Fiber to the X – Power to the X

Extending Connectivity to Remote Mission Critical Devices in Harsh Environments
Presenter

Rudi is the Regional Manager of Western Canada and also a Partner at Impact Technical Products. He has a Masters degree in Electrical Engineering from the University of Victoria (BC, Canada) and has about 30 years experience in communications technology and power monitoring & management systems. He is a member of the IEEE and has held various technical, business development and sales management roles worldwide. Rudi is based in British Columbia Canada and strives to help bring practical solutions to our clients’ real-world problems.

rudi@impacttechnicalproducts.com
https://www.linkedin.com/in/carolsfeld/
www.impacttechnicalproducts.com
Agenda

Part 1 – Fiber to the X, Power to the X - 30 min
- Intro to Power over Ethernet
- Intro to fiber
- Why Migrate to fiber?
- Managing cable

Part 2 – PttX/FttX in Harsh Environments - 20 min
- FttX in harsh environments
- Fiber + Power to the X in harsh environments
- Terminating and splicing fiber in harsh environments

Part 3 – Extending PoE in Harsh Environments – 40 min
- Design considerations for power, fiber, PoE
- Design challenge using Telecom Enclosures
- Design challenge using PoE Extenders

Part 4 – Rugged Solutions, Harsh Environments - 30 min
- Network redundancy
- Power redundancy
- Heating & cooling
- Security and access control
- Monitoring and control
Poll Questions

How much experience do you have with fiber optic installations?
- I install fiber almost every day
- I install fiber a few times per month
- I don’t install fiber but do fiber network design
- I don’t install fiber

How much experience do you have with Power over Ethernet?
- I have done many PoE installations
- I have done a few PoE installations
- I don’t have experience with PoE but know how it works
- I don’t know much about PoE

How often do you work with networks that go outside a commercial building?
- All my work is inside commercial environments
- Some of my work involves industrial, outdoor, harsh environments
- Most of my work involves industrial, outdoor, harsh environments
Part 1

- Intro to Power over Ethernet
- Intro to fiber
- Why migrate to fiber?
- Managing cable
PoE 101

Installing an Ethernet device prior to 2003:

1. Electrician installs AC power to wall outlet in convenient location
2. Device comes with a dedicated AC/DC adaptor (e.g. 115Vac to 12Vdc)
3. IT technician installs network cable to convenient location

Need all three: AC power cable + AC/DC power adaptor + network cable
PoE 101

With Power over Ethernet:
• Category cable has unused twisted pairs and can operate on DC voltage bias
• Eliminates need for AC outlet and adaptor; requires only the network cable
PoE 101

PoE uses Class 2 wiring (low voltage):

- Less than 100W, less than 100Vdc
- Distance limit unchanged at 90m (295’)

---

2020 BICSI FALL Conference & Exhibition
PoE 101

- Local Electrical Code exceptions for low voltage in **some** jurisdictions
- IT technicians can work on the lines when needed
- Saves time and money
PoE 101

PoE standard introduced in 2003
PoE started with 15W at the switch

- IEEE802.3af
- Up to 12.95W at device, e.g. fixed camera, desk phone
- Low power remote devices draw very little current
- As much as 4.5W of power lost over the length of the cable

Image source: fs.com, guardiantelecom.com
PoE 101

Since 2003, PoE standards have evolved to support ever more powerful devices as these are deployed in many new places.

• PoE+ has 30W at switch
  – IEEE802.3at
  – 25.5W at device:
    e.g. WAP, phone,
    PTZ camera

• PoE++ has 60W (type 3) to 100W (type 4) at switch
  – IEEE802.3bt
  – 51W to 71W at device
    e.g. laptop, monitor

Image source: fs.com, guardiantelecom.com
## PoE 101

<table>
<thead>
<tr>
<th></th>
<th>POE</th>
<th>POE+</th>
<th>POE++</th>
<th>POE++</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PoE Type</strong></td>
<td>Type 1</td>
<td>Type 2</td>
<td>Type 3</td>
<td>Type 4</td>
</tr>
<tr>
<td><strong>Standard</strong></td>
<td>IEEE802.3af</td>
<td>IEEE802.3at</td>
<td>IEEE802.3bt</td>
<td>IEEE802.3bt</td>
</tr>
<tr>
<td><strong>Power per port</strong></td>
<td>15.4W</td>
<td>30W</td>
<td>60W</td>
<td>100W</td>
</tr>
<tr>
<td><strong>Voltage at port</strong></td>
<td>44-57Vdc</td>
<td>50-57Vdc</td>
<td>50-57Vdc</td>
<td>52-57Vdc</td>
</tr>
<tr>
<td><strong>Power to Device</strong></td>
<td>12.95W</td>
<td>25.5W</td>
<td>51W</td>
<td>71W</td>
</tr>
<tr>
<td><strong>Voltage at device</strong></td>
<td>37-57Vdc</td>
<td>42.5-57Vdc</td>
<td>42.5-57Vdc</td>
<td>41.1-57Vdc</td>
</tr>
</tbody>
</table>
PoE 101

