WHITE PAPER

The Advantages of Single Pair Ethernet

The key market drivers and standards shaping the development of Single Pair Ethernet technology.

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With the growth of the internet of things (IoT), machine-to-machine communications, building automation sensors and other emerging communication technologies, there is greater demand for connectivity that can deliver both power and data over longer distances to support these applications. One of the most anticipated technologies to address these trends is Single Pair Ethernet (SPE), which combines reliable, economical, lightweight and space-efficient single pair cabling with Ethernet's non-proprietary protocols for greater interoperability.

HISTORY OF ETHERNET

Ethernet is one of the most widely used protocols for transmitting data between electronic devices. The concept of Ethernet was originally proposed by Bob Metcalf and David Boggs in May 1973 while working at Xerox PARC in Palo Alto, CA. IEEE turned the Ethernet concept into a global standard in 1983 with the publication of IEEE Std. 802.3a™, supporting 10 Mb/s data transmission over coaxial cable. In 1990, IEEE Std. 802.3i™ was developed to support the 10BASE-T application, providing 10 MB/s data transmission over twisted-pair cabling.

Since then, Ethernet use has grown exponentially. Ethernet applications quickly migrated from coaxial to twisted-pair copper cabling to reduce cost and increase transmission speeds. At first only two twisted pairs were used, but this evolved to four pairs to achieve higher data rates. Standards were developed for the design of building cabling systems, especially for the copper cabling that served as the last link between the switches and the Ethernet device. EIA/TIA-568 (1991) and ISO/IEC 11801 Ed.1 (1995) established a maximum reach of 100 meters for twisted-pair copper supporting data rates of up to 100 Mb/s. Eventually these standards evolved to support data rates of 10 Gb/s up to 100 meters, and data rates of 25 Gb/s and 40 Gb/s up to 30 meters.

Recognizing the benefits of transmitting data and power on the same copper cable led to the development of Power over Ethernet (PoE). IEEE Std. 802.3af™ was published in 2003, providing the ability to supply 15.4 watts of power to a remote device. Today, IEEE Std. 802.3bt™ allows for up to 90 watts of power to be supplied to a remote device using all four pairs of a category rated copper cable.

Although the historic progression of Ethernet development for copper cabling has been focused on increasing speed at the expense of distance, the most recent efforts have shifted towards slower speeds at greater distances, using one pair of conductors instead of four. Cabling that supports Ethernet using two conductors twisted together is known as Single Pair Ethernet (SPE).

SINGLE PAIR HISTORY

Single twisted-pair cabling was originally used in the 1870s to interconnect telephones. Rather than having two straight wires side-by-side, the conductors were twisted together to improve the electrical performance. Specifically, the twisting of the conductors provides for the cancellation of unwanted electrical noise from nearby pairs and other sources. Twisting the pairs provides significant improvement in transmission performance for only a minor increase in cable complexity.

Over 150 years later, single twisted-pair cabling is still used to carry both analog and telephony signals. It is also being used in industrial, building automation, and automotive applications. Use of only one pair minimizes the cost, size and weight of the cable and connectors used, and simplifies installation and termination. While the use of single twisted-pair cabling is widespread even outside of telephony, the communication protocols used remain fragmented. PROFIBUS, MOST, CANbus, Modbus, BACnet DALI, and DeviceNet™ are just a few examples. In the mid 1980s an attempt was made to standardize on single pair data transmission technology to provide for interoperability between manufacturers. However, due to the complexities of the systems and the reluctance of manufacturers to conform, a standard was never achieved. The absence of a common communication protocol is a significant drawback to fieldbus technology.

Use of only one pair **minimizes the cost, size and weight** of the cable and connectors used, and **simplifies installation and termination**.

TARGET MARKET SEGMENTS FOR SPE

There are three main market segments for which SPE applies: industrial manufacturing, building automation, and automotive technology.

As **industrial manufacturing** moves towards total automation, the same degree of compatibility is needed for the equipment that makes up the complex manufacturing machine. Solutions for industrial and process control applications do not need high-speed data transmission, but they must support a considerably longer reach. Data rates as low as 10 Mb/s are sufficient, but for lengths as high as 1000 meters.

A key driver for SPE in the industrial market is an emerging megatrend called Industry 4.0, sometimes referred to as “the fourth industrial revolution.” Industry 4.0 is the trend towards automation and data exchange in manufacturing technologies and processes which include cyber-physical systems (CPS), the internet of things (IoT), industrial internet of things (IIoT), cloud computing, cognitive computing and artificial intelligence. To achieve this level of autonomy and intelligence will require an increased level of machine-to-machine bi-directional communication. In addition to end devices receiving instructions, they will need to return information in the form of diagnostic data and status reports.

The **building automation** market is positioned to develop rapidly with the trend towards “smart buildings,” in which sensors and controls are linked together to improve energy efficiency and overall user experience within the commercial building. Traditional building automation has been limited to HVAC systems and discreet energy monitors, which for the most part are self-contained. To maximize the benefits of a smart building, all systems need to communicate on a common network, with the goal of transmitting data from the device all the way to the cloud using the same communication protocol. Stand-alone systems such as lighting control, Fire Detection, and emergency lighting are likely to be among those that are connected to a Single Pair Ethernet network.

Automotive technology is advancing in complexity as vehicles receive more entertainment, communication, and sensor options. To realize the goal of autonomous vehicle operation, all these systems must work together with very low delay in communication. Vehicles need to support high-speed data transmission so that video can be transmitted and analyzed in real time, but since the system is contained within a single vehicle the reach requirements are relatively short. Data rates of 1 Gb/s will be required initially, with data rates greater than 10 Gb/s anticipated for the future. Single Pair Ethernet offers the advantages of reduced weight (always a concern for vehicles) compared to 4-pair cabling, and unlike optical fiber, SPE can transmit power along with data.

