# industrial ethernet book

## Industrial Ethernet Automation Networking & IIoT

Special Report

## CC-Link IE TSN
## in Action

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## Next-generation connectivity

Smart manufacturing plants are fundamentally interconnected and require real-time data at all levels, from deterministic control information on machine control networks to the links to enterprise business systems. Currently, industry is on a continuing quest to discover and implement next-generation connected technology and new levels of automation solutions that will impact the future of factories.

Industrial networks are constantly evolving to meet the real-time demands of new data and applications. But the long term goal is the ability to build a converged network foundation, based on open standards, that can handle multiple applications, traffic and various industrial protocols all at once.

The industrial network of the future is deterministic, interoperable, reliable, flexible, scalable and relies on a converged network architecture.

In this issue of the Industrial Ethernet Book, we focus on two topics that are fundamental to this ongoing quest: time-sensitive networks (TSN) in manufacturing and factory automation connectivity solutions.

According to Gunnar Lessmann, Master Specialist Profinet and TSN for PLCnext Technology, "the main benefit of TSN is the converged network which enables fieldbus and IT functions without interfering with each other. The advantages of the converged network can be used in any application and industry."

Check out our cover story, "Converged IT-OT networks using TSN technology," starting on page 6 to learn what industry experts are saying about the current state and possibilities for TSN in manufacturing.

On page 14, you'll want to read how Time Sensitive Networks in combination with Profinet provides mechanisms to form an optimal architecture for AI applications.

Starting on page 21, we offer a special report, CC-Link IE TSN in Action, which provides application examples for how time-sensitive networking is being applied in industrial applications.

And then finally, starting on page 29, we offer a series of articles starting with "Factory automation solutions rely on technology innovation" that reveal the common threads and keys to next-generation factory networking solutions.

These include Industrial Ethernet at the core but also with a continual focus on IT-OT convergence, digital transformation, artificial intelligence and hardware/software solutions for IIoT edge and cloud-based computing.

Our goal is to keep you up-to-date on the latest thinking and technology innovations.

Al Presher

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**Dual-Band Industrial Wi-Fi I/O Module**

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## Contents

# Special report highlights IIoT technologies and challenges

**Survey shows that IIoT systems implementations are up year-over-year, and are set to record a 75% deployment rate for 2023.**

A NEW REPORT HIGHLIGHTS KEY TRENDS, challenges and benefits for IIoT strategies. HiveMQ, a global leader in enterprise MQTT solutions, has announced the findings of a new report in collaboration with IIoT World, "Building Industrial IoT Systems in 2024". The survey data provides insights into the trends in technology, processes, and politics of IIoT implementation.

350 professionals were surveyed across Automotive Manufacturing, Power and Utilities, Renewable Energy, Transportation and Logistics, Smart Cities, and more to share feedback on building IIoT systems. The results demonstrate that industries are embracing IIoT technologies and moving towards full implementation and deployment of IIoT solutions, up from 67% in 2022 to 75% in 2023.

As budgets for technology investments continue to shrink, more scrutiny is placed on the procurement and interoperability of new software and platforms. With 6 out of ten executives saying it is difficult to quantify investment in technology, more and more professionals are stuck in proof-of-concept purgatory. Industrial automation is no different — over a third of survey respondents said a key challenge for implementing IIoT systems is a lack of budget and uncertain ROI.

The pressures, challenges, and payoff of IIoT implementations provide an understanding as to why projects succeed or stall. Additional insights from the survey include:

*MQTT has been identified as a key enabler for IIoT projects, while data suggests Sparkplug is an emerging data framework (www.hivemq.com).*

**Productivity and efficiency are top of mind for implementation**

- Increased productivity (29%) and improved Overall Equipment Effectiveness (OEE) (23%) are the top benefits companies expect to gain from implementing IIoT systems.

**Hurdles for implementation include security, leadership and ROI**

- Leadership support (38%) and cybersecurity (35%) are the key challenges companies cite in implementing a new IIoT system.
- A quarter of survey respondents believed that executive leadership (25%) should own the project while nearly a quarter of respondents (23%) believe that a project team combining both OT and IT expertise should spearhead the IIoT strategy.

**MQTT has been identified as a key enabler for IIoT projects, while data suggests Sparkplug is an emerging data framework**

- MQTT (57%) and HTTP (58%) are considered to be essential data movement tools for fulfilling IIoT strategies.
- Sparkplug is still in its infancy but 25% of companies say they have deployed or are looking at using Sparkplug, while 35% say they need to learn more about it.
- Microsoft Azure (18%) is the leading cloud provider for IIoT systems, followed by Amazon Web Services (17%), and multi-cloud (14%).

"Industrial IoT systems provide the insights and visibility that can deliver incredible business results with the right execution. We see more and more companies improving productivity and showing ROI from their deployments which is highlighted in the survey," said Christian Meindering, CEO and Co-founder of HiveMQ.

"Adopting MQTT and platforms like ours can help them combat technical challenges to successfully implement enterprise-grade IIoT systems built for flexibility, security, and scale," he added.

*News report by **HiveMQ**.*

# Converged IT-OT networks using TSN technology

**Machine control networking is built on consistent data delivery of data between controllers, sensors and actuators. TSN is one way to ensure that deterministic control information can be prioritized and delivered on-time while simultaneously allowing non-critical forms of application data to coexist on the same network.**



SOURCE: ISTOCKPHOTO

*"The main benefit of TSN is the converged network which enables fieldbus and IT functions without interfering with each other. The advantages of the converged network can be used in any application and industry. However, this requires 1Gbps bandwidth or more." -- Gunnar Lessmann, Master Specialist Profinet and TSN for PLCnext Technology, Business Area Industry Management and Automation.*

TIME-SENSITIVE NETWORKING (TSN) FOR manufacturing applications continues to move ahead driven by use of Gigabit Ethernet and converged network architectures that combine deterministic control information and application data on the same network.

In this special report, the Industrial Ethernet Book reached out to industry experts to gain their insights into the megatrends driving adoption of Time-Sensitive Networking (TSN), and how the technology is evolving.

## Converged Ethernet networks
*Gigabit performance provides bandwidth required for real-time communication.*

According to Gunnar Lessmann, Master Specialist Profinet and TSN for PLCnext Technology, Business Area Industry Management and Automation, "the main benefit of TSN is the converged network which enables fieldbus and IT functions without interfering with each other. This is especially relevant in applications with high bandwidth requirements, such as data from vision cameras in combination with real-time data. The advantages of the converged network can be used in any application and industry. However, this requires 1Gbps bandwidth or more."

"The adoption of Gigabit and even higher link-speeds in switches, cameras, and PCs has largely occurred. For field devices and some PLCs, especially with integrated switches, Gigabit is not yet very common. Therefore, the benefit of a converged network with those components are limited," Lessmann said.

"In contrast to the 'fieldbus world', in a convergent Gigabit network, the greatest bandwidth requirement is not generated by the OT but by the IT devices. For example, a GigE Vision camera generates more than 1Gbit network load, depending on the resolution and update frequency (Frames per Second). This must be possible in a network convergent with real-time communication and without mutual influence. Therefore, market adoption to gigabit in every field device is needed," he added.

## Highly accurate timestamps
Beside the converged network, Lessmann said that another advantageous use case of

TSN is the ability to provide device data with highly accurate timestamps. This feature is very helpful for data analytics applications, e.g., "in the cloud". Typical data analytics tools are using time stamps to correlate the data from the field. Without TSN standards like PTP, this is not yet possible.

In addition to the converged network and data analytics, he added tht a major advantage of TSN is the use of standard Ethernet implementations in the devices without special fieldbus-specific chips. However, the chip industry still must learn here. For this reason, Phoenix Contact, together with other partners, has initiated an open-source testing tool for chip manufacturers.

With this tool, it is possible to validate TSN-capable hardware independently of ecosystems such as PROFINET or OPC UA. It is available at https://github.com/Linutronix/TSN-Testbench.

## TSN in manufacturing

"It is important to understand that the converged network is already usable today. Some TSN standard, such as Pre-Emption and Quality-Of-Service make this possible," Lessmann said. "Systems such as Profinet already use QoS and can be used in a convergent network together with other IT traffic."

"If the application does not have any further requirements, such as time synchronization or isochronous operation, there is nothing wrong with using it. There's no need to wait. The only thing that is needed for this are gigabit components with QoS and Pre-Emption and the ability to synchronize time via PTP."

Lessmann added that additional features may be added in future upgrades. Thanks to the common hardware platform, this is also possible independently of "ecosystems" such as OPC UA or PROFINET. Especially with PROFINET, existing 100-bit devices can also be seamlessly integrated.

## Anticipated impact of TSN

Lessmann said that, "when we take a closer look at today's machine and plant designs, we find that several Ethernet and Fieldbus systems with special properties are used for special applications. A network for motion control, a network for cameras, a network for Windows PCs, etc. The associated costs in installation, commissioning and maintenance are directly comprehensible through the switch to a converged network."

"We expect that in the 3–5-year period, the specialized communication systems will be replaced by the converged TSN network. There's no need to wait either. In particular, the switches must meet the necessary requirements for the converged network. This is already the case today," he said.



SOURCE: TTTECH
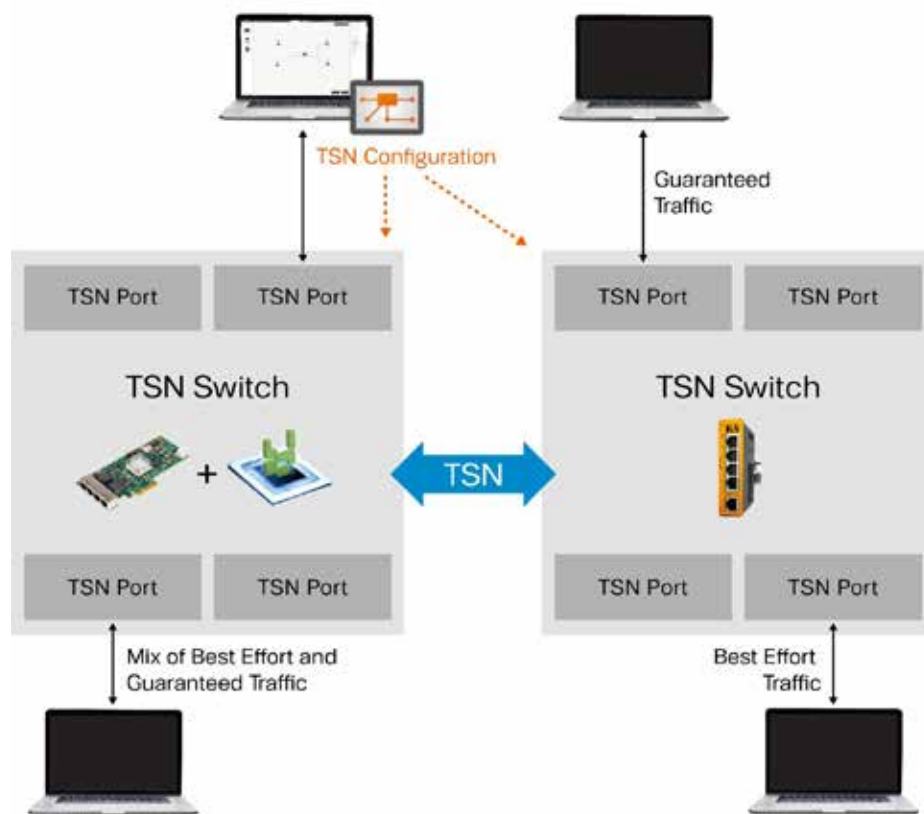
*Typical TSN network setup with different switch providers, enabling standard-compliant planning and configuration.*

## Integrated system architectures

*Higher data rates, increased flexibility and efficiency.*

"At TTTech, we observe that TSN customers typically show interest in transitioning from conventional machine network architectures to more integrated systems, often looking to upgrade to higher data rates to be able to build larger machines and gain increased flexibility and efficiency while keeping the performance of existing fieldbus-based network architectures," Georg Stöger, Director Consulting, TTTech Dependable Networks, told the Industrial Ethernet Book recently.

"Additionally, there's a noticeable trend among customers to integrate more functions into core machine networks. Obstacles to widespread TSN adoption that we observe are related to costs of upgrading existing infrastructures, specifically if more CPU power is needed to manage the upgraded network interfaces, and the lack of TSN ASICs for some use cases. Outside of machines, TSN adoption in factory automation faces challenges because the current technologies in use are firmly established, and the dominance of existing network systems creates hurdles for the smooth integration of TSN. Companies are hesitant to switch due to investments in and existing competencies with the current technologies."

## TSN technology benefits

According to Stöger, TSN provides capabilities to synchronize devices of all kinds and manage multiple classes of data traffic including critical real-time data, non-deterministic burst traffic, and various kinds of diagnostic and best-effort traffic. Precise control over data delivery times is crucial in factory automation, with some kinds of applications requiring sub-millisecond cycle times across multiple I/O elements. Before TSN, this kind of performance was only achievable with specialized fieldbus technologies, which could not provide the openness, compatibility, and scalability of standard Ethernet.

"The convergence of multiple functionalities onto a unified network infrastructure that is made possible with TSN helps to reduce complexity and can also improve overall system performance and optimization, for example by removing the need for dedicated gateways," Stöger said.

"TSN networks can utilize a combination of general purpose and automation-specific Ethernet physical layer technologies and a wide range of different bitrates, from cheap 10 Mbit per second to high-performance 10 Gbps backbones. This makes TSN uniquely flexible and adaptable to different kinds of complex network architectures."

Stöger added that time-sensitive networking also provides wide compatibility with open ecosystems, ensuring

SOURCE: ISTOCKPHOTO

*"TSN provides capabilities to synchronize devices of all kinds and manage multiple classes of data traffic including critical real-time data, non-deterministic burst traffic, and various kinds of diagnostic and best-effort traffic. Precise control over data delivery times is crucial in factory automation, with some kinds of applications requiring sub-millisecond cycle times across multiple I/O elements," Georg Stöger, Director Consulting, TTTech Dependable Networks.*

interoperability across diverse devices and vendors. This openness specifically facilitates the integration of the OPC UA for Fieldbus Exchange (OPC UA FX), which covers an extremely wide range of applications from very low latency on the field level to controller-to-controller communication and edge-cloud communication.

Compared to existing solutions, this combination of synchronization and deterministic communication capabilities, the commitment to standardized protocols, and the scalability offered by standard Ethernet networking technologies give TSN a unique edge.

## Industry focus

"As one of the first companies to offer TSN technologies, we get requests for TSN from a very wide range of industries, ranging from aerospace and railway to industrial automation and robotics,". Stöger said. "Applications for which TSN use is considered, investigated, or implemented vary from classic control applications to system-level convergence and the implementation of AI based capabilities such as digital twins at the edge. We do not currently see a pattern which specific TSN capabilities are considered the most transformative when we look across all of the industries we are operating in. However, in manufacturing, the real-time capabilities of TSN combined with the flexibility, openness and scalability in terms of bandwidth and network topologies are the main drivers for customer interest. And OPC UA is becoming more relevant as well, which gives TSN an additional push via OPC UA FX.

Stöger said that, in conclusion, the determinism, support for higher data rates, flexibility, and commitment to open standards collectively drive customers to embrace TSN as a transformative technology in manufacturing applications.

## AI-based applications

"We expect to see continued proliferation of AI-based applications and the evolution of edge-cloud interaction specifically driven by federated AI applications. TSN's deterministic communication will play a pivotal role in optimizing the synchronization of AI algorithms and data flows, enabling real-time decision-making in smart manufacturing processes. The integration of TSN with federated data acquisition for AI applications can e.g. enhance predictive maintenance, quality control, and overall operational efficiency," Stöger said.

TSN's support for higher data rates will facilitate better interaction between edge devices and cloud-based systems. More bidirectional communication between edge and cloud will enable the efficient exchange of data for analysis and near-real-time optimization, supporting more sophisticated and data-driven decision-making at both the edge and cloud levels.

"As smart manufacturing continues to evolve, we expect the confluence of TSN technology with AI applications and the refinement of edge-cloud interactions to provide the basis for a more responsive, intelligent, and interconnected manufacturing ecosystem in the coming years," Stöger concluded.

## Overlapping boundaries between IT and OT

*Converged network architectures offer integrated solutions.*

The marketplace adoption of Time-Sensitive Networking in factory automation applications, and the types of customers moving to adopt, along with obstacles and challenges to larger scale adoption, have become key issues for TSN.

"We are seeing large scale adoption of TSN in various end user applications. We have seen over 100 global companies in a wide variety of industries implement TSN systems in their applications," John Browett, General Manager, CC-Link Partner Association Europe, told the Industrial Ethernet Book recently. "These industries cover a diverse range such as consumer packaged goods, logistics, consumer electronics, automotive, semiconductor, food & beverage and lithium batteries."

According to Browett, the potential obstacles to adoption currently may include some of the adverse economic effects that we are currently seeing in some parts of the world that may be impacting plans for capital investment in various industries. In some cases, employee skill sets may also have an effect.

"TSN is an example of how the boundaries between the operational and information technology worlds are overlapping and hence this means the traditional shop floor electrician skills now also need to be supplemented by some skills from the IT sector for successful implementation and operation. However, based on the uptake we outlined above, it's clear that many companies have already successfully addressed these issues," Browett said.

### Focus on innovation

Specific technology innovations are providing the upside for use of TSN in the factory, and TSN technology does provide unique benefits compared to existing solutions.

"The key benefit that TSN is providing that no technology before successfully addressed is converged network architectures," Browett said. "In the past, multiple discrete networks were needed to handle different types of communication. So perhaps there was one network for I/O, another for motion control, a third for functional safety and then finally perhaps a general IT oriented network for handling communication with higher level systems."

With the advent of TSN and its converged network capabilities, the technology now offers an ability to move away from this scenario.

"We are in a position where previously multiple networks were required to implement an application, these can now be combined



*"TSN is an example of how the boundaries between the operational and information technology worlds are overlapping and hence this means the traditional shop floor electrician skills now also need to be supplemented by some skills from the IT sector for successful implementation and operation," John Browett, General Manager, CC-Link Partner Association Europe.*

into a single architecture. In turn, this will deliver a number of benefits such as simpler designs, reduced costs, easier maintenance and greater uptime," Browett added. "This translates to projects that can be implemented more quickly, processes that can be operated more efficiently and ultimately business that can deliver more value."

He added that there are specific industries, types of applications and types of customers, where TSN is gaining a foothold in the marketplace.

"We have seen a number of cases where the highly deterministic performance capabilities enabled by TSN help deliver sophisticated motion control applications," Browett said. "These applications are in industries whose processes typically include large numbers of motion control axes whose operations are precisely synchronized in order to deliver the required levels of product quality and productivity. The industries concerned have typically been lithium battery and printing."

In lithium battery manufacturing, for example, various motion intensive tasks are required, such as coating, winding and general product handling. These are highly demanding critical processes, which if performed incorrectly may lead to products which fall below the required performance standards, or may even be unsafe in extreme cases. Moreover, the high performance achieved by TSN based systems allows the ambitious productivity goals of the automotive industry to be met.

Printing may seem to be a less demanding application, but the need to meet quality and productivity standards is the same in the end. Printing typically requires the application of multiple colors and finishes on a product that may range from documents to containers such as bottles. Without precise synchronization enabled by deterministic TSN control between multiple axes, meeting the required quality standards is more difficult.
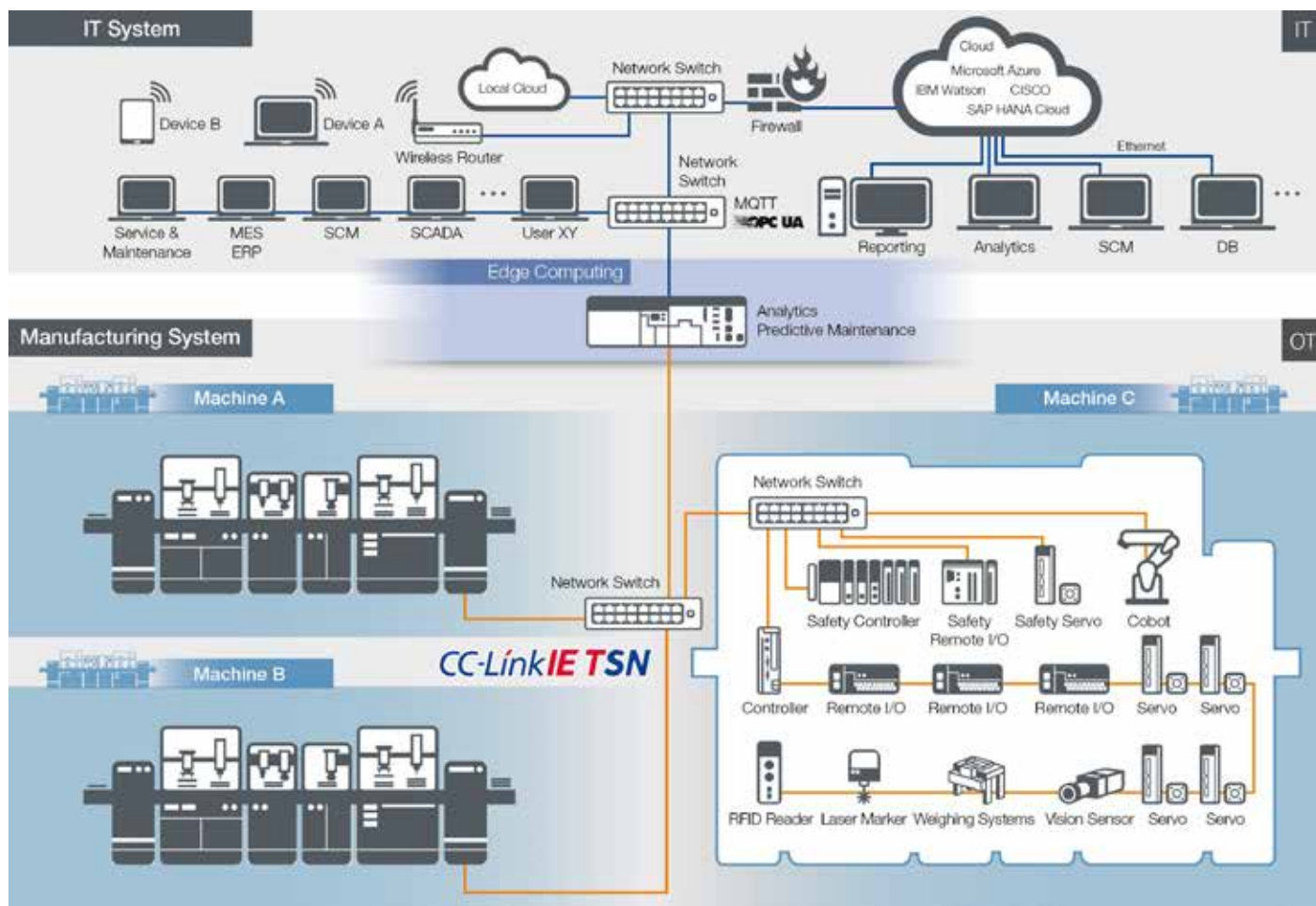
*Time-Sensitive Networking converged network architectures provides a range of benefits to end users and machine builders worldwide.*

## Anticipated impact

Browett expects that TSN technology will have an impact on smart manufacturing in the next 3-5 years.

"We anticipate that the adoption will continue. We are seeing a high level of interest from the device vendor community in TSN. This means that the catalogue of compatible products will continue to grow as we move forward," he said. "We are also seeing industry wide initiatives to continue driving the adoption of TSN. These include IEC/IEEE 60802, which is working on developing profiles for the use of TSN in industrial automation."

Building on this, TIACC is a further activity that is aimed at standardizing the conformance testing of 60802 devices. This is being supported by the key open industrial automation network organizations, meaning that there will be guaranteed interoperability of TSN compatible devices as we go forwards.

"These activities are being matched by the interest in the end user community, where we continue to see companies in a wide variety of industries recognize the benefits TSN can deliver to their operations. This in turn will drive further demand for devices and systems that can provide these benefits and hence continue to make the demand for TSN based systems increase in the future," Browett said.

## Looking at the current state of TSN technology

*Developments, specifications, challenges and what to expect to see in the future.*

Dave Cavalcanti, Avnu Alliance President and Chair of the Wireless TSN Working Group, responded to IEB with his answers to questions and insights on the keys to broadening TSN deployments, developments in the industry and what to expect in the future.

**What are the key steps needed for real deployments of TSN?**
Real deployments of TSN in large scale applications require many pieces to fit together, much like a puzzle. First, standards need to be developed, with the aim of getting vendors to implement and test products based on the core features required by the market. This is where testing is vital, ensuring the conformity of the implementations with the specification itself. It is essential that device behave in a predictable manner while delivering a consistent, reliable performance, while interoperating in their relevant field.
The development of test specifications and tools, alongside the creation of certification programs, are a key part of the work done by the Avnu Alliance and its members to enable the TSN ecosystem.

Encouraging vendors, developers and users to work together to build, test and enhance their TSN feature implementations is also crucial. This is why our Plugfests are the perfect environment for cross-industry collaborations and co-development. These events result in robust and interoperable products that, when deployed, provide assurance that they will perform and work as expected. All these steps are being facilitated by the Avnu Alliance through its certification programs for standard compliant TSN components and devices.

**What developments are we seeing within the industry? What specifications are being focused on presently?**
We have seen great progress in the development and publishing of core TSN specifications, including IEEE 802.1AS-2020, 802.1Qbv, 802.1Qbu and more. Recently, the IEEE/IEC 60802 group has also reached a significant milestone by defining the main features and requirements for the TSN profile for industrial automation.

There has also been fantastic collaboration across key industry players to define Avnu Alliance test specifications and tools for a number of TSN standards.

SOURCE: ISTOCKPHOTO

*"There has been significant progress on various fronts across the TSN ecosystem, but more can still be done. The IEEE/IEC 60802 TSN profile for industrial automation is currently going through the balloting and comment resolution process. While this is underway, several industrial organizations are already defining the expectations for TSN components and device implementations, as part of the TIACC collaboration," Dave Cavalcanti, Avnu Alliance President and Chair of the Wireless TSN Working Group.*

Our organization is actively working with several industrial organizations, as part of the TIACC collaboration, to advance the testing specification which covers the requirements in the IEEE/IEC 60802 Industrial TSN profile. With well-defined standards and test specifications for core TSN features, such as time synchronization, traffic shaping and preemption, vendors are being empowered to develop and test their own implementations.

We had a significant number of vendors participate in the latest Avnu Alliance Plugfest, where they've had the opportunity to run interoperability and conformance tests using our approved test tools. The next step will be to get TSN-capable devices and components certified through one of our certification programs. The Avnu Alliance will soon be launching a new TSN component certification, and our TSN switch certification program is currently undergoing a renovation to better streamline the process and make it easier for vendors to both submit and certify their products.

Currently, our members are working to

extend TSN capabilities across various networks, including Wi-Fi and 5G. We are already seeing good progress being made in terms of implementations and testing of wireless capabilities in both of these networks, and the Avnu Alliance are also working on the extension of our certification programs to include wireless in the near future.

**What can we expect to see in the future, and are there still challenges that need addressing?**
There has been significant progress on various fronts across the TSN ecosystem, but more can still be done. The IEEE/IEC 60802 TSN profile for industrial automation is currently going through the balloting and comment resolution process. While this is underway, several industrial organizations are already defining the expectations for TSN components and device implementations, as part of the TIACC collaboration.

The Avnu Alliance has already contributed on several TSN test specifications which will create the basis of the necessary test

requirements. Understanding the TSN toolbox approach will also play a crucial role in long-term market deployment. There will be additional features and enhancements to TSN standards and implementations that will need to be deployed over a longer period. The extensions of TSN capabilities, such as time synchronization and time-aware shaping to wireless systems (Wi-Fi and 5G), are a good example of what we can expect in the future.

Understanding the system level challenges that come with deploying and configuring TSN-based networks is another area where our members are focusing their efforts at present. We envision networks that are both configurable and autonomous, while meeting hard, real-time requirements. TSN is also expanding across many key segments, including ProAV and Automotive. Driving the concept of fundamental TSN technologies that are agnostic of applications is very important if we are to achieve the economies of scale required for success in these markets.

*Al Presher, Editor,* **Industrial Ethernet Book**

# The optimal network concept for artificial intelligence

**Time Sensitive Networks in combination with Profinet provides mechanisms to form an optimal architecture for AI applications. Compared to separate networks for field communication and IT, there are significant advantages for existing and new applications.**



*Figure 1: The mechanisms of Time Sensitive Networks in combination with Profinet form the optimal architecture for AI applications.*

TOGETHER WITH PROFINET, TIME SENSITIVE Networks (TSN) can be a game changer in automation. However, the following questions need to be answered: What new applications and solutions are made possible? How do TSN standards contribute to this? What does this migration look like? And what will happen to the technology in the future? This article provides answers to these questions.

New technologies can be considered successful when they lead to the implementation of new applications, which have major advantages. One of these new applications is the use of artificial intelligence (AI) in automation. For example, the computing power and tools available for machine learning, image recognition, and data mining are becoming increasingly cheaper and easier to use.

ChatGPT is a good example here. This development is expected to progress at a rapid pace. What requirements does the use of AI therefore place on automation and networking? The following points should be kept in mind:

1. Large amounts of data have to be transported from the field to the AI system.
2. The result of the AI operation has an effect on the process to be controlled.
3. High-precision time synchronization is essential for processing and evaluating distributed data from the field level.

A concept in which all of these requirements can be met in a single network is ideal. Profinet with Time-Sensitive Networking (TSN) is the solution here.

