THE SMART APPROACH TO INDUSTRIAL ETHERNET

Installing an Ethernet-based network is not enough. To maintain the level of performance and security expected of plant control networks, intelligent Ethernet services should be implemented.

By Larry O'Connell, Product Manager, Cisco Systems

The Collins Pine sawmill uses the power and flexibility of the Ethernet/IP standard to network all its machine centers. Upstream machine centers can monitor downstream equipment continually and use the information to redirect materials, modify cutting solutions and regulate speed.

>> Ethernet was once thought to be a front-office-only networking application, but its blue-collar brother — often referred to as industrial Ethernet — is rapidly making its way onto the factory floor. According to the ARC Advisory Group, Ethernet is becoming the technology of choice for manufacturing control networks. ARC predicts that millions of Ethernet-enabled devices will be deployed in manufacturing automation applications over the next five years.

The most widely understood networking standard today, Ethernet delivers many benefits when used in an industrial application, including cost savings, availability of information and scalability to support a wide variety of applications on the plant floor. Deploying an Ethernet-based network, however, is not enough. To maintain the level of performance and security that is expected of plant control networks, *intelligent* Ethernet services should be implemented.

Network intelligence refers to the optimization of your network in three key areas: reliability, determinism and security. An example of an intelligent network is EtherNet/IP, one of the leading open industrial networks. It provides industrial features and supports the TCP/IP/UDP standard to provide a suite of services that are essential on the factory floor.

Reliability

EtherNet/IP operates using what is known as a "producer/consumer" model in which intelligent devices send streams of data into the network, making it available to any other device that wants to read it. To communicate in this way, EtherNet/IP uses "multicast" functionality found in the standard TCP/IP stack. By definition, multicast data is delivered by default to *every* device on the network. In some industrial configurations, you will need to reduce the load on the network by limiting multicast communications to only those areas or devices that need the data.

Two intelligent switching features are essential to limit multicast traffic: Virtual local area networks (VLANs) and Internet group management protocol (IGMP) snooping. VLANs limit the transmission of network multicast transmissions to specified networks. Switches supporting

IGMP snooping will not transmit data to a device that did not request it. VLANs are easy to configure, and IGMP snooping should be enabled as a default feature.

In addition, a network also must recover quickly if one of its links fails. Two Ethernet standards support redundancy in networks: the spanning tree protocol (STP) and the rapid spanning tree protocol (RSTP). These are designed to enable the network to adjust its topology and redefine "point A to point B" data paths for every device in the network. STP should be a default feature in the Ethernet network, and RSTP can be configured for networks requiring recovery times as quickly as sub-second.

Determinism

A common misconception is that Ethernet is not a deterministic technology. This needs some clarification. Full-duplex transmission using switches provides a level of determinism that is excellent for most applications, while half-duplex transmission using hubs cannot provide any degree of determinism and should be avoided. How can the network then be configured to guarantee determinism, even during times when it is overloaded with data transmission? This is where Quality of Service (QoS) is essential.

QoS standards specify multiple data "queues." Each queue has a priority level that can be assigned to a particular type of data. For example, the highest-priority queue is assigned to mission-critical data (such as control messages). This assures that these messages will always be transmitted before any others, and the network remains up and running even when highly con-

Ethernet in Real Life: The Collins Pine Story

The Collins Pine sawmill in Chester, Calif., was outdated and failing to meet its production requirements. The only solution was to rebuild the mill completely using modern technology. Since the right control system was crucial to the success of the project, the Collins plant engineers enlisted the help of Solution Provider Concept Systems Inc. of Albany, Ore., to provide the controls and integration services.

Concept Systems developed a controls platform for each of six machine centers using proven off-the-shelf hardware. Common PLC, motion control and human-machine interface (HMI) platforms were used throughout the mill. This simplified and cut the cost of programming, operating and maintaining the systems and kept the spare parts inventory to a minimum.

Collins' breakthrough sawmill design uses the power and flexibility of the EtherNet/IP standard to network all the machine centers. Upstream machine centers can monitor downstream equipment continually and use the information to redirect materials, modify cutting solutions and regulate speed to keep processes running and reduce operator intervention.

EtherNet/IP was selected as the standard communications medium at all levels, from I/O drops to motions controllers, and for HMI and optimizer communications. The entire mill was connected to the company's intranet. All PLC programs, all motion controller configurations and most HMI interfaces followed the same design architecture.

Concept Systems chose an Allen-Bradley ControlLogix 5555 controller platform because of its proven record of performance and support, and because of its ability to fit in seamlessly with the desired network architecture. The ControlLogix platform offered the processing speed required, near-deterministic communications using the EtherNet/IP protocol, and a tag-based database structure that supports writing modular, easily maintainable control programs.

"The selection of EtherNet/IP as a networking standard was an obvious first choice," says Ed Diehl, co-owner of Concept Systems and project manager for the controls portion of the Collins mill upgrade. "First we evaluated the needs of Collins Pine. Like most companies today, they wanted access to information from any machine center from any place in the mill. Collins also desired a network platform that would easily tie into the mill's existing Ethernet intranet. Concept also required a networking platform that could handle the high-speed communications to remote I/O stations, the motion controllers and the optimizers. EtherNet/IP is able to meet all these requirements very cost-effectively."

