DESIGNING FOR POE AUTOMATION AND LIGHTING

Best Practices and Lessons Learned from Top Design Professionals and Subject Matter Experts on Designing and Constructing Power Over Ethernet Intelligent Buildings

Earn CE and GBCI Credits

Bicsi Conference

PANEL OF SPEAKERS

TOP EXPERIENCED PROFESSIONALS AND SUBJECT MATTER EXPERTS FROM THE FIELDS OF POWER OVER ETHERNET AND INTELLIGENT BUILDINGS

MODERATOR:
TYLER ANDREWS
PoE Texas

SPEAKER:
LISA ISAACSON
Mecho/NuLEDs

SPEAKER:
JOHN JUNG
Walsh PoE

SPEAKER:
STEVEN COWLES
AEM

SPEAKER:
LUIS SUAU
Sinclair Digital

SPEAKER:
JOSEPH HERBST
PoE Texas

SPEAKER:
AKRAM "AK" KHALIS
MHT Lighting

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01 **Panel Discussion – 8:35 – 9:15**
The PoE Intelligent Building Value Proposition

02 **Fundamentals of Networking – 9:15 – 9:45**
What You Need to Know About Networking for PoE Lighting

03 **Fundamentals of PoE Lighting – 9:45 – 10:15**
What You Need to Know about Lighting and Automation

04 **Navigating the Design Process – 10:30 – 11:00**
What You Need to Know about Designers and Designing

05 **Specifications and Validation – 11:00 – 11:30**
What You Need to Know about Specs and Testing

06 **Putting It Into Practice – 1:00 – 3:00**
A Practical Exercise in Design a PoE Lighting System

07 **Lessons Learned – 3:30 – 4:00**
Real World Tips from Installers Who Have Done This

08 **Q&A and Petting Zoo – 4:00 – 4:30**
Consult the Experts

Lunch – 12:00 – 1:00

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YOUR VOICE MATTERS

COMMENT
Comment and ask questions during the presentation

OPINION POLL
Take the poll at the end of the session and we'll share the results with you

REACH OUT
Reach us at our social channels as we build a discussion where you contribute

SHARE
You build your credibility sharing this content with your partners and clients

WE WANT TO GET YOUR INPUT AND FEEDBACK TO HELP US ANSWER YOUR QUESTIONS AND IMPROVE OUR MESSAGE

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VALUE PROPOSITION

THERE'S NO SINGLE REASON WHY OWNERS CHOOSE PoE FOR INTELLIGENT BUILDINGS

WHY EXPERTS AND OWNERS ARE CHOOSING PoE AND INTELLIGENT BUILDINGS

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About Me

Luis Suau
lsuau@sinclair-digital.com
(954) 579-8737

Background Summary:
40+ Years of IT Expertise: 26 Year Cisco veteran who played a key role in the research, development, and commercialization of the Cisco Digital Building Solution (2011-2020).
Resides in Fort Lauderdale, FL

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01 ***Project Scope and the Network***

02 **Endpoint Behavior Considerations**

03 **Network Topology and Design**

04 **Other Networking Considerations**

05 **Switch Powering Considerations**

06 **Observations and Lessons Learned**

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Variety of IP/POE Digital Building Endpoints

Intel NUCs

Shot Detection

RFID Reader

Raspberry Pi POE Hat

Hospital Room Patient Display

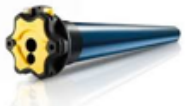
NFC Reader

Ceiling Fans

USB-C Chargers

Biometric Door Locks

Window Blind Shade Motors



Status Signs

Facial Recognition Systems

Access Points

Clocks

HVAC VAV's

Cameras

Horns and Sirens

Light Fixtures

Entry Barriers And Turnstiles

Badge Readers

Power Meter

Touchscreen PC's

IP Call Stations Phones

IP Call Tower

POE Displays

Temp Sensor

Environmental Sensor Hubs

Curtain Motors

Meeting Room Nameplate

"Complexity tends to be proportional to project size"

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01 Project Scope and the Network

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How do the endpoints behave?

- IPv4 vs IPv6
- DHCP vs Static Addressing
- Broadcast vs Unicast
- Autonomous vs Server Dependent
- If Server Dependent:
  - Cloud
  - On-Prem
    - Physical
    - Vertualized

01 Project Scope and the Network

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Will the Network be Isolated or Integrated?

- Safer
- Harder to Manage and Upgrade
- Difficult to Integrate with IT systems

- Requires cooperation with IT
- Subject to IT policies and guidelines (InfoSec)
- Allows for Integration with IT Systems
  AV/telephony, calendaring, access control, etc.

Is the Network Centralized or Distributed?

- More Cabling Required
- Controlled Access in IDF
- Greater IDF Cooling Requirements
- Power needed in IDF

- Less Cabling, patch cables to endpoints
- Allows for ring and daisy chain topologies
- Ceiling may be less secure, service requires ladder
- Less Cooling in IDF, lower cost switches
- Distributed Power required in ceiling

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POE Lighting & UL-924

Reference Only - Discussed in other section

IOTA

POE Texas

MHT

Molex
EM-Lighting
Bypass

The Emergency Lighting part of the network is generally designed by POE lighting partners such that **the network switch is passive and plays no control role; therefore the switch has no requirement to be UL-924 listed**. POE Lighting partners are aware of these design considerations. Local AHJ Acceptance will dictate option utilized. Options:

1) Uncontrolled Emergency Lighting (lights always on, no control)
Requires switch power from UL-924 Listed UPS

2) Controlled Emergency Lighting (UL-924 LED Driver)
https://www.igor-tech.com/news-and-insights/news/igor-awarded-industrys-first-central-ul-924-certification-for-a-poe-solution
Note: Control Provided by Igor Software Platform

3) Unit based battery pack on UL-924 light
Dependent on POE Lighting partner. The network switch is passive just like an electrical junction box.
https://www.iotaengineering.com/poecp12v1a.html
https://www.platformatics.com/wp-content/uploads/2019/03/ELN-CS-3-26-19v1.3-edd.pdf

4) Hybrid POE – Line Voltage Approach

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Switch Power and Resiliency Considerations

← **Line Voltage/AC Example**

Cisco Catalyst 9200/9300

← **Line Voltage/AC or DC Example**

Lantronix SM24TBT2DPA

← **DC Example**

POE Texas GBTS-28-24-M

POE Texas
GBTS-10-8-M-V2

Lantronix
LSS2200

Luum.io XS-108H

DC Examples

Other Network Considerations:

- Switch Boot Time
- Power System hold up time (switch brown-out tolerance)
- Compliance markings to meet NEC

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Network Architecture Topics

Reference Only – Consult your Network Architect

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DHCP vs Static Addressing

- Implication to speed of building cold boot

Network Segmentation and VLANs

- Use of VLANs, Firewalls, Policy/ACL's, and other networking features is fundamental to protect the network

Advanced Topics (Enterprise implementations)

- Network Access Control (device profiling)
- IETF Manufacturer's Usage Description
- Software Defined Architecture

Rat Hole Alert!

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The larger the project, the greater the complexity. Seek Network Architects and Consultants for help.

Systems Integration and other complexities

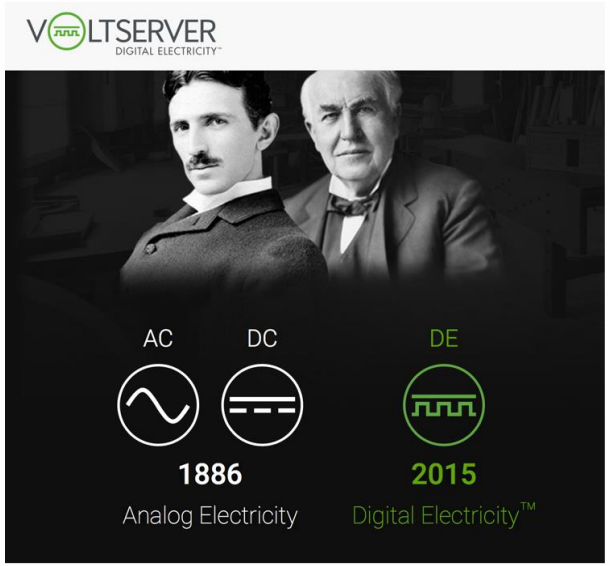
Reference Only – Consult your Network Architect

- Is integration led by the lighting partner or a 3rd party?
- Are API's well documented?
- Do API's meet security criteria?
- Is integration system to system or coordinated through middleware?
- What protocols may be involved?
  - https
  - COAP
  - MQTT
  - BACnet
  - ModBus
  - JSON

Rat Hole Alert!

The larger the project, the greater the complexity. Seek Network Architects and Consultants for help.

Digital Electricity and similar emerging Power Distribution Technologies



Voltserver Digital Electricity
Pulsed DC Power (Packet Energy Transfer)

- Safe to Touch
- NRTL listed NEC 62368-1 limited power source
  - As a listed limited power source, it qualifies to be installed under NEC Article 725
- Each Pulse Packet checks for:
  - High Current
  - Ground Fault
  - Arc Fault
  - High Resistance (loose connection)
  - Touch (resistive load)
- Range up to 2KM
- 500W at 1K ft on 1 pair 18AWG cable

2023 National Electric Code

Article 726 Established **F**ault **M**anaged **P**ower as Class 4 Power

- Must manage fault to IEC shock curve
- Power up to 450 Volts
- AC, DC, or hybrid

UL 1400-1 Standard for Transmitting and Receiving equipment from a manufacturer

- Not an interoperability standard exists
- Tx and Rx must be certified together as a system

UL 1400-2 Standard for Cables

- May share cable path with low voltage

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The importance of Lab Testing and Staging

- Prototype the deployment
  - Reduces Risks, work out control details
- Validate network and endpoint connectivity and functionality

Plan, Plan, Plan!

- Preplan as much as possible:
  - Addressing, Labelling
- Preconfigure as much as possible
  - Reduces the number of times that devices must be touched along the installation process
- Maintain documentation along the way

Cabling

18AWG Digital Electricity cabling

- **Wire Gauge is important**
- **Digital Electricity/FMP**
  - Vet cabling Digital Electricity cabling requirements with VoltServer. Cable Gauge will vary with distance and power load.
  - Prefer Outside rated cable in vertical riser applications to survive water leaks during construction.
- **POE**
  - Application is **high-power**, **low-data**. **22AWG** Cat5e or Cat6(1G) tends to be best for dealing with power loss over distance
  - Prefer UTP over STP. At longer distances STP have observed issues (possibly due to EMI)
  - Test and verify all field connections. Follow BICSI standards. If bundling pay attention bundle size, ampacity, and heat rise applicable to 2017 NEC®
  - Use factory made cables where possible to minimize field terminations. Improve reliability, speed installation.

Digital Building – Centralized Deployment

Documentation

Reference Only

- **Lighting Specific:**
  - Reflective Ceiling Plan (RCP)
  - Fixture Schedule
  - Sensor Documentation
  - Controls Narrative
  - Sequence of Operations
  - API's
- **Endpoint Documentation as available**
  - IP Addresses (if static)
  - MAC Addresses
  - Configuration Details
- **Integration Documentation**
- **Service Contacts and Support Details**
- **System High-Level Description**
  - Description of Systems Installed and Behavior (particularly UL-924)
- **Records Drawings:**
  - Network Topology, Addressing, and Configuration Specifics
  - Cabling Layout, Pathway, and Space Designs
  - Electrical line diagrams and PDU configuration
- **Other System Documentation and Manuals**

Refer to ANSI/BICSI 0007-2020 ICT Design and Implementation Practices for Intelligent Buildings and Premises https://www.bicsi.org/standards/available-standards-store/single-purchase/bicsi-007-iot-intelligent-building

Labeling

Reference Only

- Labeling is fundamental to Verification, Testing, and Maintenance
- Key to project documentation
- Follow TIA-606-C
  https://global.ihs.com/doc_detail.cfm?&item_s_key=00142041&item_key_date=820611&input_doc_number=TIA%20606%2DC&input_doc_title=

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Fundamentals of PoE Lighting and Automation

By the PoE Consortium

BICSI Conference

Who are we?

Akram AK Khalis
CTO - MHT

mht

Joe Herbst
CTO - PoETexas

PoE Texas

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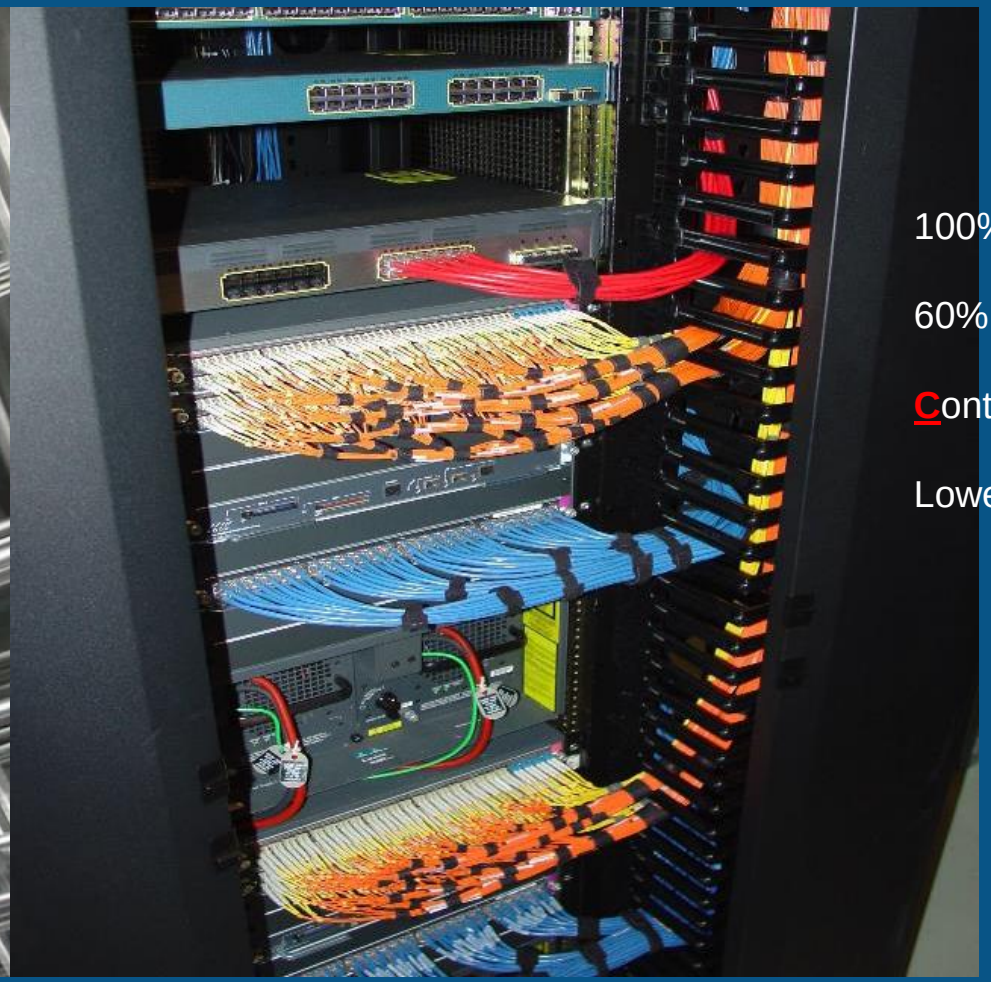
Why PoE for Buildings?



100% less Conduit

60% less Copper

Controls come for free

Lower Cost to install

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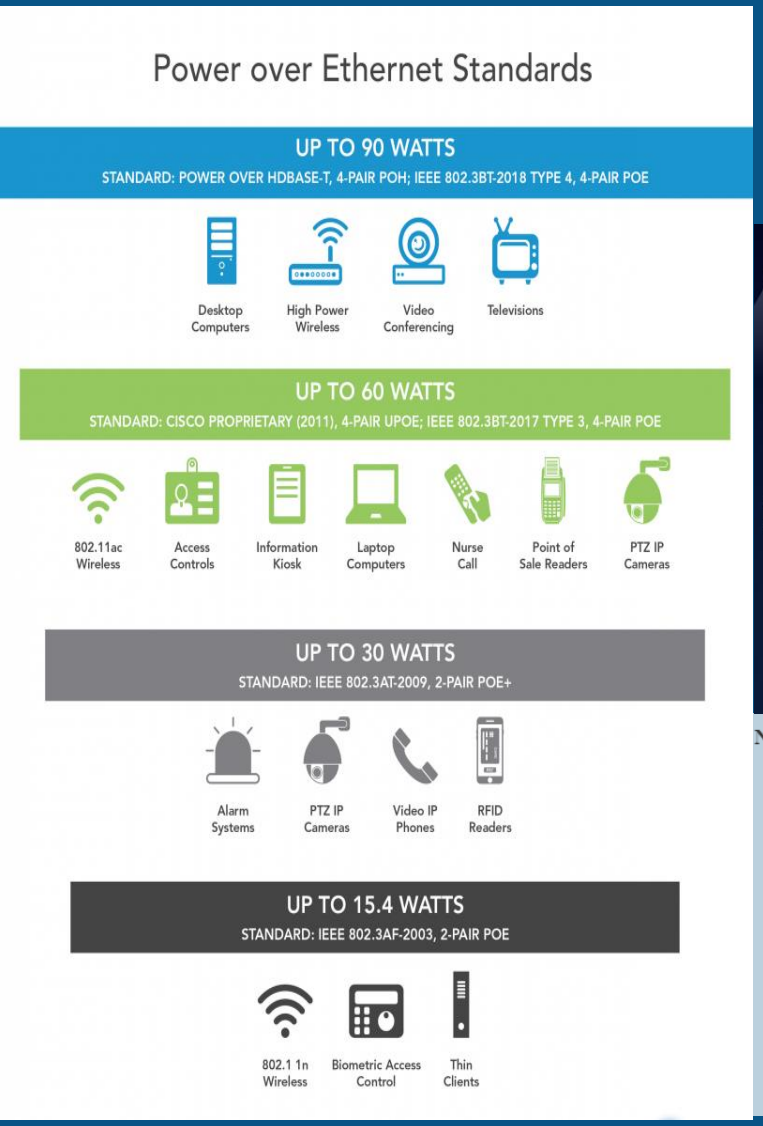
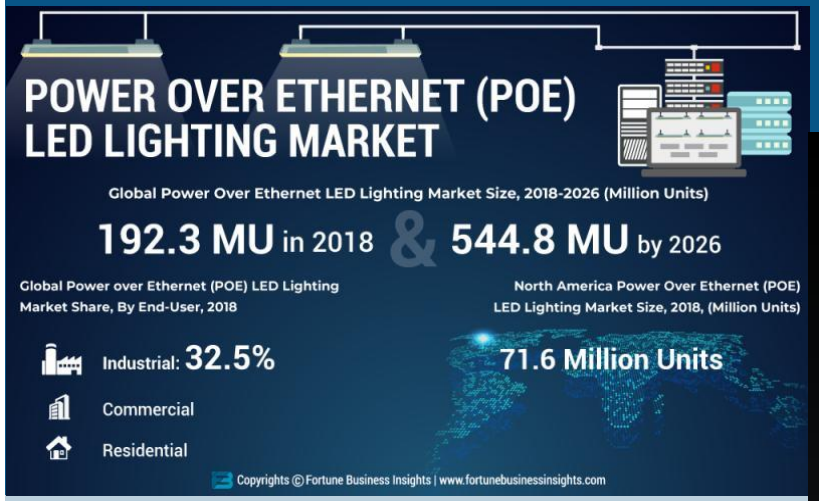
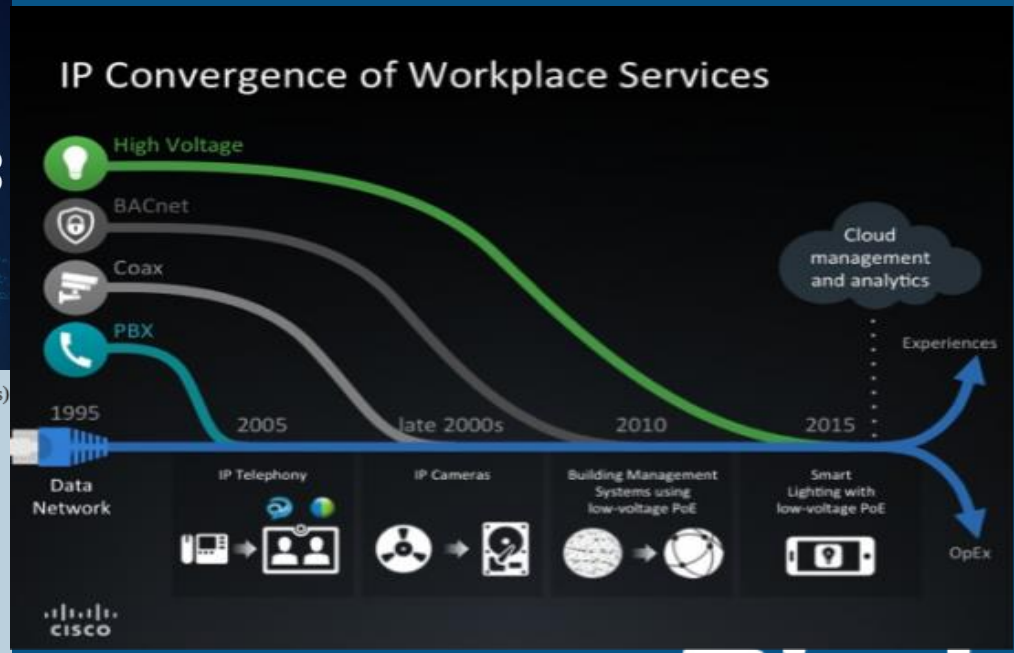
DENTON
DIGITAL BUILDING INTELLIGENCE

What is PoE ?

- 18-year-old, stable & mature technology
- Up to 90+W of power & 1Gb/s data in one cat6 wire
- Inherently safe, physical security (no wireless hacks)
- Intelligent ***distribution*** of power and data







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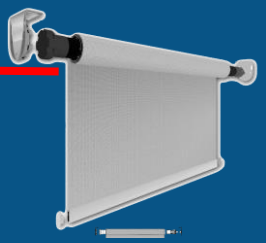
Network Architecture Model

Cameras

Network Switch
(PSE)

Servers

Shades



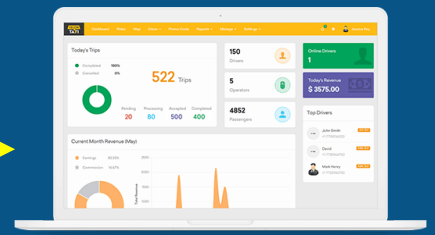
Node (PD)
192.168.71.5
A0:22:10:4E:00:23

Router (just one!)
192.168.71.x

Field
UIX's

Node (PD)
192.168.71.6
A0:22:10:4E:00:24

Laptop



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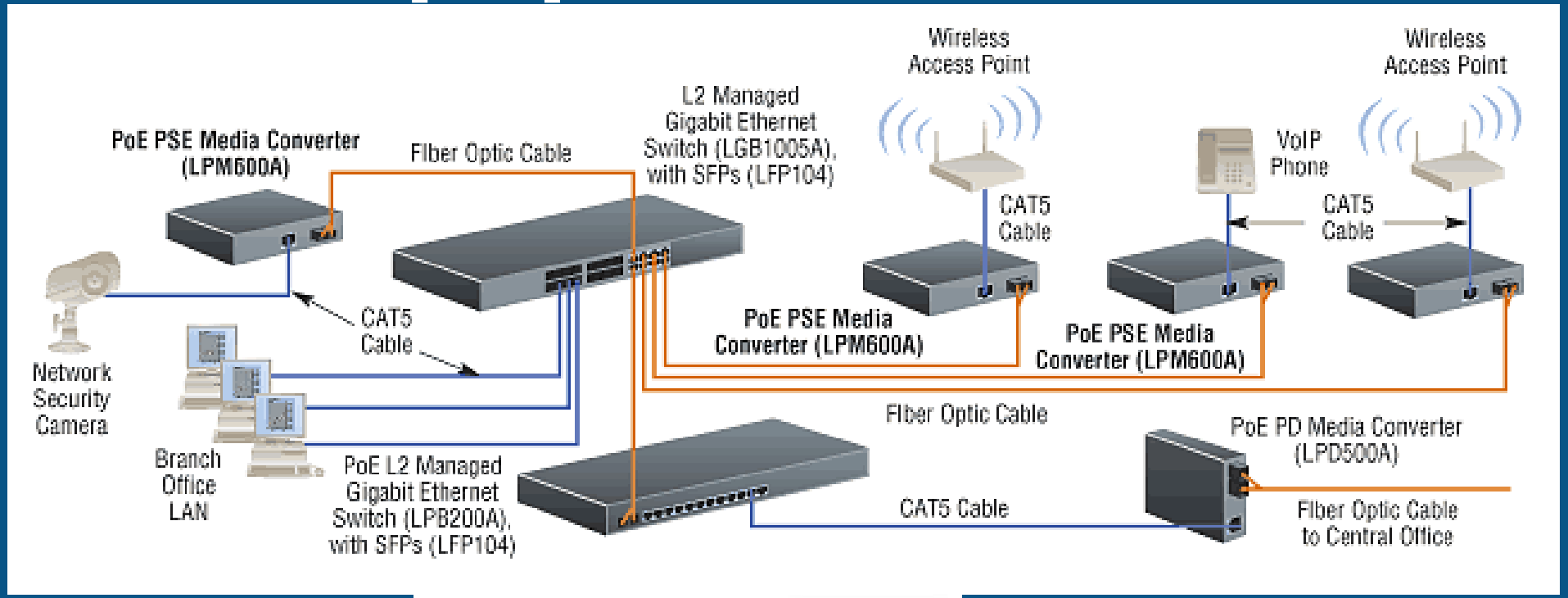
Power Source Equipment

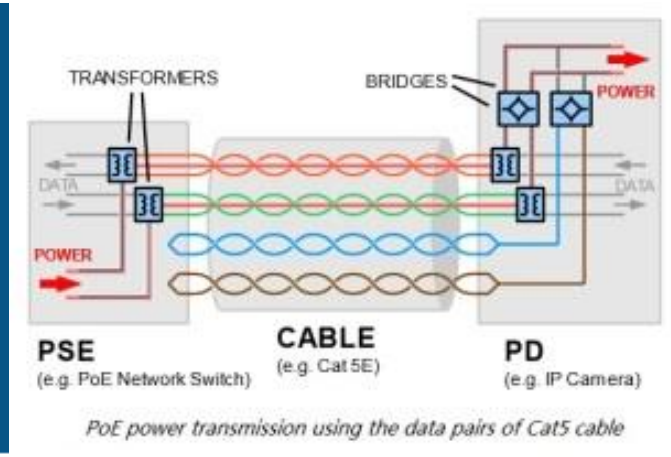
Adds power to a set of wires but keeps the signal

Able to regulate max power on each port

Able to restart port

Instant addition of power to the cable to support EM lighting





PoE power transmission using the data pairs of Cat5 cable

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What is a PD?

