Set Top Boxes

Programmable Solutions for the Broadcast Industry
Set Top Box Market Dynamics

- Specifications are and will continue evolving
- Multiple standards
  Need for Interoperability
- Leading players are indecisive towards varying technologies
- Flexibility for product differentiation
- ASSPs are not readily available
- Xilinx solutions enable you to thrive in chaos
  Time-to-Market
  Flexibility
  Low Cost
Set Top Box Evolution

- **Basic Receiver**
  - Single MPEG Decoder
  - ISDN Connection
  - Limited Interactivity

- **Interactive STB**
  - Single MPEG Decoder
  - ISDN Connection
  - Internet and Email
  - Shopping/Banking/Gaming
  - Enhanced Viewing
  - Near Video-on-Demand

- **PVR STB**
  - Dual MPEG Decoder
  - ISDN Connection
  - Internet and Email
  - Shopping/Banking/Gaming
  - Enhanced Viewing
  - Near Video-on-Demand
  - HDD Local Storage
  - Rewind/Pause Live Shows
  - Surround Sound Decoding
  - Memory Card Interfaces

- **RG/Media Server**
  - Dual MPEG Decoder
  - Broadband Connection
  - Internet and Email
  - Shopping/Banking/Gaming
  - Enhanced Viewing
  - True Video-on-Demand
  - HDD Local Storage
  - Rewind/Pause Live Shows
  - Surround Sound Decoding
  - Memory Card Interfaces
  - Video Streaming
  - Home Networking
  - Media Server Capabilities
  - Integrated Games Console
  - Integrated DVD Recorder
Xilinx in Set Top Boxes

• Proven solutions in leading set top manufacturers
  • From prototyping and field trials to production
    – Provide flexibility, time-to-market and system integration
• FPGAs/CPLDs are also enabling rapid technology convergence in next generation gateways
  – Spartan-3 FPGAs are high density, high performance devices with rich features at low costs
  – CoolRunner-II CPLDs provide high performance and low power application specific logic at extremely low cost
The Convergence Product

Integrating Broadband Access, Home Networking and Digital Video Functions into One Device

- Set-top Box/PVR
- CD/DVD Player/Recorder
- MP3 Jukebox
- PC
- Gaming Console

DSL  Cable  Satellite  Wireless

IEEE 1394  USB / USB2.0  Bluetooth
Home PNA  Power Lines  HiperLAN2
Ethernet  802.11a,b

POTS

900 MHz Cordless Phones
Issues and Challenges

- Integrating different standards
  - Broadband access
  - Home networking
  - System interfaces
- Evolving home networking specifications
- Supporting different memory and storage types
- Content protection/encryption

- EMI signal management
- Power management
- Competitive pressures to bring new features rapidly to market
- In the field bug fixes and feature enhancements
- Supply chain management
- Overall cost management

Each can be addressed with Xilinx solutions
Peripheral Interfacing and System Glue

Interface features to the host processor
Quickly add new capabilities to existing products
Bridging Disparate Protocols

**Broadband Access Technology**
- xDSL
- Cable
- ISDN
- Satellite
- Fixed Wireless
- Ethernet
- V.90 Modem
- FTTH

**Internal Residential Gateway Bus**
- PCI
- ISA
- PCMCIA
- VME
- Cardbus
- I²C
- Rapid I/O
- SPI
- Ethernet/MII
- UART
- USB
- Pick your I/F

**Home Networking Technology**
- HPNA
- HomePlug
- Bluetooth
- HomeRF
- IEEE 802.11b
- HiperLAN2
- USB 2.0
- IEEE 1394
- Ethernet
- IEEE 802.11a
- HPNA 2.0
- Etc..

