The Latest Trends in POE Solutions for Smart Cities, Smart Buildings, and Smart Infrastructure

Presented by:
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Leviton Manufacturing

Introduction to PoE

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History Lesson

RG/62 Coax

"Low Voltage" Communication Cabling

25 pair UTP

1970's Workstation - Voice & "Data"

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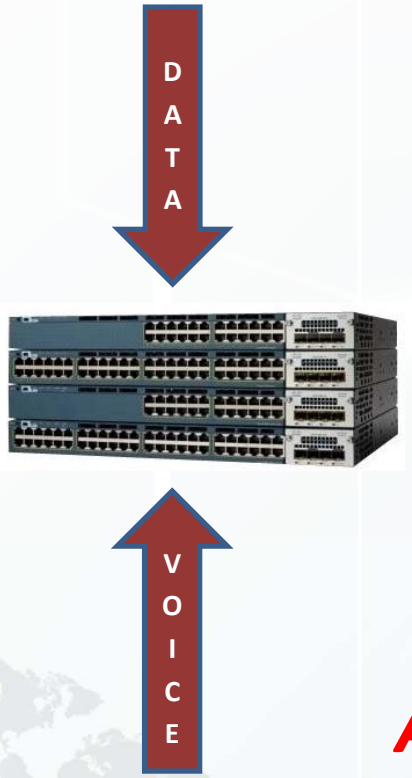
History Lesson



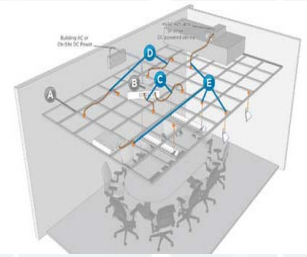
Structured Cabling

- Four Pair (4) Unshielded Twisted Pair (UTP)
- "Category" Cables
- Local Area Network (LAN)

Added Power to support VoIP

Future

We are now in a world of devices requiring Power and Data to be Functional, Valuable & Effective



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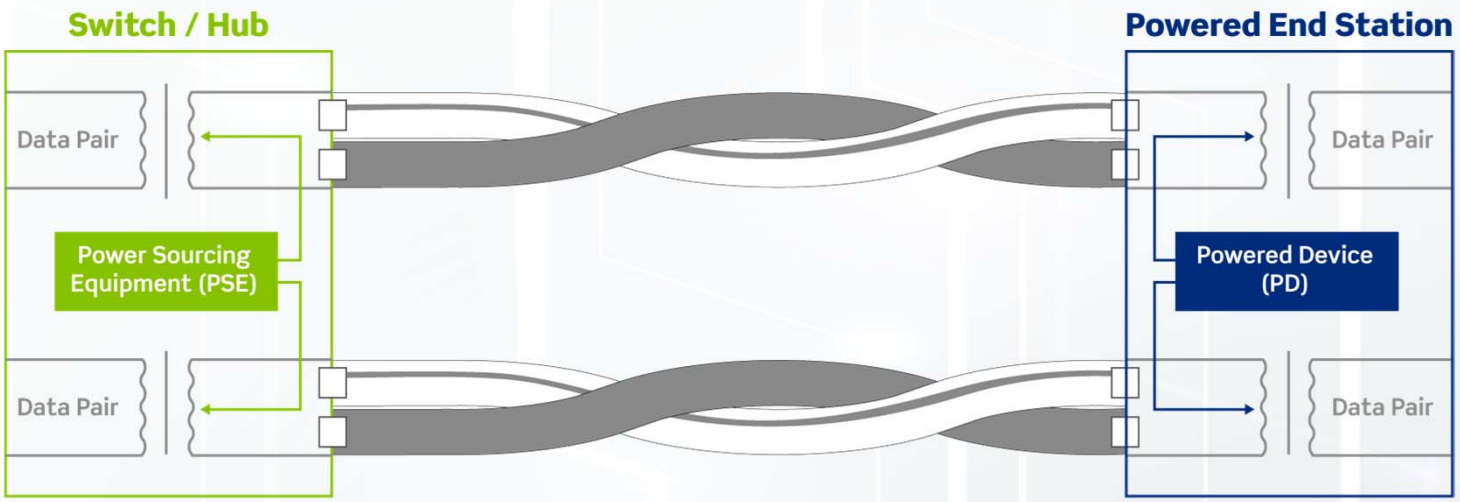
Understanding PoE
A Basic Overview

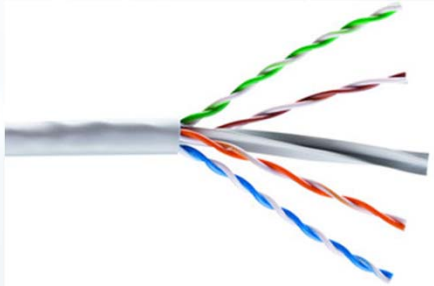
First – The Basics
What is PoE?

Delivery of power and data over the same twisted pair cable



PoE-Power over Ethernet

- **Power over Ethernet (POE) is a technology that lets network cables carry electrical power.**
- **For example, a digital security camera normally requires two connections to be made when it is installed:**
  - A *network connection*, in order to be able to communicate with video recording and display equipment
  - A *power connection*, to deliver the electrical power the camera needs to operate
- **If the camera is POE-enabled, only the network connection needs to be made, as it will receive its electrical power from this cable as well.**
- **Power over Ethernet (POE) can be delivered on standard Ethernet cabling from Cat5 to 8**
- **Cabling can be Shielded or Non-Shielded**
- **There are 2 basic methods for delivering Power**
  - Method 1
    - 2 Pairs of the cable are used for Data
    - 2 Pairs of the cable are used for Power
  - Method 2
    - Power and Data are sent over the same pairs
      - Electrical Power 60Hz or less
      - Data Signals 10 to 100 million Hz
    - These differences in Frequency allow both to coexist with no interference



