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
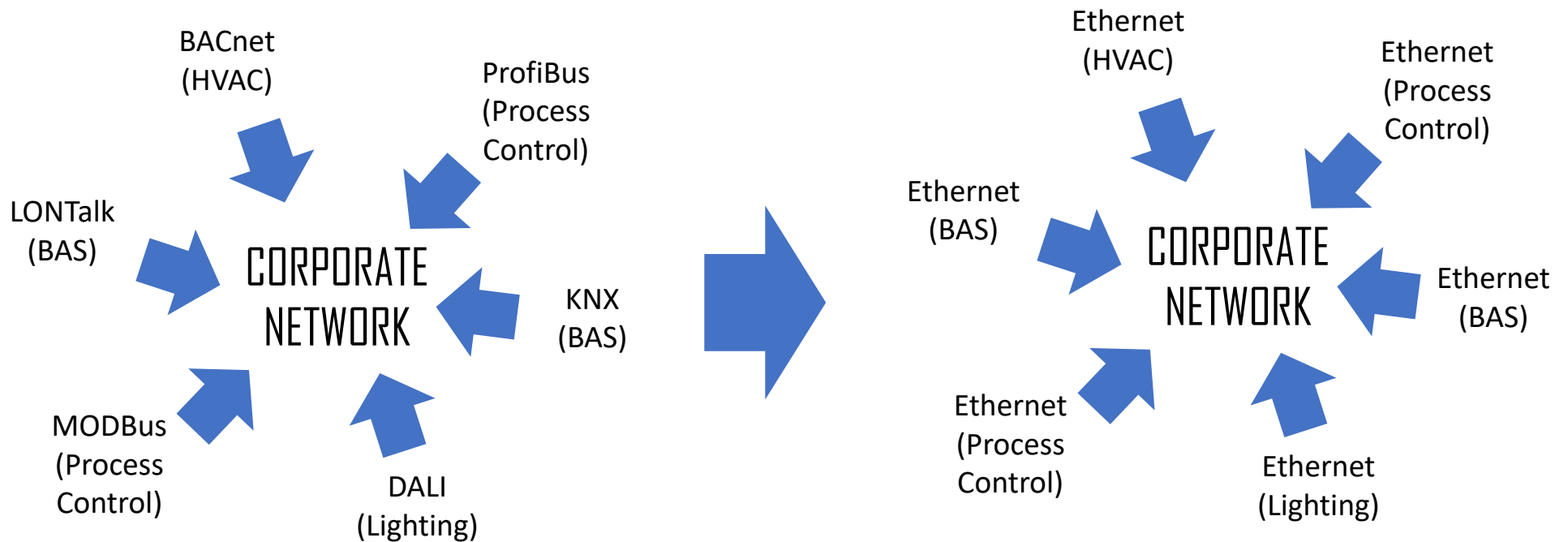
Simplified and Standardized Interfaces

- 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

BACnet
(HVAC)

ProfiBus
(Process
Control)

LONTalk
(BAS)

CORPORATE
NETWORK

KNX
(BAS)

MODBus
(Process
Control)

DALI
(Lighting)

Ethernet
(HVAC)

Ethernet
(Process
Control)

Ethernet
(BAS)

CORPORATE
NETWORK

Ethernet
(BAS)
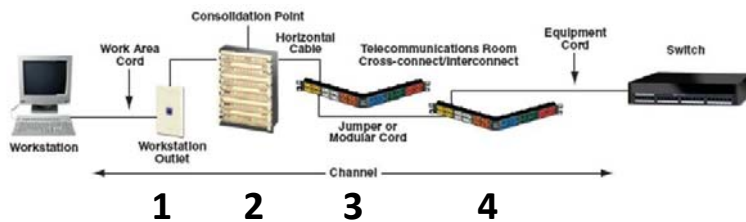
Ethernet
(Process
Control)

Ethernet
(Lighting)

Today's Standards & Terms

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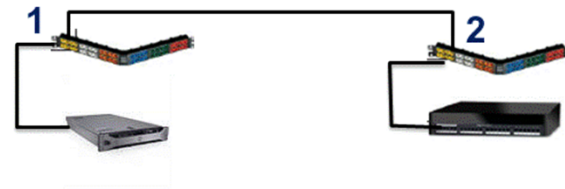
What is Structured Cabling?
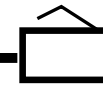
Typical Enterprise 4-connector cabling system

