

Structured Cabling System Applications for IEEE 1394 Networks

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Les Baxter
Consultant to SYSTIMAX® Labs
732-212-1400
les@baxter-enterprises.com

Masood Shariff
SYSTIMAX® Labs
Avaya Inc.
732-949-8771
shariff07724@yahoo.com

And now, for something completely different ...

- Many previous presentations on:
 - ⇒ UTP
 - ⇒ Fiber
 - ⇒ Copper vs. Fiber
 - ⇒ Testing
 - ⇒ Standards
 - ⇒ Ethernet, Token Ring, ATM, FDDI, ...
 - ⇒ Intelligent Buildings
- First BICSI presentation on IEEE 1394

Abstract

- Most LAN applications that run over structured cabling systems are optimized for support of asynchronous transmission.
- IEEE 1394 (a.k.a. FireWire and iLink) is designed from the ground up to support isochronous applications such as video. In fact, it is rapidly becoming ***THE network for transmitting digital video and audio.***
- *With the recent approval of the IEEE 1394b specification, the transmission distance has been extended from 4.5 to 100 meters and several new media options have been added including UTP and multimode fiber.*
- This paper will provide a brief introduction to IEEE 1394 networks and discuss how they can be used in conjunction with structured cabling systems to provide support for digital video and audio.



Scientific Atlanta
Set-Top Box

Outline

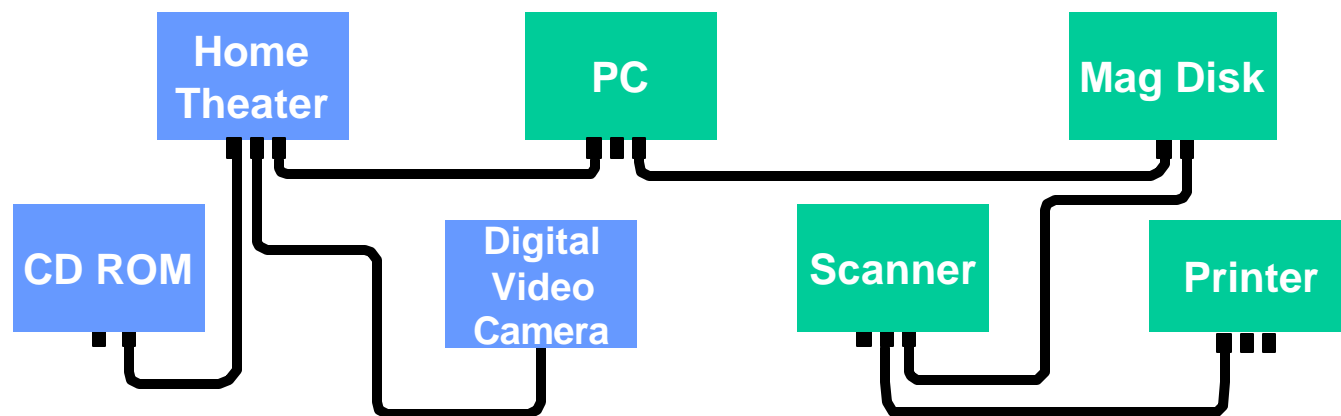
- Introduction
- What's good about 1394?
- Technical Overview
 - ⇒ Cables and Connectors
- Structured Cabling Considerations



Kodak
Digital Camera

What is IEEE 1394?

- A digital network that supports both audio/video AND data processing equipment – provides a bridge between consumer and LAN worlds



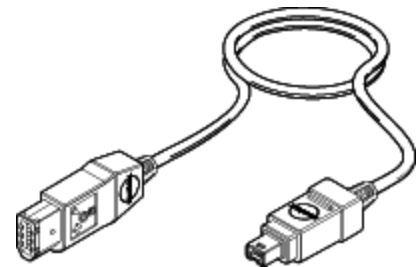
- Tree-structured network
- Multiple ports on most equipment
- Very flexible interconnection – just plug into any vacant port



Dell
Movie Studio

Advantages of IEEE 1394

- ***Built-in support for isochronous connections (e.g., digital video)***
- Hot pluggable – devices are recognized as they are plugged in
- High speed (100 to 1600 Mb/s)
- Integrated operating system support (Apple OS and Windows XP)
- Small connector, thin cable
- Large networks – up to 63 devices



