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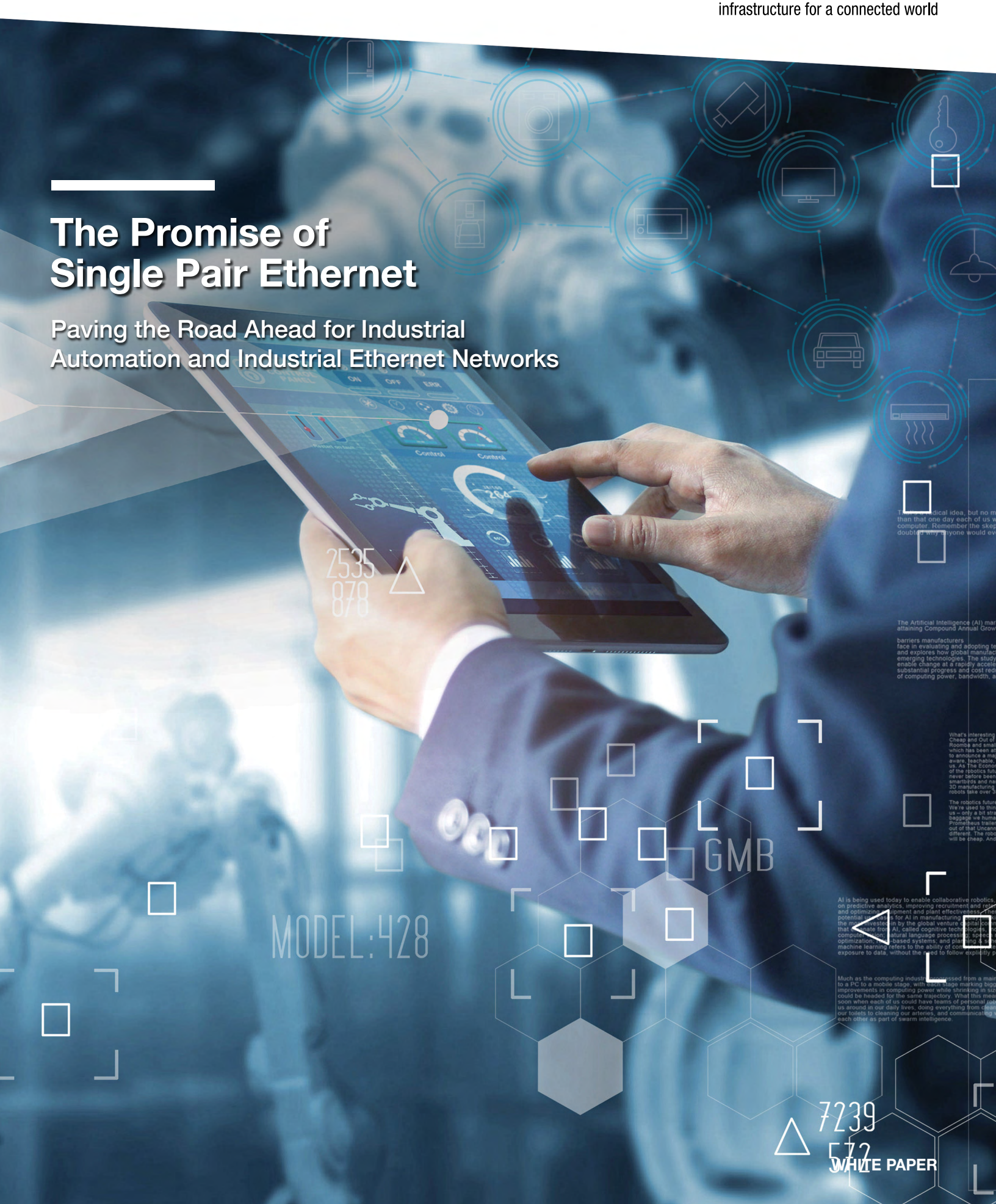
The Promise of Single Pair Ethernet

