What You Need to Know About Power over Ethernet (PoE)
Standards and Installation Best Practices

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About Today’s Presenter
Kirk Krahn, Senior Product Manager – Leviton Network Solutions

• 12 years of experience in telecommunications industry
• Held a variety of roles in manufacturing and consulting firms
• Role at Leviton is to manage copper cable and cable assemblies product line
• Graduate of Bradley University and MBA from DePaul University
• Lives in Geneva, IL with wife and son
What You Need to Know About PoE

Agenda

• PoE Overview
  – Market Drivers | The Evolution of PoE | Applications

• Understanding PoE
  – Managing Temperature Rise | Applicable Codes and Standards | LP Cabling and NEC

• Canadian differences in approach
  – The CEC perspective

• Recommendations for PoE
  – Design Advice | What to Consider
PoE Overview

Market Drivers | The Evolution of PoE | Applications
First – The Basics

What is PoE?

Delivery of power and data over the same twisted pair cable
Equipment
The Power in PoE

• Two primary components:
  – Power Sourcing Equipment (PSE)
  – Powered Device (PD)
Power and Data
Over the Same Pair Simultaneously

• Power delivered via center tap of data transformer combining power and data
• Both conductors of one pair are (+) while both conductors of the other pair are (−)
  – 2 pair PoE: pairs 1 & 4 or 2 & 3 used
  – 4 pair PoE: pairs 1 & 4, AND 2 & 3 used
• Data “rides on top” of DC voltage – DC voltage does not interfere with data
Market Drivers
Demand for PoE

• Internet of Everything (IoE)
• RJ45 compatibility
• Ease of deployment
• Economical, centralized power backup
• Device mobility
Power Over Ethernet
The Evolution – How We Got Here

• 802.3af completed in 2003
  – 15.4W power sent = 12.95W of delivered power (Type 1)

• 802.3at PoE+ completed in 2009
  – 30W power sent = 25.5W of delivered power (Type 2)

• 802.3bt PoE expected to be published in 2018
  – 60W and 100W power sent
Power Over Ethernet
Higher Power and Bandwidth Driving Cat 6A Solutions

- Next-gen devices require greater than Gigabit Ethernet
  - Wireless access points
  - HDTV, Kiosks and IP cameras

- Build networks with future needs in mind
Applications
Why We Need More Power

- Up to 15.4 Watts: Thin Clients, 802.11n
- Up to 30 Watts: Biometric Access Control
- Up to 60 Watts: Video IP Phones, PTZ IP Cameras, RFID Readers
- Up to 100 Watts: Alarm Systems, Access Controls, 802.11ac, Point of Sales, Information Kiosks, Laptop Computers, PTZ IP Cameras with Heaters, Nurse Call, Desktop Computers, Televisions, Video Conferencing, High Power Wireless

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Benefits
PoE vs. Traditional Power

- **Reduced costs**
  - One system to be installed
  - Easier to maintain and administer
  - Faster deployment of powered devices

- **Centralized control**
  - Emergency back-up power
  - Disaster recovery
  - Improved business security
Benefits Continued

PoE vs. Traditional Power

• Safety
  – Power applied and capacity reserved after handshake
  – Safer power levels than A/C circuit

• Energy Efficiency and Savings
  – Building Automation Sensors and Control

• Flexibility
  – Standardized power levels and Ethernet ubiquity
Understanding PoE
Managing Temperature Rise | Applicable Codes and Standards | LP Cabling and NEC
Excessive Temperature Rise
PoE Challenges

• The higher the category cable, the lower the temperature rise (in general)

• At levels above 60W, the heat rise for 100-cable bundles running PoE can cause:
  – Increased insertion loss
  – Reduced performance
Next Generation PoE Challenges
Managing Heat Rise – TIA

• TIA examined installed cabling issues
  – TSB 184-A (now published)
  – Bundle sizes to limit temperature rise to 15 °C with a 60 °C cable
  – Assumes 45 °C ambient and power on all 4 pairs
Next Generation PoE Challenges
Managing Heat Rise – NFPA

- National Fire Protection Agency (NFPA 70/NEC)
  - Heat-related concerns
  - New requirements for communications cable carrying power
  - Bundle sizes limited by maximum cable temperature rating and ampacity
  - Assumes 30 °C ambient temperature
Next Generation PoE Challenges
Managing Heat Rise – Canadian perspective

• **CSA Z462, Safe work practices**
  – Not a direct equivalent of NFPA 70
  – Concentrates on arc flash related concerns

