

Controls for LED Lighting

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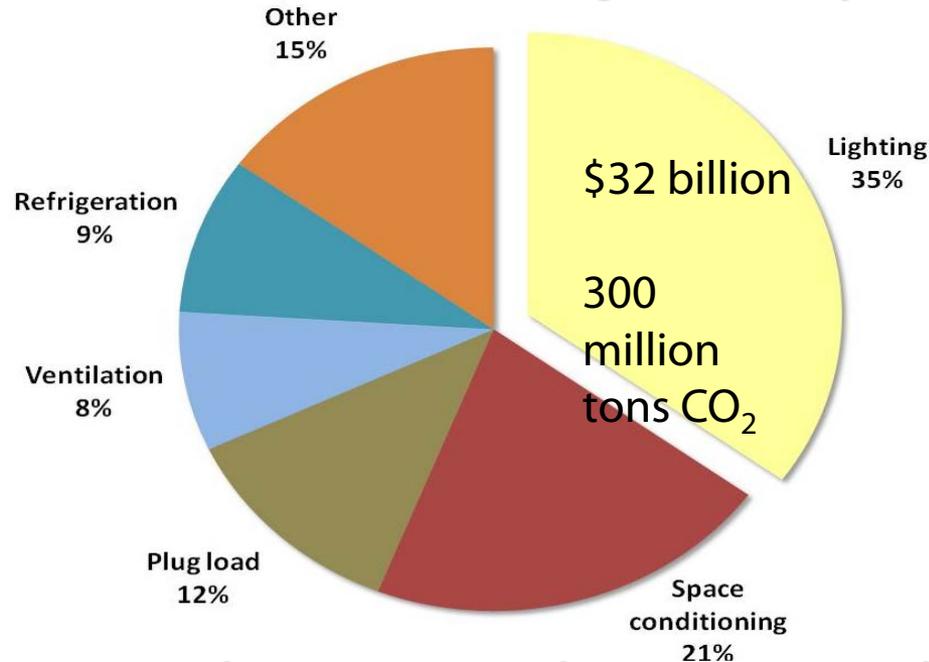
San Luis Obispo, CA

Objective

- Learn how to achieve the greatest energy savings through the simultaneous deployment of all lighting control strategies via digital wired and wireless lighting control systems.

Why Control Lighting

U.S. Commercial Building Electricity Use



Commercial lighting **fixture retrofits** get a lot of attention ...
but lighting **controls** are usually installed and updated only
in new construction projects or major renovations.

Design Process

- Owner Project Requirements - OPR
- Basis of Design - BOD
- Life Safety Code
- Energy Code
- IES
- LEED®



Energy Codes

- International Energy Conservation Code – IECC
- American Society of Heating Refrigeration & Air Conditioning Engineers / Illuminating Engineering Society – ASHRAE/IES 90.1
- California Energy Code, aka Title 24-Part 6
 - Watts per Square Foot - W/SF or LPD
 - Required Controls

Lighting Control Strategies

- **Local Controls**
- **Building Level Controls**
- **Centralized Controls**

Local Control Strategies

- Multi-Level Switching
- Occupancy/Vacancy Sensing
- Daylight Harvesting
- Architectural Dimming
- Personal Tuning
- Lumen Maintenance
- Plug Load

Building Control Strategies

- Time Schedule
- Facility Tuning
- Adaptation Compensation
- Adaptive Response
- Load Shed (initiated by building owner)
- Demand Response (initiated by utility company)
- Emergency Condition

Centralized Control Strategies

- Automated Maintenance
- BMS Integration
- Energy Management
- Energy Dashboards

Control Narratives

(Sample)

- Sequence of Operation:
Storage rooms and janitor closets shall have line-voltage wallbox occupancy sensors set for manual on, auto/manual off with their time delay set to 5 minutes, and their audible and visible alert functions enabled.

Control Narratives

- From the New Building Institute:
 - *Advanced Lighting Guidelines*
 - www.algonline.org
 - 15 different room types are available

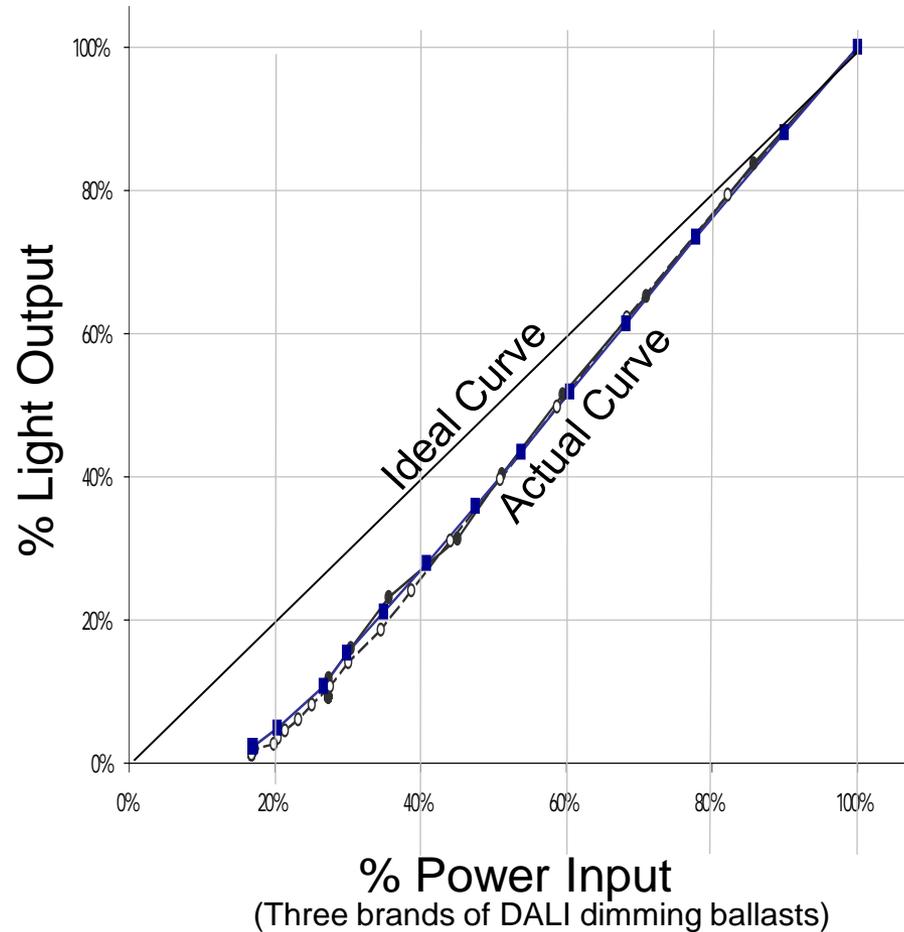
Control Narratives

- Required for system commissioning
- Must be thorough
- Needed for each scenario
- Include adaptive parameters
- Needed for components and system