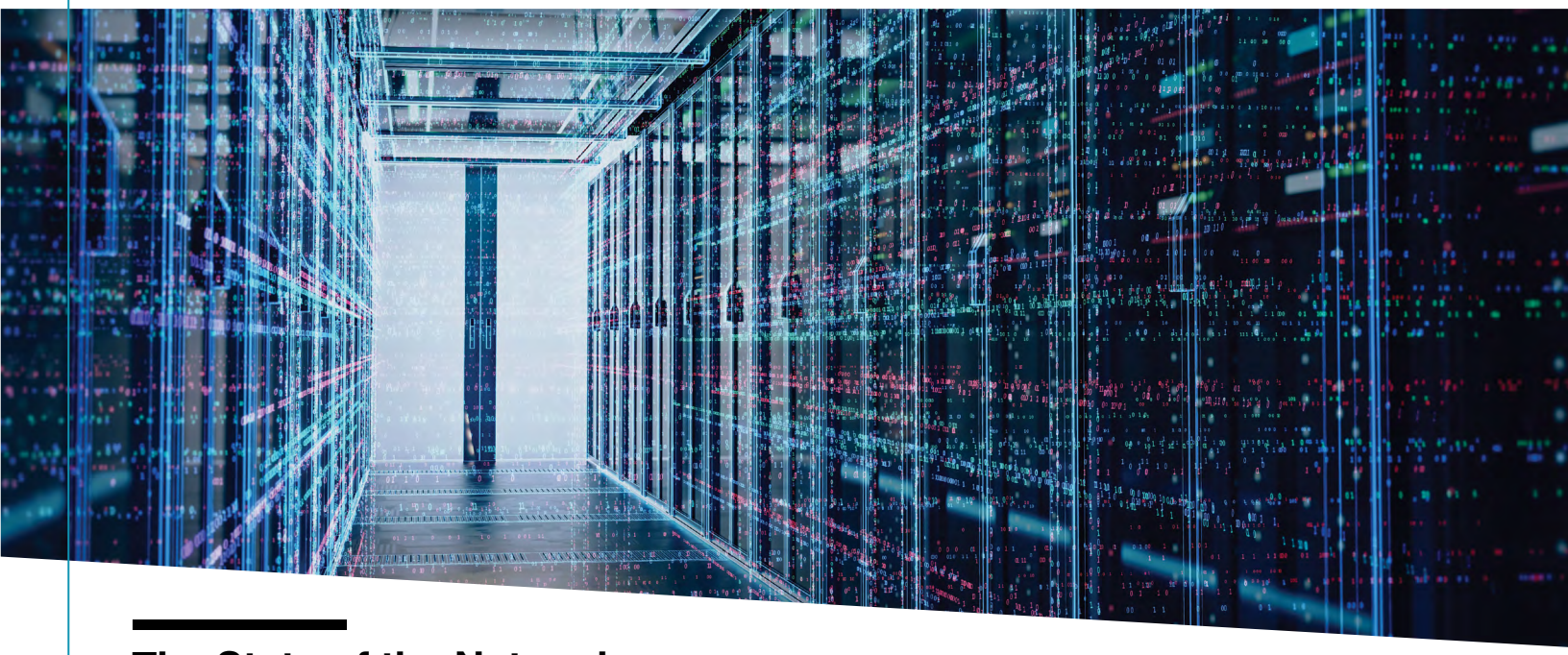
Paving the Road Ahead for Industrial Automation and Industrial Ethernet Networks



WHITE PAPER

Introduction

Legacy industrial control networks must evolve to address the demands of Industry 4.0 and IIoT. Single pair Ethernet (SPE) promises to be an enabling technology that helps with cost-effective migration from many legacy networks to one common network platform. It addresses the need for a reliable, secure infrastructure providing high-bandwidth communication, power, and control to Edge devices. Single pair Ethernet extends the network to incorporate the "last mile" of connectivity creating a seamless Ethernet TCP/IP network fabric for "enterprise to Edge". Single pair Ethernet technology will help to build out the necessary foundation so enterprises can better achieve their smart manufacturing objectives and digitally transform their businesses. SPE (IEEE Std. 802.3cg-2019, 10BASE-T1L) availability and adoption in the marketplace is projected to begin in 2021.

