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Designers Lighting Forum

Specifying for Success with Today's Wireless Mesh Controls

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

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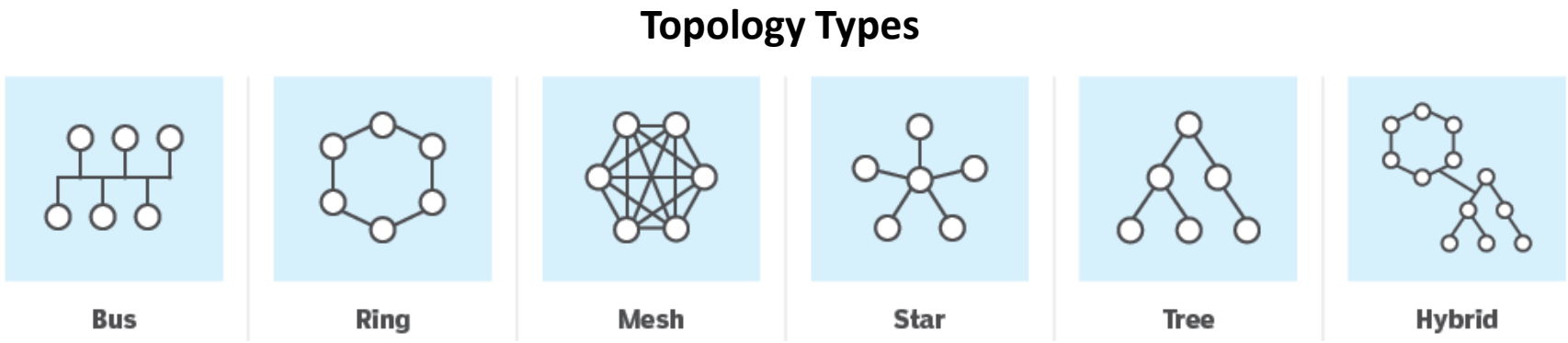
Learning Objectives

At the end of this course, participants will be able to:

- Gain a basic understanding of what wireless mesh control technology is, and “best fit” projects
- Understand best practices for building a project specification, including detailed exploration of design goals, technology, and cost-benefit evaluation
- Facilitate discussions and coordinate with a project team for selecting wireless mesh, including overcoming specific concerns
- Learn lessons from unique recent projects that inform the best practices in the specification process

Wireless Mesh: What is it?

- Many to many network topology
- Every node communicates wirelessly with every other node



Source: TechTarget

Wireless Mesh: What is it?

- No centralized gateway
- No linear topology with ‘master’ or ‘auxiliary’ relationship

Wireless Mesh: Benefits

- No single point of failure
- No requirement for a gateway or central hub
- Intelligence resides in each node
- Programmable from average smartphone or tablet

Wireless Mesh: Concerns

- Range anxiety
- Interference with other frequencies
- Security
- General lack of knowledge about the technology

Building a Project Specification: Initial Considerations

- Identify design goals for project
- Evaluate technology options for controls
  - Is wireless mesh a good fit from an economic perspective?
  - a technology perspective?

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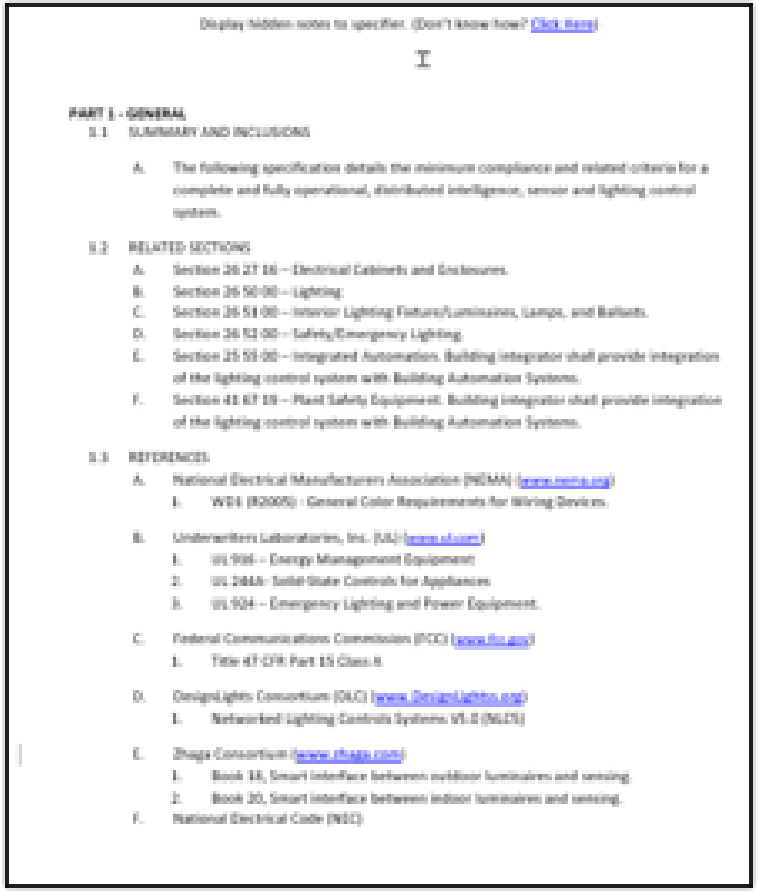
Building a Project Specification: ‘Making the sausage’

- Identify project-specific concerns and ‘must-haves’ before deciding on a specific control solution
- Any specific concerns?
- Obtain references from comparable projects for the solution finalists
- Draft project specifications as a project team effort



Display hidden notes to specifier. (Don't know how? Click here)

I

PART 1 - GENERAL

1.1 SUMMARY AND INCLUSIONS

A. The following specification details the minimum compliance and related criteria for a complete and fully operational, distributed intelligence, sensor and lighting control system.

1.2 RELATED SECTIONS

A. Section 26 27 16 – Electrical Cabinets and Enclosures.
B. Section 26 50 00 – Lighting.
C. Section 26 51 00 – Interior Lighting Fixture/Luminaires, Lamps, and Ballasts.
D. Section 26 52 00 – Safety/Emergency Lighting.
E. Section 25 55 00 – Integrated Automation. Building integrator shall provide integration of the lighting control system with Building Automation Systems.
F. Section 41 67 19 – Plant Safety Equipment. Building integrator shall provide integration of the lighting control system with Building Automation Systems.

1.3 REFERENCES

A. National Electrical Manufacturers Association (NEMA) (www.nema.org)
1. WD1 (R2005) - General Color Requirements for Wiring Devices.

B. Underwriters Laboratories, Inc. (UL) (www.ul.com)
1. UL 916 – Energy Management Equipment
2. UL 244A- Solid-State Controls for Appliances
3. UL 924 – Emergency Lighting and Power Equipment.

C. Federal Communications Commission (FCC) (www.fcc.gov)
1. Title 47 CFR Part 15 Class A

D. DesignLights Consortium (DLC) (www.DesignLights.org)
1. Networked Lighting Controls Systems V1.0 (NLCS)

E. Zhaga Consortium (www.zhaga.com)
1. Book 18, Smart interface between outdoor luminaires and sensing
2. Book 20, Smart interface between indoor luminaires and sensing.

F. National Electrical Code (NEC)

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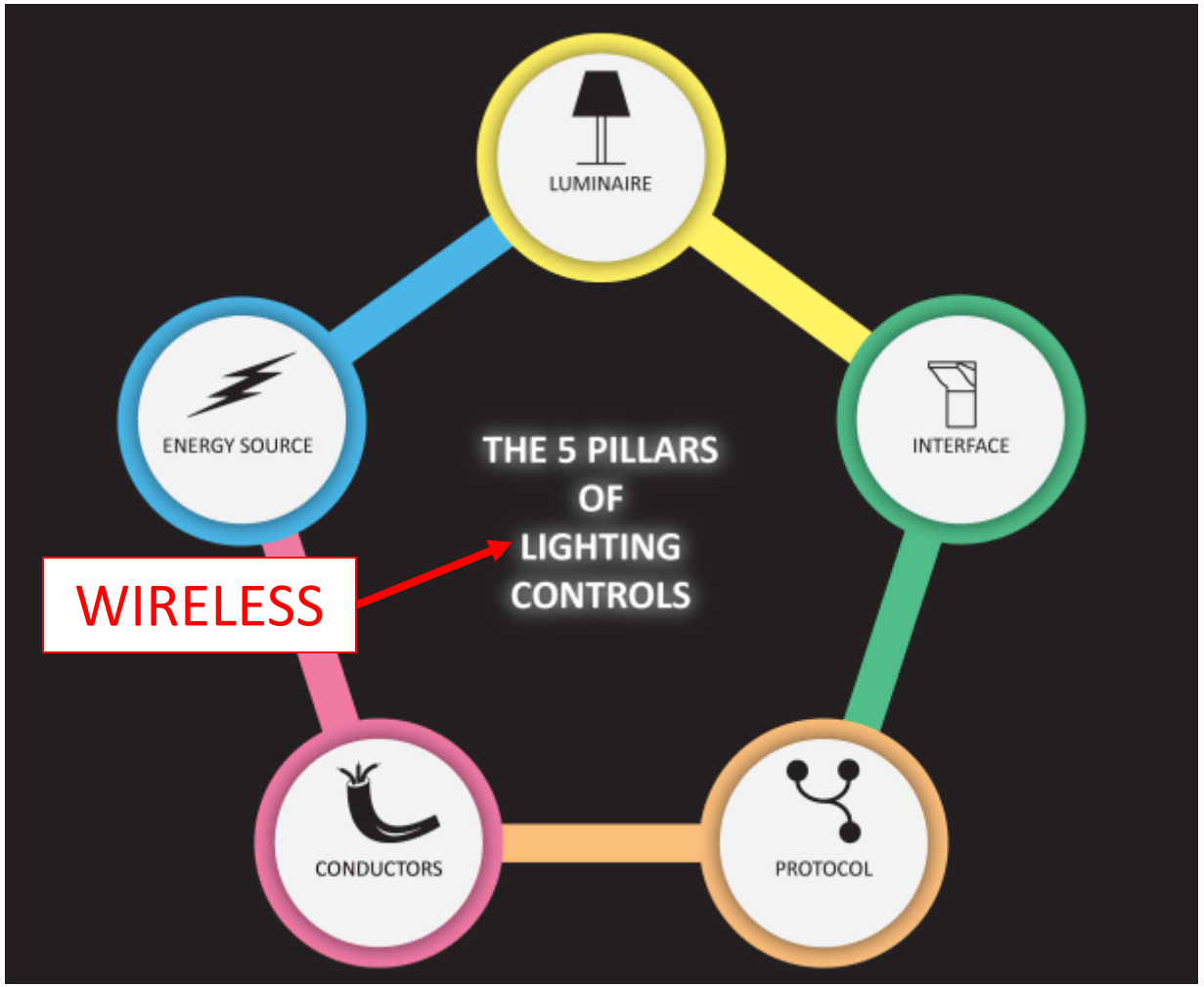

