Cable Modems

Programmable Solutions for the Broadcast Industry
The Cable Modem

- Device that allows high-speed data access to the home
  - Modulates/demodulates data signals
- Delivers Internet data to the desktop at broadband speeds (>1Mbps possible)
- Uses the increased bandwidth of fibre or hybrid fibre/coaxial (HFC) cable instead of ordinary phone line
- Can be part modem, part tuner, part encryption/decryption device, part bridge, part router, part NIC card, part SNMP agent, part Ethernet hub...
Market Accelerators/Inhibitors

+ Accelerators
  – Increasing popularity of the Internet
  – Increasing demand for high speed access to the Internet
  – Increasing availability of multimedia & interactive applications
  – Increasing use of cable modem services by small businesses and SOHOs
  – Growth in telecommuting
  – Increased deployment of hybrid fibre coax systems

− Inhibitors
  – Limited availability of cable modem services to residential and business customers
  – Speed decrease due to shared nature of cable modem services
  – Relatively expensive cost of service, equipment purchase and installation
  – Competition from ADSL services
  – Concerns over data security
  – Limited choices of Internet Service Providers (ISPs) due to fight over open access
Connection to the CMTS

- Cable Modem connected to TV outlet for cable TV
- Cable TV operator connects a Cable Modem Termination System (CMTS) at the headend
  - CMTS is a central device for connecting cable TV network to data network (e.g. Internet)
At the Customer Premise

Cable Modems

- One to Two Splitter
- RF Tuner
- QPSK/QAM Modulator
- QAM Demodulator
- MAC
- Data and Control Logic
- Set Top Box
- Cable Channel
- PCs
DOCSIS Cable Modem

- **DOCSIS - Data Over Cable Service Interface Specification**
  - Dominant standard defining interfaces for both cable modem and CMTS
  - Also known as CableLabs Certified™ Cable Modem project
  - DOCSIS2.0 product rollout has just started
  - Euro-DOCSIS meets different requirements of European market
Evolving into the Gateway
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 Bridging

Main Processor or Embedded uP

Xilinx FPGA

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)
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 updates
  – Splintered product volumes challenge the amortization in creating an ASIC
Supporting Fast Memory Types

- Cable modems 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
    - Extra cost and more board area using standard translator devices
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
  – Embedded FIFOs in Virtex-4
  – High speed FIFO for Spartan-3

Download from xilinx.com/memory
Content Protection/Encryption

• Cable modems and residential gateways require conditional access for downloading material and firewall security
  – 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></th>
<th>DES</th>
<th>Spartan-IIIE Solution</th>
<th>AES</th>
<th>AES</th>
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<td>2S100E-6</td>
<td>2S150E-6</td>
<td>2S100E-6</td>
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<td>235</td>
<td>1611</td>
<td>358*</td>
<td>231**</td>
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<tr>
<td>Performance</td>
<td>94 MHz</td>
<td>48 MHz</td>
<td>82 MHz</td>
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<tr>
<td>Area Utilization</td>
<td>19.58%</td>
<td>93.22%</td>
<td>29.83%</td>
<td>19.25%</td>
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<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>
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</tbody>
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Note: Solution includes encryption, decryption and key generation
* 128-bit key implementation
** Key Generation offloaded to embedded μC/μP
Cost Management Through System Integration

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

- Benefits
  - Cost savings
  - Fewer components
  - Board area savings
  - Higher reliability
  - Less EMI issues
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 for residential gateways
- Example 2: Supporting NAND and NOR flash memory types
  - Implementing flash controller in FPGAs allows flexibility of choice depending on immediate market availability and cost
Internet Reconfigurable Logic (IRL)

Remote update of software and hardware

- Get your Customers to Market Early
- Fix a bug
- Enhance Performance
- Ensure Compatibility
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
Low Cost Packaging Options

Pb-Free Packaging Available
Quicker time-to-market and reprogrammability provide the best chance of achieving full product profit potential.
Xilinx Cable Modem Solutions

- Xilinx provides significant value when used to interface various ASSPs together
  - Resolving differences in interface control signals
  - Bridging between disparate network protocols
  - No need to wait for an ASSP re-spin to get you to market

- In-system programming capability of Xilinx devices speeds time-to-market and increases time-in-market
  - Features can be remotely upgraded/added while product is in the field
Xilinx Cable Modem Solutions

• Cable modems expected to grow into residential gateways
  – Spartan-3 FPGAs provide rapid system integration and interconnectivity to multiple home networking interfaces

• Save money!
  – Xilinx offers low cost FPGAs and CPLDs
  – System integration lowers BOM and board costs
  – Remove the hidden costs of supply management
  – Recoup investments quicker with in-system programming and Internet reconfigurability
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 Microcontroller**
  - 8-bit Microcontroller
  - Simple state-machines and "localised" on-chip control
  - Pixel processing & display control

- **MicroBlaze & PowerPC Processors**
  - 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