

Industrial Ethernet Technology

The trend in industrial communications and automation applications



As the world's network and information technology becomes more and more mature, the trend is to use Ethernet as the major communications interface in many industrial communications and automation applications. Users have found, however, that when moving Ethernet from the comfortable office environment to the harsh and less predictable industrial environment, the commercial Ethernet equipment available in today's market simply cannot meet the high reliability requirements demanded by industrial applications. This means that a more robust type of network equipment is required for these applications.

To begin with, more and more industrial device manufacturers, such as PLC, DCS system, and field I/O manufacturers, now produce products that come with a built-in Ethernet interface, and many standards organizations and societies are introducing and promoting Ethernet Industrial Protocol, which allows the above-mentioned industrial control devices to be integrated into the same application.

Furthermore, from the user's point of view, the most obvious benefit is that Ethernet is based on an open standard, the very reason why PCs ignited the information technology revolution and made great contributions to all of us over the years. By choosing Ethernet and Ethernet products, users don't have to worry about being bound by the product manufacturer's own proprietary protocol and network structure. This simplifies the user's task substantially, since many

different types of devices can be easily connected to each other by just plugging them into the same network.

The fact that Ethernet is an open standard guarantees more support for future technical advances compared with some proprietary control networks, thus increasing the flexibility of your system. As a simple example, consider the fact that the speed of Ethernet is steadily increasing, from the current standard of 10 Mbps, to 100 Mbps, to even 1 Gbps; in fact, a standard of 10 Gbps has also been established. For both current applications and future expansion, you can rest assured that ample bandwidth will always be available.



In addition, Ethernet is already commonplace in office environments, and makes possible many useful services and applications, such as e-mail, FTP, and web browsing, all well known to users. Applying these services in an industrial control network gives users a head start over the competition, since they do not need to spend a lot of time learning new application programs. This also means that training costs can be lowered, and development time can be speeded up, since system developers are already familiar with the software that is readily available for Ethernet applications.

Besides, when developers of industrial automation systems use the same Ethernet protocol as in the office, the entire system easily links the central MIS information network to the factory floor's device-control network. With this type of setup, the remote real-time analysis of

information from the field is no longer just a dream. Undoubtedly, in this age of competition for information and speed, Industrial Ethernet will bring huge benefits to enterprises.

The factors mentioned above highlight the benefits of using Ethernet. However, serious system developers have found that when moving Ethernet from the well-controlled office environment to the harsh and less predictable industrial environment, the commercial Ethernet communication equipment in today's market simply cannot meet the high reliability requirements demanded by their industrial applications. This means that only network equipment with a more robust and industrial oriented design can fulfill the requirements of these types of applications.



Ethernet equipment designed to connect industrial devices in an industrial environment

As Ethernet moves from the office to the factory floor, it is important to keep in mind that the purpose of commercially available network equipment, such as an Ethernet switch, is for connecting PCs, printer servers, and other devices that are designed to work in the comfort of offices and climate-controlled corporate machine rooms.

This means that if you purchase Ethernet communication equipment that was originally designed for office applications, but then use the equipment in your demanding industrial environment, you run the risk of causing tremendous damage to your industrial system. Because each industrial device, such as a PLC, is networked, the device plays a very important role when it comes to the operation of the entire industrial system. This is unlike the average office application, in which the failure

of Ethernet communication equipment might merely mean that a few PCs cannot send e-mail messages for a couple of minutes. But when an industrial device loses its connection to the network, the result could be a huge financial loss.

