# Four Pair PoE: Powering the Future of Intelligent Buildings and the IoT

**Luis Suau – CISCO**

**Carol Everett Oliver, RCDD, ESS – SIEMON**

**Mark Mullins – Fluke Networks**

**Geoffrey Bauer, ESS – Axis Communications**

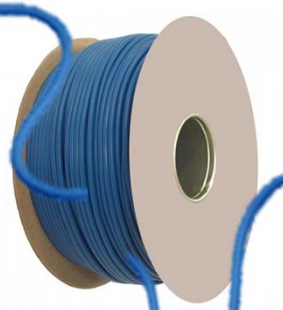
# Agenda

- **Intelligent Buildings – An Introduction to PoE**
  - **Luis Suau – CISCO**
- **Cabling Systems Design and Installation Considerations**
  - **Carol Everett Oliver, RCDD, ESS – SIEMON**
- **Testing**
  - **Mark Mullins – Fluke Networks**
- **End Products and Security**
  - **Geoffrey Bauer, ESS – Axis Communications**
- **Live Demo**
  - **All**

# Cookie and Coffee Cam

# Cookie/Coffee Cam Set-up

Axis Q1635 Network Camera
with Wide Dynamic Range



Siemon Category 6A F/UTP Cable
with Z-PLUG Field Terminated Plugs

Cisco Catalyst Digital
Building Series Switch

Cabling certified by
Fluke DSX 5000
Cable Analyzer

# Digital Buildings:
## An Introduction to 4 Pair PoE

Luis Suau


2019 BICSI Winter Conference & Exhibition
January 20-24 • Orlando, FL, USA
BICSI

# Agenda

- Introduction
- Overview
- Value Proposition
- Architecture
- Identification/Security
- Codes and Standards
- Deployment Example
- Summary

"Predicting rain doesn't count; building arks does."

- Warren Buffett

# Generation Z'ers

Born after 1995 -
World Population Age – 42% 0-24, 20% 35-49, 14% 50-64, 8% 65+

2016 entered the workforce

66% think technology makes anything possible

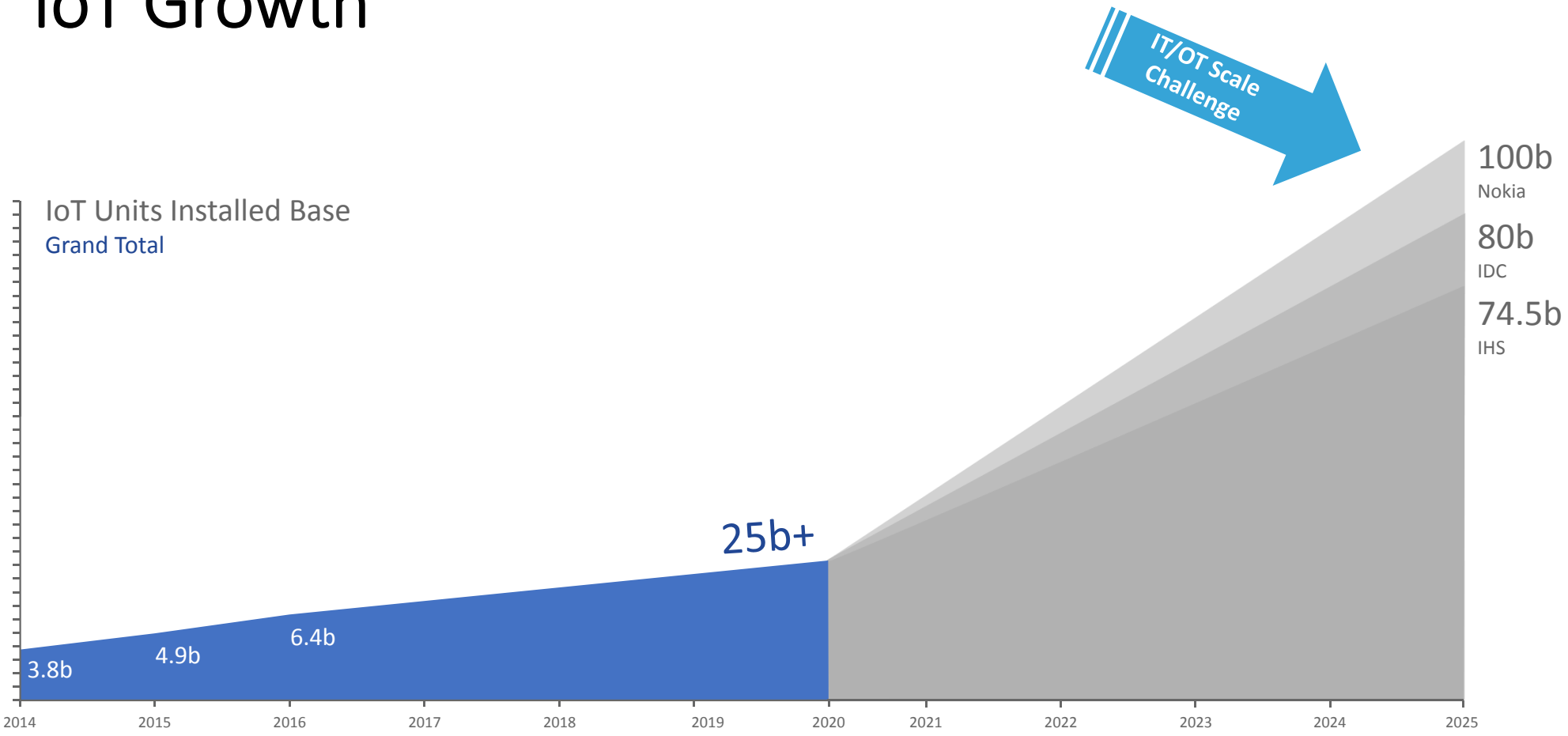
80% display emotional distress if separated from devices

90% would be upset if they had to give up the Internet

51% still want to communicate to managers in person

60% want to have an impact on the world at work

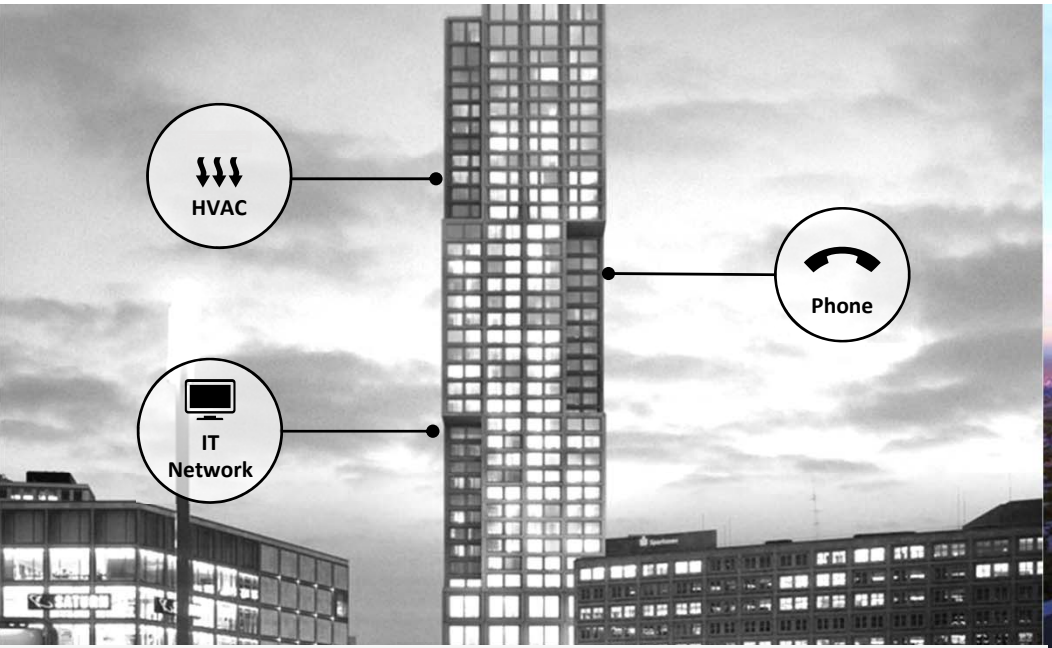
# IoT Growth



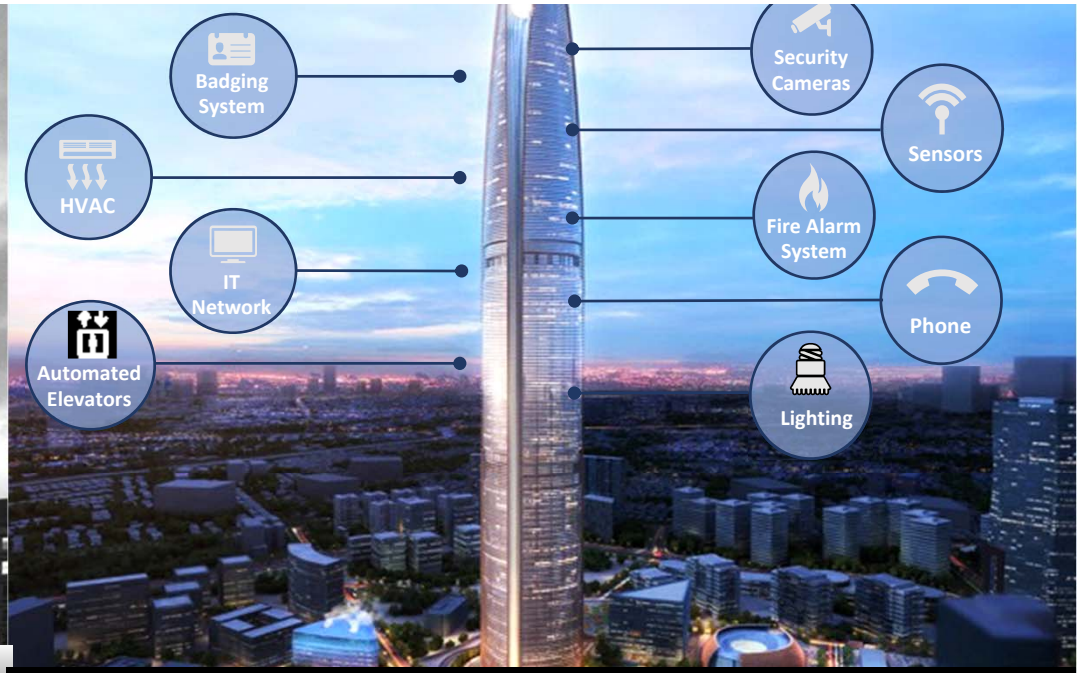

Source: http://www.cisco.com/c/en/us/solutions/service-provider/visual-networking-index-vni/index.html

# Overview

# Technology Has Changed Buildings.....




Yesterday



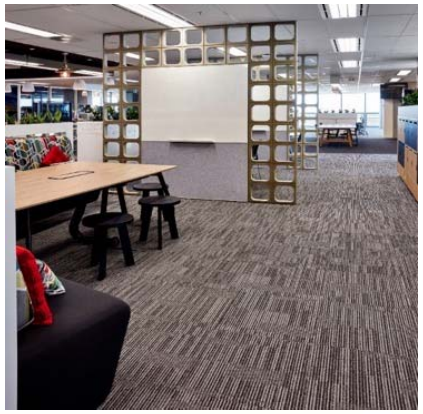

Today

**Demand for new customer experiences and workforce innovation mandate improved efficiencies**

# Activity-Based Working (ABW) *was the first wave*







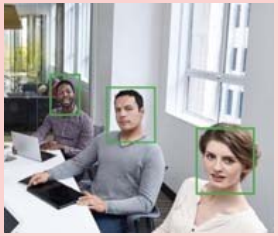

# Enablers for smart/automated workplace

**Mobile & Digital First**

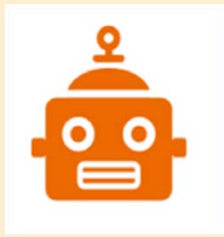
**Cloud / Hybrid Cloud**

**Virtual Assistants**

**AI & Machine Learning**



**Robotic Process Automation & APIs**



**Mobility & Location Analytics**

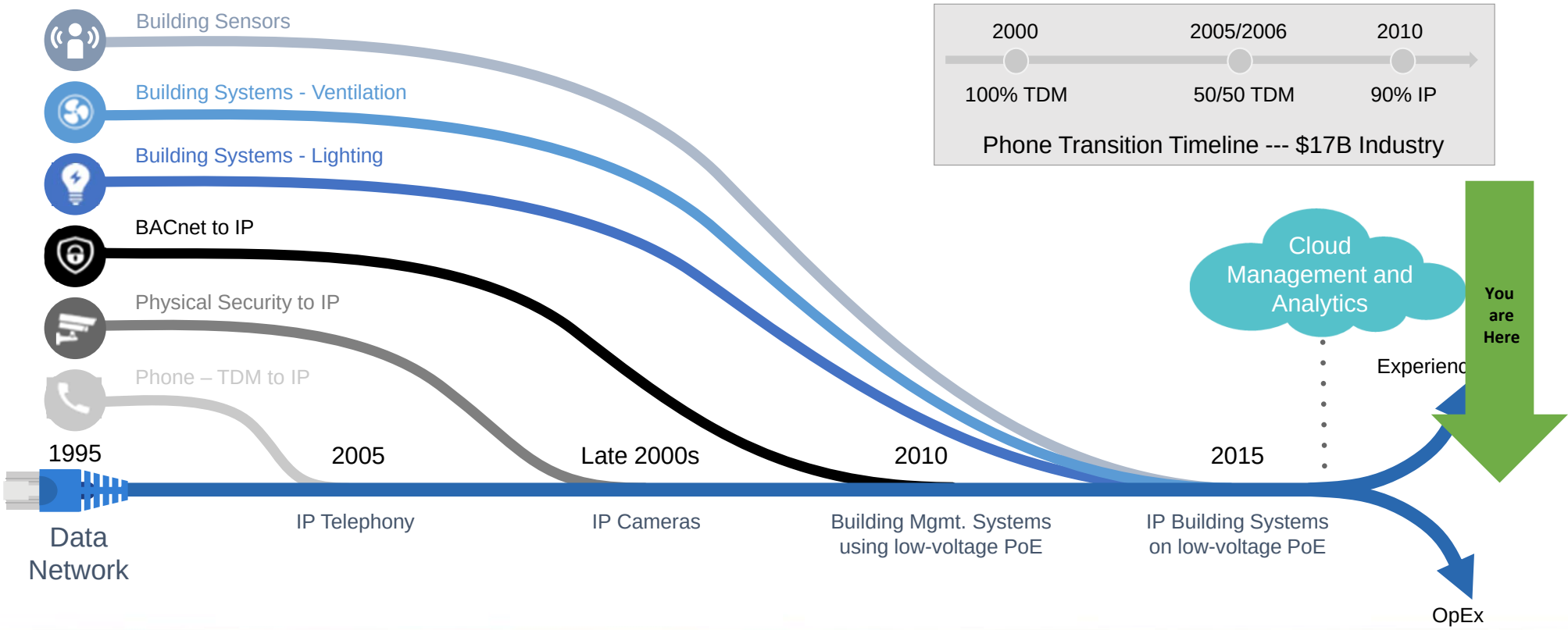
**Augmented Experiences**

**Smart Buildings Smart Communities**

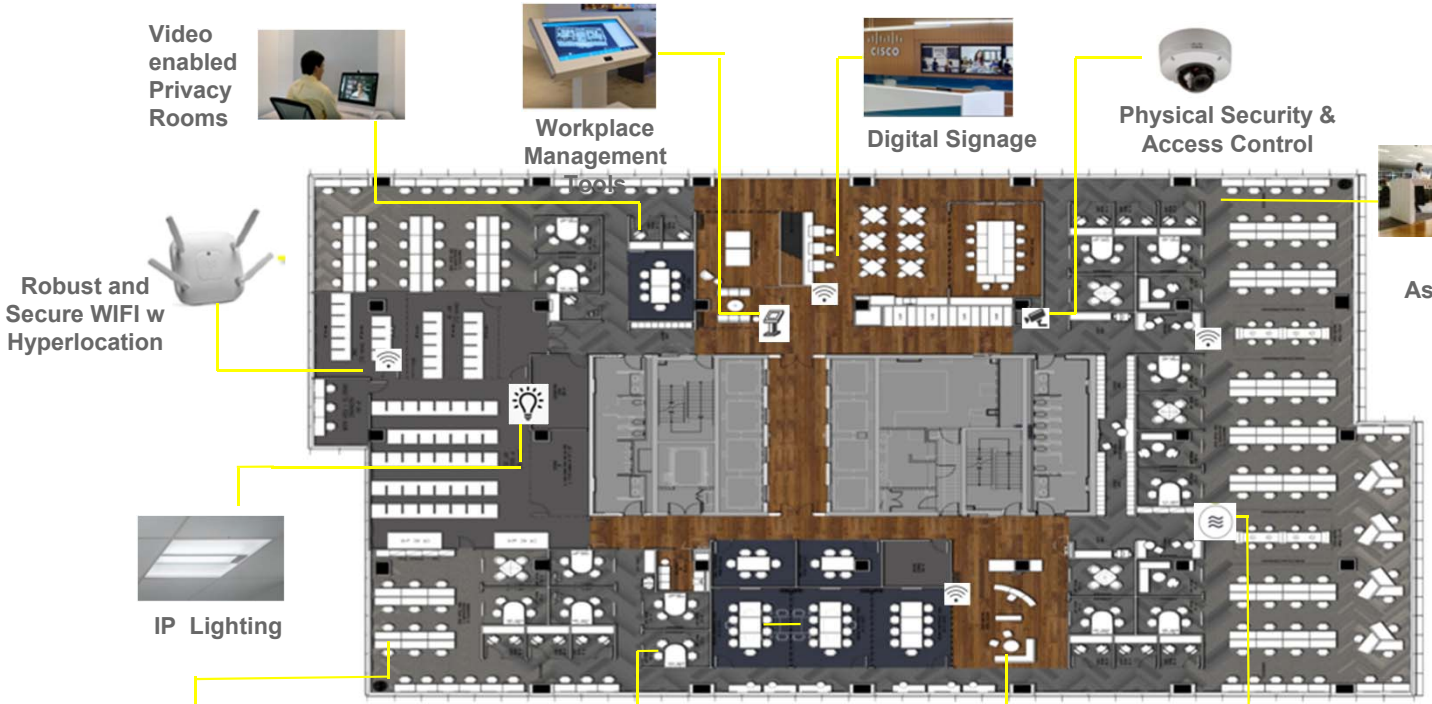
**IoT & Wearables**

**Advanced Analytics**

# IP Convergence for Digital Building Technologies



# Technology is the enabler……



Video enabled Privacy Rooms

Workplace Management Tools

Digital Signage

Physical Security & Access Control

Robot Assistance

Robust and Secure WIFI w Hyperlocation

IP Lighting

Individual video workspaces / IoT sensors

Video enabled Huddle Rooms

Innovation spaces with video & content creation

IoT-enabled building sensors

## Employee Services

Collaboration Workspaces

Working from Anywhere / Connecting to the Workplace

Secure Mobility Solutions

## Management Services

Space and Environment Management

Workspace Utilisation Analytics

# Robot Down!!

# Value Proposition

**Lower Cost Operations**


**More Data**

Granular, device-level Visibility and Control

Centrally Manage Via the Network

>More Energy Saving Over Traditional Methods

Save Energy, Lower Operations Costs

# Architecture

# Bringing it all Together

Applications

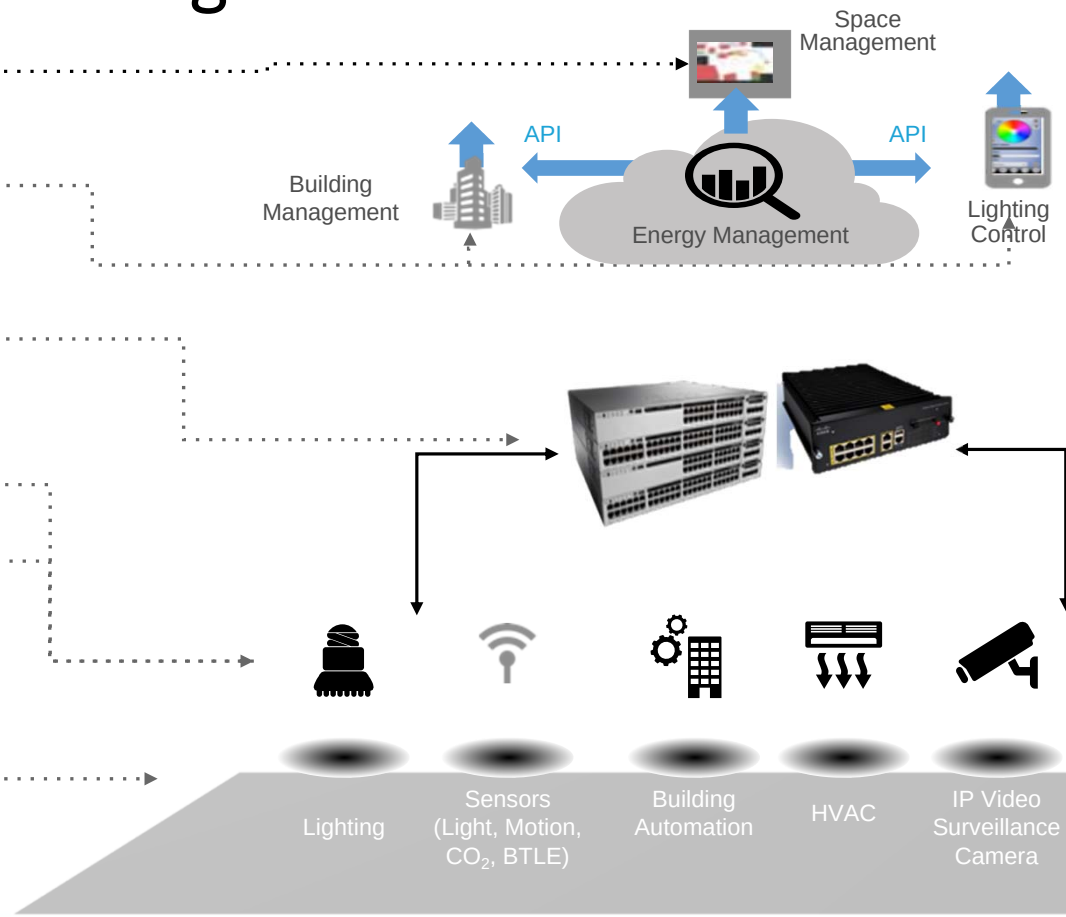
Control Systems

Network Infrastructure

Sensors

Intelligent Driver

LED fixtures/ Components




## Kinetic Software

- Cisco Kinetic (Data Fabric)
- Cisco Kinetic for Cities
- Cisco Kinetic Video
- Cisco Vision
- Cisco Space Management

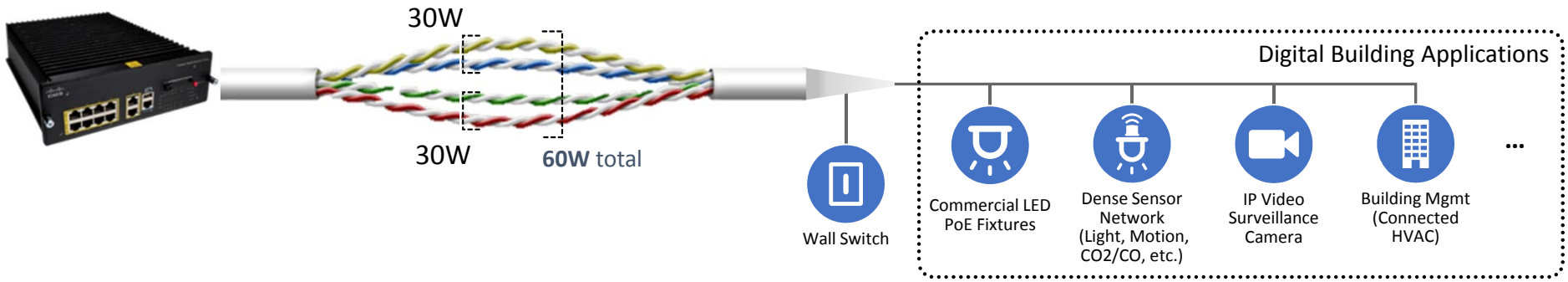
## Network Infrastructure

### Cisco Switches

- CoAP, PoE, PoE+, UPOE
- Security with ISE and DNA
- Converge disparate networks (HVAC, metering, lighting) into one IP network

