Evolution of 8-bit Microcontrollers

Steve Drehobl, Vice President
MCU8 Division
Agenda

- Embedded MCU Market Trends
- A History of the 8-bit MCU Market
- Microchip’s Architectural Approach
- Simplified Development Platform
The Embedded Marketplace

8- to 32-bit Market Size (2014)
(In Millions of Dollars)*

8-bit: $6,267
16-bit: $3,440
32-bit: $6,085

8-bit is still the most widely used architecture

*Source: Gartner Market Share Analysis: Microcontrollers, Worldwide, 2014
Fields of Play
Worldwide Microcontroller Volume

UNIT VOLUME

PIN COUNT

8-bit

32-bit
Embedded Market Trends
8-bit Microcontrollers

- **Legacy** is a primary driver for new designs
  - Familiarization, code base, tool-chain consistency
- **Investment in 8-bit by other suppliers has decreased**
  - Microchip introduces the significant majority of new 8-bit MCUs
- **“Cores” evolve slowest of all factors**
  - Functions in customers’ end applications evolve fastest
- **Realization that SW-centric design has hidden costs**
  - Software validation efforts take more time than the design itself
- **To be competitive, modern 8-bit MCUs require:**
  - Fast development time
  - High functionality & evolving peripheral integration
  - Balance software dependency with deterministic hardware performance

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Based on dollar shipment volume 1991-2014, Source: Gartner and Microchip
History of 8-bit MCUs
The Evolution of 8-bit Microcontrollers

1970
1990
2010
Present

1970
1990
2010
Present

ASIC
ROM / ROMless
ROM / ROMless
Application Balance
Software with Hardware

ASIC Approach

Fixed-Function

Advantages
- Deterministic
- Task Specific
- Parallel Processing

Disadvantages
- Rigid
- Limited Scalability

100 lb.
History of 8-bit MCUs
The Evolution of 8-bit Microcontrollers

- Flash
- “Basic” Analog Integration
- OTP
- ASIC
- ROM / ROMless

1970 1990 2010 Present

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History of 8-bit MCUs
The Evolution of 8-bit Microcontrollers

Supplier Divergence

1970  1990  2010  Present

ROM / ROMless
ASIC
OTP
ASIC

SW & MHZ
Peripherals
Application Balance
Software versus Hardware

Application-Specific Firmware

**Advantages**
- Customizable
- Configurable

**Disadvantages**
- Complexity
- Serial Processing
- Power Consumption
- Debug / Validation

MHz & Memory Approach

Software Centric

Hardware Centric

Design Focus

Application
History of 8-bit MCUs
The Evolution of 8-bit PIC® Microcontrollers

PIC® MCUs Focus on Function Enablement & Core Independence via Peripheral Interconnectivity

1970 1990 2010 Present

Core Independent Peripherals
Intelligent Analog

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Flexible Peripheral Integration

Intelligent Analog
Sensor Interfacing & Signal Conditioning

Waveform Control
PWM Drive & Waveform Generation

Timing & Measurements
Signal Measurement with Timing & Counter Control

Logic & Math
Customizable Logic & Math Functions

Safety & Monitoring
Hardware Monitoring & Fault Detection

Communications
Wired, Wireless & Encryption

User Interface
Capacitive Touch Sensing & LCD Control

Low Power & System Flexibility
XLP Low-Power Technology, Peripheral & Interconnects

8-bit PIC® Microcontrollers

CPU

ADC
ADC with Computation
Comparators
DAC
High-Speed Comparators
Operational Amplifiers
Ramp Generator
Slope Compensation
Voltage Reference
Zero Cross Detect
High-CURRENT I/O

(Enhanced) Capture Compare PWM
Complementary Output Generator
Complementary Waveform Generator
Data Signal Modulator
Numerically Controlled Oscillator
Programmable Switch Mode Controller
10-bit PWM
16-bit PWM
Cyclical Redundancy Check
Hardware Limit Timer
Windowed WDT

Memory

High-Endurance Flash (Data)
IDLE & DOZE
Peripheral Module Disable
Peripheral Pin Select
eXtreme Low Power XLP Technology
Crystal Free USB
Angular Timer
Charge Time Measurement
RTCC
Signal Measurement Timer
TEMP Indicator
8/16/20/24-bit Timers

Peripheral Module
Disable
High-Endurance
Flash (Data)
Peripheral Pin
Select
Peripheral Module Disable

Configurable Logic Cell
Hardware Multiply
Math Accelerator
Crystal Free USB
CAN
(E)USART
ETHERNET MAC
IPC
LIN
SPI
Keeloq® Sub-GHz RF

