IEEE1394 / FireWire / iLink
Agenda

• Introduction
  – Market trend and application
    • 1394 Market Analysis Data
    • 1394 and industry
    • Applications
  – 1394 Operation
  – Bus Management
  – Cable and Connection
  – Architecture
  – Topology

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  – Why 1394?
  – Applications
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    – Link Layer
    – Transaction Layer
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- **Summary**
Introduction

- Consumers Share Video, Audio, Images, and Data
- Faster and easier ways of sharing data is the ultimate goal
- This phenomenon is driving the convergence of computers, consumer equipment, and communications
- Convergence will happen when seamless, high-speed communication becomes readily available
  - The IEEE 1394 protocol appears to be a strong contender for the communications channel that will make this happen.
Multimedia Bandwidth Requirements

• High Quality Video
  – Digital Data = (30 frames / second) (640 x 480 Pixels) (24-bit color / Pixel) = 221 Mbps

• Reduced Quality Video
  – Digital Data = (15 frames / second) (320 x 240 Pixels) (16-bit color / Pixel) = 18 Mbps

• High Quality Audio
  – Digital Data = (44,100 audio samples / sec) (16-bit audio samples) (2 audio channels for stereo) = 1.4 Mbps

• Reduced Quality Audio
  – Digital Data = (11,050 audio samples / sec) (8-bit audio samples) (1 audio channel for monaural) = 0.1 Mbps
Consumer Devices Growth

Worldwide Unit Shipments (M)

- DVD Players
- Digital Cameras
- Total SHDs
- Total Game Consoles
- DVRs
- Compressed Audio Players
- NetTVs
- Email, Web Terminals, Sphones

2000

2004

Courtesy of IDC
Driving Forces For IEEE 1394

• Digital Broadcasting
• The Internet
• Digitalization Of Modern Homes
• Entertainment & Video Appliances
• Digital Home Networking
• High Bandwidth Requirements For Transmission of Audio and Video Signals
IEEE 1394 Usage & Growth

Million units

Source: In-stat
1394 Market Forecast

Source - In-Stat
IEEE 1394 & Industry

- 1394 is a low cost audio/video digital interface
- New audio/video applications are the first market for IEEE1394
  - Digital Television (DTV)
  - Multimedia CDROM (MMCD)
  - Home Networks
- IEEE 1394 has been accepted as the standard digital interface by the Digital VCR Consortium
IEEE 1394 & Industry

- The European Digital Video Broadcasters (DVB) have endorsed IEEE 1394 as their digital television interface as well
  - Several of these companies have proposed IEEE 1394 to the VESA (Video Experts Standards Association) for the digital home network media of choice
- The EIA 4.1 subcommittee has voted for IEEE 1394 as the point-to-point interface for digital TV as well as the multi-point interface for entertainment systems
IEEE 1394 & Industry

- SCSI products would be enhanced by migrating to IEEE 1394
  - Scanners
  - CDROMs
  - Disk Drives
  - Printers
- The American National Standards Institute (ANSI) has defined Serial Bus Protocol (SBP) to encapsulate SCSI-3 for IEEE 1394
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  – USB
  – DVI

• 1394 In Home Networking

• Xilinx Value

• Alliances

• Summary
Why IEEE 1394?

• A digital interface
  – There is no need to convert digital data into analog and tolerate a loss of data integrity
  – Transferring data @ 100, 200, 400 Mbps (Cable)
  – Transferring data @ 12.5, 25 or 50 Mbps (Backplane)
• Physically small
  – The thin serial cable can replace larger and more expensive interfaces
Why IEEE 1394?

• Easy to use
• There is no need for terminators, device IDs, or elaborate setup
• Hot pluggable
  – Users can add or remove 1394 devices with the bus active
• Inexpensive
  – Priced for consumer products
• Scaleable architecture
  – May mix 100, 200, and 400 Mbps devices on a bus
Why IEEE 1394?

- Flexible topology
  - Support of daisy chaining and branching for true peer-to-peer communication
- Non-proprietary
IEEE 1394b

- 1394b is a significant enhancement to the basic 1394 specification that enables:
  - Speed increases to 3.2 Gbps
  - Supports distances of 100 meters on UTP-5, plastic optical fiber, and glass optical fiber
  - Significantly reduces latency times by using arbitration pipelining
- It is fully backwards compatible with the current 1394 and 1394a specifications
New Extensions (1394b)

- Gigabit speeds for cables
- 100Mb for backplane implementations
- Longer distance cables using copper wire and fiber
- A/V command and control protocols
- 1394 to 1394b bus bridges
- IEEE 1394 gateways to communication interfaces, such as ATM
IEEE 1394 Standards Update

- 1394-1995
  - Supports up to 400 Mbps Links and PHYs
  - 6 pin cables
- 1394a (1998)
  - Power management clean up
  - Cable power specification in flux
- Open Host Controller Interface (1998)
  - Ultimate goal is a single driver for OS support
- 1394b (1999)
  - Could be a legitimate storage I/O at 800 Mbps
1394 Based Applications

- Digital camcorders and VCRs
- Direct-to-Home (DTH) satellite audio/video
- Cable TV and MMDS (microwave) set-top boxes
- DVD Players
- Video Games
- Home Theater
- Home Networks
1394 Based Applications

- Musical synthesizers/samplers with MIDI and digital audio capabilities
- Digital audio tape (DAT) recorders, mixers, hard-disk recorders, video editors, etc.
- Professionals and affluent consumers Digital Video (DV) applications
- Professional video equipment
- Fixed and removable PC disk drives
1394 Based Applications

- PC-to-PC networking and PC peripheral component sharing
- Printers for video and computer data
- Digital cameras and videoconferencing cameras
- Industrial
IEEE 1394 Protocol
IEEE 1394 Protocol Stack

- Serial Bus Management
- Link Layer (Cycle control, packet transmitter, packet receiver)
- Transaction Layer
- Physical Layer (Encode/Decode, Arbitration, Media Interface)
- Electrical Signal & Mechanical Interface
- Symbols
- Packets
- Configuration & Error Control
- Serial Soft API
- Read, Write, Lock
- Isochronous Channels

IEEE 1394 Physical Interface
1394 PHY Layer

- The Physical layer provides the initialization and arbitration services
  - It assures that only one node at a time is sending data
- The physical layer of the 1394 protocol includes:
  - The electrical signaling
  - The mechanical connectors and cabling
  - The arbitration mechanisms
  - The serial coding and decoding of the data being transferred or received
  - Transfer Speed detection
1394 PHY

