the control unit performs the tasks of fetching, decoding, managing execution and then storing results.

INTERNAL STRUCTURE OF CONTROL UNIT
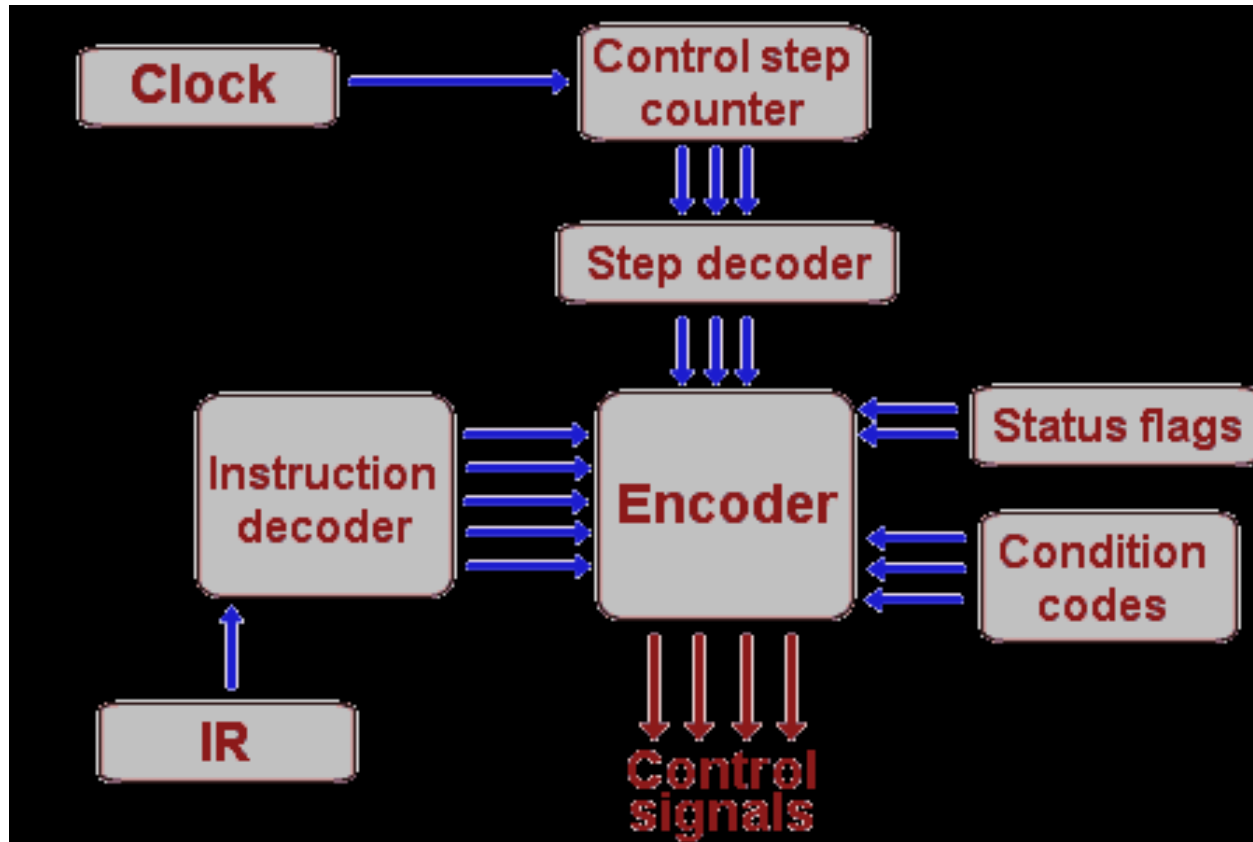
ACCUMULATOR

- a register in which intermediate arithmetic and logic results are stored.

- example for accumulator use is summing a list of numbers.

    - The accumulator is initially set to zero, then each number in turn is added to the value in the accumulator.

    - Only when all numbers have been added is the result held in the accumulator written to main memory or to another, non-accumulator, CPU register.

