LEDucation

Designers Light Forum

Assessing Connected Lighting Systems: What Works and How do we Know

Ruth Taylor, Pacific Northwest National Laboratory
Dan Blitzer, Practical Lighting Workshop

March 12, 2019

Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

This course is registered with AIA CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

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

Learning Objectives

At the end of the this course, participants will learn:

1. How installed lighting performance varied among the systems and from predictions
2. How well daylight and occupancy sensors performed
3. User operation of, and reaction to, different wall controls
4. Challenges in the measurement and assessment of installed systems

What We'll Cover Today

- NGLS Evaluations to Date
  - Evaluated Systems
  - Installation and Configuration Evaluation Recap
- Current Performance Evaluations
  - Wall Controls
  - Occupancy Sensing
  - Configuration vs. Reconfiguration
  - Configuration Methods
  - Daylight Sensing
- Next Steps

NGLS Partners

Next Generation LIGHTING SYSTEMS

IES Illuminating ENGINEERING SOCIETY

INTERNATIONAL ASSOCIATION OF LIGHTING DESIGNERS IALD

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

BUILDING TECHNOLOGIES OFFICE

Steering Committee and Advisors

Melanie Taylor, IALD, LEED AP
Vice President, Lighting Design
WSP

Craig Bernecker, Ph.D., FIES, LC
Founder and Director
The Lighting Education Institute

Charles Thompson, AIA
IALD LC LEED AP IESNA
ARCHILLUME LIGHTING DESIGN

Avi Mor, LEED AP, IESNA,
Lighting Designer
LIGHTSWITCH ARCHITECTURAL CHICAGO, LLC

Aram Ebben, IALD, LEED AP BD+C
Principal | Director of Lighting Design
exp, U.S. Services Inc.

Mary Matteson Bryan, P.E.
Energy Engineering

Chris Wolgamott
Northwest Energy Efficiency Alliance (NEEA)

Jeff Brown, IALD
Lighting Specialist
Power Design Engineering

Nancy Clanton, PE, FIES, IALD, LC, LEED AP
President
Clanton & Associates, Inc.

Ron Gibbons, Ph.D, FIES
Virginia Tech Transportation Institute (VTTI)

Chip Israel, FIALD, MIES, LEED® AP, LC
CEO & FOUNDER
Lighting Design Alliance

Mike Lambert, IES, LC
Senior Lighting Designer
KCL Engineering

Nathan Mitten, Ph.D.
Senior Manager of Property Standards & Improvements
Kimco Realty Corporation

Dan Blitzer, FIES
Practical Lighting Workshop

- Gabe Arnold - DLC, NLC
- Dave Bisbee - SMUD
- Peter Jacobson - Con Edison
- Levin Nock - DLC, NLC
- Michael Poplawski - PNNL/DOE

Next Generation
LIGHTING SYSTEMS

Understanding NGLS

Evaluating Configuration Complexity

To find the real ‘pressure points’, *people* need to observe and evaluate the *people* installing and configuring the system in real time, without assistance - it just can’t be done in a demonstration, mock-up, or testing lab.

NGLS Initial Focus

- Luminaire and control systems that are:
  - Marketed as “easy” to install and configure
  - Intended for contractor setup and configuration without prior training
  - Configurable without manufacturer assistance
  - No lighting designer involved

We had to start with the most basic systems to develop our evaluation protocols and procedures and come away with results and recommendations that are tangible and actionable.

Living Lab

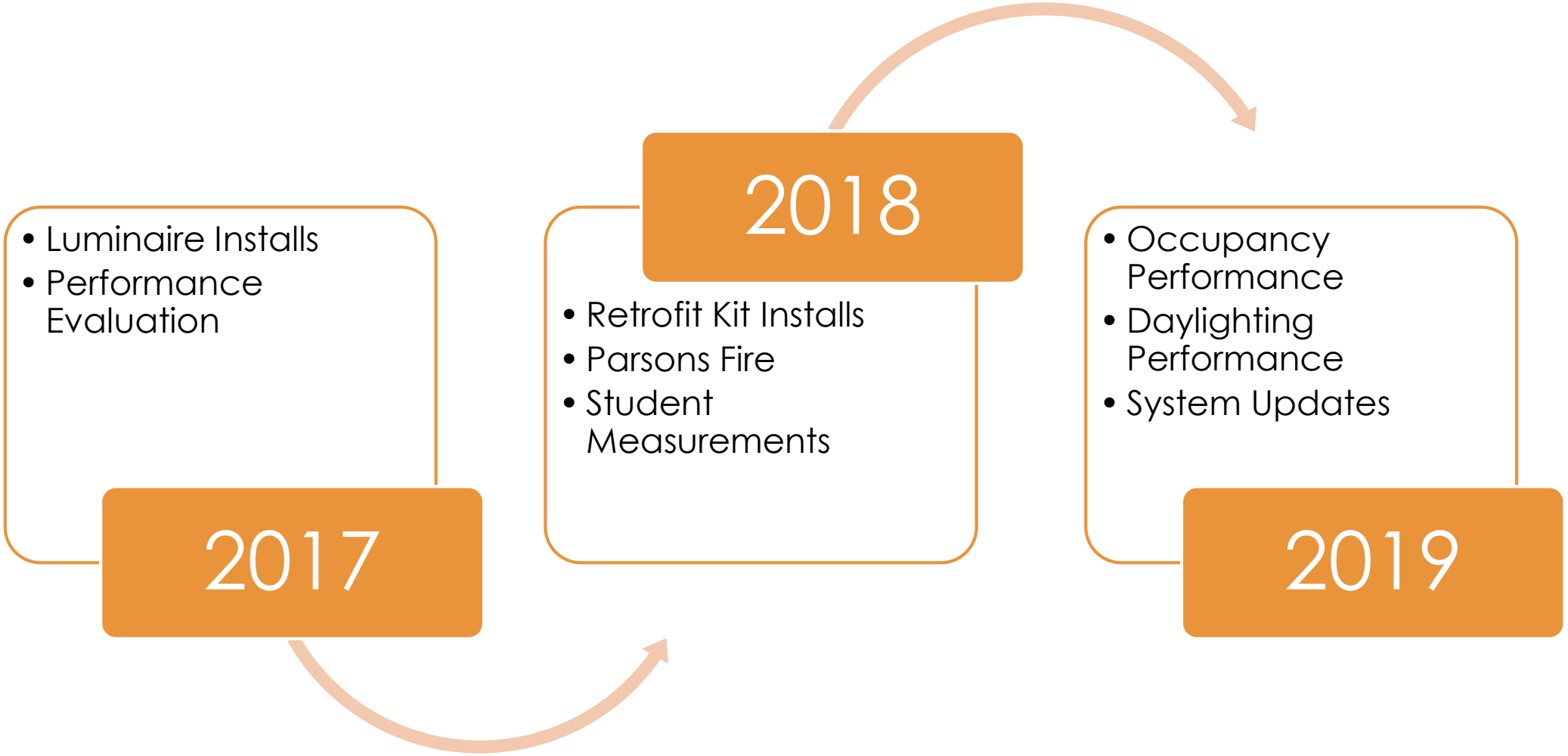

THE NEW SCHOOL
PARSONS


PARSONS
SCHOOL OF
CONSTRUCTED ENVIRONMENTS

Next Generation LIGHTING SYSTEMS

NGLS to Date

NGLS Indoor Timeline



Control Performance Requirements

1. **Vacancy control** (manual on/auto off) of two zones with a time out period of 5 minutes.
2. **Manual continuous dimming** of the same two zones indicated in item 1. Minimum dimming level of each zone shall be ≤ 10% of lumen output.
3. **Daylight harvesting** to maintain task plane illumination at the current level provided by the electric lighting (whether full output, task-tuned, or manual dimmed).
4. **Field-adjustable high-end trim** to lower maximum system light output. System shall be delivered with high-end trim set at 100%.
5. Control settings shall be adjustable by the user **without factory assistance**.