## Currently separate networks for fieldbus and IT

At present, the requirements described above are usually implemented in separate networks (See Figure 2 on next page). One such example is a camera application for optical anomaly detection using AI tools. At the very least, this requires gigabit infrastructure. However, the fieldbus systems currently in use are often based on a transmission speed of just 100 Mbps and therefore cannot be used to transport this amount of data. High-precision

time synchronization is also not currently available in IT networks and systems such as Profinet RT. For this reason, separate networks are often installed for the relevant purpose. The advantage of this separation is that, in principle, IT communication cannot have a negative impact on real-time capability. On the other hand, there are disadvantages such as the effort and costs involved in installing, maintaining, and commissioning separate systems for fieldbus, IT, and synchronization. In addition, future extensions or changes, such as the subsequent installation of new devices, are difficult or impossible to implement.

The example given clearly shows that there is considerable potential for improvement in combining all the necessary functions in a single network. This is usually referred to as a "convergent network" (Figure 3). The most important thing here is that the disciplines of the IT and OT worlds do not affect each other in a shared network. To ensure this, a number of optimizations must be made in the Ethernet structure itself, which together are referred to as Time-Sensitive Networks (TSN).

### TSN as a special purpose tool box

It is essential to understand that there is no single mechanism or single standard behind TSN. Rather, TSN can be compared to a tool box containing several tools. Each of these tools serves a specific purpose. The full benefits of a convergent network only unfold when all the tools work together correctly (Figure 4). Here is a brief explanation of the tools:

**Quality of Service (QoS)**
QoS is a well-known concept. Each telegram received at a switch, for example, is sorted into separate memory areas (queues) based on an integrated priority field (VLAN priority), which are reused when sending according to their priority. QoS ensures that real-time-critical traffic is not disrupted by other communication and is therefore the most important tool.

**Preemption**
Another problem that can occur in a convergent network is the delay of real-time-critical telegrams due to long TCP/IP telegrams. Preemption solves this problem by immediately interrupting a long low-priority packet when a high-priority packet is to be transmitted. The remainder of the low-priority packet that is still to be sent is saved and transmitted later. Preemption ensures that the data forwarding variance at 1 Gbps is reduced to around 1 μs (regardless of the telegram size).

**Precision Time Protocol (PTP, IEEE 802.1AS)**
Many applications that combine artificial intelligence (AI) require high-precision time synchronization. However, the common synchronization protocol NTP (Network Time Protocol) is not sufficient for this.
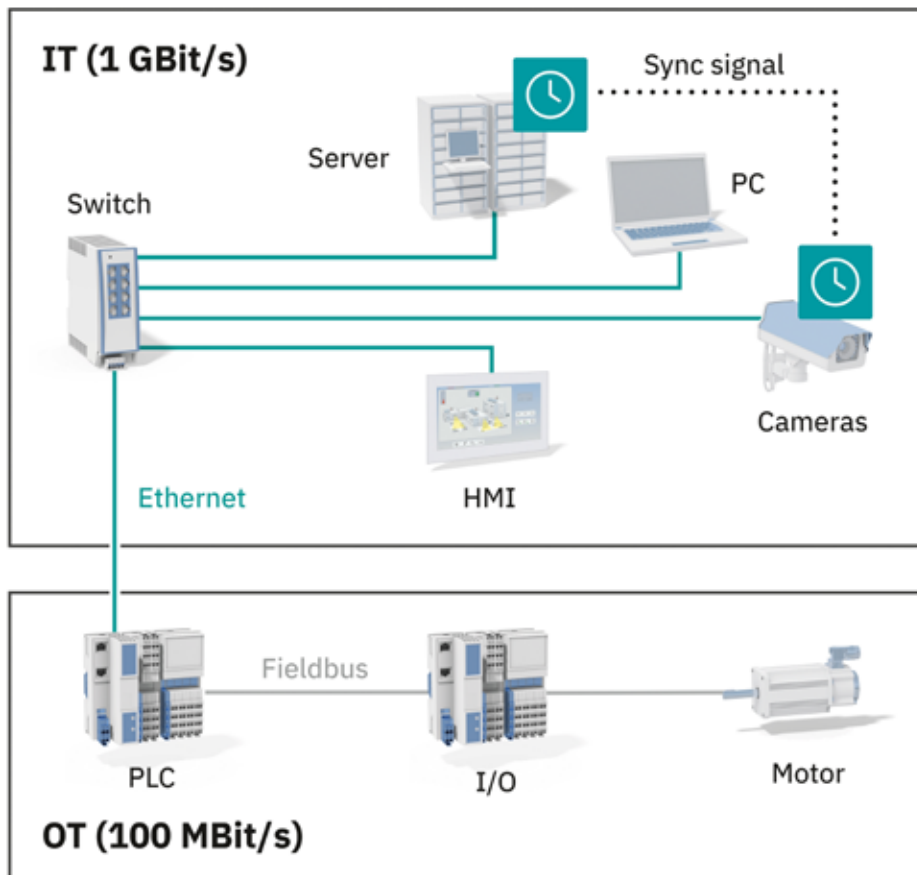


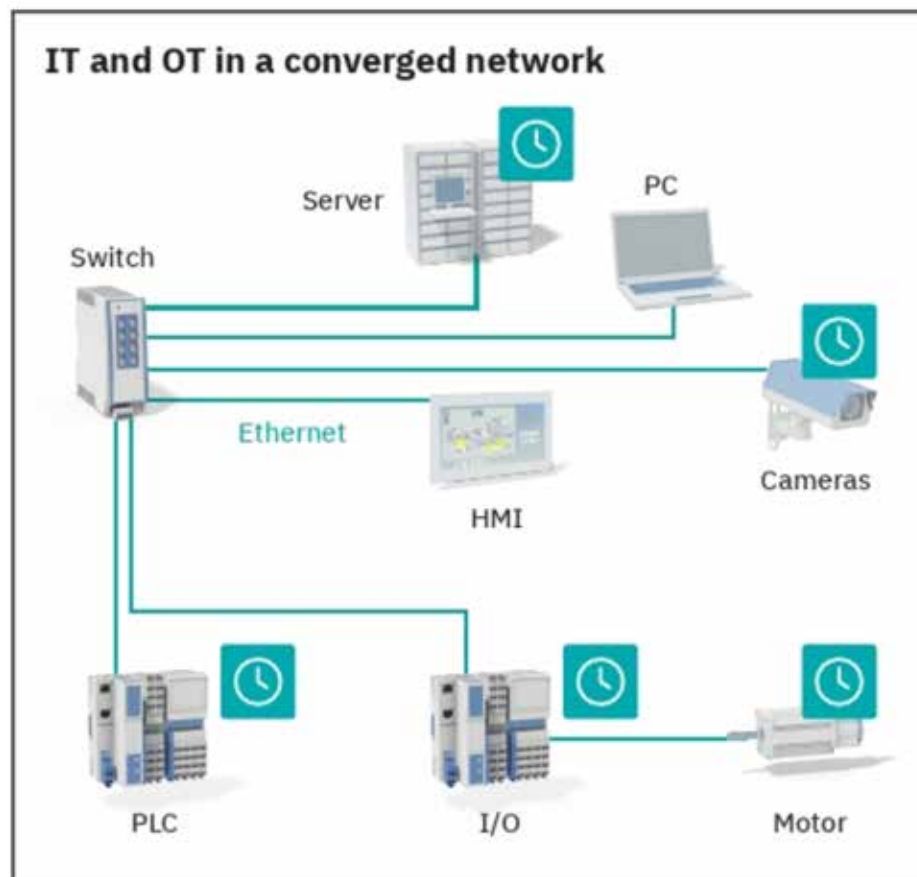*Figure 2: State of the art: separate networks for fieldbus and IT.*



*Figure 3: TSN enables the integration of fieldbus and IT in a shared network.*

# TSN tools

**Preemption**

**Compatibility**

**Synchronous communications**

**QoS**

**Quality of Service**
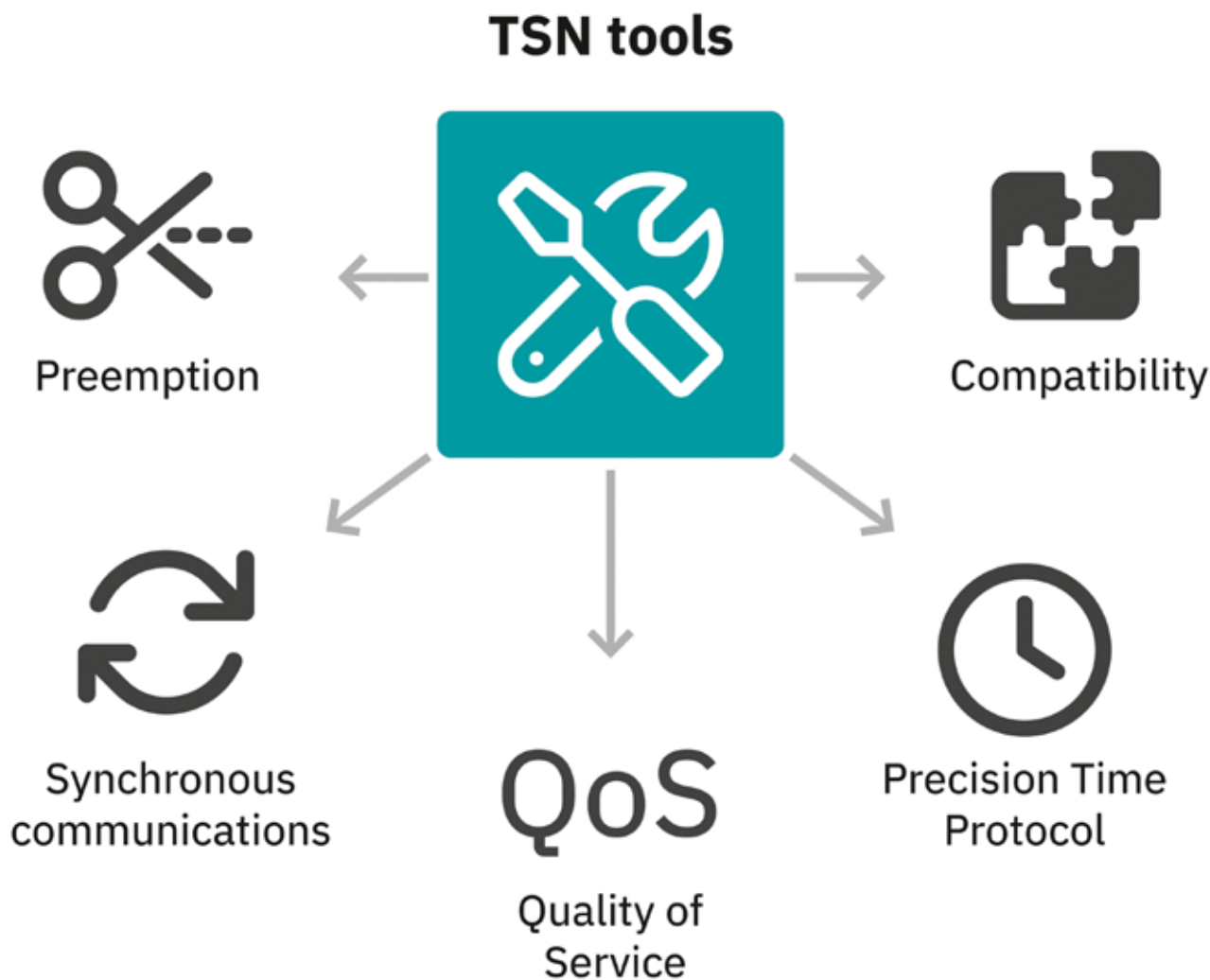
**Precision Time Protocol**

*Figure 4: TSN is not a single standard, but rather a "tool box" of mechanisms that make a shared network possible.*

Synchronization accuracies in the microsecond range can be achieved using PTP because the runtimes on the lines and in the switches are measured and compensated.

### Synchronous communication

High-precision time synchronization via PTP also allows the synchronization of communication and applications in the devices involved. Without such synchronization, it is possible for the terminal-to-terminal response time to vary over a wide range, as only one cycle can be missed on the way from the input to the output. Synchronous communication rules this out.

### Brownfield integration

Using the tools described above requires new hardware in all the devices involved. That is why TSN will initially only be introduced where there is a significant advantage. Nevertheless, a smooth transition from Profinet RT to Profinet with TSN is feasible in that any existing Profinet device can be used at the "boundaries" of a TSN area. In this way, investments in devices and expertise

can be protected. For Profinet with TSN, the listed tools are combined and used together effectively. This results in advantages without changing the look and feel.

### Areas of application for Profinet with TSN

The benefits of Profinet with TSN can be explained in concrete terms using optical anomaly detection as an application example (see graphic above).

There are also other applications, such as vibration data for predictive maintenance, 3D images via synchronized cameras, frequency synchronization in the feed-in and load management of alternative power generators, highly accurate time stamps in alarm messages to track a sequence over time, or simply updating large amounts of data, for example in the case of firmware updates, during operation. All applications in which a shared network with time synchronization promises added value are conceivable.

The tools described can be easily used for Profinet communication between controllers

and field devices without changing the application view of Profinet. In many applications, data is not only exchanged between controllers and field devices, but also between different controllers.

OPC UA with pub/sub communication is more suitable for this use case. The OPC Foundation is therefore also working on a usage concept for TSN as part of its work on OPC UA Field Exchange. The aim is to share Profinet, OPC UA, and IT data in a convergent network.

### Summary

The mechanisms of Time Sensitive Networks in combination with Profinet form the optimal architecture for AI applications. Compared to separate networks for field communication and IT, there are significant advantages for existing and new applications.

*Gunnar Lessmann, Master Specialist Profinet and TSN, Business Unit Automation Systems, Phoenix Contact Electronics GmbH.*

**Learn More**

# Anomaly detection as an application example
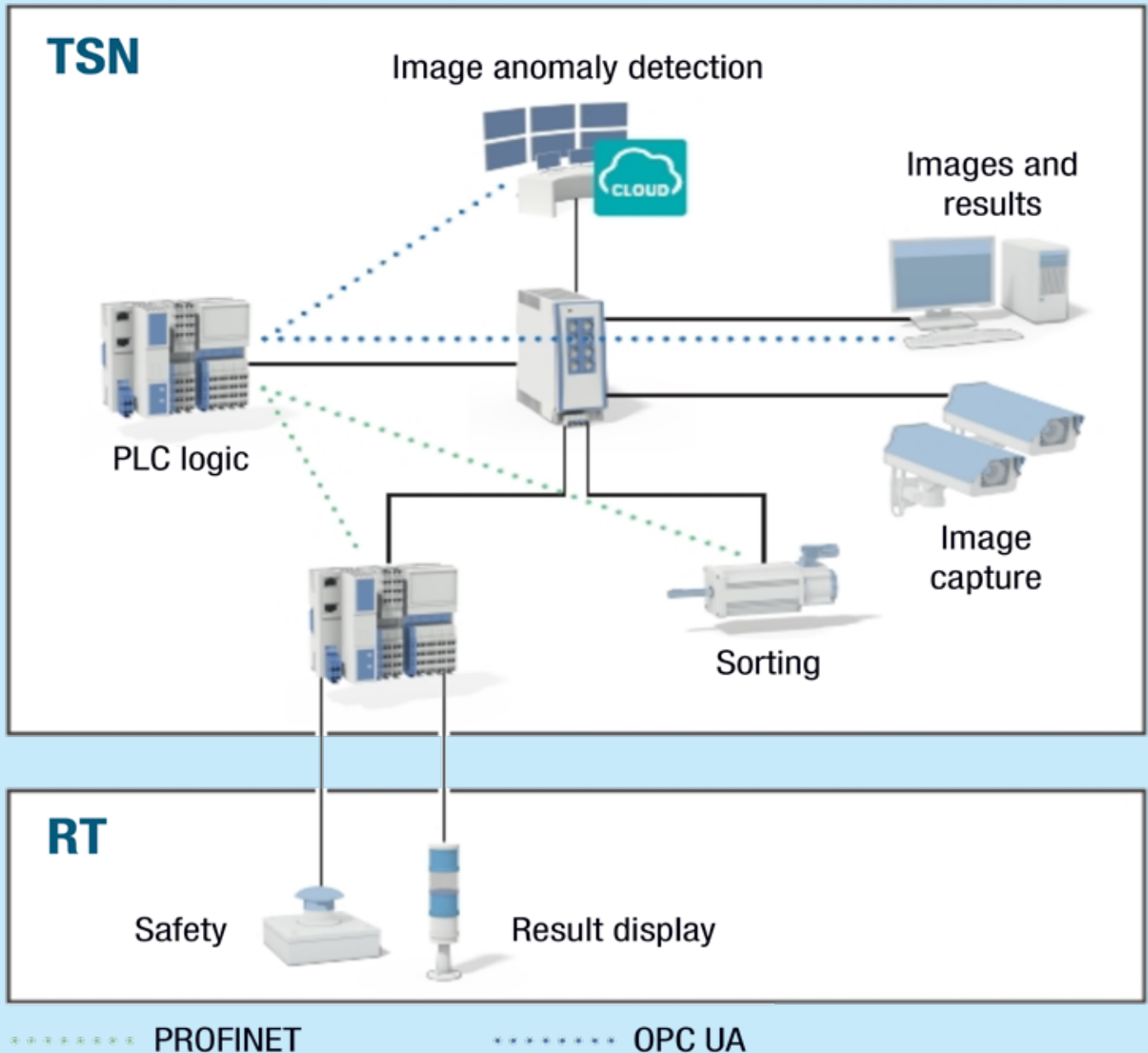


*Figure 5: Optical anomaly detection: an example of Profinet with TSN mechanisms.*

The advantages of TSN can be explained in concrete terms using optical anomaly detection as an application example. An optical quality control system is to be integrated into a continuous manufacturing process for products. Several cameras are used for this purpose, which are located above the passing products, with image capture synchronized to a production product. Due to the speed of production, one camera alone cannot capture a sharp product image. An AI application – located on an edge PC, for example – reads the individual images, compiles them into a complete product image based on the time stamp, and compares this image with a learned "normal". If the image deviates from this standard, the affected component is rejected in a downstream step (Figure 5).

The following TSN tools prove helpful here:
- Profinet with synchronous communication for production control
- PTP for synchronizing the cameras
- QoS for parallel transmission of real-time and image data
- Preemption to prevent camera data from affecting the latency of real-time telegrams

All of this can be realized in a single network. Future extensions are also possible, as any ports can be used for new devices.

# Leveraging the benefits of TSN in manufacturing

**With Time-Sensitive Networking creating a standard, unified network that supports different devices, IT and OT convergence are able to require fewer nodes, streamline cabling, and simplify maintenance. These benefits are realized by a wide range of industrial stakeholders from machine builders, to system integrators and end users.**



SOURCE: ISTOCKPHOTO

*Time synchronization on a manufacturing network enables all connected devices to share a common time reference for all data to become available at a given point in time for specific tasks.*

TIME-SENSITIVE NETWORKING (TSN) has leapt from the pages of academic journals to practical applications in the real world in recent year. Companies that want to reap the benefits of this exciting technology must understand the needs of industry players and start to build TSN-enabled systems. Even before the formation of the IEEE TSN task group, Moxa has been working with industry partners to promote digitalization in the manufacturing sector, also known as Industry 4.0, and all the key technologies for industrial automation.

Time-sensitive networking (TSN) is a crucial enabler of industrial digitization applications where Moxa has already made valuable contributions. In fact, Moxa has partnered with numerous industry stakeholders to build TSN-enabled systems and bring the proven benefits of TSN to the factory floor through several technological advances and real-world applications.

Traditionally, different equipment, interfaces, and protocols presented serious challenges to transmitting, receiving, and processing large amounts of data in a timely manner for industrial automation applications.

TSN overcomes these challenges by enabling time synchronization on the network so that all connected devices share a common time reference for all data to become available at a given point in time for specific tasks. These TSN-enabled systems are highly reliable as its built-in bounded low latency in a deterministic networking environment optimizes performance and security.

## Technical achievements

From a technological standpoint, Moxa partnered with NXP to prove the high reliability of the key TSN redundancy protocol, 802.1 CB. In addition, Moxa's cooperation with Intel and Keysight has also demonstrated the feasibility of wireless TSN networks in the future.

## Proven network redundancy

To achieve a high level of reliability, IEEE 802.1CB Frame Replication and Elimination for Reliability (FRER) works to send duplicate copies of each frame over multiple disjoint paths, so even in the event of partial network failure, proactive redundancy still allows for

seamless communication.

During Taipei automation 2022, Moxa partnered with NXP Semiconductors N.V., a Dutch semiconductor designer and manufacturer and port Industrial Automation GmbH, to test the reliability of an 802.1 CB-based ring topology that used Moxa switches to connect NXP equipment.

As engineers unplugged certain network cables to simulate network failure, the data packets that controlled the critical equipment still synchronized and operated normally. Moreover, this test also demonstrated that robust network redundancy helps recover multiple points of failure, not just a single point of failure.

## Wireless possibilities unleashed

Another important step toward implementing TSN in industrial automation is to ensure the data can be transmitted in wireless applications. As a lot of industrial equipment is mobile, true IIoT will not be possible without a wider array of TSN wireless applications. In Taipei Automation 2021, Moxa, Intel Corporation, and port Industrial
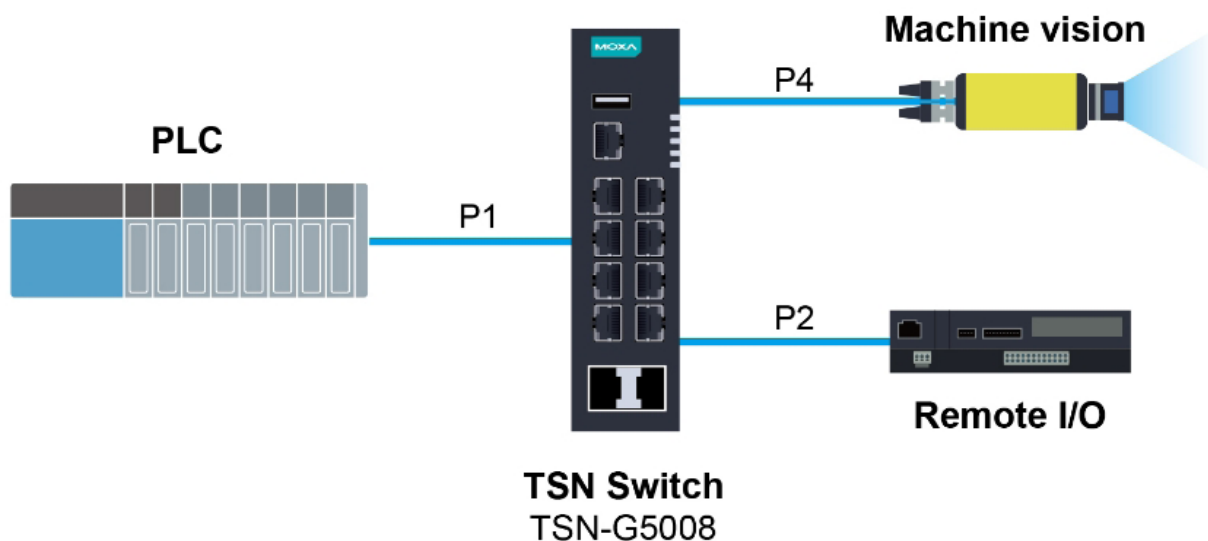
*Moxa's TSN switch allows data to be sent between the PLC and end devices.*

Automation GmbH developed a platform that demonstrates the industry's first ready-to-use, application-to-application TSN solution for instant transmission of data.

Designed to be compatible with various communication protocols, the new platform is flexible and expandable, which means it can be used to build the next generation of smart manufacturing and logistics solutions, particularly when mobile devices are not only desired but required in real-world use cases. Wireless TSN fleshes out the full potential of TSN as a truly unified and high-performance network infrastructure allows all types of traffic to coexist.

## Taking the technology further
In addition to proving that the technology works, Moxa has also implemented TSN in several real-world applications to help companies achieve tangible business benefits.

### Reduce the Total Cost of Ownership in Wafer Manufacturing
Cooperating with ELS System Technology, (a leading Taiwanese lithography solution provider), Moxa successfully integrated TSN into the wafer manufacturing process. The system includes incorporating machine vision into the wafer misalignment correction system.

The TSN technology successfully integrated a high-bandwidth video application with a high-reliability on-demand motion control CC-Link IE TSN. The solution delivered a stable motion control system, fully equipped with machine vision, for the misalignment correction system.

Moxa's TSN solution also supports different types of traffic that may have very different requirements and offers accurate motion control data about network traffic in real time using the same open and standard network. What's more, the TSN solution also helps increase the economic feasibility of the network and reduces the total cost of

ownership (TCO) as the infrastructure is easy to maintain and scale up.

## Minimize inconvenience of downtime with video component logging
Real-time video monitoring is notoriously data- and bandwidth-hungry. TSN's ultra-reliability and bounded low latency make building a converged application for recording and streaming live video over a network a feasible task.

To help the Japanese industrial conglomerate Mitsubishi Electric improve the logging of all system components during visual inspections, Moxa built a module with the capability to record the video stream, waveform, and related information to help users speed up troubleshooting when necessary. As they are no longer required to scour through different devices or networks, engineers can now conduct their forensic investigation on a TSN-based integrated system in which critical and synchronized visual data is safely accessed, stored, and protected.

## How TSN helps
TSN is the key to smart factory automation because deterministic, real-time communication allows different equipment to work seamlessly together. As networks grow in size and complexity, TSN implements traffic management and prioritizes system resources to ensure that critical data gets delivered on time, which makes the network ultra-reliable and more secure. We will now consider two use cases that showcase the capabilities of TSN, and how Moxa works with system integrators, machine builders, and end users to achieve better returns with TSN.

## Use Case 1: Machinery Manufacturer
Responding to market demands for advanced, integrated, and highly automated machinery, machinery manufacturers aim to offer

machinery that features built-in scalability, accelerated sensing, and complex laser and machine control applications. As such, however, different proprietary networks belonging to different components require seamless communication and integration in order to deliver optimal performance. Furthermore, the maintenance of these networks will present challenges for operators, especially when the machines are shipped abroad and training for operators is at times not followed through.

Moxa developed a unified TSN network to enable deterministic communication between cameras, sensors, and machine controls. Moxa's TSN-G5008 Series full Gigabit managed switch connects multiple I/Os to the servo drivers and machine vision cameras. Due to the "first-in, first-served" nature of Ethernet, it was not possible to transmit critical data on the same cable. With standard Ethernet TSN infrastructure, however, traffic management now allows critical data to share networking resources and ensures data packet delivery. The switch is designed to make manufacturing networks, such as those of machinery manufacturers, compatible with TSN to reap the benefits of Industry 4.0.

## Use Case 2: Mass Customization Production System
A shorter production cycle is beneficial to businesses because efficiency leads to lower costs and more flexibility. It also allows businesses to cater to a changing market and offer mass customized—and often higher margin—products, such as commercial-off-the-shelf (COTS) products. For manufacturers, such efficiency and flexibility can only be achieved when various systems—including production, assembly lines, and logistics—are on a unified network so changes and adjustments to the production and distribution processes can be implemented on short notice more effectively.

To make mass customization possible, manufacturers can deploy Moxa's TSN-G5004 and TSN-G5008 Series Ethernet switches to combine existing proprietary networks into a single TSN-capable network to boost efficiency. Most importantly, manufacturers can achieve information technology (IT) and operational technology (OT) convergence, so as to reduce the number of processes required to make a product. As such, adaptive production, mass customization, and production optimization are enabled because assets are managed through a TSN-enabled network, with which deterministic communication ensures effective control over the entire manufacturing process.

A simplified network topography benefits operators because maintenance becomes easier and more cost effective. As operators now maintain a unified network instead of many networks with different protocols and requirements, training can be streamlined. Cabling, too, becomes more straightforward, contributing to lower maintenance costs.

### Boundless benefits
TSN brings efficiency, easier management, and cost effectiveness to the world of industrial automation. Its deterministic communication, whether wired or wireless, contributes to the ultra-reliability needed for high-stakes and demanding industrial systems. As TSN requires a standard, unified network for different devices, IT and OT convergence offers fewer nodes, streamlined cabling, and easier maintenance. These benefits are realized by a wide range of stakeholders from machine builders to system integrators to end-users.

### Machine builders
With TSN technology, machine builders can leverage a competitive network infrastructure that allows the motion bus and information being sent across the network to be converged on the same cable.

This simplified architecture can also reduce the number of nodes thereby saving overall costs and maintenance effort. In addition, from the performance standpoint, the cycle time of the control loop can be shortened, which makes it possible to control more devices. Last, since TSN technology runs on a Gigabit network, the higher bandwidth is well-suited for adding more applications in the future.

### System integrators
The unified TSN network also simplifies network and automation architecture by reducing cabling and engineering efforts. TSN's ability to converge all proprietary networking technologies into one single cable means that network planning and scale can be controlled and predicted, thereby reducing the total cost of ownership and saving maintenance efforts.



*TSN provides a toolbox for combining networking and time-sensitive mechatronics solutions.*

SOURCE: ISTOCKPHOTO

### End users
Furthermore, TSN is compatible with existing networks so additional network gateways that connect to different proprietary systems are no longer required. In fact, TSN's compatibility with existing standard networks enables easy data access so that the system can more easily optimize resources and effort for end-users.

Compared to other existing networking technologies, TSN is also better equipped to prioritize critical packets over non-critical but high-bandwidth consuming applications, which reduces overall system downtime.