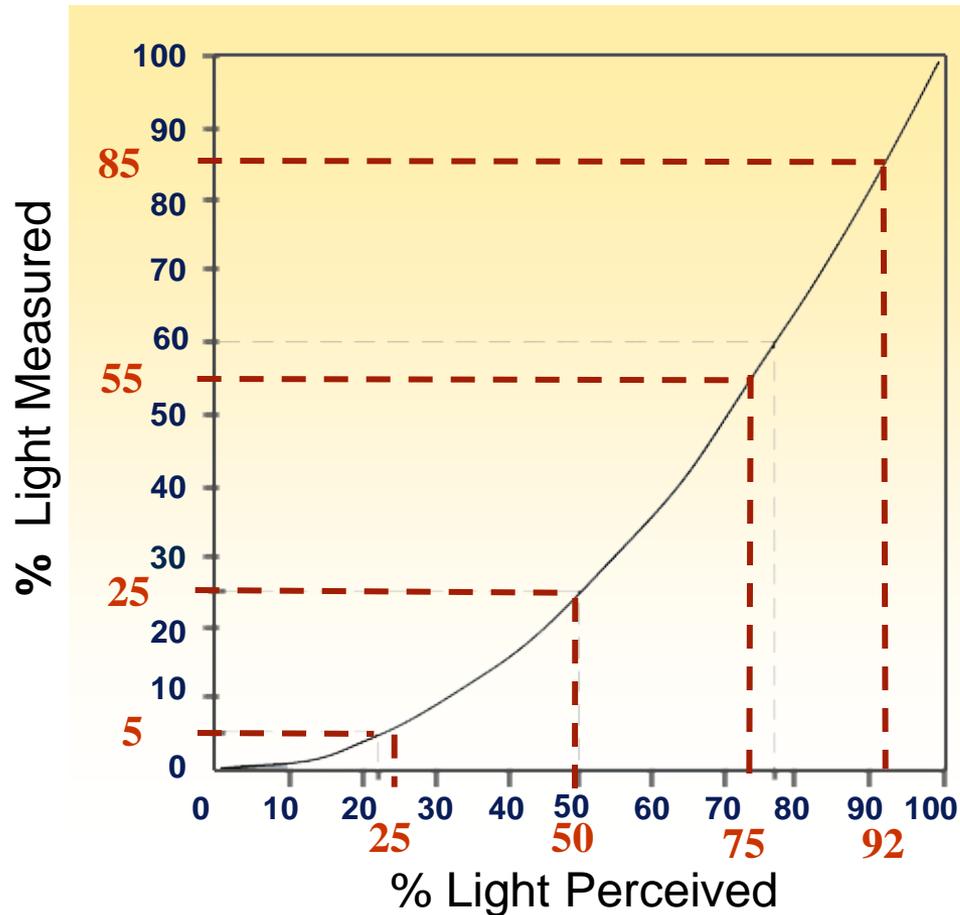
Control Narratives

- Required for system commissioning
- Must be thorough
- Needed for each scenario
- Include adaptive parameters
- Needed for components and system
- **Required to achieve maximum energy savings!**