Lighting Performance Requirements

Task Plane Illumination	Illuminance Uniformity	Maximum Luminance Ratio	
Average initial at full power	Average to minimum across work plane	Between task and immediate background surfaces	Between task and distant background surfaces (ceiling, walls, floor)
45 – 55 fc	2:1	3:1	10:1 or 1:10

Connected Lighting Power Density of not more than 1.0 w/SF

Evaluated System Luminaires

- Luminaires
  - recessed 2x2s, pendants
- Retrofit Kits
  - recessed 2x4s, 2x2s, 1x4s
- Efficacy range – 94 to 140 lm/W
- Measured Illuminance – 30 – 57 fc
- Wattage range – 24 to 70 watts
- Calculated Power Density – 0.36 – 0.81 W/sf

Evaluated System Approaches

Entries can be categorized by how manufacturers approached:

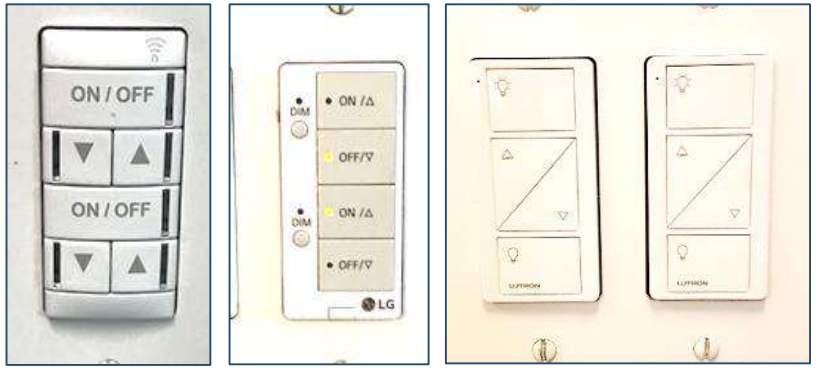
1) System Architecture
2) Initial Start Up
3) Configuration Tools
4) Wall Controls
5) Documentation and Instructions

Next Generation
LIGHTING SYSTEMS

Wall Control Performance

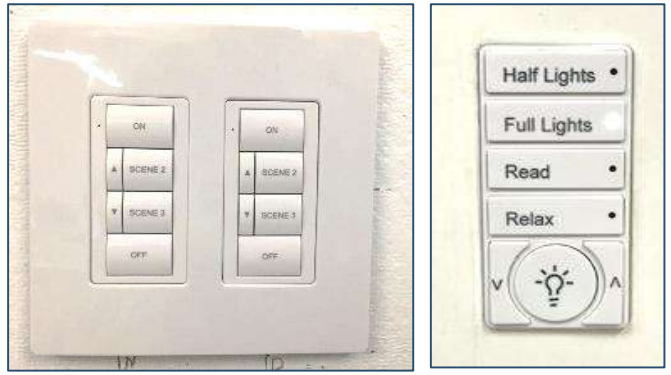
Wall Controls

Pre-configured Rocker Switch
(4 Systems)



Pre-configured Multi Button Switch
(3 Systems)

Site Configurable Rocker Switch
(2 Systems)

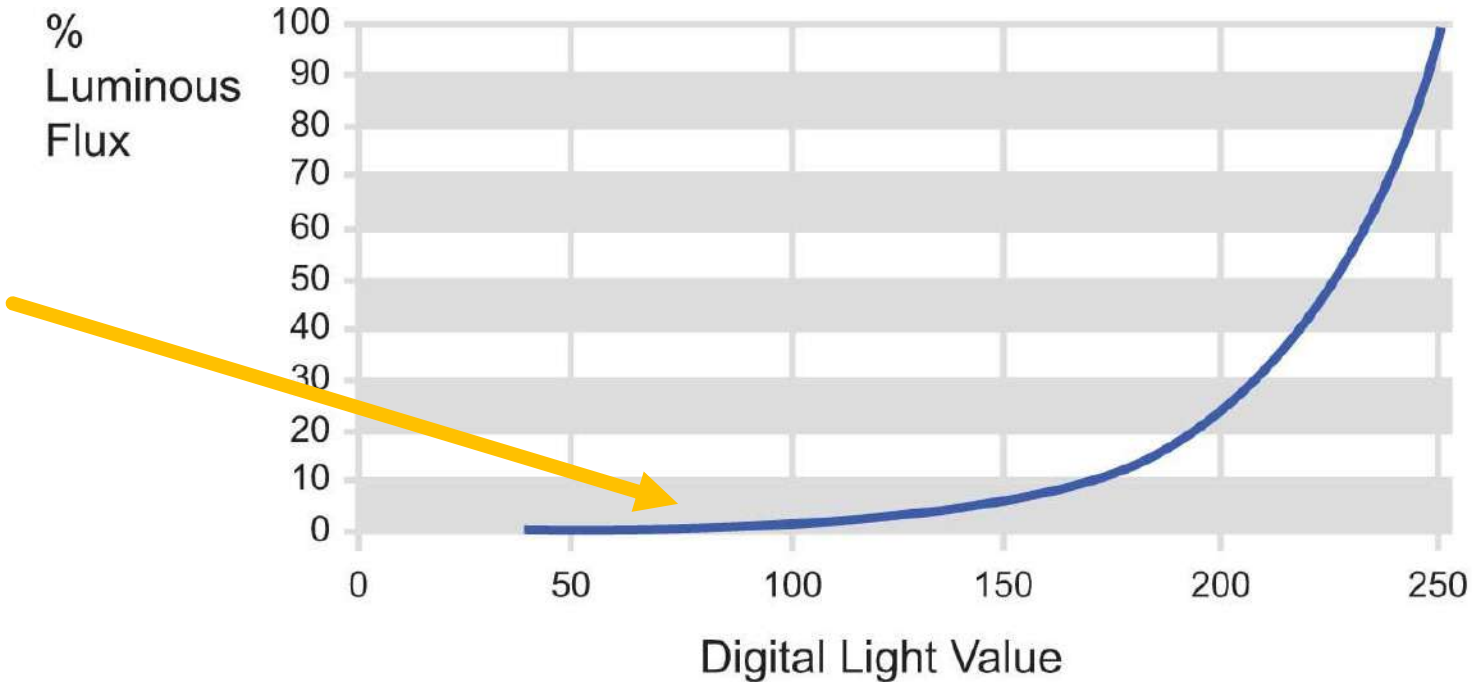


Site Configurable Multi Button Switch
(2 Systems)

Immediate Feedback

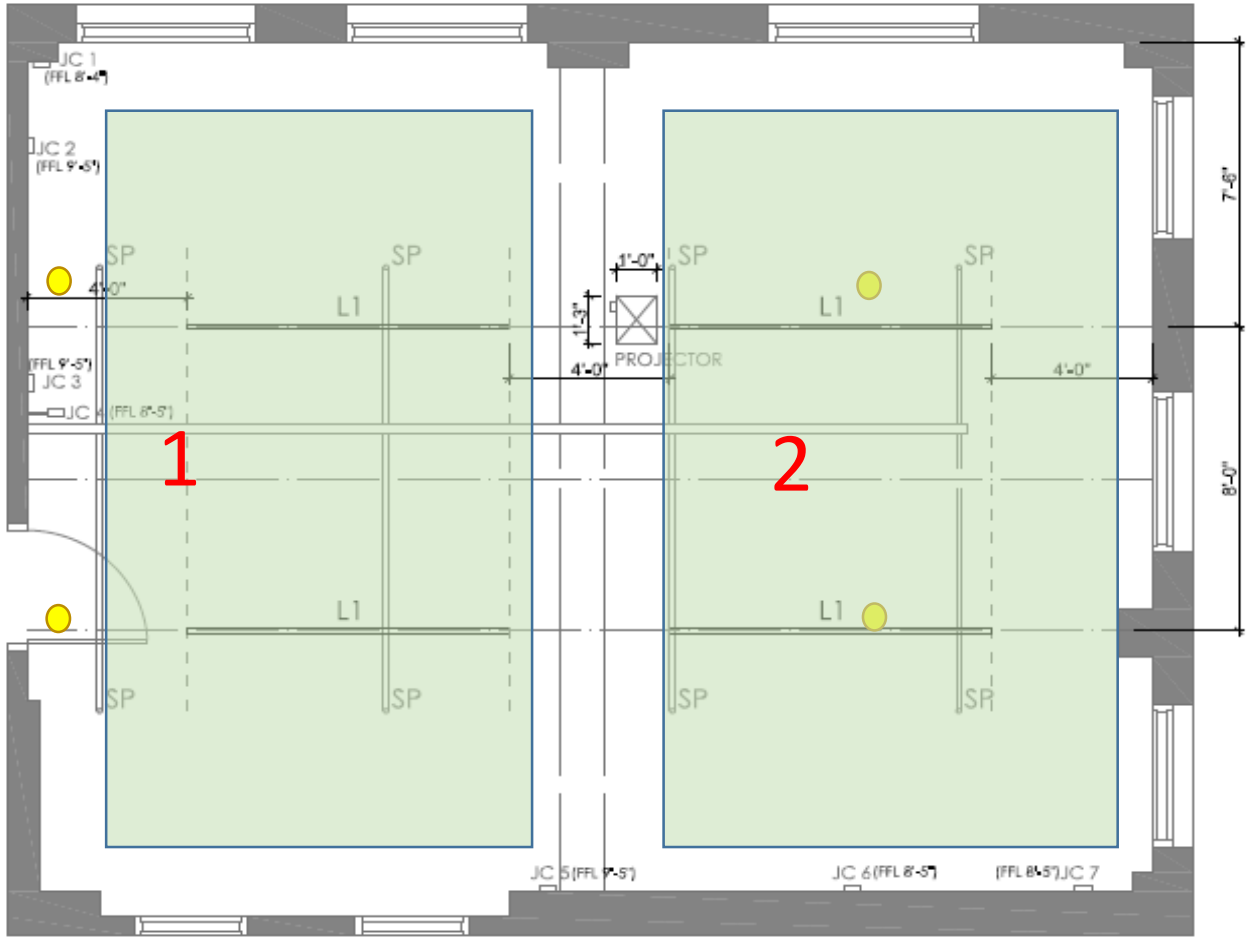
Delayed visual response when pressing the switch is a concern, users need immediate feedback

The button is pressed but users don't see any change.



