Power Over Ethernet Lighting: Why the Future Looks Bright for Building Owners

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Chief Technology Officer

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Vice President of Operations

2020 BICSI WINTER Conference & Exhibition
History of PoE
Learning Objectives

• Understand how Power over Ethernet (PoE) evolved into an IoT application platform
• Understand how to build and install a system
• Understand the limitations
• Understand ELN and Authority Having Jurisdiction (AHJ) topics
PoE Evolution

2001  Cisco Inline  6 watts
2003  IEEE PoE  15.4 Watts
2009  IEEE PoE+  30 Watts
2012  Cisco UPoE  60 Watts
2019  IEEE PoE  ~70-90 Watts
Why PoE?

- Proven technology
- Global standard
- Flexible platform for multiple apps
- Much lower cost than 277V
- Natural progression of IT
  Similar to voice over IP
- Safe
- Unified infrastructure
The Digital Ceiling is an IoT Platform

Monitor and adjust the environment for better outcomes
- Temperature
- Humidity
- Light level
- CO & CO2
- Gun shot

Improve
- Productivity
- Health
- Comfort
- Safety

Source: Building Data Book © 2015 Platformatics – All Rights Reserved. Platformatics Confidential
Why PoE For Lighting?

• Every quality LED fixture works on PoE
• 100 years of fixtures/Edison bulbs work on PoE
• Any emergency light can be monitored and tested in real time
• The system supports hundreds of sensors and critical applications
• PoE is competitive for new construction and deep *retrofit
• PoE costs will be significantly lower than AC power by 2020 with 90 Watt infrastructure

*excluding relamp
Digital Ceiling Architecture

Wiring Key
- Cat5e+ Ethernet Cable
- Enterprise Network
- 110 AC Power Input
- 18-20 Gauge Wire

Platformatics Area Controller (PAC)

Enterprise Cloud

Router

User Provided

Smart Phone, Tablet, or Computer
A Platform for Applications

1. Circadian rhythm scenes keep employees, students and physicians alert
2. Active shooter ensures fast EMS response
3. Color enhances space
4. Emergency light compliance
Are employees productive?
If you don’t monitor CO2, how do you know?

Is your building efficient?
If you don’t monitor power, how do you know?
Conference Room Utilization*

*Data collection available in SW 2.0~Sept 2019
Make Critical Information Visible (Emergency Lighting)

Will your building protect employees when the power dies?
If you don’t monitor emergency exit lighting, how do you know?
Actively Monitor Fire Extinguishers

Automate monitoring
- Low pressure
- Removal
- Blocked access
- Eliminate monthly visual inspections
Sensor Meta Data is Converted to Information

- The system can be used for a variety of location-based apps

- Heat maps can be created from a variety of sensors:
  - Temp, humidity, CO2, motion, light, gunshot, fire extinguisher and emergency nodes, etc.

- We provide time-series data through our APIs for third-party applications
Keeping Up With Your Changing Infrastructure
# 2017 NEC Limits Cable Bundle Sizes

Table 725.144 Ampacities of Each Conductor in Amperes in 4-Pair Class 2 or Class 3 Data Cables Based on Copper Conductors at an Ambient Temperature of 30°C (86°F) with All Conductors in All Cables Carrying Current, 60°C (140°F), 75°C (167°F), and 90°C (194°F) Rated Cables

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>2-7</td>
<td>8-19</td>
<td>20-37</td>
<td>38-61</td>
<td>62-91</td>
<td>92-192</td>
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</tr>
<tr>
<td>26</td>
<td>1</td>
<td>1</td>
<td>0.7</td>
<td>0.8</td>
<td>0.5</td>
<td>0.6</td>
<td>0.7</td>
<td>0.4</td>
<td>0.5</td>
<td>0.6</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>24</td>
<td>2</td>
<td>2</td>
<td>0.8</td>
<td>1</td>
<td>0.6</td>
<td>0.7</td>
<td>0.9</td>
<td>0.5</td>
<td>0.6</td>
<td>0.7</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>23</td>
<td>2.5</td>
<td>2.5</td>
<td>1.2</td>
<td>1.5</td>
<td>0.6</td>
<td>0.8</td>
<td>0.9</td>
<td>0.5</td>
<td>0.7</td>
<td>0.8</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>22</td>
<td>3</td>
<td>3</td>
<td>1.4</td>
<td>1.8</td>
<td>1</td>
<td>1.2</td>
<td>1.4</td>
<td>0.7</td>
<td>0.9</td>
<td>1.1</td>
<td>0.6</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Note 1: For bundle sizes over 192 cables, or for conductor sizes smaller than 26 AWG, ampacities shall be permitted to be determined by qualified personnel under engineering supervision.

