D4i – Data and Power to Connect!

DALI Alliance seminar at Lightfair 2021

DALI® Alliance

DALI®2 D4i™

D4i – Data and Power to Connect!

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- Principal Engineer,
  Lighting and Smart Services, **Georgia Power**

Michael Davidson

- System Architect, **Synapse Wireless**

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What is “Connected Lighting”?

Smart lighting fixtures will drive enhanced energy saving and make Lighting a key driver in the “Internet of Things”

- **Lighting is everywhere where people are**

- **Focus will gradually shift from energy savings to data insights leading to new uses**:
  - Occupancy/space management
  - Building automation / control (HVAC, security, elevators)
  - Retail engagement

- **Lighting provides an opportunity for human centric data collection**
  - Luminaires become the collecting points for local information…..data nodes…….Luminaire OEMs uniquely positioned to be the carrier

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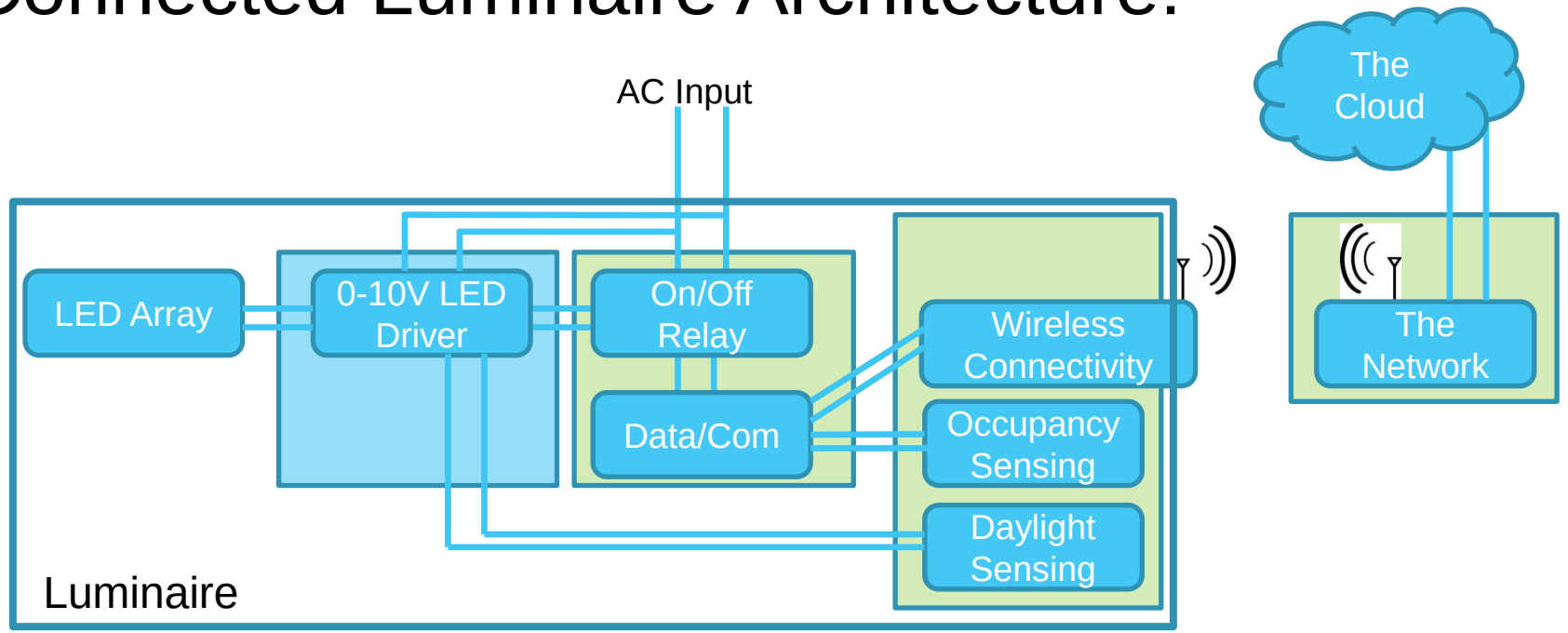
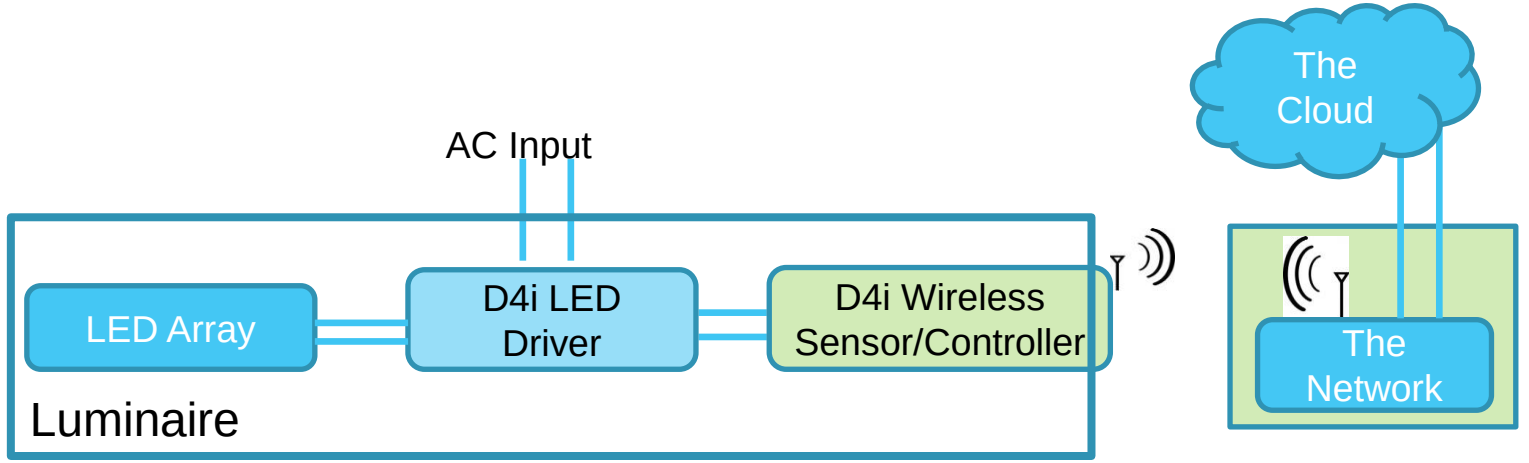
Connected Luminaire Architecture:



Analog 0-10V:

- Complex with many components
- Limited standardization
- No data capability from LED driver
- Reduced reliability - AC mains connection to multiple components

0-10V Dim2OFF with Aux is in between, but still no data from LED driver.



Digital D4i:

- Simple with few components
- Standardized connection for power and digital data from LED driver
- High reliability – AC mains to the LED driver only

D4i overview

- D4i is an extension of DALI-2 certification
- D4i components have a compulsory set of features
  - Based on power-supply and data specifications from DiiA
- All D4i LED drivers provide luminaire, energy & diagnostics data
- D4i enables DALI inside intelligent, IoT-ready luminaires
- D4i simplifies addition of sensors and communication devices (NLC) to luminaires
- D4i enables plug-and-play interoperability when combined with a connector system
  - e.g. Zhaga Book 18 & 20 or NEMA/ANSI C136.41

DiiA Specifications – Published

- The following specifications can be downloaded from the DiiA website

Specification	Name	Version	Certification?
Power supply specifications			
DALI Part 150	AUX Power Supply	v1.1, Oct 2019	✓
DALI Part 250	Integrated Bus Power Supply	v1.1, Oct 2019	✓
Data specifications for LED drivers & other control gear			
DALI Part 251	Luminaire Data	v1.1, Oct 2019	✓
DALI Part 252	Energy Data	v1.1, Oct 2019	✓
DALI Part 253	Diagnostics Data	v1.1, Oct 2019	✓
Specifications for control devices			
DiiA Part 351	Luminaire-mounted Control Devices	v1.0, Oct 2019	✓

DiiA power-supply specifications

DALI Part 250 – Integrated Bus Power Supply

- For control gear (e.g. LED drivers) with an integrated DALI bus power supply (PSU)
  - Suitable for powering some devices – such as sensors – on the bus

- PSU can be enabled or disabled – allowing use in systems with multiple bus PSUs
- For D4i certification, Part 250 must be included, with the bus PSU enabled by default

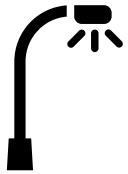
DALI Part 150 – AUX Power Supply

- 24V DC power supply
- Can be built into control gear, or designed as a stand-alone product
- Suitable for devices with higher-power requirements
  - e.g. City-wide wireless transceivers
- Provides 3W average, 6W peak

DALI data specifications for control gear

- Data for enhanced asset management & performance monitoring
- Data storage in DALI memory banks, with standardized format & locations

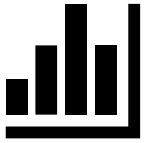
Luminaire Data



DALI Part 251 – Luminaire Data

- Information about the luminaire (e.g. ID code, light output, CCT & CRI, light distribution etc) can be stored in the control gear
- Enables asset management

Energy Data



DALI Part 252 – Energy Reporting

- Provides real-time power & energy usage for control gear

Diagnostics Data

DALI Part 253 – Diagnostics & Maintenance

- Operating data for control gear and lamps, including failure conditions, run-time data
- Enables predictive maintenance

