HDBaseT vs. IP

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Belden
Regional Sales Engineer
Broadcast and Audio Video Group
System Support All Three

**HDBaseT 5Play™**
- Video and Audio
- USB 2.0
- Control Signals
- 100BaseT Ethernet
- Power 100W

**SDVoE**
- Video
- Audio
- USB
- Control
- Ethernet
- PoE

*5Play is a trademark of HDBaseT Alliance*
Need for speed – pushing the edge

WHY HIGH END VIDEO
Bandwidth Demand

- Video makes up biggest user of bandwidth.
  - **82 percent** of all consumer Internet traffic by 2021

- Video Bandwidth 4 factors
  - Pixels
  - Frame Rate
  - Color Sampling
  - Color Depth
Pixels and Frame Rate

How many pixels?

- 1080P = 2,073,600 pixels
  - 1080 x 1920
- 4K UHD = 8,294,400 pixels
  - 2160 x 3840
- 8K UHDTV2 = 33,177,600 pixels
  - 4320 x 7680

How many frames per second?

- 30 – legacy
- 60 - Standard
- 120 – Cutting edge
Basics of Pixel

- Each pixel 3 colors of light
  - Red / Green / Blue
- Color depth
  - Each can represent 8-16 bits
    - 8bits = 16 million choices
    - 16bits = 281 trillion
- High Dynamic Range (HDR)
- Color sub sampling
  - 4:4:4 Each pixel has it own
  - 4:2:0 Pixel share colors
    (1/2 data required )

24 bit (simulated)

48 bit (simulated)

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Matrix of Data Bandwidth

<table>
<thead>
<tr>
<th>Image</th>
<th>Pixels</th>
<th>Frame</th>
<th>Color</th>
<th>Sampling</th>
<th>Bandwidth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1080P HD</td>
<td>2,073,600</td>
<td>30</td>
<td>8 Bits</td>
<td>4:4:4</td>
<td>1.87 Gbps</td>
</tr>
<tr>
<td>4K UHD</td>
<td>8,294,400</td>
<td>30</td>
<td>8 Bits</td>
<td>4:4:4</td>
<td>7.47 Gbps</td>
</tr>
<tr>
<td>4K UHD</td>
<td>8,294,400</td>
<td>60</td>
<td>8 Bits</td>
<td>4:2:0</td>
<td>7.47 Gbps</td>
</tr>
<tr>
<td>4K UHD</td>
<td>8,294,400</td>
<td>60</td>
<td>10 Bits</td>
<td>4:4:4</td>
<td>17.92 Gbps</td>
</tr>
<tr>
<td>8K UHDTV2</td>
<td>33,177,600</td>
<td>60</td>
<td>10 Bits</td>
<td>4:4:4</td>
<td>71.67 Gbps</td>
</tr>
</tbody>
</table>

\[ \text{FH} \times \text{FW} \times \text{FR} \times (\text{CD} + 2) \times 3 \times \text{CS} \]

Add in more bandwidth for frame timing, audio, control

In the end it’s all data and lots of it!
THE PLAN
Organization which adds in the interpretation and creating standard for infrastructure for data.

**Credentialing Program**
- Registered Communications Distribution Designer (RCDD®)
- Registered Telecommunications Project Manager (RTPM)
- Cabling Installer Programs

**Standard**
- Bonding And Grounding
- Education Facilities
- Healthcare
- Intelligent buildings
# Standards vs Alliances

<table>
<thead>
<tr>
<th>Standards</th>
<th>Alliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Free to use</td>
<td>• Pay to play or some incentive</td>
</tr>
<tr>
<td>• Everyone chance for input</td>
<td>• Limited participation</td>
</tr>
<tr>
<td>• Slow to change</td>
<td>• Quick to change</td>
</tr>
<tr>
<td>• Resist change</td>
<td>• Limited Interoperability</td>
</tr>
<tr>
<td>• Good Interoperability</td>
<td>• Cutting edge performance</td>
</tr>
<tr>
<td><img src="image1.png" alt="TIA" /> <img src="image2.png" alt="EIA" /> <img src="image3.png" alt="ISO" /> <img src="image4.png" alt="IEC" /> <img src="image5.png" alt="CENELEC" /> <img src="image6.png" alt="IEEE" /></td>
<td>• Tied to one technology</td>
</tr>
</tbody>
</table>

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The SDVoE Alliance is a nonprofit consortium allowing software to define AV applications over Ethernet infrastructure.

- Founding Members
  - Aquantia
  - Christie
  - Netgear
  - Sony

- ZeeVee
- SemeTech (Chipset Mfg.)
  Acquired Aptovision

- Belden is adopter member
Technology Convergence

• The combination of technology on a single network (Ethernet)
• Lots of choose for IP convergence systems
  – Compatibility issue
  – Limitations on system
• SDVoE
  – Uncompressed 4K Video
  – 10 Gigabit
  – Compatibility goal with partners
The HDBaseT Alliance is a not-for-profit organization tasked with promoting and advancing HDBaseT technology as the global standard for ultra-high-definition, digital connectivity.

