Spartan-II 8-bit Microcontroller Solutions - Customer Tutorial

March 2000

# Agenda

- Introduction

- 8-bit Microcontroller Concepts

- 8-bit Microcontroller Applications

- Spartan-II Solutions for 8-bit Microcontrollers

- Spartan-II Family Advantage

- Summary

Background

- ◆ Microprocessor
  - — 4-bit 4004 was the first developed microprocessor
  - — Introduced by Intel Corporation in 1971
  - — RAM, ROM, I/O ports, and timers all need to be added for functionality

Microprocessor System
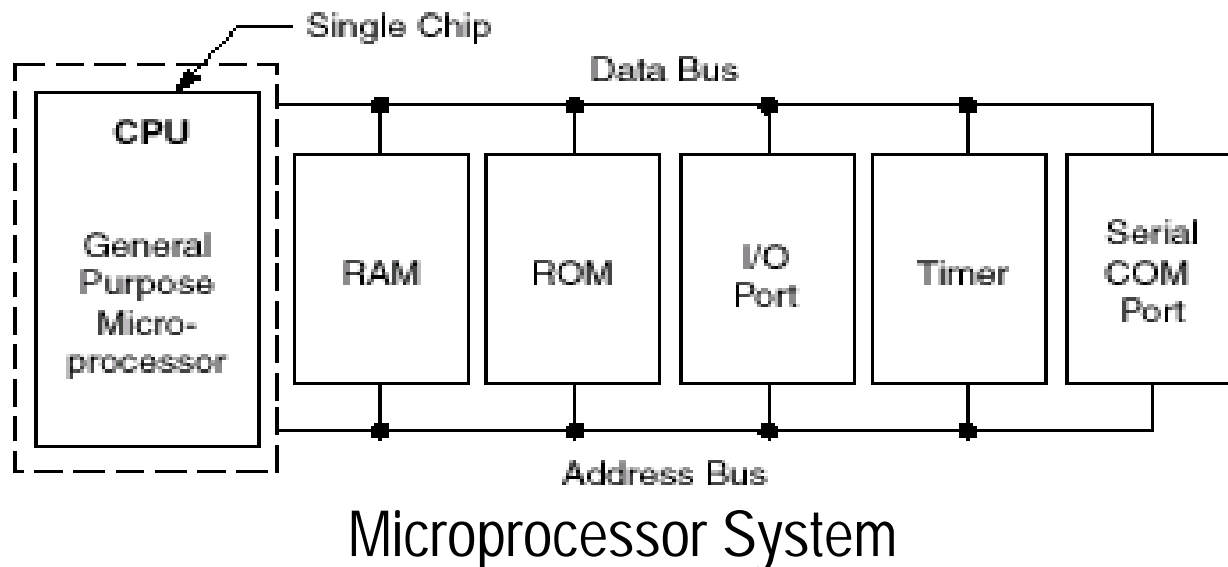
Background

- ◆ Microcontroller
  - — By product of the microprocessor development
  - — Introduced by Intel Corporation in 1971
 - — RAM, ROM, I/O ports, and timers are all on-chip
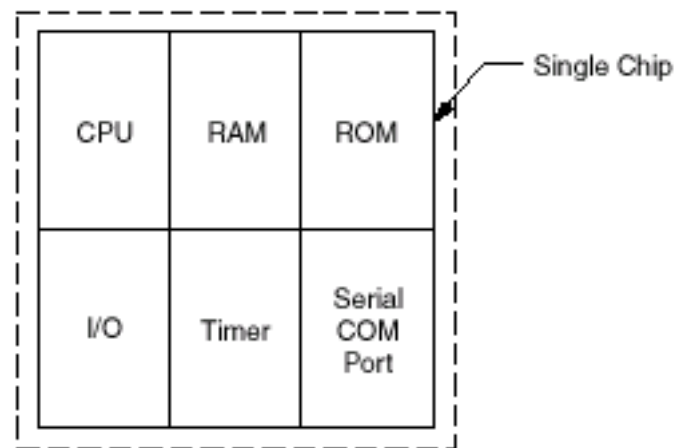
Microcontroller System