Flag	Name	Description
Z	Zero flag	Indicates that the result of a mathematical or logical operation was zero.
C	Carry flag	Indicates that the result of an operation produced an answer greater than the number of available bits. (This flag may also be set before a mathematical operation as an extra operand to certain instructions, e.g. "add with carry".)
X	Extend flag	*Masks the XIRQ request when set. It is set by the hardware and cleared by the software as well is set by unmaskable XIRQ.*
N	Negative/ Sign flag	Indicates that the result of a mathematical operation is negative. In some processors, the N and S flags have different meanings: the S flag indicates whether a subtraction or addition has taken place, whereas the N flag indicates whether the last operation result is positive or negative.
V	Overflow Flag	Indicates that the result of an operation has overflowed according to the CPU's word representation, similar to the carry flag but for signed operations.
I	interrupts	Interrupts can be enabled or disabled by respectively setting or clearing this flag. Modifying this flag may be restricted to programs executing in supervisor mode

PROGRAM COUNTER (PC)

- a 16 bit register, used to store the next address of the operation code to be fetched by the CPU.
- Not much use in programming, but as an indicator to user only.
- Purpose of PC in a Microprocessor
  - to store address of tos (top of stack)
  - to store address of next instruction to be executed.
  - count the number of instructions.
  - to store base address of the stack.

INTERNAL STRUCTURE OF PC
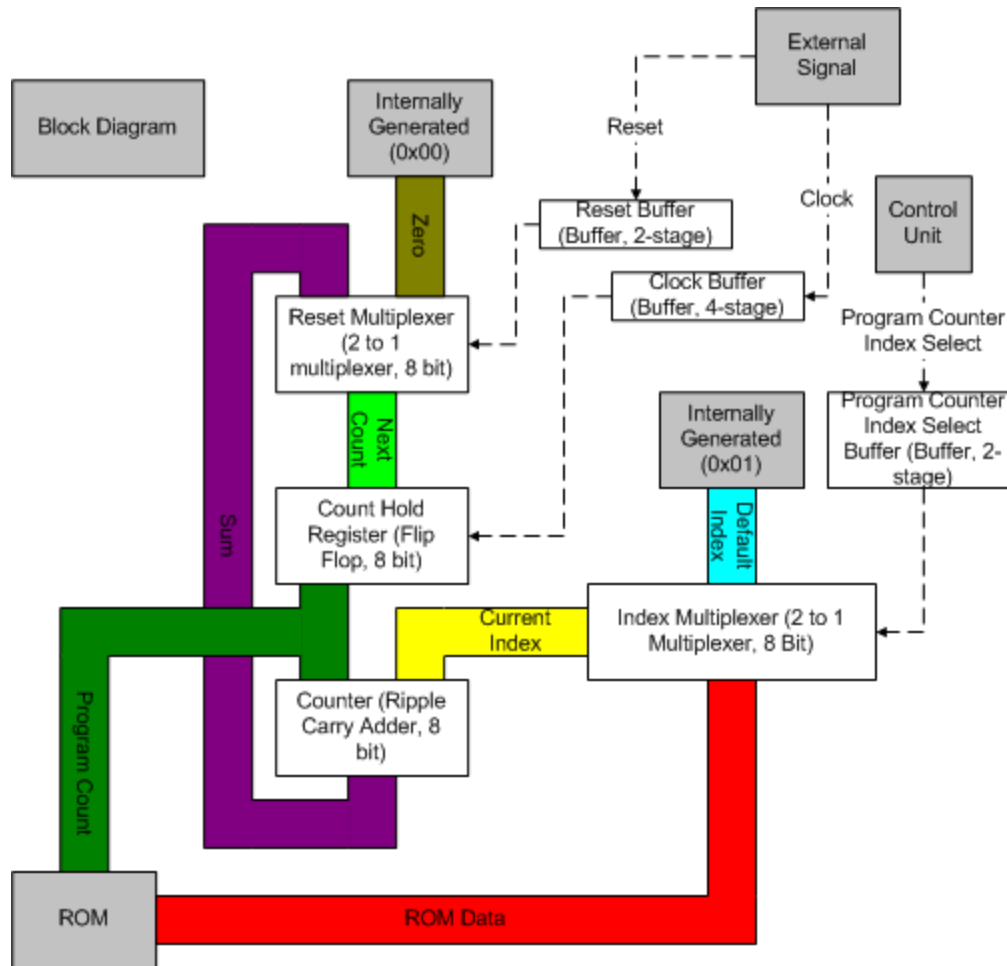
STACK POINTER (SP)

- The stack is configured as a data structure that grows downward from high memory to low memory.

- At any given time, the SP holds the 16-bit address of the next free location in the stack.