SPE STANDARDS

To ensure interoperability between cabling and devices, as well as to assure a minimum level of performance, Standards Development Organizations are creating standards to specify requirements for Single Pair Ethernet components, channels, topologies, and test equipment. The International Electrotechnical Commission (IEC) develops standards for cables and connectors, while the Telecommunications Industry Association (TIA) and the International Organization for Standardization (ISO) develop standards for channels, topologies, and test equipment.

IEEE SPE Standards

In 2013, responding to these market needs, the IEEE 802.3 Working Group began developing the first of several standards for Single Pair Ethernet. The first standards are targeted for automotive applications. IEEE Std. 802.3bw™ (2015) supports data rates of 100 Mb/s to 15 meters (100BASE-T1), which was followed closely by IEEE Std. 802.3bp™ (2016) supporting data rates of 1,000 Mb/s to either 15 or 40 meters (1000BASE-T1). IEEE Std. 802.3ch™ is the most recent effort, having published in June 2020. Necessary for future autonomous vehicle applications, 802.3ch defines three high-speed protocols supporting data rates of 2.5 Gb/s, 5 Gb/s and 10 Gb/s (Multi-Gig) for up to 15 meters.

For applications that use lower data transmission speeds, IEEE Std. 802.3cg™ was developed, supporting data rates of 10 Mb/s. The standard specifies a short channel (10BASE-T1S) up to 15 meters and a long channel (10BASE-T1L) up to 1,000 meters.

Year	Standard		Max. Distance	Data Rate
2015	802.3bw	100BASE-T1	15 m	100 Mb/s
2016	802.3bp	1000BASE-T1B 1000BASE-T1A	40 m 15 m	1,000 Mb/s
2019	802.3cg	10BASE-T1L 10BASE-T1S	1,000 m 15 m	10 Mb/s
2020	802.3ch	Multi-Gig	15 m	2.5/5/10 Gb/s

Table 1. IEEE SPE Standards

SPE Power Delivery

To enhance the usefulness of SPE, IEEE also developed the ability to transmit power and data over the same twisted pair. Power transmission over 4-pair Ethernet cabling is defined by IEEE Std 802.3bt™, commonly called Power over Ethernet (PoE). Power transmission for SPE cabling is defined in IEEE Std 802.3bu™, commonly referred to as Power over Data Lines or PoDL (pronounced “poodle”). This standard defines multiple classes of powered devices delivering between 0.5 and 52 watts of power. Even though PoDL power delivery technology is not compatible with existing 2- and 4-pair PoE equipment, it shares the same advantages as PoE in that it provides for centralized power control and backup power.

SPE Cables

SPE Cables are defined in the IEC 61156 series of standards, which are used as the basis for the design and manufacture of cable. The standards include requirements for mechanical properties (e.g. cable construction, wire gage, material strength) as well as electrical parameters.

SPE cables are designed to support a maximum frequency, which corresponds to one or more IEEE applications. There are also separate standards for horizontal cable and patch cable. While it is possible to manufacture patch cords from horizontal cable, patch cable typically employs stranded conductors instead of solid, offering increased flexibility at the expense of diminished electrical performance over very long lengths. Standards for SPE cables are shown in Table 2.

Standard	Description	Status
IEC 61156-11	SPE horizontal cable, 600 MHz	Published
IEC 61156-12	SPE patch cable, 600 MHz	Published
IEC 61156-13	SPE horizontal cable, 20 MHz	In Development
IEC 61156-14	SPE patch cable, 20 MHz	In Development

Table 2. IEC SPE Cable Standards

IEC 61156-13 and -14 have a maximum frequency of 20 MHz, supporting IEEE Std. 802.3cg (10BASE-T1) applications. IEC 61156-11 and -12 have a maximum frequency of 600 MHz, supporting applications from IEEE Std. 802.3bw (100BASE-T1) and IEEE Std. 802.3bp (1000BASE-T1), as well as being backward compatible to support 10BASE-T1. SPE cable standards allow for conductor sizes from 18 - 26 AWG (1.0 -0.4mm diameter).

SPE Connectors

SPE Connectors are defined in the IEC 63171 series of standards. There is a base document with general requirements that apply to all connectors, as well as documents for specific connector types. Like the cable standards, these documents include requirements for mechanical properties and electrical parameters. Standards for SPE connectors are shown in Table 3.

Standard	Description	Status
IEC 63171	SPE connector, general requirements	In Development
IEC 63171-1	SPE connector – Type 1 (LC)	Published
IEC 63171-2	SPE connector – Type 2 (IP20)	In Development
IEC 63171-4	SPE connector – Type 4	In Development
IEC 63171-5	SPE connector – Type 5 (IP67)	In Development
IEC 63171-6	SPE connector – Type 6 (IP67)	Published

Table 3. IEC SPE Connector Standards

The interfaces defined in the IEC 63171 standards for connector types 1-6 are open sourced, allowing any manufacturer to make connectors with these interfaces. This ensures interoperability and will increase the likelihood of broad industry adoption. Manufacturers must maintain the common interface, but they have the freedom to implement innovative and proprietary features in other areas of the connector design.

Although five different SPE connector interfaces have been defined by IEC, only two connector types are recommended in TIA and ISO/IEC standards. The Type 1 (LC) style copper connector (IEC 63171-1), with an optional shield, is recommended for use in commercial building applications. A shielded pin and socket type connector (IEC 63171-6) is recommended for use in the harsher environments of industrial and process control applications. Images of these connectors are shown in the figures below.