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Background

- 8-bit, 8051 Microcontroller
  - Originally developed by Intel Corporation in 1981
  - This had 128 bytes of RAM, 4K bytes of on-chip ROM, two timers, one serial port, four ports (each 8-bits wide) all on-chip
  - Intel allowed manufacture of different flavors of the 8051, as long as they are code-compatible
  - Different speeds and amounts of ROM marketed today
  - Total market: $1.5 Billion in the year 2000
    - Source: Dataquest
  - Monthly Shipments of 250 Million Units (in 2000)
    - Source: WSTS, Microprocessor Report

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Monthly Worldwide Shipments
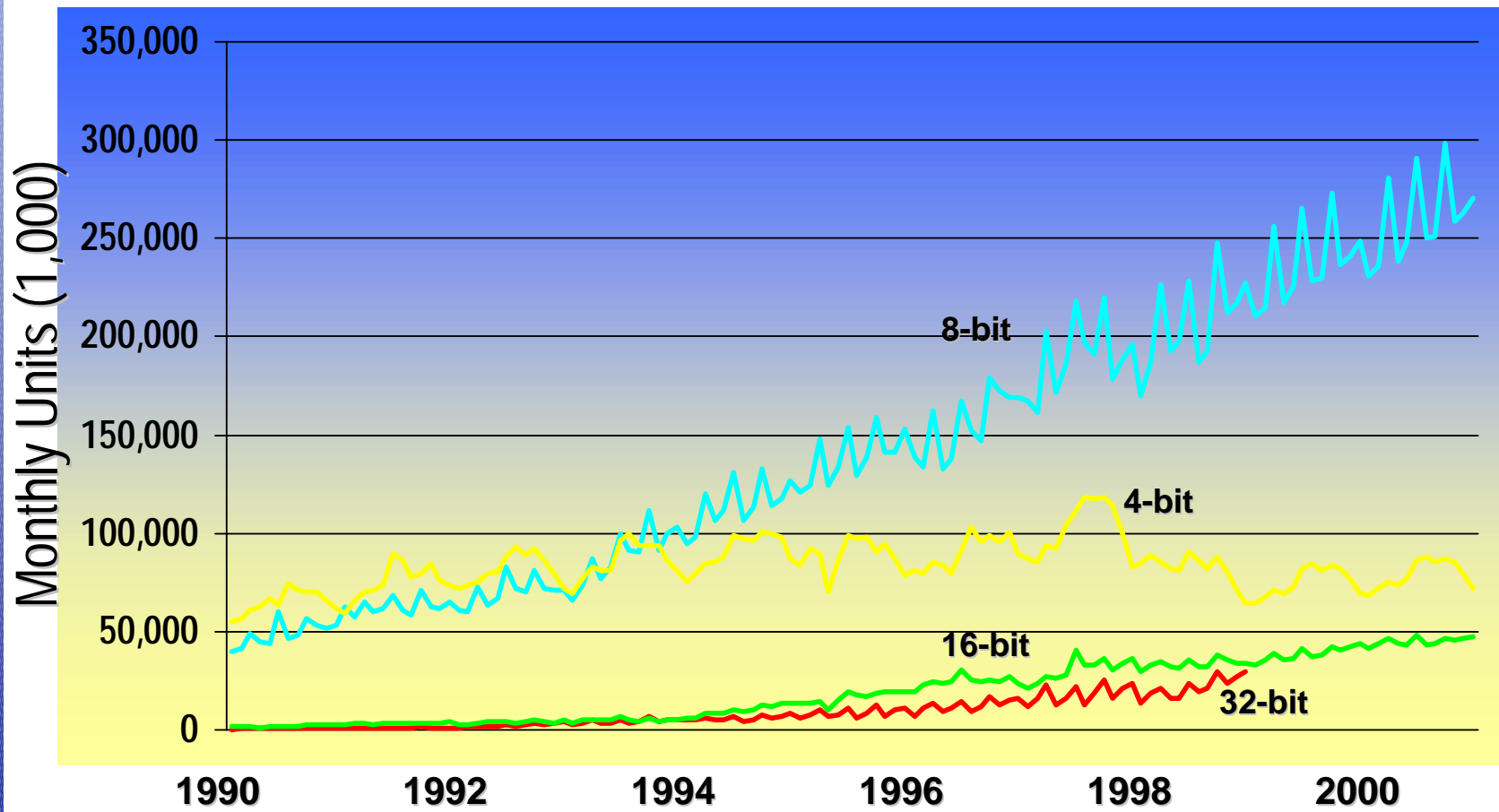
Source: WSTS, Microprocessor Report

