



An Introduction to Single Pair Ethernet



Introduction



The Internet of Things (IoT) continues to grow at a rapid pace. By 2025 it is estimated that the total global worth of IoT technology could be as much as \$6.2 T, with \$2.3T coming from manufacturing and \$2.5T coming from Healthcare. (McKinsey)

How will Enterprises incorporate these new devices into their existing networks? Many of these new devices, such as sensors, RFID readers, building automation and security devices do not require high bandwidth connections. Furthermore, they are often located further than the typical 100m structured cabling maximum distance, and may require remote power.

Meanwhile, industrial Ethernet is also seeing a huge increase in the need for remote sensors, actuators, readers, and other systems. Legacy industrial automation connections have been made with a Fieldbus (non-ethernet) type of connection. Unfortunately not all Fieldbus systems are compatible or interoperable, with several manufacturer-specific variations. What if there was a lower cost, Ethernet-compatible, secure, easily installed and maintained alternative?

IoT Industry Snapshot Monthly Data Consumption Profile

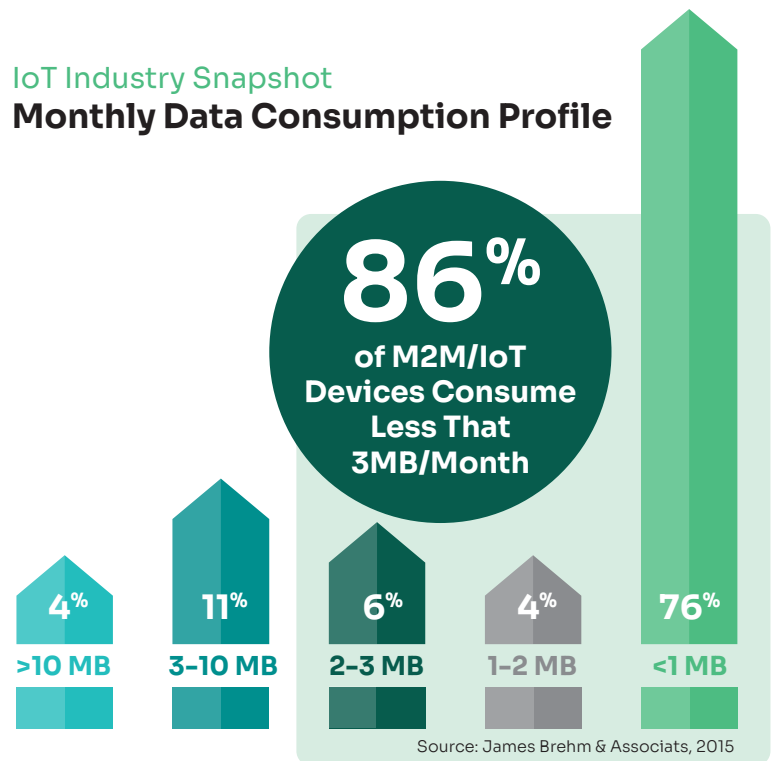


Figure 1: Monthly Data Consumption of IoT Devices (James Brehm & Associates)

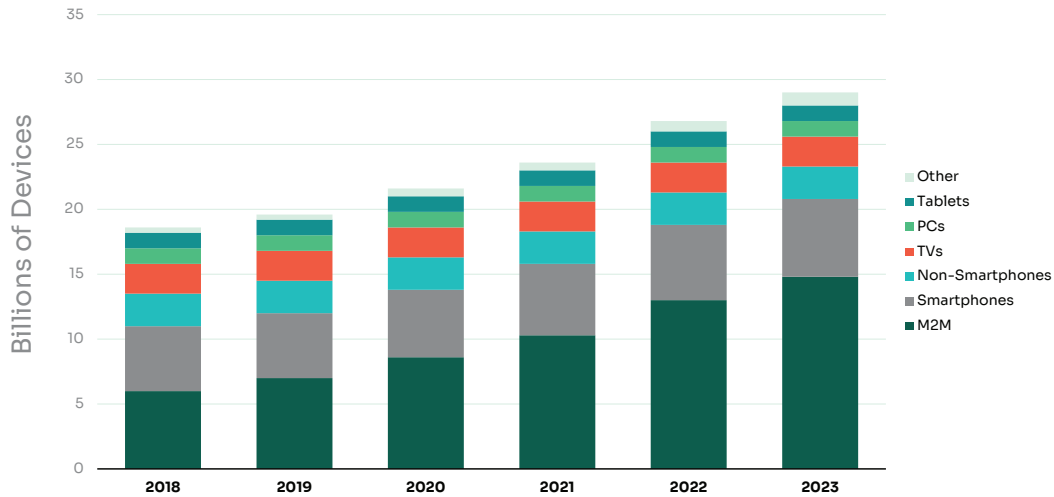
As shown in figure 1, over 75% of all IoT devices consume less than 1 MB of data per month.

