Microprocessor

Mohsen Nickray

Unversity of Qom

Text Book

- The 80x86 IBM PC and Compatible Computers (Vol.1 and 2)
- John Uffenbeck, “The 8086/8088 Family: Design, Programming and Interfacing, Prentice Hall International, Ch 1, pp. 1-27, 1987
- K. L. Short, Microprocessors and Programmed Logic Barry B. Bray, The Intel 8086/8088, 80186, 80286, 80386, and 80486
- Datasheet of AVR microcontrollers

General Information

- Lecturer: Mohsen Nickray
- Contact info:
  - Email: nickraymohsen@gmail.com
  - Office: Room 318
- Course Schedule and location:
  - Wednesday, 8:00-10:00, 10:00-12:00
- Course site:
  - http://ececm.ir/shahed (MP123)

Grading Policy

- Home work, Quiz, Short Exams, extra works:(30%)
- Midterm exam (20%)
- Final exam (50%)
- Bonus project (10%)

Grading Policy (Cont.)

- Project Bonus (up to 2), 30 hours for each point
- Home work:
  - Should be your own work
  - Talking, discussions are allowed
  - Copying, looking at other's work is not allowed
  - Penalty if discovered
- Everything is in site.

Course Load

- Course work consist of:
  - Track and follow up class presentations precisely.
  - Reading your text book.
  - Submit your paper/computer home works on time. You need to report your lab/computer/simulation assignments completely.
  - Course attendance is just helpful to know you more

Why Study Microprocessor Design?

- It's exciting!; It has never been more exciting!
- It impacts every other aspect of electrical engineering and computer science

Bionics:
Sensors in latex fingers instantly register hot and cold, and an electronic interface in his artificial limb stimulates the nerve endings in his upper arm, which then pass the information to his brain. The $3,000 system allows his hand to feel pressure and weight, so for the first time since losing his arms in a 1986 accident, he can pick up a can of soda without crushing it or having it slip through his fingers. *One Digital Day*

Only Sociology graduates help real people?

Why Study Microprocessor Design?

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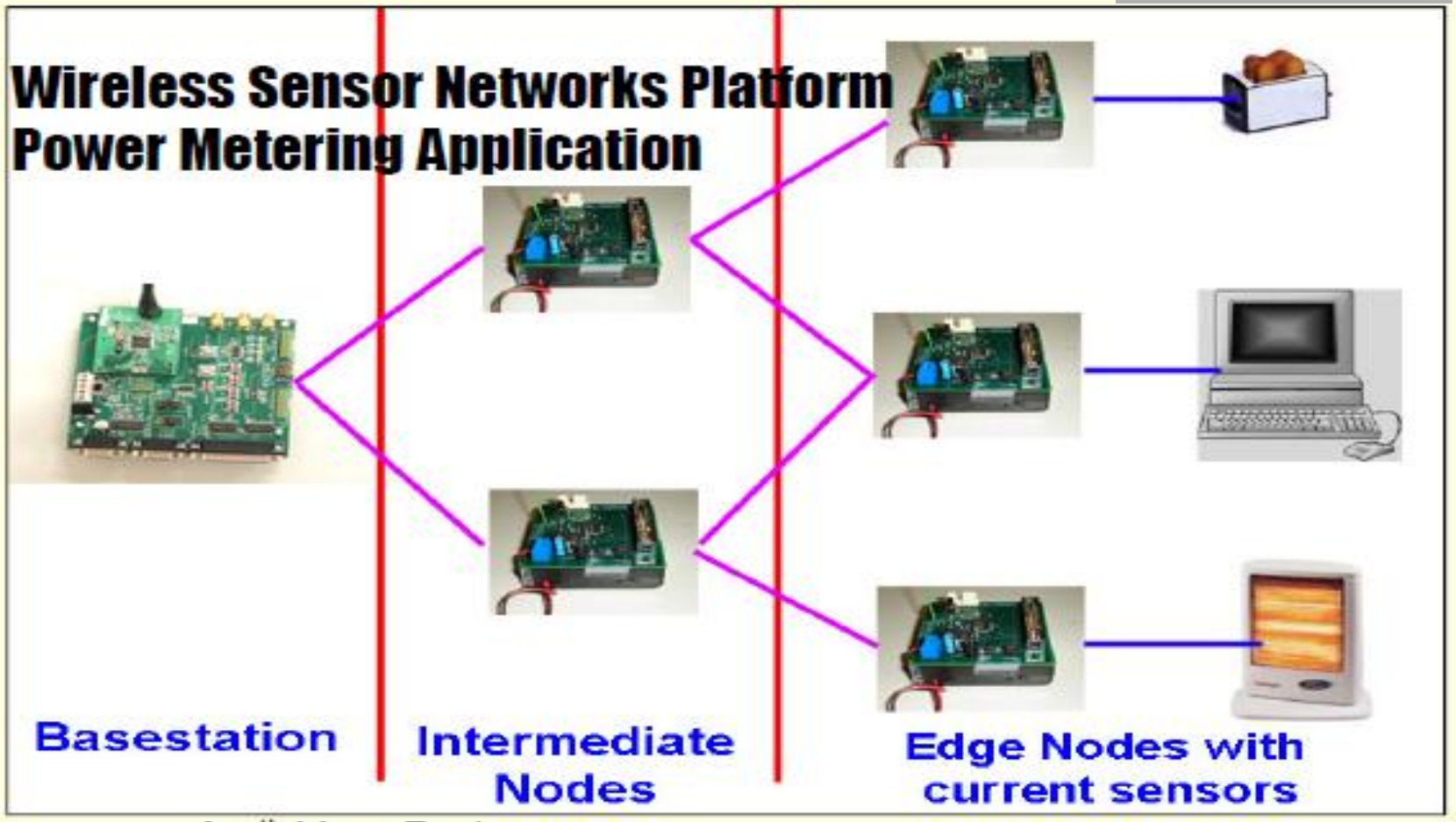
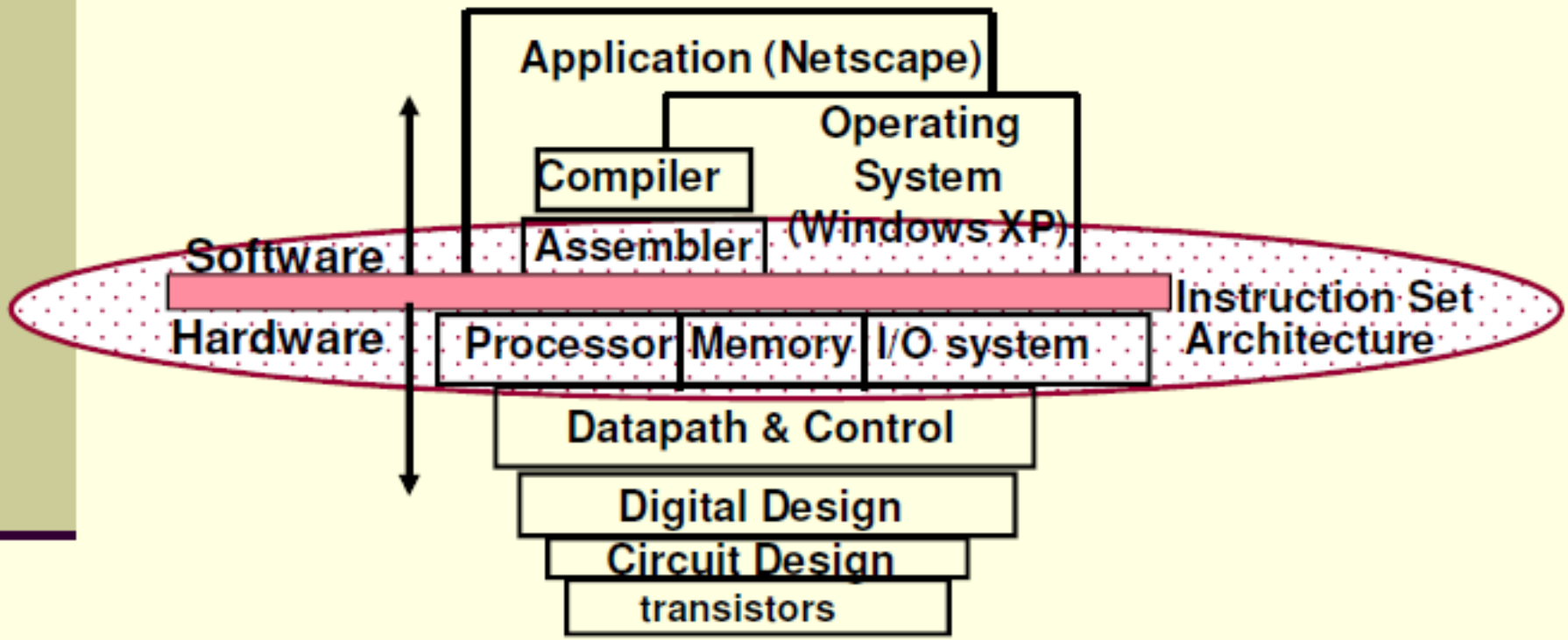