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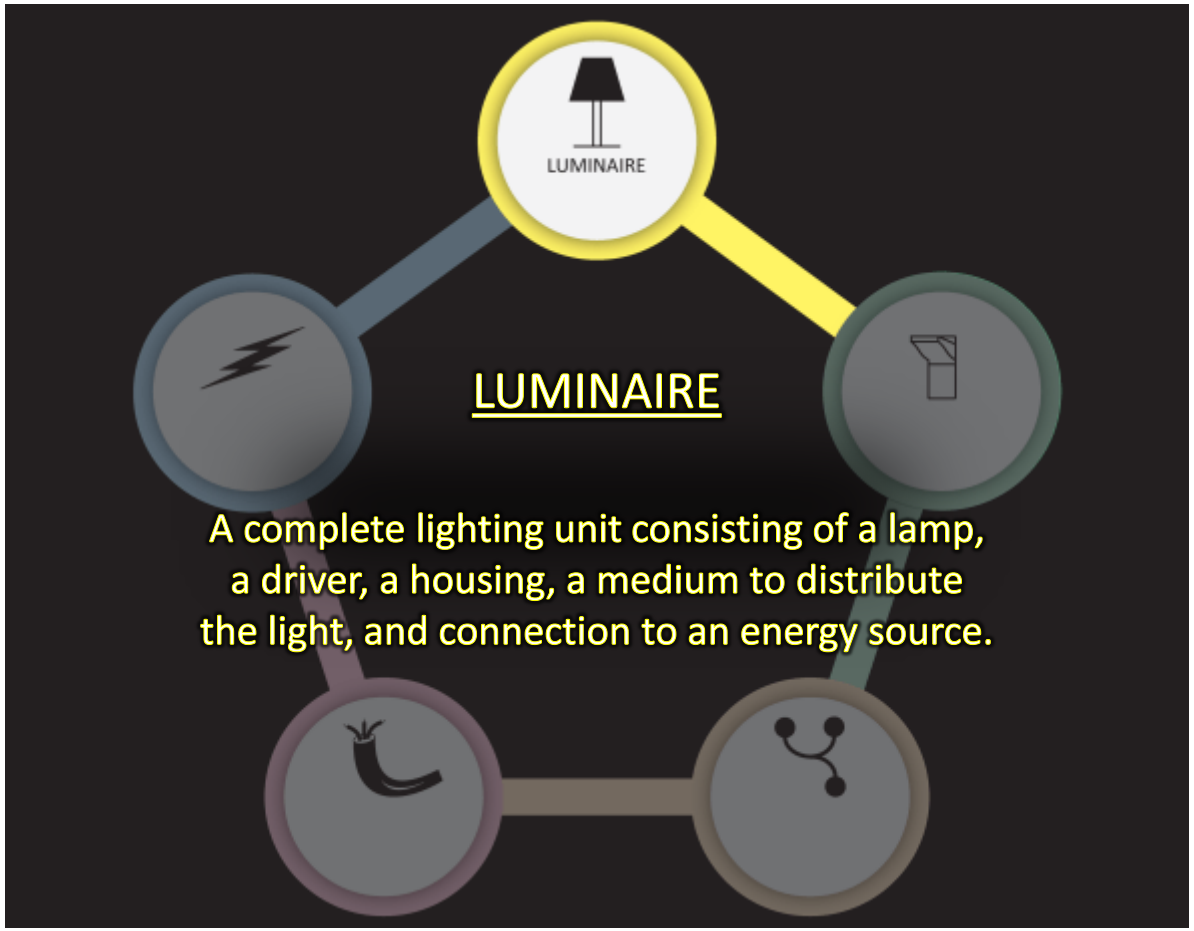

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LUMINAIRE

EXAMPLES

LED Troffer

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EXAMPLES

Canopy Light

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EXAMPLES

Pole Light

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Control Intent Narrative

1. Integral and remote occupancy and daylight sensors for individual light fixture control:
   A. Each light fixture has its own zone for independent control
   B. Each light fixture has its own occupancy sensor
   C. Each light fixture in daylight zones has its own daylight sensor
2. Wireless lighting controls with web accessible user interface to do the following:
   A. Identify lighting zones and status
   B. Toggle and dim lighting zones
   C. Collect occupancy data and space utilization

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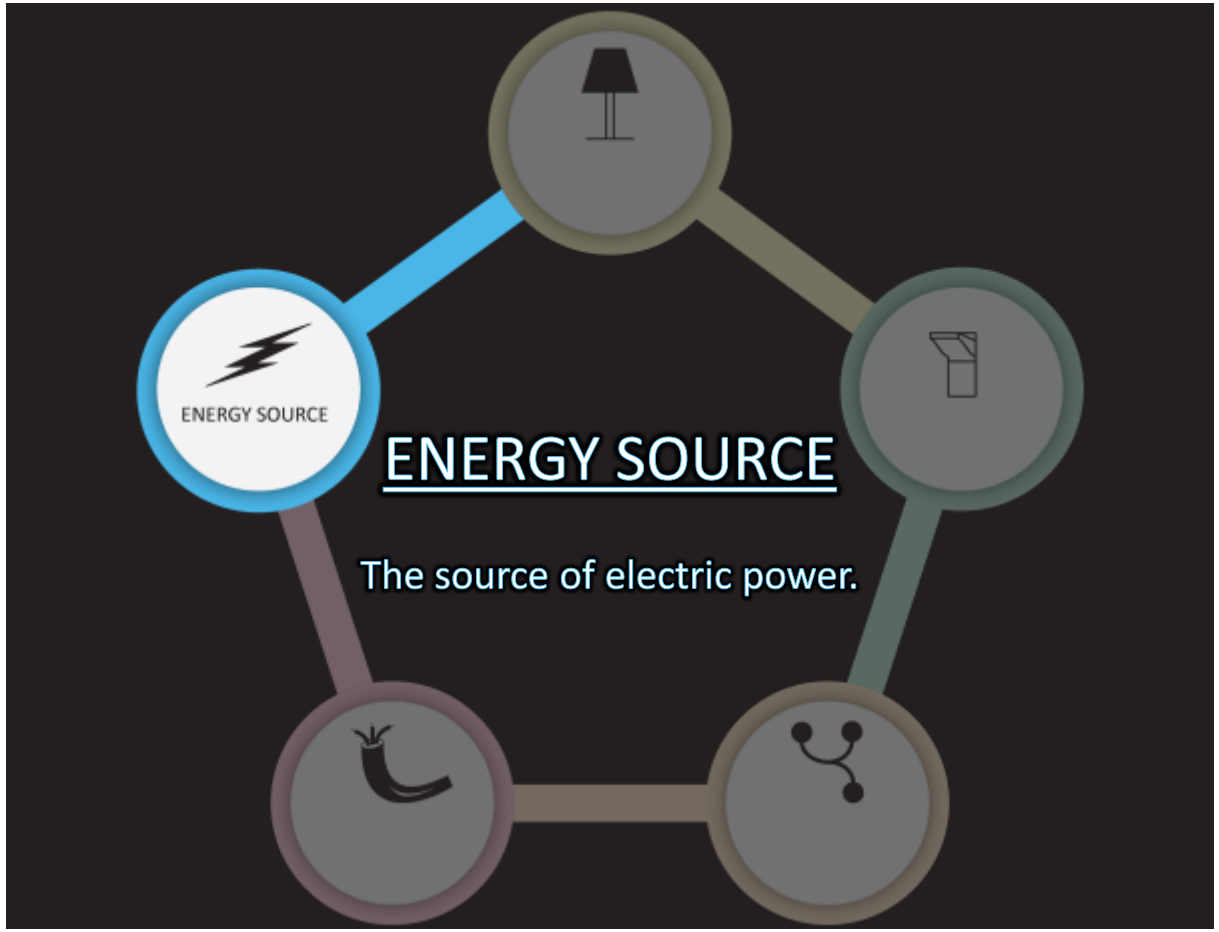
Light Fixture Schedule

TYPE	LOCATION	INTENT	POWER SUPPLY	CONTROLS PROTOCOL	CONTROLS INTERFACE
L1	VARIOUS	Recessed downlight for general illumination of various spaces.	Integral Dimmable Driver	0-10V	[Brand X] Remote Occupancy Sensor
L2	GARAGE	Canopy light for general garage illumination.	Integral Dimmable Driver	0-10V	[Brand X] Integral Occupancy and Daylight Sensor
L3	BOH SPACES	Industrial linear for BOH space illumination.	Integral Non-Dim Driver	(INTEGRAL) SWITCHED	[Brand X] Integral Occupancy Sensor
L4	ENTRY	Recessed wall wash for entry space	Remote Dimmable Driver	0-10V	[Brand X] Remote Occupancy Sensor
L5	PARKING LOT	Pole light for general parking lot illumination.	Integral Dimmable Driver	0-10V	[Brand X] Integral Occupancy and Daylight Sensor


ENERGY SOURCE
ENERGY SOURCE
The source of electric power.

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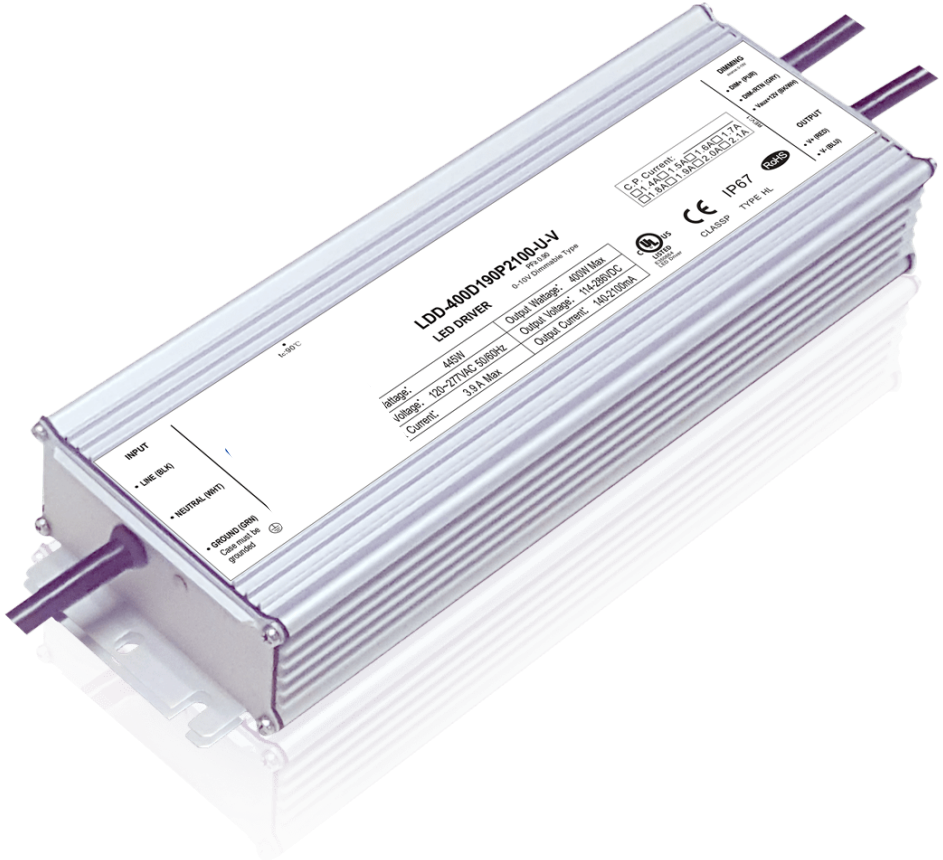
ENERGY SOURCE

