Planning a Smart Infrastructure for Intelligent Buildings

- Denise L. Pappas, Valcom/Keltron
- Carol Everett Oliver, RCDD, ESS, Siemon
- Bill MacGowan, Cisco, P.Eng., CEM

Agenda

8:30 – 8:45 AM	Welcome by Fernando Neto, RCDD BICSI Canadian Region Director
8:45 – 9:45 AM	Emerging Technologies and the Interconnectivity of Codes and Standards *(Denise Pappas)*
9:45 – 10:45 AM	Planning Your Infrastructure *(Carol Everett Oliver, RCDD, ESS)*
10:45 – 11:00 AM	Break
11:00 – Noon	Digital Transformation of Real Estate (A case study) *(Bill MacGowan)*
12:00 – 12:30 PM	Lunch
12:30 – 2:30 PM	Tours of RBC WaterPark Place
12:30 – 2:30 PM	Zone Cabling Exercise (when not on the tours)

Emerging Technologies
and the Interconnectivity of Codes and Standards

Denise L. Pappas
Valcom/Keltron

Course Outline

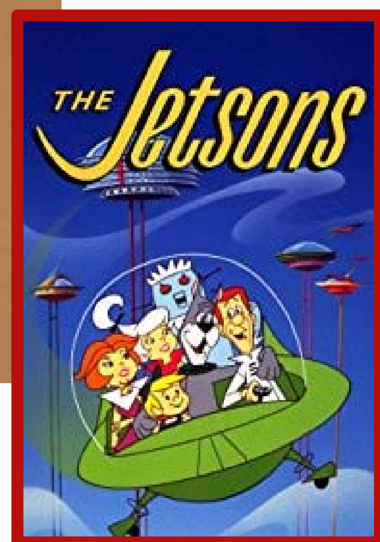
Emerging Technologies

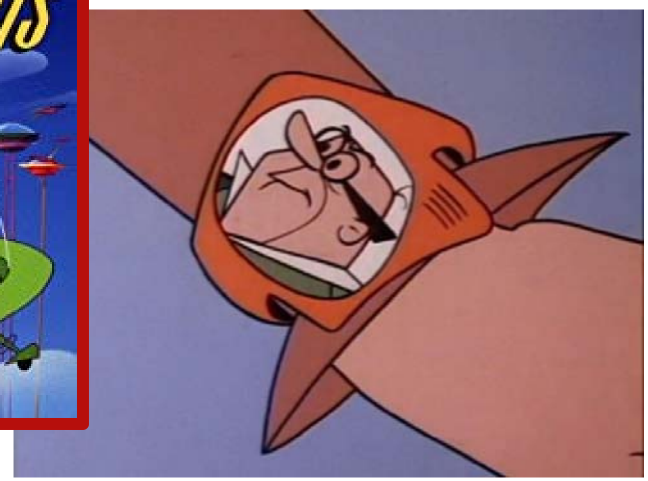
- Top 5 Trends in IT
- Intelligent Buildings
- Integration of Systems
- Codes and Standards
- Challenges

Emerging Technologies

Emerging technologies are perceived as capable of changing the “status quo” or being “disrupters”

Emerging Technologies

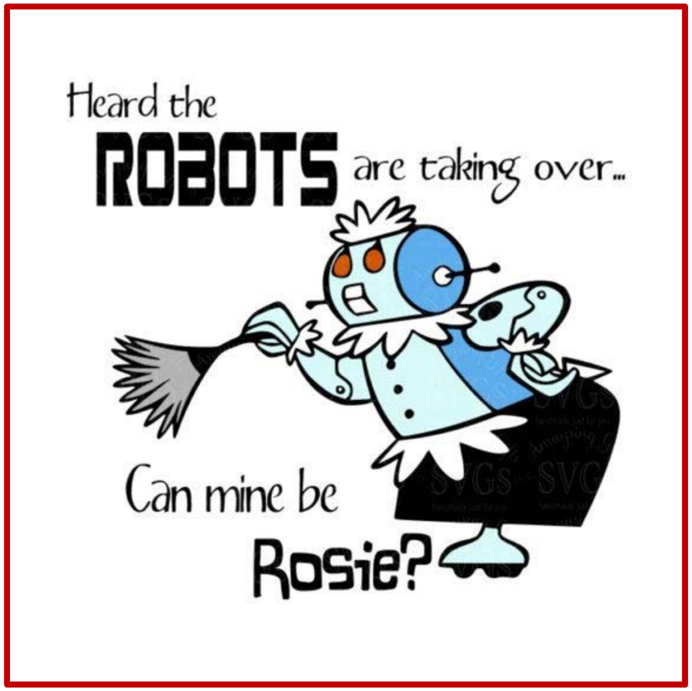




Emerging Technologies

Emerging Technologies

Emerging Technologies



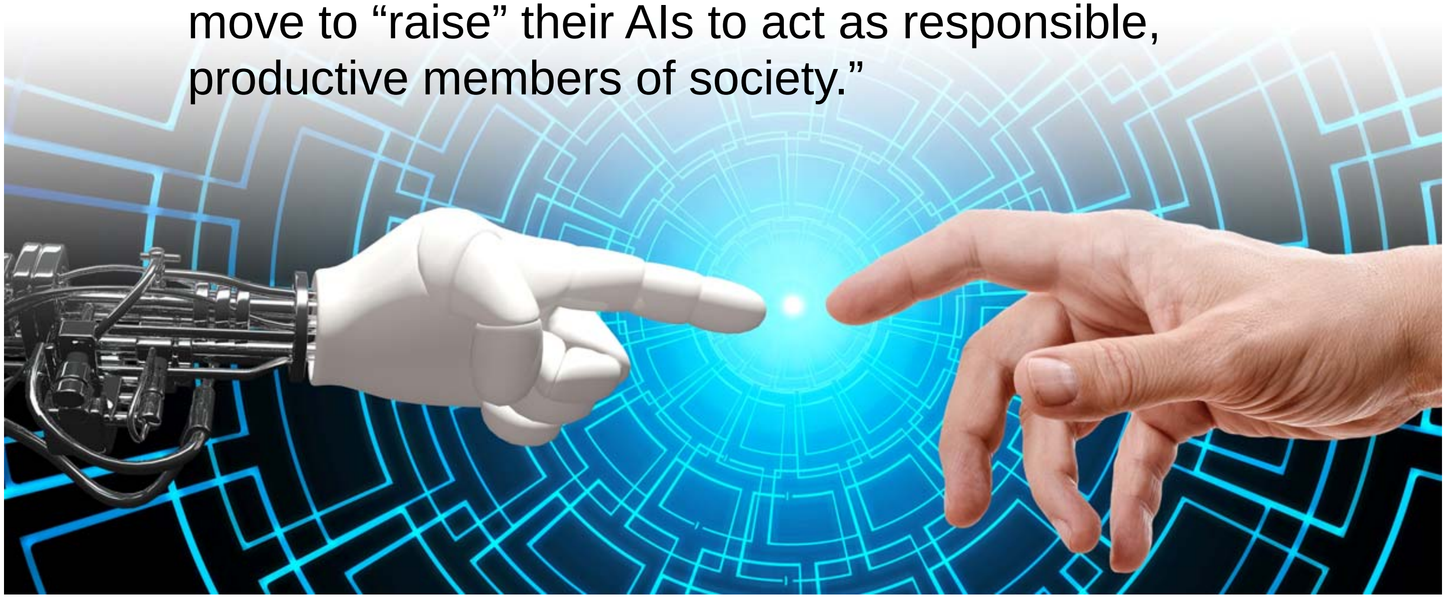
The Top 5 Trends in IT

The top 5 trends in IT as identified in the Accenture Technology 2018 Report,
"Redefine Your Company Based on the Company You Keep"

1. **Artificial Intelligence**
2. **Extended Reality**
3. **Data Veracity**
4. **Frictionless Business**
5. **Internet of Thinking**

#1 - Artificial Intelligence (AI)

"As artificial intelligence grows in its capabilities - and its impact on people's lives - businesses must move to "raise" their AIs to act as responsible, productive members of society."



#2 - Extended Reality – the End of Distance

"Immersive experiences are changing the way people connect with information, and experiences, and each other."

Extended Reality

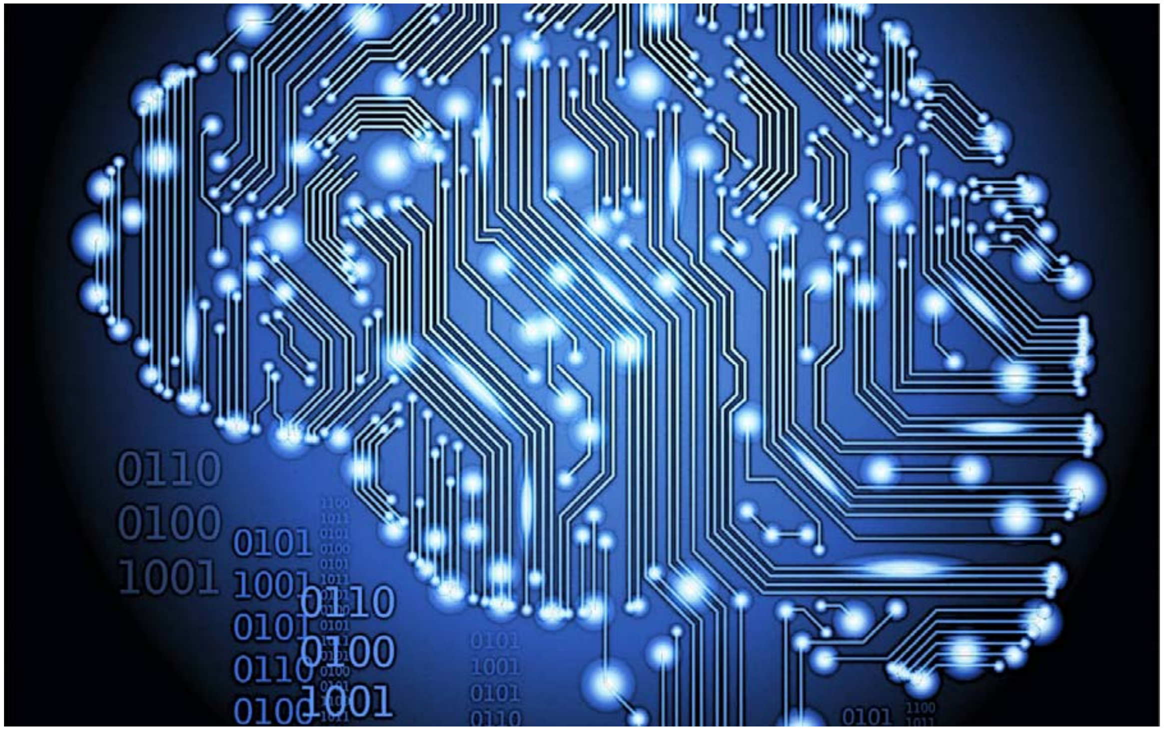
#3 - Data Veracity – the Importance of Trust

"By transforming themselves to run on data, businesses have created a new kind of vulnerability: inaccurate, manipulated, and biased data that leads to corrupted business insights, and skewed decisions with a major impact on society."

#4 - Frictionless Business – Built to Partner at Scale

Businesses depend on technology-based partnerships for growth. However, the needs of technology based partnerships are shifting towards microservices, and Blockchain.