4PPoE supports 55W to 100W

- IEEE802.3bt
- 51W or 71W at device:
  PTZ cameras with heaters,
  LED lights, door/gate
  controllers, etc.
PoE 101

PoE is still subject to the 90m/295’ limitation of category cable

- Higher current leads to more heat ($i^2R$ loss)
- When the cable gets hotter, insertion loss increases
- As much as 20% of the power can be lost in a 24-gauge CAT5e cable
- Trend toward CAT6a cable supports more data and has thicker wires to handle higher power
PoE 101

Different ways to extend the Ethernet network with PoE:

• Non-PoE switch to PoE Switch up to 90m away, which is up to 90m from X
• Non-PoE network of switches to PoE Switch, which is up to 90m from X
• Non-PoE switch to PoE injector And so on...

Image source: amcrest.com
PoE 101

In a harsh environment where security cameras, wireless access, physical access, etc. are mission critical, you will want to pay for a very reliable source of power + network connection.

PoE is only as reliable as the switch providing it!

Room temp
1 year MTBF

$\$$

-40C to +85C
25-year MTBF

Image source: fs.com, siemens.com
PoE 101

Other considerations:

- Does each PoE switch or PoE injector have a UPS?
- Is the switch/injector and UPS hardened to withstand cold & heat, dust, dirt, etc.?
- What is the failure rate of each switch/injector, and the required maintenance cycle on each UPS?

Coming up: providing network and power redundancy!
Why Migrate to Fiber?

- Connectivity to places and devices that were never anticipated
- Massive changes in physical infrastructure to support this
- Higher bandwidth required than ever before

Image source: lorilewismedia.com
Why Migrate to Fiber?

Main reasons to migrate:
1. Speed + Distance
2. Electromagnetic interference (EMI)
3. Space and cable management
4. Future-proof
Why Migrate to Fiber?

1. **Speed + Distance**
   - Copper max at 40 Gbps, whereas fiber optics 100+ Tbps
   - Copper limited to lengths of 90-100 meters (~300-330 ft.) whereas fiber optic cabling can span over 30km (20 miles)

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Cat6 Cable</th>
<th>Cat7 Cable</th>
<th>Cat8 Cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>250MHz</td>
<td>600MHz</td>
<td>2000MHz</td>
</tr>
<tr>
<td>Maximum Transmission Speed</td>
<td>1 Gbps/10 Gbps</td>
<td>10Gbps</td>
<td>25 Gbps/40 Gbps</td>
</tr>
<tr>
<td>Distance</td>
<td>100m with 1 Gbps</td>
<td>100m</td>
<td>30m</td>
</tr>
<tr>
<td></td>
<td>37-55m with 10 Gbps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Connectors in Channel</td>
<td>4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Cable Construction</td>
<td>UTP or Shielded</td>
<td>Shielded</td>
<td>Shielded</td>
</tr>
<tr>
<td>Connector Type</td>
<td>RJ45</td>
<td>Non-RJ45</td>
<td>Class I: RJ45</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Class II: Non-RJ45</td>
</tr>
<tr>
<td>Cost</td>
<td>Expensive than</td>
<td>Expensive than</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>previous categories</td>
<td>previous categories</td>
<td></td>
</tr>
</tbody>
</table>

Image source: cablek.com
Why Migrate to Fiber?

Each generation of CAT cable strives to increase bandwidth and extend distance with better shielding.
Why Migrate to Fiber?

Compared to category cable, fiber can handle more data, uses less space, has lower losses and is more secure.
Fiber 101

2. Fiber optic cable cannot generate and is impervious to:
   - Electromagnetic interference (EMI)
   - Radio frequency interference (RFI)
   - Voltage surges

Fiber cable is more difficult to tap than copper, making it more secure.

BONUS: no grounding issues, and no sparking problems!
Fiber 101

Fiber cable structure:
- Very fine core, 62.5 microns or less
- Cables may have 2, 4, 6, 12, 24, 48, 144 fibers or more
- Cladding to keep light in
- Strength member(s) to support the fiber
- Outer jacket for identification and protection
Fiber 101

Wide range of connectors available

The U.S. fiber optic connector market 2014 - 2025, (USD Million)

Image source: grandviewresearch.com
3. Space and cable management

- CAT6 cable is roughly four times the diameter of fiber cable, and carries a fraction of the data
- Freed-up space enables better circulation of a data center’s cooled air, and makes it easier to access the equipment it’s plugged into

Image source: chatsworth.com
Why Migrate to Fiber?

Recall that Power over Ethernet cables can carry a lot of power:

- Thinner wire has higher resistance; as much as 20% of the power can be lost in a 24-gauge CAT5e cable (i^2R loss)
- Heat, EMI, vibration can effect comms

The Magic Number 24:

- Keep the number of cables in your bundles <24
- Use cables that are 24 AWG or larger with a minimum operating temperature of 60°C

Image source: chatsworth.com
Why Migrate to Fiber?

