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2015

OUTDOOR LIGHTING CONTROL SYSTEM FUNDAMENTALS

9:00am Sunday 5/3/2015

Mark Wilbur, GE Lighting Solutions

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ATTENDEE SURVEY: BACKGROUND

- ❑ Manufacturer
- ❑ Municipal user
- ❑ Utility user
- ❑ Contractor, Consultant
- ❑ Market Analyst
- ❑ Investment, Finance
- ❑ Other

ATTENDEE SURVEY: BACKGROUND

Manufacturer experience

- ❑ Lighting control system
- ❑ Lighting control sub-system
- ❑ Lighting control component
- ❑ Luminaire
- ❑ Other

User experience

- ❑ Installed system
- ❑ Pilot project
- ❑ Demonstration project
- ❑ Mock-up
- ❑ Technical review
- ❑ None

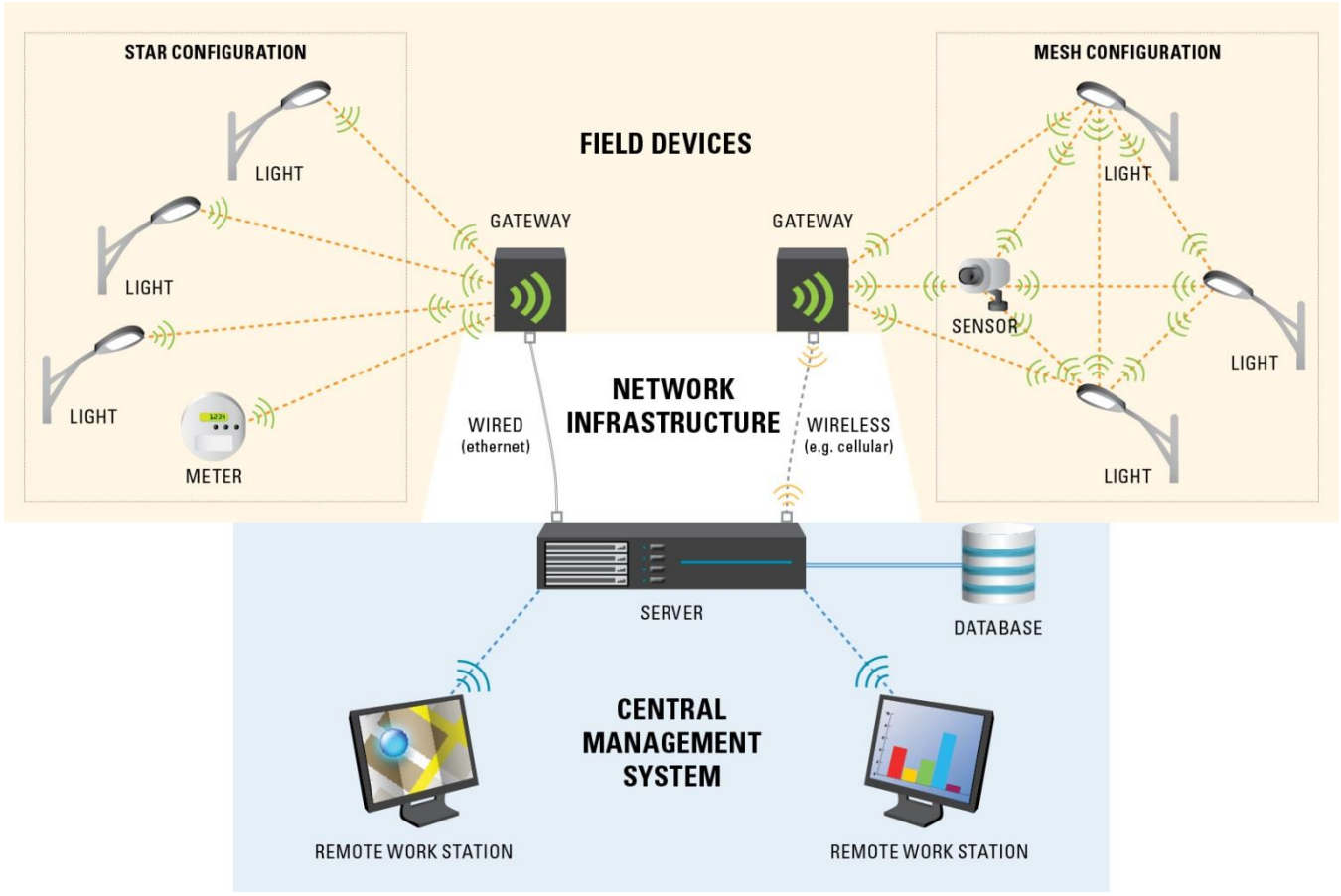
ATTENDEE SURVEY: EXPECTATIONS

- ❑ General education
- ❑ Features and options of commercially available products
- ❑ Value propositions
- ❑ Barriers to adoption
- ❑ Planning a project
- ❑ Specific questions
- ❑ Market analysis

WHO IS THIS COURSE DESIGNED FOR?

- Specifiers, owners, and operators of outdoor lighting systems
- System integrators, start-up and commissioning agents
- Manufacturers of non-lighting equipment that could get integrated into networked outdoor lighting systems

A (NETWORKED) OUTDOOR LIGHTING CONTROL SYSTEM



NETWORKED CONTROL SYSTEMS

- **Network** (from IES TM-23-11): A group of systems that function cooperatively and/or interdependently to provide a chain of command for lighting control
- **Field Device Network**: typically a Local Area Network (LAN) that connects and enables communication between (exclusively) Field Devices
- **Backhaul Network**: typically a Wide Area Network (WAN) that connects and facilitates communication between (at a minimum) one or more Field Device networks with a Central Management System.

NETWORKED CONTROL SYSTEMS

- **Field devices**: the entire set of networked Components (hardware and embedded software, consisting of Controllers and possibly Gateways) installed in the field that, following, installation, start-up and commissioning, function together to adaptively control and remotely monitor Luminaires.
- **Central Management System**: a computer environment that functions as the core of the System by providing all shared System services, and consolidating and storing (or managing the storage of) all System data

SYSTEM CONFIGURATION

Installation	Start-up	Commissioning
Devices have basic necessities for operating as intended	Devices are operating as intended, all system functions and capabilities are available to the user	System functions and capabilities are configured according to user desires
Physical configurations	Logical configurations	Functional configurations
Mechanical mounting	Evaluation of and configuration for environmental conditions (i.e. compatibility)	Grouping, associations
Electrical connection		Monitoring, reporting
Default values	Configuration for and verification of data exchanges (i.e. interoperability)	Control strategies
Provisioning		Schedules

LEARNING OBJECTIVES

1. Understand the full capabilities and underlying technology building blocks of market-available outdoor lighting control systems.
2. Understand the value propositions offered by outdoor lighting control systems, current real- world barriers to adoption, and the status of relevant research, standards and regulations.
3. Understand how to align value propositions with the needs of relevant stakeholder groups, create strategies for overcoming barriers to adoption, and draft specifications that meet user needs.
4. Understand how outdoor lighting control systems can form the backbone of future Machine-To- Machine and Internet of Things ecosystems that make tomorrow's urban environments safer and more livable.

AGENDA

1) Introduction, Assessment & Adoption
2) Technology Fundamentals
3) Basic System Capabilities & Value Propositions
4) Demonstration Part 1
5) Lunch (90 minutes)
6) Demonstration Part 2
7) Market Adoption Status
8) Future Possibilities
9) Interoperability, Standards & Specifications
10) Q&A

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OUTDOOR LIGHTING CONTROL SYSTEM FUNDAMENTALS

Assessment and adoption

Michael Poplawski

Cities account for…

70% of energy consumption

Lighting 20% of electricity consumption

OUTDOOR LIGHTING APPLICATIONS

Roadway

Urban Streets

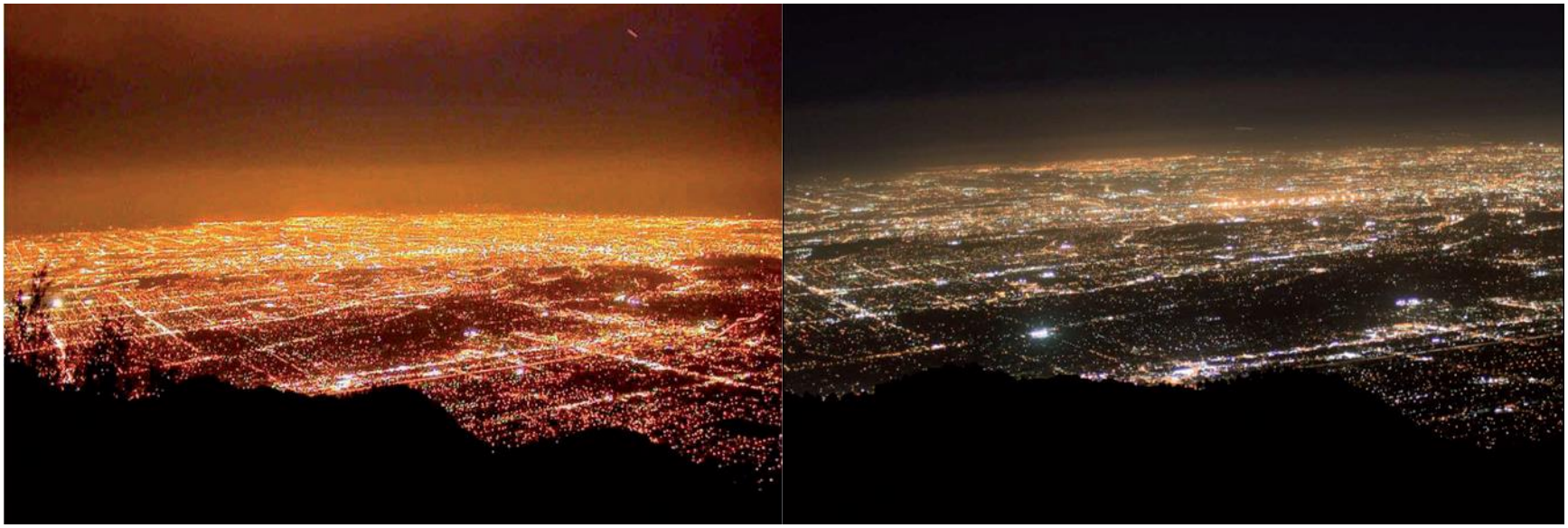
Residential

Site & Area

LED ADOPTION

- Driven by economic circumstances
  - Reduced municipal revenues
  - Higher energy costs
  - Increasing energy efficiency regulations
- Driven by falling prices and shortened payback
- Driven by successful retrofit pilot projects
- Clear transition path from traditional lighting to LED technology

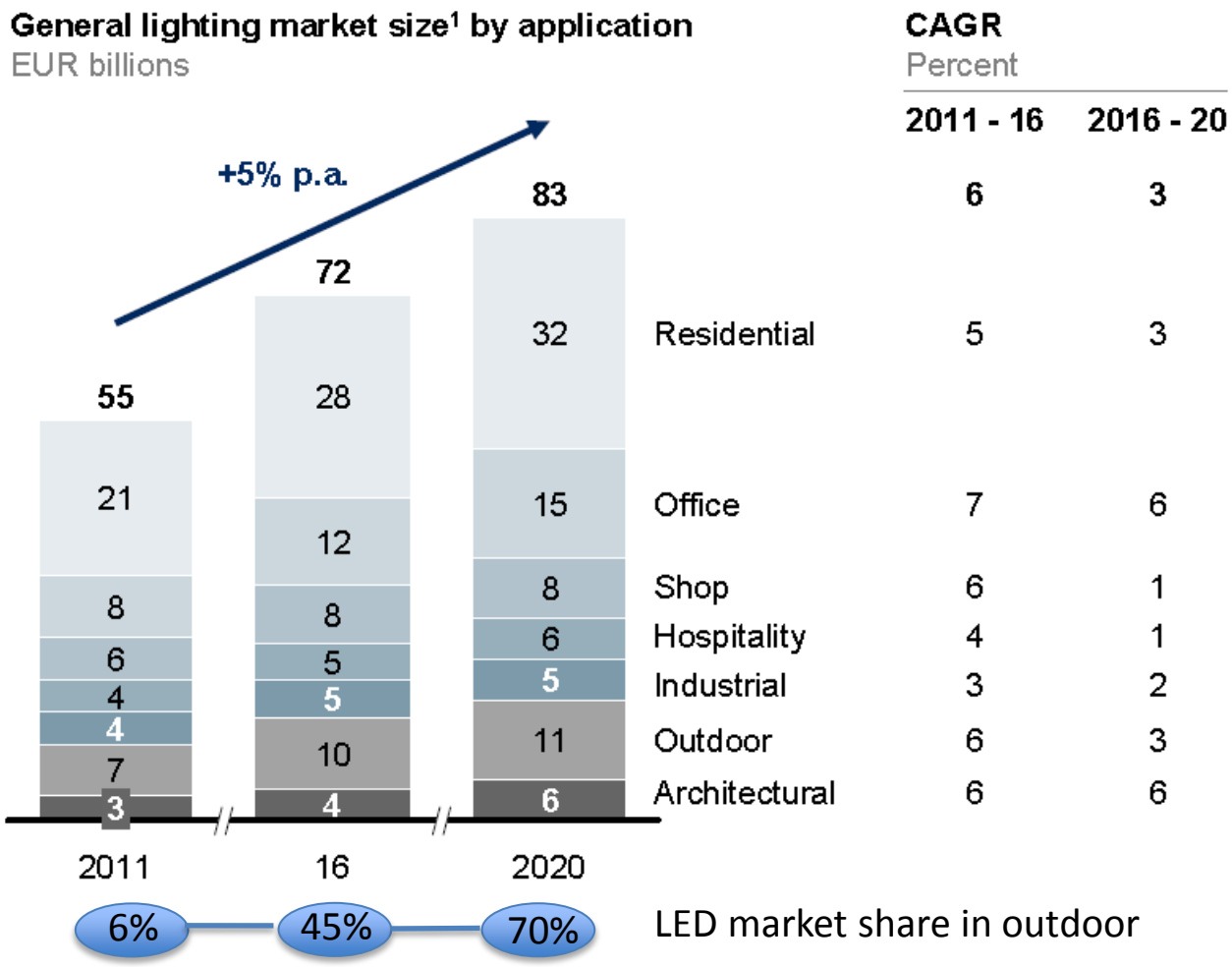
LED RETROFIT PILOTS



Los Angeles Before and After LED retrofit

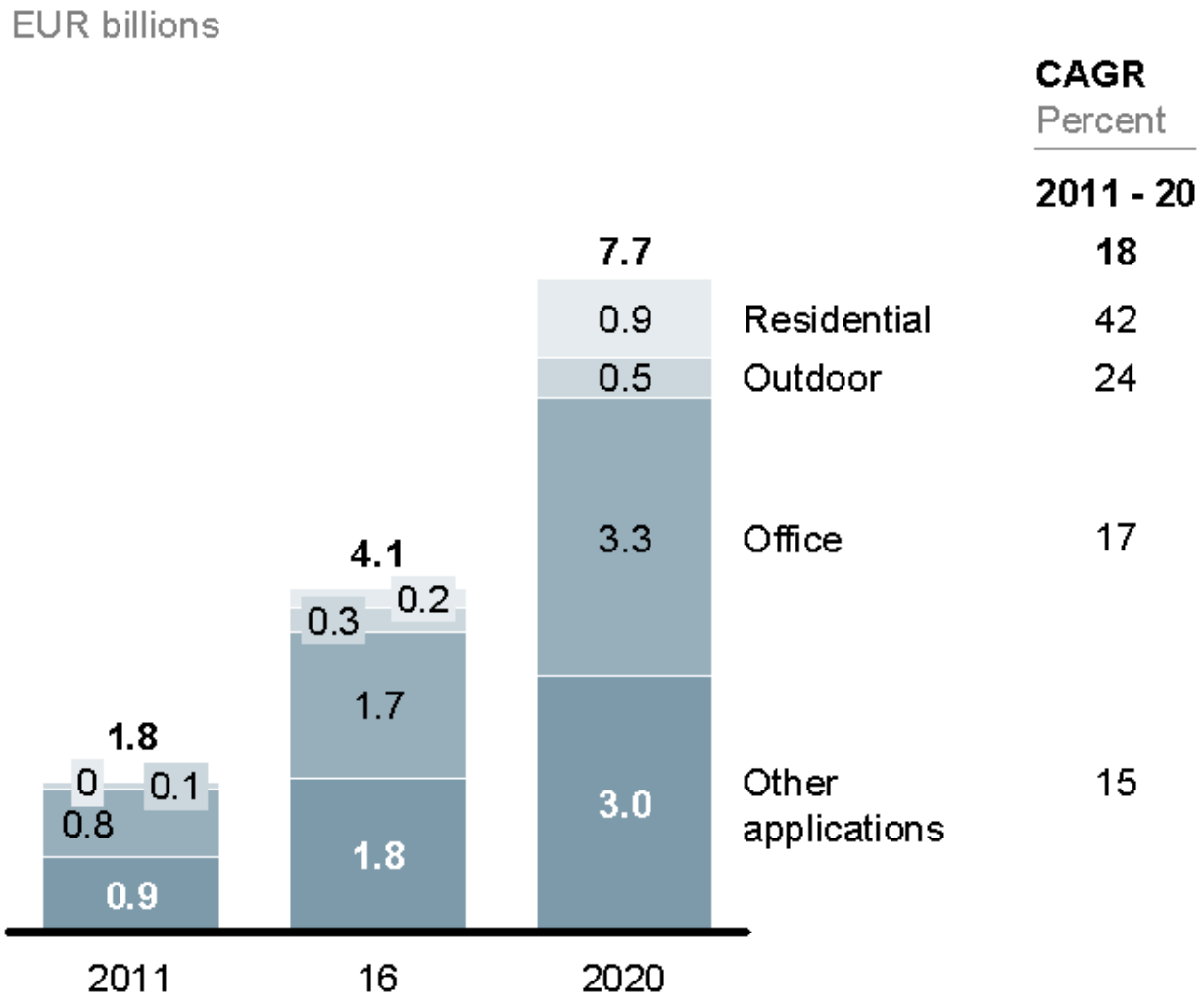
- LED luminaires have proven energy efficiency and reliability while providing high-quality lighting
- LA (142K), Seattle (42K), Boston (32K), Las Vegas (40K), NYC (250K)

LED LIGHTING MARKET IS GROWING FAST



http://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/automotive and assembly/lighting_the_way_perspectives_on_global_lighting_market_2012.ashx

STRONG GROWTH EXPECTED FOR LIGHTING CONTROLS



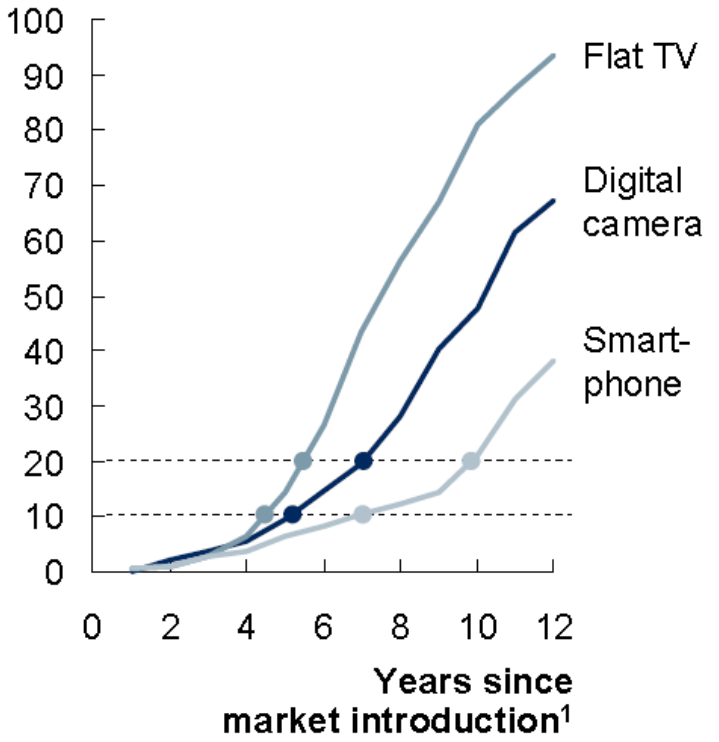
http://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/automotive and assembly/lighting_the_way_perspectives_on_global_lighting_market_2012.ashx

NEW TECHNOLOGY ADOPTION

Once new technology penetration hits 5 to 10%, the market penetration tends to accelerate

New technology penetration in high-tech products

Percent; unit basis; global figure



	Years to achieve an initial 10% penetration		Penetration uptake by another 10%
Flat TV	5 years	→	1 year
Digital camera	5 years	→	2 years
Smart-phone	7 years	→	3 years

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HOW SHOULD ONE GO ABOUT CONSIDERING AND PLANNING FOR THE ADOPTION OF AN OUTDOOR LIGHTING CONTROL SYSTEM?

A RECOMMENDED END-TO-END ADOPTION PROCESS

- Needs & goals
- Data acquisition
- Scoping & ideation
- Audit

- Priorities
- Requirements
- Evaluation criteria
- Business and partnership models

- Technology/solution
- Performance modeling
- Scenario analysis

- Installation
- Start-Up
- Commissioning
- System integration

- Measurement and verification
- Operational optimization
- Maintenance services

INFRASTRUCTURE ASSESSMENT

IDENTIFY ASSETS

- Review existing information
  - Typical data formats: Excel, GIS files
- Asset Verification
  - Validate existing assets (visualization can help)

Infrastructure Assessment → Requirements Specification → Solution Design & Selection → Deployment → Operation and Management

LIGHTING ASSET DATA ACQUISITION

- Depending on the quality and/or ownership of the data, a new asset data collection step may be required
- Asset data collection methods
  - Field data collection of pole location (GPS) and asset information
  - Done prior-installation (e.g. using mobile tools) or enabled by control system (post installation)

ASSET DATA

Typical data points per pole location:

- ID: Unique identifier
- Location (Latitude, Longitude)
- Lamp Type: HPS, LED, Metal Halide, Mercury Vapor, …
- Lamp Wattage: 100 W, 75 W, 50 W, …
- Volts: 120-277V
- Style: cobra head, decorative, architectural, …
- Additional information (e.g. pole condition, photocell, arm length)

LIGHTING ENERGY AND COST EVALUATION

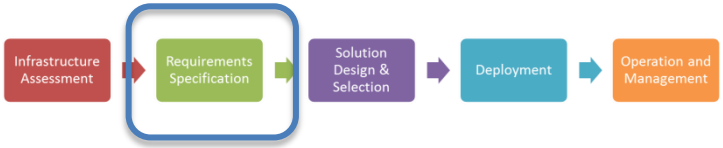
- Energy & Sustainability Impact
  - KWh/year consumed
  - CO2 impact: Emission factor
    - 6.89551×10^{-4} metric tons CO_2 / kWh
- Operational Costs
  - Energy cost
    - Estimates: Operating hours x power x energy price
  - Maintenance costs
    - Re-lamping: components + labor

LIGHTING QUALITY EVALUATION

- Lighting measurements
  - Typically at sample locations
- Refer to standard practices
  - IES RP-8-XX

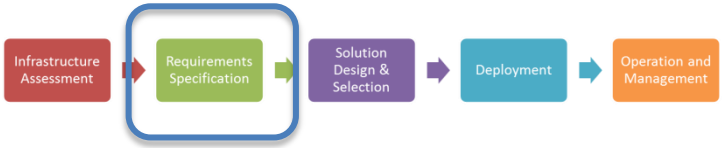
REQUIREMENTS SPECIFICATION

Goals and priorities → Requirements → Evaluation/ Business models



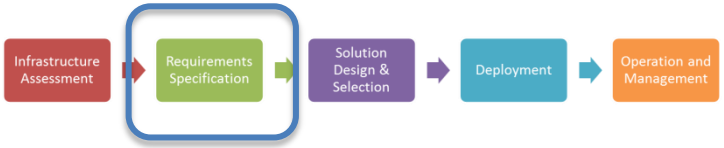
GOALS AND PRIORITIES

- Identify stakeholders and document main goals and priorities
  - Energy savings, sustainability
  - Maintenance savings
  - Lead technology deployment
  - Others???
- Understand the value of technology
  - LED and controls



DIFFERENT VIEWS AND INTERACTIONS

- Mayor
- Finance
- Building owner
- City maintenance team
- Public works department
- Site manager
- Electrician
- IT

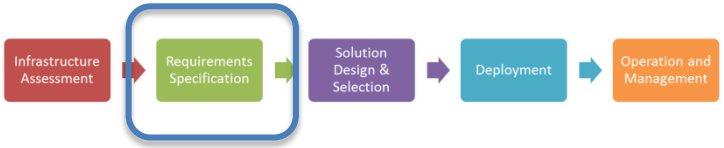


DIFFERENT NEEDS AND BENEFITS

- Energy savings
- Cost savings ($)
- Control
- Monitoring
- Maintenance optimization
- CO2 carbon reduction
- Light pollution reduction
- Safety

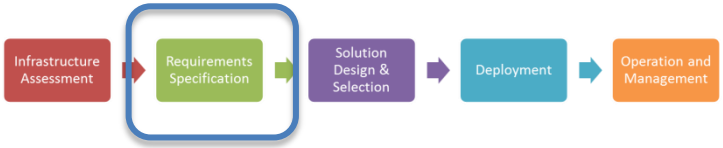






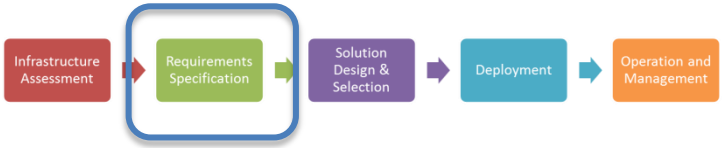
DOCUMENT REQUIREMENTS

- Use cases and application requirements
- Example:
  - Users want to define the time intervals and levels to be applied.
  - The system shall support dimming and it shall be possible to specify a target dimming level and times for the dimming actions.
- Important to set mandatory and optional features
- Supporting resources
  - DOE Model Specification



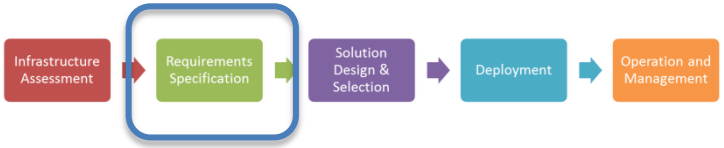
EVALUATION METRICS

- ROI (Return On Investment): measures the rate of return on money invested
  - Considers economic factors only and focuses mainly on initial costs
- Shift to new metrics that take into account other factors and long term view
  - TCO (Total Cost of Ownership)
  - TVO (Total Value of Ownership)



BUSINESS MODELS

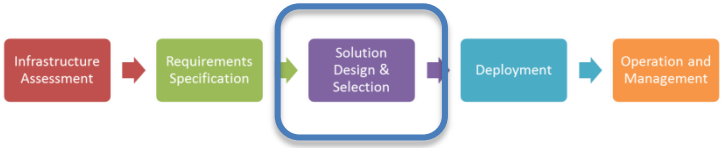
Model	What	Advantage	Disadvantage
Supplier-to-customer direct	Municipality purchases the products/services directly from manufacturers/ suppliers.	Complete transparency of costs involved Direct line of communication with system experts	Municipality responsible for the capital investment Municipality takes on project risk
Public energy service deal (PES)	Utilities team up with municipalities. Often the utility sub-contracts the lighting (installation and maintenance) to servicing companies.	All parties strongly incentivized to achieve energy savings Municipalities deal with one company and utilities can create economies of scale	Applicability depends on ownership models (areas under local vs. federal/state control)
Energy performance contract (EPC)	Municipality outsources lighting project completely in exchange for guaranteed energy savings. Most commonly a partnership with an energy servicing company (ESCO).	No capital investment required from municipalities: ESCO provides financing and takes on the risk Guaranteed energy savings and maintenance	Long contract period required to pay off the capital investment Mostly deployed between private parties
Public-private partnership (PPP)	Similar to an EPC, but municipalities retain a stake in the project. Municipalities partner with a major PPP, or tender for large PPP projects that comprise a significant lighting element (such as city street lighting)	Municipality maintains equity share in the project Performance and energy/maintenance savings guaranteed by private partners	Municipalities also take on some of the risk Most often used for projects broader than just outdoor lighting



Source: The LED Future – outdoor Lighting for sustainable and livable cities, White paper

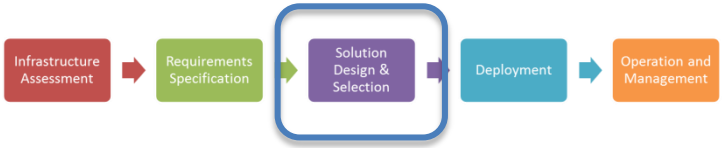
SOLUTION DESIGN & SELECTION

Technology/ System Capabilities → Performance modeling → Scenario Analysis



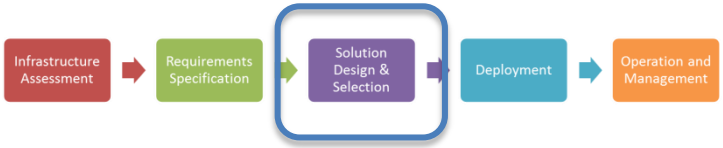
DEFINE SYSTEM CAPABILITIES

- Map use cases and application requirements to technical requirements and system capabilities
  - Example: adaptive lighting requires a system that supports dimming.
- Understand options/capabilities available and value propositions



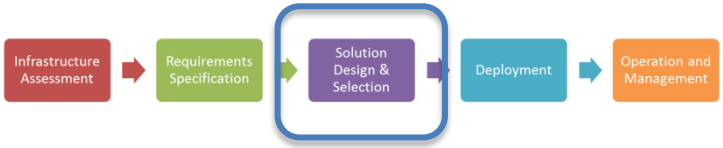
PERFORMANCE ANALYSIS

- Technical
  - Energy consumption and expected savings compared to baseline
  - System reliability (up time)
  - Response time
- Economic/financial
  - Evaluate ROI, TCO/TVO metrics
- Regulatory and Standards
  - System meet minimal lighting requirements (e.g. as defined in IES RP-8-XX)
  - Interoperability standards



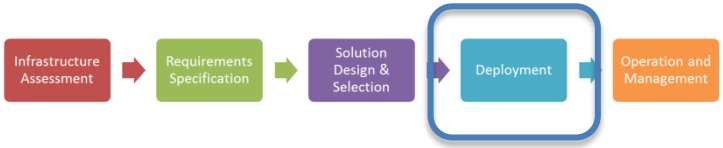
NEW SERVICES

- Financial Services
  - private vs. public financing
- Maintenance Services
  - performance contracts
  - Lighting as a Service
- Technical Solutions Services
  - System operation and optimization services (e.g. network management, troubleshooting, re-commissioning)



