Introduction to Power over Ethernet (PoE) Lighting

Presented by:

Armando Berdiel, LC, M.Eng.

Technical Development Supervisor

Lighting Design Lab

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Before we begin...

During the Webinar

- Attendees will be muted
- Please use the chat feature in the control panel to submit questions to LDL staff
- The presenter will pause to address questions every ~10 minutes
- Please participate in the online polls.

Following the Webinar

- Please take the short survey
- A recording and the slide deck will be posted on LDL's webpage
- Reach out to LightingDesignLab@seattle.gov with comments or questions.

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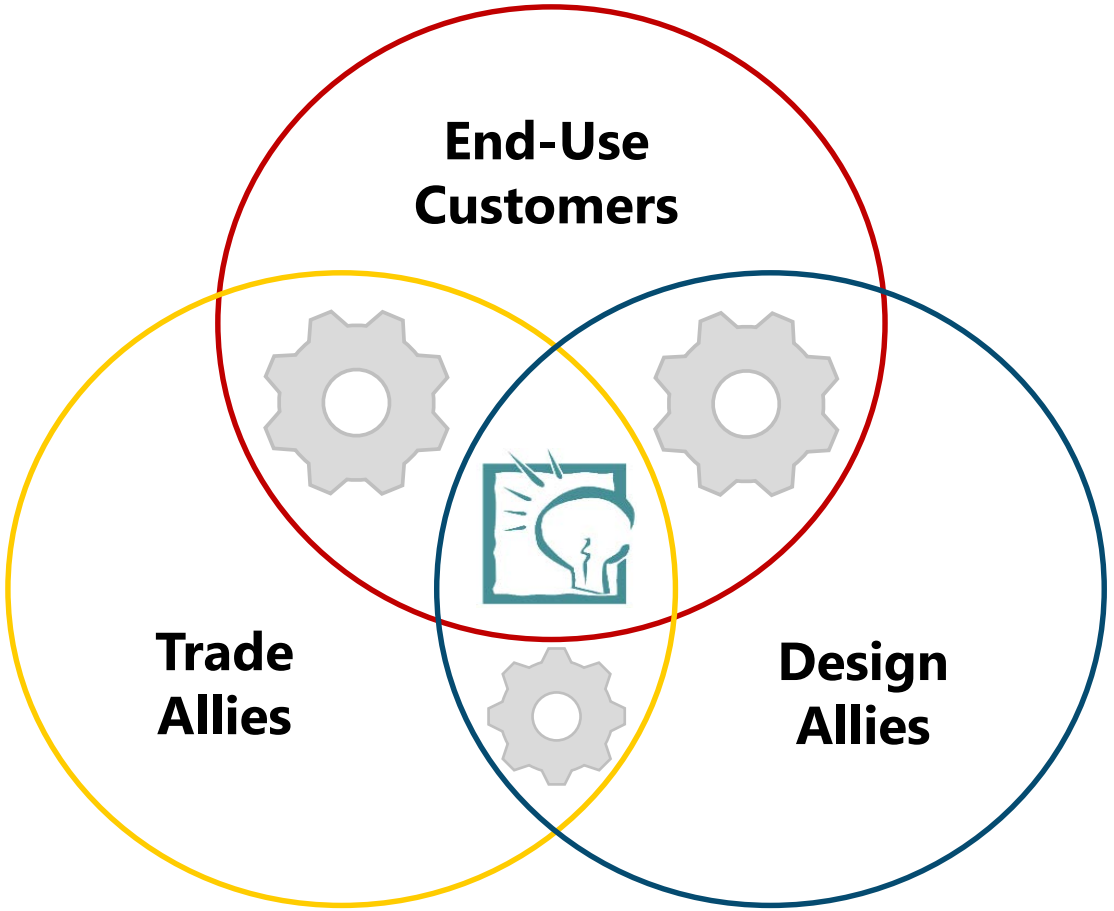
Seattle City Light

Who We Work With

It takes a village…



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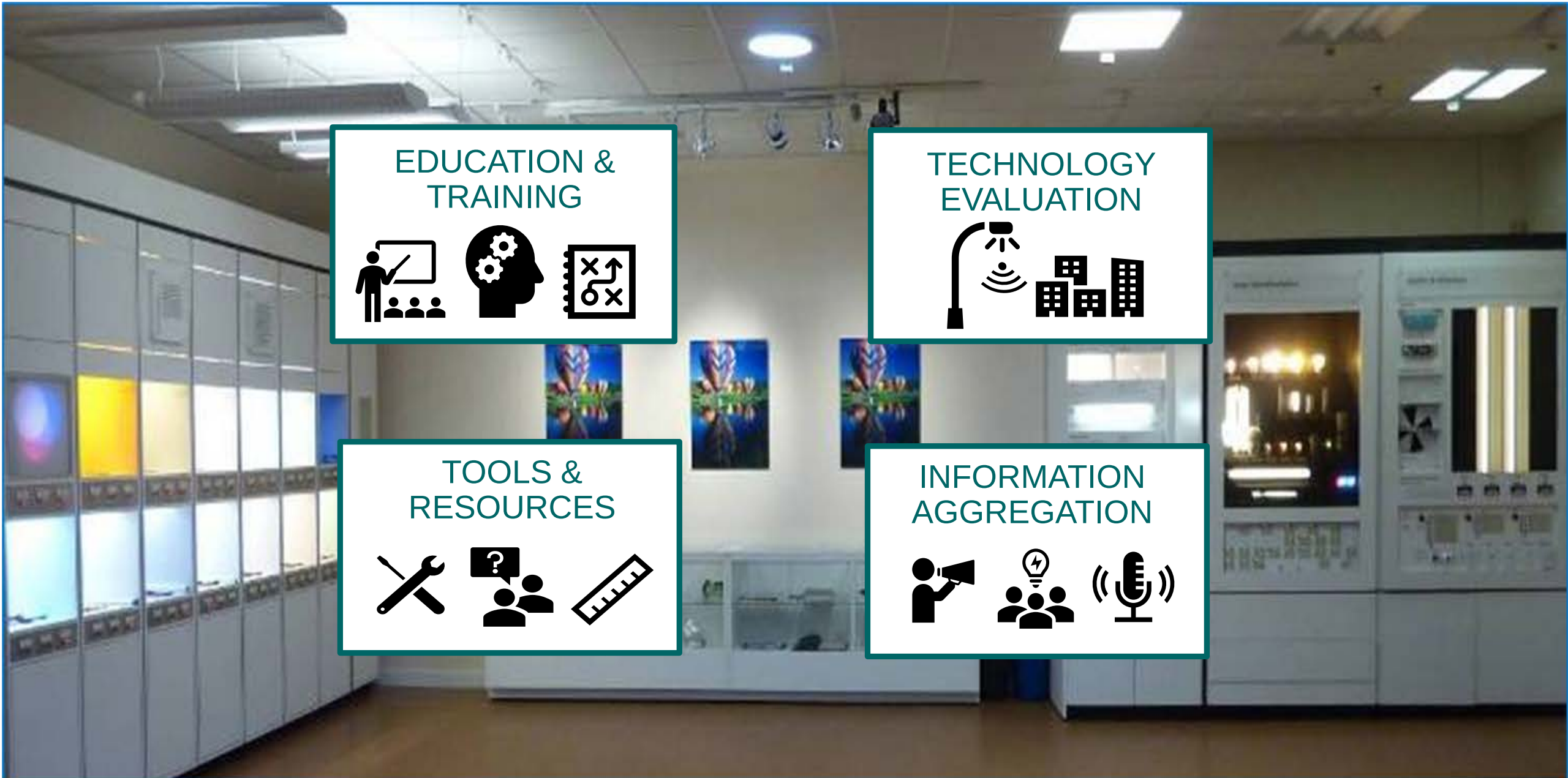
LDL’s Four Core Service Areas



Instructor Background

Armando Berdiel Chavez, M.Eng., LC
Technical Development Supervisor

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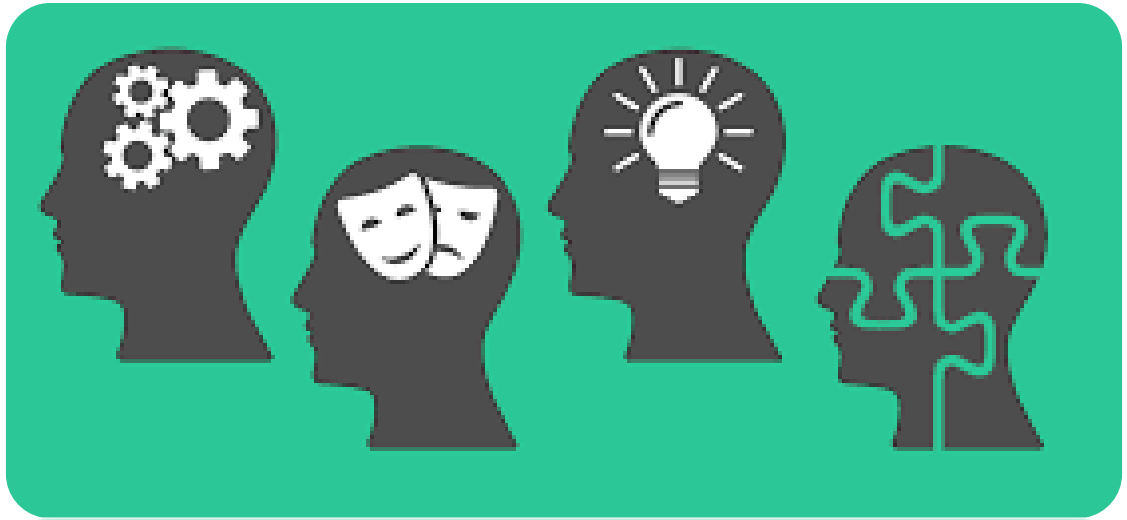
- Lehigh University, B.S.
  - Computer Science & Business
- Penn State University, Meng.
  - Engineering Management
- Lutron Electronics (PA)
  - Systems Support
  - Lead Project Coordinator
- Pearl Street LED Systems (NJ, NY)
  - Project Development Engineer

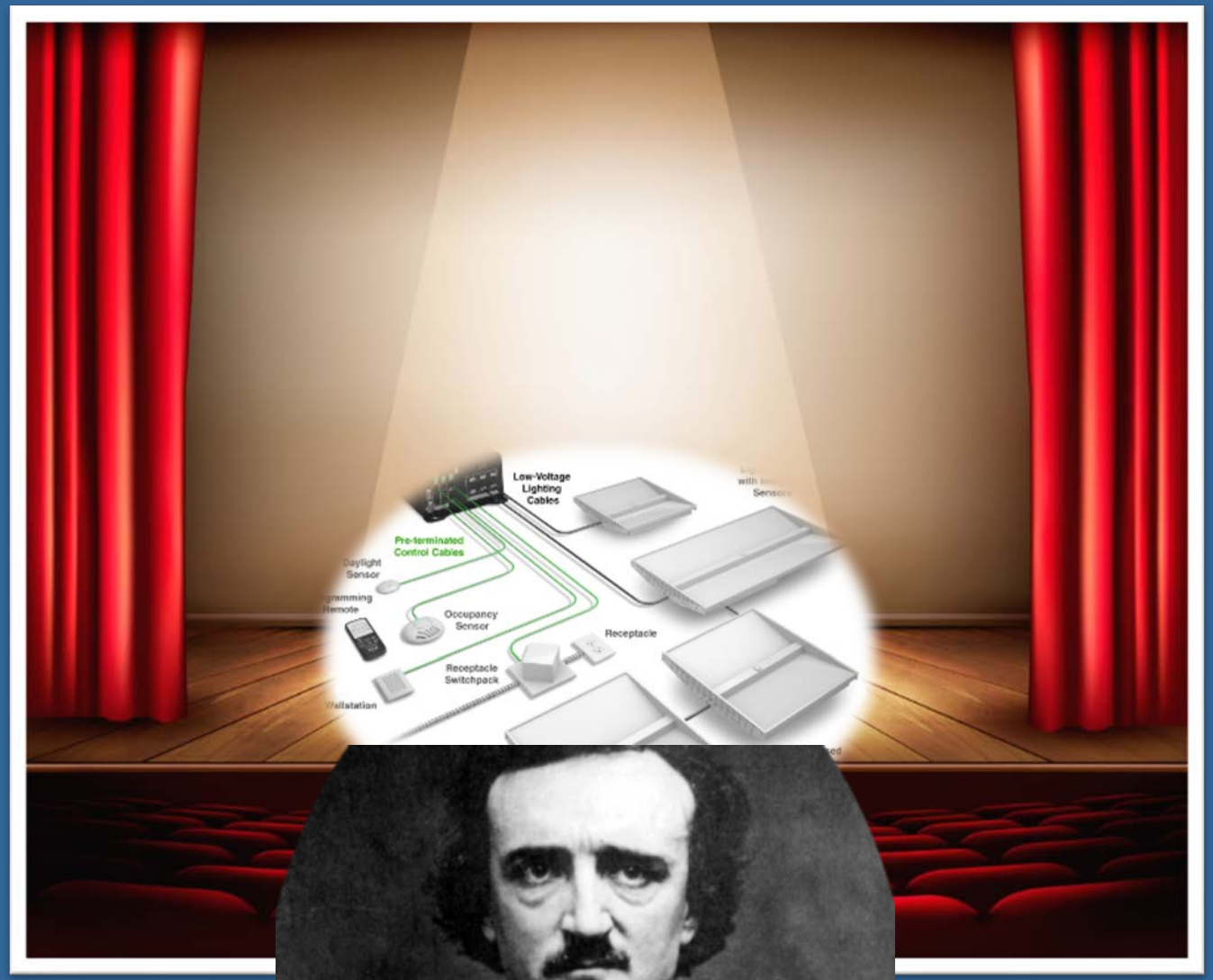
Time for a Quick Poll…

Enough about me…

Let’s talk about you…

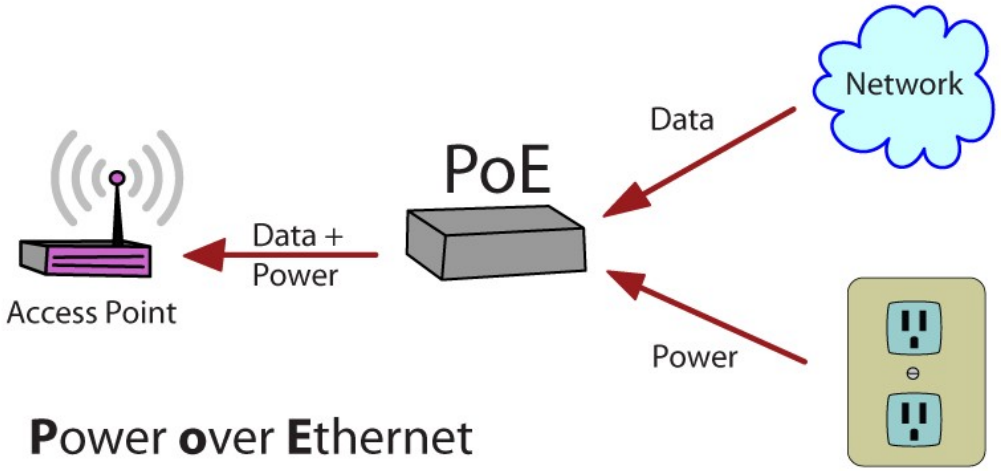


Setting the Stage

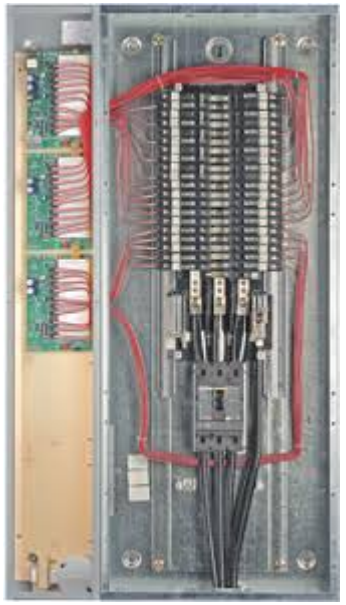


Two Functions, One Cable

PoE delivers Power and Data



AC / Line Voltage delivers Power



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Voltage Drops on Current Conversion

Converter

Inverter

Image by MDPI

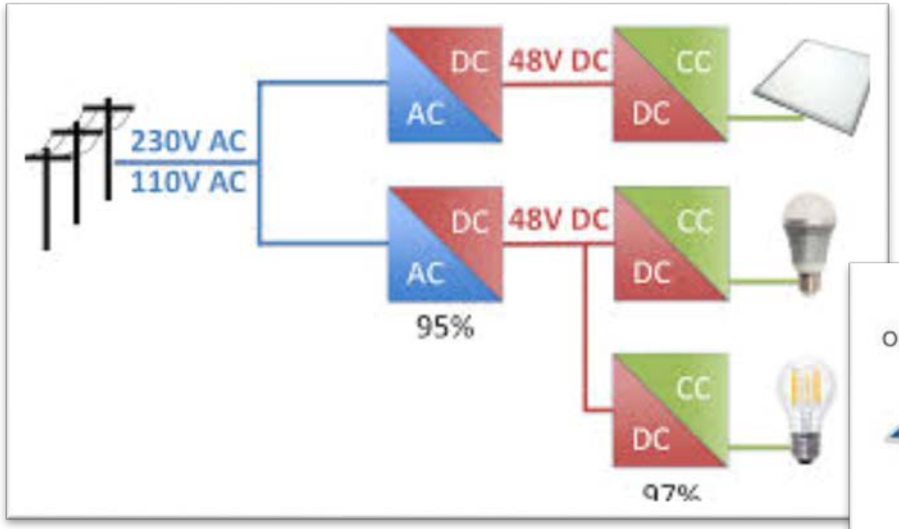
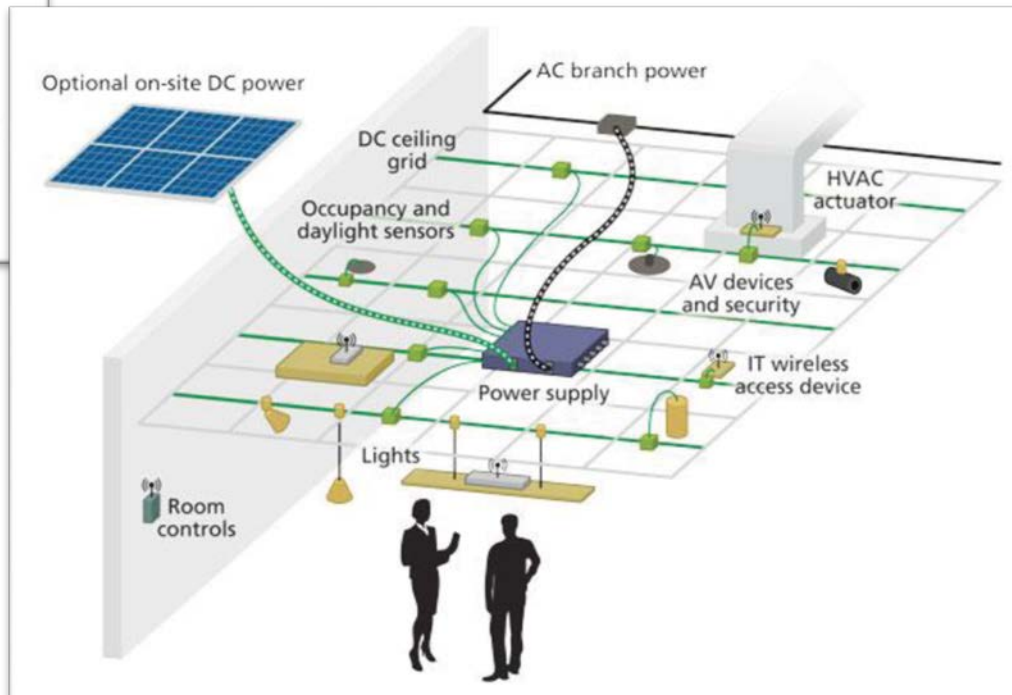
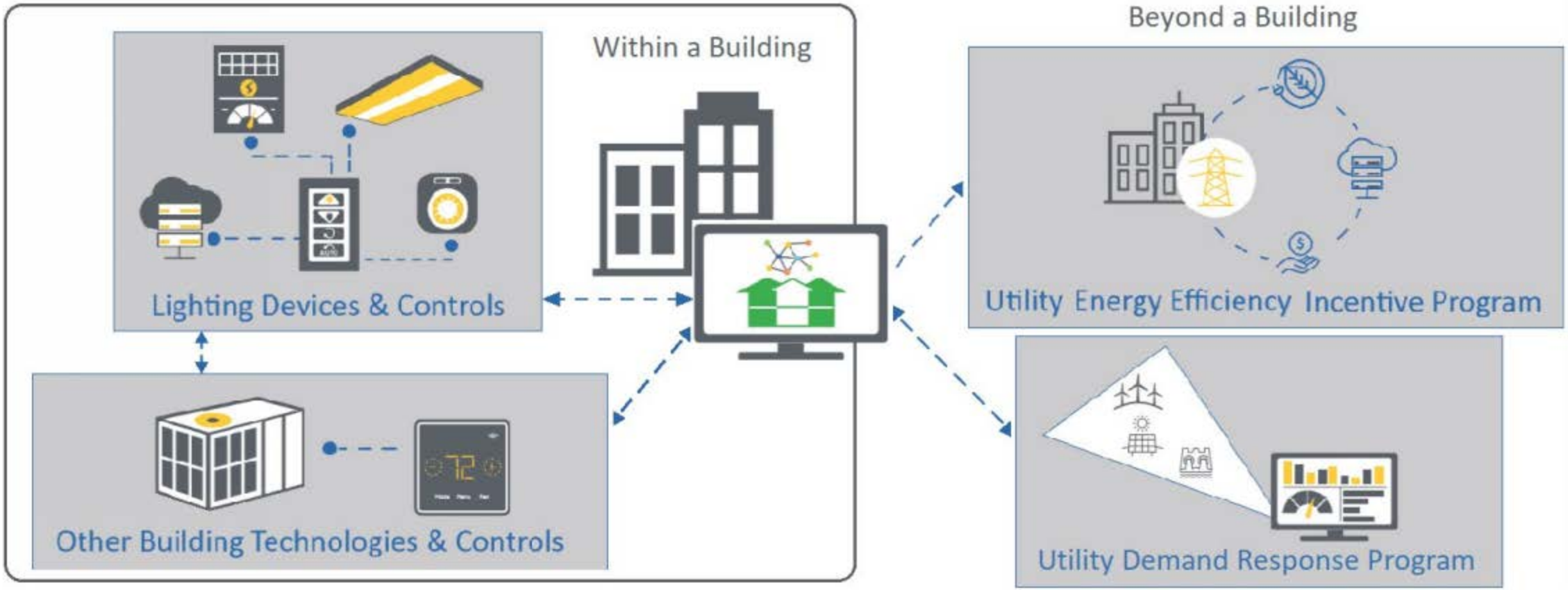


Image by EE Publishers

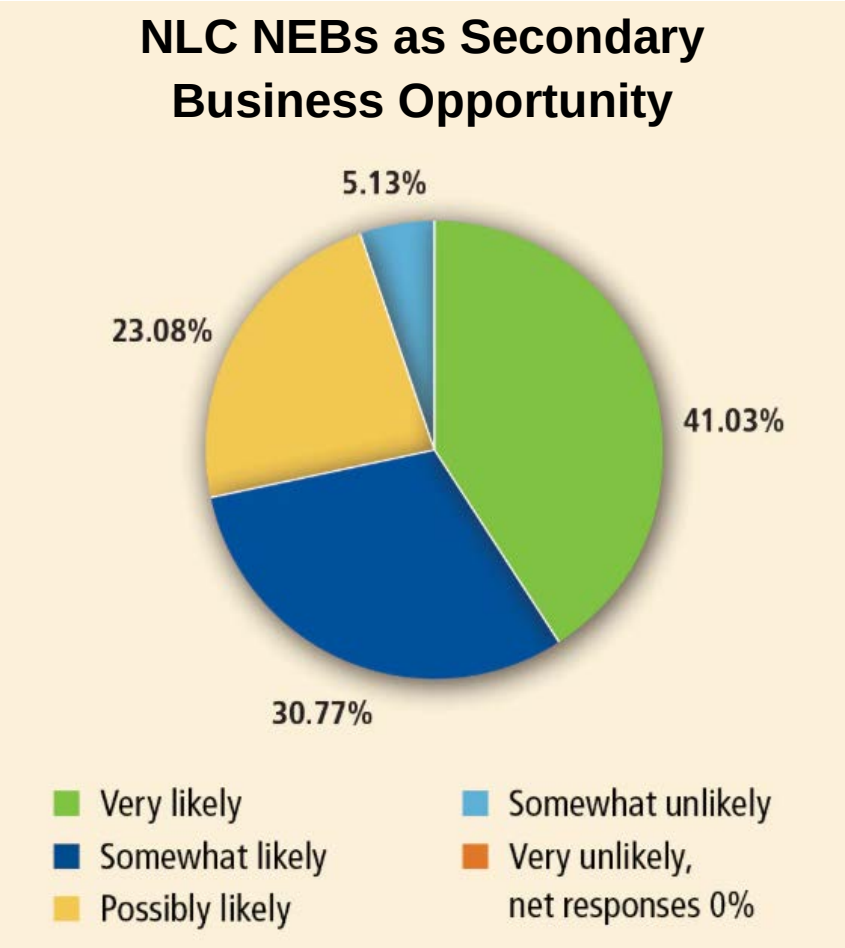


Infrastructure for the Technologies of Tomorrow



Courtesy of DLC: *Interoperability for Networked Lighting Controls (May 19 2020)*

Connected Lighting Prospectus for Buildings

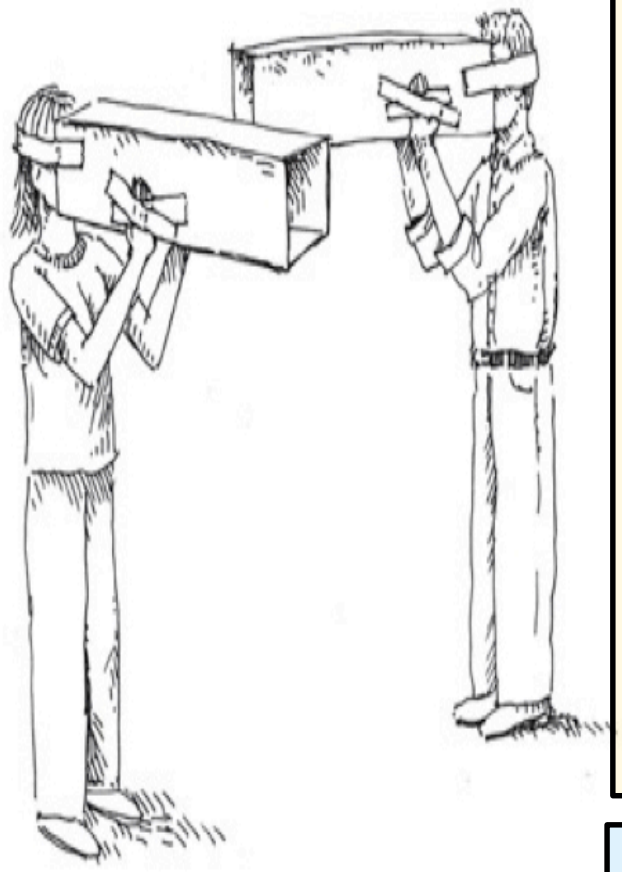


LEDs Magazine SSL “State of the Industry” 2020 Survey

The 1-9-90 Rule

- 1% Energy & Resources
- 9%: Space & Layout
- 90%: Wellness & Productivity
- +100%: Revenue & Opportunities