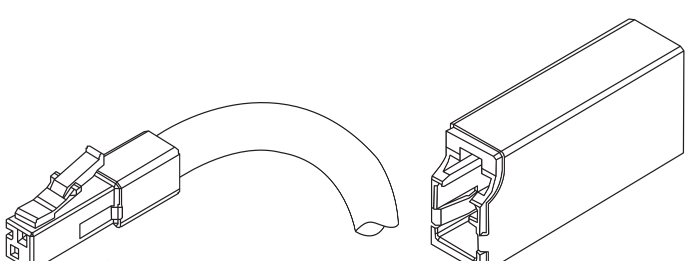

Figure 1. Type 1 SPE Connector
IEC 63171-1
Copper LC Connector

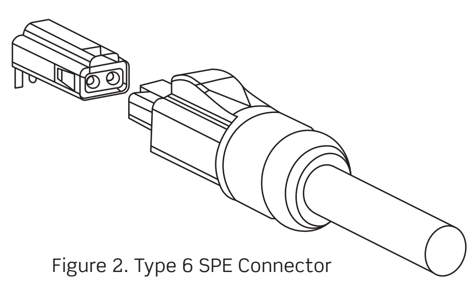

Figure 2. Type 6 SPE Connector
IEC 63171-6
Industrial Connector

The housing and locking tab of the IEC 63171-1 (LC style) connector is very similar to the proven optical fiber LC connector, providing a high degree of assurance for mechanical operation. To guard against damage from accidental insertion of a copper connector into an optical fiber port or coupler, the copper LC plug is slightly bigger than the fiber LC plug. In addition, the copper LC jack is internally keyed to prevent insertion of an optical fiber LC plug.

Like the optical fiber connector, the copper LC connector lends itself to implementation with a coupler. In addition to the traditional plug-jack configuration, there may be the option of a plug-coupler-plug configuration as shown in Figure 3.

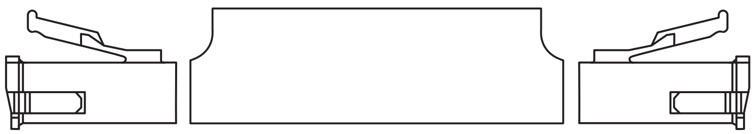

Figure 3. Plug and Coupler Configuration

SPE Performance

TIA and ISO/IEC build upon the IEC component standards to develop cabling standards that define performance specifications for the components, permanent links, and channels. Although the terminology may be different, cabling standards for a given performance level are typically consistent between the two organizations. Where the standards may differ, manufacturers will often design products to comply with both to ensure global compliance.

TIA

TIA is developing several new documents and amendments that will support Single Pair Ethernet (SPE). Table 4 lists the TIA standards that support SPE.

Standard	Description	Status
ANSI/TIA-568.5	Single Balanced Twisted-Pair Telecommunications Cabling and Components Standard	In Development
ANSI/TIA-568.6	Single Pair Multi-Drop (SPMD) Cabling and Component Specifications	In Development
ANSI/TIA-568.7	Single Balanced Twisted-Pair Telecommunications Cabling and Components Standard for $M_2I_2C_2E_2$ and $M_3I_3C_3E_3$ Environments	In Development
ANSI/TIA-568.0-E-1	Generic Telecommunications Cabling for Customer Premises – Amendment 1: Single Balanced Twisted-pair Use Cases and Topology	In Development
ANSI/TIA-862-C	Structured Cabling Infrastructure Standard for Intelligent Building Systems	In Development
ANSI/TIA-5071	Requirements for Field Test Instruments and Measurements for Balanced Single Twisted-Pair Cabling	In Development

Table 4. TIA Standards Supporting SPE

TIA has elected to focus on the cabling to support the 10 Mb/s application first, since it is expected that this will be the most widely used application. Cabling to support the 10 Mb/s application in a commercial environment will be covered in ANSI/TIA-568.5. Cabling to support the 10 Mb/s application in an industrial environment will be addressed in ANSI/TIA-568.7 which will also include cabling to support 100 Mb/s and 1000 Mb/s channels as well. TIA uses the designation “SP1” as the performance category for 10 Mb/s links, channels, and components. Within the SP1 category, there are two channel sub-categories: SP1-400 and SP1-1000.

As shown in Figure 4, channels conforming to SP1-1000 are limited to 10 connectors and a maximum distance of 1,000 meters, of which up to 100 meters can be patch cords. Although cables with conductor sizes ranging from 24-18 AWG are allowed for either sub-category, 18 AWG conductors are required to achieve the 1,000 meter maximum distance.

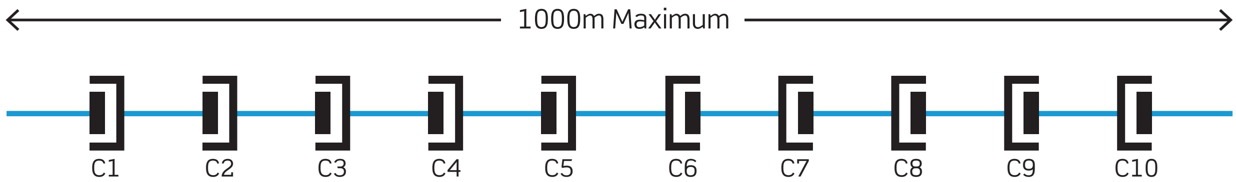

Figure 4. SP1-1000 Channel Topology

Channels conforming to SP1-400, as shown in Figure 5, are limited to five connectors and a maximum distance of 400 meters, of which up to 50 meters can be patch cords. Cables with 23 AWG conductors are likely to be used for SP1-400 channels.

