# CENG 336

# INT. TO EMBEDDED SYSTEMS DEVELOPMENT

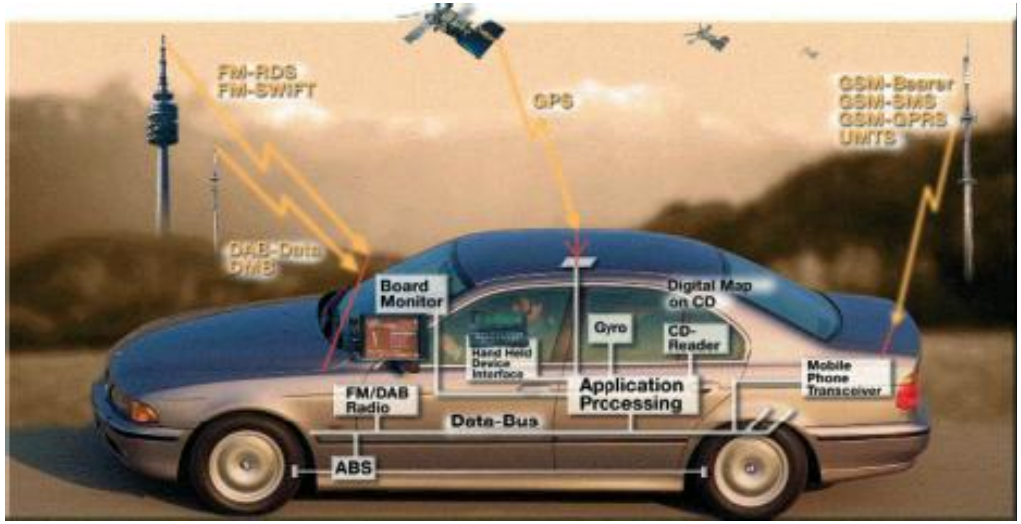
## Spring 2006

## Recitation 01

# OUTLINE

- Introduction to Embedded Systems and PIC
- Introduction to Hardware and Software Tools
- Information about HWs and Term Project

# “The World Runs on Embedded Software”




# Some Statistics

Over 8 billion embedded microprocessors are produced each year (May 2006). The number is expected to increase dramatically in the next decade

This is more than %90 of world processor market.

# Microcontroller vs Microprocessor

Microcontroller:

- Very little external support hardware.
- Most RAM, ROM and peripherals on chip.
- “Computer on a chip”, or “System on chip” (SOC)

Microprocessor:

- Requires ‘external’ support hardware
- E.g., External RAM, ROM, Peripherals.

# There are lots of microcontroller manufacturers











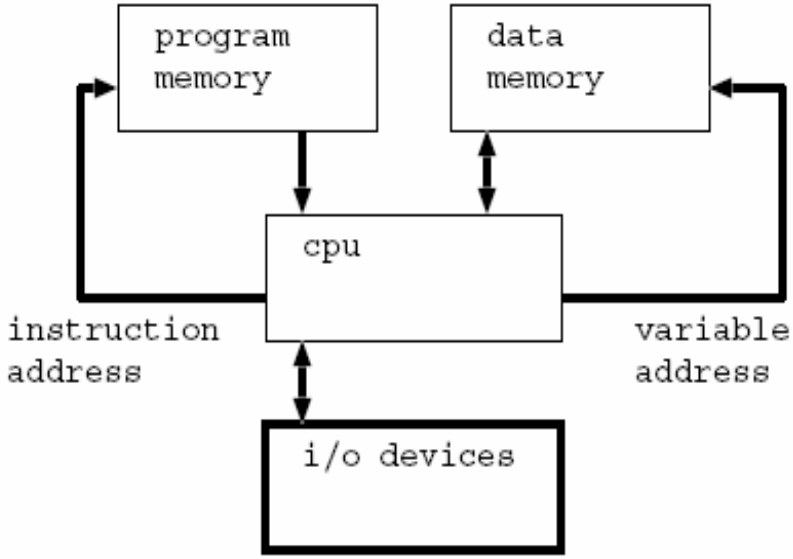

We will use


PIC (Peripheral Interface Controller)

