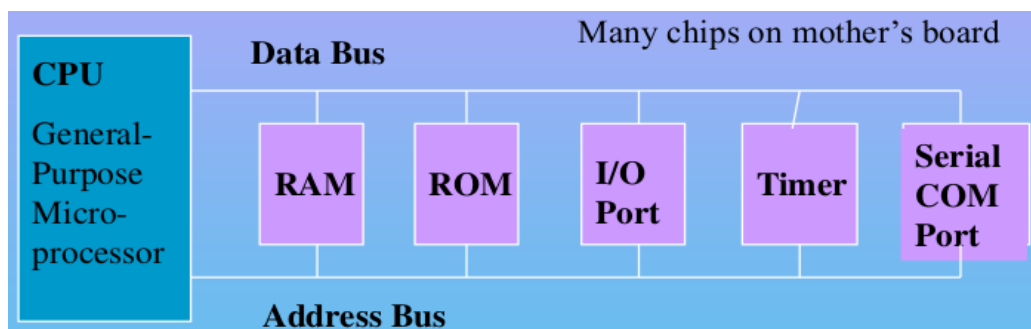## Unit-7 Microprocessor and Microcontroller
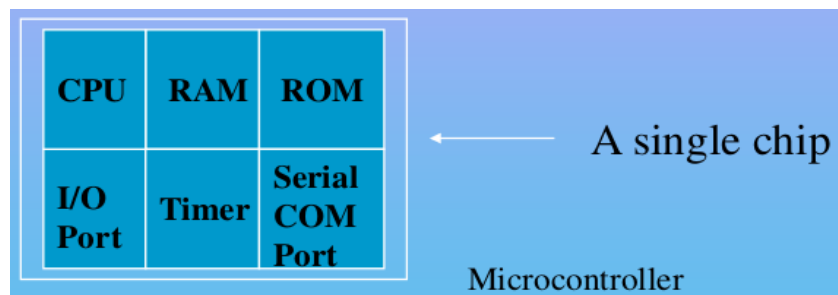
General-purpose Microprocessor

- CPU for Computers

- RAM, ROM, I/O devices, timer are connected externally
- Example:Intel's x86, Motorola's 680x0

Microcontroller :

- A smaller computer

- On-chip RAM, ROM, I/O ports...

- Example:Motorola's 6811, Intel's 8051, Zilog's Z8 and PIC 16X

| Parameters	Microprocessor	Microcontroller
Applications	General-purpose(Versatile): Gaming, web browsing, document creation etc.	Special/ single purpose: Dedicated for specific tasks (Camera, washing machine etc.)
Internal Structure	CPU is stand-alone, RAM, ROM, I/O devices, timer are connected externally	CPU, RAM, ROM, I/O and timer are present internally all on a single chip
Cost	High	Low
Power Consumption	High	Low
Memory (RAM)	512 MB to up to 32 GB	2KB to up to 256 KB
Storage	Hard Disk (128 GB to up to 2 TB)	Flash memory (32 KB to 2 MB)
Peripheral Interfaces	USB, UART, High speed Ethernet	UART, I2C, SPI
Size of registers, Adress and Data bus	32 bit or 64 bit	8 bit, 16 bit or 32 bit

Microcontrollers - 8051 Architecture

8051 microcontroller is designed by Intel in 1981. It is an **8-bit microcontroller,** which means data bus is of 8-bits. Therefore, **it can process 8-bits at a time**. It is used in wide variety of embedded systems like robotics, remote controls, automotive industry, telecom applications, power tools etc.

There are some key features of 8051. These features include :-

- **It is built with 40 pins** DIP (dual inline package)
- **4 KB on-chip ROM storage** (Program memory).
- **128 bytes on-chip RAM storage** (Data memory).
- **8 bit data bus** (bidirectional).
- **16 bit address bus** (unidirectional).
- **Two 16-bit timers.**
- **Instruction cycle of 1 microsecond with 12 MHz crystal.**
- **An on-chip crystal oscillator** is integrated in the microcontroller having crystal frequency of 12 Mhz. For the operation of timers and counters the oscillator is used inside microcontroller.
- **Four 8-bit ports**: which are programmable as well as addressable as per the requirement.

