8051 Overview

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Microprocessors vs. Microcontrollers

- **Microprocessors are single-chip Central Processing Units (CPU) used in microcomputers**
- **Microcontrollers and microprocessors are different in three main aspects: hardware architecture, applications, and instruction set features**
- **Hardware architecture: A microprocessor is a single chip CPU while a microcontroller is a single Integrated Circuit (IC) containing a CPU and much of the circuitry necessary for a complete computer (e.g., Random Access Memory (RAM), Read Only Memory (ROM), serial interfaces, parallel interfaces, timers, interrupt handling circuits, etc.)**
- **Applications: Microprocessors are commonly used as a CPU in computers while microcontrollers are found in small, minimum component designs performing control oriented activities**

Microprocessors vs. Microcontrollers

- **Instruction set features**
  - **Microprocessor instruction sets are processing intensive**
    - **Their instructions operate on nibbles, bytes, words, or even double words**
    - **Addressing modes provide access to large arrays of data using pointers and offsets**
  - **Microcontroller instruction sets cater to the control of inputs and outputs**
    - **They have instructions to set and clear individual bits and perform bit operations**
    - **They have instructions for input/output operations, event timing, enabling and setting priority levels for interrupts caused by external stimuli**
- **The processing power of a microcontroller is typically much less than that of a microprocessor**

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- **Today, over fifty companies produce variations of the 8051**
- **Several of these companies have over fifty versions of the 8051**
- **8051 cores are available for implementations in Field Programmable Gate Arrays (FPGA) or Application Specific Integrated Circuits (ASIC)**
- **Nearly a billion 8051's are sold each year**
- **The 8051 has been extremely successful, and has directly influenced many of the more recent microcontroller architectures. Even though, in the humble opinion of your instructor, it is a brain-damaged architecture.**
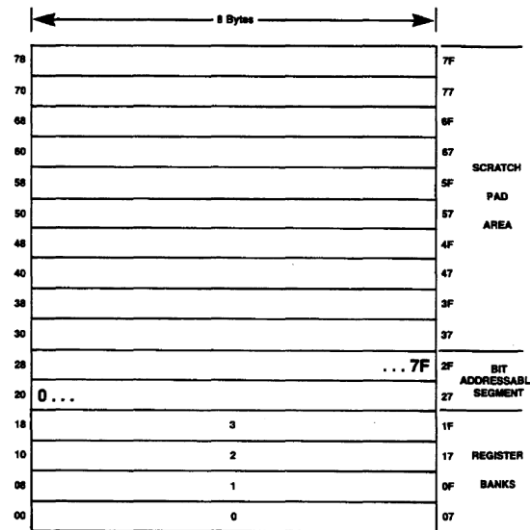
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- **The 8051 was developed by Intel but other manufacturers (e.g., Siemens, Philips, Atmel, etc.) are second sources of this family of devices**
- **Summary of features of the standard 8051**
    - **4K bytes internal ROM (program)**
    - **128 bytes internal RAM (data)**
    - **Four 8-bit I/O ports**
    - **Two 16-bit timers**
    - **Serial interface**
    - **64K external code memory space**
    - **64K external data memory space**
    - **210 bit-addressable locations**

Memory

- **The 8051 implements a separate memory space for programs (code) and data**
- **Both code and data may be internal, however, both expand using external components to a maximum of 64K code memory and 64K data memory**
- **Internal memory consists of on-chip program ROM and on-chip data RAM**
- **On-chip RAM contains a rich arrangement of general purpose storage, bit addressable storage, register banks, and special function registers**
- **The registers and input/output ports are memory mapped and accessible like any other memory location**
- **The 8051 stack resides within the internal RAM, rather than in external RAM**

Internal RAM Organization

Figure 4. 128 Bytes of RAM Direct and Indirect Addressable

Special Function Registers

- **8051 has 21 special function registers (SFRs) at the top of internal RAM from address 80H to FF$_H$.**
- **Only 21 of the 128 addresses from 80$_H$ to FF$_H$ are defined in the original 8051 architecture.**
- **Some SFR's are both bit-addressable and byte addressable, depending on the instruction accessing the register.**

Special Function Registers

SFR MEMORY MAP

8 Bytes

F8								FF
F0	B							F7
E8								EF
E0	ACC							E7
D8								DF
D0	PSW							D7
C8	T2CON		RCAP2L	RCAP2H	TL2	TH2		CF
C0								C7
B8	IP							BF
B0	P3							B7
A8	IE							AF
A0	P2							A7
98	SCON	SBUF						9F
90	P1							97
88	TCON	TMOD	TL0	TL1	TH0	TH1		8F
80	P0	SP	DPL	DPH			PCON	87

↑
Bit
Addressable

Figure 5

Mnemonic Table of the Special Function Registers

Table 1

Symbol	Name	Address
*ACC	Accumulator	0E0H
*B	B Register	0F0H
*PSW	Program Status Word	0D0H
SP	Stack Pointer	81H
DPTR	Data Pointer 2 Bytes	
DPL	Low Byte	82H
DPH	High Byte	83H
*P0	Port 0	80H
*P1	Port 1	90H
*P2	Port 2	0A0H
*P3	Port 3	0B0H
*IP	Interrupt Priority Control	0B8H
*IE	Interrupt Enable Control	0A8H
TMOD	Timer/Counter Mode Control	89H
*TCON	Timer/Counter Control	88H
*+T2CON	Timer/Counter 2 Control	0C8H
TH0	Timer/Counter 0 High Byte	8CH
TL0	Timer/Counter 0 Low Byte	8AH
TH1	Timer/Counter 1 High Byte	8DH
TL1	Timer/Counter 1 Low Byte	8BH
+TH2	Timer/Counter 2 High Byte	0CDH
+TL2	Timer/Counter 2 Low Byte	0CCH
+RCAP2H	T/C 2 Capture Reg. High Byte	0CBH
+RCAP2L	T/C 2 Capture Reg. Low Byte	0CAH
*SCON	Serial Control	98H
SBUF	Serial Data Buffer	99H
PCON	Power Control	87H

* = Bit addressable
+ = 8052 only

Bit Addressable RAM

- **Individual accessing of bits is a powerful feature of microcontrollers**
- **Bits can be set, cleared, ANDed, ORed etc, with a single instruction**
- **8051 ports are bit-addressable, simplifying the interface to single bit inputs and outputs**
- **The 8051 contains 210 bit-addressable locations**
- **128 of these locations are at addresses 20_H to $2F_H$ and the rest are in the special function registers**

Summary

- **8051 overview**
- **Available hardware**
- **Internal memory map**