What is an Embedded System?

• Loose Definition:
  ▫ A system which is part of a larger system

• What does that actually mean
  ▫ Hardware/Software co-design
    • Usually with specific purpose
    • Usually special set of constraints (size/power/time)

• Can be based on microcontroller, DSP, ASICs, even standard Microprocessor(MPU)
Examples

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Market Share

- Embedded industry represents about $17 billion in revenue per year
  - Compare to $19 B for cellphone processors
  - Compare to ~$25 B for non-mobile, non-embedded MPUs

- Embedded Systems outnumber other MPUs by over 100:1

Data pulled from icinsights.com
Microprocessor Based Embedded Systems

- Microprocessor
- Bus Logic (Address, Data, Control)
  - Minimal embedded System
  - Clock/Time
  - Watchdog Timer
  - Digital I/O
  - Program ROM
  - Data RAM

- I/O Interfaces
- Communications
- DAC
- ADC
- Other Peripherals

Embedded into microcontrollers
Why Microcontrollers?

- Peripheral loaded
  - ADC, DAC, GPIOs, Serial Interfaces
- Cheap
  - ~$1 for 8-bit processor
- Low Power
  - ~300µA operation (1 AA battery for 275 days)
  - <1µA sleep (1 AA battery for 225 years)
- Programmable
  - Assembly or C
Our Microcontroller

- **AVR Butterfly**
  - ATMEGA 169PV chip
  - Built-in peripherals
    - 120 segment LCD Screen
    - Joystick
    - Piezo element – sounds

- **Programmer**
  - AVR Dragon

- These boards will be used for projects and discussions