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The Presidents Get Connected

A Smithsonian Case Study in Connected Lighting

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Learning Objectives

At the end of the this course, participants will be able to:

1. Learn how connected Lighting technologies are integrated into a gallery setting
2. Application Program Interfaces (API's) will be described and examples will be provided on how they are used
3. A breakdown of the exact hardware and the hardware modifications required to make a wireless lighting system work will be described in detail to provide a sample specification
4. The audience will gain insight on how a BLE and Zigbee system can be brought together in a single building wide package

Intro to National Portrait Gallery

- The National Portrait Gallery was authorized and founded by Congress in 1962 with the mission to acquire and display portraits of "men and women who have made significant contributions to the history, development, and culture of the people of the United States."

- The mission of the National Portrait Gallery is to tell the story of America by portraying the people who shape the nation's history, development and culture.

- The Vision is that by 2018 the National Portrait Gallery will be recognized and celebrated across the United States and abroad as the place to meet the people who make America.

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Intro to National Portrait Gallery

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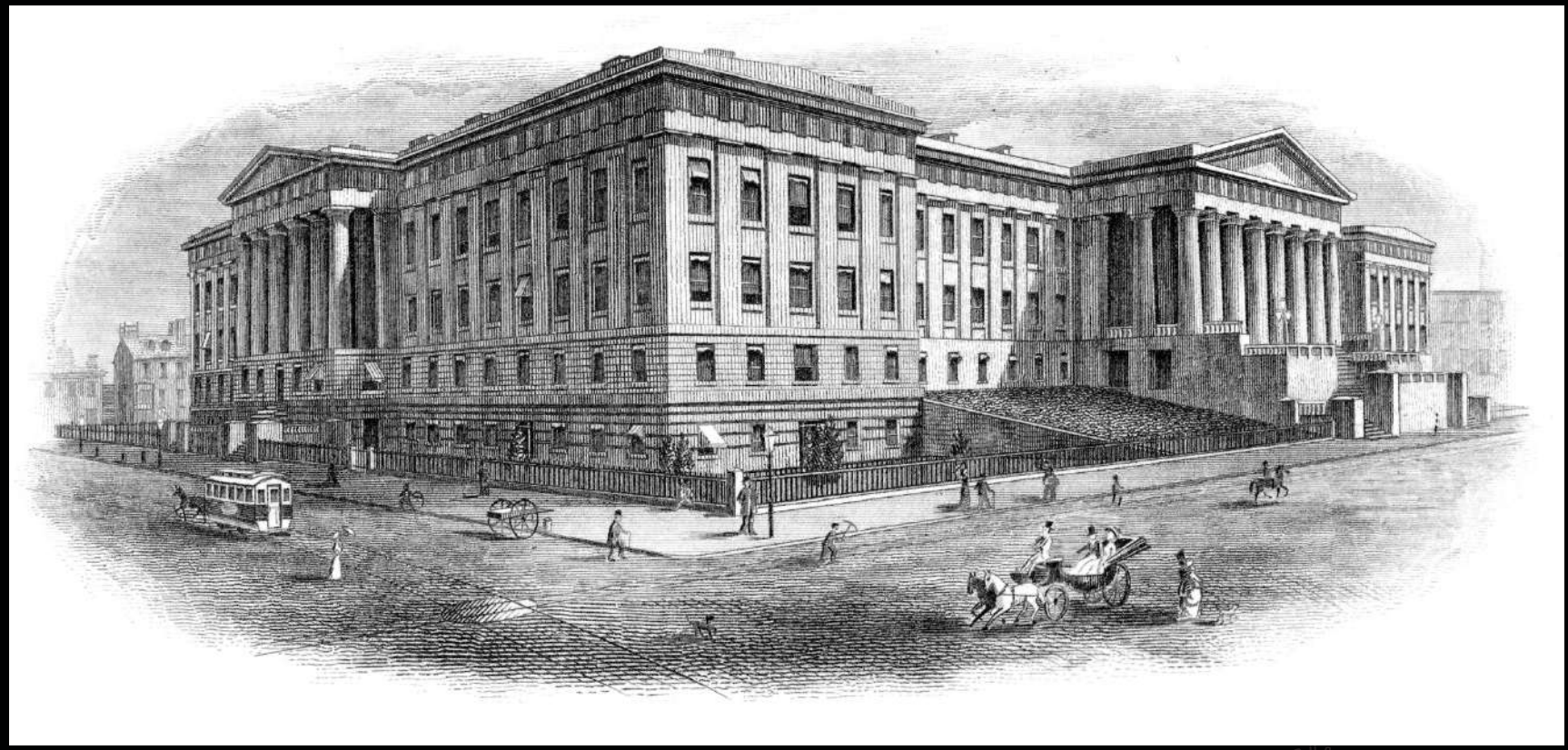
Intro to Presidents Gallery

- “America’s Presidents” lies at the very heart of the museum’s mission to tell the American story through individuals who have shaped the country.
- It showcases multiple images of the past 44 U.S. presidents, starting with Washington and continuing to Barack Obama.
- In 2017 the visitor experience was “re-Imagined” through new labels, wall texts, interior design, lighting systems, and the addition of interactive touch screens that will allow people to explore the context of each presidency and access other visual material.

Intro to Presidents Gallery

- NPG video – Deleted video to reduce size for Presentation review.
- Will bring presentation on laptop

The Donald W. Reynolds Center



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The Donald W. Reynolds Center

The Donald W. Reynolds Center

- The site was considered by City Planner Peirre L'Enfant's plan for a Capitol City to be a "Pantheon devoted to great Americans".
- Designed in the “Greek Revival” style by Architect Robert Mills in 1836, It took 36 years to complete.
- Over its 182 year life it has served as an office of patent law, a civil war barracks, and the professional home to Clara Barton, Walt Whitman, site of Abraham Lincoln's, second Inaugural Ball, and later home to the civil ServiceCommission. In 1965 it was designated a National Landmark.
- In 1968 Congress
- Was closed from 2000-2006 for a $180 million renovation.

Design Requirements - Artistic

- Color Rendering : High CRI/R9/R13

- Distribution :
  - A range of from the 4 degree (object light) to 40 degree (Architectural).
  - Wide range of beam shaping options.
  - Framing Projector Option

Design Requirements - Artistic

- Wall washing/Object lighting

- Reliability :
  - TM-21/LM-80 suggest Lumen Output, chromaticity will remain acceptable for 20 (good) to 15 (excellent) years.
  - And/Or a “Competitive” warranty.

Design Requirements - Artistic

- Form Factor :
  - Minimalist "Musuem Canister" look
  - Both PAR30 and MR16 scaled options.

Design Requirements - Control

- Purpose
  - Building Services
  - Public viewing / Museums
  - Private Tours
  - Corporate Events
- Conservation
- Life Safety
- Reliability through Technology
- Staffing/operation
- Granularity

History of Control in Museum and Gallery Space

- All manual – scrims and screens - ladders
  - Effect + Conservation
  - This is still done today!
- Phase Cut dimming
  - Ability to set control to track
  - Need for scrims, screens and ladders to individual control
- 2 Circuit Track as next step
  - 0-10 and potentiometers – still ladders involved

History of Control 1997 - 2007

- Use of DMX and gear required.
- Digital Architectural Control Systems.
- Computer-based dimming and control.

The present – current state of the art

- What “New” technologies are currently available
  - PoE
  - Wireless – BLE, ZigBee, Wi-Fi, etc.
  - Fixed White / Variable Chromaticity

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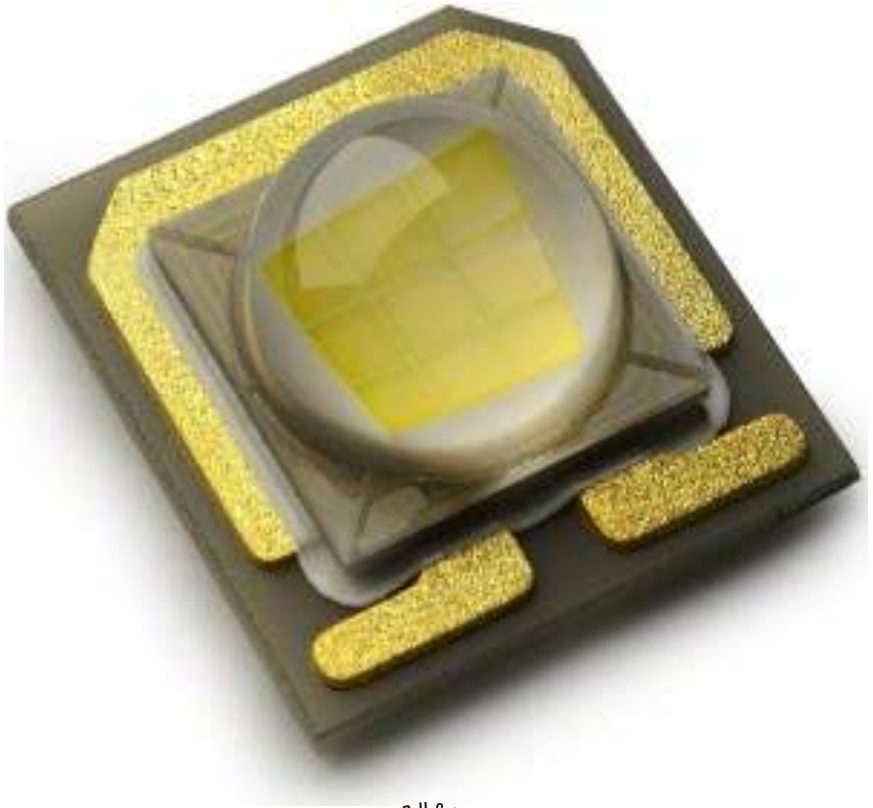
Control Requirements for the Presidents Gallery

