Fiber to the X – Power to the X

Extending Connectivity to
Remote Mission Critical Devices
in Harsh Environments

Presenter

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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

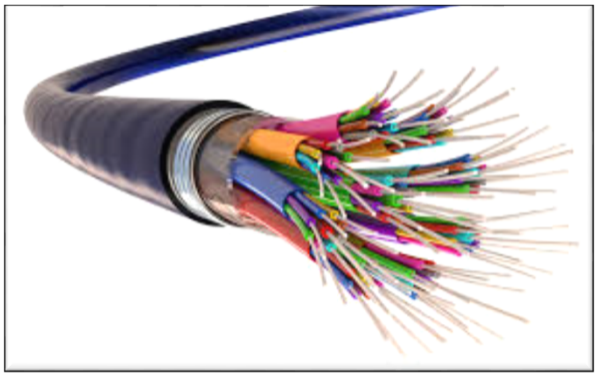
- ❑ I have done many PoE installations
- ❑ I have done a few PoE installations
- ❑ I don't have experience with PoE but know how it works
- ❑ I don't know much about PoE

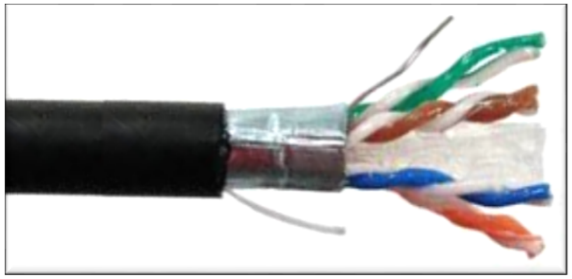
How often do you work with networks that go outside a commercial building?

- ❑ 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:

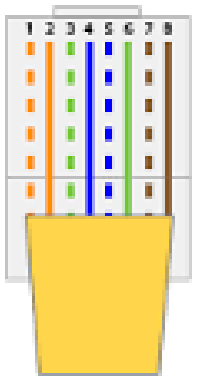
- Category cable has unused twisted pairs and can operate on DC voltage bias
- Eliminates need for AC outlet and adaptor; requires only the network cable

Image source: fs.com

PoE 101

PoE uses Class 2 wiring (low voltage):

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



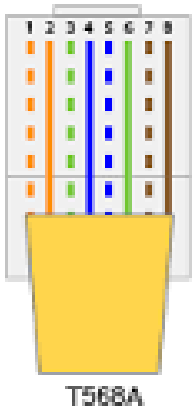
T568A

802.3af Mode A

Pins on Switch	10/100 Mbps DC & Data		1000 (1 Gigabit) DC & Bi-Data	
1	Rx +	DC +	TxRx A +	DC +
2	Rx -	DC +	TxRx A -	DC +
3	Tx +	DC -	TxRx B +	DC -
4	unused		TxRx C +	
5	unused		TxRx C -	
6	Tx -	DC -	TxRx B -	DC -
7	unused		TxRx D +	
8	unused		TxRx D -	

PoE 101

- Local Electrical Code exceptions for low voltage in <u>some</u> jurisdictions
- IT technicians can work on the lines when needed
- Saves time and money



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3	Tx +	DC -	TxRx B +	DC -
4	unused		TxRx C +	
5	unused		TxRx C -	
6	Tx -	DC -	TxRx B -	DC -
7	unused		TxRx D +	
8	unused		TxRx D -	

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

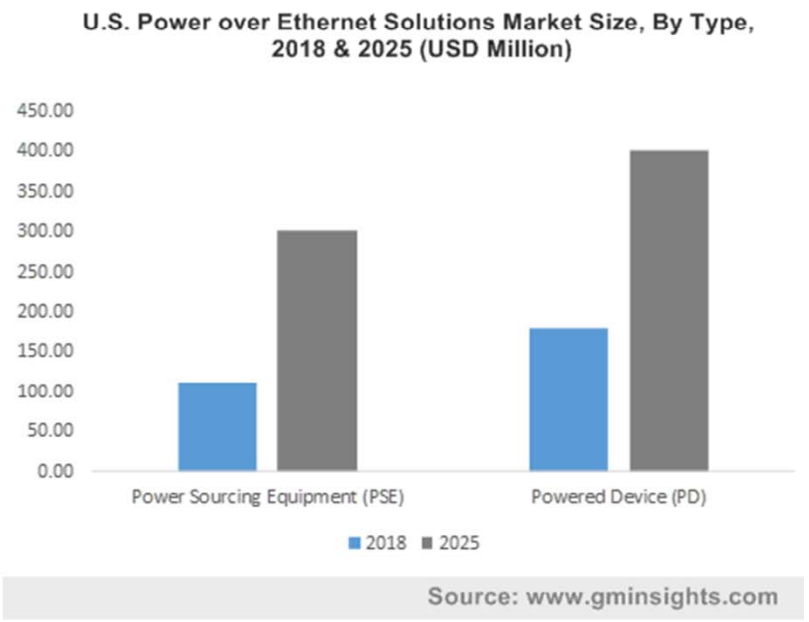
PoE 101

	POE	POE+	POE++	POE++
PoE Type	Type 1	Type 2	Type 3	Type 4
Standard	IEEE802.3af	IEEE802.3at	IEEE802.3bt	IEEE802.3bt
Power per port	15.4W	30W	60W	100W
Voltage at port	44-57Vdc	50-57Vdc	50-57Vdc	52-57Vdc
Power to Device	12.95W	25.5W	51W	71W
Voltage at device	37-57Vdc	42.5-57Vdc	42.5-57Vdc	41.1-57Vdc

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…

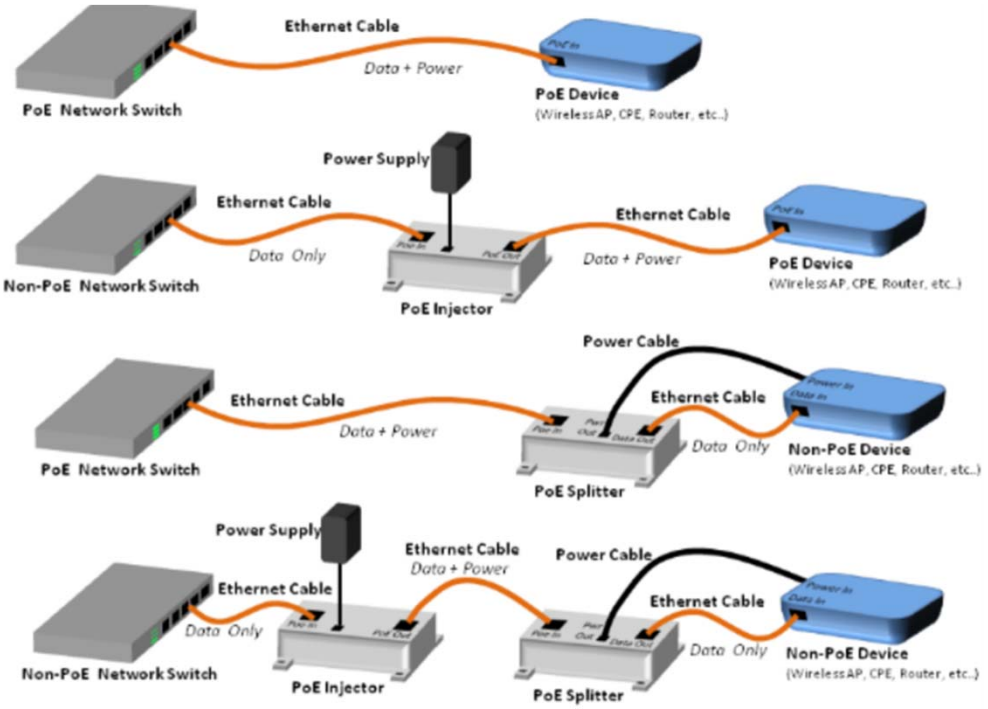


Image source: amcrest.com

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.

Room temp
1 year MTBF

$$$

-40C to +85C
25-year MTBF

PoE is only as reliable as the switch providing it!

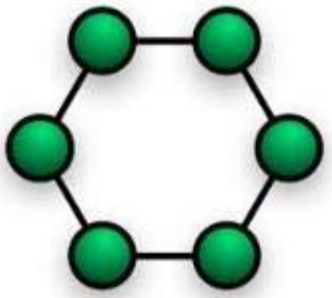
Image source: fs.com, siemens.com

PoE 101

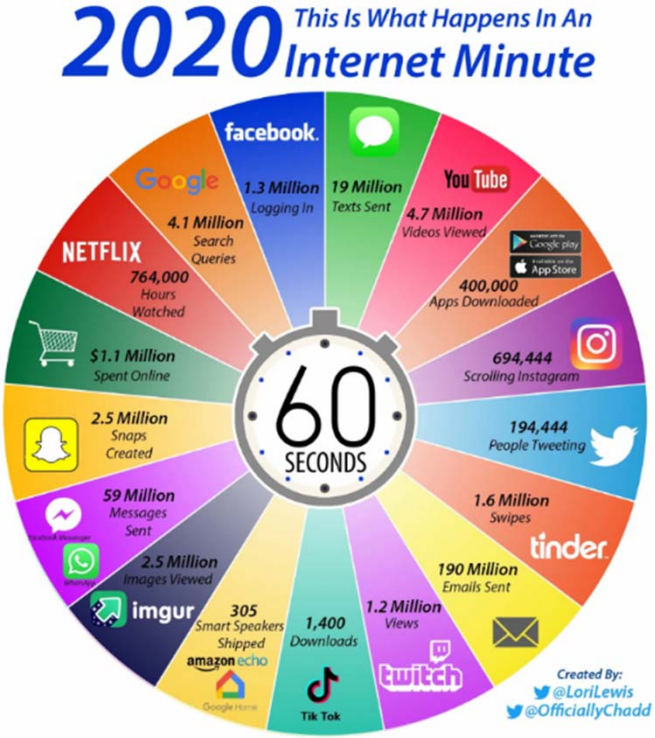
Other considerations:

- 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**

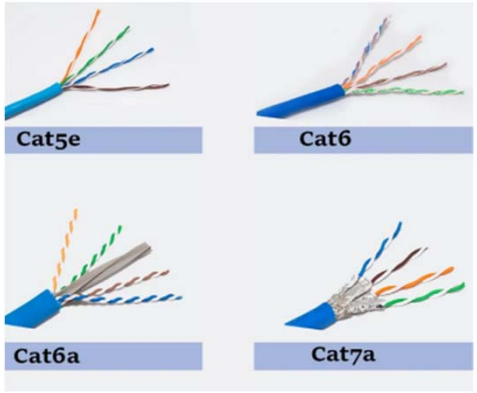
- Copper max at 40 Gbps, whereas fiber optics 100+ Tbps
- Copper limited to lengths of 90-100 meters (~300-330 ft.) whereas fiber optic cabling can span over 30km (20 miles)

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

Image source: cablek.com

Why Migrate to Fiber?

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

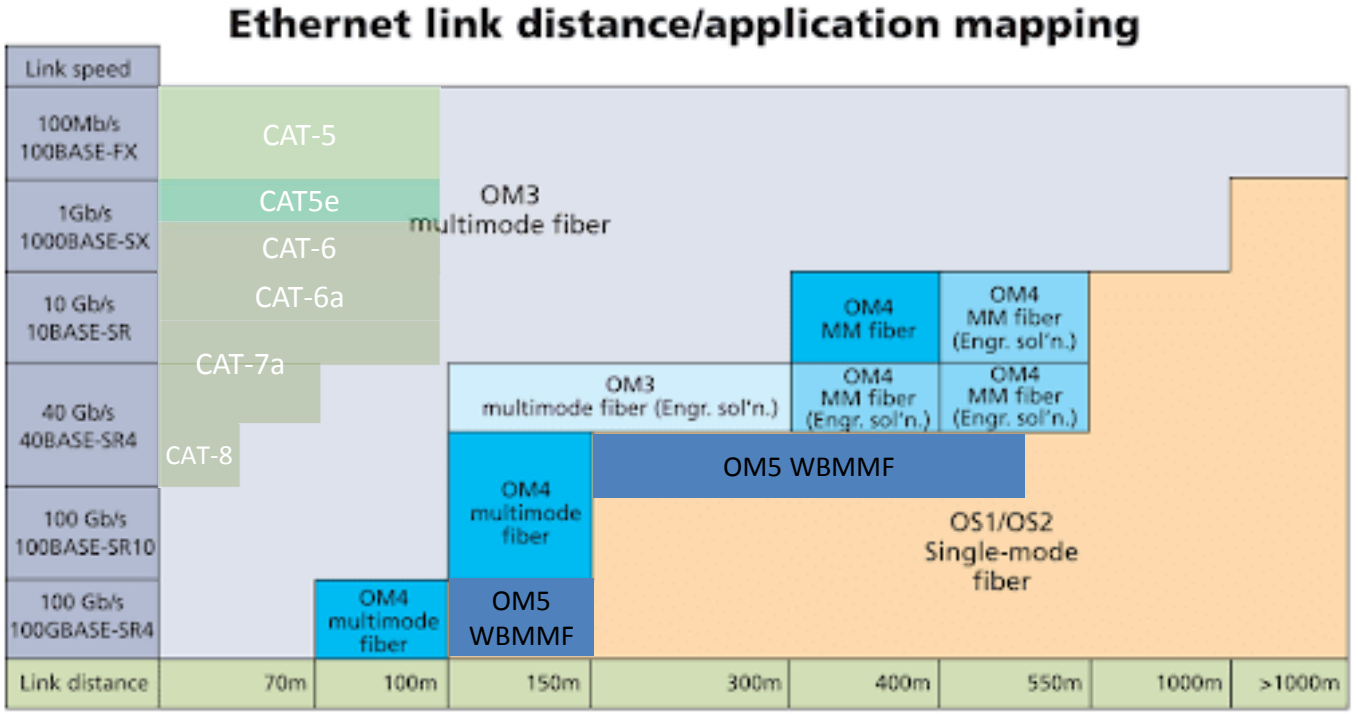


Ethernet link distance/application mapping

Link speed								
100Mb/s 100BASE-FX	CAT-5							
1Gb/s 1000BASE-SX	CAT5e	CAT-6						
10 Gb/s 10BASE-SR	CAT-6a	CAT-7a						
40 Gb/s 40BASE-SR4	CAT-8							
100 Gb/s 100BASE-SR10								
100 Gb/s 100GBASE-SR4								
Link distance	70m	100m	150m	300m	400m	550m	1000m	>1000m

Why Migrate to Fiber?

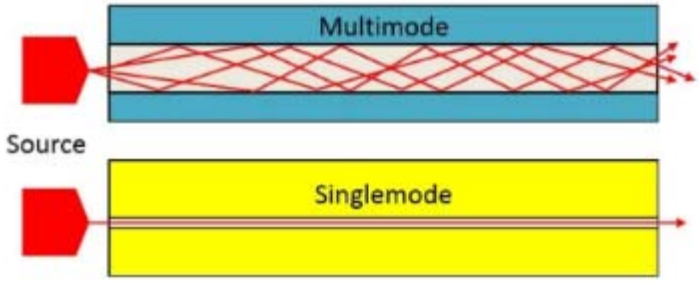
Compared to category cable, fiber can handle more data, uses less space, has lower losses and is more secure.



Fiber 101

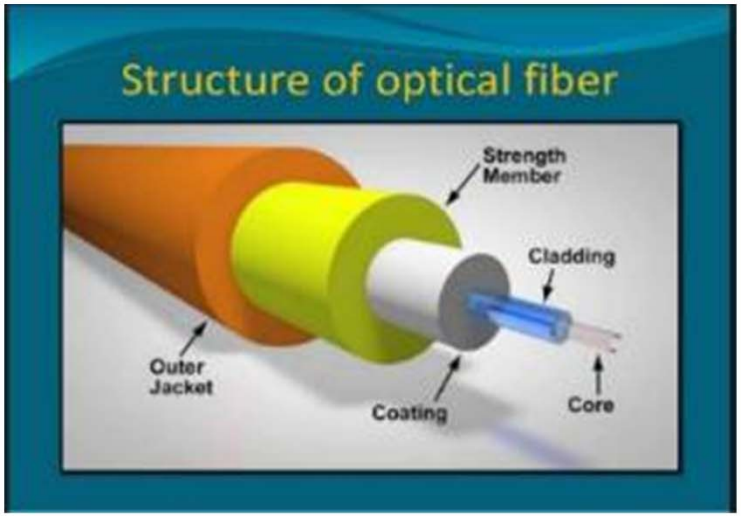
2. Fiber optic cable cannot generate and is impervious to:
   - Electromagnetic interference (EMI)
   - radio frequency interference (RFI)
   - voltage surges

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



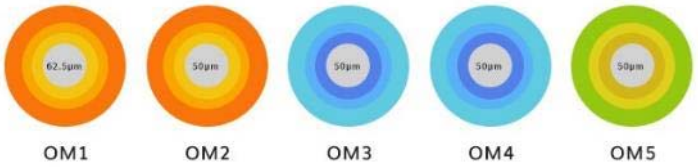
BONUS: no grounding issues, and no sparking problems!