The Disconnect…



We block out the voices trying to give us new information

Cost-Focused Stakeholder OR Implementer

Up front cost

Too complicated

Customer doesn't need it

Too time consuming

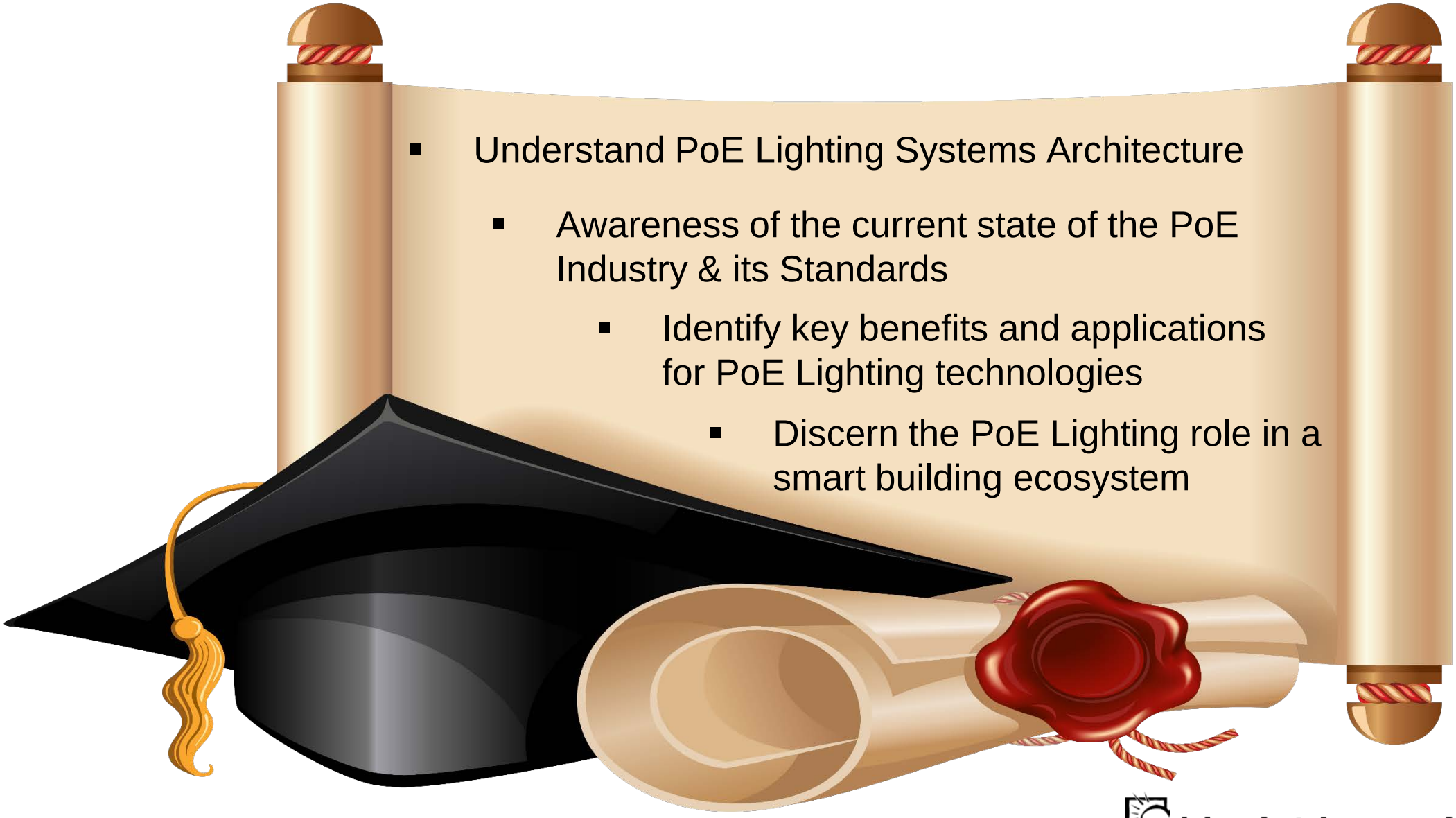
Design Ally:

I can't remember the last time I didn't spec an NLC product…

End-Use Customer:

I need integrated solutions…

Learning Objectives

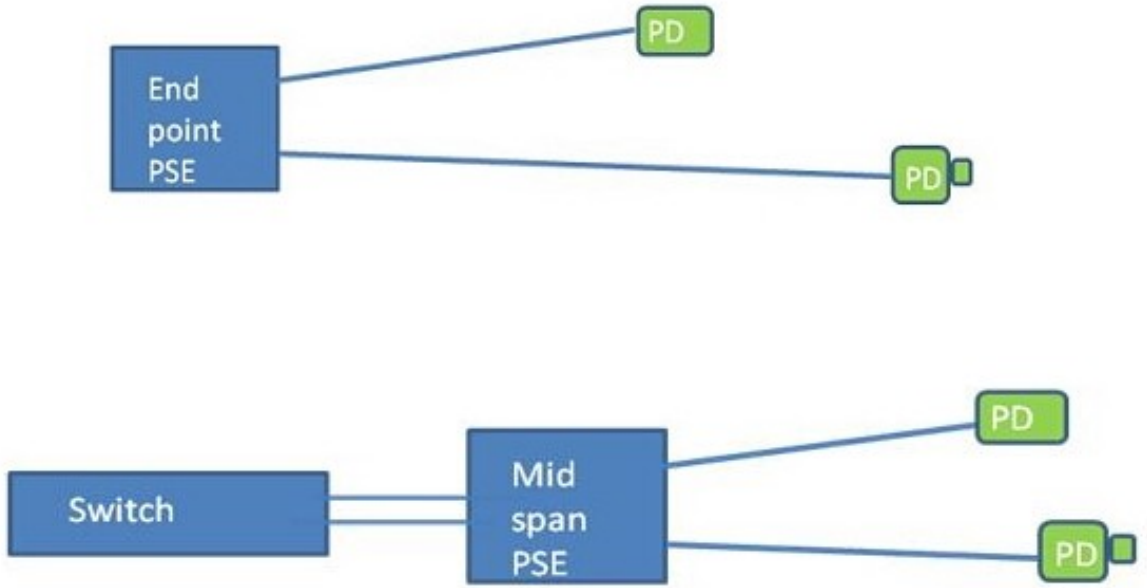


- Understand PoE Lighting Systems Architecture
  - Awareness of the current state of the PoE Industry & its Standards
    - Identify key benefits and applications for PoE Lighting technologies
      - Discern the PoE Lighting role in a smart building ecosystem

Terms, Definitions, Technicalities

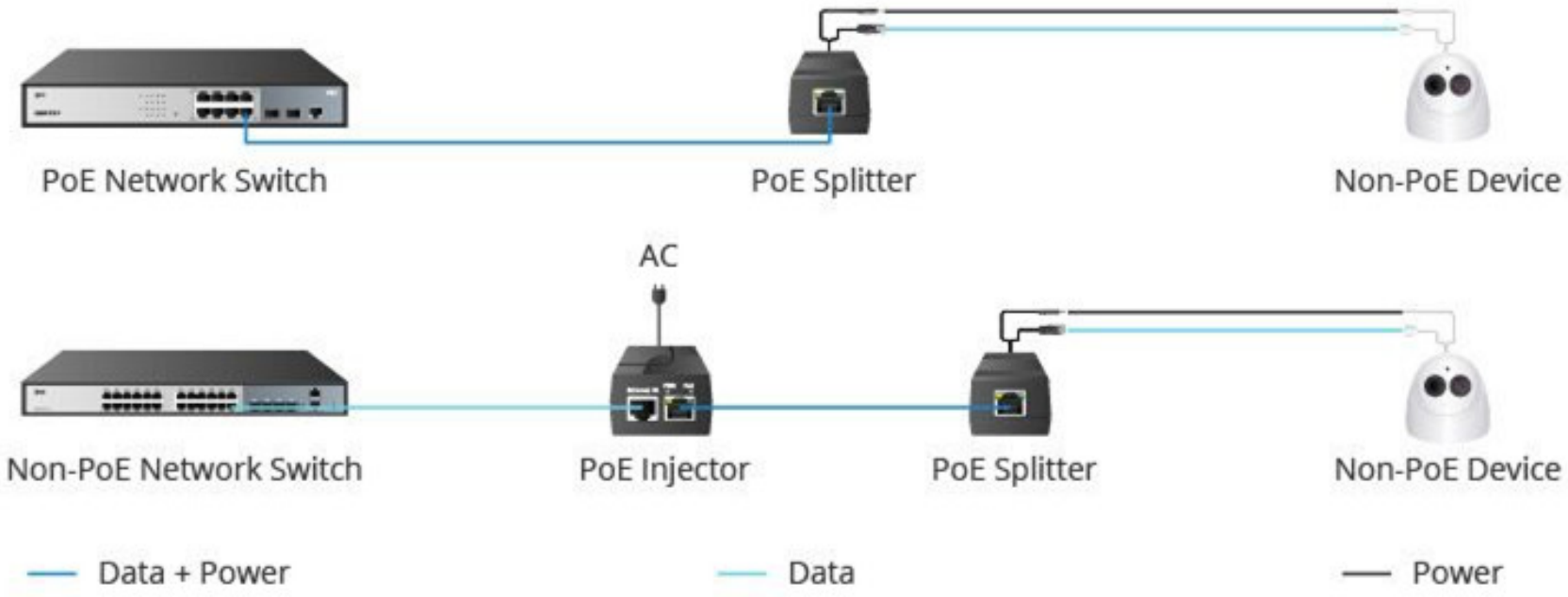
Base PoE Terminology

- PSE
  - Power Sourcing Equipment
- PD
  - Powered Device
- Institute of Electrical and Electronics Engineers (IEEE)
  - Standard 802.3xx
- Mid-Span & End-Span/Point



PoE Power Sourcing Equipment

Image by FS United States



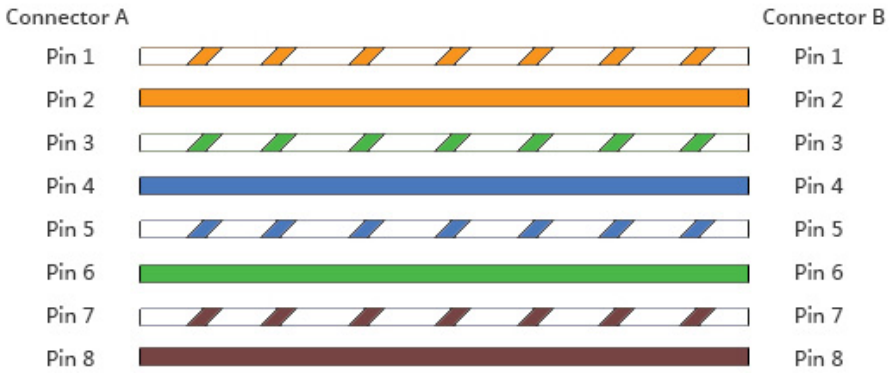
Ethernet Cable - RJ45 – and Cats

- RJ45
- 8 wires, T-568A&B
- Cat5 – 100Mbps to 125Mbps
- Cat6 – 10Gbps @55m
- Patch vs. Crossover Cables

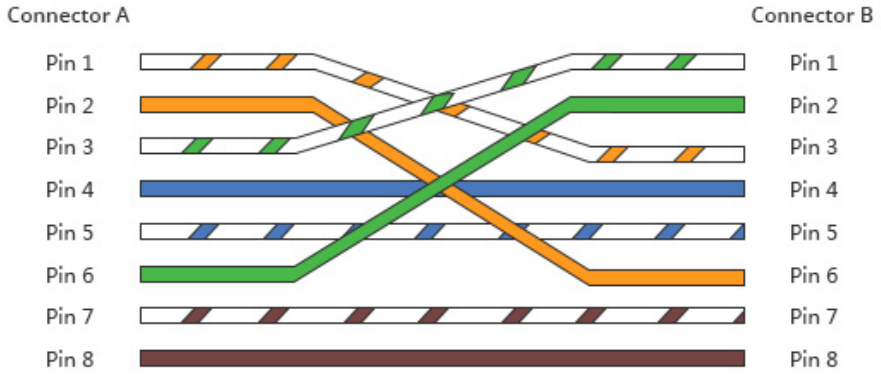
ETHERNET CABLE PERFORMANCE SUMMARY

CATEGORY	SHIELDING	MAX TRANSMISSION SPEED (AT 100 METERS)	MAX BANDWIDTH
Cat 3	Unshielded	10 Mbps	16 MHz
Cat 5	Unshielded	10/100 Mbps	100 MHz
Cat 5e	Unshielded	1000 Mbps / 1 Gbps	100 MHz
Cat 6	Shielded or Unshielded	1000 Mbps / 1 Gbps	>250 MHz
Cat 6a	Shielded	10000 Mbps / 10 Gbps	500 MHz
Cat 7	Shielded	10000 Mbps / 10 Gbps	600 MHz
Cat 8		Details to be released later	

Patch Cable/Straight Through Cable Wiring Scheme



Crossover Cable Wiring Scheme



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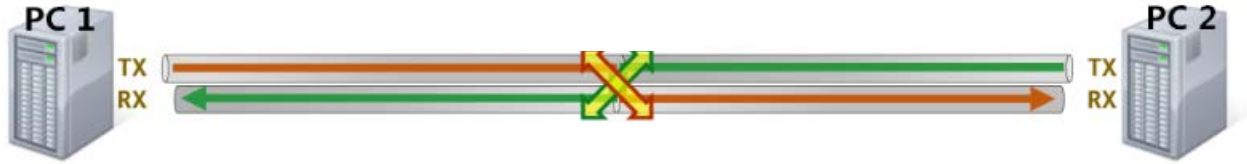
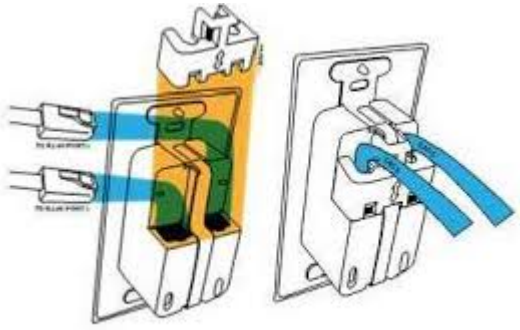
More Patch vs. Crossover

- PC to PC



- PC to Switch to PC

Daisy-



-Chaining

Cable Gauge Comparisons

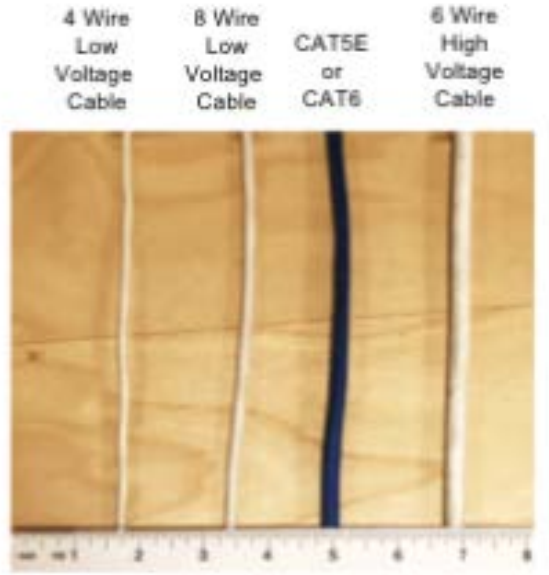
PoE
(LOW VOLTAGE)

4 Wire Low Voltage Cable	8 Wire Low Voltage Cable	CAT5E or CAT6
		
Diameter 3.45 mm [1/8 inch]	Diameter 5.58 mm [7/32 inch]	Diameter 6.0 mm [1/4 inch]

LINE VOLTAGE

6 Wire High Voltage Cable

Diameter
7.95 mm
[5/16 inch]



Ceiling Accessibility – “Finished, Dropped Ceiling”

- Acoustic Ceiling Grid, Suspended
- Accessible
- Number of Remote Devices is a Limiting Factor
- PoE and AC systems are equally viable

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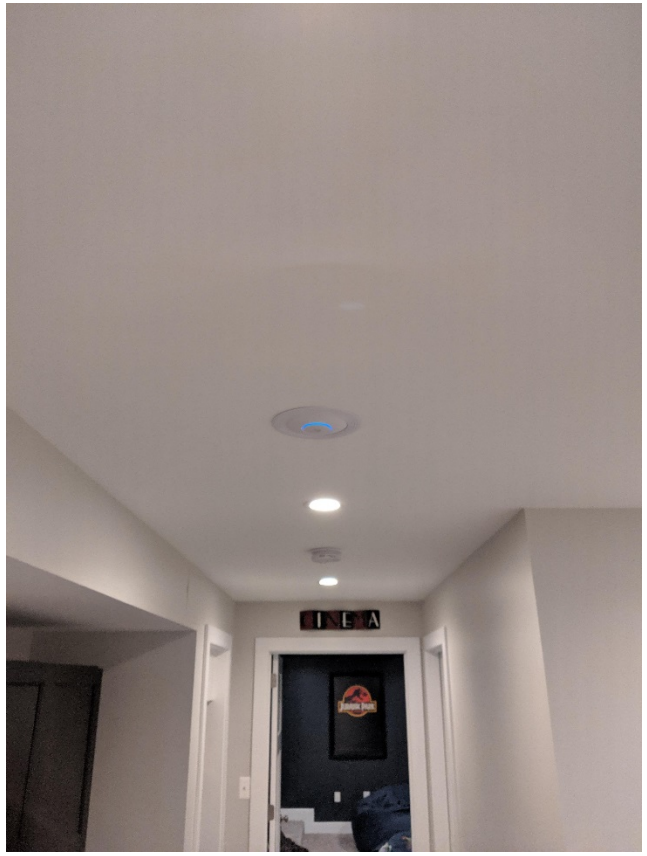
Ceiling Accessibility – “Finished, Inaccessible Hard Ceiling”

- Drywall, Paneling, Coffered/Cove, etc.
- Access to components is a challenge
- 50m runs from switch to fixtures. Access to fixture is from below
- Remote gateway requires LV wire from it to fixture.
  - Length-limited by voltage drop



TeleComm Equipment in IDF, MDF, CDF Rooms

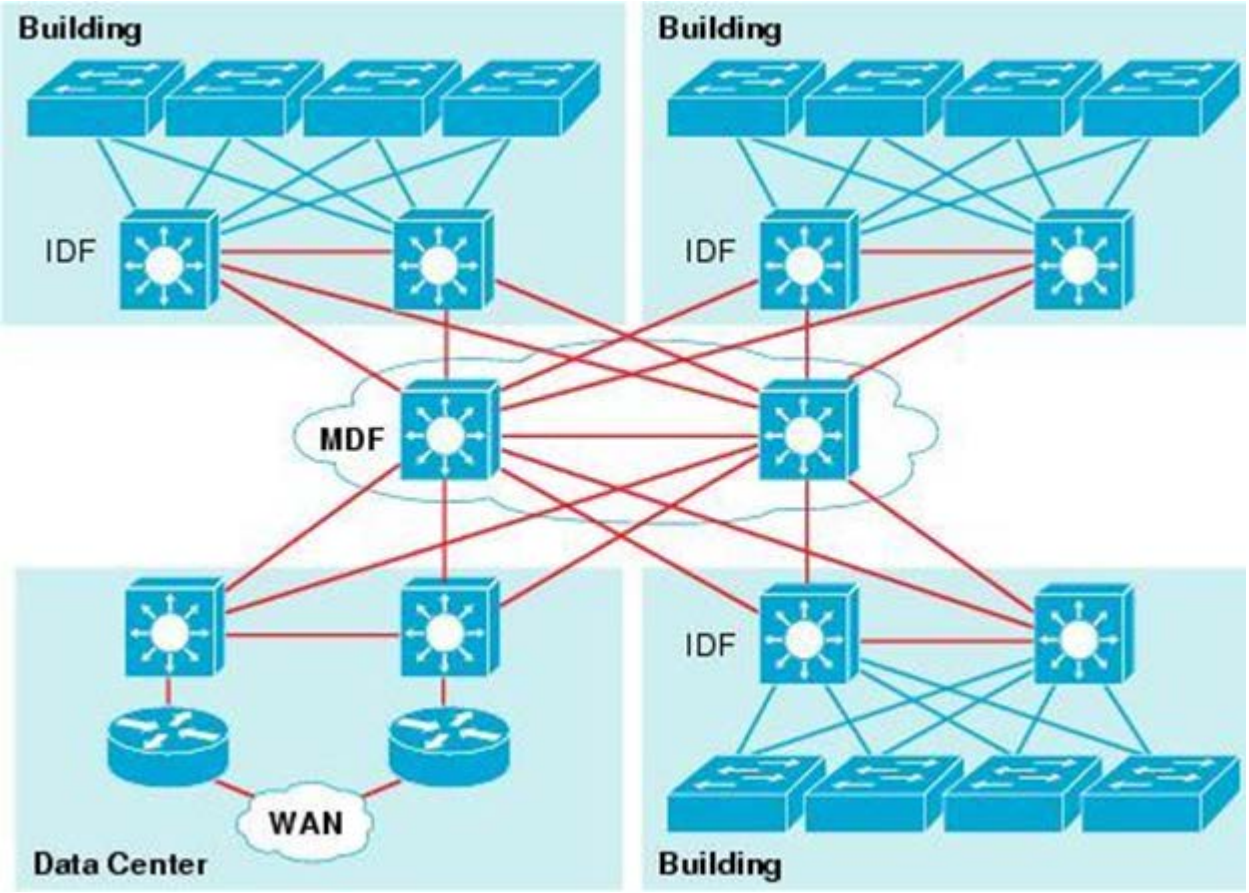


Image by “Alternate Energy Source”

Image by YannTech

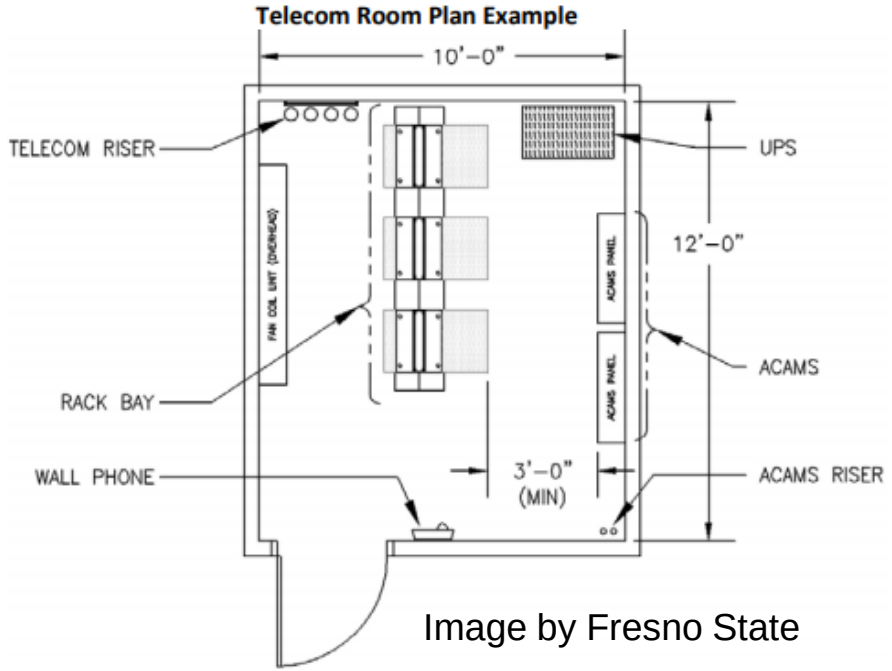
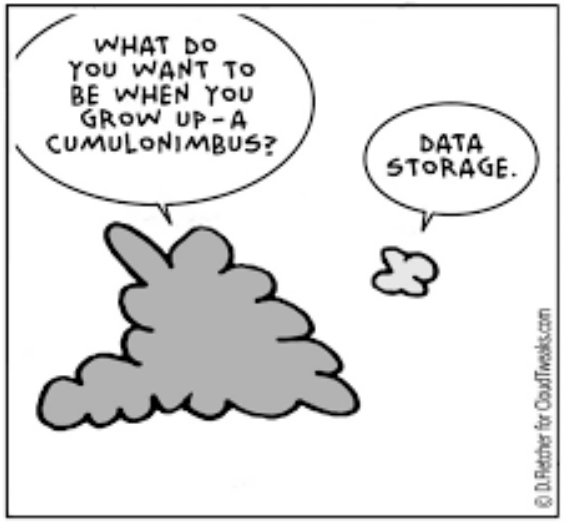


Image by Fresno State

PoE Lighting Architecture

- Power Sourcing Equipment
- PoE Fixtures with Integral Driver
- PoE Fixture with Remote Driver
- Ancillary NLC Components
- Clouds



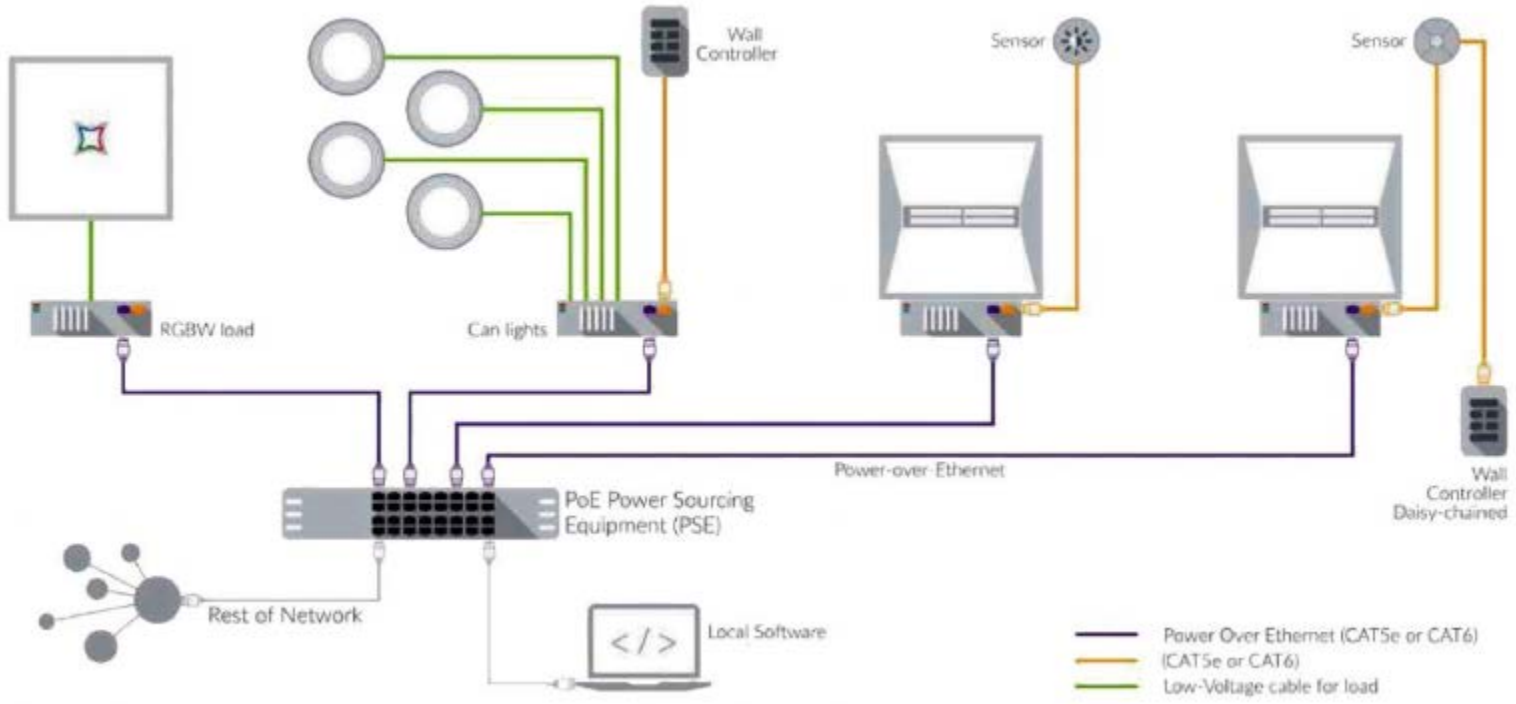


Image by NuLEDs

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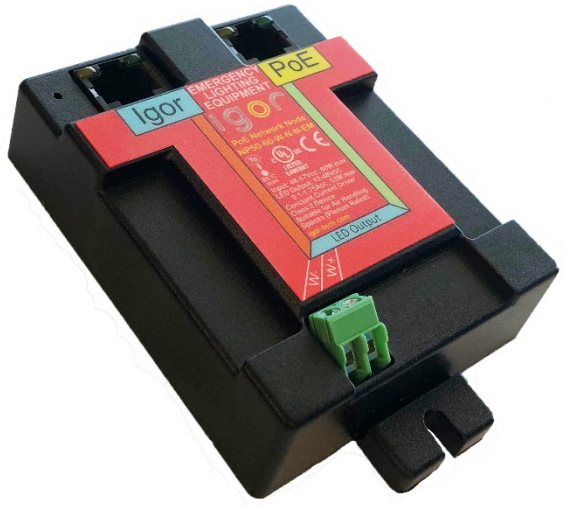
PoE Emergency Lighting Considerations

- NEC Article 700 – OK with Cat Cable
- UPS – 90min UL924
- Igor & Hubbell UL924 PoE Node