EtherNet/IP makes data requests and all peer modules on the bus broadcast at determined intervals. Because of the large amount of communications that can take place between local control system elements within the machine environment, local switches were installed, reducing bandwidth loading on the central router.

Each HMI node on the sawmill network is a Dell computer. Concept Systems' engineers use WebX, a Web-based application that allows remote computers to access other computers over the Internet, to access the Collins mill HMI computers over the Web. Concept runs Rockwell's RSView32 HMI development software or RSLogix 5000 PLC programming software and can tune and troubleshoot the machines' operations remotely.

Concept Systems' expertise in motion control, networking and knowledge of Rockwell Automation's products, make it part of the exclusive group of Rockwell Automation Solution Providers in the U.S. This article is based on one that appeared in the August, 2003 issue of Machine Design by Brad Smith, Delta Computer Systems, Inc., Vancouver, Wash.

Concept Systems:
www.conceptsystemsinc.com
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Rockwell Automation Networking Products and Services

Here are the latest Rockwell Automation products to help you more easily design, install, manage and maintain your industrial networks.

- **1734-ADNX Point I/O DeviceNet adapter.** A cost-efficient option for upgrading an existing system from an Allen-Bradley 1734-ADN, increasing the distance between a device or sensor and the controller, amplifying the node count connected to a DeviceNet link scanner or bridging multiple DeviceNet links. (www.ab.com/catalogs/b113 /io/1734.html)
- **1734-AENT Point I/O EtherNet/IP adapter.** A cost-effective, networked interface for highly distributed architectures where system determinism and repeatability are valued. Compatible with ControlLogix v.11 controllers and RSLogix 5000 v.11 software. (www.ab.com/catalogs/b113/io/1734. html)
- **AutoConfig enhancements.** AutoConfig enables a scanner to map automatically a network of slave devices into its scan lists without the use of RSNetWorx for DeviceNet, improving the ease of setting up a DeviceNet net. Another linking device, the 1757-FFLD, enables the direct connection of Allen-Bradley Logix controllers with Foundation Fieldbus H1 devices via EtherNet/IP and Foundation Fieldbus High-Speed Ethernet networks. (AutoConfig: www. ab.com/ manuals/cl/1756-rn567h-en-p.pdf 1757-FFLD: www.ab.com/manuals/pl/1757-in021b-en-p.pdf)
- **CIP Safety.** An extension to the existing CIP protocol, CIP Safety allows both standard and safety devices to operate on the same network. CIP Safety allows safety devices to seamlessly communicate across other CIP-based standard networks, such as DeviceNet, ControlNet and EtherNet/IP networks, to other safety devices with no additional programming. (www.ab.com/ networks/cip_pop.html)
- **CIP Sync.** Adds time synchronization services based on IEEE-15ii for real-time control applications to CIP. (www.ab.com/networks/cip_pop.html)
- **Industrial Network Services.** Offered through the Global Manufacturing Solutions group, Industrial Network Services can provide network consulting, assessments, design, installation, validation, troubleshooting, maintenance and training for ControlNet, DeviceNet and EtherNet/IP.
- **FAMACC Network Health.** This service provides centralized monitoring and management of enterprise-wide control network assets, coupled with distributed access to the tools needed to maintain devices on the networks. It can help reduce and prevent downtime, leading to lower maintenance and support costs, increased system availability and reduction in total cost of ownership for DeviceNet, ControlNet and EtherNet/IP networks. (http://support.rockwellautomation.com/supportprograms)

ControlLogix: www.ab.com/catalogs/b113/controllogix/overview.html
RSLogix 5000: www.software.rockwell.com/rslogix/
RSView32: www.software.rockwell. com/rsview32/

gested. Other types of traffic are assigned lower priorities. For example, the next-highest priority may be assigned to alerts and a lower priority to configuration, performance monitoring and health diagnostics.

QoS parameters may be assigned based on many variables:

- Physical interface
- Device that transmitted it, such as the media access control (MAC) address.
- Network (IP) address.
- Application that it is running (TCP port).

Applications running EtherNet/IP can prioritize specific messages to ensure determinism in the network.

