EMBEDDED SYSTEM BASICS AND APPLICATION

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TOPICS TO BE DISCUSSED

- **System**
- **Embedded System**
- **Components**
- **Classifications**
- **Processors**
- **Other Hardware**
- **Software**
- **Applications**

INTRODUCTION

What is a system?

A system is a way of working, organizing or doing one or many tasks according to a fixed plan, program or set of rules.

A system is also an arrangement in which all its units assemble and work together according to the plan or program.

SYSTEM EXAMPLES

WATCH

It is a time display SYSTEM

Parts: Hardware, Needles, Battery, Dial, Chassis and Strap

Rules

1. All needles move clockwise only
2. A thin needle rotates every second
3. A long needle rotates every minute
4. A short needle rotates every hour
5. All needles return to the original position after 12 hours
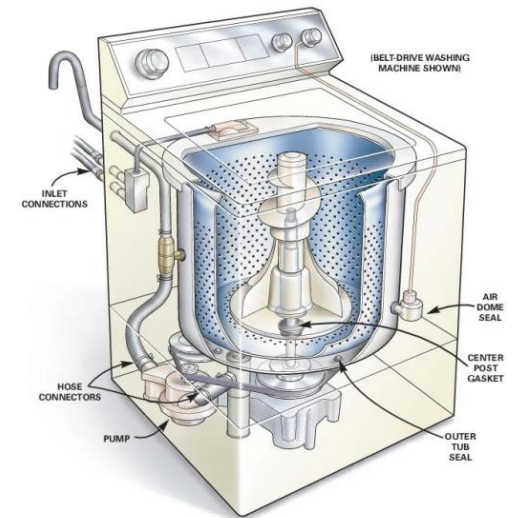
SYSTEM EXAMPLES

WASHING MACHINE

It is an automatic clothes washing SYSTEM

Parts: Status display panel, Switches & Dials, Motor, Power supply & control unit, Inner water level sensor and solenoid valve.

Rules
1. Wash by spinning
2. Rinse
3. Drying
4. Wash over by blinking
5. Each step display the process stage
6. In case interruption, execute only the remaining

EMBEDDED SYSTEM

Definition: An Embedded System is one that has computer hardware with software embedded in it as one of its important components.

Its software embeds in ROM (Read Only Memory). It does not need secondary memories as in a computer
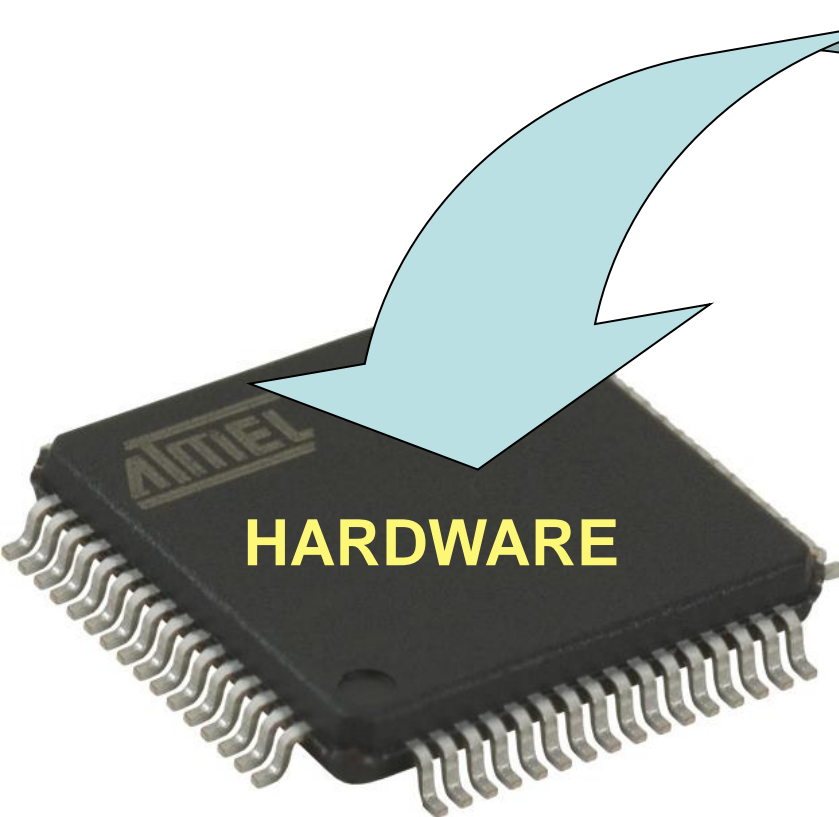
HARDWARE

SOFTWARE PROGRAM

```
#include <16f876a.h>
#use delay (clock=20000000)
#byte PORTB=6
main()
{
set_tris_b(0);
portb=255;      //decimal
delay_ms(1000);
portb=0x55;      //hexadecimal
delay_ms(1000);
portb=0b10101010;  //binary
delay_ms(500);
}
```

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COMPUTER HARDWARE

A Microprocessor

A Large Memory
(Primary and Secondary)
(RAM, ROM and caches)

Input Units
(Keyboard, Mouse, Scanner, etc.)

