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#### **Industry 4.0 Perspectives**

Welcome to the September/October 2021 issue of the Industrial Ethernet Book and our coverage of Industry 4.0 technology aand application megatrends. Advances in computing power, artificial intelligence and IoT networking are enabling to a Fourth Industrial Revolution and creating an ecosystem where data is acquired from a diverse set of devices and locations, analyzed in real time to identify valuable insights and acted upon using a combination of distributed infrastructure and applications.

In the special report in this issue (page 6), we offer the perspective of technology leaders on how Industry 4.0 solutions and products are shaping up and ways they are enabling smart manufacturing applications.

The question is not whether Industry 4.0 is coming. It is rather about how quickly implementations will happen. Organizations such as the German Engineering Association (VDMA) and the German Association of the Electrical and Electronics Industry (ZVEI), together with a host of industrial companies, have defined concepts and standards. This has laid the foundation for Industry 4.0 solutions.

Digital transformation is being driven by a series of principles.

*Interoperability:* The ability of machines, devices, sensors, and people to connect and communicate with each other.

*Information transparency:* Enabling operators to collect immense amounts of data and information from all points in the manufacturing process.

*Process monitoring:* Aggregating and visualizing information comprehensively for making informed decisions.

*Decentralized decisions:* The ability of cyber-physical systems to make decisions on their own and to perform their tasks as autonomously as possible.

On the cover of this issue (provided by Analog Devices), we see an illustration of the central role that Industrial Ethernet plays in this revolution, and the diverse set of applications that Industry 4.0 addresses.

From Big Data to augmented reality, simulations and digital twins, the key to success is connectivity, networking and lots of software at all levels. Edge computing, connectivity to the cloud, and the need for new levels of cybersecurity are important pillars in the continuing development of an Industry 4.0 ecosystem for manufacturing.

Underpinning successful factory implementations will be a secure, reliable, flexible, high-performance network infrastructure that comprises both wired and wireless technologies.

Al Presher



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#### **Industrial Ethernet Book**

The next issue of Industrial Ethernet Book will be published in **November/December 2021**. **Deadline for editorial:** November 10, 2021 **Advertising deadline:** November 16, 2021 View Industrial Ethernet Book website for latest news and products: <u>www.iebmedia.com</u>.

Editor: Al Presher, editor@iebmedia.com Advertising: info@iebmedia.com Tel.: +1 585-598-4768 Free Subscription: <u>iebmedia.com/subscribe</u>

Published by IEB Media, Div. of Stratejus, Inc. Box 1221, Fairport, NY, 14450 USA ISSN 1470-5745

# IEC 63171-7 standard for hybrid interfaces

SPE Industrial Partner Network continues to drive development of the IEC 63171-7 standard for hybrid interfaces. The group says that p owerful IIoT devices can work most effectively with the right infrastructure.

THE IEC 63171-7 STANDARD SPECIFIES HYBRID M12 interfaces with SPE and power contacts for high-power applications. This open standard increases investment certainty in the SPE market.

Through active committee work, the SPE Industrial Partner Network is driving the development of IEC 63171-7 for hybrid SPE + power interfaces in the M12 format forward. The development of the standard and of the associated hybrid interfaces in M12 is the logical and natural progression of the hybrid SPE + power interface in M8 format, as already specified in IEC 63171-6.

While it leads the development of the technology and the standard, IEC 63171-7 was nevertheless deliberately created as a new, independent standard in order to give all SPE users the confidence to invest in it.

#### Active committee work

Through active committee work, the members of the SPE Industrial Partner Network are driving forward the development of hybrid M12 SPE + power connectors and the associated new standard IEC 63171-7. It is the logical and natural progression of the M8



*M8 hybrid interface with SPE and power contacts for up to 60V DC / 8A.* 



Migration scenario for implementation of SPE in industrial automation.

hybrid connectors for SPE and power contacts, as already defined in IEC 63171-6. The M12 interface is one of the most common sizes at the field level of automation. To establish SPE as the new physical layer for the IIoT at the field level, the right infrastructure is needed.

As well as higher data rates, the SPE infrastructure should also ensure greater ranges and increased power supply to devices. To guarantee this even in the case of high-power applications, it is necessary to seek alternatives to Power over Data Line (PoDL) via data contacts, which are limited to 50W at the device and a pure point-to-point star topology.

If higher power is required or if more variable network structures are to be realised as a line or tree, hybrid cabling is needed, with separate wire pairs for SPE and power supply. To fulfil these requirements, IEC 63171-6 defines suitable PoDL and hybrid M8 interfaces with one SPE contact pair and two additional power contacts for 60V DC / 8A.

Building on this solution, the hybrid concept was further developed, adding more contacts, and integrated into the M12 size. At the suggestion of TE Connectivity, a SPE Industrial Partner Network founding member, the M12 hybrid interfaces are being standardised under IEC 63171-7. Following consultations with the members of the SPE Industrial Partner Network and with customers, up to five power contacts plus the SPE contact pair are integrated into the proven M12 format.

Different versions from 60V DC / 50V AC to 630V AC 3-phase can be realised with fool-proof coding. This makes these new M12 hybrid interfaces suitable for a wide range of applications such as DC servodrives, small three-phase drives and many more.

#### Hybrid system advantages

The hybrid system combines the advantages of a direct supply of data and power with the lower cost and compactness of cabling using only one cable and one interface at the device. In this context, M12 interfaces offer excellent EMC properties through having separate data and power contacts.

Together with IEC 63171-6, as the new standard for hybrid M12 SPE + power solutions IEC 63171-7 gives companies the confidence to invest in the successful establishment of Single Pair Ethernet at the field level.

News report from SPE Industrial Partner Network.

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## **Technology solutions powering the 4th Industrial Revolution**

Industry 4.0 has been a decade in the making but even now the technology is progressing at a rapid pace. This Industrial Ethernet Book special report on Industry 4.0 looks at the impact of cyber physical systems, data democratization and new solutions for connecting with smart manufacturing operations.



Building Industry 4.0 ready MQTT networks at scale to leverage edge and cloud computing relies on a combination of industrial-strength software solutions.

INDUSTRY 4.0 IS THE FUTURE OF INDUSTRIAL production but it also requires solutions individually tailored to each application. The megatrends emerging to drive the technology are focused on creating an ecosystem of solutions aimed at systematic production improvement.

In this special report, the Industrial Ethernet Book offers comprehensive coverage and offers the perspective of industry leaders on how Industry 4.0 technologies are shaping the future of the smart factory.

#### **Turning data into decisions**

Enabling distributed access to field data

"The Industry 4.0 focus on turning data into decisions as efficiently as possible places a much higher value on distributed access to field data," Josh Eastburn, Director of Technical Marketing at Opto 22 told IEB recently. "This continues to drive interest in edge computing as practitioners look for more efficient ways to collect, process, transform, and deliver data to connected systems. For similar reasons, adoption of MQTT and its Sparkplug B payload format continues to increase."

"Together, they are being applied to address long-standing obstacles to I4.0 integration, specifically in the areas of cybersecurity, data democratization, and brownfield retrofits," he added.

#### Industrial edge devices

According to Eastburn, unlike traditional field devices, industrial edge devices provide general-purpose computing, networking, and storage capabilities in addition to standard OT interfaces for data and control. Embedded security measures and communications protocols allow edge devices to bridge the gap between OT and IT. They are able to connect directly to IT networks and applications, processing and transmitting OT data without relying on external servers. They can also consolidate other automation functions for control, visualization, MES, and more.

SOURCE: OPTO 22

MQTT was designed to provide secure, lightweight, responsive distributed communication and has become the most popular transport protocol for IoT applications. It uses an efficient, data-agnostic, byte array payload that works for any kind of data, and introduces a novel communication model that is well suited for I4.0 applications. Rather than cyclically polling field devices, MQTTenabled field devices and gateways publish data independently to the MQTT broker (the central server) when they detect a change in a monitored value. This behavior is known as report-by-exception. Other MQTT clients, including software and other field devices, can register with the broker as subscribers to data of interest, which are identified by individual topic strings. The broker distributes updates from the field to topic subscribers as they arrive.

Sparkplug B is a popular standard for MQTT communication within industrial applications that was developed to provide greater interoperability and state management for mission-critical operations. It defines a data-rich payload format, a common topic format, and mandates the use of messages that alert the system when a client enters or exits the network. Any MQTT system can process Sparkplug B payloads if clients are able to publish in and interpret the payload format.

Both MQTT and Sparkplug B are open-source software managed by the OASIS and Eclipse foundations, respectively.

#### **Technology and application benefits**

"Industrial edge devices address modern cybersecurity requirements that support scalability and data democratization. While this enables innovative new applications, more importantly, it enables the digital transformation of existing manufacturing operations where the majority of valuable industrial data can be found," Eastburn said. "In these brownfield situations, replacing legacy PLCs and other devices with newer equipment for the purposes of digitally transforming is expensive and complicated."

He added that industrial edge devices provide a more feasible option. They can apply a layer of security, data processing, and communication above the process level without disrupting or modifying ongoing operations. This layer mediates communication directly between OT and IT networks and avoids the complexity of the Industry 3.0 technology stack (for example: PLC > HMI > SCADA > MES > ERP).

MQTT provides communication that is 80-90% more efficient than traditional pollresponse protocols. Its lightweight payload, brokered publish-subscribe architecture, and report-by-exception communication pattern reduce bandwidth requirements and eliminate redundant transmissions. Since MQTT connections originate from the clients, rather than from the MQTT server, devices can block outside (incoming) connection requests completely while still providing bi-directional communication.

Sparkplug B builds on the essential scalability that MQTT provides to make it even easier to build and manage IIoT networks. With a standard payload format, clients are able to identify and handle data from across the network without knowing the publisher's details. This also applies at scale. All publishing devices and data can be discovered automatically without inputting device addresses or tags.



In the MQTT architecture, publishers and subscribers from across the organization connect to a common data broker.

