Luminaire Level Lighting Controls
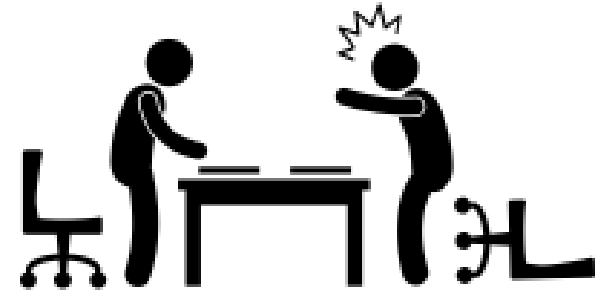
Catching on?   OR   Catching Hell?

And other highlights from
2021 lighting controls market research

Lovingly hand crafted for the IES Portland Chapter
and presented by John Arthur Wilson on February 16th, 2022

Fernhill Shopworks

What are we talking about today?

- **What Drives Specification?**
- **Areas of Common Confusion**
- **Dominant Trends in Wireless**
- **New Resources**

Highlights from two projects that recently completed In support of NEEA's LLLC initiative → neea (BETTERBRICKS *Powerful Energy Ideas. Delivered by NEEA.*)

1. **The Specifier Secret Journal**
   WASHINGTON STATE UNIVERSITY   id+cl   Fernhill Shopworks

2. **Wireless Market Trends**
   Fernhill Shopworks

# Introducing Fernhill Shopworks (Me)

Professional background

U.S. MARINE CORPS → W (University of Washington) → Peninsula Light Co. → Bonneville POWER ADMINISTRATION → lighting design lab

---

Implementing Programs

Contractors   Designers

Lighting

Developing Resources

Researchers / Policy wonks

Technology / Strategy Road mapping

I always thought I was a utility guy doing market engagement

But sometime around 2020, I began to wonder…
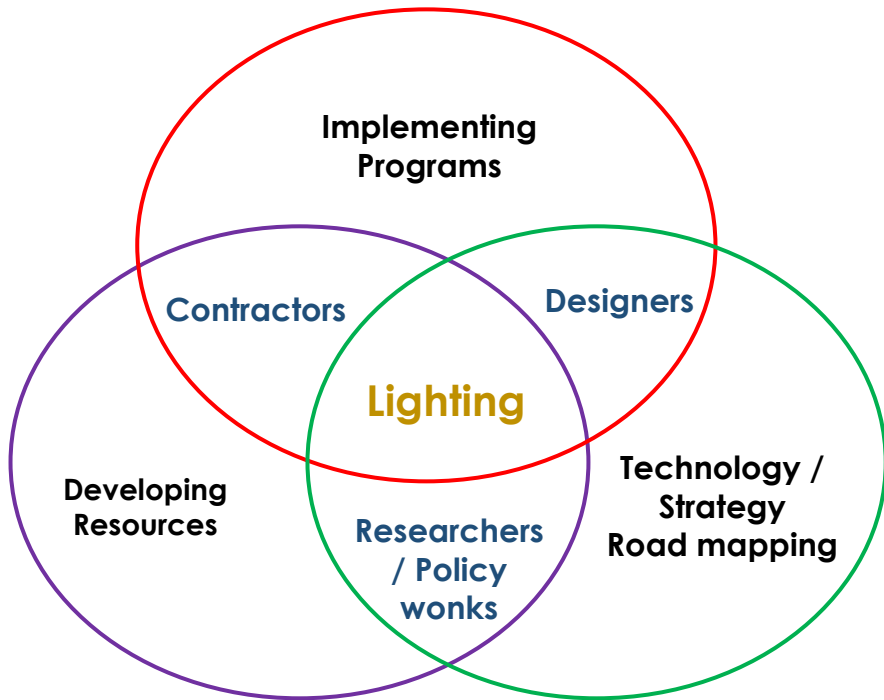
Is it possible that I'm actually a lighting guy?

Fernhill Shopworks

Founded in 2021

What does Fernhill Shopworks do?

Market Engagement & Analysis

- Technology trends
- User experience trends
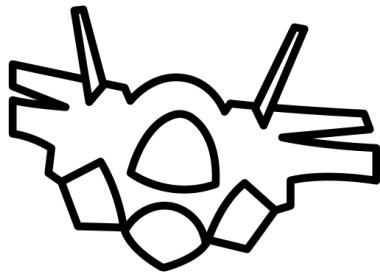- Marketing trends

Resource Development

- Curriculum
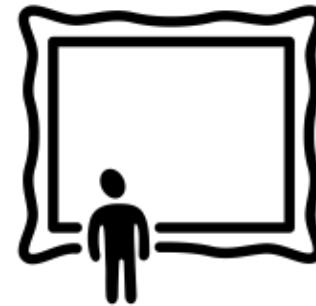- Brand analysis
- Learning Aides

For Who?

- The Lighting Industry
- EE and Utility Organizations

Unique Factors

Multi-functional

Creative approaches

Objective perspectives

Behold, a Miracle !!!

... for I have given unto you... LLLC

...and you can define it for yourselves

Today's Definition of LLLC

LLLC is a type of _networked_ lighting control system where every luminaire:

A. Has an **_integrated_** sensor for
- Occupancy / vacancy
- Daylight harvesting
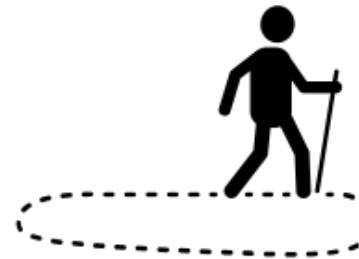
B. Is addressable

C. Has controls persistence

D. Is capable of
- High-end trim
- Continuous dimming
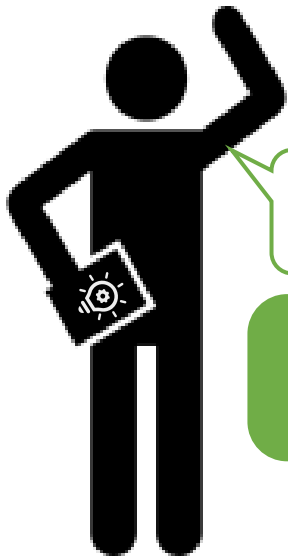
E. Is wired *or* wirelessly networked

With regards to LLLC, there are two common points of confusion…

- **Exactly *how* integrated?**
- **Exactly *how* networked?**

We'll circle back to these…

The LLLC Value Prop

Go tell it on the mountain

LLLC is better because - when you integrate *both*…

A load controller **&** a daylight + occupancy sensor

Into every single fixture

Good things start happening

To Everyone

TENANTS

DESIGNERS & ENGINEERS
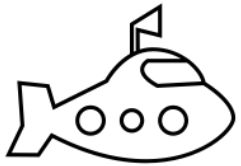
OWNERS
Investing in the system

CONTRACTORS

BUILDING OPERATORS

The 3 Value Pillars of LLLC

1. Will always meet and exceed code

2. Simple to specify, install, and configure

3. Enables IoT & connected buildings

Part 1

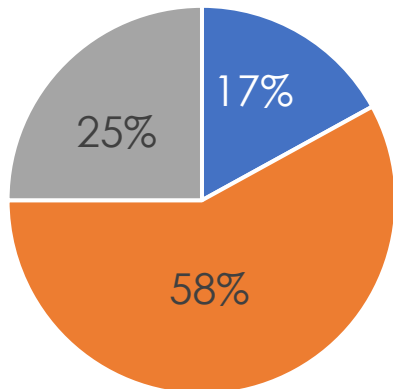## Highlights From the Specifier Journal Project

Participants & Responses

The Question
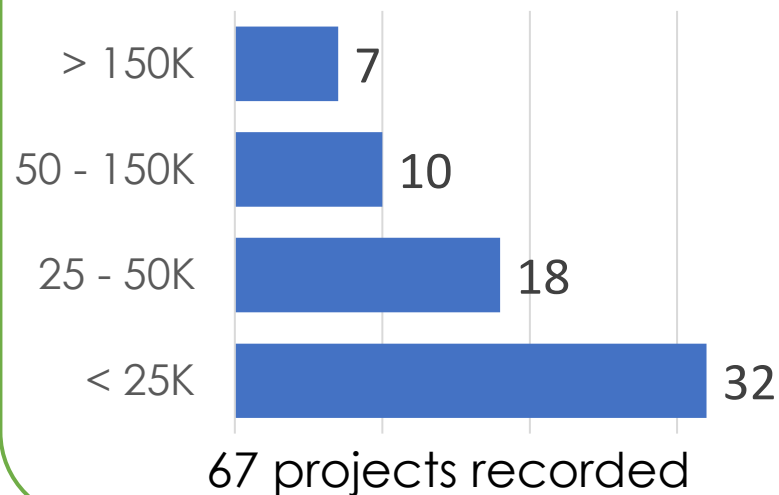What's driving specification of lighting controls?

- The research was qualitative
- Data shown here is not a statistical representation of the greater market

- 12 surveys
- 15 Interviews
- 67 project entries

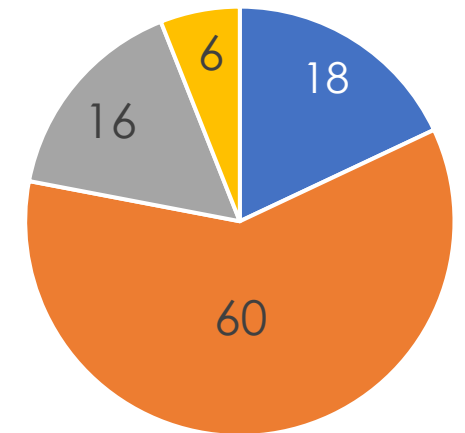### Participants identified as

- 17%
- 58%
- 25%

Legend:
- Design Build (Electrical contractor)
- Design-Bid (Lighting Designers & Engineers)
- Other Influencers (Rep Agencies)

Estimated size of controlled space (sq.ft.)