Link Interface

PLL

Rx Decoder and Timer

Link Arbitration & Control Logic

Tx Encoder

Port Interface Logic

Data
Control
LReq
Iso
Reset
PHY Clk

0:7
# Physical layer Controller Products

<table>
<thead>
<tr>
<th>Physical Layer Controllers Manufacturer</th>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fujitsu Microelectronics</td>
<td>MB8661x</td>
<td>Combined link/PHY core &amp; ICs</td>
</tr>
<tr>
<td>IBM</td>
<td>IBM21S85xPFD</td>
<td>400Mbps 1- and 3-port devices</td>
</tr>
<tr>
<td>IBM</td>
<td>IBM21S760PFD</td>
<td>200Mbps 1- and 3-port devices</td>
</tr>
<tr>
<td>Innovative Semiconductor</td>
<td>SL75x</td>
<td>Physical layer cores</td>
</tr>
<tr>
<td>Philips Semiconductor</td>
<td>PDI1394P11</td>
<td>Physical layer IC</td>
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<tr>
<td>Macro Designs</td>
<td></td>
<td>Physical layer cores</td>
</tr>
<tr>
<td>Phoenix Technologies</td>
<td>VirtualLink</td>
<td>100, 200, and 400Mbps 1394a-compatible cores</td>
</tr>
<tr>
<td>Sand</td>
<td>1394 CPHY</td>
<td>1394 cable physical layer core</td>
</tr>
<tr>
<td>Symbios (LSI)</td>
<td>SYM13FW403</td>
<td>1394 cable PHY interface IC</td>
</tr>
<tr>
<td>NEC</td>
<td>uPD72850</td>
<td>3-port PHY IC</td>
</tr>
<tr>
<td>Texas Instruments</td>
<td>TSB11C01</td>
<td>Up to 400Mbps PHY ICs</td>
</tr>
<tr>
<td></td>
<td>TSB11LV01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TSB14C01A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TSB21LV03A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TSB41LV0x</td>
<td></td>
</tr>
<tr>
<td>Sony</td>
<td>CXD1944R</td>
<td>3-Port 200Mbps PHY IC</td>
</tr>
</tbody>
</table>
Link Layer

- Gets data packets on and off the wire
- Does error detection and correction
- Does retransmission
- Handles provision of cycle control for Isochronous channels
- The Link layer supplies an acknowledged datagram to the Transaction layer
  - A datagram is a one-way data transfer with request confirmation
IEEE 1394 Link Controller

- IEEE 1394 Physical Interface
- Packet Transmit/Receive, CRC
- Packet Analyzer
- Arbiter
- Link Control
- Transmit & Receive FIFOs
- Host Interface
- CSR
- DMA
- Audio-Video Interface
- PCI Interface (PCI Master, PCI Target)
- Application Interface
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<tr>
<td>IBM</td>
<td>IBM21S650PF</td>
<td>A PCI-based link layer controller</td>
</tr>
<tr>
<td>IBM</td>
<td>IBM21S550PFB</td>
<td>Generic bus interface link layer controller</td>
</tr>
<tr>
<td>Innovative Semiconductor</td>
<td>SL75x</td>
<td>Link layer cores</td>
</tr>
<tr>
<td>Philips Semiconductor</td>
<td>PDI1394L11</td>
<td>A/V link layer controller</td>
</tr>
<tr>
<td>Phoenix Technologies</td>
<td>Virtual Link 1394a</td>
<td>Compatible link layer cores</td>
</tr>
<tr>
<td>Sand</td>
<td>1394 Device Controller</td>
<td>1394 link layer core</td>
</tr>
<tr>
<td>LSI</td>
<td>Sand Microelectronics</td>
<td>1394 Link Layer</td>
</tr>
<tr>
<td>NEC</td>
<td>uPD728xx</td>
<td>OHCI link layer IC (some integrate PHY)</td>
</tr>
<tr>
<td>Texas Instruments</td>
<td>TSB12LV21B</td>
<td>Lynx HCI (PCI) IC OHCI (PCI)</td>
</tr>
<tr>
<td>Texas Instruments</td>
<td>TSB12LV22</td>
<td>IC General-purpose bus interface IC</td>
</tr>
<tr>
<td>Texas Instruments</td>
<td>TSB12LV31</td>
<td></td>
</tr>
<tr>
<td>Sony</td>
<td>CXD1940R</td>
<td>AV protocol support</td>
</tr>
</tbody>
</table>
Transaction Layer

• Implements the request-response protocol
• This protocol is required to conform to:
  – Status Register (CSR) Architecture for Microcomputer Buses
• Conformance to ISO/IEC 13213:1994
  – Minimizes the amount of circuitry required by 1394 ICs to interconnect with 1212-standard parallel buses, such as the PCI bus
IEEE 1394 Host Controller

![Diagram of IEEE 1394 Host Controller](image)

Courtesy of Apple
IEEE 1394 Operation

• Isochronous Transfers
  – Isochronous transfers are always broadcast in a one-to-one or one-to-many fashion
  – No error correction nor retransmission is available for Isochronous transfers
  – Up to 80% of the available bus bandwidth can be used for Isochronous transfers
  – The delegation of bandwidth is tracked by a node on the bus
  – Isochronous channel IDs are transmitted followed by the packet data
  – The receiver monitors the incoming data's channel ID and accepts only data with the specified ID
IEEE 1394 Operation

• Asynchronous Transfers
  – Asynchronous transfers are targeted to a specific node with an explicit address
  – They are not guaranteed a specific amount of bandwidth on the bus
  – They are guaranteed a fair shot at gaining access to the bus when asynchronous transfers are permitted
  – Asynchronous transfers are acknowledged and responded to
    • This allows error-checking and retransmission mechanisms to take place
IEEE 1394 Operation

• Isochronous transfers are the best choice for sending time-critical, and error-tolerant data
  – Video or Audio stream

• If the data isn’t error-tolerant, such as a disk drive, then asynchronous transfers are preferable
Bus Management

• The Bus Manager must collect the self-id packets and create the topology and speed maps from them

• Bus management involves the following three services:
  – A Cycle Master that broadcasts cycle start packets (required for Isochronous operation)
  – An Isochronous Resource Manager, if any nodes support Isochronous communication
  – An optional Bus Master
Bus Management

• The structure of the bus is determined on bus reset
  – Node IDs (physical addresses) are assigned to each node
  – Arbitration occurs for Cycle Master, Isochronous Resource Manager, and Bus Master nodes

• Serial bus management in portable consumer products is handled by a microprocessor designed to minimize battery power consumption
  – Most battery-operated 1394 gear is expected to run at S100 speed for power conservation
IEEE 1394 Cabling

- It can connect up to 63 devices @ transfer rate of 400Mbps
- Is "hot-pluggable" and PnP
- A 1394 cable can be up to 15 feet in length
- The 6-pin connectors have two data wires and two power wires for devices which derive their power from the 1394 bus
- Data-only cables use one 6-pin and one 4-pin connector or two 4-pin connectors
Cable

- Serial Pair A
- Serial Pair B
- Power
- Shield
IEEE 1394 Architecture
(Bus Categories)

• Backplane bus
  – Supplements parallel bus structures by providing an alternate serial communication path between devices plugged into the backplane.