In the PoE world... a PD is the "Powered Device"

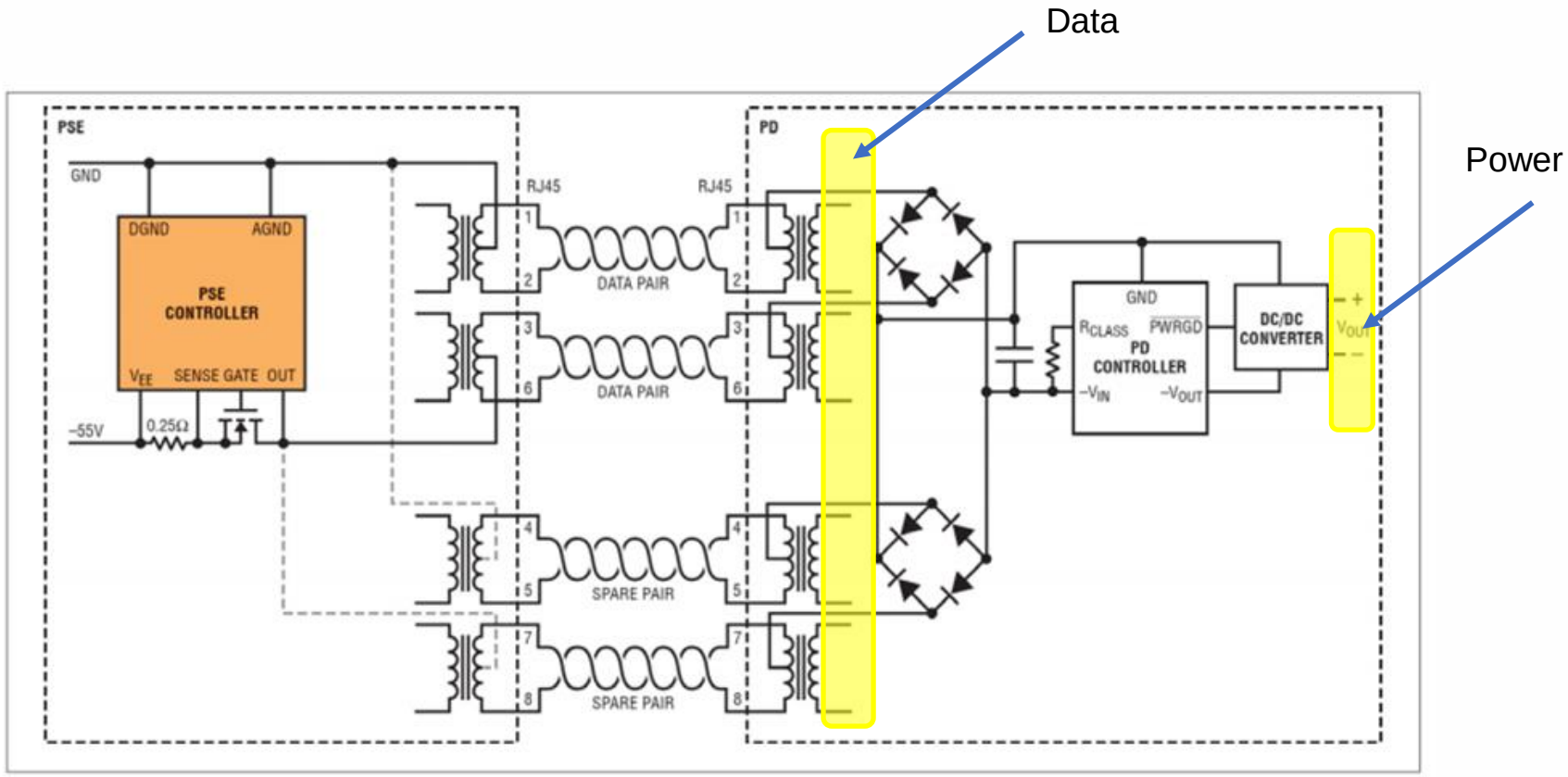


Figure 1. Heath Stewart, Analog Devices. https://www.analog.com/media/en/technical-documentation/tech-articles/lt-journal-article/LTJournal-V21N2-01-df-LTPoE__Heath_Stewart.pdf

Power or Power & Data... over a single category cable.

Any low-voltage device needing power and communications could be a PD.

Extracts power away from data

Negotiates for the power required

PD Requirements : Power

AF used by most VOIP phones

AT used most by video cameras

BT used by lighting and tablet/laptop charging

They are all backward compatible with legacy Ethernet which makes them extremely reliable

The 4 Types of PoE

POE++

	Type 1	Type 2	Type 3	Type 4
IEEE Extension	IEEE 802.3af	IEEE 802.3at/PoE+	IEEE 802.3bt/UPOE	IEEE 802.3bt
# Twisted Pair	2-pair	4-pair	4-pair	4-pair
PSE Power	15.4W	30.8W	60W	90-95W
Device Power	13W	25.5W	51W	71.3W

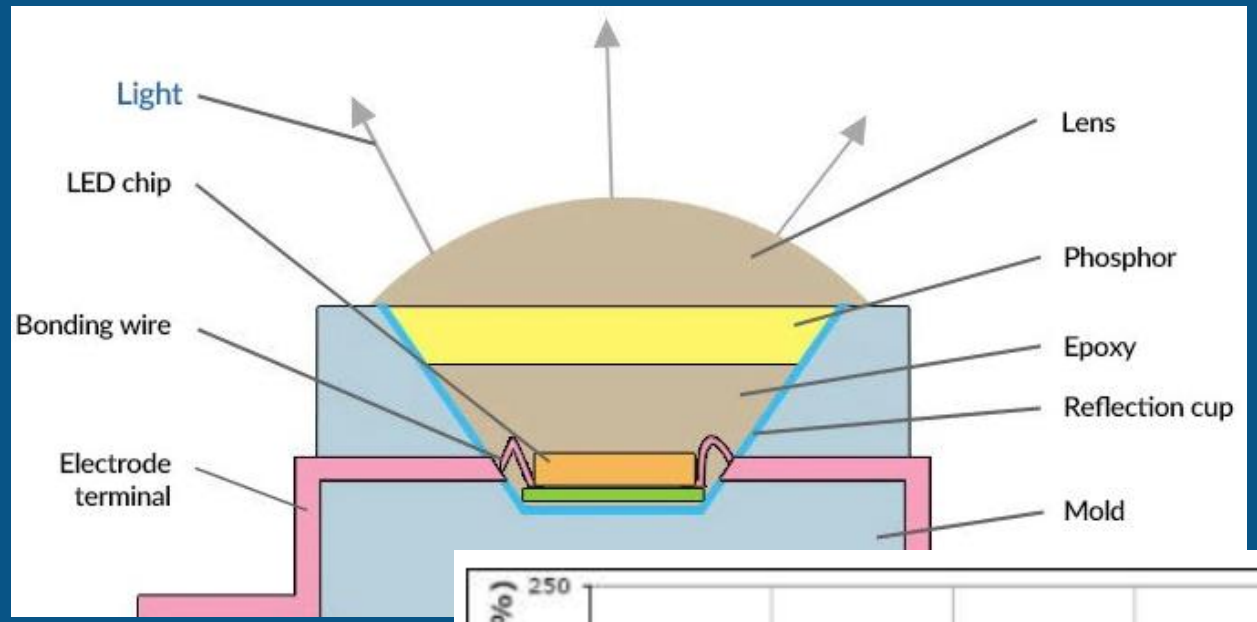
Class Number[1]	Input Power to Powered Device (watts)[1]	Output Power from Power Sourcing Equipment (watts)	Powered Device Type	IEEE Standard[2]
0	13	14	1	802.3af (2-pair PoE)
1	3.84	4	1	
2	6.49	6.7	1	
3	13	14	1	
4	25.5	30	2	802.3at (PoE+)
5	40	45	3	802.3bt (4-pair PoE, 4PPoE, PoE++)
6	51	60	3	
7	62	75	4	802.3bt (higher-power PoE)
8	71.3	90	4	

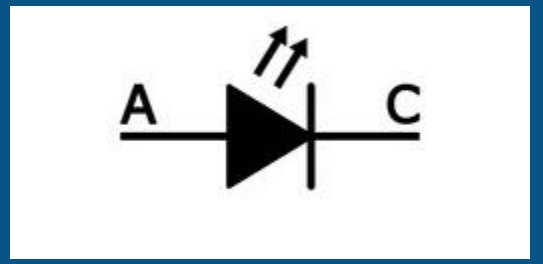
Maximum cable length = 100m / 328ft

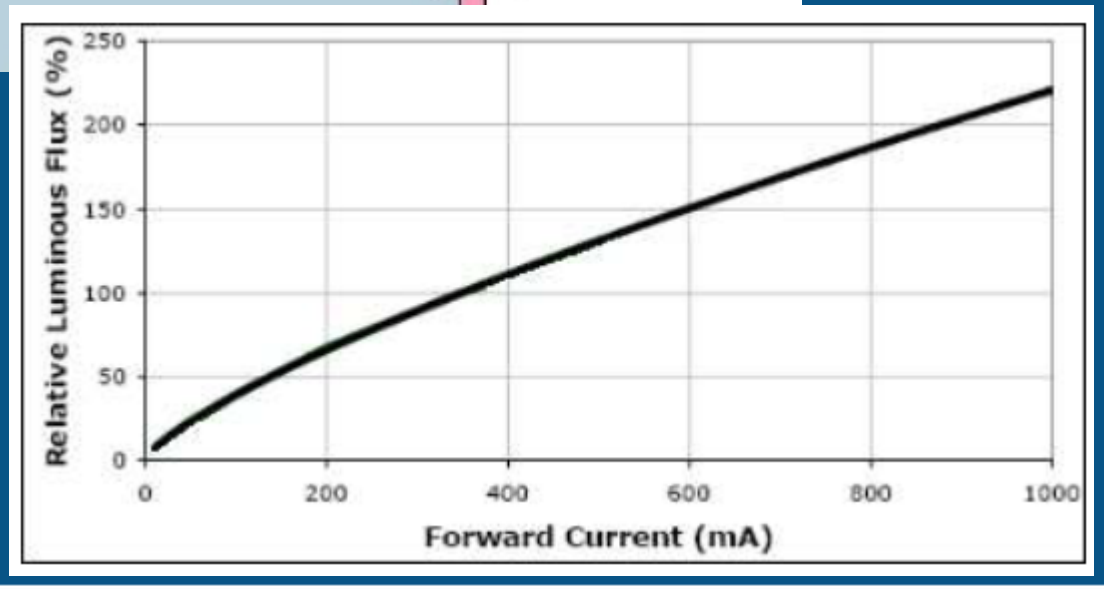
Lighting

Constant Current vs Constant Voltage

What is a Light Emitting Diode?







- Equivalent to backflow valve in water flow, from Anode (+) to Cathode (-)
- Light output (luminous flux) is proportional to the (forward) current

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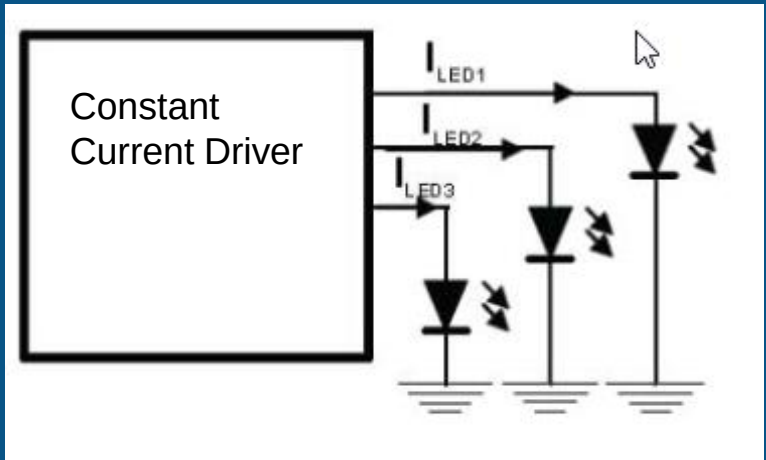
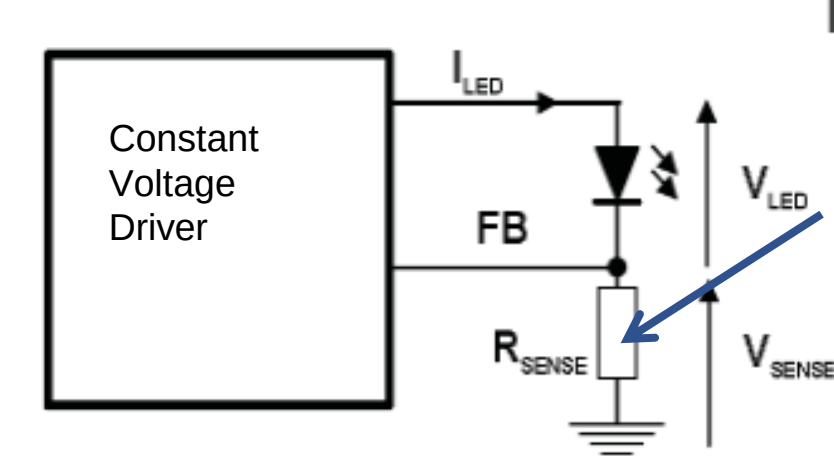
Current Limiter Required

- To avoid meltdown – there must be a current limiter in the system.
  - Constant Current: done with an electronic circuit inside driver (efficient)
  - Constant Voltage: done with a resistor inside fixture. (inefficient)
- The Power = Voltage * Current
  - LED's brightness is defined by current
  - Heat ***density*** and the heat sink design are critical





This is why CV is not as efficient as CC

Comparison

CC: Current limited by DRIVER

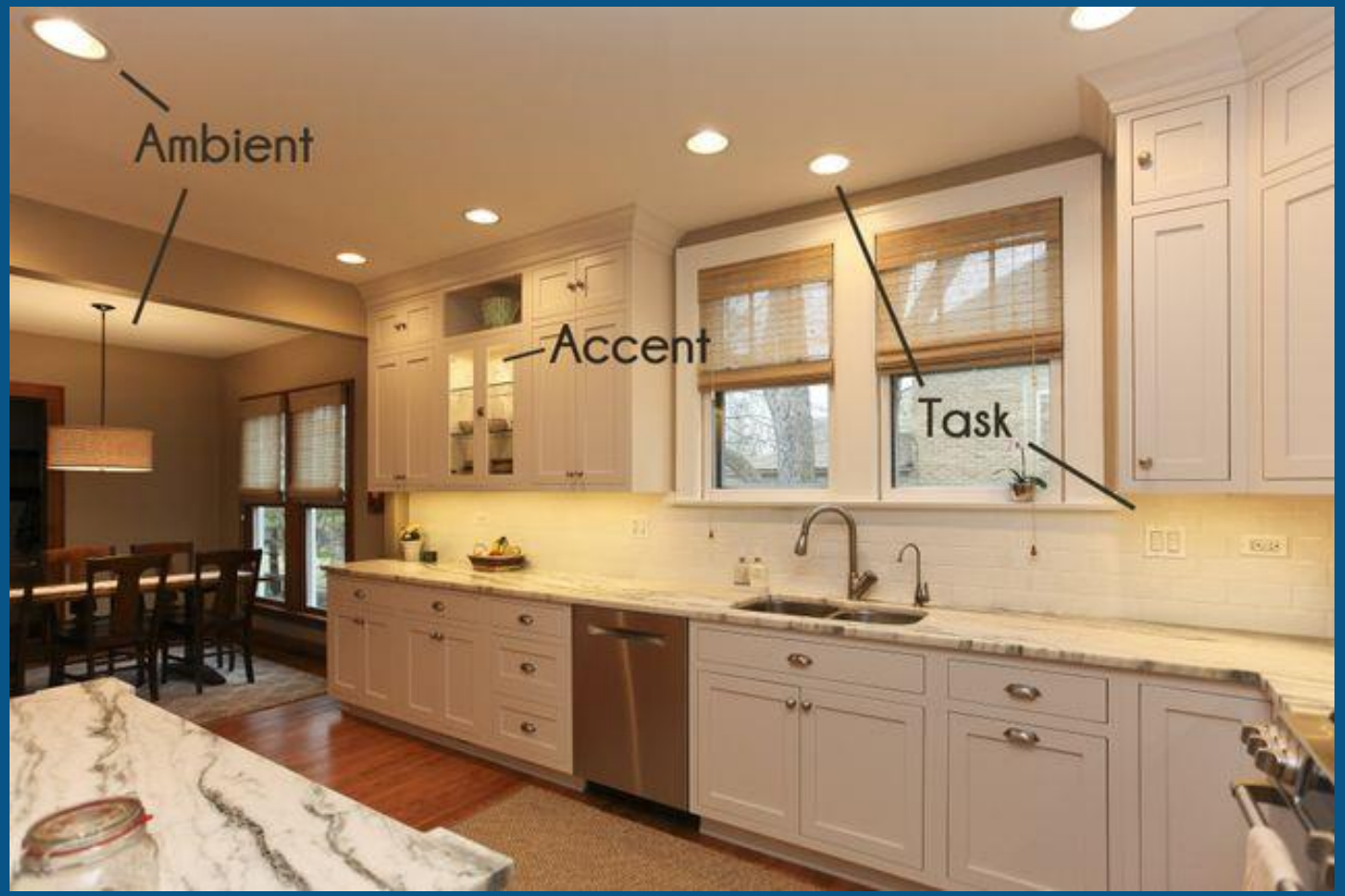
- Pro's
  - 20-30% more efficient (lumens / watt)
  - Higher Precision
  - No flicker
- Cons
  - 1 fixture per node output unless all the same fixture and more than 3 fixtures

CV: Current limited by DEVICE

- Pro's
  - Multiple fixtures per driver (wired in parallel aka daisy chained)
  - Different types of fixture on same driver
- Con's
  - Potential for flicker (depends on fixture)
  - 20-30% less efficient (lumens / watt)

3 Types of Lighting

- Ambient
  - Entire room
  - Uniformity
  - Safety
- Accent
  - Draws focus
  - Creates affect
- Task
  - Detail work
  - Reading
  - Independent



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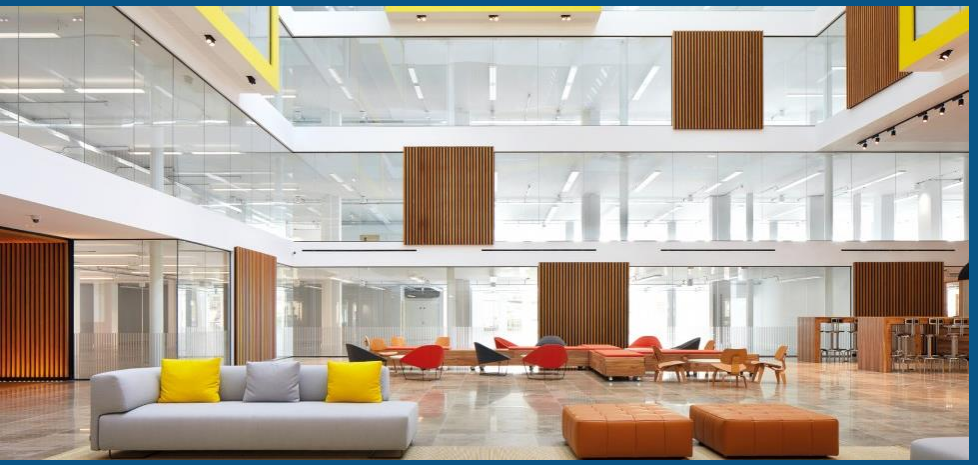
Ambient Lighting Examples



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Accent Lighting Examples

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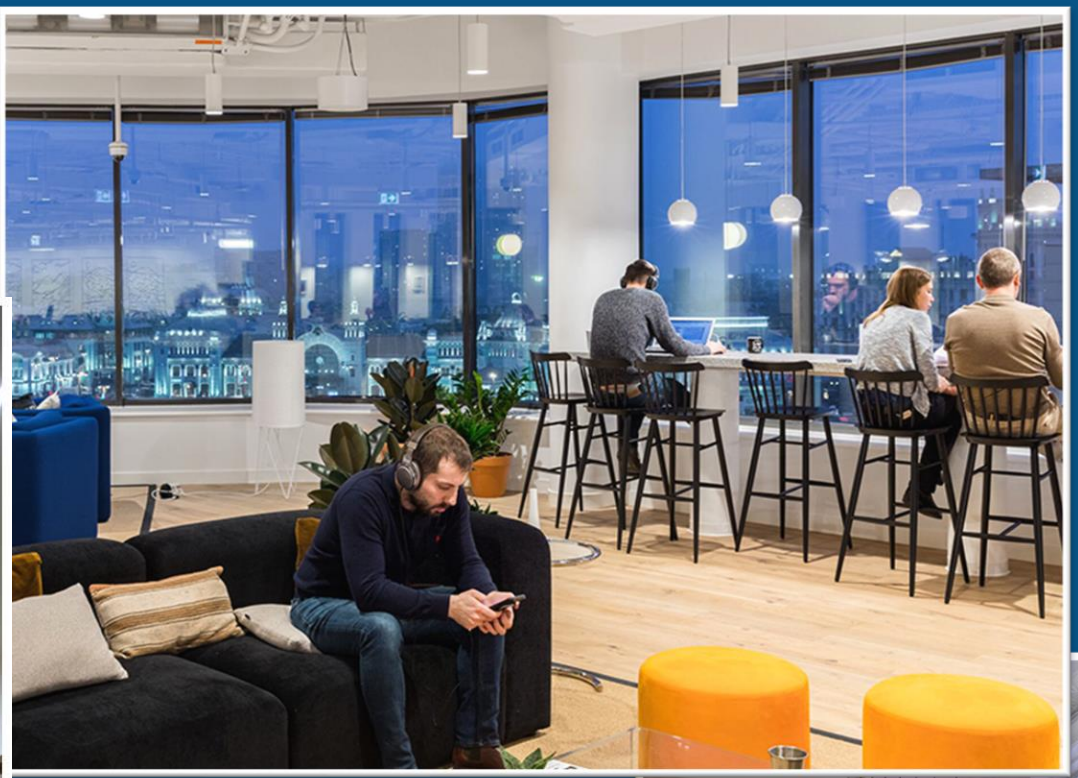
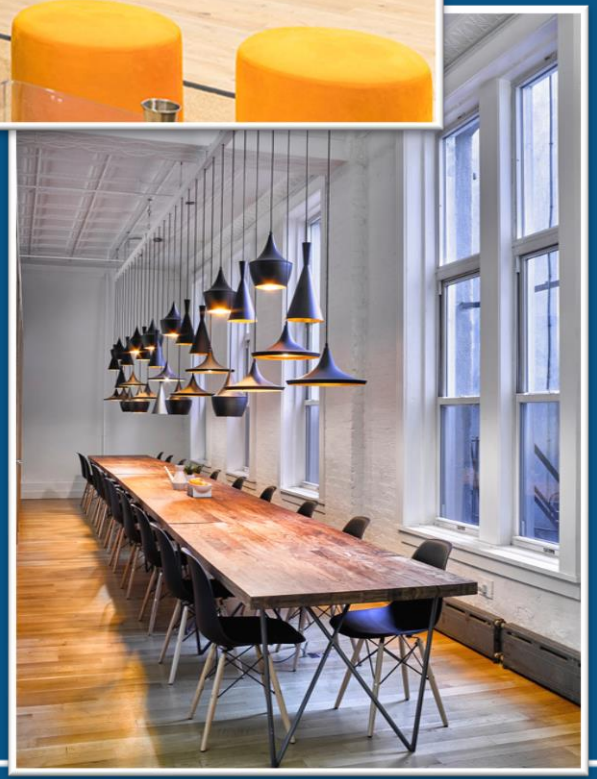
Task Lighting Examples





