

# 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

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# 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

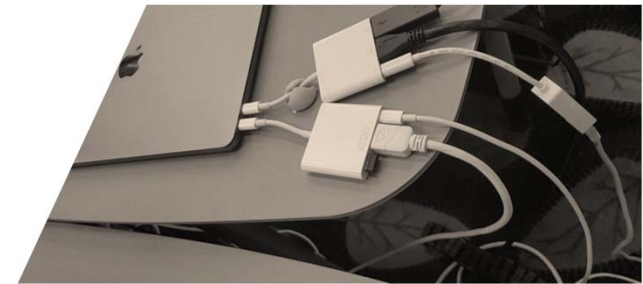


# Simplified and Standardized Interfaces

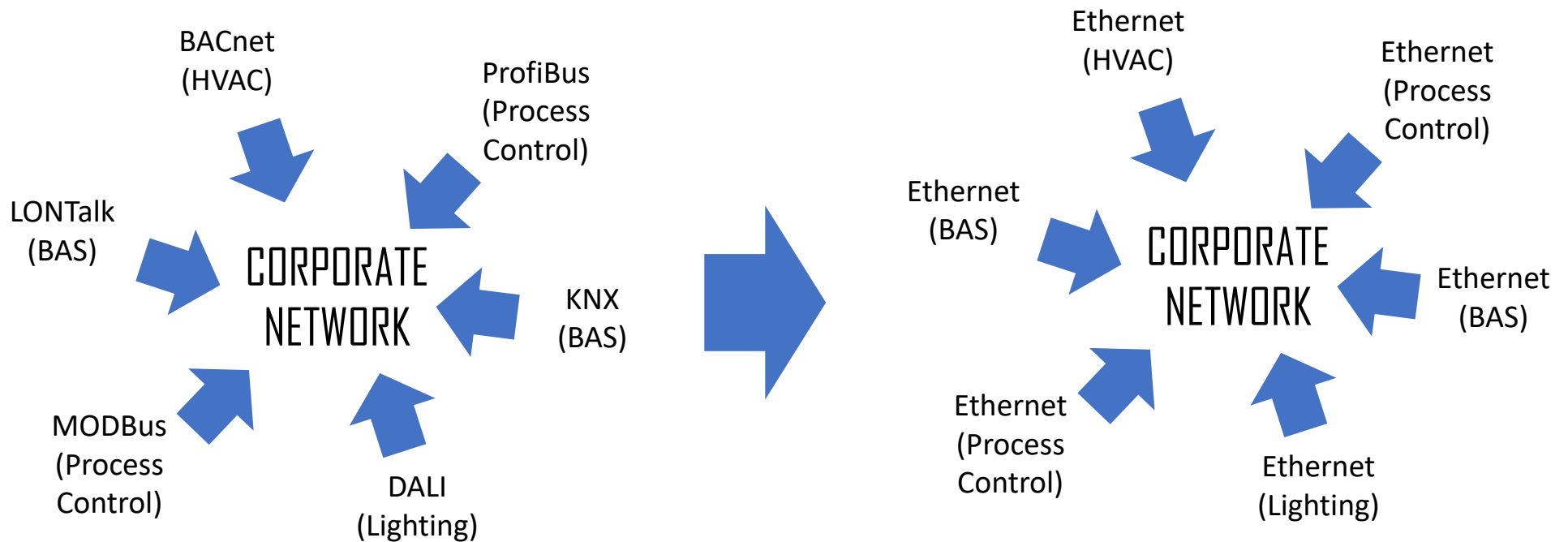
- Standardized interface offers a wide ecosystem of products & vendors
- Ensure wide product availability
- Standardization eliminates proprietary and non-compatible interfaces
- Standardization gives confidence to deploy for performance & safety
- Simplifies future upgrades



**VERSUS**



# Complex to Simple



# Today's Standards & Terms

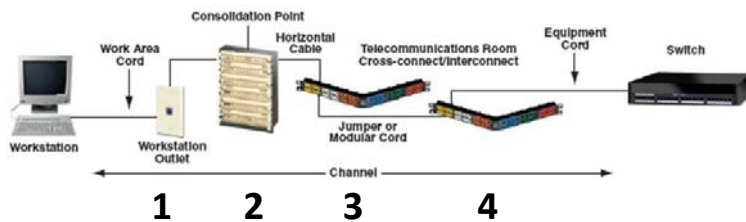
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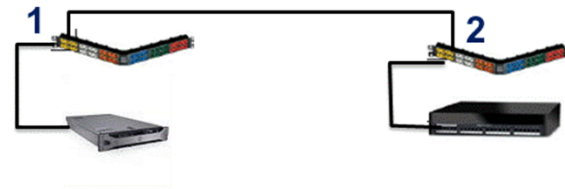
# What is Structured Cabling?

