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

Technology Keys for Connected Lighting

ENERGY STAR Webinar

May 26, 2016

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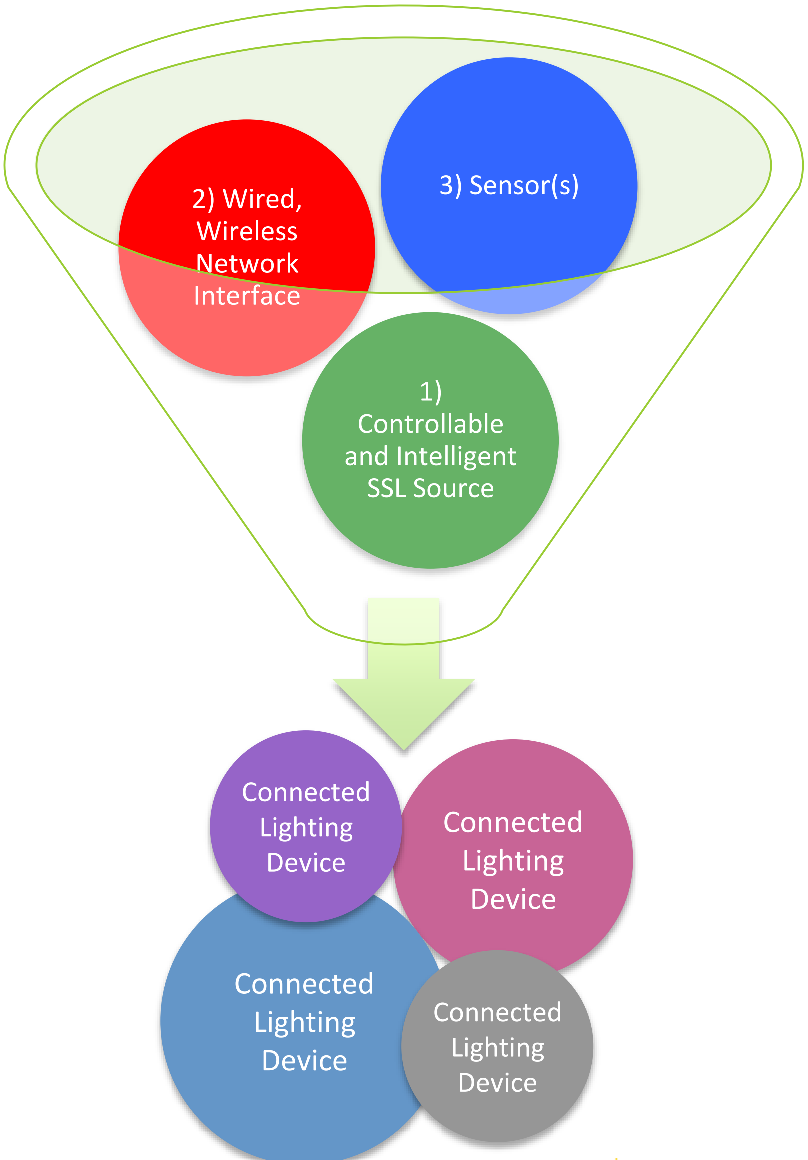
What is a Connected Lamp or Luminaire?

- No industry standard
- DOE SSL Program: controllable and intelligent SSL source (capable of using, or consuming data), one or more network interfaces, one or more sensors (i.e. data producers)
- ENERGY STAR Connected Lamp (V2.0, Rev. Feb. 2016): An ENERGY STAR eligible connected lamp includes elements (hardware and software or firmware) or instructions required to enable communication in response to consumer-authorized energy or performance related commands and complies with all requirements for connected lamps in the specification. These elements may reside inside or outside of the base lamp.

What is driving the emergence of Connected Lighting?

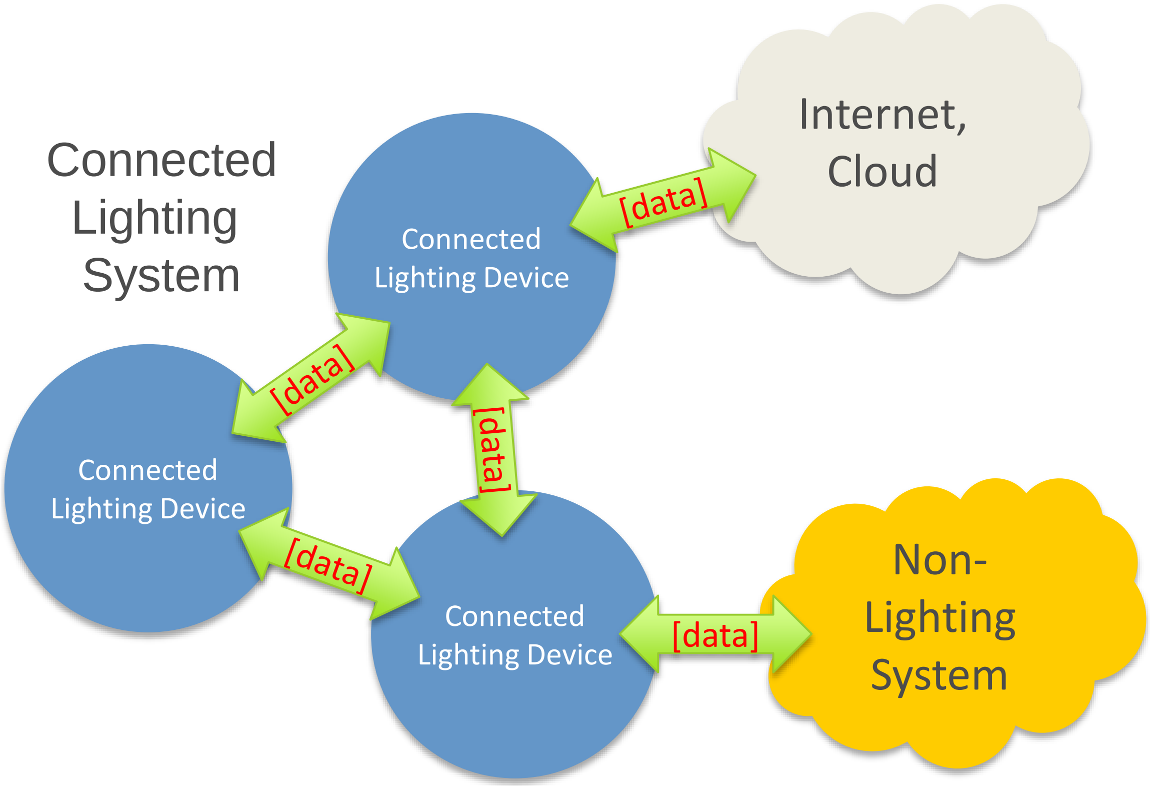
- Significant technology trends driving performance improvements and cost reductions
  - Computing
  - Mobile
  - Intelligence (i.e. microcontrollers), network interfaces, and sensors
- Solid-State Lighting
- Emergence of cloud storage, computing
- Focus on systems and data



What can Connected Lighting products do today?