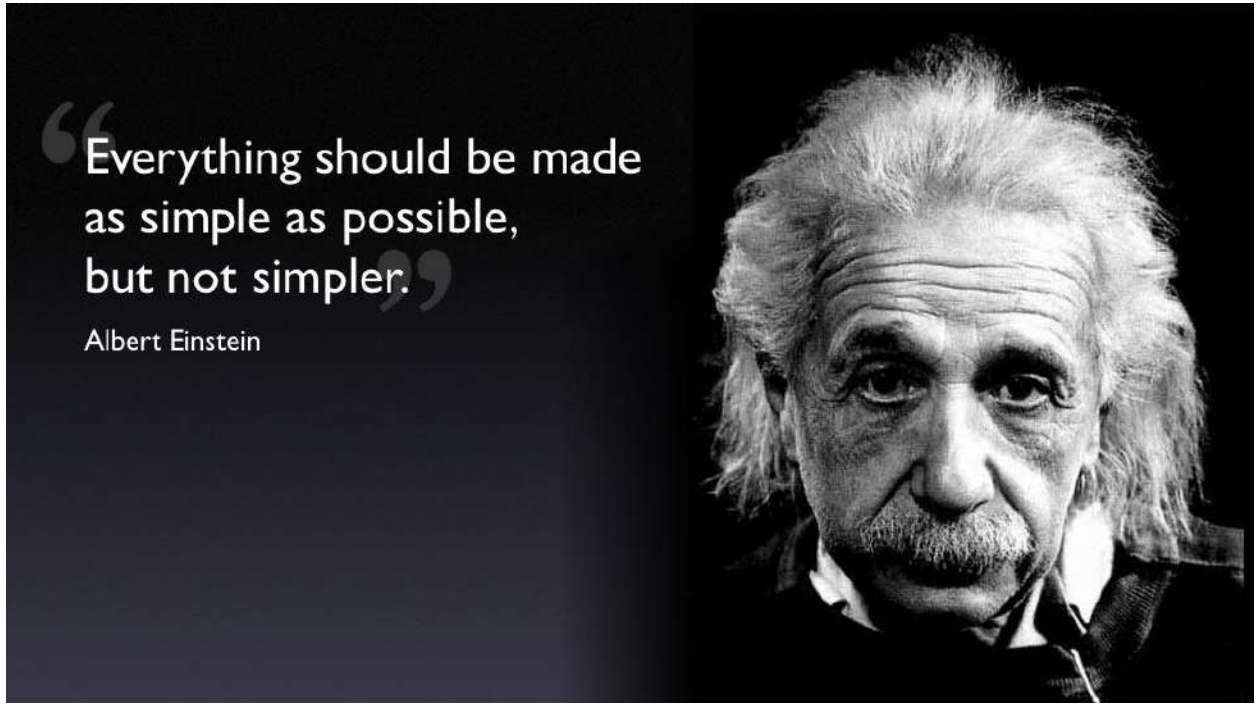
Switch Arrangement

Switch arrangement that mimics associated fixture locations could be helpful



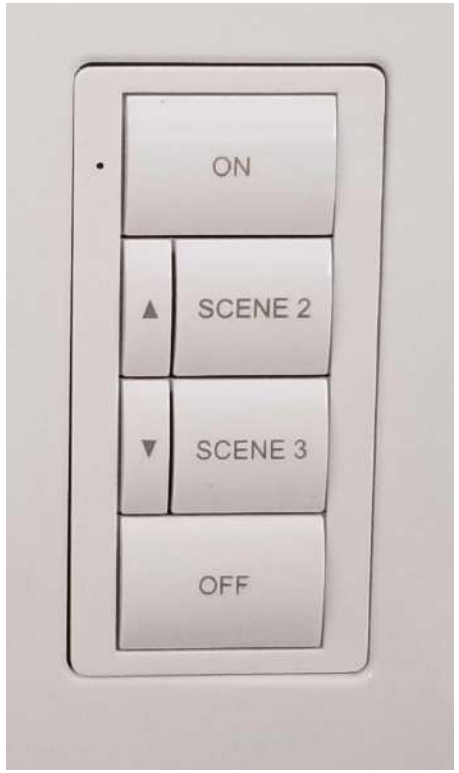
Simple is Better

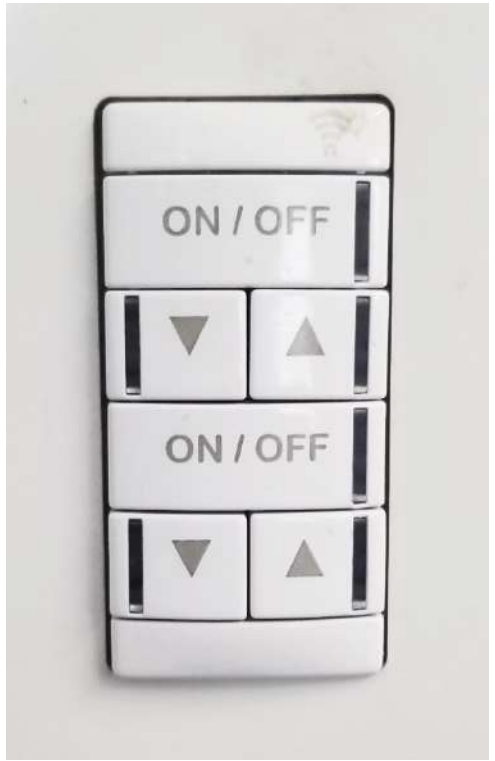
If functions of the wall controls are not obvious, users will likely not know that a particular function is even possible



Markings

Dimming function is more obvious if there is some marking on the switch





Younger Users

Younger generations are accustomed to touch screens, press and hold is not intuitive

Next Generation
LIGHTING SYSTEMS

Occupancy Sensor Performance

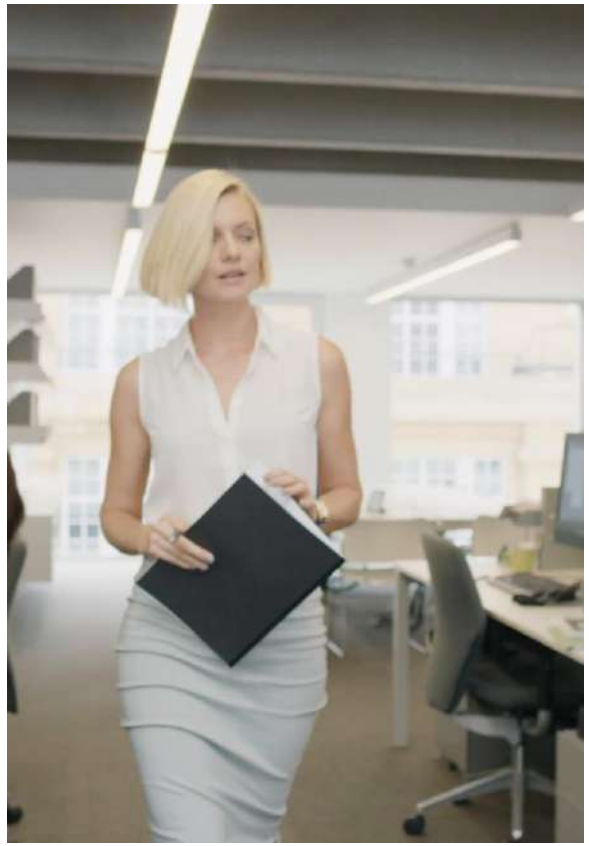
Occupancy Sensing Evaluation

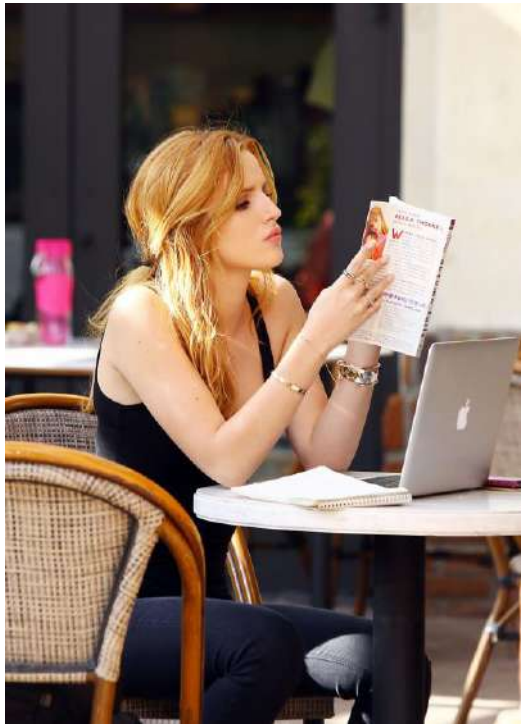
- Initial Evaluation:
  - Hard to distinguish between configuration and performance
    - Is it how the system is programmed or a hardware issue?
  - Hard to differentiate between sensitivity vs. coverage issues
- Second Evaluation Process:
  - Reset all systems to NGLS spec
  - Protocols for testing:
    - Vacancy
    - Sensitivity
    - Coverage

