IES Street and Area Lighting Conference

What to Look for Today in Control Systems

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What to Look for Today in Control Systems

Learning Objectives

1. Better understand some key differences in the technology building blocks that comprise market-available outdoor lighting control systems
2. Better understand how those key differences relate to system features, value propositions, and potential barriers to deployment
3. Be able to formulate questions to ask when evaluating a market-available system that don't require a complete understanding of the technology building blocks, but effectively uncover how they relate to user needs and concerns (i.e. system features, value propositions, and potential barriers to deployment)

Not on this agenda: common features, value propositions, barriers to adoption, conflicts of interest

Terminology

- 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
- 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.

Terminology

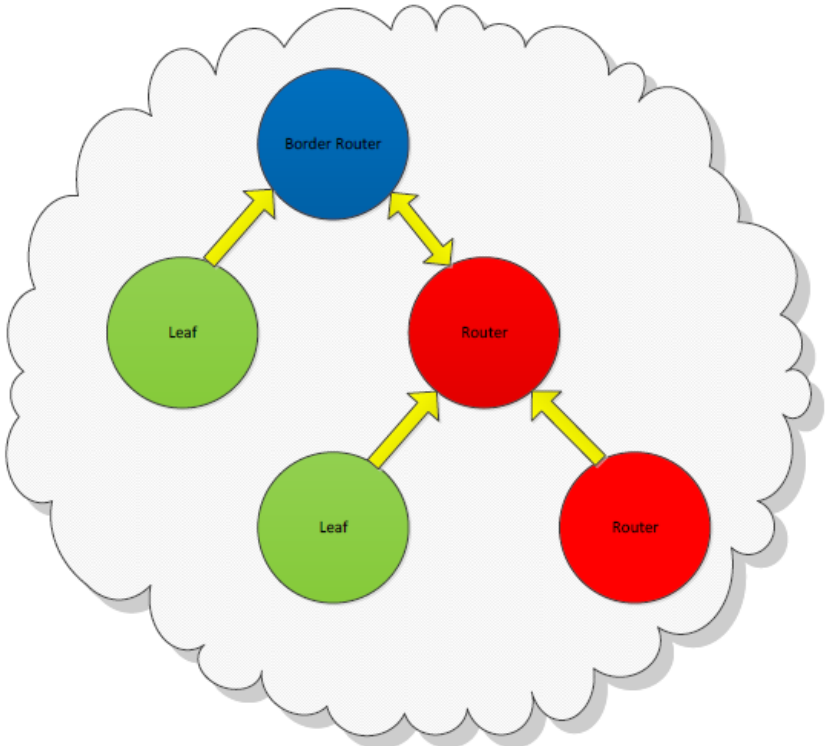
- Controller (from IES TM-23-11): the device that originates a command to execute a lighting change. Most commonly associated with a lighting control station or control console, a controller may also be a sensor or other automatic device operating without human interaction.
  - Physically monitors and 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

Terminology

- Gateway (from IES TM-23-11): 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
  - Aggregates data packets and connects to an external network
  - Typically translates 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 Release 8)
  - Sometimes referred to as a “Border Router”

Terminology

- Leaf: transmits/receives messages
- Router: generates and forwards (repeats) adjacent node's packets
- Border Router: see Gateway



Terminology

- Compatibility: Two devices (or a device and a system) are compatible if they can operate in a system (or in the same physical environment) without corrupting, interfering with, or hindering the operation of the other entity.
- Interoperability: Two devices (or a device and a system) are interoperable if they can both operate as intended, typically facilitated by an ability to share a common defined set of information.
- Interchangeability: Two devices are interchangeable if they can be physically exchanged for each other, and provide (near) identical operation in a system without additional configuration.

Terminology

- Component Installation: A process that results in a state where all Components have been provided the basic necessities required for them to operate as intended.
  - Typically includes mechanical mounting, the establishment of one or more electrical connections, and perhaps some provisioning for network communication or configuration of basic parameters to default or user specified settings.
  - Does not result in a state where all Components are operating as intended or where all System functions and capabilities are available to the User.
- System Start-Up: A process that results in a state where all Components are operating as intended and all System functions and capabilities are available to the User.
  - Typically includes the configuration of System hardware, firmware, and software.
  - Does not (necessarily) result in a state where all System functions and capabilities are configured according to User desires.

Terminology

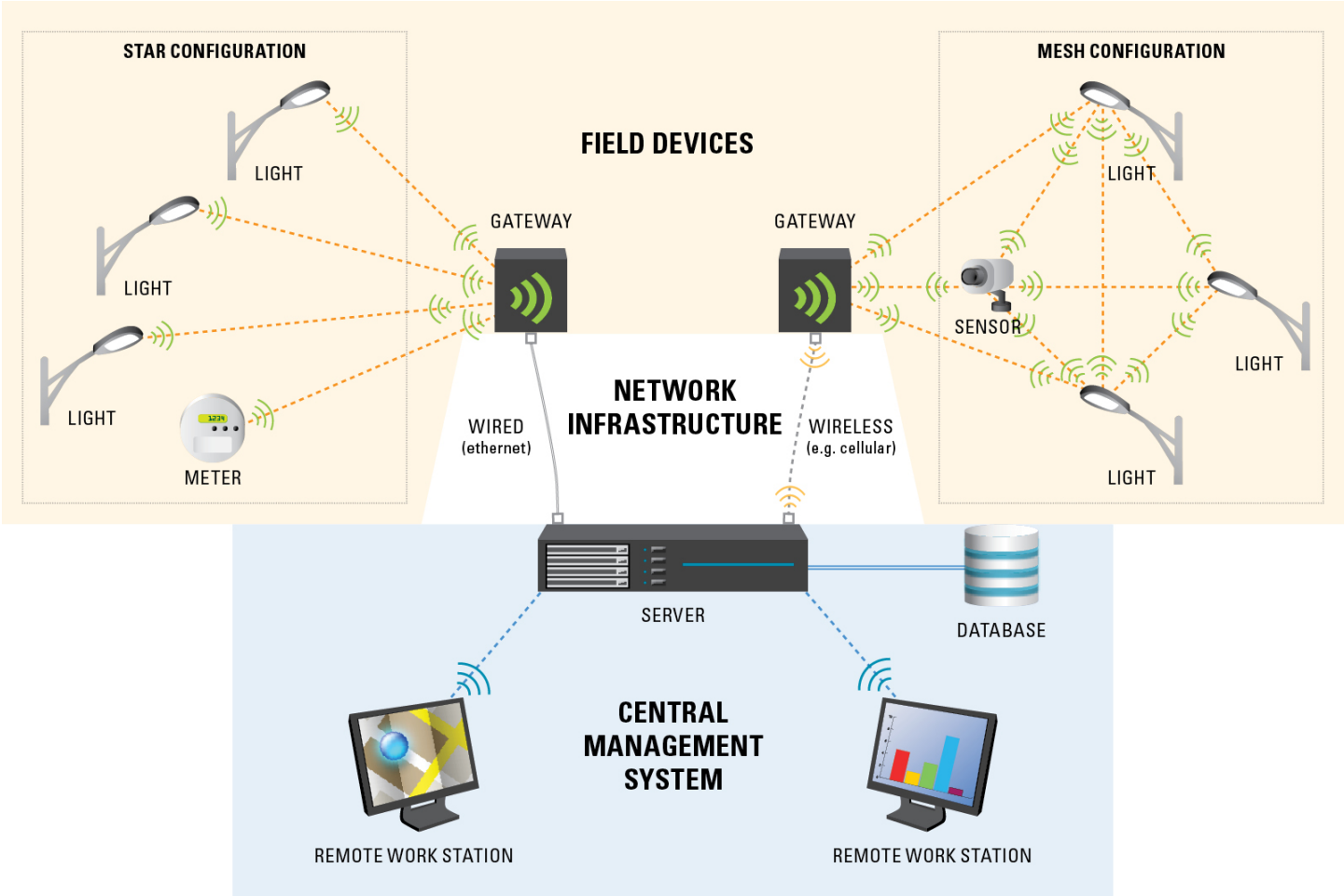
- System Commissioning: A process that results in a state where all System functions and capabilities are configured according to User desires.
  - Typically includes the modification of System software settings.