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



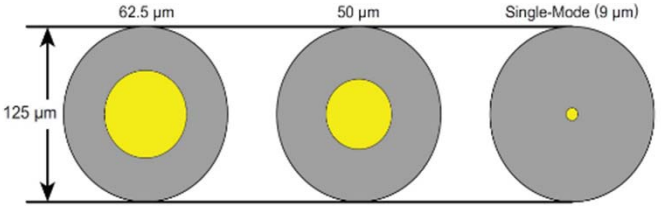
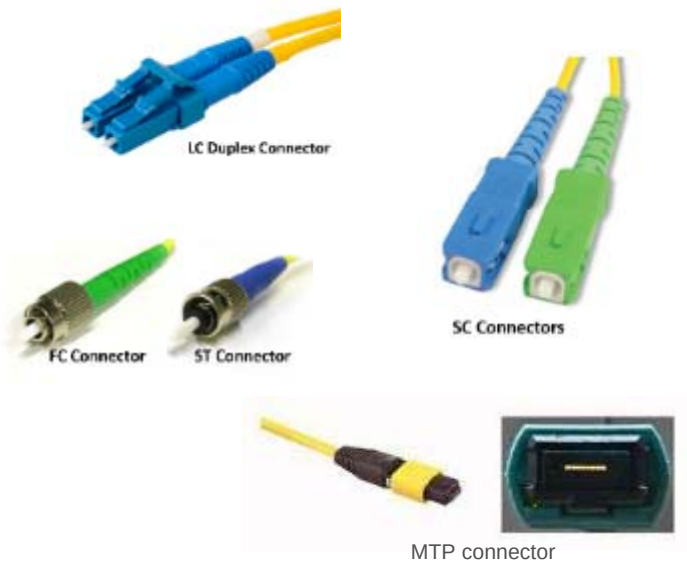


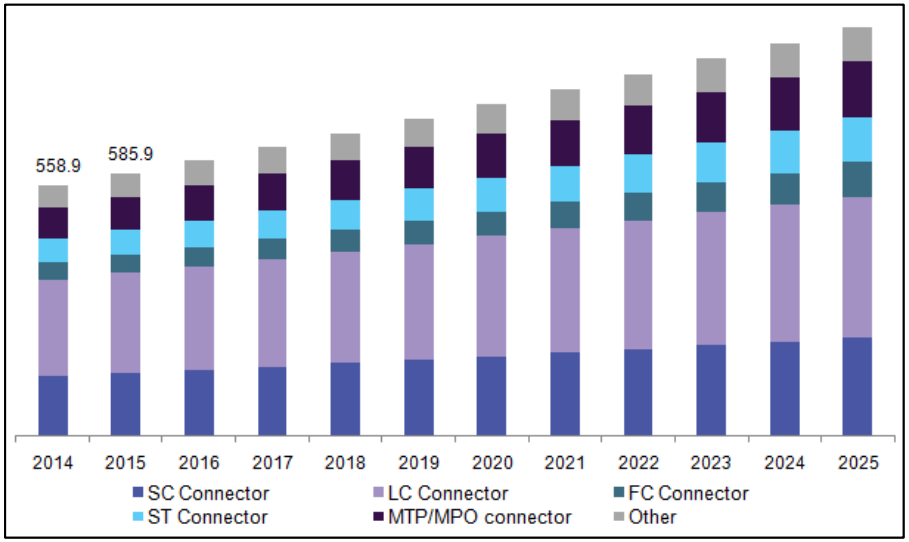
Image source: lanshack.com

Fiber 101

Wide range of connectors available



MTP connector



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

Image source: grandviewresearch.com

Why Migrate to Fiber?

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

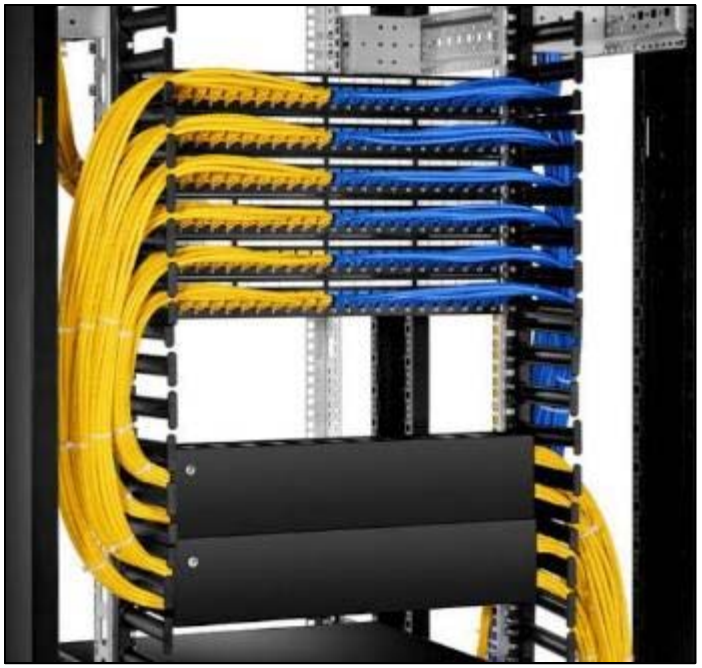


Image source: chatsworth.com

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.

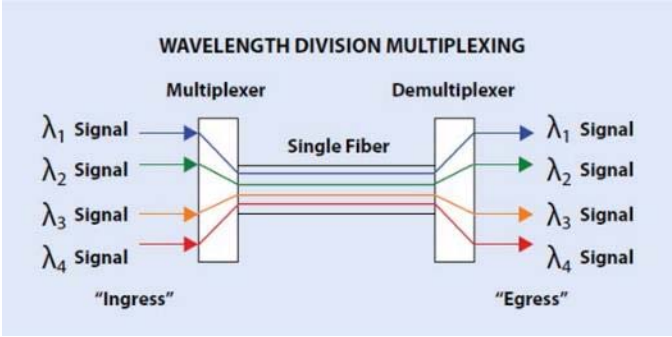


Image source: optcore.com

Cable Management

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

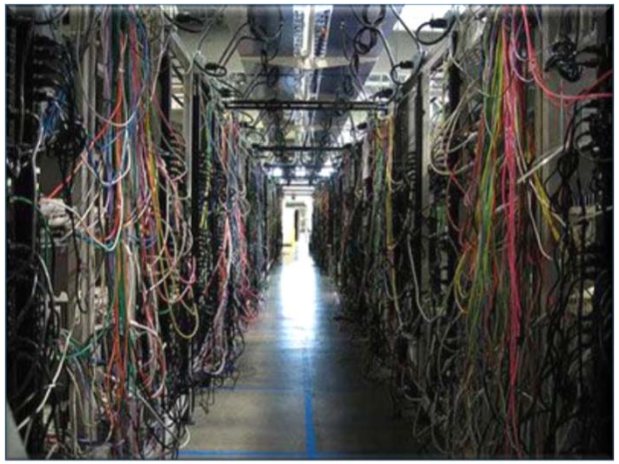


Image source: chatsworth.com

Cable Management

Even fiber installations can get out of hand!

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

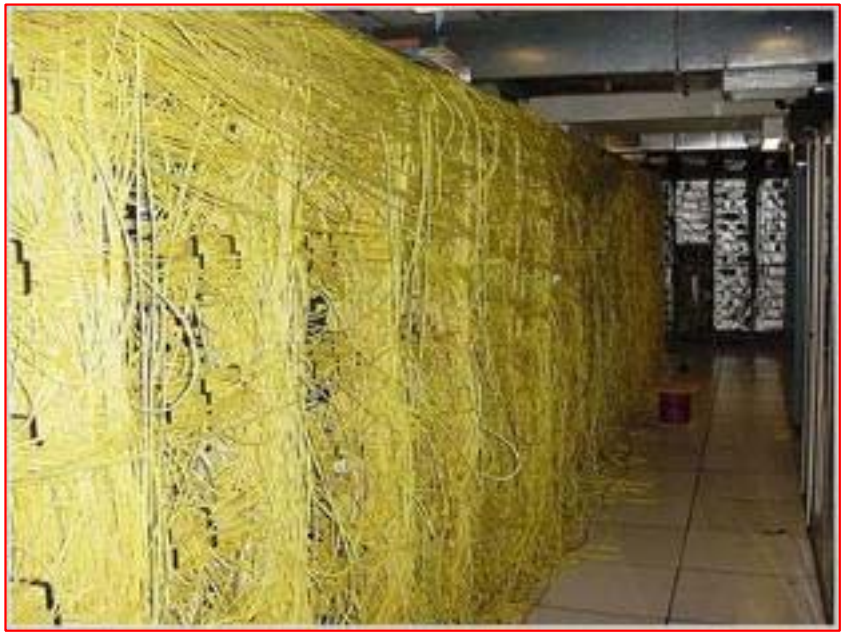


Image source: chatsworth.com

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!

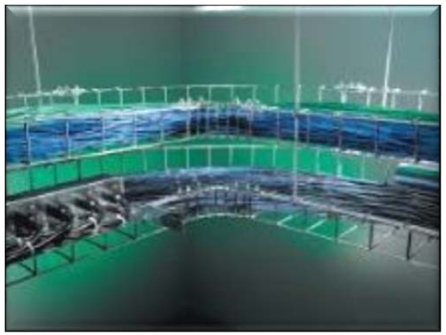


Image source: chatsworth.com

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

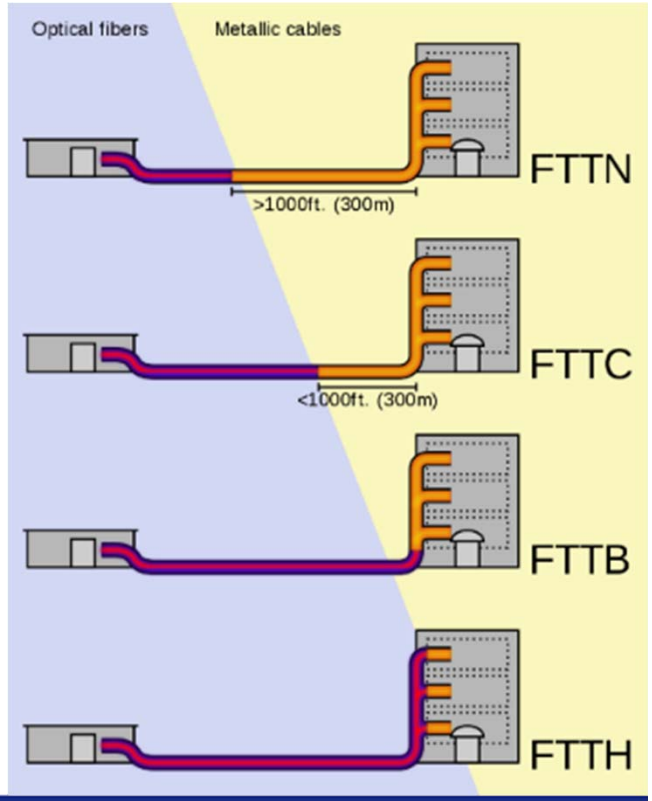
Fiber to the X

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

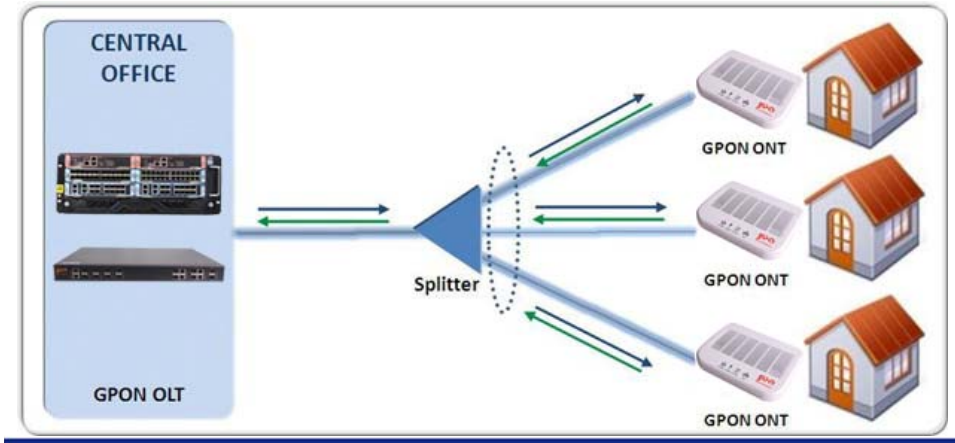
BUT: how do we still get Power over Ethernet if we migrate to Fiber???

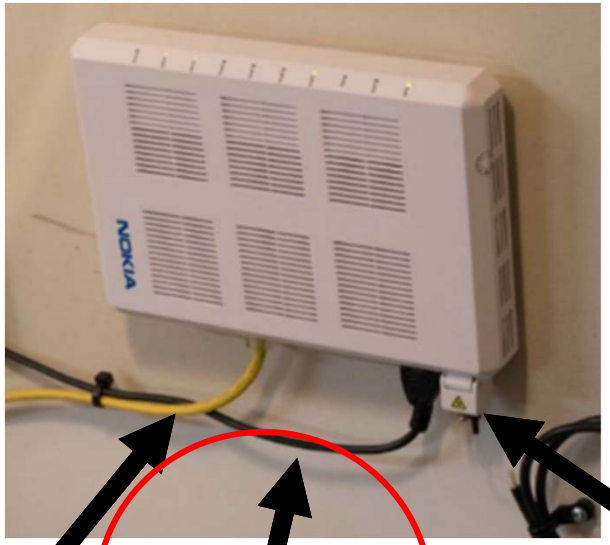
- In many FttX applications, power is available at X and you can use an AC/DC adaptor
- Or, DC power is supplied by a nearby PoE switch or media converter

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





Typical ONT to provide fiber to the home

Home network

AC/DC power

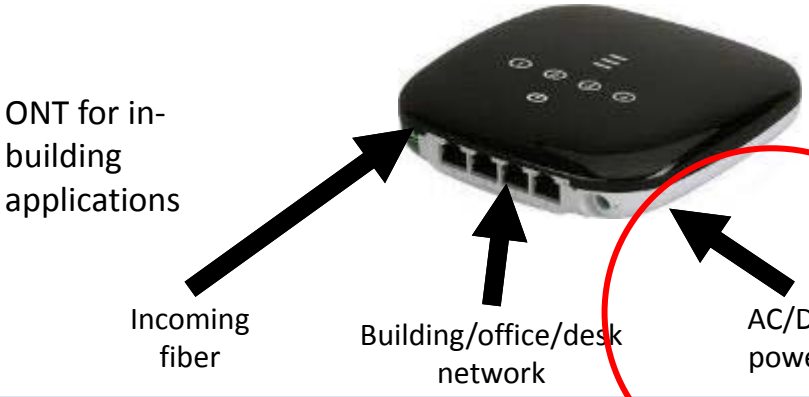
Incoming fiber

Image source: fttxftth.wordpress.com

Fiber to the X - FttW

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



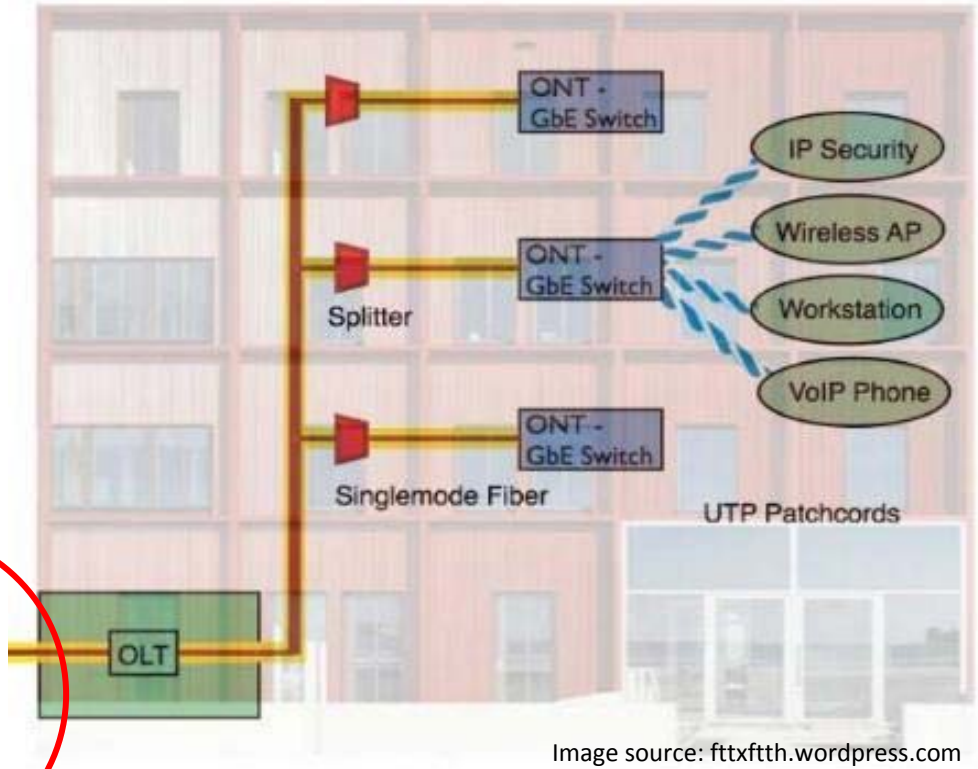
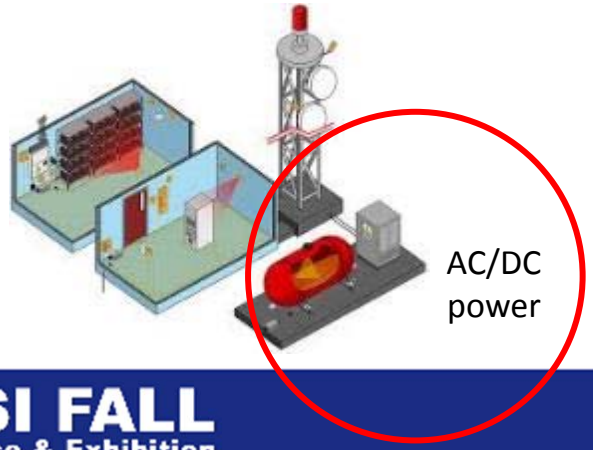


Image source: fttxftth.wordpress.com

Fiber to the X - FttA

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



AC/DC power

Outdoor Patch Panel

Image source: fiberc.com

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

Fiber Connections in Harsh Environments

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

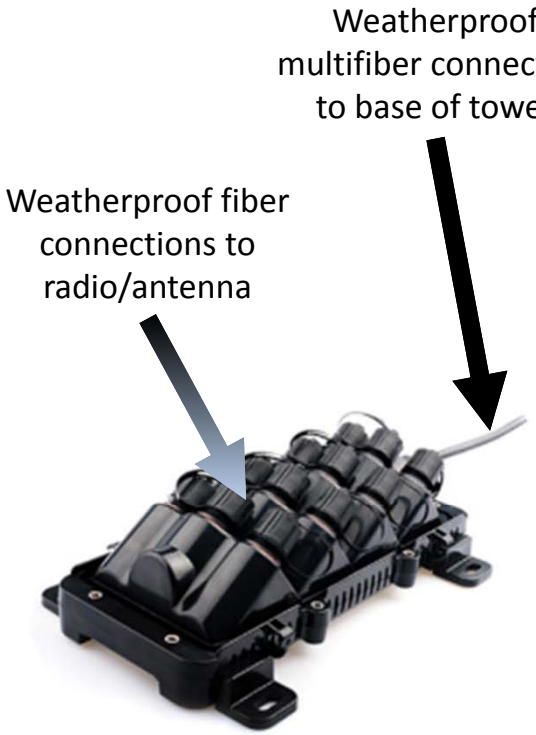


Image source: fiberc.com

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

Indoor/outdoor armored cable

IP-One connector

ODVA connector

D38999 connector

Fiber Connections in Harsh Environments

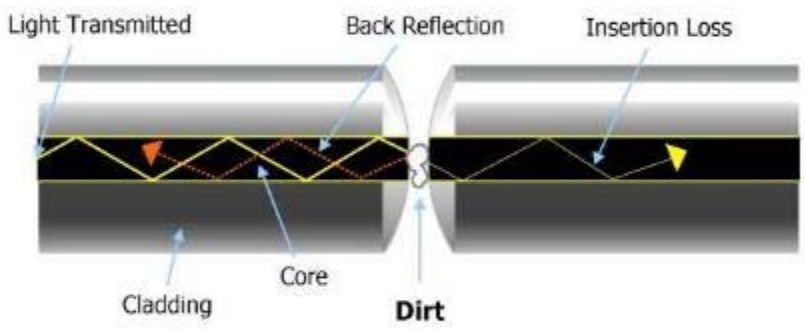
Keep those fibers clean!