9 passed, 3 failed

Testing Occupancy Sensitivity

- Major, minor and micro movement





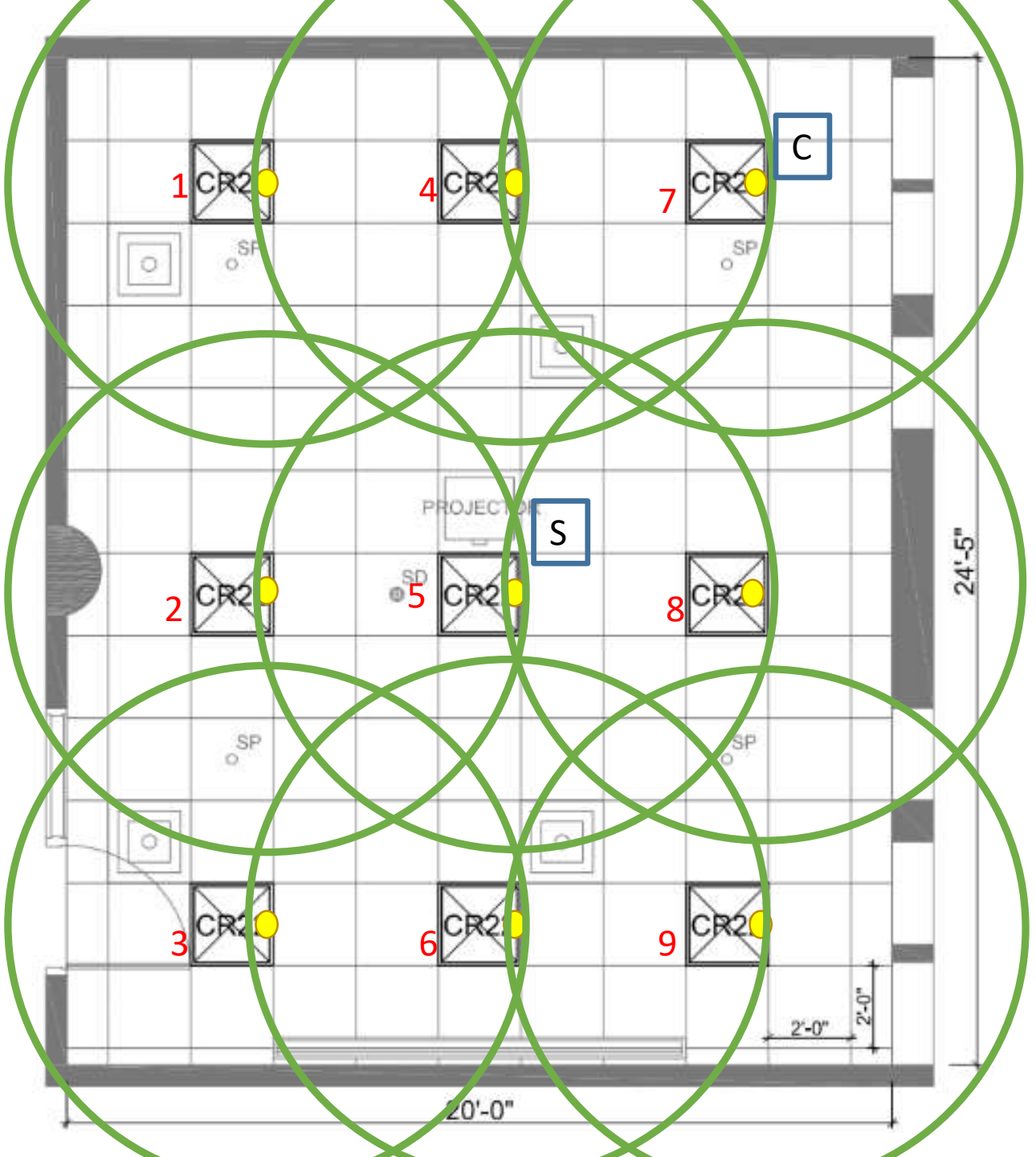
Rm 1106

Assuming 10’ mounting height for sensor.
Coverage = 6’ radius (100 sf)

Entire room is covered.

S Sensitivity Chair Location

C Coverage Chair Location



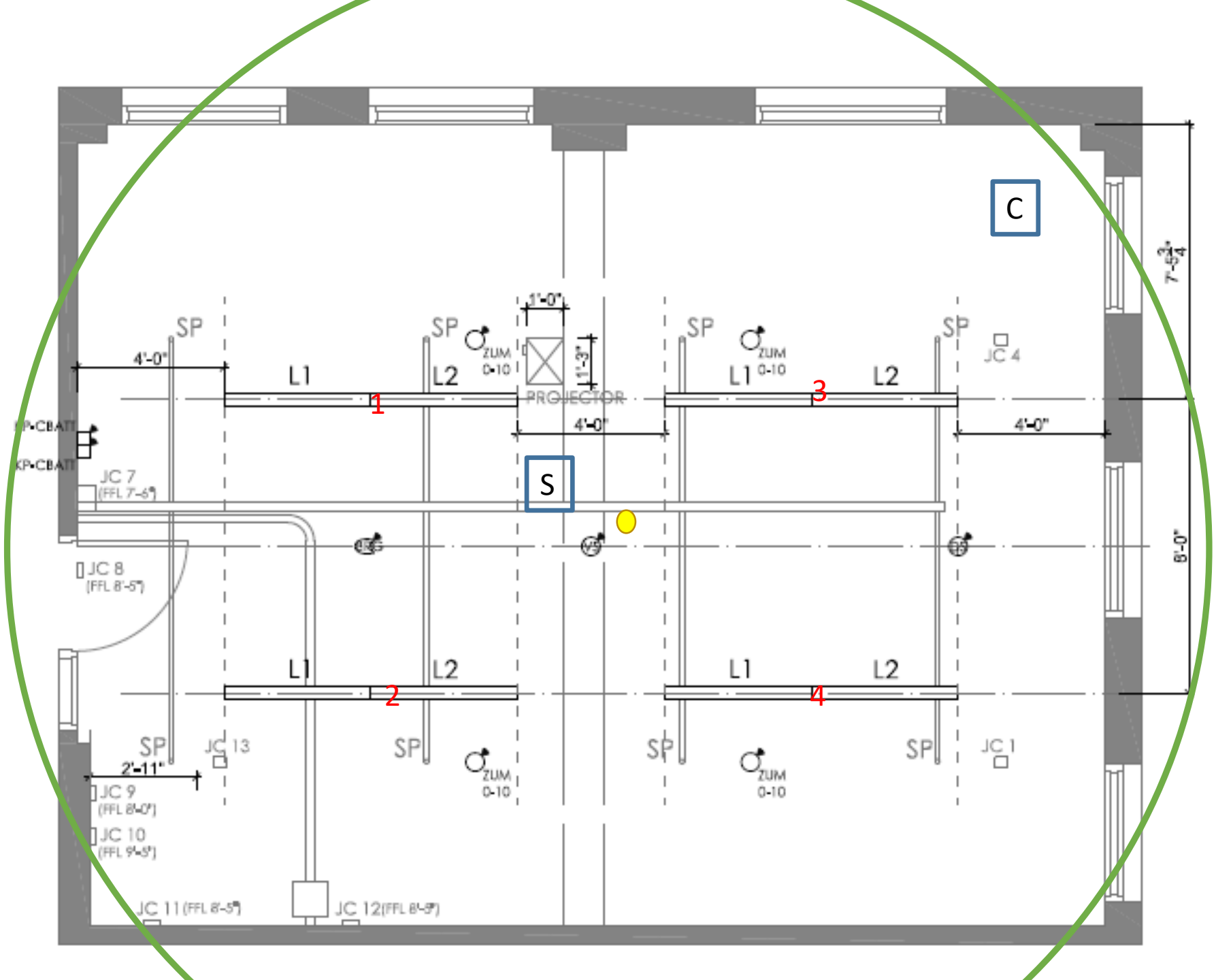
Rm 511

Assuming 10’ mounting height for sensor.
Coverage = 16’ radius

Entire room is covered.

