Implementation Considerations for Supporting Remote Powering Over Communications Cabling

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2017 BICSI Fall

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SEPTEMBER 24-28 | LAS VEGAS, NV

Outline

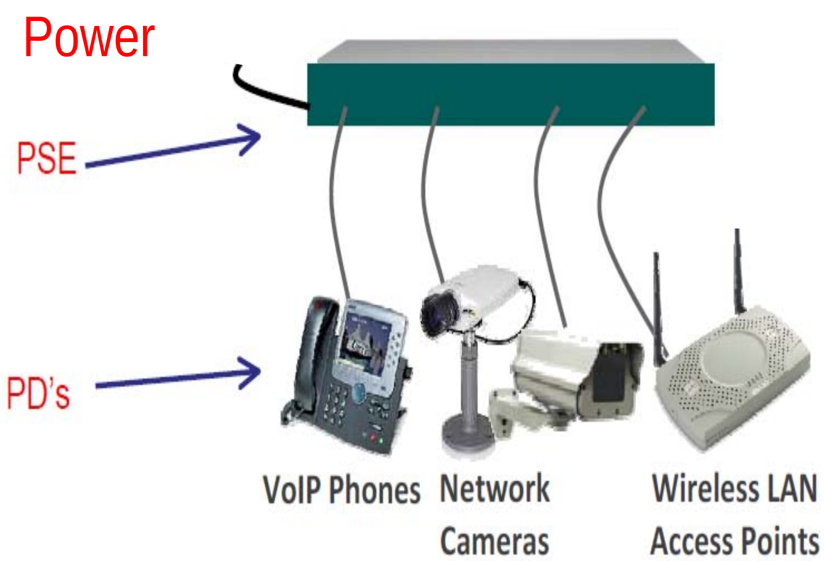
- Market Drivers
- Technology Drivers
- Standards and Codes
- Design and Installation
- Administration and Operations
- Conclusions and Next Steps