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!



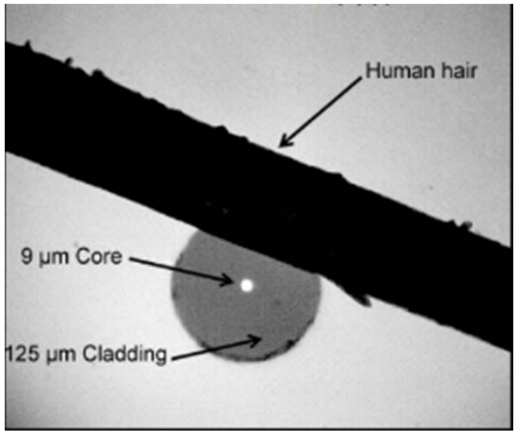
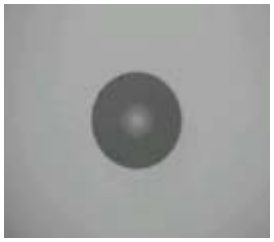


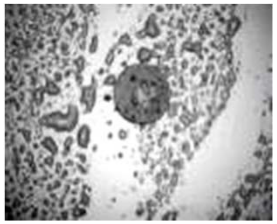
Image source: flukenetworks.com

Fiber Connections in Harsh Environments

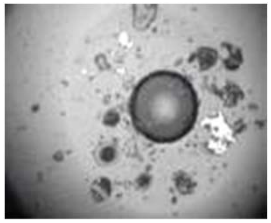
Always use Fiber cleaning & inspection tools. Even so, it can be very difficult to maintain a clean connection in a harsh environment.



Good Connector



Fingerprint on Connector



Dirty Connector

Image source: flukenetworks.com

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?

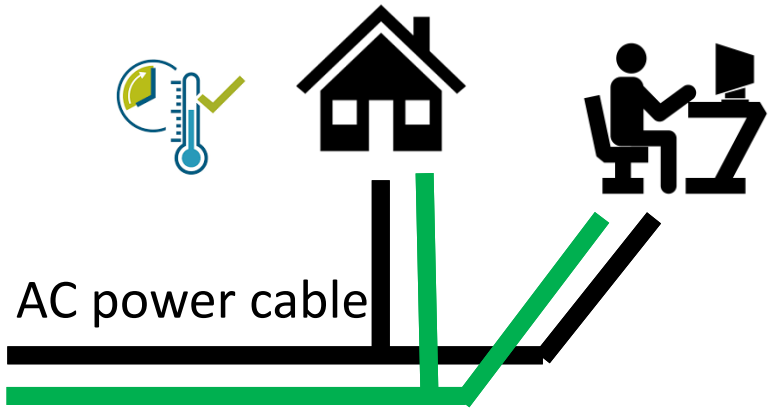
We need

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



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

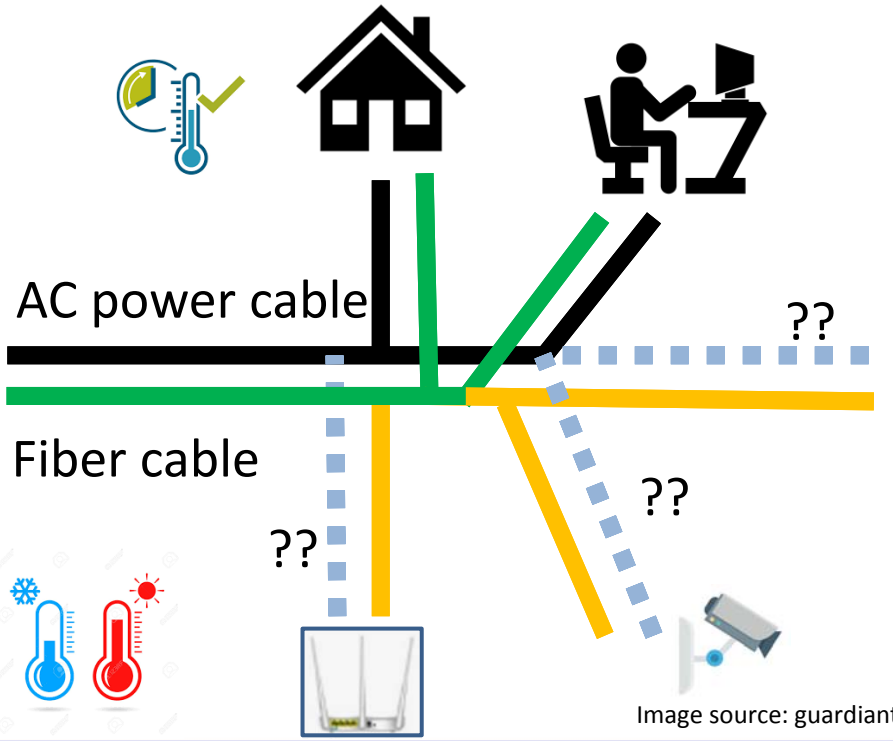


Image source: guardiantelecom.com

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

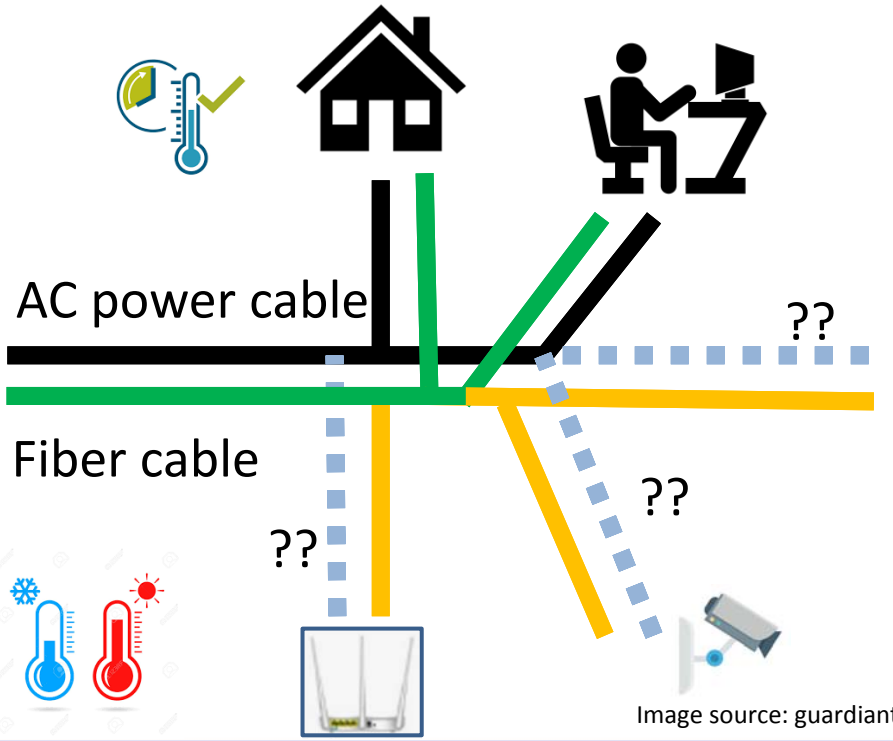


Image source: guardiantelecom.com

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

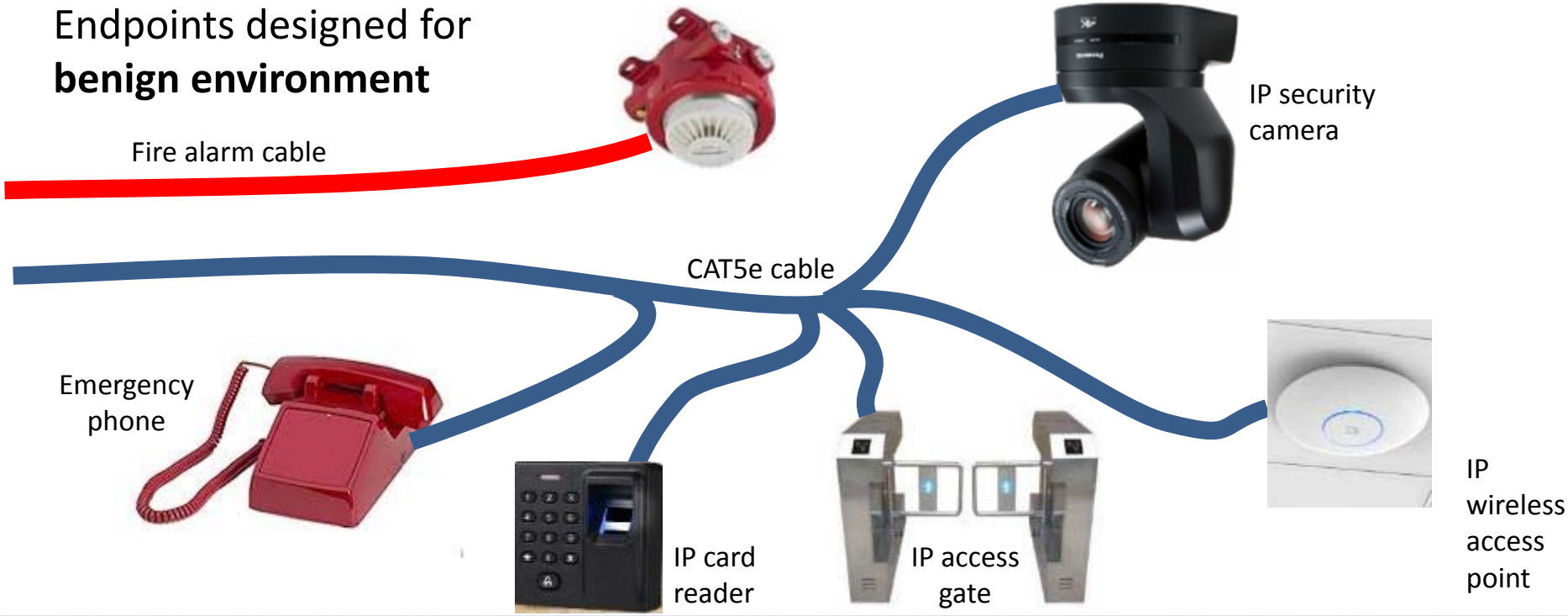
Tough Environments demand tough components

- 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
guardiantelecom.com

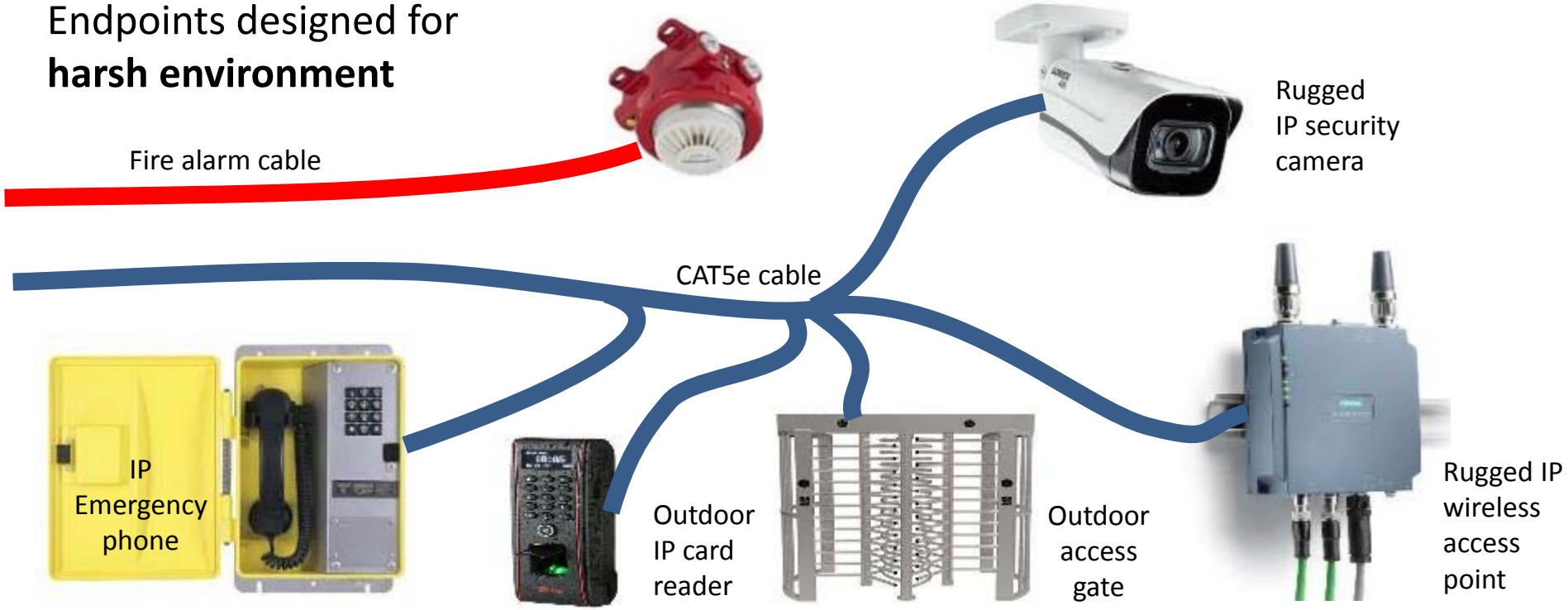
PoE in Harsh Environments

Endpoints designed for
benign environment



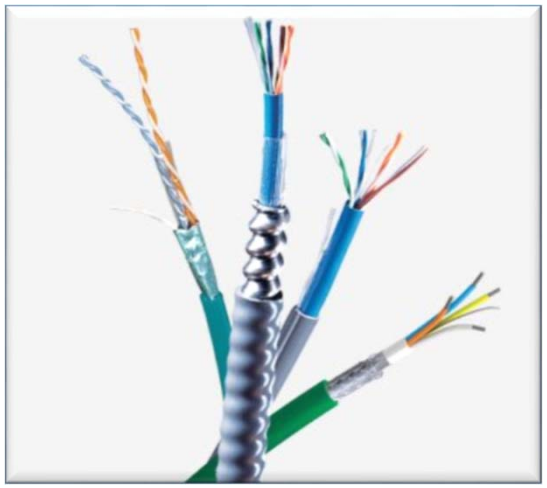
PoE in Harsh Environments

Endpoints designed for
harsh environment



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

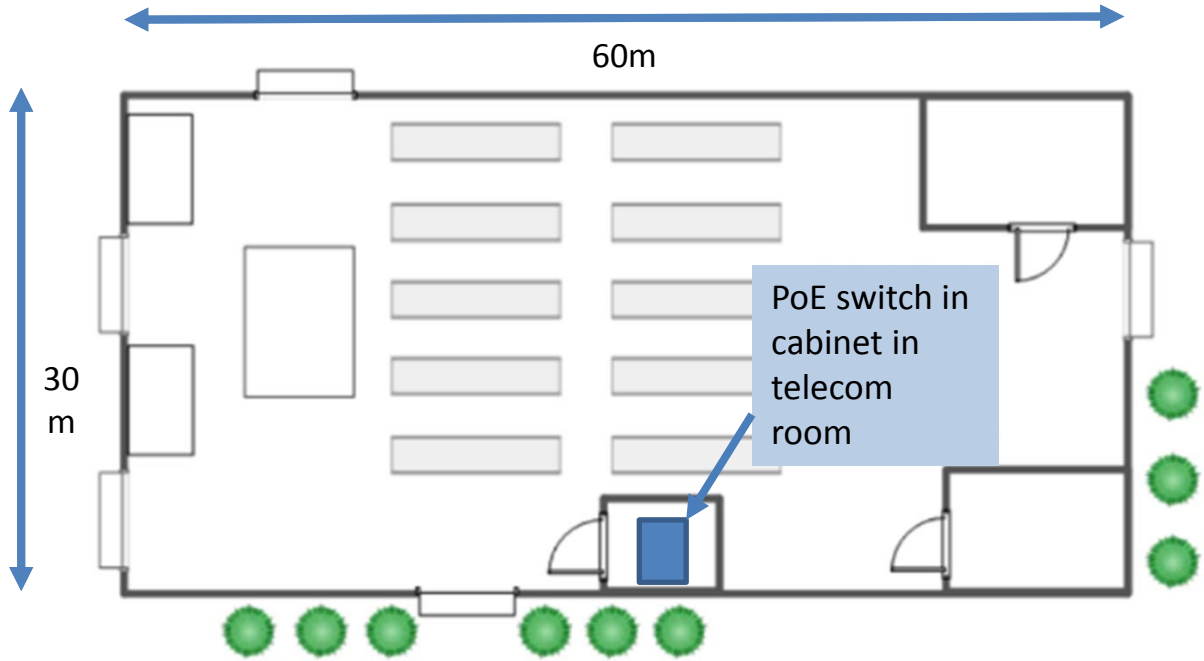
Design Challenge 1

Building needs security cameras, wireless access points, emergency phone

- Warehouse
- Underground parkade
- Manufacturing facility

Image source:
steelway.com
dailyhive.com

Design Challenge 1



Warehouse needs security cameras, wireless access points, emergency phone

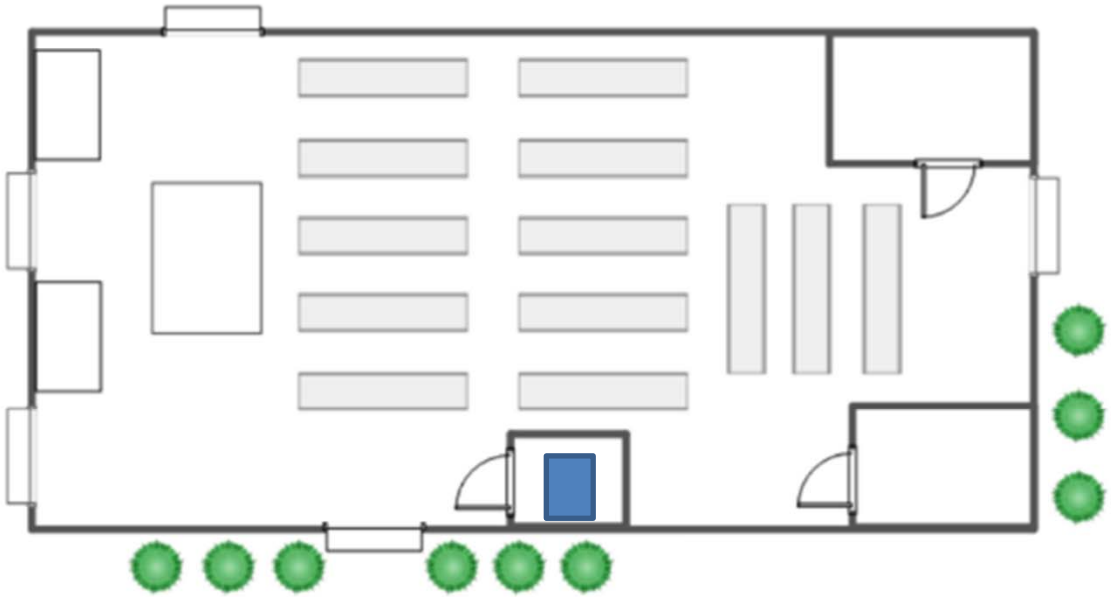
- Everything to wire back to 24-port PoE switch in IT cabinet
- Longest run <60m (200ft)

