



Cover Story

Who Puts the 'Industrial' in Ethernet?

Switches, routers, hubs, gateways, connectors, and other Ethernet hardware have been industrially hardened to take what manufacturing can dish out.

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Industrial Ethernet hardware can take plant-floor punishment without pampering in enclosures, allowing shorter cable runs with simpler distributed (rather than centralized) designs, and higher reliability than commercial-level Ethernet switches, routers, hubs, gateways, and connectors. Industrial ratings (such as NEMA 4x or IP67 and beyond) applied to Ethernet hardware mean that equipment can handle temperature extremes (as much as -40 to 85 °C), and even liquid and dust, and maintain reliable performance for years

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If commercial Ethernet devices are reliably enclosed and cooled, that might be enough to preserve reliability. Beyond that, higher costs for industrial design will cut down on mean time between failures, possibly preventing a process interruption or data loss. It all depends on the application. Cisco Systems Inc., for instance, while well-known in various network application spaces, is among companies that realize that industrial environments pose rugged challenges. Cisco forged agreements with Honeywell and Rockwell Automation, who have greater understanding of customer needs in process and discrete manufacturing operations.

Industrial wrapping

Enclosures can work wonders, admits Tom Edwards, senior technical advisor, Opto 22. Edwards contends that installation is mainly "what makes Ethernet hardware suitable for industrial environments.... Most of the off-the-shelf equipment is perfectly suitable for industrial installation if it can be protected from the normal bumps and scrapes ... in these types of settings. Most of the extra cost of 'industrial' equipment is the packaging added to keep it from being damaged and to make it fit in a 19-in. rack."

To make an Ethernet device industrial, says Greg Paukert, product manager, Tyco Electronics, using impact resistant plastics and rubber materials "seals against many chemicals including water to give the product a 10- to 20-year performance life." Connectors that use a positive locking coupling system ensure the interconnection is "fully-engaged and properly mated," Paukert adds.

When people think of industrial grade, they think of hardware that can operate under the harshest conditions, says Chris Harris, communications product manager, AutomationDirect. Various standards apply to making Ethernet industrial.

"Industrial hardware is expected to operate properly even when subjected to extreme temperatures, power surges (IEEE-472), extreme vibration (IEC 68-2-6), and when in hazardous locations [UL 1604, CSA C22.2/213 (Class 1, Div. 2)]," Harris says.

How often a switch is exposed also makes a difference, says Richard Hutton, automation product manager, Schneider Electric North America. "If a switch or cable is being accessed frequently, a more rugged connection point or device is required."

Signal interference

Skip Hansen, I/O systems product manager, Beckhoff Automation, explains that a "noisy environment may be one with welders, variable frequency drives (VFDs) and induction heaters. The switches used should have the ability to be mounted in a control cabinet or stand alone. In the case of stand-alone, switches certified to the IP67 protection class should be considered."

Other contributors to industrial electrical noise include solenoids, motors, and motion controls, says Larry Komarek, Phoenix Contact automation product manager, Americas Business Unit. "Industrial Ethernet devices designed to the IEC 61000-4 series of specifications have two to three times higher electrical noise immunity than commercial devices, which are typically designed to the EN 55024 and 50082-1 specifications," Komarek says. Paukert from Tyco says expects more use of "shielded, plated plastic receptacles for >20dB down shield effectiveness."

Hardened cabling

Whether network devices are distributed and exposed, or centralized and enclosed, "commercial off-the-shelf (COTS) Ethernet cabling and connectivity are not tough enough to withstand these stressors and continue to deliver the signal transmission performance required for automation and control networks," says Frank Koditek, Belden industrial market manager. Within a plant, Koditek warns, networking components, as well as their cables, may be exposed to temperature extremes, sunlight, solvents, oils, moisture, and chemicals.

They're also subject to mechanical stresses on cables from excessive pulling, and the risk of abrasion, crushing or cut-through resulting from plant floor activities. Category 6 or 5e Ethernet cables avoid "classic network failure scenarios, from incremental damage and performance degradation, to intermittent operation, to catastrophic failure," Koditek says.

Connectors, network failures

Connectors matter, as well. Ed Nabrotzky, general manager, industrial communication, Woodhead Industries, says, "Almost 70% of network failures happen because of a mechanical failure involving the cabling and connectors. Things can be jarred loose, worn out, improperly installed after a shut down, or even severed after being driven over by a forklift. Commercial grade cables and plastic connectors simply aren't made to withstand the abuse present on the factory floor." Special materials and design techniques create rugged products that can survive industrial conditions, Nabrotzky says.

Some off-the-shelf RJ45 connectors perform adequately when tested against the recognized shock and vibration specifications; others do not, says Brian Oulton, marketing manager, Logix/NetLinx Business, Rockwell Automation. "Many industrial Ethernet standards also recognize IP65 and IP67 environmentally sealed connectors (for example, M12) that are effective in many industrial applications," Oulton says.

Tougher protocols inside

In addition to hardened devices, cables, and connectors, plant-floor applications also can require industrial protocols running over Ethernet physical layer.