More common 2-connector cabling system
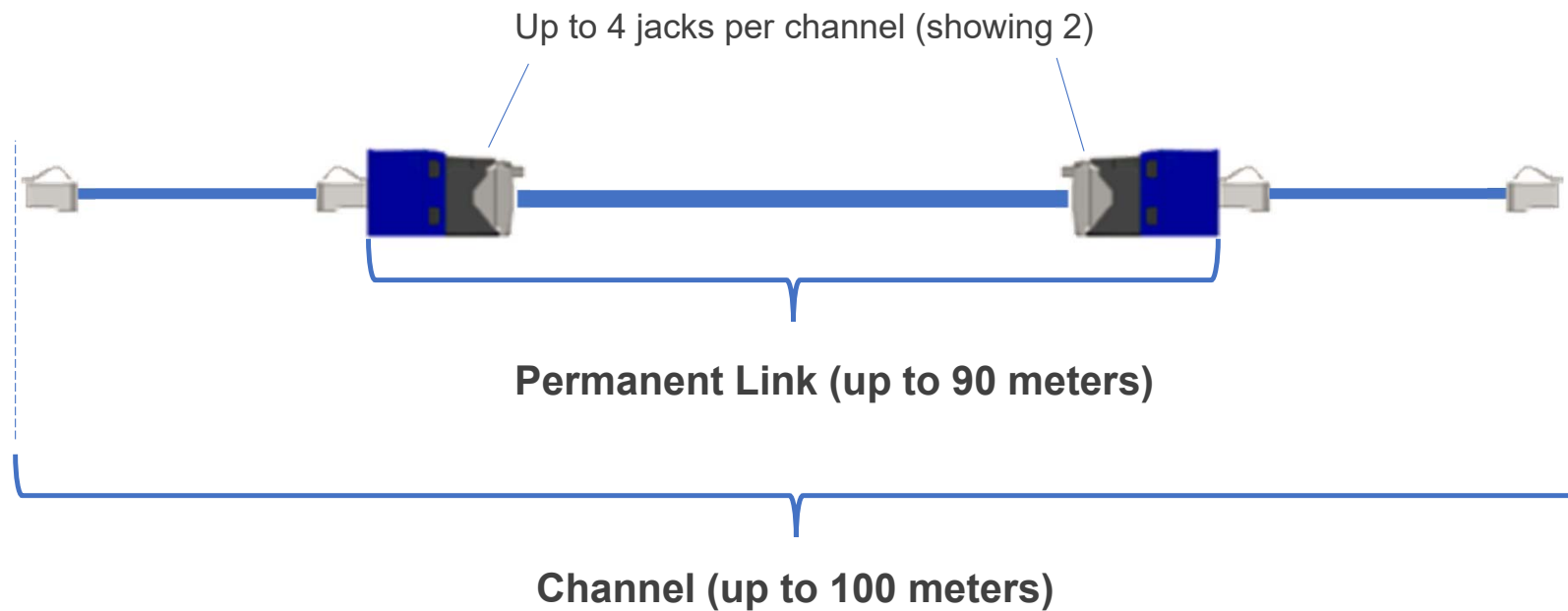

1   2   3   4

or

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

Up to 4 jacks per channel (showing 2)

Permanent Link (up to 90 meters)

Channel (up to 100 meters)

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
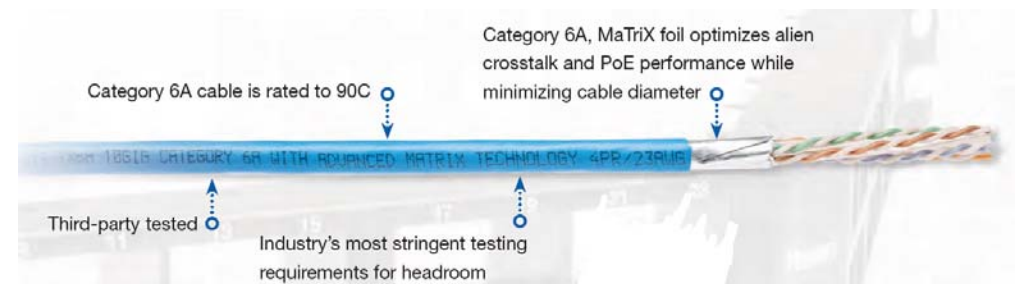
Enabling Standards & Technologies

