Implementation Considerations for Supporting Remote Powering Over Communications Cabling

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Outline

• Market Drivers
• Technology Drivers
• Standards and Codes
• Design and Installation
• Administration and Operations
• Conclusions and Next Steps
Market Drivers
Economics and Convenience

• One circuit for power and data
  ➢ Reduced material costs
  ➢ Reduced labor costs

• Controlled Power supply
  ➢ Reliability and quality of power monitored continuously
  ➢ Scalability to match needs of powered device
Basic Use Cases of Remote Power
PoE Applications are Diversifying

Source: DellOro Group, April 2016 – Ethernet Alliance PoE Webinar
https://www.brighttalk.com/webcast/6205/199275/analyst-hour-webinar-on-ieee-poe
Proliferation of Devices that Use Remote Power

- Voice and Video IP Phones
- WiFi Access Points a/b/g/n
- Network Security Cameras — Enclosures — Heaters — Pan and Tilt
- Building / Access Control — Gas and Fire Alarms — Digital Signs
- Digital and School Clocks — SIP IP Paging — Door locks - Gateways
Market Potential – Other Devices

- Industrial Automation
- Point of Sale - Retail
- Hospitality
- IP Security
- IP Turrets
- Nurse Call
- Thin Client/VDI
- Building Management

Sources:
- VDC Research
- IMS Research - Jentea Howell
- and other research reports
- Gartner Forecasts, BT Turret, Cisco Partners
Market Drives Key Objectives in IEEE 802.3bt 4PPoE

- Comply to Limited Power Source (LPS) and Safety Extra Low Voltage (SELV) requirements in ISO/IEC 60950
- Support four-pair operation
- Support for operation over the following channels that have DC loop resistance of no greater than 25 ohms:
  - Category 5e/ Class D or better cable and components
- Support operation with 10GBASE-T, 5GBASE-T, 2.5GBASE-T
- 4PPoE PDs which operate at power levels consistent with IEEE 802.3-2012 PDs will interoperate with IEEE 802.3-2012 PSEs.
- 4PPoE PSEs will be backwards compatible with IEEE 802.3-2012 PDs.
Technology Drivers
Common Data + PoE Network Use Cases

- 802.3 Ethernet and IP Phones
  - 10/100/1000BASE-T
  - Power over Ethernet

- 802.3 Ethernet and 802.11 WLAN
  - 1000BASE-T
  - Power over Ethernet
PoE Powered Lighting
Emerging Use Cases

• Industrial and Process Control
• Hybrid fiber copper cables for extended reach PoE
• IoT and M2M communications with remote power
• Automotive infotainment, sensors/controls and potentially self-driving applications
## PoE Roadmap 2017

**NOTE:** Only Type 4 PSEs source more than 300 mA/conductor

<table>
<thead>
<tr>
<th>PoE Types and Classes</th>
<th>2-Pair PoE+ – Type 2</th>
<th>2-Pair PoE – Type 1</th>
<th>4-Pair PoE in Standardization</th>
<th>4-Pair PoE Type 3</th>
<th>4-Pair PoE Type 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>0 1 2 3 4</td>
<td>0 1 2 3 4</td>
<td>5 6 7 8</td>
<td>5 6 7 8</td>
<td>5 6 7 8</td>
</tr>
<tr>
<td>PSE Power (W)</td>
<td>15.4 4 7 15.4 30</td>
<td>15.4 4 7 15.4 30</td>
<td>45 60 75 90</td>
<td>45 60 75 90</td>
<td>45 60 75 90</td>
</tr>
<tr>
<td>PD Power (W)</td>
<td>13 3.84 6.49 13 25.5</td>
<td>13 3.84 6.49 13 25.5</td>
<td>40 51 62 71</td>
<td>40 51 62 71</td>
<td>40 51 62 71</td>
</tr>
</tbody>
</table>
Standards and Codes
Heat generated = $\text{Current}^2 \times \text{Resistance}$

$\Delta T (I, N) = I^2 x (C_1 \cdot N + C_2 \cdot \sqrt{N})$ Where the variables are defined as:

$\Delta T$ is the temperature rise in °C.

$I$ is the current in amperes.

$N$ is the number of cables in the bundle.

$C_1$ is the coefficient that describes all variables associated with the geometry of the cable.