- > 150K — 7
- 50 - 150K — 10
- 25 - 50K — 18
- < 25K — 32

67 projects recorded

Project Type

- 18
- 60
- 16
- 6

Legend:
- Major Renovation
- Retrofit
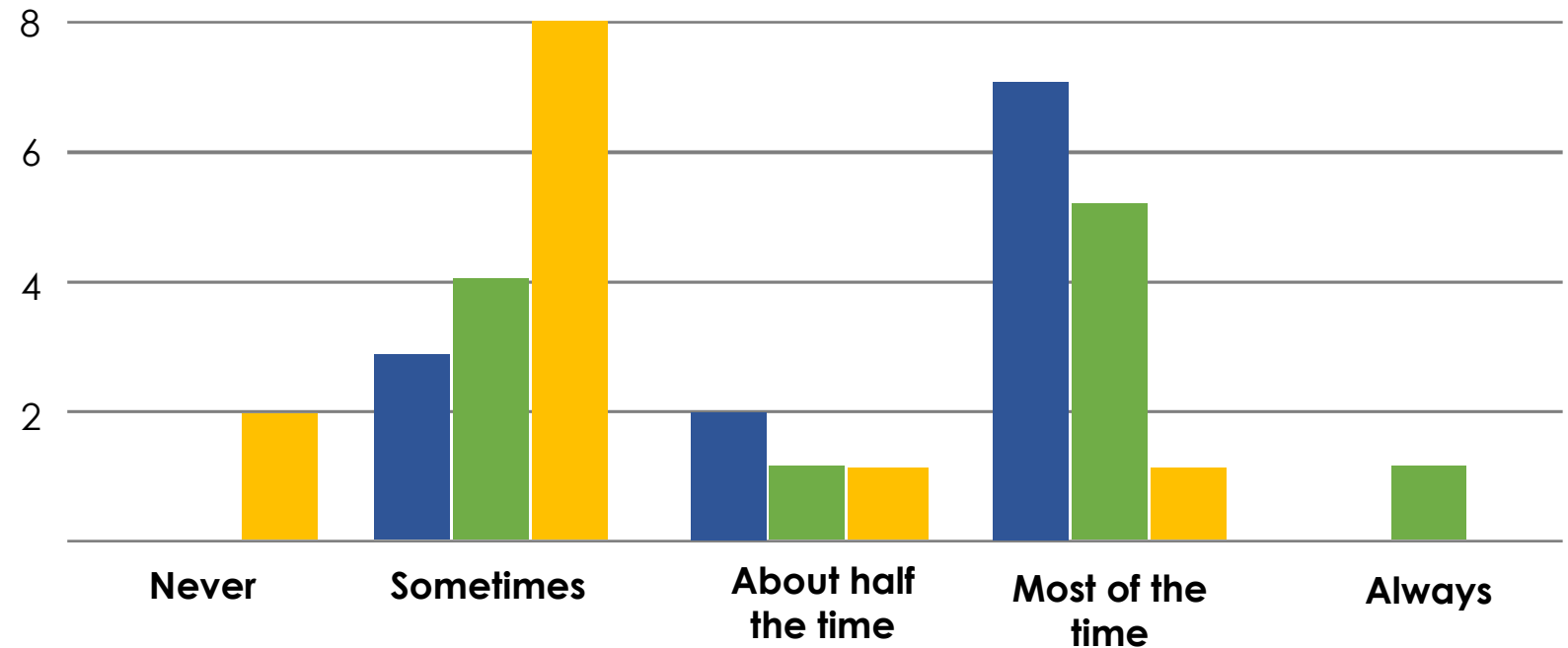- New Construction
- Other

Client Awareness & Opportunities to Inform

Are clients generally aware of the benefits of:

■ NLC systems?

■ LLLC systems?

■ **How often do you get a chance to educate clients on lighting controls before key specifications are made?**

The Takeaway
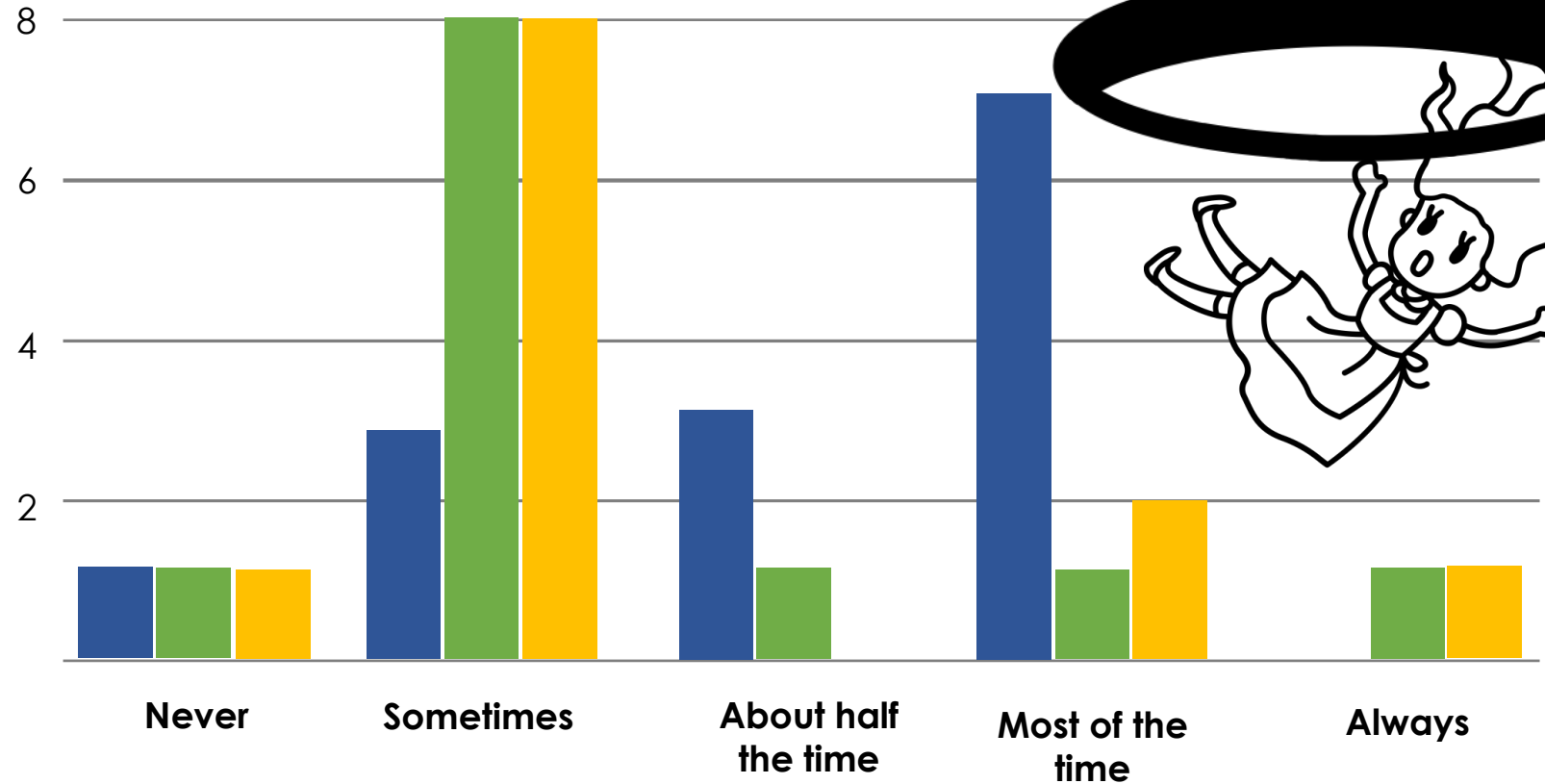
Clients are less informed about the benefits of LLLC

&

There usually is an opportunity to educate

LLLCs, Perennial Target of Value Engineering

How often are projects originally specified with:

- NLC systems, VE'd to incorporate stand alone controls? (green)
- LLLC systems, VE'd to incorporate NLC controls? (blue)
- LLLC systems, VE'd to incorporate stand alone controls? (yellow)

Bar chart categories: Never, Sometimes, About half the time, Most of the time, Always
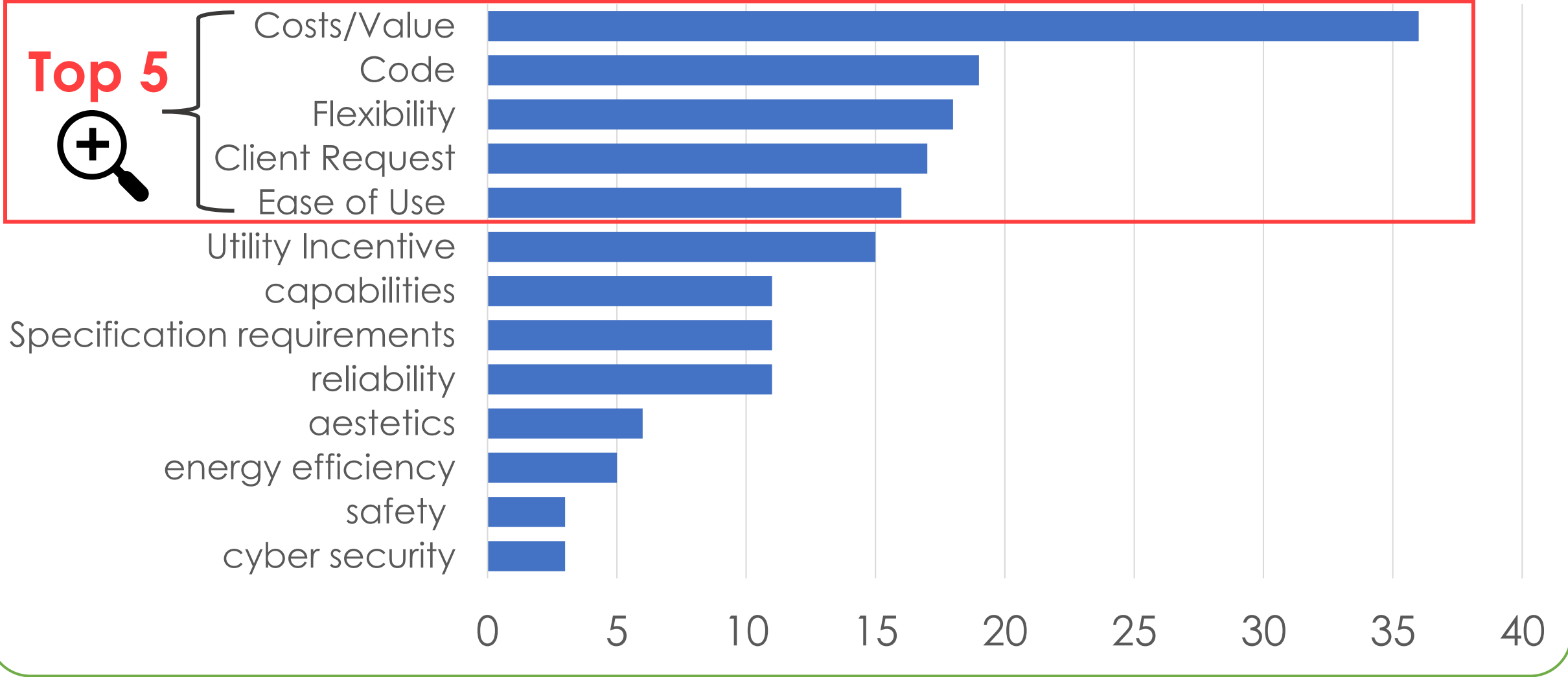
Phenomenal Quotes