Market Drivers

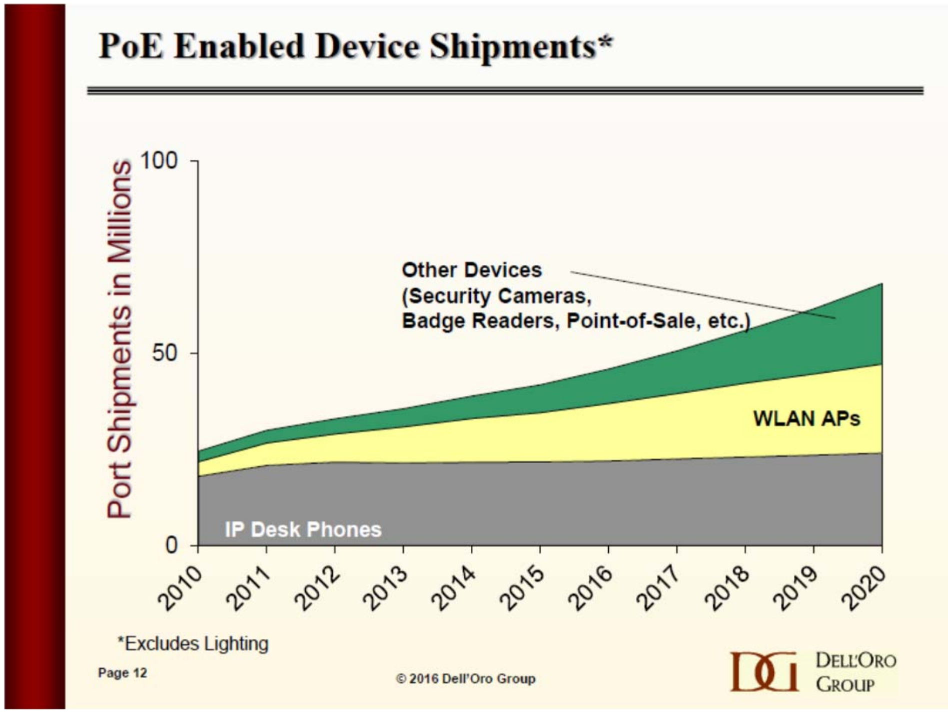
Economics and Convenience

- 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

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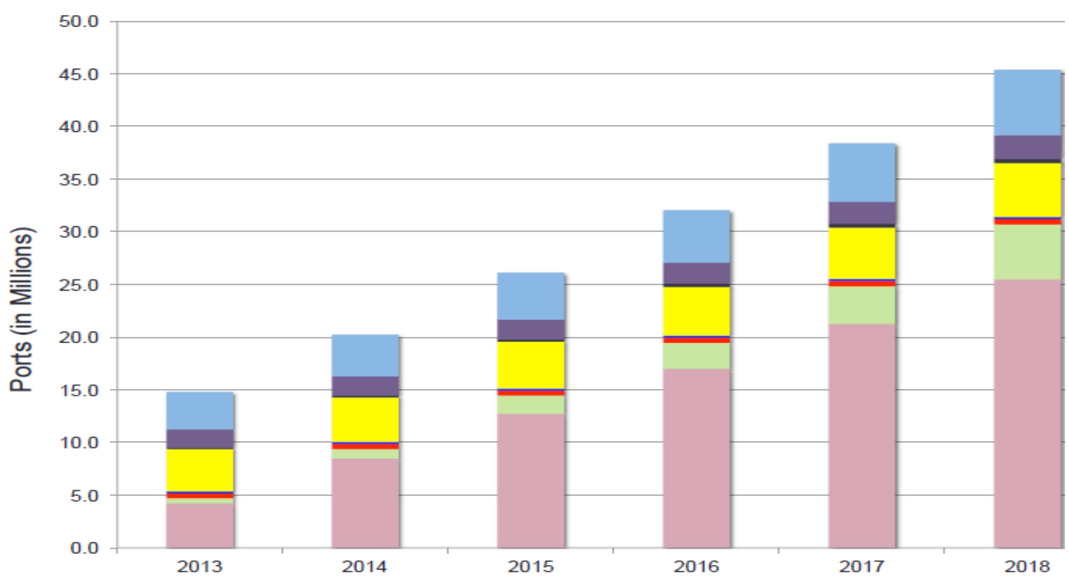
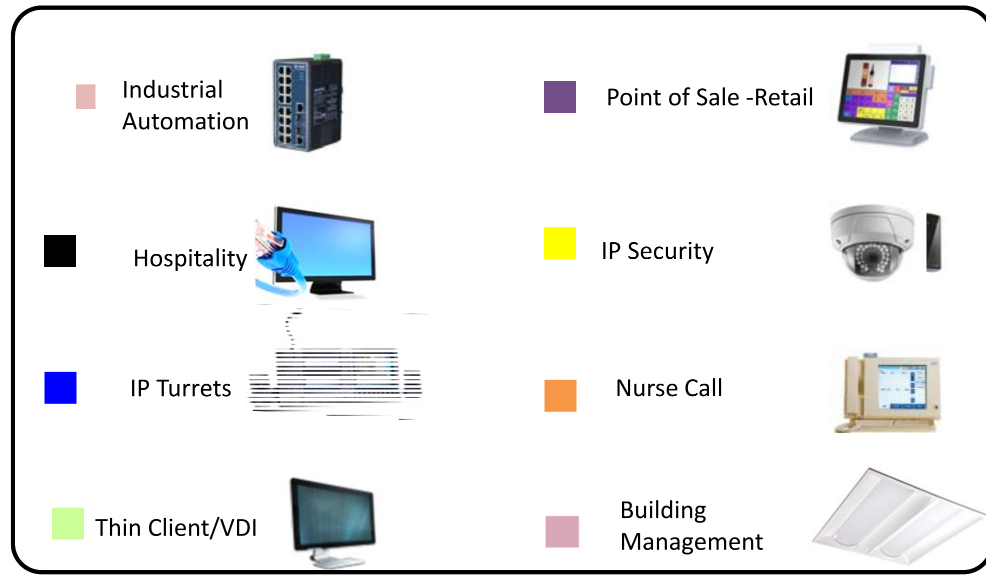
Market Potential – Other Devices





Sources:
VDC Research
IMS Research - Jenalea Howell
http://seekingalpha.com/article/101408-the-global-lighting-market-by-the-numbers-courtesy-of-philips and other research reports
Gartner Forecasts, BT Turret, Cisco Partners

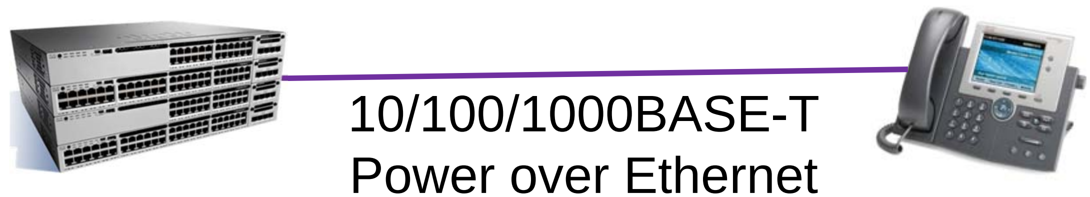
Market Drives Key Objectives in IEEE 802.3bt 4PPoE

- 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.