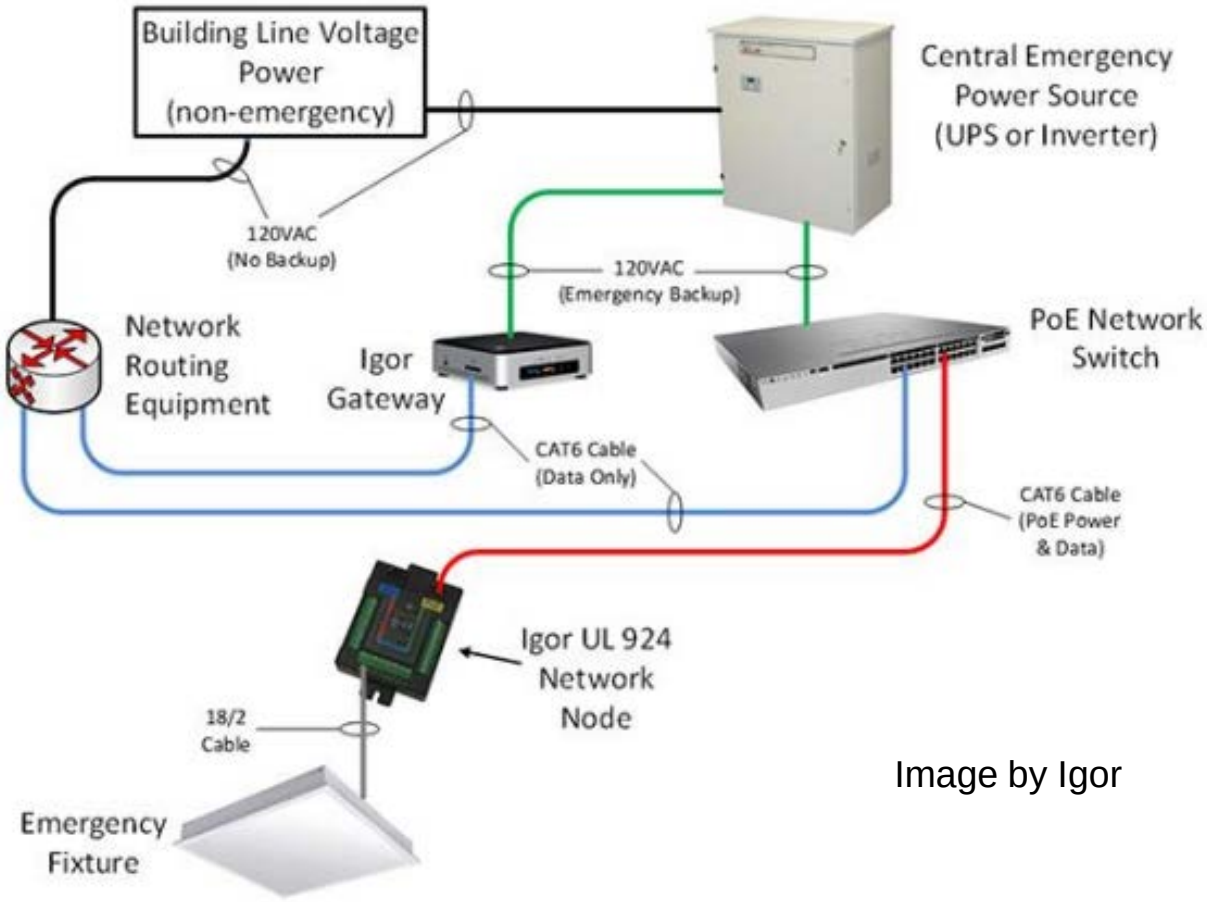
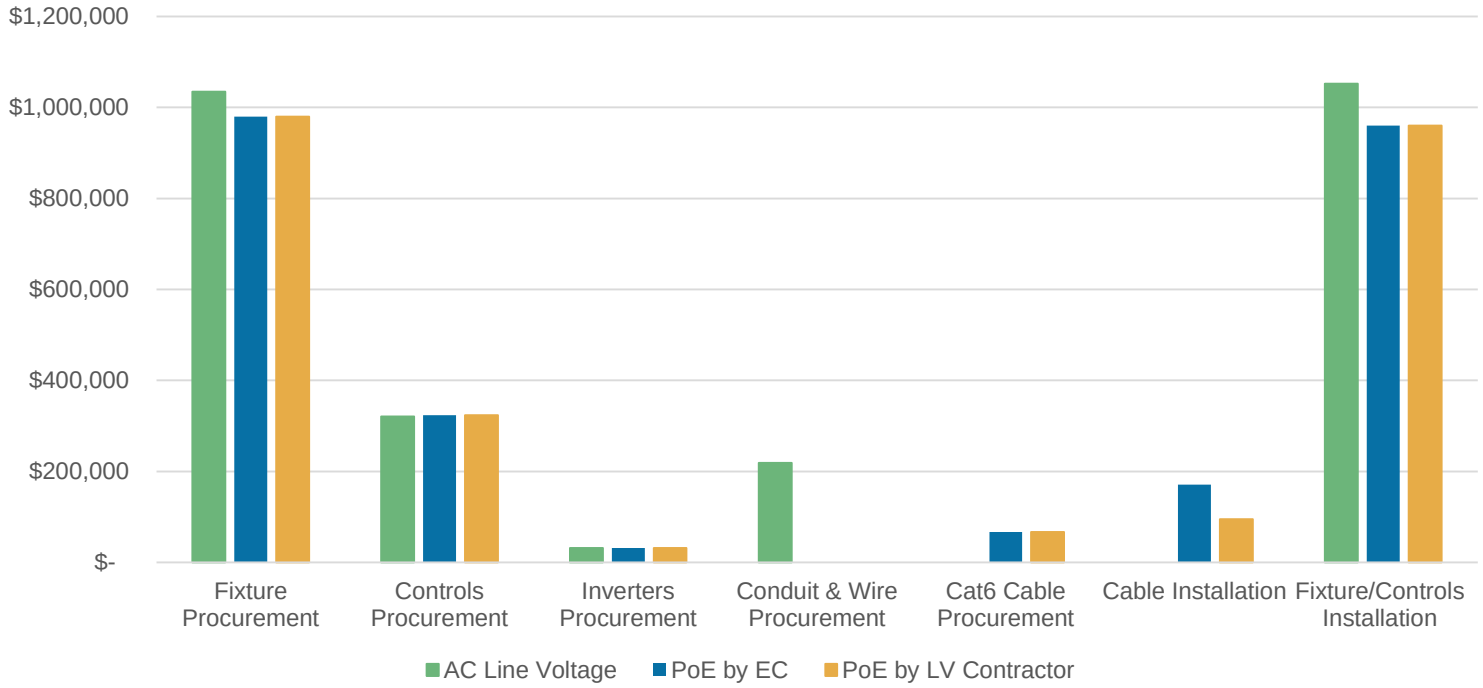


Image by Igor

PoE vs. AC Line Voltage Cost Comparisons

	AC Line Voltage	PoE by EC	PoE by LV Contractor
Fixture Procurement	$ 1,035,000	$ 980,000	$ 980,000
Controls Procurement	$ 321,000	$ 323,752	$ 323,752
Inverters Procurement	$ 32,000	$ 32,000	$ 32,000
Conduit & Wire Procurement	$ 219,000	$ -	$ -
Cat6 Cable Procurement	$ -	$ 66,857	$ 66,857
Cable Installation	$ -	$ 171,000	$ 95,000
Fixture/Controls Installation	$ 1,052,364	$ 960,320	$ 960,320
Totals	**$ 2,659,364**	**$ 2,533,929**	**$ 2,457,929**
Total / Sqft	$ 26.59	$ 25.34	$ 24.58

PoE & Line Voltage Sample Comparisons



Study by leducation.org

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Lighting as a Service = Netflix and Lit?

- No up-front capital costs
  - Equipment, Commissioning, Maintenance by Provider
  - Monthly Payment from Savings
- Energy Metering
- Contract with Provider and Implementer

Seattle City Light EEaS Pilot

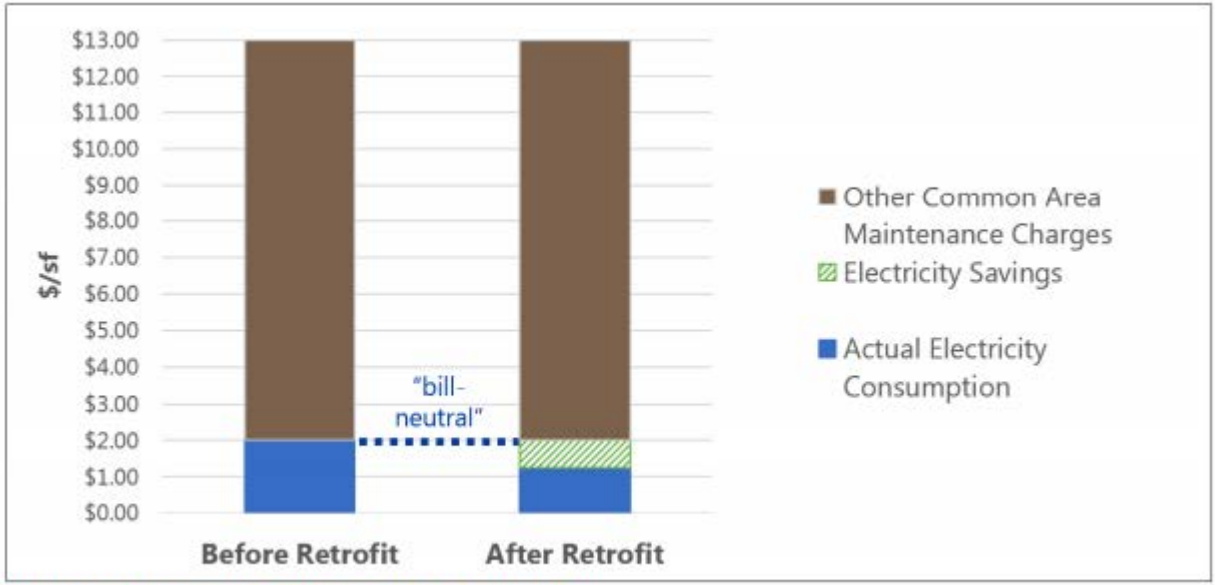

Figure 1. Example of Tenant Bill Neutrality

RENEWABLE ENERGY WORLD

Energy Efficiency, News

Seattle City Light is piloting America's first Energy Efficiency-as-a-Service program

By Jennifer Runyon | 6.19.20

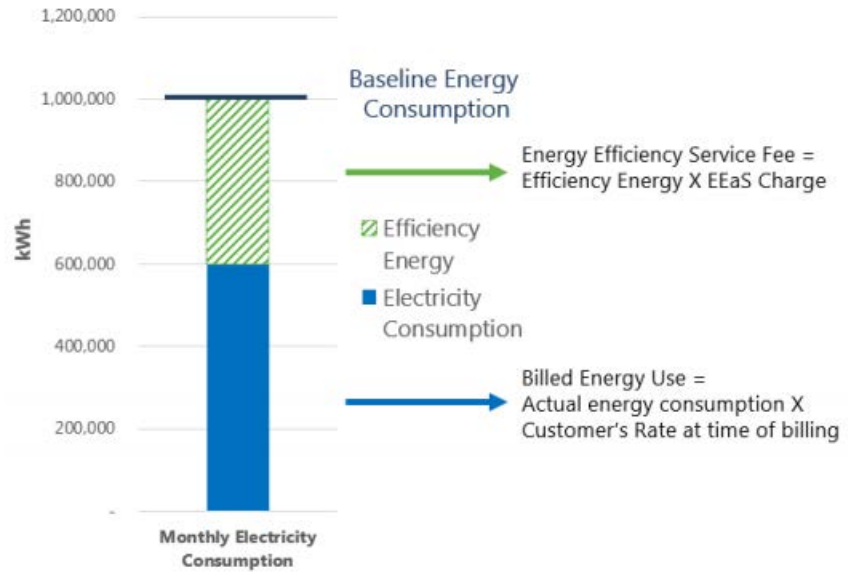

Figure 3. Basis of EEaS Seattle City Light Charges

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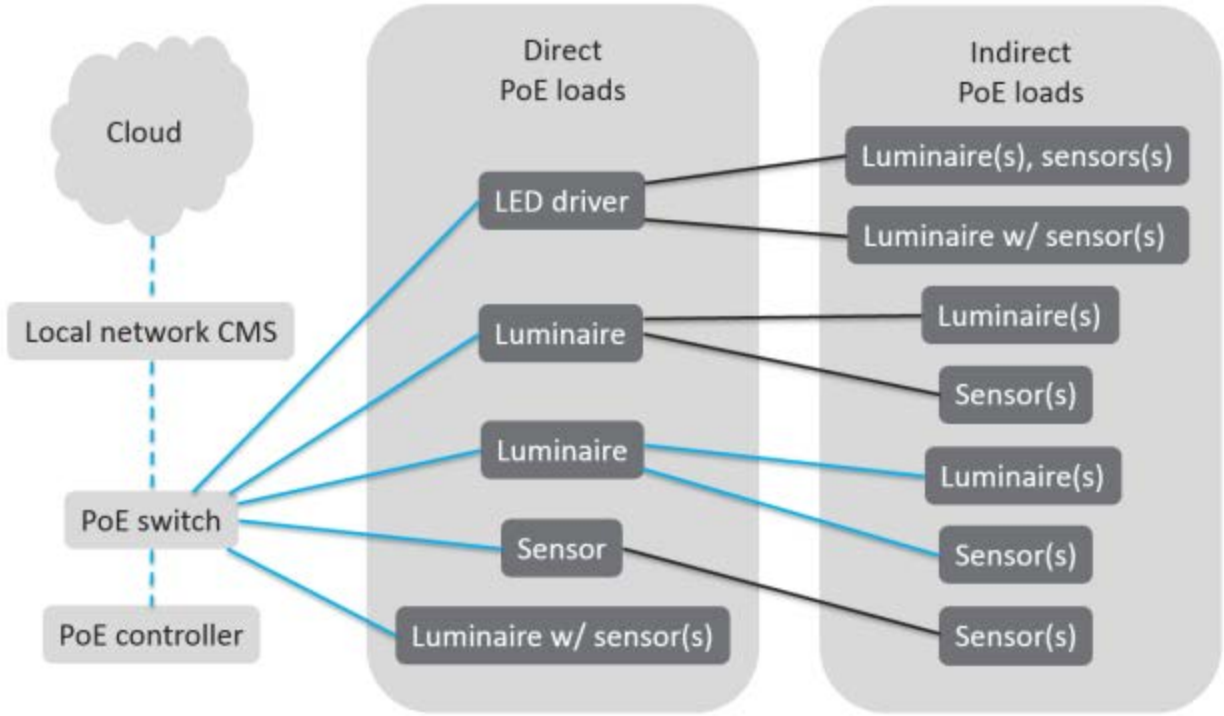
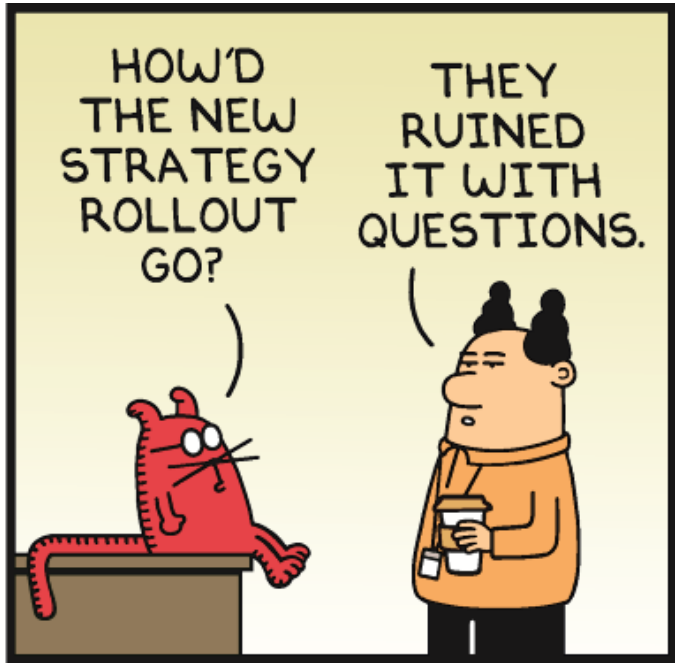
Efficiency & Savings Considerations

- System Efficiency vs. Fixture Efficiency
- Keep cable lengths to 50m or less
- System cable loss will be closer to 3% avg due to multiple lengths
- Task Tuning / HET
- Sensor Integration



From Fixture to Fixture, Should you use a Patch or Crossover Cable?

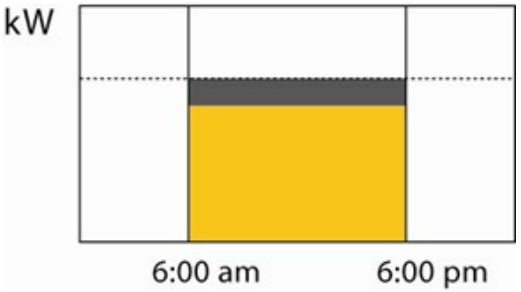
Pause for Questions



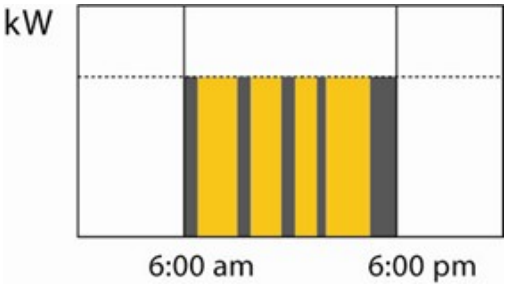
NLC Strategies Review

Four Key Control Strategies – Crash Course

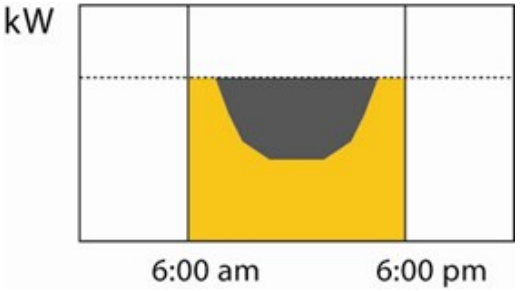
High End Trim or Task Tuning



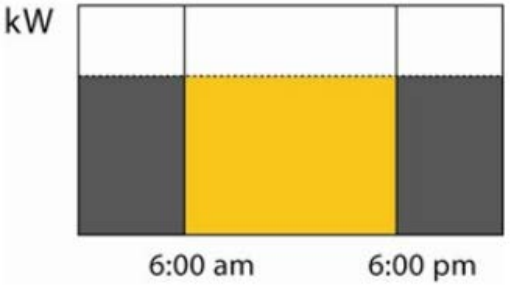
Occupancy & Vacancy



Daylight Harvesting

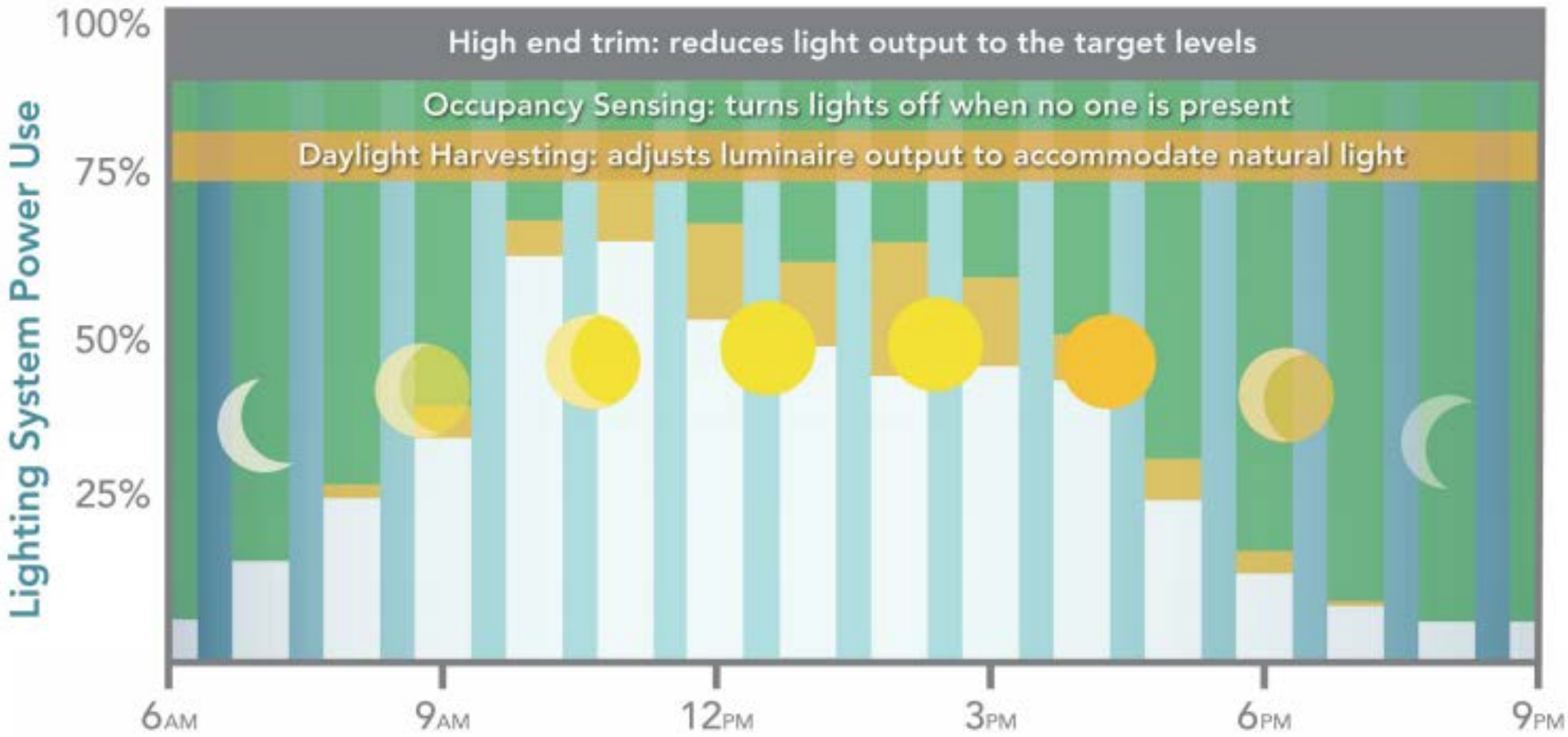


Scheduling

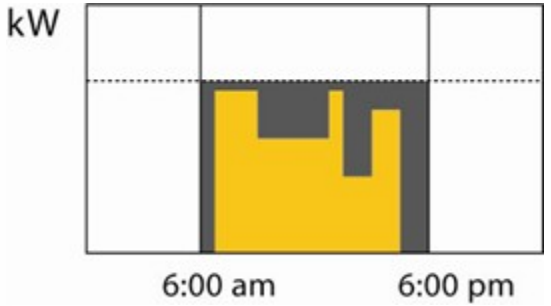


How These Control Methods Work Together

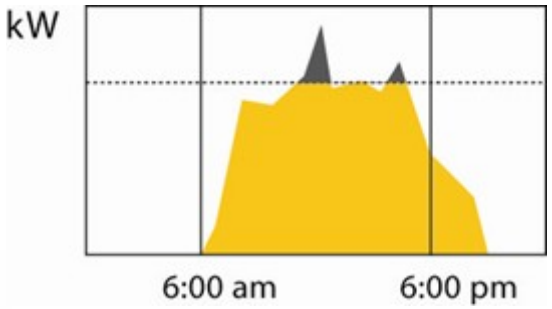
At the building level



Personal Control



Demand Response



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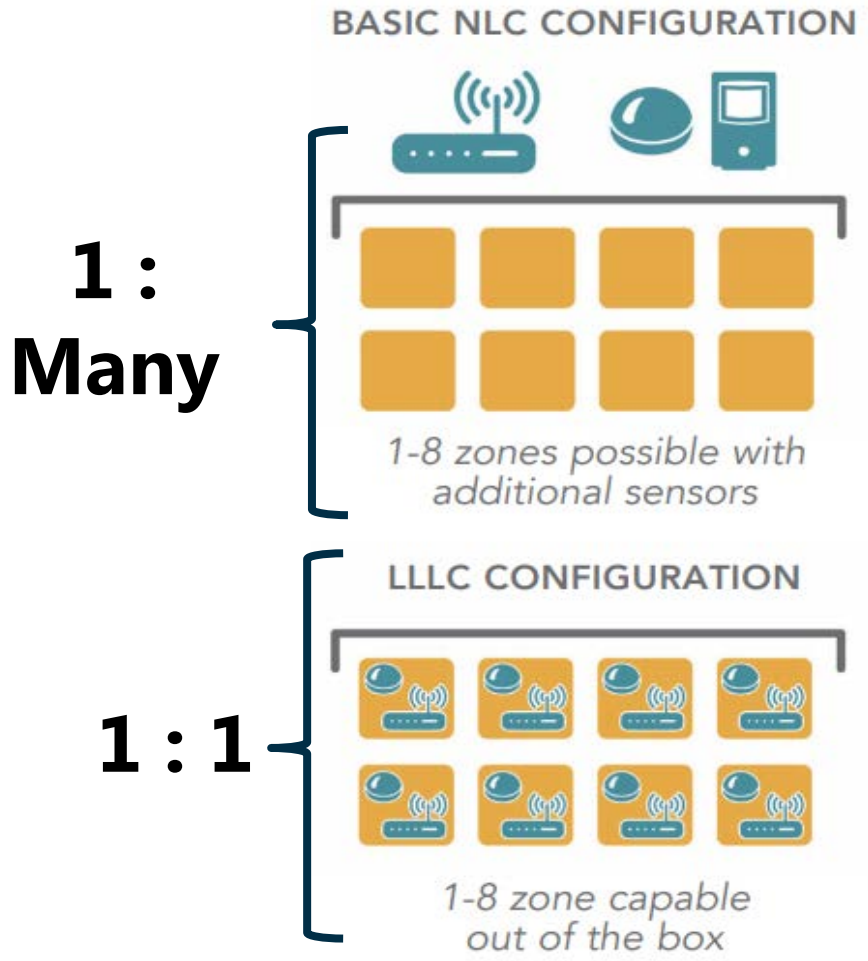
Did You Know… NLC & LLLC

- Luminaire Level Lighting Control
  - Individually Addressable
  - Integrated occupancy and daylight sensors
  - Continuous dimming
  - Networkable
- Benefits
  - Less Components
  - Labor Savings
  - Simple Configuration
  - Future Expandability
  - Reconfigurable



BONUS: Automatically Meets Code

2018 Washington State Commercial Energy Code*

C405.2 Lighting controls. Lighting systems shall be provided with controls that comply with one of the following:

1. Lighting controls as specified in Sections C405.2.1 through C405.2.7.
2. *Luminaire level lighting controls (LLLC)* and lighting controls as specified in Sections C405.2.1, C405.2.3 and C405.2.5. The *LLLC luminaire* shall be independently configured to:
   - 2.1. Monitor occupant activity to brighten or dim lighting when occupied or unoccupied, respectively.
   - 2.2. Monitor ambient light, both electric and daylight, and brighten or dim artificial light to maintain desired light level.
   - 2.3. For each control strategy, configuration and re-configuration of performance parameters including: bright and dim set points, timeouts, dimming fade rates, sensor sensitivity adjustments, and wireless zoning configuration.

