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High-performance Spartan-II 8-bit Microcontroller Solution

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Using the Spartan™-II Family in combination an 8-bit microcontroller Soft IP to effectively penetrate Industrial instruments and Consumer Applications.

Summary

High-performance 8-bit microcontrollers are deployed in a number of applications such as data networking, telecommunications, consumer products, computer peripherals, automotive systems and aerospace designs. The 8051 microcontroller IP in a Spartan-II FPGA shows the advantages of using programmable logic devices (PLDs) as 8-bit microcontrollers. The Xilinx Spartan-II 8-bit microcontroller solution is ideal for applications in which cost and integration within a system is critical. With the flexibility to allow integration of other IP on the FPGA fabric, the Spartan-II family presents an ideal embedded solution. This positions the Spartan-II family uniquely in being able to compete with stand-alone ASSPs. This white paper presents a brief history, the market space for 8-bit microcontrollers, the Spartan-II 8-bit microcontroller solutions, 8051 IP solutions, applications and the Spartan-II FPGA advantage.

Introduction

The past three decades have seen the introduction of technology that has radically changed the way in which the world is analyzed and controlled. Born of parallel developments in computer architecture and IC fabrication, the microprocessor became a commercial reality in 1971, with the introduction of the 4-bit 4004 by Intel Corporation. A by-product of microprocessor development was the microcontroller. These not as well known devices are responsible for smart VCRs, clock radios, washers and dryers, video games, telephones, microwaves, TVs, automobiles, toys, vending machines, copiers, elevators, irons, and a myriad of other products that are intelligent and “programmable.”

PLDs like FPGAs (Field Programmable Gate Arrays) have always been viewed as being expensive, slower, and less feature rich than comparable ASICs. This limited their success in penetrating the ASSP market. Bringing programmability and its traditional benefits to a design solution is always an expensive proposition and FPGAs have traditionally lost the battle to the cost-optimized custom solution or ASIC. The use of cutting edge process technologies has leveled this playing field. This approach has allowed FPGAs to significantly reduce die sizes, and therefore lower the cost of the overall solution. This rapid transition in process technology has allowed FPGA vendors to service the needs of today’s ASIC designers.

Spartan-II FPGAs offer more than 100,000 system gates at under $10 and are the most cost-effective PLD solution ever offered. The Spartan-II family addresses low cost and fast time-to-market (TTM), but more importantly integrates powerful new system-level features that provide an attractive solution for today’s system level designer. These features have taken programmability from being the nature of the product to it being a valued feature. They build on the capabilities of the very successful Virtex family and incorporate all the associated features, including SelectI/O™, Block RAM™, Distributed RAM, Delay-Locked Loop (DLL) circuits, clock speeds up to 200 MHz, and power management capabilities. The Spartan-II family is well positioned to offer a low-cost programmable ASSP alternative and expand the TTM advantage that PLDs traditionally offer. It also increases the value of the ASSP by allowing end users to customize their solutions.

The Spartan-II family, combined with a vast soft IP portfolio is the first programmable logic solution to effectively penetrate the ASSP marketplace. The high-performance 8051 microcontroller solutions from Dolphin Integration and CAST, Inc. ported on Spartan-II devices

are good examples highlighting the concept of a programmable ASSP. The cores run at several times the performance of a legacy 8051 microcontroller and target embedded applications in telecom, automotive, voice recognition, image processing, military and consumer applications. Both Dolphin and CAST are members of the Xilinx AllianceCORE™ program and have a wealth of IP cores in other applications.

Following are the two 8-bit microcontroller solutions available for the Spartan-II family:

- The Flip805x-PR Core is provided under license from Dolphin Integration for use in Xilinx devices in EDIF or NCD netlists. It is a full binary code, which is compatible with the original 8051/52. On an average, it has over eight times the performance (in terms of MIPS) of the standard 8051, at the same clock frequency. It is applied in 8-bit data processing, low-power consumption, high-speed and complex applications. The Flip805x-PR Core is available immediately for use in Spartan-II FPGAs and can be purchased directly from Dolphin.
- The D80530C Microcontroller core is developed, sold, and supported by CAST. This core is optimized for Spartan-II devices and has the same instruction set as the 80C51. This core includes an 8-bit control unit, 8-bit ALU and has two 16-bit counters. The D80530C Microcontroller core is available immediately for use in Spartan-II FPGAs and can be purchased directly from CAST.

8-bit 8051-compatible Microcontroller Solutions

Microprocessors and microcontrollers are widely used in embedded system products. An embedded product uses a microprocessor (or microcontroller) to do one task and only one task. A printer is an example of an embedded system since the processor inside performs one task only; namely getting the data and printing it. This can be contrasted with a PC which performs a number of applications such as word processor, print-server, bank teller terminal, video game player, network server, or internet terminal. A microprocessor must add RAM, ROM, I/O ports, and timers externally to make them functional. Even though this increases the cost of the solution it brings versatility. A microcontroller has a CPU (a microprocessor) in addition to a fixed amount of RAM, ROM, I/O ports, and a timer all on a single chip. All these features are embedded together on one chip, making microcontrollers ideal for the many applications in which cost and space are critical. For example, a TV remote control does not need the computing power of a microprocessor. The space occupied, power consumption and the price per unit are much more critical than the computing power. Figure 1 shows a comparison between a microprocessor system and a microcontroller system.