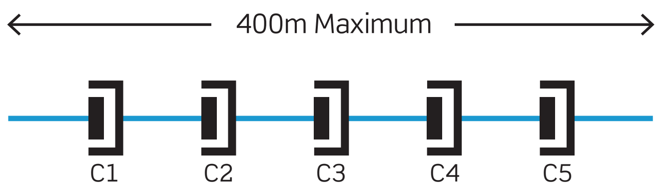

Figure 5. SP1-400 Channel Topology

While the same connector interface will be used in both channels, there may be some differences in the termination mechanism to accommodate the different conductor sizes and resulting cable diameters. The single pair cables and connectors used in the SP1-400 and SP1-1000 channels may be shielded or unshielded.

ISO/IEC

ISO/IEC is developing amendments to published standards as well as some new Technical Reports to support Single Pair Ethernet (SPE). Table 5 lists the ISO/IEC standards that support SPE.

Standard	Description	Status
ISO/IEC 11801-1 AMD 1	Amendment 1 – Information Technology – Generic Cabling for Customer Premises – Part 1: General Requirements	In Development
ISO/IEC 11801-3 AMD 1	Amendment 1 - Information Technology - Generic Cabling for Customer Premises - Part 3: Industrial Premises	In Development
ISO/IEC 11801-6 AMD 1	Amendment 1 - Information Technology - Generic Cabling for Customer Premises - Part 6: Distributed Building Services	In Development
ISO/IEC TR 11801-9906	Information Technology – Generic Cabling for Customer Premises – Part 9906 - Balanced 1-pair Cabling Channels Up to 600 MHz for Single Pair Ethernet (SPE)	Published

Table 5. ISO/IEC Standards Supporting SPE

The ISO/IEC cabling standards will support all the defined Single Pair Ethernet applications (10 Mb/s, 100 Mb/s, and 1,000 Mb/s).

ISO/IEC has defined three classes for SPE cabling (T1-A, T1-B, and T1C), supporting different frequency ranges. The T1-A class is further divided into sub-classes to designate different values for maximum length and number of connections. All information related to the T1-C class is designated as "for future study" and is subject to change. Information on the ISO/IEC Single Pair Ethernet (SPE) classes is provided in Table 6.

Class	Frequency	Max. Distance	Max. Number of Connections
T1-A-100	20 MHz	100m	4
T1-A-250	20 MHz	250m	4
T1-A-400	20 MHz	400m	5
T1-A-1000	20 MHz	1000m	10
T1-B	600 MHz	100m	4
T1-C (ffs)	1,250 MHz (ffs)	100m (ffs)	4 (ffs)

Table 6. ISO/IEC SPE Classes

Channel topologies for the ISO/IEC SPE classes are shown in Figure 6. Higher level classes are backward compatible, with some limitations. For example, T1-B channels will support T1-A applications, but only up to 100 meters with four connections.

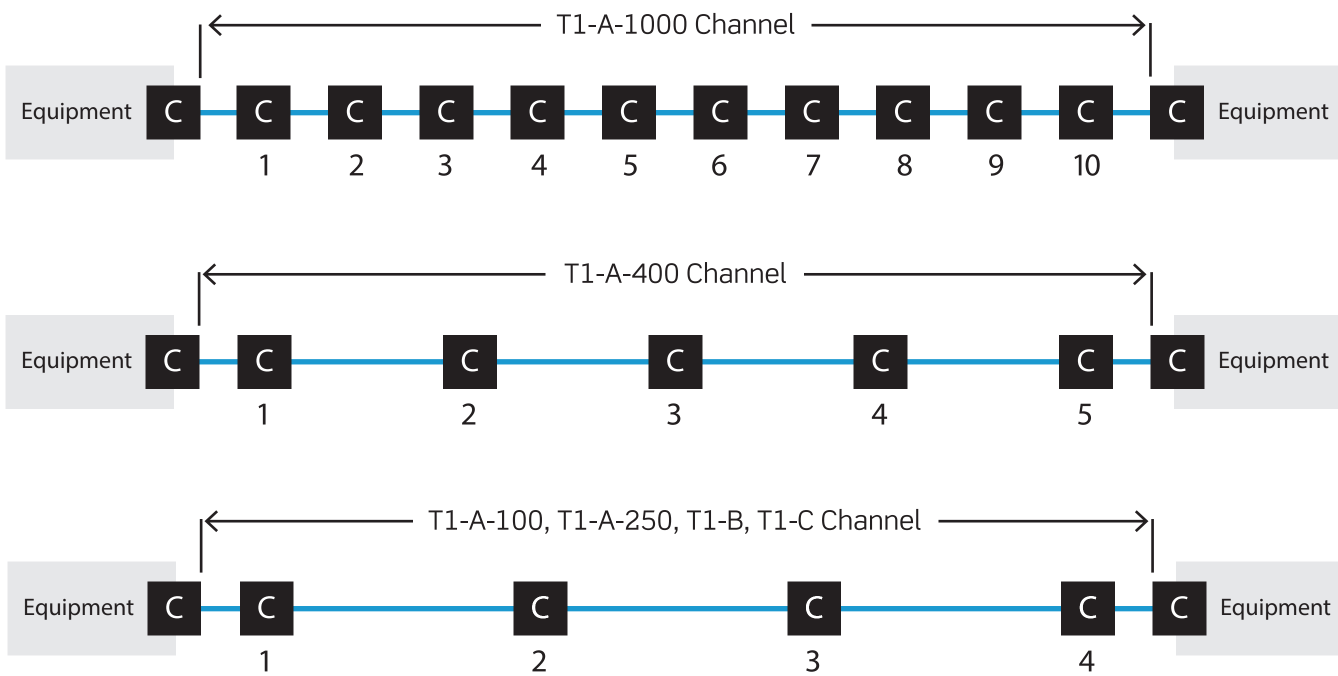

Figure 6. ISO/IEC SPE Channel Topologies

Table 7 provides a summary of the different parameters for the TIA and ISO/IEC categories for SPE.

