

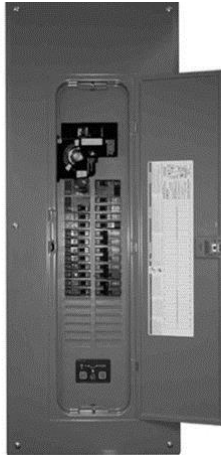


2016

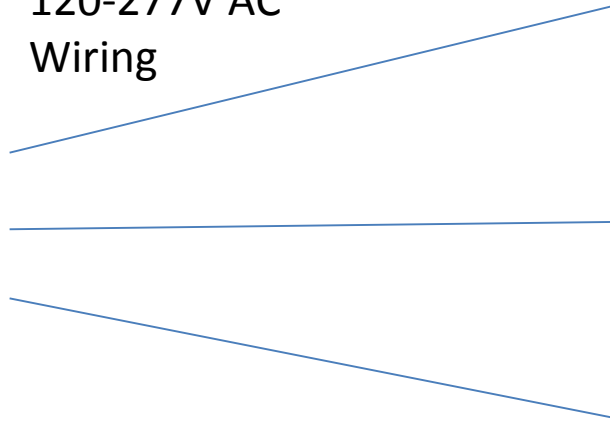
STAKEHOLDER MEETING

DC/PoE Lighting Systems

# Traditional Lighting System



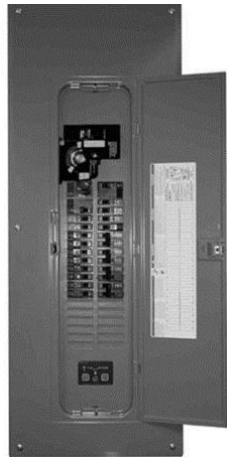
120-277V AC  
Wiring



**DLC Box**



# Distributed Low Voltage Lighting System (including PoE)



120-277V AC  
or 380V DC  
Wiring

**Corresponding  
DLC Box**

Remote AC/DC  
Power Supply  
or PoE Switch



Ethernet  
or other  
DC Cable

DC to DC Driver



# Key Challenges

- Efficiency of the system is most important for DLC Member programs
- Losses are dependent upon system parameters
  - Line losses – cable and length
  - Remote AC/DC power supply – loading conditions
- Information published in QPL could be misleading
  - Performance of DC luminaire only excludes system losses
  - AC luminaire performance is not comparable to DC performance if system efficiency is not included
- Ease of use for Member programs
  - Differing specifications between AC and DC products could require administrative challenges

- DLC seeking proposals from stakeholders
- Send to [info@designlights.org](mailto:info@designlights.org)
- Strong proposals will:
  - Take into account and address challenges discussed today
  - Applicable to various systems (i.e. not limited to proprietary designs)
  - Ideally include supporting data to aide in review

# Attend Discussion Sessions for More Info

## Wednesday, 10:30 - Noon

- DC and PoE Lighting (Ballroom B)
- Small-group discussion
- Tackling Key Challenges in developing a specification and/or policy

# Panelists



**Tom  
Herbst**

*Cisco*



**Ben  
Hartman**

*EMerge Alliance*



**Chris  
Andrews**

*Eaton*

# Thank you to our sponsors.

## EATON

*Powering Business Worldwide*

**AcuityBrands** **RAB** LIGHTING **PHILIPS** **XcelEnergy**

**Efficiency Vermont** **STD** Standard-Tech **CREE** **VaOpto** LED Manufacturer **DIGITAL LUMENS**



**LUTRON**

**FOREST LIGHTING**  
Sustainable Illumination





# Denver DLC Stakeholders Meeting

PoE Lighting

Thomas Herbst  
CTO, IoT Vertical Solutions

August 2, 2016



# Agenda



- The Digital Ceiling
- Introduction to PoE
- Network Powered Lighting
- Next Steps

# Digital Ceiling

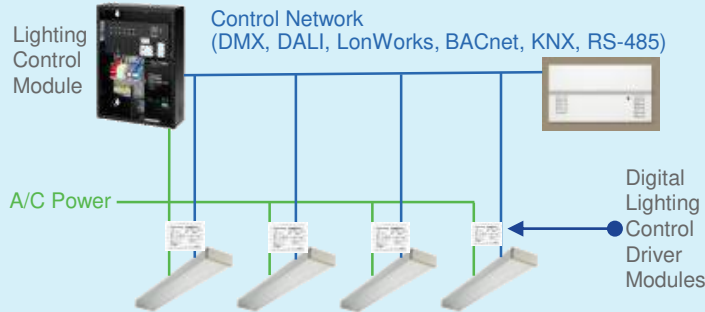
## Enabling New Workforce Experiences

# Infrastructure Convergence

## Traditional Lighting Infrastructure



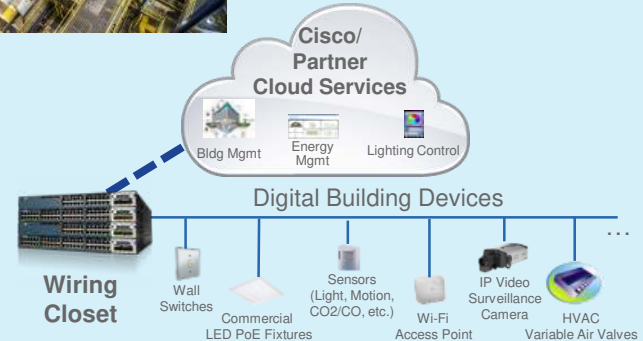
- High voltage cabling for lighting (110V or 277V Power)
- Legacy RS-485 protocol for control



## Digital Lighting Infrastructure

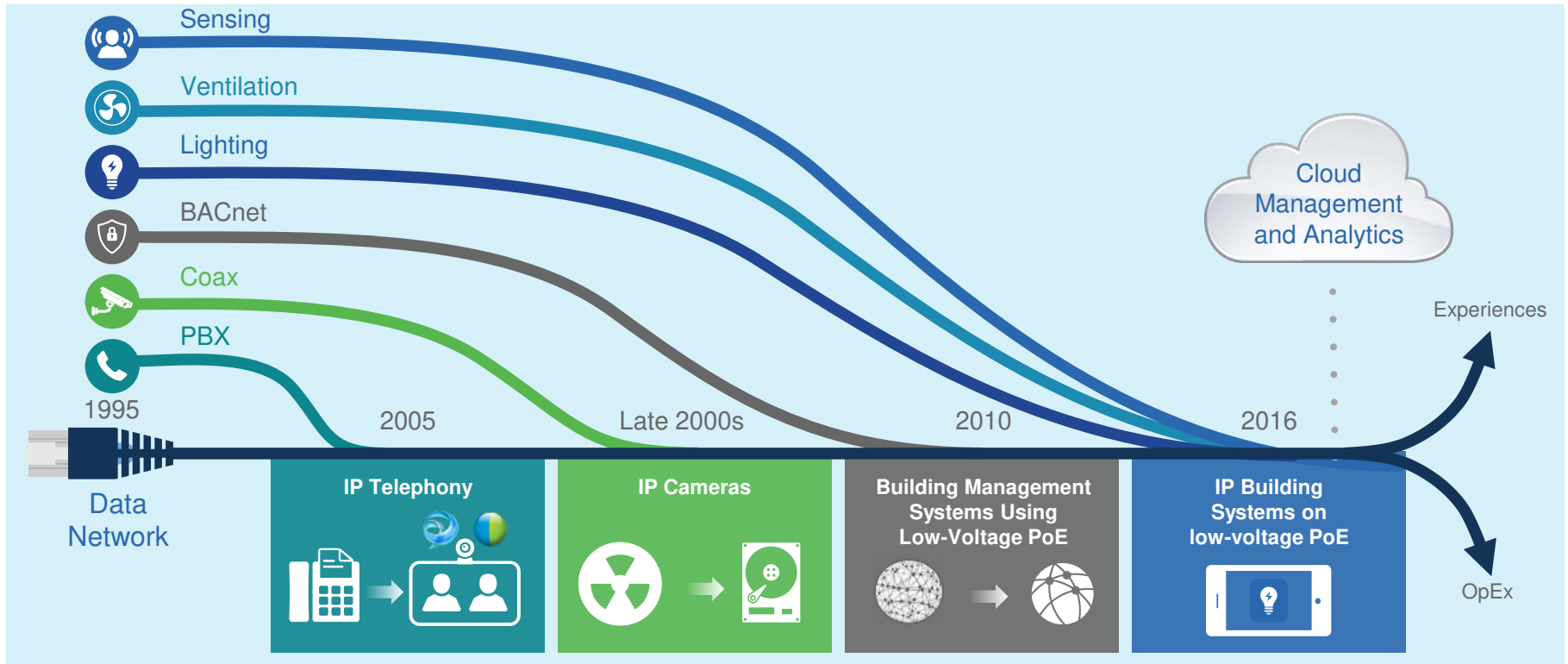


- Switch PoE powers LED lights and other edge devices
- Both power and control provided through RJ-45 Ethernet cable