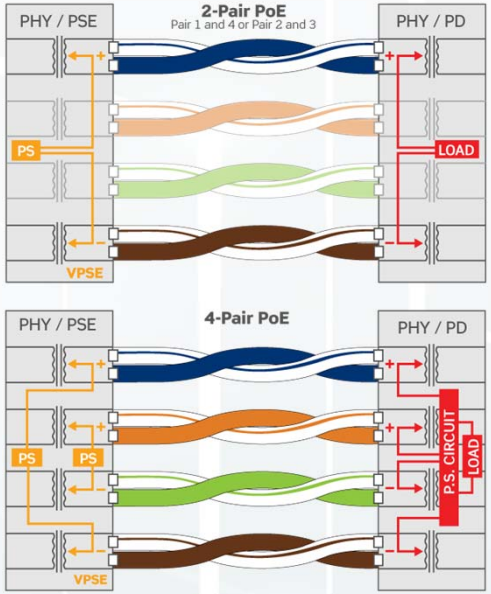
Data Signals

Electrical Power

Power and Data

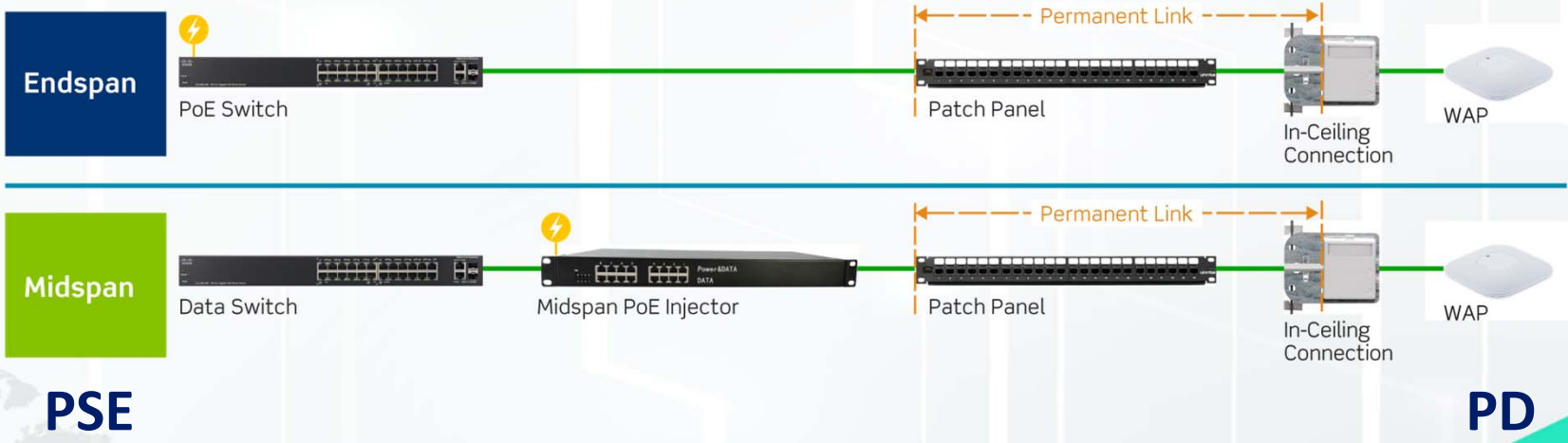
Over the Same Pair Simultaneously

- **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**



Equipment
The Power in PoE

- **Two primary components:**
  - Power Sourcing Equipment (PSE)
  - Powered Device (PD)



PoE Evolution

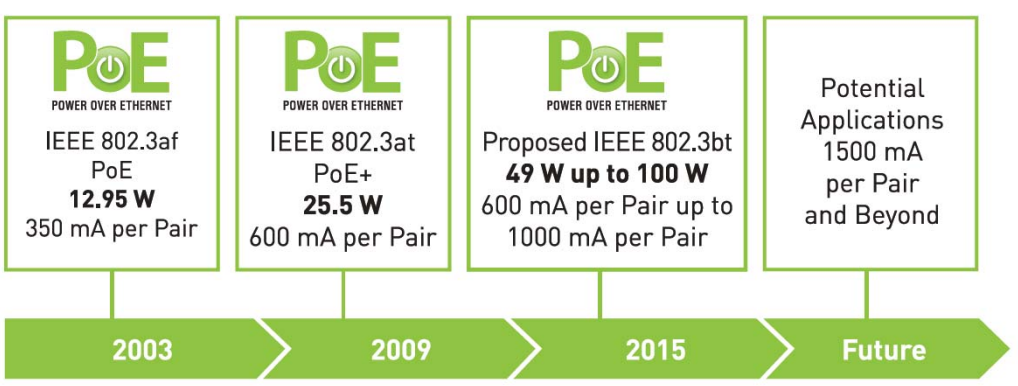
Power over Ethernet

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)
- **Since 2009 more new devices requiring increased power have hit the market**

PoE-Power over Ethernet

- Power over Ethernet technology (PoE) gaining traction in the market ever since its launch in 2003, especially in Voice over Internet Protocol (VoIP) telephony & IP Surveillance camera.
- Today's PoE landscape has effectively split into two broad categories:
  - Standards compliant 24.5 W 802.3at
  - Nonstandard applications with higher power delivery capabilities such as Cisco's UPoE 60 W and HDBaseT's 100 W.
- These non-standard applications create a significant paradigm shift in what was thought to be possible with PoE.
- Power delivery through 1000 mA per pair and beyond is looming on the horizon and steps will be necessary to ensure continued compatibility with this rapidly changing environment.



What is Digital Innovation & IoT

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Emerging Markets

Powering Over Communication Cabling (PoCC)

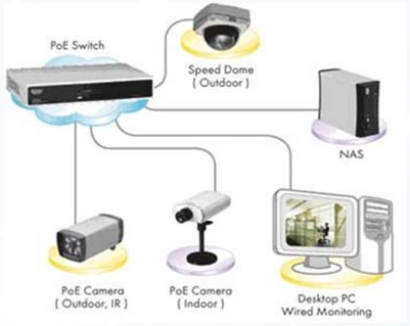
2011: UPoE (Cisco)
- **60 watts**

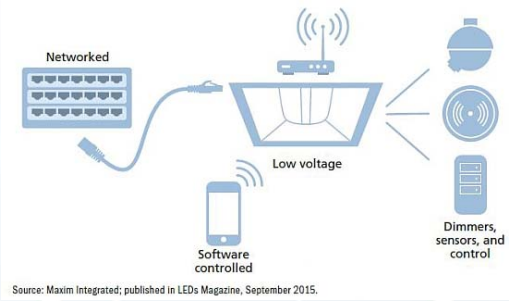
2011: POH
- **Power over HDBaseT**
- **100 watts**

TIA TSB 184-A – Published
- **Cable bundle size restrictions, recommends Cat-6A**

2018 - IEEE 802.3bt
- **High power PoE or PoE++**
- **20, 75 & 90 watts potential**

BICSI – Draft D044
- **"Practices For The Installation of Telecommunications and ICT Cabling Intended to Support Remote Power"**





Future – 200 Watts ?

