Four Pair PoE: Powering the Future of Intelligent Buildings and the IoT

Murat Erenturk – Goradata
Valerie Maguire, BSEE – SIEMON
Christian Schillab – Fluke Networks
Tertius Wolfaardt – Axis Communications
Agenda

• **Intelligent Buildings – An Introduction to PoE**
  – Murat Erenturk – Goradata

• **Cabling Systems Design and Installation Considerations**
  – Valerie Maguire, BSEE – SIEMON

• **Testing**
  – Christian Schillab – Fluke Networks

• **End Products and Security**
  – Tertius Wolfaardt – Axis Communications
Digital Buildings
An Introduction to 4 Pair PoE

Murat Cudi Erentürk, DCDC
Agenda

• Introduction
• Overview
• Value Proposition
• Architecture
• Identification/Security
• Codes and Standards
• Deployment Example
• Summary
“Predicting rain doesn’t count; building arks does.”

• Warren Buffett
Generation Z’ers
Born after 1995 -
World Population Age – 42% 0-24, 20% 35-49, 14% 50-64, 8% 65+

2016 entered the workforce
66% think technology makes anything possible
80% display emotional distress if separated from devices
90% would be upset if they had to give up the Internet
51% still want to communicate to managers in person
60% want to have an impact on the world at work
IoT Growth

IoT Units Installed Base
Grand Total

Technology Has Changed Buildings.....

Yesterday

Today

Demand for new customer experiences and workforce innovation mandate improved efficiencies
Activity-Based Working (ABW) was the first wave
Enablers for smart/automated workplace
Technology is the enabler......

- Robust and Secure WIFI w Hyperlocation
- Video enabled Privacy Rooms
- IP Lighting
- Individual video workspaces / IoT sensors
- Video enabled Huddle Rooms
- Workplace Management Tools
- Digital Signage
- Physical Security & Access Control
- Innovation spaces with video & content creation
- IoT-enabled building sensors

Employee Services
- Collaboration Workspaces
- Working from Anywhere / Connecting to the Workplace
- Secure Mobility Solutions

Management Services
- Space and Environment Management
- Workspace Utilisation Analytics

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Robot Down!!
VALUE PROPOSITION
PoE End Devices

- Use less energy due to no AC/DC Conversion
- Cheaper due to DC usage
Save Energy, Lower Operations Costs

More Data
- Granular, device-level Visibility and Control
- Centrally Manage Via the Network
- More Energy Saving Over Traditional Methods
ARCHITECTURE
Mid-Span Operation

Non-Intelligent Ethernet Switches
- No Standards
- No State Data

Mid-Span

Powered Devices (PD)

Mid-Span Impact
- Creates another failure point
- Do not participate in Data Channel
- Can’t share power information
- Cost swap between PoE Switch and Mid-Span
- Obscures power troubleshooting
Bringing it all Together

Network Infrastructure

PoE enabled Switches
- CoAP, PoE,
- Converge disparate networks (HVAC, metering, lighting) into one IP network

Applications

Control Systems

Network Infrastructure

Devices

Sensors

Intelligent Driver

LED fixtures/Components

Software

Energy Management

Building Management

API

Space Management

Lighting Control

API

API

Building Automation

HVAC

IP Video Surveillance Camera

Wi-Fi Access Point

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Power Over Ethernet – IEEE 802.3bt

Power over Ethernet (PoE) Delivers DC Power and data over a Standard Copper Ethernet Cable (RJ45)

IEEE 802.3bt

Copper Cable

Up to 91W

Proprietary high power POE available since 2012 Standardized in 2018
Enhanced PoE Capabilities

60W/100W

<table>
<thead>
<tr>
<th>Wall Switch</th>
<th>Digital Building Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial LED PoE Fixtures</td>
<td>...</td>
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<tr>
<td>Dense Sensor Network (Light, Motion, CO2/CO, etc.)</td>
<td></td>
</tr>
<tr>
<td>IP Video Surveillance Camera</td>
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<tr>
<td>Building Mgmt (Connected HVAC)</td>
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</table>

<table>
<thead>
<tr>
<th>PoE Type 3</th>
<th>PoE Type 4</th>
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</thead>
<tbody>
<tr>
<td>▪ Increased PoE Budget: 60W per port</td>
<td>▪ Increased PoE Budget: 90W per port</td>
</tr>
</tbody>
</table>
DoE Cable Testing


Figure 6.1. Range of expected cable losses for 51 W PD at 20°C ambient
Heat Dissipation Example

Power/Heat

Impact at Switch
- Switch Load
- Input Power
- BTU at the Switch Small

Impact across Cable
- Wire Gauge
- Cable Length
- Bundle Size
- 1.7 – 2.8w drop @ 100M

Wall Switch

Digital Building Applications
- Commercial LED PoE Fixtures
- Dense Sensor Network (Light, Motion, CO2/CO, etc.)
- IP Video Surveillance Camera
- Building Mgmt (Connected HVAC)

Data Sheet 600W
Power Available 480W
88-93% Efficient

Power/Heat
Existing POE Devices (Type 1,2)