• Cable bus
  – Is a "non-cyclic network"
    • Devices can not be plugged together to create loops
  – The networks has finite branches, consisting of bus bridges and nodes
  – 16-bit addressing provide for up to 64K nodes in a system
  – Up to 16 cable hops are allowed between nodes, thus the term finite branches
IEEE 1394 Architecture (Bus Categories)

- A bus bridge serves to connect busses of similar or different types
- A bus bridge also would be used to interconnect a 1394 cable and a 1394 backplane bus
- Six-bit Node_IDs allow up to 63 nodes to be connected to a single bus bridge
- 10 bit Bus_IDs accommodate up to 1,023 bridges in a system.
IEEE 1394 Architecture

• Each node usually has three connectors
• Up to 16 nodes can be daisy-chained through the connectors
  – Standard cables up to 4.5 m in length for a total standard cable length of 72 m.
• Additional devices can be connected in a leaf-node configuration
• Physical addresses are assigned on:
  – Bridge power up(bus reset)
  – Whenever a node is added or removed from the system, either by physical connection/disconnection or power up/down
Connection Steps

• Step 1: Physical connection between two nodes
  – Triggers serial bus configuration
• Step 2: Bus Reset
  – Forces all nodes to their initialized state
  – All bus topology information is cleared
• Step 3: Tree Id
  – Transforms a simple net topology into a tree topology
• Step 4: Self ID
  – Assigns physical node numbers or IDs
  – Exchanges speed capabilities with neighbors
• Step 5: Arbitration
Connection Steps (Reset)

• Reset is signaled by a node driving both TPA and TPB to logic 1.
  – A logic 1 will always be detected by a port, even if its bi-directional driver is in the transmit state.
• When a node detects a reset, it will propagate this signal to all of the other ports that this node supports.
• The node then enters the idle state for a given period of time to allow the reset indication to propagate to all other nodes on the bus.
• Reset clears any topology information within the node
Connection Steps (Tree identification)

- Defines the bus topology.
- After reset, all leaf nodes present a Parent_Notify signaling state on their data and strobe pairs.
- When a branch node receives the Parent_Notify signal on one of its ports, it marks that port as containing a child, and outputs a Child_Notify signaling state.
  - The ports marked with a “P” indicate that a device which is closer to the root node is attached to that port.
  - The port marked with a “C” indicates that a node farther away from the root node is attached.
Connection Steps (Self Identification)

• Self identification consists of:
  – Assigning physical IDs to each node on the bus
  – Having neighboring nodes exchange transmission speed capabilities
  – Making all of the nodes on the bus aware of the topology that exists

• The self identification phase begins with the root node sending an arbitration grant signal to its lowest numbered port.

• The root node will then continue to signal an Arbitration Grant signal to its lowest numbered port.
Connection Steps (Arbitration)

- Immediately following the cycle start packet, devices that wish to broadcast their Isochronous data may arbitrate for the bus.
  - Cycle is a time slice with a nominal 125μs period
- Arbitration consists of signaling a designated parent node a wish to gain access to the bus.
- The parent nodes in turn signal their parents and so on, until the request reaches the root node.
- The closest device to the root node wins the arbitration.
Topology

- The 1394 protocol is a peer-to-peer network with a point-to-point signaling environment
  - A specific host isn’t required
    - Digital camera could easily stream data to both the digital VCR and the DVD-RAM without any assistance from other devices on the bus
- Nodes on the bus may have several ports on them
  - Each of these ports acts as a repeater, retransmitting any packets received by other ports within the node
Topology

• Configuration of the bus occurs automatically whenever a new device is plugged in
• During system initialization, each node in a 1394 bus carries out:
  – A process of bus initialization
  – Tree identification
  – Self-identification
• A 1394 bus appears as a large memory-mapped space with each node occupying a certain address range
Topology

• The memory space is based to the IEEE 1212 Control and Status Register (CSR) Architecture
  – With some extensions specific to the 1394 standard
• Device addressing is 64 bits wide partitioned as:
  – 10 bits for network Ids
  – 6 bits for node Ids
  – 48 bits for memory addresses
• Each node supports up to 48 bits of address space (256 Tera Bytes)
Topology

• Each bus can support up to 64 nodes
  – The 1394 serial bus specification supports up to 1,024 buses
• The topology of a 1394 system can be:
  – Daisy chain
  – Tree
  – Star
  – Or a combination of these
• 1394 can connect devices directly without the intervention of a computer
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Data Rates Of Various Ports

Serial Port, 10BaseT, USB, Fast SCSI, 100BaseT, Ultra SCSI, Wide Ultra SCSI, Ultra 2 SCSI, 1394, USB 2.0, Wide Ultra 2 SCSI, 1394a, Ultra 3 SCSI, 1394b
# Interconnect Technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Throughput Data Rate</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple Desktop Bus</td>
<td>0.01 Mbps</td>
<td>Input Devices like Mouse, Keyboards, Joysticks, etc</td>
</tr>
<tr>
<td>Serial Port</td>
<td>0.23 Mbps</td>
<td>Printers, Telephony Devices, Modems, etc</td>
</tr>
<tr>
<td>USB at low data rate</td>
<td>1.5 Mbps</td>
<td>Most Devices</td>
</tr>
<tr>
<td>10Base-T</td>
<td>10 Mbps</td>
<td>Laser Printers, Network Connections, etc</td>
</tr>
<tr>
<td>USB at high transfer rates</td>
<td>12 Mbps</td>
<td>Most Devices</td>
</tr>
<tr>
<td>SCSI</td>
<td>40 Mbps</td>
<td>Hard Drives, Removable Storage, Scanners, etc</td>
</tr>
<tr>
<td>Fast SCSI</td>
<td>80 Mbps</td>
<td>High Performance Drives</td>
</tr>
<tr>
<td>100Base-T</td>
<td>100 Mbps</td>
<td>Laser Printers, Network Connections, etc</td>
</tr>
<tr>
<td>Ultra SCSI</td>
<td>160 Mbps</td>
<td>High Performance Drives</td>
</tr>
<tr>
<td>Wide Ultra SCSI</td>
<td>320 Mbps</td>
<td>High Performance Drives</td>
</tr>
<tr>
<td>Ultra2 SCSI</td>
<td>320 Mbps</td>
<td>High Performance Drives</td>
</tr>
<tr>
<td>1394</td>
<td>400 Mbps</td>
<td>Hard drives, Scanners, Digital Video</td>
</tr>
<tr>
<td>USB 2.0 (Intel)</td>
<td>480 Mbps</td>
<td>Most Devices</td>
</tr>
<tr>
<td>Wide Ultra2 SCSI</td>
<td>640 Mbps</td>
<td>High Performance Drives</td>
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<tr>
<td>1394a</td>
<td>800 Mbps</td>
<td>Hard Drives, Scanners, Digital Video</td>
</tr>
<tr>
<td>Ultra3 SCSI</td>
<td>1280 Mbps</td>
<td>High Performance Drives</td>
</tr>
<tr>
<td>1394b</td>
<td>1600 Mbps</td>
<td>Hard Drives, Scanners, Digital Video</td>
</tr>
</tbody>
</table>
USB 2.0 & 1394