2: Individually Addressable

2.1: Occupancy, Vacancy, Dimming

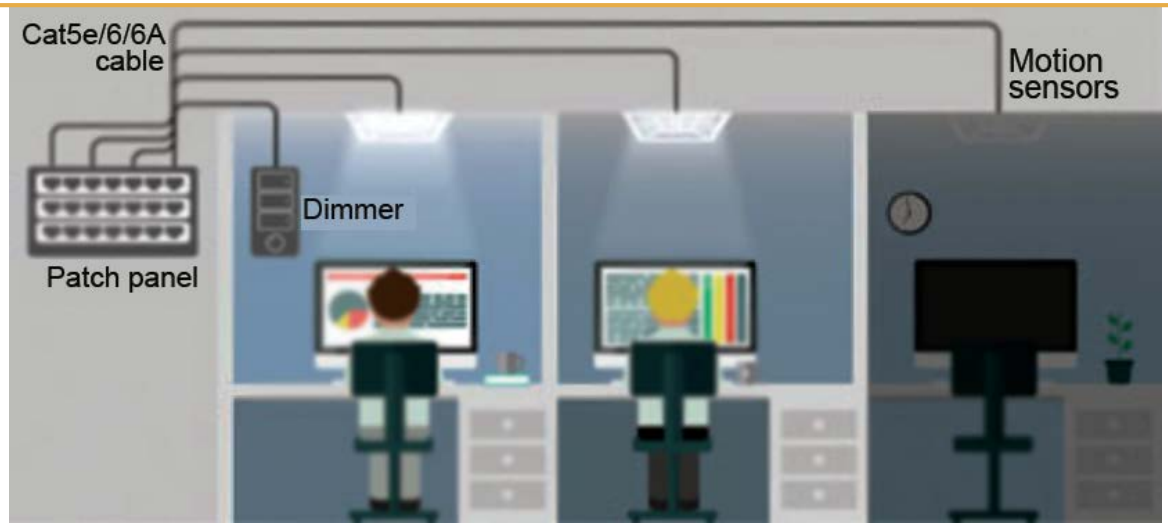
2.2: Daylight Harvesting, Dimming

2.3: Networkable

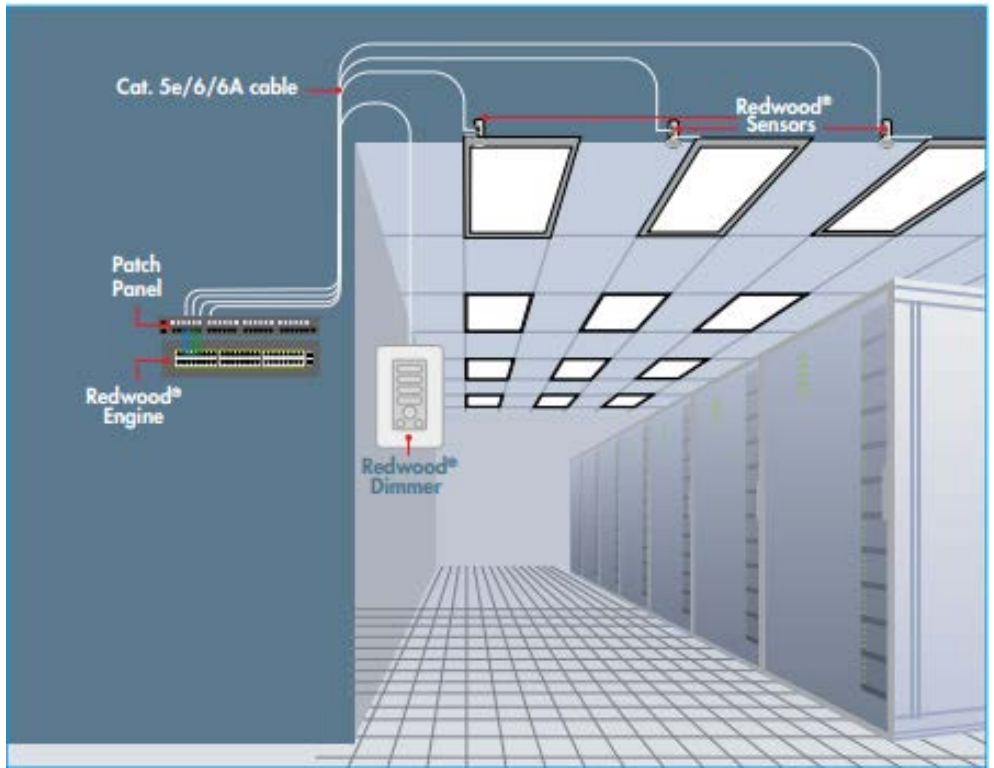
*As per Gov. Inslee – To be Applied Nov 1st, 2020

Architecture: NLC Zone Based & Faux LLLC

- Similar Functionality
- Faux LLLC More Granular Savings Potential
- Power Considerations
- Access/Location Considerations



Images by Fancom Communications Engineering

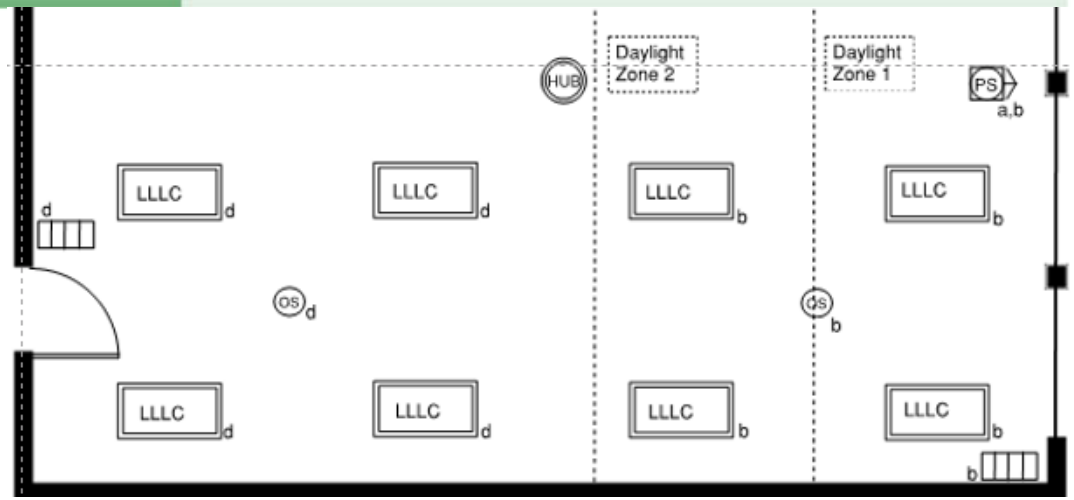


Key Collaboration Tool: **Sequence of Operations**

The Sequence of Operations communicates intent

Area	Typical open office		
Lighting and controls	Lights	Zones (a) - (d)	Fully dimmable lights controlled in this area
	Daylight Zones	Zones (a) - (b)	Daylight rows 1 and 2 will dim independently. Lights will automatically adjust to daylight maintaining recommended 30FC on task surfaces
	Manual Wall Control	Zones (a), (b), (c), (d)	For each independent zone, the user can select scenes on/off, 50%, and can raise/lower the zone

	CONTROL METHOD				
SPACE TYPE	HIGH END TRIM	DAYLIGHT SENSOR	MANUAL SWITCH	OCCUPANCY SENSOR	TIME CLOCK
Conference	X	X	X	X	
Equipment	X	X		X	
Office - open	X	X		X	X
Office - private	X	X	X	X	
Restrooms	X			X	



[Click to access LDL Sequence of Operations learning guide]

lighting design lab

PoE and Luminaire Level Lighting Controls

PoE =/= LLLC?

2018 Seattle & Washington Energy Codes

LUMINAIRE-LEVEL LIGHTING CONTROL. A lighting system consisting of one or more *luminaires* where each *luminaire* has embedded lighting control logic, occupancy and ambient light sensors, and local override switching capability, where required. Each *luminaire* shall also have wireless networking capabilities to detect and share information with other *luminaires* to adjust to occupancy and/or daylight in the space.

DLC NLC QPL Requirements

13	Luminaire Level Control (LLC, integrated)	The capability to have a networked occupancy sensor, ambient light sensor, and addressable controller installed for each luminaire, with the sensor(s) directly integrated or embedded into the luminaire form factor during the luminaire manufacturing process. In addition to these required integrated components, LLC systems must have *Control Persistence* capability as described in this document. To demonstrate commercial availability of the integrated component options, at least one family, luminaire or kit with integrated sensing and control must be provided with the application and will be publicly listed on the QPL.

PoE and DLC's Controls Resiliency Definition

NETWORKED LIGHTING CONTROL SYSTEM TECHNICAL REQUIREMENTS V2.0

		opposed to step dimming with a small number of discrete light levels).
8	Control Persistence	The capability of a networked lighting control system's lowest-level ("edge device") luminaire controllers to execute three pre-programmed energy saving strategies (occupancy sensing, daylight harvesting, and high-end trim) in the absence of communications with the next higher networked element in the system's topology.

At the QPL Level

Show All Company	Brand	System	Interior / Exterior	Show LLLC Luminaire Level Lighting Control	Show Control Persist-ence	Show Cyber-security
manufCompany	manufBrand	manufProduct	productTypeConcat	hasLLLC	hasPersist	hasCyber
Hubbell Lighting Inc.	Hubbell Control Solutions	PowerHUBB	Interior	No	No	No
Igor, Inc.	Igor	Nexos	Interior	No	No	No
Molex	CoreSync	CoreSync	Interior	Yes	No	No
Platformatics, Inc.	Platformatics	Platformatics	Interior	No	Yes	No

DLC SSL QPL - DC and PoE Lighting

- Submitted as PoE/DC Family Group in SSL QPL
- Subject to other relevant DLC testing
- IES LM-79, lm/W
- QPL Listing
  - System Type
  - DC/PoE Efficacy
  - PoE Class
  - PoE Connection

New policy enables high quality DC and PoE lighting products to be qualified and listed on the DLC SSL QPL.

The policy, in combination with supporting guidance, provides a clear methodology for efficiency program administrators and others to understand and quantify the system efficiency and electric load impacts of installing a DC or POE lighting system.

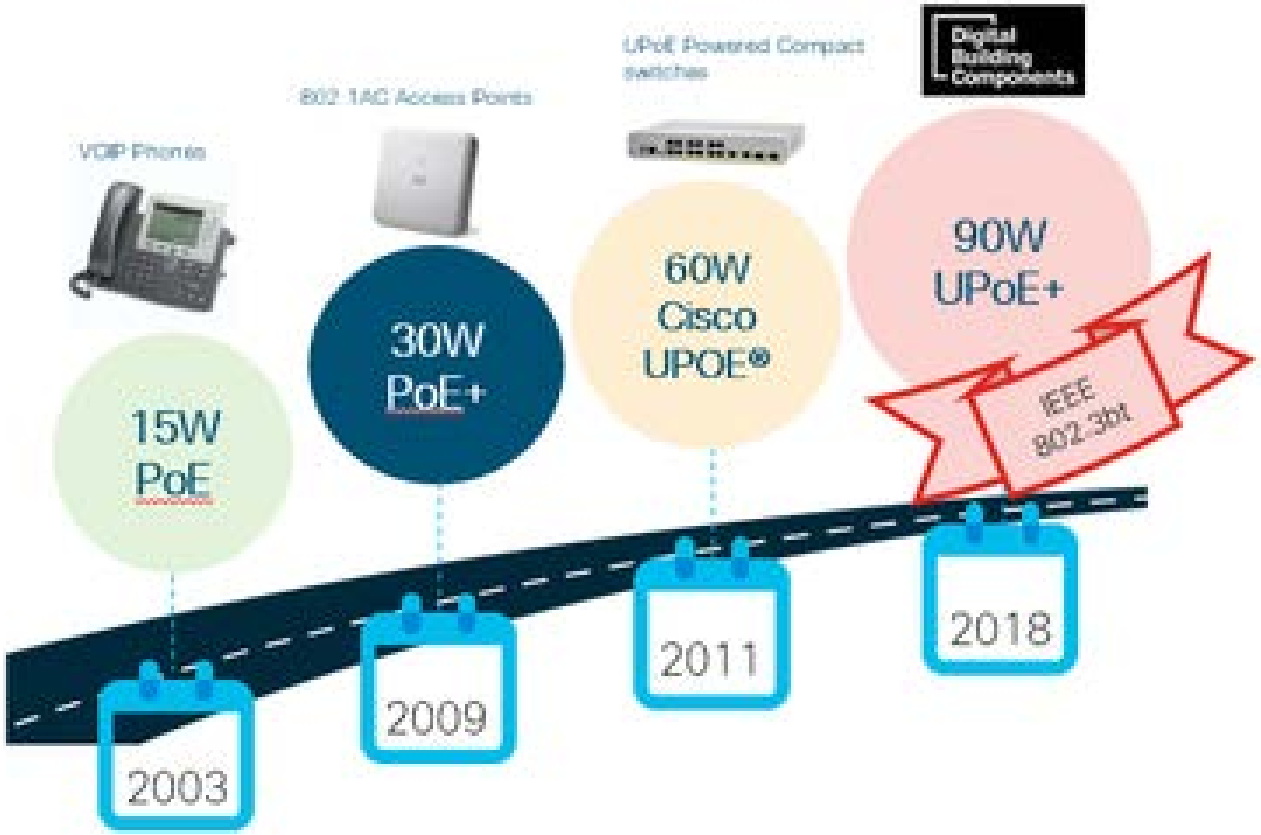
DLC listing of DC and PoE products in combination with utility rebates leads to greater market adoption advanced lighting controls that integrate and systems that integrate with clean energy generation sources.

Pause for Questions

PoE Standards and Industry Evolution

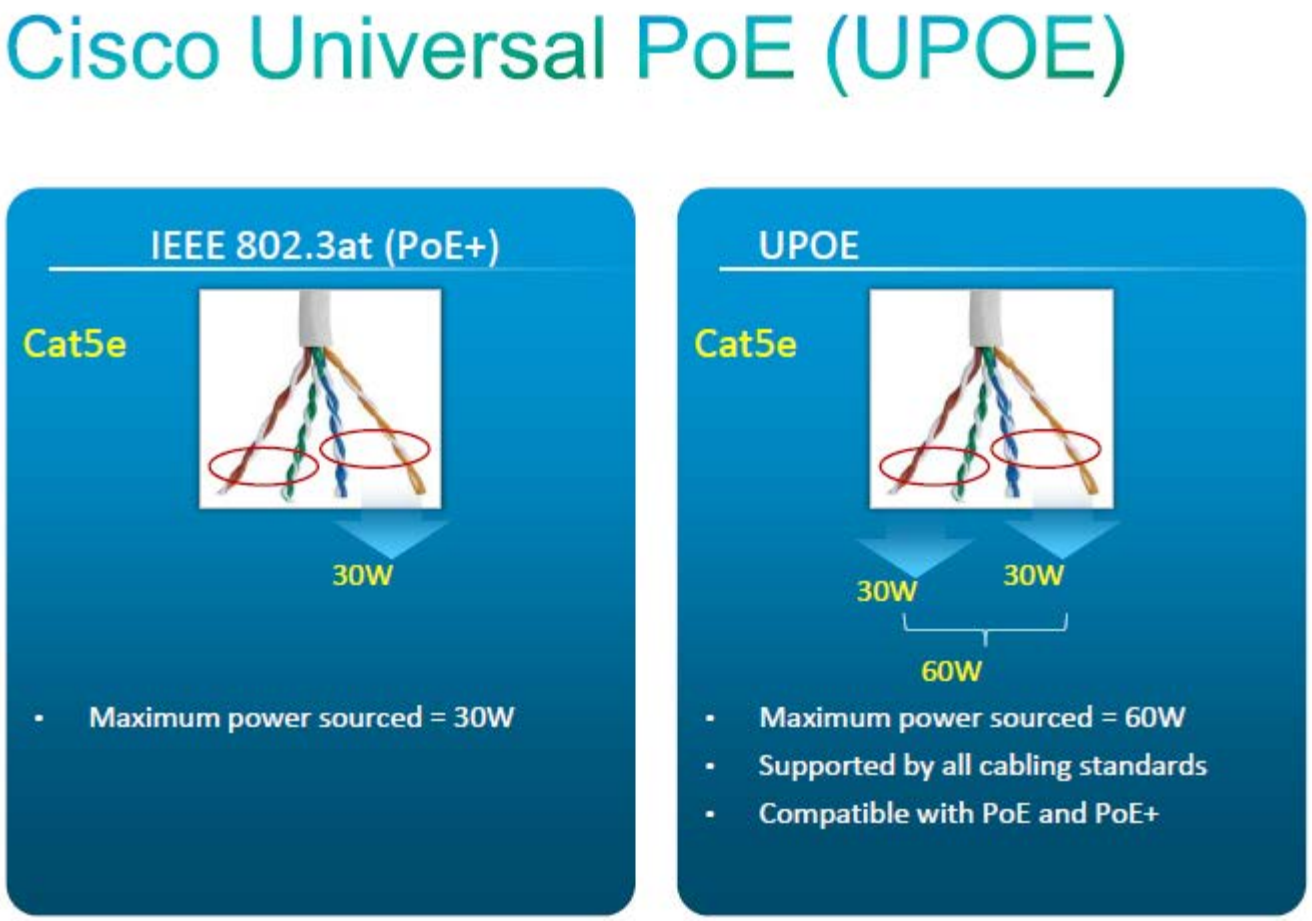
IEEE Global PoE Standard 802.3xx

- **802.3af** 15.44 W of power
- **802.3at standard (POE+)** 30W
- **802.3bt (UPoE+)**, utilize all four twisted pairs. Power in the range of 49-70 W and included 2 types
  - Type A 60W Power
  - Type B 100W Power
- Maximum Distance: 100M
- Cat 5 or Better



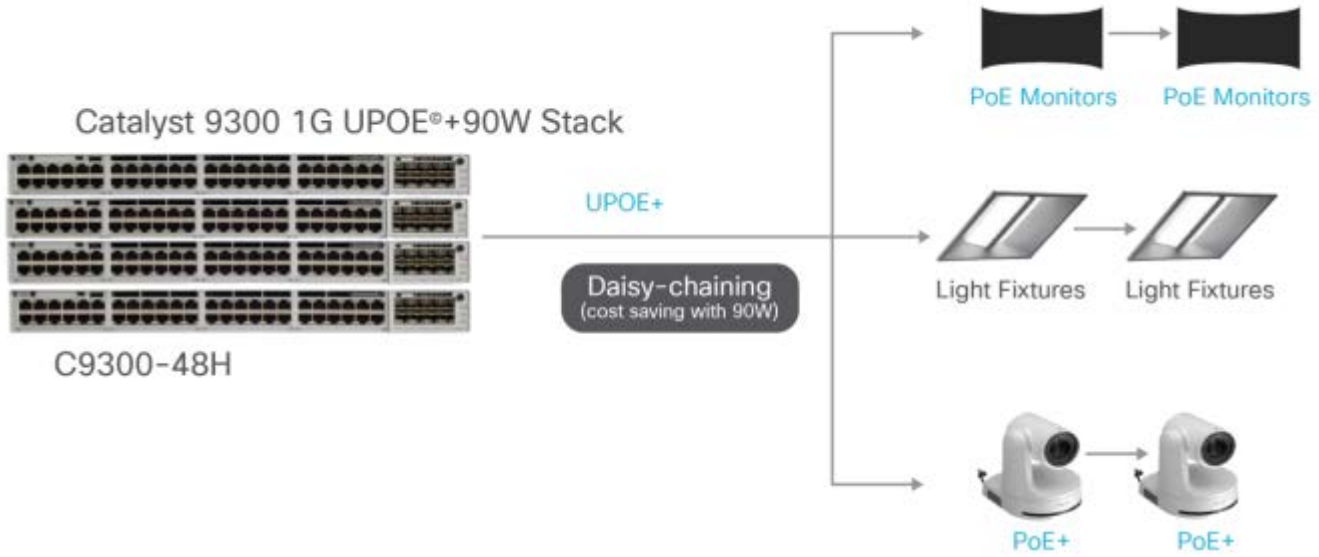
Cisco UPoE circa 2017

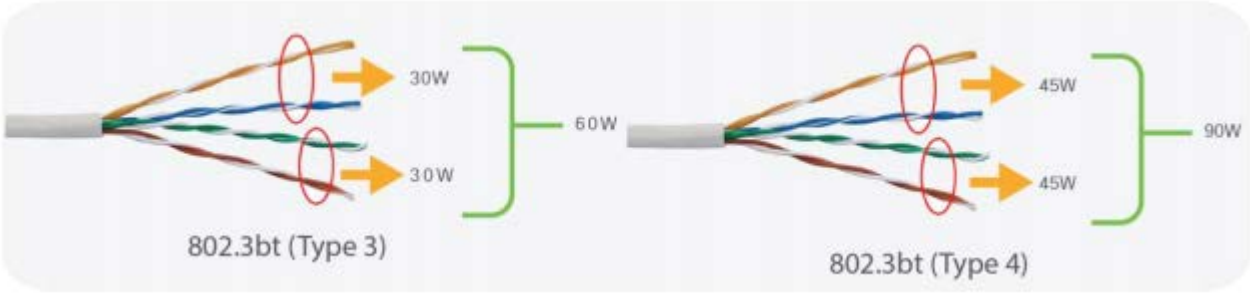
- From 30W to 60W
- Compatible with PoE and PoE+
- 10% more efficient energy use
- Standard RJ45, no Cabling changes needed



Cisco UPoE+ Circa 2018/19

- 90W/Port
  - 71W Delivered to PD
- Daisy Chaining Multiple Different PD's Possible
- Cisco Catalyst 9000 Family





PoE Lighting Partnerships with Cisco

Image by Cisco

PoE Standards Evolution – the Table

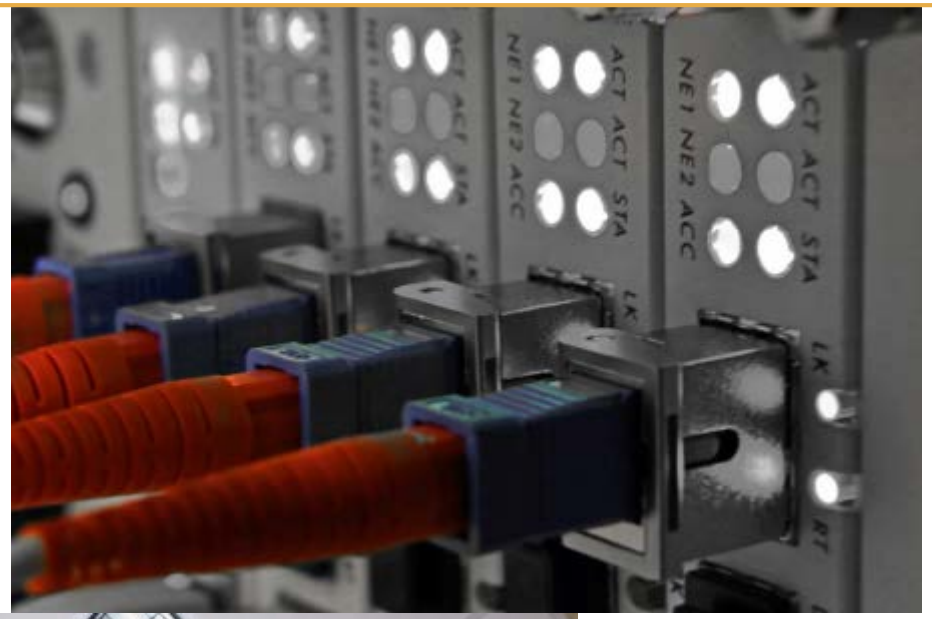
	PoE	PoE+	UPoE, PoE++, or 4P PoE	Higher-power PoE
IEEE Standard version	802.3af (802.3at Type 1)	802.3at Type 2	802.3bt Type 3	802.3bt Type 4
Ratified Date	2003	2009	2017	pending
Maximum power from PSE	15.4 W	30 W	60 W	100 W
Power available at Powered Devices	12.95 W	25.50 W	51 W	71 W
Twisted pairs used	2	2	4	6
Supported Cabling	Cat3 and Cat5	Cat5	Minimum Cat5e	Recommended Cat6

DLC NLC QPL and PoE

Show All Company	Brand	System	Interior / Exterior	Notes about distance	Local and/or cloud server	Luminaires with Power over Ethernet (PoE)	PoE standard(s) or protocol	PoE wire type and size	Luminaires with DC, not including PoE
manufCompany	manufBrand	manufProduct	productTypeConcat	netDistanceNotes	netServerConcat	netPoe	netPoeProtocol	netPoeWire	netDc
Hubbell Lighting Inc.	Hubbell Control Solutions	PowerHUBB	Interior	The Igor solution is a wired system based on IEEE 802.3at & 802.3bt PoE standards.	Local server required	Yes	IEEE 802.3at & 802.3bt	higher for PoE home runs between nodes and PSE's; for daisy-chained Igor nodes.	Yes
Igor, Inc.	Igor	Nexos	Interior	The Igor solution is a wired system based on IEEE 802.3at & 802.3bt PoE standards.	Local server required	Yes	IEEE 802.3at & 802.3bt	higher for PoE home runs between nodes and PSE's; for daisy-chained Igor nodes.	No
Molex	CoreSync	CoreSync	Interior		Local server required	Yes	IEEE 802.3bt, UPOE, PoE+ and PoE	Cat5e or Cat6 with 22 or 23AWG minimum	No
Platformatics, Inc.	Platformatics	Platformatics	Interior	Distance between nodes is unlimited. 100Base-TX (IEEE 802.3u) specifies maximum of 328 feet between an Ethernet switch and node.	Either local or cloud server is required	Yes	10/100BASE-T Auto Negotiate MDI RJ-45	Cat5e+, 22 gauge	No

PoE and UL 2108 Standard, NEC Article 411

- Safety of Low Voltage Lighting Systems
- Class 2 wire Power Source
- Power Output within Standards Voltage limits (30VAC, 60VDC. Half on wet locations)
- PoE Power Units OK to be cord or plug connected



Images & Info by Smart Cities Council & UL

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PoE Code Interior Calculation

- Input power as per UL2108
- Add all power related to lighting systems
- Subtract power not for lighting systems

C405.4.1 Total connected interior lighting power. The total connected interior lighting p determined in accordance with Equation 4-10.

TCLP = [*LVL* + *BLL* + *TRK*+ *POE* + Other]

Where:

TCLP	=	Total connected lighting power (watts)
LVL	=	For luminaires with lamps connected directly to building power, such as line voltage lamps, the rated wattage of the lamp, which must be minimum 60 lumen/watt.
BLL	=	For luminaires incorporating a ballast or transformer, the rated input wattage of the ballast or transformer when operating the lamp.
TRK	=	For lighting track, cable conductor, rail conductor and plug-in busway systems that allow the addition and relocation of luminaires without rewiring, the wattage shall be one of the following: 1. The specified wattage of the luminaires, but not less than 16 W/lin. ft. (52 W/lin. m). 2. The wattage limit of the permanent current-limiting devices protecting the system. 3. The wattage limit of the transformer supplying the system.
POE	=	For other modular lighting systems served with power supplied by a driver, power supply or transformer, including but not limited to low-voltage lighting systems, the wattage of the system shall be the maximum rated input wattage of the driver, power supply or transformer published in the manufacturer's catalogs, as specified by UL 2108 or 8750. For power-over-Ethernet lighting systems, power provided to installed non-lighting devices may be subtracted from the total power rating of the power-over-Ethernet system.
Other	=	The wattage of all other luminaires and lighting, sources not covered above and associated with interior lighting verified by data supplied by the manufacturer or other *approved* sources.

Maintenance Roles

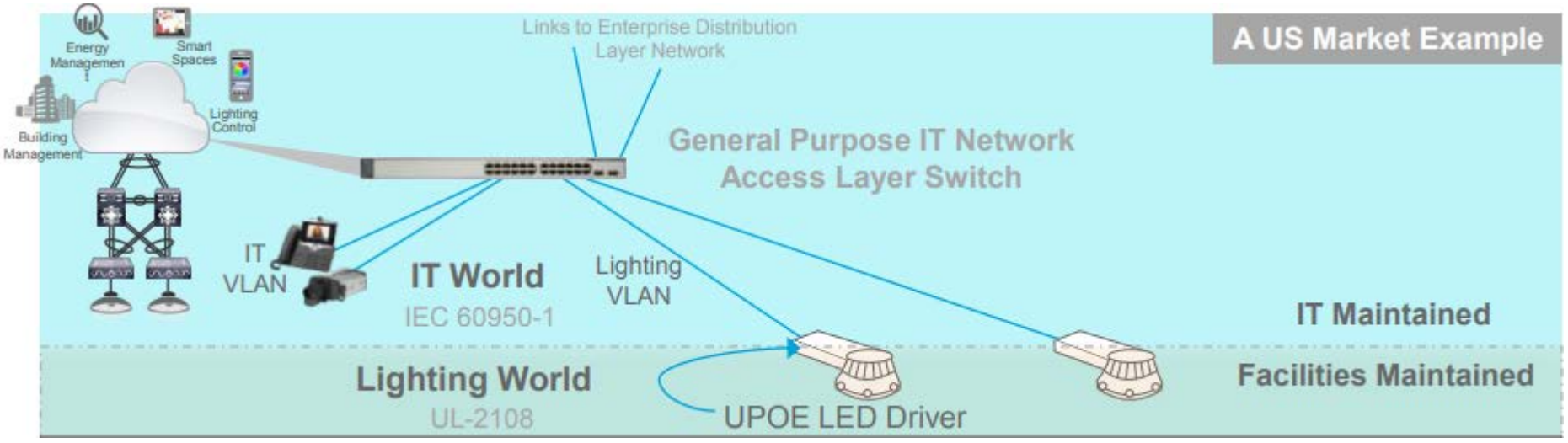
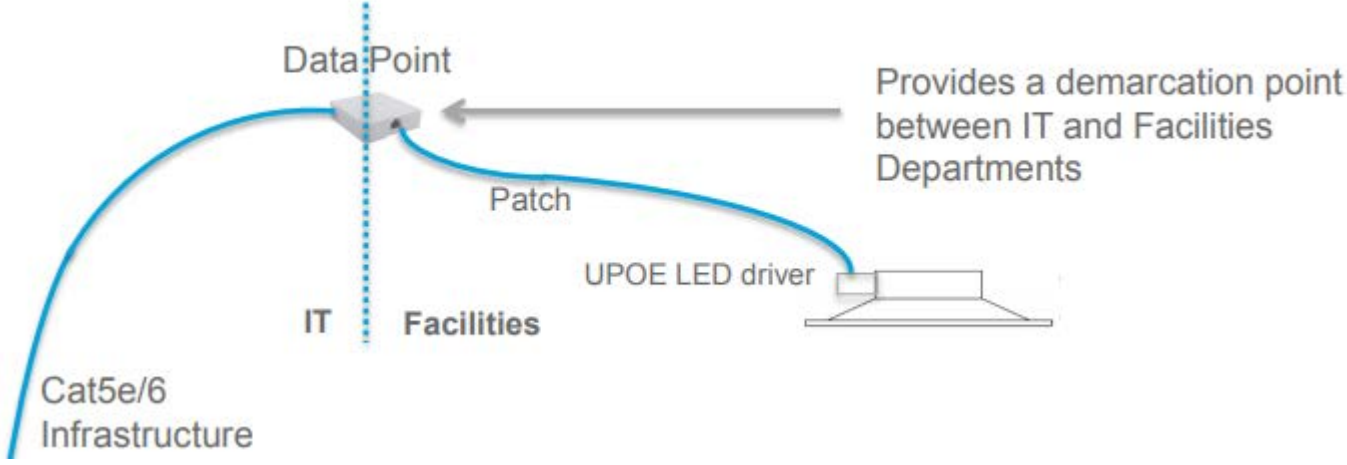
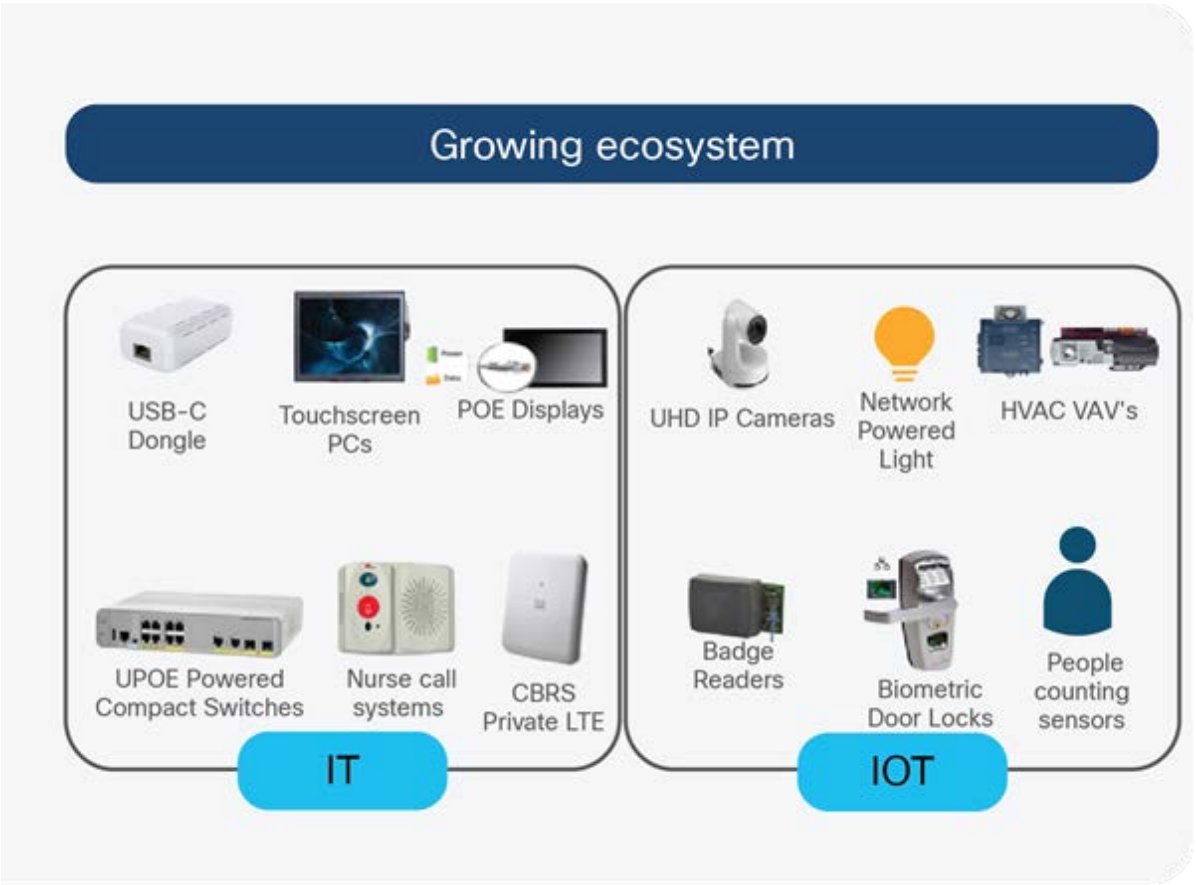