Class	Frequency	Max. Distance	Max. Number of Connections	Max. Data Rate	Application
SP1-400	20 MHz	400m	5	10 Mb/s	10BASE-T1L
SP1-1000	20 MHz	1000m	10	10 Mb/s	10BASE-T1L
T1-A-100	20 MHz	100m	4	10 Mb/s	10BASE-T1L
T1-A-250	20 MHz	250m	4	10 Mb/s	10BASE-T1L
T1-A-400	20 MHz	400m	5	10 Mb/s	10BASE-T1L
T1-A-1000	20 MHz	1000m	10	10 Mb/s	10BASE-T1L
T1-B	600 MHz	100m	4	1 Gb/s	10BASE-T1L 100BASE-T1 1000BASE-T1
T1-C (ffs)	1,250 MHz (ffs)	100m (ffs)	4 (ffs)	TBD	TBD

Table 7. TIA and ISO/IEC SPE Category Summary

Power Delivery Effect on SPE Channels

The maximum length for SPE channels is based on electrical transmission parameters. For power delivery the supported distance can be much less than the maximum channel distance. Table 8 provides examples of how the maximum theoretical length changes for different power classes using SP1-1000 and SP1-400 channels.

Power Class (watts)	TIA SPE Category	Conductor AWG	Max. Number of Connections	Max. Length (m)
13 (7.7 W)	SP1-1000	18	10	1000
14 (20 W)	SP1-1000	18	10	451
15 (52 W)	SP1-1000	18	10	118
13 (7.7 W)	SP1-400	23	5	423
14 (20 W)	SP1-400	23	5	155
15 (52 W)	SP1-400	23	5	50

Table 8. Maximum Theoretical Length of SPE Channels for Power Delivery

SPE WILL COEXIST WITH 4-PAIR ETHERNET

SPE will complement, rather than displace, traditional 4-pair Ethernet cabling. SPE is targeted for field level devices that do not currently operate on an Ethernet network, and often on legacy fieldbus networks that would require a gateway to connect to an Ethernet network. Most often these devices only need relatively low data rates, low power, a small connector interface, and may be located more than 100 meters away from the nearest telecommunications room. Ethernet devices that currently include RJ-45 connectors will continue to be supported by 4-pair copper cabling, which can support data rates greater than 1Gb/s and PoE power delivery up to 90 watts.

Designers use multiple media types to create a structured cabling system, including optical fiber, 4-pair copper cabling, and even coaxial cabling. SPE copper cabling is simply an alternate media type available to system designers. Optical fiber is the media of choice for campus backbones (between buildings) and building backbones (between floors). Copper cabling is most frequently deployed as part of the horizontal cabling systems that start in the Telecommunications Room (TR) and extend out into the building. Figures 9-11 highlight how SPE cabling might be deployed as part of the horizontal cabling structure.

Figure 7 provides an example of an active zone architecture.

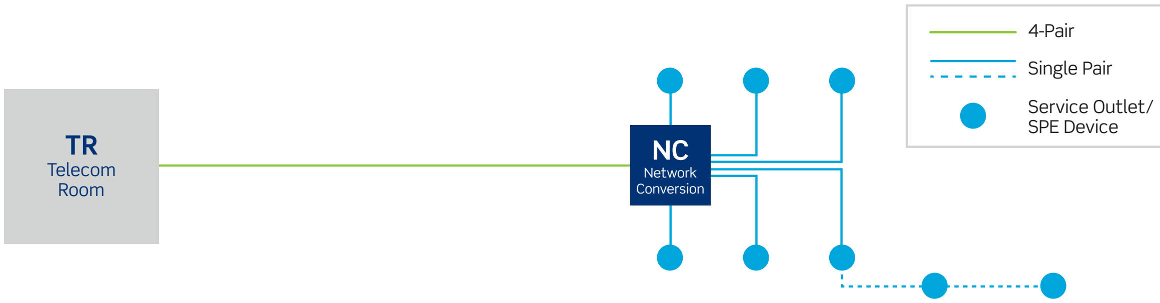

Figure 7. Active Zone Architecture

With an active zone architecture, the building floor is divided into multiple zones, each with an enclosure that can support an active piece of equipment, including power and cooling. A category rated cable (e.g. Cat 6A) runs from the TR to the zone. Within the enclosure is a switch having an RJ-45 uplink port and multiple Single Pair Ethernet (SPE) ports. SPE cabling spans out from the enclosure within the zone, ending in a Service Outlet (e.g. SPE jack), or connecting directly to the SPE device. Depending on the number of SPE ports present, it may be possible for the SPE switch to be powered by PoE from the incoming 4-pair cable.

Active zones are a good choice when there will be a high density of SPE devices within a small area. SPE cable only needs to run to the zone enclosure, rather than all the way back to the TR, and the density of devices will ensure a high port utilization for the SPE switch. This cabling design provides flexibility if new SPE devices are added, or existing devices are moved. The disadvantages for any active zone architecture are the need for local power at the enclosure, and the potential for noise from cooling mechanisms (e.g. fans) within the enclosure that may be located in an area occupied by people.

Figure 8 provides an example of a passive zone architecture.