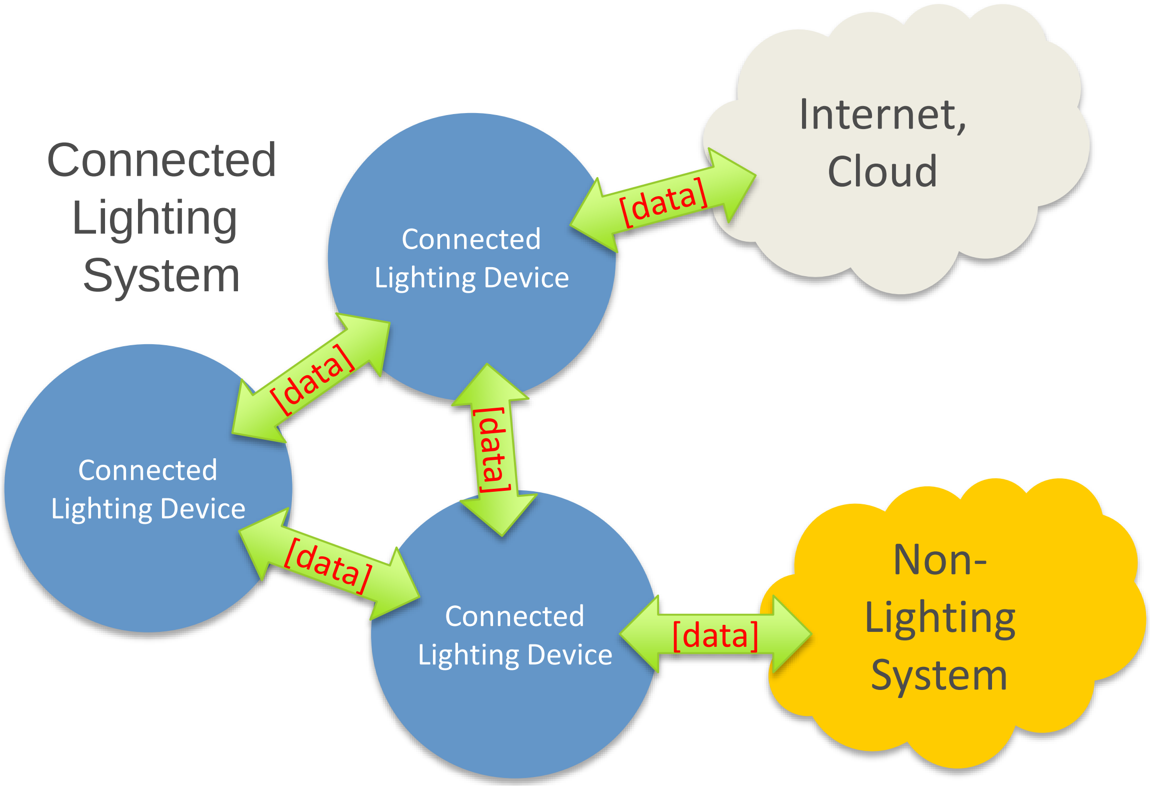
- Dimming
- Dim-to-warm
- White or color tuning
- Notification
- Sensing
- Indoor positioning
- Energy reporting

Where might Connected Lighting go in the (near?) future?



How might connected Lighting Systems change lighting?

Opportunity Enabling intelligent lighting devices with (the right type and amount of) data can result in reduced energy consumption and improved lighting performance



The collected data may enable other revenue streams that compete with lighting and energy performance. **Threat**

What can we do to accelerate Connected Lighting?

Technology Development	Technology Deployment
• Energy reporting • Interoperability • System configuration • Key new features e.g. "non-energy benefits" • Standards and specifications	• Real-world performance • User engagement and education • High performance product identification
Collaborations	**Outcomes**
• Industry Consortia • Energy Efficiency Programs • Lighting system designers, integrators	• Increased adoption, viable business models • Data-driven energy management • Transactive energy markets

Energy reporting: why?

- Enable new market opportunities
  - Energy billing for devices currently on flat-rate tariffs
  - Pay-for-performance energy efficiency incentives
  - Lower cost, more accurate energy savings validation for service-based business models
  - Self-characterization of available (i.e. marketable) “building energy services”
  - Verified delivery of utility incented energy transactions e.g. peak and other demand response
- Reduce energy consumption
  - Data-driven energy management
  - Transactive energy markets

Data driven performance management

Discovery & Measurement

Asset data, Remote monitoring

Baseline performance

Assessment & Simulation

Analytic engine, What-if scenarios

Analyze monitored data, Simulate policy scenarios

Policy & Control

Rules engine, Execution proxies

Automated deployment and execution of policies

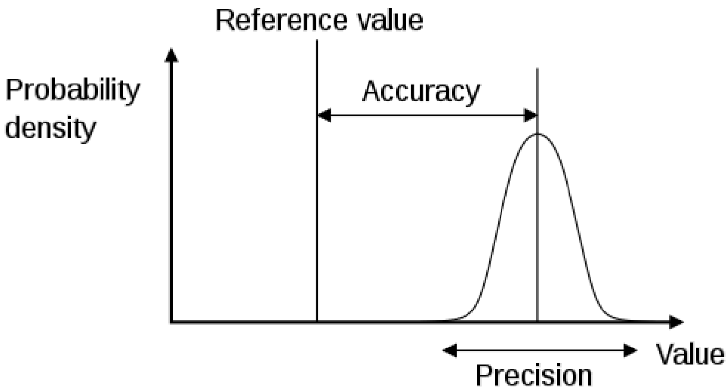
Reporting & Decision Support

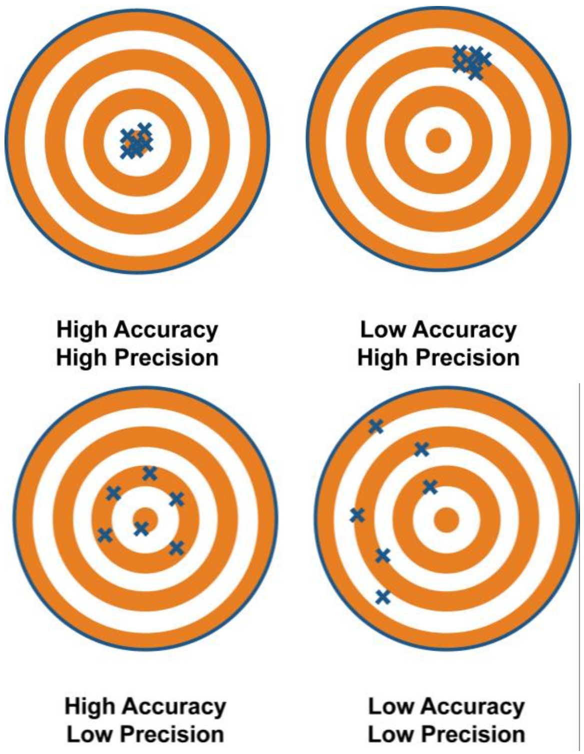
Results, Benefits, Savings

New baseline performance

Energy reporting: how?

- Identification of major energy data use cases
- Consideration of implementation cost vs. performance trade-offs
- One or more sets of accuracy, precision requirements that meet use case needs
- Standard accuracy classes, test & measurement methods, pass/fail criteria





Interoperability: what?

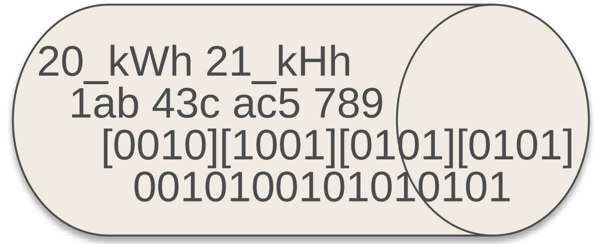
- Compatibility: The ability of two or more devices, applications, networks, or systems to coexist in the same physical environment – that is, operate without corrupting, interfering with, or hindering the operation of the other entity.
- Interoperability: The ability of two or more devices, applications, networks, or systems to work together, and (more specifically) to reliably and securely exchange and readily use data with a common shared meaning.
- Interchangeability: The ability 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.

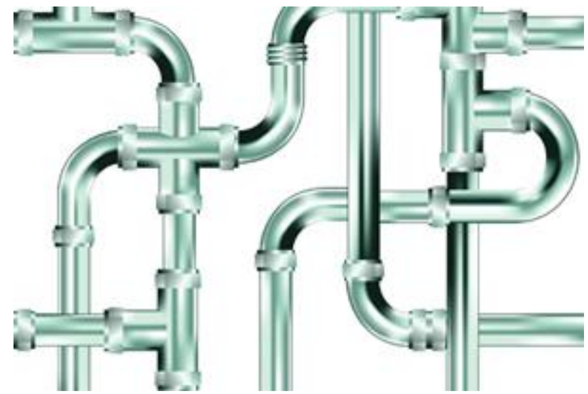
Interoperability: what?