- Status Signs
- IP Call Tower
- IP Call Stations
- Temp Sensor
- Blind Motors
- Access Points
- Ceiling Fans
- Biometric Door Locks
- Badge Readers
- HVAC VAV's
- Curtain Motors
- HVAC VAV's
- Facial Recognition Systems
- Light Fixtures
- Environmental Sensor Hubs
- Entry Barriers And Turnstiles
- Horns and Sirens
- Access Points
- Light Fixtures
- Power Meter
- Meeting Room Nameplate
- Biometric Door Locks
- Badge Readers
- HVAC VAV's
- Power Meter
- Meeting Room Nameplate
POE Devices with higher Power needs (Type 3,4)

- Pan and Tilt Cameras
- Large Displays
- 802.11ac AP
- POS Systems
- LED Lights
- Kiosks

Many more to come!
Structured Cabling Considerations

- Cable Selection – Application based
- Pathway sizing and planning
- Bundles in pathway, racks, and cabinets
Digital Building Switches have a 5x Improvement in Switch Power

Everything Active
10% Power Saving. Efficient design, 80-Plus Gold Power Supplies

No PoE Draw
Switch Idle Mode with up to 50% savings

Low Ethernet Traffic
Power Savings with EEE or Energy Efficient Ethernet

No Ethernet Traffic
Switch Hibernate Mode with up to 75% savings

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Architectures
Combined OT/IT Network

OT/IT Backbone

PoE Port
Non-PoE Port

PoE Port
Architectures

Separate OT/IT Network

IT Backbone

OT Backbone

Non-PoE Port

PoE Port

PoE Port

PoE Port

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Security Concerns

What is this thing?

Who is responsible for it?

What access does it need?

Technologies

• IEEE 802.1X,

• IEEE 802.1AR

• EAP
CODES AND STANDARDS
Protocol Stack

Application
- Binary
- JSON
- REST API’s

Web Transfer
- CoAP
- HTTP
- DTLS
- TLS

Internet
- UDP
- TCP
- IPv4
- IPv6
- 6LoWPAN

Network
- Wi-Fi
- LTE
- Bluetooth
- IEEE 802.15
Constrained Application Protocol (CoAP)

RFC 7252 – Constrained Application Protocol

- Developer Friendly
  - Available libraries in C, C#, Java, iOS, Android
  - Based on REST Model

- Made for small – lots of devices
  - Efficient

- Secure
DEPLOYMENT EXAMPLE
Marriott Sinclair Hotel (Autograph Collection)

Project Overview

- 1920’s Art Deco Building in the heart of downtown Fort Worth
  - Roof Top Bar
  - Restaurant
  - High-end Spa
- Designated in the National Register of Historic Places
  - Need for minimally invasive renovations to preserve historic value
- Technology drives Customer Satisfaction and Repeat Business
  - High Speed Internet, Room Automation, Scene Control
- Low Voltage Lowers Construction Costs
  - Faster Installation
- IP Enables Systems Integration and Better Management
  - Greater Energy Efficiency
  - Granular Controls
  - Enables Guest Room Automation
  - Increased Property Management Capabilities
  - Provides a Sustainable Message

<table>
<thead>
<tr>
<th>Expense Category</th>
<th>AC Infrastructure</th>
<th>DC Infrastructure</th>
<th>See Note 4</th>
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</thead>
<tbody>
<tr>
<td>Electrical</td>
<td>$2,000,000</td>
<td>$1,200,000</td>
<td></td>
</tr>
<tr>
<td>Network</td>
<td></td>
<td>$160,000</td>
<td></td>
</tr>
<tr>
<td>Cabling</td>
<td>$16,000</td>
<td>$20,000</td>
<td></td>
</tr>
<tr>
<td>VoltServer</td>
<td>$150,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>$2,016,000</td>
<td>$1,530,000</td>
<td></td>
</tr>
<tr>
<td>Savings</td>
<td>$486,000</td>
<td>25.00%</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1) Inclusive of Labor and Materials for the infrastructure.
2) Infrastructure Powers: Lighting, Motorized Blinds/Curtains, MiniBar, TV embedded Bathroom Mirror, Door Locks, Shower Valve
3) Device Costs (AC/POE comparable)
4) DC Infrastructure Electrical Costs include backup AC Outlet for Minibar and Bathroom Mirror in case that POE versions are not ready in construction timeline. An additional $200,000 savings (yielding 35% Savings over AC Infrastructure) would be had if these electrical circuits were not installed.
5) Building Electrical service changed from 4000A service to 2500A service.

Customer Profile Video: [https://www.youtube.com/watch?v=uomF2xznB8](https://www.youtube.com/watch?v=uomF2xznB8)
SUMMARY
Digital Transformation must be part of your Building and Cities Strategy

- Buildings and Cities are changing
  - IT and OT teams need to work together
  - Buildings and Cities are become digital
- Digital Transformation is essential in the Communities of the Future
- The Smart Infrastructure will be play a major role
- Talk to new people!!
- Build an Ark, Change the world!!
Cabling for Remote Powering

Valerie Maguire, BSEE
Agenda

• Remote Powering
  • Impact on Cabling
  • Intelligent Buildings
  • Converged Cabling Designs
Remote Powering

- Running power concurrent to data over structured cabling
- Estimated 140 million PoE enabled ports are shipping annually
- Annual Wi-Fi enabled router shipments will soon exceed 200 million
  - Power over Ethernet (PoE) is the preferred powering method
Cost Savings with PoE

• The cost of a power outlet includes conduit, wire, a back box for the outlet and the labor of an electrician
  – The average cost to provide typical power to a device is about USD $1,000
  – The average cost of a PoE network port plus the structured cable drop is USD $250 per drop
Quiz Question #1

What is the maximum power delivery associated with the four IEEE 802.3 Types of PoE?