DEPLOYMENT

- Project management
- Installation, start-up, and commissioning
- System integration



OPERATION & MANAGEMENT

- Monitoring
  - Measurements
  - Performance verification
- Maintenance
- System optimization (re-commissioning)

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Q & A

Assessment and adoption

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OUTDOOR LIGHTING CONTROL SYSTEM FUNDAMENTALS

Technology Fundamentals

Mark Wilbur

OUTDOOR LIGHTING FIELD DEVICES

- Basic
  - Photocontrols, photoelectric cells, photocells, Astronomical clocks
  - On/off only
- Advanced (but non-networked)
  - On/off and dimming
- Networked
  - One-way or two-way communication
  - Remote control
  - Remote monitoring

PHOTOCELLS

- On at dusk and off at dawn
- Dominant deployed outdoor lighting control

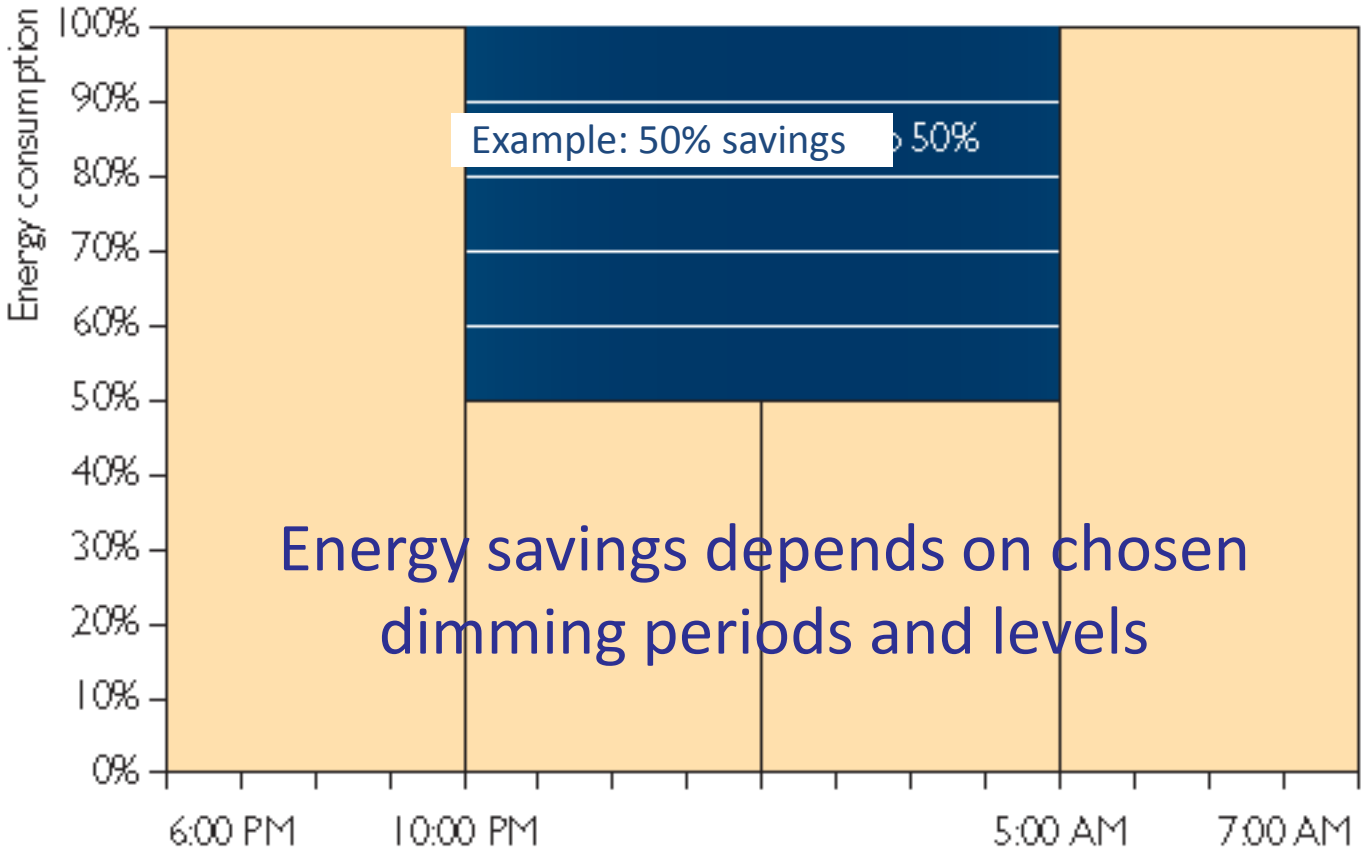
ASTRONOMICAL CLOCKS

- Devices that determine (typically from a database) the expected time of sunrise and sunset for a given calendar date (i.e. day, month, year) and geographical location
- On/off based on expected sunset and sunrise times, without the use of a photocell
- Typically allows programming of offsets around sunset and sunrise times and shifts due to daylight saving time
- Do not compensate for cloudy days, or other variables that affect light levels around sunrise and sunset

ADVANCED NON-NETWORKED CONTROLS

- Sunrise/sunset trimming (or offset)
  - Modified on/off times
  - Shorter on duration
- Part-night dimming
  - Typically pre-determined, scheduled time, configured at or prior to installation
  - Typically pre-determined, fixed dimmed light level, configured at or prior to installation

PART-NIGHT DIMMING EXAMPLE



Energy savings depends on chosen dimming periods and levels

NETWORKED FIELD DEVICES

Networked devices (hardware and embedded software, consisting of Controllers and possibly Gateways) installed in the field that, following purchase, installation, start-up and commissioning, function together to adaptively control and remotely monitor Luminaires.

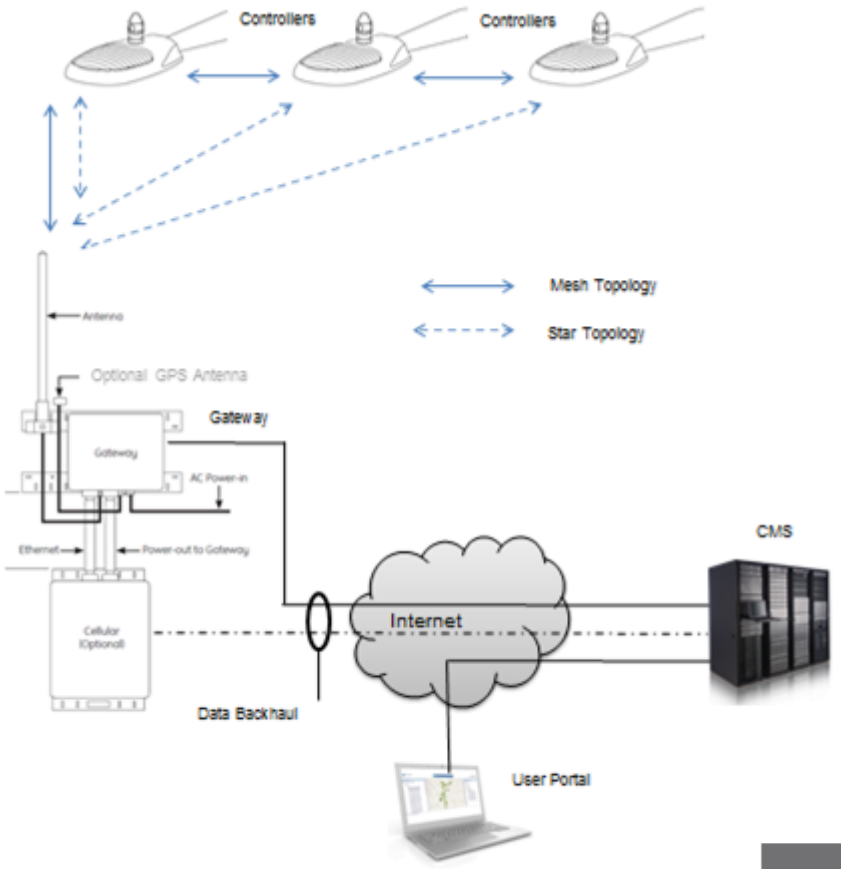


FIGURE 1
Typical Deployment

FIELD DEVICES

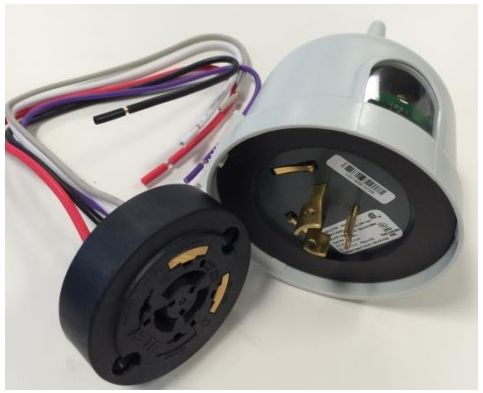
Controller - the device that originates a command to execute a lighting change. Most commonly associated with a lighting control station or control console, a controller may also be a sensor or other automatic device operating without human interaction.

- Physically monitors and controls Luminaires installed at Control Points
- Reacts and responds to logical and physical inputs
- Makes control decisions using internal algorithmic and logic functions
- Communicates via a network protocol

Gateway - a device designed for interfacing between two communication networks that use different protocols, such as BACnet to DALI, or DMX512 to 0-10VDC. A Gateway may contain devices such as protocol translators, impedance matching devices, rate converters, fault isolators, or signal translators as necessary to provide system interoperability.

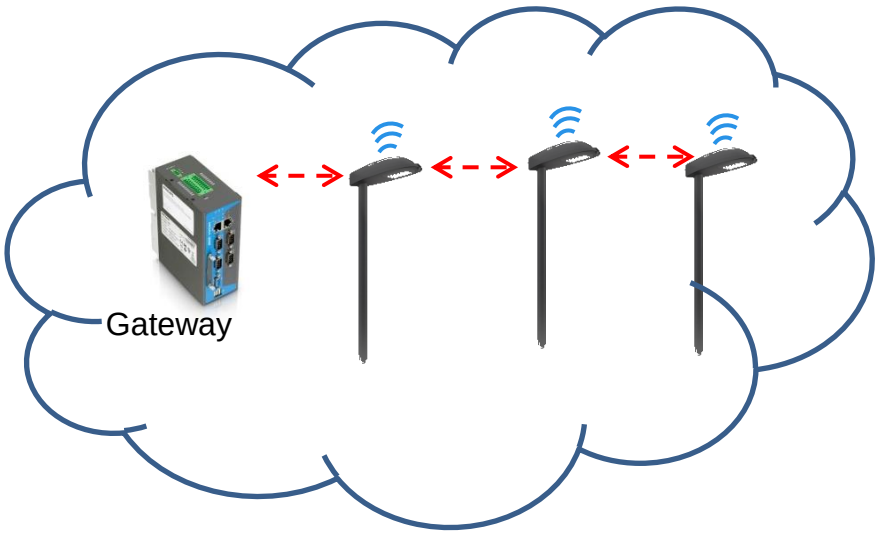
- Serves (at a minimum) as the interface between one or more Field Devices and a Central Management System
- Typically translating from a wireless Field Device protocol to a standardized Wide Area Network (WAN) protocol, such as WiFi (i.e. IEEE 802.11xx), Ethernet (i.e. IEEE 802.3), or LTE Cellular (i.e. 3GPP Releases)

NETWORKED FIELD DEVICES

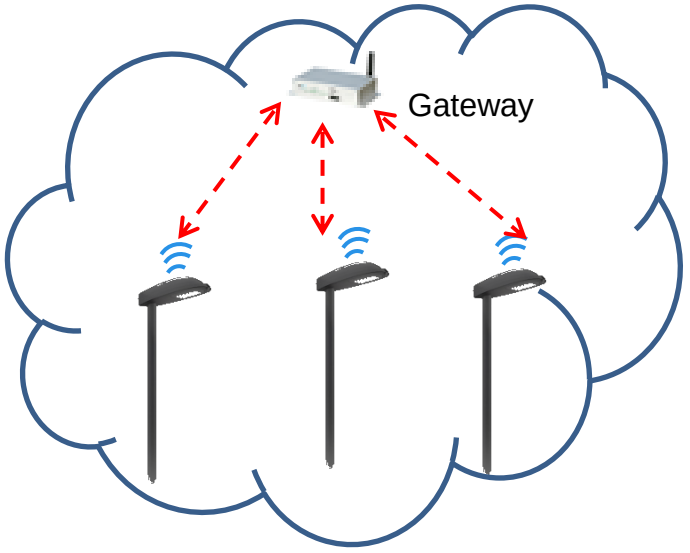


CONNECTIVITY

- Technologies
  - Wireless
  - Wired (Power Line Carrier)
- Network Topology
  - Star
  - Mesh



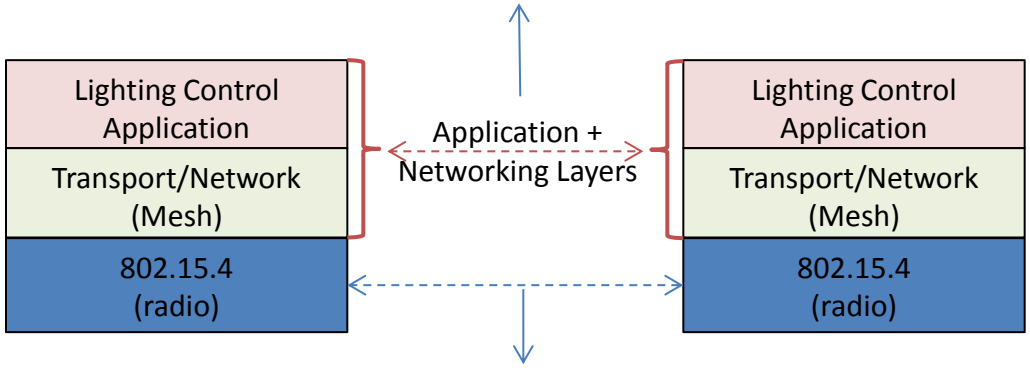
Wireless Mesh



Wireless
Star

WIRELESS CONNECTIVITY PROTOCOLS

- Application + (Mesh) network layers
  - Typically proprietary implementations



- Radio (Physical + MAC) Layers
- Typical standard implementations
  - IEEE 802.15.4 (used in ZigBee), IEEE 802.11 (WiFi)
  - Some modified, proprietary versions

EXISTING AND EMERGING WIRELESS STANDARDS

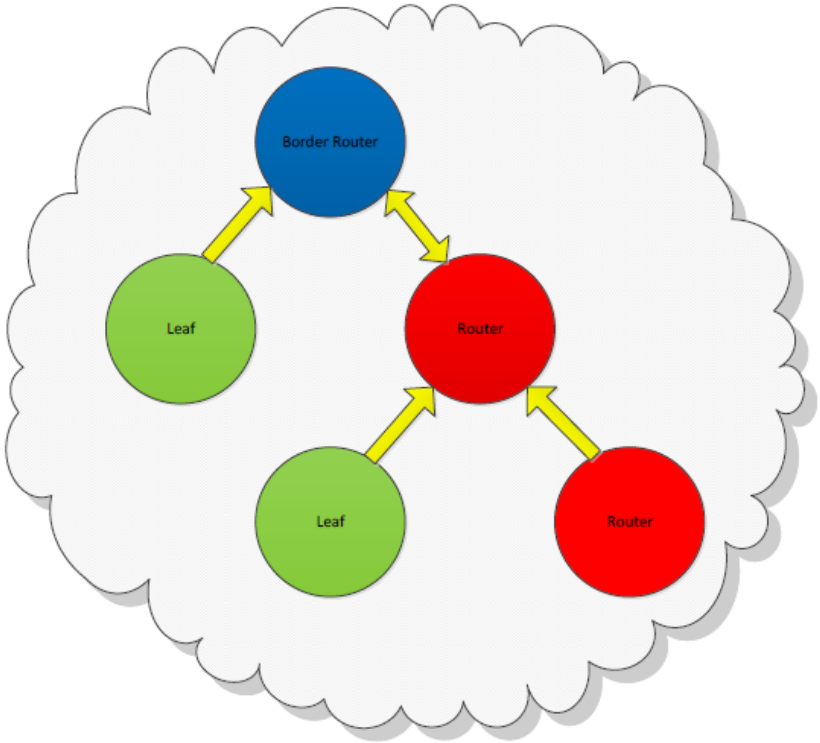
	IEEE 802.15.4 family	IEEE 802.11 family	Cellular (3G)
Data rates	20, 40, 100, 250 Kbps	Depends on standard version: 2, 5, 11, 54, 72, 150, and up Mbps …	DL: 2-28 Mbps UL: 384 Kbps -11Mbps
Spectrum	868-870 MHz (EU) 902-928 MHz (US) 2.4 GHz (Worldwide)	2.45 GHz 5 GHz	Various
Range/ Coverage	100 m – 1.5 Km Depends on frequency band	10 – 250 m	Growing coverage (depends on deployment)
Primary Applications	Building/home automation, sensor/actuator networks, healthcare, games, etc (usually low data rates and low power devices)	Wireless broadband/Internet access	Mobile broadband, M2M applications in the future
Standard Development	15.4 (most used in existing products) 15.4g new extension for smart utility networks (high data rates and range for outdoor applications)	802.11a/b/g/n and others… New sub-GHz spec under development (11ah), expected 2015	Evolving (3G, LTE, LTE advanced, …)

MESSAGE (PACKET) ROUTING

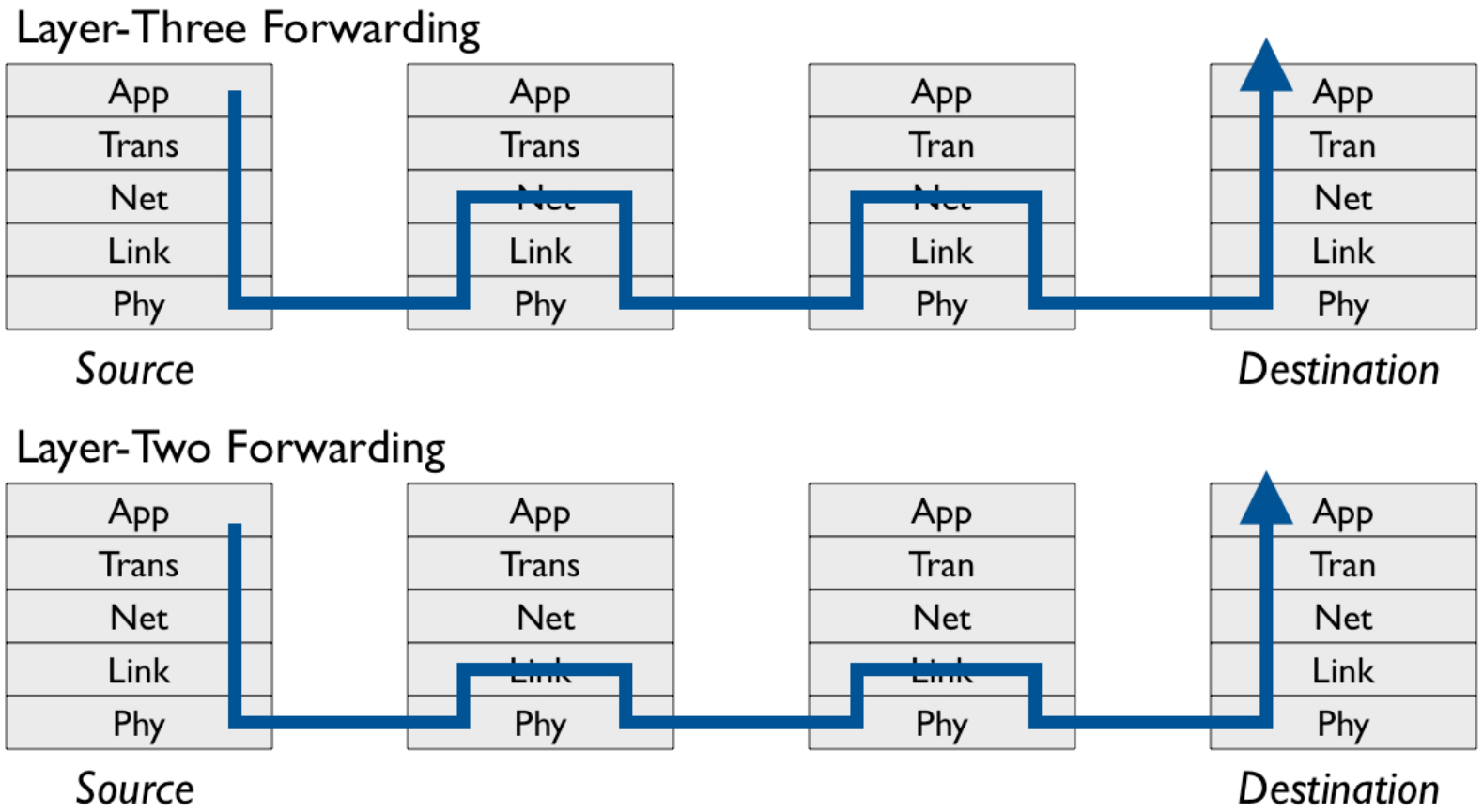
Border Router (Gateway): aggregates packets and connects to external networks i.e. internet

Router (Controller): generates and forwards (repeats) adjacent node's packets

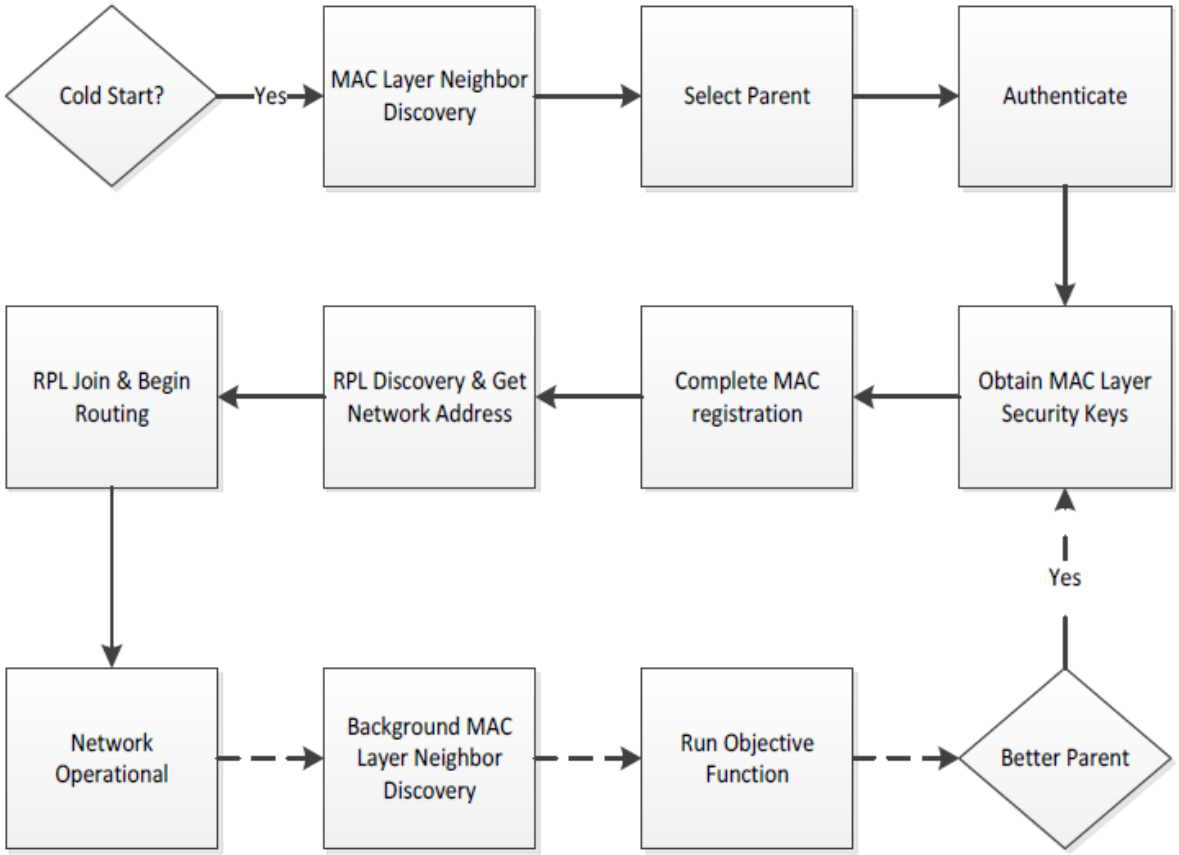
Leaf (Controller): transmits/receives messages



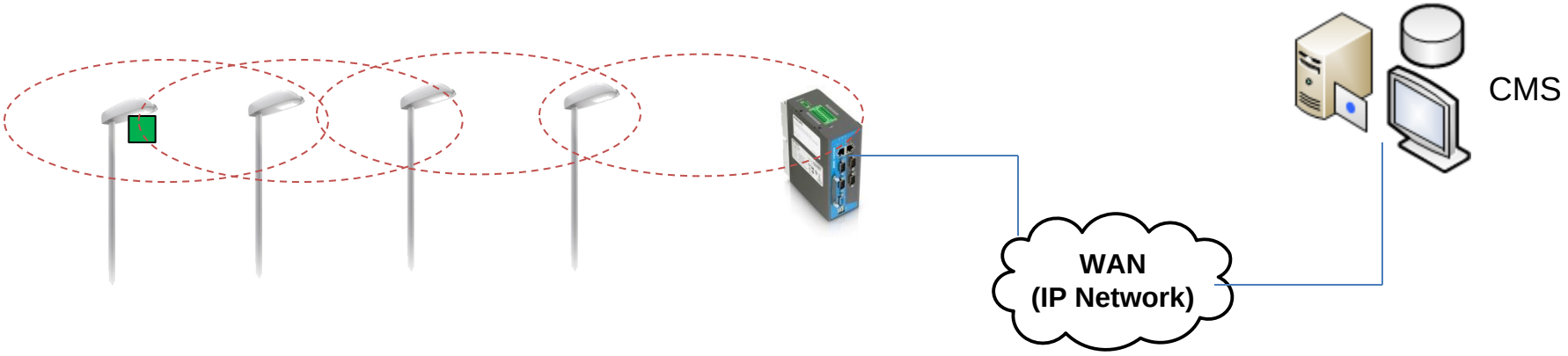
MESSAGE (PACKET) FORWARDING MODELS



MESH NETWORK FORMATION

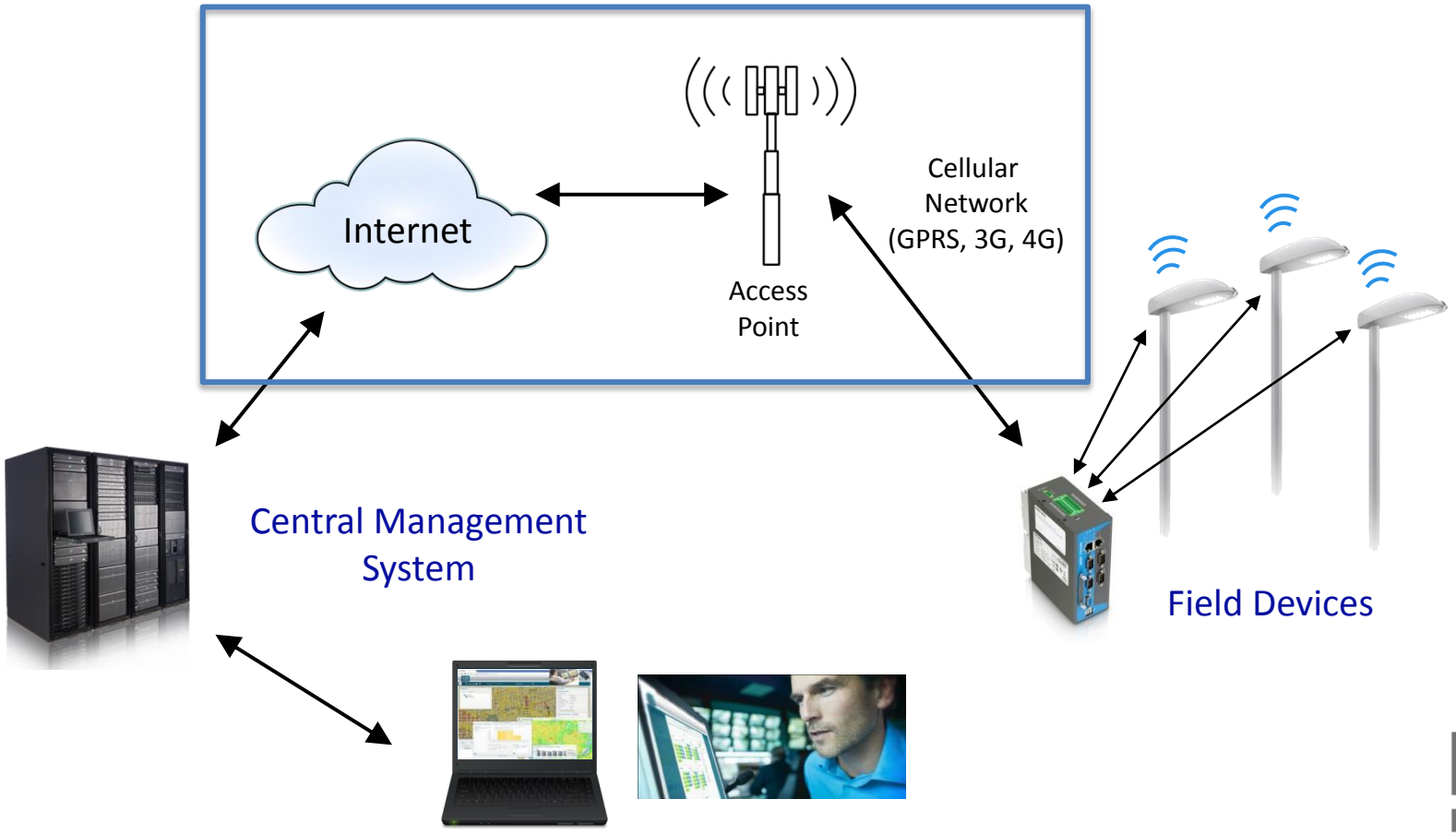


WIRELESS MESH CONNECTIVITY



- Mesh networks use packet forwarding to increase range and robustness
- Performance factors to consider in the network deployment
  - communication range of nodes
  - interference robustness
  - scalability
  - security