#### **Industry 3.0 deficiencies**

"Industry 3.0 architectures suffer from multiple long-standing weaknesses. Low-level devices are highly vulnerable to cybersecurity risks and provide a scope of communication that is generally limited to OT network protocols," Eastburn concluded.

"Other hardware and software systems, usually multiple layers, are required to safely transform and transport field data, meaning that while communication across the organization is possible with I3.0 technologies, it is expensive and complicated to scale up to the magnitude we need for I4.0."

He added that, in fact, we are seeing that many I4.0 proof-of-concept projects get stuck in so-called pilot purgatory because they are built on technologies that weren't designed for scale:

Poll-response protocols that require many point-to-point connections, which consume bandwidth without producing new data and introduce new security vulnerabilities;

Complicated network schema that mitigate the lack of endpoint security but also make it more difficult to connect distributed systems;

Closed data formats and applications that connect some parts of the organization but also become new data siloes; and

Persistent gaps in data collection and quality due to latency issues, connectivity obstacles, lack of interoperability, and the cost of expanding the system.

#### Cyber physical systems

Model physical plant and network layouts

"Cyber physical systems are one of the most promising concepts of Industry 4.0 due to their potential to transform the way that commissioning, operations, and maintenance is done within automation," Dr. Al Beydoun, President and Executive Director of ODVA told the Industrial Ethernet Book recently.

"Cyber physical systems can model physical plant and network layouts to allow for low-cost virtual tryouts that can help pinpoint the path to optimum results without having to take the time, effort, and risk of physically implementing changes. This can help to reduce costly trial and error maintenance and engineering approaches that sometimes takes place when troubleshooting a system or installing a system modification on a deadline," Beydoun added.

Well-designed and developed processes to initially commission a plant's automation system might be forgotten in the chaos and pressure of an operating facility, and cyber physical systems can allow controls engineers to quickly test out potential fixes or modifications prior to physical implementation, help to avoid unplanned downtime via prognostics, and reduce repair time via augmented reality maintenance instructions.

Cyber physical systems can be enabled at

Industry 4.0



EtherNet/IP In-Cabinet Profile Network Segment

EtherNet/IP In-Cabinet Profile Network Segment With Actual Topology Object in Router.

the most basic level by combining CAD models, augmented reality, and diagnostics. Device and instrument inventories in massive factories and plants are one specific application where there could be tremendous value in having a cyber physical system to help facilitate the process.

#### **Technology benefits**

According to Beydoun, cyber physical systems include the use of augmented reality that can overlay virtual dimensional models on top of physical reality and also provide visualization of product status and information.

"Augmented reality can be enabled through the use of CAD models that are accessed when a QR code or WiFi signal activates the virtual reality overlay on either a phone or special augmented reality glasses," he said. "Technology enabling augmented reality, such as LiDAR scanners that use 3D sensing to measure the distance to surrounding objects up to five meters away, is being implemented broadly in smart phones and will soon become common place. Network access is also required for diagnostics and can be enabled either directly through a device web server or a network gateway."

Augmented reality can offer tremendous value during the entire lifecycle of a plant: during the commissioning process by enabling physical fit to be tested and confirmed, during normal operations by allowing system performance to be checked via diagnostic and

prognostic indication, and for maintenance by providing step by step virtual instructions to change out a failing component. Automation professionals can thus be freed up from having to provide onerous documentation or direct operations and maintenance support.

#### Impact on manufacturing

Beydoun said that a virtual production model could enable new production line layouts to be tested to uncover potential bottlenecks before they happen. Potential improvements in OEE could also be vetted out in a virtual environment to result in the best outcomes actually being implemented on the plant floor. Additionally, virtual reality that is tied into both the plant system configuration and the manufacturer support documentation could reduce training requirements for new maintenance workers.

The EtherNet/IP Standard Network Diagnostic Assembly creates a known object address inside a device to make a consistent set of diagnostic information with context quickly accessible. This makes an EtherNet/ IP network effective for making key device diagnostic and network health easily available for cyber physical systems regardless of instrument type or manufacturer. The use of a common location for critical diagnostic data saves valuable engineering time and effort, which increases the odds that this critical information will make it into the decision makers' hands when they need it.

EtherNet/IP also bolsters the value of cyber physical systems by enabling the connection of low-level in-cabinet devices to the network, such as contactors and push buttons. This additional resource constrained device connectivity is made possible via Single Pair Ethernet (IEEE Std 802.3cg-2019 10BASE-T1S). Low-level device network connectivity via EtherNet/IP results in time savings in



EtherNetIP In-Cabinet Resource-Constrained Multidrop Flat Cable system offers in-cabinet device support.



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installation, easier troubleshooting, and increased diagnostic information.

The steady decline in the cost and size of semiconductor chips combined with the availability of Single Pair Ethernet has enabled an EtherNet/IP in cabinet bus solution that uses a multi-drop network and control power cable that spans a single cabinet with one interface per device and one switch port across multiple devices.

#### Automation challenges

"Automation engineers face a daunting challenge of documenting system configurations, product technical manuals, and firmware versions in an ever changing, high pressure production environment," Beydoun said. "Diagnosing production issues can also quickly sidetrack an entire work day worth of productivity given the importance of keeping the process or line running. Virtual production models that tie into actual product status, performance, layout, and revision status as well as manufacturer support information such as technical manuals and product catalogs for easy reordering could provide a tremendous amount of value. Automation engineers could then be able to better focus on preparing for upgrades or enhancing the existing system while the cyber models would help to support operations and maintenance personnel."

#### **Data democratization**

Leverage analytics to optimize performance

"Industry 4.0 and data science innovations have already played a large role in expanding analytic capabilities well beyond their historical limits," Allison Buenemann, Industry Principal – Chemicals at Seeq told IEB.

"But while many processes have been improved and some terminology has changed, the methodology behind approaching process optimization problems remains constant typically still following the framework of "define, measure, analyze, improve, control" as developed by Six Sigma more than a century ago. The problem? This approach often leads to organizational and data silos that impede rapid innovation. But as Industry 4.0 progresses, we're seeing these data silos break down, thanks to new technologies enabling the democratization of data across organizations," she added.

According to Buenemann, this data democratization trend, driven by selfservice advanced analytics applications, is helping to create an army of front-line data practitioners, each using advanced statistical concepts to solve problems, with no PhD in statistics required. Giving process engineers and other subject matter experts (SMEs) with domain knowledge direct access to process and contextual data greatly reduces the data preprocessing efforts required to do advanced



A chemical company used Seeq solutions to reduce margin losses by more than US\$1 million annually.

machine learning.

An extensible application interface can instantly scale the efforts of a single data scientist to many front-line operations employees, resulting in improved production outcomes.

#### Importance of analytics

To understand what's unique about technologies that enable data democratization, Buenemann said let's look at the example of applying machine learning in process manufacturing. When thinking about deployment, many assume a "divide and conquer" approach is required, with data scientists handling complex algorithms to deliver models, and SMEs then using these models and making changes based on operating conditions.

While seemingly ideal, this approach is flawed because of the gap between the initial model and the domain expertise of the SME. Excluding the SME from model development introduces additional iteration into the model building process, increasing time-to-value. And if SMEs are not confident in the action suggested by the ML outcome, they're not likely to take action.

Although there was a time when statistical modelling methods were considered new and complex, requiring the expertise of a data scientist, today's SMEs do not avoid statistical models. Instead, they use these and other modelling approaches daily, while also leveraging model-building experts as needed to build confidence in their workflows and recommendations.

The trend of data democratization puts the data and algorithms directly at the fingertips of SMEs who have the required domain knowledge. They can then use that data throughout the iterative improvement and control phases of operational excellence projects. Using collaborative tools, like Seeq, SMEs can their share results and document findings with colleagues (including data scientists), ensuring more expert touchpoints, while lowering the likelihood that something will be missed.

#### Focus on continuous improvement

"The megatrend of data democratization in Industry 4.0 has many benefits, but the largest is continuous improvement to significantly improve productivity and profitability," she added.

"Take refining and chemical operations, for example, which are dynamic and require constant adjustment based on changes in product demand, feed slate, catalyst deactivation, and asset/equipment availability and condition. This means SMEs must use an advanced analytics application, like Seeq, that breaks down data silos and provides direct access to near-real time data. This empowers SMEs to easily refine and update models as equipment and feed changes occur, and as new products are introduced," Buenemann said.

In fact, using a model for near-real time quality control rather than traditional feedback methods, a chemical company used Seeq

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Register now! **sps-exhibition.com/tickets** Save 50% on any ticket with the promotion code: **SPS21AZNT2**  to reduce margin losses due to low quality, saving more than US\$1 million annually. In this instance, the deployed solution was a predictive model that accurately forecasted final product quality based on conditions in an upstream portion of the process.

Applied analytical methods must keep pace with constant variations in operating conditions. Data democratization allows front-line SMEs to keep pace with changing conditions and enables them to explore processes with colleagues, including data scientists, to create continuous improvement opportunities that drive improved outcomes.

#### Facing the challenges

Buenemann said that advancements in technologies providing democratization of data across organizations directly address the historical challenge of data silos, created when the connection between SMEs and data is disrupted.

"When the era of big data emerged and complexity surrounding data storage, security and access increased, the extent to which SMEs could operate at the speed of thought was greatly reduced or eliminated," she said. "They needed others to constantly resupply data, and they then spent hours wrangling it using spreadsheets, creating bottlenecks for companies looking to leverage data analytics."

"Today, we know that having data whether process data, quality metrics, shift logs, environmental data, or any other time series data—directly accessible to SMEs from a single application is a crucial requirement for a successful manufacturing operation. Advanced analytics applications, like Seeq, empower SMEs to directly interact with data and perform calculations using their domain knowledge."

#### **Connecting automation & IoT**

Effective technology and software ecosystems

One key trend is that third-party providers are working together to offer Industry 4.0 solutions via more effective automation platform ecosystems. The goals are:

- Control multi-functionality thanks to apps
- Co-creation and new business potential
- New partnerships in the area of IoT solutions for automation

In modern automation, machine control, IT and the Internet of Things are being connected seamlessly. Using its ctrlX AUTOMATION platform, Bosch Rexroth is working to connect these worlds. Using a partner network, it offers its own IoT solutions as well as applications from third-party providers as apps.