- Fixture-Level Granular Control
- Extensibility
  - Future proof the installation
  - Create an open ecosystem of devices, including sensors
- Bi Directional Communication.
  - Status monitoring
  - Environmental Data Collection
- An Open A.P.I.
  - Integration of 3rd party controls is possible

Fixture Development

- Color Quality



Fixture Development

- Beam Control


Washington to J.Q. Adams
Building the Presidency
Forjando la presidencia
Made possible through the generous support of
Philip and Elizabeth Ryan

Fixture Development

- Level Set Control;
  - Aesthetic
  - Conservation

Fixture Development

- “Family of Fixtures

Fixture Development

- Fine tuning from a proper sight line

Fixture Development

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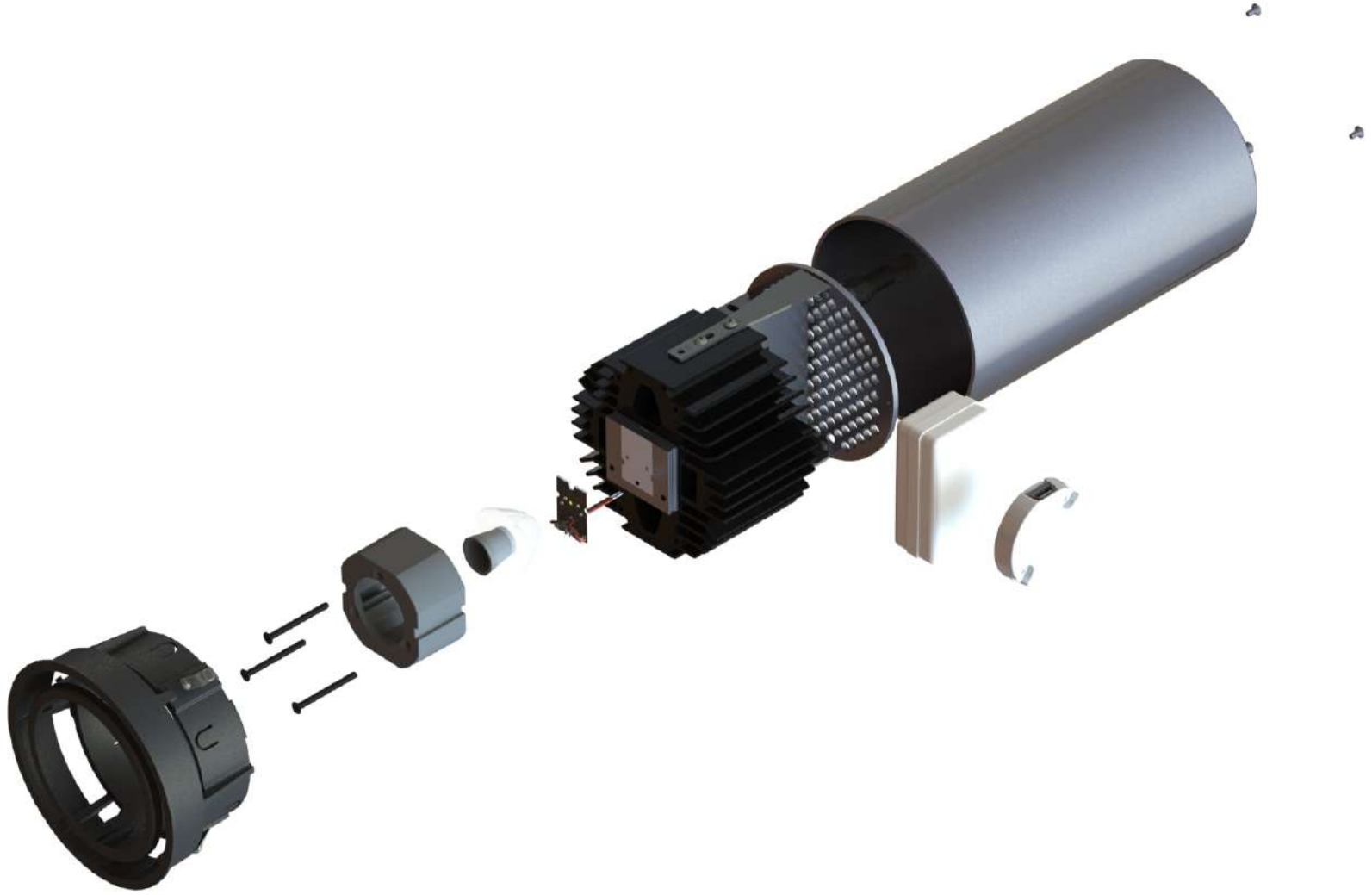
Anatomy of a Smart Fixture

Anatomy of a Smart Fixture



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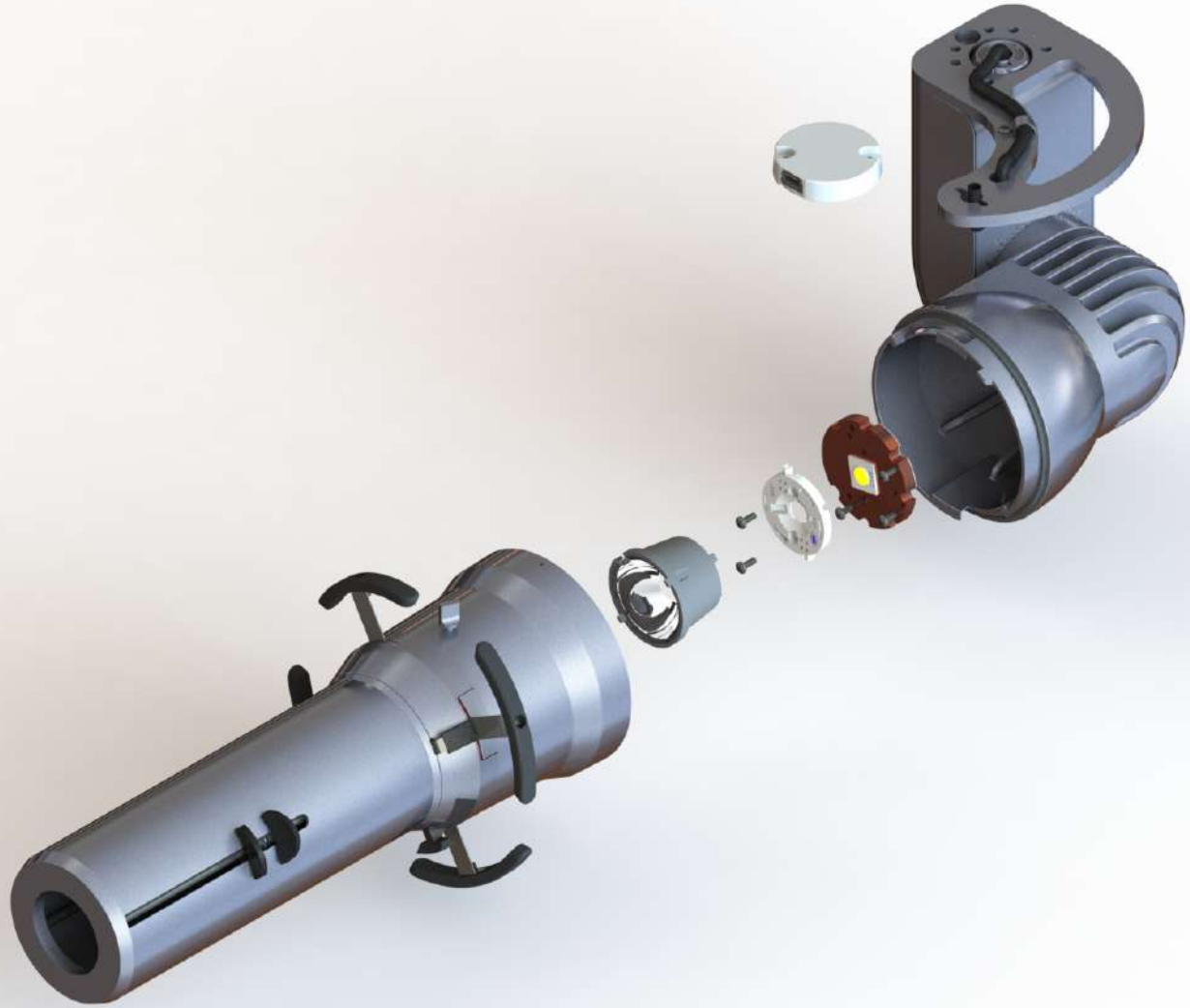
Anatomy of a Smart Fixture