Finally, leveraging standard Ethernet technologies means that the latest cybersecurity solutions developed for Ethernet are also available to TSN networks, offering greater protection and adaptability in an ever-changing threat climate.

### Preparing for TSN adoption
When it comes to implementing a TSN-capable application, a thorough understanding of the existing application requirements and network topology is a prerequisite to choosing the most suitable protocol and the right configurations for the switches and end devices.

Let us consider an example that requires both PLC communications and image capture. This application would require transmitting two types of data to the same host computer. Using a combined network topology, it is clear that the video stream is sent from port

4 to port 1, while the controller sends the synchronization message to the master server from port 2 to port 1.

Protecting the control packet from the high bandwidth video stream requires configuring the necessary protocols on the network, including time synchronization (802.1 AS) and time aware shaper (802.1 Qbv) on the related components and ports.

The control packet is sent at 1 second cycles, 300 µs for cycle date, and 200 µs for time sync data while the remaining 500 µs is running the non-cyclic data. The device can assign the corresponding VLAN ID to each slot to ensure that the cycle data will not be affected.

After clarifying the behavior of the application, the last step is to configure the necessary configurations on the Ethernet switch and end device.

### Summary
For a long time, Moxa has been working to ensure that TSN technologies are achieving their true potential and helping industry leaders accelerate their digital transformation in industrial automation. To learn more about the road to smart manufacturing and TSN, please visit Moxa's TSN microsite below.

*Theo Lai, Product Manager and Project Lead of Global TSN Initiative Project, **Moxa, Inc.***

**Visit Microsite**

industrial ethernet book

Industrial Networking & the IIoT

CLPA
CC-Link
PARTNER ASSOCIATION

OPEN AUTOMATION NETWORKS

APRIL 2024

Special Report

# CC-Link IE TSN

# in Action

## CC-LínkIE TSN

Case studies illustrate the success and benefits of
Time-Sensitive Networking in manufacturing.

# Time-Sensitive Networking in smart manufacturing

**Time-Sensitive Networking (TSN) combined with Industrial Ethernet in smart manufacturing applications offers deterministic performance for automation and control applications, along with powerful standards for implementing IT-OT convergence and Industry 4.0 digital transformation.**

TIME-SENSITIVE NETWORKING SOLUTIONS are coming of age in smart manufacturing backed by the performance of standard gigabit Ethernet networks and the ability for real-time, deterministic control information and application data to co-exist on the same network.

Success for TSN in manufacturing has been coming for a period of time. The initial Ethernet Specification was completed in 2016, and the initial work on CC-Link IE TSN was completed two years later. Next came a period of technology development, additional work on specifications and prototype systems. The CC-Link Partners Association (CLPA) played a critical role in refinement of the standards, and development of the controllers and devices that modern manufacturing systems require.

Thomas Burke, Global Strategic Advisor for the CC Link Partner Association, said that Time-Sensitive Networking is moving ahead with sweeping changes that are impacting automation and machine control networking.

"The industrial communications landscape has dramatically changed over the years. I remember when Ethernet was first coming into the factory, and it took a while to be successfully understood that this was the right technology for factory and process automation," Burke told IEB.

"The value of TSN is it's clearly about the convergence of networks and the ability to have multiple industrial Ethernet networks running on the same physical wire. But what customers are realizing with the value of the technology is the fact that they can perform control applications simultaneously and be able to configuration applications – plus they can have other applications and devices like



SOURCE: ISTOCK

*CC-Link IE TSN uses standard Ethernet to deliver technology benefits for manufacturing applications.*

printers and cameras on the same wire without affecting control."

Burke said that things like safety and motion are commonplace on industrial Ethernet networks and the fact that it will be able to add new devices to the network while the network is being used for control applications will make everyones life much easier. There a re manyopportunities to leverage deterministic performance and the ability to address digital transformation and IT to OT conversions that TSN provides. Safety and security are critical components that automation applications clearly need.

Check out the application stories in this report to learn how CC-Link IE TSN is being applied to high performance Bottle Printing Machine and Additive Manufacturing, Footwear and Battery Production.

## Simplified network architectures

The use of a simplified Ethernet backbone using TSN ultimately results in simplified machine

designs. This approach reduces system costs, shortens project timelines and increases uptime by the use of simpler network architectures.

Users implementing Time-Sensitive Networking don't need to change the entire infrastructure within a plant but can utilize TSN on a machine-by-machine basis.

## Greater process transparency

Devices and systems sharing the same network architecture to communicate avoids the complexity and cost of multiple networks, but real-time deterministic communication allows data to be shared across the entire enterprise.

A top priority for manufacturers is greater process transparency that allows data to flow from the source where can be processed to obtain actionable insights, and then fed back into the process. This ability to deliver greater process transparency and optimised operations helps create higher levels of productivity, as optimised processes run more effectively.

## Convergence of OT and IT systems

By extending Industrial Ethernet standards, TSN enables the convergence of IT and OT systems on industrial networks. Both real time-critical data for machine control networking and data-intensive applications can be implemented using a shared Ethernet cable without interfering with each other. OT and IT systems are able to leverage the converged stream of data that can be easily shared between the factory floor and supervisory systems.

## Easier integration of devices

CC-Link IE TSN offers a strong ecosystem of device suppliers and the ability to integrate solutions for complex, real-time manufacturing systems. The expansion of compatible CC-Link IE TSN products has been achieved using development methods and implementations on both hardware and software platforms. This includes ASIC and FPGA-based hardware, and development of software protocol stacks using general purpose Ethernet chips for master controllers or devices.

This flexibility has allowed device vendors to develop products using the most optimal methods while minimizing time to market and creating a wide range of products for end users.

*Al Presher, Editor, **Industrial Ethernet Book***

# CC-Link IE TSN drives innovation in bottle printing

**Time-Sensitive Networking (TSN) along with use of CC-Link IE TSN has enabled new bottle printing machines to deliver next level productivity via deterministic motion control over a multitude of servos. This has resulted in significant improvements in terms of performance, accuracy and precision.**



SOURCE: KELLER POLIGRAFIA DLA PRZEMYSŁU

*Keller identified the convergent network architecture benefits offered by CC-Link IE TSN and plan to add additional machine functions, like vision systems, on the same network architecture.*

KELLER, A LEADING OEM OF MACHINES THAT perform screen and pad printing as well as hot stamping based in Poland, has developed an innovative new system that leverages CC-Link IE TSN network technology to boost productivity.

By incorporating Time-Sensitive Networking (TSN), the new bottle printing machine delivers next level productivity via deterministic motion control over a multitude of servos. This has resulted in significant improvements in terms of performance, accuracy and precision.

Printing and stamping are among the most demanding motion control applications, as they use multiple axes that need high levels of synchronisation to operate effectively at extraordinary speed with high repeatability.

When looking at their communications requirements, these functions need to be supported by highly deterministic, real-time communications across multiple axes. At the same time, end users are demanding ever-more high-speed, advanced machines, meaning that implementing a network technology that can achieve this is key. TSN is the technology that can address these requirements today, while also offering further benefits for the future. These include the possibility of using a converged network architecture to simplify machine design, reduce costs and decrease time to market. This is enabled by multiple kinds of traffic being combined together, rather than using separate networks as in the past.

In its drive to serve the market with state-

of-the-art printing technologies, Keller was keen to adopt the most promising, innovative automation devices and industrial communications solutions. When Keller wanted to develop a universal, modular machine for direct, multi-colour printing on cylindrical goods, such as bottles, it turned to its longstanding partner, and board member of the CC-Link Partner Association (CLPA), Mitsubishi Electric. The team at the heart of the collaboration set out to identify the most suitable options from which it could create the best machine to support Keller's ambitions and the needs of its customers.

Tomasz Andrzejewski, Head of Automation Department at Keller, explains: "We started cooperating with Mitsubishi Electric in 2012. Since then, we have been able to appreciate
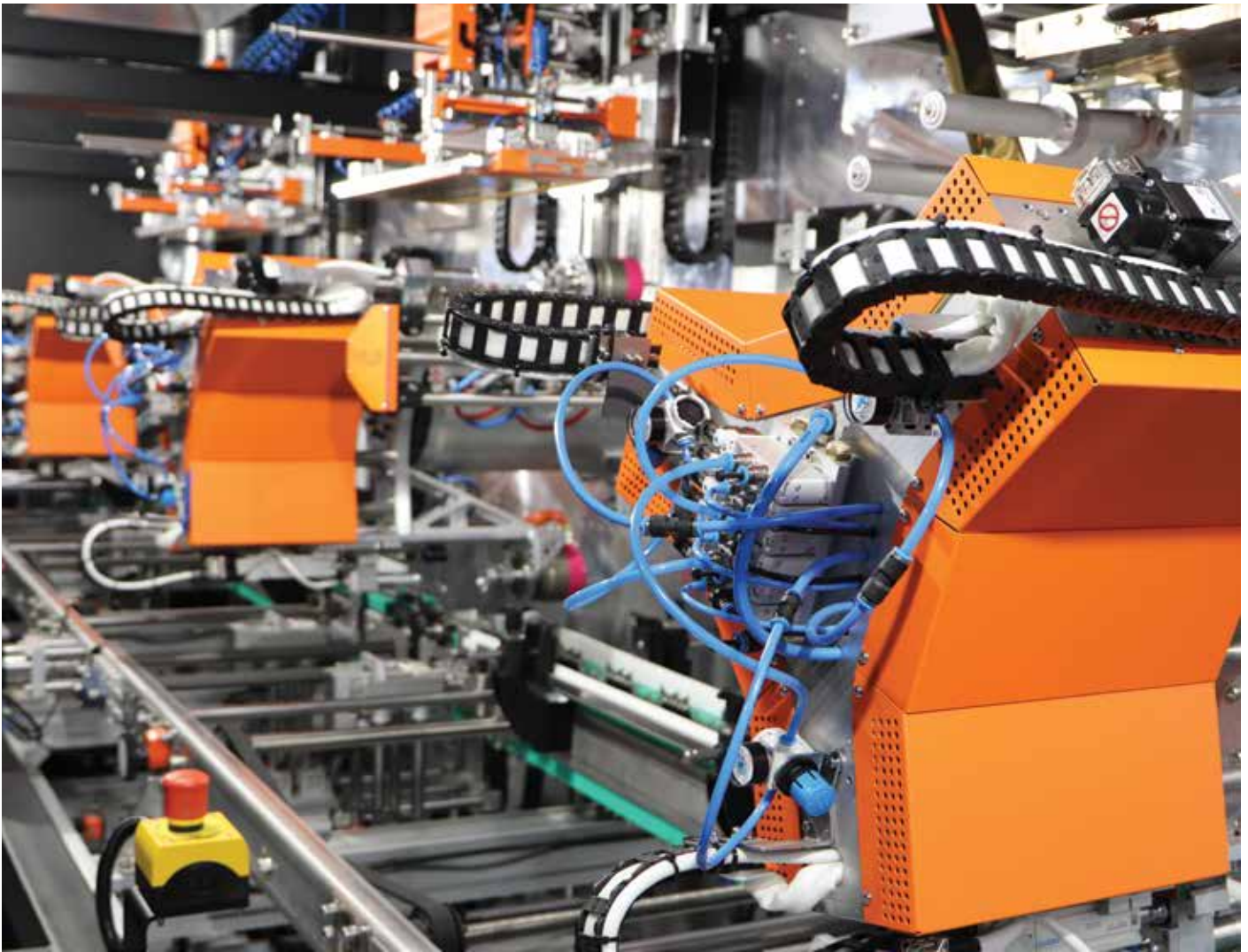
*By incorporating CC-Link IE TSN, the new bottle printing machine delivers next level productivity via deterministic motion control over a multitude of servos.*

and experience first-hand the abilities of Mitsubishi Electric's solutions, including its latest generation of servos. These are incredibly reliable and meet our strict precision requirements."

## Taking the right turn

The unique setup developed by the companies, which combines screen printing and hot stamping on cylindrical objects, utilises an industrial automation system that incorporates CC-Link IE TSN network technology to offer ground-breaking performance. This includes MELSEC MR-J5 servos controlled by an iQ-R series PLC.

As a key supporter of CC-Link IE TSN, Mitsubishi Electric used the network's industry leading combination of TSN and gigabit bandwidth to offer Keller a system that could provide fully deterministic control of up to 128 axes. It also enabled extreme synchronisation accuracy in the order of microseconds. This ensures that the machine can deliver prints of consistently high quality while maintaining a rate of 3,000 units per hour, with a plan to reach 3,600.

Michal Cydzik, Product Manager for Control Systems at Mitsubishi Electric, adds: "What Keller wanted was a really advanced and ambitious setup, with 20 axes per colour head and a total of 65 MR-J5 drives, in addition to 18 auxiliary virtual axes. CC-Link IE TSN provided the necessary determinism, capacity and bandwidth required to handle this while delivering the performance Keller needed."

## Opening the door to future-oriented manufacturing

The resulting machine offers end users a modular, versatile solution that delivers enhanced productivity, cost-effectiveness, flexibility and high print quality. Moreover, the setup is scalable, as it can incorporate up to 8 different colours (and their necessary axes) and is completely reconfigurable. It can be extended to include additional printing modules to deliver a highly integrated system. The final result was an industry leading machine which was enabled by an equally industry leading open industrial Ethernet technology.

John Browett, General Manager at CLPA

Europe, comments: "We are really pleased to see how Keller took the capabilities of CC-Link IE TSN and used them to develop a system that will allow them to remain at the leading edge of their industry. We know how capable the technology is, and it's very rewarding to see how they fully exploited it to achieve a high productivity solution for their customers. They have also identified the convergent network architecture benefits that TSN can deliver for future development and plan to add additional machine functions like vision systems on the same network architecture. This will further demonstrate how these features can simplify machine design, reduce costs and decrease time to market.

"Keller is an excellent example of how CC-Link IE TSN can drive next-level performance and capabilities in key industries. Market acceptance continues to grow and there are currently a wide variety of industries and applications where it is in use. This attests to the strength of our latest technology and its increasing global importance."

*View Application Video*

# CC-Link IE TSN adds value to additive manufacturing

**New additive manufacturing machines from Shashin Kagaku utilize gigabit bandwidth to achieve component production times that are ten times faster than existing systems. A minimum loop closure time of 125 microseconds also helps the machines to offer a step function change in productivity.**

ADDITIVE MANUFACTURING (AM), OR "3D printing", has quickly opened up new production frontiers in recent years. Structures once regarded as being impossible to fabricate with traditional machining techniques have become commonplace. Moreover, the original delicate parts formed by earlier AM technologies, suitable only for prototyping and laboratories, have now given way to methods that provide actual production parts.

These are commonly used in applications that can be as demanding as jet engine turbine blades. While material science has led the way in these advances, high precision motion control and the ability to combine this with all other machine functions has delivered significant competitive advantage for one AM machine manufacturer by adopting CC-Link IE TSN.

Now that AM has moved out of the prototyping lab and into mainstream production lines, it has become subject to all the same pressures as its subtractive manufacturing cousin. Parts must meet stringent specifications and quality standards while being produced to meet aggressive schedules and cost targets. As a result, manufacturers of AM systems have been under pressure to produce machines that continue to raise the bar on customer expectations as market forces intensify.

Shashin Kagaku is a Japanese manufacturer of AM systems that form high precision parts using a ceramics-based process. Their new SZ-6000 system uses an alumina or aluminium oxide powder mixed with a resin to form a slurry that is cured under UV light. This is then used to build up parts layer by layer by using UV light to cure the photosensitive slurry into the required form. Finally, a kiln fires the parts, evaporating the resin and making them durable enough for real applications via sintering of the ceramic powder.

The SZ-6000 can manufacture relatively large-scale parts, with dimensions exceeding 600 mm square and 300 mm deep, while maintaining manufacturing tolerances on the scale of thousandths of millimetres. To do this, extremely fine motion control of a variety of rotary and linear axes in an interpolated manner



SOURCE: SHASHIN KAGAKU

*The new SZ-6000 is an extremely productive additive manufacturing (AM) machine that provided Shashin Kagaku a significant lead over its competition while offering customers a significant increase in productivity.*

is required. These also need to operate at high speed to meet the necessary productivity targets. Of course, the complete machine architecture extends beyond just the motion control aspects. Tight control of the UV digital light processing (DLP) exposure system must be closely coupled with the motion axes, while also integrating all other machine functions.

To meet these demanding requirements, Shashin Kagaku turned to CC-Link IE TSN, the world's first open industrial Ethernet to combine gigabit bandwidth with Time-Sensitive Networking (TSN). In this application, the use of TSN technology permits disparate types of network traffic to share a single network architecture by employing IEC/IEEE standards, such as 802.1AS and Qbv. These synchronise traffic flow across the network and regulate the priority of different traffic types. By leveraging TSN along with the industry leading gigabit bandwidth of CC-Link IE TSN, Shashin Kagaku were able to realise a number of key benefits.

The convergence of different network traffic on the same architecture allowed the complex, multi axis, high precision motion

control system to be run on the same network as the rest of the system I/O. This, in turn, delivered the tight integration between the motion control systems and the operation of the UV DLP exposure system. The maximum number of axes that could be handled by this system was up to 128, providing scope for even more advanced systems in the future.

Consequently, the construction of the machine could also be simplified, as less wiring was required to construct the internal systems, leading to reduced construction time. As a result, Shashin Kagaku could offer shorter delivery times, reduced system cost and a more competitive product.

The gigabit bandwidth of the network contributed to a component production time that is about ten times faster than Shashin Kagaku's existing systems. More precisely, a minimum motion loop closure time of 125 microseconds could be achieved, allowing the company to offer a step change in productivity.

TSN's ability to converge OT and IT traffic allowed a conventional industrial PC to be integrated into the setup without the need for dedicated hardware, further simplifying the machine and helping to reduce cost. This also provided an interface to external CAD systems in order to download designs, which can be converted into the motion programs, which control part forming.

The end result was an extremely productive AM machine that provided Shashin Kagaku a significant lead over its competition in what is already a highly competitive marketplace. More importantly, its customers also benefit from a significant increase in productivity in the form of an even more cost-effective tool.

John Browett, General Manager of CLPA Europe, commented: "We have known all along that CC-Link IE TSN was capable of delivering significant productivity benefits to end users and machine builders alike. This advanced additive manufacturing system from Shashin Kagaku shows just how."

**View Application Video**

# TSN revolutionises footwear manufacturing

**Footwear equipment specialist Orisol applied TSN technology to its solutions in order to help drive forward the digitalisation of its customers. The technology provides the backbone for smart, data-driven operations by supporting the convergence of multiple types of traffic onto a single network.**

DELIVERING CUTTING-EDGE SOLUTIONS is the goal of any customer-driven, ambitious company. When Orisol, a provider of automated systems for footwear production, wanted to futureproof its offering to drive its customers' and its own competitiveness, CC-Link IE TSN offered the ideal technology. The resulting innovation delivers unprecedented speed and responsiveness as well as the connectivity required for smart manufacturing operations.

Orisol is a world-leading provider of smart, automated machines and systems for footwear manufacturing. The company is committed to delivering solutions that maximise interoperability, compatibility and scalability to support the digital transformation of its customers and advance their competitiveness.

In line with this aim, Orisol participates in key collaborations, such as Mitsubishi Electric's smart manufacturing initiative, the e-F@ctory Alliance. In addition, it focuses on the development of future-oriented systems that can support the different stages of shoemaking.

After learning about the potential of Time-Sensitive Networking (TSN), the footwear equipment specialist was keen to apply this technology to its solutions in order to help drive forward the digitalisation of its customers. In effect, TSN can provide the backbone for smart, data-driven operations by supporting the convergence of multiple types of traffic onto a single network. While doing this, TSN also ensures determinism by prioritising the transfer of time-critical messages, such as control data.

## Innovation – body and soles

Orisol saw its OFA240 series upper to sole flash activator machine as an ideal candidate to benefit from the principles of TSN technology. This system, which is a key element of footwear assembly lines, uses heat activation to effectively and homogeneously cure adhesives that are applied to bond different shoe components together.

Successful bonding requires accurate and precise control of the heat applied onto the product. In effect, the challenge in this process is the heat energy distribution that is spread out on the surfaces. It requires the machine



*When Orisol wanted to futureproof its offering, CC-Link IE TSN offered the ideal technology.*

to have precise internal communications to regulate the heating energy being released. Also, it needs to offer monitoring functions for the user to know if intervention is needed.

In terms of network requirements, optimum operations for the OFA240 demand suitable controller to device (C2D) communications, so that a single network architecture could be used for all the operational technology (OT) elements of the machine to self-adjust in real-time. These components include vision systems, temperature sensors, heat lamps, switches, indicators and alarms.

Moreover, since Orisol is focused on the digitalisation of operations to create a smart facility, a network architecture that could enable controller to controller (C2C) communications, in addition to integration with higher level information technology (IT) systems, was required. This would allow machines to operate in parallel to share information and effectively collaborate to optimise product quality, efficiency and productivity. TSN provided a single solution to address all these requirements, ultimately supporting convergence of the OT and IT domains. It also offered the ability for multiple machines to be integrated into Orisol's proprietary production monitoring and remote maintenance systems, such as its Production Data Collection System (PDCS) and Remote Operation Maintenance Platform (ROMP).

To leverage the power of TSN and meet

Orisol's requirements, CC-Link IE TSN was selected as the system's network technology. This is the first open industrial Ethernet to provide TSN functions, therefore ensuring convergence and determinism. In addition, it offers gigabit bandwidth to maximise the volume of data traffic that can be sent simultaneously. Furthermore, it is supported by leading global automation vendors with a range of compatible products.

### A foot in the door

Thanks to an established portfolio of CC-Link IE TSN compatible industrial automation devices from Mitsubishi Electric and Moxa, Orisol could leverage a comprehensive application solution to meet all their requirements.

The benefits delivered by this solution were significant. The network's gigabit bandwidth led to internal communications speed increasing 220 times. This meant that execution time was shortened by 7 times and application time by 12 times. CC-Link IE TSN also enabled machines to be synchronised to an accuracy of 1 millisecond. This delivered almost instant data sharing, delivering precise communications within the machine itself, to other devices and to IT systems, such as Orisol's PDCS and ROMPS. These provide remote monitoring and control, allowing operators to have a real-time overview of the process as well as promptly intervene, if anomalies are discovered. The end result was a system that fully addresses the demands of Industry 4.0 by using TSN technology.

John Browett, General Manager at CLPA Europe, concludes: "Orisol's OFA240 series flash activator machine is an excellent example of how TSN has been applied in a real-world application to deliver significant machine performance improvements. We are extremely proud to see CC-Link IE TSN being used to enable significant productivity increases and therefore deliver an enhanced competitive advantage to Orisol and their customers. We look forward to seeing many more companies apply CC-Link IE TSN the near future to realise similar benefits for their own machines and customers."

*View Application Video*

# CC-Link IE TSN sets battery industry in motion

**Leveraging the right network technology can help lithium-ion battery (LiB) manufacturers get the most from exciting market opportunities by meeting challenging market demands. CC-Link IE TSN networking helped a premier LiB company simplify its manufacturing systems while complying with exacting product specifications.**

LIB CELL MANUFACTURING CONTINUES TO experience exponential growth as its products find ever increasing applications such as smartphones, tablets and ear buds, as well as increasingly popular electric vehicles (EVs). To accommodate rising global demands, LiB producers need to quickly scale up their capacity while delivering high-quality products. This requires high precision, high-yield, high-throughput manufacturing systems.

LiB manufacturing is a complex, multistage process, of which the majority are based on established converting principles. An electrolyte slurry is mixed and then applied to a metal foil as a fine layer, which is dried before passing through an intricate series of slitting, winding and cutting activities to manufacture the finished cell. These require an exacting, highly coordinated series of multi-axis motion control operations to deliver the required quality and avoid waste.

The performance of the finished cell in terms of capacity, internal resistance and reliability is highly dependent on multiple parameters, such as coating uniformity, film tension and so on. Moreover, since the demand for lithium and other raw materials continues to grow exponentially, it is clear that material wastage caused by out of spec product should also be kept to an absolute minimum.

To further increase the application challenges, as battery manufacturers seek to constantly increase cell capacity, foils and their coatings are constantly getting thinner. While striving to achieve this, materials need to be handled at higher and higher speeds to meet production targets driven by insatiable market demands.

Finally, besides the critical motion control processes, a variety of associated machine functions need to be integrated into the production process to provide the required functionality. These include visual coating inspection, film tension, tab welding, general machine control and safety systems.

Key to addressing these challenges is an open industrial Ethernet technology that delivers high performance along with network convergence. This allows productivity and performance targets to be met, while simplifying machine designs by combining multiple traffic types onto a single network architecture. As a result, it is possible to reduce machine complexity, which in turn decreases



*CC-Link IE TSN converges motion control with safety and general I/O control to deliver high performance.*

SOURCE: ISTOCK/ JUST_SUPER

project lead time, accelerates scalability and maximises productivity.

## TSN's benefits to LiB manufacturing

When a leading producer of automated LiB manufacturing lines was looking for a new technology that would improve the productivity of its systems, while simplifying their designs and reducing time to market, CC-Link IE TSN stood out.

CC-Link IE TSN is an open industrial Ethernet technology that was the first to combine gigabit bandwidth with Time-Sensitive Networking (TSN). As such, it offered several benefits to machine builders in this industry. First, the gigabit bandwidth meant that large volumes of production data could be handled easily, without affecting machine performance or plant productivity. Moreover, since data is shared at gigabit speeds, the setup could offer a scalable solution that can continue to meet the increasingly more demanding needs of LiB manufacturers. Finally, operation at these speeds meant that multiple motion axes could be synchronised on microsecond intervals, providing a degree of process quality not previously possible.

Additionally, the integration of TSN into the network meant that several different traffic types could also be combined onto a single network architecture. This meant that the large and complex multi-axis motion control system of the company's machines did not have to suffer from the cost penalty of having to use

multiple networks to handle motion control separately from other machine functions such as visual inspection, safety and general machine control. Thanks to CC-Link IE TSN's capabilities, all these disparate communication needs could now share a common network architecture. The result was a simpler, less expensive machine design. In turn, this was easier to build and maintain and could be delivered more quickly, delivering significant competitive advantages.

The final benefit is that TSN's ability to allow different traffic types to share the same network also provides the foundation for OT/IT convergence. In simple terms, this means that the machine process data created by the OT of the shop floor can be more easily shared with higher level IT systems. This opens the door to further improvements, such as leveraging AI systems to analyse machine operation in order to deliver future process improvements.

John Browett, General Manager of CLPA Europe, commented: "It is very pleasing for us to see companies such as this leading producer of automated LiB manufacturing lines using CC-Link IE TSN. They are leveraging our technology to take a leap forward over their competition and provide an industry leading, scalable platform for their customers now and in the future. We are confident that CC-Link IE TSN will continue to deliver benefits to the LiB industry and many other sectors as we move forward."

*View Application Video*

# ONE

## CC-LINK IE TSN:
## ONE NETWORK. ONE SOLUTION.

Combine Time-Sensitive Networking with gigabit bandwidth to create open, converged industrial Ethernet architectures that deliver significant business benefits. And with software-based implementation, CC-Link IE TSN enables easy product development and faster time to market.

- **Simpler network architectures/machine designs**
- **Greater process transparency and better management**
- **Better integration of OT and IT systems**
- **Fast implementation in existing devices**

CC-Link IE TSN is ready to deliver these productivity benefits **now** to support your drive to Industry 4.0.

To find out more, visit **www.cc-link.org/en** or email **Tom.Burke@CCLinkAmerica.org**.