#5 Internet of Thinking - Creating Intelligent Distributed Systems



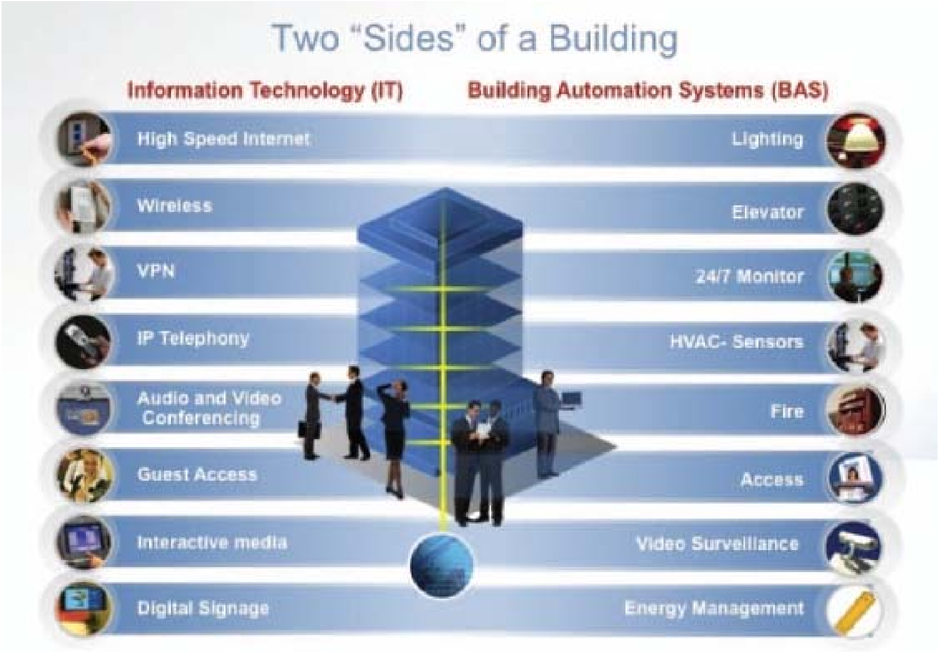
Intelligent Buildings – What Does that Mean?

A definition, coined by the **Intelligent Buildings Institute**, defines an **intelligent building** as - "*One which provides a productive and cost-effective environment through optimization of four basic elements: structure, systems, services and management, and the interrelationship between them*."

Intelligent Buildings

Integration of Systems

- Integration vs. Integral
- What are the expectations of integration?



Collision of IT and IoT

IT

- User-centric communication
- Managed by IT Experts
- Sensitive Corporate Data
- Unpredictable Traffic Behavior

OT

- Machine-to-Machine Communication
- Maintained by Facility Operators
- Critical Building Functions
- Predictable Device Behavior

Interconnectivity

Emerging Technologies and the Interconnectivity of Codes and Standards

Where worlds collide…

Codes and Standards

Regulatory Agencies that Influence Building System Integration Include:

- NFPA - National Fire Protection Association
- IBC and IFC - International Building Code and Fire Code
- Locally-Developed or Amended Building and Fire Codes
- US Government Regulations (e.g. DoD, ADA)
- UL (Underwriters Laboratories) Standards
- BICSI - Building Industry Consulting Services International
- IEEE - Institute of Electrical and Electronics Engineers
- TIA
- Other Applicable Codes and Standards

Codes and Standards

NFPA - National Fire Protection Association

- Class N Networks
- Emergency Communications
- Commissioning of Building Systems
- Building System Information Unit

Codes and Standards

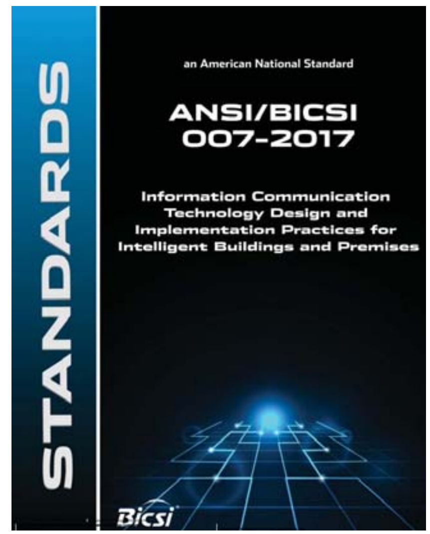
IFC - International Fire Code
IBC - International Building Code

- Mass Notification
  Section 917.1 - College and University Campuses
  Occupant load = 1,000+
- New Technology - Emergency Responder Communication Enhancement Systems (DAS)
- Occupant Evacuation Elevators
  Occupant elevator operation of the OEE

Codes and Standards

BICSI – Building Industry Consulting Service International

- First Intelligent Building Standard for Connected Buildings



Codes and Standards

IEEE - Institute of Electrical and Electronics Engineers

- The IEEE 802 LAN/MAN Standards Committee develops and maintains networking standards and recommended practices for local, metropolitan, and other area networks. This includes standards for Ethernet, Bridging and Virtual Bridged LANs, Wireless LAN, PAN, MAN, and RAN, Wireless Coexistence, and Media Independent Handover Services.
- 803.11AX – New emerging standard = Under Auspices of 802
  - Initially provide equivalent of 10GBase-T transmission
  - Will require Cat 6A or better cabling
  - Expecting adoption of PoE ++ Type 3 for access points

Codes and Standards

TIA - Telecommunications Industry Association

ANSI/TIA-568 – Telecommunications Standards that address commercial building cabling for telecommunications. As of 2017, on Revision D initial issue released in 1991.

Codes and Standards

Challenges with Codes -

- Technology always continues to advance
- Codes have a set cycle
- Adoption by local and state agencies

What's Next?

Internet of Thinking

- Smart city/response
- How do we utilize technological advances without limiting the technology?

Stay Connected

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Communications Infrastructure

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Siemon Company

Agenda

- Elements of Infrastructure
- Standards & Resources
- Design Considerations
- Remote Powering & Effects on Cabling
- Different Cabling Layouts

Planning for Intelligent Buildings

- Design 10-15 years out
  - Allow for additional systems and cabling
  - Plan for future builds
  - Accommodate future applications

Elements of the Communications Infrastructure

Topology

Spaces

Cable

Pathways

Outlets

Coverage

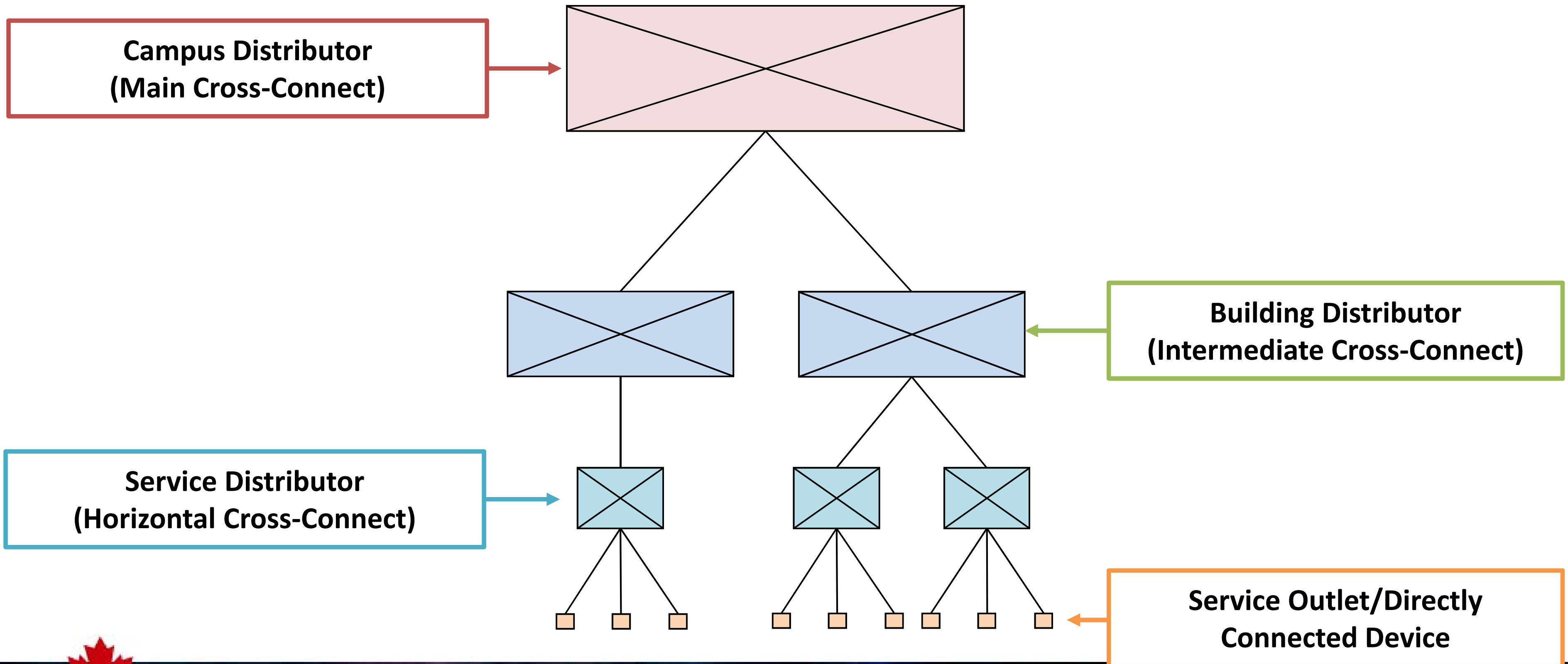
Intelligent Building Standards

ISO/IEC 11801
Information Technology—Generic Cabling for Customer Premises (Part 1, General Requirements & Part 6, Distributed Building Systems)

ANSI/TIA 862-B
Structured Cabling Infrastructure Standard for Intelligent Building Systems

ANSI/BICSI 007-2017
Information Communication Technology Design and Implementation Practices for Intelligent Buildings and Premises

