New Cabling Standards for the Buildings of Today and Tomorrow

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Buildings of Today and Tomorrow

• Why Standards Matter
• Today’s Standards & Terms
• Enabling Standards & Technologies
• Office 2.0 & Smart Buildings
• Digital Transformation
• Sustainability
Why Standards Matter
Why Standards Matter

• Lack of standardization viewed as a top obstacle to adoption of a given technology
• No standards indicates lack of an ecosystem
• No standards indicates vendor proprietary solutions
• No standards can mean no interoperability
• No standards may indicate security issues
• Integration challenges when systems speak different languages
Simplified and Standardized Interfaces

• Standardized interface offers a wide ecosystem of products & vendors
• Ensure wide product availability
• Standardization eliminates proprietary and non-compatible interfaces
• Standardization gives confidence to deploy for performance & safety
• Simplifies future upgrades
Complex to Simple

- BACnet (HVAC)
- LONTalk (BAS)
- MODBus (Process Control)
- ProfiBus (Process Control)
- KNX (BAS)
- DALI (Lighting)

CORPORATE NETWORK

- Ethernet (HVAC)
- Ethernet (BAS)
- Ethernet (Process Control)
- Ethernet (Lighting)

CORPORATE NETWORK

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Today’s Standards & Terms
What is Structured Cabling?

- Flexibility, future proofing, moves, adds, and changes
- Lower total cost of ownership
- Traditionally ran network – now expanding into new areas

Typical Enterprise 4-connector cabling system

More common 2-connector cabling system

Versus

Home run
Permanent Link and Channel

Up to 4 jacks per channel (showing 2)

Permanent Link (up to 90 meters)

Channel (up to 100 meters)
# Common Terms

<table>
<thead>
<tr>
<th>Common Term</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jacks, RJ45, information outlet</td>
<td><img src="image" alt="Jacks, RJ45, information outlet" /></td>
</tr>
<tr>
<td>Patch cord, jumper, Ethernet cable</td>
<td><img src="image" alt="Patch cord, jumper, Ethernet cable" /></td>
</tr>
<tr>
<td>Faceplate</td>
<td><img src="image" alt="Faceplate" /></td>
</tr>
<tr>
<td>Patch Panel</td>
<td><img src="image" alt="Patch Panel" /></td>
</tr>
<tr>
<td>Raw cable, bulk cable</td>
<td><img src="image" alt="Raw cable, bulk cable" /></td>
</tr>
<tr>
<td>Modular plug, field terminable plug</td>
<td><img src="image" alt="Modular plug, field terminable plug" /></td>
</tr>
</tbody>
</table>
Standards & Warranties

• Industry is very standards based
• ANSI/TIA-568.2-D is “official” standard
  • Defines performance levels (Cat 6, Cat 6A)
  • Performance requirements for:
    • Components: Jack, Patch Cord, Cables
    • Permanent Link: Jack and Cable
    • Channel: Everything
• Ensures interoperability between vendor components
  • Vendors enforce 15 to 25-year warranties through end-to-end solution requirements
# Copper Category Comparison

<table>
<thead>
<tr>
<th>TIA</th>
<th>Cat 5e</th>
<th>Cat 6</th>
<th>Cat 6A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>UTP or STP</td>
<td>UTP or STP</td>
<td>UTP or STP</td>
</tr>
<tr>
<td>Specified Bandwidth</td>
<td>100 MHz</td>
<td>250 MHz</td>
<td>500 MHz</td>
</tr>
<tr>
<td>Cable Wire Gauge</td>
<td>23/24 AWG</td>
<td>23 AWG</td>
<td>23 AWG</td>
</tr>
<tr>
<td>PoE Support</td>
<td>Yes – no LP</td>
<td>Yes</td>
<td>Optimal</td>
</tr>
<tr>
<td>Diameter (Approx)</td>
<td>.210”</td>
<td>.220”</td>
<td>.230” to 0.240”</td>
</tr>
<tr>
<td>Gigabit Ethernet</td>
<td>100 m</td>
<td>100 m</td>
<td>100m</td>
</tr>
<tr>
<td>10GBASE-T Ethernet</td>
<td>Not Supported</td>
<td>Limited distances per TSB-155-A</td>
<td>100m</td>
</tr>
<tr>
<td>25/40GBASE-T</td>
<td>Not Supported</td>
<td>Not Supported</td>
<td>Not Supported</td>
</tr>
<tr>
<td>Approx. Relative Installed Cost</td>
<td>1 X</td>
<td>1.2 X</td>
<td>1.5X</td>
</tr>
</tbody>
</table>

