Addressing Today’s Embedded Design Challenges with FPGAs

Wayne Marx
Embedded Platform Sales Mgr, North America
September 29, 2007
Agenda

• Xilinx Overview
• Programmable Technology Trends
• Meeting Embedded Design Challenges With FPGAs
• Xilinx Processing Solution Set
• Final Notes
Xilinx Overview

September 29, 2007
Mission

To help our customers attain the fastest time-to-market, flexible product life-cycle management and total cost management by focusing on **programmable technology solutions** consisting of industry leading silicon, software, IP, support and services.
Xilinx At-A-Glance

• Leader in Programmable Logic
  — Invented programmable chip in 1984
  — Went Public as XLNX on NASDAQ in 1990
  — One of the fastest growing semiconductor segments
  — 7,500+ customers; 50,000 design starts/year
  — $1.87B revenue in FY’07

• Pioneer of fabless semiconductor model
  — Focus on core competencies: Design, Marketing, Support
  — Partner for everything else

• Leader in Semiconductor Process Technology
  — First to 180nm, 150nm, 130nm, 90nm
  — First to 65nm with Virtex™-5 in 2006
Programmable Technology Trends
Typical Xilinx FPGA Pricing Roadmap

Process technology leadership drives down costs

500K Gates ~ $150-$200

30X cost reduction in 7 years exceeds the pace of Moore’s Law

500K Gates ~ $5-$7
Example: Mercedes S-Class

18 XILINX DEVICES IN EACH VEHICLE IF ALL OPTIONS ORDERED

- Rear Seat Entertainment
  - Harman Becker - 4 FPGA

- Navigation System
  - Harman Becker - 1 FPGA

- DVB-T Reception
  - Delphi/FUBA – 2 FPGA

- Night Vision
  - Bosch - 2 FPGA and 1 PROM

- Adaptive Cruise Control
  - Conti-ADC - 1 FPGA

- Short-Range Radar (Stop-and-Go System)
  - Conti-ADC – 6 CPLD and 1 FPGA
Industry Analysis - Gartner Report

Embedded Processing Moving into FPGAs

Number of FPGA/PLD Design Starts

- Without MPU
- With MPU

1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010

MPU = Microprocessor Unit

Source: Gartner Dataquest (June 2005)

40% of FPGA designs in 2010 will have Embedded Processors!
**EETimes Survey**

*Embedded Processors on FPGA*

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**2006 State of Embedded Market Survey**

**Current processor vendor**

<table>
<thead>
<tr>
<th>Vendor</th>
<th>2006 %</th>
<th>2006 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freescale/Motorola</td>
<td>36</td>
<td>4</td>
</tr>
<tr>
<td>Intel</td>
<td>24</td>
<td>3</td>
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<tr>
<td>Microchip</td>
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<td>3</td>
</tr>
<tr>
<td>Texas Instruments</td>
<td>18</td>
<td>3</td>
</tr>
<tr>
<td>Atmel</td>
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<tr>
<td>Xilinx</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>National Semiconductor</td>
<td>8</td>
<td>2</td>
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<tr>
<td>Silicon Labs</td>
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<td>Analog Devices</td>
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<td>Altera</td>
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<tr>
<td>IBM</td>
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<tr>
<td>STMicro</td>
<td>4</td>
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<tr>
<td>Renesas</td>
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</table>

**2006 State of Embedded Market Survey**

**Processor Vendor Consideration**

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<tr>
<th>Vendor</th>
<th>2006 %</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Freescale/Motorola</td>
<td>47</td>
<td>9</td>
</tr>
<tr>
<td>Intel</td>
<td>33</td>
<td>8</td>
</tr>
<tr>
<td>Texas Instruments</td>
<td>33</td>
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</tr>
<tr>
<td>Microchip</td>
<td>26</td>
<td>8</td>
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<tr>
<td>Atmel</td>
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</tr>
<tr>
<td>Xilinx</td>
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<td>National Semiconductor</td>
<td>15</td>
<td>8</td>
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<tr>
<td>Analog Devices</td>
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<td>8</td>
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<tr>
<td>Altera</td>
<td>11</td>
<td>8</td>
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<tr>
<td>ST Micro</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>National Semiconductor</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>NEC</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Zilog</td>
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</tbody>
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http://www.embedded.com//showArticle.jhtml?articleID=193101174
Embedded Design Challenges
Embedded Design Challenges