• USB and 1394 are complementary buses, differing in their application focus
• USB 2.0 is the preferred connection for most PC peripherals
• 1394’s primary target is audio/visual consumer electronic devices such as digital camcorders, digital VCRs, DVD players, and digital televisions
• Both USB 2.0 and 1394 are expected to co-exist on many consumer systems in the future
USB 2.0 & 1394

• USB requires a CPU to perform the bus master functions while 1394 is peer-to-peer
  – A D-VCR must be able to talk directly to a D-TV without going through a PC first
• USB throughput is not nearly as fast as advertised
  – When shipping data directly from a peripheral to the host, throughput is OK
  – When shipping data from a peripheral to another peripheral, real bandwidth drops in half
  – All data must be moved from the peripheral to the host and then from the host to the target peripheral
USB 2.0 & 1394

- The USB 2.0 hubs are more complicated
  - They require an entire USB 1.1 HOST controller and a new USB 2.0 hub controller
  - They require a high-speed signal repeater, routing logic, dual-function ports, etc
- 1394 is for devices where high performance is a priority and price is not
- USB is for devices where price is a priority and high performance is not
1394 & DVI

- IEEE 1394, is a two-way high-speed interface capable of sending command and control protocols
  - It enables devices to both broadcast and record data
- DVI is a point-to-point digital interface designed to send uncompressed streams
  - It is a one-way interface with a display
- IEEE 1394 is inherently suited for recording and networking applications within the home
1394 & DVI

- DVI is pitched as an interface between a graphics chip and various kinds of monitors
  - including plasma display panels, LCDs and even CRTs
- 1394 is suitable for distribution of compressed data (MPEG-2)
  - Most digital content received at home from DVD, satellite or cable is based on MPEG-2 streams
- DVI is suitable for distribution of uncompressed data
  - Designed to carry sustained HDTV data rate without interruption
1394 & DVI

- 1394 distribute video data at 100, 200, or 400 Mbps, Scalable
- 1394b is being designed to deliver data at 800 Mbps to 3.2 Gbps, Scalable
- DVI’s single link can distribute video data at 4.9 Gbps
- DVI’s double link can distribute video data at 9.9 Gbps
  - Does not support audio/video commands
## 1394 & DVI

<table>
<thead>
<tr>
<th>Stream</th>
<th>Bit Rate</th>
<th>Architecture</th>
<th>Command &amp; Control</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE 1394</td>
<td>Compressed MPEG-2 Transport</td>
<td>1394: 100, 200, or 400 Mbps, Scalable 1394b: 800 Mbps to 3.2 Gbps, Scalable</td>
<td>Peer-to-peer</td>
<td>Support for AV command &amp; control</td>
</tr>
<tr>
<td>DVI</td>
<td>Uncompressed baseband</td>
<td>Single link DVI: 4.9 Gbps Double link DVI: 9.9 Gbps</td>
<td>Point-to-point</td>
<td>No support for AV command &amp; control</td>
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The Push for Home Networking

• Rapid growth in multiple-PC household penetration (Dataquest)
  – PC penetration exceeds 50% in US households

• Increasing Internet usage (Yankee Group)
  – Nearly 90% of PC households will be online by 2001
  – Online households growth: 20% (in 1997) to 47% (in 2001)

• Broadband Internet access (Forrester Research)
  – Broadband penetration growth: less than 1M (in 1998) to more than 15M (in 2002)
  – % Penetration of online households: increases from 2% (in 1998) to 26% (in 2002)
The Push for Home Networking

• More digital appliances are coming into the home
  – DSS, DVD, Digital TV
  – Web-Top boxes, set-top boxes
  – PDAs, mobile (cellular) phones
  – Digital cameras
  – Installed base of internet appliances will exceed 50M by 2001 (by IDC)

• More digital content entering the home
  – Published Content
    • CD-ROMs, DVDs, DVRs, digital photography
  – Networked Content
    • DTV, DBS, VoIP, MP3, movies-on-demand, streaming media
Applications Driving Home Networking

Phone Line | Power Line | RF | Ethernet | Other

1999 | 2000 | 2001 | 2002 | 2003

Courtesy: Dataquest
Different Strokes for Different Folks

<table>
<thead>
<tr>
<th>Devices</th>
<th>Home Automation</th>
<th>Entertainment</th>
<th>Information</th>
<th>Personal Communications</th>
<th>Communication</th>
</tr>
</thead>
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<tr>
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<td>- Home appliances</td>
<td>- TV sets</td>
<td>- PCs</td>
<td>- Mobile phones</td>
<td>- Corded/Cordless</td>
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<tr>
<td></td>
<td>- Security/safety systems</td>
<td>- Set-top boxes</td>
<td>- Screen phones</td>
<td>- Smart phones</td>
<td>telephones</td>
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<td></td>
<td>- Utility meters</td>
<td>- DVD Players</td>
<td>- Printers</td>
<td>- Handheld</td>
<td>- Fax machines</td>
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<tr>
<td></td>
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<td>- Game consoles</td>
<td>- Modems</td>
<td>- Laptop</td>
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<tr>
<td></td>
<td></td>
<td>- VCRs</td>
<td>- Routers</td>
<td>- Pagers</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- MP3 Players</td>
<td>- Scanners</td>
<td></td>
<td></td>
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<tr>
<td>Content</td>
<td>Information on home processes, house environment,</td>
<td>Rich multimedia</td>
<td>Discrete information on external</td>
<td>Information used on the</td>
<td>- Information on how</td>
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<tr>
<td></td>
<td>remote diagnostics and technical support</td>
<td>content, electronic</td>
<td>world, shopping for household goods</td>
<td>move or requiring</td>
<td>to reach people in</td>
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<tr>
<td></td>
<td></td>
<td>programming</td>
<td></td>
<td>instant action: travel,</td>
<td>time and space</td>
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<td></td>
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<td>guides, impulse</td>
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<td>weather, local services,stock</td>
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<td></td>
<td>purchases</td>
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<td>market</td>
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<td>Usage Pattern</td>
<td>Communal</td>
<td>Communal</td>
<td>Individual Shared</td>
<td>Individual Personal</td>
<td>Communal or Individual</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Shared</td>
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<td>Connection to</td>
<td>- Power line</td>
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<tr>
<td>Outside World</td>
<td></td>
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<tr>
<td></td>
<td>- POTS</td>
<td></td>
<td></td>
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<tr>
<td>Practical</td>
<td>- CEBus</td>
<td>- Cable</td>
<td>- Cable modem</td>
<td>- GSM</td>
<td>- POTS</td>
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<td>- X-10</td>
<td>- DBS</td>
<td>- ADSL</td>
<td>- Infrared</td>
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<tr>
<td>Technology</td>
<td>- LONWorks</td>
<td></td>
<td>- POTS, ISDN</td>
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<td></td>
<td>- IEEE 1394 (Fire Wire)</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>- HomeRF</td>
<td>- HomeRF</td>
<td>- Infrared</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- HomePNA</td>
<td>- Bluetooth</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- Ethernet</td>
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</tr>
</tbody>
</table>