Enter Single Pair Ethernet. It is the perfect solution for low bandwidth, long distance, secure, powered bidirectional communications. Everyone accepts the ubiquity of Ethernet. With the advent of Single Pair Ethernet (SPE) however, reach and applications will extend even further.

SPE's advantages are clear: 75% fewer wires, less weight, reduced cost, lower complexity, a smaller footprint, up to 10x the distance, simpler to test, ability to supply power and easier installation. Traditional 4-pair Ethernet will work in harmony with SPE, as they do not compete. SPE is designed to support new use cases like interconnecting IoT, industrial ethernet (replacing Fieldbus), vehicle communications and long distance end devices.

2018-2023

10% Compound Annual Growth Rate Expected for IoT Devices



Source: Cisco, 2018

Figure 2: M2M Represents 50% of IoT devices, growing at 33%/year (Credit: Cisco)

IoT and IIoT can be supported in either in wired or wireless applications. Batteries may last for years, but the replacement effort is significant. Many IoT devices will be behind walls and other hard to reach places. Single use batteries must be regularly replaced and disposed of responsibly, which suggests a permanent power connection is the best alternative.

SPE supports Power Over Data Line (PoDL), and PoDL supported devices are greener, lower maintenance, and lower cost, since they eliminate the need for external power supplies and related wiring.

802.3 cg

Single-Pair Ethernet 10Mbps/Sec and Power

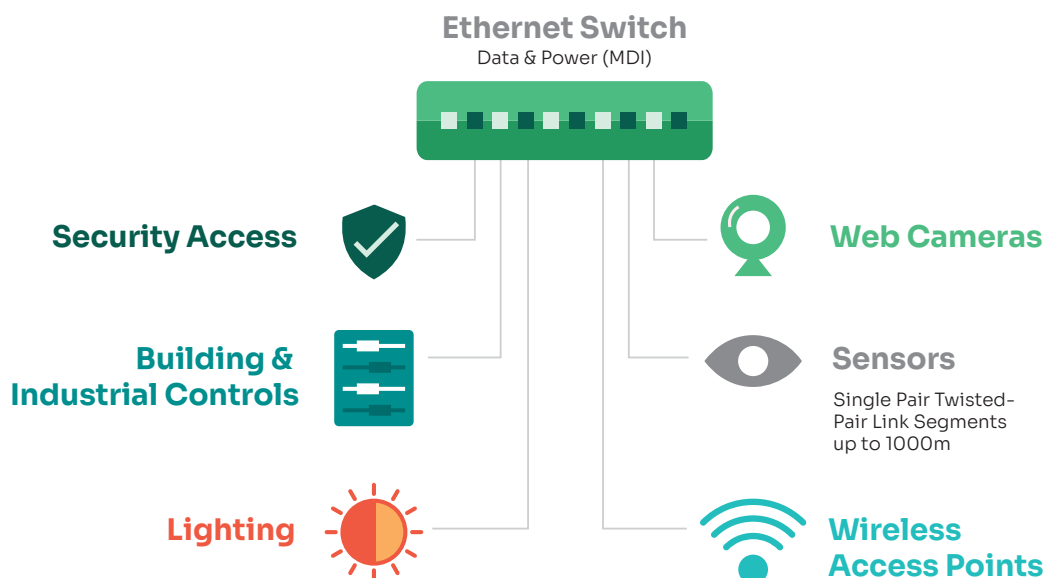


Figure 3: Single Pair Ethernet has the ability to supply power to a wide range of IoT devices