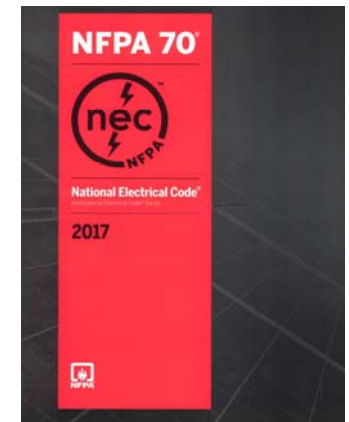NECA · BICSI
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PoE Overview

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
PoE++ **(4PPoE)**	**IEEE 802.3bt Type 3** **IEEE 802.3bt Type 4**	**600 mA** **960 mA**	**4**	**60 W** **99 W**	**51 W** **71 W**	**10GBASE-T**	**2018**
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

Category 6A, MaTriX foil optimizes alien crosstalk and PoE performance while minimizing cable diameter

Category 6A cable is rated to 90C

Third-party tested

Industry's most stringent testing requirements for headroom

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			Temp Rating		
	60ºC	75ºC	90ºC	60ºC	75ºC	90ºC	60ºC	75ºC	90ºC	60ºC	75ºC	90ºC	60ºC	75ºC	90ºC	60ºC	75ºC	90ºC	60ºC	75ºC	90ºC
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

Plug Fully Engaged with Jack
— Plug Contacts
— Jack Contacts

Plug at Disengagement Point
Jack Contacts
Plug Contacts

Test Verification of Conformity

- 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

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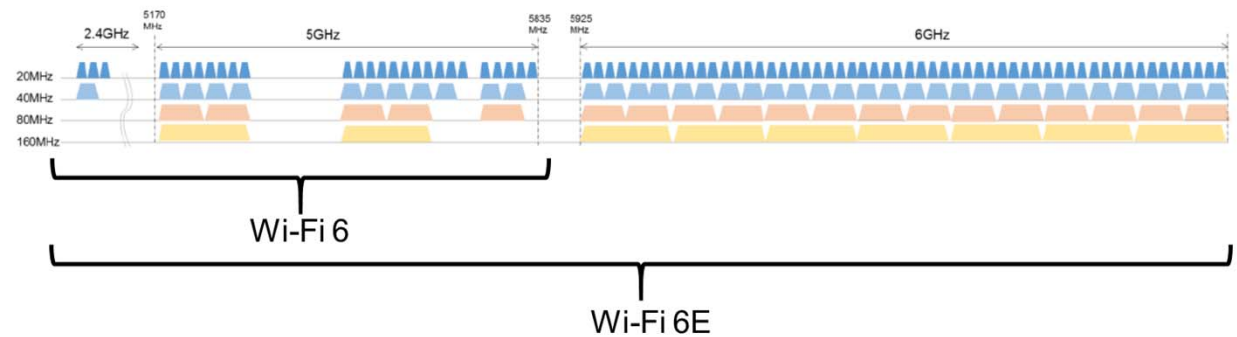
Building Type	Spectrum Partition Concepts
School	Faculty Channels & Student Channels
Healthcare	Medical Imaging Channels, Doctor/Nurse Channels, Patient Channels
Corporate	Corporate Channels, Guest Channels, IoT Channels
Retail	Retail Store Channel, Guest Channels
Corporate	Critical Machinery Channels,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

80 percent of managers say they expect more flexible work from home policies post-pandemic