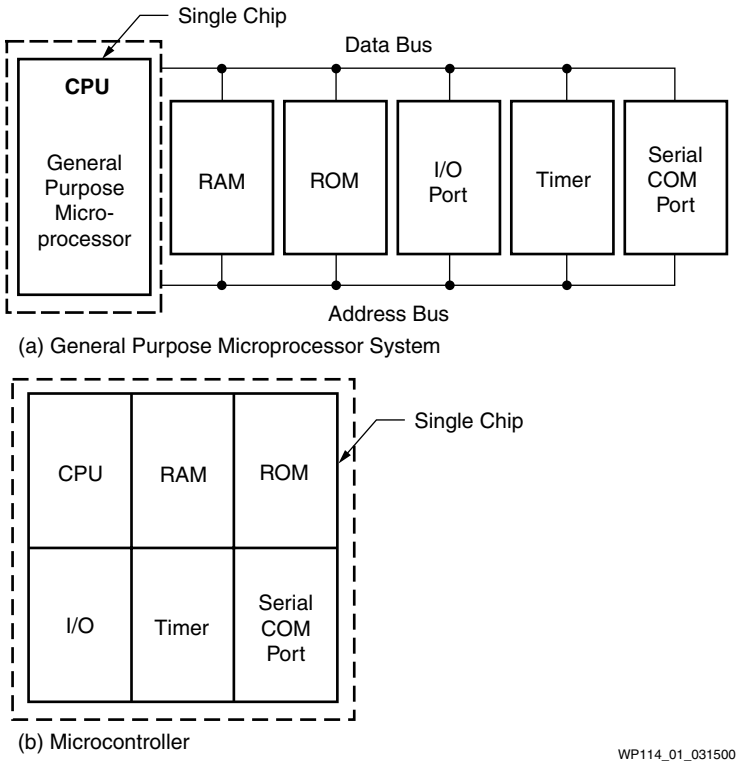

Figure 1: **Microprocessor System Contrasted with Microcontroller System**

The 8051 is an 8-bit microcontroller, originally developed by Intel Corporation in 1981. This microcontroller had 128 bytes of RAM, 4K bytes of on-chip ROM, two timers, one serial port, and four ports (each 8-bits wide) all on a single chip.

The 8051 became widely popular after Intel allowed other manufacturers to make and market any flavor of the 8051, with the condition that they remain code-compatible with the 8051. This has led to various versions of the 8051 with different speeds and amounts of on-chip ROM marketed by more than half dozen manufacturers. Today, it is the world's most popular microcontroller, made by several independent manufacturers. The total market for 8051 microcontrollers is expected to top $1.5 Billion in the year 2000 (source: Dataquest). Figure 2 compares the monthly shipments of microcontrollers and microprocessors. As a metric of its acceptance, about 250 million 8-bit microcontroller units (monthly) were shipped in 1999 (source: WSTS, Microprocessor Report).

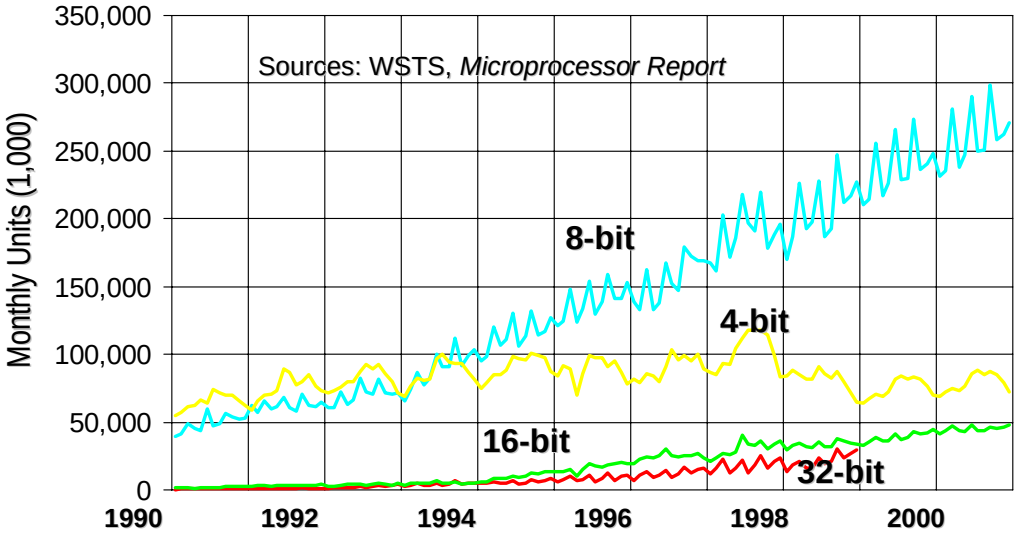

Figure 2: **Monthly Shipments of Microcontrollers and Microprocessors**

Figure 3 shows the block diagram of the 8051 microcontroller. A typical 8051 contains a CPU (with Boolean processor), internal ROM and RAM, I/O ports with programmable ports, timers and counters and serial data communication. The CPU component includes a program counter, ALU, working registers, and clock circuits.