Home appliances have different content, functionality, application, and use different interconnection technologies.
Bandwidth Requirement

- Internet: 10 Mbps
- Fast Internet: 1 Mbps
- Printing: 100 Mbps
- Share Files: 10 Mbps
- Gaming: 10 Mbps
- Voice: 1 Mbps
- MPEG Audio: 1 Mbps
- MPEG Video: 1 Mbps
Different Home Networks

**Digital Entertainment Network**
- Consumer Electronics AV Devices
- Distributed digital audio & video
- HAVi
- High Bandwidth (100-400 Mbps)
- IEEE1394 (Fire Wire)

**Computer System Network**
- Multiple PCs & Peripherals
- Print & file sharing, Internet Access
- TCP/IP
- Medium Bandwidth (10 Mbps)
- Ethernet, Home PNA, Home RF

**Home Automation Network**
- Smart appliances, HVAC, dimmers
- Lighting, Energy, Security
- CEBus, X-10, Lon Works
- Low Bandwidth (>2 Mbps)
- Power line
Four Aspects to Home Networking

**Broadband Access**
- xDSL, Cable, ISDN, Satellite, Powerline, Analog Dial-up, Phoneline

**Residential Gateway**
- Set-top Box, Digital Modems, PCs, Gaming Consoles, SOHO Routers

**Home Networking Technologies**
- Ethernet, IEEE 1394, USB 2.0, Powerlines, Phonelines, Wireless LANs (HiperLAN2 & IEEE 802.11), HomeRF, Bluetooth

**Information Appliances**
## Bandwidth Requirements

<table>
<thead>
<tr>
<th>Application</th>
<th>Technique</th>
<th>Data Rate</th>
<th>Compression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video Conference Quality</td>
<td>H.261</td>
<td>0.1 Mbps</td>
<td>Yes</td>
</tr>
<tr>
<td>Streaming Video</td>
<td>MPEG-4</td>
<td>5 Kbps ~10 Mbps</td>
<td>Yes</td>
</tr>
<tr>
<td>VCR Quality</td>
<td>MPEG-1</td>
<td>1.2 Mbps</td>
<td>Yes</td>
</tr>
<tr>
<td>Broadcast Quality</td>
<td>MPEG-2</td>
<td>2 ~ 4 Mbps</td>
<td>Yes</td>
</tr>
<tr>
<td>Studio Quality Digital TV</td>
<td>ITU-R 601</td>
<td>166 Mbps</td>
<td>No</td>
</tr>
<tr>
<td>DVD/ Studio Quality DTV</td>
<td>MPEG –2</td>
<td>3 ~6 Mbps</td>
<td>Yes</td>
</tr>
<tr>
<td>HDTV</td>
<td>CD-DA</td>
<td>2000 Mbps</td>
<td>No</td>
</tr>
<tr>
<td>HDTV</td>
<td>MPEG-2</td>
<td>25 ~ 34 Mbps</td>
<td>Yes</td>
</tr>
<tr>
<td>Audio</td>
<td>Streaming Audio</td>
<td>MPEG L3(MP3)</td>
<td>32~ 320 Kbps</td>
</tr>
<tr>
<td>Consumer CD-Audio</td>
<td>CD-DA</td>
<td>1441 Kbps</td>
<td>No</td>
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<tr>
<td>Consumer CD-Audio</td>
<td>MPEG with FFT</td>
<td>192 ~256 Kbps</td>
<td>Yes</td>
</tr>
<tr>
<td>Sound Studio Quality</td>
<td>MPEG with FFT</td>
<td>384 Kbps</td>
<td>Yes</td>
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<tr>
<td>Dolby AC-3</td>
<td>5.1 Channels</td>
<td>640 Kbps</td>
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<tr>
<td>Telephone Standard</td>
<td>G.711 PCM</td>
<td>64 Kbps</td>
<td>No</td>
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<tr>
<td>Standard</td>
<td>G.721 ADPCM</td>
<td>32 Kbps</td>
<td>Yes</td>
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<tr>
<td>Lower</td>
<td>GSM</td>
<td>13 Kbps</td>
<td>Yes</td>
</tr>
<tr>
<td>Lower</td>
<td>CELP</td>
<td>5 ~7 Kbps</td>
<td>Yes</td>
</tr>
<tr>
<td>Broadband DSL</td>
<td>ADSL</td>
<td>1.5 ~9 Mbps</td>
<td>N/A</td>
</tr>
<tr>
<td>Internet Access</td>
<td>DOCSIS</td>
<td>2 Mbps</td>
<td>N/A</td>
</tr>
</tbody>
</table>
IEEE 1394 & Home Networking

• Distribution of Video for the entertainment applications requires larger bandwidth
  – MPEG 2 (used in HDTV) requires between 24 to 35Mbps
    • 1394 delivers video data at 400 Mbps
  – CD-DA (used in high quality HDTV) requires 2Gbps
    • Bit rates required for uncompressed high definition TV (HDTV)
    • $1920 \times 1080 = 2073600$ pixels in each frame, frame rate = 60, bit rate > 2 Gbps
      • 1394b will deliver video data at 3.2 Gbps
  • 1394 is capable of delivering video data at high speed
    – 1394 has the advantage of being adopted by consumer electronics manufacturers
IEEE 1394 & Home Networking

• Using 1394 for home networking does not require using a PC
• 1394 is easy to use
• 1394 is hot Pluggable
• 1394 has scalable architecture
• 1394 is a digital interface
• 1394 has physically small serial cables
Home Networking Applications

- IEEE 1394 is an enabling technology for connecting devices such as:
  - Digital Camcorders and VCRs
  - Direct-to-Home (DTH) satellite audio/video
  - Cable TV and MMDS (microwave) set-top boxes
  - DVD Players
  - Video Games
  - Home Theater
  - Musical synthesizers/samplers with MIDI and digital audio capabilities
  - Digital audio tape (DAT) recorders, mixers, hard-disk recorders, video editors, etc.
Home Networking Applications

