The Last Yard: Optical Fiber for Next Generation Digital A/V Cables

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Agenda

• Audiovisual Bandwidth Demands
• Current Standards
• Tradeoffs
• Optical Technologies
• Conclusion
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Display Size Increasing

Bigger Displays -> Higher Resolutions
Resolutions Increasing

8K - UHDTV
7680x4320

4K
3840 x 2160

2K - HD
1920x1080
Current Resolutions (1080p)

- 48-bit
- 36-bit
- 24-bit

Frame Rate (Hz) vs. Raw Data Rate (Gbps)
4K Resolution (2160p)

- 48-bit
- 36-bit
- 24-bit

Frame Rate (Hz)

Raw Data Rate (Gbps)
Copper is Slow!

![Bar chart showing bandwidth comparison between different Ethernet cables: Cat 5, Cat 6, Cat 6A, Cat 7, Cat 7A. Cat 7A has the highest bandwidth, followed by Cat 7, then Cat 6A, Cat 6, and Cat 5.]
Copper is Power Hungry!

- 10GBase-SR
- 10GBase-T (28 nm)
- 10GBase-T (40 nm)

Power (mW)

- Copper is Power Hungry! (5400 mW)
- 10GBase-SR (2000 mW)
- 10GBase-T (28 nm) (3000 mW)
- 10GBase-T (40 nm) (5000 mW)
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HDMI

• HDMI (High Definition Multimedia Interface)
  – Consortium
  – Latest Version: 1.4b
  – Maximum Supported Resolution: 4096x2160p@24 fps

• Channels
  – 3 TMDS (Transition Minimized Differential Signaling) data
  – 1 TMDS clock
  – DDC (I^2C)
  – 5V

• Data Rate
  – 3.4 Gbps/data channel
  – Total: 10.2 Gb/s

• Ethernet (HEAC) and Audio Return Channel (ARC)
HDMI

- Limitations
  - 3.4 Gb/s over copper is lossy
  - DDC is limited to short distances

- HDMI 2.0
  - Projected: 18 Gb/s Aggregate

- Multiple Form Factors
  - Regular (Type A)
  - Mini (Type C)
  - Micro (Type D)
DisplayPort/Thunderbolt
DisplayPort/Thunderbolt

• Displayport
  – Video Electronics Standards Association (VESA)
  – Latest Version: 1.2

• Channels
  – 4 differential pairs for data
  – Bidirectional AUX channel
  – 3.3 V

• Data Rate
  – 5.4 Gbps/data channel
  – Total: 21.6 Gb/s
DisplayPort/Thunderbolt

- Thunderbolt
  - Apple/Intel
  - Serial Interface for DisplayPort and PCIe
  - Originally Light Peak (optical medium)
  - Latest Version: 2.0

- Channels
  - 2 Differential channels each way - Bidirectional
  - Power

- Data Rate
  - 10 Gbps/data channel
  - Total: 20 Gb/s
HDBaseT

- HDBaseT
  - Valens, Samsung, LG, Sony Pictures Ent.
  - Single Chip – Multiplex/Demultiplex
  - 5play (HDMI, Audio, 100 Mb Ethernet, Power, Control)
  - Latest Version: 2.0

- Channels
  - Cat 5e/6 (100 m)

- Data Rate
  - Pulse Amplitude Modulation (16-level)
  - 10.2 Gb/s (up to 20 Gb/s)
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What Exists Today?

- Copper cabling
  - Low Cost
  - Short distances
- Extenders
  - Boxes (Tx/Rx for each side if Bidirectional)
  - Simple Interface
  - Convert Format
Electronic Equalization

• Compensate attenuation of signal
• Accepted for all solutions
  – Especially ones that use advanced modulation
• Requires extra IC for some applications
• Available on market
Unidirectional vs. Bidirectional

• Unidirectional
  – Lower Cost
  – Covers most applications

• Bidirectional
  – 1 for 1 replacement for copper
  – Ease of installation
Way Ahead

• Copper will dominate short distance cabling still for some time (5+ Years)
• Better solution needed for higher data rate applications and longer distances
• No clear one size fits all solution
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A View from the Bottom

• Merchant Market
  – Datacom Suppliers
  – Low Cost

• High Volume Manufacturing
  – Quick Turn
  – Same platform, different standards
Datacenter Optics
Fiber Choices

• Multimode Fiber
  – Glass
    • OM(x)
      – Different grades of MM fiber
      – OM2 and higher for most applications
  • Ribbon/Parallel
    – Simplifies packaging
  – Plastic
    • Easy coupling
    • Robust
Fiber Choices

• Singlemode Fiber
  – Longer distance (> 2 km)
  – Cheaper than multimode
  – Higher cost for TX+RX
Integrated Circuits (i.e. Chips)

- **Datacom**
  - Designed for Ethernet
  - Multiple vendors
  - Laser Driver
    - 4x10G ICs (mass production)
    - 4x25G ICs (sampling)
  - Receiver (TIA)
    - Same as Laser Driver

- **Different IC, Different Standard**
  - IC changes
  - Optics stays the same
  - One platform
Integrated Circuits (i.e. Chips)

• Current Issues
  – AV != Ethernet
    • Different format
    • Less complicated control
    • Lower power point
    • Lower cost point
  – Small Market
Laser Choices

• Multimode Fiber
  – Vertical Cavity Surface Emitting Laser (VCSEL)
  – Low cost
  – Low power

• Singlemode Fiber
  – Edge Emitting Laser
  – High Cost – alignment is difficult
Hybrid Optical/Copper Cable

• Combine Fiber and Copper in cable
  – Fiber for high speed data
    • Reduces power consumption
    • Extends Reach
  – Copper for low speed control
    • Reduces complexity of IC – no multiplexing
    • Lower cost
Hybrid Optical/Copper Cable

• Form factor
  – Fit IC and optics inside connector shell
  – Look and feel of copper cabling

• Power
  – Scale with Moore’s law
  – USB (5V, >500 mA)
Hybrid vs. Copper Cable

• Pros
  – Higher bandwidth
  – Longer distance

• Cons
  – Higher cost
  – Lower reliability
Hybrid Cable vs. Extender

• Pros
  – Smaller footprint
  – Lower cost

• Cons
  – Format conversions
  – Can’t use installed cabling infrastructure
Conclusion

• Audiovisual data rate approaching Datacom
• Current copper solutions are not ideal
• Hybrid fiber/copper cable can alleviate
THANK YOU!