Thanks to these apps, the functions of the ctrlX CORE control functions can be configured as necessary, not only as a machine control system, but also as a secure and intelligent



The ctrlX CORE control platform can be easily integrated into existing machines to retrofit IoT connectivity and functions.

gateway solution. With its open design and numerous interfaces, the control system is also suitable for brownfield installations in order to add IoT connectivity and functions to existing machines and systems.

Using the ctrlX IOT software, the automation platform already has important basic apps such as a firewall, a VPN client and an OPC UA server and client. These are complemented by partner IoT solutions. As a result, users are offered a wide range of apps and enjoy a great deal of flexibility.

#### IoT application tools

For quick IoT application development, Prescient Devices, Inc. (PDI) is part of the ctrlX ecosystem. With the Node-RED-based Prescient Designer, the company offers a SaaS solution in order to design, simulate, distribute, operate and expand IoT/AI systems. This makes it possible to program thousands of IoT devices such as ctrlX CORE centrally in the cloud at one location and to transfer the program code to the devices with a click. As a result, these can be commissioned and maintained efficiently.

Andy Wang, founder & CEO of Prescient Devices, Inc. says: "Together with Bosch Rexroth, we'd like to simplify and speed up the development of IoT applications without having to use complex technology. The Prescient Designer is tailored to the community and platform. This allows an engineer to design and create an edge-to-cloud IoT solution for example within a few weeks. Compared to conventional IoT development, this leads to 12x quicker development, 6x lower costs and greater real-time management and analysis intelligence at all times." IXON B.V. is another ctrlX World partner. IXON offers an end-to-end IIoT solution for all remote maintenance requirements from the hardware to the cloud. Bart van den Corput, Key Account Manager at IXON, explained: "Our aim is to encourage and support the IIoT transition among machine manufacturers by providing a secure cloud environment with all the technology needed to make the IIoT directly accessible anywhere in the world."

IXON is cooperating in order to offer machine manufacturers even greater flexibility when creating an IIoT solution, which meets their requirements. As a result, they can easily integrate the IIoT into their automation solutions. Users can download the IXagent app from the App zone.

This creates an ability to access to all IXON cloud platform functionalities, including solutions for remote access, cloud data logging, alarms and messages.

Solutions from HiveMQ GmbH are also available, offering an MQTT broker for the ctrlX CORE control system. This allows data to be exchanged between various hardware and software platforms. MQTT is an industry standard which is now very popular for IoT use cases such as intelligent production. At the same time, it is the basis for use cases such as connected vehicles, logistics, Industry 4.0 and connected IoT products.

Hans Michael Krause, Head of ctrlX World Product Management at Bosch Rexroth, said that "with all these IoT solutions which are available through the ctrlX World, users can easily connect the necessary automation processes as they would with a smartphone. Simply download and launch the app."

"Bosch Rexroth also provides numerous



The findings reflect steady progress in the development of Industry 4.0 initiatives across the industrial automation ecosystem.

sector-specific applications of its own," he added. "If the user would like to bring in their own personal knowledge, they can create apps themselves in all popular programming languages using the automation platform.

#### State of Industry 4.0

Global survey results report progress

Molex has announced the results of a global survey of Industry 4.0 manufacturing stakeholders driving advancements in robotics, complex machines and device or control systems. The findings reflect steady progress in the development of Industry 4.0 initiatives across the industrial automation ecosystem, including smart automation, connectivity and analytics that add efficiency and intelligence throughout the manufacturing lifecycle.

#### **Key findings**

The Molex survey illustrates evidential data of progress made, key business outcomes and benefits of Industry 4.0.

- 51% report having a well-defined Industry 4.0 corporate priority with executive sponsorship; 49% have already achieved success while 21% are still in the investment stage.
- More than half of the respondents expect to meet their Industry 4.0 goals within two years, while a third believe that milestone will take three-to-five years.

- 58% say that digital transformation investments have accelerated Industry 4.0 efforts.
- 44% find organizational and cultural adoption barriers hardest to overcome.
- Operational efficiency, manufacturing flexibility and advanced analytics are poised to propel customer benefits.
- Major implementation barriers span from cultural, business model and technology challenges.

"It's gratifying to see widespread Industry 4.0 progress, as the Fourth Industrial Revolution is pivotal to fulfilling the promises of digital manufacturing," said John Newkirk, VP and general manager, Industrial Solutions, Molex.

"Ensuring success requires a pragmatic approach, organizational alignment and secure connectivity solutions that drive operational efficiency while boosting manufacturing flexibility and reducing costs," he added.

Molex commissioned third-party research firm, Dimensional Research, to conduct The State of Industry 4.0 Survey in June 2021, polling 216 qualified participants in a variety of roles, such as R&D, engineering, production manufacturing, strategy, innovation, and supply chain management. The primary research goal was to capture data on practical real-life Industry 4.0 experiences and opinions. Overall, the survey respondents validated continued growth, potential customer benefits and expected business outcomes emerging from the Industrial Internet of Things (IIoT) and smart manufacturing.

#### **Outcomes and benefits**

According to the survey, the most impactful business outcomes encompass the ability to build better products (69%), reduce overall manufacturing costs (58%), increase revenues (53%), offer products at lower prices (35%) and decrease time-to-market of new solutions (35%). For machine builders, robot manufacturers and systems integrators, the opportunity to expand factory-floor automation and intelligence is expected to drive significant customer gains.

Among the most anticipated customer benefits are increased efficiency of robots, machines, and other manufacturing assets (58%); greater flexibility on manufacturing lines (50%); the use of advanced analytics or Digital Twins to self-optimize operations (50%); virtual design and simulation of new production facilities before making capital expenditures (42%); elevated labor productivity (41%); and unlocked access to real-time data across facilities (26%).

Overall, a significant majority of survey respondents (87%) are excited about the transformative power of Industry 4.0 over the next decade.

Al Presher, Editor, Industrial Ethernet Book.

# Industry 4.0: the next step in smart manufacturing

Inside the innovations leading the Industry 4.0 manufacturing transformation, there is an emergence at the sensor-driven level. For manufacturers, taking that next step into the future depends on further investment in the technology underpinning advances in factory automation and flexibility.



Industry 4.0 data generated by sensors and digital systems allow businesses to more effectively monitor processes taking place in the physical world.

TODAY, THE MOST PRECIOUS RESOURCE in the manufacturing industry isn't steel, coal or electricity, it's data. Companies are beginning their journey of Industry 4.0 manufacturing, the latest industrial revolution driven by artificial intelligence and massive connectivity.

In this new age, data generated by sensors and digital systems allow businesses to monitor processes taking place in the physical world, laying the foundation for more flexible modes of production—an approach increasingly required by changing consumer demands. But consumer demand is just the tip of the iceberg when it comes to the current emphasis on industry 4.0. With economic, geopolitical, environmental, and population issues and crises rippling across the globe, industrial labor supply and supply chains are being impacted like never before.

The COVID-19 pandemic, for example, is shining a light on this need for advanced technology, real-time data, and flexible manufacturing and supply chains.

With increased automation and robots taking on repetitive, dangerous work, manufacturers can augment human labor and

ensure continuity of production. This frees up workers to leverage their cognitive brain power and enables re-shoring of previously off-shored automated and repetitive work.

"There are more and more capabilities people are discussing, like the use of IoT, robots and augmented reality in manufacturing settings," says Kaibo Liu, associate director of the IoT Systems Research Center and associate professor at the University of Wisconsin-Madison. "You'll start to see higher and higher resolution data gathered from the manufacturing process, making more aspects of decision-making possible in real time."

Industry 4.0

Manufacturers are forced to change how they operate to respond this new type of demand, including more localized manufacturing facilities and by designing production lines that can be quickly reconfigured for different batch sizes," stated Nicola O'Byrne, Marketing Manager, Connected Motion and Robotics for ADI.

More localized supply chains can also add new flexibility to manufacturing, with the added benefit of reduced environmental impact from lower transportation complexity. Finally, with reliable and real-time data and easily reconfigurable systems, manufacturers can make decisions quickly such as scheduling maintenance, adjust a machine setting, or pivot from making shirts to face masks.

While some elements of the next industrial revolution remain aspirational - like fleets of autonomous robots cooperating on advanced tasks like construction, recovery and rescue, others are already being realized. One example here is decentralized 3D printing facilities, which are reducing time to market and time to customer for advanced manufacturing. With the right partners, today's businesses can access many of the gains in efficiency, safety and productivity promised by Industry 4.0 manufacturing—and set the stage for the transformative next step in manufacturing.

"You'll start to see higher and higher resolution data gathered from the manufacturing process, making more aspects of decision-making possible in real time," said Liu.

#### The 4th revolution

The 3rd Industrial revolution brought us electronics, computing, telecommunications and digital technologies. This allowed manufacturers to design plants to mass produce a small number of products, or even a single product, at high volume. Today, a greater level of flexibility is required as



Unplanned downtime has a steep cost for manufacturers and is a priority for Industry 4.0 technologies.

consumers expect more options and levels of customization than what was available in the 1920s—or the early 2000s, for that matter.

"If you want to buy a car, there are many options you can choose from," said Kevin Carlin, vice president of condition-based monitoring Otosense AI at Analog Devices. "Manufacturers need to be able to cater to hundreds of thousands, even millions, of different configurations. Then they need to manage the entire plant and supply chain to be able to respond to that in real time, and configure their factories to move from one model to another."

Making the leap is no simple matter. Most factories rely on an existing, sometimes dated, technology ecosystem. Simply replacing old equipment with new equipment is expensive and often unrealistic. It's one reason why the road to Industry 4.0 manufacturing may be a matter of augmentation rather than replacement, bringing the intelligence enabled



Industry 4.0 manufacturing, is being driven by gains in artificial intelligence and massive connectivity.

by modern-day IT down to the machines already on the factory floor.