- Digital Video (DV) applications (including security cameras)
- Fixed and removable PC disk drives
- PC-to-PC networking and PC peripheral component sharing
- Printers for video and computer data
A Networked home
(Mixture of Technologies)

- Public network
- Phone line network
- Power line network
- Home net hub
- Web phone
- Security
- HVAC
- Entertainment center

- Communications and control
- Camera
- Scanner
- IEEE 1394

- Communications
- HomeRF
- Printer
- Home net hub
A 1394 Networked Home

DBS

Cable

DSL

1394 Switch

Family Room

Study

DVC

MD

STR

Camcorder

TV

1394 Bridge

1394 Bridge

XILINX
Agenda

• Introduction
  – Market trend and application
    • 1394 Market Analysis Data
    • 1394 and industry
    • Applications
  – 1394 Operation
  – Bus Management
  – Cable and Connection
  – Architecture
  – Topology
• Technology
  – What is 1394?
  – Why 1394?
  – Applications
  – 1394 Protocol
  – PHY
  – Link Layer
  – Transaction Layer
• Other Technologies
  – USB
  – DVI
• 1394 In Home Networking
• Xilinx Value
• Alliances
• Summary
Introduction to Xilinx
Where Does Xilinx Fit In the Electronics Industry

Key components of an electronics system:

- Processor
- Memory
- Logic

Xilinx is the Leading Innovator of Complete Programmable Logic Solutions
Strategic Business Model Ensures Focus

- “Fabless” strategy
  - Leading edge IC process technology
  - Wafer capacity at competitive prices
  - Fastest, lowest cost, densest parts
- Independent sales organization (Reps & Distributors)
  - Sales is a variable cost
  - Permits greater reach—over 20,000 Customers
  - Over 10,000 “Feet On The Street”
- Focus on key strengths
  - Product design
  - Marketing
  - Applications & Technical Support
Xilinx Product Portfolio

Advanced Products Group
Virtex
High Performance
High Density

General Products Division
Spartan-II
High Volume
Low Cost

CPLD Division
CoolRunner
Low Power
Low Cost

Software Solutions
Foundation
Alliance
IP Center
WebPACK
WebFitter
Xilinx Online
### Xilinx - Leader in Core Solutions

<table>
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<th>Base Level Functions</th>
<th>Communication &amp; Networking</th>
<th>Standard Bus Interfaces</th>
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<td>- Cell assem/delin</td>
<td>- CAN</td>
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<tr>
<td>- 66MHz DRAM, SDRAM I/F</td>
<td>- CRC</td>
<td>- TSB PnP</td>
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<tr>
<td>- Memory blocks</td>
<td>- HDLC</td>
<td>- 12C</td>
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<tr>
<td>- 29xx</td>
<td>- Reed-Solomon</td>
<td>- PCI 32-bit</td>
</tr>
<tr>
<td>- Proprietary RISC Processors</td>
<td>- Viterbi</td>
<td>- PCMCIA</td>
</tr>
<tr>
<td></td>
<td>- UTOPIA</td>
<td></td>
</tr>
</tbody>
</table>

- 8051, IEEE 1284, 200MHz SDRAM I/F, SGRAM, ZBTRAM I/F, Multi-channel DMA
- JAVA, Adv 32-bit RISC Processes, 64-bit RISC, DDR/QDR RAM, 622 Mbps LVDS
- 128-bit processors, Reconfigurable processors

- 10/100 Ethernet, ATM/IP Over SONET, Cell scram/descram, SONET OC3/12, ADPCM, IMA
- Network processors, 1Gb Ethernet, SONET OC48/192, CELP, VoIP, ADSL, HDSL, xDSL, UMTS, wCDMA
- Software Radio, Modems, Neural networking, Emerging Telecom and Networking Standards

- Basic Math, Correlators, Filters: FIR, Comb, Multipliers, FFT, DFT, Sin/Cos, DCT, Adaptive filters, Cordic, DES, DES, Divider, NCO, Satellite decoders
- MP3, QAM, JPEG, Speech Recognition, DSP Processor I/Fs, Wavelet
- MPEG, DSP Functions, > 200 MSPS, Programmable DSP Engines

- CardBus, FireWire, PCI 64-bit/66MHz, Compact PCI Hot-Swap, PC104, AGP, PCI-X 133MHz
- InfiniBand, Emerging High-Speed Standard Interfaces

---

![Xilinx Logo](image)
Introducing the Spartan-II FPGA
Spartan-II: Extending the Spartan Series

More Gates
- 2X gates/$
- 3X gates per I/O
- 2X I/O Performance
- 3X number of gates

Feature Rich
- DLLs
- Select I/O
- Block RAM
- Distributed RAM

More Performance
- Cores
- Easy Design Flow
- Re-programmable
- Fast, Predictable Routing

Time to Market

100,000 Gates for $10

Programmable ASIC/ASSP Replacement!
FPGA Application Trends

Programmable ASIC/ASSP Replacement!
The Spartan-II family, in our opinion, may be the closest that any FPGA has come to being at a low-enough price to compete against an ASIC.”

--Dan Niles, Industry Analyst
Spartan-II - System Integration
Spartan-II Core Support

- On-chip memory & storage
  - Distributed, BlockRAM, FIFOs
- Bus products
  - PCI (64- & 32-bit, 33/66MHz), Arbiter, CAN bus interface
- DSP Functions (FIR filter)
- Error correction
  - Reed-Solomon, Viterbi
- Encryption (DES & triple DES)
- Microprocessor
  - ARC 32-bit configurable RISC, 8-bit 8051 microcontroller
- Memory controllers (10+)
  - SDRAM, QDR SRAM
- Communications
  - ATM (IMA, UTOPIA), Fast Ethernet (MAC)
- Telecom
  - CDMA matched filter, HDLC, DVB satellite, ADPCM speech codec
- Video & image processing
  - JPEG codec, DCT/IDCT, color space converter
- UARTs
Xilinx CPLD Families

- High Speed
- Low Cost

XC9500 Family
- 5 Volt
- 3 Volt
- 2.5 Volt

CoolRunner
- Lowest Power
- Highest Density
- XPLA (Original & Enhanced)
- XPLA2 SRAM Based
- XPLA3 (Released)
- PAL (Simple PLD-22V10)
Spartan-II End Applications

- Consumer
  - Set Top Boxes/Digital VCRs
  - DTV/HDTV
  - Digital Modems
    - xDSL, Cable, Satellite
  - Home Networking products
  - Bluetooth appliances
  - LCD/Flat-Panel Displays
- Networking
  - Telecom linecards
  - DSLAMs
  - LAN Hubs/Switches
  - SOHO Routers
  - Cellular base stations
- Computer/Storage
  - Printer/Scanner
  - Multi-function office equipment
  - Storage devices
  - Home servers
  - Audio/Video add-in cards
- Industrial/Medical
  - Medical Imaging
  - Industrial automation/control
  - Data acquisition
  - Video capture/editing
  - Automated test equipment
  - Automotive Info-tainment systems
CoolRunner Technology