Installation
- Physical configurations
- Mechanical mounting
- Electrical connections

Start-Up
- Logical configurations
- Network configuration and connection
- Sensor configuration and connection

Commissioning
- Functional configurations
- Grouping, scheduling, reporting
- Adaptive lighting

A networked outdoor lighting control system



Source: CTLC for MSSLC

15 things to look for

1. Interoperability
2. Luminaire integration options
3. Input voltage options
4. Lighting control options
5. Energy metering
6. Location commissioning
7. Sensor options
8. Network architecture
9. Wireless spectrum
10. Backhaul selection
11. Software
12. Security
13. Data access
14. Business models
15. Integration with other (non-lighting) systems

1) Interoperability

- Facilitates ability to integrate best-of-breed components (e.g. controllers, sensors, software) into a system
- Facilitates ability to modify and improve an existing system as you learn what you (really) need/want
- Helps manage risk of component, manufacturer obsolescence
- Many types/levels
  - Between a Controller and a Luminaire
  - Between a Central Management System and Field Device Network
  - Between a Field Device and Communication Network
  - Between Field Devices
- Sharing of application data requires a common application definition (sometimes referred to as a protocol or profile)

  … or an up-to-date “translator”

Some interoperability specifications & standards

- ANSI C136.10 and C136.41 (http://www.nema.org/Technical/Pages/ANSI-C136-Series-Standards-for-Roadway-and-Area-Lighting-Equipment.aspx)
- LonMark (http://www.lonmark.org/connection/solutions/lighting/streetlighting)
- 3GPP (http://www.3gpp.org)
  - LTE (http://www.3gpp.org/technologies/keywords-acronyms/98-lte)
  - LTE-Advanced (http://www.3gpp.org/technologies/keywords-acronyms/97-lte-advanced)
  - Small Cells (http://www.3gpp.org/hetnet)
  - LTE-Direct (http://www.qualcomm.com/research/projects/lte-direct)
- TALQ (http://www.talq-consortium.org)
- ZigBee NAN (http://www.zigbee.org/default.aspx?Contenttype=ArticleDet&tabID=332&moduleId=&Aid=484&PR=PR)
- Wi-SUN (http://www.wi-sun.org)
- NTCIP (http://www.ntcip.org)
- Qualcomm / AllSeen Alliance AllJoyn (https://www.alljoyn.org)

There are many possible levels of interoperability

Application Specific
- Jargon, Lingo
- Slang, Colloquialisms

Language
- English, French
- Dialects

Delivery
- Pony Express, Rail, Air
- Wired, Wireless

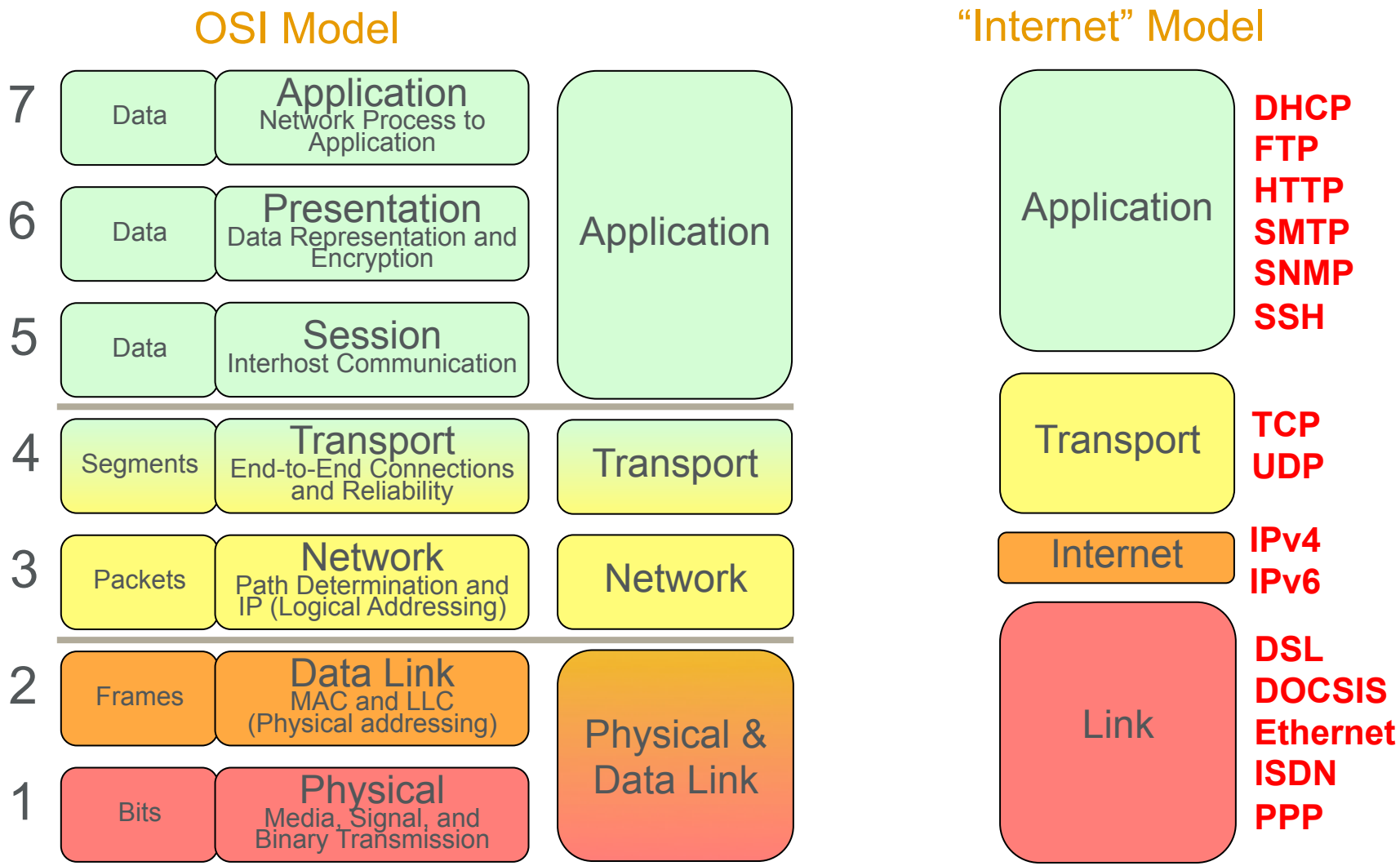
Format
- Face-to-face, phone
- Mail, Email

Method
- Verbal
- Written

OSI Model

7	Data	**Application** Network Process to Application	Application
6	Data	**Presentation** Data Representation and Encryption	
5	Data	**Session** Interhost Communication	
4	Segments	**Transport** End-to-End Connections and Reliability	Transport
3	Packets	**Network** Path Determination and IP (Logical Addressing)	Network
2	Frames	**Data Link** MAC and LLC (Physical addressing)	Physical & Data Link
1	Bits	**Physical** Media, Signal, and Binary Transmission	

There are many possible levels of interoperability



Gateway caveats

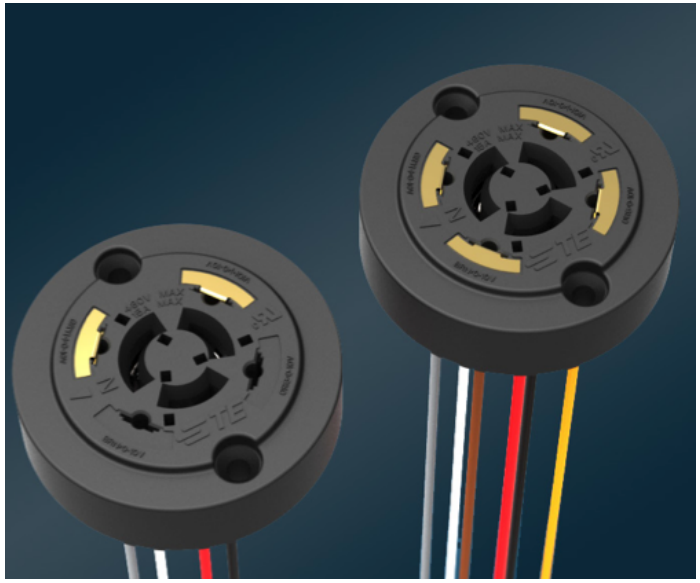
- Gateways serve a bridge between systems
  - At one or more communication layers (physical/data link, network, transport, application)
  - Translate across one or more layers
- The successful translation of application data is susceptible to changes or additions to application definitions
- Deeper levels of device-to-device interoperability can deliver greater system flexibility and performance

ANSI C136.10-2010

"American National Standard For Roadway and Area Lighting Equipment – Locking-Type Photocontrol Devices and Mating Receptacles – Physical and Electrical Interchangeability and Testing"

ANSI C136.41-2013

"American National Standard For Roadway and Area Lighting Equipment – 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	RoHS 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*	RoHS 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	RoHS 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	RoHS 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	RoHS 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!

FEATURES:

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

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

Today's field devices

Application (Lighting Control)	Typically Proprietary
Transport & Network (Mesh)	Typically Proprietary
Physical & Data Link	Typically standards-based IEEE 802.15.4 (ZigBee), IEEE 802.11 (WiFi)

- **NTCIP 1213 ELMS**
- **LonMark**
- **TALQ**
- **Allseen Alljoyn**

LonMark International

- Vendor consortium (http://www.lonmark.org/connection/solutions/lighting/streetlighting)
  - 14 street lighting members
- Full interoperability (including application layer), primarily for wired physical implementations
- Based on the ISO/IEC 14908 series of standards
- Compliance testing and certification

LonMark International

01.00 - Network Infrastructure
04.00 - Programmables
05.00 - I/O
06.00 - Generic Controllers
07.00 - Generic Actuators
08.00 - Generic Human-Machine Interface
10.00 - Sensors
20.00 - Energy Management
30.00 - Lighting
40.00 - Wiring Devices
50.00 - Access/Intrusion/Monitoring
60.00 - Motor Controls
70.00 - Gateways
80.00 - HVAC
90.00 - Transportation
100.00 - Refrigeration
110.00 - Fire & Smoke Devices
130.00 - Industrial
140.00 - Vertical/Conveyer Transportation (Elevator)
150.00 - Whitegoods
170.00 - Automated Food Service
180.00 - Semiconductor Fabrication

Address MANY applications

30.00 - **Lighting**
30.10 --- Dimmer 1-10V
30.11 ------- 8-Channel dimmer 1-10V
30.12 ------- 3-Channel dimmer 1-10V
30.20 --- Transistor Dimmer
30.30 --- Thyristor Dimmer
30.40 --- Lamp Actuator
30.41 --- ISI Lamp Actuator
30.50 --- Constant Light Controller
30.71 --- Occupancy controller
32.00 --- Switch