$C_2$ is the coefficient that describes all variables associated with the environment surrounding the cable bundle.
Measurement Setup in TIA TSB-184-A

thermocouple insertion

open bundle

enclosed bundle
Temperature Rise vs. Bundle Size in Open Air @ 1A/Pair

Number of cables in bundle

Temperature rise, degrees C

26 AWG
Category 5e
Category 6
Category 6A
Category 8

0 1 0 2 0 3 0 4 0 5 0 6 0 7 0 8 0 9 100

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Temperature Rise vs. Bundle Size in Conduit @ 1A/pair
Modelling Temperature Rise vs. Bundle Sizes and Ambient Temperatures
TR 29125 Showing Current Capacity Increases with Allowed Temperature Rise

Table 1 – Maximum current per pair versus temperature rise in a 37 cable bundle in air and conduit (all 4 pairs energized)

<table>
<thead>
<tr>
<th>Temperature rise °C</th>
<th>Current per pair mA 0.4 mm cords</th>
<th>Current per pair mA Category 5 cables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>air</td>
<td>conduit</td>
</tr>
<tr>
<td></td>
<td>air</td>
<td>conduit</td>
</tr>
<tr>
<td>5</td>
<td>583</td>
<td>475</td>
</tr>
<tr>
<td>7.5</td>
<td>715</td>
<td>581</td>
</tr>
<tr>
<td>10</td>
<td>825</td>
<td>671</td>
</tr>
<tr>
<td>12.5</td>
<td>933</td>
<td>751</td>
</tr>
<tr>
<td>15</td>
<td>1011</td>
<td>822</td>
</tr>
<tr>
<td>17.5</td>
<td>1092</td>
<td>888</td>
</tr>
<tr>
<td>20</td>
<td>1167</td>
<td>950</td>
</tr>
</tbody>
</table>

NOTE 1: These values are based on conductor temperature measurement and modelling of typical cables and cordage.

NOTE 2: The 0.40 mm cordage results are based on measurements of stranded construction which typically has a slightly lower DC resistance than cordage of solid cable construction.

NOTE 3: Temperature rise above 10 °C shown in gray background is not recommended.

**PRINCIPLES USED**

- Heat generated in cabling = Current² x Resistance
- Steady state reached when Heat generated = heat dissipated
- Resultant temperature rise in cable should not exceed the temperature rating of the cable (60 C for commercial office rated cables).
NFPA 70 NEC 2017
NEC 840.160 Powering Circuits

“Communications cables, in addition to carrying the communications circuit shall also be permitted to carry circuits for powering communications equipment. Where the power supplied over a communications cable to communications equipment is more than 60 watts, communications cable and the power circuit shall comply with 725.144 where communications cables are used in place of Class 2 and 3 cables.”
Article 725.144 Option (A) for Network Power Cables in NEC 2017

(A) Use of Class 2 or Class 3 Cables to Transmit Power and Data. Where Types CL3P, CL2P, CL3R, CL2R, CL3, or CL2 transmit power and data, the following shall apply:

- (1) The ampacity ratings in Table 725.144 shall apply at an ambient temperature of 30°C (86°F).
- (2) For ambient temperatures above 30°C (86°F), the correction factors of 310.15(B)(2) shall apply.
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>AWG</th>
<th>Number of 4-Pair Cables in a Bundle</th>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>1</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>
<td>25</td>
<td>60°C 75°C 90°C</td>
<td>60°C 75°C 90°C</td>
<td>60°C 75°C 90°C</td>
<td>60°C 75°C 90°C</td>
<td>60°C 75°C 90°C</td>
<td>60°C 75°C 90°C</td>
<td>60°C 75°C 90°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>2 2 2</td>
<td>1 1.4 1.6</td>
<td>0.8 1 1.1</td>
<td>0.6 0.7 0.9</td>
<td>0.5 0.6 0.7</td>
<td>0.4 0.5 0.6</td>
<td>NA NA NA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>2.5 2.5 2.5</td>
<td>1.2 1.5 1.7</td>
<td>0.8 1.1 1.2</td>
<td>0.6 0.8 0.9</td>
<td>0.5 0.7 0.8</td>
<td>0.5 0.7 0.8</td>
<td>0.4 0.5 0.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>3 3 3</td>
<td>1.4 1.8 2.1</td>
<td>1 1.2 1.4</td>
<td>0.7 0.9 1.1</td>
<td>0.6 0.8 0.9</td>
<td>0.6 0.8 0.9</td>
<td>0.5 0.6 0.7</td>
<td></td>
<td></td>
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<td></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.
(2) Ambient Temperature Correction Factors. Ampacities for ambient temperatures other than those shown in the ampacity tables shall be corrected in accordance with Table 310.15(B)(2)(a) or Table 310.15(B)(2)(b), or shall be permitted to be calculated using the following equation:

\[ I' = I \sqrt{\frac{T_r - T_s'}{T_r - T_s}} \]

where:
- \( I' \) = ampacity corrected for ambient temperature
- \( I \) = ampacity shown in the tables
- \( T_r \) = temperature rating of conductor (°C)
- \( T_s' \) = new ambient temperature (°C)
- \( T_s \) = ambient temperature used in the table (°C)
Article 725.144 Option (B) for Network Power Cables in NEC 2017

(B) Use of Class 2-LP or Class 3-LP Cables to Transmit Power and Data. Types CL3P-LP, CL2P-LP, CL3R-LP, CL2R-LP, CL3-LP, or CL2-LP shall be permitted to supply power to equipment at a current level up to the marked ampere limit-located immediately following the suffix LP and shall be permitted to transmit data to the equipment.
NEC Correlating Committee Task Group

- Definition of nominal current to account for current unbalance and implement 0.3 A exemption
- Safety emergency due to lack of ampacity in 840.160 60W exception
- Safety emergency due to missing temperature adjustment for LP cabling

- Equipment labeling (aligns with other changes)
- Incorrect ampacity on 8P8C connectors – connector may limit allowed current
- Results relate to 4-pair LAN cabling and no other
- LP cabling may be used also as regular CL2/CL3 cabling – out of informational note restatement as requirement
- Communications at >60C cable

*NOTE: Above Issues in Red are balloted as TIA (Tentative Interim Amendment) to NEC 2017 code with public comment closing on 9/14/2017*
Design and Installation
Overall Approach to Design and Installation for Remote Powering

• Take the holistic approach including all aspects:
  ➢ Cable types and installation practices
  ➢ Pathway types and routing distances
  ➢ Accurate administration and optimal operations
Design Concept

Limit bundle sizes and organize to avoid stacking and packing.

Recommended maximum bundle size is 24 cables.
Installation at Patch Panels

Cable bundles open to air flow throughout rack space
Separation Between Bundles

Some amount of space should be implemented between bundles to allow for free air flow.

Aligned strap positioning can be used to create gap.
Overhead Bundle Management
Non-Continuous Cable Support
Administration and Operations
Cable and Bundle Identifiers

- Cables should be linked to bundles to facilitate accurate record keeping of remote powering installation configurations.
- The intent is to keep track of the heat generation within a cable bundle and avoid over heating of any cables in the bundle.
- AIM (Automated Infrastructure Management) can help with assignment of circuits to reduce heat generation and improve heat dissipation.
TIA and ISO Developments

- ANSI/TIA-606.C Annex C has details on cable and bundle identifiers/records needed for management of remote powering
- ISO has started an amendment to ISO/IEC 18598 AIM standard to add automated functions for remote power management
- ANSI/TIA-568.D-2 draft has pathway qualification table for remote powering
Conclusions and Next Steps
Conclusions

- Market for Remote powering such as PoE continues to expand as increased power levels support broader range of powered devices
- TIA TSB-184-A, ISO TS 29125, and CENELEC EN 50174-99-01 contain detailed information on cable heating under various bundled configurations
- NEC NFPA 70 articles 725.144 and 840.160 on remote powering focus is on cable types and represents worst case installation conditions
- Recommend a multi-faceted holistic approach including design, installation, administration and operation to control and manage remote powering
Next Steps

• Better collaboration and coordination between SDOs including NEC NFPA 70 2020, TIA TR42 568, ISO WG3, IEEE 802.3, CENELEC TC215 and BICSI to avoid conflicts and confusion in specifications
• Address 1-pair applications supported by IEEE 802.3bu PoDL
• Incorporate remote powering for a wide range of small and large IoT and M2M communication devices
Thank You!