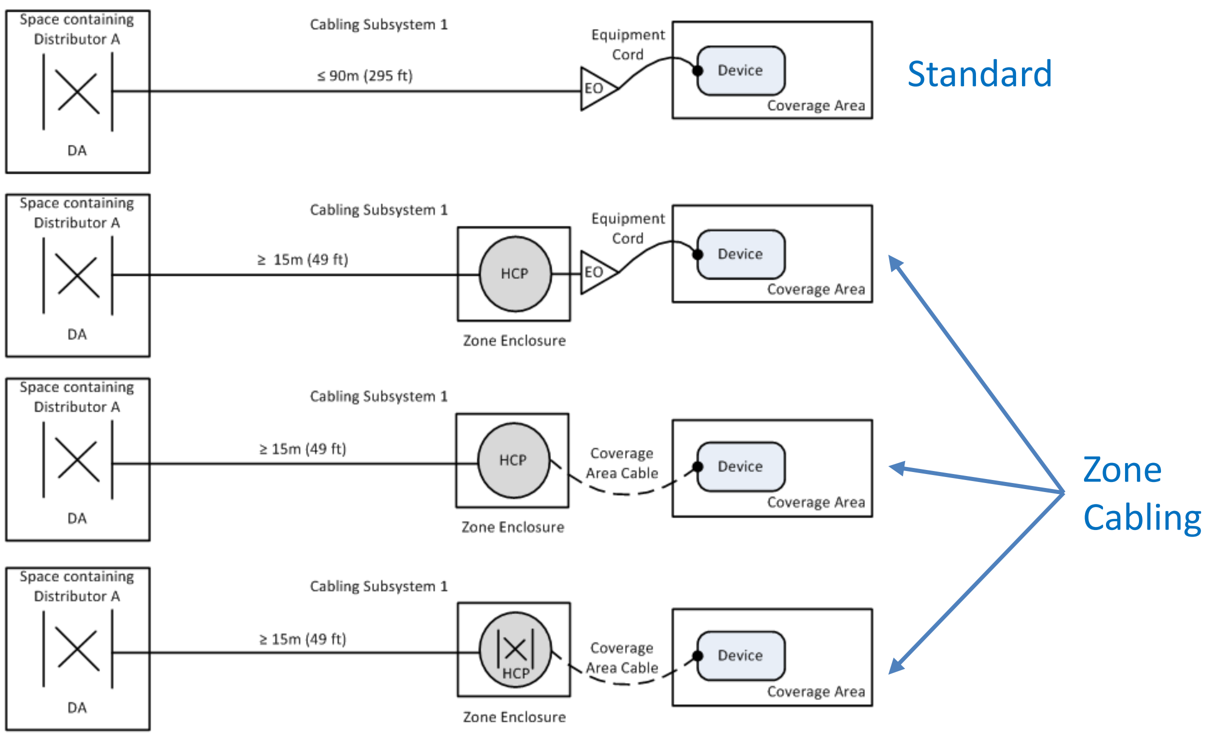
Required Topology: Hierarchical Star



TIA-862-B-2016

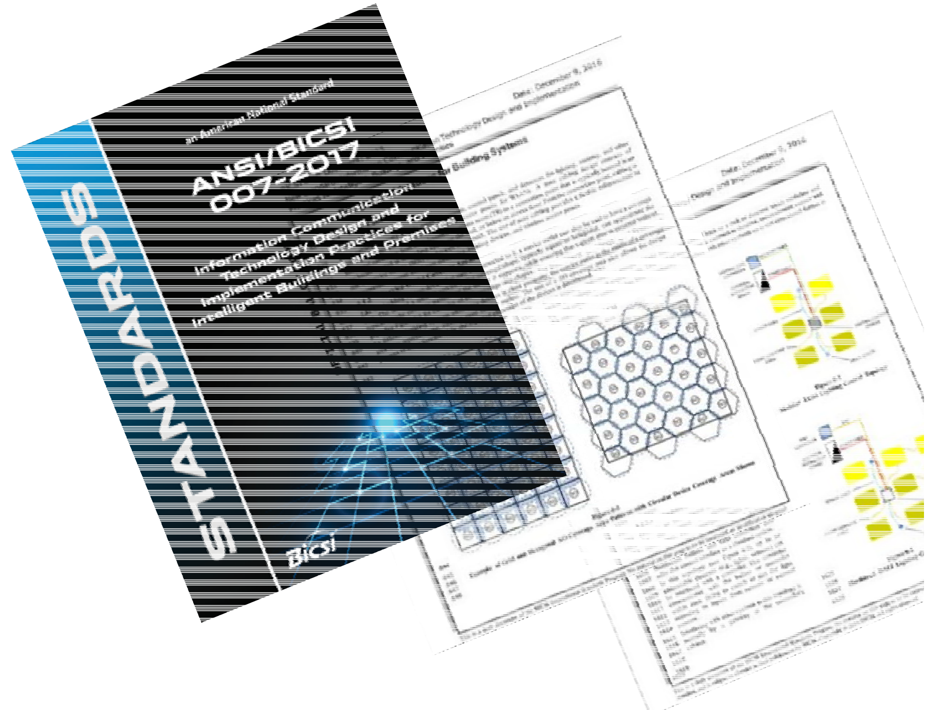
- *Structured Cabling Infrastructure Standard for Intelligent Building Systems*
  - Change of title (was Building Automation Systems Cabling Standard)
- General substitution of the term “intelligent building system” for the previous term “building automation system”
- Addition of guidance for cabling for:
  - Wireless systems
  - Remote powering over balanced twisted-pair cabling
  - Smart lighting

TIA-862-B Horizontal Topology

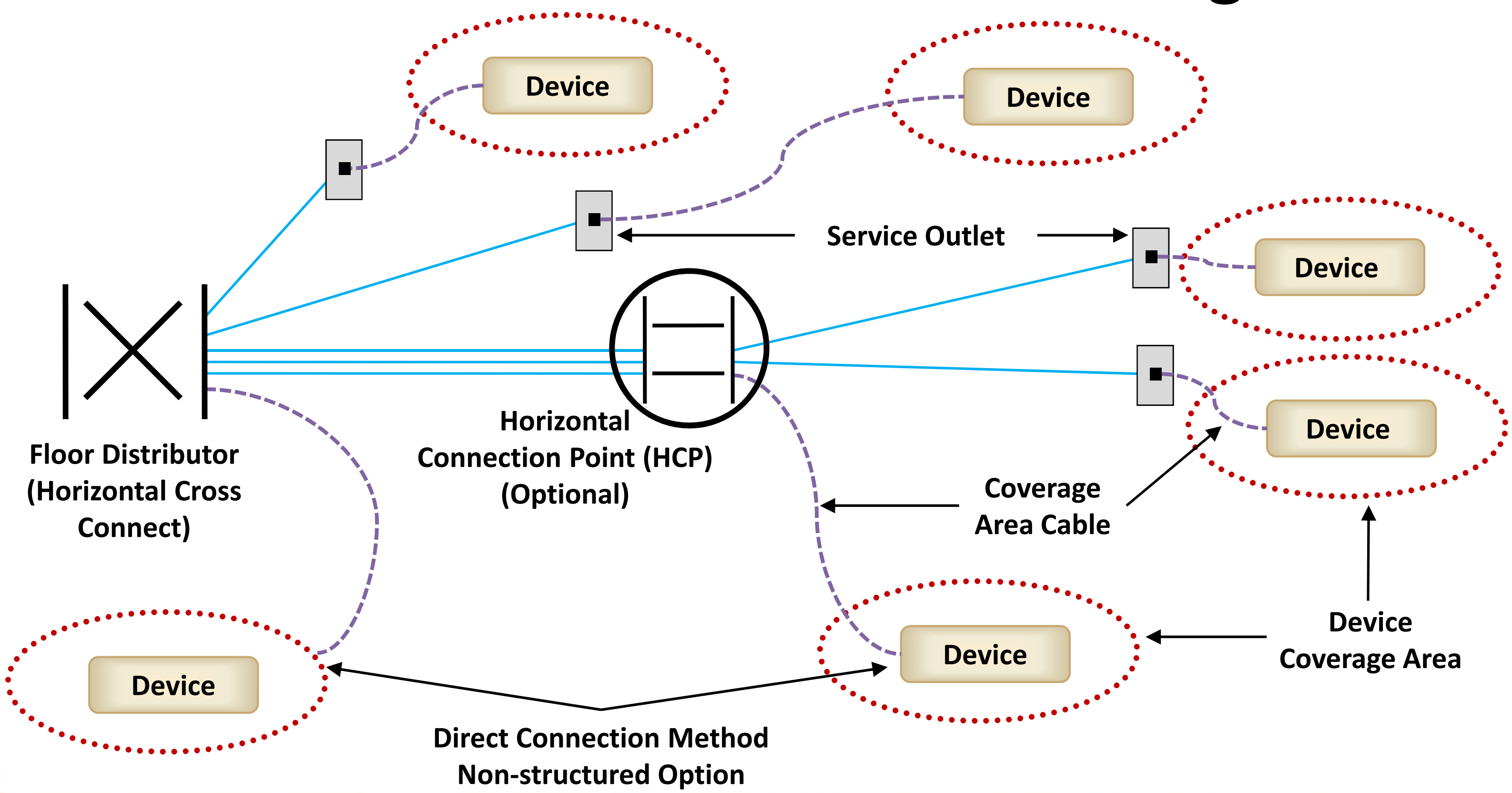


ANSI/BICSI 007-2017

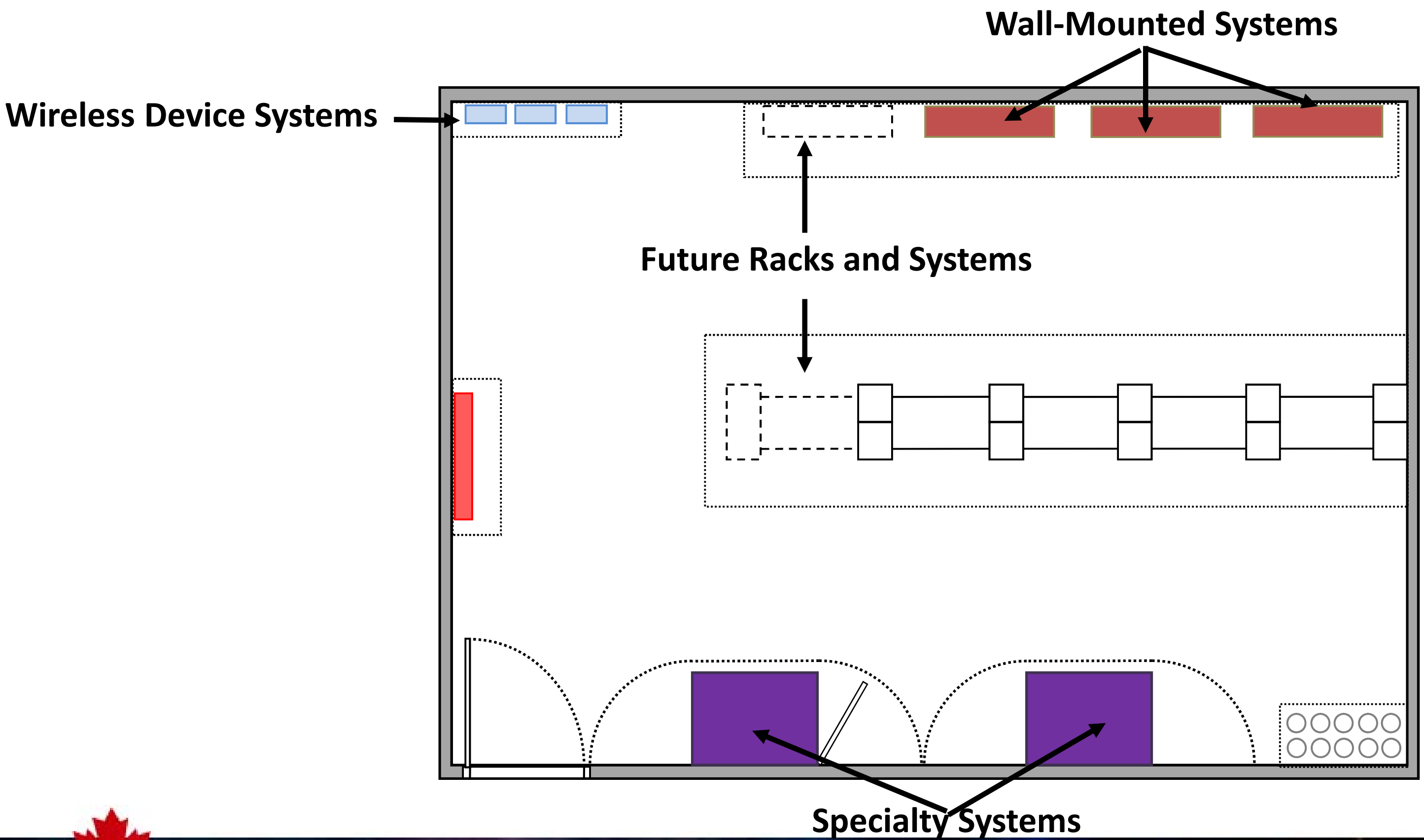
- *Technology Design and Implementation Practices for Intelligent Buildings and Premises*
- Communications Infrastructure & Network Integration
- Design Considerations (Power, Data, Zone Cabling)
- Building Systems (Lighting, Digital Signage, Vertical Transportation, Sound Systems, ESS, etc.)
- Building Monitoring Systems
- Commissioning