LCD
mTouch®
Software versus Peripherals
Serial versus Parallel Processing

"Conventional" MCU

Central Processing Unit

Firmware

Interrupt

Basic Timer

Sensor Interface

Signal Generation

Basic PWM

Power Conversion

Basic Analog

Interrupt Prioritization

Return

Peripheral completes task then notifies CPU

8-bit PIC® MCU

Central Processing Unit

Firmware

Start

Supervise System

Peripheral

Sensor Interface

Comparator

Configurable Logic Cell

Hardware Limit Timer

Signal Generation

PWM

Complementary Output Generator

Angular Timer

Zero Cross Detect

Power Conversion

 PWM

Complementary Output Generator

Comparator

Op Amp

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Application Balance
Software with Hardware

Optimized Firmware

**Advantages**
- Configurable
- Customizable
- Flexible
- Faster Design
- Reduced Complexity

Core Independent Peripherals

**Advantages**
- Deterministic
- Validated HW
- Building Blocks
- Low Power
- Parallel Functions
- Increased Performance

8-bit PIC® Microcontroller Approach

Software Centric

**Design Focus**

Hardware Centric

Application

500 lb.
Application Balance
Software with Hardware

Strengthening the Balanced Solution with a Modern Development Environment

Merges Software with Hardware

Optimized Firmware
- Configurable
- Customizable
- Faster Design
- Reduced Complexity

Core Independent Peripherals
- Deterministic
- Validated HW
- Low Power
- Parallel Functions
- Increased Performance

500 lb.

Software Centric

Design Focus

Hardware Centric

From Concept to Prototype in Minutes

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MPLAB® Code Configurator
Development Platform

FREE Graphical Programming Environment
Intuitive Interface for Quick Start Development
Automated Configuration of Peripherals & Functions
  • Minimized reliance upon product datasheet
  • Reduces overall design effort & time
From Novice to Expert…
  • Accelerates generation of production ready code
Software Centric Solution
Development Cycle

CPU

Output & Signal Generation
Dynamically activate ignition circuit at specific angle in engine revolution

Conditioning Circuit

Ignition Circuit

Engine RPM

Sparkplug

Function Development Cycle:

Definition
Days

Datasheet Deep Dive
Weeks

Write Code
Weeks

Validate
Months

Deploy

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Function Development Cycle:

- **Definition**: Days
- **Datasheet Deep Dive**: Days
- **Write Code**: Weeks
- **Validate**: Months
- **Deploy**:
Peripheral Centric Solution
Development Cycle

8-bit PIC® MCU
CPU Configures and Supervises
Output & Signal Generation
Angular Timer
Configurable Logic Cell

Conditioning Circuit
Engine RPM
Sparkplug

Function Development Cycle:

MCC Minimizes reliance on datasheet
MCC Graphical code generation
CIP hardware validated by Microchip

Definition Days
Deploy

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Function Development Cycle:

Definition 4 Days
Validate 2 Weeks
Deploy
• **Applications** are Comprised of **Functions**
  • Application = Function 1 + Function 2 + Function …
• **Functions** are a Compilation of **Peripherals**
  • Function x = Peripheral 1 + Peripheral 2 + Peripheral ..
MCC 2.x

- Peripheral Configuration
- Accelerates Creation of Application Specific Code
MCC 3.0

- Peripheral Configuration
- Function Enablement
- Board Support
- Library Support
- Data Logging
- Improved User Interface
Customer Testimonials
MCC Development Experiences

“It was quite easy. You could graphically see what you wanted to do, and then go in and decide how you wanted to set things up and it took care of all the details.”
- Kevin Rochford, Autoliv

“We use the MCC all the time. It allowed us to do in 2 hours what took several days of digging through datasheets in the past.”
- Patrick Marcus, Marcus Engineering

“I had five peripherals running in less than 30 minutes, and this was the very first time I used this tool.”
“I have configured registers by hand and I can safely say this program saves at least 90% of project startup time.”
- Craig Beiferman, Universal Laser Systems

“It was the tool I was looking for to speed up development with new boards.”
- Saul Ollenides, General Electric
Flexible Hardware Options
Development Platform

Curiosity
(part # DM164137)
- Entry-level / low-cost tool
- Integrated programmer & debugger
- Easy IoT connectivity
- mikroBUS™ socket, supporting over 140 Click boards

Explorer 8
(part # DM160228)
- Rapid proof-of-concept tool
- Extensive integration for optimized “out-of-box” experience
- Widest variety of PIC® MCUs supported
- 2 Pmod™ sockets supporting Digilent Pmods™
- 2 mikroBUS sockets supporting over 140 Click boards

PICDEM™ LAB2
(part # DM163046)
- Comprehensive development and experimentation tool
- Analog & mixed-signal focus
- 2 mikroBUS sockets supporting over 140 Click boards

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The 8-bit MCU Evolution

- Microchip is driving the 8-bit MCU evolution

- Enabling Scalability & Flexibility
  - Peripheral Interconnectivity
  - Core Independence & Function Enablement
  - Balance of Software & Hardware

- Intuitive & Rapid Development Approach
  - Flexible Board Options
  - MPLAB® Code Configurator (MCC)