- The stack acts like any other stack when there is a subroutine call or on an interrupt. ie. pushing the return address on a jump, and retrieving it after the operation is complete to come back to its original location.
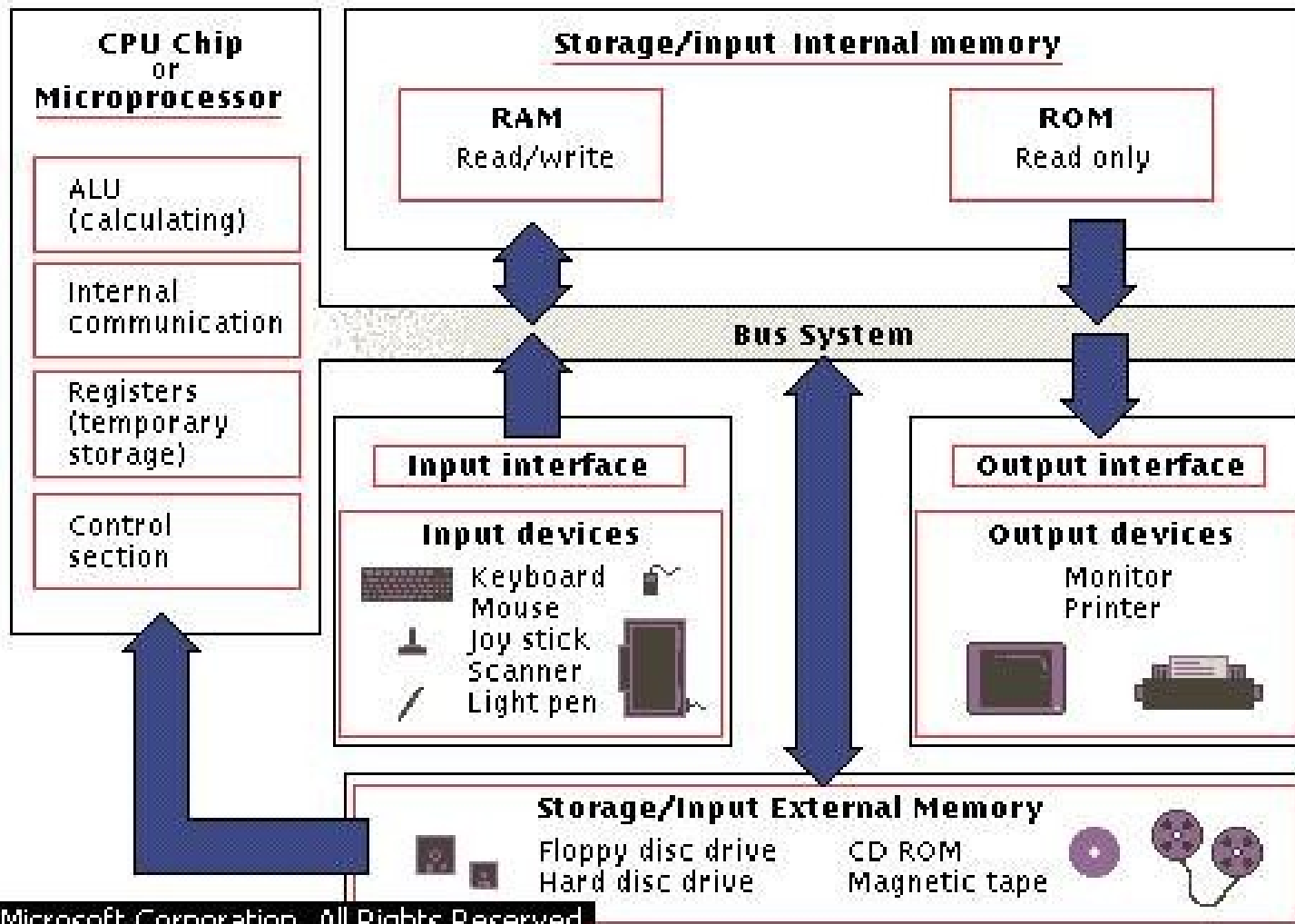
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Bus system

o a subsystem that transfers data between computer components inside a computer or between computers.
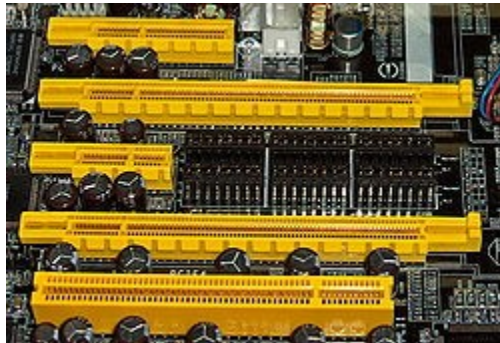
4 PCI Express bus card slots (from top to bottom: x4, x16, x1 and x16), compared to a traditional 32-bit PCI bus card slot (very bottom).