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Anatomy of a Smart Fixture

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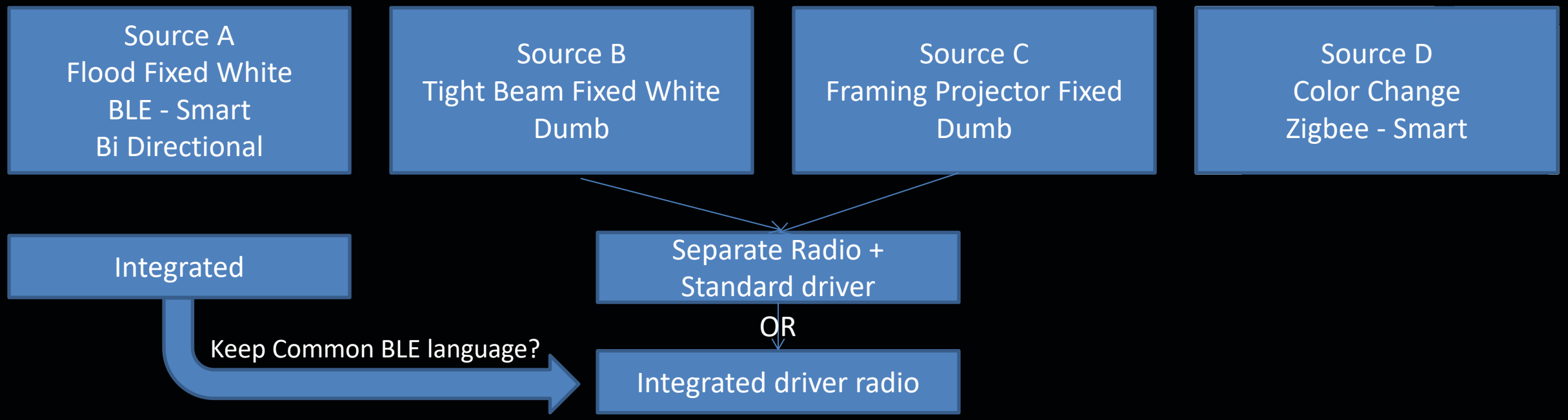
Integration Diagram



3 different communication systems or 2

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Anatomy of a Smart System

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Lighting Demo

(4) Different Sources Used
(4) Different Applications
(1)Backbone for the System
(1)Control Protocol Grouped Together

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Bits and Pieces of a Connected Lighting System

PSU/Driver

Radio (or POE port),
Memory, Processing

Commissioning Tool

Switch/UI?

Gateway
Internet portal

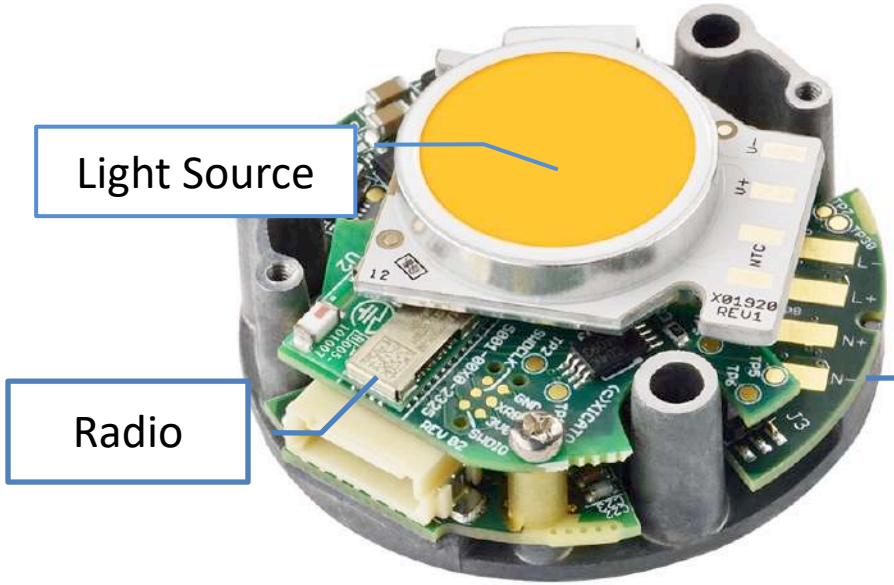
Light Source

Sensor ?

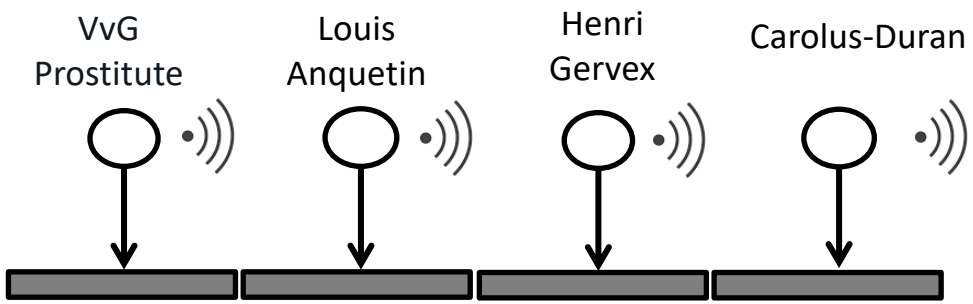
Methods of Integration

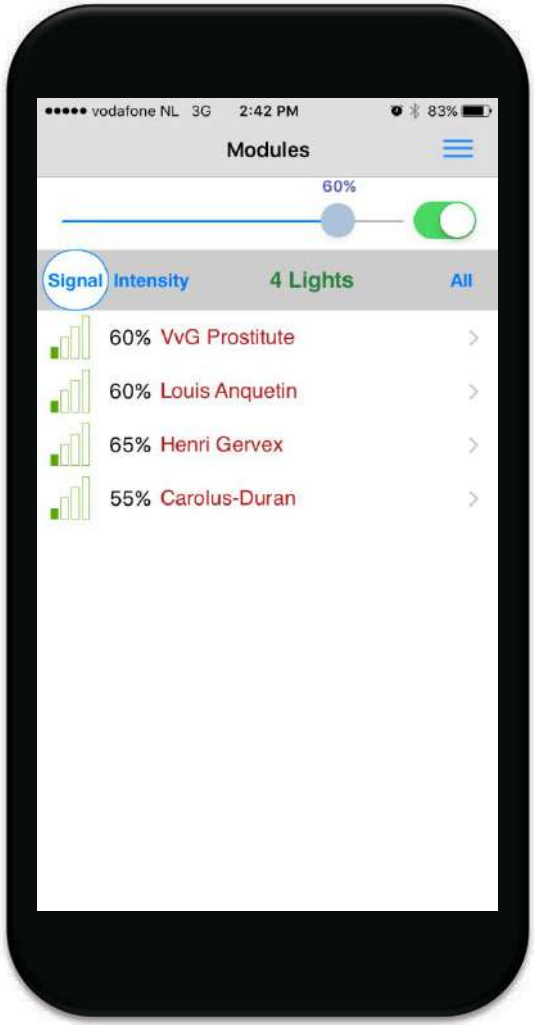
Radio Incorporated in Driver

Radio Incorporated in module



Bi Directional Information – Talk & Listen





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Comparing Wireless Standards

	Wifi	BLE	Zigbee	Thread	Sub-GHz 1
On mobile devices?			×	×	×
Bandwidth			×	×	×
Power Draw	×				
Practical Range					
Scalability					×
Secure					?
Standard					×