"LLLC never gets VE'd because the only time I ever spec it is if the client specifically requests it"

"sometimes I spec LLLC thinking… at least when it gets VE'd we'll have a solid NLC system"

Top Factors That Determined Controls Specification

Top 5 (enclosed in red box with magnifying glass icon):
- Costs/Value — ~36
- Code — ~19
- Flexibility — ~18
- Client Request — ~17
- Ease of Use — ~16

Other factors:
- Utility Incentive — ~15
- capabilities — ~11
- Specification requirements — ~11
- reliability — ~11
- aestetics — ~6
- energy efficiency — ~5
- safety — ~3
- cyber security — ~3

(x-axis: 0 5 10 15 20 25 30 35 40)

Top 5 Factors Driving Specification

#1 Cost / Value — *Well of course…*

#2 Code — Low Bar Requirement
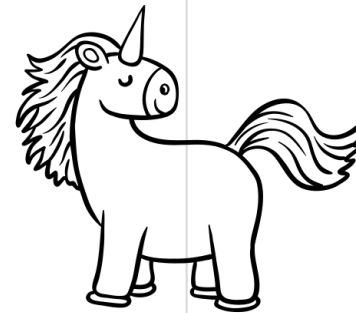
#3 Flexibility — System benefit

#4 Client Request — The Unicorn

#5 Ease of Use — System benefit

0   5   10   15   20   25   30   35   40

What drives investment beyond code?

Control Types

capabilities

- IoT life changing
- LLLC
- Individual Addressability
- Networked
- Stand alone

Code

$ cost $$$
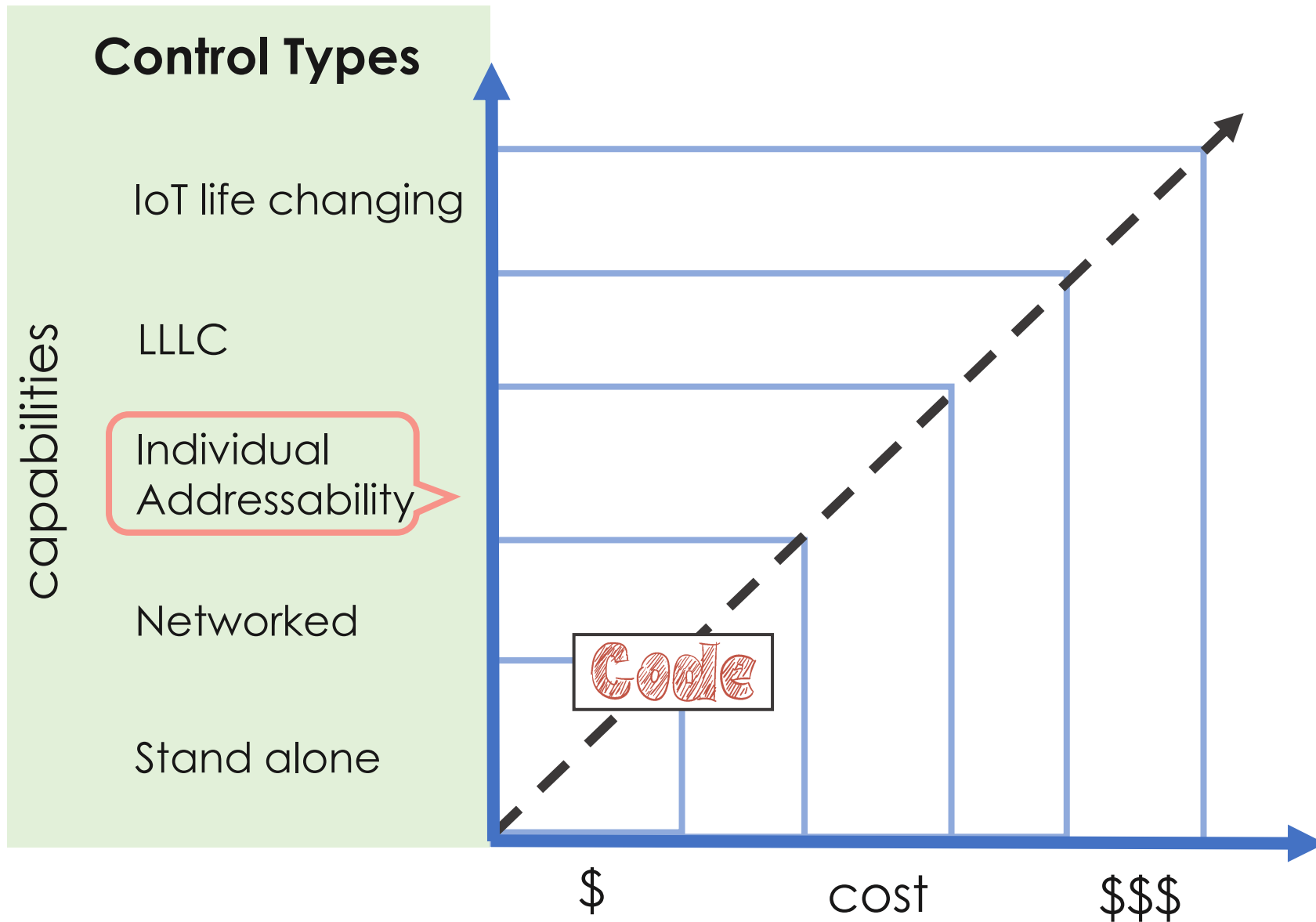
Motivators that matter

- Big tech IoT
- Certification programs

… but currently only apply to a small percentage of the market

What matters the **MOST,** *for the* **MOST** *projects?*

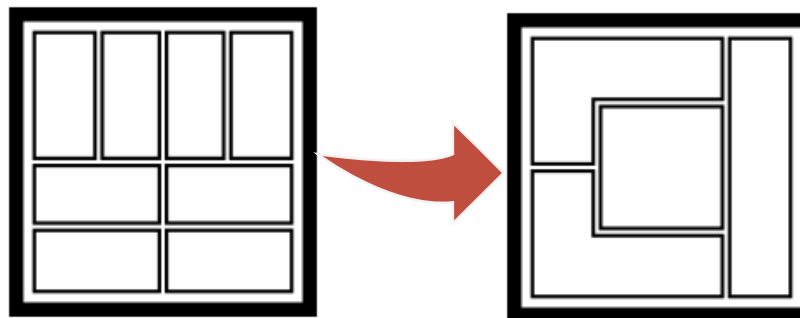- *System **flexibility***
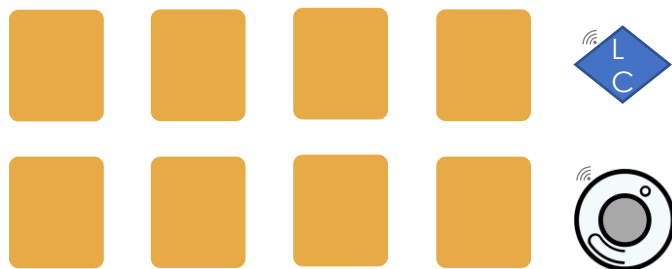- *and **ease of use***

Flexibility = Individual Addressability

In practical terms: Flexibility means the ability to wirelessly rezone and reconfigure spaces with only an app

This is what conventional NLC systems cannot do.
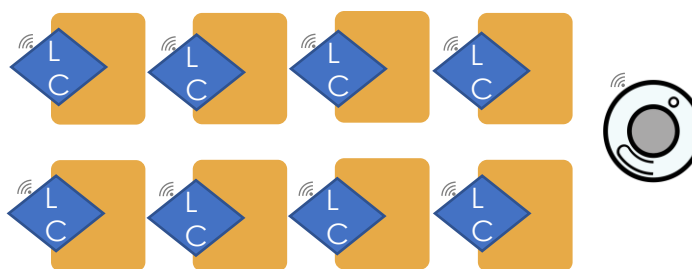
NLC Configuration

1 sensor : many fixtures
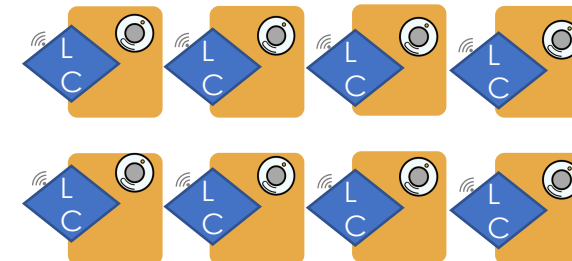
1 load controller : many fixtures