Dimming Saves Energy



Perceived vs Measured Light



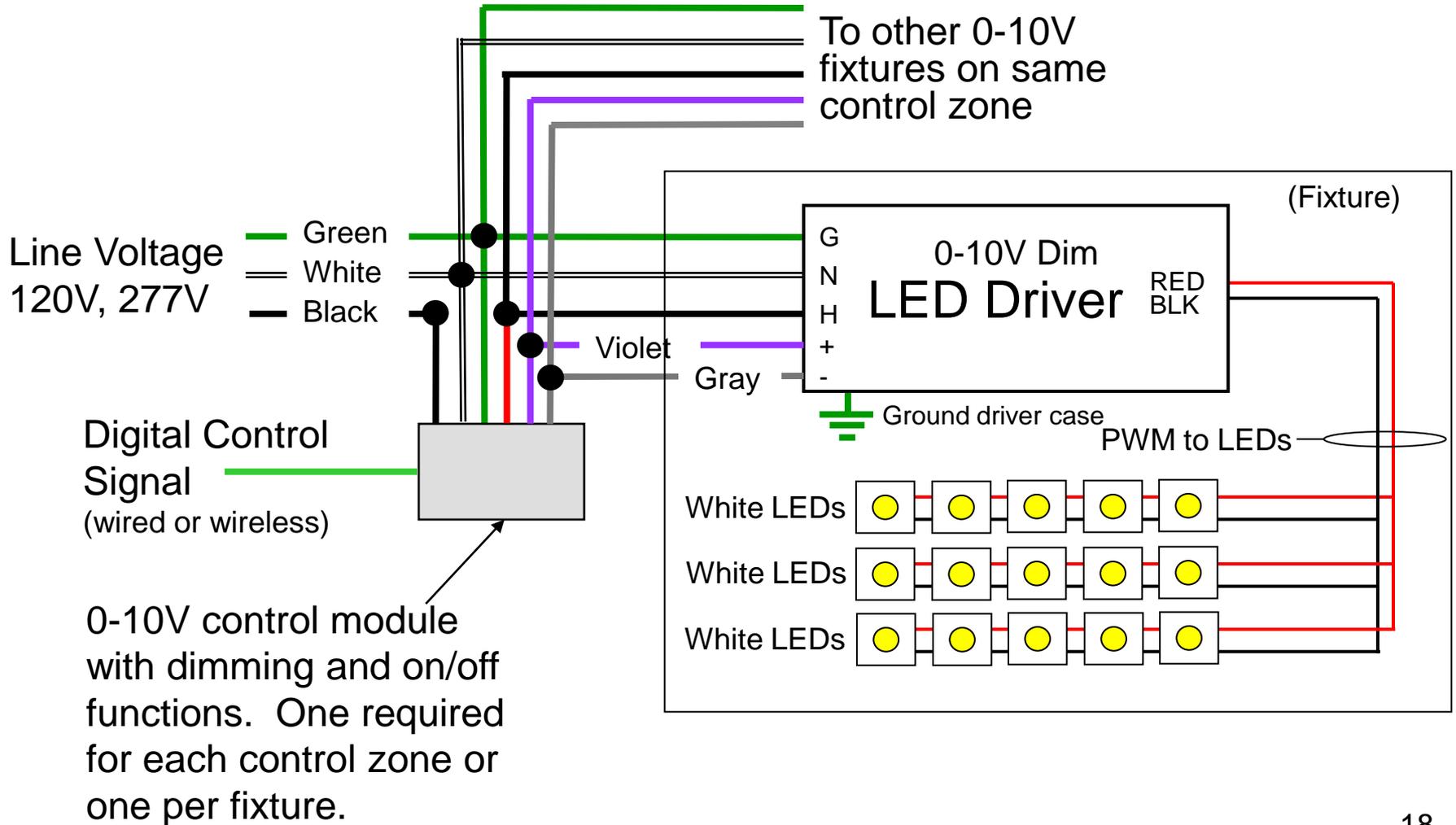
Dimming Control Protocols

- 2-Wire Line Voltage Phase Cut
- 3-Wire Line Voltage Phase Cut

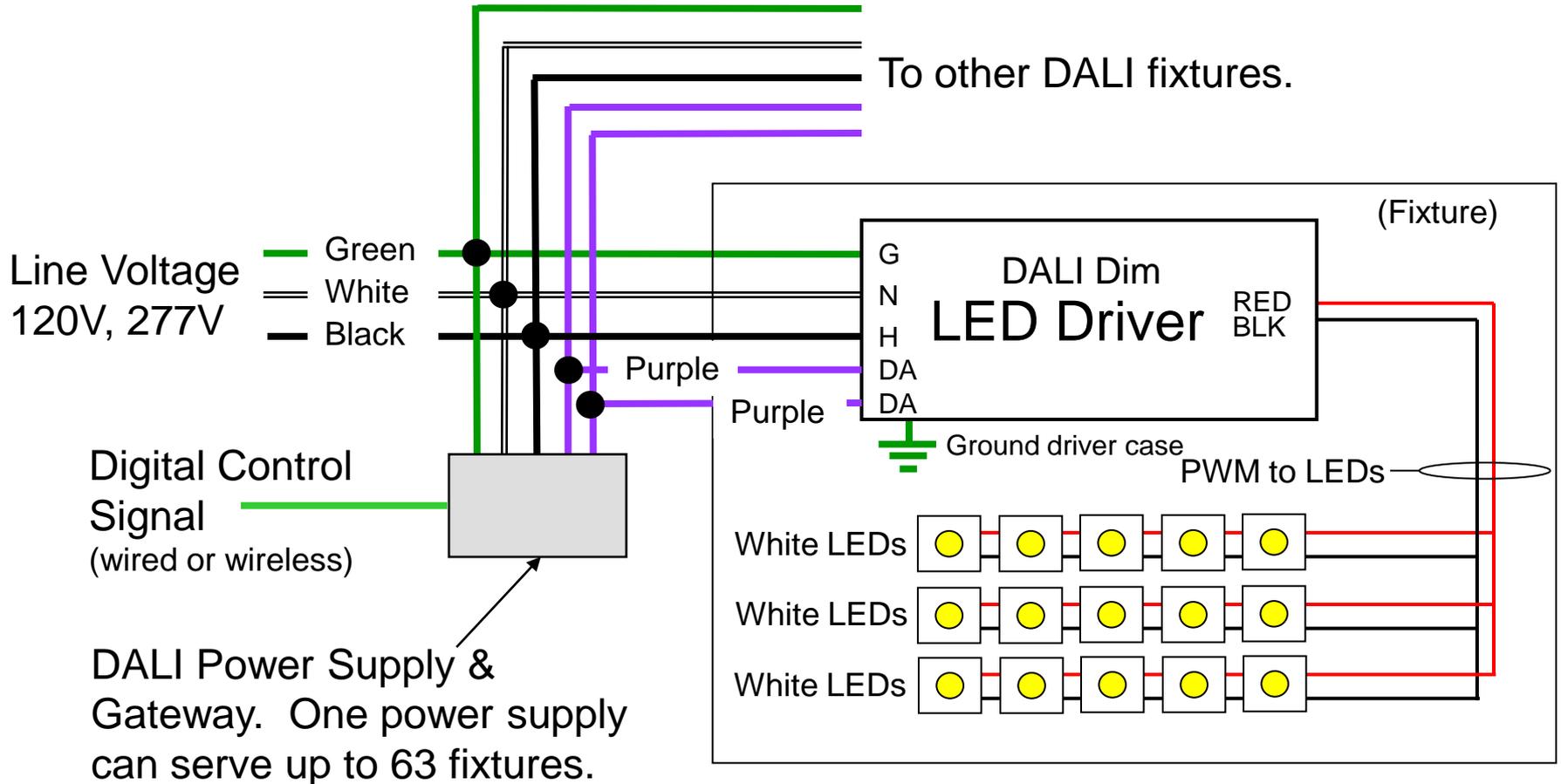
Dimming Control Protocols

- 2-Wire Line Voltage Phase Cut
- 3-Wire Line Voltage Phase Cut
- 0-10VDC Dimming
- DALI Dimming & Control
- DMX512 Control

