How You Can Optimize Passive Optical LAN Through Structured Cabling

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Passive optical LAN (POLAN) architecture differs significantly from traditional switch-based LANs, causing many to question how a POLAN may fit into existing cabling standards for commercial buildings.

But several attractive benefits have helped POLANs gain traction as an alternative to traditional switch-based Ethernet LANs:

- Space savings (80% space savings)
- Lower installation costs (between 40% and 50% less)
- Reduced power consumption (up to 60% less power utilization)
- Greater inherent security (immune to electromagnetic interference and difficult to tap)
- Increased fiber optic cabling distances

While still considered an emerging technology, POLAN acceptance is being driven by industry standards endorsement, ongoing product development and proven installed performance.

Further driving adoption is the fact that POLAN technology can be integrated into structured cabling to overcome concerns about its ability to support traditional Ethernet protocols and network applications such as Power over Ethernet (PoE).

What is a POLAN?

A POLAN is a point-to-multipoint LAN architecture that uses optical splitters to split an optical signal from one strand of singlemode optical fiber into multiple signals to serve users and end devices. Rather than using active switches connected on a multi-link system via fiber backbone cabling and copper horizontal cables to each network device, a POLAN originates at an optical line terminal (OLT) in the main equipment room. Downstream passive optical splitters then split the signal from one singlemode fiber into multiple singlemode fibers that connect to optical network terminals (ONTs) located at work areas (offices, patient rooms, guestrooms, etc.).

Upstream, signals are combined back to one singlemode fiber, enabling bidirectional communication. The optical signals are transmitted simultaneously in both directions using wavelength division multiplexing (WDM) technology that combines multiple signals over a single fiber using different wavelengths. Downstream signals are transmitted at the 1490 nm wavelength and upstream signals at 1310 nm.

Based on bandwidth needs, optical loss budget, density and redundancy, optical splitters are available in several split ratios: 1:8, 1:16, 1:32, 2:8, 2:16 and 2:32. Splitters with lower split ratios offer higher bandwidth per user; splitters with two inputs support redundancy.

At the work area, ONTs convert the optical signal to gigabit Ethernet twisted-pair copper outputs (1000BASE-T). Category 6 copper patch cords connect a variety of IP-based devices:

- Computers
- VoIP phones
- Printers
- Wireless access points
- IP cameras
- Other network devices

Powered locally or remotely, ONTs incorporate PoE for VoIP phones, wireless access points and other PoE-enabled devices. POLANs support the same applications as traditional switched-based LANs:

- End-to-end IEEE 802.3 Ethernet interfaces for voice, data, video, Wi-Fi and security
- Up to 1000 megabits per second (10/100/1000BASE-T) bandwidth per user/device
- PoE, both IEEE 802.3af (15.4W) and IEEE 802.3at PoE+ (25.6W)
- Advanced Quality of Service (QoS) to prioritize traffic and deliver Virtual LAN (VLAN) support

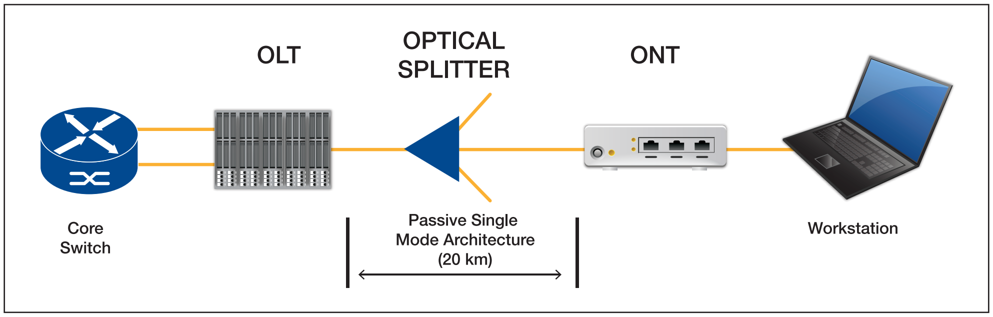

Figure 1: Basic components of a POLAN (Source: APOLANglobal.org)

Deploying a POLAN

POLANs are often deployed in a zone configuration: each ONT serves multiple users. The ONTs are located near users, often placed in an enclosure or above-ceiling zone box. Individual ONTs may also be placed at the work area to serve single users (often small, 2-port versions mounted under the desk or in the wall).