EXAMPLES

Driver



ENERGY SOURCE

EXAMPLES

Power Pack

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DOCUMENTATION

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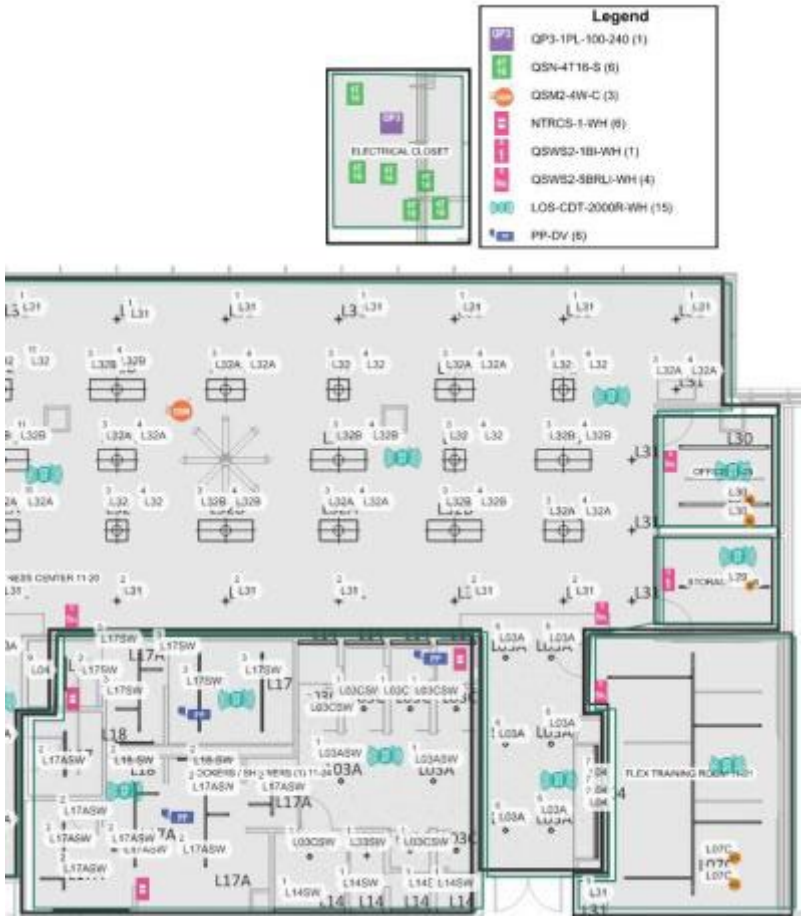
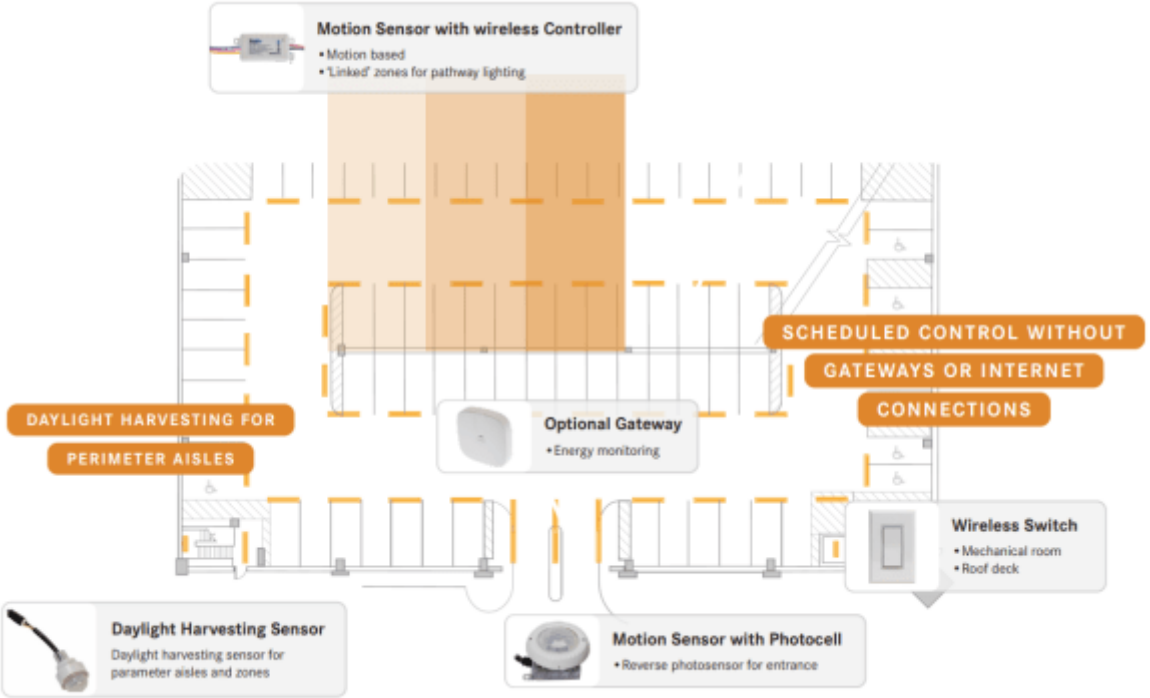
ENERGY SOURCE

DOCUMENTATION

Device Layout and Schedule





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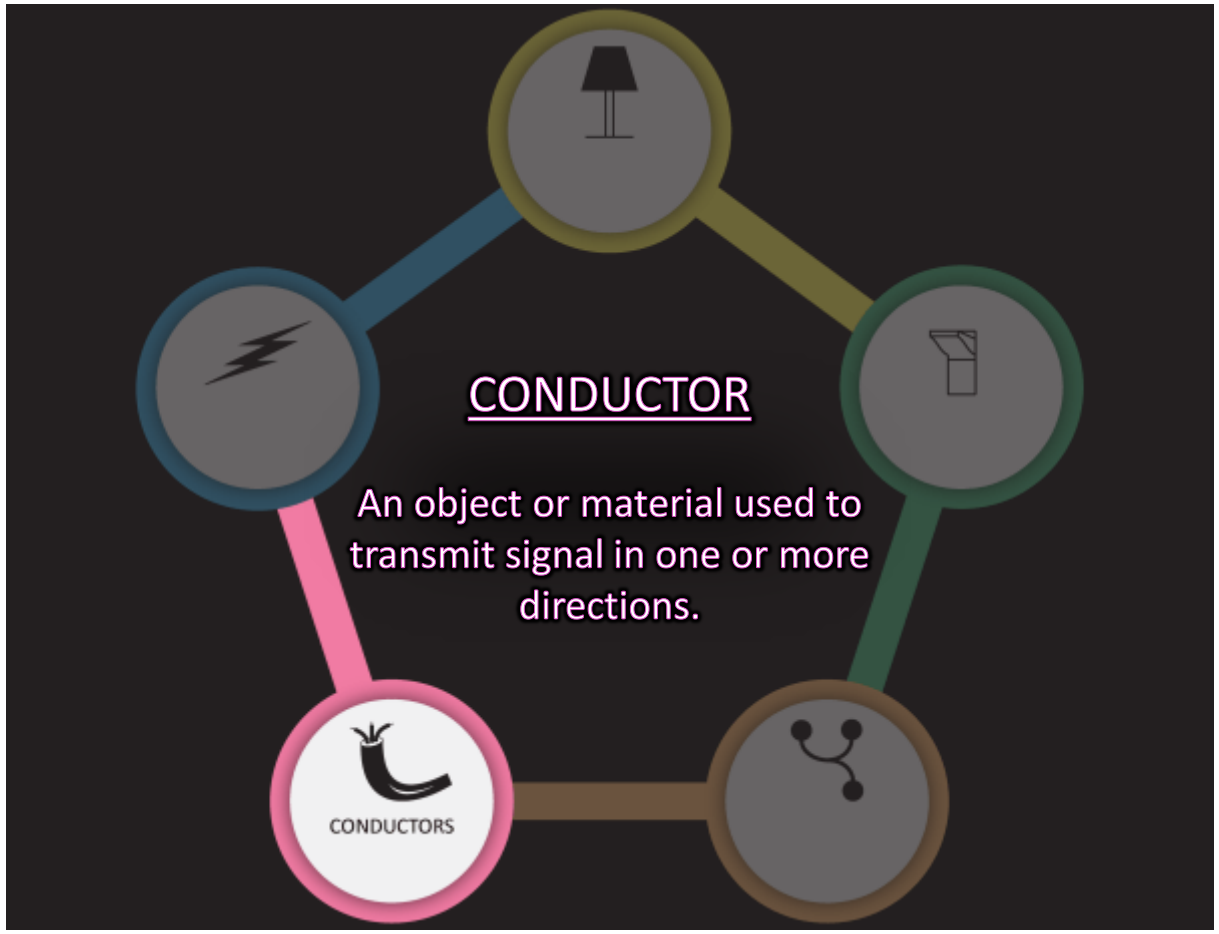
CONDUCTOR
An object or material used to transmit signal in one or more directions.
CONDUCTORS

CONDUCTORS

EXAMPLES

Wireless Transceiver

Sends and Receives data

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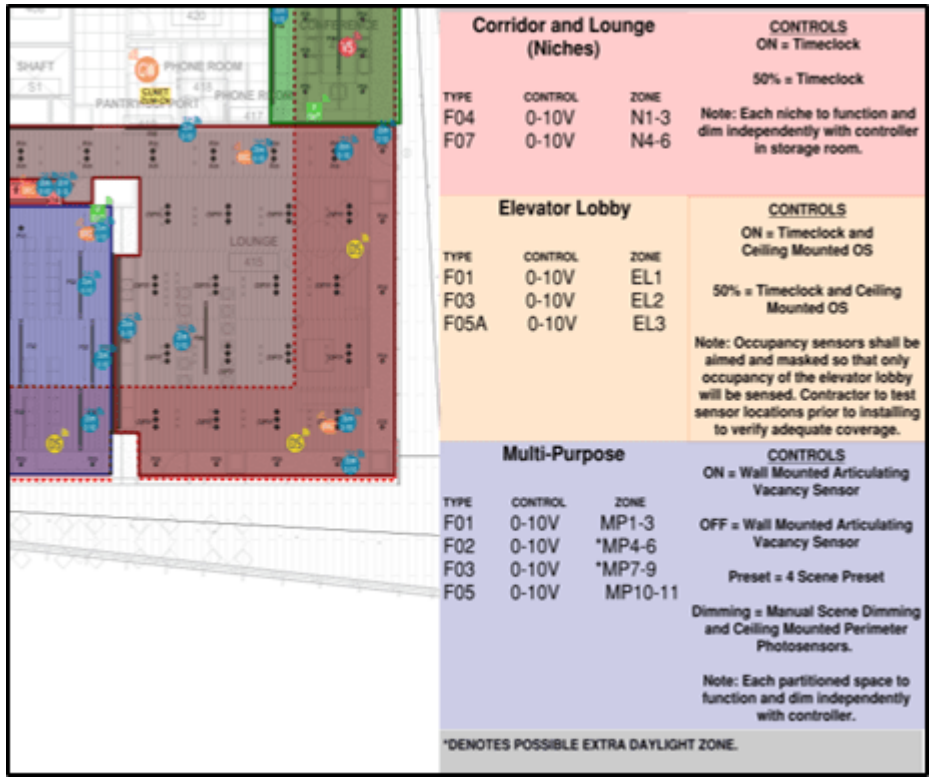
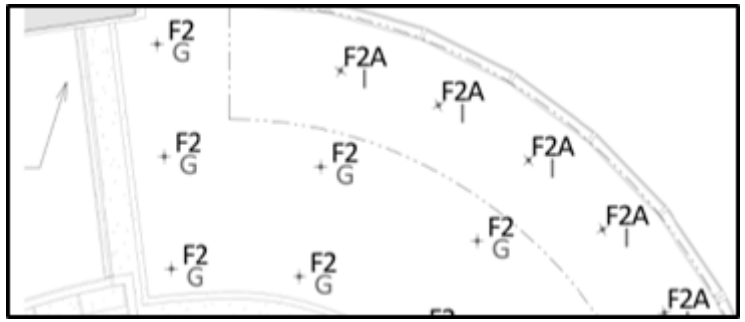
Zoning Diagram





