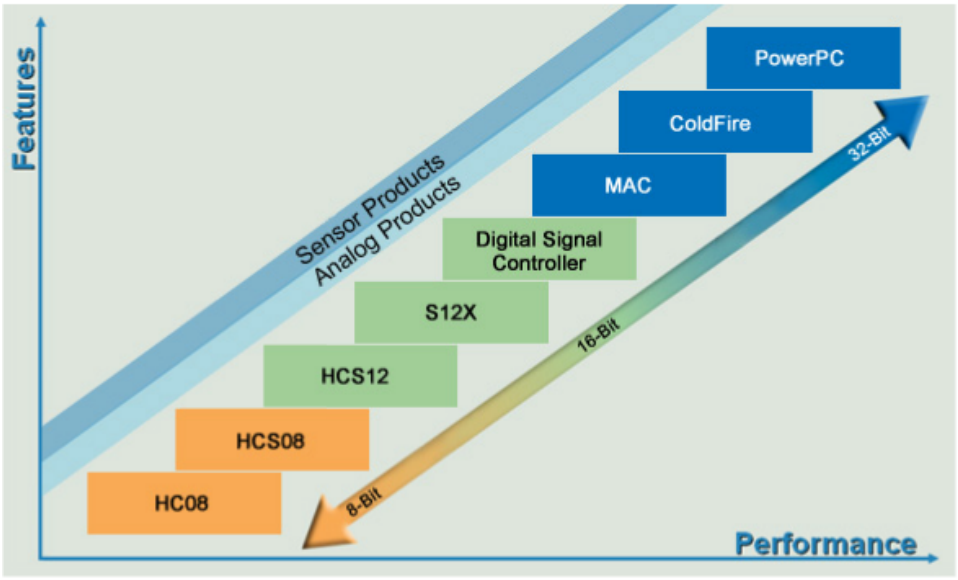
Microcontroller Architectures
Things to Consider

- Performance vs. Cost
  - Speed (instructions/second)
  - Precision (8, 16, 32 or 64 bits, fixed or floating point)
  - Princeton or Harvard Architecture
  - RISC or CISC?
    - RISC: Reduced Instruction Set Computer
      - Very few instructions (8-bit PIC uses 33 instructions)
      - Each instruction takes one cycle to execute
      - Each instruction takes one word of memory
      - Reduces hardware size, increases software size
      - Easier to implement pipelines, etc.
    - CISC: Complex Instruction Set Computer
      - Larger number of more specialized instructions
      - Increases hardware size, reduces software size
- Voltage
- Peripherals
  - A/D converter (number of bits)
  - COM ports (how many, what type – SCI, SPI I^2C)
  - USB
  - Ethernet
  - Timers
  - Specialized items
    - PWM
    - Media control (Compact Flash, Secure Digital cards)
    - Many others
- Memory
  - Address bus size
  - RAM
  - EEPROM
  - Flash EEPROM
- Special Requirements
  - Low power for battery applications
  - Radiation hardened for space applications
  - Temperature range

- Development Tools
  - Software Tools
    - Assembler
    - C Compiler
    - IDE
  - Hardware tools
    - Evaluation boards
    - In Circuit Emulators
    - Background Debug Mode
- Familiarity
  - Different lines from same manufacturer often have similar programming models and instruction forms
  - For example, consider writing the byte $AA to address held in the X register:
    - `Motorola:  movb  #$AA, 0,X`
    - `Intel:     mov   [ECX] 0AAH`
  - Consider the way the 16-bit $1234 number is stored in memory location $2000
    1. `Motorola:  $12 is stored in address $2000,`
       `$34 is stored in address $2001`
    2. `Intel:     $34 is stored in address $2000,`
       `$12 is stored in address $2001`

Freescale (Motorola) Microcontrollers



- HC08 (8 bit)
  - $1.00 each
  - 8 pins to 80 pins
  - 128 bytes to 2 KB RAM
  - 1.5 KB to 7680 KB Flash EEPROM
  - 2 MHz to 8 MHz clock
  - Lots of different peripherals
- HCS08 (8 bit)
  - $2.00 each (and higher)
  - 8 pins to 64 pins
  - 512 bytes to 4 KB RAM
  - 4 KB to 60 KB Flash EEPROM
  - 8 MHz or 20 MHz clock
  - Lots of different peripherals
- HCS12 (16 bit)
  - $10.00 each (and higher)
  - 48 pins to 112 pins
  - 2 KB to 12 KB RAM
  - 1 KB to 4 KB EEPROM
  - 32 KB to 512 KB Flash EEPROM

  - 25 MHz to 50 MHz clock
  - Lots of different peripherals
- S12X (16 bit)
  - $20.00 each (and higher)
  - 48 pins to 112 pins
  - 4 KB to 12 KB RAM
  - 1 KB to 4 KB EEPROM
  - 32 KB to 512 KB Flash EEPROM
  - 25 MHz clock
  - Lots of different peripherals
- 56800 DSP (32 bit)
  - $7.00 each (and higher)
  - 48 pins to 112 pins
  - 4 KB to 32 KB RAM
  - 16 KB to 512 KB Flash EEPROM
  - 32 MHz to 120 MHz clock
  - Specialized for such things as audio processing
- MAC (32 bit)
  - $20.00 each (and higher)
  - 32-bit upgrade of 9S12 line for automotive applications
  - 112 pins to 208 pins
  - 16 KB to 48 KB RAM
  - 384 KB to 1024 KB Flash EEPROM
  - 40 MHz to 50 MHz clock
  - Specialized for such things as audio processing
- ColdFire (32 bit)
  - $40.00 each (and higher)
  - 144 pins to 256 pins
  - 16 MHz to 266 MHz clock
- Power PC (32 bit)
  - $40.00 each (and higher)
  - 272 pins to 388 pins
  - 26 KB to 32 KB RAM
  - 448 KB to 1024 KB Flash EEPROM
  - 40 MHz to 66 MHz clock

Other Manufacturers

- Low end (8 bit)
  - PIC from Microchip
    - Very inexpensive ($0.50)
    - Low pin count (6 to 100)
    - Often small memory (16 bytes RAM, 128 bytes ROM)
    - RISC
  - 8051 (Originally Intel, now National, TI)
  - Z8 (Zilog – similar to 8051)
- Mid-Range (16 bits)
  - Z80 and Z180 from Rabbit
- High End (32 bit)
  - ARM - licensed to Intel, TI, many others
  - MIPS - licensed to Hitachi
- Soft Core
  - Altera NIOS
    - Can customize to meet needs
    - Speed vs. size (number of logic gates)
    - 16-bit or 32-bit
    - Fixed point or floating point
    - Memory management or no memory management
    - Can build specialized instructions to increase performance
  - Xilinx ARM (soft core or hard core)