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industrial ethernet book

The Journal of Industrial Networking & IIoT

Special Supplement

TSN: The Case for Action Now

Page 19

Time Sensitive Networking technology update 6

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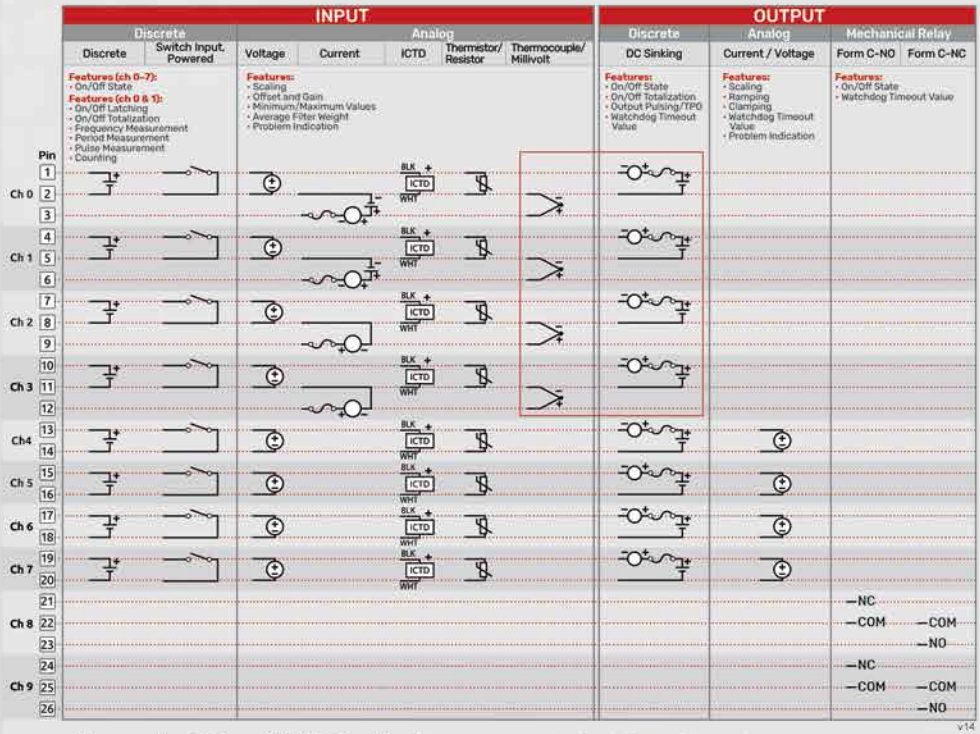

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Redefining the times …

The world of industrial networking, along with automation and control, are being redefined by the emergence of powerful new standards such as Time Sensitive Networking (TSN), 5G and OPC UA.

Time Sensitive Networking has the potential to change the landscape of Industrial Ethernet protocols and network solutions, with the possibility of new levels of convergence and interoperability. In this issue, we take a deep dive look at TSN through a series of industry experts who weigh in on the benefits of TSN, what it offers and the expected timeline and impact on factory automation. The coverage starts on page 6, and you will see a divergence of opinions into how the emergence of TSN plays out.

In this report, IEB offers comprehensive coverage and provides the perspective of industry leaders, along with a picture of how TSN is moving ahead in a quest that most agree will ultimately transform smart manufacturing.

This issue (starting on page 55) also features expanded coverage of New Products, starting with a Product Showcase on Industrial Ethernet switches. Our goal is to help you learn about the technology and trends shaping the newest generation of Industrial Ethernet Switches.

Industrial Ethernet switches and routers are effective building blocks for corporate and manufacturing networks worldwide. In this special report, industry experts provide information on the latest trends in new products, solutions to improve network management and support for new technologies such as TSN.

And lastly, we focus in the issue on the topic of IT-OT Convergence with a special report on connectivity.

Perhaps more than any of the trends shaping industrial networking, IT-OT convergence focuses on the overarching objective driving many new technology. Intelligent systems in the IoT age need to collect and analyze mass quantities of data, and findings should be accessible to edge devices and embedded systems. But the key to the IIoT is how to leverage these findings to produce actionable decision-making that drives results.

As we look a the future that embraces the Industrial Internet of Things, there are a series of technology initiatives that are all driving toward a single purpose. The magnitude of the solutions, however, is redefining how smart manufacturing networks will operate over the long term. The result is that, in the immediate future, there are questions about the timeline for innovation and what to expect in 2021 and beyond.

Al Presher

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Industrial Ethernet Book

The next issue of Industrial Ethernet Book will be published in **May/June 2021.**
Deadline for editorial: May 15, 2021 **Advertising deadline:** May 25, 2021

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40% increase in edge deployment of resources forecast by 2022

A new research paper highlights the importance of preparing content delivery for edge compute, enabling business leaders to leverage the agility of network resources.

A 40% INCREASE IN EDGE DEPLOYMENT OF network resource is forecast to occur by 2022, according to the research paper 'Outlook for Edge Services' from IDC and Limelight Networks.

By next year, 60% of all network resources will be deployed at remote edge or service provider locations, allowing business leaders to leverage the agility of their network resources, up from 20% in 2020.

Research report findings

Here are findings of the research report from IED and Limelight Networks:

- By 2022, 60% of all network resources will be deployed at remote edge or service provider locations, up from 20% in 2020
- By 2023, over 50% of new enterprise IT infrastructure deployed will be at the edge rather than corporate data centers
- 73% of industry professionals interviewed by IDC said they view edge as a strategic investment; another 17% say it is required by business operations

The report reinforces the trend for content processing to move increasingly to the edge, which can offer high-quality video experiences with minimal buffering and cost reductions.

The report also explores the benefits that industry professionals expect edge to add to their business:

- 45% believe edge will bring increased productivity or efficiency
- 44% believe edge will bring increased security and compliance
- 42% believe edge will bring faster decision making
- 40% believe edge will bring improved customer relations or customer experience

Edge technology advances

Steve Miller-Jones, VP of Strategy, Industry & Partnership at Limelight Networks commented: "In the last few years, we have seen advances in both the range of edge services and their adoption within a variety of content and enterprise workflows. In 2021, we can expect the variety and scope of customization capabilities to grow, helping enterprises meet high end user expectations for accessing and consuming content."

According to Miller-Jones, "The network edge makes it possible to affect data as it flows towards end users and devices, and to control the flow of data from those devices. Shipping large quantities of raw data towards cloud providers is expensive and can introduce significant latency."

"This is why the network edge will be used more for data processing and decision making. It allows access to multiple compute locations close to end users and devices, therefore removing the potential for latency without incurring additional operational overheads. The net result is improved content performance in a cost efficiency way, with built-in security and scale."

Limelight Networks' Edge Compute and EdgeFunctions, allow professionals to spend their time, effort, and money scaling their businesses instead of scaling the underlying infrastructure.

Executing compute tasks closer to the end user can significantly lower latency enabling workflows and content experiences to be optimised for performance, personalized experiences and real-time interactivity.

The complete 2021 Outlook for Edge Services report can be downloaded here: https://www.limelight.com/lp/what-is-to-come-in-edge-services-2021/

*Technology report by **IDC and Limelight Networks**.*

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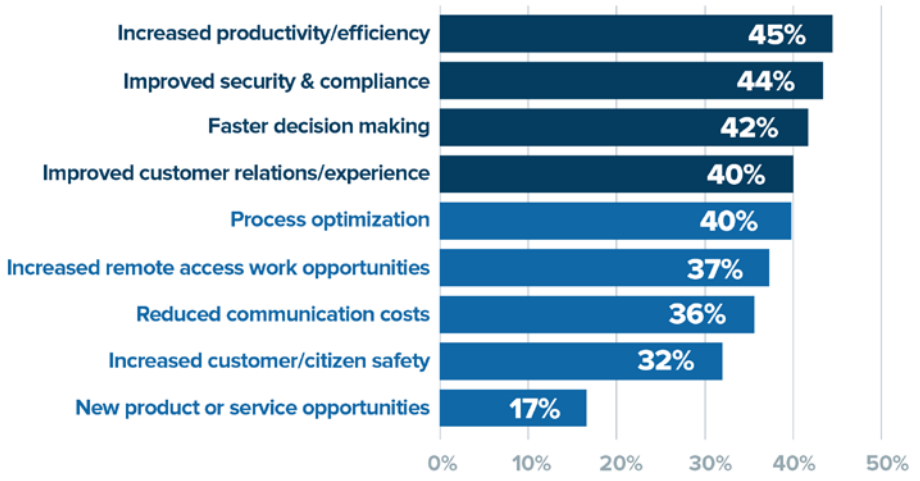
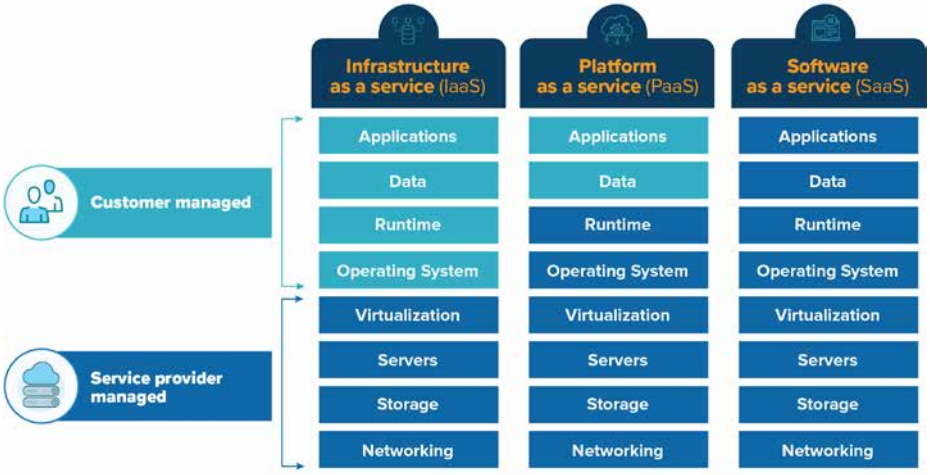


Benefits of edge computing.



Edge computing service types.

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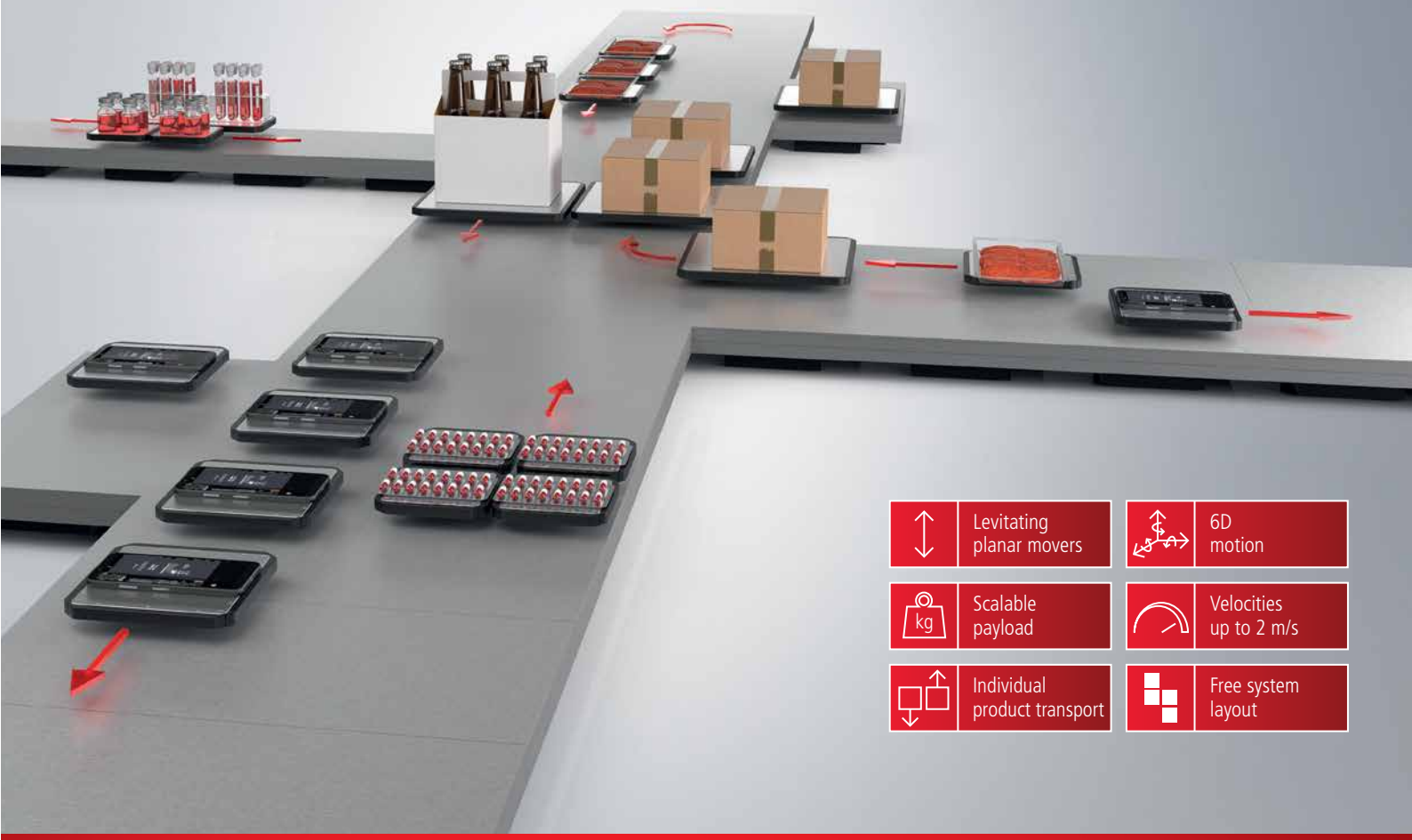

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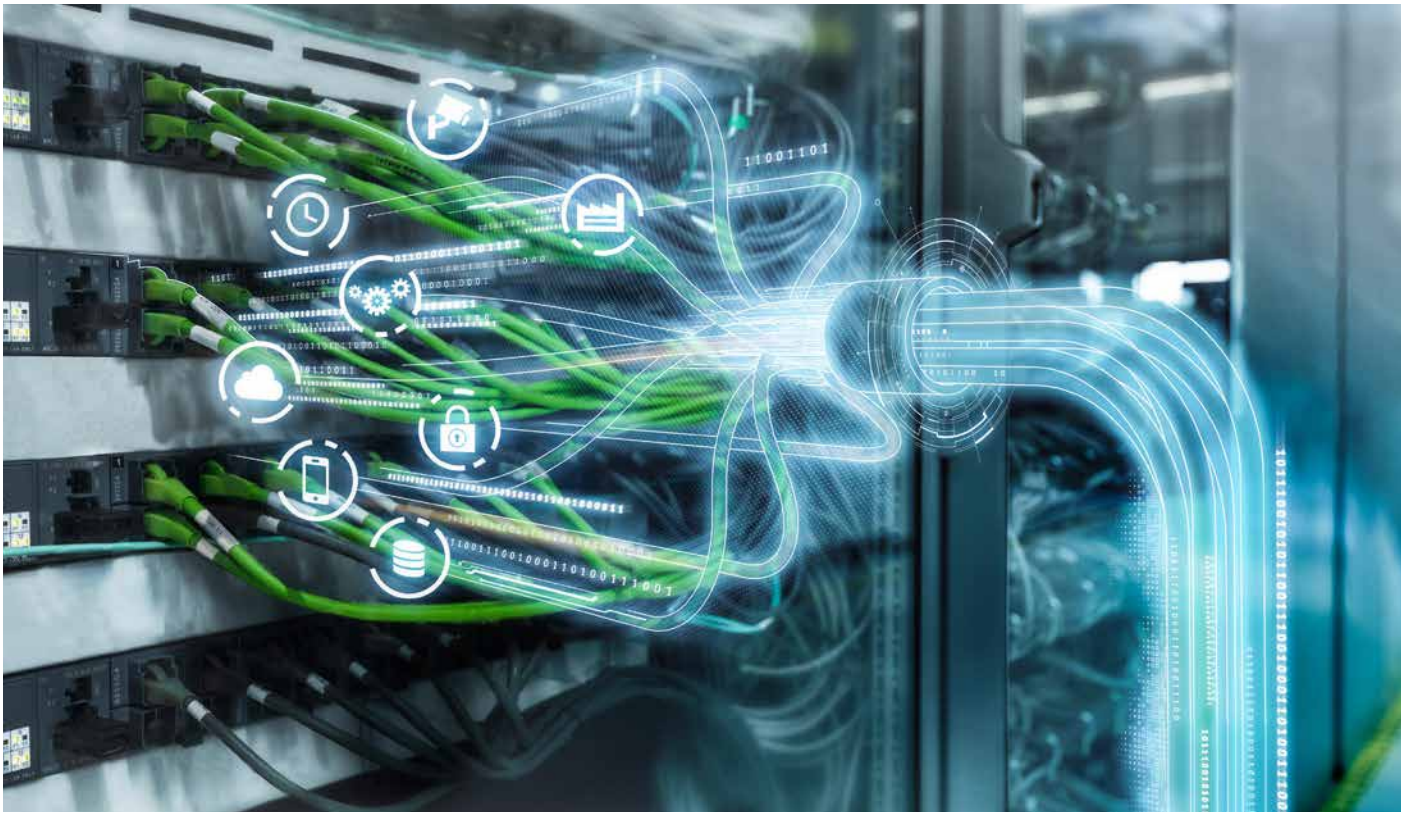
New Automation Technology **BECKHOFF**

TSN Technology Update: impact on factory automation

Time Sensitive Networking is changing the landscape of Industrial Ethernet protocols and network solutions with the possibility of new levels of convergence and interoperability. In this special report, industry experts weigh in on the benefits of TSN, what it offers and the expected timeline and impact on factory automation.



SOURCE: SIEMENS

A converged network architecture based on IEC/IEEE 60802 (TSN Industrial Automation profile) is a benefit that TSN will bring to industrial automation.

TSN TECHNOLOGY OFFERS TANTALIZING possibilities for the world of Industrial Ethernet automation and control networking. Never before have we seen enabling technology standards offer this kind of disruptive change, intermingled with the new requirements put into focus by the emergence of the IIoT and Industry 4.0.

The promise of Time Sensitive Networking (TSN) leveraging existing Industrial Ethernet network protocols, wireless TSN leveraging 5G communications, and technologies such as OPC UA TSN creates a preview of a new emerging landscape for industrial networks.

In this report, IEB offers comprehensive coverage and provides the perspective of industry leaders, along with a picture of how TSN is moving ahead in a quest that most agree will ultimately transform smart manufacturing. The broad range of perspectives demonstrates the potential of the technology, and illustrates how TSN will create new solutions for a wide range of applications.

Focus on converged networks

Expected emergence of IEC/IEEE 60802

The ability for TSN to help achieve a converged network architecture based on IEC/IEEE 60802 (TSN Industrial Automation profile) is a primary benefit that time-sensitive networking will bring to industrial automation applications. Along with that is delivering a plug & produce technology solution, as defined by Industrie 4.0, into the realm of smart manufacturing.

"The main innovation possible due to the availability of Time Sensitive Networks is the converged network," Günter Steindl, Enterprise Architect at Siemens Digital Industries told IEB. "Thus, many automation companies like Siemens, ABB, Mitsubishi, Rockwell and others are started together the standardization of a TSN industrial automation profile as a joint IEC/IEEE 60802 project."

Based on these definitions, devices with different middleware--such as PROFINET and OPC UA--can share in Time Sensitive Network quality of service guarantees. This converged network includes wireline and wireless, including Industrial 5G or Wi-Fi communication. Altogether, it represents the networking pillar "Vernetzung" from Industrie 4.0 and thus, fulfills the communication requirements of Plug & Produce.

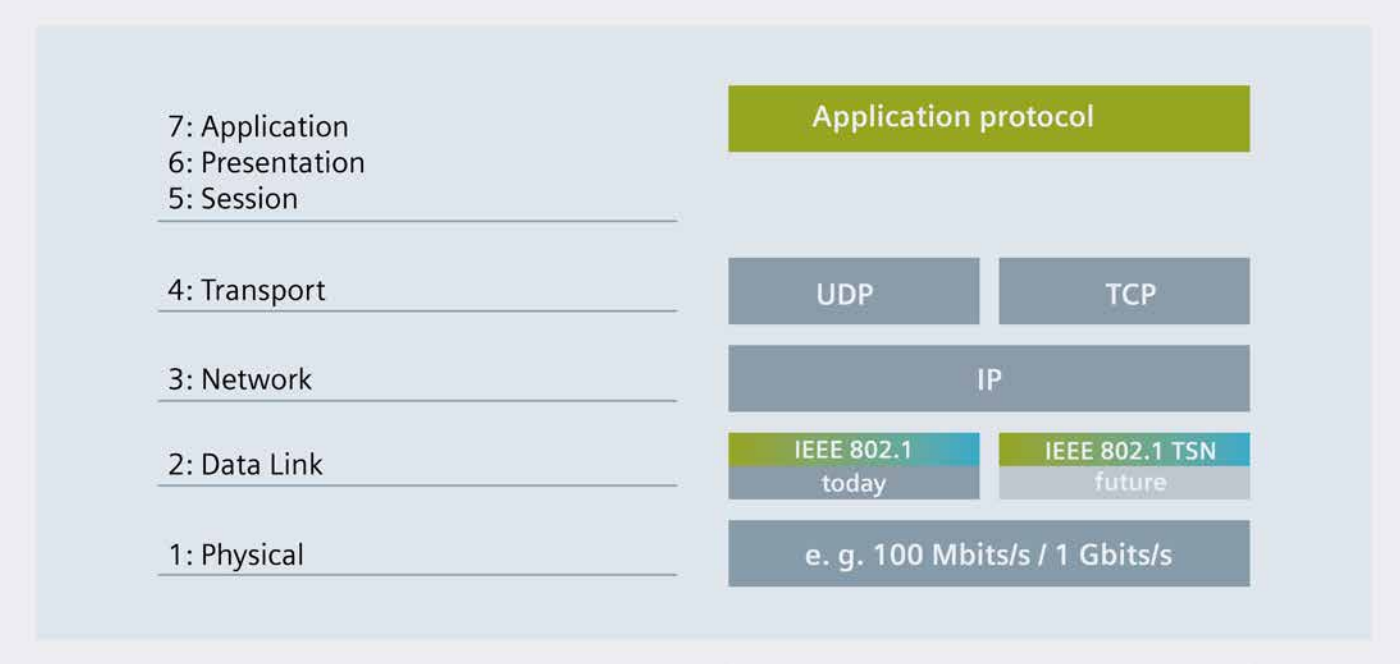
Structured network design

According to Steindl, structured network design defining TSN Domains as areas of the industrial network, for production machines, production cells or production lines allow separation of concerns.

These converged networks provide a series of benefits for industrial communication:

- Scalability: machine to production line
- Provide guaranteed quality of service
- Protection of network resources
- Excellent network and connection diagnosis
- Support for splitting of application and communication

SOURCE: SIEMENS



Time Sensitive Networking (TSN) in ISO-OSI model.

- Dynamic adaption – plug & produce
- Flexible network infrastructure – wireline and wireless with data rates from 10 Mbit/s to
- 10 Gbit/s; linear, star, ring, tree and hybrid topologies
- Scalable reliability from media redundancy to system redundancy
- Reliable and precise synchronization

Along with required quantities and flexible system architectures:

- Up to 1,000 devices
- Multiple PLCs

The IEC/IEEE 60802 (TSN Industrial Automation profile) selected features are used to solve the requirements for converged networks.

"Time-aware streams are the basis for zero congestion loss," Steindl said. "Bridges and end station Ethernet interfaces configured by the TSN Domain Management Entity together with TSN Domain boundaries protect non-real time traffic. Quality of service guarantees for time-aware streams are ensured by end stations supporting time-aware network access and strict priority and preemption (IEEE 802.1AS, IEEE802.1Q, MEF 10.3, IEEE802.3) in the bridges."

Middleware agnostic

He added that a main advantage of the TSN Industrial Automation profile is the possibility to create a converged network which is middleware (PROFINET, OPC UA, EtherNet/IP, CC-LINK) agnostic. The feature sets for Ethernet interfaces and bridges are defined, and silicon vendors can provide appropriate hardware.

"Almost all these new IEEE802 features are already available at PROFINET and thus, moving the 'machine room' of PROFINET to the TSN Industrial Automation profile is invisible for the PROFINET device developer. The customer of PROFINET over TSN devices will get the all the benefits of the converged network," he added.

Steindl said that since the development and integration of this technology cannot be implemented in one single step, so a continuous and agile investigation of the technology, proof of concepts, first pilots and then products are a reasonable approach to the development process.

"Various developments are in different steps. We expect a broad acceptance because of the beneficial technology and the great market awareness," he said.

The possible release of the TSN Industrial Automation profile is projected at the end of 2022, together with the specification of TSN over Industrial 5G, which will be a major push for this technology as well.

ODVA perspective on TSN

Impact on EtherNet/IP & CIP Motion

For users of EtherNet/IP and CIP Motion, the technology path to move forward with TSN is being shaped by the IEC/IEEE 60802 TSN Profile for industrial automation. This standard applied at the data link layer will allow for greater network coexistence at the application layer while maintaining network integrity.

Building on CIP Motion

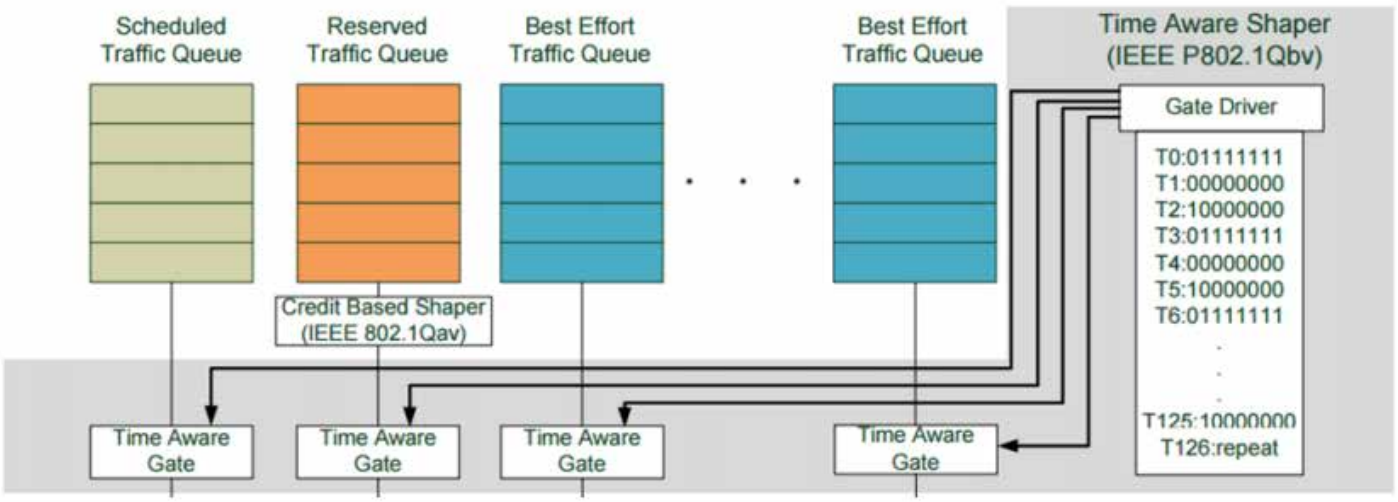
According to Dr. Al Beydoun, President and Executive Director of ODVA, the EtherNet/IP communication network will be a critical enabler of Time Sensitive Networking within industrial automation. The significant number of EtherNet/IP installations globally will provide a strong starting point that will allow for existing capital investments and training to be leveraged. EtherNet/IP, aided by continuous specification enhancements, is already well-positioned to meet the needs of time sensitive applications, flexibility in network design, and Industry 4.0/IIoT with implementation of proper network segmentation.

"EtherNet/IP is designed to both move I/O traffic deterministically and quickly via low overhead UDP while at the same time allowing for more complex messaging to higher network levels including ERP systems and the cloud with TCP," Beydoun told IEB. "EtherNet/IP will be uniquely positioned for the future with the addition of TSN, and will be able to both fully adhere to the mechanisms outlined in the IEC/IEEE 60802 TSN profile as well as the IEEE 1588 Precision Time Profile through CIP Sync and CIP Motion. CIP Sync is an existing network mechanism for applications where tight real-time synchronization is vital between distributed intelligent devices and systems."

CIP Motion is a current deterministic network solution for multi-axis, distributed motion control. 60802 based TSN will serve as an additional layer of control and interoperability that EtherNet/IP users can take advantage of to enable network convergence with other types of Ethernet traffic, such as coexistence with cameras for high-speed scanning or security, while having all applications respect the same Quality of Service considerations.

IEEE 60802 TSN Profile

Beydoun said that the IEC/IEEE 60802 TSN Profile for Industrial Automation joint project will create one overarching implementation of TSN standards at the data link layer that



IEEE802.1 Qbv Queuing Structure.

will allow for increased network coexistence across the application layer while meeting the Quality of Service requirements of each industrial application.

The idea is that this will enable different industrial communication network traffic, including EtherNet/IP, to all co-exist on one deterministic network and respect the same Quality of Service considerations, with the addition of common time and common prioritization. Data packets with common headers and standardized priority levels will make this possible.

"Once finalized, 60802 will enable prioritization of time critical data on industrial networks, including EtherNet/IP, based on specific rules and methodologies that will be applied by 60802 compliant network switches and embedded switches," Beydoun said. "Master time will need to be kept by specially designated TSN devices known as grandmaster clocks while other TSN devices will need to be capable of synchronizing with the master time clock. TSN uses 802.1AS-2020 which implements a peer-to-peer time delay mechanism, per the graphic below, and is a profile of the IEEE 1588 Precision Time Protocol. The CIP Sync protocol of today uses an end-to-end time delay mechanism and is the default profile in the IEEE 1588 Precision Time Protocol. Both CIP Sync and the 802.1AS time profiles are sufficiently precise, and can be converted to each-other via a dedicated device."

Peer-to-Peer and End-to-End Clock

60802 based TSN is an additional solution that an EtherNet/IP network can employ to drive up utilization while minimizing the consequences of network traffic exceeding bandwidth limitations, which can cause issues due to delayed or lost message packets.

60802 based TSN provides a further option for flexibility in EtherNet/IP network design that makes it possible for I/O devices demanding high determinism and video cameras that transmit large amounts of data to coexist on the same network, as an example. This is possible through prioritization of data that takes place within Ethernet bridges in different ways based on user commissioning. The IEEE 802.1Qbv Queuing Structure creates solutions for TSN prioritization using some of the following key prioritization mechanisms:

Shapers: Such as strict priority Quality of Service and the credit-based shaper. These algorithms give precedence to high priority traffic and ensure fairness on the wire. While these mechanisms are not new, the shared language to configure them is.

Preemption: Pauses an existing packet transmission to allow higher priority data through.

Scheduled Traffic: The ability to control transmission of traffic based on enabling and disabling switch queues on a configured time-based schedule.

IEEE 802.1Qbv Queuing Structure

According to Beydoun, industrial networks are now facing the impending addition of large amounts of data from the factory floor to edge devices and/or the cloud and back regularly for system analysis and prognostic purposes due to Industry 4.0 and IIoT.

The 60802 profile of TSN standards for sending time critical data via industrial Ethernet, along with existing EtherNet/IP network extensions, are a pragmatic way to meet the needs of high determinism applications, to add network design options, and to plan for the significant future increases in data traffic brought about by IT and OT convergence.

"EtherNet/IP will continue to meet critical industrial communication and control needs into the future, including coexistence with other protocols and a performance guarantee for highly-engineered applications with TSN," Beydoun said.

ODVA's members are currently contributing to the IEC/IEEE 60802 TSN Profile for Industrial Automation joint project that is selecting the TSN mechanisms that will be used and determining how they will be used. This work will likely be completed in late 2022 to 2023.

ODVA anticipates that the changes necessary for the EtherNet/IP specification will be minor and backwards compatible because EtherNet/IP was designed using the standard Ethernet data-link layer and the standard IETF defined IP/TCP/UDP layers above it. ODVA's publication of EtherNet/IP enhancements to incorporate TSN will be coordinated with the publication of the 60802 TSN Profile to ensure a stable standard.

TSN-compatible protocols

Industrial Ethernet protocol compatibility

According to ChihHong Lin, Global Technology Partner Manager at Moxa Inc., industrial networking and control suppliers have responded to TSN with the development of compatible industrial Ethernet protocols.

"Since the dawn of TSN technology, major industrial Ethernet protocol organizations have begun actively formulating standards and developing TSN-compatible industrial Ethernet protocols," Lin said. "Take these organizations for instance: the CC-Link Partner Association (CLPA), the PROFIBUS & PROFINET International (PI) organization, the OPC UA FLC initiative launched by the OPC Foundation, and EtherNet/IP--an industrial Ethernet protocol developed by ODVA. This allows users of different industrial Ethernet protocol ecosystems to take full advantage of the latest TSN technology."

In 2018, the CLPA completed and issued the "CC-Link IE TSN" specification based on the TSN standard. A subsequent CLPA white paper described several application cases such as an automotive paint shop and semiconductor processing tools, illustrating the practical advantages of a unified network using the CC-Link IE TSN protocol.

As of September 2020, the CLPA has more

Q&A on TSN technology: EtherCAT Technology Group

The emergence and development of time-sensitive networking standards has left each industry trade group to formulate a path which makes sense for their technology. The EtherCAT Technology Group offers its perspectives on the possibilities with TSN, and the expected impact on EtherCAT solutions.

MARTIN ROSTAN, EXECUTIVE DIRECTOR OF the EtherCAT Technology Group, provides perspectives on the development and roll-out of TSN technologies and its impact on EtherCAT solutions.

What technology do you see as enabling development of Time Sensitive Networking application solutions in 2021 and beyond?

M. Rostan: TSN technologies will certainly find their use cases - however not yet in 2021 and not to the extent that was expected 2-3 years ago. I still hope that it will be possible to agree on a reasonable TSN feature set for factory networks so that real-time communication between controllers becomes affordable and manageable. It is at this level that I see the meaningful use of TSN in our industry, and here EtherCAT will make use of TSN technologies: but without changing EtherCAT itself.

Other Industrial Ethernet systems, on the contrast, have fallen to the temptation of a completely new version of their bus systems based on TSN. They are now starting again from zero, or rather from minus 5, since TSN is not yet as complete and available as they had hoped. TSN technologies will probably also find their way into the 5G infrastructure, and some other special applications.

However, I do not believe that TSN will become a general IT commodity, i.e. that it will find its way into every switch. This means that the expectation of low-cost IT chip sets for TSN solutions in automation will not be fulfilled.

Please provide readers a general description to understand how this technology works.

M. Rostan: It is important to understand that there is no such thing as “the TSN technology”. TSN consists of many projects and thus technologies -- some of which are fully specified, some of which are under development, and some of which have just been launched. Each consortium assembles its own special TSN recipe from this technology portfolio. Almost all recipes use a time-slice process to tunnel so-called ‘streams’ through the network, sorted by priority. But everyone does it a little differently.

The prerequisite for time slices is a uniform time base, i.e. exact synchronization of the nodes. The TSN Task Group has recently published specifications for this, which are currently being tested. The configuration of TSN features remains a challenge; here I do not see convergence towards a uniform, manufacturer-independent solution. So, each consortium will go its own way here as well.

What are specific technical benefits that this technology provides that will enable adoption of TSN, versus what is possible with typical applications today?

M. Rostan: Here, too, a distinction must be made. Above the controller or between controllers, TSN technologies will enable real-time communication where "best effort" has prevailed up to now - provided that a reasonable subset of TSN features can be agreed upon, which will still be difficult.

Below the controller, i.e. in the fieldbus area, those whose previous real-time solution was not successful are hoping for improved real-time characteristics at lower cost. To do this, they are prepared to develop a completely new generation of their bus technology, which requires new hardware, new software, new tools, new configuration, and a lot of IT know-how.

The argument is continuity - but it is completely impractical to rely on a shared network above and below the controller instead of structured networks. This is now also reflected in the first TSN-at-Fieldbus-level-specifications, which therefore provide for separate TSN domains - and thus the separation that is required and is given with EtherCAT anyway.

SOURCE: ETG

TSN technologies below the controller therefore lead to a technology break that is not matched by an appropriate advantage. EtherCAT will benefit from not doing this.

What is the expected impact that TSN technology will have on smart manufacturing, and the general timeline for these innovations?

M. Rostan: The impact is rather limited: Some processes can be improved by better real-time properties between controllers, whereas the real-time properties below the controller have always been excellent, at least with EtherCAT. Access to data from above to the field level is already possible today without any problems, as far as desired and allowed. For security reasons, the often-cited process data access ‘from the sensor to the cloud’ is only allowed in exceptional cases anyway.

Even though it should be possible to implement TSN island solutions based on FPGAs today, it will be years before TSN-based approaches are truly mature. The results of the IEC/IEEE Joint Working Group, which aims at co-existence (not interoperability!) of TSN approaches in automation, are not expected before 2024.

Martin Rostan, Executive Director, ***EtherCAT Technology Group.***

than 300 corporate members, with several manufacturers having released products compatible with the CC-Link IE TSN standard. Moxa has a lineup of Layer 2 Ethernet switches that are compatible with the Class A and Class B CC-Link IE TSN Standard.

Deterministic performance

Lin said that TSN is a collection of standards that enables deterministic messaging over standard Ethernet networks. As defined by the Institute of Electrical and Electronics Engineers (IEEE), TSN involves a form of network traffic management to ensure non-negotiable time frames for end-to-end transmission latencies.

Consequently, all TSN devices must synchronize their clocks with each other and use a common time reference to support real-time communications for industrial control applications. In general, TSN technology can be introduced as four parts:

Time Synchronization: As the name suggests, time-sensitive networking focuses on establishing a common time reference between all devices within a unified and interoperable infrastructure, which forms the foundation of its entire operations.

Bounded Low Latency: By adopting the concept of non-negotiable time period allocation for end-to-end transmissions, these components ensure deterministic data transmission over the network.

Ultra-reliability: To implement and maintain all aspects of a deterministic networking environment, a set of components has been defined to ensure optimal reliability and security.

Resource Management: When the network and applications become more converged and larger in scale, additional tools are required to provide better manageability and visibility.

One unified network

"One of the major benefits of TSN is that it can turn a complex network infrastructure into one unified network," Lin said. "For the time being, your organization may be satisfied with production output. However, in the long term, you will find it difficult to keep up with your competitors as they embrace TSN technologies. On the one hand, you can still expand your production based on the existing infrastructure, but the expansion will be stretched to the limit when you find, for instance, the conveyor belt is communicating with the HMI by PROFINET. On the other hand, the motion control that requires hard real-time is using EtherCAT, and the robotic arm control is using another protocol, for example, Mitsubishi CC-Link IE."

He added that, even though it is comparatively easy to make use of add-on blocks as you deem necessary, managing all of these devices from different vendors who utilize different industrial Ethernet technologies is very difficult. When each cell is isolated, there are many obstacles to just integrating the data, not to mention if you want to fine tune the processes and improve production efficiency.

In the long term, the result will see you moving in the opposite direction of realizing Industry 4.0 and IIoT applications. More importantly, TSN technology also allows for a plug-and-produce solution when extra applications such as machine vision and motion cameras are added onto one unified network.

Impact of TSN technology

"The automation industry has long been looking forward to the possibility of a unified network that can address the challenges many factories face today. This is where time-sensitive networking (TSN) technology comes into play," Lin said. "Based on standard Ethernet, TSN can achieve network-wide time synchronization, lower latency, higher reliability, and optimized management along with support for industrial Ethernet protocols."

With these enhancements, TSN effectively solves the complications of IT and OT convergence, breaking through the islands of automation to realize the future imagined by smart manufacturing. One unified network includes the following benefits:

- A single industry standard used for communication.
- Minimal training effort to understand different vendor's protocols
- Reduced cabling and maintenance costs

Therefore, the plug-and-produce solution can actually be achieved.

"Regarding the timeline, we have seen the completeness of the TSN ecosystem from PLCs, IO, drives, servo, Ethernet switches, IPC, to software-based controllers," Lin concluded.

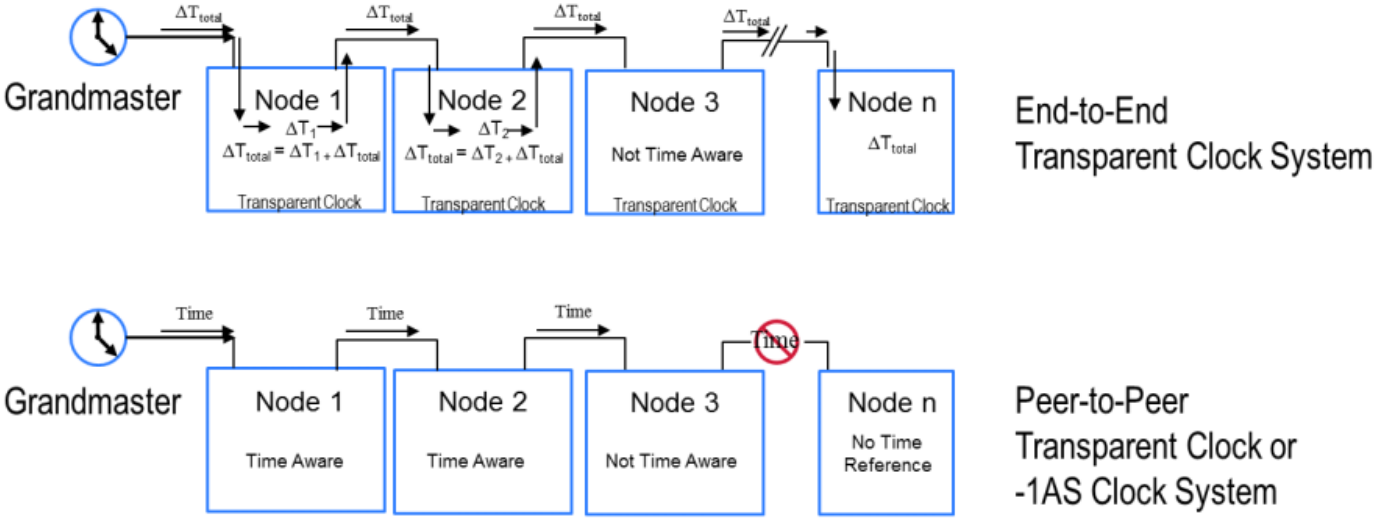
"Throughout 2020, the industry players who have started to utilize TSN technologies have demonstrated to the world that TSN is not just an embryonic idea, but a concrete technology through multiple virtual demonstrations. In 2021, we foresee that there will be pioneering TSN cases landing in smart manufacturing."

Data link layer innovations

CC-Link IE TSN leverages enabling technologies

As TSN emerges as an enabling technology that will help fulfill the vision of a converged network, time-sensitive networking standards are primarily focused on updates to the Data Link Layer of the Open Systems Interconnection (OSI) model.

"It's important to note what TSN can and cannot do. It is a modification of the standards related to the Data Link Layer (Layer 2) of the OSI hierarchy. It is primarily concerned with getting '1's and '0's from one place to another in a predictable, deterministic manner," said John Browett, General Manager at CLPA Europe. "For this reason, it does not address higher level application functions, such as safety or motion control. We believe that the best TSN implementations will combine its



SOURCE ODVA

System diagrams showing end-to-end transparent clock versus peer-to-peer.

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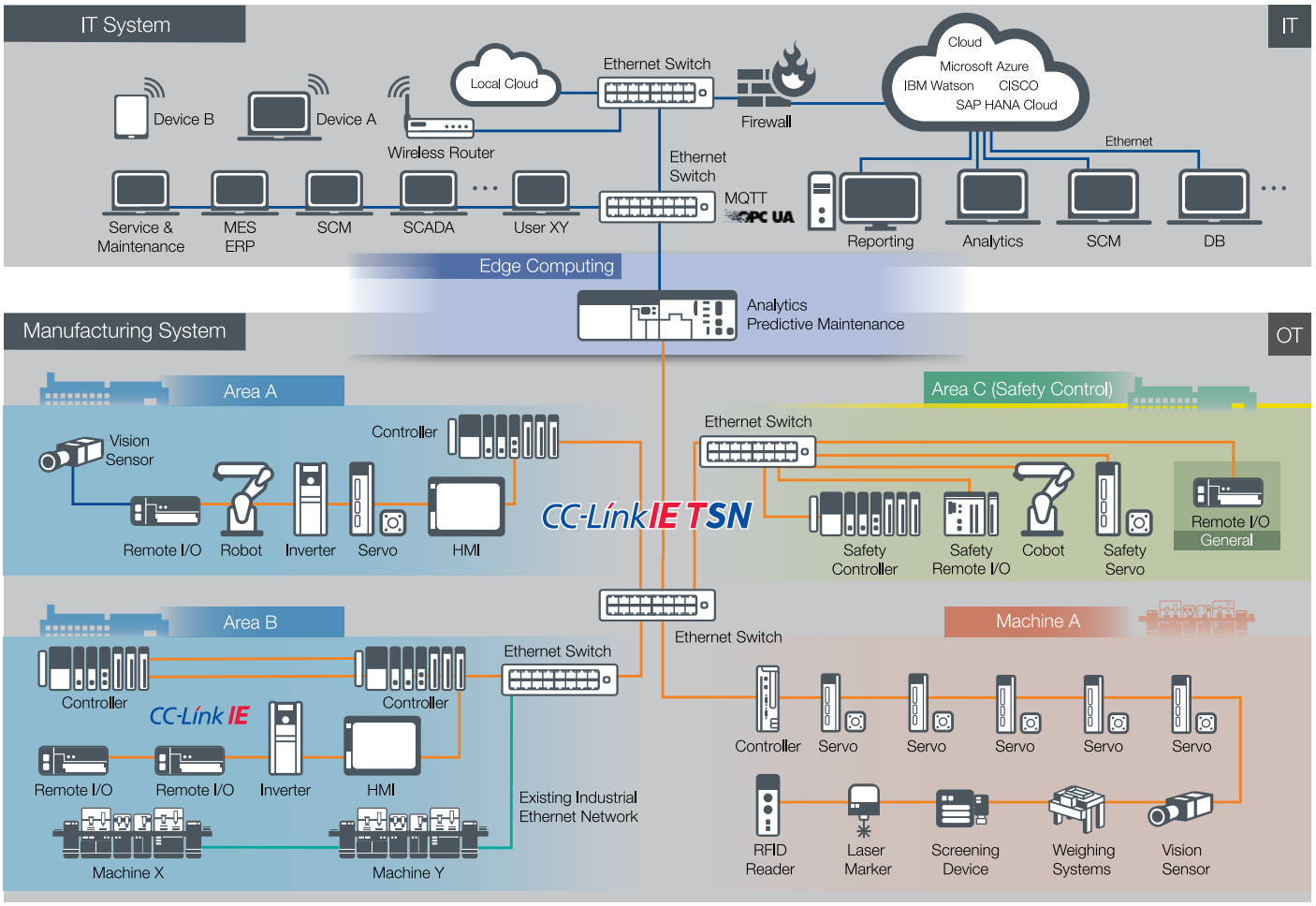

SOURCE: CLPA

A converged network architecture using CC-Link IE TSN provides an approach to unify manufacturing and enterprise data.

deterministic capabilities with higher level protocols that will provide these additional application functions."

Browett said that CC-Link IE TSN is an example of how a familiar, existing industrial Ethernet protocol can be extended to be TSN-compatible and therefore address these needs.

"It provides a way to handle current demands while providing a path to address future requirements. This is being supported by key members of the CLPA such as Mitsubishi Electric who have already introduced a varied line-up of products that offer TSN capabilities," Browett added. "These will enable capabilities like high performance motion control to be combined with other application needs such as safety to provide a flat hierarchy that addresses today's needs with the route to the future that TSN offers."

CC-Link IE TSN

The key for CC-Link IE TSN is its ability to extend the existing technology of CC-Link IE and, as its name suggests, combines it with TSN compatibility. CLPA also says that CC-Link IE TSN solution is currently the only open industrial Ethernet that combines TSN with gigabit Ethernet.

TSN technology advances are based on two core IEEE standards, 802.1AS and 801.1Qbv, which provide a way for Ethernet traffic to travel in a deterministic manner. 802.1AS synchronizes all network devices, preventing drifting that leads to delays and variation in transmission (latency and jitter), enabling deterministic data transfer. 802.1AS Qbv defines queues of different traffic types and controls their access to the network. This permits prioritization of what traffic can travel when, further supporting determinism.

"Gigabit bandwidth increases the overall network traffic capacity. Once thought to be 'overkill' in industrial automation, there is now a clear trend in this direction. It is being driven by Industry 4.0, which is causing a clear increase in the amount of process data," Browett added.

"The idea is to provide better transparency and hence improved process management. For this to happen, the data needs to be processed in a timely manner in order for actionable insights to be generated. This is why network bandwidth is also becoming a key concern."

TSN technology benefits

Compared with typical applications today, the adoption of TSN will bring forward specific technical benefits that will have a lasting impact on industrial automation.

"The key benefit is converged networks. Today, some industrial Ethernet protocols allow multiple types of application data (often I/O, motion and safety) to share a network. However, usually it is not easy or even possible to have this traffic run alongside other types, for example machine vision video frames, barcode scanner data, print outs, etc. on the same network," Browett said.