Design Challenge 1

Building envelope is:

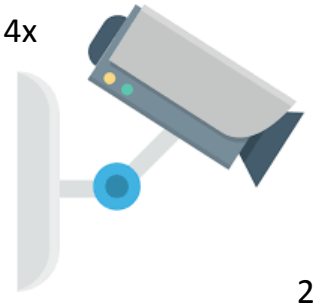
- Weatherproof, so we can use a standard IT cabinet
- Secure, so standard door locks will work
- Air conditioned, so conventional PoE switch is good enough
- Standby generator backup, so no need for UPS
- Some dust and dirt may be expected

Design Challenge 1



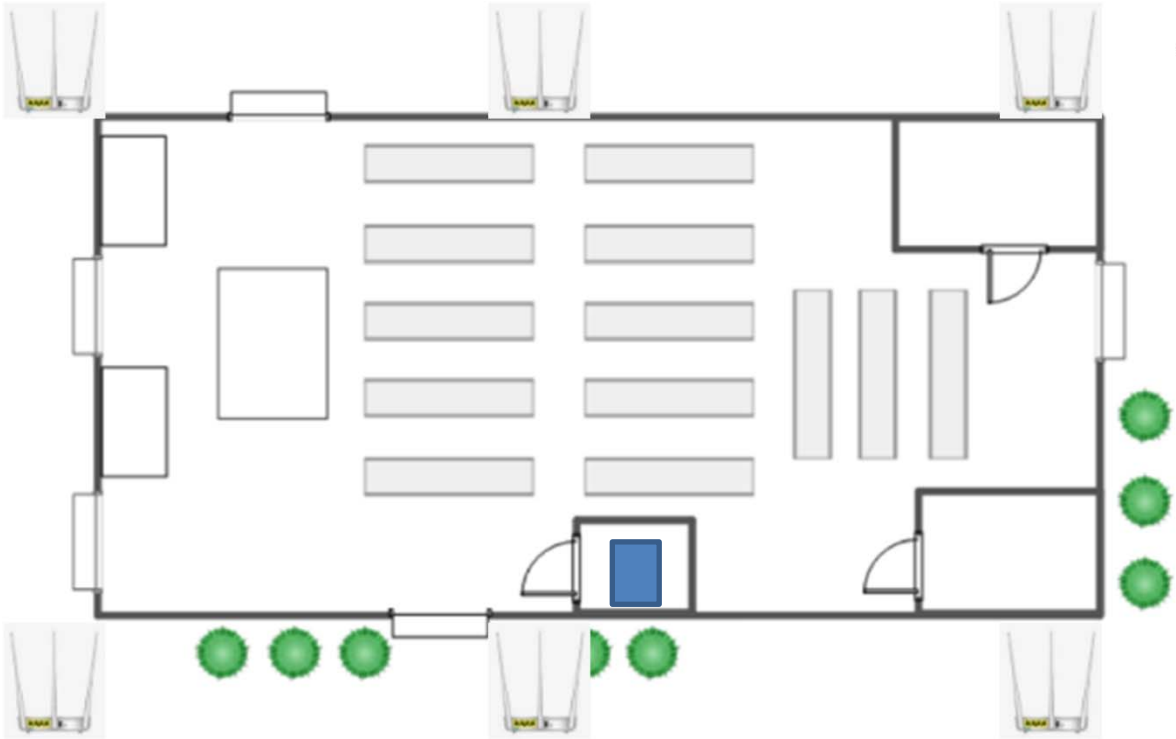
6 x

4x

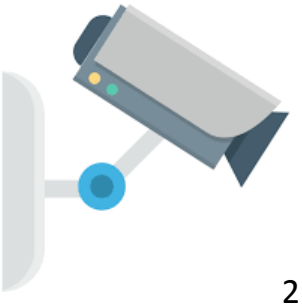


2 x

Design Challenge 1

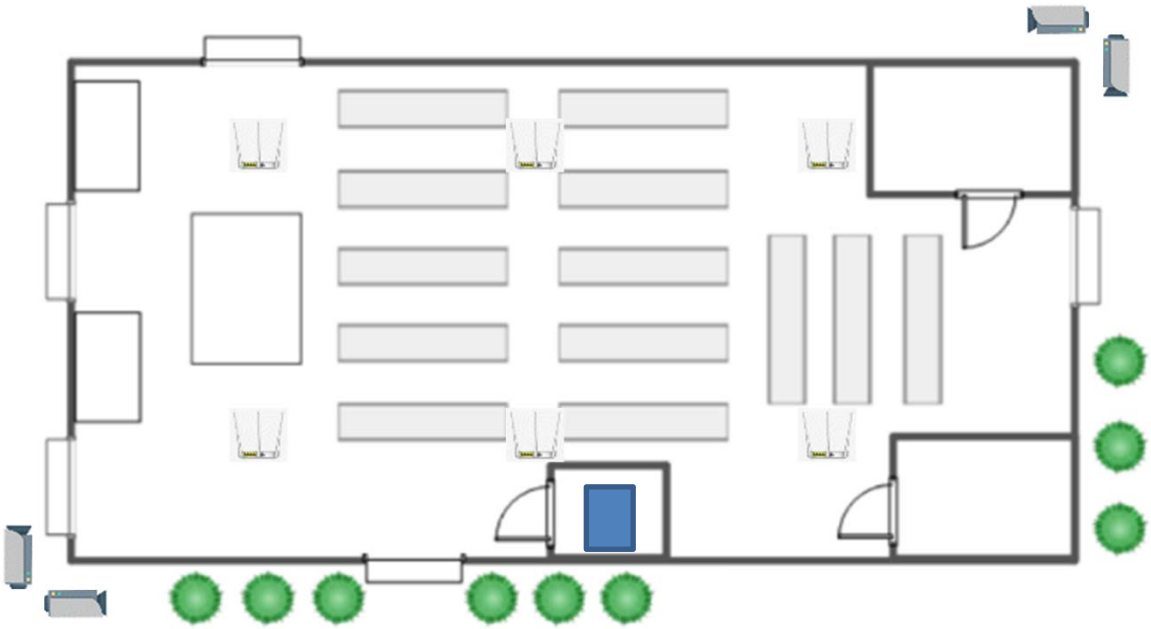


- Distribute the access points for best coverage



2 x

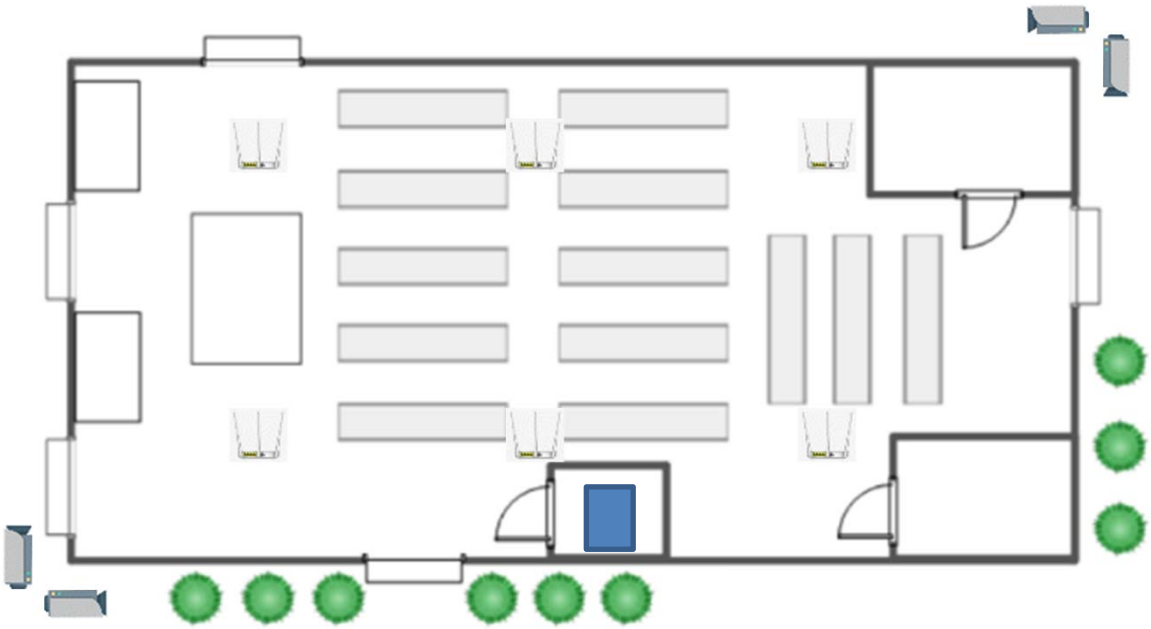
Design Challenge 1



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

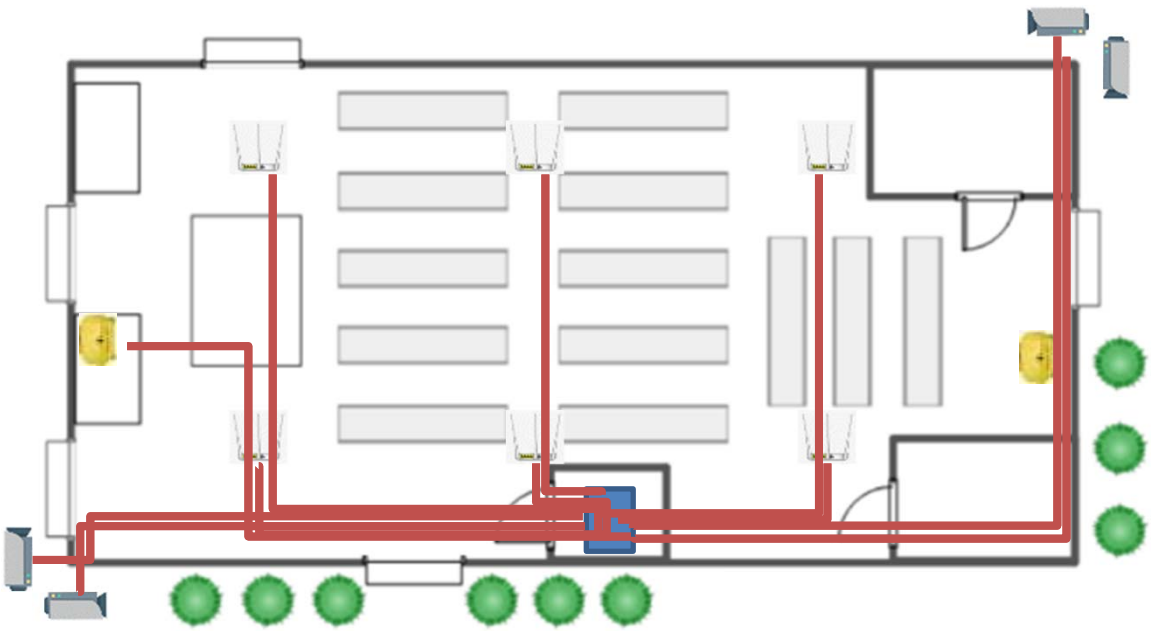
2 x

Design Challenge 1



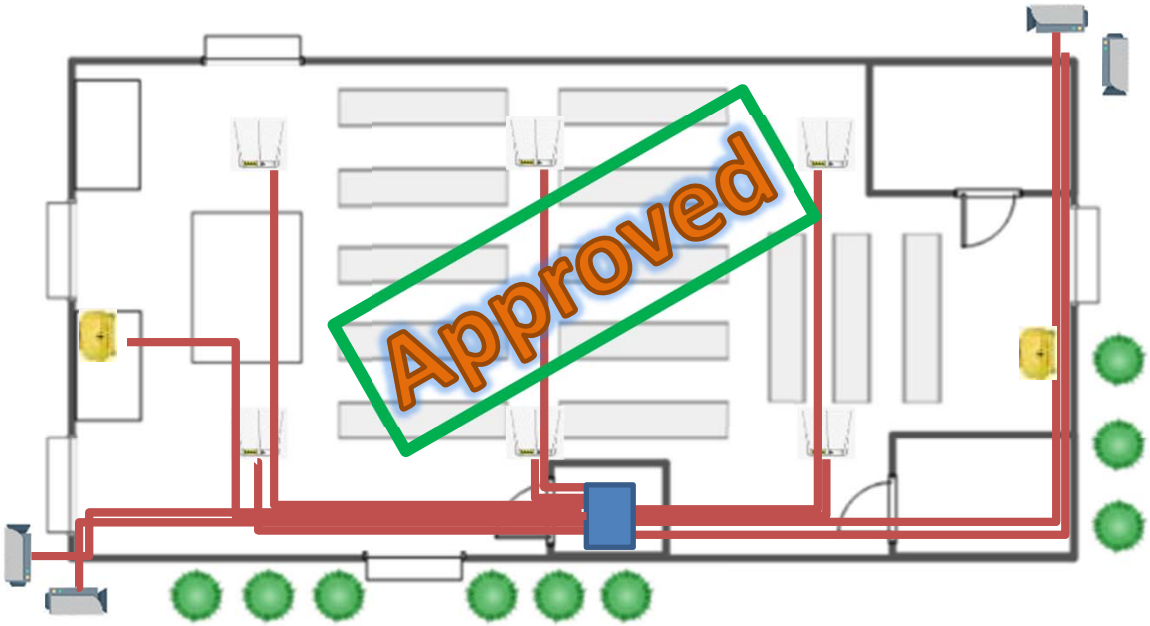
- Distribute the access points for best coverage
- Position the security cameras for all angles
- Install emergency phones for easy access throughout warehouse

Design Challenge 1



- Star network layout
- CAT5e/6a cable in cable trays throughout

Design Challenge 1



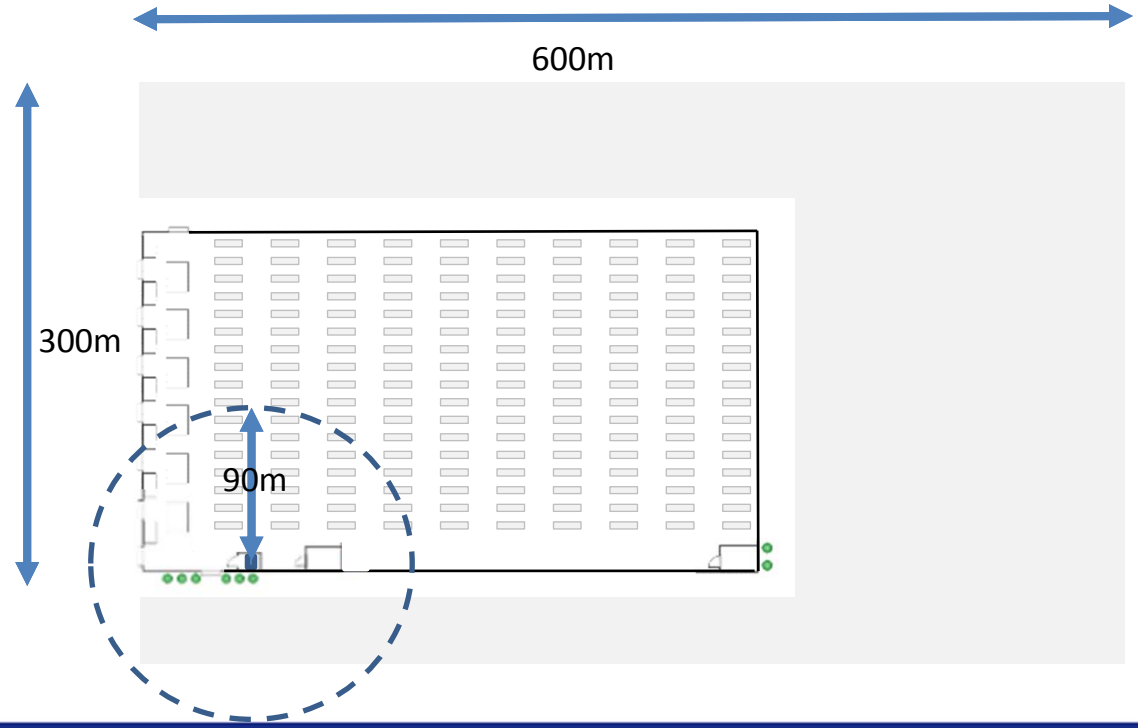
- PoE quickly and easily provides:
  - **network**
  - **power**
- Easy to deploy and manage, easy to expand
- Good for warehouse, manufacturing facility, campus, hospital, transit station, etc.

Design Challenge 2

Now for a more challenging design for extending PoE:

- Petrochemical
- Drydock
- Airport
- Transit
- Etc.