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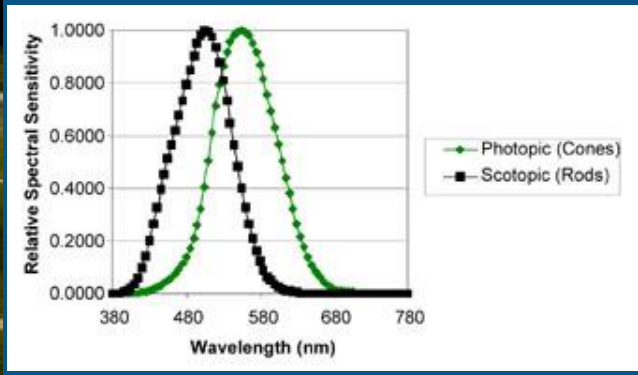
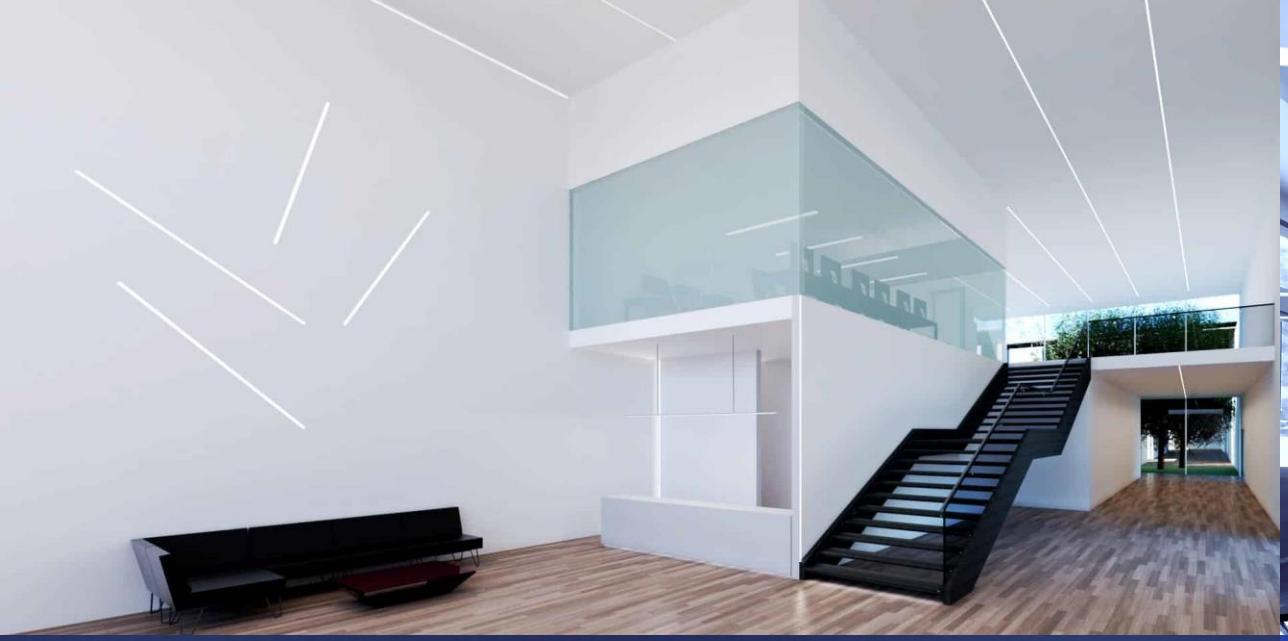
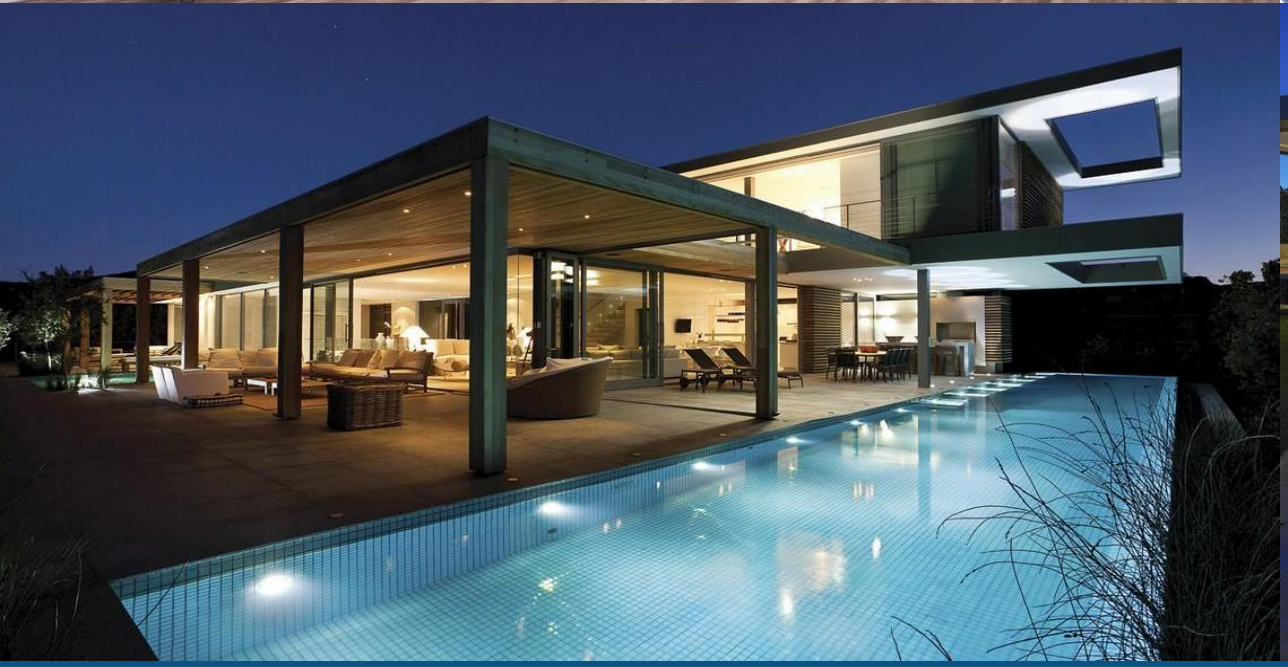


Color Rendering Index (CRI) is a measurement of how natural colors render under an artificial white light source when compared with sunlight





Good lighting *with controls* creates an emotional connection to the space

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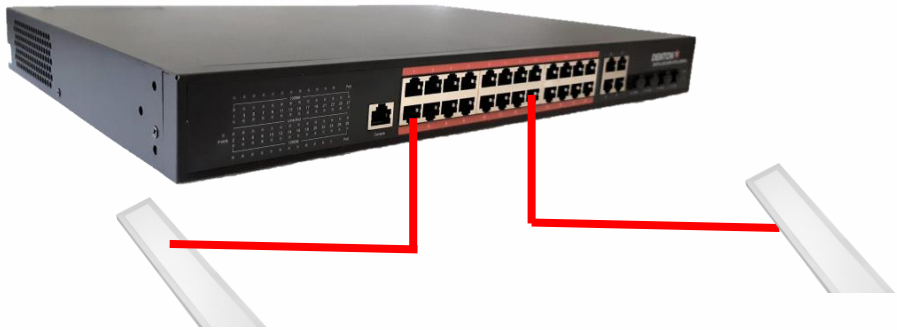
Applications of PDs : Lighting

1:1

Fixture Centric

One to One

More Powered Ports



PoE driver inside fixture

Just cat6 wiring

Typically, more expensive

Fixtures > 50W

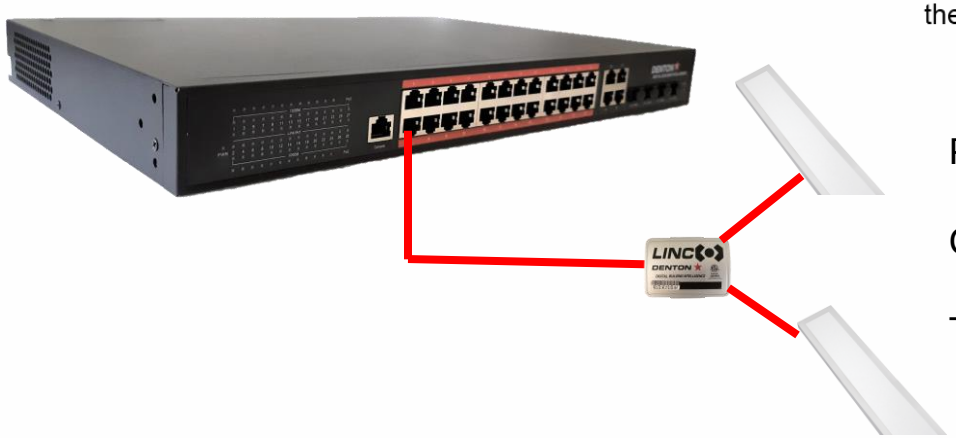
Node Centric

One to Many

Less Powered Ports

1:N

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



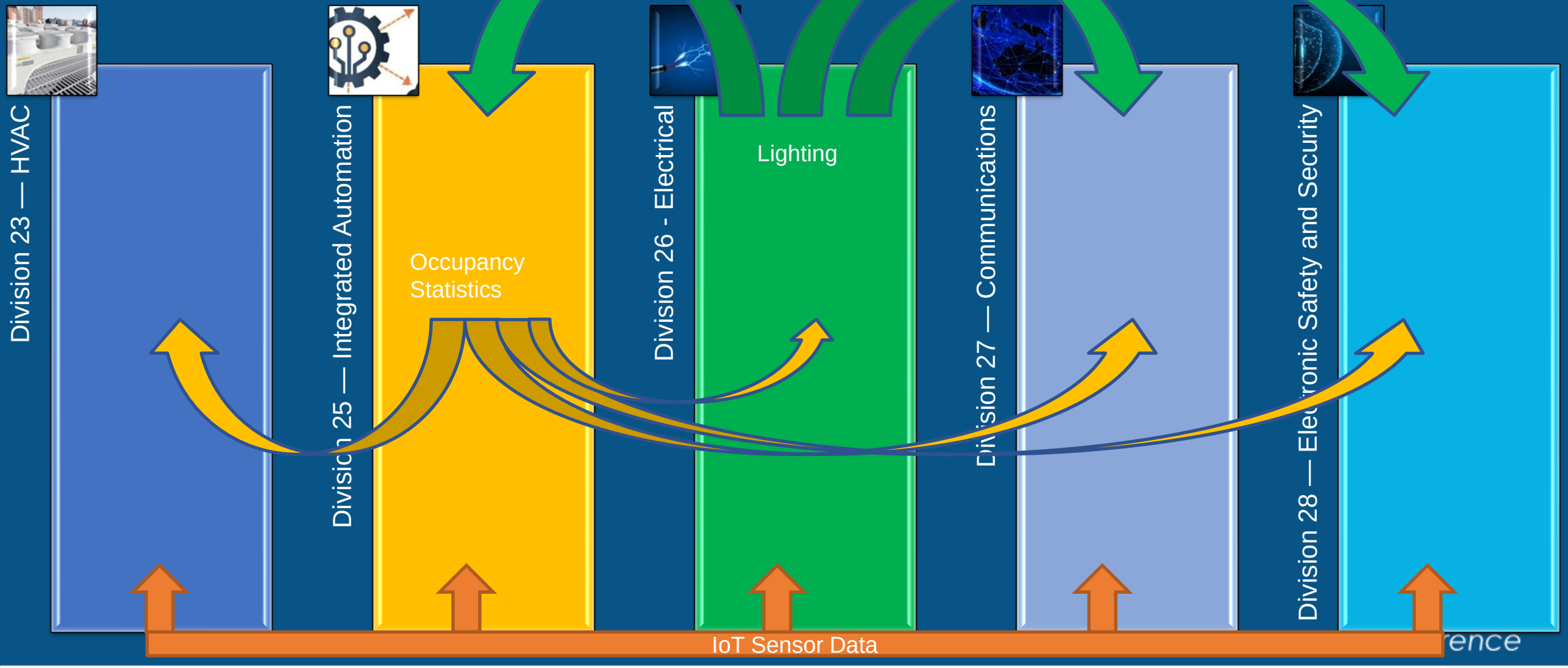
PoE driver outside fixture

Cat6 + AWG18 wiring

Typically, less expensive

Fixtures < 50W

PoE unifies M-E-P but…..it disrupts the classic model



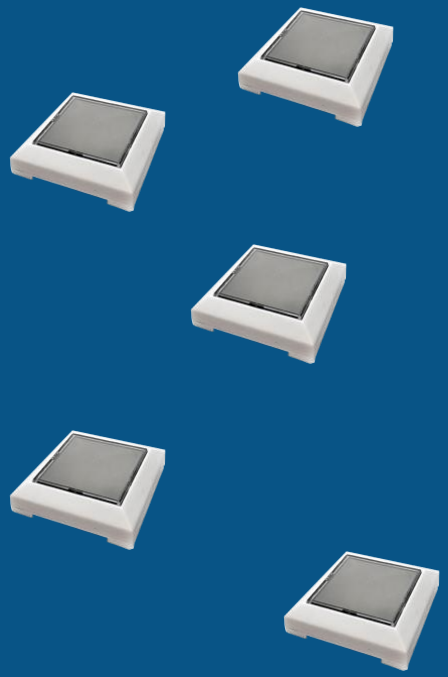
w/o PoE

Call for cool

Call for heat

One temp sensor per floor/building

With PoE



Call for cool

Call for heat

Call for fan

Raise/Lower shades

Adjust Light Level

One Sensor (light, temp, humidity) per room

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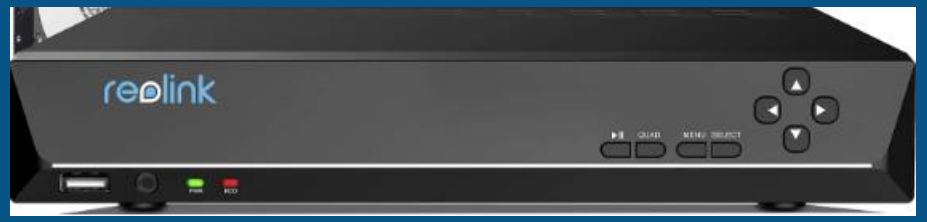
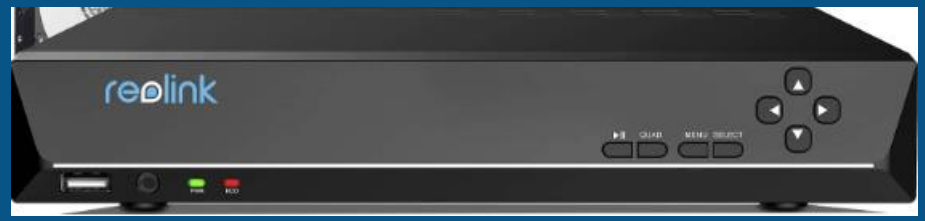
w/o PoE

PoE Camera

Stream video to disc or cloud



Stream video to disc or cloud



with PoE

Brighten Lights to 100%

Email / Text if after hours

Contact HVAC to adjust temp

One Sensor (light, temp, humidity) per room

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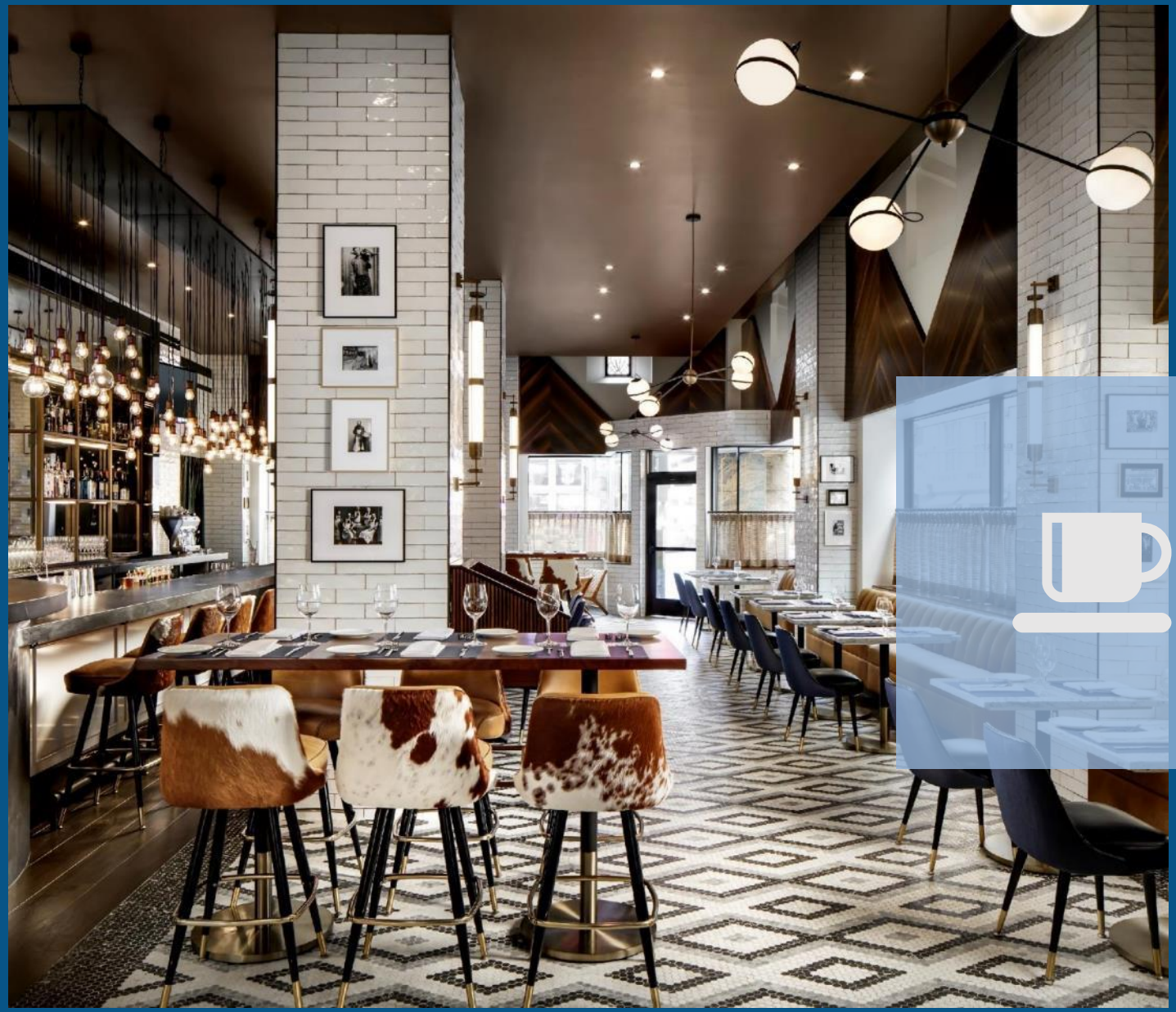
PoE: It brings worlds of information together!!!

Thank you



SECTION BREAK

Break – 10:15 – 10:30 am

Courtesy of the Sinclair Marriott

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ABOUT ME

I have been a pioneer in the Power-over-Ethernet Lighting Space. Co-founder of the company, NuLEDs, the company that developed and introduced the first network-controlled PoE lighting system. Her background includes over 35 years in the electrical industry as an electrician, contractor and lighting specialist

Lisa Isaacson

Sr Field Applications Engineer at Mecho

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NAVIGATING THE DESIGN PROCESS

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01 ***Project Planning***

02 **PoE Components**

03 **Players Involved**

04 **Things to Consider**

05 **Project Implementation**

06 **Construction Drawings & Docs**

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PROJECT PLANNING PHASE

Intelligent Building Considerations

- Design Consultants
- Selecting Intelligent Building Systems
- IT and OT Systems
- Establish roles and responsibilities

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PROJECT PLANNING PHASE

Architect and Owner Establish Design Parameters

- What is needed
- When it is needed
- Quality desired
- Sustainability
- Project Budget

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SCHEMATIC DESIGN PHASE

Code Considerations:
Key Codes that Apply to Design and Installation of PoE lighting:

- Electrical Code:
- Building Code:
- Energy Code: State and Local Licensing
- Division 26 vs 27
- Emergency Lighting

01 Project Planning

02 ***PoE Components***

03 Players Involved

04 Things to Consider

05 PoE Implementation

06 Construction Drawings and Docs

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Components

Designing for Success

- PoE Switches
- PoE Drivers
- Cable
- Fixtures
- Shades
- Controls
- Sensors

Other Devices….

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01 Project Planning

02 PoE Components

03 ***Players Involved***

04 Things to Consider

05 Project Implementation

06 Construction Drawings and Docs

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RECOMMENDED BEST PRACTICES

- Plan for PoE lighting and other intelligent building systems from the onset of the project

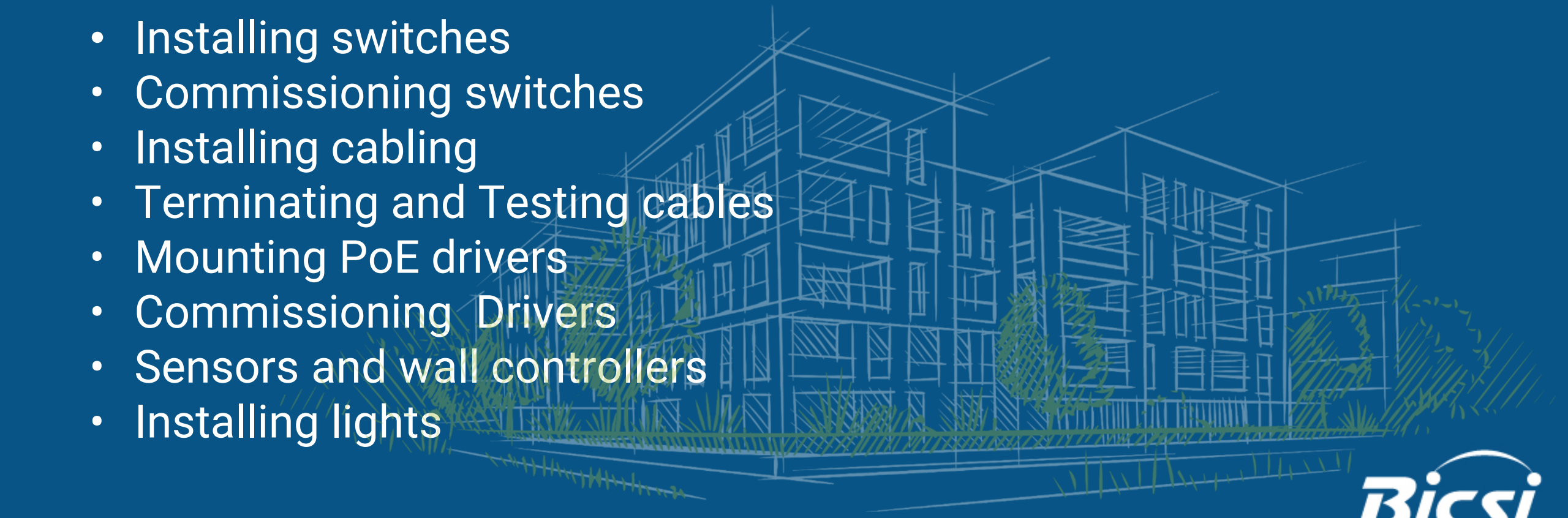
- Conduct a design charrette involving all stakeholders

  ✓ Stakeholder Responsibilities
  ✓ Corporate Standards
  ✓ Preferred Topology
  ✓ Level of Systems Integration

Components and Responsibility

Designing the Responsibility Matrix

- Installing switches
- Commissioning switches
- Installing cabling
- Terminating and Testing cables
- Mounting PoE drivers
- Commissioning Drivers
- Sensors and wall controllers
- Installing lights



DESIGN: *DRAWING RESPONSIBILITIES*

Once the drawing phase begins, the Lighting Designer will begin to lay out the fixtures based on the design rules produced by the low voltage designer. Throughout the rest of the drawing phase there should be constant communication between the team as revisions and new requirements become known.