S Sensitivity Chair Location

C Coverage Chair Location

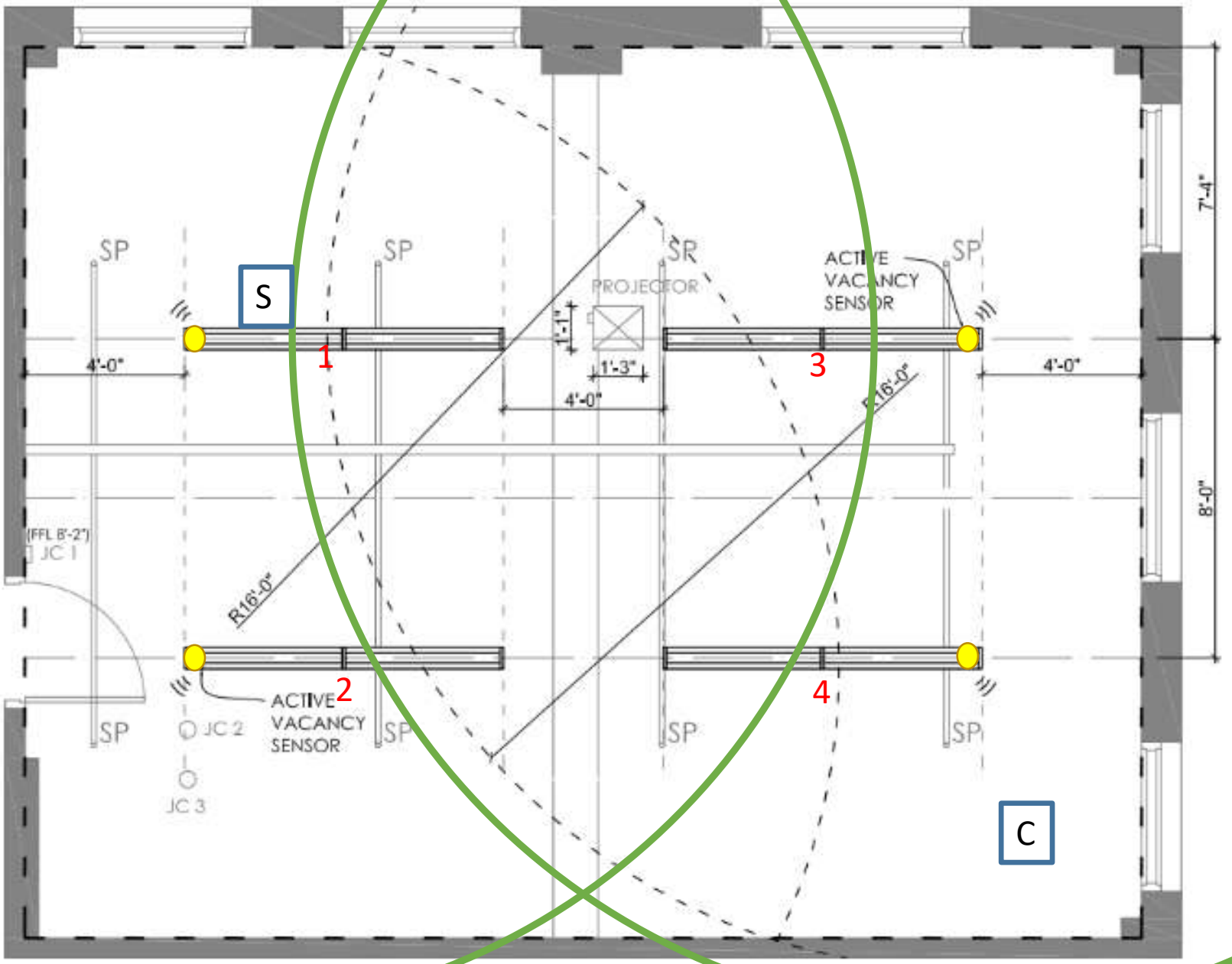


Rm 612

Coverage for each sensor = 16’ radius
Two coverage areas shown for upper luminaires. Other two not shown, as it is clear the entire room will be covered by the 4 sensors.

S Sensitivity Chair Location

C Coverage Chair Location



Rm 811

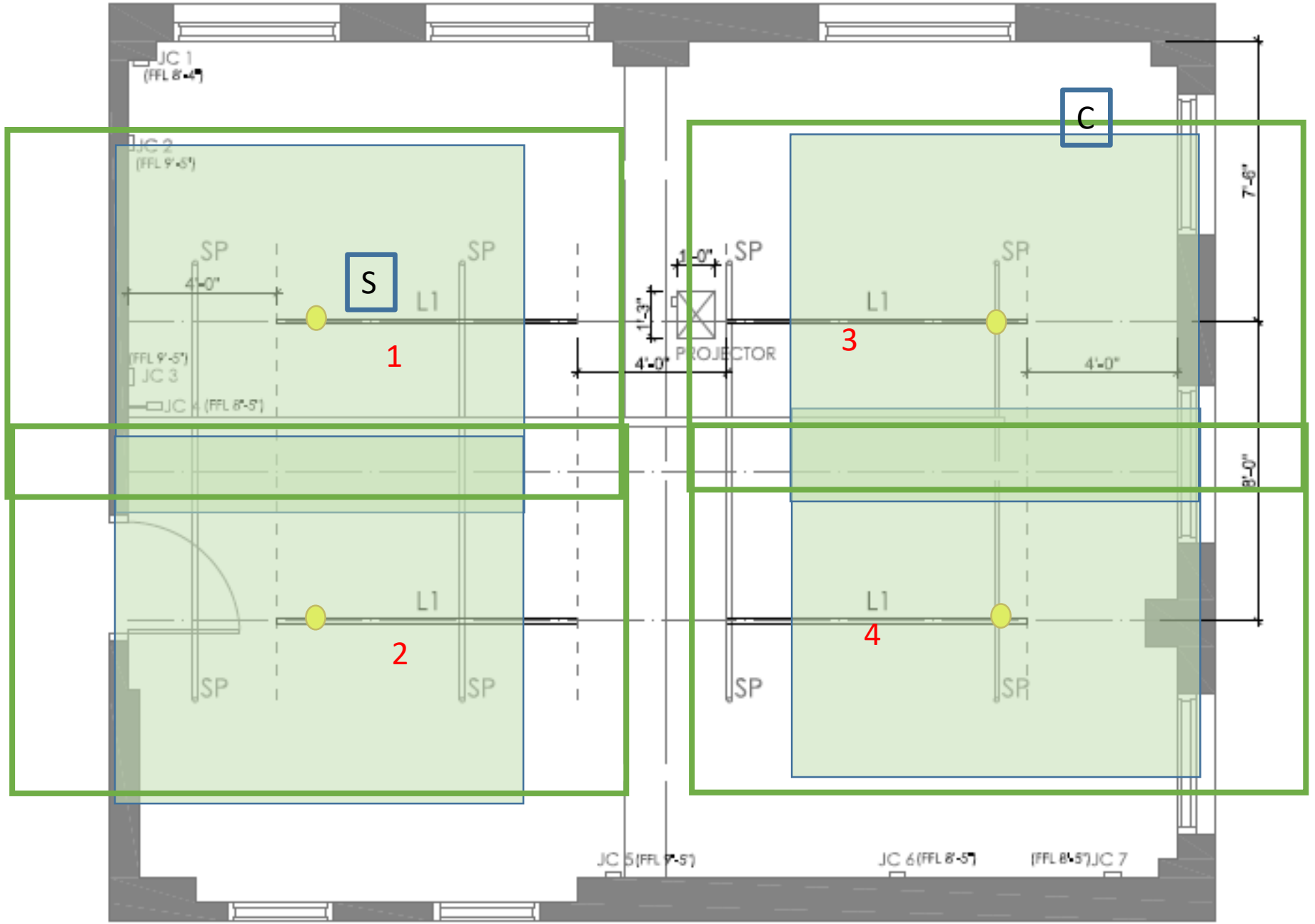
Minor movement
10’ L x 9’ W

Major movement
15’ L x 9’ W

S Sensitivity Chair Location

C Coverage Chair Location

Coverage lacking center and perimeter of room.