A: 15, 30, 60, 90
IEEE Std 802.3bt™-2018

- “Physical Layer and Management Parameters for Power over Ethernet over 4 pairs” (September 2018)
- Employs four balanced twisted-pairs to deliver remote power
  - Improves efficiency and increases power
- Introduces Type 3 (≥ 60W at the PSE output) and Type 4 (≥ 90W at the PSE output) technologies
- Compatible with 10GBASE-T
- Operates over category 5e or higher cabling
## Remote Powering Applications

<table>
<thead>
<tr>
<th></th>
<th>Minimum Power at PSE Output</th>
<th>Number of Pairs</th>
<th>Maximum Current per Pair</th>
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</thead>
<tbody>
<tr>
<td>Power over Ethernet</td>
<td>15.4 W</td>
<td>2-pairs</td>
<td>350 mA</td>
</tr>
<tr>
<td>(Type 1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power over Ethernet</td>
<td>30.0 W</td>
<td>2-pairs</td>
<td>600 mA</td>
</tr>
<tr>
<td>Plus (Type 2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-pair PoE</td>
<td>60.0 W</td>
<td>4-pairs</td>
<td>600 mA</td>
</tr>
<tr>
<td>(Type 3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-pair PoE</td>
<td>90.0 W</td>
<td>4-pairs</td>
<td>866 mA</td>
</tr>
<tr>
<td>(Type 4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power over HDBaseT</td>
<td>100.0 W</td>
<td>4-pairs</td>
<td>960 mA</td>
</tr>
<tr>
<td>(POH)</td>
<td></td>
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</tr>
</tbody>
</table>
Agenda

• Remote Powering
• Impact on Cabling
• Intelligent Buildings
• Converged Cabling Designs
Implications of Remote Powering

1. Heat builds-up within cable bundles

2. Bundle sizes may need to be reduced to improve heat dissipation

3. Overall channel length may need to be reduced to offset increased insertion loss resulting from a higher operating temperature

4. Contact arcing occurs when un-mating pairs under load and may affect connecting hardware reliability
Quiz Question #2

What is the TIA specified operating temperature range for cabling?

A: -20°C to 60°C (-4°F to 140°F)
Temperature Rise Considerations

- Remote powering can cause heat build-up within cable bundles
- Cabling insertion loss increases at temperatures above 20°C/68°F
- The temperature of any cable should not exceed the temperature rating for the cable
  - Generally, cables used in commercial premises have a temperature rating of 60°C
  - Exceeding a cable’s specified operating temperature may result in long term cable degradation
  - Cables with higher temperature ratings are listed and marked accordingly
  - Exceeding 60°C/140°F DOES NOT result in cables melting or safety risks
It’s not getting colder...
PoE Cable Temperature Rise

Temperature Rise vs. Current in 100-Cable Bundle

- Type 2/3
- Type 4

Categories:
- Category 5e
- Category 6
- Category 6A UTP
- Category 6A F/UTP
- Category 6A UTP, slim profile
- Category 7A S/FTP
Channel Length De-Rating

- **TIA, ISO/IEC Category 6A UTP**
  Subtract 18 m at 60°C/140°F

- **TIA, ISO/IEC Category 6A F/UTP**
  Subtract 7 m at 60°C/140°F
Remote powering applications do not apply DC power until a PD is sensed by the PSE.

Device disconnections can’t be anticipated.

“Un-mating pairs under load” produces an arc as the applied current transitions from flowing through conductive metal to air before becoming an open circuit.

Arcing can result in corrosion and pitting damage on the plated contact surface at the arcing location.

Potential for Arcing Under Load
Ensuring Contact Integrity

• Informative Annex B of TSB-184-A contains the following guidance:
  – Connecting hardware having the required performance for mating and un-mating under the relevant levels of electrical power and load should be chosen
  – IEC 60512-99-001 is referenced as a suitable test schedule
Standards Resources

- NFPA 70 (2017 NEC)
- TIA TSB-184-A-2017
- TIA-569-D-2-2018
Part VI. Premises Powering of Communications Equipment over Communications Cables

840.160 Powering Circuits. Communications cables, in addition in 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 greater than 60 watts, communication cables and the power circuit shall comply with 725.144 where communications cables are used in place of Class 2 and Class 3 cables.
• Conductor gauge, bundle size and temperature rating are used to establish a safe power rating (Ampacity) for each conductor

<table>
<thead>
<tr>
<th>AWG</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>
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<tr>
<td></td>
<td>Temp Rating</td>
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<td>Temp Rating</td>
<td>Temp Rating</td>
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<tr>
<td></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>
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<td>26</td>
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<td>24</td>
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<td>2</td>
<td>1</td>
<td>1.4</td>
<td>1.6</td>
<td>0.8</td>
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<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>0.7</td>
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<td>3</td>
<td>3</td>
<td>3</td>
<td>1.4</td>
<td>1.8</td>
<td>2.1</td>
<td>1</td>
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</tbody>
</table>
Example: Can this cable support Type 4?