Output Units
(Monitor, printer, etc.)

Networking Units
(Ethernet Card, Drivers, etc.)

I/O Units
(Modem, Fax cum Modem, etc.)

COMPONENTS OF EMBEDDED SYSTEM

- ## It has Hardware
  Processor, Timers, Interrupt controller, I/O Devices, Memories, Ports, etc.

- ## It has main Application Software
  Which may perform concurrently the series of tasks or multiple tasks.

- ## It has Real Time Operating System (RTOS)
  RTOS defines the way the system work. Which supervise the application software. It sets the rules during the execution of the application program. A small scale embedded system may not need an RTOS.

EMBEDDED SYSTEM HARDWARE
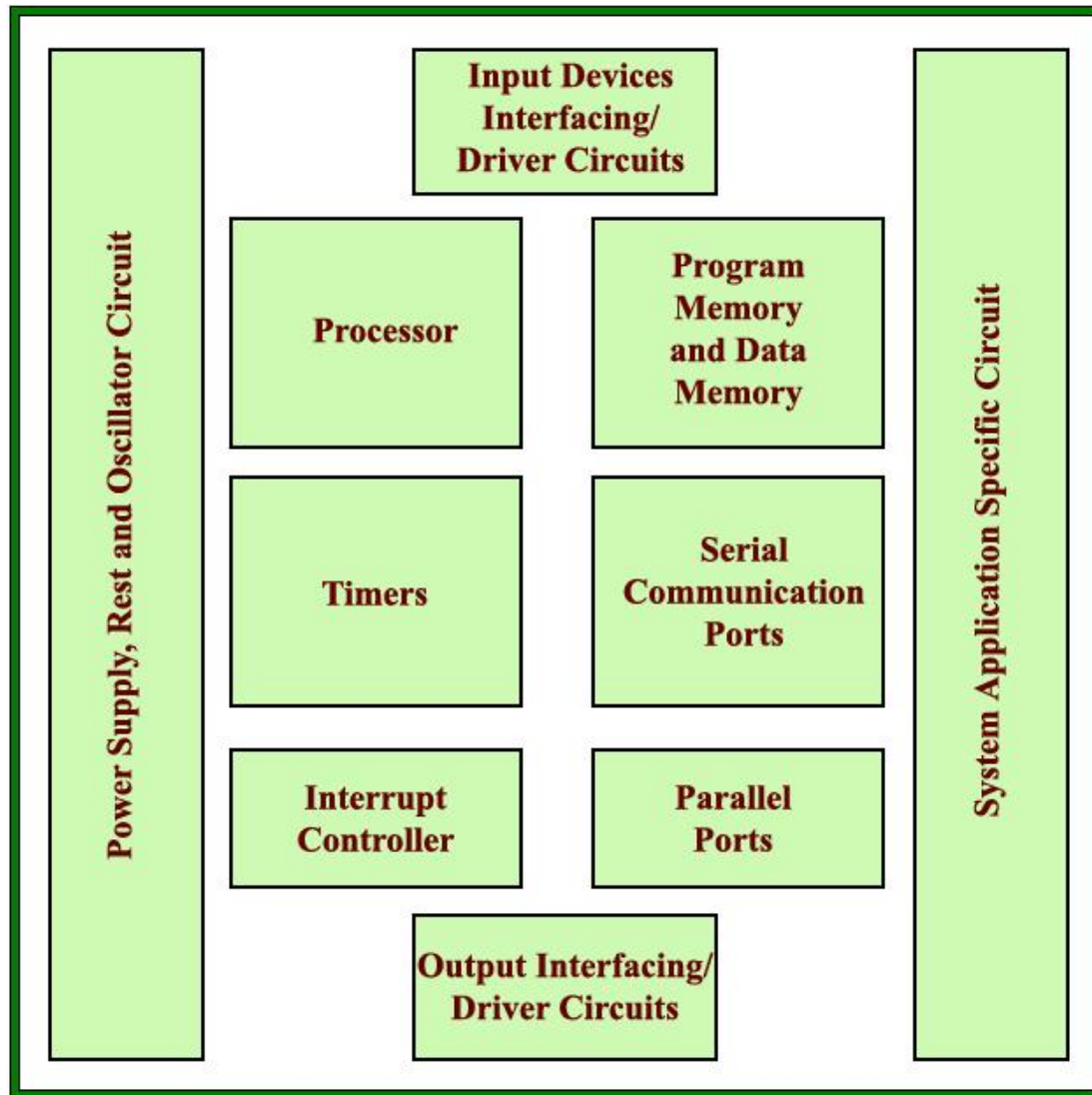
EMBEDDED SYSTEM CONSTRAINTS

An embedded system is software designed to keep in view three constraints:

- **Available system memory**

- **Available processor speed**

- **The need to limit the power dissipation**

When running the system continuously in cycles of wait for events, run, stop and wakeup.

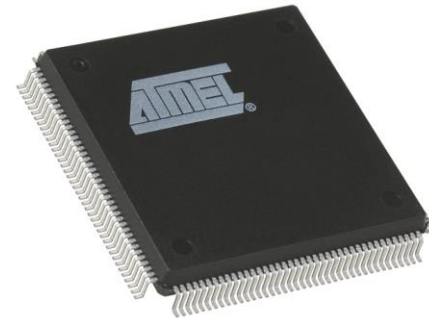# What makes embedded systems different?

- Real-time operation
- size
- cost
- time
- reliability
- safety
- energy
- security

CLASSIFICATIONS OF EMBEDDED SYSTEM

1. **Small Scale Embedded System**

2. **Medium Scale Embedded System**

3. **Sophisticated Embedded System**

SMALL SCALE EMBEDDED SYSTEM

- **Single 8 bit or 16bit Microcontroller.**

- **Little hardware and software complexity.**

- **They May even be battery operated.**

- **Usually "C" is used for developing these system.**

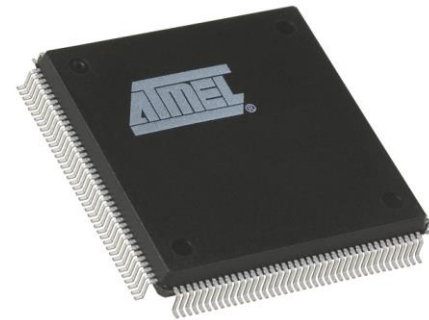- **The need to limit power dissipation when system is running continuously.**

Programming tools:
          Editor, Assembler and Cross Assembler

MEDIUM SCALE EMBEDDED SYSTEM

- **Single or few 16 or 32 bit microcontrollers or Digital Signal Processors (DSP) or Reduced Instructions Set Computers (RISC).**

- **Both hardware and software complexity.**

Programming tools:

RTOS, Source code Engineering Tool, Simulator, Debugger and Integrated Development Environment (IDE).

SOPHISTICATED EMBEDDED SYSTEM

- **Enormous hardware and software complexity**

- **Which may need scalable processor or configurable processor and programming logic arrays.**

- **Constrained by the processing speed available in their hardware units.**

Programming Tools:

       For these systems may not be readily available at a reasonable cost or may not be available at all. A compiler or retargetable compiler might have to br developed for this.

PROCESSOR

- **A Processor is the heart of the Embedded System.**

- **For an embedded system designer knowledge of microprocessor and microcontroller is a must.**

Two Essential Units: **Operations**

Control Unit (CU),   **Fetch**

Execution Unit (EU)   **Execute**
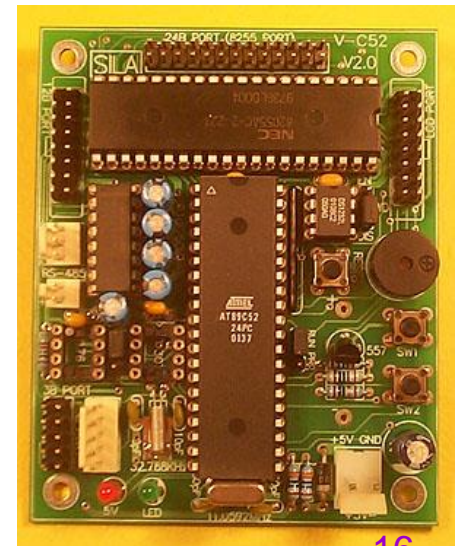
VARIOUS PROCESSOR

1. General Purpose processor (GPP)

Microprocessor

Microcontroller

Embedded Processor

Digital signal Processor

2. Application Specific System Processor (ASSP)

3. Multi Processor System using GPPs

MICROPROCESSOR

- **A microprocessor is a single chip semi conductor device also which is a computer on chip, but not a complete computer.**