Choice of protocols "depends on the nature of the automation equipment in a particular location," says Brian Tutor, product manager for Lantronix, "however the most commonly utilized protocols in industrial environments are Modbus TCP, EtherNet/IP, and Profinet. (*Control Engineering* provided research on Industrial Ethernet protocol usage in the December 2006 issue.) "Typical rugged characteristics of Ethernet protocols include: wide temperature (-40 to 70 °C), high shock and vibration tested, electric isolation and FM Class 1, Div. 2 approval for hazardous locations," Tutor says.

Rockwell's Oulton suggests that industrial Ethernet protocols and connected products should contain appropriate error checking and diagnostics to take action if communications is in-error or interrupted. "For example, many protocols contain checksums and appropriate acknowledgement to ensure timely and reliable data delivery, and many I/O products are designed to move to a user-selected value if communications stops," Oulton says.

Switched Ethernet cuts collisions

Today's switched Ethernet has moved past prior issues with communications reliability and performance, according to Paul Wacker, product manager, Advantech Inc. "Network contention issues (called collisions) have virtually been eliminated with the use of Ethernet switches, which intelligently forward messages from one device to another, ensuring deterministic performance," Wacker says. "Magnetic coupling and differential signaling utilized by 10/100 Base-TX Ethernet reduces communications disturbances caused by differences in ground potential between devices and external EMI/RFI sources. For additional levels of protection, fiber optic cable should be used."

Schneider Electric's Hutton likes industrial Ethernet hardware designs that incorporate added security or redundancy measures to keep a system up and running, such as the use of rapid spanning tree functionality, individual IP address filtering and the use of fiber optic dual cabling.

Installation, maintenance

Because industrial Ethernet is rapidly becoming the primary real-time network within and between automation control systems, Phoenix Contact's Komarek says, network infrastructure products often are supported by the plant floor personnel who support the control systems. "Software configuration interfaces, wiring and mounting arrangements must be similar to the PLC/PC-based control systems they are supporting," Komarek says. "In IT-based systems, software configurations are made in DOS-like text screens. Industrial options such as memory modules, diagnostic displays, etc., allow installation by plant personnel without access to laptops. IT devices rely on a central supervisory console to diagnose system status."

Self-serve design is an advantage, adds Hutton, when "industrial Ethernet systems are being designed for minimal upkeep with simple tools and interface methods like Web browser views for data and configuration. Plant maintenance personnel can maintain and monitor the system themselves, rather than waiting for an IT professional for assistance."

Mounting expediency is another reason to go industrial, says Moxa's Lee. Industrial Ethernet switches are often housed in rugged metal enclosures using DIN-rail or panel mounting options, he says, while most commercial switches cannot mount conveniently inside control panels without the inefficiencies of building a shelf and strapping the unit in place. Also, Lee adds, industrial grade equipment often has an alarm contact, which could help avoid or minimize downtime.

Capital versus lifecycle costs

Sometimes people select commercial products because of lower capital costs. Lifecycle costs can make an industrial design worth the investment when environmental factors cause more frequent replacement of commercial products.

Companies with capital cost constraints no longer have to choose lower-cost commercial products that are less rugged, suggests Larry Winchester, business development manager, Ethernet Direct. "Many companies are using commercial switches or unmanaged industrial switches due the high price of industrial managed switches. Ethernet Direct has lowered the cost of Industrial Ethernet products up to 40% compared to other industrial brands without sacrificing quality, reliability, and performance," Winchester says, by automating comparison, selection, quotation, and ordering. Online support and extensive industrial Ethernet reference libraries provide a high level of support, he adds.

For more information, visit:

www.ab.com/networks/ethernet.html (Rockwell Automation)

www.advantech.com

www.automationdirect.com

www.beckhoffautomation.com

www.belden.com

www.cisco.com/web/strategy/manufacturing

www.ethernetdirect.com

www.gefanuc.com

www.lantronix.com

www.moxausa.com

www.opto22.com

www.phoenixcon.com

www.tycoelectronics.com

www.us.schneider-electric.com

www.woodhead.com

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Industrial Ethernet: Switches, hubs, gateways

Industrially hardened Ethernet products abound, and numerous technical papers and spec sheets describe essential attributes. In addition to the resources listed here, find more linked to this article at www.controleng.com/archive for June 2007.

Industrial Ethernet expands networking globally

Industrial technologies are helping expand the world's \$1.7 billion industrial wireline networking infrastructure market, according to a Venture Development Corp. (VDC) research study. "Industrial Networking Global Market Intelligence Service" projects the global market for network infrastructure products shipped for use in industrial facilities will increase at almost a 25% compound annual growth rate (CAGR) through 2011.

Of three regions in the research (Asia-Pacific; Europe, Middle East, Africa; and the Americas), the highest overall market growth rate through 2011 is forecast for Asia-Pacific. In the markets studied, much of this investment is being directed toward Ethernet-based networking products.

Industrial network shipments to Asia-Pacific markets were \$298 million in 2006. Of that total, 76% were products for Ethernet networks, and the Ethernet share is forecast to increase to over 81% of a \$1 billion market in 2011. These are the highest Ethernet shares among the three regions. Bus and network use in the other two regions is more established and harder to displace, though Ethernet shares there also are expected to increase, VDC says. www.vdc-corp.com