4. Future-proof

• The *average* lifespan of a copper category specification is a little over five years

• A solid multifiber backbone will last for years, if not decades, and will likely continue to support increasing bandwidth needs
Why Migrate to Fiber?

Today: Install one pair of fibers for a dedicated ethernet path
Tomorrow: Add more light paths over the same optical fiber
• This is known as wavelength division multiplexing (WDM)
• WDM is widely used in passive optical networks (PON), which are common in telecom service provider networks e.g. fiber to the home.
Cable Management

Improperly installed cabling can cripple network performance, create maintenance headaches, and lead to hidden costs!

Image source: chatsworth.com
Even fiber installations can get out of hand!

Anticipating change is crucial – get the best cable management you can afford

Image source: chatsworth.com
Cable Management

Some tips for your next project:

• Design layout to allow room for access and growth.
• Plan for change - organize cable properly and labeling cable that may need to be quickly and easily identified. Avoid blocking access to equipment inside and outside the racks.
• Use sweeping 90-degree bends when transitioning from the pathway support to the racks.
• Keep in mind how many rack units are being utilized with horizontal wire managers.
• Select a vertical cable manager that lines up with the horizontal managers.
• Use waterfalls and spools to maintain proper bend radius on copper and fiber cables.
• Use velcro cable supports to secure the cable without damaging it.
• Stay under 50% capacity to avoid kinks and to make moves, adds and changes easier.
Cable Management

There are many good cable runways, cable trays and cable management solutions available to manage these massive deployments of both category and fiber optic cables – Use them!
Part 1 Summary

Fiber to the X, Power to the X
• Intro to Power over Ethernet
• Intro to fiber
• Why Migrate to fiber?
• Managing Cable
Part 1 Questions

The maximum recommended distance for PoE over category cable is approximately
- 150ft (45m)
- 300ft (90m)
- 1650ft (500m)
- 3300ft (1000m)

If a security camera uses up to 23W of power you need to use a port compliant with:
- IEEE 802.11at (PoE)
- IEEE 802.11af (PoE+)
- IEEE 802.11bt (PoE++)

How much power can be lost to heat when using Category cable for PoE:
- <5%
- Approx. 10%
- Approx. 20%
- >25%

Multimode fiber is widely used for:
- Data rates in excess of 10Gbps
- Distances over 500m
- Both of the above
- Neither of the above

Compared to Multimode fiber, Single mode fiber is:
- More brittle
- Able to handle higher data rates
- Thinner in the middle, but thicker overall
- Less expensive

Cable management products will
- Improve ability to change and upgrade cables
- Improve airflow around cables
- Protect cables from tight bends and kinks
- All of the above
Part 2

- FttX in harsh environments
- Fiber + Power to the X in harsh environments
- Terminating and splicing fiber in harsh environments
Fiber to the X

FTTX is a generalization for fiber deployment:
- FTTP = Fiber laid to the premises
- FTTH = Fiber laid to the home
- FTTB = Fiber laid to the building
- FTTC = Fiber laid to the cabinet
- FTTN = Fiber laid to the node

As cost of fiber decreases, it is deployed further into the premises.
Devices requiring very high bandwidth may use a direct fiber connection (e.g. SFP)
Fiber to the X

BUT: how do we still get Power over Ethernet if we migrate to Fiber???

- In many FttX applications, power is available at X and you can use an AC/DC adaptor
- Or, DC power is supplied by a nearby PoE switch or media converter
Fiber to the X - FttH

Fiber to the Home (FttH) includes wide area networks where fiber replaces copper telephone lines and cable
- Usually uses passive optical networks (PON, GPON, etc.)
- Always assumes local AC power source

Image source: fttxftth.wordpress.com
Fiber to the Workstation (FttW) is now popular for in-building networks

- Usually uses passive optical networks (PON, GPON, etc.)
- Always assumes local AC power source
- End device may use POE
Fiber to the Antenna (FttA) includes fiber links for most cell tower backhaul networks (SDN, MPLS, etc.)

- Fiber connections to radios and antennae at the top of towers
- Always assume local AC power source
Fiber Connections in Harsh Environments

What if you need to provide a low loss connection, but the environment is not agreeable to such delicate work??

**Option 1:** use a preterminated weatherproof fiber patch panel

**Option 2:** use a rugged core alignment fusion splicer

Image source: fiberfoxamerica.com
Using a **Weatherproof Fiber Patch Panel** is highly recommended when installing fiber in harsh environments

- Avoid splicing in dirty, dusty cold locations
- Keeps connectors clean for quick and easy installation and changes

**Weatherproof multifiber connection to base of tower**

**Weatherproof fiber connections to radio/antenna**

Image source: fiberc.com
Fiber Connections in Harsh Environments

To avoid complex splicing tasks in unfriendly environments, consider getting cables that have:

- Pre-terminated multi-fiber specialty connectors, e.g. ODVA, expanded beam D38999, etc.
- Pre-terminated hybrid cables combining copper and power with specialty connectors, e.g. IP-One
- Pre-terminated outdoor rated armored jacket cable with pull kitsull kits
Fiber Connections in Harsh Environments

Keep those fibers clean!
Contaminated connector end-faces is the leading cause of fiber link failures
Fingerprints, particles of dust and debris can cause:
- signal loss
- back reflection
- equipment damage

#1 Problem: Dirt!