# Enhanced PoE Capabilities
## Cisco Digital Building

**UPOE supports an Expanding Ecosystem of PoE devices**




### Full UPOE

- Increased PoE Budget: 480W of UPOE (8 x 60W)
- Fanless, silent reliable operation with increased MTBF and system life (10 yrs)

### Perpetual UPOE

- Provides non-stop UPOE power
- Switch can continue to provide power during configuration and reboot

### Fast UPOE

- Restores power to powered device within 5 secs of power resumption

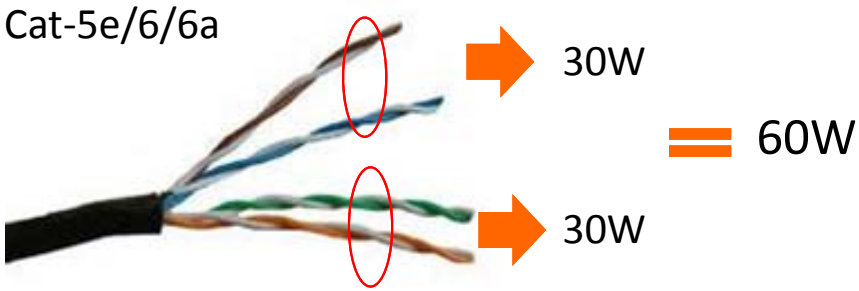
### 2-Event Classification

- Simplified power negotiation without LLDP
- Physical layer negotiation < 1s based on class/type

# Power Over Ethernet – IEEE 802.3af/at (Future bt)

Power over Ethernet (PoE) Delivers DC Power and data over a Standard Copper Ethernet Cable(RJ45)

IEEE 802.3af/at




Cisco UPOE
Universal POE available since 2012

Cisco chairs IEEE 802.3bt working group standardizing (type 3 @ 60W, type 4 @ 91W)

# DoE Cable Testing

https://www.energy.gov/sites/prod/files/2018/01/f47/cls_poe-cable-pt1_nov2017_0.pdf

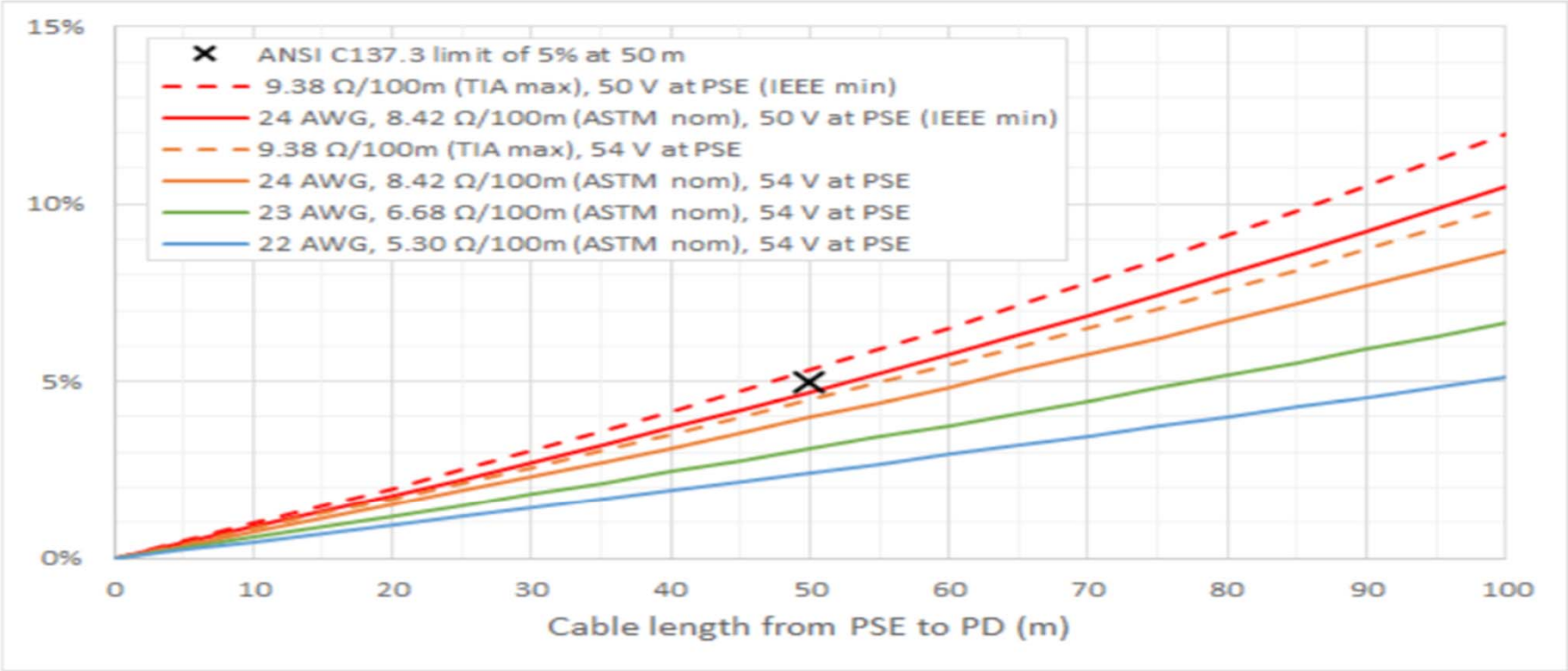


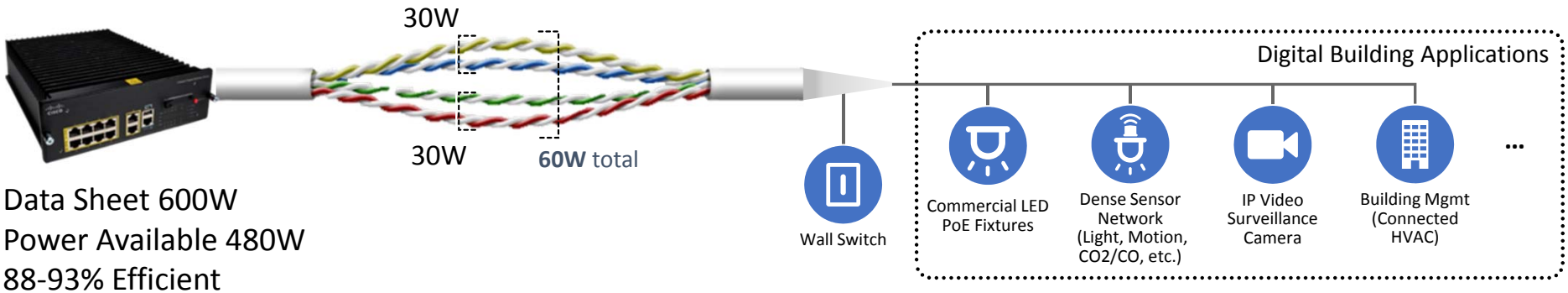

**Figure 6.1. Range of expected cable losses for 51 W PD at 20°C ambient**

# Heat Dissipation Example

Power/Heat

Power/Heat

Power/Heat




Data Sheet 600W
Power Available 480W
88-93% Efficient

**Impact at Switch**

- Switch Load
- Input Power
- BTU at the Switch Small

**Impact across Cable**

- Wire Gauge
- Cable Length
- Bundle Size
- 1.7 – 2.8w drop @ 100M

**Impact at the Powered Device**

- Most of the Energy goes here

| Voltage | Load | Efficiency | PF |
|---|---|---|---|
| 115VAC | 20% | 88% | .985 |
| 115VAC | 50-100% | 91% | .99 |
| 230VAC | 20% | 89% | .84 |
| 230VAC | 50-100% | 93% | .96 |

https://www.cisco.com/c/en/us/solutions/collateral/workforce-experience/digital-building/datasheet-c78-738206.html

# Mid-Span Operation

Non-Intelligent
Ethernet Switches

No Standards

No State Data

Mid-Span

Mid-Span Impact

- Creates another failure point
- Do not participate in Data Channel
- Can’t share power information
- Cost swap between PoE Switch and Mid-Span
- Obscures power troubleshooting

Powered Devices (PD)

# Existing POE Digital Building Endpoints

Status Signs


Temp Sensor


Blind Motors


Access Points




Biometric Door Locks


Ceiling Fans


Cameras


Badge Readers


HVAC VAV's



Horns and Sirens


Facial Recognition Systems

Meeting Room Nameplate


Touchscreen PC's


IP Call Stations


Light Fixtures


IP Call Tower


Entry Barriers And Turnstiles


Environmental Sensor Hubs


POE Displays

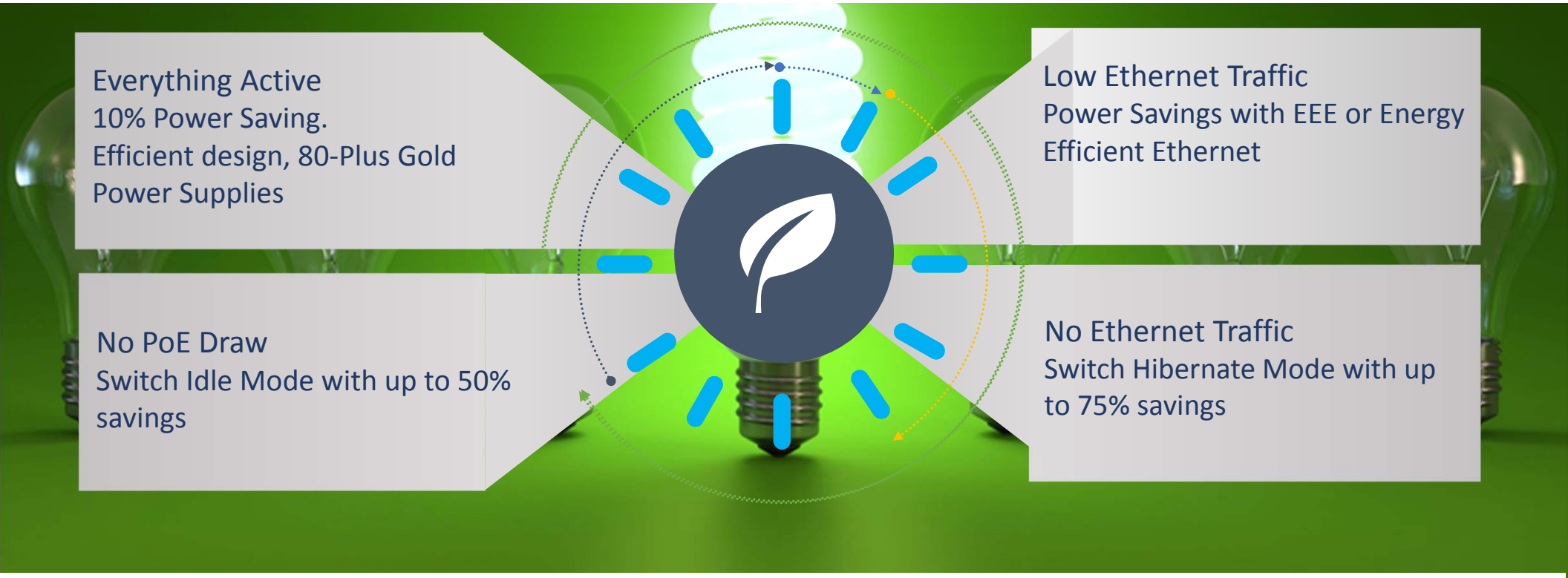

Curtain Motors


Power Meter

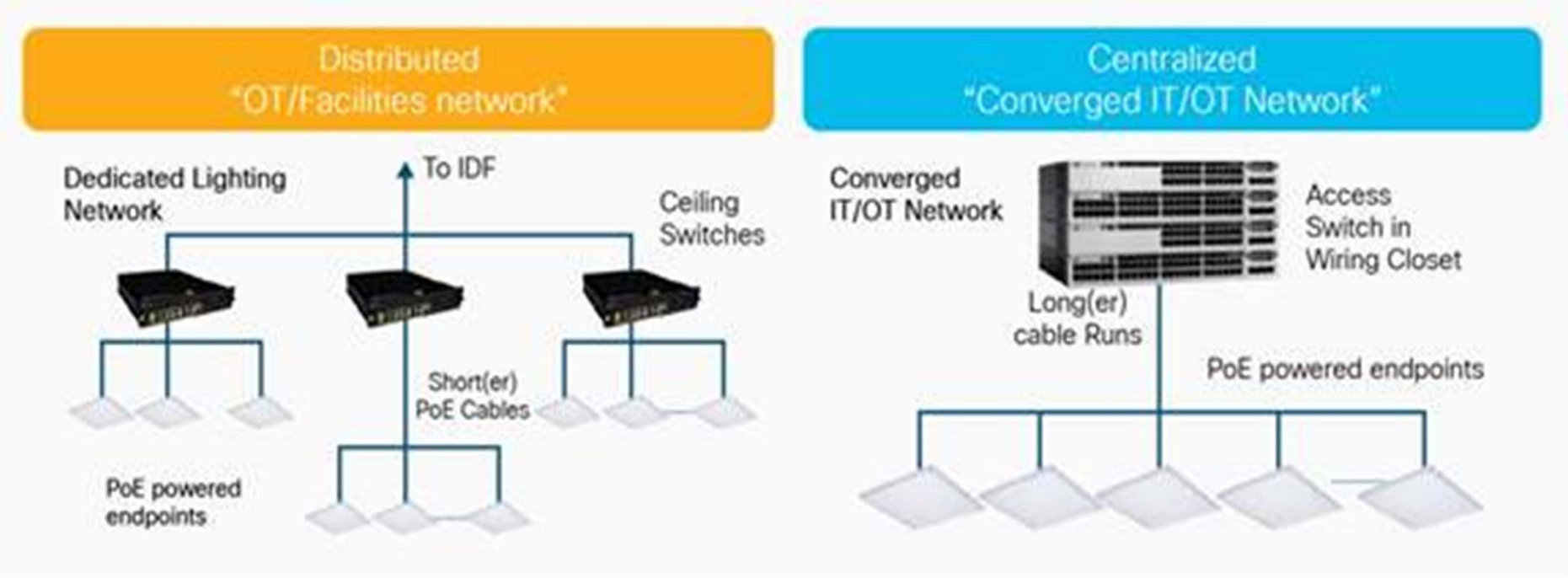
# Structured Cabling Considerations

- Cable Selection – Application based
- Pathway sizing and planning
- Bundles in pathway, racks, and cabinets

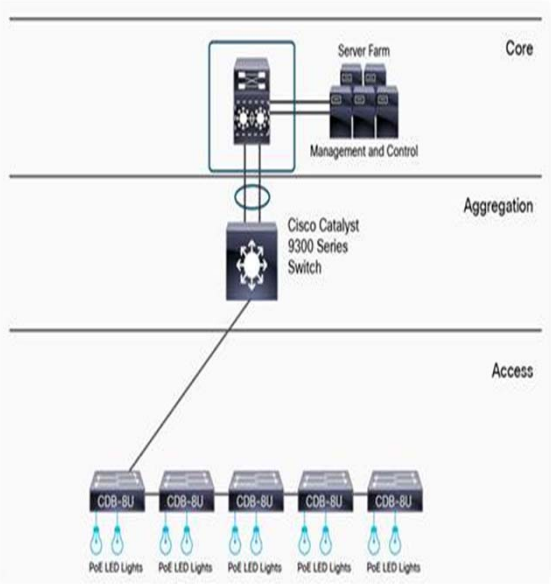
# Digital Building Switches have a 5x Improvement in Switch Power

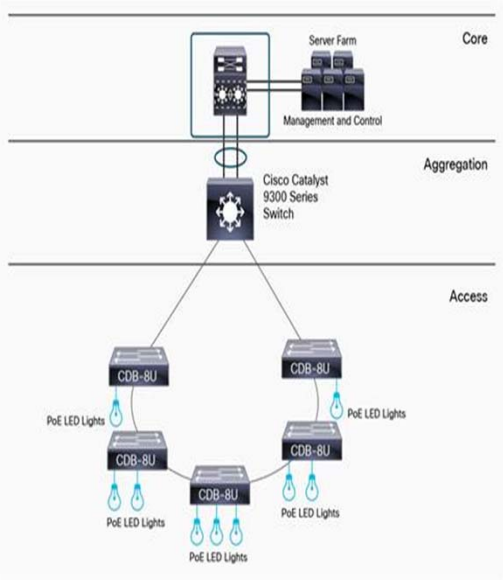


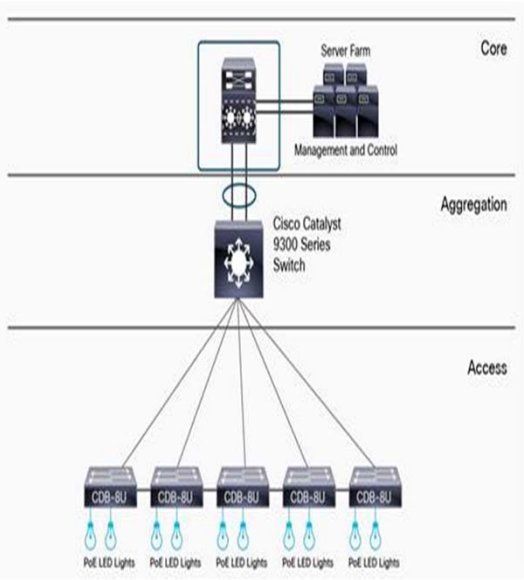
# Deployment Models



# Differentiated Access Layer Approaches




https://www.cisco.com/c/en/us/products/collateral/switches/catalyst-digital-building-series-switches/guide-c07-740588.html

# Building Management Systems

## Cisco Network Architecture

**1 / Secure**

BMS Fieldbus visible to IT and secured to prevent exploits on Enterprise infrastructure

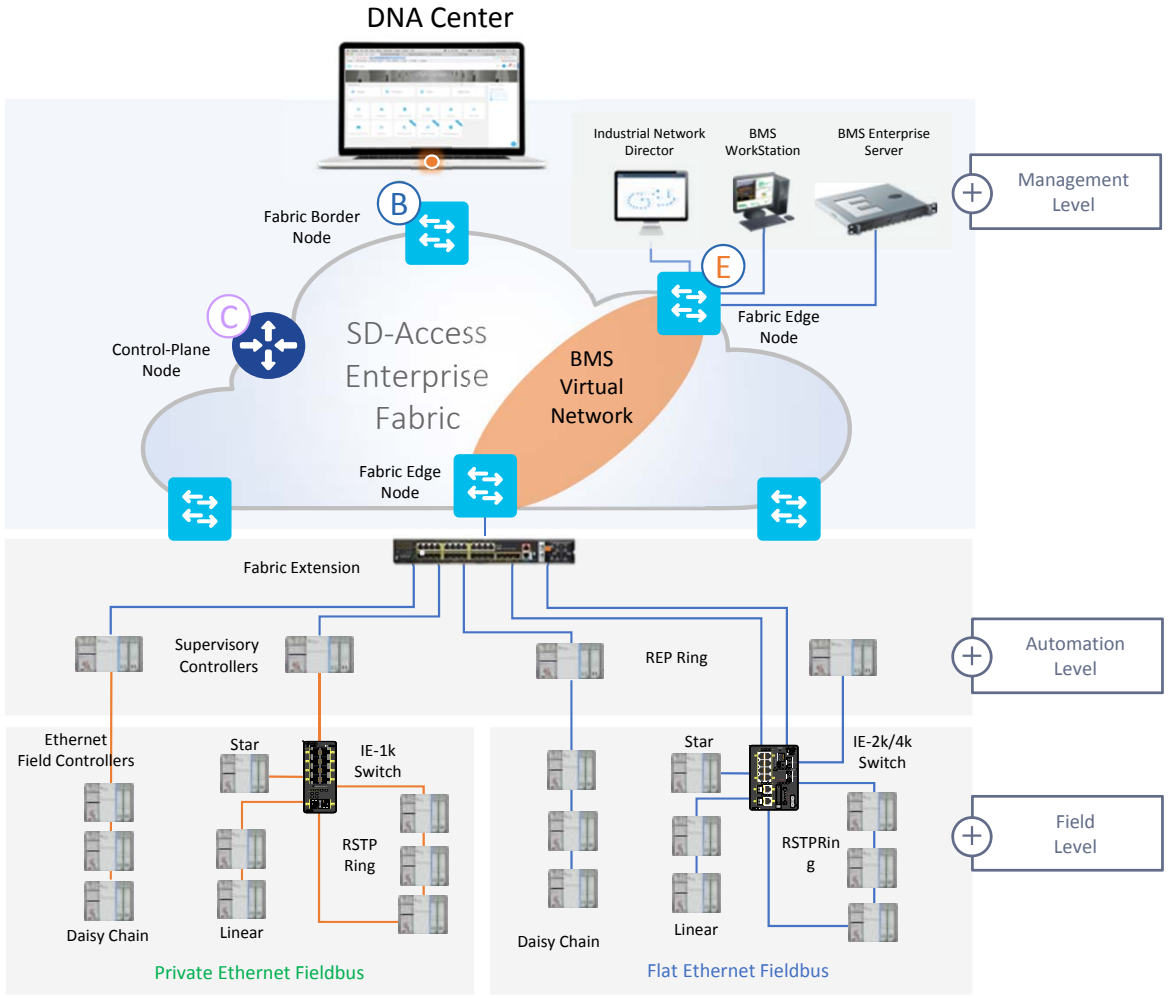
**2 / Efficient**

Converged infrastructure for IT & BMS applications

BMS network is a SD-Access extension over the enterprise fabric

**3 / Intelligent**

Analytics combined with automation reduces time spent on troubleshooting



# Identification/Security

# IoT Device Business Challenges

## Device Visibility

Do you know devices well enough to differentiate service?

## Intent-based Policy

Does customer knows behavior of devices to build their policy?

## Standard based

Is there any industry standard way of connecting IoT devices to enterprise network?

# Questions that need answering

**What is this thing?**

**Who is responsible for it?**

**What access does it need?**

**Is it doing what it should be doing?**

Standards Technology
- IEEE 802.11i, IEEE 802.1X, IEEE 802.1AR, EAP, ANIMA BRSKI

Products
- Industrial Network Director®, Identity Services Engine(ISE)®, DNA Center®, Switches and APs

Products
- ISE and DNA Center

Standards Technology
- **Manufacturer Usage Descriptions (MUD)**

Products
- ISE, DNA Center, the Industrial Security Appliance® (ISA), Switches and Access Points

Standards
- **MUD**, SNORT, DNS

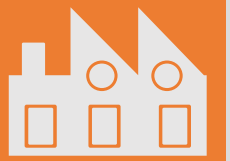
Products
- StealthWatch®, ISA, OpenDNS Umbrella®

# Benefits

**Customer**

- Reduces threat surface of exploding number of devices
- Almost no additional CAPEX
- Standard approach to determining manufacturer intent
- Eases and scales access management decisions

**Manufacturer**



- Reduces manufacturer product risk at almost no cost
- Will increase customer satisfaction and reduce support costs
- Avoids the front page
- Standards-based approach

# Codes and Standards

# ASHRAE 90.1 (Similar to IEC)

This standard provides the minimum requirements for energy-efficient design of most buildings, except low-rise residential buildings. It offers, in detail, the minimum energy-efficient requirements for design and construction of new buildings and their systems, new portions of buildings and their systems, and new systems and equipment in existing buildings, as well as criteria for determining compliance with these requirements. It is an indispensable reference for engineers and other professionals involved in design of buildings and building systems.