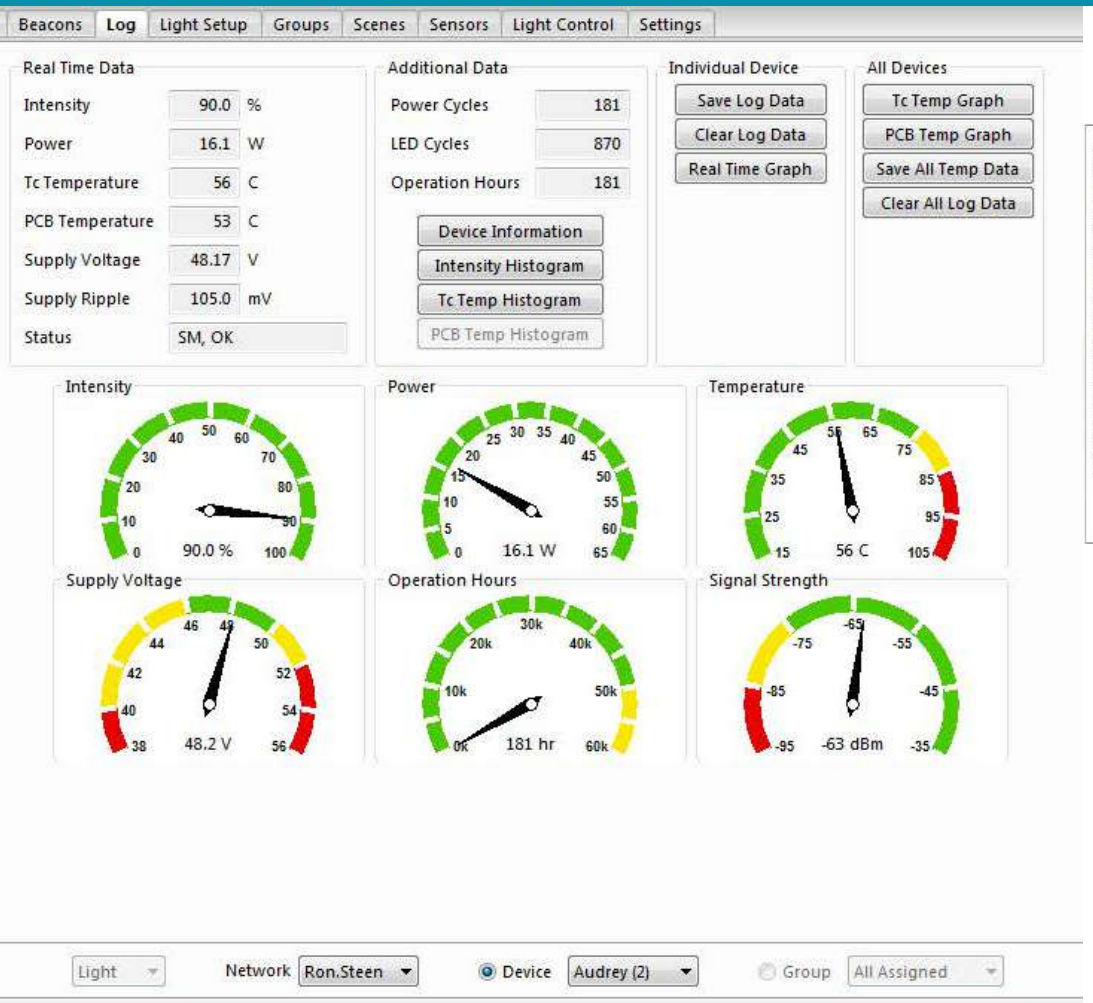


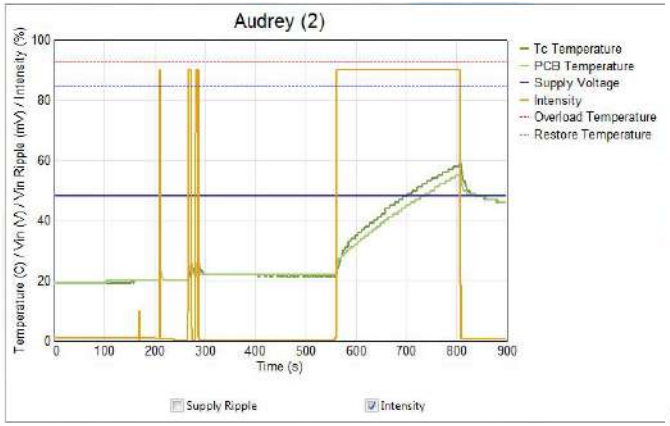
How Standard is the Standard?

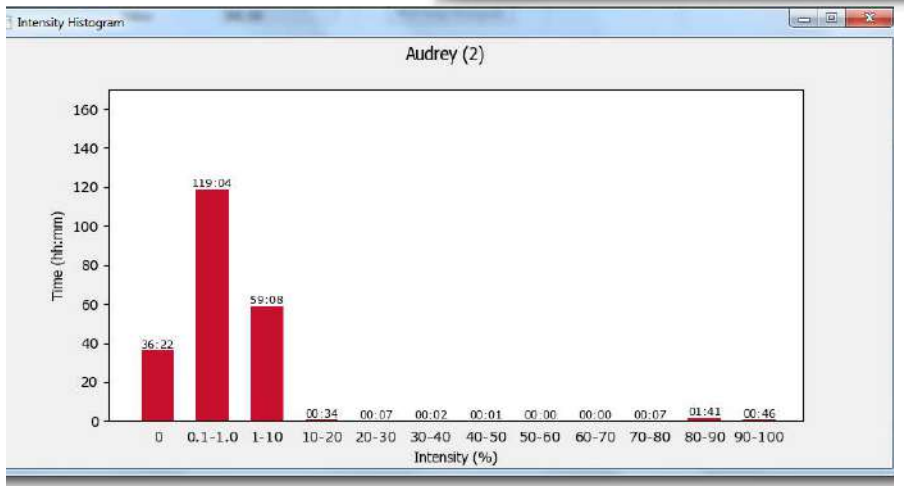
Layer	WIFI	Bluetooth	Zigbee	Thread	Sub-GHz
Physical	2.4 GHz & 5 GHz	2.4 GHz	2.4 GHz or 900 MHz	2.4 GHz	200, 400, 866 or 900 MHz
MAC	802.11	Bluetooth	802.15.4	802.15.4	?
Transport/ Network	✘	Bluetooth → Mesh	Zigbee	6LoWPAN	?
Application	✘	Bluetooth Mesh	Zigbee	Zigbee models?	✘ Proprietary

Excellent whitepaper by Silvair: Https://silvair.com/A_tale_of_five_protocols_by_Silvair_2.0.pdf

Data Publication

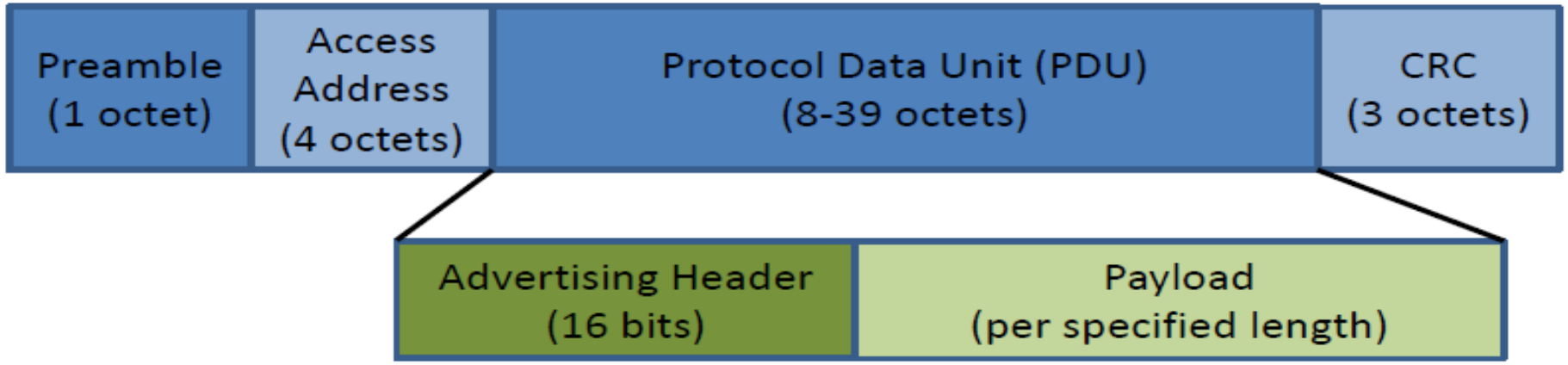






Data Packets

BLE Example



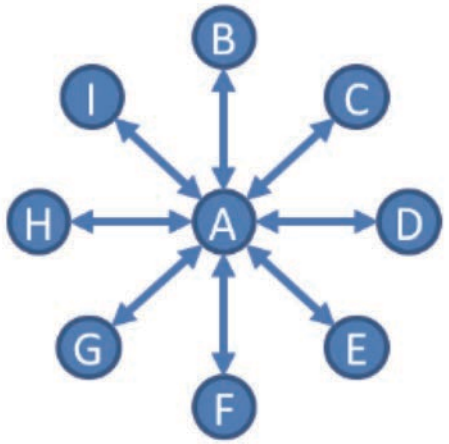
- Advertising PDU Consists of
  - Header that contains
    - PDU Type: 7 types for advertising
    - Address Type: public or random
    - Payload length: 6 to 37 bytes
  - Payload: 6 octets Address + 0-31 octets Data