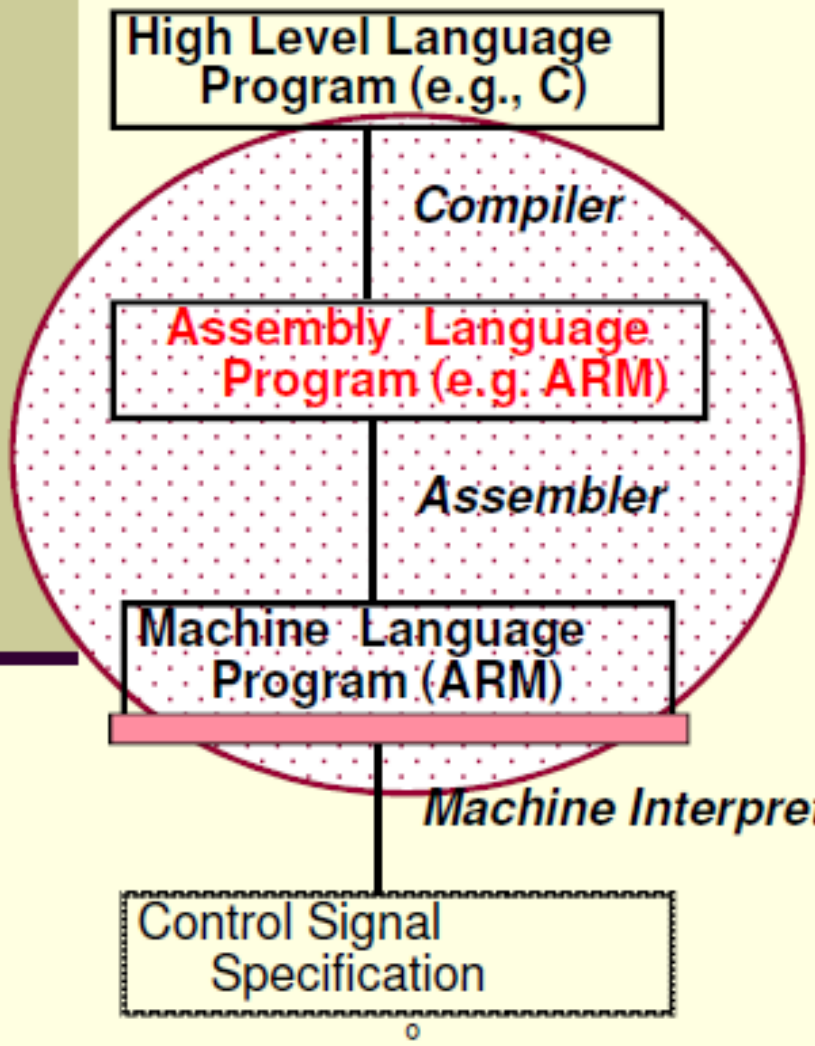
A 4th Year Project-2005

What is this course about?