Individually Addressable

1 sensor: many fixtures

1 load controller : 1 fixtures

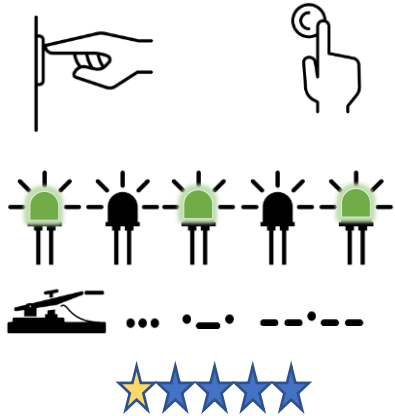## LLLC
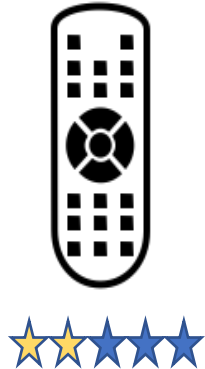### (also individually addressable)

1 sensor : 1 fixtures

1 load controller : 1 fixtures
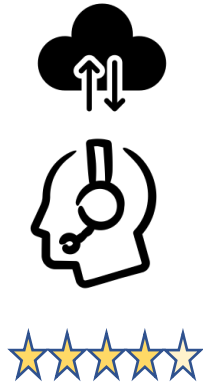
Ease of Use | Methods for System Configuration

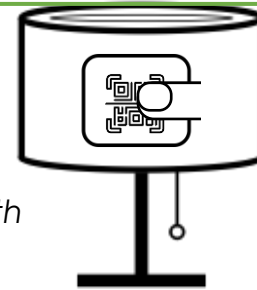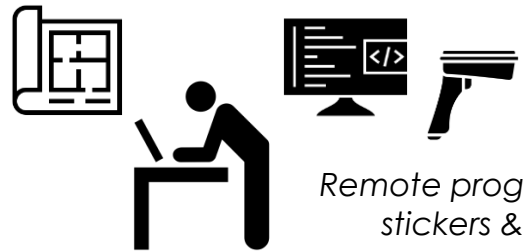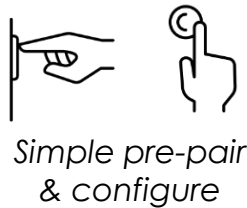| Push n' Program	Remote Control	Totally Remote	Desktop / Web Applications	App-Based
★★★★★	★★★★★	★★★★★	★★★★★	★★★★★

Pre-configuring: Simple pre-pair & configure | Remote programming with stickers & scanning | Remote web portal or app
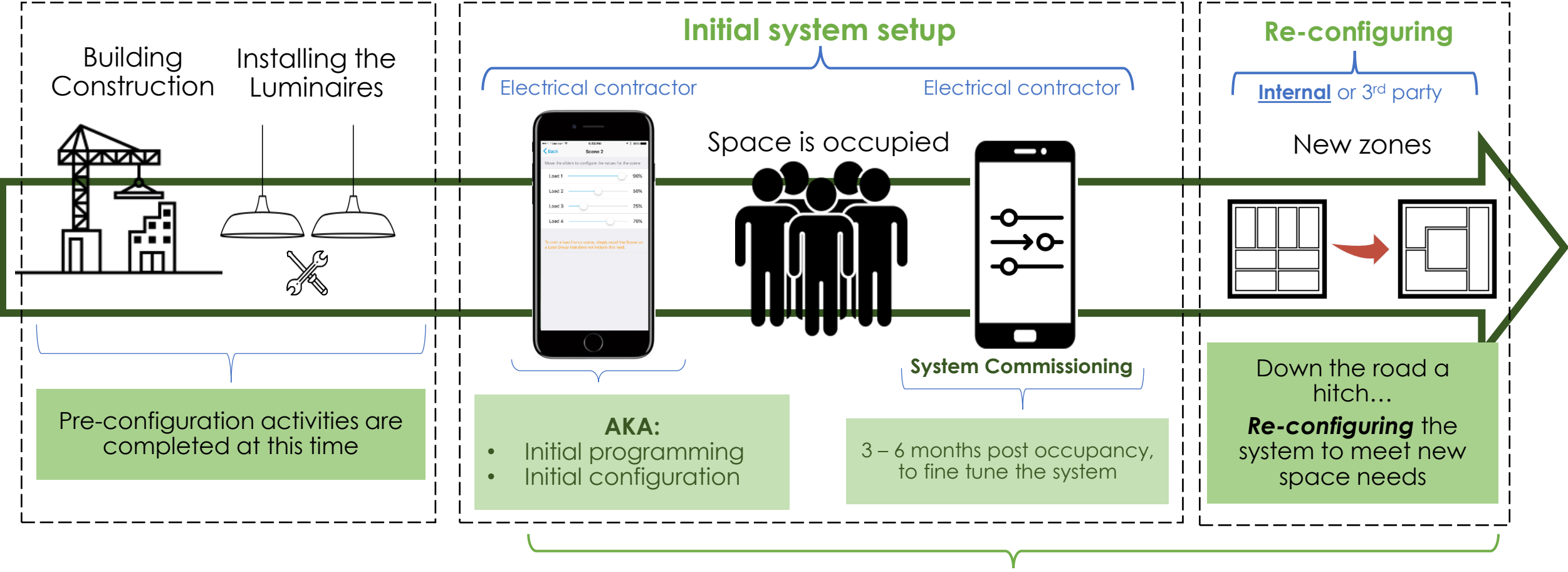
Most systems offer a hybrid approach

Pre-configuring only streamlines initial setup

App-based solutions are the most accessible and user friendly for *two distinct groups*

Flexibility & Ease of Use | Most Important Stakeholders

Initial system setup

Re-configuring

Building Construction

Installing the Luminaires

Electrical contractor

Electrical contractor

Internal or 3rd party

Space is occupied

New zones

System Commissioning

Pre-configuration activities are completed at this time

AKA:
- Initial programming
- Initial configuration

3 – 6 months post occupancy, to fine tune the system

Down the road a hitch…

Re-configuring the system to meet new space needs

Before you can unlock all that other value… this is what you've gotta do *really well*.

Ease of Use | Quality App-Based Features

Ease of use:	Access	Streamlining Process	Multiple Ways to Win

Weak-Sauce

- Supports **only** iOS or Android *(not both)*

- Uses IR / requires dongle

- Requires manual action for pairing

Yum-Sauce

- Personal Control & layered user authentication

- Automatic device detection based on signal strength

- Device types are known when added to the system

- *See example*

Other helpful features: In app help menus, templates, ect.

Ease of Use | Multiple Paths to Winning

The scenario: daylight zoning with LLLC...

To zone?

- Requires specific daylight zones

- Ceiling looks more consistent

- Less energy savings

Or not to zone?

- Every luminaire is an independent daylight zone

- Ceiling doesn't look consistent **but** the work plane does

- More energy savings

Fun Fact: Even when LLLC fixtures were installed, participants overwhelmingly favored grouping daylight zones

Configuration tools increasingly offer group vs individual sensors toggle options:

Select how you want occupancy sensors to control this room:

All sensors work together to turn all lights in the room on & off with occupancy

All sensors work separately to turn individual lights in the room on & off with occupancy

(for both occupancy & daylight harvesting)

Screenshot from Lutron Vive

Specifier Journal Conclusion

Key Findings

There is an **opportunity and need to increase clients awareness** of LLLC benefits.

&

Flexibility and *ease of use* are the two benefits which offer clients the <u>most practical benefits to invest beyond code</u>.

The Rub

Flexibility and *ease of use* are future benefits which still have to compete against **LOWEST COST**

The Other Rub

Most specifiers expressed some combination of:
- *LLLC usually overshoots the mark*
- *I can achieve flexibility without going full LLLC*

Positive Trends for LLLC

- Support for individual addressability

- Increased LLLC fixture options

No longer the barriers they once were

Part 2

Common Areas of Confusion

Two Common LLLC Definition Issues

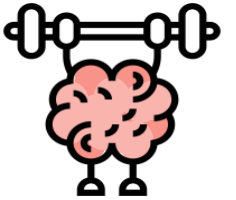## 1. 50 shades of integrated

Does *fixture adjacent* count?
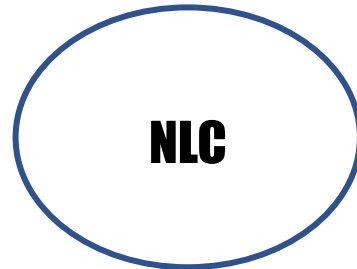
Does *fixture mounted* count?

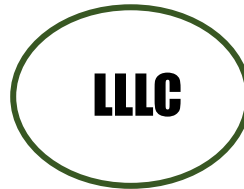Exactly *how* integrated

For today, Let's not worry about this…

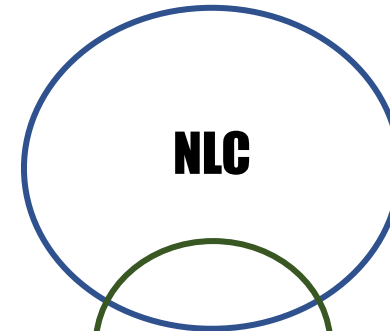## 2. The ambiguities of "networked" and LLLC
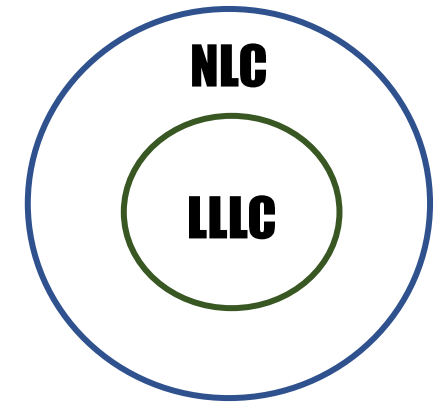
Thought exercise:

NLC

LLLC

What makes LLLC, LLLC, *has nothing to do* with being networked.