- **Its CPU contains an ALU, a program counter, a stack pointer, some working register, a clock timing circuit and interrupt circuit on a single chip.**

- **To make complete micro computer, one must add memory usually ROM and RAM, memory decoder, an oscillator and a number of serial and parallel ports.**

HISTORY OF MICROPROCESSOR

1st Generation (4 bit processors)
4004 and 4040 4 bit   in early 1970 by Intel (Integrated Electronics)

2nd Generation (8 bit processors)
8008 and 8080 8 bit in 1974 Intel with +5 V Input supply 8080 → 8085 8 bit

3rd Generation (16 bit processors)
8086 16 bit. Same as 8086, the 8088 introduced 8088 has only 8 bit data bus (This made it easier to interface to the common 8 bit peripheral devices available at the time)

Followed by:
The 80186 & 80286 (16 bit processor), the 80386 & 80486 (a 32 bit processor), leading to the Pentium range of microprocessors (64 bit processors) available today. The 80x86 and Pentium processors have all been designed for use in personal computer type applications and have large memory maps.

VARIOUS MICROPROCESSORS

Intel

    4004, 4040
    8080, 8085
    8086, 8088,
    80186, 80188
    80286, 80386
    x86-64

Motorola

    6800
    6809
    68000
    G3, G4, G5

Zilog

    Z80, Z180, eZ80
    Z8, eZ8

and others

MICROCONTROLLER

- A **microcontroller** is a functional computer system-on-a-chip. It contains a processor, memory, and programmable input/output peripherals.

- Microcontrollers include an integrated CPU, memory (a small amount of RAM, program memory, or both) and peripherals capable of input and output.

VARIOUS MICROCONTROLLERS

INTEL
  8031,8032,8051,8052,8751,8752
PIC
   8-bit PIC16, PIC18,
   16-bit DSPIC33 / PIC24,
   PIC16C7x
Motorola
  MC68HC11

MICROPROCESSOR Vs MICROCONTROLLER

MICROPROCESSOR	MICROCONTROLLER
The functional blocks are ALU, registers, timing & control units	It includes functional blocks of microprocessors & in addition has timer, parallel i/o, RAM, EPROM, ADC & DAC
Bit handling instruction is less, One or two type only	Many type of bit handling instruction
Rapid movements of code and data between external memory & MP	Rapid movements of code and data within MC
It is used for designing general purpose digital computers system	They are used for designing application specific dedicated systems

EMBEDDED PROCESSOR

- **Special microprocessors & microcontrollers often called, Embedded processors.**

- **An embedded processor is used when fast processing fast context-switching & atomic ALU operations are needed.**

Examples : ARM 7, INTEL i960, AMD 29050.

DIGITAL SIGNAL PROCESSOR

- DSP as a GPP is a single chip VLSI unit.

- It includes the computational capabilities of microprocessor and multiply & accumulate units (MAC).

- DSP has large number of applications such as image processing, audio, video & telecommunication processing systems.

- It is used when signal processing functions are to be processed fast.

Examples : TMS320Cxx, SHARC, Motorola 5600xx

APPLICATION SPECIFIC SYSTEM PROCESSOR (ASSP)

- **ASSP is dedicated to specific tasks and provides a faster solution.**

- **An ASSP is used as an additional processing unit for running the application in place of using embedded software.**

Examples : IIM7100, W3100A

MULTI PROCESSOR SYSTEM USING GPPs

- **Multiple processors are used when a single processor does not meet the needs of different task.**

- **The operations of all the processors are synchronized to obtain an optimum performance.**

Moore's Law

- **Moore's law describes a long-term trend in the history of computing hardware.**

- **Since the invention of the integrated circuit in 1958, the number of transistors that can be placed inexpensively on an integrated circuit has increased exponentially, doubling approximately every two years.**

- **The trend was first observed by Intel co-founder Gordon E. Moore in 1965.**

- **Almost every measure of the capabilities of digital electronic devices is linked to Moore's law: processing speed, memory capacity, etc.**