Xilinx at Work in High Volume Applications

www.xilinx.com

Xilinx Spartan-II FPGAs

◆ Spartan-II FPGAs

— 100,000 system gates at under $10 in High Volumes

— Extensive features: Block RAM, DLL, Select I/O

— Vast IP portfolio for embedded solutions

— Provide density, features, performance at ASIC prices

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8-bit Microcontroller Concepts

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8051 Concept

- ◆ 8051 Microcontrollers Contain
  - — CPU (with Boolean processor)
    - – Includes program counter, ALU, working registers, clock circuits
  - — Internal RAM
  - — I/O ports with programmable ports
  - — 5 or 6 interrupts (2 are external with 2 priority levels)
  - — 2 or 3 16-bit counters/timers
  - — Programmable full-duplex serial port
  - — 32 I/O lines (four 8-bit ports)
  - — Some models have a ROM/EPROM

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8051 Block Diagram
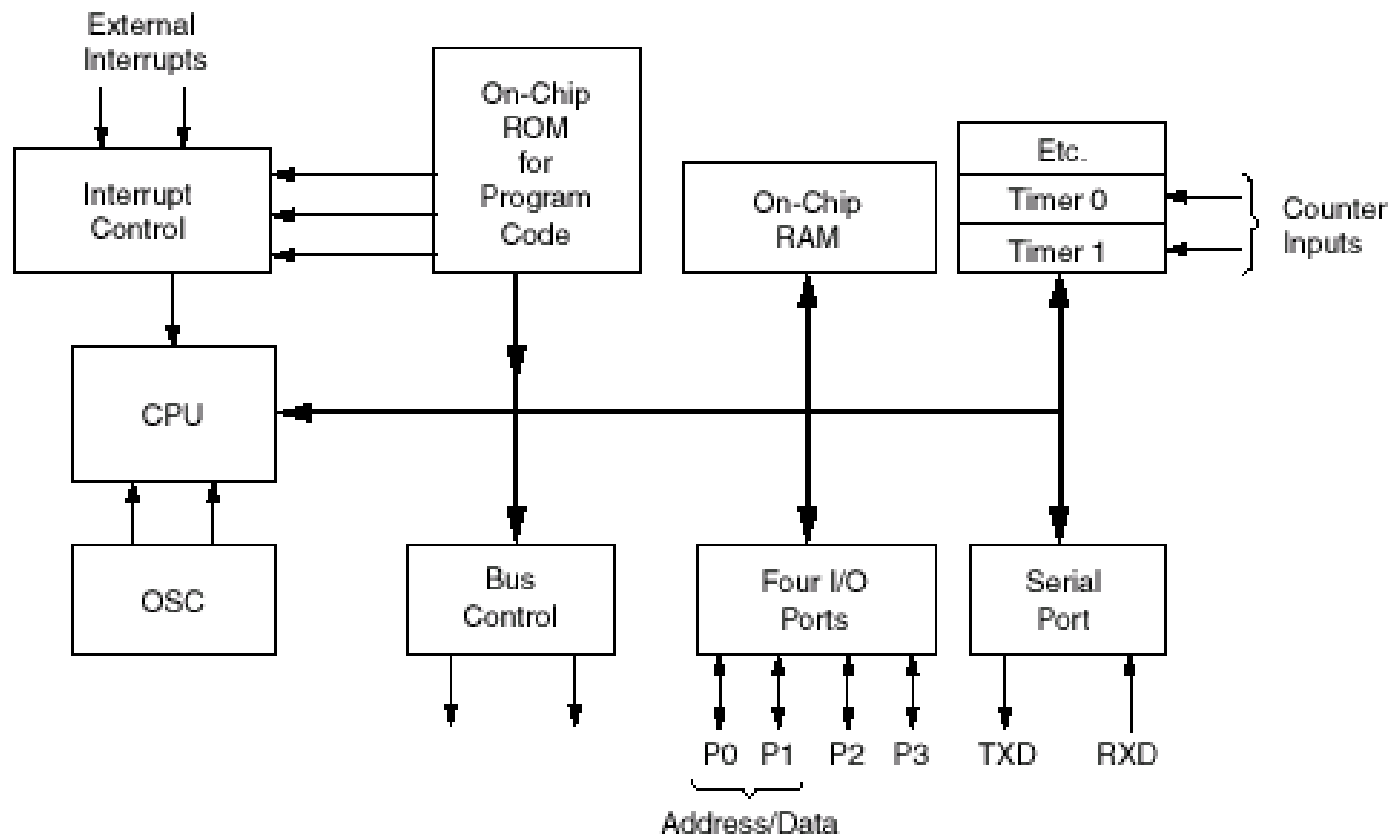
(source: The 8051 Microcontroller and Embedded Systems)