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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**

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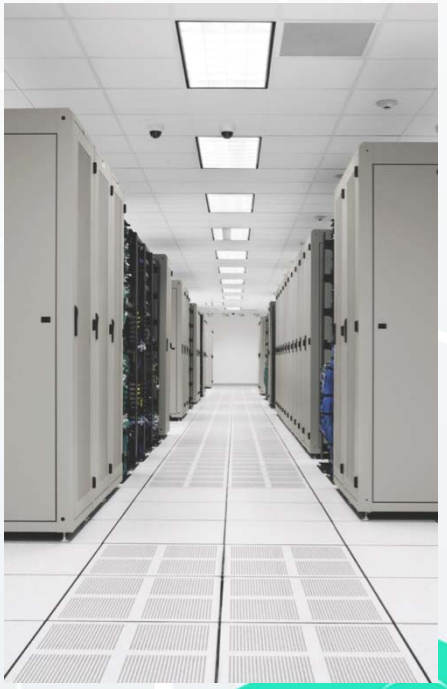
Benefits
PoE vs. Traditional Power

- **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

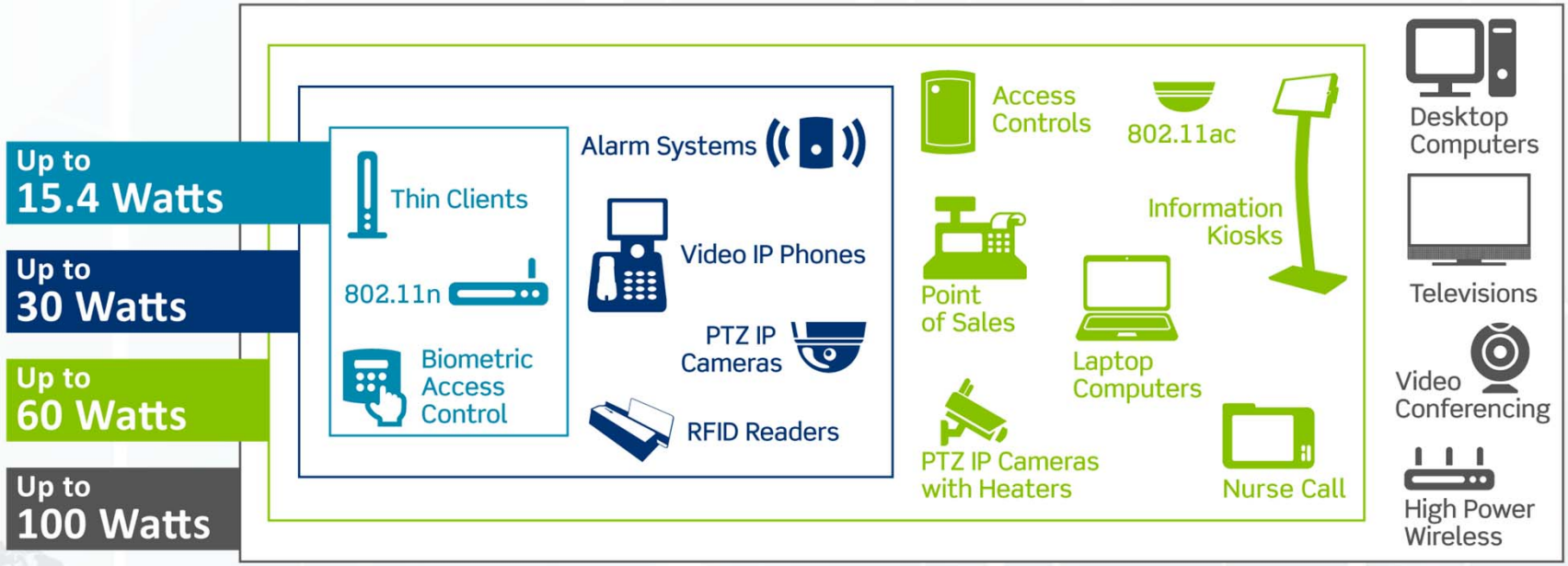


Benefits Continued
PoE vs. Traditional Power

- **Enables enhanced applications**
  - Adapt to individual user's needs in real-time
  - Improved business security
- **New Business Insights**
  - Informed decisions regarding business operations and planning