Larger 24-port rack-mounted ONTs can reside within a telecommunications room (TR) and connect up to 90 m of Category 6 twisted-pair copper cabling out to work areas, much like a workgroup switch in a typical LAN. ONTs placed in the TR could serve an entire floor or connect wireless access points, cameras or other IP-based devices.

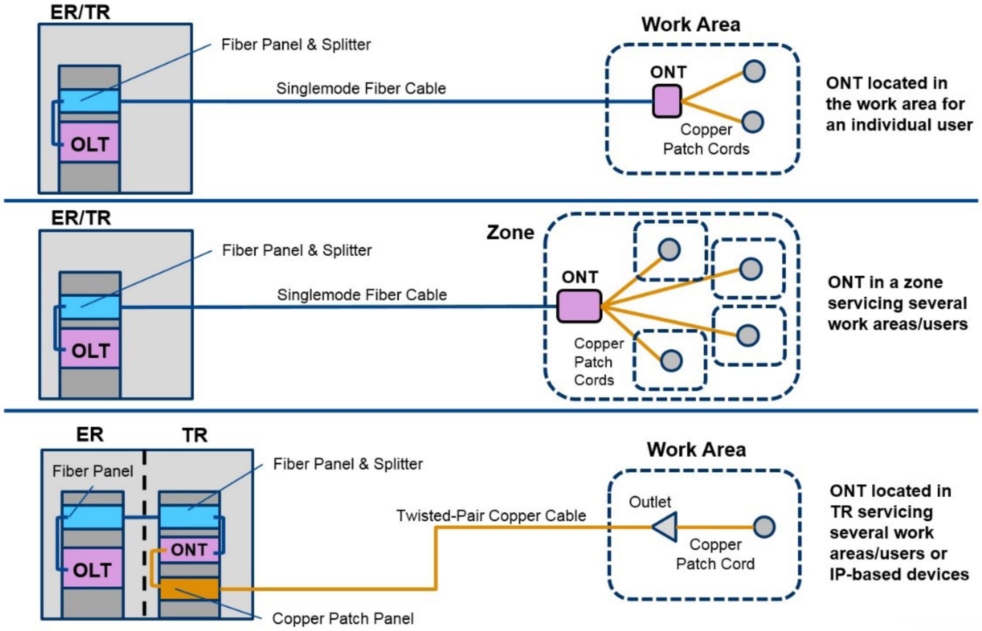

Figure 2: Examples of POLAN topologies

The Benefits of a POLAN

A POLAN infrastructure can bring many advantages to commercial buildings in order to reduce operating costs, save time and resources, maximize space, keep data secure and accommodate longer cabling distances.

Reduced power and cooling
The cable plant to support a POLAN between the OLT in the main equipment room and the ONTs at the work area requires passive components, including fiber optic cabling and passive splitters. The splitters serve the same purpose as a switch, but require no power or cooling. As a result, up to 60% less power consumption is achieved with a POLAN than a traditional LAN, increasing energy efficiency and lowering operating costs.

Less time spent on maintenance
Fewer active electronics reduces maintenance, troubleshooting and installation time, and also requires less space in TRs. Installation savings can be up to 20% on equipment installation, and up to 40% for the cabling plant.

Significant space savings
Singlemode fibers offer a small diameter, reducing required pathway space and material while helping installation move faster. POLANs provide up to 80% pathway space savings over traditional LANs.

Greater distances
Standards limit the distance of horizontal copper cabling to each end device to 100 m in a traditional switch-based LAN. Because a POLAN uses bandwidth-intensive singlemode fiber cabling with the furthest available transmission distances, ONTs can be located up to 12 miles (20 km) from the OLT.

Inherent security
Immune to electromagnetic interference and more difficult to tap than copper cabling, the fiber optic cable plant of a POLAN is also inherently more secure.