Image source: flukenetworks.com
Fiber Connections in Harsh Environments

Always use Fiber cleaning & inspection tools. Even so, it can be very difficult to maintain a clean connection in a harsh environment.
Fiber Connections in Harsh Environments

If you **have to** splice in a harsh environment, maybe get a splicer that can withstand some abuse!

Image source: fiberfoxamerica.com
Fiber + Power to the X

In all our FttX examples we had a local source of AC power:

What do we do if there is no local source of AC power? How do we provide reliable power at a distance?

We need Fiber + Power to the X!
Fiber + Power to the X

In many buildings we can assume local UPS-backed **AC power** and air-conditioned **room temperature**:

- Fiber to the Home
- Fiber to the Workstation

AC power cable
Fiber cable

Not a harsh environment
Fiber + Power to the X

Outside and very harsh environments (e.g. radio towers, rail tunnels, parkades):

- emergency phone
- security camera
- access point

Image source: guardiantelecom.com
Fiber + Power to the X

Outside and very harsh environments (e.g. radio towers, rail tunnels, parkades):
- emergency phone
- security camera
- access point

Need reliable local **DC Power**
Need wider temperature range
Part 2 Summary

- FttX in harsh environments
- Terminating and splicing fiber in harsh environments
- Fiber + Power to the X in harsh environments
Part 2 Questions

IT equipment deployed in a harsh environment might be exposed to:
- High humidity
- Dust and/or fumes
- Extreme temperatures
- All of the above

When deploying fiber to a remote location, power is often provided by:
- AC/DC power source in the remote location
- A battery in the remote location
- Hybrid cable deployed with the fiber
- All of the above

A major source of failed fiber connections is due to:
- Dirt on the fiber end face
- Signal loss in the fiber
- Electromagnetic interference and crosstalk

Splicing fiber in a harsh environment:
- Should never be attempted because of temperature, dirt and humidity
- Is better than using pre-terminated fiber assemblies with connectors
- Is best done using a rugged splicer

Fiber to the X:
- May reduces labor costs
- May reduce cabling costs
- May support higher data rates in future
- All of the above

Power to the X:
- Must always be delivered by hybrid cable
- Must always be supplied locally
- Is not required because the fiber carries power
- None of the above
Part 3

Extending PoE in Harsh Environments

• Design considerations for power, fiber, PoE
• Design challenge using Telecom Enclosures
• Design challenge using PoE Extenders
PoE in Harsh Environments

Tough Environments demand tough components

• Able to handle wide temperature range
• Able to handle high humidity (temperature variation can cause condensation)
• Able to withstand shock & vibration, impact, ice build up, driving rain and snow

Image source:
whiteriverdivision.blogspot.com
guardianetelecom.com
PoE in Harsh Environments

Endpoints designed for benign environment

- Fire alarm cable
- CAT5e cable
- Emergency phone
- IP card reader
- IP access gate
- IP security camera
- IP wireless access point
PoE in Harsh Environments

Endpoints designed for harsh environment

- Fire alarm cable
- CAT5e cable
- Rugged IP security camera
- Rugged IP wireless access point
- Outdoor access gate
- Outdoor IP card reader
- IP Emergency phone
PoE in Harsh Environments

End point POE loads are more robust, but the cable may also need to be more robust

- Direct burial cable
- Armored cable
- Oil resistant
- Sunlight resistant
- Temperature resistant
PoE in Harsh Environments

Let’s consider two design challenges to illustrate using PoE for remote devices:
1. Small facility with mission critical devices but not a harsh environment
2. Large facility with mission critical devices, some in a harsh environment
Design Challenge 1

Building needs security cameras, wireless access points, emergency phone
• Warehouse
• Underground parkade
• Manufacturing facility
Design Challenge 1

Warehouse needs security cameras, wireless access points, emergency phone

- Everything to wire back to 24-port PoE switch in IT cabinet
- Longest run <60m (200ft)
Design Challenge 1

Building envelope is:
- Weatherproof, so we can use a standard IT cabinet
- Secure, so standard door locks will work
- Air conditioned, so conventional PoE switch is good enough
- Standby generator backup, so no need for UPS
- Some dust and dirt may be expected
Design Challenge 1
Design Challenge 1

- Distribute the access points for best coverage

- Position the security cameras for all angles

- Install emergency phones for easy access throughout warehouse
Design Challenge 1

- Distribute the access points for best coverage
- Position the security cameras for all angles

2 x
Design Challenge 1

- Distribute the access points for best coverage
- Position the security cameras for all angles
- Install emergency phones for easy access throughout the warehouse
Design Challenge 1