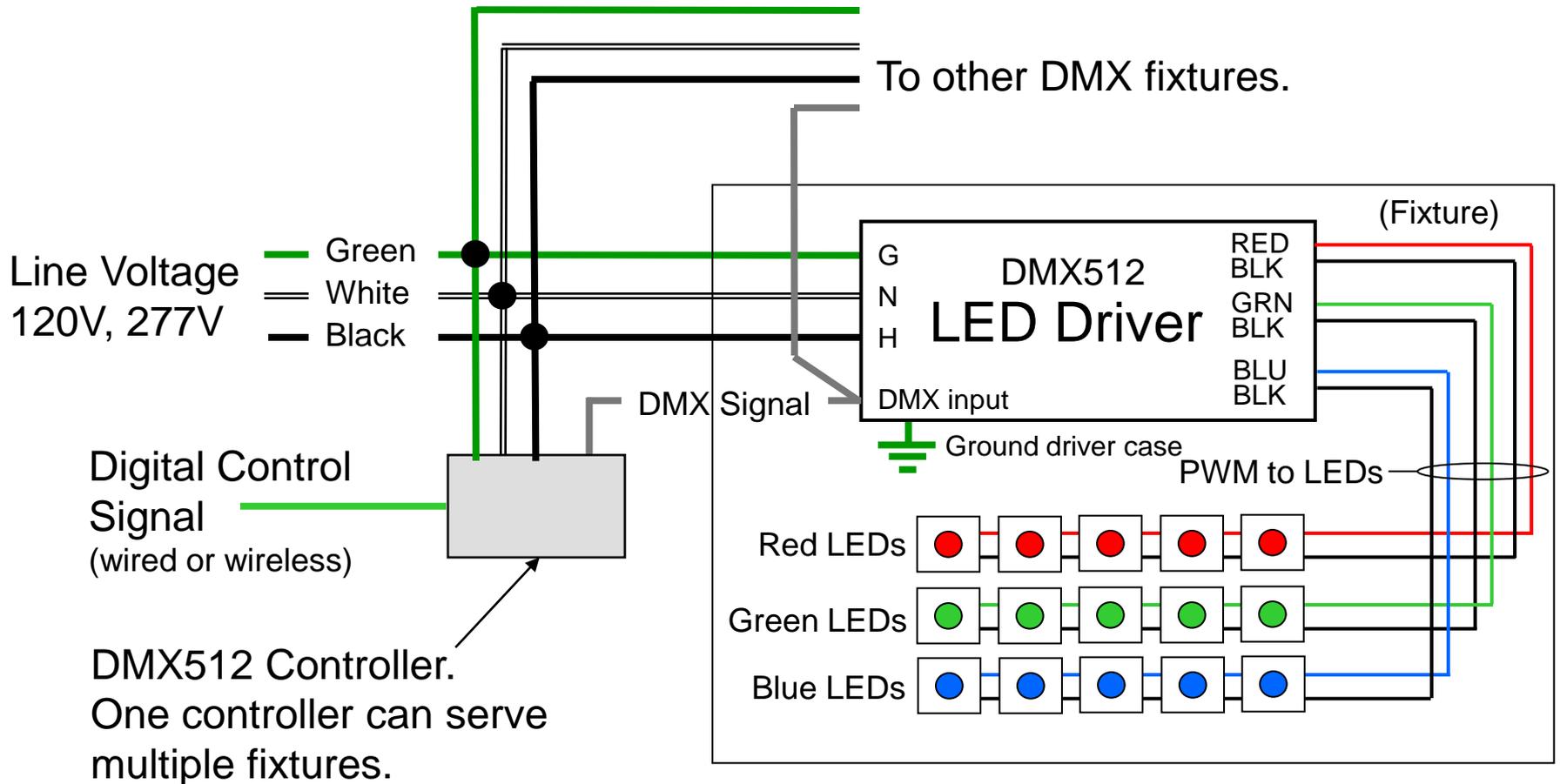
0-10VDC Dimming



DALI Dimming & Control



DMX512 Control



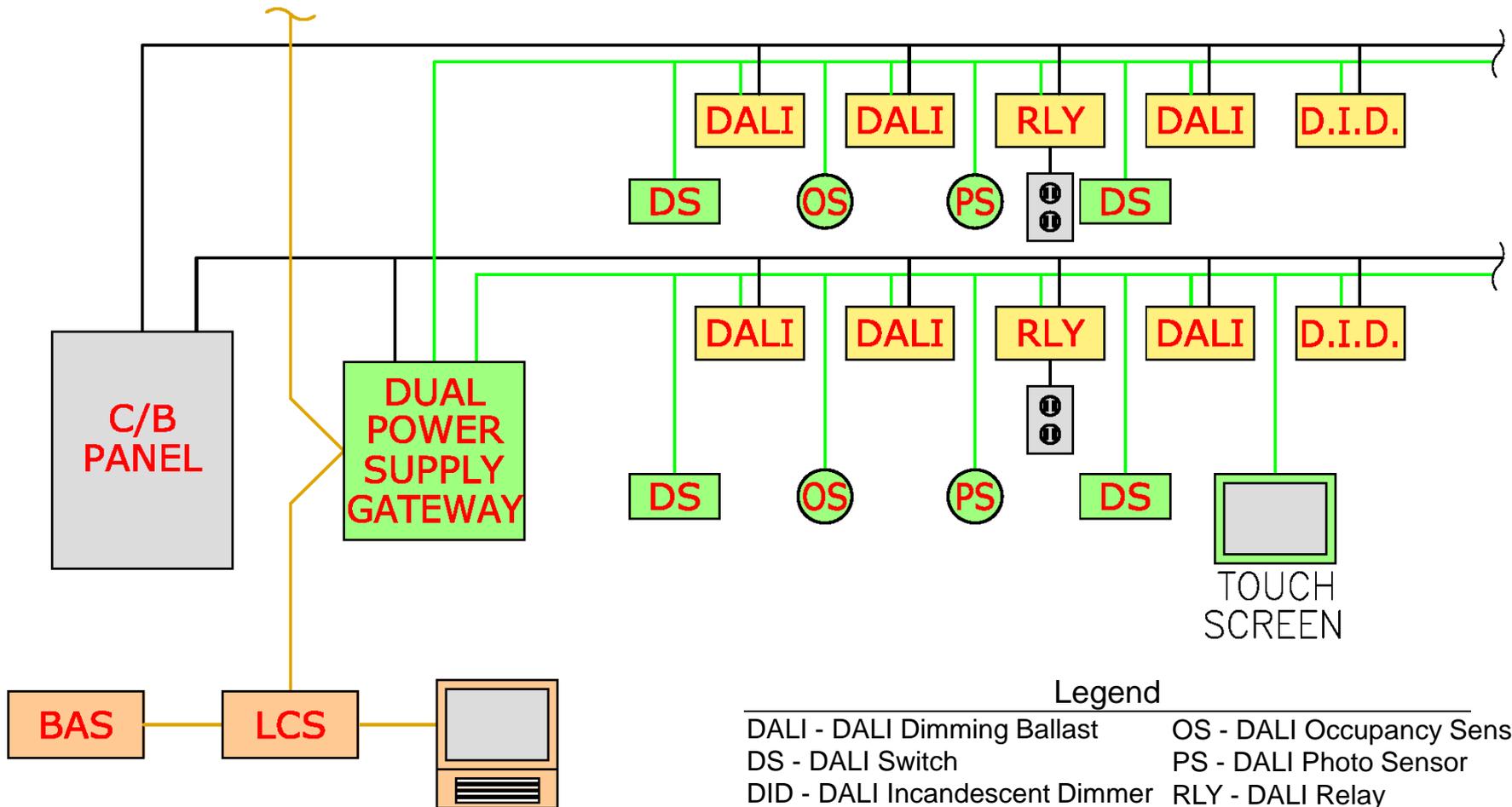
Systems

- Wired Digital
 - DALI
 - Digital Components
 - Low-Voltage Powerline for LED
- Wireless Digital
 - Mesh Network vs Star Network
 - Micro Power
 - Mixed Protocols

DALI

- Digital Addressable Lighting Interface (DALI) Protocol
- Components
- Wiring
- Systems integration
- Integration with BAS
 - Access to lighting system information
 - Access to setpoints, control templates
- Input sensors (DALI, RS485, wireless)

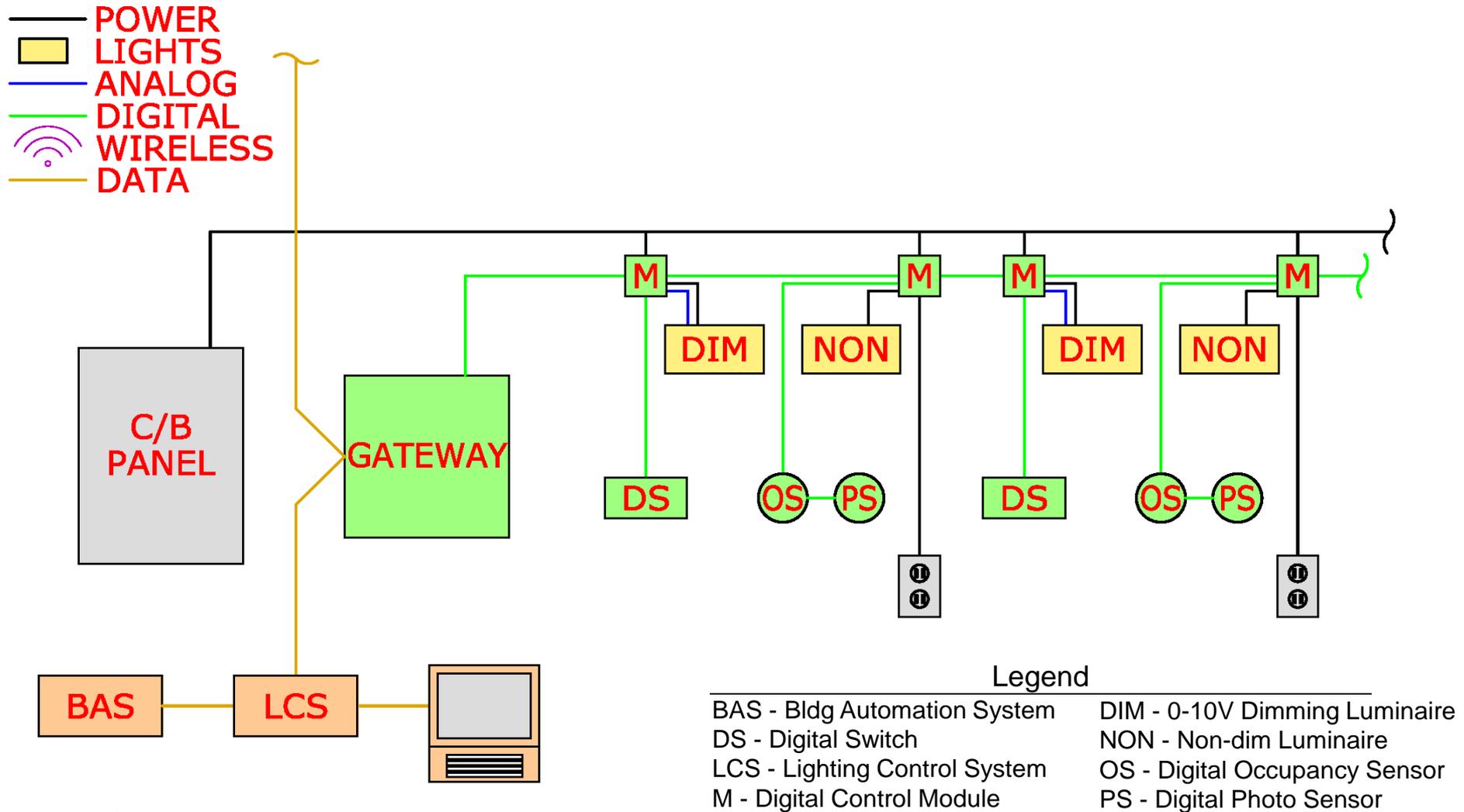
DALI



Digital Component System

- Modular per room
- Module per luminaire
- Plug-and-Play components
 - Occupancy sensor
 - Photo sensor
 - Scene control
 - Handheld control
 - Remote commissioning
- Integration with BAS
 - Access to energy information
 - Access to setpoints, control templates

