The Future of Lighting Is Smart

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The Future of Lighting Is Smart

• What is Smart Lighting and how do we get there?
• Communication methods
  – DALI
  – BLE
• Communication: lighting services
• Communication: new services
• Wrap-up
What Is Smart Lighting and How Do We Get There?
Quality of Light

Red line: Xicato source
Black line: reference illuminant

Color Vector Graphic

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What Is a Smart Light and Smart Lighting?

Smart Lights:
• Monitors internal operating conditions and responds autonomously to fault conditions
• Two way communications capability to receive commands and sensor inputs, responding autonomously, and transmit status and event information
• Able to be programmed to modify response to sensor inputs
• Tracking, storing and reporting operating history

Smart Lighting:
• A combination of smart lights and the software program(s) used to set-up and configuring an installation to behave as we want when an event happens
Smart Lighting - How Do We Get There?

- Peer-to-peer two way communications
- Autonomous response
- A clear user interface for set-up, control and monitoring

Size, price and capability of localized “intelligence” (microcontroller) and support for communication protocols.

Ease of use and apps
Monitors Internal Conditions and Responds Autonomously to Faults
Thermal Foldback Example

Thermal Overload

- Commanded Intensity
- Temperature
- LED Intensity

TC > 93°C: reduce light to 85% of commanded
TC < 80°C: increase light to 100% of commanded

98°C
93°C
85°C

85% + x

60s

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Review and Comparison
DALI & BLE
What is DALI?

DALI is a digital control interface

- Control Device (DALI master)
- Control Gear
- DALI Bus Power Supply
- Switch Gear
- Interface Cable

A DALI interface can control up to 64 individually devices
DALI masters that support more than 64 devices have multiple DALI interfaces.
What is DALI?

- System is digital, providing precise control of lights
- Codes state ‘where to’:
  - Broadcast
  - Group (1-16)
  - Address (1-64)
- And ‘information’ for:
  - Configuration: fade rates, intensity, scenes and groups
  - Commands: to recall scenes or set levels
- Additional status information can be provided through device (control gear) memory bank accesses like
  - Real time operating temperature
  - Input operating voltage and voltage ripple
  - Operating hours
  - Historical data for temperature, intensity, etc.

<table>
<thead>
<tr>
<th>Bank</th>
<th>Description</th>
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<tbody>
<tr>
<td>0</td>
<td>Gear Information</td>
</tr>
<tr>
<td>1</td>
<td>OEM Information</td>
</tr>
<tr>
<td>3</td>
<td>LED Temperature History</td>
</tr>
<tr>
<td>4</td>
<td>LED Intensity History</td>
</tr>
<tr>
<td>5</td>
<td>LED Vf History</td>
</tr>
<tr>
<td>6</td>
<td>DALI Operation Type History</td>
</tr>
<tr>
<td>7</td>
<td>Operational History</td>
</tr>
<tr>
<td>8</td>
<td>Real-Time Data</td>
</tr>
</tbody>
</table>
 DALI – Is It Smart?

• YES, in that 2 way communication is possible

• But limited:
  – No autonomous responses to external events or peer to peer communication. Everything via Master.
  – Latency issue - can be unacceptably slow
  – Difficult to build multi-layered causal relationships between light points
  – No reporting of fault conditions to peers
  – Programming and data collection possibilities limited to DALI standards and what the DALI Master supports

• Provisioning / commissioning far large installations is complex:
  – All processing for every sensor response takes place in a central place
  – Expansion beyond 64 services requires bridging between DALI bus Masters
Comparing DALI and BLE

• BLE solves these issues, and:
  – Allows for possibility for indoor positioning services
  – Allows for web or app based developments
  – Advantages of wireless systems into no ‘above the ceiling’ expense
  – No 64 device limit on a single interface

• BUT:
  – Requires additional security layers
  – Suitable for local networks: for wider systems gateways needed.
Bluetooth Low Energy – a Brief Introduction

BLE is completely different from traditional Bluetooth

• Traditional Bluetooth
  – Dedicated pairings. Point to point connections.
  – Designed to support data streaming (e.g., voice/audio)

• Bluetooth Low Energy
  – No dedicated pairing – peripherals advertise presence and availability to support connections
  – Star connection topology
  – Small data transfers
    • Device state information (temperature, device ID, light level, turn on, turn off, etc.)
    • Not for large data transactions – e.g., file transfers, streaming, etc.
Why Bluetooth LE?