Typical Enterprise 4-connector cabling system



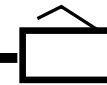
or

More common 2-connector cabling system



## Versus

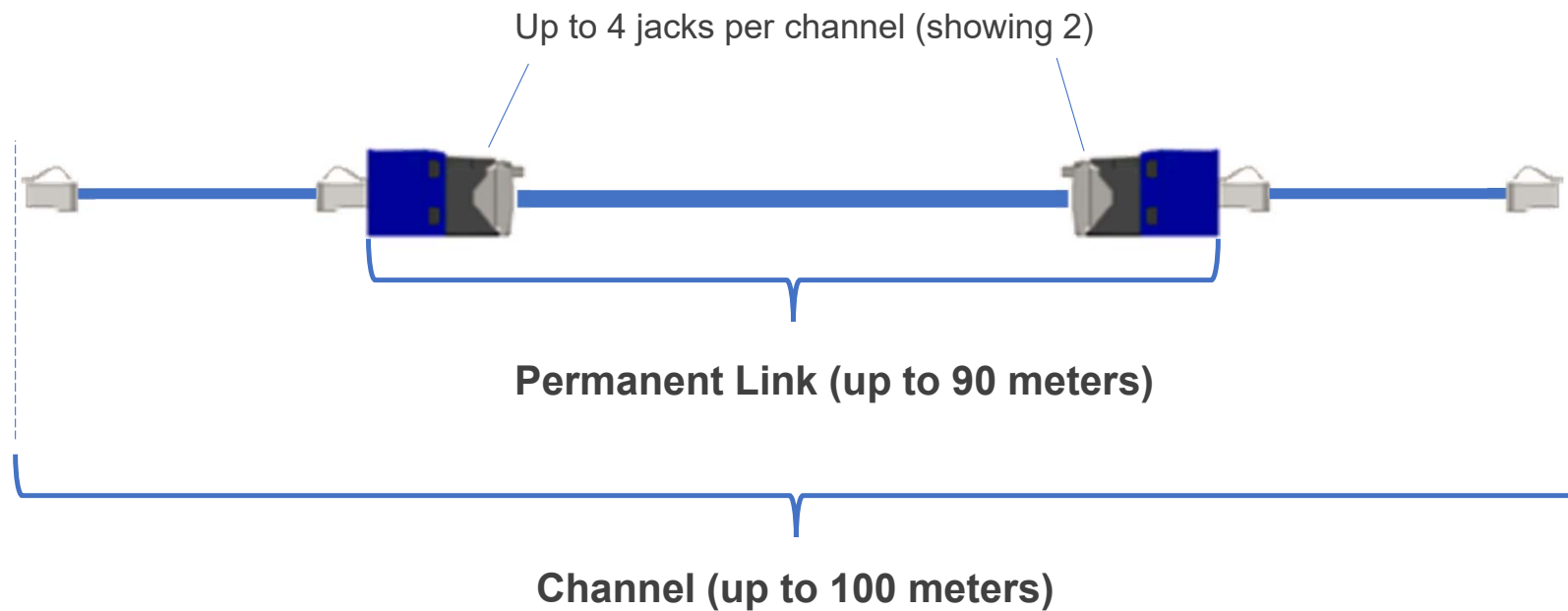
Home run



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



# Permanent Link and Channel



# Common Terms



Jacks, RJ45,  
information outlet



Patch Panel



Patch cord,  
jumper,  
Ethernet cable



Raw cable, bulk  
cable



Faceplate



Modular plug, field  
terminable plug,  
MPTL

# 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

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



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

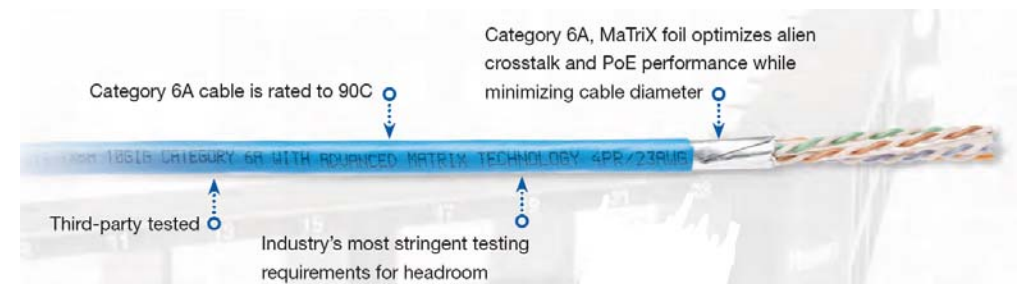
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# PoE Overview

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

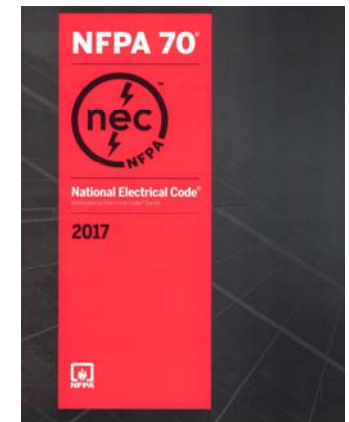
- Next generation of PoE is a 3X increase in power
- Next generation of PoE supports 10GBASE-T
- Category 6A
  - 10GBASE-T
  - Optimal thermal efficient & performance