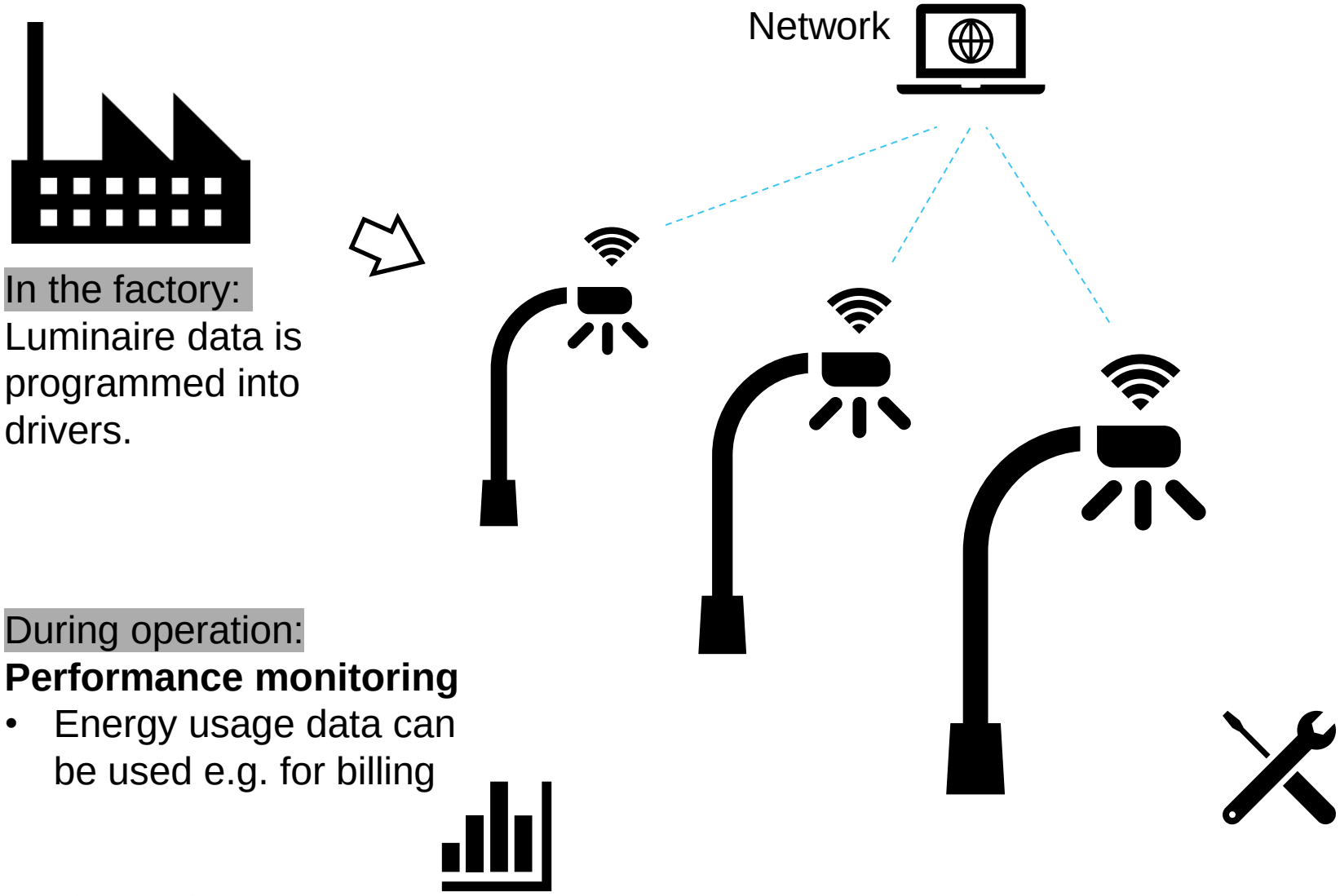
Benefit Summary – D4i Drivers vs 0-10V

Benefit	Driver Feature	Feature Description	0-10V	0-10V Dim2OFF w/Aux	D4i
Ease of maintenance and Asset Management	Asset management via DALI scenes	Use limited space in DALI scenes for unique vendor code and manual lookup tables to correlate to specific fixture			✓
	Asset management via MB1	Standardized method for storing vendor specific information in the driver; No lookup table required.			✓
	Memory Banks with Diagnostics Data	Data such as voltages, surges, currents and thermals made available back through NLC for analysis			✓
Ensure/monitor energy savings	Memory Banks with Power/Energy metering Data	Measured power and energy data. Supports DLC NLC QPL listing and thus qualify for utility rebates.			✓
High reliability	Integrated switching, and Low Voltage power supply	Eliminates mains protection and relay. No need for separate low voltage supply for the NLC.		✓	✓
Easy integration	Built-in DALI Bus Power Supply	Simple two wire connection from the driver to the NLC node to supply power and data			✓
System interoperability assurance	D4i Certification program	Testing assures DALI communication protocol robustness and D4i specified power and data availability to NLC.			✓

Part 351 for control devices

- **DiiA Part 351 – Luminaire-mounted control devices**
  - Examples: Sensors, wireless communication nodes
- Control devices can be bus-powered or externally powered (e.g. by AUX supply).
- Part 351 specifies four types of control device (types A-D)
  - Covering both indoor and outdoor applications
  - Including devices such as wireless network lighting controllers (NLCs), photocells (light sensors), movement sensors and timers
- Specification includes:
  - Requirements for power consumption
  - A mechanism to arbitrate between multiple application controllers
  - A memory bank definition for multi-master devices
- Part 351 is mandatory for D4i certification

DALI data: An outdoor lighting example



In the factory:
Luminaire data is programmed into drivers.

During operation:
Performance monitoring
- Energy usage data can be used e.g. for billing

In the field:
Automated commissioning
- When installed, luminaire can automatically transfer data to remote network
- Reduces human error, saves installation time and cost
- Operator has a full map of asset information

During operation:
Predictive maintenance
- Diagnostics data allows network operator to anticipate need for maintenance
- Repair team has knowledge of location and type of fixture

Technology standards driving connected lighting adoption

Introduced **North America standard** for *energy reporting, diagnostics,* and *asset management* for LED drivers (C137.4)

Defined **global requirements** for *energy reporting, diagnostics,* and *asset management* for LED drivers (D4i)

Energy monitoring is a *required* interior/exterior NLC system capability (V4.0)

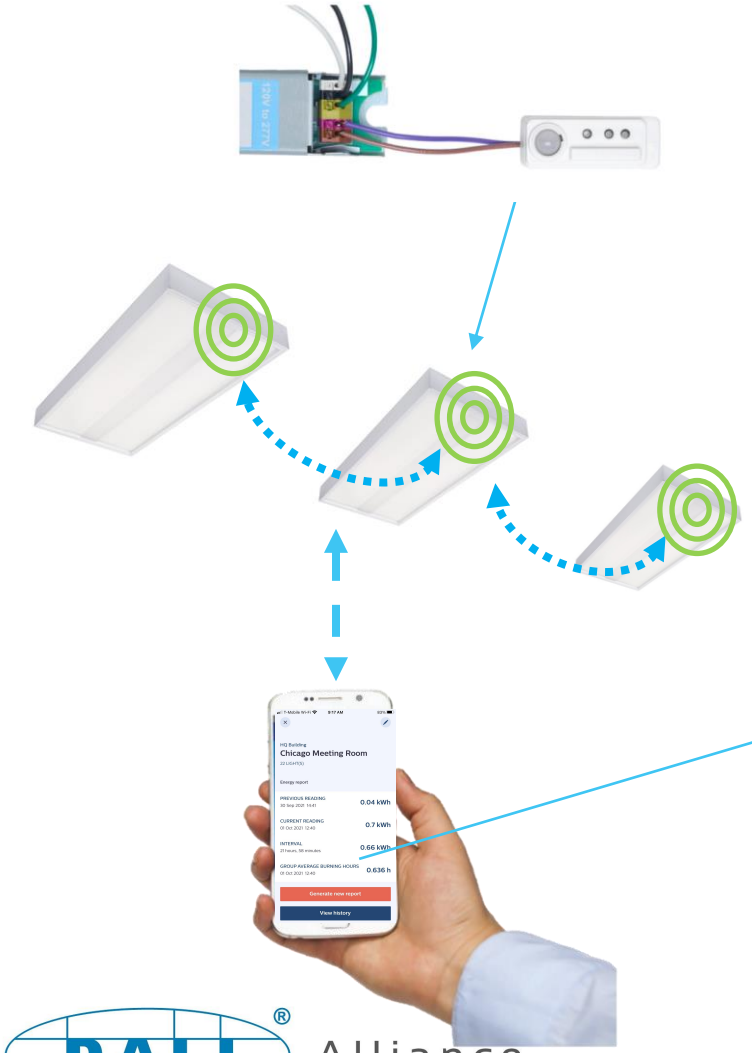
- Standardize luminaire data format (e.g. luminaire asset data)
- Encourage new usage of data
- Accelerate adoption of connected lighting
- Greater design flexibility in lighting control

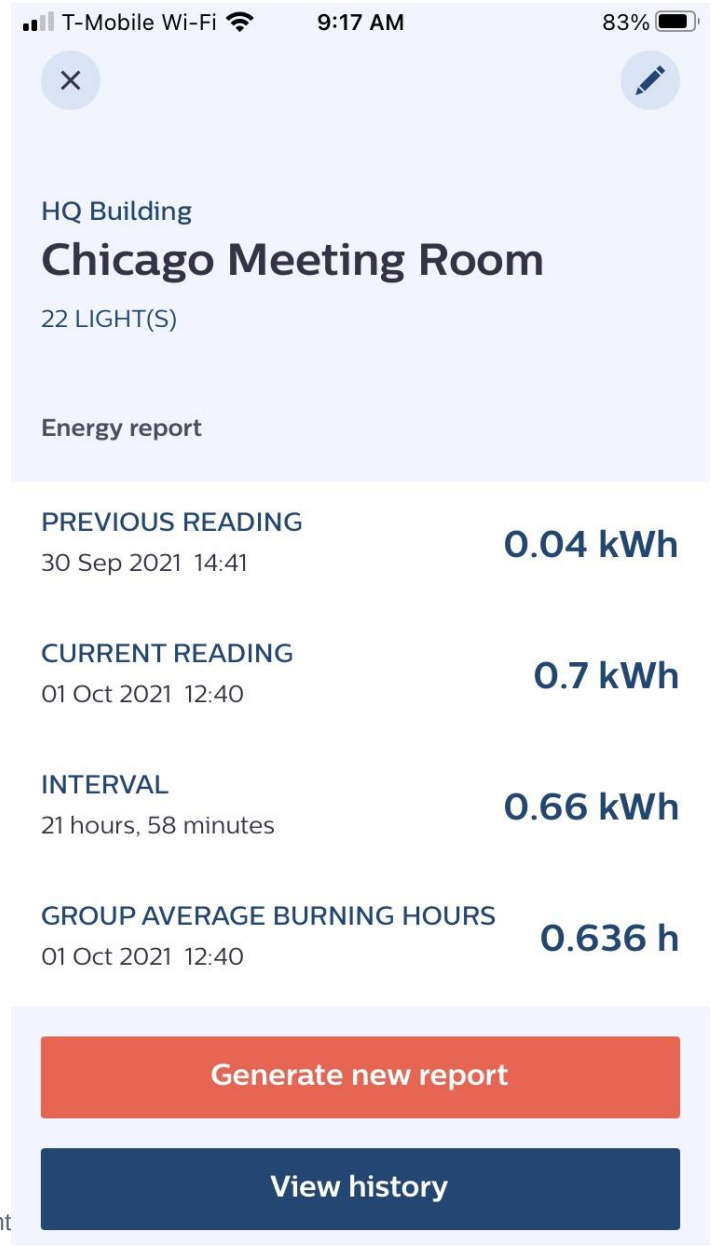
Application Examples : Benefits of D4i/DALI-2 Data

- *Next few slides show application examples from several Lighting Control system manufacturers*
- *Some of the controllers/systems are still under development as noted.*
- *Controllers may not be D4i/DALI-2 certified.*

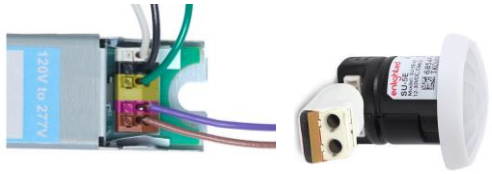
Indoor Application: Philips EasySense with Energy Report for a Room