BACKHAUL COMMUNICATION NETWORKS



BACKHAUL COMMUNICATION OPTIONS

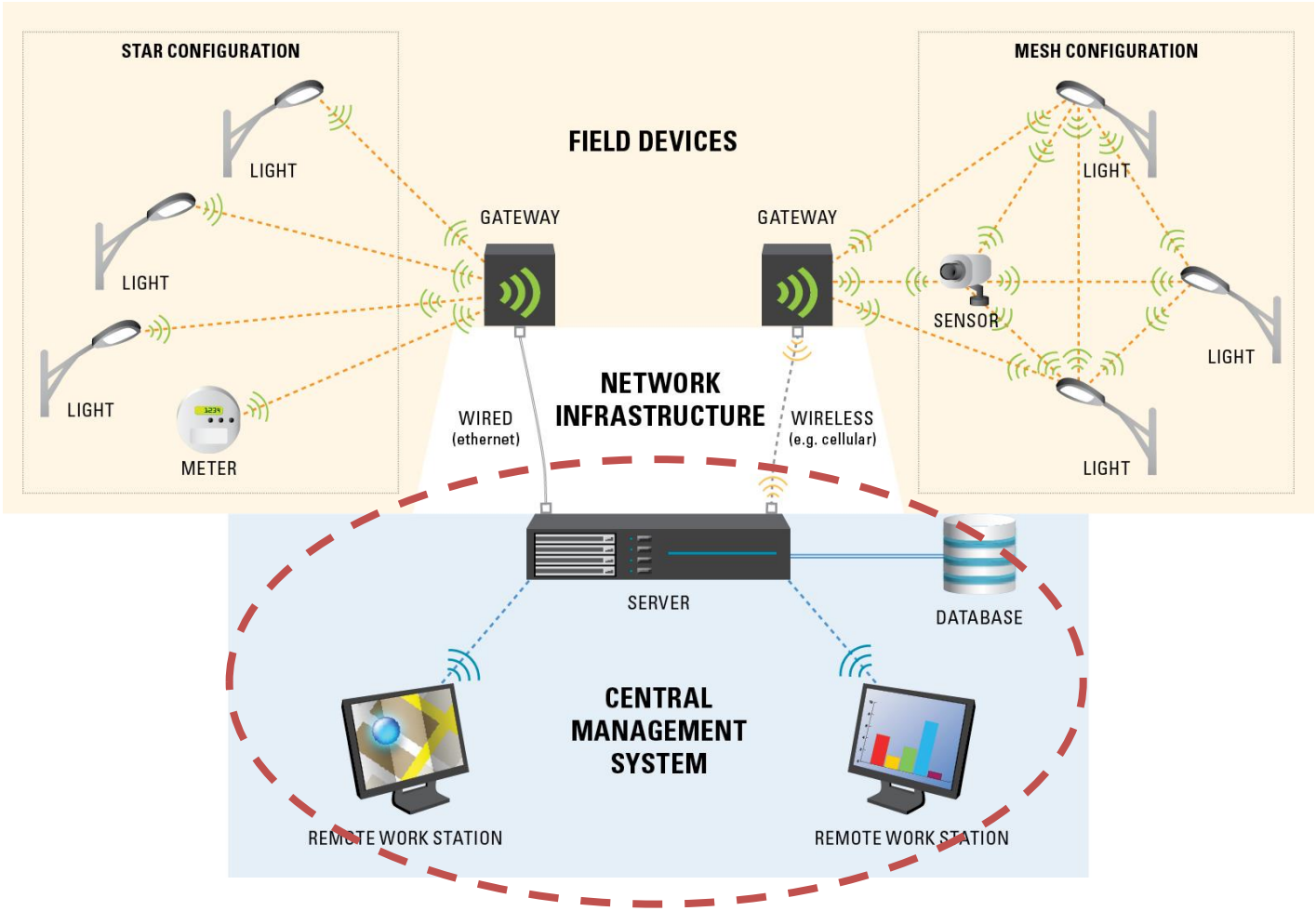
- Cellular
  - GRPS, 3G, LTE/4G
  - Wide availability and coverage
  - Must consider propagation conditions at gateway locations to avoid coverage holes
- Wired (Fiber)
  - IEEE 802.3 (Ethernet)
  - Limited availability and (pole) coverage in outdoor environments
  - Fastest and most reliable

NETWORK SECURITY

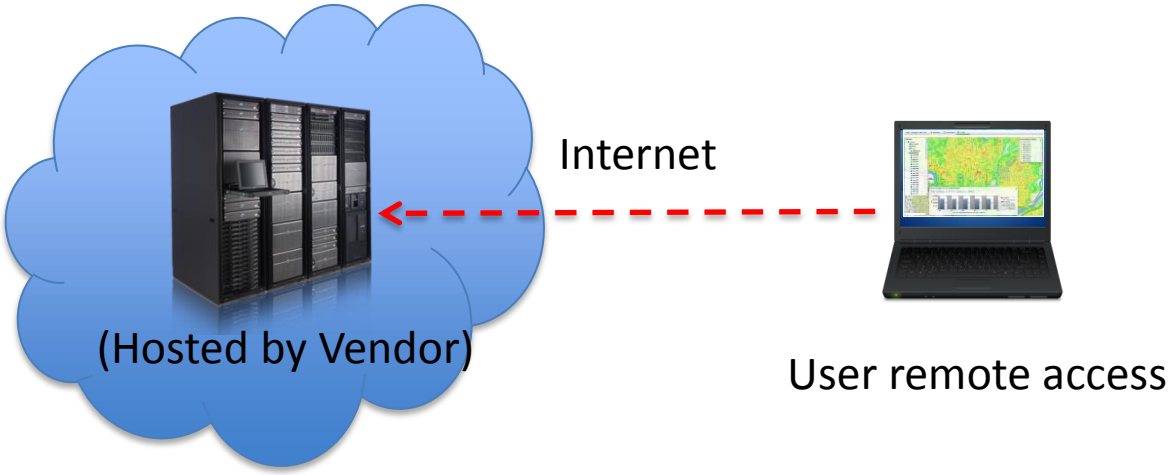
Secure deployment and commissioning	• To prevent the connection of malicious devices to the system
Encryption of data	• To prevent eavesdropping on the communications in the system
Authentication	• To prevent unauthorized people or devices from controlling or disrupting the system
Secure software updates	• To prevent hackers from uploading non-functional or malicious software to the system

CENTRAL MANAGEMENT SYSTEMS

Computer environments that function as the core of a System by providing all shared System services, and consolidating and storing (or managing the storage of) all System data



CLOUD-BASED HOSTING



- Complexity (application management, software upgrades, security management) handled by Vendor
- Access through encrypted user sessions (https) – technology similar to online banking
- Reliable infrastructure with multitenant software and automated backups
- Cost effective (leverage the cloud scale)
- Typically involves a service fee (per-light-point-per-year fee)

USER SITE BASED HOSTING

1

(Hosted by User)

User remote access

2

Standalone desktop application

- End user and vendor coordinates application management and software upgrades
- All data stays within the user's premises
- End user responsible for data backup and security management
- Typically, one time software cost + support services (helpdesk/upgrades)

CENTRAL MANAGEMENT SYSTEM CORE CAPABILITIES

- Graphic User Interface (GUI)
- Commissioning
  - Control strategies
  - Fault thresholds
- Asset management
- Reporting
  - Remote monitoring
  - Energy consumption
  - Fault detection, tracking, alarm generation
- Diagnostics and manual control

DELETE?

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Q & A

Technology Fundamentals

Mark Wilbur

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OUTDOOR LIGHTING CONTROL SYSTEM FUNDAMENTALS

Basic System Capabilities & Value Propositions

Michael Poplawski

BASIC SYSTEM CAPABILITIES

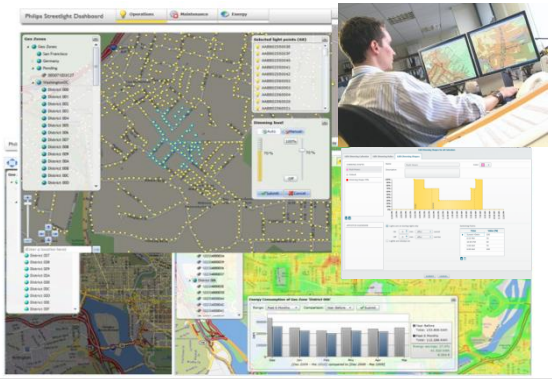
High performance sources

Connected

Wireless, scalability, security

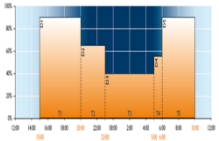
Remote monitoring & control

metering, status, energy reports



Adaptive

schedules, presence, weather, traffic



Sensing

cars, pedestrians, bicycles, environment…

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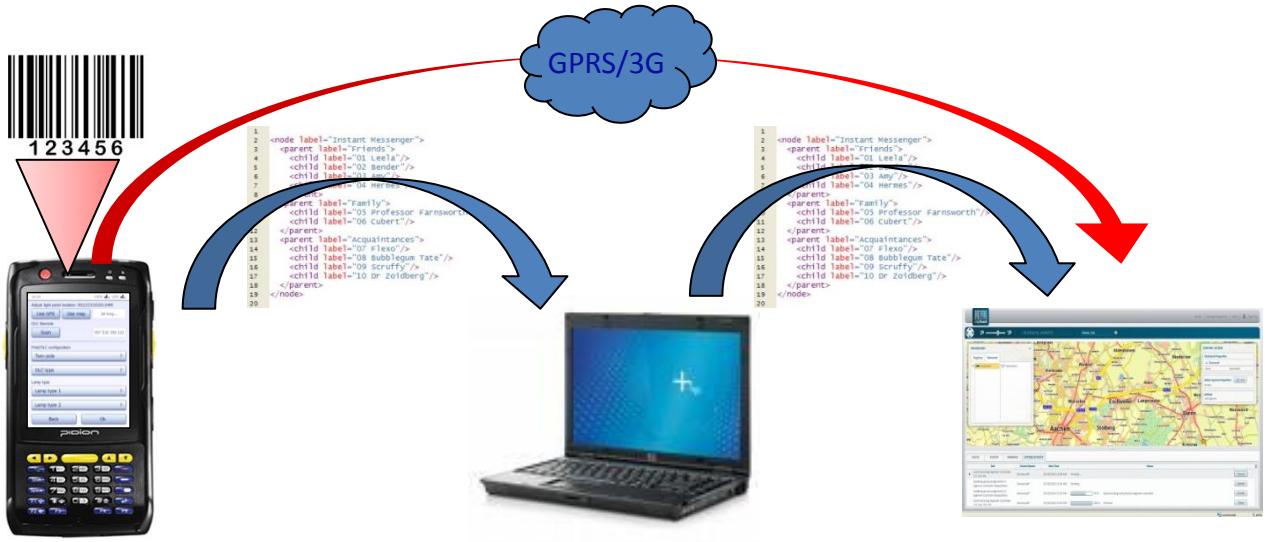
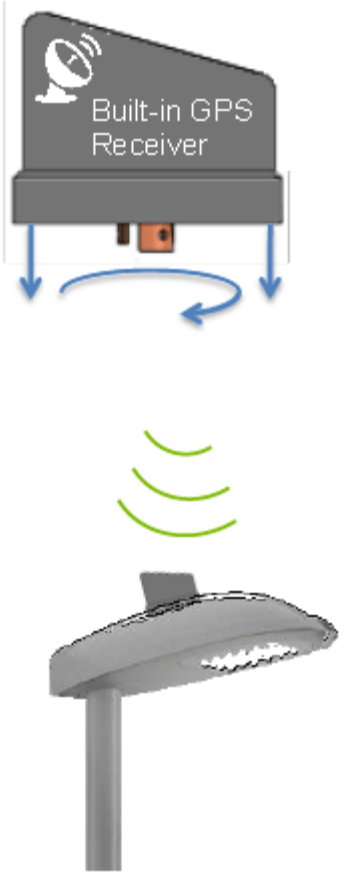
LOCAL START-UP

- Upload light plan (if available)
- Scan barcodes
- Collect GPS coordinates (with handheld GPS)
- Send handheld data file to PC or directly to CMS
- Configure devices from CMS



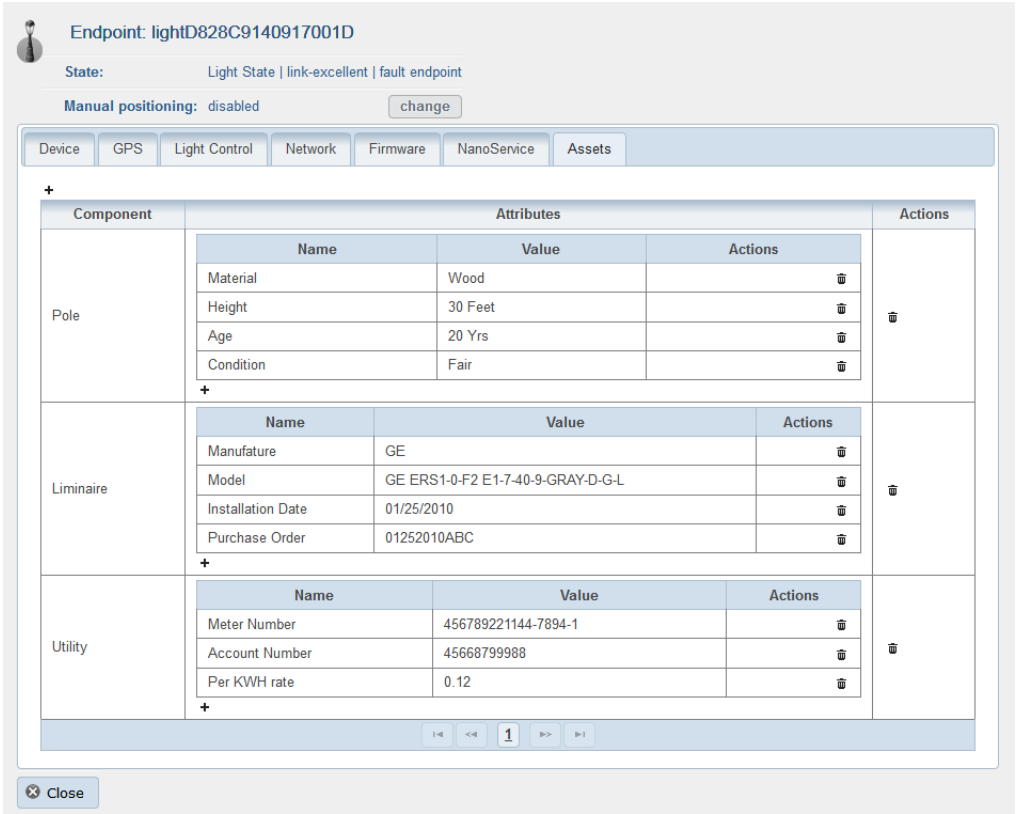
REMOTE START-UP

- Plug in twist-lock module
- Watch Indicator lights
- Input Fixture information (Lamp, Driver, etc.) - Proceed to next Fixture
- Behind the scenes
  - GPS Coordinates acquisition & storage
  - Sync clock with GPS time
  - Auto Join mesh network & register
  - Sync schedule and settings info from CMS
  - Run initial diagnostics
  - Register collected information with CMS
  - Blink indicator lights for success/fail code

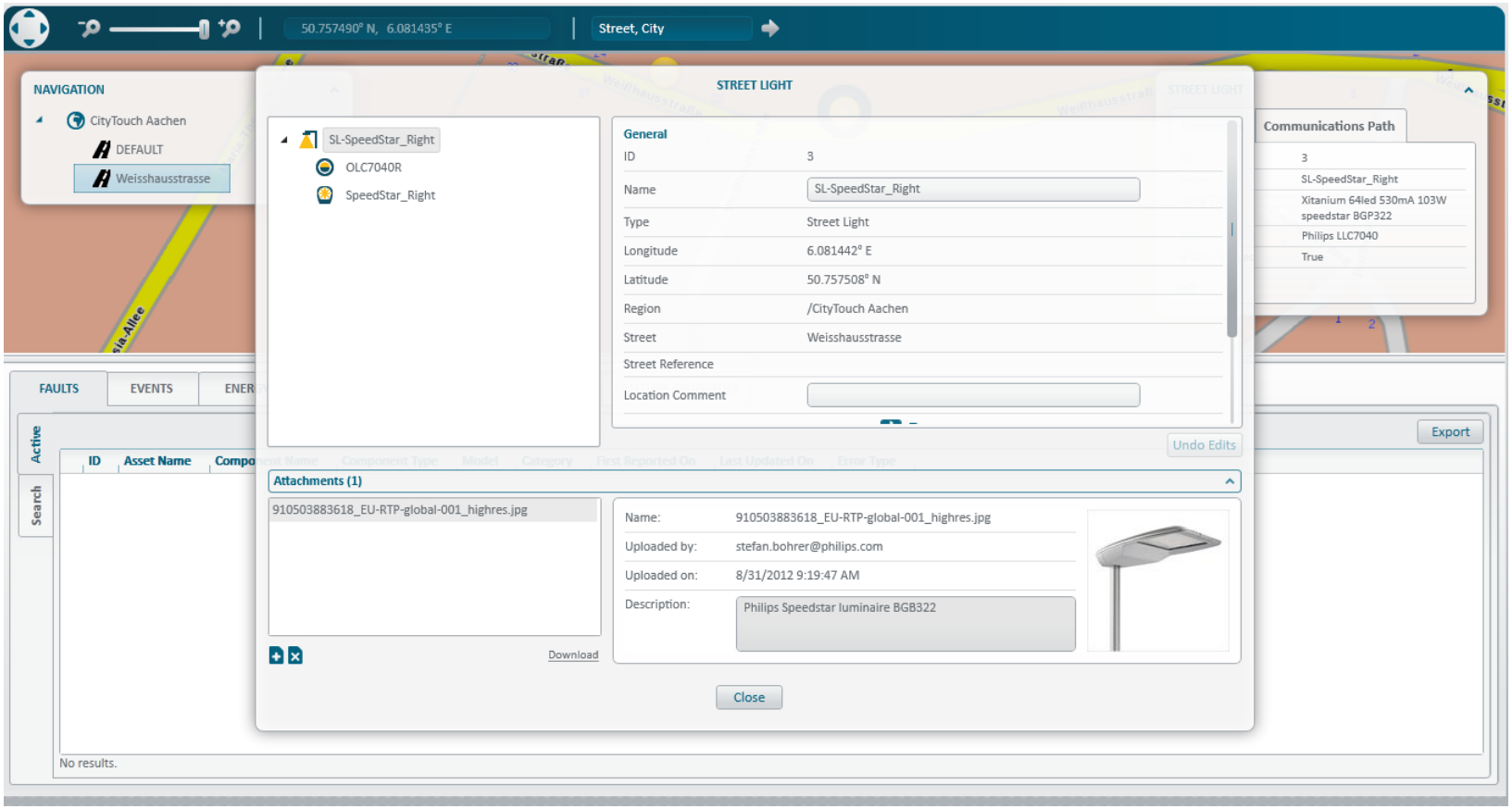


ASSET TYPES

- Street light
  - Pole
  - Controller
  - Luminaire
- Cabinets
  - Gateway
  - Traffic management equipment



ASSET MANAGEMENT



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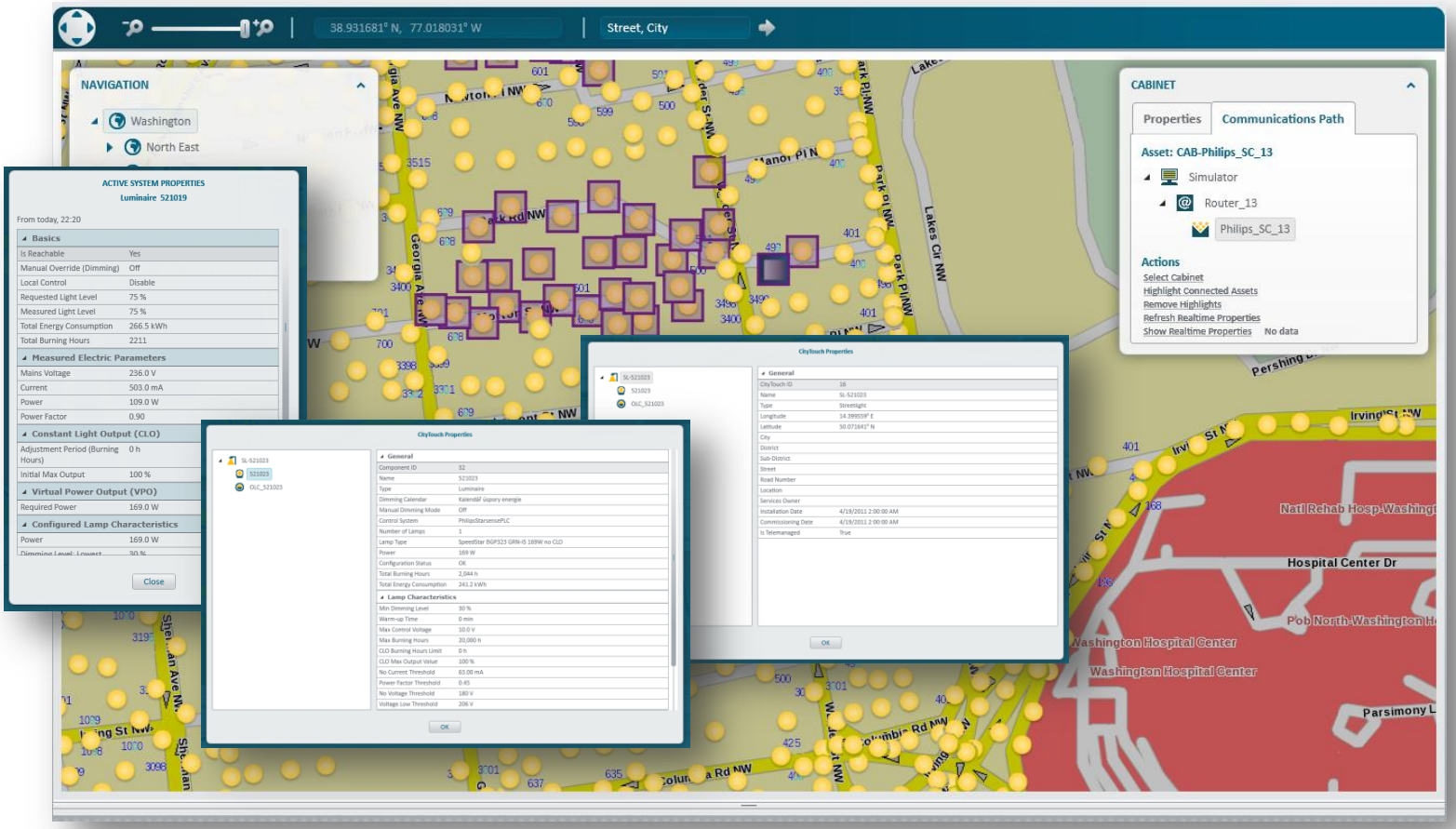
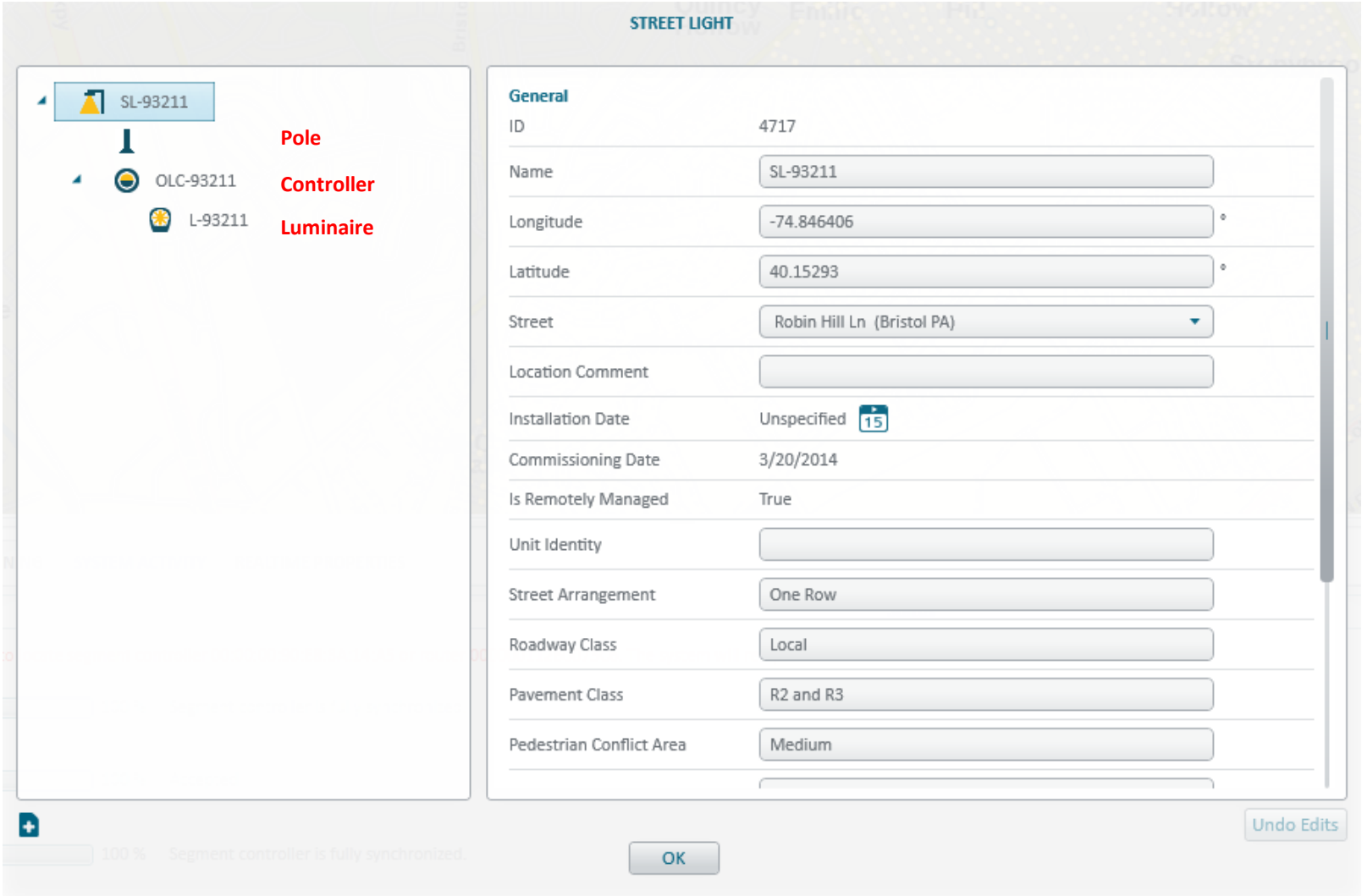
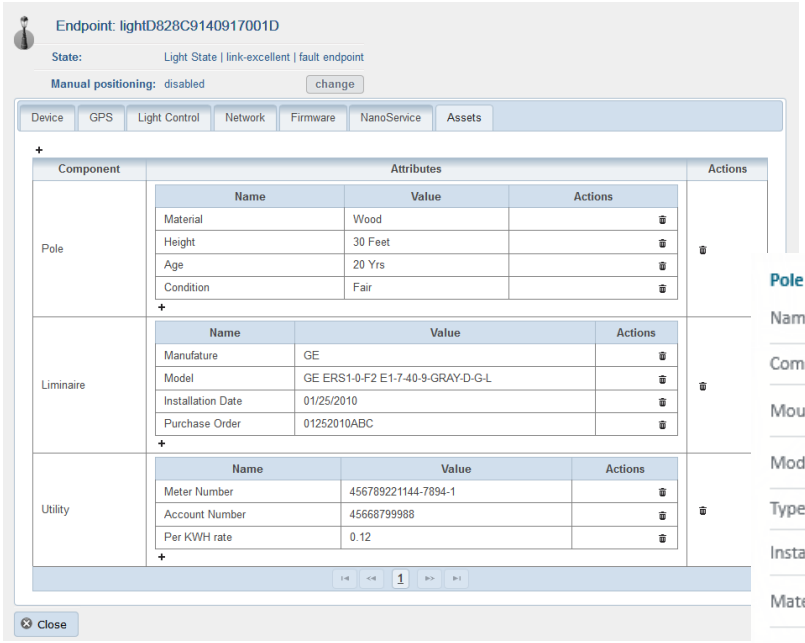
ASSET LOCATION

