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The Role of Ethernet in Today´s Industrial Applications

Author: Advantech ICOM Product Division

E-mail: CustomerCare@advantech.eu

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The Role of Ethernet in Today's Industrial Applications

Industrial Ethernet refers to the use of the Ethernet network protocol in an industrial environment, for automation and process control. A number of techniques are used to adapt the Ethernet protocol for industrial applications, which must be more reliable and provide real time behavior. By using non-proprietary protocols, automation systems from different manufacturers can be interconnected throughout a process plant. Industrial Ethernet takes advantage of the relatively larger marketplace for computer interconnections to reduce cost and improve performance of communications between industrial controllers.

Industrial Ethernet has experienced a surging adoption rates in recent years by providing an inexpensive communication and control network with a low total cost of ownership and virtually 100% uptime. A key to getting things right is the use of suitable technology, such as industrial managed switches. These devices are more rugged and intelligent than their consumer counterparts, a difference that enables them to offer advanced traffic control, greater redundancy, better security, as well as remote monitoring and management capabilities. All of these characteristics are important to successful networking in an industrial environment.

In general, Industrial Ethernet technology is ruggedized for use in harsh environments with special materials and longer product life cycles than consumer devices. But why has Industrial Ethernet, which was not originally developed for industrial applications experienced such success? That's because Industrial Ethernet:

- Is inexpensive compared to proprietary communication and control networks.
- Is well established, based on open standards, and has good market acceptance.
- Allows multiple protocols to exist on the same wiring and enables easy integration of systems and components from multiple vendors.
- Provides future-proof compatibility, very flexible network topologies, and is highly scalable.

Industrial vs. Standard Ethernet

Industrial Ethernet looks exactly like the office variety, at least with regard to signals on the wiring. As for the wiring itself, the two can also look quite similar. Standard Ethernet Category 5 (Cat5) and later (Cat5e and Cat6) cabling uses twisted-pair wiring that is transformer coupled, which provides noise immunity and ground fault protection required by industrial networks.

In other circumstances, though, Industrial Ethernet demands a different wiring solution. For runs longer than 300 feet, or about 100 meters, fiber optics is the best choice, as it offers total electrical isolation in electrically noisy environments. Because of vibration, solid wiring should never be used on a factory floor. For the same reason, special attention must be paid to cable terminations and connectors. For the former, a quality terminated cable or one adhering to the RJ45 standard should be used. For the latter, bulkhead connectors should be used beyond a panel. When it comes to machine-mount devices, specialized connectors, like RJ45 with a screw-on cap or the M12 industrial connector, should be used.

As might be expected, Industrial Ethernet has the form and fit required for a factory. They are also ruggedized, which means their protection against electromagnetic and radio frequency interference (EMI and RFI) is enhanced. Because plant floors can be harsh environments in terms of electrostatics, part of the ruggedization extends to improved protection against electrostatic discharge. Similarly, factories can be challenging with regard to temperature and vibration, so Industrial Ethernet components must function in these extremes. This is accomplished by shock and vibration protection and an extended temperature rating.

A final difference between industrial and traditional Ethernet lies in the life-cycle of products. Whereas those intended for the office may be obsolete in a few months, the availability of Industrial Ethernet products is measured in years, with a 5 to 7 year life-cycle being typical. The shared features of industrial and traditional Ethernet extend to the network topologies as well. Fortunately, Ethernet is extremely flexible, which means there are a lot of possible choices. At least one, and probably more, will almost certainly be the right one for a given situation.

Network Topologies

As for possible network topologies, those vary by application and include Star, Tree, Mesh and Ring. These configurations can be mixed and matched to give the best possible arrangement. A star topology works well for simple and small networks. In it, all nodes connect back to a central switch through a single cable. Because of its simplicity, a star layout is the easiest of all to implement. It would be suitable within a single panel or between just a few panels.

Managed vs. Unmanaged Switches

No matter what topology or mix of topologies is used, the type of switch selected can make a crucial difference between a successful network and one that is not. Switches process the basic Ethernet communication unit, a frame, at the physical and data-link layers, the first two in the seven layer OSI communication model. Switches are agnostic to higher layer protocols and have two basic transmission modes: one to one unicast or one too many broadcasts. Like all Ethernet devices, switches are identified by their MAC, or media access control, address.

When it comes to switches, the choice is between an unmanaged and a managed one. The first is a plug-and-play device that acts as network connection point. It receives a frame from a source and sends it to its destination. A managed switch, in contrast, is a more intelligent and robust device. It has its own processor and that intelligence brings a number of benefits:

- Manual port settings and advanced traffic control.
- Improved security.
- Remote monitoring and management.
- Greater robustness and media redundancy

As for security, a managed switch can limit access by Ethernet MAC address, using an allowed and blocked list. This method secures the network from unauthorized access. Another means of increased network security is a virtual LAN, a logical network that runs within a single physical network along with other logical networks. This restricts users and devices to only particular parts of the network.

A managed switch can mirror traffic from one or more ports to another, enabling remote traffic monitoring. A managed switch itself can be managed remotely, though a web interface or SNMP, the simple network management protocol standard

As for robustness, a managed switch will often have redundant network connections. The onboard CPU allows it to rapidly recover from a failure because the processor can quickly implement corrective action. In a ring configuration for example, if a link goes down than the switch can reach a device on the other end and thus heal the breach. Besides self-healing rings, managed switches can implement the Spanning Tree and Rapid Spanning Tree Protocols (RSTP) for recovery.

The benefits of managed switches are not free though, as managed switches are more expensive than unmananaged ones. Against that, though, must be weighed the cost of downtime. That will vary for different situations and different plant floors, but in many cases it will be substantial. That's particularly true for a factory full of expensive equipment, which may sit idle due to a network problem.

Even the best hardware and cables can fail, so there's a need for redundancy in those areas most likely to do so. One of these involves power supplies, which are usually the most common point of failure. Thus, having two or more power supplies in a switch can ensure that downtime is minimized. Another likely point of failure involves the links between devices. Cables can disconnect or break, which makes media redundancy important. This can be achieved by trunking,

which physically duplicates links, or through the use of a self-healing ring using RSTP or a vendor specific implementation for more rapid recover.

What about security?

At one time an afterthought, the security of an automation network is now increasingly important. This greater emphasis is partly due to the success in networking the factory floor. It's now possible to access devices from around the world, which makes them much more vulnerable to casual hacking or outright attack.

In some ways, security improvement ties into uptime efforts, since a compromised network is more likely to go down than one that has not been infiltrated. Here, again, managed switches can play an important role. Because they allow for the use of VLANs, managed switches can ensure that maintenance personnel or the HMI for operators on the line can only get to those devices that are needed to do the job. By disabling unused ports, managed switches can decrease the area vulnerable to attack, making an assault harder to carry out.

Conclusion

Industrial Ethernet is not only the best choice for networking in an industrial environment today; it's also the best choice for many years to come.