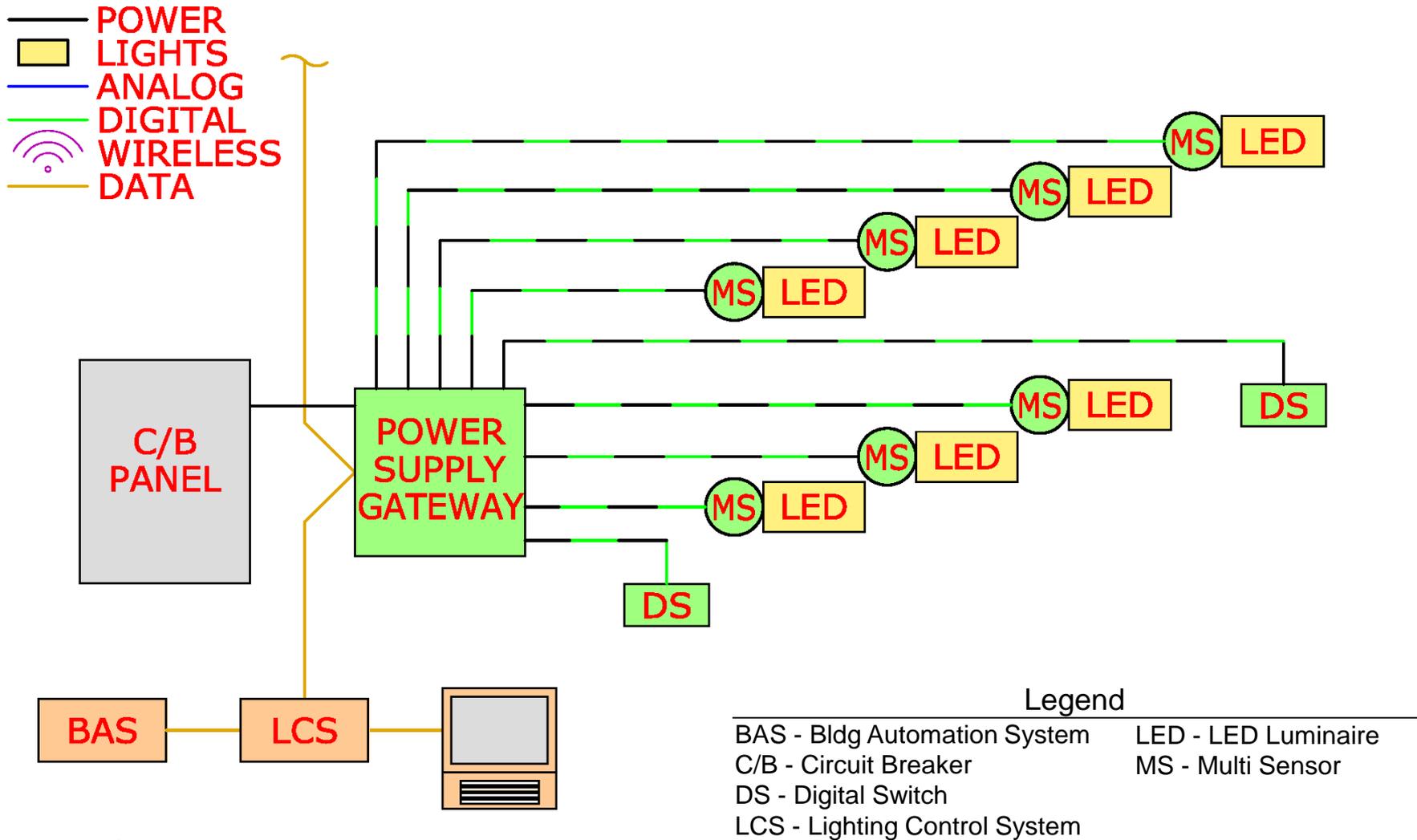
Digital Component System



LoVo Powerline Carrier for LED

- LED luminaires
 - each on separate cable:
 - ≤ 20 watts,
 - CAT5 up to 150 ft, 18AWG up to 100 meters
 - 350 mA at 60VDC
 - each addressable
- Sensors for motion, daylight, task light, LED temp, volts, amps
- Hub power supply and controller, 64 channels
- Centralized driver delivers DC power and a network link to each luminaire
- A single pair of wires will carry both the DC needed to power one LED fixture and a proprietary power-line communication signal

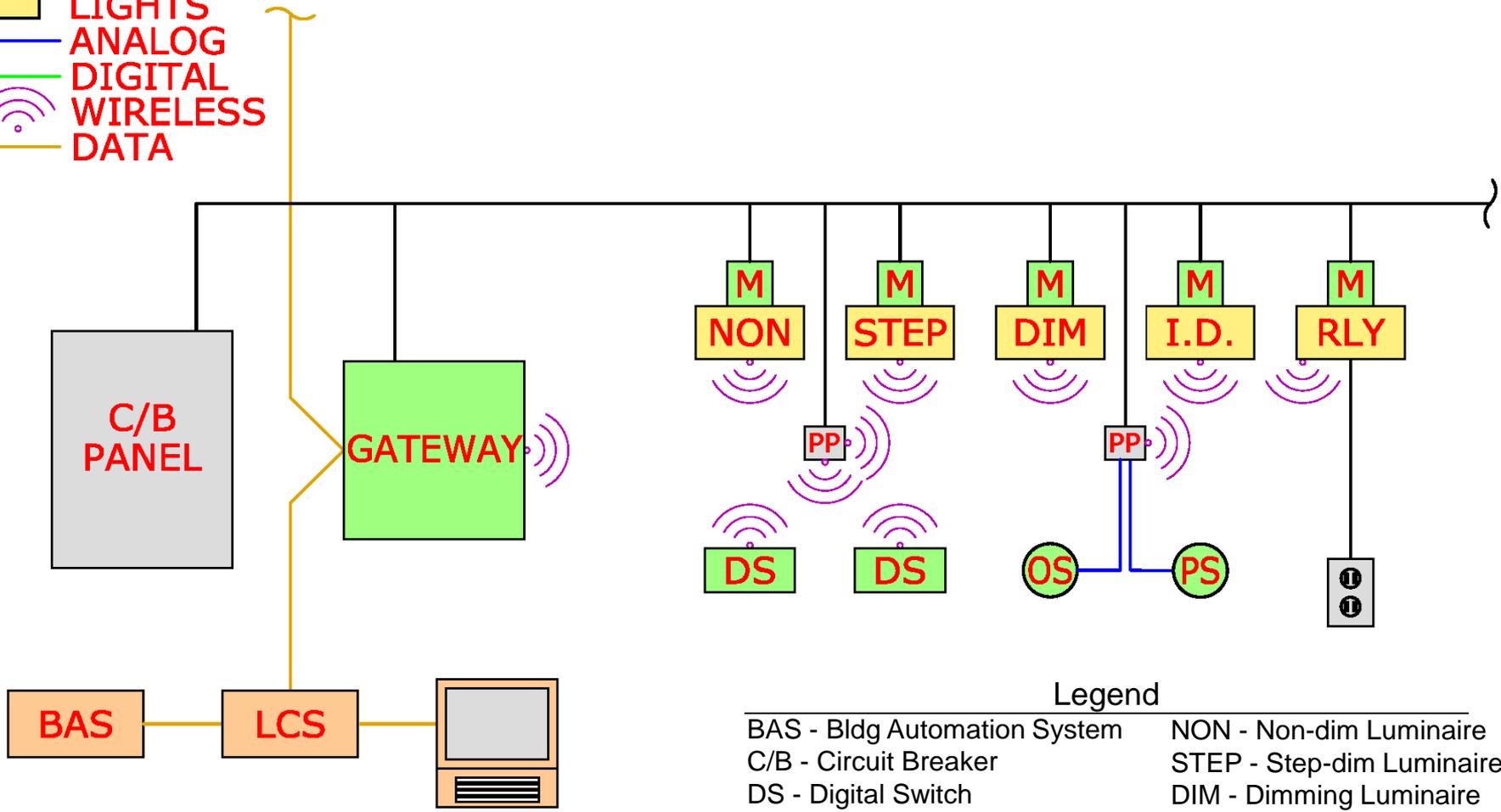
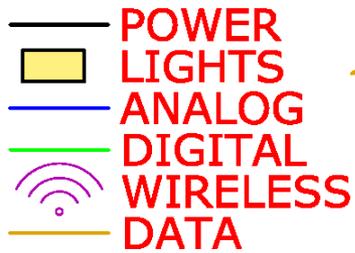
LoVo Powerline Carrier for LED