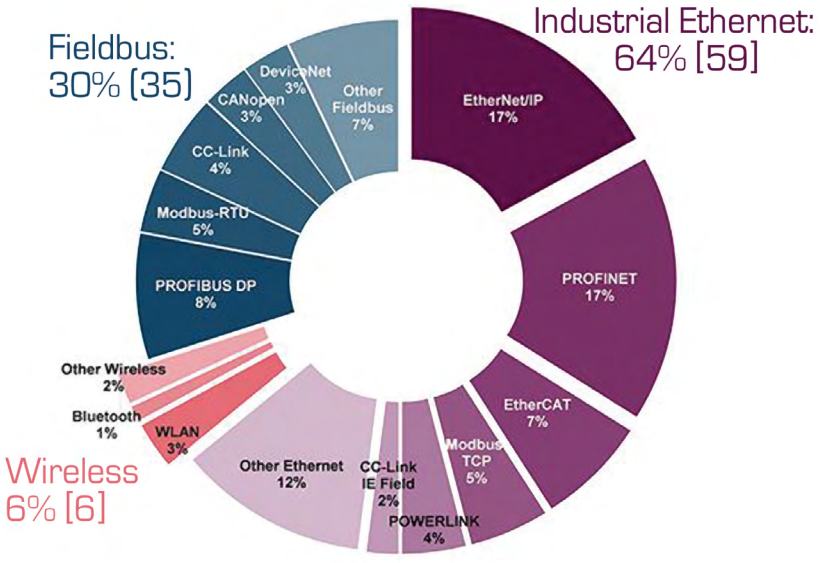


The State of the Network

More and more industrial equipment and devices are being connected to networks. Today's OT networks are a composite of Ethernet and legacy fieldbus networks. What does the industrial network landscape look like? In terms of new installed nodes, HMS Industrial Networks concluded that industrial Ethernet had surpassed traditional fieldbuses for the first time in 2018, and this progress continued in 2019. Industrial Ethernet continues with a steady growth rate of 20% and now makes up 59% of the global market, an increase of 7%. Globally, EtherNet/IP is the largest industrial Ethernet network with 15% of the market followed closely by PROFINET at 14%. As the chart shows, other significant Ethernet technologies include EtherCAT, POWERLINK, and Modbus-TCP all of which are showing steady growth.

Most notably, 2019 was the first year of decline for new fieldbus nodes declining by -5% compared to 6% growth in 2018. Fieldbuses in the aggregate now account for 35% of the global market, a decline of 7% compared to the 7% growth seen for industrial Ethernet. The leading fieldbus is still PROFIBUS at 10% of the global market followed by CC-Link at 6% and Modbus-RTU at 5%. Wireless technologies maintained its 6% share and is also growing steadily at 30%.

This all illustrates that industrial networks evolve over time and this evolution has seen the gradual "cooling" of fieldbus deployments driven by the stronger growth of industrial Ethernet. As Andres Hansson, Chief Marketing Officer at HMS has noted, "The transition to industrial Ethernet continues and is driven by the need for high performance and the need for integration between factory installations and IT-systems/IIoT applications." The arrival of single pair Ethernet promises to further accelerate this transition.



Source: HMS Industrial Networks, 2020

Meeting the Workforce Challenge

The advent of single pair Ethernet technology is very timely, if not seemingly planned. Industrial operations are being both pushed and pulled to transform their network infrastructure. Industries are at a crossroad with legacy systems nearing end-of-life while at the same time the workforce versed in supporting these systems is also reaching an end of their tour of duty. Forward-thinking organizations are putting in place processes to document and retain this knowledge. But for many, it is unlikely that the collective knowledge of this experienced workforce will be effectively transferred to the new and inexperienced one coming in.