# 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



Type	Standards	Maximum Current	Number of Energized Pairs	Power at Source	Power at Device
PoE	IEEE 802.3af (802.3at Type 1)	350 mA	2	15.4 W	13 W
PoE+	IEEE 802.3at Type 2	600 mA	2	30 W	25.5 W
PoE++ (4PPoE)	Proposed IEEE 802.3bt Type 3	600 mA	4	60 W	51 W
PoE++ (4PPoE)	Proposed IEEE 802.3bt Type 4	960 mA	4	90 W	71.3 W

NEC® 2017 not a concern



NEC® 2017 imposes new requirements

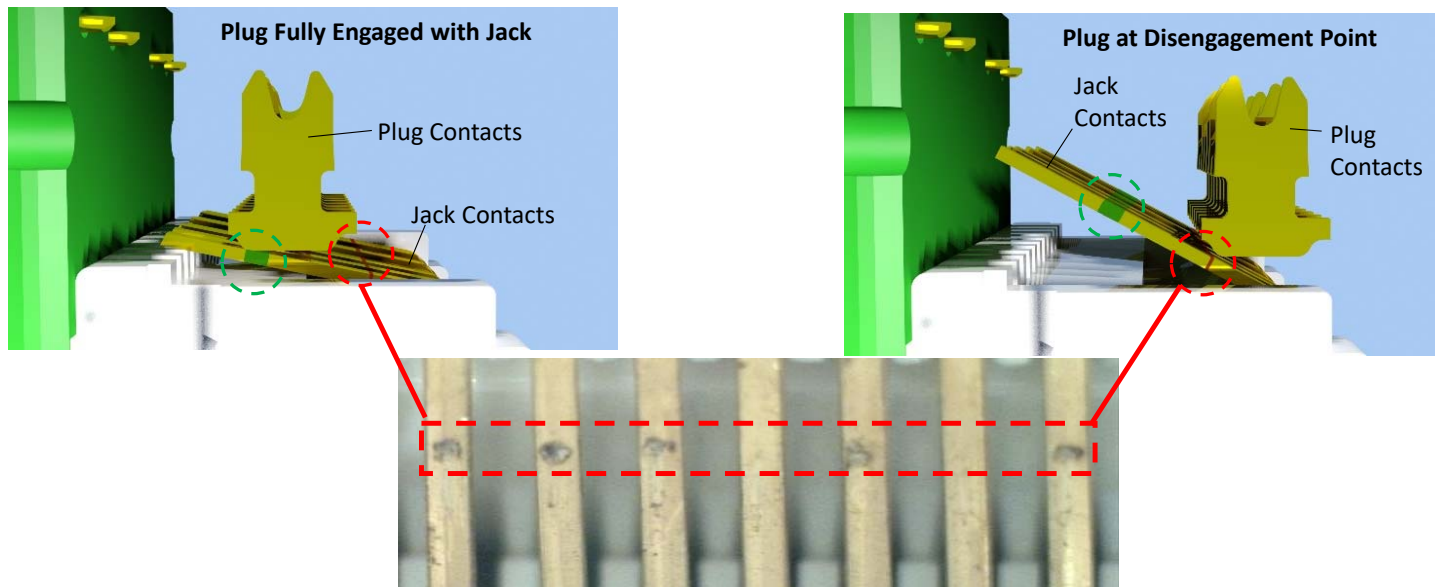
# Ampacity Table

AWG	Number of 4-Pair Cables in a Bundle																				
	1			2-7			8-19			20-37			38-61			62-91			92-192		
	Temp Rating			Temp Rating			Temp Rating			Temp Rating			Temp Rating			Temp Rating					
	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C
26	1.0	1.0	1.0	1.0	1.0	1.0	0.7	0.8	1.0	0.5	0.6	0.7	0.4	0.5	0.6	0.4	0.5	0.6	NA	NA	NA
24	2.0	2.0	2.0	1.0	1.4	1.6	0.8	1.0	1.1	0.6	0.7	0.9	0.5	0.6	0.7	0.4	0.5	0.6	0.3	0.4	0.5
23	2.5	2.5	2.5	1.2	1.5	1.7	0.8	1.1	1.2	0.6	0.8	0.9	0.5	0.7	0.8	0.5	0.7	0.8	0.4	0.5	0.6
22	3.0	3.0	3.0	1.4	1.8	2.1	1.0	1.2	1.4	0.7	0.9	1.1	0.6	0.8	0.9	0.6	0.7	0.8	0.5	0.6	0.7

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)

**intertek**  
Test Quality Assured

### Test Verification of Conformity

On the basis of the tests undertaken, the sample(s) of the below product have been found to comply with the requirements of the referenced standard and actions at the time the tests were carried out. This verification is part of the full test report(s) and should be read in conjunction with them.