Note 2: Where only half of the conductors in each cable are carrying current, the values in the table shall be permitted to be increased by a factor of 1.4.

Informational Note: The conductor sizes in data cables in widespread use are typically 22-26 AWG.

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Telecommunications Room Considerations for PoE Lighting

- Dedicated, secure space
- Floor space for additional racks
- Dedicated pathways for PoE structured cabling
- Method of separating cable bundles if necessary
- Power and cooling for additional switches
PoE for Lighting Uses Standard Structured Cabling

- PoE Lighting is distributed on standard structured cabling

- The cabling for lighting is a separate system from the cabling for networking, but it uses the same standards, components and installation practices.

- Use separate racks for the lighting system and PoE switches/controllers that power the lighting system.

- Reference ANSI/BICSI_007, and ANSI/BICSI_N2
Racks and Cable Management for PoE Lighting

- Two- or Four-Post Racks or enclosures?
  - Size and weight of switches, UPSs
  - Physical Security

- Cable Management
  - Ability to separate bundles
  - Clean install for quick tracing of cables

- Cable Pathway
  - Ability to separate bundles
  - Maintain cable radii in transitions
  - Store service loops
Cable Management Advancements for PoE Lighting

• Enhanced Vertical Cable Management that allows direct support and spacing of cable bundles.
Additional Enclosure Considerations for Public Spaces

- Security
- Safety and reliability
- Cooling without disruption
- Alternative zone cabling options
- Retrofit applications
Implementing PoE Powered Buildings

The Good, the Bad, and the “Not so Pretty”
Sharing Experience

- What makes PoE lighting installations different?
- What are some things to consider and plan for?
- Where are PoE powered buildings headed?
- What does it take for successful deployments?
- Delivering unique customer value with PoE!
The Rack…

Nothing exciting here…

…or is there?

• POWER!

• HEAT!

• FACILITY!
‘Distributed’

The_\textsuperscript{^A}Rack...

Rethink your plan!

• POWER?

• LOCATION?

• CABLELING?
Devices
Placing PoE devices?

• INSTALLATION?
• SERVICEABILITY?
• ASTHETICS?
802.3bt

What is it?

• IEEE Standard
• 90W PSE

PoE Game Changer

Ethernet Alliance – “Overview of 802.3bt – Power over Ethernet standard”
Plan the Build – Build the Plan

Start with your RCP
Add icons for:
1. Lights
2. Wall switches
3. Sensors
4. Nodes
5. Emergency exits
Dimension Mill
Co-work Space - Bloomington, IN
Dimension Mill

**Project Goals**
- Reduce energy use
- Leverage architectural fixtures
- Tunable white workspaces
- Color accent lighting

**Challenges and Tips**
- Unique fixtures
- Historic building with high tech
- Individually tailored offices
- Special event lighting
BBA Signature Aviation
Global HQ - Orlando, FL
Signature Aviation

Project Goals

• Reduce energy use
• Design for well building (Tunable White Light)
• Include emergency lighting battery packs with remote monitoring

Challenges and Tips

• Demountable walls
• Complete PoE Emergency lighting
• Troubleshooting fixtures
West Baden Hotel, IN

- The system used 170-1000 Watt bulbs
- They wanted to reduce electricity spend and enhance the color show
- Our system typically consumes only 3kw/hr.
- The customer reduced energy by 98%
West Baden Hotel

**Project Goals**

- Significantly reduce energy use
- Create color light show ‘playlists’
- Remote mount the nodes in a bird coupe on the roof