Let us now discuss the architecture of 8051 Microcontroller.

In the following diagram, **the system bus connects all the support devices to the CPU**. The system bus consists of an 8-bit data bus, a 16-bit address bus and bus control signals. All other devices like program memory, ports, data memory, serial interface, interrupt control, timers, and the CPU are all interfaced together through the system bus.
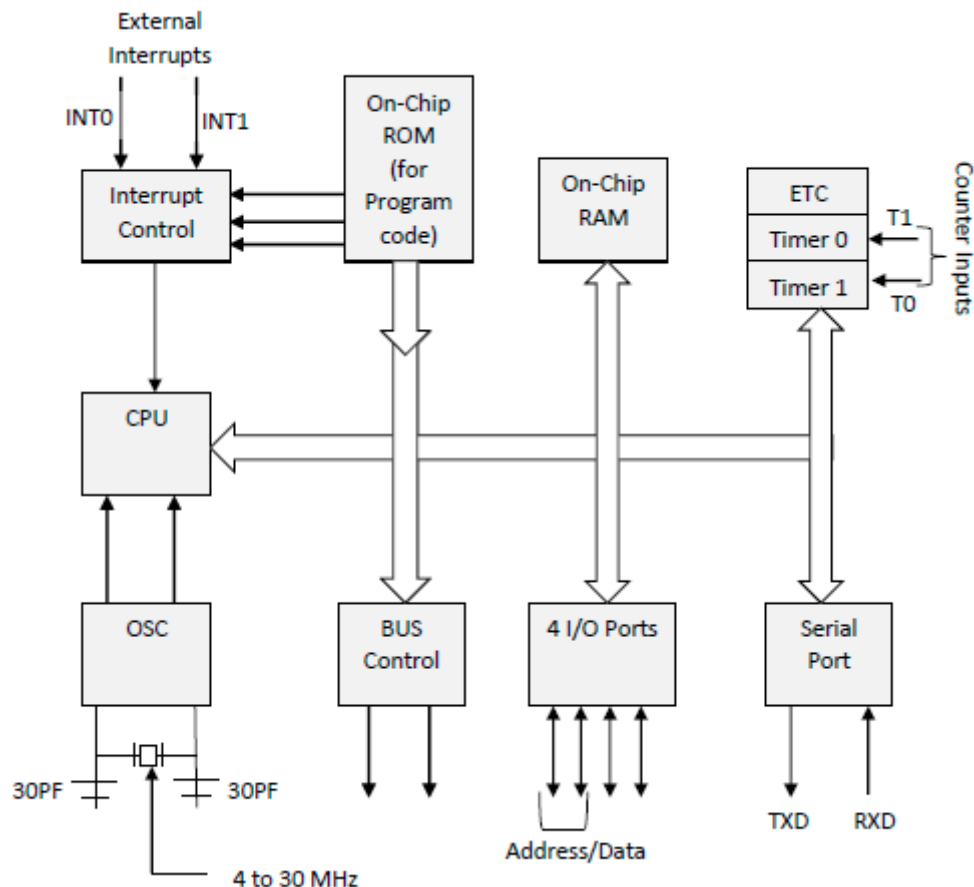
CPU (Central Processing Unit): CPU act as a mind of any processing machine. It synchronizes and manages all processes that are carried out in microcontroller.

Interrupts: When some other program with high priority is requesting for acquiring the system buses then interrupts occur in current running program. Interrupts provide a method to postpone or delay the current process, performs a sub-routine task and then restart the standard program again.