**Applicant Name & Address:** Panduit Corporation  
6200 175th Street  
Twin Park IL 60477  
USA

**Product Description:** Connecting hardware identified with the following part numbers:  
NXP588M\*\*, CSE88T0\*\*, CSE88T1\*\*, CSE88T2\*\*, CSE88T3\*\*, CSE88T4\*\*, CSE88T5\*\*, CSE88T6\*\*, CSE88T7\*\*, CSE88T8\*\*, CSE88T9\*\*, CSE88T10\*\*, CSE88T11\*\*, CSE88T12\*\*, CSE88T13\*\*, CSE88T14\*\*, CSE88T15\*\*, CSE88T16\*\*, CSE88T17\*\*, CSE88T18\*\*, CSE88T19\*\*, CSE88T20\*\*, CSE88T21\*\*, CSE88T22\*\*, CSE88T23\*\*, CSE88T24\*\*, CSE88T25\*\*, CSE88T26\*\*, CSE88T27\*\*, CSE88T28\*\*, CSE88T29\*\*, CSE88T30\*\*, CSE88T31\*\*, CSE88T32\*\*, CSE88T33\*\*, CSE88T34\*\*, CSE88T35\*\*, CSE88T36\*\*, CSE88T37\*\*, CSE88T38\*\*, CSE88T39\*\*, CSE88T40\*\*, CSE88T41\*\*, CSE88T42\*\*, CSE88T43\*\*, CSE88T44\*\*, CSE88T45\*\*, CSE88T46\*\*, CSE88T47\*\*, CSE88T48\*\*, CSE88T49\*\*, CSE88T50\*\*, CSE88T51\*\*, CSE88T52\*\*, CSE88T53\*\*, CSE88T54\*\*, CSE88T55\*\*, CSE88T56\*\*, CSE88T57\*\*, CSE88T58\*\*, CSE88T59\*\*, CSE88T60\*\*, CSE88T61\*\*, CSE88T62\*\*, CSE88T63\*\*, CSE88T64\*\*, CSE88T65\*\*, CSE88T66\*\*, CSE88T67\*\*, CSE88T68\*\*, CSE88T69\*\*, CSE88T70\*\*, CSE88T71\*\*, CSE88T72\*\*, CSE88T73\*\*, CSE88T74\*\*, CSE88T75\*\*, CSE88T76\*\*, CSE88T77\*\*, CSE88T78\*\*, CSE88T79\*\*, CSE88T80\*\*, CSE88T81\*\*, CSE88T82\*\*, CSE88T83\*\*, CSE88T84\*\*, CSE88T85\*\*, CSE88T86\*\*, CSE88T87\*\*, CSE88T88\*\*, CSE88T89\*\*, CSE88T90\*\*, CSE88T91\*\*, CSE88T92\*\*, CSE88T93\*\*, CSE88T94\*\*, CSE88T95\*\*, CSE88T96\*\*, CSE88T97\*\*, CSE88T98\*\*, CSE88T99\*\*, CSE88T100\*\*

**Test description:** Performance testing of connecting hardware endurance to the standard requirement of IEC 60512-99-002 for support of IEEE Std 802.3at™ Type 4 remote powering applications

**Standard used:** IEC 62512-99-002 Connectors for electrical and electronic equipment – Tests and measurements – Part 99-002: Endurance test schedule – Test 99a: Test schedule for unimittig under electrical load, Edition 1.0 dated March 2019

**Verification Issuing Office Name & Address:** Intertek Testing Services NA, Inc.  
3818 US Route 15  
Cortland, NY 13045

**Test Report Number(s):** 102629202CRF-001, issued 30-August-2016 revised 01-November-2019

*Antoine Pelletier*  
Signature  
Name: Antoine Pelletier  
Position: Project Engineer  
Date: 01-November-2019

Page 1 of 1  
IPT-OP-114 (9-October-2017)

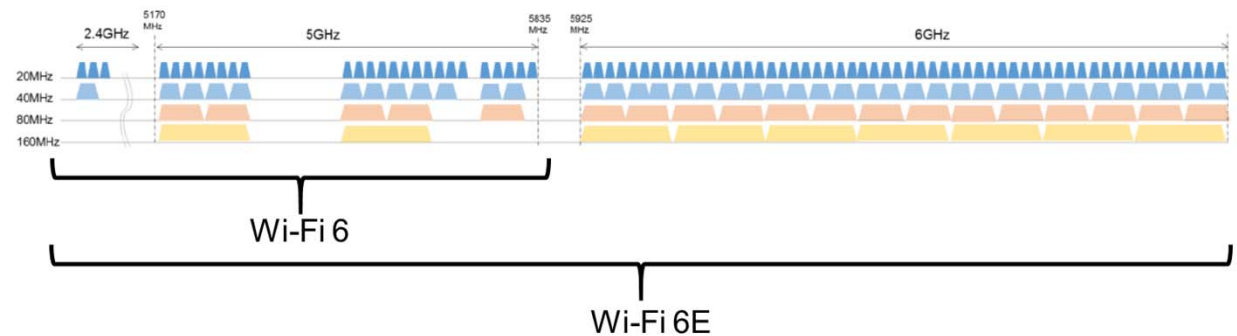
# Wi-Fi Now and Into the Future

	Wi-Fi 4	Wi-Fi 5	Wi-Fi 6 and 6E	Wi-Fi 7
Bands	2.5 / 5 GHz	5 GHz	2.4/5 6E will use 6 GHz band	2.4/5/6 GHz
Density of APs	+	++	+++	++++
Data Rates	0.6 Gbps	6.9 Gbps	9.6 Gbps	10+ Gbps
Cable	Cat 6	Cat 6A	Cat 6A	2x Cat 6A