- **Dying**
- **Biggest market, Largest base (~60%)**
- **Growing**
Summary

• Structured cabling is a common way to connect elements together
• Several elements come together to form a system or channel
• Industry is very standards based
  • Allows interoperability
  • Cat 6 is most common
  • Cat 6A is growing
Enabling Standards & Technologies
## PoE Overview

<table>
<thead>
<tr>
<th>Type</th>
<th>Standards</th>
<th>Maximum Current</th>
<th>Number of Energized Pairs</th>
<th>Power at Source</th>
<th>Power at Device</th>
<th>Maximum Data Rate</th>
<th>Standard Published</th>
</tr>
</thead>
<tbody>
<tr>
<td>PoE</td>
<td>IEEE 802.3af (802.3at Type 1)</td>
<td>350 mA</td>
<td>2</td>
<td>15.4 W</td>
<td>13 W</td>
<td>1000BASE-T</td>
<td>2003</td>
</tr>
<tr>
<td>PoE+</td>
<td>IEEE 802.3at Type 2</td>
<td>600 mA</td>
<td>2</td>
<td>30 W</td>
<td>25.5 W</td>
<td>1000BASE-T</td>
<td>2009</td>
</tr>
<tr>
<td><strong>PoE++ (4PPoE)</strong></td>
<td><strong>IEEE 802.3bt Type 3</strong></td>
<td><strong>600 mA</strong></td>
<td><strong>4</strong></td>
<td><strong>60 W</strong></td>
<td><strong>51 W</strong></td>
<td><strong>10GBASE-T</strong></td>
<td><strong>2018</strong></td>
</tr>
<tr>
<td></td>
<td><strong>IEEE 802.3bt Type 4</strong></td>
<td><strong>960 mA</strong></td>
<td></td>
<td><strong>99 W</strong></td>
<td><strong>71 W</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No IEEE standard</td>
<td>Cisco UPOE</td>
<td>600 mA</td>
<td>4</td>
<td>60 W</td>
<td>51 W</td>
<td>Varies</td>
<td>Exists today – no official ratification</td>
</tr>
<tr>
<td></td>
<td>HDBaseT (<a href="http://www.hdbaset.org">www.hdbaset.org</a>)</td>
<td>1000 mA</td>
<td></td>
<td>100 W</td>
<td>100 W</td>
<td></td>
<td></td>
</tr>
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</table>

- Next generation of PoE is a 3X increase in power
- Next generation of PoE supports 10GBASE-T
- Category 6A
  - 10GBASE-T
  - Optimal thermal efficient & performance
Impact of 2017 National Electric Code

- Recognizes new UL listing for Limited Power (LP) cables
  - LP not required
  - Need at least a 0.5A rating
  - Example: TYPE CMP–LP(0.5A) (UL) 23 AWG 90°C
- LP simplifies installation and inspection
  - With no LP, refer to ampacity table

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<td>960 mA</td>
<td>4</td>
<td>90 W</td>
<td>71.3 W</td>
</tr>
</tbody>
</table>

NEC® 2017 not a concern

NEC® 2017 imposes new requirements
## Ampacity Table

<table>
<thead>
<tr>
<th>AWG</th>
<th>Number of 4-Pair Cables in a Bundle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Temp Rating</td>
</tr>
<tr>
<td>26</td>
<td>1.0</td>
</tr>
<tr>
<td>24</td>
<td>2.0</td>
</tr>
<tr>
<td>23</td>
<td>2.5</td>
</tr>
<tr>
<td>22</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Note 1: For bundle sizes over 192 cables, or for conductor sizes smaller than 26 AWG, ampacities shall be permitted to be determined by qualified personnel under engineering supervision.

Note 2: Where only half of the conductors in each cable are carrying current, the values in the table shall be permitted to be increased by a factor of 1.4.