Profile-Specific Usage:

00 -- Discrete Output (ON/OFF)
01 -- Discrete Output (ON/OFF) with Feedback Input
02 -- Discrete Output (ON/OFF) with Setting Control
03 -- Discrete Output (ON/OFF) with Feedback Input and Setting Control
20 -- Variable Output
21 -- Variable Output with Feedback Input
22 -- Variable Output with Setting Control
23 -- Variable Output with Feedback Input and Setting Control

32.01 ------- 4-Switch relay
32.02 ------- Multi-switch/multi-sensor
32.03 ------- Switch/sensor
32.50 --- Scene Panel
32.51 --- Scene Controller
32.52 --- Partition Wall Controller
32.53 --- ISI Keypad
33.00 --- Real-Time Keeper
33.01 ------- Real-Time-Based Scheduler
34.00 --- Lighting Controller
34.01 ------- Lighting Panel Controller
35.00 --- Outdoor Lighting
35.12 ------- Outdoor Luminair Controller
35.14 ------- Smart Luminair Controller

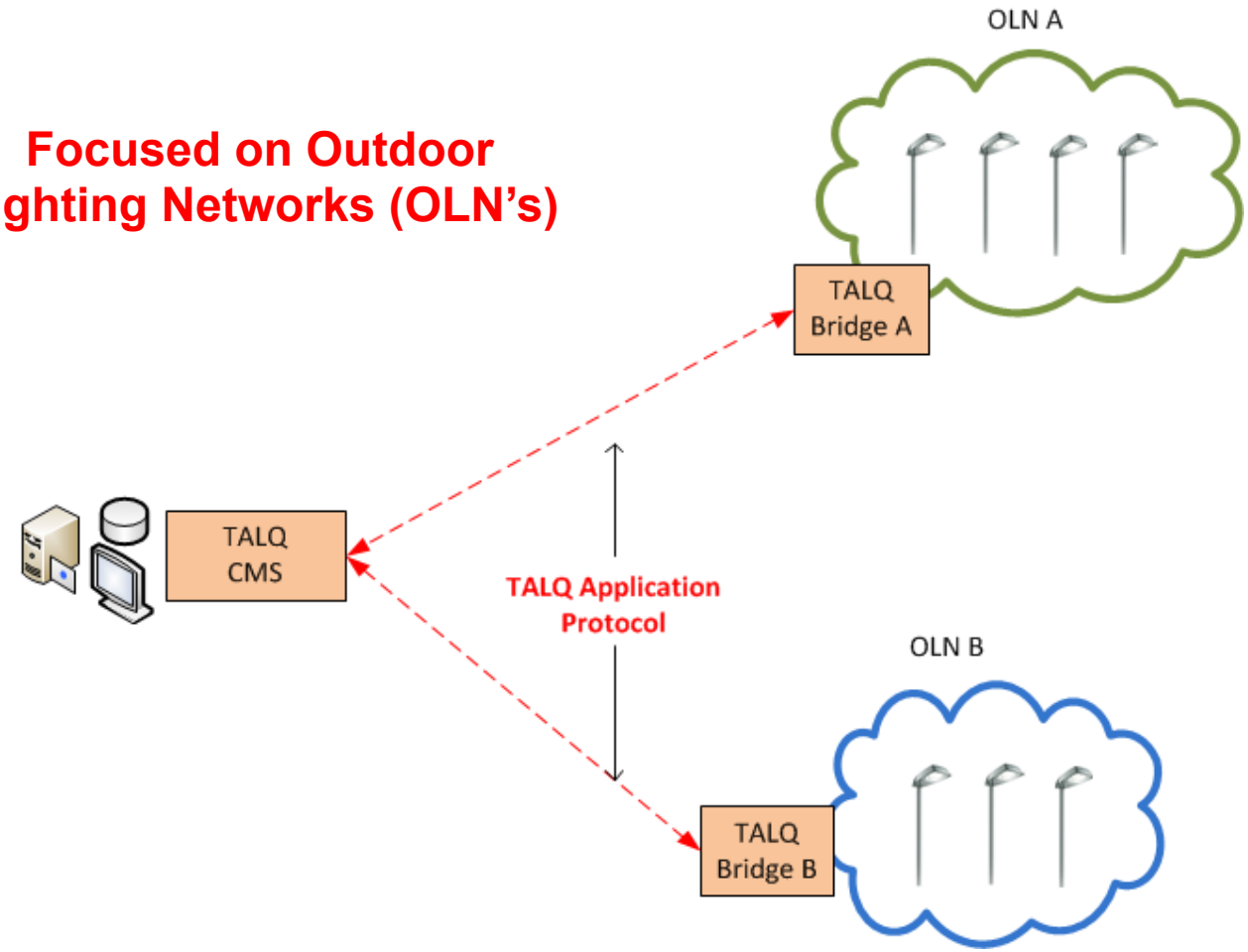
http://www.lonmark.org/technical_resources/resource_files/spid_master_list#DeviceClasses

The TALQ Consortium

- Vendor consortium (http://www.talq-consortium.org)
  - 11 regular members
  - 11 associate members
  - 4 partners
- Standardized interface (including application layer) between central management systems and outdoor lighting networks
- Design specification(s)
- Compliance testing and certification

The TALQ Consortium

Focused on Outdoor Lighting Networks (OLN's)

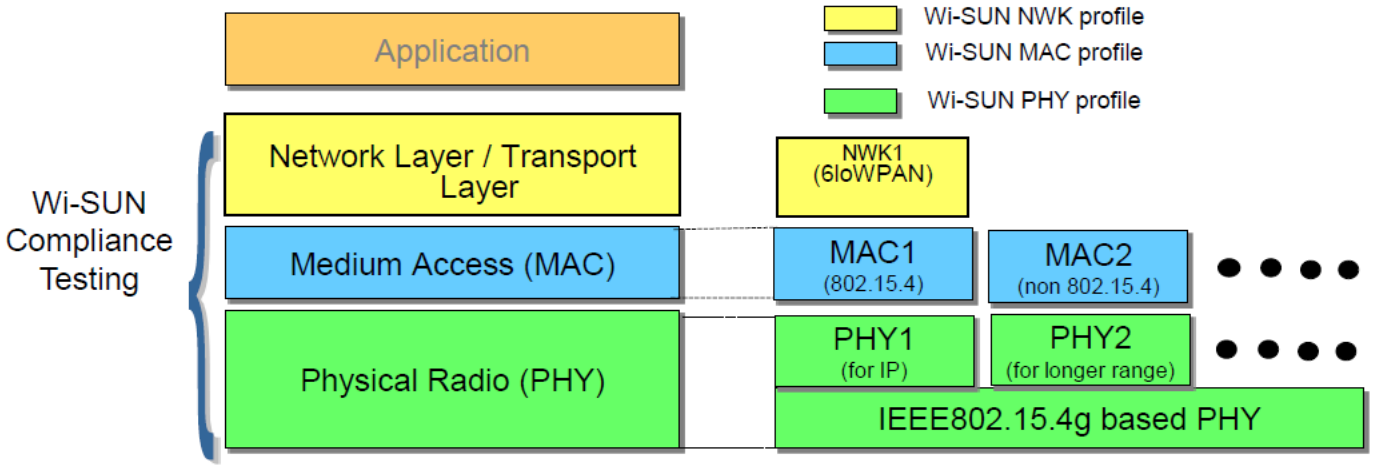


Wi-SUN Alliance

- Vendor consortium (http://www.wi-sun.org)
  - 10 promoter members
  - 44 contributor members
  - 2 observer members
- Physical/Data Link, Network and Transport layer interoperability (i.e. everything EXCEPT the application layer)
- Based on IEEE 802.15.4g, 6loWPAN standards
- Compliance testing and certification

Wi-SUN Alliance

Focused on
Smart Utility Networks



- Primarily Wi-SUN develops Technical Profile specifications of Physical Layer (PHY) and Medium Access Control (MAC) layers, with NWK layer as required.
- Develop Interoperability test programs to ensure implementations are interoperable
- Wi-SUN Physical layer specifications is based on IEEE802.15.4g but the profile specification is categorized based on Application
- The MAC layer may use different options depending on the application (Smart Meter, Home Automation ...).