When choosing Ethernet communication equipment to fulfill the requirements of industrial applications, and to ensure that your entire industrial system keeps running smoothly, you should keep the following points in mind:

- **Higher reliability, compared to office products, is essential for industrial applications**
- **Providing fast recovery capability and security helps ensure continuous and safe industrial operation**
- **Dynamic status reports that give the status of industrial equipment and devices can prevent system damages and losses**
- **Key management functions make it easy to master industrial Ethernet networks**

Higher reliability, compared to office products, is essential for industrial applications

A whole new industry has sprung up to provide Ethernet products that comply with the requirements of demanding industrial applications. To ensure essential reliability for industrial applications, users should at least demand Industrial Ethernet products that come with the following features:



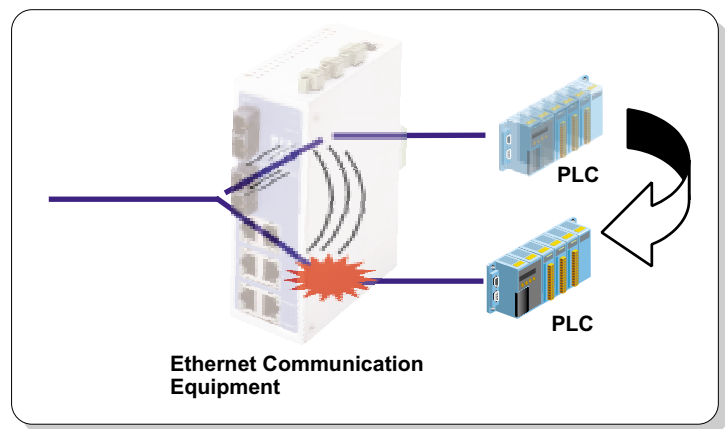
- Redundant power inputs to prevent single power failure
- Ring topology support to provide redundant path backup
- Industrial Ethernet products built with components that are better quality and more reliable, ensuring a higher MTBF (e.g., industrial equipment does not use fans, since fans have a short life cycle).
- The ability to withstand extreme temperature conditions, such as from -20°C to 70°C.
- Industrial Ethernet products designed with a rugged high-strength case to keep out harmful substances.
- Industrial Ethernet products that not only comply with industrial regulatory conditions (CE, FCC, UL, etc.), but also are designed to withstand shock, drop, and vibration conditions.

Providing fast recovery capability and security helps ensure continuous and safe industrial operation

The above list only gives the basic requirements for industrial applications. When considering industrial communications, reliability means more than just a strong casing and good endurance to extreme temperatures, but also involves more fault resilience functionality.

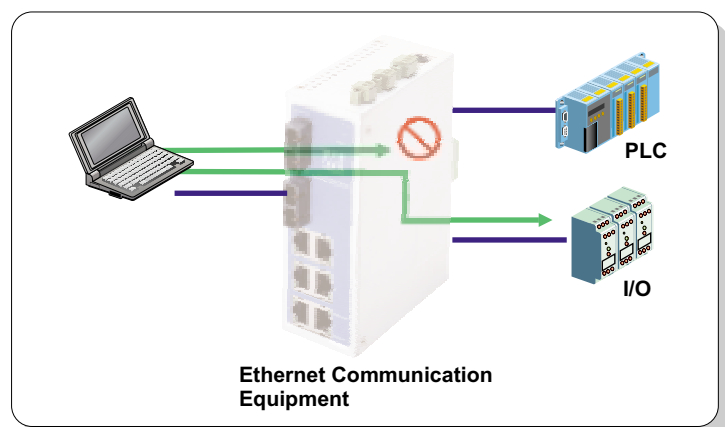
In the office, a 3-minute communication failure could be passed off as a minor inconvenience, whereas in an industrial setting, the same 3 minutes could cause a tremendous loss in investment. With this in mind, the following self-recovery functions can provide the essential functionality needed to keep the network running continuously.

- Self recovery watch-dog to prevent random service interruptions
- Line-swap fast recovery that responds when devices change their port position, so that networked devices can keep communicating without facing several minutes of downtime.



Another important consideration is that when industrial Ethernet communication equipment is used as part of an automation system, it is more often used to connect devices, as opposed to computer hosts. And since all automation systems incorporate sensitive devices that must be protected from unauthorized access, it is very important to have some type of authentication system set up that only allows authorized users to access the system.