1. Drive Towards System Integration - More into Less
2. Finding the Right Part for the Job
3. Addressing Changing System Requirements
4. Protecting Against Part Obsolescence
5. Addressing Bottlenecks - After the Fact
Embedded Design Challenges

1. Drive Towards System Integration - More into Less
2. Finding the Right Part for the Job
3. Addressing Changing System Requirements
4. Protecting Against Part Obsolescence
5. Addressing Bottlenecks - After the Fact
FPGAs Are Perfect for Integrating Several Functions into One Device

- Reduces board size
- Reduced cost
- Less parts inventory
- Lower Power

Highest level of integration reduces board size and cost
Embedded Design Challenges

1. Drive Towards System Integration - More into Less
2. Finding the Right Part for the Job
3. Addressing Changing System Requirements
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Embedded Design Challenges

… rarely the ideal mix of peripherals

- Difficult to Find the Required Mix of Peripherals in Off the Shelf (OTS) Microcontroller Solutions
  - Even with variants, compromises must still be made

**FPGAs flexibility allows ideal mix of peripherals for YOUR application**
Embedded Design Challenges

1. Drive Towards System Integration - More into Less
2. Finding the Right Part for the Job
3. Addressing Changing System Requirements
4. Protecting Against Part Obsolescence
5. Future Proofing – Path to Upgradeability
Embedded Design Challenges

... and the requirements are?

- Selecting a Single discrete Processor Core with Long Term Solution Viability is Difficult at Best
  - Future proofing system requirements is difficult at best

Today's System Requirements
- 100 MHz
- 2@ UART
- TIMER
- I2C
- SPI
- GPIO
- FLASH
- DDR SDRAM
- 10/100 Ethernet

Future System Requirements
- 100 MHz
- 2@ UART
- TIMER
- I2C
- SPI
- GPIO
- FLASH
- DDR SDRAM
- Gigabit Ethernet

- Changing discrete processor cores to accommodate new requirements consumes valuable design resources

**Xilinx’s processor cores offer wide range of proven IP to accommodate!**
Embedded Design Challenges

1. Drive Towards System Integration - More into Less
2. Finding the Right Part for the Job
3. Addressing Changing System Requirements
4. Protecting Against Part Obsolescence
5. Addressing Bottlenecks - After the Fact
Embedded Design Challenges

... here today, gone tomorrow

- Without Direct Ownership of the Processing Solution, Obsolescence is Always a Concern
  - A single core is used to create a family of μCs
  - The sheer number of μC configurations can lead to obsolescence of lower volume configurations/variants

*Longevity of FPGAs is generally in excess of 10 years*
Embedded Commitment

100% Code Compatible!
Embedded Design Challenges

1. Drive Towards System Integration - More into Less
2. Finding the Right Part for the Job
3. Addressing Changing System Requirements
4. Protecting Against Part Obsolescence
5. Addressing Bottlenecks - After the Fact
Embedded Design Challenges

... fixed architecture limit limits choices

- OTS Microprocessor Based Solutions have fixed interfaces
  - Fixed Bus Interfaces
  - Fixed I/O Interfaces

- An external, pre-defined interface between a μP imposes architectural limits on achieving performance/ cost targets

FPGA Integration provides endless Architectural Choices...
Performing some SW tasks in HW can be expensive

Performing some HW tasks in SW can be slow

Tune your system for the optimum Hardware/Software balance. Off-the-shelf processors can not deliver this!
Accelerating Software Emulation Floating Point

MicroBlaze/FPU Benefit

- Intermediate between general purpose and highly-optimized
- Out-of-the-box and go. Shun additional gates
- Use in horizontal applications where standards are still evolving

SW Emulation FP versus FPU

Note: This data is with MicroBlaze v5.00 on Virtex-5. Similar results for MicroBlaze v4.00 on Spartan3.
Tailor the System to Achieve Performance
Take MP3 Decoding with Custom Hardware Logic

Custom Hardware Logic

- 100MHz MicroBlaze, pure software = 146 seconds
- 100MHz MicroBlaze + FSL + LL MAC = 9 seconds
- 100MHz MicroBlaze + FSL + DCT + IMDCT + LL MAC = 7 seconds