CoolRunner-II and Spartan-3 are perfect solutions to bridge disparate chipsets
Storage Reference Designs

- **PCMCIA**
  - Card-side (Spartan & CPLD)
  - Host-side (Spartan only)

- **CompactFlash+**
  - Card-side (Spartan & CPLD)
  - Host-side (Spartan only)

- **SD/MMC**
  - Card-side (Spartan & CPLD)
  - Host-side (Spartan only)

- **IDE/ATA**
  - Host-side only (Spartan)
System Voltage Integration

Support for multiple I/O voltages in the same chip facilitates interfacing to multiple peripherals.
Supporting Fast Memory Types

• Residential gateways use different memory types
  – SRAM - ZBT, QDR (currently 200MHz speeds)
  – DRAM - DDR, SDRAM (currently 200MHz speeds)
  – Flash - NAND, NOR
  – Some boxes use multiple memories in the same gateway

• Interfacing to the different memories requires high speed interfaces and memory controller IP
  – Require discrete level translators
  – Cost, board area, performance
Supporting Fast Memory Types

• Spartan-3 FPGAs
  – Unique and extensive features, flexible architecture
  – 24 high speed interfaces supported
    • HSTL I, III, IV for high speed SRAM
    • SSTL2, SSTL3 for SDRAM
  – Eliminates external translators
    • Lower cost, higher performance, less board space

• Comprehensive memory controller IP & reference design portfolio for interface to SRAM, DRAM, flash memory
  – Xilinx provides FREE VHDL source code for implementing the memory controllers in Spartan-3
  – Accelerates time-to-market
Memory Controller Reference Designs

- DRAM reference designs
  - 64-bit DDR DRAM controller
  - 16-bit DDR DRAM controller
  - SDRAM controller
- SRAM reference designs
  - ZBT SRAM controller
  - QDR SRAM controller
- Flash controller (FPGAs/CPLDs)
  - NOR / NAND flash controller
- Embedded memory reference designs
  - CAM for ATM applications
  - CAM using shift registers
  - CAM using Block SelectRAM
  - Data-width conversion FIFO
  - 170MHz FIFO for Virtex
  - High speed FIFO for Spartan-IIE

Download from Xilinx Memory Corner
A World of Choices Needs Flexibility

• Broadcast technologies
  – DTT (terrestrial), DBS (satellite), cable, DSL, ISDN, fixed wireless
  – DVB, ATSC, ISDB, DMB

• Home networking technologies
  – No new wires: phonelines, power lines
  – New wires: IEEE 1394, USB 1.1/2.0, Ethernet, optic fiber
  – Wireless: HomeRF, Infrared, Bluetooth, 802.11b/a, HiperLAN2

• System interfaces/buses (interconnectivity)
  – PCI, USB, AGP, processor, Ethernet (MII), proprietary

• Video standards
  – VGA, SVGA, XGA, SXGA, UXGA, WXGA, …
  – NTSC, PAL, SECAM, HDTV, SDTV
Evolving Specifications

• Home networking technologies continue to emerge
  – Wireless LANs - IEEE802.11 to IEEE802.11b to IEEE802.11a
  – Powerlines - CEBus, LONWork, CSMA/CD, X-10, Plug in, ....

• Home networking specifications continue to evolve
  – HomePNA v2.0 released earlier this year (10Mbps)
    • A 40Mbps specification is already in the works
  – HomeRF SWAP v1.3 spec is already out
  – With Bluetooth spec 1.1 out
    • Bluetooth SIG is already developing 2Mbps and 10Mbps spec

• FPGAs provide the flexibility to support continuously evolving specs - reprogramming the FPGA with minor spec updates
  – Splintered product volumes challenge the amortization in creating an ASIC
Content Protection/Encryption

• Set-top boxes and residential gateways require conditional access for downloading video, access, firewall
  – Authenticating the source of the information
  – Data privacy/encryption (integrity and secrecy)
• Several standard & proprietary encryption algorithms exist
• Lack of consensus between companies on the encryption schemes and their implementation is leading to chaos
  – Gateways require different encryption algorithms for different applications
  – These keep changing as well!
Content Protection - Significant Value Add

- Spartan-3 encryption solutions are NIST approved
- Programmable nature allows easy customization and improved flexibility
- Hardware-based solutions provide higher performance - software can’t keep up!