2) Luminaire integration options

- External to luminaire, on/off only (no dimming)
  - 3-prong receptacle (ANSI C136.10)
  - 5-7 prong receptacle (ANSI C136.41)
- External to luminaire, with dimming
  - 3-prong receptacle (ANSI C136.10) + wired solution
  - 3-prong receptacle (ANSI C136.10) + power-line carrier (PLC) solution
  - 3-prong receptacle (ANSI C136.10) + wireless solution
  - 5-7 prong receptacle (ANSI C136.41)
- Internal to luminaire
  - Installation, responsibility
  - LED driver interaction (heat, unintentional radiation)
  - Antenna
- Integral to luminaire

Luminaire integration options

- **Internal to luminaire (today)**
- **Integral to luminaire i.e. internal to the ballast/driver (soon)**

3) Input voltage options

- Universal (120 – 277 Volt)
- 240 Volt
- 347 Volt
- 480 Volt
- Internal (to luminaire) transformers required for high(er) voltage luminaires if suitable controller is not available
- Emerging options powered by driver/ballast

Vendor	120 Volt	240 Volt	277 Volt	120 – 277 Volt	347 Volt	480 Volt
A				X	X	X
B				X	X	X
C				X		S
D		X				
E				X		
F				X		
G		X				
H		X				

4) Lighting control options

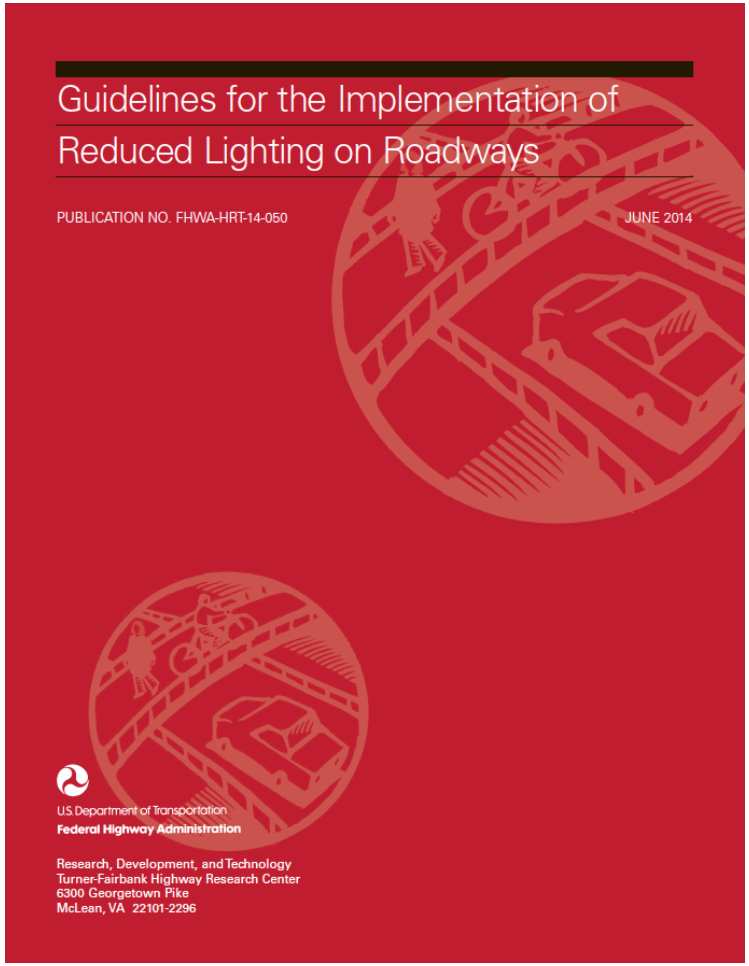
- 0-10V
  - One-way analog communication driver/ballast
  - Can not set power or light level
- DALI
  - Two-way digital communication with driver/ballast
  - Can set light level
  - Can (theoretically) extract luminaire characteristics (e.g. make/model, power profile)
  - Can report driver/ballast characteristics (e.g. temperature)
- Integral to luminaire driver/ballast

“Control-Ready” luminaires

- What?
  - Dimmable driver/ballast
  - 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

Light level considerations

- Identifying conditions that warrant different (from nominal) light levels
- Identifying when those conditions occur
- Light level vs. power expectations, realities
- Establishing the desired light level
- Billing for the resultant (varying) power level



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

5) Energy metering

- For generating “revenue-grade billing data”
- For monetizing “adaptive lighting”
- Accuracy, precision
- Data security
- Standards
  - ANSI C12.1 – 2008 “American National Standard for Electric Meters, Code for Electricity Metering”
  - ANSI C12.20 – 2010 “American National Standard for Electric Meters, 0.2 and 0.5 Accuracy Classes”
  - ANSI C136.50 – TBD, “American National Standard For Roadway and Area Lighting Equipment, TBD (Revenue Grade Energy Measurement)”

Energy metering claims

Metering Node

An energy meter on every fixture.

- Delivers billable-quality energy data
- Enables transition from flat rate to metered energy billing
- Provides individual fixture energy measurement and control
- Maximizes energy savings on dimmable fixtures
- Identifies malfunctioning or failed fixtures quickly

Features:

- +/- 2% accuracy (per ANSI C12.1 & C12.20)
- 1060 Joule, 10kA surge protection
- Conformal-coated circuit boards
- Protection against LED inrush current
- Self-diagnostic capabilities

Dimming *and* Monitoring are Now in ONE control!

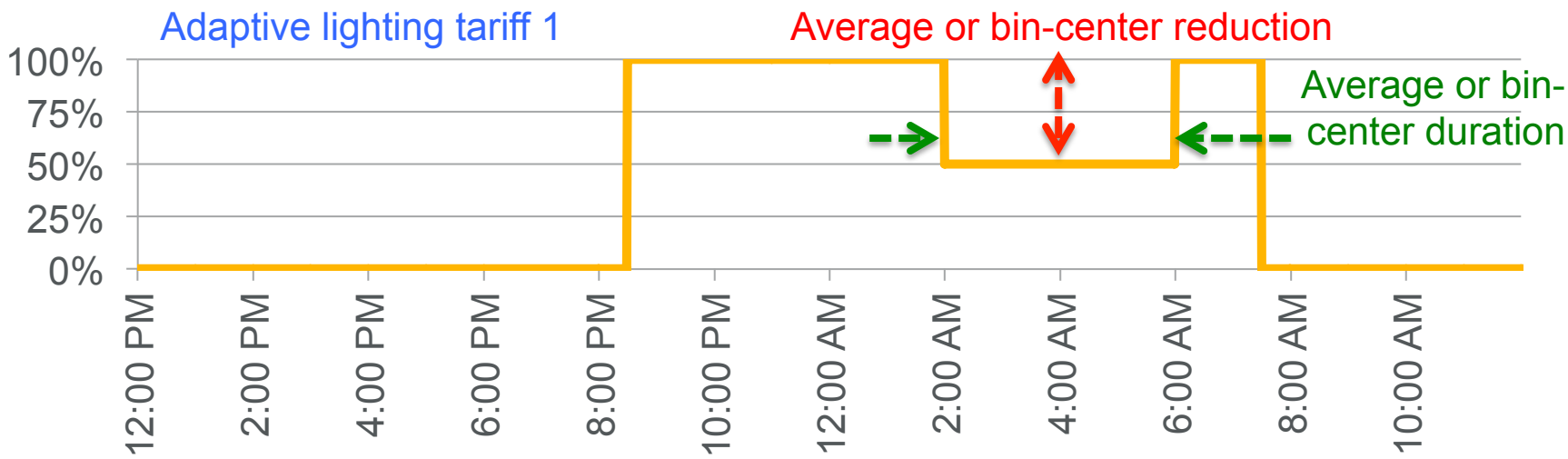
- Delivers revenue grade energy data with 0.5% accuracy per ANSI C12.20

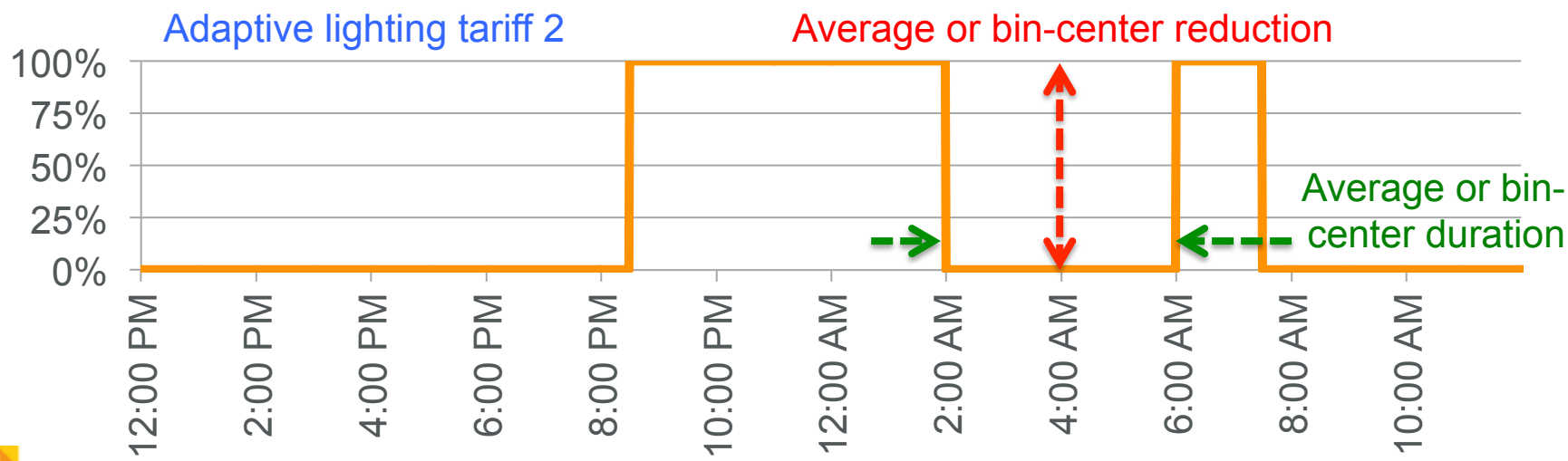
Q5. What is the accuracy and resolution of the power monitoring?
A5. Better than 1% non-revenue-grade reporting, with a resolution of watt- seconds (Ws).