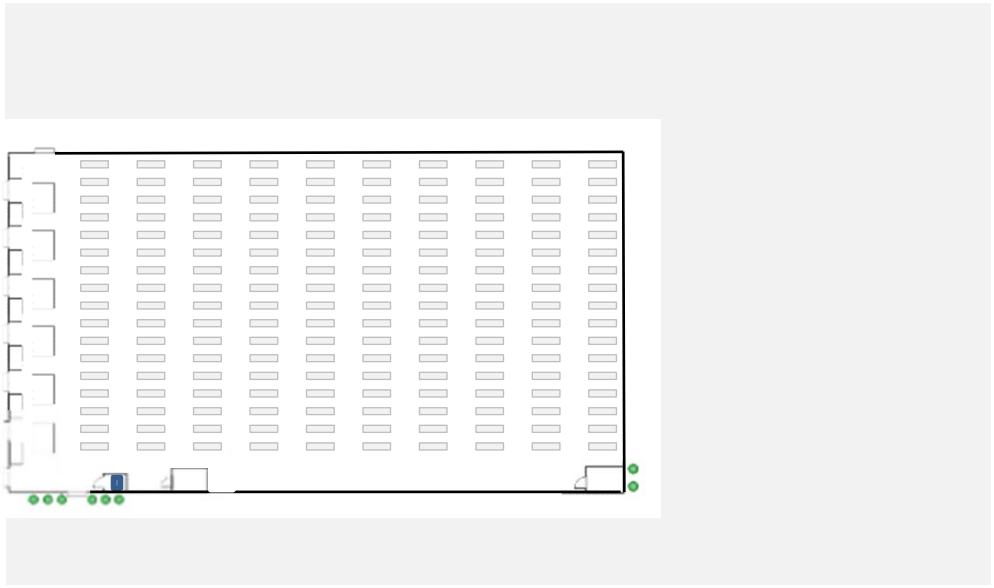
Design Challenge 2



To keep things simple:

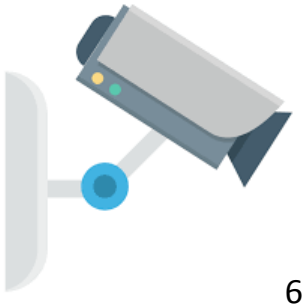
- Bigger building and outdoor works yard or parking lot area
- Harsh outdoor and indoor environments
- Longest run > 90m

Design Challenge 2



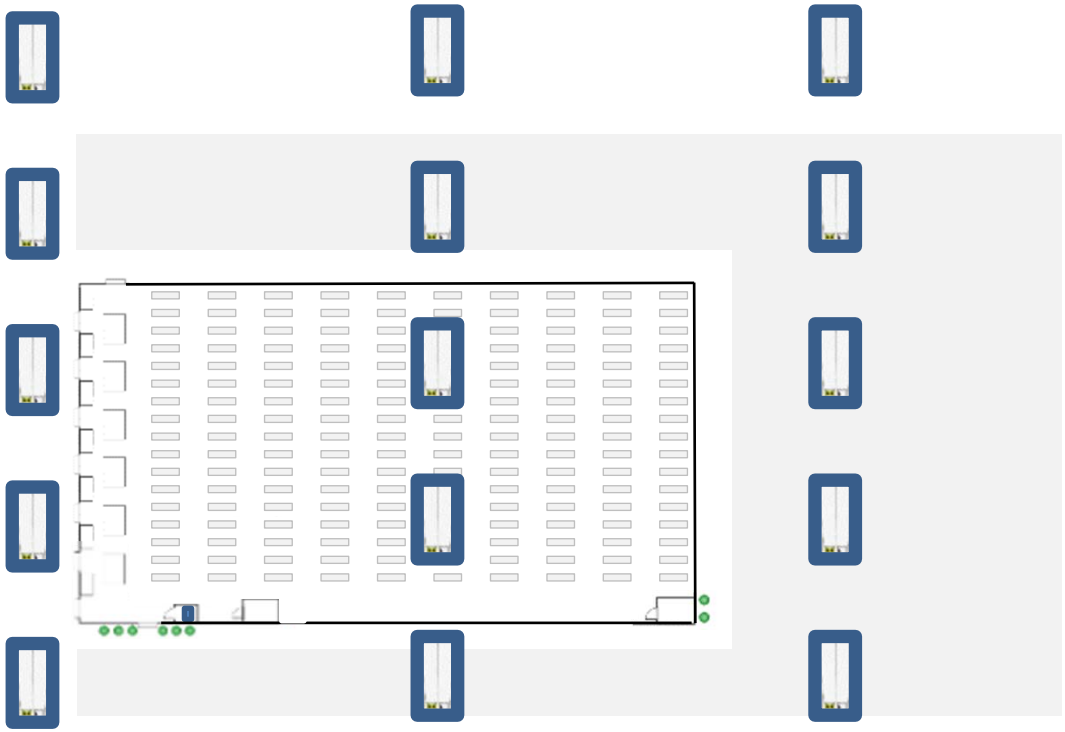
30 x

13 x



6 x

Design Challenge 2

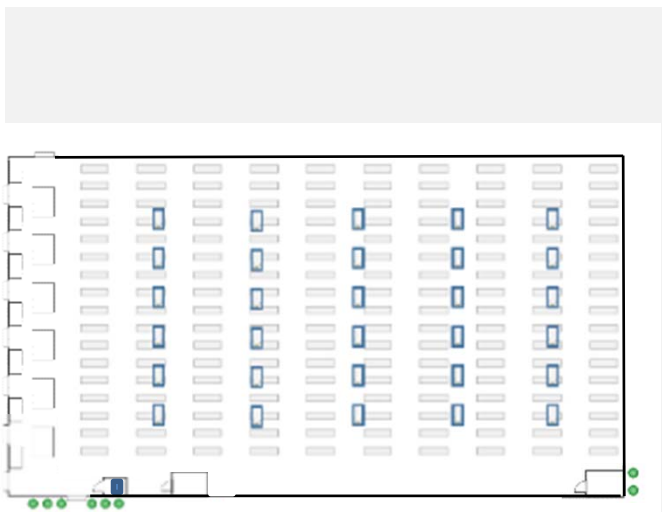


- Distribute the access points for best coverage

13 x

6 x

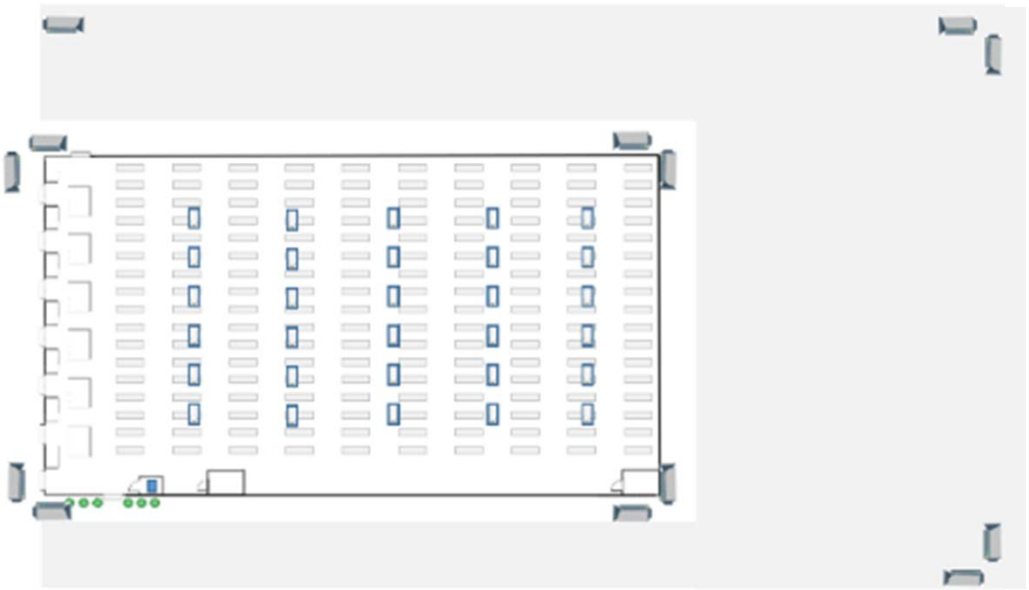
Design Challenge 2



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

6 x

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

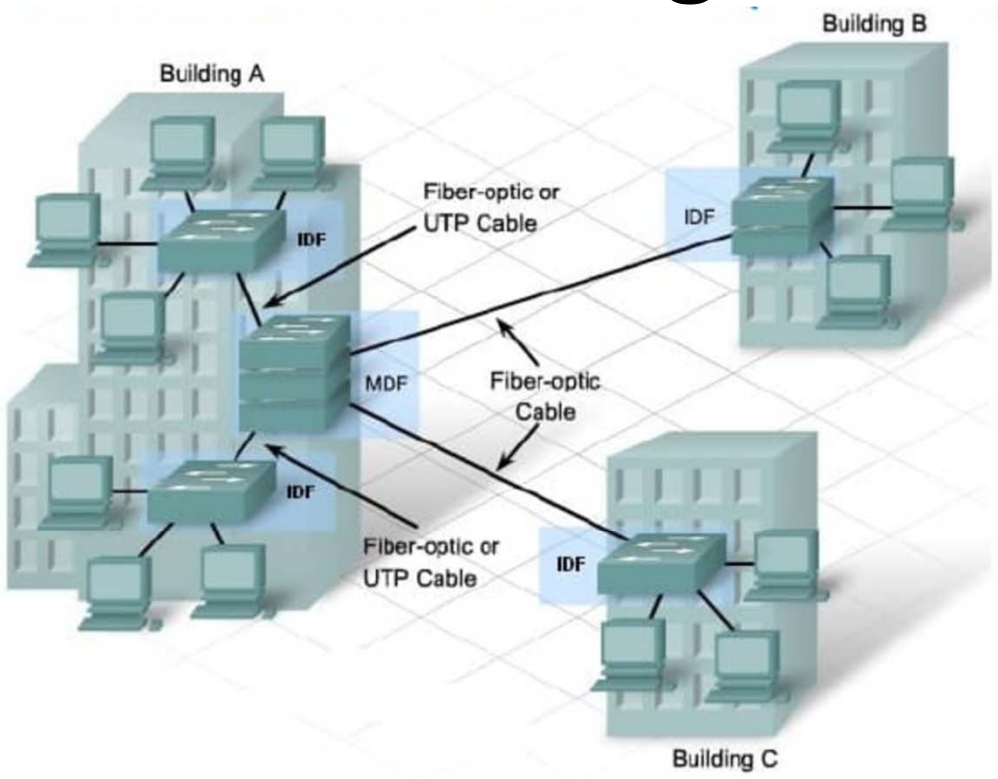
Design Challenge 2

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

Image source: asmed.com

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

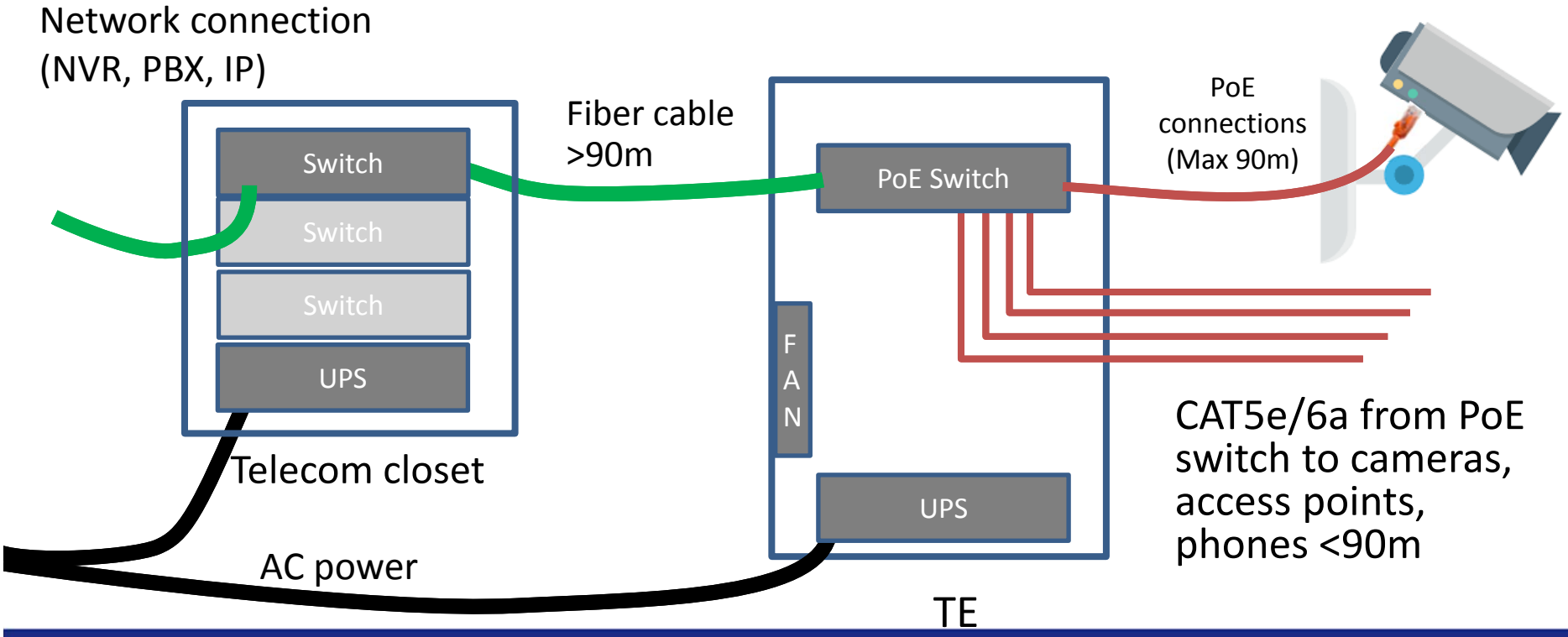
Outdoor heated & cooled enclosure

Wall/Post mounted enclosure

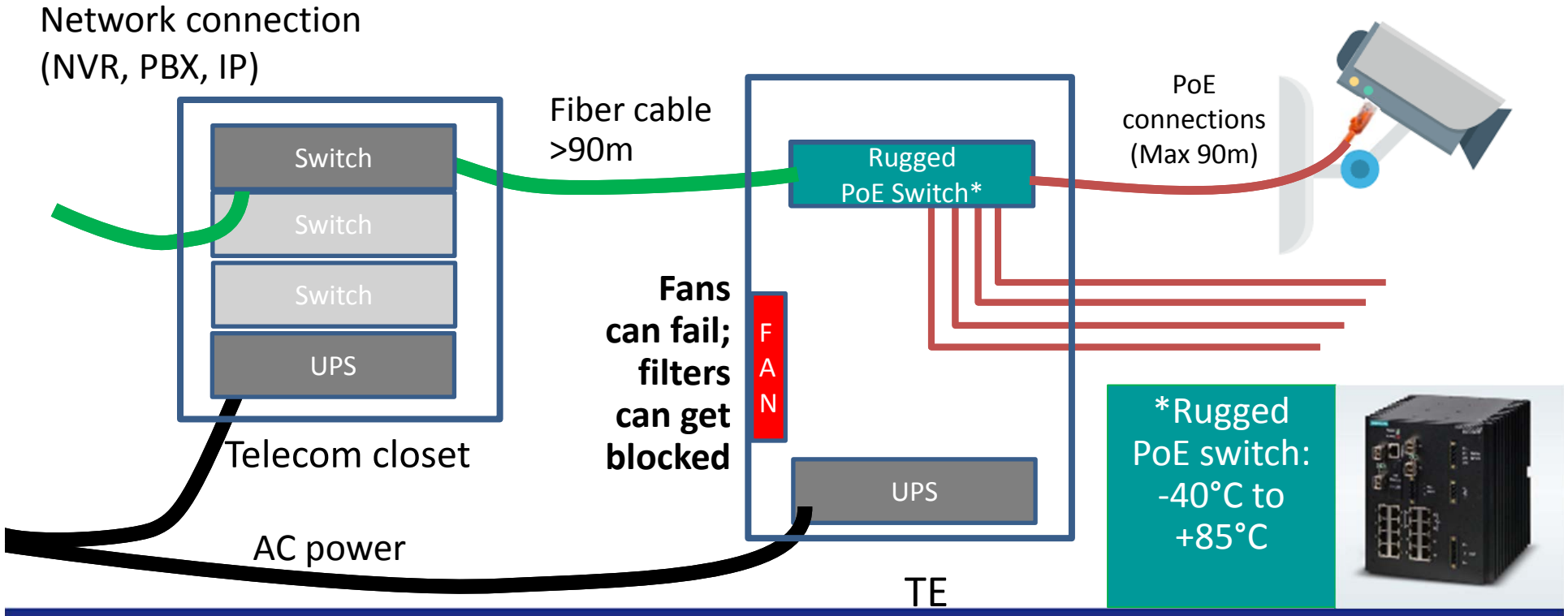
Consider dust, temperature, humidity, accidental damage, vandalism!