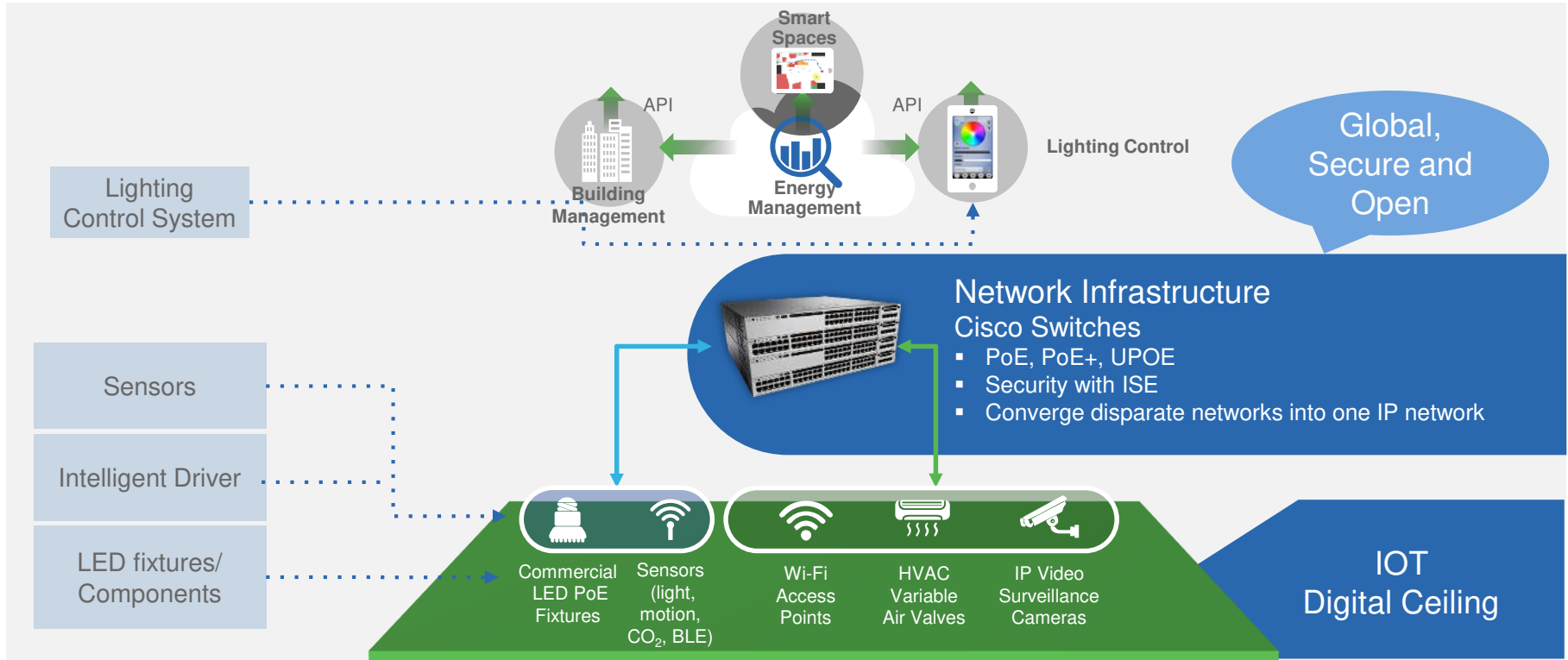
- **Lower TCO:** Reduced material and labor cost, energy savings
- **Intelligent IP platform:** software analytics for broader building automation initiatives

# IP Convergence Drives the Internet of Things

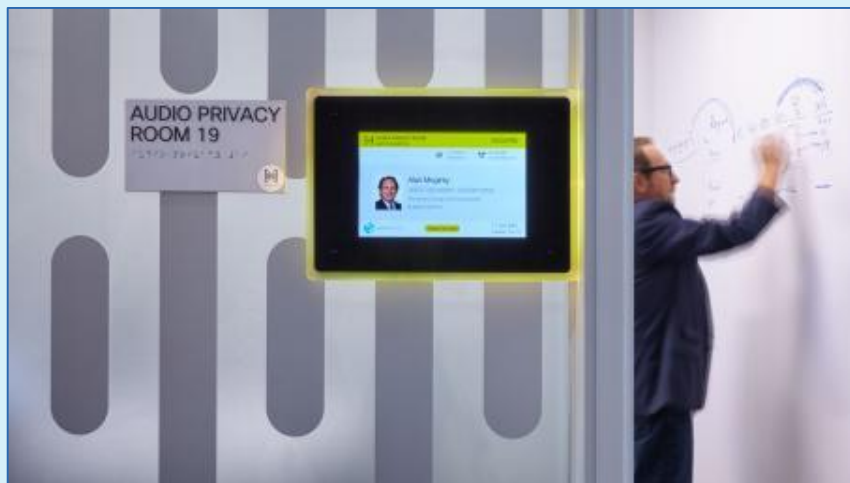


IP Convergence Lowers OpEx, enables remote management and results in better People Experiences

# Digital Ceiling High Level Architecture



# New Workforce Experiences Enabled by the Digital Ceiling



Behavior

Environment

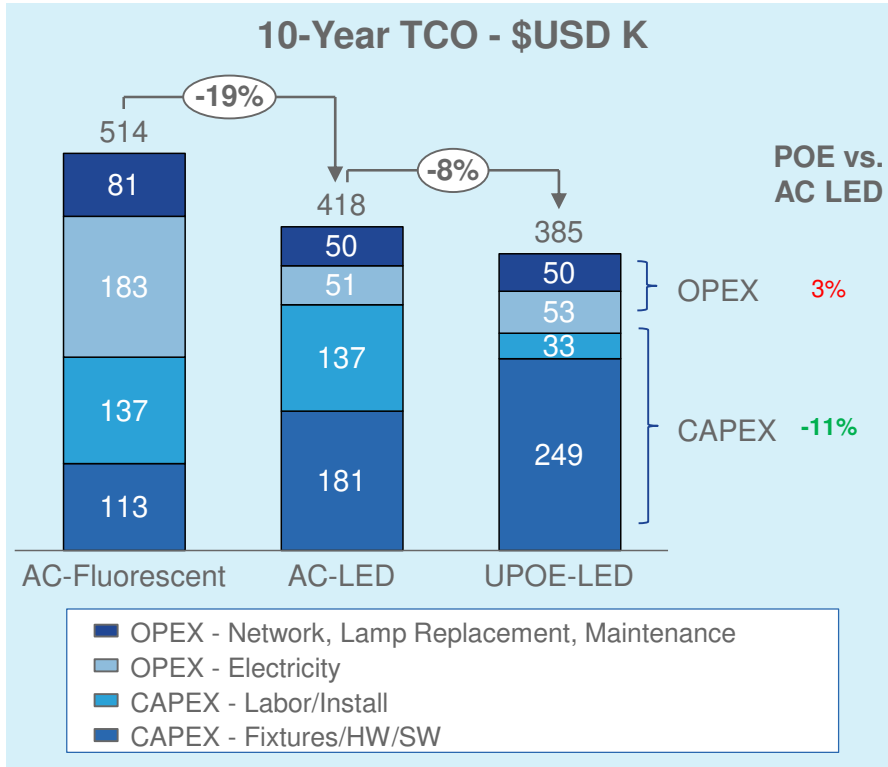
Meeting

Collaboration

Drives New User Experiences and Space Optimization

- Coordinates physical and virtual aspects of the workplace
- Personalizes the experience giving a sense of place
- Enables minimal interaction experiences
- Optimizes office space and resource utilization
- Provides greater insight into occupant's behavior, collaboration touch points, and workflows
- Make workspaces available, when and where people need them, on demand
- Understand work patterns and performance

# Digital Smart Lighting – Lower TCO Advantage



- Key factors driving lower TCO for PoE LED
  - Lower installation costs
  - Incremental overall energy savings
  - Future PoE light fixtures will cost less
- TCO expected to improve
  - LED price/performance increase 20% per year
  - LED luminous efficacy will continue to improve