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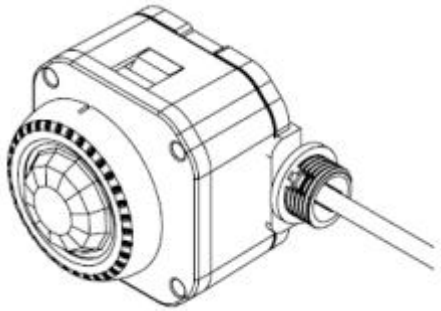
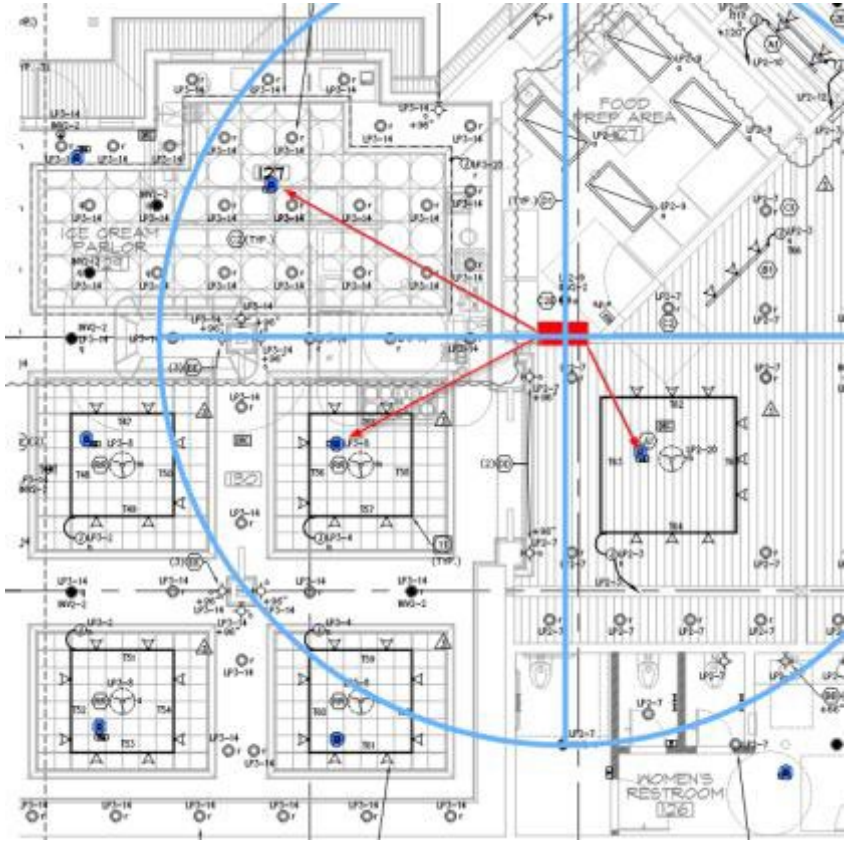
Signal Range Diagram

Max Bluetooth Range[1]
100ft (30.4m)





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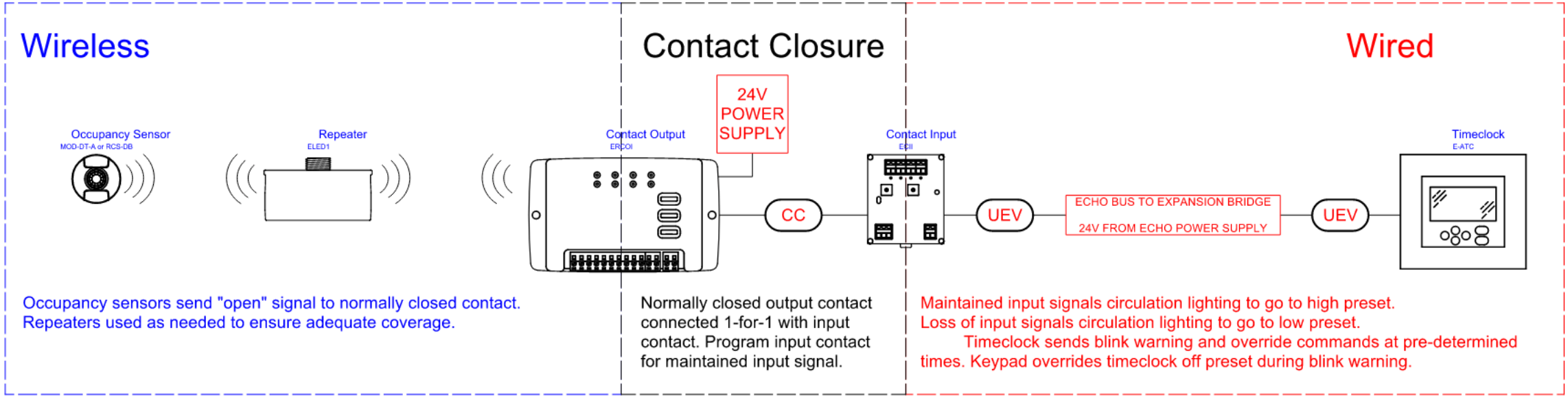
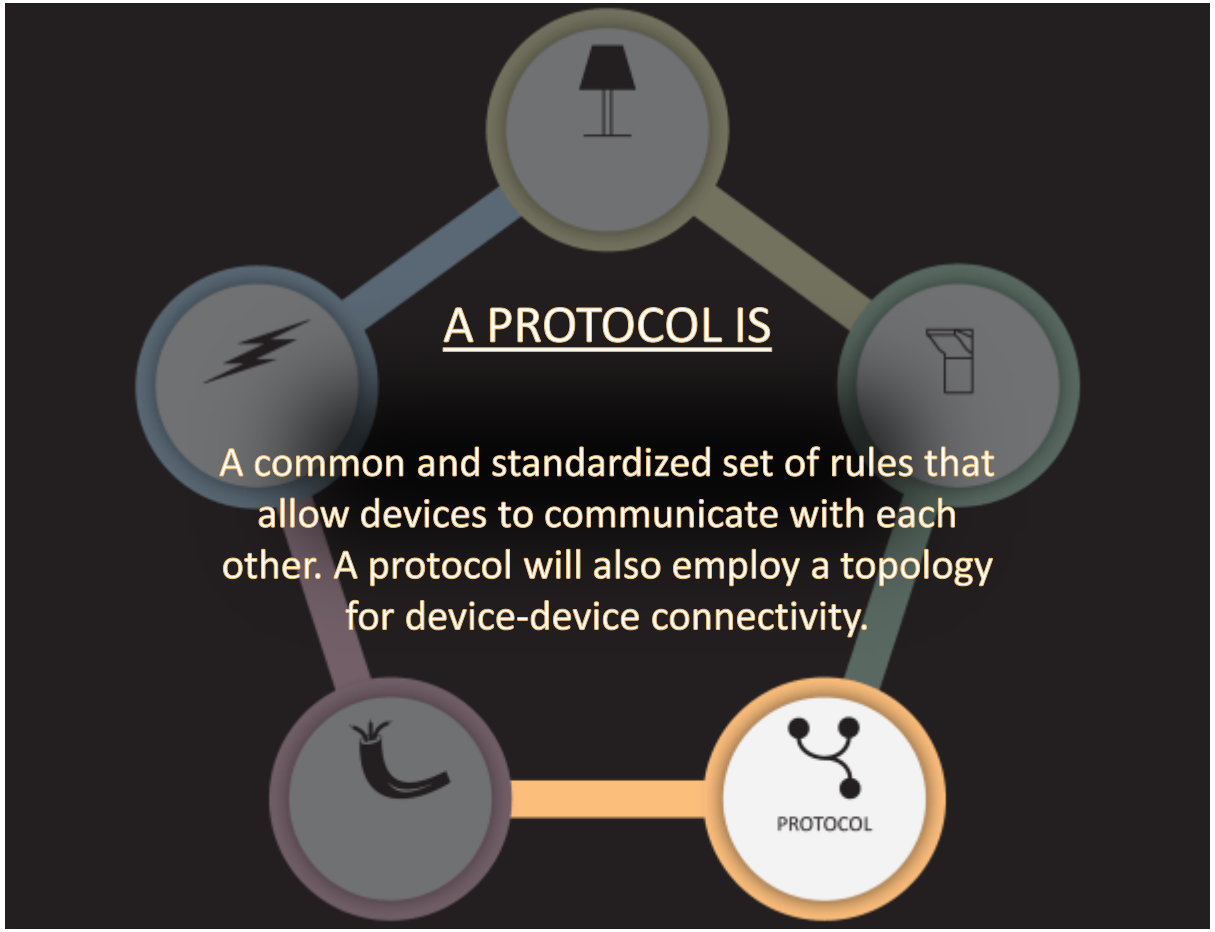
One-line Diagram



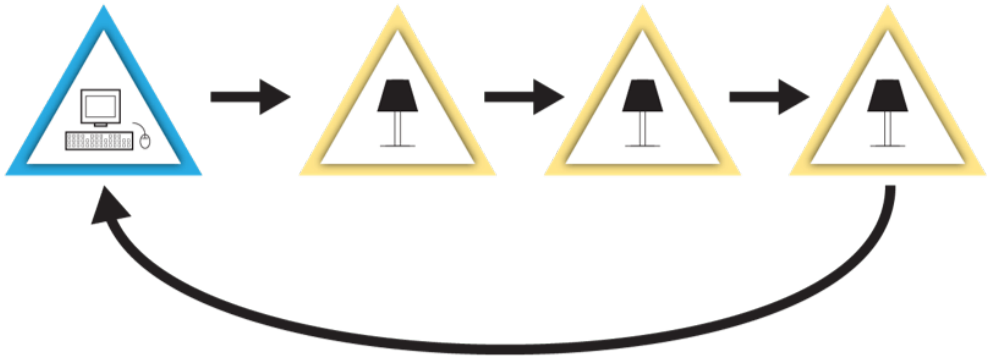

A PROTOCOL IS
A common and standardized set of rules that allow devices to communicate with each other. A protocol will also employ a topology for device-device connectivity.
PROTOCOL

PROTOCOL

EXAMPLES

0-10V

- Uses two low voltage conductors
- Hardwired terminations
- 10V = Full
- <1V = Lowest output
- Requires a relay to turn off
- Driver provides voltage, dimmer reduces voltage

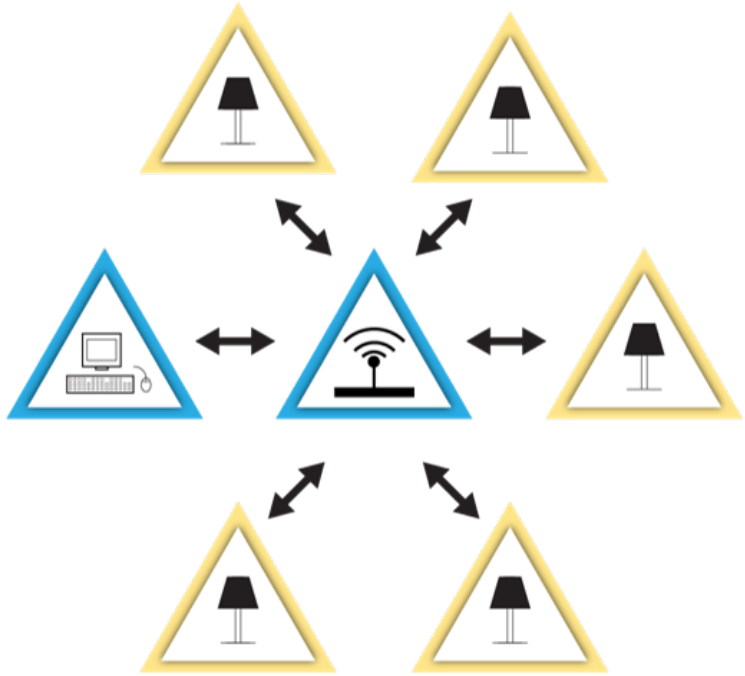


PROTOCOL

EXAMPLES

Wi-Fi

- Uses wireless gateways and transceivers
- Uses CAT5 between local devices
- Gateways often need line voltage or transformer for power
- Commands are given from a source and distributed by gateways
- Can dim to OFF without a relay