Image by Cisco



IP Convergence Paving the Way in IT and IoT



Images by Cisco

Initial PoE Value Proposition

- Time & Cost Savings
- Flexibility & Access
- Safety
- Reliability
- Scalability
- Beyond Lighting

Image by Signify

PoE Challenges & Thoughts

- Distance Issues
  - Fiber Optic + Media Converter
- Data Integrity
- High Power Applications
  - Increasing LED Efficiency
- Network Infrastructure Cost
  - ~$7k / 48-port Switch
- Retrofit Market

Image by FS United States

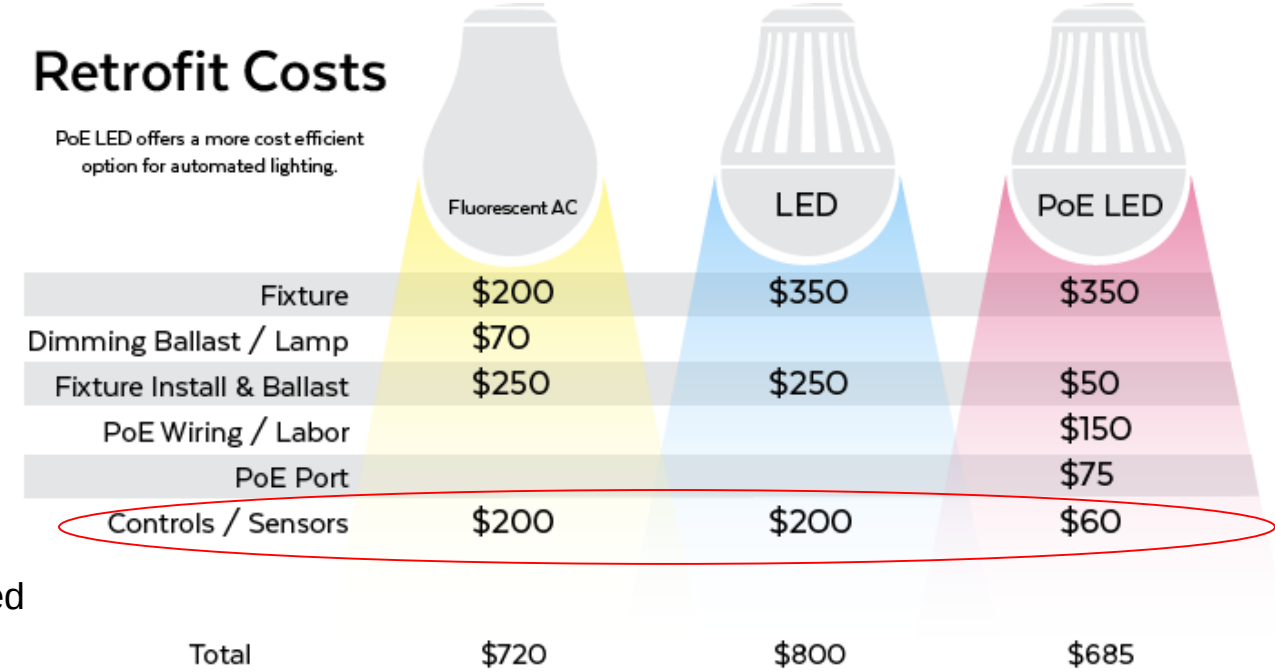
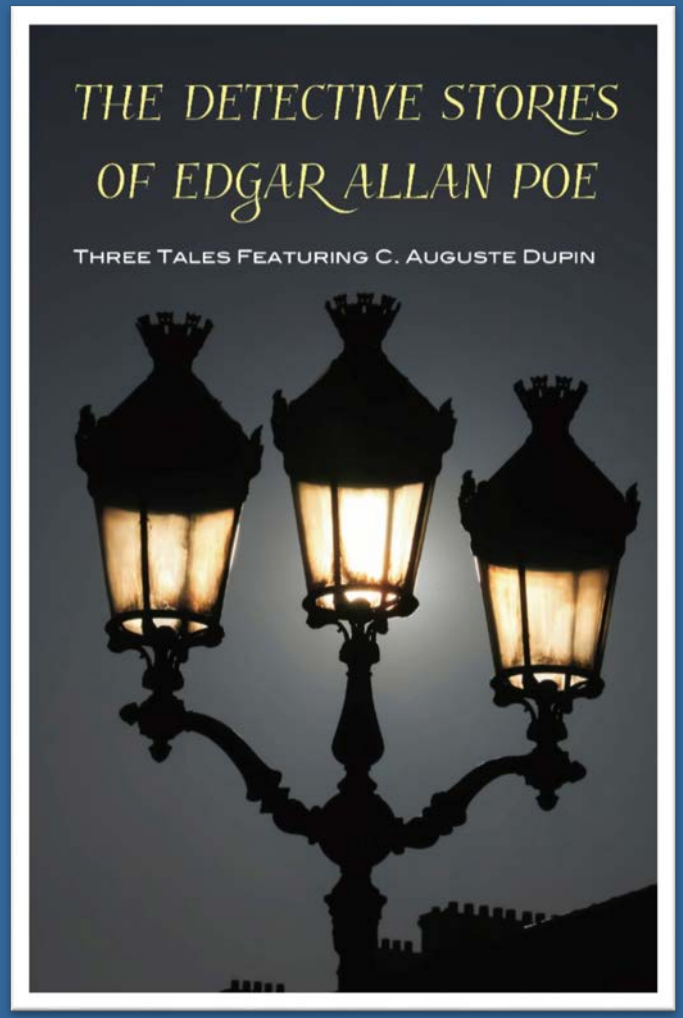


Image By XS Applied Technologies

In the latest 802.3bt or UPoE+, how many maximum watts can be delivered to a Powered Device?

Pause for Questions

PoE Systems Examples & Benefits for Select Verticals



PoE Lighting Systems Sample Summary

Manufacturer		Cree	Igor	Innovative Lighting	LumenCache	MHT Lighting	Molex	NuLEDS	Philips	Platformatics	Redwood/CommScope
Energy management access	Direct via VLAN	✓						✓	✓		✓
	Indirect via router	✓	✓	✓		✓	✓		✓	✓	✓
PoE controller	Required		✓		✓	✓	✓		✓	✓	✓
	Optional	✓						✓			
PoE switch	802.3af		✓				✓				
	802.3at	✓	✓	✓		✓	✓	✓	✓		
	UPOE	✓	✓	✓		✓	✓	✓		✓	
	Other				✓						✓
Direct PoE loads	LED drivers		✓	✓			✓	✓			
	Luminaires	✓	✓		✓	✓	✓	✓	✓	✓	
	Sensors	✓	✓		✓				✓		✓
	Luminaires w/ sensors	✓	✓			✓	✓	✓	✓		✓
Cabling to indirect PoE loads	Ethernet		✓	✓	✓	✓		✓			✓
	Non-Ethernet					✓	✓	✓		✓	✓

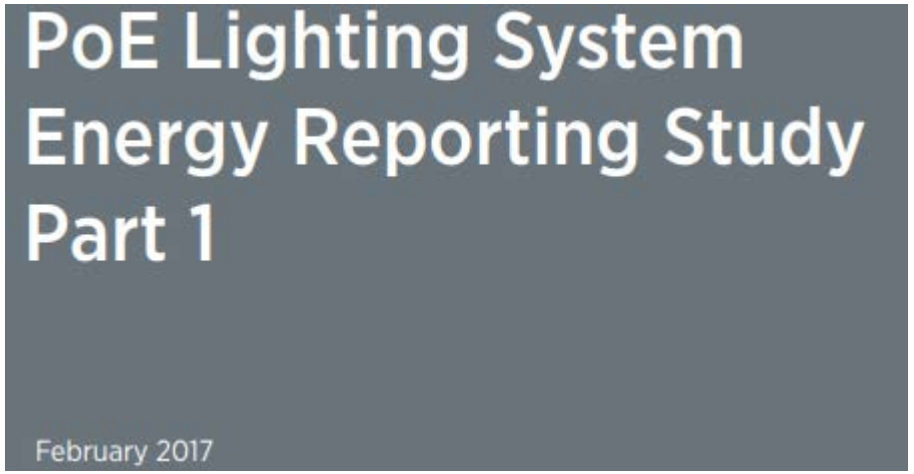
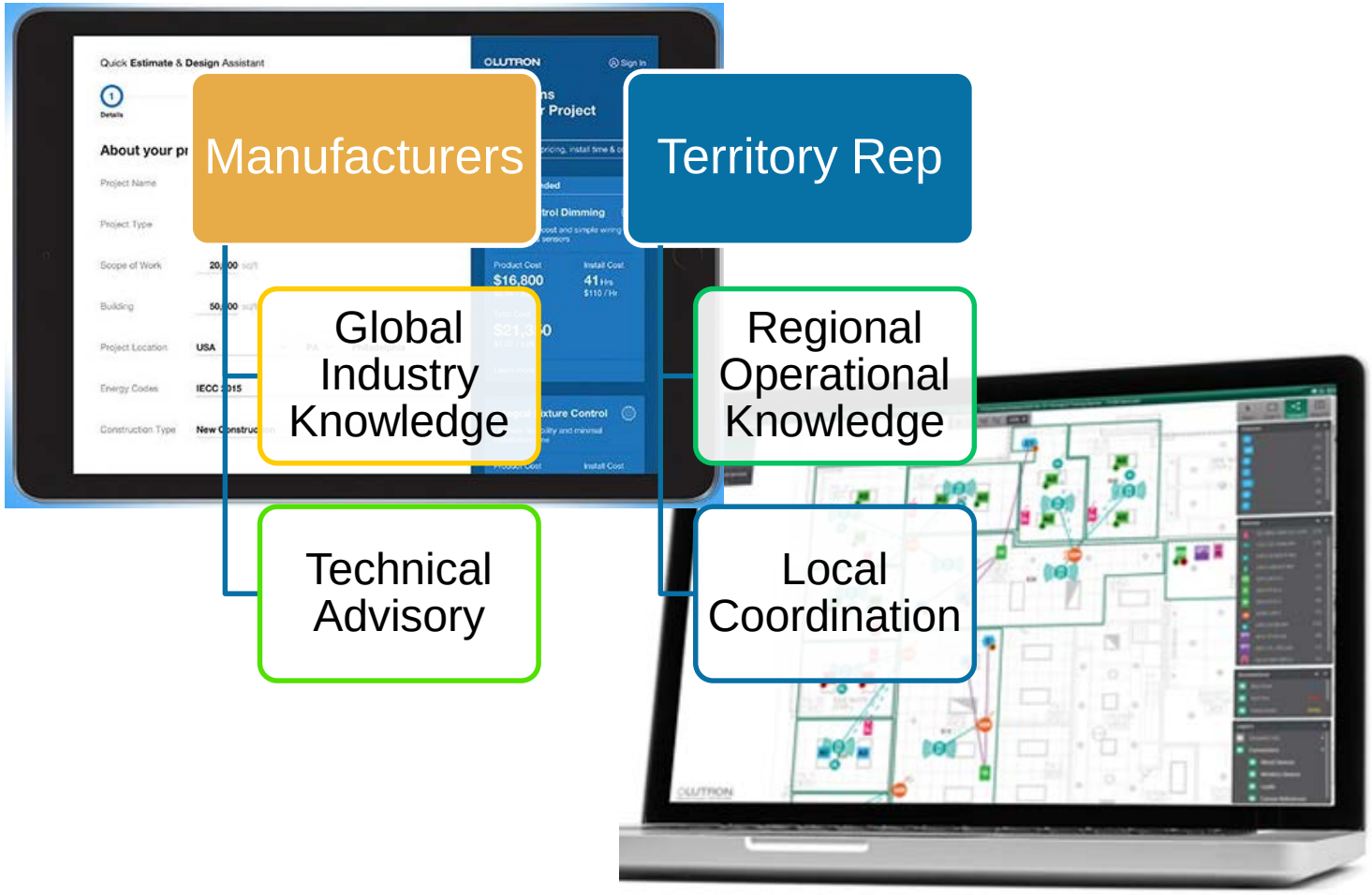


Image by DOE

Leverage Manufacturer's Procedural Efficiency

- Quoting tools
- Project Development tools
- One lines with Packaging
- Room Packaging
- Pre-Pairing
- Pre-Commissioning



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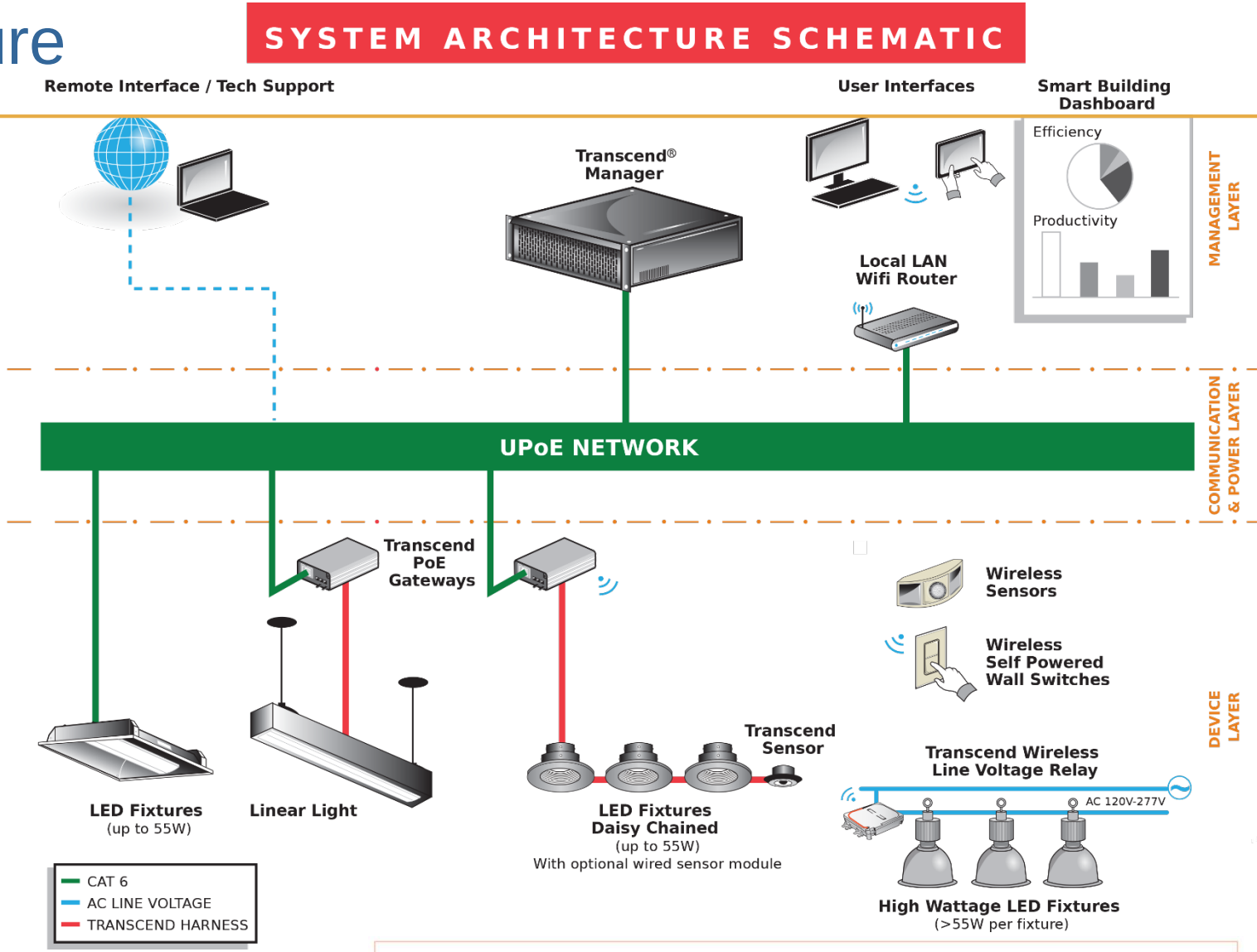
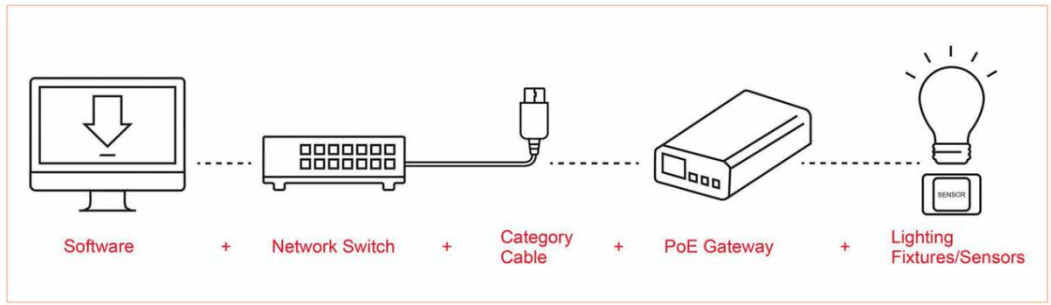
Molex (2009) PoE Architecture

- Separate PoE Remote 60W Gateway
  - Needs More Install Coordination
- Integral/Remote Fixture Driver separate from Gateway
- 1 Gateway Supports 8-10 Drivers
  - More Flexibility to handle smaller loads per driver



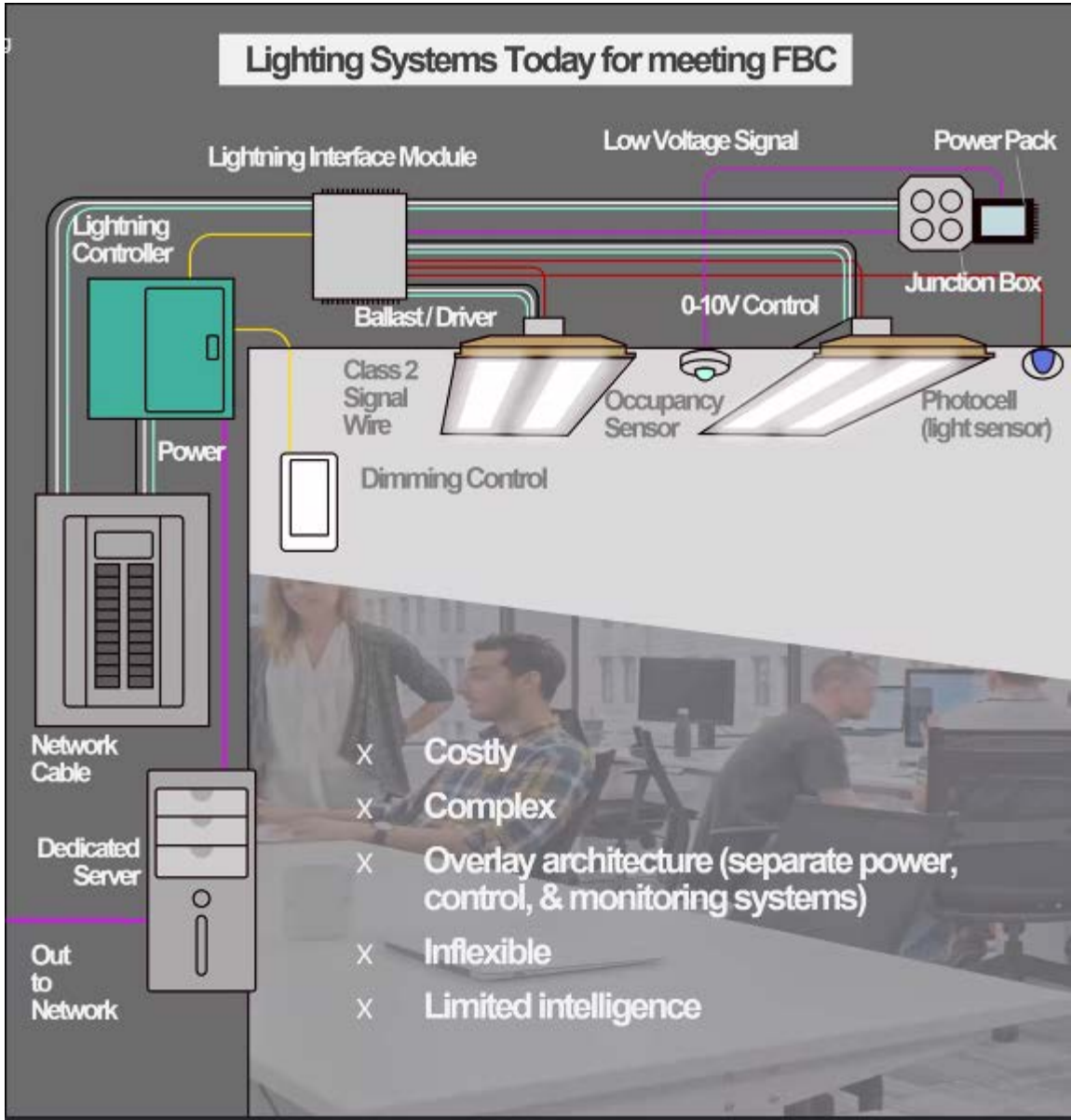
Images by Molex



Igor (2014) PoE Architecture

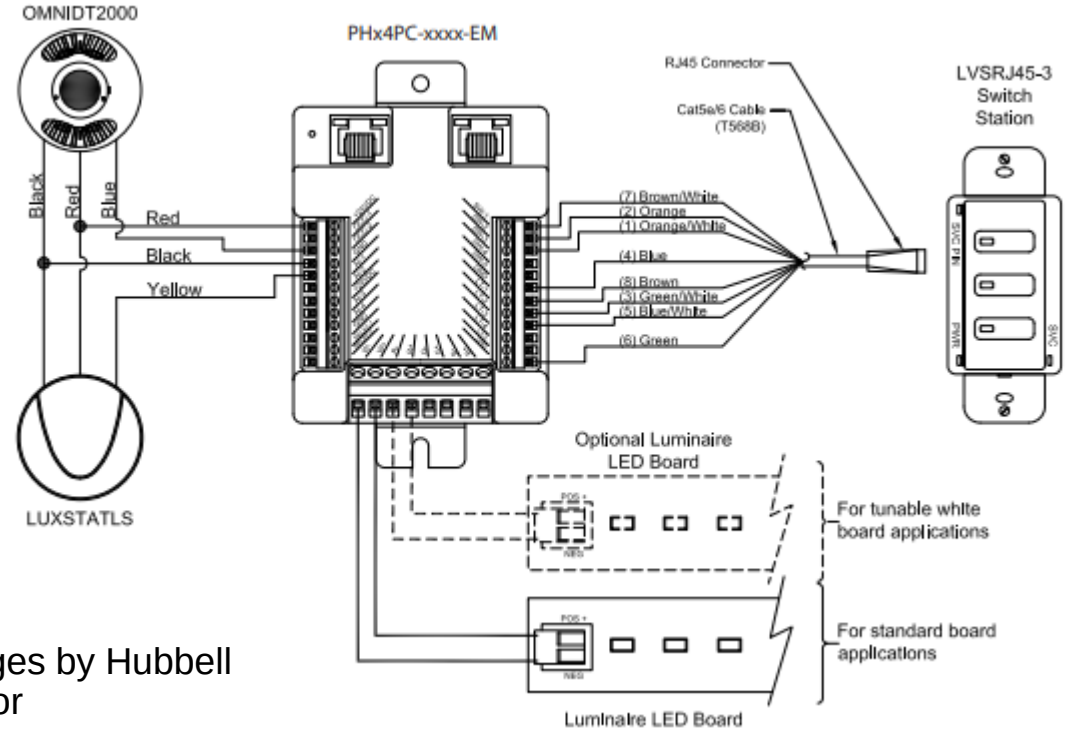
- Small Gateway + Driver called PoE Node.
  - Linear & Square
- Node inside fixture OR
- Can be Remote for smaller wiring to suspended fixtures
- Daisy Chain 5 nodes on a PSE Port

Images by Igor



PoE Square & Linear Nodes

- A “Universal” PoE Connector Node
- Analog Devices → Digital Responses
- EM Flavors Available



Images by Hubbell & Igor

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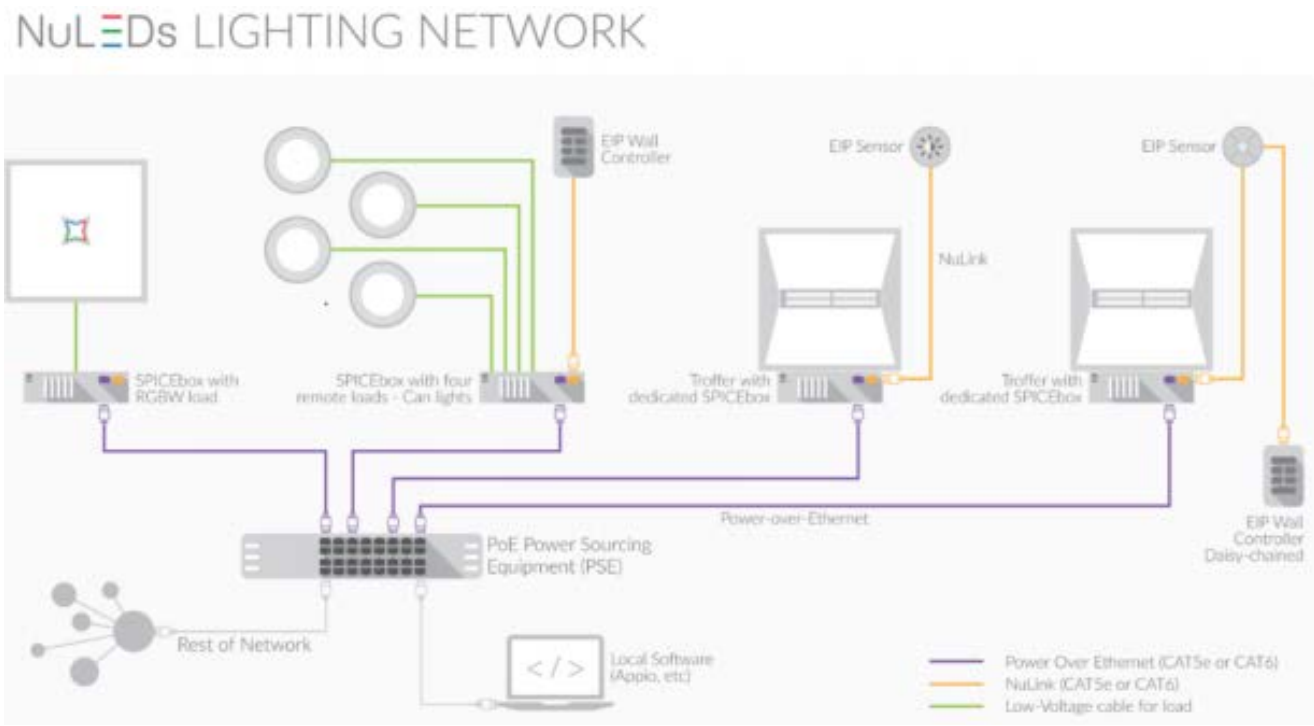
NuLEDs (2012) PoE Architecture