Sony
PlayStation2

IEEE 1394 Introduction

- “FireWire” technology invented by Apple in 1986
- IEEE Standards committee formed in Dec. 1986
- Original application was video editing -- has since expanded into a general computer peripheral interface
- Being marketed under trade names by Apple (FireWire) and Sony (iLink)
- Apple received an Emmy award for FireWire technology on 8/22/2001



IEEE 1394 Standards

- First specification: IEEE 1394-1995 (IEEE Standard for a High Performance Serial Bus)
 - ⇒ Basic operation up to S400 on shielded cords (max length 4.5m)
- IEEE 1394a-2000 (Amendment 1)
 - ⇒ Improvements to arbitration, power management, and PHY (including 4-pin connector)
- IEEE 1394b-2002 (Supplement)
 - ⇒ Improvements in arbitration, speed, bandwidth, distance, and cost effectiveness, several new media options
- P1394.1 – (High Performance Serial Bus Bridges)
 - ⇒ Networking multiple 1394 busses, out for ballot now
- More than 60 other application specs written or in progress



Panasonic
DVCR

What's right about 1394?

- The design focus was on
 - ⇒ Low cost
 - ⇒ Usability for both the designers and the end user
 - ⇒ Extendability
- For the user:
 - ⇒ Easy to use, great real performance
- For the designer:
 - ⇒ Achievable high performance, lower system cost, a long life



Apple
iMac DV

Great performance

- SBP-protocol disk reads > 40 Mbyte/sec
 - ⇒ **Continuous**, not burst
- You only pay for what you need
 - ⇒ All speeds fully compatible
- Real-time data delivery
 - ⇒ Smooth video
 - ⇒ No sound dropouts
- Memory-based architecture provides scalable performance
 - ⇒ Each device can implement its own DMA optimized for its own characteristics
- Much lower S/W processing needed

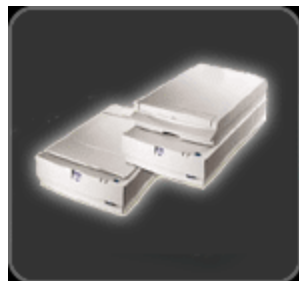
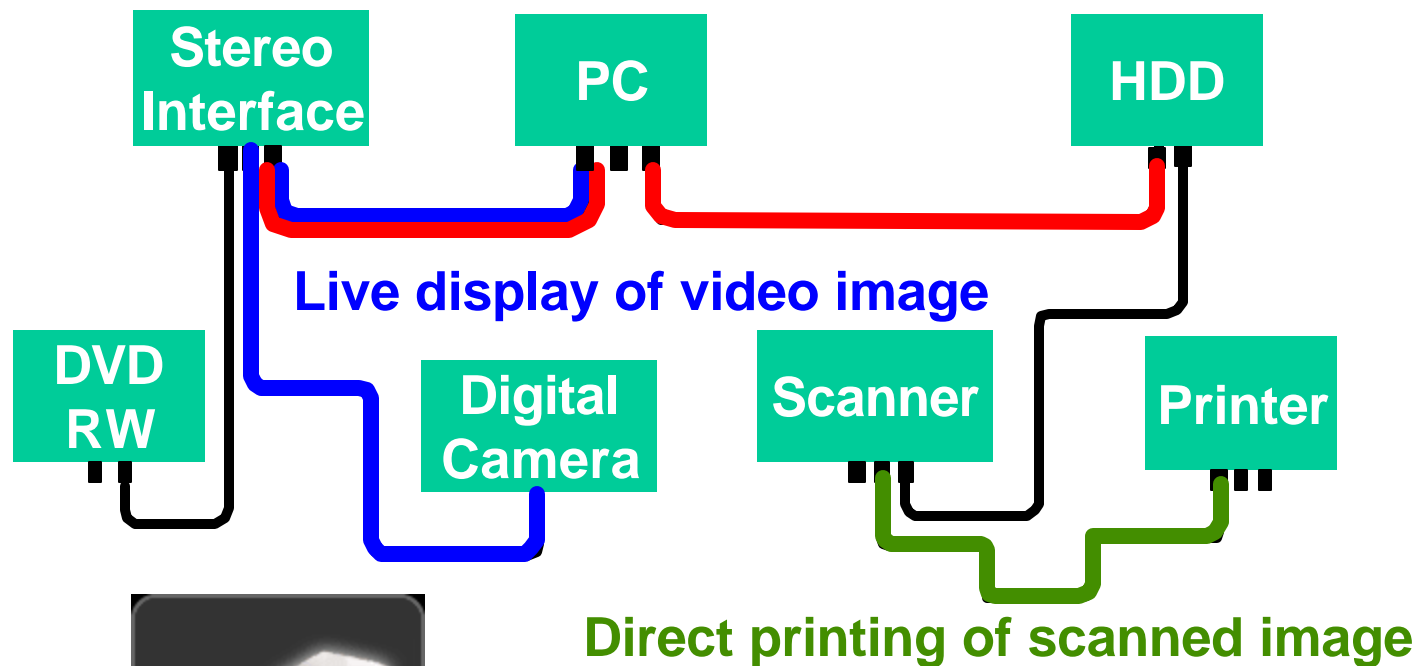


