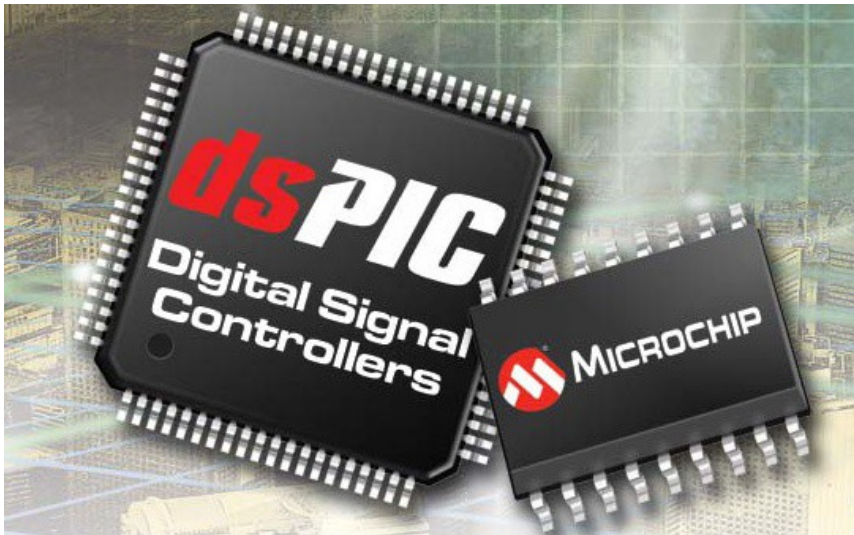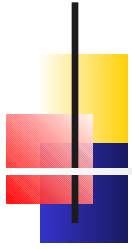# EE427 Advanced Microcontrollers

Evolution of DSP Processors

DSP Processors

- DSP has become key component in many consumer, communications, medical, and industrial products

- Programmable "DSP processors," a class of microprocessors optimized for DSP

Architecture Features

- **Fast Multipliers**

  - convolution, IIR filtering, and Fourier transforms

  - microprocessors implemented multiplications by series of shift and add operations, consuming one or more clock cycles

  - the first "DSP processor," the TMS32010, incorporated specialized hardware to compute multiplication in single clock cycle
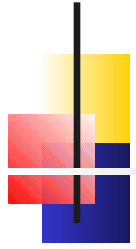
- DSP processors include at least one dedicated single-cycle multiplier or combined multiply-accumulate (MAC) unit

- **Multiple Execution Units**
  - include several independent execution units that are capable of operating in parallel
  - for example, in addition to the MAC unit, they contain an arithmetic-logic unit (ALU) and a shifter.

- **Efficient Memory Accesses**
  - Requires ability to fetch the MAC instruction, a data sample, and a filter coefficient from memory in a single cycle

- Hence, good DSP performance requires high memory bandwidth— higher than was supported the general-purpose microprocessors

- DSP processors have different memory architectures that could support multiple memory accesses per cycle
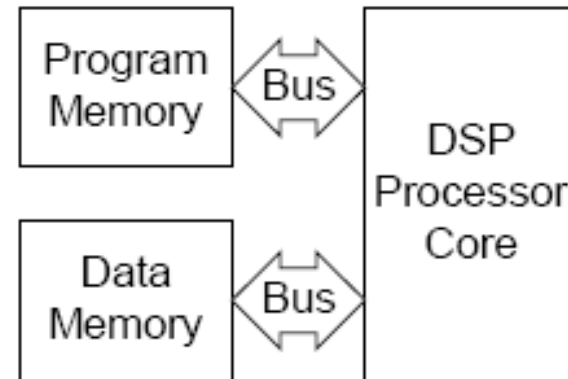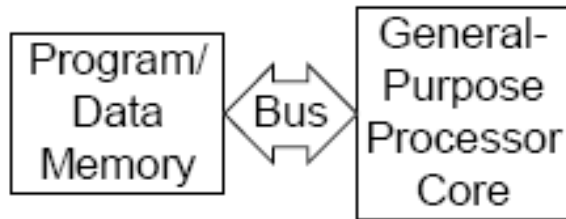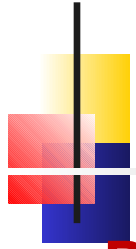
Data Format

- DSP processors use a fixed-point numeric data type instead of the floating-point format most commonly used in scientific applications