**Recent Changes:**

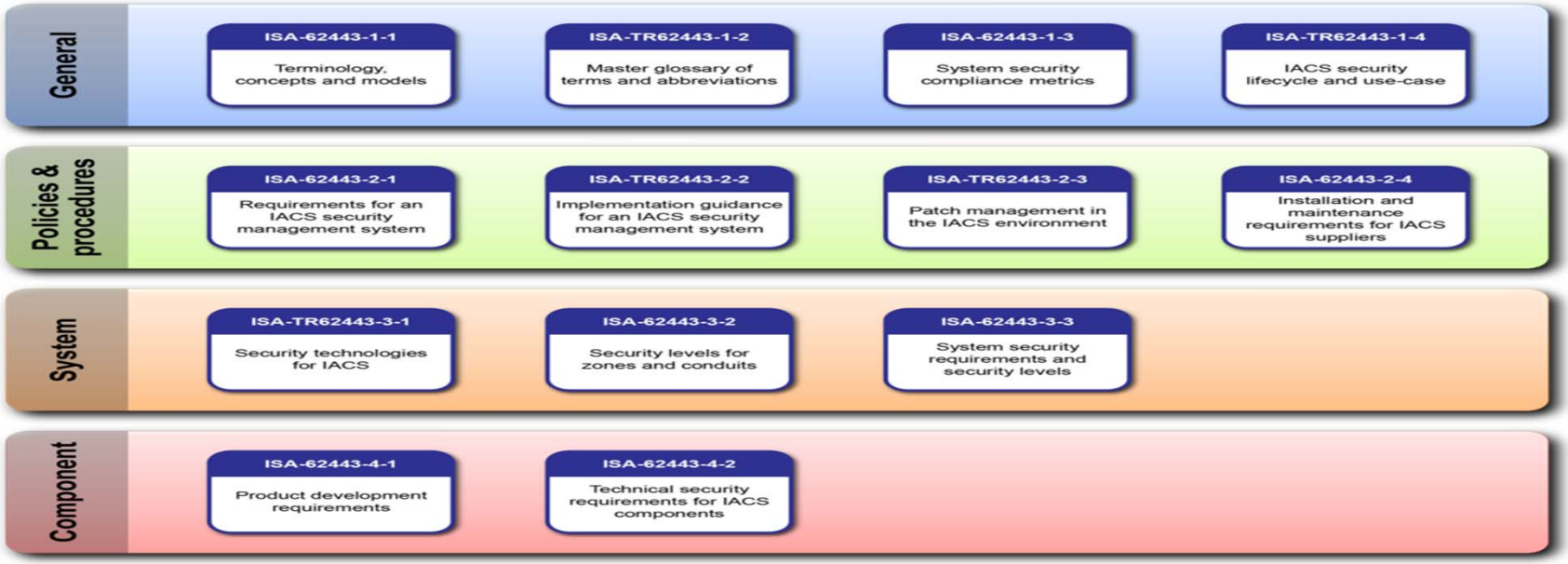
**Building Envelope**
Envelope verification in support of reduced air infiltration and increased requirements for air leakage of overhead coiling doors.
Increased stringency requirements for metal building roofs and walls, fenestration, and opaque doors.
Improved clarity on defining exterior walls, building orientation, fault assumptions for the effective R-value of air spaces, and calculation procedures for insulating metal building walls.

**Lighting**
Modified requirements for exterior and interior lighting power densities to reflect new lighting levels in the IES Lighting Handbook.
Modified requirements for lighting control to add additional controls in some space types and options to others to allow easier application of advanced controls.

**Mechanical**
Large, electrically driven chilled-water plants are now required to be monitored for electric energy use and efficiency.
Dedicated outdoor air systems now include both efficiency and rating requirements for compliance.
Requirements are introduced for designs to include both use category and efficiency class.
Requirement that air-cooled DX cooling units with economizers have a monitoring system to determine that the air economizer is working properly.

# ANSI/ISA-62443 (Formerly ISA-99)

ISA/IEC-62443 is a series of standards, technical reports, and related information that define procedures for implementing electronically secure Industrial Automation and Control Systems (IACS). This guidance applies to end-users (i.e. asset owner), system integrators, security practitioners, and control systems manufacturers responsible for manufacturing, designing, implementing, or managing industrial automation and control systems.



# Deployment Example

# Marriott Sinclair Hotel (Autograph Collection)

## Project Overview

- 1920's Art Deco Building in the heart of downtown Fort Worth
  - Roof Top Bar
  - Restaurant
  - High-end Spa
- Designated in the National Register of Historic Places
  - Need for minimally invasive renovations to preserve historic value
- Technology drives Customer Satisfaction and Repeat Business
  - High Speed Internet, Room Automation, Scene Control
- Low Voltage Lowers Construction Costs

| Expense Category | AC Infrastructure | DC Infrastructure | |
|---|---|---|---|
| Electrical | $2,000,000 | $1,200,000 | See Note 4 |
| Network | | $160,000 | |
| Cabling | $16,000 | $20,000 | |
| VoltServer | | $150,000 | |
| Total | $2,016,000 | $1,530,000 | |
| **Savings** | | **$486,000** | **25.00%** |

  - Faster Installation
- IP Enables Systems Integration and Better Management
  - Greater Energy Efficiency
  - Granular Controls
  - Enables Guest Room Automation
  - Increased Property Management Capabilities
  - Provides a Sustainable Message

Customer Profile Video:
https://www.youtube.com/watch?v=uomF2xznbB8

Future Marriott Sinclair Hotel, Fort Worth, TX

**Notes:**

1) Inclusive of Labor and Materials for the infrastructure.
2) Infrastructure Powers: Lighting, Motorized Blinds/Curtains, MiniBar, TV embedded Bathroom Mirror, Door Locks, Shower Valve
3) Device Costs (AC/POE comparable)
4) DC Infrastructure Electrical Costs include backup AC Outlet for Minibar and Bathroom Mirror in case that POE versions are not ready in construction timeline. **An additional $200,000 savings (*yielding 35% Savings over AC Infrastructure*) would be had if these electrical circuits were not installed.**
5) Building Electrical service changed from 4000A service to 2500A service.

CompuCom Digital Campus  Charlotte, NC

# Leveraging Technology and Innovation to Drive Collaboration, Productivity and Operational Efficiency

## Challenge

- Enable a vison of the modern workplace
- Meet construction deadlines
- Incubate and advance digital workplace technologies and services

## Solution Implemented

- Cisco's Digital Building Switches
- PoE Lighting
- Ethernet Building Field Controllers
- Extensive Cisco Collaboration, Networking, Wireless
- PoE Access Control and Physical Security

## Results

- Tree's to keys in under 12 months
- Reduced Labor by two-thirds saving $275,000
- 16% less expensive overall per square foot than previous project

https://www.compucom.com/news/compucom-unveils-new-digital-campus-headquarters

# Summary

# Digital Transformation must be part of your Building and Cities Strategy

- Buildings  and Cities are changing
  - IT and OT teams need to work together
  - Buildings and Cities are become digital
- Digital Transformation is essential in the Communities of the Future
- The Smart Infrastructure will be play a major role
- Talk to new people!!
- Build an Ark, Change the world!!


CISCO

# Cabling for Remote Powering

**Carol Everett Oliver, RCDD, ESS**

Network Cabling Specialist

# Agenda

- Remote Powering
- Impact on Cabling
- Intelligent Buildings &  Standards
- Converged Cabling Designs

# 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**

# Quiz Question #1

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

A: 15, 30, 60, 90

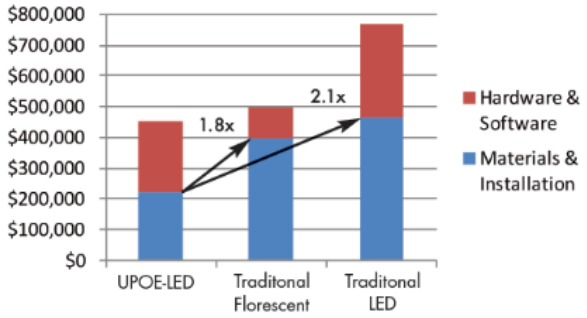
# Existing IEEE PoE Applications

| | 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[1] (Type 3) | 60.0 W | 4-pairs | 600 mA |
| 4-pair PoE[1] (Type 4) | 90.0 W | 4-pairs | 960 mA |
| Power over HDBase-T (POH) | 100.0 W | 4-pairs | 960 mA |

[1] *Under development via IEEE 802.3bt*

# PoE Lighting: Unleashing Cost and Integration

- Delivers significantly lower capital and labor investment
- LED lights consume half the energy of fluorescents and last 5X longer
- Earth and tenant friendly with less emissions and no hazardous mercury
- Integrates with other IoT applications and can receive centralized IT back up power




Upfront Cost Comparison for a 35,000ft$^2$ building in New York City

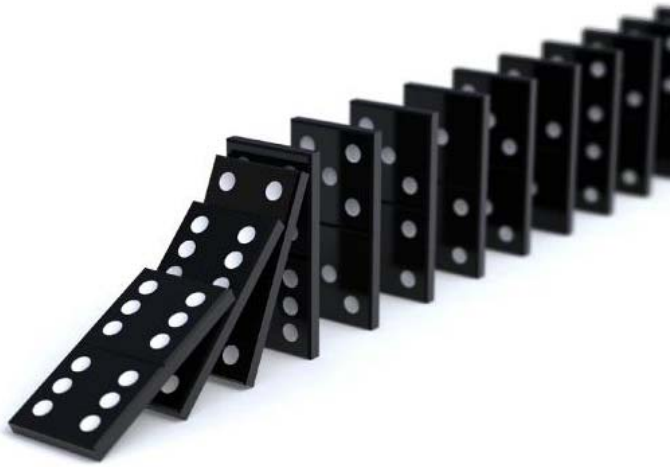
# PoE Lighting: Unleashing Cost and Integration

- Centralized control
- Occupancy sensors
- $CO_2$ sensors
- Humidity sensors
- Daylight harvesting
- Energy consumption
- LiFi network connectivity
- Intelligence to adapt to patterns and preferences
- Color coding and flashing patterns for security and/or threat level notification

# Agenda

- Remote Powering
- **Impact on Cabling**
- Intelligent Buildings & Standards
- Converged Cabling Designs

# Implications of Remote Powering



- Heat builds-up within cable bundles
- Bundle sizes may need to be reduced to improve heat dissipation
- Overall channel length may need to be reduced to offset increased insertion loss resulting from a higher operating temperature
- Contact arcing occurs when un-mating pairs under load and may affect connecting hardware reliability

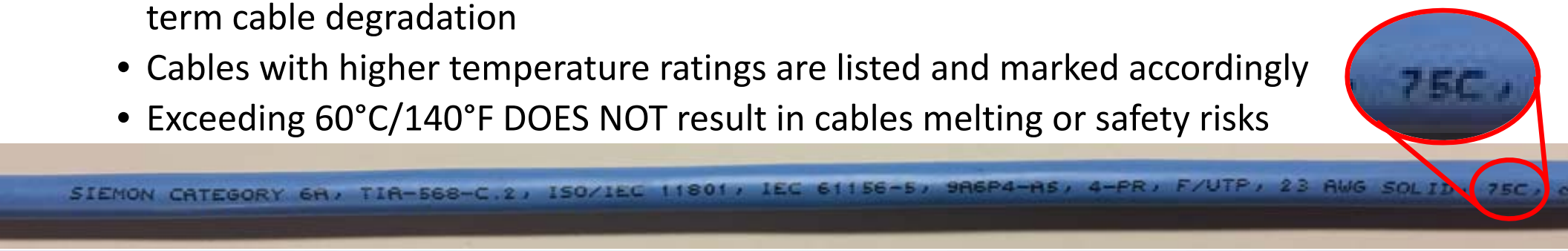
# Quiz Question #2

What is the TIA specified operating temperature range for cabling?

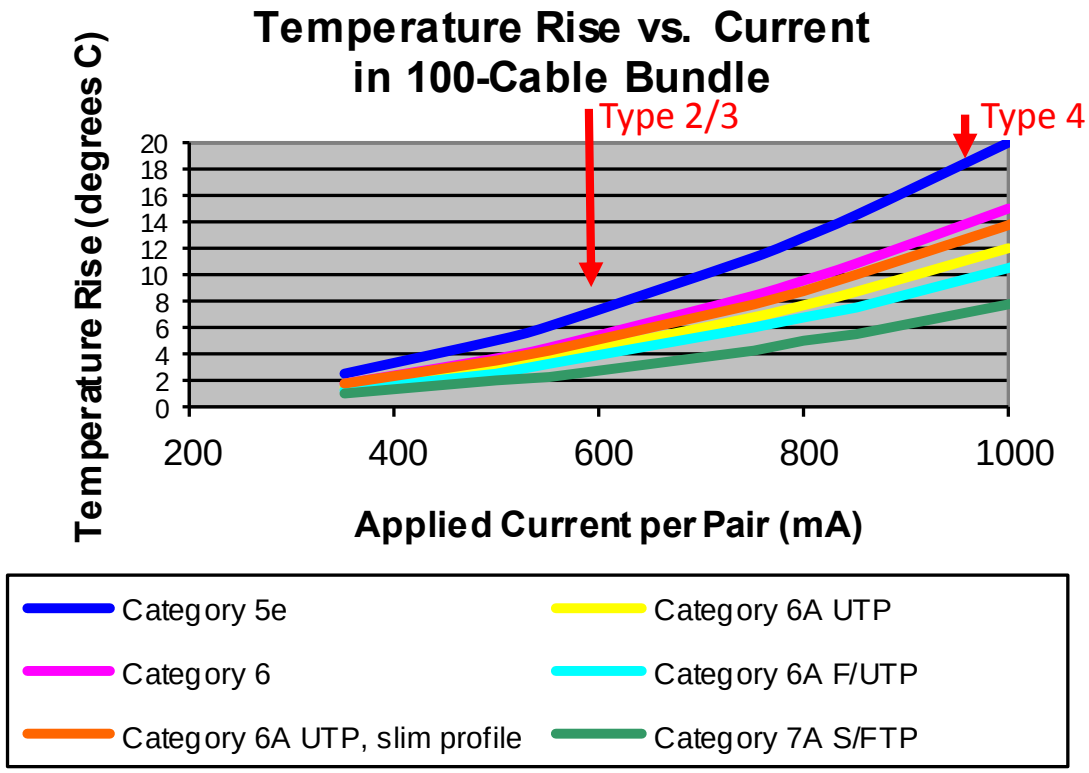
A: -20°C to 60°C (-4°F to 140°F)

# Temperature Rise Considerations

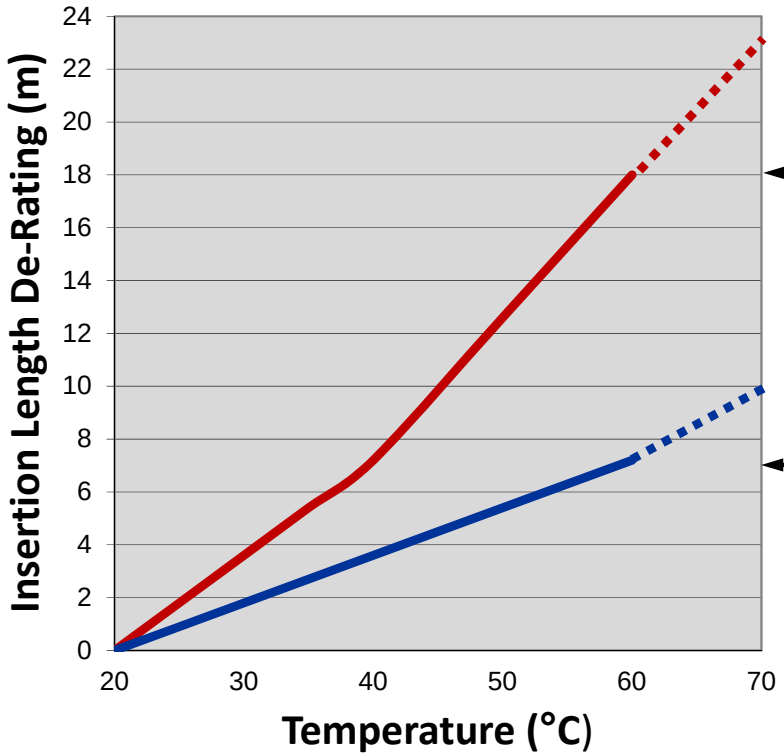

- Remote powering can cause heat build-up within cable bundles
- Cabling insertion loss increases at temperatures above 20°C/68°F
- The temperature of any cable should not exceed the temperature rating for the cable
  - Generally, cables used in commercial premises have a temperature rating of 60°C
  - Exceeding a cable's specified operating temperature may result in long term cable degradation
  - Cables with higher temperature ratings are listed and marked accordingly
  - Exceeding 60°C/140°F DOES NOT result in cables melting or safety risks



# PoE Cable Temperature Rise



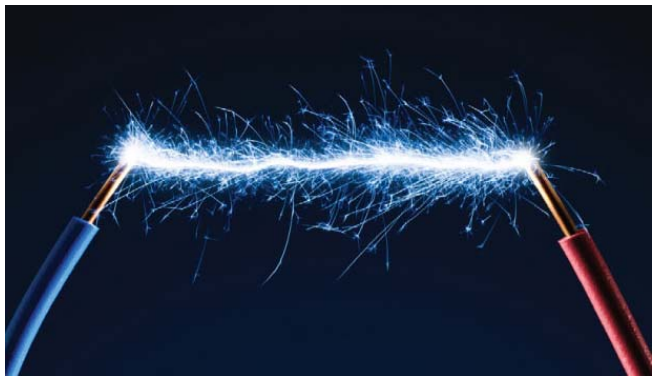
# Channel Length De-Rating




**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

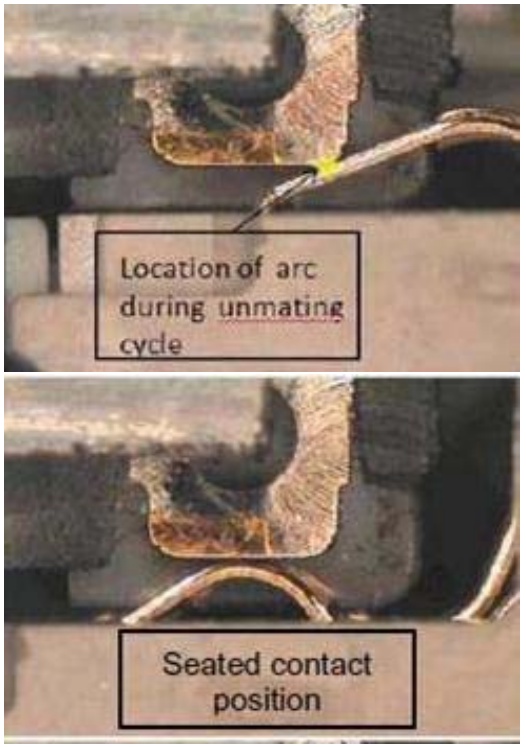
# Potential for Arcing Under Load Conditions



- 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

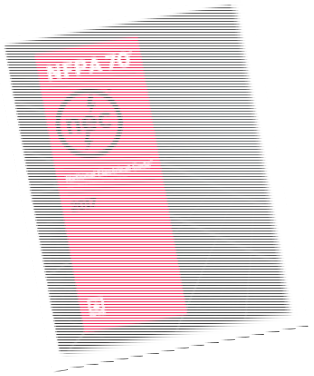
- Informative Annex B of TSB-184-A contains the following guidance:
  - Connecting hardware having the required performance for mating and un-mating under the relevant levels of electrical power and load should be chosen
  - IEC 60512-99-001 is referenced as a suitable test schedule



# Standards Resources

- 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 each conductor

| 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

| 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 |

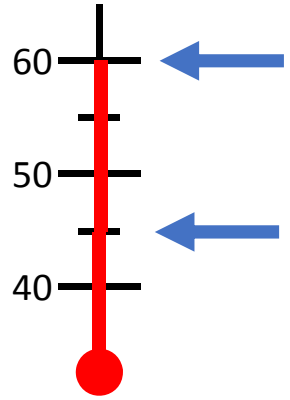
# Alternatives

1. Use cables with a larger conductor or higher mechanical rating
2. 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
  - The maximum ambient temperature along the link (length of at least 1m) should be used as the basis for the calculation

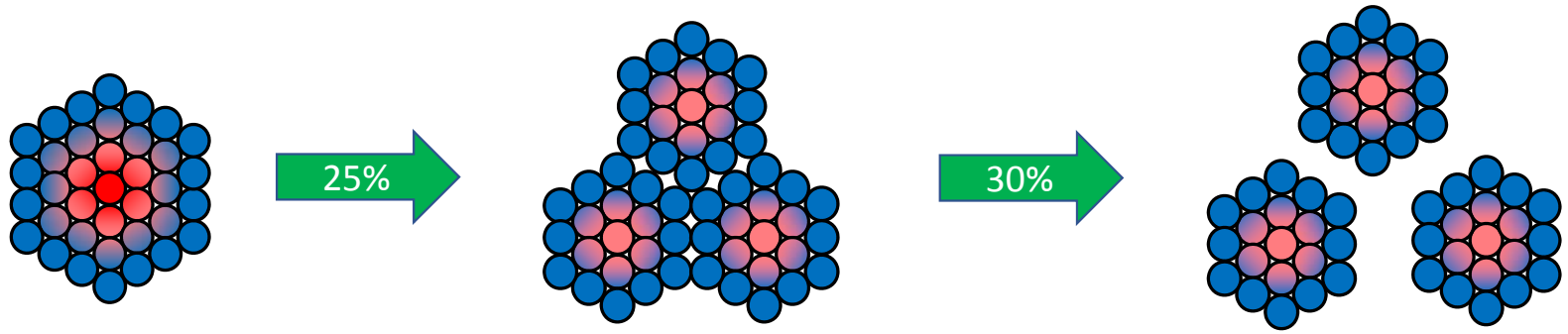


# Mitigation Recommendations

- Use Category 6A or higher-performing 4-pair balanced twisted-pair cabling
- Install shielded cables
- Reduce channel length, as necessary, to offset increased insertion loss
- Minimize cable lengths in order to reduce dc loop resistance

# Mitigation Recommendations

- Leave cables unbundled
  - If bundling, smaller bundles are recommended




  - Limit the number of cables per bundle to 24

# Cable Bundle Recommendations

- When in doubt about cable mechanical or heat dissipation capability, installation environment, or remote powering application, a conservative practice is to limit maximum bundle size to 24 cables

| 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 |

# Mitigation Recommendations

- 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

# TIA-569-D-2-2018

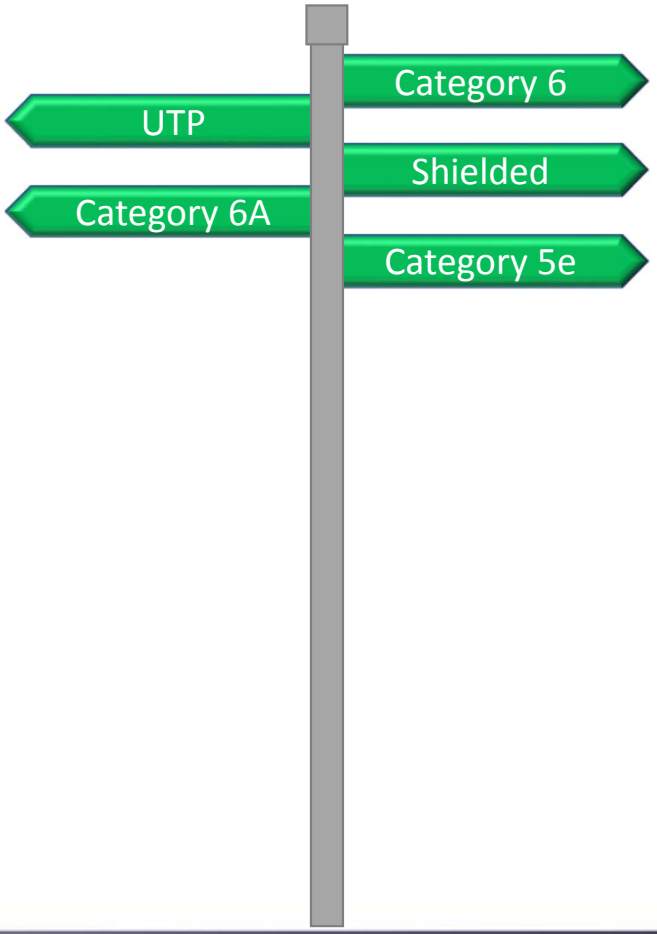
- *Additional Pathway and Space Considerations for Supporting Remote Powering Over Balanced Twisted-Pair Cabling* (July 2018)
- Pathways differ in regard to geometry and contact area between cables, pathway, and air
- Provides general guidance on heat dissipation of various pathways by bundle size

| 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 |

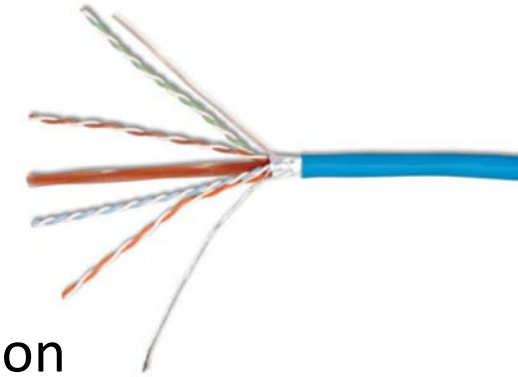
| Tray Type | Fill Depth (in.) | | |
|---|---|---|---|
| | 1 | 2 | ≥ 3 |
| Wire Mesh/Ladder | High | High | High |
| Ventilated | High | Medium | Low |
| Unventilated | Medium | Medium | Low |

# Media Selection

- 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



# Benefits of Shielded Cabling



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

# Agenda

- Remote Powering
- Impact on Cabling
- **Intelligent Buildings & Standards**
- Converged Cabling Designs

# Planning for Intelligent Buildings

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

# Quiz Question #3

What is the TIA standard for the Structured Cabling Infrastructure Standard for Intelligent Building Systems?