• 24 AWG category 5e cable
• Bundle size of 75 cables
• Mechanically rated to 60°C
Alternatives

1. Use cables with a larger conductor or higher mechanical rating
2. Reduce bundle size
3. Changes to the table to improve precision and correct errors expected in 2020
TIA TSB-184-A

• “Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling” (March 2017)

• The standard presumes a maximum ambient temperature of 45°C/113°F in conjunction with cabling with a maximum rating of 60°C/140°F, thus allowing a maximum temperature rise of 15°C/27°F on any cable within the bundle due to dc powering
  – The maximum ambient temperature along the link (length of at least 1m) should be used as the basis for the calculation
Mitigation Recommendations

- Use Category 6A or higher-performing 4-pair balanced twisted-pair cabling
- Install shielded cables
- Reduce channel length, as necessary, to offset increased insertion loss
- Minimize cable lengths in order to reduce dc loop resistance

<table>
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<tr>
<th>AWG</th>
<th>Ω/100m (solid)</th>
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<td>23</td>
<td>7.32</td>
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<tr>
<td>24</td>
<td>9.38</td>
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<tr>
<td>26</td>
<td>14.8</td>
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</table>
Mitigation Recommendations

• Leave cables unbundled
  – If bundling, smaller bundles are recommended

  – Limit the number of cables per bundle to 24
Cable Bundle Recommendations

- When in doubt about cable mechanical or heat dissipation capability, installation environment, or remote powering application, a conservative practice is to limit maximum bundle size to 24 cables.

<table>
<thead>
<tr>
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<th>1</th>
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<td>3</td>
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<td>1.4</td>
<td>1.8</td>
<td>2.1</td>
<td>1</td>
</tr>
</tbody>
</table>
Mitigation Recommendations

• Use open wire tray or similar cable management that provides for largely unrestricted airflow around the installed cables
  – Disperse cables evenly across the width of the tray

• Reduce maximum operating temperature

• Mix unpowered cables with powered cables
TIA-569-D-2-2018

• “Additional Pathway and Space Considerations for Supporting Remote Powering Over Balanced Twisted-Pair Cabling” (July 2018)

• Pathways differ in regard to geometry and contact area between cables, pathway, and air

• Provides general guidance on heat dissipation of various pathways by bundle size
# Pathway Heat Dissipation Effectiveness

## Pathway Type

<table>
<thead>
<tr>
<th>Pathway Type</th>
<th>Cable Routing</th>
<th>Cable Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1-37</td>
</tr>
<tr>
<td>Non-continuous</td>
<td>Bundled</td>
<td>High</td>
</tr>
<tr>
<td>Unbundled</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Conduit (Metallic &amp; Non-metallic)</td>
<td>Bundled</td>
<td>Low</td>
</tr>
<tr>
<td>Unbundled</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Sealed Conduit</td>
<td>Bundled</td>
<td>Low</td>
</tr>
<tr>
<td>Unbundled</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

## Tray Type

<table>
<thead>
<tr>
<th>Tray Type</th>
<th>Fill Depth (in.)</th>
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<tr>
<td></td>
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</tr>
<tr>
<td>Wire Mesh/Ladder</td>
<td>High</td>
</tr>
<tr>
<td>Ventilated</td>
<td>High</td>
</tr>
<tr>
<td>Unventilated</td>
<td>Medium</td>
</tr>
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</table>
Agenda

• Remote Powering
• Impact on Cabling
• Intelligent Buildings
• Converged Cabling Designs
Planning for Intelligent Buildings

• Design 10-15 years out
  – Allow for additional systems and cabling
  – Plan for future builds
  – Accommodate future applications
Quiz Question #3

What is the TIA standard for the Structured Cabling Infrastructure Standard for Intelligent Building Systems?

A: ANSI/TIA-862-B
Quiz Question #4

What is the BICSI standard for the Information Communication Technology Design and Implementation Practices for Intelligent Buildings and Premises?

A: BICSI 007
Meeting Applicable Codes & Standards

• ANSI/TIA-862-B “Structured Cabling Infrastructure Standard for Intelligent Building Systems”

• BICSI 007, “Information Communication Technology Design and Implementation Practices for Intelligent Buildings and Premises”
TIA-862-B-2016

- Structured Cabling Infrastructure Standard for Intelligent Building Systems
  - Change of title (was Building Automation Systems Cabling Standard)
- General substitution of the term “intelligent building system” for the previous term “building automation system”
- Addition of guidance for cabling for:
  - Wireless systems
  - Remote powering over balanced twisted-pair cabling
  - Smart lighting
Topology Options

- **Standard**
  - Cabling Subsystem 1
  - ≤ 90m (295 ft)
  - Zone Enclosure
  - Coverage Area

- **Zone Cabling**
  - Cabling Subsystem 1
  - ≥ 15m (49 ft)
  - Zone Enclosure
  - Coverage Area
## Terminology

<table>
<thead>
<tr>
<th>Location/Device</th>
<th>TIA Standard</th>
<th>Terminology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermediate connection location in a zone cabling topology supporting a voice/data device</td>
<td>ANSI/TIA-568-0.D</td>
<td>Consolidation Point (CP)</td>
</tr>
<tr>
<td>Outlet connecting to a voice/data device</td>
<td>ANSI/TIA-568-0.D</td>
<td>Telecommunications Outlet (TO)(^1)</td>
</tr>
<tr>
<td>Intermediate connection location in a zone cabling topology supporting a building device</td>
<td>ANSI/TIA-862-B</td>
<td>Horizontal Consolidation Point (HCP)</td>
</tr>
<tr>
<td>Outlet connecting to a building device</td>
<td>ANSI/TIA-862-B</td>
<td>Equipment Outlet (EO)(^2)</td>
</tr>
</tbody>
</table>