Philips EasySense &
Advance Xitanium SR - **D4i LED Driver**

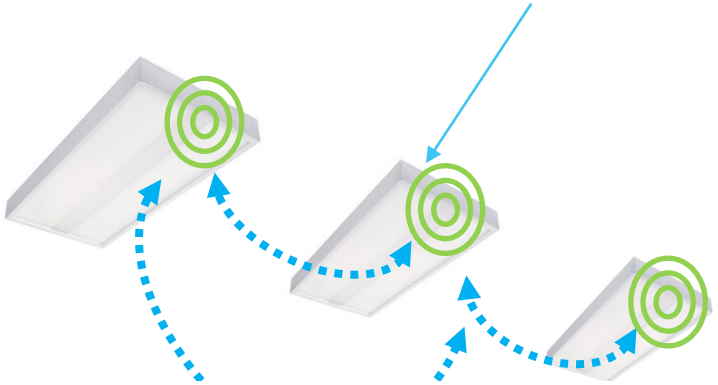


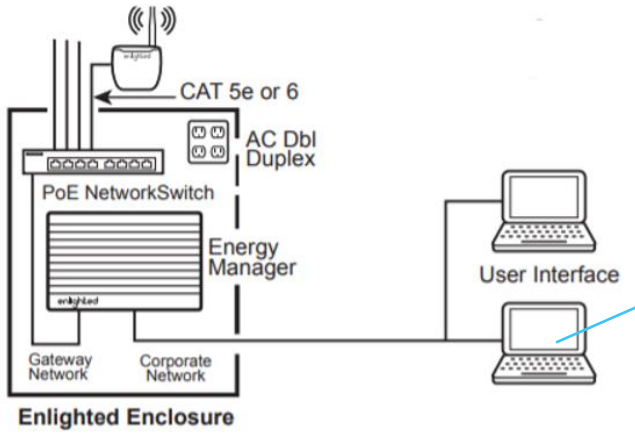


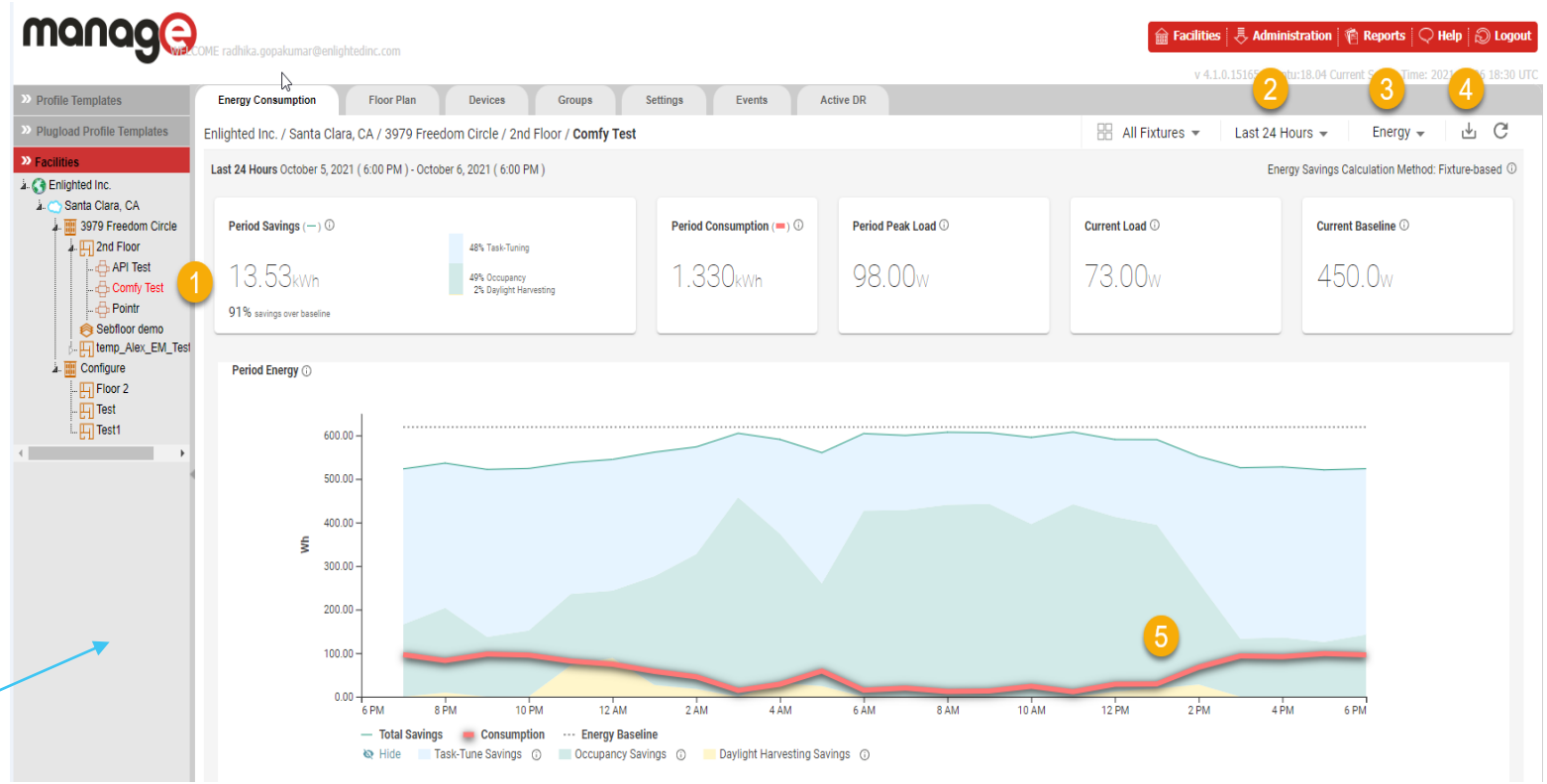
Indoor Application: Enlighted System featuring Energy Report for full facility



Enlighted Sensor &
Advance Xitanium SR - **D4i LED Driver**



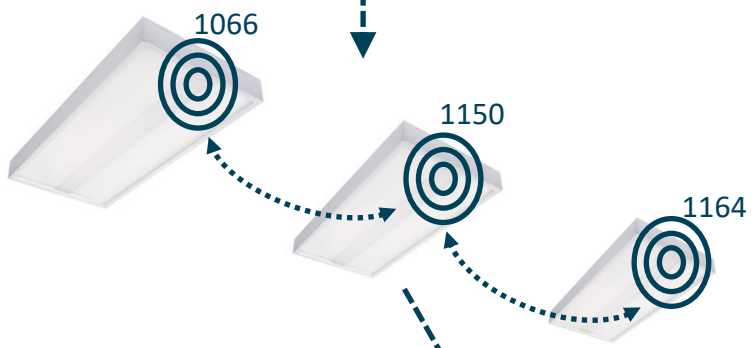


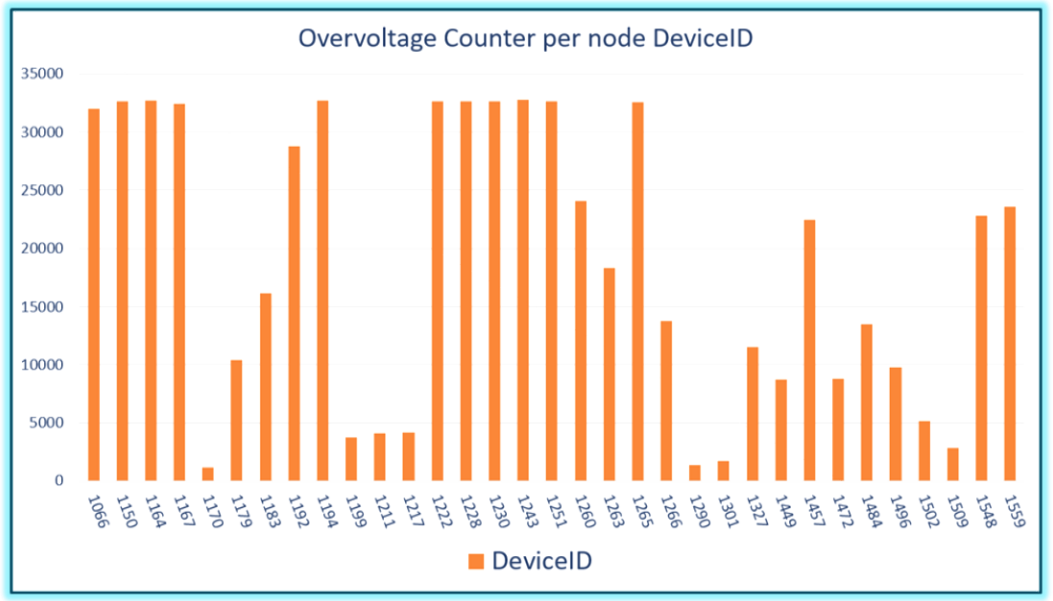


Indoor Application: Nedap System featuring Over-Voltage Diagnostics

Philips Xitanium SR
D4i LED Driver

Nedap
Luxon IoT Node





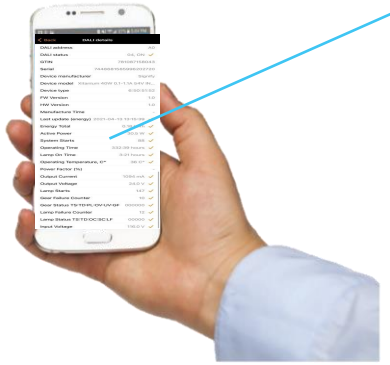
Data from actual installation.
Commercial Dashboard under development

Outdoor Application: Comprehensive set of Luminaire data using McWong Wireless System

Advance Xitanium SR - D4i LED Driver

McWong DALI Wireless Fixture Controller*

** Product under development / not certified*

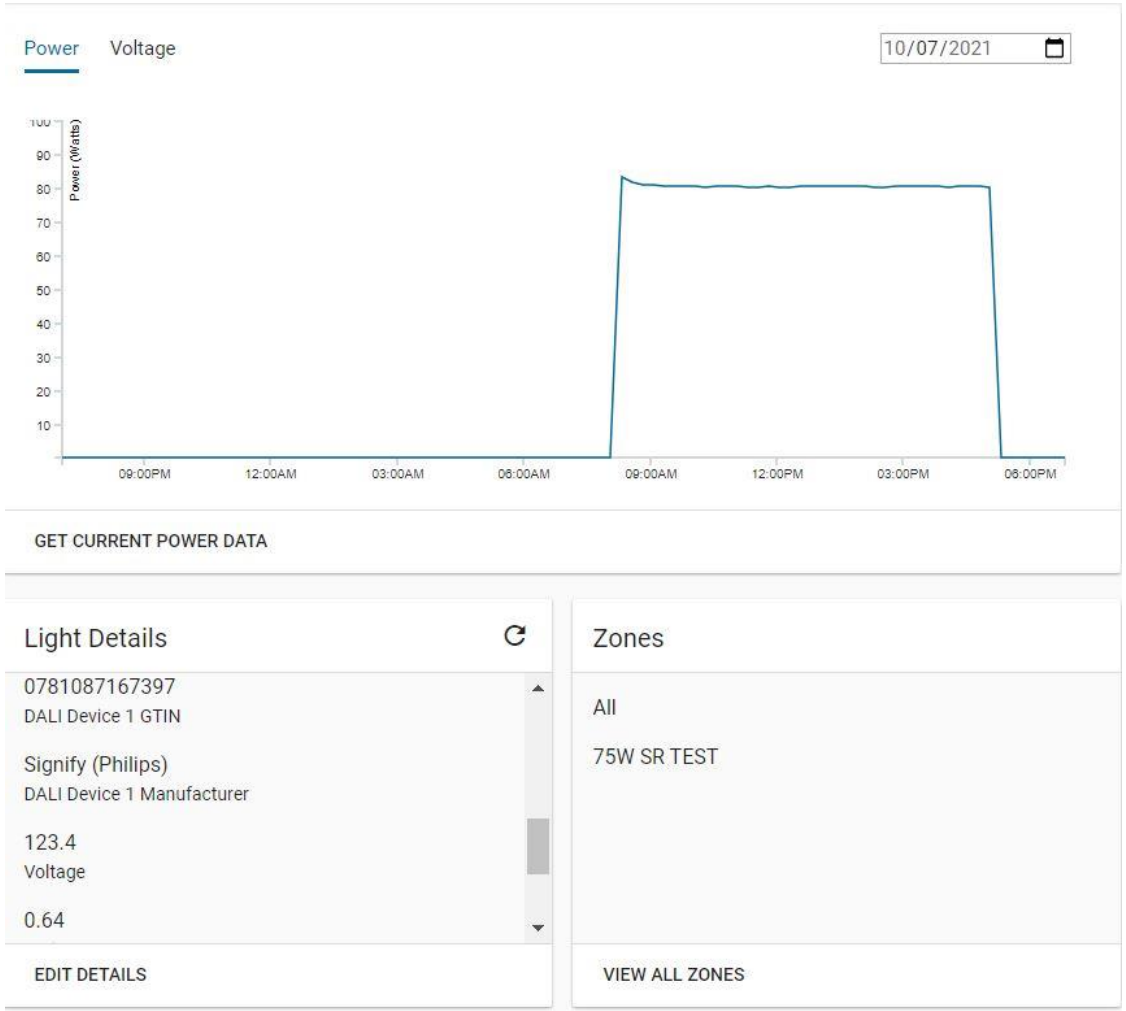


Back	DALI details
DALI address	A0
DALI status	04, ON ✓
GTIN	781087158043
Serial	74486815859962027 20
Device manufacturer	Signify
Device model	Xitanium 40W 0.1-1.1A 54V IN...
Device type	6:50:51:52
FW Version	1.0
HW Version	1.0
Manufacture Time	-
Last update (energy)	2021-04-13 13:15:39 ✓
Energy Total	0.18 kWh ✓
Active Power	30.5 W ✓
System Starts	88 ✓
Operating Time	332:39 hours ✓
Lamp On Time	3:21 hours ✓
Operating Temperature, C°	36 C° ✓
Power Factor (%)	-
Output Current	1094 mA ✓
Output Voltage	24.0 V ✓
Lamp Starts	147 ✓
Gear Failure Counter	10 ✓
Gear Status TS:TD:PL:OV:UV:GF	000000 ✓
Lamp Failure Counter	12 ✓
Lamp Status TS:TD:OC:SC:LF	00000 ✓
Input Voltage	116.0 V ✓

Outdoor Application: Luminaire asset & power data using Synapse system

Advance Xitanium SR
D4i LED Driver

Synapse
Wireless DALI Controller



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DALI® Alliance

Georgia Power

Lighting & Smart Services

Earning customer loyalty by delivering exceptional value through lighting and smart services.