BICSI-007 Horizontal Cabling

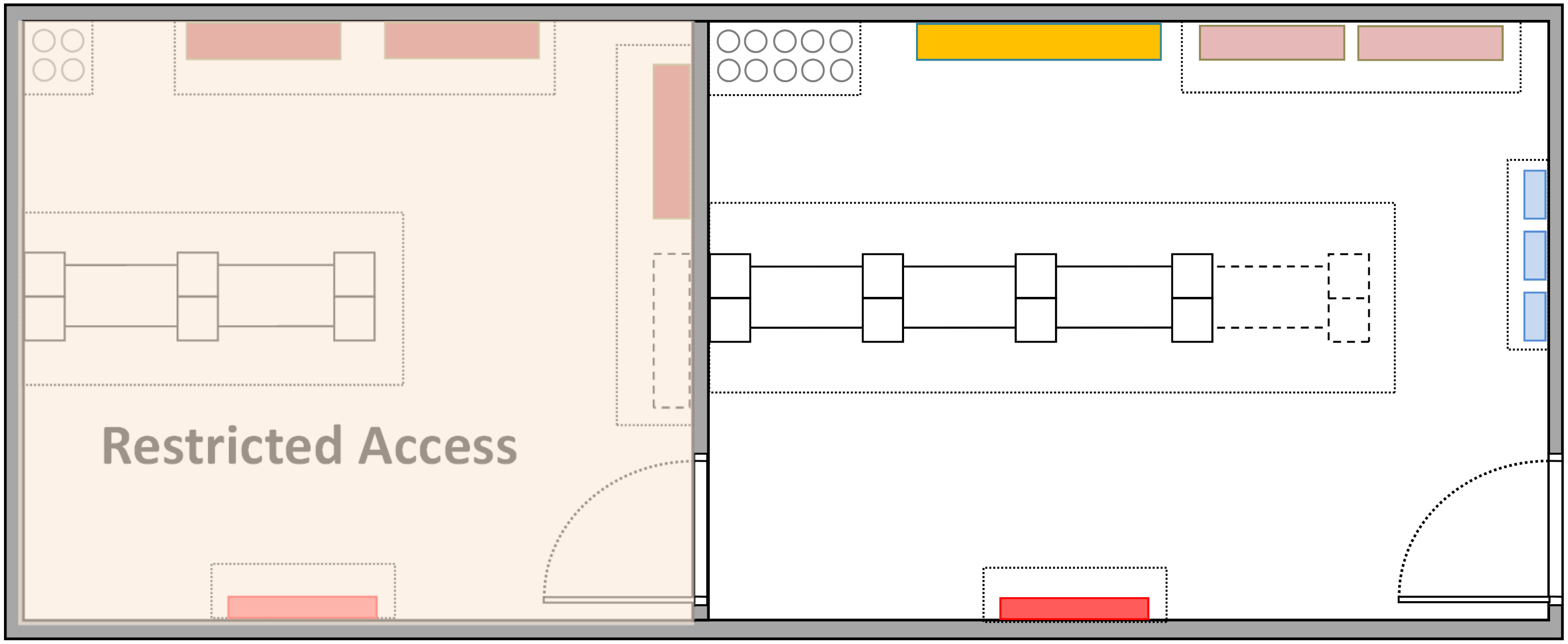


Example of a TR that Supports Multiple Systems



Example of a TR that Provides Restricted Access

Critical/Sensitive Information Systems



Quiz Question #1

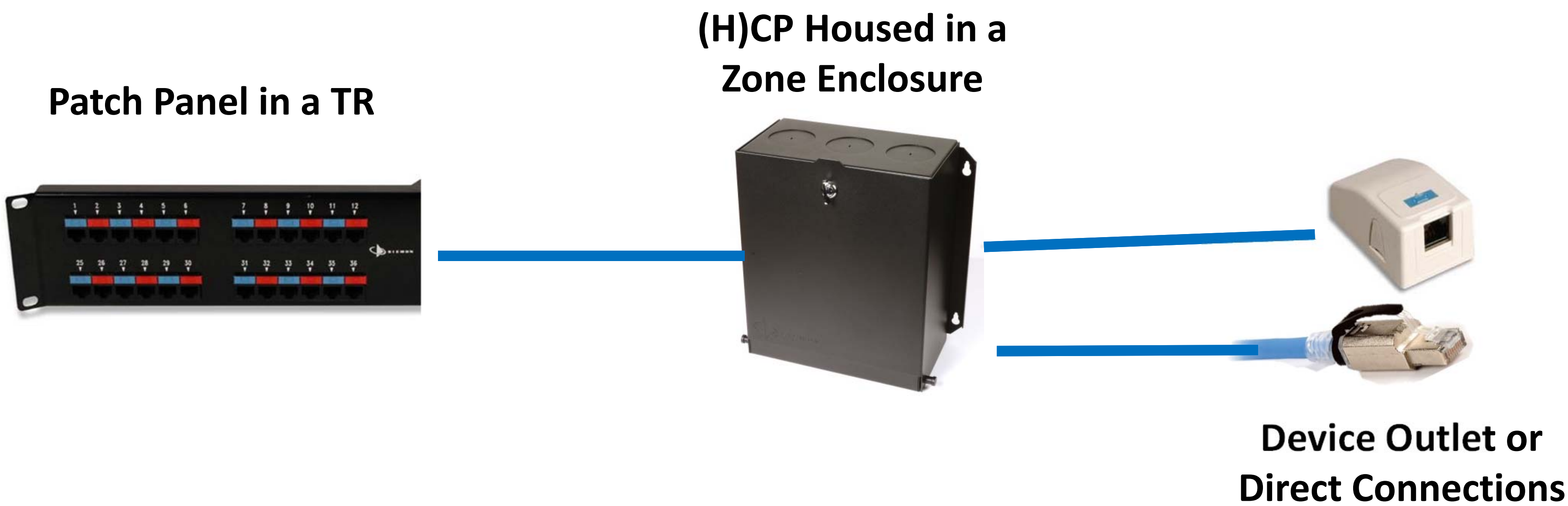
What is Zone Cabling?

What is Zone Cabling?

Zone cabling supports convergence of data and voice networks, wireless (Wi-Fi) device uplink connections, and a wide range of sensors, control panels, and detectors for lighting, security, and other building communications

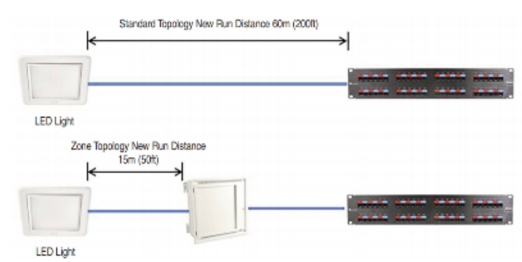
BICSI

Zone Cabling Topology



Zone Cabling Methodology

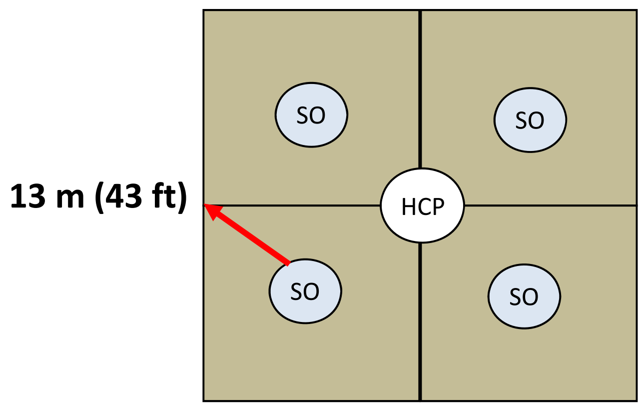
- Zone cabling is a standards-based approach to support convergence of devices
- Consists of cables run from connections in the telecommunications room (TR) to outlets housed in a zone enclosure servicing coverage areas
- Shorter cables run from outlets in the zone enclosure directly to devices or to outlets servicing devices

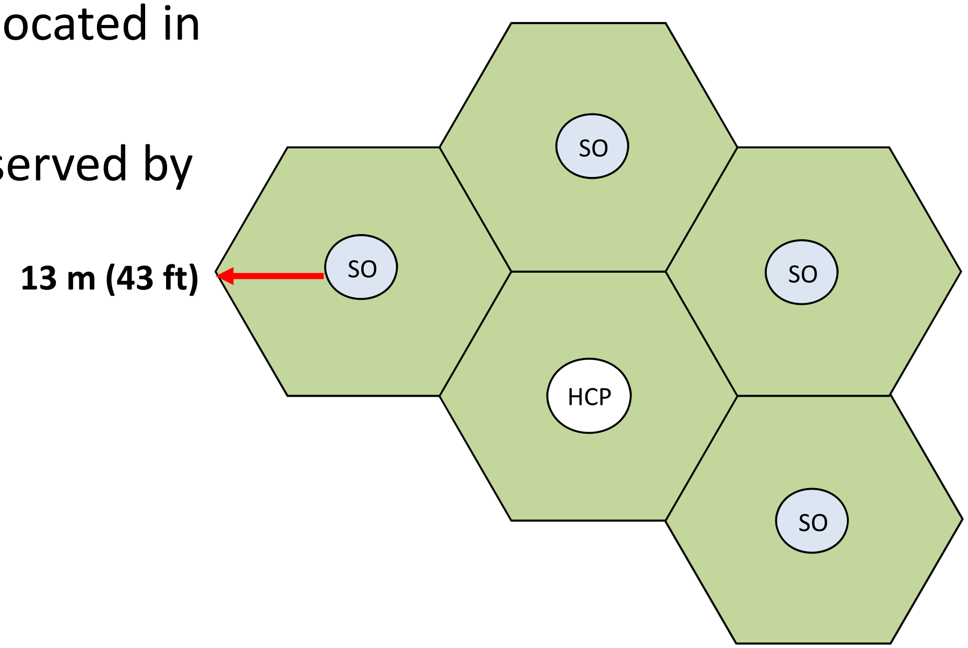


- 25% spare port availability recommended for best ROI
- Supports rapid reorganization and deployment of new devices and applications
- MAC work costs less, is faster and less disruptive
- Factory pre-terminated and tested trunking cables can be installed from the TR to the zone enclosure for quicker deployment

Zone Cabling Planning

- Different patterns may be used but the radius should not exceed 13m/43 ft.
- Zone enclosures should be centrally located in their coverage areas.
- A zone area refers to multiple areas served by a zone enclosure.



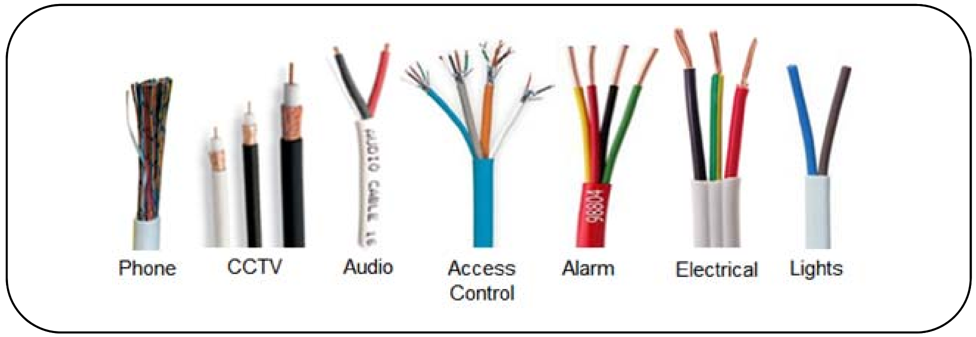


Zones Cabling Exercise:

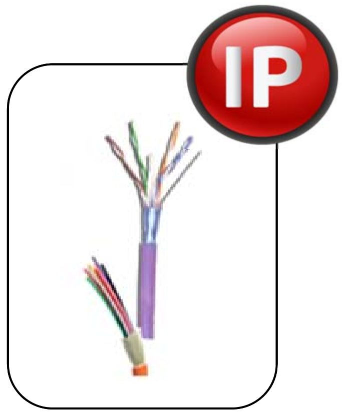
Later Today

Cable Selection

Traditional Building
Employ a vast array of different protocols and cabling systems



Converged Building
Multiple building systems over a single IT cabling infrastructure (fiber and copper)



One cable type means:

- Rapid deployment
- Reduced labor costs

Cabling for Intelligent Buildings

Copper

Category 6_A/Class E_A

(Recommended)