- Coordination of many *levels of abstraction*

Programming Levels of Representation




```
temp = v[k];
v[k] = v[k+1];
v[k+1] = temp;
```

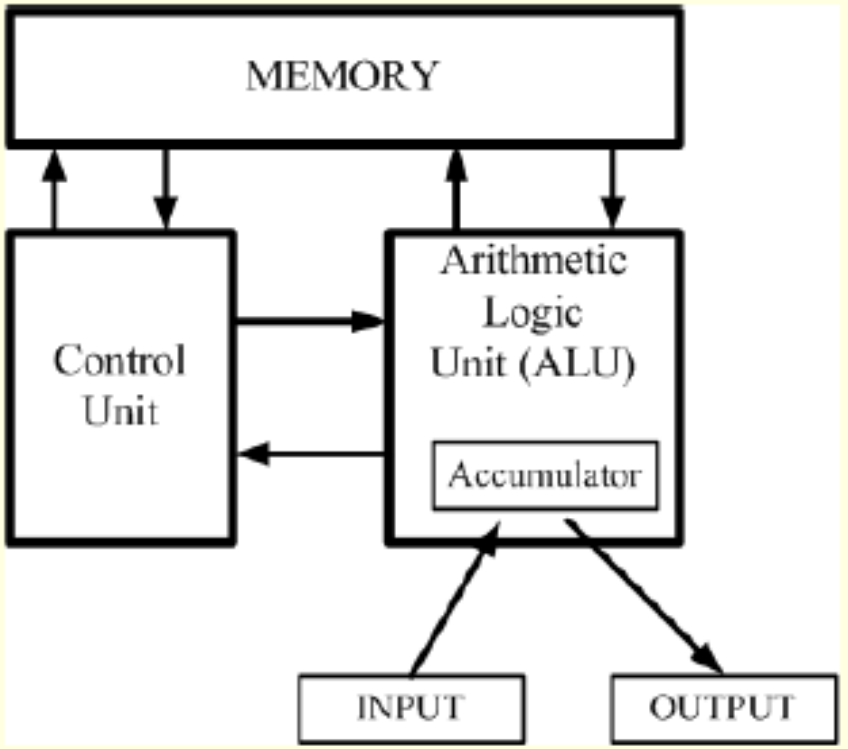
```
ldr  r0 , [r2, #0]
ldr  r1 , [r2, #4]
str  r1 , [r2, #0]
str  r0 , [r2, #4]
```

```
1110 0101 1001 0010 0000 0000 0000 0000
1110 0101 1001 0010 0000 0000 0000 0100
1110 0101 1000 0010 0001 0000 0000 0000
1110 0101 1000 0010 0001 0000 0000 0100
```

ALUOP[0:3] <= InstReg[9:11] & MASK

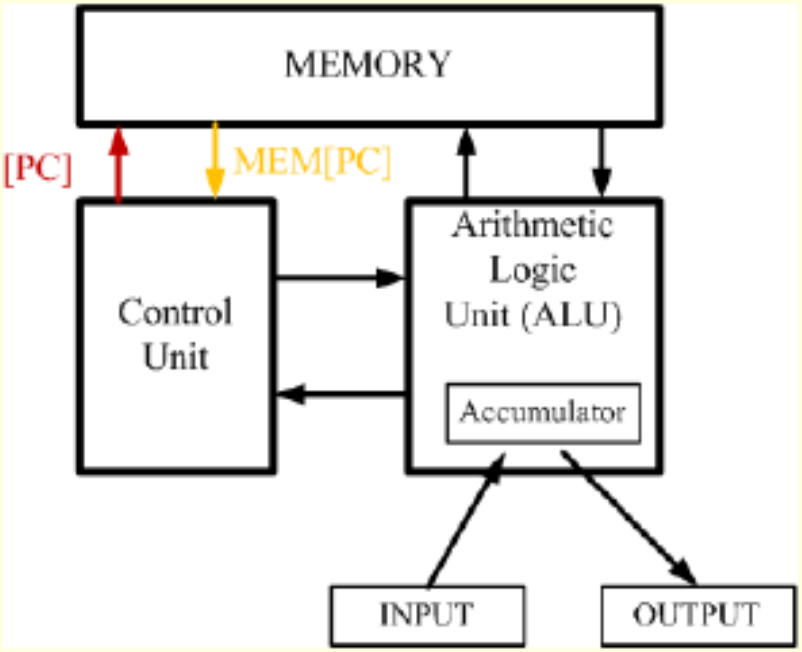
Modern computer

- The von Neumann architecture – 1940s and 50s
  - A stored-program computer that uses a central processing unit and a single separate storage structure that hold both instructions and data.



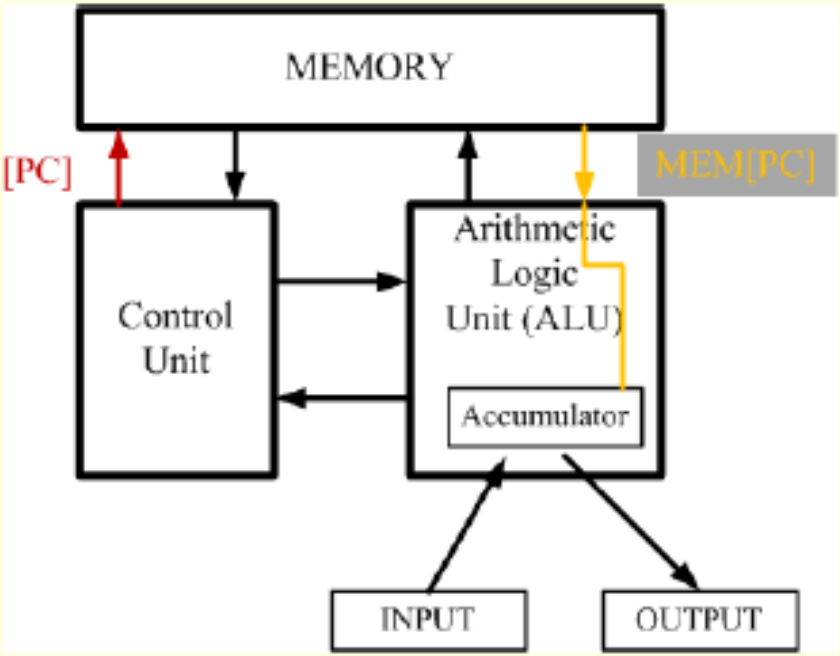
Basic operation of architecture

- Instructions are executed in sequence
- First step during execution
  - MEM(PC) ➔ IR
    - Send contents of PC (Program counter) to memory
    - Memory responds with the contents at that address placing it on the data bus.
  - Increment the PC (PC+1->PC)
  - The values on the data bus are loaded into the instruction register