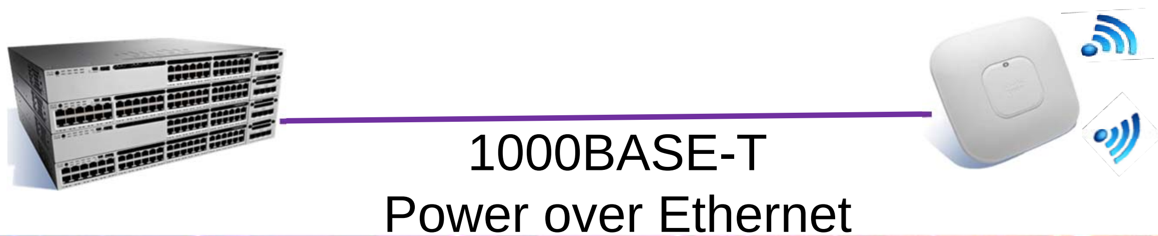
Technology Drivers

Common Data + PoE Network Use Cases

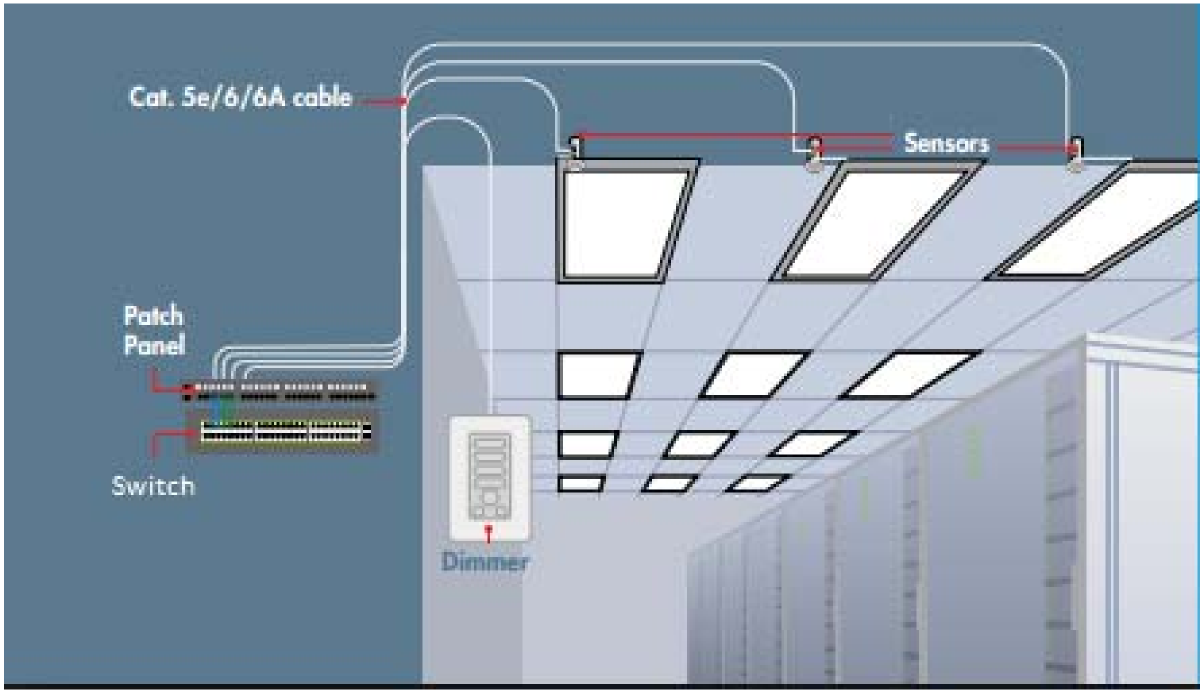
- 802.3 Ethernet and IP Phones



- 802.3 Ethernet and 802.11 WLAN



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

< 300 mA/conductor nominal (Classes 0–6)

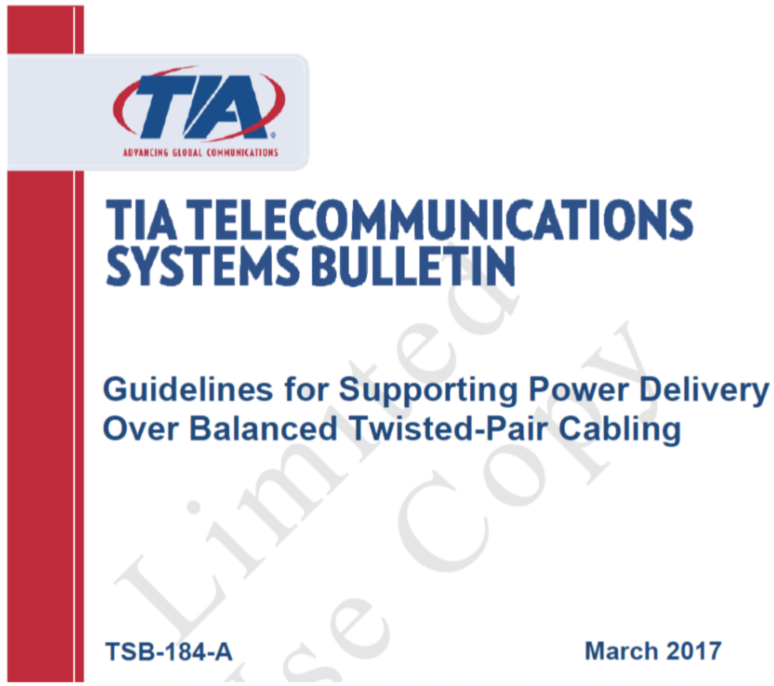
< 480 mA/conductor nominal (Classes 7–8)