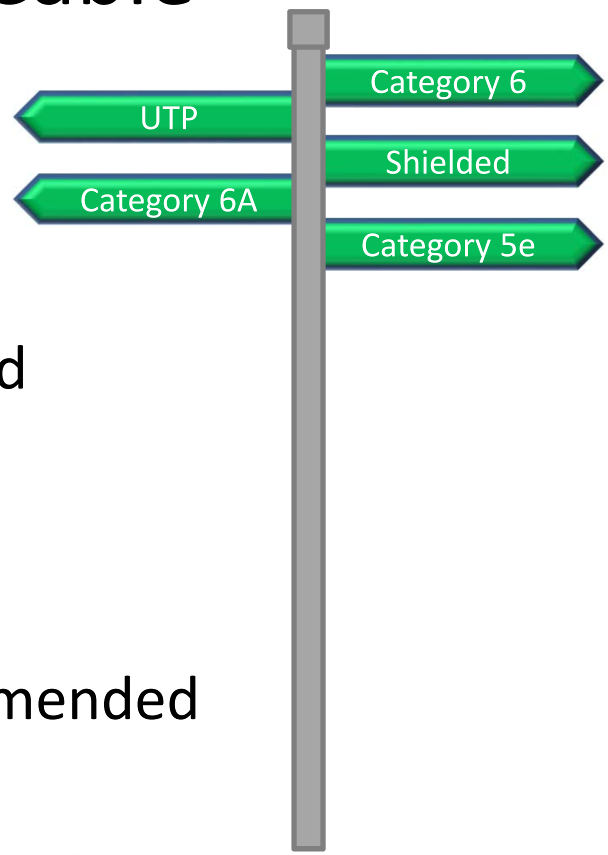
Fiber

Multimode (OM3, OM4, OM5)

Singlemode

Recognized Copper Cable

- **TIA TSB-184-A-2017**
  - Category 6A recommended
- **TIA-862-B-2016**
  - Category 6; category 6A recommended
- **ISO/IEC 11801-6 Ed1.0**
  - Class E_A or higher
- **BICSI 007-2017**
  - Category 6A/Class E_A or higher recommended



Non-Recognized Horizontal Cabling (Retrofit)

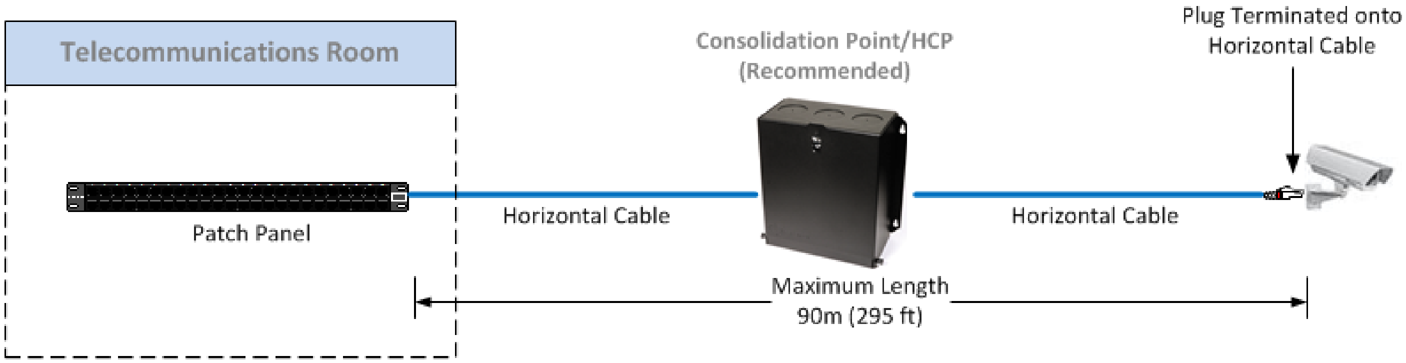
1. **Does not violate current code or authority having jurisdiction (AHJ) requirements**
2. **Results from the movement, alteration, or changes to current system**
3. **Meets or exceeds the performance of the existing cabling in use by the system**

Quiz Question #5

What is an MPTL?

A: Modular Plug Terminated Link

Modular Plug Terminated Link (MPTL)



- The MPTL is constructed by direct field termination of horizontal cabling at the device end with a modular plug - replacing the TO/SO and associated Work Area (WA) cord.
- ANSI/TIA-568.2-D requires that horizontal cable be terminated onto a TO. In certain cases there may be a need to terminate horizontal cables directly to a plug.
- ANSI/BICSI-007 recognizes the MPTL and refers to it as a direct connection method, with or without an HCP.
- ANSI/TIA-862-B-2016 recognizes direct connections – should be limited to devices in fixed locations that are not expected to be replaced or required to be directly connected by the AHJ

What are the market drivers?

- IoT and Intelligent Buildings are driving the proliferation of IP-based and PoE-based devices in the walls and ceilings of modern buildings

- LED lights, security cameras, wireless access points, digital displays, distributed antenna systems (DAS), building automation control devices and more can be directly connected using plug-terminated links rather than via boxes, outlets and patch cords

What are the benefits of an MPTL?

- Custom length, quick connections in the field
  for direction connection to devices
- Improves performance and allows for more efficient power delivery by eliminating patch cords and outlets
- Improves security for devices like surveillance cameras by eliminating exposed patch cords

Photo taken at McCarran Airport in Las Vegas – Anyone could jump up and pull out the patch cord to the surveillance camera and wireless access point.

Quiz Question #2

What are the four IEEE PoE power levels (W)?

A: 15, 30, 60, 90

Existing IEEE PoE Applications

	Minimum Power at PSE Output	Number of Pairs	Maximum Current per Pair
Power over Ethernet (Type 1)	15.4 W	2-pairs	350 mA
Power over Ethernet Plus (Type 2)	30.0 W	2-pairs	600 mA
4-pair PoE (Type 3)	60.0 W	4-pairs	600 mA
4-pair PoE (Type 4)	90.0 W	4-pairs	960 mA
Power over HDBase-T (POH)	100.0 W	4-pairs	960 mA

Advantages of Remote Power/PoE

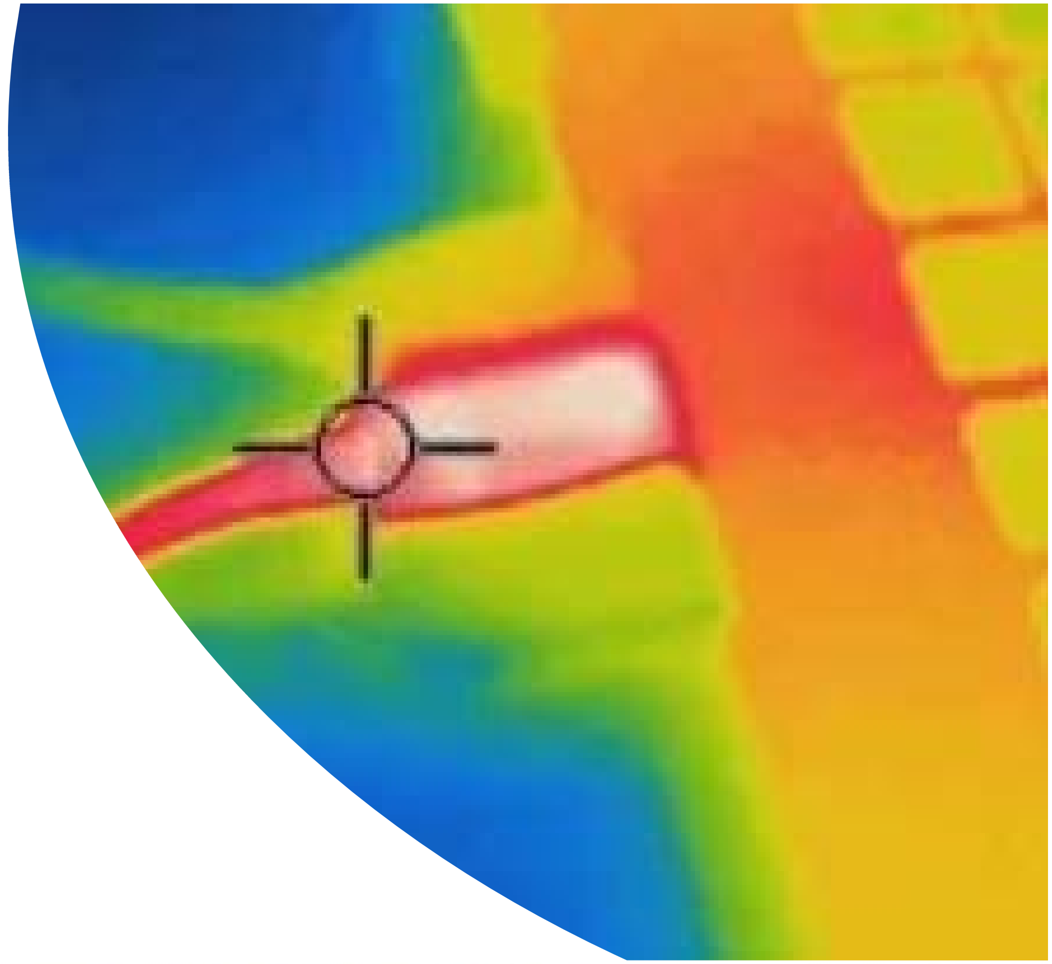
- Running power concurrent to data over structured cabling
- The cost of a power outlet includes conduit, wire, a back box for the outlet and the labor of an electrician
  - The average cost to provide typical power to a device is about $1,000
  - The average cost of a PoE network port plus the structured cable drop is $250 per drop

UPoE Compatible Cisco Catalyst 4500E Series Switching platform

Cisco UPoE Plenum Digital Building Switch - 30 & 60W

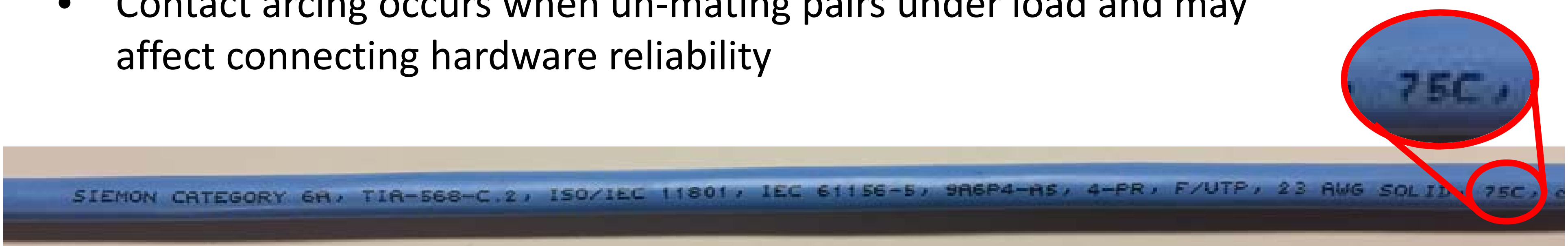
Implications of Remote Powering

- Heat builds-up within cable bundles
- Contact arcing occurs when un-mating pairs under load and may affect connecting hardware reliability



Temperature Rise Considerations

- Heat builds up within cable bundles:
  - Cabling insertion loss increases at temperatures above 20°C/68°F
  - The temperature of any cable should not exceed the temperature rating for the cable
  - Cables with higher temperature ratings are listed and marked accordingly
- Contact arcing occurs when un-mating pairs under load and may affect connecting hardware reliability



Do you know the 3 temperature ratings for a Category cable?