The 8051 Architecture Advantage

- ◆ Very Short & Efficient Interrupt Handling Routines
  - — Fits into 8-byte area
  - — With longer interrupt routines, the 8051 jumps to the appropriate routine from within the 8-byte interrupt region

- ◆ Fixed 8-byte Areas are Convenient & Efficient

- ◆ Instruction Set is Optimized for 1-bit Operations
  - — Real-world & real-time applications

- ◆ Boolean Processor provides Direct Support for Bit Manipulation
  - — Provides efficient programs for binary inputs and output conditions in digital-control problems

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Applications of 8-bit Microcontrollers

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8-bit Microcontroller Advantage

- ◆ 8-bits are a Useful Word Size for Small Computing Tasks
  - — 256 decimal value capability
  - — 1-byte word size is used for control & monitoring applications
  - — Serial ASCII data is stored in byte sizes
    - – 8-bits are a natural choice for data communications
  - — IC memories & logic functions are arranged in a 8-bit configuration
    - – Interface easily to 8-bit data buses

- ◆ Application Sophistication
  - — Simple appliance control
  - — High-speed machine control
  - — Data collection

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The 8051 Advantage

- ◆ Popularity
  - — Readily available & widely supported

- ◆ Fast & Effective
  - — Architecture correlates closely with control systems
  - — Specialized instructions
    - – Fewer bytes of code need to be fetched
    - – Fewer conditional jumps are processed

- ◆ Low Cost
  - — High-level system integration is possible with one component

The 8051 Advantage

- ◆ Wide Range
  - — Variants of high performance & low power products are available
  - — Amount of internal ROM, RAM and other cost-sensitive features differ
  - — Provides real cost savings in tools, training & software support

- ◆ Compatibility
  - — Opcodes & binaries are the same for all 8051 variants
  - — All variants feature a common language allowing real-time control compatibility

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The 8051 Advantage

- ◆ Multiple Sources
  - — Over 12 manufacturers & hundreds of varieties

- ◆ Constant Improvements
  - — Constant silicon & design improvements allow
    - – Increased speed
    - – Lower power consumption
    - – Lower cost

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8051 Applications at Home

- Home Networking Appliances

- Bluetooth Appliances

- xDSL Modems

- Cable Modems

- Set-top Boxes

- Voice Recognition

- Video-processing

- Secure Surveillance Systems

- TVs, HDTV, Digital TV

- Home PCs & Notebooks
  - CD-ROM & tape drives
  - Keyboards & mouse
  - Printers & scanners
  - Modems
  - PC & Digital Cameras

- VCRs, DVD/VCD Players

- Camcorders & Camera

- Remote Control

- Cable TV Tuner

- Microwave

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8051 Applications at Home & Office

- Printers
  - Laser
  - Inkjet
- Scanners
- Digital Telephones
- Copiers
- Vending Machines
- POS Terminals

- Security Systems
- Answering Machines
- Fax Machines
- Garage Door Openers
- Lighting Control
- Intercom
- LCD Displays

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8051 Applications in Automotive

- Trip Computer

- Engine Control

- Air Bag

- ABS

- Instrumentation

- Security System

- Transmission Control

- Entertainment
  - Radio/Cassette/CD controls
  - CD Changers
  - GPS Navigation Systems