PoE Types and Classes	2-Pair PoE+ – Type 2 / 2-Pair PoE – Type 1				2-Pair PoE+ – Type 2	4-Pair PoE in Standardization			
Class	0	1	2	3	4	5	6	7	8
PSE Power (W)	15.4	4	7	15.4	30	45	60	75	90
PD Power (W)	13	3.84	6.49	13	25.5	40	51	62	71
	4-Pair PoE – Type 3							4-Pair PoE Type 4	

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

Standards and Codes

TIA TSB-184-A March 2017



TIA
ADVANCING GLOBAL COMMUNICATIONS

TIA TELECOMMUNICATIONS
SYSTEMS BULLETIN

Guidelines for Supporting Power Delivery
Over Balanced Twisted-Pair Cabling

TSB-184-A March 2017

TSB-184-A Theory and Modelling

Heat generated = Current ^{2} x Resistance

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

ΔT is the temperature rise in °C.

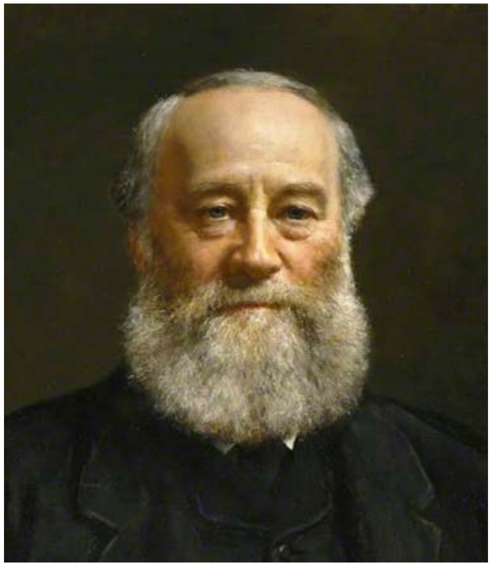
I is the current in amperes.

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.