Power over Ethernet: Standards Based & Proprietary Applications

Applications
Why We Need More Power



The Technology Gap

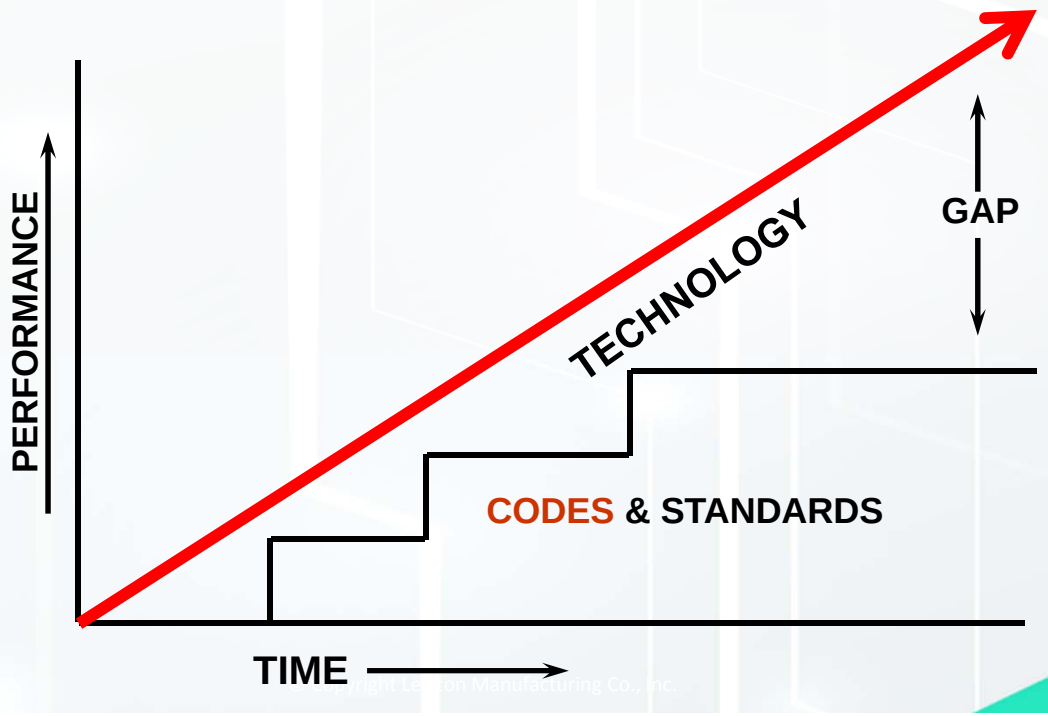
Standards can Not Keep Up

Design & Technology Integration

National Society of Professional Engineers®

CTS CompTIA Certified Technology Specialist General

AIA The American Institute of Architects



BICSI Registered Communications Distribution Designer

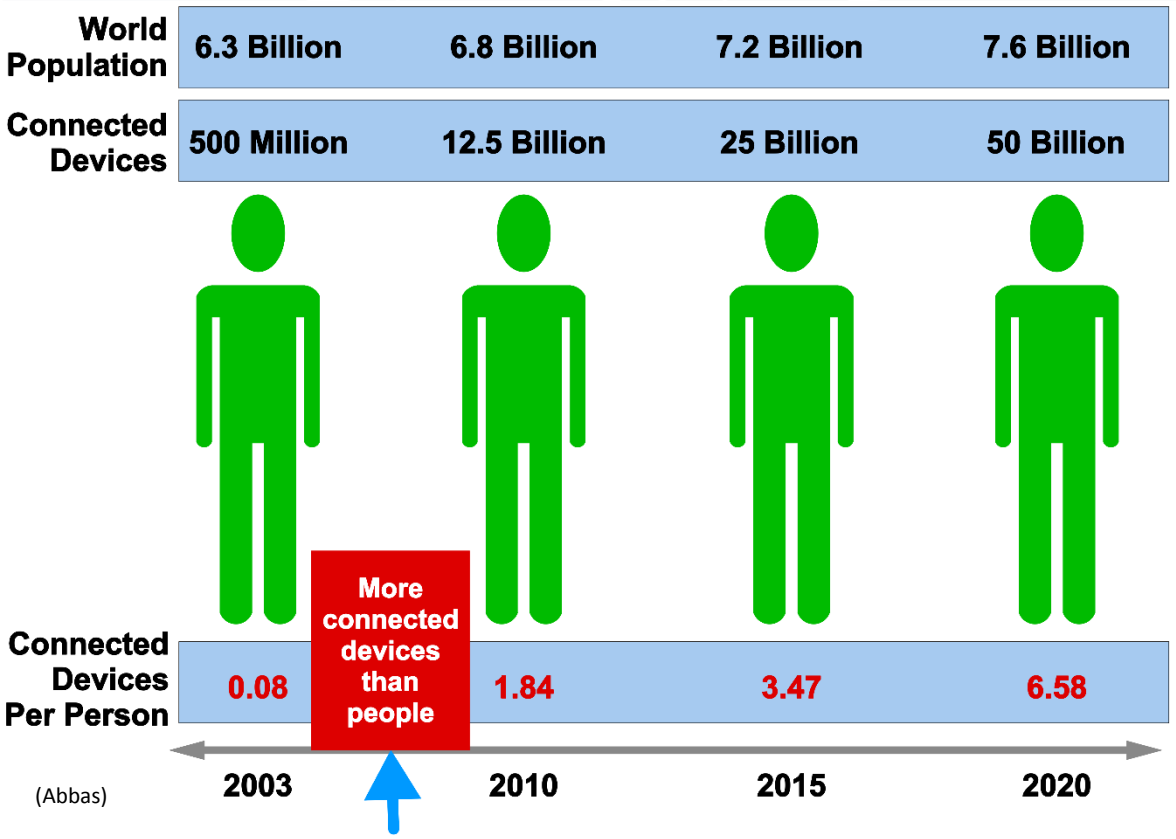
BICSI Middle East & Africa

The Internet of Things

- The Internet of Things, commonly abbreviated "IoT," is an umbrella term that refers to anything connected to the Internet. It includes traditional computing devices, such as laptops, tablets, and smartphones, but also includes a growing list of other devices that have recently become Internet enabled. Examples include home appliances, automobiles, wearable electronics, security cameras, and many other things.

The Internet of Things

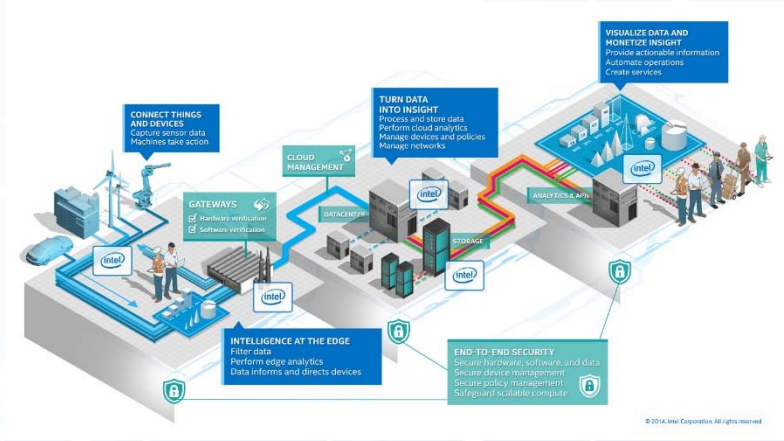
- Economic impact estimated at $7.1 trillion globally (2020).



The Internet of Things

This increase in IoT device usage means:

- The need for broadband access will be greater than ever.
- Businesses must have access to broadband networks.
- Investment in broadband infrastructure to support speed and data demands will be extremely important for these IoT ecosystems to function properly.