- Climate Control

- Cellular Phone

- Keyless Entry

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8051 - Other Applications

- Industrial Controls

- System Supervision

- Motor Control

- Aerospace

- Biomedical Instruments

- Telecom, Datacom & Networking
  - Line cards
  - Wireless: Cellular phones, pagers
  - Repeaters & Switches

- Communication Through Power Lines

- Video Games, Toys, Exercise Equipment

- Hand-held/Portable Devices

- Data Logging Equipment

- Light-rail Equipment

- Satellite Base Stations

- Wireless Monitoring Systems

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Spartan-II 8-bit Solutions

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Spartan-II 8051 Solutions

	Dolphin Integration	CAST
Part No.	Flip805x-PR Core	D80530C Microcontroller Core
Part Description		
Speed	29.8MHz	51MHz
Performance	20 MIPS	
Memory	Dual Data Pointer, De-Multiplexed Address/Data bus	Addressable up to 256 bytes of Read/Write (internal), Addressable 64K bytes (external), Dual Data Pointer, Variable MOVX to access fast/slow RAM/Peripheral
Serial Interface	Provides 4 I/O ports	Provides 4 I/O ports
Counter/Timer	2 or 3 timers	Two 16-bit timers/counters, 15-bit programmable watchdog timer
Interrupts	6 external interrupt plus software interrupt	14 interrupt sources
Functional Description	IR Unit, Control Unit, ALU, Boolean Operation Unit, Multiply/Division Unit, Register Unit, PC Unit	8-bit Control Unit, 8-bit ALU, Memory Control Unit, RAM & SFR CU, 32-bit fast multiple/division unit

Dolphin Integration
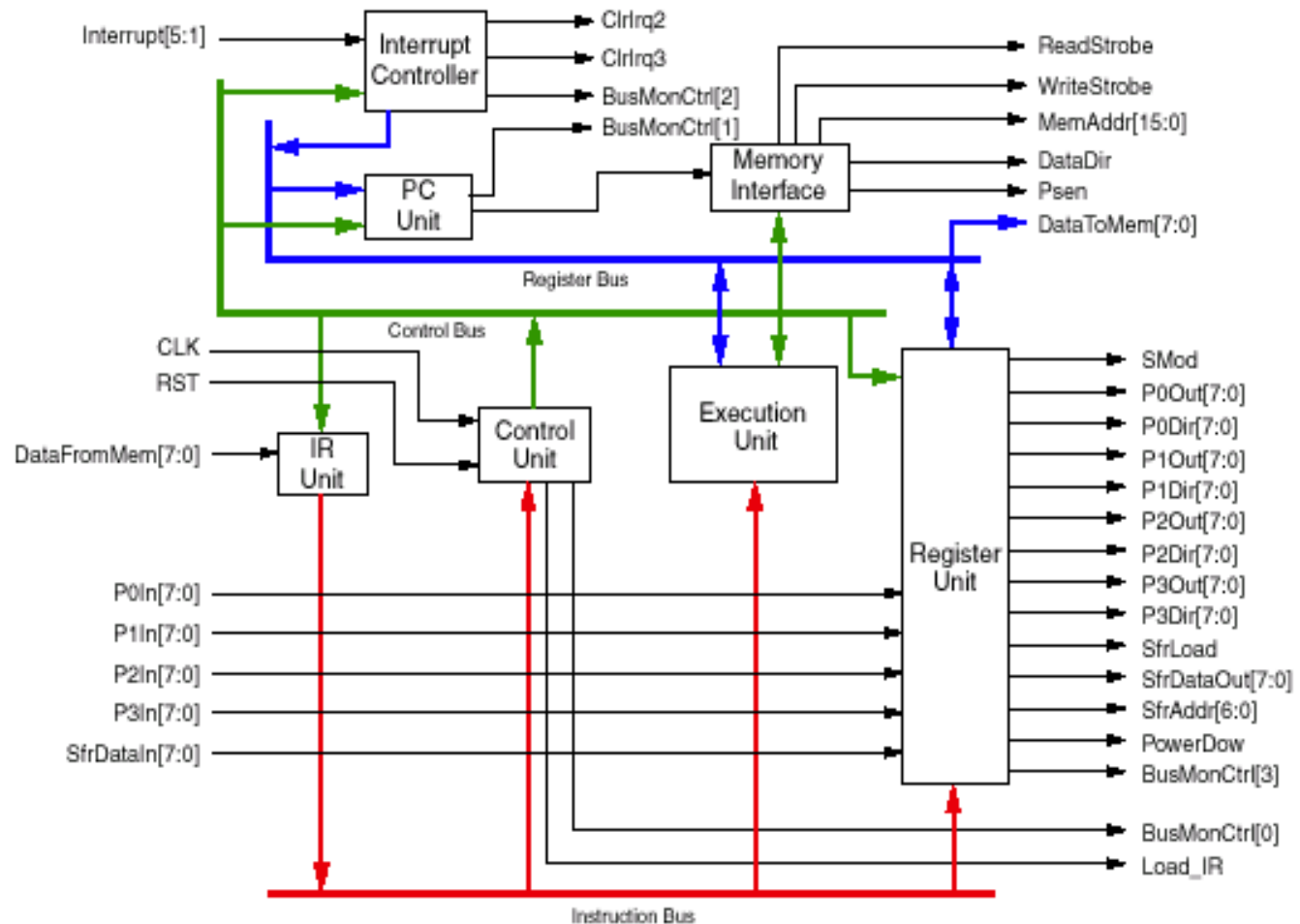
Flip805x-PR Core - Block Diagram