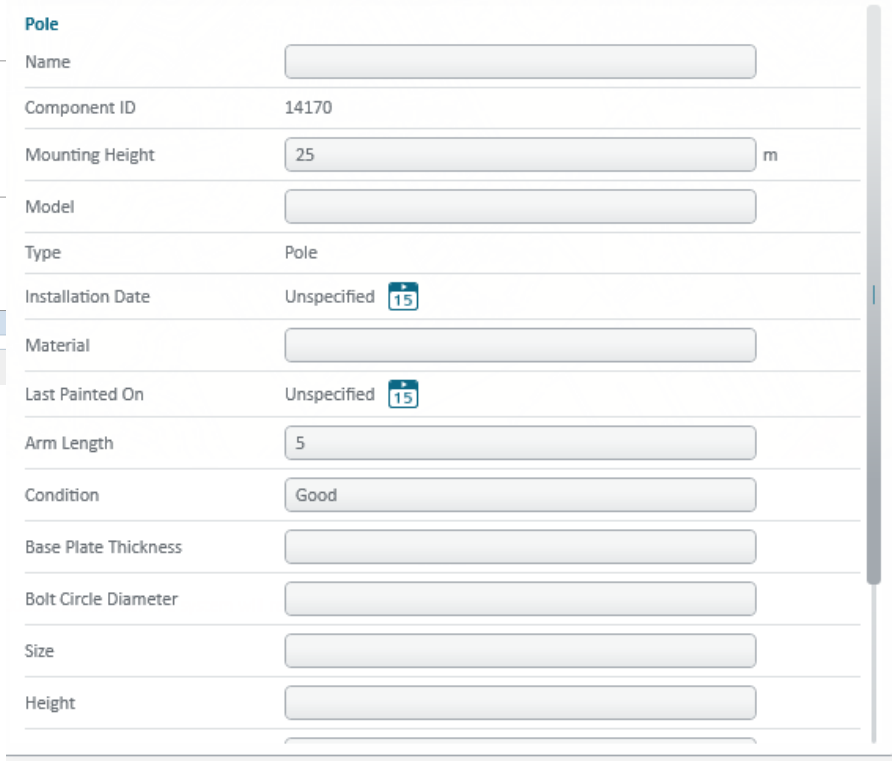


COORDINATED ASSETS

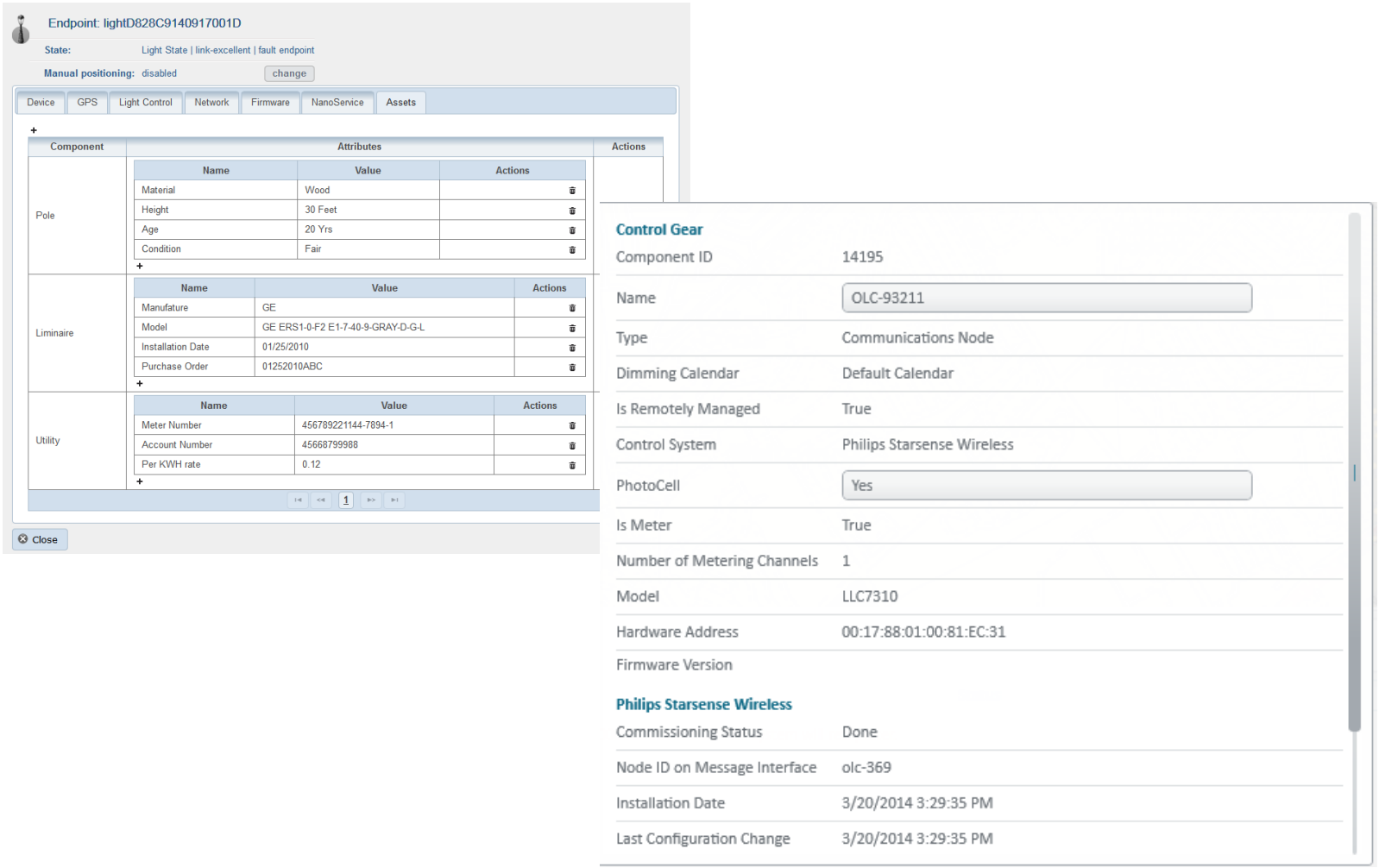


POLE ASSET FIELDS

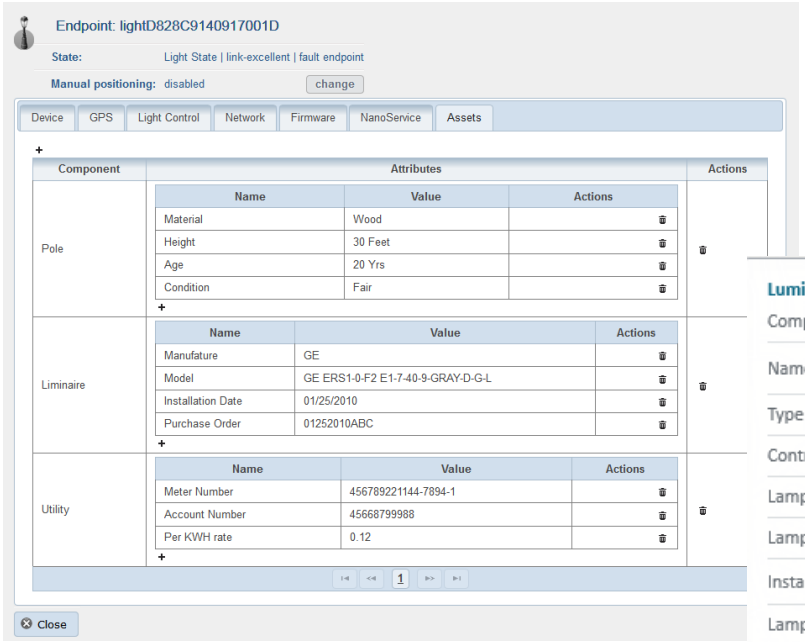


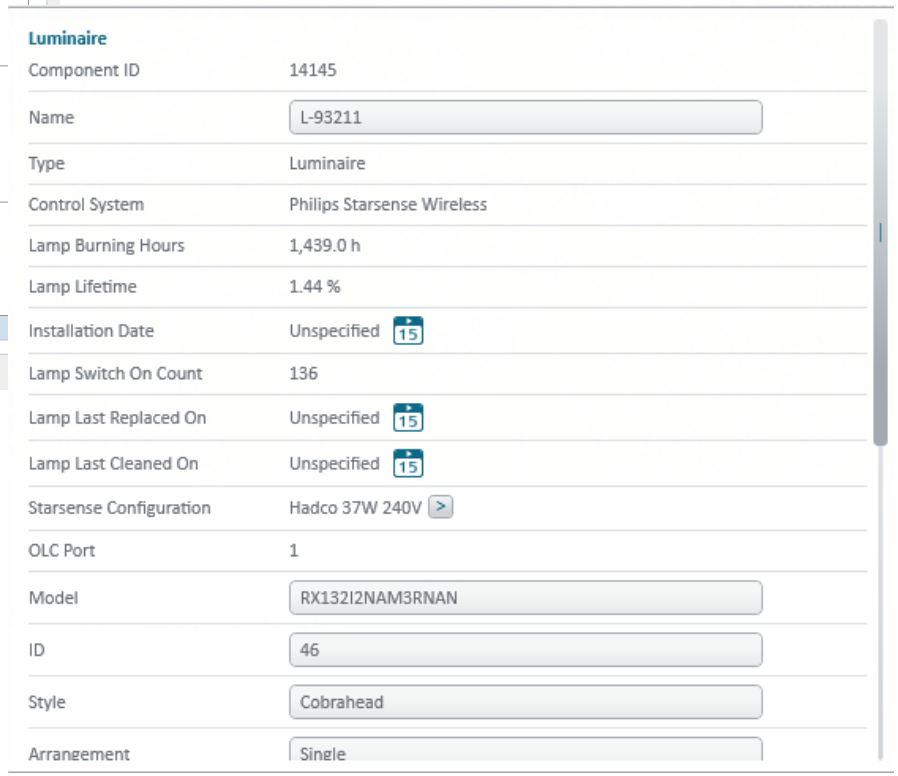


CONTROLLER ASSET FIELDS



LUMINAIRE ASSET FIELDS





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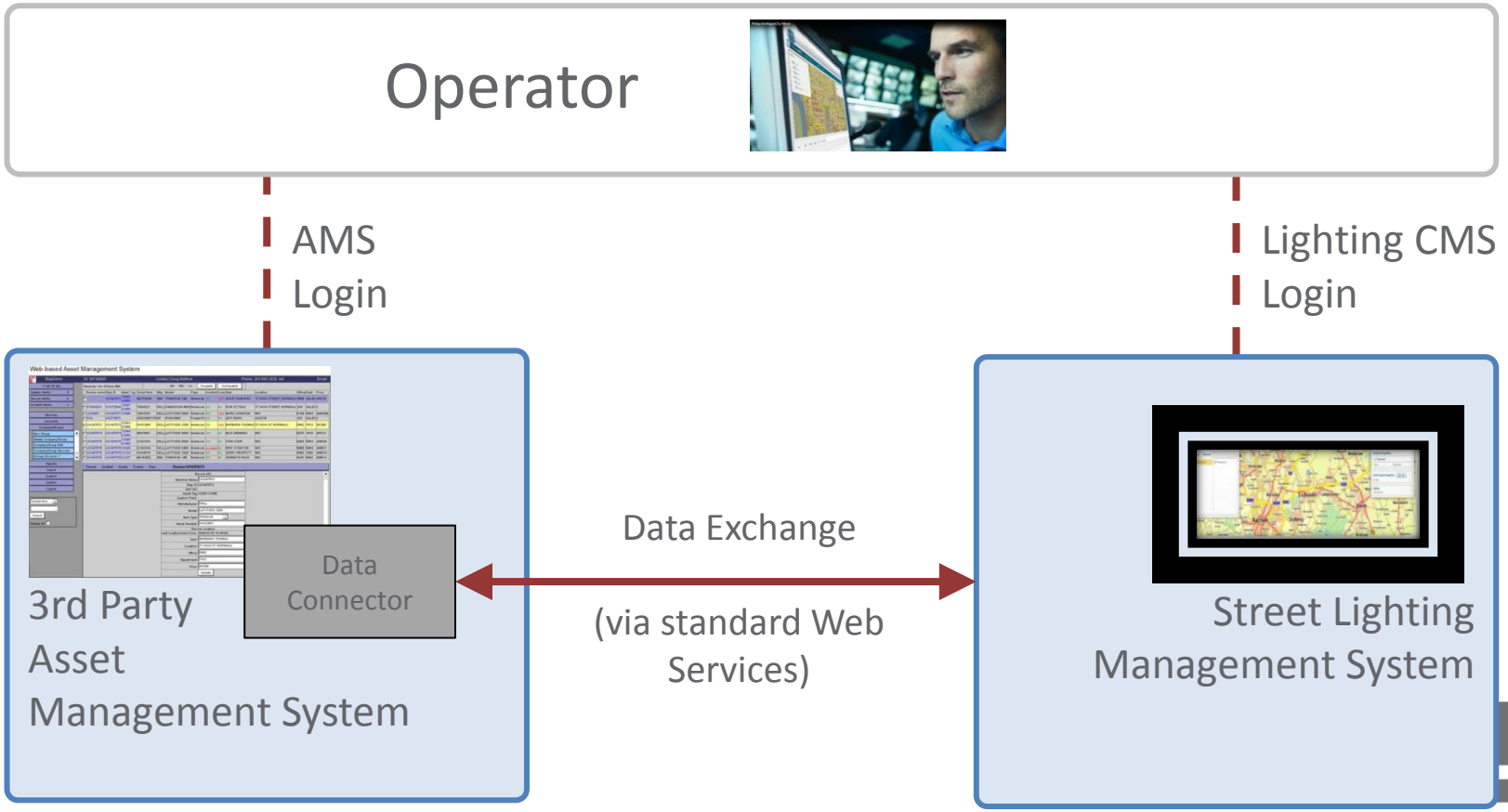
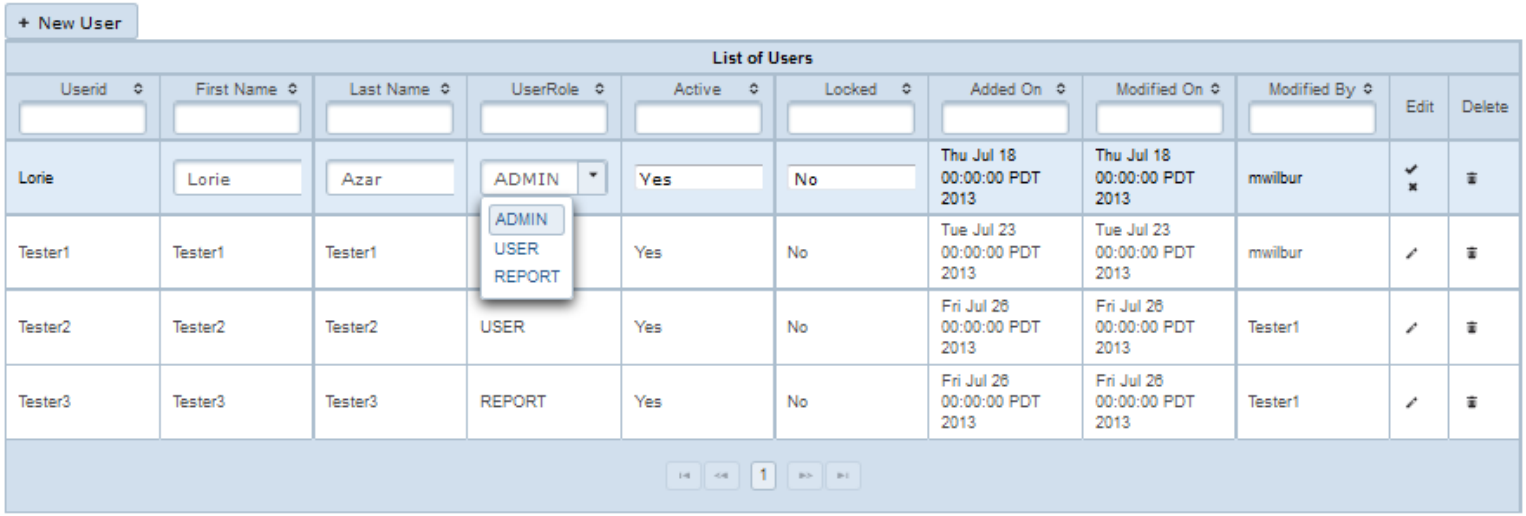
IMPORTING LEGACY OR EXISTING ASSET DATA

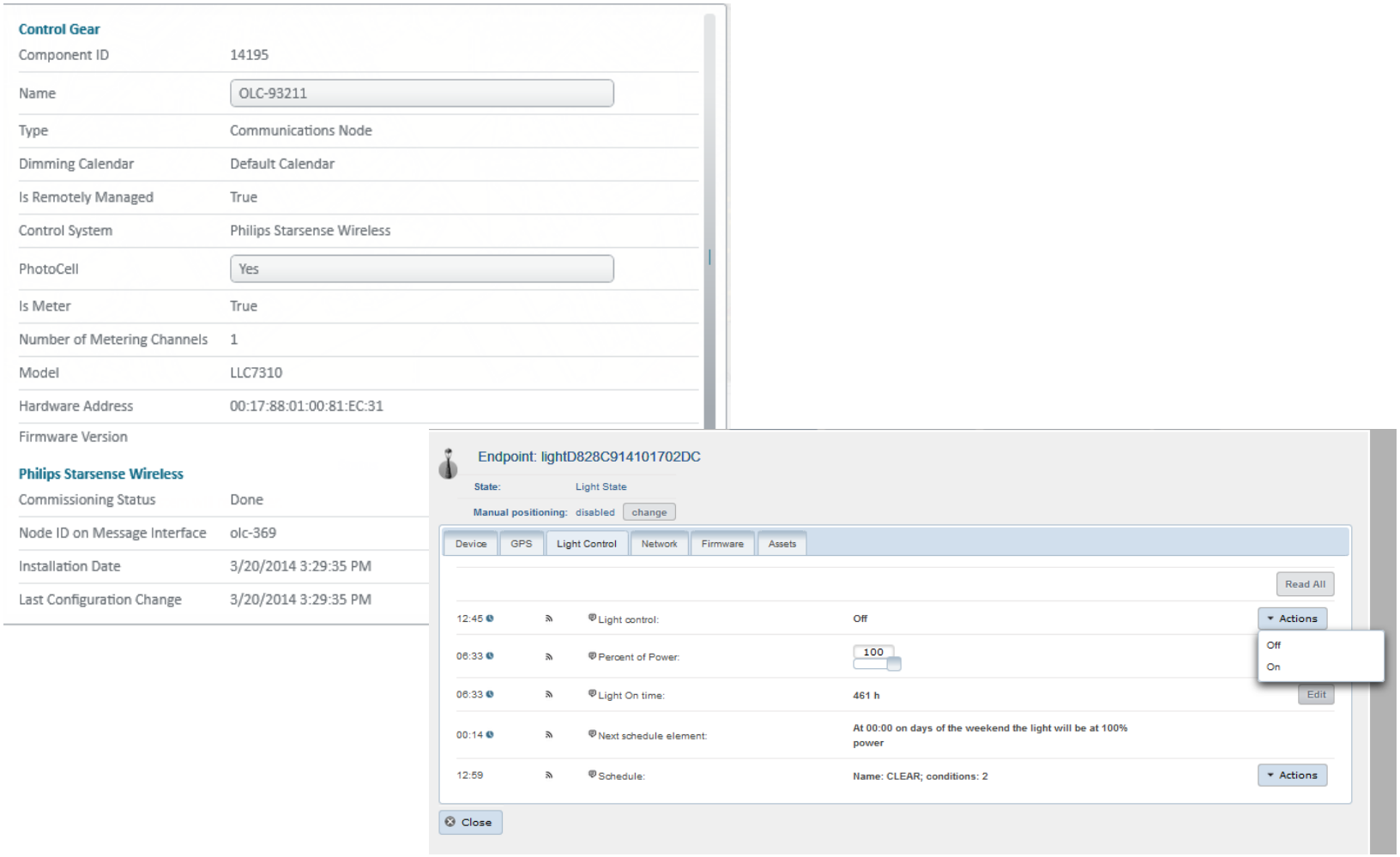


USER MANAGEMENT

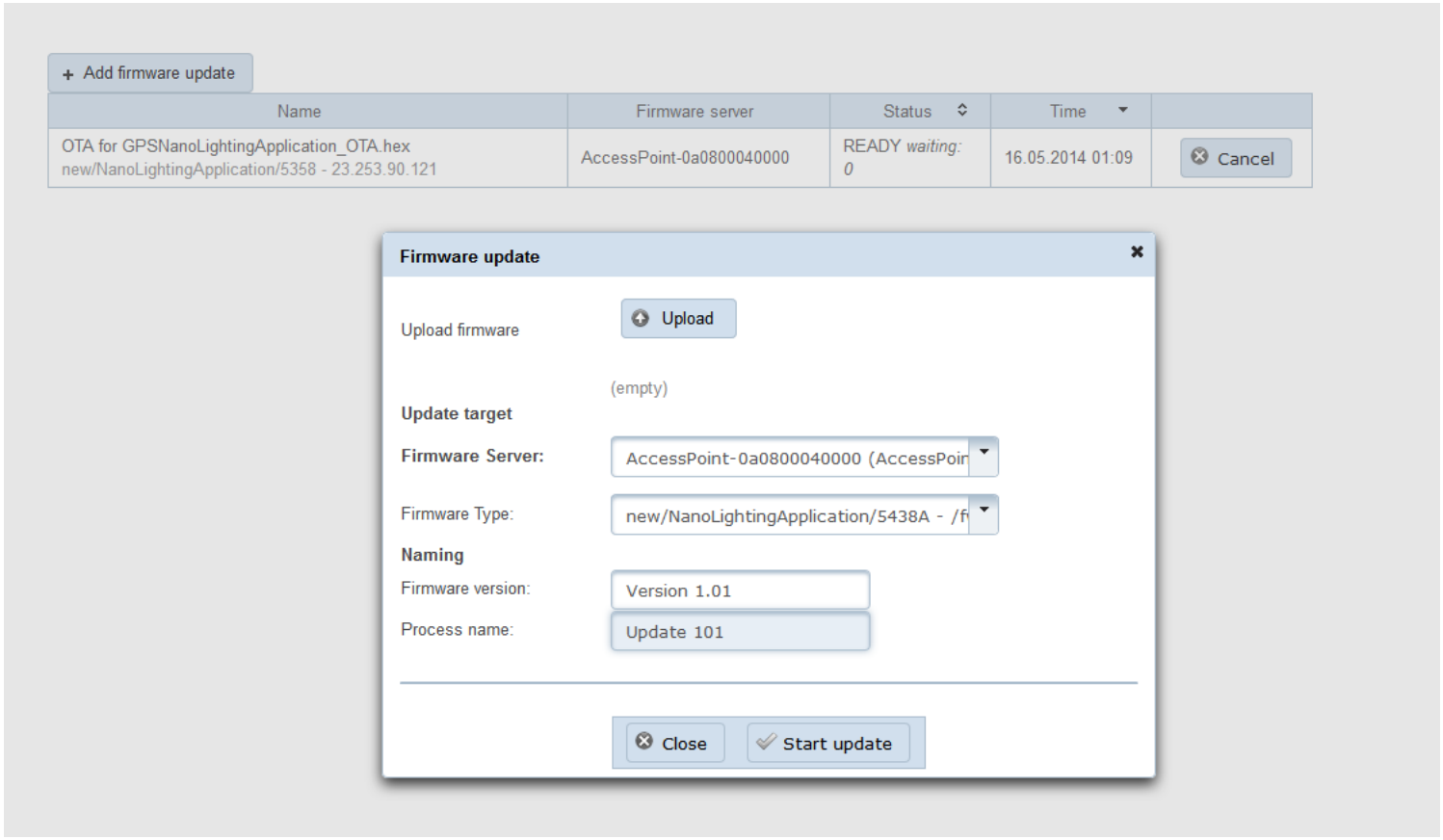
- Configure user roles and access rights
- Use roles
- Administrator (full access)
- User (standard/normal operational access)
- Report (view only access)



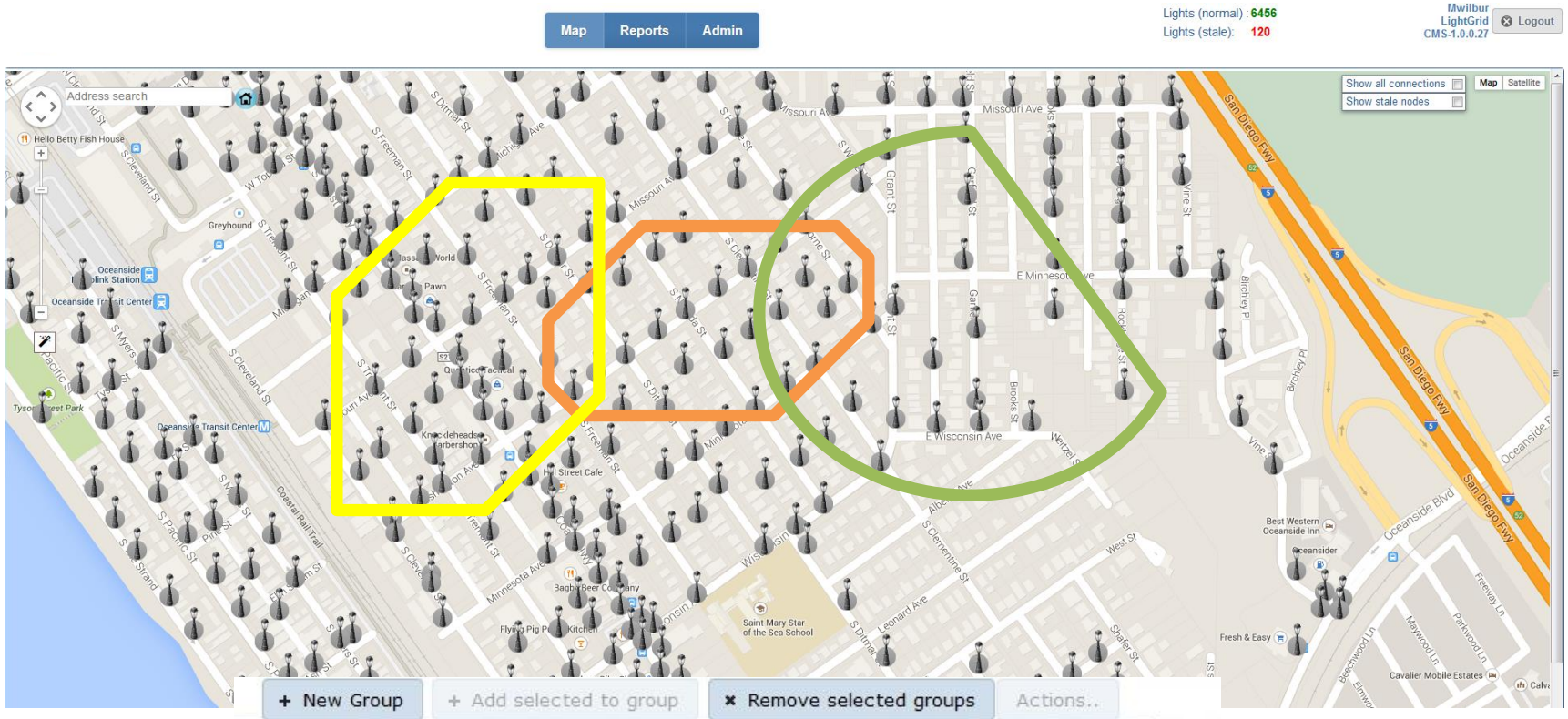
DEVICE CONFIGURATION



OVER-THE-AIR FIRMWARE UPDATES

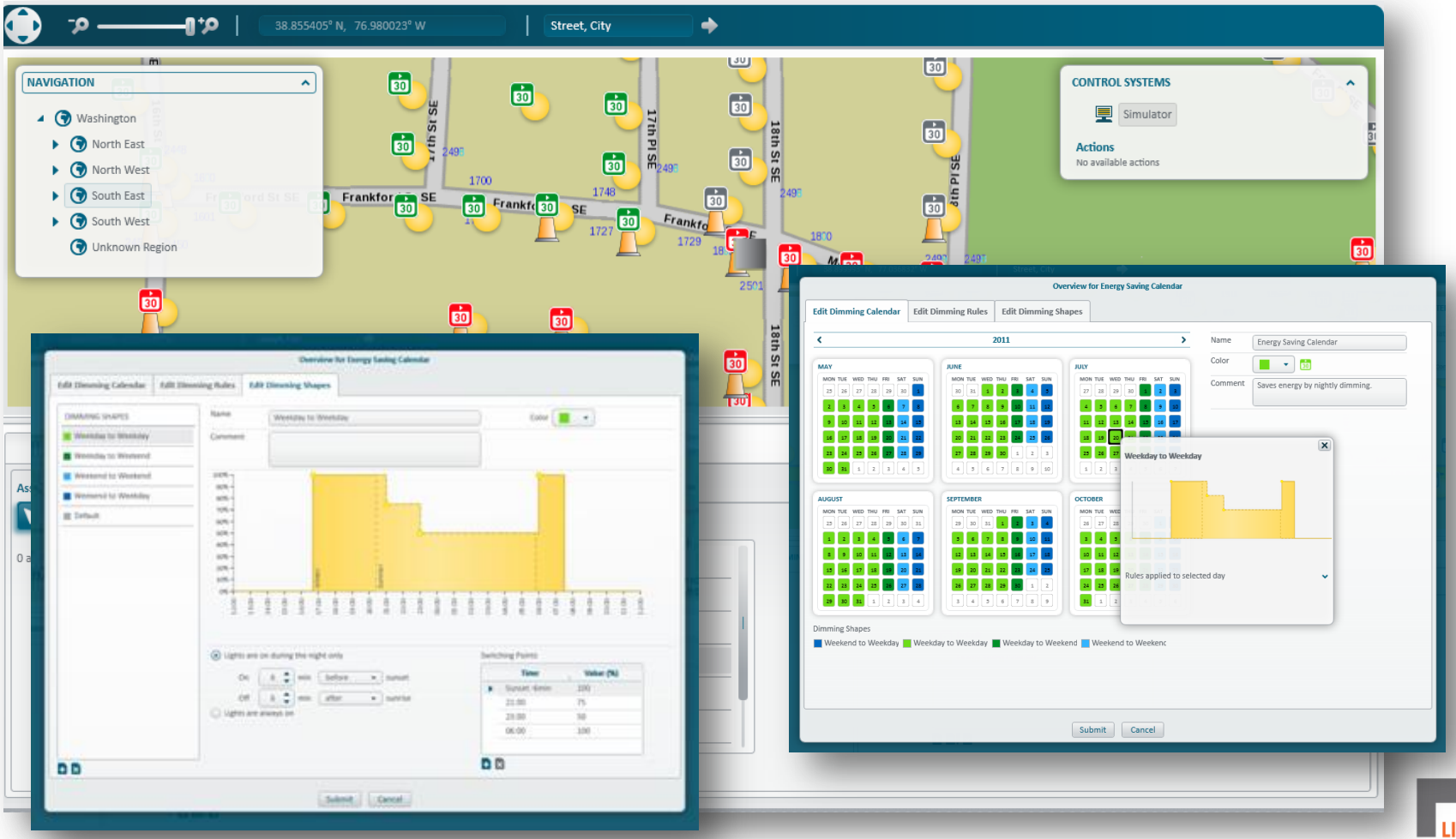


GROUPING

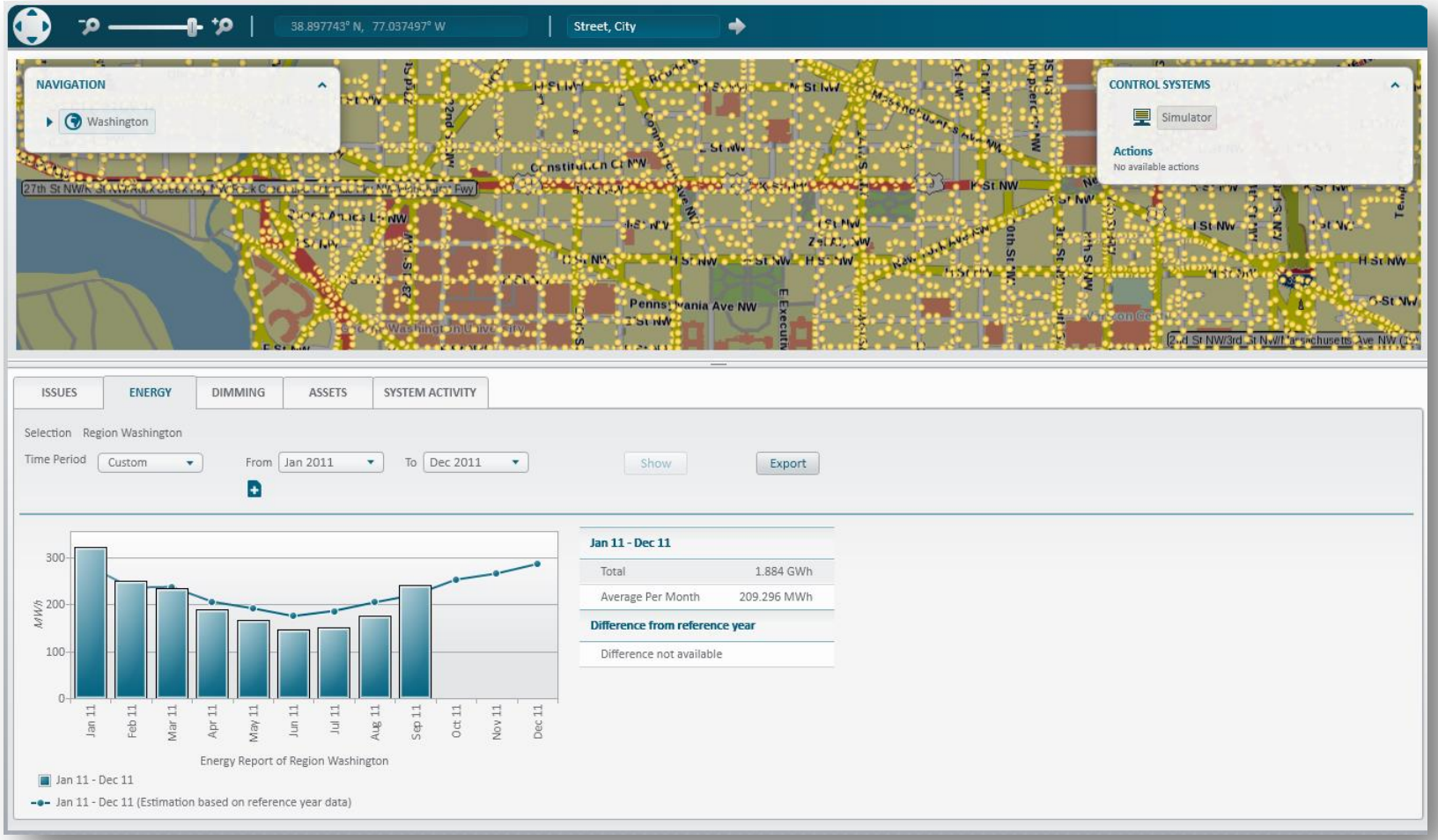


	Name	Domain	Type	Status	Action
☑	LSBU2		Group	9 endpoints	show on map
☑	LSBUTucker		Group	5 endpoints	show on map
☑	altec		Group	56 endpoints	show on map