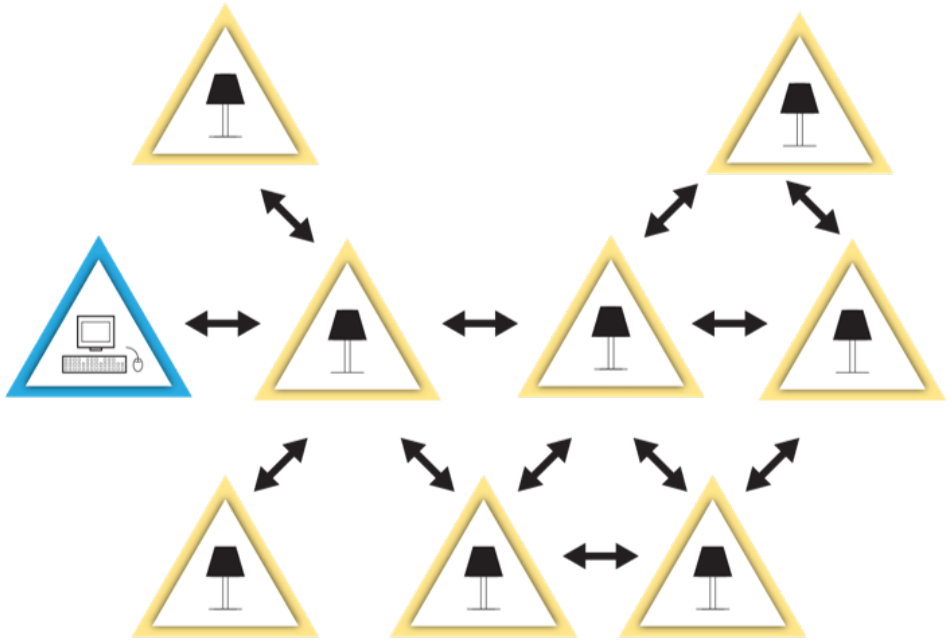


PROTOCOL

EXAMPLES

Bluetooth Mesh

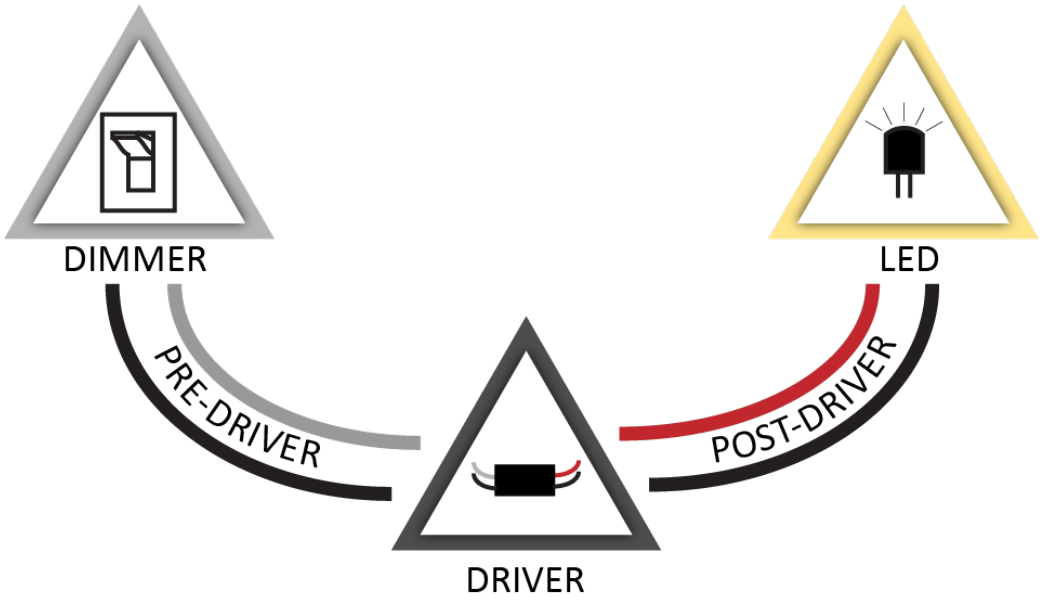
- Radio frequency wireless signal
- Uses wireless transceivers
- IP addresses for all devices
- Does not require a gateway
- Commands are given from a source and repeated
- Can dim to OFF without a relay



PROTOCOL

PRE-DRIVER VS. POST-DRIVER

- Pre-driver is between the energy source and the driver
- Post-driver is between the driver and the LED



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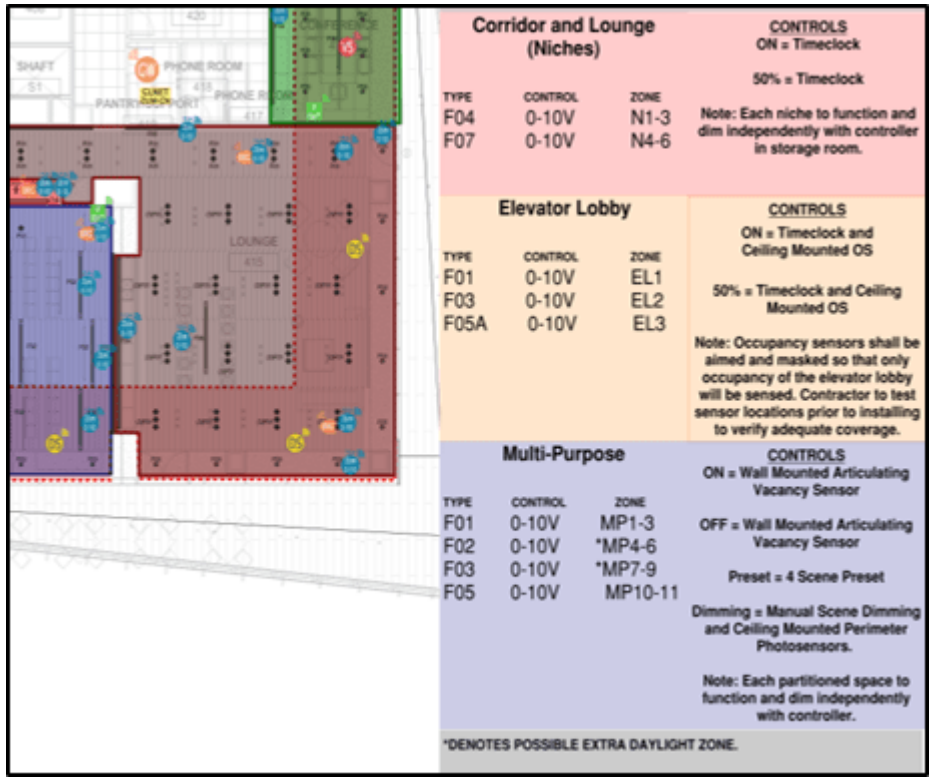
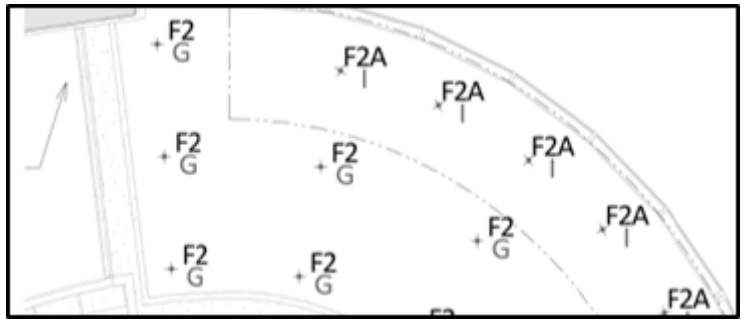
PROTOCOL

DOCUMENTATION

Zoning Diagram





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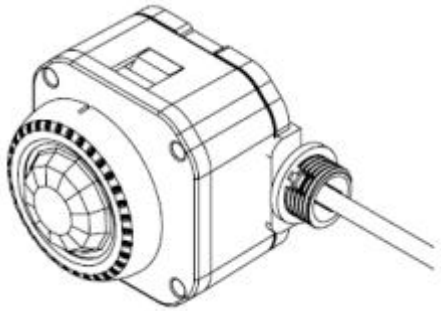