OSI Model

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

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



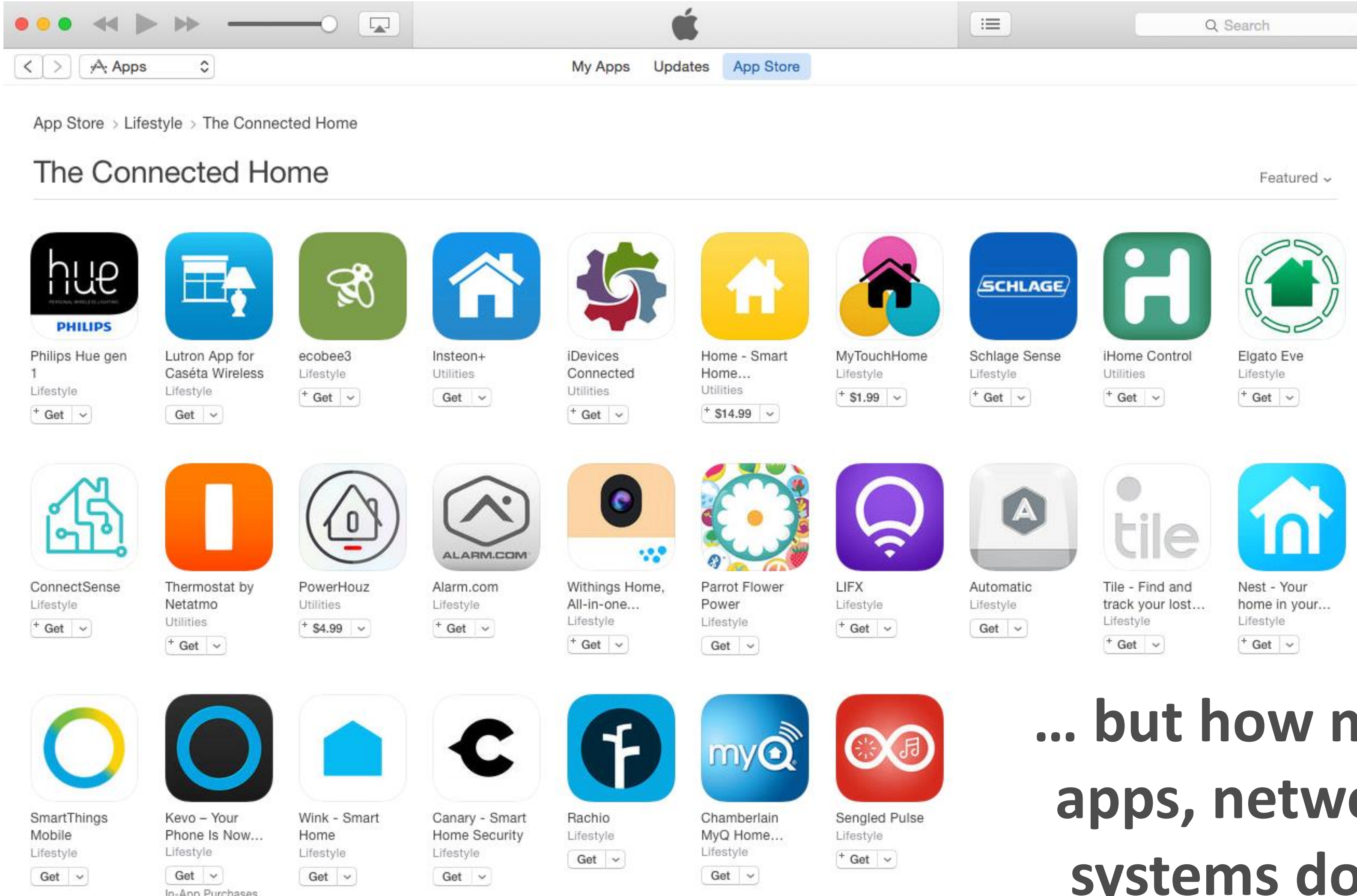


There are many possible levels of interoperability

Interoperability: why?

- Facilitates competition
- Facilitates collaboration
- Reduces risk
- Enables choice
- Enables integration
- Reduces cost
- Facilitates greater data exchange
- Facilitates more sophisticated automation, and thereby improved performance and user satisfaction

There is an app for that …



… but how many apps, networks, systems do you want to manage?

It’s déjà vu all over again?

Interoperability: why now?

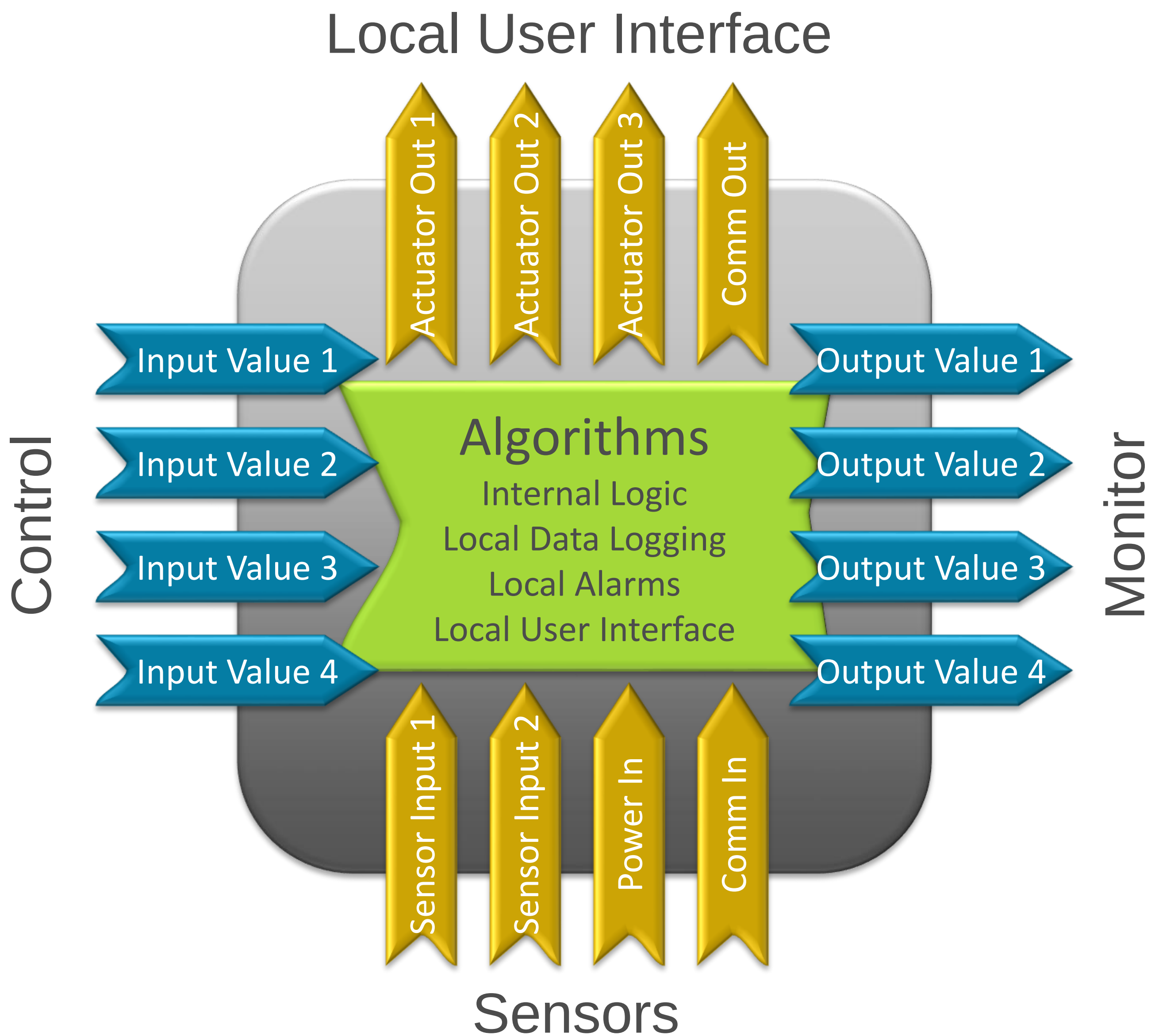
2010	2015	2020?
Compatibility	**Interoperability**	**Interchangeability**
1) Interference with broadcast or communication networks (e.g. FCC, CISPR) 2) Phase control and SSL source issues (e.g. NEMA SSL-7a)	1) 0-10V, DALI 2) ZigBee, EnOcean 3) Connected Lighting Alliance, TALQ, ANSI C137, AllJoyn, many others…	1) ANSI bases 2) Electrical, mechanical, thermal interfaces (e.g. Zhaga) 3) ANSI C137?