**CLPA**
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**OPEN AUTOMATION NETWORKS**

*CC-Link IE TSN*

# Factory automation showcase focuses on technology innovation

**Industry experts agree that the foundation of Industrial Ethernet solutions for factory automation remains laser-focused on smart connected machines, edge and cloud-based computing, the potential impact of AI technology and new products and tools that simplify the ongoing quest for IT-OT integration.**
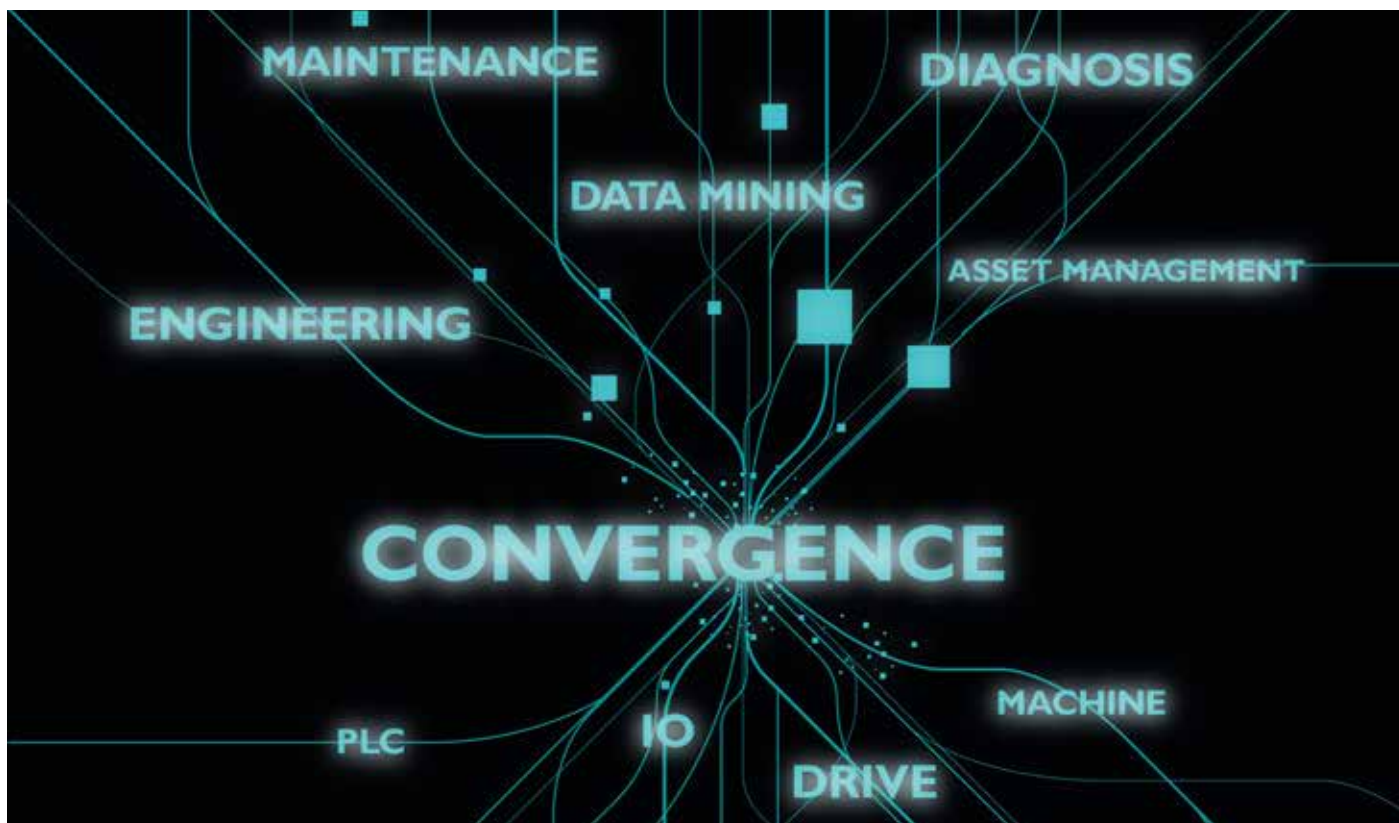


*SOURCE: PHOENIX CONTACT*

*Industrial Ethernet is not just a foundation for digital transformation but an active driver of innovation and progress. By focusing on advanced integration, edge computing, convergence, and robust security, Industrial Ethernet can unlock even greater potential for IIoT and enterprise connectivity.*

INDUSTRIAL ETHERNET FACTORY AUTOMATION solutions represent critical, foundational technology that provide a communications backbone for smart connected machines, improved convergence of IT-OT functions, cybersecurity and new capabilities based on industrial edge and cloud-based architectures.

For this Factory Automation solutions update, the Industrial Ethernet Book reached out to industry experts to gain their perspectives on how technology is continuing to move ahead with a range of effective innovations targeting factory automation.

## Smart connected machines
*Improving production flexibility to adapt quickly to changing market demands.*

According to Vivek Bhargava, Product Marketing Manager at Cisco Industrial IoT,

"the key factory automation trend that we see is the rise of connected factories with smart connected machines. Manufacturers are investing in technology that would help them in making data-driven business decisions, countering cybersecurity threats, increasing sustainability, and improving production flexibility to adapt quickly to changing market demands.

"Being a foundational technology for Industry 4.0 and providing the communications backbone for interconnected devices, Industrial Ethernet is critical to realizing these objectives. Continuing innovation in industrial switching is helping build a scalable, flexible, and resilient network for uninterrupted operations minimizing unplanned downtime and allowing faster adjustments to the product mix," Bhargava said.

Bhargava said that modern Industrial Ethernet powered industrial networks share

architectural elements with their enterprise counterparts, which enables closer partnership between OT and IT teams to help bring IT practices to rapidly expanding OT networks.

Today's Industrial Ethernet unifies OT security with the network which helps manufacturers simplify network design and eliminate single function "point" products. Further advances in Industrial Ethernet enable manufacturers to collect, transform, and transmit process data to analytical applications in the cloud for actionable insights. Sustainability innovations in Industrial Ethernet such as modular designs, high MTBF, and industrial PoE help reduce and reuse of components and energy.

## Importance of Industrial Ethernet
In the next 3-5 years, as manufacturers continue to invest in smart production initiatives, Bhargava said that Industrial

*Cisco Industrial Ethernet switches feature the best of industrial and enterprise characteristics.*

Ethernet with higher performance, edge compute, built-in security, easy installation, configuration, and troubleshooting, will play a key role in determining the success of such initiatives.

"Gigabit or even 10Gbps high-speed ports and high switching capacity enables real-time monitoring and communications for applications like machine vision, robotics, and AI analytics," Bhargava said.

Edge compute within Industrial Ethernet allows applications to run directly on network equipment and avoid separate dedicated appliances. It is ideally suited for running advanced cyber security features such as visibility into OT assets and zero-trust network access (ZTNA) gateways, or collect and transmit process data, etc. Running advanced features as software applications embedded in Industrial Ethernet makes the overall architecture simpler, more scalable, and more secure.

Multi-level granular segmentation capabilities within Industrial Ethernet allows ISA/IEC 62443 based creation of zones and conduits to help limit effects of security breaches.

"An ecosystem of supporting management and security applications allows for easy installation, configuration, redeployment, and monitoring to ensure performance, making the industrial network scalable and flexible," Bhargava said.

"Modular designs, and innovations in industrial power-over-ethernet (PoE) technology help manufacturers extend the life of existing equipment and have a better control over power consumption."

## Future enhancements

Bhargava said that advances in Industrial Ethernet will help unlock Industry 4.0 benefits with a secure, adaptable foundation which will help simplify deployments, strengthen security, and enable scalable cloud connectivity. Moreover, Industrial Ethernet innovations can make industries more sustainable through resource optimization and reduce environmental impact throughout the product lifecycle.

"By replacing discrete hardware resources with software running in central virtual machines, Control Systems virtualization is certainly one of the most innovative applications that a modern Industrial Ethernet network can enable. Such virtualization can make operations even more agile and scalable, increase security, improve disaster recovery, and reduce costs," he said.

He added that industrial networks can also benefit with edge-compute capabilities in modern Industrial Ethernet, that can host visibility, segmentation, and remote access applications unifying OT security with networking. Such a converged architecture reduces complexity, making it easier to scale operations, and allows engineering teams to focus on product and process innovation rather than the network itself.

## Digital transformation

Bhargava said that Industrial Ethernet remains a key enabler of digital transformation and IIoT. Industrial Ethernet provides a stable and secure foundation for connecting machines, devices, and sensors, enabling real-time data exchange and communication

crucial for data-driven decision-making. High-performance Ethernet solutions support the high bandwidth and low latency requirements of advanced applications like machine learning, predictive maintenance, and remote monitoring, key components of IIoT and Industry 4.0.

Edge computing capabilities within Industrial Ethernet allow visibility and security applications to run within the network without additional appliances and can also enable real-time data analysis and decision-making closer to the source. Seamless integration of Industrial Ethernet with IT systems allows for enterprise-wide data visibility, centralized management, and improved collaboration between OT and IT teams.

"Overall, Industrial Ethernet is not just a foundation for digital transformation but an active driver of innovation and progress. By focusing on advanced integration, edge computing, convergence, and robust security, Industrial Ethernet can unlock even greater potential for IIoT and enterprise connectivity, paving the way for a smarter, more efficient, and secure industrial future," he said.

## Leveraging cloud data

*End-to-end communication between controls, sensors and actuators, plus vertical communication with higher-level MES or ERP systems.*

Frank Schewe, Deputy Vice President Automation Infrastructure at Phoenix Contact told IEB that, these days, with the help of connected sensors and actuators, factory automation applications are able to collect a wide range of data from the field in cloud-based systems, making it available for more in-depth analysis.

"Machine learning and artificial intelligence can be used to derive information, for example, for optimizing technical processes and to enable a proactive approach to maintaining technical systems. State-of-the-art industrial Ethernet networks make it possible to establish the necessary end-to-end communication between control systems and the connected sensors and actuators, and also vertical communication between the technical process and higher-level MES or ERP systems,"

*Cisco Industrial Ethernet host OT security functions eliminating the need for separate servers.*

Schewe said.

He added that, with the bandwidth available in these networks, data from the field can be stored and processed in cloud-based systems. One important prerequisite for any subsequent analysis and evaluation of the large amounts of data generated in this way is a precise time stamp that enables correlations to be recognized and derived. In addition to the system operator, the data can also be used by system suppliers and manufacturers to offer value-added services such as customer service and quality enhancements, for example.

Another prerequisite for many pay-per-use business models is the availability of process data in the cloud. Instead of investing in a technical system or an asset, manufacturers offer these business models as an added service that is billed by use.

## Technology innovations

"The focus in the past was on extending data rates and different transmission media while further developing Ethernet as part of the IEEE 802 project, but important innovations are now being developed in the data link layer (DLL) and higher layers, i.e., above the physical layer and media access control (MAC) layer," Schewe said.

Over the past few years, the IEEE 802.1 working group has created and published a host of new Ethernet standards under the
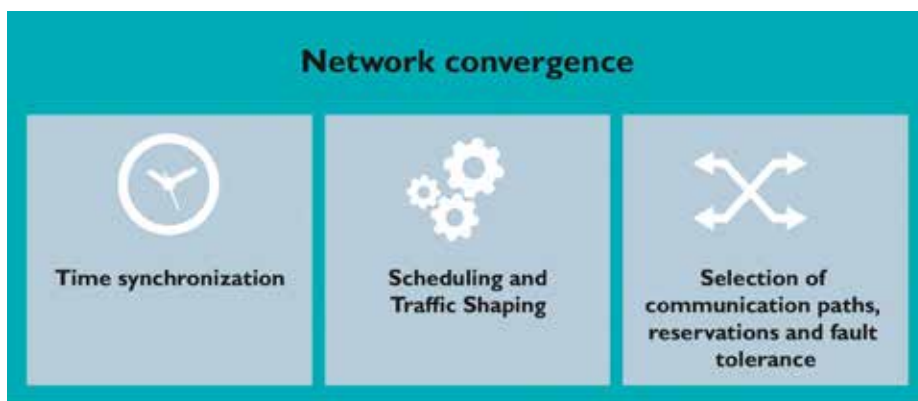


*TSN components enable network convergence.*

umbrella term, Time Sensitive Networks (TSN).

The TSN components created as a result can be assigned to the following thematic groups:

- Latency (e.g., frame preemption, scheduled traffic, and traffic shaping)
- Availability (e.g., frame replication and elimination, path control, and reservation)
- Synchronization (timing and synchronization)
- API and resource management (e.g., stream reservation protocol, YANG models)

Combined, the TSN tools enable a guaranteed and short latency time (deterministic) in the transmission of high-priority data between a transmitter and one or more receivers.

Data packets can be duplicated and sent via different routes in the network to ensure the seamless compensation of any equipment or transmission link failures. Where possible, the network recognizes and eliminates duplicates before delivery to the recipient. The 802.1AS standard describes the synchronization of distributed clocks, creating the prerequisite for the planned transmission of data in high-priority data streams.

A profile for industrial automation is currently being specified as part of the IEC/IEEE 60802 project which describes how these standards are to be applied in detail, so that even the most demanding industrial applications can be operated in convergent networks.
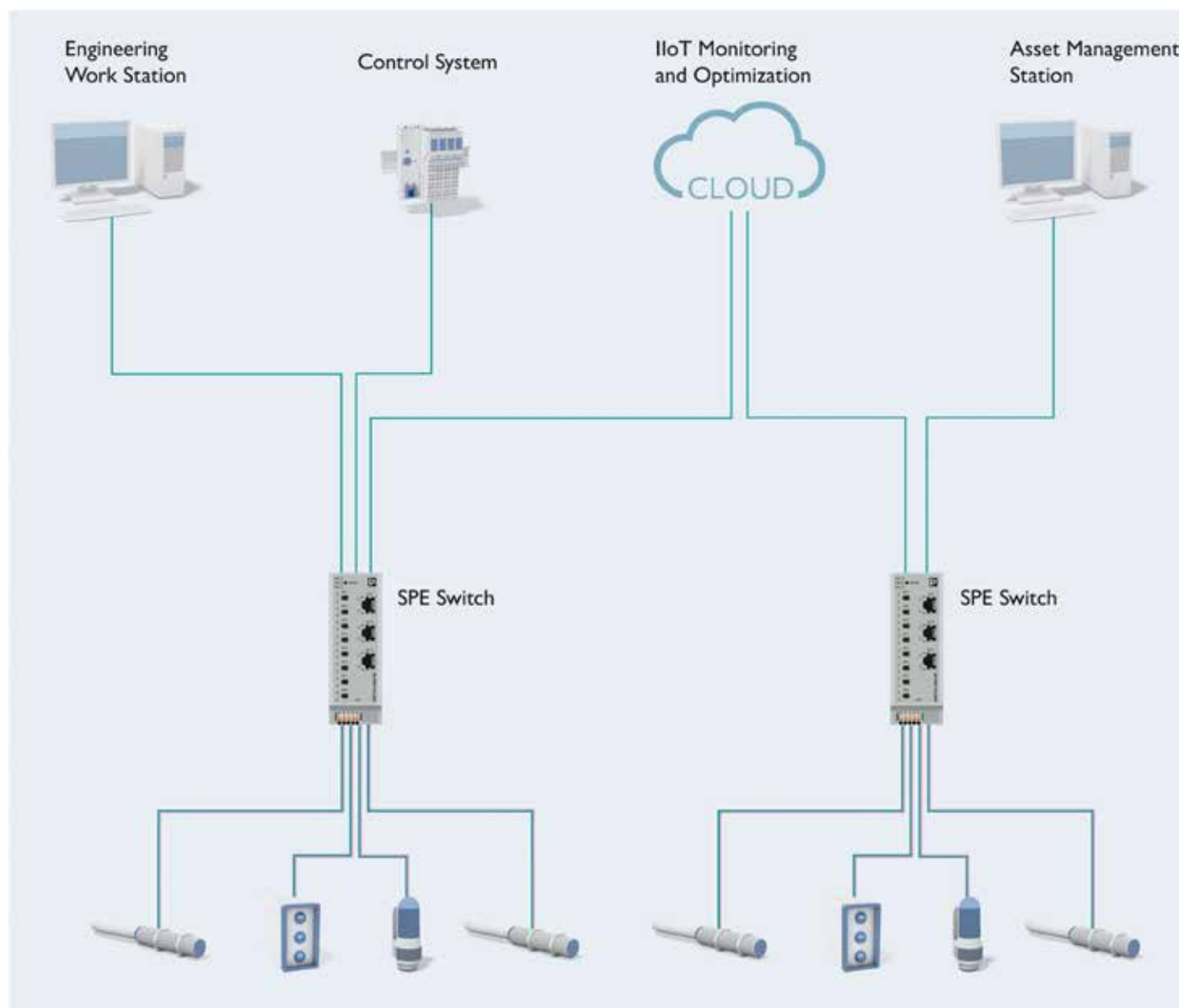
*Uniform Ethernet-based communication from the sensor to the cloud.*

## Industrial Ethernet technology

Schewe said that the Single Pair Ethernet (SPE) transmission physics developed by IEEE 802.3 provides data rates of 10 Mbps to 1 Gbps via a single two-wire line. This reduces installation costs and enables the direct connection of even very small sensors and actuators to the industrial Ethernet network with a range of up to 1,000 meters. Power can be transmitted to wherever supply voltage is required, to a sensor for example, via Power over Data Line (PoDL) in different performance classes using the same wire pair. SPE technology also enables the development of easy-to-handle connectors that can be assembled in the field, offering many advantages for the user in contrast to the RJ-45 connectors used so far. This means that small and compact end devices with direct Ethernet connectivity can now be realized with SPE.

"The biggest advantage of Single Pair Ethernet technology, however, lies in the end-to-end, IP-based networking from the sensor via connectors to the cloud. Until recently, applications of this kind were implemented using special gateways, requiring complex configuration. This end-to-end approach creates the basis for cross-manufacturer asset management and enables value-added services such as patch and device management down to the smallest sensor," he said.

## IIoT and enterprise connectivity

Schewe said that the key concepts of Industry 4.0 are based on simple and consistent networking at all levels of the automation pyramid and TCP/IP-based data exchange. Industrial Ethernet systems have been making a triumphant advance over a number of decades from the top of the pyramid right down to the field level. As a result, classic traditional fieldbus systems for communicating between the controller and end devices have now been replaced by Ethernet-based industrial communication systems. With this approach, TSN creates the prerequisites for deterministic Industrial Ethernet communication and SPE technology enables the connection of simple sensors and actuators.

He added that there are two things that are still required, however, for realizing Industry 4.0 solutions in the context of the digital transformation with IIoT devices: first of all, unique and tamper-proof device identities that manufacturers apply to the devices during the production of the device instances.

"These verifiable device identities enable secure connections to be established to the assets. Second of all, IIoT devices must have standardized data models (administration shells), enabling a much easier and efficient implementation of cross-manufacturer functions such as asset and configuration management. Concepts such as the digital twin of a device or system, which can be extended to include data regarding the use

of the asset during its life cycle, cannot be realized in any other way," Schewe said.

## Focus on Edge Computing
*Processing data near where it's collected, at the edge of the network.*

"In the realm of factory automation, a notable megatrend is the focus on edge computing, which is about processing data near where it's collected, at the edge of the network. This approach is crucial for linking factory operations with cloud-based systems, where further analysis and storage can happen," Dan White, Director of Technical Marketing at Opto 22 told the Industrial Ethernet Book recently.

But White said that understanding and setting up these cloud connections is essential before fully utilizing them.

"It's important to ensure that edge devices are securely connected to the cloud, which involves proper setup and security measures. Look for devices that are "zero trust", meaning that no one is permitted access to any resources unless explicitly granted. This careful approach prevents unauthorized data access and ensures that only secure, meaningful data exchanges occur between the factory floor and cloud services," he said.

## Industrial Ethernet technologies
White said that MQTT with Sparkplug B, OPC UA, and RESTful APIs will be pivotal in the evolution of Industrial Ethernet technologies.

"All of these technologies rely upon TCP/IP—the standard for network communication and winner of the protocol wars—for their foundation. MQTT, known for its lightweight and efficient messaging protocol, especially when combined with Sparkplug B, facilitates outbound originated communication between devices and applications," White said.

OPC UA stands out for reliable interoperability in industrial automation, enabling diverse systems to speak a common language. APIs—RESTful being the most popular one—which have been widely utilized in the IT sector, will continue to grow their footprints and play a crucial role in facilitating flexible and accessible integration between different software components.

"The unique appeal of Industrial Ethernet lies not in its distinctiveness but in its universality and compatibility with widespread commercial technology. By leveraging the same Ethernet used across various IT applications, from online banking to social media, Industrial Ethernet ensures seamless integration with existing networks," White said.

He added that this approach eliminates the need for proprietary protocols, emphasizing the importance of standardization and interoperability in industrial settings. The key advantage here is the ability to adopt secure, reliable, and high-speed communication technologies that are already proven in the broader IT world, making it easier for industrial systems to connect, communicate, and scale within the modern digital landscape.

"Industrial Ethernet solutions are pivotal in the digital transformation journey, embracing openness by supporting any protocol that operates over the TCP/IP stack," White said. "This inclusivity extends to legacy proprietary Ethernet protocols like ProfiNET, Modbus/TCP, and EtherNet/IP as well as to newer, open protocols like OPC UA and MQTT Sparkplug B. Industrial Ethernet covers the gamut from traditional wired connections to wireless technologies like WiFi, cellular networks, satellite communications, and even emerging systems like Starlink. This flexibility means that Industrial Ethernet can adapt to diverse industrial needs and IIoT integration."

## Artificial Intelligence (AI)
*Large language models and custom AI models set to make an impact on manufacturing.*

"The expectations are extremely high for the potential improvements that Artificial

*Expectations are high for use of large language and custom AI models in industrial applications.*

Intelligence (AI) can make in productivity across industries for good reason. Large language models are already proving out to be very effective as translation tools and custom AI models are allowing for control of sophisticated food manufacturing equipment that was only previously possible with highly experienced operators," Dr. Al Beydoun, ODVA President and Executive Director told IEB.

Beydoun did say, however, that it will take time for AI to be fitted, improved and rolled out cost effectively across all of the different organizational areas where it can add the most value.

One of the hurdles that AI will need to overcome to optimize production in automation facilities will be the transfer of device level data back and forth to the cloud securely.

"Security has been growing in importance over time as ransomware attacks have proven to be profitable. The growing number of breaches that have affected consumers via large retail credit card exposures along with sabotage at power and wastewater facilities have led governments to develop security

regulations with additional laws currently under consideration," Beydoun said.

## Looking ahead

Beydoun said that utilizing control networks that support data models that include semantics, context, and consistent measurement scales is another way to accelerate the deployment of AI. Otherwise, significant resources can be needed to clean the data to get it ready for use. Data preparation can both slow projects and even make them economically unviable. Also, information models are a very practical and low-cost solution that will enable end users to utilize their existing control networks to connect their valuable automation data to the cloud for analysis and optimization. That's why EtherNet/IP supports the Process Automation Device Information Model (PA-DIM) for process and OPC UA for other industries.

"The thing that is unique about AI is that it is a dynamic tool in the same way that people are. AI is typically comprised of multidimensional mathematical models that utilize probability and repeated trials to predict accurate results. In the same way

that people will answer the same question in different ways at different times, an AI model will do the same," Beydoun said.

He added that AI can handle a high level of real-world complexity because the models are built with many different levels and types of mathematical algorithms to be able to recognize different trends and potential optimizations in the same data set. AI models can be revised to increase or decrease the number of processing layers depending on the task. While the current cost of AI is higher than that of simple search algorithms, the potential value of being able to help people to do their jobs better is also much higher. AI has the potential to optimize production cycle times, reduce energy usage, improve quality, and more in industrial automation. The challenge will be to take the time to properly implement custom AI models for the specific needs of the business.

## Impact on digital transformation

"Technology has been an enabler of prosperity over the past century, allowing for an increased standard of living for billions of people globally. AI promises to be the next stage in technology development that will allow for increased worker productivity leading to enhanced output and wages," Beydoun said.

"Furthermore, AI can help us to minimize waste in automation to help drive sustainability forward in a cost-effective manner. It's critical that security is built into the foundation of industrial control networks now to ensure that the progress that AI can allow for isn't derailed. Automation solutions such as CIP Security for EtherNet/IP offer benefits such as device-level firewalls as a part of a defense in depth security approach. The future of digital transformation is one of self-sustaining, exponential improvement that is enabled by AI. Workers can only do so much on their own and it looks like technology is ready to help them take the next step forward. Industrial Ethernet networks that are built on a solid foundation of security and allow data to be transported to the cloud and back via data models will be the future of IIoT automation."

## Enabling IT-OT integration
*Switches integrate IT standards and provide factory automation users ease of use features.*

Mike Willett, Network Engineer at Red Lion Controls highlighted key industry megatrends and how Industrial Ethernet solutions are evolving to provide continuing innovation in factory automation applications.

"The biggest trend is the ability to provide a product that can integrate within the standards of an IT department while giving users on the factory automation side the ease of use to take complete control of their

application," Willett said.

For example, N-Tron series NT5000 switches provide a user-friendly graphical interface that has ease of use functionality. However, the NT5000 also has the features the IT department requires. All the necessary aspects from both sides are available. In most cases the factory automation network must integrate within the IT infrastructure. So, this makes that connection far more efficient to build and maintain a complete solution. Speaking of the requirement to integrate with an IT department, another big trend is the addition of more advanced security features. The NT5000 switch has added more advanced security features within a platform that again caters to both controls engineers and the more IT centric user.

*N-Tron series NT5000 switches provide a user-friendly graphical interface and ease of use functionality.*

## Industrial Ethernet technologies

Willett added that the use of high-speed fiber for internetwork communications and even copper connections will continue to be a huge necessity.

"The use of gigabit on every port and not just your uplink connections will continue to be important as more and more devices are added into the network and require the use of higher bandwidth. Also, VLANs have always been a great way to segment local network traffic and minimize congestion. The use of features like this to make the network more efficient is a huge benefit," Willett said.

The new NT5000 switch from Red Lion was specifically designed to support the ease of use to deploy features just like this. In the web interface of the NT5000 switch there is an interactive visual under the VLAN section that displays what VLANs are associated to what ports and what the port states of the VLANs are.

A graphical representation of the VLANs is a tool to visualize this concept, especially if the user is not a networking expert. Instead of just having a check box for a tagged VLAN, for example, this visual can give the user a much more intuitive view of the VLAN implementation. It helps to take a potentially confusing topic and break it down into something more visual, so it is much easier to see, understand and ultimately to configure properly. One last thing to mention is the use of diagnostics on site. Diagnostics is extremely valuable to gain insight into the network to make troubleshooting easier and to constantly monitor the network. The NT5000 switch from Red Lion has great diagnostics tools as well.

"New enhancements will make using Industrial Ethernet Technology unique because the ease of use will be there and the learning curve for users that are not network experts will be less," Willett added.

The NT5000 switch from Red Lion was designed specifically with that ease of use. This

is going to allow users and administrators of the industrial network to have greater control over the network and also build the network more efficiently as the complication of implementing the proper features drops. So, now with less complication the network can have proper security measures, proper segmentation methods and proper methods to easily diagnose and troubleshoot potential issues. Also, with the "IT Like" command line interface and the ability to also be administered by an IT individual as well, this makes the integration between IT and OT much more efficient.

## Transformational technology

"As more and more devices need to be seen remotely or within a cloud environment the transformation of Industrial Ethernet will certainly provide more insight into user data as well as the network infrastructure itself," Willett said. "Having insight into the network devices as well as the relevant data is extremely important. With the use of managed switches users will be able to gather more diagnostic and monitoring information from the switches themselves to help passively monitor the network and also be able to gain more insight into the network remotely before even having to travel to a site. If a potential network issue can be diagnosed or even handled and solved remotely this is a great way to add efficiency into the process as well as save on the cost to travel to a site."

## IT-OT innovations

*Products that integrate with IT standards and provide factory automation users ease of use.*

Dr. Christopher Anhalt, VP Product Marketing at Softing Industrial Automation GmbH told IEB that software and standard IT technologies have already gained significant relevance in factory automation, and they will continue to do so.

"The integration of Ethernet based communication protocols in field devices, PLC virtualization, or the deployment of Kubernetes cluster for industrial edge solutions are examples. While discrete manufacturing may have started to adopt such technologies earlier, we see that process industries are

catching up. End customers and users often need to go through a learning curve, but the cost saving- and efficiency gain potential of these technologies including Industrial Ethernet is high. This trend will persist," Anhalt said.

## Key technologies looking ahead

Looking at the market environment and at the demand for various Industrial Ethernet protocol stacks which Softing has offered during the past years, Anhalt said that Profinet and Ethernet/IP have seen the strongest increase, often replacing fieldbus solutions.

"OPC UA as Ethernet based interoperability standard for OT/IT integration will continue to play a major role. In the coming years, we expect a growing interest in the Ethernet-APL physical layer and its increasing adoption in the process industries," he said.

Anhalt added that the adoption of Ethernet based communication allows users to benefit from cost-effective and widely known IT standards, for control as well as for OT/IT integration. Using Industrial Ethernet for control allows plant operators to increase the level of automation, and to simplify cabling. With Industrial Ethernet, automation networks are more efficient, more secure, and at the same time easier to maintain. Regarding the integration of Industrial Ethernet in field devices, FPGA based hardware solutions can offer significant benefits for device manufacturers regarding flexibility and time-to-market.

"It's fair to say that Industrial Ethernet protocols are the technical backbone of digital transformation," Anhalt said. "The integration of Industrial Ethernet protocols in field devices has become easier and cheaper. It leads to better connectivity, based on simplified network and system architectures with increased robustness and reduced failure risk. Also, Industrial Ethernet protocols are fast, allowing the transmission of huge volumes of data. Centralized plant asset management applications, e.g. for remote maintenance, can be used to their full potential, and more data driven IoT applications are enabled."