Decode Instruction and execute

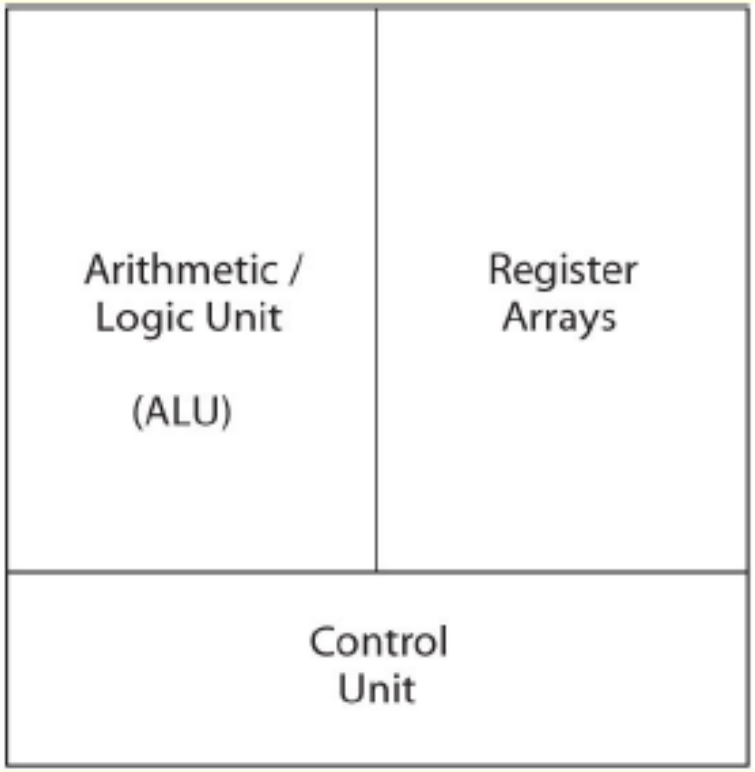
- Say the instruction was a load immediate
- This means that the next word in the instruction stream is the data that we want loaded into the accumulator
- Operation is now
  - MEM(PC)→ Accum
  - Also increment the PC



Microprocessor vs. Microcontroller

- Microprocessor – (*the physical processor chip*)
  - Composed of control unit, register, arithmetic and logic units
  - NO Memory, MaybeTimers, No direct external I/O ports
    - Does have pins for a data bus and an address bus
  - When implemented in a PC, add a keyboard for input, a monitor, a mouse, a printer, etc.
- Mircocontroller
  - Central core of microprocessor but limited capabilities in regards to registers, memory size, and speed.
  - On board memory
  - Several Timers
  - I/O configurable ports
  - In implementation, may or may not have a keyboard, rather a keypad/switches for input or other types of control, often does not have monitor

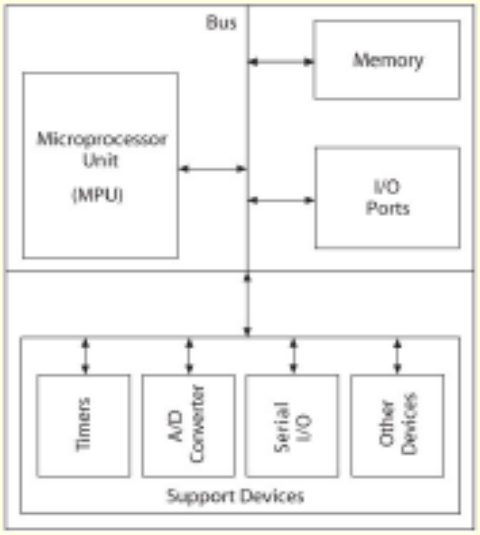
Microprocessor (MPU)