\*US NYC customer, 35K Sq Ft space



# Introduction to PoE

## Data and Power on One Cable

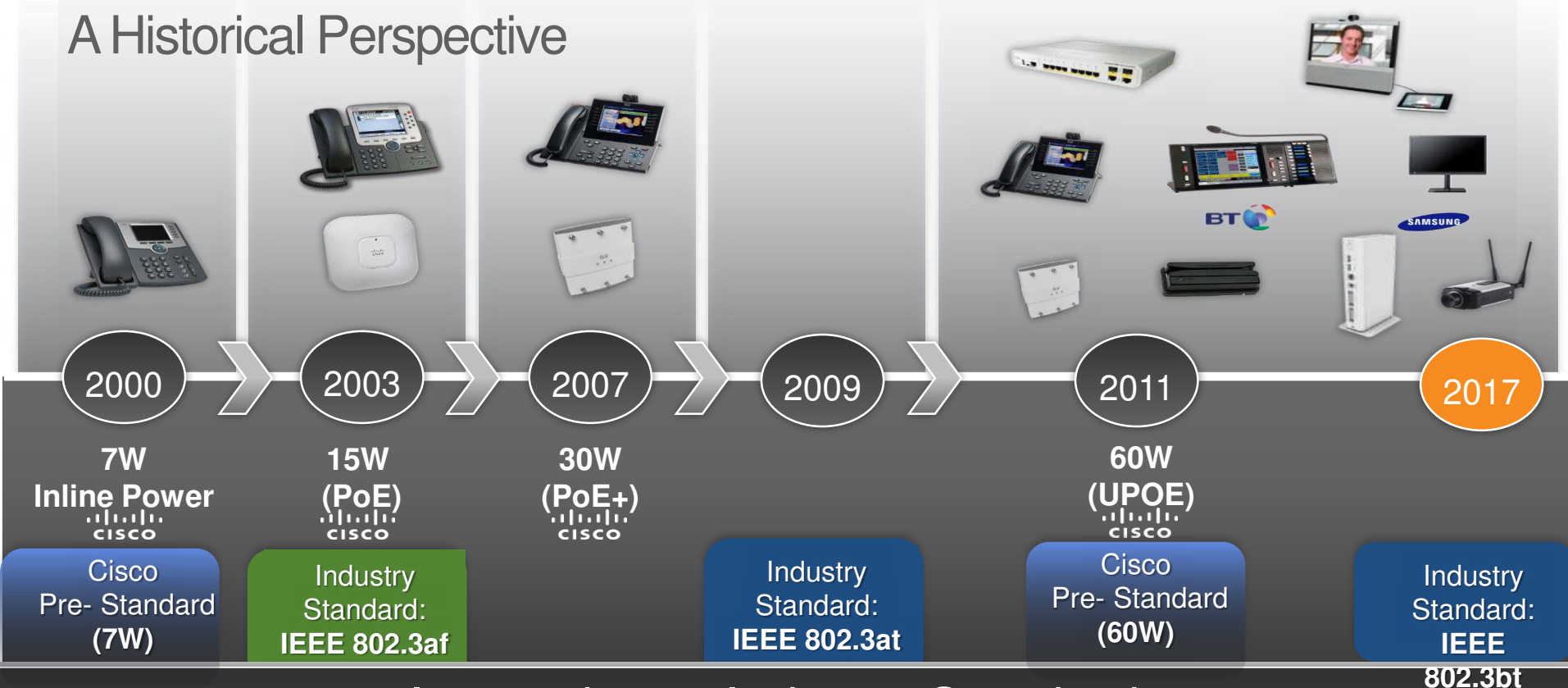
# Power over Ethernet Defined

- Power over Ethernet (PoE) is a standardized way of passing both power and data over the same cable (IEEE 802.3af and 802.3at).
  - Power can be carried on the same conductors as network data or on separate conductors in the same cable.
  - 10/100/1000Mbps Data
  - Max Distance – 100 meters
  - Power Device (PD) – Consumes Energy
  - Power Sourcing Equipment (PSE) – Provides Power
  - PD devices negotiate power from the PSE
  - PoE is delivered over Category 5 or better cable
  - PoE is a global standard
- A Cisco PSE can source up to 60W today
- 802.3 devices are listed as a power source for Low Voltage Lighting under UL-2108



# Power Over Ethernet

## A Historical Perspective

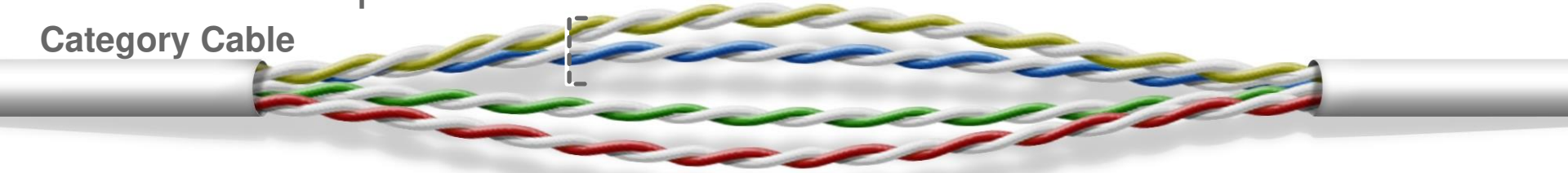


### Innovation to Industry Standards

# PoE and PoE+

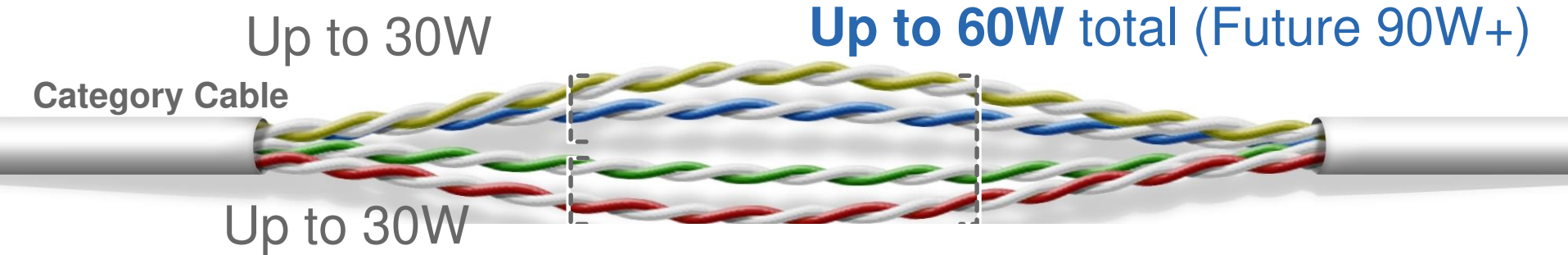
Up to 30W

Category Cable



- **PoE and PoE+ use Ethernet pairs (1,2 & 3,6) to deliver power and data**
- **802.3af Standard – up to 15.4 watts at PSE, 350mA max**
- **802.3at Standard – up to 30 watts at PSE, 600mA max**

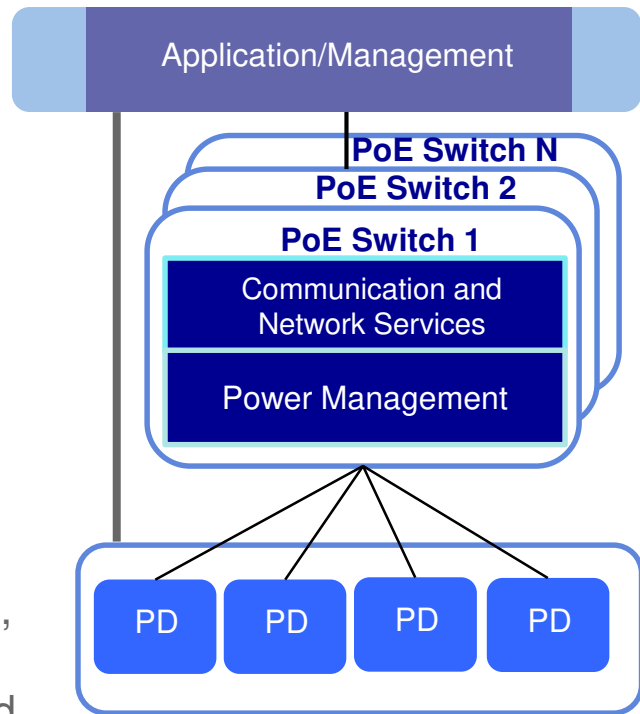
# Cisco UPOE and Future Standard



- Combine two pairs of 30W to form 60 Watts of power
- UPOE and the new standard will use all four pairs to deliver power
- Cisco innovation delivering 60 watts today (Pre-Standard)
- 802.3bt standard is expected in late 2016 or early 2017
- Proposed Type 3 (up to 60W) and Proposed Type 4 (<100W) in 802.3bt

# Functionality of Cisco PoE Switches

- Provide power management to the Powered Devices (PDs)
  - Provide negotiated power to PDs based on device requirements
    - 2-event classification
    - LLDP
  - Power management and reporting
    - Actual power consumed per PoE device
    - Total power consumed by whole switch
- Serve as a Gateway for network communications and intelligent services
  - Provide Layer 2 and Layer 3 network connectivity
  - Serve various network functions such as segmentation, security, resource management/QoS, monitoring, etc
  - More application specific processing done in partitioned resources on switch



# Network Powered Lighting System

# Connected Light



Color beacons create pathway lighting or indicate room status



Any light can be backed up with a UPS



Integrated BTLE for nearby devices

Integrated CO2 and other gas or particle sensors



Integrated Speaker modules

One lighting fixture facilitates many applications

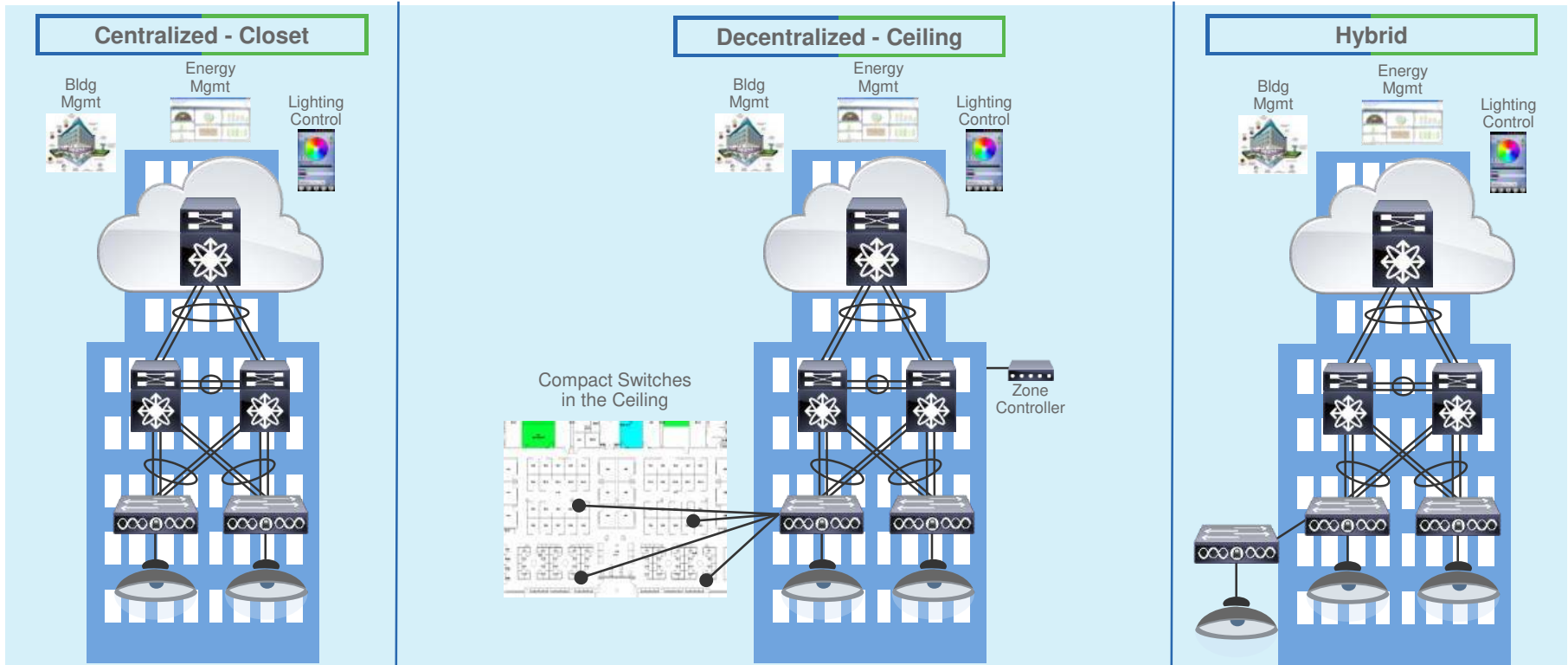
VLC data applications



Network Power creates a secure and scalable path for Applications; Connectivity drives new functionality in Light fixtures