**Challenges and Tips**

- From incandescent to high-performance LEDs
- Remote nodes
- Keeping historic aesthetics
…and many more, each providing unique customer value!
Case Study One
The Sinclair Autograph
The Sinclair Autograph: Marriott & CVS
Everyday Devices Powered by PoE
## CVS PoE Installation

- 2-story CVS with all PoE lighting in downtown Fort Worth
- Running for 18 months with no issues
- Cost savings
- Installed by low-voltage contractor
The Sinclair Marriott

16-story historical building with basement restaurant and rooftop bar
What Is Being Powered by PoE

All light fixtures
What is Being Powered by PoE
What Is Being Powered by PoE

In-room mini bar
What Is Being Powered by PoE

Somfy shades
What Is Being Powered by PoE

Electric mirrors
What Is Being Powered by PoE

Custom touch panels
## Digital Electricity Backbone

- Powering all CDB switches with 18/4 through the riser
- Emergency lighting powered from ESS room with digital electricity
- Saves space
Overall Cabling Installation

<table>
<thead>
<tr>
<th>Length</th>
<th>Product Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>350,000’</td>
<td>Superior Essex Cat5e PowerWise</td>
</tr>
<tr>
<td>10,000’</td>
<td>Superior Essex VoltServer Rated 18/12</td>
</tr>
<tr>
<td>20,000’</td>
<td>Superior Essex VoltServer Rated 18/8</td>
</tr>
<tr>
<td>185,000’</td>
<td>Superior Essex VoltServer Rated 18/4</td>
</tr>
<tr>
<td>225,000’</td>
<td>Superior Essex VoltServer Rated 18/2</td>
</tr>
</tbody>
</table>
Typical Room Layout

- Intelligent Building Infrastructure can be incorporated with all other Infrastructure designs
- Choose the right layout
- Make sure the design can adapt to change
- Don’t be afraid to customize
Lessons Learned

- Be Ready For Change
- Design For Change
- Coordinate with Partners
- Think Outside The Box
- Educate Yourself and Team
- Don’t Stop Learning
Future Possibilities For PoE
Where Is This Going?

Digital Electricity Explained
How Can Electricity be Made Inherently Safe?
What is Different about Digital Electricity (DE)?
DE is the Only Technology That Can Prevent a Resistive Fault

Poor termination, 5 Ohms

12 Amps

Double Insulated Appliance

720W Heat
Causes of Electrical Fire in North America

- **40%** RESISTIVE
- **19%** UNKNOWN
- **12%** DIRECT
- **29%** ARCING

Electrical Ignition Causes

NA Major Fires (2002 - 2007)

Source: 2D2C, Inc.
The Only Thing That Can Prevent a Line-to-Line Touch Fault

Line

Double Insulated Appliance

Neutral

0.1 Amps

Fibrillation Region

12 Amps
The Only Thing That Can Do This

Transmitter

1,000W

Two Wires
Class 2 Circuit

<100W

Receiver

1,000W
How?

1,000W

Transmitter

Two Wires
Class 2 Circuit

<100W

Receiver

1,000W

Energy = The potential to do Work
Two Wires
Class 2 Circuit

How?

Transmitter  Two Wires  Receiver

1,000W  Class 2 Circuit  1,000W

<100W

Energy = The potential to do work

Power = The rate of converting energy to work
How?

**Energy** = The potential to do work

**Power** = The rate of converting energy to work

Power is needed to hurt someone or start a fire
DE is the Only Thing That Can Separate Power and Energy

Power is needed to hurt someone or start a fire

DE transmission is almost exclusively energy
## Electrical Hazards Mitigated by DE

<table>
<thead>
<tr>
<th>HAZARD</th>
<th>YEAR</th>
<th>ANALOG AC/DC</th>
<th>DIGITAL ELECTRICITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Current</td>
<td>1960</td>
<td>Circuit Breaker</td>
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<tr>
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<td>1971</td>
<td>GFCI/RCD</td>
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</tr>
<tr>
<td>Arc Fault</td>
<td>1999</td>
<td>Arc Fault Detector</td>
<td>✓</td>
</tr>
</tbody>
</table>

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**BICSI WINTER**

Conference & Exhibition

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2020
# Electrical Hazards Mitigated by DE