- PoE Multi-Node combining gateway & driver
  - Larger form factor
  - Remote
- PoE Cat5/6 to Node, LV Wire for the rest
- No integration of components in fixture
- Can work with any size fixture
- Needs More Install Coordination



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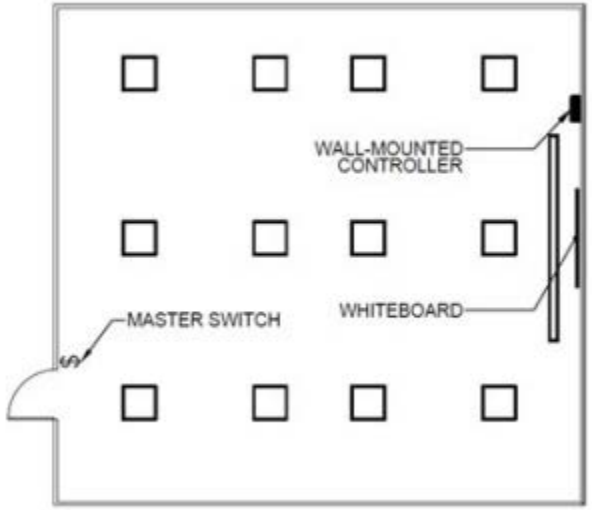
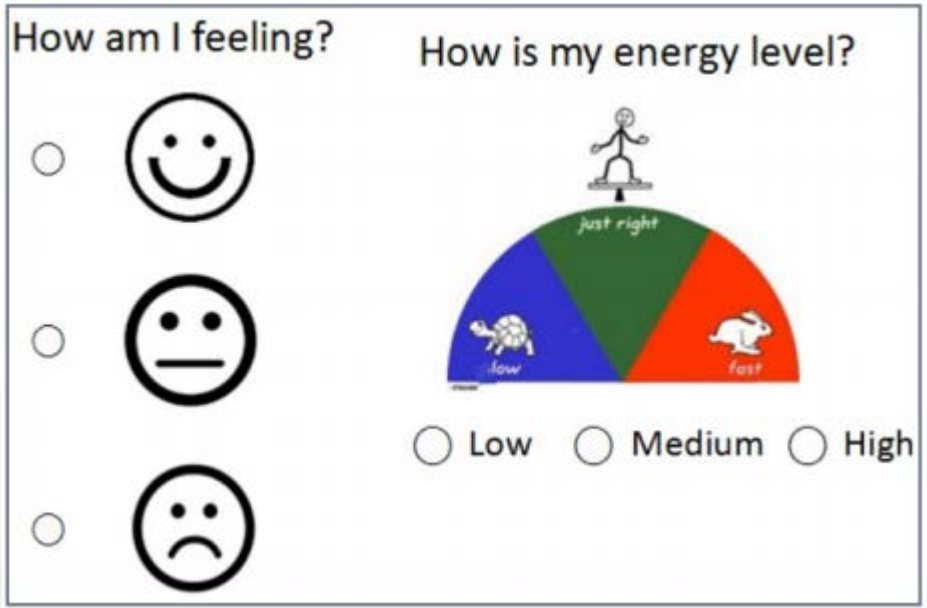
Schools and PoE

Images by DOE and PNNL

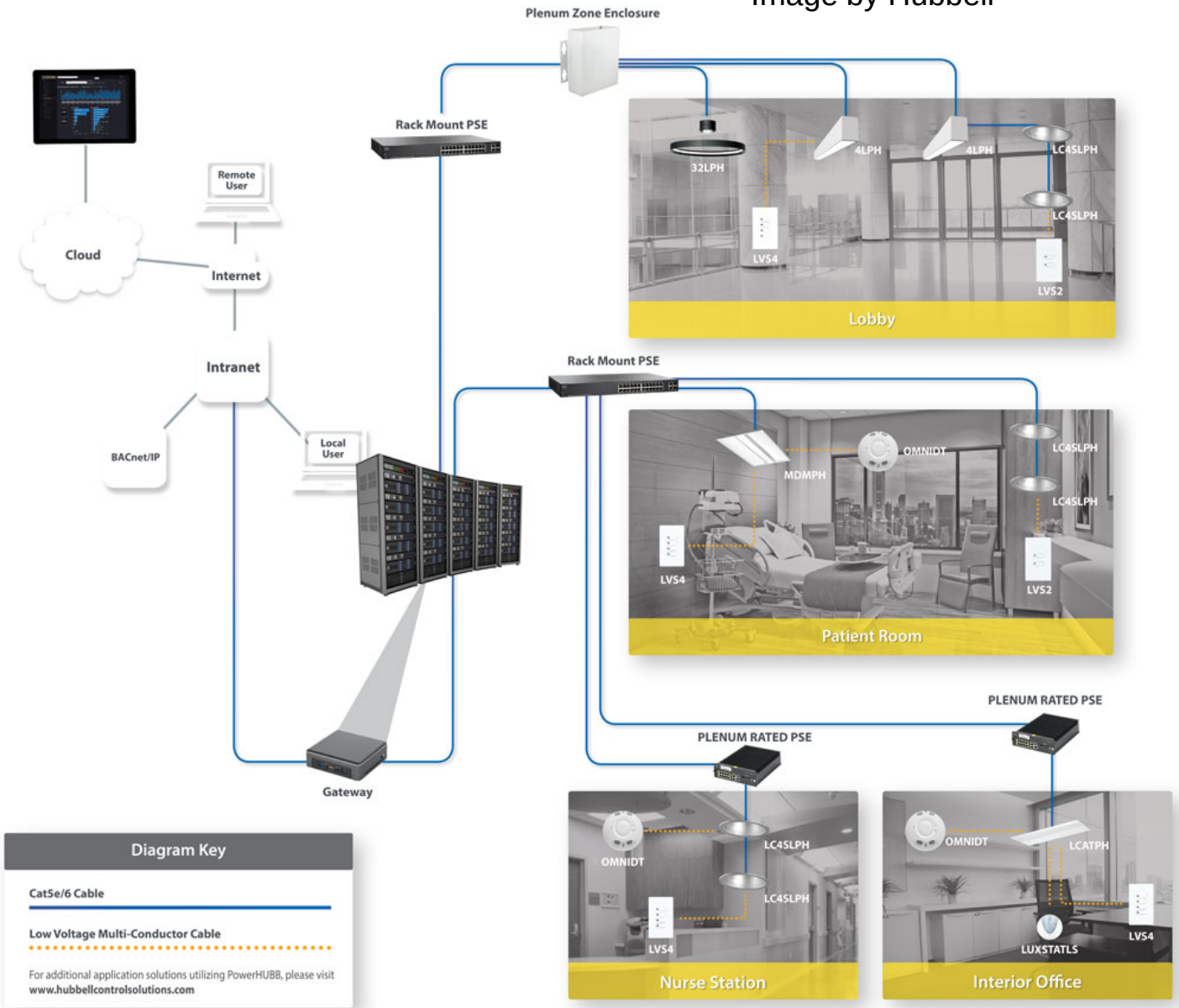
- Make Schools Safer
  - Security Cameras – Lighting
- Improve student experience and performance
  - Attendance - Occ
  - Cues: Dimming + Color Tuning
- Energy Efficiency + Cost Savings



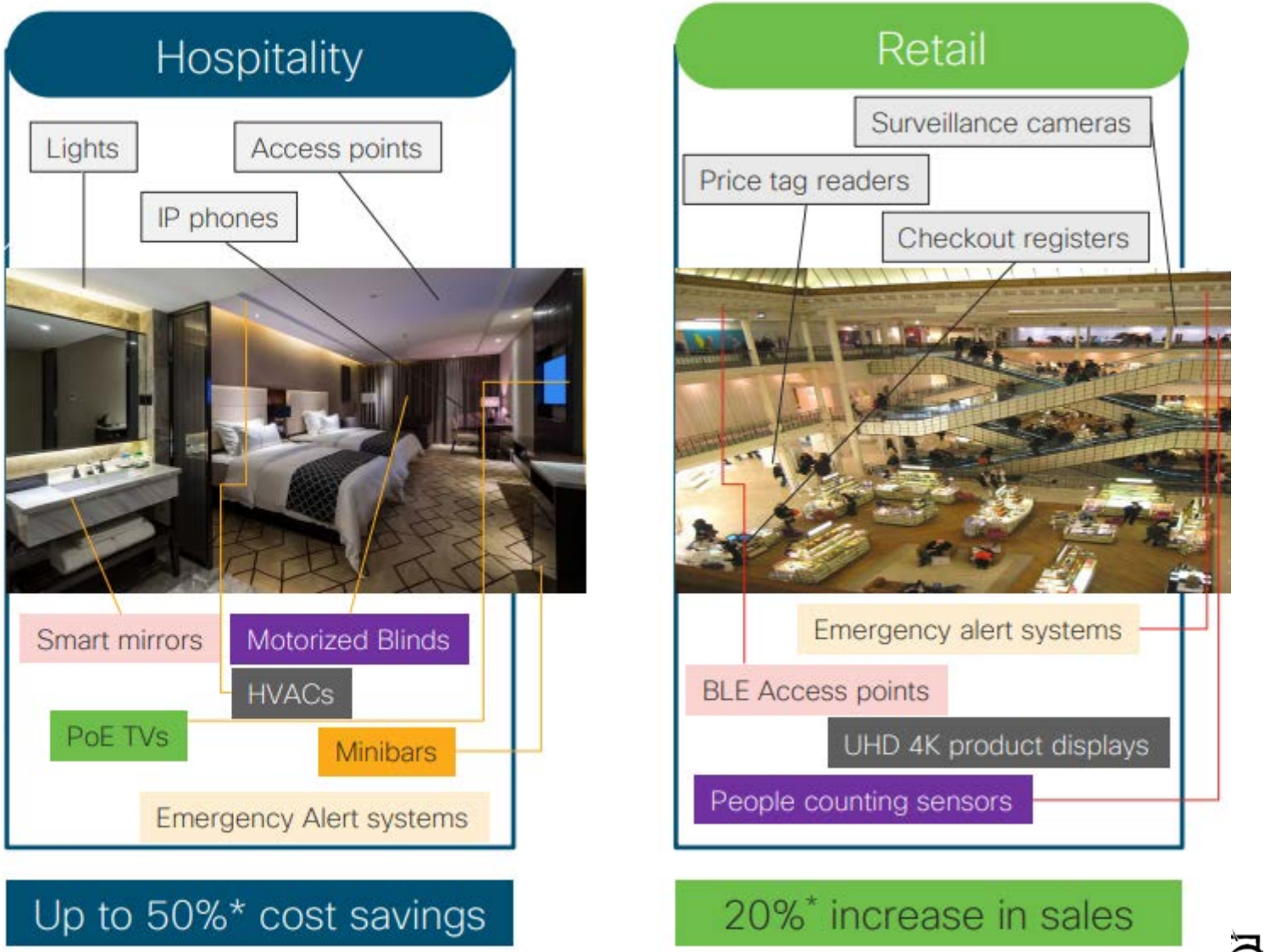


Healthcare with PoE

Image by Hubbell



Other Verticals' PoE Proposition



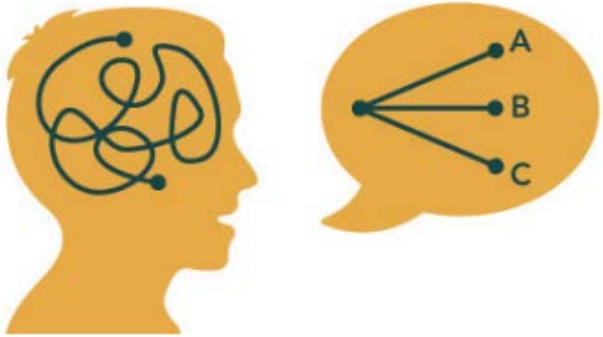
Images by Cisco

Right-size the Solution

EDN

Merging power and data: good, bad, or both?

“Right Postage, Right Address”



Tenants

Living with the system

Facility Professionals

Leveraging the system

Implementers

Implementing the system

Owners

Invested in the system

Pause for Questions

Examples of Non-Energy Benefits

Leverage Non-Energy Benefits When Discussing Value

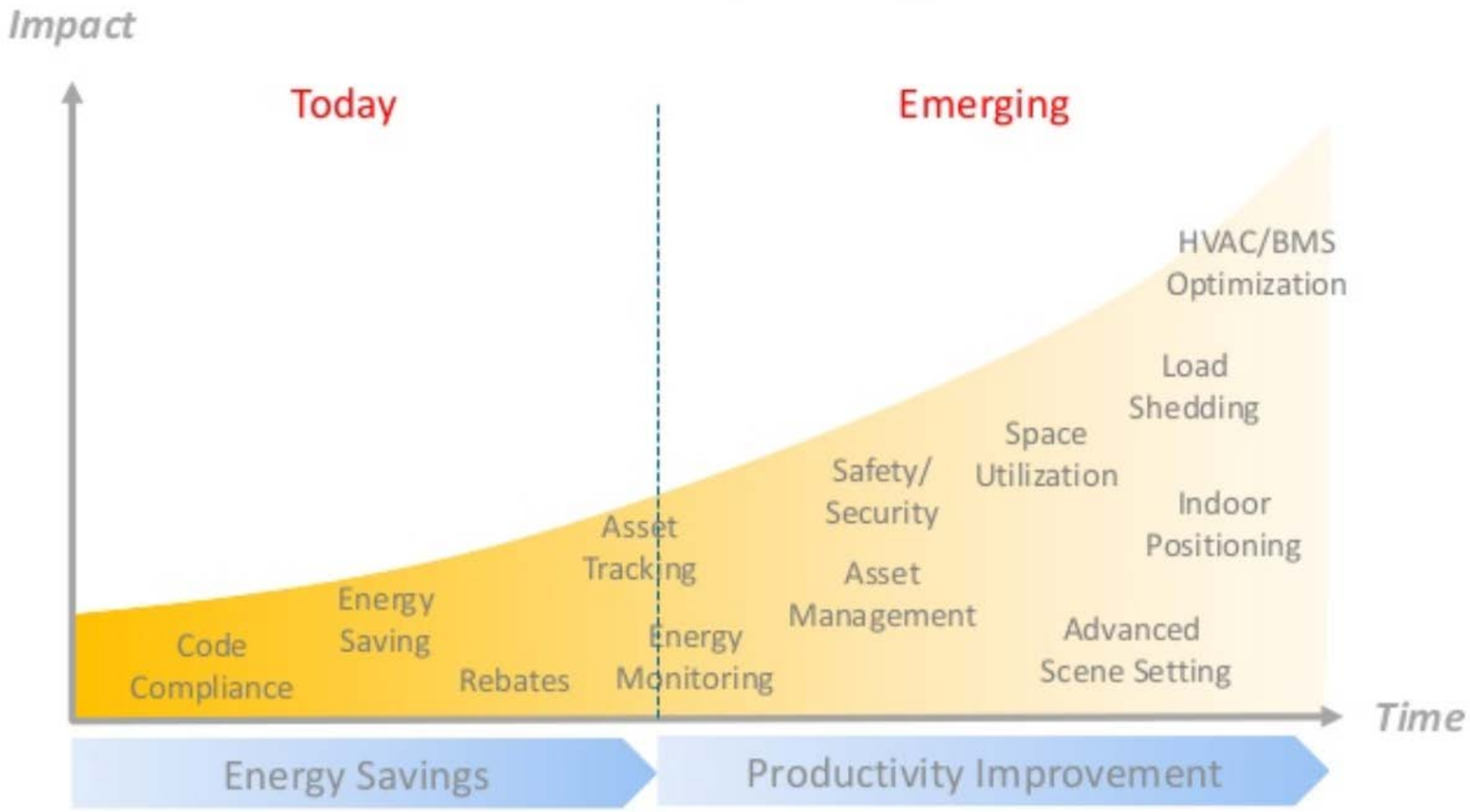
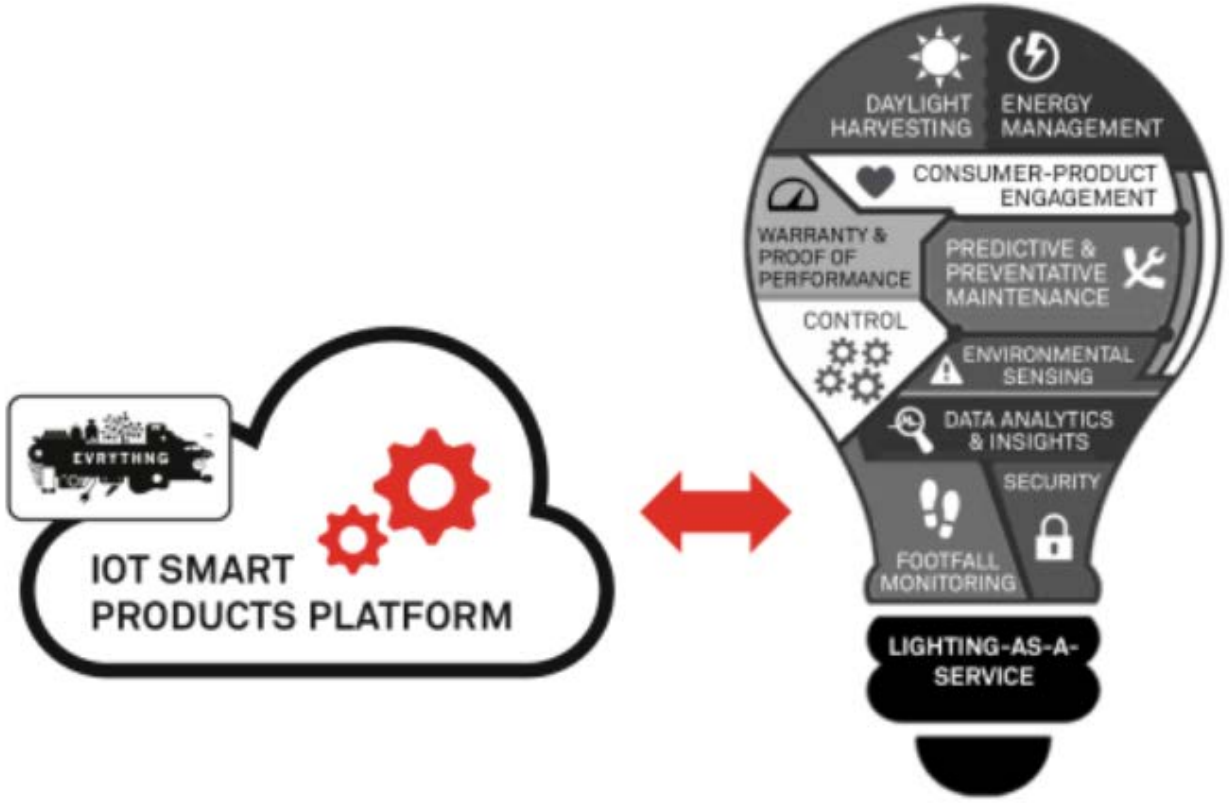


Image by DLC

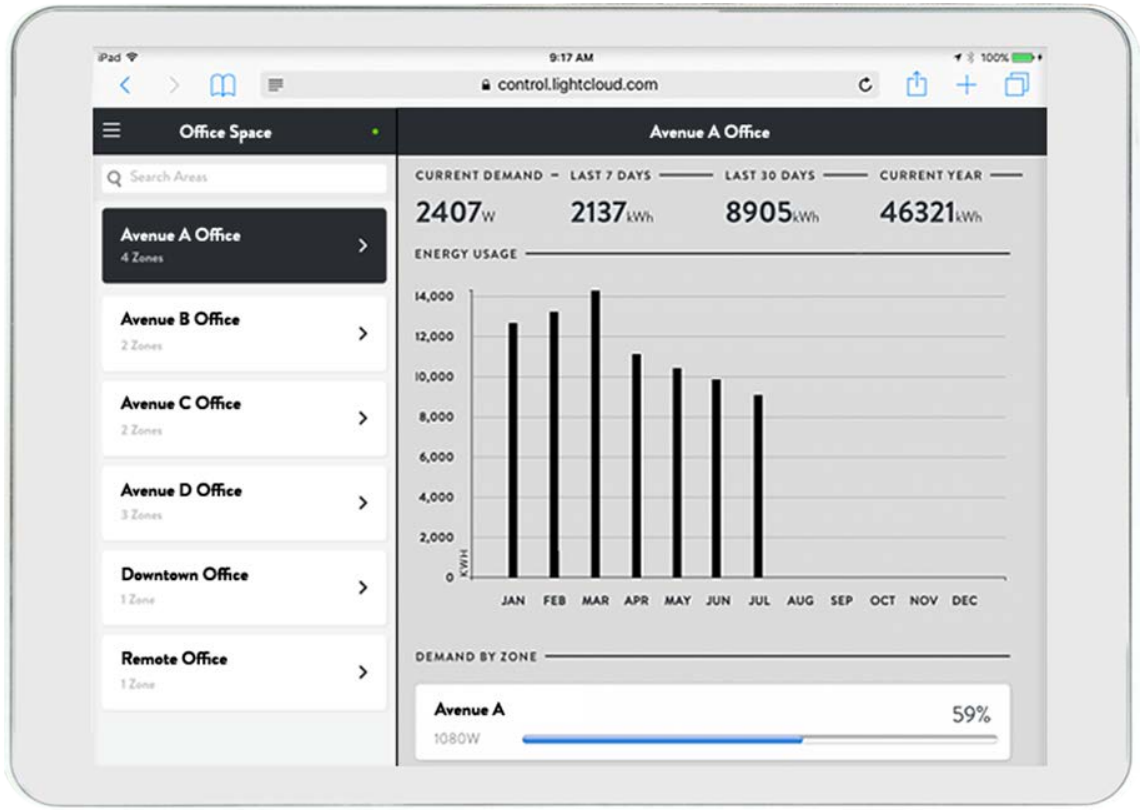
Machine Learning & Interoperability with 3rd Parties

- IP Convergence
- Building vs. Campus Management
- Continuous [AI] Optimization
- Smart DER Operations
- Mitigate Physical & Cyber Security Risks



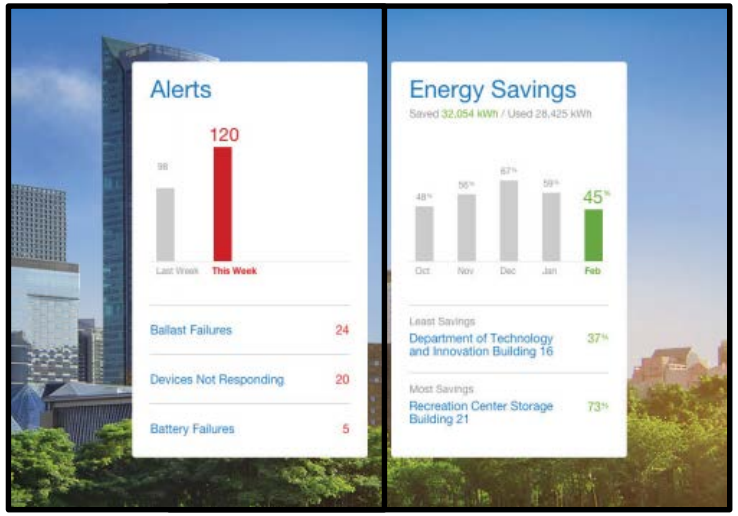
Smart Building Platforms without IP Convergence

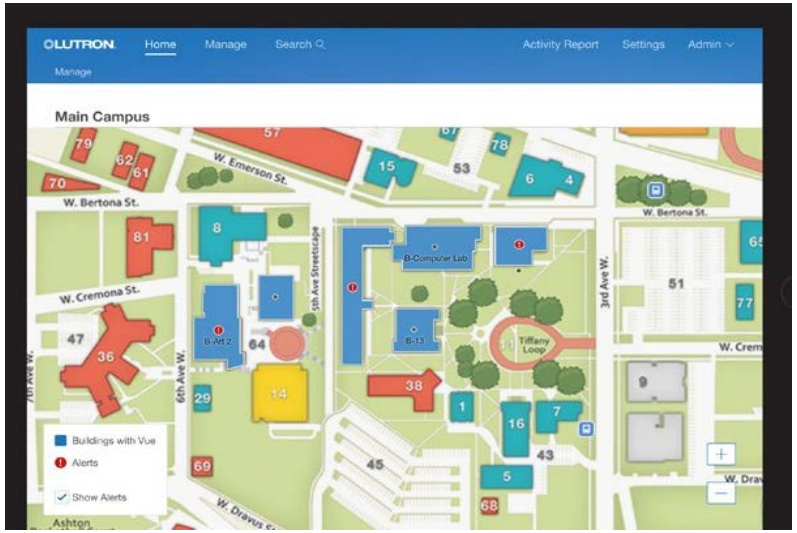
NLC/LLLC Energy Monitoring, Control, & Diagnostics



RAB Lightcloud

Lutron Vive





Lutron Vive

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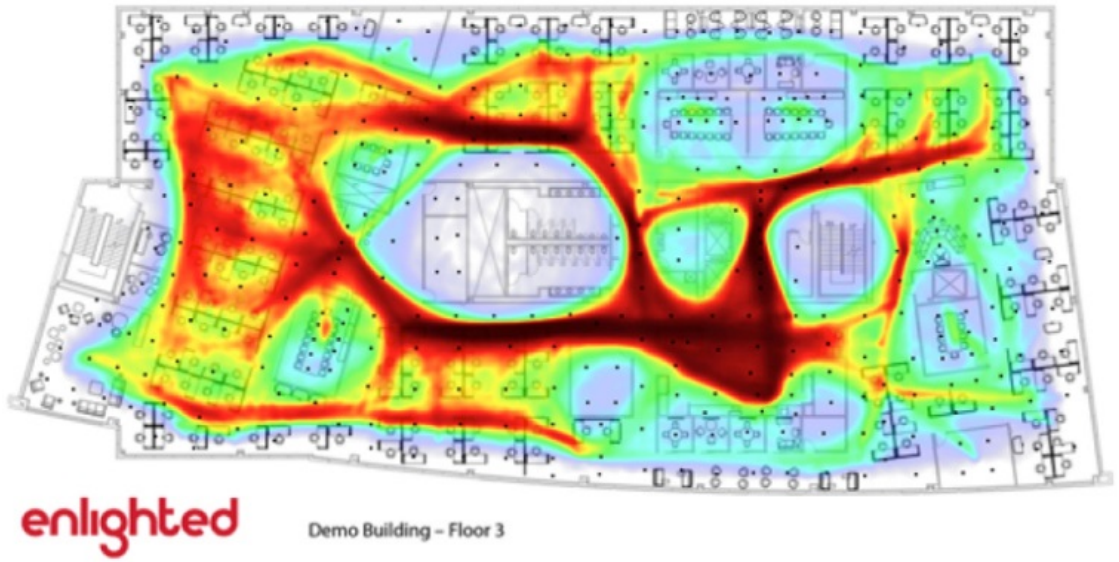
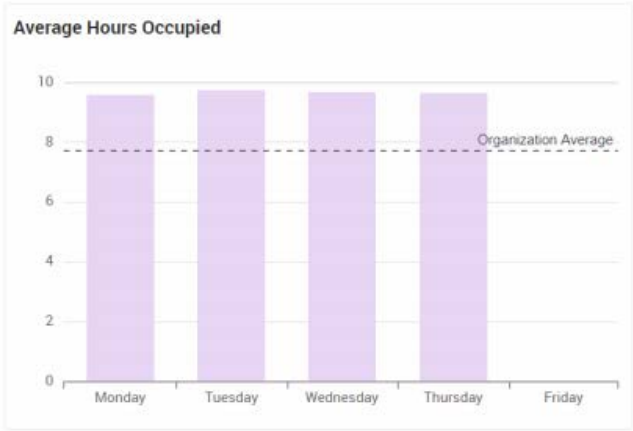
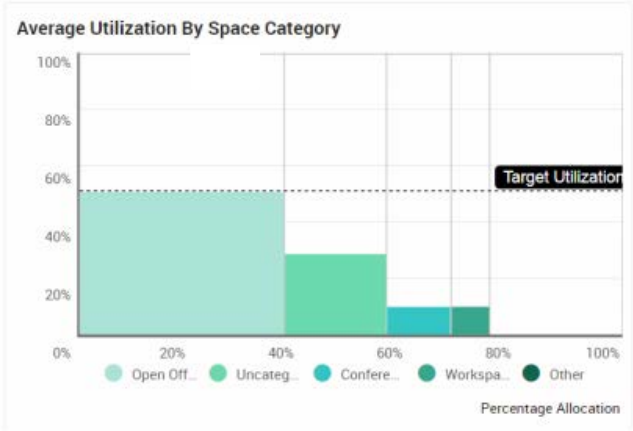
Space Utilization

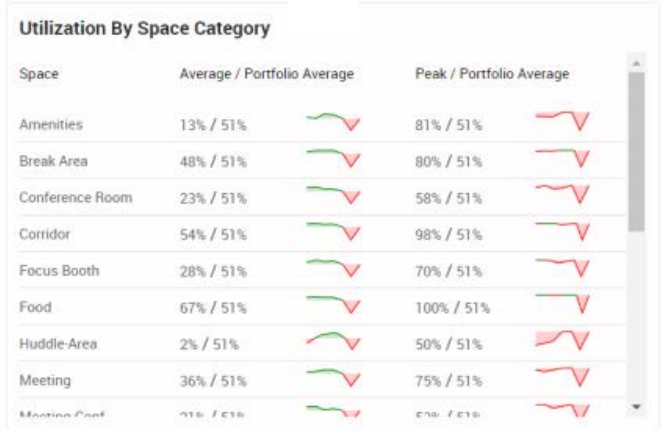
- Cost of Empty Space?