A: ANSI/TIA-862-B-2016

# Quiz Question #4

What is the BICSI standard for the Information Communication Technology Design and Implementation Practices for Intelligent Buildings and Premises?

A: BICSI 007-2017

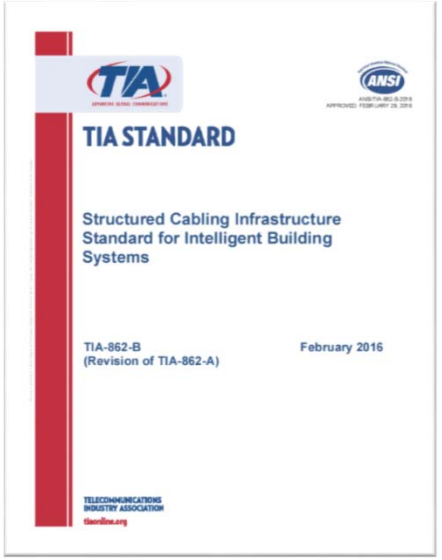
# Meeting Applicable Codes & Standards

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

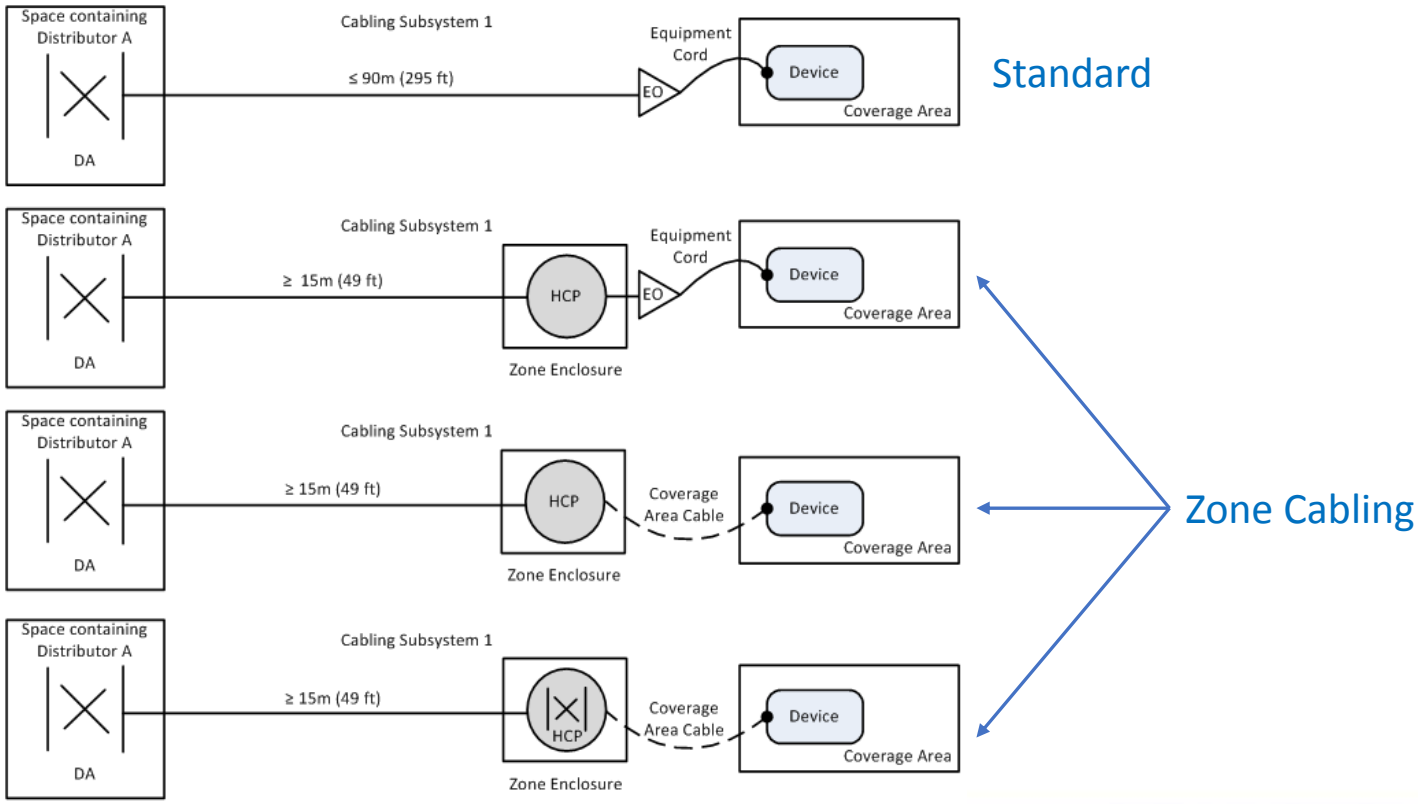
- BICSI 007-2017, “Information Communication Technology Design and Implementation Practices for Intelligent Buildings and Premises”

# 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



# Topology Options



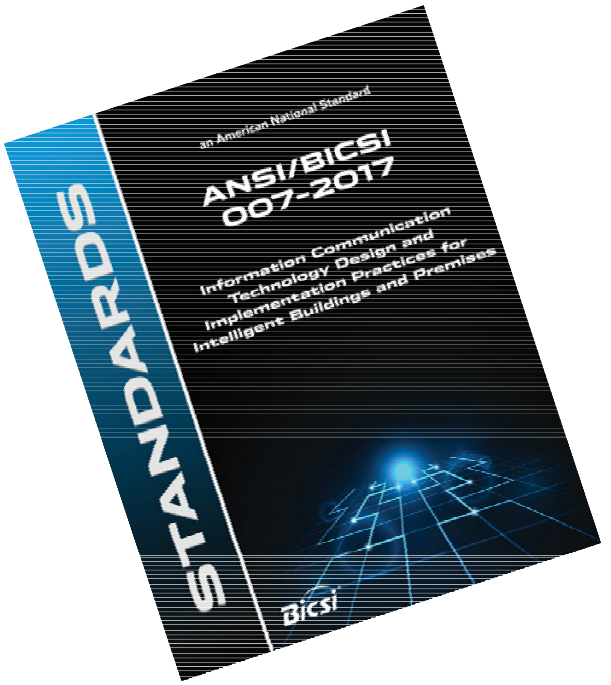
# Terminology

| Location/Device | TIA Standard | Terminology |
|---|---|---|
| Intermediate connection location in a zone cabling topology supporting a voice/data device | ANSI/TIA-568-0.D | Consolidation Point (CP) |
| Outlet connecting to a voice/data device | ANSI/TIA-568-0.D | Telecommunications Outlet (TO)[1] |
| Intermediate connection location in a zone cabling topology supporting a building device | ANSI/TIA-862-B | Horizontal Consolidation Point (HCP) |
| Outlet connecting to a building device | ANSI/TIA-862-B | Equipment Outlet (EO)[2] |

[1] *A TO must always be present even if a CP is present*
[2] *An EO is optional if an HCP is present*

# 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



# Agenda

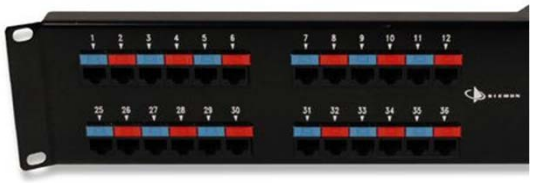
- Remote Powering
- Impact on Cabling
- Intelligent Buildings
- **Converged Cabling Designs**

# 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

# What is Zone Cabling?

**(H)CP Housed in a Zone Enclosure**

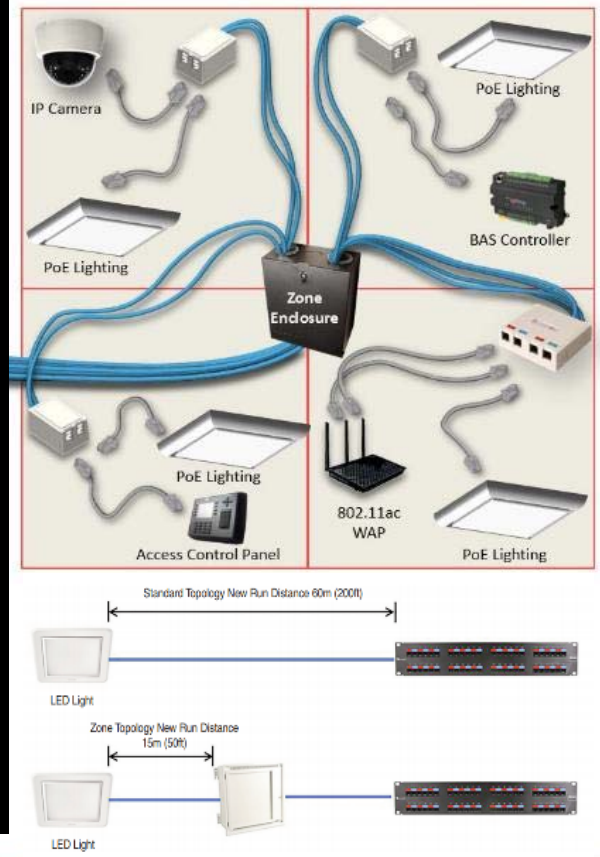


**Patch Panel in a TR**

**Device Outlet**

# 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



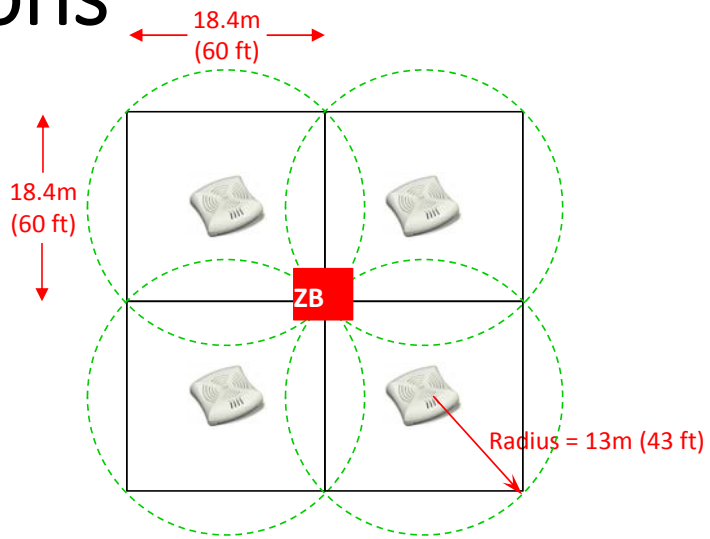

- 25% spare port availability recommended for best ROI
- Supports rapid reorganization and deployment of new devices and applications
- MAC work costs less, is faster and less disruptive
- Factory pre-terminated and tested trunking cables can be installed from the TR to the zone enclosure for quicker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

# Zone Cabling Considerations

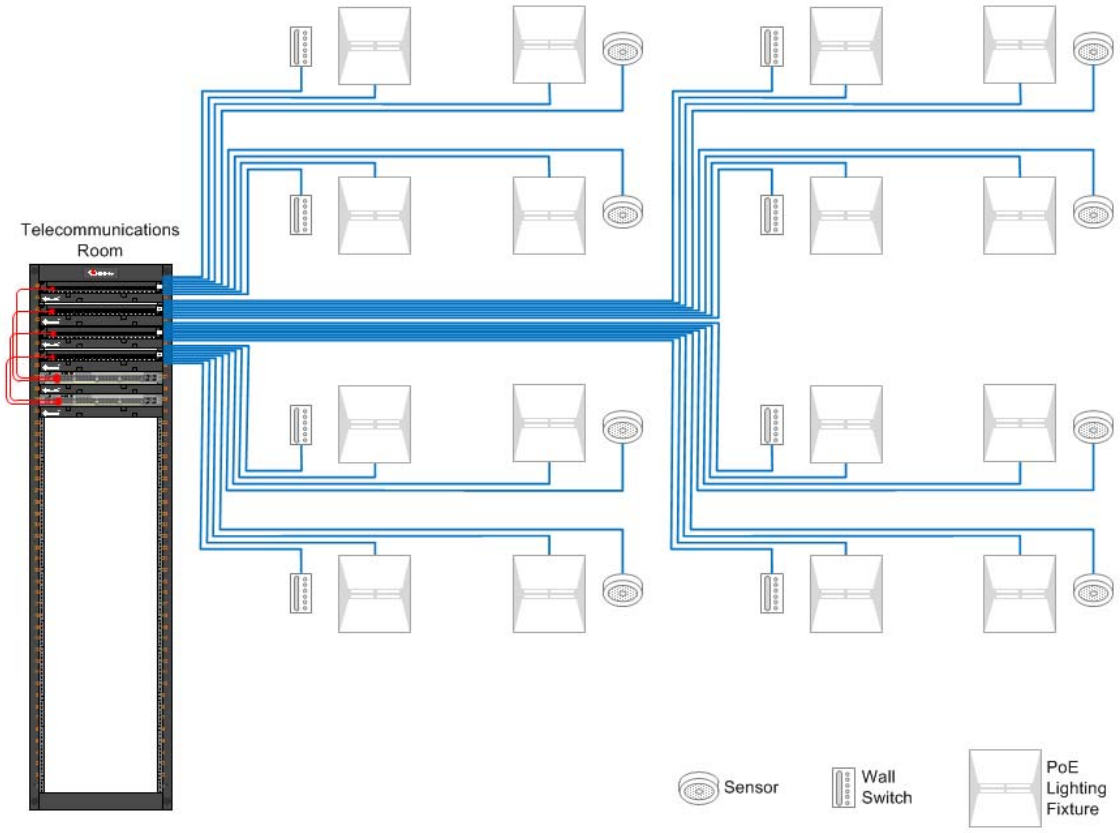
- A coverage area radius of 13m is generally recommended as an optimum size to accommodate most converged cabling networks