NLC

LLLC

LLLC may be connected at the "room-level", but it's not networked.

NLC

LLLC

LLLC is always networked, end of story.

Room-based systems & the networked schism

The Question…

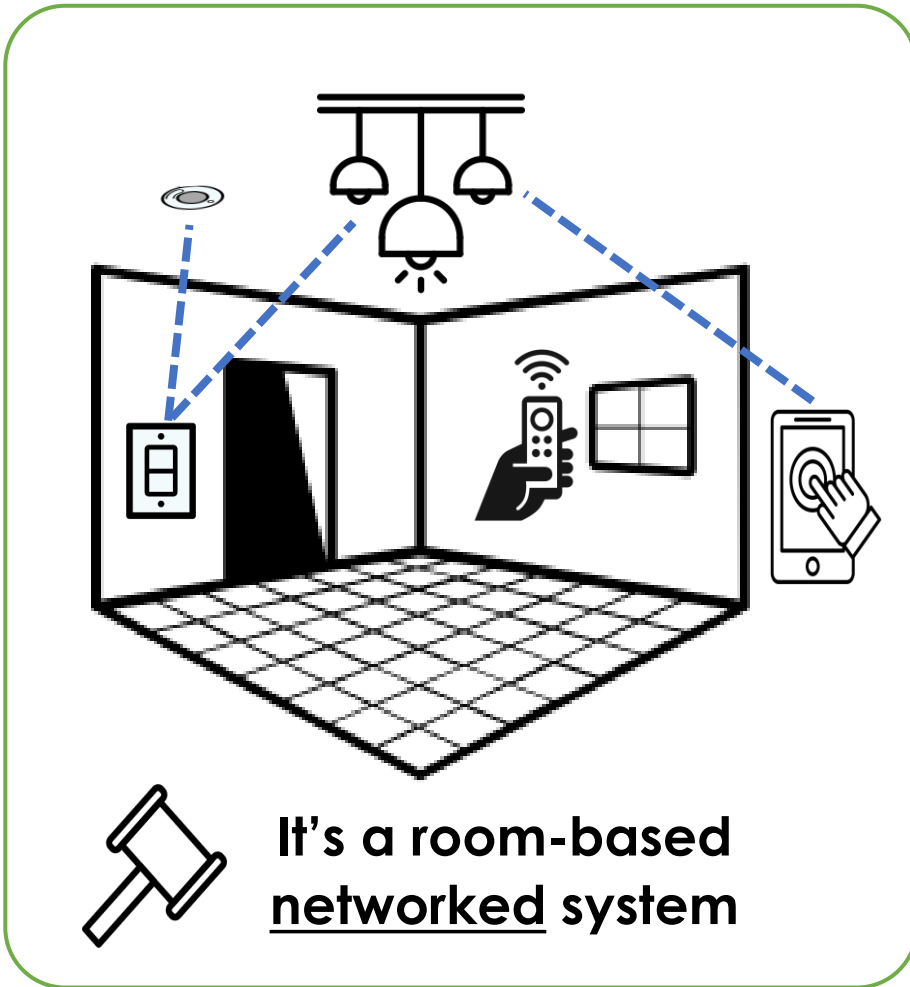If you can only talk to devices right next to you – *are you really networked?*

Some people say NO

these devices may be **connected** at the room level, but they aren't *networked*

Other people say uh… YES

These systems are networked, if only at the room (device) level.

It's a room-based **networked** system

The Evolution of Networked Lighting

'til around 2018

1. Standalone Controls

Non-networked

2. Room-Based Systems

Networked-*ish*

3. Networked Systems
with gateways

4. Networked Systems
with gateway + server = IoT capable
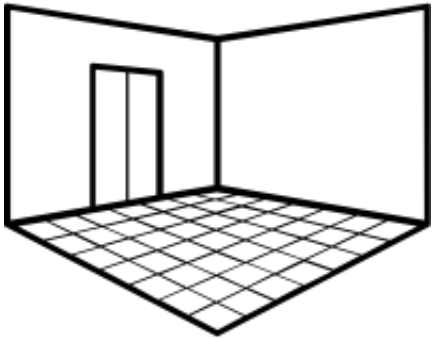
Networked

What about mesh?!?

Hold your horses

Gateways Enable Certain Capabilities

Conventional room-based systems are reliably restricted to the same:

Capabilities

- Occupancy / Vacancy Sensing
- Photo sensing
- Grouping / Zoning
- High End Trim

Configuration Methods

- *Pre-configured*
- Push 'n Pair
- Remote control

Adding a **gateway** expands the network and enables
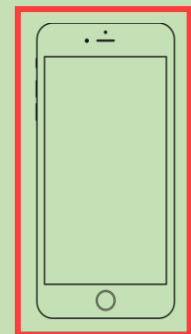
Additional Capabilities

- Scheduling
- Energy monitoring
- BACnet / HVAC
- Automatic demand response
- Remote system access

Additional Methods

- App-based
- Web-based (*remote*)

It's a bridge It's a hub

It's probably...

the... "Gateway"

A gateway is a hardware device that connects two networks with different protocols

In the context of networked lighting systems, the gateway is <u>connecting and translating</u> between

Intranet & Internet
example
WiFi and IPv6

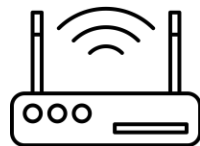**The Lighting Network**
example
Bluetooth or IEEE 802.15.4

So multi-purpose

In addition to functioning as a *gate that* translates between two different protocols, **gateways commonly include:** APIs, routers, hubs, and firewalls.

Gateways you already know and love

Your wireless router

Your smart phone

For clarity: A bridge connects two networks using the same protocol.

In a mesh system, the bridges are expanding the lighting network across the building, but not out to the internet.

The Industry Obfuscation of Gateways

"GATEWAY" has become a *trigger word* that ostensibly implies:

- **Cyber security threats**
- **System complexities**

How has industry responded?

By marketing systems as *"gateway-less"*
(real text from real websites)

- *Patented no gateway architecture*

- *No IT, no gateways, no wiring*

- *Gateway-free, distributed control, no extra cost / hassle, and no special network or panel installation*

When they should be saying…

- No gateway required *for basic operation!*

- "Scale up for more benefits by adding a gateway"

By calling their gateway anything other than "gateway"

- Hub

- WAC

- Bridge + Router

Another common source of confusion

I'm going to use the phrase "Load Controller"

When describing the thing that controls the load...

Casambi controller
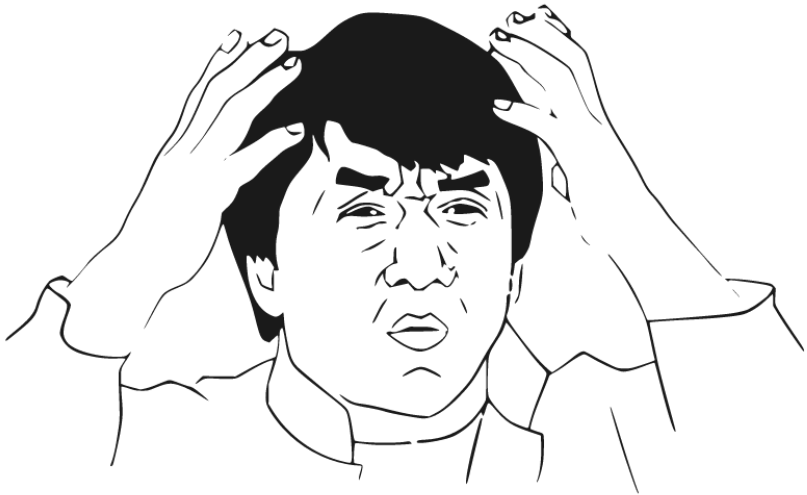
AKA

- Fixture control unit
- Control module
- Adapter
- Load controller
- Zone controller
- Room controller
- Relay pack
- Power Packs
- Pow-Packs

This *THING*, is WAY too important to have this many different names (and confusion)

Additional Sources of Load Controller Confusion

(besides the name)

In most NLC systems… the load controller is the physical device that:

1. Controls
the light levels and color output

2. is addressable
by other devices

3. is configurable
with embedded logic

Load controllers come in many different flavors

Source of Power
- Line voltage
- Low voltage

Wired / Wireless
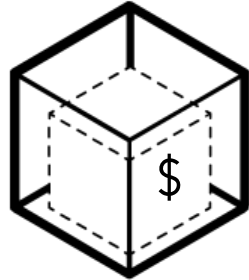- Wired
- Wireless

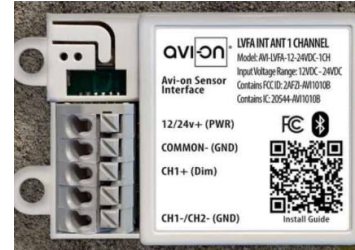**Protocols Supported**
Wi-Fi, BLE, Zigbee, DALI, proprietary

Control Method
0-10V, reverse-phase, DALI

Load Controller Trends

Increasingly smaller & cheaper

$
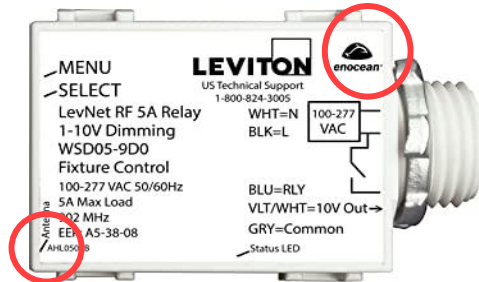
and widely available at the fixture level

low-voltage fixture controller by AVI-on

Fixture controller by Watt Stopper

increasingly wireless

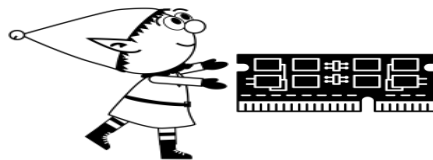Leviton fixture controller with enOcean wireless