(Intel)

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Safety & Performance
A Look at
Current and Emerging
Standards

Power Over Ethernet: 100W

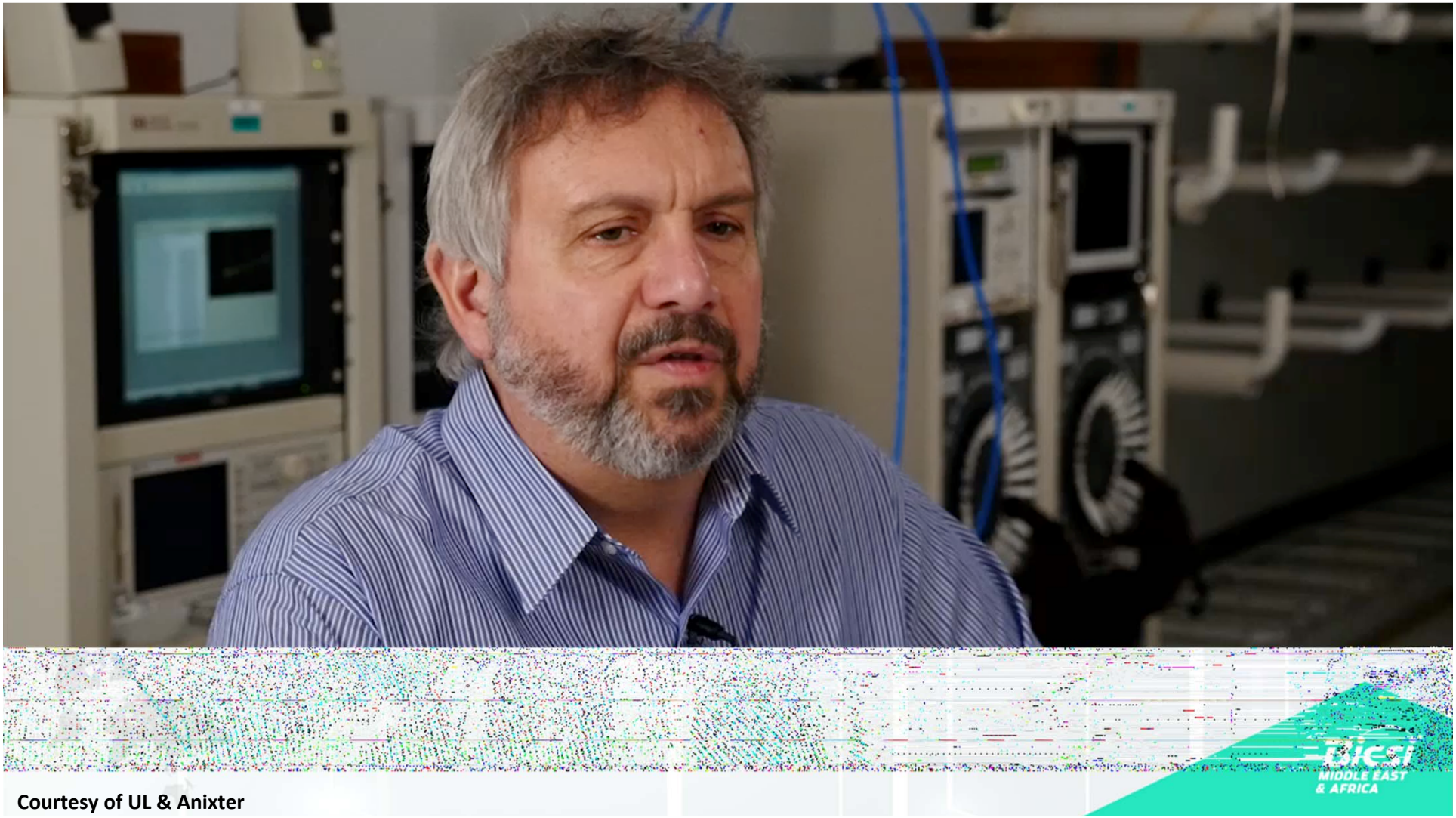
- PoE was created with safety and interoperability in mind. IEEE802.3af-2003 was the first version of PoE, which supported loads of up to 12.95W, such as IP phones, IEEE802.11g WLAN access points and network cameras.
- As IEEE802.11n was about to become a reality, it was clear that more power was needed and the IEEE802.3at-2009 standard was created, increasing power to 25.5W per device and allowing two devices to be powered over a single Cat5 cable, for a total of 51W.
- The POH standard is based on the IEEE 802.3at standard with the appropriate modifications to enable safe delivery of up to 100W over the four-pairs of the Ethernet cable.
- HDBaseT's powering capabilities are increasingly important as consumers bring more and more electronic devices into the home.

Power Over Ethernet: 100W

- Using HDBaseT, a single LAN cable can provide up to 100W of power, over distances up to 100m, requiring no additional power source.
- Unlike in PoE, where the PD must assume a worst-case cabling infrastructure at all times, POH enables the PD to identify the cable length/resistance and draw more power, as long as the overall power consumption does not exceed 100W.
- POH is fully backwards-compatible with the IEEE802.3at-2009 PoE specification, including the section 33.7.1 mandate that all power sourcing equipment (PSE) conform to IEC 60950-1:2001 and be classified as a Limited Power Source (LPS) carrying no more than 100 volt-ampere (VA) per port without the need for special over-current protection devices.
- POH also does not infringe on any of the mandated PoE safety requirements.

Underwriters Laboratories, a USA based testing laboratory, was commissioned to investigate and create a fact finding study regarding possible safety issues created with the transmission of power over communication cabling:

- Investigate the effects of higher levels of power applied over communications cables under typical installation practices permitted by the NEC
- Support Public Inputs
- Determination and evaluation of realistic worse-case conditions
- Gather data for the development of comments related to the first revisions to the NEC including:
  - Conductor Ampacities
  - Bundle Sizes
  - Installation Practices
- Mitigate safety concerns
- **Focus on power (volts, watts, amps), not applications**



Courtesy of UL & Anixter

New Ampacity Table 725.144

Table 725.144, Ampacities of Each Conductor (in Amperes) in a 4-Pair Class 2 or Class 3 Data Cables, Based on Copper Conductors at 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	1.0	1.0	1.0	1.0	1.0	1.0	0.7	0.8	1.0	0.5	0.6	0.7	0.4	0.5	0.6	0.4	0.5	0.6	NA	NA	NA
24	2.0	2.0	2.0	1.0	1.4	1.6	0.8	1.0	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	3.0	3.0	3.0	1.4	1.8	2.1	1.0	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.