- 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)

# 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



Building Type	Spectrum Partition Concepts
School	Faculty Channels & Student Channels
Healthcare	Medical Imaging Channels, Doctor/Nurse Channels, Patient Channels
Corporate	Corporate Channels, Guest Channels, IoT Channels
Retail	Retail Store Channel, Guest Channels
Corporate	Critical Machinery Channels, Worker Channels

# 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**



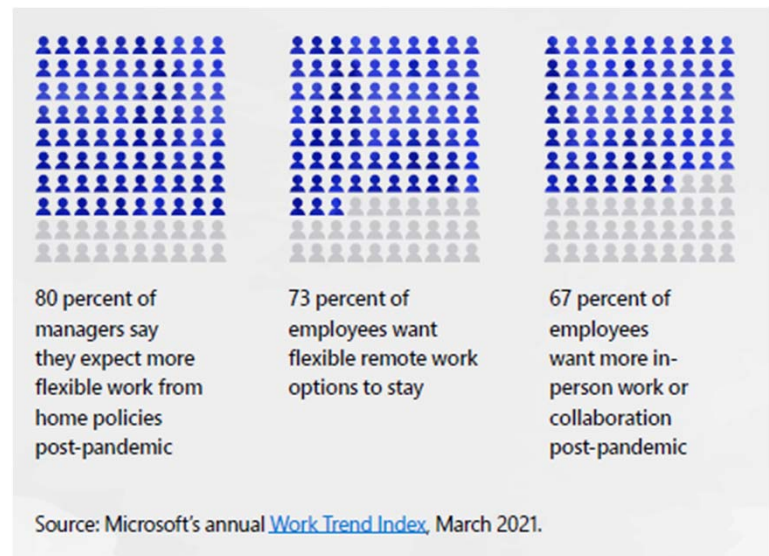
# Office 2.0 & Smart Buildings

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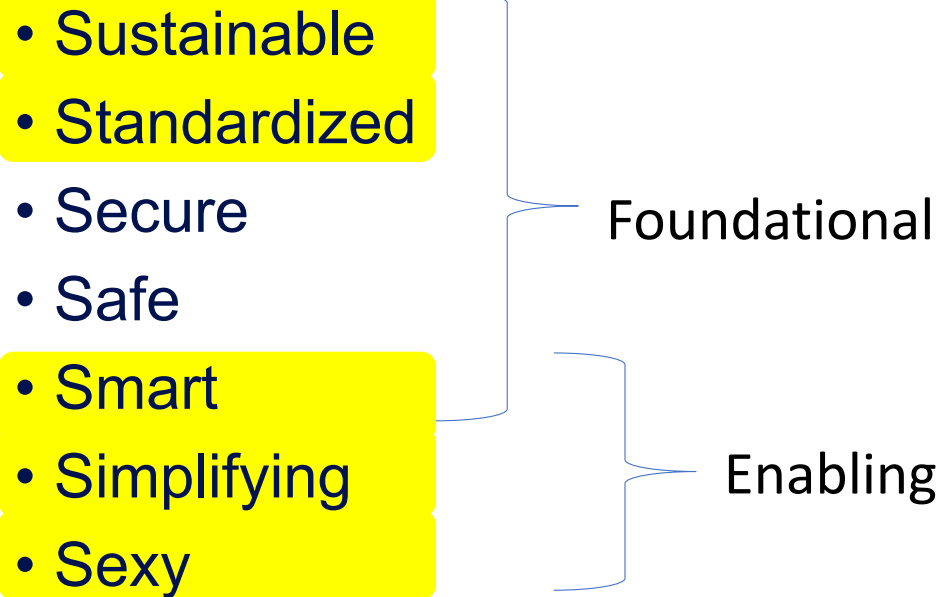