# Possible Deployment Scenarios



# Example Switches for Both Scenarios

## 3560CX Compact Switch



- Fanless design with flexible mounting options
- 240W power budget for **POE+**
- Industry first to support **Perpetual POE**
- **2-event POE classification** support
- **Fast POE** Support
- Ideal for in-ceiling applications/distributed deployment model

## 3850UPOE Switch Family



- Flagship **UPOE** switch with and dual 1.1KW Power Supplies
- Converged Wired and Wireless access
- Stack Power support
- Perpetual POE Support
- 2-event classification support
- Fast POE Support

# Category Cable

Cat 5e, Cat6, Cat6a  
Crosstalk between pairs



Individual Conductor Thickness  
22 to 28 gauge

Wire Gauge Conversion Chart		
Sizes listed are AWG (American Wire Gauge)		
Wire Gauge	Inches	Millimeters
14 •	0.064	1.63
15 •	0.057	1.45
16 •	0.051	1.30
17 •	0.045	1.14
18 •	0.040	1.02
19 •	0.036	0.914
20 •	0.032	0.813
21 •	0.029	0.737
22 •	0.025	0.635
24 •	0.020	0.508
25 •	0.018	0.455
26 •	0.016	0.406
28 •	0.013	0.320
30 •	0.010	0.254
32 •	0.008	0.203

# Factors in Efficiency



## Fixtures

- LED efficacy
- Power Conversion
- Other Functions



## Cable Line Loss

- Gauge
- Length



## Functions in Switch

- Switch Packets
- Other CPU Tasks
- Power Conversion

# Best Actual Lab Test



138 lm/W PoE+ Fixture



Cisco Catalyst 3560cx  
(240v input)



10 Meters 22 Gauge  
Cat 6a

Observed System Performance 121.32 lm/W  
(24 Gauge – 120.88 lm/W)

# Lowest Actual Lab Test



125 lm/W UPOE Fixture



100 Meters 24 Gauge  
Cat 5e



Cisco Catalyst 3850  
(120v input)

Observed System Performance 100.19 lm/W

# Theoretical Example of a Poor PoE System



100 lm/W Fixture



**Not a Real Switch!**



100 Meters 28 Gauge  
Cat 5

Theoretical System Performance 87.27 lm/W

# Next Steps



# Moving Forward

## **Luminaire Listings**

LM-79 testing already can report results of DC fixtures  
Efficiency of DC-DC better than AC-DC

## **PoE Switch Listings**

Testing Methodology similar to NEMA ANSI C82.16

## **Guidelines on wire loss verses run length**

x gauge if runs average more than y meters



Reinventing Building Power



# DC in an AC World

an EMerge Alliance Perspective

Ben Hartman, Board Member– EMerge Alliance  
CTO, Nextek Power Systems



DESIGNLIGHTS  
CONSORTIUM

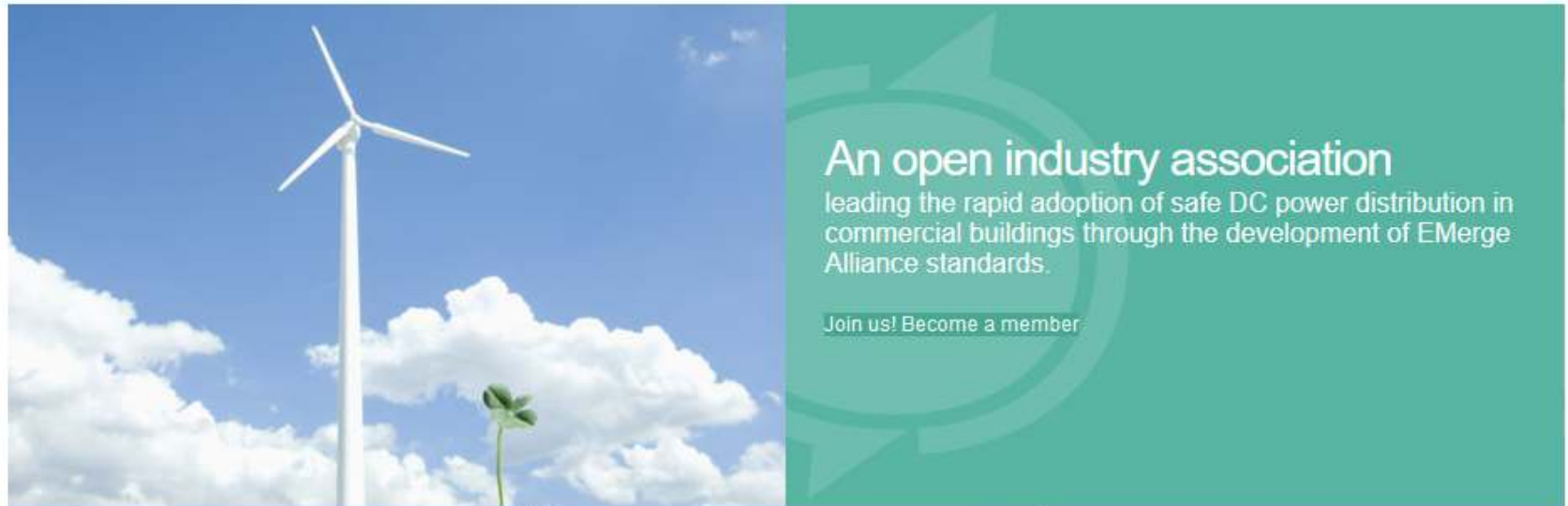
2016

STAKEHOLDER  
MEETING  
August 2-3 • Denver, CO

# What is the EMerge Alliance?



[HOME](#) | [ABOUT](#) | [STANDARDS](#) | [PRODUCTS](#) | [JOIN](#) | [NEWS & EVENTS](#) | [RESOURCES](#) | [CONTACT](#)

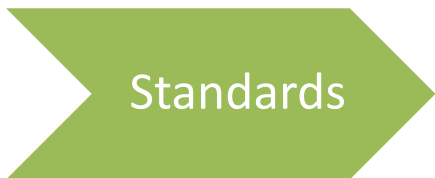


An open industry association  
leading the rapid adoption of safe DC power distribution in  
commercial buildings through the development of EMerge  
Alliance standards.

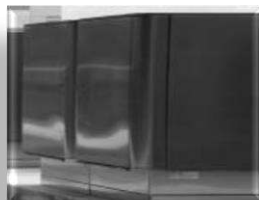
[Join us! Become a member](#)

<p><b>Flexibility</b> Do More with Unimaginable Ease...</p>	<p><b>Sustainability</b> Meet Needs for Today and Tomorrow...</p>	<p><b>Savings</b> Reap Rewards for Decades to Come...</p>
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# What's in the works?



## Standards that are Modular Providing an Opportunistic Path Forward



### Standards Activities

- Issued** • *Occupied Space*
- Issued** • *Data Center & Central Office*
- Active** • *Task Level (desktop & plug loads)*
- Active** • *Whole Building Microgrids*
- Pending** • *Outdoor DC / Electric Vehicle Charging*
- Pending** • *Building Services (HVAC)*
- New in 2014** • *Residential & Light Commercial*
- Plan for 2015** • *Remote Residential & Small Village*
- Plan for 2016** • *Retail Commercial*