<table>
<thead>
<tr>
<th>Device</th>
<th>DES</th>
<th>Spartan-II Solution</th>
<th>AES</th>
<th>AES</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLB Slices</td>
<td>235</td>
<td>2S100E-6</td>
<td>2S150E-6</td>
<td>358*</td>
</tr>
<tr>
<td>Performance</td>
<td>94 MHz</td>
<td>48 MHz</td>
<td>82 MHz</td>
<td>82 MHz</td>
</tr>
<tr>
<td>Area Utilization</td>
<td>19.58%</td>
<td>93.22%</td>
<td>29.83%</td>
<td>19.25%</td>
</tr>
<tr>
<td>Key Size</td>
<td>56-bit</td>
<td>128-bit or two 64-bit</td>
<td>128/192/256-bit</td>
<td>128/192/256-bit</td>
</tr>
</tbody>
</table>

Note: Solution includes encryption, decryption and key generation

* 128-bit key implementation
** Key Generation offloaded to embedded µC/µP
Power Management
Different Operating Modes

- Micro can typically take 30% of system power
- Range from 720µW to 1W in normal operation
- Operating modes
  - Normal, Run, Sleep, Suspend, Standby, Stop, and Idle
  - Up to 230mW between states
Keeping Processors Asleep

• Reducing the number of interrupts to a processor will increase its time in a power saving state
• A low power CPLD that responds to and handles system interrupts will perform such a task
Power Saving Benefits

- **Standalone Microprocessor**

- **CoolRunner-II**

![Diagram comparing power consumption and operating time between Standalone Microprocessor and CoolRunner-II.](image)
EMI / Signal Management

• Tackling EMI issues is “Black Magic”
  – Failure to comply with FCC regulations leads to
    • Costly product redesigns/shielding and board re-layout
    • Additional delays in bringing product to the market
  – Reduced market share and revenues

• Xilinx solutions
  – SelectIO - 24 IO standards
    • HSTL, SSTL, LVTTL, LVCMOS, LVDS, PCI, GTL+, AGP, ..
    • Fewer devices required on the board due to support of multiple IO standards
  – Clock management using DLLs
  – Programmable output driver
  – Post-PCB signal integrity adjustment
Fewer Pins = Lower EMI

I/Os required with Select I/O

I/Os required without Select I/O

Xilinx Select IO

Traditional TTL IOs

Save money & pins with SelectI/O
Field Upgrades and Fixes

• Competitive pressures and continuous differentiation are bringing new features/capabilities rapidly to market
  – Disk drive storage of broadcast channels (PVR)
    • Ability to support evolving disk drive technologies
    • Optimization for simultaneous disk read and write
  – Encryption capabilities for adding “pay per view” services

• FPGAs enable new gateway features in 1-2 months
  – ASSPs/ASICs-based solutions will take 8-12 months
  – ASIC bug fixes are expensive!

• Fixing bugs and enabling new features after product deployment requires expensive truck rolls
Internet Reconfigurable Logic (IRL)

Remote update of software and hardware

- Get your Customers to Market Early
- Fix a bug
- Enhance Performance
- Ensure Compatibility

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Value of Remote Upgrades

• Adds key differentiation between competitive products
  – Future-proofs your products
    • Enables instant compliance to new standards
    • Continuous improvement
    • Results in increased lifetime for the gateway
  – Enable product features per end-user needs
  – Large “bottom line” impact
    • Reduce maintenance costs
    • New Internet-based revenue opportunities
  – Increased market share
    • Get in earlier and stay in longer
    • Develop customer loyalty
• ASSPs/ASICs cannot provide this capability
Quicker time-to-market and reprogrammability provide the best chance of achieving full product profit potential.
Managing Supply Chain Issues

• Eliminate manufacturing lines down due to component shortage

• Example 1: Streaming hard-disk drives
  – Employing FPGAs for HDD controllers allows dual sourcing of multiple hard disk drives