# Office 2.0 (The Future of the Office)

- 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

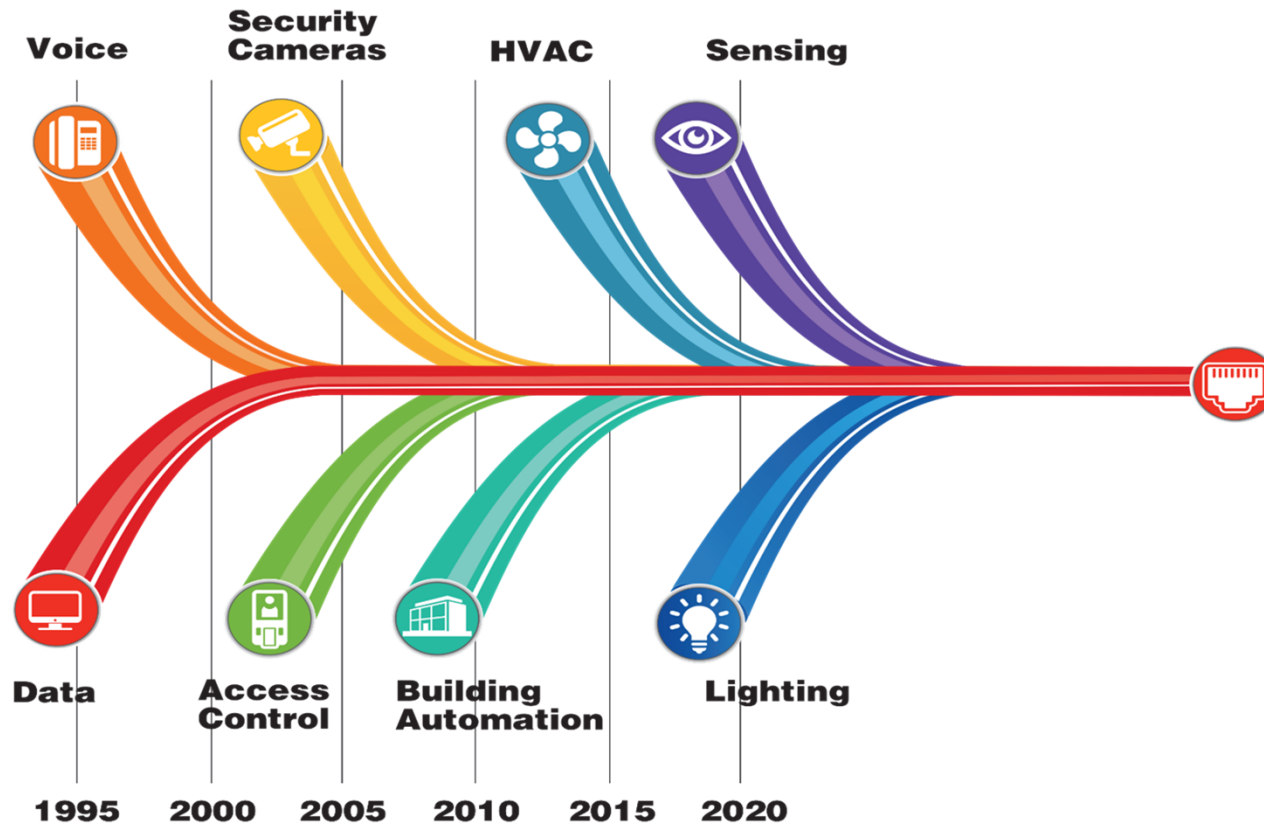


# Definition of a Smart Building

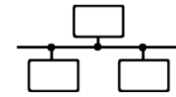
- A smart building is one that uses technology to enable efficient and economical use of resources, while creating a safe and comfortable environment for occupants.
  - Lighting, HVAC, access control, temperature, and other systems can be integrated, monitored, optimized, and controlled.
  - Typically 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