# PIC Architecture

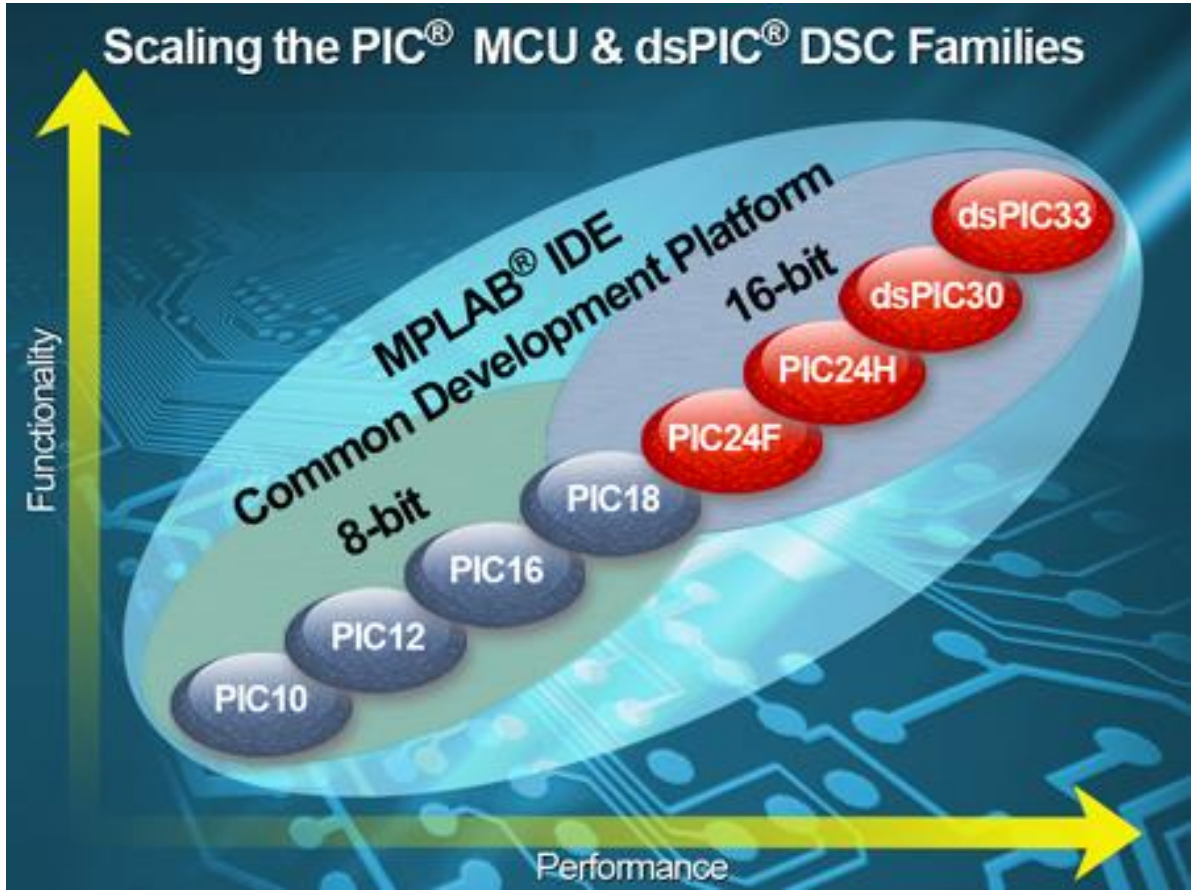
PICs use the Harvard Architecture

- Used mostly in RISC (Reduced Instruction Set Computer) CPUs
- Separate program bus and data bus: can be different widths!
- For example, PICs use:
  - Data memory (RAM): a small number of 8bit or 16bit registers
  - Program memory (ROM): 12bit, 14bit, 16bit or 24bit wide (in EPROM, FLASH, or ROM)