2017 Edition

Ampacity Table 725.144

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

8 Conductors

Bundle Sizes 4-Pair Cables

LAN wire gauges

Cable Temperature Rating Choices

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	1.0	1.0	1.0	1.0									0.4	0.5	0.6	0.4	0.5	0.6	NA	NA	NA
24	2.0	2.0	2.0	1.0									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	3.0	3.0	3.0	1.4	1.8	2.1	1.0	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

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Source NEC 2017

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	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	1.0	1.0	1.0	1.0	1.0	1.0	0.7	0.8	1.0	0.5	0.6	0.7	0.4	0.5	0.6	0.4	0.5	0.6	NA	NA	NA
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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	3.0	3.0	3.0	1.4	1.8	2.1	1.0	[Engineering Supervision]						0.8	0.9	0.6	0.8	0.9	0.5	0.6	0.7

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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. [Correction for Energized Pairs]

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

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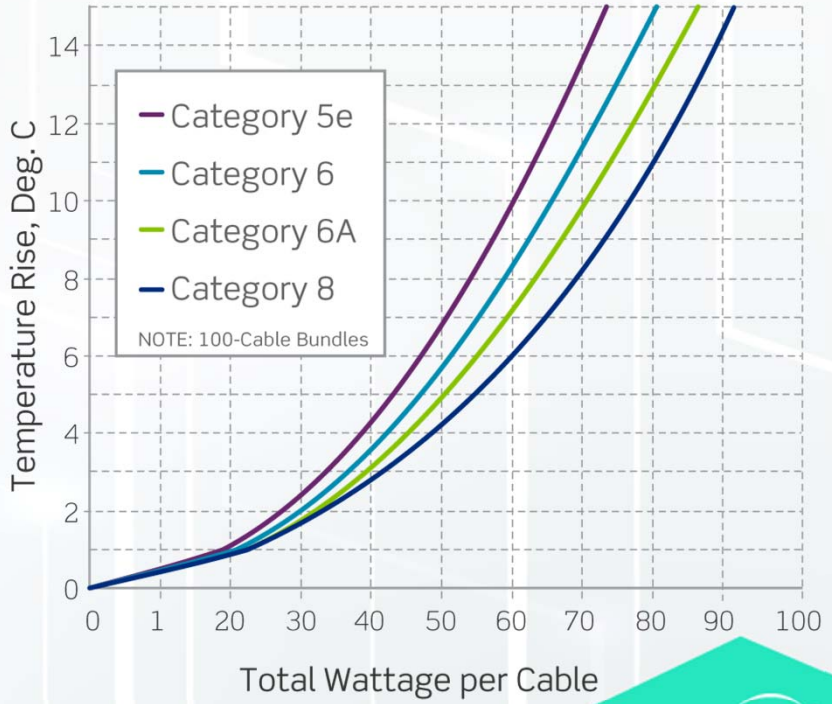
Excessive Temperature Rise

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



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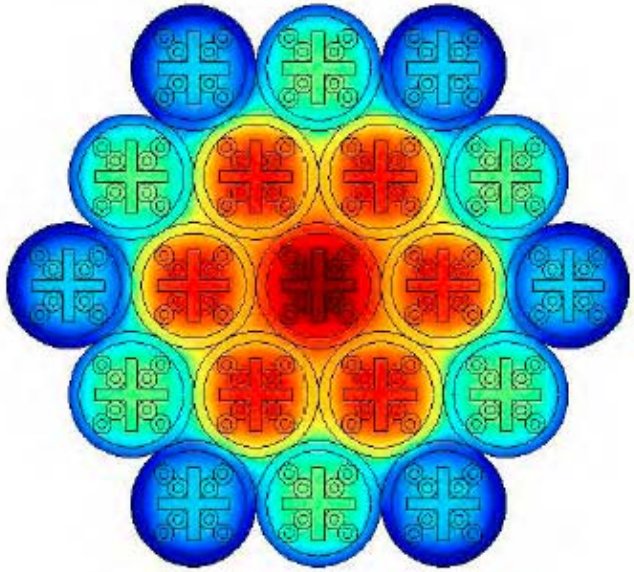
Excessive Temperature Rise

PoE Challenges

Temperature Rise

- Temperature of the cabling will rise due to heat generation of the conductors.
- Generally, heat will dissipate until a steady state is reached with the ***temperature of the cable bundle higher than the ambient temperature*** of the surrounding environment.



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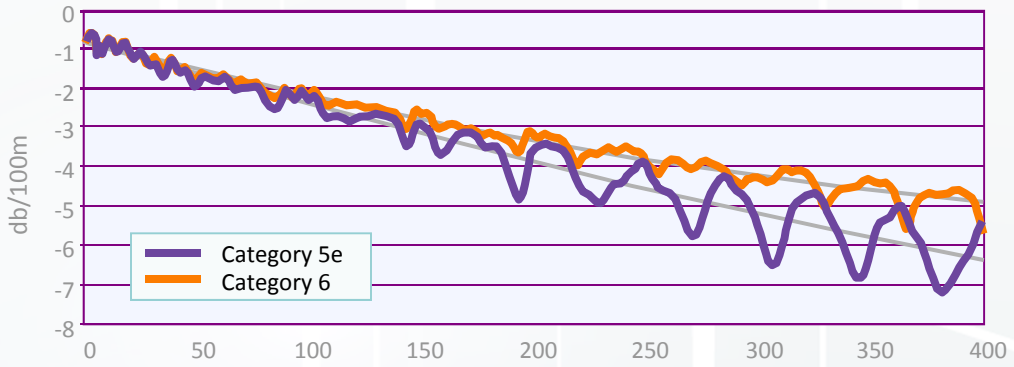
Excessive Temperature Rise

PoE Challenges

Cable Heating & Performance

- **Conductive properties of copper change**
  - DC resistance a function of conductor size
  - DC resistance increases with temperature
- ***Impact on cable performance has traditionally been addressed***
- **Cable heating in bundles cause for concern**



Cable Type	DC Resistance Initial	DC Resistance After 24 Hours	Calculated Temperature Delta
Category 5e	120 milliohms	124 milliohms	10%
Category 6	88 milliohms	90 milliohms	4%

Bottom line: There is a 25 percent increase in signal loss with Category 5e vs. Category 6 cable.