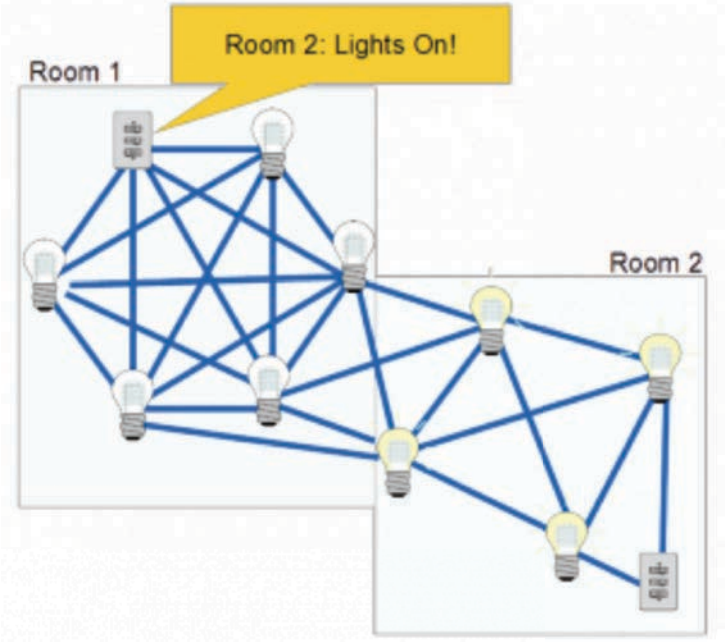
Enabling Bi-Directional Communication

- Control Topologies : Broadcast & Mesh Networks.
  - Broadcast Networks:
    - Low(er) Latentcy.
    - Limited transmission distance.
    - More integration challenges.
  - Mesh Networks:
    - Not limited to line of sight.
    - Higher Latency.
    - Easier to integrate into 3rd party control systems.

Types of Topologies

Broadcast topology	Broadcast / Flood Mesh topology
One to many	One to Many of Many to Many





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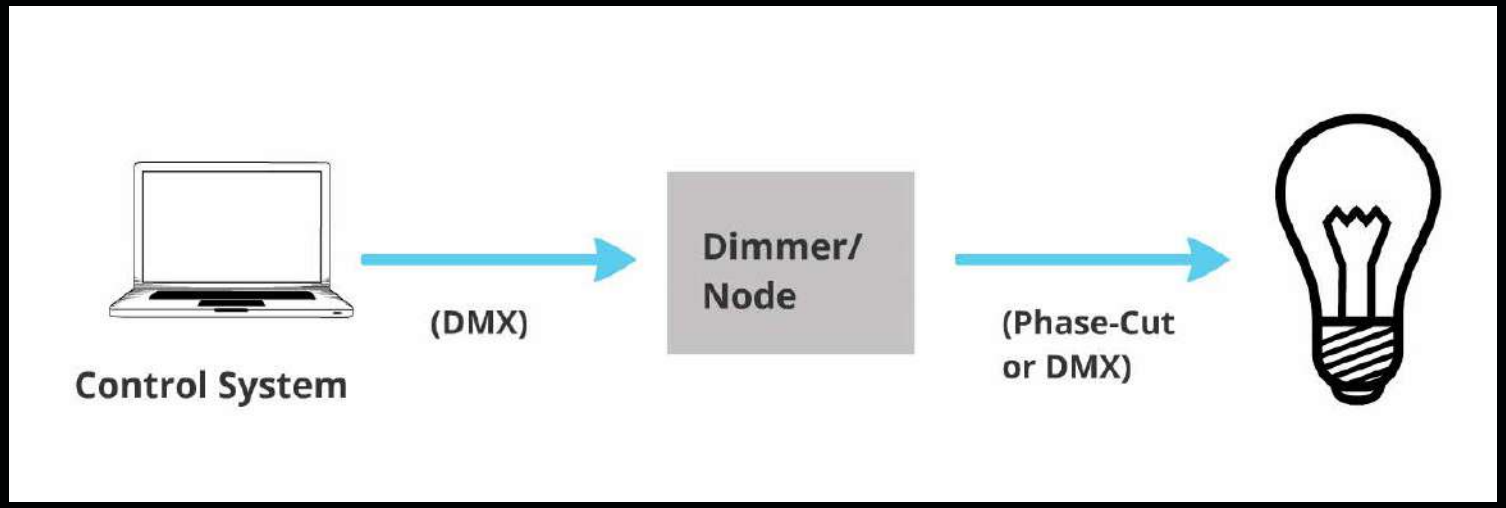
Anatomy of a Connected Architecture

- Bi-Directional Communication
- Data-Rich Environment.
- Extensibility:
  - O.E.M. Hardware Integration.
  - O.E.M. Controls Integration.