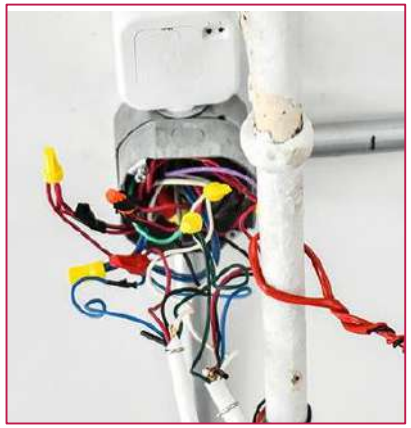


Next Generation
LIGHTING SYSTEMS

Configuration vs. Reconfiguration

System Architecture

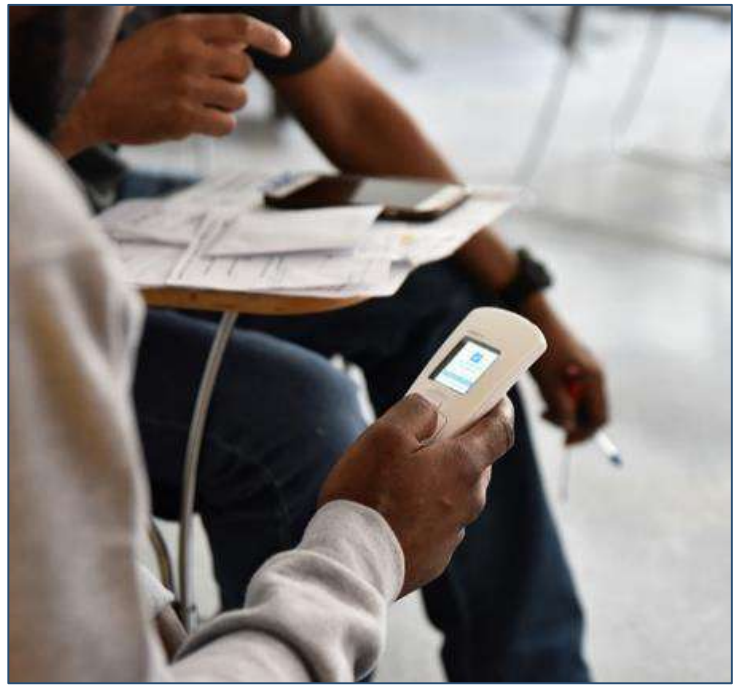
	Least Complex (7)	Moderately Complex (2)	Most Complex (3)
Components	Luminaire-integrated sensor and control Wall switch	Luminaire-integrated sensor and control Wall switch Local area network device	Remote mounted sensor and control Wall switch
Connection	Wireless	Wireless	Wired Wireless PoE



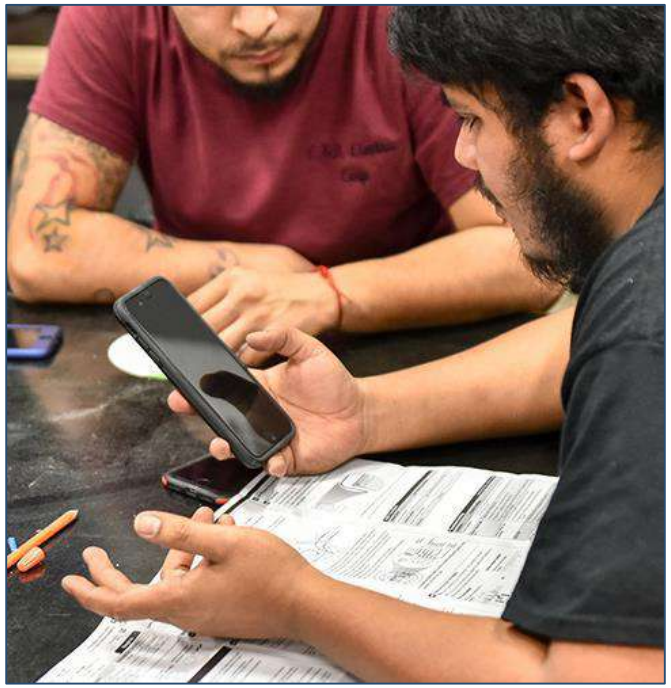
Initial Startup Approach

Pre-configured out-of-the box operation	Onsite pairing of luminaires to wall switches Factory-set default operational settings	Onsite pairing of luminaires to wall switches Various additional steps Factory-set default operational settings	Onsite pairing of luminaires to wall switches Onsite configuration of external daylighting and occupancy sensors
2	4	3	2

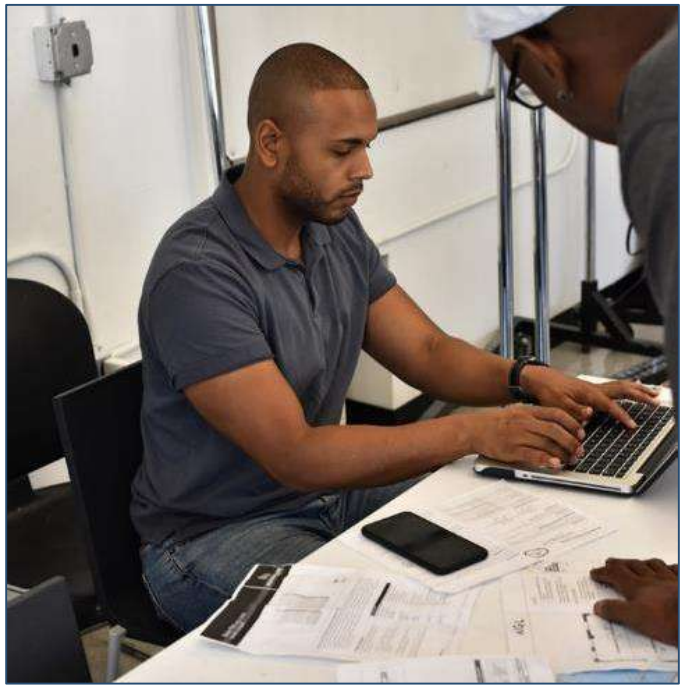
Configuration Tools



Handheld Tool
(1)



Phone App
(8)



Computer Front-end
(3)

Reconfiguration

- How do you figure out if a system is performing correctly?
- How do you change settings if it's not?
- Have you downloaded the app? Is it the latest version? Who has the password?
- Do the instructions you have match the new version of the app?
- Vocabulary!
- What if a switch breaks?
- What if you need to apply a firmware update?

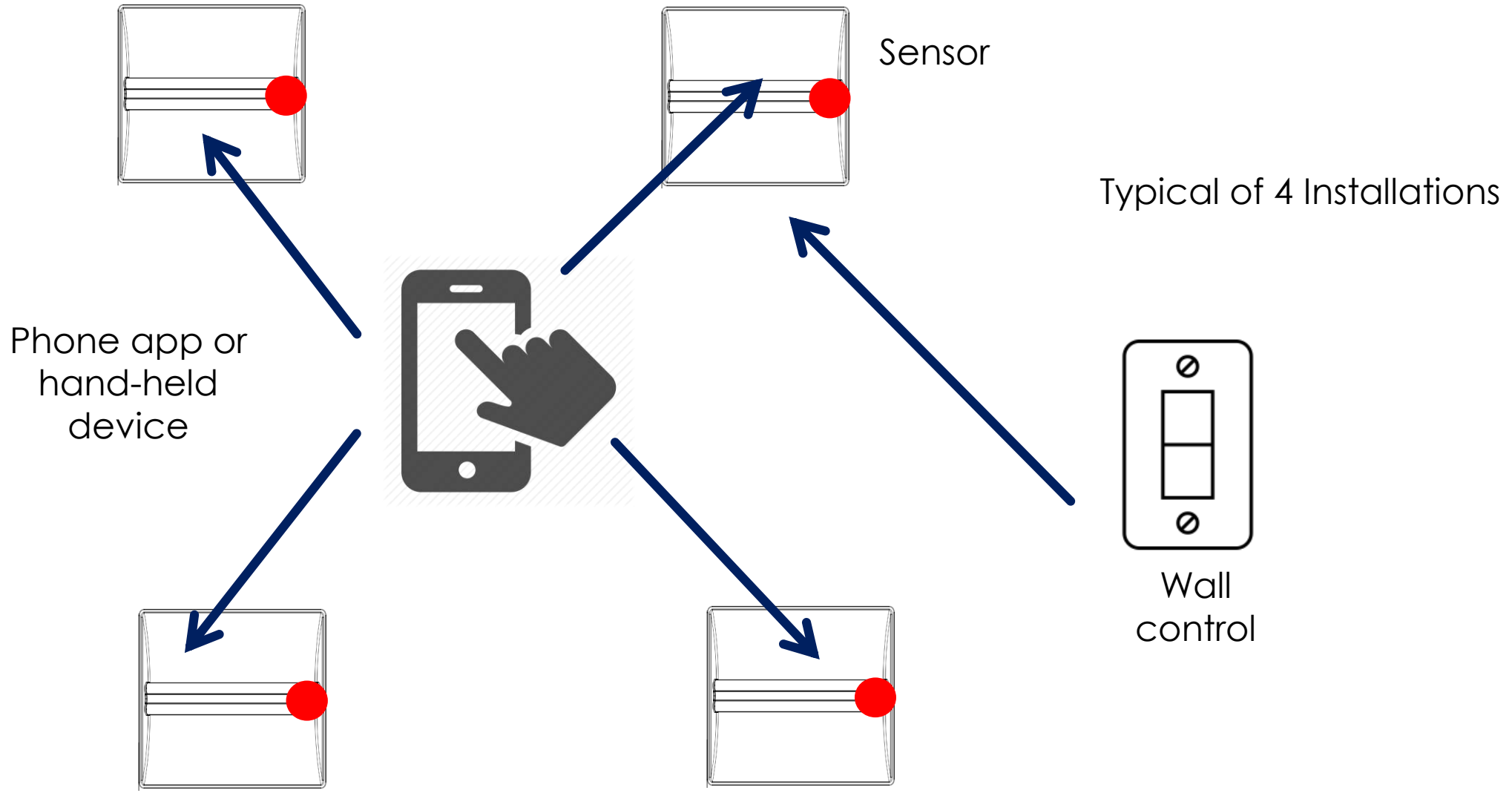
Vocabulary

- Site, building, project
- Room, group, zone
- Device, fixture, switch, sensor, node
- Hub, bridge, gateway
- Discover, find
- Profile, scene, behavior
- Configure, program, adjust
- Write, save, apply, confirm, push
- Timeout period, hold time, prolong time