Traditional LAN

Active Ethernet switches for LAN core, aggregation and access functions

Cable infrastructure per service
- Category cabling
- Coaxial cabling
- Multimode fiber cabling

Passive Optical LAN

Passive optical network (PON)
- Optical line terminal (OLT)
- Passive optical splitters
- Optical network terminations (ONT)

Single mode fiber converges all building ICT services over single infrastructure

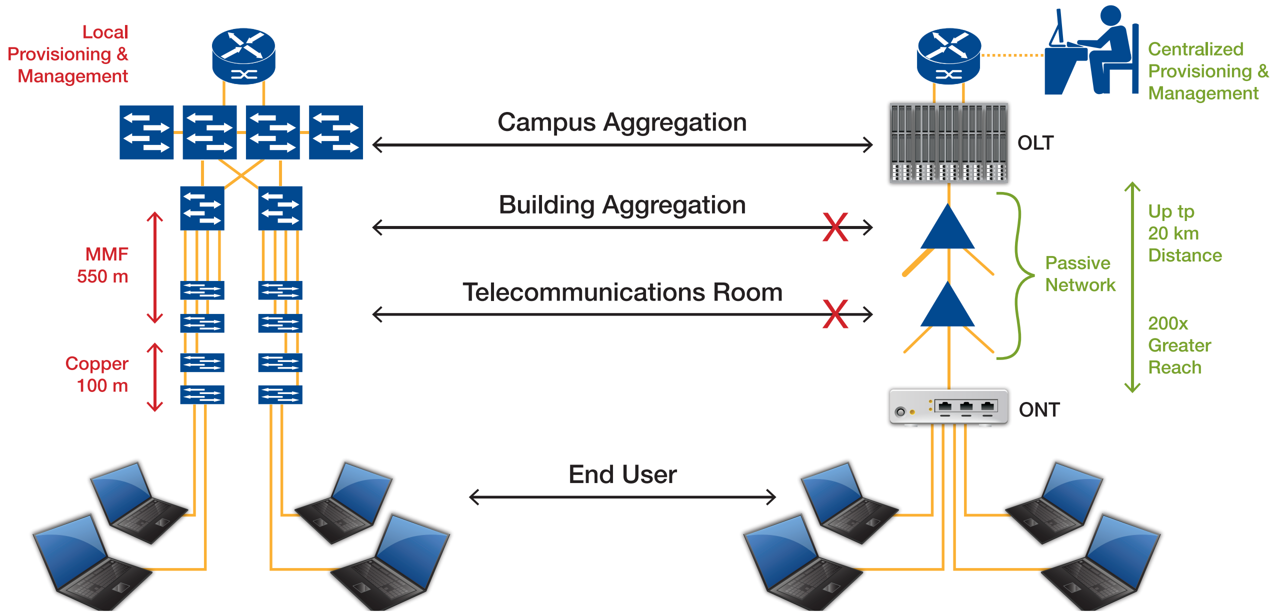

Figure 3: POLAN vs. Traditional Switched-based LAN (Source: APOLANglobal.org)

Where POLAN Can Be Used

From enterprise and hospitality to education and healthcare environments, POLAN is suited for large multi-user venues with limited space to support traditional switched-based LANs. Large environments that cannot support the 100 m distance limitation of a traditional switch-based LAN are also viable POLAN candidates.

Case in point: a hotel. Large hotels provide network access in each guestroom to support VoIP phones, IPTVs, wireless access points and wired connections for guests. Depending on its size, there may be 3,000+ guestrooms to connect in a limited amount of space. Deploying TRs with power and cooling for active equipment to serve each hotel room within the 100 m distance limitation isn't always feasible – and that's where the benefits of a POLAN come into play.

Splitters can be housed in much smaller, mini TRs placed in an enclosure or a wall-mounted panel without power and cooling. Splitters can even be housed alongside the OLT in the main equipment room with longer singlemode fiber distribution cables to ONTs in each room, eliminating additional telecommunications space requirements.

Delivering access to multiple users despite limited pathway space, these environments can count on a POLAN infrastructure to lessen installation time and reduce operating costs:

- Hotels
- Sport venues
- Dormitories
- Conference centers
- Hospitals
- Campus buildings

Industry Standards for POLANs

While POLANs have recently grown in popularity, especially among government entities, commercial adoption is limited. Many believed that POLANs could not support traditional Ethernet protocols and network applications. Several of these myths have been dispelled, but some concern remains surrounding standards compliance, flexibility, scalability and redundancy.