- Fixed-point processors tend to be cheaper and less power hungry than floating-point processors at comparable speeds
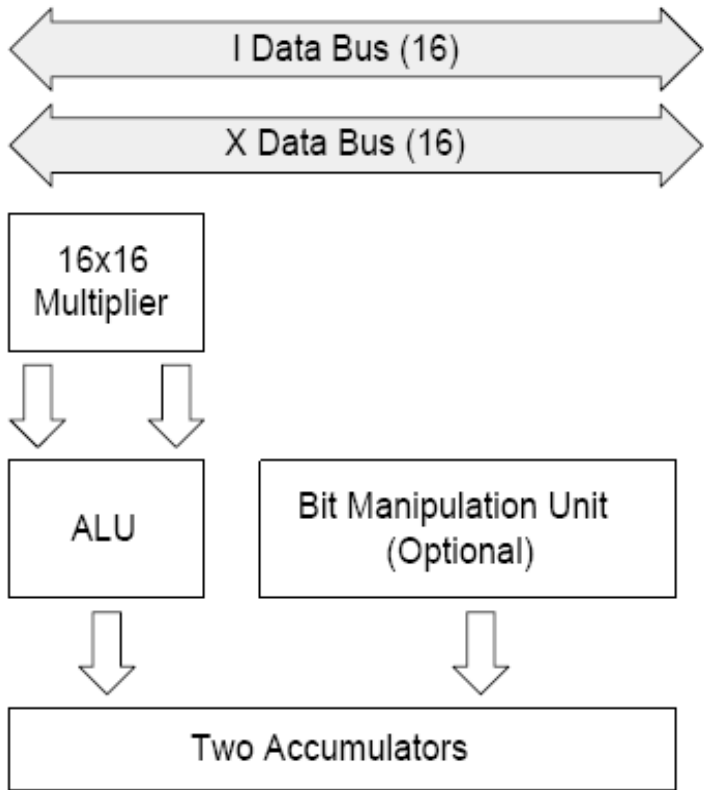
Zero-Overhead Looping

Streamlined I/O

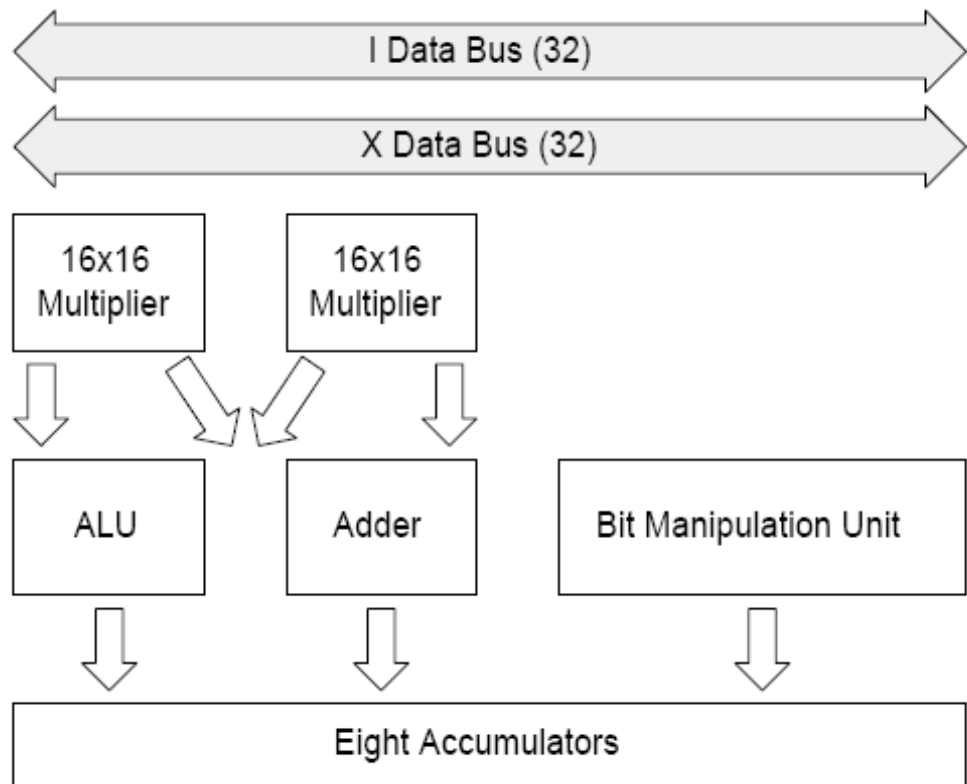# Specialized Instruction Sets

- Allows programmer to specify several parallel operations in a single instruction