- Cat 5e (24 AWG, 60C): Maximum bundle size of 61
- Cat 6A (23 AWG, 75C): Maximum bundle size of 192
Connectivity and Next Generation PoE

- Arcing (spark) occurs when plug is removed
  - Does not occur when plug is inserted
- Carbon buildup may prevent data transmission
- Jack must be designed for (meet IEC 60512-99-002)
## Wi-Fi Now and Into the Future

<table>
<thead>
<tr>
<th></th>
<th>Wi-Fi 4</th>
<th>Wi-Fi 5</th>
<th>Wi-Fi 6 and 6E</th>
<th>Wi-Fi 7</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bands</strong></td>
<td>2.5 / 5 GHz</td>
<td>5 GHz</td>
<td>2.4/5 GHz 6E will use 6 GHz band</td>
<td>2.4/5/6 GHz</td>
</tr>
<tr>
<td><strong>Density of APs</strong></td>
<td>+</td>
<td>++</td>
<td>+++</td>
<td>+++++</td>
</tr>
<tr>
<td><strong>Data Rates</strong></td>
<td>0.6 Gbps</td>
<td>6.9 Gbps</td>
<td>9.6 Gbps</td>
<td>10+ Gbps</td>
</tr>
<tr>
<td><strong>Cable</strong></td>
<td>Cat 6</td>
<td>Cat 6A</td>
<td>Cat 6A</td>
<td>2x Cat 6A</td>
</tr>
</tbody>
</table>

- Wi-Fi 5 and 6 need up to 10GBASE-T
- 10GBASE-T requires Category 6A cabling
- Wi-Fi 6 can allow increased densities
- Wi-Fi 7 needs 2 Category 6A cables for data (per 802.11be)

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Wi-Fi 6E Discussion

- Wi-Fi 6E is a significant upgrade to spectrum partitioning
- Significantly more bandwidth
- Spectrum partitioning
- Recommend 2 to 4 cables in planning per access point

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Spectrum Partition Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>School</td>
<td>Faculty Channels &amp; Student Channels</td>
</tr>
<tr>
<td>Healthcare</td>
<td>Medical Imaging Channels, Doctor/Nurse Channels, Patient Channels</td>
</tr>
<tr>
<td>Corporate</td>
<td>Corporate Channels, Guest Channels, IoT Channels</td>
</tr>
<tr>
<td>Retail</td>
<td>Retail Store Channel, Guest Channels</td>
</tr>
<tr>
<td>Corporate</td>
<td>Critical Machinery Channels, Worker Channels</td>
</tr>
</tbody>
</table>
Category 6A Products

- Category 6A offers optimal Power over Ethernet and 10GBASE-T transmission
- Newer products offer smaller diameters on cable and patch cords
- Likely LP rated
- Simplified upgrades from Category 6
Field Terminable Plugs

- Standardized
- Terminates like a jack
- Enable clean & cost-effective terminations
Office 2.0 & Smart Buildings

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Office 2.0 (The Future of the Office)

• Truly enabling the hybrid office
  • Hybrid work is more challenging
  • Someone working remote has the same experience as someone in the office
  • Think about white boarding in a meeting room
• Making the office somewhere you want to go
  • Smart buildings are ideal for this
  • Customize lighting, temperature
  • Everything needs to work!
• Expecting at least a return to 75-85% occupancy
  • Seeing large innovative firms pushing for a return
  • Not necessarily a drop in space usage
The 7 S’s of Commercial Building’s Future

- Sustainable
- Standardized
- Secure
- Safe
- Smart
- Simplifying
- Sexy
Definition of a Smart Building

- A smart building is one that uses technology to enable efficient and economical use of resources, while creating a safe and comfortable environment for occupants.
  - Lighting, HVAC, access control, temperature, and other systems can be integrated, monitored, optimized, and controlled.
  - Typically utilize elements like sensors, building management systems, and artificial intelligence to help.
- Smart Buildings are ~30% lower cost to implement when using “open” systems
  - 30% is compared against similar systems that are closed
  - Savings only seen when comparing systems with similar functionality.
The History of Convergence
A Big Change in the Market

RJ45 is the Global Unifying Connector!
Example – Traditional Lighting Design

**Rigid and complex**

**Occupancy / Vacancy**

**Dimming**

**NOTES**

1. ELECTRICAL CONTRACTOR SHALL VERIFY QUANTITIES OF ALL DEVICES. ADDITIONAL DEVICES MAY BE NECESSARY. REFER TO REFLECTED CEILING PLANS FOR ADDITIONAL DEVICES.

2. A MAXIMUM OF 10 SENSORS SHALL BE ENERGIZED PER POWER PACK. SUPPLEMENT WITH ADDITIONAL POWER PACKS IF OVER 10 SENSORS.

3. AUXILIARY RELAY Requires SENSOR POWER TO FUNCTION. AUXILIARY RELAY CHANGES STATE WHEN ALL CONNECTED SENSORS REGISTER OCCUPIED. GREY AND BROWN WIRES ARE CONNECTED DURING OCCUPIED STATE. VIOLET AND BROWN WIRES ARE CONNECTED DURING UNOCCUPIED STATE.