Note: MicroBlaze v4.00 core, ML40x board, 100MHz system clock, EDK8.1
Xilinx Processing Solution Set
The FPGA Technology
Cost Optimized Spartan Architecture

- Cost and size are premium
- Low power is key; “Just enough performance”
- Shorter time-in-market

Xilinx Processing Solution Set

Low Cost:
Performance Optimized Virtex Architecture

- Performance & capability are premium
- Power & cost constrained
- Longer time-in-market
Microprocessors and IP
ESD’06 Industry Survey Results:
Xilinx eSolutions Meet/Exceed Market Requirements

Clock Rates

Xilinx Processing Solutions cover nearly 80% of the 32 bit market based on clock rates

* Data from Embedded Systems Design Mag Survey 2006’
# Xilinx Embedded PowerPC Evolution

<table>
<thead>
<tr>
<th>Feature</th>
<th>PowerPC 405 on V2 Pro</th>
<th>PowerPC 405 on V4 FX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipeline Depth</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Processor Frequency</td>
<td>300 Mhz</td>
<td>450 Mhz</td>
</tr>
<tr>
<td>Max Integer Performance</td>
<td>450+ DMIPS</td>
<td>700+ DMIPS</td>
</tr>
<tr>
<td>Cache Size (Instruction &amp; Data)</td>
<td>16 KB</td>
<td>16 KB</td>
</tr>
<tr>
<td>Dedicated Memory Interface</td>
<td>DOCM &amp; IOCM</td>
<td>DOCM &amp; IOCM</td>
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<tr>
<td>PLB Interface</td>
<td>64-bit PLB</td>
<td>64-bit PLB</td>
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<tr>
<td>Floating Point Unit</td>
<td>--</td>
<td>Single &amp; Double Precision FPU</td>
</tr>
<tr>
<td>Coprocessor Interface</td>
<td>--</td>
<td>APU (64-bit)</td>
</tr>
<tr>
<td>Primary FPGA Targets</td>
<td>Virtex-2 Pro</td>
<td>Virtex-4 FX</td>
</tr>
</tbody>
</table>

Backwards Compatibility = Customer Software Investment is Protected
## MicroBlaze Processor Evolution

<table>
<thead>
<tr>
<th>Features</th>
<th>MicroBlaze versions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>V1.0</td>
</tr>
<tr>
<td>Pipeline Depth</td>
<td>3</td>
</tr>
<tr>
<td>Max Integer Perf.</td>
<td>82 DMIPS</td>
</tr>
<tr>
<td>Local Memory</td>
<td>0 or 8 - 64 KB</td>
</tr>
<tr>
<td>Multiplier, Barrel Shifter</td>
<td>option</td>
</tr>
<tr>
<td>Divider</td>
<td>option</td>
</tr>
<tr>
<td>Coprocessor Interface</td>
<td>--</td>
</tr>
<tr>
<td>Instr. &amp; Data Cache</td>
<td>--</td>
</tr>
<tr>
<td>Cache Interface</td>
<td>Cache Link</td>
</tr>
<tr>
<td>Floating Point Unit</td>
<td>--</td>
</tr>
<tr>
<td>Max FPU Performance</td>
<td>--</td>
</tr>
<tr>
<td>Debug Interface</td>
<td>ROM monitor</td>
</tr>
<tr>
<td>Primary FPGA Targets</td>
<td>Virtex II</td>
</tr>
<tr>
<td></td>
<td>Spartan 2</td>
</tr>
</tbody>
</table>

Backwards Compatibility = Customer Software Investment is Protected
# PicoBlaze

## Simple 8-bit Microcontroller Core

### Processor

<table>
<thead>
<tr>
<th>Processor (CPU) Type</th>
<th>8-bit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor Architecture</td>
<td>PicoBlaze</td>
</tr>
<tr>
<td>Processor Frequency</td>
<td>25 Mhz to 100 Mhz</td>
</tr>
</tbody>
</table>

### Peripherals (IP cores)

<table>
<thead>
<tr>
<th>Memory</th>
<th>On-Chip RAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP Peripherals</td>
<td>GPIO, Custom User Peripherals</td>
</tr>
</tbody>
</table>

### Software

<table>
<thead>
<tr>
<th>Languages</th>
<th>Assembly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tools</td>
<td>Free Assembler, Simulator</td>
</tr>
</tbody>
</table>
Growing Suite of Peripheral IP