• Star network layout
• CAT5e/6a cable in cable trays throughout
Design Challenge 1

- PoE quickly and easily provides:
  - network
  - power
- Easy to deploy and manage, easy to expand
- Good for warehouse, manufacturing facility, campus, hospital, transit station, etc.
Design Challenge 2

Now for a more challenging design for extending PoE:

• Petrochemical
• Drydock
• Airport
• Transit
• Etc.
Design Challenge 2

To keep things simple:

- Bigger building and outdoor works yard or parking lot area
- Harsh outdoor and indoor environments
- Longest run > 90m
Design Challenge 2
Design Challenge 2

- Distribute the access points for best coverage
- Position the security cameras for all angles
- Install emergency phones for easy access throughout warehouse
Design Challenge 2

- Distribute the access points for best coverage
- Position the security cameras for all angles
Design Challenge 2

- Distribute the access points for best coverage
- Position the security cameras for all angles
- Install emergency phones for easy access throughout warehouse
Design Challenge 2

How best to provide:
- network
- power
to each access point, emergency phone, and security camera?
Design Challenge 2

Option A: Telecommunications Enclosure (TE)

- Smaller than Intermediate Distribution Facility (IDF) widely used in telecom applications
- Smaller than the Telecommunications Room (TR) used in Design Challenge 1
Option A - TE

Telecommunications Enclosure (TE)

- Is there space available, within 90m range?
- Do you need outdoor enclosures, with A/C and heaters?
- Do you need to support other IT needs on the floor (SCADA, FA, BMS, IoT gateway, workstations, etc.)
Option A – TE

- Floor mounted enclosure
- Outdoor heated & cooled enclosure
- Wall/Post mounted enclosure

Consider dust, temperature, humidity, accidental damage, vandalism!

Image source: chatsworth.com
Option A - TE

Network connection (NVR, PBX, IP)

Fiber cable >90m

PoE Switch

CAT5e/6a from PoE switch to cameras, access points, phones <90m

PoE connections (Max 90m)

Telecom closet

AC power

Switch

Switch

Switch

UPS

TE

UPS

FAN
Option A - TE

Network connection (NVR, PBX, IP)

- Switch
- Switch
- Switch
- UPS

Telecom closet

Fiber cable >90m

FANS

Fans can fail; filters can get blocked

Rugged PoE switch:
-40°C to +85°C

PoE connections (Max 90m)

*Rugged PoE switch: -40°C to +85°C

AC power

TE
Option A - TE

Network connection
(NVR, PBX, IP)

Switch
Switch
Switch
UPS

Telecom closet

AC power

Fiber cable
>90m

PoE Switch

UPS

Closed loop cooling

PoE connections
(Max 90m)

Closed loop cooling does not exchange air, just heat
Option A - TE

- Connections from Telecom Room to TE uses fiber cable and AC power
- PoE connections from TE to loads use CAT5e/6a cable
- Need conduit & cable tray
Option A - TE

- TEs provide data and power spanning 90m radius
- PoE provides network and power connections
- Requires floor/wall space, heating/cooling, security
- Can be costly
Option B – PoE Extenders

Requires fiber backhaul and DC power – hybrid cable to DC powered media converters
Option B - PoE Extenders

Change from this:

- **Telecom closet**
- **Switch**
- **UPS**
- **Fiber cable >90m**
- **PoE Switch**
- **PoE connections (Max 90m)**
- **AC power**
- **TE**
Option B - PoE Extenders

To this:

- Switch
- Media converter & DC Source
- UPS
- Media converter & PoE Source
- PoE connection (Max 90m)
- Hybrid cable (up to 7500m)
Option B - PoE Extenders

It’s important to think of the end-to-end solution when extending PoE.

Do you have a redundant DC power source? Are the copper to fiber media converters reliable?

Will you run fiber + copper separately or use a hybrid (composite) cable? How will it be terminated?

Are the remote fiber to copper media converters, PoE injectors able to withstand a harsh environment?
Option B - PoE Extenders

Look for:

- Rackmount modular system
- Pluggable media converters
- Hot-swap DC power modules
- Compact media converters & power injectors for smaller systems
- Wide temperature rating for harsh environments

Do you have a redundant DC power source? Are the copper to fiber media converters reliable?

Image source: fiberc.com
Option B - PoE Extenders

Look for:

- Range of copper gauge and fiber cores
- Pre-terminated pluggable connectors
- If separate cables, consider armoured fiber and shielded copper

Will you run fiber + copper separately or use a hybrid (composite) cable? How will it be terminated?