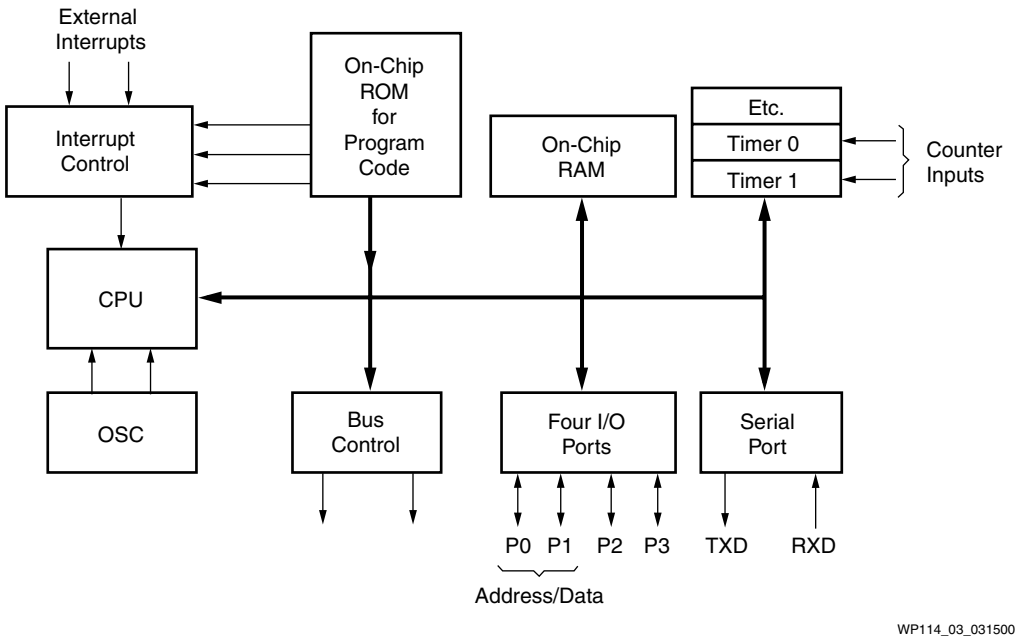

Figure 3: **The 8051 Microcontroller Block Diagram**
(courtesy: The 8051 Microcontroller and Embedded Systems)

The 8051 microcontroller has five or six interrupts (two are external with two priority levels). There are two or three 16-bit timers (counters). There is a programmable full-duplex serial port (baud rate is provided by one of the timers). There are 32 I/O lines (four 8-bit ports), with RAM. Some 8051 models have a ROM/EPROM also. One vexing problem with the 8051 is its very non-orthogonal instruction set - especially the restrictions on accessing the different address spaces. One advantage of the 8051 is in the way that it handles interrupts. Also vectoring to

fixed 8 byte areas is convenient and efficient. Most interrupt routines are very short, and generally can fit into the 8-byte area. If the interrupt routine is longer, it can jump to the appropriate routine from within the 8-byte interrupt region.

The 8051 instruction set is optimized for the one-bit operations so often desired in real-world, real-time control applications. The Boolean processor provides direct support for bit manipulation. This leads to more efficient programs that need to deal with binary input and output conditions inherent in digital-control problems. The bit addressing can be used for test pin monitoring or program control flags.

Xilinx 8-bit Microcontroller IP Partners

The Spartan-II family inherits unique features, density, an extensive synthesizable IP portfolio and the cost structure to effectively compete against ASSPs (Application Specific Standard Products). The programmable solution provided by the Spartan-II family requires a soft IP core. This is supported by the AllianceCORE program, which is a cooperative effort between Xilinx and independent third-party core developers. It is designed to produce a broad selection of industry-standard solutions dedicated for use in Xilinx's FPGAs. A programmable logic version of a core must have value over an ASIC/ASSP version of the same function. It must be cost effective and make sense for use in a programmable device in a production system. As a result, Xilinx does not promote generic, synthesizable cores as AllianceCORE products. Instead, they are generally provided as black boxes. This guarantees that the implementation is optimized for density while still meeting performance, preserving the TTM value of programmable logic. Allowing quick implementation of unique logic on the same device provides flexibility. Partners may provide cores customized to meet specific design needs. Source code versions of the cores are often available from the partners at additional cost for those who need ultimate flexibility.

With the availability of the Spartan-II family, the 8051 microcontroller solution can be implemented using a single Spartan-II device and the IP provided by Dolphin Integration and CAST, Inc. This presents the low-power and high-performance 8051 microcontroller solution from Xilinx. It is worthy to note that the cores provided by the two core partners have separate features, which allows both solutions to serve separate markets.