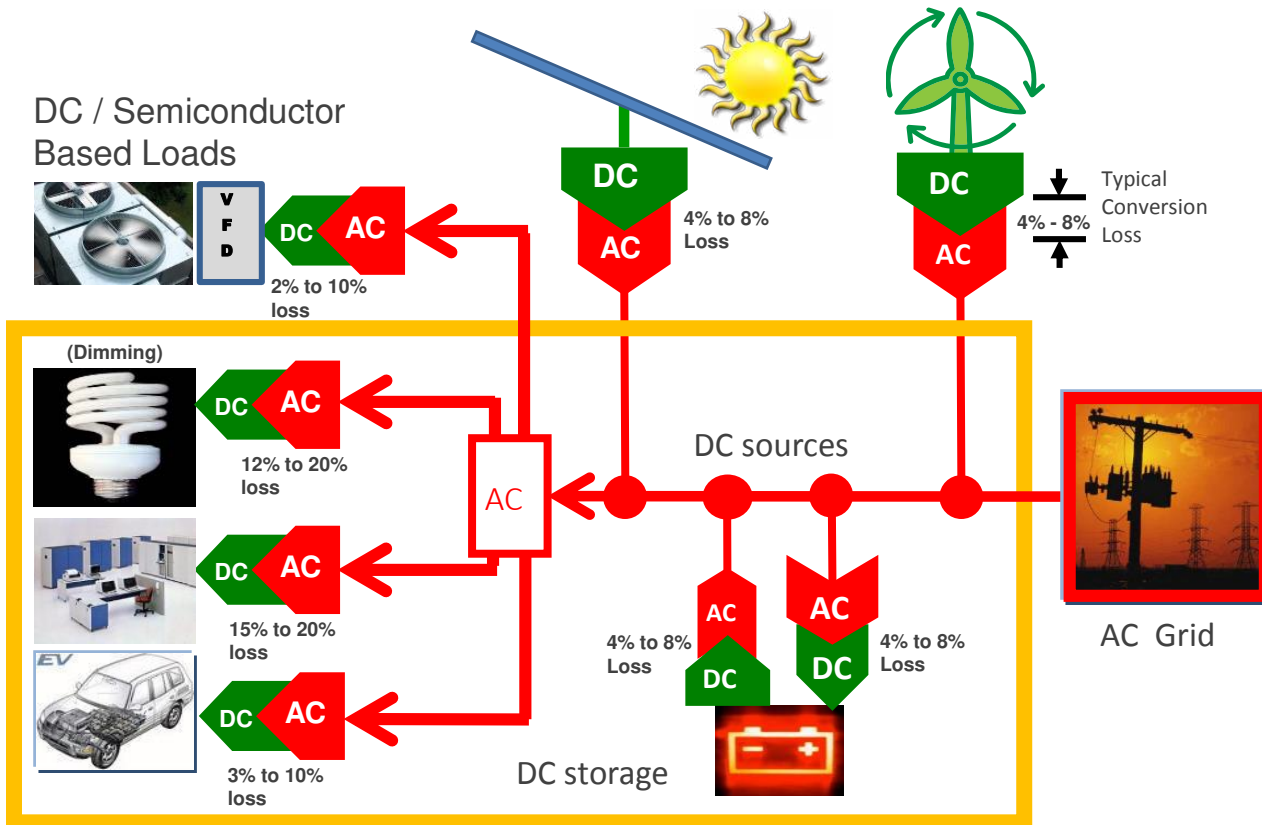


# **EMerge**<sup>®</sup> **ALLIANCE** Connecting the Dots...



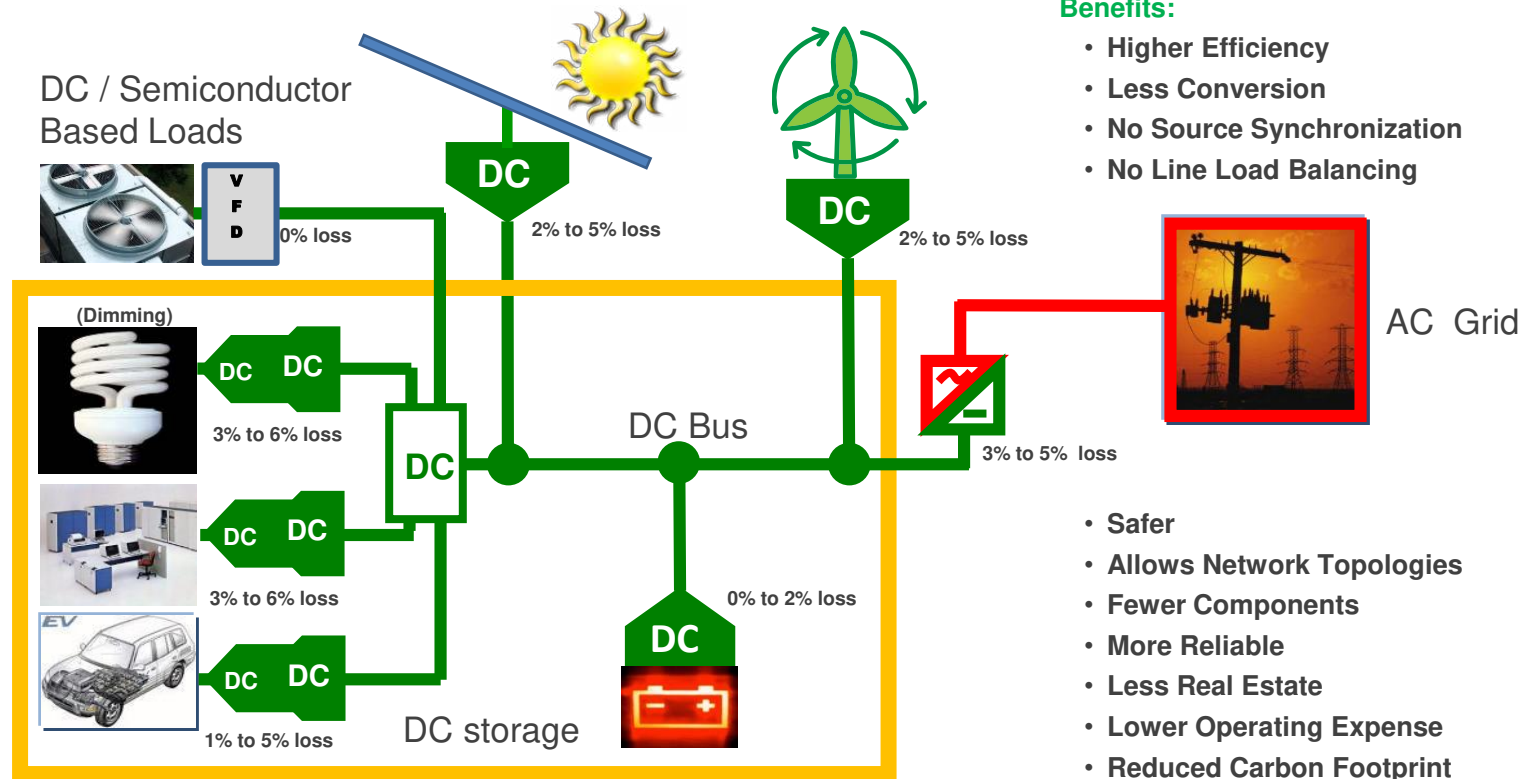
# About Hybrid AC/DC Microgrids

The Status Quo...



# About Hybrid AC/DC Microgrids

The Ideal End State...



## Benefits:

- Higher Efficiency
- Less Conversion
- No Source Synchronization
- No Line Load Balancing

- Safer
- Allows Network Topologies
- Fewer Components
- More Reliable
- Less Real Estate
- Lower Operating Expense
- Reduced Carbon Footprint



# What are the benefits?

1. DC input increases the flexibility, modularity and resiliency
2. Increased Safety – Low voltage, SELV, NEC Class 2
3. Improved efficiency
  1. Centralized power conversion
  2. > 95% AC-DC conversion above 40% load
  3. Wide input range of 208-277Vac, 200-420Vdc
  4. EMerge standard allows for 2% wiring loss
  5. Overall system electrical efficiency >93% at maximum loss with controls, energy metering built in.
4. Option to reduce luminaire cost by eliminating driver entirely, driving LEDs with constant voltage and PWM dimming at 1kHz

## More benefits?

5. Fast simple installation of low voltage parts with less low voltage trades.
6. Recommend wireless controls to reduce wiring and simplify commissioning: Members use Zigbee, 6LoWpan, and 900 MHz mesh.

# Hybrid AC/DC Buildings

Transformation

## Beginning with the Occupied Space

*Developed for commercial interiors*

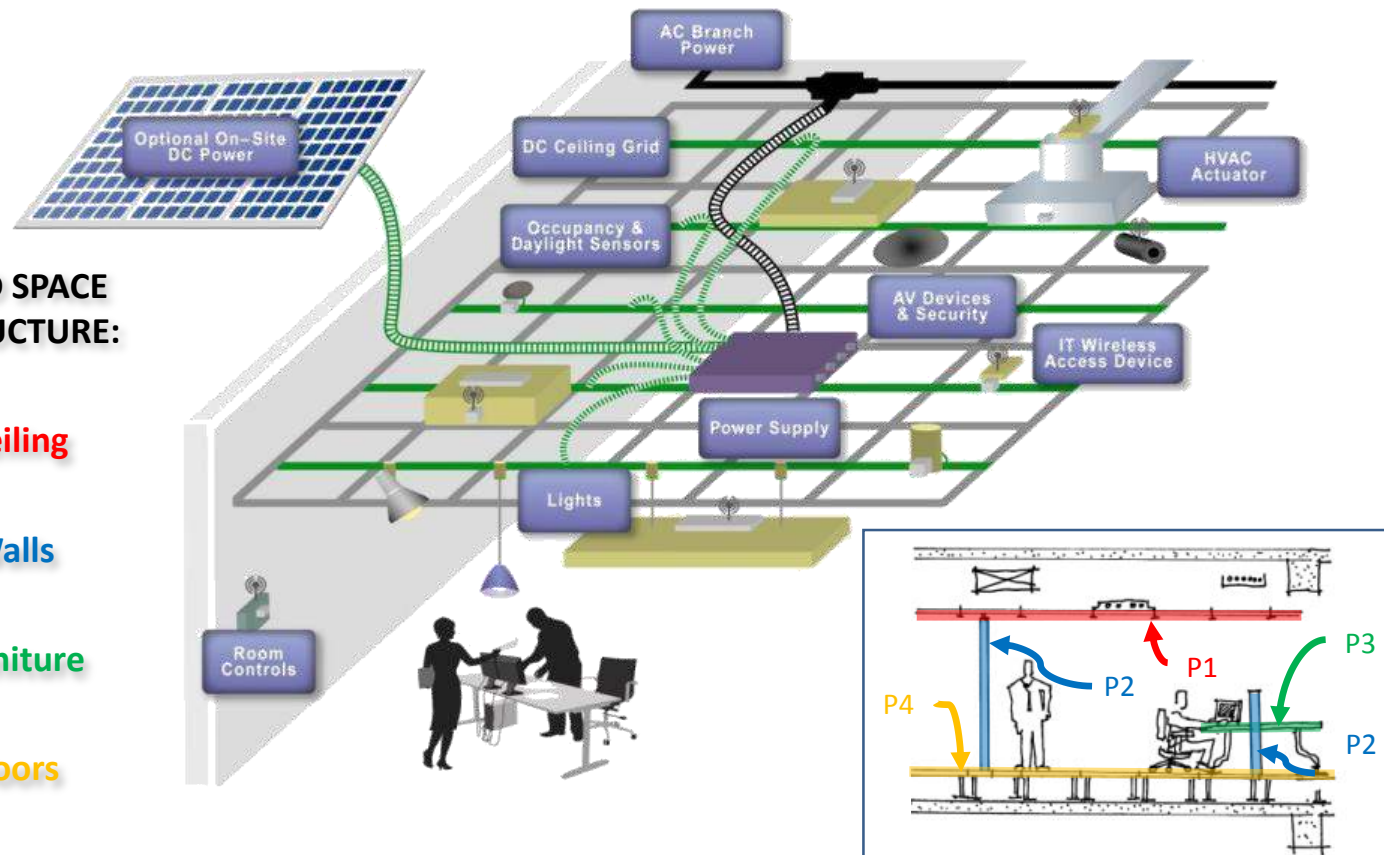
OCCUPIED SPACE  
INFRASTRUCTURE:

P1 = Ceiling

P2 = Walls

P3 = Furniture

P4 = Floors



# What is the Emerge Alliance?

and why would a Lighting company care?

Mark Hand

VP Engineering, Indoor



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 AcuityBrands.

# Why DC Microgrids?

- Real Question - Why centralized power?
  - Nothing new
    - Master – Satellite
  - More Efficient - **>7% Less**
  - Lower Install Cost – **90% Less (excludes lighting equipment)**



**AC System Installation Cost = \$1650**



**DC System Installation Cost = \$165**

©2015 Acuity Brands

# Challenge of Existing Buildings

85% of buildings that will exist in 2030 are here today!

“The Need for Standards that allows an Opportunistic Transformation Strategy”

## Must Consider:

- Retrofits
- Renovation
- Re-Use
- New Builds



# A Family of Open Power Application Standards for Hybrid DC Microgrids

## THE HYBRID BUILDING



## THE HYBRID HOUSE



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**Reinventing Commercial Building Power**



**Reinventing Residential Power**

# Hybrid AC/DC Buildings



## Building Campus DC Microgrids

Full Scale Applications Under Development

**PURE MICHIGAN<sup>®</sup>**  
Michigan Economic Development Corporation

**DC MICROGRID IMPLEMENTATION AT THE NEXT ENERGY CENTER**

(Copyright 2011 Nextek Power Systems. All rights reserved.)

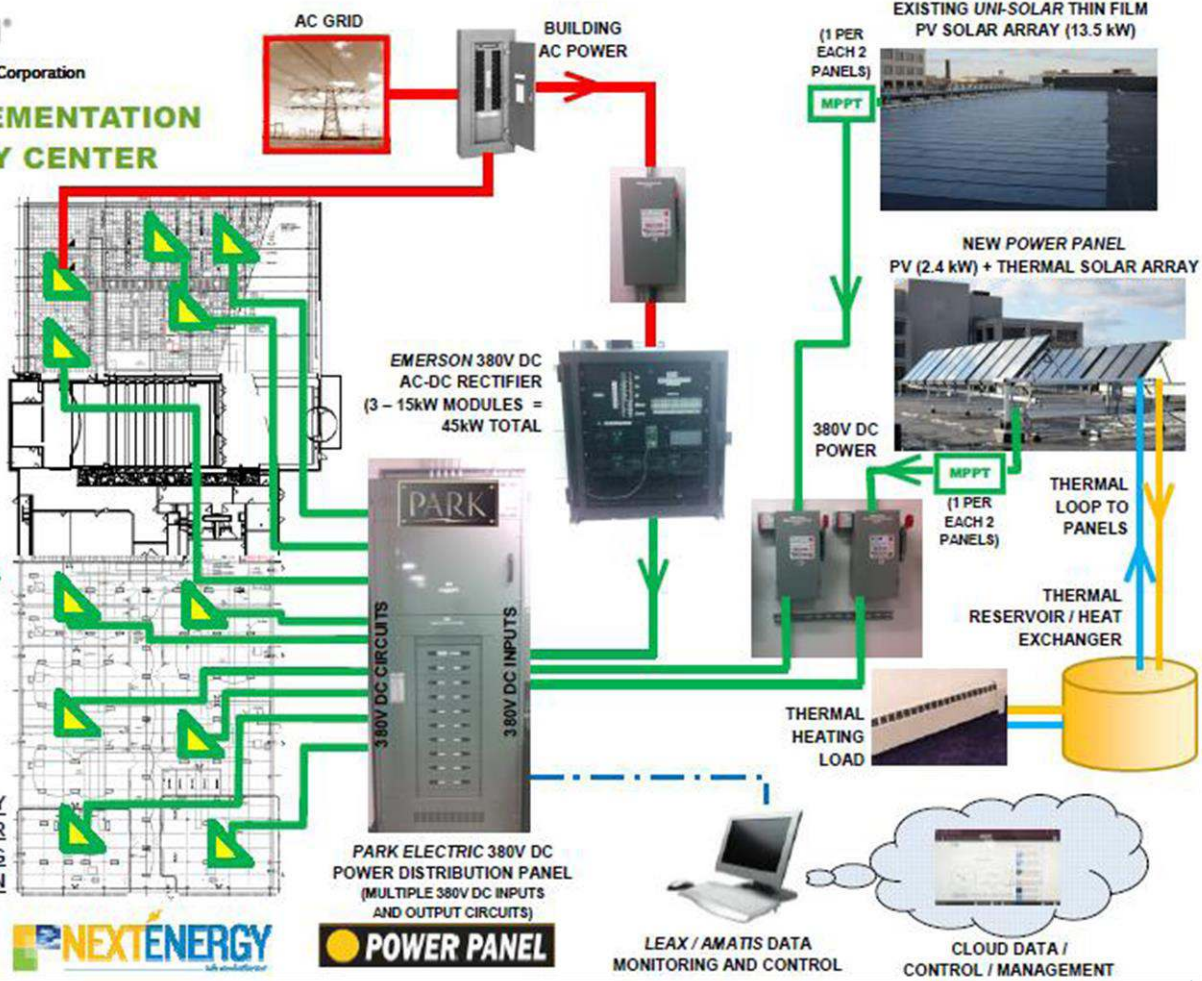
24v DC OFFICE AREA LIGHTING (RETROFIT OF EXISTING T5 LAMP FIXTURES)

PSM  
NEXTEK POWER SERVER MODULES  
16 CHANNELS @ 24vDC / 95 watts ea.

24v DC HIGH BAY ALUMALIGHT 6 LAMP T8 FLUORESCENT LAB LIGHTING (NEW FIXTURES TO REPLACE EXISTING HID)

24v DC NEXTEK FANS

NEXTEK CENTER BUILDING PLAN





# Hybrid AC/DC Buildings



Transformation

## Local Utility Rebates and Incentives

Challenges to DC Alternatives

- Encourage the establishment of a level playing field for DC/PoE systems in the DLC processes
- Welcome the DLC proposed DC/PoE rules
- Strive for QPL listing for a DC/PoE luminaires using some accepted AC-to-DC conversion efficiency number.
  - Weighted average loading, like CEC ratings for inverters?
  - Avoid end-user specific installation

Ben Hartman, Nextek Power  
& The Emerge Alliance

[Ben.hartman@nextekpower.com](mailto:Ben.hartman@nextekpower.com)

[www.emergealliance.org](http://www.emergealliance.org)

# Energy Efficiency & Low-Voltage Systems



Chris Andrews

August 2, 2016



*Powering Business Worldwide*

We help the world use electrical, fluid and mechanical power more **reliably, efficiently, safely and sustainably**