- Cost of Space Analysis









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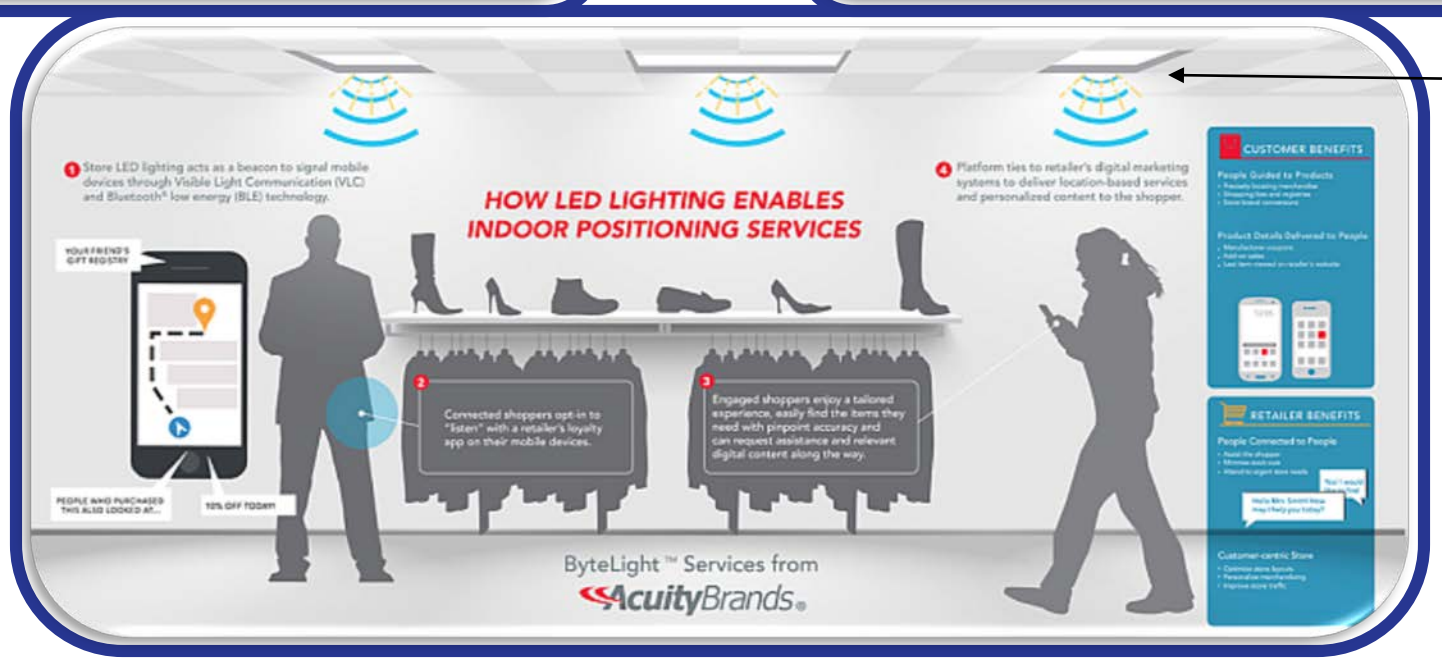
Indoor Positioning & Wayfinding

LLLC

LEDs MAGAZINE

Target gives the go-ahead on IoT lights at half its stores

LLLC



ATRIUS™

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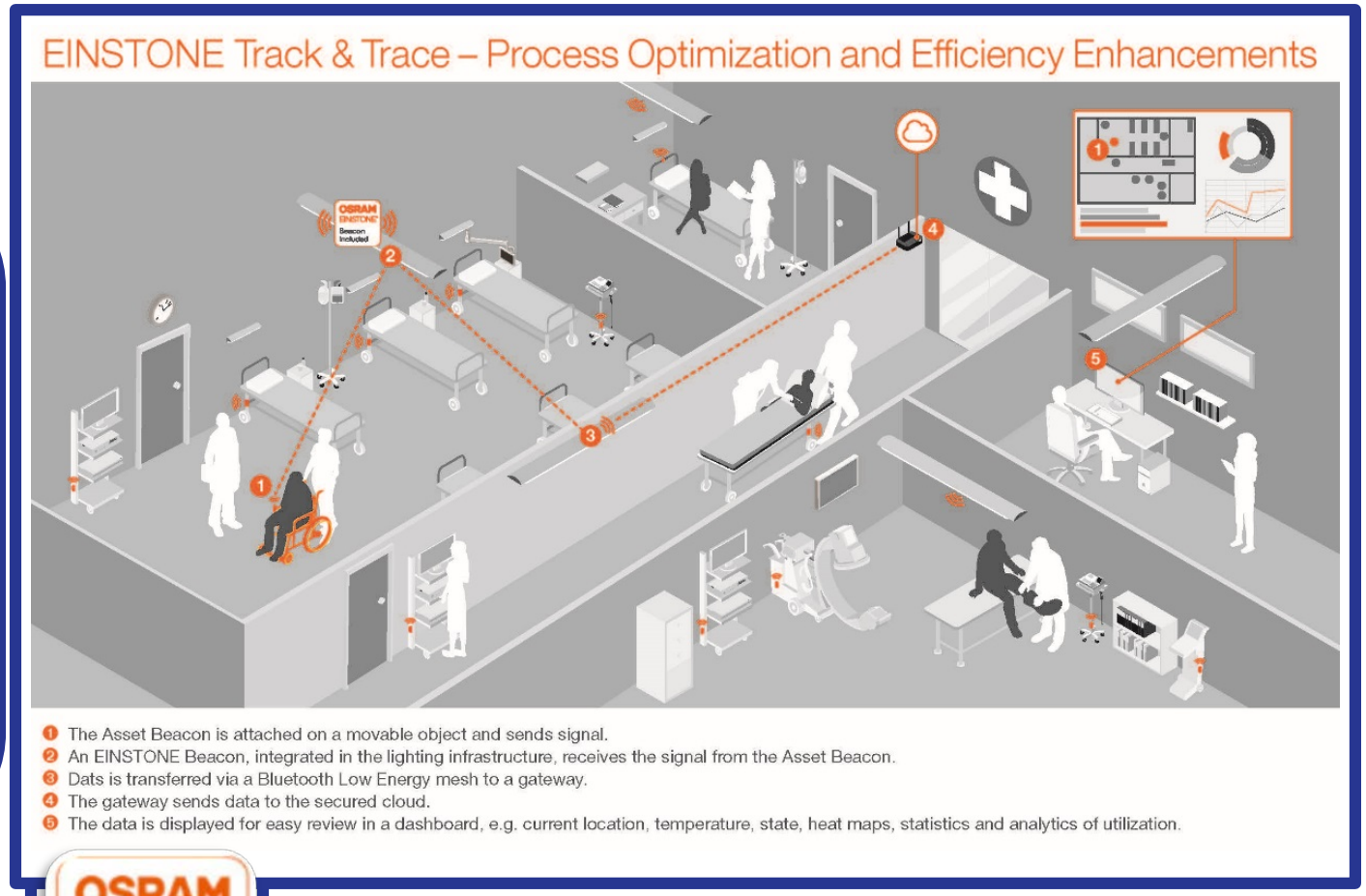
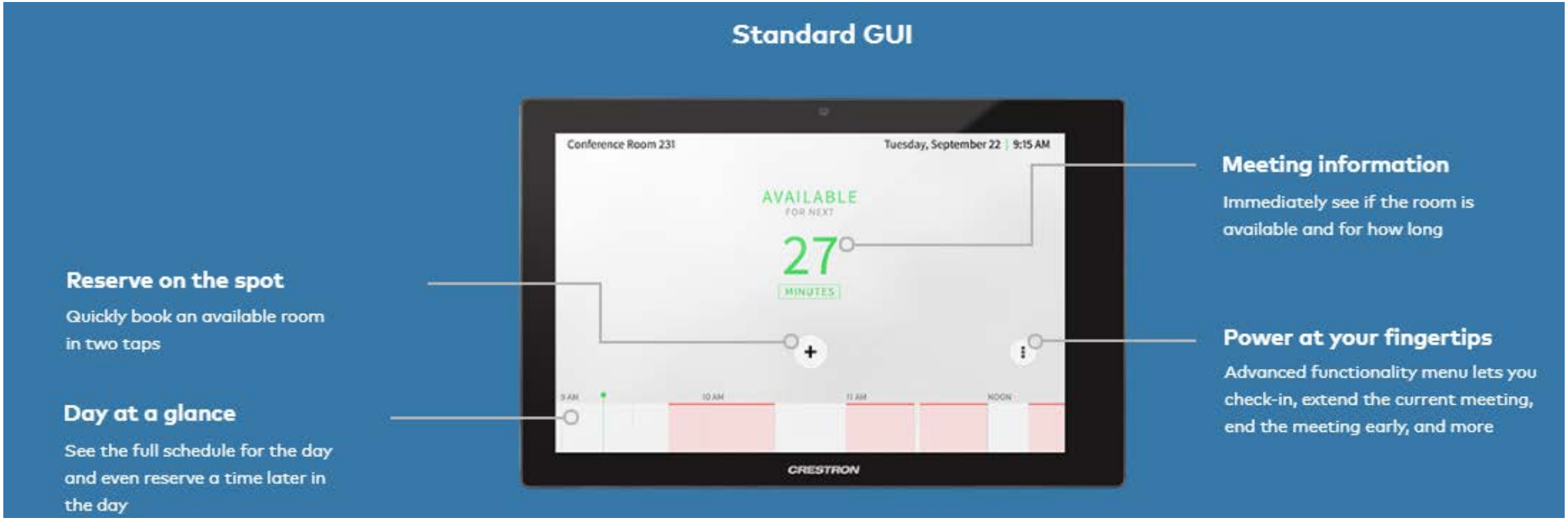
Asset Tracking

VA Pittsburg Healthcare Case Study



Room Scheduling and Wayfinding

Image by Crestron

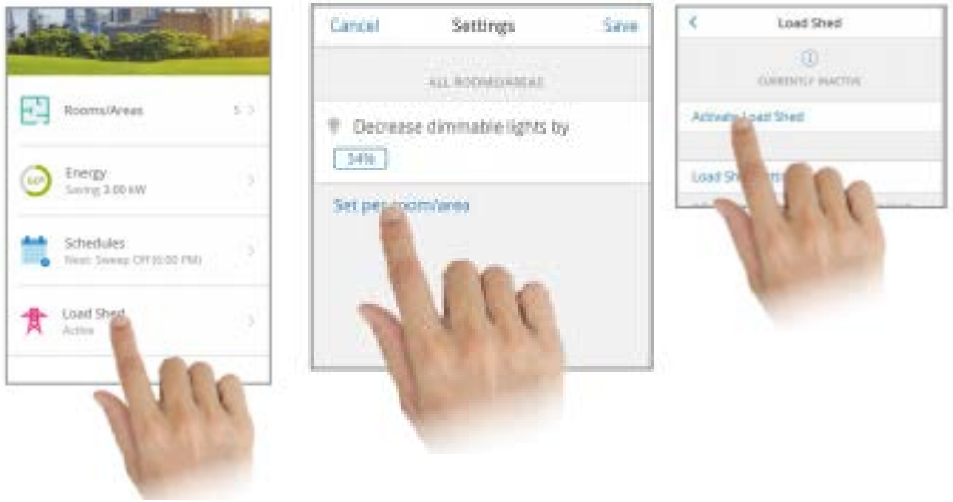


Horticultural Lighting & Automation

Demand Response (and Sneaker-net)

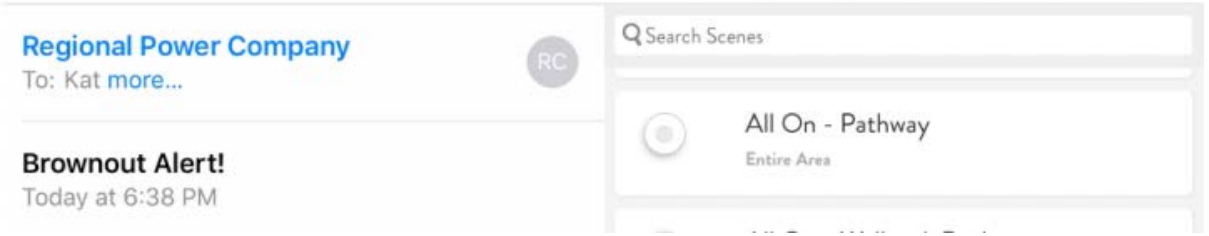
NLC/LLLC Automatic Demand Response

Lutron Vive



RAB LightCloud

When you receive a Demand Response alert from your utility, turn the Scene On.



Leviton Sector Distributed Lighting

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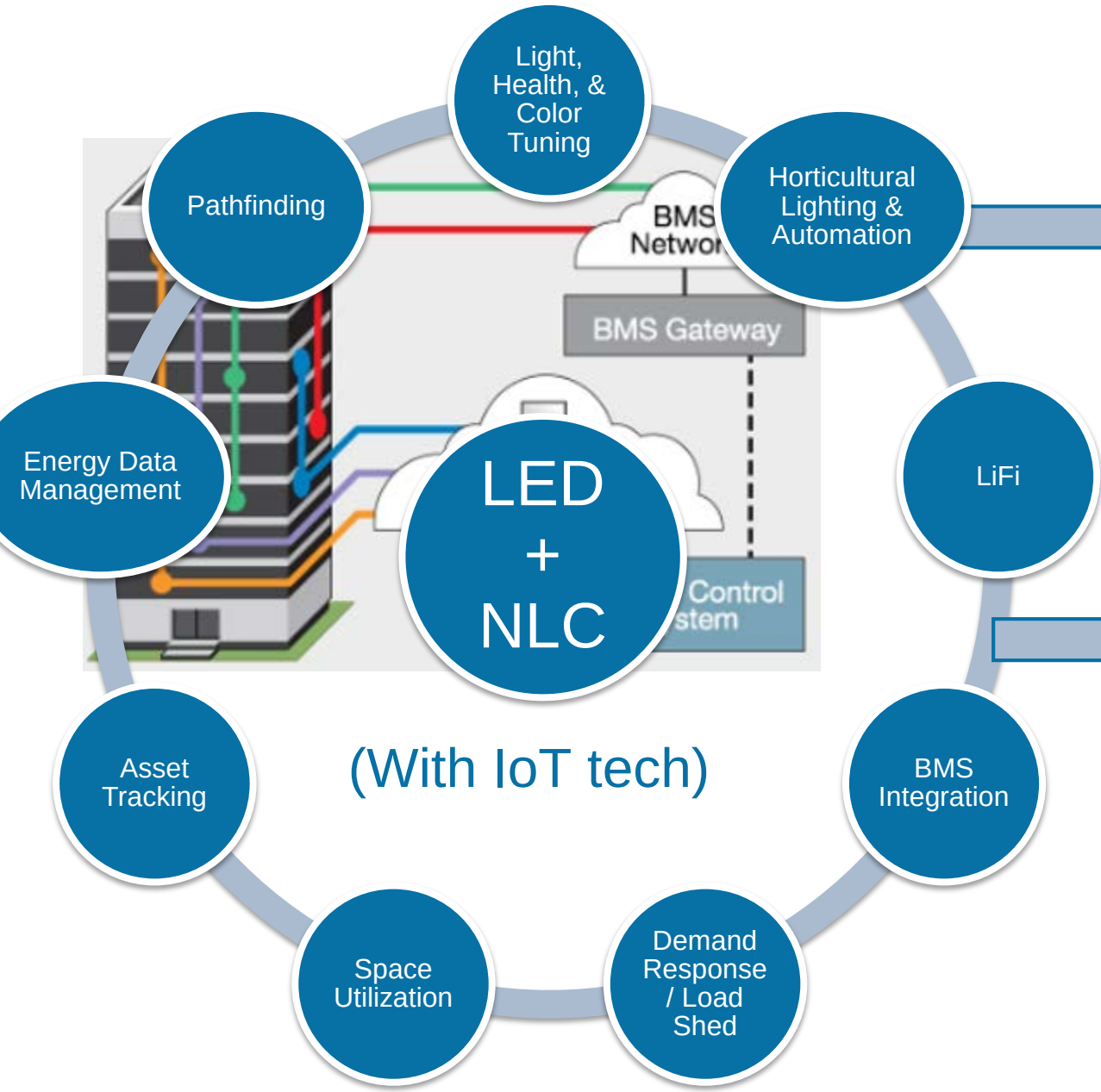
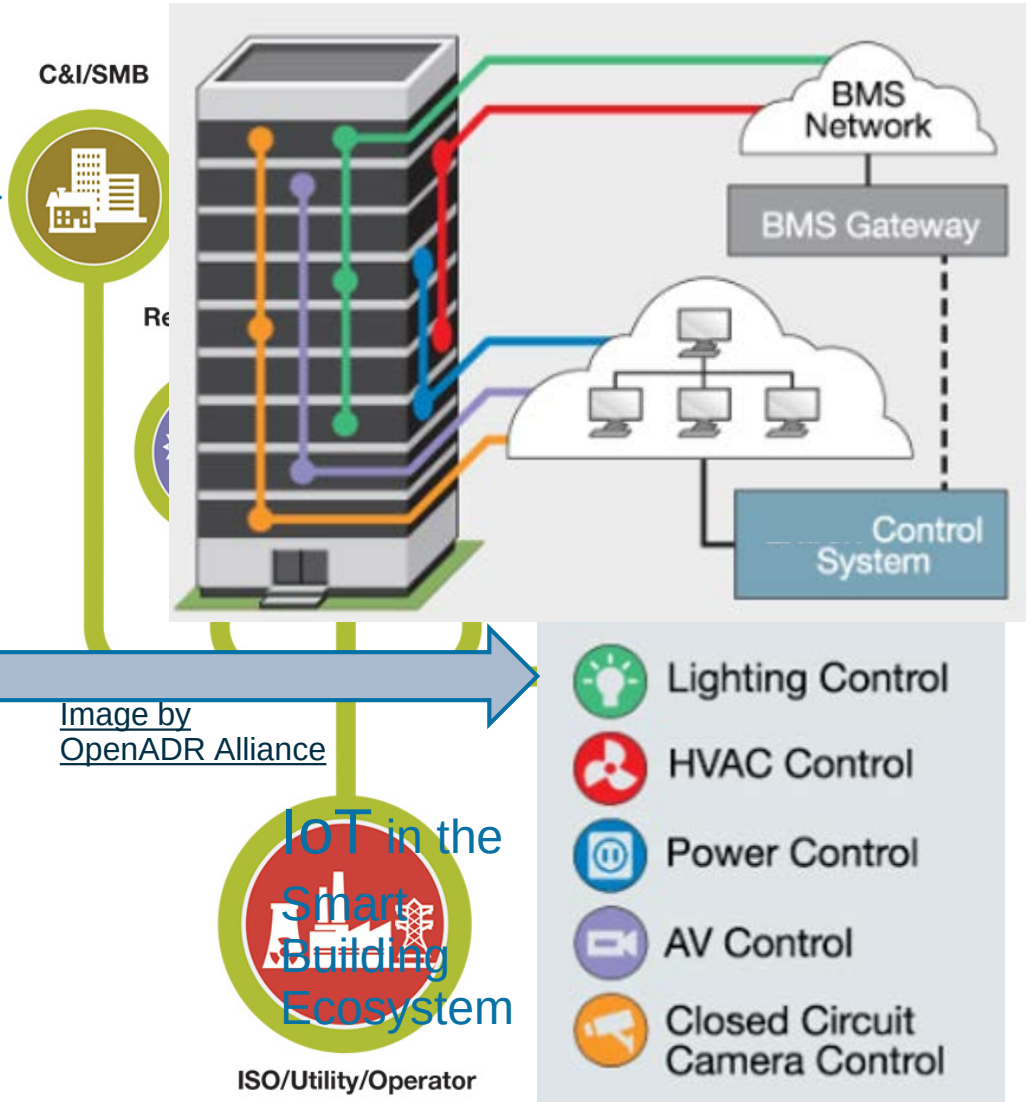
DERM & IoB

Image by Extron



IoB



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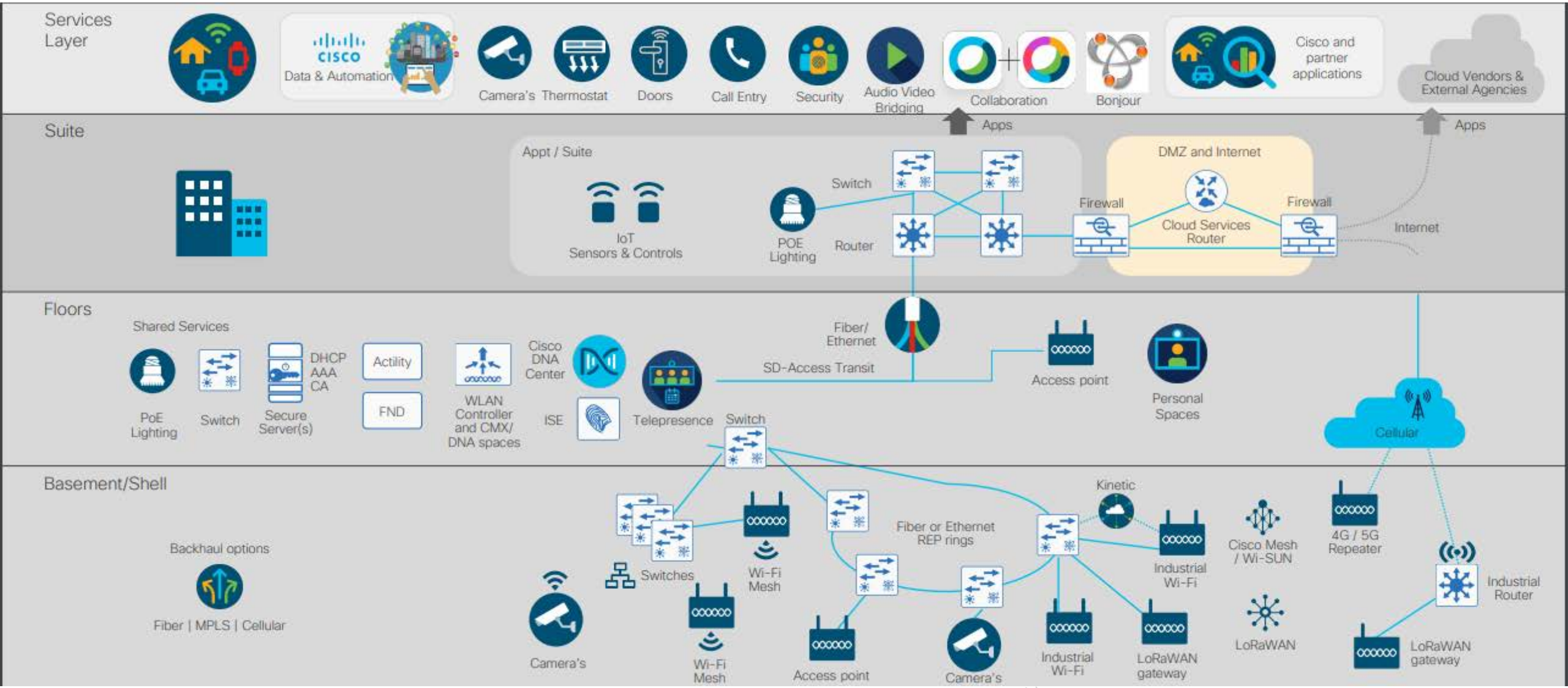
Smart Building Ecosystem

Image by Cisco



Sample Data Set for NLC Manufacturer “SMARTS Race”

	Signify	Cooper Lighting	Lutron Electronics	Igor (PoE Lighting)	Acuity
NLC System	Interact Office	Wavelinx	Vive	Igor	nLight
Smart Platform	Interact Pro	Trellix	Vive Vue -> Enterprise Vue	Nexos	Eclypse -> Atrius
Shared Features	Reporting Dashboards, System Control & Diagnostics, Dynamic Scheduling, Energy Monitoring, BMS Integration (digital), HVAC Integration (digiral and analog), Floorplan View, Luminaire Level Lighting Control, Space Utilization Reporting, Tunable White Control, Open API				
Unique Features	Energy Optimization, System Asset Mgt, Room Scheduling, Scene Mgt, Indoor Positioning, Pathfinding, Bio-Adaptive Lighitng	Energy Optimization, System Asset Mgt Asset Tracking, Room Scheduling, Security Integration, Demand Response via OpenADR	Aggregate Lutron Systems' data, Demand Response via OpenADR	Pair almost any device (analog or digital), Asset Tracking, Room Scheduling, Security Integration Air Quality Monitoring	Asset Tracking, Contextual Spatial Analytics, Indoor Positioning, Demand Reponse via OpenADR
DLC QPL?	Yes	Yes	Yes	Yes	Yes

From Each Manufacturer’s Sell Sheets

What strategy[ies] should be most successful in promoting networked lighting systems?

- Energy Savings
- Infrastructure for Connected Technologies
- Directly solving stakeholder problems
- Utility Dollar Injections

Pause for Questions

Utility & Industry Resources – Teamwork Makes the Dream Work

Why Utilities like City Light Care About Connected Lighting?

Cost Effective Energy Savings

Ensures optimal project savings for lifetime of EE upgrade

Elite Customer Service

Relationship with customers for continuous improvements

Gateway to Connected Stuff

Keeps utilities relevant and part of the solution

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Benefits of plugging in to your Territory Utility

- Investment on innovation and energy efficiency
- Customer and technical support on specific projects
  - Or access to resources for these
- Access to tools and resources
- Access to encyclopedia of implementation knowledge
- Access to impactful programming

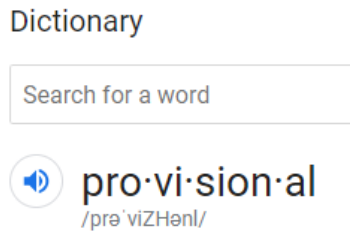
Program Design *Considerations:* **Savings & Incentives**

Example of prescriptive savings in City Light's lighting program

Space Use Type	Networked Lighting Controls	Luminaire Level Lighting Controls
Break Room	40%	50%
Classroom	25%	25%
Hallway	40%	50%
Lobby	40%	50%
The Loo	40%	50%
Warehouse	40%	50%

And so on and so forth…

Regional Technical Forums: Non-Residential Lighting Retrofits protocol



1. Arranged or existing for the present, *possible to be changed later*

Simplify Approach:

- prescriptive savings
- prescriptive incentives

Right-Sized Incentive

- $50-75 incentive bonus –

In addition to performance savings!

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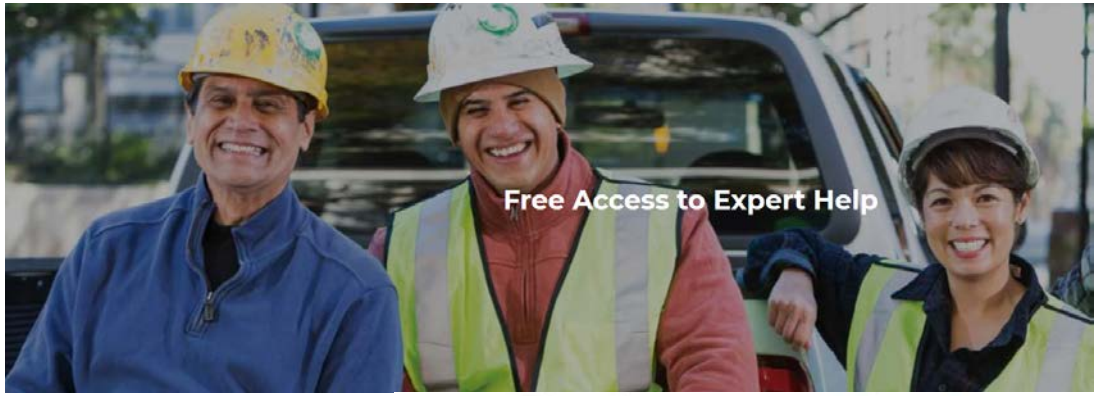
PoE and $50-$75/Fixture Prescriptive Incentives

- PoE =/= LLLC
  - Does not mean PoE =/= $50-$75/fixture
- Engage your utility EARLY
  - “Does this meet your Criteria?
  - “How do I fill in the Workbook?