VST Technologies
FireWire Zip Drive

Data paths (peer-to-peer)

- Peer-to-peer operation allows direct copies between devices without going through a central CPU

Digitized sound direct playback



Epson FireWire Scanner

Self-management

- A network of 1394 busses and nodes work in a 64-bit address space
 - ⇒ Each node and bus has an automatically assigned dynamic address
- When a new node is plugged in:
 - ⇒ A bus reset occurs
 - ⇒ All nodes self-identify and are assigned addresses
 - ⇒ A (new) root node is selected
 - ⇒ Normal bus operation continues in less than 100 μ s
 - ⇒ Existing connections (both isochronous and asynchronous) are not affected.



Compaq
Presario

1394 Technical Overview – Physical Layer

- 1394a uses STP cable with two connector types: 6-pin and 4-pin.
 - ⇒ The 6-pin is used to connect to computers and computer peripherals, such as storage devices, scanners, printers, hubs, etc.
 - ⇒ The 4-pin connects to audio/video devices, like digital camcorders, cameras, and VCRs.
- 5 speeds defined in 1394b: 100, 200, 400, 800, 1600 Mb/s (S3200 will be added in a future release)
- 1394b has several cable and connector options (see next chart)



Dap Design
Fire Spy 400

1394b Physical Layer Media

Media	Reach (m)	Max Speed	Connector
Cat 5 UTP	100	S100	Modular
1000 μ POF (10 MHz-km@650 nm)	50	S200	PN
225 μ HPCF (25 MHz-km@650 nm)	100	S200	PN
50 μ MMF (500 MHz-km@850 nm)	100	S1600	LC
Short-Haul Copper (3-pair shielded cord)	4.5	S1600	Beta

TIA-568B.2

TIA-568B.3

1394b Technical Overview – Encoding and Arbitration

- New encoding technique:
 - ⇒ 1394a used non-DC-balanced data/strobe coding
 - ⇒ 1394b uses 8b-10b coding
- New arbitration scheme – BOSS (Bus Owner/Supervisor/Selector) – allows arbitration to be done in parallel with data transfer.
- Extensive requirements for backwards compatibility (encoding and arbitration) to ensure support of legacy devices.
- Up to 63 devices per 1394 bus.

Support for Isochronous and Asynchronous Streams

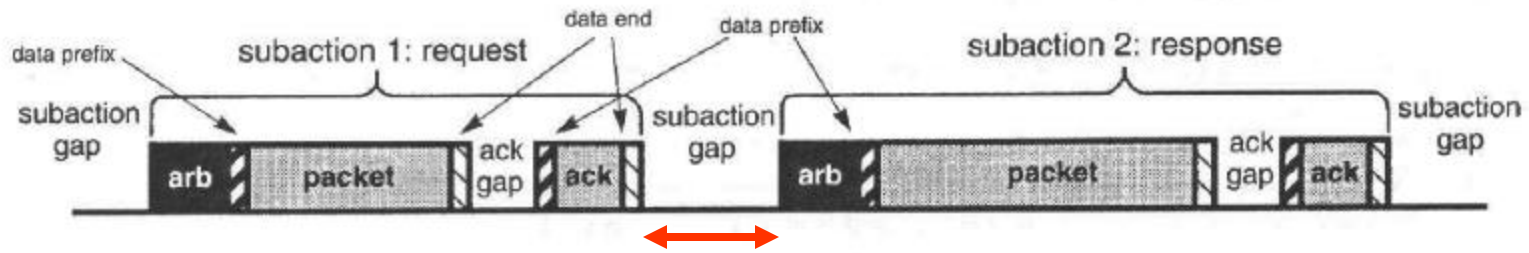


Figure 3.8—Example asynchronous subactions

[From IEEE 1394-1995, p. 25]