By setting up a wireless, sensor-driven communication network at the production level, partners like Analog Devices help manufacturers realize the promise of emerging technologies such as condition-based monitoring. Here, the health of a specific machine or part can be monitored by sensors, allowing plants to identify, diagnose and solve abnormalities before they become an issue or possibly even fail outright. This real-time monitoring can help extend equipment lifespans and increase throughput. Given that unscheduled downtime can amount to nearly a guarter of total manufacturing costs, predictive maintenance has the potential to unlock significant savings and productivity.

The COVID-19 pandemic has shown us how important it is not only to be able to quickly retool an entire factory floor, where manufacturers are able to switch from manufacturing one type of product to personal protective equipment, diagnostic equipment and health care devices such as ventilators, for instance, but also how necessary it is to keep machines running and prevent downtime as much as possible.

#### The cost of downtime

Unplanned downtime has a steep cost for manufacturers—and preventing it is a major goal of the technologies that will define Industry 4.0 manufacturing.

According to "The Costs and Benefits of Advanced Maintenance in Manufacturing," a U.S. Department of Commerce report published in April 2018, the percentage of total manufacturing costs caused by downtime is 23.9% including lost production, lost capacity, the cost of labor per unit and the cost of holding inventory.



#### Hardware meets hard hats

At the heart of Industry 4.0 manufacturing is a concept known as interoperability, or the ability to communicate real-time data across numerous Industrial IoT devices. Manufacturing floors use equipment, software protocols and proprietary networks from a number of equipment manufacturers. To date, there hasn't been a way for these individual protocols and networks to talk to each other. The emergence of Time Sensitive Networking (TSN) technology will enable this for the first time.

Given the high volume of data produced by today's smart factories, a robust on-site network is a prerequisite for interoperability. One technology helping to enable it is real-time Deterministic Ethernet, which can better manage the high volume of data in a connected factory. In addition to leading the charge on sensor technology, partners like Analog Devices are pioneering the hardware (such as real-time Deterministic Ethernet switches), forming what amounts to a factory's central nervous system.

#### Bringing IT to the factory floor

As industry 4.0 approaches, manufacturers are making the jump from legacy computer infrastructure to new network solutions driving faster speeds, better data management and increased energy efficiency.

"Our role in translating the physical to the digital means that the insight we generate at the edge now must talk to everything else that's in a particular plant," says Martin Cotter, senior vice president of worldwide sales and digital marketing at Analog Devices.

"Having a real-time, high-bandwidth connection across each system enables greater control of various production processes. That's driving efficiency, it's driving more certainty of output and it's driving a next-generation industrial process," he said.

With the bedrock of interoperability in place, manufacturers can begin to adopt Industry 4.0 manufacturing's most exciting advances, such as robots and "cobots" capable of working alongside humans on the factory floor. Like autonomous vehicles, these machines are supported by advanced sensing solutions that intuit their surroundings three-dimensionally, ensuring a high degree of safety while they perform repetitive and complex tasks.

Partners like ADI can combine different sensing modalities, like vision and time of flight, with connectivity technology such as Deterministic Ethernet to transfer data in real time and have more precise control of robots and cobots.

According to one report, the use of these tools could help drive an estimated net savings of \$40.4 billion per year for U.S. manufacturers.

"We are the source of data. We are where data is born. For 50 years, we've been the company people rely on to solve their toughest engineering challenges. Our experience in this space is the basis for all of the future advancements we're building with our clients today," Cotter said.

For manufacturers, taking that next step into the future depends on further investment in the technology underpinning advances in factory automation and flexibility. It's here, at the sensor-driven level where the physical world meets the digital one, that the gains promised by Industry 4.0 are truly being realized.

Technology report by Analog Devices.

SOURCE: SIEMENS

# Wi-Fi 6: boost in efficiency for industrial applications?

The guestion is not whether, but how IEEE 802.11ax (also known as Wi-Fi 6) and 5G are driving wireless mobile communications in the industrial environment. Siemens supports both technologies in order to offer optimal solutions for the most diverse requirements.



Thanks to shorter latency, automated guided vehicles can be safely operated in large numbers even at higher speeds.

WI-FI 6 IS THE FIRST WLAN STANDARD TO NO longer mainly focus on greater bandwidth, but on the more efficient use of frequencies by each individual client as the number of participants increases. The standard provides functions that need to be implemented in industrial-grade components.

Wireless LAN in the industrial environment has long been much more than the mere wireless connection of a few stationary participants. With proprietary industrialoriented additional functions, the so-called iFeatures - such as the industrial Point Coordination Function (iPCF) - Siemens already has augmented earlier WLAN standards with real-time capability and prepared them for the most demanding industrial applications. Applications with mobile participants such as crane trolleys, automated guided vehicles and shuttle systems, high-rack warehouses / rack feeders, overhead monorails, and increasingly mobile robots in modular



Industrial Ethernet/PROFINET

Thanks to shorter latency, automated guided vehicles can be safely operated in large numbers even at higher speeds.

production environments are now established worldwide. The technology has become an integral part of the world of automation. Even more so in the end-to-end digitalized factory with more and more IIoT devices and mobile virtual/augmented reality devices for the visualization of data and processes, e.g., for assisted work. The number of participants in wireless networks continues to rise, and with it the need for even more flexible, efficient communication. Still handling and coordination, service and maintenance must remain easy to manage for the user.

SOURCE: SIEMENS For this, the latest WLAN standard - IEEE 802.11ax - the sixth generation, succinctly dubbed Wi-Fi 6 by the Wi-Fi Alliance, brings a series of high-performance functions that can be expanded.

#### Communicating more efficiently

A major step towards higher efficiency is made possible by the OFDMA (orthogonal frequencydivision multiple access) function, a method of data transmission already established in mobile communications but new for WLAN. Up to now, WLAN utilized the orthogonal frequency-division multiplexing (OFDM) method.

With it, only one client can communicate with the access point at a specific time and the client exclusively occupies the communication channel for data transmission.

#### OFDM transmission



Wi-Fi 6 introduces simultaneous usage of one WLAN channel for up to nine participants (OFDMA) to reduce latency. Up to Wi-Fi 5, only one participant can communicate at a specific time (OFDM).

With OFDMA, the communication channel is divided into multiple subchannels, so-called resource units (RUs). These subchannels can be variably bundled and used by different clients. In this way, data can be transmitted simultaneously and therefore at shorter intervals. This can reduce latency, especially for small packets such as PROFINET telegrams, and ultimately lead to shorter cycle and response times for automation solutions.

A WLAN with end-to-end OFDMA-capable access points and clients enjoys various advantages. For instance, more participants can communicate in a shorter time than before, or more data can be transmitted in the previous time window with the same number of participants.

This, for example, makes it possible for an automated guided vehicle (AGV) or a skillet conveyor to respond more quickly to unforeseen events, such as people in the travel range. It can therefore be operated at a higher speed without increasing the risk. In a high-rack warehouse, this means significantly higher transshipping rates.

This creates also the basis for the parallel handling of the more and more frequently arising requirements of reliable real-time in automation components and data-intensive applications such as camera transmissions.

#### Energy usage and wireless load

Another new function of Wi-Fi 6 enables a defined target wake time (TWT) to be stipulated for each participant so that clients are only addressed and "woken up" when necessary. The clients thus use less energy, which can result in longer runtimes and maintenance cycles for battery-powered WLAN devices.

In complex systems, however, the more important aspect is that "sleeping" participants do not transmit and thus do not occupy the communication channel. This in turn facilitates the planning and coordination of large numbers of participants and more easily leads to a stable, interference-free communication. Three different TWT modes make this part of the standard very flexible.

#### Reusing channels spatially closer

The aim of the new standard function "Spatial Reuse with Basic Service Set (BSS) Coloring" is the ability to reuse channels that are spatially closer together. Even if they are spatially so close that severe impairments would normally be expected. To this end, a "color" is assigned and a dynamic channel release threshold defined for each BSS consisting of an access point and related clients. As a result, the participants can communicate reliably even if the channel is in fact occupied by participants of another color, but they are transmitting with a lower power. This eliminates the waiting times for a free channel, and the channels can be reused more efficiently.

"Spatial Reuse" allows for a significantly more efficient usage of the frequency spectrum and new paradigms when planning facilities. The reusability of spatially closer channels simplifies the coordination between multiple equipment suppliers in a factory. In industrial IoT environments, a better distribution of the many clients across the different access points and thus a higher interference immunity (transmission quality) is expected to be achieved in high density areas.

#### **Greater industrial efficiency?**

The standard with its improvements alone cannot yet portray all requirements of automation solutions in the various industries.

To use OFDMA in real-time, the correct scheduling (communication planning or communication control by the access points) must be implemented, for example. The critical point in wireless communications, namely the transition of a client from one access point to another, was neither considered nor improved upon in the standard. That will require additional industrial-oriented adjustments in the manner of the already familiar industrialoriented function iPCF for deterministic real-time communication.

#### Conclusion

The trend in automation is towards automation protocols with hard real-time requirements that are operated in parallel with data-intensive applications. To operate all applications trouble-free via a wireless connection, extensions to the mechanisms already existing in the standard are needed.

To not only use the possibilities of the new standard, but to go beyond it and create real added value in automation with regard to real-time and reliability – that is exactly the aspiration Siemens is already implementing with Industrial Wireless LAN and will also be implementing with Wi-Fi 6.

Kilian Löser, Product Manager for Industrial Wireless LAN, **Siemens.** 

# **Digital twins create the perfect match**

In the words of the Greek philosopher, Aristotle: "The whole is greater than the sum of its parts." Although this conclusion was made long before Industry 4.0 and the Smart Factory even came to be, it hits the nail on the head when it comes to machine manufacturing.



The digital twin accompanies a machine through each stage of its lifecycle – from development and commissioning to ongoing operation.

COMBINING HARDWARE, SOFTWARE AND programming code does not automatically produce a functional machine. Only the perfect interaction of these combined "parts" will result in a functioning "whole". Simulation plays a key role in achieving this.