# Lighting and security

Improved efficiency, comfort and safety in the home and the workplace



**Recessed lighting**



**Ambient lighting**



**Outdoor lighting**

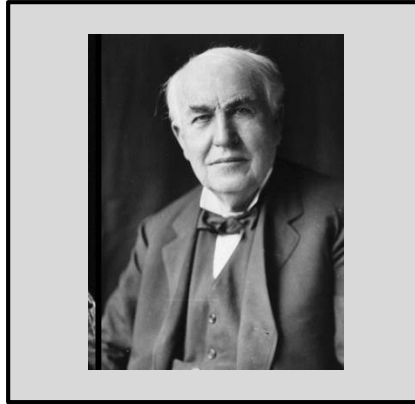


**Emergency lighting**



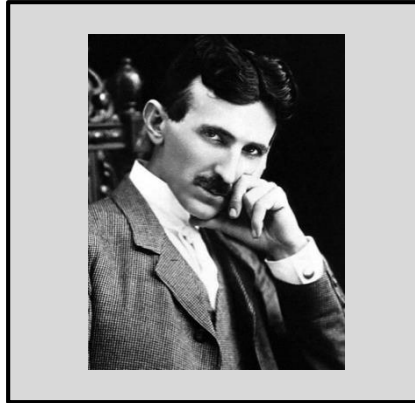
**Fire systems**

# A History of Invention



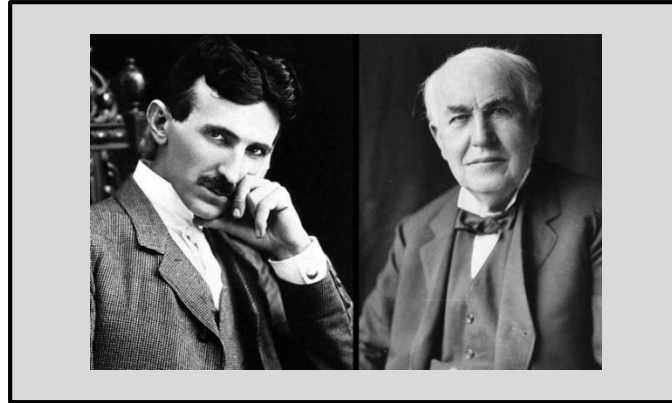
- Thomas Edison (1847 – 1931)
- Electric light bulb invented (1878)
- Patent granted (1880)
- Multiple patents around DC power
- General Electric standardized DC power

# A History of Contention



- Nicola Tesla (1856 – 1943)
- Protégé of Edison
- Championed AC for transformation
  - DC poor at stepping voltages

# “War of the Currents”



<http://energy.gov/articles/war-currents-ac-vs-dc-power>





# AC Electrical Power



**Distribution**



**Infrastructure**



**Transmission**



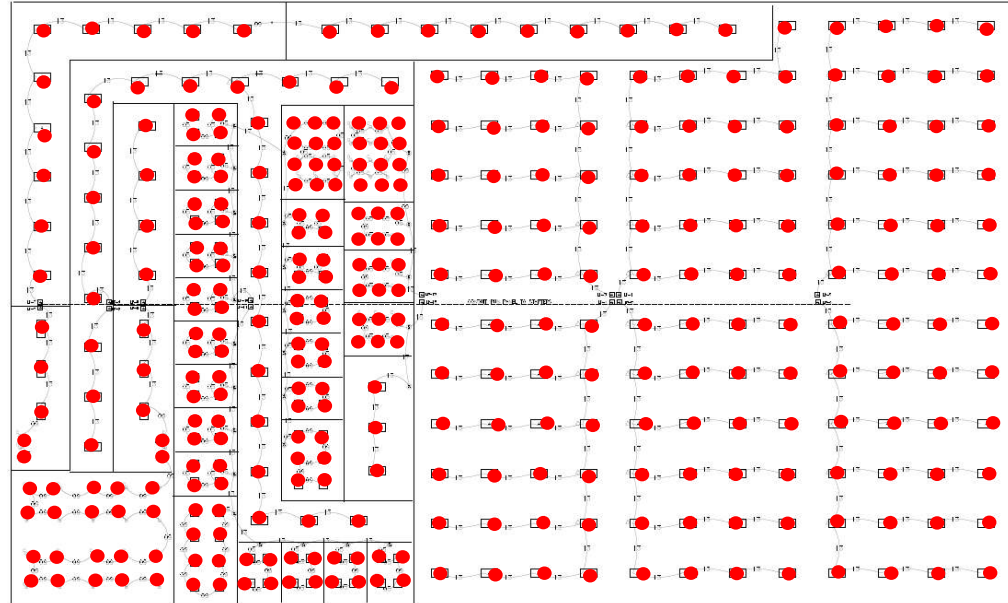
**Connections**

# Proliferation of DC Devices



# AC Building Infrastructure

- 35,000 sq. ft. building
- 348 AC-DC Transformations for LED lighting
- 1.5 miles of class 1 material
- 2 tons of protections
- 16-man weeks of labor
- 50% total installed cost



## Pros

Electrically efficient transmission

Typical installation techniques

## Cons

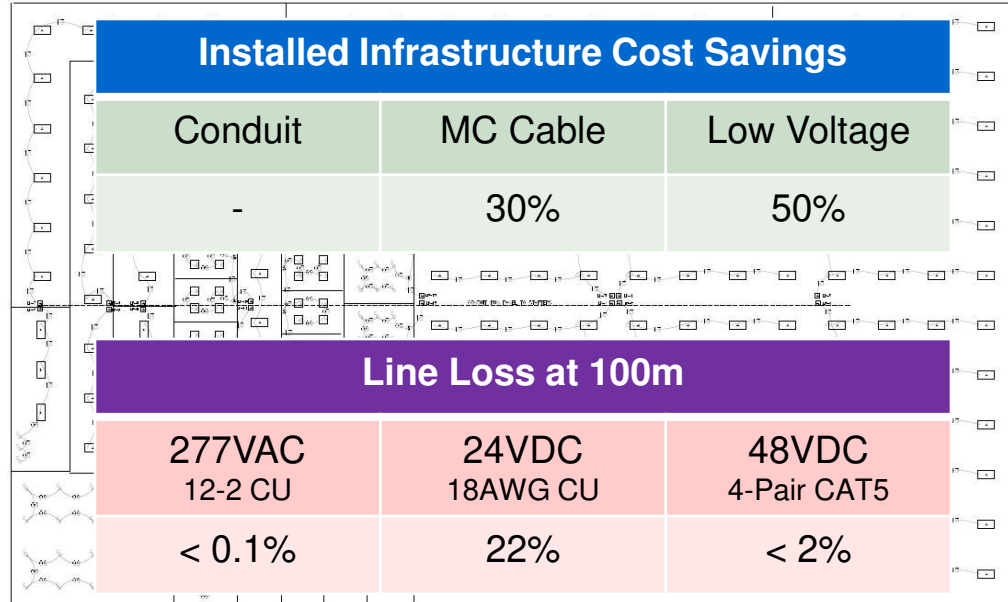
Many small transformations

Protections and specialized labor

Overlay Control System

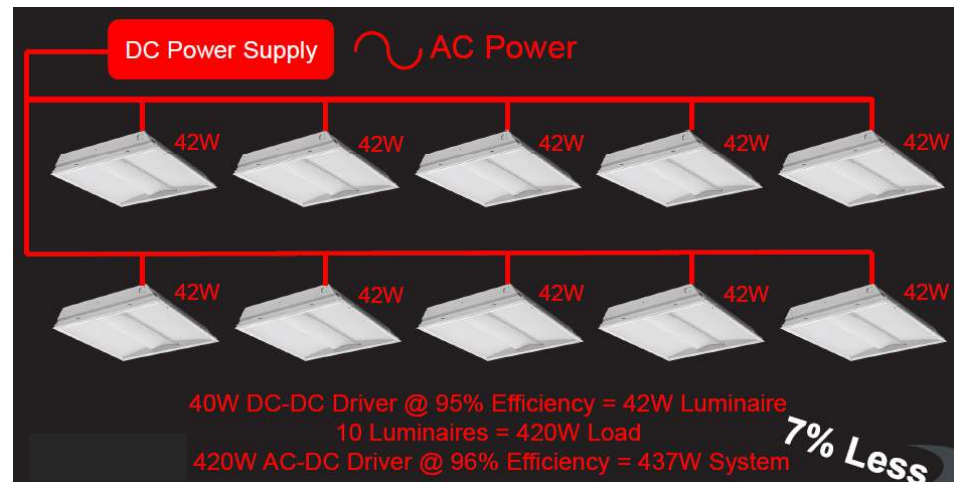
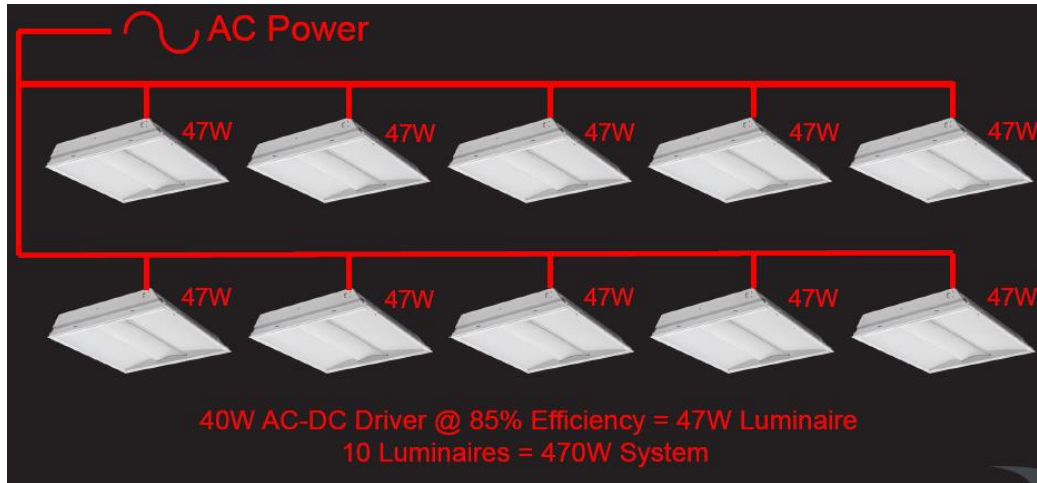
## DC Building Infrastructure

- 35,000 sq. ft. building
- ~~348~~ AC-DC Transformations for LED lighting
- ~~1.5~~ miles of class 1 wiring
- ~~2~~ tons of protections
- ~~16~~-man weeks of labor
- ~~50~~% total installed cost