Lighting Designer

- Establish lighting levels required
- Design lighting layout in coordination with architect
- Select light fixtures
- Select light temperatures and finishes

Electrical Engineer

- Place emergency lighting on drawings for permit
- Coordinate with LV designer to ensure all distribution systems have adequate power
- Coordinate with LV designer to coordinate layouts

Low Voltage Designer

- Place distribution systems in drawings
- Produce wiring/connection drawings for all LV systems
- Ensure all systems are compatible for communication and collaboration

Electrical Responsibilities

Ensure correct bidding parties

- High Voltage Devices and Wiring
- High voltage power to LV distribution systems
- Light Fixture Installation
- Battery Backup System installation

ELECTRICAL CONTRACTOR

Reduction/Shift of Scope

LOW VOLTAGE CONTRACTOR

Increase of Scope

- Low voltage Lighting Wiring
- Racks and Patch Panels
- Wall Controllers and Sensors

SYSTEM SETUP/COMMISSIONING

01 Project Planning

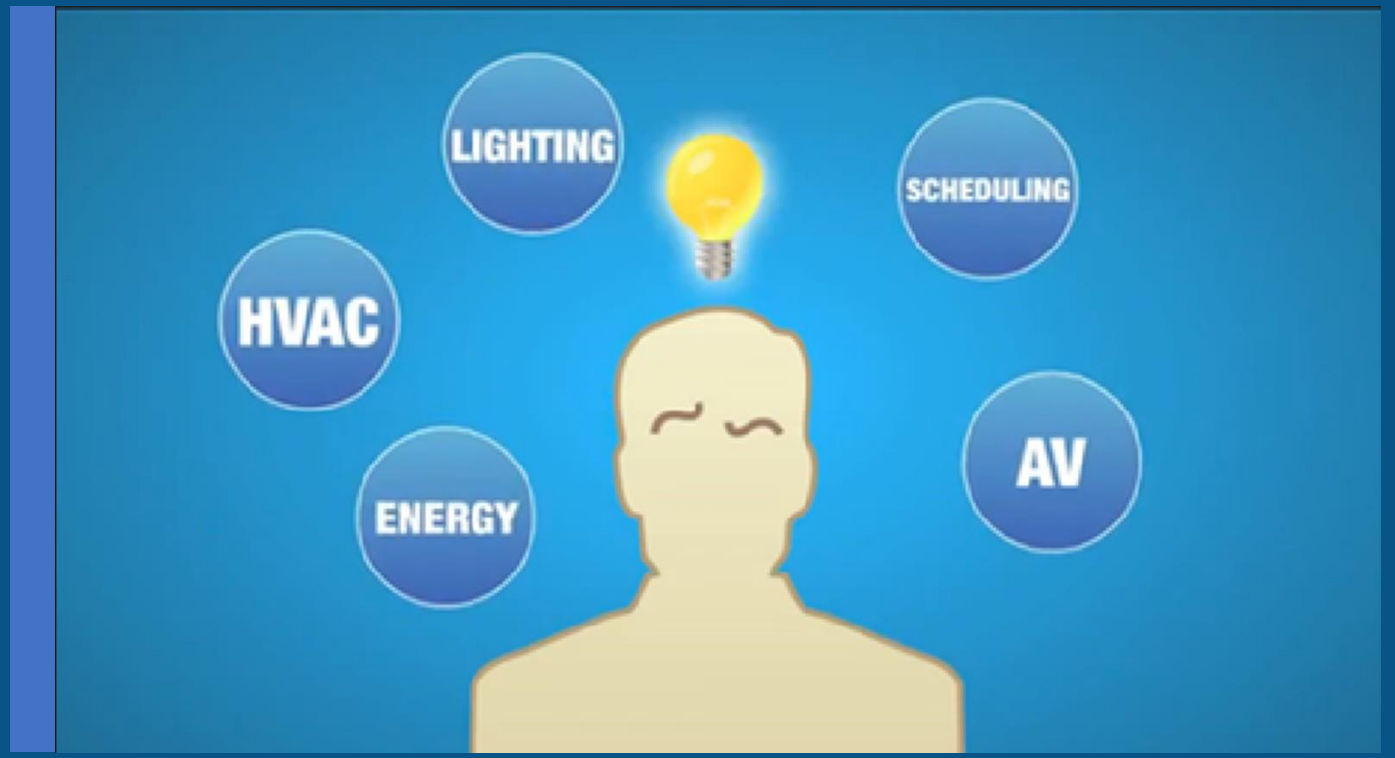
02 PoE Components

03 Players Involved

04 *Things to Consider*

05 Project Implementation

06 Construction Drawings and Docs



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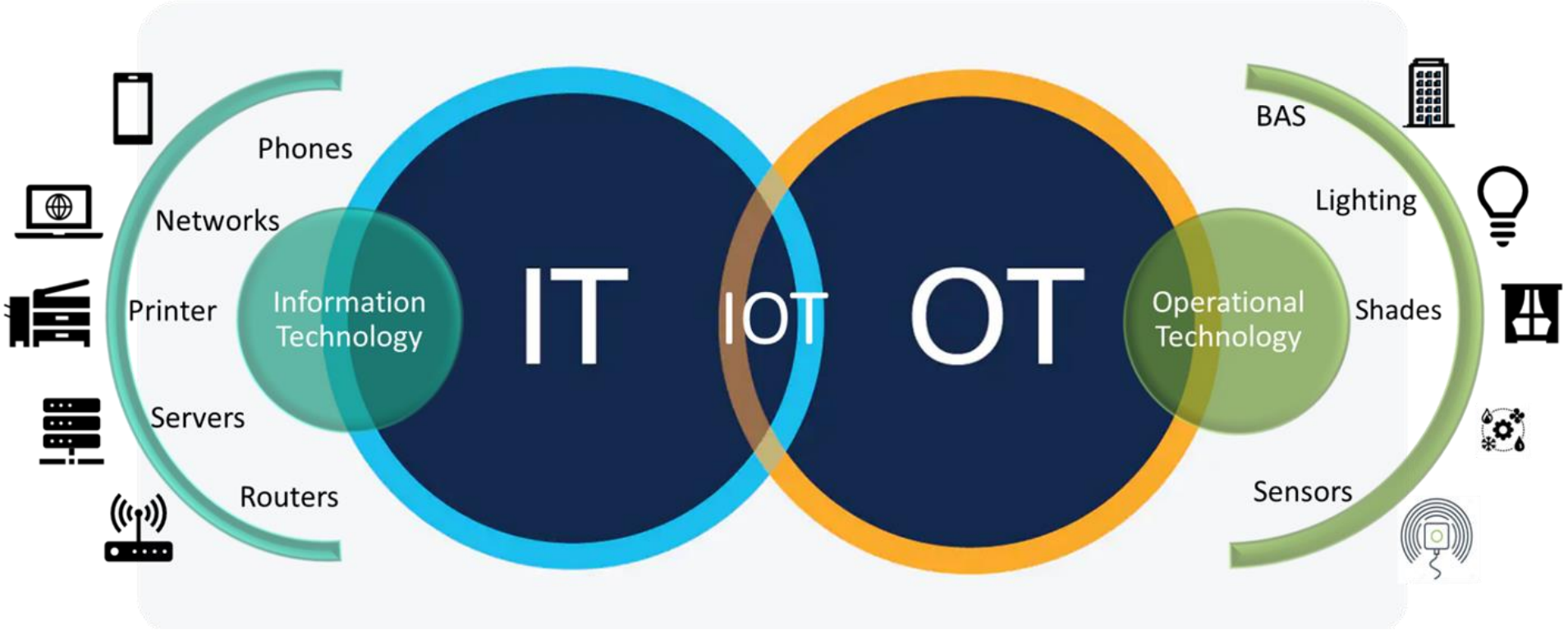

IT Network vs OT Network

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Is the Network Centralized or Distributed?

- More Cabling Required
- Controlled Access in IDF
- Greater IDF Cooling Requirements
- Power needed in IDF

- Less Cabling, patch cables to endpoints
- Allows for ring and daisy chain topologies
- Ceiling may be less secure, service requires ladder
- Less Cooling in IDF, lower cost switches
- Distributed Power required in ceiling

01 Project Planning

02 PoE Components

03 Players Involved

04 Things to Consider

05 ***Project Implementation***

06 Construction Drawings and Docs

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CONSTRUCTION SEQUENCING CHANGES

01 *Framing*

02 *Rough-in MEP*
Electrical/Mechanical

03 *Back Boxes/Stub-ups*
Electrical

04 *Equipment Racks*
Low Voltage

05 *Low Voltage Cabling*
Low Voltage

06 *Switch Installation*
Low Voltage

07 *Drywall*
Drywall Contractor

08 *Lighting Installation*
Electrical

09 *Lighting Wiring*
Low Voltage

10 *FF&E Install*
FF&E Installers

11 *Shade Install*
Shade Installers

12 *Commissioning*
Low Voltage/Manufacturer

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01 Project Planning

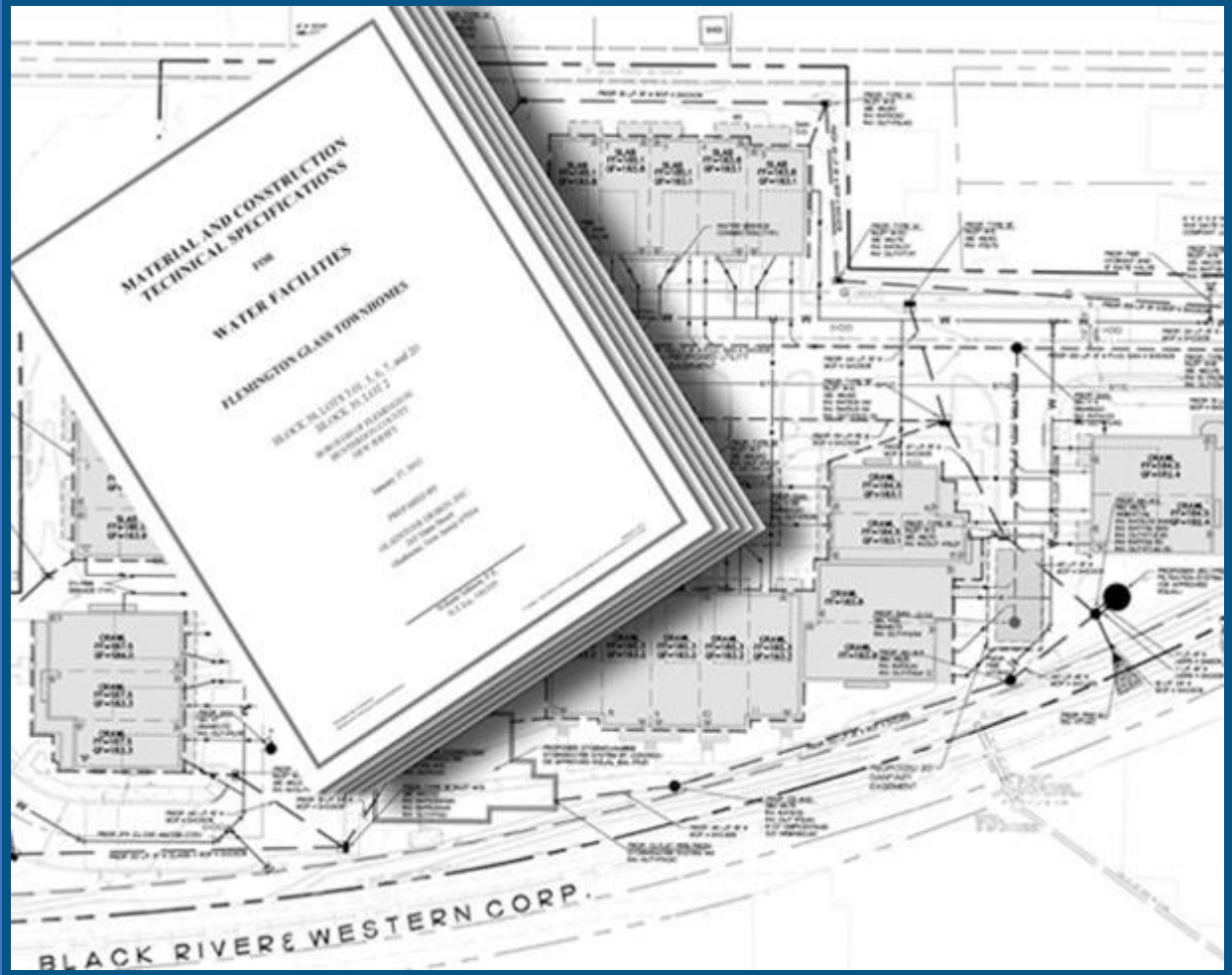
02 PoE Components

03 Players Involved

04 Things to Consider

05 Project Implementation

06 ***Construction Drawings and Docs***



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Deliverables

Must-Have Docs:

- As built Plans
  - MAC Addresses
  - Zones
  - Wiring

- Spreadsheet Master Book
  - Devices
  - MACs
  - Cable/Port
  - Peripherals
  - Zones
- PoE light fixtures and runs lighting level calculations

- Design Docs and Specs

Day 2

- Who is in charge
- Service Contracts
- Replacement parts

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THANK YOU!

Lisa.Isaacson@mechoshade.com

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Starts at – 2:40 pm

ABOUT ME

Product Manager at AEM Precision Cable Test, providing field applications support and training for customers on AEM's test and measurement products. Involved in the ICT industry for 37 years, the last 24 focused on test equipment applications for Copper & Fiber Certification, WiFi, PoE, Ethernet and xDSL. Steve has been a BICSI member for 28 years and holds the RCDD and NTS credentials.

Steve Cowles RCDD/NTS

Product Line Manager
AEM Precision Cable Test

AEM

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Specifications and Assuring Infrastructure Readiness

Correctly communicating the scope of the project up front and testing to ensure quality and compatibility with intended applications

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Specifications/Scope of Work

The Specifications document defines everything about the project, and is essentially our “Go-To” when any questions arise about the scope of work to be performed and typically includes:

- General Section
- Products Section
- Execution Section

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Part 1 General

The General section lays the foundation for everything else and the other sections of the specifications document and typically includes the following information:

- Summary
- Related Requirements
- Standards Reference
- Administrative Requirements
- Submittals
- Quality Assurance
- Delivery, Storage and Handling of materials related to the job
- Warranty

Part 1 General – *Summary Section*

Summary is where we provide a “snapshot” of the project. It should include information about the work to be performed and the list of what is included in the system being installed. The details of the included parts of the section are defined in detail in Part 2.

PART 1 GENERAL

1.01 SUMMARY

A. Furnish all labor, materials, services, equipment, and appliances required in conjunction with the installation of low voltage nodes for Power over Ethernet (PoE) lighting management system as indicated in the Contract Documents. System includes:

1. Lighting Management System Server
2. Core Switch for Lighting Management System
3. Nodes for packet distribution
4. Peripheral Sensors for daylight, motion, and occupancy data collection
5. Peripheral Input Switches for user input
6. Communications pathways
7. Copper cable and terminations
8. Communications equipment room fittings
9. Communications identification
10. Lighting fixtures

Part 1 General – *Related Requirements/Standards Reference*

The list of related requirements provides a baseline for construction specifications, codes and standards relative to the project that need to be adhered to. From firestopping to cabling support structures and installation methods, everything is key to a successful project. ***Note: Construction Specifications Sections 26 & 27 as well as Section 25 may all apply and be part of the specifications document.***

1.02 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

B. Section 26 0533.13 - Conduit for Electrical Systems.

C. Section 26 0536 - Cable Trays for Electrical Systems.

D. Section 26 0533.16 - Boxes for Electrical Systems.

E. Section 26 0553 - Identification for Electrical Systems: Identification products.

F. Section 26 2726 - Wiring Devices.

G. Section 26 50 00 – LIGHTING; for LED luminaires, selections, and installation requirements.

1.03 REFERENCE STANDARDS

A. EIA/ECA-310 - Cabinets, Racks, Panels, and Associated Equipment; Electronic Industries Alliance/Electrical Components Association; Revision E, 2005.

B. FM (AG) - FM Approval Guide; current edition.

C. ICEA S-90-661 - Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cables (With or Without An Overall Shield) For Use in General Purpose and LAN Communications Wiring Systems Technical Requirements; 2012.

D. ICEA S-116-732-2013 - Stand for Category 6 and 6A. 100 Ohm, Individually Unshielded Twisted Pairs, indoor Cables (With or Without and Overall Shield) for Use in LAN Communication Wiring Systems.

E. NECA/BICSI 568 - Standard for Installing Building Telecommunications Cabling; National Electrical Contractors Association; 2006.

F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set; 2015.

H. TIA-568.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards; 2009c, with Addendum (2016).

I. TIA-569 - Telecommunications Pathways and Spaces; 2015d, with Addendum (2016).

J. TIA-606 - Administration Standard for Telecommunications Infrastructure; 2017c.

K. UL (DIR) - Online Certifications Directory; current listings at database.ul.com

L. UL 444 - Communications Cables; Current Edition, Including All Revisions.

M. UL 1863 - Communications-Circuit Accessories; Current Edition, Including All Revisions.

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Part 1 General – *Administrative Requirements*

Defines coordination and communication during the project implementation for things like

- Coordination with other trades to avoid conflict
- Equipment placement relative to space
- Communication with architect/specifier, owner/customer or other stakeholders when there are conflicts with/deviations from Contract Documents

Part 1 General – *Submittals*

Provides reference point for process of submitting all required documentation and will typically include

- Product Data (manufacturer's data sheets/catalog pages)
- Shop Drawings
- Installer Qualifications
- Manufacturer Installation Instructions
- Test Plan
- Field Test Reports
- Project Record Documents (location of outlets, frames, color coding, ER locations)
- Operation and Maintenance Data

Part 1 General – *Submittals Section Example*

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

C. Shop Drawings:

1. Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
2. Provide reflected ceiling plans at minimum scale 1/8 inch per foot. Reflected ceiling plan shall indicate the following:
   - LED luminaire locations
   - Node locations
   - Peripheral Sensor locations
   - Peripheral Input Switch locations
3. For communication racks, frames, and enclosure dedicated to the lighting management system. Include plans, elevations, sections, details, and attachments to other work.
   - Detail equipment assemblies and indicated dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   - Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
   - Grounding: Indicate location of TGB and its mounting detail showing standoff insulators and wall-mounting brackets.
4. Provide a schedule for each network switch connected to the lighting management system. Schedules shall reflect the following:
   - Location of Switch
   - Maximum Wattage
   - Conductor Size
   - Node Type
   - Port Switch Designation
   - Patch Panel Designation
   - Port Number Assignment
   - Clear description of each Port assignment.

D. Evidence of qualifications for installer.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

F. Test Plan: Complete and detailed plan, with list of test equipment, procedures for inspection and testing, and intended test date; submit at least 60 days prior to intended test date.

G. Field Test Reports.

H. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
1. Record actual locations of outlet boxes and distribution frames.
2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
3. Identify distribution frames and equipment rooms by room number on drawings.

I. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of project record documents.
1. Include software and firmware operational documentation:
   - Software operating and upgrade manuals,
   - Program Software backup: On USB media, complete with data files.
   - Device Address List.
   - Printout of software application and graphic screens.

Part 1 General – *Quality Assurance*

More than just a definition of the quality of product and workmanship, this covers all aspects of the project, the installer and necessary communication before/during/after the project and typically includes

- Site copy of each referenced document prescribing execution requirements
- Manufacturer's qualifications
- Qualifications for
  - Installer, including manufacturer-specific training details, approval as an installer and credentialed personnel which installer must have on staff (RCDD, for example)
  - Layout Responsibility incl preparation of drawings and field testing program development
  - Installation Supervision (Installer 2, for example)
  - Testing Supervision (RCDD/TECH for example) with documented training in equipment being used
  - Field Inspector (RCDD or TECH for example)
- Products: Listed/classified/labeled as suitable for intended purpose
- Provide cabling system from single manufacturer or cabling & components designed for use as a system
- Provide major lighting mgmt. system components by single manufacturer
- Provide listing organization qualifications (OSHA recognized NRTL)
- Pre-installation conference prior to commencing installation

Part 1 General – *Delivery/Storage/Handling and Warranty Sections*

- Delivery/Storage/Handling specification ensure product remains in good condition until installation commences
- Warranty typically includes product as well as manufacturer extended warranty for the cabling system to ensure support for future use

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Keep stored products clean and dry.

1.08 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Manufacturer's Warranty: Manufacturer's standard form in which the manufacturer agrees to repair, restore, or replace defective lighting management system equipment within a specified period.

1. Warranty Period for each component:
   - Cabling System: 25 years from Substantial Completion
   - Server: 5 Years from Substantial Completion
   - Node: 5 Years from Substantial Completion
   - Switching: 5 Years from Substantial Completion
   - Peripheral Sensors: 5 Years from Substantial Completion
   - Peripheral Input Switches: 5 Years from Substantial Completion

C. Correct defective Work within a 2 year period after Date of Substantial Completion.

Part 2 Products

The Products section is a crucial component of the specifications as it provides the specific details on all aspects of what is being installed, for example:

- PoE Lighting Control System
- Network Switches
- PoE Motorized Window treatments
- Support System Design
- Pathways
- Copper Cable and Terminations
- Communications Equipment Room Fittings
- Identification Products (labeling tool/labels, Standards compliance)
- Source of Quality Control including factory testing of cables per Standards

Part 2 Products – *Section Example*

PART 2 PRODUCTS

2.01 POE LIGHTING CONTROL SYSTEM

A. Specified Manufacturer: Igor Power Over Ethernet Lighting: 2700 Westown Pkwy #400, West Des Moines, IA 50266 - Telephone: (515) 661-4412: https://www.igor-tech.com/

1. Node Types:
   a. 60W Rev 5 Max Network Node
   b. 60W Rev 5 Max Network Node Emergency Rated
   c. 90W Linear Node Driver
   d. 90W Linear Node Driver Emergency Rated
   e. 90W Rev 7 CV Network Node
   f. 90W Rev 7 CV Network Node Emergency Rated
   g. 60W Rev 5 Max Device Node
2. Server: Specified Dell R340 1U 500
   a. Operating System: Windows
   b. Mounting: Rack
   c. Memory Requirements: 16 GB
   d. Processor: Intel® Xeon® E-2276G 3.8GHz, 12M cache, 6C/12T, turbo (80W)
   e. Storage Capacity: 500 gigabytes HDD or greater
   f. Power Supply: 200W, 100-240V, 50-60Hz 3-15A Amp Max

2.02 NETWORK SWITCHES

A. Core Switch
   1. Performance Requirements:
      a. DHCP Server Capability
      b. Layer 3 Capable
   2. Acceptable Products:
      a. C9300-24T by Cisco

B. PoE Switch
   1. Performance Requirements:
      a. Capable of delivering a minimum of 90W per port for all ports.
      b. LLDP Enabled.
      c. Dual power supply
   2. Acceptable Products:
      a. C9300-24H by Cisco

2.03 POE MOTORIZED WINDOW TREATMENTS

A. Specified Manufacturer: Somfy Systems: https://www.somfy.com/fr-fr/
   1. PoE Powered through Molex Driver
   2. Suitable for Commercial Office
   3. Controllable through PoE lighting manufacturer control system

2.04 SUPPORT SYSTEM DESIGN

A. Provide a complete permanent system of cabling and pathways for PoE lighting, motorized window treatments and sensors, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
   1. Comply with TIA-568 (SET) (cabling) and TIA-569 (pathways) (commercial standards).
   2. Provide fixed cables and pathways that comply with NFPA 70 and TIA-607 and are UL listed or third party independent testing laboratory certified.
   3. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F (0 to 60 degrees C) at relative humidity of 0 to 95 percent, noncondensing.
   4. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.