*Al Presher, Editor, **Industrial Ethernet Book***

# Digital transformation: make your digital factory a reality

**As digital transformation accelerates, factories face both opportunities and challenges. New technologies are key to increased efficiency, but implementing these technologies can be complex and requires thoughtful execution. Explore how digital factory implementations can help realize manufacturing plant efficiencies.**
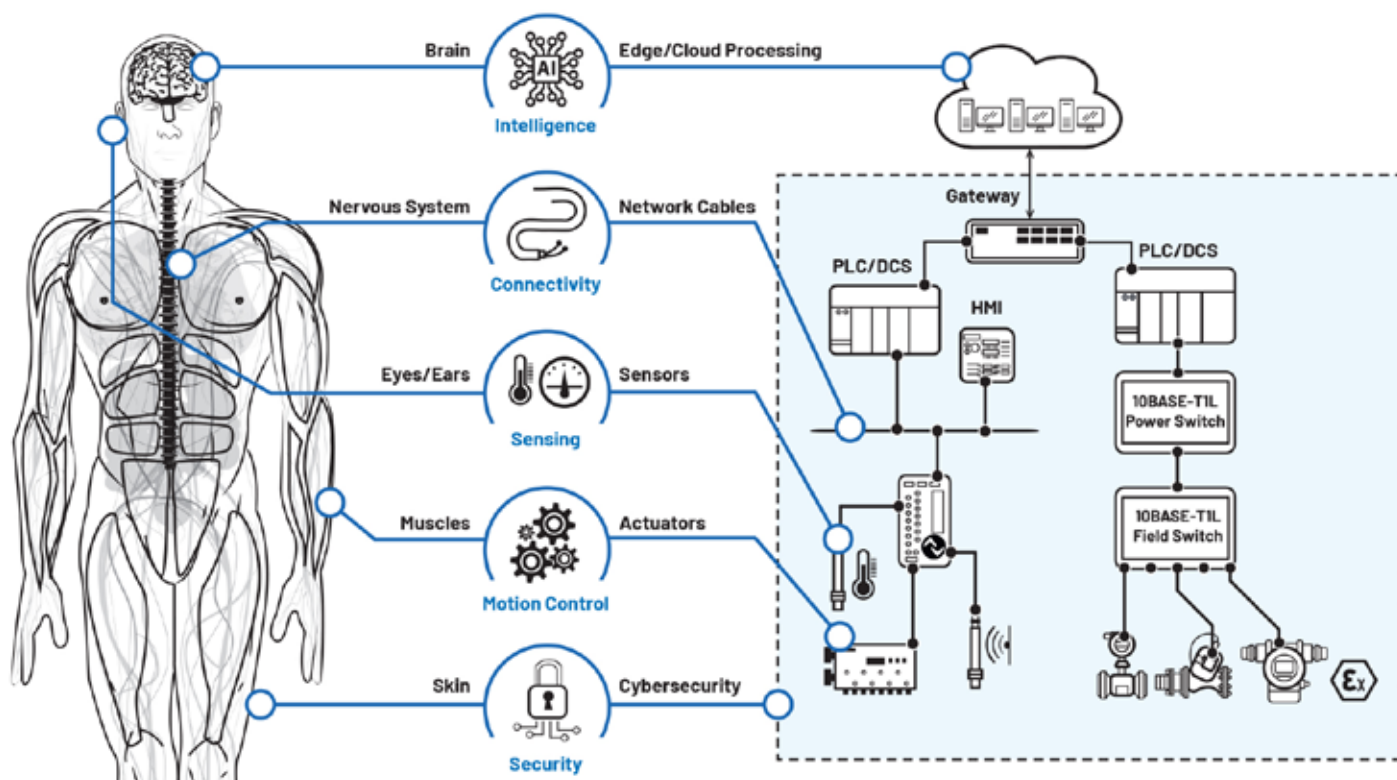


SOURCE: ANALOG DEVICES

*Figure 1. The anatomy of the digital factory.*

ARE YOU INTERESTED IN HOW A DIGITAL factory works and operates? This article parallels the operation of the digital factory to the workings of the human body, outlining the importance of data as the lifeblood of the digital factory. Explore how digital factory implementations can help realize manufacturing plant operational efficiencies through Intelligent Edge insights.

The digital factory, whose operations are built on data, represents a system of component elements working in harmony to optimize operational efficiency across the factory floor. In some ways, it could be likened to the human body. The sensors act as the eyes and ears that allow a central controller—or brain—to be aware of its surroundings. The actuators act as the muscle to make adjustments as required. The factory connectivity network can be equated to the nervous system deployed throughout the body, while the skin is representative of the cybersecurity technology crucial to protecting the data.

## Benefits of the digital factory

Before exploring the components of the digital factory, let's first outline the benefits. The benefits of the digital factory are centered on enabling greater productivity, which is transforming the manufacturing landscape. New insights from the digital factory ecosystem help to inform real-time decision-making. This results in improved product quality and increased overall operational efficiency, culminating in more sustainable production processes. Given that the industrial sector consumes approximately 50% of the world's total energy,for manufacturers with a net zero goal, the digital connected factory is at the heart of this transformation. In addition to sustainability benefits, digital factories provide the flexibility and real-time configurability to rapidly respond to evolving changes in consumer demand. For example, in the healthcare sector, there is an increasing demand for personalized medical devices such as 3D-printed joint implants tailored to an individual patient's anatomy. As factory designs

become more modular and production cells become smaller and more adaptable, workflows can be scheduled and changed in real time, boosting manufacturing speed and supporting the viability of cost-competitive on-shoring efforts across Europe and North America.

## Data: lifeblood of the digital factory

Both real-time and nonreal-time data, derived from multiple sources across the factory, must be analyzed quickly and reliably, at the Intelligent Edge—where the data is born— and aggregated at a central level to reveal a holistic picture of the complete factory operation. Operational insights derived from this data are integral to realizing the full operational efficiency potential of the factory.

## Sensors: eyes and ears of the digital factory

More sensors and varieties of sensing modalities such as temperature, pressure, flow rate, proximity, and vibration need to be deployed to acquire the necessary
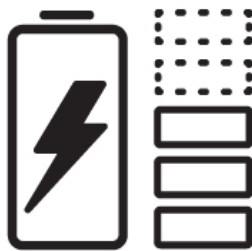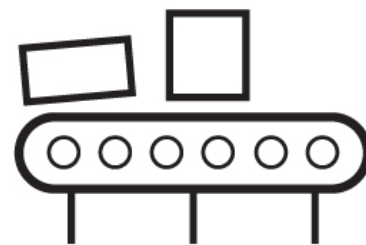
Figure 2. Benefits of the digital factory.

data. Precision measurement and sensing technology is required to continuously sense, measure, and interpret factory assets. IO-Link® technology enables sensors to become intelligent. A pressure sensor locally decides if the pressure exceeds the required threshold and thus only needs to provide the controller with a single Boolean bit variable (yes or no), representing one bit of data instead of a full digital value representing the actual pressure measurement. Localized decision-making saves communication and processing time, making for efficient distributed control.

### Actuators: muscle of the digital factory

Actuators, often the unsung heroes of the digital factory, act as the muscle—critical to getting the job done. These actuators are used to control valves, pistons, and other mechanical devices. This allows the flow of fluids to be controlled precisely, ensuring that the correct amount of material is delivered to each part of the process.

Both sensors and actuators need to be tolerant of conditions found in their application space. Harsh factory environments include high temperature and electromagnetic compatibility (EMC) emission exposure, as well as supply voltage transient spikes and mechanical vibration. For these edge sensing and actuating systems, power delivery is another key consideration.

Power delivery performance requirements increase as sensors and actuators become smaller, with the accuracy and quality of the signal acquisition increasing at the same time. This demands highly efficient, low noise power management solutions with reduced footprint, critical in what can often be space constrained designs. Without the necessary power technology suitable for specific sensing requirements, the real-time configurability benefits of the digital factory cannot be realized.

### Edge and central intelligence: brain of the digital factory

Given that the digital factory requires devices at the edge to have increased levels of functionality and intelligence, more computations and analytics must occur within

the device itself to enable localized decision-making. To enable such edge autonomy, local artificial intelligence (AI)/machine learning (ML) engines, low power accelerators, increased memory, and processing power are required.

Sensor fusion is another type of edge intelligence where data from multiple different types of sensors can be simultaneously combined to reveal a more accurate measurement—one that would be impossible using sensors singularly.

With new high precision and high bandwidth ADCs, a single sensor front end can be used to monitor multiple sensor elements, saving space and power. AI microcontroller technology enables neural networks to execute at ultra low power, while low power transmitters enable enhanced diagnostic capabilities even in remote process plants, often an extension of the smart factory.

### Connectivity: nervous system of the digital factory

Despite this edge device autonomy, for manufacturers to extract valuable and productivity-improving insights from the abundance of available data, the ability to transport, analyze, and merge this data with existing information streams within the factory is paramount. This requires low latency, time-bound, low power, robust, industrial connectivity technology. 10BASE-T1L is an Ethernet physical layer standard (IEEE 802.3cg-2019) set to dramatically change the process automation industry by significantly improving plant operational efficiency through seamless Ethernet connectivity to field-level devices (sensors and actuators).

In today's factories, an information technology (IT) network is deployed at an office/enterprise level. The IT network is traditionally concerned with things like data storage, data analytics, and business applications. While these are important, they are not typically as time critical as data exchange on the factory floor. The network running the production lines on the factory floor is referred to as the operational
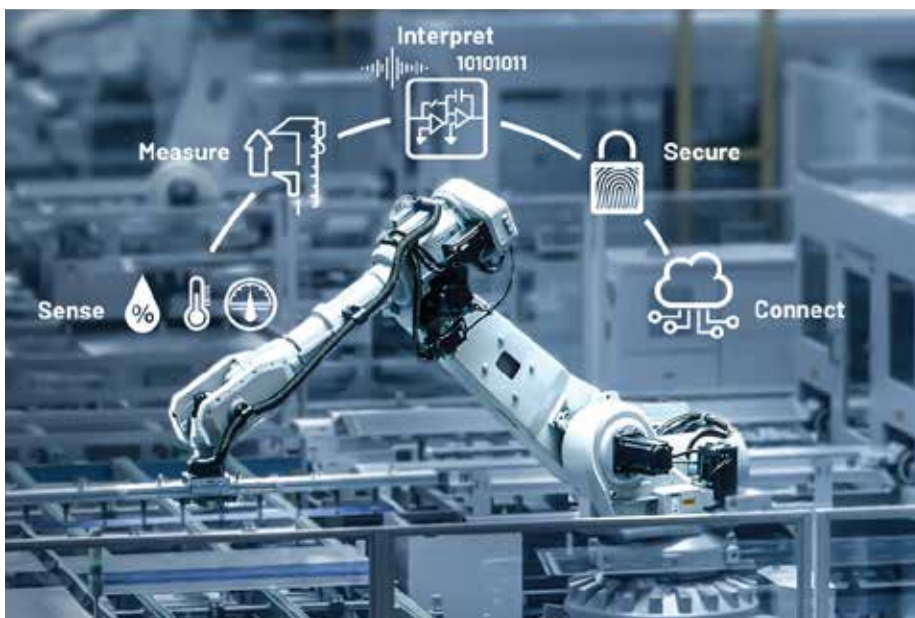


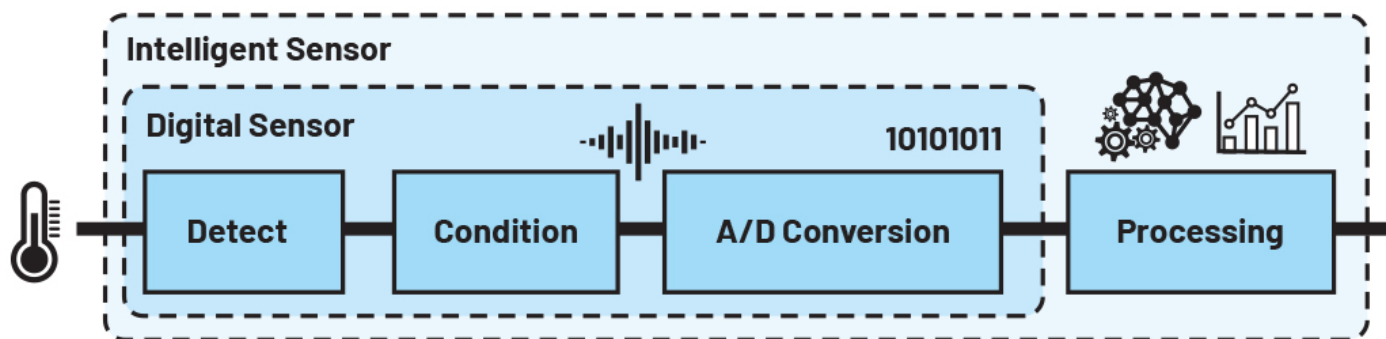Figure 3. Building blocks of the modern digital factory.

SOURCE: ANALOG DEVICES

*Figure 4. Enabling edge autonomy with intelligent sensors.*

technology (OT) control network. Within that control network, there can be multiple different production cells or machines that often have limited ability to communicate with each other. The concept of the converged IT/OT network within the digital factory changes all of this. It offers one unified factory network, where all devices, machines, and robots are connected and interconnected, and speak the same language.

Each IP-addressable device can be communicated with in real time or near real time and be configured independently of other devices on the network. Key enabling technologies for such a converged digital factory network are Industrial Ethernet, time sensitive networking (TSN), Ethernet-APL (advanced physical layer), and IO-Link. With all devices speaking the same Layer 2 language, it is now possible to control both the IT and the OT portions of the network with the same control and network management system, while the time sensitive traffic of the operational network is respected.

The sheer volume of both time-critical and nontime-critical traffic demands network upgrades for increased bandwidth to ensure the latency-free delivery of data, which is critical to the high product quality and operational efficiency of the manufacturing plant. The convergence of OT and IT makes scalability opportunities virtually limitless.

## Cybersecurity: layer of skin protecting trusted digital factory data

With increased interconnectivity comes the need for heightened data security, as smart factory environments expose people,

technology, processes, and intellectual property to cyber threats. This is driving the need for features like secure boot, secure software update, secure transmission authentication, and hardware root of trust.

A fundamental aspect of securing a network is the authentication of each new device attempting to connect to the network. It consists of checking that the device is genuine before authorizing any network transaction with it. Like device authentication, secure boot is a must have, ensuring field equipment executes only software coming from a trusted source with public key cryptography employed to verify the digital signature of the firmware.

## What technology solutions are available today?

Analog Devices has always been valued for innovative precision technology used to sense, measure, and accurately control devices throughout the factory. Combining this with an expansive industrial connectivity and power portfolio, and additional digital capabilities, including AI expertise, ADI has the technology and domain expertise to make advanced digital factory capabilities become a reality.

Low bandwidth, multichannel sigma-delta ADCs such as the AD4130 family integrate the full analog front-end circuitry for effortless interfacing to multiple sensor types. This enables sensor fusion with advanced diagnostics to support localized fault detection and fast decision-making.

The industry's lowest power 10BASE-T1L ADIN1110 MAC-PHY and accompanying ADIN1100 PHY enable the transition to seamlessly connected field devices, bringing Ethernet-APL all the way to the process edge,

over 1.7 km of single-pair Ethernet cables.

For cybersecurity, turnkey, hardware-based solutions allow customers to easily integrate data security into their products. The DS28S60 and MAXQ1065 are ultra low power secure integrated circuits (ICs) that enable public key cryptography even in the most power and computational-resource constrained designs.

The MAX78000 AI microcontroller enables neural networks to execute at ultra low power, providing actionable insights from AI at the edge.

## Path to the pervasive deployment of the digital factory

Industry surveys suggest that 85% of companies have accelerated digital transformation within their manufacturing plants in the past 2 to 3 years. However, full digital factory implementations are not the norm yet.

The World Economic Forum's global lighthouse network of leading manufacturers is demonstrating how digitalization strategies and digitally infused operations bring benefits beyond productivity gains to create a base for sustainable, profitable growth. These manufacturers are capitalizing on productivity improvements by unlocking capacity through the deployment of innovative technologies. These technologies accelerate efficiencies and, in turn, yield environmentally favorable outcomes. This is resulting in a dual benefit of increased productivity with increased sustainability—effectively eco-efficiency.

## Conclusion: make your digital factory a reality

Leveraging partners with deep domain expertise is paramount to enhancing operations and unlocking efficiencies. This collaboration lies at the heart of the most robust and adaptable digital factories of tomorrow.

*Tracey Johnson, Senior Marketing Manager, and Margaret Naughton, Marketing Engineer, **Analog Devices**.*

**Learn More**



SOURCE: ANALOG DEVICES

*Figure 5. IT/OT convergence within the digital factory.*

# PROFINET controller for safety controls uses FPGA-based design

**As plants completes the digital transition, communication with process control systems is more and more important. HIMA's digitalization strategy for functional safety has prioritized offering the most popular industry-standard protocols for safety systems, and now includes PROFINET to handle distributed I/O.**



SOURCE: SOFTING

*Softing has designed an FPGA-based PROFINET controller for safety controls in the HIMax and HIMatrix series.*

IN PROCESS MANUFACTURING, SIGNIFICANT demands are made on safety controls, with many applications requiring a very large number of inputs and outputs, for example. Increasingly, PROFINET is now being used to handle communication with distributed I/O. Given these concerns, HIMA opted to design a PROFINET controller for its safety controls together with industry specialist Softing Industrial.

HIMA Group is an independent global supplier of safety-focused automation solutions to the process manufacturing and rail sectors. Typical safety applications include Emergency Shutdown Systems (ESD), Burners and Boilers (BCS/BMS), Turbomachinery and Compressors (TMC), Pipeline Management Control with Leak Location (PMC), and Fire and Gas (F&G). The number of inputs and outputs can be very high in many of these safety applications, which ensure the safe and uninterrupted operation of plants used in the chemicals, petrochemicals, energy, oil, gas, and rail industries. The scalable safety platform from safety expert HIMA unifies the hardware

and software designed and developed in-house onto a single technology platform that also implements a uniform security model. The discrete safety controls utilize open standards but are both independent and autonomous. This lets the end customer combine the right safety solution for their needs with any leading Basic Process Control System (BPCS).

## Future-proof digital communication with PROFINET

As more machinery and plant completes the digital transition, communication between the various parts of the control and automation systems as well as the process control system is becoming more and more important. HIMA's digitalization strategy for functional safety has prioritized offering the most popular industry-standard protocols for safety systems. PROFINET is a communication protocol that is now increasingly widespread in the industry sectors where HIMA products are typically deployed. Corresponding communication modules have now been designed to facilitate PROFINET communication for safety controls

in the HIMax and HIMatrix series. "While deployment of PROFINET and PROFIsafe is still sparse within process manufacturing in particular, we expect to see significant mid-term growth here," says Stefan Ditting, HIMA's product manager for safety control systems.

## A reliable partner for development and long-term project management

HIMA was looking for a highly capable partner to design its communication modules for PROFINET communication. "In fact, it took us some time to find the right design partner for our controller," Ditting recalls. Ultimately, the HIMA project team brought Softing Industrial Automation GmbH on board – an experienced partner able to offer wide-ranging know-how in the field of industrial communication design and development.

HIMA also gains a decisive advantage from this partnership, because the industrial communication experts at Softing not only handle the original design engineering work but also ensure that the communication

*Integrating the PROFINET controller into the HIMA device architecture.*
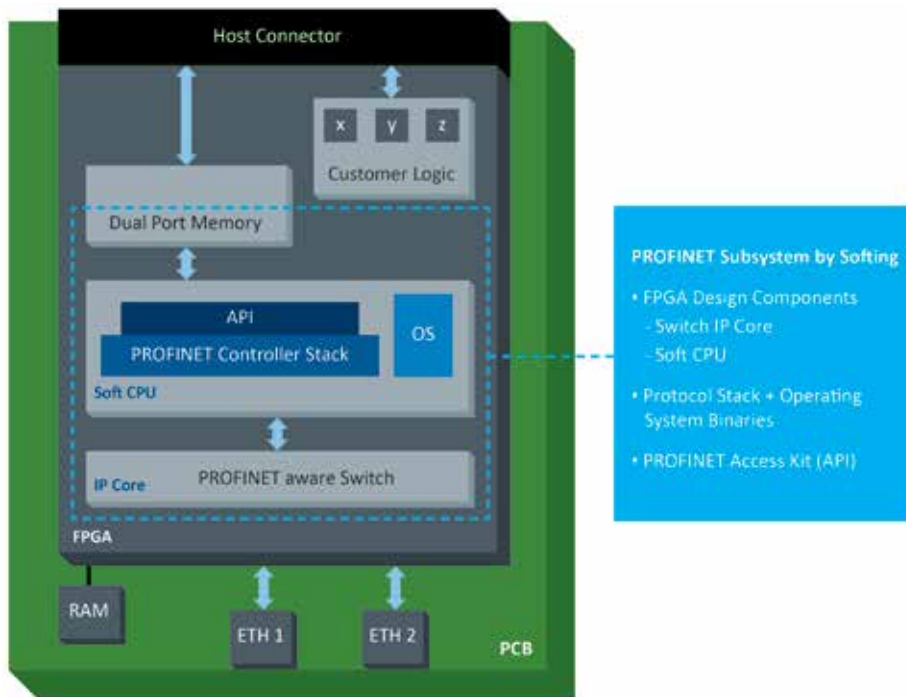
Thanks to Softing's experience with PROFINET and its reference implementation of a real-time Ethernet module (RTEM II), which was used as the reference design, the controller design project was completed successfully over a very short timeframe.

## Key strengths

To implement connectivity with the existing HIMA host system and its expansion slots, only a few adjustments needed to be made to the RTEM II hardware design. The Industrial Ethernet switch plus two external ports included in the communication subsystem ensures a very short cycle time while maximizing determinism in process data processing.

Thanks to filtering capabilities offered by the built-in firewall, the integrated protocol software is also protected from harmful flooding while achieving Netload Class III robustness – the highest level of PROFINET conformance testing. "That the controller is regularly updated to match the current specification from the PROFIBUS User Organization is a priority issue for us," Ditting explains. Every year, the PNO publishes two to three updated versions of the communication standard. Softing updates the controller to reflect the changes, allowing HIMA to focus on application development work.

## Collaborative spirit

During the controller design and test project, regular meetings and workshops were organized to promote close coordination between the two partners. The experts at Softing also completed several other work packages alongside controller design, including support for carrying out firmware updates in the field as well as unit testing software for use in module production. Ditting: "The level of cooperation that was achieved throughout – from planning to testing – really made life easy for us. The teams complemented each other perfectly and inquiries from our side were always answered very quickly."

The PROFINET controllers from Softing can now be supplied for the latest versions of the HIMax- and HIMatrix-series safety controls, and offer uncompromising reliability during operation. As Ditting explains, improvements to controller functionality are already part of the planning pipeline. "One example is the Media Redundancy Protocol, which we would like to implement as this offers higher availability in combination with a ring topology." Whatever new features are needed, HIMA is certain to be working with the specialists at Softing to implement them.

*Dr. Jörg Lantzsch (Agency Dr. Lantzsch) and Christian Bräutigam, Product Manager, Softing Industrial Automation.*

module is kept up-to-date going forward. These maintenance tasks make up a large workload that Softing handles for HIMA. "Specifically, we would have found the steady stream of protocol updates from the PROFIBUS User Organization (PNO) especially challenging," Ditting explains. These updates then have to be integrated and tested in each of the communication modules – a job HIMA is happy to delegate to the experts at Softing.

## A hardware-based FPGA solution

Softing has spent many years implementing, improving, and maintaining its proprietary software stack for PROFINET communication. And this is also the reason why the PROFINET controller design project for the HIMA controls could be completed so quickly. The solution is based on an FPGA hardware module designed for integration into the HIMA devices.

Ditting: "This provides us with a very sharply defined interface between control system and controller." The interface uses shared memory to ensure a highly streamlined design, with another benefit here being the configuration options offered by the Intel FPGA hardware used. Thanks to loadable processors and logic components like the Ethernet switch developed and optimized by Softing, this makes the hardware simple to scale, highly flexible, and easy to update. The controller's entire communication subsystem consists of a single binary block, containing the logic, processor, operating system, and associated communication software, which can be integrated easily without any modifications being necessary.

"A Profinet controller is always an advanced design project," Ditting explains, "because you have to account for not just the communication but also the configuration." Added to that, PROFINET also defines a great many features. All of the functions required have to be both implemented and then also configurable.
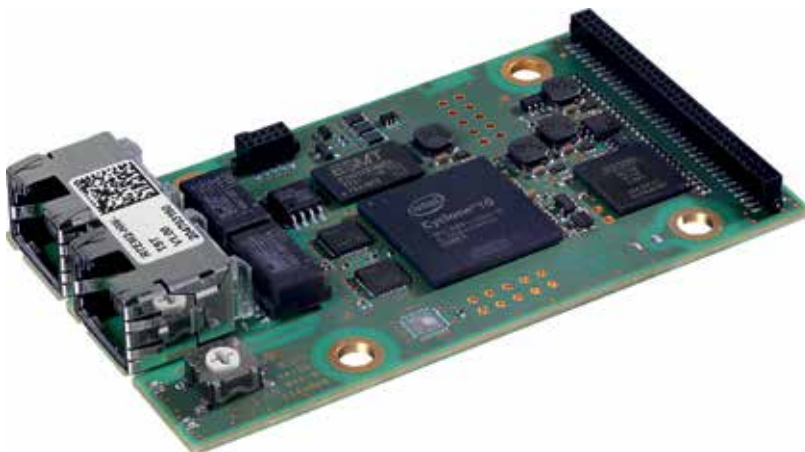
*PROFINET controller integration is achieved using a separate card*

# Next generation factory demands a next generation network

An OMSPE sensor network concept enables EtherNet/IP connectivity from sensor to controller and compute. It also enhances the current DLR protocol with new linear network discovery and commissioning functions to simplify the OMSPE sensor network discovery, commissioning, and diagnosis.
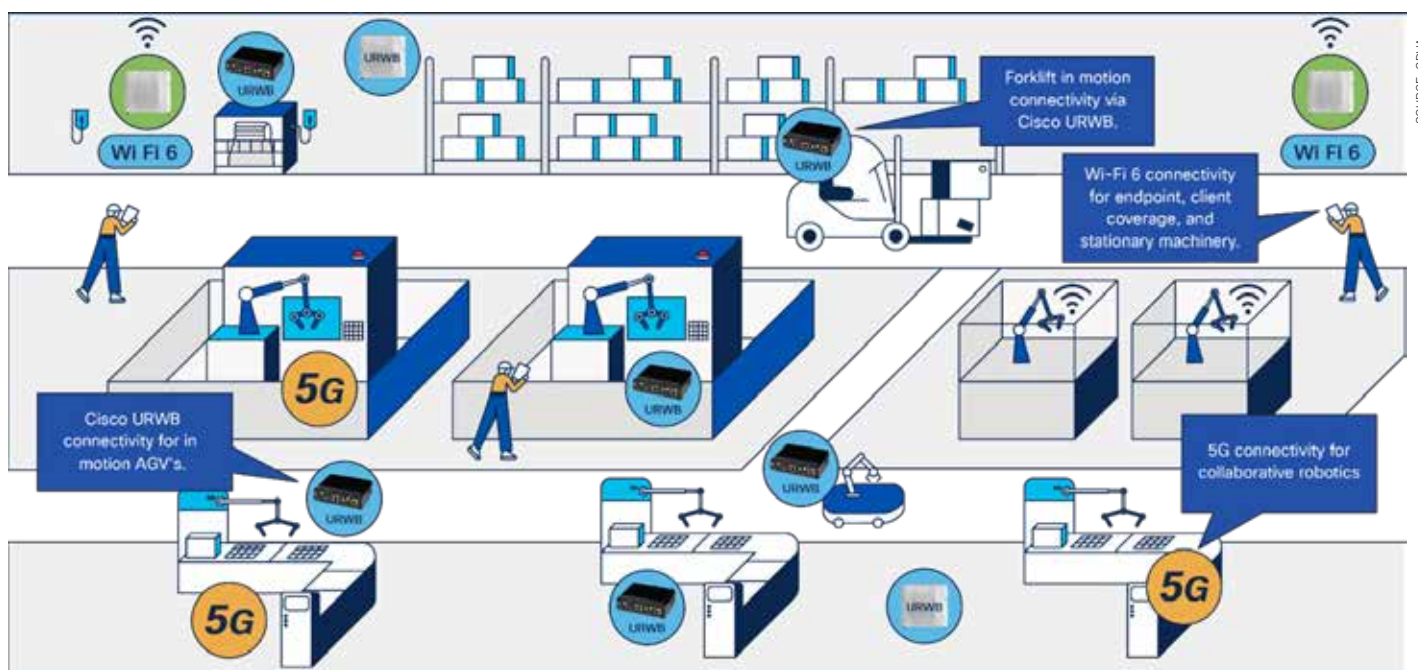


*Figure 1: Manufacturing environments may need more than one wireless connectivity technology.*

THIS ARTICLE DESCRIBES TOMORROW'S SMART factories, and how Cisco is delivering on this vision today with a unified industrial security and networking architecture that simplifies and helps scale deployment, brings seamless mobility, and positions manufacturers to better achieve their Industry 4.0 objectives.

## Introduction

When you think about what the next generation factory would look like, what comes to mind? Is it a factory that can rearrange itself like Lego blocks, adapting production lines to fluctuating demand and new product lines with moving vehicles and robots? Or is it a factory with ubiquitous connectivity where a digital nervous system of sensors, wireless networks, and where data flows freely, fueling AI-powered insights and decisions? Or is it a factory with an upskilled workforce where humans won't be replaced, but their roles will evolve, where they'll become the designers, programmers, analysts, and problem-solvers, working in tandem with technology to optimize and oversee production? Or even a factory with software controlled closed-loop automation where process data informs cloud applications that continuously optimize processes?

Whatever your vision for the next generation factory is, you will agree that the future of efficient manufacturing will be built on the backs of a resilient, secure, and intelligent industrial network and security foundation.

However, despite their critical role in modern manufacturing, many industrial networks have been built over time in an ad-hoc manner without regard to a consistent architecture. This has led to a patchwork of solutions for connectivity, mobility, visibility, security, and remote access, leading to unnecessary hardware deluge, increased complexity, and higher costs.

## Key pillars of a robust foundation

To ensure success of their Industry 4.0 initiatives, manufacturers must evaluate the strength of their networking foundation, and invest strategically to buttress it so that they can focus on growth initiatives and not worry about network performance and security breaches.

Let us consider the key pillars of such a foundation:

## A high-performance network

1. A network that gives you the freedom to easily add, remove, or modify network devices, create blueprints to easily deploy new production lines, and offer deterministic performance to support the latest software innovations.
2. Secure and seamless communication channels between the industrial and enterprise networks for access to advanced analytical applications for data-driven decision-making.
3. High-speed low-latency mobility solutions that offer a choice of wireless connectivity technologies that work best for your factory use cases.

## Comprehensive visibility & security

4. Security functions such as deep visibility into all connected assets, traffic, and security vulnerabilities, as well as segmentation capabilities to carve your production processes into zones and conduits to control traffic flows and limit malware spread.
5. A secure remote access capability that gives your staff, vendors, and contractors the ability to monitor, maintain, and manage your production assets without costly site visits particularly for remote locations.