\(^1\) A TO must always be present even if a CP is present  
\(^2\) An EO is optional if an HCP is present
ANSI/BICSI 007-2017

• Technology Design and Implementation Practices for Intelligent Buildings and Premises
• Communications Infrastructure & Network Integration
• Design Considerations (Power, Data, Zone Cabling)
• Building Systems (Lighting, Digital Signage, Vertical Transportation, Sound Systems, ESS, etc.)
• Building Monitoring Systems
• Commissioning
Agenda

• Remote Powering
• Impact on Cabling
• Intelligent Buildings
• Converged Cabling Designs
Zone cabling supports convergence of data and voice networks, wireless (Wi-Fi) device uplink connections, and a wide range of sensors, control panels, and detectors for lighting, security, and other building communications.
Zone Cabling Methodology

- Zone cabling is a standards-based approach to support convergence of devices.
- Consists of cables run from connections in the telecommunications room (TR) to outlets housed in a zone enclosure servicing coverage areas.
- 25% spare port availability recommended for best ROI.
- Supports rapid reorganization and deployment of new devices and applications.
- Factory pre-terminated and tested trunking cables can be installed from the TR to the zone enclosure for quicker deployment.
What is Zone Cabling?

Patch Panel in a TR

SCP/HCP Housed in a Zone Enclosure

Device Outlet
Benefits of a Zone Cabling Design

• Supports rapid reorganization of work areas and equipment
• Simplifies deployment of new devices and applications
• Improved pathway utilization
• MAC work
  – Less costly
  – Faster to implement
  – Less disruptive
• Creates a flexible, “futureproof” infrastructure for voice, data, building devices, and wireless access points
Zone Cabling Considerations

• A coverage area radius of 13m is generally recommended as an optimum size to accommodate most converged cabling networks

• The number of connections within the zone enclosure should not exceed 96

• Need to factor in future expansion
PoE Lighting: Unleashing Efficiency

• PoE now delivers enough power to operate commercial LED lighting
• Delivers significantly lower capital and labor investment
• LED lights consume half the energy of fluorescents and last 5X longer
• Earth and tenant friendly with less emissions and no hazardous mercury
• Integrates with other IoT applications and can receive centralized IT back up power
PoE Lighting: Unleashing Efficiency

- Centralized control
- Occupancy sensors
- CO₂ sensors
- Humidity sensors
- Daylight harvesting
- Energy consumption
- *Li-Fi network connectivity*
- Intelligence to adapt to patterns and preferences
- Color coding and flashing patterns for security and/or threat level notification
Quiz Question #5

What is an MPTL?

A: Modular Plug Terminated Link
The Modular Plug Terminated Link (MPTL) is constructed by direct field termination of horizontal cabling at the device end with a modular plug replacing the TO/SO and associated Work Area (WA) cord.

- ANSI/TIA-568.2-D requires that horizontal cable be terminated onto a TO. In certain cases there may be a need to terminate horizontal cables directly to a plug.
- ANSI/BICSI-007 recognizes the MPTL and refers to it as a direct connection method, with or without an HCP.
- ANSI/TIA-862-B recognizes direct connections – should be limited to devices in fixed locations that are not expected to be replaced or required to be directly connected by the AHJ.
MPTL Market Drivers

• IoT and Intelligent Buildings are driving the proliferation of IP-based and PoE-based devices in the walls and ceilings of modern buildings.

• LED lights, security cameras, wireless access points, digital displays, distributed antenna systems (DAS), building automation control devices and more can be directly connected using plug-terminated links rather than via boxes, outlets, and patch cords.
MPTL Considerations

• Benefits:
  – Custom length, quick connections in the field for direction connection to devices
  – Simplifies project bill of materials and eliminates the need for predetermined patch cord lengths

• Disadvantages:
  – No provision for service loops/ cable slack
  – Reduced “plug and play” functionality
  – Abandoned cabling needs to be removed when device is removed

Photo taken at McCarran Airport in Las Vegas
– Anyone could jump up and pull out the patch cord to the surveillance camera and wireless access point.
Media Selection

- TIA TSB-184-A
  - Category 6A recommended

- TIA-862-B
  - Category 6; category 6A recommended

- ISO/IEC 11801-6 Ed1.0
  - Class $E_A$ or higher

- BICSI 007
  - Category 6A/Class $E_A$ or higher recommended
Benefits of Shielded Cabling

• Typically qualified for higher temperature (75°C) operation
• Reduced length de-rating
• Superior heat dissipation supporting larger bundle sizes
The Shielded Evolution

• Shielded outlet technology has improved significantly
• Termination practices simplified
• Outlets can be color coded
Summary

• Remote powering puts increased demands on network cabling systems
• Consider PoE implications when specifying cabling infrastructure
• Zone cabling provides a flexible infrastructure
• Modular plug terminations have a role
Testing for Four Pair PoE

Christian Schillab

FLUKE networks
| Modular Plug Terminated Link | Ethernet Alliance Certification | Resistance Testing for PoE |
A Simplified Installation Technique

✓ AP’s, Cameras, Locks, Sensors, etc.