**HDMI**



**S/PDIF**  
OPTICAL AUDIO

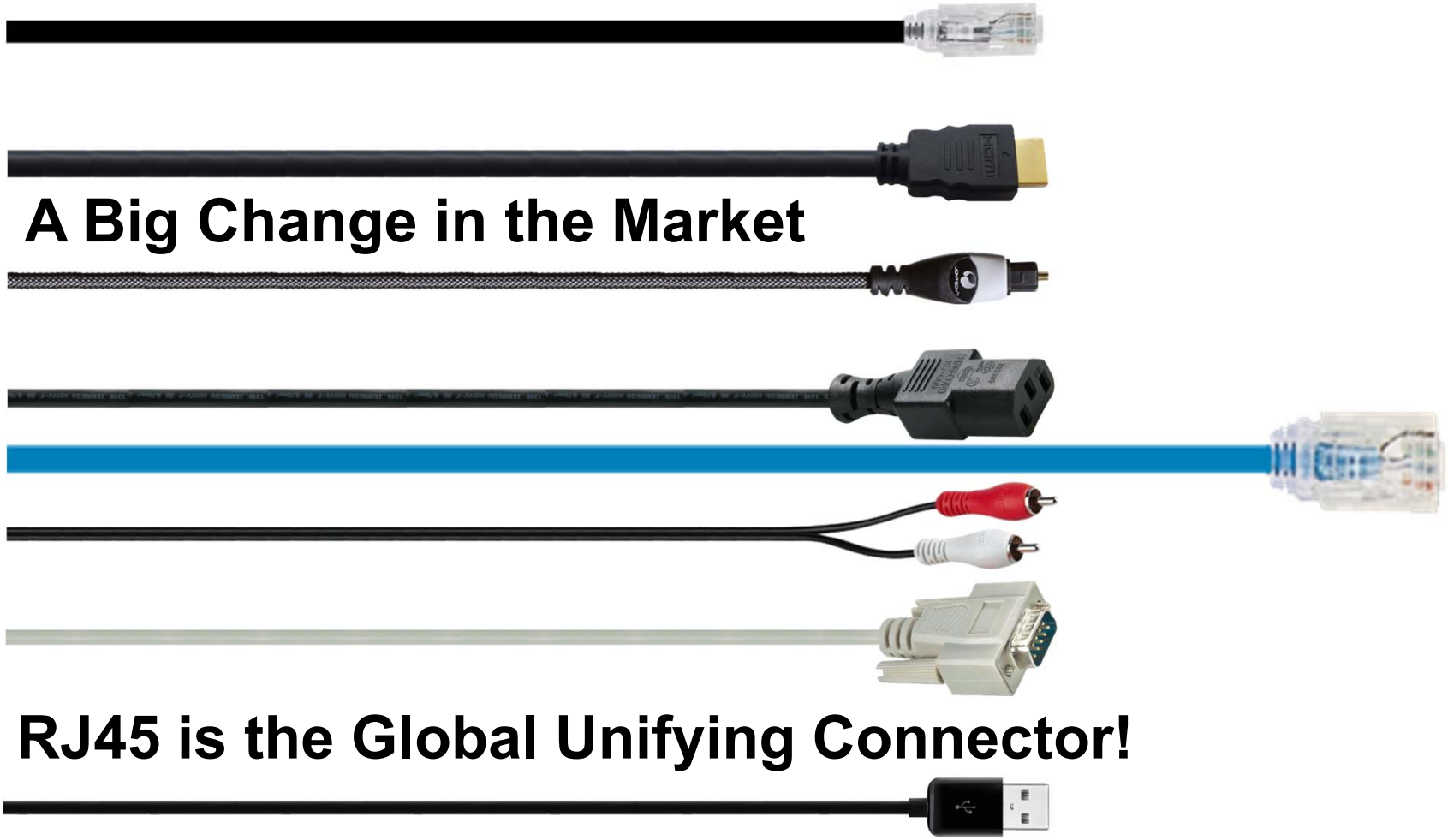


**RCA**  
AUDIO



**RS** 232  
485





**A Big Change in the Market**

**RJ45 is the Global Unifying Connector!**

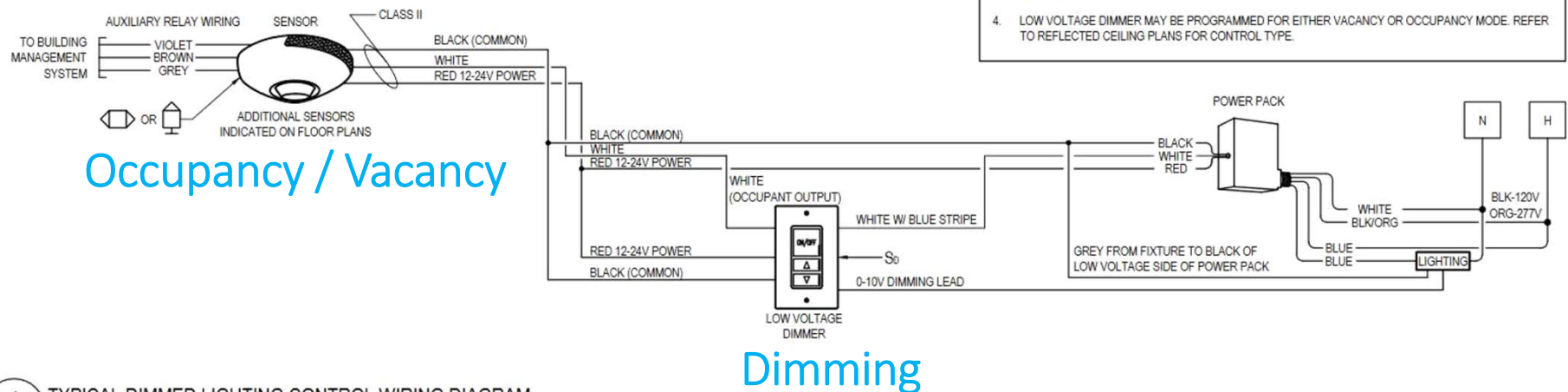


# Example – Traditional Lighting Design

*Rigid and complex*

## 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 UNOCCUPIED. 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.



4 TYPICAL DIMMED LIGHTING CONTROL WIRING DIAGRAM  
E-602 SCALE: NONE

# Example – Smart Lighting Design

*Flexible and simple*

Daylight Harvesting

High / Low Trim

Utilization

Power Reporting

Dimming  
Scenes

White Light Color Tuning

RGB Notification Lighting



# 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

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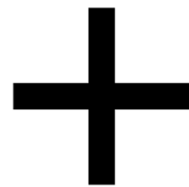
# The 4<sup>th</sup> Utility & Smart Buildings

- 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?

Token Ring Thick Net  
Burroughs Poll/Select  
Hewlett Packard Thin Net  
HDLC VT100 Sperry X.25  
Novell Network  
MicroSoft  
IBM  
AppleTalk  
DEC  
WANG  
Token Bus  
LU6.2 Telnet RS485  
Novell  
Novell  
Apple TD830 Olivetti Decnet  
ISDN Burroughs SNA  
Dial Up UUCP SDLC  
ARCnet RS232  
Banyan Vines



## State of Building Automation Today

EtherNet/IP  
Foundation FieldBus  
Mitsubishi Electric  
RS232 Yokogawa DALI  
Modbus Signify CAN  
Schneider Electric Pepperl Fuchs  
HART  
ABB Kone VAN  
RS485 MOST FDI  
Emerson Byteflight Siemens CIP  
EtherCAT IEBUS D2B Omron  
FlexRay Endress Hauser  
Rockwell Automation  
ProfiBus 4-10mA  
PROFINET  
Two Wire