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<td>✓</td>
</tr>
<tr>
<td>Arc Fault</td>
<td>1999</td>
<td>Arc Fault Detector</td>
<td>✓</td>
</tr>
<tr>
<td>High Resistance</td>
<td>—</td>
<td>X</td>
<td>✓</td>
</tr>
</tbody>
</table>
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<tr>
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<td>1999</td>
<td>Arc Fault Detector</td>
<td>✓</td>
</tr>
<tr>
<td>High Resistance</td>
<td></td>
<td>X</td>
<td>✓</td>
</tr>
<tr>
<td>Touch</td>
<td></td>
<td>X</td>
<td>✓</td>
</tr>
</tbody>
</table>
Digital Electricity Explained

**Transmitter**

- Line Power
- LPS (Limited Power Supply)

**NEC Art 725**
- CEC Sec. 16-200
- Class 2 Circuit
- 1000s of feet

**Receivers**

- Receivers
- NEC Art 725
- CEC Sec. 16-200
- Class 2 or NOT Depending on receiver

**Energy Packet**

**PROCESS HOW it works**

<table>
<thead>
<tr>
<th>SEND pulse (~500 per second)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. STOP</td>
</tr>
<tr>
<td>2. LOOK for arc, thermal, touch, overcurrent, ground fault</td>
</tr>
<tr>
<td>3. VERIFY Is it safe? send another pulse; else STOP</td>
</tr>
<tr>
<td>4. CONVERT Receiver converts back to Analog Electricity (AE)</td>
</tr>
</tbody>
</table>

Class 2 or NOT Depending on receiver
Electrical Hazard Category (IEC 62368-1)

Class 2, 150V RMS
110V RMS
Class 2, 60Vdc PoE
Digital Electricity

Safe Region
PoE
Heart Effects
Class 2
150V
Danger Region
(Fibrillation)

Ref: IEC 60479-1

Footnotes:
1 Peak value of 212V, 8.5ms repetitive peak less than 3s minimum rest time
2 Actual exposure 3ms, IEC 62368-1 standard does not consider less than 10ms
## Circuit Heating?

<table>
<thead>
<tr>
<th>Parameter</th>
<th>PoE+</th>
<th>UPoE</th>
<th>DE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance (ft.)</td>
<td>328</td>
<td>328</td>
<td>328</td>
</tr>
<tr>
<td>Cables</td>
<td>96</td>
<td>96</td>
<td>4</td>
</tr>
<tr>
<td>Pairs</td>
<td>384</td>
<td>384</td>
<td>8</td>
</tr>
<tr>
<td>Gauge</td>
<td>24</td>
<td>24</td>
<td>18</td>
</tr>
<tr>
<td>Bundle Diameter (in.)</td>
<td>2.25</td>
<td>2.25</td>
<td>0.5</td>
</tr>
<tr>
<td>Power Delivered (W)</td>
<td>4,200</td>
<td>8,400</td>
<td>8,400</td>
</tr>
<tr>
<td>Heating (W/ft)</td>
<td>2.23</td>
<td>4.45</td>
<td>1.11</td>
</tr>
</tbody>
</table>
Typical Installation

- DE can run in risers or trays
- Can be in same duct or jacket with Ethernet/Fiber
- DE can not run with Power & Lighting circuits
- Install according to NEC Art 725

Basement Electrical Rm
I had to change the pic because it was a competitor
Kallail, Lauren S., 1/9/2020
# Power/Distance

## Power and Number of Pairs vs. Distance (feet)

<table>
<thead>
<tr>
<th>Power (W)</th>
<th>200</th>
<th>400</th>
<th>600</th>
<th>800</th>
<th>1000</th>
<th>1200</th>
<th>1400</th>
</tr>
</thead>
<tbody>
<tr>
<td>1pair</td>
<td>1,888</td>
<td>936</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2pairs</td>
<td>3,744</td>
<td>1,840</td>
<td>1,205</td>
<td>888</td>
<td>698</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3pairs</td>
<td>5,568</td>
<td>2,712</td>
<td>1,761</td>
<td>1,285</td>
<td>999</td>
<td>809</td>
<td>673</td>
</tr>
<tr>
<td>4pairs</td>
<td>6,000</td>
<td>3,553</td>
<td>2,284</td>
<td>1,649</td>
<td>1,269</td>
<td>1,015</td>
<td>833</td>
</tr>
</tbody>
</table>