Flip805x- PR Core from Dolphin Integration

The *Flip805x-PR core* (Figure 4) supports the Spartan-II FPGAs. Some of its features include

- It provides full binary code compatibility with the original 8051/52.
- It requires a single cycle instruction execution for most of the opcodes.
- On an average, the core ported on a Spartan-II device has over 8 times the performance (in terms of MIPS) of the standard 8051/52 at the same clock frequency.
- Some instructions are even up to 12 times the standard 8051/52.
- The demultiplexed address/data bus allows easy connection to the memory.
- There is dedicated hardware to accelerate multiply and division instructions.
- There are two data pointers for faster memory copies and indexing.
- The I/O ports (P0, P1, P2, P3) and the alternate functions like external interrupts are separated, providing extra port pins when compared with the standard 8051/52.
- There is an extra bus for easy integration of extra peripherals and Special Function Registers.
- There are up to six external interrupts plus a software interrupt (Trap instruction).
- There is an extra-dedicated output bus (Bus Monitor) for real-time trace disassembly of the code execution, easing hardware/software co-verification.
- This is a static synchronous design with no internal tri-states.

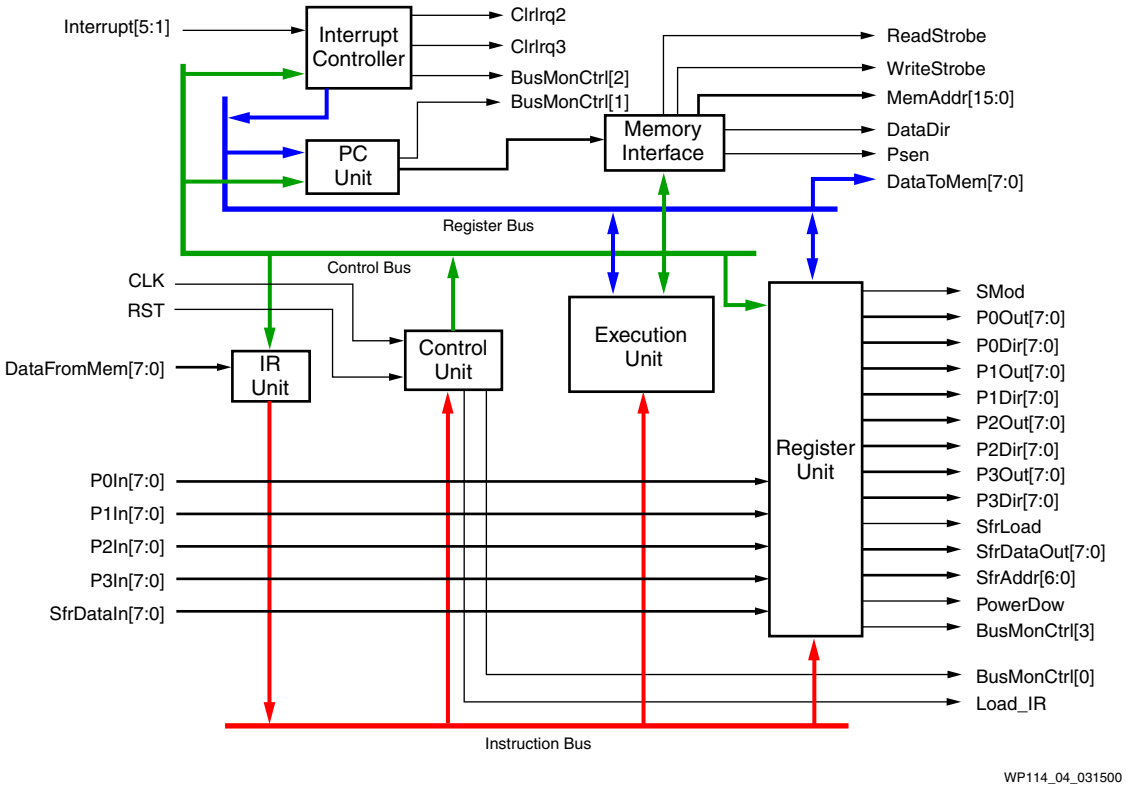

Figure 4: **Flip805x-PR Core Block Diagram** *(Courtesy: Dolphin Integration)*

The Flip805x-PR core is an enhanced version of the 8051/52 microprocessor (peripherals, such as Timers and Serial Interface, are not included). It is 100% code compatible with the original 8051/52 and uses modern processor techniques to increase processing speed an average of eight times while running at the same clock frequency. The extra processing power can be used to perform high speed applications, or to run the same software at a slower clock speed, for saving power consumption, or even to increase the complexity of your 8051/52 based application. The Flip805x-PR core is partitioned into modules like the IR (Instruction Register) Unit, Control Unit, Execution Unit, Register Unit, PC (Program Counter) Unit, Memory Interface and Interrupt Controller. More information on the Flip805x-PR core can be obtained from http://www.xilinx.com/products/logicore/alliance/dolphin/flip805x-pr.pdf.