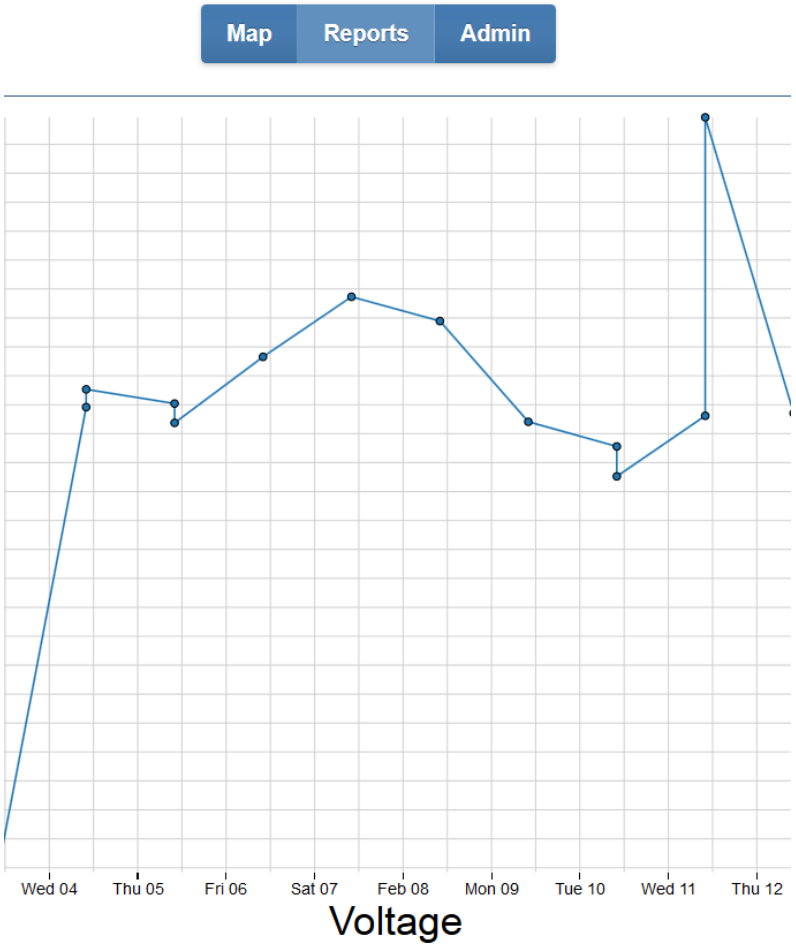
TIME AND CALENDAR SCHEDULING

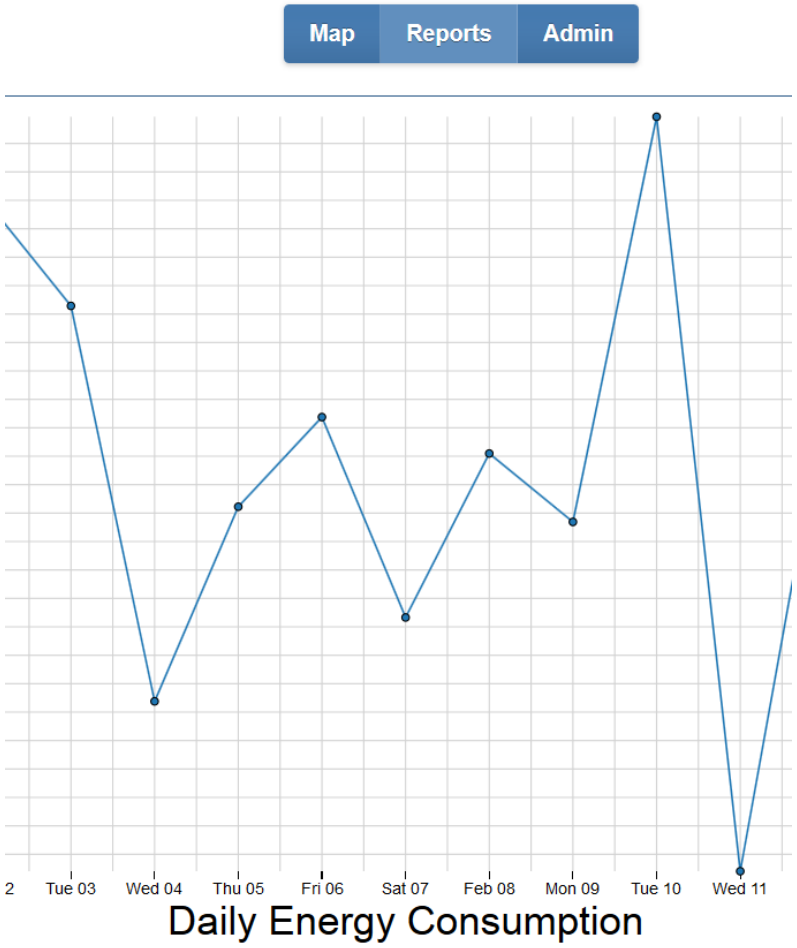


ENERGY CONSUMPTION

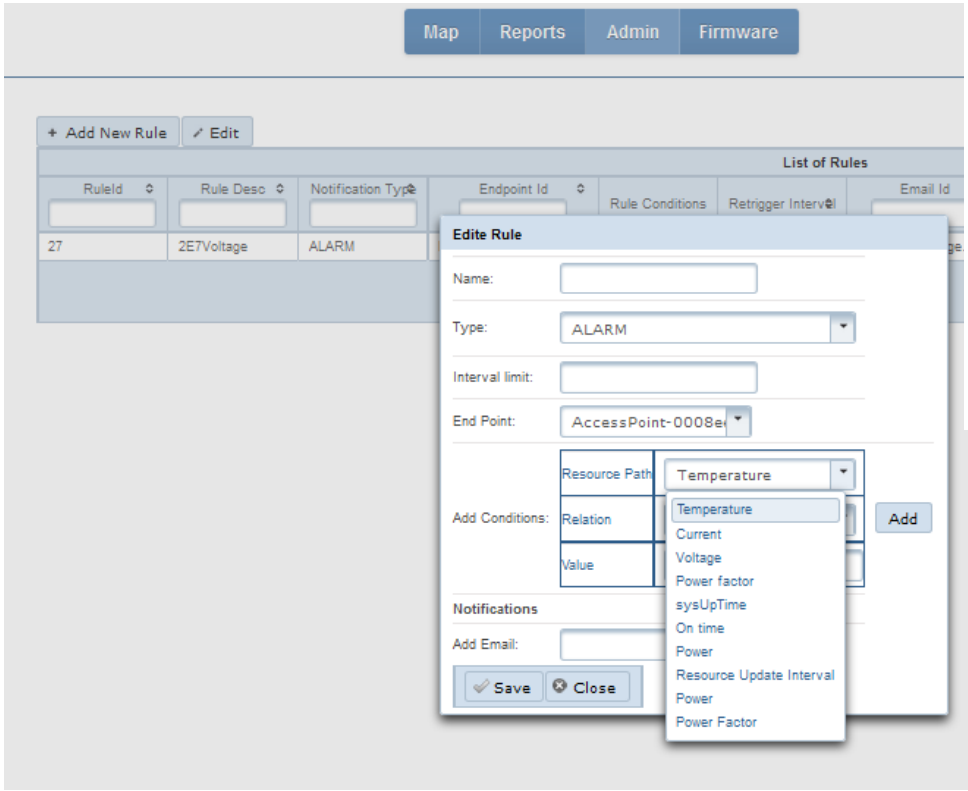


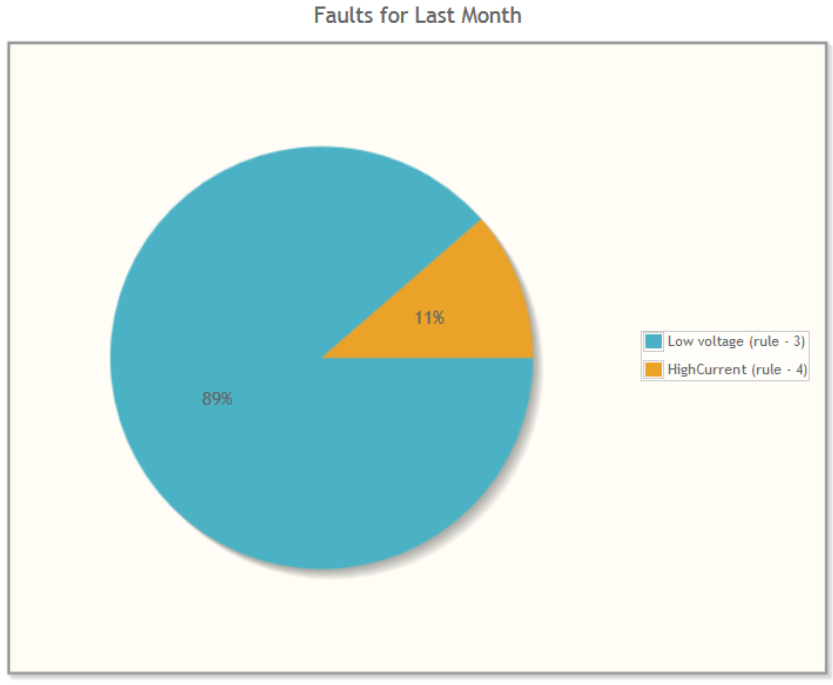
ELECTRICAL PARAMETERS





CONFIGURING FAULTS AND NOTIFICATIONS





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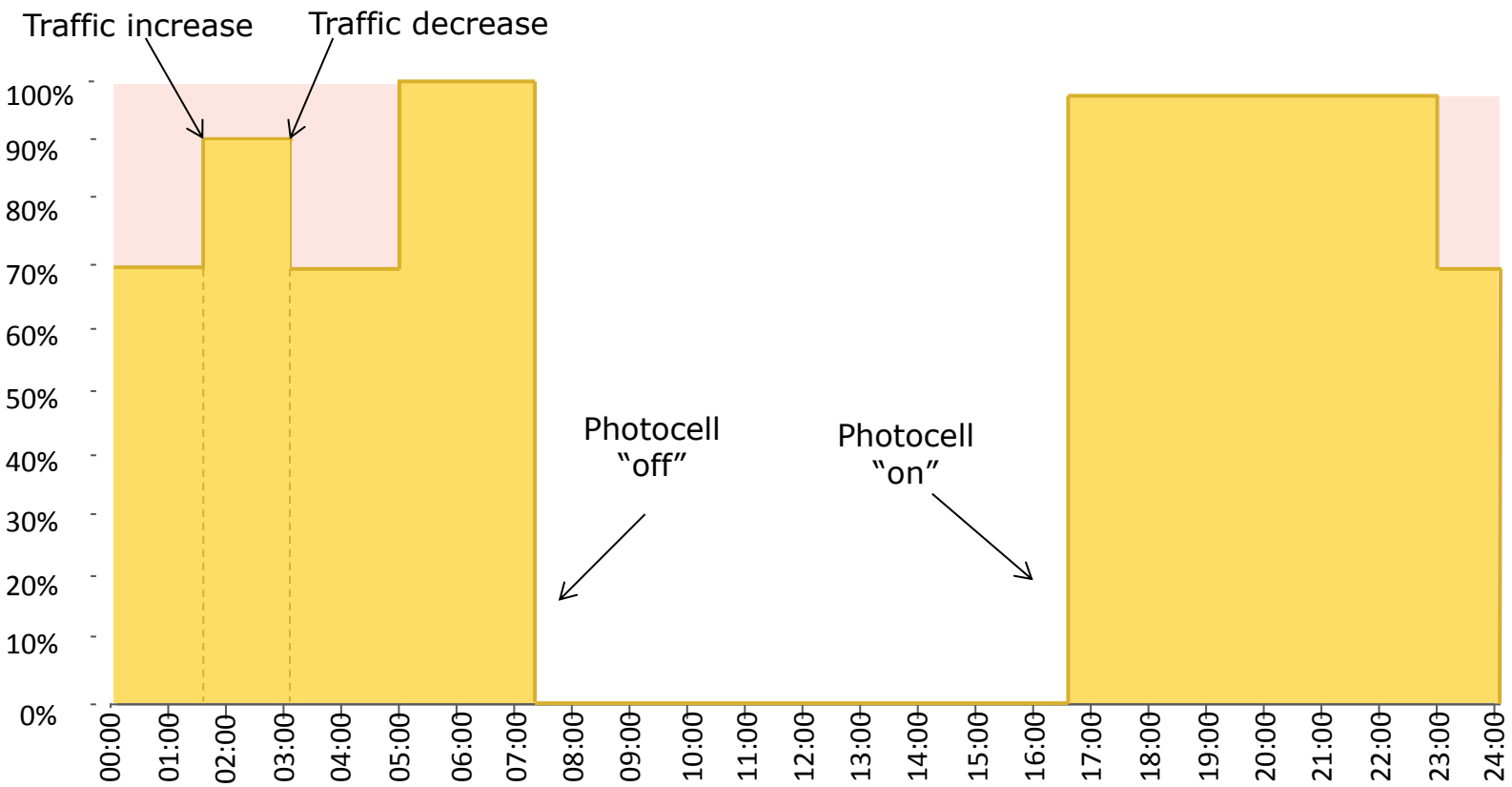
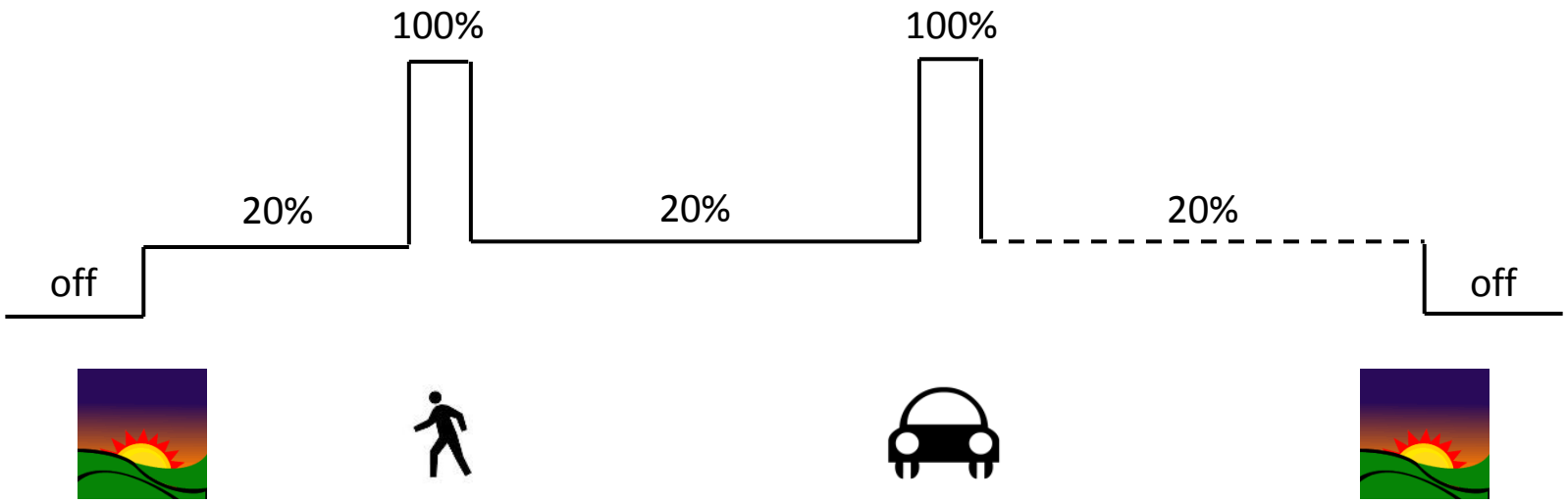
ADAPTIVE CONTROL STRATEGIES

- Time based
  - Scheduled by time (and possibly calendar date)
  - Fixed, finite number of switching times and light levels
- Event based
  - Triggered by data from one or more sources
    - Sensors, networked data sources
    - Traffic, ambient light, motion, environmental conditions)
  - Dynamically varying switching times and light levels in response to event triggers

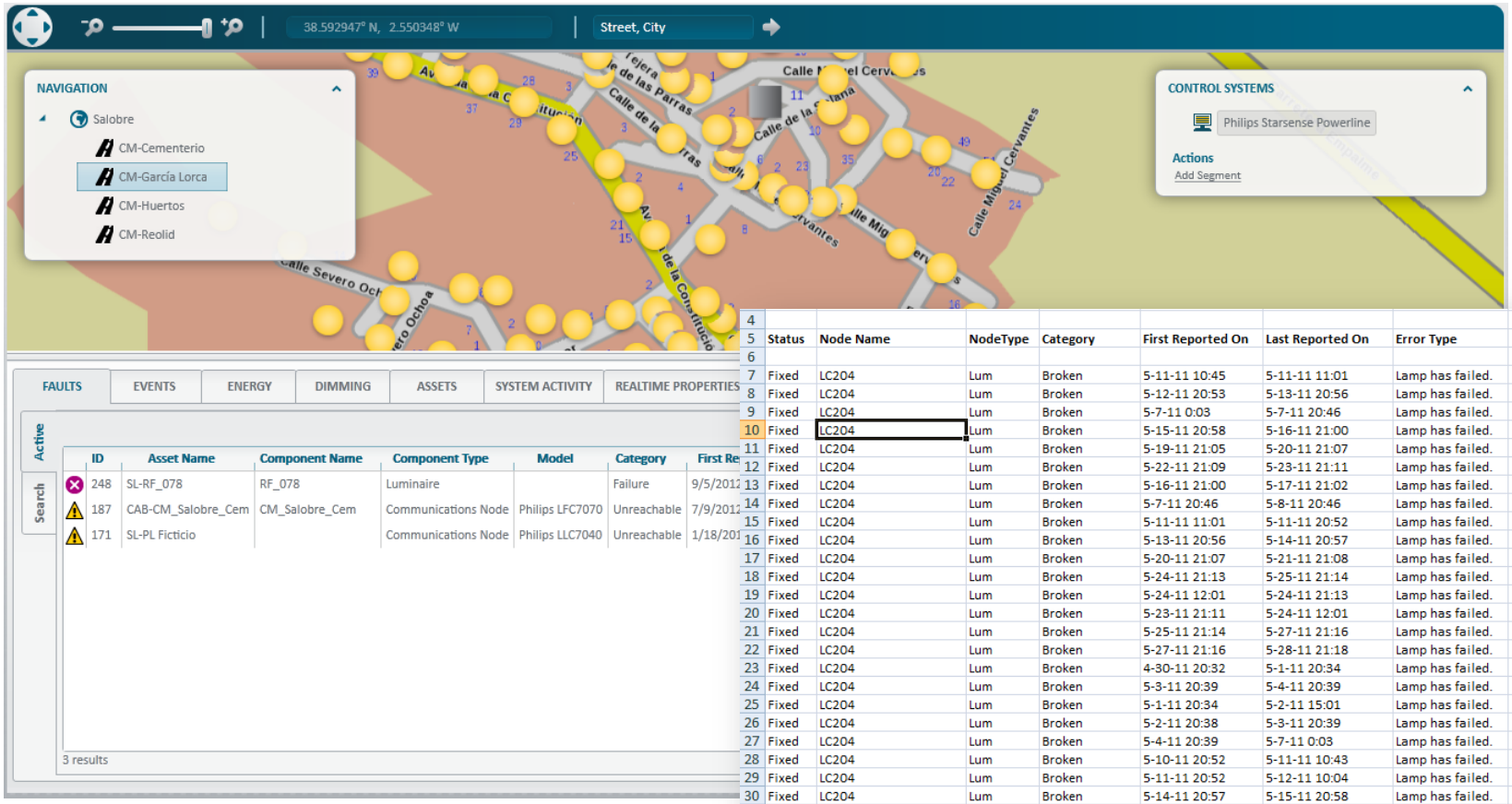
TIME AND EVENT-BASED CONTROL (E.G. TRAFFIC SENSOR)



TIME AND EVENT-BASED CONTROL (E.G. MOTION SENSOR)

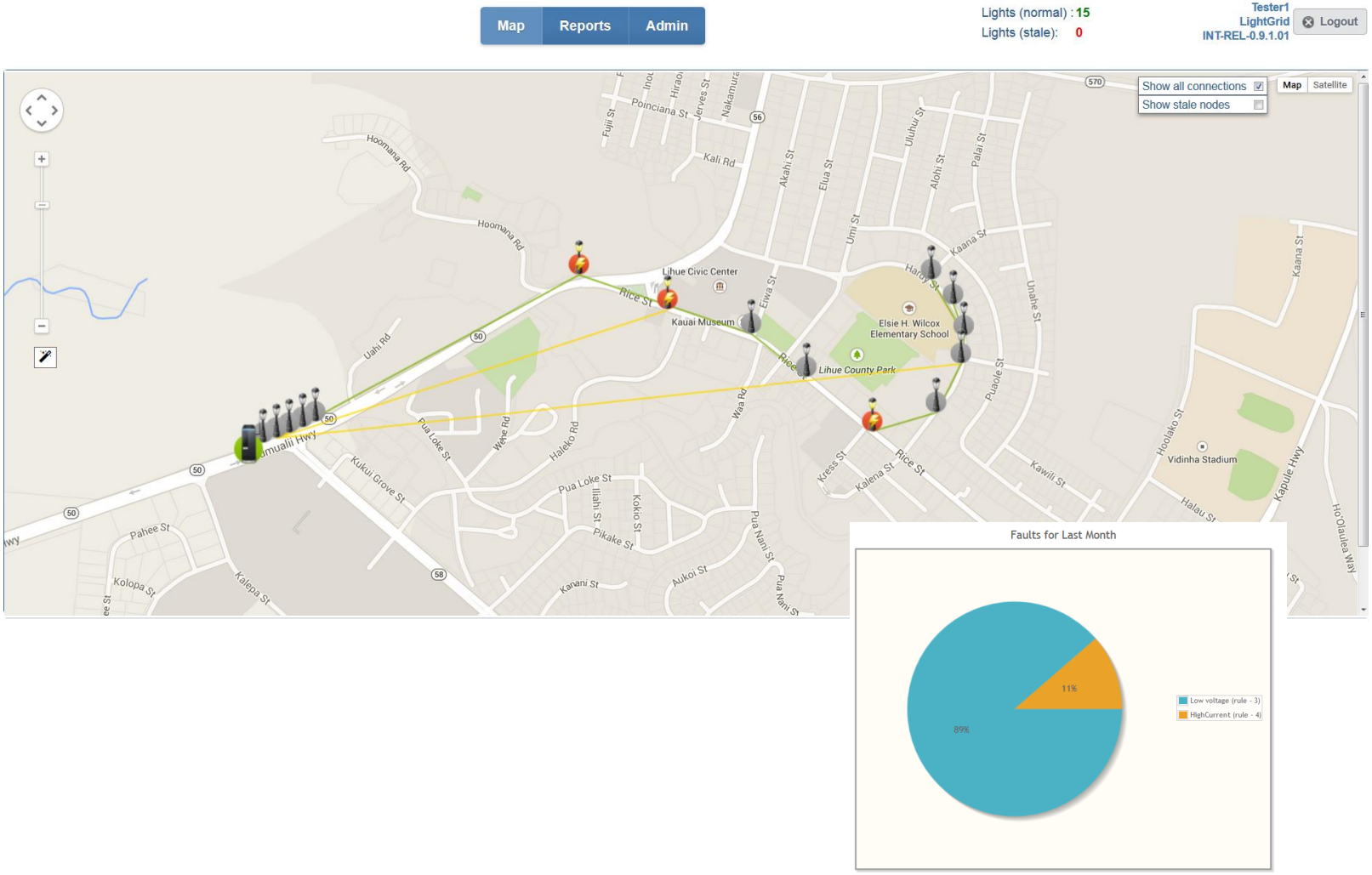


FAULT REPORTING

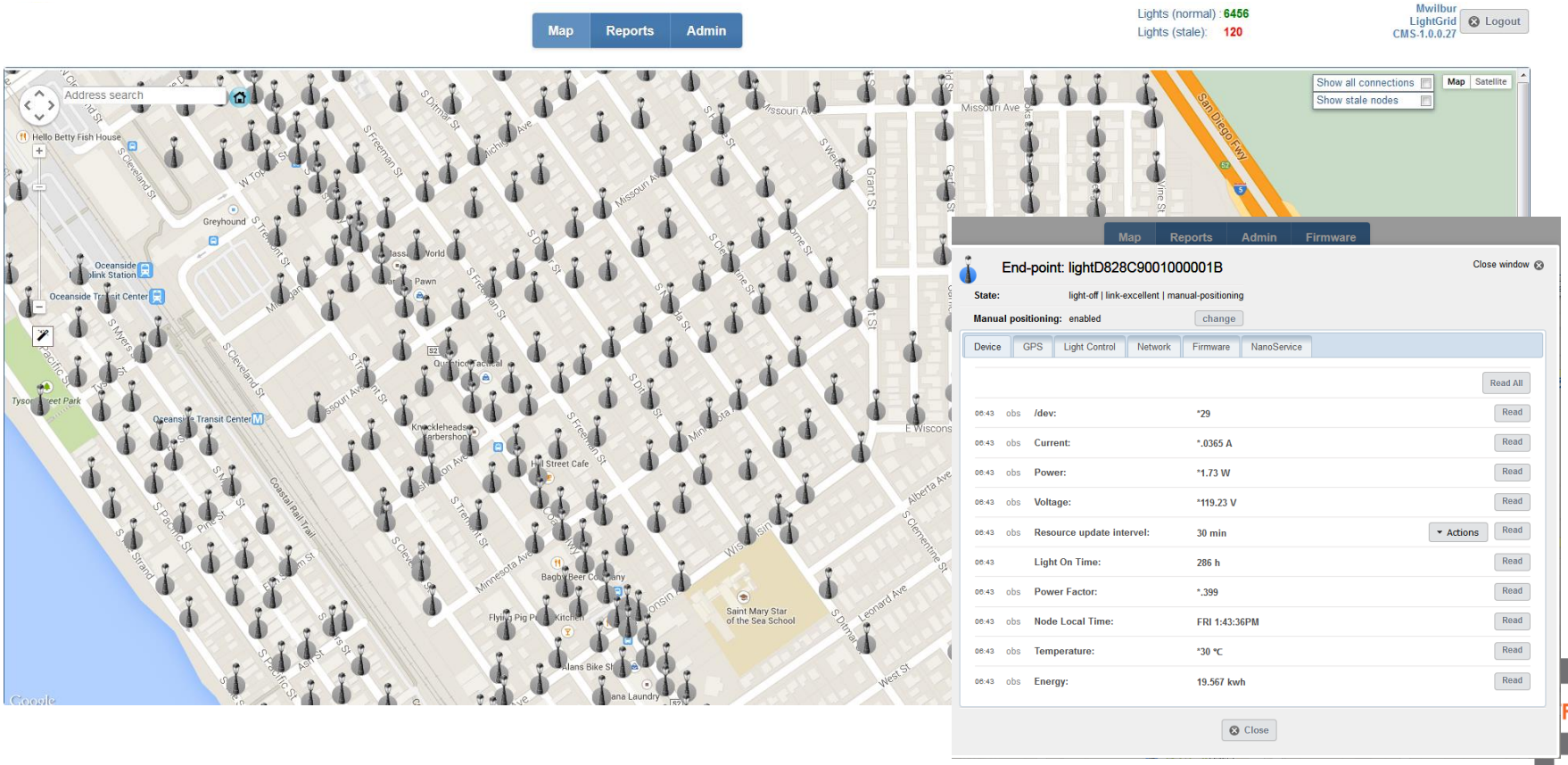


Status	Node Name	NodeType	Category	First Reported On	Last Reported On	Error Type
Fixed	LC204	Lum	Broken	5-11-11 10:45	5-11-11 11:01	Lamp has failed.
Fixed	LC204	Lum	Broken	5-12-11 20:53	5-13-11 20:56	Lamp has failed.
Fixed	LC204	Lum	Broken	5-7-11 0:03	5-7-11 20:46	Lamp has failed.
Fixed	LC204	Lum	Broken	5-15-11 20:58	5-16-11 21:00	Lamp has failed.
Fixed	LC204	Lum	Broken	5-19-11 21:05	5-20-11 21:07	Lamp has failed.
Fixed	LC204	Lum	Broken	5-22-11 21:09	5-23-11 21:11	Lamp has failed.
Fixed	LC204	Lum	Broken	5-16-11 21:00	5-17-11 21:02	Lamp has failed.
Fixed	LC204	Lum	Broken	5-7-11 20:46	5-8-11 20:46	Lamp has failed.
Fixed	LC204	Lum	Broken	5-11-11 11:01	5-11-11 20:52	Lamp has failed.
Fixed	LC204	Lum	Broken	5-13-11 20:56	5-14-11 20:57	Lamp has failed.
Fixed	LC204	Lum	Broken	5-20-11 21:07	5-21-11 21:08	Lamp has failed.
Fixed	LC204	Lum	Broken	5-24-11 21:13	5-25-11 21:14	Lamp has failed.
Fixed	LC204	Lum	Broken	5-24-11 12:01	5-24-11 21:13	Lamp has failed.
Fixed	LC204	Lum	Broken	5-23-11 21:11	5-24-11 12:01	Lamp has failed.
Fixed	LC204	Lum	Broken	5-25-11 21:14	5-27-11 21:16	Lamp has failed.
Fixed	LC204	Lum	Broken	5-27-11 21:16	5-28-11 21:18	Lamp has failed.
Fixed	LC204	Lum	Broken	4-30-11 20:32	5-1-11 20:34	Lamp has failed.
Fixed	LC204	Lum	Broken	5-3-11 20:39	5-4-11 20:39	Lamp has failed.
Fixed	LC204	Lum	Broken	5-1-11 20:34	5-2-11 15:01	Lamp has failed.
Fixed	LC204	Lum	Broken	5-2-11 20:38	5-3-11 20:39	Lamp has failed.
Fixed	LC204	Lum	Broken	5-4-11 20:39	5-7-11 0:03	Lamp has failed.
Fixed	LC204	Lum	Broken	5-10-11 20:52	5-11-11 10:43	Lamp has failed.
Fixed	LC204	Lum	Broken	5-11-11 20:52	5-12-11 10:04	Lamp has failed.
Fixed	LC204	Lum	Broken	5-14-11 20:57	5-15-11 20:58	Lamp has failed.
Fixed	LC204	Lum	Broken	5-17-11 21:02	5-18-11 21:03	Lamp has failed.
Fixed	LC204	Lum	Broken	5-18-11 21:03	5-19-11 21:05	Lamp has failed.
Fixed	LC204	Lum	Broken	5-21-11 21:08	5-22-11 21:09	Lamp has failed.
Fixed	LC204	Lum	Broken	5-28-11 21:18	5-29-11 21:19	Lamp has failed.
Active	LC204	Lum	Broken	5-29-11 21:19	5-29-11 21:19	Lamp has failed.
Fixed	OLC_C174	OLC	Unreachable	5-9-11 11:43	5-9-11 11:45	OLC is not reachable.