What role does simulation play in machine manufacturing and plant engineering? "The answer is simple", said B&R's product manager for simulation, Isabella Laasch. "It is the key to the next level of efficiency throughout every phase of a machine's lifecycle."

Machines are becoming more and more complex. This also means that the interplay between mechanics, electrical equipment and automation is becoming increasingly difficult. Testing possible machine sequences directly on a physical system incurs high costs and is all-around inefficient. This applies to each phase of the machine's life: development, commissioning and ongoing operation.

#### Costly, time consuming design flaws

Even in the first phase of its lifecycle, the machine goes through multiple stages. Major

defects can occur in any of them. The Rule of Ten states that the cost of correcting a defect increases by a factor of 10 for each stage of machine development at which the defect was not detected. Correcting the defect as soon as possible will therefore speed up the development process and save costs.

If defects occur throughout the entire development process, however, they won't be detected until the commissioning stage. "If one problem after another arises while the machine is being commissioned, the outcome will be disastrous," says Laasch.

Not only have they already gone to the expense of producing a prototype, the development team is now occupied with finding and resolving the source of the problems.

If the hardware is damaged, there will be additional expenses for spare parts as well as a possible delay due to long delivery times. In the worst case scenario, the machine builder may even be subject to contractual penalties if the new machine cannot be delivered to the customer on time.

#### Simulation is the key

"Essentially, we have to find a way to digitally map a machine during each phase of its lifecycle," said Laasch. "The way I see it, there is only one way to do this and that is with simulation." A digital twin of the machine is created in the virtual simulation environment. With the help of the digital twin, the interaction of the individual components can be checked during development and the machine can be commissioned virtually.

According to Philipp Wallner, Industry Manager at MathWorks, "With model-based development, it is possible to ensure that the machine will work at an early stage, thereby reducing the risk of failure to a minimum. Simulation models form the basis for the design phase, virtual commissioning and digital twins. An investment in simulation will usually pay for itself within the first year."

#### **Cooperation with simulation experts**

Machine builders can choose from a wide variety of simulation tools. The offer ranges from tools for hardware and machine simulation to process simulation. For this reason, B&R has dedicated many years to working together with various simulation experts and integrating different tools into its automation system.

"In cooperation with our partners such as MathWorks, Maplesoft, machineering and ISG, we offer a wide range of simulation options and have the right solution for each application. "The decisive factor here is that our customers are free to choose which simulation tool is best suited for their machine. The B&R development environment is the central tool in every case."

#### The right tool for any requirement

The simulation software from Maplesoft and MathWorks can efficiently and accurately map machine components, for example, and momentum and forces can be simulated for machine designs. Here, it will be easy to test various load cases. Testing on a real system would require many working hours and numerous resources. An oversized load could result in damage to valuable hardware that will then need to be replaced. With simulation, however, the machine builder can see at a glance whether or not the machine can handle a given load.

"When machine builders face performance issues, they need a quick fix that doesn't eat away at their profit margins. Dynamic, physics-based digital twins allow machine builders to detect problems in their designs and figure out how to solve these problems without additional hardware costs," said Chris Harduwar, VP of Business Development at Maplesoft.

The tools from machineering and ISG, on the other hand, cover the area of process simulation. They show the dynamic behavior of a complete machine in 3D. This allows all dynamic factors that affect the material



Simulation tools like machineering's iPhysics offer effective process simulation and show the dynamic behavior of a complete machine in 3D.



Unplanned downtime has a steep cost for manufacturers and is a priority for Industry 4.0 technologies.

flow to be tested in real time with the digital twin. The machine builder gets instant visual feedback about how behavior is affected by different combinations of machine components. Unnecessary downtime can also be identified and eliminated at an early stage.

#### Using data for predictive maintenance

Even after the machine has been developed and deployed, the digital twin is not done adding value. The digital twin continues to run in the control cabinet as a virtual copy of the machine, using real-time operating data to make accurate forecasts about the health and remaining service life of the machine's components.

"If the behavior of the real machine deviates from that of the digital twin, because of a worn out bearing, for example, the difference is detected immediately", Laasch explained.

The collected data is used for predictive maintenance, fault documentation, remote maintenance systems, etc.

Dr. Georg Wünsch, Managing Director, machineering GmbH & Co. KG added that "our iPhysics simulation software provides consistency in engineering. It combines all disciplines ranging from MCAD, ECAD and automation to production and after sales service. With the additional connection of AR and VR systems, complex mechatronic machines are completely secured at all times."

#### **Reduced training time**

The digital machine counterpart also opens up new possibilities for training machine operators and service technicians. Theoretically, they can learn how to work with the Human Machine Interface or the machine itself before it actually arrives on site. This significantly reduces the time required for training new operators.

The digital twin is also increasingly being used in virtual showrooms, which allows the

sales department to present new machines to potential customers at any time, even outside of trade fairs or events. With the help of augmented reality headsets, the digital machine can even be superimposed in realistic environments. This makes it possible to test what-if scenarios when planning and developing machines with moving objects.

Dr. Christian Daniel, Business Manager for Simulation Technology, ISG Industrielle Steuerungstechnik GmbH said that "if you configure simulation scenarios as digital twins with virtual reusable components from a library, then they can also be used by the plant operator for production optimizations, retrofits and as a basis for innovative training and service concepts."

#### Faster machine development

"The digital twin accompanies a machine through each stage of its lifecycle," says Laasch. "Furthermore, it forms the basis for new functions and future improvements to the machine." The machine builder can use insight gained during operation to optimize the system, for example. The simulation model can then be used to test the planned modifications. This reduces the downtime for upgrades to a minimum and speeds up the development process for the next generation of machines.

"In cooperation with our partners such as MathWorks, Maplesoft, machineering and ISG, we offer a wide range of simulation options and have the right solution for each application. Our customers are free to choose which simulation tool is best suited for their machine. The B&R development environment is the central tool in every case," Laasch added.

Carola Schwankner, Corporate Communications Editor, **B&R Automation.** 

# Individualisation of mass production core for Industry 4.0

At the highest level of "hard customisation" driven by the goals of Industry 4.0, customer-specific interfaces are developed to meet individual customer requirements, with the aim of meeting even the most "unusual" customer wishes in mechanical and plant engineering.

ONE OF THE MOST SIGNIFICANT CHALLENGES in today's manufacturing technology is the question: How do I serve the "very special and unusual" wishes of end consumers? As things stand today, this would appear to apply only to the end consumer worlds. But the current trend towards factoring in individual customer wishes entails consequences that extend deep into production technology.

The scope and degree of Individualisation as is currently strived for, can no longer be achieved with the tool kit of conventional mass production, and calls for a completely different design of production processes, including machines and systems. The individualisation of mass production is one of the core aspects of Industry 4.0.

The resulting challenge for the manufacturers of production systems (OEMs) is as follows. How should the necessary equipment and how should the processes for "individualised production" be shaped and designed so that the costs will not explode and resources required will not rise sky high?

KUKA, the leading robot manufacturer, has formulated a conclusive answer: "The key [to mass customisation] lies in a high degree of standardisation and automation, which at the same time affords scope for variations of customer-relevant product features. What's more, the concept of modularisation, which provides customers specific, tailored product configurations based on a modular building block system, is a cost-effective way to meet individual customer needs ..."

This results in three central perspectives for OEMs:

- 1. The shift towards individualised serial customisation
- 2. Modularisation as the key, in combination with automation and standardisation
- 3. Preservation of latitudes for the variation of customer-specific product features

This perfectly describes the conflicting demands made on OEMs in the mechanical and plant engineering sector. The dilemma is very reminiscent of the statement ascribed to the philosopher Hegel: "Freedom is the insight of necessity".

#### **Importance of interfaces**

Interfaces are a vital component of modularisation. But do they always have



Customer-specific interface solutions for a control cabinet: René Heiden, Operations Manager at SUATEC (right), in conversation with Guido Steenbock, Sales Engineer at HARTING Germany.

to adhere certain standards or not? The increasing automation and modularisation of production systems is delivering technical and business advantages for both OEMs and end users. As the degree of automation rises and modularisation deepens, however, it is precisely the interfaces that play an increasingly decisive role as the link between the elements or modules. This is because the following holds true: The interfaces do not determine the entire modularity, but without interfaces the modules will never become a whole!

This will be further differentiated in the following, because in some instances standardised interfaces and in others "individualised" interfaces will be more advantageous. HARTING commands many years of in-depth experience in this area, based on the production of industrial interfaces and close cooperation with customers from various industrial sectors. Practical recommendations and experience can be derived from these strengths. The importance of customer-specific product definitions for OEMs in the mechanical and plant engineering sector can be well illustrated by the system shown on page 22. The possible degree of product individualisation by the end user is related to the life cycle of production systems. The further the cycle progresses, the smaller is the remaining scope for individualisation (transition from "hard" to "soft customisation").

In order for OEMs to determine the right degree of individualisation for their machines and to bring them into line with the different automation and modularisation requirements along the life cycle, it is expedient to think in terms of different "clusters" or functional groups.

#### Sensor and actuator technology

The development of electronic components has enabled a tremendous compression of functions. Higher energy efficiency and greater packing densities go hand in hand with these ongoing developments. The technology boost



in this cluster is encountered in many places in the production system: in the processintegrated acquisition of input parameters and signals, in the on-site pre-processing of this input data, in the energy-efficient triggering and control of actuators, in brilliant image processing and reproduction, as well as in the touch functionalities of the operating units.

On the one hand, this technological progress facilitates the decentralisation, modularisation, and the scaling of machines. On the other hand, thinking in terms of ever more compact building blocks and elementary functions is becoming necessary, and the initial input and efforts required to develop such systems is on the rise.

In spite of these partially negative implications, the advantages of customeroriented individualisation of the product range in mechanical engineering outweigh the disadvantages. This is due to the fact that the appropriate overall arrangement of sensors, actuators, and other machine control components, as well as the interconnection of the functions and processes based on them, are absolute OEM domains. They alone hold comprehensive system competence here. These are the key assets they can leverage to their advantage.