2.05 PATHWAYS

A. Conduit: As specified in Section 26 0533.13; provide pull cords in all conduit.

B. Cable Trays: As specified in Section 26 0536.

C. J-Hooks: Erico Caddy J-Hook CAT Link System

D. Cable Tie Mount: Hilti X-ECT Cable Tie Mount: X-ECT MX #285709

E. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.
   1. Products:
      a. HoldRite, a brand of Reliance Worldwide Corporation; HydroFlame Pro Series/HydroFlame Custom Built: www.holdrite.com/#sle.
      b. Hilti North America: CFS-SL SK Firestop sleeve kit.
      c. Substitutions: See Section 01 6000 - Product Requirements.

2.06 COPPER CABLE AND TERMINATIONS

A. Manufacturers:
   1. Southwire: https://www.southwire.com

B. Copper Horizontal Cable:
   1. Description: 100 ohm, balanced twisted pair cable complying with TIA-568.2 and listed and labeled as complying with UL 444.
   2. Cable Type - PoE Lighting Driver and PoE Shades: TIA-568.2 Category 6 UTP (unshielded twisted pair); 23 AWG.
   3. Cable Capacity: 4-pair.
   4. Cable Applications: Use listed NFPA 70 Type CMP plenum cable unless otherwise indicated.
   5. Cable Jacket Color -Gray: To be verified with architect to match ceiling color
   6. Product(s): Southwire CAT6 23 AWG/4P SOL BC UTP CMP-LP(0.5A) 250 MHZ CABLE: https://www.southwire.com

C. Device Wiring Cable:
   1. Description: 18 AWG 7/.0150 BC, 2 Conductors twisted pair cable listed and labeled as complying with UL 1424
   2. Cable Type - PoE lighting fixtures: 18/2 AWG stranded unshielded cable
   3. Cable Capacity: 2 conductor: To be verified by manufacturer's instructions
   4. Cable Applications: Use listed NFPA 70 Type CMP plenum cable unless otherwise indicated.
   5. Cable Jacket Color -Gray: To be verified with architect to match ceiling color
   6. Product(s): Southwire 18 AWG 2/C STRANDED UNSHIELDED CMP/CL3P/FPLP CABLE: https://www.southwire.com

D. Copper Cable Terminations: Insulation displacement connection (IDC) type using appropriate tool; use screw connections only where specifically indicated.

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Part 3 Execution

Execution defines the installation itself, including specifying compliance to applicable Standards and typically includes:

- Examination of project conditions and completed work
- General Installation specifications for applicable standards/construction specifications, firestopping, raceway, etc.
- Installation of Lighting Management Equipment
- Installation of Pathways
- Installation of Equipment Cabling
- Grounding
- Field Quality Control - Visual inspection and field cable testing with Certification Tester
- Identification – Standards compliant labeling throughout the system, cabling administration drawings and records
- Demonstration
- Maintenance - Software/hardware service agreement, tech support, upgrades and final testing

Part 3 Execution – *Examples*

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine Project conditions and completed Work, with Installer present, and verify that conditions are satisfactory to proceed with work under this Section.

1. Confirm area in lighting management system equipment spaces is compliant with BICSI TDMM for layout and conditions are satisfactory to proceed with work under this Section.
2. Confirm communication pathways dedicated to lighting management system are in place and ready to receive work under this Section.

B. Immediately correct all deficiencies and conditions which would cause improper execution of Work specified in this Section and subsequent Work.

C. Proceeding with Work specified in this Section shall be interpreted to mean that all conditions were determined to be acceptable prior to start of Work.

3.02 INSTALLATION - GENERAL

A. Comply with latest editions and addenda of TIA-568 (SET) (cabling), TIA-569 (pathways), TIA-607 (grounding and bonding), NECA/BICSI 568, NFPA 70, and SYSTEM DESIGN as specified in PART 2.

B. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400

C. Comply with BICSI TDMM for layout of lighting management system equipment spaces.

D. Comply with BICSI ITSIMM for installation of lighting management system equipment spaces.

E. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

F. Coordinate location of power raceways and receptacles with locations of lighting management system equipment requiring electrical power to operate.

3.03 INSTALLATION, LIGHTING MANAGEMENT SYSTEM EQUIPMENT

A. Install lighting control server in equipment rack designated for lighting management system.

B. Install nodes within 330 feet (100 m) of network switch.

1. Connect node to network switch with horizontal cabling.
2. Connect horizontal cabling from PoE port on node to designated port indicated on prepared Shop Drawings.

- Route cabling through pathways designed for lighting management system.

C. Install node within 35 feet (10 m) of connected luminaires

1. Connect luminaires to node with horizontal cabling.
2. Output: Connect luminaires directly to RGBW channels on nodes
3. Input: Connect peripheral input switch or peripheral sensor to 'POE' port on the node.

3.04 INSTALLATION OF PATHWAYS

A. Install pathways with the following minimum clearances:
1. 48 inches (1220 mm) from motors, generators, frequency converters, transformers, x-ray equipment, and uninterruptible power systems.
2. 12 inches (300 mm) from power conduits and cables and panelboards.
3. 5 inches (125 mm) from fluorescent and high frequency lighting fixtures.
4. 6 inches (150 mm) from flues, hot water pipes, and steam pipes.

B. Conduit, in Addition to Requirements of Section 26 0533.13:
1. Arrange conduit to provide no more than the equivalent of two 90 degree bend(s) between pull points.
2. Conduit Bends: Inside radius not less than 10 times conduit internal diameter.
3. Arrange conduit to provide no more than 100 feet (30 m) between pull points.
4. Do not use conduit bodies.
5. Minimum Cover - Underground Service Entrance: Comply with NFPA 70 and Communications Service Provider requirements.

C. J-Hooks: Install J-hooks on separate support system from ceiling supports so that distance between supports does not exceed 5-feet between supports.

3.05 INSTALLATION OF EQUIPMENT AND CABLING

A. Cabling:
1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter. All bends to be installed using 90 degree bend radius.
2. Do not over-cinch or crush cables.
3. Do not exceed the manufacturer's recommended cable pull tension.
4. When installing conduit, use only lubricants approved by the cable manufacturer and do not chafe or damage the outer jacket.
5. Cables located in cable tray to be bundled and managed neatly

B. Copper Cabling:
1. Category 6 and Above: Maintain cable geometry; do not untwist more than 1/2 inch (12 mm) from point of termination.
2. For 4-pair cables in conduit, do not exceed 25 pounds (110 N) pull tension.
3. Use T568B wiring configuration.
4. Cabling to light fixtures to be secured tightly to support structure for minimal visibility

C. Floor-Mounted Racks: Permanently anchored to floor in accordance with manufacturer's recommendations.

D. Identification:
1. Use wire and cable markers to identify cables at each end.
2. Use identification nameplate to identify cross-connection equipment, equipment racks, and cabinets.

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Part 3 Execution – *Examples*

3.06 GROUNDING

A. Comply with TIA-607-B and NECA/BICSI 607.
B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Chapter.
C. Locate TGB to minimize length of bonding conductors. Fasten to wall, allowing at least 2 inches (50 mm) of clearance behind TGB. Connect TGB with a minimum no. 4 AWG grounding

electrode conductor from TGB to suitable electrical building ground. Connect rack TGB to near TGB or the TMGB.

1. Where screened twisted-pair cables and coaxial cables reside in lighting management system equipment spaces, bond the shield of shielded cable to patch panel, and bond patch panel to TGB or TMGB.
2. Bond metallic equipment to the TGB, using not smaller than a No. 6 AWG equipment grounding conductor.

3.07 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Comply with inspection and testing requirements of specified installation standards.

C. Visual Inspection:
1. Inspect cable jackets for certification markings.
2. Inspect cable terminations for color coded labels of proper type.

D. Testing - Copper Cabling and Associated Equipment:
1. Category 5e and Above Backbone: Perform near end cross talk (NEXT) and attenuation tests.
2. Category 5e and Above Links: Perform tests for wire map, length, attenuation, NEXT, and propagation delay.

3.08 IDENTIFICATION

A. Coordinate system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Section 27 05 53 – IDENTIFICATION FOR COMMUNICATIONS SYSTEMS.

1. Color-code cross-connect fields and apply unique color to light management system backboards, connections, covers, and labels.

B. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for lighting management system closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
D. Cable and Wire Identification:

1. Label each cable within 4 inches (100mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

   - Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
   - Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Use unique color for jacks and plugs utilized in lighting management system.

E. Machine-print labels. Type shall be 1/8-inch (3 mm) in height, minimum.

3.09 DEMONSTRATION

A. Upon completion of installation and conclusion of field testing, schedule training session to provide instruction to Owner's designated attendees.

1. Schedule training with Owner at mutually agreed upon dates and times.
2. Schedule location of training on-site.
3. Assembly educational and training materials for each scheduled attendee.

3.10 MAINTENANCE

A. Software Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software service agreement includes software support for two years.
2. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Verify that upgrading software includes operating system and new or revised licenses for using software.

   - Upgrade Notice: No fewer than 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed

B. Final Testing: After all work is complete, including installation of telecommunications outlets, and telephone dial tone service is active, test each voice jack for dial tone.

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What is Infrastructure Readiness?

When considering the underlying physical cable plant that supports the development of a smart building, there are different types of cabling, each with its own set of requirements for certification and testing to ensure infrastructure readiness from both a pre-development and post-development perspective:

- Ability and Readiness to Support IoT Devices and their cable management
- This can be Four-Pair and Single-Pair Ethernet, and Fiber Optic, including Hybrid Powered Fiber
- How devices are powered - via Power over Ethernet (PoE) or Single-Pair Power over Ethernet (SPoE) or Hybrid Powered Fiber

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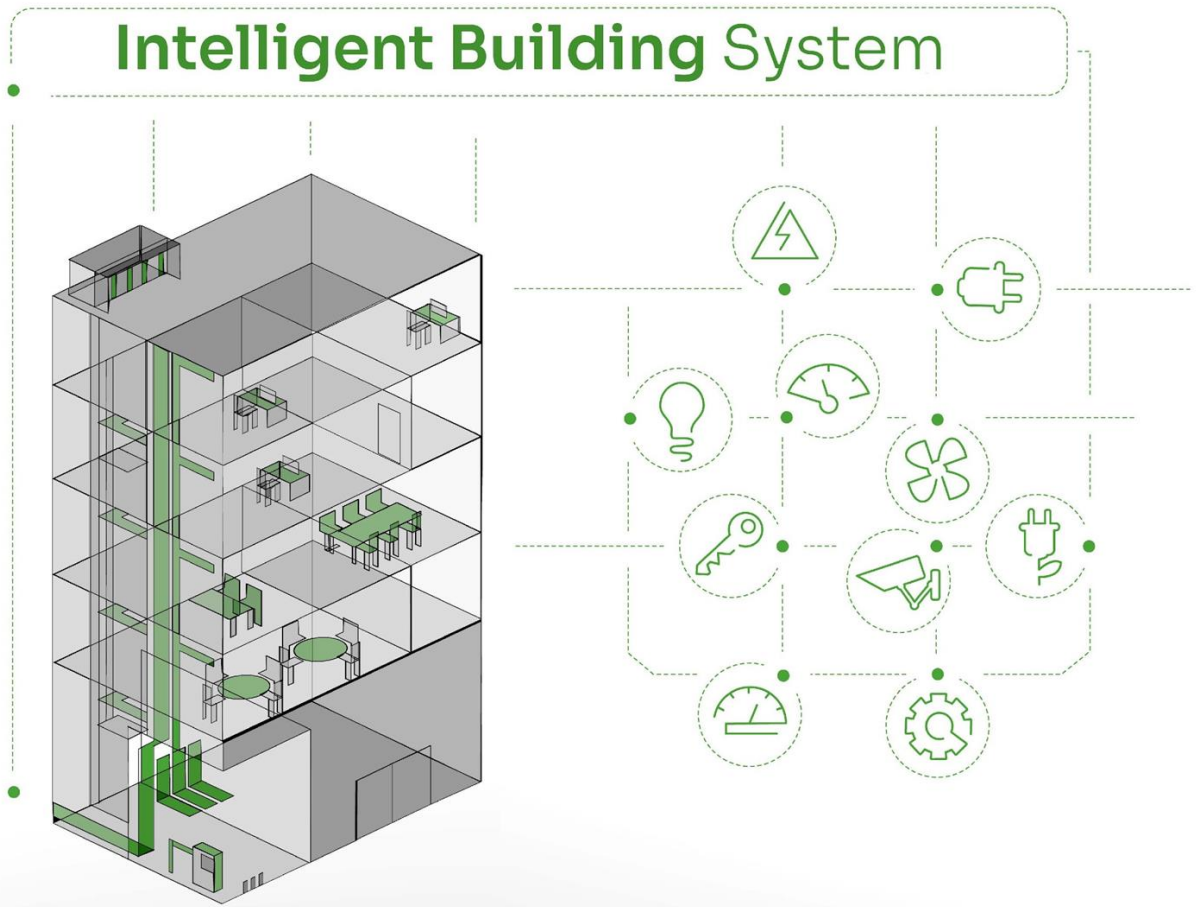
Key Drivers for Smart Building Systems



✓Combine many disparate building systems into a single platform

✓Optimize operations, maintenance and overall cost

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Test Parameter Considerations for Smart Buildings

Times have changed….

- Could noise on the link affect overall performance?
- Will this link support the multiple speeds required ?
- Is this link capable of supporting power over the same cable the network data is on?

Testing needs have evolved just as the modern network infrastructures of today has evolved

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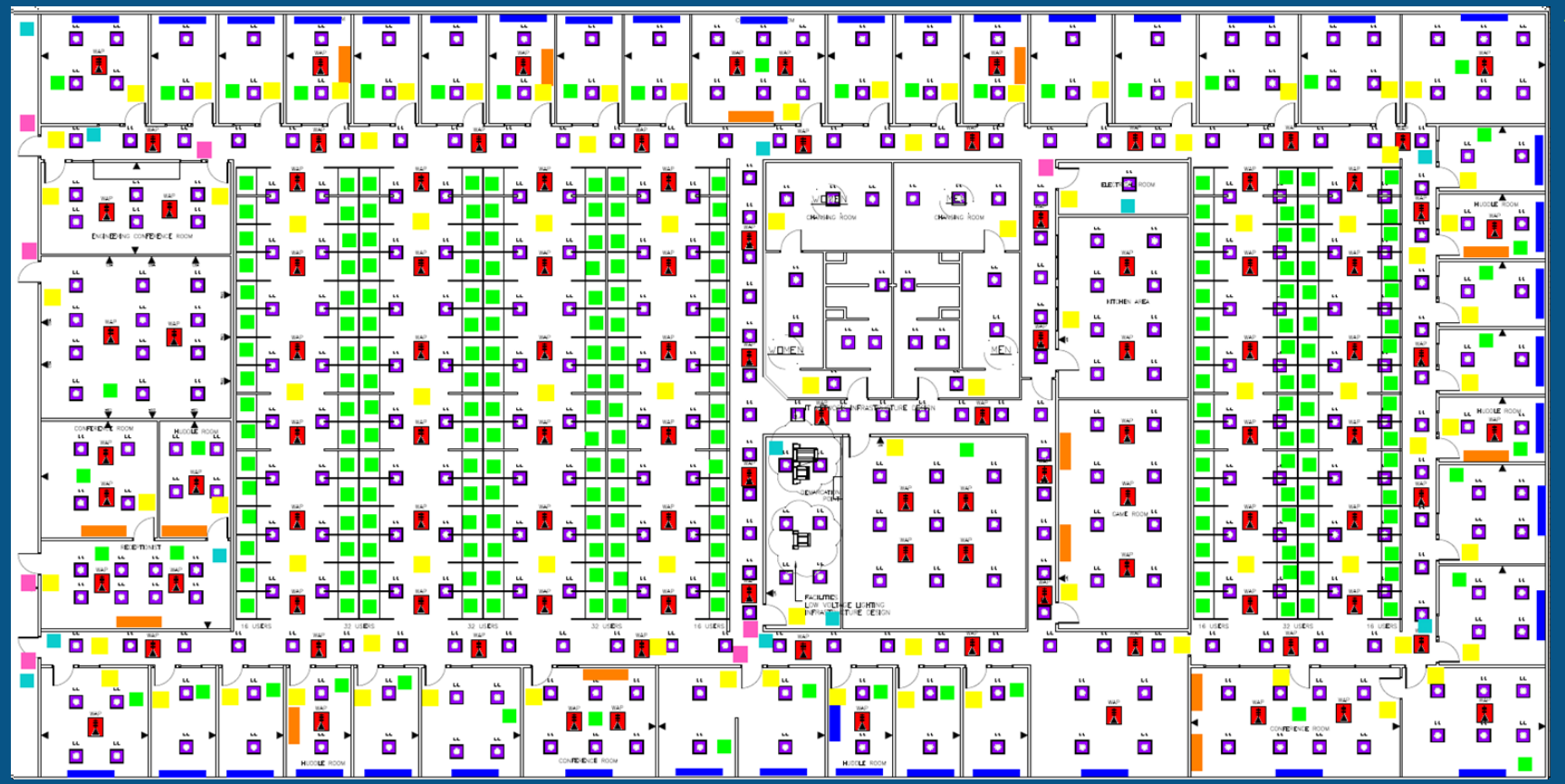
Demanding More from the Network Infrastructure

PoE Infrastructure	
LED Lighting	389
Phone, Client, Monitor	192
Display	15
Occupancy Sensors	89
WAP	10
Shade Control	40
Security Camera	12
Access Controls	8
Total	755

2,312 SQM



34 m

68 m

Thousands of meters of cable to support data and power

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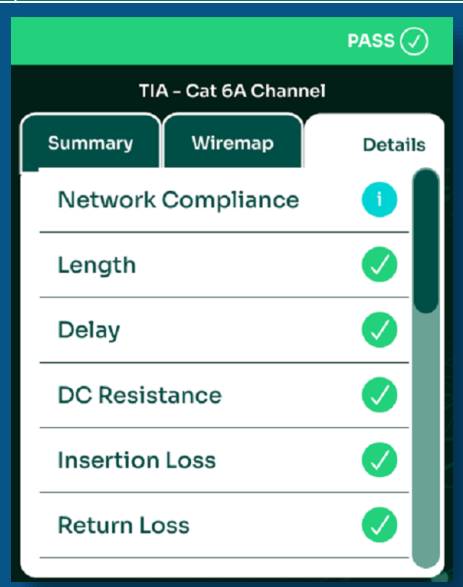
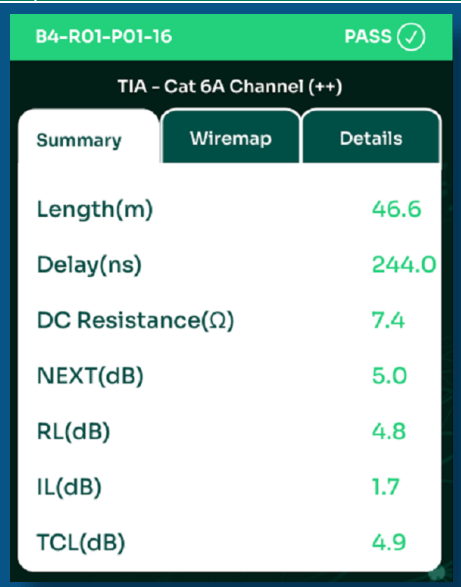
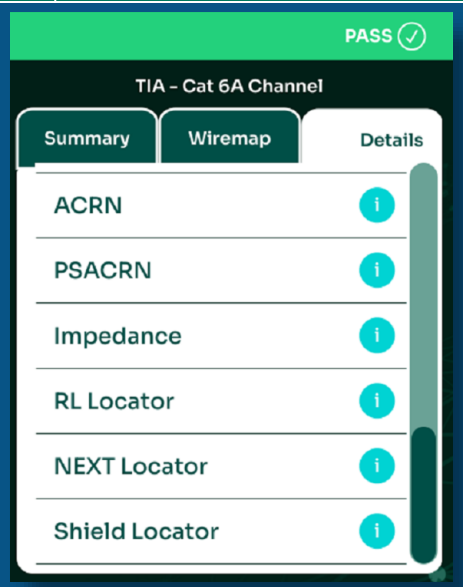
Overview of Testing Needs

	ANSI/TIA 1152-A / IEC 61935-1 TIA-568 / ISO 11801 Pass/Fail	ANSI/TIA 1152-A / IEC 61935-1 TIA-568 / ISO 11801 Optional Parameters (++) or(+) Pass/Fail	TIA 1152-A / IEC 61935-1 TIA-568 / ISO 11801 Additional Parameters Informational Only	Additional Testing for IB Support
Configurations	Channel, Permanent Link, MPTL			
Field Test Parameters	Length**, Delay, DC Loop Resistance**, Insertion Loss, Return Loss, NEXT, PSNEXT, ACRF, PSACRF, ACRN**, PSACRN**	DC Resistance Unbalance (in Pair & Pair to Pair), TCL**, ELTCTL**	TDR to Fault Location for RL, NEXT, Shield. Impedance	2.5/5/10GBASE-T PoE 802.3 af/at/bt, UPoE Hybrid Powered Fiber







**Note: Some field test parameters are required under one standard, but optional/not required under another

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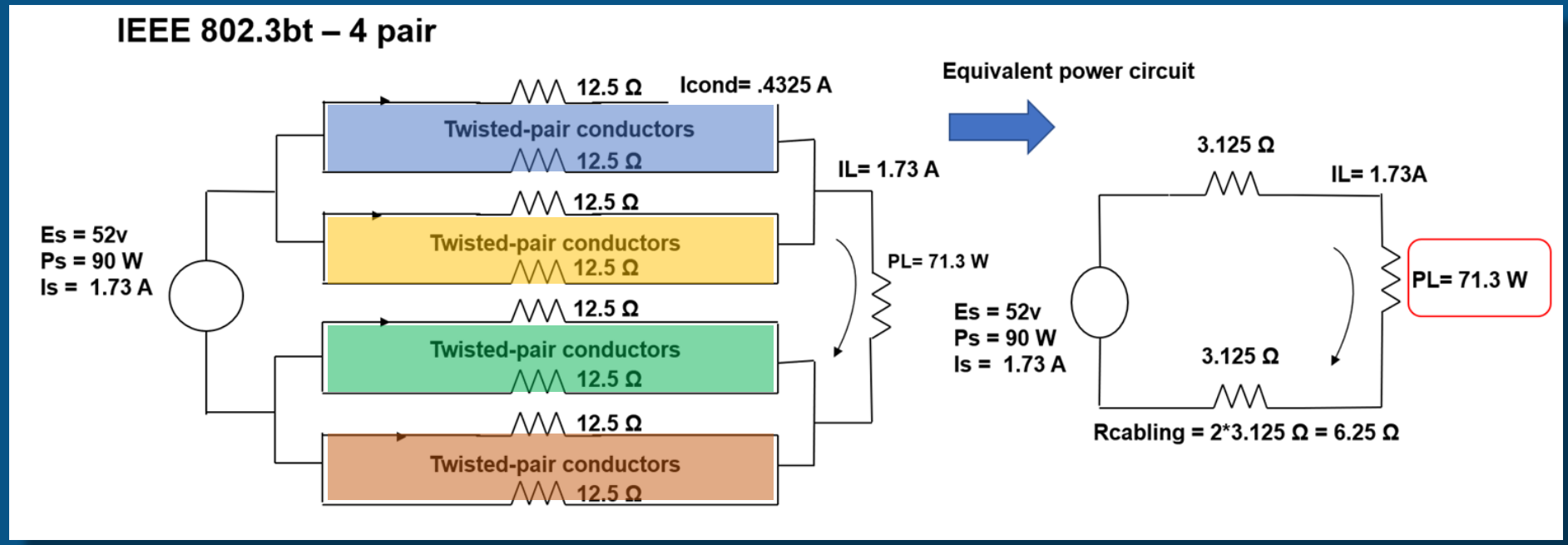
Resistance Requirements for Channels to be compliant for PoE delivery