Pros	Cons
Bulk AC-DC transformations	DC line losses & load matching
Eliminates class 1 protections	New installations techniques

# Get the Facts...

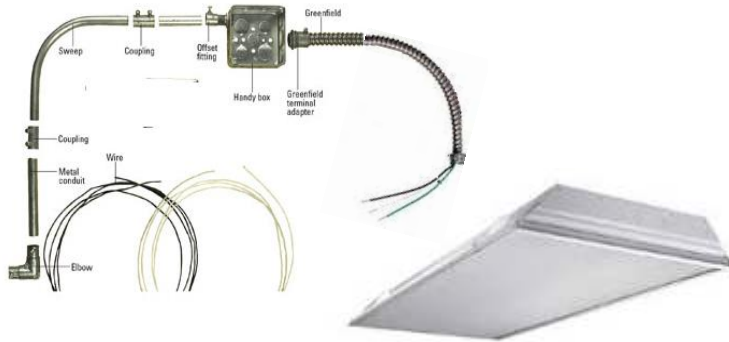


# Distributed Low Voltage Power system



# Low Voltage Power Program

## Existing Lighting Wiring Requirements

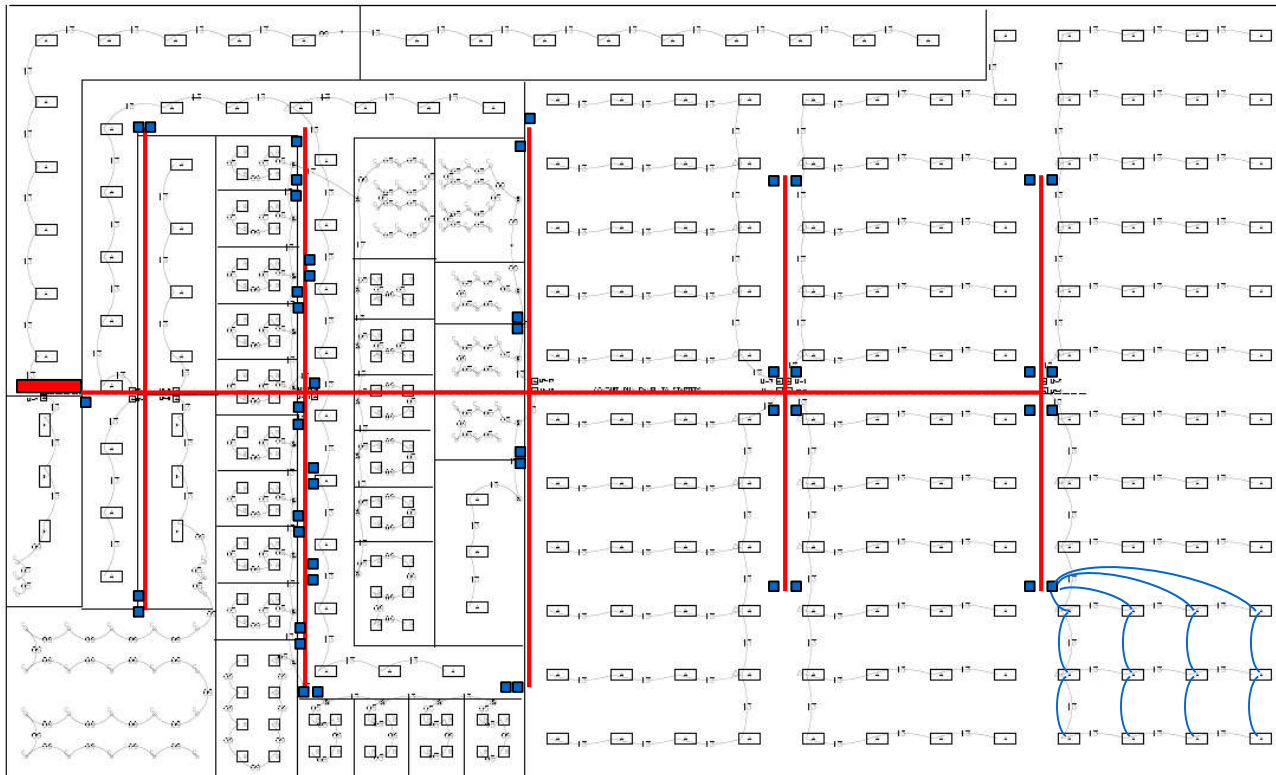


## Future Low Voltage Power Wiring Requirements



# DLVP System Architecture

- Leverage AC line voltage for infrastructure transmission
- Utilize Class 2 DC for load connectivity

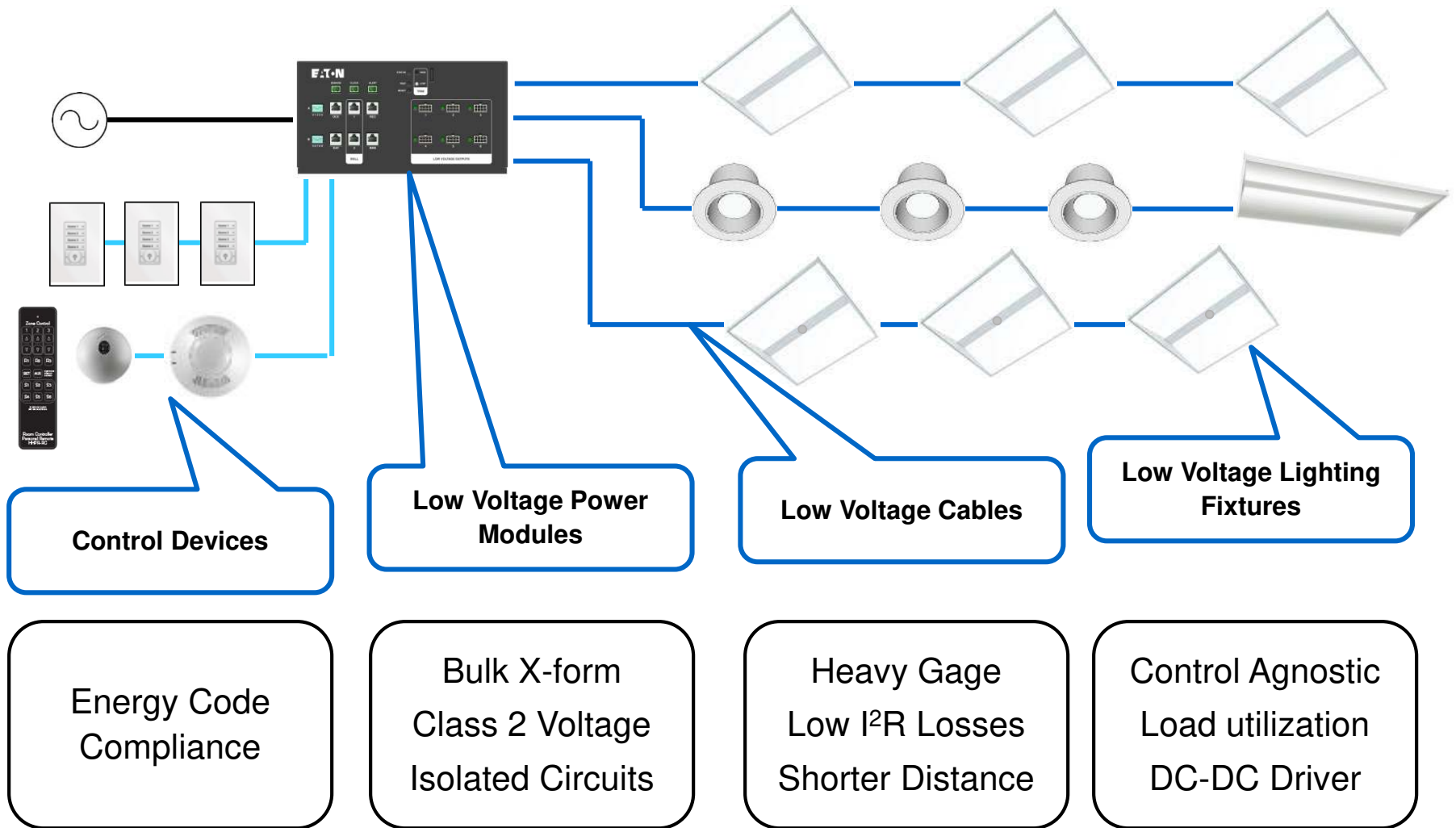


**~10-20% Lower Installed Cost**

**~25-40% Labor Reduction**

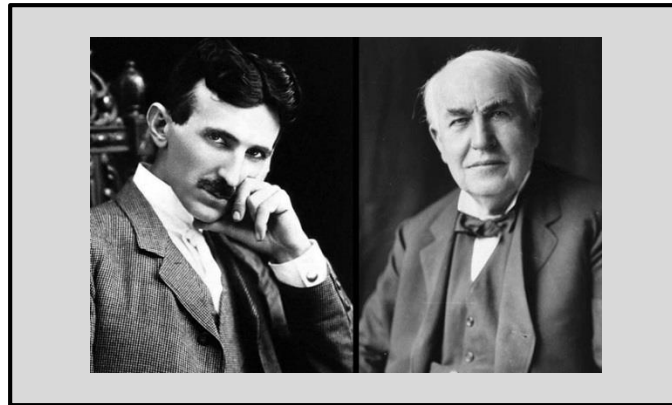


# DLVP System Components



# DLVP System Summary

**“DLVP blends the benefits of both AC and DC power distribution to reduce the total installed cost of a lighting project by up to 20% while providing a completely flexible and electrically efficient solution.”**



# Chris Andrews

[jamescandrews@eaton.com](mailto:jamescandrews@eaton.com)

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