#### **Drive technology**

There are similar significant and far-reaching shifts here. While know-how was at the core of mechanical development in the past, in recent decades it has migrated almost entirely to software departments or electrical design. Due to the enormous increase in performance of the technologies for electronic drive controls matched with decreasing prices at the same time, entirely new concepts for machine and production plants have emerged. The function group for the complex control of the motion sequences and related processes also forms a central competence of machine manufacturers.

#### Specialised Technology Units

It is noticeable that the manufacturers of manufacturing systems are increasingly concentrating on a few technologies in their development activities. The generalist perspective remains with the overall system suppliers, whose know-how resides precisely in the application and connection of technologies. With regard to the guestion of the right interfaces, however, it is precisely the highly specialised technology units that are of interest. A common, defining aspect of these functional groups is the fact that they are deployed as finished units or aggregates with firmly circumscribed physical and technical functions and precisely defined interfaces. The linking of the units represents the central OEM know-how, not the components used themselves.

#### Digitalisation

This term is omnipresent in today's technical literature and other media and comprises many aspects, but applied to interfaces in mechanical engineering, it refers to data transmission technologies. Data transmission in the form of industrial bus systems and as Industrial Ethernet has long been shaped and used by the players in manufacturing technology.

The possibilities of cost-effective data connection to higher-level systems up to the cloud with ever greater data throughput and real-time capabilities, however, are genuinely revolutionary in technology terms. These technologies would enable OEMs active in the mechanical and plant engineering sector to reshape their entire business approaches: Different manifestations of these changes are described and designed under the heading of Industrial IoT. All data transmission aspects, including industrial buses and industrial Ethernet, are considered here from the perspective of interfaces as a functional group or functional layer.

HARTING

SOURCE

While the solutions in this area are not part of the OEM's core competence, they hold the greatest potential for change in today's manufacturing systems.

HARTING offers solutions for all electromechanical interfaces required in modern control, drive, HMI, and communication technology for production systems at work in all branches of industry. Based on the analysis of customer applications already realised to date, the following advice for the individualised interfaces of the abovedescribed function groups.

Generally speaking, it makes sense to use individualised or customer-specific electromechanical interfaces for the functional groups, which largely represent the core OEM know-how.

Customer specific, tailored interfaces are most often used for those modules and aggregates that are developed or manufactured directly by the respective manufacturer. This applies to all degrees of product individualisation in mechanical engineering from "soft customisation" through the various stages of "hard customisation" to one-of-akind productions. With regard to sensors and actuators, the typical interfaces for the respective industry sector are usually opted for. Trendsetters and innovators, however, do try to set themselves apart from the market by deploying specific, tailor-made interfaces.

When it comes to data interfaces, machine manufacturers rely entirely on standardised solutions. This applies both to the industrial bus and Ethernet connections employed and to all other forms of digital data transmission.

### What are the main reasons behind this design of the interfaces?

In terms of data transmission, it is evident that both Industrial Ethernet and bus systems in the manufacturing area and the higher-level data interfaces are subject to tremendous change. The technologies deployed are largely determined by the suppliers of the control components. Therefore, the recommendation for production system OEMs is as follows.

As far as possible, these interfaces should follow the latest standards of the control technology employed and ensure the modularity and scalability of the machines and systems.

With regard to interfaces beyond the machine edge - e.g. for connection to higherlevel systems - the interfaces should always represent the advanced state-of-the-art. Consequently, as an OEM, an economically and technically optimally designed system for current requirements is in place; a system that is at least in part capable of meeting future (as yet unknown) requirements. Moreover, company will then also be ideally equipped for the continuous expansion of after-sales and service activities based on digital services.

With regard to other functional groups, the advantages and disadvantages of individualised interfaces should be systematically weighed and listed individually. What are the arguments in favour of customised interfaces and what are the arguments against them? There are HARTING customers who have deliberately opted for non-standard interfaces on their technology units, modules, and machines. Here are the key reasons:

- There are end user requirements who operate specific production lines and want to consciously differentiate themselves from individual suppliers or focus on them.
- Differentiation vis-à-vis competitors in the expansion of business models to offer after-sales, service and similar services aimed at a long overall life cycle of production systems. Individualised interfaces allow these services to be controlled and expanded in a userfriendly manner.
- 3. Intentionally non-standard design of machine interfaces or equipping technology with specific interfaces in



HARTING har-motion connectors: developed to customer specifications.

order to stand out from the competition. In particular, OEMs that perceive themselves as technology leaders, innovators or trendsetters are taking advantage of these opportunities.

4. Use of sensors/actuators or their combination developed according to specific specifications of individual manufacturers: In these instances, too, the protection of one's own know-how is the strongest motive for leveraging individualised interfaces.

What individualisation options does HARTING offer for customising electromechanical interfaces in order to meet even the most unusual OEM requests for interfaces in the mechanical engineering sector? In the following, the customer-specific design potentials are listed according to their increasing degree of individualisation.

Thanks to the modular design principle of HARTING connector products, most contact inserts can be combined with different housing types. This results in convenient scalability with regard to the required IP protection class, EMC protection or the installation situation – whether in the device, as a docking solution, in the housing, on the housing wall, in the machine or cable duct, as well as indoors or outdoors.

Cable entries and imprints on housings can be freely configured and custom ordered via online configurators.

As many product families offer the possibility of customer-side placement with contacts with different characteristics, existing contact inserts can be designed customer-specifically; as an additional variant partial assembly should be mentioned, thereby achieving higher voltages.

The contact inserts of most standard

connectors can be provided at individual locations with coding pins instead of contacts.

Instead of fixing screws, pin and socket combinations can be used which have a coding function, these can also be provided with special heads.

Also with regard to data transmission, where standardisation places great emphasis on the transmission characteristics of the entire interconnections and routes at work, there are options for the customer-specific design of interfaces. By means of standardised preLink® contact blocks at the respective end of the data line, suitable connector types for different ends of the data lines can be realised in terms of the respective protection types required. In this way, sub-routes can be designed that are precisely tailored to the end-user environment.

In the case of modular connector systems, contact inserts for signals, data, electrical currents, and other media such as pneumatics or fibre optics can be combined into one single connector. Based on the multitude of existing modules, an almost infinite number of different combinations can be created, representing de facto unique specimens.

Customer specified products specified by the customer that are assembled and individually tested by HARTING at the factory, from connector sets to complete cable assemblies.

At the highest level of "hard customisation", customer-specific interfaces are developed to meet individual customer requirements - with the aim of meeting even the most "unusual" customer wishes in mechanical and plant engineering.

Technology article by HARTING.

# **CC-Link update focuses on time-sensitive networking**

The Industrial Ethernet Book reached out to CLPA for a general update on CC-Link technology, technical priorities and areas of concentration for new applications. This special report provides insight into the direction of CC Link, application successes and its focus on time-sensitive networking solutions.



An effective TSN network infrastructure addresses solutions for both automation and control networking along with enterprise connectivity to the cloud.

THE CC-LINK PARTNERS ASSOCIATION (CLPA) is committed to delivering state-of-the-art technologies that support highly effective industrial communications. To this end, the organization invests in on-going improvement of its solutions, continually adding advanced technologies and recently launching the innovative CC-Link IE TSN to leverage timesensitive networking technology.

"With CC-Link IE TSN, the CLPA is currently the only open industrial Ethernet association that offers a technology that combines gigabit bandwidth with Time-Sensitive Networking (TSN). We were first to market with this in late 2018 and continue to maintain this leadership position," John Browett, General Manager for CLPA Europe, told the Industrial Ethernet Book recently.

"As we move further in the direction of

increasing digitalization of manufacturing via Industry 4.0, we believe TSN will become more and more important. This is due to the increased process transparency it can offer via converged network architectures as well as OT/IT convergence. We strongly feel this is the future of industrial Ethernet and are continuing to work with leading vendors in the industry, such as Mitsubishi Electric, to expand the range of compatible products, Browett said."

"We have seen adoption of CC-Link IE TSN across a range of industries, and we continue to facilitate its greater adoption worldwide. We also continue to expand our development ecosystem and are working with leading development platform vendors, such as Analog Devices, NXP and Intel, to continue this expansion. From a development perspective, our aim is to ensure there are no technical barriers to adoption of our technology in vendors' products," he added.

#### **Technology challenges**

Browett said that emergence of Industry 4.0 means shop floor systems generate more and more data. But there is a huge difference between data and information. To be useful, data needs to be processed to generate actionable insights to feed back into the process to optimize it.

"To do this, there are several requirements that need to be addressed. Firstly, the ability to extract the data from systems in a transparent way. Secondly, once extracted, it needs to be able to flow to the systems that can analyze it and produce the necessary insights. Finally, this information then

## **Development of TSN devices for automation control**

TSN is the future of industrial Ethernet and an enabling technology to support connected industries. To tap into this new market, vendors of automation devices and machines should start to offer key TSNcompatible options now. Selecting the right development path is key to ensuring success.

TSN IS AN INNOVATIVE TECHNOLOGY THAT enhances the capabilities of industrial Ethernet. It is considered the future of industrial communications, as it supports the transfer of different types of data traffic with high predictability, delivering essential determinism for time-critical control functions on the shop floor. As a result, TSN is key to supporting network convergence, ultimately enabling the merge of operational technology (OT) and information technology (IT) domains.

The ability to share information between the OT and IT worlds is essential to gain comprehensive, data-driven insights for smart manufacturing – and it is at the core of the Industrial Internet of Things (IIoT). The convergence offered by TSN is a must to futureproof production activities, creating highly effective connected industries.

#### **TSN development options**

Automation vendors play a key role in supporting companies in the implementation of this innovative technology. To address the current and future market needs, forward-looking device developers should begin to offer TSN-compatible products and systems quickly. By doing so they can help shape the future of industrial automation while enhancing their competitiveness.