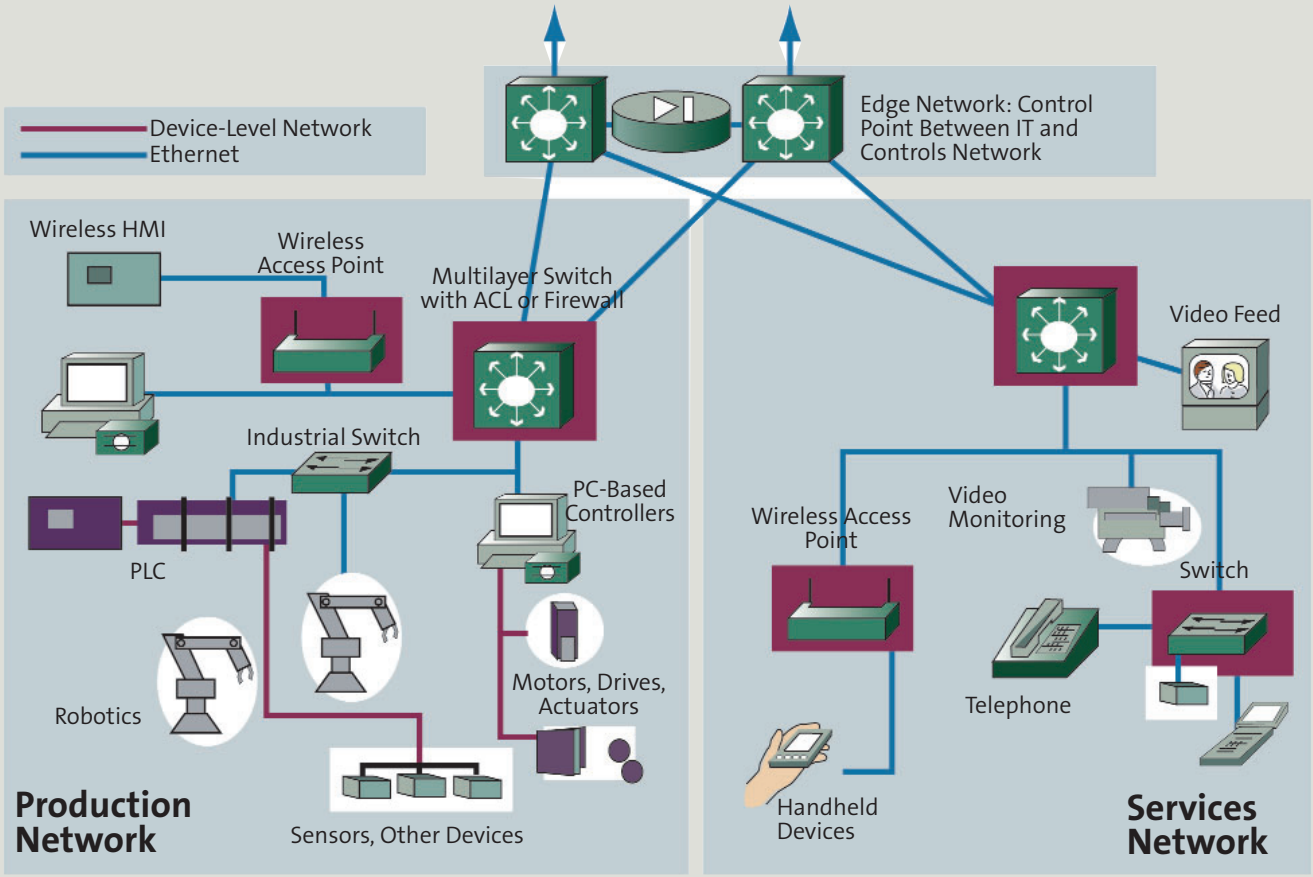
Security

Two general concerns arise when it comes to securing the industrial Ethernet network. The first is at the plant level, where firewall and virtual private network (VPN) applications are deployed to protect the overall plant from outside threats. The second is within the actual production line, where the concern is protecting the network against the unintentional injection of data into the production process.

For example, the production line should be transmitting control and configuration data only — a large Internet file download should not travel through the production line's network. If an employee accidentally plugs a laptop into the wrong network port, the laptop should not be able to transmit data into the production network.

These concerns are addressed by using an intelligent service known as access control. Access control lists (ACLs) restrict access according to preset parameters, based on the same variables described above for QoS. The protection network will

An Intelligent Ethernet Network



A robust, intelligent network delivers more than a solid industrial system. The network can scale to handle any technology that is based on IP. For example, wireless 802.11 applications eventually could be delivered by leveraging the same infrastructure.

block any data that did not come from an authorized port, device, network or application.

Looking Ahead

A robust, intelligent network delivers more than a solid industrial Ethernet system. The network infrastructure can now scale to handle any technology that is based on TCP/IP standards. In time, wireless 802.11applications can be delivered by leveraging the same infrastructure. A Voice-over-IP (VoIP) network can be deployed easily when it is time to upgrade from the legacy private branch exchange installation. Finally, the coaxial cable video security network in the plant can be upgraded to an all-IP video model.

All of these networks (production, wireless access, voice and video) are logically separate and secure: Data for these applications is not mixed. They are also deployed using the same networking hardware and software technology. The overall operational cost savings potential for the entire enterprise is an appealing proposition.

Ethernet is an exciting technology that brings a number of benefits to the factory floor. It is important to deploy an intelligent Ethernet network to support the infrastructure and to address the issues of reliability, determinism and security. The investment will pay off as your enterprise moves to run all of its applications on a cost-effective, scalable Ethernet platform. ABJ

Cisco Systems is a Rockwell Automation Encompass Partner specializing in networking systems. As a leading supplier of Ethernet gear, Cisco delivers products and features that enable greater acceptance of Ethernet for factory control and information applications.

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