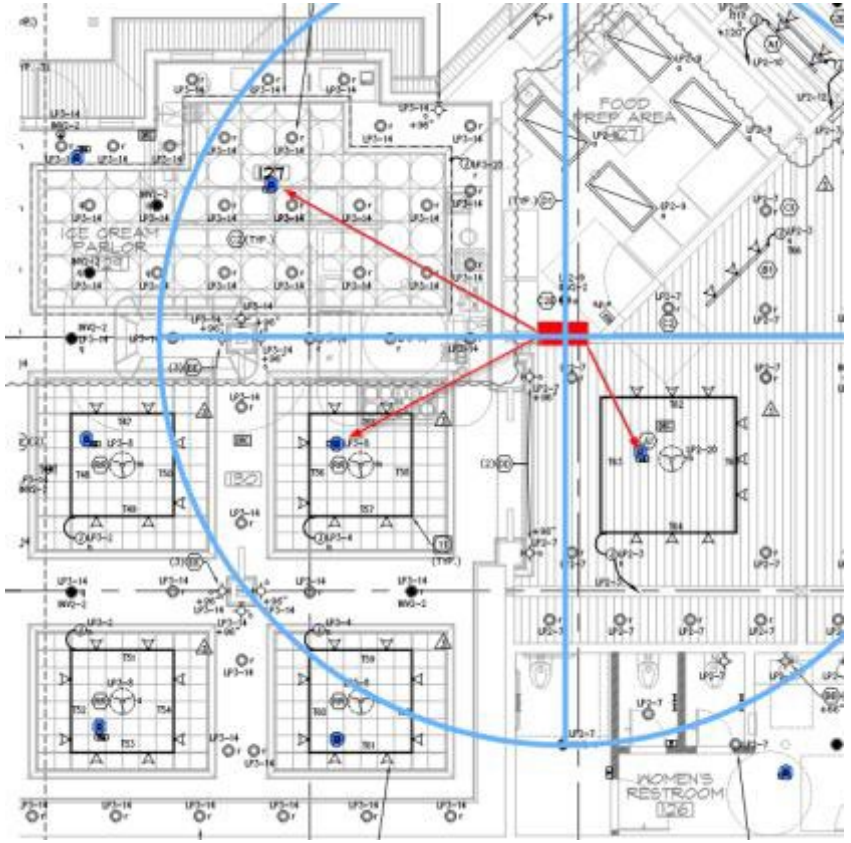

PROTOCOL

DOCUMENTATION

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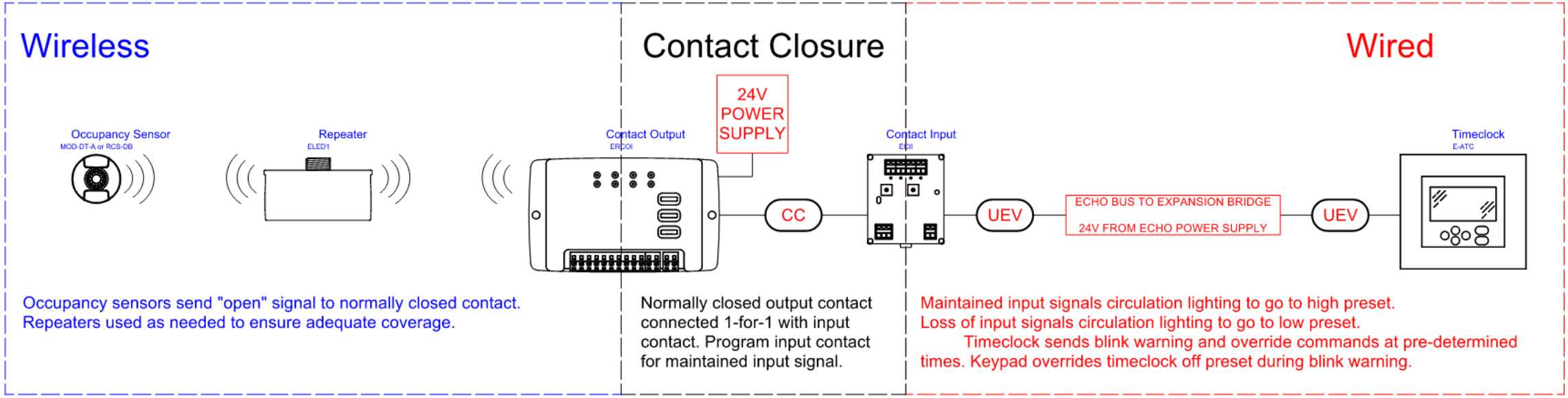

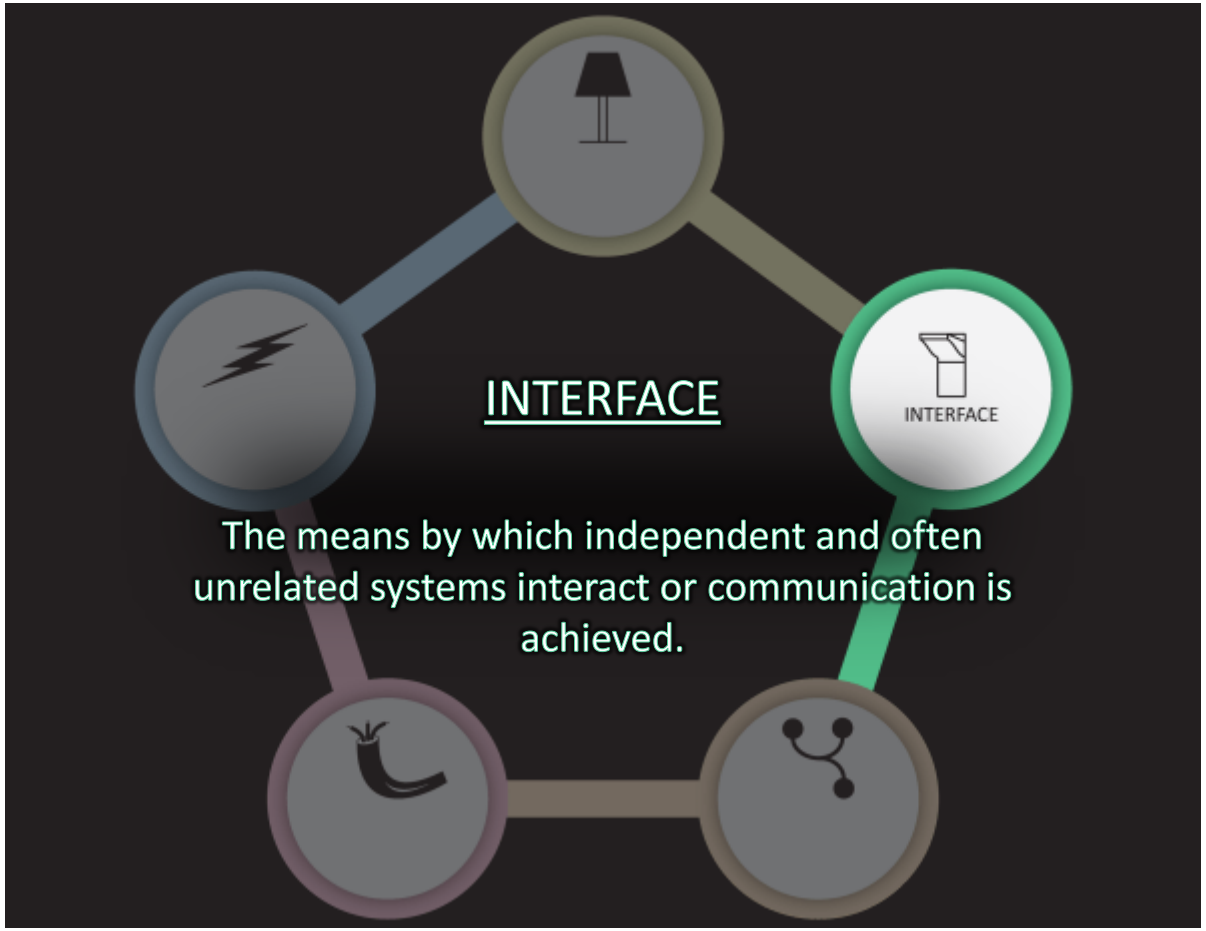
INTERFACE
INTERFACE
The means by which independent and often unrelated systems interact or communication is achieved.

INTERFACE

EXAMPLES

Wireless Router

Image Credit: https://freesvg.org/wireless-router-22770

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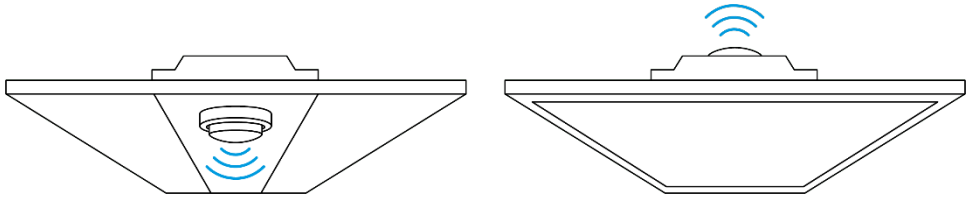
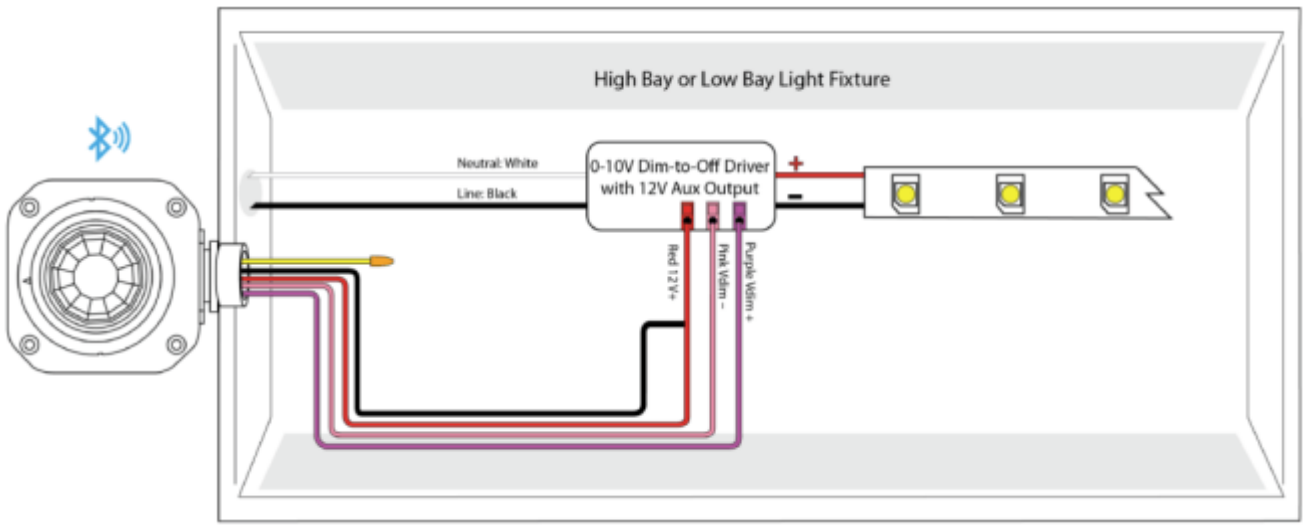
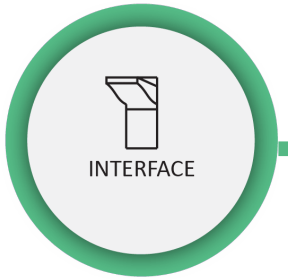
INTERFACE

EXAMPLES

- Integral Sensor







DOCUMENTATION

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INTERFACE

DOCUMENTATION

Sequence of Operations

	ON/OFF Control							Light Level Control		Additional Control		Exterior	
Application	**Local (i.e. Switch) Control**	**Manual ON**	**Partial Automatic ON**	**Full Automatic ON**	**Automatic Partial OFF via Occupancy Sensor**	**Automatic Full OFF via Occupancy Sensor**	**Scheduled Shut-off & OFF during non-business hours**	**Bi-level Lighting Control**	**Automatic Daylight Responsive Controls for Side-lighting and Top-lighting**	**Parking Garage Lighting Power Set Back**	**Automatic Receptacle (i.e. Plug Load control)**	**Exterior Lighting Controls**	
Code Detail	There shall be one or more readily accessible manual lighting controls in the space that controls all lighting in the space. Note: Remote locations permitted for reasons of safety or security.	None of the lighting in the space shall be automatically turned on.	The general lighting shall be allowed to be turned on automatically to 50% of the lighting power.	Automatically controlled spaces are allowed to turn on to full.	The general lighting power shall be automatically reduced by at least 50% within 20 minutes of all occupants leaving the space. Note: Full Off also complies.	All lighting shall be automatically shut off within 20 minutes of all occupants leaving the space.	All lighting shall be automatically shut off during periods when the space is scheduled to be unoccupied using a time-of-day operated control. Note: A signal from another automatic control device complies.	Controlled lighting shall have at least one control step between 30% and 70%, or continuous dimming, in addition to full on and full off.	If the general lighting load is ≥150W in the primary sidelighted or toplighted areas, or ≥150W in the primary & secondary sidelighted areas, the general lighting in these areas shall be controlled by multi-step or continuous dimming photocontrols.	Lighting power of each luminaire shall be automatically reduced by a minimum of 50% when there is no activity detected within a lighting zone for 10 minutes.	50% of all receptacles and 25% of branch circuit feeders installed for modular furniture, shall be automatically turned off by an occupant sensor within 20 minutes of all occupants leaving the space. Note: A time-of-day schedule or a signal from another automatic control device complies.	9.4.1.4[a] OFF control 9.4.1.4[b] Daylight Shutoff 9.4.1.4[c] Scheduled OFF control	9.4.1.4[d] Scheduled light reduction control 9.4.1.4[e] Occupancy sensing light reduction control
Code Address / Space Type	9.4.1.1[a]	9.4.1.1[b]	9.4.1.1[c]	9.4.1.1	9.4.1.1[g]	9.4.1.1[h]	9.4.1.1[i], 9.4.1.1[j]	9.4.1.1[d]	9.4.1.1[e], 9.4.1.1[f]	9.4.1.2[b]	8.4.2	9.4.1.4[a,b,c]	9.4.1.4[d,e]
Enclosed Office, Copy / Print	■	■ OR	■	—	—	■	—	■	■	—	■	—	—
Open Office Plan	■	■ OR	■	■	—	■ OR	■	■	■	—	■	—	—
Conference, Meeting, Multi-purpose Room	■	■ OR	■	—	—	■	—	■	■	—	■	—	—
Classroom, Lecture Hall, Training Room	■	■ OR	■	—	—	■	—	■	■	—	■	—	—
Lobby	■	—	—	■	■	■ OR	■	■	■	—	—	—	—
Corridor, Egress	■	—	—	■	■	■ OR	■	■	■	—	—	—	—
Restroom	■	—	—	■	—	■	—	■	■	—	—	—	—
Non-exit Stairwell	■	—	—	■	■	■ OR	■	■	■	—	—	—	—
Gymnasium, Fitness Center	■	■ OR	■	—	—	■ OR	■	■	■	—	—	—	—
Warehouse, Storage Area	■	■ OR	■	—	■	■ OR	■	■	■	—	—	—	—
Parking Area (Garage Interior)	—	—	—	—	—	—	■	—	—	■	—	—	—
Exterior Lighting	—	—	—	—	—	—	—	—	—	—	—	■	■