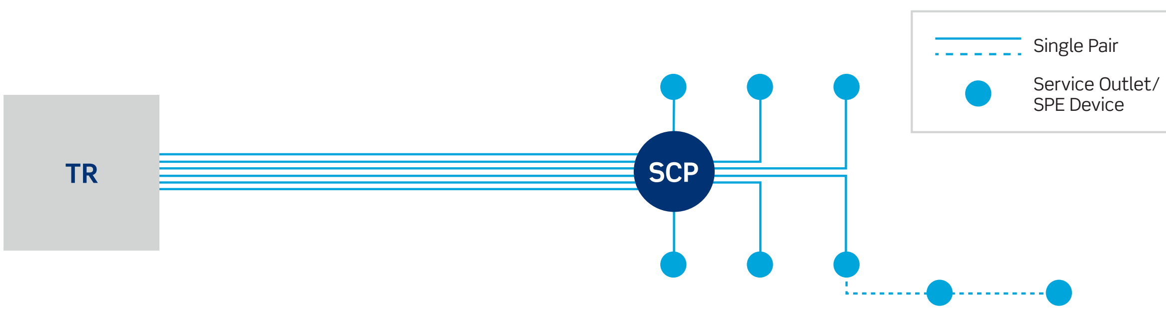

Figure 8. Passive Zone Architecture

With a passive zone architecture, the building floor is also divided into multiple zones, but each zone contains a passive Service Concentration Point (SCP). The SCP could take the form of a patch panel or a 110-style cross-connect block installed in an enclosure. For each SPE device, an individual cable runs between the TR and SCP, and then from the SCP to either a Service Outlet (e.g. SPE jack) or directly to the device.

Passive zone architectures provide flexibility for moving devices, do not require local power at the zone, and without the need to support active equipment the enclosures can be less expensive. The disadvantage is the increased quantity of cabling required with the need for a dedicated cable between the TR and each device.

Figure 9 provides an example of extended distance cabling for SPE.

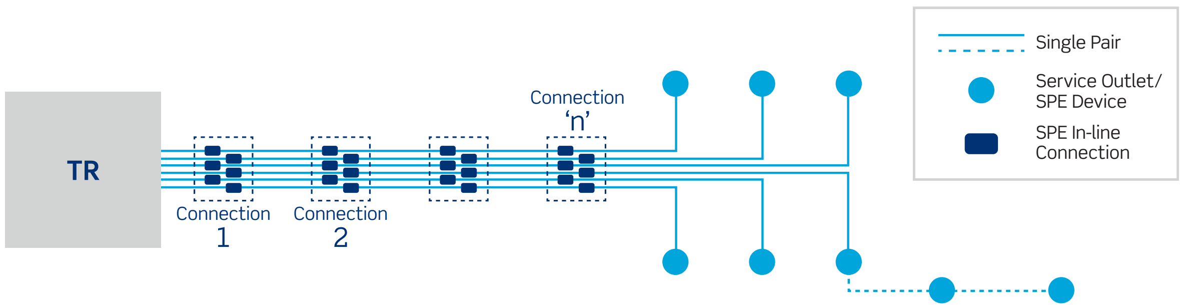

Figure 9. Extended Distance SPE Cabling

Traditionally horizontal cabling within a building is limited to 100 meters. Structured cabling designers understand that if a device will be placed more than 100 meters from the TR, then accommodations must be made in the form of another TR or selecting an alternate media type (typically optical fiber). The extended distances supported by Single Pair Ethernet can provide additional flexibility for system designers. For example, an intelligent building may have HVAC equipment located on the roof. Rather than place a TR on the roof, SPE cabling could run to the TR on the floor below.

While 4-pair copper cabling channels are limited to 100 meters and 4 connections, the TIA SPE channels are limited to 400 meters with 5 connections (SP1-400) and 1,000 meters with 10 connections (SP1-1000). Rather than pull a single length of cable for the SPE runs, installers will split the runs into shorter segments with an in-line connection. For building cabling, these types of channels would be the exception rather than the rule, taking advantage of the SPE length to avoid installing additional TRs.

Figure 10 provides an example of how 4-pair cabling might be used with SPE cabling to support SPE devices.

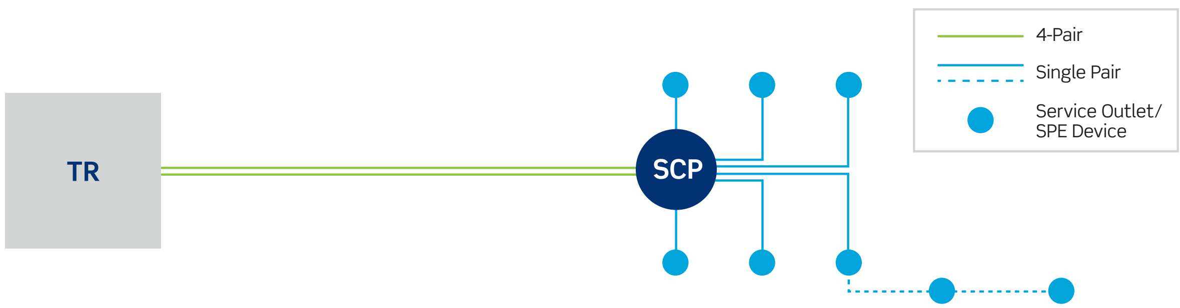

Figure 10. Use of 4-Pair Cabling to Support Multiple SPE Devices

This example is like the passive zone architecture shown in Figure 8, but instead of an individual SPE cable for each device, a 4-pair category-rated cable is run between the TR and SCP, supporting up to 4 SPE devices.

Designers must exhibit caution when considering the use of 4-pair category rated cable for SPE applications. The performance requirements for 4-pair cables and SPE cables are not the same, and further study is needed to understand whether the 4-pair cabling will support SPE applications.

While TIA has excluded cable sharing from the initial release of the ANSI/TIA-568.5 standard, it is currently included in the ISO/IEC 11801-6 AMD1 draft.