- Number of connections within the zone enclosure should not exceed 96

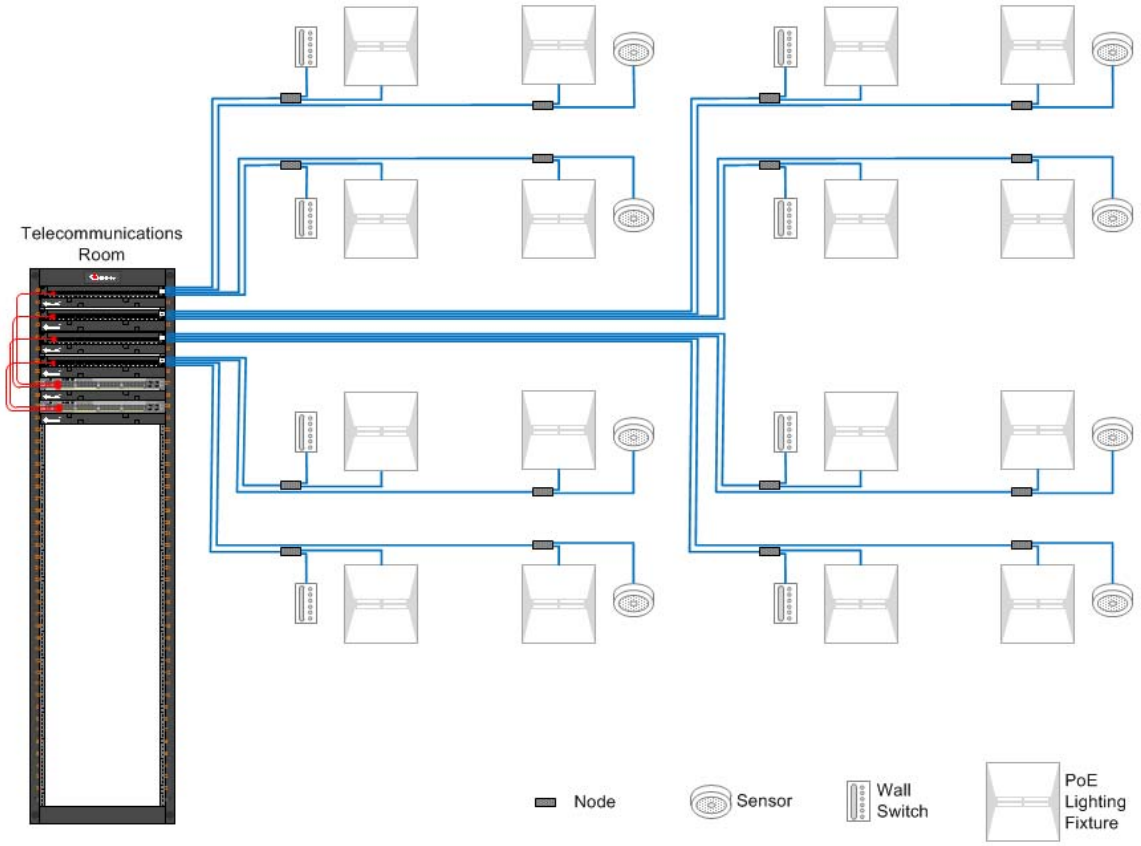
- Need to factor in future expansion



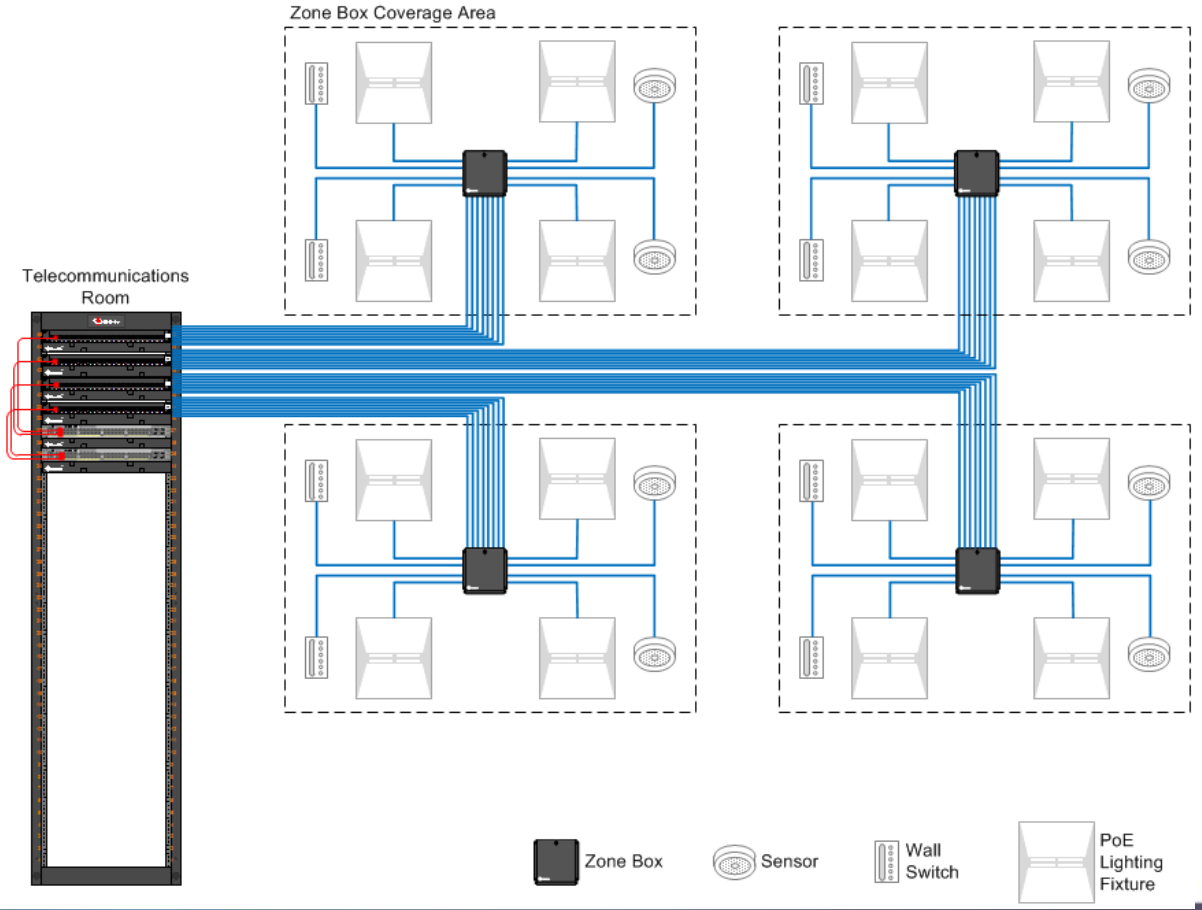
# Centralized – Fixture Centric



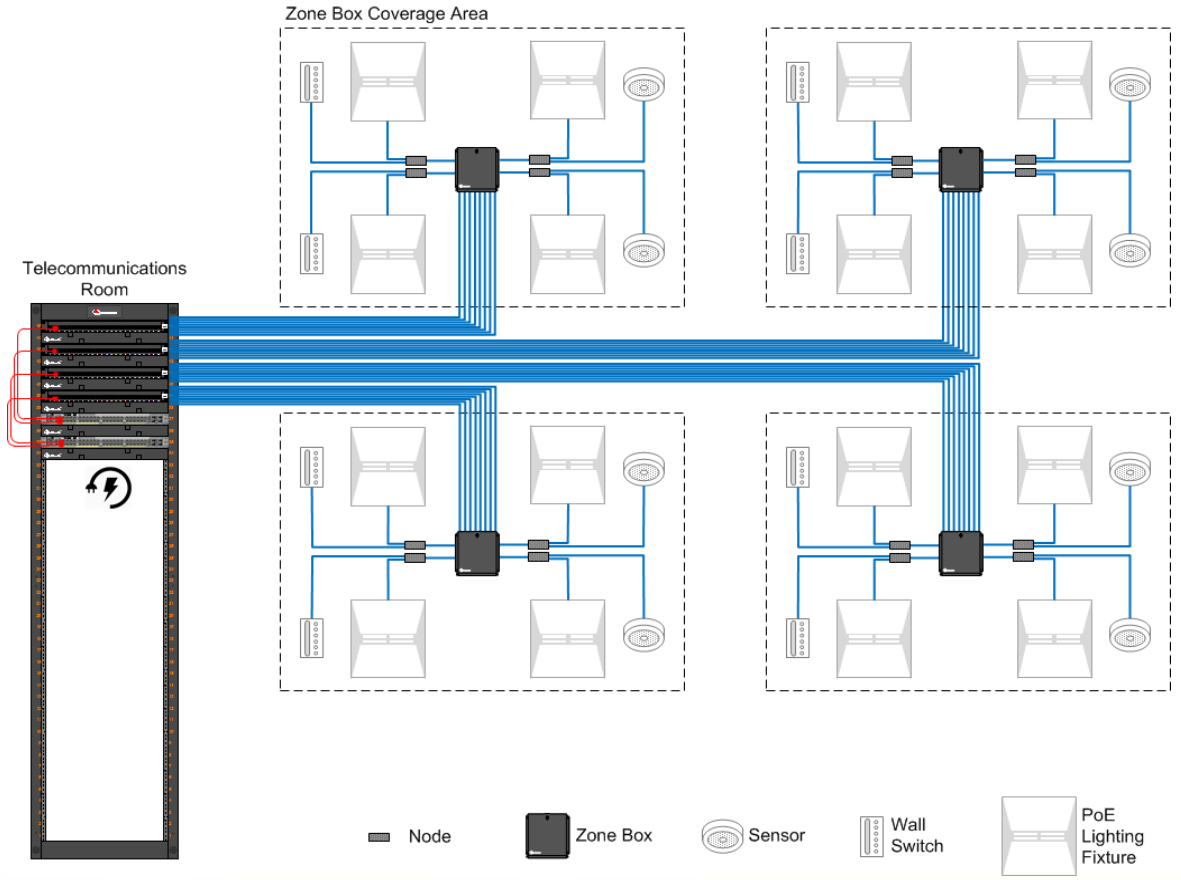
# Centralized – Node Centric



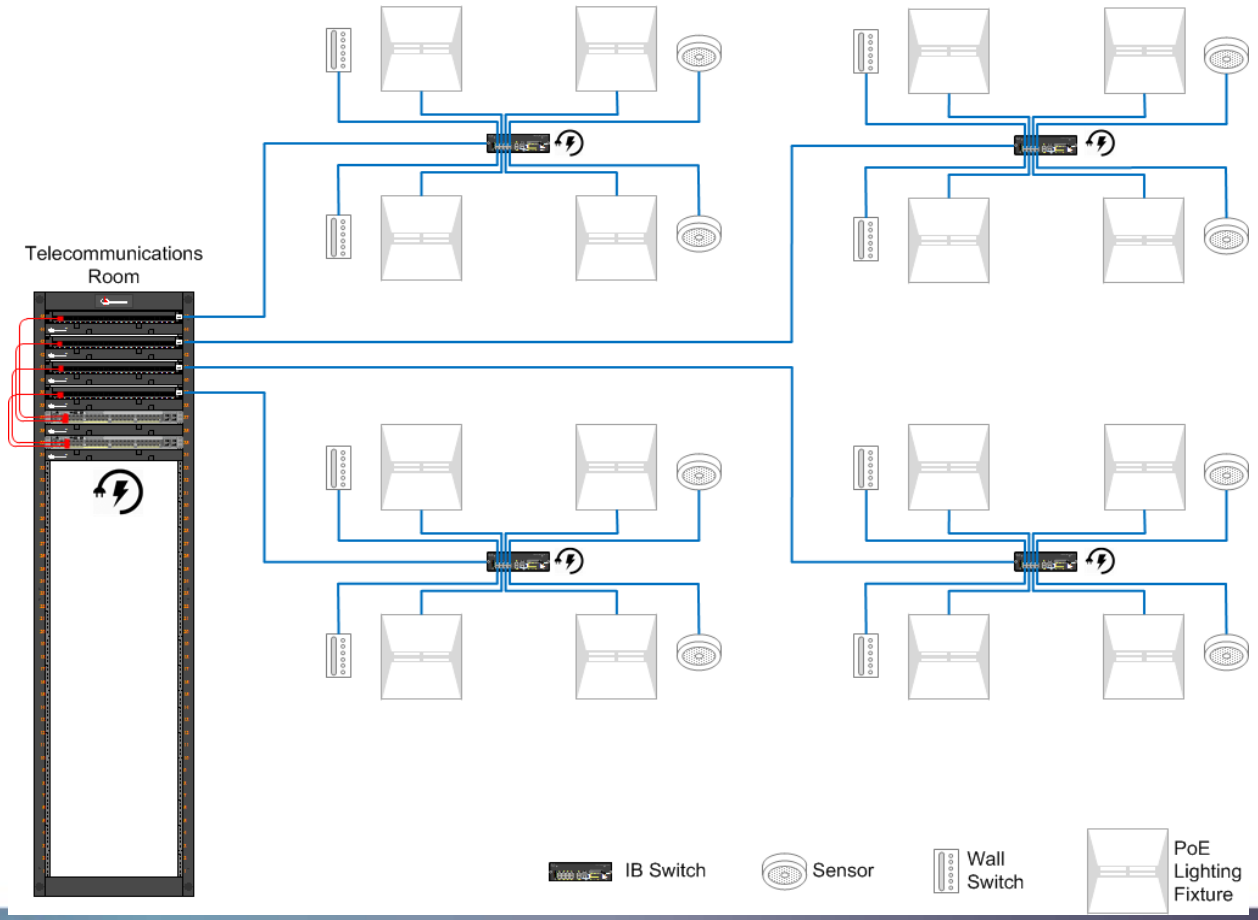
# Centralized Zone - Fixture Centric



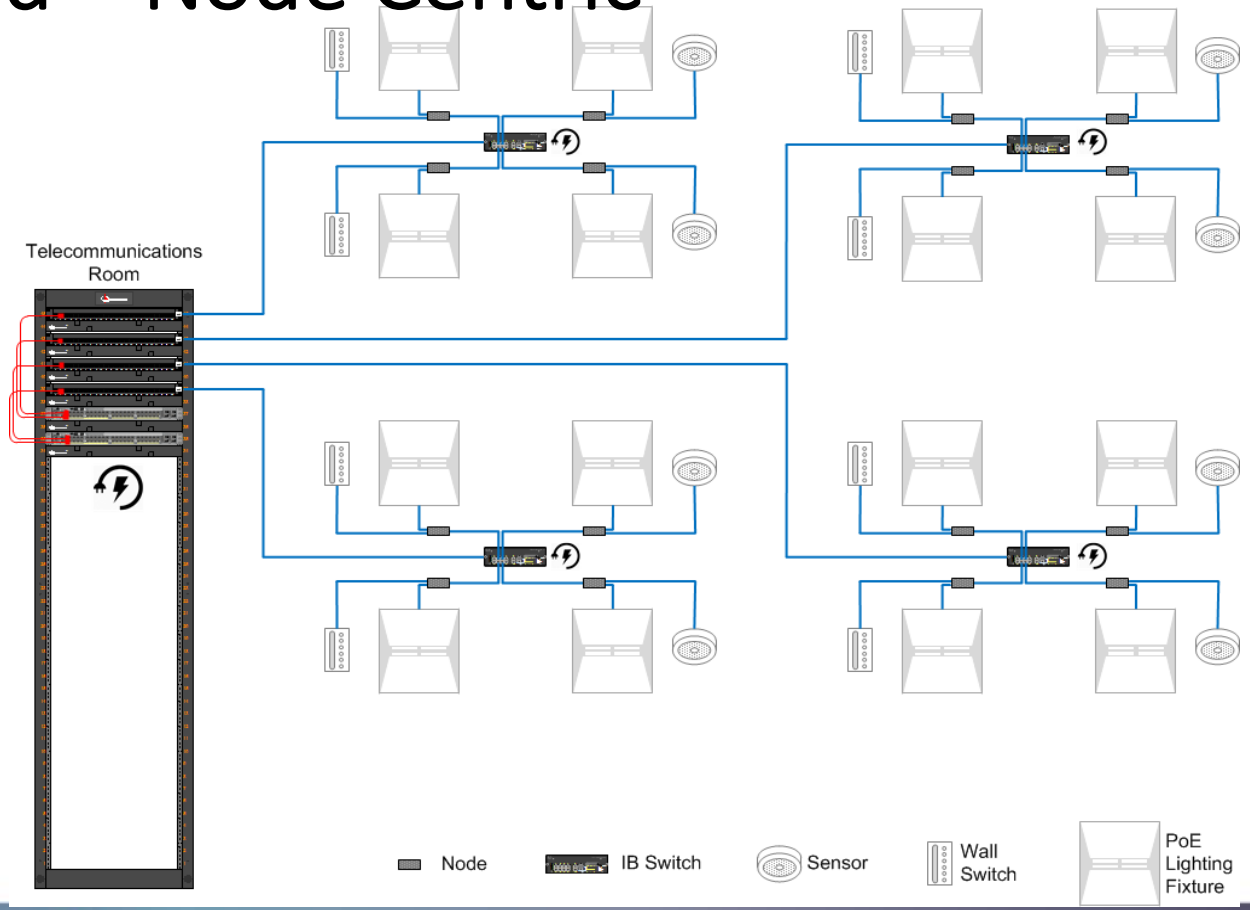
# Centralized Zone – Node Centric



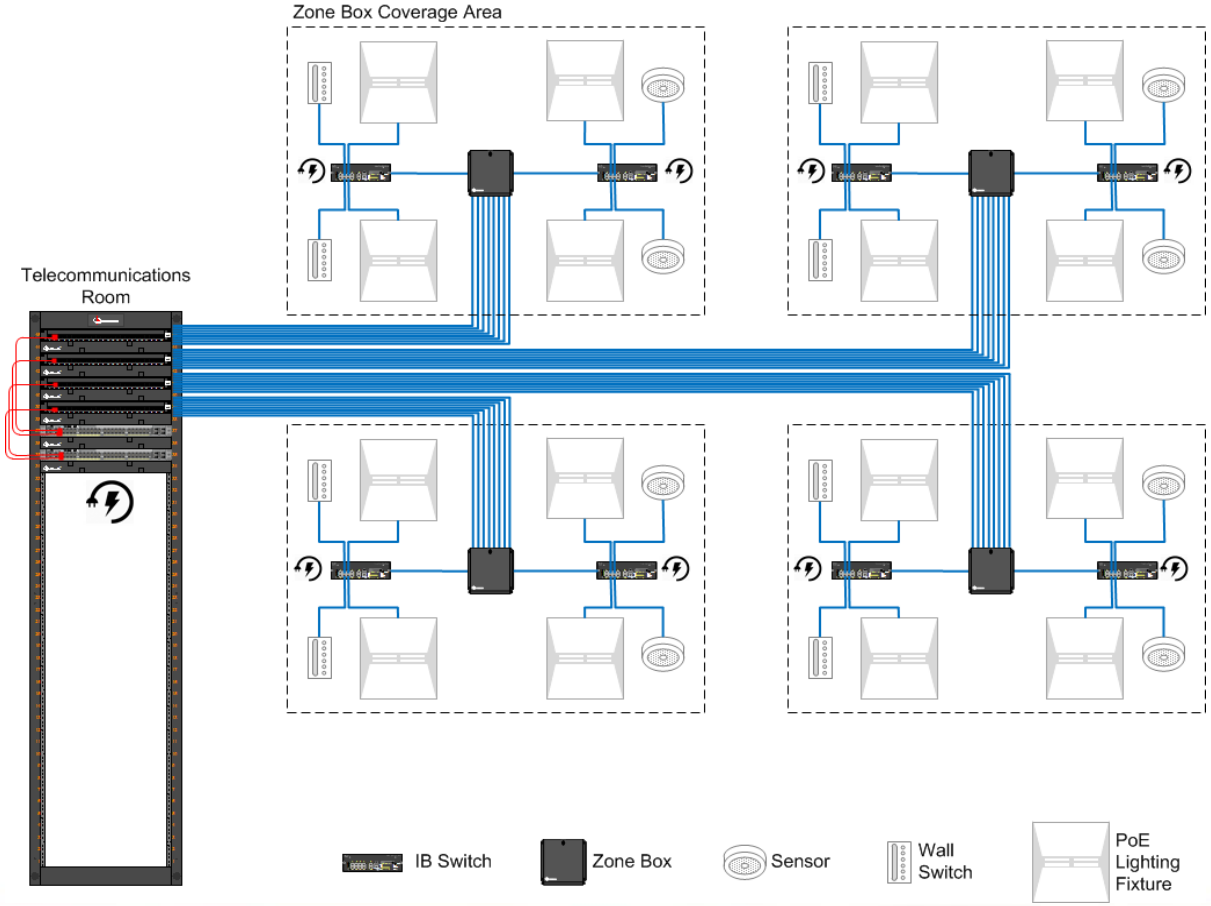
# Decentralized – Fixture Centric



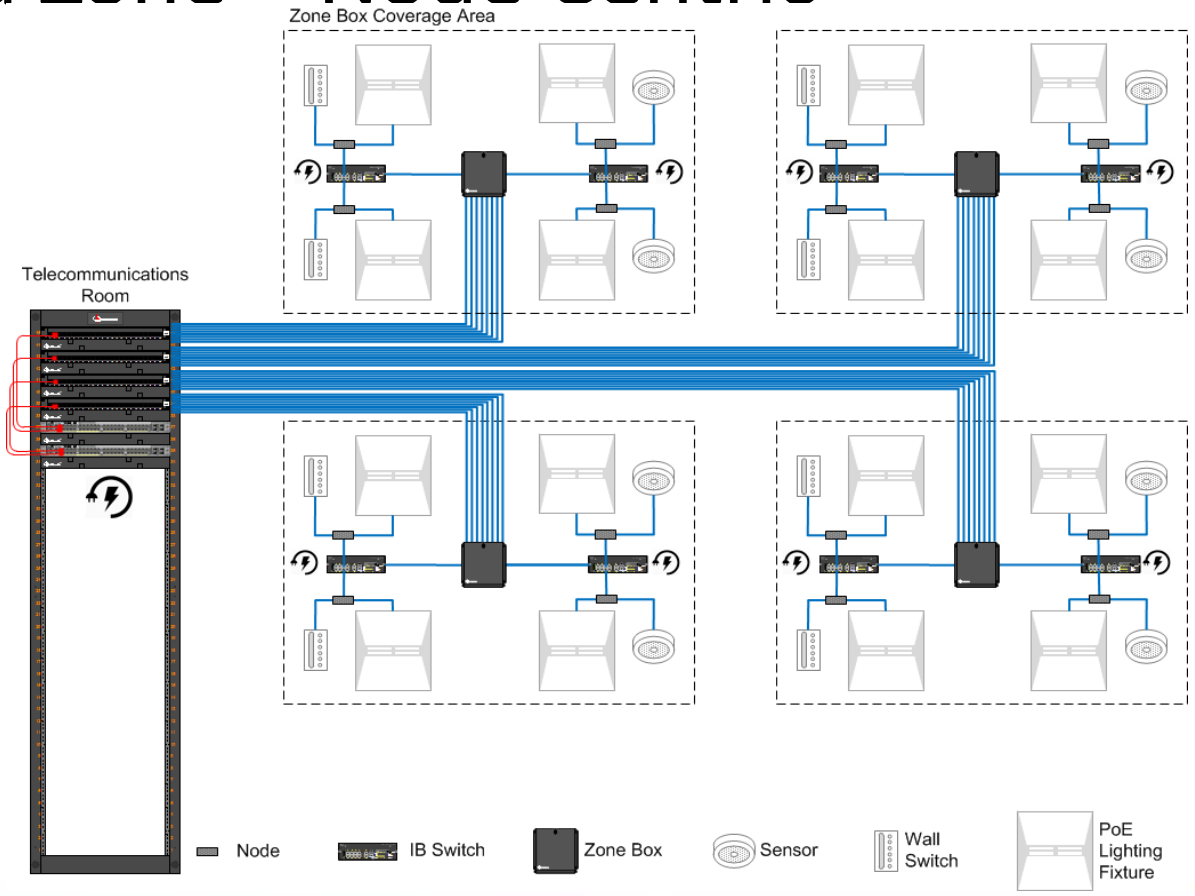
# Decentralized – Node Centric



# Decentralized Zone – Fixture Centric



# Decentralized Zone – Node Centric



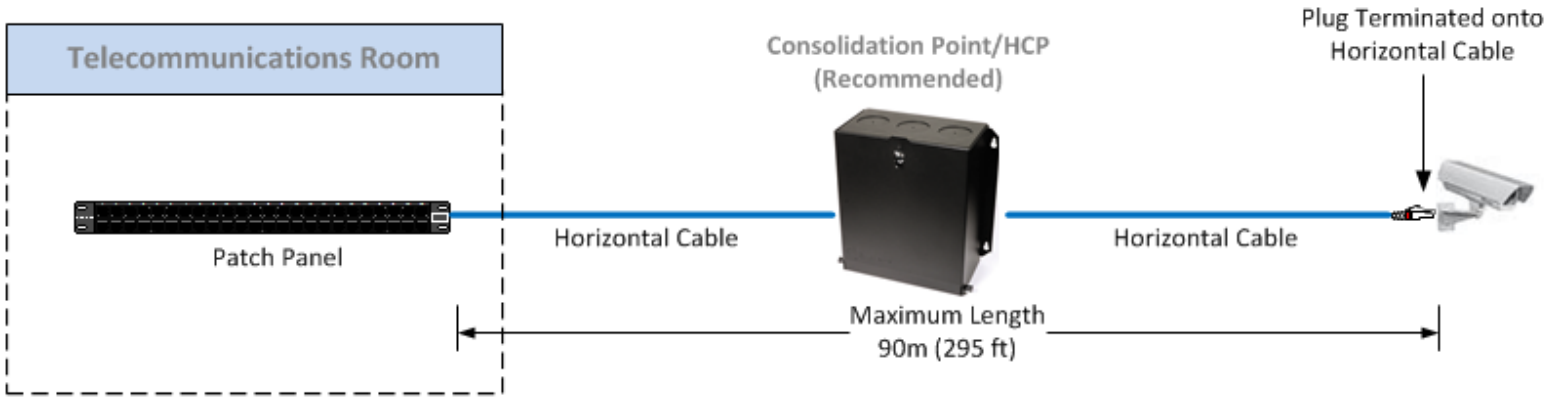
# Quiz Question #5

What is an MPTL?

A: Modular Plug Terminated Link

# 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?

*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.*

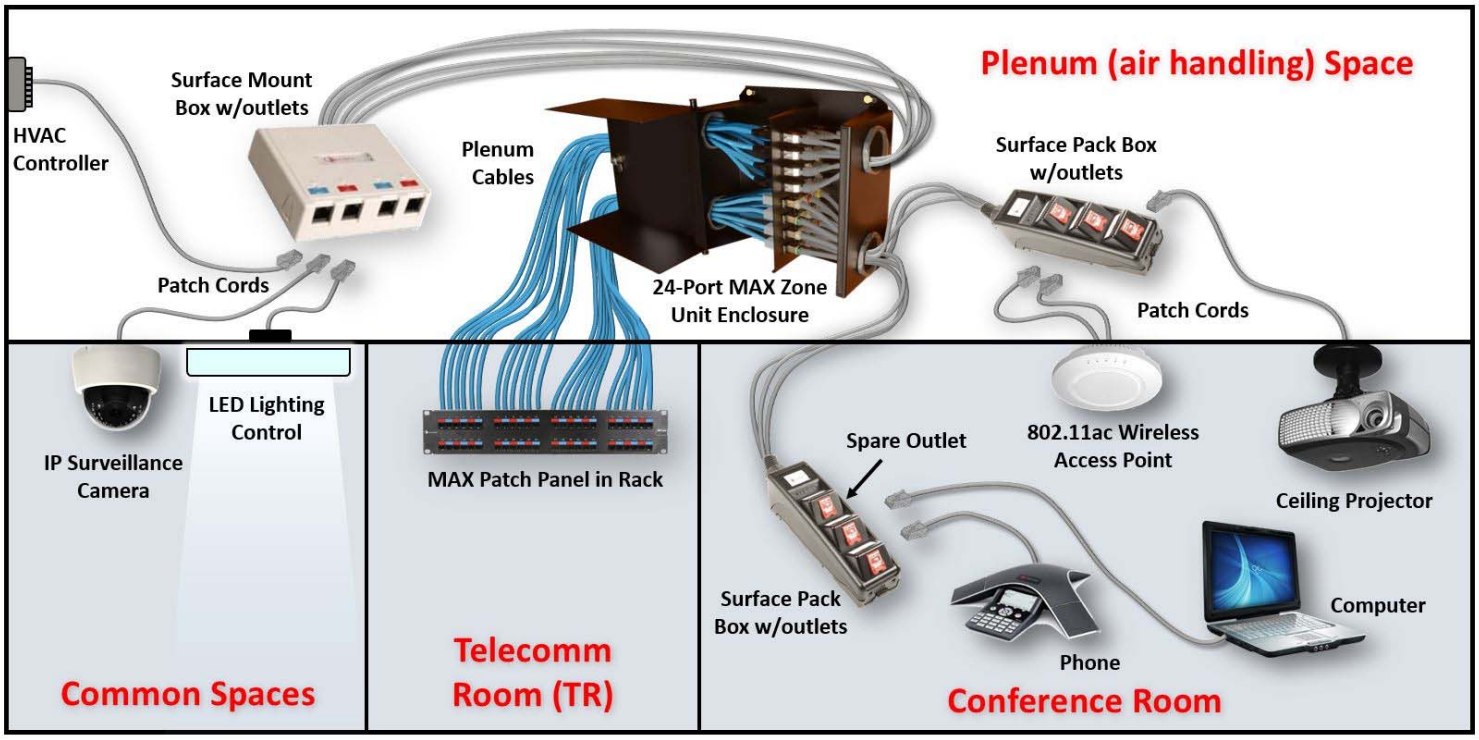
- Custom length, quick connections in the field for direction connection to devices
  - Ideal for a zone cabling design methodology
  - Can be plugged into the zone enclosure on one end and terminated to outlets on the other end for computers, phones, etc.
  - Simplifies project bill of materials and eliminates the need for predetermined patch cord lengths
- 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

# Quiz Question #4

What type of rating must a product have to be installed within a plenum environment?

A: A plenum rating!