Usually, separate networks are necessary to handle different tasks. This increases cost, complexity, engineering time and maintenance.

TSN allows virtually any kind of Ethernet traffic to share a network. Hence one network should be able to address all application needs. The promise is that this approach will deliver cost savings and performance benefits by removing multiple networks running parallel functions.

By running all traffic together, increased process transparency is also enabled. If the data all flows together, collecting and processing data from multiple different places and systems can be avoided and it becomes easier to understand what the process is doing and therefore manage it better. It will also potentially avoid "islands" of data where incompatible systems cannot talk to each other, as TSN offers the chance for different

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industrial Ethernet protocols to also run on the same network and further increase transparency.

Looking ahead

The benefits of TSN will come from network convergence, and its ability to deliver the process transparency demanded by Industry 4.0.

The expectation is that it will also become easier to get data to edge servers and the cloud for processing and insight. Smart manufacturing takes the manufacturing data, and processes it in various ways to produce actionable information. TSN will enable this by getting the data where it needs to be in easier, timelier ways.

"TSN is already here. We introduced CC-Link IE TSN in 2018, and since that time our partners such as Mitsubishi Electric introduced various compatible products. We are also seeing various plans to support TSN by other players. It's not a question of if, but when," Browett said.

He added that TSN is probably in a similar stage to where Industry 4.0 was about five years ago.

"Everyone understood the benefits and early implementations were underway. Possibly two to three years from now, TSN will be as commonplace as general industrial Ethernet is today, which may begin to be viewed with the same legacy status as fieldbuses. Hence for companies looking for a competitive edge, there is a narrow window of opportunity to start implementing TSN before it becomes commonplace and the chance to get ahead is lost!"

Next generation architectures

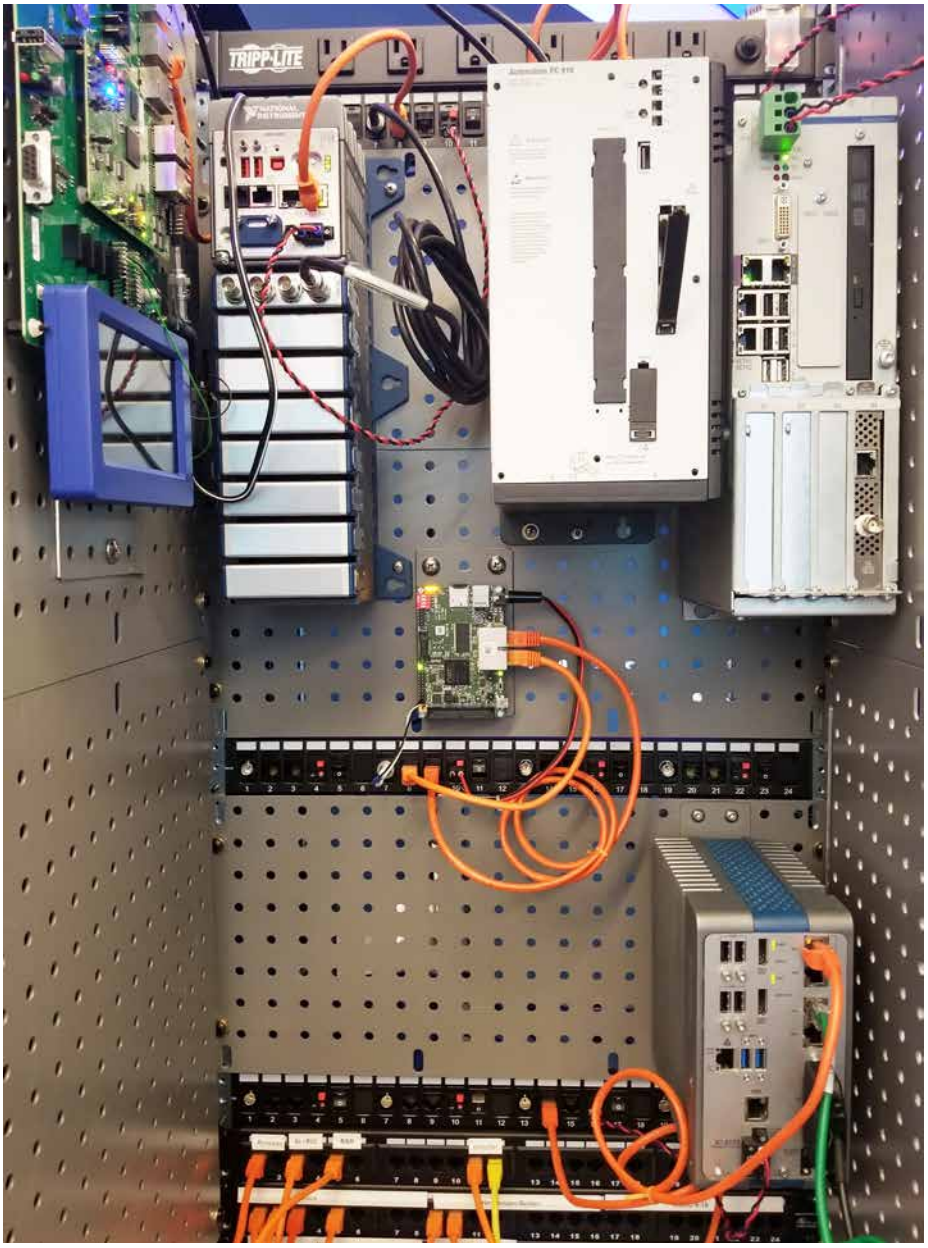
Traffic co-exists on a single Ethernet network

According to Bastian Otto, Product Management at Hilscher Gesellschaft für Systemautomation mbH, TSN is not a product or a protocol, but a series of standard Ethernet extensions, defined by the IEEE, in support of next-generation automation architectures.

It is based on the concept of common time domains within which a variety of automation components from different vendors (in theory anything from simple sensors up to multiple PLC combinations) can co-operate in time sensitive environments.

The concept will allow many different types of data traffic to co-exist on a single Ethernet network, and enable clusters of control and monitoring components to work together to create smarter manufacturing units. This demands sophisticated time synchronization AND prioritisation mechanisms.

"The emerging TSN solution is based on a toolset of multiple OSI Layer 2 standards that describe how existing Real-time Ethernet protocols can be extended to meet the required behaviours," Otto said. "They cover only the data transport layer but they can meet a very wide spectrum of use cases. No installation will deploy all the standards at once, so "use cases" will determine the roll out. The introduction of TSN will therefore depend on 'profiles' - collections of features taken from some or all the standards to meet a particular need. The first of these, a real-time "machine-to-machine" profile, is currently being finalized. A 'controller-to-device' profile is expected thereafter."



SOURCE: HILSCHER

This IIC Testbed Demonstrator in Austin, Texas, shows multi-vendor products that were "plug-and-play" tested for interoperability of TSN synchronization. At center is a Hilscher netX chip-based board.

How TSN is transformational

Otto said that the ability to support multi-PLC configurations carrying status, configuration, control, video, audio, and motion control data over the same media is the starting point.

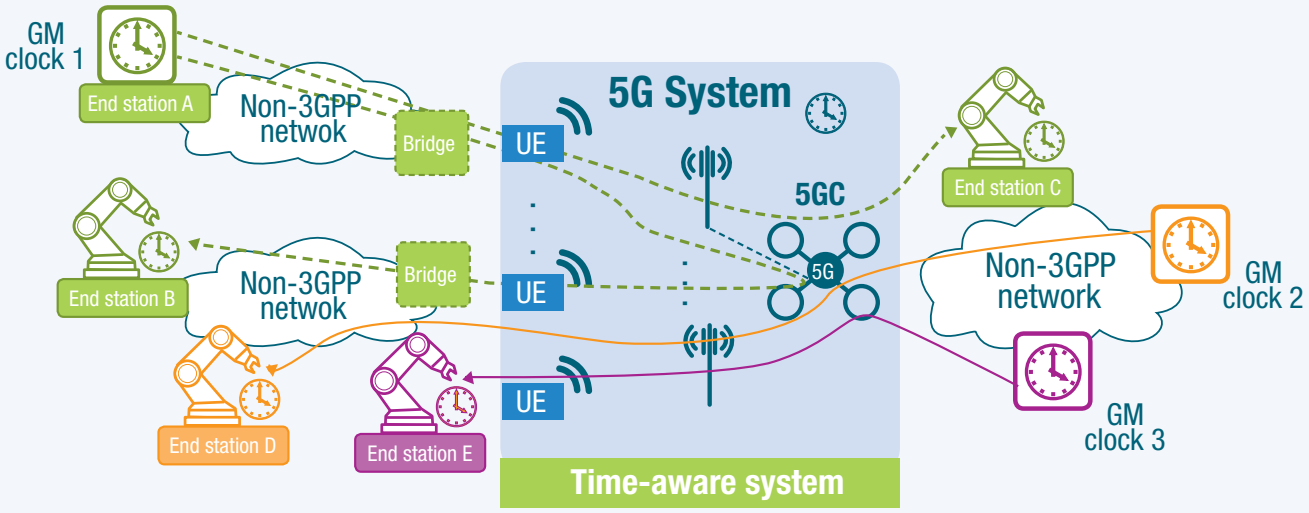
Gigabit Ethernet will make far more data available than is possible today and, with higher speed and more reserved bandwidth, will allow the transmission of more real-time protocols over the same wire. This will lead to new production control, asset management and preventive maintenance regimes being introduced, particularly when edge and cloud computing concepts are included. TSN will only allow raw data to be exchanged.

Therefore, higher level application layer differences will remain. However, multiple PLC structures will be able to co-exist within a TSN domain and inter-communicate successfully when the same protocol is supported.

"TSN will lead to new control regimes being developed, particularly in the context of flexible manufacturing. Real-time machine-to-machine communications will be possible and having a combination of PLCs in one TSN

5G combined with TSN for industrial communications

One prevailing view is that integration of 5G and TSN will increasingly become more important to industrial automation in the future. The thinking is that TSN, as enabling technology of Industry 4.0 together with 5G URLLC, can be combined to provide deterministic connectivity end-to-end.



SOURCE: 5G ACIA

5G support for multiple time synchronization domains and uplink synchronization via the network.

THE INTEGRATION OF 5G AND TSN COULD BE an important future step to make smart factories more fully connected, and able to meet all key requirements for more effective industrial communication technology.

Industrial automation is already in the midst of digital transformation, and a process of interconnecting multiple machines, devices, the cloud and people with a goal of making information accessible from anywhere within a factory.

5G has the potential to provide a highly effective wireless solution that could be used in combination with TSN especially in time-sensitive applications that require deterministic, reliable and low-latency communications.

5G ACIA

With a goal to make 5G a success for industrial applications, the trade group 5G-ACIA (ww.5g-acia.org) is bringing together organizations from the OT and OT worlds.

According to the "Integration of 5G with Time-Sensitive Networking for Industrial Communications" white paper published by 5G ACIA, 5G has been standardized with all the necessary support to seamlessly integrate with industrial TSN networks. But they also acknowledge that the future evolution of TSN will have to be matched by 5G enhancements in coming releases.

The executive summary of the paper states that "fifth-generation wireless communications (5G) and time-sensitive networking (TSN) technologies are key to future industrial communications: 5G for wireless connectivity and TSN for wired connectivity."

"Both technologies have been designed to provide converged communication for a wide range of services on a common network infrastructure, including for time-sensitive applications that require deterministic, reliable and low-latency communications. Significant benefits can be achieved for corresponding industrial use cases by introducing TSN and 5G wireless communication, e.g., increased flexibility in the deployment of industrial equipment and the network."

The 5G-ACIA white paper describes the main TSN features including TSN traffic scheduling (IEEE 802.1Qbv), per-stream filtering and policing (IEEE 802.1Qci), time synchronization (IEEE 802.1AS), frame replication and elimination for reliability (IEEE 802.1CB), and TSN network configuration (IEEE 802.1Qcc).

It also addresses the work-in-progress in IEC/IEEE 60802 on defining a TSN profile for industrial automation along with typical use cases for TSN in industrial automation, different traffic types and the corresponding communication requirements.

View white paper

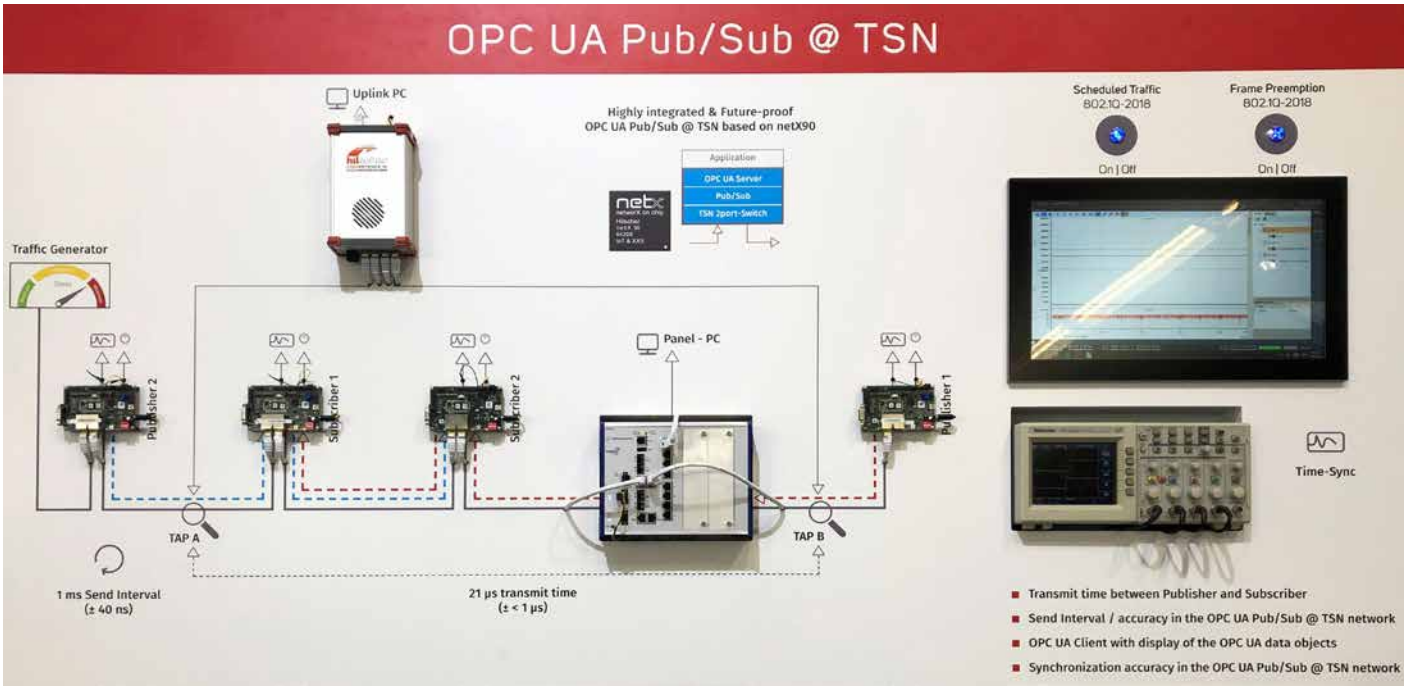
Avnu Alliance

The Avnu Alliance (www.avnu.org) has also published a white paper "Wireless TSN –Definitions, Use Cases & Standards Roadmap" that provides insights into the potential of 5G and TSN working together.

It concludes that "recent advances in 5G and IEEE 802.11 wireless connectivity technologies in providing low latency and high reliability have generated significant interest in extending TSN capabilities over wireless. Wireless communication systems are beneficial for many obvious reasons, including enabling flexibility and reducing wiring costs as well as enabling mobility."

Because of the complexity of wireless communications, enabling TSN capabilities that are interoperable and compatible with existing wired TSN standards will be challenging but the potential benefits could make a major impact in industrial automation.

View white paper



SOURCE: HILSCHER

At the most recent SPS Fair in Nuremberg (pre-pandemic), Hilscher demonstrated its netX 90 slave communications chip running OPC UA Pub/Sub data transmission over TSN.

domain will lead to 'virtual PLCs.' The current hierarchical 'pyramid' structure will disappear and be replaced by a pillar-like architecture in which remote control of actuators and sensors becomes possible. The goal of truly flexible manufacturing down to one-offs comes into view, and a merging of the traditional 'pyramid' layers, such as ERP and MES, is certain to occur," he added.

Replacing Ethernet protocols

At the start of the TSN standardization process, many expectations were raised, including the possibility that TSN would replace existing Industrial Ethernet standards. Niels Trapp, Vice President Business Development, Hilscher Gesellschaft für Systemautomation mbH told IEB that this will not happen based on the explanations above.

Some of the TSN sub-standards are still under development and there will be updates arising from experience in the field," Trapp stated. "Driven by the industrial automation industry, the deployment of TSN will lead the adoption of new control concepts. The machine-to-machine profile will have an early impact, especially in greenfield applications. I can also see brownfield applications being possible. As industries move towards greater TSN usage, controller-to-controller networking will be deployed. In other words, the adoption of TSN will be an evolutionary process that will lead to controller architectures being fundamentally altered."

He added that the problem presented by raw data only being available via TSN networks will lead to new meta-data mechanisms being developed, and OPC UA (in its pub/sub incarnation) is one way the semantic challenges can be met.

5G will also play a role: release 16 of the 5G standard will improve latency so that TSN routing over wireless systems should eventually be realized. However, we should understand that it will be challenging to merge OPC UA into field devices.

Challenges to TSN adoption

According to Trapp, Hilscher expects TSN will become a standard in controller interfacing based on Gigabit Ethernet to allow clustering of control units. This will enable highly distributed systems operating transparently from the field right up to the cloud. But he adds that we must be realistic about the huge challenges involved.

"Wider roll-out of TSN may begin in 2022, but I believe that TSN will not see widespread uptake for some while. Several issues will need to be resolved, including: the actual speed of standardization, security at the field level, and trends encompassing the use of data pre-processing within field devices themselves."

He said that real-time Ethernet protocols such as PROFINET and EtherNet/IP, both comparable disrupting technologies, took many years to become widely used. But the disruption that TSN will bring has already started and engineers everywhere should "get involved" now.

There are many opportunities for learning, and RTE organizations have all announced TSN support. Many companies have launched TSN "compatible" products. Hilscher has been demonstrating TSN systems at trade fairs for more than three years based on its own netX chips, which are software-configurable and therefore easily adapted to any changes in the TSN specifications.

OPC UA over TSN

Open standard emphasizes interoperability

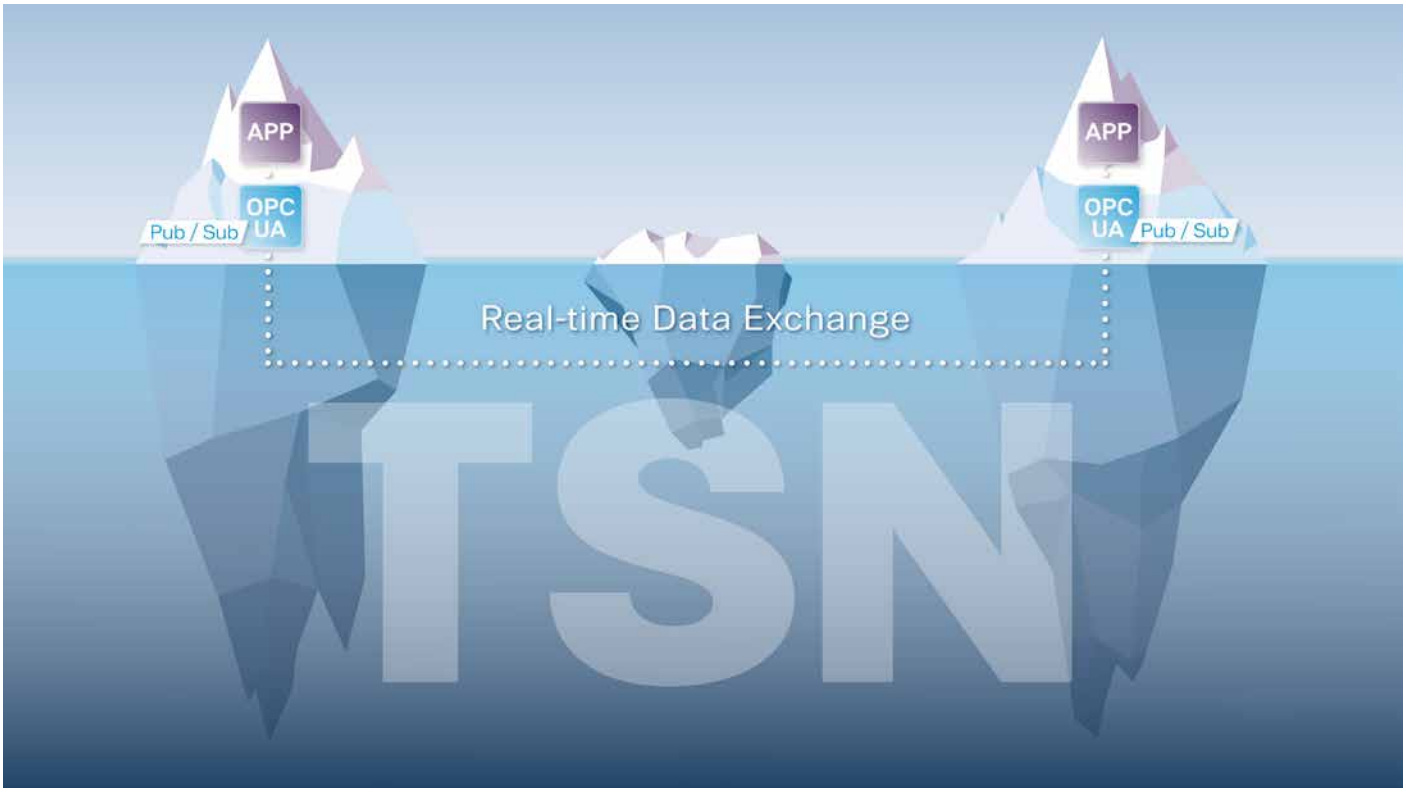
The promise of Time-Sensitive Networking and OPC UA over TSN specifically, is focused on two areas: an increased use of open standards that ultimately leads to a new level of interoperability on industrial networks.

"For TTTech Industrial, openness and interoperability are the key components of IIoT. In our solutions, we use TSN and OPC UA in combination, because both are standardized by international organizations and thus vendor-independent," Wolfgang Leindecker, Member of the Executive Board at TTTech Industrial, told IEB.

"This is a decisive factor as no two customers are the same and therefore have very specific requirements for implementation of IIoT on their shop floor."

Leindecker said that, with OPC UA over TSN, users have a range of products to choose from and they can combine them to best fit with their individual situation. Open interfaces allow guaranteed communication and message delivery between devices from different vendors and also extend to device configuration and network planning interaction.

Thanks to this, customers can reduce initial commissioning effort and they have more flexibility in system extension and reconfiguration.



SOURCE: TTTECH INDUSTRIAL

OPC UA over TSN offers guaranteed and interoperable communication for industrial automation. TTTech Industrial's Slate product line includes TSN switched endpoint IP and software, along with advanced network planning tools.

Two sets of standards

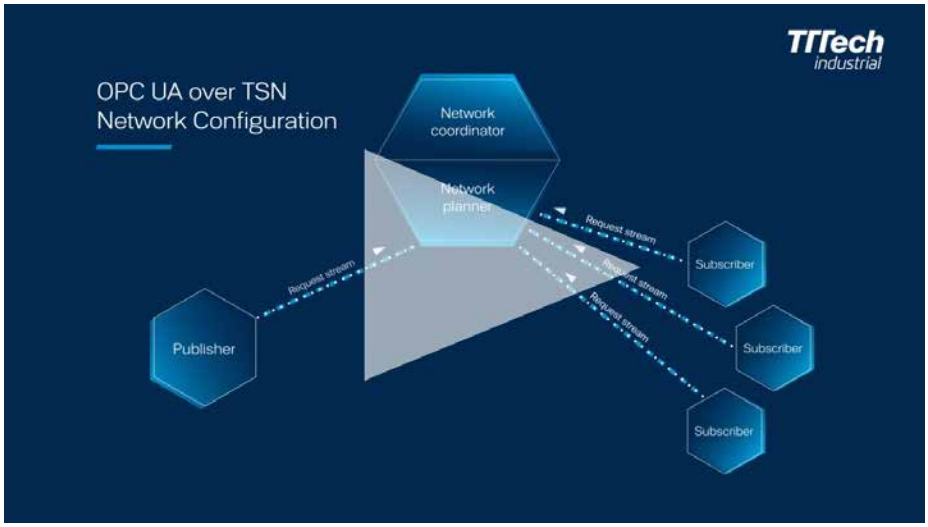
OPC UA over TSN makes use of two sets of standards. TSN, which is a group of mechanisms that enable precise timing and guaranteed delivery of messages and OPC UA, which is a widely used protocol allowing data to be modeled and exchanged in a standard format.

"When OPC UA devices publish data over TSN networks it can be received by OPC UA subscribers in the network. TSN devices in the network forward messages according to a plan, ensuring that published OPC UA data is received in a predictable way and with low latency," Leindecker added. "TTTech Industrial also uses OPC UA as a means of gathering device requirements in order to build products that offer automated and dynamic configuration of TSN networks. "

IT-OT convergence

According to Leindecker, OPC UA over TSN brings the flexibility and interoperability from IT into the OT world. One of the main benefits is a standardized information model that enriches raw data with semantic descriptions, offering immediate context to data without the need for interpretation. This contrasts with today's proprietary fieldbuses, which primarily deliver raw data that is unreadable by devices from different vendors.

Along with TSN, this provides a fully interoperable method of sharing data between any industrial devices. Inherent to OPC UA are also a range of sophisticated IT security mechanisms that go beyond the level of security that OT networks can offer today. Implementing IT grade security methods such as user authentication and authorization, encryption and certificate handling to OT networks will further accelerate the convergence of IT and OT systems. That convergence will improve data access by providing connectivity from sensor to cloud without the need for gateways.



SOURCE: TTTECH INDUSTRIAL

TTTech Industrial's OPC UA over TSN platform Slate. Click to view YouTube video.

Emergence of TSN technology

When asked about the expected impact that TSN will have on smart manufacturing, and the general timeline for these innovations, Leindecker sees a long-term emergence of the technology.

"It is difficult to give a precise timeline. Chip makers and industrial automation vendors are already releasing TSN products so now is the time for integration projects to pioneer TSN networked production lines and factories," Leindecker said. "In the next years, we will see fully smart factories that use TSN as a backbone network connecting cells, machines and devices from various industrial automation vendors in a way that would previously have been unthinkable. These end users will reap the benefits of greater efficiency and costs savings provided by TSN."

SOURCE: ROCKWELL

TSN has the potential to converge technologies onto a single network, and help users overcome a key challenge associated with today's industrial network architectures.

TSN and 5G

Potential focus on new applications

According to Paul Brooks, technology manager - business development at Rockwell Automation, he believes it makes sense for customers to start with a focus on potentially implementing TSN in applications that can't be solved today using available technology—and where users have real need.

One obvious application area would be coordinating motion control across a wireless link to leverage the capabilities of TSN and 5G.

"If the combination of TSN and 5G actually helps organizations, then this will drive adoption," Brooks told IEB recently. "Whether or not TSN and 5G proves to be a practicable solution, however, remains to be seen.

"Today, users have to segment different industrial automation protocols like EtherNet/IP and Sercos onto separate network segments. So, if TSN makes it easier to converge these technologies onto a single network, it would help users overcome a key challenge associated with today's industrial network architectures," he added.

Brooks added that OPC UA FX (Field Exchange) is what he views as the most likely technology to drive this convergence, as all ecosystems are supporting its development. And if TSN simplifies users' deployments of UA FX technologies, then TSN becomes an easy decision.

"But it's far too early, with respect to standards development, to talk with any certainty about TSN. Without an agreed and published common profile of TSN for Industrial Automation (IEEE/IEC 60802), none of the capabilities mentioned above can be realized," he said.

Network management tools

One interesting technology area is how TSN provides network management to ensure that the most time-critical packets get delivered within a guaranteed transmission window. To do this, all the TSN devices and infrastructure agree in advance about when to transmit these packets. This makes certain that there are no obstacles (lower-priority packets) in the way before transmission.

Brooks said that key technologies that make these TSN capabilities possible include a common time reference, shared by devices and switches, and packet (stream) scheduling which reveals when critical packets will be on the wire, along with cut-through to speed packets through the network.

Preemption features also keep big packets from getting in the way of time-critical packets. And topology discovery creates an ability to plan the path that packets will take through the network. A fundamental challenge, however, is that TSN is really "these technologies" rather than "this technology." The result is that many different stakeholders (and many different systems in the field) will have to implement TSN in different ways.

"At this moment early in 2021, we simply don't know which of the component technologies will ultimately be carried forward to IEEE/IEC 60802," Brooks added, "nd which will be used by communications protocols like OPC UA FX. So, for now, making any meaningful plans for TSN is all but impossible."

Keys to TSN adoption

Specific technical benefits that the technology provides will enable early adoption of TSN, versus what is possible with typical applications today.

"The real key to the adoption of TSN will be the availability of good software tools. TSN will live or die by the software tools that are delivered by vendors. TSN provides tool vendors with a set of services that allow software tools to replace engineers, and for network designs to be less bounded," Brooks said.

"But these software tools must be easy to use in a heterogeneous network that combines IT and OT equipment—from multiple vendors using multiple technologies. If the tools aren't easy to use, however interesting the technology might be, widespread adoption (of TSN) won't happen."

He added that most new applications today can be solved with standard, unmodified Ethernet. But the catch is that, for more challenging applications, users need highly qualified engineers to design the system and also need to be working within bounded design recommendations such as Rockwell Automation's Converged Plantwide Ethernet Reference Architecture, for example.

TSN impact and timeline

When asked about the impact that TSN technology will have on smart manufacturing and the general timeline for innovations, Brooks cited TSN's strengths and how it operates with the network architecture.

According to Brooks, TSN helps protect time-critical motion traffic from the increased traffic volume brought about by smart manufacturing. But smart manufacturing actually happens at a higher layer, at the Application layer, of the technology stack. It's a reminder that TSN operates down at Layer 2 of the OSI network model.

"Smart manufacturing is fundamentally about IIoT; it is this merging of OT and IT that results in increasing non-time-critical (IT) network traffic—across the same wire," Brooks said. "This is where TSN comes in, creating new standards for Ethernet such that it can become deterministic by default, and support motion control."

In a more standardized way than today's installed Industrial Ethernet implementations, he notes that TSN has an important role to play in smart manufacturing, but that role must not be overstated. Other technologies are more important; today's users will do best by starting the journey to the Connected Enterprise. Within the Connected Enterprise, smart manufacturing empowers flexibility and reconfiguration of machines.

"TSN is an enabling technology, providing a protected boundary within a machine, so that it can operate predictably wherever that machine is located in the wider network," he added. "But smart manufacturing is in the cloud, while TSN operates narrowly within a production cell—with limited relevance to the broader enterprise."

industrial ethernet book
Industrial Networking & the IIoT

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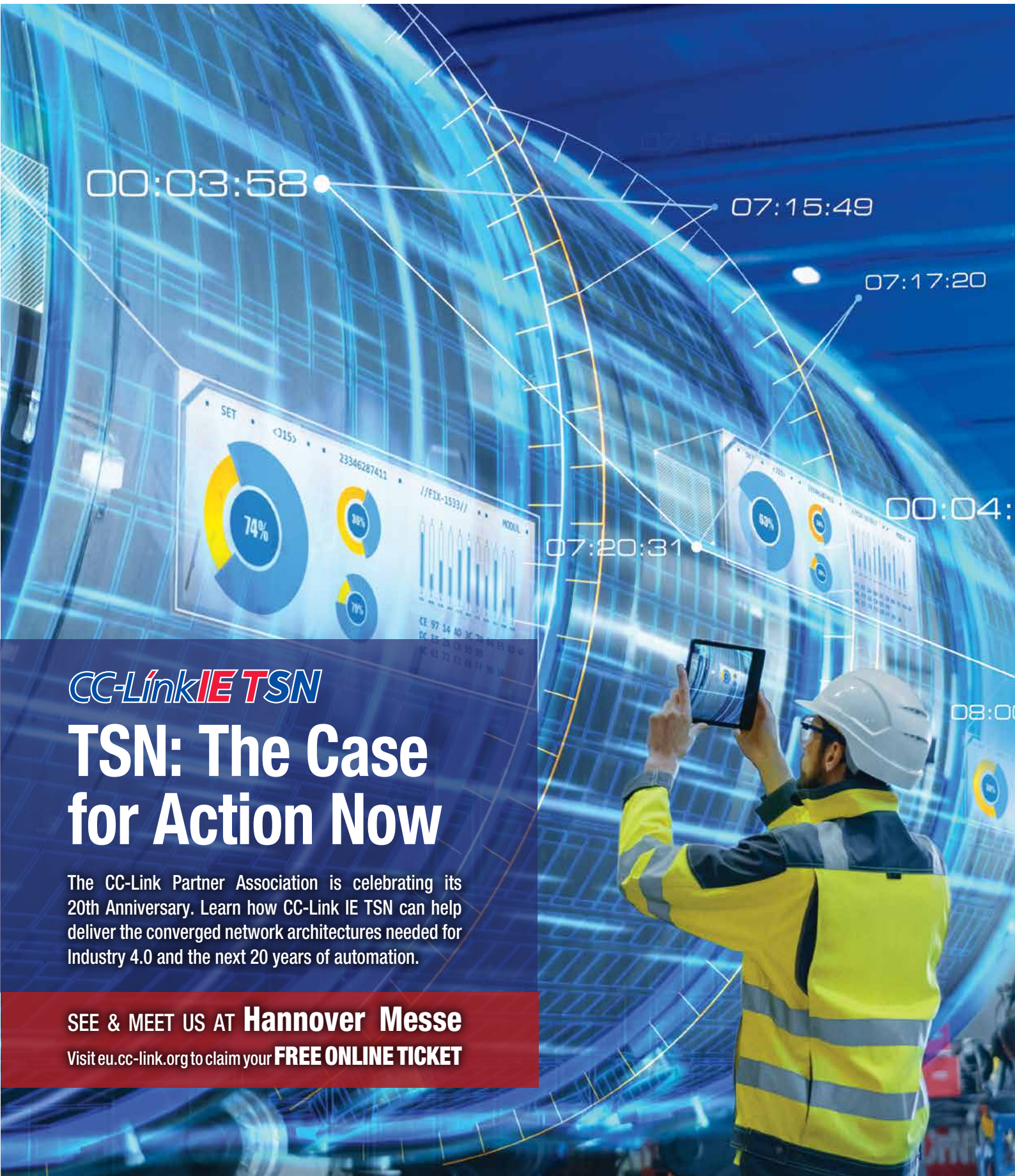

CC-LinkIE TSN

TSN: The Case for Action Now

The CC-Link Partner Association is celebrating its 20th Anniversary. Learn how CC-Link IE TSN can help deliver the converged network architectures needed for Industry 4.0 and the next 20 years of automation.

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TSN: delivering convergence and transparency

OPEN AUTOMATION NETWORKS

The CC-Link Partner Association has combined the proven gigabit technology of CC-Link IE with Time-Sensitive Networking to deliver the future of open industrial Ethernet.

CC-Link IE TSN
Open the Future of Connected Industries

SOURCE: CLPA

CC-Link IE TSN delivers the necessary network convergence required to address the process transparency demands of Industry 4.0.

WITH A TOTAL MEMBERSHIP OF OVER 3,800 companies and about 30 million devices installed globally, the CLPA has established itself as a key player in automation worldwide.

We have led the way in open industrial Ethernet for many years. We were the first organisation to offer gigabit bandwidth for industrial Ethernet applications with CC-Link IE. In 2018, we continued our leadership by being the first to combine open gigabit industrial Ethernet with Time-Sensitive Networking (TSN).

TSN is a set of IEEE standards that adds deterministic features to standard Ethernet by making changes to layer 2 of the 7 layer OSI model. By incorporating this technology, CC-Link IE TSN is now setting the standard for connectivity in the Industry 4.0 age.

The main purpose of this special feature is to outline how TSN delivers the necessary network convergence required to address the process transparency demands of Industry 4.0. No matter whether you are an end user, a machine builder or a device vendor, TSN has the potential to add significant benefits to your business.

To highlight these benefits, the CLPA has recently written a white paper explaining what TSN is, how it works, why it is important and what the benefits are. This special feature gives you a quick overview of the contents and we encourage you to visit eu.cc-link.org to download the full version.

While TSN is arguably the most important trend in automation currently, unless it is implemented in actual devices that can be applied to produce a solution to real world problems, it will only be a novelty.

Hence, another key part of this special feature is to highlight what products have already been developed for CC-Link IE TSN by CLPA board member Mitsubishi Electric and hence can be used today to implement TSN based solutions.

2020 was the year when the CLPA marked its 20th Anniversary. As I wrote above, during the first 20 years of its existence, the CLPA has been an industry leader, with an established track record of introducing ground breaking new technologies for open automation networking. We have included a short overview of the first 20 years in this special feature, and why the CLPA expects to maintain its leading position for the next 20 years.

Finally, 2020 also saw a tenth industry leading company join the CLPA's board of directors. Analog Devices became a CLPA board member in November 2020 and we are looking forward to the additional strength this leader in IIoT technologies will deliver to the organisation moving forward. You can read more details about this in the following pages.

We believe that CC-Link IE TSN represents the future of open industrial Ethernet. We and our partners would like the opportunity to discuss this with you further. Please get in touch!

John Browett, General Manager at ***CLPA Europe.***
Email: partners@eu.cc-link.org
Website: eu.cc-link.org

Time Sensitive Networking: the case for action now

The adoption of Industry 4.0 is being driven by its ability to address the challenges faced by today's users of industrial automation control systems, allowing them to increase competitiveness by optimizing their operations. TSN directly supports these requirements.

SOURCE: ISTOCK

TSN offers the potential for the convergence of the OT and IT parts of an enterprise.

INDUSTRY 4.0 ADOPTION DEMANDS GREATER process transparency which, in turn, allows businesses to better manage their activities.

Transparency is all about being able to extract more data from processes and analyze it to gather meaningful information to get a better and deeper comprehension of what is happening on the factory floor. It is not possible to know how to improve and control a process if there is not a clear understanding of what it is doing.

This need to extract process information has led to the rise of the Industrial Internet of Things (IIoT), as it provides an effective framework to generate, collect, share and analyze data. This solution is based on the Internet of Things (IoT) with the idea of connecting physical assets, such as sensors and actuators, to controllers and higher-level systems to monitor, control and manage them.

In practice, the IIoT applies the IoT to industrial activities, such as manufacturing. The result is an ecosystem of sensors, machinery and people all connected together that offers a granular view of operations and enables control of any variable that could affect production. The two technologies not only differ in their areas of application, but in their performance capabilities. For example, the IIoT was developed to handle highly time critical processes, such as high-speed packaging machines. Therefore, it required very reliable and predictable communication methods to connect devices such as sensitive and precise sensors to highly sophisticated, advanced controls and analytics. Collected together, these properties as are known as determinism, which is an essential requirement for industrial Ethernet applications.

While the IIoT offers an effective technology platform for Industry 4.0 applications, its foundation is a suitable network with the necessary level of determinism to share all data generated by a process. This transparency depends on convergence, i.e. the ability to combine multiple types of traffic on a single network, which in turn depends on determinism.

The technology that automation is moving towards to address this need for convergence is Time-Sensitive Networking (TSN).

What is TSN, how does it work & why is it important?

OPEN AUTOMATION NETWORKS

TSN is an extension of standard Ethernet that regulates the data communication in Layer 2 – Data Link of the OSI reference model. Its main aim is to make standard Ethernet deterministic but it also provides the mechanisms to allow multiple types of traffic to share the same network, providing the basis of convergence.

TSN ALLOWS ENGINEERS and technicians to precisely understand the exact time it will take for traffic to travel across a network, and also the nature of any delays (called "latency") and variation in travel time (called "jitter") that the traffic will experience. Latency and jitter were some of the main reasons why it took time for Ethernet to enter the industrial space. In the IT world, there is a far higher tolerance for latency and jitter, beyond what could be accepted in many industrial processes. Since originally Ethernet could not guarantee when events would happen (a lack of determinism), it could not be used reliably in many machine applications where this lack of determinism could lead to poor quality or even machine damage.

Various open protocols, such as CC-Link IE, were adopted to address these issues, and they will still provide valuable functionality for Industry 4.0 applications when combined with TSN.

While these protocols provided a way to make Ethernet deterministic for industrial applications and hence enabled what is now called industrial Ethernet, they still did not offer much of a solution for convergence. The current trend towards TSN will finally address this missing piece.

However, it is important to not forget that TSN is only a "pipe" for getting data from one place to another in a deterministic way. It does not address higher level application functions such as safety or motion control. Hence these protocols will still be required to deliver these functions.

LAYER	OSI MODEL
7	APPLICATION
6	PRESENTATION
5	SESSION
4	TRANSPORT
3	NETWORK
2	DATA-LINK
1	PHYSICAL

SOURCE: CLPA

TSN technology lies at Layer 2 of the OSI 7 layer model, defined by ISO/IEC 7498.

The importance of bandwidth

A further consideration in TSN networks is bandwidth. In addition to determinism, the standards behind TSN allow industrial Ethernet to utilize this typically fixed commodity with greater efficiency.

The prioritization features of TSN allocate the necessary bandwidth required to allow all traffic to flow on the network without less critical data interfering with that of higher priority. In the past, many industrial Ethernet technologies ran using 100Mbit bandwidth. While TSN will allow this bandwidth to be used in the most effective manner, the increase in data generated by Industry 4.0 is driving the trend towards gigabit bandwidth. TSN is well placed to benefit from this trend. Even though it can improve the use of bandwidth, it is clear that a wider "pipe" will infer fewer compromises between types of traffic and hence the performance of even less critical data transmissions can be improved.

This trend also addresses the way that some systems may have multiple networks to cope with occasional traffic peaks. The move to gigabit will ensure that a single network can meet increased bandwidth requirements, with TSN providing the scope for making sure it is used in the most efficient way as traffic volume increases.

This means that we will have the scope to build future systems where networks have the capacity to combine multiple types of industrial Ethernet protocols along with conventional TCP/IP traffic on a single network, therefore reducing costs and improving productivity and transparency.

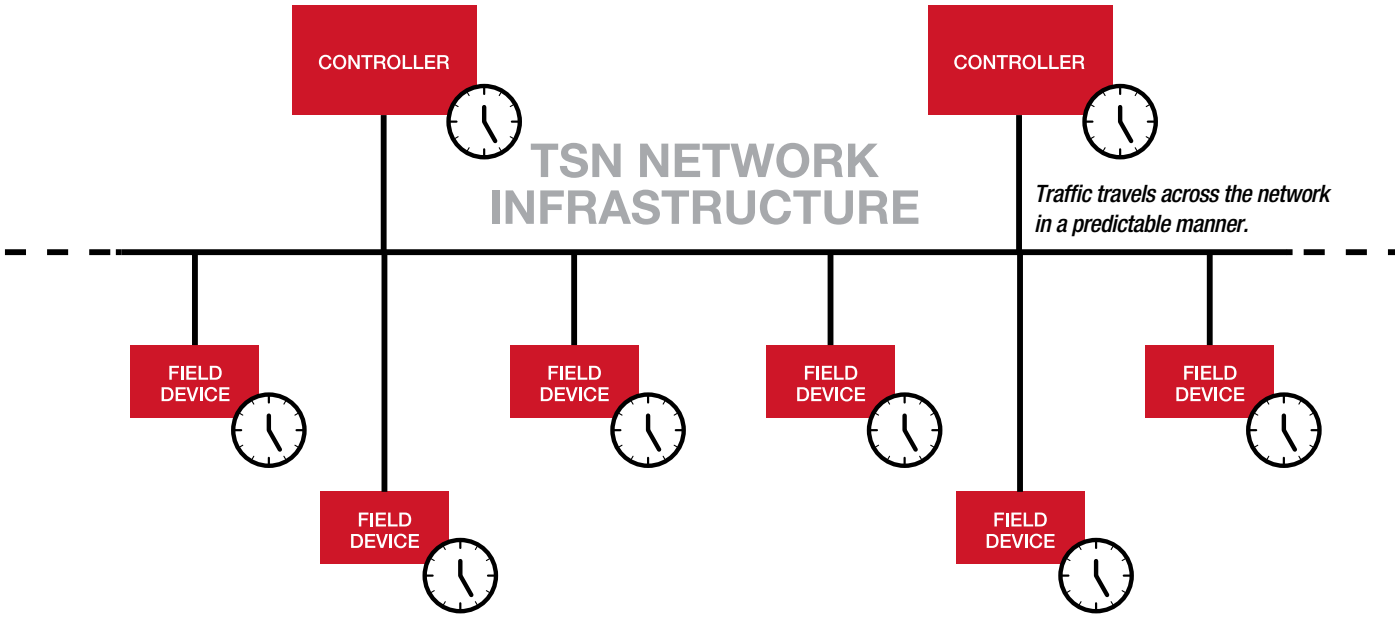
IEEE 802.1 specifications

TSN is defined by the IEEE 802.1 Ethernet specifications, which describe how the technology can provide deterministic performance and consequently convergence by implementing time synchronization and traffic prioritization, amongst other functions.

TSN provides the required mechanisms for all types of network traffic to coexist on the same network and hence finally provide the convergence necessary to enable the transparency required by Industry 4.0.

TSN standards

IEEE 802.1AS - Timing and Synchronization for Time-Sensitive Applications: Time synchronization provides the basis for determinism, as it ensures that all devices on a network share the same sense of time. For example, if it is 10:00 AM, then all the devices on the network know this and their operations are synchronized to the same clock. Therefore,



SOURCE: CLPA

By using IEEE 802.1AS, all devices on the network have a shared time reference. This provides deterministic communications by controlling latency and jitter.

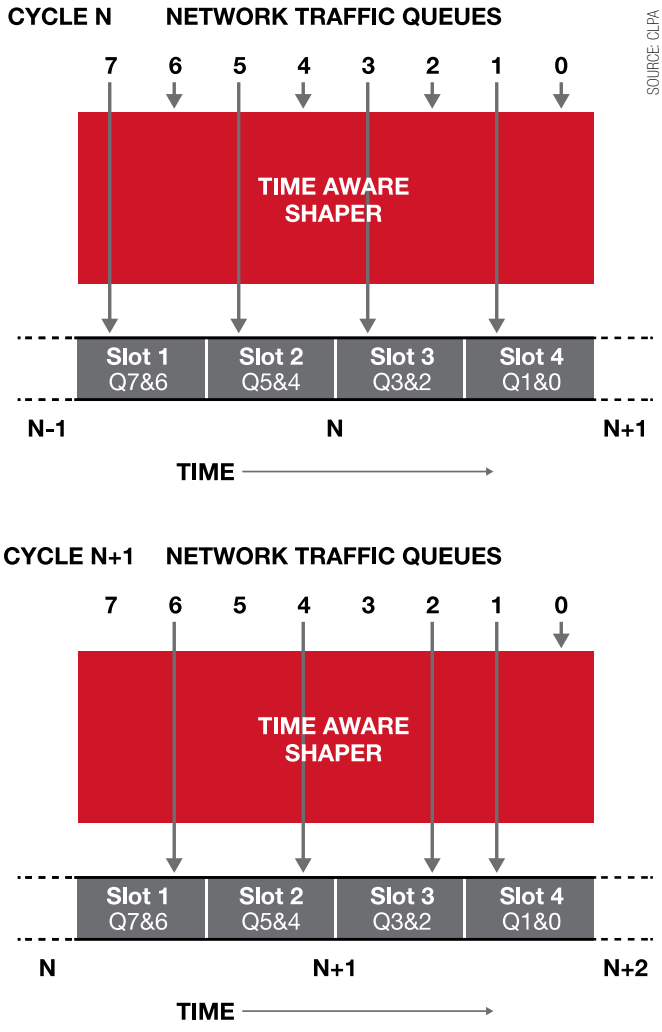
this makes it possible to minimize the likelihood of time drifts that may lead to delays and variation in data transfer (latency and jitter), thus supporting the timely and predictable transfer of critical data traffic.

IEEE 802.1Qbv - Enhancements for Scheduled Traffic: Once a shared sense of time is in place across a network, IEEE 802.1 Qbv defines "time-aware shapers". These define specific time "slots" that are assigned to different types of network traffic, which are prioritized according to the type of traffic. For example, the traffic related to an emergency stop being pushed would take priority over video frames from a machine vision system.

Different types of traffic can all travel across the network in a predictable way, further supporting deterministic communications, and this method supports convergence, while maximizing the use of network bandwidth.

Evolution of TSN standards

As with any technology, the IEEE 802.1 standards that define TSN are continuously evolving, with existing standards being refined while new ones emerge. Even as the standards evolve, the technology is mature enough to be implemented in projects. An evolving technology can be regarded as more valuable – as it continues to change, it continues to address current



SOURCE: CLPA

IEEE 802.1Qbv allows transmission time slots for network traffic queues to be defined. This controls when each traffic type has access to the network. In this example, four time slots are divided between eight queues. Within each slot, the higher numbered queue takes priority.

demands, hence is less likely to become obsolete. Therefore, this evolution is positive.