73 percent of employees want flexible remote work options to stay

67 percent of employees want more in-person work or collaboration post-pandemic

Source: Microsoft's annual Work Trend Index, March 2021.
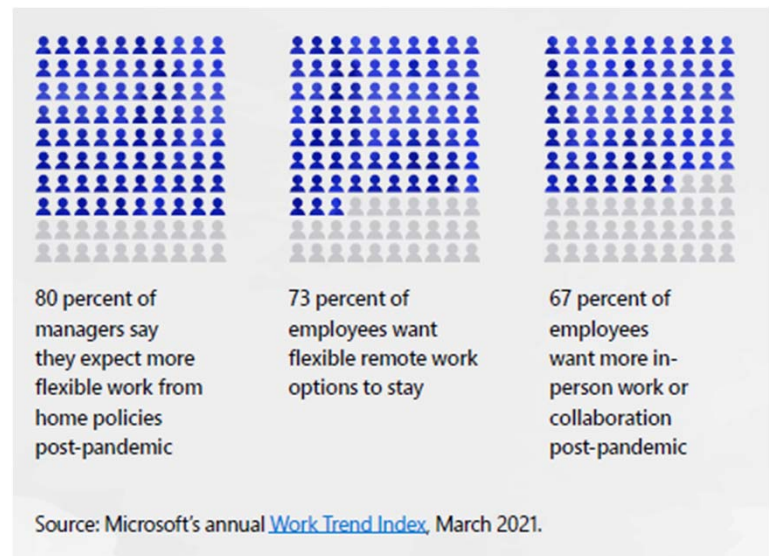
The 7 S's of Commercial Building's Future