- Full density range 32 to 960 macrocells
- World’s only TotalCMOS CPLD
  - Bipolar style sense amps eliminated
  - Virtually no static power dissipation
- Advanced PLA Architecture
  - Product term sharing (no redundant logic)
  - No wasted product terms
- 3.3v and 5.0v devices
- ISP/JTAG compatible & full software support
The CoolRunner Advantage

• Industry’s lowest power CPLDs
  – Standby current < 100uA
  – High speed  TPD = 6 ns
  – Revolutionary XPLA architecture
    • Exceptional routability & pin-locking
    • Fast, predictable timing
  – Small form factor packaging
    • New 0.5mm 56-pin MicroBGA
• No Speed / Power tradeoffs in scaling
  – Can build very large / very fast devices
  – 960 macrocell device @ 7.5 nsec t_{PD}
XC9500XL Key Features

- High performance
  - $t_{PD} = 5\text{ns}$, $f_{SYS} = 178\text{MHz}$
- 36 to 288 macrocell densities
- Lowest price, best value CPLD
- Highest programming reliability
- Most complete IEEE 1149.1 JTAG
- Space-efficient packaging, including chip scale pkg.

Lowest Price Per Macrocell
XC9500XL/XV System Features

- **I/O Flexibility**
  - XL: 5V tolerant; direct interface to 3.3V & 2.5V
  - XV: 5V tolerant; direct interface to 3.3V, 2.5V & 1.8V
- **Input hysteresis on all pins**
- **User programmable grounds**
- **Bus hold circuitry for simple bus interface**
- **Easy ATE integration for ISP & JTAG**
  - Fast, concurrent programming times
System Block Diagrams for 1394 Solutions
Block Diagram Template / Index

- Xilinx Solution
- Peripheral Components
- Memory
- Mixed Signal / RF / Analog Component
- \( \mu P/ \mu C \)
- Embedded Chip/ ASSP
Set-Top Decoder Box
Digital VCR Set-Top Box

Clock Generator & DLLs

Satellite
Tuner, QPSK Decoder and FEC

Tuner, OFDM Decoder and FEC

Terrestrial
DSL Driver/Receiver, Transceiver and FEC

xDSL

I/O Control

RAM
Memor y Controller
MPEG Encoder
HDD Interface
Hard Disk Drive

NTSC PAL Decoder

CPU
MPEG Decoder & CPU
AC3 Decoder

On Screen Display & Graphics Controller

Audio-Video DACs

Smart Card Reader/Interface

Conditional Access for Smart Card Readers

Modem IF

Modem

PCMCIA IF

PCMCIA

USB Device Controller

1394 PHY

1394 MAC

HomePNA

10/100 Base-TX Transceiver

10/100 Base-TX Ethernet MAC

MII

AFE

HomePNA I/F

Ethernet I/F

USB I/F

Key board, Infrared, RS232
Residential Gateway (STB)
Gaming Station
Desktop PC
Multi-Function Peripheral

- Power Management
- USB Node
- Fax Modem Controller CPU/DSP
- FLASH Adapter/SDRAM Interface
- FLASH Memory/ROM
- DRAM
- Fax System Controller (UART, CODEC, DMA)
- Image Sensor Processor
- Motor
- Scanner
- Miscellaneous I/O
- Serial Peripheral Interface
- Fax Modem Controller
- CPU/ DSP
- 1394 MAC
- 1394 PHY
- Printer
- Motor

XILINX
Scanner

LENS

CCD Array → A/D → DSP → Memory Interface → Memory

PC → Data Transmission → Pixel Co-Processor

POS → NTSC/PAL Encoder → 1394 PHY

JPEG Codec → System Control & I/O Interface

1394 MAC
Home Security
Digital Camera

Diagram of a digital camera system showing various components and their connections:
- **LENS**
- **FLASH Memory**
- **DRAM**
- **Memory Card**
- **Camera DSP**
- **CCD**
- **A/D**
- **JPEG Co-Processor**
- **Graphics Controller**
- **FLASH Adapter/Memory Control**
- **I/O Control**
- **1394 Interface**
- **1394 Interface**
- **1394 Interface**
- **Video Encoder**
- **LCD Controller Driver**
- **IrDA Module**
- **Bluetooth Module**
- **RS-232C Interface**
- **Home Network**
- **Video Out**
Satellite Modems

Quadrature Data from Tuner
I - Channel Input  Q - Channel Input

ADC  ADC  Clock Generator

QPSK/BPSK Demodulator  Viterbi Decoder

De-Interleaver  Reed-Solomon Decoder  Descrambler

Synch & De-Interleaver

Tuner Interface

CPU

Decryption

MPEG Transport & A/V

Video Encoder

MPEG A/V

Flash

RAM

1394 Interface

Data  Clock

Home Network

System Interconnectivity
Cable Modem Residential Gateway

- Analog IF/AGC
- SAW
- ADC
- Tuner
- QAM Demodulator
- FEC Memory
- FEC Decoder
- Decryption Conditional Access
- 8-/16-/32-bit Microcontroller
- QPSK/16QAM Modulator
- FEC Encoder
- Encryption
- 1394 MAC
- 1394 PHY
- USB Device Controller
- USB Transceiver
- DMA
- DMA Interrupt Controller & Central Arbiter
- USB Device
- SDRAM Controller
- SDRAM Controller
- SDRAM
- SDRAM
- IP Telephony
- Direct TDM CODEC Interface
- IP Security Module (DES & Triple-DES)
- UART
- Power Supply
- Clock Generator & DLLs
- DAC
- Interface
- 4 voice channels or 1 video & 1 voice channel
DSL Modem Home Gateway

- 1394 PHY
- 1394 MAC
- Expansion Bus Interface
- DRAM
- 32-bit Processor
- Network Interface Block
- PCI Bus Interface
- 8 KB Internal SRAM
- Hasher List Manager
- PCI

- 8 MHz Oscillator
- Clock Generator & DLLs
- UTOPIA I/F or ATM
- DSL Driver/Receiver Chipset

Home Network

Home Network
DSL CPE
(Customer Premise Equipment)
HomePlug to 1394 Bridge
ISDN Modems

- ISDN "U" or "S" Interface
- PCMCIA Interface
- CPU
- UART

- I/O Control
- RS-XXX Interface

- 1394 MAC
- 1394t PHY

- FLASH Adapter/ SDRAM Interface
  - FLASH Memory
  - DRAM

- Home Network

- ISDN Modems
- Home Network
- 1394t PHY
- 1394 MAC
- I/O Control
- RS-XXX Interface
- PCMCIA Interface
- CPU
- UART