• Example 2: Supporting NAND and NOR flash memory types
  – Implementing flash controller in FPGAs allows flexibility of choice depending on market availability and cost
Cost Management Through System Integration

- Replacing discrete parts
  - Dual port memory/ FIFO
  - Clock buffers
  - Localized clock drivers
  - DLLs
  - Level translators
  - Hot socketing
  - Schmitt triggers
  - TTL devices
  - Backplane drivers
  - Board deskew

- Benefits
  - Cost savings
  - Fewer components
  - Board area savings
  - Higher reliability
  - Less EMI issues
Low Cost Packaging Options

- QFG32 (5 x 5mm)
- CP56 (6 x 6mm)
- CS48 (7 x 7mm)
- VQ100 (16 x 16mm)
- FT256 (17 x 17mm)
- PC44 (17.5 x 17.5mm)
- FG320 (19 x 19mm)
- FG400 (21 x 21mm)
- TQ144 (22 x 22mm)
- FG484 (23 x 23mm)
- PQ208 (30.6 x 30.6mm)
- FF1760 (42.5 x 42.5mm)

Pb-Free Packaging Available
The Video Processing FPGA

- Analog Video
- RGB Video
- Digital RGB
- PHY
- Select I/O
- SDRAM Controller
- SRAM Controller
- FLASH Controller
- EIDE Controller
- Block RAM
- Distributed RAM
- uc
- Image Processing
- XtremaDSP
- Decode & Decrypt
- DCT, IDCT
- JPEG
- DES, AES
- 3DES
- YCrCb2RGB
- RGB2YUV
- 2D FIR Filter
- YUV2RGB
- PCI, PCI-X, AGP
- LVDS / BLVDS
- PCI
- PCIX
- AGP
- Etc.

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Xilinx Set Top Box Solutions

• Xilinx solutions enable customers to thrive in chaos
  – FPGAs/CPLDs traditionally offer fast time-to-market
    • First to market, gains market share and revenue advantage
  – Xilinx Online offers reconfigurability in the field
    • Allows shipped product to support revisions to the spec
    • Enables unique opportunities to add value
    • Increases lifecycle revenue yield & hence time-in-market
  – Enables rapid product proliferation
    • New designs can be quickly turned into derivatives
  – Superior lifecycle component logistics
    • Proven technology, software, test benches

• FPGAs/CPLDs Provide Lower Total System Cost
Xilinx in the Broadcast Chain

- Gamma Correction
- Codecs
- Scaling/Resampling
- Colour Space
- Network Interfacing
- Chip Interfacing
- Video Filtering
- Effects (Wipe/Key)
- Memory Control
- FEC/Modulation
- System Control
Real Time HD/Multichannel DSP

- Highest performance on-chip DSP blocks, multipliers and memory
- Reduce size of DSP farms
- Support real time HD processing
- Support multiple channels of SD processing through resource sharing
- Reduce cost-per-channel for FEC and modulation
Cost Effective Connectivity

- Significant cost-per-channel reductions
- Portfolio of audio/video connectivity solutions
  - SDI, HD-SDI and DVB-ASI
  - Video-over-IP
- Wide range of general telecom, datacom and backplane solutions available
  - Ethernet, PCI Express, ATM, Fibre Channel, SONET, SPI RapidIO, HyperTransport...

~70% cheaper than ASSP SDI solutions!
Flexible Embedded Processing

**PicoBlaze**
- 8-bit Microcontroller
- Simple state-machines and “localised” on-chip control
- Pixel processing & display control

**MicroBlaze PowerPC™**
- 32-bit Microprocessors
- Cost/performance tradeoffs
- Extensive peripherals, RTOS & bus structures
- Networking & wireless comms, control & instrumentation
Xilinx in Broadcast

Programmable Solutions for the Broadcast Industry

More info on a wide range of applications and technologies

www.xilinx.com/broadcast