Image source: fiberc.com
Option B - PoE Extenders

Look for:

- Compact and easy mounting options
- Wide temperature range, weatherproof option (IP67)
- Modular connectors for easy field installations avoiding splices
- Signal and power conditioning, surge suppression, high MTBF

Are the remote fiber to copper media converters, PoE injectors able to withstand a harsh environment?
Option B - PoE Extenders

Key design element is to know the power/distance requirements for each remote location, e.g.:

• 2 cameras requiring 22W each
• line loss over the cable
• power for the remote media converter

Media converter & DC Source

46W plus line losses

Media converter & PoE Source

Approx. 2W

22W

22W
PoE Power/Distance Limitations

<table>
<thead>
<tr>
<th>Remote Configuration</th>
<th>P/Ns</th>
<th>&lt;20m Cords at remote</th>
<th>up to 90m cords at remote</th>
<th>&lt;20m Cords at remote</th>
<th>up to 90m cords at remote</th>
<th>&lt;20m Cords at remote</th>
<th>up to 90m cords at remote</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 port PoE (lit spd)</td>
<td>CR100PSyLOD-001 01002576</td>
<td>5340</td>
<td>17515</td>
<td>4750</td>
<td>15580</td>
<td>2870</td>
<td>8750</td>
</tr>
<tr>
<td>1 Port Industrial PoE w/Boost</td>
<td>CR100PSyCOS-001</td>
<td>760</td>
<td>2493</td>
<td>650</td>
<td>2132</td>
<td>380</td>
<td>1246</td>
</tr>
<tr>
<td>1 Port PoE++ (lit spd)</td>
<td>CR100PysyLOD-001 01000218/579 01000301/560</td>
<td>380</td>
<td>1246</td>
<td>310</td>
<td>1017</td>
<td>90</td>
<td>290</td>
</tr>
<tr>
<td>1 Port Industrial PoE++ w/Boost</td>
<td>CR100PysyCOS-001</td>
<td>380</td>
<td>1246</td>
<td>310</td>
<td>1017</td>
<td>90</td>
<td>290</td>
</tr>
<tr>
<td>2 Port PoE (lit spd)</td>
<td>CR200PysyG00-001</td>
<td>2870</td>
<td>8756</td>
<td>2220</td>
<td>7283</td>
<td>1330</td>
<td>4362</td>
</tr>
<tr>
<td>2 Port PoE+ (lit spd)</td>
<td>CR200PysyB00-001</td>
<td>730</td>
<td>2394</td>
<td>600</td>
<td>1968</td>
<td>380</td>
<td>1246</td>
</tr>
<tr>
<td>4 Port PoE (lit Spd)</td>
<td>CR400PysyMG0-001 01000572 01000595</td>
<td>1330</td>
<td>4362</td>
<td>1200</td>
<td>3836</td>
<td>680</td>
<td>2165</td>
</tr>
<tr>
<td>4 Port PoE+ (lit spd)</td>
<td>CR400PysyMG0-001 01000572 01000595</td>
<td>1330</td>
<td>4362</td>
<td>1200</td>
<td>3836</td>
<td>680</td>
<td>2165</td>
</tr>
<tr>
<td>4 Port PoE+ (lit spd) Dual Class 2 Power Input</td>
<td>CR400PysyMG0-001 01000572 01000595</td>
<td>1330</td>
<td>4362</td>
<td>1200</td>
<td>3836</td>
<td>680</td>
<td>2165</td>
</tr>
<tr>
<td>6 Port PoE (lit spd)</td>
<td>CR600PysyMH0-001</td>
<td>870</td>
<td>2819</td>
<td>800</td>
<td>2624</td>
<td>440</td>
<td>1443</td>
</tr>
<tr>
<td>6 Port PoE+ (lit spd)</td>
<td>CR600PysyMH0-001</td>
<td>240</td>
<td>787</td>
<td>200</td>
<td>656</td>
<td>120</td>
<td>394</td>
</tr>
</tbody>
</table>

BICSI Fall Conference & Exhibition
Option B - PoE Extenders

In some situations, a cluster of loads can be driven from a single multi-port media converter and PoE injector.
Option B - PoE Extenders

To determine the maximum distance that can be spanned, check each PoE port requirement, and add up the loads to confirm power supply:

![Diagram showing the connection of AC power, Switch, Media converter & DC Source, Media converter & PoE Source, and various devices with power consumption values. The diagram illustrates the flow of power and the power consumptions at each device.]

- AC power
- Switch
- Media converter & DC Source
- Media converter & PoE Source

60W plus line losses

Power consumption for devices:
- 22W
- 4W
- 7W
- 5W
- 22W
PoE Power/Distance Limitations