Dolphin Integration, created as a French SA in 1985, has a rich history as a fabless microelectronics development center. Dolphin has considerable experience in the design of library cells, mixed signal and pure logic ICs, and ASICs. Dolphin's R&D efforts have resulted in a portfolio of key patents and algorithms that can be embedded either in software or hardware. In July 1994 reassessing its direction, Dolphin put itself on a new course towards aggressive growth with an innovative product strategy in the two areas of Intellectual Property (IP) and Electronic Design Automation (EDA). The company's products, coupled with their technically skilled design teams offer the best integration solution for Xilinx customers through product sales, support and development services, prototyping and serial parts delivery. More information about Dolphin and their IP portfolio for Xilinx's products can be obtained at www.xilinx.com/products/logicore/alliance/dolphin/dolphin.htm

D80530C 8-bit Microcontroller Core from CAST, Inc.

The *D80530C Microcontroller core (Figure 5)* supports Spartan-II devices. Some of its features include:

- 8-bit Control Unit
- 8-bit Arithmetic Logic Unit (ALU)
- 32-bit Input/Output ports
- Two 16-bit Timer/Counters
- Interrupt Controller
- Internal Data Memory interface can address up to 256 bytes of Read/Write Data Memory Space
- External Memory interface can address up to 64K bytes of External Program Memory Space and up to 64K bytes of External Data Memory Space
- Dual Data Pointer
- Variable length MOVX to access fast/slow RAM/peripherals
- Special Function Registers interface
- Early-warning power-fail interrupt
- EMI reduction mode disables ALE

Some of the optional features provided by CAST for the D80530C Microcontroller core are:

- Three 16-bit Timer/Counters
- Two Serial Peripheral Interfaces in full duplex mode
- 15-bit Programmable Watchdog Timer
- 32-bit Fast Multiplication-Division Unit
- 4x16-bit Compare/Capture Unit
- 15-bit Programmable Watchdog Timer
- Real Time Clock