Use Cases



1) IIoT

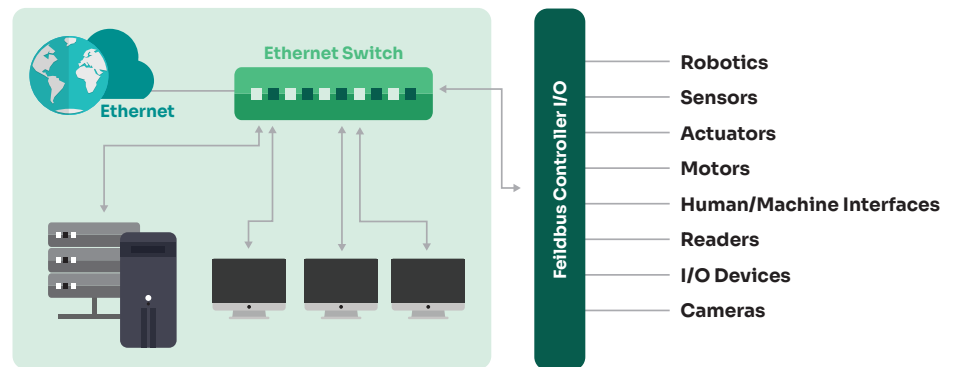
Until recently, there was no specification for Ethernet that supported long distances (>>100m). Many applications for remote sensors, gauges, cameras and IoT devices have had to be served with other technologies because Ethernet couldn't go the distance.

Now, with 10BASE-T1L, 10Mbps communication and power delivery up to 1 km is supported. Since many IoT devices were designed for Ethernet, SPE eliminates the need for protocol conversion, additional controllers, and more complex cabling required for legacy non-Ethernet architectures.

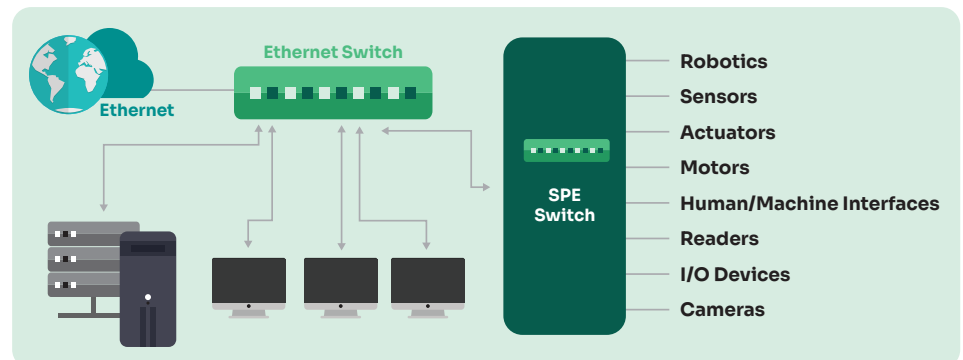
The Industrial Internet of Things (IIoT) is a major use case, as SPE can replace many instances of Fieldbus or other non-Ethernet automation networks. SPE is perfect for sensors and devices that don't need much power or bandwidth but do require efficient, fast, reliable transmission.

Maximum distance depends on gauge of wire used. For example, to get 1000m @ 7.7W of power deliver you would need 18 AWG.