<table>
<thead>
<tr>
<th>Remote Configuration</th>
<th>PNs</th>
<th>Cable with 4X 12awg conductors</th>
<th>Cable with 2X 12awg conductors</th>
<th>Cable with 2X 18awg conductors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&lt;20m Cords at remote (m)</td>
<td>up to 90m cords at remote (m)</td>
<td>&lt;20m Cords at remote (m)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Claim max (ft)</td>
<td>Claim max (ft)</td>
<td>Claim max (ft)</td>
</tr>
<tr>
<td>1 port PoE (1 spd)</td>
<td>GR106PcLY2D-001 01000375</td>
<td>6500</td>
<td>15500</td>
<td>2670</td>
</tr>
<tr>
<td>1 Port Industrial PoE w/Boost</td>
<td>GR106PcLY2D-001 01000375</td>
<td>7500</td>
<td>24000</td>
<td>3750</td>
</tr>
<tr>
<td>1 port pol+ (1 spd)</td>
<td>GR106PcLY2D-001 01000375</td>
<td>1100</td>
<td>3600</td>
<td>720</td>
</tr>
<tr>
<td>1 Port Industrial PoE+ w/Boost</td>
<td>GR106PcLY2D-001 01000375</td>
<td>2500</td>
<td>8200</td>
<td>400</td>
</tr>
<tr>
<td>1 port PoE++ (1 spd)</td>
<td>GR106PcLY2D-001 01000375</td>
<td>1300</td>
<td>4200</td>
<td>1300</td>
</tr>
<tr>
<td>1 Port PoE+++ w/Boost</td>
<td>GR106PcLY2D-001 01000375</td>
<td>1000</td>
<td>3000</td>
<td>900</td>
</tr>
<tr>
<td>2 port PoE (1 spd)</td>
<td>GR206PcLY2D-001 01000375</td>
<td>1000</td>
<td>3000</td>
<td>900</td>
</tr>
<tr>
<td>2 Port PoE (1 spd)</td>
<td>GR206PcLY2D-001 01000375</td>
<td>1300</td>
<td>4300</td>
<td>1110</td>
</tr>
<tr>
<td>4 port PoE (1 spd)</td>
<td>GR106PcLY2D-001 01000375</td>
<td>1300</td>
<td>4300</td>
<td>1110</td>
</tr>
<tr>
<td>4 Port PoE+ (1 spd)</td>
<td>GR106PcLY2D-001 01000375</td>
<td>1300</td>
<td>4300</td>
<td>1110</td>
</tr>
<tr>
<td>4 Port PoE++ (1 spd)</td>
<td>GR106PcLY2D-001 01000375</td>
<td>1300</td>
<td>4300</td>
<td>1110</td>
</tr>
<tr>
<td>4 Port PoE+++ (1 spd)</td>
<td>GR106PcLY2D-001 01000375</td>
<td>1300</td>
<td>4300</td>
<td>1110</td>
</tr>
</tbody>
</table>

Note: The highlighted values indicate the maximum power distance limitations for different configurations.
Option B - PoE Extenders

A connectorized Zone Box using a small ceiling or wall mount NEMA enclosure may also be useful:
Option B - PoE Extenders

In some situations, reliable remote power is already available and there’s no need to run hybrid cable; just need fiber
Option B - PoE Extenders

- Use PoE Extenders rated for harsh environments
- Use redundant power source to deliver reliable DC power
- Use hybrid cables where needed
- Use connectorized zone boxes to simplify installation
Fiber and Power to the X

Telecom enclosures floor, wall or post mounted with heating & cooling, or rugged rated PoE switches

Secure PoE extenders rated for harsh environments, using redundant power source & hybrid cables
Part 3 Summary

Extending PoE in Harsh Environments

• Design considerations for power, fiber, PoE
• Design challenge using Telecom Enclosures
• Design challenge using PoE Extenders
Part 3 Questions

PoE should not be used to power:
- Cameras, wireless access points, phones
- SCADA devices, controllers, actuators
- Lights, laptops, access control points
- Fire alarms and suppression devices

There is no need for POE extenders if:
- All devices are within 300ft (90m) of a PoE port
- Power consumption is under 15W per port
- Devices are not installed in a harsh environment
- All of the above

When using a Telecom Enclosure:
- Heating and cooling is a concern
- A battery in the remote location
- Hybrid cable deployed with the fiber
- All of the above

PoE Extenders will:
- Sometimes eliminate the need for telecom enclosures
- Never be used in an outdoor or remote location
- Never be subject to voltage surges
- Always require a suitable enclosure

Extending PoE to a harsh environment requires:
- Hybrid cable to deliver power and fiber to the remote location
- Connectorized media converters to simplify deployment and swap out failed devices
- Heating, cooling and air handling solutions for remote telecom enclosures
- None of the above
- All of the above
Part 4

Rugged Solutions for Harsh Environments

• Network redundancy
• Power redundancy
• Heating & cooling
• Security and access control
• Monitoring and remote control
Critical Assets in Harsh Environments

A data center provides infrastructure that encloses all critical assets.
Critical Assets in Harsh Environments

The challenge is to deliver this infrastructure on a distributed basis to enclosures that protect critical assets in harsh environments!
Network Redundancy

PoE can take advantage of flexible IP Network Topologies
Analog vs VoIP in tough environments

Consider a simple star network for VOIP telephony:
- Direct PoE network connection to each phone
- UPS for the PBX

Network Redundancy

Image source: guardiantelecom.com
Network Redundancy

If there is no direct PoE network available, you may use a similar star network for DC power – UPS for the DC Power source.
Network Redundancy

Bus topology can reduce wiring complexity
– Network path requires switches or passive splitters

Image source: guardiantelecom.com, siemens.com
Network Redundancy

Path redundancy improves field reliability:

– Switch or optical line terminals in the communications circuit
– Redundant network paths

Image source: guardiantelecom.com, siemens.com
Power Redundancy

Redundant DC Power source

- UPS
- Hot swap DC power modules

Image source: fiberc.com, guardiantelecom.com
Power Redundancy

Bus topology can reduce wiring complexity:
– DC power bus to the phones, or local adaptor(s)

Image source: guardiantelecom.com, siemens.com, fiberc.com
Network Redundancy

Path redundancy improves field reliability:
- Switch or optical line terminals in the communications circuit
- Redundant power path
- Redundant network paths

Image source: guardiantelecom.com, siemens.com, fiberc.com
Heating & Cooling

Unless you use rugged components and power supplies, outdoor enclosures may require heating and/or cooling.
Heating & Cooling

Avoid need for air flow if possible:

- Use equipment that does not require cooling
Heating and Cooling

- Rugged IP67 outdoor rated media converter
- Rugged rated 140W DC power supply
- Rugged rated 28-port layer 2 PoE switch

Image source: siemens.com, fiberc.com
If you must use cooling fans:

- Place the intake near the base and exhaust near the top.
- Place the filter fan on the intake to pressurize the enclosure and reduce dust penetration.
Heating & Cooling

In environments with a lot of dust or damaging vapors, a closed loop cooling/heating system may be required so the enclosure remains completely sealed.
Security

- Physical security
  - Door locks, sensors
  - Audit trail, secure networks?
  - Remote locations, no network?

- Cyber Security
  - Rugged router, intrusion detection, etc.
Security

Telecom enclosures may be exposed to harsh environments, but often this also means they are subject to vandalism and at higher risk of security breaches!

<table>
<thead>
<tr>
<th></th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical keys</td>
<td>Simple</td>
<td>Expensive to manage, easy to share keys, no audit trail</td>
</tr>
<tr>
<td>CatX-connected door locks</td>
<td>Audit trail</td>
<td>Easy to hack, easy to share RFID cards, difficult to extend network</td>
</tr>
<tr>
<td>Fiber-connected door locks</td>
<td>Audit trail</td>
<td>Easy to share RFID cards, difficult to extend network</td>
</tr>
<tr>
<td>Off-network door locks</td>
<td>Simple, audit trail, impossible to hack</td>
<td>Needs smart phone</td>
</tr>
</tbody>
</table>
Security

If the installation is in a harsh environment and/or remote location, eliminating the need for a network connection to access an enclosure may be critical!

Use a system that:

- Requires no network connection
- Provides a complete audit trail
- Makes it difficult to share keys
- Is impossible to hack

Image source: sera4.com
Monitoring

Remote monitoring & control of critical assets can save $$ $$ $$ in remote service calls:

• Use Smart devices
  – Remote access, status alarms, controls over network
  – Remote alarm dialer if network fails

• Use Smart power distribution units (PDU)
  – Door access alarm
  – Temperature/humidity sensors
  – Power drop/surge on outlets
Monitoring

What if the connection to the remote enclosure fails?
• Can’t reach system!
• Don’t know what failed!
• Expensive trip to troubleshoot

Consider using an alarm dialer/controller to provide backup access to a remote enclosure in a harsh environment:
• Call over alternate telephone, radio, cellular link
• Send alarm info
• Remotely control/restart equipment
Monitoring

Within a remote enclosure, you can use a smart PDU to:

– Power all IT equipment
– Detect when door is opened
– Monitor temperature & humidity
– Monitor high consumption on outlet
– Monitor power drop on outlets indicating equipment failure
– Remote control/restart IT equipment
Critical Assets in Harsh Environments

Many products are available to protect critical assets in harsh environments!
Part 4 Questions

When deploying a network into a harsh environment the following concerns may need to be addressed:
- Extreme temperatures
- Dirt, dust, fumes, solvents
- Vandalism, access control
- All of the above

In mission critical installations, redundancy for network and power connections are:
- Always required and easy to deliver
- Often required but difficult to deliver
- Rarely required
- Recommended and can be designed using standard products

Remote monitoring of critical installations:
- Always required and easy to deliver
- Often required but difficult to deliver
- Rarely required
- Recommended and can be designed using standard products
Review Summary

Part 1 – Fiber to the X, Power to the X
• Intro to Power over Ethernet
• Intro to fiber
• Why Migrate to fiber?
• Managing cable

Part 2 – PttX/FttX in Harsh Environments
• Power to the X (PttX), fiber to the X (FttX)
• Terminating and splicing fiber in harsh environments
• Extending PoE using powered fiber in Harsh Environments

Part 3 – Extending PoE in Harsh Environments
• Design considerations for power, fiber, PoE
• Design challenge using Telecom Enclosures
• Design challenge using PoE Extenders

Part 4 – Rugged solutions for Harsh Environments
• Network redundancy
• Power redundancy
• Heating & cooling
• Security and access control
• Monitoring and remote control
Rudi@ImpactTechnicalProducts.com