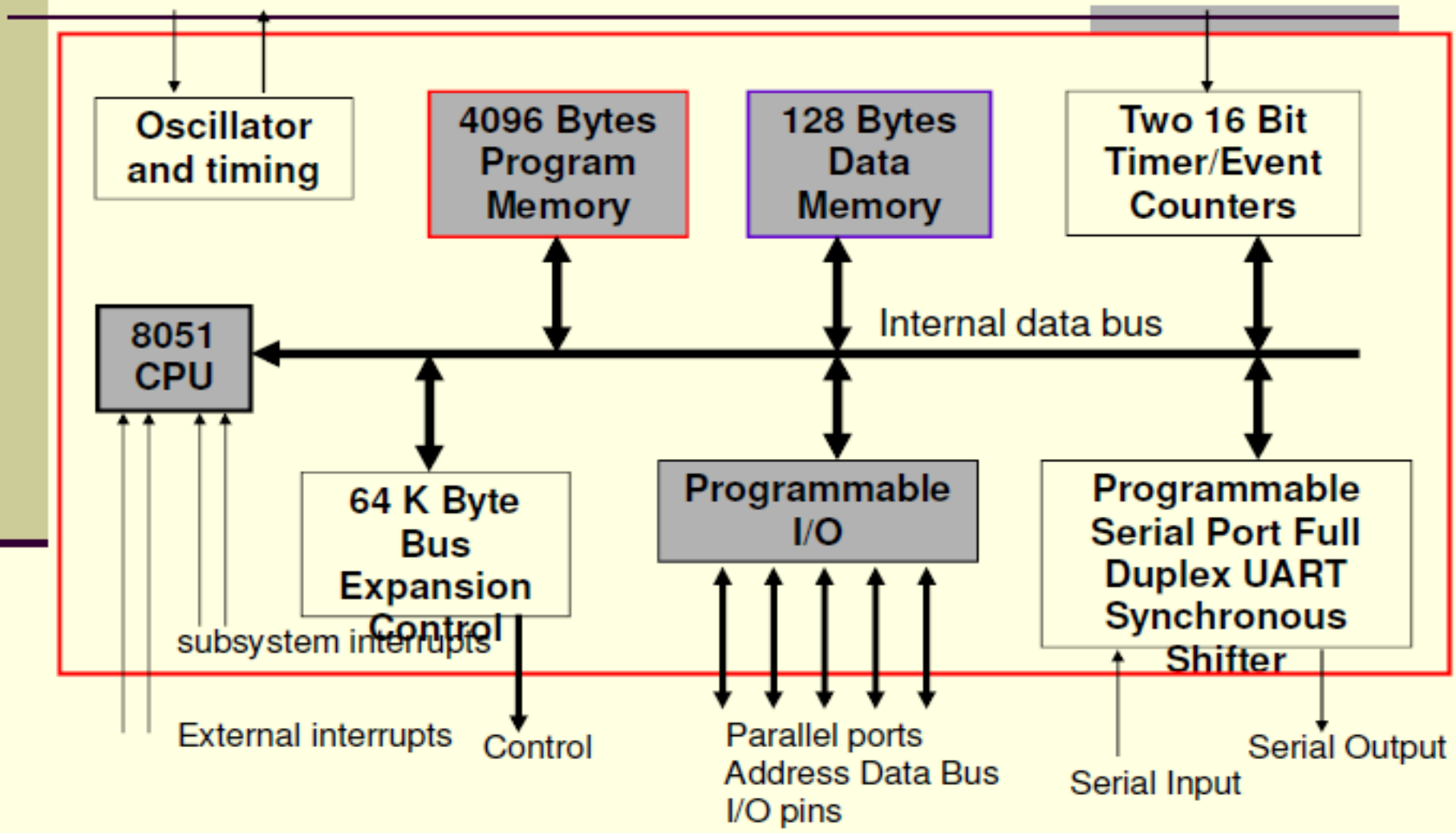
- MPU (CPU)
  - Read instructions
  - Process binary data

Microcontroller Unit (MCU)
Block Diagram

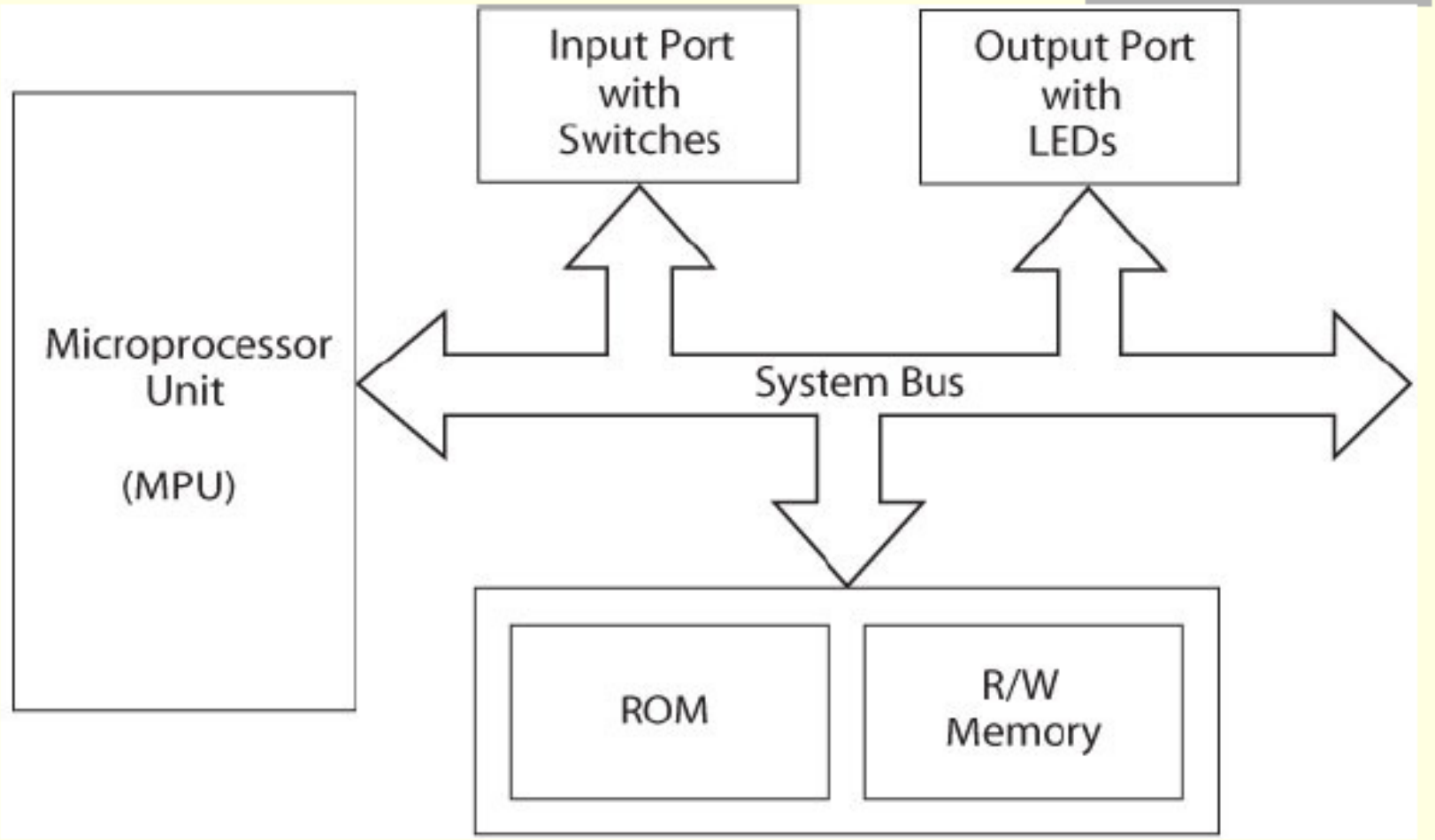
- An integrated electronic computing and logic device that includes three major components on a single chip
  - Microprocessor
  - Memory
  - I/O ports
- Includes support devices
  - Timers
  - A/D converter
  - Serial I/O
  - Parallel Slave Port
- All components connected by common communication lines called the system bus.