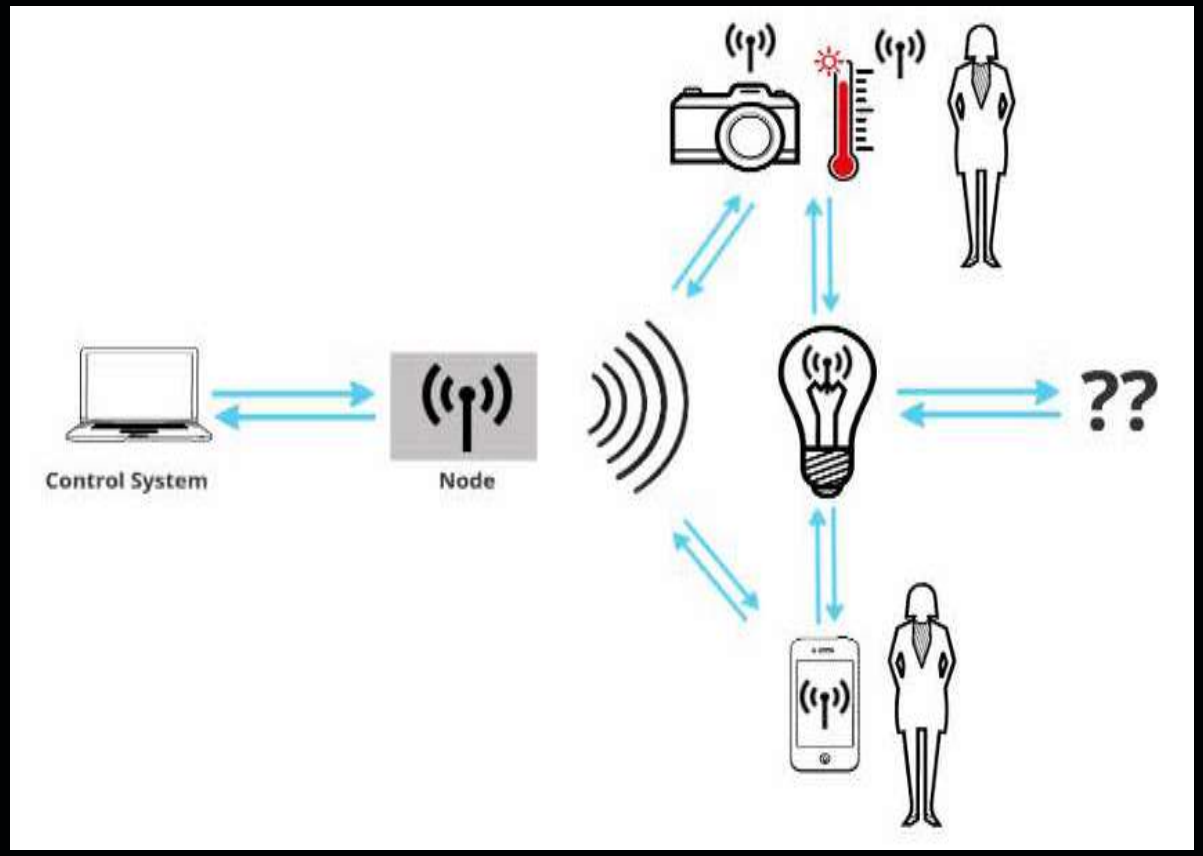
Anatomy of a connected architecture

Traditional Control Architecture



Anatomy of a connected architecture

“Connected” Control Architecture



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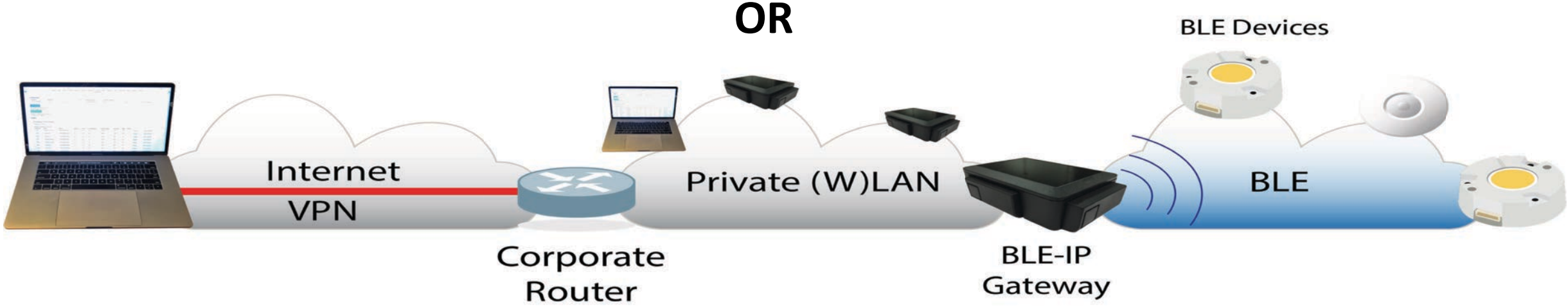
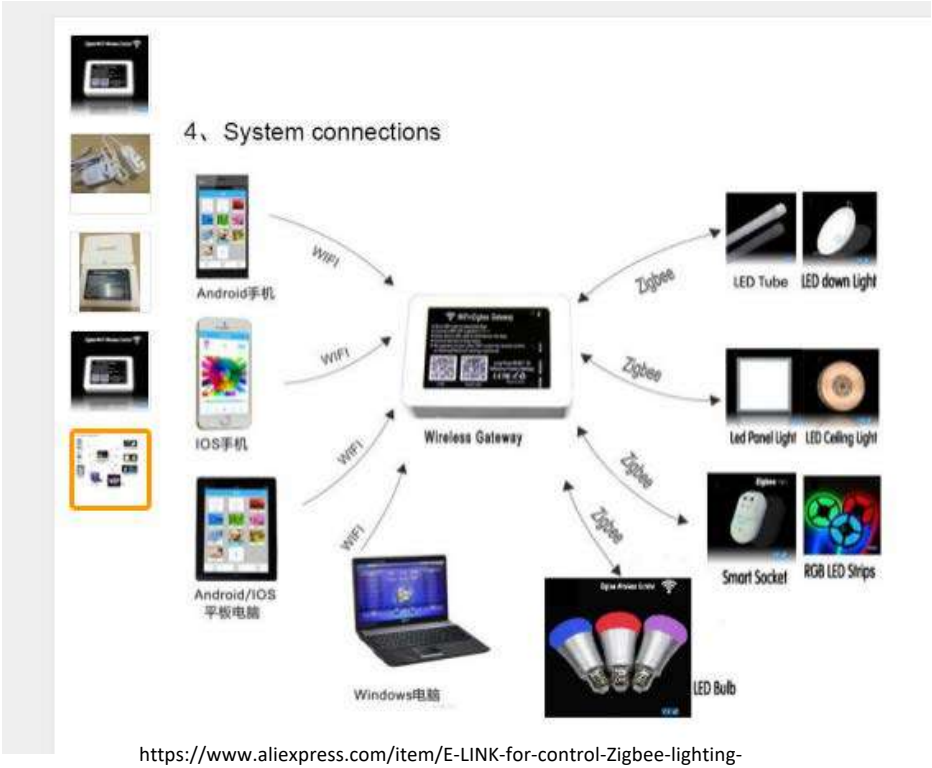
What a Connected Lighting System could look like

OR



Getting to the Net – The Gateway



https://www.aliexpress.com/item/E-LINK-for-control-Zigbee-lighting-equipment-and-the-development-of-a-gateway-for-smart-bulb/32356310157.html

http://www.hotenda.com/media/articles/How-To-Add-Lighting-To-The-Internet-Of-Things.html

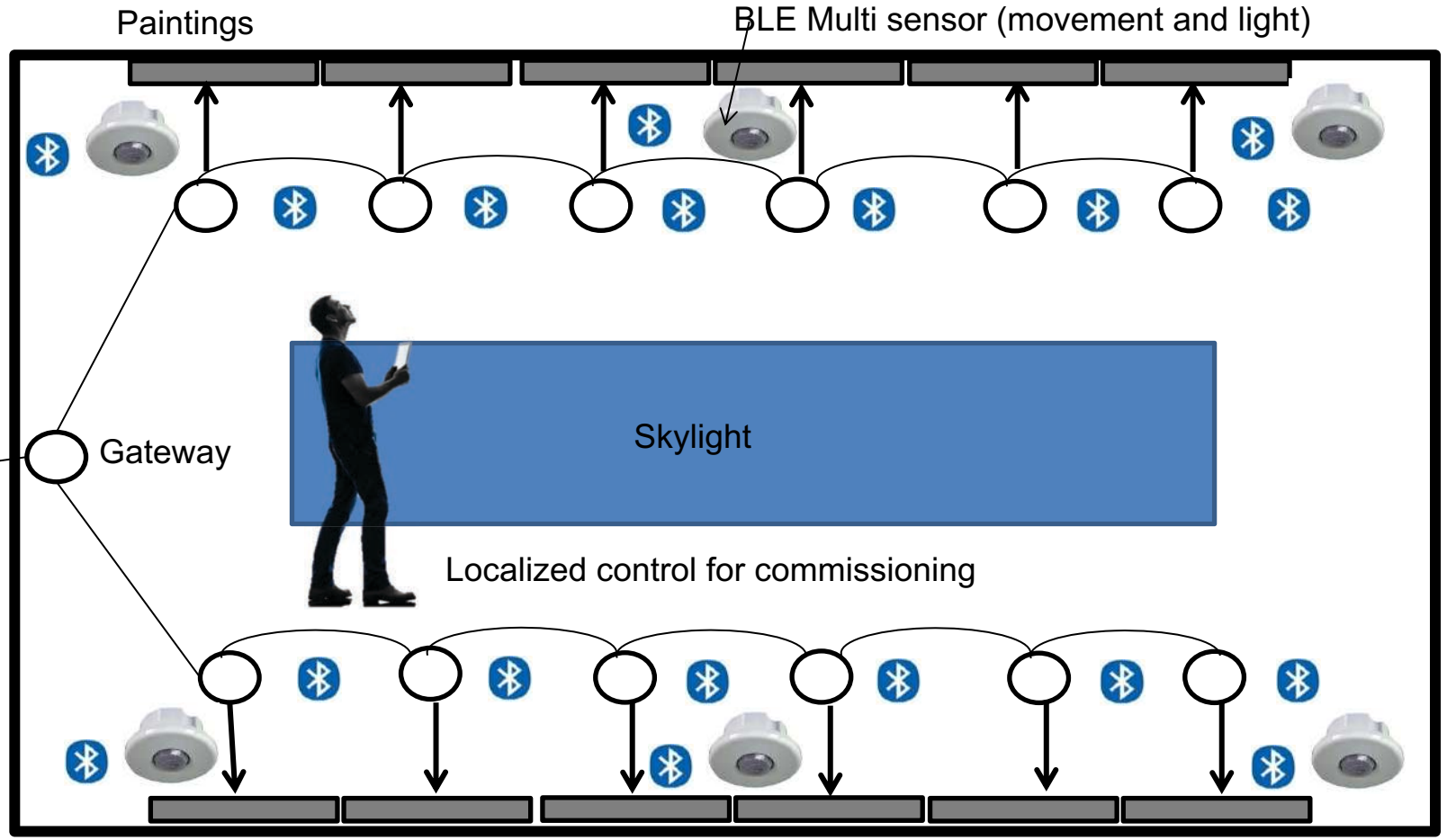
Single Language (protocol)