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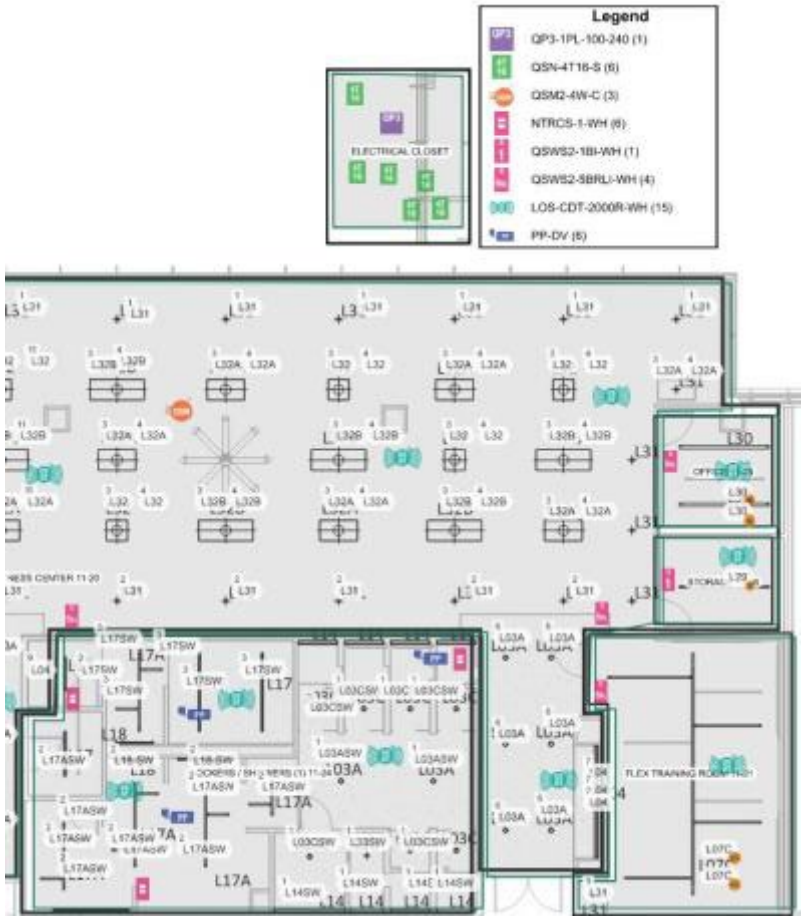
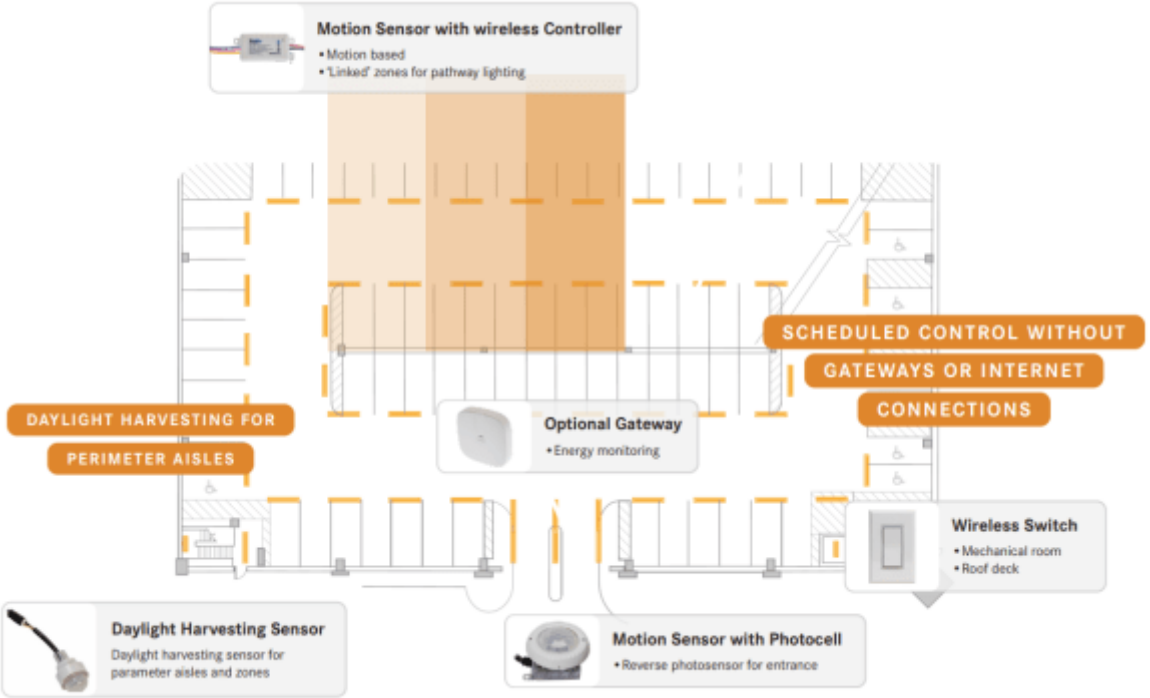
Device Layout and Schedule





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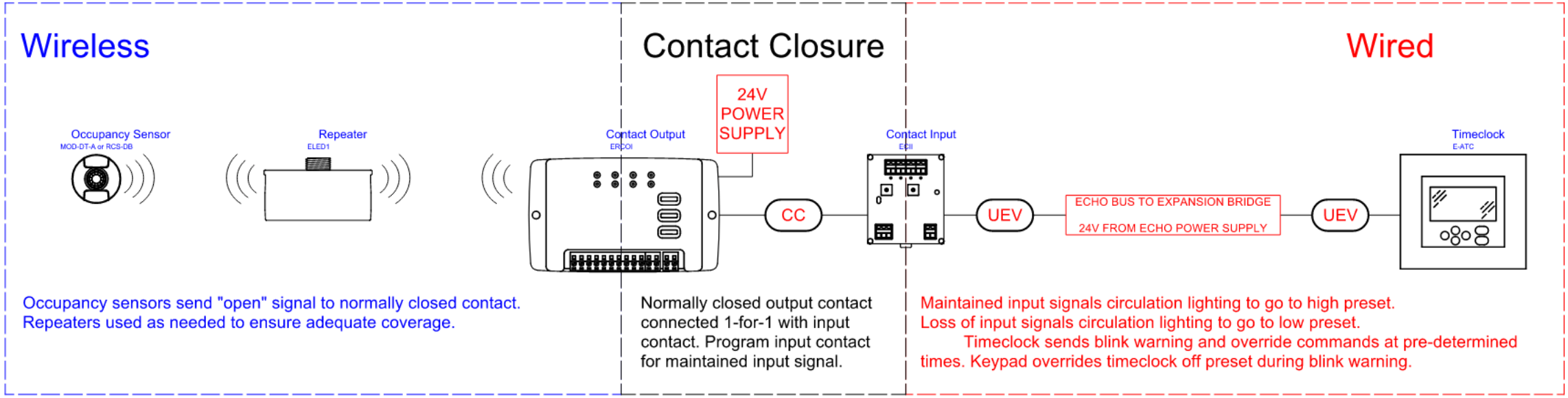
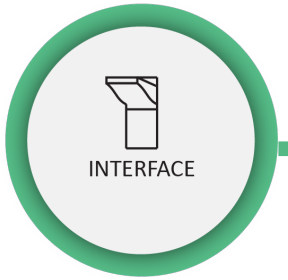
One-line and Wiring Diagram





DOCUMENTATION

The "Specs"

PART 2 PRODUCTS

2.01 0-10V Dimming Controller

A. General
   1. Basis of Design:
   2. Convert DMX512 signal to analogue DC.
   3. Convert DMX512 signal to relay control.
   4. Variants:
      a. Variant 1: Eight relays.
      b. Variant 2: Sixteen relays.

B. Mechanical
   1. Housing:
      a. Type 1 NEMA enclosure.
      b. Black powder coat 18-gauge steel.
      c. Four 3/4 inch, 1-inch, 1.25-inch line voltage conduit knockouts.
      d. Two 3/4-inch low voltage conduit knockouts.
      e. Front hinged cover.
      f. Steel internal dead front hinged door and high voltage barrier.
   2. Mounting: Four round keyholes.
   3. Ports:
      a. Two 3-pin male headers for DMX512.
      b. One 14-pin double row male header for power in.
      c. Four 10-pin double row male headers for relay output and input.
      d. One 3-pin male header for contact closure.

