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POWERING IoT AND EMBEDDED INNOVATION

Why Smart Factories Need Time-Sensitive Networking

By now, the benefits of the Industrial Internet of Things (IIoT) are obvious. Yet many manufacturers still struggle to implement the technology.

The problem often comes down to limitations of legacy assets. Although most industrial equipment can collect data, it can be difficult to extract and share data from older machines. As a result, data often remains siloed.

Even when data can be collected, it is often gathered asynchronously and in a format that cannot be easily shared off-site. These limitations preclude real-time control and prevent enterprises from gaining visibility across their operations.

Then there is the problem of cost. The amount of data manufacturers want to collect can overwhelm existing networks and storage systems—and upgrading these facilities can be prohibitively expensive.

Finally, there is the disconnect between operations technology (OT) and IT. In many industrial settings, OT systems use specialized networks and protocols, while IT systems use general-purpose technology. The gap between these systems can be difficult to overcome. For example, IT systems rely on Ethernet networks that use a "best effort" approach unsuitable for time-critical data.

Time-Sensitive Networking (TSN) and Edge Processing

To get around these challenges, industrial organizations can deploy a combination of time-sensitive networking (TSN) and edge processing.

TSN is an evolution of the Ethernet IEEE 802.1 standard designed for real-time, deterministic communications. It introduces two key concepts:

- **Synchronization**—All devices on the network have a shared time reference. Typically, this is accomplished using IEEE 1588 Precision Time Protocol, which uses Ethernet frames to create a distributed clock.
- **Scheduling**—All devices observe the same rules for processing and forwarding packets. These include rules for reserving bandwidth and time slots, and for selecting communication paths—including using multiple paths for fault tolerance.

In short, TSN prioritizes network traffic to ensure the availability of time-critical data for industrial applications that rely on accurate, coordinated data for insight into assets and processes. And because TSN is a form of Ethernet, it's compatible with existing IT systems.

At the same time, TSN is notably different from the best-effort methods of traditional Ethernet. Resending data from point A to point B after it fails to arrive the first time may be acceptable for email and other applications, but it cannot offer the synchronization of data needed to make industrial equipment work in a reliable, safe, and proper manner.

Thanks to its mix of standard IT technology and real-time determinism, TSN is well-suited to edge computing architecture that moves data capture and processing out of the data center to the edge of the network. This move cuts the amount of operational data needed to be uploaded to the cloud, and provides another technical benefit: It enables near-real-time response to control tasks necessary to deploy and execute predictive maintenance programs **(Figure 1)**.

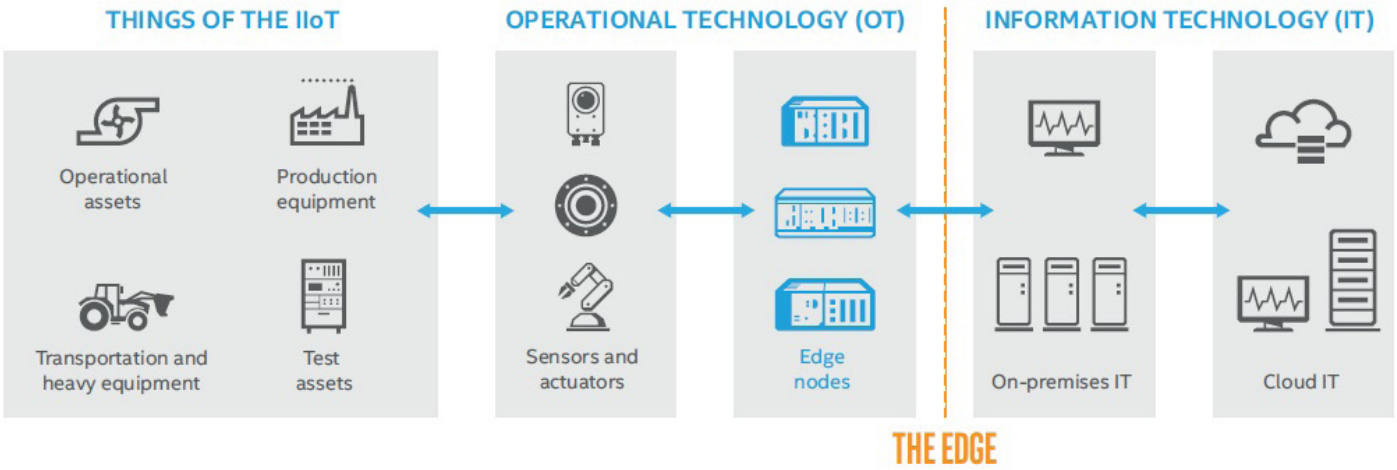

Figure 1. Moving data capture and processing to edge nodes enables near-real-time response to control tasks and reduces the amount of data uploaded to the cloud. (Source: National Instruments)

A Rugged Solution for a Tough Challenge

The CompactRIO system from National Instruments provides IT teams responsible for industrial plant and facilities with a solution designed for IIoT, monitoring, and control applications. The system provides high-performance processing, sensor-specific conditioned I/O, and a closely integrated software toolchain that helps digitize and connect legacy equipment.

CompactRIO is built to tolerate the extreme conditions found in industrial and manufacturing sites, and features integrated vision, motion, industrial communication, and human machine interface (HMI) capabilities. The CompactRIO system is compatible with the open TSN standard, enabling closely synchronized data to be shared across a network with multiple devices.

The CompactRIO system features a heterogeneous computing architecture that:

- Combines an Intel Atom® processor with an FPGA
- Provides interchangeable I/O modules that direct sensor connectivity to signal sources
- Includes bus/protocol specific modules configured in the real-time OS, or via the FPGA, to allow flexibility in communication and system integration

Each I/O module is either connected directly to the FPGA, providing low-level customization of timing and I/O signal processing, or is routed to the real-time processor, using the intuitive NI-DAQmx API for measurement and control.

CompactRIO's real-time controllers are TSN-enabled, eliminating the need for separate subsystems. More than 100 I/O modules are available with measurement-specific signal conditioning, all able to connect directly to the CompactRIO Controller.

The CompactRIO system uses LabVIEW, a systems engineering tool that makes it simple to integrate measurement hardware from any vendor. LabVIEW's graphical programming approach enables the user to visualize each aspect of an application, including hardware configuration, measurement data, and debugging. The software also simplifies representation of complex logic, development of data analysis algorithms, and design of custom engineering user interfaces **(Figure 2)**.

Users of the CompactRIO system will benefit from the security and reliability that come with native support for Security-Enhanced Linux (SELinux), a system based on mandatory access control (MAC) that uses a security policy to explicitly specify actions that each component of the system is allowed to perform.

Figure 2. CompactRIO is available in both a rugged industrial form factor and board-level design, and comes preloaded with software and the LabVIEW tool. (Source: National Instruments)

Reduce Unplanned Downtime

Engineers in the industrial sector are being tasked to recommend or select a solution that can reduce unplanned downtime of legacy equipment. Given the complexity of the systems involved, they are seeking solutions from companies that have both industrial and technological expertise, and that possess the knowledge and resources needed to design effective and scalable IIoT edge solutions.

IIoT edge solutions, such as the CompactRIO system from National Instruments, help extract insight from data produced by legacy equipment at the edge. By acquiring visibility into a wide range of metrics and taking advantage of data-driven decision-making, these solutions enable industrial operations to move from a reactive to a predictive maintenance program.

And by reducing unplanned downtime, industrial, manufacturing, and energy sector businesses can boost productivity, improve equipment and operational efficiencies, reduce costs, and increase safety.