There are numerous development methods that are theoretically available to support businesses during the creation of devices with TSN capabilities. These can be broadly divided into software- or hardwarebased alternatives and can offer distinct capabilities in terms of performance, ease of implementation, flexibility and cost.

For example, software development kits (SDKs) or stacks generally offer an economical and rapid route, however they may not be able to achieve the highest performance levels. Conversely, field programmable gate arrays (FPGAs) typically provide high flexibility and capabilities, but their cost may make them more suited to higher end products. Device makers should therefore identify the industrial Ethernet technology solution with the open development ecosystem that best addresses their needs.



There are numerous development methods that are theoretically available to support businesses during the creation of devices with TSN capabilities. (© istock.com/ krystiannawrocki)

#### Consider development ecosystem

When offering a variety of products, different development methods may be necessary to meet the individual specifications or target market.

This is why it is highly beneficial for device manufacturers to rely on technologies that offer a comprehensive development ecosystem when looking at incorporating 'the future of industrial Ethernet' in their solutions.

In particular, this should offer both hardware and software solutions in order to address the specific needs and requirements of various applications. In effect, this flexibility can help to utilise existing products or platforms, upgrading them to offer TSN compatibility and minimising design cost and effort.

In this way, it may be possible to avoid costly development expenses while helping customers implement the technology in stages, replacing their existing components with new alternatives. Ultimately, this makes it easier for both automation vendors and end users to approach TSN and experience its benefits.

An industrial Ethernet technology with this kind of broad development ecosystem is CC-Link IE TSN. This supports both software- and hardware-based strategies for master, remote and local stations. In particular, solutions such as SDKs, dedicated integrated circuits and embedded modules are available for automation vendors. Additionally, businesses can leverage PC boards to support TSN on industrial PCs as well as specialised development options for safety applications.

By choosing CC-Link IE TSN, device manufacturers can therefore find suitable alternatives to streamline the upgrade of their existing solutions to TSN. As a result, they can quickly bring to market innovative products and systems, enhancing their own competitiveness and that of their customers.

John Browett, General Manager, **CLPA Europe.** 



The goal of CC-Link IE TSN is to address industrial networking and connectivity between IT and manufacturing systems. Time-sensitive networking supported by a large community of vendors provides a solution that enhances interoperability and a rich ecosystem to support automation and control.

needs to be fed back into the plant systems to produce the desired results," Browett said.

He added that CC-Link IE TSN offers a solution to address all these challenges. First, it provides the basis for a converged network architecture that allows different traffic types to share the same infrastructure. This makes getting the data out of the process simpler.

Second, this also facilitates OT/IT convergence, so that getting the data to edge servers and the cloud is also simplified. Finally, these architectures are bidirectional, so the derived insights can be easily fed back into the required systems. The result is the basis for increased process transparency and highly optimized operations.

#### New technology developments

Cyber security has become a critical area for industry over the past few years as the blurring of OT and IT has offered both opportunities and challenges. CLPA recently published an extensive set of guidelines for how CC-Link IE TSN can help companies meet the challenges of preventing unauthorized access to their systems (see https://www.cc-link.org/en/ cclink/security/pdf/en\_security\_guideline\_ outline.html). These explain how the network can assist with helping to maintain compliance to standards, such as IEC 62443 and ISO 27001. This is achieved by offering a variety of capabilities, such as authentication, traffic limiting and network filtering plus logging and management functions. CLPA is working with a variety of partners and other third parties, such as Belden, Cisco and HP, to introduce a range of products and systems that support these capabilities. Full details are available at https://www.cc-link.org/en/cclink/security/ pdf/en\_security\_compatible\_products.html)

#### **CC Link resources**

CLPA also continues to offer a global network of conformance test laboratories to its partner companies. These ensure that all CLPA technology compatible products can be used with confidence by end users and OEMs alike.

They also work with our partners during the product development phase as required to make sure that the conformance testing process goes as smoothly as possible. A global network ensures maximum convenience to partners, by offering support in local time zones and languages.

This is in addition to the local support

that all partners can offer on their own CLPA compatible solution offerings.

#### **Future developments**

Looking to the future, there are new areas for CC Link development and CLPA envisions continuing to make an impact on Industrial Ethernet automation and control networking.

"This is an exciting time for industrial Ethernet. TSN is one of several technologies that offer tremendous promise for the future," Browett said. "Along with technology, we also see a greater need for cooperation between different organizations, and the CLPA has an established track record of doing this to provide better connectivity solutions. We will continue to innovate as the industry adopts new technology trends such as wireless networks. By working with our partners and other organizations, we intend to maintain our position as a technology leader with the best connectivity solutions."

To learn more about CLPA and CC-Link IE TSN, download the white paper, "TSN – The Case for Action Now" at https://eu.cc-link. org/en/campaign/2020/tsnwp.

Al Presher, Editor, Industrial Ethernet Book.

# **Toyota upgrades to CC-Link IE at engine manufacturing plant**

Toyota's engine and power transmission manufacturing plant in Wałbrzych, Poland, looked to increase the availability of its production lines and improve the transparency of data. It faced the challenge of network performance, and also of integrating multiple devices from a range of different vendors.

WHEN THE MANAGEMENT AT TOYOTA'S ENGINE and power transmission manufacturing plant in Wałbrzych, Poland, looked to increase the availability of its production lines and improve the transparency of data, it faced the challenge of not only ensuring the implemented network would offer the necessary performance, but also of integrating multiple devices from a range of different vendors. It met these challenges by implementing open gigabit CC-Link IE technology, the industrial Ethernet technology with the greatest bandwidth.

Spread across two sites in south-western Poland at Wałbrzych and Jelcz-Laskowice, Toyota Motor Manufacturing Poland (TMMP) represents Toyota's biggest engine and transmission manufacturing operation in Europe. While the larger engines in the Toyota range are produced at the Jelcz-Laskowice, with a capacity of 180,000 units per year, the bulk of the engine production, as well as manufacture of power transmission products, takes place at the Wałbrzych plant.

Constructed in 1999, the Wałbrzych plant commenced production in April 2002, and today produces over 633,000 units per year, with a capacity of over one million units when running three shifts. The plant's output includes the 1L petrol engine for the Toyota Aygo and shared platform vehicles from Citroen and Peugeot, as well as forged parts. These include crankshafts and connecting rods to supply Toyota Manufacturing UK (TMUK) in Deeside where the engines for the Avensis and Auris are manufactured, plus, gear blanks and forged sleeves to supply Toyota's plant in India.

With a total site area of 520,000 m2, including a plant floor area of some 100,000m2, the Wałbrzych plant includes engine assembly lines and forging lines. When the lines were constructed, the communications requirements were quite simple. However, an increasing need to extract greater volumes of data in order to better monitor the manufacturing processes had led the company to reassess its networking requirements, with the idea of upgrading network systems in both the engine assembly area and forging area.

#### Forging line upgrade

Within the forging lines, the network upgrade requirements were just as extensive, as TMMP



The team at TMMP Wałbrzych was looking to integrate around 2,000 I/O points, connecting numerous devices from different vendors, including 48 Mitsubishi Electric HMIs, and ensure fast data exchange.

manager for manufacturing within the forging plant, Manufacturing Engineering Manager for TMMP Damian Mrozinski, explains: "There are nine forging lines, each with a number of different machines. The largest of which is a 5,000-tonne press that was originally designed separately, with only basic data transfer between each machine. But we wanted the capability to transfer increased volumes of data between the various machines, so looked at an appropriate network choice to connect



Toyota Motor Manufacturing Poland (TMMP).

the various machine controllers."

CC-Link IE (Industrial Ethernet) and CC-Link fieldbus proved the obvious choices. "We opted for CC-Link technologies because they are so easy to implement," says Mrozinski. "In all, we integrated 13 stations, with CC-Link IE providing the communications from machine to machine, and CC-Link providing data transfer between each machine and its subsystems, such as our FANUC robots. Despite the seeming complexity of the requirement, we completed the whole installation during our two weeks of scheduled annual shutdown."

#### **Engine assembly**

Investigation of the options led TMMP to CC-Link IE, the world's only open gigabit industrial Ethernet network technology. This was seen to offer a number of benefits for the engine assembly area.

As TMMP Assistant Manager, Maintenance Engineering, Andrzej Zebek explained: "The engine assembly is carried out across four lines – an inner assembly line, a head



Going forward, the increased data transparency could also provide TMMP with key tools in a journey towards Industry 4.0.

assembly line, a middle assembly line and a finish assembly line. Not only did we want to be able to ensure better data transparency across these lines, but also integrate a range of third party products, including Mitsubishi Electric GOT2000 HMIs and Balluff IP67 I/O blocks to create a poka-yoke system to improve quality in areas of assembly involving manual component picking. We wanted a network that would give us the freedom to choose products from several vendors."

Maintenance Engineer Radosław Serafin adds: "In all, we were looking to integrate around 2,000 I/O points, connecting numerous devices from different vendors, including 48 Mitsubishi Electric HMIs, and ensure fast data exchange. We didn't want to end up being tied into buying products from a single brand – that was very important for this project."

TMMP opted for CC-Link IE as it provided the required communications speeds, with the capability of delivering a flexible and modular solution. Further, with over 1,700 CC-Link IE and CC-Link enabled devices available from over 300 vendors, TMMP could select the best devices to build the poka-yoke system that it wanted.

John Browett, General Manager of the CC-Link Partner Association (CLPA) in Europe, commented: "CC-Link IE has built its success on the twin pillars of performance and openness. This openness was key in Toyota's case, as it meant they had the freedom to source products from leading suppliers, including Balluff and Mitsubishi Electric."

The technology quickly proved its worth, with TMMP enjoying maximum availability, increased data transparency and improved production quality, across a production line that is now able to make a new engine every 50 seconds. Damian Mrozinski confirmed: "CC-Link IE was quick and easy to implement, and simple to use."

#### Benefits of connected production

TMMP is already reaping the benefits of the installation across the engine plant and forging line. Not only has the CC-Link IE network proven to be exceptionally robust, the diagnostics capabilities mean that when there are problems they can be fixed very quickly.