Future Proofing and Interoperability from a Utility's Perspective

Kevin Fitzmaurice - Principal Engineer - Georgia Power

Vision

To be the most valued and trusted utility lighting and smart solutions provider.

Mission

To earn customer loyalty by delivering exceptional value through lighting and smart services.

Guiding Principles

- Guided by CULTURE
- Lead by STRATEGY
- Focused on CUSTOMER
- Informed by DATA
- Enabled by TECHNOLOGY
- Optimized for RESULTS

Georgia Power – What do we do?

Investor owned utility (IOU) providing electricity to 2.6 million customers

Own, operate and maintenance ≈900,000 outdoor luminaires

- ≈350,000 roadway luminaires
- ≈550,000 area luminaires

Provide "Smart Services" such as:

- Monitoring and control of outdoor luminaires
- Video and license plate recognition (LPR)
- Gun shot detection
- Environmental monitoring
- Pedestrian and vehicle counting
- Small cellular (4G/5G) on lighting poles

Georgia Power – What are we doing?

- Converting ≈900,000 luminaires to LED with networked lighting controllers (NLC)
- Monitoring LED luminaires with a wireless network and central management system
- Utilizing digital communication protocols (e.g., DALI, DALI-2, D4i) in our LED luminaires
- Using sensors for additional functionality
- Actively participating on lighting standards committees (e.g., ANSI, IES)

Why do we use digital communication protocols and which ones do we use?

To provide two-way communications between LED drivers, sensors and networked lighting controllers (NLCs)

DALI, DALI-2 and D4i were selected because they are established protocols with published standards, have a positive track record and provide the functionality needed

Lighting & Smart Services

What about sensor interfaces?

- Georgia Power needs standardized sensor interfaces
- These interfaces need to be locking type for easy installation or removal of sensors
- These interfaces are needed so Georgia Power can “future proof” its luminaires
- Georgia Power selected the 7-pin ANSI C136.41 control receptacle on the top of the luminaire for NLCs or PCs
- Georgia Power selected the 4-pin ANSI C136.58 (Zhaga Book 18) interface on the bottom of the luminaire for sensors

Lighting & Smart Services

Do these standardized control and sensor receptacles meet Georgia Powers' needs?

Yes!

- Provides a standardized environment for digital communication between our digital drivers, sensors and networked lighting controllers (NLCs)
- It allows Georgia Power to "future proof" its luminaires
- It allows for easy installation and removal of controls and sensors
- It provides a standard framework for manufacturers of drivers, sensors, controllers and luminaires to use for design and production of the tools the lighting industry and Georgia Power need today

Lighting & Smart Services

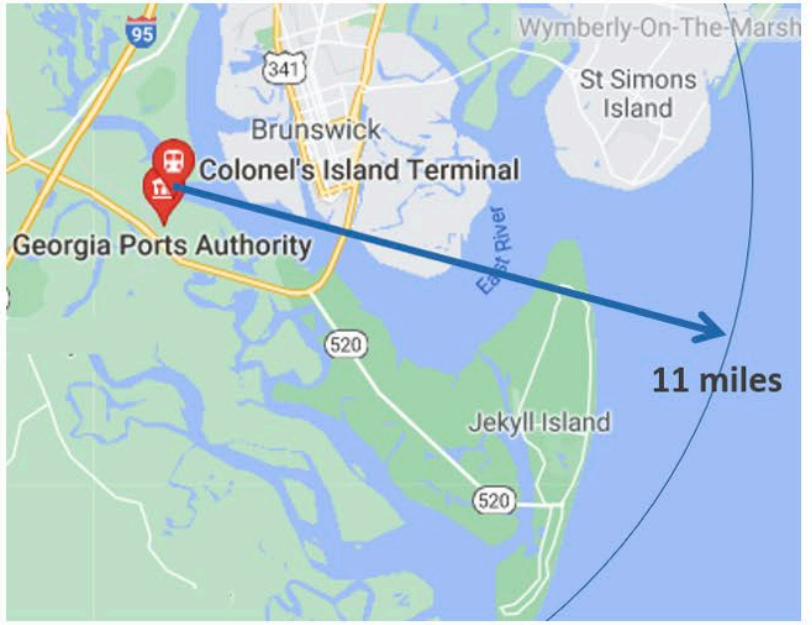
Let’s conclude with a case study

Lighting & Smart Services

Georgia Ports Authority - Port of Brunswick, GA

The port on Colonel's Island is less than 11 miles from turtle sanctuaries on Jekyll Island

Photo by Georgia Ports Authority



Google Maps

Lighting & Smart Services

Case Study: Georgia Ports Authority

Georgia Power installed Cooper Lighting Solutions Navion LED luminaires with Signify sensor ready (SR) drivers, Legrand Wattstopper presence sensors and Telensa NLCs

This configuration provides low lumen output (30% of full) during nighttime hours unless activity (presence) is detected. Activity triggers 100% lumen output until there is 15 minutes of inactivity when the power reduces back to low output (30%)

This assembly provides automatic low or high lumen output, remote monitoring, energy metering and remote operational control

The customer reduces sky glow near a sea turtle nesting area and reduces energy usage


Georgia Power

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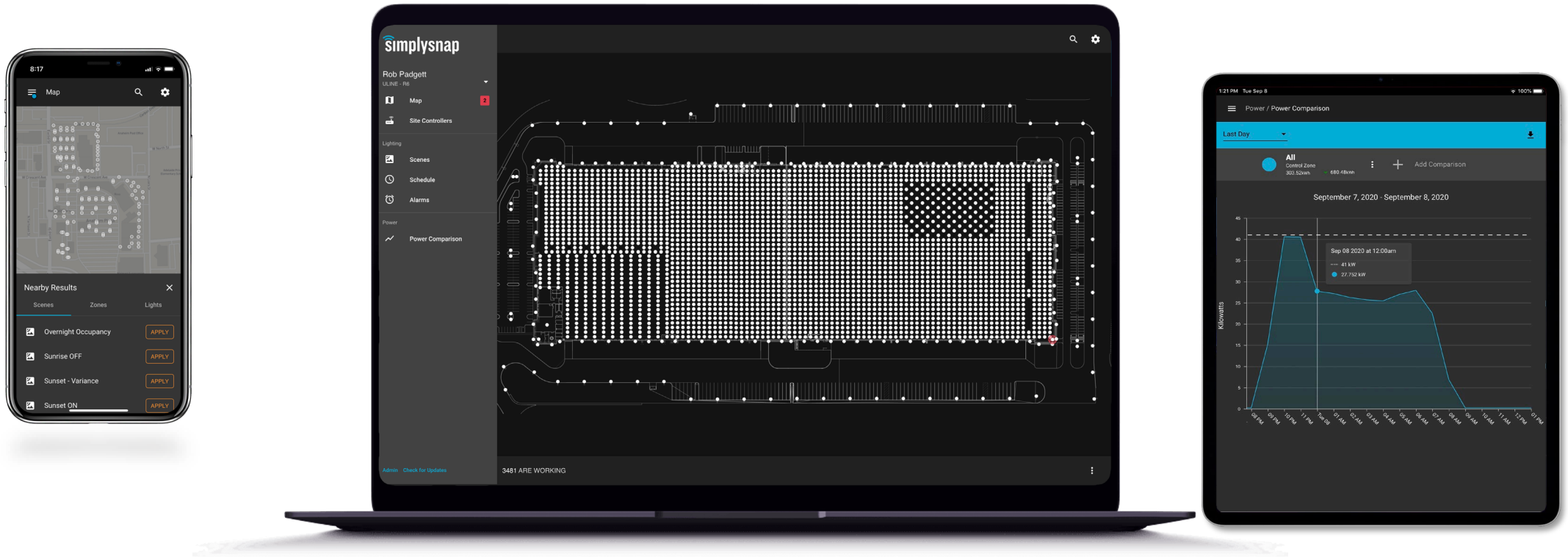
DALI® Alliance

- What else can DALI-2 and D4i Provide?
- What applications can we Specify for D4i?
- Does D4i Help with Energy Audits?
- Can D4i Help save Energy?

D4i Brings the Information that lives on the DALI-2/D4i LED Driver Front and Center – Asset Info, Power Info, Power Saving Strategies, Temperature, Voltage Spikes, and Diagnostics



COMPLETE CONTROL

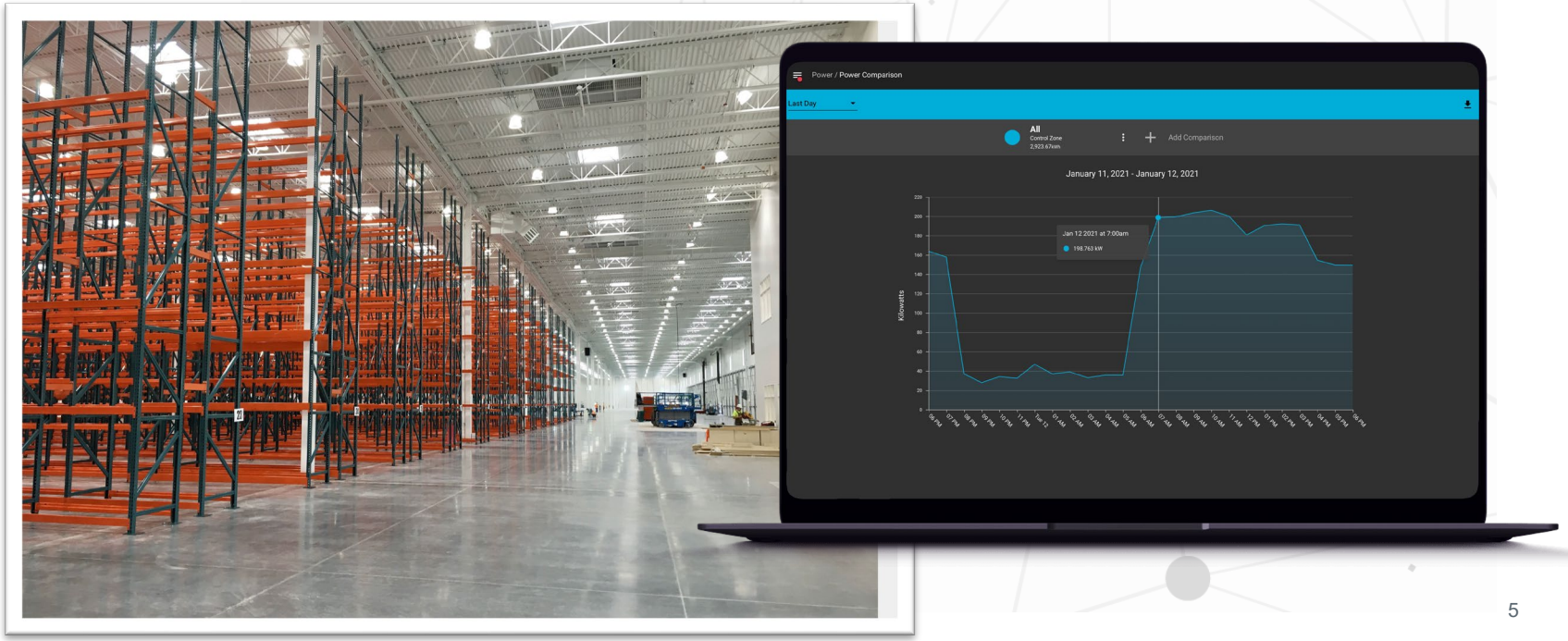
- Zoning
- Task Tuning
- Flexible Schedules