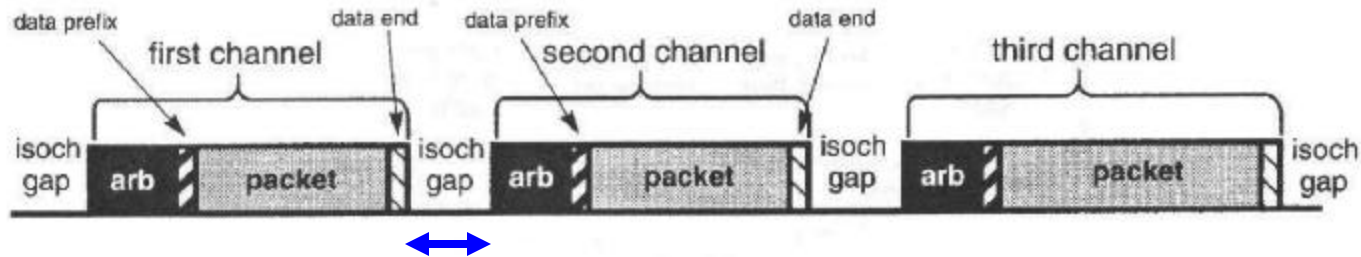


Figure 3.9—Example isochronous subactions

Speed	Max Iso. Rate
S100	64 Mb/s
S3200	2 Gb/s

Digital TV Example

- EIA-775 – DTV 1394 Interface Specification
- Uses IEEE 1394 bus at the physical layer
 - ⇒ References IEC 61883 for video signals
- Isochronous connections are used to send an MPEG2 video signal
- On-Screen Display (OSD) data is sent via asynchronous connections
 - ⇒ Sub-titles
 - ⇒ VCR programming info
 - ⇒ Etc.



Samsung Digital HDTV

1394 Additional Applications (in addition to A/V)

- Industrial
 - ⇒ Currently working on machine vision (for quality control, etc.)
 - ⇒ Considering robotic systems next
- Instrumentation – working on replacing IEEE 488 GPIB
- Automotive
 - ⇒ Entertainment systems and Instrumentation for diagnostics and servicing
 - ⇒ POF spec issued, working on UTP spec
- Extension to 100m opens up home and office networking also



Canon
Mini DV Camera

IEEE 1394 Market Summary

- IEEE 1394 is the preferred interface for video editing and multimedia applications.
- 1394b chips are available from a number of vendors.
- Over 35M IEEE 1394 devices were shipped in 2000 (192% growth over 1999). Market is projected to be 200M units/year by 2005 (>40% CAGR).
- New applications are being aggressively targeted.
- Innovative products such as Apple iPOD) are being announced.

Comparison of USB and IEEE 1394

	USB 2.0	IEEE 1394b
Standards Bodies	USB-IF	IEEE, 1394 TA
Initial Application	Computer peripherals	Video
Speeds (Mb/s)	1.5, 12, 480	100, 200, 400, 800, 1600
Media	STP	Cat5 UTP, STP, POF, HPCF, MMF
Distance (m)	5	100 (50 for POF) (4.5 for STP)