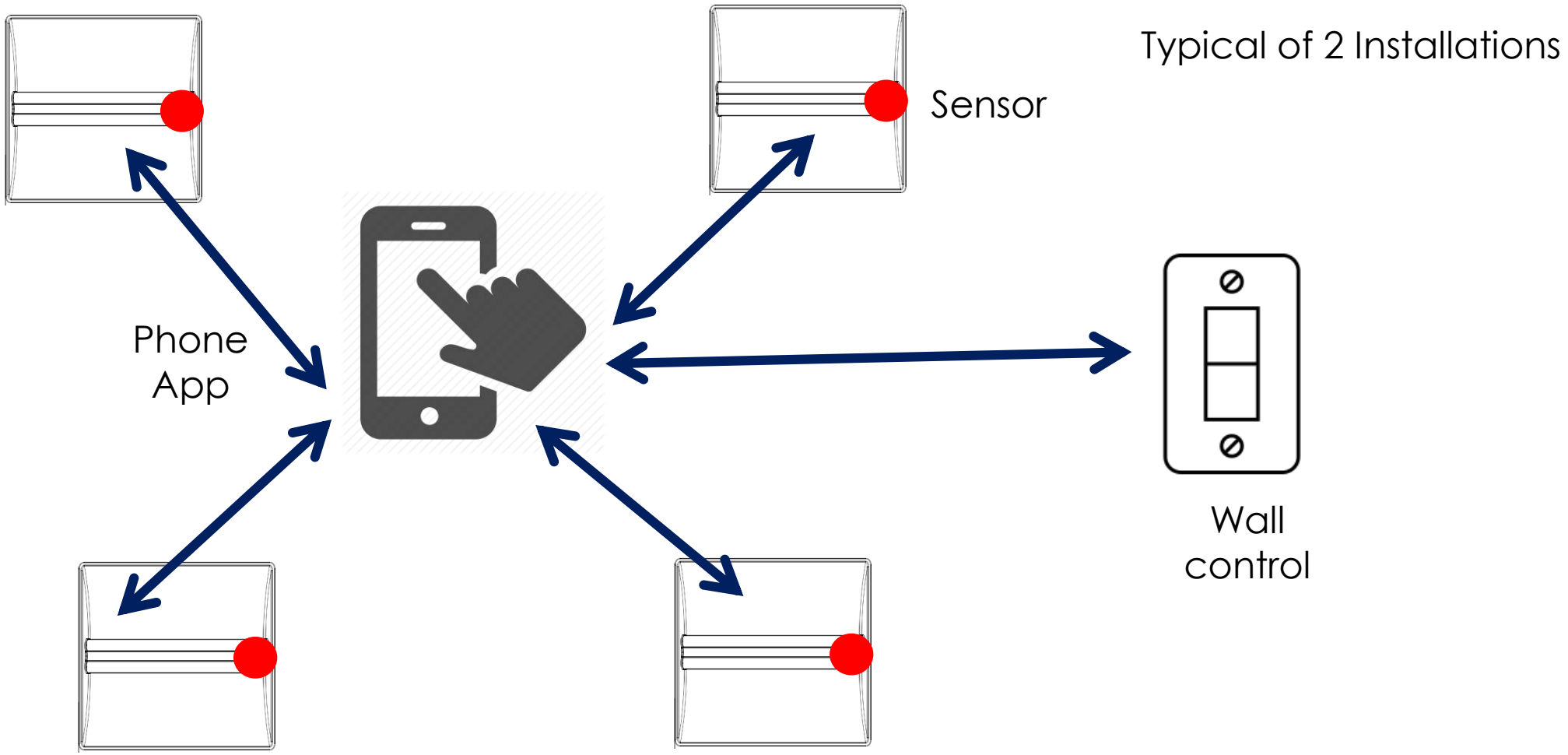
Next Generation
LIGHTING SYSTEMS

Configuration Methods

One-way Communication

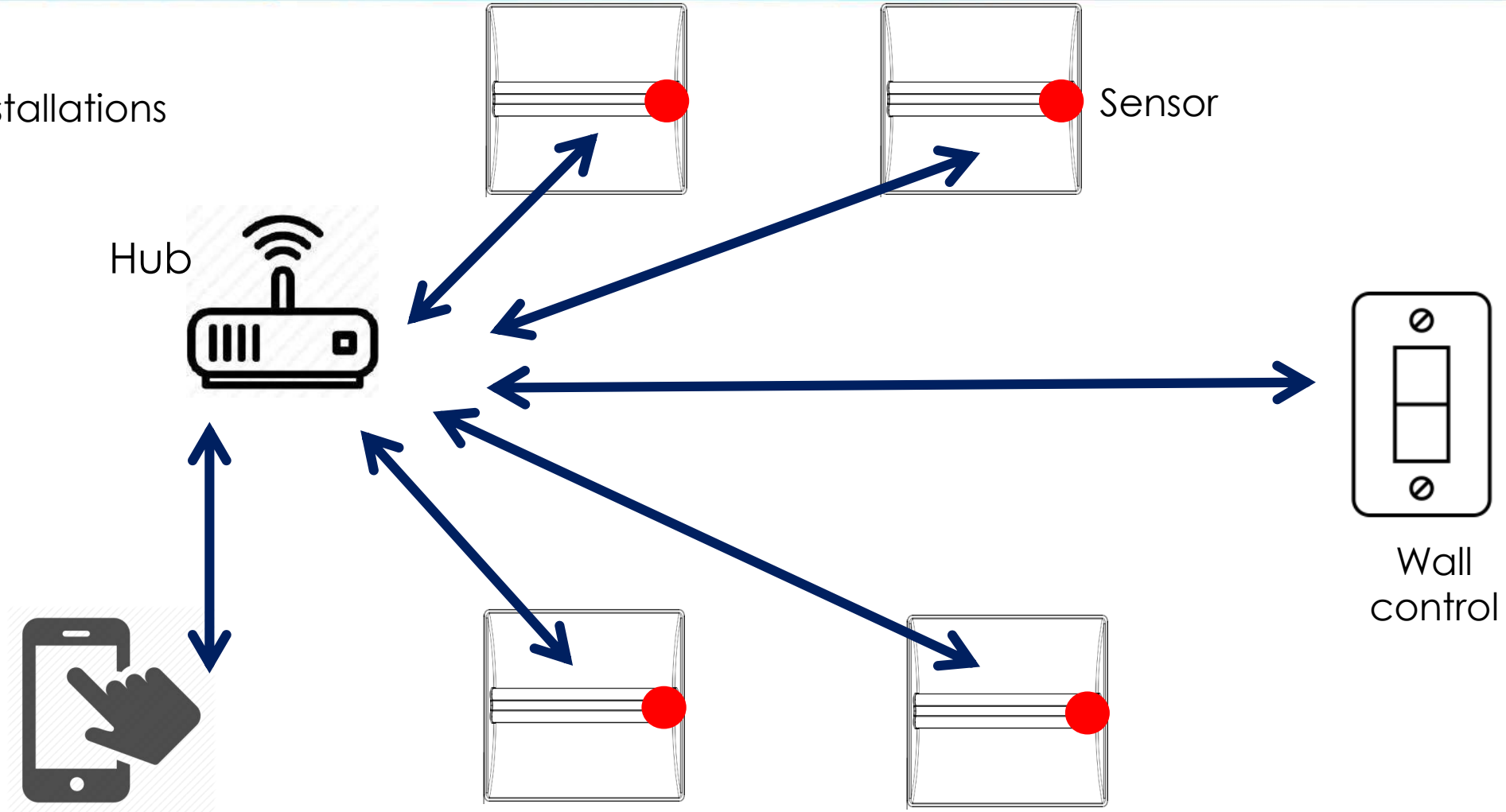


Two-way Communication

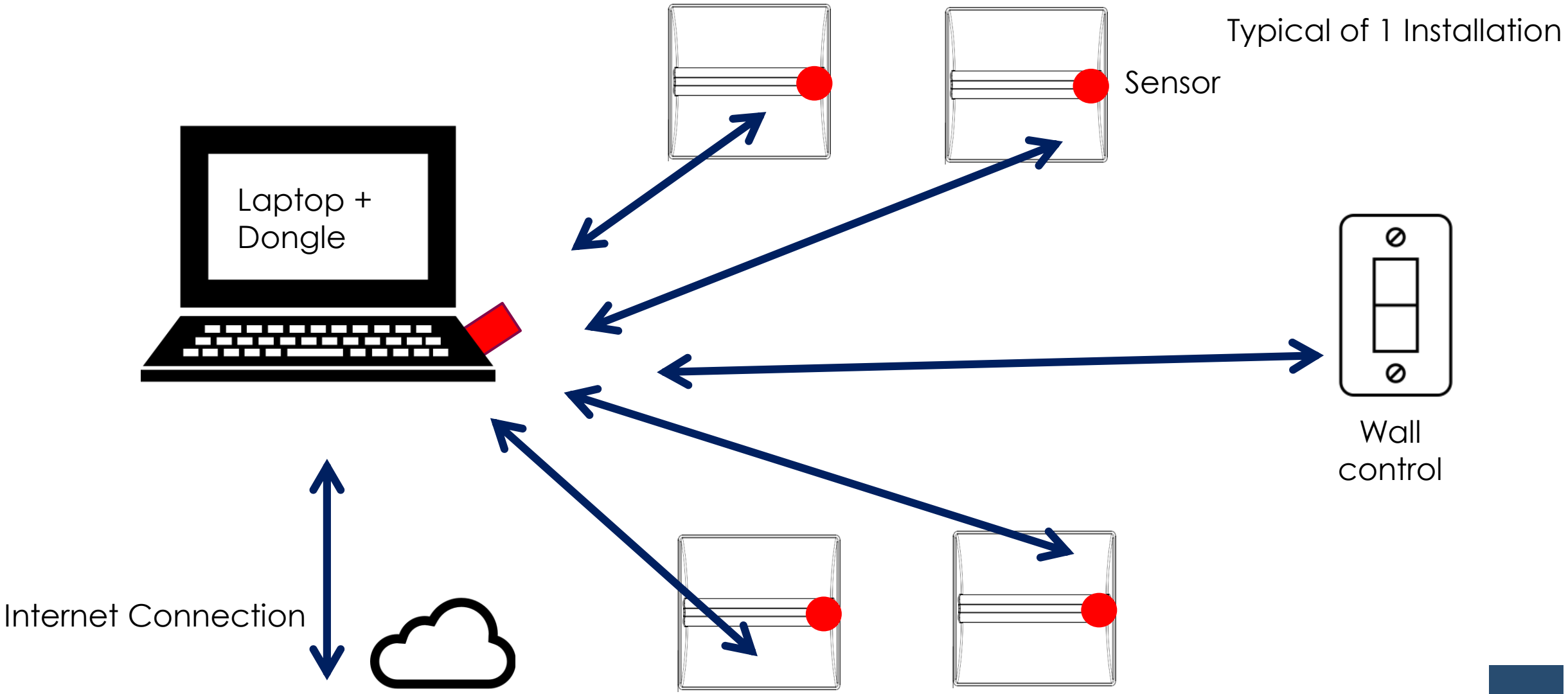


Hub and Phone App

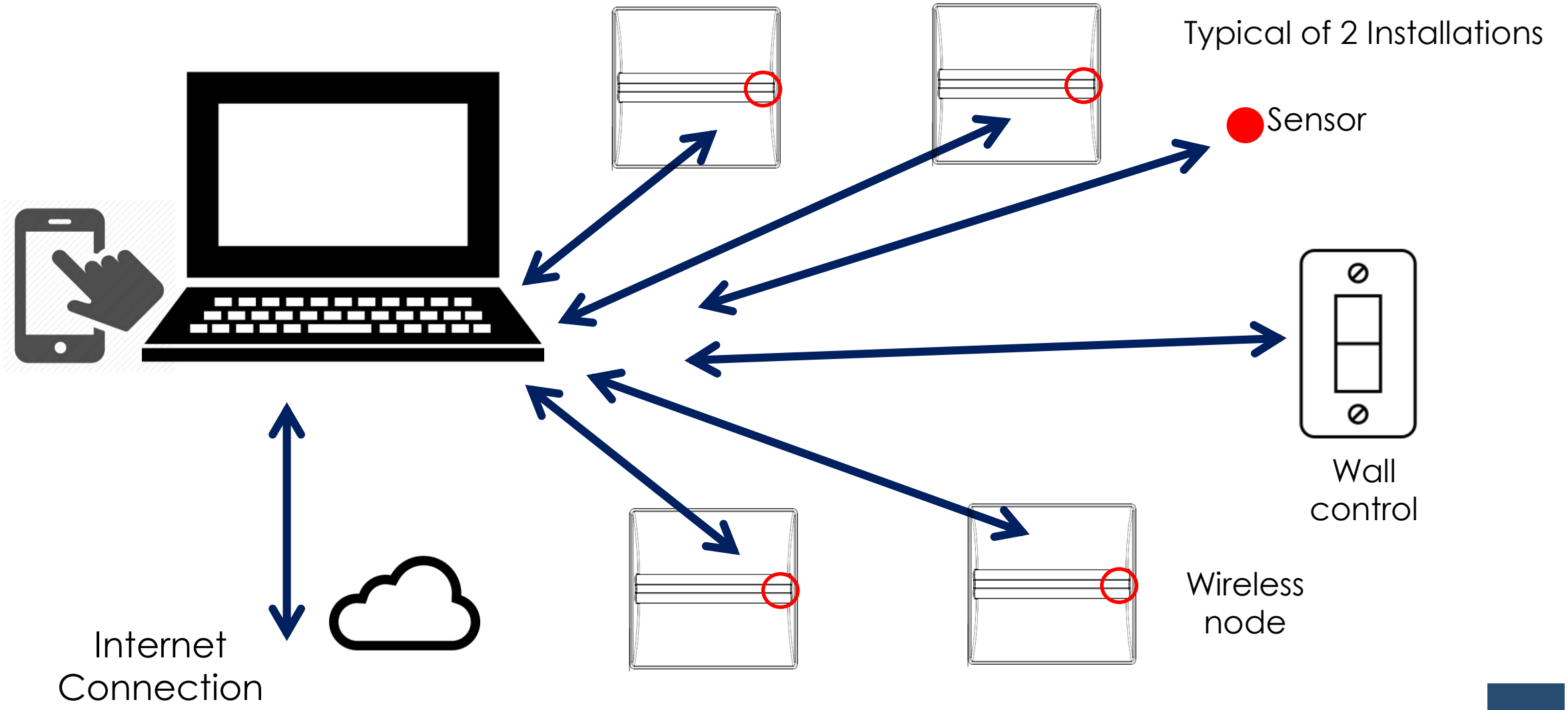
Typical of 2 Installations



Laptop/Tablet + Dongle



Laptop or Phone App and Internet Connection



Upcoming Daylighting Evaluation

- Challenging to determine if daylight response is functioning properly. Visual evaluation is not reliable. Where should illuminance measurements be made? Are luminance measurements better?
- Manufacturers appear to take different approaches to default daylighting algorithms. Some have more aggressive dimming, capturing more energy savings. Some have conservative dimming, lower energy savings but less noticeable to occupants.
- What is the appropriate level of commissioning? Can NGLS inform an effective, easily replicable procedure?

Next Steps

- Updates to currently installed systems
- New indoor evaluations at Parsons
- Outdoor evaluations – parking lot systems, Virginia Tech Transportation Institute

Thanks!

Questions?

This concludes The American Institute of Architects Continuing Education Systems Course