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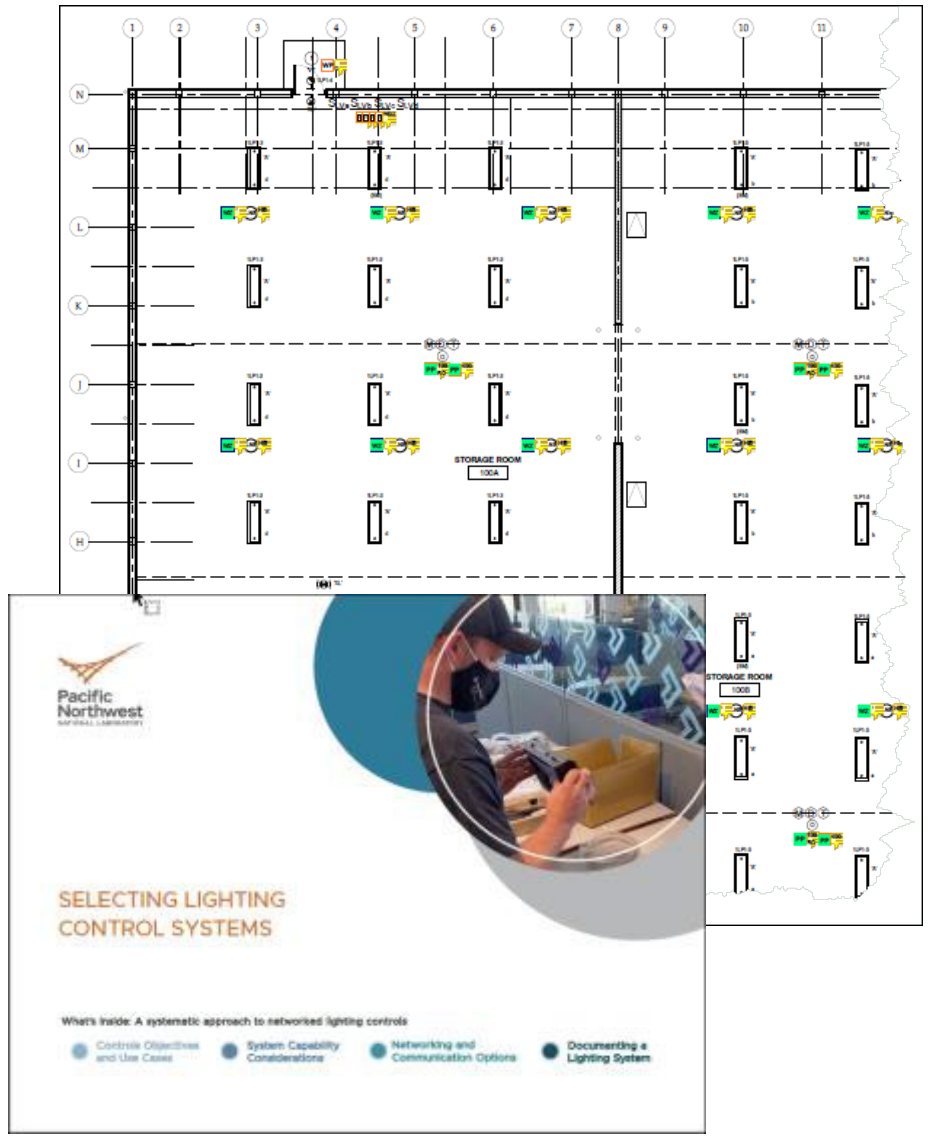
Building a Project Specification: Tips and Tricks

- Use manufacturer guideform specifications
- Most manufacturers will assist with drawings, wiring diagrams
- Refer to previous similar projects to leverage prior work
- New guide from PNNL



CONTINUING EDUCATION AIA

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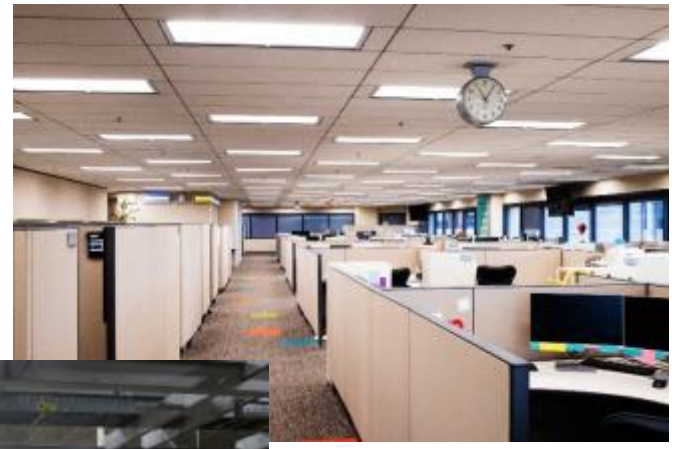
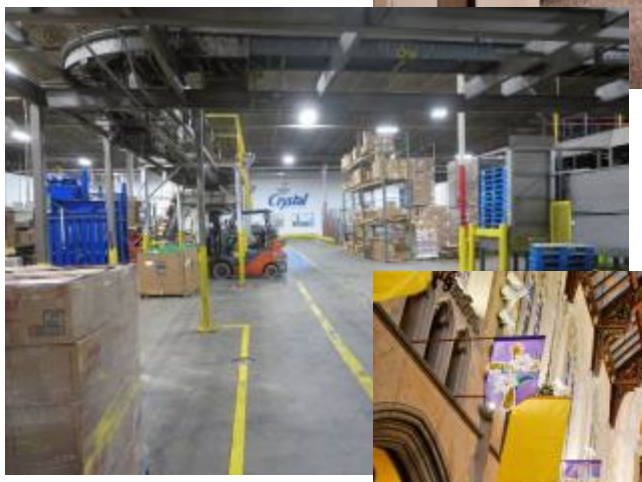
Applications

- Ideal for retrofits
  - Reduces materials and installation costs by reducing need for wiring
  - Easy to scale over time
  - Flexible for challenging installation environments (concrete construction, historically significant structures)



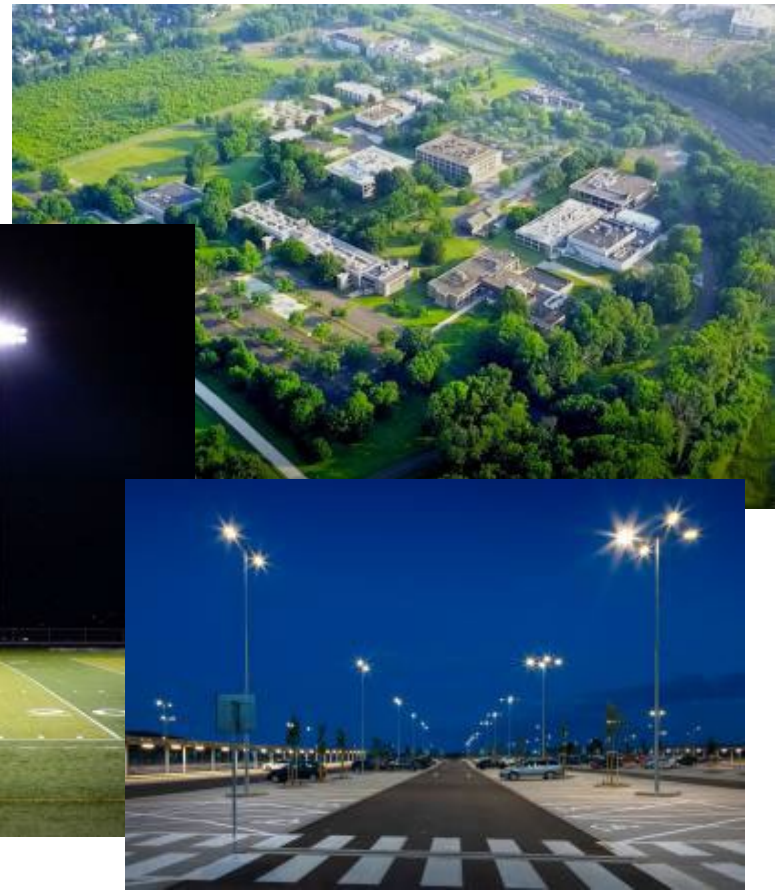


Applications

- Great fit for new construction
  - Scalability and ease of adjustability for commercial office space
  - Dynamic scene control for hospitality and retail
  - Ease of use for education

Applications

- Robust enough for outdoor projects
  - Area lighting
  - Sports fields
  - Parking lots
  - Parking garages



Learnings from the Field

- No longer ‘early adoption’ stage . . . millions of square feet of installed wireless mesh projects in operation > 2 years

- Many manufacturers have published case studies on these projects that can provide insights into best practices and challenges encountered

Image credit: Packback.co

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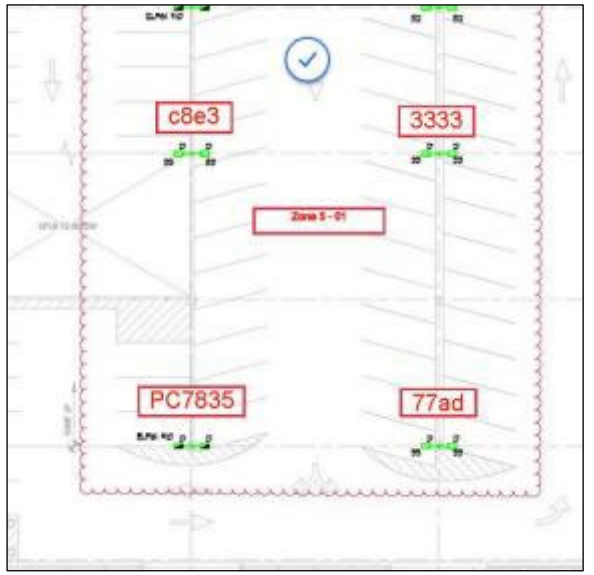
Learnings from the Field: Range Anxiety

- Unanticipated environmental aspects can impact range
  - tree canopies in outdoor applications
  - wind in parking structures
- If these are possibilities, spec in more nodes to boost range

Learnings from the Field: Zone control or LLLC?

- It doesn't have to be an 'either/or' proposition unless project goals specifically drive to one outcome
- Consider using both for different project spaces
- Consider using zone control as a 'starting point' since one of the benefits of wireless mesh is ease of future scalability



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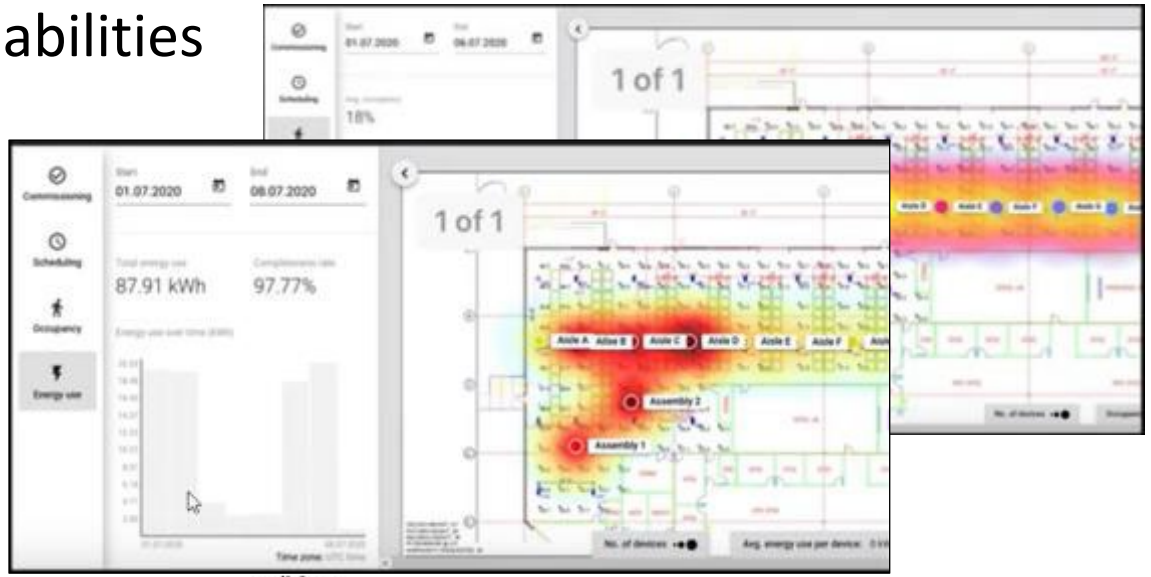
Learnings from the Field: Gateway or No Gateway?

- Let the project goals drive this decision
- Many wireless mesh systems don't require gateways for basic functionality but do for advanced capabilities
- How important are:
  - Remote access
  - Data on occupancy patterns
  - Data on energy usage



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Additional Resources

- Lighting Controls Association
  - Education Express
  - LCA TV
- Bluetooth mesh or Bluetooth NLC
- Zigbee
- IES eLearning Portal
- Pacific Northwest National Lab (PNNL)
- Lighting Controls Podcast

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This concludes The American Institute of Architects Continuing Education Systems Course

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