- Utility-grade metering means you pay for actual energy use, with measurement accuracy of ± 2%

- Energy metrology at 1 % accuracy, with per day, per hour, or per minute records and robust utility billing integration

Alternatives to energy metering





6) Location commissioning

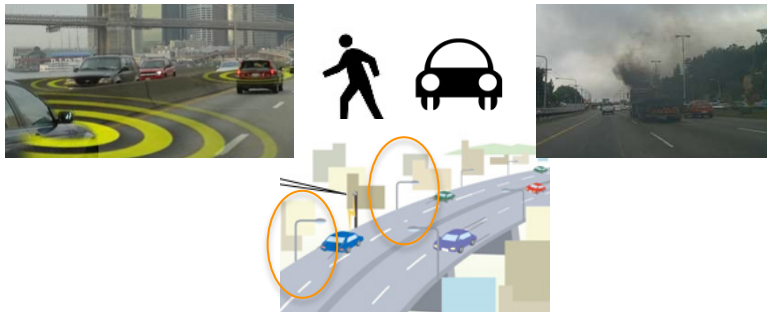
- Options
  - None
  - Controller location is assigned from an existing database
  - Controller location is captured using a field commissioning device (with GPS)
  - Controller captures its own location (via integral GPS)
- Key considerations
  - GPS cost (one-time use?)
  - GPS accuracy vs. lock-in time

7) Sensor options

- Ambient Light (photocell)
- Traffic (inductive loop, camera-based)
- Occupancy (PIR, camera-based, microwave)
- Environmental conditions
- Video (requires high-bandwidth network)
- Audio (gunshot)
- Air quality (chemical, particle)
- Radiation

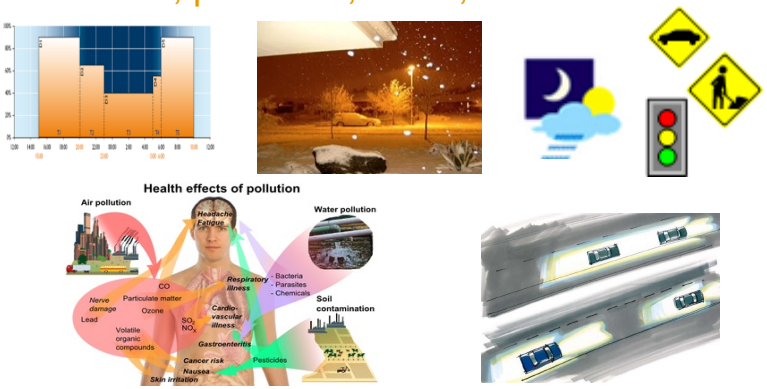
Sensing

cars, pedestrians, bicycles, environment…



Adaptation

schedules, presence, traffic, weather



Sensor options

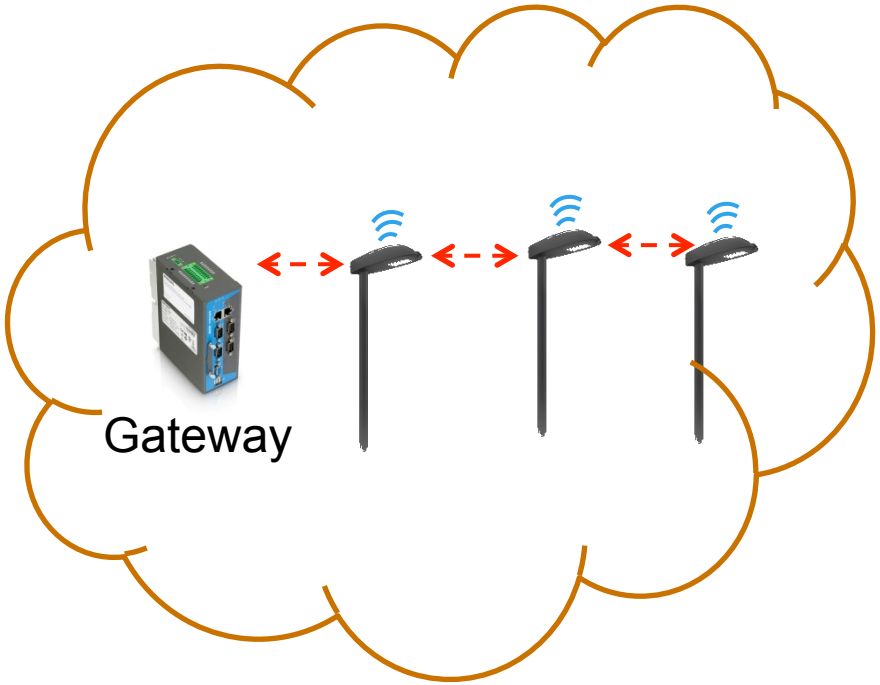
- Many existing and emerging device options
- Raw data (e.g. video stream) vs. locally processed/analyzed data (e.g. number of parked cars, traffic volume)
- Varying system integration schemes
  - Integrated into luminaire or controller
  - Analog signal input to device on lighting control network
  - Digital signal input to device on lighting control network
  - Connected to lighting control network through a gateway
  - Directly connected to lighting control network
  - Shared data through Central Management System
- Data sharing facilitated by application level interoperability

Sensor examples

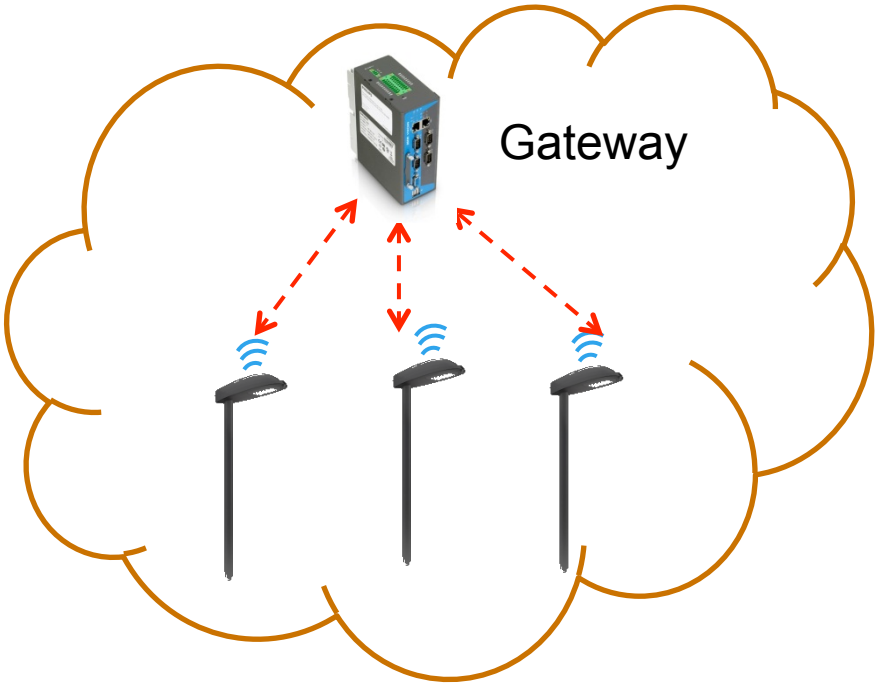
8) Network architecture

- Primary market-available options
  - Wired (PLC) LAN
  - Wireless Mesh LAN
  - Wireless Star LAN
  - Wireless direct connect to WAN (e.g. cellular)
- Number or presence of gateways
  - Electrical connection, energy consumption
  - Maintenance
  - Aesthetics
- Connection challenges, solutions
  - Repeaters
  - RF power adjustment
  - Additional gateways