- **Sustainable**
- **Standardized**
- Secure
- Safe

Foundational

- **Smart**
- **Simplifying**
- **Sexy**

Enabling
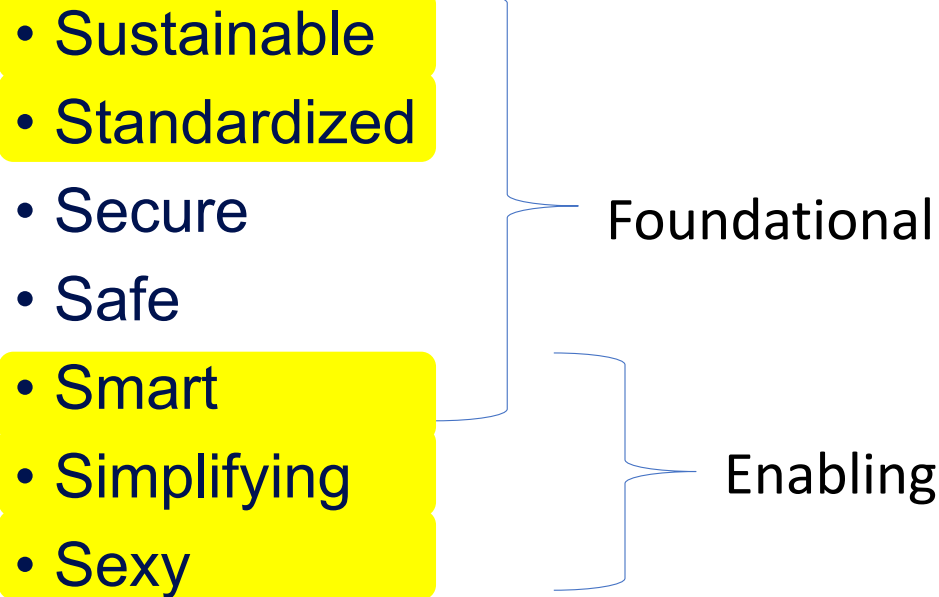
Definition of a Smart Building

- 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

Voice

Security Cameras

HVAC

Sensing

Data

Access Control

Building Automation

Lighting

1995   2000   2005   2010   2015   2020
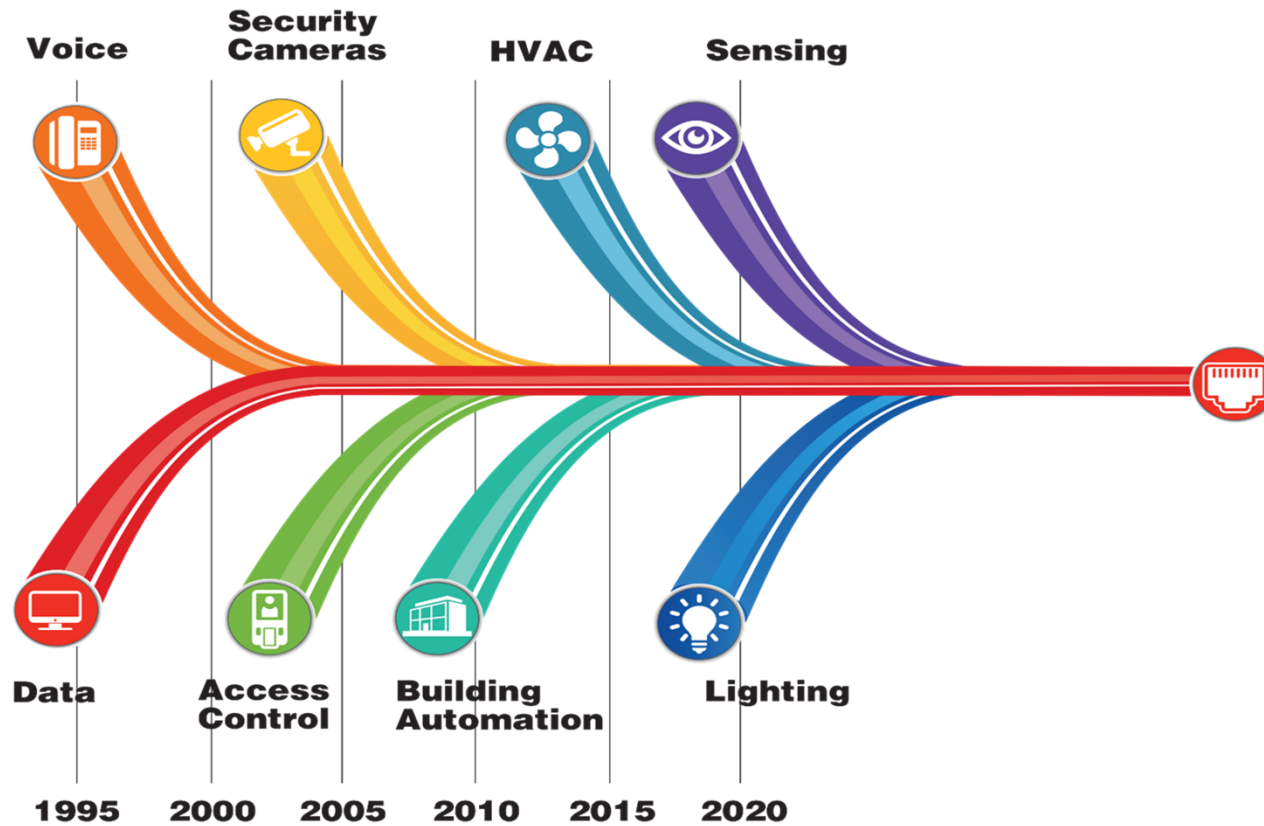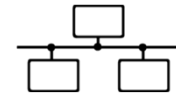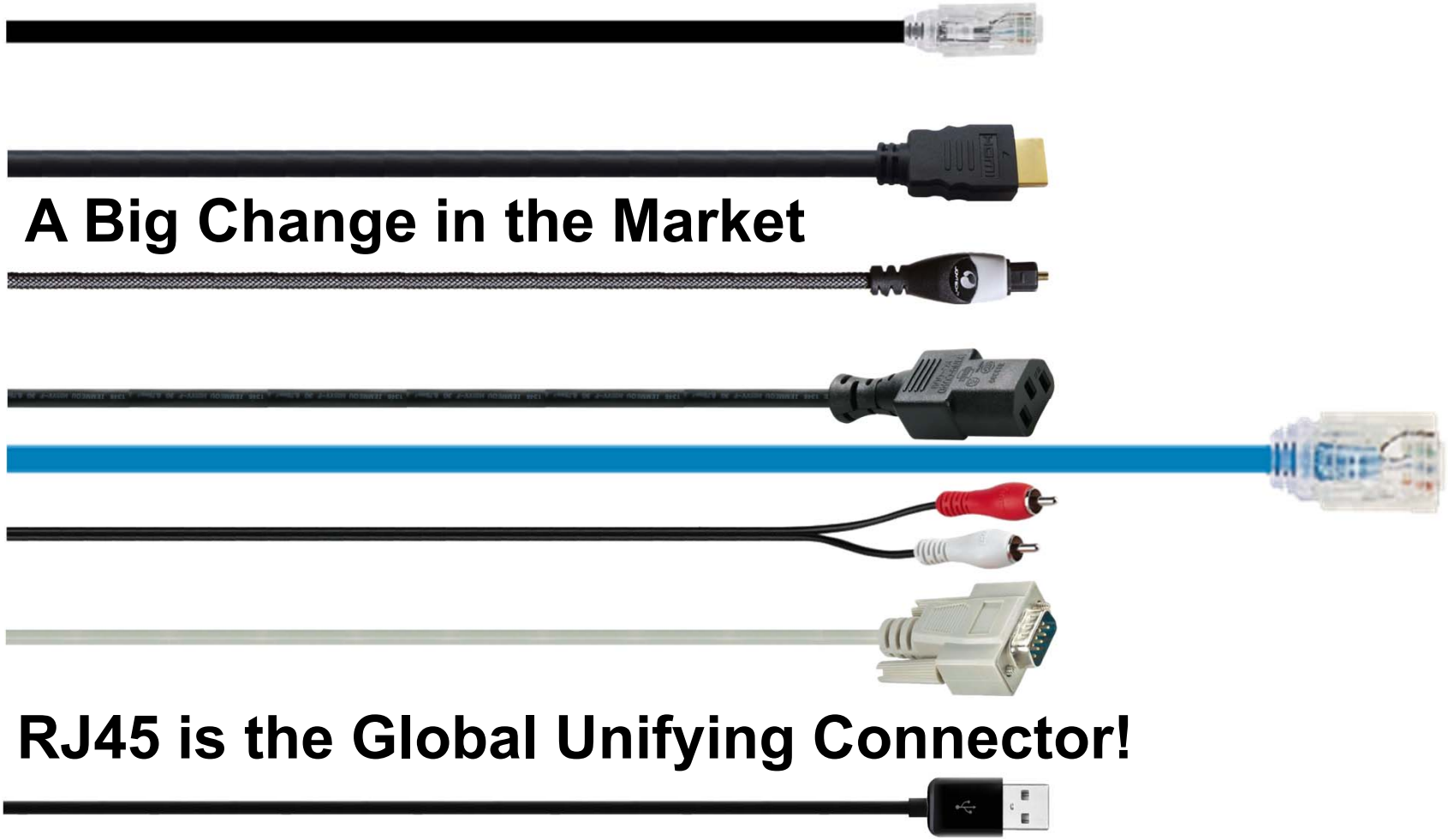
A Big Change in the Market

