FUTURE-PROOF YOUR FACILITY WITH INDUSTRIAL ETHERNET AND FIELDBUS SYSTEM SOLUTIONS

WHITE PAPER

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With the advent of the Internet of Things (IoT) a few years ago, more devices are now connected and online than ever before. In fact, 50 billion devices are forecast to be networked via the internet by 2020. In the consumer world, this enables activities such as remotely adjusting the lights and thermostat from a mobile device. In the world of smart factories and highly automated plants, things get more complicated and the stakes are higher due to safety and productivity benchmarks. With the Industrial Internet of Things (IIoT), the spotlight is on manufacturing operations and data gathering to optimize production processes and realize the potential of truly predictive maintenance. Due to data speed and integrity requirements, the modern factory is still heavily reliant on wired systems–the cables and connectors that carry critical power and data signals over long transmission runs at lightning fast speeds. With IIoT, both the sheer number of connected devices and their variety are increasing. This means the physical connectivity layer on the shop floor is more important than ever before.

One of the enabling technologies behind IIoT involves adding machine intelligence at the device level through smart sensors that allow two-way communication with the larger plantwide system. Such a networked system makes it possible to perform data harvesting in real time and to use data analytics to make tweaks to improve productivity. Because time is such a critical factor with regard to industrial cable and connected components, we will explore the recent development of time sensitive networks (TSNs).

UNITRONIC® Bus Cables

These include new open protocols such as OPC UA and MQTT as well as the new physical layer coming soon, single-pair Ethernet. Choosing a cable specifically designed for either industrial Ethernet or the modern fieldbus systems, depending on your plant setup, is an important step in optimizing your industrial process control system.

Further, when choosing a cable supplier it is important to look for a manufacturer that is communication system agnostic and supports all of the communication systems available for modern industrial environments. This means the major industrial Ethernet systems such as EtherNet/IP, PROFINET, CC-Link IE, EtherCAT and PowerLink as well as fieldbus systems such as DeviceNet, AS-Interface, DeviceNet, CC-Link and CAN Open. Working with a knowledgeable manufacturer will help you connect smart field devices and communicate in real time with the larger enterprise system. Rather than intelligence ending at the control system level, it is beginning to extend into the device level with smart sensors and actuators that send information directly to the enterprise system. The industrial data cable that is specified must support this activity with appropriate transmission speeds and guaranteed data integrity.

TIME SENSITIVE NETWORKS

A few milestones are noteworthy to recall with regard to industrial communication over the past few decades. Around 1980, RS485 serial communication protocols were widely used in industry. Next, the fieldbus proponents introduced PROFIBUS around 1990 as another step improvement. PROFINET was introduced in 2003. In 2010, both PROFIBUS and EtherNet/IP introduced real-time protocols–IRT for PROFINET and CIP Sync for EtherNet/IP. Industrial Ethernet came about due to the increased network size, higher data rates for more devices, the need for more flexible topologies and expandability (star, tree, ring layouts), a desire for one network for mixed services and the move toward enterprise-level and cloud connectivity.

CABLE FOR DATA COMMUNICATION AND INDUSTRIAL ETHERNET

LAPP's high-quality UNITRONIC® data network cables and fieldbus components provide reliable solutions for applications in industrial machinery and plant engineering. From transmission of simple control signals to fieldbus signals in complex network structures, LAPP offers a dependable cabling and connection solution for almost any situation. Cables are suitable for a wide range of uses including chemical and mechanical stress, humid conditions, and various temperatures. Applications include:

- Measurement and control technology
- Automated manufacturing processes and industrial robots
- Bus systems
- Machine and appliance electronics

Industrial Ethernet systems such as EtherNet/IP, PROFINET and EtherCAT were specifically developed for industrial applications, enabling the use of one communication system throughout all areas of your facility. These systems require fewer interfaces to connect unlimited numbers of locations. LAPP's ETHERLINE® products offer the most advantages for commercial fieldbus systems and provide dependable real-time control within automated industrial facilities of all types and sizes. A full range of CAT.5 to CAT.7 cable and connection options is available across multiple protocols. Benefits include:

- High data transmission rate for fast information exchange
- Improved efficiency and workflow
- Company-wide access to data and applications
- Better monitoring and control for optimized manufacturing processes
- Simple, unlimited expansion possibilities
- Fast assembly due to connection technology with field wireable RJ45 or M12
- Dynamic bandwidth adjustment with 10/100 Mbit/s, 1 Gbit up to a current 10 Gbit/s

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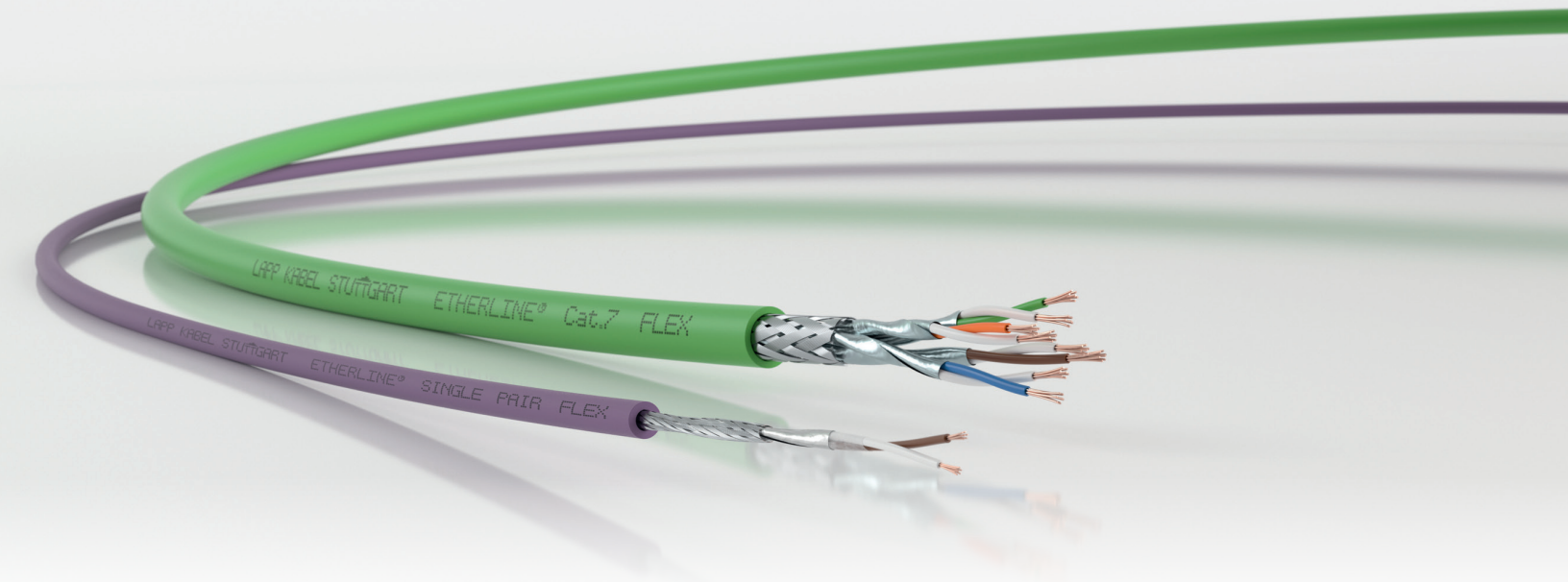

Single pair Ethernet cables are more compact, lighter, easier to install, and cheaper than traditional Ethernet cables with four wire pairs–and sufficient for many applications on the field level.