The biggest concern for many stems from comfort with the existing installed base of structured cabling and the standards supporting it. ANSI/TIA standards for commercial buildings have recommended generic structured cabling infrastructure that supports a multiproduct, multivendor environment using a hierarchical star topology. This allows network equipment and devices to be connected and disconnected without disrupting the network.

A standards-based structured cabling system for a LAN encompasses:

- Backbone cabling between telecommunications spaces
- Horizontal cabling between telecommunications spaces and outlets at the work area
- TRs for connecting horizontal and backbone cabling systems
- Work area outlets for connecting end devices

TIA standards cover the following provisions, which need to be examined in detail when deploying POLANs:

- There must be at least one TR located on the same floor of the work area outlets it serves
- Each TR should be cabled via backbone cabling to a main cross-connect in the main equipment room
- Each work area outlet should be cabled via horizontal cabling to a horizontal cross-connect in the TR
- No more than one consolidation point can exist within the horizontal cabling system
- A minimum of two telecommunications outlets are required per work area
- Application-specific devices, such as ONTs, need to be external to the wall outlet

Of these requirements, the deployment of connection points within the POLAN infrastructure offers the greatest flexibility by allowing network moves, adds and changes (MACs) with minimal disruption.

TIA standards recommend connection points at patching areas for horizontal and backbone cabling systems because they permit quick, easy changes using patch cords while critical equipment and permanent links remain intact to avoid service disruption. Connection points also improve troubleshooting and the ability to rearrange individual network connections, as well as maintain proper administration at a single location.

TIA is in the process of establishing POLAN design, deployment and performance requirements and recommendations, with the goal of integrating POLAN with existing structured cabling best practices (including the use of connection points). Not only will TIA endorsement accelerate POLAN product development, but it will also increase adoption.

Deploying POLAN Over Standards-Compliant Structured Cabling

Many POLANs have been successfully deployed using direct point-to-multipoint architectures where singlemode fiber connects directly from the OLT to the splitter, and from the splitter to the ONTs. There is, however, another option: Deploying these systems over a standards-compliant structured cabling system significantly improves POLAN flexibility and eliminates performance concerns by:

- Maintaining physical separation between POLAN components
- Enabling easier equipment change-outs and upgrades
- Facilitating MACs with minimal service disruption
- Allowing for enhanced labeling and administration
- Providing better support for establishing back-up or redundant connections

Depending on the topology, deploying a POLAN over structured cabling involves adding connection points between the OLT and splitters, and between splitters and ONTs. This is accomplished by simply incorporating fiber patch panels at the ONT in the main equipment room, and another at the splitter in the TR. An additional fiber patch panel placed between the splitter and ONT serves as fiber distribution to the work areas.

If splitters are located in the main equipment room alongside the OLT, one of the fiber panels between the OLT and splitter is typically eliminated.

Optional consolidation points can also be placed within the horizontal fiber distribution to optimize zone configurations.