BubblyNet 0-10V fixture controller with BLE Mesh wireless

Specific to DALI

Increasingly achieving price parity with 0-10V

increasingly programable

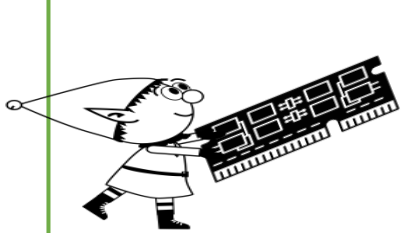*We're talking about a microprocessor & memory*

Which enables capabilities, like
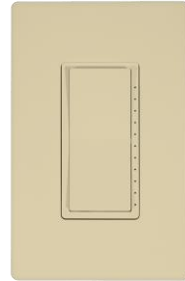
- **controls persistence** and
- (pre)-programming

Distributed Logic & Controls Persistence

The MACRO trend is distributive logic in everything

Enlighted smart sensors

RAB dimmer switch

Aleo Blue wireless control node

Increasingly, manufacturers are embedding logic **in both sensors & controllers** which supports controls persistence (and other capabilities)

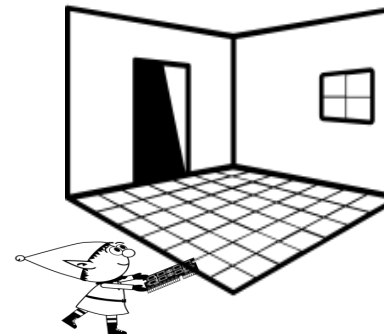## Controls Persistence

The Scenario
New building, works great!

Two years later, the gateway konks out…

The room is no longer communicating with the next higher network level

However…

Within the room, devices are still connected, performing:
- Presence detection
- Daylight harvesting
- High-end trim

Load Controller Common Confusion | 0-10V & DALI

Via additional network hardware **(gateways, bridges, routers)** lighting systems can be accessed remotely and integrate with other systems ❓

Exactly *WHAT* is controlling *WHAT*?
- From a network level
- From a hardware level

Local and wide area networked devices

BACnet

Local servers

Remote servers

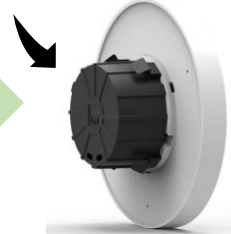## Low energy networked devices

Wall stations

Sensors

Smart devices

(LE) Protocols
e.g. BLE, Zigbee, and sub 1MHZ ❓

(LE)Protocols
e.g. D4i, BLE, or Zigbee ❓

0-10V load controller

❓ **Control method:** 0-10V ➡️

Integrated DALI load controller & driver

❓ **Control method:** DALI = *Digital* ⬅️➡️

2-way communication

The driver

The load

The load

Part 3
Wireless Trends

Wireless Trends | The Evolution of Networking

1. Standalone Controls

2. Room-Based Systems

5. Low Energy Mesh

3. Networked Systems
with gateways

4. Networked Systems
with gateways *and* IoT capable

"Wireless"

is a <u>catch all phrase</u> in a market where distinction matters

Wi-Fi

Wi-fi is designed for very **high** data transfer & energy use.

Not super important for modern lighting systems

Low Energy (LE) Protocols

Are designed for low power and low bandwidth applications

LE protocols you're probably already familiar with

Bluetooth

BLE

zigbee

D4™

enocean®

Two reasons LE protocols are a big deal

1. Very low power consumption enables wireless, battery powered devices

If lighting is the *backbone* of IoT – **because it is powered…**

then wireless, battery powered (edge-devices) using *LE protocols* are like the central nervous system

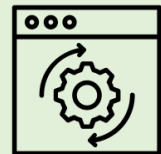2. LE protocols offer improved capabilities and network performance

MESH networks
- Resilient
- Self-healing
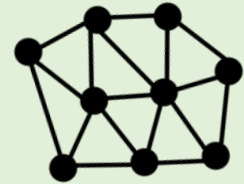
Software based vs. Hardware based
- Increased interoperability
- Increased futureproofing

LE protocols are the cornerstone of IoT

Wireless Trends | The Evolution of Networking

1. Standalone Controls

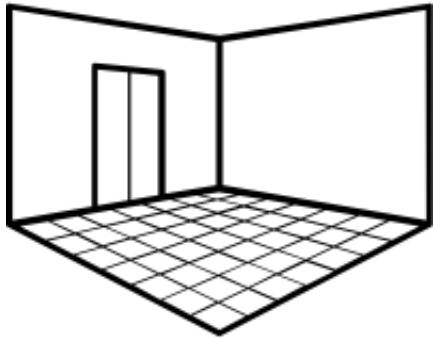2. Room-Based Systems

5. Low Energy Mesh

3. Networked Systems
with gateways

4. Networked Systems
with gateways *and* IoT capable

Remember this slide, about gateways?

Conventional room-based systems are reliably restricted to the same:

Capabilities

- Occupancy / Vacancy Sensing
- Photo sensing
- Grouping / Zoning
- High End Trim

Configuration Methods
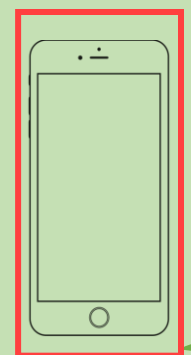
- *Pre-configured*
- Push 'n Pair
- Remote control

Adding a **gateway** expands the network and enables

Additional Capabilities

- Scheduling
- Energy monitoring
- BACnet / HVAC
- Automatic demand response
- Remote system access

Additional Methods

- App-based
- Web-based (*remote*)

Mesh networks extend capabilities w/o a gateway
But they don't entirely replace gateways or other network hardware

#2 Room Based Systems

No gateway required

Network limited to
• room based devices

Capabilities limited to
• Occ / Vac sensing
• Photo sensing
• Plug load
• Grouping / Zoning
• High End Trim

Configuration Methods
• Push n' Program
• Remote control
• Pre-config

#3 Beyond Room Based Systems

Gateway Required
Plus additional hardware *

Network expanded to • Floor, building, portfolio (enterprise)

Additional Capabilities
• Scheduling
• Energy monitoring*
• Personal control
• Demand response
• API integration
• BACnet / HVAC

Additional Configuration Methods
• App-based configuration
• Offsite / remote web portal

#4 IoT Capable Systems

Additional Hardware
Local or cloud based server

Additional Capabilities**
• Beaconing
• Crowd & temp. tracking
• IoT expanded & optimized
• All sorts of crazy stuff
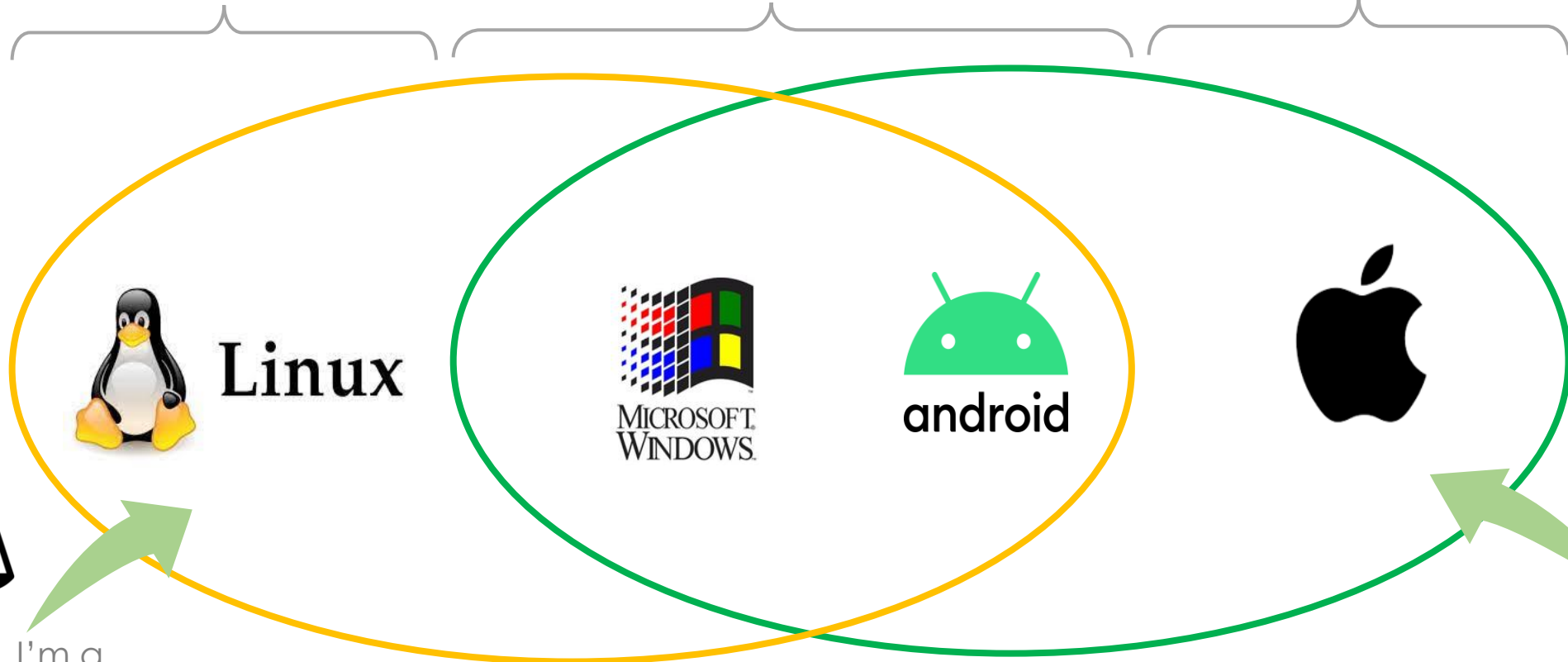
****Additional hardware requirements**