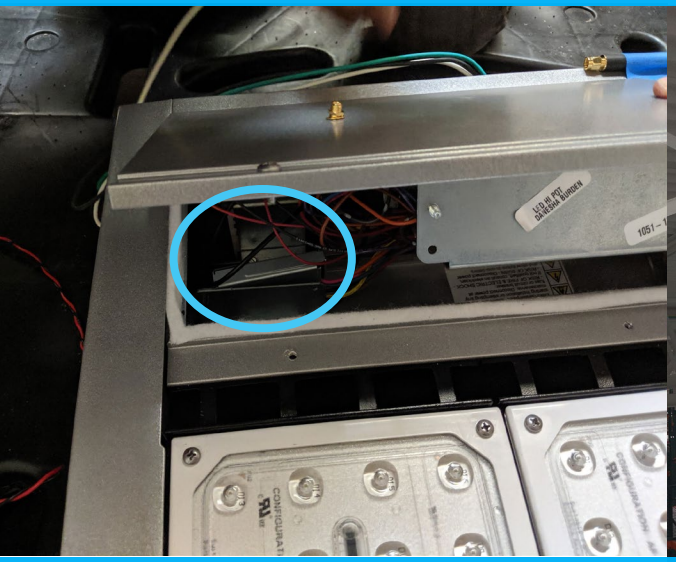
ENERGY SAVINGS

- Daylight Harvesting
- High-end Trim
- Scenes and Lighting Behaviors

MONITORING

- Fault Detection
- Notifications
- Power and Cost
- Power Saving Strategies






D4i AVAILABLE WITH OVER 70 LUMINAIRE MANUFACTURES

D4i comes in Different Shapes & Sizes

COOPER Lighting Solutions

CREE LIGHTING

Signify

HUBBELL Lighting

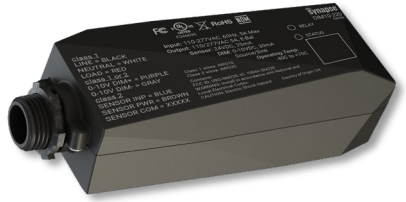
orion

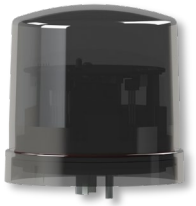
VISIONAIRE LIGHTING

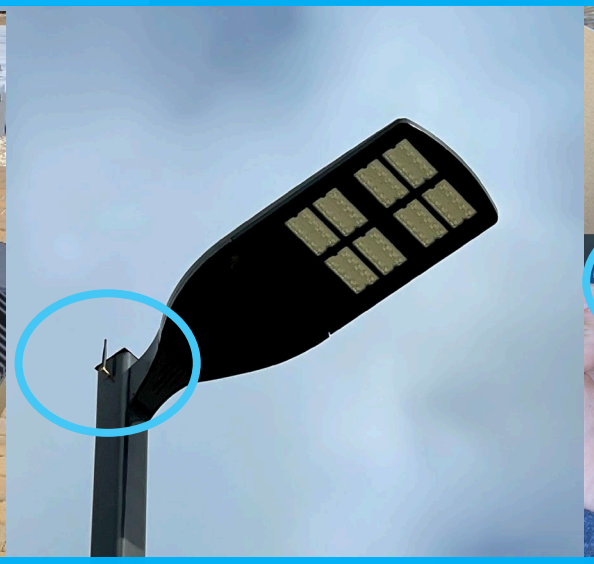
LSI

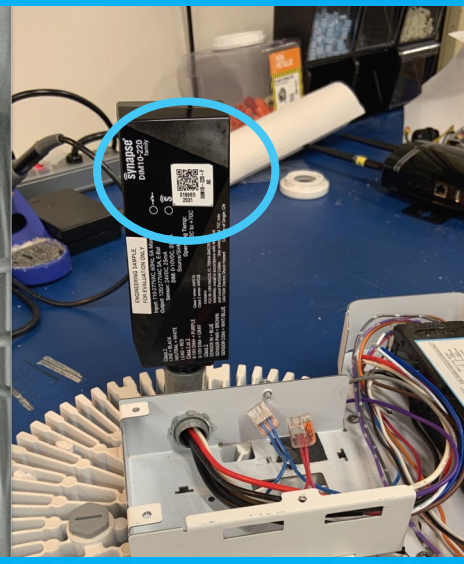
AcuityBrands

Plug & Play





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D4i comes in Different Shapes & Sizes