CAST - DS80530C Core
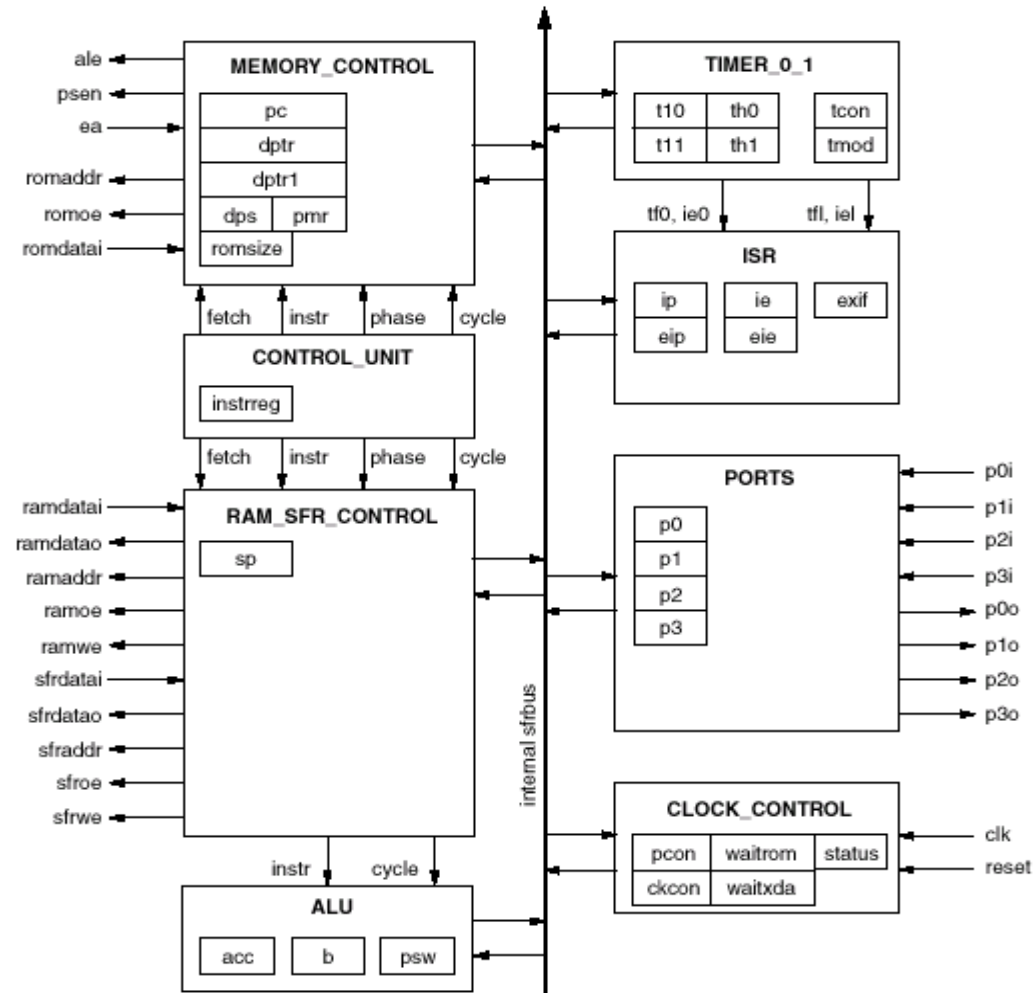
DS80530C Microcontroller Core - Block Diagram