Wireless Trends | The Open Source Movement

A helpful way to think about the openness of lighting protocols

Most Open Source

Proprietary built on Open
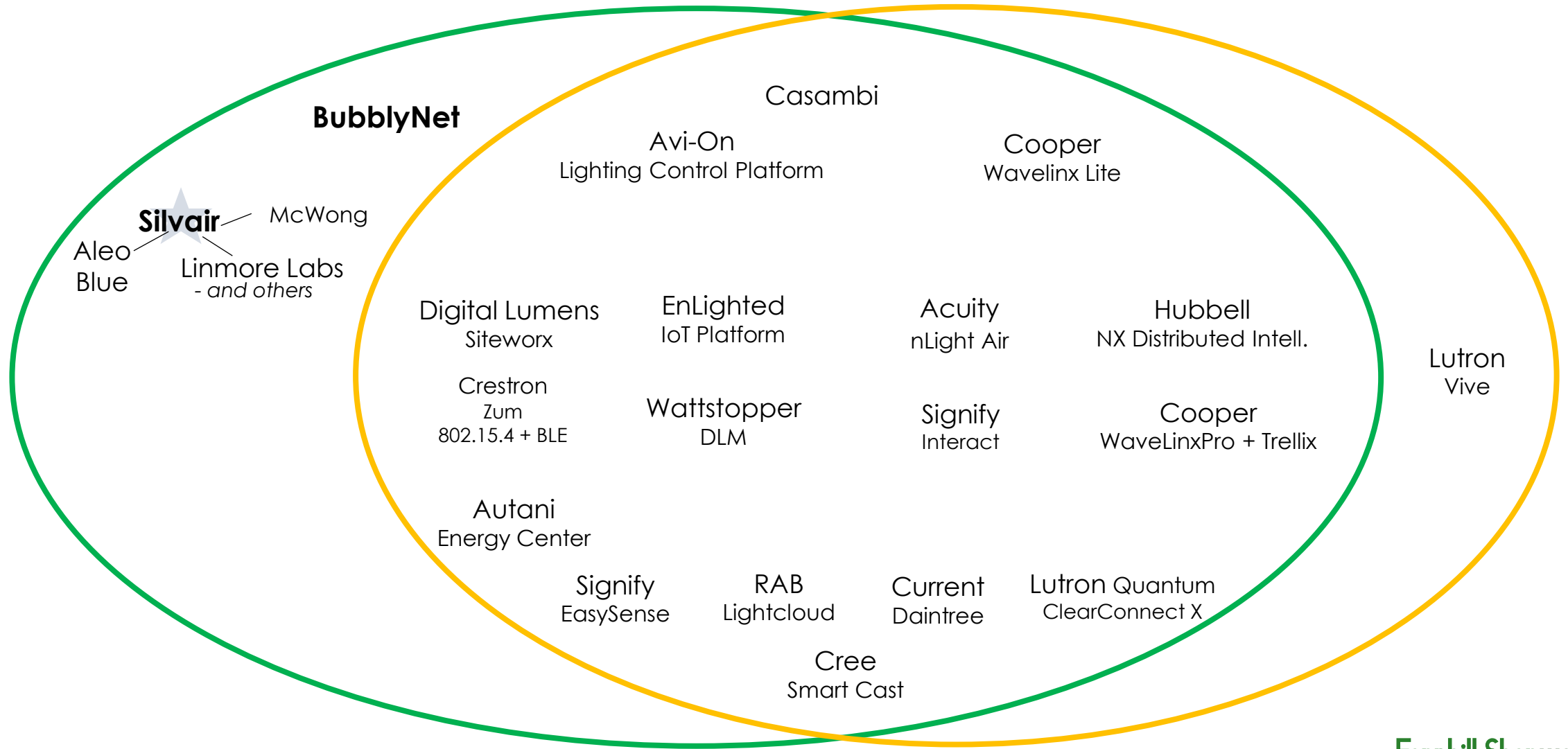
Least Open Source

Disclaimer… I'm a little biased here

Also, I'm an iPhone guy so…

LE Protocol Approaches by System | Open Source vs. Proprietary

Casambi

BubblyNet

Avi-On
Lighting Control Platform

Cooper
Wavelinx Lite

Silvair — McWong

Aleo
Blue
Linmore Labs
- *and others*

Digital Lumens
Siteworx

EnLighted
IoT Platform

Acuity
nLight Air

Hubbell
NX Distributed Intell.

Crestron
Zum
802.15.4 + BLE

Wattstopper
DLM

Signify
Interact

Cooper
WaveLinxPro + Trellix

Lutron
Vive

Autani
Energy Center

Signify
EasySense

RAB
Lightcloud

Current
Daintree

Lutron Quantum
ClearConnect X

Cree
Smart Cast

Fernhill Shopworks

LE Protocol Approaches by System | Primary Protocol Approaches

Bluetooth *based*

IEEE 802.15.4 *based*

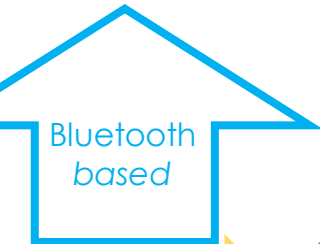Primary network is IEEE 802.15.4 but uses BLE for configuration tool and some edge devices

BubblyNet

Casambi

Silvair — McWong

Aleo Blue

Linmore Labs - *and others*

Avi-On
Lighting Control Platform

Cooper
Wavelinx Lite

Digital Lumens
Siteworx
802.15.4 + BLE

EnLighted
IoT Platform
802.15.4 + BLE

Acuity
nLight Air
802.15.4 (900MHZ)+BLE

Hubbell
NX Distributed Intell.
802.15.4 + BLE

Crestron
Zum
802.15.4 + BLE

Signify
Interact
ZigBee + BLE

Wattstopper
DLM
6LoWPAN + BLE

Cooper
WaveLinxPro + Trellix
802.15.4 + BLE

Lutron
Vive
433 MHZ

Autani
Energy Center
Zigbee

Zigbee

Current
Daintree
Zigbee

Signify
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Zigbee

Lutron Quantum
ClearConnect X

Cree
Smart Cast

Fernhill Shopworks

LE Protocol Approaches by System | Primary Protocol Approaches

Most Open Source

Proprietary built on Open-Source

Least Open

Bluetooth *based*

IEEE 802.15.4 *based*

Primary network is IEEE 802.15.4 but uses BLE for configuration tool and some edge devices

BubblyNet

Casambi

Silvair — McWong

Aleo Blue

Linmore Labs *- and others*

Avi-On
Lighting Control Platform

Cooper
Wavelinx Lite

BLE Mesh

Bluetooth with proprietary mesh

Digital Lumens
Siteworx
802.15.4 + BLE

EnLighted
IoT Platform
802.15.4 + BLE

Acuity
nLight Air
802.15.4 (900MHZ)+BLE

Hubbell
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IEEE 802.15.4 with proprietary mesh

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Lutron Quantum
ClearConnect X

Signify
EasySense
Zigbee

RAB
Lightcloud
Zigbee

Cree
Smart Cast

Fernhill Shopworks

LE Protocol Approaches by NLC manufacturer / system   with available DALI2 or D4i

Most Open Source   Proprietary built on Open-Source   Least Open

Bluetooth *based*

IEEE 802.15.4 *based*

Primary network is IEEE 802.15.4 but uses BLE for configuration tool and some edge devices

BubblyNet

Silvair ⭐ — McWong

Aleo Blue   Linmore Labs *- and others*

Casambi

Avi-On Lighting Control Platform

Cooper Wavelinx Lite

BLE Mesh

Bluetooth with proprietary mesh

| Digital Lumens Siteworx 802.15.4 + BLE | EnLighted IoT Platform 802.15.4 + BLE | Acuity nLight Air 802.15.4 (900MHZ)+BLE | Hubbell NX Distributed Intell. 802.15.4 + BLE |
| Crestron Zum 802.15.4 + BLE | Signify Interact ZigBee + BLE | Wattstopper DLM 6LoWPAN + BLE | Cooper WaveLinxPro + Trellix 802.15.4 + BLE |

IEEE 802.15.4 with proprietary mesh

Autani Energy Center Zigbee

Zigbee

Signify EasySense Zigbee

RAB Lightcloud Zigbee

Current Daintree Zigbee

Lutron Quantum ClearConnect X

Cree Smart Cast

Lutron Vive 433 MHZ

Fernhill Shopworks

Part 4

New Resources

Brought to you by NEEA / Better Bricks

Part V | Sweet Resources for Use

Available for download from Better Bricks | **Wireless Technology in Lighting Resource Guide**

Available for download from Better Bricks | **Questions to ask before going wireless in lighting**

NLC / LLLC Demo Board

What is it?

<u>Hands-on</u> resource for

- the lighting industry

- utility programs

- facility operators

- And more…

Available by request

Fernhill Shopworks

Demo Board | Cooper Wavelinx

Wireless Zoning & Controls

Office Space | Configuration 1

Open Office

Scenes   dimming   switching

- Full Lights
- Reading
- Presentation
- Off

- Raise
- Lower

Why integrated controls?