# Plenum Products



# Summary


- Increasing numbers of IB applications will run over a low voltage RJ 45 platform
- Remote powering places increased demands on network cabling systems
- Zone cabling provides a flexible infrastructure
- Modular plug terminations have a role

# Thank You

Carol Everett Oliver, RCDD, ESS
Network Cabling Specialist
Siemon Company
Carol_oliver@Siemon.com

# Testing for Four Pair PoE

Mark Mullins

mark.mullins@flukenetworks.com

FLUKE networks

Booth 215

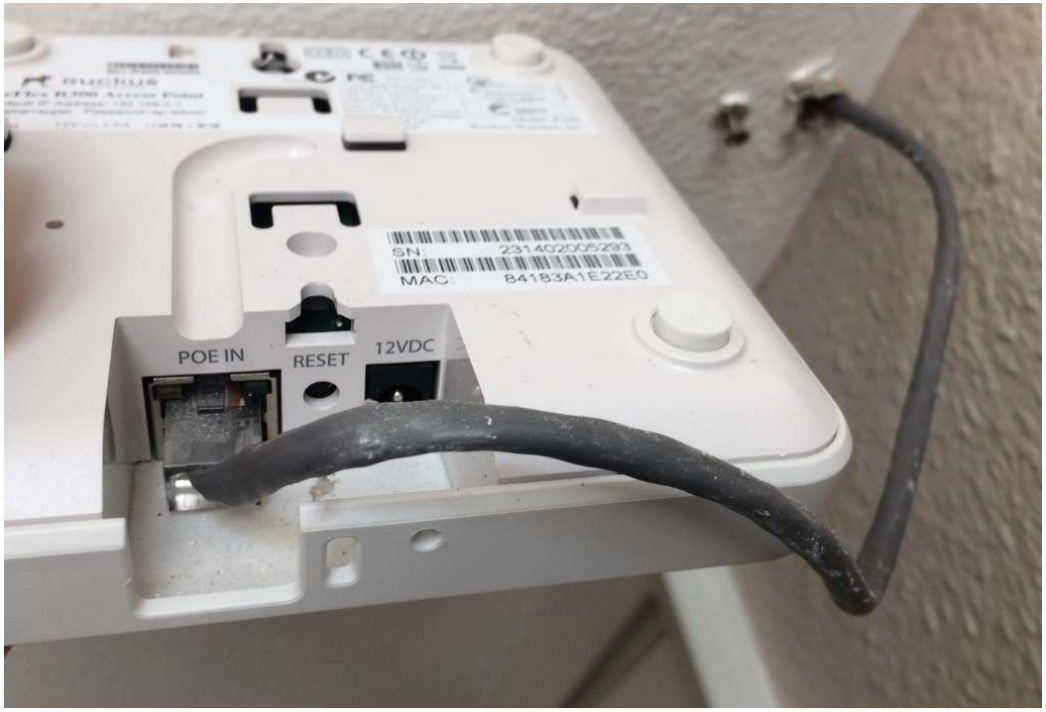
**Modular Plug Terminated Link**

**Ethernet Alliance Certification**

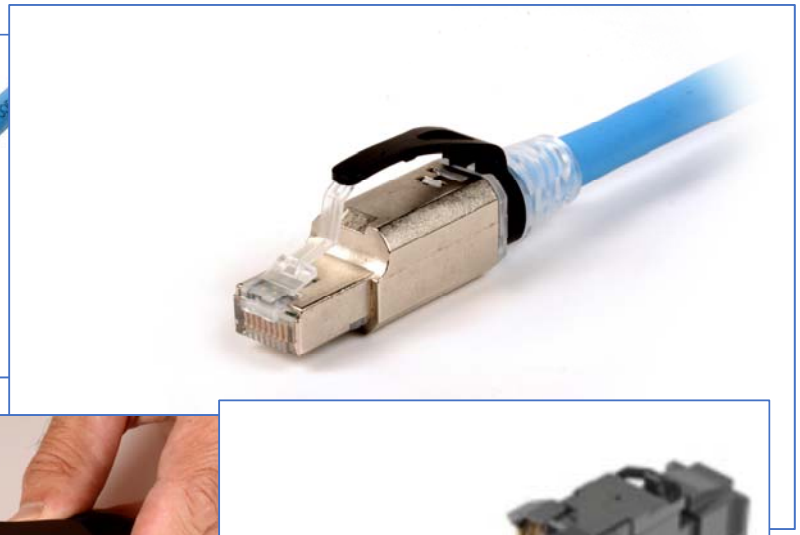
**Resistance Testing for PoE**

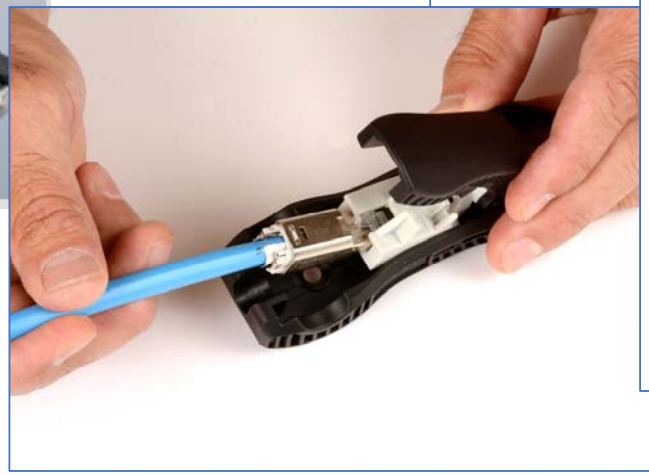
# A Simplified Installation Technique

- ✓ AP's, Cameras, Locks, Sensors, etc.
- ✓ Lower Cost
- ✓ Cleaner Look
- ✓ More Secure

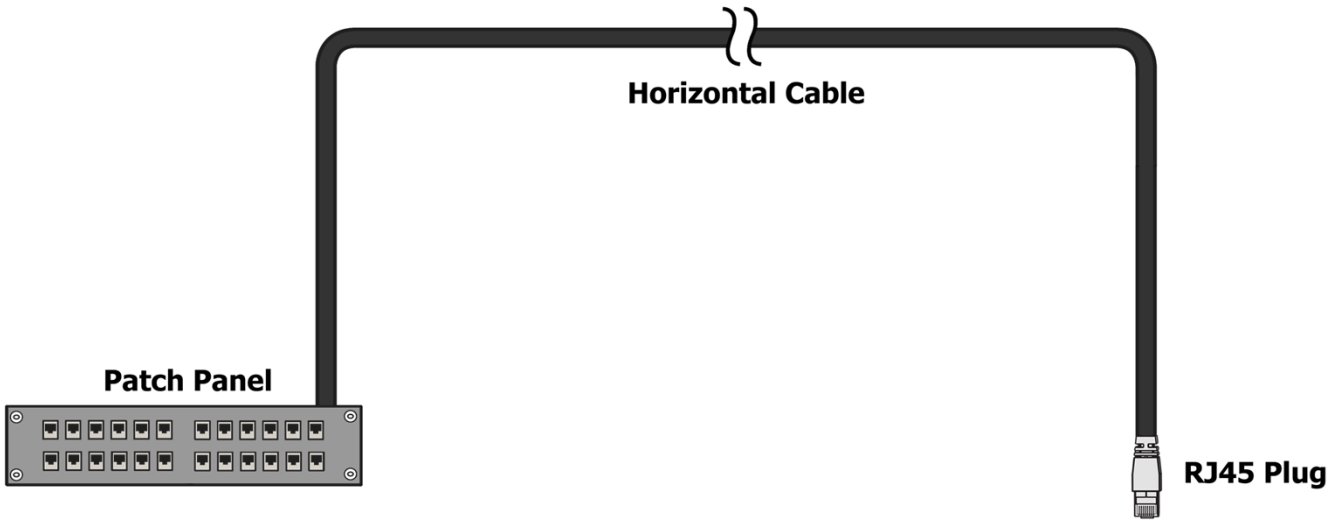


# Field Terminated Plug Examples





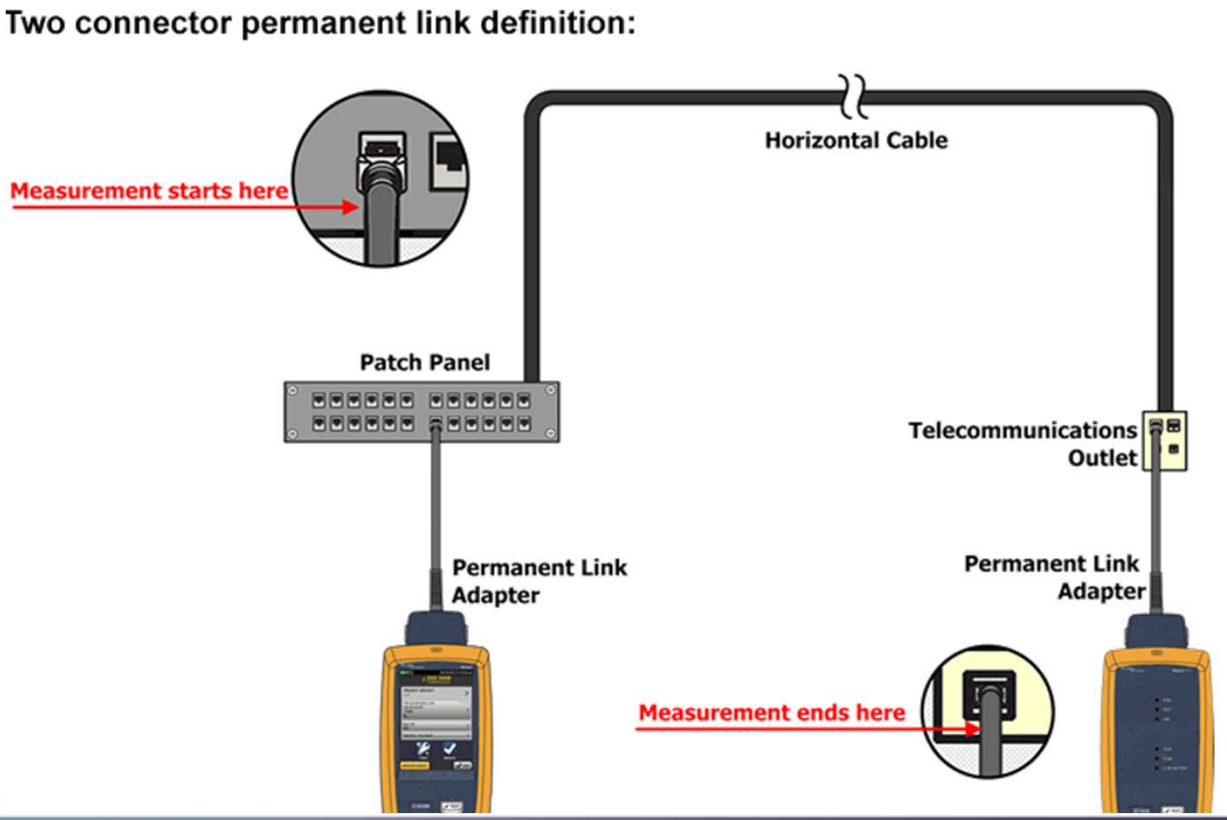
# Modular Plug Terminated Link (MPTL)



# So, How Do I Test This Thing?

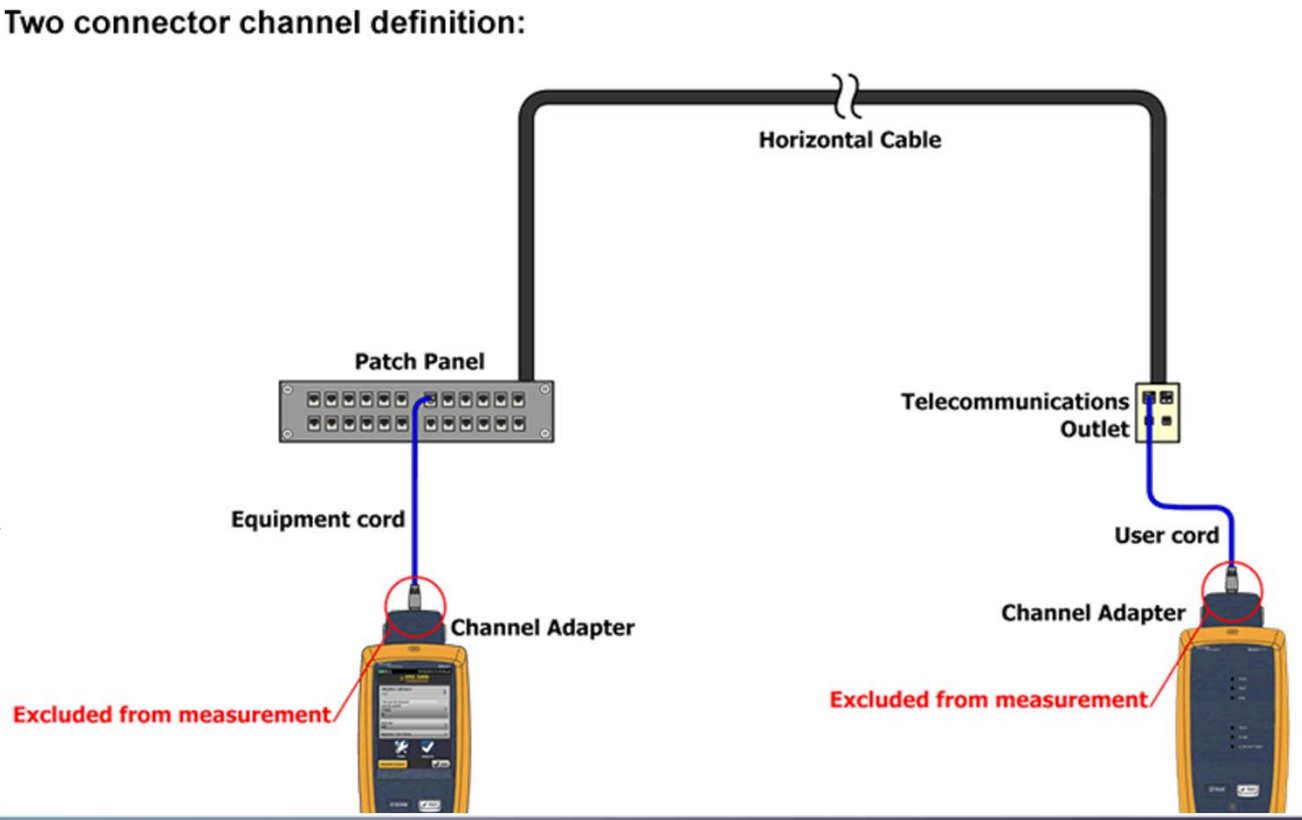
# Is This a Permanent Link?

- ✓ Starts at a Patch Panel
- ✗ Includes Outlet
- ✗ No Final Plug



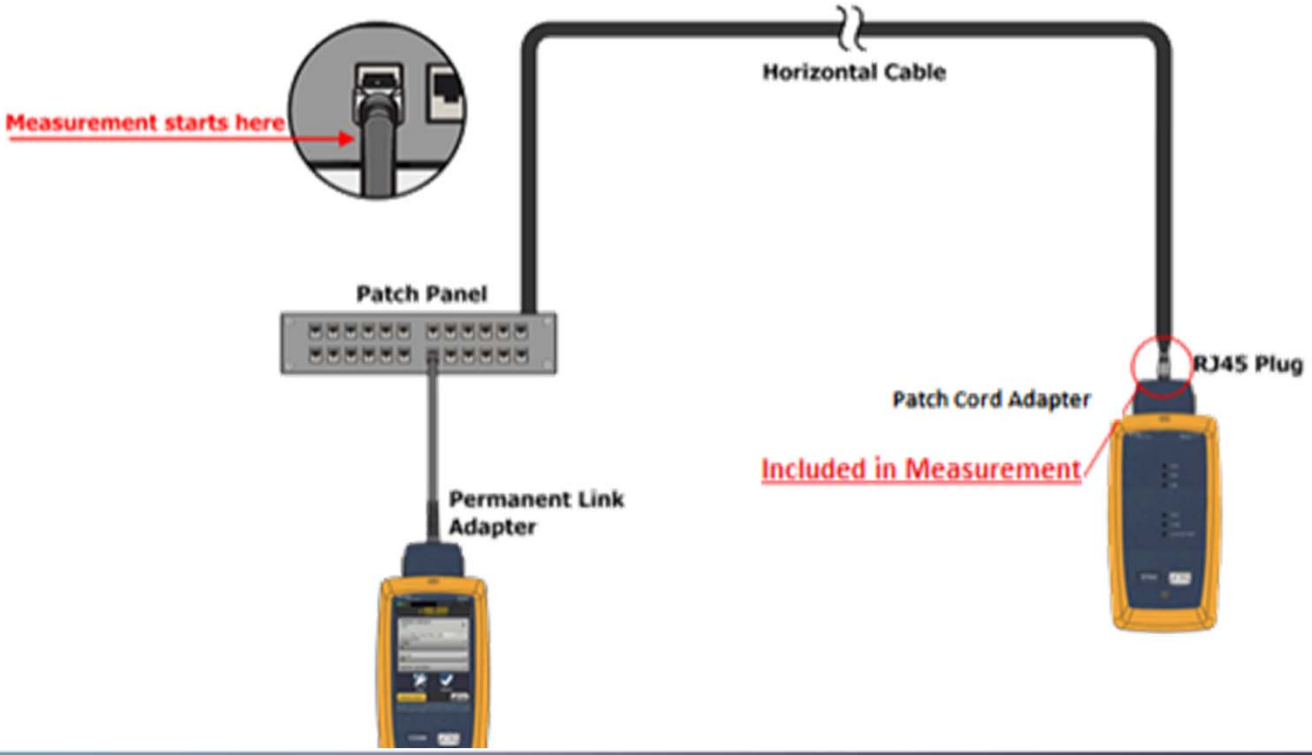
# Is This a Channel?

- ✓ Includes Patch Cord
- ✗ Starts with Patch Cord
- ✗ Doesn't Include Last Plug



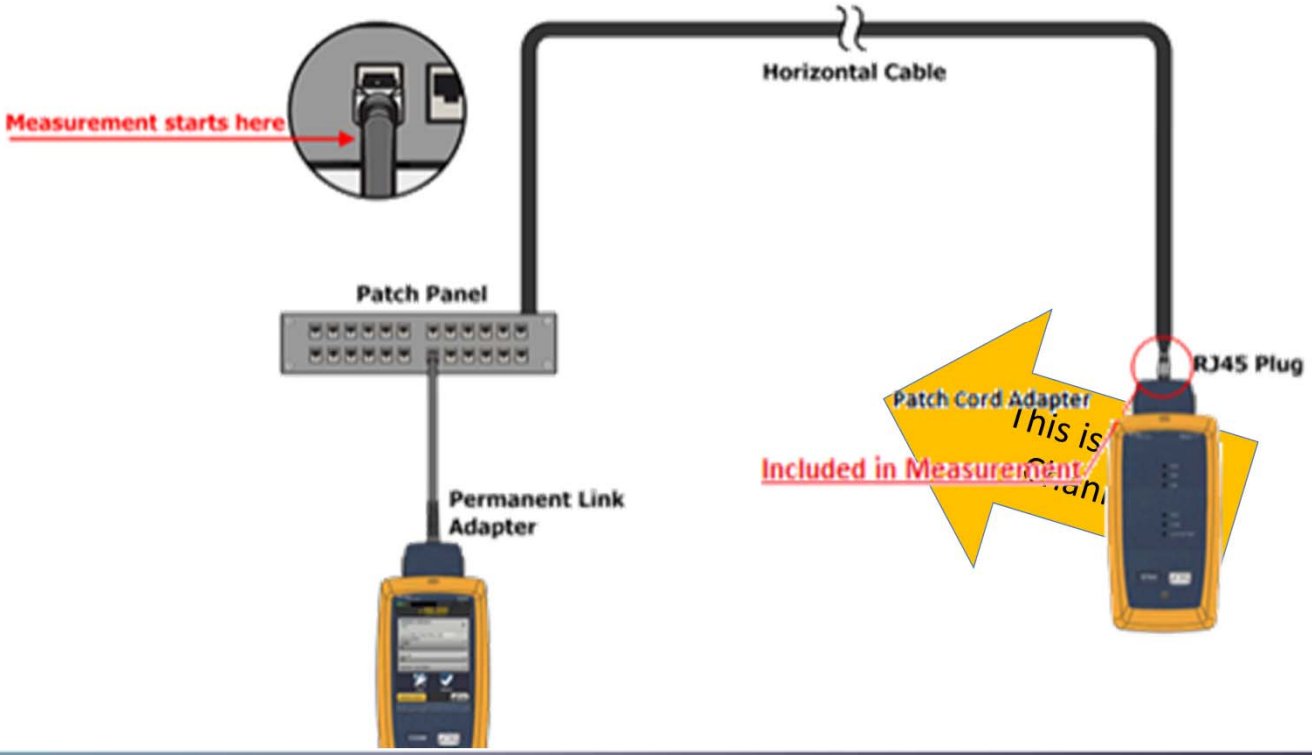
# MPTL Definition

- Formerly Defined by BICSI as “Direct Attach”
- Defined in ANSI/TIA 568.D-2 (Approved June 2018) Annex F
- ISO to Discuss in Fall 2018
- Max. 295 ft. (90 m)
- Category 5e, 6, 6A

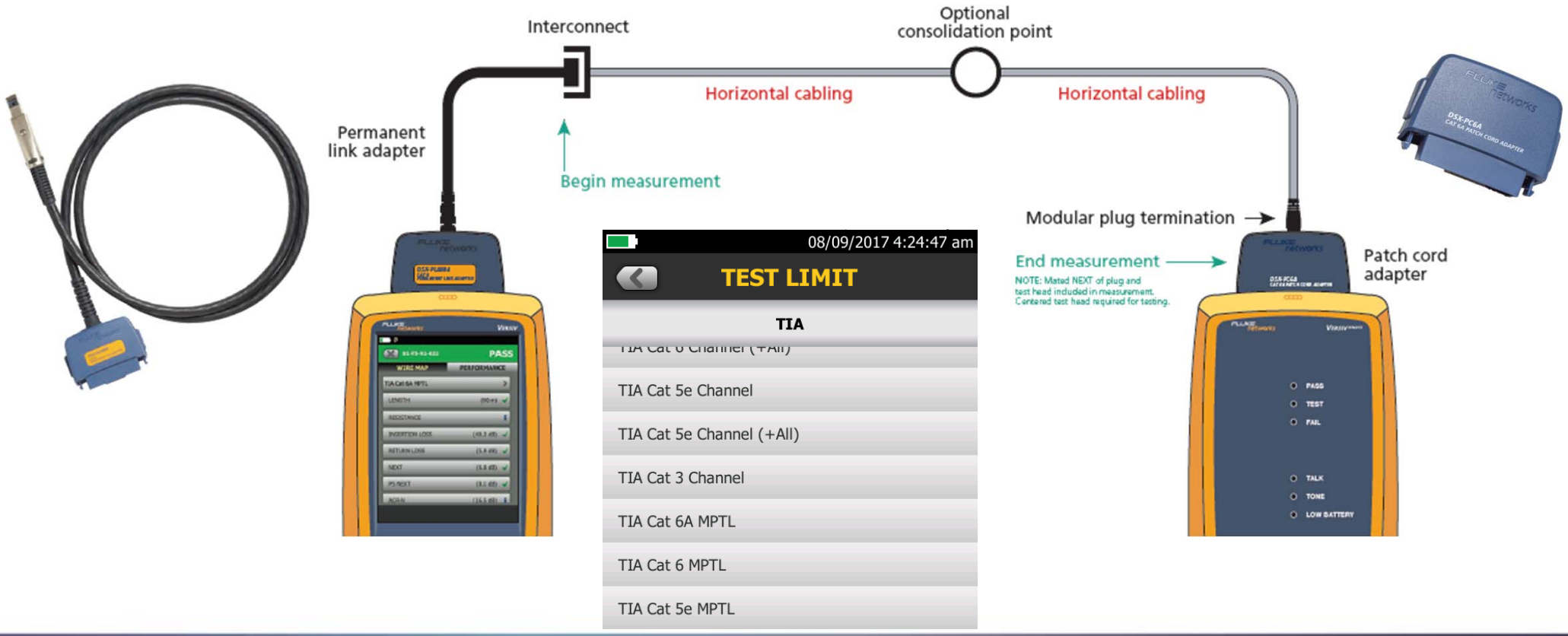


# MPTL Definition

This is like a Permanent Link



# Testing the MPTL: What You Need



**Modular Plug Terminated Link**

**Ethernet Alliance Certification**

**Resistance Testing for PoE**

# Quiz Questions

- What's the power available at the PD for Class 3?
- 13W

- Based on 802.3bt, what class of power is available from a PoE++ device?
- Class 5 or 6

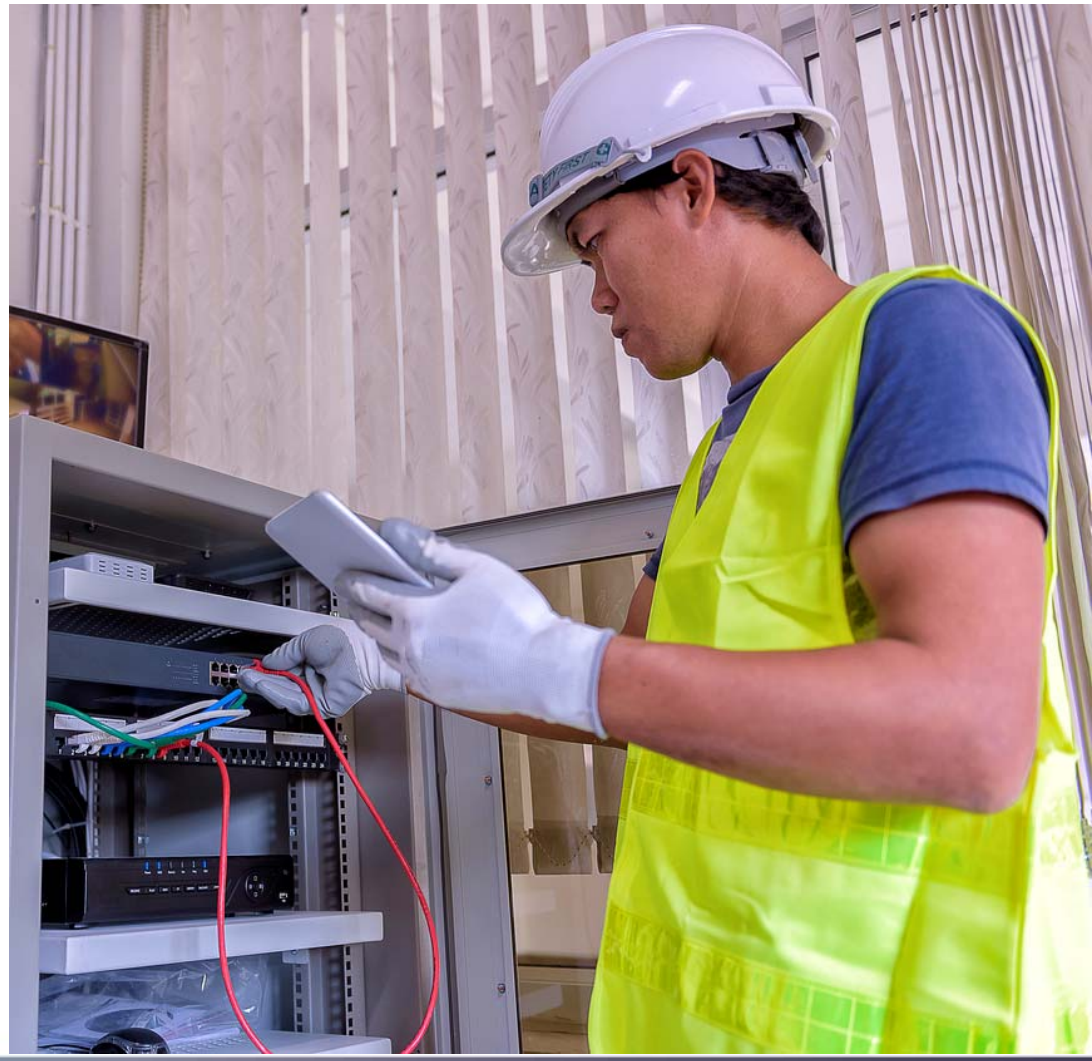
- How many pairs are used in Class 4 implementations?
- Two or Four