• **CE Code, Electrical installation code**
  – One year behind NEC in edition
  – 2018 Edition will not contain product requirements: this is the scope of product standards
  – Very similar to NEC but contains some more stringent requirements
  – Sometimes NEC requirements cannot be bridged to CEC
Adopted changes have little effect on PoE installations at 60W and below, per article 840:

- NEC 2017 places no new restrictions on bundle size
In June 2016, NFPA finalized Articles 725 and 840 (published in August 2016)

- New Ampacity table 725.144
  - Maximum bundle sizes
  - This table referenced in Article 840 (when above 60W)
  - Only when ambient temperature at/below 30 °C

- Ambient temperatures above 30 °C
  - Refer to table 310.15(B)(2)(a)
  - De-rating may impact bundle size and cable selection
**NEC 2017 Code Requirements**

**Article 725 Table 725.144**

<table>
<thead>
<tr>
<th>AWG</th>
<th>Number of 4-Pair Cables in a Bundle</th>
<th>1</th>
<th>2-7</th>
<th>8-19</th>
<th>20-37</th>
<th>38-61</th>
<th>62-91</th>
<th>92-192</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Temperature Rating</td>
<td>60°C</td>
<td>75°C</td>
<td>90°C</td>
<td>60°C</td>
<td>75°C</td>
<td>90°C</td>
<td>60°C</td>
</tr>
<tr>
<td>26</td>
<td>1</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>0.7</td>
<td>0.8</td>
<td>1.0</td>
<td>0.5</td>
</tr>
<tr>
<td>24</td>
<td>2</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>1.0</td>
<td>1.4</td>
<td>1.6</td>
<td>0.8</td>
</tr>
<tr>
<td>23</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>1.2</td>
<td>1.5</td>
<td>1.7</td>
<td>0.8</td>
<td>1.1</td>
</tr>
<tr>
<td>22</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>1.4</td>
<td>1.8</td>
<td>2.1</td>
<td>1.0</td>
<td>1.2</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.

“existing low power implementations of powering (<60 watts), such as PoE and PoE+, there is little chance of overheating the cables regardless of cable type, bundle size or installation method” UL Document
CEC 2015 Requirements for PoE

- **Next edition of CEC is 2018**
  - Proposal similar to NEC not yet submitted to CEC for 2018 edition
    - CEC will not reflect NEC until 2021!
- **Ampacity configurations different than NEC**
  - CEC has only partial configuration overlap with NEC
  - In the end, similar results but different installation
- **Ambient temperatures above 30 °C**
  - De-rating tables may impact bundle size and cable selection same as NEC
NEC 2017
LP Cabling

- New UL optional Limited Power (LP) cable rating
  - Alternative to table in 725.144, bundle size agnostic
  - Same 30 °C ambient temperature limitations apply
  - Above 30 °C, refer to 310.15 for cable derating

<table>
<thead>
<tr>
<th>Ambient Temp. °C</th>
<th>60 °C</th>
<th>75 °C</th>
<th>90 °C</th>
<th>Ambient Temp. °F</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-25</td>
<td>1.08</td>
<td>1.05</td>
<td>1.04</td>
<td>70-77</td>
</tr>
<tr>
<td>26-30</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>78-86</td>
</tr>
<tr>
<td>31-35</td>
<td>0.91</td>
<td>0.94</td>
<td>0.96</td>
<td>87-95</td>
</tr>
<tr>
<td>36-40</td>
<td>0.82</td>
<td>0.88</td>
<td>0.91</td>
<td>96-104</td>
</tr>
<tr>
<td>41-45</td>
<td>0.71</td>
<td>0.82</td>
<td>0.87</td>
<td>105-113</td>
</tr>
<tr>
<td>46-50</td>
<td>0.58</td>
<td>0.75</td>
<td>0.82</td>
<td>114-122</td>
</tr>
<tr>
<td>51-55</td>
<td>0.41</td>
<td>0.67</td>
<td>0.76</td>
<td>123-131</td>
</tr>
<tr>
<td>56-60</td>
<td>—</td>
<td>0.58</td>
<td>0.71</td>
<td>132-140</td>
</tr>
<tr>
<td>61-70</td>
<td>—</td>
<td>0.33</td>
<td>0.58</td>
<td>141-158</td>
</tr>
<tr>
<td>71-80</td>
<td>—</td>
<td>—</td>
<td>0.41</td>
<td>159-176</td>
</tr>
</tbody>
</table>
New UL Rating Program
What are LP-rated cables?