*Figure 2: Networking solution eliminates single-point solutions in favor of converged architecture.*

## Building a strong networking foundation

A high-performance, resilient, scalable, flexible, and deterministic network is the key first step in building the foundation. Such a network should bring different connectivity technologies including wired and a choice of wireless solutions so operations can choose the best technology that fits each of their use cases. Besides reliable and assured connectivity, the network can deliver the following benefits:

*Scalability and flexibility:* Bring new machinery online and build entirely new production lines quickly, or reconfigure and reassign existing assets to new tasks, with a managed automated network that can be expanded with ease.

*No compromise mobility:* Choose the best high-speed, low-latency wireless technology including Wi-Fi 6/6E, Cisco Ultra Reliable Wireless Backhaul (Cisco URWB), and Private 5G for factory mobility use cases, knowing that you may need more than one technology to address all your use cases effectively.

*Data-driven decision making:* Integrate AI/ML assisted analytical applications with your production processes with a dependable and secure connection from your operations to the cloud. Such applications can help optimize processes, improve product quality, and assist in preventive and predictive asset maintenance.

*Control systems virtualization:* Evolve your operations by replacing discrete control systems hardware with software running in virtual machines. Such a replacement adds to the flexibility and resiliency of operations. Unifying visibility and security with the network

Factory networks can be built with single-function solutions from different vendors. But such a patchwork can be very complex, require extra hardware resources, and difficult and expensive to scale, manage, and maintain as your requirements grow and evolve.

A better solution is to utilize the network devices themselves to provide visibility, segmentation, and zero-trust network access (ZTNA) functions. Edge compute capability

in modern networking equipment allows running these functions as embedded software applications within them. Embedding these functions avoids the need for separate dedicated appliances, making the overall architecture simpler, more scalable, and more secure.

Such a unified architecture brings the following benefits to manufacturing operations:

*Simplicity:* Make deployments simpler by eliminating point solutions including servers for visibility and data extraction, firewalls and complex ACLs for segmentation, and VPN aggregators and jump servers for remote access.

*Comprehensive cybersecurity:* Shore up defenses and detect any breaches faster with increased visibility into connected assets, traffic flows, security vulnerabilities and continuous monitoring. Automated and segmented segmentation contains breaches to a small section of operations and prevents their spread. Moreover, removal of unnecessary appliances from security operations decreases the attack surface and further improves protection.

*Secure remote operations:* Increase control, offer least privileged access, and reduce site visit costs, with a simple to install and scale zero-trust network access solution without VPN or jump servers, with a zero-trust network access (ZTNA) gateway built into the network.

A blueprint for a strong networking foundation

A simplified reference architecture, as shown in Figure 3, overlays the typical devices, applications, network infrastructure, and security technology onto the Purdue model to give context to the design of such a converged industrial network.

The Cell/Area Zone consist of the network that connects sensors, actuators, drives, controllers, robots, machines, and any other IACS devices that need to communicate in real-time and consists of both wired and wireless technologies.

The Operations Zone incorporates all the key applications and functions that support the production facility, including those for visualization, network control, and manufacturing support.

The Industrial Demilitarized Zone (iDMZ) separates the industrial and enterprise zones ensuring that the industrial zone is not impacted by any outside influences. Network access is not permitted directly between the enterprise and the plant and the IDMZ allows the secure transport of data between the industrial network and applications in the enterprise zone and the cloud.

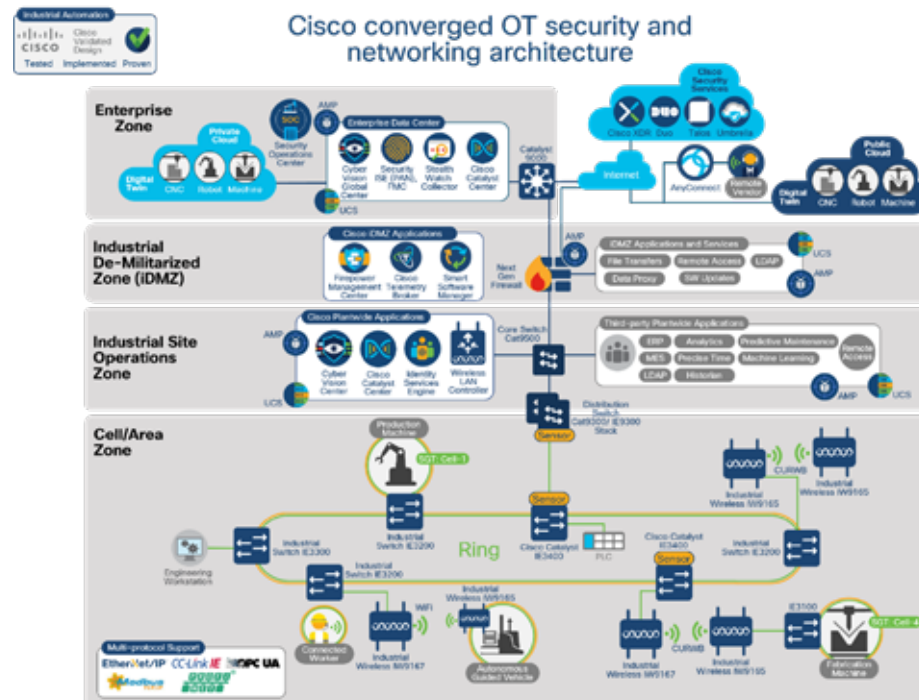*Vivek Bhargava, Product Marketing Manager, Cisco.*



*Figure 3: A reference converged industrial networking and security architecture*

**Learn More**

# Replacing outdated controls with IIoT edge solution

**Point Energy Partners has replaced outdated controls with an IIoT Edge Solution that is preventing spills and improving efficiency using Opto 22's groov RIO. Automating water level monitoring and pump operation has not only made the jobs of field operators easier, but has also resulted in significant cost savings.**



SOURCE: OPTO 22

*Point Energy Partners pump equipment at SWD site.*

IN AN INDUSTRY WHERE EVERY SPILL CARRIES a hefty price tag, Point Energy Partners (PEP) found that the manual and low-tech systems at their saltwater disposal (SWD) sites were a significant problem.

SWD sites are where the byproduct water from oil and gas production is managed and disposed of. These low-tech systems for SWD level management posed several operational challenges—the worst among them being the environmental impacts and financial costs of overflow spills.

Led by industry specialists and U.S. military veterans Bryan Moody and John Sabia, PEP specializes in acquiring and developing onshore U.S. oil and gas properties, with a current focus on the Delaware Basin, situated across West Texas and southeastern New Mexico.

The company has grown its operating production significantly over the past 5 years, mostly focused on midstream assets. PEP is dedicated to the sustainable development of oil and gas resources across the U.S., aiming to create value for its stakeholders and reduce energy costs for Americans.

PEP is unique in its approach, working to assemble small acreage footprints in strategic locations, fostering strong relationships with mineral/royalty owners and service providers, and ensuring high-quality operations.

PEP also operates a substantial water recycling program, showcasing their commitment to sustainable and efficient resource management. This approach not only reflects their dedication to environmental stewardship but also enhances the efficiency and sustainability of their oil and gas production activities in the Delaware Basin.

## The challenge: high tech, low price

The SWD sites, where water laden with salts, hydrocarbons, and industrial compounds is managed and disposed of, required immediate attention. Manual, onsite checks of their flow measurement systems resulted in inaccurate measurements and unreliable information. In addition, the existing water management system at these sites was heavily dependent on hydrostatic head level switches—technology that had become obsolete and unreliable over time.

Beyond that, the level switches were part of an antiquated system of control that attempted to maintain safe tank levels by toggling transfer pumps based solely on the current switch status (or an onsite manual override). This outdated control methodology left no room for the possibility of remote control or oversight—and absolutely no SCADA overview.

And these existing operational sites did not have a big budget for upgrades, so most control solutions on the market just wouldn't fit the bill. But after a recent internal study determined each overflow spill costs the firm

*Tanks at Point Energy Partners SWD site.*

roughly $200,000, Automation Engineer Scott Adams knew the status quo would not suffice.

## Head level sensing vs. radar level sensing
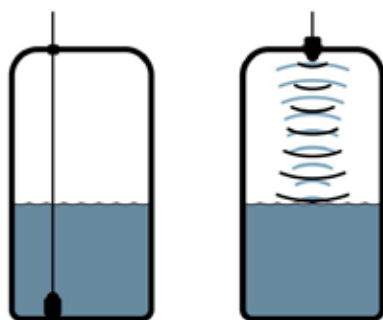


*Illustration of differences between hydrostatic pressure and radar level sensors.*

The next generation solution should utilize radar level sensing, a superior solution compared to hydrostatic head level sensing. Unlike hydrostatic sensors, which measure pressure exerted by a liquid column, radar sensors utilize microwave pulses to determine liquid levels. This non-contact method ensures no direct interaction with the liquid, making it ideal for corrosive substances—like the water being stored at SWD sites. Radar sensors, unaffected by changes in liquid density, temperature, or pressure, provide better precision and durability in challenging conditions.

## Visibility: to see or not to see? Definitely to see.

The lack of visibility into the operations at the SWD sites, coupled with an over-reliance on manual checks and operations, underscored the urgent need for a modern, automated solution.

A recent corporate initiative led PEP to use Inductive Automation's Ignition software as a SCADA platform for their collective sites. Their burgeoning IIoT infrastructure would use MQTT Sparkplug B as a means for getting live, reliable data on their operations into their new SCADA platform. And Ignition's Perspective® web-based HMI would soon make remote monitoring a reality.

## Keeping costs under control

PEP faced significant financial constraints—the budget for improvements on existing sites was tight. The company needed to ensure that any investment made would pay itself back in efficiency, reliability, and spill prevention. They explored various PLC solutions on the market, but price tags were high, and many of the manufacturers required expensive software licenses and support contracts.

As Scott Adams said, "In our industry, these applications are typically done two different ways: low-tech, like our existing solution, or they utilize a $10,000 PLC panel, which is beyond our budgetary constraints for existing sites."

## Blending brownfield with greenfield

When PEP started down their IIoT discovery



journey, it was clear that MQTT with Sparkplug B—lightweight, efficient, and reliable—was the way to go. But there were also cases where legacy support was needed, like brownfield installations where Modbus/TCP was highly utilized. Adams also needed an I/O platform that was flexible enough to simply turn on a contactor to run a pump, read an analog signal from modern radar level sensors, or calculate flow from a pulse input generated by a turbine flowmeter.

## The solution: groov RIO with CODESYS and MQTT Sparkplug B

"We were looking for I/O that would fit with our new SCADA—we just Googled to learn more about MQTT and Ignition, and Opto 22 hardware kept coming up." Adams said. "We planned to use Ignition's Historian, Alarming, and Perspective visualization to keep tabs on our SWD sites from anywhere in the world."

So PEP turned to Opto 22's *groov* RIO for a transformative solution. The modern

communication methodologies onboard, namely MQTT with Sparkplug B payloads, would allow the *groov* RIOs to reliably transmit real-time tank levels, flow rates/totals, and pump operational states into PEP's Ignition SCADA.

They could seamlessly and efficiently move data between their field operations and Ignition SCADA software.

## Flexible I/O

The multi-signal, multifunction nature of Opto 22's *groov* RIO's I/O gave PEP the flexibility to adapt these edge devices for a number of their applications.

The relay outputs could be used to fire pump contactors on and off based on more accurate level readings, which were now being fed from radar transmitters connected directly into RIO's analog input channels.

Utilizing *groov* RIO's flexible I/O along with the recent addition of a CODESYS® runtime engine allowed them to implement radar level transmitters in the tanks and automatic pump control.

PEP had experimented with groov devices in the past, but the unique aspect of this setup was the utilization of the CODESYS runtime engine, a feature added in *groov* RIO firmware 3.5. This addition leveled up the capabilities of *groov* RIO, providing a cost-effective and powerful automation solution.

## More than I/O: control at the right price

At right around $1,000, Scott Adams described RIO as the "Goldilocks solution"—not a $10,000 panel with unnecessary extras nor a $100 PLC lacking the I/O and modern communications needed for their IIoT architecture.
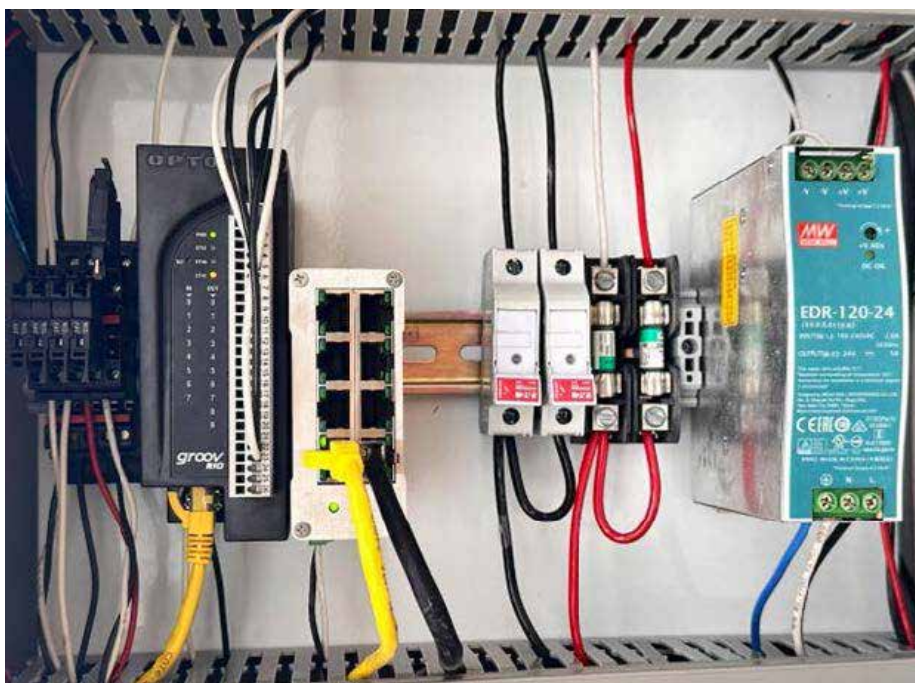


*Point Energy Partners' groov RIO enclosure.*

## Modern yet supportive of our legacy

Support for all of the company's I/O, control, and communication requirements as future IIoT infrastructure continues to grow was paramount, but the cherry on top was *groov* RIO's support for legacy devices. Point Energy Partners had numerous pressure transmitters across their SWD sites around the area that used legacy Modbus/TCP communications.

Using *groov* RIO as a Modbus master allowed PEP to collect existing data that was once trapped in the field, and add it to the new collection being amassed in their data historian.

## Technical implementation

Implementing *groov* RIO into PEP's existing infrastructure was a smooth and straightforward process, highlighting the system's user-friendly nature.

Technicians, regardless of their programming experience, found the system easy to work with thanks to an intuitive interface and comprehensive training resources available on Opto 22's website.

As Scott Adams recollected, "We only have one PLC programmer on our staff. He's the one who programmed CODESYS, but our other five technicians found that commissioning groov RIO was something they could do themselves.
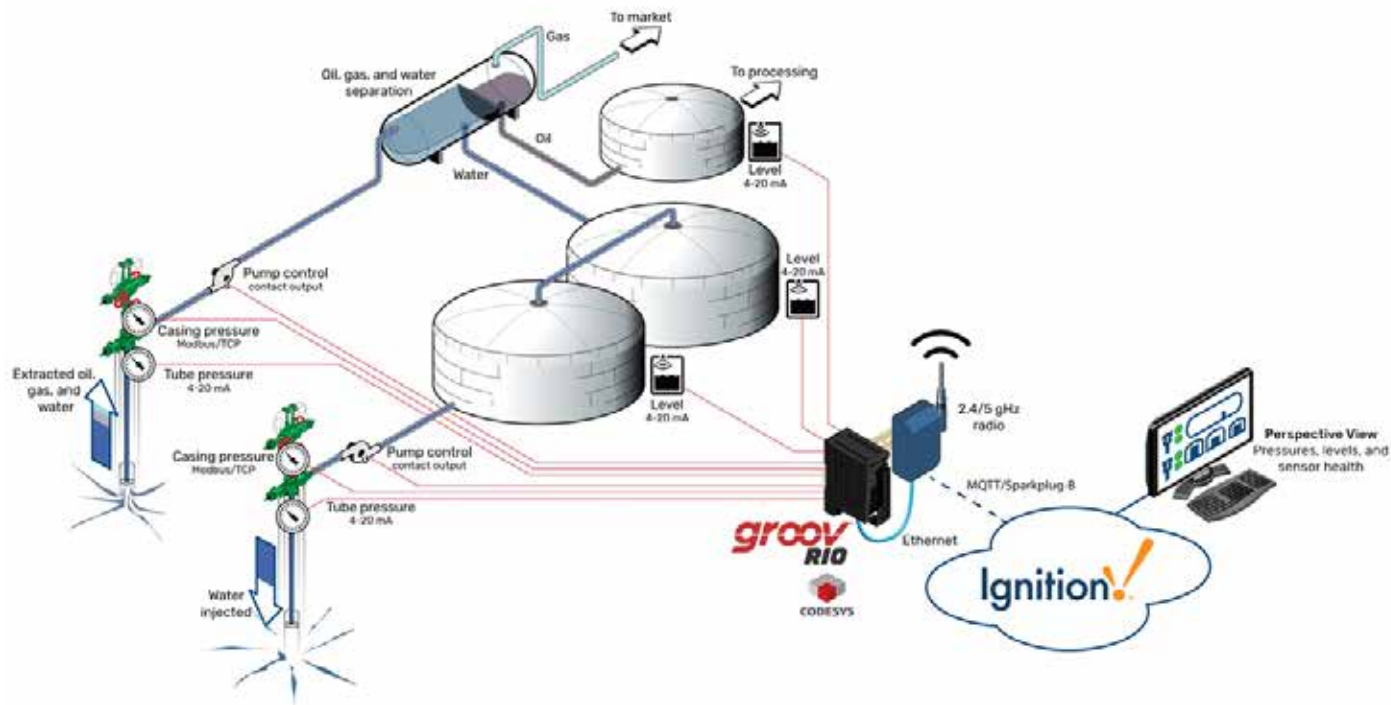


*Example of a Rajant wireless mesh network.*

SOURCE: OPTO 22

*Illustration of SWD site technology.*

Working within *groov* Manage and Node-RED is something our techs found very accessible." The ability to learn and implement the system on the job stands as a testament to *groov* RIO's intuitive design and ease of use. "I haven't even been to Opto 22 for training yet!" Adams exclaimed when describing just how quickly they were able to deploy their solution.

## Rajant wireless mesh

One of the pivotal components in this implementation was the integration of a wireless mesh radio network provided by Rajant®, a leader in industrial wireless mesh network solutions. Rajant's technology ensured a robust and reliable communication



SOURCE: OPTO 22

network, vital for the remote monitoring and control capabilities required at the SWD sites. Combine that with an industrial-grade device like *groov* RIO with IT-friendly networking tools, and seamless data transmission—even in challenging and remote environments—is a reality.

## Netonix PoE switch

The implementation was further simplified and enhanced by the use of a Power over Ethernet (PoE) network switch from Netonix®. Netonix is renowned for their innovative PoE switches, designed specifically for demanding industrial environments. The use of a PoE switch streamlined the installation process as it allowed for the transmission of both power and data over a single cable, reducing complexity and the need for additional wiring when installing *groov* RIO in the field.

## Software stack

Using CODESYS for automated pump control and tank level management was just a part of this solution. PEP is also using Node-RED software running onboard their RIO, which allows them to move data from physical I/O points, CODESYS tags, and various Modbus/TCP sensors into OptoMMP registers,

which are then published on change to their Ignition-based MQTT broker.

## Results and impact

The implementation of *groov* RIO at the SWD sites has resulted in a paradigm shift for PEP. Automating water level monitoring and pump operation has not only made the jobs of field operators easier, but has also resulted in cost savings—most importantly, by preventing potential spills—occurrences that negatively affect both PEP's bottom line and the environment.

The field operators, who previously had to manually check tank levels and ensure the proper functioning of head switches, now enjoy a more streamlined and efficient workflow. Operators still check on the sites daily, but the systems can be fully monitored remotely, and tank level setpoints can be securely adjusted from anywhere in the world. The enhanced data reliability and real-time monitoring have also shown PEP the value of further automation across other sites.

PEP management, originally hesitant to make the investment in automation at SWD sites, has shifted their approach to automation and technology, opening doors to new possibilities and applications across their portfolio. The significant improvements in efficiency, reliability, and environmental safety have showcased the transformative power of automation, proving that with the right technology, safe and sustainable energy development is not just a goal, but a reality.

*Application article by **Opto 22**.*

**Learn More**
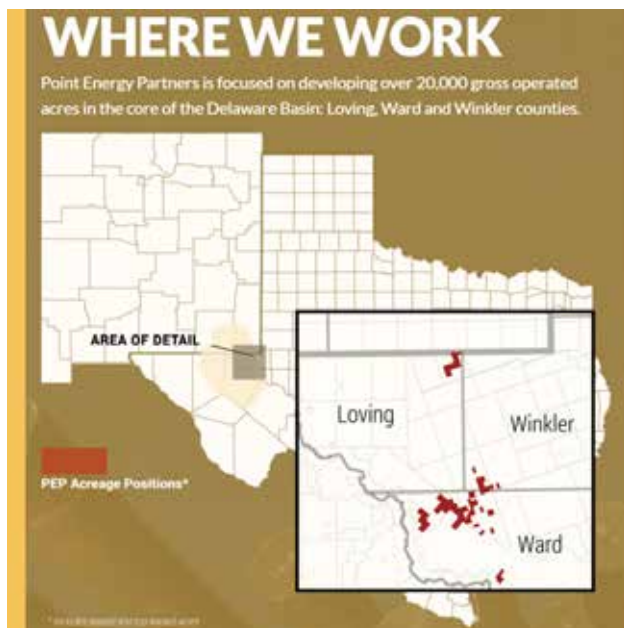
# Process Device Profiles come to life in multi-vendor environment

**This article highlights how Process Device Profiles can be utilized in a multi-vendor environment. The focus is on a use-case in which an operator is informed of an error, and able to take action, leading to resolution of the problem through replacement of the instrument with an alternative from another supplier.**

THE VALUE OF ETHERNET/IP IN THE PROCESS industries is well recognized and is also a recommended Ethernet-based standard that is specified in NAMUR NE168 in 2018. However, adoption has faced a number of challenges.

A review of the state of the art was conducted in 2021 and identified areas such as the standardization of diagnostics, the ability to deploy instrumentation in hazardous environments, the need for long cables and the integration of legacy HART-based instrumentation into EtherNet/IP installations. Since then, some of these challenges have been addressed with vendors starting to bring new functionality to the market.

This article highlights how recently published functionality has been realized in a multi-vendor environment. The focus is on a use-case in which an operator is informed of an error and able to take action, leading to resolution of the problem through replacement of the instrument with an alternative from another supplier.

## Real-life scenario in a process plant

Isabelle works in a large plant experiencing the industry-wide shortage of skilled technicians. Edward, the instrumentation engineer, tries to have multiple sources of instrument suppliers for each device technology (Flow, Pressure, Temperature, Level) to keep the process running if a problem arises. This creates a lot of extra work for Cassie, the control engineer, for device integration and configuration.

Friday, June 30th a nice summer day, Isabelle is starting her work after a shift change at the tank farm. Everything points to a pleasant working day before the upcoming long weekend. Suddenly the calm is broken by an annoying alarm, indicating that one of the flowmeters at tank 13 has stopped measuring. Diagnostic information on the Asset Management display shows that measuring hasn't stopped due to missing flow but due to a flowmeter malfunction. To get more information about the root cause of the problem, Isabelle asks Edward, the instrument engineer, to look at the faulty flowmeter.

Edward determines that something has crashed into the flowmeter's transmitter, the component of the flowmeter which is in charge of the communication. Fortunately,

*Standardization of diagnostics is an important area of development for process manufacturing users.*

the pipe has not been damaged so the oil is still flowing into the tank and not onto the ground, but the flowmeter has to be replaced. Edward informs Isabelle about the situation and asks her if she can get a new device from stock for the exchange. Looking at the stock inventory list, Isabelle finds out that there is one flowmeter left but its vendor is different from the damaged one. Fortunately, it has the same device dimensions and should fit.

This story has two versions, one without the Process flow device profile (which is presented first) and the other with a Process flow device profile (which follows after the first).

## Without the Process Flow Device Profile

A call to the vendor of the damaged device shows that due to the upcoming long weekend, a replacement device cannot be delivered before the end of next week. Since the tank farm is massively dependent on tank 13, the

damaged device must be replaced as quickly as possible. Therefore, Isabelle removes the damaged device and replaces it with the one from stock.

After Isabelle has finished replacing the device and made the device connections correctly, the controller was not able to receive measurement data, because the data assemblies are completely different from the former, damaged device. For this reason, the program within the controller must be adapted to the communication structure of the new device.

Isabelle calls Cassie, the Control Engineer, to inform her about the situation and to ask her to reprogram the controller. Cassie is understandably upset, but if she doesn't follow Isabelle's request, the tank farm would have to be taken offline for the long weekend. This would result in financial loss and angry management so there is no alternative solution; Cassie must interrupt her long weekend break to get the plant producing again.
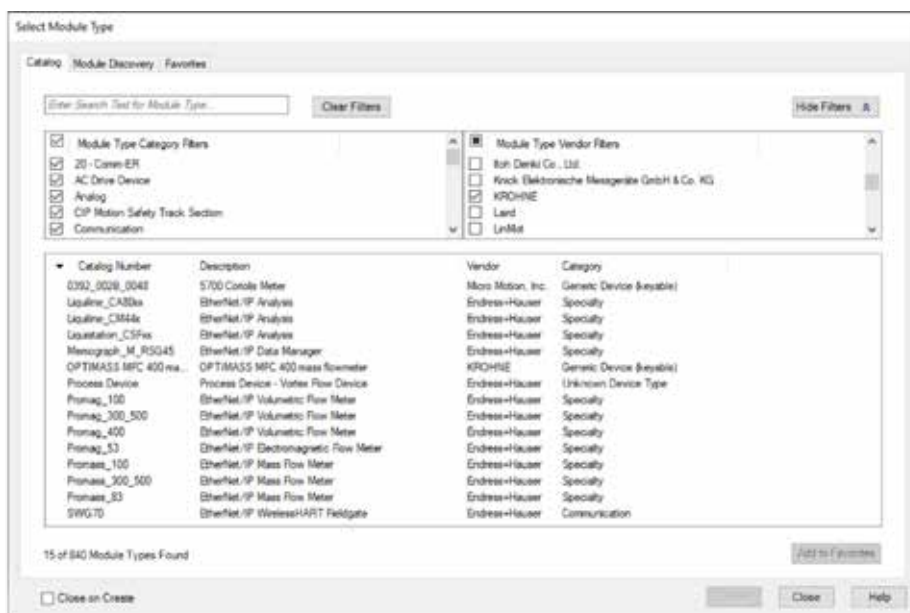
SOURCE: ODVA

*Figure 1: Device Selection in Logix Designer.*

### With the Process Flow Device Profile

Isabelle had such a situation years ago and she remembers that replacing a device by one of a different vendor resulted in lots of problems reprogramming the controller. In addition, Cassie is the only one who can change the control program and she has already left for her long weekend tour.

But wait! Last year Isabelle had an invitation to the ODVA Annual Meeting and she remembers that in a presentation someone introduced the Process Device Profiles. That means, two devices from different vendors supporting the same Process Device Profile may be interchanged without the need of adapting the control program. From the controller's point of view, nothing has to be modified.

Cassie showed Isabelle how to do this some time ago and it is quite easy. Hoping that the two devices support the same Process Device Profile, she has a look at the device's data sheets. Fortunately, both devices support the ODVA-defined Flow Profile, so Isabelle removes the damaged device and replaces it with the one from stock.

Even though the presenters from the ODVA meeting last year were totally convinced that replacing one profile device by another is quite easy, Isabelle is skeptical. Isabelle starts some standard systems tests that check the consistency of the plant's control program. And voilà: Each of the test pass; the measurement values and the status are visually verified.

The story on the right side was showing that the Process Device Profiles are working, and they delivered what was promised: easily replacing one device with another of a different vendor supporting the same Process Device Profile. It saved a lot of money and more importantly: No one was angry due to emergency operations during personal time.

More than just another technical improvement, this story shows that devices with Process Device Profiles also reduce stress in daily activities in the process industry.

### Prerequisites for ease-of-use

Prior to the availability of networking technologies, connecting instrumentation to a control system was straightforward. The extensive use of 4-20mA transducers, and a single process value from an instrument made it very easy to connect devices. Once configured, exchanging a device was very straightforward.

Whilst flexible, 4-20mA signals connected through I/O modules have limitations. Today's more advanced field devices include many diagnostic capabilities, error-reporting and a multitude of variables that can be used in more complex applications. However, each device works in its own way, making an exchange very difficult. Engineering effort is needed to add or configure the replacement instrument in a fault scenario.

The need for Standardization is therefore clear and needs to address the following areas:
- Commissioning
- Data exchange
- Diagnostics
- Compute Connectivity
- Support

The NAMUR NE 131 standard addresses some of these areas, and it follows that an instrument on EtherNet/IP should also follow this standard.

### Commissioning

Prior to the definition of Process Device profiles, DCS systems typically offered configuration methods that were based on selecting the vendor of a device based on the presence of an EDS file, custom code, or other configuration

SOURCE: ODVA

mechanism such as a DTM or FDI package.