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.

Occupancy / Vacancy
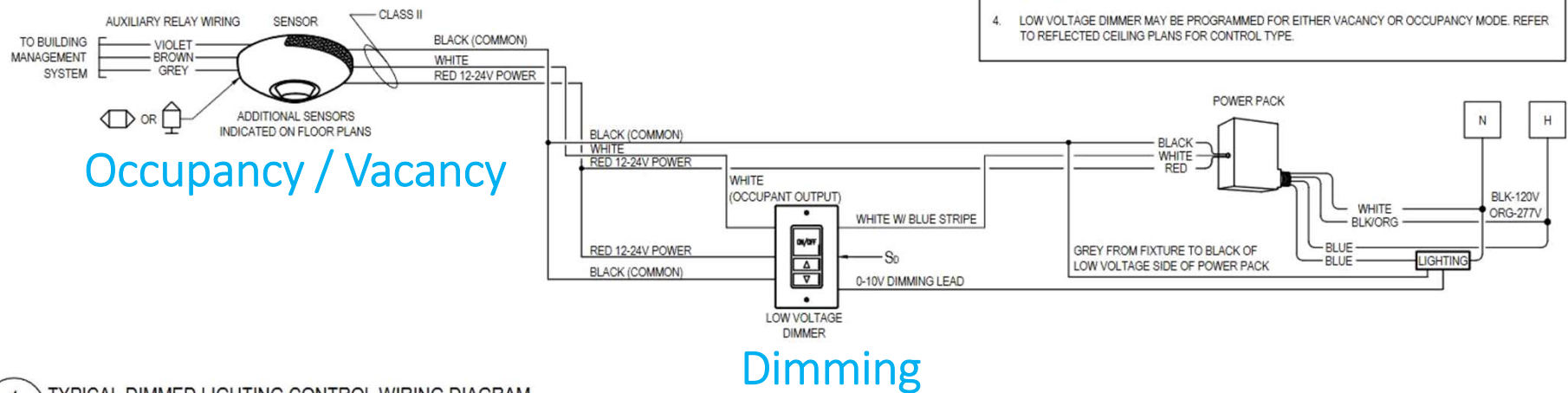
Dimming

TYPICAL DIMMED LIGHTING CONTROL WIRING DIAGRAM
4 / 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 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