SPE ADVANTAGES VS. FIELDBUS

SPE with a 10 Mb/s data rate is targeted for the industrial process control and building automation applications. These two applications have similar network architectures, and both currently experience multiple types of proprietary communication protocols at the field level.

Figure 11 shows the Six Level Model for industrial process control, sometimes referred to as the Perdue Reference Model (PRM), which reflects the current network architecture for most industrial and building automation applications. The six levels can be grouped into Management, Automation, and Field operations. The Management levels interface with the Enterprise network over 4-pair Ethernet, controllers and devices at the Field level communicate with proprietary Fieldbus protocols, while the conversion between the two occurs at the Automation level.

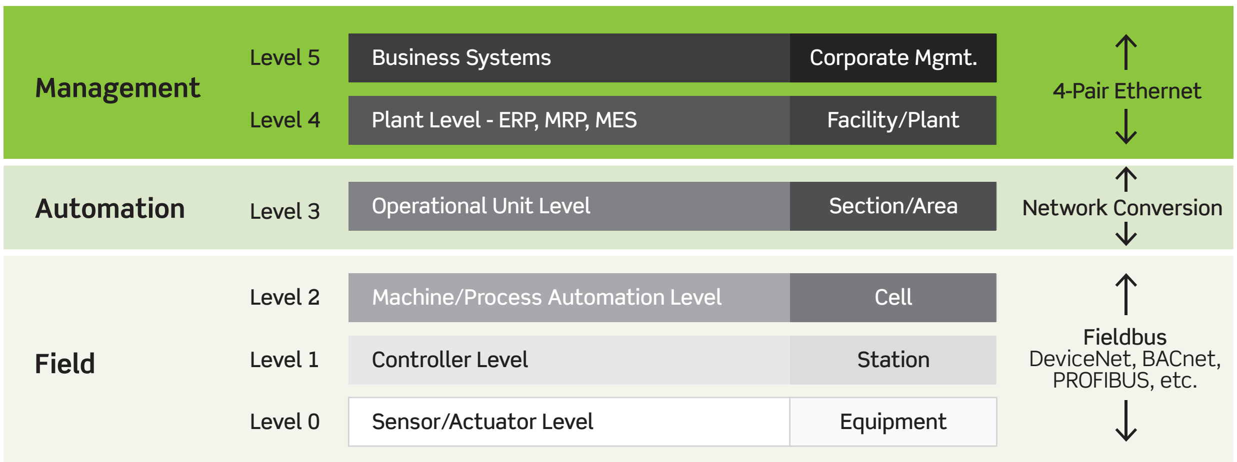

Figure 11. Industrial Process Control Six Level Model

Figure 12 provides an example of this architecture model for the HVAC portion of a building automation system.

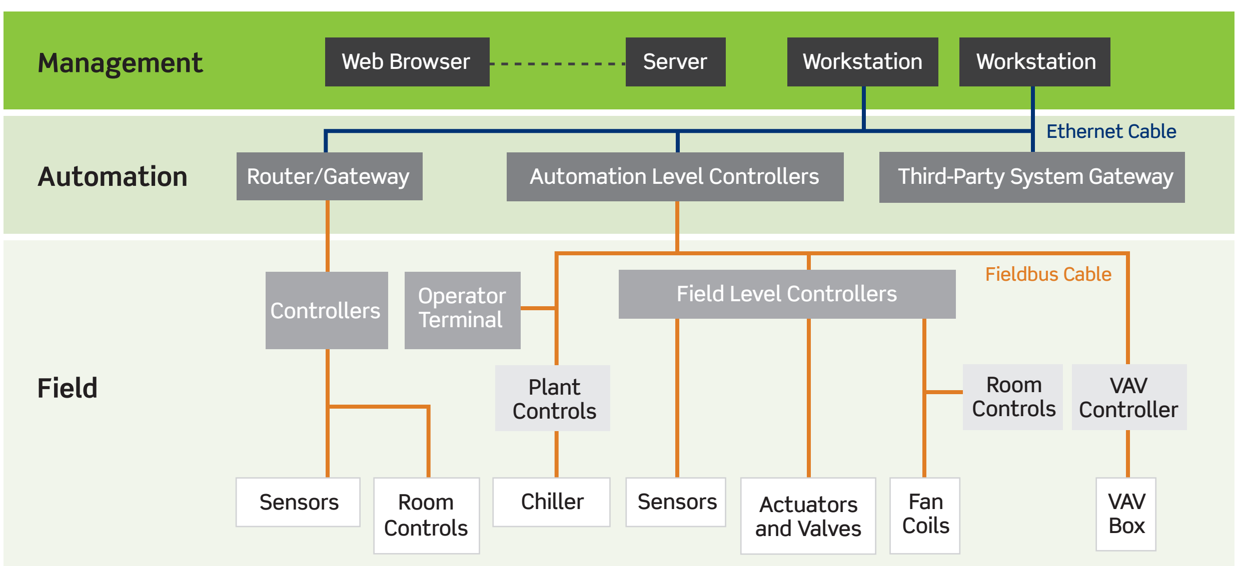

Figure 12. Network Architecture for Building Automation (HVAC).

Single Pair Ethernet (SPE) technology can simplify this architecture by collapsing the three levels at the Field level. Equipment at Level 0 (sensors, actuators, valves, etc.) equipped with SPE technology would be able to communicate directly with network switches at the automation level. In addition to potentially eliminating multiple levels of active equipment, SPE devices could be powered centrally, further simplifying network design and installation. Network conversion would still be required, but only to convert SPE to 4-pair Ethernet.

Figure 13 provides an example of how the network architecture might look if the HVAC system included SPE end devices.