Wireless Mesh Network

- ZigBee carrier
- Available as open or as proprietary
- Discrete MAC address
- Mesh Network
- 2.4 GHz

Wireless Mesh Network



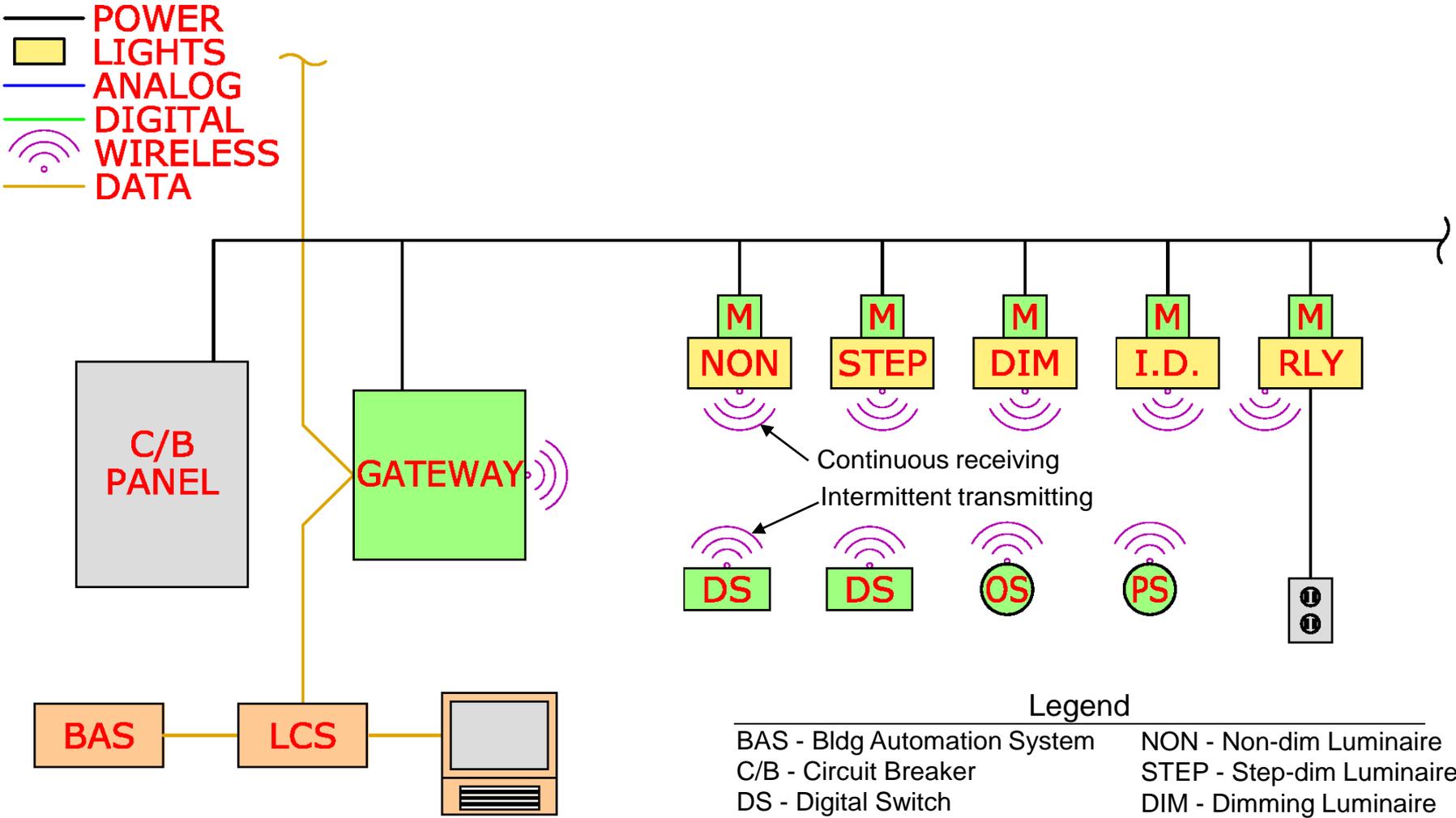
Legend

- | | |
|-------------------------------|---------------------------|
| BAS - Bldg Automation System | NON - Non-dim Luminaire |
| C/B - Circuit Breaker | STEP - Step-dim Luminaire |
| DS - Digital Switch | DIM - Dimming Luminaire |
| LCS - Lighting Control System | PP - Power Pack |
| ID - Incandescent Dimmer | RLY - Relay |

Wireless Micro Power

- EnOcean protocol
- 868 MHz (International) and 315 MHz (N.A.)
- Flea power (microwatts)
- Energy harvesting
 - Photovoltaic (light to electricity)
 - Peltier (heat to electricity)
 - Piezo (mechanical to electricity)
 - Inductive (magnetic to electricity)

Wireless Micro Power



A Life Cycle Cost Evaluation of Multiple Lighting Control Strategies

Commissioned By: **Daintree Networks**

Prepared By: **Clanton & Associates, Inc.**

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Group 14 Engineering

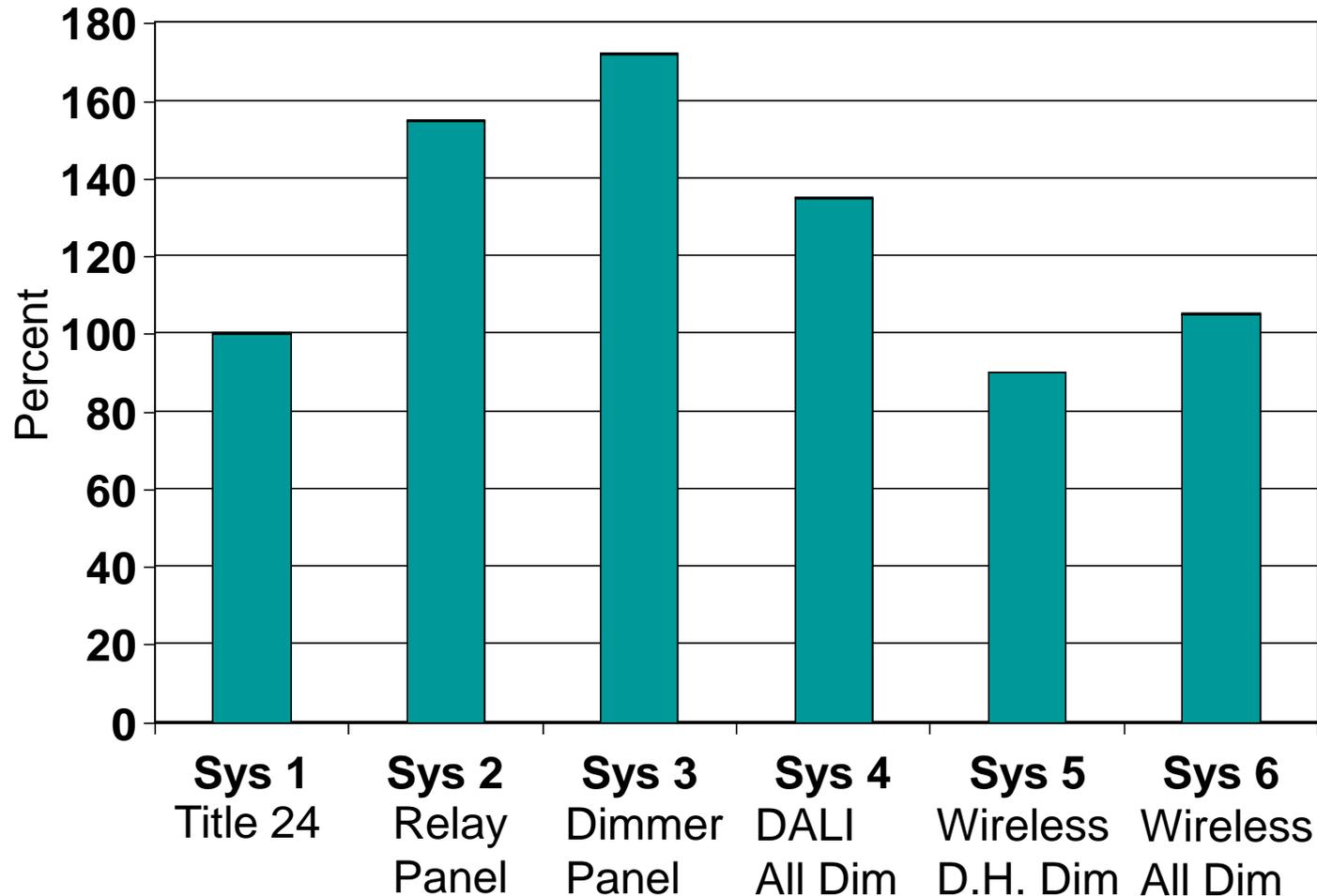
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Energy Products Associates, LLC