The counterpoint to this evolution is that the Ethernet standards have a track record of backwards compatibility. Ethernet technology has been around for about forty years and yet in many cases, earlier devices can often be used with more recent devices. TSN is expected to also follow this trend. Therefore, companies who need to get projects done now can include TSN in them now, confident that they are unlikely to face obsolescence in a few years. There is no need to wait for some undetermined future point when TSN will be "ready", as this time is not likely to arrive.

This confidence will be further reinforced by the IEC/IEEE 60802 project on the use of TSN in industrial automation, whose role is to define standardized profiles for use of the technology in a variety of use cases.

As a result, forward-looking businesses implementing this innovative technology will be able to benefit from a migration path that addresses current needs while providing a way to support future requirements. Thus, the adoption of TSN now can offer a system that helps companies to optimize their current systems and operations while offering the scope for future enhancements.

Benefits of network convergence

OPEN AUTOMATION NETWORKS

The aim of TSN is to make standard Ethernet deterministic. As a result, it is possible to deliver information in a predictable manner and enable converged networks. Hence it is a technology that will benefit vendors, machine builders and end users.

SOURCE: ISTOCK

Typical production lines will benefit from the implementation of TSN..

TIME SENSITIVE NETWORKING IS A TECHNOLOGY that will benefit device vendors, machine builders and end users.

For vendors: build devices that offer precise control of latency and jitter while being able to share networks with devices using dissimilar traffic. This will provide the key components of future automation systems.

For machine builders: design systems that are simpler, lower cost and easier to maintain, as the convergence enabled by TSN will allow all traffic to be handled by the same network.

For end users: benefit from the transparency delivered by these converged networks in order to gain better understanding of their processes and hence optimize them.

Benefits of converged networks

In the past, it was commonplace to have multiple networks, each dedicated to a specific task. For example, one would address general control, such as communications between PLCs, I/O and similar devices. Another network would handle communications for safety functions, such as emergency stops, light curtains, and safety controllers. There could also be a separate network responsible for motion control communications, connecting servos, drives, encoders, and motion controllers.

Getting these isolated setups to work together could be a significant engineering challenge. Time to market was slow, project timeframes were long, costs were high and maximizing performance could be an issue, along with maintenance.

To address these challenges, many modern-day industrial Ethernet technologies allow the combination of general, motion and safety control on one network, delivering substantial improvements.

However, Industry 4.0 is requiring end users to go beyond this. In order to address the challenges outlined in the overview, it is necessary for Ethernet to support the convergence of all kinds of networks and traffic types typically found in an industrial setting. Therefore, the integration of equipment such as barcode readers, vision systems and printers that may be using normal Ethernet networks without any specific industrial protocol also needs to be considered.

Moreover, it is commonplace for plants to evolve over time, with different projects using different technologies. As a result, many factories have multiple incompatible industrial Ethernet 'islands'. Since it is often difficult to combine this dissimilar traffic to get the 'big picture', process transparency is hampered and hence optimization and management is difficult. As TSN will allow this dissimilar traffic to share the same network, these islands will become a thing of the past.

TSN also allows this to be taken one step further. As the concept model of Industry 4.0 matures, common IT technologies such as cloud computing are entering manufacturing.

While many cloud systems can theoretically absorb a large volume of plant data, in practice, it is not necessary for these IT systems to track every tiny detail of machine operation. This is why so called 'edge servers' have also appeared.

Their function is to act as a filter to transmit the most valuable data to the cloud, where it can be processed into information that provides the required process insights.

It is clear to see that network architectures that deliver a single converged stream of data to these edge servers will provide a more efficient base for operation and optimization. This is one of the main ideas behind 'OT/IT convergence' where 'OT' is Operational Technology, or the factory floor.

CC-Link IE TSN: delivering the promise of Industry 4.0

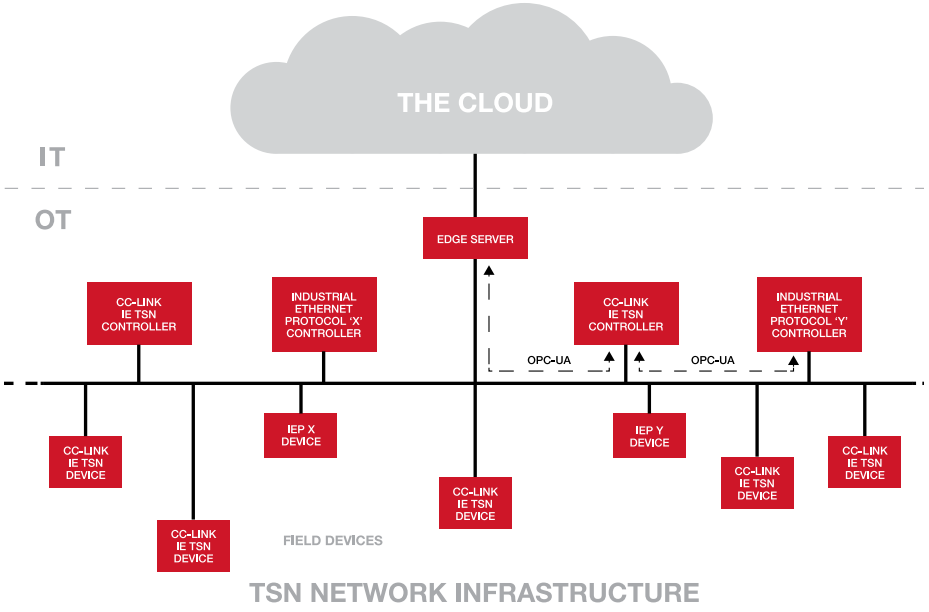
With the CLPA introducing CC-Link IE TSN, the established open industrial Ethernet solution provided by CC-Link IE added Time-Sensitive Networking compatibility. This delivered the world's first open industrial Ethernet technology to combine gigabit bandwidth with TSN.

THE IMPORTANCE OF TSN TECHNOLOGY IS reflected by the way that many standards bodies and industrial Ethernet organizations have quickly taken positions on incorporating it into their respective portfolios. Their work will provide a solid foundation for data and information integration between all the complex, disparate devices and applications that have previously been disconnected and which we think of as 'islands' of automation.

TSN is a platform that will provide many opportunities for convergence and interoperability and enable us to have devices and applications, which were previously disconnected, be part of a cohesive system.

So what does a company convinced of the benefits of TSN and wanting to adopt it now do? The answer is to look for a current technology that supports TSN now while also providing the necessary application functionality, such as safety and motion control. This will then address current project requirements, while providing future compatibility with other TSN-based technologies as they are introduced since multiple protocols will be able to share the same network.

In 2018, the CLPA introduced CC-Link IE TSN. This took the established open industrial Ethernet solution of CC-Link IE and added TSN compatibility to it. This delivered the world's first open industrial Ethernet technology to combine gigabit bandwidth with TSN. As such, CC-Link IE TSN clearly provides the gateway to the future of open industrial Ethernet. The result is a proven technology that end users, machine builders and vendors should adopt now in their respective products and projects.



SOURCE: CLPA

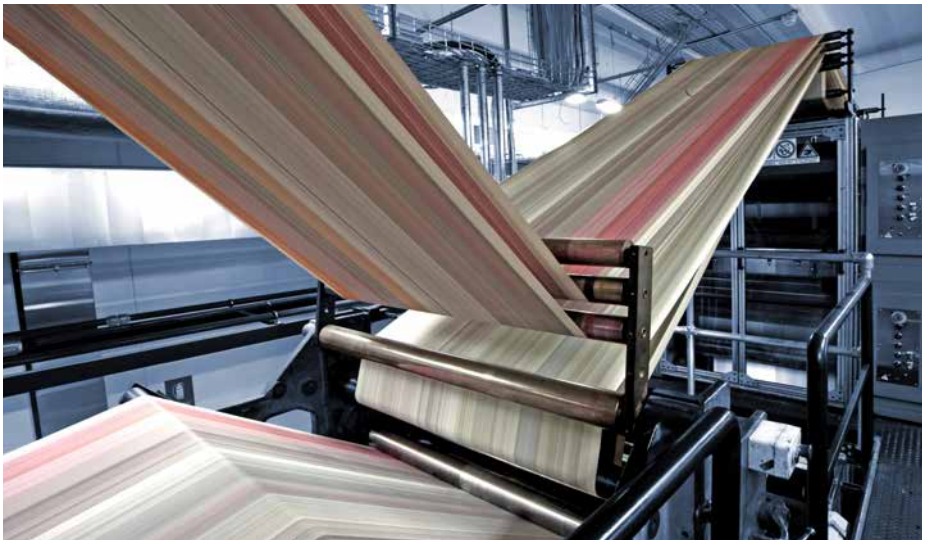
CC-Link IE TSN delivers process transparency by converging the various aspects of the OT and IT worlds.

The ecosystem of development options that are available to vendors who want to offer CC-Link IE TSN certified products is broad and flexible. Compatible products and solutions from leading vendors such as Mitsubishi Electric are already available. Therefore, end users and machine builders can leverage this opportunity today. For device vendors, by developing CC-Link IE TSN compatible products now, it will be possible to help shape the future of automation by participating in this new market opportunity.

CC-Link IE TSN helps to deliver the promise of Industry 4.0 in three key ways:

- *Performance*: The only open industrial Ethernet currently available to combine gigabit bandwidth with TSN to provide the highest productivity via maximum bandwidth availability.
- *Connectivity*: Being an open technology maximizes the freedom of choice for end users and machine builders, while also providing implementation flexibility for vendors. TSN takes openness one step further by offering the ability to combine CC-Link IE TSN traffic with that of other protocols.
- *Intelligence*: Reduce engineering time and maximize uptime with a range of features intended to simplify system design and maintenance.

In summary, the risk is not in adopting TSN now, but rather in waiting several more years to implement it while possibly watching competitors move ahead in the meantime.



SOURCE: ISTOCK

CC-Link IE TSN will benefit a wide variety of applications.

TSN: the future of open industrial Ethernet

OPEN AUTOMATION NETWORKS

Time-Sensitive Networking is the most significant technology for the future of industrial automation. It offers a number of opportunities, with the key ones being determinism and hence complete industrial and commercial network convergence.

NETWORK CONVERGENCE IS A KEY COMPONENT addressing the challenge of greater transparency identified by Industry 4.0, allowing processes and manufacturing to be highly efficient, streamlined operations.

For current industrial automation projects, organizations need to investigate which technologies will address this challenge. Existing technologies that offer features, such as gigabit Ethernet, help with this. And of course, they should also be open.

At the same time, it is important to keep an eye on the future. This means identifying current technologies that will support TSN. These are important, as they provide an upgrade path to TSN-enabled systems of the future.

Ground breaking technologies like TSN are going to continue to evolve to meet current needs while helping to shape the next industrial revolution. Machine builders and end users are going to be able to depend on TSN technology to connect their legacy systems with the systems of today and, at the same time, be able to address the complex needs of tomorrow.

SOURCE: ISTOCK

TSN is the most significant technology for the future of industrial automation.

TSN literally provides timeless durability. Hence it is important that vendors, machine builders and end users invest in TSN technology now, because as it continues to evolve, they will be able to stay ahead of the curve and be able to take advantage of seamless new functionality that TSN brings to the table.

Conclusion: The Business Benefits of TSN

In summary, the automation marketplace is a symbiosis of end users, who specify projects to machine builders, who in turn look for vendors who can offer products and solutions that meet these specifications. TSN can deliver benefits to all market participants as follows:

Simpler network architectures/machine designs

In general, the advantages highlighted here allow end users to reduce the number of networks required for their operations to just one. This, in turn, allows machine builders to pass on substantial decreases in costs, as less equipment is required and engineering work to design, configure and install network systems is also minimized. In addition, timescales for complete factory automation projects are decreased.

Greater process transparency and better management

The convergence supported by TSN strengthens data transfer across the enterprise, allowing end users to have greater process transparency. In effect, transparency is all about being able to extract more data from industrial processes and analyze it to gather meaningful information that helps to better understand factory floor operations. This insight can then be leveraged to optimize performance, productivity, efficiency and end product quality.

More productivity

By supporting the creation of single networks that transfer all types of traffic, it is easier to troubleshoot and identify any potential issues. Therefore, downtime associated with maintenance or repair activities can be reduced, while overall uptime can be increased. As a result, the entire end user's manufacturing system can become more productive.

Better integration of OT and IT systems

By converging multiple types of process data, TSN offers a key way to merge OT and IT. This convergence is at the heart of data-driven smart manufacturing, as it promotes innovation and collaboration by sharing and utilizing actionable information across the entire enterprise. Consequently, by embedding TSN capabilities within their products, vendors can deliver solutions with increased interoperability, along with the capability for device data to be visible across the enterprise via cloud connectivity.

Mitsubishi Electric's CC-Link IE TSN solutions

As a world leading automation vendor and board member of the CC-Link Partner Association, Mitsubishi Electric offers a comprehensive CC-Link IE TSN product line up. These form flexible solutions to meet the needs of industries across the world.

CREATING A SMART FACTORY REQUIRES THE REAL-TIME COLLECTION of shop floor data, utilizing edge-computing devices to enable point-of-origin processing, instantaneously providing results to machines, the cloud or other IT systems. This must all be done over an open, robust, deterministic, high-speed network having a high-capacity data bandwidth capable of transmitting large volumes of data seamlessly across the factory. Mitsubishi Electric's solutions provide the interconnectivity for entire factories to realize IIoT infrastructures, simultaneously improving productivity and quality while reducing overall cost.

MELSEC iQ-R Series Integrated Modular Controller

iQ-R

The MELSEC iQ-R Series line-up offers master/local modules that can be used as CC-Link IE TSN master/local stations. By supporting the simultaneous use of real-time motion control communication and TCP/IP communication, CC-Link IE TSN performance and functionality are maximized. MELSEC iQ-R Series motion modules also allow the use of multiple control functions, such as synchronization, cam, speed, and torque control using PLCopen® Motion Control function blocks. The ability to embed motion control software in industrial computers (IPCs) has enabled the realization of CC-Link IE TSN-compatible motion control systems

MELSERVO-J5 Series AC Servo

MR-J5

MELSERVO-J5 Series servo amplifiers communicate with iQ-R motion modules over CC-Link IE TSN to realize highly accurate motion control that contributes to performance of smart factory production systems.

FREQROL FR-A800 & E800 Inverter Series

FR-E800

Both A800 and E800 inverter series offer CC-Link IE TSN and integrated PLCs, combining high performance and high speed communication for maximized productivity and efficiency.

FR-A800

GOT2000 Series HMI

Improves productivity and efficiency through advanced visualization of production equipment using CC-Link IE TSN communications.

GOT2000

NZ Series I/O

The NZ Series provides a flexible, high performance, decentralized CC-Link IE TSN based I/O system in slice or block formats. Various models cover digital and analog I/O with a variety of termination types.

NZ

20 years of innovations in open automation networks

OPEN AUTOMATION NETWORKS

November 2020 marked a milestone for the CC-Link Partner Association (CLPA), its 20th anniversary. Over two decades, CLPA has supported automation vendors and end users worldwide by providing state-of-the-art open network solutions leveraging the latest technologies, such as Time-Sensitive Networking (TSN).

SINCE ITS FOUNDATION, THE CLPA has actively contributed to advancing manufacturing, such as supporting the current focus on Industry 4.0. This has resulted in the development and application of innovative open networking technologies that help manufacturers leverage the power of data. Ultimately, this capability empowers companies to enhance flexibility in their processes, helping them to be competitive in a dynamic, global market.

In particular, the CLPA has supported the creation of well-integrated platforms that link together all the different domains of manufacturing. These are an essential element of smart, connected factories that are ready for Industry 4.0. This is why the last decades have seen key advances in network technologies, which evolved from fieldbuses to industrial Ethernet and is now seeing the adoption of TSN.

Addressing current & future needs

At the forefront of these innovations and developments, the CLPA has provided ever evolving, ground-breaking solutions to address the changes in the industry. The organisation's very first technology, CC-Link open fieldbus, quickly became a de facto networking standard in Japan and then in the entire Asian market as well as globally

Perceptive to the most promising new technologies, the organisation subsequently launched a world's first – CC-Link IE, the only open industrial Ethernet with 1 Gbit/s bandwidth for industrial automation applications.

Back when the solution was released in 2007, only 10 to 100 Mbit systems were common. CC-Link IE was therefore offering a futureproof network technology that would be able to address the continually increasing need for bandwidth in manufacturing.

In effect, this solution still leads the global market today, 14 years after its initial release. The popularity of the industrial Ethernet and fieldbus systems are also confirmed by the continuous growth in the number of nodes, CLPA partners and compatible automation products.

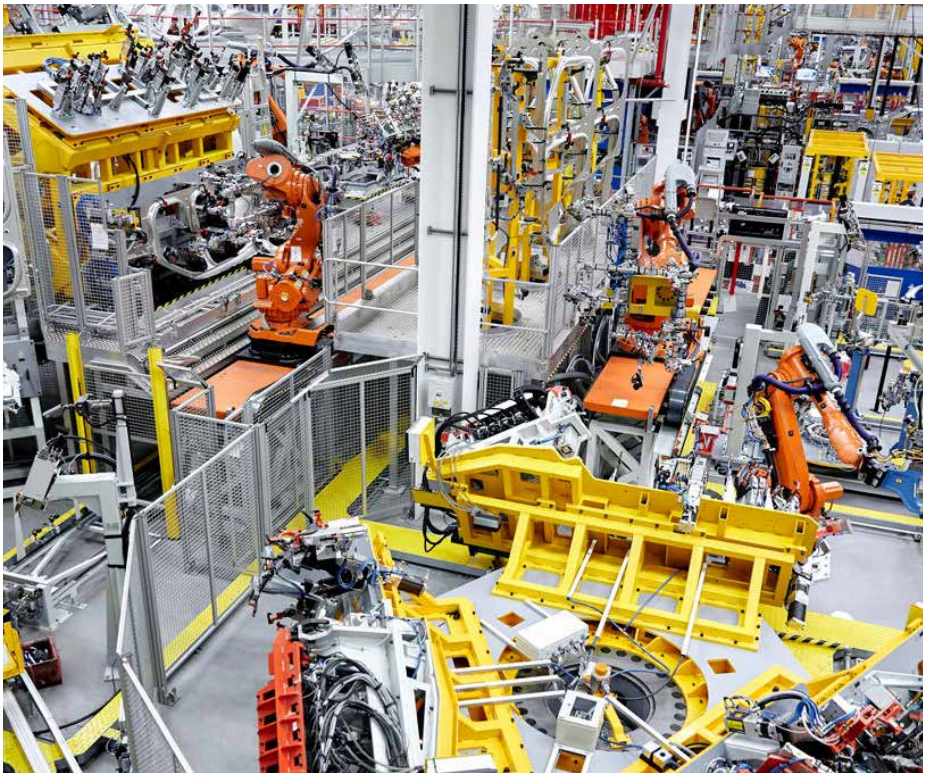
According to the latest reports, there are nearly 30 million installed nodes, 3,800 partner companies and more than 2,200 certified products available from over 350 manufacturers. These figures are no longer a representation solely of the Asian market, but refer to the global acceptance of the organisation and its technologies.

Ready for the next 20 years

While CC-Link IE is still widely used and offers state-of-the-art performance, the CLPA continues to look forward and provide solutions to address current and future needs.

Having recognised the benefits of innovative TSN technology and its potential in supporting the factories of the future, the organisation released CC-Link IE TSN. This is another world's first, as the solution is the only one currently available to bring open gigabit Ethernet to the next level by leveraging key TSN capabilities. Furthermore, the technology was designed to support manufacturing businesses in the forthcoming years, as TSN evolves.

John Browett, General Manager at CLPA Europe, commented: "We were delighted to celebrate our 20th anniversary and reach this milestone. The success and continuous growth we have experienced over the years clearly demonstrates the acceptance of our family of open networks in a broad range of industries. As an established industry player, we offer a strong, proven and future-oriented open networking technologies. We look forward to innovating further within the sector to continue delivering solutions that will lead the industry for the next 20 years and beyond."



SOURCE: ISTOCK

The CLPA has provided ever-evolving, ground-breaking solutions to address the challenges in industrial networks.

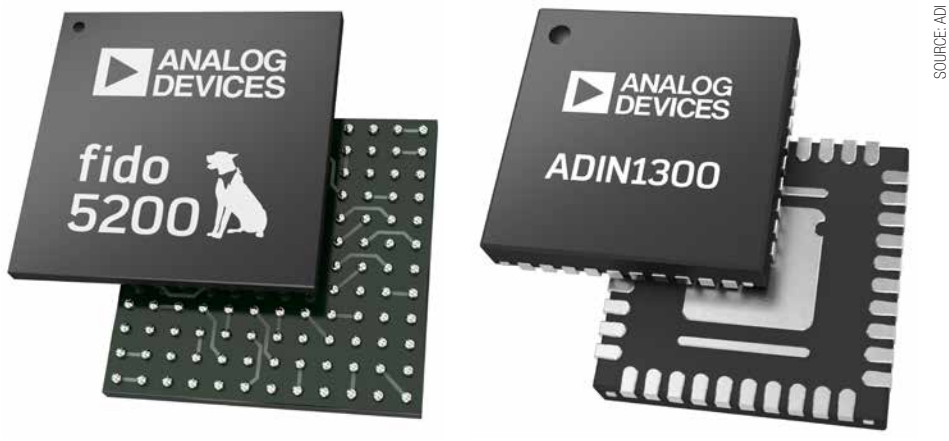
Analog Devices joins the board of the CLPA

Analog Devices has introduced a Scalable Ethernet Switch for Industrial Ethernet applications in response to increasing demand for this technology in the global automation market. ADI plans a CC-Link IE TSN implementation on their Scalable Ethernet Switch as part of their commitment to the CLPA.

THE CC-LINK PARTNER ASSOCIATION (CLPA) (headquarters: Nagoya, Japan), which promotes the widespread usage of the CC-Link open industrial network family, announced that Analog Devices, Inc. (ADI) (headquarters: Massachusetts, USA) has become a CLPA Board Member.

Through active participation in CLPA management, ADI aims to expand its business globally, especially in the Asian region, where the CC-Link family is a de-facto standard.

The company expects to now be fully involved with CLPA board activities and will join promotional activities to increase their presence and sales to the world from the vital Asian manufacturing market.



SOURCE: ADI

The FIDO5200 real time Ethernet multi-protocol (REM) switch and the ADIN1300 gigabit Ethernet transceiver are some of ADI's industrial Ethernet solutions.

ADI-CLPA cooperation

ADI is a leading global high-performance analog technology company that enables customers to interpret the world around us by intelligently bridging the physical and digital with an array of unmatched technologysolutions that sense, measure, power, connect and interpret.

Recently, ADI introduced a Scalable Ethernet Switch for Industrial Ethernet in response to increasing demand for this technology in the global automation market. As part of their commitment to the CLPA, ADI plans CC-Link IE TSN implementation on their Scalable Ethernet Switch.

The CLPA's key technology is CC-Link IE TSN, which is the first open Industrial Ethernet to combine gigabit Ethernet with Time-Sensitive Networking (TSN) technology. ADI has maintained a leadership role in the development of TSN technology for automation applications. Hence their decision to join the board of the CLPA indicates the company's belief in the potential of CC-Link IE TSN globally.

CC-Link IE TSN implementation on their Scalable Ethernet Switch will further increase the range of development options available to vendors looking to add the protocol to their portfolio.

The CLPA expects that this in turn will further contribute to their rapidly increasing global market share. Working with their partners, the CLPA is continuously promoting CC-Link IE TSN to increase its adoption globally.

CC-Link Partner Association (CLPA)

The CC-Link Partner Association (CLPA) is an open network organization established in 2000 and recently celebrated its 20th anniversary.

The mission of CLPA is to increase the adoption of the CC-Link family of open automation network technologies worldwide. CC-Link is the open fieldbus network standard which originated in Japan, after being developed by industry leaders such as Mitsubishi Electric Corporation.

The year 2007 saw the release of CC-Link IE as the first 1Gbps Ethernet-based open industrial network. Subsequently, the year 2018 saw the release of CC-Link IE TSN, a network which significantly improves the performance and functions of the current CC-Link IE.

The main activities of the CLPA include the development of the CC-Link family of technical specifications, conducting conformance tests, development support and user support for device selection and application.

In addition, the CLPA conducts promotional activities on a global basis in order to achieve wider adoption of the CC-Link family. The CLPA, which began with 134 corporate members, has expanded yearly and, as of the end of October 2020, boasts over 3,800 members, of which 80% are overseas corporations.

CLPA Board

The CLPA Board takes a leadership position in decisions regarding CLPA activities. Aiming for acceptance of CC-Link IE TSN at the global level, the Board is becoming an increasingly globalized management organization. After adding Analog Devices (ADI) as the latest member, the Board now consists of following ten firms.

CLPA Board Members

In alphabetical order: 3M Company, Analog Devices, Inc., Balluff GmbH, Cisco Systems, Inc., Cognex Corporation, IDEC Corporation, Mitsubishi Electric Corporation, Molex Inc., NEC Corporation, Schneider Electric Japan Holdings Ltd.

CC-Link IE TSN

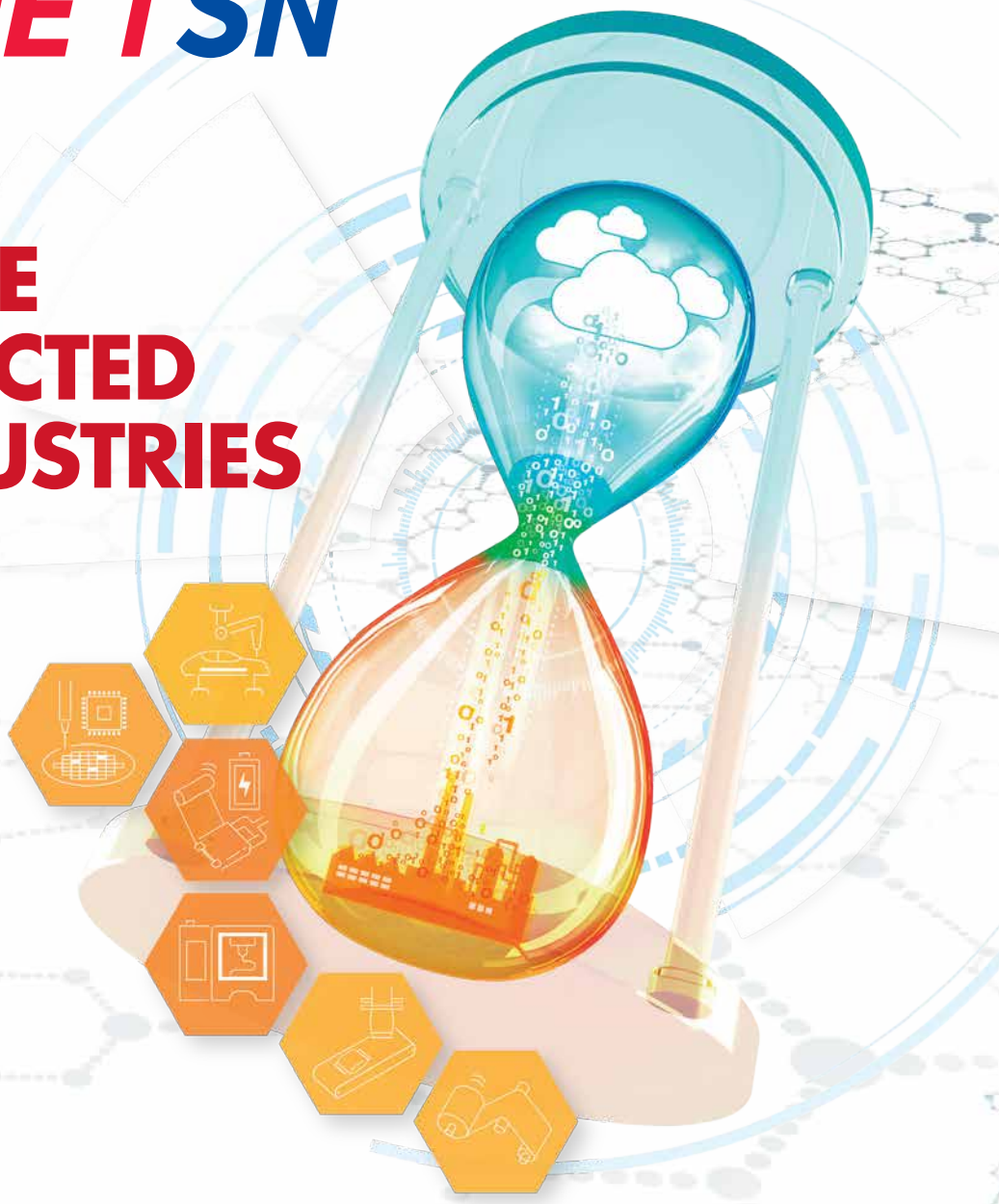
CC-Link IE TSN combines the gigabit bandwidth of CC-Link IE with TSN to meet future automation market demands, such as Industry 4.0. This provides flexible integration of Operational Technology (OT) and IT while further strengthening performance and functionality.

A comprehensive portfolio of device development options also ensures that any vendor can easily add this technology to their product line-up. The aim is to improve efficiency and reduce time to market for Smart Factories utilizing the IIoT and the products they manufacture.

As of November 2020, two years after the announcement of the CC-Link IE TSN specifications, more than 100 models of partner products have been released or are under development.

CC-Link IE TSN

OPEN the FUTURE of CONNECTED INDUSTRIES



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CC-Link IE TSN: Time-Sensitive Networking joins open gigabit Ethernet to deliver the world's most advanced automation network technology for Industry 4.0.

- **Performance:** Combines gigabit bandwidth with TSN to deliver the highest productivity network solution for Industry 4.0.
- **Connectivity:** Open technology provides freedom of choice for end users, OEMs and device vendors.
- **Intelligence:** A wealth of intelligent features reduce time to market and downtime while increasing productivity.

Contact us now to see how CC-Link IE TSN can meet your needs or visit our websites to download your free copy of the white paper – **Time-Sensitive Networking: The Case For Action Now**.

Europe: **partners@eu.cc-link.org** | **eu.cc-link.org**
Americas: **Info@CCLinkAmerica.org** | **am.cc-link.org**

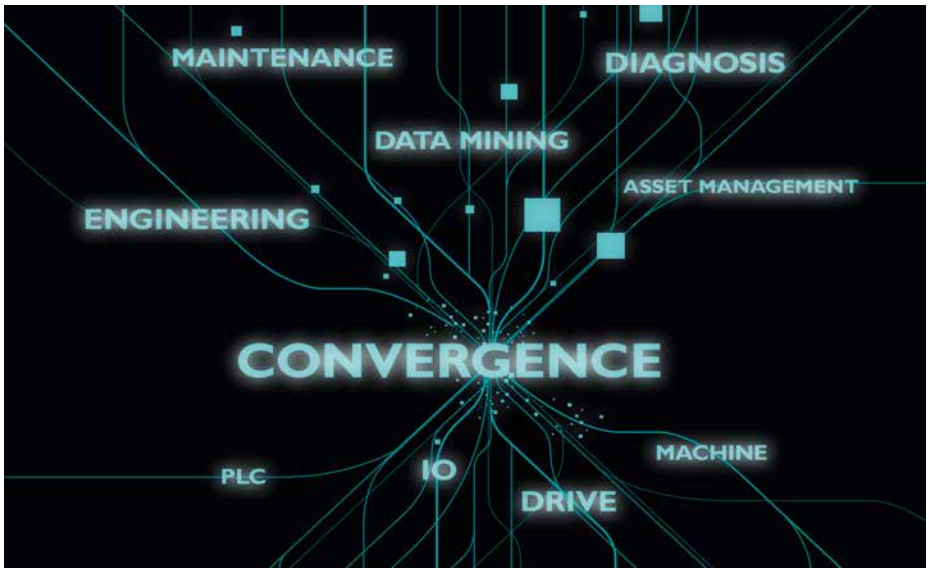
CLPA
OPEN AUTOMATION NETWORKS

20th Anniversary CLPA

CC-Link IE TSN

The path to TSN offers key technology for IIoT applications

Comprehensively networking everything with everything is the basis for future scenarios such as Industry 4.0 and the IIoT. To achieve this, currently separate fields of automation and information technology will have to be integrated even better. Time Sensitive Networking (TSN) standards can play a key role.



Josep.Ng@shutterstock.com

WHAT IS TSN, WHICH STANDARDS ARE relevant, and how can the development work be assessed? At this point, it's time for an overview. The classic bus systems, such as Profibus and CANopen, can still be found at the field level in current automation architectures. These systems and their use are currently proving to be a key discipline in automation technology (Operational Technology - OT).

Any additional TCP/IP communication necessary, for example between the field and the control level or image transmission via webcams, is currently via separate Ethernet-based networks (Information Technology - IT). Such a split means that users have to master both specialist fields, which brings with it a corresponding level of complexity and the need for further qualifications.

IT and real-time critical applications

One huge advantage of Ethernet, however, is the cross-market and cross-application standardization work of the responsible body, the IEEE (Institute of Electrical and Electronics Engineers), and in this case the IEEE 802 project. This standardization ensures the broad, cost-effective, and interoperable availability of foundational Ethernet technologies and blocks.

Systems based on Ethernet, such as Profinet RT and Modbus/TCP, benefit from these advantages because every IEEE 802-compliant end device and every switch can be used for data exchange. However, the IEE 802 work so far has not focused on the use of Ethernet in applications with hard real-time requirements, such as motion control applications. As a result, there are now special configurations available for such application scenarios, such as Profinet IRT, that are not standardized through IEEE 802, and in part only support data rates up to 100 Mbps, and that also require special device hardware.

This situation can change with TSN. With an appropriate bundle of mechanisms that are standardized through IEEE 802, Ethernet becomes real-time capable and allows bandwidths higher than 100 Mbps with simultaneous use of the network for both IT and automation applications. This means that the network can be used for all IT and real-time critical applications.

This characteristic is known as convergence and provides a series of additional advantages. For users and applications, these include bandwidths of 1 Gbps and more, transmission guarantees, seamless media redundancy, the use of standard switches, short cycle times, and, prospectively, comparable device costs.

Manufacturers benefit from the use of standard chips in controllers, switches, and field devices, and one product hardware system for all TSN use cases. It has become clear that the TSN standards apply to the lower Ethernet layers. The user layer is largely independent and can be retained as it is for existing standards such as Profinet.

IEEE	Designation	Details
802.1Q	Streams	Robust routing through the network
802.1AS	Time synchronization	One synchronous time in the system
802.1Qbv	Scheduled Traffic	Communication according to timetable
802.1Qbu	Frame Preemption	High priority interrupts low priority
802.1Qcc	Stream Routes Configuration	Configuration options for TSN Networks
802.1Q ...	...	...

IEEE 802 TSN standards: All standards have now been released.

Profiling TSN standards for OT use

One important and necessary characteristic of the current fieldbus systems is their cross-manufacturer interoperability. Automation experts have become used to combining devices from different manufacturers to create workable solutions in a machine or system. This interoperability is assured by the large fieldbus organizations via specific measures, such as certifications.

The convergent use of a TSN network can only be successful if it also provides a comparable level of interoperability. To achieve this, a cross-manufacturer definition of which mechanisms from the TSN bundle are to be used and how is necessary.

Here, IEEE 802 does not make any provisions to guarantee the cross-sector use of Ethernet. Therefore, the IEC organization responsible for the fieldbus systems has joined forces with the IEEE 802 body responsible for Ethernet to establish the joint IEC/IEEE 802 60802 activity. This cooperation is targeted at

profiling TSN standards for use in automation applications. Therefore, this activity is also referred to as the Industrial Automation Profile (IAP), and makes applications.

Role of the fieldbus organizations

Will the well-known fieldbus organizations, such as Profibus and Profinet International (PI), become superfluous to requirements with the introduction of TSN? At the moment, this question can be answered with a clear no.

The tasks that are currently being performed by these organizations will also have to be performed when TSN is used in order to guarantee a comparable level of operability. Moreover, the users will expect a comparable level of user-friendliness when using TSN in Ethernet networks. Therefore, Profinet has been approved for use with TSN since specification 2.4, for example. This means that users can benefit from the advantages of TSN without having to change their familiar view.

But it is not just Profinet that is specified for TSN. The OPC Foundation is also working on describing TSN standards for automation via the so-called Field Level Communication Initiative (FLC). In this context, creating another proprietary fieldbus system for TSN that does not take other systems into account is to be avoided.

Rather, the goal is the convergent use of a network, for example for OPC UA, Profinet, and other protocols. The Industrial Automation Profile (IAP) IEC/IEEE 60802 is fundamental for implementing this.

From standard to solution

The figure (right) illustrates the fundamental process of the IEEE 802 standard up to a workable solution for the user and provides a classification in terms of the current status of TSN. Because the TSN mechanisms also have an effect on the Ethernet hardware, new products or new versions of the products with corresponding Ethernet blocks are necessary. This applies in particular if the user also wants to benefit from the advantage of higher bandwidths, such as 1 Gbps.

These bandwidths are necessary in a convergent IT and OT network, for example, because video data streams demand it. At this point, it should be noted that a comparable status was achieved by the Ethernet-based fieldbus systems used today around 15 years ago, meaning that the fieldbuses have already gone through this development.

The convergence of IT and OT is also possible today with systems such as Profinet RT, and is sufficient for many applications in production and process automation, except high-end motion control applications. It can therefore be assumed that widespread use of TSN in real solutions is still some time away. The benefit of a convergent network is, however, high for both device manufacturers and users, because it is a key empowering factor for the IIoT.

Gunnar Leßmann, Master Specialist Profinet & TSN, ***Phoenix Contact Electronics GmbH.***

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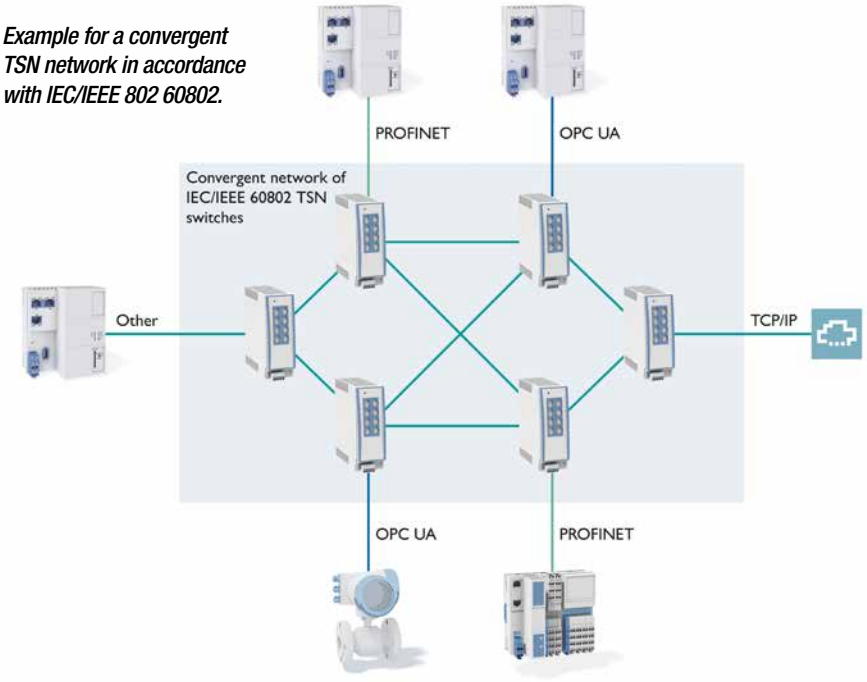
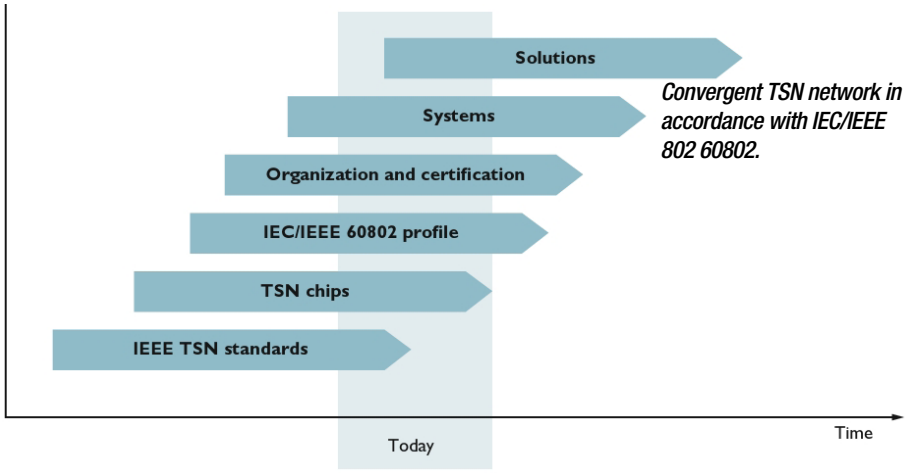
Example for a convergent TSN network in accordance with IEC/IEEE 802 60802.



SOURCE: PHOENIX CONTACT

Several real-time protocols and TCP/IP communication share one network.



Convergent TSN network in accordance with IEC/IEEE 802 60802.

SOURCE: PHOENIX CONTACT

The TSN streams in a network can be used by different protocols, necessitating cross-manufacturer and cross-protocol standardizationstandardization

Active cooperation on new communication technologies

In terms of TSN, Phoenix Contact is actively participating in all relevant standardization activities.

At the same time, TSN-capable platforms and products are already being developed. Here, the company is focusing on upgrading the existing Profinet solutions with TSN standards and, in this context, is taking the convergence of OPC UA and TSN in accordance with IEC/IEEE 60802 into consideration.

This will enable a fluid and needs-based transition from the current OT-centered view to convergent IT and OT networks with extended capabilities and characteristics.

In this context, the influences of further new technologies such as Single Pair Ethernet (SPE), 5G, and security will also be taken into account in the considerations. Phoenix Contact is thus focused on future-oriented products and solutions.

How TSN is revolutionizing industrial automation

Digital transformation is opening up exciting new opportunities for industrial automation and manufacturing. The benefits for manufacturers to embrace the IIoT are manifold, providing deterministic services and integrating the "islands of automation" isolated by the purpose-built protocols of the past.

FROM REDUCING MACHINE DOWNTIME TO adopting entirely new business models, Industry 4.0, as this new wave of digital transformation has also been called, is revolutionizing the global economy in unprecedented ways.

In the past, manufacturers often had to adopt purpose-built protocols and systems, instead of standard Ethernet technologies, for specific industrial control applications. Although early Ethernet networks were only capable of best-effort communications, standard Ethernet has come a long way in recent years.

With the advent of Time-Sensitive Networking (TSN), standard Ethernet networks are now able to provide deterministic services and integrate the "islands of automation" that were isolated by the numerous purpose-built protocols of the past.

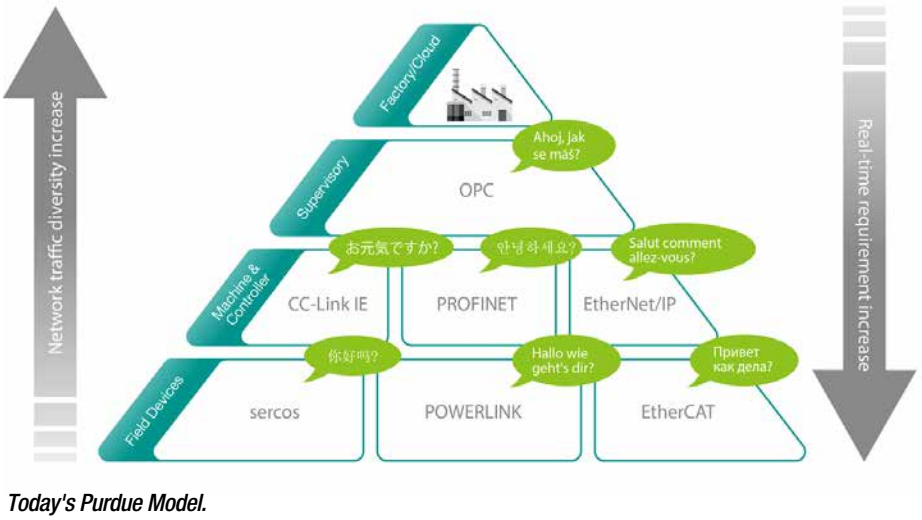
To define a truly unified network infrastructure for the future of smart manufacturing, international standards organizations and hardware vendors such as Moxa are coming together to develop solutions with Time-Sensitive Networking as the foundation.

With TSN forming a solid base for implementing true IIoT networks, global manufacturers can finally reap the full benefits promised by Industry 4.0.

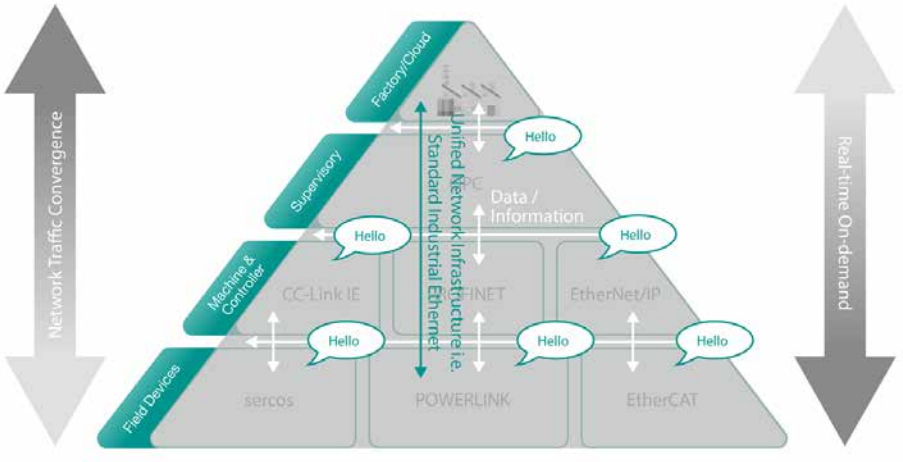
In this article, you will learn:

- How smart manufacturing and the IIoT require deterministic networking and real-time communications for industrial applications over high-bandwidth, low-latency networks
- How traditional best-effort Ethernet networks are evolving into Time-Sensitive Networks that enable deterministic services on standard Ethernet technologies
- How international standards organizations and device vendors such as Moxa are collaborating to make TSN the future foundation of industrial networking

SOURCE: MOXA



Today's Purdue Model.



Tomorrow's Purdue Model.

Going beyond the digits

The world today is witnessing a new dawn for digital transformation that will require manufacturers to rethink their existing business models and industrial automation infrastructures.

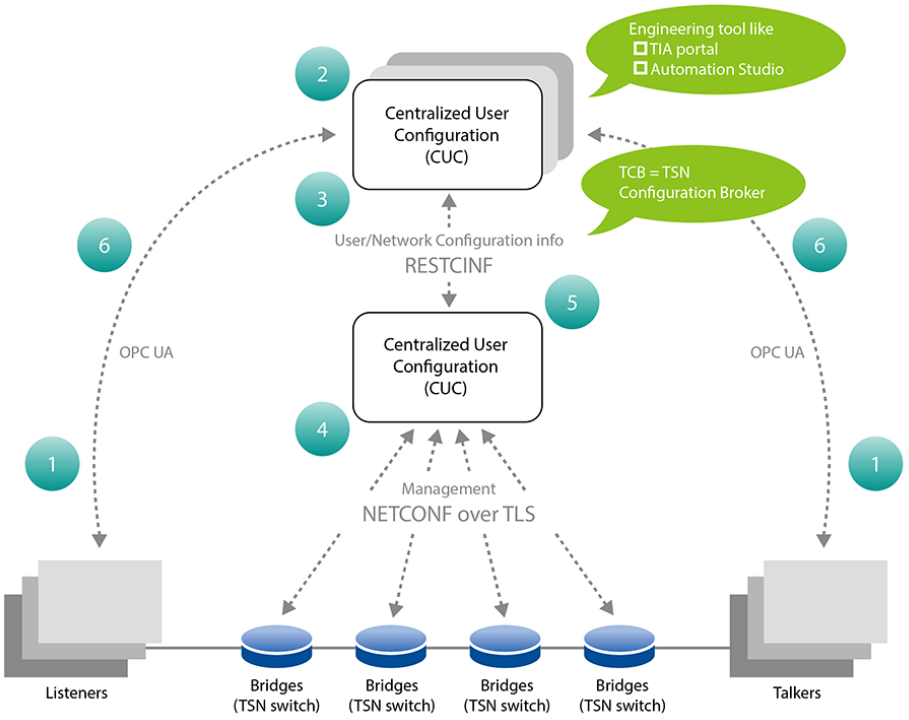
To remain relevant and competitive in the age of "Industry 4.0", manufacturers need to do more than simply adopt digital technologies and deploy predefined processes in isolated islands of automation as they have done in the past.

The future of industry rests on understanding the factors driving this new wave of digitization, the limitations of the current model of industrial automation to achieving digital transformation, and how to overcome these limitations to realize the full benefits of Industry 4.0.

Driving digital transformation

The foundation of the current trend of automation and data exchange in manufacturing technologies, also called "Industry 4.0" or the "Industrial Internet of Things" (IIoT), is essentially digitization. By converting analog signals, sounds, images, texts, and other information into a computer-readable format, digitization has been transforming the very nature of industries for decades.