COOPER Lighting Solutions

CREE LIGHTING

HUBBELL Lighting

Signify

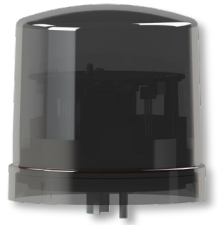
orion

VISIONAIRE LIGHTING

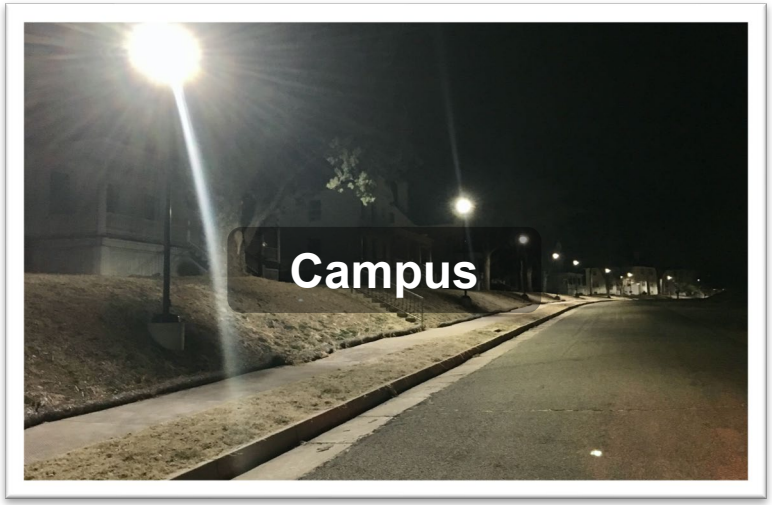
LSI

AcuityBrands™

Plug & Play

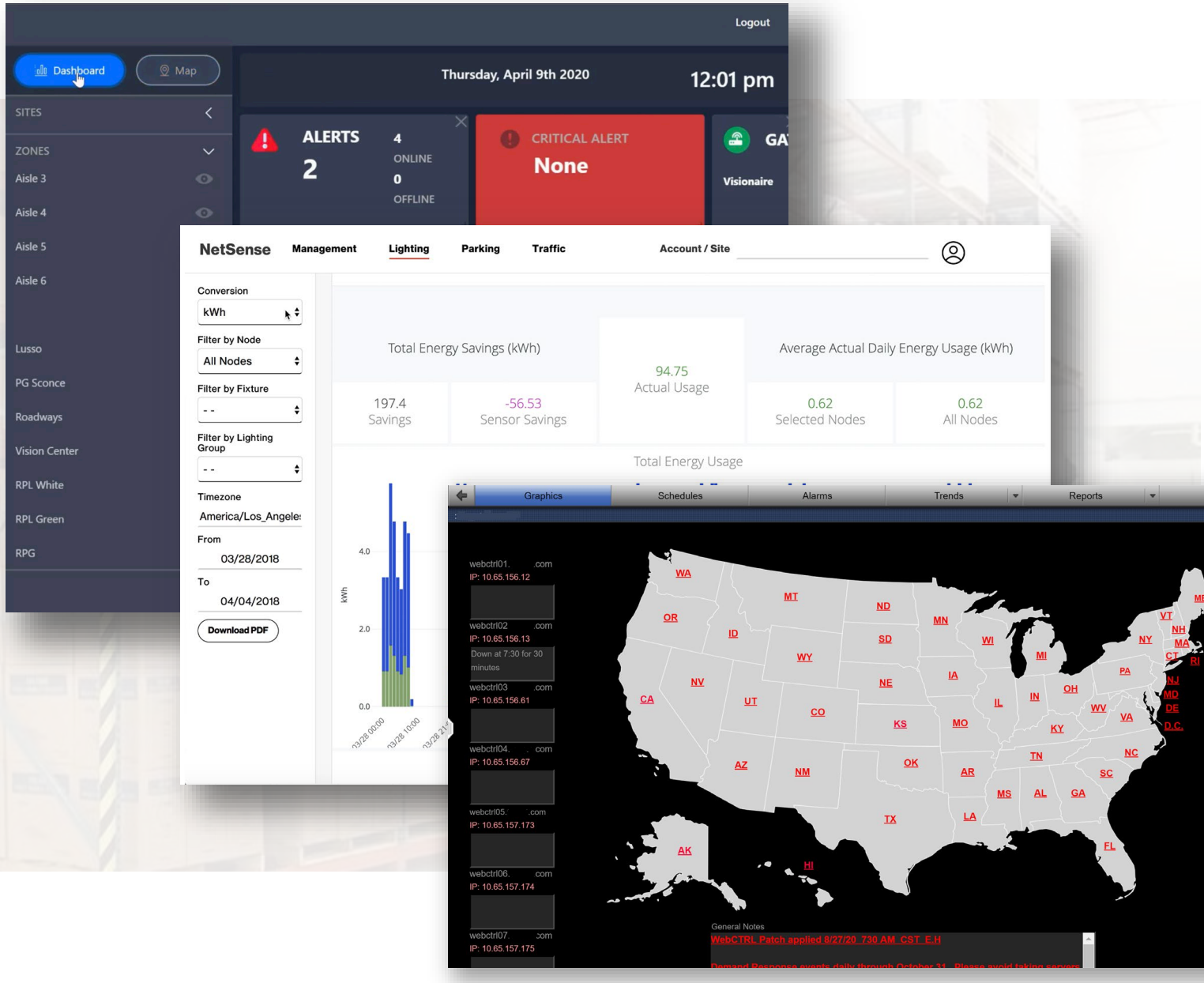


APPLICATIONS



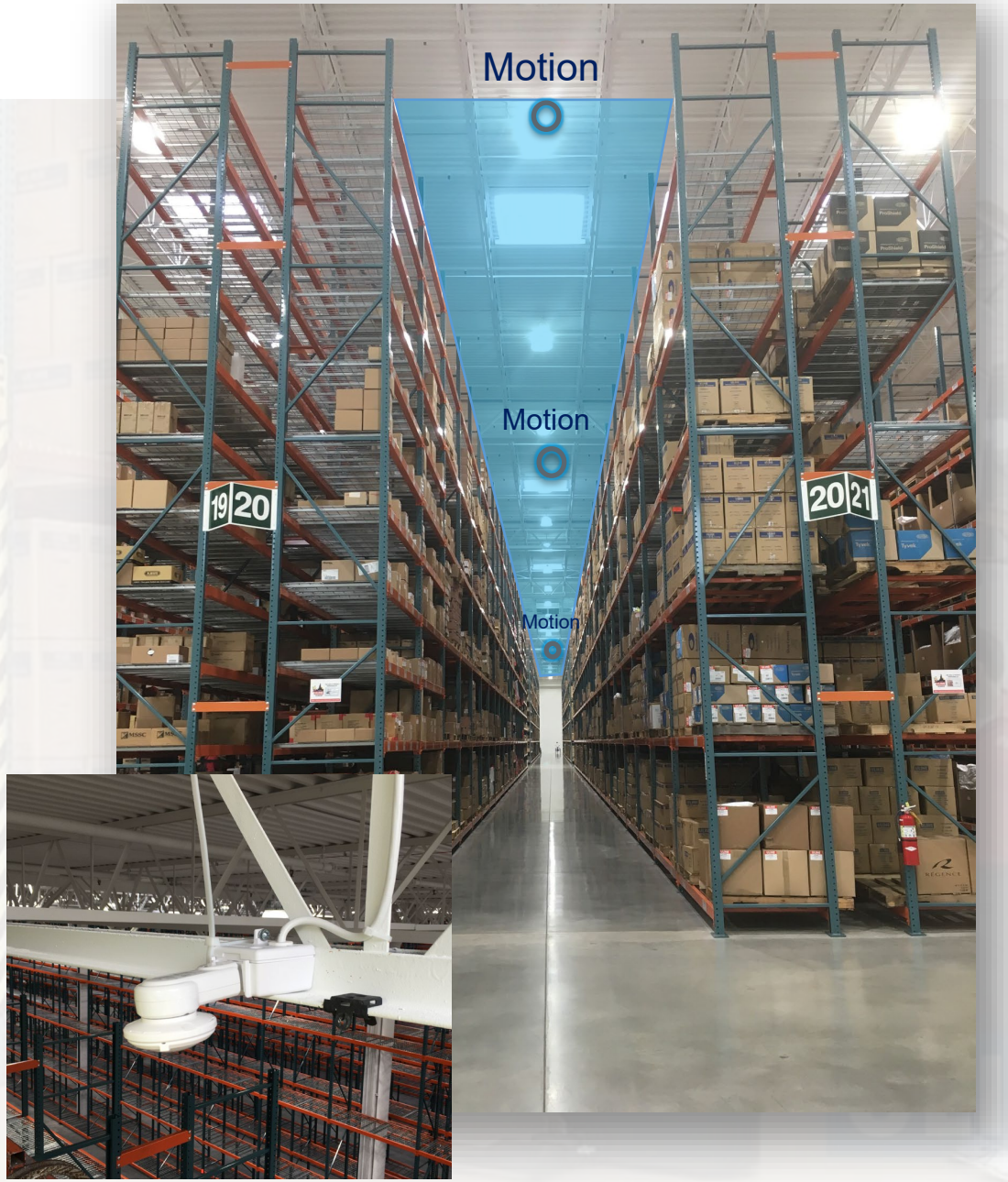
INTEROPERABILITY

- Standard interface at the lighting layer (DALI2/D4i, AC/DC Power, Sensor input)
- Connect to existing IT infrastructure
- BACNET or Modbus
- Standard interfaces at Cloud layer (GraphQL API)

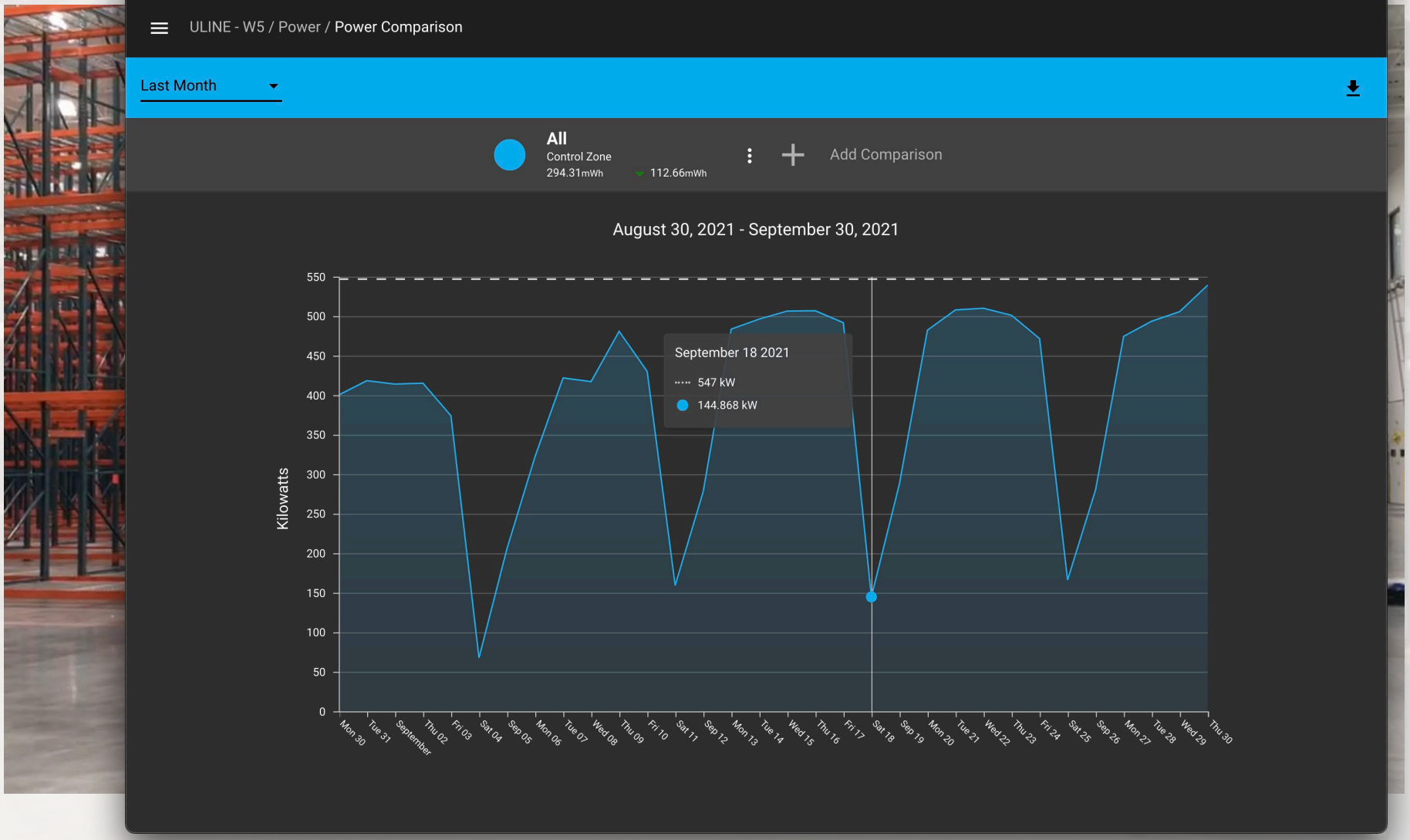


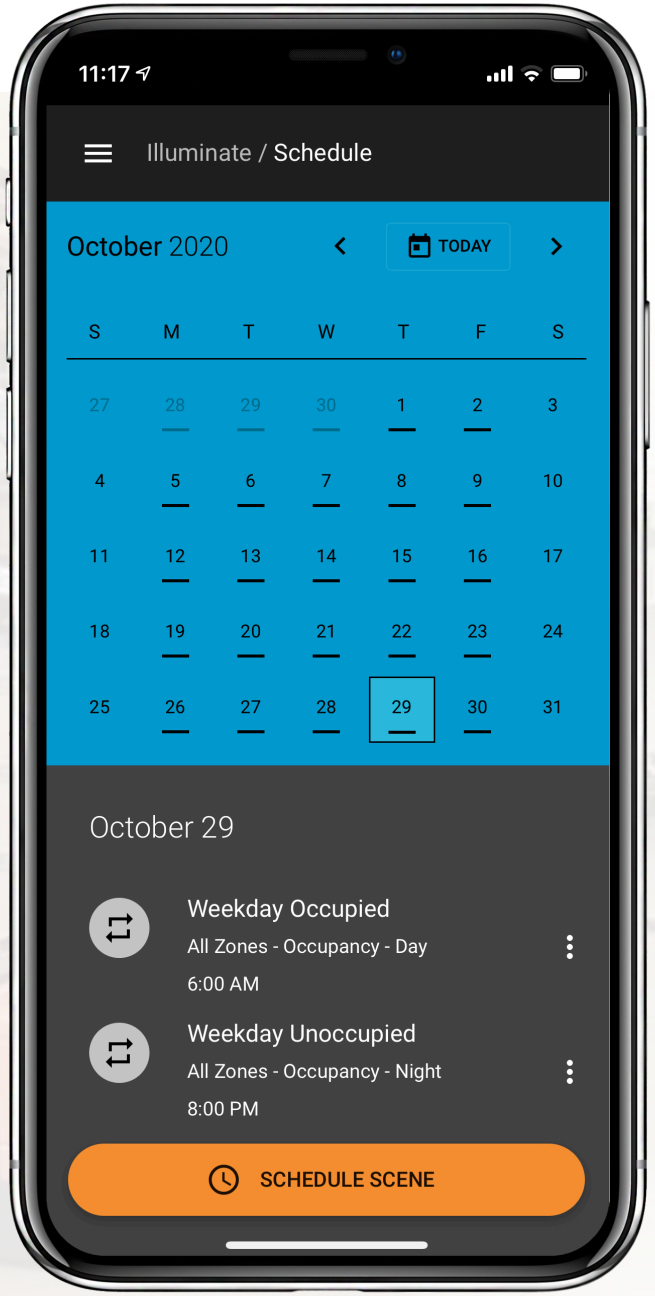
FLEXIBLE ZONING

- Motion sensor settings managed in the Networked Lighting Control and not on the sensor
- Flexible dimming and hold times to follow facility schedule
- Fewer number of sensors needed
- Up to 60% energy savings
- DALI-2 Motion with FDP-301
  - D4i driver, Programmable settings
  - DALI-2 Sensor Programmable settings