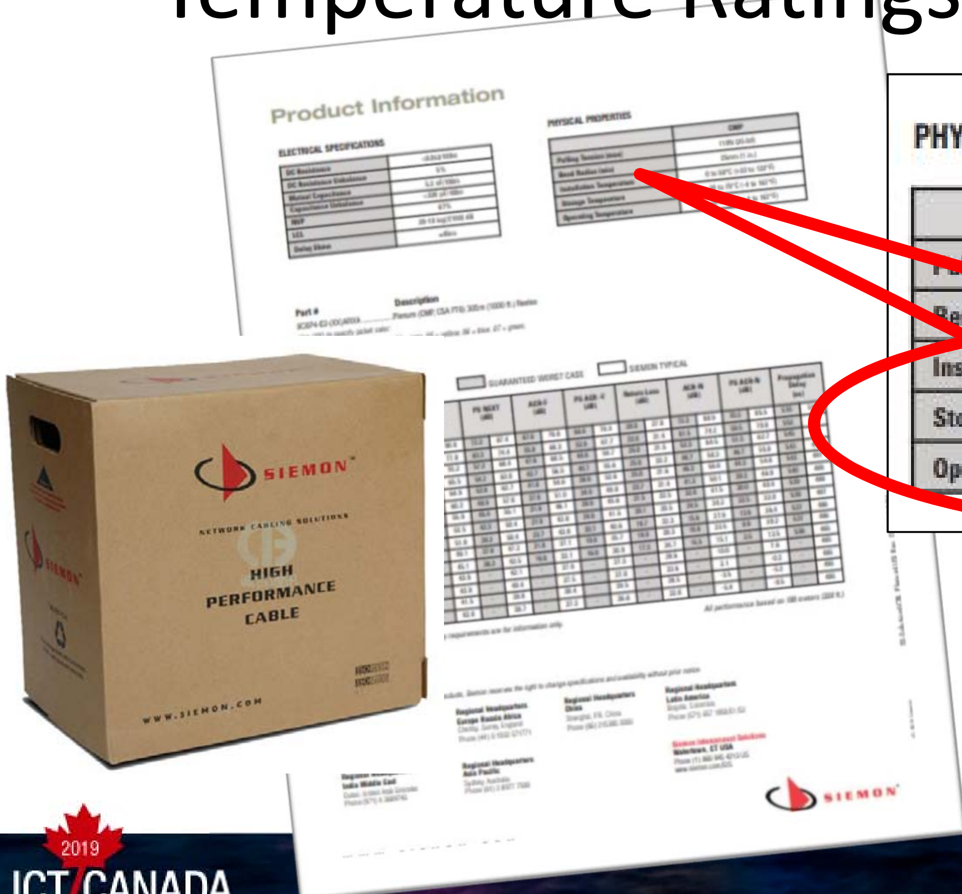
Installation,
Storage,
Operating

General,
Riser,
Plenum

Max Cold,
Max Hot,
Ambient

30W
60W
90W

Temperature Ratings for Category Cable



PHYSICAL PROPERTIES

	CMP
Pulling Tension (max)	110N (25 lbf)
Bend Radius (min)	25 mm (1 in.)
Installation Temperature	0 to 50°C (+32 to 122°F)
Storage Temperature	-20 to 75°C (-4 to 167°F)
Operating Temperature	-20 to 75°C (-4 to 167°F)

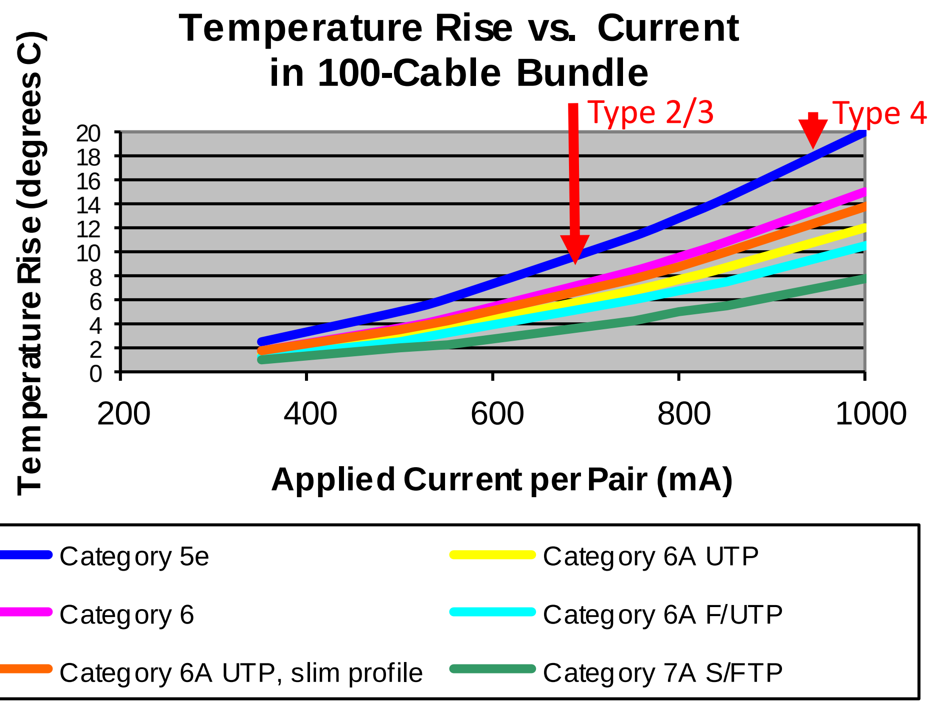
- Installation
- Storage
- Operating

Quiz Question #4

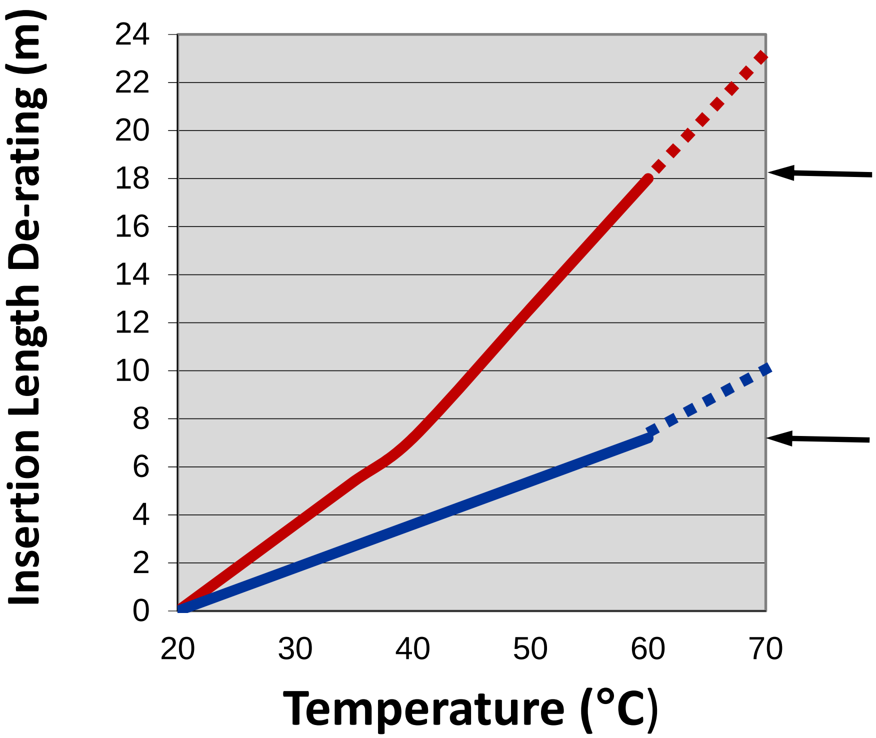
What is the TIA specified operating temperature range for cabling?

A: -20°C to 60°C (-4°F to 140°F)

PoE Cable Temperature Rise



Channel Length De-Rating

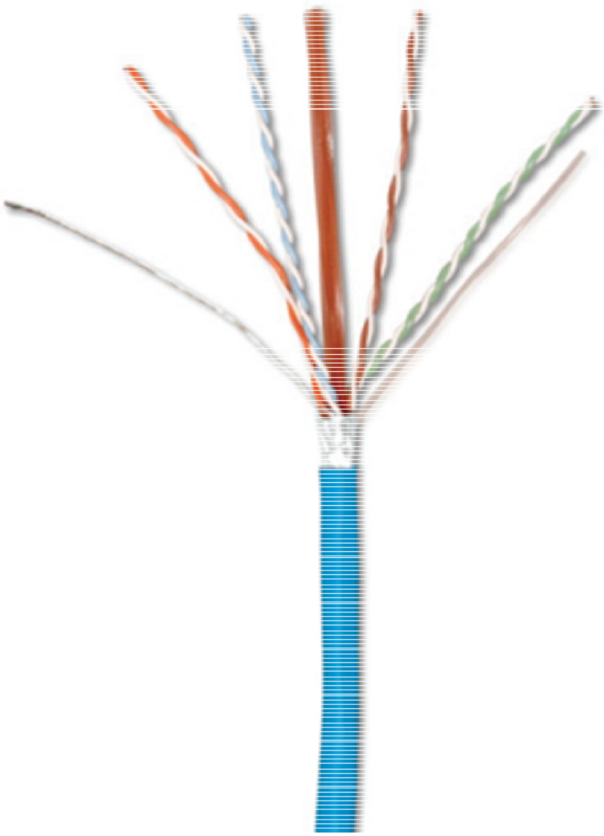


TIA, ISO/IEC Category 6A U/UTP
Subtract 18 m at 60°C/140°F

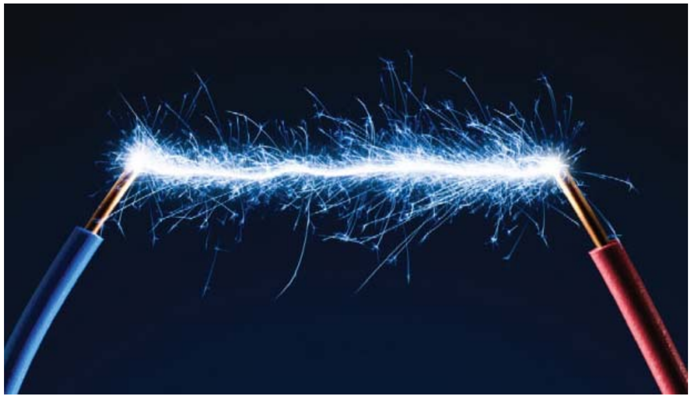
TIA, ISO/IEC Category 6A F/UTP
Subtract 7 m at 60°C/140°F

Benefits of Shielded Cabling

- Typically qualified for higher temperature (75°C) operation
- Reduced length de-rating
- Superior heat dissipation supporting larger bundle sizes



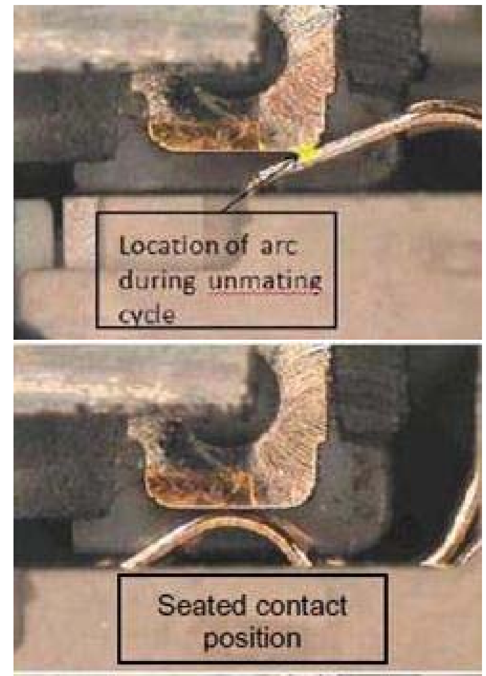
Potential for Arcing Under Load Conditions



- Remote powering applications do not apply DC power until a PD is sensed by the PSE
- Device disconnections can't be anticipated
- "Un-mating pairs under load" produces an arc as the applied current transitions from flowing through conductive metal to air before becoming an open circuit
- Arcing can result in corrosion and pitting damage on the plated contact surface at the arcing location

Ensuring Contact Integrity

- Informative Annex B of TSB-184-A contains the following guidance:
  - Connecting hardware having the required performance for mating and un-mating under the relevant levels of electrical power and load should be chosen
  - IEC 60512-99-001 is referenced as a suitable test schedule

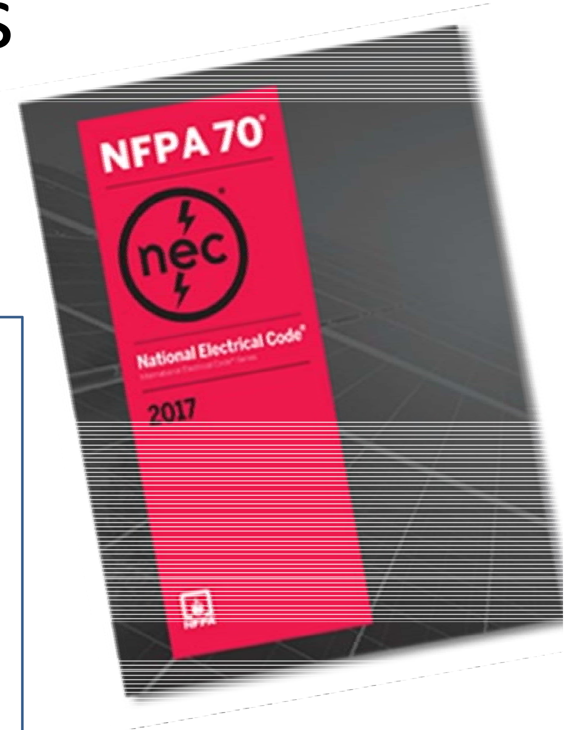


Resources for Cabling Heat Concerns

- NFPA 70 (2017 NEC)
- TIA TSB-184-A-2017
- TIA-569-D-2-2018

2017 NEC Code Revisions

- Cable Ratings and Markings for Safety
- Ampacity Table for Bundles



Part VI. Premises Powering of Communications Equipment over Communications Cables

840.160 Powering Circuits. Communications cables, in addition in carrying the communications circuit, shall also be permitted to carry circuits for powering communications equipment. Where the power supplied over a communications cable to communications equipment is greater than 60 watts, communication cables and the power circuit shall comply with 725.144 where communications cables are used in place of Class 2 and Class 3 cables.