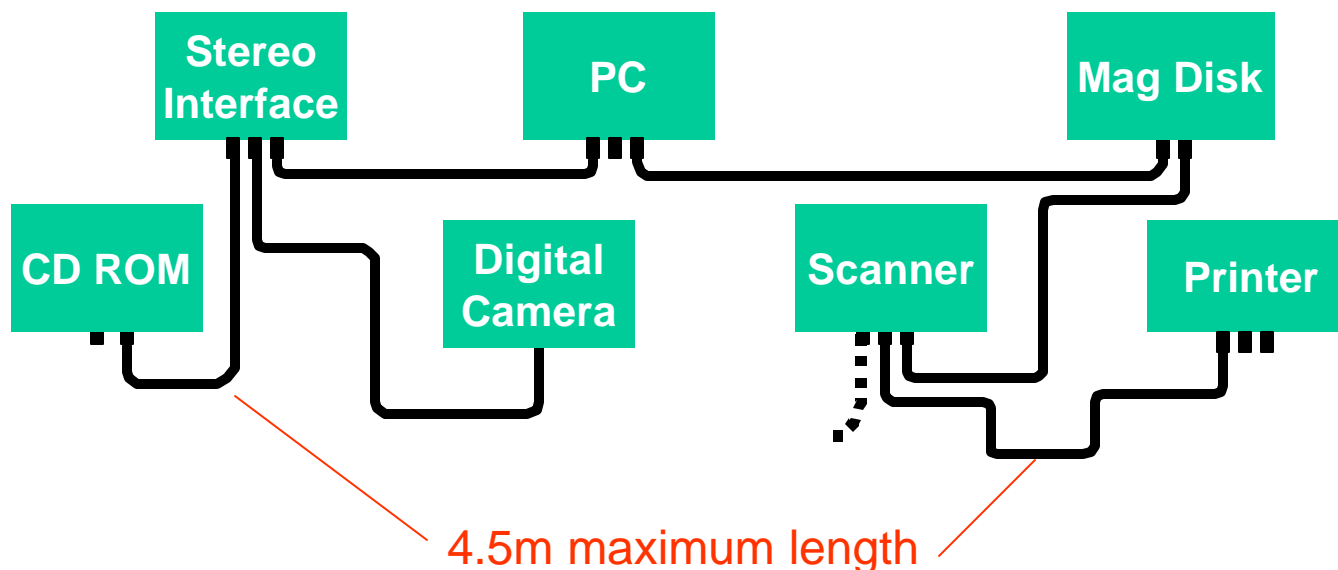
Structured Cabling Considerations

- When users can communicate throughout a building or campus, they inevitably find ways to use this capability.
- When UTP interfaces are available, they are preferred almost exclusively over other media (STP, fiber, coax, ...)
- Users of LANs have historically shown a strong preference for structured cabling solutions.
- *The combination of 1394b and 1394.1 allows 1394 networks to be wired up in a structured manner.*
- As IEEE 1394 equipment becomes more prevalent, there will be a strong demand to use it with structured cabling systems.