# Power Over Ethernet

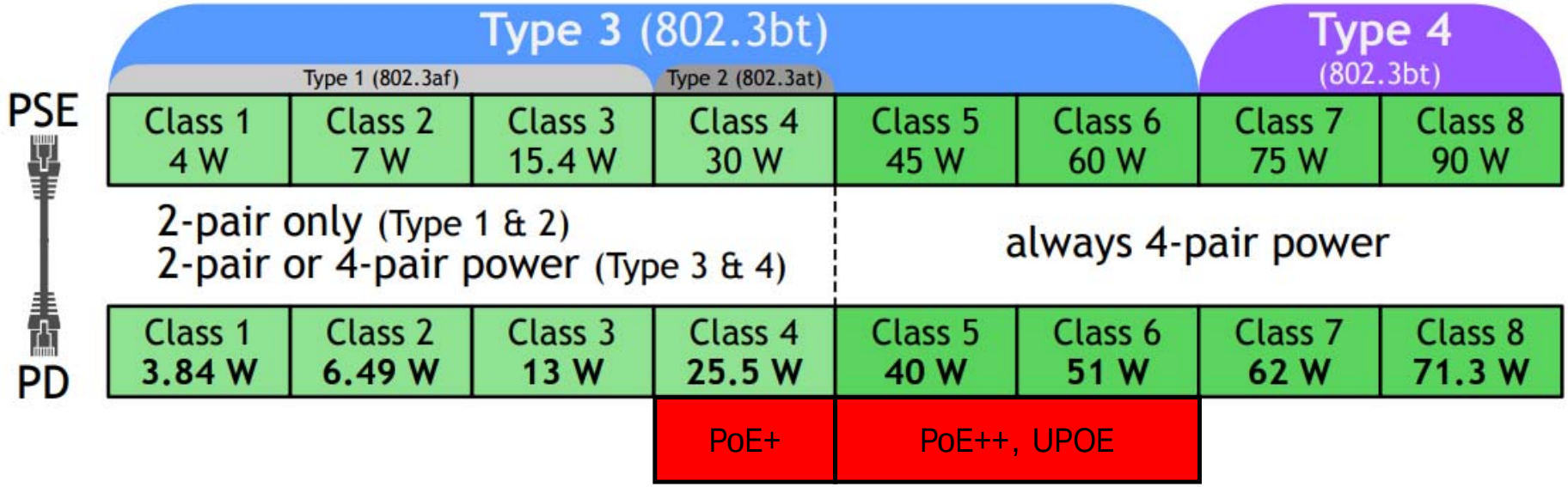
- IEEE 802.3bt – 4 pair Power over Ethernet
  - Now technically complete and no new features to be added
    - Type 1 and Type 2 PSE devices are as per 802.3af and at standards
    - Type 3 and Type 4 PSE devices added, 60W and 90W respectively
      - Updated end types to support 2.5G, 5G and 10G Ethernet
      - New midspan PSE to support the higher speeds
    - Warning added not to use smaller than 26AWG cabling with PoE
  - Out for sponsor ballot, expected to publish Q3 2018.

# PoE Confusion

- Not a Licensed Term
- Three Standards: 802.3af, 802.3at, 802.3bt
- Eight Classes / Wattage Levels
- Four Types: 1 and 2 (two pair), 3 and 4 (four pair)
- Common Names: PoE, PoE+, PoE++, UPOE
- Passive, LLDP, and Negotiated Implementations
- Interoperability?



# Understanding Classes and Types



# Ethernet Alliance PoE Certification

*(Number Indicates Class of Device)*

ethernet alliance

**Power Sourcing Equipment**


**Powered Device**

# This Won't Work

ethernet alliance

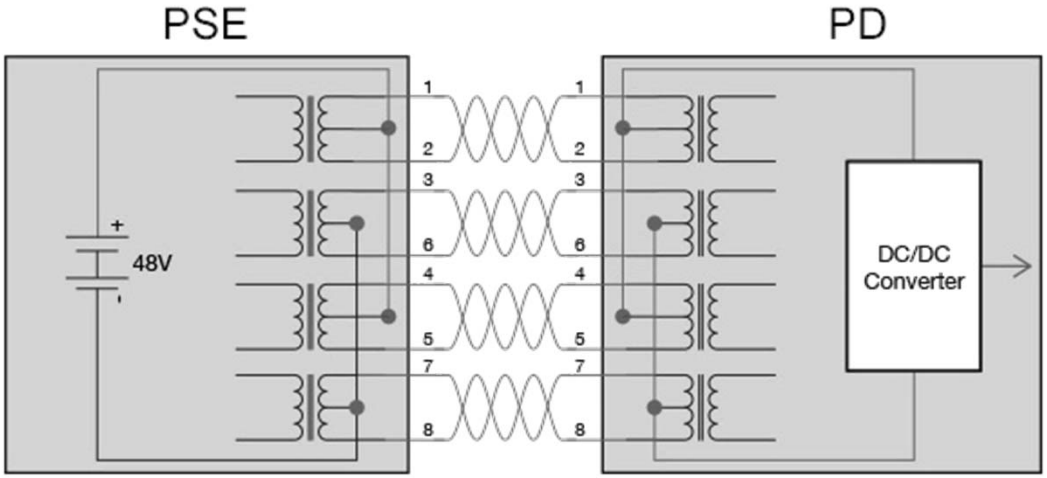

**Modular Plug Terminated Link**

**Ethernet Alliance Certification**

**Resistance Testing for PoE**

# Four Pair PoE in Operation

- The powered device completes the current loop, enabling the device to work
- The current is “balanced” across all 4 wires used.
- Requires low and balanced cable resistance



# Cabling Requirements

- Your standard Cat 5e, 6, or 6A field test is probably not good enough
- Within ANSI/TIA-568.2-D and IEEE 802.3, you will find:
  - dc loop resistance
  - dc resistance unbalance within a pair
- The measurements are “optional” in TIA-1152-A

# 1. Loop Resistance


**All Four Pairs < 25 Ω**

# 2. P2P Resistance Unbalance


$$\text{Resistance Unbalance}_{\text{between pairs}} = \left[ \frac{|R_{P1} - R_{P2}|}{R_{P1} + R_{P2}} \right] 100\%$$

**All Six Measurements < 0.2 Ω or 7.5%**

# 3. Pair Resistance Unbalance

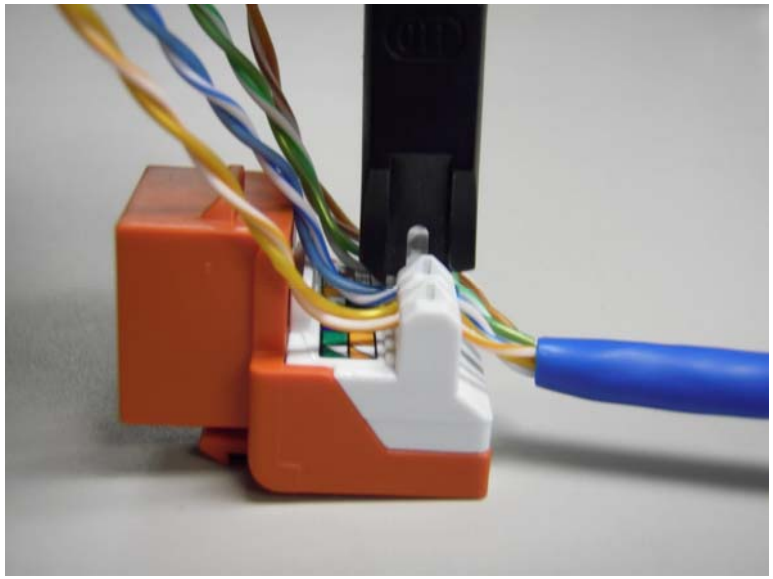

$$\text{Resistance Unbalance}_{\text{within a pair}} = \left[ \frac{|R_{C1} - R_{C2}|}{R_{C1} + R_{C2}} \right] 100\%$$

**All Four Measurements < 0.2 Ω or 3.0%**

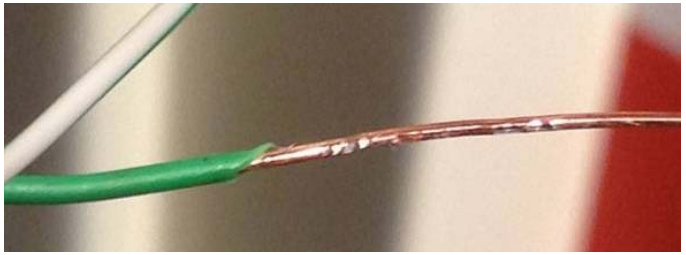
# Problems Resulting From Resistance Issues

- Overheating
- Power Loss
- Data Loss

# Causes of Resistance Issues

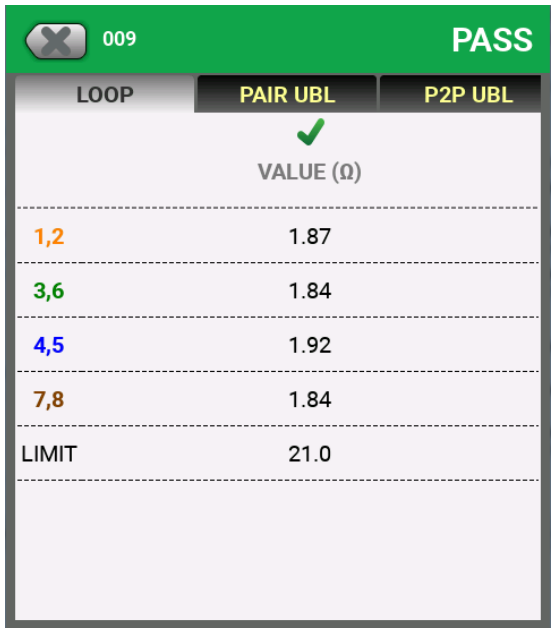


**Workmanship**

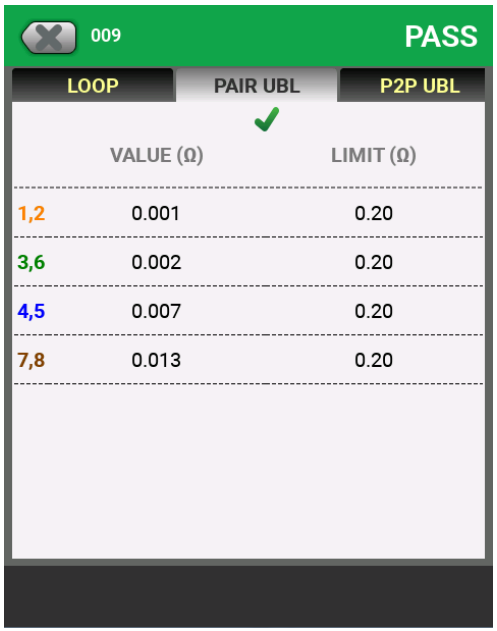


**Cable Quality**

# Resistance Testing




**Loop Resistance**

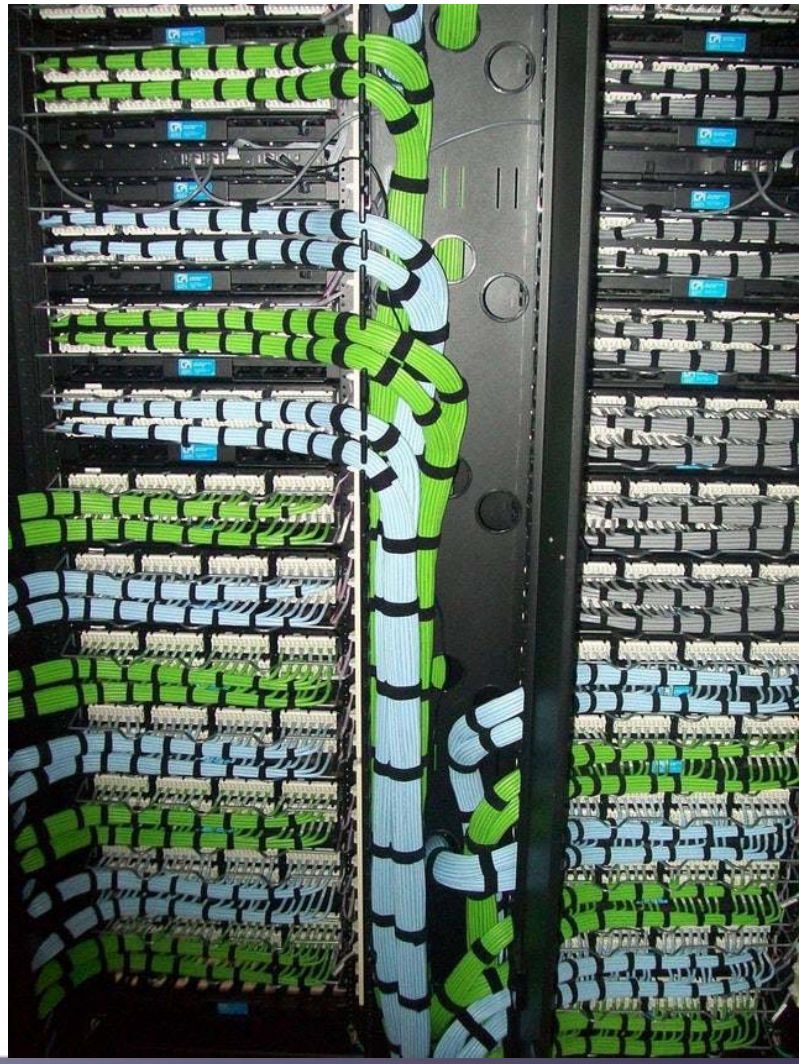



**Pair Unbalance**


**Pair-to-Pair Unbalance**

# Questions

# Thanks for Your Attention

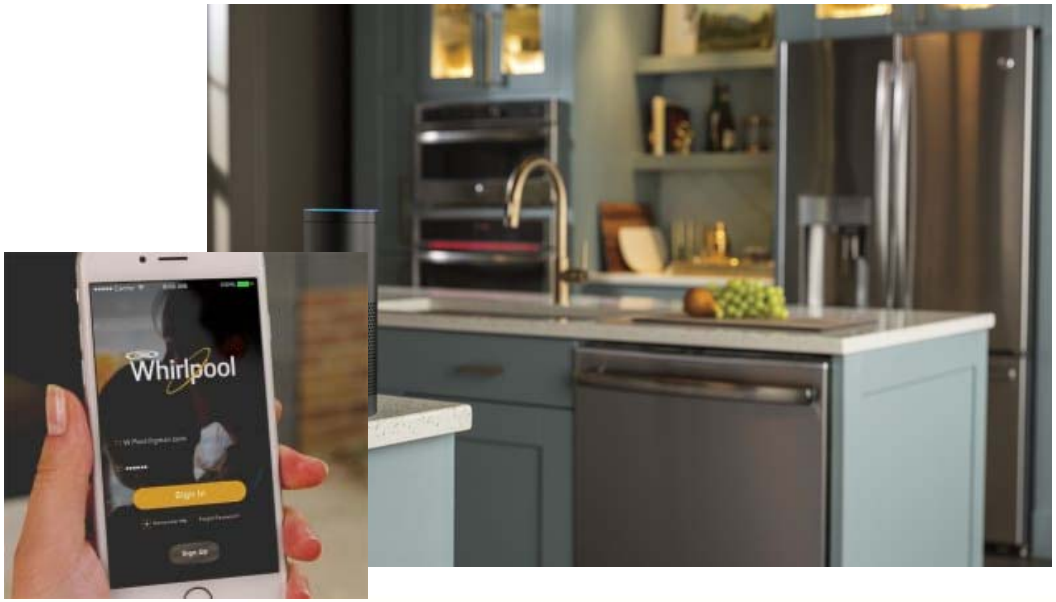


# End Products and Security

Geoffrey Bauer, ESS, PSP
Manager, A&E Program
Axis Communications

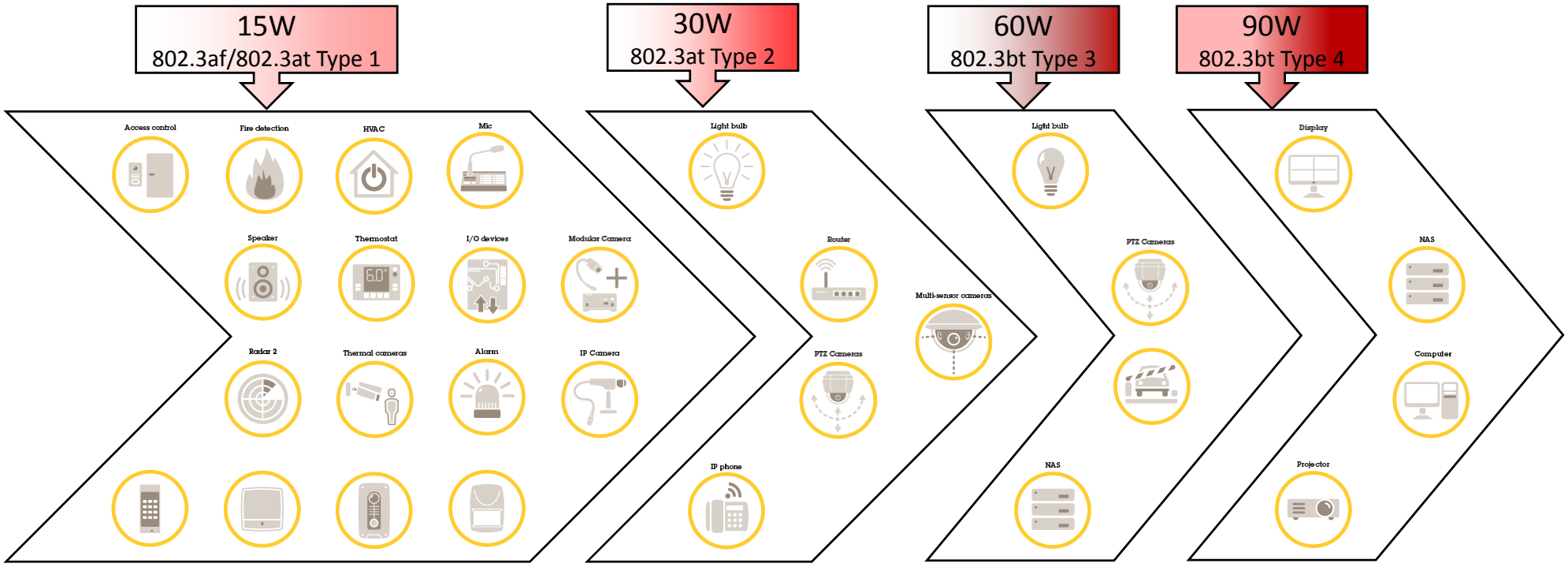
# Internet of Things (IoT)

- 50 Billion Internet Of Things Connections Projected By 2022
  (www.mediapost.com)



# Internet of Things (IoT) - Security

# We need more power



# PoE Midspan devices

- PoE “injector” options
  - 15W (IEEE 802.3af)
  - 30W (IEEE 802.3at) PoE+
  - 60W (IEEE 802.3bt) PoE++
  - 90W (IEEE 802.3bt)


- Midspans are either unmanaged or managed out of band
  - PoE is managed as part of the data path and the statistics show up as part of the line communication and on the switch
    - Midspan power information has to come from the midspan or through a separate tool

# Physical Security

"Detect"

# PoE Intrusion Monitoring

- Motion Detectors
  - Powered by the device (camera) via the I/O port
  - Z-Wave Connectivity (wireless to PoE device)
  - Hidden sensors for video (covert)
- Laser scan detector
  - Detects object's size, speed, and distance
- LIDAR & RADAR
  - Delivers exact position of a moving object
  - Minimizes false alarms from spiders, small animals
  - Reliable detection even in bad weather (rain, fog, snow)

# Monitoring and Control

"Detect" and "Deter"

# Network Input / Output control

- Powered using PoE/PoE+ (or external power)
  - Analog alarm inputs
    - Supervised / Non-supervised inputs
      - Door contact, Window sensor, Motion detector, all things analog
  - Relays
    - TTL and Form C relays
      - Typical 12VDC / 24VDC / Dry contact relays
    - Trigger analog audio devices
    - Trigger analog lighting displays
    - Trigger ADA release sequence for entry doors
  - Elevator Control
    - Control what floors are accessed
    - Provide details of persons movement

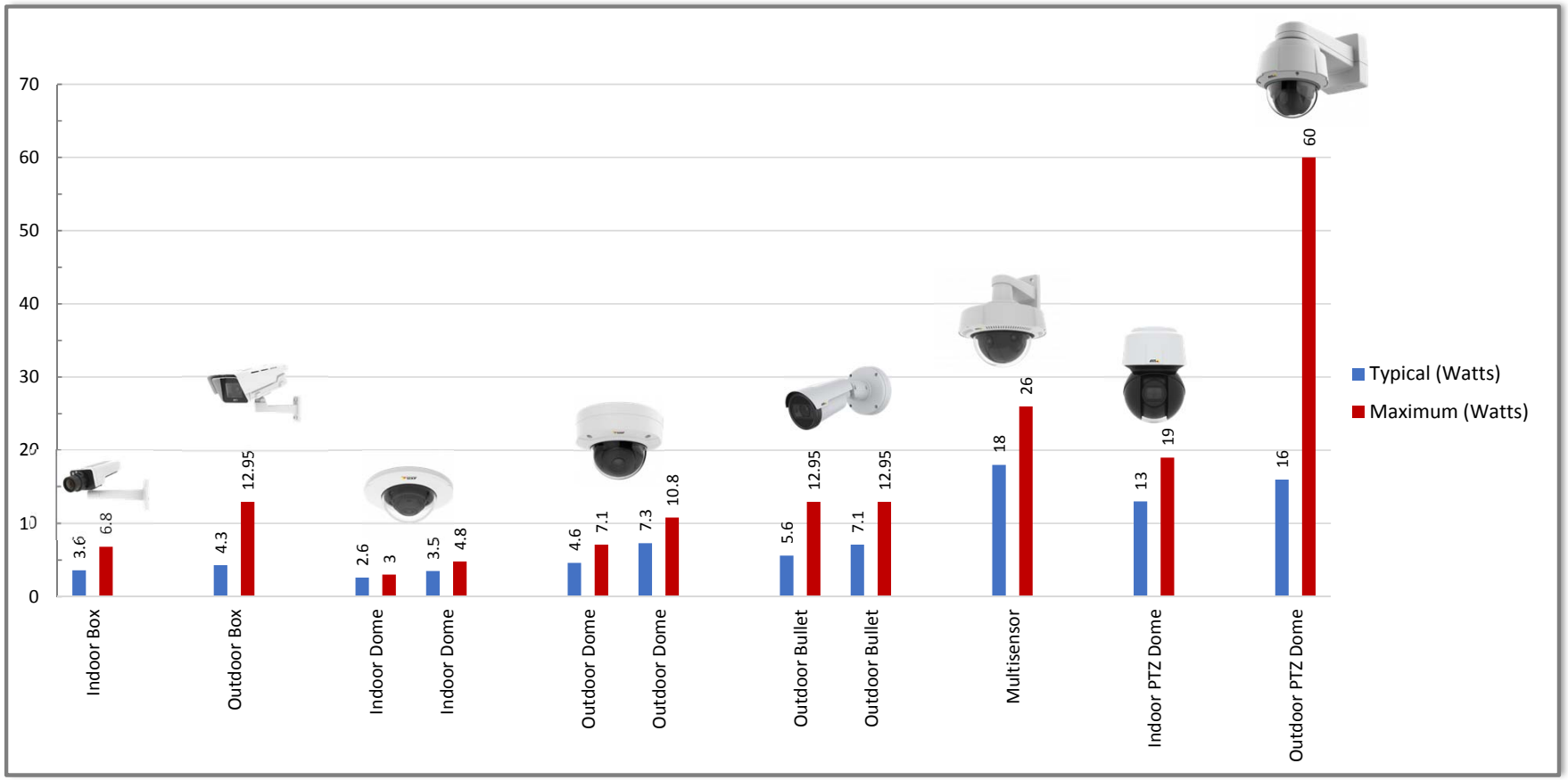

# IP Surveillance

IP Cameras for the “eyes”