Spartan-II 8-bit μC Solutions

♦ Spartan-II 8051 Microcontroller Solutions from CAST & Dolphin Integration

Features	Spartan-II Solutions	
	CAST	Dolphin Integration
Spartan-II Device	XC2S150-6	XC2S150-6
CLB Slices	1515	1171
Clock IOBs	1	1
IOBs	143	
Performance (MHz)	51	29.8
Percentage Device (CLBs) Use	87.76%	67.94%

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Spartan-II Value Proposition

- ◆ High Performance
  - — DS80530C Core by CAST in a Spartan-II
    - – Operates at 51MHz
    - – Instruction execution performance equal to 2.5 times legacy 8051s
  - — Flip8051 by Dolphin in a Spartan-II
    - – Operates on an average 8 times faster than legacy 8051s
  - — Higher performance than other 8051 ASSPs
    - – Expensive (16- or 32-bit) microcontrollers are not required for higher processing power
  - — Advanced power management capabilities

- ◆ High Flexibility
  - — Programmable Logic

Spartan-II Value Proposition

- ◆ Advantages of Programmable ASSP over ASSPs

- ◆ Embedded Solutions
  - — Choosing right feature set & optimization
  - — Value proposition within same piece of silicon
    - – FPGA logic not used from the 8051 IP can be integrate other IP
    - – Product Customization
    - – Reduced cost
  - — High-performance "8051 + other IP" Integrated solutions
    - – PCs, cable modems, set-top boxes, home networking, Bluetooth, image processing, wireless, voice recognition

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Programmable ASSP Advantages

- ◆ Benefits
  - — Time to Market
  - — Flexibility
    - – Product Customization to meet customer needs
    - – Adapt to Specification Updates
    - – Feature Upgrades
    - – Low risk evaluation of new market segments
  - — Field Upgradability
    - – Hardware and Software upgradability opens new applications
  - — Efficiently Address Low Volume Strategic Applications
  - — Distribution and Inventory Management

Programmable ASSP Advantages

- ◆ Accommodate Specification Changes
  - — Multiple standards and specification changes are accommodated

- ◆ Testing and Verification
  - — Stand-alone ASSPs usually do not perform as expected
  - — Being re-programmable, allows risk aversion which is a tremendous value-add

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Programmable ASSP Advantages

- ◆ Xilinx On-line - Field Upgradability
  - — Remote update of Software and Hardware
  - — Results in increased lifetime for a product
  - — Enable product features per end-user needs

- ◆ Issues in Creating a Stand-Alone ASSP
  - — Choosing the right ASSP
  - — Product customization
  - — Development cost and amortization
  - — Spartan-II family has amortized cost by selling to the traditional PLD marketplace

Additional Support

- Xilinx At Work Website Contains Detailed Information
  - Market Overview
  - Glossary
  - Applications Notes
  - White Papers
  - Lobby Pitch
  - Reference designs

- FPGA Strategic Applications Group
  - System level expertise for Xilinx At Work vertical markets

Summary

- 8-bit Microcontrollers are Widely Used
  - Networking, Telecom & Wireless, Home Networking, Home appliances, Biomedical instruments, Bluetooth, Automotive, Multimedia, Video, Audio, and Imaging Applications

- The Spartan-II Family provides Significant Strengths with its 8-bit Microcontroller Solution due to:
  - Performance & Features
  - Reconfigurable Fabric
  - Embedded Solutions (IP) within the same device
  - Scalability and Flexibility: Internet Reconfigurable Logic
  - Cost effectiveness

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