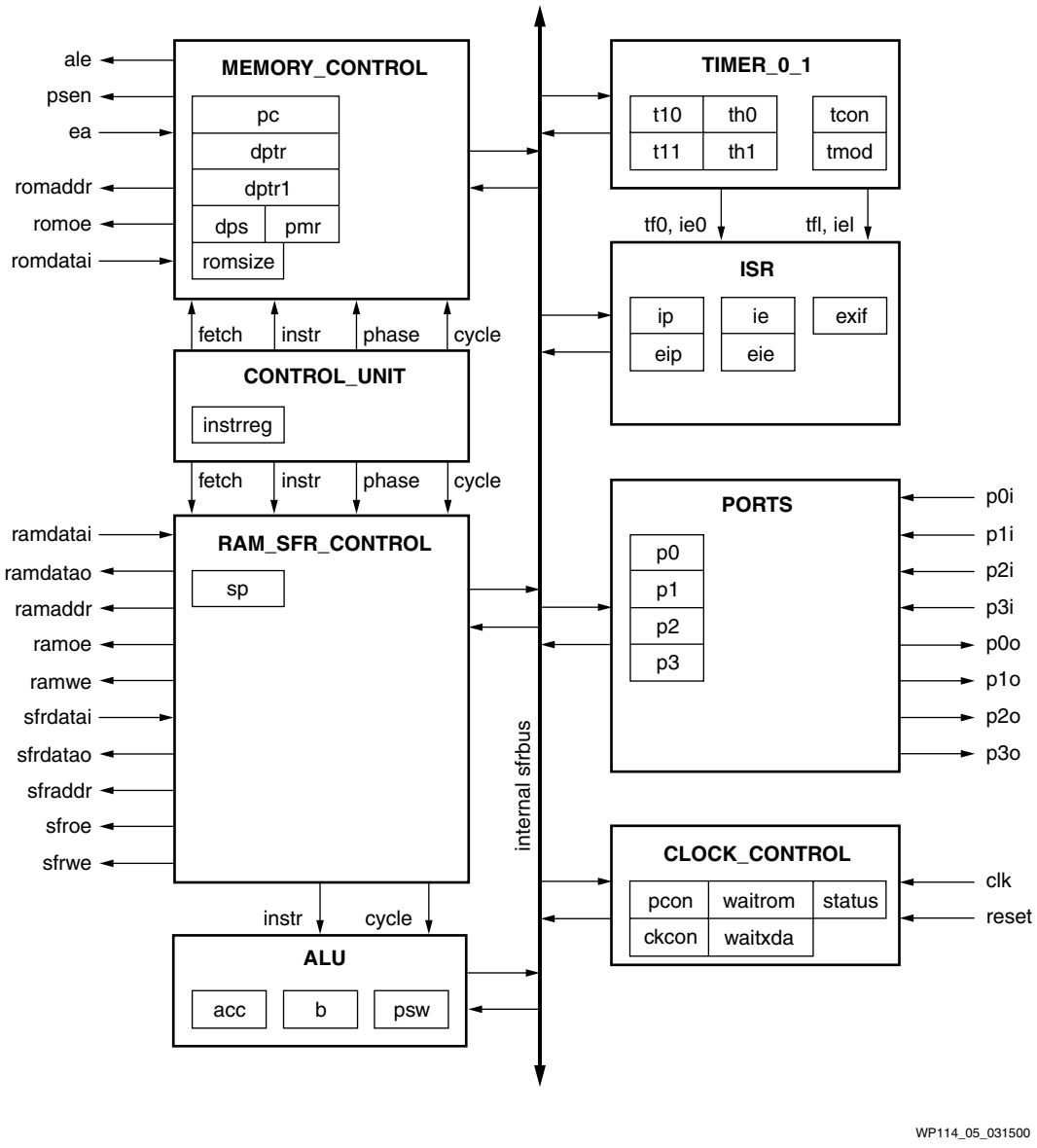

Figure 5: **D80530C Microcontroller Core** *(Courtesy: CAST, Inc.)*

The D80530C core ported on a XC2S150 (-6 speed grade) boasts performance up to 51 MHz. The D80530C core is a fast single-chip 8-bit Microcontroller, and is a fully functional 8-bit embedded controller that executes all ASM51 instructions and has the same instruction set as the 80C51. The D80530C serves software and hardware interrupts, provides an interface for serial communications, a timer system with auto-reload resources and a watchdog timer. The D80530C is a microcode-free design optimized for FPGA implementations. The design is strictly synchronous with positive-edge clocking, no internal tri-states and a synchronous reset; therefore, scan insertion is straightforward. The block diagram of the D80530C core is shown in Figure 5. More information on the D80530C core can be obtained from: http://www.xilinx.com/products/logicore/alliance/cast/d80530c.pdf.

CAST Inc. focuses on maximizing the success of FPGA designs by supplying high-quality, high-value models for simulation and synthesis. CAST provides a total modeling solution for FPGA design by delivering and supporting accurate, reliable, and affordable VHDL models ready for use by designers worldwide. CAST supplies a variety of support programs, VHDL training programs, consulting services, and custom modeling services. For more information regarding CAST and their IP portfolio for Xilinx's products please visit www.xilinx.com/products/logicore/alliance/cast/cast.htm.

Applications of 8-bit Microcontrollers

Eight bits have been proven to be a useful word size for small computing tasks. Capable of 256 decimal values, or quarter-percent resolution, the 1-byte word is adequate for many control and monitoring applications. Serial ASCII data is also stored in byte sizes, making eight bits the natural choice for data communications. Most integrated circuit (IC) memories and many logic functions are arranged in an 8-bit configuration that interfaces easily to data buses of eight bits. Hence, application sophistication can also range from a simple appliance control to high-speed machine control and data collection. This has caused the microcontroller vendors to establish extensive "families" of similar models. All feature a common language, but differ in the amount of internal ROM, RAM, and other cost-sensitive features. This allows performing of complex data manipulation functions and real time control capability.

There are significant advantages realized in implementing control applications with 8051 microcontrollers:

- **Popularity** – Readily available and widely supported
- **Fast and effective** – The architecture correlates closely with control systems, and the specialized instructions mean that there are fewer bytes of code that need to be fetched and fewer conditional jumps are processed.
- **Low cost** – High-level system integration is possible within one component, and only a handful of components are needed to create a working system
- **Wide range** – Variants of high performance and low power products are available, hence providing a real cost savings in tools, training, and software support
- **Compatibility** – Opcodes and binaries are the same for all 80x51 variants (unlike most other microcontroller families)
- **Multisourced** – Over 12 manufacturers and hundreds of varieties are available
- **Constant improvements** – Improvements in silicon/design which increase speed and power are made constantly, low cost models are also available

Applications for 8-bit microcontrollers like the 8051 are in the area of data communications, consumers, defense, space, video, biomedical, and industrial applications. Some popular applications that use 8051 microcontrollers are in:

Home

- Home networking appliances
- Bluetooth appliances
- xDSL modems, cable modems
- Set-top boxes
- Voice recognition (video phone) and video-processing
- Home PCs and Notebook computers (CD-ROM drives, tape drives, keyboards, mouse, printers, modems, scanners)
- Appliances:
  - Digital telephones, answering machines, fax machines
  - Secure surveillance systems (security video cameras)

  - TVs, HDTV (High-definition TV), Digital TV (DTV)
  - VCR, DVD/VCD players
  - Remote control
  - Cable TV tuner
  - Intercom
  - Garage door openers, lighting control
  - Microwave
- Camera, PC and digital camera, camcorder
- Wireless telecommunications: cellular phones, pagers
- Video games, toys, exercise equipment

Office

- Digital telephones, fax machines
- PCs: (laser and color printers, scanners)
- Security systems
- Copiers
- Vending machines
- POS terminals

Automotive applications

- Trip computer
- Engine control
- Air bag
- ABS
- Instrumentation
- Security system
- Transmission control
- Entertainment
- Climate control
- Cellular phone
- Keyless entry

Other applications

- Industrial controls
- System supervision
- Motor Control (Brushless motors control in avionics)
- Aerospace
- Biomedical instruments (activity control of a pace maker through RF link)
- Communication through power lines
- Telecom, datacom and Networking (linecards)
- Light rail transportation
- Hand-held/Portable devices
- Data logging