- ISDN Modems
- Home Network
- 1394t PHY
- 1394 MAC
- I/O Control
- RS-XXX Interface
- PCMCIA Interface
- CPU
- UART

- ISDN Modems
- Home Network
- 1394t PHY
- 1394 MAC
- I/O Control
- RS-XXX Interface
- PCMCIA Interface
- CPU
- UART

- ISDN Modems
- Home Network
- 1394t PHY
- 1394 MAC
- I/O Control
- RS-XXX Interface
- PCMCIA Interface
- CPU
- UART

- ISDN Modems
- Home Network
- 1394t PHY
- 1394 MAC
- I/O Control
- RS-XXX Interface
- PCMCIA Interface
- CPU
- UART

- ISDN Modems
- Home Network
- 1394t PHY
- 1394 MAC
- I/O Control
- RS-XXX Interface
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Spartan-II IP Solutions for 1394 Enabled Devices

- I/O Control
  - Multiple front end interfaces
  - Multiple back end interfaces
- Hard disk drive interface
- Clock distribution
  - DLLs
- MPEG decoder
- Ethernet MAC
- Error Correction
  - Reed-Solomon, Viterbi
- Memory solutions
  - Distributed memory, BlockRAM
  - Memory controllers
- CPU
- HDLC controller
- PCI
- Glue Logic
  - LCD controllers
  - UARTs
  - DMA controllers
Programmable Solutions Advantages
Xilinx Programmable Solutions Provide Several Benefits

• Time to market
  – Consumer devices require fast time-to-market
  – ASICs & ASSPs take 12-18 months to spin out

• Flexibility
  – Product customization to meet customer needs
  – Accommodate multiple standards & spec updates/changes
  – Feature upgrades

• Testing and verification
  – Re-programmable allows risk aversion
  – Your solutions are built on a proven FPGA technology with pre-verified silicon and IP that guarantees performance
Xilinx Programmable Solutions Provide Several Advantages

- Xilinx On-line - field upgradability
  - Remote update of software and hardware
  - Results in increased lifetime for a product (time-in-market) and allows new, interesting applications
  - Enable product features per end-user needs
- Issues in creating a stand-alone ASIC/ASSP
  - Choosing the right solution
  - Product customization
  - Development cost and amortization
- Low Cost
Lifecycle Component Logistics

- Xilinx is an assured source of supply
  - Spartan FPGAs are high volume standard parts
  - Xilinx is a Strategic customer to our fab partners
  - If a device is retired, designs are quickly portable
- Xilinx’s solutions reduce exposure to component supply issues
  - Designs can be quickly adapted to efficiently address component supply problems
    - NAND to NOR type Flash support for example
  - Gives latitude in maintaining a cost effective BOM in dealing with the allocation, end of life & generational migration realities of today’s component market
Specification Changes

• Emerging markets are exposed to multiple standards and specification changes
  – DSL Modem market
    • 6 different variations
  – DTV market
    • 18 different formats

A Programmable Solution Future Proof’s Success
New Flexibility from FPGAs

Driving down the cost of consumer products with low cost reprogrammable products

Enabling a whole new breed of consumer products

Reprogrammable nature allows
- Field upgrades
- Field fixes
- Mars probe repair from earth
- Support for numerous standards

Xilinx & Replay TV
- Revolutionizing consumer TV
FPGAs, the Unsung Hero

*Driving the Consumer Digital Logic Revolution*

- The digital consumer world is here
  - Imperatives driving market success
    - Time to market and time-in-market
    - Flexibility
    - Custom digital logic
- Xilinx - The answer for consumer digital applications
  - Introducing the low cost Spartan-II programmable family
    - Cost reduced for the consumer market
    - Fully programmable at the desktop, in the field or in the application
    - Future proofed for changing standards
Xilinx Digital Consumer Logic

A Natural Fit for Home Networking

- Xilinx solutions enable you to thrive in chaos
  - Fastest time-to-market
    - First to market, gains market share and revenue advantage
  - Xilinx Online provides reconfigurability in the field
    - Allows shipped product to support revisions to the spec
    - Enables unique opportunities to add Value
    - Increases life-cycle revenue yield & hence time-in-market
  - Enables rapid product proliferation
    - New designs can be quickly turned into derivatives
  - Feature superior lifecycle component logistics
  - Testing and Verification
    - Proven FPGA technology, software, test benches
- Cost Effective!!!
Agenda

• Introduction
  – Market trend and application
    • 1394 Market Analysis Data
    • 1394 and industry
    • Applications

• Technology
  – What is 1394?
  – Why 1394?
  – Applications
  – 1394 Protocol
    – PHY
    – Link Layer
    – Transaction Layer
  – 1394 Operation
    – Bus Management
    – Cable and Connection
    – Architecture
    – Topology

• Other Technologies
  – USB
  – DVI

• 1394 In Home Networking

• Xilinx Value

• Alliances

• Summary
IEEE 1394 Trade Association

• Was founded in 1994
• Supports the development of electronics systems which can be connected with each other via a single serial multimedia link
• Comprised of more than 170 member companies
  – Sony, Intel, Microsoft, JVC, IBM, Matsushita, Compaq, NEC, Philips, Samsung, and …..
• Is incorporated as a nonprofit trade organization
HAVi
(Home Audio Video interface)

• Is a non-profit association of leading consumer electronics, software, semiconductor, and computer manufacturers

• The goal is to promote a network architecture for Home Audio/Video Interoperability

• Was founded by
  – Grundig AG, Hitachi, Matsushita (Panasonic), Philips, Sharp, Sony, Thomson, Toshiba

• Xilinx is a participant member of HAVi
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• 1394 In Home Networking
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• Summary
1394 In Your Home

- Digital broadcasting, the Internet, digitalization of modern homes, entertainment & video appliances are driving demand for 1394-based products
- Supports data transfer rates @ 100, 200, 400 Mbps
- 1394 benefits
  - No need for terminators, device IDs, or elaborate setup
  - 1394 is Hot pluggable
  - 1394 has scaleable architecture
    - May mix 100, 200, and 400 Mbps devices on a bus
  - 1394 has flexible topology
    - Support of daisy chaining and branching without CPU
Summary

• Various 1394-based products are being developed
  – Residential gateways: DSL, cable, satellite modem
  – Technology bridges: Ethernet-to-1394, 1394-to-HomePNA, 1394-to-wireless LANs
  – 1394 enabled information appliances: digital TV, DVD player, Internet screen phones, PCs, printers, etc.
• Spartan-II FPGAs, CoolRunner & 9500 CPLDs provide system interconnectivity in 1394/Firewire based products