2017 NEC Table 725.144

- Conductor gauge, bundle size and temperature rating are used to establish a safe power rating (Ampacity) for <u>each</u> <u>conductor</u>

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		
	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	1	1	1	1	1	0.7	0.8	1	0.5	0.6	0.7	0.4	0.5	0.6	0.4	0.5	0.6	NA	NA	NA
24	2	2	2	1	1.4	1.6	0.8	1	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	0.7	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	3	3	1.4	1.8	2.1	1	1.2	1.4	0.7	0.9	1.1	0.6	0.9	1.1	0.6	0.8	0.9	0.5	0.6	0.7

Example: Can this cable support Type 4 PoE?

- 24 AWG category 5e cable
- Bundle size of 75 cables
- Mechanically rated to 60°C *(Operating Temperature)*

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		
	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	1	1	1	1	1	0.7	0.8	1	0.5	0.6	0.7	0.4	0.5	0.6	0.4	0.5	0.6	NA	NA	NA
24	2	2	2	1	1.4	1.6	0.8	1	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	0.7	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	3	3	1.4	1.8	2.1	1	1.2	1.4	0.7	0.9	1.1	0.6	0.9	1.1	0.6	0.8	0.9	0.5	0.6	0.7

Alternatives

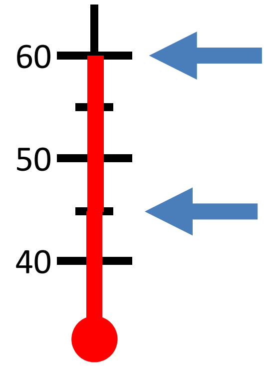
- Use cables with a larger conductor or higher mechanical rating *(Operating Temperature)*
- Reduce bundle size

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		
	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	1	1	1	1	1	0.7	0.8	1	0.5	0.6	0.7	0.4	0.5	0.6	0.4	0.5	0.6	NA	NA	NA
24	2	2	2	1	1.4	1.6	0.8	1	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	0.7	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	3	3	1.4	1.8	2.1	1	1.2	1.4	0.7	0.9	1.1	0.6	0.9	1.1	0.6	0.8	0.9	0.5	0.6	0.7

TIA TSB-184-A

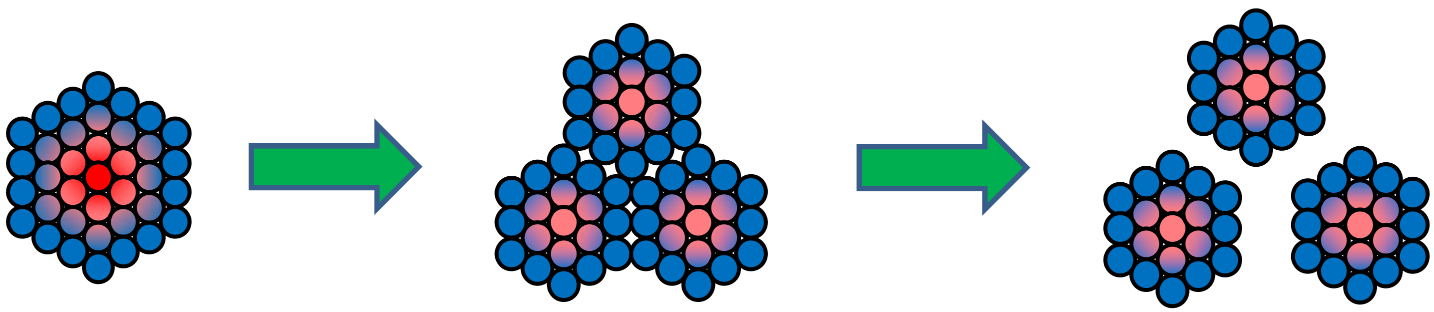
Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling (March 2017)

- The standard presumes a maximum ambient temperature of 45°C/113°F in conjunction with cabling with a maximum rating of 60°C/140°F, thus allowing a maximum temperature rise of 15°C/27°F on any cable within the bundle due to dc powering



Mitigation Recommendations

- Use Category 6A or higher-performing 4-pair balanced twisted-pair cabling, or larger AWG or shielded cables
- Reduce channel length, as necessary, to offset increased insertion loss
- Reduce bundle size (24) and allow space between bundles



TIA-569-D-2-2018

- *Additional Pathway and Space Considerations for Supporting Remote Powering Over Balanced Twisted-Pair Cabling* (July 2018)

- Pathways differ in regard to geometry and contact area between cables, pathway, and air
- Provides general guidance on heat dissipation of various pathways by bundle size

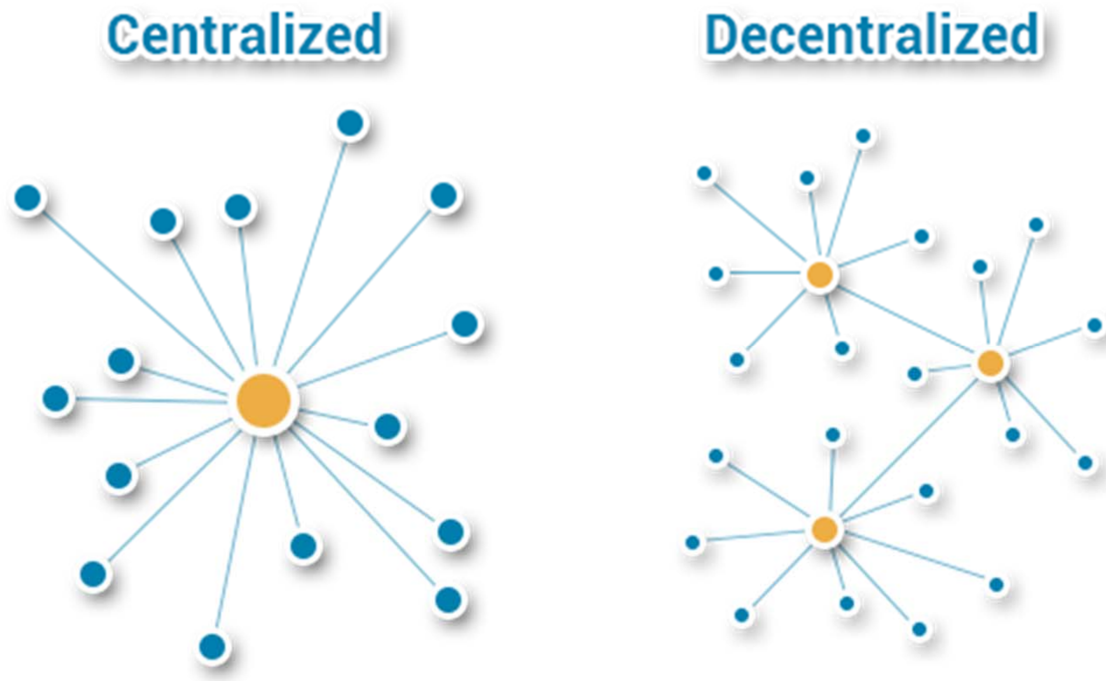
Pathway Type	Cable Routing	Cable Quantity			
		1-37	38-61	62-91	> 91
Non-continuous	Bundled	High	High	High	N/A
	Unbundled	High	High	High	N/A
Conduit (Metallic & Non-metallic)	Bundled	Low	Low	Low	Low
	Unbundled	Medium	Low	Low	Low
Sealed Conduit	Bundled	Low	Low	Low	Low
	Unbundled	Low	Low	Low	Low

Tray Type	Fill Depth (in.)		
	1	2	≥ 3
Wire Mesh/Ladder	High	High	High
Ventilated	High	Medium	Low
Unventilated	Medium	Medium	Low

Additional Pathway Mitigation

- Use open wire tray or similar cable management that provides for largely unrestricted airflow around the installed cables
  - Disperse cables evenly across the width of the tray
- Reduce maximum operating temperature
- Mix unpowered cables with powered cables