## 18AWG

<table>
<thead>
<tr>
<th>Power (W)</th>
<th>200</th>
<th>400</th>
<th>600</th>
<th>800</th>
<th>1000</th>
<th>1200</th>
<th>1400</th>
</tr>
</thead>
<tbody>
<tr>
<td>1pair</td>
<td>2,996</td>
<td>1,485</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2pairs</td>
<td>5,942</td>
<td>2,920</td>
<td>1,913</td>
<td>1,410</td>
<td>1,108</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3pairs</td>
<td>6,000</td>
<td>4,305</td>
<td>2,794</td>
<td>2,039</td>
<td>1,586</td>
<td>1,284</td>
<td>1,068</td>
</tr>
<tr>
<td>4pairs</td>
<td>6,000</td>
<td>5,639</td>
<td>3,625</td>
<td>2,618</td>
<td>2,013</td>
<td>1,611</td>
<td>1,323</td>
</tr>
</tbody>
</table>
700+ Installations in Marquee Venues
Transmitters

- Four 20A AC input feeds (110-208VAC)
- Up to 12kW bulk output (9kW N+1)
- 24 output channels (transmitter cards)
- 500W max per channel
- 2RU, 17.7” deep
- 39 lbs.
- UL/IEC 60950-1, 62368-1 (LPS)

- One 20A AC input feed (110-277VAC)
- Up to 3kW bulk output
- 8 output channels
- 500W max per channel
- 1RU, 14.5” Deep
- 11.5 lbs.
- UL/IEC 60950-1, 62368-1 (LPS)
Receivers

- Up to 4 DE inputs
- 2.4kW output at 40 °C
- HVDC Output (336VDC)
- 13” x 14.5” x 1.77”
- 3 lbs.
- IP 66
- UL/IEC 60950-1

- Up to 4 DE inputs
- 1.4kW output at 40 °C
- 54 VDC
- 10.04” x 9.45” x 3.99”
- 9.5 lbs.
- IP 66
- UL/IEC 60950-1
### Receivers

<table>
<thead>
<tr>
<th>Single DE Inputs</th>
<th>Two DE Inputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 DE inputs</td>
<td>2 DE inputs</td>
</tr>
<tr>
<td>500W output @ 40°C</td>
<td>8 LPS output chans.</td>
</tr>
<tr>
<td>HVDC Output (336VDC)</td>
<td>Output 57VDC</td>
</tr>
<tr>
<td>4.72” x 2.56” x 1.59”</td>
<td>80W per channel @ 40°C</td>
</tr>
<tr>
<td>0.49 lbs.</td>
<td>13.5” x 10.33” x 2.33”</td>
</tr>
<tr>
<td>IEC/UL 60950-1</td>
<td>10.5 lbs.</td>
</tr>
<tr>
<td></td>
<td>IEC/UL 60950-1</td>
</tr>
</tbody>
</table>
**Connected Stadium/Arena**

**College Sports Stadium – Mobile densification project**

- **$136,000 VoltServer equipment**
- **Saved MSO Operator 21,000 feet of conduit + core boring**
- **Reduction from $34 to $10 per ft.**
Mercedes-Benz® Stadium – 280 Miles of DE
Indoor Agriculture
1MW Hardee County, Florida, Food/GreenSeal Cannabis 250kW, Stratford, Ontario
Indoor Agriculture Architecture

Driverless LED lights in Grow Room
Digital Electricity in Data Tray
Facility Power Bus
VoltServer Transmitter Cabs.

Grow Rooms
Electrical Room
DAS Installation – High Rise

- 64 story, 950’ tall office tower
- Floors 1-18 were done “old school”
- Floors 19-64 were VoltServer application
- VoltServer equipment cost- $110,000
- $3M Project

When directly compared to the traditional wiring on the lower levels the estimate savings was:

$800,000
Questions?
Thank You!