- Isolate selected groups of devices to prevent unauthorized access

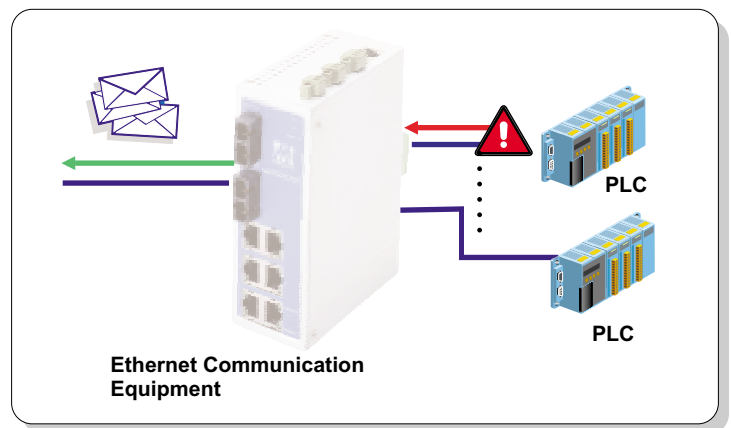


Dynamic status reports that give the status of industrial equipment and devices can prevent system damages and losses

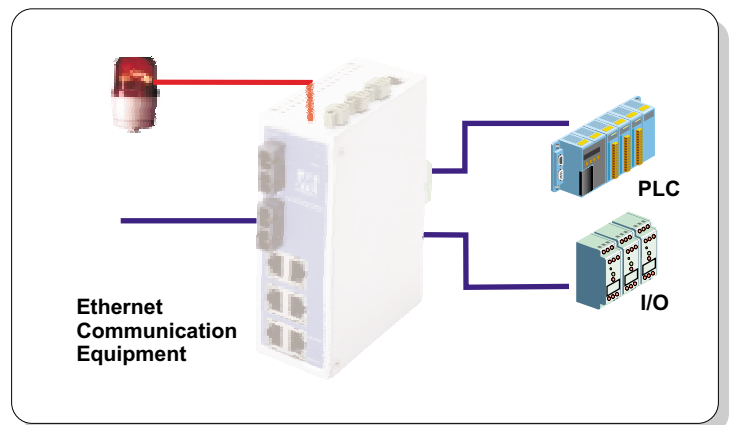
Since industrial Ethernet devices are often located at the endpoints of a system, such devices cannot always know what's happening elsewhere on the network. This means that industrial Ethernet communication equipment that connects these devices must take responsibility for providing system maintainers with real-time alarm messages. Even when control engineers are out of the control room for an extended period of time, they can still be informed of the status of devices almost instantaneously when exceptions occur.

The traditional way of determining device status is to poll devices periodically, but this is not "real-time" enough, and is not very efficient. Warning messages must be actively triggered by events. In consideration of these requirements, industrial network equipment must have features such as:

- Send out a warning message (e.g., by e-mail) when an exception is detected, such as when an important device is disconnected or network traffic is overcrowded



- Provide signal outputs (e.g., digital output, relay contact) to warn engineers in the field, so they can respond quickly with appropriate emergency maintenance procedures.



Key management functions make it easy to master industrial Ethernet networks

- **Identify network segment integrity by sending a *ping* command**

Troubleshooting a network that is experiencing problems can be a real nightmare for maintenance personnel. Quick recovery from network problems is particularly important for industrial applications, since when communication is interrupted, production lines could be halted while waiting for the communication problems to be fixed. The first problem is how maintenance personnel can quickly and effectively find which network segment needs to be fixed. Being able to send ping commands that originate from key Ethernet communication equipment gives network maintainers an essential tool for diagnosing such problems.