4. LOW VOLTAGE DIMMER MAY BE PROGRAMMED FOR EITHER VACANCY OR OCCUPANCY MODE. REFER TO REFLECTED CEILING PLANS FOR CONTROL TYPE.
Example – Smart Lighting Design

Flexible and simple

Daylight Harvesting

High / Low Trim

Utility

Power Reporting

Dimming

Scenes

RGB Notification Lighting

White Light Color Tuning
Smart Building Summary

• Foundational and enabling technology for the next generation of buildings
• Will help encourage people to return to the office
• Will be standards based
• Will be more cost effective
Digital Transformation
The 4th Utility & Smart Buildings

• What is a utility?
  • A utility is a business that furnishes an everyday necessity to the public at large

• Everyday necessities includes:
  • Electricity
  • Water
  • Gas
  • Network

The network has become a necessity that can provide data AND power

*The foundation of the network is a robust cabling infrastructure*
Two Foundations of Digital Transformation in Infrastructure:
Single Pair is the Next Generation

Remember?

State of Building Automation Today

Single Pair Ethernet
Standardization Solutions for Today’s Problems

- RS 485 → Ethernet
- Proprietary Interfaces → Standardized Interfaces
- Inconsistent Security → Consistent & Robust Security
- Different topologies → Consistent topology
- Different data rates → Standardized data rates
- Lack of Interoperability → Complete Interoperability

Standardization solves many of the issues seen today
Reliable Wireless is a Business Necessity

• A good and reliable network is a business necessity
  • Reliable connectivity brings people to the office
  • People do not want to live / shop / work in places that do not enable seamless connectivity

• Wireless has two elements
  • Wi-Fi
  • Cellular

• A robust wired system is critical to support
Building Communication Systems
Strengths of Wi-Fi and DAS

**Wi-Fi**
- Used for Data Transmission
- Suitable for Streaming
- Supports IoT Devices
- Supports Security Devices

**DAS**
- Used for Voice and Data Transmission
- Distributes Cellular Signal
- No Login Needed
Seamless Connectivity Together

Wi-Fi AND DAS

Seamless Mobile Connectivity

- Used for Data Transmission
- Suitable for Streaming
- Supports IoT Devices
- Supports Security Devices

- Used for Voice and Data Transmission
- Distributes Cellular Signal
- No Login Needed
Digital Transformation Summary

• Further convergence over Ethernet
  • Single Pair Ethernet is a future enabling technology
  • Expect most systems to converge over Ethernet

• Wireless is a building necessity
  • Wi-Fi
  • Cellular coverage with IBW
Sustainability
Sustainability is a Business Necessity

- It is imperative for companies to develop a message of sustainability
  - The environment is Gen Z’s No. 1 concern
  - Gen Z, Millennials Stand Out for Climate Change Activism
  - Joe Biden calls climate change the ‘number one issue facing humanity’

- A company’s buildings are a very visible element of their commitment to sustainability
What Does Sustainability Mean?

• Measure and be transparent about your impact
• Reduce carbon footprint
  • Construction
  • Operationally
• Drive towards a business model that has no environmental impact
• Look to a future where you have a positive environmental impact
Sustainable Building Programs

- Different levels for many of these programs
- Points via EPDs and HPDs
  - USGBC- LEED
  - WELL
  - Greenstar
  - BREEAM
- Selling point / feature of many buildings
Structured Cabling & Sustainability

- Material Impact Reporting (MIR)
  - 1000 ppm to 100 ppm

- Environmental Product Declaration (EPD)
  - Impact of your product on the environment
  - Does not mean product is environmentally friendly
  - Can be used by sustainability programs like LEED, WELL, Greenstar, BREEAM if they are 3rd party certified

- Health Product Declaration (HPD)
  - Impact of your product on human health
  - Can also be used in sustainability programs if 3rd party certified

- Red List Free
  - Used in Living Building Challenge
  - Supposed to avoid chemicals harmful to human health
Conclusions

• The cabling industry is very standards based
• Power over Ethernet and Wi-Fi are two important enabling technologies
• The future of the office is somewhere people want to go but also enables the hybrid meeting
• Convergence is an ongoing trend accelerating the adoption of category cabling
• Good wireless (both Wi-Fi and IBW) is a business necessity
• Sustainability is critical and consider how sustainable your structured cabling system is
Thank You!

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