Fieldbus Topology



Single Pair Ethernet Topology



2) Higher Density Enterprise Applications

SPE has double the packing density of RJ45, lower cost, and allows designers for the first time to easily extend Ethernet to the edge of the network's most remote devices

3) Eliminate the Need to Supply Power at the Edge

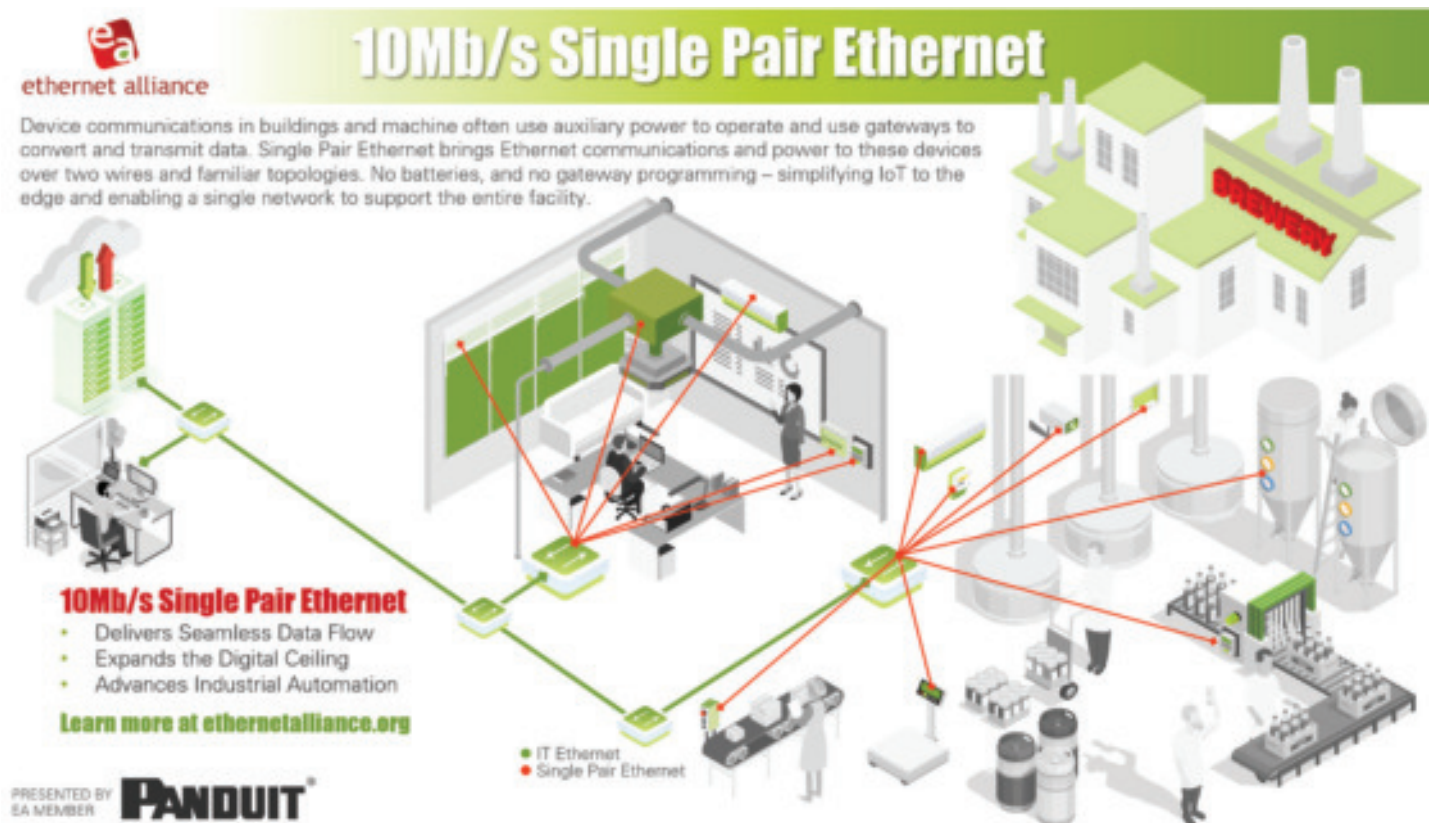
Power over Data Line (PoDL) is inherent in SPE. It can deliver up to 52W for shorter distances, or 7W at 1000m. Lower cost, higher security and provides power vs wireless alternatives. Greater power efficiency of SPE vs alternative methods, thus reducing carbon emissions.

4) Automotive Applications

Automotive industry has replaced the old CAN (Controller Area Network) bus systems with SPE.