- Code compliance ☑
- Simple operation ☑
- Labor Savings ☑
- Space flexibility ☑

L₁   L₂   L₃   L₄

COOPER
Lighting Solutions

WAVELINX®

- Scheduling ☑
- Connected receptacle ☑
- Demand Response ☑
- BACNET Integration ☑
- Energy monitoring ☑
- App-based configuration ☑

This demonstration board is made possible with support from

BETTERBRICKS
Powered Energy saves money

SOLUS

Easy to configure control strategies

High-end Trim — Set the light levels

Prescence Detection — Occupancy / vacancy

Daylight Harvesting — Reduces luminaire output

Scheduling — Safety & convenience

Sequence of Operations
generic example

Feature	Setting
Scheduling	7 a.m. – 6 p.m. 8 p.m. – 10 p.m.
Auto On / Auto Off	Vacancy	15 minute timeouts
Daylight Harvesting	X2 zones
Demand Response	Enabled – 40% reduction

One button scene control
conference room example

Scene	Setting
Full Lights	100%
Presentation	20%	40%
Reading	60%
Off	0%

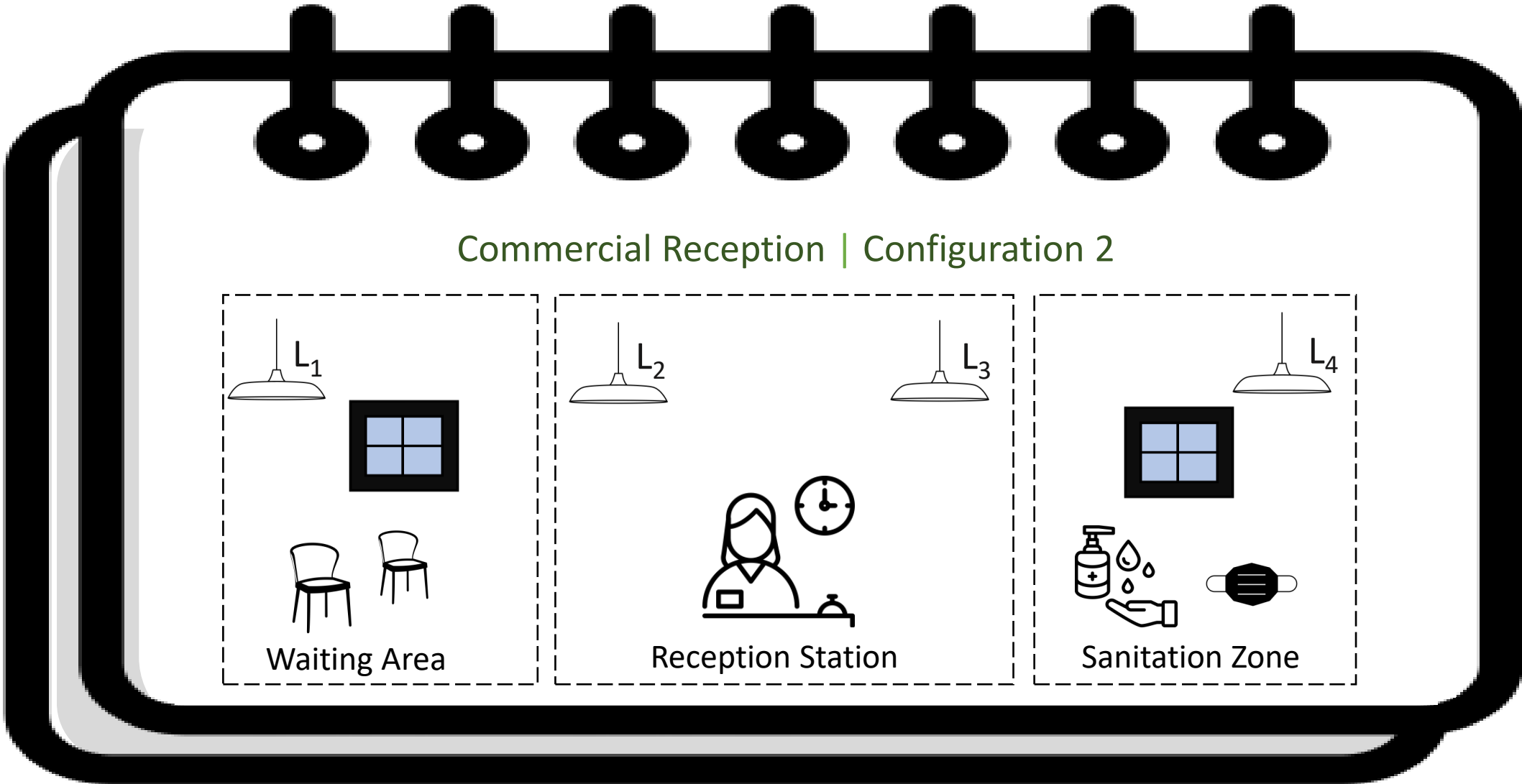Wireless wall stations can be programmed and control the luminaires

Plug n' Play Ready!

Demo Board | Lutron Vive

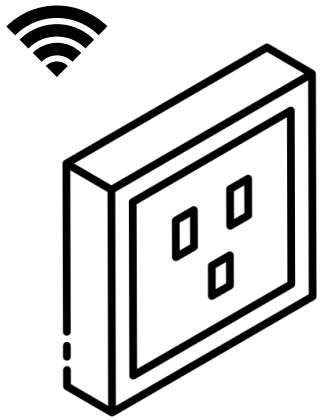**Where can it be used?** Utility training events | trade shows | as a sales aide | SEM workshops | and more

Fernhill Shopworks

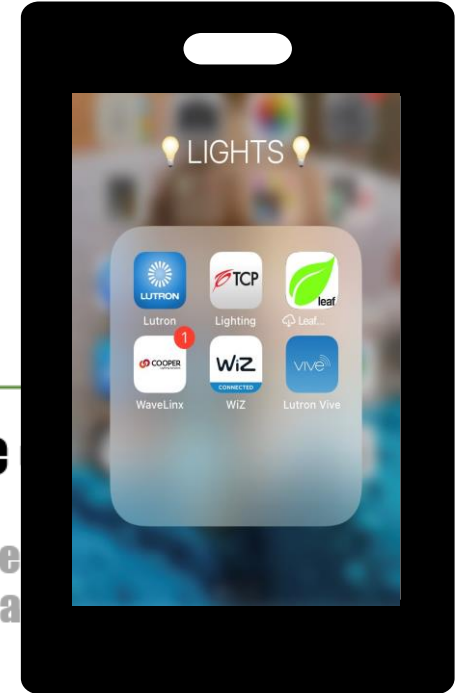Wireless Rezoning / Space Flexibility

Commercial Reception | Configuration 2

L_1

L_2 L_3

L_4

Waiting Area

Reception Station

Sanitation Zone

Fernhill Shopworks

Connected Plug Load & Helpful Graphics

COOPER
Lighting Solutions

WAVELINX®

- Scheduling ✓
- **Connected receptacle** ✓
- Demand Response ✓
- BACNET Integration ✓

Sequence of Operations
generic example

Feature	Setting
Scheduling	7 a.m. – 6 p.m. 8 p.m. – 10 p.m.
Auto On / Auto Off	Vacancy | 15
Daylight Harvesting	
Demand Response	4

One button scene
conference room example

Scene	Se...
Full Lights	1
Presentation	20%
Reading	
Off	0%

LIGHTS

Lutron | Lighting | Leaf

WaveLinx | WiZ | Lutron Vive

Easy to configure control st

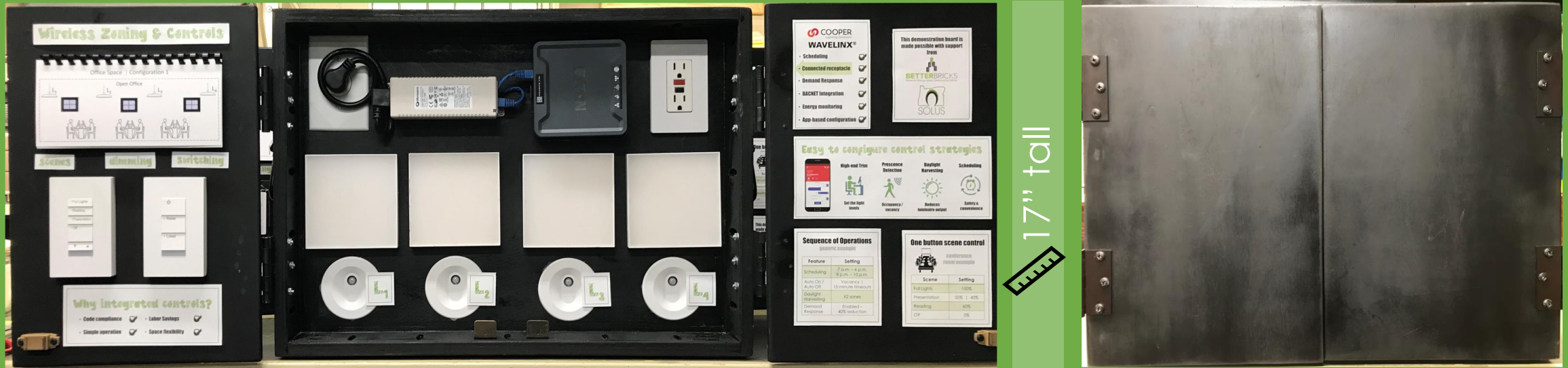| High-end Trim	Prescence Detection	Daylight Harvesting	Scheduling
Set the light levels	Occupancy / vacancy	Reduces luminaire output	Safety & convenience

Physical Dimensions & Weight

48" wide – open

24" wide – closed

17" tall

6 ½" deep

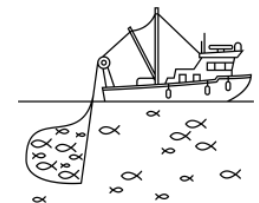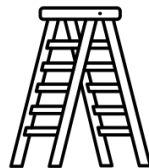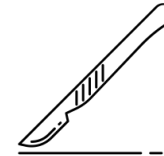Weight: 28 lbs

Available by Request / Pending Availability

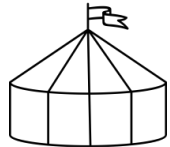**Contact:** John Arthur Wilson
253.732.5996
Wilson@Fernhillshopworks.com

Fernhill Shopworks

TheNounProject.com

1001FONTS.COM

Fernhill Shopworks
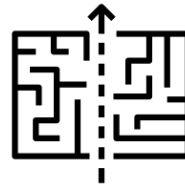
Thank You & Time For Questions

Time for Questions

Hopefully…

Thanks for the opportunity to share…

It's been fun!

I want to hear from you…

Got questions, feedback, constructive criticism… please reach out!

Contact: John Arthur Wilson | 253.732.5996 | Wilson@Fernhillshopworks.com

Fernhill Shopworks