✓ Lower Cost

✓ Cleaner Look

✓ More Secure
Field Terminated Plug Examples
Modular Plug Terminated Link (MPTL)
So, How Do I Test This Thing?
Is This a Permanent Link?

✓ Starts at a Patch Panel

✗ Includes Outlet

✗ No Final Plug
Is This a Channel?

- ✓ Includes Patch Cord
- ❌ Starts with Patch Cord
- ❌ Doesn’t Include Last Plug

Two connector channel definition:
MPTL Definition

- Formerly Defined by BICSI as “Direct Attach”
- ISO to Discuss in Fall 2018
- Max. 295 ft. (90 m)
- Category 5e, 6, 6A
MPTL Definition

This is like a Permanent Link
Testing the MPTL: What You Need

Interconnect

Optional consolidation point

Horizontal cabling

Begin measurement

08/09/2017 4:24:47 am

TEST LIMIT

TIA

TIA Cat 6 Channel (+All)
TIA Cat 5e Channel
TIA Cat 5e Channel (+All)
TIA Cat 3 Channel
TIA Cat 6A MPTL
TIA Cat 6 MPTL
TIA Cat 5e MPTL

End measurement

NOTE: MDTL and TIA test head included. Interconnect test head required for testing.

Modular plug termination

Patch cord adapter

Permanent link adapter
Modular Plug Terminated Link

Ethernet Alliance Certification

Resistance Testing for PoE
Quiz Questions

• What’s the power available at the PD for Class 3?
  • 13W

• Based on 802.3bt, what class of power is available from a PoE++ device?
  • Class 5 or 6

• How many pairs are used in Class 4 implementations?
  • Two or Four
Power Over Ethernet

- IEEE 802.3bt – 4 pair Power over Ethernet
  - Now technically complete and no new features to be added
    - Type 1 and Type 2 PSE devices are as per 802.3af and at standards
    - Type 3 and Type 4 PSE devices added, 60W and 90W respectively
      - Updated end types to support 2.5G, 5G and 10G Ethernet
      - New midspan PSE to support the higher speeds
    - Warning added not to use smaller than 26AWG cabling with PoE
  - Out for sponsor ballot, expected to publish Q3 2018.
PoE Confusion

- Not a Licensed Term
- Three Standards: 802.3af, 802.3at, 802.3bt
- Eight Classes / Wattage Levels
- Four Types: 1 and 2 (two pair), 3 and 4 (four pair)
- Common Names: PoE, PoE+, PoE++, UPOE
- Passive, LLDP, and Negotiated Implementations
- Interoperability?
Understanding Classes and Types

Type 3 (802.3bt)

- Class 1: 4 W
- Class 2: 7 W
- Class 3: 15.4 W
- Class 4: 30 W
- Class 5: 45 W
- Class 6: 60 W

2-pair only (Type 1 & 2)
2-pair or 4-pair power (Type 3 & 4)

Type 4 (802.3bt)

- Class 7: 75 W
- Class 8: 90 W

always 4-pair power

PoE+  PoE++, UPOE
Ethernet Alliance PoE Certification
(Number Indicates Class of Device)

Power Sourcing Equipment

3
EA Certified™

Powered Device

1
EA Certified™
This Won’t Work
Modular Plug Terminated Link  Ethernet Alliance Certification  Resistance Testing for PoE
Four Pair PoE in Operation

- The powered device completes the current loop, enabling the device to work.
- The current is “balanced” across all 4 wires used.
- Requires low and balanced cable resistance.
Cabling Requirements

• Your standard Cat 5e, 6, or 6A field test is probably not good enough

• Within ANSI/TIA-568.2-D and IEEE 802.3, you will find:
  – dc loop resistance
  – dc resistance unbalance within a pair

• The measurements are “optional” in TIA-1152-A
1. Loop Resistance

All Four Pairs < 25 Ω
2. P2P Resistance Unbalance

\[
\text{Resistance Unbalance}_{\text{between pairs}} = \left[ \frac{|R_{P1} - R_{P2}|}{R_{P1} + R_{P2}} \right] 100\%
\]

All Six Measurements < 0.2 \(\Omega\) or 7.5%
3. Pair Resistance Unbalance

\[
\begin{align*}
R_{c1} & \quad \text{[Blue Cable]} \\
R_{c2} & \quad \text{[Red Cable]}
\end{align*}
\]

Resistance Unbalance within a pair \(= \left[ \frac{|R_{c1} - R_{c2}|}{R_{c1} + R_{c2}} \right] \times 100\% \)

All Four Measurements < 0.2 Ω or 3.0%
Problems Resulting From Resistance Issues

• Overheating

• Power Loss

• Data Loss
Causes of Resistance Issues

Workmanship

Cable Quality
Resistance Testing

Loop Resistance

Pair Unbalance

Pair-to-Pair Unbalance
Questions
Thanks for Your Attention
End Products and Security

Tertius Wolfaardt
Internet of Things (IoT)

• 50 Billion Internet Of Things Connections Projected By 2022 (www.mediapost.com)
Internet of Things (IoT) - Security
We need more power

- **15W**
  - 802.3af/802.3at Type 1
- **30W**
  - 802.3at Type 2
- **60W**
  - 802.3bt Type 3
- **90W**
  - 802.3bt Type 4

Diagram showing various devices requiring different power levels.
PoE Midspan devices