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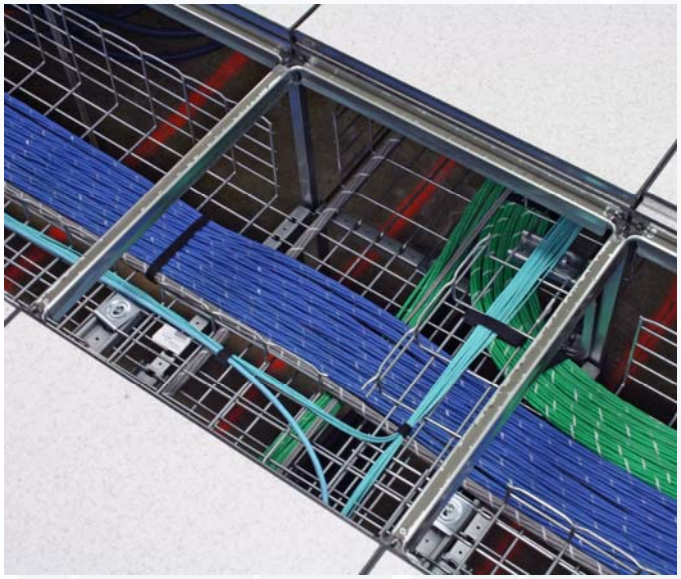
Design Considerations

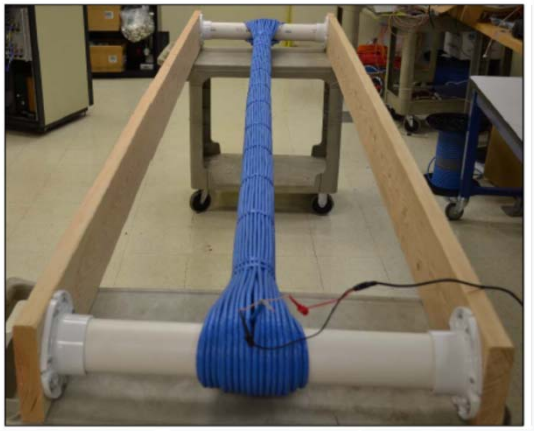
Design Considerations

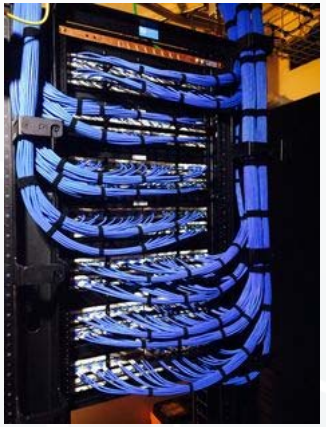
- **Reduce number of cables per bundle**

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

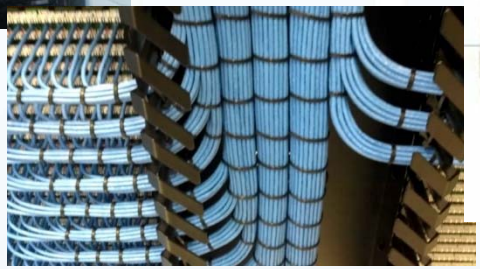


Cable Bundles





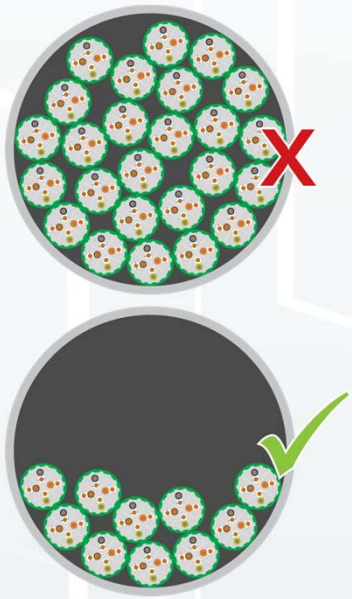
Cable Bundles



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 (birdcage them) on either side to help dissipate heat**



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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**

What 100 Watt PoE Means to Cabling

Use Cat 6A

- **Installers need to consider bundle size, environmental temperatures and power level**
- **Cat 6A delivers best performance, supports future applications**
- **Cat 6A handles higher speeds and exhibits lower heat rise in PoE environments**
- **Lower costs by supporting higher power per cable, avoiding additional bundles and trays**
- **23 AWG conductors generate less heat 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

CAT 6A

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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**

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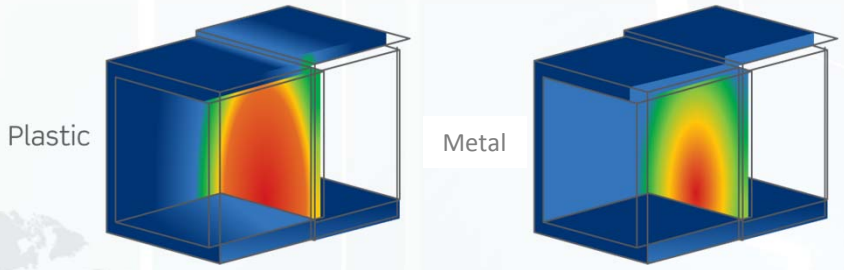
Use Cat 6A Connectors

PoE Installation Best Practices

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

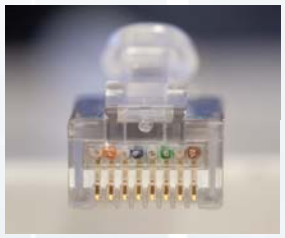
Thermal simulation of connector bodies using plastic and zinc



Patch Cords

Look to the Standards

- **TIA-568-C.2 Compliant Patch Cords**
- **IEEE 802.3af/at/bt Power Over Ethernet**
- **ISO/IEC TR 29125 Telecommunications cabling requirements for remote powering of terminal equipment**
- **TIA TSB-184 Guidelines for supporting power delivery over balanced twisted-pair cabling**
- **ANSI/TIA-1096-A requires 50 micro-inches of gold**



Non-compliant cords will have lower reliability when used in PoE applications

Design Takeaways

- *The NEC 2017 set ampacity limits on traditional small gauge cables and conductors typically used for communication*
- *Heat is the enemy – Installation practices will require mitigation techniques in the field and design phase.*
- *Designer's, Integrators and Installers need to balance code requirements for safety and systems data transmission performance for reliable data transmission.*

