

Ethernet Infrastructure

Environmentally hardened design is key to superior network performance, reliability.

By Brian Shuman

With industrial Ethernet becoming the preferred data communications infrastructure for mission-critical industrial automation and control, the challenge is to design an infrastructure made to withstand extreme environmental conditions. Built on the same standards-based networking platform as enterprise Ethernet (Ethernet LAN standard IEEE 802.3), industrial Ethernet provides secure and seamless interoperability when connecting the plant to the central administration office and the Internet.

Every industrial site imposes harsh conditions that can threaten the performance of communication system components. In water and wastewater treatment plants, cabling, connectivity, and networking devices must endure high levels of humidity, grit, sludge, and other contaminants. In some cases, lime, iron, and corrosive gases such as methane, hydrogen sulfide, and chlorine can contribute to the deterioration of electronic equipment.

These factors can wreak havoc on networks tasked with transmitting signals among instruments for measuring fill levels, flow rates, oxygen, pH levels, and the like, and the programmable logic controllers (PLCs) that interpret the signals. In addition, remote facilities such as storage tanks and pumping stations are frequently unstaffed and housed in locations exposed to temperature and weather extremes, making it even more critical to install hardened telemetry components.

The Real Costs of Downtime

Analysts report that a large percent-

age of unplanned downtime in industrial operations can be attributed to network infrastructure failure. According to one network management report, fully 72 percent of network faults can be attributed to failure at the OSI (Open Systems Interconnection) Layer 1 (Physical Media), Layer 2 (Data Link) and/or Layer 3 (Network).

In water/wastewater treatment plants, downtime is not an option. These facilities rely 24/7 on automation, instrumentation, and control data communications to relay signals and activate events on an exacting schedule, with little or no margin for error. If a switch, connector, or cabling system should fail, the cost of parts replacement and repair represents only a tiny fraction of the overall costs associated with downtime.

The indirect costs of Ethernet system failure include lost productivity, delayed processes, cost of system shutdown and start-up, possible lapses in security and safety, and the loss of service to customers relying on the plant's mission-critical output. These indirect effects can send total downtime costs soaring to hundreds of thousands, even millions of dollars.

This dire scenario can largely be prevented by installing a robust, ruggedly engineered network infrastructure, which enables the facility to carry out its functions with the highest possible level of network performance, reliability, and uptime.

Select Hardened Components

In office settings, the Ethernet infrastructure is installed in a relatively clean, quiet environment in which cables, hardware, and connectivity components

are sheltered and protected. Industrial facilities present a different reality. Here, many network components reside in harsh and potentially hazardous settings, which even the best commercial off-the-shelf (COTS) Ethernet systems are not made to withstand. These harsh environments typically expose network components to temperature extremes, UV radiation (sunlight), moisture, humidity, and exposure to chemicals and other contaminants—all of which can seriously degrade the cables' physical integrity and electrical performance, resulting in intermittent outages or even total system shutdown.

That is why, in specifying industrial Ethernet physical media, data links, and network hardware, it is extremely important to select hardened, industrial-grade components offering rugged construction and durability to provide optimal performance over a long service life. Following are some selection guidelines.

Physical Media—Cabling and Connectivity.

For the physical media layer, there are a host of industrial-grade products that conform to the Ethernet LAN.IEEE 802.3 standard, while resisting the effects of sunlight, volatile temperatures, moisture, and chemicals. Industrial-grade cables will operate effectively in a wider temperature range (-40°C to +85°C) than commercial cables (0°C to +60°C). Selection will depend on each plant's network configuration and application requirements.

Industrial Ethernet cables/connectivity include:

- Heavy-duty, all dielectric,

indoor/outdoor-rated optical fiber cabling in single-mode and multi-mode constructions. Many feature water-blocking agents for added protection in moisture-laden environments.