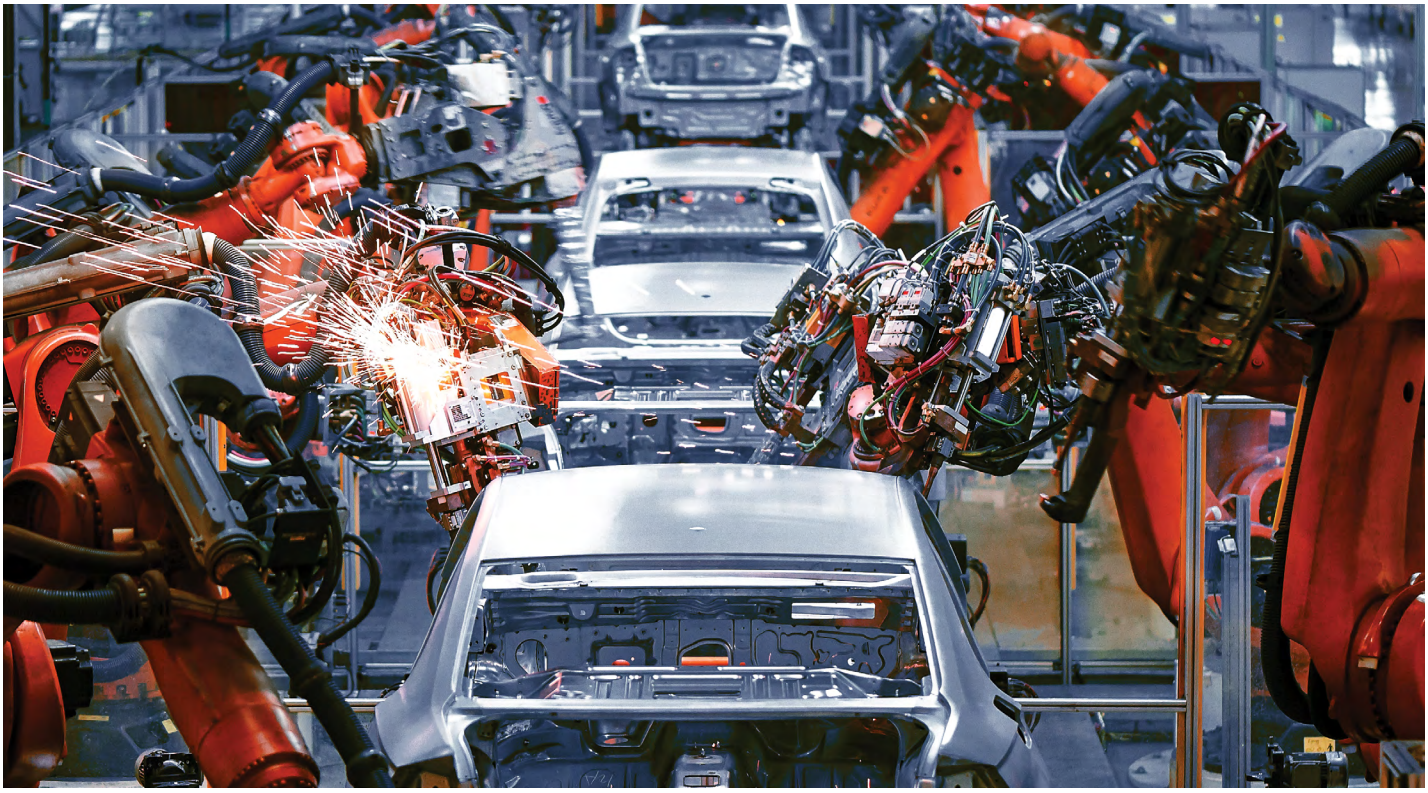
As a stop-gap measure, some industrial operations retain service organizations to support their OT networks, meanwhile these end-of-life systems with limited integration leaves manufacturers vulnerable and at risk. This is the 'push' driving a change. The 'pull' is reflected in the positive business outcomes that smart manufacturing and digital transformation deliver. Standing in the way of this, in part, are the machines, skids and field devices connected with legacy networks that are not easily synchronized to 'uptake' into the enterprise systems for insights and action. Single pair Ethernet provides a standard Ethernet physical layer that the incoming workforce is already familiar with and presents a clear and cost-effective migration path.

Industry Adoption

For decades, Ethernet cabling has used two/four twisted pairs of copper conductors to carry data and power. But as a breakthrough technology and paradigm shift, Ethernet can now be deployed over a single balanced pair, single pair Ethernet.

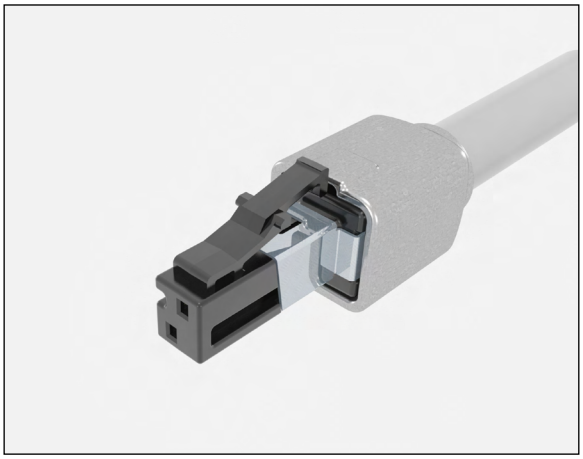
In recent years, the automotive industry became the first to develop and adopt SPE, in this case for in-vehicle networks. This innovation was driven by the increasing number of applications and the complexity of features being added to cars. With each feature introduced, the number of subsystems proliferated along with much higher bandwidth requirements. Current bus topologies and a fragmented network architecture deployed in the vehicles were ill-equipped to meet these demands. The industry needed to converge the growing number of disparate systems and provide higher bandwidth–all within very small spaces. Reducing the wire count was a driving force. The industry responded by establishing the IEEE 802.3bw standard for 100BASE-T1 for in-vehicle networks published in 2015. Moreover, the supplier ecosystem worked with the automakers to develop and commercialize the technology for the benefit of the industry.