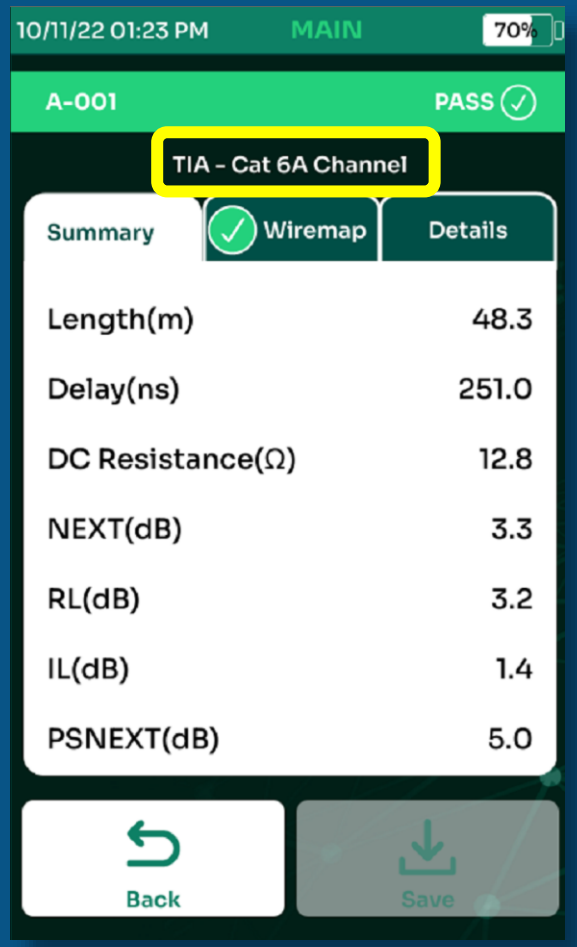
- Specified in ANSI/TIA-568.2-D and TIA TSB-184A D3.0
  - DC Loop Resistance for Cat3/5e/6/6A shall not exceed 25 Ohms
    - Included with Certification pass/fail. Optional under ANSI/TIA-1152-A, required under IEC 61935-1.
  - DC Resistance Unbalance <200mOhms or <3% of Unbalance in pair (750mOhms)
    - Optional with certification as a pre-qualifier for PoE support
  - DC Resistance Unbalance between pairs <200mOhms or <7% of unbalance between pairs
    - Optional with certification as a pre-qualifier for PoE support
- DC Resistance Unbalance tests are NOT a PoE test

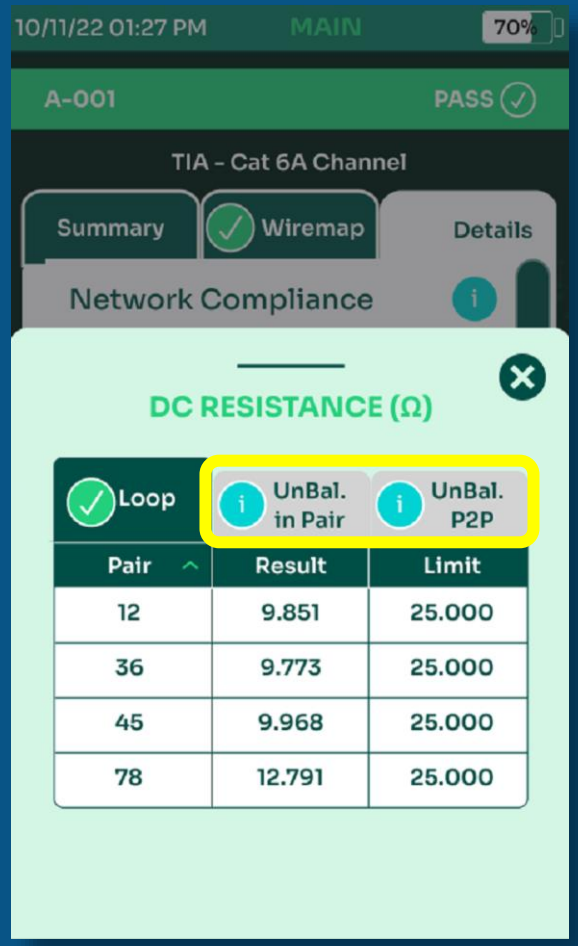
Why Resistance Matters - *I²R Power Loss*

- In an ideal circuit, the power applied to the link would be delivered to the endpoint (load) with no energy wasted or dissipated in the wiring or components along the path
- Real circuits, however, have resistance. Even a small amount can cause electrical losses dissipated as heat
- These losses can be calculated by using the current squared multiplied by the resistance (I^2R)



Importance of Testing for Smart Building Needs





- Remember those optional tests we just talked about?
- A cable that passed a “standard” autotest …….

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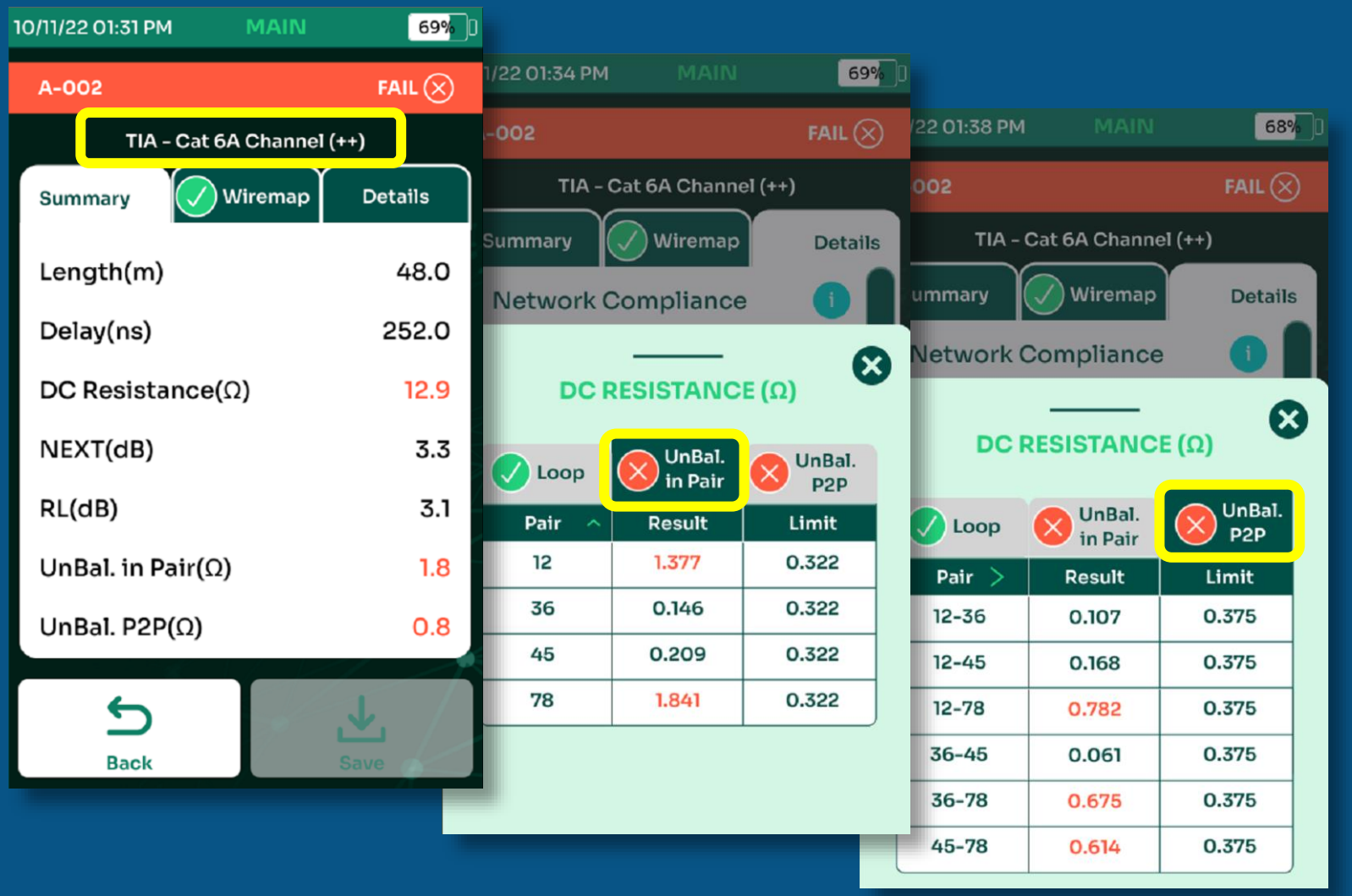
Importance of Testing for Smart Building Needs



- May fail an autotest with the optional parameters
- This underscores the importance of complete testing to ensure support of the IoT technologies that will be deployed to avoid problems during device install

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Category Cabling Factors

Installing devices on a legacy system or considering use of lesser categories of cabling?

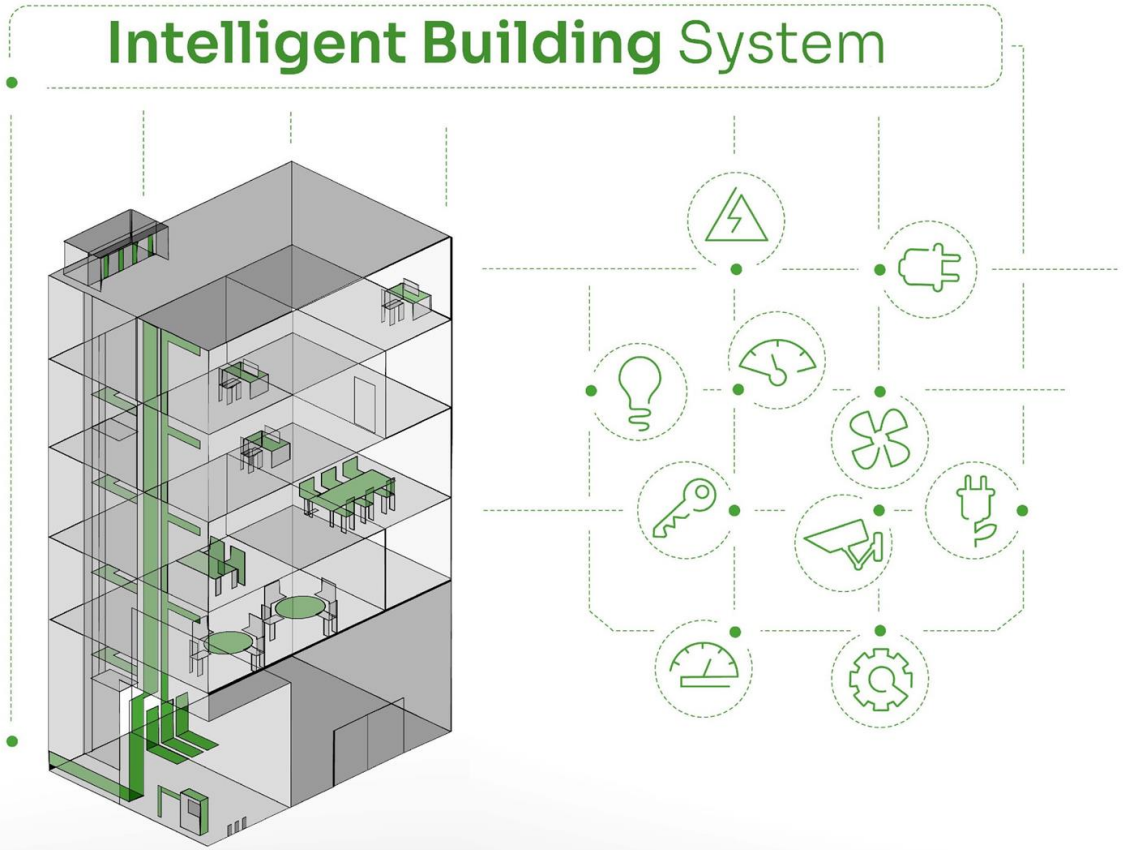
Bundled Cable Length 0m to 55m	CAT5e	CAT6	CAT6A
2.5GBASE-T			Assured
5GBASE-T			Assured
10GBASE-T	NA	Subject to Alien Crosstalk Testing	Assured
Bundled Cable Length 55m to 100m	**CAT5e**	**CAT6**	**CAT6A**
2.5GBASE-T			Assured
5GBASE-T			Assured
10GBASE-T			Assured

✓ Cat6A was designed such that it is assured to support all GBASE-T link speeds up to 100m

Resistance – Wire Size Matters

- Cabling
  - Typical Cat5e and Cat6 Cabling is 24AWG (minimum recommended size for PoE)
  - Typical Cat6A is 23AWG (Better for PoE)
  - 22AWG cables exist which are designed for extended distance and power
  - Solid conductors are recommended
- For new installations, consider using 22AWG if:
  - The system is expected to require power exceeding 60W during the life cycle of the building
  - Future flexibility is desired in the types of systems which could be supported
- Heating considerations
  - Higher resistance = more heat generated

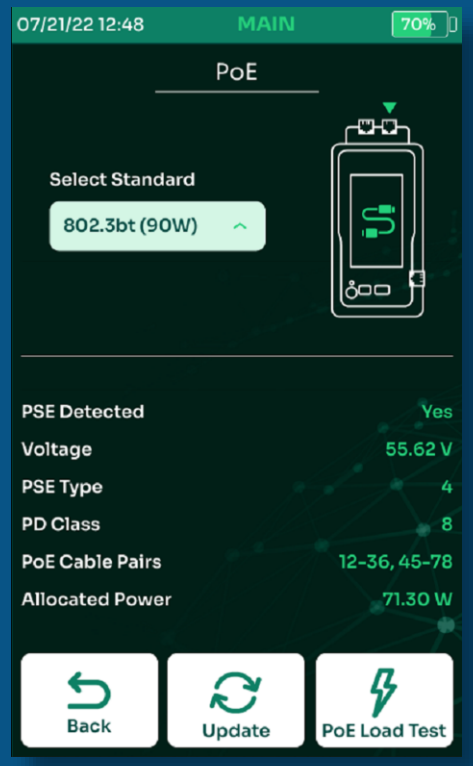
Ability to Perform PoE Load Testing is Critical

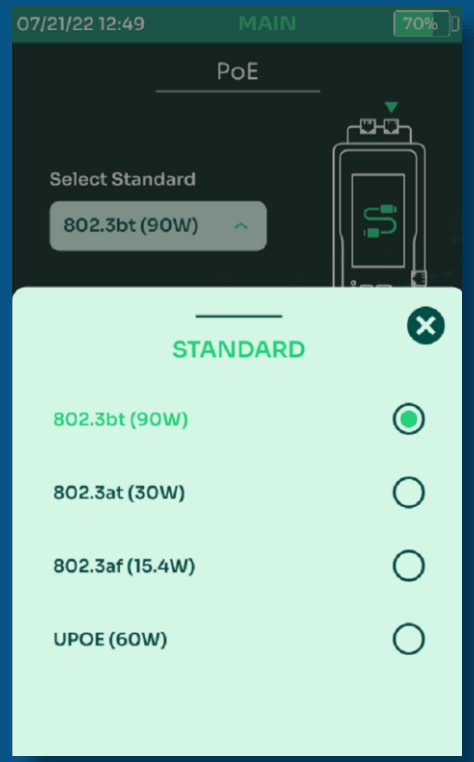


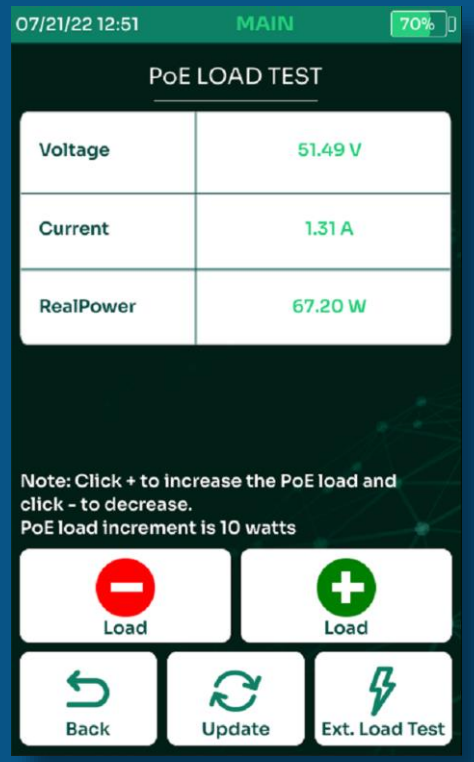
- Things can go wrong
  - PSE misconfiguration
  - PSE overprovisioning
  - Not enough power at the PD
- And, there's always the blame game to deal with when something doesn't work
  - When something doesn't turn up, who's likely to get the phone call…
- Ability to perform load testing is critical
  - Exonerate the cable infrastructure
  - Be the hero and find problem domain

PoE Load Testing

- PoE Load Test validates the **Real Power received at end point device**







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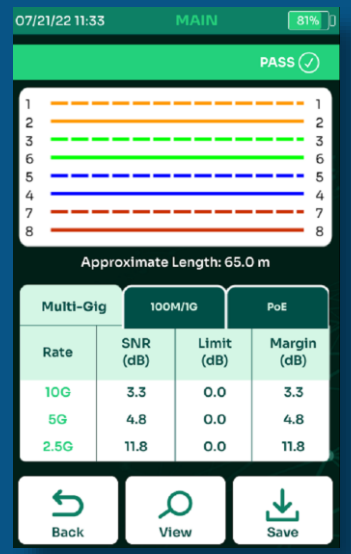
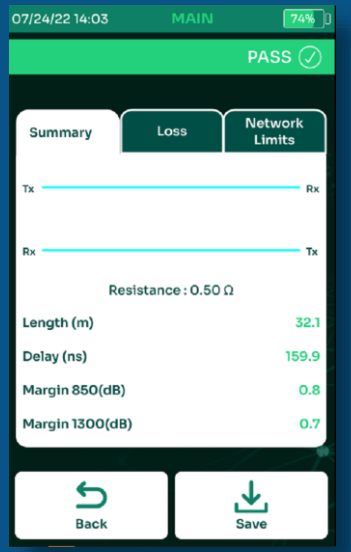
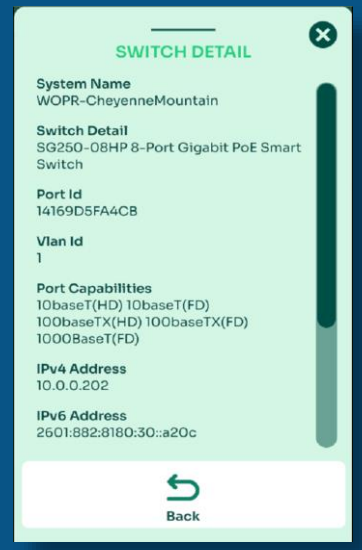
Other Testing Considerations

- MultiGigabit Link Speed SNR Testing with PoE Load
- Fiber Optic Testing, including Hybrid Powered Fiber
- Network Connectivity Testing (Wired & WiFi)
  - IP/MAC address discovery
  - DHCP, DNS, Subnet of connected LAN
  - Switch Detail with port/VLAN, capabilities
  - Ping, Traceroute, TCP Connect
  - WiFi SSIDs with channel and RSSI, roaming signal strength testing
- Re-testing of the cabling system over time can help ensure performance is still at acceptable level to provide adequate support for current and future applications







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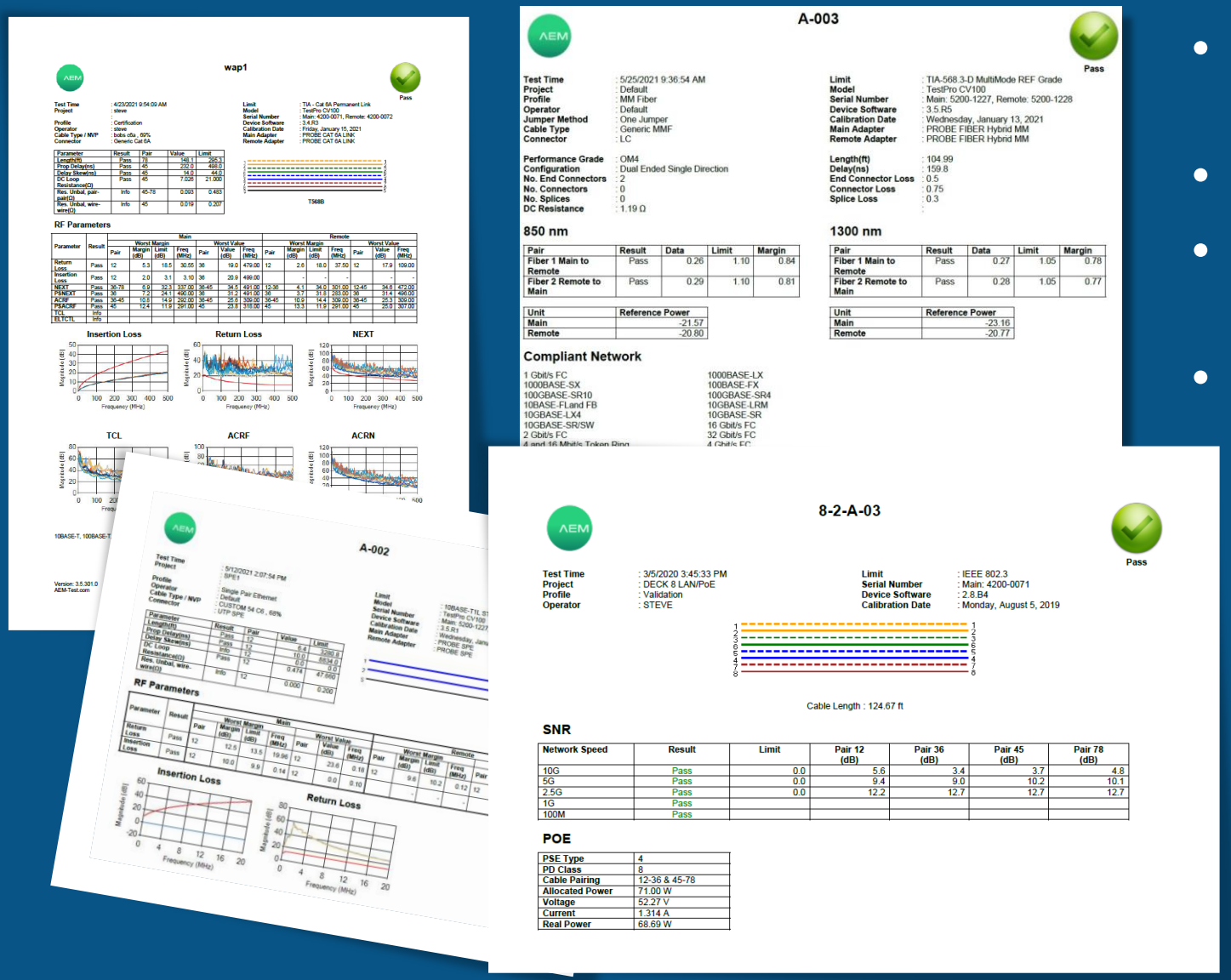
Smart Building Test Results Documentation



- Provides end customer a proof of quality
- Protects the installer
- Supports manufacturer's system warranty
- Includes complete test results, details about the equipment used, test configuration and application compatibility
  - Copper Certification including DC Resistance Unbalance
  - Fiber Certification including Hybrid Powered Fiber
  - MultiGig Ethernet SNR Test with PoE Load

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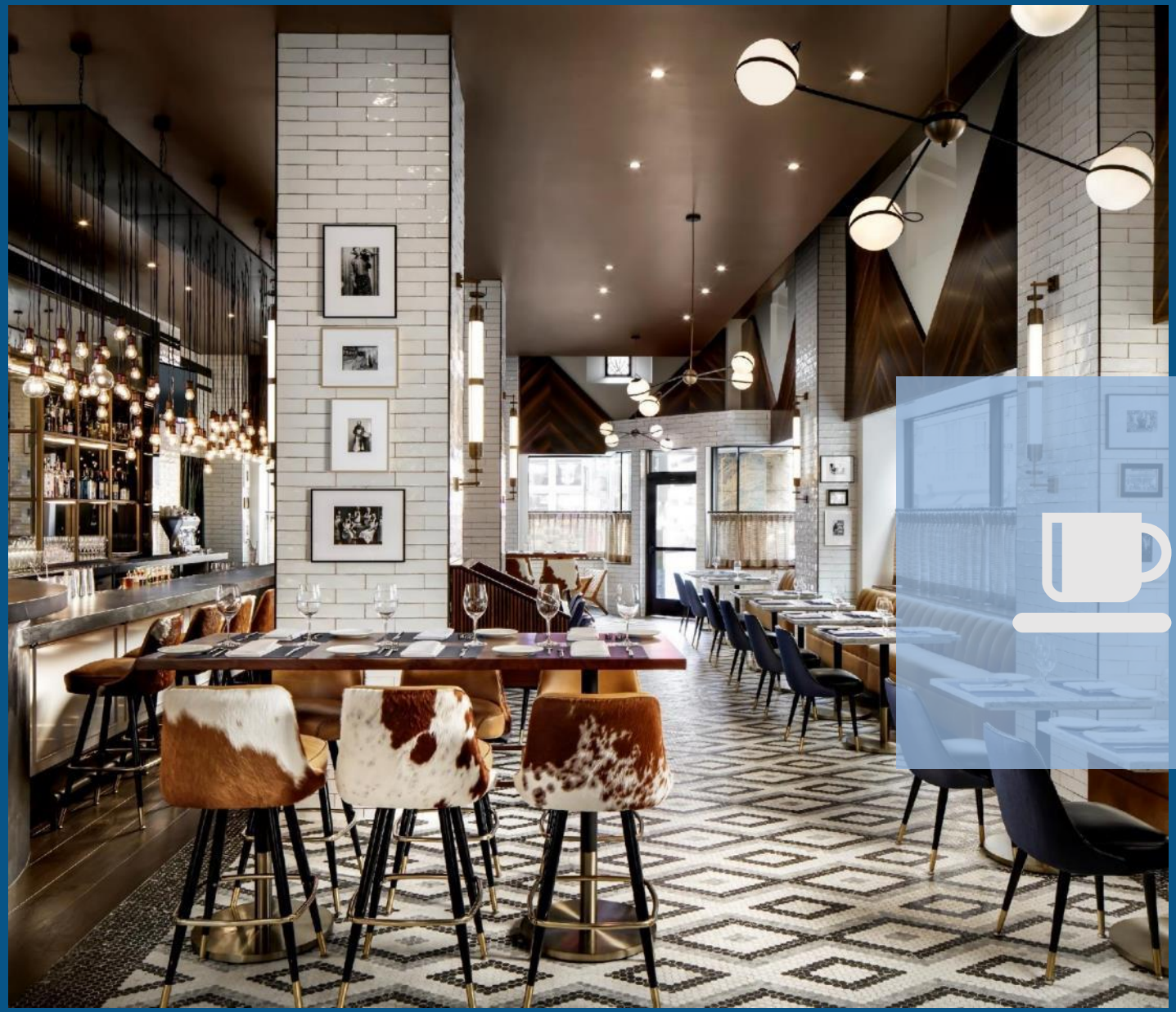
Conclusion

- Detailed Specifications provide a clear picture of what is expected for all parties involved. This can avoid time-consuming and costly interruptions/change-orders during the project.
- Communication prior to installation commencement, during the project and in the project wrap-up is critical.