DSP Landscape
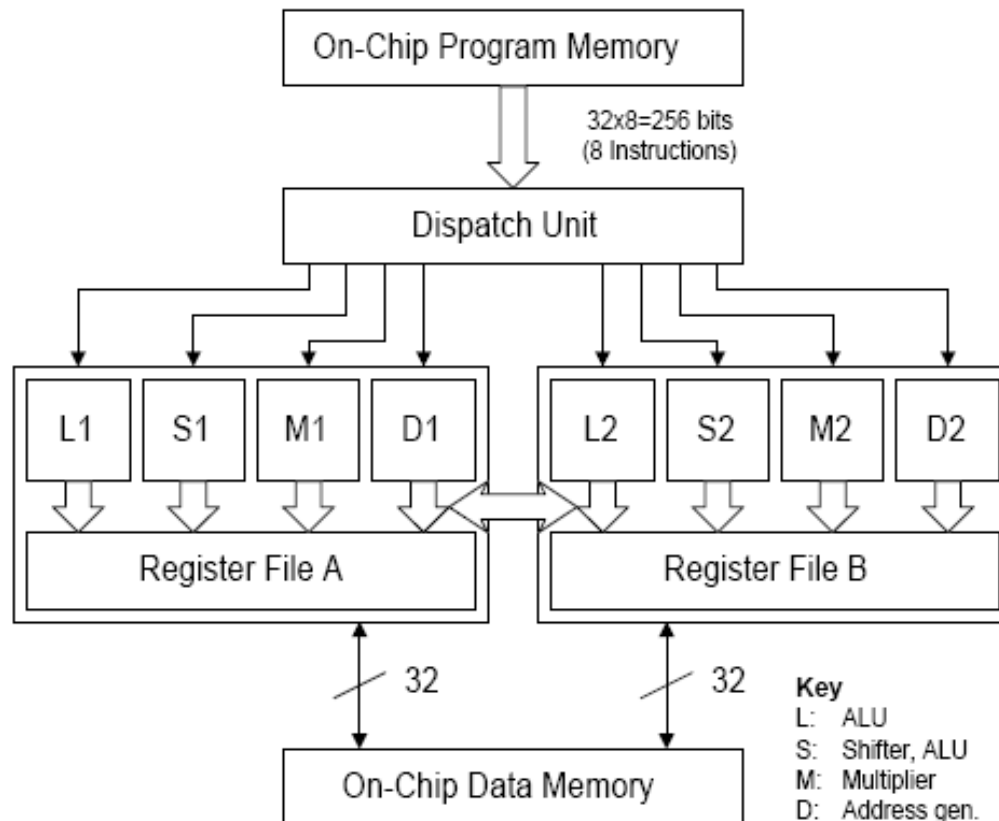
Conventional DSP Processor

Enhanced DSP Processor

DSP Landscape

- VLIW architecture

- SIMD – Single instruction, multiple data

On-Chip Program Memory

32x8=256 bits
(8 Instructions)

Dispatch Unit

| L1 | S1 | M1 | D1 | | L2 | S2 | M2 | D2 |

Register File A

Register File B

32

32

On-Chip Data Memory

Key
L: ALU
S: Shifter, ALU
M: Multiplier
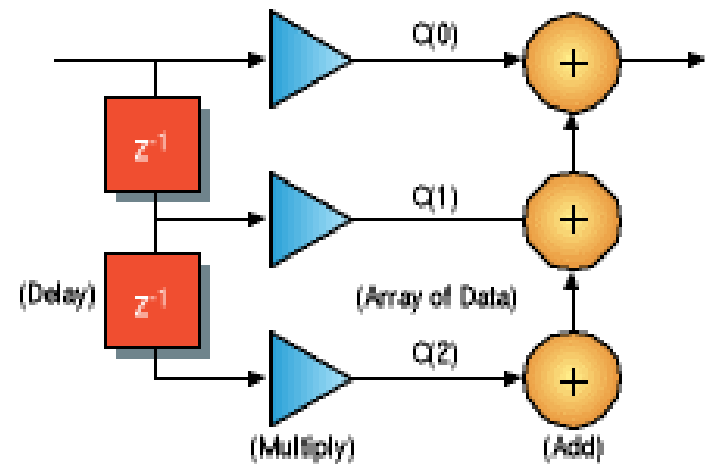D: Address gen.

Why DSP?