Interoperability: how?

- Leverage, lean on industry consortia and standard development organizations (SDO's)
- Let technology providers and the market pick winners
- Characterize and promote maturity (e.g. compliance testing programs, databases)
- Identify priorities

- Focus: Useable data
- Application layer i.e. information models
- Start with API's
- Power and energy data
- Key non-energy or non-lighting data opportunities?
  - Lighting quality
  - Human factors
  - Non-energy benefits
  - Non-lighting systems

A black box device model



Example: LonMark data model

NV # (M/O)*	Variable Name	SNVT Name	SNVT Index	Description
1 (M)	nviLampValue	SNVT_switch_2	189	Used for scheduled and Occupancy events.
2 (M)	nviStatReset	SNVT_stat_control	216	Sets/initializes energy, runtime, and error counts.
3 (M)	nvoLampFb	SNVT_switch_2	189	Feedback of current nviLampValue.
4(M)	nvoControlData	SNVT_control_data	218	A structured variable describing all current operating values and state of the SLC.
5(M)	nvoLcStatus	SNVT_faults	217	Latched alarm values are updated only when the condition is asserted active to limit alarm log size and minimize the data sent to the system management software.
6(M)	nvoVersion	SNVT_version	220	A structure with three fields `major.minor.build`.
7(O)	nviTimeNow	SNVT_time_stamp	84	For LCs supporting a HW real-time clock, updates to this variable set the clock time. The profile implementation should display the local time value by updating the value allowing a UI to poll the value to determine the local time base.

* M = mandatory, O = optional

Example: LonMark data model

Man. Opt. *	SCPT Name NV Name Type or SNVT	SCPT Index	Associated NVs **	Description
Man	SCPTcontrolCfg cpControlCfg SNVT_control_cfg	382	Entire Object	Defines many of the operating parameters for the SLC.
Man	SCPTlimits cpLimits SNVT_fault_limits	383	Entire Object	Used for alarm thresholds as defined in Alarming, below.
Man	SCPTsceneDef cpSceneTbl structure	384	Entire Object	Defines a table containing between 4 and 12 lighting scenes. Each scene is defined by a scene_number, a level, an unoccupied_scene_number which isused when the controller determines the luminaire light levels should be lowered due to lack of traffic
Opt	SCPTgeoLocatoin cpLocation SNVT_geo_loc	350	Entire Object	Provides tagging for GPS location, and physical asset tagging. Version 13.04 standard type.
Opt	SCPTlightingGroupMembership cpGroupMember structure	361	nviLampValue	Defines membership in one or more lighting groups
Opt	SCPTbkupSchedule cpBkUpSchedule enumeration structure	344	Entire Object	Defines a backup schedule to be used if the device determines the segment controller is not updating the one of the control inputs. Using this Cp requires the node to apply only if it has a valid local time value.
Opt	SCPTpowerProfile cpPowerProfile SNVT_power	381	Entire Object	Defines the nominal power measured at 5 commanded nviLampValues (.5% 25% 50% 75% 100%)

* Man = mandatory, Opt = optional

** List of NVs to which this configuration property applies.

Example: AllSeen Alliance data model

5 LampParameters Interface

This chapter defines the LampParameters interface used by the Lighting service framework.

5.1 Interface name

Interface name	Version	Secured	Object path
org.allseen.LSF.LampParameters	1	no	/org/allseen/LSF/Lamp

5.2 Properties

Property name	Signature	List of values	Writable	Description
Version	u	Positive integers	No	Interface version number
Energy_Usage_Milliwatts	u	Positive integers	No	Lamp current energy usage in milliwatts
Brightness_Lumens	u	Positive integers	No	Lamp current brightness in lumens

5.3 Methods

None.

6 LampDetails Interface

This chapter defines the LampDetails interface used by the Lighting service framework.

6.1 Interface name

Interface name	Version	Secured	Object path
org.allseen.LSF.LampDetails	1	no	/org/allseen/LSF/Lamp

6.2 Properties

Property name	Signature	List of values	Writable	Description
Version	u	Positive integers	No	Interface version number
Make	u	Positive integers	No	Lamp make
Model	u	Positive integers	No	Lamp model
Type	u	Positive integers	No	Type
LampType	u	Positive integers	No	Lamp type
LampBaseType	u	Positive integers	No	Lamp base type
LampBeamAngle	u	Positive integers	No	Lamp beam angle
Dimmable	b	▪ true ▪ false	No	Can lamp be dimmed
Color	b	▪ true ▪ false	No	Color
VariableColorTemp	b	▪ true ▪ false	No	Color temp
HasEffects	b	▪ true ▪ false	No	Has effects
MinVoltage	u	Positive integers	No	Minimum voltage
MaxVoltage	u	Positive integers	No	Maximum voltage
Wattage	u	Positive integers	No	Wattage
IncandescentEquivalent	u	Positive integers	No	Incandescent equivalent
MaxLumens	u	Positive integers	No	Maximum lumens
MinTemperature	u	Positive integers	No	Minimum temperature
MaxTermperature	u	Positive integers	No	Maximum temperature
ColorRenderingIndex	u	Positive integers	No	Color rendering index
LampID	s	String	No	Lamp ID

6.3 Methods

None.

https://wiki.allseenalliance.org/tsc/connected_lighting

Example: AllSeen Alliance data model

7 LampState Interface

7.1 Interface name

Interface name	Version	Secured	Object path
org.allseen.LSF.LampState	1	no	/org/allseen/LSF/Lamp

7.2 Properties

Property name	Signature	List of values	Writable	Description
Version	u	Positive integers	No	Interface version number
OnOff	b	True or False	Yes	On or off state of lamp
Hue	u	Positive integers	Yes	Hue of lamp
Saturation	u	Positive integers	Yes	Saturation of lamp
ColorTemp	u	Positive integers	Yes	Color temp of lamp
Brightness	u	Positive integers	Yes	Current brightness of lamp

7.3 Methods

The following methods are exposed by a BusObject that implements the org.allseen.LampState interface.

7.3.1 TransitionLampState

Inputs

Parameter name	Mandatory	Signature	List of values	Description
Timestamp	Yes	t	Positive integers	Timestamp (in ms) of when to start the transition
NewState	Yes	a{sv}	Array of variants	New state of the lamp to transition to
TransitionPeriod	Yes	u	Positive integers	Time period (in ms) to transition over to new state

Output

Return signature	Parameter name	Mandatory	Description
u	LampResponseCode	Yes	The result code of the operation.

Description

Change the state of the lamp to the specified OnOff, Brightness, Hue, Saturation, and ColorTemp at the specified time.