Not only have traditional industries been able to improve efficiency and productivity, but previously unimaginable opportunities



SOURCE: MOXA

Fully Centralized Time-Sensitive Networking (TSN) Model.

have also opened up and revolutionized the way we do business all over the world. For the foreseeable future, these trends are going to keep pushing growth at a very strong rate and there is expected to be significant benefits to not just the industrial sector, but the global economy.

Yet digital transformation in industry involves more than the process of converting analog information into a series of 1s and 0s. For manufacturers to make sense of all these bits of information, the data must be transported from countless sensors and equipment on the factory floor and processed for humans or other machines to make informed decisions in real time. Necessarily, digital transformation for smart manufacturing encompasses the various networking technologies and protocols that enable seamless communication and greater visibility among all walks of digitized equipment from sensors to sophisticated robots with artificial intelligence.

Indeed, the ability of digitization to enable the integration of data from connected devices and the ability to collect and act upon performance-enhancing feedback is driving many manufacturers to adopt IIoT technologies. Companies have clear motivations to adopt smart manufacturing in order to improve operational efficiency and business practices. Whether they seek to reduce machine downtime, improve performance to open new opportunities for business innovation, or adopt entirely new business models, such as offering products-as-a- service—manufacturers are embracing digital transformation.

Limits of industrial automation

Ever since the industrial revolution, manufacturers have been looking for ways to increase productivity. Following the mechanization of production, manufacturers have embraced device connectivity as a means to improving efficiency and profits.

Beginning in the 1980s, manufacturers began adopting digital devices, which led to the emergence of industrial automation as we know it today. A helpful way to visualize the current architecture of industrial automation is the often-referenced Purdue model.

In the current Purdue model, industrial automation forms a pyramid where isolated purpose- built protocols occupy distinct layers.

However, this model also gives rise to a number of infrastructure challenges for industrial networks today. Although independent purpose-built protocols may be very good at automating the original tasks for which they were developed, they are essentially speaking different "languages" which results in real-time communication difficulties.

Traditional industrial networks in this model are also tuned for latency and control, unable to "share the wire", and are often limited to 100 Mb/s (or lower) transmission speeds that ultimately hinder scalability.

Furthermore, using proprietary hardware and software for multiple applications obstruct interoperability and increases maintenance and operation costs. Consequently, systemic integration and visibility across layers becomes difficult to achieve, which negatively affects the overall value chain.

Evidently, manufacturing strategies also need to evolve for companies to remain globally competitive. Today, customer demands are becoming increasingly diversified and companies are looking for ways to satisfy these new and future needs while also increasing operational efficiency. Businesses strive to remain competitive globally by becoming as nimble, efficient, and responsive as possible.

Gone are the days when manufacturers could scale their production based on sales forecasts alone. Instead, manufacturers may need to leverage relevant insights from big data analytics to help fulfill customer demands in real time and optimize production at lower costs. This is just one example of how manufacturers can deploy the latest technology to move towards "Industry 4.0" and come out ahead.

Equipment, devices, and people in complex and global operations are more connected than ever due to the fact that industries are continuing to digitize, automate, and innovate.

Ultimately, industrial networks need to catch up with market and industry developments to ensure that businesses can turn the efficiency, flexibility, and availability made possible by a more reliable and scalable network into better performance, higher employee and customer satisfaction, as well as more growth.

The future of industrial automation

The traditional Purdue model, as represented by the "automation pyramid", outlines different layers of network communication that remain fragmentary and potentially unreliable and difficult to maintain, particularly in the long term.

Calls within the industry have been made to move towards an "autonomous pyramid" that is capable of responding to market and business conditions in real-time. In this newly envisioned architecture, isolated islands of automation and network data flows are able to communicate with each other through common semantics and a unified infrastructure.

This new "autonomous pyramid" envisions the future of industrial automation as a seamlessly connected system where:

- Small-scale, static, and isolated control loops evolve into larger-scale, dynamic, and open control loop communications, also known as cyber-physical systems" (CPS) that deeply intertwine software and physical components.
- Formerly closed loop data can openly communicate across a common foundation, enabling new bilateral data communication flows that can intelligently interact with each other.
- All business assets, from equipment to materials to personnel, are intelligently connected in a unified infrastructure that enables the fulfillment of diverse customer needs through end-to-end

"autonomous" communications, collaboration, reaction, adaptation, and optimization, all at the "right times".

By using a unified network infrastructure for a multitude of disparate applications—including automation, maintenance, analytics, and more—manufacturers can achieve the following benefits.

As different end devices are able to talk to each other in real time, configuring the system, devices, and applications to enable a real-time feedback loop becomes significantly easier.

A unified, context-driven network structure also allows machine learning to take place, so in the long term, it is possible to leverage big data analytics and respond accordingly, further increasing made-to-order flexibility and efficiency.

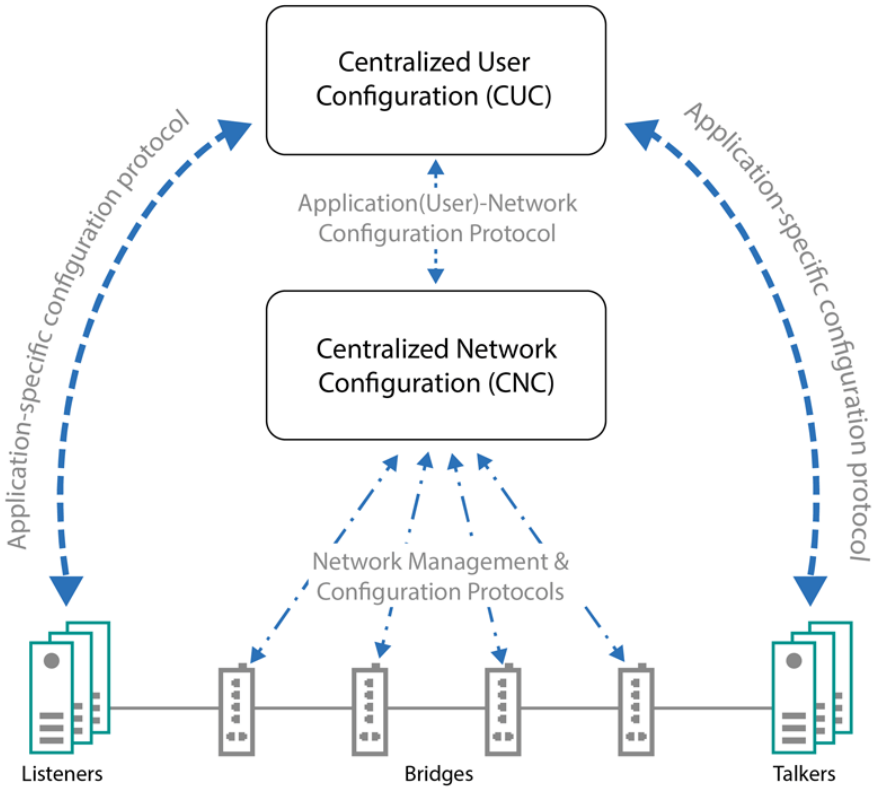
Improved access to data allows for production monitoring to be conducted in real time, so higher quality, more detail-oriented KPIs can be established under different scenarios.

A more robust network infrastructure can support more applications for equipment on the shop floor, such as counting, sorting, quality control, and video surveillance. Machines no longer work in isolation but act in tandem with other machines to improve productivity, thanks to all the real-time data fed into the system. Combined with developing technologies in robotics and machine sensing, such as motion guidance, augmented reality, machine vision, and haptics, factory assets can deliver optimized performance at lower costs.

Standardized technologies and a scalable structure, such as those based on Ethernet standards, afford much greater flexibility. Through standardization of infrastructure technologies and protocols, topological differences—which used to present significant challenges for network configuration—can be managed in similar ways as other modular units or extensions. Building, maintaining, and removing layers are more cost-effective and less time-consuming.

Indeed, a unified infrastructure that breaks down the barriers separating the islands of automation in today's Purdue model will create a system of connected, physical industrial objects and allow them to exchange and analyze data with the purpose of generating value- added information. In doing so, the Industrial Internet of Things enables the right decisions to be made at the right time and place, thereby transforming formerly predefined processes into truly dynamic processes.

Ultimately, the future of industrial automation and control systems is about the integration of information and Internet technologies that continue to satisfy requirements for high availability and real-time communications, and also supports the development of new products and innovative solutions based on the optimal balancing of costs and benefits. More precisely, the unified network infrastructure of the future also requires deterministic communication capabilities that can ensure performance and QoS as well as, or better than, the purpose-built protocols that isolate our current islands of automation today.



SOURCE: MOXA

Fully Centralized Time-Sensitive Networking (TSN) Model.

Thankfully, standards organizations and independent vendors have recognized the potential benefits of Industry 4.0 and are working together to develop a new, unified foundation for industrial networks: Time-Sensitive Networking.

Setting the standards: TSN

Heeding the call for a unified yet deterministic infrastructure, TSN is a collection of standards that enables deterministic messaging over standard Ethernet networks. As defined by the Institute of Electrical and Electronics Engineers (IEEE), TSN involves a form of network traffic management to ensure non-negotiable time frames for end-to-end transmission latencies.

Consequently, all TSN devices must synchronize their clocks with each other and use a common time reference to support real-time communications for industrial control applications. Although TSN standards were initially developed by the IEEE, it is important to recognize that TSN goes beyond the main IEEE standards and includes the hard work and collaborative efforts of many international organizations and companies.

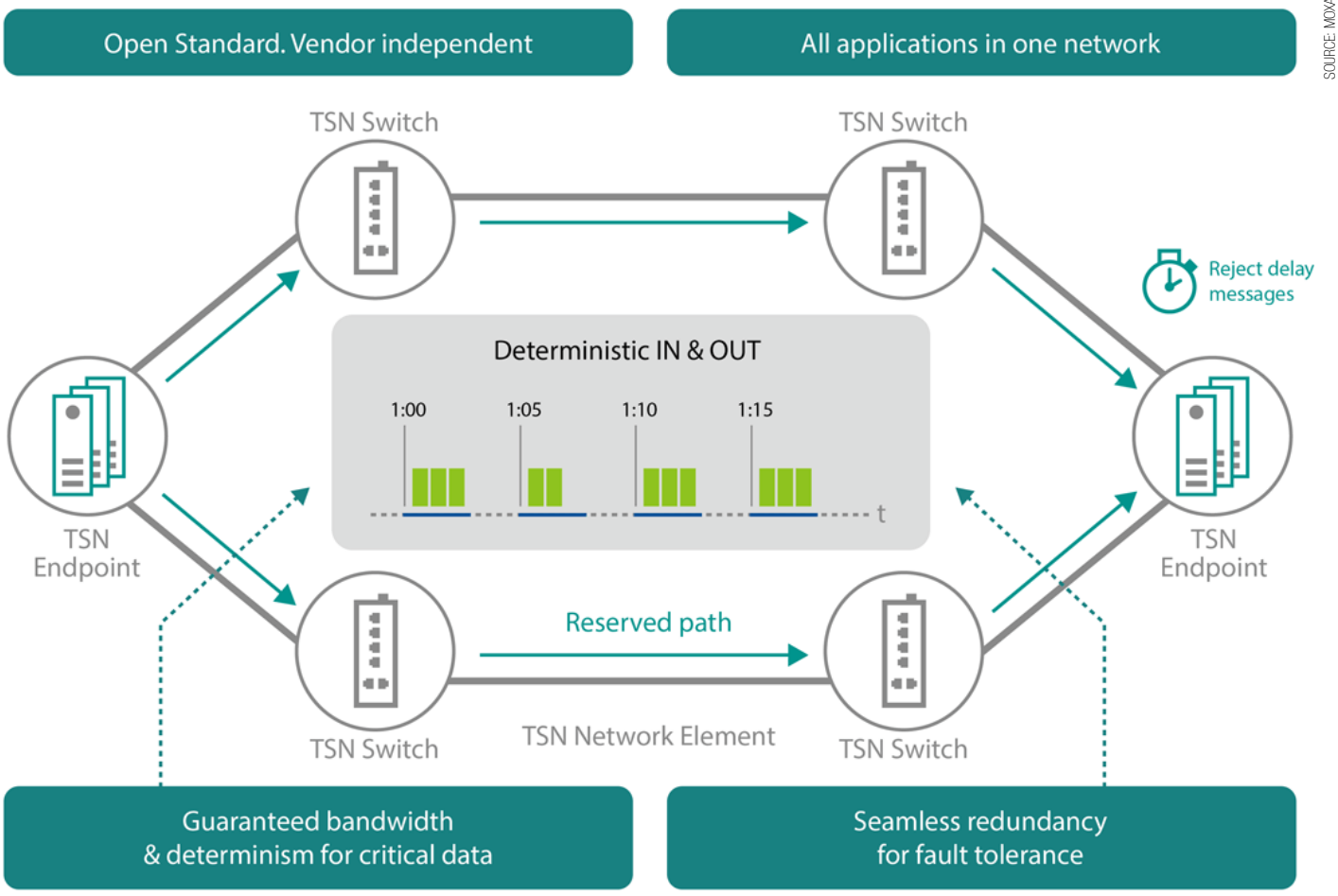
Early standard Ethernet networks were incapable of guaranteeing data delivery and subject to high latency. As a result, industries that required high network reliability and availability developed their own specialized, proprietary networking solutions (e.g., modified Ethernet networks, fieldbuses) for industrial control systems and automation.

To meet the high availability and low latency requirements of industrial applications for manufacturing, traditional best-effort Ethernet technologies have had to evolve to become more deterministic. TSN is essentially the next stage in the evolution of standard Ethernet technologies to satisfy the requirements of our IIoT future.

Besides providing a set of standards for deterministic services over Ethernet, TSN is bringing together many different industry organizations and market leaders under a common goal to realize the full potential of Industry 4.0 and the promise of digitization.

Evolving best-effort networks

Traditional Ethernet networking technologies generally include hubs and switches that employ best-effort packet delivery. Most of the time, data packets are successfully delivered in sequence, but there are no guarantees. Although best-effort networks may perform adequately for web browsing applications, industrial control applications require higher availability, zero packet loss, and lower latency. After all, if there are no guarantees for packet delivery, critical control data might



What's Time-Sensitive Networking?

not be delivered to the right place at the right time.

In the 1980s, when manufacturers started migrating to digital technologies from mechanical or analog technologies, best-effort Ethernet networks were not considered a suitable infrastructure option for industrial control systems that required high precision, availability, and guaranteed real-time transmissions, despite offering higher bandwidths compared to traditional fieldbuses.

Besides the prohibitive costs of Ethernet technologies at the time, Ethernet retransmission algorithms and collision detection could not satisfy the performance requirements for industrial control systems. Consequently, manufacturers had to develop purpose-built systems and protocols to enable digitization through deterministic networking.

Unlike best-effort networking, deterministic networks support the following services:

- Time synchronization
- Resource reservation
- Extremely low packet loss
- Guaranteed end-to-end latency and bandwidth

Since those early days of Ethernet and industrial automation, networking technology has evolved considerably. In fact, modern Ethernet technologies can even supply deterministic services that meet the needs of many industrial applications that formerly required proprietary systems and protocols.

Due to the growing trend towards converged networks and the corresponding increase in demand for bandwidth, truly deterministic Ethernet networks could be more cost-effective and future-proof than purpose-built networks.

Determinism and TSN

To enable truly converged networks that can stream real-time controls, as well as audio/video in industrial facilities, the TSN task group of the IEEE 802.1 working group is defining a set of standards for the deterministic data transmission over Ethernet networks. As a collection of standards, TSN is more like a tool box than an all-in-one solution; you need to understand what "tools" are available and how each tool works in order to determine which tools are suitable for your application.

As the key protocols described in the following table indicate, Time-Sensitive Networking standards focus on the following main areas:

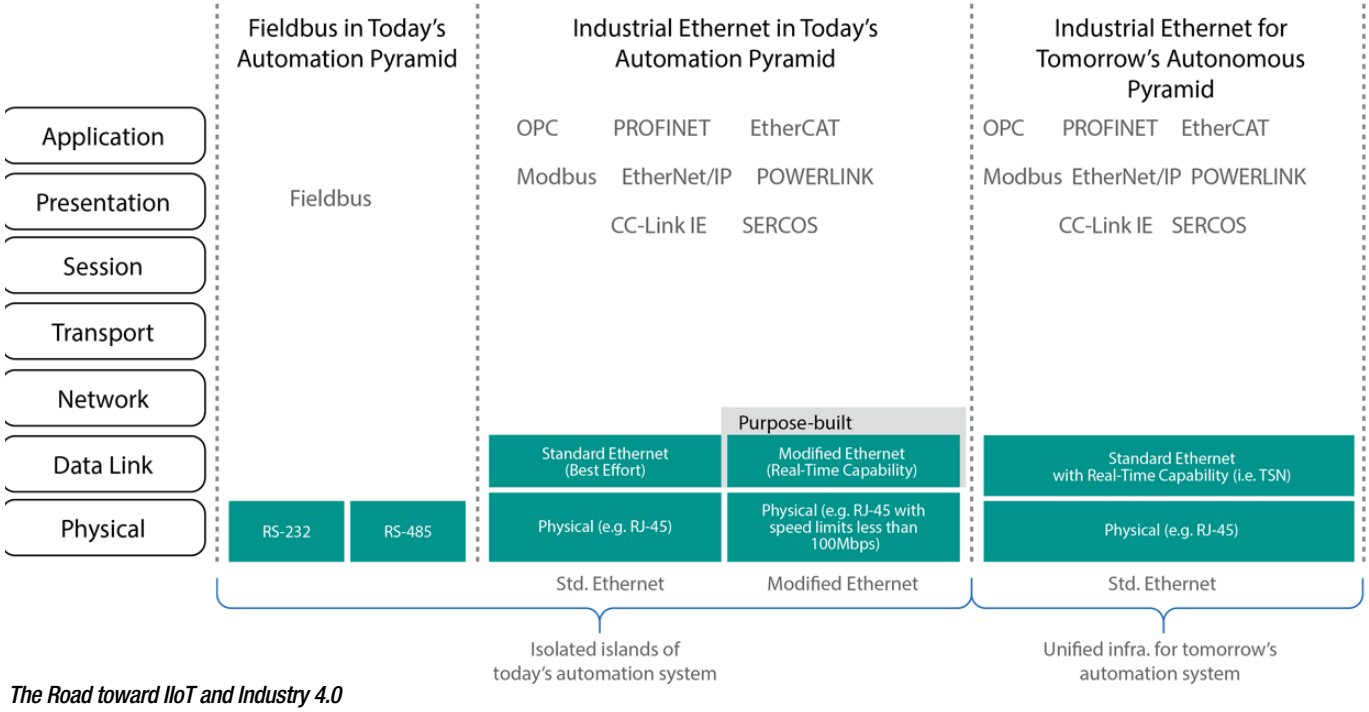
- Time synchronization
- Latency
- Reliability
- Resource management

As the name "Time-Sensitive Networking" suggests, TSN requires all network equipment to implement IEEE 802.1AS (IEEE 802.1AS-Rev in the future), which defines standards for timing and synchronization. After all, a shared concept of time among all end devices and Ethernet switches is one of the key characteristics of deterministic networking. In addition, IEEE 802.1Qbv defines how devices must transmit time-critical frames according to a hard schedule, but also retain best-effort communications for other bulk traffic sharing the same "line".

Besides the network infrastructure itself, TSN also requires a new approach to handling data streams and corresponding requirements that require more complex computations.

Consequently, IEEE 802.1Qcc defines the management interfaces, mechanisms, and principles for enabling a new approach to network administration.

For illustrative purposes, TSN can be viewed as a railway system where trains are analogous to Ethernet frames of data. In this example, Ethernet switches and end devices are like railway stations. Imagine what would happen if each railway station kept a different local



SOURCE: MOXA

The Road toward IIoT and Industry 4.0

time without following a strict timetable for the entire system.

If a train departs from Station A, how will passengers know when the train will arrive at Station B if the stations do not share a common reference for time? This problem was precisely why railroads began standardizing time for railway passengers and trains, and also demonstrates why industrial networks require time synchronization.

Managing network traffic

An integral part of TSN is a management model that manages and directs traffic streams on the network and allows the family of IEEE protocols to be configured for successful operation on the same network.

In our railway system analogy, the network management model is akin to a railway signaling system that handles train (data) traffic, so the trains (payloads) arrive at their destinations without colliding with one another. As stated in the IEEE P802.1Qcc protocol, there are three possible management models, which include a fully centralized model, a fully decentralized model, and a partially centralized model.

In the fully centralized model, end devices initiate communication with the centralized management entity regarding their stream requirements. The centralized management entity then uses these requests to work out the necessary schedule of streams on the network to satisfy those requirements and configures the switches and end devices (represented by railway stations in our analogy) accordingly.

In the fully decentralized model, open streams are offered by talkers to listeners (usually end devices) and an application on an end device notifies the network elements along the way to reserve the resources required for a particular stream. No central management entity is necessary in this approach.

Although there is a centralized management entity in the partially centralized model, the data from the end devices are passed to the closest bridge over a standardized protocol before being forwarded to the centralized management entity. In other words, the centralized management entity in the partially centralized model only manages individual network traffic streams and resources without addressing, at a global level, the stream requirements or payload data from every end device.

As defined by the IEEE 802.1CB protocol, "Standard for Local and metropolitan area networks - Frame Replication and Elimination for Reliability", TSN stream identification offers several different ways to identify streams. These methods include destination MAC address and VLAN identifier, source MAC address and VLAN identifiers, and others. In addition, stream Identification is used to compute the flow of data for a specific stream through the network as well as to handle redundant paths for fault tolerance.

Fully centralized model

Although the fully centralized network management model is not the only approach for handling traffic in Time-Sensitive Networking, the model is the most straightforward of the three methods for illustrative purposes. As previously discussed, the fully centralized network management model has a centralized management entity that performs two critical roles. In the following diagram, these functions are represented by the Centralized User Configuration (CUC) and Centralized Network Configuration (CNC).

The fully centralized TSN model includes the following five components:

End Stations (Talkers and Listeners): These end devices run applications that require time-critical deterministic communications and function as the sources (talkers) and destinations (listeners) of the Ethernet frames transmitted through the TSN system.

Bridges (Ethernet switches): TSN bridges are Ethernet switches that send and receive the Ethernet frames comprising the time-critical communication streams. The hardware can be developed by any vendor but must be capable of transmitting messages according to a strictly synchronized schedule.

Centralized User Configuration (CUC): The Central User Configuration is a vendor-specific application that communicates with the CNC and the end devices. The CUC represents the control applications and the end stations, requesting deterministic communication with the CNC.

Central Network Configuration (CNC): The Central Network Controller is a vendor-specific application that facilitates deterministic messaging for control applications on the network and defines the schedule according to which all the time-critical information streams are transmitted and then deployed to the TSN-enabled bridges (Ethernet switches).

Time-Critical Information Streams: The information transmitted between talkers and listeners in the TSN model comprise time-critical "streams". Each time-critical information stream between talkers and listeners in the TSN model is uniquely identified by the end devices and has stringent time requirements that need to be honored for deterministic messaging.

In contrast to the fully distributed or partially centralized models that only handle individual requirements or network capabilities separately, the fully centralized TSN model uses centralized methods to represent both the "user requirements" and the "network capabilities" in order to automatically integrate all components throughout the entire system. Although the fully centralized model offers improved integration, more complex computations are required to ensure better network utilization. In the end, whichever TSN model you choose depends on the particular requirements for your application and fall outside the scope of the IEEE standards developed by the TSN task group.

Coming together for Industry 4.0

TSN technologies offer a scalable, predictable approach to deterministic networking over standard Ethernet. But since TSN is more of a toolbox than a single, comprehensive solution, system integrators must ultimately rely on independent vendors and multiple protocols to satisfy the specific requirements for each industrial application. This predicament is precisely why interoperability is the key to ensuring the success of TSN adoption. Ultimately, a unified infrastructure based on TSN fundamentally requires interoperability on two critical fronts:

- A common architecture that is TSN-compliant for Layer 2 networking and messaging
- Common semantics for communication across multiple protocols throughout the network

Recognizing the benefits of Industry 4.0 and the future of smart manufacturing, global standards organizations, working groups, and independent vendors are putting their "best effort" into building a common infrastructure and enabling interoperability so that machine-to- machine collaboration, data access from cells, and more applications can be realized.

Layer 2 interoperability

As a deterministic Ethernet standard, TSN is essentially a Layer 2 technology within the Open Systems Interconnection (OSI) model of computer networking. Also called the Data Link Layer, Layer 2 encompasses technologies that are programmed to forward Ethernet frames.

In order to fulfill the Industry 4.0 requirements of real-time communication over low-latency networks, robustness despite high network loads, and converged data transport for both information technology (IT) and operation technology (OT), many Ethernet switch manufacturers and industry organizations are adopting the open TSN standards developed by the IEEE.

In collaboration with other leading Ethernet switch providers, Moxa contributes directly to the development of Layer 2 technologies by implementing deterministic Ethernet communications on future-ready solutions that conform to IEEE 802.1 TSN standards. With TSN-ready Ethernet switches from manufacturers like Moxa, system integrators can fulfill the high-bandwidth real-time requirements of Industry 4.0 without changing their existing application programs.

Furthermore, they can do this and add "plug-and-produce" devices to converged networks by simply using standard IEEE Ethernet switches. Indeed, TSN-ready Ethernet switches enable highly deterministic networks for IIoT and Industry 4.0 applications that perform as well—if not better than—traditional proprietary systems. In addition to delivering scalability, flexibility, high bandwidth, and high availability, TSN Ethernet switches are cost effective to deploy and maintain.

Besides providing the standard Ethernet hardware used to construct a unified infrastructure that conforms to TSN standards, Moxa has been actively participating in cross-vendor TSN plugfests (events where the designers of electronic equipment test the interoperability of their products for a technical standard with products of other manufacturers) and testbeds around the world.

Interoperability beyond Layer 2

Even though devices within the "autonomous pyramid" of the future can be developed by independent vendors, each piece of equipment must be able to communicate with every other component in the system—not just Layer 2 devices—in order to realize the full benefits of the Industrial Internet of Things. Besides removing the barriers that isolate traditional islands of automation at the Layer 2 level, a successful TSN implementation requires protocol interoperability across layers to enable more flexible topologies and open up new opportunities for industrial applications.

OPC UA companion specifications

The OPC UA companion specs allow companies with existing machines communicating via different protocols to map to the OPC Unified Architecture enabling the IIoT communications. In fact, EtherCAT, MTConnect, PROFINET, Sercos, Powerlink, and others has accomplished their mapping into OPC UA companion specification.

The OPC UA companion specs provide a way to represent different industrial protocols where the information usually structured in different format into a shared universal language (OPC UA). In this way, machines from different vendors can enable interoperability without immediately abandoning their existing systems and protocols.

A universal language: OPC UA

Although the OPC UA companion specs provide an intermediary solution for machine interoperability, a new initiative is to leverage OPC UA as a common platform for all levels of applications from field to cloud no matter horizontally or vertically. Since OPC UA can be used to completely describe complex systems and semantics, it is possible for industrial automation applications to leverage OPC UA for "native" protocol interoperability combining with the support of TSN technologies. For instance, if everyone in the world spoke the same language, nobody would require a dictionary to communicate with anyone else.

Indeed, the benefits of seamless interoperability without the need to translate between different protocols are clearly driving industry organizations and independent vendors to support a common language (OPC UA) for the future of industrial automation.

By adopting one unified network infrastructure, it is possible to enable bilateral IIoT data communications from sensors, actuators, machines, and controllers on the factory floor to the cloud without sacrificing performance on the industrial control/ automation. However, greater integration and interconnection also exposes industrial systems to cybersecurity risks. But just because there are risks involved does not mean manufacturers should avoid adopting IIoT technologies and forgo the benefits of Time-Sensitive Networking over standard Ethernet.

Thankfully, IEC is also developing global standards for industrial network and system security, such as IEC 62443. Consequently, choosing these advanced technologies can shore up the unified architecture of future IIoT networks and mitigate the risks of tapping into the opportunities afforded by Industry 4.0 and digital transformation.

Unified foundation for success

Today, the arrival of Time-Sensitive Networking means that standard Ethernet technologies are able to provide deterministic services, evolving beyond the traditional limitations of best- effort communications. With TSN, manufacturers no longer need to confine their applications to isolated islands of automation with purpose-built protocols and control systems.

Instead, industrial applications can look forward to an integrated future with new bilateral communication flows that transcend the horizontal and vertical compartments of the traditional Purdue model.

Indeed, as international standards organizations and device vendors like Moxa continue to coalesce around TSN, standard Ethernet technologies are well positioned to become the future foundation of industrial networking in the IIoT era.

*Jack Lin, Product Manager, **Moxa**.*

Visit Website

OPC UA over TSN – experiences with integration and evaluation

The need for edge computing means more connected devices that interact with the real-world based on the data they receive. As computing power becomes pervasive, so does the need for security to address increased cyber risk. Only relying on firewalls is no longer effective with converged IT and OT networks.

IN SEPTEMBER 2016, A GROUP OF THE WORLD'S largest automation companies announced an initiative at SPS for the standardization of OPC UA over TSN as a universal, vendor-independent industrial communication platform. From the onset the goals of full interoperability and convergence for industrial automation components and data access "from sensor to cloud" were clear.

However, large parts of the technology were new and not yet proven in industrial use, industrial standards needed to be created to achieve openness and interoperability, and major obstacles to technical realization were expected by some skeptical voices.

In this article, we will look at the situation today and see how users of the technology who are currently integrating and evaluating OPC UA over TSN for their automation components and systems fared with respect to these concerns.

SOURCE: SHUTTERSTOCK

OPC UA over TSN has already proven itself ready for several industrial use cases.

Users of OPC UA over TSN

As a supplier of the core technology elements, TTTech Industrial is working with automation component manufacturers that are integrating TSN capabilities into their products. We are also discussing benefits, developing prototypes, and evaluating functionality and performance of OPC UA over TSN with potential end users who want to prepare for the introduction of the technology into their systems and get a better understanding of the implications, capabilities and possible pitfalls.

This has given us insight not only into requirements and upcoming use cases for this technology, but also into the practical issues that potential users of this technology have encountered, and will encounter, when getting hands-on with OPC UA over TSN products.

Depending on the position of their product in the automation system hierarchy, companies need very different building blocks and steps for integrating and utilizing these technologies.

Chip makers adding TSN capabilities to their switch chips or NIC components can integrate TSN features into their FPGAs and ASICs for use in standalone switches or switched endpoints. There are also some TSN-enabled endpoint chips such as the Intel i225.

Device manufacturers developing TSN enabled industrial switches and endpoints using either dedicated ASICs or an FPGA-based solution for TSN networking, as well as software stacks implementing various Ethernet and TSN related protocols and functions such as synchronization and configuration. For OPC UA, embedded stacks are available from several vendors and open source initiatives.

System integrators building entire systems such as machines or production cells can most clearly see the benefits of OPC UA over TSN, as they are particularly evident on the system level.

The controllers and devices used to build the system must include the hardware and software components to enable the use of OPC UA over TSN on the system level, and the system integrator needs configuration and testing capabilities for OPC UA over TSN.

In this article, we are contrasting the expectations and doubts that accompanied the initial steps to develop OPC UA over TSN as an industry-wide standard for communication with the experiences and feedback regarding OPC UA over TSN prototypes for machine-to-machine use cases. These experiences result from concrete evaluations and integration of solutions by technical specialists together with customers during the past year.

This provides a 'snapshot' which shows which steps are typically taken to evaluate current state-of-the-art building blocks for this technology, how relevant some of the initial concerns were and if they have been resolved, which expectations were met, and where more development is needed. It also shows how different use cases can drive and adopt the same technology with very different focus and speed.

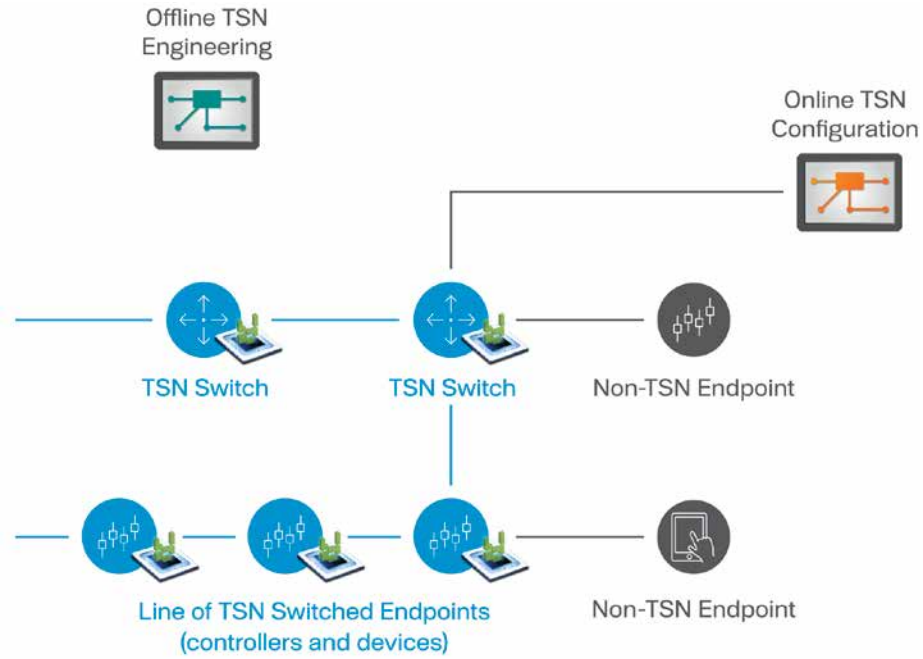
When we discuss various issues that early adopters encountered with this technology, we will try to separate what is inherent in the technology e.g. resource consumption of software stacks, from what is related to product design e.g. user interfaces of configuration tools.

Feedback from early customers allows vendors to improve their products with respect to functionality, performance, and usability, while constraints and issues relating to the technology itself should not be resolved by vendors in a proprietary way and instead need to be addressed by industry standards. The ongoing TSN work on configuration enhancements (IEEE 802.1Qdj) is an example for this.

Evaluating TSN separately from OPC UA

To fully experience the benefits of vendor-independent interoperability and IoT connectivity from sensor to cloud requires that OPC UA and TSN are used in combination, but this is not a hard technical requirement and the two technologies offer independent functionality.

Many companies interested in the combination of OPC UA and TSN have prior



SOURCE: TTTECH INDUSTRIAL

The software and hardware elements delivered by TTTech Industrial for OPC UA over TSN components

experience with OPC UA Client/Server, and therefore several evaluation projects specifically focus on TSN to find out how the networking hardware is impacted and how the TSN software stack interacts with the hardware and the operating system.

Many of the integration and evaluation projects we have supported fall into this category. The application layer in such projects sometimes consists of existing OPC UA applications, showing (not surprisingly) that an incremental approach to the introduction of OPC UA over TSN is possible. More often the application layer is simple benchmarking and measurement code to evaluate and analyze performance, latency, and other relevant properties of the TSN subsystem.

Readiness of the standards

The number of standards related to OPC UA over TSN is growing, with the aim of using the technology to address use cases for interoperability in specific applications such as the plastics industry standard EUROMAP 79, or the OPAS standard for process automation.

Any companion specification defining not only OPC UA data models for Client/Server but also the use of the OPC UA Publish/Subscribe mechanism can utilize the combination with TSN. Our customers' primary concerns were about TSN standards and their potential impact on networking hardware design.

The IEEE/IEC 60802 standard defines which of the many capabilities standardized by the IEEE TSN working group should be mandatory for TSN use in industrial automation, and how these capabilities should be utilized to achieve interoperability as well as configurability. There is a compact set of required TSN capabilities for industrial automation components: network-wide synchronization service (IEEE 802.1AS-2020), mechanisms required to achieve deterministic communication latency (known as IEEE 802.1Qbv) and frame preemption (known as IEEE 802.3br/802.1bu). The configuration services are currently extended (IEEE 802.1Qdj) and will also be part of the reference set of capabilities. TSN network redundancy capabilities (IEEE 802.1CB) are currently considered optional and will likely not be mandatory for TSN components in industrial automation, although at least some products already today support this standard and customers are beginning to evaluate these capabilities for increased network resiliency.

Although some elements of these standards are still ongoing, several chip makers have already created TSN switch components suitable for OPC UA over TSN. Sufficient progress was made concerning the capabilities related to OPC UA and TSN on hardware to provide improved latency and more determinism in networks used for real-time applications with OPC UA PubSub (and other real-time protocols, industrial or other) in combination with regular non real-time traffic such as for OPC UA Client/Server.
The resulting FPGAs and ASICs are one essential building block for the subsequent evaluations of the technology.

Benchmarking OPC UA & TSN stacks

Another important concern was and is whether OPC UA over TSN solutions require substantially more resources – mainly concerning RAM and CPU utilization – on embedded devices compared to other industrial networking technologies. Here we observed that the resource consumption of OPC UA and TSN on embedded devices in an automation system varies a lot with the amount of application functionality required by the customer for networking on the specific device.

Devices with a simple static application can be implemented with a very resource-efficient profile of OPC UA and TSN functionality. Devices that need to provide more functionality and flexibility and generally have a more demanding role in the system architecture require substantially more resources for OPC UA and TSN.

The reason for this is that there are two main storylines for OPC UA over TSN in industrial automation, the C2C (controller-to-controller or machine-to-machine) and C2D (controller-to-device) use cases.

As of today, most of the integrations and evaluations for OPC UA over TSN are focused on the C2C use case. Controllers already run operating systems where many shared libraries and existing functionality can be re-used by the TSN network stack.

Still, the full networking protocol suite has substantial memory demands. On 64-bit architectures running Linux, the average additional RAM usage for Ethernet/TSN networking on switches and switched endpoints was four to five megabytes for a NETCONF server, network clock synchronization, and networking protocols required for dynamic Ethernet/TSN operation such as LLDP and MSTP.

Similar observations have been made for other embedded operating systems. The OPC UA server's memory requirements depend on the chosen server profile and the size of the information model needed for the application. As a reference point, the frequently evaluated open62541 stack supporting the "micro embedded" server profile adds less than 100 kilobytes for very small information models.

The RAM usage then increases linearly with the amount of data elements managed, and experiments show that with one megabyte of additional RAM several hundred data elements used for Client/Server and Publish/Subscribe access can be managed in an OPC UA stack.

CPU load for TSN networking was found to be low – for a typical setup of the synchronization protocol, less than one percent of an embedded 800 MHz CPU core is utilized. In a case where an existing SNMP stack was replaced with NETCONF, the CPU utilization allocated by networking functions has even been observed to decrease.

To sum up, the resource consumption by the full OPC UA and TSN feature set can be accommodated in typical controllers of C2C use cases, such as industrial edge servers, IPCs, and high-performance PLCs. For resource-constrained PLCs and field devices in C2D use cases this might be different. But that is not necessarily an obstacle for using the technology.

Most applications using TSN only require

regular Ethernet plus clock synchronization on endpoint devices without switching functionality, and OPC UA information models will be smaller.

Easy to configure and use

The goal of deterministic application-level end-to-end communication with OPC UA over TSN is currently defined only for the Publish/Subscribe functionality when using the UADP mapping to the Ethernet/TSN driver and requires appropriate configuration of the TSN network to provide guaranteed latency for the PubSub network streams.

All other OPC UA communication over TSN capable networks is intended to use TCP/IP communication over regular Ethernet mechanisms which are provided by TSN networks as well. This is in line with the use cases defined by the various consortia and with the users' expectations of the technology.

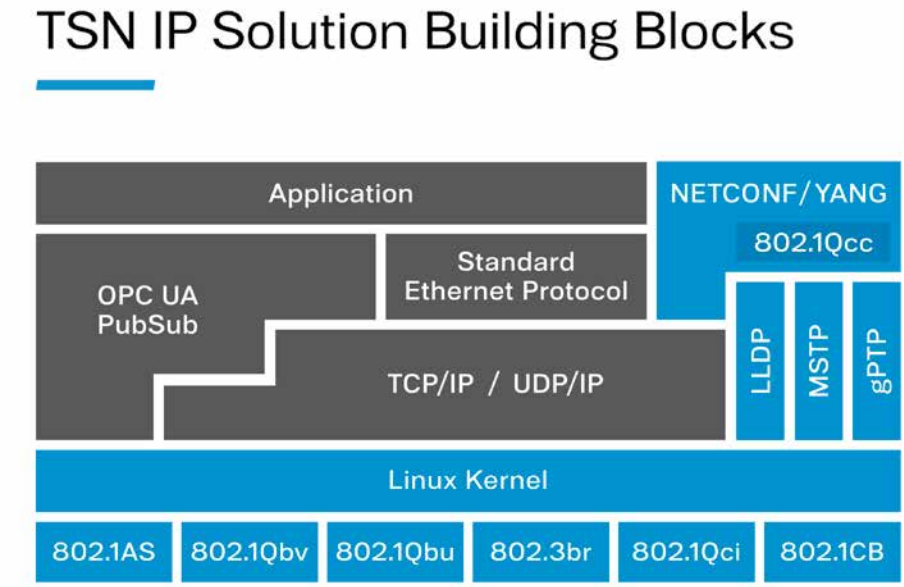
Users expect the benefits of network convergence i.e. using deterministic traffic with regular traffic on a single network infrastructure, on the same wire, even in the same network interface. However, network convergence should not require dedicated network configuration for regular traffic, it should be easy to implement, and it should be fully transparent to deterministic traffic. In addition, creating and running OPC UA applications on TSN networks should require no expert knowledge in Ethernet and TSN mechanisms from the end user.

In this area we observed very different experiences for different customers. Some configured their system with TSN configuration tools and mechanisms adhering to the official TSN standards for configuration of network components and experienced little or no issues. However, this approach requires the full TSN networking software stack (notably NETCONF) on the network elements.

Others need to or prefer to integrate the configuration capabilities into their existing configuration management system, which was found to be challenging because the TSN configuration elements needed for deterministic communication (scheduling) are different than other Ethernet QoS features.

Nevertheless, both paths – the IEEE standards for configuration, and the integration with vendor-specific configuration – are observed in evaluations, which makes it interesting to see just how well vendor-independent configuration of complex systems based on OPC UA and TSN will work for dedicated TSN network configuration mechanisms.

Here, the outlook is important. The intended solution for full integration of OPC UA PubSub with TSN, which lets the Publisher and Subscriber applications configure the TSN network automatically by means of a broker architecture, has not yet been finished in standardization.



SOURCE: TTTECH INDUSTRIAL

TSN components in Industrial Ethernet network.

Once it is available, the configuration of the TSN network streams for deterministic C2C (and C2D) communication between OPC UA PubSub endpoints will be transparent to the application developer and integrator and not require dedicated separate TSN network configuration mechanisms to be used by the integrator.

This capability, so far only shown in demonstration systems, is the important next step in the development of mature solutions.

OPC UA over TSN suppliers

The biggest benefits of OPC UA over TSN come from interoperability and convergence on the system level and therefore are most attractive to the OEM or system integrator. However, it is their component suppliers who must integrate and support the technology in their devices, and those companies have less incentive to do so, especially if their current products – without OPC UA and TSN – are functionally adequate.

This creates a "pull" situation, where the end customers in a field team up and jointly require that the technology becomes standard for the components.

Such requirements can be found e.g. in the upcoming EUROMAP 79 standard for the interface between injection molding machines and handling robots, or in the OPAS OCF (Open Connectivity Framework) which describes the open communication interfaces for process automation components such as DCS and MES. Component suppliers who are interested in supporting this kind of standard are faced with a double challenge: They have to not only integrate OPC UA and TSN as platform technologies for communication, but – and this may be the bigger challenge – also the application interfaces and functionalities defined by these standards.

For example, the OPC UA Motion Working Group defines a vendor-independent model for configuration and interaction of controllers and devices in the area of industrial motion control. For motion-control-specific functions in these devices, OPC UA over TSN is defined as the underlying communication technology, as it provides real-time capabilities, precise synchronization and very short latencies.

Conclusions

TTTech Industrial has supported and continues to support multiple integration and evaluation projects of the OPC UA and TSN technologies, mostly targeting C2C use cases by component suppliers and system integrators who need to understand how their existing products or solutions will be impacted.

In these cases, the biggest change required to support OPC UA over TSN is the introduction of switched endpoint nodes that combine controller and network switch functionalities. The necessary building blocks to add to the hardware and software stacks of automation components are already available and have successfully been evaluated in the field in various configurations and combinations.

OPC UA over TSN is still a relatively young technology, but it has been established as a common, open, interoperable platform for industrial automation communication from sensor to cloud. It has also proven itself in first use cases, showing that the technology can be applied successfully. Based on the experience gained from project implementation and customer use cases, TTTech Industrial offers OPC UA over TSN products that allow customers to quickly develop components and easily set-up networks.

*Georg Stöger, Director Technical Presales and Training, **TTTech Industrial.***

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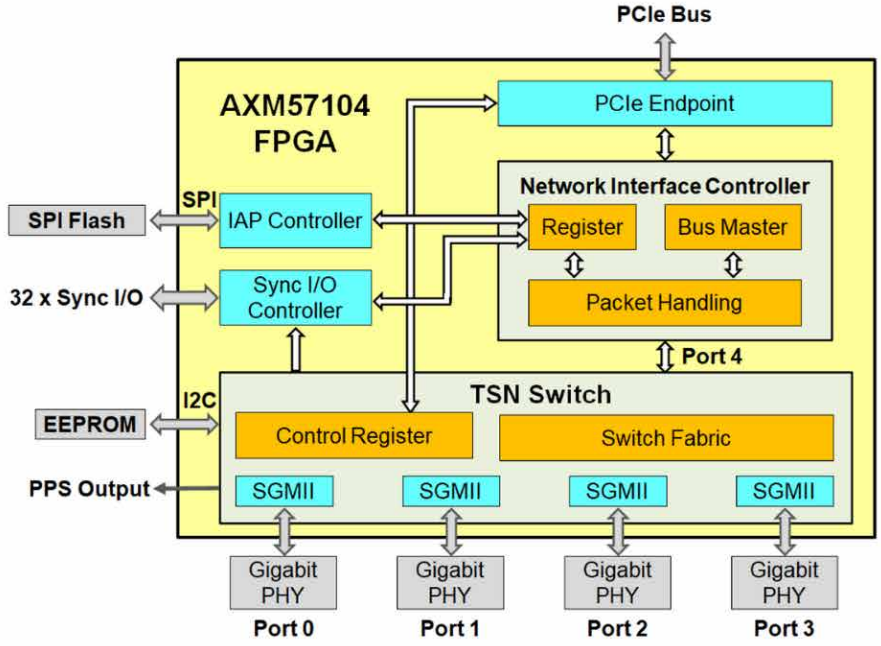
How to "practice" TSN on a Linux platform

An easy way to enter the new generation Industrial Ethernet, Time Sensitive Networking (TSN) world is by connecting PCI Express TSN network card on an industrial computer. TSN network cards on Linux platforms can provide a convenient development and testing environment to verify enhanced TSN functionalities.



SOURCE: ASIX

THE GLOBAL CORONAVIRUS (COVID-19) EPIDEMIC has continued to spread since Year 2019, COVID-19 lockdown had significantly affected the operating mode and working habits of manufacturing industry around the world, such as factory production drop, goods delivery limitation, travel restrictions, etc. The use of Human-Robot Collaboration (HRC) between human and machine is used to improve factory production efficiency and manufacturing quality. This marketing trend brings new opportunities to accelerate the development of smart factory industrial automation applications.

The global strong smart manufacturing demands brings the rapid growth of Industrial Ethernet market shares compared to classic fieldbuses. Industrial Ethernet market shares (52%) have overtaken fieldbuses (42%) since Year 2018 according to HMS' Industrial Network Market Shares Annual Reports.

The newest HMS Industrial Network Market Shares 2020 Report mentioned "HMS Networks annual study of the industrial network market shows that Industrial Ethernet increases its market share to 64% of new installed nodes (59% last year), while fieldbuses drop to 30% (35)." It means the Industrial Ethernet market shares are going higher and the classis fieldbuses market shares are going lower every year.

Time Sensitive Networking (TSN)

The standard Ethernet with TCP/IP is non-deterministic communication and is not suitable for industrial automation applications. To support real-time, deterministic communications over Ethernet, the global industrial network manufacturers have developed different industrial Ethernet solutions, such as PROFINET, EtherCAT, EtherNet/IP, Modbus TCP, POWERLINK, SERCOS, CC-Link IE, etc., and these industrial Ethernet solutions have also been practiced on respective isolated industrial Ethernet networks in factory. These isolated industrial Ethernet networks can only be connected by using different industrial fieldbus gateways.

For an Industry 4.0 smart manufacturing ecosystem, the smart factory cloud server should be able to collect and analyze all ecosystem information, such as engineering design sub-system, factory manufacturing sub-system, stocks and supply chain sub-system, etc. so manufacturers can maintain the engineering design, factory manufacturing, stocks and supply chains, etc. resources based the real customer demands more efficiently.

To reach these requirements, manufacturers need converge the non-real-time IT (Information Technology) networks and real-time OT (Operation Technology) networks into a single network. It is hard for the traditional industrial Ethernet solutions, but the new generation industrial Ethernet, Time Sensitive Networking (TSN) technology can easily converge the IT and OT networks with real-time, deterministic, security communications.

Time Sensitive Networking (TSN) technology is a set of IEEE 802.1 standards under development by the Time Sensitive Networking Task Group (TSN TG) of IEEE 802.1 Working Group. TSN is an OSI model Layer 2: Data Link Layer (DLL) communication technology so it can support hard real-time, deterministic and low latency communications over standard Ethernet. Different industrial automation machines have different industrial communication languages in factory. This problem cannot be improved by TSN technology.