- Many applications require a mixture of control-oriented software and DSP software

- Using a single processor to implement both types of software is attractive, because;

  - simplify the design task

  - save circuit board space

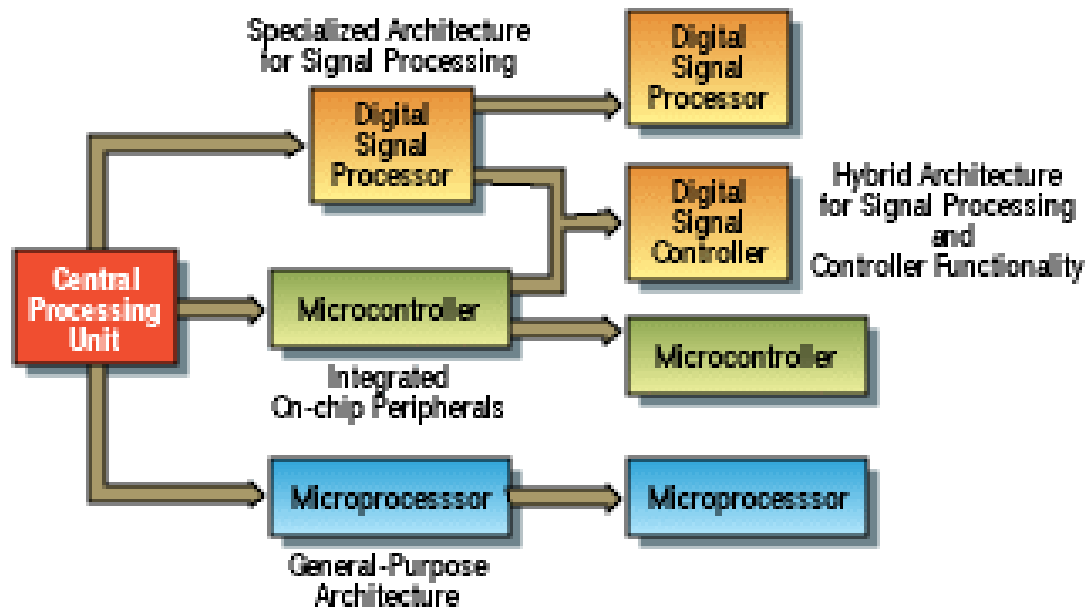 - reduce total power consumption

  - reduce overall system cost

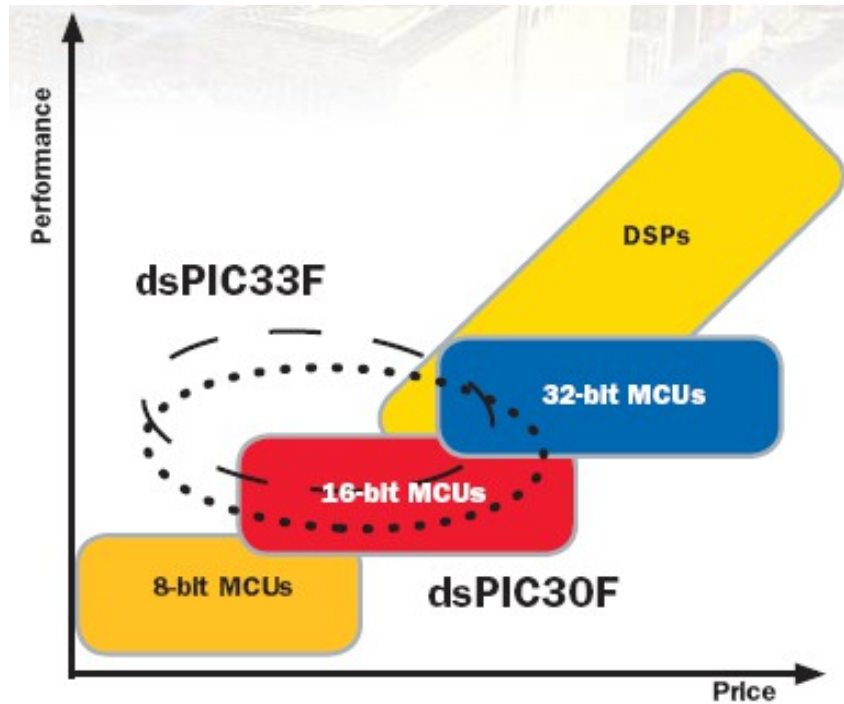# What is a Digital Signal Controller?