# Types of cameras

- > Covert
- > Fixed Box
- > Fixed Dome
  - Panamorph
  - Multi-Sensor
  - PTRZ
- > Bullet
- > Thermal
- > Positioning
  - Dome
  - Bi-spectral
  - Professional AV
- > Explosion proof

# PoE requirements for Surveillance



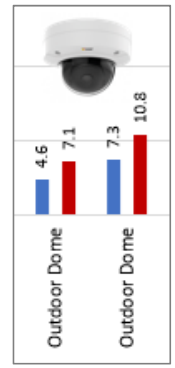
# PoE requirements for Surveillance

- Positioning Camera
  - SFP or RJ45 10BASE-T/100BASE-TX/1000BASE-T network connector
  - 24VAC/VDC Max 200-300 W, typical **16-64 W** (IR)
    - Temperature:  Normal: -50 °C to 55 °C (-58 °F to 131 °F)
      - Arctic Temperature Control: start-up at -40 °C (-40 °F)
    - Operational wind load of 106mph
    - Precision motors with presets
    - Bi-spectral

# How does more power influence project designs?

Using surveillance as an example …

# Resolution

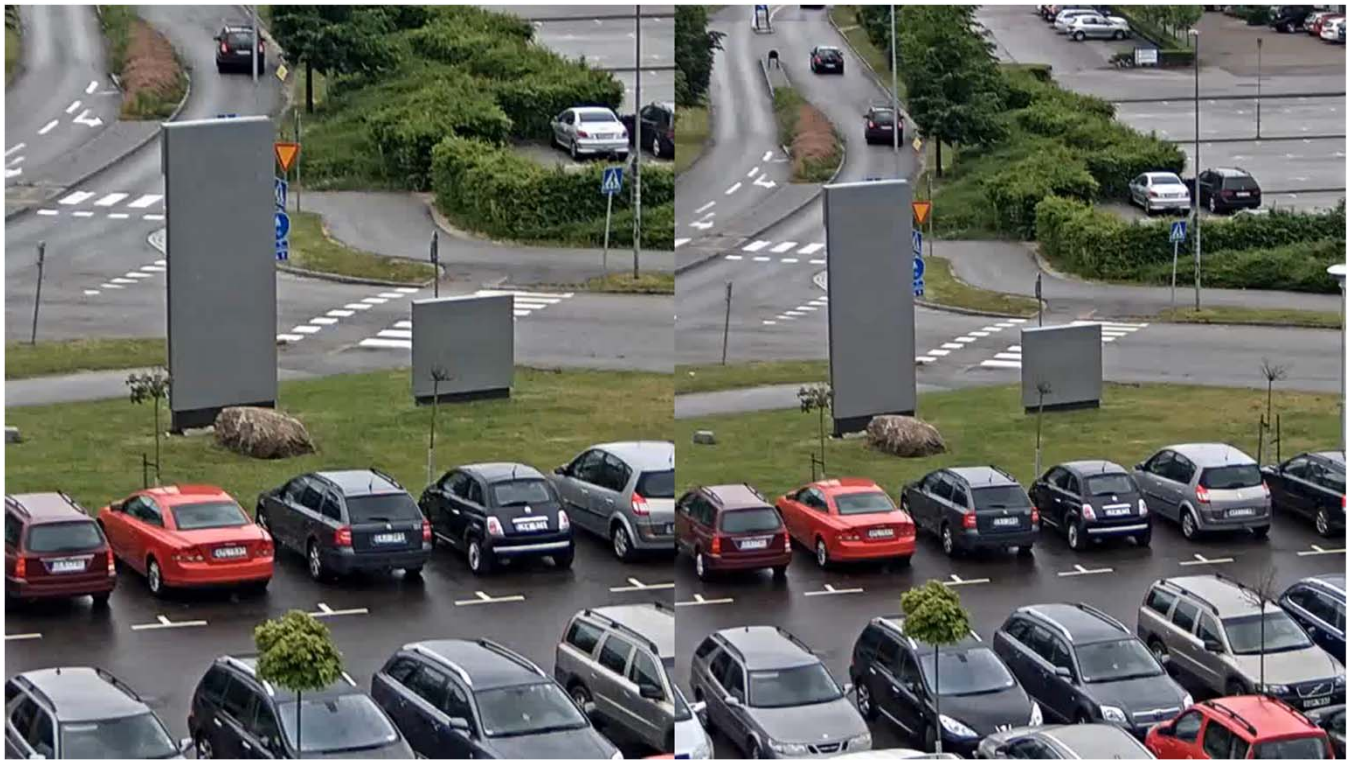


# Wide Dynamic Range

WDR - On

WDR - Off

# Image stabilization



# Low-light

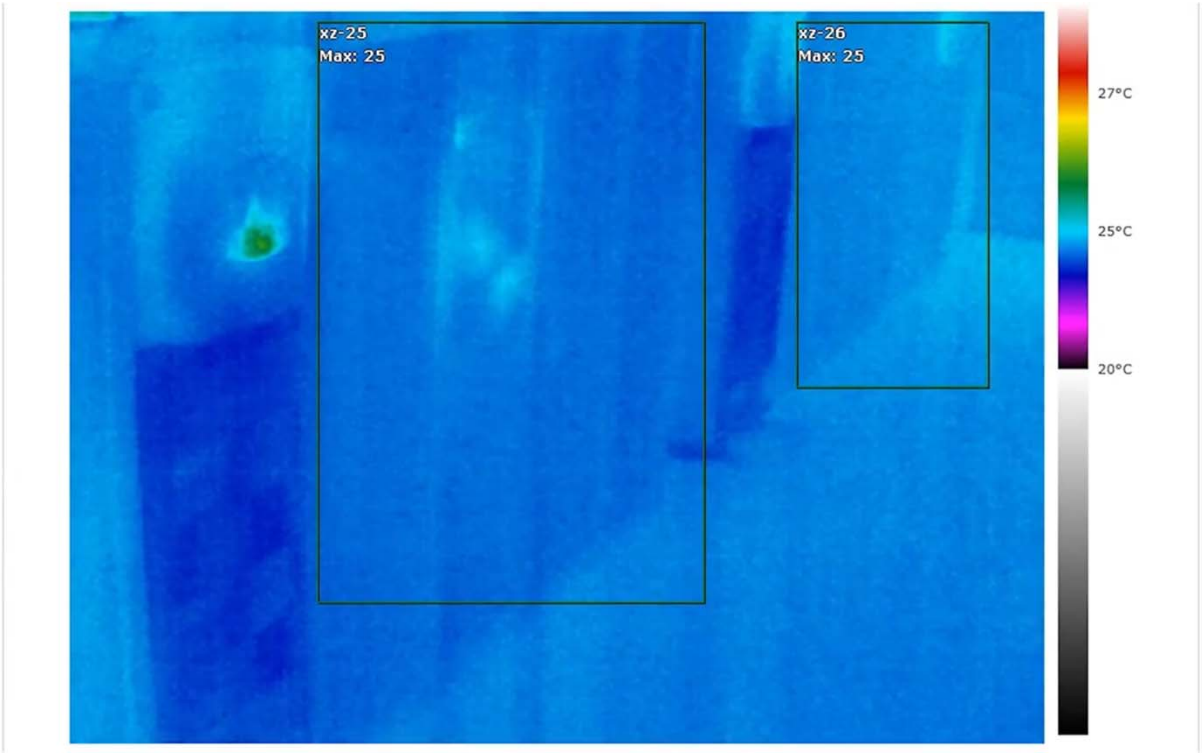
- Indoor storeroom at approximately 0.4 lux.

# IR illumination

# Operational in extreme cold and extreme heat

# Long-range video surveillance

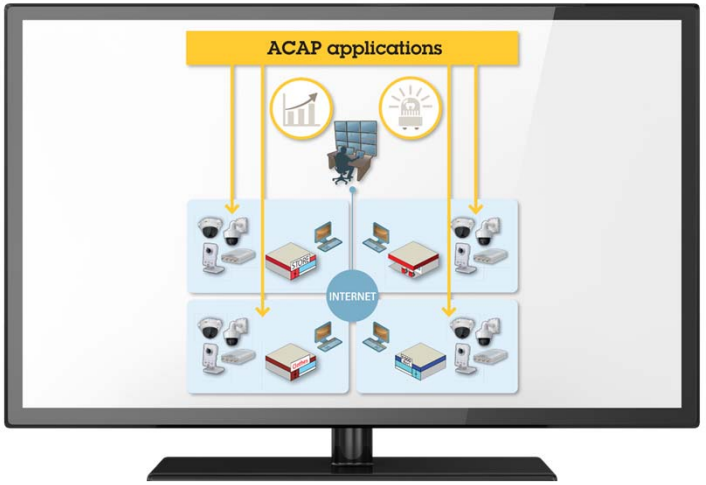
# Thermal



# Video compression

# Intelligent Applications

- Edge processing
  - Access to applications **at the edge**
    - Present a wide range of intelligent applications for efficient surveillance, data analysis and business management
    - Open platform allows for application development partners to meet specific needs
- Adapting to the IoT world will require the ability to connect in ways beyond standard security
- Almost all of the enterprise customers desire customization to accomplish business goals

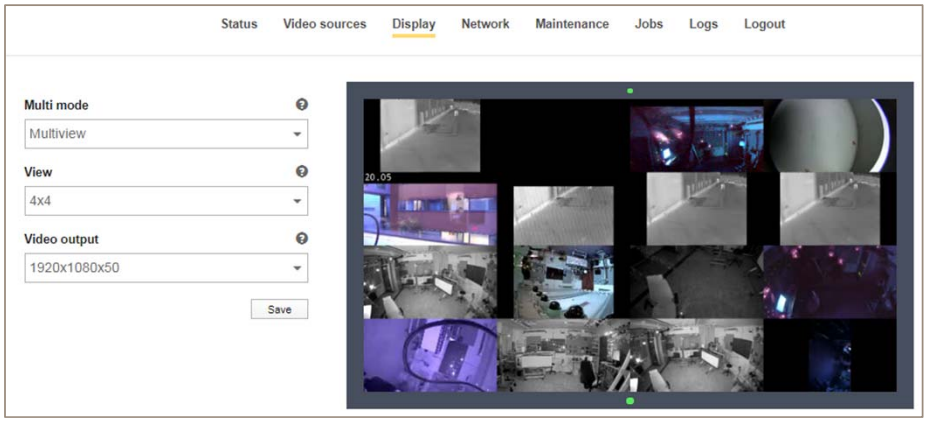


# Decoding

"Detect"

# PoE Decoders

- Decoding
  - Connecting digital monitors to display live video from network cameras

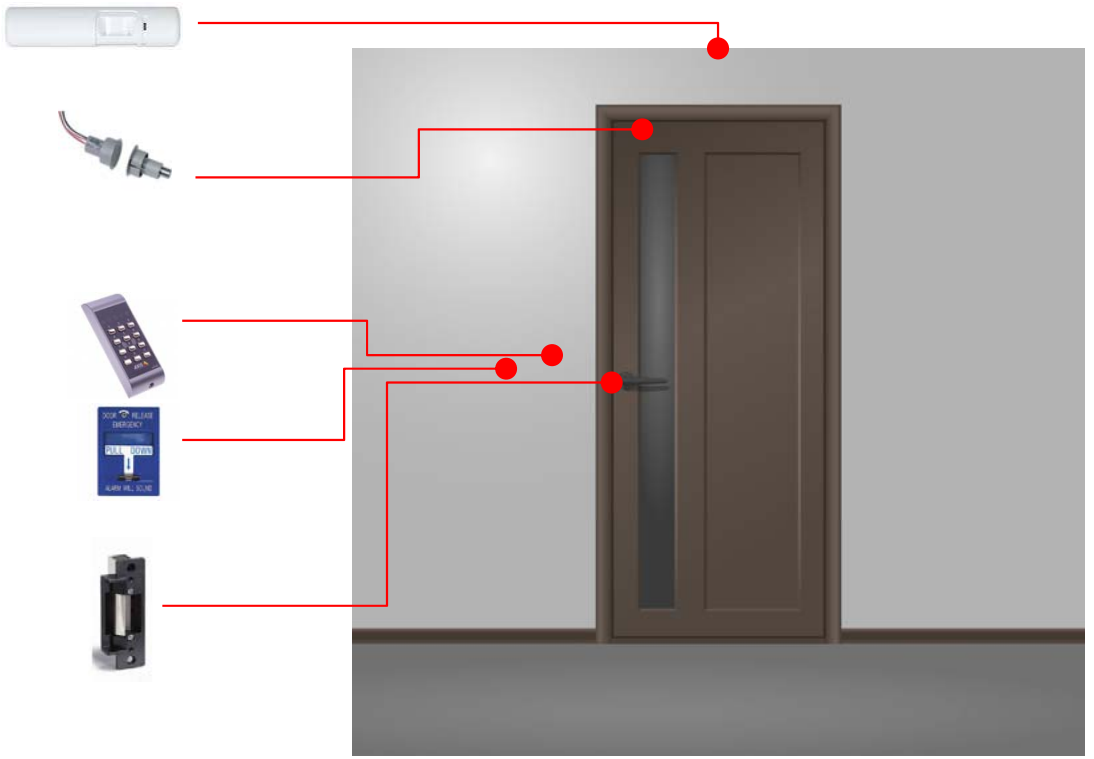


# Access Control

"Delay"

# PoE Controllers

> Door connections
  - Request-to-Exit
  - Door Position Switch
  - Card Reader
  - Emergency Door Release
  - Power for Electric Lock (Strike)



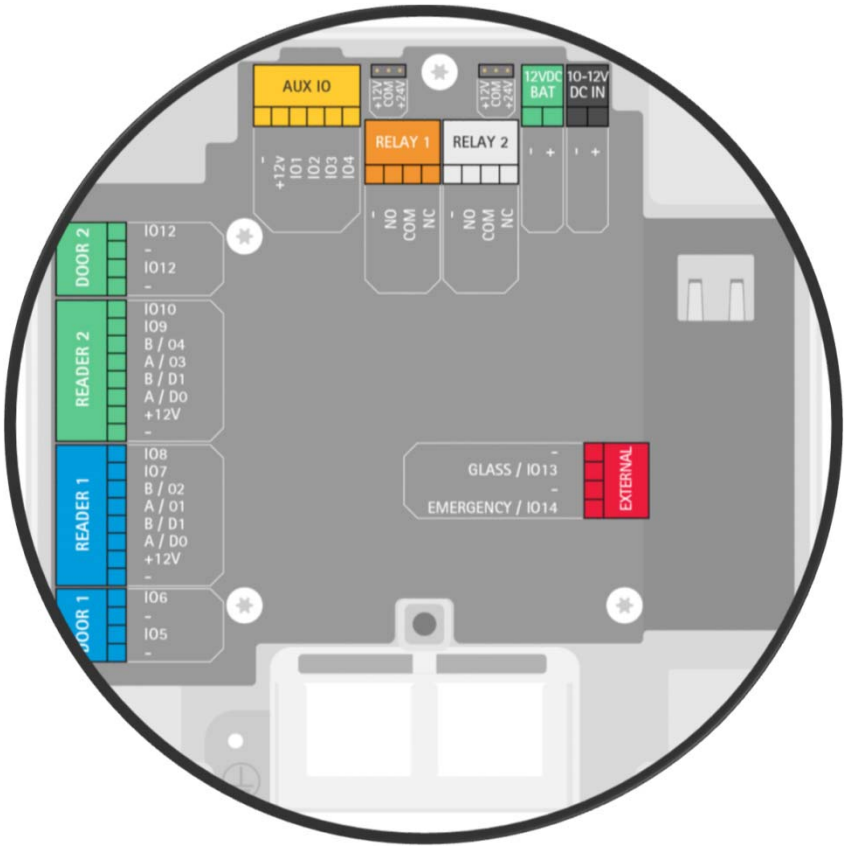
# PoE Door Devices

- RFID Door Readers
- Biometric Readers
- Door Locking Hardware

- Electromechanical / Card Reader
  - Power when required
  - Part of complete solution
    - Requires management software


# PoE Controllers

- > Powers door devices
  - Request-to-Exit motion
  - Card Reader
  - Power for Electric Lock (Strike)
- > Runs autonomous from software
  - Controls access to access portal
    - Stores cardholder records
    - Stores time schedules
    - Stores user permissions
  - Alarm and Relay Linking
  - Event recording



# IP Intercom

Devices for “Communication”

# Types of IP Intercom

- Facility
  - Building entrance
    - Front / Employee / Dock doors
  - Remote building Remote gate
  - Parking Garage
  - Parking Lot
- Residence
  - Entry gate
  - Apartment call center
- Management

# SIP Communication – an overview

- **S**ession **I**nitiation **P**rotocol
  - SIP is the standard protocol used in Voice over IP (VoIP) applications and unified communication platforms.
    - Initiate, maintain and terminate sessions between clients
    - Usually audio, but video too
    - SIP phones, Intercom devices, Audio, Radio-over-IP, etc.







# IP Audio

La …la …la …la

# PoE Loudspeakers

- “See something … Say Something”
  - Extending the reach of a security program
    - The loudspeaker can be remotely accessed and/or play a pre-recorded audio file when it is manually or automatically triggered (alarm event)
  - Compatible with major video management software and SIP-based VoIP systems
  - Address individual speaker from anywhere with network connectivity

# PoE Speakers

- PoE (IEEE 802.3af/802.3af Type 1 Class 3)
- A complete audio system
  - Speaker
  - Amplifier
  - Signal processing, equalization
  - Microphone
- Streaming audio
- Customized announcements

# PoE Speakers

**Traditional analog speaker solution**

Speaker

Speaker audio cable

Amplifier

Line level audio cable

Tone control / Equalizer

Line level audio cable

Streaming box

Network cable

Network switch

**Network speaker solution**

All-in-one

Network cable

Network PoE switch

# IP Lighting

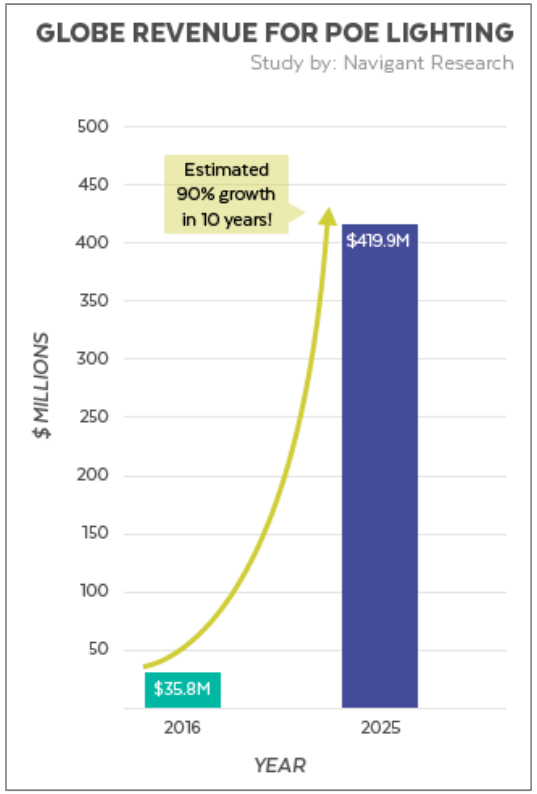
# PoE Lighting - Security

> Security
  - Visible Light
    - 802.3af compliance – draws 12W
  - IR (850nM or 940nM)
    - 802.3af compliance – draws 12W

iluminar

# PoE Lighting - Buildings

- > Intuitive sensors to learn and interact
  - Occupancy – turn on and off
  - Dimming – adjusts to ambient lighting
  - Color temperature
  - Business analytics
- > Efficient
  - Dramatic energy savings
- > Installation
  - Eliminate heavy duty copper wire and conduit used for traditional lighting
- > Flexibility
  - Ability to easily move or replace fixture



# Cyber

IoT and the precautions for networked devices

# High profile breaches make headlines

Powered by ThreatCloud Intelligence

THREATCLOUD

# LIVE CYBER ATTACK THREAT MAP

Check Point SOFTWARE TECHNOLOGIES, INC.

# What is cybersecurity?

- Cybersecurity refers to a set of techniques used to protect the integrity of networks, programs and data from attack, damage or unauthorized access.
- Cybersecurity involves mitigating risks by reducing the attack surface area, or more simply – by reducing exposure.
- Cybersecurity cannot be defined as a single product or tool.

# What is cybersecurity?

- It is important to understand that 100% protection against intrusion is very hard to achieve, if indeed possible at all.

# IoT and Network Device Cybersecurity Concerns

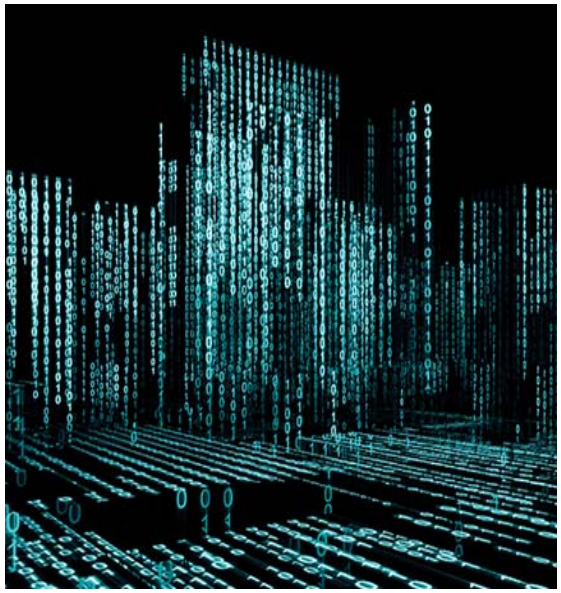
- **Unsecured endpoints used as a point-of-entry on the network**
- *Poor password complexity protocol*
- *Open ports and unused services*
- *Man-in-the-middle packet capture*
- *Malware*
- *UDP-flood, DoS, DDoS*

# Where should I start?

- To protect a network against attack, various security controls can be implemented.  These controls are safe guards or countermeasures to avoid, detect, or mitigate secure interest to **physical property**, **networks**, appliances, servers, information, or other assets.

# Where should I start?

- In a security system, the main areas to focus on are:
  - **Physical exposure** - protecting the system hardware
  - **Network exposure** - preventing unauthorized access
  - ***Service exposure*** *- preventing access via unused services*
  - ***Encryption*** *- securing transmission to/from appliance*
  - ***Credentials*** *- the use of robust credentials*
  - ***Authentication*** *- authentication policies (certificates)*



# Where should I start?

- Physical
  - The first line of defense is the physical protection of the primary access points to your network
  - Various measures may include:
    - Secure network equipment and servers
    - Mounting appliances out-of-reach
    - Using tamper switches
    - Using vandal-resistant enclosures
    - Use protective shielding for exposed cabling
    - Protect the cable ends and open ports

# Where should I start?

- Network
  - The second line of defense is protecting your network infrastructure from unauthorized access
  - Various measures may include:
    - Protect the perimeter
      - Control access to the facility - Manage who comes and goes
      - Video Surveillance – Record the identity of each person
    - Protect the interior
      - Conceal cabling - Structured cabling should be out of sight
    - Control access from public and employees
      - Physically secure MDF/IDF locations
      - Control access to internal sensitive areas
      - Security at the cabinet level

# Final thoughts …

- IoT drives appliances to the network
  - Integration between appliances transitions from “Analog” to “Digital”
  - IPV6 implementation is absolutely necessary
- PoE will continue to drive edge-based technology
  - Security industry is quickly adapting and innovating
- PoE will challenge the status-quo
  - Video / Audio / LED Lighting / Automation / Smart buildings / BYOD
- PoE standards will recognize higher power requirements
- PoE requires different design considerations
- Cyber threats will keep you up at night


Thank you!