5) Building Automation

Digital signage, RFID and card readers, sensors, elevator and escalator control, fire alarms, HVAC and more.



Status of Standards



Standard	Description	Status
IEEE 802.3bw	100BASE-T1, 15m automotive focus	Published 2015
IEEE 802.3bp	1000BASE-T1 15m automotive, 40m aircraft/railway/bus/truck and IIoT	Published 2016
IEEE 802.3bu	Power over data lines (PoDL). Up to 52W over single pair	Published 2016
IEEE 802.3cg	10BASE-T1L, 10Mbps with PoDL power up to 1km	Published 2019
IEC 63171-1	LC connector for SPE	Published 2020
IEC 63171-6	Industrial connector for SPE	Published 2020
IEC 61156-13	SPE 1 pair patch cable to 20MHz, supporting 10 Mbps	By March 2022
IEC 61935-e ED1	SPE cable testing requirements	2022
TIA 568.5	Single pair cabling and components, electrical and mechanical specifications for cable, connectors, cords and channels	Published March 2022
TIA 568.6	Single pair multidrop (SMPD) cabling and components	Draft late 2021
TIA 568.7	Single pair cabling and components for industrial applications	By end of 2021
TIA 5071	Single pair field testing. Measurements, reporting and accuracy requirements for SPE field testers	By end of 2021
ISO 11801-1	Generic single pair requirements	By end of 2021
ISO 11801-3 AMD1	Single pair requirements for industrial applications	By end of 2021
ISO 11801-6	Additional guidelines for SPE for building automation	By end of 2021

What About Connectors?



Unlike normal RJ45 structured cabling, SPE allows for wires to be terminated in common spade lugs and screw terminals. But to get higher speeds, impedance-matching connector pairs must be used.

Single pair Ethernet connectors are specified in IEC 63171. There are 6 proposed variants:

- 63271.1 – Commscope, Panduit
- 63271.2 – Phoenix Contact, Weidmuller
- 63271.3 – Siemon
- 63271.4 – BKS
- 63271.5 – Phoenix Contact, Weidmuller
- 63271.6 – Harting

The IEEE has weighed in and recommends using 63171.1 & 63171.6 compliant connectors. It should be noted that even within one variant, there can be different connector housings.



ISO/IEC 63171 Connectors for Electrical and Electronic Equipment

	IEC 63171.1	IEC 63171.2	IEC 63171.3	IEC 63171.4	IEC 63171.5	IEC 63171.6
Company	Commscope, Panduit	PxC, WM, RdM	SIEMON	BKA	PxC, WM, RdM	Harting
Picture						
Type	LC-Style	Rectangle	TERA IP	Square-Shaped	M8 / M12	Rectangle / M8 / Push Pull
#Pairs	1	1	1 / 4	1	1 / 4	1
Degree of Protection	IP20	IP20	IP20	IP20	IP67	IP20 / IP67

Note that the 63171.1 connector has the unfortunate and confusing designation as a “LC” connector. This is a copper SPE connector and has nothing to do with fiber optics.

AEM currently supports M12, Tera, and the 63271.6 Harting connector, and will deliver a 63271.1 compatible version in first half 2021.

Testing Requirements



Field testing requirements for SPE will be specified in TIA 5071. AEM is very active in the development of this standard.

AEM recognizes that structured cabling professionals who deploy SPE will also be supporting traditional copper and fiber cabling, and will be reluctant to purchase an entire new test set just for SPE installations. The TestPro has been designed to be fully modular, and testing SPE will be as simple as snapping in a new interface module and updating the software.

TestPro will support both 63271.1 and 63271.6 connector styles, and will be fully compliant with the new SPE test standard.

AEM's Testpro is the only tester to offer SPE certification testing compliant to the TIA 568.5 standard. TestPro covers test requirements for both high-speed short reach SPE links, and long distance SPE links with the same device. It can support both four-pair and single-pair on the same platform through hot swappable test adapters. Finally, the measurements and limits can scale with emerging standards without having to send the tester back to the factory.



Single Pair Ethernet
System Alliance



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