- Board Members
  - GM
  - LG
  - Samsung
  - Sony

- Valens (Chipset MFG.)
- 190 Members
- HDBaseT 2.0 specification

- Belden is adopting member
Infrastructure Convergence

- HDBaseT is based on category cabling
- Category UTP not enough for:
  - Higher bandwidth signals 4K and above
  - 330 feet distances
  - Bundled cabling
- 1080P signal
  - Minimum Category 6A or Shielded F/UTP
- 4K and above
  - Specialty cables
  - Class F / Category 7A*
What HDBaseT IP Does

• Combines:
  – 10Gigabit Ethernet
  – HDBaseT signal
• Then signals is package together at 4 through 6 layers of OSI model
Getting the stream

TO FIT INTO THE PIPE
Video Quality Formula

Quality = Bandwidth / Latency

What level quality you get is dependent on bandwidth (speed) and Latency (time) of the video data.

**Bandwidth**
- 1Gigabit – Minimum
- 10 Gigabit – 4K Better
- 40 /100 Gigabit – Future

**Latency**
- Buffering
  - 4k Movie – 100 Gigabits
  - 10 Mbps – 24 hours
How to Address Bandwidth Issue

• Compression
  – There are lot of ways to compress video
  – Color Compression 4:2:0
  – Grouping areas data
  – Forward / Backward looking packets

• Error correction
  – Also takes time

• Compressing takes time
• Compression can leave artifacts or errors
# Compression Chart

<table>
<thead>
<tr>
<th>Compression</th>
<th>Picture</th>
<th>Latency</th>
<th>Bandwidth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncompressed</td>
<td>Exceptional</td>
<td>Extreme low</td>
<td>Very high</td>
</tr>
<tr>
<td>1.5 – 3 to 1</td>
<td>Very good</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>5 – 8 to 1</td>
<td>Good</td>
<td>Light</td>
<td>Good</td>
</tr>
<tr>
<td>20 to 1 *</td>
<td>Acceptable</td>
<td>Medium</td>
<td>Fair</td>
</tr>
<tr>
<td>100 to 1</td>
<td>Fair</td>
<td>High</td>
<td>Marginal</td>
</tr>
</tbody>
</table>

- Static pictures show more errors – than moving pictures
- HDMI Standard for Picture quality – 1 / Billion
- *4K – compression required for existing networks
CABLING FOR AV
Cabling Choices

Ethernet – IP

• Assemblies (HDMI, DisplayPort, Etc...)
• Traditional Network UTP
  – Category 5e
  – Category 6
• Category 6A
  – 4K Video -
  – SDVoE and HDBaseT

HDBaseT

• Assemblies (HDMI, DisplayPort, Etc..)
• 1080P signal
  – F/UTP Category Cables
  – UTP Category 6A
• 4K Signal
  – Special cables
  – Class F / Category 7A

Fiber cables are option for both for increase bandwidth and increase distance.
**Infrastructure**

<table>
<thead>
<tr>
<th>Signal</th>
<th>Copper Cable</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDVoE</td>
<td>Category 6A UTP</td>
<td></td>
</tr>
<tr>
<td>HDBaseT</td>
<td>Specialty / Class F</td>
<td></td>
</tr>
<tr>
<td>HDBaseT – IP</td>
<td>Category 6A UTP</td>
<td></td>
</tr>
</tbody>
</table>

- **15 ft – 50 ft**
- **150 - 330 ft**

Assemblies

Copper Cables

330 ft
Infrastructure

~ 330 ft

~ 330 ft

~ 330 ft

~ 330 ft
Infrastructure

~ 330 ft

~ 330 ft

~ 330 ft

~ 330 ft
Daisy Chaining
Types of Connectors

MAKING THE CONNECTIONS
Direct Attach vs Channel vs Direct Connect
RJ45 Plug Issues

- “Ice Cube” Style
  - Cheapest item in network cause most issues
  - Time to terminate
  - Error in termination
  - Sized for specific cable
  - Poor performance field term
  - Cheap tools - issues
Field RJ45 Plugs Types

**Printed Circuit Board**
- Reliable performance
- Easy to terminate
- Error free
- Standard tools
- Larger size
POWER IS THE NEW SIGNAL
PoE / POH Adoption

Installed Devices using PoE (12 months)