The five sources of interrupts in 8051 Microcontroller:

- Timer 0 overflow interrupt - TF0
- Timer 1 overflow interrupt - TF1
- External hardware interrupt - INT0
- External hardware interrupt - INT1
- Serial communication interrupt - RI/TI

Memory: For operation Micro-controller requires a program. This program guides the microcontroller to perform the specific tasks. This program installed in microcontroller requires some on chip memory for the storage of the program. Microcontroller also need memory for storage of data and operands for the short duration. In microcontroller 8051 **there is code or program memory of 4 KB (ROM)** and it also comprise of **data memory (RAM) of 128 bytes**.
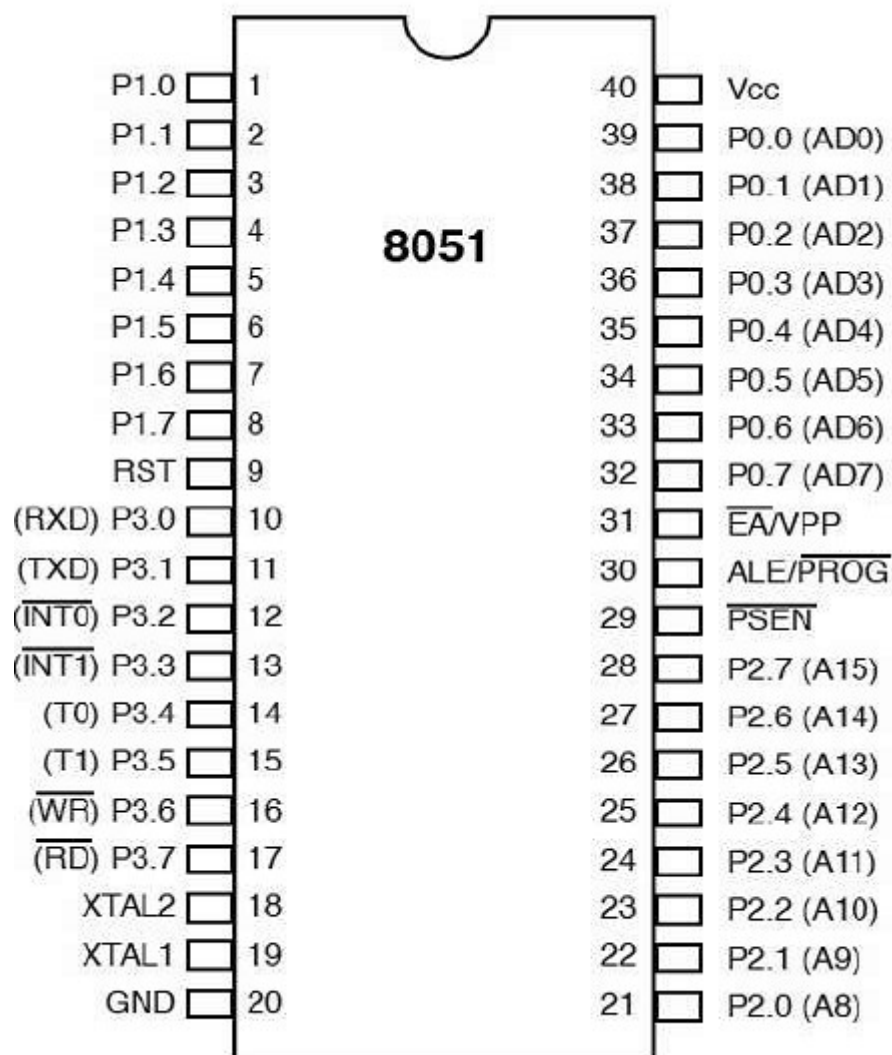
Bus : Bus is a group of wires, used as a communication canal or acts as means of data transfer. The two types of bus used in 8051 microcontroller:

- **Address Bus**: 16 bit address bus, used for transferring the data from Central Processing Unit to Memory.
- **Data bus**: 8 bits data bus, used for transferring the data from one peripherals position to other peripherals.