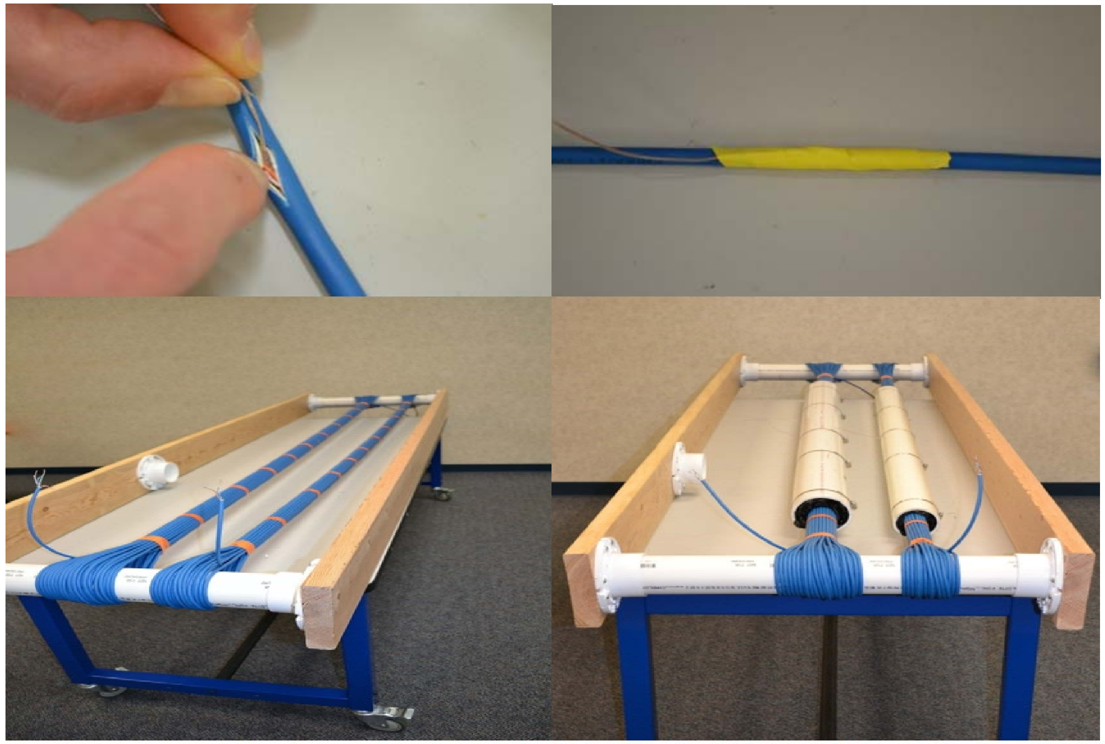
James Prescott Joule



1818 - 1889 Manchester UK

Measurement Setup in TIA TSB-184-A

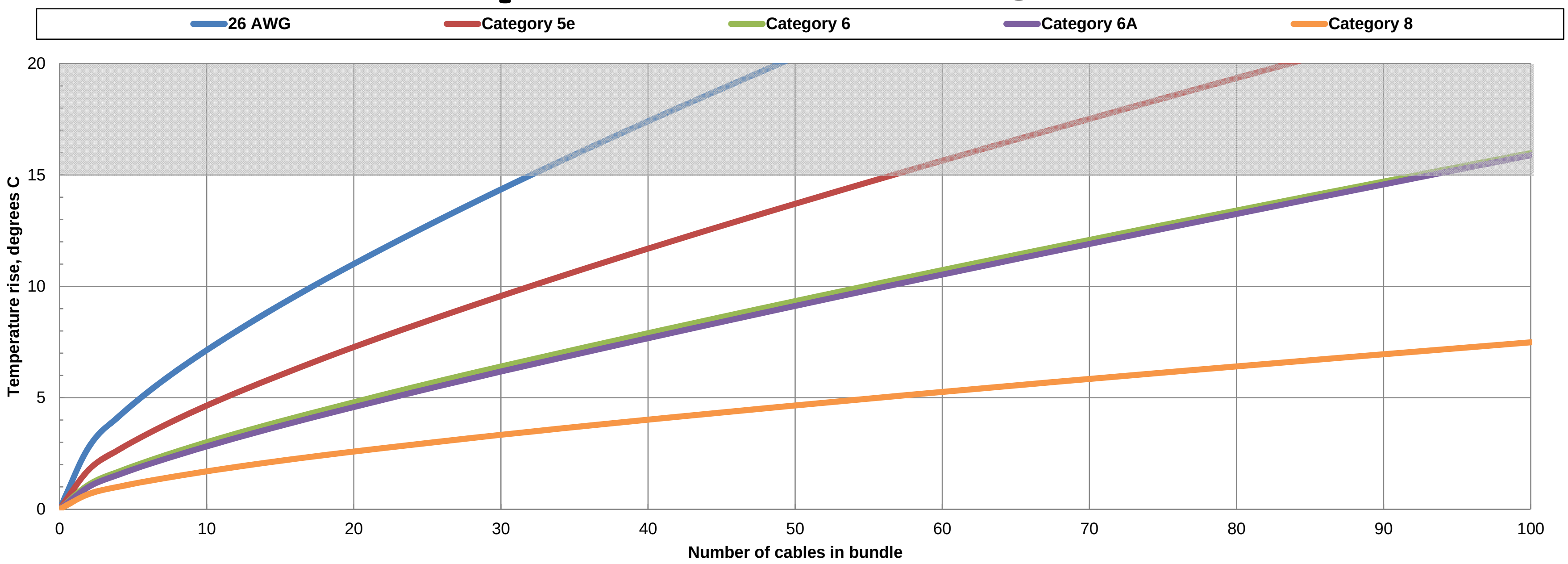
thermocouple insertion



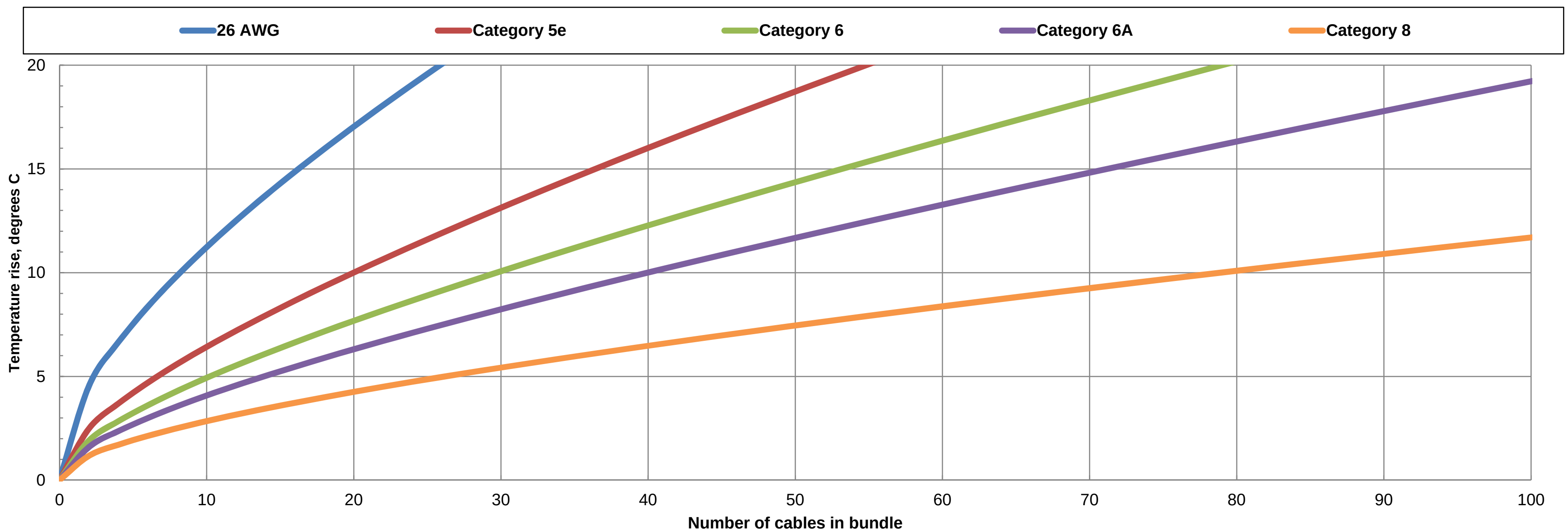
open bundle

enclosed bundle

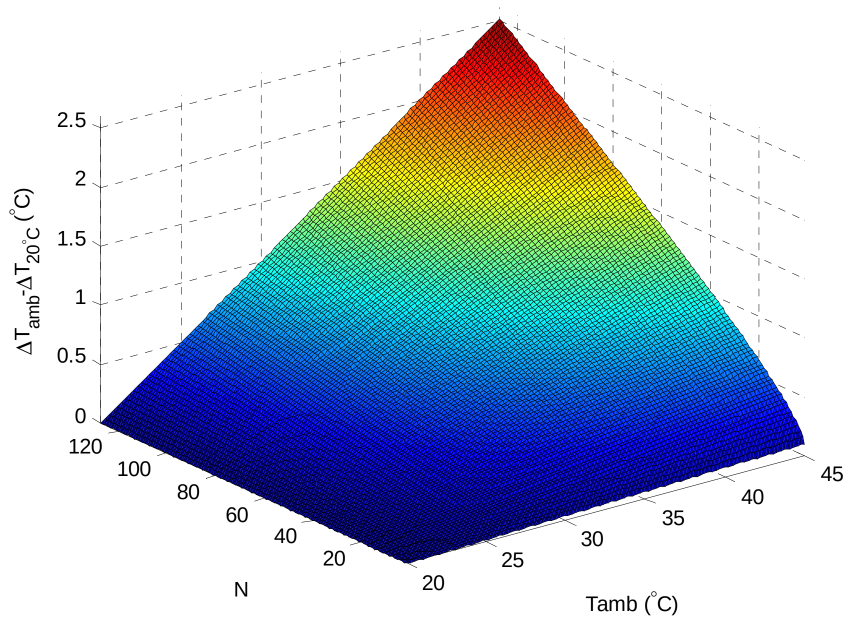
Temperature Rise vs. Bundle Size in Open Air @ 1A/Pair



Temperature Rise vs. Bundle Size in Conduit @ 1A/pair



Modelling Temperature Rise vs. Bundle Sizes and Ambient Temperatures



ISO/IEC TS 29125 April 2017

ISO/IEC TS 29125:2017(en) Information technology — Telecommunications cabling requirements for remote powering of terminal equipment

ISO/IEC TS 29125

Edition 2.0 2017-04

TECHNICAL SPECIFICATION