Wireless topologies

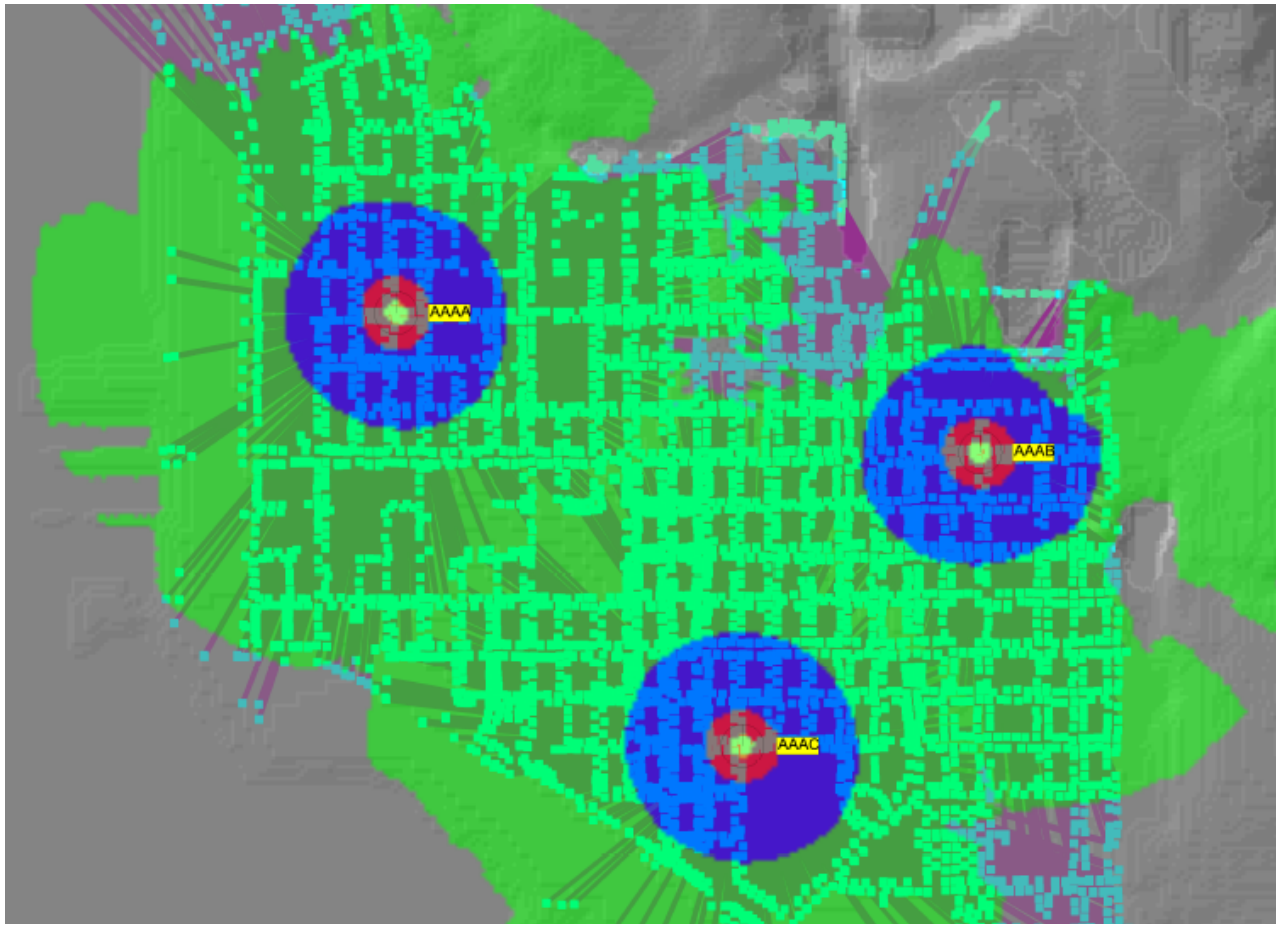


Mesh

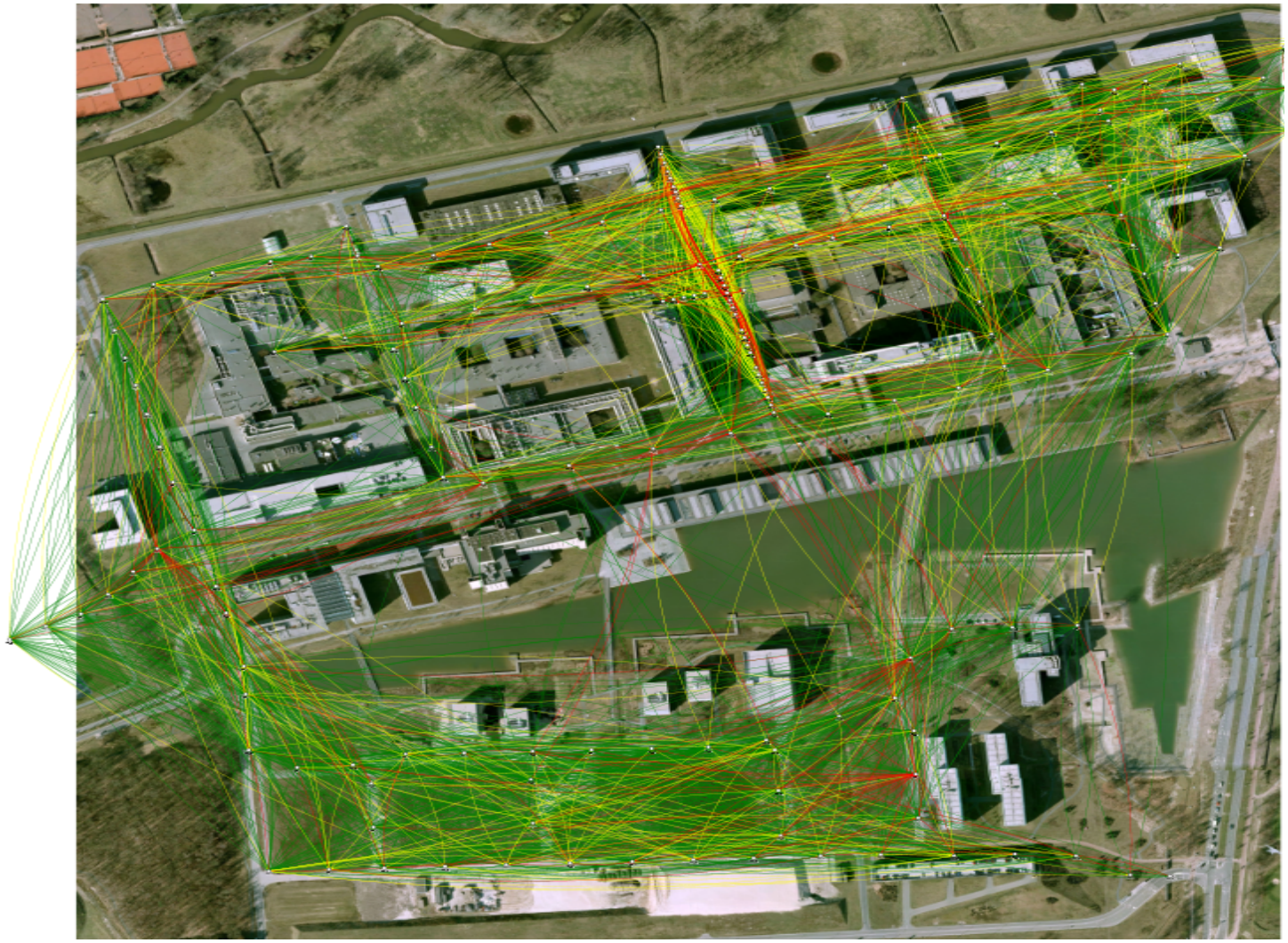


Star

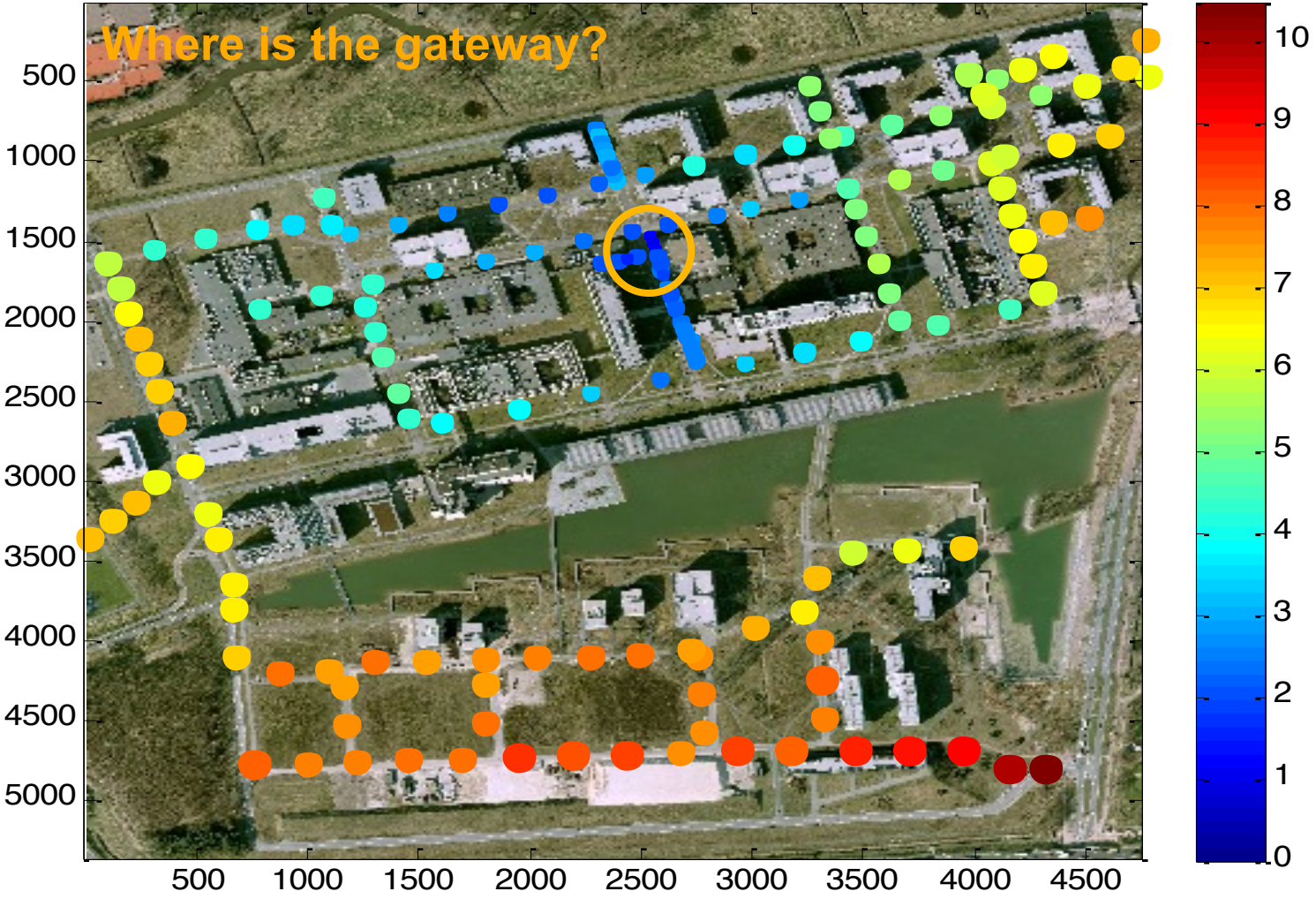
Propagation simulation example



Mesh network formation example



Average mesh hop count example



9) Wireless spectrum

- Managed (legal protection and enforcement) by Federal Communications Commission (FCC)
- Unlicensed (ISM Applications)
  - Free access granted to all users
  - Most devices in 900-928 MHz, 2400-2483 MHz bands
  - One watt or less transmit power
  - Must obey FCC “good neighbor” rules
  - Must be able to live in crowded, noisy environment
- Licensed
  - Fee-based access granted to one user
  - Various portions of RF spectrum over a designated geographic area
  - Higher allowed transmit power
  - Knowledge of and control over all transmitters
  - Lower noise

