Sensor-Based Configuration of Lighting Controls

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Acuity Brands Lighting
Four Paradigm Shifts

• Software Driven Control
• Distributed Intelligence
• Sensor Integration
• Internet of Things
Once we break the connection between how lighting is powered and how it is controlled...
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Once we break the connection between how lighting is powered and how it is controlled...

... we move from hardware-based control to software-based control.
Software is a new frontier for the Lighting Industry
Paradigm Shift #1

Software
## Hardware vs. Software Development

<table>
<thead>
<tr>
<th></th>
<th>Hardware</th>
<th>Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Process</td>
<td>Linear</td>
<td>Iterative</td>
</tr>
<tr>
<td>Defects</td>
<td>Expensive</td>
<td>Inexpensive</td>
</tr>
<tr>
<td>Testing</td>
<td>Simple</td>
<td>Complex</td>
</tr>
</tbody>
</table>
Software

• Design
• Configuration
• Management
• EMS Integration
• Mobile apps
• Cloud integration
• Sensor-rich data stream
Empowering Users with Software

Desktop Apps

Mobile Apps

Smart Lighting ≠ No user control
Paradigm Shift #2

Distributed Intelligence
Centralized control

- **Advantages**
  - Less computing per node

- **Disadvantages**
  - Increased latency
  - Single point of failure
  - Less scalable
Distributed control

- **Advantages**
  - Lowest latency
  - No single point of failure
  - Most scalable

- **Disadvantages**
  - Increased computing at node

Monitoring & Configuration…
Paradigm Shift #3

Integration
Traditional industry model
Issues with traditional model

- Higher Cost
  - Multiple AC/DC conversions
  - Excess labor for assembly/installation/planning
  - SKU management
  - Interoperability problems
- Reduced Performance and Reliability
Fixtures, Sensors and Controls Are Merging

**Yesterday**

Independent Fixture

Independent Controls/Sensors

**Today**

Combined Fixture/Sensors/Controls Solution
Integration Benefits

- Lower hardware cost
- Lower assembly cost
- Lower installation cost
- Lower design cost
- Optimized performance
- Higher reliability
What is driving system cost?

- Fixture costs are going down
- Controls costs are going down
- Start-up costs are going…. Up?

Why?
Location

Location

Location
Location, Location, Location…
Location, Location, Location…
How do we get location?

- **Manual**
  - Barcode stickers/floorplan
  - Predefined locations
  - “Blinky blinky”

- **Automatic**
  - Neighbor detection
    - Light sensors
    - RF signal strength

- **Hybrid**
  - Automated start
  - Easy manual correction

- **Labor/time Intensive**
- **Error Prone**: 80%-90% accuracy is not good enough
- **Best**
Configuration data

Low bandwidth... perfect “aim”
## Sensor Technology for Configuration

<table>
<thead>
<tr>
<th>Technology</th>
<th>Bandwidth</th>
<th>Aim</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light level</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>BLE or WiFi</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>VLC</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>VLC w/ beaconing</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Laser</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Imagesensor</td>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>
Scaling

- From demo

- to
Paradigm Shift #4

IoT
Internet of Things

- Sensors are at the heart of IoT
- Sensor/fixture integration can lead to rich data
  - Light
  - Energy use
  - Thermal
  - Occupancy patterns
  - Space utilization
  - Thermal
  - New control concepts
    - Dynamic control
    - Personalized response
    - Color
What do we need?

✓ Standards
  • Communication
    • Networking
    • Bandwidth management
  • Application
    • Settings – common language
    • Control Behavior

✓ Sensor Research
  • Low-cost sensors
  • Image sensing/processing