Moore's law
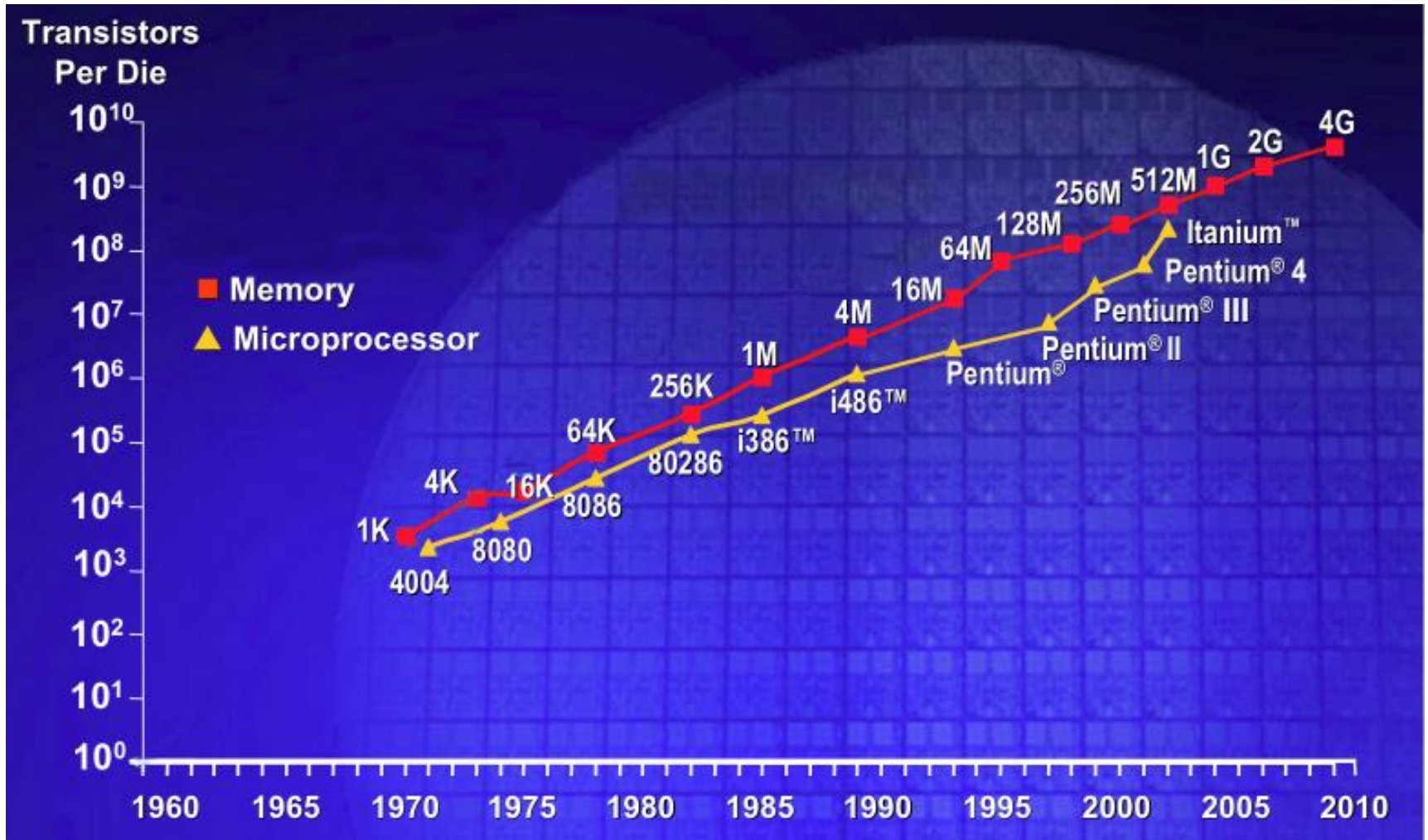
OTHER HARDWARE

- **Power Source**

- **Clock Oscillator**

- **Real Time Clock (RTC)**

- **Reset Circuit, Power-up Reset and watchdog timer Reset**

- **Memory**

- **I/O Ports, I/O Buses**

- **Interrupt Handler**

- **DAC and ADC**

- **LCD and LED Display**

- **Keypad/Keyboard**

SOFTWARE

SOFTWARE

C
C++
Dot Net

SIMULATOR

Masm

COMPILER

RIDE
KEIL

APPLICATIONS

- **Household appliances:**
  - **Microwave ovens, Television, DVD Players & Recorders**
- **Audio players**

- **Integrated systems in aircrafts and missiles**

- **Cellular telephones**

- **Electric and Electronic Motor controllers**

- **Engine controllers in automobiles**

- **Calculators**

- **Medical equipments**

- **Videogames**

- **Digital musical instruments, etc.**

TELEVISION

REMOT CONTROL

REFRIGERATORS

ELEVATORS

VIDEO GAMES

SET-TOP BOX

PLANES

CARS

Learn by Doing

Excel Thru Experimentation

Lead by Example

Acquire skills and get employed

Update skills and stay employed

THANK YOU