- With the changes in technology is increasingly important to have test equipment which can adapt to new methods of testing.
- Having test equipment purpose-built for smart building infrastructure testing will help ensure the cabling system will support the information transport and power applications for which it was designed, as well as future applications.



SECTION BREAK

Lunch – 12:00 – 1:00 pm

Courtesy of the Sinclair Marriott

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PUT IT INTO PRACTICE

Three Working Sessions:

Conference Room – Joe & John

Multi-Tenant - Tyler

Office – Lisa & AK

Equipment Petting Zoo - Steve

- Class 4 Power
- Testing & Verification
- Switches & Nodes

Connect With Us

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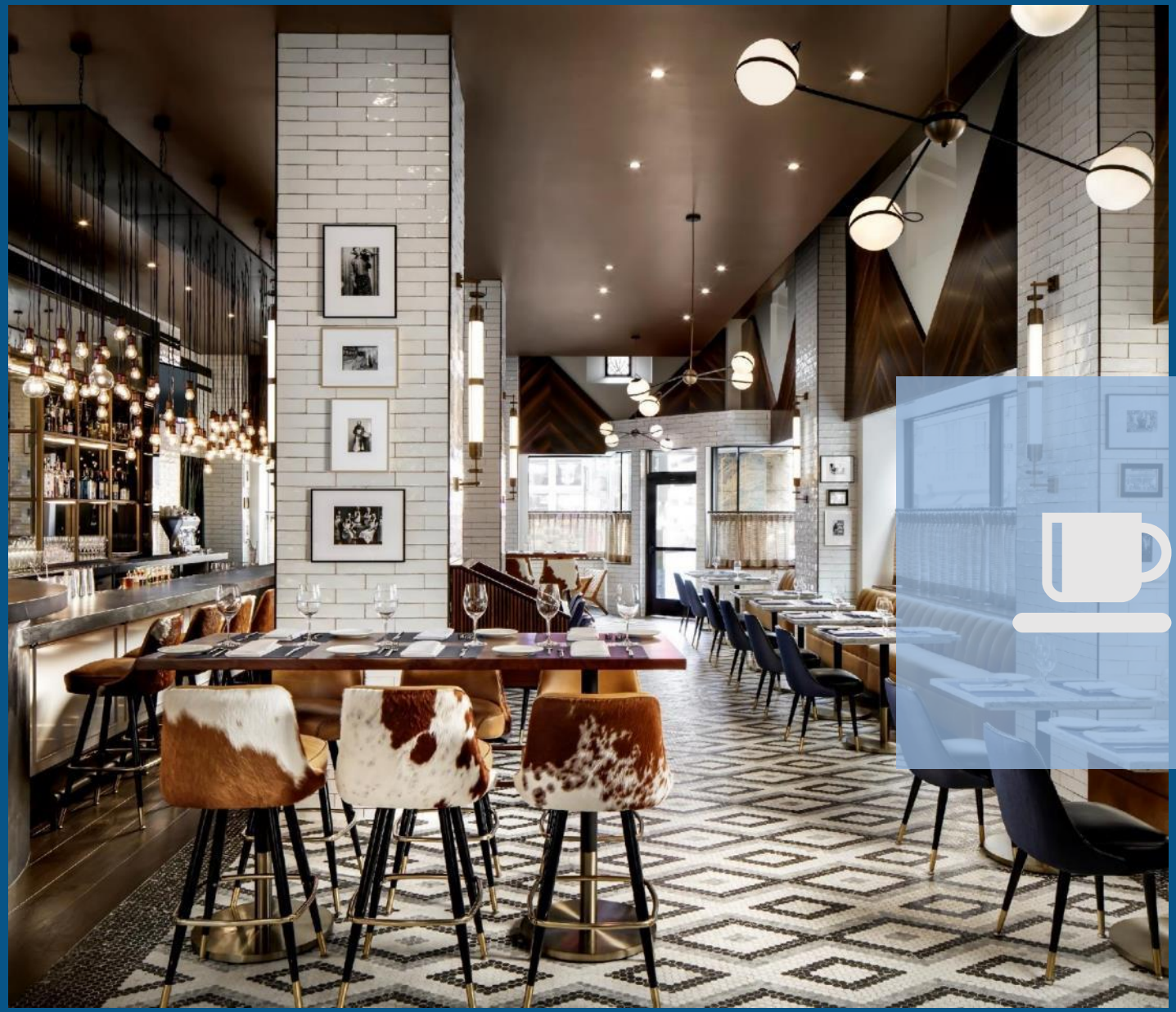

SECTION BREAK

Q&A Break – 3:00 – 3:30 pm

Courtesy of the Sinclair Marriott

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Lessons Learned

ABOUT ME

I spent over 10 years in the residential A/V industry when a client asked if I had ever heard of PoE lighting. Like many others at the time I hadn't but after a bit of discussion I now work for that client and have over a million sq/ft of projects under our belt.

John Jung

Project Manager/Technical Advisor– Walsh PoE

WALSH
PoE Lighting
Design, Installation & Integration

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Topics

- Documentation
- Programming and Commissioning
- Creating an as-built and handover
- What have we learned?

Good Documentation is VITAL

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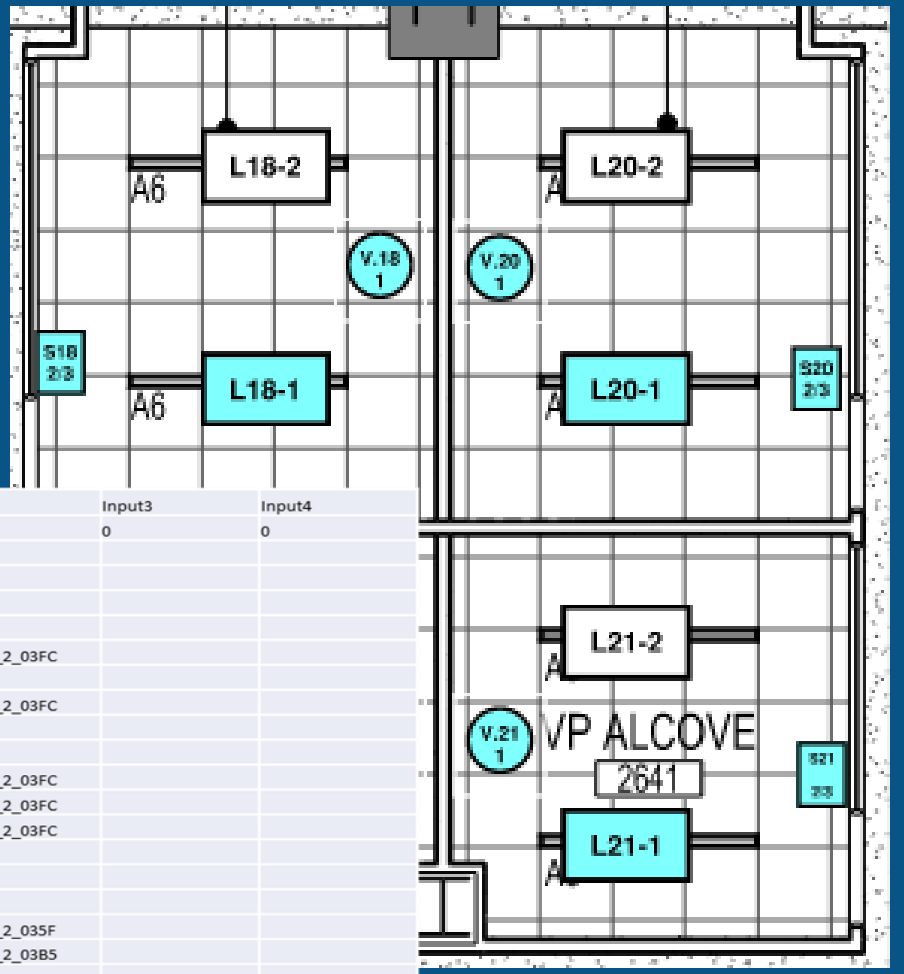
Documentation

- **Lighting Specific:**
  - Reflective Ceiling Plan (RCP)
  - Fixture Schedule
  - Sensor Documentation
  - Controls Narrative
  - Sequence of Operations
- **Endpoint Documentation as available**
  - IP Addresses (if static)
  - MAC Addresses
  - Configuration Details
- **Integration Documentation**
- **Service Contacts and Support Details**
- **System High-Level Description**
  - Description of Systems Installed and Behavior (particularly UL-924)
- **Records Drawings:**
  - Network Topology, Addressing, and Configuration Specifics
  - Cabling Layout, Pathway, and Space Designs
  - Electrical line diagrams and PDU configuration
- **Other System Documentation and Manuals**

Refer to ANSI/BICSI 0007-2020 ICT Design and Implementation Practices for Intelligent Buildings and Premises https://www.bicsi.org/standards/available-standards-store/single-purchase/bicsi-007-iot-intelligent-building

Examples of good documentation



MAC Address	IDF	SW#	SW IP	SW/Port	Gateway	Output1	Output2	Output3	Output4	Input1	Input2	Input3	Input4
A0:22:4E:10:03:B4	IDF1	1	10.9.0.11	1	#N/A	#N/A	#N/A	Outside_3_03B4	0	0	0	0	0
A0:22:4E:10:03:F1	IDF1	1	10.9.0.11	2	#N/A	Z226_1_03EB							
A0:22:4E:10:03:F8	IDF1	1	10.9.0.11	3	dent-cortap-31	Z226_1_03EB							
A0:22:4E:10:03:F0	IDF1	1	10.9.0.11	4	dent-cortap-31	Z226_1_03EB							
A0:22:4E:10:03:D0	IDF1	1	10.9.0.11	6	dent-cortap-31	Z222_1_03C7							
A0:22:4E:10:04:02	IDF1	1	10.9.0.11	8	dent-cortap-31	ZXXXX_2_03FC			Z240_3_03FC	WS240_1_03FC	WS240_2_03FC		
A0:22:4E:10:03:F2	IDF1	1	10.9.0.11	9	dent-cortap-31	Z226_1_03EB							
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A0:22:4E:10:03:D1	IDF1	1	10.9.0.11	11	dent-cortap-31	Z222_1_03C7							
A0:22:4E:10:03:F9	IDF1	1	10.9.0.11	12	dent-cortap-31	Z226_1_03EB							
A0:22:4E:10:03:FF	IDF1	1	10.9.0.11	13	dent-cortap-31	ZXXXX_2_03FC			Z240_3_03FC	WS240_1_03FC	WS240_2_03FC		
A0:22:4E:10:03:FE	IDF1	1	10.9.0.11	14	dent-cortap-31	ZXXXX_2_03FC			Z240_3_03FC	WS240_1_03FC	WS240_2_03FC		
A0:22:4E:10:04:00	IDF1	1	10.9.0.11	15	dent-cortap-31	ZXXXX_2_03FC			Z240_3_03FC	WS240_1_03FC	WS240_2_03FC		
A0:22:4E:10:03:AF	IDF1	1	10.9.0.11	16	dent-cortap-31	Z217_1_03AD				WS217_1_03AD			
A0:22:4E:10:03:CA	IDF1	1	10.9.0.11	17	dent-cortap-31	Z222_1_03C7							
A0:22:4E:10:03:9A	IDF1	1	10.9.0.11	18	dent-cortap-31	Z287_1_0397							
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A0:22:4E:10:03:B6	IDF1	1	10.9.0.11	20	dent-cortap-31	Zxxxx_1_03B5				WS218_1_03B5	WS218_2_03B5		
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A0:22:4E:10:03:F6	IDF1	2	10.9.0.12	1	dent-cortap-31	Z226_1_03EB							
A0:22:4E:10:04:11	IDF1	2	10.9.0.12	2	dent-cortap-31	Z282_1_040F				WS282_1_040F	WS282_2_040F		
A0:22:4E:10:04:27	IDF1	2	10.9.0.12	3	dent-cortap-31	Z240_1_0426							
A0:22:4E:10:04:20	IDF1	2	10.9.0.12	4	dent-cortap-31	Z219A_1_0413				WS219B_1_0413	WS219B_2_0413		
A0:22:4E:10:04:1D	IDF1	2	10.9.0.12	5	dent-cortap-31	Z219A_1_0413				WS219B_1_0413	WS219B_2_0413		
A0:22:4E:10:04:19	IDF1	2	10.9.0.12	6	dent-cortap-31	Z219A_1_0413				WS219B_1_0413	WS219B_2_0413		
A0:22:4E:10:04:2B	IDF1	2	10.9.0.12	7	dent-cortap-31	Z240_1_0426							
A0:22:4E:10:04:2A	IDF1	2	10.9.0.12	9	dent-cortap-31	Z240_1_0426							
A0:22:4E:10:04:1A	IDF1	2	10.9.0.12	10	dent-cortap-31	Z219A_1_0413				WS219B_1_0413	WS219B_2_0413		
A0:22:4E:10:04:1C	IDF1	2	10.9.0.12	11	dent-cortap-31	Z219A_1_0413				WS219B_1_0413	WS219B_2_0413		
A0:22:4E:10:04:10	IDF1	2	10.9.0.12	12	dent-cortap-31	Z282_1_040F				WS282_1_040F	WS282_2_040F		
A0:22:4E:10:03:F4	IDF1	2	10.9.0.12	13	dent-cortap-31	Z226_1_03EB							

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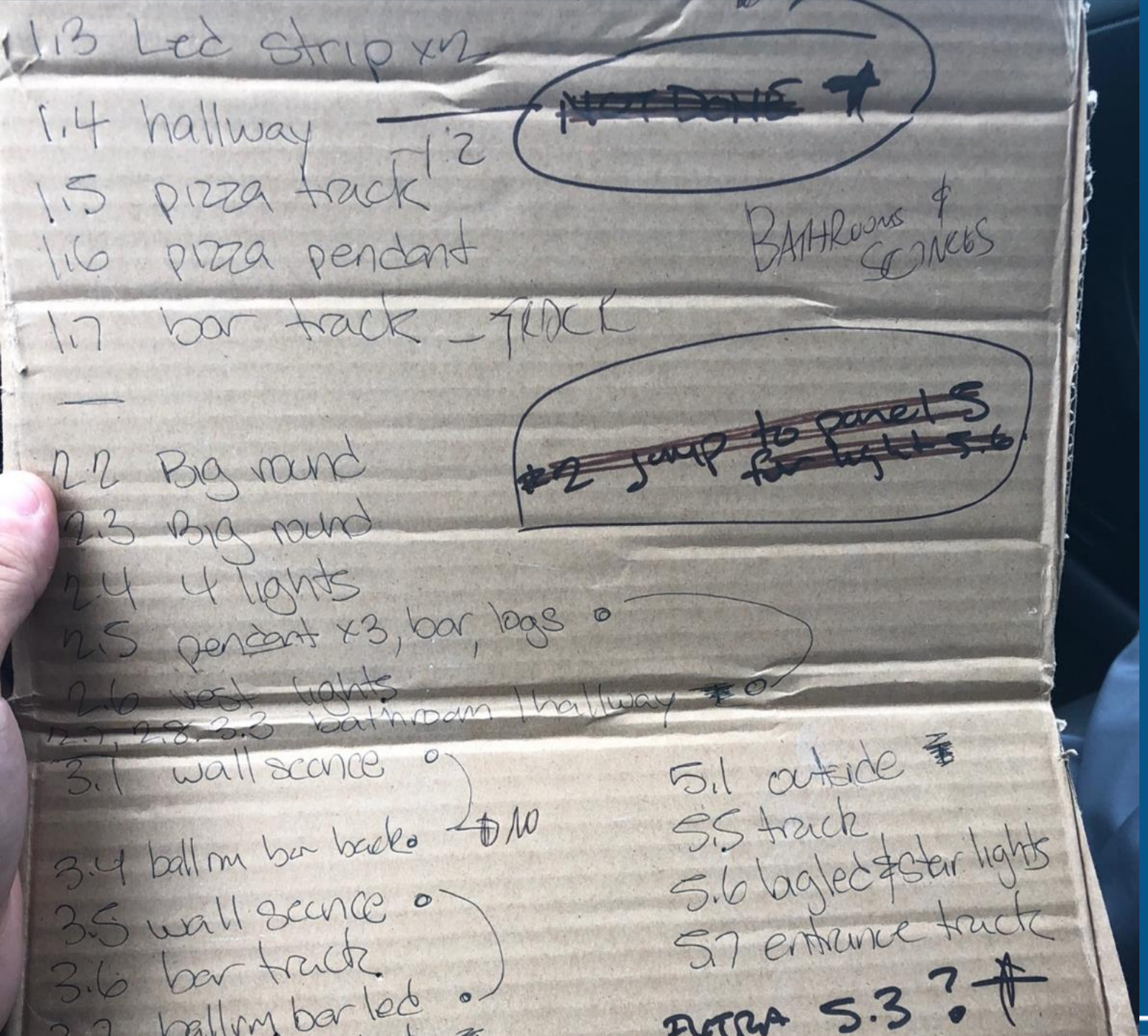

Example of BAD documentation

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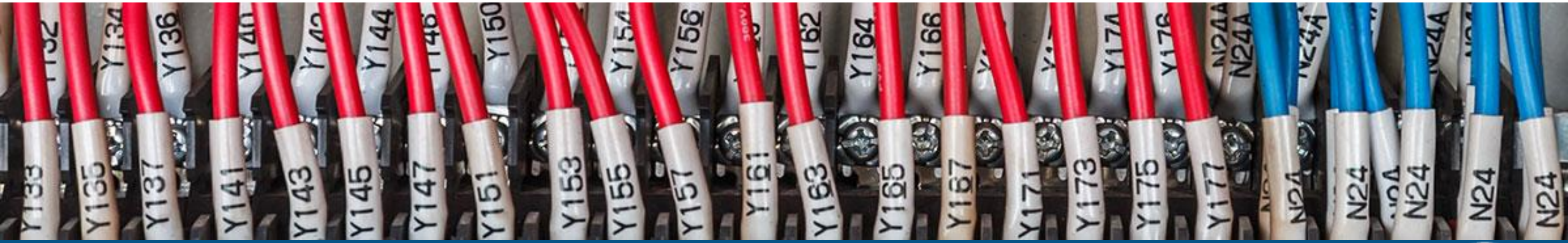
Labeling

- Labeling is fundamental to Verification, Testing, and Maintenance
- Key to project documentation
- Follow TIA-606-C
  https://global.ihs.com/doc_detail.cfm?&item_s_key=00142041&item_key_date=820611&input_doc_number=TIA%20606%2DC&input_doc_title=



Programming/Commissioning

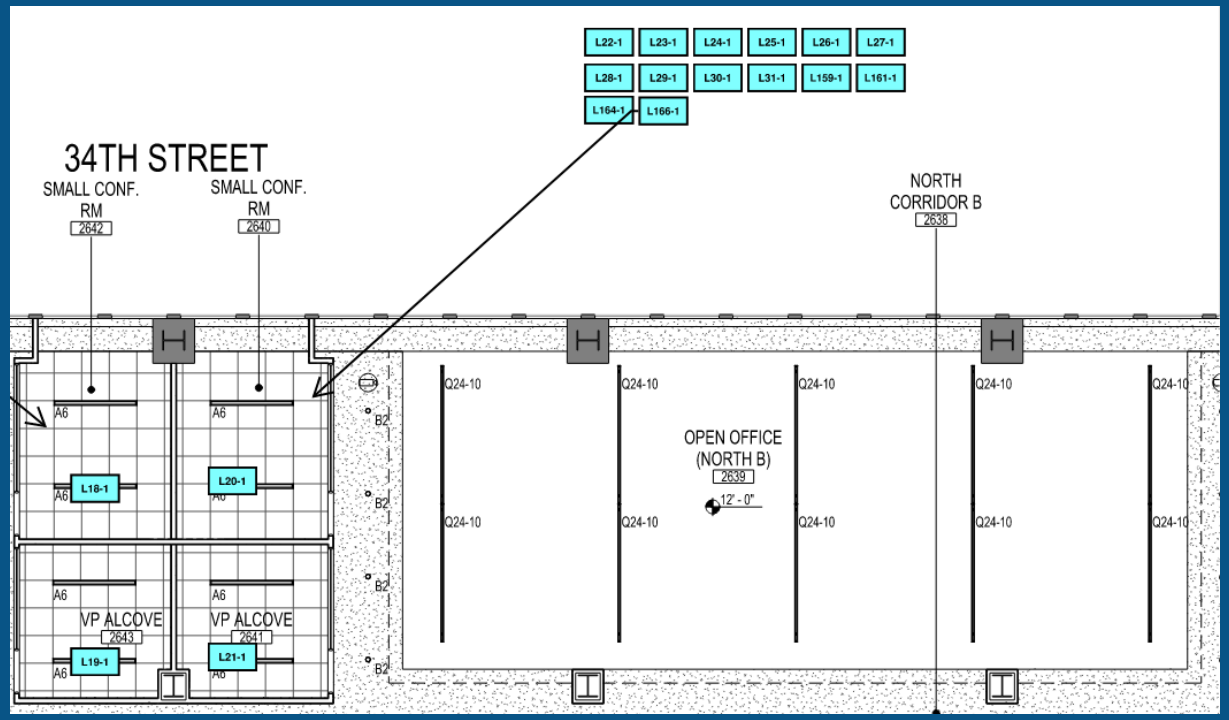
- Build from the Controls Narrative
  - Controls Best Practices
  - Engage with the end customer, not the GC. (Call backs can be avoided here)
- Connecting Inputs to Outputs
  - How do they interact?
- Crucial Documentation
  - Combine all field drawings into one master drawing.
  - Compare As-built connection list with your design docs to ensure proper labeling.
- Creating Your First Back Up
  - Save early, save often.