However, all of these proprietary technologies led to the development of "real-time islands" inside factories. In this context, real time refers to cycle times below one millisecond. For example, synchronized cycle times of roughly 62.5 or even 31 microseconds are typical requirements for drive systems. This is where the concept of time sensitive networks (TSNs) comes in. TSN is an open standard that aims to enhance traditional Ethernet by improving quality of service (QoS) in terms of bandwidth reservation (devices and activities can easily be prioritized via switches and software), synchronization (using perfectly synchronized clocks within each device), low latency times and seamless redundancy (for no service interruptions or data delays). In this scenario, mixed services are possible, e.g., PROFINET and OPC UA. TSN is implemented on the data link layer (where switches typically work, just above the physical device level) and standardized in IEEE 802.1. The beauty of TSNs is threefold: no changes in existing application software, easy integration for device manufacturers, and the end of real-time islands. Products should be available for industrial use within the next few years. Prototypes from different manufacturers have already been presented and industrial Ethernet workgroups are now in meetings to work out the details.

OPC UA MAKES HEADWAY

The next open technology to be familiar with is OPC Unified Architecture, or OPC UA, a machine-to-machine protocol for industrial communication developed by the OPC Foundation. OPC UA is manufacturer neutral and supported by all major PLC suppliers. It is standardized in IEC 61850 and designed for communication between PLCs, and from PLCs to ERP systems. In April 2018, OPC UA released PubSub (publisher/subscriber) for the lowest levels of the factory floor—controllers and sensors (1-10 ms range, i.e., for streaming real-time data). The main advantages include end-to-end encryption for high security and the fact that OPC UA is supported by many industrial device manufacturers with a large installed base. Further, OPC UA can be used in combination with the TSN for real-time communication between machines. With regard to industrial data communication, be sure to work with a cable supplier who is familiar with recent industry trends in connectivity and knows where the industry is headed. Better yet, look for a provider who is involved in the various workgroups that are developing the standards and helping define the specs for future industrial products.

UNDERSTANDING MQTT

Another modern protocol to become familiar with is message queue telemetry transport—MQTT—a very lightweight IoT protocol for small devices such as sensors and networks with high latency and low bandwidth. MQTT, standardized by OASIS (Organization for the Advancement of Structured Information Standards), is best described as an optimized solution for directly connecting devices from the lowest field level to the cloud. For example, a sensor could publish information such as temperature to an MQTT "broker," and this intermediate device could share it with a "subscriber" such as a cloud server or an enterprise-level server within the factory. All of this information can be exchanged without making any changes to the PLC.

SINGLE-PAIR ETHERNET

Originally used in the automotive industry, a new standard called single-pair Ethernet is making gains in IIoT connectivity in other industries as well. Consider that the PROFIBUS fieldbus had two cores to connect to cable with two cores. DeviceNet had four cores—two for data and two for the power supply. For industrial Ethernet, four and eight cores are typically used. The growing number of required cores was making installation more cumbersome, so the automotive industry spearheaded the

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movement to single-pair Ethernet, with new standards from IEEE (such as IEEE 802.3) in 2015. So, new chips were developed for automotive that support Ethernet communication for 10 Mbit/s, 100 Mbit/s and 1 Gbit/s with just one pair. Benefits include reduced installation effort and cost along with less demanding space requirements inside vehicles.

With regard to IIoT and connected field devices in factories, the most promising aspect of single-pair Ethernet is the ability to transmit data at 10 Mbit/s for 1,000 meters. This is a true fieldbus replacement because protocols such as PROFIBUS, DeviceNet and CAN bus also cover around 1,000 meters, but at a reduced data rate. Different user groups are now exploring single-pair Ethernet, including various industrial Ethernet, PROFINET and EtherNet/IP workgroups. Although it may take two or three years to see the first devices, proactive cable manufacturers are now developing cable and connectors to meet the requirements of single-pair Ethernet and “Ethernet to the edge” plant designs.

FOR MORE INFORMATION

Navigating the evolving world of communication protocols in the context of IIoT can be challenging. Today’s automation environments are still heavily reliant on wired systems including cable and connectors to transmit data and power over long transmission runs at incredibly fast speeds. Data integrity and speed are key. As smart products are developed to bring intelligence to the device level, specifying the appropriate physical layer of industrial data communication is more important than ever. Be sure to work with a cable provider who is knowledgeable about the various protocol choices and has products to meet the needs of both current and future plant layouts. For more information about specifying the best cable for your next application, contact the engineering team at LAPP USA.