- **PoE “injector” options**
  - 15W (IEEE 802.3af)
  - 30W (IEEE 802.3at) PoE+
  - 60W (IEEE 802.3bt) PoE++
  - 90W (IEEE 802.3bt)

- **Midspans are either unmanaged or managed out of band**
  - PoE is managed as part of the data path and the statistics show up as part of the line communication and on the switch
    - Midspan power information has to come from the midspan or through a separate tool
Physical Security

“Detect”
PoE Intrusion Monitoring

• **Motion Detectors**
  – Powered by the device (camera) via the I/O port
  – Z-Wave Connectivity (wireless to PoE device)
  – Hidden sensors for video (covert)

• **Laser scan detector**
  – Detects object's size, speed, and distance

• **LIDAR & RADAR**
  – Delivers exact position of a moving object
  – Minimizes false alarms from spiders, small animals
  – Reliable detection even in bad weather (rain, fog, snow)
Monitoring and Control

“Detect” and “Deter”
Network Input / Output control

• Powered using PoE/PoE+ (or external power)
  – Analog alarm inputs
    • Supervised / Non-supervised inputs
      – Door contact, Window sensor, Motion detector, all things analog
  – Relays
    • TTL and Form C relays
      – Typical 12VDC / 24VDC / Dry contact relays
    • Trigger analog audio devices
    • Trigger analog lighting displays
    • Trigger ADA release sequence for entry doors
  – Elevator Control
    • Control what floors are accessed
    • Provide details of persons movement
IP Surveillance

IP Cameras for the “eyes”
Types of cameras

- Covert
- Fixed Box
- Fixed Dome
  - Panamorph
  - Multi-Sensor
  - PTRZ
- Bullet
- Thermal
- Positioning
  - Dome
  - Bi-spectral
  - Professional AV
- Explosion proof
PoE requirements for Surveillance

<table>
<thead>
<tr>
<th>Camera Type</th>
<th>Typical (Watts)</th>
<th>Maximum (Watts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor Box</td>
<td>3.6</td>
<td>6.8</td>
</tr>
<tr>
<td>Outdoor Box</td>
<td>4.3</td>
<td>12.95</td>
</tr>
<tr>
<td>Indoor Dome</td>
<td>2.6</td>
<td>3.5</td>
</tr>
<tr>
<td>Outdoor Dome</td>
<td>4.6</td>
<td>7.3</td>
</tr>
<tr>
<td>Indoor Dome</td>
<td>7.1</td>
<td>10.8</td>
</tr>
<tr>
<td>Outdoor Dome</td>
<td>7.1</td>
<td>12.95</td>
</tr>
<tr>
<td>Outdoor Bullet</td>
<td>5.6</td>
<td>12.95</td>
</tr>
<tr>
<td>Outdoor Bullet</td>
<td>7.1</td>
<td>12.95</td>
</tr>
<tr>
<td>Multisensor</td>
<td>18</td>
<td>26</td>
</tr>
<tr>
<td>Indoor PTZ Dome</td>
<td>13</td>
<td>19</td>
</tr>
<tr>
<td>Outdoor PTZ Dome</td>
<td>16</td>
<td>26</td>
</tr>
</tbody>
</table>

Legend:
- Blue: Typical (Watts)
- Red: Maximum (Watts)
PoE requirements for Surveillance

• Positioning Camera
  – SFP or RJ45 10BASE-T/100BASE-TX/1000BASE-T network connector
  – 24VAC/VDC Max 200-300 W, typical 16-64 W (IR)
    • Temperature: Normal: -50 °C to 55 °C (-58 °F to 131 °F)
      – Arctic Temperature Control: start-up at -40 °C (-40 °F)
    • Operational wind load of 106mph
    • Precision motors with presets
    • Bi-spectral
How does more power influence project designs?

Using surveillance as an example ...
Resolution
Wide Dynamic Range

WDR - On

WDR - Off
Image stabilization
Low-light

• Indoor storeroom at approximately 0.4 lux.
IR illumination
Operational in extreme cold and extreme heat
Long-range video surveillance
Thermal
Video compression
Intelligent Applications

> Edge processing
  - Access to applications at the edge
    - Present a wide range of intelligent applications for efficient surveillance, data analysis and business management
    - Open platform allows for application development partners to meet specific needs
> Adapting to the IoT world will require the ability to connect in ways beyond standard security
> Almost all of the enterprise customers desire customization to accomplish business goals
Decoding

“Detect”
PoE Decoders

- Decoding
  - Connecting digital monitors to display live video from network cameras
Access Control

“Delay”
PoE Controllers

> Door connections
  – Request-to-Exit
  – Door Position Switch
  – Card Reader
  – Emergency Door Release
  – Power for Electric Lock (Strike)
PoE Door Devices

- RFID Door Readers
- Biometric Readers
- Door Locking Hardware
- Electromagnetic / Door Strike
Powers door devices
- Request-to-Exit motion
- Card Reader
- Power for Electric Lock (Strike)

> Runs autonomous from software
- Controls access to access portal
  - Stores cardholder records
  - Stores time schedules
  - Stores user permissions
- Alarm and Relay Linking
- Event recording