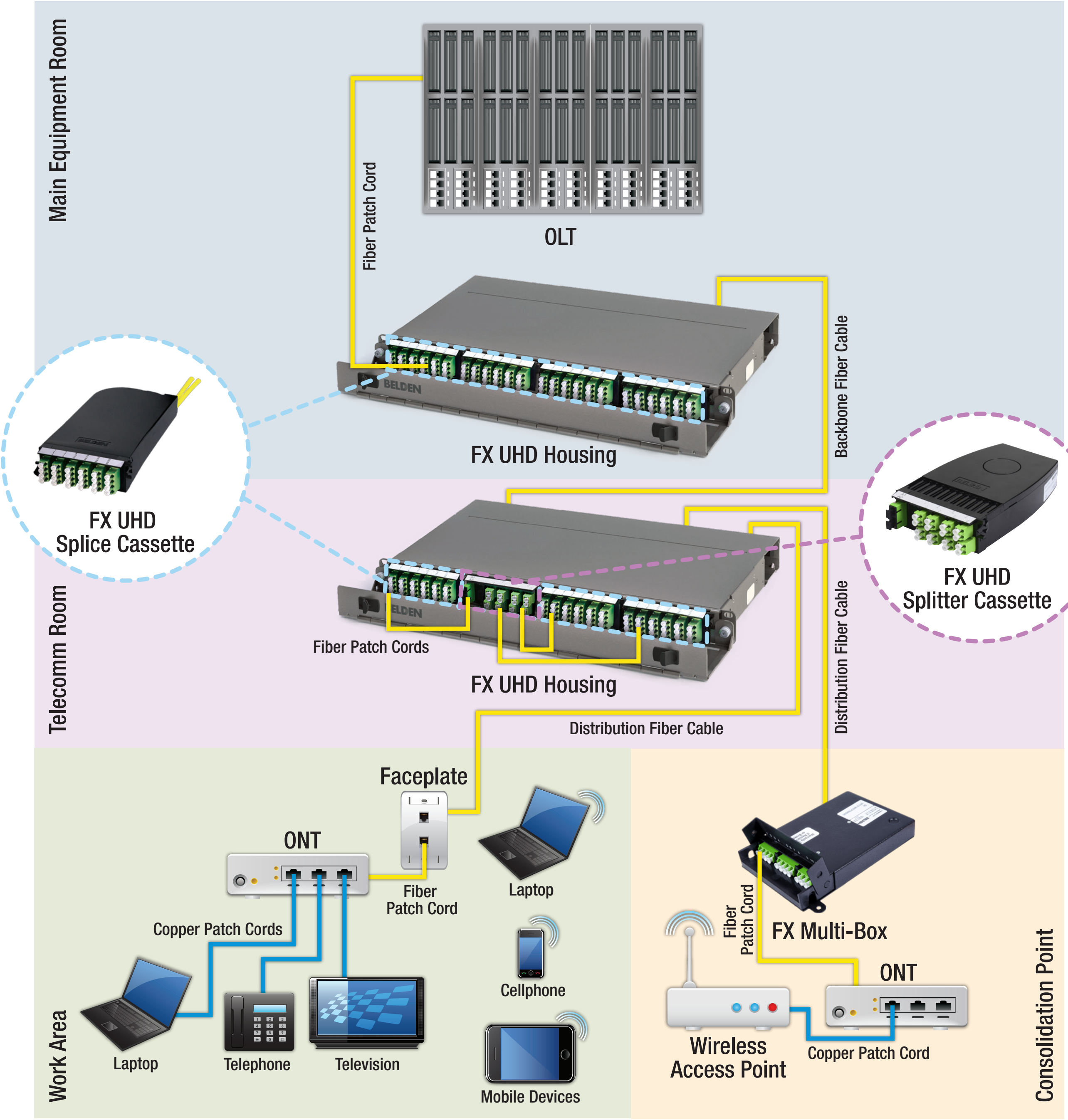

Figure 4: Belden POLAN Solution configuration example and main components

Using the structured cabling approach allows individual OLT ports to be designated to any splitter by reconfiguring patch cords. Singlemode fibers from the splitter can be designated for any ONT with fiber patch cords from the splitter to the fiber distribution panel. This facilitates faster MACs, as well as easier troubleshooting, maintenance and upgrades.

It also supports backup/redundant connections. For instance, if a permanent backbone fiber is damaged, a simple patch cord move connects an OLT port to another backbone fiber.

Connection points also provide a point of administration where individual ports can be adequately labeled per TIA-606-A labeling standards to clearly identify the start and end of each connection.

While some deployments place multiple splitters out in the open environment, deploying a POLAN over standards-compliant structured cabling houses splitters in a TR or mini TR (enclosure or wall-mount cabinet). This offers a more centralized location, as well as better splitter protection.

Delivering Remote Power

ONTs require power to convert optical signals to copper twisted-pair outputs, and to support PoE applications.

While ONTs can be powered locally via AC power connections, this has been another factor limiting adoption. Traditional switched-based LAN deployments allow delivery of remote power capabilities over the same copper horizontal cable used for transmitting data signals, which is highly valued for supporting PoE applications and eliminating the need for AC power connections at every work area outlet. (For example, if a call center work area needs to support VoIP phones, a traditional switched-based network can transmit the power and voice signal over a single Category 5e or Category 6 cable. In a POLAN, the ONT requires some additional method of receiving power since it cannot be delivered over the fiber optic cable.)