7.3.2 ApplyPulseEffect

Inputs

Parameter name	Mandatory	Signature	List of values	Description
FromState	Yes	a{sv}	Array of variants	Current state of the lamp to transition from
ToState	Yes	a{sv}	Array of variants	New state of the lamp to transition to
period	Yes	u	Positive integers	Time period (in ms) to transition over to new state
duration	Yes	u	Positive integers	Time period (in ms) to remain in new state
numPulses	Yes	u	Positive integers	Number of pulses
timestamp	Yes	t	Positive integers	Timestamp (in ms) of when to start the pulses

Output

Return signature	Parameter name	Mandatory	Description
u	LampResponseCode	Yes	The result code of the operation.

Description

Change the state of the lamp at the specified time, between the specified OnOff, Brightness, Hue, Saturation, and ColorTemp values. Pulse for the specified number of times, at the specified duration.

7.4 Signals

Signal name	Parameter name			Sessionless	Description
LampStateChanged	Name	Signature	Mandatory	Yes	A way to notify a listener (e.g. lamp controller) that the lamp state has changed.
	LampID	s	Yes		

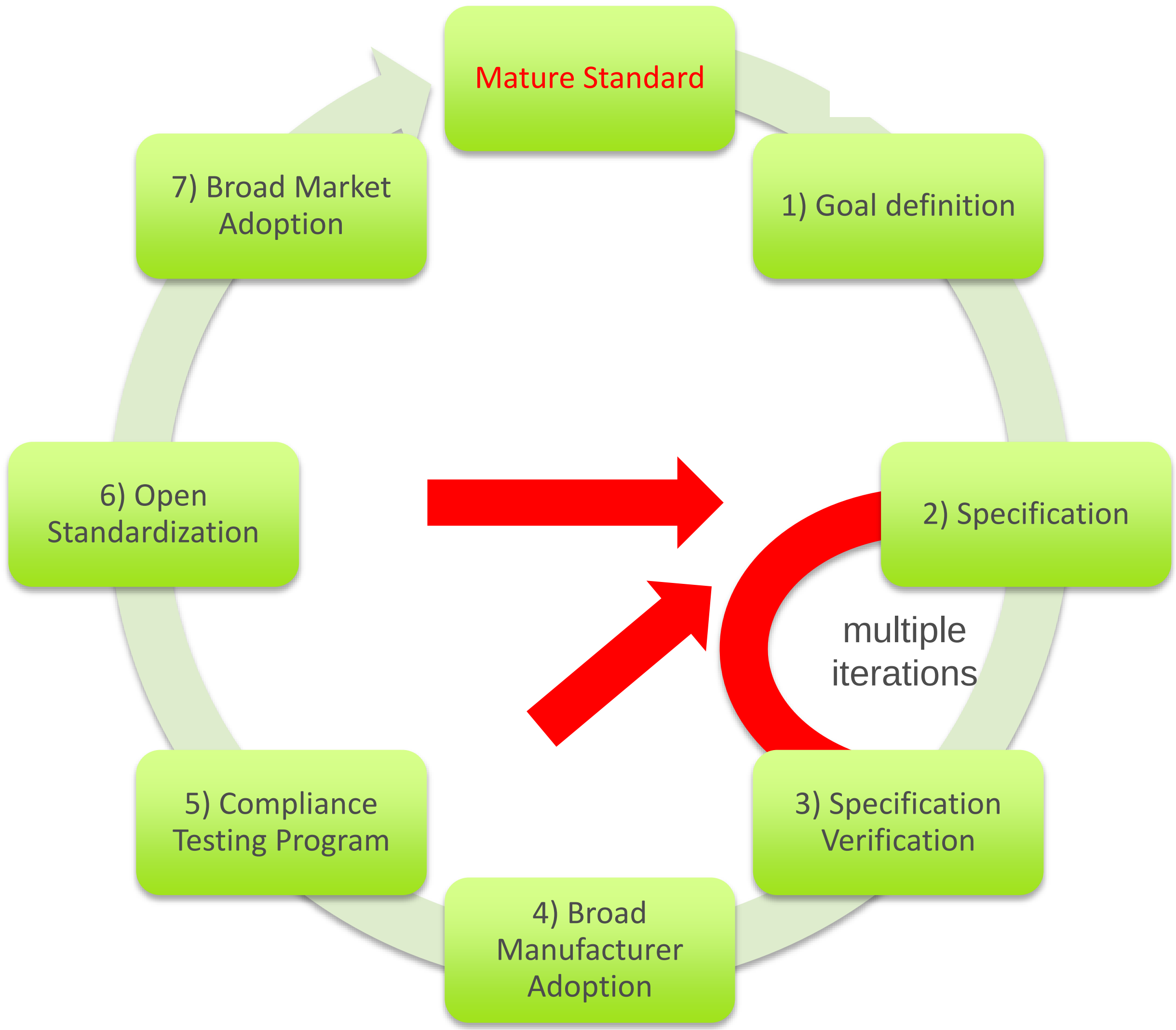
https://wiki.allseenalliance.org/tsc/connected_lighting

Example OCF/OIC data models:

```
#%RAML 0.8
title: OICIlluminanceSensor
version: v1.1.0-20160229
documentation:
 - title: © 2016 Open Interconnect Consortium, Inc. All rights reserved.
   content: |
     Redistribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:
     1.  Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.
     2.  Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.

     THIS SOFTWARE IS PROVIDED BY THE OPEN INTERCONNECT CONSORTIUM, INC. "AS IS" AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE OR WARRANTIES OF NON-INFRINGEMENT, ARE DISCLAIMED. IN NO EVENT SHALL THE OPEN INTERCONNECT CONSORTIUM, INC. OR CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.
schemas:
 - Illuminance: !include oic.r.sensor.illuminance.json
traits:
 - interface:
    queryParameters:
     if:
      enum: ["oic.if.s","oic.if.baseline"]

/IlluminanceSensorResURI:
 description: |
  This resource describes an illuminance sensor
  illuminance is a float and represents the sensed luminous flux per unit area in lux.

 displayName: Illuminance Sensor
 is: [ interface ] # valid for all methods

 get:
  responses:
   200:
    body:
     application/json:
      schema: Illuminance
      example: |
       {
        "rt":         "oic.r.sensor.illuminance",
        "id":         "unique_example_id",
        "illuminance":  450
       }
```

```
#%RAML 0.8
title: OICMotionSensor
version: v1.1.0-20160229
documentation:
 - title: © 2016 Open Interconnect Consortium, Inc. All rights reserved.
   content: |
     Redistribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:
     1.  Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.
     2.  Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.

     THIS SOFTWARE IS PROVIDED BY THE OPEN INTERCONNECT CONSORTIUM, INC. "AS IS" AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE OR WARRANTIES OF NON-INFRINGEMENT, ARE DISCLAIMED. IN NO EVENT SHALL THE OPEN INTERCONNECT CONSORTIUM, INC. OR CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.
schemas:
 - Motion: !include oic.r.sensor.motion.json
traits:
 - interface:
    queryParameters:
     if:
      enum: ["oic.if.s","oic.if.baseline"]

/MotionResURI:
 description: |
  This resource describes whether motion has been sensed or not.
  The value is a boolean.
  A value of True means that motion has been sensed.
  A value of False means that motion not been sensed.

 displayName: Motion Sensor
 is: [ interface ] # valid for all methods

 get:
  responses:
   200:
    body:
     application/json:
      schema: Motion
      example: |
       {
        "rt":   "oic.r.sensor.motion",
        "id":   "unique_example_id",
        "value": true
       }
```

The path to mature interoperability standards



ENERGY STAR Lamp V2.0 Specifications

11.4. Start Time: All Lamps

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
Non-Connected Lamps	Reported value of time for lamp to remain continuously illuminated shall be within 750 milliseconds of application of electrical power.	**Measurement:** ENERGY STAR Start Time Test **Measurement (fluorescent):** U.S. Department of Energy Conservation Test Procedures for Compact Fluorescent Lamps (once final)	**Sample Size**: 3 units per model. The reported value shall be the average of measured unit values tested, rounded to the nearest millisecond.
Connected Lamps	Reported value of time for lamp to remain continuously illuminated shall be within 1 second of application of electrical power.		