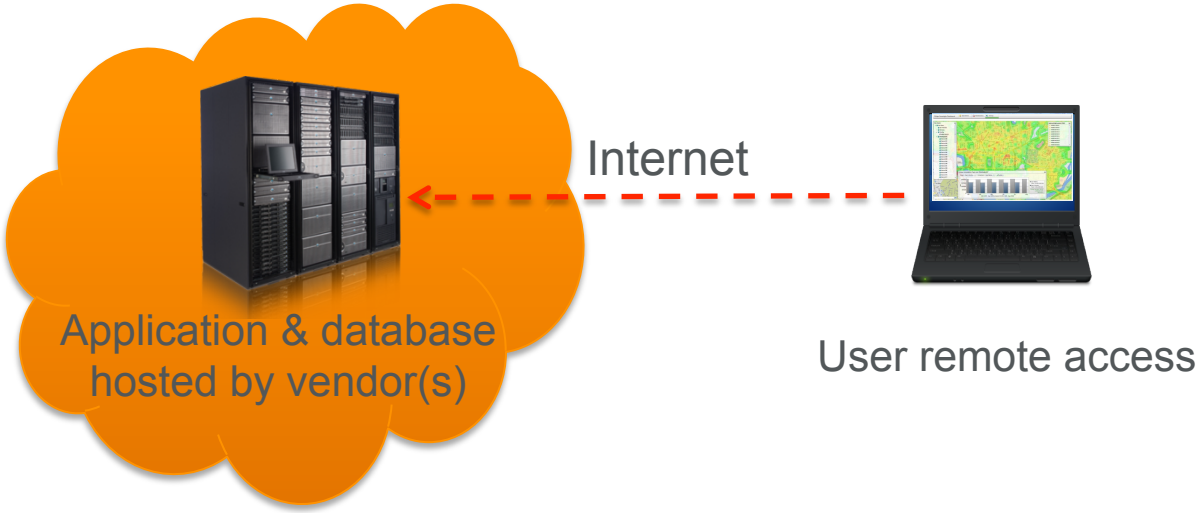
10) Backhaul selection

- Wired - Fiber
  - IEEE 802.3 (Ethernet)
  - Availability at utility/light pole, lighting boxes, traffic management boxes?
  - New install expense (perhaps covered by small cell installation?)
  - Fastest and most reliable
- Wireless – Cellular
  - GRPS, 3G, LTE/4G
  - Wide availability and coverage
  - Must consider propagation conditions at gateway locations to avoid coverage holes
- Wireless – Other
  - WiMax
  - Line-of-sight (e.g. 60GHz)

11) Central Management Software

- System integration
  - Vendor hosted CMS (cloud-based)
  - User hosted CMS (application installed on user system)
- Capabilities & Features
  - Many purposes, including commissioning, asset management, remote monitoring and reporting, diagnostics and manual control, etc.
  - Varying formats (GUI's, levels of customization/complexity)
  - Not all formats ideally suited for all users and/or staff (e.g. system administration, field maintenance) needs
- Interoperability facilitates the installation of different, multiple software tools to suit user and/or staff needs

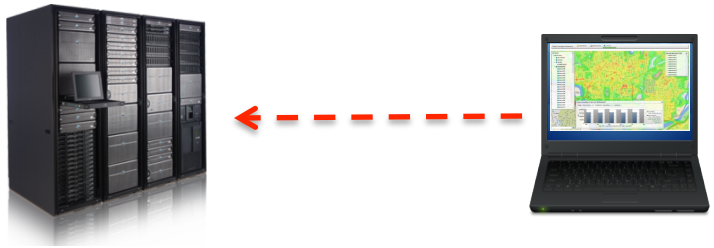
Vendor-based hosting



- Access application & database through encrypted user sessions using technology (https) similar to online banking
- Application management (e.g. upgrades, security) handled by Vendor(s)
- Database backups handled by Vendor(s)
- Cloud-based multi-user management is potentially more cost-effective
- Typically involves a service fee (per-light-point-per-year fee)

User-based hosting

1



Application & database hosted by user

User remote access

2

Standalone desktop application & database

- User and vendor coordinates application management and software upgrades
- All data stays on the user's premises
- User responsible for data backup and security management
- User typically pays one-time software cost + additional cost for support services (e.g. help desk) and software upgrades

12) Security

- Security is not (just) a feature or set of features
  - 128/256-bit AES
  - MAC address filtering
  - TLS, DTLS, IPsec
  - IPV6
- Security is a process and commitment
  - Secure deployment and commissioning, to prevent the addition of malicious devices in the system
  - Authentication, to prevent unauthorized people or devices from gaining access to the network to control or disrupt it
  - Data encryption, to prevent eavesdropping of network data
  - Secure software updates, to prevent hackers from loading non-functional or malicious software
  - Ongoing maintenance

Network security certification tools

- Federal Information Processing Standard (FIPS) 140-2
  - Level 1 (minimum security, PC)
  - Level 2
  - Level 3
  - Level 4 (maximum security)
- Department of Defense Information Assurance Certification and Accreditation Process (DIACAP)
  - Severity Codes: CAT I, CAT II, and CAT III
  - Accreditation decisions: Authorization to Operate, Interim Authorization to Operate, Interim Authorization to Test, Denial of Authorization to Operate

13) Data access

- Vendor-based or user-based CMS hosting
- Tiered access fees
- Microdata vs. aggregate data
- Raw/measured sensor data
- Facilitated data exchange via Application Programming Interfaces (API's)
  - Standards (REST, JSON, XML)
  - Push, Pull (Query)
  - Example: http://www.lightingfacts.com/Library/API
  - Example: http://portfoliomanager.energystar.gov/webservices/home/api

14) Business models

- User financed purchase
  - Private vs. public financing
  - Energy Efficiency incentives or loans (requires energy savings)
  - Capital cost recovery (utilities)
- 3rd party financed purchase
  - ESCO, paid by future savings
  - ESCO, paid by previous savings
- Service contract
  - Per networked device fee
  - Per data usage fee
- Revenue generating opportunities
  - Shared electrical/mechanical infrastructure (poles, electricity)
  - Shared LAN
  - Shared WAN (backhaul)
  - Shared bandwidth
- Revenue generating examples
  - Repeaters for other (e.g. smart meter) networks
  - Access points for other networks (e.g. cellular small cells)