<table>
<thead>
<tr>
<th>Device Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>WAP</td>
<td>44%</td>
</tr>
<tr>
<td>Laptops</td>
<td>39%</td>
</tr>
<tr>
<td>LED Lighting</td>
<td>32%</td>
</tr>
<tr>
<td>Access Control</td>
<td>38%</td>
</tr>
<tr>
<td>Digital Signage</td>
<td>30%</td>
</tr>
<tr>
<td>VoIP Phones</td>
<td>27%</td>
</tr>
<tr>
<td>Audio / Video</td>
<td>26%</td>
</tr>
<tr>
<td>Smoke Detection</td>
<td>24%</td>
</tr>
<tr>
<td>CCTV</td>
<td>21%</td>
</tr>
<tr>
<td>Intruder Alarms</td>
<td>21%</td>
</tr>
<tr>
<td>White Boards</td>
<td>15%</td>
</tr>
<tr>
<td>POS</td>
<td>14%</td>
</tr>
<tr>
<td>BACS</td>
<td>9%</td>
</tr>
</tbody>
</table>

Audio/Video is 26%: Component of this is PoH
# PoE and POH Applications

<table>
<thead>
<tr>
<th>Capability</th>
<th>POE / POH Type 1</th>
<th>POE / POH Type 2</th>
<th>POE # 3 * POH Twin #2</th>
<th>PoH Twin #3</th>
<th>PoE Type 4*</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSE Minimum voltage</td>
<td>44V</td>
<td>50V</td>
<td>50V</td>
<td>50V</td>
<td>52V</td>
</tr>
<tr>
<td>PSE Minimum Out</td>
<td>15.4W</td>
<td>30W</td>
<td>60W</td>
<td>95W</td>
<td>90-99W</td>
</tr>
<tr>
<td>PD Maximum input Power</td>
<td>13 W</td>
<td>25.5W</td>
<td>51W</td>
<td>71.25W-95W **</td>
<td>68.3W-99W**</td>
</tr>
<tr>
<td>Low Minimum Power Signature</td>
<td>No</td>
<td>No</td>
<td>Yes (PoE)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No (PoH)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Support PSE classes ***</td>
<td>Class 0-3</td>
<td>Class 0-4</td>
<td>Class 0-6 (PoE)</td>
<td>Class 0-4</td>
<td>Class 7-8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0-4 (PoH)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*PoE type 3 & 4 as defined in 802.3bt draft. ** Extended capability depends on cable quality, cable length, PSE output voltage and the ability to support Auto Class *** PoE PSE base Classes: 1 = 4W, 2 = 7W, 3 = 15.4W, 4 = 30W, 5 = 45W, 6 = 60W, 7 = 75W, 8 = 90W. Task force is considering the removal of class 7.
Wire Gauge and Efficiency

↑ Wire Diameter
↓ DCR
CAT 5e - 24awg
CAT 6 – 23awg
CAT 6A – 23awg
Shield F/UTP can help with heat
New Safety Codes

• Cable over 60 watts
  1) bundling
    OR
  2) have LP rating printed on cable

• Test done by UL Certification labs
• Not a performance measurement

• UL 4299 Specification: PoH
• Supports 100W power
• Performance with signal
• Part new certification program
Testing

**Ethernet Work**
- Cable Analyzer
  - Test TIA standards
  - by Category Level
- Signal Tester
  - 1G – 10G signal

**HDBaseT**
- Specialty Tester
  - Test signal
- Cable Analyzer
  - Category test not enough
  - Special parameter can be loaded

Using a Cable Analyzer to Testing to new wire layouts

Direct Attach  Direct Connect  Channel

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Direct Connect Assemblies

• Modular Plug Terminated Link (aka Direct Connect)
• Will meet PL tests
• Normative Annex
• Standard expected in 2018,
  – (TIA 568.2-D)
SVDoE + / -

**Advantages**
- Support all AV signals
  - 4K video
  - Audio
  - Control
- IEEE standard based infrastructure
- Good at large networks
- Off the shelf switches / routers
- Low Latency across multiple hops
- Compatibility

**Disadvantage**
- New Technology
- Shares network with other traffic
- 6a cabling upgrade bandwidth
- Switches to support 10G
- Pricing within room
- Compatibility
HDBaseT + /-

**Advantages**
- Support
  - 4K Video
  - Audio
  - Control
- Large installed base
- Low Latency
- Design small and mid size deployments
- Certified products program
- Compatibility

**Disadvantages**
- Not optimal for Category UTP infrastructure for high end requirements
- Requires separate infrastructure
- HDBaseT Switches
- Expensive for large deployments
- Compatibility
HDBaseT over IP +/-

**Advantages**

- Support
  - 4K video
  - Audio
  - Control
- Blends HDBaseT with IP infrastructure
- IEEE standard based infrastructure
- Good at large networks
- Off the shelf switches / routers
- Compatibility

**Disadvantages**

- Shares network with other traffic
- 6A cabling upgrade bandwidth
- New technology
- Latency
- Compatibility
Conclusions

• Lots of options we only looked at three of them

• What kind of video and quality do need
  – 4K video
  – How much latency is expectable

• Who is going to manage your AV System
  – IT Staff
  – AV Staff

• Distances from source to displays

• Size of installation
  – Within a signal room
  – Within a building
  – Within a campus / more

• Universal compatibility