Design Takeaways

- ***Stay tuned – Codes & Standards will continue to evolve for Power Over Communications Cables (PoCC) as converged technologies continue to take advantage of power and data on a single physical infrastructure***
- ***Engage with the AHJ early in any project that may include "non-traditional" or unfamiliar systems – become an educator !***
- ***Look to professional organizations such as BICSI and manufactures' for guidance and updates.***

Smart Buildings
&
Smart Cities

A World of Change & Opportunity

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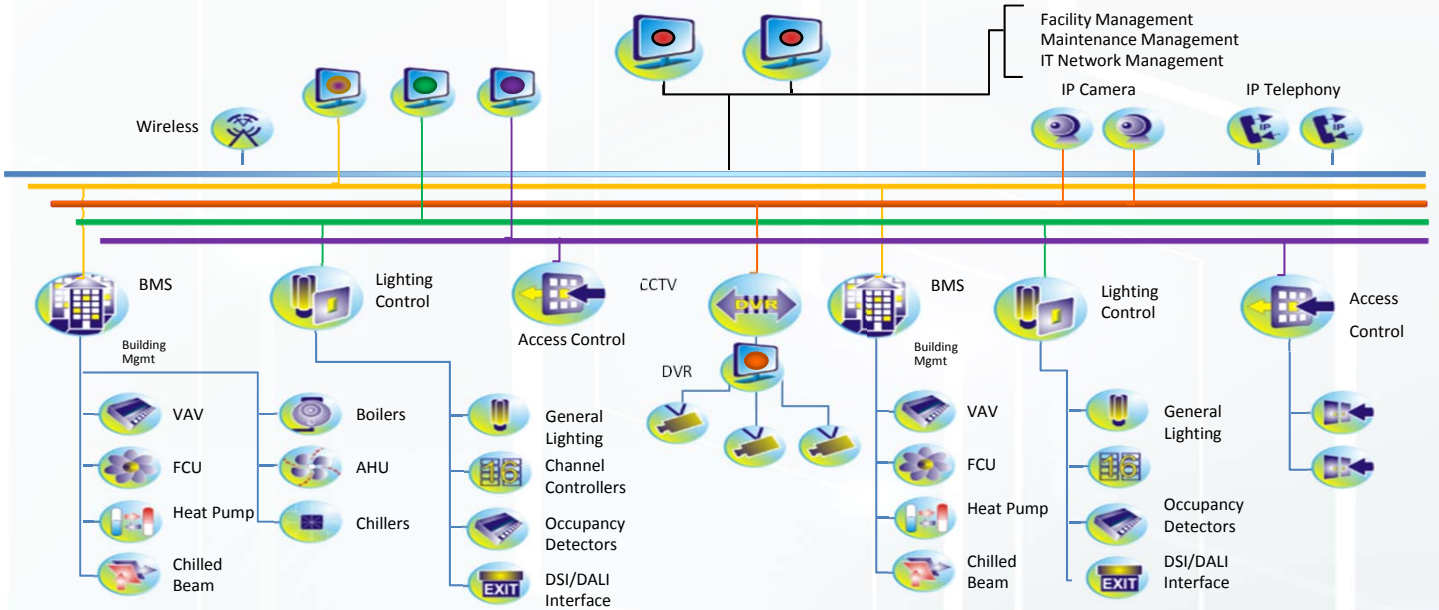
Typical Building Networks Operate in Silos



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Connect Your Devices

Wireless Access Points

Sound Masking Speakers

Mass Emergency Notification Speakers

Cellular Antennas

Speakers

CCTV Equipment

Lighting

Microphones

Projectors

Projection Equipment

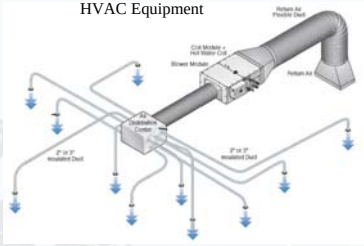
GPS/Donor Antennas

First Responder Antennas

Sprinkler Heads

Smoke Detectors

HVAC Equipment



Occupancy Sensors

Exit Signs

Environmental Sensors

Bluetooth Sensors

RFID Sensors

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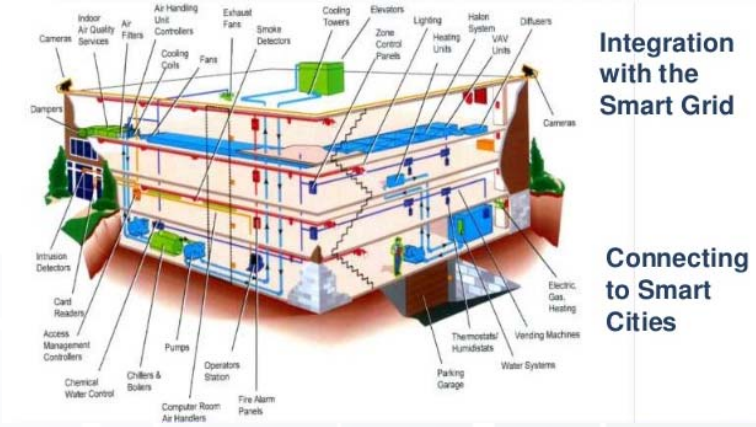
Conclusions

- PoE and the Associated Communication Cabling Infrastructure provide the means to power and communicate with devices
- Machine-to-Machine communication is what will enable the continuing emergence of the IoT
- PoE Technologies provide the platform to connect currently disparate networks and allow the creation of an integrated technology ecosystem



Conclusions

- **PoE may Represent a means of homogenizing Global Power Delivery Systems**
- **PoE and Communication cabling together can be viewed as an enabling technology allowing:**
  - Machine-to-Machine communication
  - Gathering of Metrics required for improved efficiencies
  - Reduction in physical Infrastructure
- **Base Technologies such as PoE and 5G Networks will allow the creation and realization of the Smart Buildings and Smart Cities of the future**


thank you
danke
謝謝
ngiyabonga
teşekkür ederim
gracias
merci
go raibh maith agat
obrigado
dziękuję
bedankt
sukriya
kop khun krap
terima kasih
grazie
arigatō
dakujem
takk
tapadh leat
dank je
спасибо
рахмат
Баярлалаа
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matondo
paldies
grazzi
mahalo
хвала
asante
manana
obrigada
tenki
mauruuru
hvala
kiitos
dankie
nandri
nanni
dhanyavad
gracie
bayarlalaa
enkosi
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شكراً

Questions?