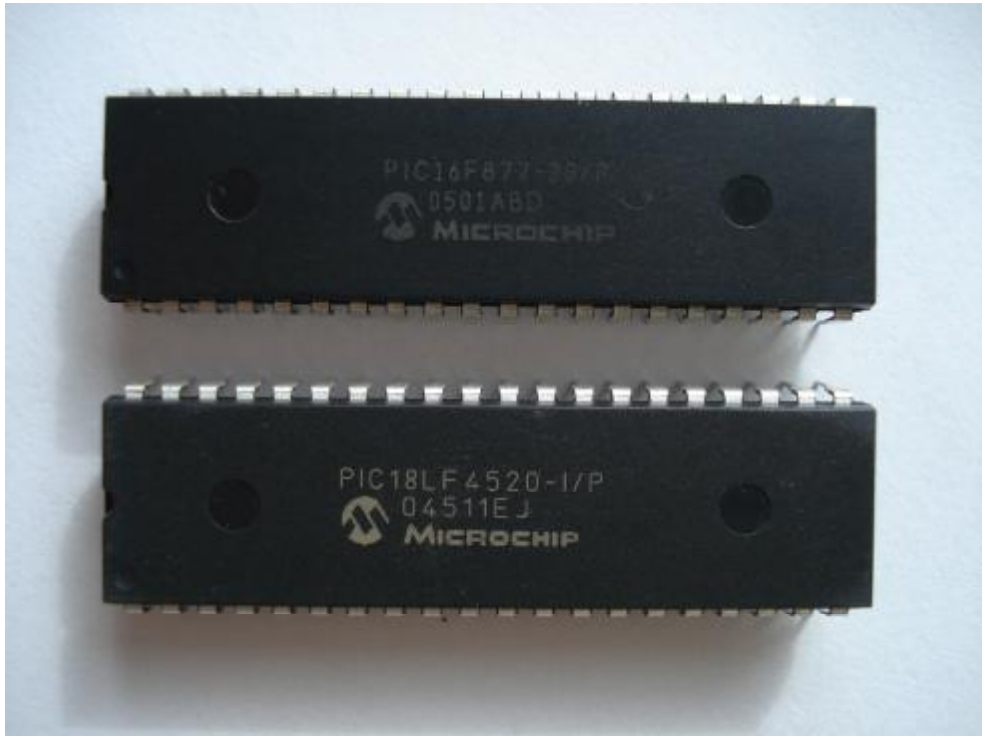



Harvard Machine

# The PIC Microcontrollers (MCU) & dsPIC Digital Signal Controllers (DSC) Families



# We will use
# PIC16F877 and PIC18F4520



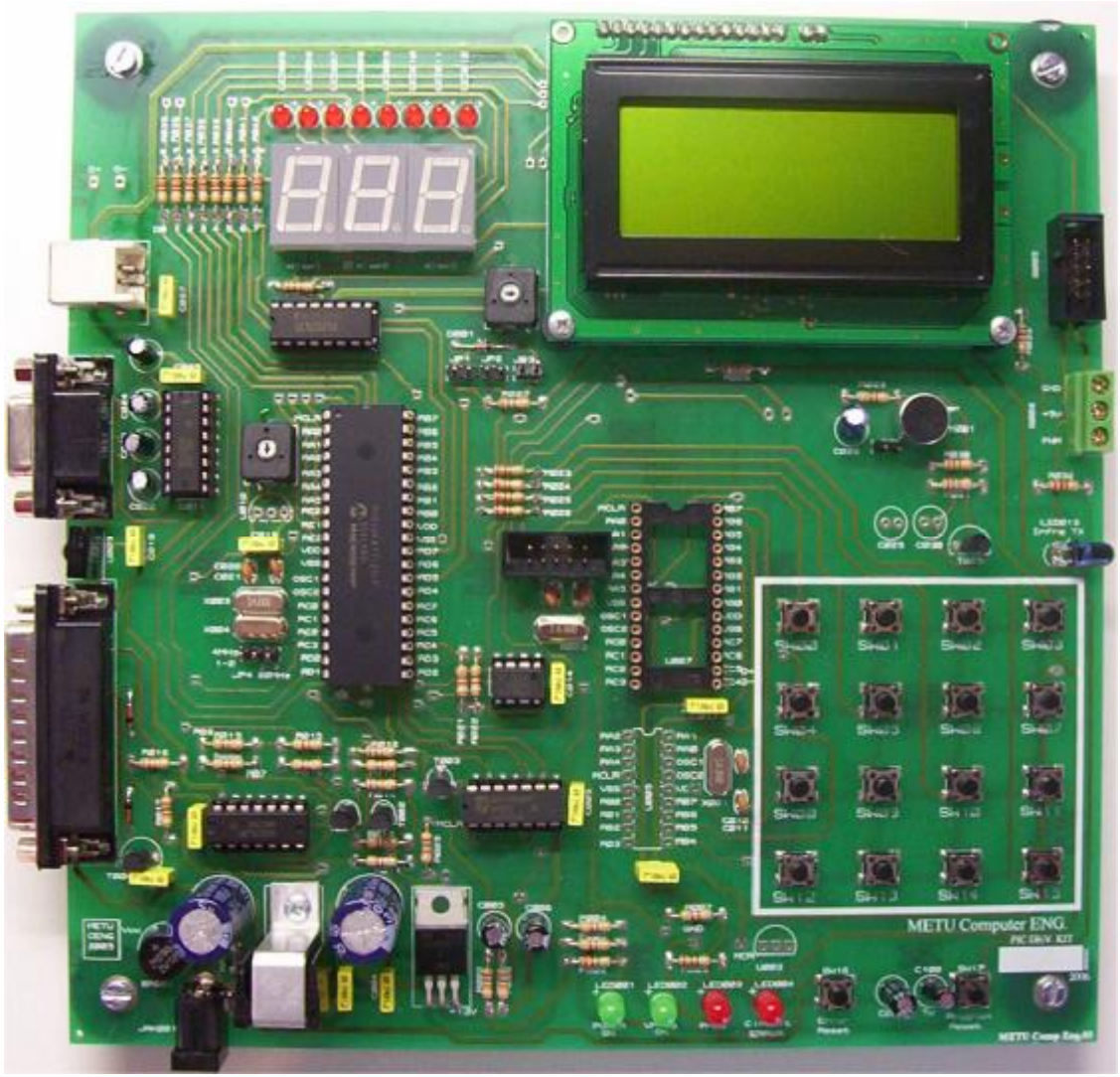
# PIC16F877

- 14bit core - 35 instructions
- 200ns instruction time (Tclk = 20MHz)
- 8,092 14bit FLASH *program* memory
- 368 8bit *data* memory or registers (“File registers”)
- 256 8bit EEPROM (nonvolatile) data registers
- 8 level hardware stack
- Interrupt capability (up to 14 sources)
- 33 pin I/O (for 40 pin package)
- 3 Timer/Counter modules
  - Timer0: 8-bit
  - Timer1: 16-bit
  - Timer2: 8-bit

# PIC16F877

- Two Capture, Compare, PWM modules
  - Capture: 16-bit
  - Compare: 16-bit
  - PWM: max. resolution is 10-bit
- 10-bit 8 channel Analog-to-Digital Converter
- Synchronous Serial Port (SSP) with SPI and I2C
- Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9-bit address detection
- Parallel Slave Port (PSP) 8-bit

# Hardware Tool: PIC DEMO BOARD




Features:

- 18, 28 and 40-pin MCU support
- Parallel port programmer
- RS232 Serial interface
- USB interface with 28-pin MCU
- 4x4 Keypad
- 7-Segment displays
- Led display
- 16x4 LCD
- Infrared transmitter/receiver
- I2C Serial EEPROM
- Speaker
- Potentiometer for ADC

# Software Tools

For PIC16F877:

- MPLAB IDE with PIC Assembler
- SDCC - Small Device C Compiler open source development tool (from command line)

For PIC18F4520:

- We will use FreeRTOS open source development tool.
  - MPLAB IDE with MPLAB C18 Compiler (Student edition)

WinPic800

- To program the PIC on the development board

# Resources

- Datasheet (s) **ß MOST IMPORTANT!!!**
- Reference Book: Design with PIC Microcontrollers, John B. Peatman, Prentice Hall,1998.
- Alper & Fatih
- Internet
  - Course's web site

    http://www.ceng.metu.edu.tr/courses/ceng336/
  - Vendor's web site
    - www.microchip.com, http://forum.microchip.com
- Your friends (not recommended **J**)

# HWs and Term Project

- 4 HWs (PIC16F877) + 1 Term Project (PIC18F4520)
- 1st HW → Coding in PIC assembler language
  - Individual
  - No demonstration
- 2nd, 3rd and 4th → Implementation on PIC Demo Board
  - Group work (3 Students) but **individual grading**.
  - You will make **demonstration**.
  - 2nd HW in PIC assembler language
  - 3rd and 4th is SDCC (Small Device C Compiler)
- 1 Term Project
  - FreeRTOS to be used

# HWs and Term Project

- Grading

| | HW1 | HW2 | HW3 | HW4 | Term Project | Total |
|---|---|---|---|---|---|---|
| % | 4 | 6 | 7 | 8 | 15 | 40 |

- Cheating Policy

  Any student involved in cheating will be remained pointless from all HWs and Term Project.