Figure 1 highlights the challenge of selecting a process instrument. Whilst it is clear that there is a mechanism for achieving connectivity, it remains heavily vendor dependent. Devices of the same class have different names and characteristics and it is not clear whether these devices are similar – nor can one identify the differences. In addition, the functions that are visible in the DCS are a result of what has been presented by the device vendor, or which is exposed by the supplier of the DCS. As a consequence, every device looks different, complicating the configuration process. Furthermore, it limits the ability to exchange a device with one from another vendor.

### Data exchange

After selecting a device, the DCS creates input, output and configuration data structures based on how the DCS vendor chooses to present the data. In some cases, this is taking a structure that is provided in the EDS file and creating tags that are in line with the information that has been provided in the EDS.

In other cases, this is achieved using custom code. Regardless of the mechanism used, the tag structures that are created are not consistent between vendors. Different devices will have different tag structures, making it difficult to identify the information needed. This in turn can make it challenging to identify the information needed for diagnostic purposes.

Configuring devices that do not have a pre-defined or standardized interface can also be difficult. Some device vendors may choose not to implement an EtherNet/IP Configuration Assembly. Other vendors may opt for their own design. In both cases, this adds an additional burden on the user who has to understand how to configure multiple devices by studying documentation and then to implement a configuration schema to meet the needs of their plant strategy.

### Diagnostics

A standardized method to ensure that device diagnostics are easily accessible, understood, and easy to monitor is desirable. The simple traffic light system is used in the NAMUR NE107 standard to indicate the status of a device and aims to draw the attention of an operator when required. With the NE107 recommendations having broad adoption and
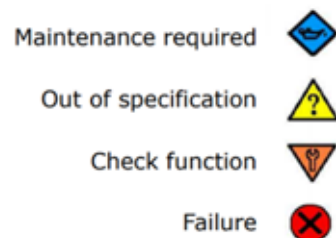


SOURCE: ODVA

*Figure 2: NE107 Icons.*

acceptance across the industry, it makes sense for a process instrument on EtherNet/IP to align with this standard.

## Compute connectivity
A broadly accepted standard for interfacing devices to PC's, servers and the cloud is OPC-UA. This includes the support for data models and defines a wide range of companion specifications for achieving connectivity to a wide range of applications. The data model of interest to the Process industries is the PA-DIM model. It follows that any EtherNet/IP device that wishes to provide information outside the DCS should include the ability to align with the constructs defined in this standard.

## Support
The variability that exists in terms of configuring and setting up devices today means that support personnel have to have awareness of multiple techniques for diagnosing and solving problems. This scenario exists not just with CIP devices, but also with legacy technologies such as HART, Profibus and Foundation Fieldbus. A Process device profile therefore can simplify the learning process for a maintenance technician because he will have to learn and understand the capabilities of just one profile per class of device.

## Process Device Profile to the rescue
The Process Device Profiles are a collection of CIP objects to standardize the data and services provided for a process measurement. To date, Process Device Profiles have been published for Coriolis Flow, Electromagnetic Flow, Vortex Flow, Standard Pressure and Scaled Pressure. Figure 1 is an example object model for a Process Device Profile and will be described in the following paragraphs.

To support Process device profiles, two new objects were introduced in the April 2023 CIP specification:

The Process Measurement Value Object (Class Code 0x112) contains the measurement values and status along with common configuration attributes such as engineering units, damping, cutoff and zero point. The Process Measurement Value Object also allows for the measurement values and status to be simulated. All Process Device Profiles will contain at least one instance of a Process Measurement Value Object.

The Process Totalized Value Object (Class Code 0x113) is a companion object that is associated with a Process Measurement Value instance and accumulates that measurement value to report it as a total. The Process Totalized Value Object also provides attributes to start, stop and reset the totalized value. Not all Process Device Profiles will contain an instance of a Process Totalized Value Object.
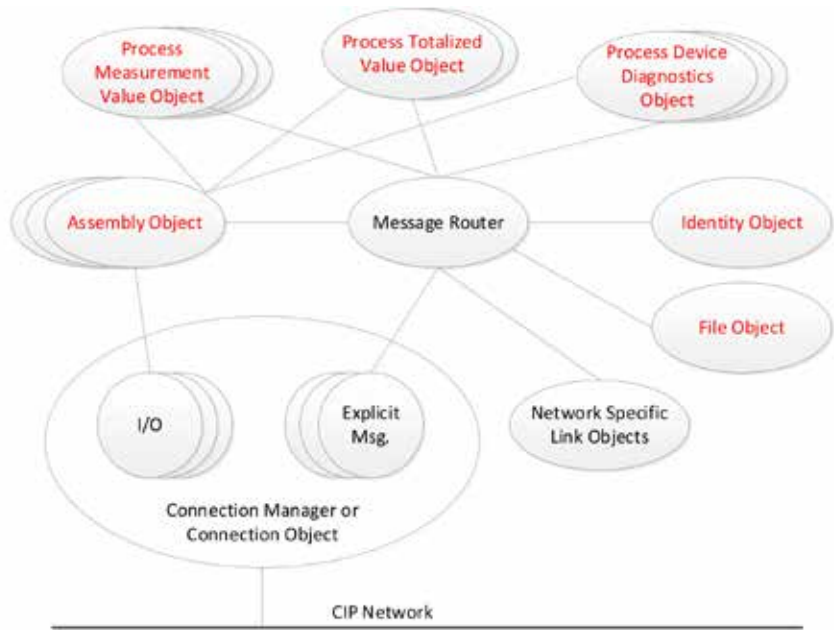
Each Process Device Profile specifies which



*Figure 3 - Example Process Device Profile Object Model.*

measurement and totalizer instances are to be supported and what data is to be included in the input, output, and configuration assemblies. Because the CIP Spec has created separate assembly number ranges for profile specific assemblies (ID 1-99) and vendor specific assemblies (ID 100 – 199), there is no danger in the profile and vendor assembly numbers to conflict with each other.

Each Process Device Profile also specifies which instances of the previously published Process Device Diagnostics Object (Class Code 0x108) are to be supported. The supported instances were obtained from the NE 107 guidelines. An improvement was made to the Process Device Diagnostics Object in the April 2023 CIP specification that allows for the diagnostic instances to be simulated.

Each Process Device Profile specifies which Identity Object attributes are required to be supported to ensure alignment with the device representation in PA-DIM. The Process Measurement Value Object and the Process Totalized Value Object were also designed to be compatible with PA-DIM.

Each Process Device Profile may contain the File Object so that an end user can download the supported EDS file(s) from the device.

## Device interchangeability
To achieve device interchangeability between vendors with ease of use in mind, a new Profile Vendor ID (0xFFFB) was introduced. A device that implements a Process Device Profile will accept a Forward_Open service targeting the Profile Vendor ID or the manufacturer's Vendor ID. This segregation of the two vendor IDs allows for the implementation of profile specific EDS files that are maintained by ODVA and makes it clear to the end user that their system is only using profile specific features.

This gives the end user confidence that devices of the same profile can be interchanged.

With the addition of the new objects and Process Device Profiles, users can easily interchange devices from different vendors and controller manufacturers can assist with the ease of use.

## Conclusion - "pièce de résistance"
The definition of profile-based connection mechanisms simplifies the experience of the end-user. At system design time, they can now choose an ODVA profile that provides standard connections and diagnostics, or a vendor-defined implementation that allows additional capability specific to a vendor's device.

All Profile EDS files will use the Profile Vendor ID. They will be created and maintained by ODVA in the Process Industries SIG and should not be modified by vendors or users.

Both end users and vendors of controllers can benefit from the approach outlined in this paper. User application logic should be easily re-usable, due to the use of identical data assemblies for each vendor's device. Additionally, DCS/PLC suppliers can develop and provide to customers one set of user interfaces, such as for device configuration and HMI faceplates. These features will drastically reduce the time required by Control Systems Engineer Cassie during the system development phase.

*Dawn Kelsch,* **Emerson;** *Michaël Voegel,* **Endress + Hauser Digital Solutions;** *E Rizwan Mohammed,* **Honeywell;** *Winfried Ernst and Carsten Fuchs,* **KROHNE;** *Arnold Offner,* **Phoenix Contact;** *Carl Schumaker and Vivek Hajarnavis,* **Rockwell Automation.**

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# Onboard processing of train condition-based monitoring data

**Moxa partners with IT consulting company to develop first condition-based monitoring system for South Korean rail system. As with any AI system, preprocessing the data gathered aboard the train is essential for CBM data analysis.**

CONDITION-BASED MONITORING (CBM) IS A maintenance strategy in the railway industry that uses data from onboard sensors and other sources to monitor the real-time state of railway assets. CBM detects potential issues before they become major problems, allowing for more efficient maintenance and improved passenger safety.

Despite the numerous challenges of setting up a system for continuing, real-time monitoring, Globiz, a South Korean IT consulting firm, saw an opportunity to make a difference in the railway business with CBM. The issue for Globiz was that while the concept behind CBM was valuable on a global scale, its actual application and standards were still in their infancy. As a result, regulation bodies, railway operators, and solution providers like Globiz had to navigate uncharted waters and figure out CBM implementation on their own. Despite these challenges, Globiz successfully developed the first CBM system for South Korea's rail system (KORAIL).

## Partnership with Moxa

As with any AI system, preprocessing the data gathered aboard the train is essential for CBM data analysis.

To achieve real-time analysis, Globiz found a partner in Moxa, a world leader in industrial connectivity. Moxa's V2406C Series industrial computer, compliant with global railway EN 50155 standards, performs as the local server to preprocess data collected from onboard sensors and other sources before sending it onto a web server. The onboard diagnostic system powered by Globiz's CBM utilizes Moxa's computer to enable edge computing. Designed for heavy-duty data processing tasks, Moxa V2406C computers are built around an Intel® Core™ i7/i5/i3 or Intel® Celeron® high-



*SOURCE: MOXA*
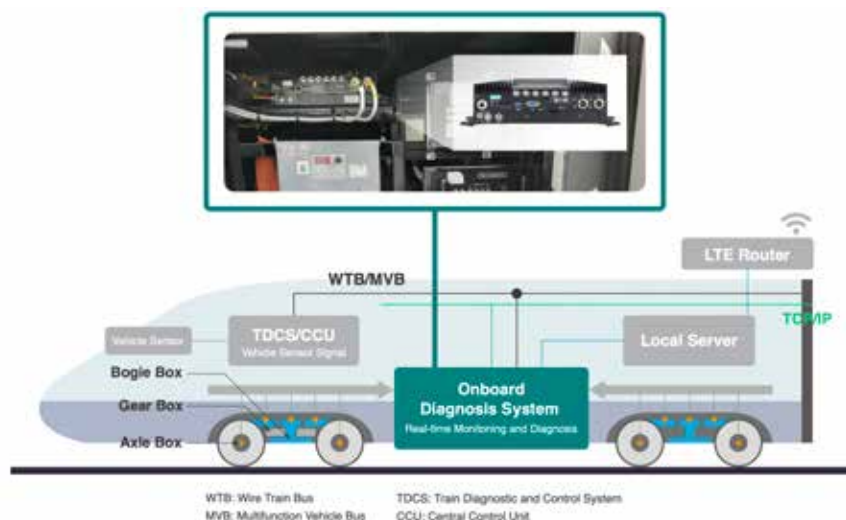
*Moxa's computer aids onboard diagnostics while the train is in motion.*

performance processor and with up to 32 GB RAM. Additionally, Moxa offered Linux Drivers for the platform.

JunSik Im, Director/Principal Research Engineer of Globiz commented: "Globiz has found a valuable partner in Moxa, who has provided exceptional local support since the early stages of their collaboration. In previous projects, relying on a computer from a different company meant enduring lengthy support calls to headquarters whenever issues arose."

Moxa assembled a knowledgeable team of local staff and technical experts from headquarters to ensure the partnership with Globiz was successful. This team worked closely with Globiz from the POC stage to the final deployment, addressing issues that arose along the way. Globiz and Moxa built a long-term relationship based on reliability, integrity, and sincerity over two years. Together, they provided technical support to

fulfill KORAIL's requirements and complete the Korea Laboratory Accreditation Scheme (KOLAS) verification and Korean Certification.

The CBM project was a significant milestone for Globiz, being the first in South Korea. JunSik Im stated: "Moxa's extensive product portfolio for railways makes them an ideal partner. We look forward to collaborating with Moxa on future projects."

Globiz estimates that the benefits of the system in this project include:
- 25-30% reduction in life-cycle costs
- 20-30% reduction in spare parts costs
- 40% increase in the lifetime of devices

Because of the success of this project, Globiz has been recognized by Hyundai and train operators and will continue to be a partner to help promote CBM to more cities across Korea.

"In a bid to expand into the global market, our company recognizes the value of partnering with Moxa, whose worldwide coverage and certifications provide a unique opportunity for growth. Together, our companies have the potential to achieve great things, making this partnership a promising one," JunSik Im said.

Moxa offers solutions based on the EN 50155 standard including wired and wireless devices, computing equipment, and I/O controllers for various onboard systems.

*Technology report by **Moxa.***

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*Moxa V2406C Series Intel® 7th/8th Gen Core™/Celeron® railway computers.*

# Industrial switch challenges in artificial intelligence deployments

**AI is highly dependent on communications from sensors, intelligent machines neural networks and other devices with neural networks. A high-bandwidth, low-latency neural network built on fast, reliable and secure Ethernet switches can keep pace with the flow of data and ensure efficient management of traffic.**

INDUSTRIAL IOT APPLICATIONS ARE increasingly incorporating artificial intelligence (AI) into the managing, controlling, and monitoring of operations. When properly implemented, AI empowers plant management to focus on the larger picture and gain visibility into uncovering new ways to optimize workflows, enhance safety and sustainability, streamline supply chains, improve asset reliability, or make more efficient use of resources.

AI puts factories and plants in a continuous state of self-optimization, able to detect anomalies with advanced pattern recognition, conduct root-cause analysis, and take actions that minimize risk and maximize profits — all without human intervention.

Although AI is only in its early stages of adoption, it is already transforming industry and society as we know it.

With so many potential benefits of AI seemingly within reach, you are probably wondering how to implement AI in your organization. To begin with, you'll need access to significant computing resources. Basic AI workloads can be handled by CPUs, yet multi-core GPUs are required for machine learning, deep learning, complex algorithms, and specific tasks involving large data sets. Massive amounts of storage are also vital to hold training data, software, and models.

However, the focus of this article is not on GPUs, CPUs, TPUs, or the intricacies of cloud storage. Instead, we are looking at another key component of AI: networking infrastructure, and specifically, the hurdles faced when deploying AI with industrial switches. AI is highly dependent on communications from sensors intelligent machines neural networks and other devices with neural networks. Only a high-bandwidth, low-latency neural network built on fast, reliable, and secure Ethernet switches can keep pace with the flow of data and ensure efficient management of the network traffic.

Below are five common industrial switch issues that may bottleneck an AI project and five effective strategies to overcome them.

## Issue 1: Data Management and Synchronization

Industrial Ethernet switches handle vast amounts of raw data from diverse sources. Ensuring efficient data management and



SOURCE: ANTAIRA

*Industrial 10-Gigabit managed Ethernet switches check all the boxes for artificial intelligence and machine learning applications. High port counts supporting both copper and fiber cables, combined with PoE up to 100W, enable the deployment of multiple edge devices.*

synchronization with machine learning and deep learning models is a significant challenge.

*Solution*: Develop efficient data handling techniques, including data preprocessing and compression, to minimize data overload on industrial switches and enable smooth AI data integration for machine learning.

## Issue 2: Real-time Processing and Low Latency

Demand for real-time decision-making in industrial settings requires industrial switches to process data rapidly and exhibit minimal latency input data only.

*Solution*: Implement edge AI processing on industrial switches to reduce latency and achieve real-time machine learning, deep learning, and big data analysis without overburdening the central network infrastructure.

## Issue 3: Security and Resilience

Integrating AI with industrial switches necessitates robust security measures to protect sensitive data and maintain system resilience against cyber threats.

*Solution*: Utilize secure communication protocols and encryption methods to safeguard data transmission between industrial switches and AI-enabled systems.

## Issue 4: Interoperability and Protocol Compatibility

Industrial switches must be compatible with various other industrial network protocols and existing network infrastructures to facilitate seamless AI integration.

*Solution*: Deploy industrial switches with flexibility and adaptability to support multiple protocols, ensuring seamless compatibility with existing network frameworks.

## Issue 5: Scalability and Redundancy

Achieving scalability and redundancy in AI-enabled industrial computer systems, AI tools, and computer vision systems is vital for ensuring uninterrupted and reliable operations, particularly in large-scale industrial environments.

*Solution*: Incorporate redundancy and failover mechanisms in AI-integrated industrial switches to further network redundancy to ensure system reliability and minimize disruptions in critical operations.

## AI-Ready Industrial Switches

Purpose-built to deliver speed and reliability, Antaira's industrial 10-Gigabit managed Ethernet switches check all the boxes for AI/ML applications. High port counts supporting both copper and fiber cables, combined with PoE up to 100W, enable the deployment of multiple edge devices while industrial-grade housings and wide temperature ranges protect connectivity in the most extreme environments.

Antaira switches are also available in DIN-rail mount models to fit inside tight control cabinets and in standard rack mount designs.

*Henry Martel, Field Application Engineer,*
***Antaira Technology.***

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# Industrial Wi-Fi I/O module

**WISE-4250 redefines data acquisition efficiency and cuts wiring costs using dual-band 2.4/5 GHz Wi-Fi I/O.**



SOURCE: ADVANTECH

*Smart roaming for reliable connections along with remote and diverse I/O management.*

Advantech has introduced the new WISE-4250 dual band based Industrial Wi-Fi I/O Module. The WISE-4250 features interchangeable I/O and sensors integrated with IoT data acquisition, processing and publishing. Data can be sent directly from Edge to Cloud with higher security and no loss functions. All Wi-Fi channels can be flexibly connected with a smart roaming function. Users can directly configure products with devices via a HTML5 based web page user interface. Products support RESTful API in JSON format for any IoT integration.

The WISE-4250 supports 2.4/5GHz dual band concurrently, enabling leverage of both frequencies at the same time, reducing wireless interference against device data transmission delay. Diverse I/O modules support a wide range of data acquisition. WISE-4250 provides a number of embedded drivers which can easily plug-and-play with wireless modules.

The data logger provides data resume functions ensuring zero data loss during on-line, off-line and power off situations.

Users can easily find real data with RTC time stamps.

Secure Edge-to-Cloud AES encrypted security is built-in with 802.1x, up to WPA3 Personal and Enterprise, and effortlessly configurable via P2P (peer to peer) functions with mobile devices. Push data to SCADA, the cloud, or private servers while integrating IoT through RESTful web APIs or diverse protocols.

The WISE-4250 features and industrial-Grade design suitable for use in harsh environments. The device will operate over wide temperature and humidity ranges and provides voltage endurance. Diverse mounting methods and fast roaming simplify implementation in a wide variety of applications.

Elevate system connectivity with WISE-4250 key features include the following.

## Key Features
- Wi-Fi IoT Wireless I/O Module
- Wi-Fi Dual band 2.4/5 GHz up to 802.11 a/b/g/n/ac
- Supports X.509 and up to WPA3 / TLS1.3

- Support for interchangeable I/O and sensor module along with easily configured with web UI
- MQTT, Modbus/TCP, SNMP, SNTP, TCP/IP, HTTP, HTTPS, UDP, and DHCP protocols supported
- Supports smart roaming function
- UDP based AES-128 encrypted wireless P2P (Peer to Peer) function for multiple modules
- 10000+ data logger with SNTP/RTC time sync and WDT auto connection recovery
- Reduces installation wiring costs

The Advantech WISE-4250 is available now. Visit the website www.advantech.com/en-eu for more information.

A video demonstration is available to view at https://www.advantech.com/en-eu/resources/video/wise-4250-dual-band-wi-fi-wireless-io-module

*Advantech*

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# IO-Link device software stack solution

**Solution enables customers to integrate the latest IO-Link smart sensors and actuators into EtherCAT industrial Ethernet networks to achieve more flexible and efficient smart factory environments.**



*SOURCE: ASIX*
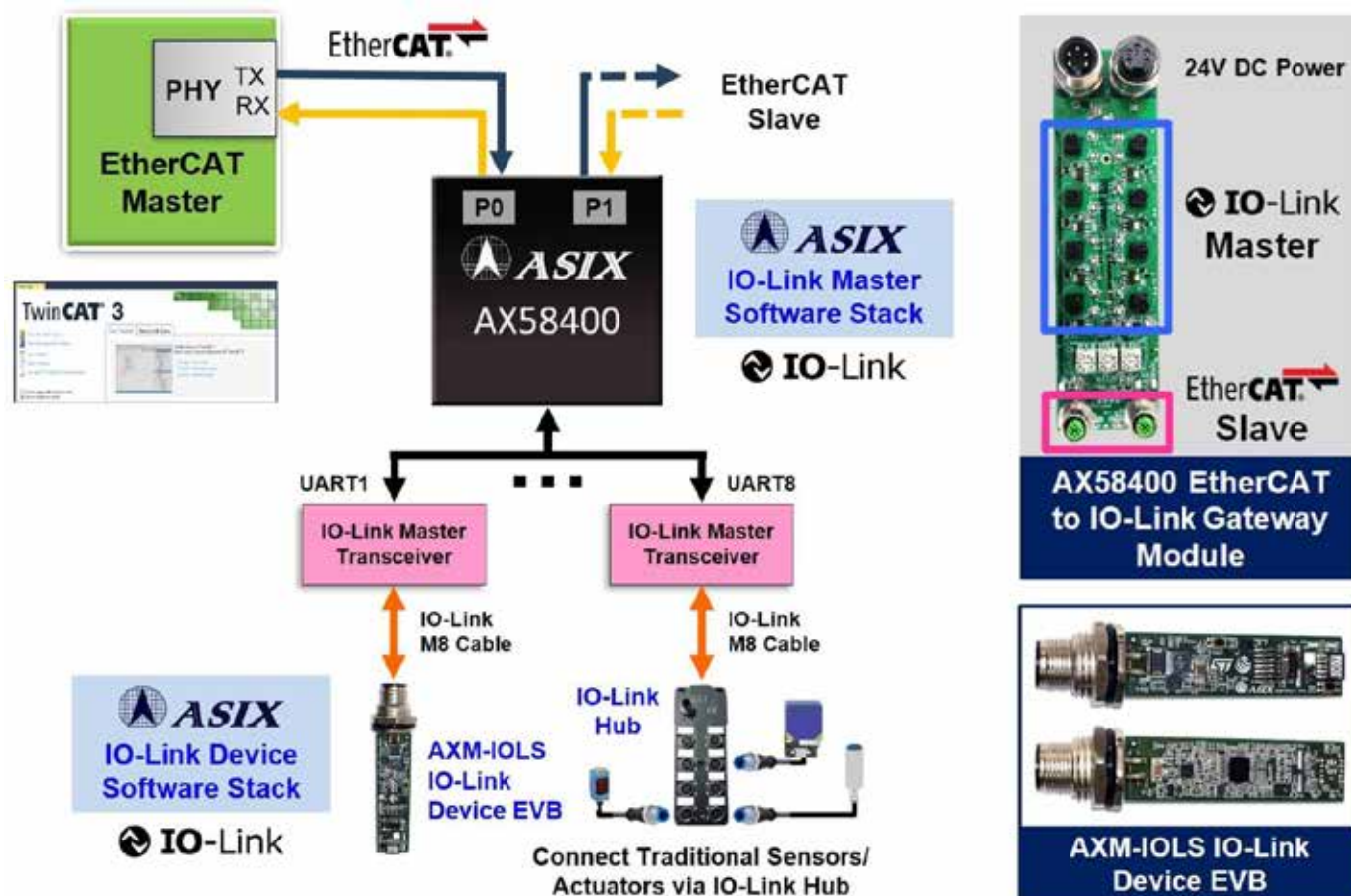
*ASIX is engaged in the industrial Ethernet controllers and I/O interface markets, with a focus on developing IO-Link intelligent communication.*

ASIX Electronics offers a comprehensive solution incorporating an EtherCAT to IO-Link Master Gateway and IO-Link Device Software Protocol Stack. In this era of booming AI technology, IO-Link intelligent communication technology offers key technology in Industry 4.0 smart manufacturing and Artificial Intelligence Internet of Things (AIoT) by harnessing a flexible real-time bidirectional data exchange mechanism.

With support for flexible dynamic equipment configuration, IO-Link enables instant adjustments to production equipment configurations based on real-time factory production demands. This capability results in a streamlined production process and increased efficiency. IO-Link's equipment status diagnosis and reporting features contribute significantly to achieving predictive maintenance for production equipment, reducing unexpected equipment failures and downtime, and enhancing the stability and reliability of smart factory production lines. By introducing IO-Link technology into smart factories and combining it with AI edge computing technology, real-time analysis and feedback of production data become achievable. This integration facilitates comprehensive data monitoring and management of production equipment, thereby achieving the automated production management in smart factories.

The ASIX IO-Link Device Software Stack is developed on the AXM-IOLS IO-Link device evaluation board, which is equipped with STMicroelectronics STM32F469AI microcontroller and L6362A IO-Link device transceiver. The software stack is developed using the STM32CubeIDE development tool, based on the STMicroelectronics STEVAL-BFA001V2 software development kit, and seamlessly integrates ASIX's proprietary IO-Link device software stack library.

The design of this software stack complies with the IO-Link Interface and System Specifications V1.1.3, ensuring backward compatibility for IO-Link V1.0 master support. It supports advanced features including the ISDU communication, data storage, both IO-Link and standard I/O operating modes.

Additionally, it supports all telegram types and various data transmission rates, including 4.8Kbps (COM1), 38.4Kbps (COM2), and 230.4Kbps (COM3). The software stack also allows for online firmware updates via the IO-Link interface, with a minimal firmware footprint of less than 1KB of RAM and less than 10KB of flash memory. This solution provides customers a cost-effective IO-Link device software stack solution for smart IO-Link device applications, such as IO-Link sensors (temperature, humidity, pressure, photoelectric, vision, ToF gesture sensors), IO-Link actuators (valve actuators, motor controllers, smart LED towers), IO-Link hubs, and IO-Link valve islands.

The ASIX IO-Link device software stack package includes ASIX IO-Link device software stack trial library, a demonstration application, the AXM-IOLS evaluation board reference circuit and PCB layout file, etc.

*ASIX*

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# New-generation x86 industrial computers

**New-Generation x86 industrial computers to top up data connectivity at Industrial Edge.**

Moxa has officially announced the launch of its new family of x86 industrial computers (IPCs) with exceptional reliability, adaptability, and longevity to address the increasing demands of data connectivity and real-time processing of large volumes of sensor and device data at the industrial edge.

The industrial sector is rapidly embracing digital transformation with increased awareness about resource optimization, which is driving up the demand for reliable x86 IPCs as edge devices to interface with the industrial IoT application platforms and accelerate the deployment of Industry 4.0-enabled solutions.

According to ABI Research's research report on Industrial Automation Hardware Innovation: PLCs, IPCs, and HMIs, the industrial personal computer (IPC) market will see the highest growth rate of the three industrial automation hardware types—the other two being the programmable logic controller (PLC) and human-machine interface (HMI) markets, with spending increasing by a CAGR of 6% and from US$11 billion to US$19.7 billion between 2023 to 2033.

To respond to the need for reliable and rugged IPCs in retrofit and upgrade projects at the industrial edge, Moxa has new x86 IPC families—the BXP, DRP, and RKP series, in multiple form factors, adaptable interface combinations, and with various options of Intel® processors, totaling 75 different models. The comprehensive IPC portfolio is specially designed to meet the changing needs in the industrial automation field.

"To see strong growth in the IPC market, we have deployed an innovative process to create a new-generation IPC portfolio to tackle customer issues when purchasing IPCs, including product life-cycle costs, product features such as fanless design and easy configuration options, as well as life-cycle services," said Jonas Chen, head of x86 IPC Business at Moxa.

"With more than 35 years of OT experience and expertise in various industries, we aim to offer best-in-class IPCs to the market, thereby reinforcing a critical piece in the edge-connectivity jigsaw—seamless connectivity between edge devices and industrial automation systems facilitated by Moxa's good track record in helping industrial users effectively manage data connectivity and networking at the edge," he added.

The BXP, DRP, and RKP series are each backed by a robust 3-year hardware warranty and 10-year longevity commitment (released



SOURCE: MOXA

*Engineered to maximize capabilities in industrial automation edge connectivity, Moxa's new-generation x86 IPCs set a new standard for reliability, adaptability, and longevity.*

in 2023). These products reaffirm Moxa's dedication to delivering exceptional product quality and ensuring stable, long-term support for our customers' evolving business needs. Furthermore, the simplified configure-to-order service (CTOS) also supports customers in quickly identifying the best fit for their applications in just a few steps.

## High reliability to ensure 24/7 operation and product longevity

The BXP, DRP, and RKP series are rugged, fanless computers designed to operate reliably in harsh environments. The sealed design effectively dissipates heat and reduces unexpected maintenance and system failure, keeping the 24/7 operations running in POS systems for transportation and petrol stations wherein massive data processing is required, and equipment is most likely exposed to harsh outdoor environmen.

Furthermore, the computers have passed rigorous tests for adherence to safety standards, including continuous exposure to extreme temperatures, power surges, and shock, so they can withstand extreme weather conditions and work non-stop without overheating or freezing up.