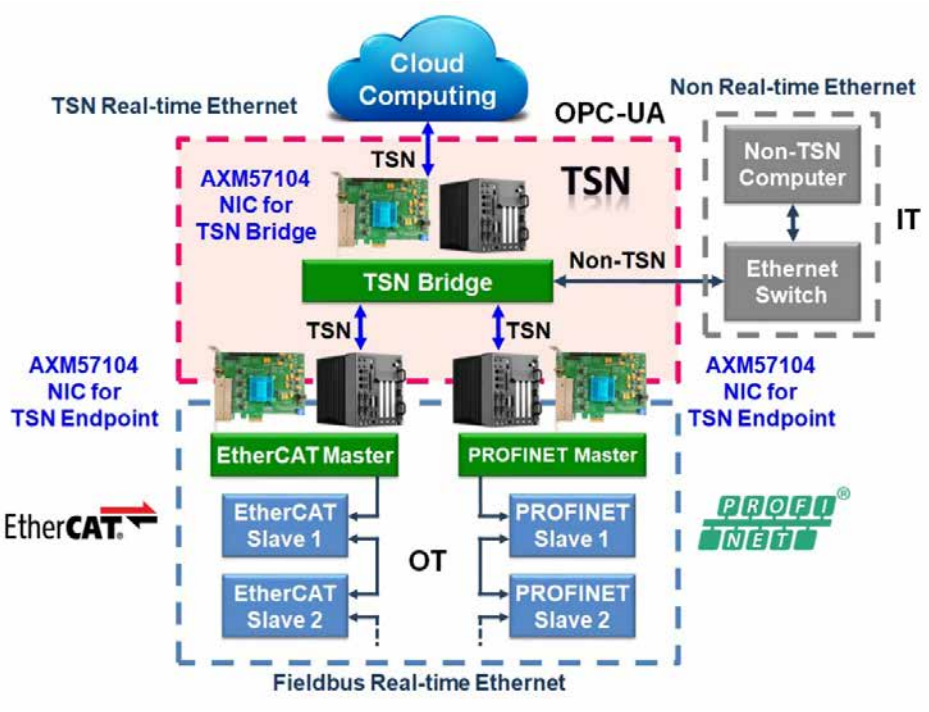
The Open Platform Communication Unified Architecture technology is a cross-platform machine-to-machine industrial communication protocol standard developed by the OPC Foundation based on the application layer of the OSI seven-layer model, which provides common industrial communication languages between different industrial automation machines. The combination of TSN with OPC UA, which provides the

key technology to realize Smart Factory and Industrial Internet of Things (IIoT), becomes a rising star of next generation industrial communication technologies.

PCIe TSN network card solutions

To help designers to evaluate TSN functionalities on industrial computers, ASIX AXM57104 Quad Port TSN Gigabit Ethernet PCIe NIC Card offers free Board Support Package (BSP) for designers to easily implement TSN functions on industrial Linux platforms.

AXM57104 supports enhanced TSN functions included the timing and synchronization compliant to IEEE 802.1AS-Rev/AS and IEEE 1588V2, the Forwarding and Queuing of Time Sensitive Streams (FQTSS): Specifies Credit-Based Shaper (CBS) compliant to IEEE 802.1Qav, the Time-Aware Shaper (TAS) compliant to IEEE 802.1Qbv, and the Per-Stream Filtering and Policing (PSFP) compliant to IEEE 802.1Qci. AXM57104 also supports 32 synchronous I/O pins, one Pulse Per Second (PPS) output and FPGA hard-core field upgradable via In Application Programming (IAP) for TSN standards evolution.



SOURCE: ASIX

The AXM57104 is a cost-efficient PCIe TSN Network Card solution for Industrial Internet of Things (IIoT) applications to enable TSN functions on industrial automation platforms, Fieldbus over TSN gateways and converge the non-real-time IT network and real-time OT networks (included different industrial Ethernet protocols such as PROFINET/EtherCAT/ EtherNet IP/etc.).

TSN NIC system architecture

The AXM57104 BSP is developed under Ubuntu 16.04 LTE with Linux kernel 4.15.0 platform, which includes AXM57104 Linux PCIe network driver, AXM57104 TSN service and applications modules, etc. Designers can easily evaluate the supported TSN functionalities on Linux platforms by running these Linux software stacks.

The system architecture of TSN network card includes the hardware blocks and software blocks as below figure. The hardware blocks with blue color are ASIX AXM57104 FPGA controller with TSN Gigabit Switch and PCIe NIC functions. The software blocks with green color are provided by ASIX AXM57104 BSP, the software blocks with yellow color can be manually installed from Linux kernel open

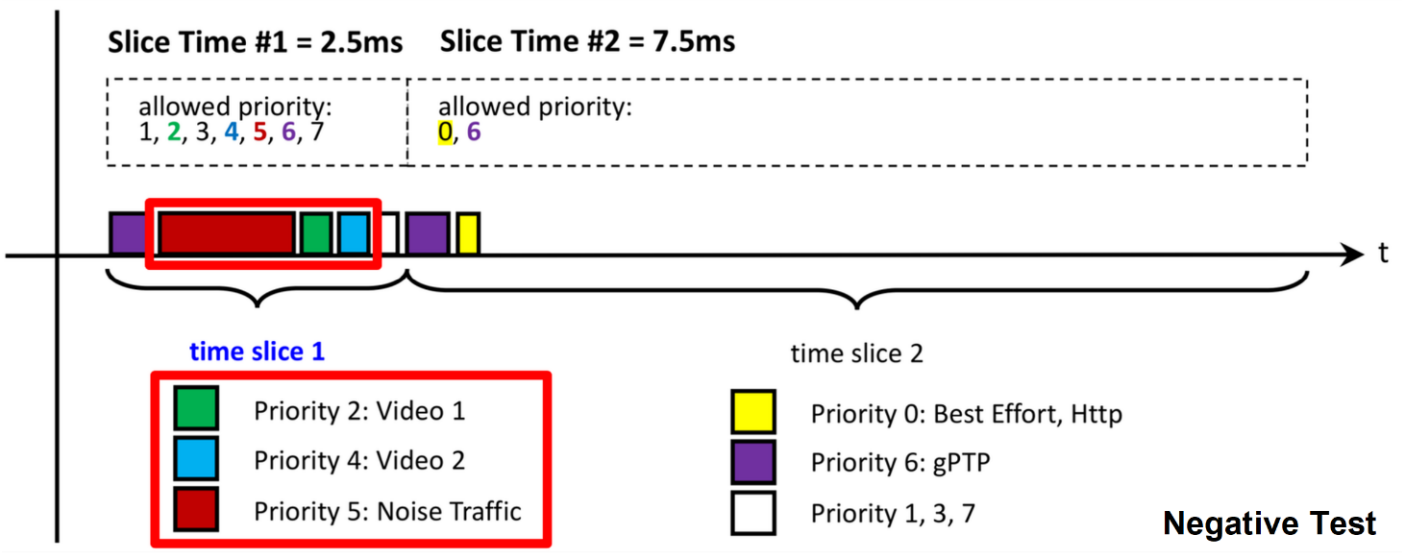
Practice TSN on Ubuntu Linux Platform

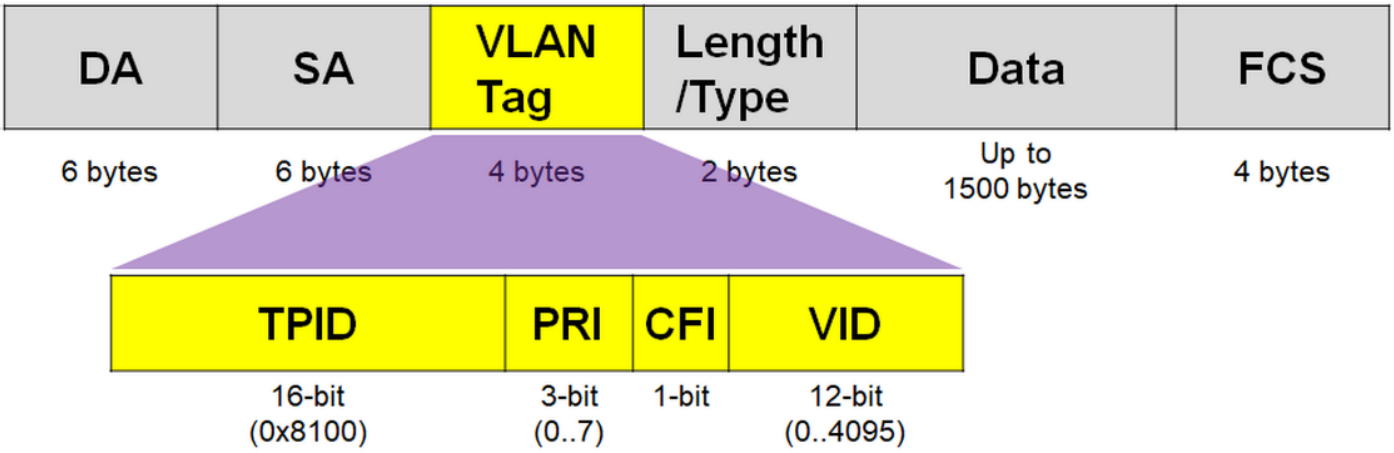
Designers can connect AXM57104 TSN network cards on Linux platforms to practice the enhanced TSN functionalities, such as gPTP Time Synchronization (IEEE 802.1AS_Rev), Time Aware Shaper (IEEE 802.1Qbv), Credit Based Shaper (IEEE 802.1Qav), etc. and run Linux VLC Media Player to verify these TSN functions.

There are three Linux platforms installed AXM57104 PCIe TSN network card to establish a TSN-enabled network. All devices in the TSN-enabled network MUST support TSN functions.

The Linux Media Server platform is configured as VLC media player server to generate the demo video streams. Need to add two visual network interfaces on AXM57104 NIC for two VLC Server video streams, one visual network interface assigns VLAN priority level 2 for VLC Server Video #1 stream; another one visual network interface assigns VLAN priority level 4 for VLC Server Video #2 stream.

The Linux Media Client platform is configured as VLC media player client to display the demo videos for verifying TSN IEEE 802.1Qbv & 802.1Qav functionalities. Need to add two visual network interfaces on AXM57104 NIC for two VLC Client video streams, one visual network interface assigns VLAN priority level 2 for VLC Client Video #1 stream;





SOURCE: ASIX

another one visual network interface assigns VLAN priority level 4 for VLC Client Video #2 stream.

The Noise Traffic Generator platform is used to generate the broadcast noise traffic. Need to add a visual network interface on AXM57104 NIC with VLAN priority level 5 for broadcast noise traffic. The priority level 5 of broadcast noise traffic is higher than VLC Video #1 and #2 streams so the VLC Video #1 and #2 streams will be stopped while the Noise Traffic Generator is generating heavy broadcast noise traffic on the same network segment. By enabling TSN IEEE 802.1Qbv or 802.1Qav functions, the VLC Video #1 or #2 streams can play smoothly even though the Noise Traffic Generator is generating heavy broadcast noise traffic in this practice.

The TSN IEEE 802.1Qbv and 802.1Qav standards are Ethernet extensions of IEEE 802.1Q standards. Therefore, the IEEE 802.1Qbv and 802.1Qav networks use 802.1Q VLAN Ethernet packets for industrial communications. The 4-byte IEEE 802.1Q VLAN header includes 16-bit TPID (0x8100), 3-bit Priority (0..7), 1-bit CFI and 12-bit VLAN ID (0..4095). The VLAN packets with higher Priority level have higher priority for data transfer. Designers need to configure proper VLAN priority values based on the pre-defined TSN network configuration.

The following are the procedures to practice TSN functions on Linux platforms by installing AXM57104 PCIe TSN Network card.

Step 1.

Load TSN PCIe NIC Linux Driver & Configure VLAN Priority Level

Install Linux kernel ptp and dsa_core modules firstly before installing AXM57104 PCIe Network Driver; restart "axm57104_service" module and then run "AXM57104_Init.sh" script to configure the network interfaces with proper VLAN priority levels based on the pre-defined VLAN network configuration.

```
# modprobe ptp
# modprobe dsa_core
# insmod axm57104.ko
# systemctl restart axm57104_service
# /usr/local/bin/AXM57104_Init.sh
```

For example, the following commands in "AXM57104_Init.sh" script will add two visual network interfaces on enp3s0 network interface, one with VLAN ID 1 and priority level 2; another one with VLAN ID 2 and priority level 4. The visual network interfaces need to be assigned with respective VLAN IDs on Linux kernel system.

```
# ip link add link enp3s0 name enp3s0.11 type vlan id 1 egress 0:2
1:2 2:2 3:2 4:2 5:2 6:2 7:2
# ip link add link enp3s0 name enp3s0.12 type vlan id 2 egress 0:4
1:4 2:4 3:4 4:4 5:4 6:4 7:4
# ifconfig enp3s0.11 192.168.5.100 up
# ifconfig enp3s0.12 192.168.6.100 up
```

Step 2.

Configure gPTP Time Synchronization

The ptp4l program is a popular Linux open source for realizing IEEE 1588 Precise Time Protocol (PTP) and TSN IEEE 802.1AS-Rev Generic Precision Time Protocol (gPTP). The ptp4l program uses TSN gPTP profile to establish gPTP time synchronization by referring to the GrandMaster (GM) clock elected by the Best Master Clock Algorithm (BMCA).

SOURCE: ASIX

SOURCE: ASIX

To run the ptp4l command on all Linux Media Server, Linux Media Client and Network Noise Traffic platforms to establish gPTP time synchronization on the TSN-enabled network.

```
# cd AXM57104_BSP_v100/Application/AXM57104_Ptp4l/AXM57104_
Ptp4l_v1.0.0
# ./ptp4l -f /etc/linuxptp/gPTP.conf
```

After establishing the gPTP time synchronization, the delta time of gPTP time synchronization between these platforms can be measured via AXM57104 PPS (Pulse Per Second) signals, the measured result is around 26 ns in this practice.

Step 3.

Verify TSN IEEE 802.1Qbv and 802.1Qav Functionalities

After finishing the pre-defined TSN network configuration, designers can run Linux VLC Media Player to verify these TSN functions.

Firstly, run the "send_stream.sh" script on Linux Media Server platform to start VLC media server for sending demo video streams.

```
# cd AXM57104/AXM57104_BSP_v100/Application/ASIX_demo/
VLC_server/
# ./send_stream.sh
```

And then, run "opera &" on Linux Media Client platform to start AXM57104 TSN Demo console.

```
# cd AXM57104/AXM57104_BSP_v100/Application/ASIX_demo/
opera-12.16-1860.x86_64.linux
# ./opera &
```

During the "AXM57104 Negative Test", which IEEE 802.1Qbv is enabled and 802.1Qav is disabled, all Video #1, Video #2 and Noise Traffic streams are allocated in the same time slice so both Video #1 (priority 2) and Video #2 (priority 4) will stop playing video while starting generating the noise traffic (priority 5). This test result is similar to the test scenario on Non-TSN-enabled networks, and it shows the non-deterministic communication disadvantage on Non-TSN-enabled networks.

During the "AXM57104 Time Award Shaper Test (Qbv)", which IEEE 802.1Qbv is enabled and 802.1Qav is disabled, Video #1 stream is allocated in time slice 1, Video #2 and Noise Traffic streams are allocated in time slice 3.

To start generating noise traffic (priority 5) will stop playing Video #2 (priority 4) in the same time slice, but won't affect Video #1 (priority 2) playing since the Video #1 is playing in different time slice based on IEEE 802.1Qbv (Time Aware Shaper) standard. This test result shows the TSN deterministic communication benefit by enabling IEEE 802.1Qbv (Time Aware Shaper) function.

During the "AXM57104 Credit Based Shaper Test (Qav)", which both IEEE 802.1Qbv and 802.1Qav are enabled, Video #1 stream is allocated in time slice 1, Video #2 and Noise Traffic streams are allocated in time slice 3.

To start generating noise traffic (priority 5) won't affect either Video #1 (priority 2) or Video #2 (priority 4) playing since the Video #1 is playing in different time slot (based on IEEE 802.1Qbv) and the idle slope of noise traffic is set to 5% based on IEEE 802.1Qav (Credit Based Shaper) standard for playing Video #2 smoothly.

Network interfaces with lower idle slope occupy less network bandwidth in the same time slice. This test result clearly shows the TSN deterministic communication benefit by enabling both IEEE 802.1Qbv (Time Aware Shaper) and IEEE 802.1Qav (Credit Based Shaper) functions.

FPGA Hard-Core Field Upgradable

Time Sensitive Networking (TSN) is a set of IEEE 802.1 standards under development by TSN TG. TSN TG continues to develop more advanced TSN standards for new industrial automation applications.

Therefore, the PCIe TSN network card solutions (like ASIX AXM57104) are developed based on FPGA controller to support hard-core field upgradable via In Application Programming (IAP) for TSN standards evolution.

Conclusion

The new generation industrial Ethernet, TSN technology enables real-time, deterministic communications over standard Ethernet for industrial automation applications, and can also converge the non-time-critical IT and time-critical OT networks to meet the requirements for Industry 4.0 smart manufacturing.

The combination of TSN with OPC UA, which provides the key technology to realize Smart Factory and Industrial Internet of Things (IIoT), becomes a rising star of next generation industrial communication technologies.

To enable TSN functions on existing industrial computers, ASIX AXM57104 Quad Port TSN Gigabit Ethernet PCIe NIC Card solution provides an easy way to evaluate TSN functionalities on industrial Linux platforms.

Allan Chou, Director of Marketing, ***ASIX Electronics Corporation.***

Visit Website

Seamless Ethernet to field devices in process automation

10BASE-T1L is a new Ethernet physical layer standard (IEEE 802.3cg-2019) that will dramatically change the process automation industry by significantly improving plant operational efficiency through seamless Ethernet connectivity to field-level devices (sensors and actuators).

10BASE-T1L SOLVES THE CHALLENGES THAT, to-date, have limited the use of Ethernet to the field in process automation. These challenges include power, bandwidth, cabling, distance, data islands, and intrinsically safe Zone 0 (hazardous areas) applications.

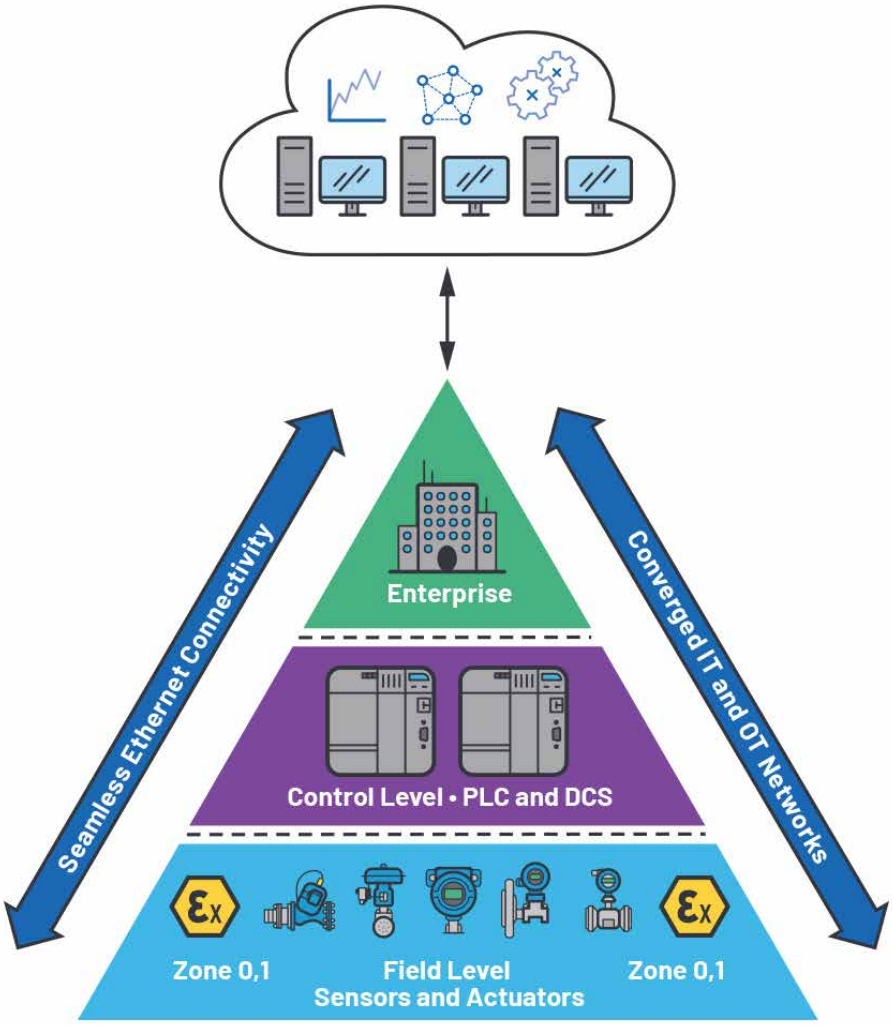
By solving these challenges for both brownfield upgrades and new greenfield installations, 10BASE-T1L will enable new insights that were previously unavailable, such as combining process variables, secondary parameters, asset health feedback, and seamlessly communicating them to the control layer and to the cloud. These new insights will awaken new possibilities for data analysis, operational insights, and productivity improvements through a converged Ethernet network from the field to the cloud.

To replace 4 mA to 20 mA or field bus communications (Foundation Fieldbus or PROFIBUS PA) with Ethernet in process automation applications, both power and data need to be provided to the sensors or actuators over a shielded single twisted pair cable. Single twisted pair cabling has the advantage of being lower cost, smaller size, and easier to install when compared to more complex cabling.

The distance between field-level devices in process automation applications has been a significant challenge with existing Industrial Ethernet physical layer technologies being limited to 100 m. With distances of up to 1 km required in process automation applications combined with the need for very low power and robust field devices suitable for use in Zone 0 (intrinsically safe) applications, a new approach to realize Ethernet physical layer technology for process automation was required. 10BASE-T1L is this new approach.

10BASE-T1L core capability is a full duplex, dc balanced, point-to-point communication scheme with PAM 3 modulation at a 7.5 MBd symbol rate with 4B3T coding. It supports two amplitude modes: 2.4 V peak-to-peak up to 1000 m cable and 1.0 V peak-to-peak at a reduced distance.

The 1.0 V peak-to-peak amplitude mode means that this new physical layer technology can also be used in the environment of explosion-proof (Ex-proof) systems and meet the strict maximum energy restrictions. It enables long transmission distance on 2-wire technology with both power and data on a single twisted pair cable and it belongs to the family of single-pair Ethernet (SPE) media.



SOURCE: ANALOG DEVICES

Seamless Ethernet connectivity to process automation field sensors and actuators.

10BASE-T1L enables significantly higher power delivery to field devices; up to 500 mW in Zone 0 (intrinsically safe) applications. This is compared to approximately 36 mW with 4 mA to 20 mA devices. In non-intrinsically safe applications, up to 60 W of power is possible depending on the cable used. With significantly more power available at the edge of the network, new field devices with enhanced features and functions can be enabled because the power limitations of 4 mA to 20 mA and field bus no longer apply.

For example, higher performance measurement and enhanced edge processing of data is now possible with the additional power. This will unlock valuable insights about process variables that will now be made accessible via a web server running on the field-level devices (field assets), and which will ultimately drive improvements and optimizations in process flows and asset management.

To exploit the rich dataset containing these valuable new insights, a higher bandwidth communications link is required to deliver the dataset from the field devices across the process installation, to plant-

level infrastructure or up to the cloud for processing. 10BASE-T1L removes the needs for complex, power hungry gateways, and enables a converged Ethernet network across the information technology (IT) and operating technology (OT) networks.

This converged network delivers a simplified installation, easy device replacement, faster network commissioning and configuration. This results in faster software updates with simplified root cause analysis and maintenance of field-level devices.

Ethernet-based solution

By converging on Ethernet as the method of communication across the enterprise, control- and field-level in process automation, the need for complex and power-hungry gateways has been removed. This also enables a transition from the hugely fragmented field bus infrastructure that has created data islands where access to the data within field-level devices is limited. By removing these gateways, the cost and complexity of these legacy installations is significantly reduced and the data islands they created are removed.

Process automation applications, to-date, have used the legacy communications standards shown in Table 1, which have several limitations that the new 10BASE-T1L standard overcomes. There is also a knowledge base challenge within process automation. Through retirement, technicians and engineers are leaving the workforce and taking with them the detailed knowledge of how to deploy, debug, and maintain installations of 4 mA to 20 mA with HART or field bus communications systems. College graduates are not familiar with these legacy technologies, but are very familiar with Ethernet-based technology and can quickly ramp up Ethernet-based networking solutions.

Ethernet standards ensure that all higher protocol layers with 10BASE-T1L work exactly as with 10BASE-T, 100BASE-TX, and 1000BASE-T, eliminating the need for complex gateways. IEEE 802.3 is where all physical layers in the ISO 7-layer model are defined

Layer	Type	OSI Model	TCP/IP Model	Authority
7	Data	Application Layer	Application Layer	RFCs, IETF, Industry Organizations, etc.
6	Data	Presentation Layer		
5	Data	Session Layer		
4	Segments	Transport Layer	TCP/UDP	
3	Packets	Network Layer	IP	
2	Frames	Data Link Layer	Ethernet Data Link	IEEE 802.1
1	Bits	Physical Layer	Ethernet 10BASE-T1L	IEEE 802.3

10BASE-T1L in the ISO 7-layer model.

SOURCE: ANALOG DEVICES

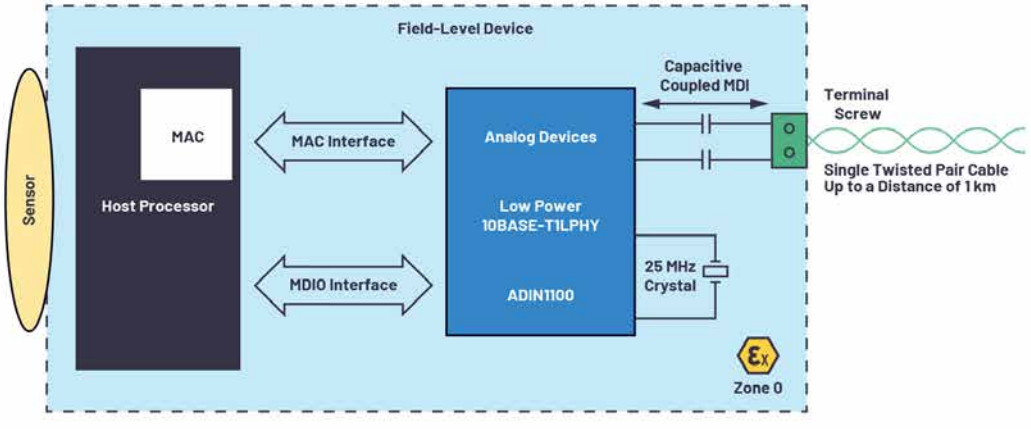
for Ethernet: 10BASE-T1L. This means that devices can now use the PROFINET, EtherNet/IP, HART/IP, OPC UATM, or MODBUS/TCP and support IoT protocols such as MQTT, which offers a simple yet powerful way to connect a field device to the cloud. Ethernet also enables simple, centrally controlled software updates right down to the end nodes, which enables faster network commissioning.

To communicate with a 10BASE-T1L enabled device, a host processor with integrated medium access control (MAC), a passive media converter, or a switch with 10BASE-T1L ports is required. No additional software, no customized TCP/IP stack, and no special drivers are required. This results in clear advantages for 10BASE-T1L devices.

Although a media converter is required for the connection of 10BASE-T1L, it only converts the physical encoding, not the content of the Ethernet packets. From the point of view of software and communication protocols, it is transparent.

With Ethernet connectivity, it is possible to configure sensors with a laptop or mobile phone, regardless of whether the sensor is on the desk or is deployed in a manufacturing plant. For example, a temperature transmitter today has an additional interface (for example, in the form of USB), in order to be able to configure the converter. Depending on the manufacturer, there are well over 100 adjustment options.

These parameters are simply not accessible today via 4 mA to 20 mA. HART allows access but is often unavailable for cost reasons. So, if



SOURCE: ANALOG DEVICES

Field-level device connectivity with a 10BASE-T1L PHY.

a mistake was made during setup at the desk, a 4 mA to 20 mA sensor would need to be reconfigured after installation on site. A sensor connected with 10BASE-T1L is accessible over the network and can be remotely updated anywhere, at any time.

- The 4 mA to 20 mA devices can only transfer one process value. Ethernet provides direct access not only to process values but to all device parameters such as asset management, life cycle management, predictive maintenance, configuration, and parameterization.
- Sensors are becoming more complex and the probability of software updates increases. This is now possible within realistic periods of time via a fast Ethernet connection, anywhere, anytime.
- Access to advanced Ethernet network diagnostic tools to simplify root cause analysis.

Process automation deployment

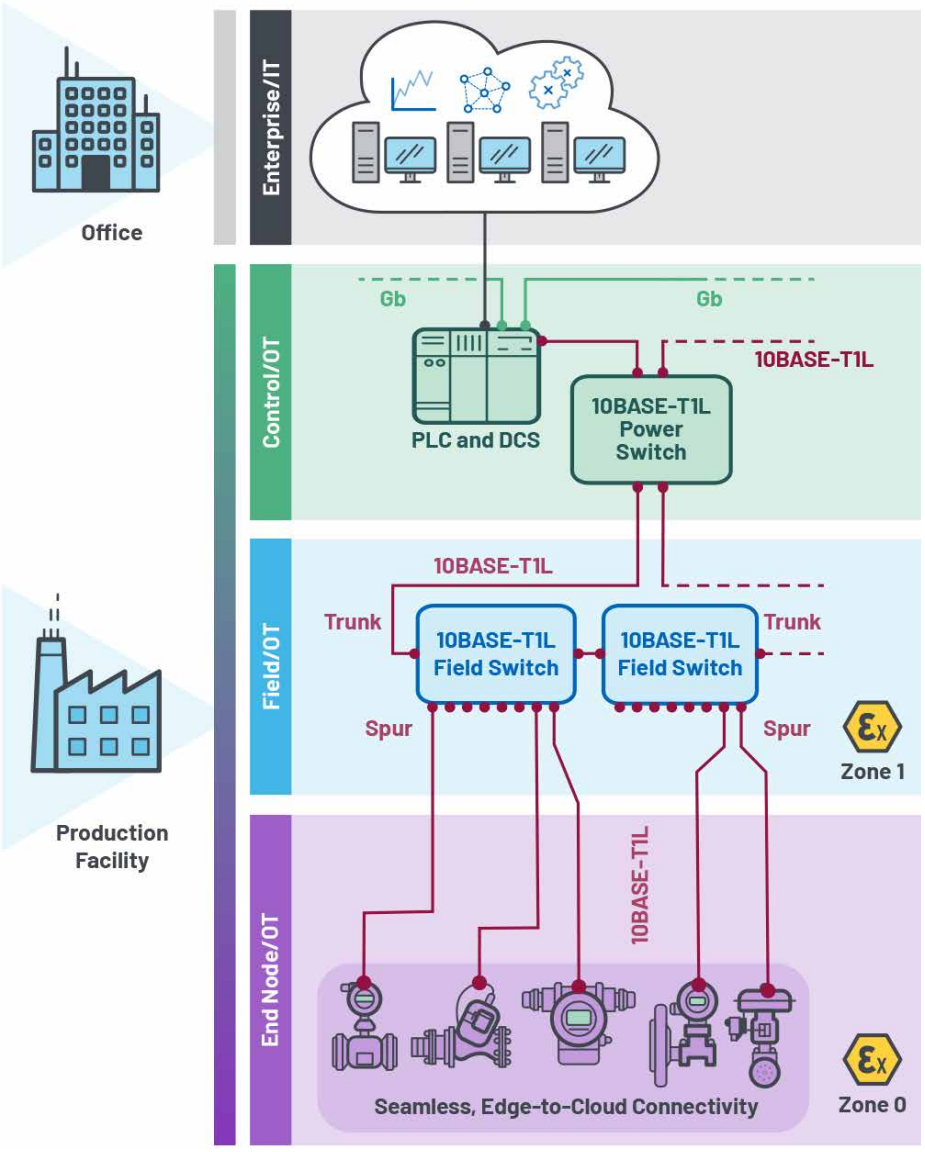
In process automation, unlike in machine building or factory automation, these sensors and actuators (flow, level, pressure, and temperature) do not sit close to the controller. Distances of 200 m between sensors and I/O are not uncommon and from there it can be up to 1000 m between field switches. Process automation uses a Type A field bus cable, as it is already used for PROFIBUS PA and Foundation Fieldbus installations today.

The 10BASE-T1L standard does not define a specific transmission medium (cable); instead, it defines a channel model (return loss and insertion loss requirements). The 10BASE-T1L channel model fits well with a field bus type A cable, therefore some installed 4 mA to 20 mA cables can potentially be reused with 10BASE-T1L, creating significant opportunities for brownfield upgrades of process automation installations.

As 10BASE-T1L allows the signal amplitude voltage to be reduced to 1 V on lines of up to approximately 200 m, 10BASE-T1L can be used in the environment of explosion-proof systems and meet the strict maximum energy restrictions of hazardous areas with up to 500 mW of power.

With the significant increase in power compared to 4 mA to 20 mA (500 mW vs. ~36 mW), today's 4-wire devices that require an external power supply due to the limited power of 4 mA to 20 mA can now be replaced with 2-wire devices enabled by 10BASE-T1L, providing more installation flexibility for new devices by removing the need for an external power supply.

The proposed network topology for the process industry is referred to as a trunk and spur network topology. The trunk cables can be up to 1 km with a PHY amplitude of 2.4 V peak-to-peak and reside in Zone 1, Division 2. The spur cables can be up to 200 m in length with a PHY amplitude of 1.0 V peak-to-peak and reside in Zone 0, Division 1. A power switch resides at the control level, provides Ethernet switch functionality, and supplies the power to the cable (over the data lines).



SOURCE: ANALOG DEVICES

10BASE-T1L network topology for the process industry.

Field switches reside at the field level in the hazardous area and are powered by the cable. The field switches provide the Ethernet switch functionality that connects the field-level devices on the spurs to the trunk and pass the power to the field-level devices. Multiple field switches are connected on a trunk cable to provide for the high numbers of field-level devices to be connected to the network.

The field switches can be connected via a ring topology to enable redundancy. At the edge, up to 10 Mbps is a major advance for most applications previously limited to a data rate of less than 30 kbps. As Ethernet is now used to connect the end node devices at the field level, IT and OT have been converged onto a Ethernet network, enabling IP addressability to any end node device from anywhere.

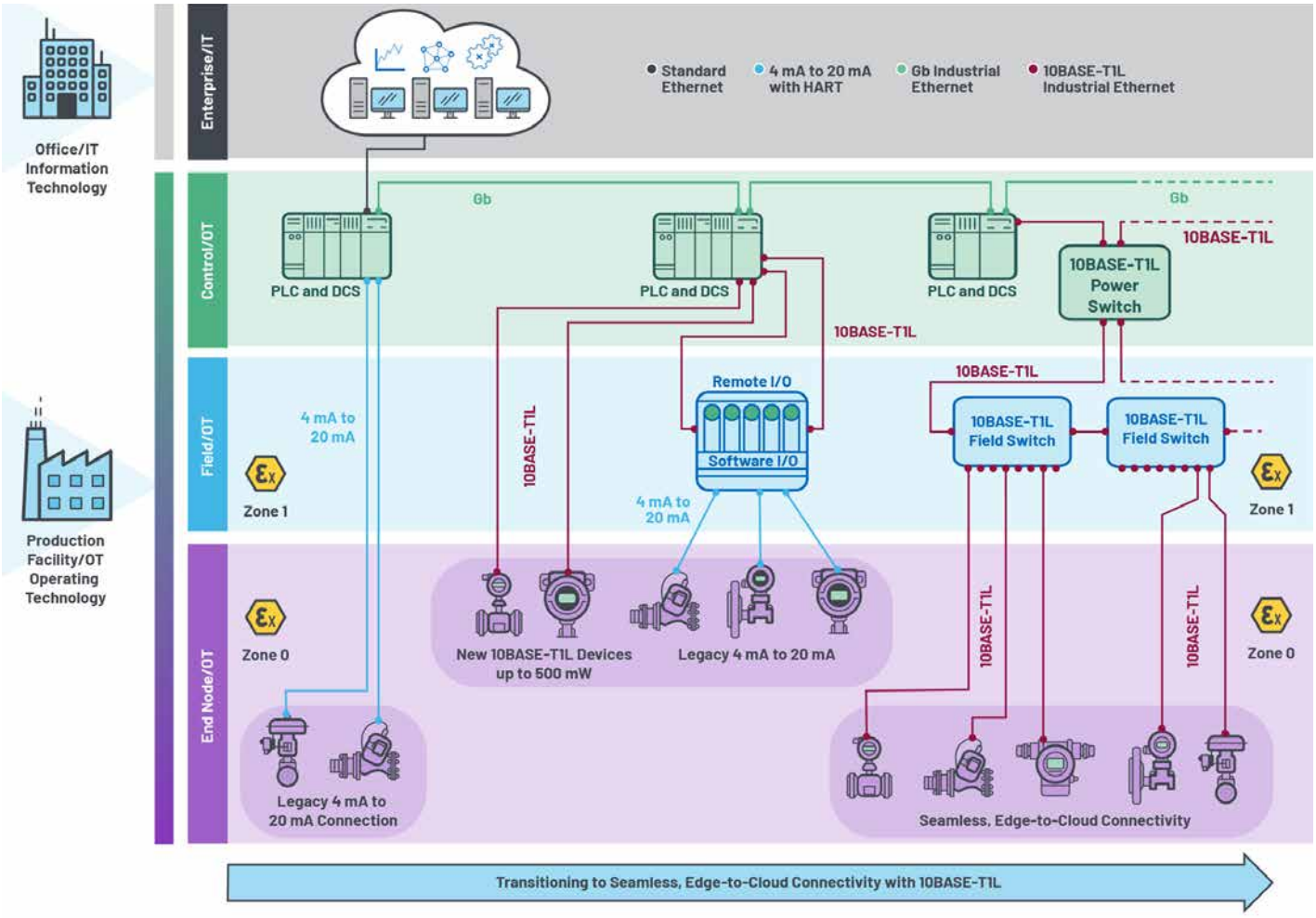
Ethernet-APL with 10BASE-T1L

Ethernet-APL (advanced physical layer) specifies the details of the application of Ethernet communication to sensors and actuators for the process industry and will be published under the IEC. It is based on the 10BASE-T1L Ethernet physical layer standard and specifies the implementation and explosion protection methods for use in hazardous locations.

The leading companies in process automation are working together under the umbrella of PROFIBUS and PROFINET International (PI), ODVA, Inc., and FieldComm Group to make Ethernet-APL work across Industrial Ethernet protocols and to accelerate its deployment.

Future seamless connectivity

The 4 mA to 20 mA connection with HART has been successfully deployed in process automation applications for many years and is a proven, robust solution that will not disappear overnight.



SOURCE: ANALOG DEVICES

Legacy discrete wiring will gradually become a smart Ethernet network of all sensors and actuators.

There is a large, existing install base of 4 mA to 20 mA with HART-enabled instruments and Analog Devices is investing in software configurable I/O, which enables more installation flexibility for these existing devices by allowing any industrial I/O function to be accessed on any pin, allowing channels to be configured at any time in remote I/O applications.

This means customization can happen right at the time of installation, resulting in faster time to market, fewer design resources, and universal products that can be leveraged broadly across projects and customers. Examples of software programmable I/O circuits from Analog Devices are the AD74413 and the AD4110-1.

The transition from legacy 4 mA to 20 mA connected instruments to a brownfield Ethernet means that new 10BASE-T1L-enabled instruments will coexist with legacy 4 mA to 20 mA instruments. Software configurable I/O connects these legacy instruments where remote I/O provide the aggregation point to a 10 Mb Ethernet uplink to the PLC.

Seamless, edge-to-cloud connectivity will be achieved in process automation with 10BASE-T1L technology. 10BASE-T1L removes the need for gateways and I/O, as well as enables Ethernet connectivity from the field devices to the control level and eventually to the cloud. Unlocking field devices will result in rich datasets for advanced data analytics.

Applications beyond process

10BASE-T1L is now gaining significant traction in building automation, factory automation, energy supply, monitoring, automation of waterworks and wastewater treatment, and, finally, elevators. All these applications share the requirements for higher bandwidth, seamless Ethernet connectivity (no gateways) to the sensor, on a single twisted pair cable supporting both power and data. Table 2 compares 10BASE-T1L with the incumbent wired technologies used today. Application examples include RS-485 used in building automation and I/O link used in factory automation.

Drive process optimization

With the addition of 10BASE-T1L physical layer products to Analog Devices' Chronous portfolio of Industrial Ethernet solutions, ADI will enable the transition to field-to-cloud connected process automation installations, including hazardous locations for food and beverage, pharmaceutical, and oil and gas installations. New 10BASE-T1L physical layer transceivers will provide the physical layer interface to unlock the many advantages of an Ethernet connected plant.

With 10BASE-T1L, Ethernet packets move from the field level to the control level, and eventually to the cloud, without gateways, realizing the goals of an Industrial 4.0 unified IT/OT network.

With significantly more power available, new types of field devices with enhanced features and functions can be enabled. Transparent IP addressability of each field-level device will dramatically simplify the installation, configuration, and maintenance of 10BASE-T1L connected instruments.

10BASE-T1L will unlock field devices, rich datasets for cloud computing, and advanced data analytics. Plant operational efficiency will be increased through the access of actionable insights from their processes, accelerating the deployment of more complex process automation production facilities in the future.

Maurice O'Brien, Strategic Marketing Manager and Volker Goller, System Applications Engineer, ***Analog Devices.***

Visit Website

CIP Safety: wireless functional safety

New designs are possible utilizing wireless communications. Plan for a collaboration between the wireless device vendor, the equipment builder and the end user. CIP Safety has been deployed already to hundreds of installations and the list continues to grow, along with a reduction in the cost of systems.

Wireless medium	Max throughput speed	Typical latency	Type	Distance
Zigbee (802.15.4)	0.25 Mbit/s	40-350 ms	Mesh	10-20 m
Bluetooth (802.15.1)	1-2 Mbit/s	40-100 ms	Point-to-point	2-5 m
Wi-Fi 3 (802.11g)	3-54 Mbit/s	1-4 ms	WLAN	35-100 m
Wi-Fi 4 (802.11n)	72-600 Mbit/s	1-4 ms	WLAN	35-100 m
Wi-Fi 5 (802.11ac)	433-6933 Mbit/s	1-4 ms	WLAN	35-50 m
Wi-Fi 6 (802.11ax)	600-9608 Mbit/s	0.1-1 ms	WLAN	35-50 m
5G	100-2000 Mbit/s	0.1-1 ms	Large Area	Wide Area

SOURCE: ODVA

Wireless EtherNet/IP: companson of wireless communications options.

APPLYING FUNCTIONAL SAFETY communication, like the CIP Safety distinctive network service on the EtherNet/IP network, over wireless/cableless communication networks can provide distinct technical benefits on moving and remote equipment. This article covers the advantages for wireless networks, followed by principles for functional safety.

Industrial communication networks, particularly EtherNet/IP, are reviewed in both wired and wireless contexts. The diagnostic capabilities of CIP Safety are introduced, followed by the procedures for deploying a successful wireless network using CIP Safety.

The last 15 years have seen unprecedented growth in industrial connectivity. This has been driven by increasing demand for system performance while being supplied by consumer and IT communication technologies that brought costs down.

At home and in the office, we have built up an expectation of how well wireless should perform. And that has led wireless communications to become the first-choice connection method at home and for many communications at the office.

Wireless solutions are becoming more common in industrial environments and for good reason.

These are some of the many places that wireless industrial communications are enabling more effective production:

- Modular and flexible plant design
- Remote process instrumentation
- Data collection on legacy equipment
- Automated guided vehicles (AGV)
- Automated mobile robotics (AMR)
- Independent cart technology (ICT)
- Automated storage and retrieval systems
- Predictive analytics for moving machinery
- Reducing cabling for hygienic design

With each new advance in technology, wireless communications achieve better performance, so there are likely to be even more cases that can be enabled. There are some organization cultural and technical barriers that must be addressed at companies adopting wireless communications within operational environments, such as achieving employee safety.

What about safety?

Safety is particularly important for mobile equipment, moving machinery, reconfigurable plants and anywhere where humans are in immediate proximity to dangerous items in the industrial control system.

These applications present unique challenges for industrial communications, such as how to communicate industrial information wirelessly and how to keep employees safe while interacting with mobile machinery. Wireless communications have been making steady improvements and many applications can be accomplished today with functional safety as part of the design.

How can safety work over wireless? First, it makes sense to consider functional safety requirements generally, and how those work over industrial communications. There are many standards related to functional safety in different contexts. The common themes for industrial control systems are:

- Reduce the risk of a component failure or system failure
- Quantify the risk of failure after reductions are in place
- Detect when failures occur
- Ensure that failures always lead to a safe state

This is done by using good design practices, applying oversized components, performing statistical analysis of failure modes and running diagnostics regularly among other techniques. Modern standards for safety system design, such as IEC 61508 and IEC 62061 specify how to apply those techniques to electronics in the system, while IEC 13849 adds in electromechanical systems. How do those good principles apply to something like networked communications, especially wirelessly?

Foundations of EtherNet/IP

We will begin with examining how standard industrial communications work. It is helpful to review the OSI model and the TCP/IP model for communications to understand how different parts of the communication system work together for the EtherNet/IP industrial communication network.

Data that must be communicated between two devices is generated in the higher, or application layer, using the Common Industrial Protocol, or CIP protocol. This is the same layer that familiar functions like HTTP and SMTP exist in.

In the transport layer, the CIP information is encapsulated. In the case of EtherNet/IP, that is a TCP or UDP header.

In the network layer, logical addressing information is added. In the case of EtherNet/IP, that is the Internet Protocol (IP) information; the packet is now ready for network access.

In the datalink layer and the physical layer, the packets are converted to the transmission media, sometimes with additional measures to avoid packet collisions. Combined these may be called network access layers.

This hierarchical organization is important because the critical user data for CIP is completed in the first step, independent of the transport, network, datalink or physical layers. With that independence different networks are possible, as well as different transmission media. That means you can use one protocol, EtherNet/IP, for communications over copper, fiber and wireless, through Layer 2 switches and Layer 3 routers. Next, we will examine how those communications work over wired links.

Wired EtherNet/IP

When using different network access layer implementations of EtherNet/IP, there are key differences to consider. Different transmission speeds, packet per second limitations and collision detection/prevention mechanisms may be in place. Further, the quality of the physical media is important to consider. These differences can be demonstrated to a small degree with fixed media like copper wiring.

One advantage of fixed systems is that their reliability is highly predictable. While there are different speeds shown, the achievable net data rate can be impacted by a limited number of factors. The primary impact for reductions in throughput is based on lost, dropped or damaged packets. This can be measured by packet loss and the bit error rate (BER). With Ethernet communications, the higher levels of the OSI model are designed to detect errors in the lower levels. The errors referenced here are primarily physical layer errors.

Packet loss can occur when cables are broken, collisions occur, or switch firmware mishandles the packet. These are all rare events when full-duplex communications are used, however the lack of full- duplex communications can increase the packet collisions; this is mitigated by the CSMA/CD protocol. This protocol allows each transmitter to listen to the shared media before starting to transmit. When a collision is detected, the two (or more) guilty transmitters stop transmitting and wait a random time interval before trying again.

Individual bit issues when using physical media usually arise from interference on the transmission media. For copper, that can be electromagnetic interference. The different grades of cables, shielding, twisting, and distance are all part of strict requirements around the physical media to reduce the risk of electromagnetic interference.

Sometimes, electromagnetic interference cannot be avoided, or long distances must be employed; fiber-optic transmission presents an effective, but costlier solution. The most common bit errors in fiber come from dirty connectors, crushed media, and imperfections in the fiber.

Wireless EtherNet/IP

For wireless (or cableless) communications, the two dominant methods use radio frequency or optical means. Most of this article will be focused on radio frequency, since radio frequency products for the industrial space are more available than optical products. When considering using wireless communications, the same metrics can be applied as wired communications.

Note that the latency is many orders of magnitude more than wired transmission. Based on the statistics above, there are fundamental differences between the different technologies available, which will dictate how they can be applied. The specifications shown can be misleading for industrial applications that may not be able to use the full capabilities. Even when multiple technologies are available, there should be some aspects of the application that can help you decide which to use – see later sections on choosing wireless technologies.

The factors driving the differences between transmission methods are separate from that of wired media, but the same metrics can be examined. For example, the bit error rate can be used to characterize wireless communications. For radio frequency transmissions between two devices there are many different factors contributing to the bit error rate, including:

- Distance
- Obstacles
- Interference

The radio waves from the transmitting devices lose strength exponentially as they propagate away from the transmitter. Even when two devices are physically close to each other, if their transmitting equipment and receiving equipment are focused for a narrow transmission field but not aligned to each other, the communications could be transmitted without being received. Similarly, obstacles can block the signal or weaken it. Finally, the geometry of a structure, the material composition and even the paint finishes can generate interference with the signal.