- Industrial grade Cat 5e and Cat 6 cables with heavy-duty oil- and UV-resistant jackets. Some category cables feature a Bonded-Pair inner construction in which the conductor insulation of the pairs is affixed along their longitudinal axis to ensure consistent conductor concentricity to prevent any performance-robbing gaps between the conductor pairs during installation and use.
- Upjacketed and armored cables for more extreme environments.
- Continuous flex cables designed for use with continuous motion machines and automation systems.
- Low smoke zero halogen (LSZH) cables, waterblocked, and burial cables are also available.
- Cables designed for use with leading industrial automation networking and communications protocols, such as EtherNet/IP (ODVA), Modbus TCP/IP, ProfiNet, and Fieldbus HSE.
- Industrial-grade connectivity components, such as: IP67- or IP20-rated UTP or FTP patch cords, connectors, modular jacks and plug kits, adaptors, faceplates, and surface mount boxes.
- Industrial-grade Cat 5e RJ45 and Micro (M12) cordsets and patch cords, including high flex versions.

Hardware: Switches, Active Network Devices, and Accessories.

A wide range of hardware is available to enable management of industrial Ethernet networks at the information, control, and device levels. There are products to support both copper and optical fiber media, as well as switches capable of data speeds as high as ten Gigabits per second. At a minimum, all of these components—switches, con-

nectors, and other hardware—should offer robust construction and resistance to high temperatures, vibration, and electromagnetic interference.

Typical COTS hardware is designed to operate from 0°C to +40°C, while industrial-grade Ethernet hardware operates efficiently from 0°C to +60°C—extendable to -40°C to +85°C (conformal coating is also available for humid/moist applications). Also, excessive moisture and corrosive chemicals can inflict serious damage to the electronics in commercial switches, whereas ruggedized industrial switches are securely sealed to prevent ingress of these substances.

Industrial Ethernet hardware components include:

- Hardened managed and unmanaged switches, which come in a variety of copper/fiber port configurations, port densities, industry approvals, and mounting options.
- Firewalls to secure and isolate a network while still permitting authorized data communications to pass through. Firewalls with VPN capabilities also allow secure, encrypted communication from a remote location through the Internet.
- Wireless access points, clients, and bridges in either DIN rail mount or IP67 enclosure-less housings now also support the faster, more secure, and noise-immune 802.11n standard.
- Related accessories such as hardened power supplies, SFP fiber transceivers, and even software that provides network status, alerts, and control from the automation network's software or PLC.

Another Ethernet factor considered to be an industry best practice for mission-critical applications is redundancy, which is extremely important, but sometimes overlooked in selecting industrial Ethernet switches. Two kinds of redundancy are key to maintaining uninterrupted signal transmission and maximum uptime. The first is power source redundancy, which means having an uninterruptible power source (UPS) to provide consistent and reliable switch


performance. Specifying switches that have dual power input capabilities means that if one power source fails, the other immediately takes over.

The second essential form of redundancy is data path redundancy. The daisy-chain network topologies used by many industrial plants to connect automated machinery and devices have one inherent flaw—if any link between the two switches fails, the entire system could potentially go down, as the devices on one network segment can no longer communicate with devices in other segments. The solution is to ensure that the system designer builds a redundant data path into the network topology.

Field-Proven Solutions

The most effective—and cost-effective—path to ensuring long-term performance and reliability of the industrial Ethernet is to invest in network infrastructure components designed and rated specifically for use in harsh, demanding environments. End-to-end industrial-grade cabling products are more ruggedly engineered and constructed in every way, incorporating design features and materials capable of withstanding the severe environmental and physical stressors to which they are exposed.

During the selection process, it is important to take the time to evaluate the marketplace and select a qualified supplier capable of providing a top-quality, end-to-end Ethernet framework tailored to the application and environmental conditions. As many adopters of industrial Ethernet have already discovered, taking a “total system” approach will result in a more integrated system with all products seamlessly matched to deliver interoperability and consistently reliable performance day after day, and year after year.

And that, of course, is a primary objective for owners and managers of water and wastewater treatment facilities—as it is for every other mission-critical industrial plant. 

Mr. Shuman, RCDD, is a Senior Product Development Engineer for Belden. For more information and Belden's Industrial Ethernet white paper, visit www.belden.com/industrial.