Ethernet

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
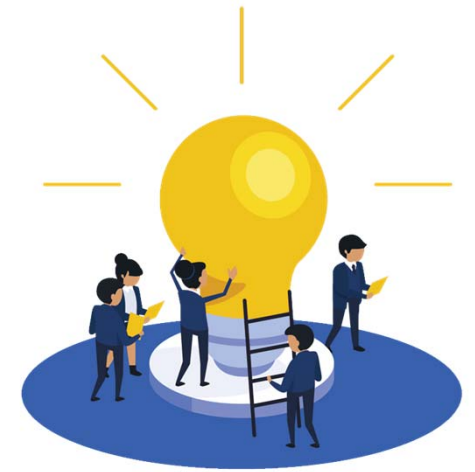
Standardization solves many of the issues seen today

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

Wi-Fi vs DAS → Wi-Fi AND DAS
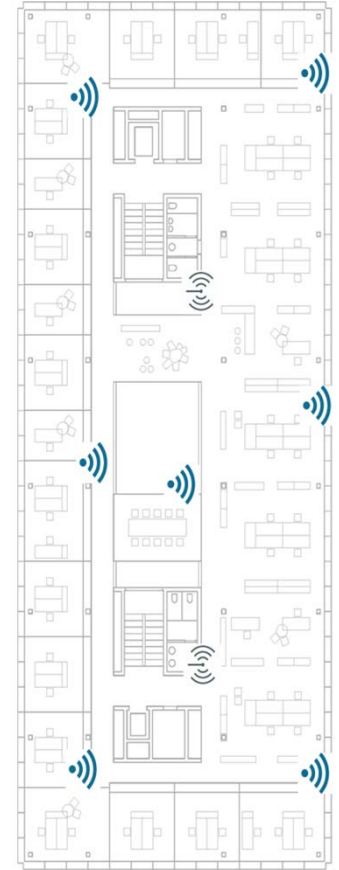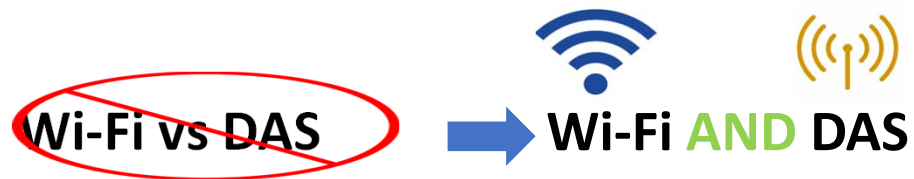
Strengths of Wi-Fi and DAS

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
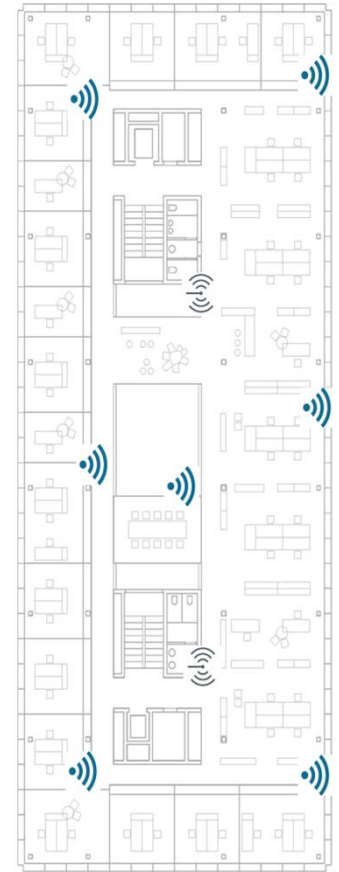
Seamless Connectivity Together

Wi-Fi AND DAS

- 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

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/joe-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	Gold	Silver	Certified
80+ points earned	60-79 points earned	50-59 points earned	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 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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