The interferences mentioned mean that wireless networks are reconfiguring much more frequently than typical wired networks. As signal strength changes, wireless devices will hop to another transmitter, which can create packet timeouts. In an office Wi-Fi environment, walking between your desk and a conference room with your laptop will likely trigger the transition to a new access point, however that transition does not change your productivity for the day. It happens fast enough not to interrupt your work.

Industrial communications that transition could take long enough to disrupt the process if the devices and network are not configured properly. The amount of motion will impact how often reconfiguration happens, so you should consider these four different movement profiles:

- Fully fixed point-to-point
- Movement around a fixed point
- Movement on a fixed pattern
- Irregular movement

In these cases, proper antenna design and a site survey must be considered for reliable wireless performance, as well as the impact of what roaming between base stations will do to the performance of the system.

Wi-Fi: What are the different versions?

There are many different versions of Wi-Fi that have been developed. Here are the most common designations you'll find:

Early Wi-Fi (802.11a/b/g)
Clocking in at up to 54 Mbit/s, these standards are suitable for many industrial applications.

Current Wi-Fi (802.11n/ac)
Called Wi-Fi 4 and Wi-Fi 5, each of these revisions focused on improving throughput; the bulk capacity increases benefited consumer use cases, such as file transfer and web traffic. There is not typically a benefit to using these for industrial control traffic but they can still be useful for other plant data; in rare cases, some of these features can work against industrial control reliability.

Wi-Fi 6 (802.11ax)
New additions are targeted at improving industrial applications and the Internet of Things (IoT). This includes connecting to more devices per area, lower latency, better time determinism and higher overall speed.

Fully fixed point-to-point

Fully fixed point-to-point transmission is very useful when there is no easy way to get communications between the two stations, such as through the walls of a fully sealed vessel or where adding cable ducts could cause challenges for personnel and forklifts. There is a single point-to-point connection between the wireless stations.

Movement around a fixed point

Transmission for movement around a fixed point could be best characterized as monitoring rotating equipment. A single point- to-point connection is likely to be used, however the geometry and obstacles between those points may be changing. These applications do not usually need long-range transmission, but the constant movement may influence antenna design so that it can cover the path of the moving parts. Wireless communications offer a lower-maintenance solution compared to the traditional answer, slip rings.

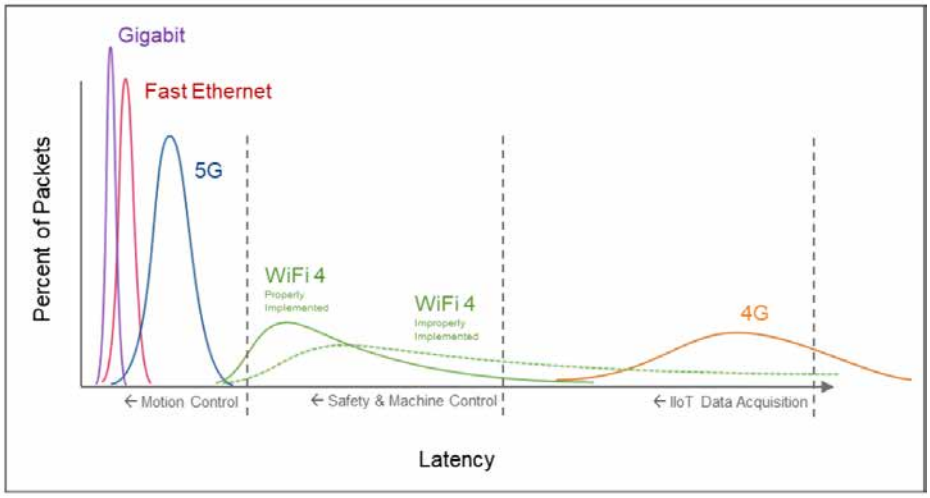
Movement on a fixed pattern

Movement on a fixed pattern can take a few forms. The simplest form could be an automated storage and retrieval system (AS/RS) or gantry crane – out and back on a straight line. A more complex pattern could be an automated guided vehicle (AGV) following an embedded path in the floor, a roller coaster following the fixed rails of the ride or a monorail transport system in an automotive factory. Each example has different considerations.

Any of these may be a long enough distance that multiple radio base stations would be required for a system like Wi- Fi to work across its entire range.Another option to consider if the path is a single continuous loop is radiating cables, also known as leaky feeders or leaky coax. These coaxial cables with engineered modifications to the outer shield create a tunnel of signal to follow curvilinear paths without creating excess radio noise outside of the path. Straight systems can sometimes use infrared or laser-based optical communications, although that requires maintaining line-of-sight between the transmitter and receiver.

Irregular movement

More intelligence in devices is contributing to an increase in irregular movement, such as autonomous mobile robots (AMR). Another example of irregular movement would be humans with a wireless communication device that is part of the automation system, such as a wireless teach pendant or emergency stop device. Keep in mind that a tablet computer used for dashboards is likely not going to cause the process to stop if communications are lost, so it should be considered more like an IT asset than an OT asset. For this case and the other cases in this section, it is likely that multiple base stations will be required to cover the space adequately.



SOURCE ODVA

Wireless EtherNet/IP: companson of wireless communications options.

More devices=more planning

Each of the examples so far considered a single wireless bridge. Realistically, your application is likely to have many wireless bridges, each following the planned motion. For a wired network, that is of little concern – full-duplex communication means that each link is an independent network connection.

With wireless, the air between stations represents a commonly shared media. Not only do wireless networks often have more constrained operating parameters than wired networks, they also behave differently as the network becomes congested. On each frequency, only one device within the transmission range can be transmitting at a time. If two devices begin talking simultaneously, both will stop, wait a random amount of time, then attempt to transmit again. Even though wireless transmitters spread their communications across many frequencies to reduce interferences, too many transmitters on too small of a frequency range will produce more collisions and reduce the overall effective throughput of the network. In these conditions, transmitting longer bursts of data is slightly more efficient from a pure measurement of throughput like bits per second (hence features like packet aggregation in 802.11n), however those benefits for raw throughput come at the cost of latency. For industrial applications, latency is usually more important than throughput. This problem plagued early wireless technologies, but modern wireless technologies like 5G and Wi-Fi 6 (802.11ax) have been tailored to higher device densities by increasing the transmission frequencies and improving the efficiency frequencies with scheduling.

CIP Safety in wireless applications

Both wired and wireless communication networks have complexity, from the device to the switch, router, through all the network media, and to another device. It would be a massive undertaking to try to make an entire communication network meet the principles of functional safety, and any change to any part of the network could require revalidation. While this idea is a theoretical possibility, functional safety over communication networks instead follow a concept called the "black channel principle", which is laid out in IEC 61508.

The black channel principle stipulates that 2 safety devices must have enough intelligence and diagnostics in their communications, that the entire communication network has zero impact on the ability of the device to detect communication errors. Even though Ethernet communication networks have considerable error detection built into them, none of that may be used to satisfy any part of the safety function.

CIP Safety devices create a logical connection to each other, independent of the network technologies being used. In the devices, common errors are mitigated with various techniques, as described in IEC 61784-3-2. Time stamps are used with time expectation to detect if packets are lost, delayed, repeated or transmitted out of order. Unique device identifiers are used to authenticate the communication between two safety devices. Additional diagnostics and checks are included to validate that the messages are not corrupted in transit and all these features are separate from standard communication methods. When these mitigations are put together as CIP Safety, a single connection between two devices, wired or wireless, can be used for communications certified up to SIL 3 per IEC 61508 and up to Category 4/PLe per ISO 13849-1.

Security for wireless applications

It is especially important to acknowledge security if you are considering a wireless installation, since it has a different attack

surface than wired networks. Traditional physical media networks have defined access points, such as cables and switches, which must be protected from access. It is relatively easy to add physical security to a traditionally wired network; if you prevent someone from plugging into the network by locking doors, you can maintain access control.

Wireless adds another dimension since anyone nearby has potential access. Luckily, the possibility for eavesdropping has been addressed for every wireless system through encryption. Any wireless system – whether deployed for home use, office use or operations use – should activate the security features available. This will typically authenticate transmitting devices, encrypt traffic between nodes and provide mechanisms to lock the configuration. Wireless networks may be more susceptible to denial-of-service (DoS) attacks because the media is the air rather than a cable in a protected facility.

Additionally, there are decisions you can make throughout the design process that can reduce the risk of stray signals being sent outside of your intended area, such as a radiating cable and smart placement of the antennae.

Additional methods should be considered for protecting all industrial traffic from end device-to-end device, such as CIP Security. That adds protection over wired links that may not have integrity or confidentiality today.

Wireless EtherNet/IP installations

There are best practices to follow as you are planning, designing and implementing your wireless system. The graphic shown to the right demonstrates how different technologies can be applied for different use cases. While not comprehensive of technologies or applications, this can be a guideline for where to start. This also shows how the distribution of packets can be dramatically changed by the specific features implemented, as shown with the Wi-Fi example.

Which technology will work best?

For motion control and very high-speed reaction times, wired networking is recommended between the controller and the device. It is possible to do some coordination of servo axes on different sides of a wireless bridge, if both of their respective controllers are local to the drives and if there is suitably small network latency and clock jitter for the time synchronization. Wireless technology available today, such as Wi-Fi (see sidebar), can be used for this with careful tuning of the system. However, Wi-Fi 6 and private 5G systems should improve the reliability of this type of deployment.

Public cellular systems like 4G LTE are unlikely to succeed due to long round-trip times, and private 4G LTE implementations never took hold in the market. Bluetooth and ZigBee systems are unlikely to succeed in these applications.

For time-critical safety and I/O applications, there are slightly more options. While the individual devices will use the safety protocol to detect failures in communications and bring the system to a safe state, it is still important to use a reliable network to get the appropriate uptime without nuisance trips. Wired networks and Wi-Fi systems have been proven for these applications when properly used. The latest revision of Bluetooth has increased its applicability to industrial control applications, including safety protocols.

While 5G and Wi-Fi 6 are still emerging at the time of this writing, preliminary testing shows that safety protocols work well over those new technologies. Be sure to compare your requirements against the capabilities of the technology you are investigating.

For other data monitoring applications, if you can tolerate higher latency, the full range of wireless technologies are available including cellular and mesh networks.

Determine application needs

You must understand what your needs for wireless will be before you start choosing technology. There are a few different characterizations that should be applied, but the first to consider will be the wireless traffic requirements.

You should try to predict what will be going across the wireless bridge: what kinds of packets (big or small), how many packets per second will be transmitted and your application information, such as control loop times and safety reaction time limits that will need to be accounted for. Vendor tools can help you to illustrate what those requirements will look like for your application.

With the basic information about what needs to be transmitted, review what kind of motion path is being considered, how many devices are transmitting wirelessly and how far the transmissions need to go. This is a good time to also consider the environmental factors that are involved, such as heat, humidity, shock and vibration.

Power consumption may influence the technology you choose. Certain wireless technologies are optimized for lower power consumption so that they can be effectively used with batteries – others are not. Is there sufficient power where your wireless bridge will be located?

Many applications that use wireless power have access to significant power, either through electrified rails or wireless inductive power transfer; both options can be coupled with rechargeable batteries. Some applications, particularly for periodic data collection, may employ single-use batteries designed for many years of operation. Your process for choosing a wireless communication technology must include power consumption analysis if batteries are the primary power source.

All factors mentioned can influence your decision for what kind of technology to use, along with which specific product characteristics are required for your antennae.

Perform a site survey

Each facility can be different and bring unique challenges to implementing a wireless system. How a facility was constructed and arranged will change where devices must be placed because different surface finishes and geometries reflect and dampen radio waves.

During the site survey, wireless equipment should be placed around the site to measure signal strength based on the placement and number of the wireless devices. It is important to perform site surveys. Your partner for wireless equipment will often have services to assist with the site survey.

Commissioning and tuning

Your wireless partner should help commission and tune the system so you reach the desired level of uptime. Since missed or delayed packets can lead to the safety function being activated, you want to make sure that packets are making it across the wireless bridge as expected.

In addition to tuning the control system, there are likely settings in the wireless devices that can be optimized to confirm that the frequent, small CIP Safety packets are prioritized over other traffic that may be on the wireless link. These settings may have small differences between vendors.

Implementing the following will help optimize and prioritize CIP Safety packets over an EtherNet/IP network:

- *A fully switched network*. This will eliminate collisions and improve the deterministic behavior of the data network.
- *Quality of Service (QoS) traffic prioritization*. QoS prioritization allows time critical traffic to have preferential handling over supervisory traffic.
- *Logical segmentation of the network*. VLANs improve security and contain broadcast messaging.
- *IGMP snooping*. This will control multicast messages that can slow the performance of the network hosts. It also exponentially reduces the amount of traffic on the network, reducing the chance for congestion and consequent packet loss.

Oliver C. Haya, ***ODVA.***

Visit Website

Signal meets power meets data in miniaturized connectors

The miniaturization of devices has led to a drive toward more compact connector solutions for both power and data transfer applications. New technology is adding building blocks to produce more compact designs, including hybrid and power applications and new HD card edge options for transferring at high data rates.

MINIATURIZATION IS A MEGATREND DRIVING development of miniaturized and flexible PCB connections technology, and often leads to clever solutions. One challenge is that there is no place where the miniaturization takes greater effect than inside the device itself.

In this regard, har-flex® technology from HARTING has already been providing flexible and compact connection solutions but now it is being equipped with two important building blocks for wide-ranging possibilities in device development: har-flex hybrid and power for compact applications with power, and the har-flex HD card edge with an 0.8 mm pitch for transferring at high data rates.

SOURCE: HARTING

The miniaturization of devices has led to the need for compact connectors for power and data transfer.

Miniaturization of devices

The miniaturization of devices is a steady process in industry but components such as connectors need to shrink even more. To address needs, HARTING has expanded its har-flex technology. Flexibility in pin count from 6 – 100, and stacking height from 8 - 20 mm, lets developers enjoy all freedoms in the development of their devices.

This factor is increasingly gaining in importance because every case is unique in the construction of industrial devices. Every connector housing needs to be able to cater to the needs for different sizes, shapes and requirements. The PCBs inside devices also are constantly required to make up for other spatial conditions. Every board needs to be at a firmly defined position for interfaces with the housing wall or other electronic components. These vary depending on the device and use. To achieve the required miniaturization here, the har-flex interface makes for a particularly space-saving option with its 1.27 mm pitch.

Signal meets power

To enable the simultaneous transfer of signals and power from one PCB to the other, the har-flex family offers a new Hybrid variant that needs to be small, flexible and robust. The har-flex Hybrid enables signal and power contacts to be combined in one insulator. A current carrying capacity of 18 A permits power to be provided while providing space-savings transferred by way of few contacts.

In the past, several signal contacts needed to be combined in this for power transmission, which was linked with greater space requirements, as well as the use of a separate connector just for the power supply. The throughput times in production are also improved, so the placement of an additional power connector can be avoided.

To prevent the power from inductively interfering with transferable data, adjoining pins can be earthed. Whoever has the room and still wants to transfer power in a small space can bank on the separate har-flex Power connector. This is of the same type as the already familiar har-flex Signal connectors and thus offers the ideal complement.

Besides the pin counts, users can choose between SMT fixing or with additional hold downs in the Hybrid or Power variant, depending on the application. The power pins are all available as THR or SMT contacts.

While the SMT contacts will leave the back of the board virtually untouched, the THR contacts offer a better heat dissipation and higher stability. Hybrid & Power variants have been created in familiar designs and offer solutions for mezzanines, motherboard-to-daughterboard and extender card connections.

Card edge for high data rates

Advanced Ethernet for IIoT applications is also an important topic on the circuit board. With the introduction of the har-flex HD (high density) card Edge, this is now advancing into even smaller ranges of board connectivity and bringing GBit Ethernet to the PCB from autumn 2020. The start is made with the har-flex HD card series Edge in a 0.8 mm pitch, which transfers up to 25 Gbit/s from board to board.

The series is designed as a one-piece-connector with pin counts from 20 to 140 contacts, meaning that the mating contacts are directly integrated in the board layout and no further connector is required.

Quality and precision

To cater to the increasingly automated production, all har-flex connectors are pick & place capable and contactable in the reflow soldering process. To also support users in their processing, HARTING sets great store by absolute precision with its components.

To be mentioned in this context is coplanarity. This describes how parallel and evenly signal contacts and retaining pins are mutually oriented in a SMD connector, which is decisive for the later quality of the solder connection. If connecting pins deviate too much from one another, the connection can be of a bad to faulty quality.

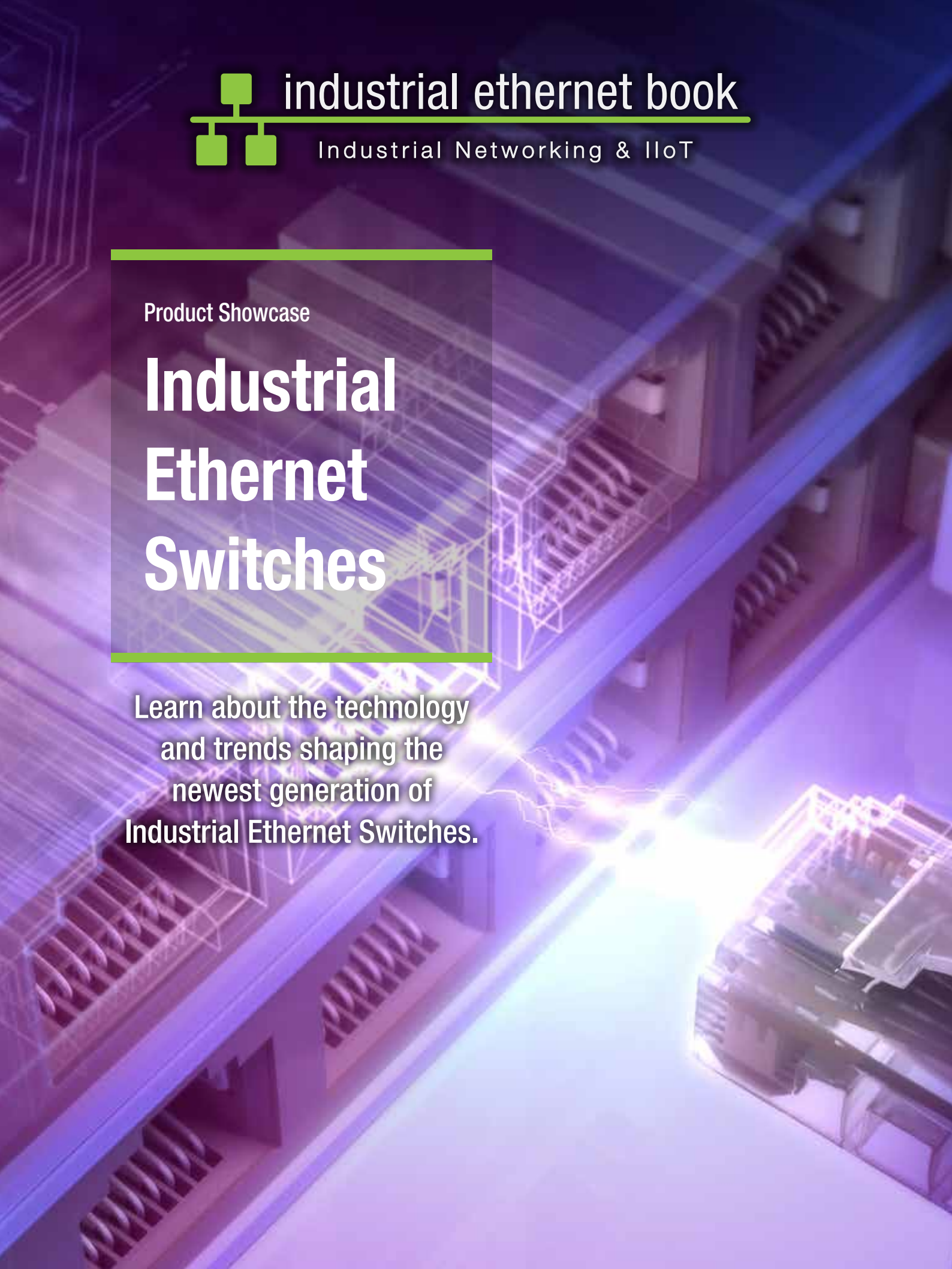
To ensure good solderability, the coplanarity of all contacts is thus continuously monitored in the production already. This guarantees the h igh quality and HARTING's own claim to reliable interfaces.

Besides an optical monitoring in keeping with IPC-A-610 Class 3 standards, which is based on externally visible criteria such as the wetting angle and filling degree, the HARTING labs also use metallographic specimens and radiotechnology to monitor the quality of soldered joints.

For a good connection besides the correct position of the contact pins is the coating used, so contacts are equipped with a tin coat that forms a reliable bond with the solder pad in the reflow process.

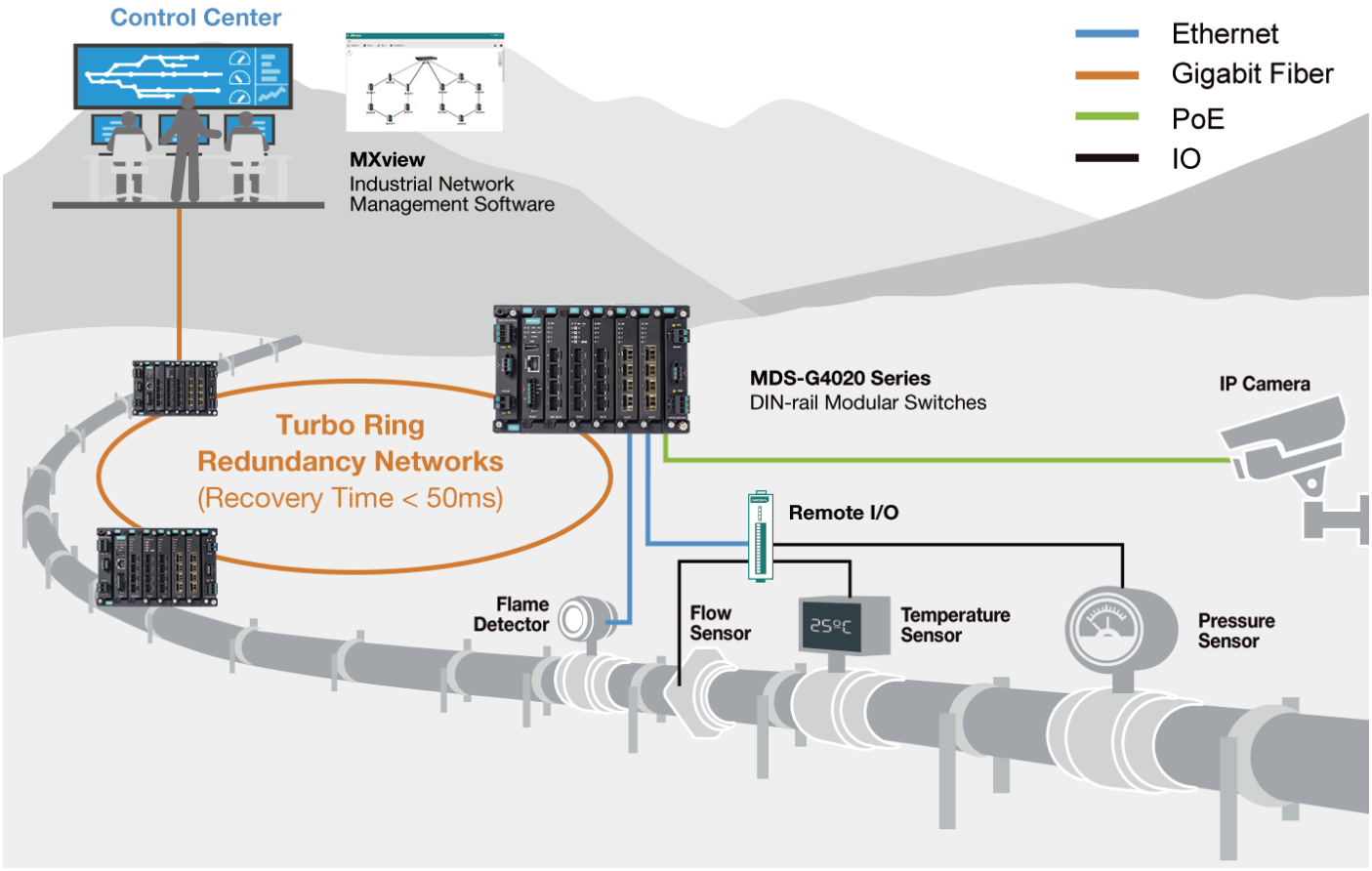
*Technology report by **HARTING**.*

Visit Website


industrial ethernet book
Industrial Networking & IIoT
Product Showcase
Industrial Ethernet Switches
Learn about the technology and trends shaping the newest generation of Industrial Ethernet Switches.

Industrial Ethernet Switches: Industry Trends

Industrial Ethernet switches and routers are effective building blocks for corporate and manufacturing networks worldwide. In this special report, industry experts provide information on the latest trends in new products, solutions to improve network management and support for new technologies such as TSN.



SOURCE: MOXA

For oil and gas companies developing a fully digitalized oilfield, switches play a key role in building a reliable network backhaul for monitoring the various integrated pipeline subsystems including IP surveillance, ventilation and fire control.

A NEW GENERATION OF ETHERNET SWITCHES is designed for industrial applications with goals of leveraging available bandwidth, increasing flexibility and implementing new technologies such as Time Sensitive Networking.

In this article, a series of industry experts provide insights into the trends shaping Industrial Ethernet switches and routers. The impact of digital transformation, and much higher numbers of connected devices, is resulting to a constantly growing number of "intelligent" network-capable components in the production environment and increases in the amount of network data.

Networking megatrends

According to Jan Aulenberg, product manager network technology at Phoenix Contact Electronics, there are currently many trends in the field of industrial network technology that are intended to enable end-to-end networking from the sensor to the cloud. Common to all technologies is the goal of ever greater networking of devices, areas and industries.

"The resulting increase in communication will become a major challenge in the future, as it negatively affects the real-time capability of networks," Aulenberg stated. "The Time Sensitive Networking (TSN) technology has been developed to ensure that the real-time properties of industrial networks can still be maintained. TSN is a set of standards that includes rules and mechanisms for achieving real-time capability in a standard Ethernet network."

This includes, for example, control and prioritization of the data streams. Individual requirements of applications such as reserved bandwidth, time synchronization or low latency are taken into account and also guarantee the real-time capability of the system. This ensures that despite the increased data traffic in the network, one application neither interferes with nor can be interfered with by other communications.

Since Industrial Ethernet Switches play an important role as communication nodes for future TSN networks, Phoenix Contact has developed the new FL Switch TSN 2300 as its first Ethernet switches for TSN.

Advantages of TSN switches

"The new switches enable the setup of time-synchronous applications and ensure real-time communication and increased availability in automation networks," Aulenberg said. "They create convergence between information

technology (IT) and industrial operating technology (OT) by implementing both real-time-critical data and data-intensive applications (e.g. video streams) over a common Ethernet line without interfering with each other."

Specifically, the devices ensure precise time synchronization with other network nodes thanks to support for the IEEE 802.1AS standard, or the gPTP protocol. For highly efficient communication of real-time critical OT and data-intensive IT traffic, the switches support the Frame Preemption function. This function enables the lossless interruption of the ongoing transmission of a large Ethernet frame until a later point in time, in favour of real-time critical data. Thanks to TSN streams, communication paths can also be selected and line capacities reserved.

Profinet TSN profile

Aulenberg added that, in total, the switches fulfill the requirements for supporting the Profinet TSN profile. At the same time, the FL Switch TSN 2300 enable user-friendly TSN configuration via Profinet 2.4 engineering.

This comprehensive managed switch feature set also makes universal use of the TSN switches possible in classic applications. Users can therefore initially implement conventional applications with the FL Switch TSN 2300 and benefit from the advantages of TSN at a later date without having to replace the communication nodes.

Application challenges

Aulenberg said that the communication of real-time-critical applications (e.g. motion control) and data-intensive applications (e.g. video streams or IT systems) is usually implemented in separate networks to prevent mutual interference. However, the increasing flexibilization and digitization of work processes require increasing networking of IT and OT and thus a merging of the previously separate systems.

"The challenge for plant planners and operators in the future will therefore be to structure and prioritize critical and non-critical data traffic in such a way that neither real-time characteristics nor performance are impaired," he added. "As a result, it is foreseeable that TSN will be relevant for almost all industries and automation applications in the future."

Making the transition to the new TSN technology as smooth and convenient as possible for users and getting one step closer to comprehensive, end-to-end networking is a major goal of Phoenix Contact. For this reason, the company participates in all relevant standardization organizations, such as the OPC Foundation or PI-International, and is actively involved in implementing the standards developed in IEC/IEEE-60802. The FL Switch TSN 2300 is only the first step towards a consistent TSN product portfolio with further devices and system solutions, but already it offers the possibility to benefit from the advantages TSN offers today.

SOURCE: PHOENIX CONTACT

One trend in the latest Industrial Ethernet switches is support for Time Sensitive Networking.

Speed, flexibility and security

Michael Lefeuvre, Product Marketing Manager-Europe for Red Lion Controls, told IEB that the prevailing technical trends for Industrial Ethernet switches are a focus on increased bandwidth, application flexibility and meeting security requirements.

"We see a trend towards Gigabit connectivity as a standard even for edge devices," Lefeuvre told IEB recently. "Additionally, communication will be prioritized in support and compatibility with industrial real-time Ethernet protocols such as PROFINET, Ethernet/IP and TSN."

"It is also important to have protection against unauthorized network ingress and communication spying. Advanced security tools supported by industrial network assets such as ARP inspection or VPN are common in order to protect the enterprise network system," he said.

The key is that new advanced technologies must be made accessible by field engineers to improve the assistance in configuration and monitoring. Assets are designed to be compatible with the automation software or be configurable by using a graphical user interface.

Technology impact on applications

Lefeuvre said that the emergence of Gigabit connectivity enables enterprise networks to use their full communication potential, and it will also open opportunities to add high-resolution videos. Advanced real-time Ethernet protocols in best conditions makes the communication reliable and stable regardless of the devices demands. So, optimization of network assets is needed.

"Security tools enable the network to detect any ingress and instability. They are improving safety, privacy and uptime in production," he added. "Intuitive and assisted solutions increase the amount of people who handle these key technologies. They learn how to develop new solutions using business standards without needing networking experts."

Challenges for applications

One impact on new innovations in switch technology is that every sector is investing in Industry 4.0 projects and, because of that, the amount of data transmitted by networks is increasing. A good example is video surveillance where high bandwidth is required for effective remote monitoring.

"Gigabit connectivity with highest network bandwidth will calibrate to support new traffic," Lefeuvre said. "On the production/machine level, data from a PLC has more priority for real-time communication such as web pages or Email. Manufacturing would be more stable and efficient if you can prioritize the individual traffic by assets."

Nevertheless, network cyber-attacks and inattention errors can have a big influence on the network uptime. Detecting unexpected connection or exchange to avoid inappropriate actions is important. Lefeuvre added that the ability for small structure/companies to implement advanced tools themselves for highly secured and reliable Ethernet must be supported.

SOURCE MOXA

The MDS-G4020 from Moxa offers a fully modular platform that can be outfitted with fiber interfaces to connect subsystems to a remote control center, over long distances, while providing wire-speed Gigabit bandwidth to aggregate and process video, voice, and data transmissions from the field.

Impact of digitization

According to Hannes Barth, Vice President - Business Line Industrial & Rugged Networks for Siemens, Industrial networking trends are influencing the development of the latest generation of Industrial Ethernet switches and routers, as suppliers develop solutions that respond to the need for higher performance, diverse application requirements and effective solutions.

The goal of the rapidly advancing digitalization of the industrial world is to make all processes along the value chain more transparent and more efficient through automation. This leads to a constantly growing number of "intelligent" network-capable components in the production environment and to sharply increasing the amount of data.

"As a result, there is a growing need for high-performance, industrial-grade network technology to ensure coordinated transfer and processing of all data," Barth told IEB recently. "The 'digital factory' places significantly higher demands on network components in OT than it is the case in IT."

"Beyond the issues of integrity, reliability and robustness, it is primarily issues such as availability, determinism and security in the industrial environment that concern the operators and users. Compared to IT security, OT has to use other protective measures. Industrial security, for example, uses the defense in depth concept in accordance with the standard IEC 62443," Barth said.

Another issue he cited is also becoming increasingly important: flexibility. And as a result, two aspects are being incorporated into future Industrial Ethernet switches and routers. On the one hand, it must be possible to flexibly integrate end devices into the network regardless of the time and space without major wiring.

"The latest Power over Ethernet standard offers, for example, a convenient solution to address this. On the other hand, flexibility is also supported by greater intelligence in end devices and network components. They have to provide, for instance, edge functionality that is easy to administer for users," he added.

Technical benefits

To be able to implement holistic OT networks, a broad portfolio of network components is required. Industrial Ethernet switches and routers are available in unmanaged and managed variants, as well as suitable for Layer 2 and Layer 2/3, from the cell to the aggregation level and even into the industrial backbone.

Barth said that, even at the cell level, high-performance Industrial Ethernet switches with up to 10 Gbit/s ensure sufficient bandwidth to connect machines and plants to the OT network. This performance can now also be combined with the latest Power over Ethernet standard, IEEE 802.3at. With up to 60 watts of power per port, even data-intensive end devices such as Wi-Fi 6 WLAN access points, HD cameras or even the latest 5G cellular routers can be flexibly integrated into the production network with just one cable for data and power.

He added that Industrial Ethernet switches with certifications such as IEC 62443 ensure the required data security in the OT area as well. This standard from the German TÜV enables operators to implement secure system architectures, which significantly increases the overall security of a plant. Network components with edge functionality represent an investment in the future. Equipped with additional data storage, application-specific software can be installed on them depending on individual customer requirements and also flexibly integrated into an edge ecosystem.

Facing innovation challenges

"Digitalization is finding its way into all areas of industries – from discrete manufacturing and process industry and electric power," Barth said. "In this context, one major aspect stands out: mobility. Over the past decades, the use of radio technologies in industry has increased rapidly. Completely new solutions will be created for industrial applications in the next years, especially with the emerging 5G cellular standard."

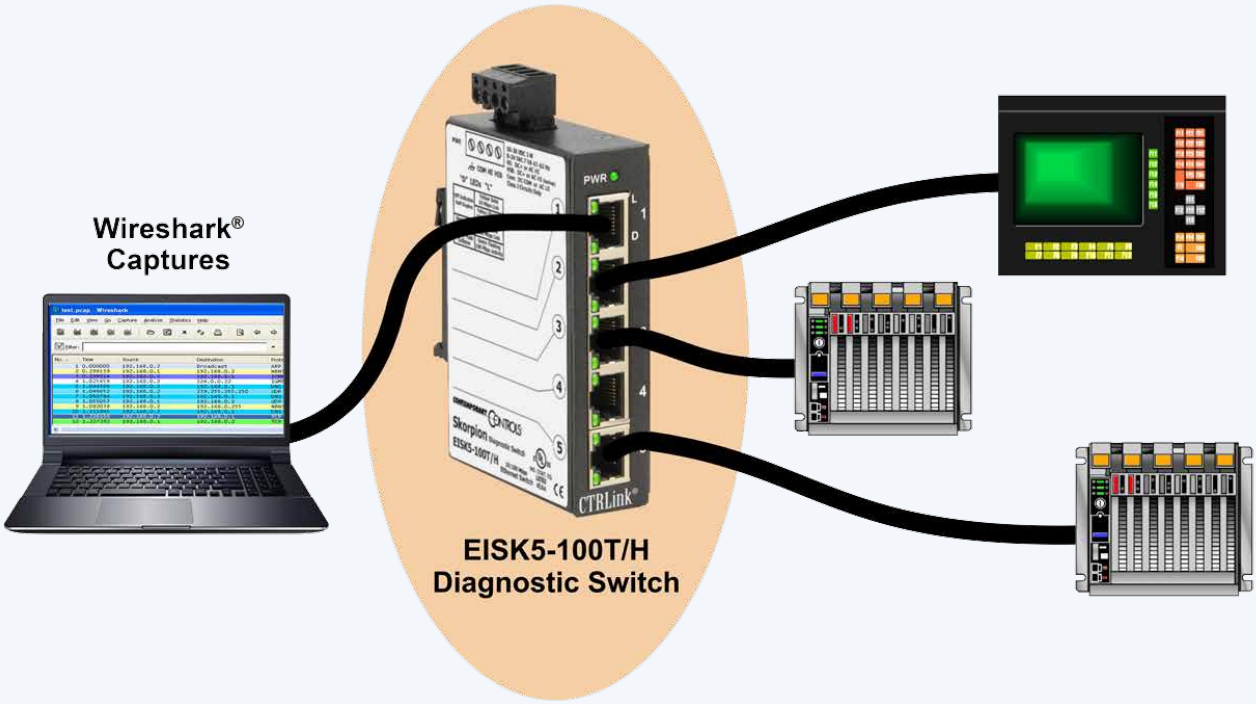
Whether it is for ports, in tunnel applications or in intralogistics – industrial components – regardless of whether wireless or wired – must be able to exchange data with the industrial network reliably, but also securely.

"As the backbone of the production network, Industrial Ethernet switches and routers must therefore provide several aspects: Robustness, security, performance and flexibility," Barth concluded. "The latter in particular is reflected in the way industrial applications will be implemented in the future. The increasing intelligence of end devices also makes it possible, depending on the production process currently taking place, to install the appropriate user software on the devices and reduce the amount of hardware required."

Particularly in industries such as specialty chemicals or pharmaceuticals, in which small quantities are often produced individually, this

Industrial diagnostic switch simplifies system testing

Testing and system debugging Ethernet switches is a significant issue for machine builders. One solution is a switch retains all the features of an unmanaged switch such as auto-negotiation and auto-MDIX while also simplifying testing and eliminating the need to cycle power for each phase of testing.



SOURCE: CONTEMPORARY CONTROLS

Protocol tools such as Wireshark can capture any network traffic that goes through the switch regardless of the port location of the traffic.

A MACHINE BUILDER COMPLAINED THAT testing with Ethernet switches was often a headache. Although one benefit of an Ethernet switch is that messages are only directed to ports party to the communication, that makes protocol debugging difficult.

"I had to turn off the Ethernet switch to clear its MAC Address table each time I moved the Ethernet cables around for different devices on the machine," the machine builder said. "Having to cycle power for each test increased the time it took to complete the project, plus it was a hassle. I wanted a way to have an easily accessed test port."

Replacing the Ethernet switch with a Skorpion diagnostic switch from Contemporary Controls simplified testing and eliminated the need to cycle power for each test.

The switch retains all the features of an unmanaged switch such as auto-negotiation and auto-MDIX except for one significant feature; it does not learn. Because it does not update its database of source MAC addresses and switch port pairings, the switch continues to flood all ports with messages as if they were broadcast messages. This allows protocol tools such as Wireshark to capture any network traffic that goes through the switch regardless of the port location of the traffic.

Instead of installing a managed switch with port-mirroring in each equipment room, the machine builder installed a switch in each control panel that had an Ethernet connected PLC Controller.

"Most of the traffic I was interested in was related to the PLC controller," the machine builder said.

The machine builder inserted the switch between the PLC controller and the IP network. Because the controller was located at the end of a single Ethernet drop, the switch acted as a three-port active tap with one connection to the PLC controller, one connection to the IP network and one connection reserved for a protocol tool such as Wireshark running on a laptop. In fact, with this setup the machine builder gained two additional spare ports.

"I don't need to leave my laptop connected," said the machine builder. "I just connect when I need to do protocol analysis, configure a device on-line, or observe web pages. With this set-up, I've gained a network diagnostic port ready at all times to be used."

The Skorpion Diagnostic Switch can be permanently installed on an installation or replaced with a regular Skorpion switch once a system is commissioned. This device can also be useful when developing embedded Ethernet devices because you can connect the switch between two embedded Ethernet devices and view their messages using Wireshark.

The switch can also be used for control panel installations where one needs the ability to diagnose problems in the field. It can also be used in a development environment when debugging code. A metal DIN-rail clip attached to the aluminum enclosure can survive the toughest installation.

Application article by ***Contemporary Controls.***

Learn More

provides great potential for savings. Industrial Ethernet switches and routers must ensure that the user software is also available ad hoc at the desired time in different areas of the industrial network.

Expansion of connected devices

Patricia Costa, Product Marketing Manager for Cisco IoT, told IEB that the challenges of increased digitization and the number of connected devices expanding exponentially are driving the need for solutions that support increased levels of automation.

"Customers are rapidly digitizing all aspects of their business to improve operational efficiency, reduce downtime and increase employee safety. But digitization comes with challenges," Costa said. "The first challenge is security. As the network expands to connect more and more devices, the threat surface also increases, which impacts the organizations' ability to identify and prevent risks."

A second challenge is asset deployment and management at scale. While the number of devices being connected is growing exponentially, resources aren't. The result is that organizations need a solution that supports automation as much as possible. Plus, new technology advances are driving the need for both higher bandwidth and Power over Ethernet (PoE) solutions.

According to Costa, high volumes of data from hundreds of devices need to be moved to datacenter and cloud in real-time for analytics. One such example is the deployment of the latest high-definition cameras such as 4K, 8K and Point-Tilt-Zoom.

High-bandwidth downstream is also needed. As an example, connecting high-speed conveyor systems, automated guided vehicles and robots to assist human staff requires fast and reliable wireless connectivity such as WiFi 5 Wave2 and WiFi 6. Many connected devices such as digital signage, HD cameras, wireless access points and Point-of-Sale terminals also need to be powered by PoE and require high wattage.

"Manufacturing and utilities plants, roadways, warehouses, distribution centers, etc. are increasingly becoming more automated to achieve more efficiency, reduce downtime and improve personnel safety and productivity," Costa said. "Secure, fast, reliable connectivity is key to realize the benefits of automation as downtime caused by network and security issues can have serious consequences and significant impact on revenue."

Routers leverage cellular technology

According to Harpartap Parmar, Senior Product Manager at Contemporary Controls, there is an industry trend that includes use of cellular technology in the newest generation of industrial routers.

SOURCE: SIEMENS

PoE capability offers method to provide network end devices with power and data via one cable.

"The adoption of cellular technology is the biggest trend in the latest generation of Industrial Routers. This includes the LTE technology for high speed networks from CAT1 onwards to the inclusion of LTE-M and NB-IoT modems for access to low data throughput sensors and devices," Parmar stated. "The high-speed cellular routers can act as backups for internet access if wired internet access is interrupted and provide continued operation and accessibility."

Parmar added that s7 support for aggregating data on these routers and gateways, along with processing data as an Edge device on the routers, has become popular. The use of common platforms like Linux provides additional capabilities for custom applications to be included on them by the end customer that were only possible on a PC before. Additional protocols like MQTT for cloud integration are also supported, and VPN support is also becoming standard on the new routers for secure remote access and IIOT applications.

Focus on integration simplicity

"The industrial routers with cellular connectivity are providing a means for quicker integration at the job site," Parmar added. "There is a requirement for access to devices without integrating them with the IT infrastructure and the cellular connectivity provides that."

"The new routers have enabled access to all sorts of application for small to medium size businesses whereas the expense for earlier devices was cost prohibitive for them," he added.

These new solutions are also easy to setup and configure providing security benefits. The ability of cellular networks to not be on public internet or to only have outbound connections is paramount importance for some applications, and this allows them to only provide data updates without the ability to local device access for security.

Remote applications

"The greatest benefit can be seen in for applications in remote locations where wired internet connectivity was not possible before," Parmar said. "The cellular routers have enabled multiple applications from managing and troubleshooting solar farms, wind turbines to name a few instances."

He also noted that processing data at the edge, and only passing the relevant information to the cloud, has resulted in cost savings. The diagnostics and analytics at the edge allow preventative maintenance to be performed resulting in no downtime.

The use of VPN technologies has enabled the use of applications from the home or office rather than having to leave a dedicated PC at the site for some applications. This has resulted in significant licensing and hardware cost savings as well.

Focus on "lean" switches

"As more devices on the factory floor are Ethernet enabled, plant engineers and technicians are in need of tools to help them increase network availability, improve network security all while reducing costs," Charlie Norz, product manager automation at WAGO told IEB recently. "Controls engineers are asking for products that can help them with network performance and reducing downtime without creating more complexity."

WAGO has developed a line of new lean managed switches that can help users with enhancing network security, increase network availability and reduce troubleshooting time. These streamlined "lean" switches provide users with all of the industrial networking features they need, without all the non-used, IT features typically found in managed switches.

"Controls engineers are looking for innovative solutions to enhance network functions while reducing system complexity," Norz added. He said that lean managed switches are focused on providing all the features needed for industrial networking by offering "a network health dashboard that uses traffic light indicators for instant recognition of a potential problem".

In addition, a topology map provides users with an easy-to-read map of connected devices and their health. Plant floor operators, technicians and engineers, as a result, can use these tools to quickly track down any networking issues.

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

Secure and reliable network switches increase productivity

A state-of-the-art industrial network provides a stable, reliable, and secure communication backbone for all operations at the Orkla Group facility in Indre Arna. The solution provides excellent availability and performance of operations technology (OT) thanks to a segmented and redundant Layer 3 network.

A HIGHLY AUTOMATED FACTORY THAT HAS been modernized and expanded nine times over the years manufactures the dry mixes for soups, sauces, cakes, and waffles that are produced by Toro, an Orkla Group brand, in its Indre Arna facility.

The latest addition to the facility is a state-of-the-art industrial network that provides a stable, reliable, and secure communication backbone for all operations. The solution provides excellent availability and performance of the Operation Technology (OT) for today and for many years to come, thanks to a segmented and redundant Layer 3 network from Siemens. It also provides a defined interface to the company's enterprise network.

According to Ståle Faugstad, technical lead for automation and IT for Orkla in Indre Arna, using the latest production technology has always been part of the Orkla tradition.

"We upgraded our operations with state-of-the-art automation systems in the mid-90s, and even today, the Indre Arna factory is very advanced in this respect. Nevertheless, several components had reached the end of their lifecycle, and Orkla could not upgrade its network security to today's standards with the existing capabilities," Faugstad said. "With the existing systems, we couldn't operate the factory any longer as we needed to. We needed to act."

SOURCE: SIEMENS

The Orkla factory in Indre Arna is highly automated and requires reliable communication for applications such as automated transport of raw materials and finished products.

Addressing the upgrade challenge

At first, a pure IT solution seemed to be insufficient. "We cannot have a failure in the network, because then we lose production," Faugstad said. So the solution had to have robust, stable, industrial-grade components and he emphasized that "we needed to have the ability to service the network ourselves locally to make sure we would have the shortest possible response times should something go wrong." In an IT environment with a standard service provision, you would typically have just one virtual local area network (VLAN).

The problem with this is that any issue can then quickly spread through the entire factory. "It´s obvious that a physically separated OT network became necessary," Faugstad said.

At the same time, need for real-time communication occurred with all the associated requirements. Finally, planning and building a new OT network is a challenging task, so a reliable partner with expertise for consultancy had to be integral part of all activities.

He said that they had gone through several re-automation phases recently, where the company upgraded installed systems to improve performance but also to maintain service the components for the long term. Among the components recently upgraded were the programmable logic controllers (PLCs) on the various machines for mixing and packaging, where Orkla introduced Simatic S7-1500 PLCs. The facility also uses many other Siemens systems, including Sitop power supplies and Simatic HMI systems. However, the automation and IT systems were proving increasingly hard to maintain in recent years, and Orkla was experiencing network stability issues.

Faugstad and his team carefully evaluated the various options and finally proposed implementing a new, dedicated industrial network for the OT level.

"The challenge was clear," he said, "but what was not so obvious was which solution would fit our requirements – a new fieldbus at the automation level or a dedicated OT network? We went to trade shows and contacted various

Solution Highlights

- Eliminated network-related production downtimes (before 3 or 4 days a year)
- Freeing up of resources for further improvements and extensions
- Higher plant performance thanks to the use of advanced applications utilizing process data
- Highly available and reliable network with real-time and safety related communication
- Sophisticated but easily manageable architecture reducing OPEX significantly

SOURCE: SIEMENS

Inside the system: Two of the high-performance Scalance XR-500 switches that form the new network backbone at the Indre Arna facility.

vendors as well as our own IT department, and in the end, we decided that the OT solution made the most sense for us."

He added: "we already had TCP/IP (Transmission Control Protocol/Internet Protocol) communication for several processes such as printing and connecting to the enterprise resource planning (ERP) level; and by upgrading our network, we could have both communications between our production departments and between the management and production floors."

Faugstad and his team opted for an industrial network solution from Siemens – and they have not regretted this decision, he says. The new network provides the uptime, reliability, security, and serviceability that the production communication requires.

At first, the IT department had some concerns regarding the type and structure of the OT systems, Faugstad said, "but we were able to demonstrate that what we needed from the network was not achievable with an IT solution alone but required production and automation expertise as part of the application."

One key differentiator between OT and IT is uptime without any failures, Faugstad said. The new OT network consists of a redundant backbone implemented as a fiber-optic Industrial Ethernet ring that links the individual VLANs

Layer 3 switches

Scalance X Layer 3 switches handle the traffic within the backbone. "This way, we can route the traffic in the OT network, which makes the backbone very fast and stable," Faugstad said. Connected to this backbone are the virtual data servers: "We have a total of 18 servers in a virtual environment that are part of the Orkla domain managed by our IT department. But we perform all day-to-day service locally ourselves. That way, we really have the best of both worlds," he added.