11.7. Standby Power Consumption: All Lamps

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
All Source Types	Lamps without integral controls shall not draw power in the off mode. Exception: Lamps with integral controls (e.g., motion sensors, photosensors, wireless control, standby mode, or connected functionality) shall consume no more than 0.5 watt in standby mode or network mode. Standby power (if applicable) shall be reported for equipment (outside of the lamp) required for connectivity (e.g., gateways, hubs, and network controllers, excluding equipment typically found in the home such as a Wi-Fi router).	IEC 62301 Edition 2.0 2011-01 Household electrical appliances - Measurement of standby power U.S. Department of Energy Conservation Test Procedures for Compact Fluorescent Lamps (once final) U.S. Department of Energy Conservation Test Procedure for Integrated Light-Emitting Diode Lamps (once final)	**Sample Size**: One unit per model. Laboratory test results shall detail off-state power consumption to the tenth of a watt. This applies to lamps that may have wireless controllability but may not meet all connected criteria as identified in the specification definition for connected lamp and Section 12.7 Connected Product Criteria. If required for connectivity, the lamp manufacturer shall specify one set of representative equipment (outside of the lamp) for which standby power shall be reported.

ENERGY STAR Lamp V2.0 Specifications

12.6. Products with Connected Functionality – Optional

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
All source types	Product must continue to comply with the applicable product safety standards – the addition of the functionality shall not override existing safety protections and functions. Product must comply with Section 11.7 Standby Power Consumption. Power consumption (if applicable) shall be reported for equipment (outside of the lamp) required for connectivity (e.g., gateways, hubs, and network controllers, excluding equipment typically found in the home such as a Wi-Fi router).	**Measurement:** None	Test Requirements: Connected products without color tuning capabilities shall be tested at full power for all applicable requirements. Connected products with color tuning capabilities shall be tested under the conditions specified under Section 5.1. Compliance with connected functionality requirements, in Sections 12.7-12.12, shall be demonstrated through examination of product and/or product documentation. If required for connectivity, the lamp manufacturer shall specify one set of representative equipment (outside of the lamp) for which power consumption shall be reported.

12.7. Connected Product Criteria:

To be recognized as connected, a “connected lamp” shall include elements (hardware and software or firmware) or instructions required to enable communication in response to consumer-authorized energy or performance related commands (e.g., instructions for downloading a mobile application, Bluetooth syncing guidance) and shall meet the requirements in Sections 12.8-12.12. These elements may reside inside or outside of the base lamp. For example, a “base lamp” may connect wirelessly via a home gateway or network controller to a cloud service that implements energy estimation functions.

The specific design and implementation of the connected lamp is at the manufacturer’s discretion provided it is interoperable with other devices via open communications protocol and enables economical, consumer-authorized third party access to the functionalities provided for in sections 12.9, 12.10 and 12.11. Capabilities of system controller and connected protocol shall be reported as applicable.

ENERGY STAR Lamp V2.0 Specifications

12.8. Open Access

The product shall enable connectivity by one of following means:

1. Open-standards communications from the lamp, or
2. Open-standards communications from an external controller, included with the product or available separately.
3. Where no suitable open standards communications method exists (e.g., an IP interface), an available and documented communication method must be used. In these cases, a manufacturer-specific method to implement the functions in sections 12.9, 12.10, and 12.11 shall be published for use with the product.

To enable interconnection with the product; an interface specification, Application Programming Interface (API) or similar documentation shall be made available to interested parties that enables sections 12.9, 12.10 and 12.11 connected functionality, and includes accuracy, units and measurement or estimation interval for Energy Consumption Reporting.

12.9. Energy Consumption Reporting

The lamp, or the gateway device or cloud service connected to it, shall be capable of interconnecting with consumer authorized entities to communicate data representative of its interval energy consumption. It is recommended that data be reported in watt-hours for intervals of 15 minutes; however, representative data may also be reported in alternate units and intervals as specified in the product manufacturer's interface specification or API. If the lamp does not provide power consumption directly in watts, the manufacturer shall make available a method for estimating power consumption, in watts, from the representative data that is provided by the lamp.

12.10. Operational Status Reporting

At a minimum, the lamp, or the gateway device or cloud service connected to it, shall be capable of providing the following information to energy management systems and other consumer authorized devices, services or applications via a communication link: operational status (e.g., on/off).

ENERGY STAR Lamp V2.0 Specifications

12.11. Remote Management

The product shall be capable of receiving and responding to energy management system or other consumer authorized remote requests, via devices, services or applications, similar to hard-wired consumer controllable functions.

12.12. Information to Consumers

If additional devices, services, and/or infrastructure are required to activate the product's connected capabilities, prominent labels, or other forms of consumer notifications shall be displayed at the point of purchase and in the product literature. (e.g., "This product has Z-wave control capability and requires interconnection with a Z-wave controller to enable local lighting control.")

Future Connected Lighting Specification Considerations

- Energy reporting accuracy determined according to industry standard (perhaps ANSI C137.XX)
- User interface requirements (e.g. industry standard white or color picker)
- Compliance with a qualified or industry standard Data/Information Model for energy data/information
- Reporting of other data/information (e.g. occupancy, ambient lighting, environmental conditions)
- Compliance with a qualified or industry standard Data/Information Model for other data/information
- Certified compliance with industry standard or industry consortia interoperability specification

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

Questions?

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ENERGY STAR Webinar

May 26, 2016

Michael Poplawski

Pacific Northwest National Laboratory

Connected Lighting Webinar

Amanda Parrilli

May 26, 2016

Introduction/Bio

Amanda Parrilli, The Home Depot

Strategic Business Development – Smart Home

- Responsible for leading Smart Home strategy and strategic partnerships at The Home Depot for the past two years
- Previous experience at The Home Depot and in the Payments industry, specifically on Issuing and Mobile Payments
- What Smart Products do I have in my home?
  - Thermostat
  - Irrigation Controller
  - Wi-Fi Camera
  - Voice Control (Amazon Echo)
  - Lighting (multiple): switches/dimmers for outdoor lights, bulbs indoor

THE PROMISE

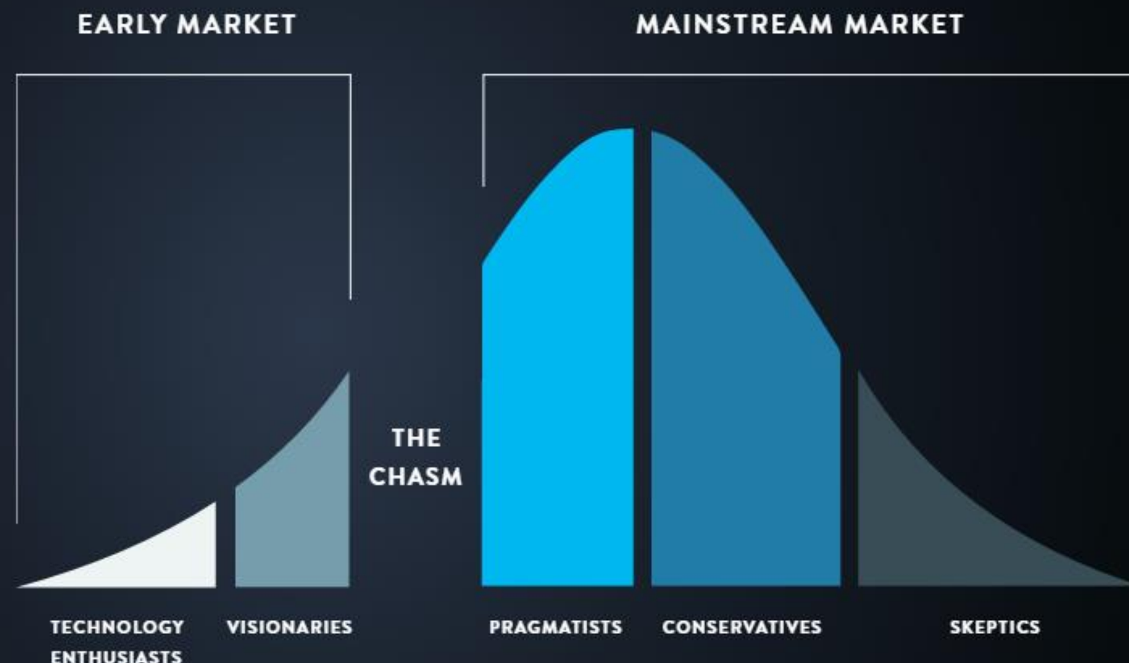
By 2020, Gartner expects there will be more than 25 billion IoT endpoints driving more than $263 billion on services spending