- Ubiquitous support on Smartphones/Tablets
  - Natively supported by iOS, Android, Windows 8, OSX, Linux and Blackberry
- Technology underlying iBeacon, Physical Web, Eddystone
- Strong momentum driven by IoT
- Easy to integrate into embedded devices
- Open Standard
  - Free to join SIG
  - Standards available for no charge
  - No licenses, etc.
BLE – Radio Overview

- Operates in 2.4GHz ISM band (same as WiFi, traditional Bluetooth and ZigBee)
- 40 Channels on 2MHz spacing
  - 3 dedicated Advertising Channels (37, 38 and 39)
    - Frequencies chosen to have minimum interference from primarily used WiFi channels
    - Used for broadcast advertising and scan request/response
  - 37 Data Channels
    - Used for 1:1 connections between devices
BLE Operating Principle

Advertising Interval

Advertising Event

Preamble (1 byte)

Access Address (4 bytes)

Protocol Data Unit (PDU)

4.1: (2-39 bytes)

4.2: (2-257 bytes)

CRC (3 bytes)

ADV

ADV

SCAN REQ

SCAN RESP

ADV

ADV

Channel 37

Channel 38

Channel 39

0

AD Flags

1

Field Length <0x1B>

2

Field Header <0xFF>

3

Xicato Company ID

4

0x0253

5

Device/Packet Type

6

Device ID

7

Sequence ID

8

RFU

9

Module Intensity

10

Module Status

11

Module Power

12

Status/Power Extension

13

LED Temperature

14

PCB Temperature

15

Input Voltage

16

Input Voltage Ripple

17

Voltage Extension

18

RFU

19

Data Protection
BLE – Is It Smart?

• Data collection can be done by devices distributed throughout the space
  – No central device
  – Data collection directly from the lights

• Sensors can be easily mapped directly to lights in the space.
  – Sensor events can be handled directly by the light autonomously.
  – The “control system” becomes a light configuration tool that is used to establish rules for the lights to follow based on bonded sensors
  – The system can be web or app based

• Lights can directly communicate with each other as well as sensors

• Programming / Data collection and monitoring are not limited to DALI command response – more feature support options
Communication: Lighting Services
Applications: OEM Configuration

**Context:** For OEMs to deal with the huge variation of lamps has always been an ordeal.

Configurable smart modules?
- **Max flux, min flux**
- **Fade-rate**
- **Dimming curve**
- **End of life behavior** (when, how manifested)
- **OEM / fixture information**
- Security in operation (e.g., thermal capability of luminaire cannot be exceeded)
Applications: Commissioning and Usage

**Context:** low adoption of lighting controls to date but at the same time as tighter energy conservation requirements

- Detect or set **location** address
- Define **groups** and scenes
- **Binding** to switches and sensors
- **Localisation** programming (e.g. avoiding cocoons)
- Set **security access** levels
- **Configure network** connection (DALI, Wi-Fi, Zigbee etc.)
Applications: Maintenance and Diagnostics

**Context:** maintenance is expensive, especially where image is concerned, eg retail. Constant surveillance, stock keeping of spares, keeping track on warranties ….

With smart diagnostics:
- Instantaneous information on running status
- Historical data
- Warranty options
- BIM
Overlaying Systems

- Provide individual light control to occupants
- Individual override can work seamlessly with a centralized lighting control system such as DALI or a centralized BLE based control system
Applications: Overlaying Systems

- Localised control
- Real time data
- Historical data
- Beacon technology
- Push firmware updates

BMS / control system
- Real time data
- Historical data

DALI Master control

BLE GUI
Applications: Overlying Systems

- Real time data
- Historical data
- Control

WiFi router

BMS / control system

DALI Master control

Gateway Smart Light

BLE GUI
Applications: Cloud Based System

- Real time data
- Historical data
- Control
- Beacon setup

WiFi router

Gateway
Smart Light

BLE GUI

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Communication: New Services
Indoor Location / Proximity Detection
Lighting allows for **greater coverage** of the space c/w separate boxes. Less cluttered ceilings, less hardware to install and maintain. Location becomes **more precise** as multiple beacons can be seen by a device.
Beacon Types

- There are many ways to configure beacons within the SIG guidelines.
- Two companies have layered some conventions over BLE:
  - Apple with the iBeacon
  - Google with the Eddystone or Uri beacon

**iBeacon**

- Key inclusions:
  - A proximity universally unique identifier (UUID) (16 Bytes)
  - A major and minor code (each 2 Bytes)
- iBeacons do the following:
  - Alerts
  - Ranging
- Apps can now be made “iBeacon aware” If the user is *this* close to *this* Beacon, then do *this*. 
Beacon Types

URI or Eddystone Beacon

• The Physical Web is positioned as “interaction on demand”. It uses BLE to advertise from physical things URLs to “whomever is interested” nearby.
• The URL may lead to a simple Web page, an interactive website or a deep link in to a mobile application.
• C/w iBeacon:
  – Its open
  – Its not being “interrupt” driven
  – Ultimately no app needed.
Indoor Location Services and Analytics
If the user is this close to this Beacon, then do this

- **Analytics**: tracking people’s movements, how long they stay, where they linger. Space management
- **Interaction**: information on merchandise, works of art etc
- **Way finding** – especially airports
- **Emergency** phone services
- **Asset tracking**
Arup ‘24:0:0’ Exhibition
December 2014 to March 2015
Wrap-Up
State of Connected Lighting

- Connected Modules
- Connected Sensors
- Cloud Storage and Computing
- Connected Switches
- Multiplatform Apps
- Beacon Management
- BMS Systems
The Big Picture - **Interoperability**