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



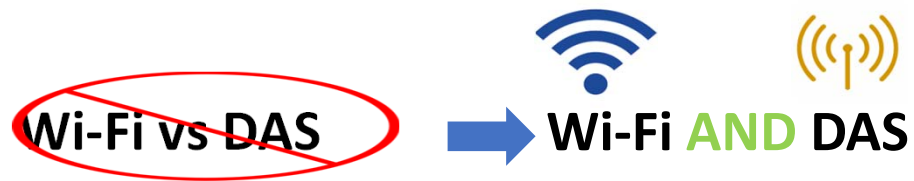
**Standardization solves many of the issues seen today**

# 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



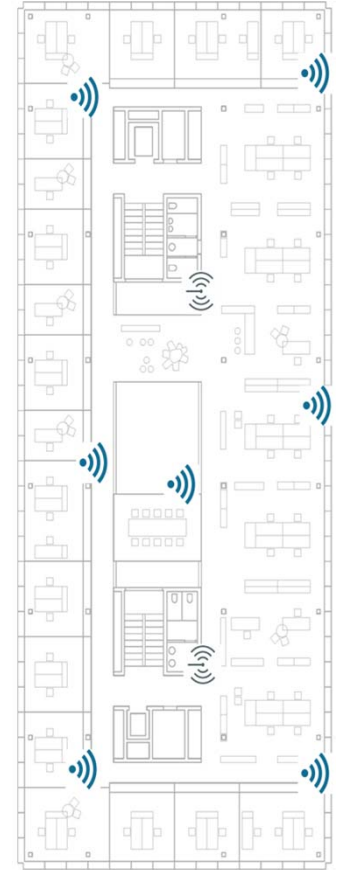
## Wi-Fi

- 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



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

Seamless Mobile Connectivity

- 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

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# 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
    - <https://www.cnbc.com/2021/08/10/the-environment-is-gen-zs-no-1-concern-but-beware-of-greenwashing.html>
  - Gen Z, Millennials Stand Out for Climate Change Activism
    - <https://www.pewresearch.org/science/2021/05/26/gen-z-millennials-stand-out-for-climate-change-activism-social-media-engagement-with-issue/>
  - Joe Biden calls climate change the 'number one issue facing humanity'
    - <https://www.cnbc.com/2020/10/24/oe-biden-climate-change-is-number-one-issue-facing-humanity.html>
- 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



Platinum

80+ points earned



Gold

60-79 points earned



Silver

50-59 points earned



Certified

40-49 points earned



# 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 3<sup>rd</sup> party certified
- Health Product Declaration (HPD)
  - Impact of your product on human health
  - Can also be used in sustainability programs if 3<sup>rd</sup> party certified
- Red List Free
  - Used in Living Building Challenge
  - *Supposed* to avoid chemicals harmful to human health

**ENVIRONMENTAL PRODUCT DECLARATION**  
**PANDUIT RJ45 JACK MODULES**  
 CATEGORY 5E, CATEGORY 6, CATEGORY 6A

**Health Product Declaration v2.0**  
 by Panduit Corporation

**Section 1: Summary**

**CONTENT INVENTORY**

Threshold per material	Residuals and impurities considered in	Characterized	Based on the selected Content Inventory Threshold:	Yes	No
<input type="radio"/> 100 ppm	5 of 4 materials	Screened	Are the Percent Weight and Role provided for all substances?	<input type="radio"/>	<input type="radio"/>
<input type="radio"/> 1,000 ppm	See Section 2	Screened	Are all substances screened using Priority Hazard Lists with results disclosed?	<input type="radio"/>	<input type="radio"/>
<input type="radio"/> Per GHS SDS	See Section 5	Identified	Are all substances disclosed by name (Specific or Generic) and identifier?	<input type="radio"/>	<input type="radio"/>
<input type="radio"/> Per OSHA MSDS	General Notes	Identified		<input type="radio"/>	<input type="radio"/>
<input type="radio"/> Other				<input type="radio"/>	<input type="radio"/>

**CONTENT IN DESCENDING ORDER OF QUANTITY**

Summary of product contents and results from screening individual chemical substances against HPD Priority Hazard Lists and the GreenScreen for Safer Chemicals. The HPD does not assess whether using or handling the product will expose individuals to its chemical substances or any health risk. Refer to Section 2 for further details.

**MATERIAL | SUBSTANCE | RESIDUAL OR IMPURITY**

**GREENSCREEN SCORE | HAZARD TYPE**

**INVENTORY AND SCREENING NOTES:**

At the time of publication, this product contains substances that are considered special conditions in the HPD v2.0 standard. These special conditions include metal alloys and electronic components. Since these special conditions do not have guidance on how to present the associated and relevant health hazards, single line entries have been made to transparently disclose these components.

**GREENSCREEN SCORE: 0.00**

**UL CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION**

**RED LIST FREE**

**CERTIFICATIONS AND COMPLIANCE**

LCA: Environmental Product Declaration Panduit RJ45 Jack Modules

VOC Content data is not applicable for the product category. See Section 3 for additional settings.

Self-Declared:  Verified:  SCREENING DATE: January 18, 2017 REPORT DATE: January 18, 2017  
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# 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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