Nearly 7 in 10 Americans are confident smart homes will be as commonplace as smartphones within 10 years." - Intel

wink

THE REALITY

- There are many smart products, but few smart homes
- Technology and user experience lagging behind hype
- Home automation enthusiast make up the majority of users

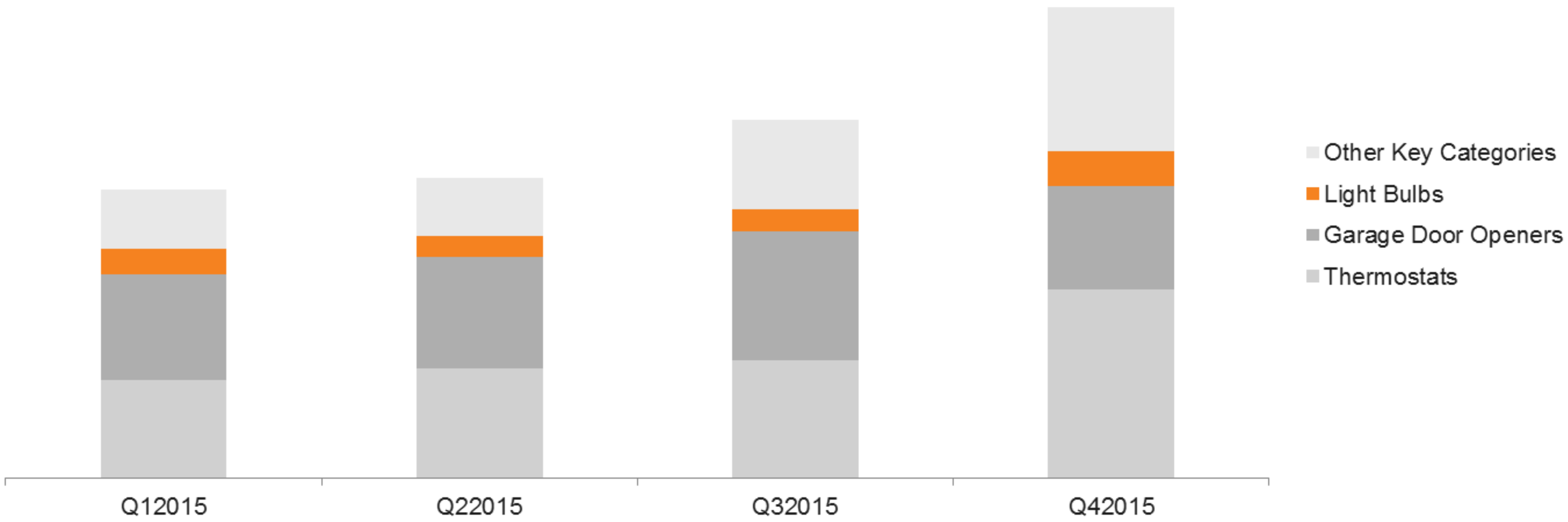


THD Key Brands with Connected Products

ecobee
rachio
CREE
PHILIPS
nest
amazon echo
Rheem
ring
iHome
Honeywell
canary
Bali your home, your style
GE
LEVITON
SCHLAGE
OSRAM SYLVANIA
Kwikset
Kidde
LUTRON
wink
Commercial Electric
sen|si
CHAMBERLAIN

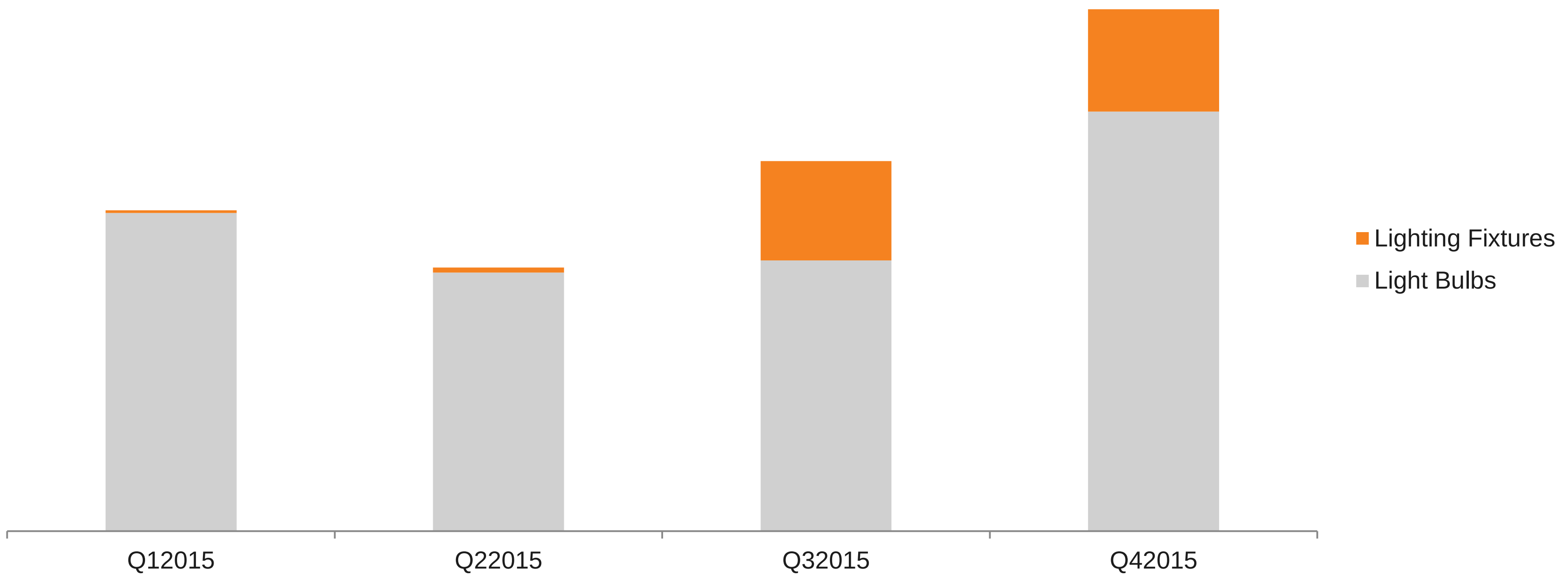
THE HOME DEPOT

Smart Home Customer Adoption at THD



Key categories demonstrated in THD customers' purchase behavior are Thermostats and Garage Door Openers.

Connected Lighting Bulbs vs. Fixtures



Connected Fixtures beginning to enter market and make traction with The Home Depot customer.