Cabling Layout Selection



Node Centric vs. Fixture Centric

1:1

Fixture Centric

<u>One to One</u>
More Powered Ports
More Costly

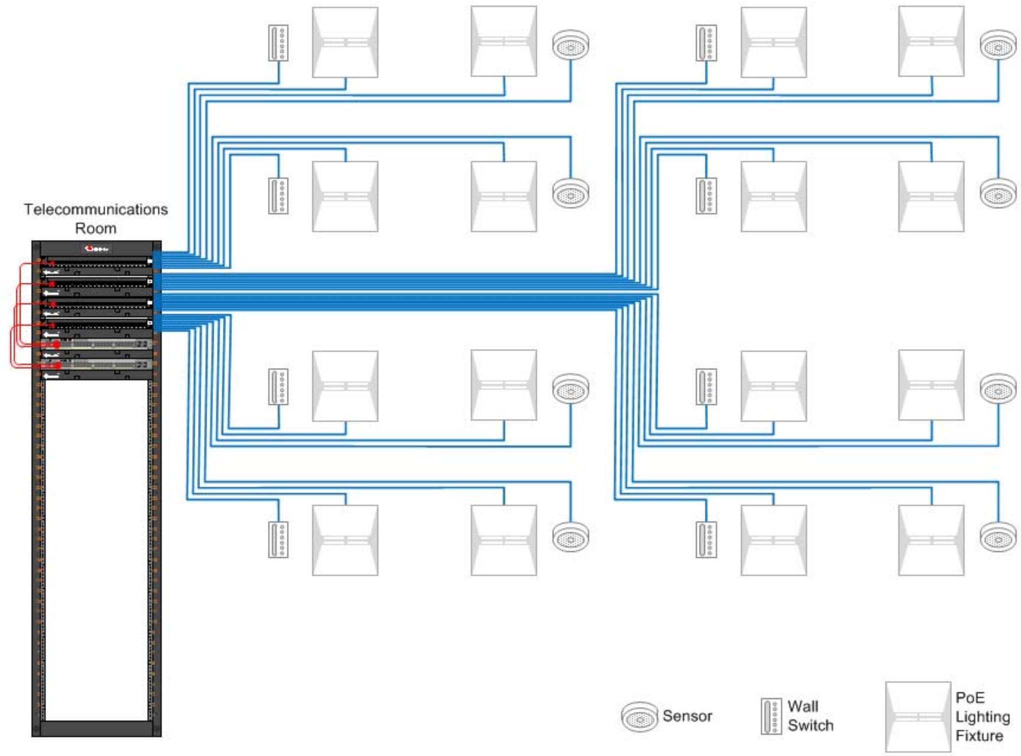
1:N

Node Centric

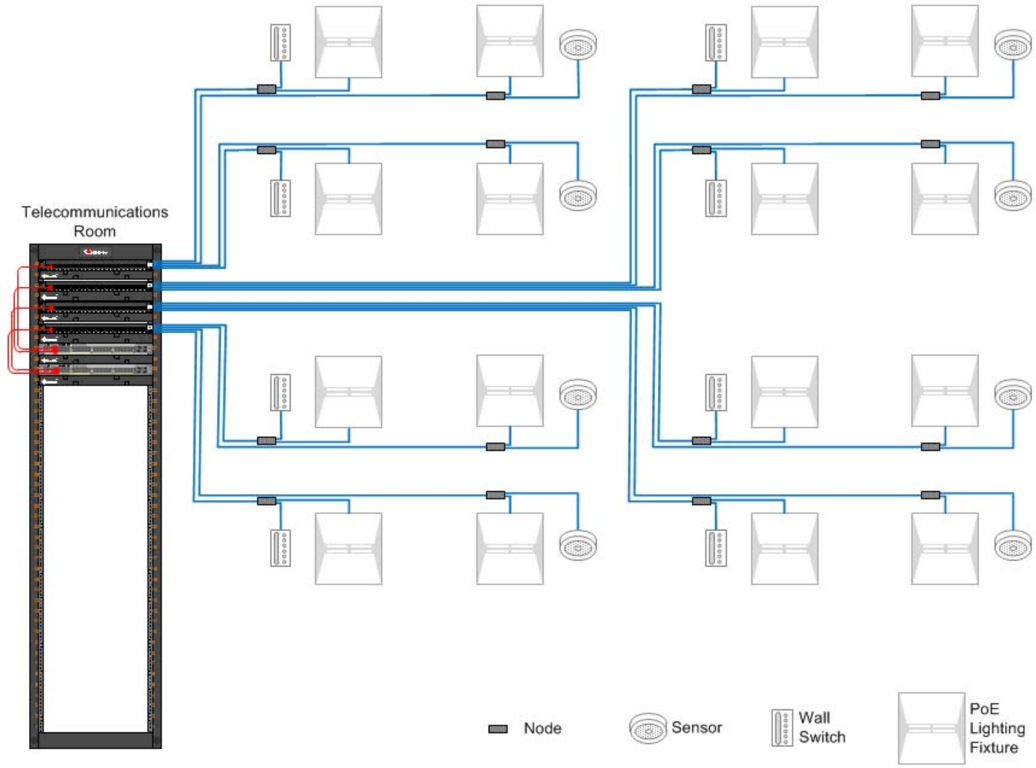
<u>One to Many</u>
Less Powered Ports
Less Expensive

Where N fixture(s) power requirements are less than the supplied PoE power

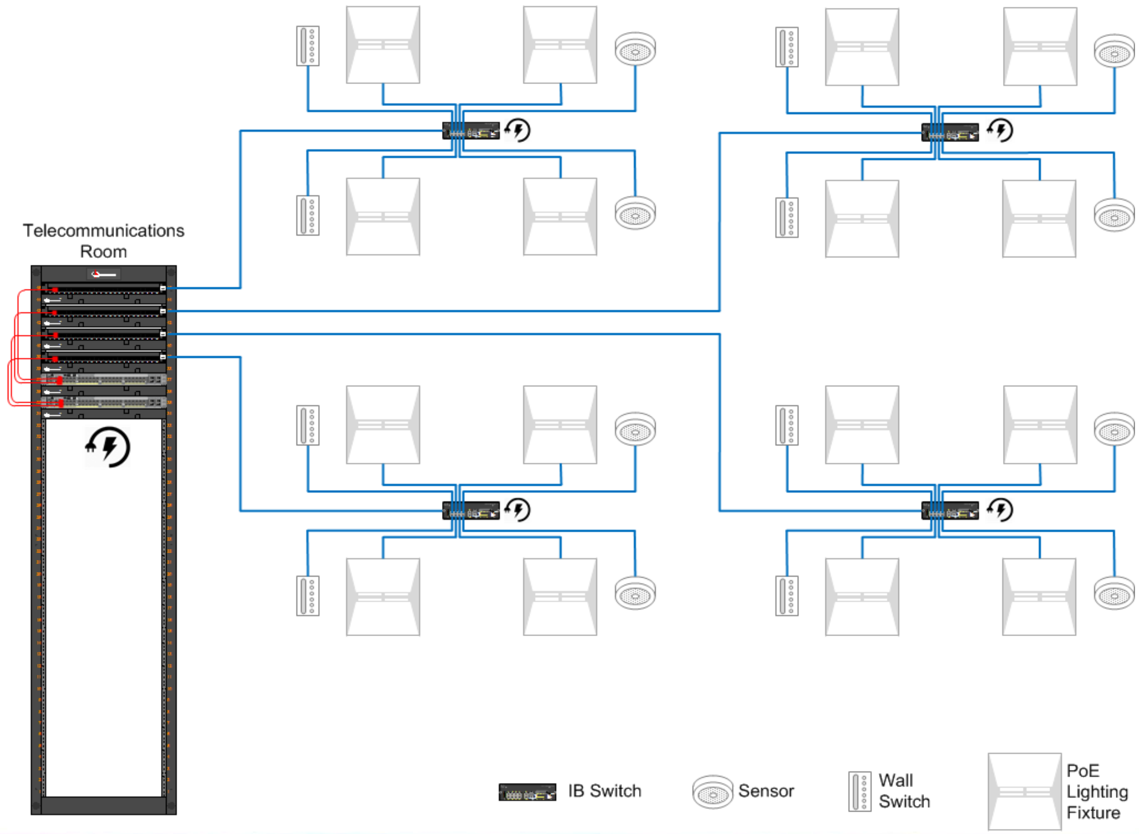
Centralized – Fixture Centric



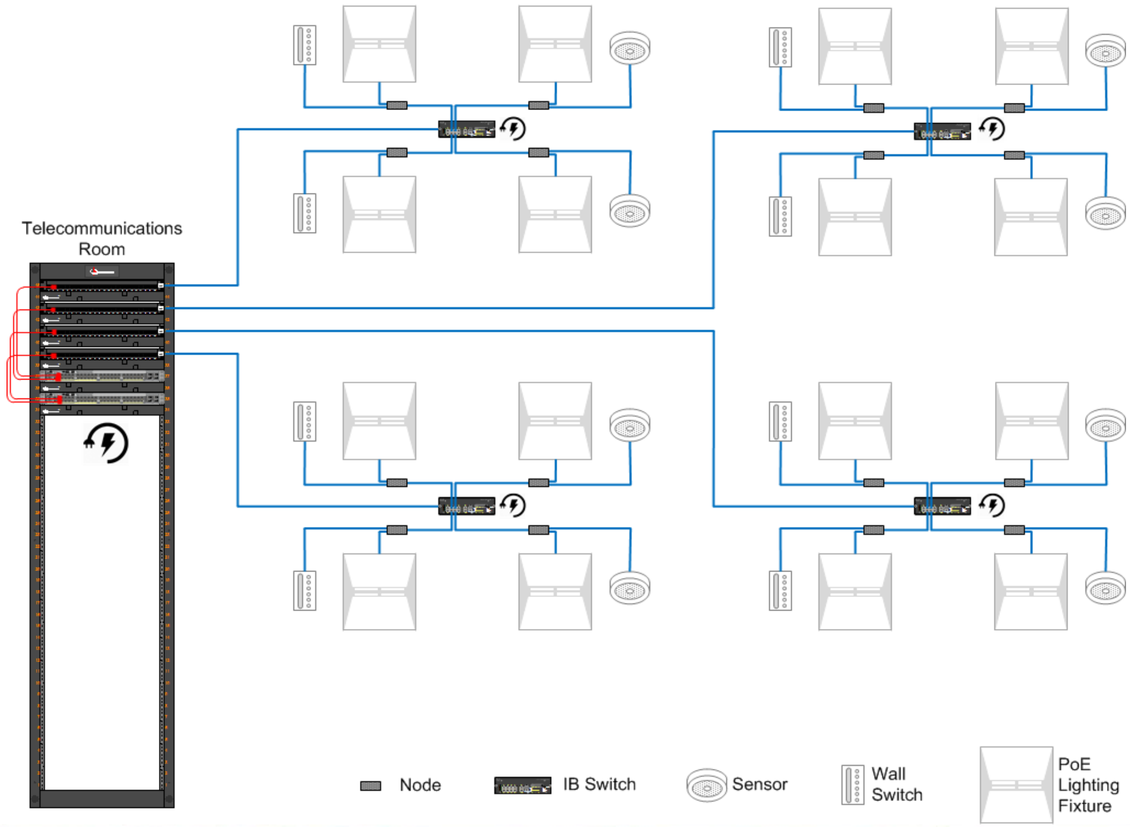
Centralized – Node Centric



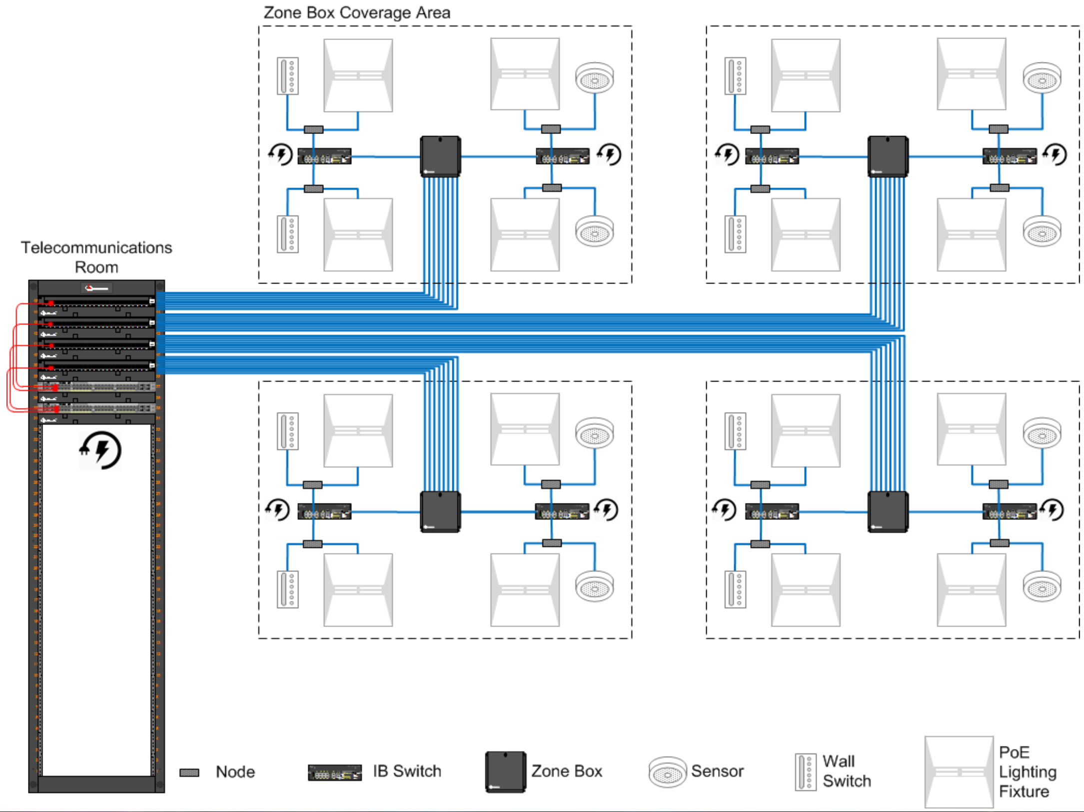
Decentralized – Fixture Centric



Decentralized – Node Centric



Decentralized Zone – Node Centric



Summary

- Increasing numbers of IB applications will run over a low-voltage cabling platform
- Know the resources, codes and standards to help you design your infrastructure
- Zone cabling and modular plug terminations have a role
- Remote powering places increased demands on network cabling systems
- Design according to proper device coverage area

Thank You

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