The following solutions exemplify the working of the 8-bit microcontrollers in embedded systems:

- **Keyboards:** The 8051 microcontrollers are used to interface between the keyboard and the main processor in PCs.
- **Displays:** Seven-segment numeric displays (LED) are increasingly used in handheld wands, factory-floor terminals, vending machines, and automotive dashboard; and LCD displays are used in medical diagnostic systems. In seven-segment numeric and LCD displays, 8051 microcontrollers are used and optimized to accept an 8-bit ASCII character and convert the ASCII code to the corresponding alphanumeric pattern.
- **Pulse measurement instruments:** Sensors used for industrial and commercial control applications frequently produce pulses that contain information about the quantity sensed. Varying the sensor output frequency, using a constant duty cycle but variable frequency pulses indicate changes in the measured variable, is most common. Varying the duration of the pulse width results in constant frequency but a variable duty cycle.
- **D/A (digital-to-analog) and A/D (analog-to-digital) conversions:** Conversions between the analog and digital worlds requires the use of ICs that have been designed to interface with computers. Intelligent microcontrollers like the 8051 are used since they have a 8-bit and tri-state parallel data bus, and a control bus.
- The fast-growing industries of **home networking and Bluetooth** use 8051 microcontrollers in embedded devices like home appliances that can be connected to the internet and controlled remotely using a standard web browser.

These examples and the home, office, automotive and other applications mentioned highlight the wide-spread use of 8051 microcontrollers in embedded applications.

High-performance Spartan-II 8-bit Microcontroller Solution

PLDs and FPGAs have always been viewed as being expensive, slower, and less feature rich than comparable ASICs. This limited their success in penetrating the ASSP market. Bringing programmability and its traditional benefits to a design solution is always an expensive proposition and PLDs have traditionally lost the battle to the cost-optimized custom solution or ASIC. The use of innovative process technologies has leveled this playing field. This approach has allowed PLDs to significantly reduce die sizes, and therefore lower the cost of the overall solution. This rapid transition in process technology has allowed PLD vendors to service the needs of today's ASSP designers.

The Spartan-II FPGA family addresses fast TTM by integrating powerful new system-level features that provide an attractive solution for today's system level designer. Some of the associated features include SelectI/O, Block RAM, Distributed RAM and DLLs. The product family has high performance with clock speeds up to 200 MHz, and power management capabilities at much lower costs. These features position the Spartan-II family as a low-cost, low-power and high- performance programmable ASSP alternative of the most prevalent 8-bit microcontroller—the 8051.

The extensive features position the Spartan-II family as a low-cost, high-performance ***programmable ASSP*** alternative and expand the TTM advantage that PLDs traditionally offer. There are some significant advantages in using the 8051 microcontroller soft-IP in a Spartan-II device.

Speed and Performance

The 8051 microcontroller IP (Flip805x-PR core) from Dolphin Integration ported on a Spartan-II device runs at speeds up to 29.8 MHz; additionally the D80530C core from CAST ported on a XC2S150 (-6 speed grade) operates at 51 MHz. The Flip8051 core runs on an average, eight times faster than a legacy 8051. The 80530 cores are targeted for low gate densities and have instruction execution performance equivalent to 2.5 times the legacy 8051 microcontroller. This means that one does not have to move up to more expensive (16- or 32-bit) microcontroller architectures to get higher processing power. Operating at these speeds allows higher

performance than other ASSPs in the 8051-microcontroller market. The higher performance coupled with the advanced power management capabilities in the Spartan-II devices, competitively positions this solution with other ASSPs.

Embedded Solution

Using the Spartan-II family in conjunction with appropriate IP cores allows the designer to choose the right feature set and optimize the programmable ASSP, to achieve the desired results. Designers can also integrate their value proposition within the same piece of silicon, to allow product customization and reduced costs. This flexibility comes at a significantly lower cost when compared to the fixed ASSP solution, due to the inherent low cost of the Spartan-II family. Being integrated in consumer applications like PCs, cable modems, set-top boxes, LANs, home networking, and Bluetooth wireless systems, image processing and voice recognition application, highlights the value proposition of Spartan-II FPGAs. The Spartan-II FPGA enabled high-speed microcontroller fits in any system where high performance and/or low power are required. This microcontroller is used in 8-bit data processing, low-power consumption, complex processing and other high-speed applications.

Value Addition Through Flexibility Provided by a Reconfigurable Fabric

Stand-alone ASSPs do not and cannot provide the flexibility provided by the Spartan-II FPGA fabric. With the recently introduced Spartan-II FPGA offering more than 100,000 system gates at under $10, increased densities and higher performance are available at lower costs. Spartan-II devices provide flexibility due to logic being leftover, and this allows integration of other soft IP with the 8051 IP, hence creating an embedded solution such as a high-speed memory interface.