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)

Temperature rise °C	Current per pair mA 0,4 mm cords		Current per pair mA Category 5 cables	
	air	conduit	air	conduit
5	583	475	722	603
7,5	715	581	884	738
10	825	671	1021	853
12,5	923	751	1141	954
15	1011	822	1250	1045
17,5	1092	888	1351	1128
20	1167	950	1444	1206

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

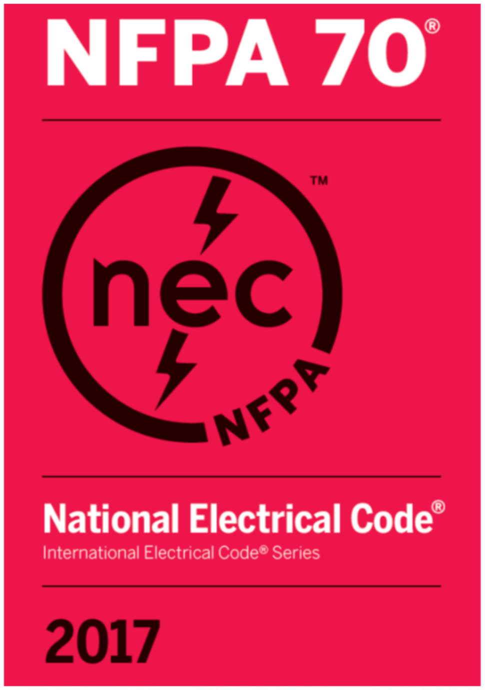
NOTE 2: The 0,40 mm cordage results are based on measurements of stranded construction which typically has a slightly lower DC resistance than cordage of solid cable construction

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

PRINCIPLES USED

- **Heat generated in cabling = Current ^{2} 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