Image source: chatsworth.com

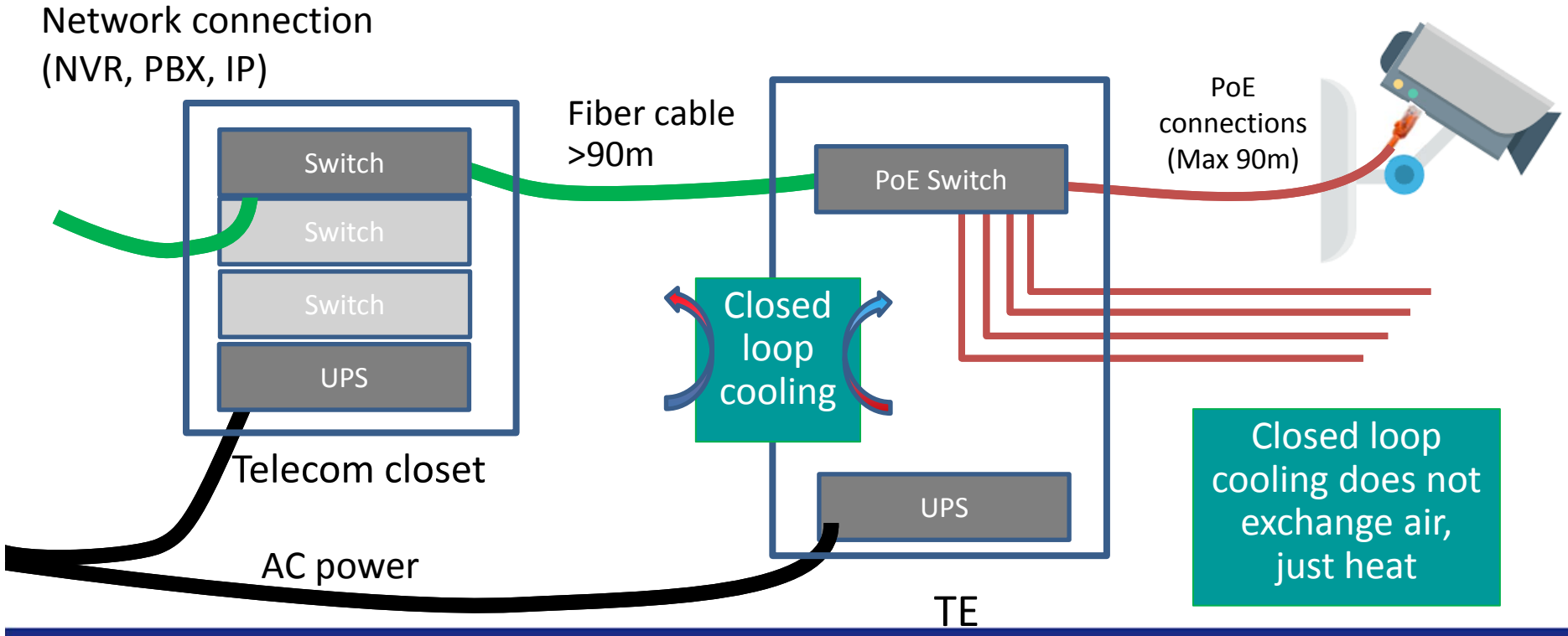
Option A - TE


Network connection
(NVR, PBX, IP)
Switch
Switch
Switch
UPS
Telecom closet
Fiber cable
>90m
PoE Switch
F
A
N
UPS
PoE
connections
(Max 90m)
CAT5e/6a from PoE
switch to cameras,
access points,
phones <90m
AC power
TE

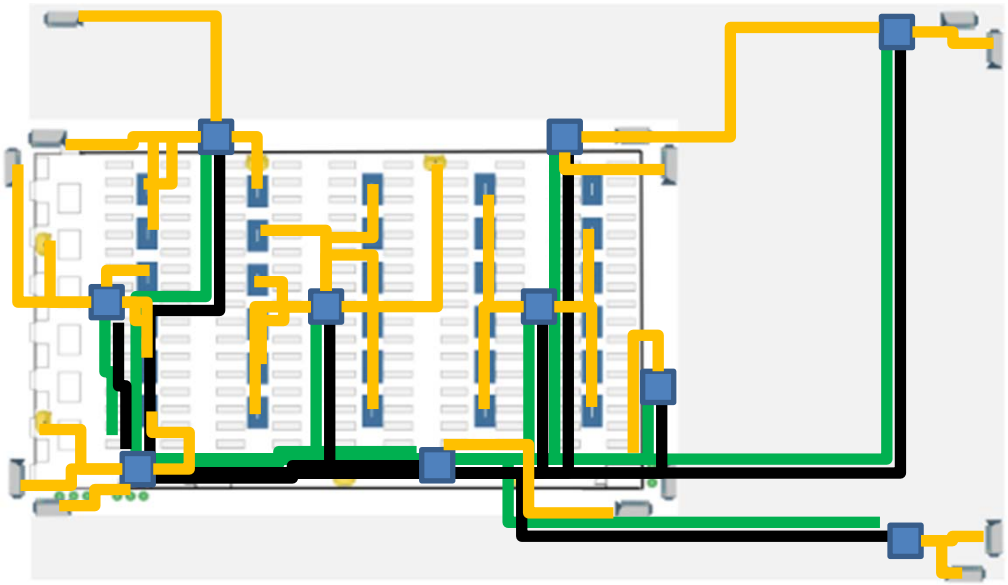
Option A - TE


Network connection
(NVR, PBX, IP)
Switch
Switch
Switch
UPS
Telecom closet
Fiber cable
>90m
Rugged
PoE Switch*
PoE
connections
(Max 90m)
Fans
can fail;
filters
can get
blocked
F
A
N
UPS
AC power
TE
*Rugged
PoE switch:
-40°C to
+85°C

Option A - TE

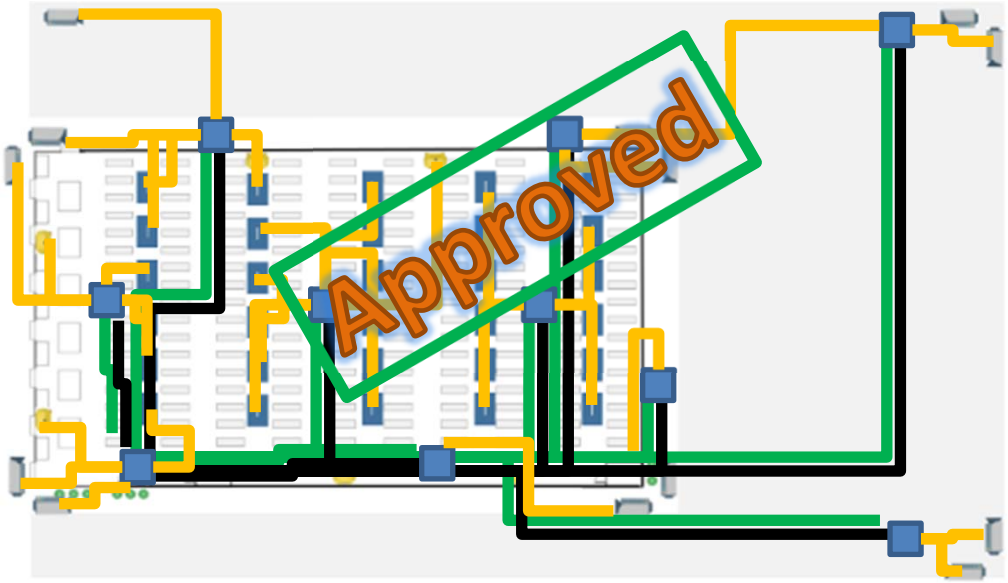

Network connection
(NVR, PBX, IP)
Switch
Switch
Switch
UPS
Telecom closet
Fiber cable
>90m
PoE Switch
PoE
connections
(Max 90m)
Closed
loop
cooling
UPS
AC power
TE
Closed loop cooling does not exchange air, just heat

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



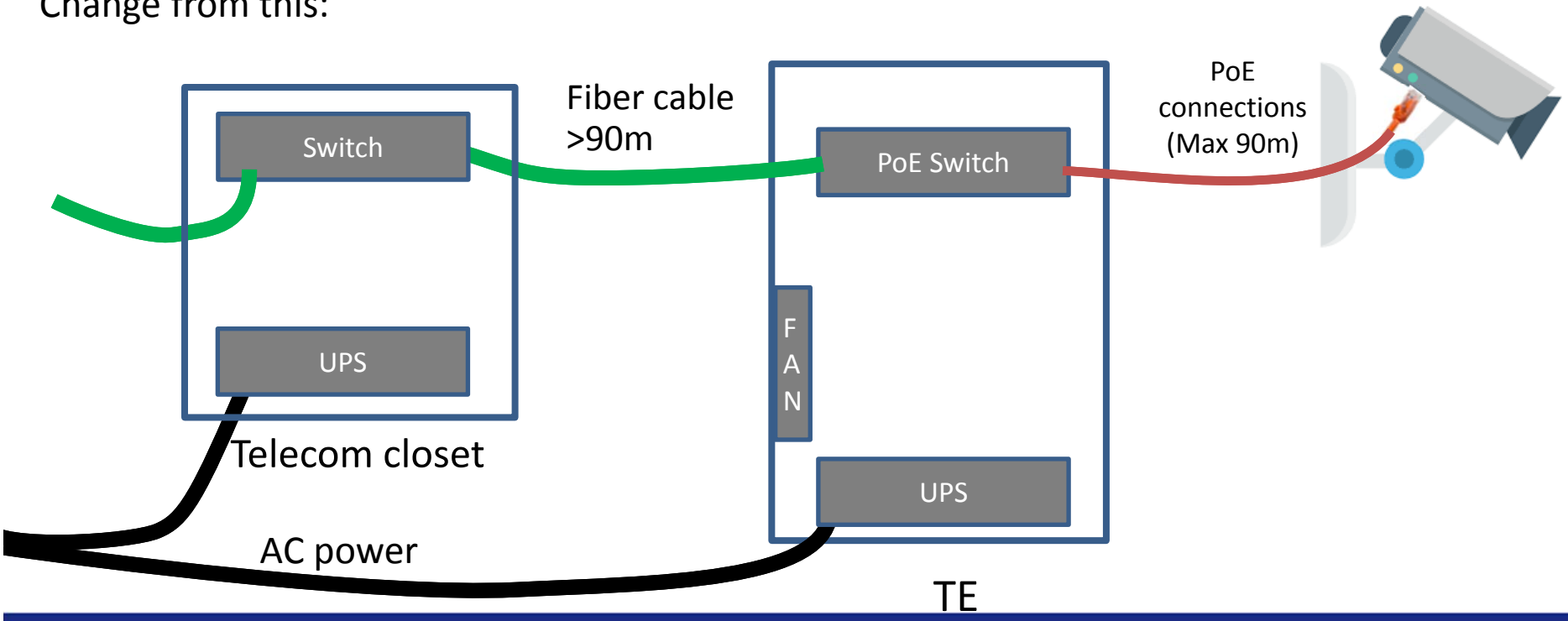
- TEs provide data and power spanning 90m radius
- PoE provides network and power connections
- Requires floor/wall space, heating/cooling, security
- Can be costly

Option B – PoE Extenders

Requires fiber backhaul and DC power – hybrid cable to DC powered media converters

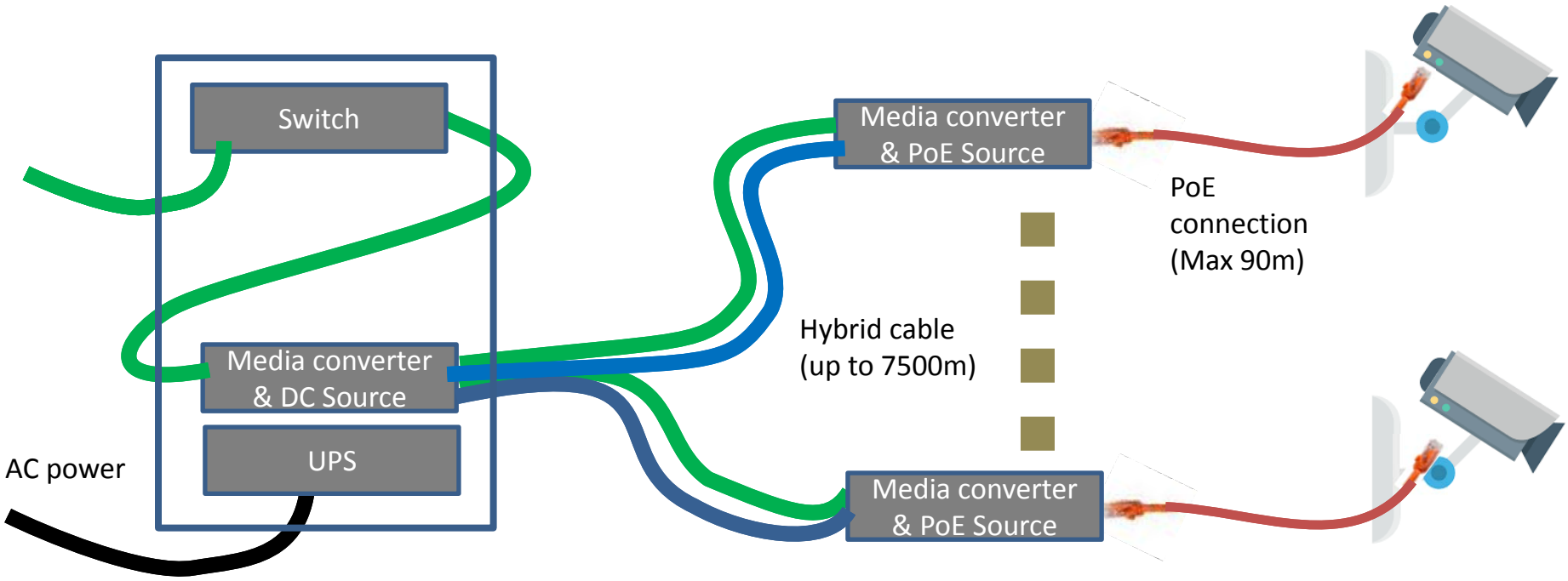
Option B - PoE Extenders

Change from this:



Option B - PoE Extenders

To this:



AC power

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?

Image source: fiberc.com

Option B - PoE Extenders

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

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

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

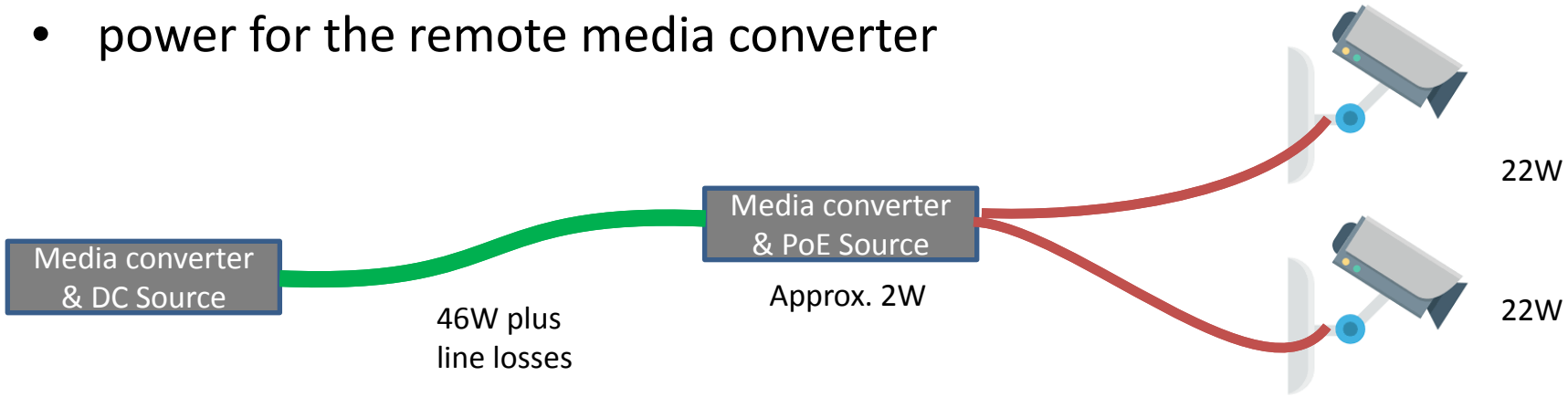
Are the remote fiber to copper media converters, PoE injectors able to withstand a harsh environment?

Image source: fiberc.com

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



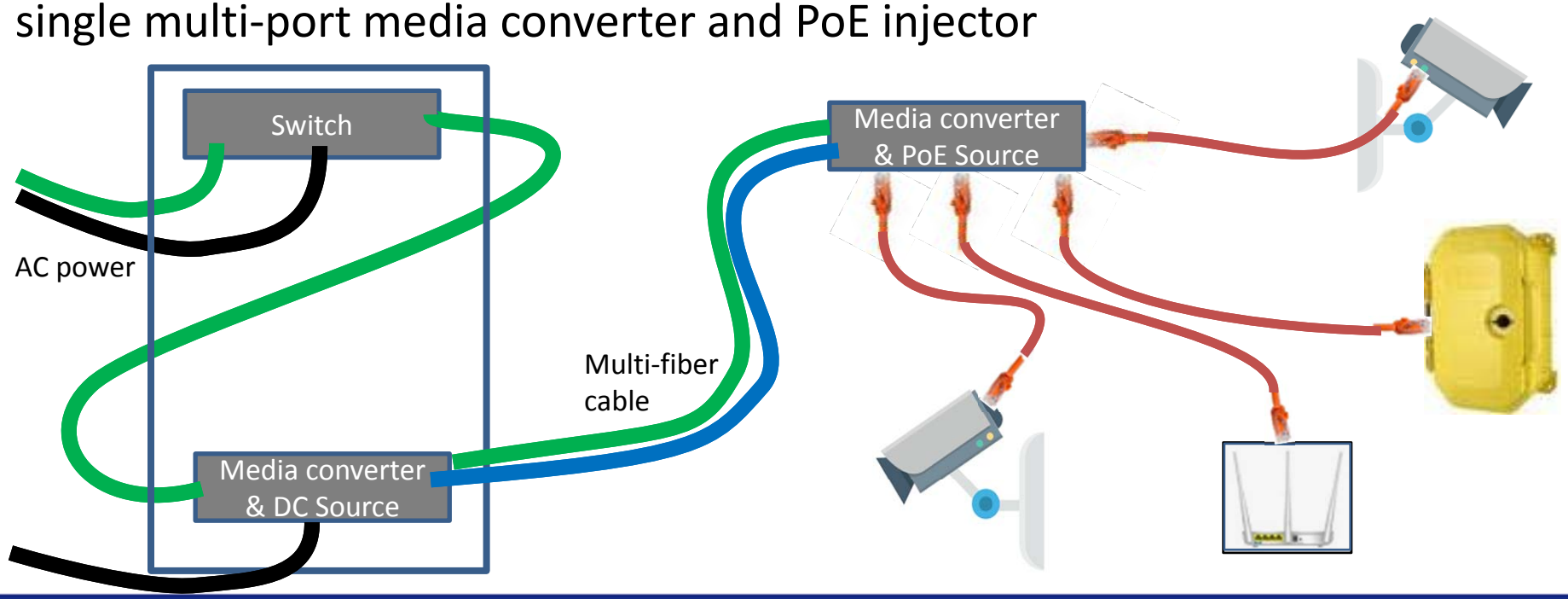
PoE Power/Distance Limitations

Power Distance Limits	When mated with compatible Source Unit	Cable with 4X 12awg conductors				Cable with 2X 12awg conductors				Cable with 2X 18awg conductors				
		<20m Cords at remote		up to 90m cords at remote		<20m Cords at remote		up to 90m cords at remote		<20m Cords at remote		up to 90m cords at remote		
Remote Configuration	P/Ns	Claim max (m)	(ft)	Claim max (m)	(ft)	Claim max (m)	(ft)	Claim max (m)	(ft)	Claim max (m)	(ft)	Claim max (m)	(ft)	
1 port PoE (tri spd)	GR10xPSyL0B-001 81000576	5340	17515	4750	15580	2670	8750	2	8200	660	2165	600	1968	x
1 Port Industrial PoE w/Vboost	GR10xPSyC0S-001			7500	24600			3	12300			950	3116	x
1 port poE+ (tri spd)	GR10xPPyL0B-001 81000218/579 81000381/580	1470	4822	1100	3608	730	2394		2132	180	590	165	541	x
1 Port Industrial PoE+ w/Vboost	GR10xPPyC0S-001			2500	8200				4100			300	984	x
1 port PoE++ (tri spd)	GR10xPHyL0B-001 81000462/581 81000545/582	760	2493	650	2132	380	1246	310	1017	90	295	85	279	x
1 Port Industrial PoE++ w/Vboost	GR10xPHyC0S-001			1300	4264			650	2132			155	508	x
2 port PoE (tri spd)	GR20xPSyB0B-001	2670	8756	2220	7282	1330	4362	1110	3641	330	1082	270	886	x
2 port poE+ (tri spd)	GR20xPPyB0B-001	730	2394	600	968	360	1181	300	984	90	295	70	230	x
4 port PoE (tri Spd)	GR40xPSyM0B-001 81000572 81000586	1330	4362	1200	3936	660	2165	600	1968	160	525	150	492	x
4 port PoE+ (tri spd)	GR40xPPyM0B-001 81000177 81000415	360	1181	320	1050	180	590	165	541	40	131	40	131	x
4 port PoE+ (tri spd) Dual Class 2 Power Input	GR40xPPYD0B-002 In development	360	1181	300	984	NA	NA	NA	NA	NA	NA	NA	NA	x
6 port PoE (tri spd)	GR60xPSyM0B-001	890	2919	800	2624	440	1443	400	1312	110	361	100	328	x
6 port PoE+ (tri spd)	GR60xPPyM0B-001	240	787	200	656	120	394	100	328	30	98	25	82	x