- **Assigning IP addresses to connected devices**

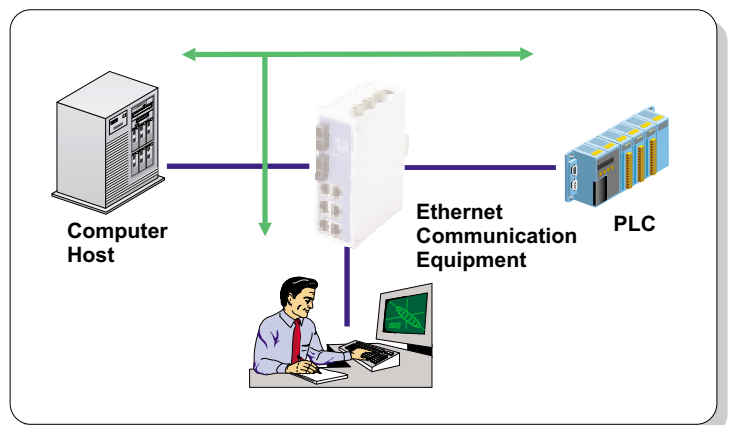
Setting up IP addresses is one of the biggest headaches faced by maintenance personnel assigned the task of connecting industrial Ethernet-enabled devices to a network. Unlike PCs, most industrial devices are essentially a black box, and do not come with a direct human interface. Once the network topology changes or maintenance personnel change, the bothersome process has to be repeated. Making use of Ethernet communication equipment that can automatically set up your devices' IP addresses can help reduce the effort.

- **Remote data scope analyzes local network behavior from a remote location**

The remote data scope utility allows users to easily monitor specific network behavior from a remote networked PC. This utility operates in a manner similar to a regular Data Scope, by allowing users to set a trigger condition, capture port data, and monitor signal status with time stamp. The difference, however, is that instead of monitoring equipment located right next to the Data Scope, users can monitor activity from a remote location, thus giving one maintenance person the ability to monitor many different devices dispersed over a wide area.

- **Setting up mirroring ports for better online data monitoring**

Sometimes a network is so large that it is difficult to achieve the expected communications behavior. Industrial communications applications use more of a command-response style than the file-transfer style used in office network environments. This means that when first setting up an industrial Ethernet network, control engineers may need to use a second port to monitor the actual activity between their devices and computer host. This mirroring port helps to ensure that the system behaves as expected.



- **SNMP support for easy network analysis**

SNMP (Simple Network Management Protocol) is the most popular network analysis protocol used with today's network technology. In fact, it includes many types of well-defined parameters that are available to help you analyze network problems. For example, if too many packets are being broadcast over the network, causing network traffic to build up, it could be due to a device with a bad link, or because of interruptions caused by someone who connects to your network without permission. SNMP gives you the ability to obtain this type of information anytime, and from virtually anywhere.

- **OPC Server support for easy integration into your automation system**

The OPC specification is a non-proprietary technical specification that defines a set of standard interfaces based on Microsoft's OLE/COM technology. The application of the OPC standard interface makes possible interoperability between automation/control applications, field systems/devices, and business/office applications. Traditionally, each software or application developer was required to write a custom interface, or server/driver, to exchange data with hardware field devices. OPC eliminates this requirement by defining a common, high performance interface that permits this work to be done once, and then easily reused by HMI, SCADA, Control, and custom applications.

Conclusion

The benefits of using industrial Ethernet technology with industrial automation systems are now generally accepted by the industrial community. These benefits include the open architecture of Ethernet and TCP/IP, as well as the continuous upgrading of technology, such as an increase in transmission speed. We have also established the fact that commercial Ethernet communication equipment is definitely not suitable for use in industrial environments. This means that a special type of Industrial Ethernet product is required. We not only need Ethernet communication equipment that has a hardened industrial design and that must work in demanding environments, but also equipment that comes with many useful management and monitoring functions. Such functions include a self recovery watch-dog, the ability to isolate selected groups of ports, and the automatic issuance of warning e-mail when an exception to regular network or device operation is detected. Additional functions that users should look for are the ability to send *Ping* commands to detect which network segment has problems, the ability to set up IP addresses of connected devices, and an implementation of mirroring ports to monitor true port activity.

State of the art Industrial Ethernet products should provide:

- ◆ **The ability to keep industrial automation systems running continuously**
- ◆ **Real-time alerts that provide the status of networked industrial devices**
- ◆ **The capability to easily master the integrity of the industrial network**
- ◆ **An industrial device oriented design**