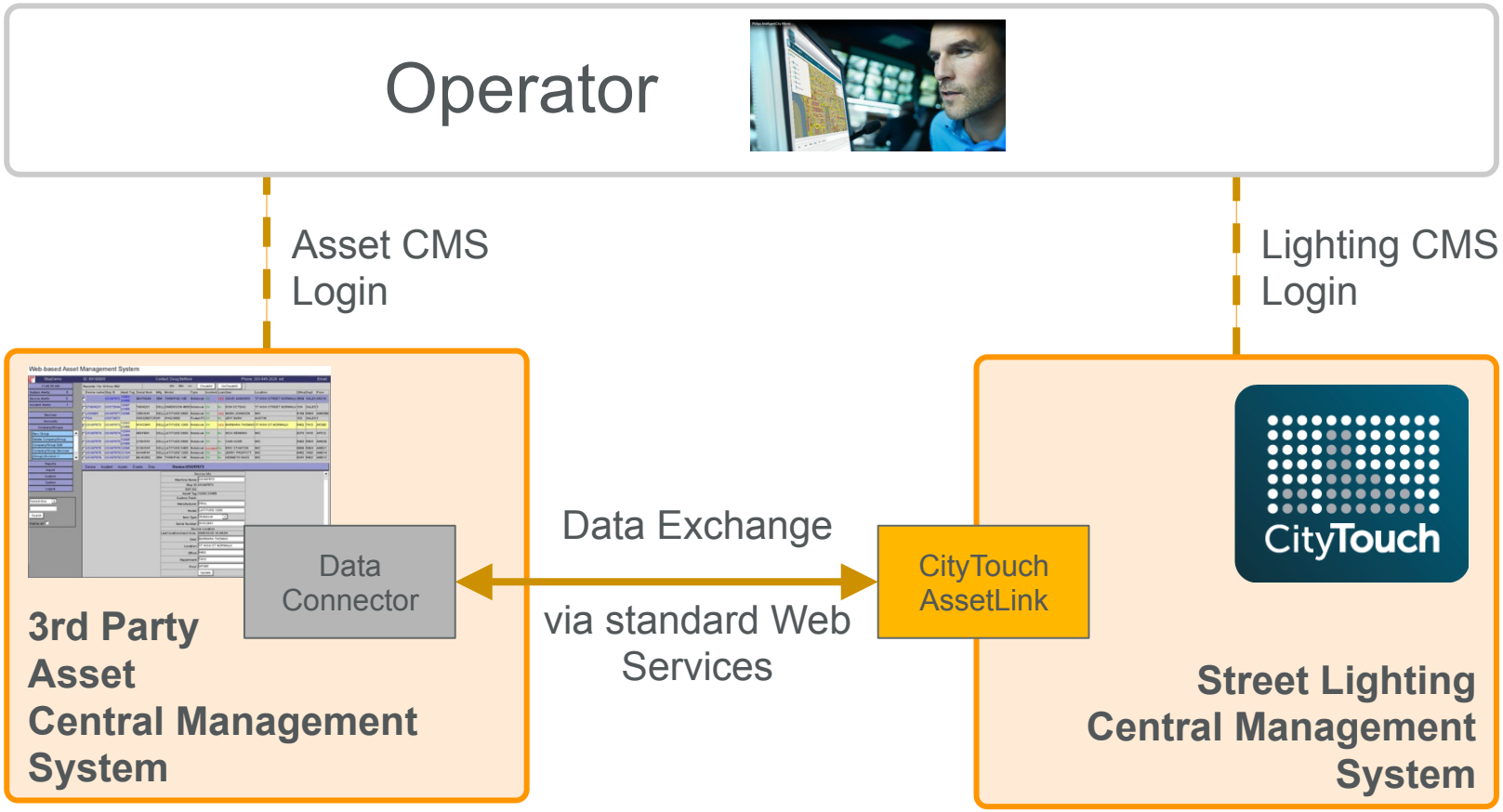
Investment analysis

- Payback analysis
  - Accounts for maintenance savings (varies significantly)
  - Based (mostly) on lighting control energy savings (rare)
  - Based (solely) on LED retrofit energy savings (becoming more common, requires combined project)
  - Accounts for non-energy benefits (rare)
- Evaluation metrics
  - Return-on-Investment (ROI)
  - Total Cost of Ownership (TCO)
  - Total Value of Ownership (TVO)

15) Integration with other systems

- Comprised of lighting or non-lighting devices
- Shared central management system, separate networks
  - Municipal and DOT lighting systems
- Shared network, separate central management systems
  - Smart meter and lighting systems
- Shared data via communication with other central management systems
  - Lighting and asset management systems
  - Lighting and traffic systems
- Shared network and data via field-to-field communication with other devices
  - Lighting systems and vehicles (Vehicle to Infrastructure or V2I)
- Facilitated by interoperability, gateways, etc.

Lighting and Asset Management Systems



Lighting and Traffic

SNAPS PROFESSIONAL

SENSYS networks

Sensys Networks VDS240 Wireless Vehicle Detection System

SNAPS Professional v2.8 Set Up and Operating Guide

P/N 152-240-001-050, Rev B
October 2012

Appendix A

SNAPS XML Feeds

This appendix provides examples of the three primary XML data feed types that are supported by SNAPS 2.8:

- *Diagnostics*
- *Statistics*
- *Raw Events*

XML Examples

All XML feeds are available in *Push* or *Pull* configurations. In the *Push* feed configuration, SNAPS originates the socket connection to an external server. Push *Raw Events* feeds result in a long term socket connection between SNAPS and the receiving system. *Diagnostic* and *Statistic* feeds result in periodic connections at configured intervals.

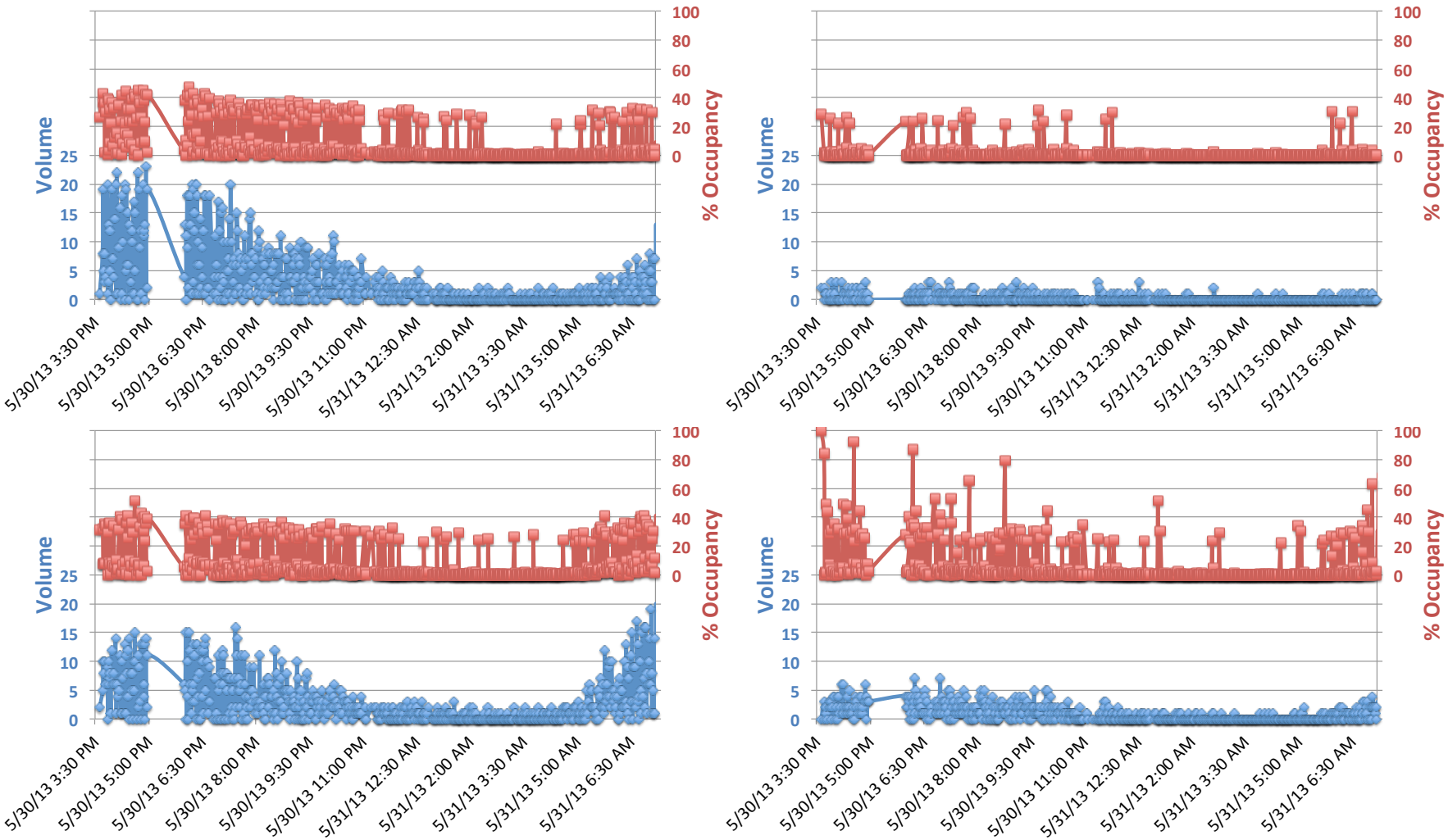
NOTE: Push feed configurations are performed via the SNAPS GUI.

In the *Pull* configuration, Pull feeds are initiated by an external system and are implemented as Web services. Pull *Raw Events* feed request results in SNAPS sending Raw Events messages as long as the socket connection is open. *Diagnostic* and *Statistic* feed requests result in a single data response.

Sensys Networks, Inc.

SNAPS Professional
Set Up and Operating Guide | 97

Imported XML traffic data



DOE SSL Program Resources: Model Specification

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Model Specification for Networked Outdoor Lighting Control Systems

The DOE Municipal Solid-State Street Lighting Consortium's Model Specification for Networked Outdoor Lighting Control Systems is 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. While the capabilities of monitoring and control systems on the market are enticing, many of these raise questions for users who are uncertain about how (or even if) they should be implemented, and how their true value can be assessed. As a result, user interests currently vary widely and are likely to do so for the foreseeable future, until adaptive lighting best practices and the ability to forecast energy and maintenance savings (along with the value of other features) becomes more universally proven.

A major update to the original Model Specification for Adaptive Control and Remote Monitoring of LED Roadway Luminaires has been released and this version, V2.0, has been renamed "Model Specification for Networked Outdoor Lighting Control Systems" to better reflect its evolving scope. The Model Specification remains a work-in-progress, a living document that reflects user experiences and the changing commercial market. Major updates in V2.0 include: the 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; and further refinement focused on facilitating independent bids for Central Management System(s), Backhaul Communication Network(s), and Field Devices. The latter focuses on improving user ability to tender multi-vendor, multi-bid projects. V2.0 also includes 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.

Download the Model Specification for Networked Outdoor Lighting Control Systems, V2.0

The MSSLC welcomes questions about the goals and development of this tool, and any suggestions for its further improvement. Municipalities or utilities who are particularly interested in future developments regarding the model specification are encouraged to inquire about joining the MSSLC task force that continues to engage and track the development and deployment of this energy-saving technology, and seeks ways to improve this resource. Please send comments and questions to MSSLC@pnnl.gov.

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

QUESTIONS?

What to Look for Today in Control Systems

Michael Poplawski
Pacific Northwest National Lab