Exceeds class 2 circuit power levels

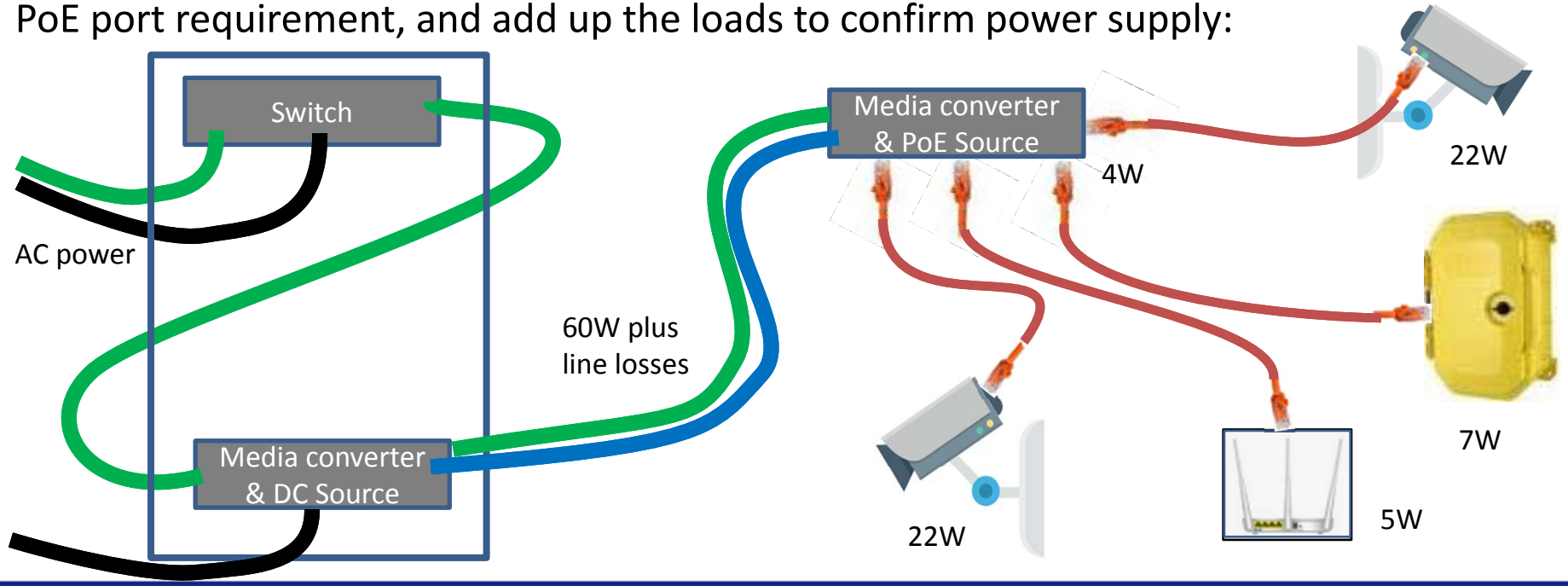
Option B - PoE Extenders

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:



PoE Power/Distance Limitations

Power Distance Limits	When mated with compatible Source Unit	Cable with 4X 12awg conductors				Cable with 2X 12awg conductors				Cable with 2X 18awg conductors				
		<20m Cords at remote		up to 90m cords at remote		<20m Cords at remote		up to 90m cords at remote		<20m Cords at remote		up to 90m cords at remote		
Remote Configuration	P/Ns	Claim max (m)	(ft)	Claim max (m)	(ft)	Claim max (m)	(ft)	Claim max (m)	(ft)	Claim max (m)	(ft)	Claim max (m)	(ft)	
1 port PoE (tri spd)	GR10xPSyL0B-001 81000576	5340	17515	4750	15580	2670	8750	2500	8200	660	2165	600	1968	x
1 Port Industrial PoE w/Vboost	GR10xPSyC0S-001			7500	24600			3750	12300			950	3116	x
1 port poE+ (tri spd)	GR10xPPyL0B-001 81000218/579 81000381/580	1470	4822	1100	3608	730	2394	650	2132	180	590	165	541	x
1 Port Industrial PoE+ w/Vboost	GR10xPPyC0S-001			2500	8200				4100			300	984	x
1 port PoE++ (tri spd)	GR10xPHyL0B-001 81000462/581 81000545/582	760	2493	650	2132	380	1246		1017	90	295	85	279	x
1 Port Industrial PoE++ w/Vboost	GR10xPHyC0S-001			1300	4264				2132			155	508	x
2 port PoE (tri spd)	GR20xPSyB0B-001	2670	8756	2220	7282	1330	4362	1110	3641	330	1082	270	886	x
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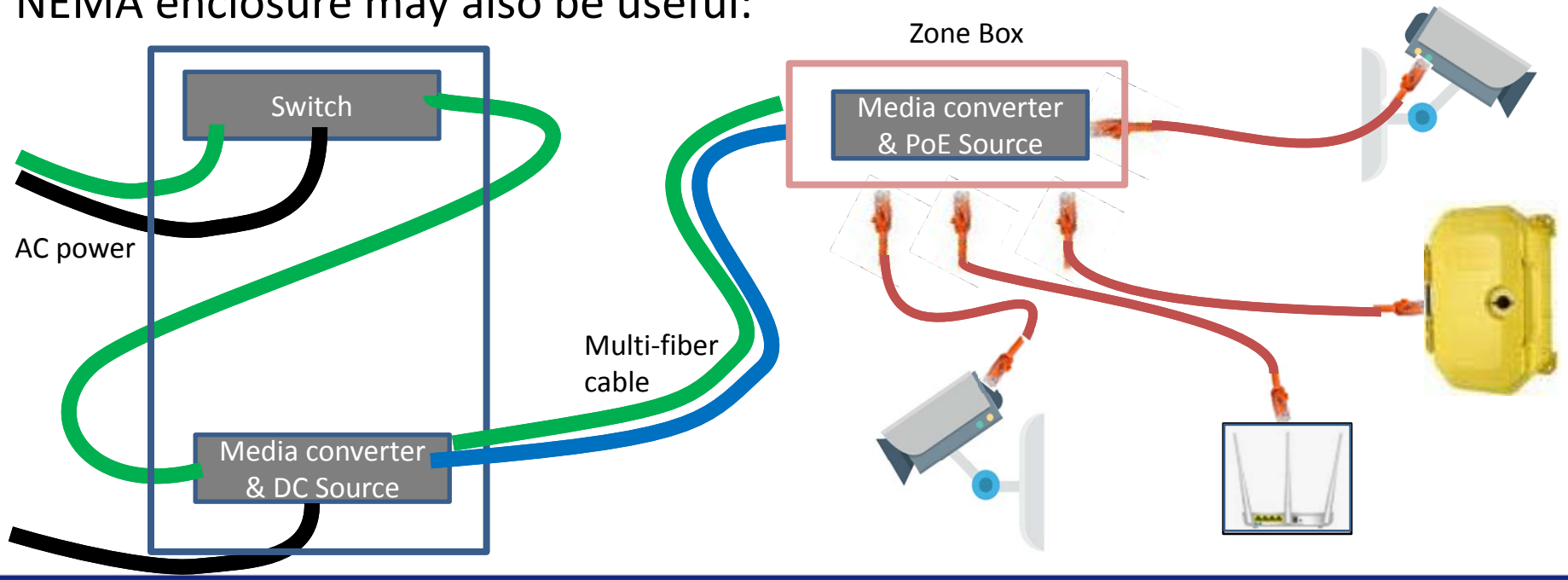
6 port PoE+ (tri spd)	GR60xPPyM0B-001	240	787	200	656	120	394	100	328	30	98	25	82	x

Exceeds class 2 circuit power levels

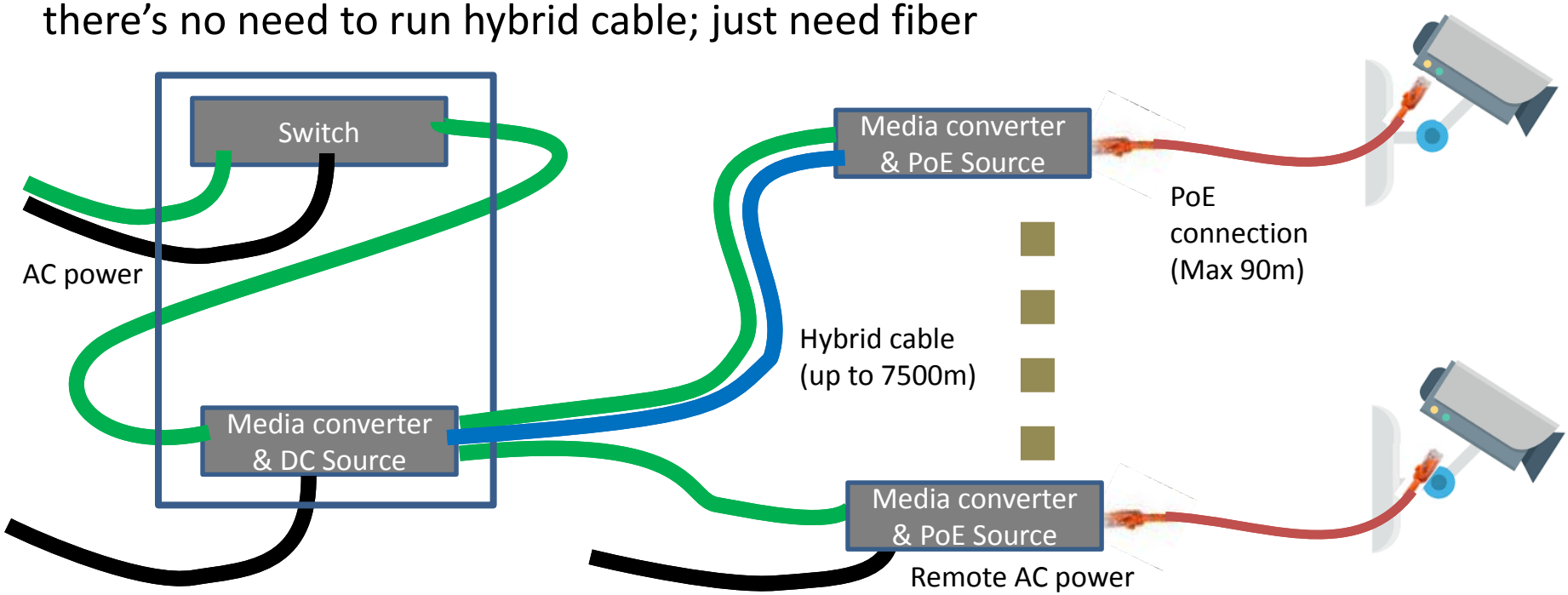
Option B - PoE Extenders

A connectorized Zone Box using a small ceiling or wall mount NEMA enclosure may also be useful:



Option B - PoE Extenders

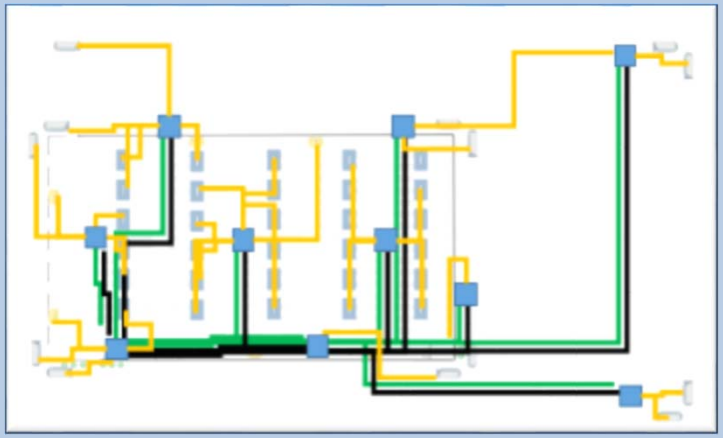
In some situations, reliable remote power is already available and there's no need to run hybrid cable; just need fiber



Option B - PoE Extenders

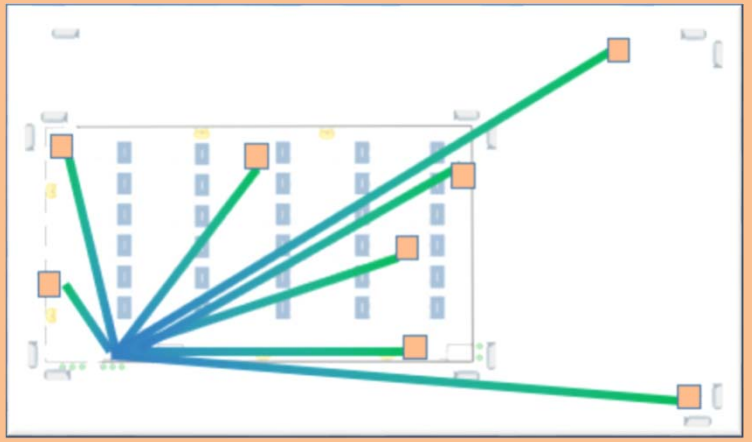
- Use PoE Extenders rated for harsh environments
- Use redundant power source to deliver reliable DC power
- Use hybrid cables where needed
- Use connectorized zone boxes to simplify installation

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!

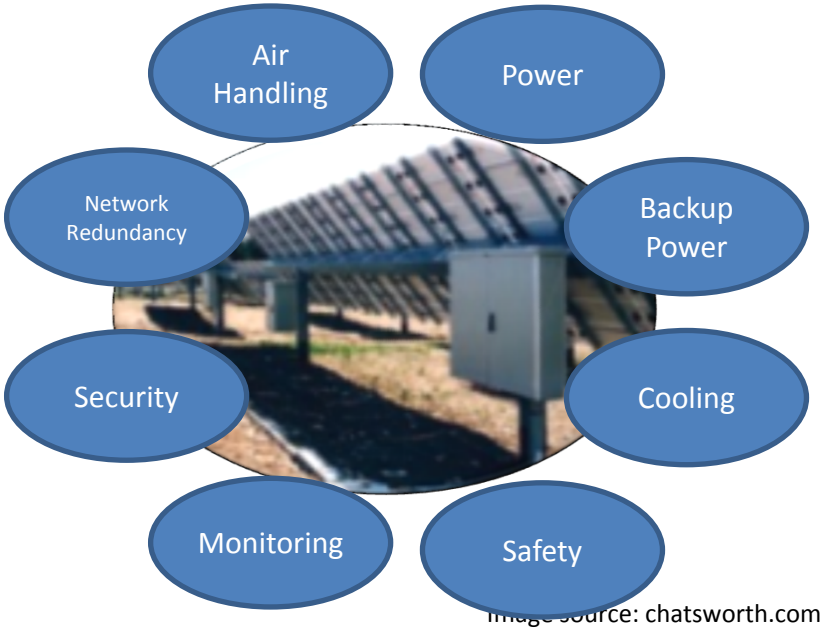
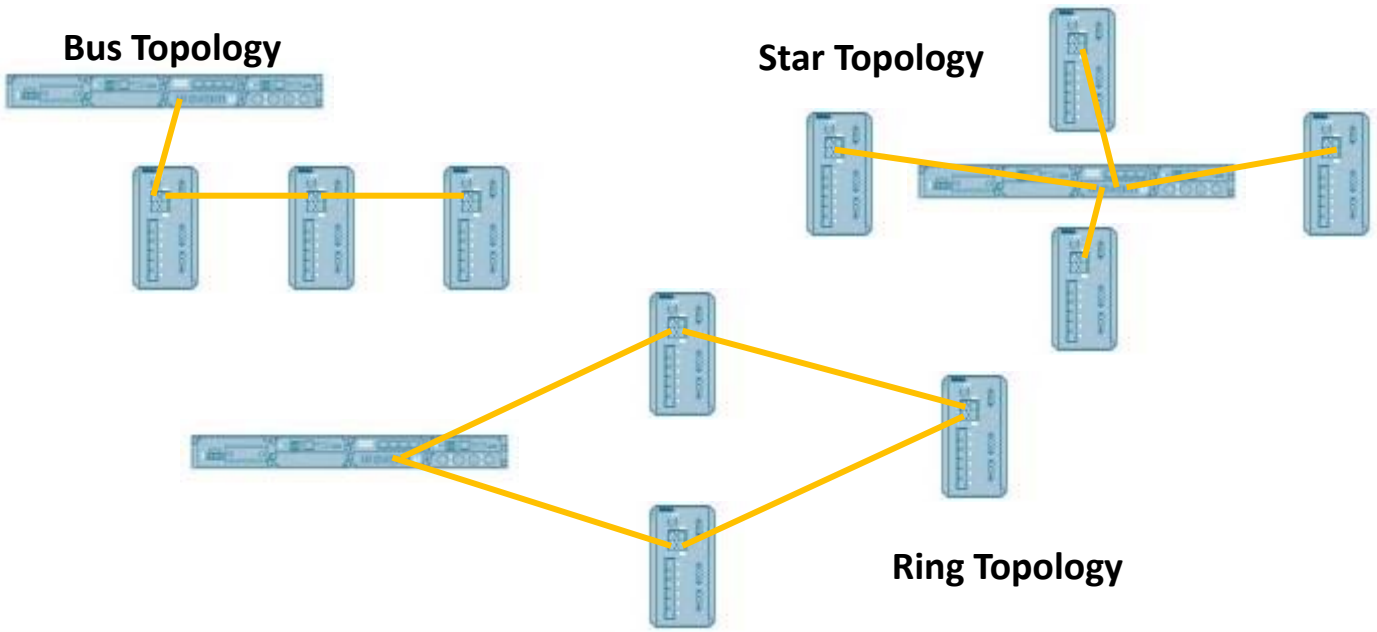