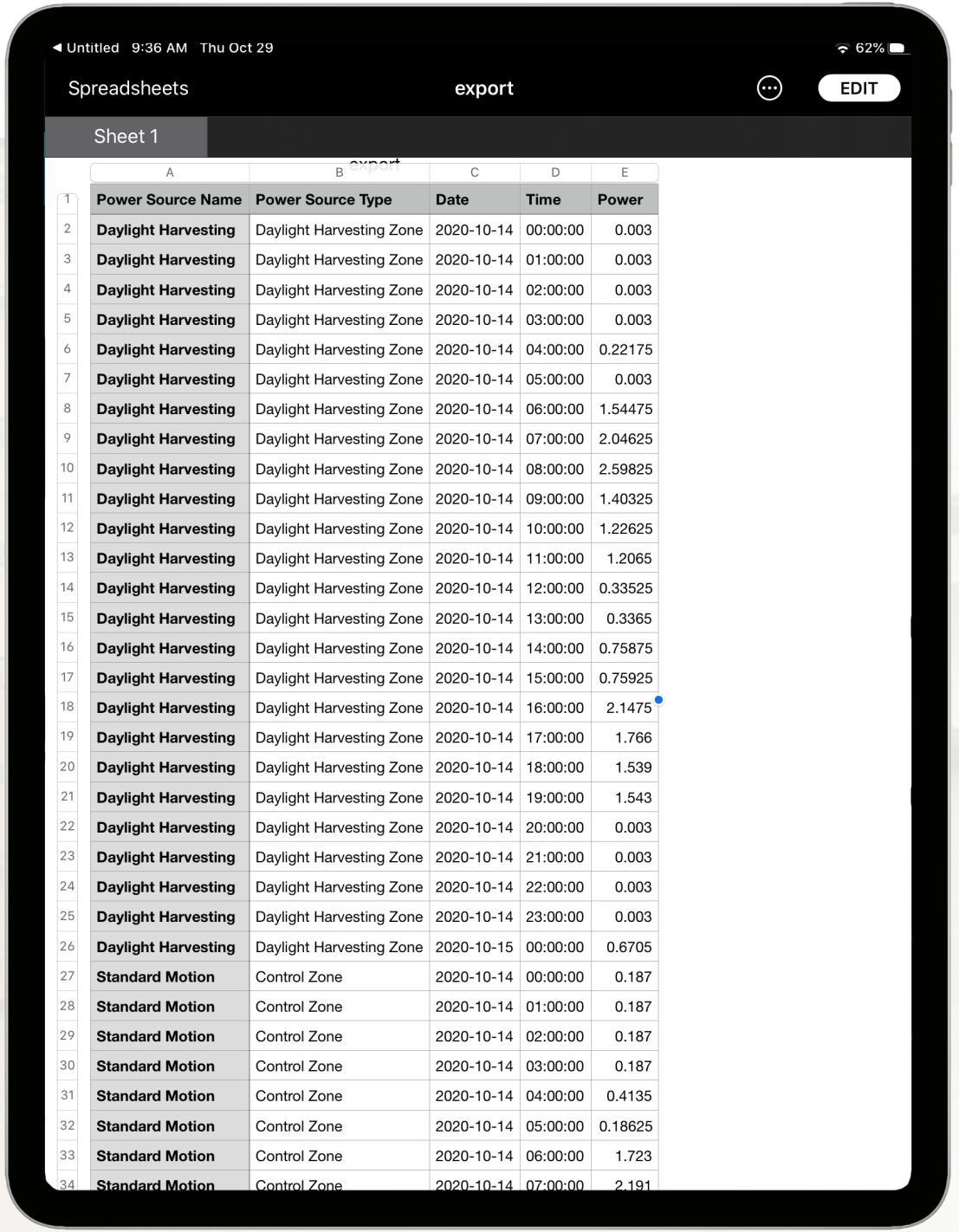
ENERGY SAVINGS VERIFIED





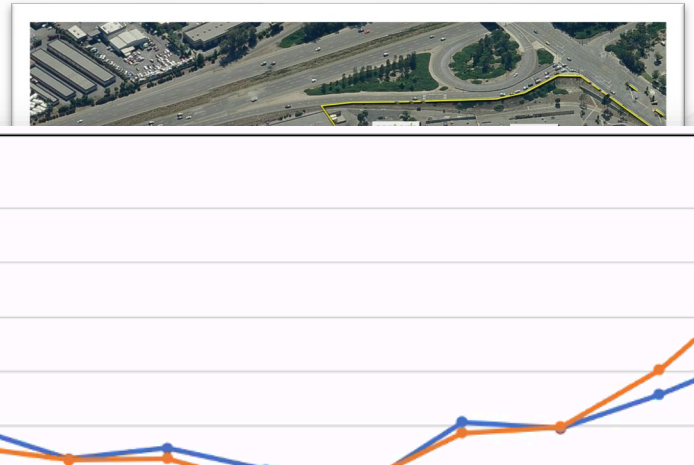
D4I ENERGY REPORTING

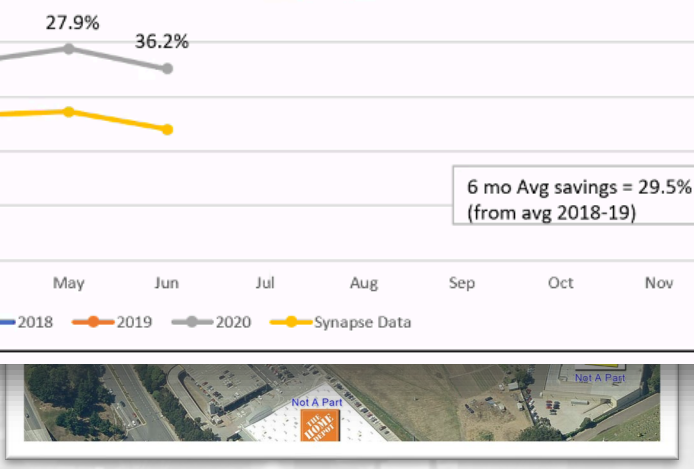
- Compare zone power against baseline
- Generate reports in real-time
- Use data for rebates and controls optimization

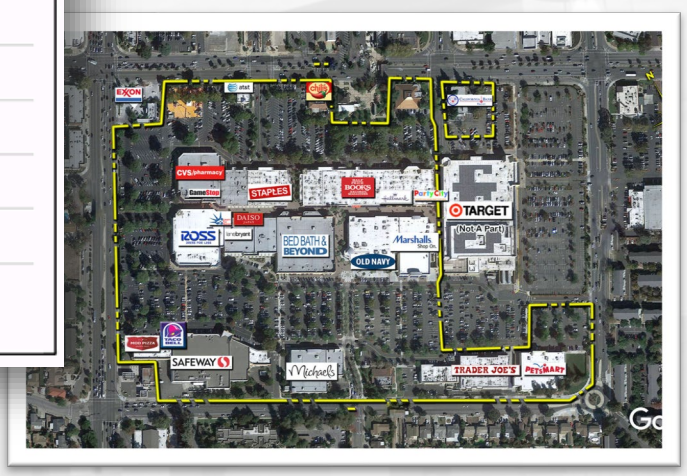


	A	B	C	D	E
1	**Power Source Name**	**Power Source Type**	**Date**	**Time**	**Power**
2	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	00:00:00	0.003
3	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	01:00:00	0.003
4	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	02:00:00	0.003
5	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	03:00:00	0.003
6	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	04:00:00	0.22175
7	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	05:00:00	0.003
8	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	06:00:00	1.54475
9	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	07:00:00	2.04625
10	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	08:00:00	2.59825
11	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	09:00:00	1.40325
12	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	10:00:00	1.22625
13	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	11:00:00	1.2065
14	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	12:00:00	0.33525
15	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	13:00:00	0.3365
16	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	14:00:00	0.75875
17	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	15:00:00	0.75925
18	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	16:00:00	2.1475
19	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	17:00:00	1.766
20	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	18:00:00	1.539
21	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	19:00:00	1.543
22	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	20:00:00	0.003
23	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	21:00:00	0.003
24	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	22:00:00	0.003
25	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-14	23:00:00	0.003
26	**Daylight Harvesting**	Daylight Harvesting Zone	2020-10-15	00:00:00	0.6705
27	**Standard Motion**	Control Zone	2020-10-14	00:00:00	0.187
28	**Standard Motion**	Control Zone	2020-10-14	01:00:00	0.187
29	**Standard Motion**	Control Zone	2020-10-14	02:00:00	0.187
30	**Standard Motion**	Control Zone	2020-10-14	03:00:00	0.187
31	**Standard Motion**	Control Zone	2020-10-14	04:00:00	0.4135
32	**Standard Motion**	Control Zone	2020-10-14	05:00:00	0.18625
33	**Standard Motion**	Control Zone	2020-10-14	06:00:00	1.723
34	**Standard Motion**	Control Zone	2020-10-14	07:00:00	2.191