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Bus system connection

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DATA BUS

- The data bus is 'bi-directional'
  - data or instruction codes from memory or input/output are transferred into the microprocessor
  - the result of an operation or computation is sent out from the microprocessor to the memory or input/output.
- Depending on the particular microprocessor, the data bus can handle 8 bit or 16 bit data.

ADDRESS BUS

- The address bus is **'unidirectional'**, over which the microprocessor sends an address code to the memory or input/output.

- The size (width) of the address bus is specified by the number of bits it can handle.

- The more bits there are in the address bus, the more memory locations a microprocessor can access.

- A 16 bit address bus is capable of addressing 65,536 (64K) addresses.

Control bus

- The control bus is used by the microprocessor to send out or receive timing and control signals in order to coordinate and regulate its operation and to communicate with other devices, i.e. memory or input/output.

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MICRO PROCESSOR CLOCK

○ Also called clock rate, the speed at which a microprocessor executes instructions. Every computer contains an internal clock that regulates the rate at which instructions are executed and synchronizes all the various computer components.

○ The CPU requires a fixed number of clock ticks (or clock cycles) to execute each instruction. The faster the clock, the more instructions the CPU can execute per second. Clock speeds are expressed in megahertz (MHz) or gigahertz (GHz).

○ Some microprocessors are superscalar, which means that they can execute more than one instruction per clock cycle.

○ Like CPUs, expansion buses also have clock speeds. Ideally, the CPU clock speed and the bus clock speed should be the same so that neither component slows down the other. In practice, the bus clock speed is often slower than the CPU clock speed, which creates a bottleneck. This is why new local buses, such as AGP, have been developed.

EXAMPLES OF MICRO PROCESSOR

o Intel 8085
o Intel 8086

8086

- The 8086 is a 16-bit microprocessor chip designed by Intel, which gave rise to the x86 architecture; development work on the 8086 design started in the spring of 1976 and the chip was introduced to the market in the summer of 1978.

- The Intel 8088, released in 1979, was a slightly modified chip with an external 8-bit data bus (allowing the use of cheaper and fewer supporting logic chips and is notable as the processor used in the original IBM PC.
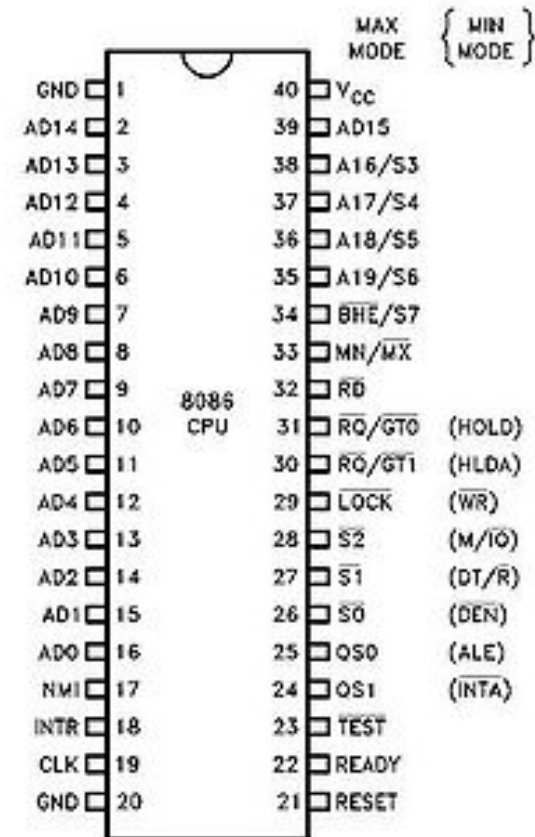
8085

- The Intel 8085 is an 8-bit microprocessor introduced by Intel in 1977.

- It was binary-compatible with the more-famous Intel 8080 but required less supporting hardware, thus allowing simpler and less expensive microcomputer systems to be built.

An Intel 8085AH processor.	
Produced	From 1977 to 1990s
Common manufacturer(s)	•Intel and several others
Max. CPU clock rate	3,5 and 6 MHz
Instruction set	pre x86
Package(s)	•40 pin DIP