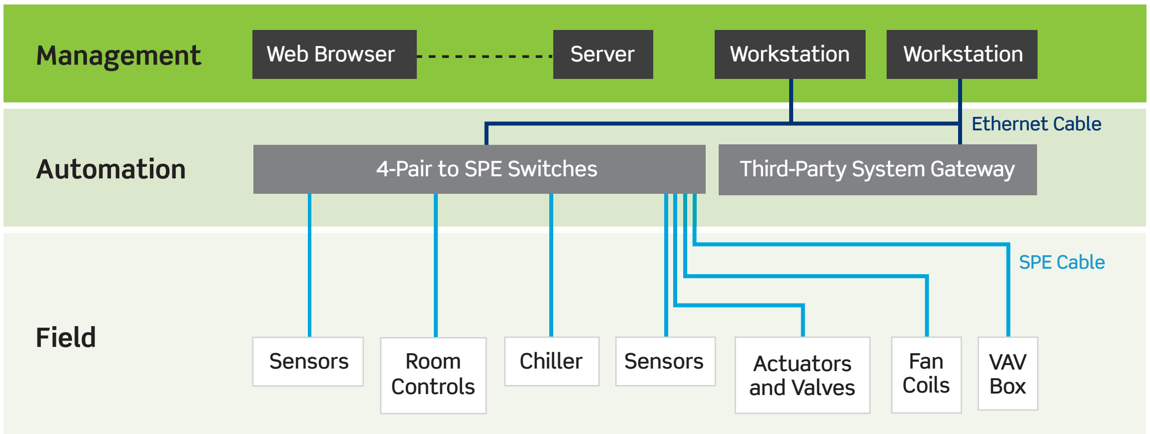

Figure 13. Network Architecture for Building Automation (HVAC) with SPE end devices.

SPE provides industrial process control and building automation system designers the opportunity to implement a single harmonized ecosystem based on open network protocols. A single network based on Ethernet provides many advantages versus a fieldbus network, including:

- Higher performance for a similar cost
- Elimination of multiple application-specific gateway devices
- More efficient installation, maintenance and management of network and devices
- Less complex integration with cloud-based management applications
- Less interoperability issues between field devices
- Centralized powering using the same cable for power and data

SPE ADVANTAGES VS. WIRELESS

Wireless connectivity is one of the fastest growing methods for device communication within the building network. Wi-Fi is the most common wireless technology used in commercial applications, but other technologies include Zigbee and Z-Wave, and Bluetooth.

For mobile devices, such as laptops, tablets, and phones, wireless communication is a critical part of the device value. For devices that remain in a fixed position, wireless provides the flexibility to place the device without having to consider the proximity of a data port. A quick and easy way to increase the intelligence and control within building is to replace legacy devices with “smart” devices that communicate wirelessly. Common examples include lighting controls and thermostats.

Single Pair Ethernet (SPE) offers three primary advantages relative to wireless technology:

- Security of data transmission
- Reliability of the connection
- Power delivery

SPE devices will support critical infrastructure for commercial buildings and industrial process control operations, so security of the data and reliability of the connection will be paramount. The reliability of device data, especially sensor data, is highly dependent on the reliability of the device connection to the network and its power source. Lost connections can mean the loss of critical data needed for building operations.

Many of these devices will be in challenging environments for wireless communication. Industrial settings can see high levels of electromagnetic interference (EMI) and radio frequency interference (RFI), while building automation devices are likely to be located behind walls or in enclosed spaces.

But the biggest advantage SPE offers relative to wireless technology is the capability for remote power delivery. For the quantity and size of the sensors and controls, the optimal power source is a battery. Having to replace thousands of batteries in a building would be a maintenance nightmare, as the devices could be located in enclosed, hard to reach locations. In the event that the device becomes non-responsive, SPE power delivery provides the ability to perform a remote power-on reset.

One hidden cost that is frequently overlooked when deploying battery operated devices is the responsible disposal of used batteries. While the size of a battery is relatively small and its lifespan likely to be several years, the sheer quantity of devices anticipated for IoT applications makes for a significant consideration. Businesses are looking for ways to increase use of sustainable materials and lower their carbon footprint. Deploying many thousands of devices with single-use batteries may not make sense if a more sustainable alternative is available

SPE MARKET TIMING

As of late 2020, the SPE market is still in the early stages, with many of the IEEE, TIA, and ISO standards still in development. However, there are some early indications that SPE-enabled equipment is coming. At a recent industry trade show, Analog Devices, Inc. demonstrated data transmission, based on the IEEE 802.3cg standard for 10BASE-T1L communication, between process control devices using ADI's prototype PHY (physical layer interface) technology. The process control devices included a pressure transmitter, a level meter, and a flow meter.

As PHY manufacturers near the end of their development cycles, further collaboration will occur between manufacturers to incorporate SPE technology into field devices, eventually giving factories, businesses, and auto manufacturers a reliable and interoperable solution for delivering power and data.

Leviton is an active participant in the development of IEEE, TIA, ISO/IEC, and ODVA standards, contributing to all aspects of SPE standards development. Leviton is a member of TIA-SPEC and the SPE Industrial Partner Network. Leviton design engineers, manufacturing engineers and product managers are working together to deliver products that exceed industry standards to create the highest return on infrastructure investment (ROii) for our customers.

To learn more about Leviton cabling and connectivity solutions, go to **Leviton.com/NS**.

Today's networks must be fast and reliable, with the flexibility to handle ever-increasing data demands. Leviton can help expand your network possibilities and prepare you for the future. Our end-to-end cabling systems feature robust construction that reduces downtime, and performance that exceeds standards. We offer quick-ship make-to-order solutions from our US and UK factories. We even invent new products for customers when the product they need is not available. All of this adds up to the **highest return** on **infrastructure investment**.

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