SYSTEM STATUS

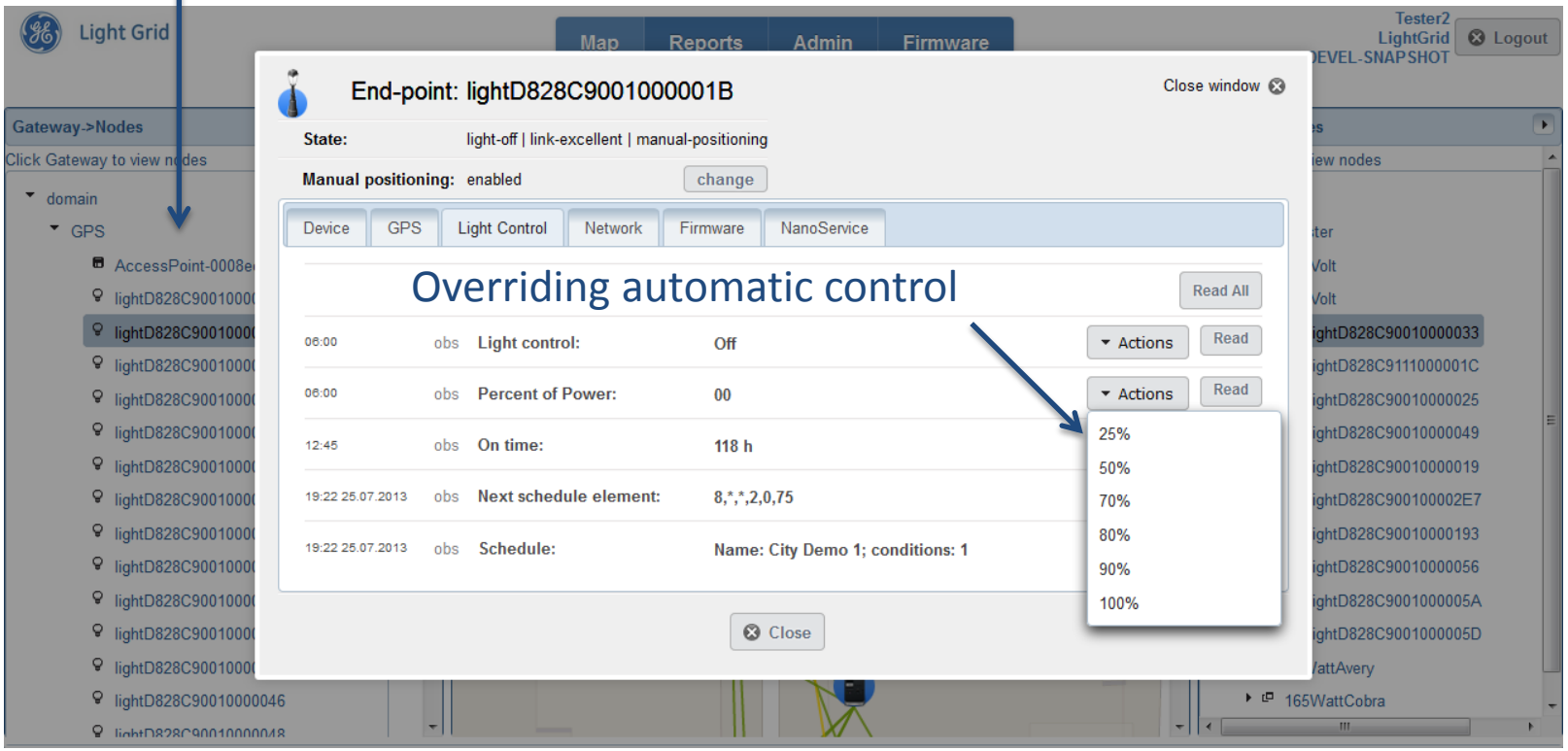


DIAGNOSTICS



MANUAL CONTROL

Luminaire or group selection



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Q & A

Basic System Capabilities & Value Propositions

Michael Poplawski

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OUTDOOR LIGHTING CONTROL SYSTEM FUNDAMENTALS

Demonstration Part 1

Mark Wilbur

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OUTDOOR LIGHTING CONTROL SYSTEM FUNDAMENTALS

Lunch (90 minutes)

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OUTDOOR LIGHTING CONTROL SYSTEM FUNDAMENTALS

Demonstration Part 2

Mark Wilbur

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OUTDOOR LIGHTING CONTROL SYSTEM FUNDAMENTALS

Market Adoption Status

Michael Poplawski

KEY MARKET ADOPTION ISSUES

- Market and user maturity
- Upfront cost and/or payback time
- Quantifiable value propositions
- Game changers
  - Managing modularity vs. integration
  - Interoperability
  - Future city visions, interdepartmental or municipal-utility collaboration models, business models
  - New value propositions, revenue opportunities

USER AND MARKET MATURITY

- Utilities and municipalities and have different vested interests
- Different utilities/municipalities see value propositions differently
- Size matters
- User learning curve
  - Networks, communication
  - New/additional devices to maintain
- Young market
  - Mature core technology
  - Start-up and commissioning processes viewed as complex and time-consuming
  - Rapid product evolution
- One size does not fit all
  - Match desirable feature set(s) to user type(s)
  - MSSLC Model Specification

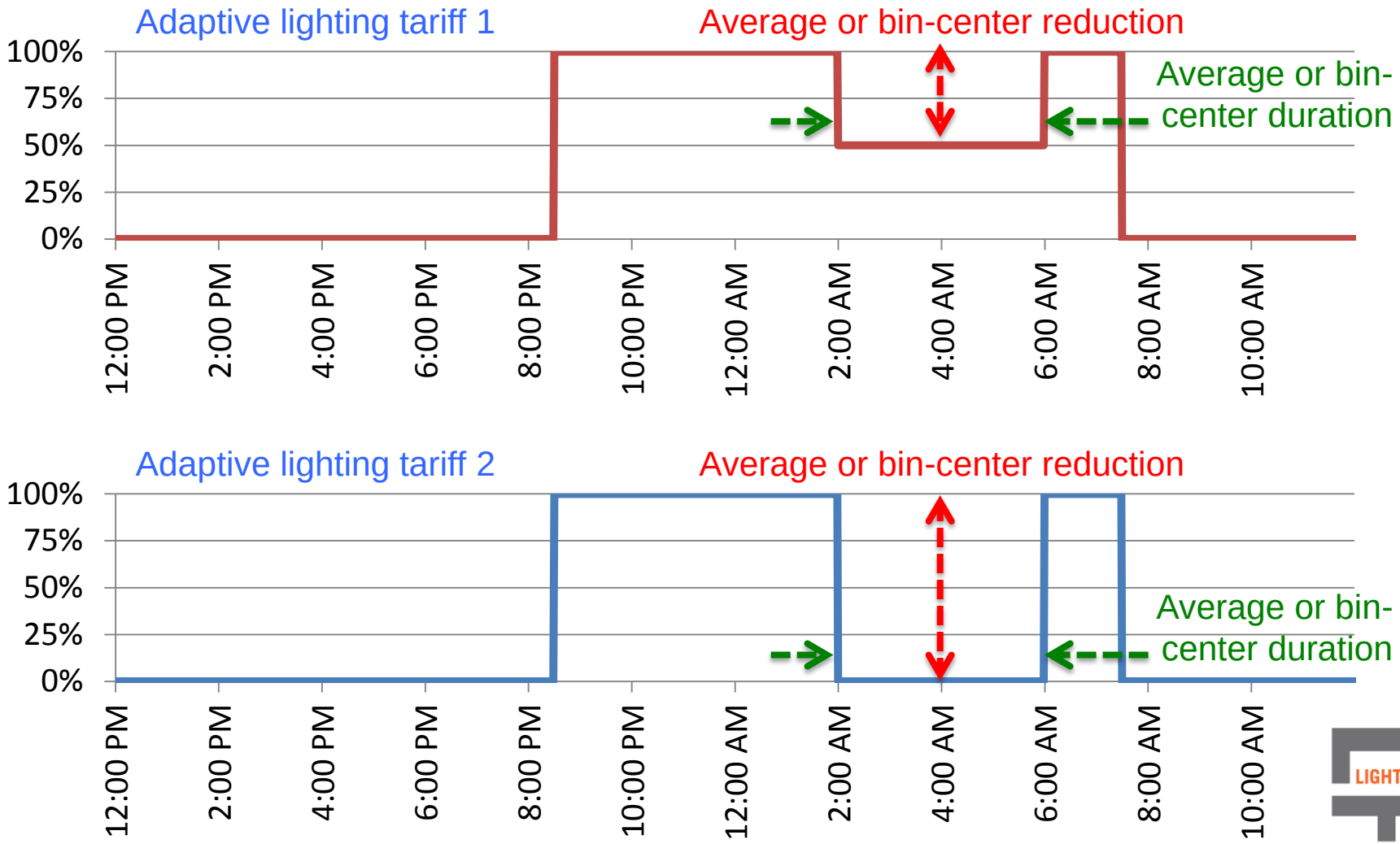
UPFRONT COST AND PAYBACK TIME

- Controls cost on par with LED luminaire
- Focus on simple value propositions may not lead to acceptable payback
  - Maintenance and energy cost savings from remote monitoring are straightforward, but vary by user
  - Energy savings from adaptive lighting are difficult to monetize due to lack of metered tariffs and regulatory guidance

MONETIZING ENERGY SAVINGS

- Requires new utility tariff(s)
- Existing utility infrastructure does not support accepting metering data
- Existing metering standards not (directly) applicable
  - ANSI C12.1, 12.20
  - Meter accuracy
  - Data security for billing purposes
- New ANSI C136.50 “revenue grade energy measurement device” standard (specific for lighting) under development

ALTERNATIVES TO ENERGY METERING



MUNICIPALITIES VS. UTILITIES

- New fixed tariff vs. metered tariff
- Responsibility, liability
  - Meter ownership, accuracy requirements
  - Network infrastructure ownership
  - Data security
- Future opportunities
  - Integration with other systems
  - Revenue stream

ADAPTIVE LIGHTING IMPLEMENTATION STRUGGLES

- Adjust light levels according to what? How? Based on what data?
  - Pedestrian traffic
  - Automobile traffic
  - Mass transit schedules
  - Lighting zones, condition
  - Weather
- Liability concerns
- IES RP-8-14
  - Some adaptable recommended light levels
  - Limited specific guidance

MODULARITY

- Easy incorporation of new or exchange of existing component, typically facilitated by plug/receptacle or some other connector
- May better facilitate gradual adoption of new/upgraded component
- Separation of components with different expected lifetime/reliability may lead to lower life-cycle cost
- Typically leads to higher up-front (material) cost
- Modularity + standardization (leading to high volume) may limit increase in up-front cost

INTEGRATION

- Co-design of single system previously comprised of two or more sub-systems, typically resulting in fewer components, circuit boards, connectors, manufacturing steps
- Typically leads to lower up-front (material) cost, and higher reliability
- Need to get the feature set right
  - Compromised ability to incorporate new or exchange existing component later
  - Typically driven by clear feature demand, standards

TERMINOLOGY

- **Compatibility**: The capability of two or more devices, applications, networks, or systems to coexist in the same physical environment – that is, operate without corrupting, interfering with, or hindering the operation of the other entity.
- **Interoperability**: The capability of two or more devices, applications, networks, or systems to reliably and securely exchange and readily use data with a commonly shared meaning.
- **Interchangeability**: The capability of two or more devices, applications, networks, or systems to be physically exchanged for each other and provide a defined level of identical operation without additional configuration.

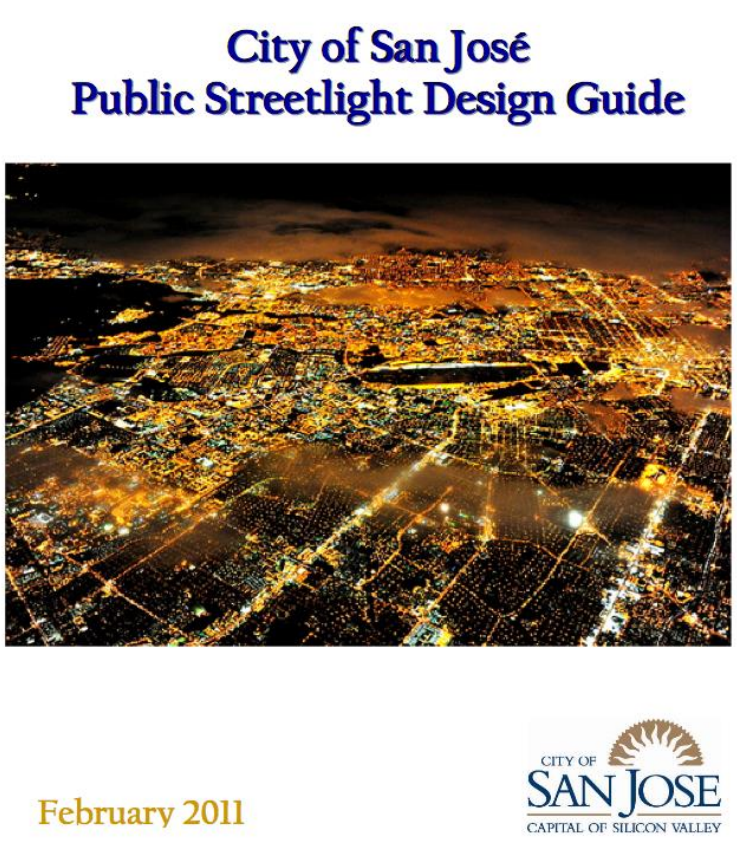
THE IMPACT OF GREATER INTEROPERABILITY

- Facilitates the incorporation of best-of-breed devices, deployment of an energy-saving platform (i.e. multi-phase, not limited to initial install choices)
- Reduces incremental cost of system enhancement (e.g. software vs. hardware)
- Facilitates crowd-sourced development (software, use cases)
- Reduces user risk (e.g. device, manufacturer obsolescence), increase user satisfaction and adoption
- Facilitates greater data exchange
  - Use data from, share data with non-lighting systems
  - Improved performance of lighting and non-lighting systems
  - Non-energy benefits
  - Communicate measured performance (hours-of-use, energy)

INTEROPERABILITY QUESTIONS

- Where?
  - Physical/MAC layers?
  - Network stack?
  - Application layer?
- When?
  - Market adoption bottleneck
  - Mature feature definition, technology
- How?
  - Requires understanding of industry standards and specifications
  - Careful, comprehensive specification, certification and compliance testing

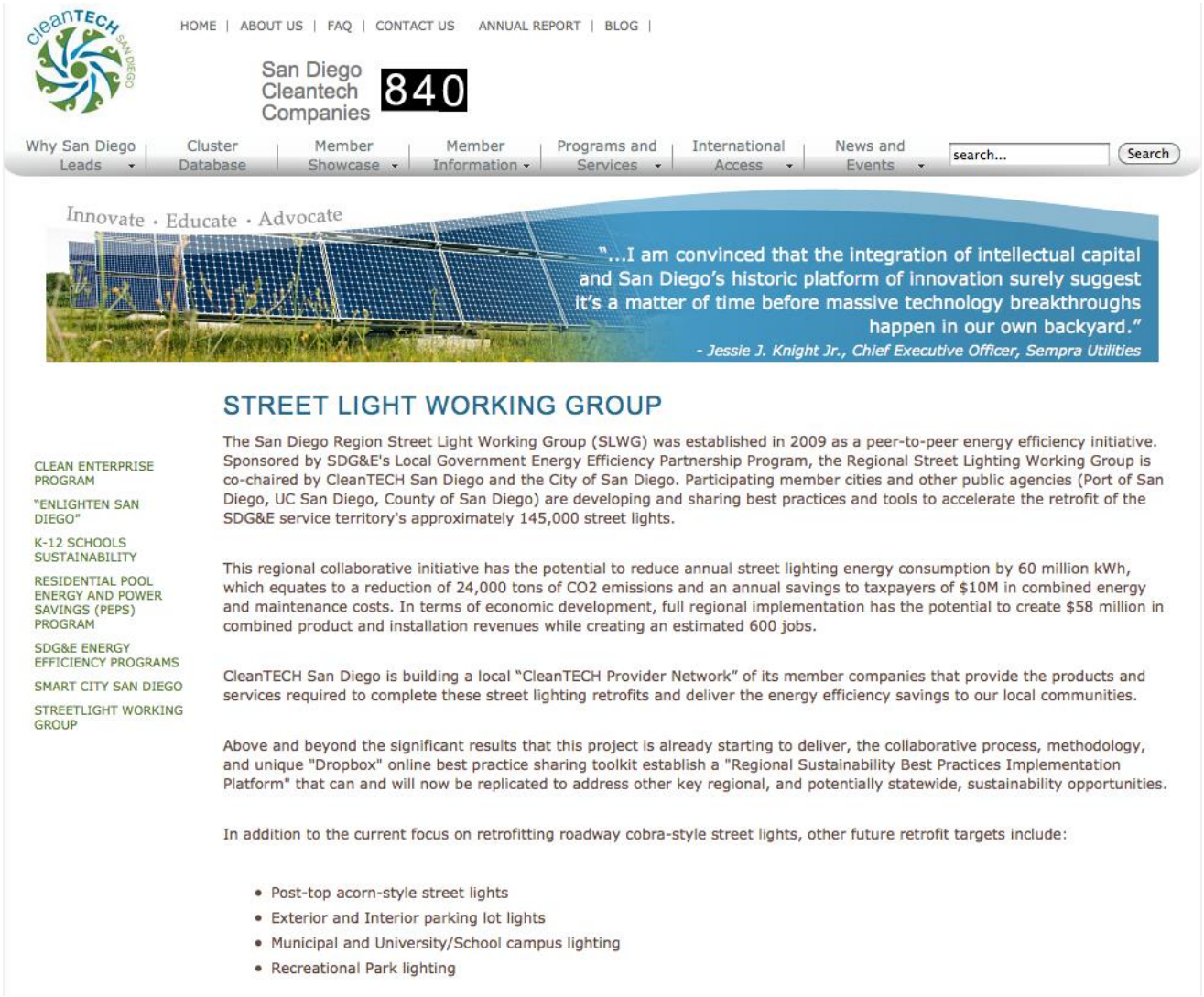
CITY VISIONS



http://ca-sanjose.civicplus.com/DocumentCenter/Home/View/242

http://www.nyc.gov/html/dot/downloads/pdf/2013-dot-sustainable-streets.pdf

COLLABORATIVE EFFORTS



http://www.cleantechsandiego.org/streetlight-working-group.html

SERVICE-BASED BUSINESS MODELS

- Many implementations
  - Energy service contract (ESCO)
  - Lease-to-own
  - Pay for performance
- Many financing benefits
  - Capital vs. Operating cost flexibility, optimization
  - Reduced risk
- Many owner and operator benefits
  - Reduced or eliminated system management, re-commissioning
  - Improved system optimization, performance

http://www.wmata.com/about_metro/news/PressReleaseDetail.cfm?ReleaseID=5613
http://greatergreaterwashington.org/post/21636/wmata-gets-turned-on-to-public-private-partnerships/

Metro to overhaul parking garage lighting for safety, efficiency

Brighter garages to benefit 66,000 parking customers while reducing expenses for Metro

Metro has awarded a zero-cost, performance-based contract for the replacement of over 13,000 parking garage light fixtures in the next year—a key part of *Metro's Sustainability Agenda*.

Under the 10-year contract, outdated and inefficient lighting will be replaced with new high-efficiency LED lighting that will create a brighter environment for riders, use less electricity, and lower costs. The contract was awarded to Philips Electronics through a competitive, technology-neutral procurement process that will be funded entirely through the resulting $2 million in energy and maintenance savings annually.

Metro has 25 parking facilities that will benefit from improved lighting as a result of the project.

"Today's contract award advances our commitment to improving the system's infrastructure for our customers for years to come," said Richard Sarles, Metro General Manager and CEO. "This high-efficiency LED lighting overhaul not only means increased safety and visibility for riders, but also a 68 percent reduction in energy consumption at these facilities."

The contract award will provide light quality that is far superior to Metro's existent yellowish, high-pressure sodium lighting. Designed to each garage's unique characteristics, the new LED lighting will direct light when and where it is needed. Each fixture will respond to its environment by automatically dimming in response to motion and ambient light from the sun or other sources. As a secondary benefit, the performance of existing security cameras will improve as a result of the higher quality light. The project is expected to save Metro more than 15 million KWh in energy per year, reducing carbon emissions by the equivalent of 140 tanker trucks of gasoline — or the electricity used by 1,456 homes — annually. Each garage will be individually metered to allow real-time performance tracking and automated reporting.

In addition to the energy savings, the contract also includes the maintenance of the lighting system for the life of the contract. This will allow resources to be redeployed to other operational and maintenance needs throughout the system, redirecting approximately $600,000 annually in labor and material resources to other system maintenance tasks.

The *Metro Sustainability Agenda* sets an Authority-wide commitment to modernize Metro's infrastructure with sustainable, resource-efficient operations.

News release issued at 3:11 pm, November 12, 2013.

LEGISLATED MANDATES AND FUNDING SUPPORT?

http://www.its.dot.gov/

http://www.fhwa.dot.gov/everydaycounts/technology/adsc/intro.cfm

http://www.fhwa.dot.gov/federalaid/projects.pdf#its

Q & A

Market Adoption Status

Michael Poplawski

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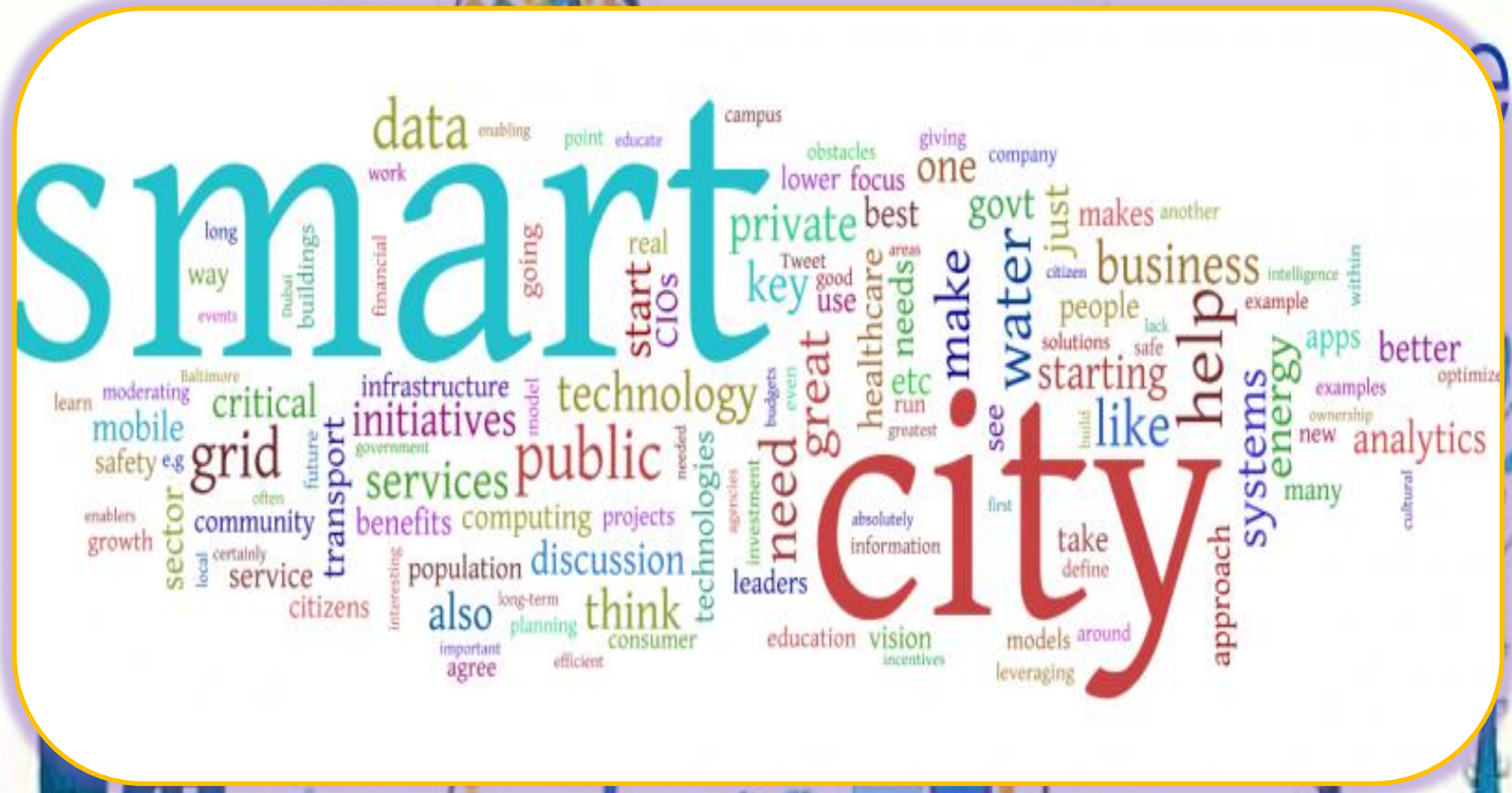
OUTDOOR LIGHTING CONTROL SYSTEM FUNDAMENTALS

Future Possibilities

Mark Wilbur

Big City, Bigger Infrastructure



FUTURE OPPORTUNITIES FOR THE LIGHTING INFRASTRUCTURE

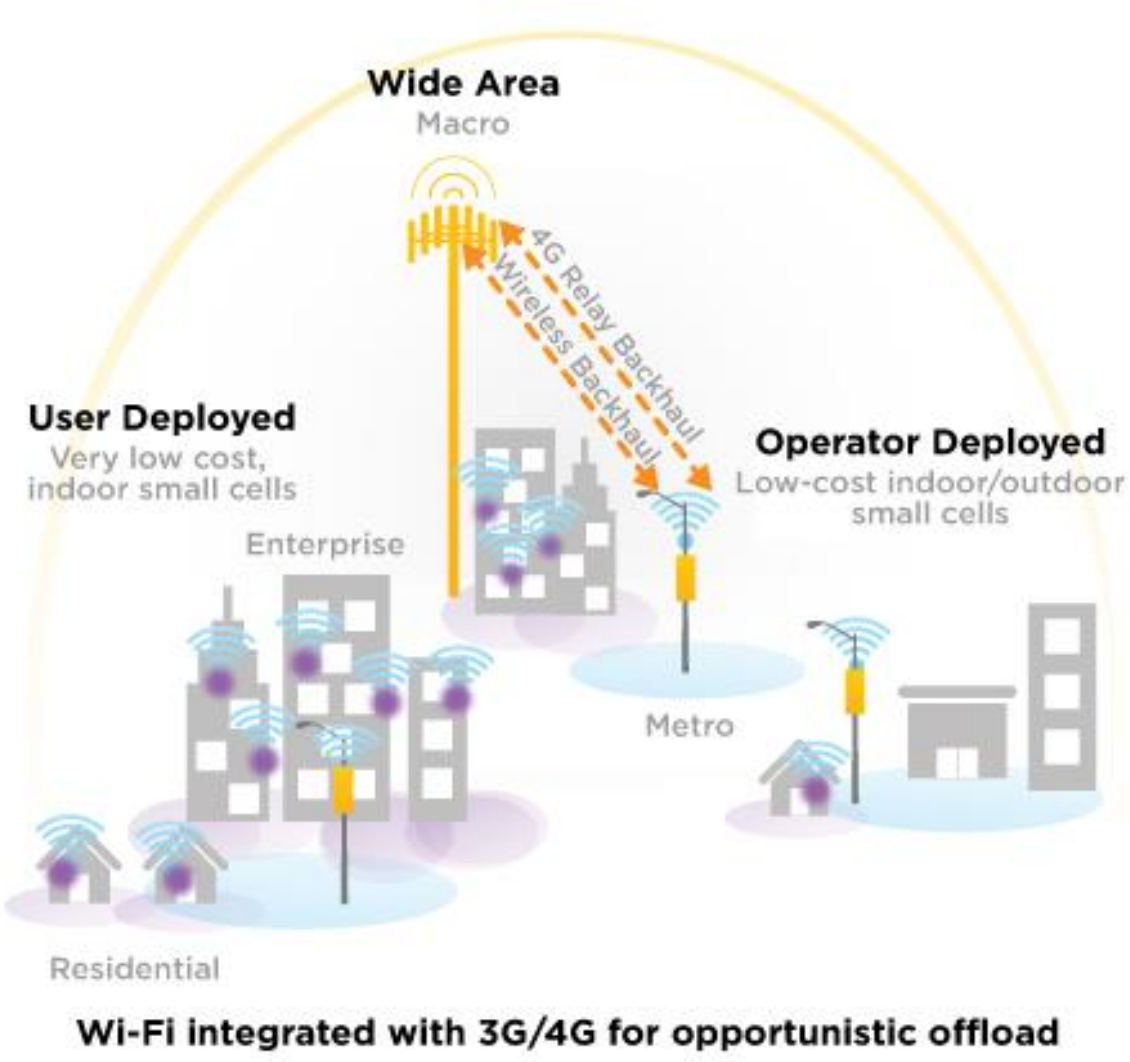
- Mini-Cell Tower Deployments: ATT / Verizon Leases
- Parking Availability: Parking Location Provider Fees
- Parking Metering: Parking Fines
- Interactive LCD Billboards: Retail Advertising Fees
- Weather Reporting: Weather Service Fees
- Air Quality Reporting: Industrial Offender Fines
- Illegal Dumping Detection: Dumping Fines

MICRO CELL TOWERS

Small Cells

are low-powered radio access nodes that operate in licensed and unlicensed spectrum that have a range of 10 meters to 1 or 2 kilometers.