An option for overcoming this challenge is to use a composite fiber/copper cable for distribution to the ONT. A power distribution unit located near the splitter injects low-voltage DC power over the cable's copper conductors. At the ONT, the composite cable breaks out to connect the fiber to the ONT for information transfer, and the copper conductors to the ONT for providing power (see Figure 5).

Only one singlemode fiber is required to connect to the ONT, but cables with a duplex fiber offer a higher level of redundancy, as well as support for alternative protocols that may require a duplex fiber for transmitting and receiving data.

Moreover, while only a two-conductor copper cable is required for delivering power to the ONT, a composite copper/fiber cable that includes a 4-pair Category 6 cable with eight 23 AWG conductors offers futureproofing benefits.

Unlike a two-conductor cable, a Category 6 cable delivers more power over greater distances to the ONT to support emerging PoE Type 3 (60W) applications. Category 6 cable can also provide network access for alternative protocols, such as traditional switch-based Ethernet, if ever needed in the future.

To compare the difference between using a cable with two 22 AWG conductors versus a Category 6 cable, see Table 1 (below). Supporting PoE Type 3 to just 44 m renders a two-conductor cable impractical for virtually any POLAN deployment that may need support future PoE applications.

To adequately support PoE Type 3 using a two-conductor cable, conductor size would need to increase to 18 or 16 AWG, which is costly and does not support other applications.

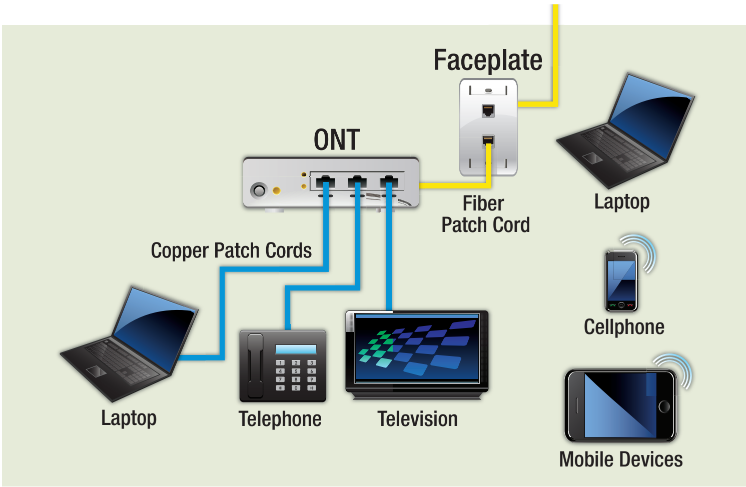

Figure 5: Delivering remote power to ONTs with composite copper/fiber cable. The copper and duplex fiber can terminate to a wall outlet, and connect to the ONT via patch cords.

Cable Type	Number of Conductors	PoE Type 1 (15W) Reach	PoE+ Type 2 (30W) Reach	PoE+ Type 3 (60W) Reach
22 AWG	2	128 m	87 m	44 m
Category 6	8	371 m	252 m	126 m

Table 1: PoE support for two-conductor cable vs. Category 6 cable

Belden's POLAN Structured Cabling Solution

Belden's POLAN Structured Cabling Solution

Belden offers high-performance, easy-to-install POLAN components to optimize design, installation, management and scalability over standards-compliant structured cabling, as well as eliminate concerns surrounding this emerging technology. Belden's POLAN solutions include the following components:

- FX UHD Fiber Connectivity System
- FX UHD Splitter Cassettes
- FX Connectivity
- FX Distribution Cables
- FX Composite Cables

Belden also offers a wide range of copper connectivity solutions, including KeyConnect Frames with modular inserts, copper patch cords, faceplates and outlets to facilitate complete end-to-end POLAN deployments.

Download the POLAN Brochure

To learn more about Belden POLAN solutions
call **1.800.BELDEN.1** (1.800.235.3361)
or visit **www.belden.com**