PoE Controllers
IP Intercom

Devices for “Communication”
Types of IP Intercom

- **Facility**
  - Building entrance
    - Front / Employee / Dock doors
    - Remote building Remote gate
    - Parking Garage
    - Parking Lot
- **Residence**
  - Entry gate
  - Apartment call center
- **Management**
• **Session Initiation Protocol**
  – SIP is the standard protocol used in Voice over IP (VoIP) applications and unified communication platforms.
    • Initiate, maintain and terminate sessions between clients
    • Usually audio, but video too
    • SIP phones, Intercom devices, Audio, Radio-over-IP, etc.
IP Audio

La ...la ...la ...la
PoE Loudspeakers

• “See something ... Say Something”
  – Extending the reach of a security program
    • The loudspeaker can be remotely accessed and/or play a pre-recorded audio file when it is manually or automatically triggered (alarm event)
  – Compatible with major video management software and SIP-based VoIP systems
  – Address individual speaker from anywhere with network connectivity
PoE Speakers

- PoE (IEEE 802.3af/802.3af Type 1 Class 3)
- A complete audio system
  - Speaker
  - Amplifier
  - Signal processing, equalization
  - Microphone
- Streaming audio
- Customized announcements
PoE Speakers

Traditional analog speaker solution

Speaker
Speaker audio cable
Amplifier
Line level audio cable
Tone control / Equalizer
Line level audio cable
Streaming box
Network cable
Network switch

Network speaker solution

All-in-one
Network cable
Network PoE switch
IP Lighting
PoE Lighting - Security

> Security
   - Visible Light
     • 802.3af compliance – draws 12W
     • IR (850nM or 940nM)
   - IR (850nM or 940nM)
     • 802.3af compliance – draws 12W
PoE Lighting - Buildings

> Intuitive sensors to learn and interact
  – Occupancy – turn on and off
  – Dimming – adjusts to ambient lighting
  – Color temperature
  – Business analytics

> Efficient
  – Dramatic energy savings

> Installation
  – Eliminate heavy duty copper wire and conduit used for traditional lighting

> Flexibility
  – Ability to easily move or replace fixture
Cyber

IoT and the precautions for networked devices
High profile breaches make headlines

- The New York Times
  Millions of Anthem Customers Targeted in Cyberattack
  - The New York Times, Feb 2015

- The Huffington Post
  Apple Hacked: Company Admits Development Website Was Breached
  - Huffington Post, July 2013

- CNN
  South Carolina taxpayer server hacked, 3.8 million Social Security numbers compromised
  - CNN, Oct 2012

- The Guardian
  Facebook hacked in ‘sophisticated attack’
  - The Guardian, Feb 2013

- Bloomberg
  Target’s Data Breach: The Largest Retail Hack in U.S. History
  - Bloomberg, 2014

- The Wall Street Journal
  NASDAQ Confirms Breach in Network
  - The Wall Street Journal, Feb 2011

- Wired
  Chinese hacking of US media is ‘widespread phenomenon’
  - Wired, Feb 2013
What is cybersecurity?

- Cybersecurity refers to a set of techniques used to protect the integrity of networks, programs and data from attack, damage or unauthorized access.
- Cybersecurity involves mitigating risks by reducing the attack surface area, or more simply – by reducing exposure.
- Cybersecurity cannot be defined as a single product or tool.
What is cybersecurity?

- It is important to understand that 100% protection against intrusion is very hard to achieve, if indeed possible at all.
IoT and Network Device Cybersecurity Concerns

- Unsecured endpoints used as a point-of-entry on the network
  - Poor password complexity protocol
  - Open ports and unused services
  - Man-in-the-middle packet capture
  - Malware
  - UDP-flood, DoS, DDoS
Where should I start?

- To protect a network against attack, various security controls can be implemented. These controls are safe guards or countermeasures to avoid, detect, or mitigate secure interest to **physical property**, **networks**, appliances, servers, information, or other assets.
Where should I start?

• In a security system, the main areas to focus on are:
  – Physical exposure - protecting the system hardware
  – Network exposure - preventing unauthorized access
  – Service exposure - preventing access via unused services
  – Encryption - securing transmission to/from appliance
  – Credentials - the use of robust credentials
  – Authentication - authentication policies (certificates)
Where should I start?

• Physical
  – The first line of defense is the physical protection of the primary access points to your network
  – Various measures may include:
    • Secure network equipment and servers
    • Mounting appliances out-of-reach
    • Using tamper switches
    • Using vandal-resistant enclosures
    • Use protective shielding for exposed cabling
    • Protect the cable ends and open ports
Where should I start?

• Network
  – The second line of defense is protecting your network infrastructure from unauthorized access
  – Various measures may include:
    • Protect the perimeter
      – Control access to the facility - Manage who comes and goes
      – Video Surveillance – Record the identity of each person
    • Protect the interior
      – Conceal cabling - Structured cabling should be out of sight
    • Control access from public and employees
      – Physically secure MDF/IDF locations
      – Control access to internal sensitive areas
      – Security at the cabinet level
Final thoughts …

• IoT drives appliances to the network
  – Integration between appliances transitions from “Analog” to “Digital”
  – IPV6 implementation is absolutely necessary
• PoE will continue to drive edge-based technology
  – Security industry is quickly adapting and innovating
• PoE will challenge the status-quo
  – Video / Audio / LED Lighting / Automation / Smart buildings / BYOD
• PoE standards will recognize higher power requirements
• PoE requires different design considerations
• Cyber threats will keep you up at night
Thank you!
Thank You