ENERGY OPTIMIZATION

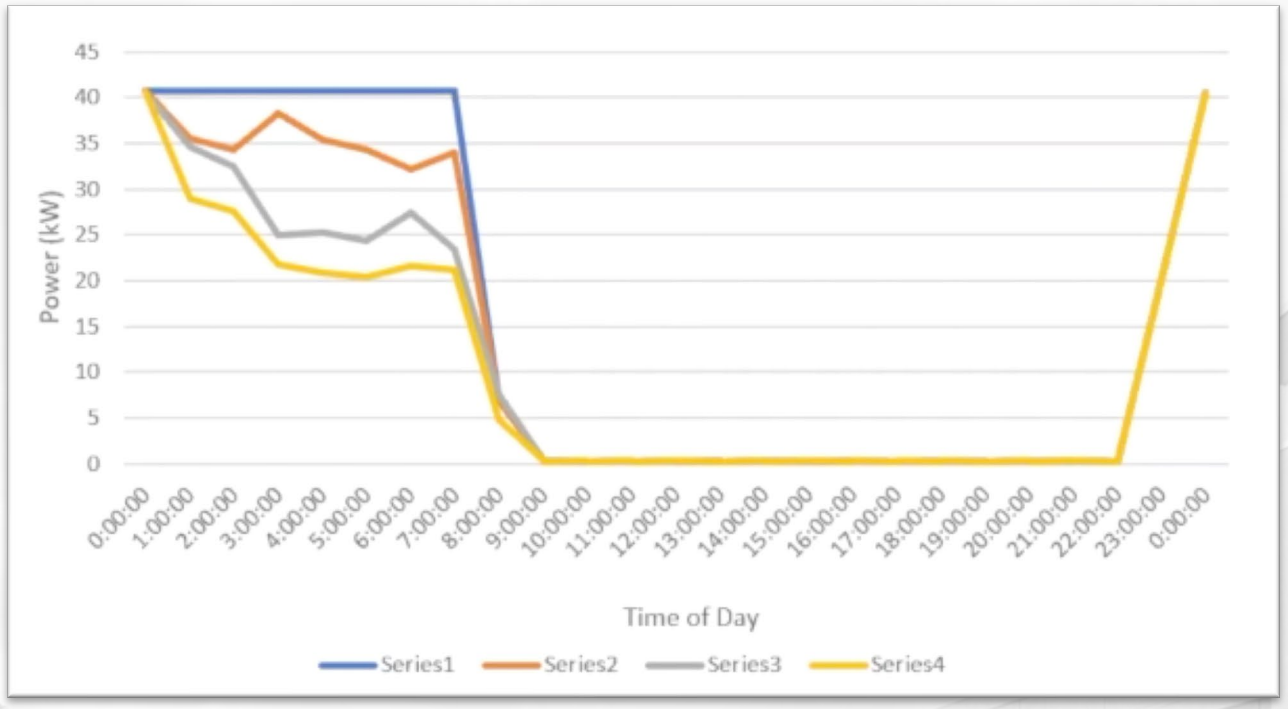


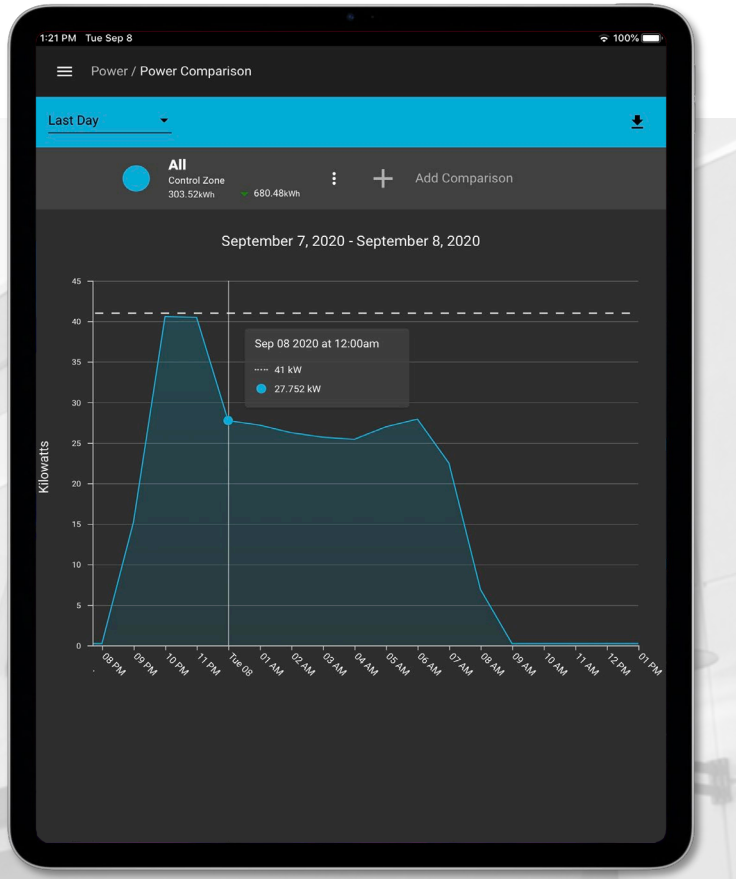




Site A	Site B	Site C	Site D	Site E	Site E
30%	34%	29%	36%	27%	24%

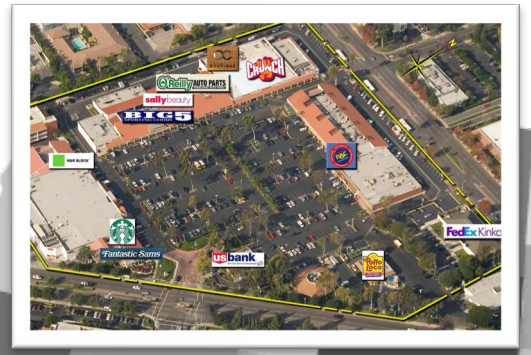
ENERGY OPTIMIZATION

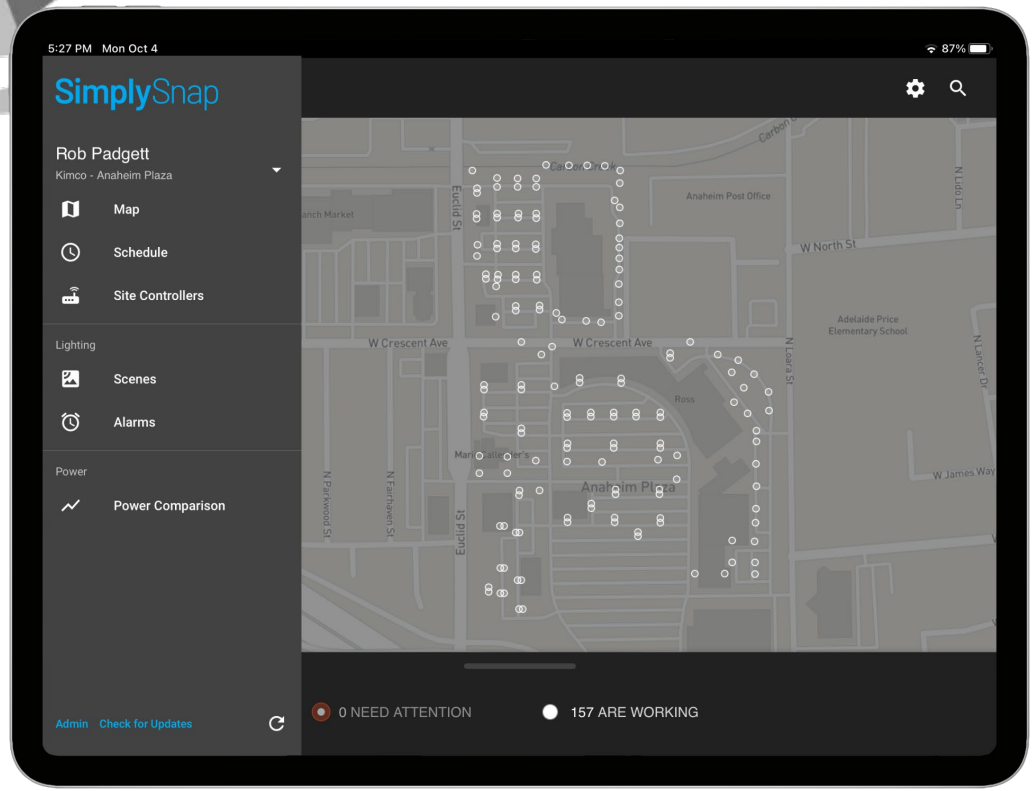




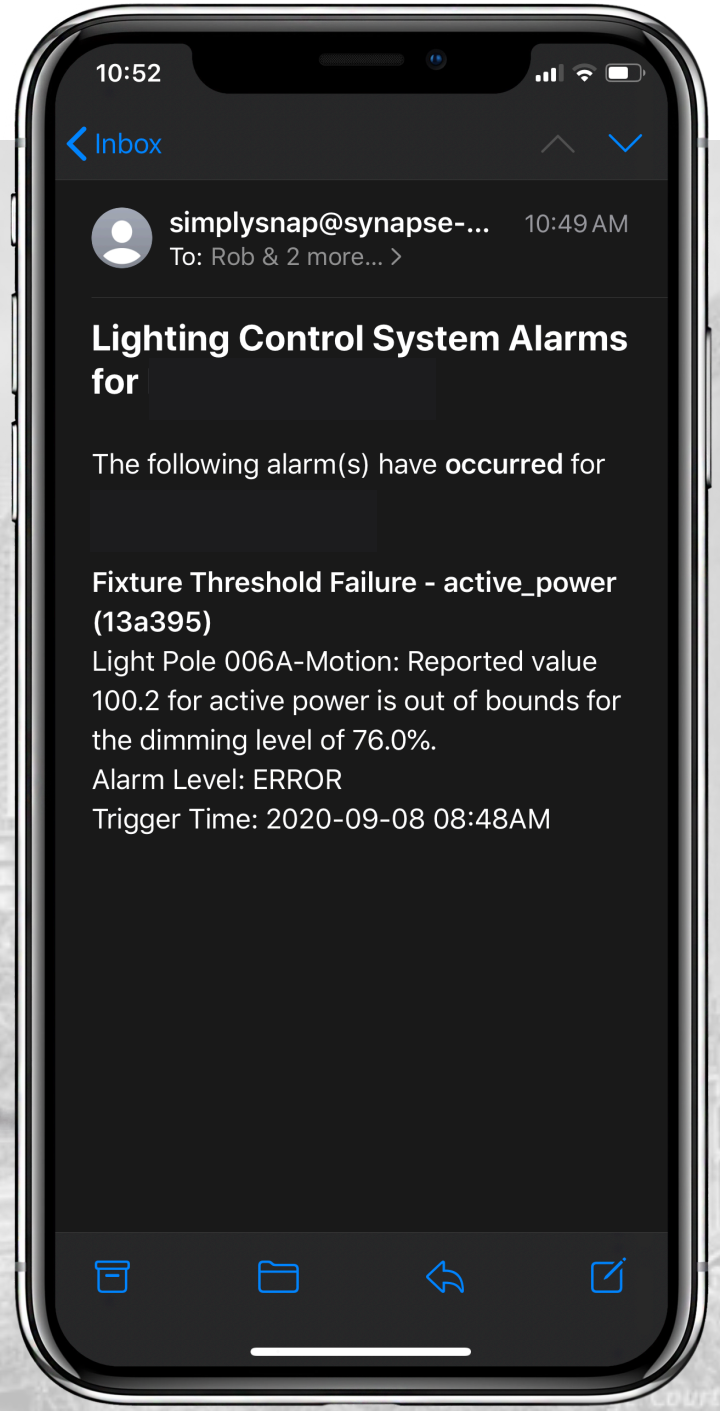
Site A	Usage (kWh)	Usage (kWh)
1. Baseline with No Occupancy Detection	397	0%
2. Initial Synapse Deployment	356	10%
3. Improved Occupancy Detection Zone	305	23%
4. Optimized Setback	273	31%

MANAGE MULTIPLE LOCATIONS USING DALI-2/D4I LUMINAIRES AND A NETWORKED LIGHTING CONTROL SYSTEM



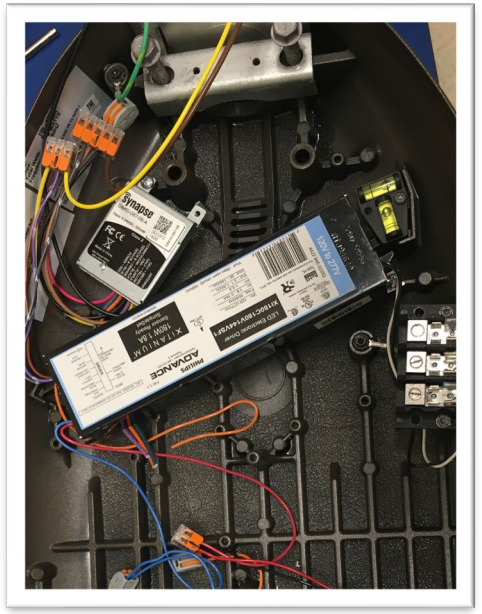


PROACTIVE MONITORING

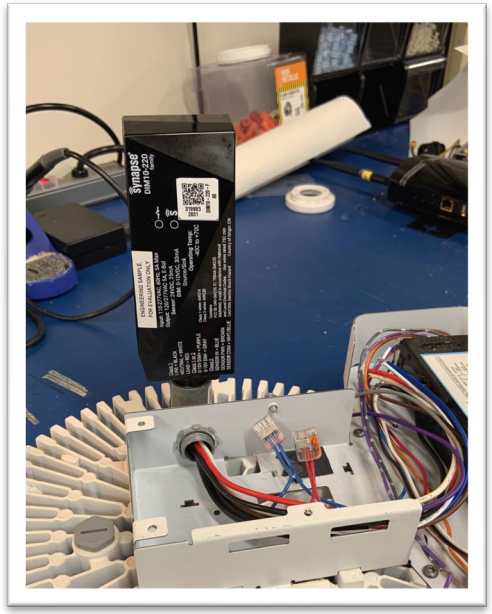


DALI-2 / D4i Brings **Plug and Play** to the Lighting Market
Mix and Match Luminaires from any OEM with D4i Ready Luminaire.

1. Specify DALI-2 / D4i Luminaires
2. Pick Controls: Zigbee – Bluetooth – SNAP – Thread
3. Mix and Match Luminaires for OEMs

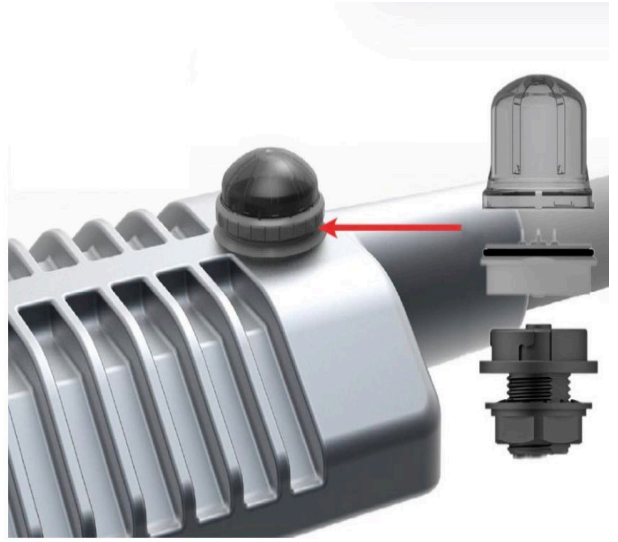


Embedded D4i



Bolt-on 0-10V Retrofit

Twist Lock 0-10V



Zhaga D4i Controller

Questions?