Image source: chatsworth.com

Network Redundancy

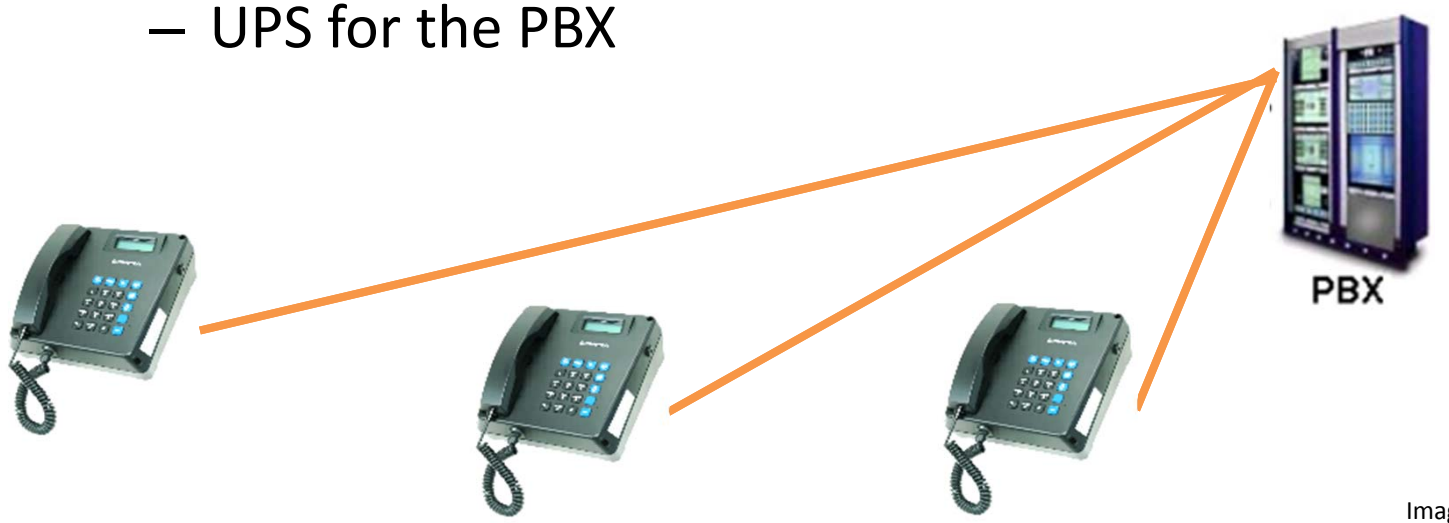
PoE can take advantage of flexible IP Network Topologies



Network Redundancy

Consider a simple star network for VOIP telephony:

- Direct PoE network connection to each phone
- UPS for the PBX



PBX with UPS directly connected to each phone

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

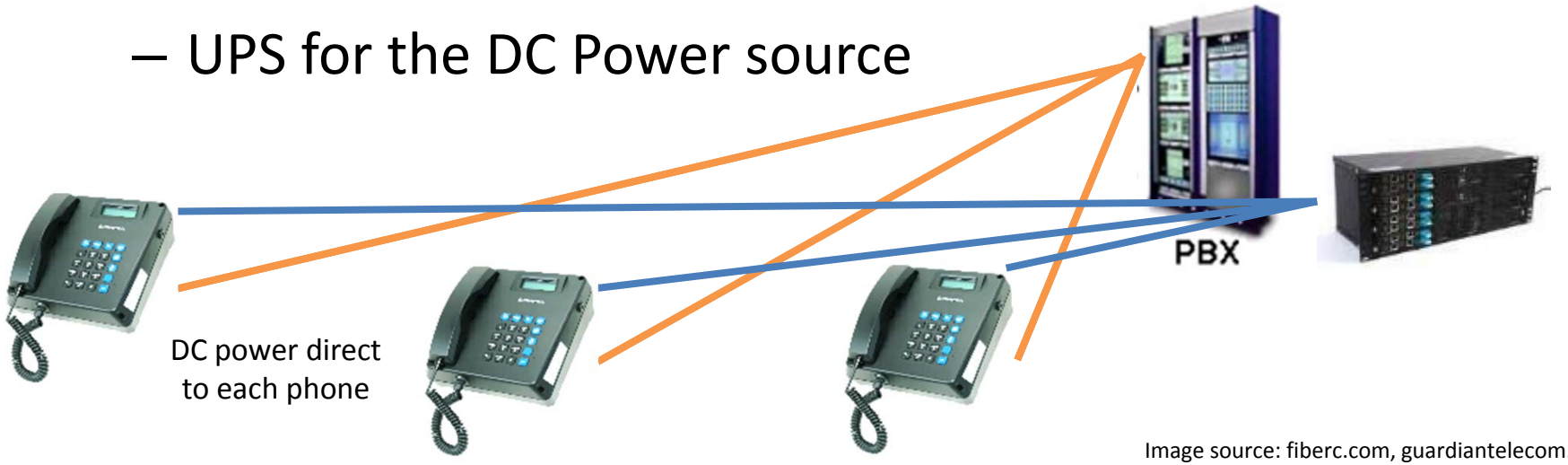


Image source: fiberc.com, guardiantelecom.com

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

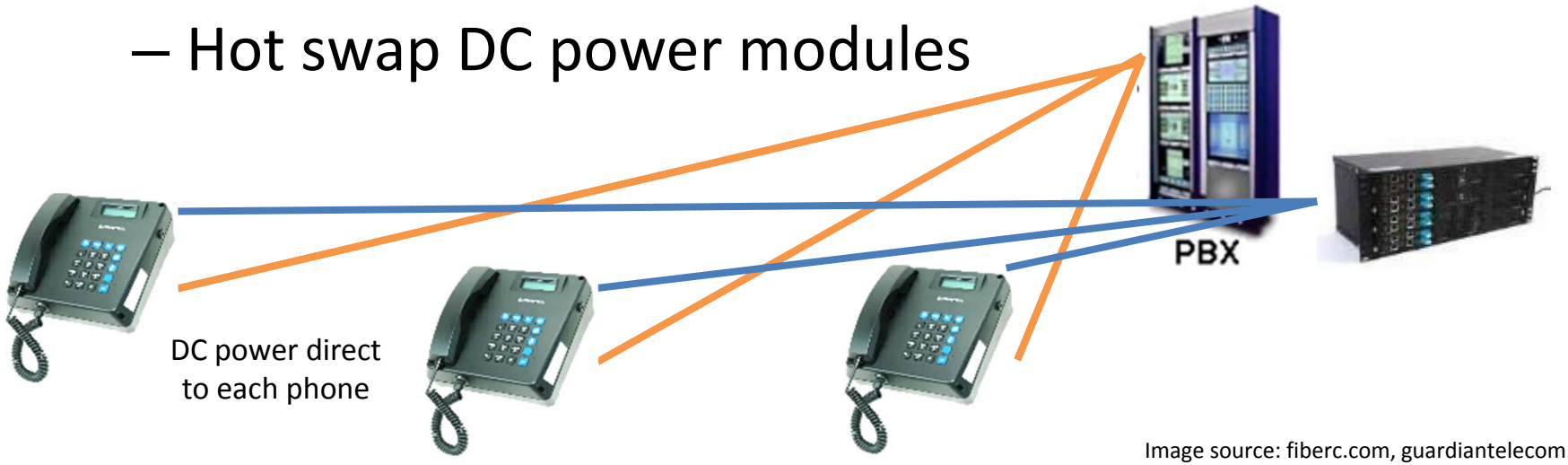


Image source: fiberc.com, guardiantelecom.com

Power Redundancy

Bus topology can reduce wiring complexity:

- DC power bus to the phones, or local adaptor(s)

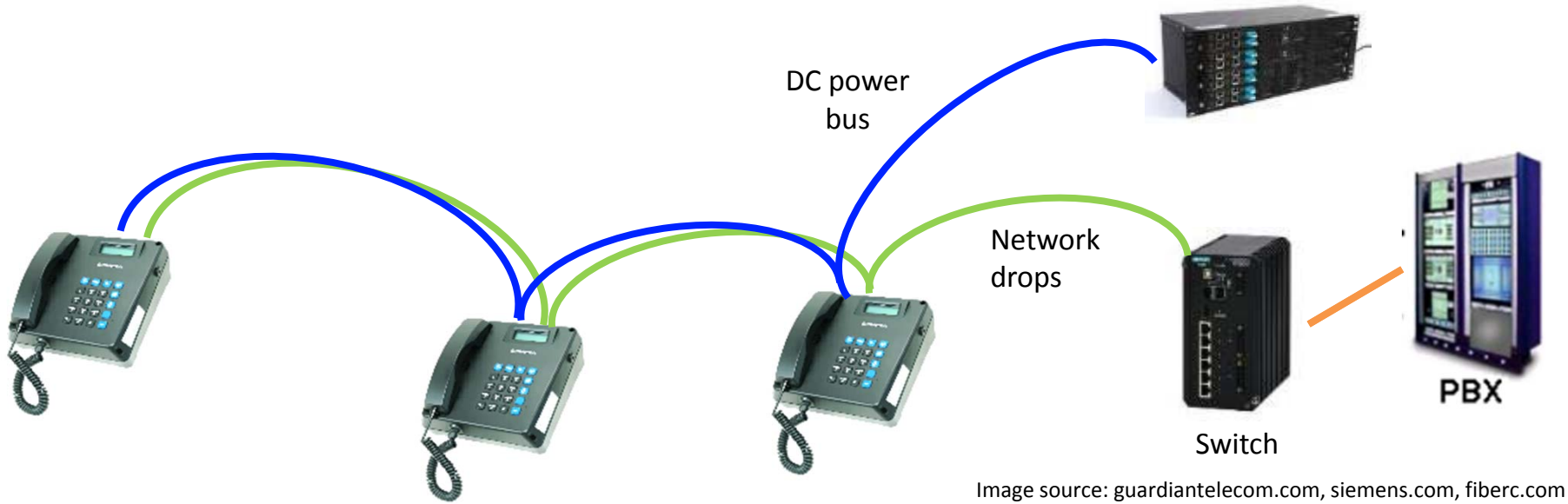


Image source: guardiantelecom.com, siemens.com, fiberc.com

Network Redundancy

Path redundancy improves field reliability:

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- Redundant network paths

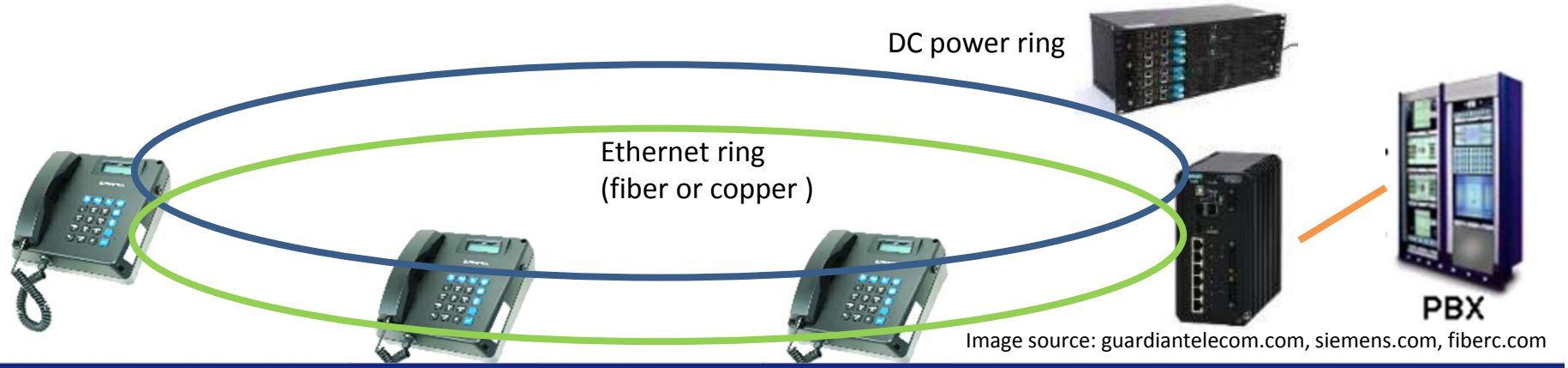


Image source: guardiantelecom.com, siemens.com, fiberc.com

Heating & Cooling

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

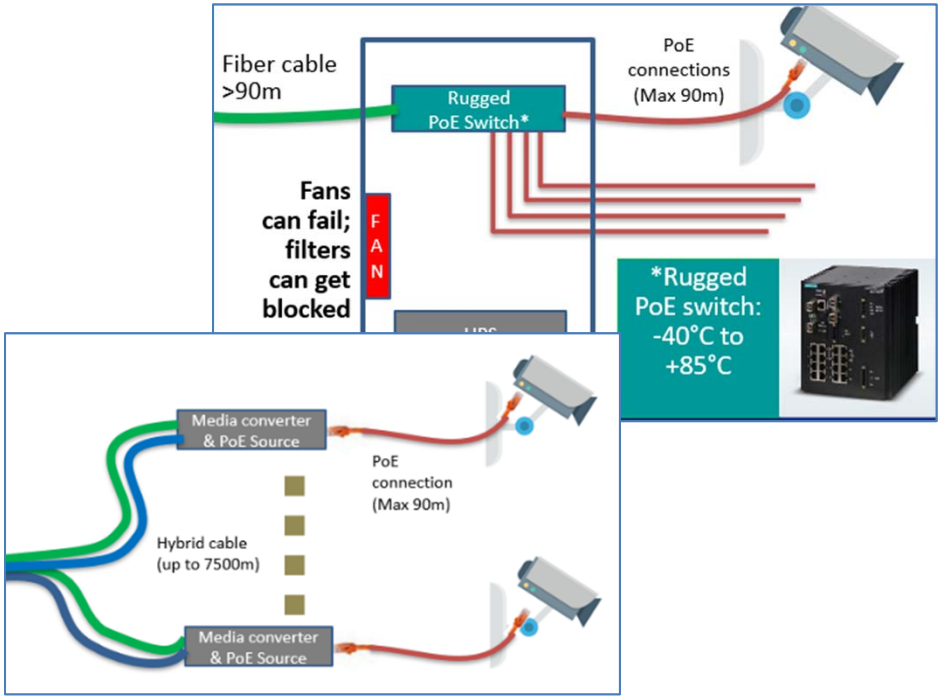


Image source: guardiantelecom.com

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

Heating & Cooling

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.

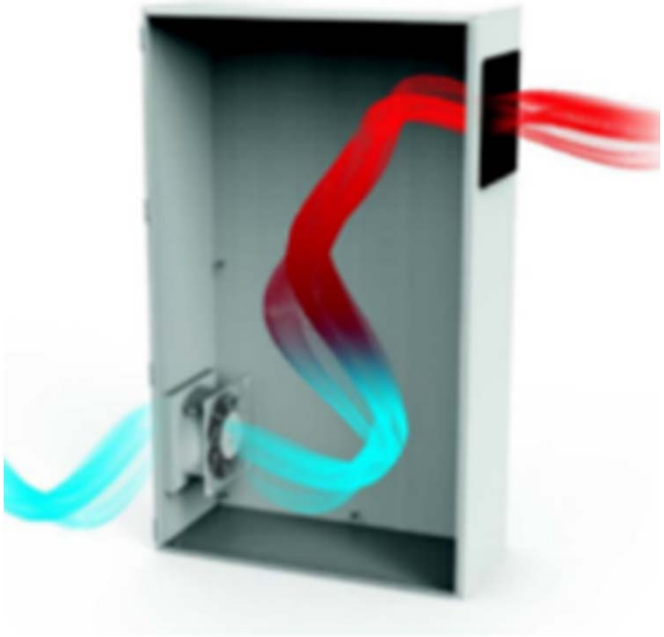


Image source: chatsworth.com

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.

Image source: chatsworth.com

Security

- Physical security
  - Door locks, sensors
  - Audit trail, secure networks?
  - Remote locations, no network?
- Cyber Security
  - Rugged router, intrusion detection, etc.

Image source: sera4.com

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!

	Pros	Cons
Physical keys	Simple	Expensive to manage, easy to share keys, no audit trail
CatX-connected door locks	Audit trail	Easy to hack, easy to share RFID cards, difficult to extend network
Fiber-connected door locks	Audit trail	Easy to share RFID cards, difficult to extend network
Off-network door locks	Simple, audit trail, impossible to hack	Needs smart phone

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

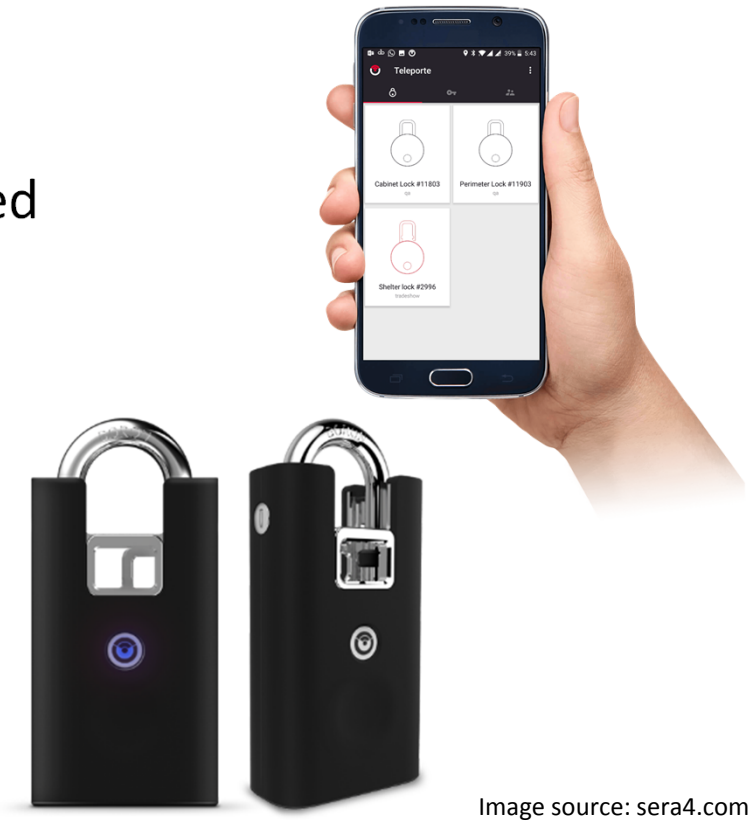


Image source: sera4.com

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

Image source: sera4.com

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

Image source: protalk.com

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

Image source: chatsworth.com

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

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Thank You!

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