Memory Interface Cores
- External Memory Controller (SRAM/Flash)
- SDRAM Memory Controller
- DDR SDRAM Memory Controller
- DDR2 SDRAM Memory Controller
- System ACE Interface Controller
- LMB BRAM Interface Controller
- OPB BRAM Interface Controller

Peripherals
- PCI Arbiter
- External Peripheral Controller
- CAN Controller
- HDLC Interface
- Chipscope Integrated Controller
- Chipscope Integrated Logic Analyzer
- Chipscope OPB Integrated Bus Analyzer

Peripherals (continued)
- Interrupt Controller
- 16450/16550 UART
- UART Lite
- IIC
- SPI
- Ethernet (EMAC)
- Ethernet Lite (EMAC Lite)
- ATMC (Trace Core)
- Timer/Counter
- Fixed Interval Timer
- Watchdog Timer
- GPIO
- Central DMA Controller

...And More!

Pre-Designed, Verified and Validated for Xilinx Solutions
Tools
Platform Studio

- Intuitive design environment for Xilinx Platform FPGAs
  - One environment for both MicroBlaze and PowerPC
  - HW and SW platform definition and generation
  - Extensive IP library
  - Comprehensive design verification and debug

- Integrated verification and debug
  - Platform Debug
  - SW simulation models
  - Automated paths to development kits
Platform Studio SDK

- Intuitive SW environment for Xilinx uProcessors
  - Focused on software design/ debug
  - Software project management
  - Same environment for both MicroBlaze and PowerPC
  - Built on Eclipse framework
- Integrated profiling views
- Simple HW & SW platform integration
Platform Debug
Integrated HW/SW Debuggers

- Cross Trigger HW and SW Debuggers to Find and Fix Bugs Faster!
- Enable better insight into the HW/ SW code dynamics
Complete Embedded Processing Solutions

ChipScope Debug Tools

Embedded Tools

SW & Programming Platform
- Protocol Stacks
- Device Drivers
- BSP Generation
- Source Included
- Virtual Board

IP Library

Reference Designs
- Ultra Controller II
- Gigabit System Reference Design
- APU/FPU
- Applications/Reference Design
- Multiple Processors others...

Complete Kits

Development Boards

3rd Party

Documentation & Training

Xilinx Processing Solution Set
Embedded HW/SW Kits

Complete development Kits

- Development Board
- EDK/XPS and ISE design software tool suites
- Pre-Verified Reference Designs
- JTAG Probe (USB/PC4), Regional Power Supply
- FLASH device, Ethernet & Serial Cables
- Documentation

Embedded Processing Success

By Market Segment

Success in All Major Segments:
• Audio, Video & Broadcast
• Automotive & Transport
• Computing & Data Processing
• Consumer
• Defense & Aerospace
• Industrial, Scientific & Medical
• Military Communication, Intel, & Sensors
• Storage
• Test & Measurement
• Wired Comms & Networks
• Wireless Comms & Networks

Processing Systems Tailored for Target Applications
To Find Out More....

• Xilinx Embedded Magazine
  – Latest Issue – *On the Move*
  – A Xilinx Xcell Publications Technology Magazine

• On the web at Xilinx.com
  – Xilinx Processor Central site
  – Xilinx Embedded Development Kit, Platform Studio Tools
    • [www.xilinx.com/ise/embedded_design_prod/platform_studio.htm](http://www.xilinx.com/ise/embedded_design_prod/platform_studio.htm)
  – Xilinx Embedded Training Courses
    • [www.xilinx.com/support/training/XPS-package.htm](http://www.xilinx.com/support/training/XPS-package.htm)
  – Xilinx Design Services
    • [www.xilinx.com/xds/index.htm](http://www.xilinx.com/xds/index.htm)
  – Xilinx and Partner Boards (Reference, Development, Eval)
    • “Xilinx On Board”
      • [www.xilinx.com/xlnx/xebiz/board_search.jsp](http://www.xilinx.com/xlnx/xebiz/board_search.jsp)
    – Xilinx and Partner IP
      • [www.xilinx.com/ipcenter/](http://www.xilinx.com/ipcenter/)
    – Xilinx Online Store
      • [www.xilinx.com/onlinestore/index.htm](http://www.xilinx.com/onlinestore/index.htm)

• On the web at Xilinx.com
Thank You!