ADAPTIVE LIGHTING CONTROLS PANEL:

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TOPICS

• Desired System Features
• Communication Methods Evaluation
• Chosen System and Performance
• Commissioning Experiences
• Standards
• Commissioning Spectrum
• Diming
• Demonstration
Los Angeles
San Jose
TOPICS (Airinet)

• Communication and Networking standards
• Commissioning
• Dimming Profiles
• Brief Demonstration
Typical outdoor LED fixture configuration
Future: Outdoor Lighting Networks

Network Gateway

Central Management Server

Desktop Access

Mobile Access

WAN / Internet

Zigbee Network

IP Network
Basic Features:

- Registration of burning hours
- Detailed Energy consumption metering
- Failure detection & Diagnostics
- Switch control and State detection
- Line voltage registration
- Time clock
- Ambient Light Sensor
- Stand-alone operation and data storage
- Staggered switching (Inrush current mitigation)

Extended Features:

- GPS Commissioning, tracking and time clock synchronization
- Reserve power for uninterrupted operation during outages
- Real-time light & energy statistics for immediate remote diagnostics
Gateway

Basic Features:
- Connectivity to Server
- Bridge between mesh network and IP network
- Access point for the outdoor lighting network
- Secure communication

Extended Features:
- Connectivity to external sensors & systems for enhanced sensor based operation or backbone sharing
- Server emulation for fault tolerance/redundancy
- GPS commissioning, tracking & time sync
Connectivity & Topologies

- Wireless Mesh Topology
  - Gateway

- Wireless Star topology
  - Gateway

- Power line Topology
  - Transformer Bridge
  - Gateway
Protocol Stacks and Usage

Central Management Server

Desktop Access

Mobile Access

IEEE 802.15.4 Radio Platform

Zigbee Mesh Network Protocol

Lighting Control Application

WAN / Internet

Gateway

Multiple transport options: Ethernet, Fiber, 3G, WiFi, etc.

TCP/IP Protocol

Lighting Control Application
Wireless Connectivity Standards

<table>
<thead>
<tr>
<th></th>
<th><strong>IEEE 802.15.4</strong></th>
<th><strong>IEEE 802.11 family</strong></th>
<th><strong>Cellular (3G)</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Data rates</strong></td>
<td>20, 40, 100, 250 Kbps</td>
<td>Depends on standard version: 2, 5, 11, 54, 72, 150, and up Mbps</td>
<td>DL: 2-28 Mbps</td>
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<tr>
<td></td>
<td></td>
<td>...</td>
<td>UL: 384 Kbps -11Mbps</td>
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<tr>
<td><strong>Spectrum</strong></td>
<td>868-870 MHz (EU)</td>
<td>2.45 GHz</td>
<td>Various</td>
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<td></td>
<td>902-918 MHz (US)</td>
<td>5 GHz</td>
<td></td>
</tr>
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<td></td>
<td>2.4 GHz (Worldwide)</td>
<td></td>
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<tr>
<td><strong>Range/Coverage</strong></td>
<td>Up to 2 miles</td>
<td>10 – 250 m</td>
<td>Growing coverage</td>
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<td></td>
<td>Depends on frequency band and Environment</td>
<td></td>
<td>(depends on deployment)</td>
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<tr>
<td><strong>Primary Applications</strong></td>
<td>Building/home automation, sensor/actuator networks, healthcare, etc (usually low data rates and low power devices)</td>
<td>Wireless broadband/Internet access.</td>
<td>Mobile broadband, M2M applications in the future.</td>
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<tr>
<td><strong>Standard Development</strong></td>
<td>15.4 Complete</td>
<td>802.11a/b/g/n and others...</td>
<td>Evolving (3G, LTE, LTE advanced/4G, ...)</td>
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<tr>
<td></td>
<td>15.4g extension for smart utility networks completed (2012)</td>
<td>New sub-GHz spec under development (11ah), expected 2015</td>
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Open vs. Proprietary Protocols

**Open Standards**
- IEEE 802.15.4 is widely used for low data rate wireless control
- ZigBee is a popular standard
- LonWorks® is the available standard for power line deployments
- NTCIP 1213 is a lighting application standard, though not yet widely adopted by the Industry
- Web based technologies are being used in several systems/solutions
- Adaptability and integration with other systems possible
- Vast global knowledge and experience base
- Unlikely to become abandoned tech in the foreseeable future

**Proprietary protocols**
- Vendors have flexibility to customize the communication protocol to the application/environment
- Many utilize existing connectivity standards and open platforms (e.g. 802.15.4 radios)
Commissioning
Traditional Commissioning Steps

1. Upload Light Plan (if available)
2. Scan OLC barcode
3. Collect and Input GPS Coordinates (with handheld GPS receiver)
4. Scan Fixture barcode (if available)
5. Input Fixture information (Lamp, Driver, etc.)
6. Copy Handheld data file to PC
7. Upload data from PC to Server
8. Configure OLC schedule from Server
GPS Commissioning

1. Plug in twist-lock module
2. Watch Indicator lights
3. Input Fixture information (Lamp, Driver, etc.)
   - Proceed to next Fixture

Behind the scenes:

- GPS Coordinates acquisition & Storage
- Sync clock with GPS time
- OLC wireless network self configuration
- Auto Join mesh network & register with server
- Sync schedule and settings info from server
- Run initial diagnostics
- Register Collected information with server
- Blink indicator lights for Success/Fail code
The range and curve dimming characteristics of each fixture vary due to differences in LED’s and Driving components.

In order for a large scale control system to accommodate dimming a wide variety of lamps and fixtures dimming profiles must be used.

Two different fixtures showing their dimming response to a 0-10 volt control.
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