ARCchart estimates that by 2017 a total of 5 million small cells will ship annually



2015

AUTOMATED PARKING SPACES

Smart phone application developers charge a small fee to guide users to the nearest available parking space

The same communications network can interact with the local parking meters to notify the parking enforcement team of violations

INTERACTIVE
RETAIL / INFORMATIONAL DISPLAYS

- Interactive Directions
- Local Retailer Advertisements
- Tourist Information
- Interactive Sightseeing Challenges

WEATHER MONITORING

- Temperature
- Barometric Pressure
- Wind Speed and Directions
- Humidity
- Rain Fall
- Snow Accumulations
- Roadway Surface Temperatures

OCCUPANCY DETECTION

3 Primary sensor technologies used in motion/occupancy detectors

Passive Infrared

Radiation IR wavelength detection ideal indoors away from direct sunlight lowest cost and complexity

Doppler

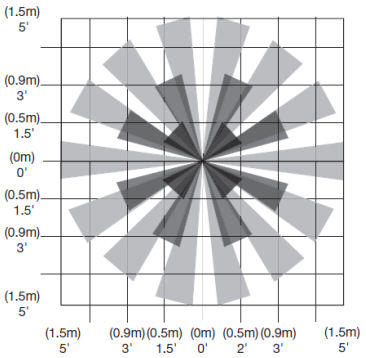
Audio Frequency Shift Ideal for outdoor applications Many manufactures offer hybrid PIR/Doppler sensors

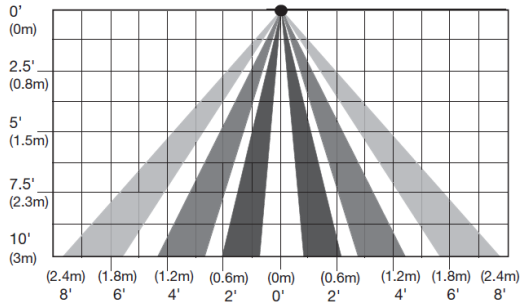
Microwave

RF pulse reflection strength delay Ideal for applications that report velocity and direct detection

Lighting Network Uses:

- Adaptive lighting during of peak activity
- Security Lighting
- Energy Conservation





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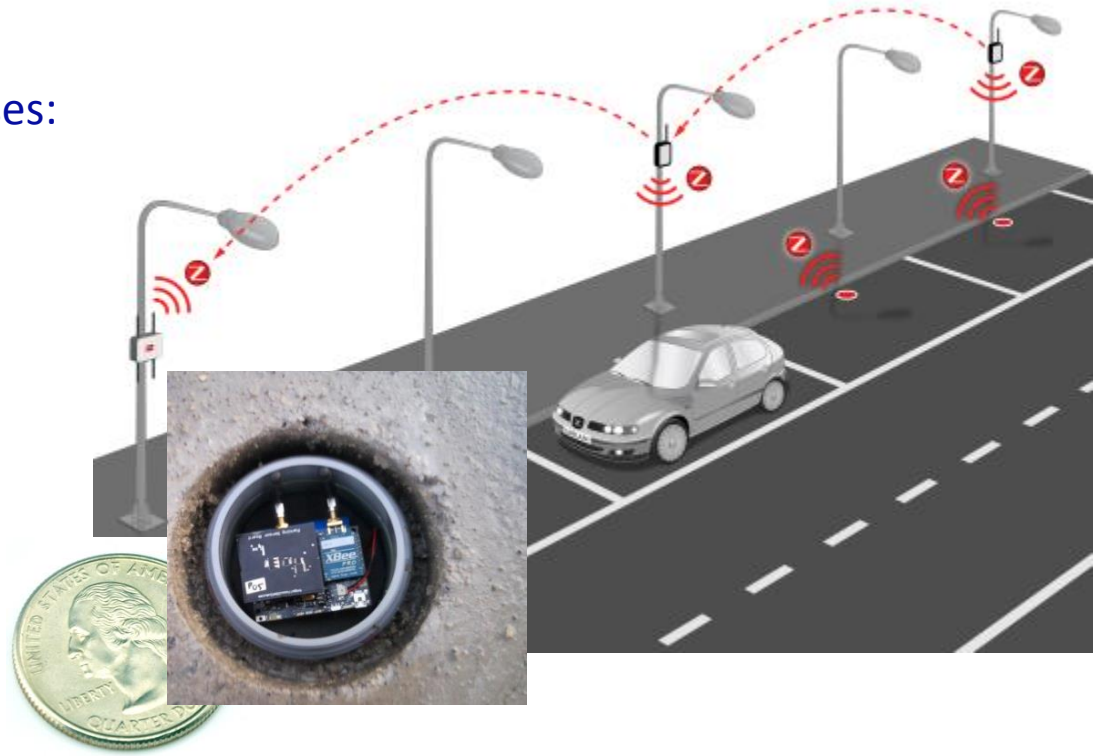
MAGNETOMETERS

The outstanding performance of in-roadway sensors such as inductive loops, magnetic detectors, and magnetometers is due partly to their close proximity to the vehicles passing over them. Another advantage is that they are insensitive to inclement weather such as rain, fog, and snow.

Lighting Networks Uses:

Vehicle Detection
Vehicle Velocity
Vehicle Direction
Parking Availability



VIDEO CAMERAS

Video cameras are the fastest growing sensor technology with an estimated 10,000 new cameras being deployed every day

Lighting Networks Uses:

Pole Mounted Imaging opportunities including…

Pedestrian Congestion
Vehicle Congestion
Parking Availability
Parking Violations
Illegal Dumping Detection
Vandalism Detection

Real progress being made with distributed pattern matching VS real time video transmission and external image evaluations

DRONES ARE ON THEIR WAY TO A COMMUNITY NEAR YOU

Light fixtures are the ideal charging and staging locations

Life saving opportunities include:

Police: Saving lives by providing advance video surveillance of active crime scenes

Fire: Saving lives by advanced surveillance of active fires and rescues, optimization of asset deployments to minimize risks

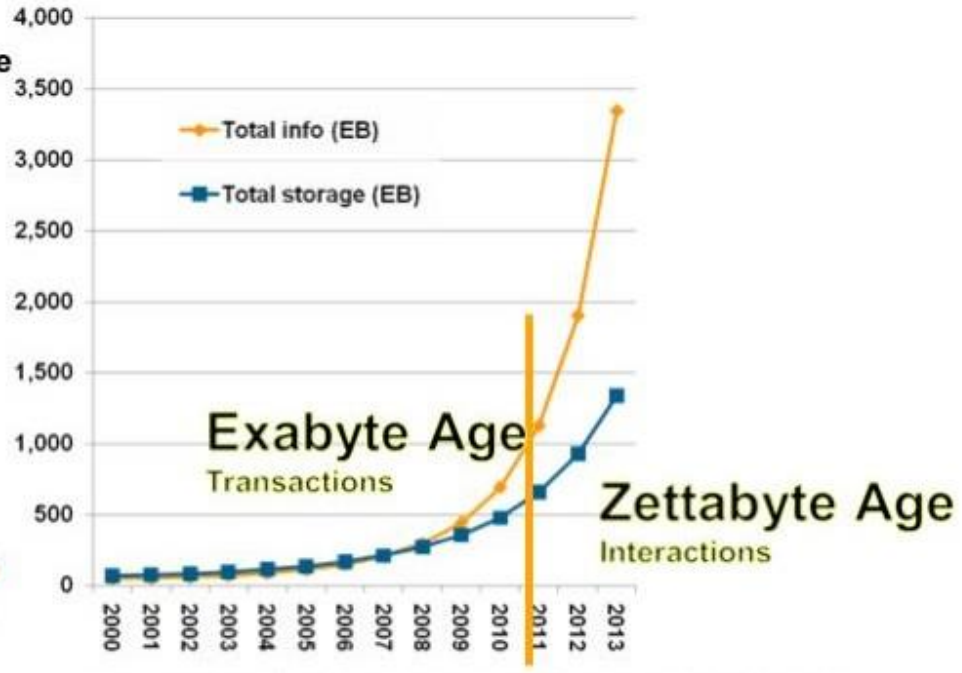
Home Land Security: Video Surveillance of reported national security treats

Emergency Medical: Delivery of portable defibrillators and other self administered aid prior to the arrival of EMS personnel

DATA COLLECTION GROWTH CONTINUES TO EXCEED ALL PREDICTIONS

- More data has been created in the last three years than in all past 40,000 years.
- Almost all of this data has a location
- Business and government decision-makers must have a strategy for dealing with location based data

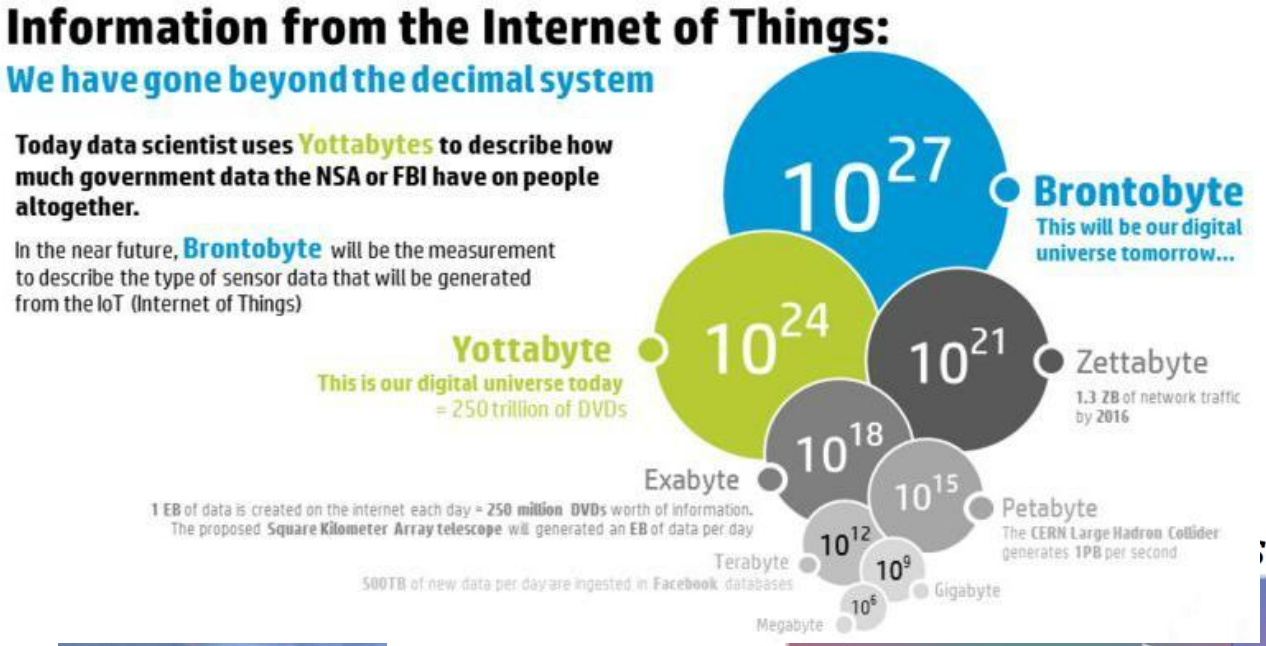
Technology Trend: (1) Sensor data and mobility apps are creating more data tagged with location. (2) Increasing number of apps are location-aware, so queries involve spatial dimension. High confidence that analytic apps will include who-what-when-**where** dimensions.

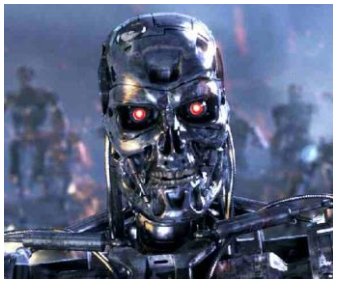


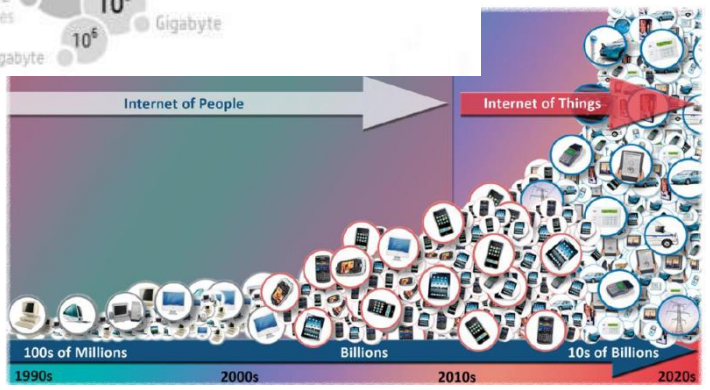
One Zettabyte (ZB) = 1,000,000,000,000,000,000,000 bytes = 10^{21} bytes.
Based on IDC and UC Berkeley data growth estimates.

TERADATA
Raising Intelligence

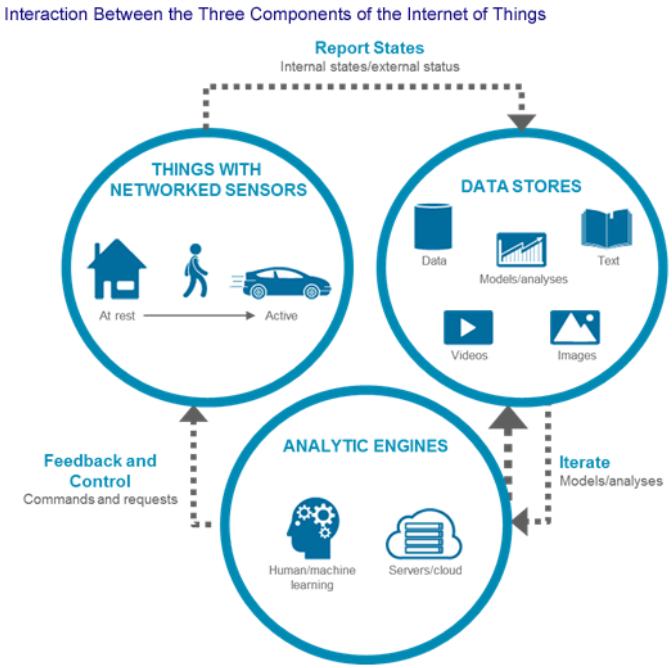
THE MACHINES HAVE TAKEN OVER
MACHINES HAVE SILENTLY TAKEN OVER THE INTERNET GENERATING MORE TRAFFIC THAN ALL OF THE PEOPLE ON THE PLANET COMBINED

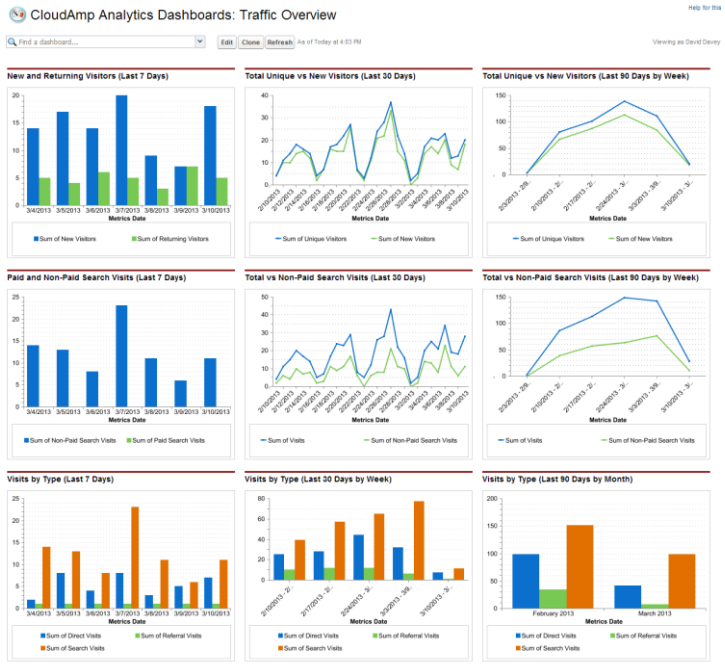






DATA ANALYTICS
APPLICATIONS USE AVAILABLE SENSOR DATA TO PROVIDE REAL WORLD ACTIONABLE DATA YOU AND YOUR CUSTOMERS CAN USE





- Where has increased lighting levels reduced crime ?
- Where has additional lighting levels increased retail sales ?
- Where has increased lighting levels increased property values ?
- Where has roadway temperature reporting reduced salt usage and slow plow cost ?
- Where has reducing time looking for a parking space increase retail sales ?

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Q & A

Future Possibilities,
Mark Wilbur

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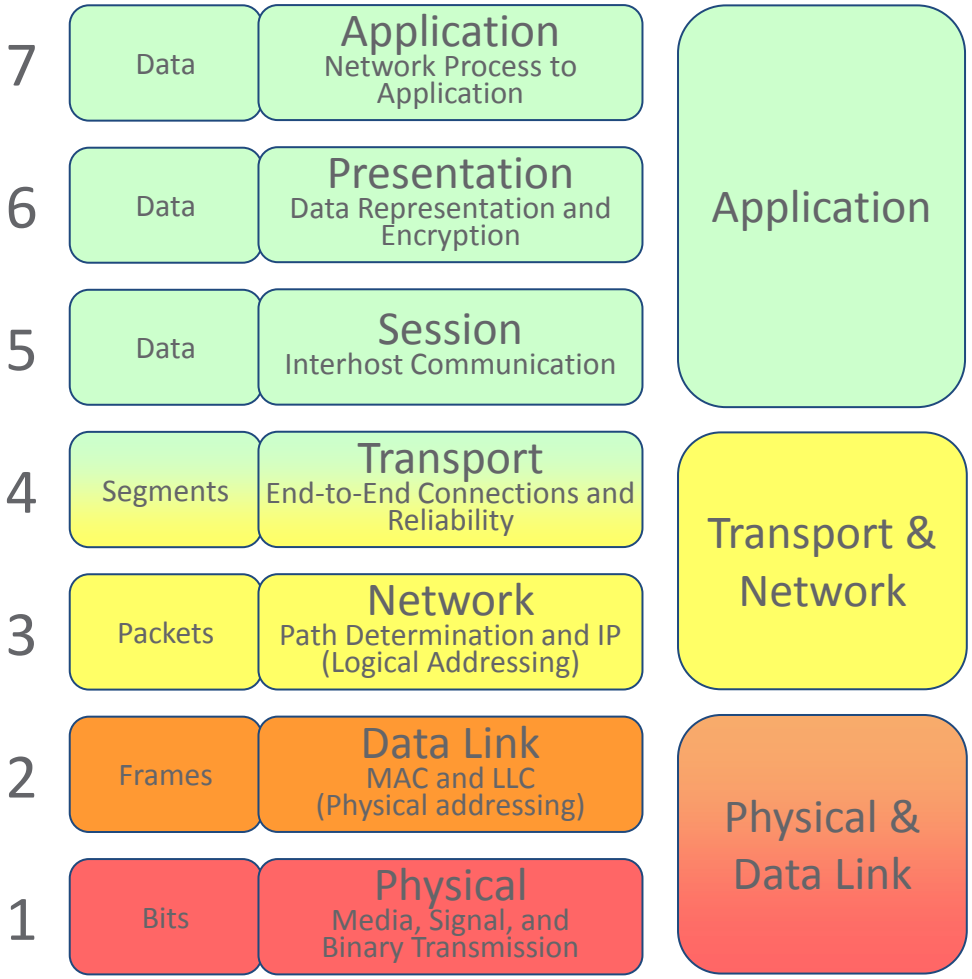
2015

OUTDOOR LIGHTING CONTROL SYSTEM FUNDAMENTALS

Interoperability, Standards & Specifications

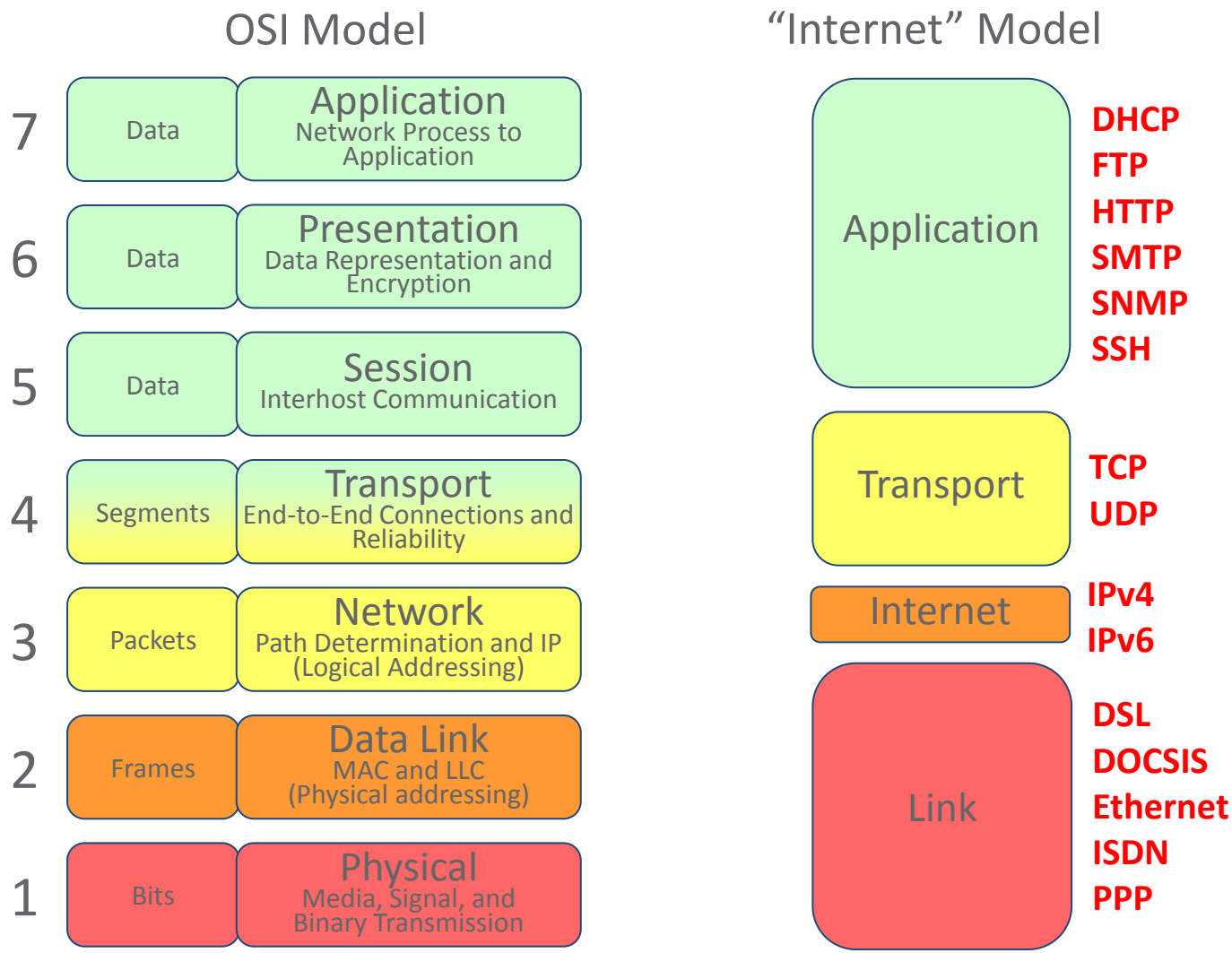
Michael Poplawski

THERE ARE MANY POSSIBLE LEVELS OF INTEROPERABILITY



http://en.wikipedia.org/wiki/OSI_model

THERE ARE MANY POSSIBLE LEVELS OF INTEROPERABILITY



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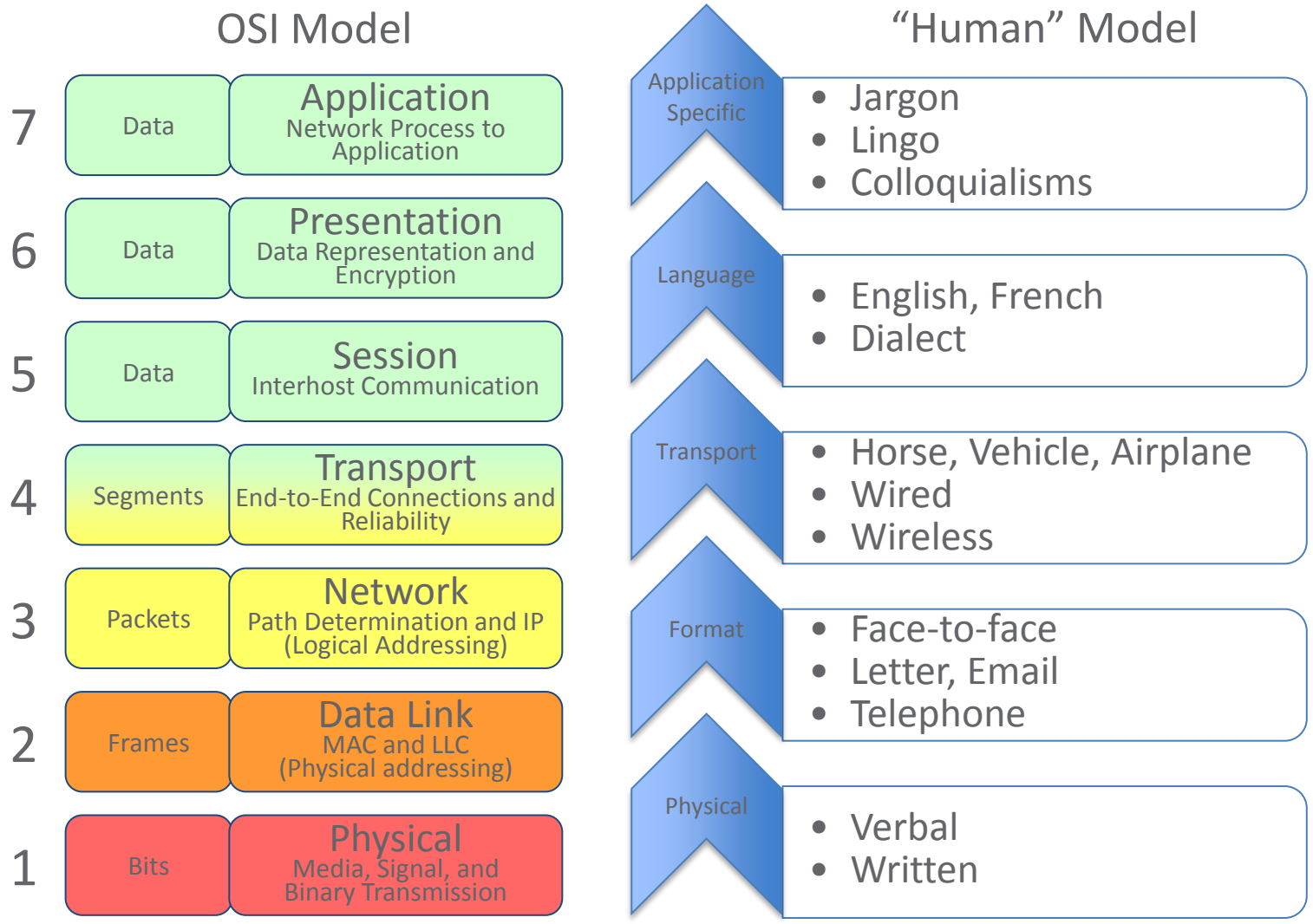

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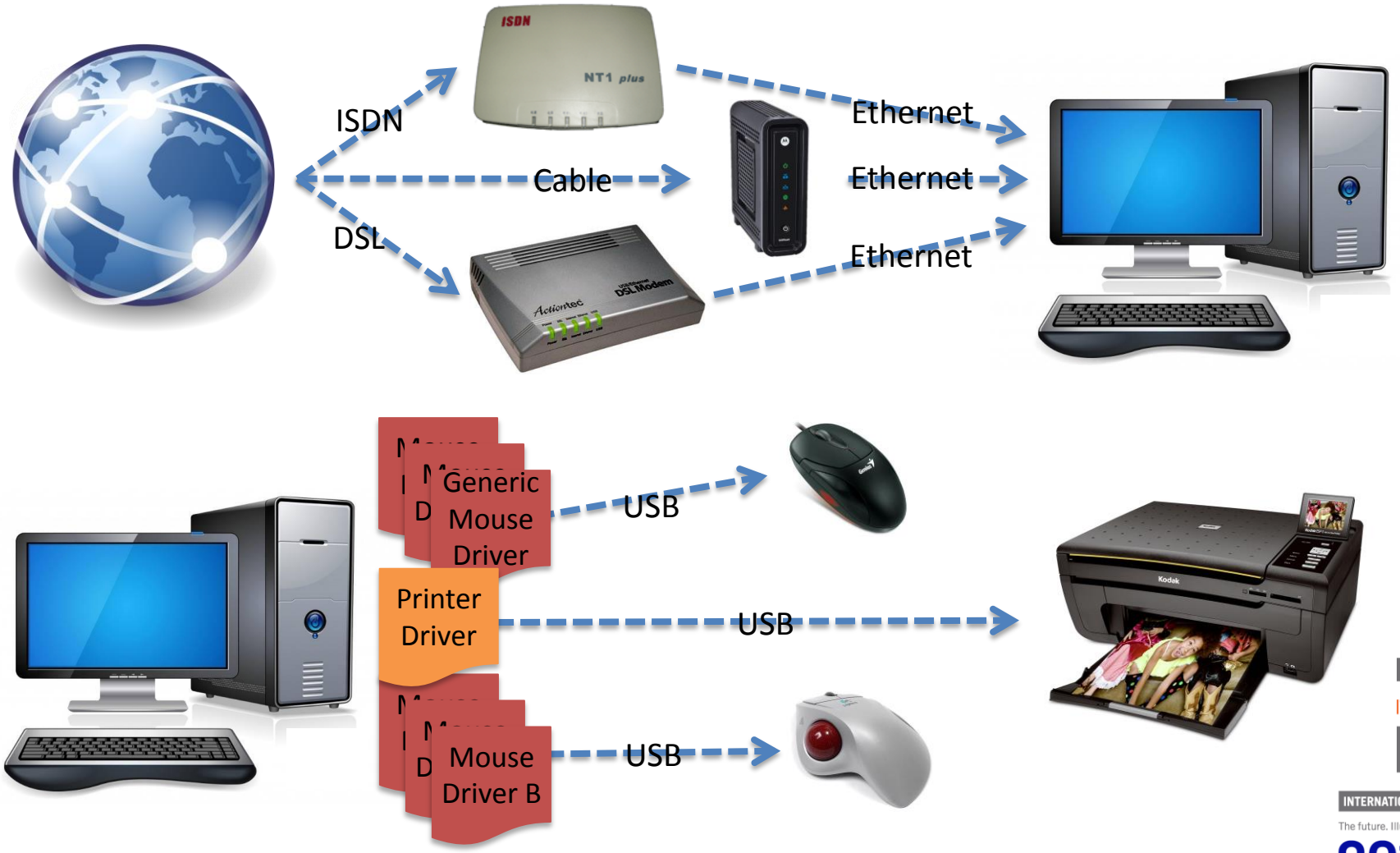
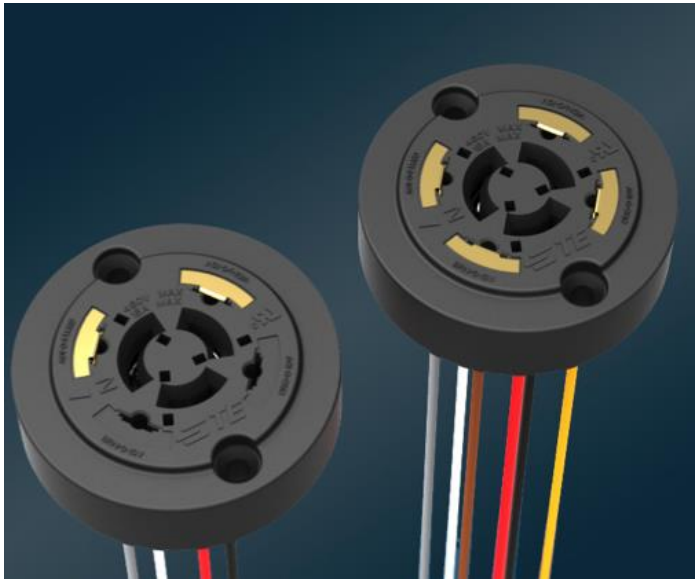


ANSI C136.10-2010

"Locking-Type Photocontrol Devices and Mating Receptacles—Physical and Electrical Interchangeability and Testing"

ANSI C136.41-2013

"Dimming Control Between an External Locking Type Photocontrol and Ballast or Driver"



https://www.nema.org/Standards/Pages/For-Roadway-and-Area-Lighting-Equipment-Dimming-Control-Between-an-External-Locking-Type-Photocontrol-and-Ballast-or-Driver.aspx

ANSI C136.41-2013 COMPLIANT COMPONENTS

Buy Selected | Compare Selected | Compare up to 20 parts.