Linked to the backbone are more than 40 VLANs for the production floor. All VLANs are also equipped with Scalance X switches and protected by Scalance S Industrial Security Appliances. The highly segmented network architecture is another aspect that differentiates an OT network from an IT network.

"By isolating units in their own VLANs, we can limit the effect to just one cell – if anything goes wrong, the communication with parts of the mixing unit, the packaging department, or the utilities might have some issues, but not the entire production process," Faugstad said.

Some parts of the OT network require real-time communication, said Faugstad: "We have many Automated Guided Vehicles (AGVs) on the production floor, for example, in the weighing and dispensing area. Some of these have their own scales, and they need to communicate their weight readings back to the PLC for confirmation in real time – and do so every time, as the weighing of products and ingredients is critical for product quality."

In this part of the facility, the wired network is extended by a wireless solution with Scalance W, "which we have had absolutely no issues with," Faugstad added. "It works reliably in an industrial environment, and it has done so from day one. A very good solution."

Combining expertise and services

Faugstad and his team developed the application for the AGVs themselves with support from Siemens.

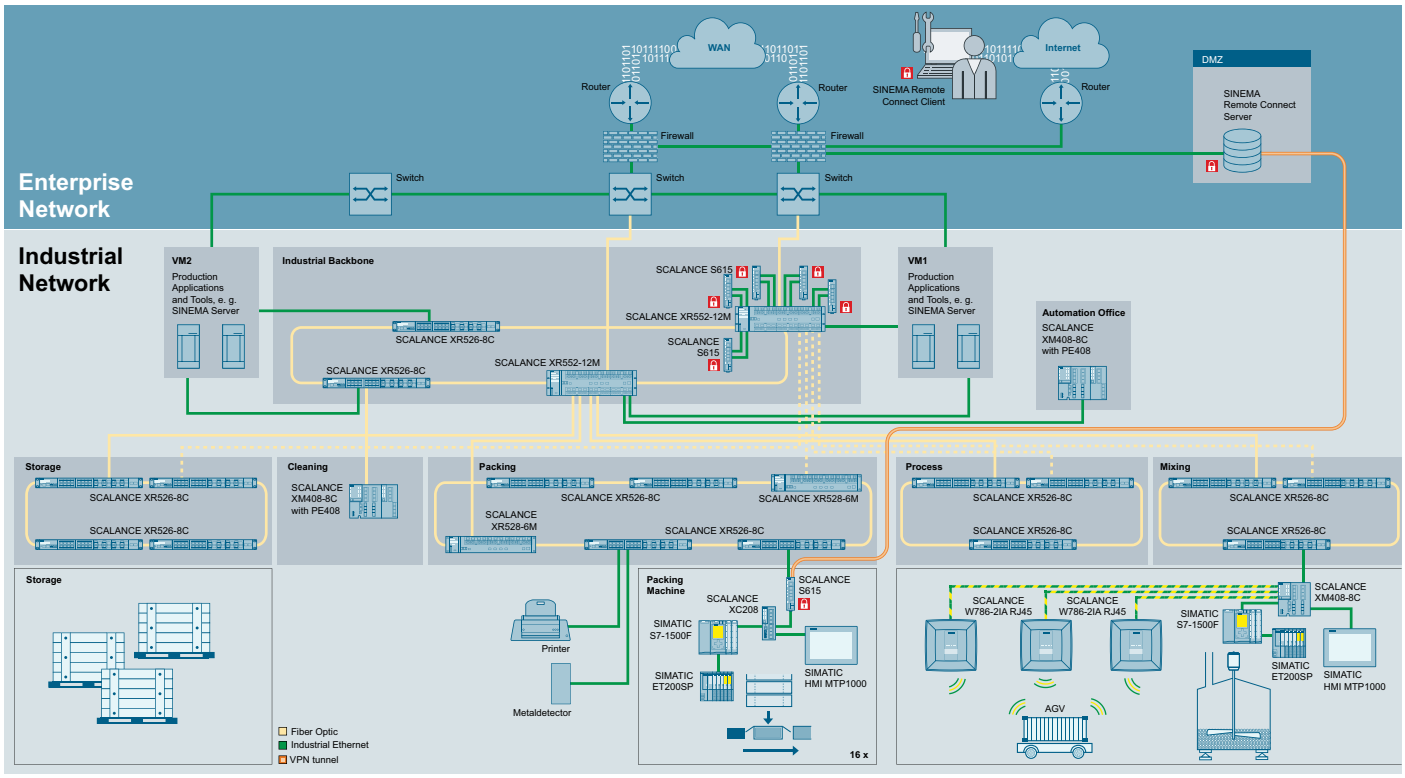
"That way, we could implement exactly what we needed and integrate it with the automation level," Faugstad explained. "This is also why we chose Siemens as a partner: they have both automation and network expertise, so you can discuss the entire application with them. For example, we had some issues with communication across VLANs, and we got the Siemens support team involved. They identified the cause and came up with a solution within just a few hours, because they know how PLC-to-PLC communication works, they know the protocols, and they know how to integrate this with the OT network."

Siemens took a consultative approach for

SOURCE: SIEMENS

In the weighing and dispensing area, AGVs can communicate weight readings back to the PLC in real time via a wireless network that is also part of the Scalance W solution.

SOURCE: SIEMENS



System diagram shows relationship of industrial control network and connectivity to the company's enterprise network.

the planning, design, and implementation phases of the industrial network through its Professional Services team, helping Orkla to choose the best network architecture and system solution, and the team will also service the OT network. The result is a stable, reliable, and secure solution for data acquisition, order handling, and equipment service.

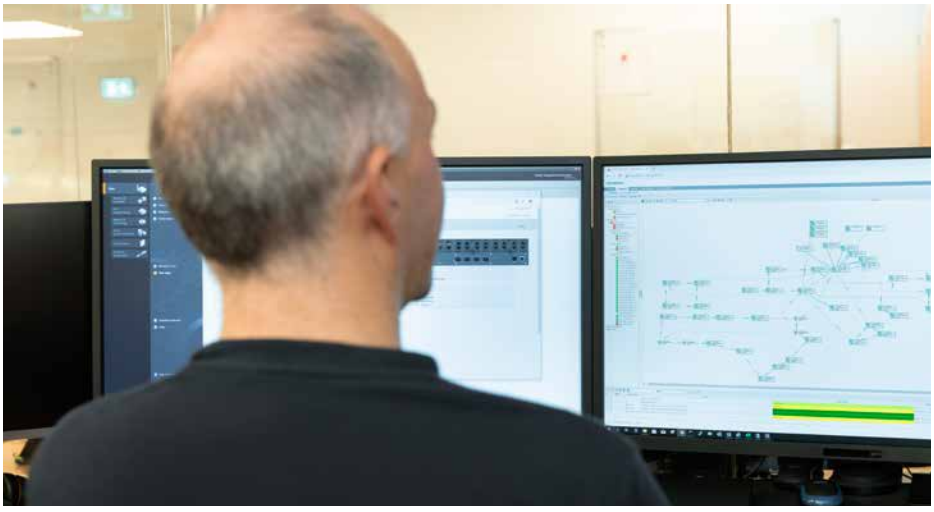
"Our colleagues in the automation team have their own VLAN for remote servicing of the PLCs and automation systems, and they can fix the majority of issues via the network from their central office," Faugstad stated. "We can provide partners and vendors with secure VPN access to machines or equipment units, and we can manage this access through the management software for VPN and remote connections. We are using Sinema Remote Connect for this. We also use the Sinema Server network monitoring software to identify issues in the network and fix them ourselves. It's very convenient – so convenient that Orkla considers this solution as a model for other sites as well."

Looking at further expansions

The Siemens´s solution provides stable communication for current operations, and having a robust and reliable network has made day-to-day work easier.

"As we are no longer busy addressing network issues, we have the resources for upgrading and expanding the solution, improving things and not just keeping them running," Faugstad said. "Current projects include an in-depth security assessment of the VLANs, along with ongoing expansions of the systems and putting production data to use in new applications."

"We are already calculating performance indicators such as overall equipment efficiency (OEE) from the production data we acquire over the OT network," he added. "Now, we are discussing measuring OEE based on operator inputs and linking the HMI systems with the calculations on the management level. This is also why we needed a new network – to be able to service and upgrade our network for at least another 10 years, and expand the functionality for new data applications."



SOURCE: SIEMENS

Using the Sinema Server network monitoring software, the staff at the Indre Arna facility can identify issues in the network and resolve them directly by themselves.

Network solution: zero downtime

Thanks to the upgrade, Orkla now benefits from a solution that is secure, offers maximum uptime, and is easy to maintain with local resources. The benefits of the new OT network are visible today at the facility in Indre Arna.

"By moving to the new network and the robust solution from Siemens, we have reduced production downtimes due to network issues from maybe three or four days a year to zero," Faugstad explained.

Ståle Faugstad, Technical Lead for Automation and IT, ***Orkla Indre Arna.***

Learn More

Gigabit managed PROFINET switches

NT4008 full Gigabit managed PROFINET Ethernet switches are designed for Industry 4.0 environments.

Red Lion's new NT4008 Layer 2 PROFINET switches integrate seamlessly PROFINET networks into industrial applications, along with being designed for new Industry 4.0 environments.

The NT4008 PROFINET series is built to manage next generation bandwidths as well as support any extreme industrial conditions and maintain uptime. The NT4008 switches simplify and accelerate data transition for real-time data exchange in PROFINET applications.

Red Lion's NT4008 Gigabit Managed Industrial Ethernet switches are certified to meet PROFINET PNIO v2.34 conformance class B (CC-B), RT Class 1 standards. They ensure seamless integration into PROFINET networks using standard PLC configuration and management tools.

Highlights of the new switches include:

- PROFINET PNIO V2.34, conformance Class B
- (CC-B), RT Class 1
- MRP (Media Redundancy Protocol): client or client/manager configurations
- 10/100/1000 RJ45 ports
- Dual mode SFP ports support 100Base and 1000Base SFP transceivers

SOURCE: RED LION

Managed switches are certified to meet PROFINET PNIO v2.34 conformance class B (CC-B), RT Class 1 standards.

Features of the new switches include: LED alarm and power status indicators; LED port status indicators; redundant 12–58 VDC power inputs; configurable alarm, contact relay; console port; IP-30 metal enclosure; wide -40 to 75°C operating range; and extreme shock and vibration tolerance.

The new NT4008 switches provide seamless PROFINET integration, high bandwidth at a very competitive price, future-roof and High availability and suitable for many operating conditions.

Red Lion Controls

Visit Website

Managed switches with TSN capability

FL Switch TSN 2300 devices facilitate the setup of time-synchronous applications for real-time performance.

The new FL Switch TSN 2300 devices are the first Ethernet Switches for Time-Sensitive Networking (TSN) from Phoenix Contact. They facilitate the setup of time-synchronous applications, thus ensuring real-time communication and increased availability in automation networks.

With the frame preemption and stream management functions as well as the precise time synchronization in accordance with IEEE 802.1AS, the switches support the Profinet TSN profile in the first step. They allow a user-friendly TSN configuration via Profinet 2.4 engineering, just as easy as with classic Profinet RT.

In addition, the comprehensive managed switch feature set enables universal use of the TSN switches even in classic applications, the same as other Phoenix Contact switches. This makes it easy to migrate today's network solutions to modern TSN architectures.

Time Sensitive Networking (TSN) describes a series of standardized transmission mechanisms for data in Ethernet networks that allow deterministic real-time communication, regardless of the protocol. Precise time synchronization facilitates the combination of hard real-time demands and classic IT services in one network – the basis for network convergence.

SOURCE: PHOENIX CONTACT

TSN mechanisms increase the performance, robustness, and availability of current networks.

These managed TSN switches from Phoenix Contact facilitate the setup of applications with precise time synchronization, thus ensuring real-time communication and increased availability in a user's automation network.

Phoenix Contact

Visit Website

Multi-service platforms

New rugged multi-service platforms offer enhanced switching, routing and security for OT networks.

Siemens has launched two new rugged Multi-Service Platforms, the Ruggedcom RX1524 and RX1536, extending its portfolio of carrier-grade switches and routers for mission-critical applications in harsh environments. They are ideal for electric power utilities, rail operations and traffic control systems.

The Ruggedcom RX1524 is a carrier-grade, integrated layer 3 Ethernet switch and router. Its modular and hot-swappable platform allows customers to select amongst cellular, serial and Ethernet options, with 24 ports overall, up to 8 Gigabit Ethernet ports, and dual redundant power supplies.

The Ruggedcom RX1536 offers customers a greater port density with support for up to 36 ports. Both devices support advanced switching, routing, firewall and management functionalities in a 1U form factor, allowing customers the flexibility to modify their hardware configurations in the field as their needs evolve and grow.

The Ruggedcom RX1524 and RX1536 operate reliably over an extended temperature range of -40°C to +85°C and have a high level of immunity to EMI (electromagnetic interference), minimizing the risk of non-malicious cyber events like equipment failures and further improving the network availability.

SOURCE: SIEMENS

Do more with less by using multiple functions on the same physical infrastructure.

The Ruggedcom RX1500 series is well-known for its maintenance-free operation with long field MTBFs exceeding 200 years. The Ruggedcom RX1524 and RX1536 switches take this legacy forward with significant performance enhancements, including upgraded hardware, more processing power, and improved security features such as higher IPsec VPN throughput and faster encryption.

Siemens

Visit Website

Unmanaged Ethernet switches

New unmanaged Ethernet switches offer a compact footprint as small as a credit card.

The EDS-2000-EL and EDS-2000-ML Series create a new lineup of industrial unmanaged Ethernet switches with options for 5 to 18 ports, and Gigabit combo ports to reliably connect more nodes and at higher bandwidths.

These industrial unmanaged Ethernet switches, featuring Quality of Service (QoS) and Broadcast Storm Protection (BSP) by DIP switch, also allow field-site engineers to easily expand reliable networks with plug-and-play simplicity.

The more data points users can connect, the more insights they can leverage. Therefore, the need for rapid and reliable network expansion is crucial to enhancing operational efficiency for industrial applications. With their compact design and rich features that enhance reliability, the EDS-2000-EL and EDS-2000-ML Series have been design specifically for a wide variety of industrial applications.

The EDS-2000-EL Series is an entry-level unmanaged switch for general automation that is almost as small as a credit card, so it can fit in any industrial cabinet, but is still jam-packed with feature sets, such as QoS and BSP, to ensure reliable Ethernet connectivity.

SOURCE: MOXA

Edge gateway provides native support for field industrial protocols, advanced data and device management.

With the same features as the EDS-2000-EL Series, the EDS-2000-ML Series is a mainstream-level unmanaged switch for mission-critical automation that is designed with greater versatility, instant relay alarms, flexible mounting options, and dual power inputs to ensure greater reliability in the field. Furthermore, the EDS-2000-ML Series will also comply with industrial certifications for applications in key vertical markets.

Moxa

Visit Website

Industrial Ethernet long-term availability

New KSwitch family switches offer high-performance, cost-effective models implementing Gigabit Ethernet.

Modern high-performance chips, automation solutions, 5G connectivity and, last but not least, industrial switches are essential components for successful Industry 4.0 and IoT applications.

New KSwitch models are suitable for fast and gigabit networks up to 10G and were specially developed for use in industrial environments. In addition to a compact design, the switches offer the possibility of easily connecting machines, controls and other components with one another on the basis of industry standards.

All switches can be flexibly combined with one another, thereby making it easier to set up a future-oriented IT environment.

Further cost savings result from the use of standardized RJ45 and optional SFP (Small Formfactor Pluggable) slots. SFPs are available as modular, optical or electrical transceivers for fiber optics or "Direct Attach Copper" and can be used flexibly and scalably depending on the application. The compact design reduces the space required in the control cabinet or industrial rack by up to 35%.

The switches have a high-quality metal housing, for use in robust environments. They

SOURCE: KONTRON

Single-chip design provides reliability and high performance while reducing power consumption at the same time.

can be used as standard at temperatures from -40 to + 75 ° Celsius or from -10 to + 60 ° Celsius, and most products also support an extended supply voltage range from 12 to 58V DC. Thanks to the robust power supply unit and an electrical immunity at each port of up to 2KV surge, the switches work safely and reliably even in harsh production environments with strong magnetic fields or unstable power supply. The switches partly support Power Over Ethernet (PoE / PoE +, Ultra PoE) or can be operated as powered devices.

Kontron

Visit Website

M12 IP65/67 PoE Ethernet Switch

PoE switches can be decentralized without needing a control cabinet, directly in the field.

The new SPARK-XS41 M12 Industrial PoE Ethernet switch is designed for use in harsh industrial environments.

The switches offer power and data over one cable for robust and efficient supply of data and power in machines, trains, commercial vehicles and agricultural machinery. Units can be decentralized without a control cabinet, directly in the field.

With a supply voltage of 24 VDC, the switch supplies connected end devices on the four D-coded M12 ports with data and power in accordance with the IEEE 802.3at (Type 1) standard with a total power budget of 40 watts.

With the X-coded M12 uplink port, sufficient reserves are available for data transmission thanks to the high bandwidth.

Dustproofed and protected against water jets, the switch saves valuable space in control cabinets and reduce the costs and expense of network cabling.

The retrofitting of existing applications in which the installation space in the control cabinet is exhausted, is just as possible as the construction of optimized new installations

SOURCE: TERZ

Designed for harsh conditions, the switch saves space in control cabinets and reduces the cost of network cabling.

with the focus on the decentralization of the components.

Due to the extended temperature range of -40°C to +70°C, excellent EMC performance (DIN EN 50121-3-2) and fire protection according to DIN EN 45545, the SPARK is suitable for use in trains and comply with DIN EN 50155. By supporting Autonegotiation and Auto MDI-X quick and easy commissioning is possible.

TERZ

Visit Website

Five-port PoE+ powered Gigabit switch

Five-port PoE+ powered Gigabit switch, with PoE pass-through, eliminates the need for a power supply.

A new five-port PoE+ powered Gigabit switch with PoE pass-through, the SW-100-05PD from Luxul, is powered by a PoE+ switch or injector, eliminating the need for a power supply. It also offers multiple mounting options.

The SW-100-05PD features a dedicated PoE+ input port, a pass-through Gigabit PoE port capable of powering a PoE/802.11af device up to 15 Watts such as an IP camera, control system interface, or AV-over-IP receiver, and four additional non-PoE Gigabit ports.

The unit offers a durable metal enclosure and includes attachable rubber feet for desktop mounting, mounting wings with keyhole features for surface mounting, and magnetic feet for easy mounting to metal surfaces.

"The SW-100-05PD provides the ultimate in flexibility for integrators," said Mike Grubb, vice president of marketing at Legrand, AV Residential Solutions.

"Without the need for a power supply, the switch doesn't have to be located near an outlet, and its variety of included attachments allow for a wide range of mounting methods. In addition, its PoE pass-through port greatly simplifies installations when adding PoE devices," he added.

SOURCE: LUXUL

SW-100-05PD Five Port Gb Multi-Mount Switch w/ PD Power.

The Luxul PoE+ switch family was recognized with a Residential Systems magazine 2020 CEDIA EXPO Best of Show Award. The SW-100-05PD is now available to dealers.

Key features include 5 auto-negotiation Gigabit ports, one PoE+ PD Gb port to power the switch, and one PoE output port to power a PoE device (15 watts maximum).

More information on the SW-100-05PD switch and other Luxul solutions is available at https://www.legrandav.com.

Luxul

Visit Website

PROFINET switches compact design

Unique, compact design for limited space requirements, and a range of key technical benefits.

ETHERLINE ACCESS switches from Lapp are available in different versions with four to 16 ports, also in combination with ports for fibre optic cables and as a Power-over-Ethernet variant.

All switches have robust metal housings and are designed for DIN rail mounting. Special highlights includes units claimed to be the smallest Profinet switches on the market.

This switch is used where there are conflicts due to multiple IP addresses. It has three LAN ports and one WAN port that connects the switch to a higher-level corporate network. The NAT functionality translates the same IP addresses at machine level into different IP addresses at company level. The switch translates different external IP addresses into a different address range for the machine-level network. Port forwarding and routing mode are also on board.

In addition to the eight RJ45 ports, each of these two managed switches also has two SFP ports for connecting fibre optic cables, with the ETHERLINE ACCESS M08T02GSFP for fast Gigabit Ethernet.

The switches withstand temperatures between -40 °C and +75 °C, implement IP40 protection against the ingress of foreign bodies and can be supplied with redundant power. SFP standard modules are readily available for converting optical into electrical signals.

With even simpler installation, high transmission rates in large temperature ranges and under harsh operating conditions can guarantee consistent quality.

SOURCE: LAPP

All switches have robust metal housings and are designed for DIN rail mounting.

Lapp

Visit Website

PoE & Non-PoE Ethernet switches

High-power 802.3bt PoE++ connectivity solutions with new 6-port managed Industrial Ethernet switches.

New compact, six-port managed 802.3BT PoE and Non-PoE inustrial Ethernet switches provide a new level of performance.

Antaira Technologies, a leading developer and manufacturer of industrial networking devices and communication solutions for harsh environment applications, has announced the expansion of its 802.3bt industrial PoE switch family with the introduction of the LMP-C602G-SFP-bt(-T)-V2 and LMX-C602G-SFP(-T)-V2 series.

The LMP-C602G-SFP-bt-V2 industrial Ethernet switch is rugged, reliable and designed for applications that require up to 90 Watts of PoE power.

The LMP-C602G-SFP-bt series are light layer 3 industrial managed Ethernet switches, with a 48 to 55 VDC high voltage power input (LMP-C602G-SFP-bt-V2) and a 12 to 48VDC wide voltage power input (LMX-C602G-SFP-V2). Each industrial switch is designed with four gigabit Ethernet ports and two dual rate SFP slots. The LMP-C602G-SFP-bt-V2 is IEEE 802.3bt compliant (PSE: 90W/port) and has a built-in PoE DIP switch with which you can control certain Ethernet ports to enable or disable the PoE function.

SOURCE: ANTAIRA

The LMP-C602G-SFP-bt-V2 switch is designed for applications that require up to 90 Watts of PoE power.

This industrial switch series provides high EFT surge (2,000VDC) and ESD (6,000VDC) protection to prevent any unregulated voltage and can support the power redundancy feature using a dual-power input design with reverse polarity protection. There is also a built-in relay warning function to alert maintenance when power failures occur. Also, with the compact size, all connections input, including power input and grounding screw facing the front side, this makes it easy to install and view connections in a confined space.

Antaira Technologies

Visit Website

Switch offers intelligent connections

Data and power supply can be provided for up to 26 devices using Power over Ethernet (PoE).

Siemens has expanding its Scalance X portfolio with the new Power over Ethernet (PoE, power and data via one cable) variants of the Scalance industrial Ethernet switches XC-200PoE, XR-100PoE WG, and XR-300PoE WG.

With this solution, up to 26 end devices can be supplied with data and power via one data cable. All new PoE switches supports the latest IEEE 802.3bt standard and provide up to 30 watts of power per port. Using the 10 Gbit/s copper ports of the Scalance XR-300PoE WG products even up to 60 watts per port are possible.

Power over Ethernet (PoE) is a method to provide network end devices with power and data via one cable. The power and data transmission takes place via the applied Ethernet cables, which connect the individual network components.

Since this enables a quick and wiring-free installation of various components such as wireless LAN access points as well as IP cameras and IP phones, PoE is becoming an essential part of digitalization for many modern companies.

SOURCE: SIEMENS

PoE capability offers method to provide network end devices with power and data via one cable.

Industry uses the technology known from the office and home and adopts it into industrial components such as industrial Ethernet switches, Real-Time Locating System (RTLS) gateways and identification components.

The new PoE switches expand the Scalance X family's product portfolio and provide the right solution for every area of the industrial network.

Siemens

Visit Website

Catalyst IE3x00 rugged switches

New switches offer full Gigabit Ethernet speed, modular design and high-level security features.

Cisco Catalyst IE3x00 Rugged Series switches deliver full Gigabit speed Industrial Ethernet switching and a modular form-factor optimized for size, power and performance.

The switches provide security with software-based segmentation and real-time flow visibility for threat-detection and isolation. Select models support Cisco Cyber Vision sensor for deep visibility across a wide range of industrial networks, and advanced threat detection.

Scalability with intent-based networking and centralized policy-based automation offers the visibility and control needed to manage all network devices, allowing shorter deployment cycles and greater agility as the network grows. High-speed connectivity are provided by up to 10 Gigabit Ethernet uplinks (expand to up to 26 ports of Gigabit Ethernet or up to 24 ports of Gigabit Ethernet and 2 ports of 10 Gigabit Ethernet). 2.5 Gigabit Ethernet downlink with expansion module.

A high-density Power over Ethernet (PoE) solution supports up to 24 PoE/PoE+ ports or 8 "802.3bt type 3" ports or 4 "802.3bt type 4" ports with the 10G, PoE enabled system offering a system power budget of up to 480W.

SOURCE: CISCO

Switches feature advanced, full Gigabit Ethernet speed for rich real-time data and a modular, optimized design.

The switches' compact form factor and fanless design is hardened to withstand extreme temperatures, shock and vibration. Some models are IP67 rated providing dust and water protection, and compliance with multi-industry specifications for automation, ITS, and substation environments.

Edge computing can be implemented via Cisco IOx, which can host and execute services to reduce costs and improve efficiency by enabling data analysis and applications at the edge.

Cisco Systems

Visit Website

Extended portfolio of TSN devices

SoC-e's Time Sensitive Networking technology (MTSN IP Core) offers comprehensive TSN solutions.

RELYUM is leveraging its MTSN IP Core to offer comprehensive TSN solutions. For getting started with TSN, RELYUM launched RELY-TSN-KIT, a starting kit that includes a demo application for evaluating the performance of the most relevant TSN standards: IEEE 802.1AS, IEEE 802.1Qbv, IEEE 802.1Qav and IEEE 802.1CB.

To move one step forward, the combination of RELY-TSN-BRIDGE, RELYUM's first TSN switch device, and RELY-TSN-PCIe, a full height TSN PCIe NIC, allows users to implement flexible testbeds for analyzing TSN mechanism behavior with real application data.

As a complement to these devices, RELY-TRAF-GEN traffic generator device can be used to transmit up to 3Gbps congestion traffic, in order to validate the performance of TSN technology in the worst-case scenario.

These testbeds remain incomplete without testing tools capable to measure the latency of the traffic transmitted into a TSN network. RELY-TSN-LAB, a testing tool that implements traffic timestamping, error injection or latency calculation, responds to that need.

Additionally, for a deeper analysis, RELY-TSN-REC timestamps and records in an internal 256GB hard disk, with filtering capabilities for optimization. Data is saved in PCAP files that can be accessed simultaneously from a remote location and can be open with a standard application like Wireshark.

Finally, RELYUM's latest release has been RELY-MIL family, a TSN rugged switch targeting application in the aerospace and defence sector.

SOURCE: RELYUM

RELYUM's first TSN switch device and a full height TSN PCIe NIC allows users to implement flexible TSN testbeds.

Relyum

Visit Website

Modular Ethernet switches

Next-level network versatility enables industrial users to optimize future networking investments.

The MDS-G4000 Series provides a fully modular platform with a variety of hot-swappable media interface and power modules, enabling hundreds of port combinations for on-demand flexibility. Hot-swappable modules and redundant isolated power design combined with an intuitive web interface and MXview support enable the MDS-G4000 Series to provide 24/7 operations while lowering the total cost of ownership.

As industrial networks continue to expand, the MDS-G4000 Series offers five types of 4-port media interface type modules and two types of power modules to mix and match, delivering the flexibility necessary to connect the increasing volume of different devices.

The ultra-compact size, together with DIN-rail, wall-, and rack-mounting options provide installation versatility when deploying the MDS-G4000 Series in challenging industrial environments such as inside machines and in narrow underground and outdoor cabinets.

The tool-free module design allows on-site personnel to add and replace modules effortlessly without shutting down the switch. The MDS-G4000 Series features a highly durable die-cast frame and resilient modules that can withstand shocking of up to 30G in force, enabling solid performance in harsh environments. These switches also meet the requirements of industrial certifications for power substation automation systems (IEC 61850-3, IEEE 1613), railway wayside (EN 50121-4), oil and gas (ATEX and C1D2), and intelligent transportation systems (NEMA TS2). By merging next-level versatility with enhanced reliability, the MDS-G4000 Series offers a single expandable platform that provides 24/7 operations.

SOURCE: MOXA

Hundreds of port combinations use five types of four-port media modules and two power modules.

Moxa

Visit Website

Managed Layer 2 Ethernet switches

Industrial managed 2.5G/10G switches provide stable, reliable Ethernet transmissions over optical fiber.

The IQS-402XSM is an 1G/2.5G/10G managed Layer 2 Ethernet switch. It provides 4 port of electrical 10M/100M/1G/2.5GBase-T via RJ-45s plus 2 ports SFP slots of 100M/1G/2.5G/10GBase-X which provide stable and reliable long-distance Ethernet transmission over optical fiber.

Built to Industrial grade standards, the FANLESS design provides high MTBF in indoor environments of operating temperature from -10 to 60°C (14 to 160°F), and incorporates redundant 12/24/48VDC power input.

With available Din-Rail or wall mounting metal housings, these switches are perfect choices for heavy duty use in harsh environments, such as industrial factory automation, data center networking, intelligent transportation systems (ITS) and are also suitable for many military and utility market applications where environmental conditions exceed commercial product specifications.

These managed switches also support a wide variety of Ethernet Layer 2 functions, including CTC Union proprietary µ-Ring, ERPS, MSTP, RSTP and STP.

SOURCE: CTC UNION

Switches support µ-Ring, ERPS, MSTP, RSTP and STP for redundant cabling.

They also support Layer 2 IGMP, VLAN, QoS, ACL, Security, IPv6, bandwidth control, and port mirroring.

Additionally, these switches can also be managed by CTC Union's SmartView Element Management System, which offers a user-friendly and centralized device management platform and provides administrators the ability to monitor and configure these connected switches remotely.

CTC Union

Visit Website

Compact Ethernet switches connect new LCD train displays

ORLYVAL Service SA, a subsidiary of RATP, has developed an innovative way for passengers to gain access to real-time information. Using smart LCD windows, an ORLYVAL shuttle is now able to display information relating to departing flights, the weather forecast for destination cities and more.

MOBILITY AS A SERVICE (MAAS) IS A CONCEPT that aims to provide alternatives to private-owned transport that are just as convenient, but more sustainable and cost-efficient for travellers. At the forefront of the MaaS movement is RATP Group, the French public transport operator, which is putting users at the core of transport services, offering them tailor-made mobility solutions based on their individual needs.

To enrich the journey experience for its customers, ORLYVAL Service SA, a subsidiary of RATP, has developed an innovative way for passengers to gain access to real-time information. Using smart LCD windows, an ORLYVAL shuttle that travels to and from the Paris-Orly airport, is now able to display information relating to departing flights, the weather forecast for destination cities and more.

The information provided is adapted and specific to the direction of the shuttle. The innovation also enables announcements to be broadcasted to travellers, providing them with real-time news and information pertinent to their journey. The innovative displays will be deployed on a further seven trains by the end of the year.

Communication to the innovative systems requires an internet connection, but because this was a refurbishment project, space was extremely limited. Only an exceptionally compact Ethernet switch would be suitable, and the device would also need to cope with the challenging operational environments found on-board trains, including constant vibration, humidity and electrical interference.

SOURCE: RATP GROUP

Smart window onboard ORLYVAL Service SA shuttle.

Based on a successful existing relationship, Orlyval Service chose Westermo to provide the industrial data communication technology for the project. Westermo's Viper-212-T5G-P8, a compact routing switch designed specifically to meet the demands of on-board train applications, was selected.

Measuring only 178 cm x 110 cm x 100 cm, the Viper fit comfortably into the confined space on board the shuttle. Its Power over Ethernet (PoE) ports offered an effective power supply for the connected devices and the Gigabit ports supported the need for high bandwidth.

ORLYVAL service SA designed and configured the data network, simplified by Westermo's "Made Easy" concept which ensures the operating system for the Ethernet switches is extremely simple and intuitive to use.

"For us, choosing Westermo was a guaranteed that we had a product that met the requirements of railway equipment. We are grateful for their professionalism, which contributed to the success of this project," said Lionel Le Fessant, sales and quality director, ORLYVAL Service.

"Providing journey information to passengers as part of MaaS relies on robust and resilient data networks," explained Fabian Vandendyck, sales manager for train networks at Westermo. "Westermo Viper switches are ideally suited for these onboard transport applications, able to fit into the confined spaces presented by refurbishment projects and providing reliable performance in the difficult environment."

SOURCE: RATP GROUP

The Viper switch in the confined space onboard the ORLYVAL shuttle.

*Application article by **Westermo**.*

Visit Website

Dignified Motors introduces technology to mobility industry

An innovative engineer turns to edge controller technology to power an EPIC Chevy Silverado lift system. Opto 22 encourages you to think about how you can put your engineering skills to work to improve the life of someone near you.

WHAT DO YOU DO IF YOU OWN A BEAUTIFUL truck but one day find yourself a wheelchair user? Chances are you've never considered that possibility, but answering that kind of question is what Dave Aitchison of Dignified Motors does every day. Aitchison and his team specialize in vehicle conversions and accessories that meet a variety of accessibility needs. Their work improves the quality of life of all kinds of drivers: veterans, the elderly, and families with special needs children.

The challenge

As a mechanical engineer and a wheelchair user himself, Aitchison sees the opportunity to introduce better technology to the mobility industry. For instance, typical accessible entry-exit systems like automatic ramps use limit switches that may lose their proper activation position over time and end up failing in problematic ways.

"Imagine that you aren't able to get out of the vehicle on your own because now the door limit switch doesn't quite make its activation position. So the ramp just doesn't deploy," Aitchison said. "I've been trapped in everything from a 1975 Chevy full-size van to a 2004 Toyota minivan."

That observation led Dignified Motors to look for technologies designed for harsher environments and extended cycle times. They reached out to Opto 22 when they were approached by a customer who needed to upgrade her Chevy Silverado's entry system. It had been modified previously with an inventive but slow wheelchair lift.

In the Arizona heat, the slow speed wasn't just an inconvenience: "Temperature exposure is a risk for people with spinal cord injury. Two and a half minutes sitting in 115° F weather [waiting for your lift to deploy] is dangerous."

The solution

Dave replaced slow-moving DC actuators with a properly sized hydraulic system and installed a groov EPIC edge programmable industrial control system sped up the deploy time to 14 seconds. The groov EPIC controls the hydraulic valve and pump system and monitors system health and passenger safety using pressure transducer readings, door proximity sensors, and I/O checks for vehicle position and state. If the truck is not in park, EPIC will not power the lift system, preventing accidental deployment while driving.

SOURCE: OPTO 22

The groov EPIC embedded inside the truck's lift system.

Take a look at DM's Silverado upgrade in this video, showing a full deploy-stow time under 30 seconds.

Next conversion

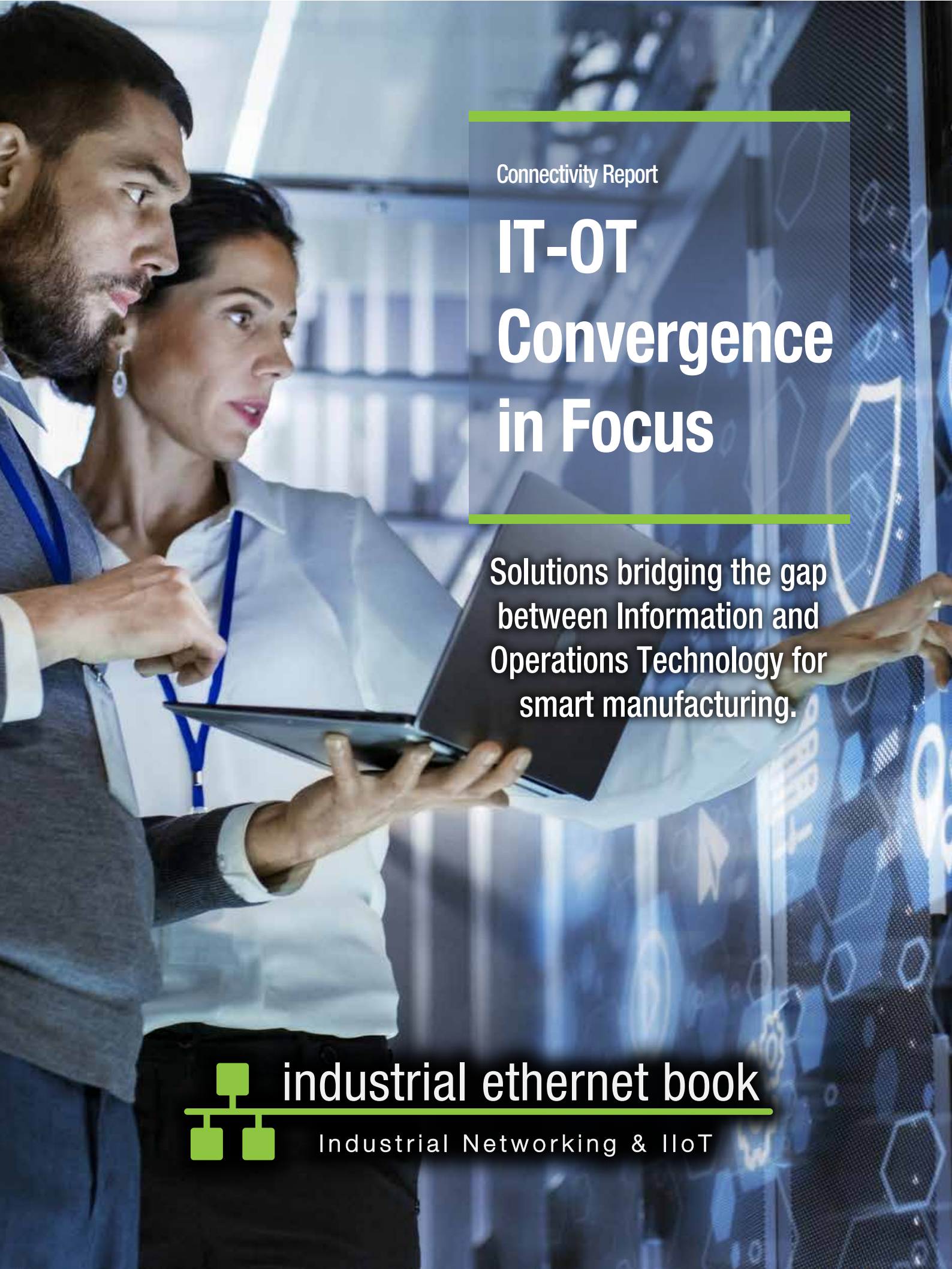
Dignified Motors is working on a similar conversion for a quadriplegic veteran. They'll raise the truck body and drop the floor to accommodate the additional height of the wheelchair and lift system. The truck will also be outfitted with drive-by-wire speed control, reduced effort power steering, and a tri-pin orthotic using a spinner knob bearing, giving the driver full control without requiring full grip strength or manual dexterity.

With EPIC's embedded groov View HMI server, Dave can offer clients the option of mobile interaction with the lift system using their cell phone, which, he adds, is "a massive convenience for the mobility industry."

When asked what else led him to choose groov EPIC, Dave is quick to mention that "Opto 22 has a history going all the way back to the SSR. That's the kind of equipment and technology that you want to partner with when you are looking at potentially life-critical systems."

*Application report by **Opto 22**.*

Visit Website



Connectivity Report

IT-OT Convergence in Focus

Solutions bridging the gap between Information and Operations Technology for smart manufacturing.

industrial ethernet book

Industrial Networking & IIoT

Secure and flexible IT-OT integration based on OPC UA

The OPC UA (Unified Architecture) standard has established itself as an enabling technology for ensuring seamless data transfer between these various subsystems, allowing the production (operational technology, OT) and management (information technology, IT) domains to be tightly coupled together.

MIDDLEWARE OFFERS THE POSSIBILITY OF seamless and secure data transfer based on OPC UA.

Data transfer plays an especially important role in the integration of the production and management domains, with the large number of variables, heterogeneous interfaces, rights management, and specific security requirements being just some of the key challenges faced in this context. Middleware offers a particularly elegant approach to implementation here.

Driven by factors such as the Industrie 4.0 initiative and concepts like the Industrial Internet of Things, a major trend that can now be seen in production units is the integration of individual components into a coherent overall solution. Increasingly, companies are linking older siloed applications from a wide range of manufacturers with their enterprise resource planning (ERP) and manufacturing execution systems (MES).

SOURCE: SOFTING

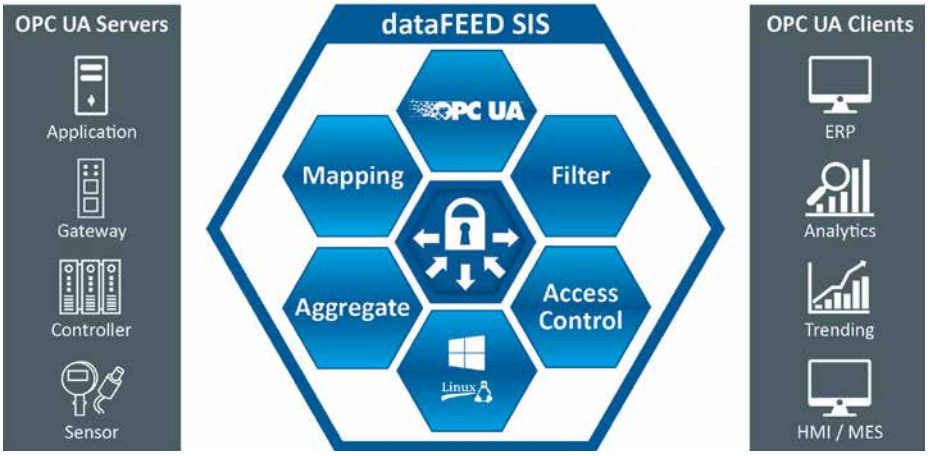
Middleware can be effectively used to link OT and IT levels flexibly and quickly.

Seamless data transfer

The OPC UA (Unified Architecture) standard has now established itself as the enabling technology for ensuring seamless data transfer between these various subsystems, allowing the production (operational technology, OT) and management (information technology, IT) domains to be tightly coupled together. One of the more recent OPC UA extensions, OPC UA Publisher/Subscriber, builds on this by offering an elegant solution for achieving interoperability between control systems.

To handle data exchange within the application as a whole, OT components typically take on the role of OPC UA servers, while IT components play the role of OPC UA clients. Network structure complexity rises exponentially, however, in proportion to the OT and IT applications involved. Data volumes are correspondingly large, and the effort required for installation, setup, and maintenance also increases accordingly. Nor should data security be overlooked in such setups: the automated standalone systems often utilize small OPC UA nanoprofiles that do not support encryption.

This is in contrast to the IT systems, for which special security requirements have developed naturally over time, reflecting the fact that these components have to run 24/7. This makes protection from attack of paramount importance, as geographically distant production facilities now need to be connected together around the world and company-to-company networking becomes increasingly desirable.

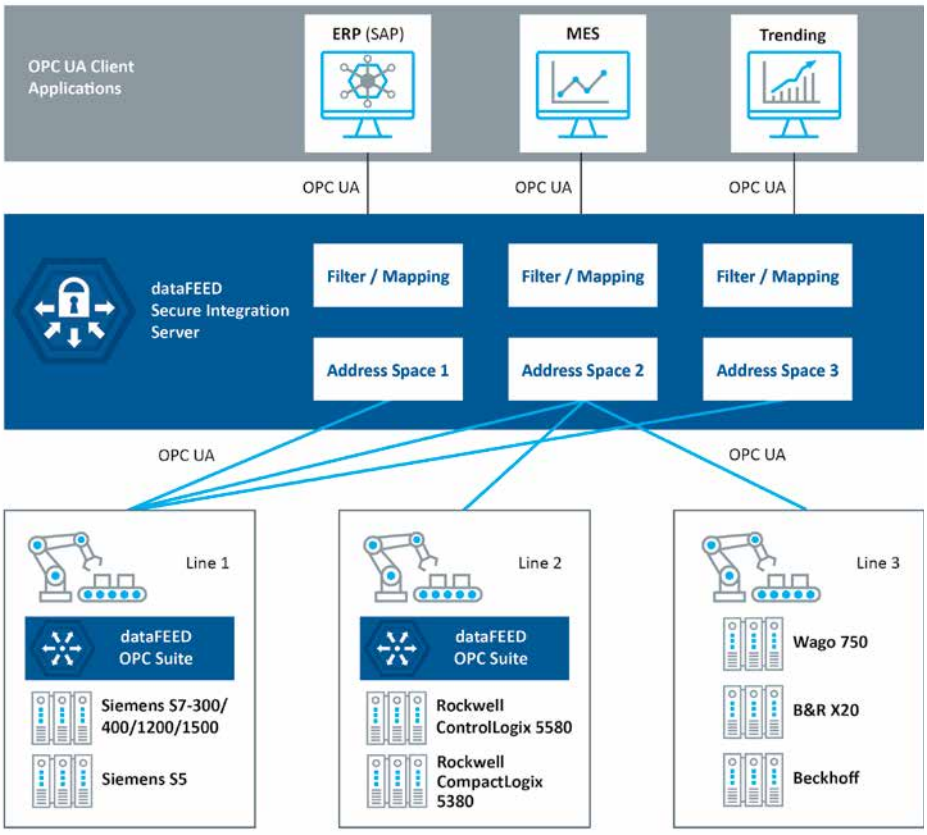


SOURCE: SOFTING

Aggregation server drastically reduces the communication connections in an Industrie 4.0 application.

Middleware: a key component

For the successful implementation of integration applications, these challenges play a central role: to meet them, industry groups like Platform Industrie 4.0 are looking at possible approaches to the optimum solution. The group's position paper 'Secure intercompany communication with OPC UA' (available in German) introduces a number of solution strategies and focuses in particular on the advantages of an aggregating server.



SOURCE: SOFTING

The dataFEED Secure Integration Server meets all of the requirements of a middleware component.

This is the approach taken by the dataFEED Secure Integration Server, a middleware component from Softing Industrial, which provides an abstract interface between the OT and IT domains. Based on the address space modeling defined in the OPC UA standard, the interface utilizes this in particular for interface abstraction and data aggregation.

Interface and data aggregation

Interface abstraction handles changes or extensions within one domain (OT/IT) without any modifications then being required in the other. A user could integrate a new IT application into the overall solution, for example, without needing to make changes to the OPC UA interface at the OT end. Conversely, IT applications do not need to be adjusted to match changes made on the production side, as long as the OPC UA interface implemented in the middleware is kept unmodified.

For software suppliers, this simply involves integrating a standard interface for their application into customer-specific equipment and environments. Users gain considerable flexibility and can exploit short innovation cycles in the IT domain to the full, enjoying an unrestricted choice of the IT applications and platforms to deploy with reduced integration effort. They also benefit from being able to make any changes necessary in the OT domain without having to restart the IT integration process from scratch.

Data aggregation permits data from multiple sources to be consolidated on a single OPC UA server: since IT applications now only need to access this one server, this simplifies and streamlines the underlying communications structures.

This also reduces configuration effort for users, as administrators no longer need to maintain separate sets of configurations for the various IT applications used to access the individual OT data sources. In addition, dataFEED Secure Integration Server also supports the loading of OPC UA Companion Specifications with the information model that these define.

These information models either cover the particular task specifications for a specific industry or define an enterprise object domain. Since this approach also ensures compatibility at the semantic level, users can immediately make use of appropriate objects such as variables or alarms. As one example, the variables defined are all made available with their respective properties such as the unit, the available methods, and services.

Security by design

All of the key mechanisms a comprehensive security model needs for management, policies, and monitoring are consolidated and centralized by dataFEED Secure Integration Server as part of the overall solution. Access rights can therefore be used to control access to individual data items, while applications can also be given their own set of access privileges as well as their own certificates, for example. Filters can be used to further restrict rights. As a result, individual OPC UA client applications can not only limit the entire address space available but can also be required to use the appropriate access service—read, write, browse, or subscribe—to make use of specific data items.

The level of data security provided by dataFEED Secure Integration Server also corresponds to the security functions anchored in the OPC UA standard, which implements Internet security standards as three separate layers. First, user authentication can be handled either by username and password or by digital certificates.

Second, application security can also be achieved by using digital certificates for application authentication. Last but not least, data and messages can be encrypted using the Advanced Encryption Standard (AES) in conjunction with a 128- or 256-bit key. The available security standards are therefore the same as those used for online banking, for example.

To improve security yet further, dataFEED Secure Integration Server also supports the definition of whitelists and blacklists to control data access from specific IP addresses, plus the detection of Denial of Service (DoS) attacks targeting OPC UA authentication.

Benefits for customers

From existing production setups to new installations, choosing to deploy dataFEED Secure Integration Server offers all customers a significant set of advantages when running their applications.

In one recent example, a leading provider of power station process control systems faced the challenge of integrating 1.5 million variables into an overall system. For many OPC UA clients, this volume of variables would be a major stumbling-block. Accordingly, the power station application instead made use of the variable filtering option to restrict access for individual OPC UA clients. To prevent the unauthorized overwriting of assigned values, access to the individual variables configured was also set to read-only.