"Original" 8051 Microcontroller



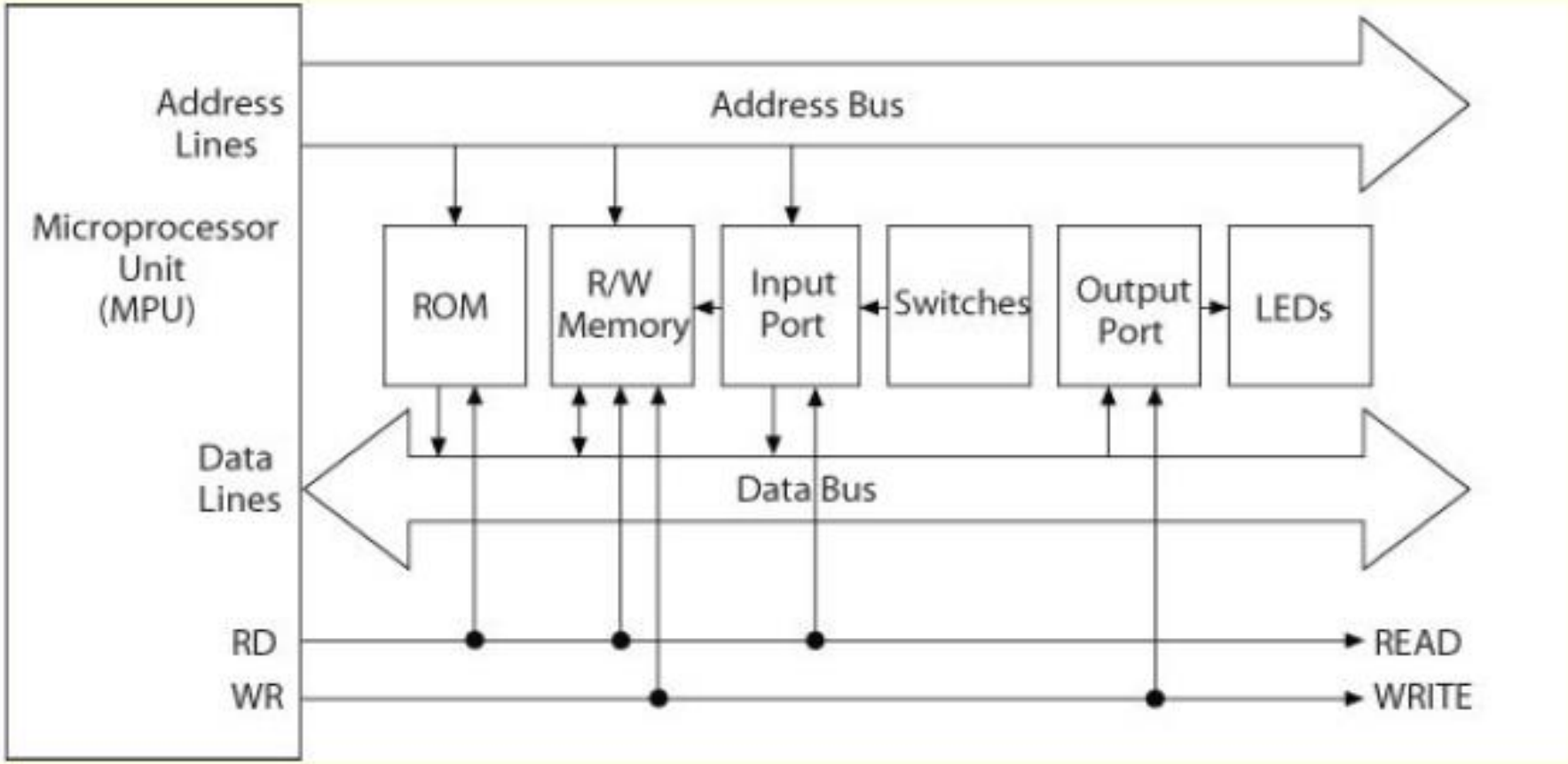
Microprocessor-Based Systems



Microprocessor Architecture

- The MPU communicates with Memory and I/O using the System Bus
  - Address bus
    - Unidirectional
    - Memory and I/O Addresses
  - Data bus
    - Bidirectional
    - Transfers Binary Data and Instructions
  - Control lines
    - Read and Write timing signals