Select	Image	Mouser Part #	Mfr. Part #	Mfr.	Description		Availability	Pricing (USD)	Quantity	RoHS	Product	Type	Termination Style	Contact Plating	Contact Material	Housing Material	Current Rating	Voltage Rating
☐	Enlarge	571-2213362-1	2213362-1 New At Mouser	TE Connectivity / AMP	Lighting Connectors Dimming Photocell Recpt Assy 3/2 150 C Learn More	Page 1,682 Data Sheet	128 In Stock	1: $8.03 10: $7.65 50: $6.88 100: $6.49 200: View	Buy Min.: 1 Mult.: 1	Details	Connectors	Receptacle	Crimp	Tin	Copper Alloy	Polybutylene Terephthalate (PBT)	15 A	600 V
☐	Enlarge	571-2213365-1 To purchase full reel, order in multiples of 2000:	2213365-1 New At Mouser	TE Connectivity / AMP	Lighting Connectors Dimming Photocell Brush Contact Learn More	Page 1,682 Data Sheet	1,460 In Stock	**Cut Tape** 1: $0.52 10: $0.47 100: $0.43 500: $0.40 **Reel** 2,000: $0.40	Buy Min.: 1 Mult.: 1 **Reel: *2,000***	Details	Contacts		Through Hole	Gold	Copper Alloy		0.1 A	10 V
☐	Enlarge	571-2213362-3	2213362-3 New At Mouser	TE Connectivity / AMP	Lighting Connectors Dimming Photocell Recpt Assy 3/2 105 C Learn More	Page 1,682 Data Sheet	70 In Stock	1: $7.54 10: $6.90 50: $6.39 100: $6.04	Buy Min.: 1 Mult.: 1	Details	Connectors	Receptacle	Crimp	Tin	Copper Alloy	Polybutylene Terephthalate (PBT)	15 A	600 V
☐	Enlarge	571-2213362-4	2213362-4 New At Mouser	TE Connectivity / AMP	Lighting Connectors Dimming Photocell Recpt Assy 3/4 105 C Learn More	Page 1,682 Data Sheet	59 In Stock More Info Available	1: $9.75 10: $8.83 20: $8.07 50: $7.54	Buy Min.: 1 Mult.: 1	Details	Connectors	Receptacle	Crimp	Tin	Copper Alloy	Polybutylene Terephthalate (PBT)	15 A	600 V
☐	Enlarge	571-2213362-2	2213362-2 New At Mouser	TE Connectivity / AMP	Lighting Connectors Dimming Photocell Recpt Assy 3/4 150 C Learn More	Page 1,682 Data Sheet	52 In Stock	1: $10.02 10: $9.36 20: $8.93 50: $8.42	Buy Min.: 1 Mult.: 1	Details	Connectors	Receptacle	Crimp	Tin	Copper Alloy	Polybutylene Terephthalate (PBT)	15 A	600 V

Buy Selected | Compare Selected | Compare up to 20 parts.

ANSI C136.41-2013 COMPLIANT PRODUCTS

Dimming *and* Monitoring are Now in ONE control!

ANSI C136.41 Dimming Control

The DIM-3 is a Dusk-to-Dawn Twistlock Photocontrol that sends an LED dimming signal through an ANSI C136.41 compliant receptacle at MidNight. The DIM-3 is a Long Life Photocontrol.

Product	No. & Type of LEDs	Voltage	Nominal Color Temperature[1]	Distribution	Finish[2]	Drive Current[3]	Options
AR18	6M 10M 15M 18M 20M 24M 30M	MV 120-277V HV 347-480V	NW 4000K	2 Type 2 3 Type 3 4 Type 4 5 Type 5	BK Black DB Dark Bronze WH White	350 350mA 530 530mA 700 700mA	BSK Bird Spider Kit RPA Round Pole Adaptor HSS[4] House Side Shield FDC[5] Fixed Drive Current PCR NEMA Photocontrol Receptacle PCR5 ANSI 5-wire Photocontrol Receptacle PCR7 ANSI 7-wire Photocontrol Receptacle SC PCR Shorting Cap MSL7[6] Motion Sensor with Photocontrol, L7 Lens PPS[7] Programmable Power Supply ORR Optics Rotated Right ORL Optics Rotated Left

FEATURES:

- Uses the ANSI C136.41 receptacle developed for 0-10V dimming driver connectivity

"CONTROL-READY" LUMINAIRES

- What?
  - Dimmable LED driver
  - Low additional up-front material cost
  - Low future upgrade labor cost
- Why?
  - Growing adoption of controllable (e.g. LED) luminaires
  - Minimize cost to add control later
- How?
  - Exterior plug/receptacle
  - Power-door replacement
  - LED driver replacement
  - Interior plug/receptacle
  - Firmware upgrade

ANSI C136 STANDARDS IN DEVELOPMENT

- ANSI C136.48 – “Remote Monitoring and Control for Roadway and Area Lighting Equipment”
  - Defines the minimal requirements for remote control and monitoring systems used for roadway and area lighting
- ANSI C136.50 – “Revenue Grade Energy Measurement”
  - Defines the minimal requirements for energy metering devices in a roadway and area lighting control system

LONMARK INTERNATIONAL

- Industry consortium
  - Many applications
  - 15 street lighting members
- Based on the ISO/IEC 14908 series of standards for networked control
- Full interoperability (including application layer), primarily for wired physical implementations
- Design specification(s) + compliance testing and certification

http://www.lonmark.org/connection/solutions/lighting/streetlighting

THE TALQ CONSORTIUM

- Industry consortium
  - 13 regular members
  - 15 associate members
- Defines a standardized interface (including application layers) between central management systems and outdoor lighting networks
- Does not specify Physical or Data Link layers
- Design specification(s) + compliance testing and certification

http://www.talq-consortium.org/

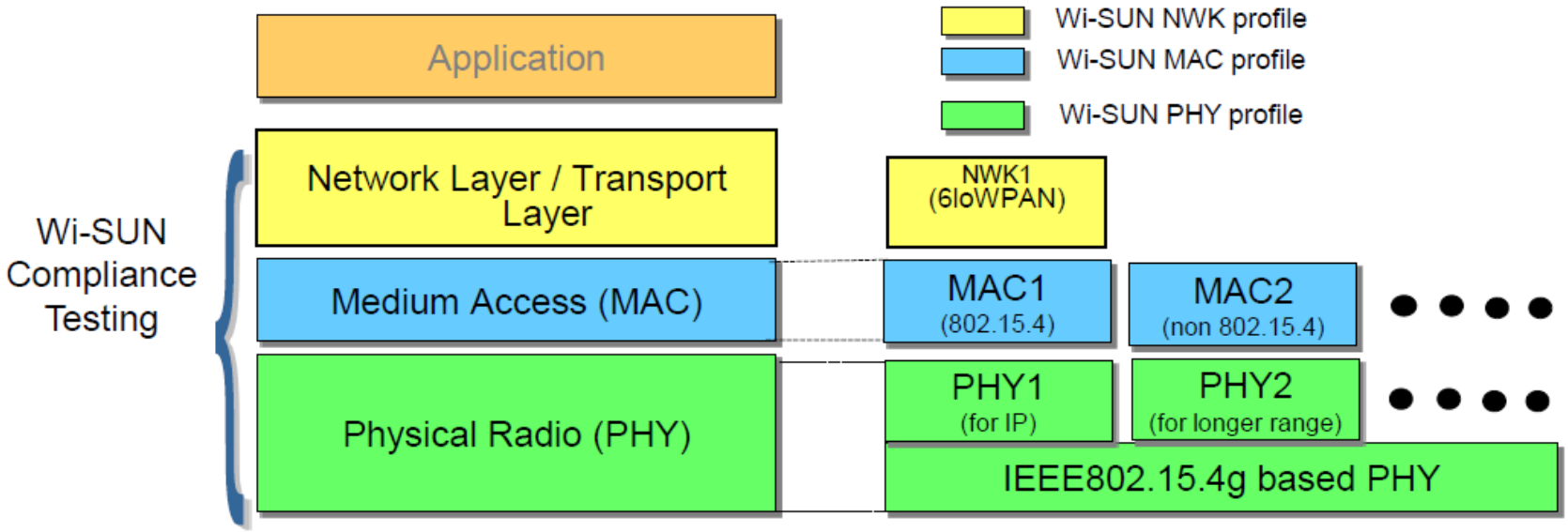
WI-SUN ALLIANCE

- Industry Consortium
  - 9 Promoter Members
  - 49 Contributor Members
  - 5 Observer Members
- IEEE 802.15.4g Physical and Data Link
- IPv6, 6loWPAN Network and Transport protocols
- Does not specify Application layer
- Design specification(s) + compliance testing and certification

http://www.wi-sun.org

WI-SUN ALLIANCE

- Primarily focused on Physical & Data Link Layers, with Network layers as required
- Does not specify Application layer



http://www.wi-sun.org

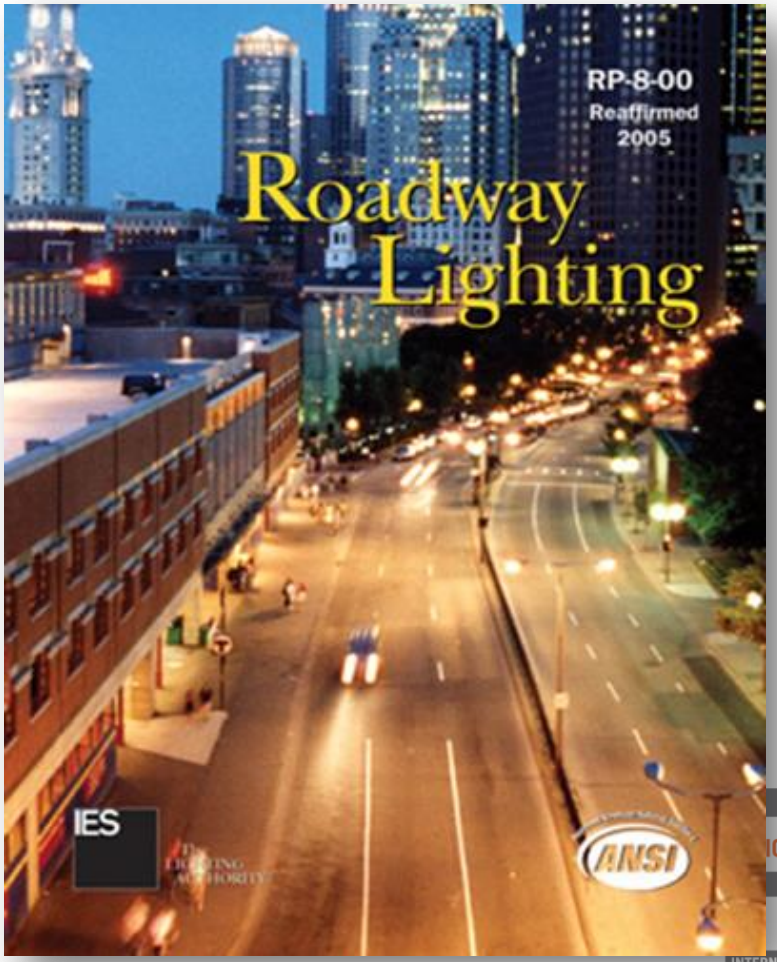
ZIGBEE NEIGHBORHOOD AREA NETWORK

- Industry consortium
  - Many applications
  - NAN members currently not specified
- Intended to be the last-mile, outdoor access network that connects smart meters and distribution automation devices to Wide Area Network (WAN) gateways
- IEEE 802.15.4g Physical and Data Link
- IETF Network and Transport protocols, including IPv6, RPL, UDP and TCP
- Does not specify Application layer
- Design specification(s) + compliance testing and certification

http://www.zigbee.org/what-is-zigbee/utility-industry/

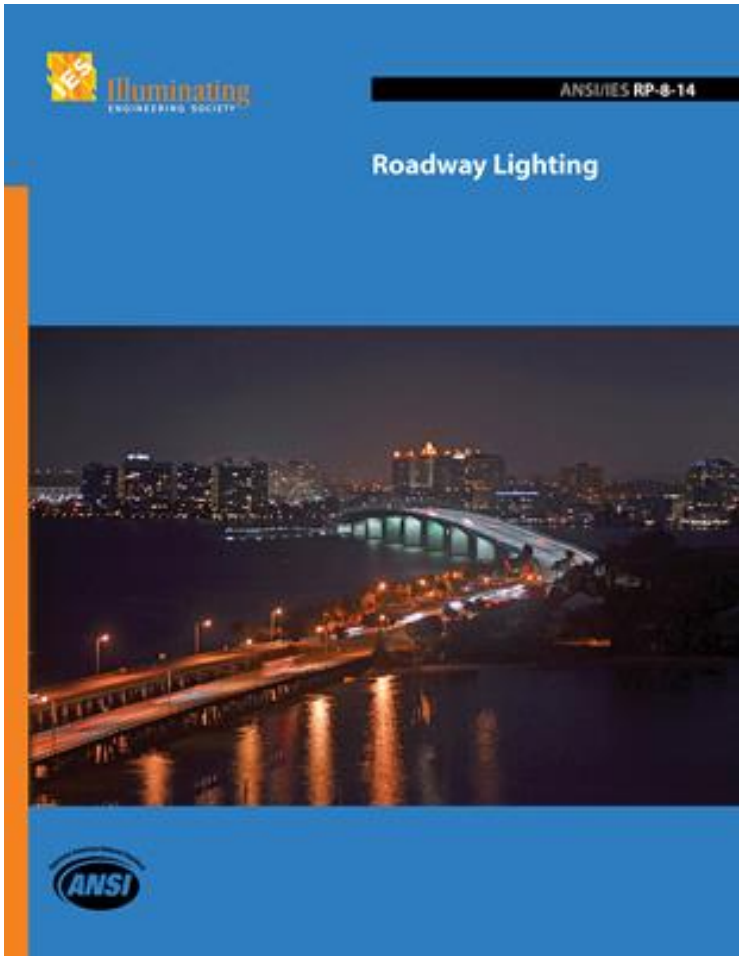
LIGHTING STANDARDS AND RECOMMENDED PRACTICES

- Have focused on illumination requirements to meet visual task requirements and ensure safety
- Based on legacy technology; largely do not take into account newer technologies, connected lighting, and adaptive strategies
- Need to evolve in sync with LED source and networked lighting control adoption



IES RP-8-14 – ROADWAY LIGHTING

- Includes adaptive lighting recommendations
- Light levels based on road classification
- Suggests that road classification may be adapted based on actual traffic conditions
- Refers to emerging international guidelines on adaptive lighting (CIE – 115-2010)



CIE 115:2010 – LIGHTING OF ROADS FOR MOTOR AND PEDESTRIAN TRAFFIC

- Takes improved performance of luminaires and lamps and introduction of controls into account
- Provides a structured model for the selection of the appropriate lighting classifications, taking into account parameters relevant to visual tasks requirements
- By taking into account time dependent variables like traffic volume or weather conditions, the model offers the possibility to use adaptive lighting systems

CIE 115:2010 – LIGHTING OF ROADS FOR MOTOR AND PEDESTRIAN TRAFFIC

- Six Illuminance Classes
- M = 6 – Vws
- Vws = Sum of Vw
- Higher Speed, Higher Volume, Higher Density, More Parked Vehicles
  - → Lower M
  - → Higher illuminance

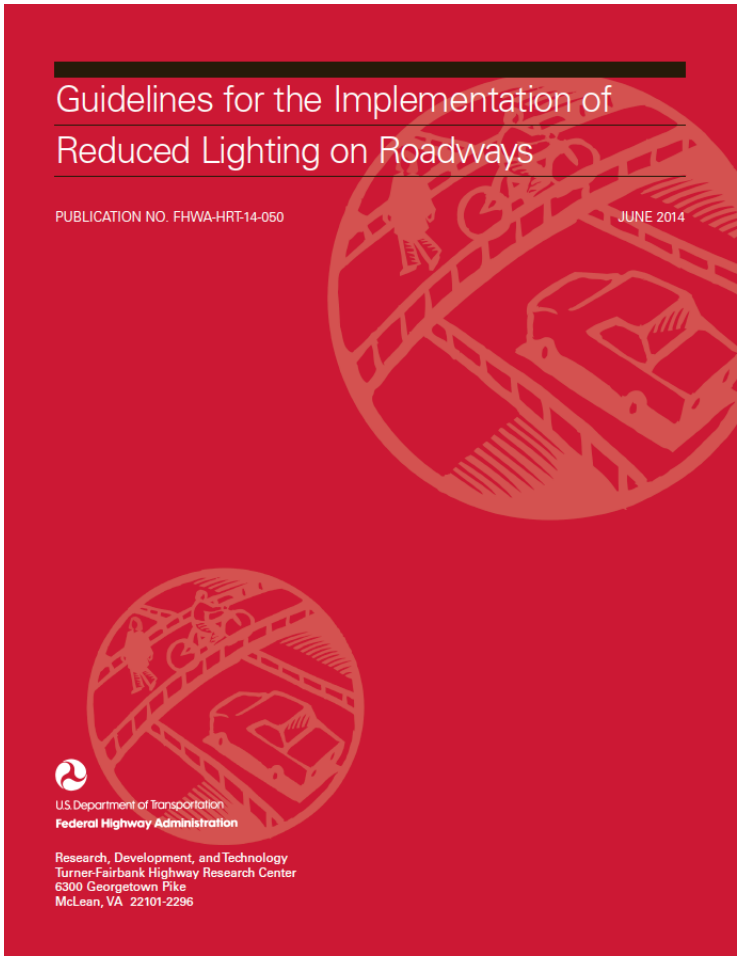
Class	M1	M2	M3	M4	M5	M6
Avg. Luminance	2.0	1.5	1.0	0.75	0.5	0.3
Avg. Illuminance	50	30	20	15	10	7.5

Parameter	Weighting Values (Vw)
Speed	1, 0.5, 0
Traffic Volume	1, 0.5, 0, -0.5, -1
Traffic Composition	2, 1, 0
Separation of Carriageways	1, 0
Intersection Density	1, 0
Parked Vehicles	0.5, 0
Ambient Luminance	1 ,0,-1
Visual Guidance, Traffic Control	0.5, 0

FHWA GUIDELINES

Criteria for Luminance Selection

- Speed
- Traffic Volume
- Median
- Intersection/Interchange Density
- Ambient Luminance
- Guidance
- Pedestrians and Bicycles
- Parked Vehicles
- Facial Recognition



http://www.fhwa.dot.gov/publications/research/safety/14050/14050.pdf

DOE MODEL SPECIFICATION FOR NETWORKED OUTDOOR LIGHTING CONTROL SYSTEMS

- A tool designed to help cities, utilities, and other local agencies accelerate their adoption of systems that can further reduce the energy and maintenance costs of operating their streetlights.
- A major update to the original “Model Specification for Adaptive Control and Remote Monitoring of LED Roadway Luminaires”
  - Renamed to better reflect its evolving scope
  - A work-in-progress, a living document that reflects user experiences and the changing commercial market

http://www1.eere.energy.gov/buildings/ssl/control-specification.html

VERSION 2.0

- Released April, 2014
- Introduction of a Backhaul Communication Network section with associated requirements
- Separation of the Start-Up and Commissioning sections with updated or enhanced requirements for both
- Further refinement focused on facilitating independent bids for Central Management System(s), Backhaul Communication Network(s), and Field Devices.
- More user notes, new and updated references to industry standards activities, and continued clarification of specifications recommended for all users vs. those deemed optional and likely to be only required by some users.

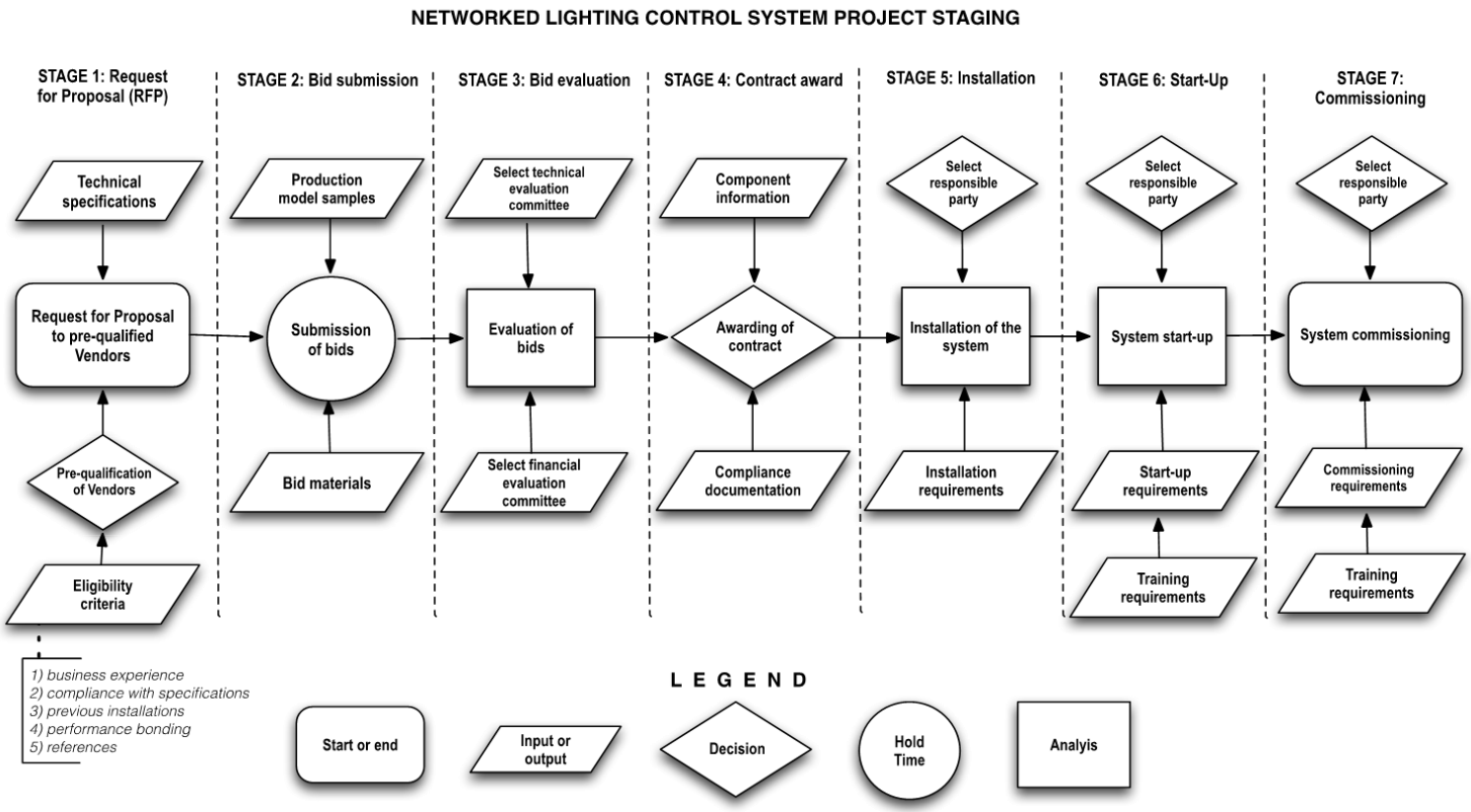
INTENDED USE

- Intended to serve as a modular reference for drafting Requests for Qualifications (RFQ's), Requests for Information (RFI's), Requests for Proposals (RFP's) or similar documents
- Not intended to serve as a standard specification, and therefore should not (and in unedited form, can not) be used to create a list of qualified products
- Intended to be customized as needed to meet the needs of a specific User

CONTENT

- A template for translating unique user needs into clear and consistent specification language
- Some suggested content is considered suitable for all Users, and therefore presented as mandatory requirements.
- Other suggested content is considered suitable for only some Users, and is therefore presented as Optional requirements.

ORGANIZED TO SUPPORT TYPICAL PROJECT STAGES



ORGANIZATION

- PART 1 – INTRODUCTION
  - Lists of normative and informative standardized references
  - A structure for incorporating user-specific references
  - A set of definitions
- PART 2 – SUBMITTED MATERIALS
  - Suggested non-technical content that might be included in a RFQ, presented at the announcement of an RFP, included in a RFP, presented prior to signing a Contract, or included in Contract terms
- PART 3 – SYSTEM DESCRIPTION
  - Suggested content for describing the scope of a new project in terms of what Components are being procured as well as what Components comprise an existing System

ORGANIZATION

- Parts 4-7 focused on Component types and warranty terms
  - PART 4 – CENTRAL MANAGEMENT SYSTEM
  - PART 5 – BACKHAUL COMMUNICATION NETWORK
  - PART 6 – FIELD DEVICES
  - PART 7 – COMPONENT WARRANTY

ORGANIZATION

- Parts 8-11 focused on post-procurement project stages and maintenance terms
- PART 8 – COMPONENT INSTALLATION
- PART 9 – SYSTEM START-UP
- PART 10 – SYSTEM COMMISSIONING
- PART 11 – SYSTEM MAINTENANCE

ORGANIZATION

- Appendices A-G contain suggested structure and examples for describing existing equipment that comprise an existing System, or will be integrated separately into the System
  - Appendix A: Existing Central Management System
  - Appendix B: Existing Backhaul Communication Network(s)
  - Appendix C: Existing Field Devices
  - Appendix D: Existing Luminaires
  - Appendix E: Existing Sensor(s)
  - Appendix F: Existing Asset Management System(s)
  - Appendix G: Existing Intelligent Traffic System(s)

SPECIFYING INTEROPERABILITY

6.5 INTERCHANGEABILITY AND INTEROPERABILITY

A. ☐ Optional: Field Devices or Field Device networks shall be certified as compliant with the TALQ v_____ standard, and Interoperable with TALQ certified Central Management Systems.
B. ☐ Optional: Field Devices or Field Device networks shall be certified as compliant with the LonMark v_____ Outdoor Luminaire Controller standard.
C. ☐ Optional: Field Devices or Field Device networks shall be certified as compliant with the LonMark v_____ Smart Luminaire Controller standard.
D. ☐ Optional: Field Devices shall be Interoperable with the Central Management System specified in Appendix A.
E. ☐ Optional: The Vendor shall demonstrate Field Device Interoperability with the existing Central Management System described in Appendix A prior to INSTALLATION.
F. ☐ Optional: The Vendor shall provide standard production model samples of all Field Device Components required for User verification of Interoperability with the existing Central Management System described in Appendix A prior to INSTALLATION.
G. ☐ Optional: Field Devices shall be Interoperable with the Backhaul Communication Network(s) specified in Appendix B.
H. ☐ Optional: The Vendor shall demonstrate Field Device Interoperability with the existing Backhaul Communication Network(s) described in Appendix B prior to INSTALLATION.
I. ☐ Optional: The Vendor shall provide standard production model samples of all Field Device Components required for User verification of Interoperability with the existing Backhaul Communication Network(s) described in Appendix B prior to INSTALLATION.
J. ☐ Optional: Field Devices shall be Interchangeable with the Field Devices specified in Appendix C.
K. ☐ Optional: The Vendor shall demonstrate Field Device Interchangeability with the existing Field Devices described in Appendix C prior to INSTALLATION.
L. ☐ Optional: The Vendor shall provide standard production model samples of all Field Device Components required for User verification of Interchangeability with the existing Field Devices described in Appendix C prior to INSTALLATION.

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Interoperability, Standards & Specifications

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PLEASE REMEMBER TO COMPLETE THE COURSE EVALUATIONS.

Thank you!