Wallace Collection, London

Administration & Database Remote Access

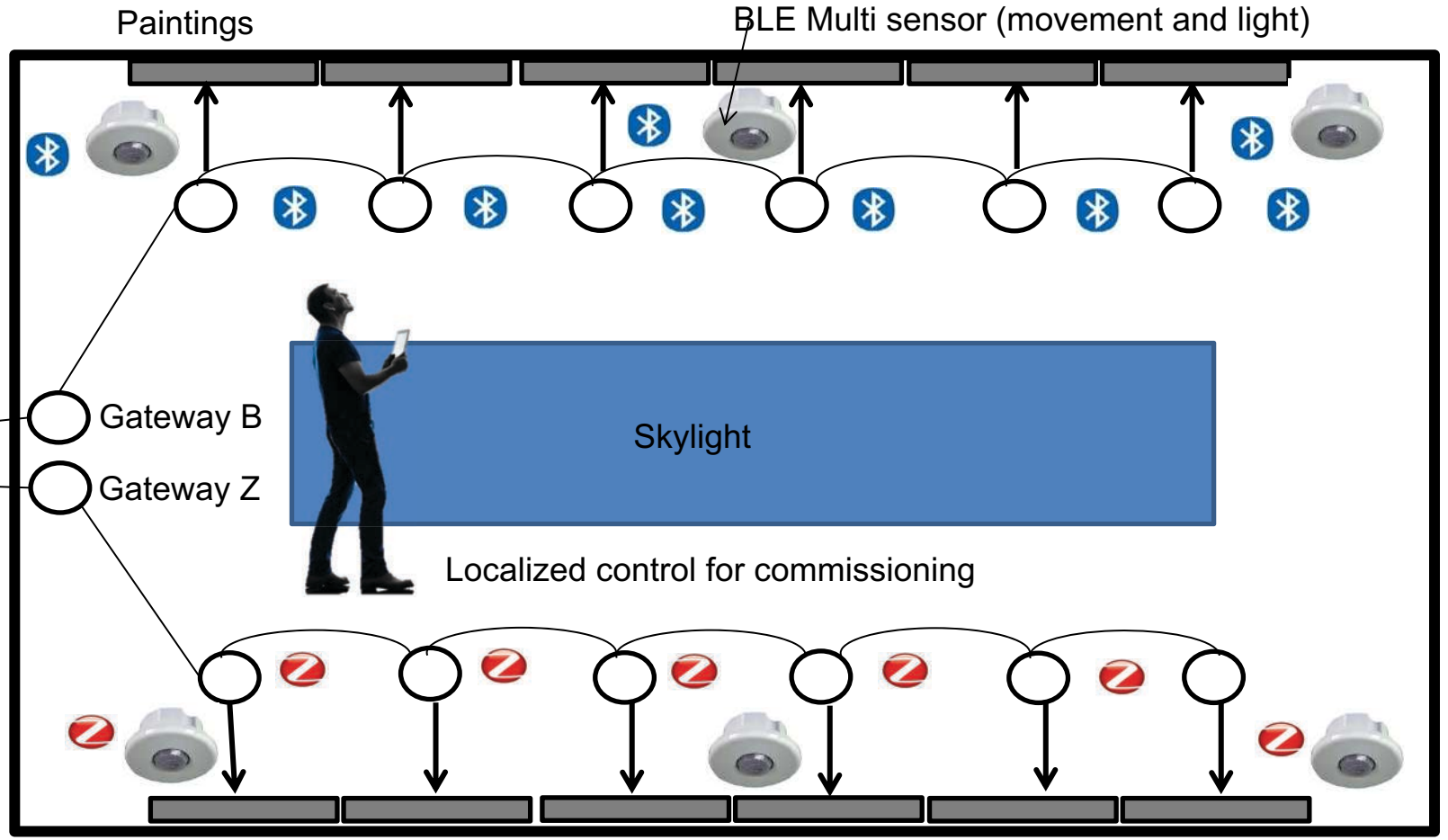
BMS / CMS

- Overall power management
- Energy data
- Maintenance alerts



Multiple Languages

Wallace Collection, London



Administration & Database Remote Access

BMS / CMS

- Overall power management
- Energy data
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What is an API?

- Application Programming Interface (A.P.I.)
  - The “Lingua Franca” of the control system and wireless node.
  - Defines Control Functionality and Data Models.
  - Extensible – Can change with firmware upgrades.
  - The “backbone” of web-based applications.

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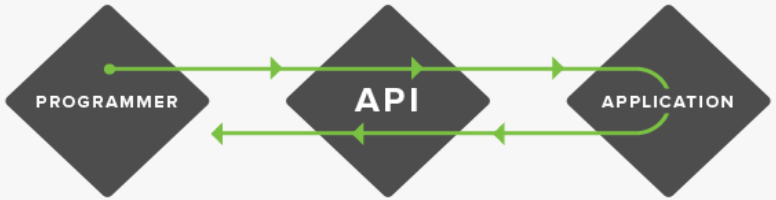
API – Facilitating Interoperability

https://www.intersystems.com/data-matters-blog/three-drivers-propelling-the-database-revolution-the-case-for-a-data-platform/

"An… Application Programming Interface (API), which at its most basic, acts as a door or window into a software program, allowing other programs to interact with it without the need for a developer to share its entire code."

http://www.govtech.com/applications/whats-an-api-and-why-do-you-need-one.html



https://sproutsocial.com/insights/what-is-an-api/

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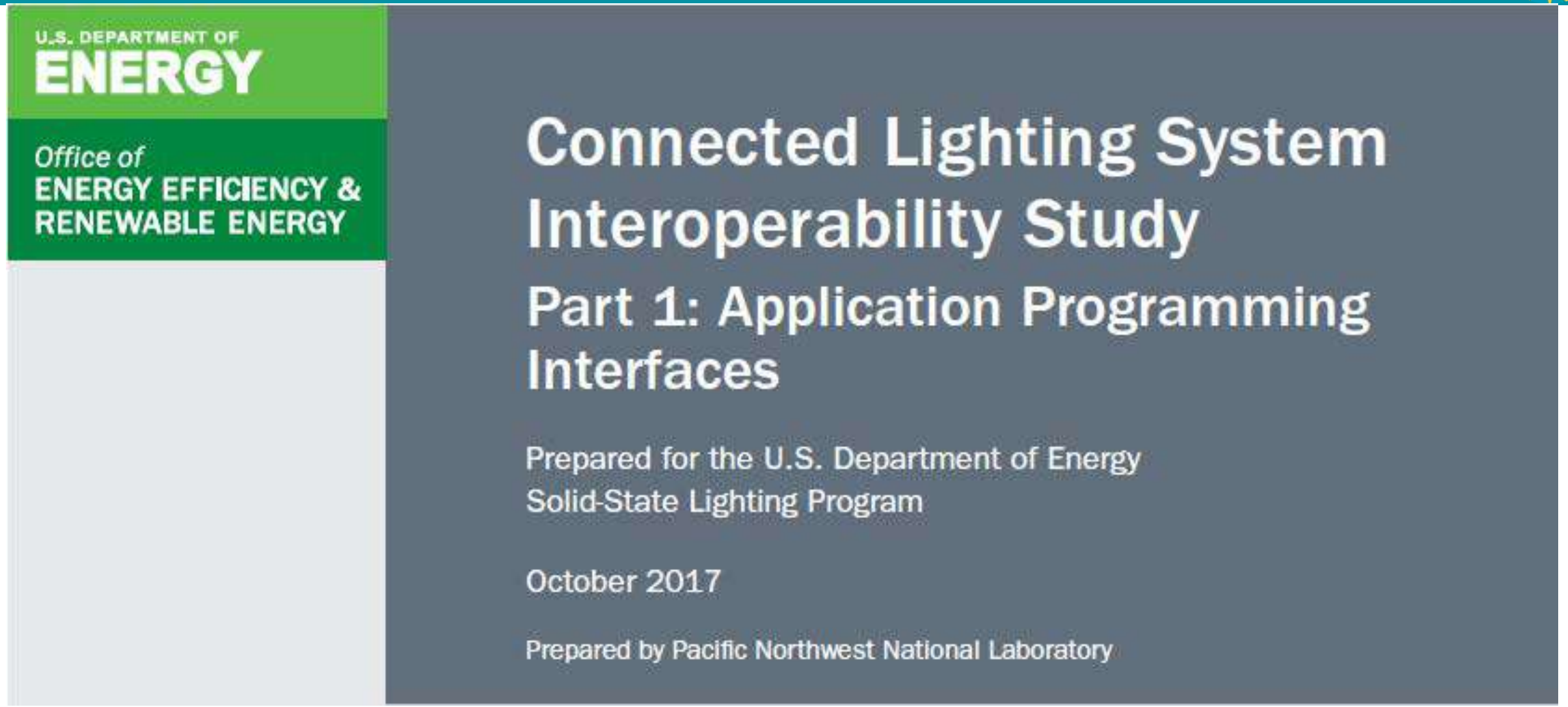
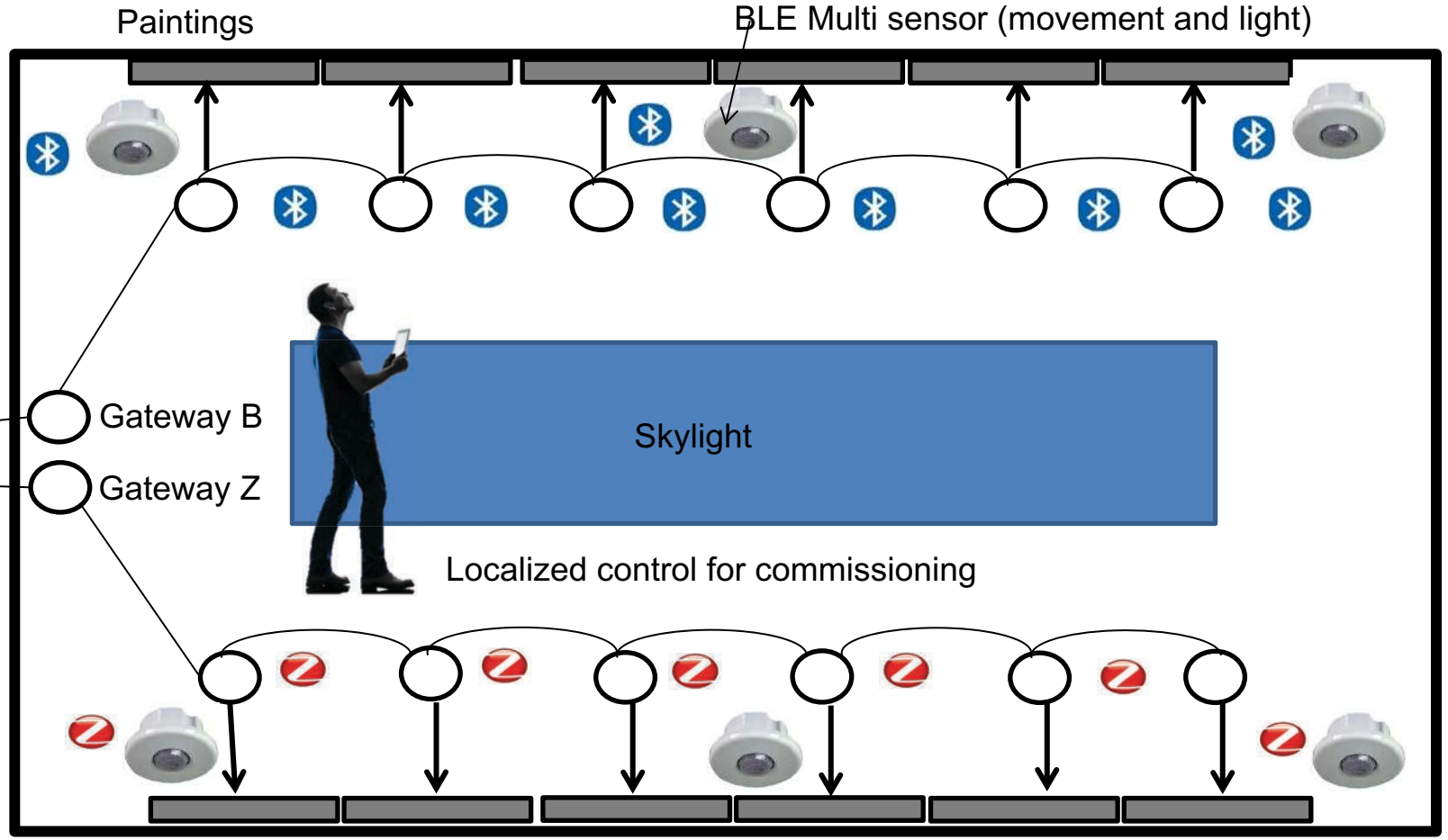
API – Facilitating Interoperability