Microprocessor-Based System



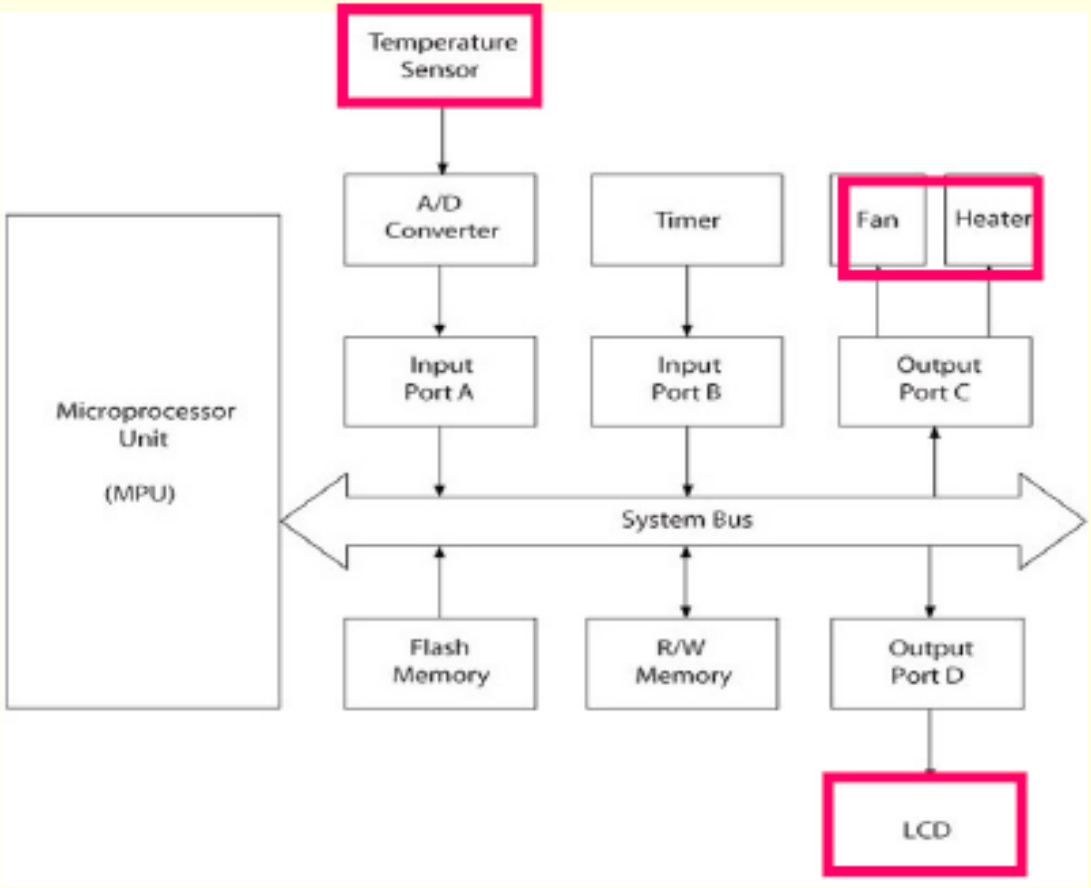
MCU-Based Systems

- Includes microprocessor, memory, I/O ports, and support devices (such as timers) on a single semiconductor chip
- Buses are generally not available to a system designer
- I/O ports are generally multiplexed and can be programmed to perform different functions

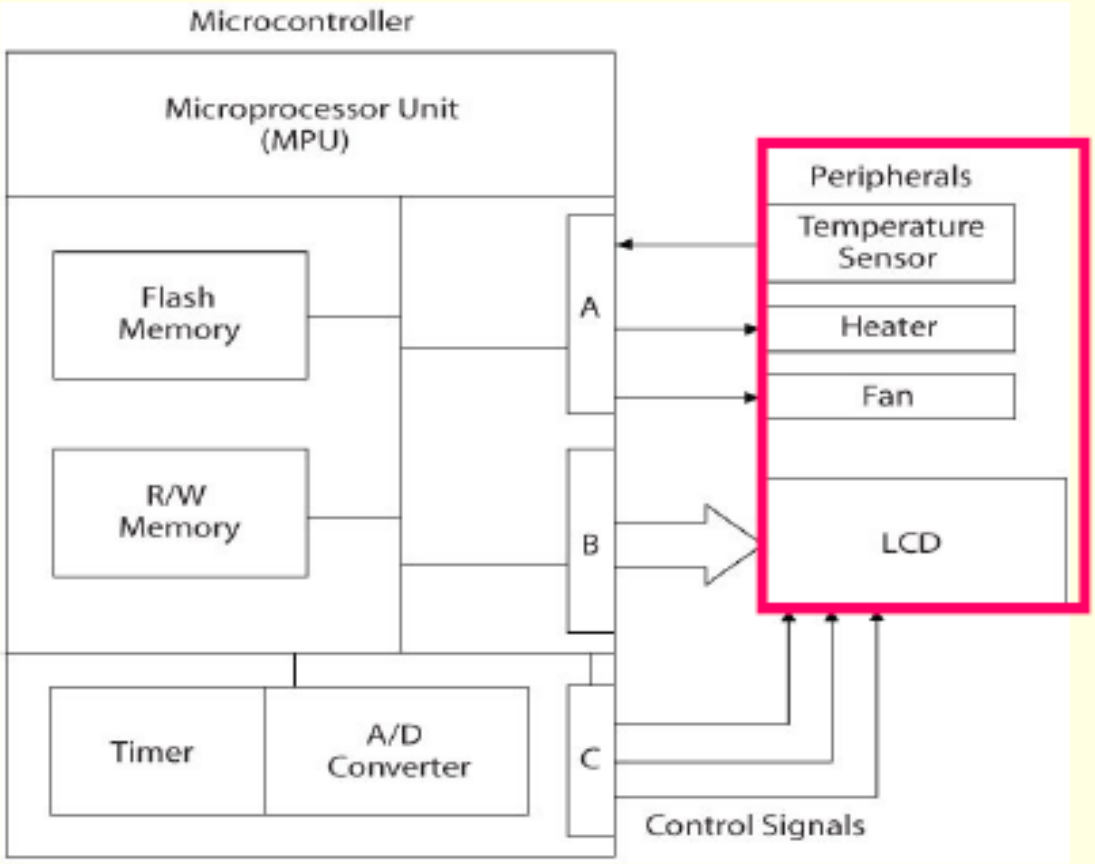
Design Examples …..