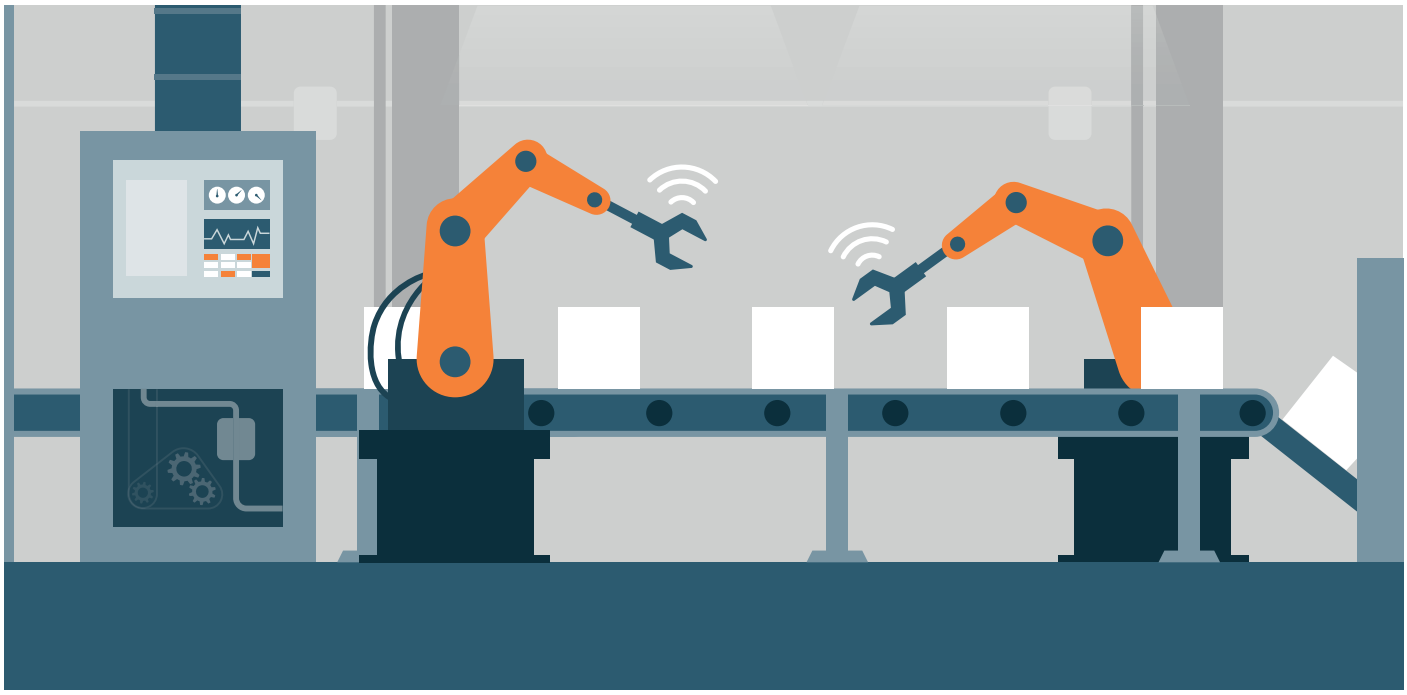
A major automotive parts supplier likewise chose dataFEED Secure Integration Server to handle the aggregation and filtering of variables from a wide range of heterogeneous OPC UA servers: this enabled access to specific variables from the OPC UA clients over a standard, harmonized interface. Another important reason for this purchase decision was the need to implement state-of-the-art security standards.

Andreas Röck, Product Manager, ***Softing Industrial Automation GmbH.***

Visit Website

Essentials of IoT device data management

A key to IT-OT convergence is device data management solutions for effectively monitoring, processing and managing large amounts of data from IoT devices. Traditional embedded database solutions fall short in understanding and fulfilling the sophisticated data processing and management requirements of IoT devices.



SOURCE: ISTOCK

Intelligent systems in the IoT age collect and analyze mass quantities of data, and findings should be accessible to edge devices and embedded systems.

SMART SENSORS AND DEVICES ARE BECOMING an important part of the Internet of Things, IoT, and are continuously changing the way we automate tasks. We employ intelligent systems to improve production in factories, manage smart home energy to monitor and reduce energy costs, build industrial automation systems to replace human assignments, and develop autonomous transportation to improve driver safety.

Inside these embedded systems are sensors which rapidly transmit data that must be immediately captured, processed, and acted on. But how are we able to capture, process and manage the flow of massive amount of data continuously coming to the system and empower devices to make decisions or take actions?

Traditional embedded database solutions fall short in understanding and fulfilling the sophisticated data processing and management requirements of IoT devices. IoT edge database solutions designed to understand the continuous stream of data produced by sensors enable devices to make important decisions in microseconds. What are the available device data management solutions for IoT devices to monitor, process, and manage data?

In this article, we will review some embedded IoT device data management options available for edge devices and highlight the distinct design primitives' approach for addressing device data processing.

IoT edge device data challenges

First, what is an embedded system? An embedded system is a device that performs tasks automatically through self-learning and self-management, which often connects to other systems.

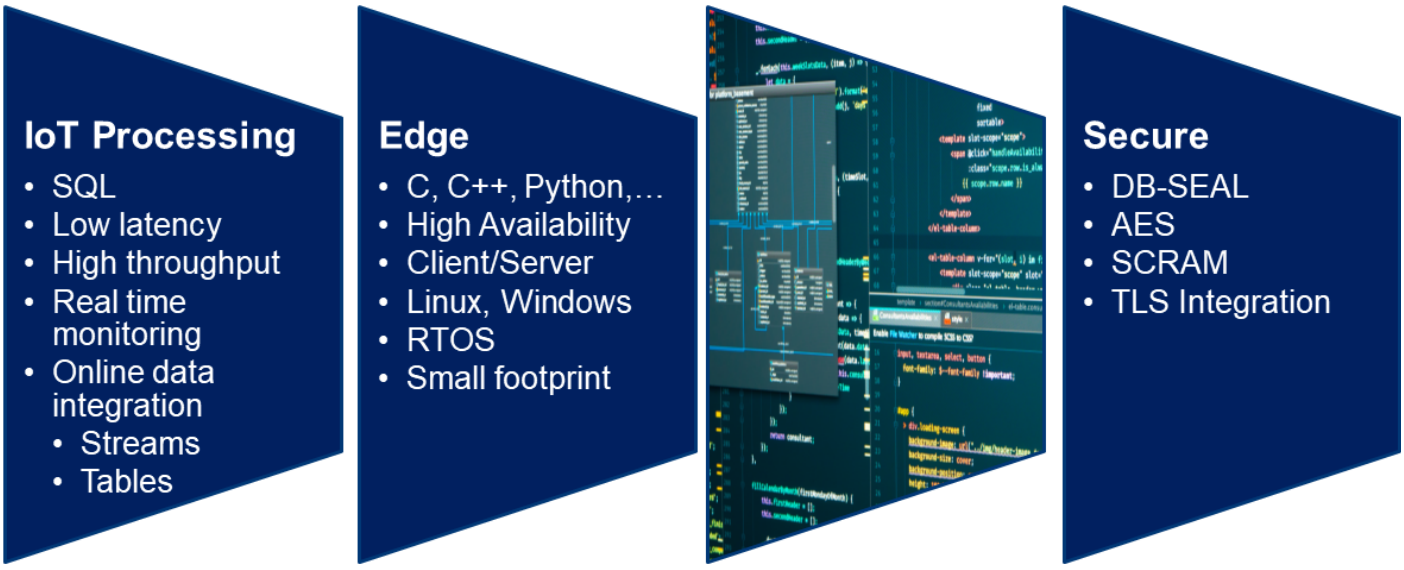
These systems are starting to use the IoT to improve lives. But as a significant volume of data accumulates on each connected device, a comprehensive approach to data management is required.

Across these embedded systems, the primary challenge is to monitor, capture and process the data to intelligently ensure safe behavior and fault-free operation of the devices. More than simply streaming data and receiving commands, these devices run complex, high level software programs that operate with or without a network and cloud connection.

Meanwhile, devices embedded in these systems must handle large transactions for various tasks and need to be able to connect to each other on multiple networks. Therefore, IoT data management needs to be divided into real-time interaction with objects, or things, as well as offline mass storage and long-term trend analysis.

In the real world, device manufacturers seek a scalable edge data management solution to deploy hundreds of IoT devices, so each can collect, analyze, and manage the flood of data that IoT sensors produce, without losing performance. These devices do not need to permanently store all real time data but must capture and store critical information. Simultaneously, each IoT node must make independent decisions that trigger appropriate reactions.

Database queries enable device applications to gain the intelligence to make informed decisions in real time: efficiently and without delay. Succeeding on the IoT requires both the right data management software and the capability to quickly collect and connect device data at the right throughput rate to achieve low latency.



SOURCE: ITTIA

DB SQL data processing capabilities enable edge application to analyze data, perform continuous analysis, and configure data distribution. It is scalable to any number of edge devices, so edge applications can capture data flows from multiple sources, analyze data, and emit valuable findings as events.

Traditional vs. IoT data management

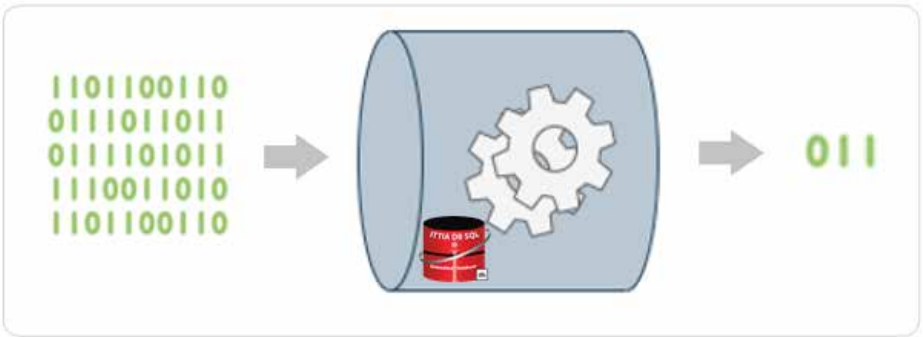
Microchips and devices are now, more than ever, used to build autonomous systems that collect data and gain intelligence. When it comes to data management on these systems, a device application may connect directly to the cloud, buffer data on the device until connectivity is available, or manage data directly on the device. Possible candidates for local device data management include storing arrays and data streams in flat files, creating tables with data management software, or developing a custom data storage solution.

Traditional storage-centric embedded databases generally manage the storing, retrieving, and updating IoT data with records, tables, and files. In the context of IoT, data management software must start by monitoring data in real time, while also providing storage and logging options for future analysis. Data-centric solutions expand the role of data management from simple data storage and analysis to include online data monitoring, continuous query processing, intelligent filtering, and automatic data distribution, in real time. For example, flat file formats such as CSV, JSON and XML are notoriously difficult to update and search, especially for the large volume of data typical of autonomous systems. But how can a device avoid concurrency race conditions and data corruption? Developing a custom solution to index information is not a trivial task and would essentially drive you to become your own database provider! Data management system software updates and new database features each introduce new challenges for application developers.

IoT data processing and management

Common data management solutions currently available for devices do not fully address to the complexity of architecting software for IoT data processing on the edge. Sensors are the primary source of data, but they are constrained by their limitations from facilitating sophisticated analysis.

The focus of data analysis and management on the Internet of Things is to harvest real time information and make sense of data in a very limited time, even without permanent storage available to save what is important to keep or reject what isn't. A good solution seamlessly extends technologies familiar to many developers, such as SQL, to the new problem of analyzing IoT sensor on directly on edge devices.



SOURCE: ITTIA

DB SQL advantages include device data processing and management for edge applications to filter and process data originating from a complex flow of data events.

Case Study

Animal healthcare is an interesting sector that can employ and benefit from IoT systems. Devices now monitor feeding activities for cattle, horses, and other livestock to determine the most efficient milk yield, weight control, and best health care practices. In addition, a prediction algorithm can continuously collect sensor readings to monitor animals' temperatures 7x24. These goals require processing time series data in real time.

Animal healthcare systems, embedded with IoT devices, are expected to search for feeding instructions, capture temperature for different animals, and track feeding history. Data may be communicated with a central cloud data management location, but it also must be indexed on each animal and system individually. The instructions given by the RFID sensors on animal body (i.e. ears) issues immediate alert and communicates with other part of the system within.

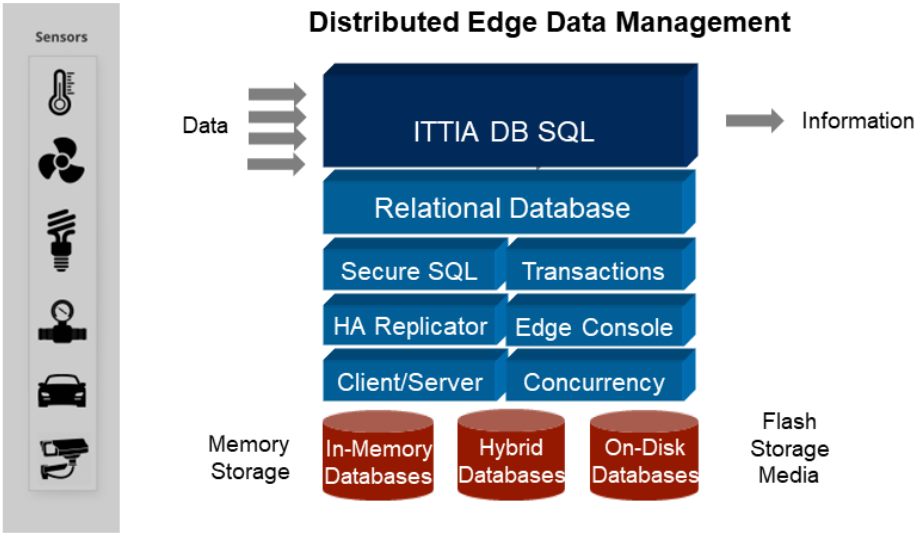
After obtaining the data by an RFID reader, the database must be robust enough to continuously monitor, catalog and retrieve data and prepare the system locally for feeding information/health, as well as temperature data management challenges, even when there is failure such as power loss. The main goal is to monitor the real food consumption of animals as well as abnormal temperature behavior to monitor and guarantee health and prosperity. High performance concurrent read and write is a common characteristic of such an IoT data management.

For this scenario, animals need to be monitored in real time, communications must be handled with a monitoring module and obtained information must yield to immediate act or storage of the data locally on the device. In addition, as explained earlier, each animal is connected via RFID to a sensor, and

sensors are connected to an edge device to be remotely, on premises, for data analysis.

In these embedded systems, low power consumption must work with various desired microcontrollers or applications processors, and the system must be programmed for data acquisition according to the integration period desired, and the data is sent wirelessly to the central device in each facility. Therefore, a database for distributed embedded data across heterogeneous devices is required.

As a company often has different global sites, the number of edge devices that are connected to each network is practically unlimited, and each new site can add new device modules as required. Additionally, each device can be programmed to manage the data per each location's particular needs.



SOURCE: ITTIA

ITTIA DB SQL is a relational database management software library for embedded systems and intelligent IoT devices. SQL features not typically available on an embedded device greatly simplify data management for software developers.

IoT data management framework

Process time series data in real time: Through years of engagement with customers, we recognized special needs for IoT edge data management. Therefore, we decided to implement a new generation of embedded database software with a special focus on IoT data streaming, processing, and management. We recognized that sensors need to collect and aggregate a massive amount of data, which must be queried in real time, and for which results must be shared with other embedded systems. We decided to handle this common scenario by implementing two engines: one for data management and the other for IoT stream processing. In our framework, we paid close attention to the benefits and tradeoffs between the cost of data processing and storage on the edge in comparison to fundamentally utilizing entire cloud data processing and management approach.

High performance concurrent read/write on flash media: Due to the nature of IoT systems interaction with real time data, which is generally fresh information that requires deterministic online analysis, as well as collection for future analysis requirements, both processing and management tiers made sense. Therefore, we designed our database to be an optimization engine to aggregate a large volume of data collected from the sensors, find its detailed value, and save important information while other garbage data is automatically discarded. This aggregation is aimed toward minimizing data storage and maintenance cost for embedded systems. We also added a data distribution layer that enables other parts of the system to receive information from both the data processing and data management engines.

We also developed a union layer which is enables different sensors' streams to join from various desired sources and direct them for further processing.

Distribute embedded data across heterogeneous devices: We designed our solution to be highly available, so when there is a failure due to any reason, a single crash cannot stop the system and real time data management operation can continue. Although archiving and backing up data is an option, that approach is not fully capable for mission critical systems. High availability makes the data record recoverable and provides peace of mind against general failures.

Security is another important factor that we had to pay close attention to. It has been estimated that device application security concerns are expected to remain an important and frequent cause of confirmed breaches. With devices increasingly collecting, storing, and connecting critical data, the risk of a breach grows continuously.

Meanwhile, manufacturers building embedded systems for various markets—including industrial automation, medical devices, power grid, or transportation—all largely face the same device security challenges, as they need to harness the incredible power of data management and connected computing.

SQL injection is one of the most common database attacks. This involves the injection of malicious code into a device to execute malicious queries. Another vulnerability that accelerates injection attacks is when the database is not adequately isolated from the running code. Though isolation may reduce some of these attacks, it is better to look for alternatives.

While the ITTIA DB SQL cockpit tool, know as Web Console, allows developers and end-users to monitor database activities, ITTIA DB Security Agent, DB SEAL, monitors those database activities automatically, isolates databases stored on devices, decides between alternatives to mitigate an attack, and keeps the database contents always available. This proactive monitoring of the data and database by our agent will allow the device to issue an alert, block access, or shut down when data management metrics fall out of the expected range. This is a virtual agent that monitors database responsibilities and metrics in real time, and responds when there is an outage, or other security concern.

Conclusion

At every stage in building a device application, developers grapple with decisions around the best data management software for a successful development and launch of their edge centric IoT system. Such decisions as selection of database software consume significant development and validation time and cost.

Intelligent systems in the IoT age collect and analyze mass quantities of data throughout the system. These valuable findings should become accessible to other edge devices and embedded systems. As the most common IoT data management use case, devices produce a large quantity of continuous raw data which must be collected, analyzed, and distributed. Devices require a data management framework that empowers local applications to process data, capture events and share important information to many other devices deployed on the IoT edge network.

ITTIA DB SQL© is an ideal data management product for manufacturers developing Internet of Things solutions that must collect data from sensors nodes for real time and historical data management.

*Sasan Montaseri, Founder, **ITTIA**.*

Visit Website

Software technology solution bridges gap between IT & OT

New exOS software offers machine builders a solution to the divide traditionally separating IT and OT. Using exOS gives Linux software developers an option to develop, compile and debug their code using their preferred environment, in coordination with B&R's Automation Runtime real-time operating system.

HOW DO COMPANIES BRING IT AND OT together? It's a question that must be answered by any company hoping to realize the visions of Industry 4.0. It's a puzzle, so far, without a real solution. But new technology is now bridging the IT/OT divide, and offering machine builders access to the world's largest software ecosystem.

To pull off today's more advanced manufacturing solutions, machine builders need experts from the fields of IT and OT collaborating on interdisciplinary teams. That's the key to leveraging the full potential of the Industrial IoT.

But it also becomes an arena of conflict between two different worlds. While OT experts are well-versed in machine design, PLC programming and commissioning, their IT colleagues are more at home using high-level programming languages like C++, Python or JavaScript and working with open-source software and Linux. Common ground can prove hard to find.

A team is only ever as good as its members. But picking the best and brightest from individual fields and gathering them around a table will only get you so far. You also need to give them the tools and opportunities to apply their craft toward a common solution. And all too often, there lies the rub.

SOURCE: B&R

Flexible exOS technology offers a crossover solution that bridges the divide between IT and OT.

Exploring new horizons

The challenge is to overcome the obstacles that stand in the way of harmonious, effective IT/OT collaboration. Traditionally, the two domains have existed more or less as parallel universes. "But with the rise of the Industrial IoT, the time has come to change that," said Stefan Bina, B&R's product manager for Industrial IoT network solutions. "It's time to erase the lines between IT and OT." Among the biggest obstacles is a lack of support in today's control systems for the full bandwidth of high-level programming languages. As a prerequisite for true IT/OT connectivity, control systems must therefore be given the ability to access and understand Linux software.

SOURCE: B&R

The exOS technology gives control systems the ability to access and understand any Linux software.

This is exactly where new technology from B&R comes in – with its new enhanced crossover Operating System, or exOS for short. "With exOS, we bridge the divide that has traditionally separated IT and OT, and finally give machine builders a connection between the two worlds," said Bina. "In doing so, we give them access to the world's largest software ecosystem."

exOS gives every Linux software developer the freedom to develop, compile and debug their code using their preferred environment. Then, the Linux application can be easily integrated into the control system with the help of exOS and used hand-in-hand with B&R's real-time operating system, Automation Runtime.

"This offers the huge advantage that developers can work in their familiar environment, like Eclipse or Visual Studio, where they can make the best use of their knowledge and experience," explained Bina.

One central engineering tool

Developers simply import their completed Linux application into the B&R system as an exOS package. From that point on, they can use Automation Studio as a central engineering tool. Managing and debugging software solutions becomes simple and straightforward. No other tools are required. "What that means is that the developer creating the Linux software and the engineer commissioning the machine can each work in the environment they're used to," noted Bina, "because they have the exOS crossover solution bringing it all together seamlessly."

Efficient maintenance

In addition to streamlined development and commissioning, another hallmark of an intelligent machine is that any required maintenance can be performed quickly and easily. In the event of a malfunction, service technicians need to be able to locate the problem and contact the machine builder as quickly as possible. exOS also offers an array of diagnostics functions for installation and code execution. The B&R system provides the user with a complete log of all error messages from both the Linux application and the controller operating system. Hardware components are also easy to replace.

The machine is back up and running again in minutes without any reprogramming. "exOS makes maintenance much more efficient and significantly reduces downtime," says Bina. Not only is it easy to replace hardware when necessary, any updates to the machine software can also be installed, for example via remote access.

SOURCE: B&R

Integrated functions simplify hybrid solutions combining machine control and Linux applications.

Futureproof solution

B&R's crossover solution offers numerous integrated functions that make it easier to implement hybrid solutions combining machine control and Linux applications. The integrated functions are executed symmetrically in Automation Runtime and Linux. "exOS uses technology and tools from the B&R system and integrates the Linux application into the B&R engineering environment. All the freedom of Linux remains," said Bina.

Features include uniform project management for Linux and control applications in Automation Studio as welas automatic transfer of Linux applications from Automation Studio to the controller and the Linux environment. exOS also includes a user-friendly API for high-performance data exchange. The API ensures easy, buffered process data communication between the controller operating system and Linux, consistently in the millisecond range.

Scalable for any application

Machine builders can choose between two different types of exOS implementation. "One option is to run Automation Runtime and Linux on the same device, such as an Automation PC," explained Bina.

This is useful if the Linux application is to be executed hand-in-hand with cyclic control applications, as is the case with automated guided vehicles (AGVs). Such systems are often based on the open-source robotics platform ROS. In ROS, dynamic path planning is executed in Linux, while motion control tasks are handled in Automation Runtime. With exOS, the two can be optimally synchronized in a hypervisor configuration and installed on one Automation PC.

Another way to implement an exOS automation solution is to combine an X20 PLC and an Automation PC. In this setup, the control system and Linux system are connected via an Ethernet interface. Having the two systems running on separate hardware maximizes utilization of the available processing capacity.

IT and OT hand-in-hand

As a flexible crossover solution, exOS breaks down longstanding barriers between IT and OT to create common ground for effective collaboration. "With this move, B&R opens up the world's largest software ecosystem – where the best of both worlds can contribute to convergent, adaptive machine concepts," says Bina. OEMs can fully leverage the know-how of their developers and engineers in both domains and implement innovative machine concepts for smart factories.

Carola Schwankner, editor, ***B&R.***

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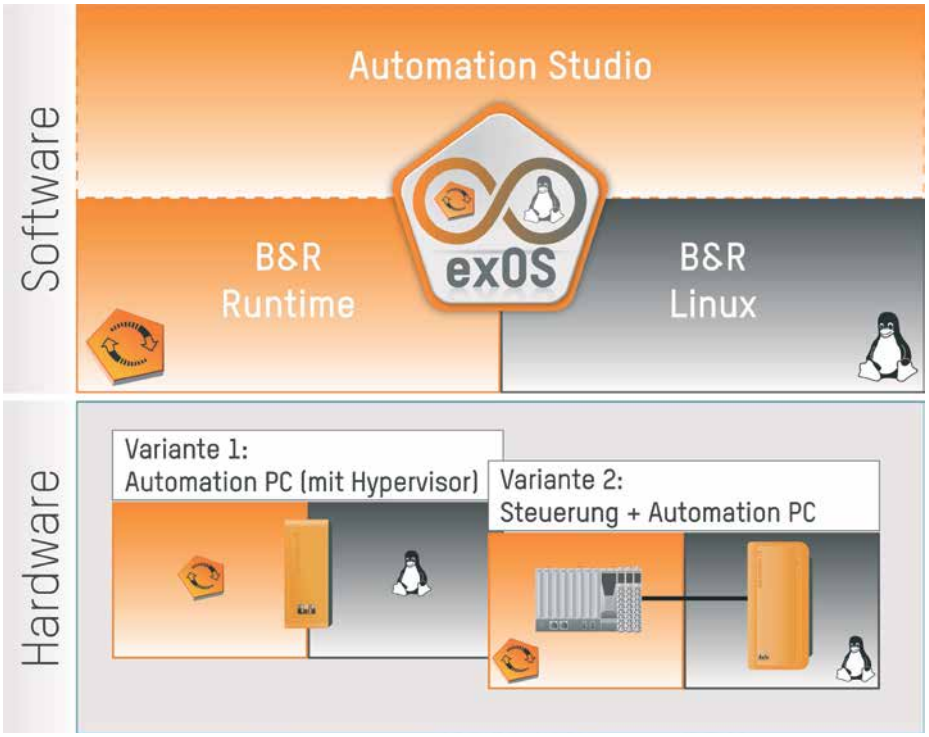


SOURCE: B&R

Machine builders can choose different types of exOS implementation: Automation Runtime and Linux.

First industrial 5G router and starterkit

HMS Networks releases commercially available industrial 5G router optimized for private networks.

A new Wireless Router 5G from HMS Networks supports Ericsson Industry Connect 5G networks, and allows users to get started with 5G in their own location. HMS also offers a ready-made starterkit for test and evaluation of typical industrial use cases.

The Wireless Router 5G is developed by HMS Networks' technology initiative "HMS Labs" and allows early adopters of 5G to try out the new technology. It is the first commercially available Industrial 5G router optimized for private networks to pass the CE conformance test. With 5G in a factory, users benefit from a wireless network, which is fit for industrial demands in terms of communication speeds and security – along with all the flexibility that comes with wireless.

The Wireless Router 5G has been extensively tested with the Ericsson Industry Connect 5G solution in standalone (SA) operation using band n78. It enables users to create a robust cellular connection in an industrial production environment. Supporting 4G and 5G cellular technology, it is a communication solution for automated guided vehicles, AGVs, and other industrial machines.

The Starterkit includes the Wireless Router 5G and two industrial IO-Link sensors sending data across the 5G network. This allows users to try out 5G in their own facilities without having to set up applications of their own from scratch.

SOURCE: HMS NETWORKS

HMS offers a starterkit for evaluation of 5G and starting up a network with Ericsson Industry Connect.

Data from the sensors can be accessed using the Modbus TCP and MQTT protocols as well as in JSON format. There is also a web-based demo ready to show the sensor data across the 5G network in a regular browser.

Initially, the router is available only to users of the Industry Connect system from Ericsson.

HMS Networks

Visit Website

TwinCAT supports S7 communications

TwinCAT software supports S7 protocol, enabling communication with Siemens S7 controllers.

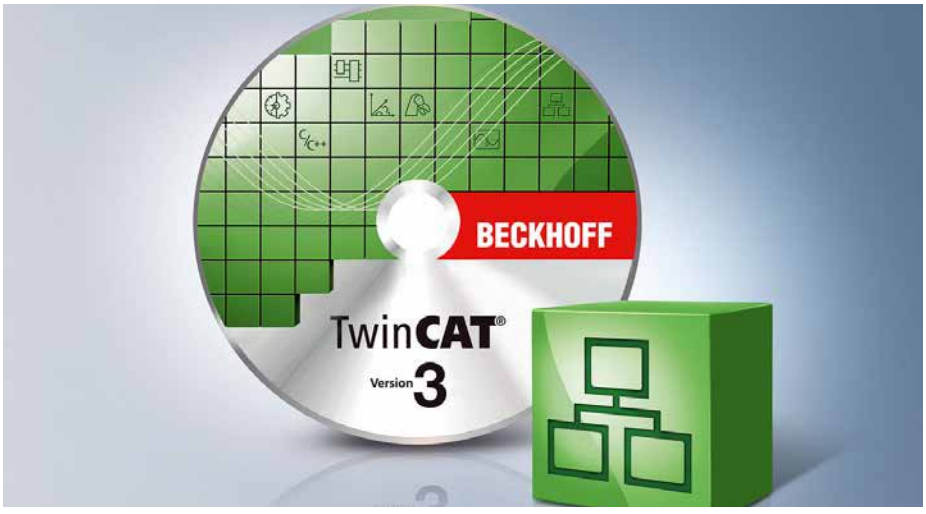
The openness of PC-based control and the resulting array of connectivity options with other systems number among the fundamental advantages of TwinCAT automation software for industrial control applications.

A new add-on now also enables easy and efficient communication with Siemens S7 controllers.

TwinCAT 3 offers numerous options for connecting TCP/IP-based third party systems to the main control program: OPC UA, MQTT, HTTPS and Modbus are only a few prominent examples of an entire range of communication protocols. The TwinCAT S7 Communication (TF6620) function now expands this broad spectrum to include the S7 communication protocol.

This product implementation enables reading and writing of variables from an S7 controller. The PLC application program carries this out directly – either via dynamically parameterizable PLC function blocks or via easily configurable I/O mapping.

No additional hardware is required and the local TCP/IP network serves as the transport medium.



SOURCE: BECKHOFF

TwinCAT 3 software now offers efficient connectivity with S7 controllers.

TwinCAT 3 highlights include: only one software for programming and configuration; Visual Studio integration; freedom in selecting programming languages; support for the object-oriented extension of IEC 61131-3; use of C/C++ as the programming language for real time applications; link to MATLAB/Simulink; open interfaces for expandability and adaptation to the tools landscape; and a flexible runtime environment.

Beckhoff

Visit Website

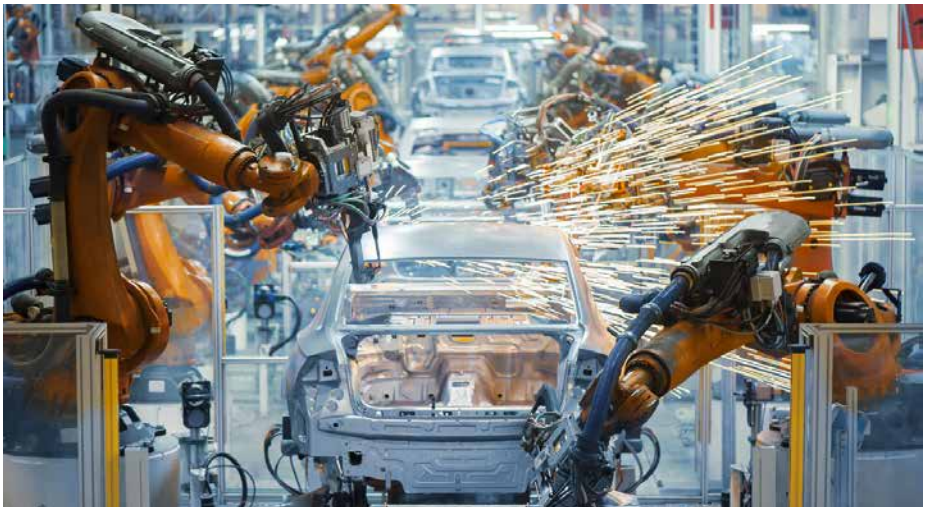
iOS Software upgrade for Industry 4.0

Embedded OPC UA Server enables open platform communications for factory automation applications.

The latest version of its Hirschmann Operating System (HiOS) is complete with an embedded Open Platform Communications Unified Architecture (OPC UA) server. The software provides a seamless, brand-agnostic solution as industrial automation moves towards Industry 4.0. Belden claims it is the only manufacturer to offer switches that can natively run this communication protocol.

Now with universal communication capability, customers can reap the benefits of a more tightly integrated network within the factory automation system, including openness, interoperability and scalability. As the de-facto communications standard for Industry 4.0, OPC provides a communication bridge between all levels of the automation architecture, from embedded components on the factory floor to the enterprise.

Benefits with the upgraded HiOS software include: Industry 4.0 ready, providing a future-proof solution to ensure existing products will continue to support future technologies; seamless integration into existing OPC UA-based applications; and less complexity and higher network availability since there is no requirement for SNMP to OPC gateways.



SOURCE: BELDEN

The LMP-C602G-SFP-bt-V2 switch is designed for applications that require up to 90 Watts of PoE power.

HiOS is suited for any industrial setting that requires immediate, reliable communication between devices, especially for machine-to-machine communication and motion control applications. Comprehensive security features make it a solution for high-risk industries, such as power transmission and distribution, oil and gas, manufacturing, automotive, transportation and aerospace markets.

Belden offers a comprehensive portfolio of interoperable products to ensure seamless, secure and future-proofed solutions.

Belden

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IEEE 802.3bt PoE to USB-C adapter

USB Type-C devices supporting a variety of input PoE standards up to 90W and output power up to 60W.

A new PoE to USB-C adapter converts both power and data, while offering up to 60W USB output power via an Ethernet cable supported by the PoE infrastructure.

The adapter can accept up to 90W of PoE and convert it to 60W output over USB-C that will power most cameras, laptops, tablets and other devices using USB-C for input power. This adapter simplifies installation by reducing dependency on AC infrastructure. Without the dependency of an AC outlet, power can be delivered over 100 meters.

This adapter enhances the remote power management capabilities of the USB-C power device. The remote power reset capability, provided by the PoE source, allows power cycling via web interface or Simple Network Management Protocol (SNMP) to reset the device, rather than having to manually unplug and restart at the location of the equipment.

Microchip's PoE to USB-C adapter can connect to a variety of PoE sources with various standards deployed. It supports newer IEEE 802.3af/at/bt standards as well as legacy PoE standards. Having a versatile adapter is crucial due to the many different implementations of PoE already installed.

SOURCE: MICROCHIP

Without dependency of an AC outlet, power can be delivered over 100 meters.

Having the capability of converting 90W input to 60W output enables devices requiring higher power charging to make use of PoE that could not have done so before. The adapter can be paired with Microchip's cost-effective single-port and multi-port (up to 24) PoE injectors/midspans and switches that comply with IEEE 802.3af/at/bt industry standards and provide up to 90W power per port.

Microchip

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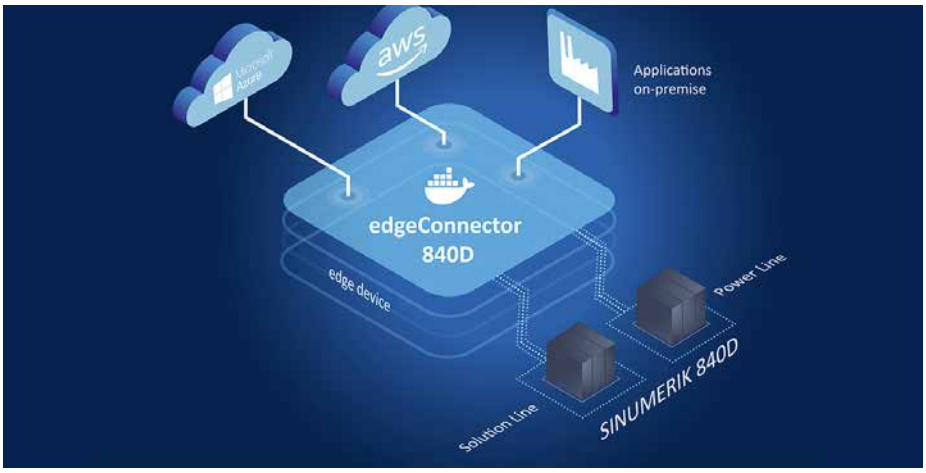
CNC data integrated into industrial edge

Softing expands its dataFEED edgeConnector product family based on Docker technology.

The new edgeConnector 840D container supports easy access to data from SINUMERIK 840D controllers, and makes it available on edge devices or virtual environments via OPC UA and MQTT. This enables flexible integration of local OPC UA clients and MQTT brokers in a cloud environment and the Industrial IoT.

Following dataFEED edgeConnector Siemens for the connection of SIMATIC S7 controllers, Softing now introduces dataFEED edgeConnector 840D. This software module is the world's first container application for accessing SINUMERIK 840D Solution Line and Power Line controls. It supports the reading of all process parameters and drive data without the need to intervene in the configuration of the machine tool.

The 840D allows integration of up to five CNC controllers into a cloud environment such as Azure IoT Edge or AWS IoT Greengrass. It can be used, for example, to check production quality and tolerances, record machine data and integrate it into higher-level management systems or visualize process parameters and other performance indicators. Configuration can be done locally via an internet browser or remotely via the REST interface.



SOURCE: SOFTING

Despite high-performing CPUs, industrial PCs are designed to be fanless, increases their range of applications.

A central deployment of all connected edge devices with their containers, e.g., for updates or security patches, can be carried out using an optional device management system.

It is planned to grow the dataFEED edgeConnector product family further and, for example, also support the control connection via Modbus TCP or Ethernet/IP. Containers for data aggregation and preprocessing as well as address space modeling are in the planning stage. Options for configuration from the cloud plan to be expanded.

Softing

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Module for Powerlink connectivity

Option module provides way to connect to all POWERLINK networks.

The SI-POWERLINK option module serves applications ranging from simple open-loop systems through to those demanding precise motion control.

The protocol is based upon standard Ethernet and provides a solution for real-time Industrial Ethernet to satisfy the requirements of industrial automation and process control applications.

POWERLINK is used in applications in industries including automotive, energy management, machinery, industrial automation, railway and maritime transportation, robotics, vision systems and more. The new module is compatible with Control Techniques Unidrive, Digitax and Commander families, and conforms to the latest release of the POWERLINK standard.

It offers full cyclic (PDO) and non-cyclic (SDO) access to all drive parameters, with PDO cycle times down to just 500 µs. Additionally, drive synchronization is supported on Unidrive M600, M70X and Digitax HD M75X.

Richard Smith, Global Product Manager at Control Techniques, said: "Integration is at the heart of everything we do at Control Techniques. Our modular drive expansion systems are designed to allow integration into virtually any setup, no matter which communication protocol you use."

"Our communication, I/O, feedback and machine control modules ensure anyone can experience the benefits of Control Techniques drives, regardless of their system," he added.

SOURCE: CONTROL TECHNIQUES

Unidrive, Commander, Digitax and the Pump Drive families can now connect to all POWERLINK networks.

Control Techniques

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New smart transmitter uses Bluetooth

Embedded OPC UA Server enables open platform communications for factory automation applications.

A new, rugged field transmitter provides innovative functionality, improved measurement performance, and ease of use for applications in harsh environment conditions.

The iTEMP TMT142B, a new generation smart temperature transmitter with Bluetooth, delivers accurate and reliable measurements, wireless communication via Bluetooth, and user-friendly operation—all packaged in a robust, single-chamber field housing.

In industrial process engineering applications, temperature transmitters are an important link between temperature sensors and the higher levels of automation.

Measurement instruments are often installed in difficult-to-access locations, which frequently makes commissioning, operation and servicing more difficult.

To address these and other issues, the transmitter features a highly secure integrated Bluetooth interface that enables users to wirelessly visualize measured values, NAMUR NE 017 diagnostic information, as well as perform configuration tasks.

The device is extremely easy and fast to operate using your phone or tablet and the Endress+Hauser SmartBlue app. No special tools required.

SOURCE: ENDRESS+HAUSER

Technology offers significant improvements in process efficiency and plant availability while reducing costs.

The newly developed backlit display provides excellent readability under all environmental conditions, both in the dark and bright sunlight. Diagnostic messages are highlighted when the normally white background turns red.

The conversion of different sensor signals into a stable, standardized output signal (4 to 20 mA) represents a logistical challenge as systems often require multiple transmitter variations.

Endress+Hauser

Learn More

Support for CC-Link IE TSN capabilities

New embedded devices for real-time, high-performance control of industrial automation applications.

Semiconductor supplier NXP's new products are the LS1028A industrial applications processor and i.MX RT1170 crossover microcontroller (MCU). In addition to TSN capabilities and Arm Cortex cores, they also offer a host of other features designed to provide a fully integrated and scalable solution for real-time control in increasingly ambitious automation applications.

These devices, among the first to leverage Time-Sensitive Networking (TSN) technology, provide next-generation functions and features for advanced Connected Industries applications.

More precisely, these devices offer high performance and extreme accuracy with elements that include 64 bit processors and 12ns interrupts along with support for display controllers, gigabit Ethernet and a secure architecture. This provides an foundation for implementations of CC-Link IE TSN.

NXP collaborated with another CLPA partner, port industrial automation GmbH, to enable full CC-Link IE TSN master and remote station communication stacks on both devices. By combining these devices with CC-Link IE TSN connectivity, they will provide a strong foundation for vendors looking to offer TSN products that will support the creation of converged networks, where information and operational technology traffic can share a single network architecture. Components act as the core of advanced Industry 4.0 applications that provide data-driven, intelligent operations across an enterprise, optimizing productivity and flexibility.

SOURCE: NXP SEMICONDUCTORS

Crossover microcontroller (MCU) is designed to provide fully integrated, scalable solution for real-time control.

NXP Semiconductors

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New wireless access point

New access point from WAGO offers through-panel mounting and optional PoE power.

WAGO has released a new Wireless Access Point (758-919) that enables fast Ethernet access to remote or non-stationary equipment.

Easy to install, this NEMA 4X-rated device is through-panel mounted via a 2 inch knockout. Hardwire interface is achieved using a standard RJ45 Ethernet cable and 24 VDC power or an alternative option includes using a single cable Power over Ethernet (PoE) connection.

This device offers flexibility with configuration for WLAN, Bluetooth or Bluetooth low energy up to 650 feet and can be set for three communication profiles: Access Point, Gateway or Client. The Wireless Access Point has the ability to connect up to seven smart devices for machines using WAGO's Ethernet controllers and web visualizations for mobile devices HMIs.

This NEMA 4X-rated Wireless Access Point is easy to install and enables fast Ethernet access to remote or non-stationary equipment via a through-panel mount with a 2 inch knockout. With a standard RJ45 Ethernet cable and 24 VDC power users can hardwire your network or use a single cable Power over Ethernet (PoE) connection as an alternative.

SOURCE: WAGO

New Wireless Access Point (758-919) enables fast Ethernet access to remote or non-stationary equipment.

Benefits include:

- Flexibility with configuration for WLAN, Bluetooth or Bluetooth low energy up to 650 feet
- Ability for the user to set three communication profiles: Access Point, Gateway or Client.
- Provision to connect up to seven smart devices for machines using WAGO's Ethernet controllers and web visualizations for mobile devices and HMIs.

WAGO

Visit Website

Ewon Flexy: ThingWorx Ready Status

The Ewon extension for ThingWorx has been validated by PTC and has achieved ThingWorx Ready™ status.

HMS Networks, a member of the PTC Partner Network, announced the availability of a new extension which integrates the Ewon Flexy edge gateways, and associated Ewon Talk2M cloud, with PTC's ThingWorx Industrial IoT (IIoT) Solutions Platform.

The PTC ThingWorx Ready program enables technology companies to validate their products' interoperability with the ThingWorx platform. Following a product's ThingWorx Ready designation, that product becomes available on the PTC Marketplace, a digital space where PTC's partners and customers can access and promote IIoT tools, market-ready solutions, and innovative technologies designed to aid solution deployments.

The Ewon Flexy extension for ThingWorx allows machine OEMs and systems integrators easy and secure data integration from PLCs from all major PLC vendors over the internet to the ThingWorx platform.

With this integration, PTC partners and customers can implement state of the art remote machine service solutions customized to their specific markets.

"Remote machine connectivity is a core market for HMS Networks" said Kevin Knake, Vice President and Americas GM at HMS. "We are excited to be able to offer secure, out-of-the-box machine connectivity to ThingWorx via our proven Ewon Flexy and Talk2M solution. With this, we open a clear path for customers to offer market leading service solutions. ThingWorx services, including Asset Advisor, can be a great value for our machine OEM customer base."

SOURCE: HMS NETWORKS

The extension for ThingWorx allows machine OEMs and integrators easy and secure data integration from PLCs.

HMS Networks

Visit Website

Advanced servo drive solution

Systems offer a frequency response of 3.5kHz and a communication cycle time of 31.25µs.

The MELSERVO MR-J5 series of TSN-compatible servo drives meets exacting requirements for precision, dynamics and multi axis synchronisation in food and beverage, life sciences and printing/converting production applications. They integrate a full suite of standard safety and predictive maintenance functions, giving users the tools to increase machine productivity and availability.

End users and machine builders can drive up the performance of their lines and systems thanks to a frequency response of 3.5kHz and a communication cycle time of 31.25µs. Using associated MELSERVO J5 motion module, users can synchronise up to 256 axes.

This increased performance does not come at the cost of more complex set-up. No tuning experience is required, with a quick-tuning function generating all of the gain values automatically within approximately 0.3 seconds. The machine is then ready to run as soon as the servo is enabled, assuring smooth running with significantly reduced commissioning time and effort.

A key enabler for improved performance across multi-axis servo systems is the integration of CC-Link IE TSN (time sensitive network) technology with 1Gbps transmission speeds, assuring synchronisation across all connected devices – including safety devices, which can be connected on the same network as standard control products such as inverters, HMI and I/O. Other network protocols such as EtherCAT are also offered as standard.

Predictive maintenance functions have also been embedded, helping to reduce unplanned machine downtime and drive-up asset availability, saving both time and money. before a maintenance is required.

SOURCE: MITSUBISHI

Integration of CC-Link IE TSN technology, with 1Gbps speeds, assures synchronisation across connected devices.

Mitsubishi Electric

Visit Website

Starter set for Ethernet connectivity

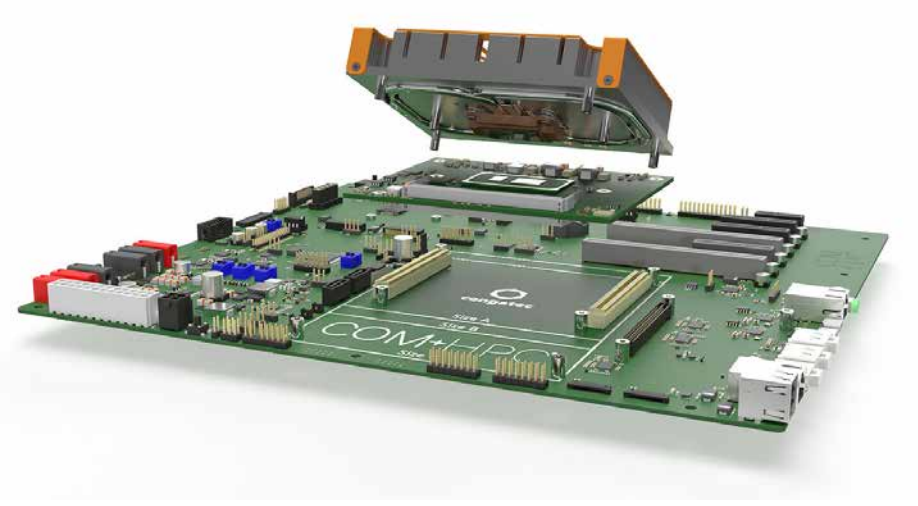
New starter set for COM-HPC offers 11th Gen Intel Core processors and options for Ethernet connectivity.

A new COM-HPC starter set is optimized for modular system designs utilizing the latest high-speed interface technologies such as PCIe Gen4, USB 4.0 and up to ultra fast 2×25 GbE connectivity as well as integrated MIPI-CSI vision capabilities. The starter set is based on congatec's PICMG COM-HPC Computer-on-Module conga-HPC/cTLU, which leverages 11th Gen Intel Core processor technology (code name Tiger Lake).

This high-end embedded module generation targets system engineers working on the broadband connected edge devices that are emerging in industrial IoT. Target markets include medical, automation, transportation and autonomous mobility, vision based inspection and video surveillance systems.

The starter set's various Ethernet configuration options range from 8x 1GbE switching options and 2x 2.5 GbE including TSN support up to dual 10 GbE connectivity. congatec's comprehensive AI support for MIPI-CSI connected cameras from Basler adds further application readiness to IIoT and Industry 4.0 connected embedded systems. AI and inferencing acceleration can be achieved with Intel DL Boost running on the CPU vector neural network instructions (VNNI), or with 8-bit integer instructions on the GPU (Int8).

Attractive in this context is the support of the Intel Open Vino ecosystem for AI, which comes with a library of functions and optimized calls for OpenCV and OpenCL kernels to accelerate deep neural network workloads across multiple platforms to achieve faster, more accurate results for AI inference.



SOURCE: CONGATEC

Embedded module targets system engineers working on the broadband connected edge devices.

congatec

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