City Light NLC $50/Fixture 2020 Requirements

- DLC Listed System
- Programmed HET, Occupancy, Daylight Harvesting
- Min (2) Zones per 300sqft
- Pre-Install
  - SOO
  - Floor Plan
- Post-Install
  - As Builts
  - Site Visit

- TLEDs
- Fixtures under 20W
  - HET under 20W = prorated $50 incentive

Seattle City Light

CUSTOMER ENERGY SOLUTIONS
PROGRAM REQUIREMENTS

Commercial and Industrial Retrofit Program

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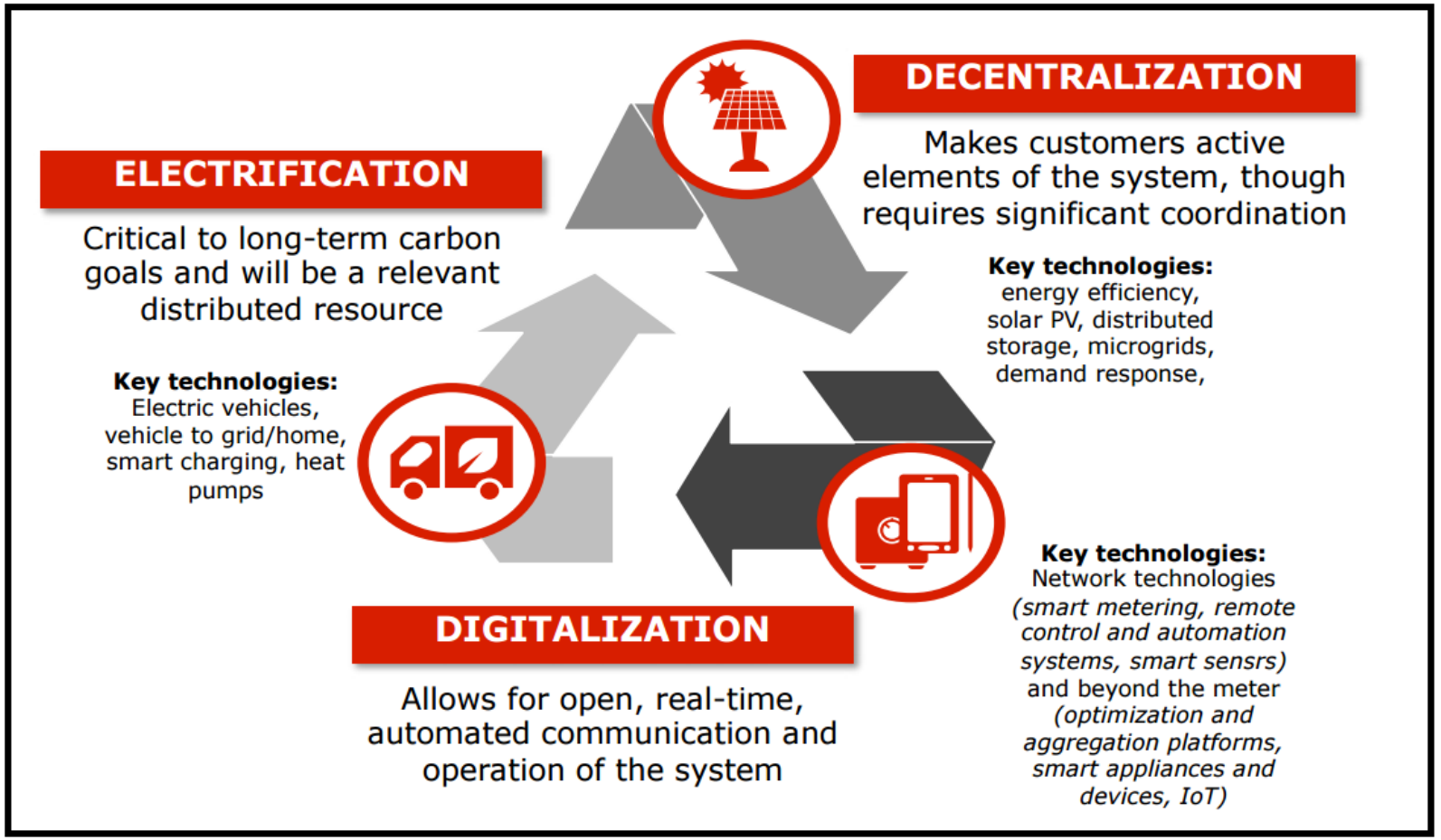
PoE in Grid-Edge and Efficient Green Energy



By World Economic Forum

DOE & PNNL – Integrated Lighting Campaign

ILC Goals

Provide resources for new integrated lighting systems


Promote use of innovative lighting sensors


Encourage integration with other building systems such as HVAC and plug loads


Document and recognize integration and innovation

- **Participants**
  - Organizations—including building owners, operators, and managers—have access to resources and technical assistance
- **Supporters**
  - Supporting partners include utilities, manufacturers, energy-efficiency organizations, lighting designers, and energy service companies (ESCOs)

integratedlighting@pnnl.gov

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Education & Market Development

1 & 2 Day NLC Workshops
for
EVERYBODY…
featuring
Hands-On Learning & Practical Application

LDL's Flagship Workshop

- Specifics of control methods
- Developing sequence of operations
- Specification writing & interpreting
- System design & set up
- And so much more!!!

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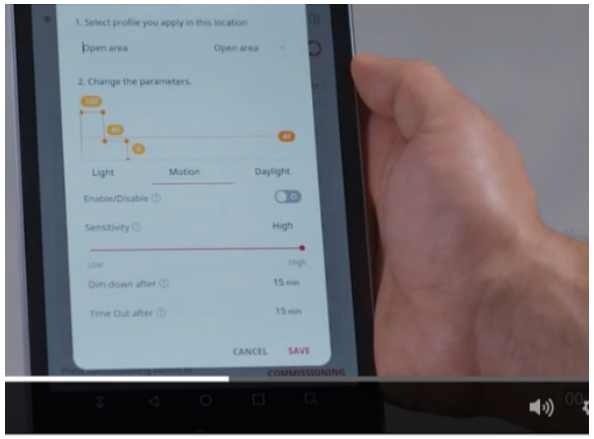
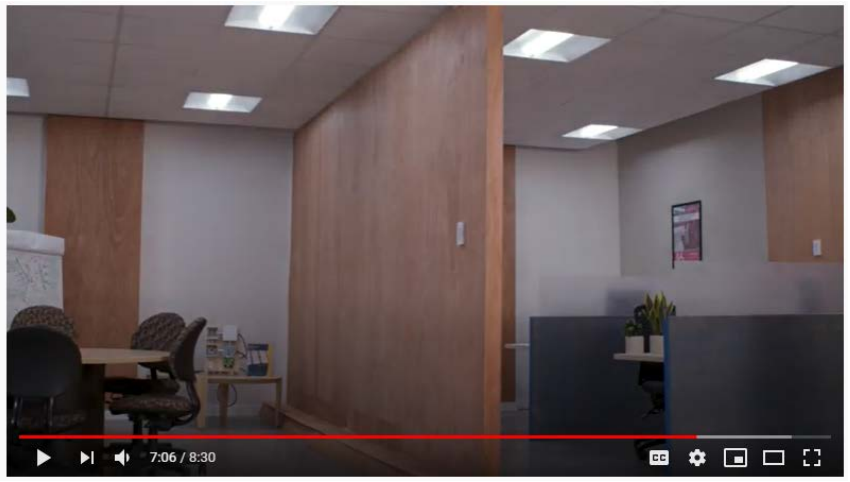
Networked Lighting Controls Learning Guides & Video

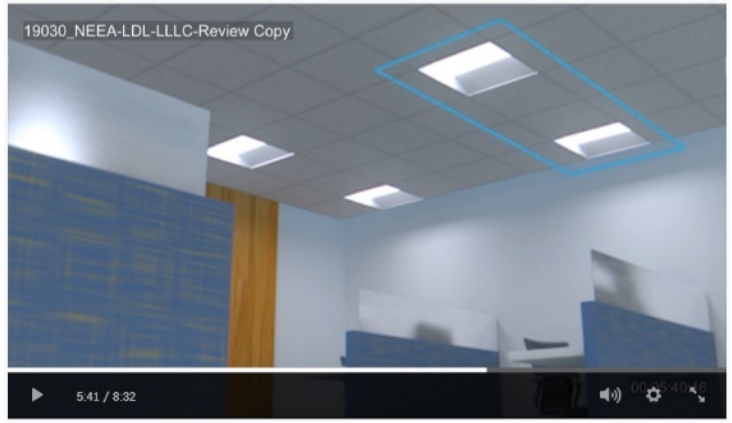
- LLLC Video
  - X3 short vids
  - ***Demonstrates*** primary control strategies
  - Simulates tenant improvement to highlight system flexibility
- For utility staff, TA's / DA's / Customers

CHECK IT OUT!

Click here to watch now!







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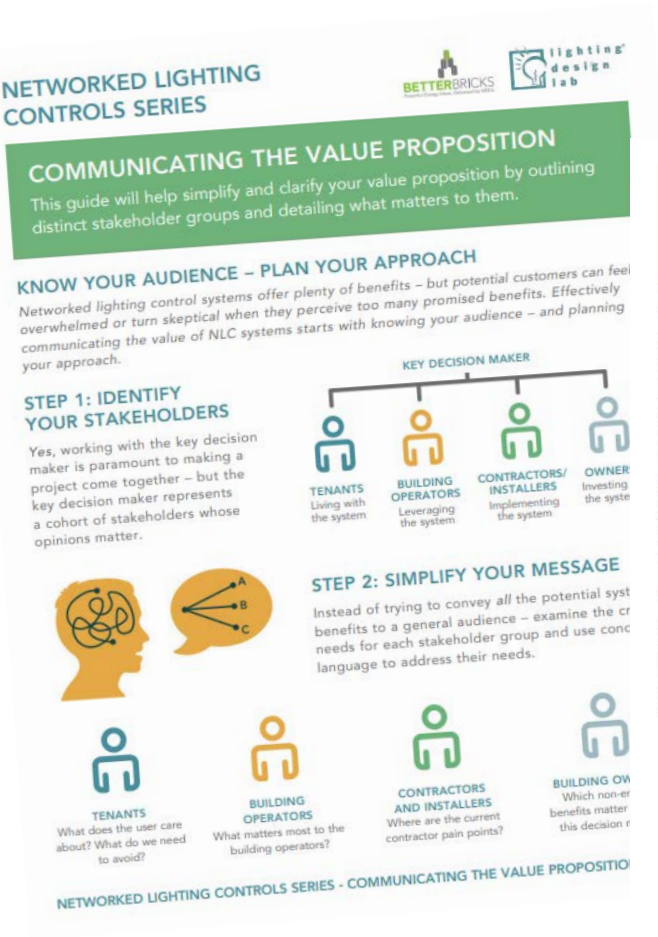
NLC / LLLC Best Practice Guides



NETWORKED LIGHTING CONTROLS SERIES

BETTERBRICKS

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COMMUNICATING THE VALUE PROPOSITION

This guide will help simplify and clarify your value proposition by outlining distinct stakeholder groups and detailing what matters to them.

KNOW YOUR AUDIENCE – PLAN YOUR APPROACH

Networked lighting control systems offer plenty of benefits – but potential customers can feel overwhelmed or turn skeptical when they perceive too many promised benefits. Effectively communicating the value of NLC systems starts with knowing your audience – and planning your approach.

STEP 1: IDENTIFY YOUR STAKEHOLDERS

Yes, working with the key decision maker is paramount to making a project come together – but the key decision maker represents a cohort of stakeholders whose opinions matter.

KEY DECISION MAKER

TENANTS Living with the system

BUILDING OPERATORS Leveraging the system

CONTRACTORS/ INSTALLERS Implementing the system

OWNER Investing the syste

STEP 2: SIMPLIFY YOUR MESSAGE

Instead of trying to convey *all* the potential syst benefits to a general audience – examine the cr needs for each stakeholder group and use conc language to address their needs.

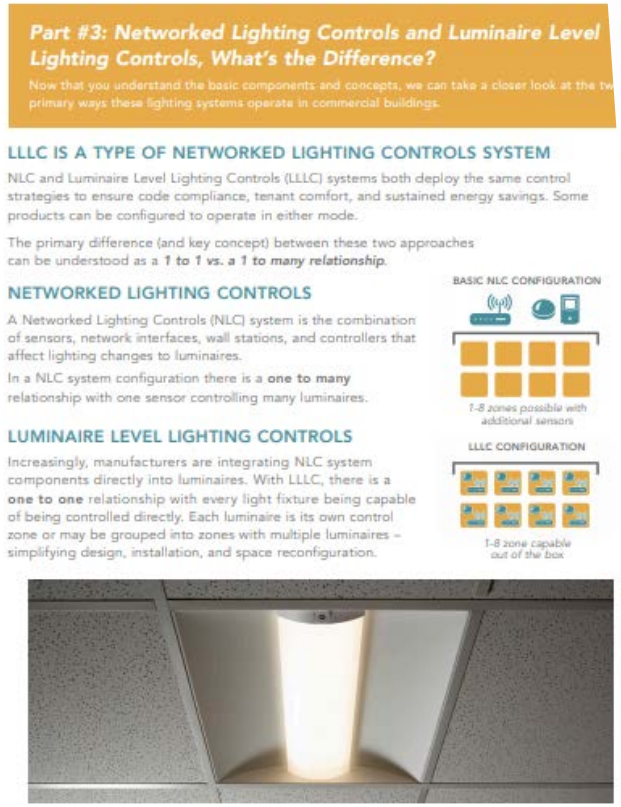
TENANTS What does the user care about? What do we need to avoid?

BUILDING OPERATORS What matters most to the building operators?

CONTRACTORS AND INSTALLERS Where are the current contractor pain points?

BUILDING OW Which non-er benefits matter this decision r

NETWORKED LIGHTING CONTROLS SERIES - COMMUNICATING THE VALUE PROPOSITIO



Part #3: Networked Lighting Controls and Luminaire Level Lighting Controls, What's the Difference?

Now that you understand the basic components and concepts, we can take a closer look at the tw primary ways these lighting systems operate in commercial buildings.

LLLC IS A TYPE OF NETWORKED LIGHTING CONTROLS SYSTEM

NLC and Luminaire Level Lighting Controls (LLLC) systems both deploy the same control strategies to ensure code compliance, tenant comfort, and sustained energy savings. Some products can be configured to operate in either mode.

The primary difference (and key concept) between these two approaches can be understood as a ***1 to 1 vs. a 1 to many relationship***.

NETWORKED LIGHTING CONTROLS

A Networked Lighting Controls (NLC) system is the combination of sensors, network interfaces, wall stations, and controllers that affect lighting changes to luminaires.

In a NLC system configuration there is a **one to many** relationship with one sensor controlling many luminaires.

BASIC NLC CONFIGURATION

1-8 zones possible with additional sensors

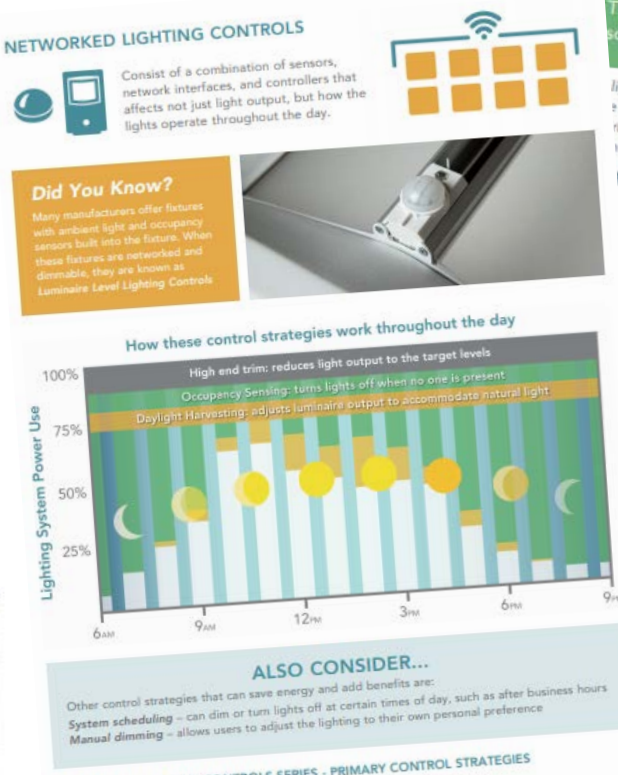
LUMINAIRE LEVEL LIGHTING CONTROLS

Increasingly, manufacturers are integrating NLC system components directly into luminaires. With LLLC, there is a **one to one** relationship with every light fixture being capable of being controlled directly. Each luminaire is its own control zone or may be grouped into zones with multiple luminaires – simplifying design, installation, and space reconfiguration.

LLLC CONFIGURATION

1-8 zone capable out of the box

NETWORKED LIGHTING CONTROLS SERIES - CONTROL TECH TERMS 3



NETWORKED LIGHTING CONTROLS

Consist of a combination of sensors, network interfaces, and controllers that affects not just light output, but how the lights operate throughout the day.

Did You Know?

Many manufacturers offer fixtures with ambient light and occupancy sensors built into the fixture. When these fixtures are networked and dimmable, they are known as Luminaire Level Lighting Controls

How these control strategies work throughout the day

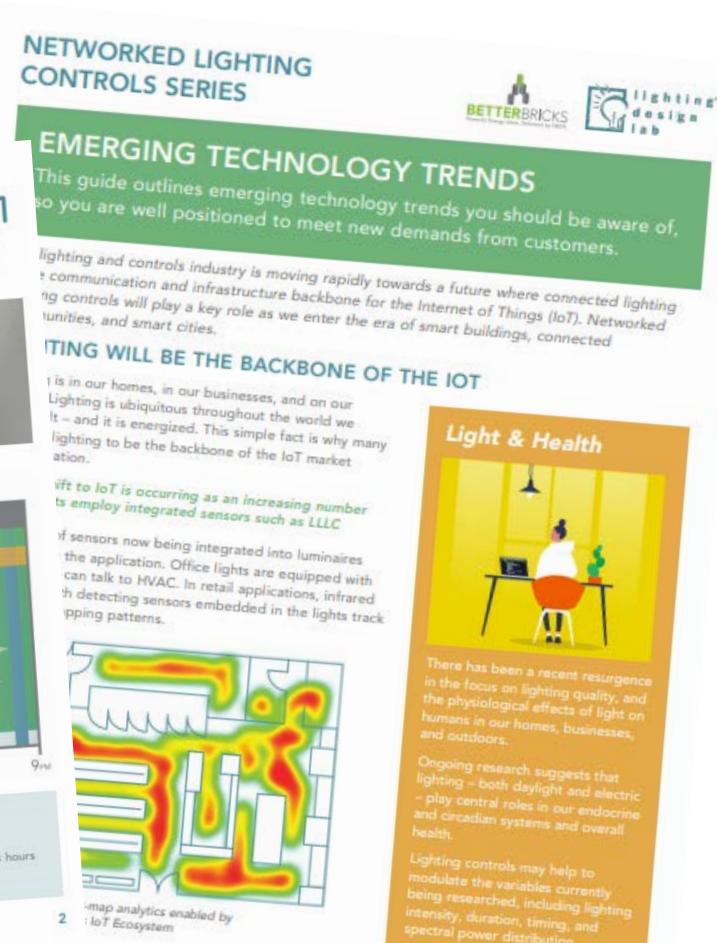
ALSO CONSIDER...

Other control strategies that can save energy and add benefits are:

System scheduling – can dim or turn lights off at certain times of day, such as after business hours

Manual dimming – allows users to adjust the lighting to their own personal preference

NETWORKED LIGHTING CONTROLS SERIES - PRIMARY CONTROL STRATEGIES 2



NETWORKED LIGHTING CONTROLS SERIES

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EMERGING TECHNOLOGY TRENDS

This guide outlines emerging technology trends you should be aware of, so you are well positioned to meet new demands from customers.

lighting and controls industry is moving rapidly towards a future where connected lighting e communication and infrastructure backbone for the Internet of Things (IoT). Networked ng controls will play a key role as we enter the era of smart buildings, connected unities, and smart cities.

ITING WILL BE THE BACKBONE OF THE IOT

is in our homes, in our businesses, and on our Lighting is ubiquitous throughout the world we lt – and it is energized. This simple fact is why many lighting to be the backbone of the IoT market ation.

ift to IoT is occurring as an increasing number ts employ integrated sensors such as LLLC

f sensors now being integrated into luminaires the application. Office lights are equipped with can talk to HVAC. In retail applications, infrared h detecting sensors embedded in the lights track pping patterns.

-map analytics enabled by IoT Ecosystem

Light & Health

There has been a recent resurgence in the focus on lighting quality, and the physiological effects of light on humans in our homes, businesses, and outdoors.

Ongoing research suggests that lighting – both daylight and electric – play central roles in our endocrine and circadian systems and overall health.

Lighting controls may help to modulate the variables currently being researched, including lighting intensity, duration, timing, and spectral power distribution.

NETWORKED LIGHTING CONTROLS SERIES - EMERGING TECHNOLOGY TRENDS 1

[Click to access the LDL networked lighting control learning guides]

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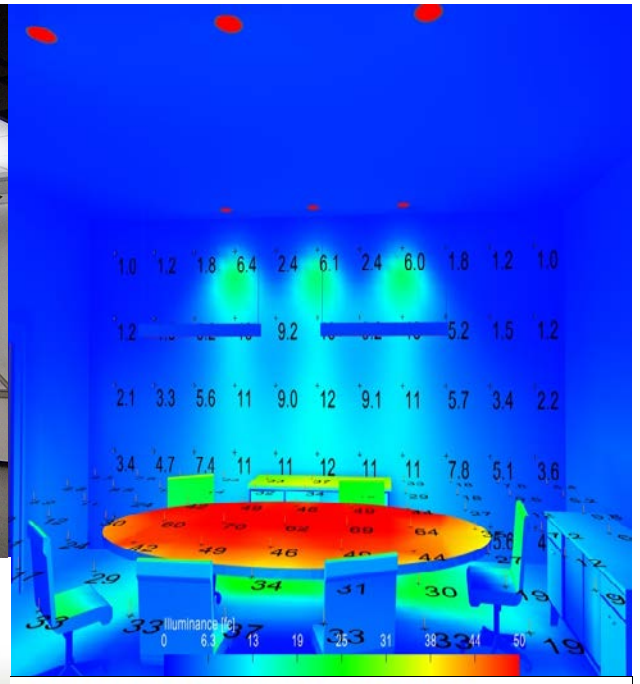
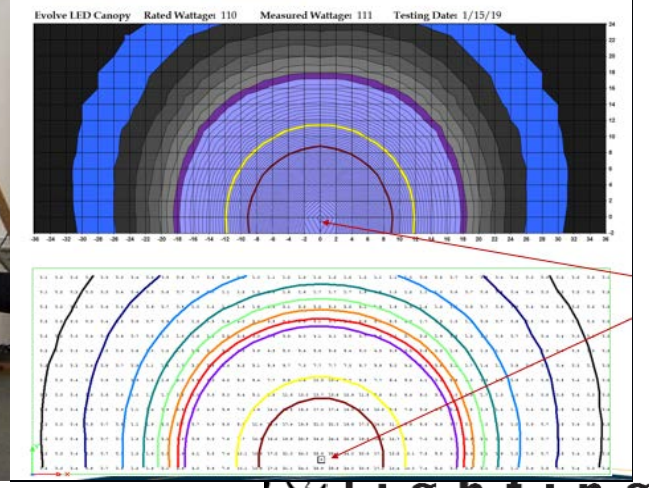
Project Specific Consults and Mockups



Comparing the tested sample (top) to the IES file (bottom)



Informing and Increasing Acceptance: The NLC User Experience

Tenants

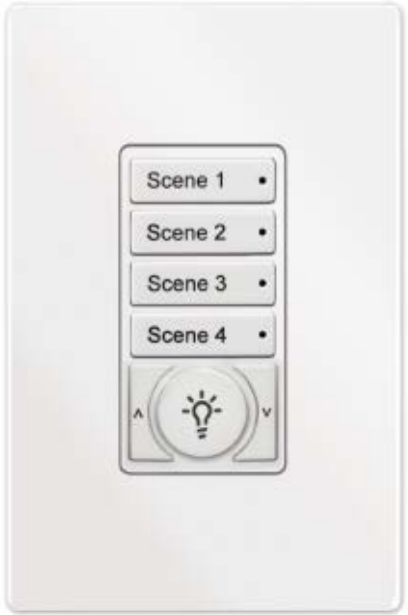


Image by Cooper

Ease of Use

Functionality

Operations

Image by Lutron

Facility Professionals

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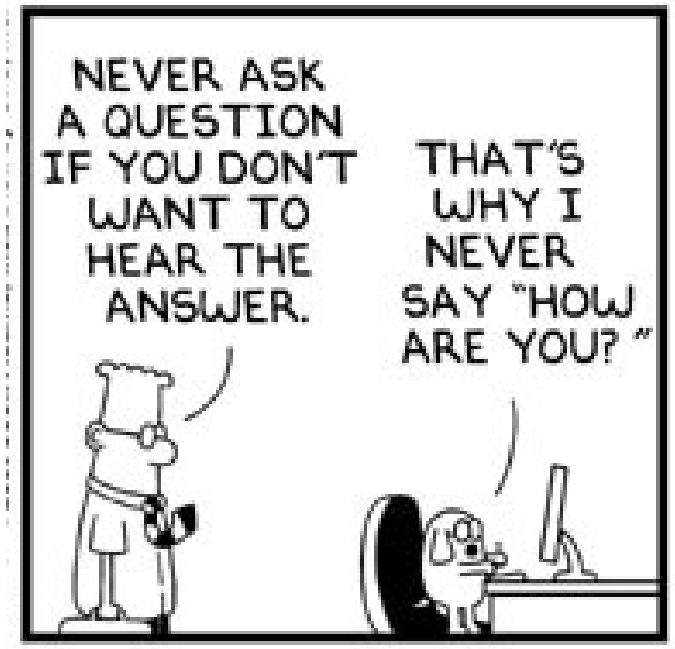
Pause for Questions



And now – a few words from LDL

Upcoming LDL Online Events

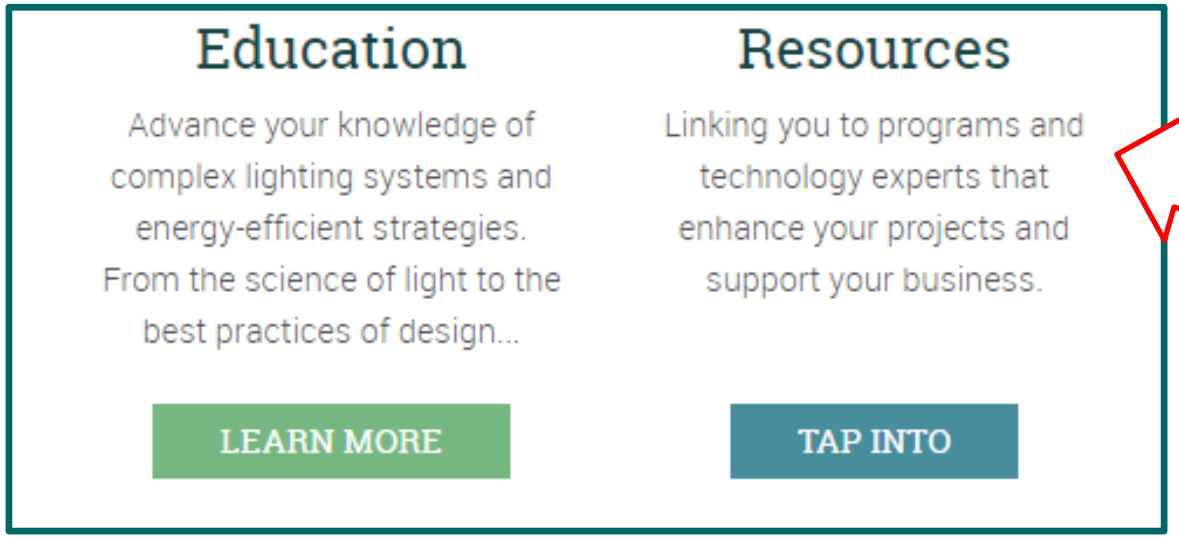
LDL Course	Delivery Date	Time
NLC for Healthcare Environments	Oct 20	10:00 - Noon
Fundamentals of NLC (Side A – Theory & Technology)	Nov 3	10:00 - Noon
Fundamentals of NLC (Side B – Practical Application)	Nov 4	10:00 - Noon
NLC for Warehouses	Nov 17	10:00 – Noon
NLC for Schools	Dec 1	10:00 – Noon

Today's slide deck and previous online courses can be found on our website

Click – Call – Connect

- Armando Berdiel Chavez
  - 206-475-2722
  - armando.berdiel@seattle.gov

Visit us online



OR

Email Us

lightingdesignlab@seattle.gov

Todays slide deck will be posted here!

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We'll *SEE* you on the next call… ☺

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