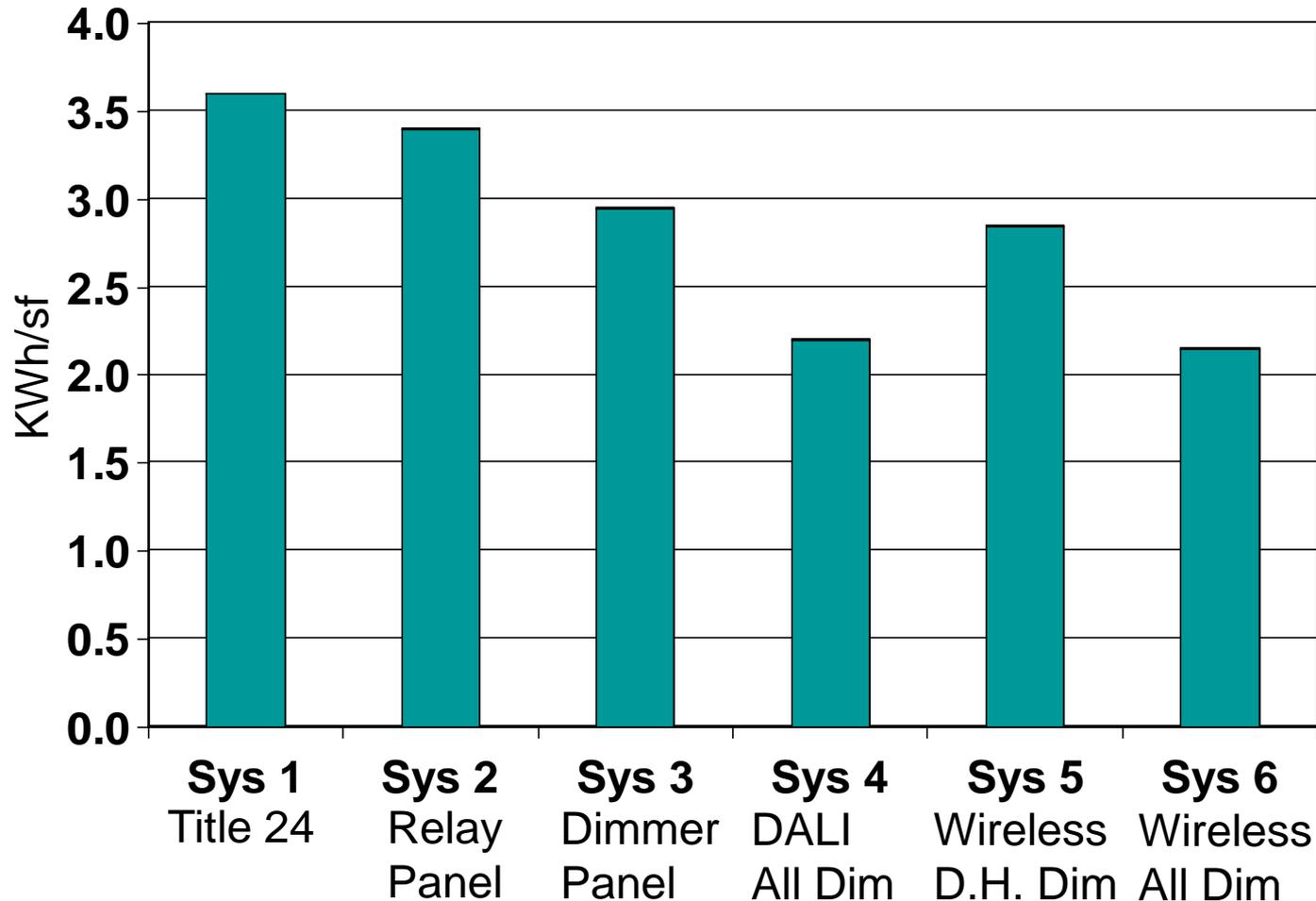
Systems Evaluated

- 1 – Localized Control (Title 24 compliant)
- 2 – Relay Panel for Switching
- 3 – Relay & Dimming Panel for Daylight
- 4 – DALI Dimming everywhere
- 5 – Wireless Dimming near windows (D.H.)
- 6 – Wireless Dimming everywhere

