Ethernet/IP Overview

Ethernet is gaining acceptance in the industrial arena. Personal computers, printers, and other peripheral equipment with Ethernet-ready Network Interface Cards (NICs) have moved into the industrial arena and, when used with intelligent switches and routers, Ethernet is gaining more and more acceptance. Only the lack of an accepted application layer and industrial-hardened Ethernet connectivity targeted at industrial automation has presented any barrier to Ethernet acceptance in the industrial arena.

Ethernet/IP is an industrial application layer protocol for industrial automation applications. Built on the standard TCP/IP protocols, it utilizes long-established Ethernet hardware and software to define an application layer protocol for configuring, accessing and controlling industrial automation devices. Ethernet/IP classifies Ethernet nodes as predefined device types with specific behaviours. The Ethernet/IP application layer protocol is based on the Control and Information Protocol (CIP) layer used in both DeviceNet™ and ControlNet™. Building on these protocols, Ethernet/IP provides a seamless integrated system from the Industrial floor to the enterprise network.

History

The physical medium of Ethernet, the cable and connectors that connect office PCs, printers, and other peripheral devices, handles a series of communication protocols such as IP (Internet Protocol), TCP (Transport Control Protocol) and numerous other network messaging protocols. This group of protocols and connectivity is well suited for the office environment. It allows users to share files, access printers, send email, search the Internet and perform all other communications used in an office environment. The needs on a factory floor are much more demanding and need to meet some special requirements. On the factory floor, controllers must access data from drive systems, workstations, and I/O devices. In normal operation, software makes a user wait while a task is being performed. Factory floor data, on the other hand, is time sensitive and requires real-time communications. Stopping a robotic welder or the fill operation on a bottle at the correct time requires very precise timing compared to accessing a file stored on a remote server or opening an Internet website.

Ethernet/IP is an application layer protocol that was designed for the industrial environment. There are four groups that have joined forces to develop and promote Ethernet/IP as a publicly available Ethernet application layer for industrial automation: The Open DeviceNet Vendor Association (ODVA), The Industrial Open Ethernet Association (IOANA), Control Net International (CI) and the Industrial Ethernet Association (IEA). Their common goals show how Ethernet/IP can provide a common standard suitable for a wide range of automation devices. These same groups are working on the physical layer connectivity requirements that are needed in the harsh environments of the factory floor.

Ethernet/IP Technology

Ethernet/IP uses all of the protocols of traditional Ethernet including the Transport Control Protocol (TCP), the Internet Protocol (IP) and the media access and signalling technologies found in all Ethernet network interface cards (NICs). Building on standard Ethernet technologies means that Ethernet/IP will work transparently with all the standard Ethernet devices found today. Even more importantly, basing Ethernet/IP on a standard Ethernet technology platform ensures that as the technology evolves, Ethernet/IP will evolve with it.

The groups supporting Ethernet/IP are working together to write a comprehensive, consistent standard. Work on Ethernet/IP is being performed by multi-vendor participation, includes writing the specification and thorough comprehensive testing at certified test labs.

Broadly Established Protocol Layer

Ethernet/IP is constructed from a broadly implemented standard used in DeviceNet and ControlNet called the Control and Information Protocol (CIP). This standard organizes networked devices as a collection of objects. It defines the access, behavior and extensions, which allow vastly different devices to be accessed using a common protocol. Ethernet/IP is based on widely understood and implemented standard.

CIP to Ethernet/IP

The advantages of the Control and Information Protocol (CIP) layer over Ethernet/IP are abundant. Offering consistent device access means that one configuration tool can be used to configure CIP devices on different networks from one access point without proprietary software. Classifying all devices as objects decreases the training and start-up costs required when new devices are incorporated into the network. Ethernet/IP lowers response times and greater data throughput than DeviceNet or ControlNet. Ethernet/IP links devices from bus level, to the control level, and to the enterprise level with a consistent application interface.

Industrialized Connectivity on the Factory Floor

Traditional connectivity products provide customers years of reliable service in the typical office environment. However, expose the same copper or fibre connectors to extreme conditions such as dust, temperature, moisture, electromagnetic interference, or vibration and performance and reliability will suffer. In harsh environments where exposure to some or all of these elements is a daily occurrence, the typical mated connection for Ethernet (i.e., RJ-45 outlet and plug) may corrode, wear, clog with debris, and eventually fail. In the end, customers are faced with high maintenance costs due to trouble-shooting and component replacement.

Enter a new breed of connector designed to deliver a robust Ethernet connection in even the harshest environments — tougher, stronger, and more resistant than any previous Ethernet connector. This new interface is commonly referred to as the "industrial connector", however applications are not limited to manufacturing. While the connector is designed to withstand the most punishing industrial conditions, applications will exist in environments subject to moisture, liquids, airborne contaminants, vibration and/or temperature extremes.

Industrial Connector Solutions Available Today

The Siemon Company has developed an industrial RJ-45 connector that meets all pending TIA and IEC requirements and has been recognized by ODVA. The Siemon industrial MAX outlet and plug provide superior resistance to harsh environmental conditions.

Siemon's industrial solution achieves an IP 67 rating primarily by means of a sealed RJ-45 plug and outlet. The plug's body has a unique bayonet-style coupling nut that mates with the outer shell of the outlet via a simple quarter turn of the coupling nut. The RJ-45 plug and outlet is category 5e compliant and can be field terminated to create custom length patch cords in the field.

The mating style prohibits ingress of moisture from either airborne humidity or by direct contact with liquid. Additionally, the mating style resists vibration by maintaining the plug's relative position to the outlet. It does not allow the plug to shift with vibration, which would otherwise cause damage to outlet contacts.

The Siemon Industrial MAX design also incorporates materials that are more resistant to chemicals and have wider operating temperature ranges than traditional connectors. The connector's expanded temperature range is from -25° C (-13° F) to 85° C (185° F). Compared to the operational temperature range for standard connectivity, Siemon's industrial connector expands the overall operational temperature range by over 50%.

Finally, for environments with high EMI, Siemon offers a screened (ScTP) version of the industrial connector. ScTP solutions, which are essentially UTP cable with an overall shield or foil, are ideal for environments where additional protection from EMI is needed to ensure the integrity of data signals. In addition to the screened cable, the connecting hardware also has high screening effectiveness and low transfer impedance to shield the data signal as it transitions from horizontal cable to the equipment cord.

Installation Challenges

Implementing Ethernet/IP is not without its challenges. A common problem is the lack of trained staff who understand both the IT fundamentals and the automation network. Both the Automation Team and the IT staff must work together to install and implement an Ethernet/IP system. Proper network configuration presents the second challenge. Correct planning of Ethernet factory automation infrastructure is critical. Careful documentation of the pathways, spaces, cabling, devices, and device connections is critical to meet the networks intended operation, as well as, having to choose the correct routers and switches. Ethernet/IP once installed correctly requires little maintenance.

There are many competitors to Ethernet/IP including Modbus/TCP, ProfiNet, HSE Fieldbus and many other proprietary protocols. Opposition to Ethernet on the factory floor often uses the argument that Ethernet lacks the level of fortitude needed in automation applications. While this argument would hold true in the past, intelligent switches have largely eliminated this argument. Switches create separate collision domains that offer the reliability required of just about all automation applications.

The movement toward Industrial Ethernet standardization and factory floor implementation is upon us.

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