Oscillator: As the microcontroller is digital circuit therefore it needs timer for their operation. To perform timer operation inside microcontroller it require externally connected or on-chip oscillator. Microcontroller is used inside an embedded system for managing the function of devices. Therefore, 8051 uses the two 16 bit counters and timers. **For the operation of timers and counters the oscillator is used inside microcontroller.**

Pin Diagram of 8051

8051 microcontroller is a 40 pin Dual Inline Package (DIP). These 40 pins serve different functions like read, write, I/O operations, interrupts etc. **8051 has four I/O ports wherein each port has 8 pins** which can be configured as input or output depending upon the logic state of the pins. Therefore, **32 out of these 40 pins are dedicated to I/O ports**. **The rest of the pins are dedicated to VCC, GND, XTAL1, XTAL2, RST, ALE, EA' and PSEN'.**

Pin	Left		Right	Pin
1	P1.0		Vcc	40
2	P1.1		P0.0 (AD0)	39
3	P1.2		P0.1 (AD1)	38
4	P1.3	8051	P0.2 (AD2)	37
5	P1.4		P0.3 (AD3)	36
6	P1.5		P0.4 (AD4)	35
7	P1.6		P0.5 (AD5)	34
8	P1.7		P0.6 (AD6)	33
9	RST		P0.7 (AD7)	32
10	(RXD) P3.0		$\overline{EA}$/VPP	31
11	(TXD) P3.1		ALE/$\overline{PROG}$	30
12	($\overline{INT0}$) P3.2		$\overline{PSEN}$	29
13	($\overline{INT1}$) P3.3		P2.7 (A15)	28
14	(T0) P3.4		P2.6 (A14)	27
15	(T1) P3.5		P2.5 (A13)	26
16	($\overline{WR}$) P3.6		P2.4 (A12)	25
17	($\overline{RD}$) P3.7		P2.3 (A11)	24
18	XTAL2		P2.2 (A10)	23
19	XTAL1		P2.1 (A9)	22
20	GND		P2.0 (A8)	21

- **Pins 1 to 8** −**Pin 1 to Pin 8 are assigned to Port 1 for simple I/O operations.** They can be configured as input or output pins depending on the logic control i.e. if logic zero (0) is applied to the I/O port it will act as an output pin and if logic one (1) is applied the pin will act as an input pin. This port doesn't serve any other functions. It is bi-directional I/O port.

- **Pin 9** − **It is a RESET pin**, which is used to reset the microcontroller to its initial values.

- **Pins 10 to 17** − Pin 10 to pin 17 are port 3 pins. These pins can be used as universal input or output pins. These pins are bidirectional pins. These pins also have some additional functions which are as follows:

  - **P3.0 (RXD) :** 10th pin is RXD (serial data receive pin) which is for serial input.
  - **P3.1 (TXD) :** 11th pin is TXD (serial data transmit pin) which is serial output pin.
  - **P3.2 and P3.3 (INT0′, INT1′) :** 12th and 13th pins are for External Hardware Interrupt 0 and Interrupt 1 respectively.
  - **P3.4 and P3.5 (T0 and T1) :** 14th and 15th pin are for Timer 0 and Timer 1 external input.
  - **P3.6 (WR') :** 16th pin is for external memory write i.e. writing data to the external memory.
  - **P3.7 (RD') :** 17th pin is for external memory read i.e. reading data from external memory.

- **Pins 18 & 19** − These pins are used for **interfacing an external crystal oscillator** to get the system clock.

- **Pin 20** − This pin is **connected to the ground**. It has to be provided with 0V power supply.

- **Pins 21 to 28** − Pin 21 to pin 28 are port 2 pins. It serves as bidirectional I/O port. When additional external memory is interfaced with the 8051 microcontroller, **pins of port 2 act as higher-order address bytes**. These pins are bidirectional.

- **Pin 29** − This is PSEN pin which stands for **Program Store Enable. It is used to read a signal from the external program memory.**

- **Pin 30** − This is EA pin which stands for **External Access input**. It is **used to enable/disable the external memory interfacing.**

- **Pin 31** − This is ALE pin which stands for **Address Latch Enable**. It is also **used to de-multiplex the multiplexed address and data signals** available at port 0.

- **Pins 32 to 39** − Pin 32 to pin 39 are port 0 pins . They are bidirectional input/output pins. Lower order address and data bus signals are multiplexed using this port.

- **Pin 40** − This pin is used to provide power supply to the circuit.