Moxa is dedicated to product quality, and its 3-year hardware warranty is on par with the best in the industrial computer market,

demonstrating our confidence in the product quality. Our long-term 10-year product life-cycle support further commits to product longevity.

## Comprehensive x86 industrial computer portfolio

The BXP, DRP, and RKP series offer three form factors based on the installation type, which include wall-mount, DIN-rail mount, and rackmount options. Users can choose the most suitable installation type based on their application scenario, considering space constraints and installation costs.

Furthermore, a variety of interface combinations top up the base models to provide models with up to 12 LAN ports and 10 serial ports, depending on the series. The computer models are powered by an Intel Atom®, Intel® Celeron®, or Intel® CoreTM processor to face different complexity levels of your application.

Moreover, the configure-to-order (CTO) service offers a variety of operating systems, memory, and storage options, making system assembly more manageable than ever and enabling faster time to market.

*Moxa*

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# EL6821 EtherCAT Terminal

**Flexible EtherCAT communication interface for DALI-2 provides support for 64 slaves and input devices.**

The new EL6821 EtherCAT Terminal from Beckhoff allows up to 64 DALI/DALI-2 slaves and 64 DALI-2 input devices to be connected. The TwinCAT 3 System Manager makes it easy to configure and parameterize DALI devices flexibly.

Programming the EtherCAT Terminal is effortless; it is programmed using TwinCAT 3 function blocks. The EL6821 also contains an integrated DALI bus power supply that can be switched off with a guaranteed output current of 220 mA.

The galvanically isolated input voltage is supplied via an EL9562 EtherCAT power supply terminal. The EL6821 EtherCAT Terminal is certified according to the DALI-2 standard.

This means that a maximum of 64 DALI control gears and 64 DALI control devices can be seamlessly integrated into a superordinate EtherCAT network via a compact terminal measuring 12 x 100 x 68 mm (W x H x D). Commissioning and use of the EtherCAT Terminal are supported in a variety of ways: with signal LEDs as status indicators and two digital inputs, commissioning is child's play. The TwinCAT 3 System Manager makes it simple and easy



SOURCE: BECKHOFF

to configure and parameterize the EL6821 and the DALI devices. The tried-and-tested TwinCAT 3 PLC library Tc3_DALI is available for programming.

*Beckhoff*

**Visit Website**

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# Intelligent edge automation platform

**New strain gauge modules and J1939 and CAN protocol sleds for the FlexEdge platform.**

The FlexEdge Intelligent Edge Automation Platform is now scalable with Strain Gauge Modules and J1939 and CAN Protocol Sleds.

The new strain gauge modules are easily installable and configurable and come in both SSR output and relay output options. Both offer single loop PID capabilities to monitor, measure, and control equipment.

Designed to thrive in harsh environments, the modules accept signals from load cell, pressure, and torque bridge transducers. With a software-selectable 5 VDC or 10 VDC stable bridge excitation voltage, each strain gauge module can drive up to four 350W bridges. The inputs are also software selectable for low level inputs at ±20 mV, ±33 mV, and ±200 mV full scale.

Alongside the new strain gauge capabilities, Red Lion launched two field-installable sleds, serving either the J1939 or CAN protocol. Providing a seamless interface between industrial equipment and the controller environment, the protocol sleds can be powered and configured directly from the FlexEdge® DA50 or DA70 controller using Red Lion's Crimson software.



SOURCE: RED LION

The new modules make critical performance data easier to gather, more accurate, and actionable in real time. This lets equipment operators and business leaders drive more value out of industrial data. Easy-to-use installation and configuration save time, boost operational performance, improve plant efficiency, and minimize downtime.

For more information and model specifications for the Strain Gauge Modules and the J1939 and CAN Protocol Sleds for use with Red Lion's FlexEdge platform, visit the website.

*Red Lion*

**Visit Website**

# Upgrades for Sinamics servo drives

## V6 software generation offers new functions including single positioner and EtherNet/IP connectivity.

The Siemens Sinamics S210 servo drive system now offers new hardware and software for an even larger range of applications:

- New V6 software generation with new functions like a single positioner to reduce the load of the controller, and EtherNet/IP to allow third-party controllers to be connected.
- Simulation via DriveSim Advanced enables virtual commissioning in advance, ensuring drive process requirements are met efficiently and cost-effectively
- New hardware architecture with functional enhancements like a second encoder interface and 3C3 (H2S and SO2) coating increases precision and robustness

Siemens is innovating the well-established Sinamics S210 servo drive system with a new hardware architecture and new V6 software generation that expand the system's range of applications. The servo drive system is especially suitable for applications with high dynamics in the power range between 50 W and 7 kW: for example, machines for packaging, pick & place applications, and digital printing.

### New options

To make it even easier to control individual axes in the future, the new generation of the Sinamics S210 comes with a second encoder interface and offers the option to connect a direct measuring system to compensate for mechanical looseness and tolerances. This significantly increases precision, which makes more applications possible. With its Basic and Extended Safety Integrated functions, the new Sinamics S210 ensures the comprehensive implementation of the safety concept in the machine and meets the requirements of SIL3 (EN 61508) and PL e (EN ISO 13849-1). Another new feature of the system is the Security Integrated functions that ensure greater safety in industrial systems with user management and access protection.

In addition to Profinet IRT, the Sinamics S210 now offers communication via EtherNet/IP. This means that third-party controllers can also be connected to the servo system, which significantly increases the range of applications, especially in the U.S. market.

With the new 3C3 (H2S and SO2) coating, the new generation of the Sinamics S210 is extremely robust and can resist aggressive environmental influences like sulfur gases.

*SOURCE: SIEMENS*

*Simulation via DriveSim Advanced enables virtual commissioning in advance, ensuring drive process requirements are met efficiently and cost-effectively.*

This means that the servo system also guarantees high system availability and productivity under difficult production conditions: for example, in the tire industry. The EPOS single positioner is now also available as a technology function for the Sinamics S210. With this function module, high-precision motion control positioning tasks can be implemented quickly and easily in the converter because positioning tasks can be calculated directly in the drive. This reduces computing power in the controller, which can instead calculate more complex tasks or a larger number of drive axes.

### Simulation of motion applications

The new generation of the Sinamics S210 also enables the simulation of motion control applications. Using the DriveSim Advanced simulation software, a digital twin of the Sinamics S210 can now also be created in the TIA Portal. This can be used to virtually commission the drive system in advance and perform engineering tasks. Requirements for the processes in the drive train can therefore be ensured cost-effectively and efficiently. In addition, the digital twin offers the opportunity to create virtual training courses and demonstrations and to optimize real machines by eliminating problems in the drive train, which are simulated with the digital twin.

A well-established feature of the Sinamics S210 is the integrated Web server, which has been redesigned to support the new Web server platform and operating philosophy of the new Sinamics inverter generation: for example, the Sinamics S200 and Sinamics G220. The Web server enables efficient commissioning, fast diagnostics, and maintenance from a variety of devices like tablets and PCs.

*Siemens*

**Visit Website**

# VisuNet FLX HMI series

## Pepperl+Fuchs VisuNet FLX HMI series now offers extended temperature range.

Pepperl+Fuchs is expanding the VisuNet FLX HMI series with a new option, making it even more flexible. The series offers various HMI systems for a wide range of applications and installation requirements in ATEX/IECEx Zone 2/22, NEC 500 Div. 2, and non-Ex areas. The modular "one-fits-all" design allows for the precise HMI solution configuration and enables easy and quick adaptation in the field. It will now also offer an extended temperature range.

In addition to the stainless-steel housing, a new aluminum housing is now available in the VisuNet FLX series. This means that the FLX can also be used in extended temperature ranges from -20 °C to +50 °C, making it perfect for outdoor applications. The aluminum housing not only provides optimal heat dissipation, but also high temperature resistance. To ensure good readability at all times, even in very bright lighting conditions, the FLX has an optically bonded display. With the housing, additional sun shields can be attached to the sides, top edge, and rear as required. They also serve as protection against rain and other environmental conditions. And, like the stainless-steel version, the aluminum housing is approved for explosion-hazardous areas.



SOURCE: PEPPERL+FUCHS

As before, the modular design of the popular FLX solutions provides additional advantages, including the ability to upgrade to future processor generations on demand by easily replacing a thin client or PC unit. This feature makes the FLX solutions a future-oriented investment. Similarly, display units, and power supplies can be replaced easily during service work, keeping costly downtimes to a minimum.

This "one size fits all" principle also opens up new potential for OEMs and machine builders by simplifying inventories and enabling quick customization based on end customer application requirements.

*Pepperl+Fuchs*

**Visit Website**

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# Power supplies set new standard

## With protective-coated PCB, new power supply ensures high system availability in extreme ambient conditions.

The new third generation Trio Power power supply is now available for the first time with a protective coating on the PCB. This enables reliable use, even under extreme ambient conditions. The power supplies set a new standard in machine building.

The power supplies are compact, robust, reliable, and impress with their easy handling. With the protective-coated PCB, the new power supply ensures high system availability, even under extreme ambient conditions. The coating protects against dust, corrosive gases, and humidity. Failures due to creepage currents and electrochemical migration caused by corrosion are also prevented.

The new Trio Power power supplies save space due to their narrow overall width and capability of being mounted directly side by side. The low overall depth enables installation in 125 mm small housings. The power supply units also enable particularly easy handling: Push-in connection technology allows for quick and tool-free installation. Integrated marking fields can be used for easy EID and circuit marking. Due to an intuitive commissioning concept, the devices are quickly ready for use.



SOURCE: PHOENIX CONTACT

The mechanical lock of the potentiometers ensures that the devices are also tamper-proof. Furthermore, the power supplies feature smart diagnostic options. The multicolor LEDs and a collective relay contact are used to signal all relevant states, such as DC OK, overload, and short circuit. The dynamic boost (150 percent/5 seconds) also enables difficult loads to be started. With the powerful output characteristic curve, even capacitive loads up to 960 W output power in 1 AC and 3 AC can be charged without any problems.

*Phoenix Contact*

**Learn More**

# Edge software solutions from Softing

**Two new software solutions expand use of ARM processors and offers new support for MQTT protocol.**

By integrating ARM 32-bit compatibility into its edgeConnector products, Softing Industrial is responding to the increasing demand for edge applications using ARM processors.

Customer demand for compact devices for edge applications powered by ARM processors is experiencing a significant increase. Softing Industrial is responding to this trend and has successfully integrated ARM compatibility into its proven edgeConnector products.

Previously, edgeConnector solutions were only available for integration into large PCs. In June last year, the integration of ARM 64-bit was successfully implemented. Now Softing Industrial presents the latest version 3.80 of edgeConnector Siemens, edgeConnector 840D and edgeConnector Modbus, which also offers ARM 32-bit support for compact hardware solutions.

"The introduction of ARM 32-bit compatibility in our edgeConnector products marks an important step in our innovation strategy," explained Abel Jimenez, Product Manager at Softing Industrial. "This development opens up the possibility for our customers to use our solutions in a wider range of devices for edge applications, such as WAGO Compact Controller 100, WAGO PFC 200, and Open-Source Hardware Boards like Allwinner A20. We remain committed to providing the most advanced and flexible solutions for the changing needs of the industrial environment."

The Docker-based software modules of the edgeConnector product family enable access to process data in SIMATIC S7, SINUMERIK 840D and Modbus TCP controllers. They can be deployed quickly, run on standard hardware, and can be easily managed centrally. They provide users with a straightforward and secure way to integrate data from production into innovative and flexible industrial IoT solutions.

*https://industrial.softing.com/products/docker.html*

### MQTT for connectivity and security using Secure Integration Server

The Secure Integration Server (SIS) from Softing Industrial now supports the MQTT protocol, improving connectivity and security for data integration in IT/OT cloud applications.

The Secure Integration Server (SIS) from Softing Industrial offers a structured solution for complex server architectures. It combines various OPC UA servers at the automation level with their associated address spaces. This enables a standardized mapping of these address spaces in accordance with the OPC UA Companion Specification. The data



*ARM 32-bit extension unlocks deployment options for edgeConnector Products from Softing Industrial.*



*MQTT provides enhanced security and connectivity features for Secure Integration Server.*

provided in this way is then available for IoT cloud applications via a standardized OPC UA interface.

The latest version of the SIS, V1.30, integrates the MQTT protocol (versions 3 and 5), making data integration more secure and flexible. The most significant benefits include:

*MQTT Publisher & Subscriber:* enables bi-directional data traffic for efficient communication.

*MQTT Authentication Settings:* Ensure security and identification between clients and brokers through various authentication methods such as anonymous, username or certificates.

*MQTT Store&Forward Function:* Protects against data loss.

*Various Publishing Modes and "Dynamic Payload":* Guarantee high flexibility for different data requirements.

*Up to 25 MQTT Connections:* Ensure seamless communication and provide a scalable solution.

Product Manager Andreas Röck commented on this development: "The integration of the MQTT protocol into our Secure Integration Server underlines our commitment to advanced solutions in industrial data integration. The enhanced security and connectivity features open up new possibilities for efficient and reliable data transmission for our customers."

*Softing Industrial*

**Visit Website**

# Integrated actuators and sensors

**The IIO 041 master module enables the connection of up to four intelligent SDCI sensors and actuators.**

The compact IIO 041 from SIGMATEK's S-DIAS series has four SDCI master ports and four digital inputs (+24 V DC/3.7 mA/0.5 ms). With SDCI Single-Drop Digital Communication Interfaces (IO-Link), a manufacturer-independent point-to-point connection can be realized for connecting intelligent actuators and sensors in accordance with IEC 61131-9.

The IIO 041 module is therefore ideal for all automation applications with many intelligent actuators and sensors, such as in robotics, as SDCI devices can be easily integrated into the system. This is becoming increasingly important due to the growing complexity and flexibilization in manufacturing and production as well as the high demands on quality standards.

SDCI devices can be configured quickly and easily using a configuration tool integrated into the LASAL software environment. This allows an SDCI configuration file (IODD) to be loaded for each SDCI unit during project planning and parameterization to be carried out. The device can therefore be easily integrated into the overall system, which significantly minimizes cabling work and reduces costs. In addition, the commissioning



SOURCE: SIGMATEK

of a machine or system is shortened and productivity is increased.

**Technical data**
- 4 SDCI-Ports (+24 V DC)
- 4 digital inputs (+24 V DC)
- IP20 protection type
- UL verified

*SIGMATEK*

*Visit Website*

# Digital load cells

**LAUMAS' CC-Link IE Basic compatible LCB model offers advanced performance and ease of use.**

The connection of analog applications to smart, networked systems is an elementary step towards the digitalization of the manufacturing and processing industry. Companies that want to develop their weighing systems can successfully advance their digital transformation with the new CC-Link IE-compatible universal digitizer for load cells and weight transmitters LCB from LAUMAS.

The latest model of the LCB offers greater performance and ease of use through a series of upgrades. The upgrades meet the growing needs of competitive Industry 4.0 applications in numerous industrial sectors, from applications in chemical and pharmaceutical production to applications in heavy industry.

Given the importance of data communication in the digital age, LAUMAS has expanded the network technologies that the latest LCB solution supports. One of the most important added functionalities of the LCB universal load cell digitizer is its compatibility with the open industrial Ethernet CC Link IE for efficient data exchange. Specifically, this solution uses the popular CC Link IE Field Basic protocol. With this protocol, connectivity is realized via the



SOURCE: LAUMAS

standard Ethernet port and with a transfer speed of 100 MBit/s.

This allows the LCB to communicate with many different system components, for example with the PLCs from international providers. LAUMAS end customers can use this component to implement automated processes, condition monitoring, predictive maintenance and other

Industry 4.0 applications with weighing. Additionally, this compatibility paves the way for future integrations and smart, large-scale networked configurations.

*LAUMAS*

*Learn More*

# 8-Port PoE+ Gigabit Switch

## Industrial Ethernet switch is 30 percent smaller for flexible deployment in space-constrained areas.

Antaira has launched its most compact industrial-grade PoE+ Gigabit unmanaged Ethernet switch, the LNP-C800G, a plug-and-play networking solution designed for space-constrained areas including control cabinets and tight machinery. Thirty percent smaller than conventional switches, the LNP-C800G brings unmatched reliability, versatility, and value to factory automation, Intelligent Transportation Systems, on-vehicle networks, solar power stations, video surveillance, and remote outdoor installations.

Measuring 3.7" x 2.1" x 3.3", the LNP-C800G houses eight RJ45 ports simultaneously supplying both Gigabit speed and 802.3af/at PoE+ 30W power per port. Each port has automatic MDI/MDI-X detection, meaning the switch can connect to another switch or workstation without changing the straight-through or crossover cabling. The store-and-forward architecture meets modern industrial requirements with backplane speed of 16 Gbps and support for 9.2Kbytes jumbo frames to efficiently transmit larger files. Put together, these features make for lower infrastructure costs, less downtime during deployment or network expansion, and easier



SOURCE: ANTAIRA

connectivity of PoE-enabled devices without requiring separate power supplies or outlets.

The LNP-C800G is hardened and certified to operate resiliently in harsh environments. Its extended temperature version has a tolerance of -40°C to 75°C, enabling expansion of connectivity to a spectrum of applications. The high-strength IP30-rated metal case withstands vibration, shock, and free-fall while offering

flexible wall or DIN-rail mounting options.

When combined with an optional power supply, the LNP-C800G's redundant 48 to 55VDC power input design allows for a total PoE budget of 240W.

*Antaira*

**Visit Website**

# Embedded protocol converter/gateway

## Embedded solution of the new UNIGATE FALCON protocol converter/gateway generation of products.

An embedded version of the new generation UNIGATE FALCON protocol converter/gateway series can be immediately integrated to quickly and easily provide an Industrial Ethernet or fieldbus interface. The embedded version can be integrated directly into existing final products as a complete module without a housing. Thanks to the low installation height of approximately 25mm, the embedded version is suitable for installation situations where space is limited, and a redesign of the existing electronics is not planned. It is also suitable for applications that do not allow or should avoid DIN rail mounting of a separate or external protocol converter or gateway.

Mounting of the UNIGATE FALCON Embedded is via four fixing holes, which also allow individual mounting even within the product housing. The position and dimensions of the holes are identical in all bus versions. The module is simply wired within the product, whereby the device configuration or programming can be used. The electronics of the final product do not need to be adapted or changed. The compact embedded version of the UNIGATE FALCON series can be directly



SOURCE: DEUTSCHMANN AUTOMATION

integrated into final products without any development effort and is therefore also ideally suited for small series production. By using the ready-to-run solution, design time and time-to-market of the individual automation solution can be significantly optimized.

The UNIGATE FALCON protocol converter/gateway series is of modular design with the

aim of realizing the best possible solution for the respective application. The option of cascading is of course also retained with UNIGATE FALCON Embedded.

*Deutschmann Automation*

**Learn More**

# Updated drive controllers

**New firmware enables faster drive-to-drive communication and flexible exchange of CANopen process data.**

The COMBIVERT F6 and S6 drive controllers from KEB Automation are now available with new firmware that includes a special highlight: CAN cross-communication. This means that plant and machine builders using the corresponding drives benefit from faster and more flexible communication between the inverters. Users can also utilise all process data-capable parameters.

The new firmware, including CAN cross-communication, is available for the APPLICATION and PRO device variants of the COMBIVERT F6 and S6 drive controllers.

The fact that data can now be exchanged independently and no longer necessarily via other fieldbus participants means that a faster data flow can be achieved. In the drive trains of many machines, milliseconds can be critical.

With a rigidly coupled shaft, even the smallest of delays can lead to considerable damage to the shaft in the long term and therefore to machine downtime. This makes the fast and flexible exchange of CANopen process data between the inverters all the more important.

Up to 10 COMBIVERT F6 or S6 drive

controllers can communicate directly with each other. The independent exchange of data also has the advantage of reducing the load on the machine's Ethernet-based fieldbus communication.

Last but not least, cross-communication also enables multi-level communication systems to be set up in which the fieldbus 'slave' of one system acts as the fieldbus 'master' of another system. Parallel fieldbus communication is supported by EtherCAT and Profinet.

*KEB Automation*

**Visit Website**

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# Unmanaged industrial Ethernet switches

**Reliable, versatile and user-friendly compact switches provide cost-effective solutions.**

Westermo has launched a new range of plug-and-play, unmanaged industrial Ethernet switches. The SandCat five port fast Ethernet switch series offers a cost-effective, plug and play solution for industrial applications that complements Westermo's range of managed switches. Supporting 100 Mbit/s, these versatile devices have been designed to meet the increasing network complexity, reliability and bandwidth demands of utilities, marine, manufacturing and energy industries.

The SandCat switches provide a low-cost option for connecting multiple end-devices to the network and the availability of a fibre port enables communication over larger distances or different sites. Although managed switches are used widely to enhance configuration and security of data networks, the SandCat series is ideally suited to extend the port count of managed switches, enabling the installation of more end-devices. The switches can also be used when a central device is required to create a physical topology for optimal redundancy and remote access or to act as a simple switch within factory automation applications.

The SandCat series is designed for mission-

critical applications using DIN rail mounting in harsh industrial environments allowing Ethernet connections to be established between drives, inverters, HMIs, PLCs and I/O units. The switches meet EMC, isolation, vibration and shock standards enabling installation in challenging industrial environments. An IP30 grade metal housing, operating temperature of -40°C to 75°C, wide power input range, multiple small form-factor pluggable (SFP) transceiver options, and extensive industry approvals and certifications ensures maximum flexibility.

*WESTERMO*

**Learn More**

# Industrial edge data visualization

**Emerson's new compact, rugged PC is built to connect industrial plant floor applications to the cloud.**

PACSystems IPC 2010, pre-loaded with Movicon software and PACEdge IIoT platform, delivers high-performance computing for industrial edge data visualization applications.

The new solution is designed to serve manufacturing sites and OEM machine builders who need a ruggedized, compact, durable IPC to cost-effectively support their Industrial Internet of Things (IIoT) and other digital transformation initiatives.

The IPC 2010 addresses this by pre-loading the PACEdge industrial edge platform and elements of Movicon.NExT SCADA software, helping users run applications quickly using browser-based configuration. Provisions are included for keeping the software platform current and passively maintained, minimizing user effort, while maximizing reliability.

Running an industrial version of Linux, and including serial and Ethernet connectivity, the IPC 2010 can be used as a communications gateway in a variety of topologies, and simultaneously or separately as an edge computing device.

Users can implement the IPC 2010 as a flexible protocol converter—and for many other computing functions—in many IIoT,



*SOURCE: EMERSON*

edge, OT/IT convergence, HMI visualization, SCADA connectivity, and digital transformation roles.

Both the hardware and software are designed to be adaptable, universal, and scalable, providing a standardized and unified user experience that is easy-to-use, powerful, and supported by Emerson's lifecycle services. The compact form factor IPC 2010 features

the widest operating temperature range of any passively cooled IPC, with a low power consumption of just four watts, and tough packaging so it can be installed virtually anywhere.

*Emerson*

**Visit Website**

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# Graph UX for machine learning modeling

**Imagimob's visual Graph UX revolutionizes machine learning modeling on the edge.**

Users can now visualize machine learning (ML) modeling workflows and leverage advanced capabilities to develop edge device models better and faster. The latest release of Imagimob's development platform for AI/ML on edge devices includes the roll-out of a major user experience upgrade. The all-new Graph UX interface is designed to bring greater ease and clarity to the ML modeling process while offering advanced new capabilities such as built-in data collection and real-time model evaluation for Infineon hardware.

"What we've done here is represent ML projects in a way that makes more sense to users and gives them more freedom to operate," said Alexander Samuelsson, CTO of Imagimob. "Compared to our previous workflow which was more top-down with a fixed pipeline, visualizing the entire workflow as a graph allows for a better overview of your process while unlocking the possibility to combine and test things in new and different ways – and ultimately build better models and accelerate time to market. Moving over to the Graph UX and its capable ML backend is a big change for us and our users. We are taking a holistic approach to ML
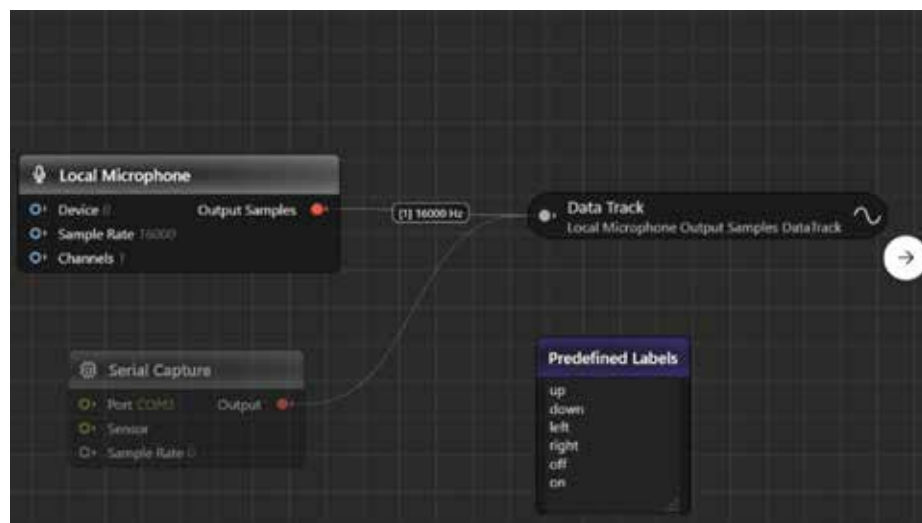


*SOURCE: IMAGIMOB STUDIOS*

modeling which, in our industry, is unique."

Imagimob Studio's new Graph UX allows ML engineering teams to gain a complete visual overview of their modeling canvas, with the ability to zoom in and out and work at different levels of complexity. In addition to making it easier to work more efficiently as a team, Graph UX makes ML modeling projects more accessible

to team members with varying skill sets and experience levels thanks to the ability to work at different levels of complexity and abstraction all in the same workspace.

*Imagimob Studio*

**Learn More**
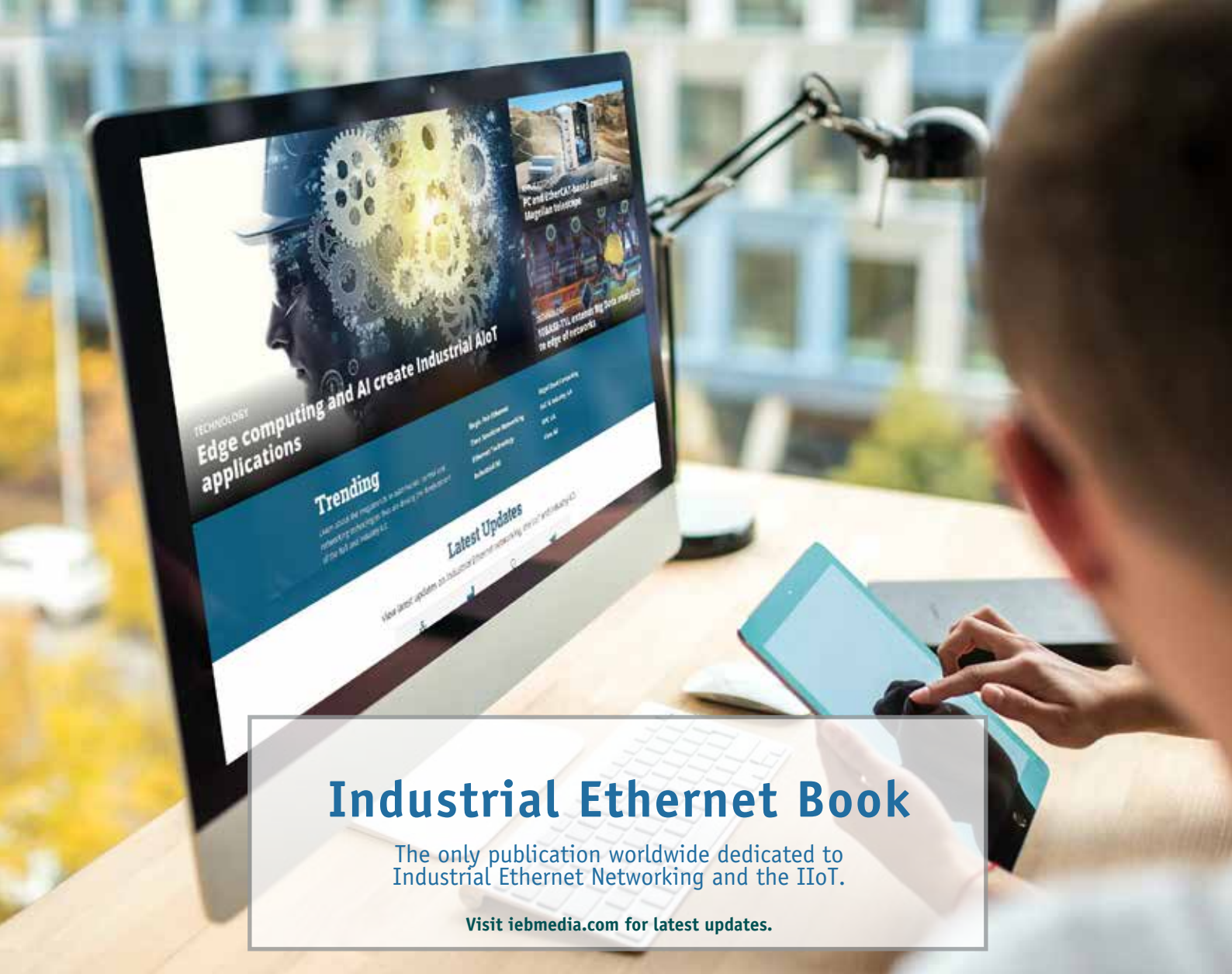
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