Multiple Languages – Integrate through API

Wallace Collection, London

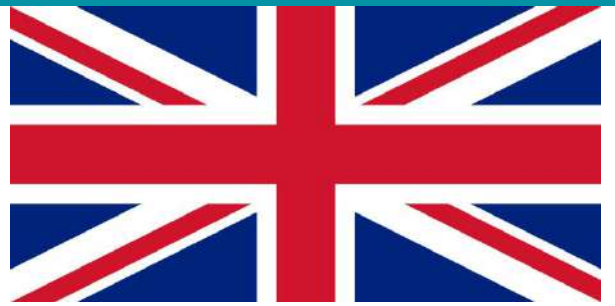


- Overall power management
- Energy data
- Maintenance alerts

API – Example

```
{ "00. Index" : Integer
, "01. Device ID" : String (for various reasons, this can't be
treated as an integer although it almost always is)
, "02. Name" : Nullable String
, "03. Device" : Nullable String
, "04. Intensity" : Float
, "05. Power" : Float
, "06. Tc temperature" : Integer
, "07. supply_voltage" : Float
, "08. on_hours" Nullable : Integer
, "09. signal_strength" : Nullable Integer
, "10. status" : Nullable Integer
, "11. Last Update" : Nullable Float
, "12. Adv Interval" : Float
, "NetworkName" : Nullable String
}
```

Each Scene is a JSON dict containing the following fields and their associated types:



Need for Open and Quality API's

- Interoperability is the goal
- Will be living in the world multiple protocols for a while
- API's can tame the Cowboys

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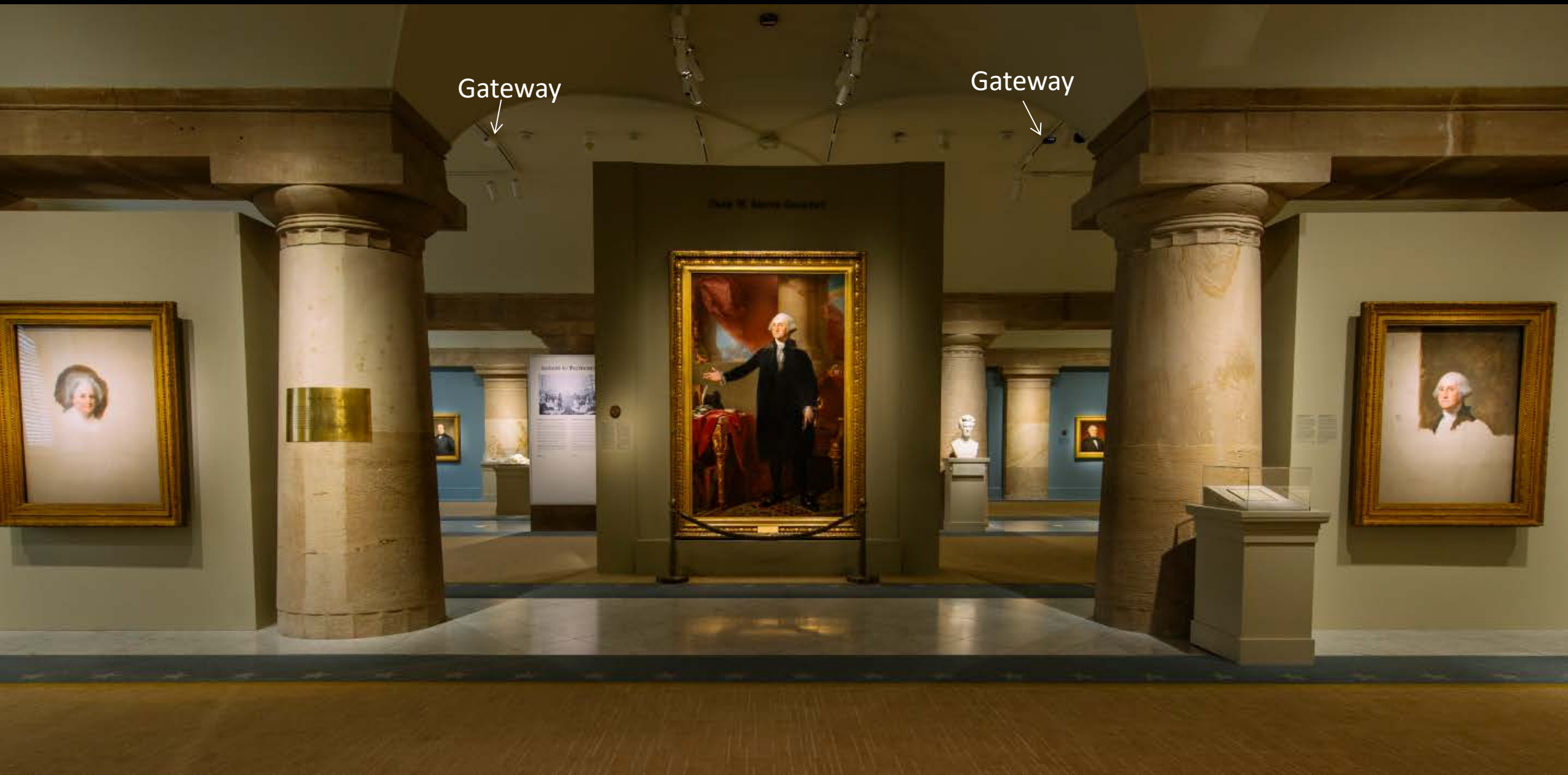

Data Publication

- “Connected” Systems are data-rich environments.

Data Publication

- Data video – Deleted video to reduce size for Presentation review.
- Will bring presentation on laptop

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Using APIs at the NPG

- Integrating data into a centralized system.
- Use of API calls used to broadcast commands to intelligent nodes – both ZigBee and BLE.

Using APIs at the NPG

- API video – Deleted video to reduce size for Presentation review.
- Will bring presentation on laptop

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Creating custom data visualization

- Development of a Graphic User Interface to manage a single system.

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Creating custom data visualization

- GUI video – Deleted video to reduce size for Presentation review.
- Will bring presentation on laptop

The Future - Sensing

- What is a future proofed system?
- Adding sensors – adding without need for re-wire
  - Use of sensors to trigger other devices
  - Advantages for daylighting in Gallery.
  - How to deal with Occupancy.
  - How to interact with after hour housekeeping and events.

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The Future – Content Delivery – Location Service

- Mobile Apps in Museum - thumbs up or thumbs down
- Content delivery options
  - BLE beacon delivery
    - iBeacon
    - Eddystone Beacon
  - Visual Light Communication
    - How this technology may or may not work in a gallery
- Location services

This concludes The American Institute of Architects Continuing Education Systems Course

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