The Spartan-II family accommodates specification changes that can be easily adopted, in post volume production as part of the solution. Conflicting specifications and lack of a clear direction create the need for programmable ASSP solutions. The reprogrammable FPGA fabric permits the use of the Spartan-II 8051 microcontroller within applications where specifications have not been decided. Using Spartan-II devices in applications such as home networking and Bluetooth allows the ability to include any specification changes made by the governing board (such as the Bluetooth SIG (Special Interest Group)) later. It would be nearly impossible and cost-prohibitive for an ASSP vendor to cater to all the various specifications. However, at the same time betting on the success of one single product may preclude them from being successful in the marketplace. These conditions create many opportunities for the Spartan-II family–the industry's first programmable ASSP. Because of the high profit margins involved with these products, designers can easily continue using programmable ASSPs in volume production.

Additionally, most stand-alone ASSPs never behave as expected, due to reasons ranging from bugs in the silicon, system integration issues, software drivers, or even user error. Irrespective of the cause, verifying and identifying device problems can be very difficult with ASSPs, but a lot easier with programmable ASSPs. Having been built on the fabric of a proven FPGA technology and having silicon that is pre-verified and guaranteed to perform, potential problems in the Spartan-II family are narrowed down to a software-only issue. Xilinx provides powerful tools that improve the transparency of the final solution. With the help of HDL simulators, test benches, and run-time debugging tools like ChipScope designers can easily identify the problem. Because a programmable ASSP is inherently reprogrammable, fixing the problem is also simple. This is a tremendous value-add feature that a stand-alone ASSP cannot offer. It is much simpler to integrate an 8051 microcontroller that is reprogrammable, than an ASSP which performs its specific task.

IRL: Internet Reconfiguration Logic

Through the Xilinx Online (IRL) program, a programmable ASSP, such as the Spartan-II family, allows a designer to gain market share by bringing them to market sooner than a stand-alone ASSP. Spartan-II FPGAs are based on SRAM technology and are customized by loading

configuration data into the internal memory cells and therefore it is very easy to re-program them an unlimited number of times. Updating the functionality of the FPGA only requires that the designer include a mechanism for updating the configuration bitstream. Remotely updating software with any new enhancements and bug fixes, increases the life of the 8051 microcontroller within any solution. Designing systems that do remote upgrades can also provide new revenue opportunities. After the initial product is released, new hardware features can be developed, sold and distributed inexpensively to existing customers in much the same way as new versions of software can be distributed today. In addition, a standard "off-the-shelf" application can be developed so that the features can be swapped in and out depending on what the end-user purchases or needs. The designer can hence take advantage of the fact that the solution now allows them to upgrade their hardware and stay in the market-place longer, thus maximizing profitability.

These significant features of the Spartan-II solution like high performance, power management capabilities, reconfigurable logic, reduced TTM, improved testing and verification, field upgradability (through IRL) and cost effectiveness show the advantage presented by Spartan-II devices. This positions the Spartan-II FPGAs to be superior than other programmable logic and ASSP solutions, making the Spartan-II family a clear winner in not only the 8-bit microcontroller market, but in other ASSP niche areas also.

The Spartan-II family is unaffected by the hurdles that an ASSP vendor needs to overcome, and offers a cost-effective programmable ASSP solution. The solution's inherent advantages extend the reach of the Spartan family to new levels and create new opportunities for PLDs in the ASSP market.

The dynamics in the ASIC/ASSP marketplace are opening up new opportunities for PLDs and is allowing them to compete against ASSPs. Due to its extensive features and cost effectiveness, the Spartan-II solution has all the unique ingredients that enable Xilinx to succeed against traditional ASSPs. The underlying programmable nature to the solution further bolsters the value of a programmable ASSP. An end customer can choose to use the 8051 solution as sold by Xilinx or choose to augment or change the solution to best suit their needs. This is a testimonial to the tremendous potential that PLD vendors have for addressing the ASSP marketplace.

Conclusions

8-bit microcontrollers, like the 8051 are deployed within a number of applications ranging from consumer products and computer peripherals to automotive systems and aerospace designs. The Spartan-II devices with their extensive features and cost effectiveness compete effectively against ASICs and ASSPs in all these systems. Through the value proposition of the 8051 microcontroller (and its variant) IP in a Spartan-II FPGA, the programmable ASSP message is further confirmed. The Xilinx Spartan-II 8-bit microcontroller solution is ideal for the many applications in which not only cost and space is critical, but also intelligence and programmability is key. Because today's 8-bit designs require increasing performance, Spartan-II FPGAs provide a solution with increased performance and additional features for real-time applications. A Spartan-II FPGA-based 8051 solution provides the necessary scalability and flexibility to allow integration of other IP on the FPGA fabric, making it an embedded solution. This positions the Spartan-II family uniquely in being able to compete with ASSPs.

References

- Flip805x-PR core can be obtained from http://www.xilinx.com/products/logicore/alliance/dolphin/flip805x-pr.pdf
- D80530C core can be obtained from: http://www.xilinx.com/products/logicore/alliance/cast/d80530c.pdf
- "*The 8051 Microcontroller and Embedded Systems*," Mazidi and Mazidi
- "*The 8051 Family of Microcontrollers*," Barnett
- Intel Corporation

Revision History

The following table shows the revision history for this document.

Date	Version	Revision
03/16/00	1.0	Initial Xilinx release.