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

AWG	Number of 4-Pair Cables in a Bundle																				
	1			2–7			8–19			20–37			38–61			62–91			92–192		
	Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating		
	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C
26	1	1	1	1	1	1	0.7	0.8	1	0.5	0.6	0.7	0.4	0.5	0.6	0.4	0.5	0.6	NA	NA	NA
24	2	2	2	1	1.4	1.6	0.8	1	1.1	0.6	0.7	0.9	0.5	0.6	0.7	0.4	0.5	0.6	0.3	0.4	0.5
23	2.5	2.5	2.5	1.2	1.5	1.7	0.8	1.1	1.2	0.6	0.8	0.9	0.5	0.7	0.8	0.5	0.7	0.8	0.4	0.5	0.6
22	3	3	3	1.4	1.8	2.1	1	1.2	1.4	0.7	0.9	1.1	0.6	0.8	0.9	0.6	0.8	0.9	0.5	0.6	0.7

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 wide-spread use are typically 22–26 AWG.

Article 310.15(B)(2) & Table 310.15(B)(2)(a)

(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:

[310.15(B)(2)]

$$I' = I\sqrt{\frac{T_c - T_a'}{T_c - T_a}}$$

where:

I' = ampacity corrected for ambient temperature
I = ampacity shown in the tables
T_c = temperature rating of conductor (°C)
T_a' = new ambient temperature (°C)
T_a = ambient temperature used in the table (°C)

Table 310.15(B)(2)(a) Ambient Temperature Correction Factors Based on 30°C (86°F)

For ambient temperatures other than 30°C (86°F), multiply the allowable ampacities specified in the ampacity tables by the appropriate correction factor shown below.

Ambient Temperature (°C)	Temperature Rating of Conductor			Ambient Temperature (°F)
	60°C	75°C	90°C	
10 or less	1.29	1.20	1.15	50 or less
11–15	1.22	1.15	1.12	51–59
16–20	1.15	1.11	1.08	60–68
21–25	1.08	1.05	1.04	69–77
26–30	1.00	1.00	1.00	78–86
31–35	0.91	0.94	0.96	87–95
36–40	0.82	0.88	0.91	96–104
41–45	0.71	0.82	0.87	105–113
46–50	0.58	0.75	0.82	114–122
51–55	0.41	0.67	0.76	123–131
56–60	—	0.58	0.71	132–140
61–65	—	0.47	0.65	141–149
66–70	—	0.33	0.58	150–158
71–75	—	—	0.50	159–167
76–80	—	—	0.41	168–176
81–85	—	—	0.29	177–185

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**

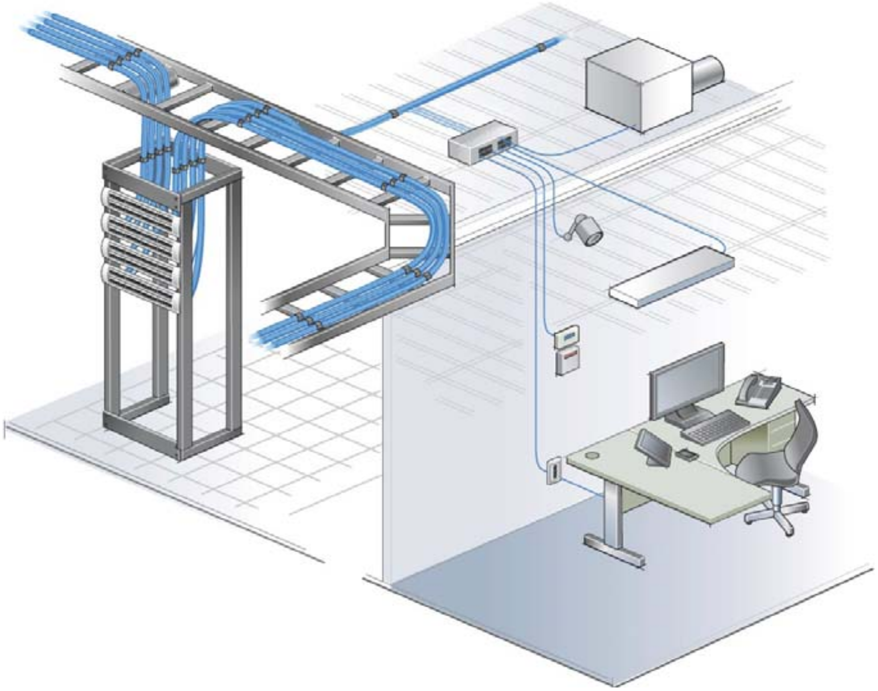
NOTE: Above Issues in Red are balloted as TIA (Tentative Interim Amendment) to NEC 2017 code with public comment closing on 9/14/2017