- Cables are tested to assure temperature rating is not exceeded when used at the LP-rated current – 30 °C is ambient regardless of the number of cables in the bundle

- Cable legend to include: “…CMP-LP(0.xA)”
New UL Rating Program
LP Cables Continued

- $x = \text{Ampacity of the cable (A = Amps)}$
  - 0.5A = 100W using 50 Volts over 4 pairs
  - 0.6A = 120W using 50 Volts over 4 pairs
  - 0.7A = 140W using 50 Volts over 4 pairs
  - LP cables are not mandated by the 2017 NEC but included as an option

- Refer to UL.com guide information for LP-rated cable

- Do not forget Little “c” in front of UL mark for Canadian certification!
2017 NEC
What happens next, what do you need to know?

• Adopted changes have little effect on PoE applications at 60W or lower, per Article 840

• Impact to PoE greater than 60W are more significant
  – New NEC was published in August 2016
  – Every state has different process/timeline for adopting codes
  – Check with local authority on PoE installation codes/requirements
  – Using LP cabling is optional, check with cable manufacturer for specific information on product capability
2018 CEC
What happens next, what do you need to know?

• We have to wait for 2021 edition for full consideration of PoE by the CEC
  – New CEC gets published at the January 2nd mark of edition year
  – Every province/territory has similar timeline for adopting CEC, usually within 6 months of new edition, with 100% adoption
  – Local authority on PoE installation requirements not covered yet by CEC may require special inspection
Recommendations for PoE Using Non-LP Cable

Design Advice | What to Consider
Design Considerations

• Reduce number of cables per bundle

• Use wire cable trays or similar cable management
  – Allows for largely unrestricted airflow around the cables or cable bundles

• Keep cables loosely bundled
No Cramming
PoE Installation Best Practices

• Avoid cramming or “necking down” cables into small areas

• Provide as large an area possible for this transition
  – Keep transitional length as short as possible – use multiple conduits or larger conduit as needed

• If available area is limited, loosely arrange cables on either side to help dissipate heat
Use Cables With Higher Temperature Ratings
PoE Installation Best Practices

• Consider using cables with higher temperature ratings
  – Assures that cables stay below their maximum rated temperature

• 60 °C has been a very common rating for premise cables

• Today 70 °C and 75 °C and even 90 °C cables readily available
Why Category 6A?
Operational Advantages

- **23 AWG conductors generate less heat than 24 AWG**
  - 23 AWG is larger in diameter than 24 AWG
  - Limits cable derating – running cooler without compromising insertion loss, enabling longer runs
  - Cooler temp maintains cable integrity and lifespan
  - Reduced OPEX, less facility cooling required
  - Improved environmental impact

- **Lower costs by supporting higher power per cable, avoiding additional bundles and trays**

- **Cat 6A delivers best performance, supports future applications**
Consider Shielded Cabling
PoE Installation Best Practices

- Consider using a shielded cabling system, or unshielded cables with patented metallic isolation wrap
  - Radiates heat better than traditional unshielded cables
  - Reduces the cables’ temperature rise

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Use Metal Bodied Connectors
PoE Installation Best Practices

- Shielded and solid metal bodied UTP Cat 6A connectors dissipate heat better than plastic alternatives

Thermal simulation of connector bodies using plastic and metal
TIA-568-C.2 Compliant Patch Cords

- ANSI/TIA-1096-A requires 50 micro-inches of gold
- Arcing from disconnect under load causes pitting and wears away gold over time
- Gold plating is a big part of cord cost
- Non-compliant cords will have lower reliability when used in PoE applications
Use Category 6A Systems for New Installations

• Solutions that meet and exceed current standards
  – 802.3at (Type 1) = 15.5 Watts
  – 802.3at (Type 2) = 30 Watts
  – 802.3bt (Type 3) / UPOE = 60 Watts

• Capable of meeting emerging standards, up to 100 watts
  – 802.3bt (Type 4) / PoH = 100 Watts

• Component-rated end-to-end system with enhanced margins for better performance and easier installation
Conclusions

• When designing structured cabling solutions consider both current and future possible PoE applications

• New applications are being developed daily
  – PoE enabled LED Lighting
  – Cisco Digital Ceiling
Conclusions

Continued

• **High-quality connectivity and cabling is essential**
  – Use standards-based solutions designed to support emerging PoE applications

• **Be aware of any changes to local codes as they relate to PoE installations**
Thank You