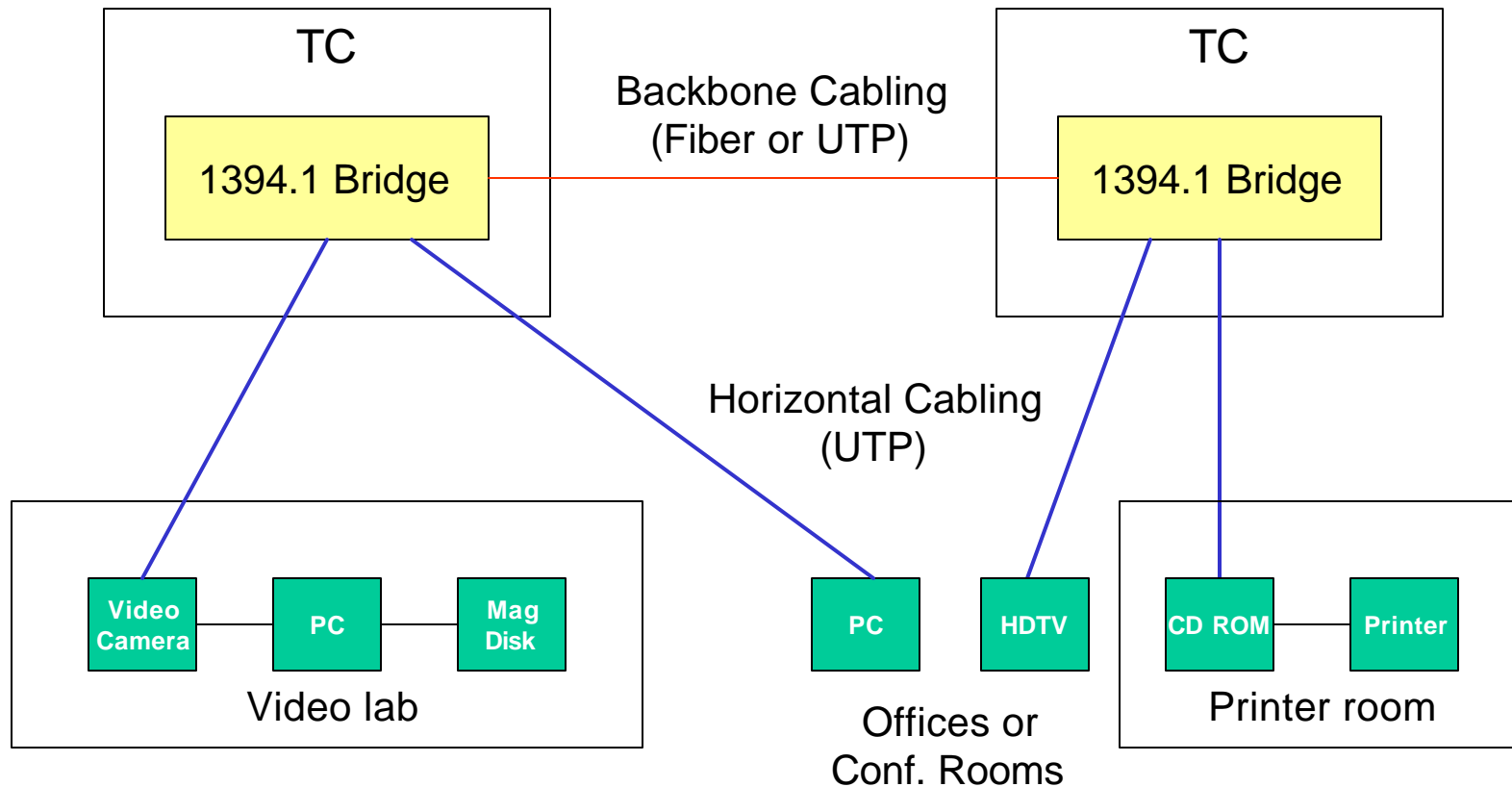
Unibrain
FireRepeater

1394a Unsupervised Cabling



- All cabling is accessible and replaceable
- No terminators
- Arbitrary locations and topology
- Hot Plugin
- Automatic address recognition
- Loops are ok (1394b)
- No Rules !!!

Structured cabling in 1394b networks



IEEE 1394 Device

1394 Trade Association

- The 1394 Trade Association (1394 TA) is a non-profit organization whose mission is to “promote the proliferation of the IEEE 1394 Serial Bus standard technology into the computer, consumer, peripheral, and industrial markets to enable a truly interoperable, standardized, universal I/O and backplane interconnect.”
- About 200 member companies.
- Board of Directors (officers in bold type) are from:
 - ⇒ **Cypress Semiconductor**
 - ⇒ **Molex**
 - ⇒ **Texas Instruments**
 - ⇒ **Apple**
 - ⇒ **LSI Logic**
 - ⇒ **Sony**
 - ⇒ NEC
 - ⇒ Intel
 - ⇒ H-P
 - ⇒ FCI Automotive
 - ⇒ Newnex
 - ⇒ Oxford Semiconductor
 - ⇒ Yokogawa
 - ⇒ Phillips Semiconductor
 - ⇒ Agere
 - ⇒ Panasonic

Yamaha
Music
Synthesizer



1394 TA, cont'd

- Major functions include marketing, public relations, and market research
- Several technical working groups, primarily devoted to application specifications such as Audio/Visual, Automotive, etc.
- Have recently reached agreement with Apple to use the FireWire logo.
- Working on a compliance testing program.
- www.1394ta.com
www.askfor1394.com

Conclusion

- Due to its ease of use and inherent support of isochronous signals (e.g., digital video and audio), IEEE 1394 is poised to become a major force in the market.
- IEEE 1394 extends LAN connectivity to include digital audio and video (e.g., video cameras, etc.)
- The publication of IEEE-1394b extends this network into the structured cabling domain.
 - ⇒ For residential applications, there are lots of 1394 video and audio products hitting the market.
 - ⇒ For commercial applications, 1394 complements Ethernet as an overlay network to handle isochronous traffic.