leducation.org

Participating Manufacturers

Installation One – July 2017

Company	Control System	Luminaire
Lumenwerx	Magnum	Reven SIB
Selux	Easy Sense	M36 D-1
Crestron	Zum	Starfire Versalux D-I
Philips Lighting	SpaceWise DT	Sona
RAB Lighting	RAB LightCloud	Swish 2x2
Cree	SmartCast	CR22
Nextek Power Systems	Sky Control	Independence iLED R Series

Installation Two – January 2018

Company	Control System	Retrofit Kit
Philips Lighting	SpaceWise DT	EvoKit Troffer Retrofit Kit
Lutron Electronics	Vive	Orion Ison Retrofit Modular
Acuity Brands	nLIGHT AIR	BLT Relight Series Kit
Eaton	WaveLinx	Metalux Cruze LED Retrofit Kit
LG Electronics	Sensor Connect	Simple Choice Retrofit Kit

Summary of System Performance

	# of Systems Each Rating		
Installation and Configuration Evaluation	**Good**	**Fair**	**Poor**
Ease of Luminaire/Kit Installation	6	3	3
Ease of Control Component Installation	4	4	4
Ease of Initial Configuration	2	5	5
Ease of Adjustment of Control Settings	5	4	3
Ability to Install without Manuf Assistance	6	3	3
Usability of Installation Instructions	0	6	6

Operation Evaluation	**Good**	**Fair**	**Poor**
Operation to Specification	5	2	5
Ability to Operate without Manuf Assistance	5	3	4
Limited Punch List Items	5	1	6