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

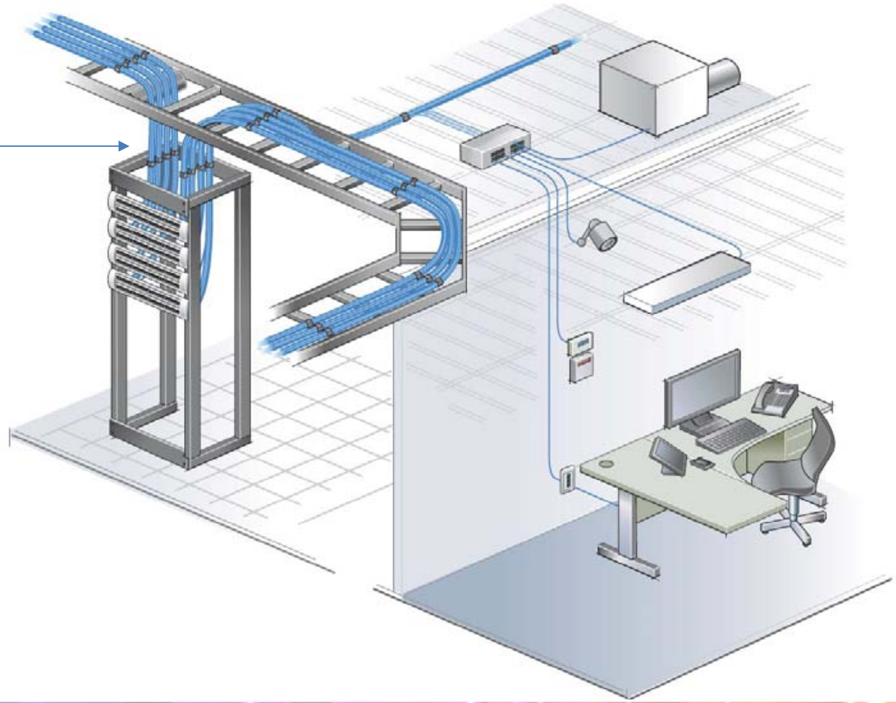


Limit bundle sizes and organize to avoid stacking and packing

Recommended maximum bundle size is 24 cables

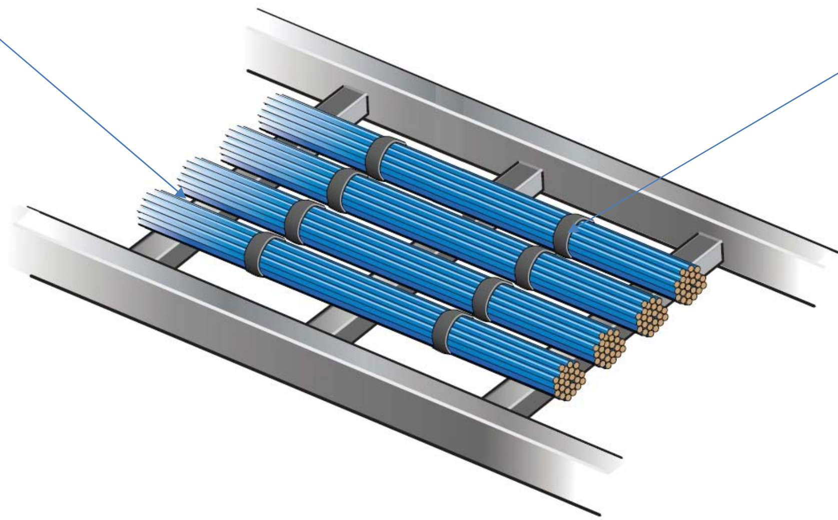
Installation at Patch Panels

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

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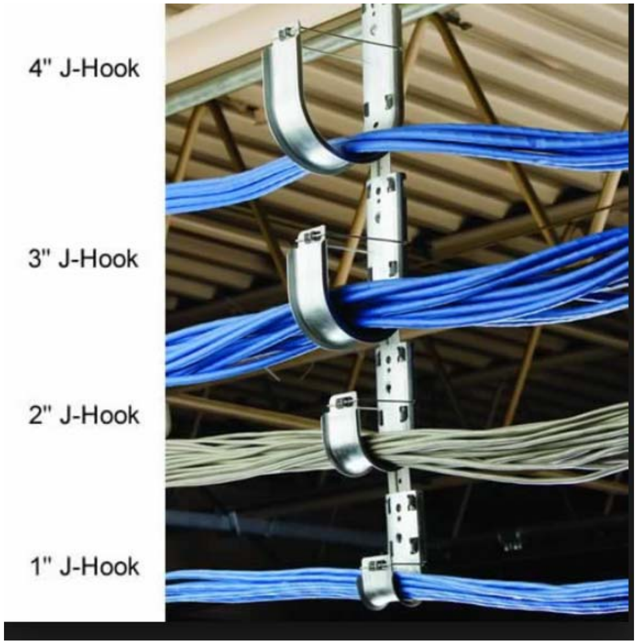
Non-Continuous Cable Support



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!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