The automotive industry's success with SPE serves to strengthen its foundation for use in manufacturing and process industries. Similarly, these industries are embracing the technology to achieve a single converged network – enterprise to device – and displace the prevalent legacy systems. Here, higher data bandwidth and power delivery requirements are inexorably linked. Pursuant to these goals, an Ethernet Task Force group was formed to study fieldbus technologies and create a standard for SPE to address the needs of OT networks for manufacturers and process industry, leading to the formation and publication of IEEE Std. 802.3cg-2019 (10BASE-T1L), which provides for a 10 Mb/s Ethernet connection with a potential distance of a full kilometer.



The economy of SPE

Compared to the task of terminating 2/4-pair cable to TIA-568A/B standards, field terminating 1-pair cable with the LC-style connector will be exceedingly simple. Using common tools, it is fair to say that the same technician will be able to perform an SPE (10BASE-T1L) termination in far less than half the time that it takes for a 2/4-pair termination. Also, the SPE connector termination will be less prone to error, minimizing any rework. Further, given the decreased weight and size, more cable runs can be pulled together.



Another attractive prospect of SPE (10BASE-T1L) implementation is the potential to reuse existing twin-axial cable media. Many of today's facilities have an abundance of legacy single-pair twisted cable, usually shielded, that presumably can be reused as SPE cable media if properly tested and verified first. For instance, much RS-485 cable in use or abandoned is 18 AWG gauge making it a viable candidate. The cables will need to be tested, but has potential to meet electrical performance relative to the TIA-568.5 standard for 10BASE-T1L link transmission parameters.

Given its economy of scale, lower media cost, extended reach, flexibility of design, potential cable reuse, and reduced installation labor, SPE (10BASE-T1L) might be a very cost-effective alternative to standard 2/4-pair Ethernet deployments for edge device connectivity.

Application Use Cases

Single pair Ethernet is flexible in its manufacturing and process industrial network applications. Foreseen applications for SPE include connecting the following:

- Skid and machine I/O blocks to the OT network
- On-machine devices to an on-machine or cell area industrial network switch
- Field sensors and actuators to industrial network switches point-to-point or via structured cable link channels, both with lengths up to 1km (10BASE-T1L) far exceeding the current 100m limit
- Field devices connecting in a daisy-chain fashion with embedded 2-channel switches
- Remote I/O modules to one another, the network switch, or to the controller
- In-panel devices together over a single cable via the multi-drop topology (10BASE-T1S)

SPE is expected to be a key enabling technology for manufacturers and industrial plants to:

- Achieve a seamless network technology with visibility from enterprise to edge
- Increase bandwidth at the edge for implementing advanced diagnostics
- Simplify edge networks by eliminating protocol/network translation gateways
- Transform and simplify DC control power infrastructure
- Improve cybersecurity by extending Industrial IT defense-in-depth technologies
- Connect miniaturized micro-IoT and otherwise constrained form factor devices
- Lower TCO for the OT network

Perspectives and Conclusion

Single pair Ethernet (10BASE-T1L) is a transformative technology forthcoming for manufacturers and process plant facilities. For the manufacturing space, a model for success has been set by the automakers and their ecosystem of suppliers with the development and adoption of SPE (100BASE-T1) for in-vehicle networks. Other market segments such as rail transportation and building automation will also begin to adopt SPE networks in the ensuing years.

Progressing into late 2020 and early 2021, look for product roadmaps and offerings from device, connectivity, and network equipment manufacturers. Reference architectures, like Converged Plantwide Ethernet (CPwE), will be updated to incorporate SPE (Ethernet-APL, based on 10BASE-T1L) into validated designs with a vertical application focus.

The advent of single pair Ethernet (10BASE-T1) will significantly evolve the industrial operations and industrial network Edge paving the way for a “enterprise-to-Edge” seamless network technology fabric. This will create the foundation for Industry 4.0 and IIoT enabling both quantity and time precision of information for enterprises to gain more control over and insights into their underlying processes. As you prepare to adopt and implement Single Pair Ethernet, count on Panduit and our partners to deliver the solutions you need.

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Since 1955, Panduit's culture of curiosity and passion for problem solving have enabled more meaningful connections between companies' business goals and their marketplace success. Panduit creates leading-edge physical, electrical, and network infrastructure solutions for enterprise-wide environments, from the data center to the telecom room, from the desktop to the plant floor. Headquartered in Tinley Park, IL, USA and operating in 112 global locations, Panduit's proven reputation for quality and technology leadership, coupled with a robust partner ecosystem, help support, sustain, and empower business growth in a connected world.

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