Digital Signal Controllers (DSC)

- Hybrid of microcontroller and DSP

- DSC is a single-chip embedded controller that seamlessly integrates the control attributes of a microcontroller (MCU) with the computation and throughput capabilities of a Digital Signal Processor (DSP)
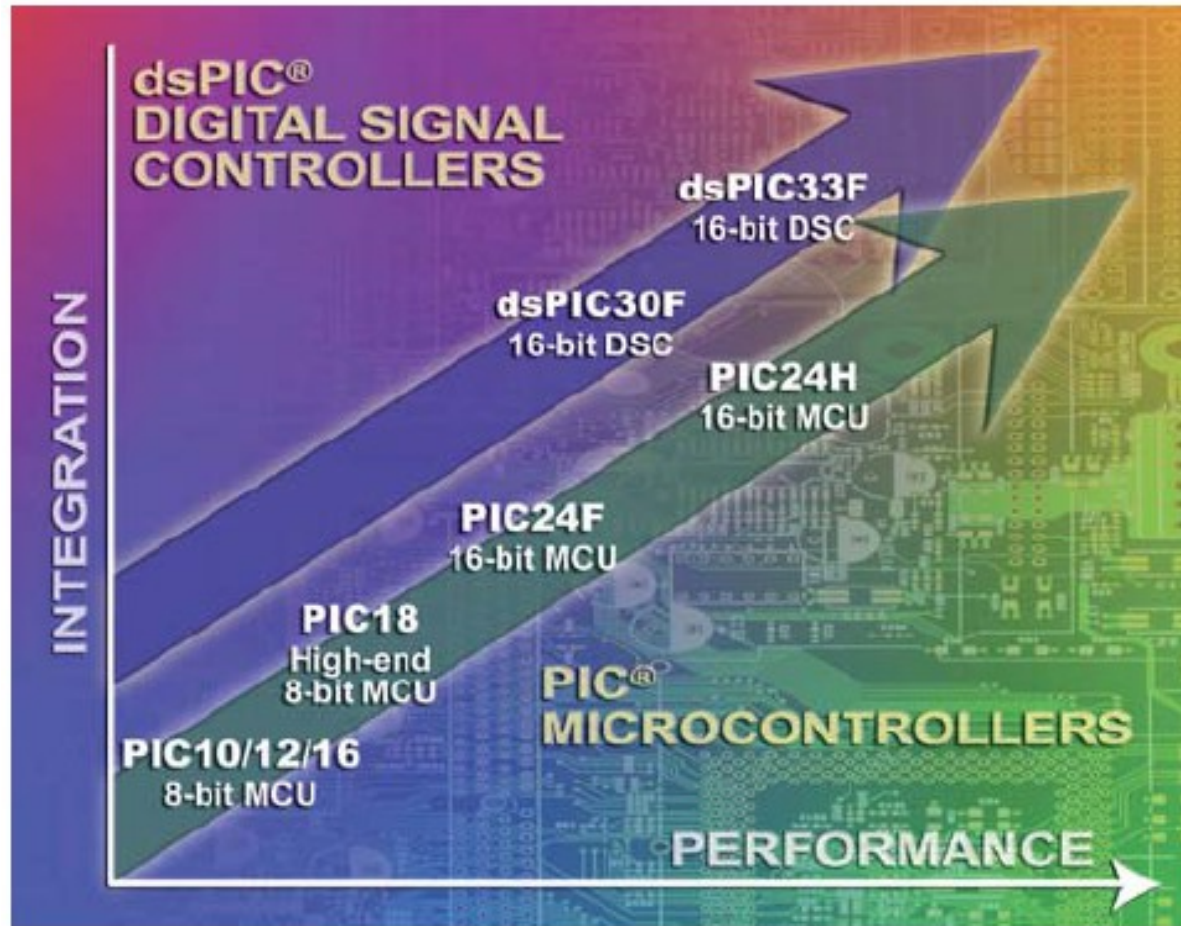
dsPIC30F

- DSP capability added to a high-performance 16-bit MCU

dsPIC30F capability

MCU Attributes
- State-centric
- Interrupt intensive
- Cost driven
- Flash capability
- Robust peripherals

dsPIC
Single core architecture
Familiar MCU look and feel
DSP performance
Rich peripheral options
Advanced interrupt capability
Flexible Flash memory
Self-programming capability
Low pin count options
Optimized for C

DSP Attributes
- Flow-centric
- Interrupt averse
- Performance driven
- Emerging Flash
- Limited peripherals

Microchip Embedded controller families

One Architecture, Many solutions