Connected Lighting is often a customer entry point

1. Costs are lower

2. Installation barrier is low

3. Applicable for many areas in the home

4. Fits multiple use cases

Multiple Use Cases for Lighting

1. **Energy Management:** LED connected lights
2. **Security/Timers:** "Never come home to a dark house"
3. **On/Off/Dim:** "Control your lights from your phone"
4. **Voice Control:** "Alexa, turn on my lights"
5. **Colored lights:** "Change my lights to red when my team scores"
6. **Circadian Rhythm:** "Adjust the white color during the day to promote health and sleep cycle"

New Products/New Trends In Lighting

1. **Incorporation of different technologies and sensors:**
   - Security and motion sensors
   - Occupancy sensors
   - Speakers

2. **Energy Star Certification**

3. **Smart without the Smartphone:**
   - Gesture Control
   - Voice Control
   - No need to use a phone or App

CONNECTED LIGHTING

EPA Energy Star Webinar

May 26, 2016

- Connected lighting is:
  - Personalized
  - Dynamic
  - Optimized for application and time
- The lighting industry is undergoing a value transformation driven by LED adoption
- Looking at other industries provides framework

Transformation of Value in Computing

Hardware → Software → Network → New Value

KETRA

New Ways of Consuming Media

comcast

NETFLIX

Hardware → Software → Network → New Value

There's an App for That

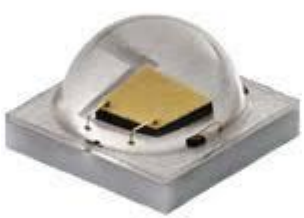
iOS

at&t

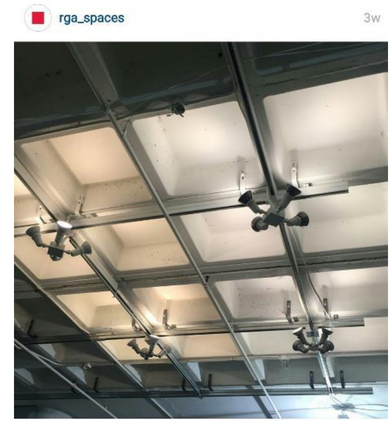
Hardware → Software → Network → New Value

KETRA

Connected Lighting



ZigBee®



Hardware → Software → Network → New Value

KETRA

Content is King

- We used to go to light, now light goes to us
- Value evolves to new functions and experiences

KETRA

Circadian Lighting in Offices

Drama in Hospitality

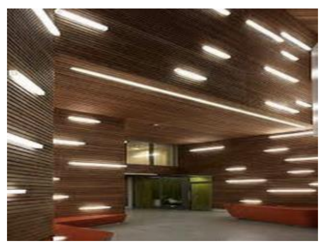
Tuning White in Retail

Connected lighting is dynamic lighting:

- Changing color and intensity with time and events

Mostly Static ⟷ Completely Dynamic

General Illumination › Architectural Accent › Architainment › Entertainment



Light for Sight ⟷ Light for Effect

Where does connected lighting fit?

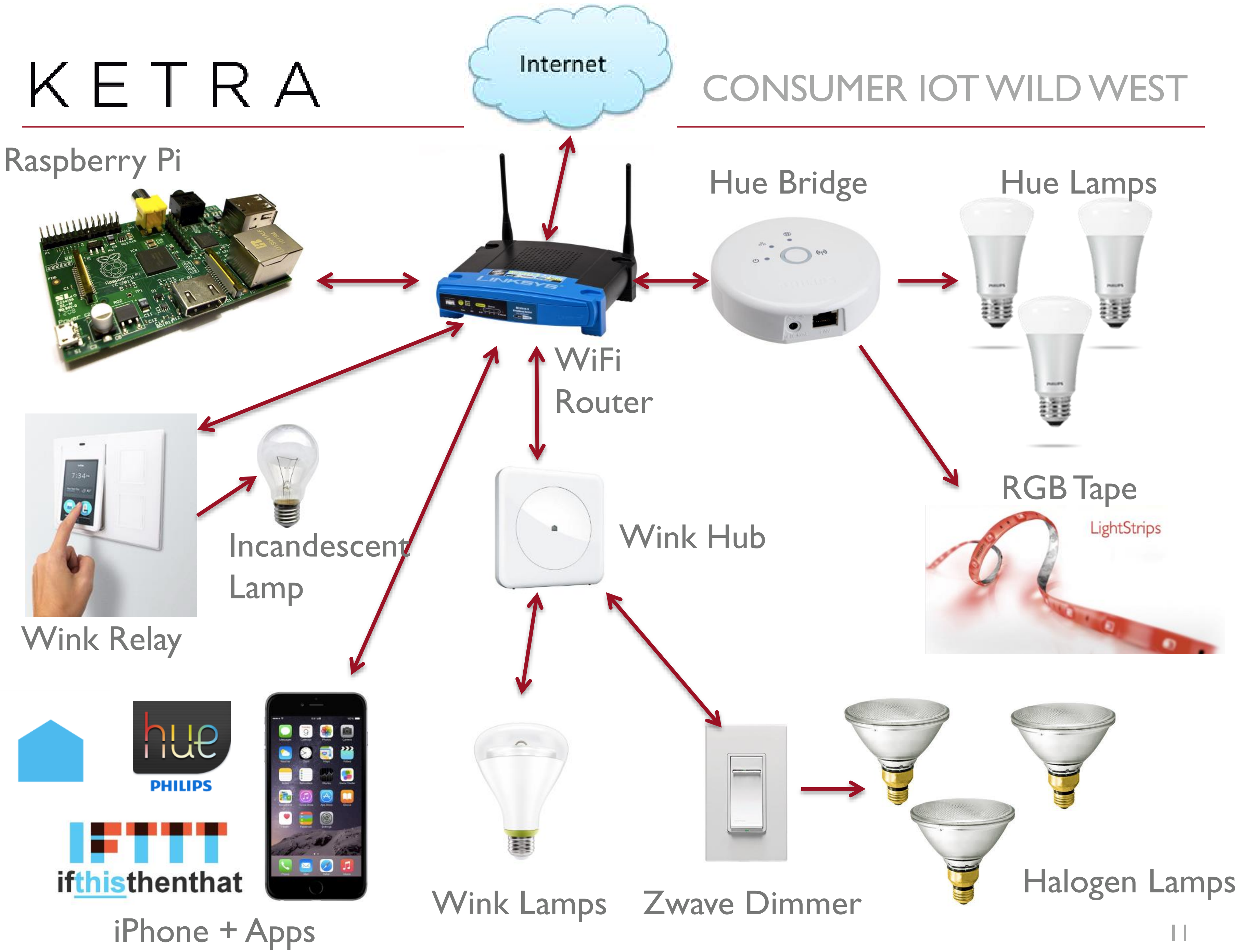
KETRA

Consumer Lighting: Information overload!

Most consumers are overwhelmed by choosing lighting for their home
Wattage isn’t relevant, now they need to think about CCT, CRI, dimmers…
Connected lighting adds network protocols, tunable color, user accounts…

KETRA

CONSUMER IOT WILD WEST



Rise of Platforms

Mac: tight integration

PC: high modularity

Are you a Mac or a PC?

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Commercial Lighting: What's Missing?

- Clear communication of design intent and controls narrative
- Controls & Systems thinking, understanding of interfaces
- Specifier-friendly programming
- Communication among trades and specifiers
- Clear project documentation

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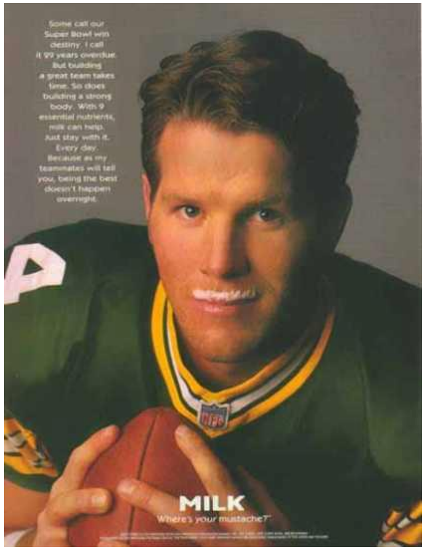
Lighting Has a PR Problem

- When we're unable to communicate value we can only lower price
- Lighting becomes commoditized
- "We spend too much time talking to ourselves…" - Zia Eftekhar
- What's our version of the "Got Milk" campaign?



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THANK YOU

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