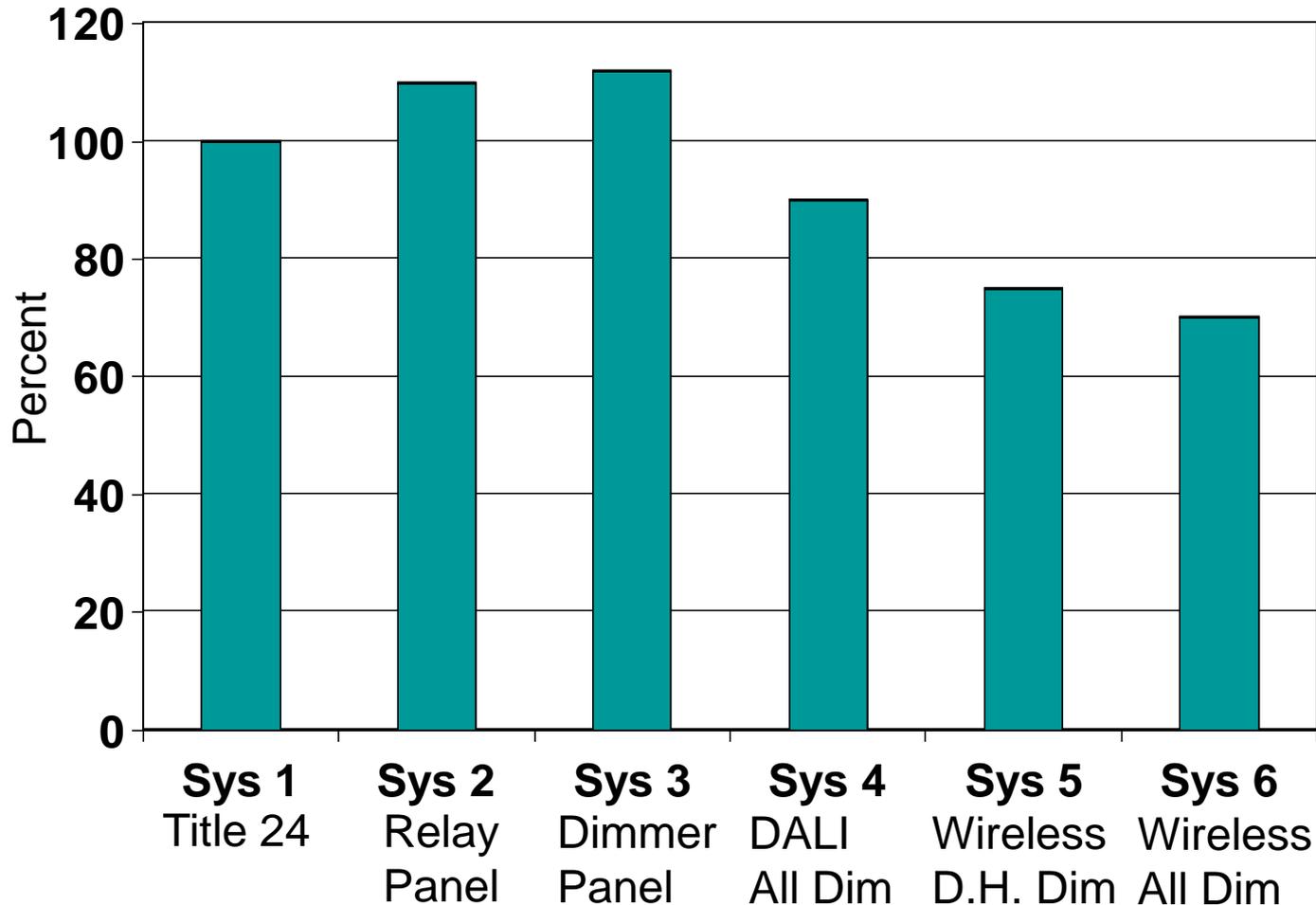
Relative Capital Cost



Annual Energy Use



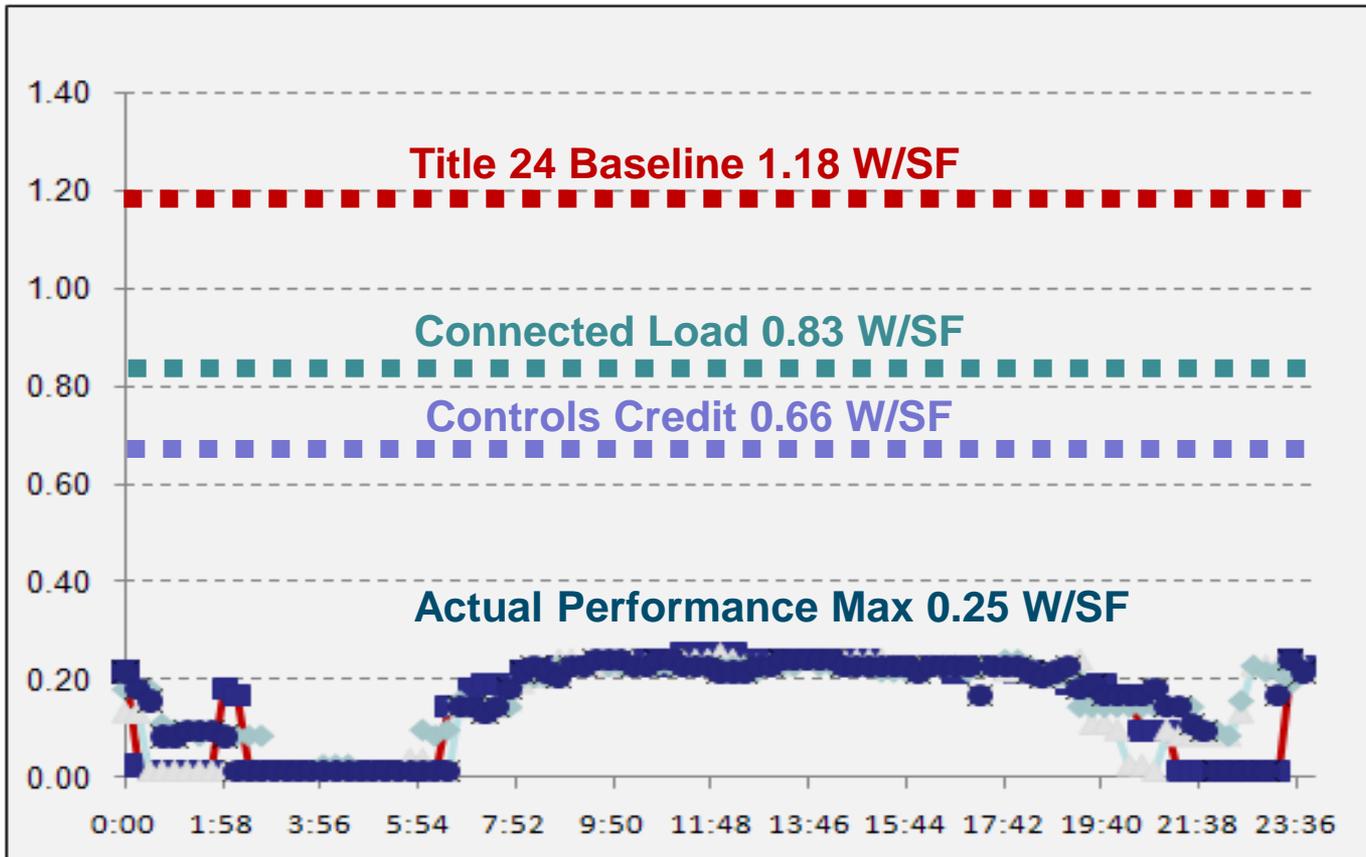
Relative Life Cycle Cost



LA Engineering Office

- System:
 - Wireless, addressable
 - EnOcean protocol
 - Wall Switches, Vacancy Sensors, Photosensors
- Strategies
 - Daylight harvesting, Vacancy, Multi-level
 - Task/Ambient Lighting (each controlled separately)
 - Occupancy sensor informs HVAC to change setpoint
 - Demand response
 - Personal control
 - Energy dashboard

Real Measured Data



Control of LED Luminaires

- LEDs are inherently controllable
 - Efficient dimming – 50% light is 50% power
 - Lumen maintenance – maintain light output as LED depreciates, while initially reducing power of the lighting system
- LED lifetime and efficiency improves when dimmed
 - Dimming an LED runs it cooler, which makes it more efficient and reduces depreciation
- Market shift to LED offers opportunity for controls
 - Control for lighting quality (including color control)
 - Dim corridors and parking garages when unoccupied

Summarize

- Implement all Control Strategies
- Write thorough Control Narrative
- Dimming via DALI or 0-10VDC
- Digital Control Network via wire or wireless

Conclusion

- The greatest energy savings are achieved through the simultaneous deployment of all lighting control strategies.
 - and -
- For simultaneous deployment of all lighting control strategies, wired and/or wireless digital lighting controls are required.

References

- Clanton & Associates: “A Life Cycle Cost Evaluation of Multiple Lighting Control Strategies”
- IES Seminar: Lighting Controls for Nonresidential Buildings
- LCA: Education Express:
<http://www.aboutlightingcontrols.org/EducationExpress/welcome.php>
- NBI
- NEMA
- DOE

Credits

- Acuity Brands
- Advance - Philips
- Adura Technologies
- CAN2GO
- Clanton & Associates, Inc.
- DALI
- Douglas
- Daintree Networks
- Dynalite - Philips
- Eaton/Cutler Hammer
- Echoflex
- EMerge Alliance
- Encelium
- enLighted, Inc.
- EnOcean
- ETC
- Functional Devices
- ILC
- Illumra
- LC&D
- Leviton
- Lumenergi
- Lutron
- Redwood Systems
- Siemens
- Square D
- Sylvania
- The Lighting Quotient
- Universal Lighting Tech.
- Watt Stopper

THE END