LIGHTING CONTROL NARRATIVE		
AREA CONTROLLED	DEVICE CONTROLLING AREA	CONTROL SEQUENCE IN ROOM
CONFERENCE/ BOARD ROOM/ LOUNGE	• WALL MOUNTED 2 BUTTON RAISE LOWER WALLSTATION • CEILING MOUNTED DUAL TECHNOLOGY VACANCY SENSOR (MANUAL ON/ MANUAL OR AUTO OFF). • CEILING MOUNTED PHOTO SENSOR DEVICES (ONLY FOR ROOMS WITH DAYLIGHT ZONES).	FIXTURES LOCATED WITHIN THE ROOM SHALL BE TURNED ON VIA THE LOCAL 2 BUTTON RAISE LOWER WALLSTATION. LIGHT FIXTURES SHALL BE ZONED AS PER PLANS. LIGHTS ARE TURNED OFF BY VACANCY SENSOR CONTROL AFTER 15 MINUTES OF VACANCY OR MANUAL SWITCH (MANUAL ON / MANUAL OR AUTOMATIC OFF). THE WALL STATION SHALL BE PROGRAMMED FOR THE FOLLOWING SETTINGS: "MEET" -ILLUMINATES ALL FIXTURES TO ILLUMINATION LEVEL SET BY TARGET FOOT CANDLE LEVELS. "PRESENT"-FIXTURE CLOSEST TO SCREEN (ZONE A) IS TURNED OFF AND ALL OTHER FIXTURES ARE DIMMED TO ILLUMINATION LEVEL SET BY TARGET FOOT CANDLE LEVELS. THE SENSOR IN THE FIVE (5) CONFERENCE ROOMS AND BOARD ROOM IN THE CONFERENCE CENTER SHALL BE TIED INTO THE EAST CORRIDOR ZONE.THE PROGRAMING SHALL BE SUCH THAT DURING AFTER HOURS PERIODS, THE EAST CORRIDOR ZONE SHALL REMAIN DIMMED TO 20% IF ANY OF TEH FIVE (5) CONFERENCE ROOMS OR BOARD ROOM IS OCCUPIED.
OFFICES	• WALL MOUNTED 4(2-ZONE) BUTTON RAISE/ LOWER WALLSTATION • CEILING MOUNTED DUAL TECHNOLOGY VACANCY SENSOR (MANUAL ON/ MANUAL OR AUTO OFF)	FIXTURES LOCATED WITHIN THE ROOM SHALL BE TURNED ON VIA THE LOCAL 2 BUTTON RAISE LOWER WALLSTATION. LIGHT FIXTURES SHALL BE ZONED AS PER PLANS. LIGHTS ARE TURNED OFF BY VACANCY SENSOR CONTROL AFTER 15 MINUTES OF VACANCY OR MANUAL SWITCH (MANUAL ON / MANUAL OR AUTOMATIC OFF). THE WALL STATION SHALL BE PROGRAMMED FOR THE FOLLOWING SETTINGS: "FULL" -ILLUMINATES ALL FIXTURES TO 100% OF ILLUMINATION LEVEL SET BY TARGET FOOT CANDLE LEVELS. "HALF"-ILLUMINATES ALL FIXTURES TO 50% OF ILLUMINATION LEVEL SET BY TARGET FOOT CANDLE LEVELS. THE SENSOR IN OFFICES SHALL BE TIED INTO THE WEST CORRIDOR ZONE.THE PROGRAMING SHALL BE SUCH THAT DURING AFTER HOURS PERIODS, THE WEST CORRIDOR ZONE IMMEDIATELY OUTSIDE AN OCCUPIED OFFICE SHALL REMAIN DIMMED TO 20% UNTIL OCCUPANT VACATES OFFICE

Programming/Commissioning

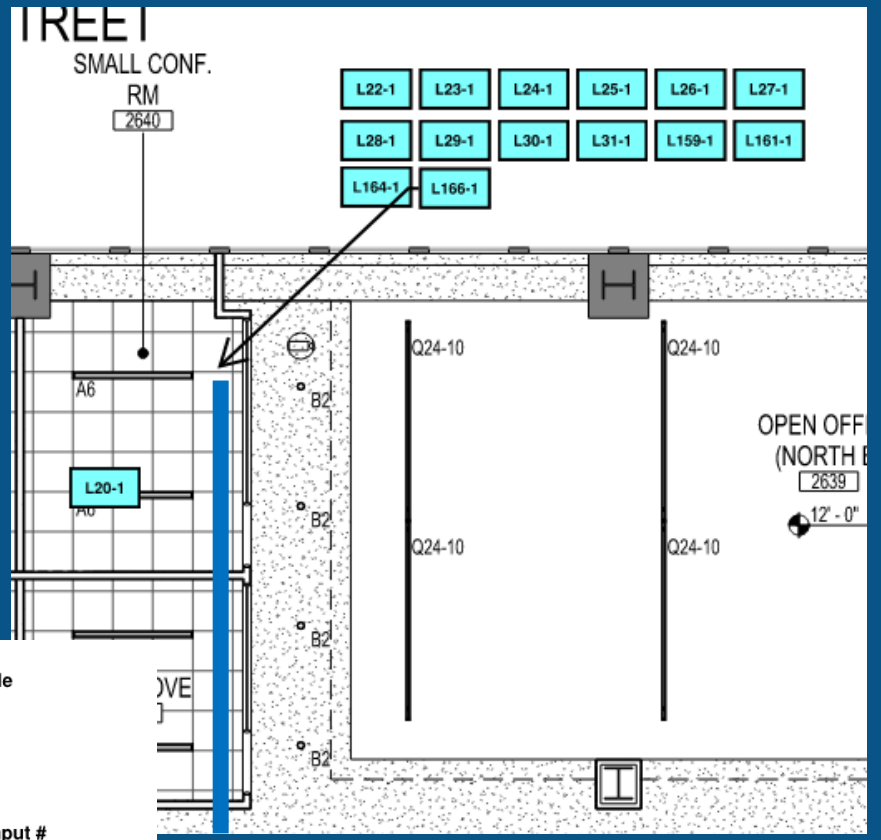
(cont.)

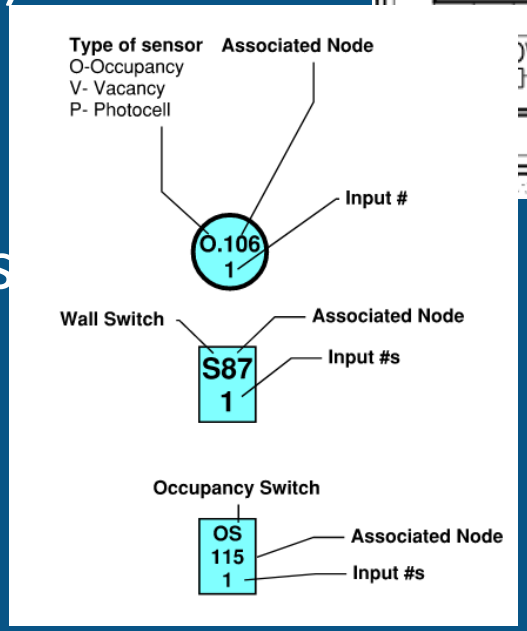
- Testing and Commissioning Best Practices
  - Walk through device by device to double check functionality
  - Let it run for a few days to find any bugs
  - LABEL EVERYTHING!!
    - Switches
    - Cables
    - Light switches
    - Power cords in racks
- Necessary Documentation:
  - Create As-Built Drawings and Tables of Devices
  - Collect Manuals, Cut Sheets,
  - Back Up's of Configurations, Control Systems, and any Files



Creating As Builts

- Show exactly where devices are located.
- Show paths of cabling.(Blue Line)
- Provide any information that would be helpful for service.
- Create legends on your drawings that show detailed info.





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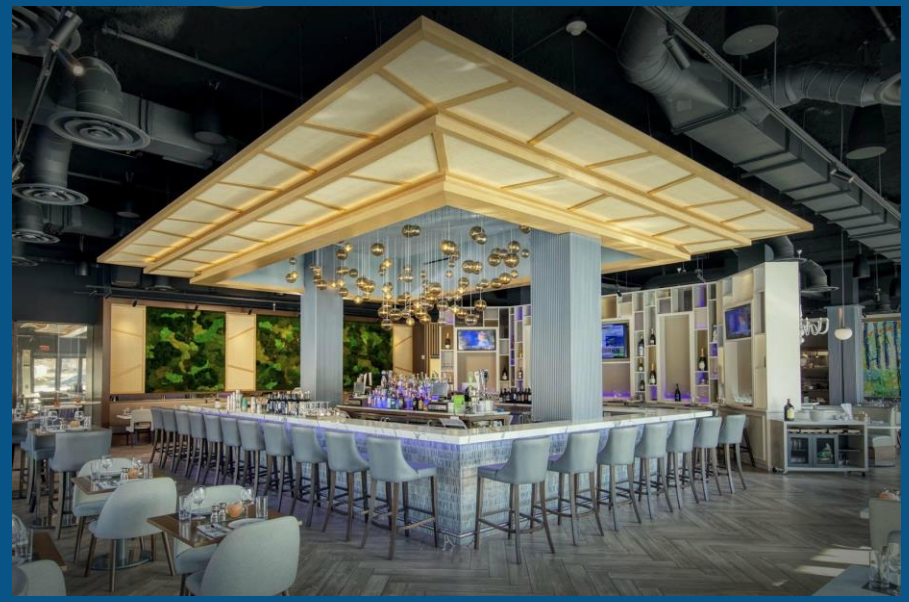
Client Handover

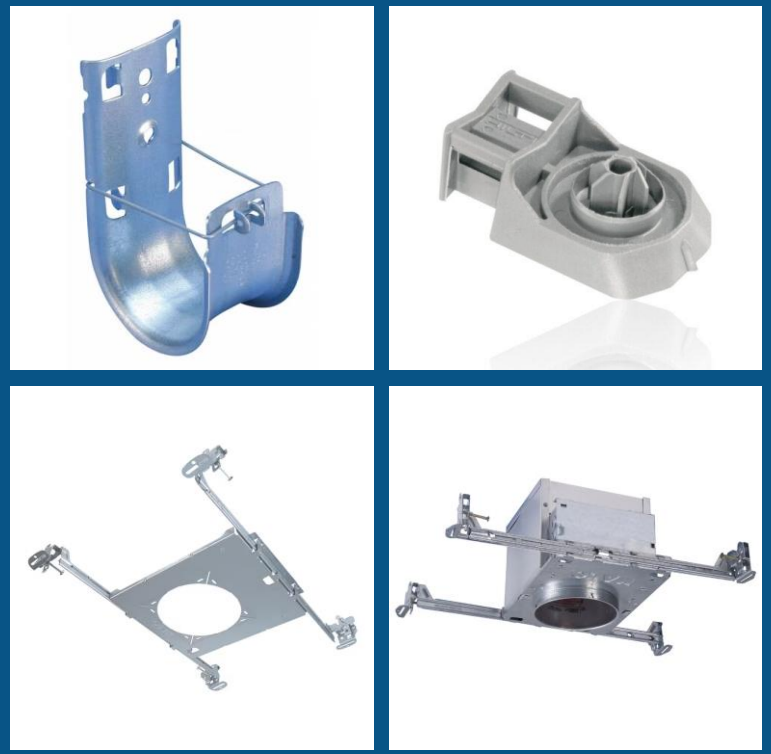
- Schedule with your manufacturer in advance
- Expect & Demand 1-2 hour training with owner/GC
  - Where are the switches? Servers? Devices?
  - How does the system operate?
  - How can you break the system?
  - Video the Training
- Create a Share Folder
- Offer Ongoing Services & What To Expect from the Warranty
- Create a Golden Configuration and File it with Manufacturer



What have we learned?

Installing lighting and cables

- Always support your cables
- Use back boxes for connections and to make finding wires easier in hard ceilings
- Use painters tape and a sharpie to label fixture with node number.



Do’s and don'ts

Do’s

- Plan for scalability
- Ground and bond your equipment!
- Keep master drawings up to date
- Label everything
- Know your system

Don’ts

- Underestimate install and commissioning time.
- Hide nodes in hard ceilings.
- Use zip ties.
- Overdesign the system

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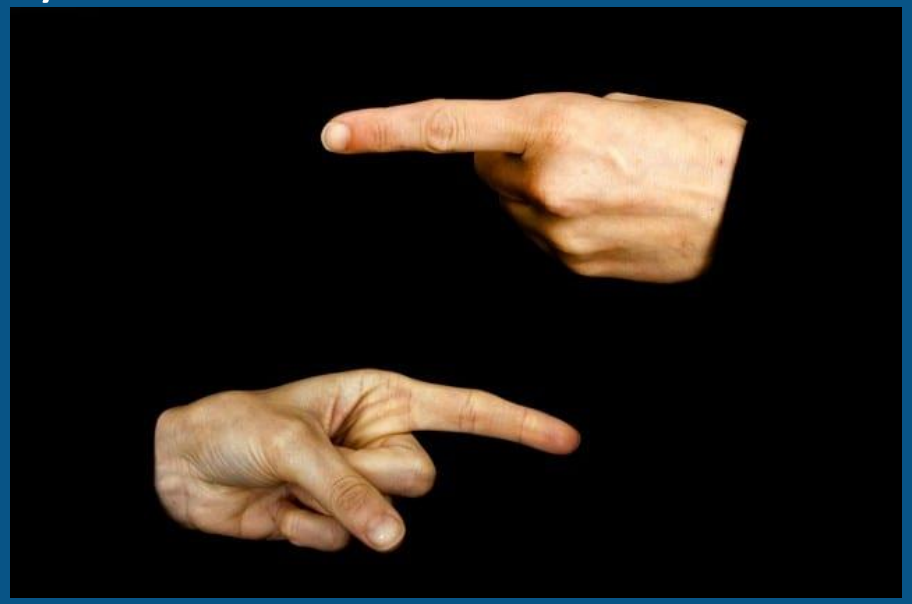
Roles and Responsibilities

- Who is pulling cable?
- Who is installing light fixtures?
  - Who is installing back boxes?
  - Who is connecting the fixture?
  - Whose responsibility is it if it doesn't work?

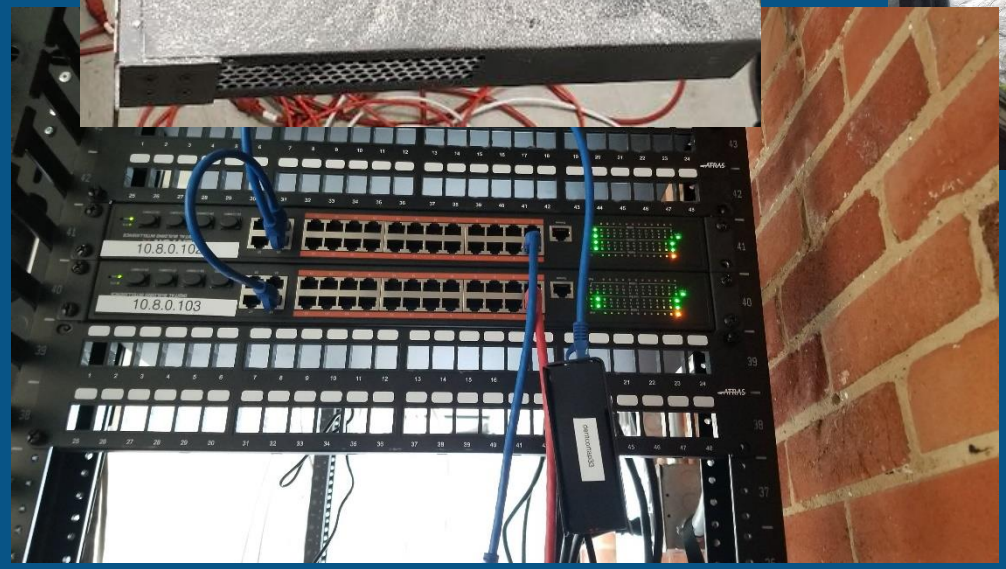


- Scope of work and exclusions should be clearly called out in your proposal or contract. Minimize finger pointing.

SCHEDULE CONSIDERATIONS

SERVER ROOM (MDF / IDF) COMPLETE WITH “DRY IN”

- CONSTRUCTION CLEANED
- DOOR INSTALLED
- TEMPORARY POWER IN WALL



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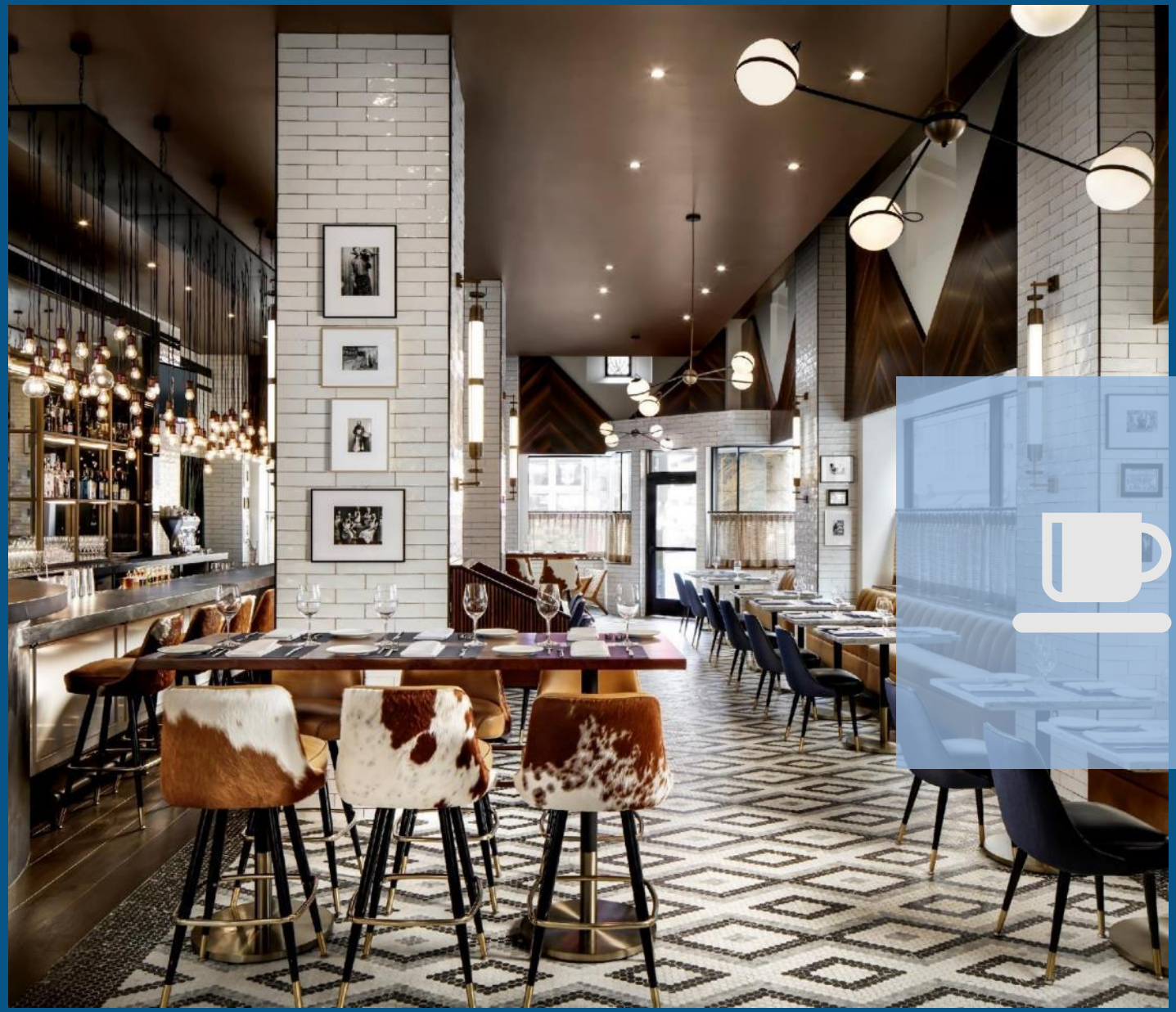

SECTION BREAK

Q&A & Petting Zoo
– 3:30 – 4:00 pm

Courtesy of the Sinclair Marriott

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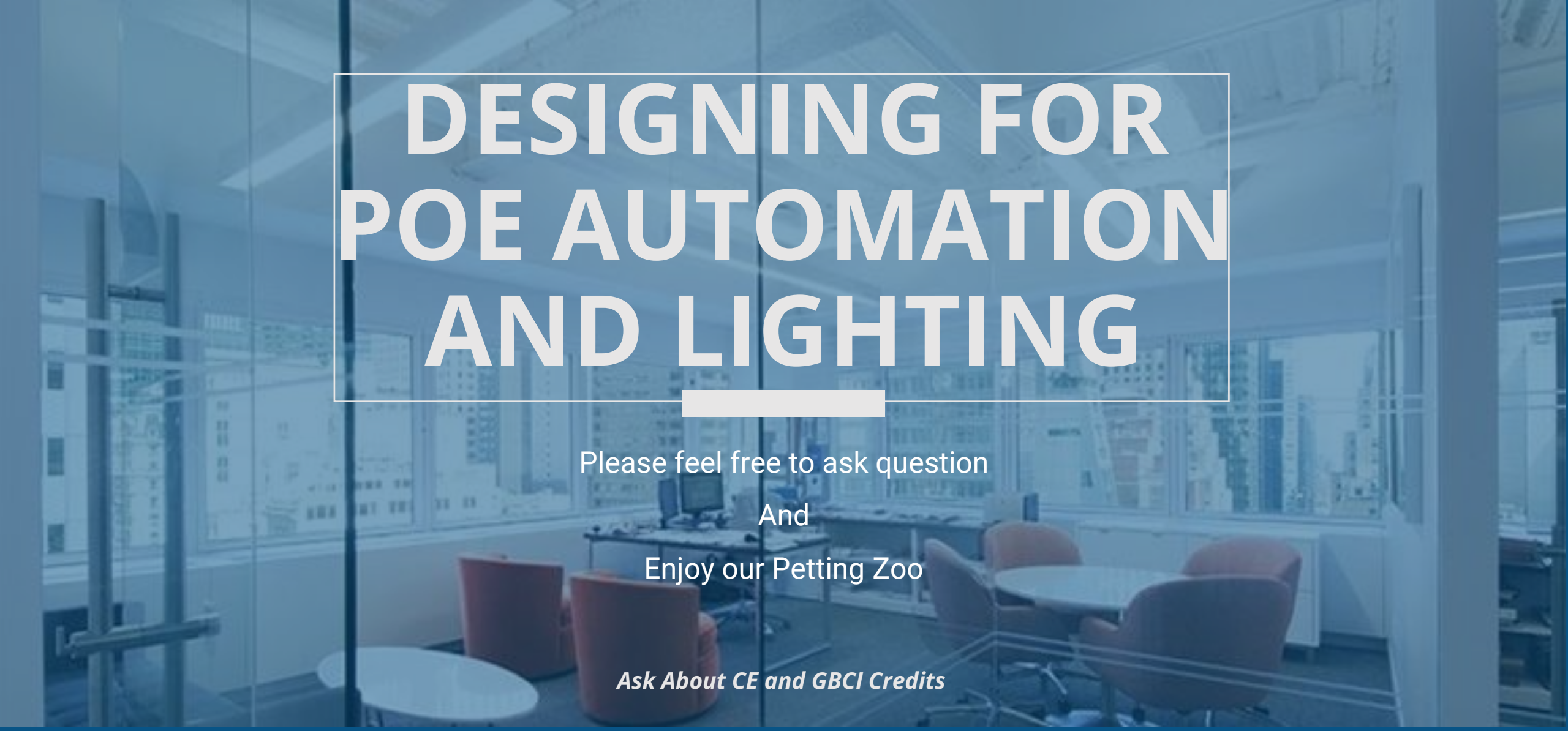

DESIGNING FOR POE AUTOMATION AND LIGHTING

Please feel free to ask question

And

Enjoy our Petting Zoo

Ask About CE and GBCI Credits

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