Microcontrollers vs. Microprocessors

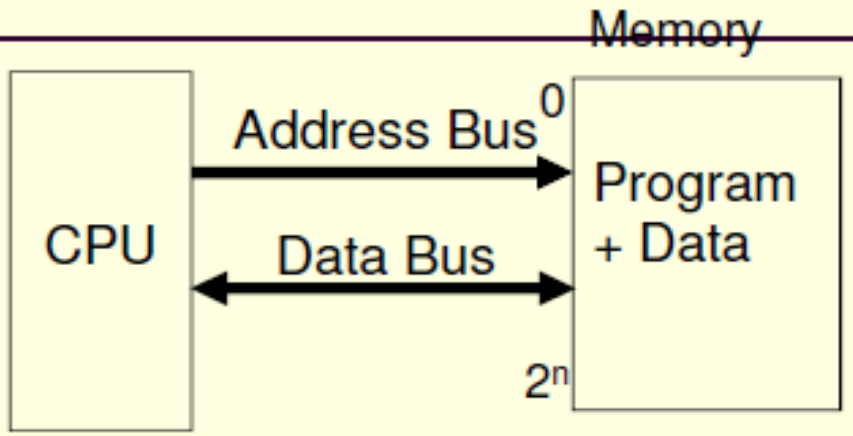
MPU-Based Time and Temperature System



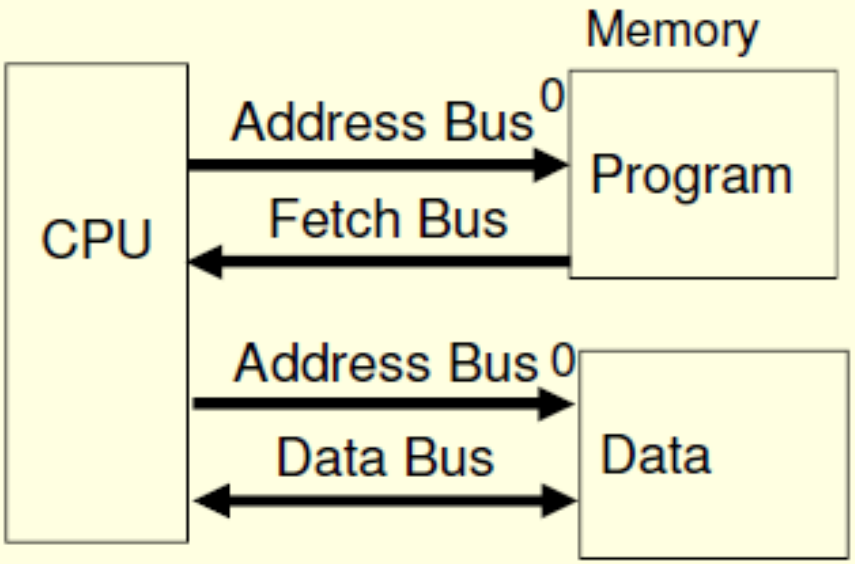
MCU-Based Time and Temperature System



Microcontroller Architectures



Von Neumann Architecture



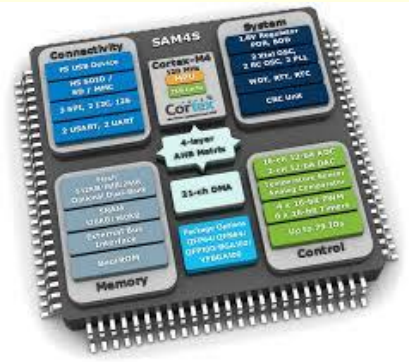
Harvard Architecture

CISC versus RISC

CISC	RISC
Emphasis on hardware	Emphasis on software
Includes multi-clock complex instructions	Single-clock, reduced instruction only
Memory-to-memory: "LOAD" and "STORE" incorporated in instructions	Register to register: "LOAD" and "STORE" are independent instructions
Small code sizes, high cycles per second	Low cycles per second, large code sizes
Transistors used for storing complex instructions	Spends more transistors on memory registers

Common Microcontrollers

- Atmel
- ARM
- Intel
  - 8-bit
    - 8XC42
    - MCS48
    - **MCS51** ←
    - 8xC251
  - 16-bit
    - MCS96
    - MXS296
- National Semiconductor
  - COP8
- Microchip
  - 12-bit instruction PIC
  - 14-bit instruction PIC
    - PIC16F84
  - 16-bit instruction PIC
- NEC
- Motorola
  - 8-bit
    - 68HC05
    - 68HC08
    - 68HC11
  - 16-bit
    - 68HC12
    - 68HC16
  - 32-bit
    - 683xx
- Texas Instruments
  - TMS370
  - MSP430
- Zilog
  - Z8
  - Z86E02



Microprocessor Vendors

- The top 5 Microprocessor vendors:

Leading MPU Suppliers ($M)

2013 Rank	Company	2012	2013	Percent Change	Marketshare	Main Product Lines
1	Intel	36,892	36,325	-2%	62.0%	x86 PC, tablet, and server MPUs
2	Qualcomm	5,322	6,884	29%	11.7%	ARM mobile app processors
3	Samsung (+Apple)	4,249	4,850	14%	8.3%	ARM mobile app processors
4	AMD	3,605	2,831	-21%	4.8%	x86 MPUs for PCs and servers
5	Freescale	1,070	1,247	17%	2.1%	ARM and embedded MPUs

Source: IC Insights

*Includes Apple's custom processors made by Samsung's foundry business

The top 5 MPU suppliers in 2013

Intel Processors

- 4004 was a 4-bit CPU in 1971
- 8080 and 8085
- 8086 and 8088 in 1978
- 80186 and 80286 (16 bit processors)
- 80386 and 80486 (32 bit processors)
- Pentium, Pentium Pro, Pentium II, Pentium III, Pentium Celeron (32 bit processors)
- Intel Core 2, Intel Dual Core, Core i3, Core i5, Core i7 (64 bit)

Digital System Design Applications

- Signal processing
- Control systems
- Communications
- Micro-computers
- Robotics
- Multimedia
- Internet , Distance learning

Solutions (Digital System Design)

- LSI chips
  - PCB, 74 series
- VLSI design (ASIC)
  - Standard cells
  - Gate arrays
  - FPGA
- Embedded micro controllers, Real-time Operating systems
- General purpose processors
- Special purpose processors
- System on a chip (SoC)

Microprocessor Based

- More reliable
- Less expensive
- Easier to debug
- Easier to maintain
- Easier to upgrade

- Disadvantage:
  - Speed
  - Less flexible in terms of signals
  - More power consumption

GOOD LUCK WITH THIS COURSE