There is more to come at the plant as well,

as Mrozinski explains: "The upgrade of the single forging line was really a pilot project, to assess the benefits. We are now looking to roll out CC-Link IE technology one by one across the remaining forging lines."

SOURCE: CLPA

Going forward, the increased data transparency could also provide TMMP with key tools in a journey towards Industry 4.0. Providing a foundation of interconnectivity between production machines, and to field devices, the network is ready for wider connection to higher-level enterprise systems. This sort of connectivity enables manufacturers to push further in addressing the production challenges of tomorrow.

Browett concluded: "We're very pleased to see a major international corporation like Toyota using CC-Link IE and CC-Link in their manufacturing lines. This is a very good demonstration of the many benefits that this robust, reliable, open network technology offers."

Application story by CLPA Europe.

# **CC-Link IE networking at Roana's biomass power plant**

The Italian farm Roana has invested in a biomass plant that utilises livestock manure and other organic waste to generate energy. To optimise its automation infrastructure, the farm required an advanced control network to monitor the anaerobic digestion process and maximise productivity.

MAXIMISING THE USE OF AGRICULTURAL by-products to reduce waste and improve sustainability has several positives; including reducing a business' environmental impact and maximising an important profit opportunity. This is why Italian farm Roana has invested in a biomass plant that utilises livestock manure and other organic waste to generate energy.

To optimise its automation infrastructure, the farm required an advanced control network to monitor the anaerobic digestion process and maximise productivity. CC-Link IE Field provided the right solution, connecting a series of Mitsubishi Electric factory automation components with a flexible open industrial Ethernet solution delivering Gigabit bandwidth.

Roana Zootechnical farm is in the countryside of Latina, Italy, and is home to approximately 1100 water buffalos. Every day, these animals provide over 3 tonnes of milk, which is used to produce a celebrated buffalo mozzarella cheese.

Along with product, the herd produces approximately 60 m3 per day of useable livestock manure. Before this becomes fertilizer for Roana's agricultural fields, however, it can be used to produce bioenergy. The farm was interested in maximising the use of this by-product to have a positive impact on the environment whilst generating increased revenue for the business. Local renewable energy specialist ProgestAmbiente was chosen



#### System diagram.

to build the green power plant.

Carmen Iemma, Co-owner of Roana, explains: "Roana has been interested in implementing a biomass plant for years. The project suggested by ProgestAmbiente was particularly appealing, as the company was



Roana has invested in a biomass plant that utilises livestock manure and other organic waste to generate energy. Now that the biomass power plant and its network infrastructure are operational, Roana can produce 2,400 kWh of electric energy every day.

able to tailor a solution that would address our commercial requirements and still fit with our existing operations and infrastructure."

#### Roana's biomass power plant

The plant consists of scrapers and pipelines, collecting all the manure from the stables into a pre-treatment tank, which homogenises and equalises the material. This tank is connected to an anaerobic digester system equipped with submersible mixers. At this stage, different bacterial strains digest biomass in an oxygen-free environment at temperatures similar to those in a buffalo's stomach. As a result of this biochemical process, bacteria break down complex organic substances, generating a methane-rich biogas.

The gas produced in the digester moves upwards, towards the dome, and is then directed to a gas treatment unit, where a thermal process helps to purify the gas, increasing the concentration of methane. The end product is sent to a gas-powered generator, which produces enough electricity push power back to the grid.

The control of critical process parameters,



Roana has invested in a biomass plant that utilises livestock manure and other organic waste to generate energy.

such as temperature, gas pressure, in-feed rates and mixing within the digester, plays a crucial role in maximising both the volume of methane produced and its purity. The sensitivity of the system and its coordination can make the difference between it being profitable or not, so responsive automation and network communications are vital to the commercial success of the project.

#### **High-quality automation solutions**

Michele Di Stefano, Project Manager at ProgestAmbiente, adds: "One of the most important aspects for ProgestAmbiente is offering the best functional process equipment and operator tools, featuring state-of-the-art technologies and high reliability. In this case, we chose a combination of Mitsubishi Electric and CC-Link IE.

"We rely on Mitsubishi Electric's automation products and the CC-Link IE family of open industrial Ethernet technologies for our biogas production and water treatment projects. In fact, we believe that the performance offered by these solutions is currently unmatched on the market."

To support Roana's biogas operations, CC-Link IE Field gigabit Ethernet connects a number of automation devices from Mitsubishi Electric to ensure high-performance communications.

More precisely, MAPS SCADA system is linked to a MELSEC Q series PLC. This is then connected to five inverters, from Mitsubishi Electric's energy-saving FR-F800 series, that regulate the functioning of all the electromechanical devices and components used in the process. As a result, operators have a comprehensive view of the entire plant and its processes in real-time, adjusting critical process parameters as well as conducting predictive maintenance strategies.

Alberto Griffini, Product Manager at Mitsubishi Electric, comments: "Our main goal was delivering a system that is highly functional but also easy to use, maintain and expand. For example, as the plant develops and increases its volume of processed livestock manure, Roana could easily upgrade its system by installing a newer MELSEC iQ-R controller, which provides more advanced onboard features and supports a broader range of I/O modules. The networking solution is already very flexible and advanced so effectively futureproofs the installation."

#### Network speed and openness

Key elements of CC-Link IE Field that helped implement the vision described by Alberto Griffini are the network technology's gigabit bandwidth and its openness. Michele Di Stefano explains: "Thanks to CC-Link IE Field, Roana could leverage a high-speed system that benefited from a fast response time as well as an infrastructure that can be easily modified and upgraded to address future needs."

John Browett, General Manager at CLPA, adds: "By offering gigabit bandwidth, we can help processing plants, such as Roana, to make sure time-critical data is shared in a highly deterministic manner. CC-Link IE Field supports interconnectivity between 1Gbit devices from multiple vendors so allows the integrator to choose from more options."

Carmen Iemma adds: "Using a reliable

and responsive monitoring system and highperformance communications is particularly important for Roana, as it allows us to promptly intervene if anomalies are detected, reducing downtime."

#### Benefits of by-product synergy strategy

Now that the biomass power plant and its network infrastructure are operational, Roana can produce 2,400 kWh of electric energy every day. This is supplied to the national electrical grid, generating an extra revenue of EUR 15'000 per month for Roana.

Carmen Iemma comments: "We are very happy with the solution provided, as it clearly shows the benefits of shifting towards renewable energy and maximising by-product synergies. In particular, we appreciate the fact that the plant can manage itself autonomously, without requiring our staff to acquire new technical skills in order to control the plant. The system is intuitive and easy to use, helping all of our operators to effectively use the system."

John Browett concludes: "Reducing the environmental impact of manufacturing and processing activities is a global priority and we are happy to play a key role, helping businesses adopt more sustainable practices. In addition, by supporting Roana, we can show how our open network technologies can address the needs of a wide variety of industrial sectors."

Application story by CLPA Europe.

# industrial ethernet book

Industrial Networking & IloT

Corporate Profiles

# Industrial Automation Networking Solutions

Learn about the companies and technologies shaping the future of Industrial Ethernet, the IIoT and Industry 4.0.

## **Beckhoff Automation: new automation technology**

Beckhoff implements open automation systems using PC-based control technology. The product spectrum comprises these main areas: Industrial PCs, I/O and fieldbus components, drive technology and automation software.



PRODUCT SERIES ARE AVAILABLE FOR ALL industries, and they can be used as individual components or function collectively as a complete, harmonized control system. Our New Automation Technology philosophy stands for universal and open control and automation solutions that are used worldwide in a wide variety of applications ranging from CNC machine tools to intelligent building automation systems.

#### PC-based control technology

Since Beckhoff's foundation in 1980, the development of innovative products and solutions on the basis of PC-based control technology has been the foundation of the company's continued success. We recognized many standards in automation technology that are taken for granted today at an early stage and successfully introduced to the market as innovations. Beckhoff's philosophy of PC-based control as well as the invention of TwinCAT automation software and EtherCAT are milestones in automation technology and have proven themselves as powerful alternatives to traditional control technology. EtherCAT, the real-time Ethernet solution, provides a powerful and future-oriented technology for a new generation of control concepts.

#### Worldwide presence on all continents

The corporate headquarters of Beckhoff

Automation GmbH & Co. KG in Verl, Germany, is the site of the central departments such as development, production, administration, sales, marketing, support and service. Beckhoff's presence in the international market is guaranteed by its subsidiaries. Beckhoff is represented in more than 75 countries by worldwide subsidiary offices and technology partners.

#### EtherCAT - the Ethernet Fieldbus

Selecting communication technology is important: it determines whether the control performance will reach the field and which devices can be used. EtherCAT, the industrial Ethernet technology invented by Beckhoff, makes machines and systems faster, simpler and more cost-effective.

EtherCAT is regarded as the "Ethernet fieldbus" because it combines the advantages of Ethernet with the simplicity of traditional fieldbus systems and avoids the complexity of IT technologies. The EtherCAT Technology Group (ETG), founded in 2003, makes the technology accessible to everyone. With over 6,000 member companies from 67 countries (as of Dec. 2020), the ETG is the world's largest fieldbus user organization.

EtherCAT is an international IEC standard that not only stands for openness, but also for stability: from day one to today, the specifications have never been changed, but only extended with full compatibility assured. This means that current devices can be used in existing systems without any problems and without having to consider different versions. The extensions include Safety over EtherCAT for machine and personnel safety in the same network, and EtherCAT P for communication and supply voltage ( $2 \times 24$  V) on the same 4-wire cable. A more recent extension is EtherCAT G/G10, which introduces higher transfer rates, while all existing EtherCAT devices can be integrated via a branch concept: even here the technology remains fully compatible.

#### Beckhoff Automation at a glance

- 2020 worldwide sales: €923 million (+2%)
- Headquarters: Verl, Germany
- Managing owner: Hans Beckhoff
- Employees worldwide: 4,500
- Engineers: 1,900
- Subsidiaries/representative offices worldwide: 39
- Sales offices in Germany: 22
- Representatives worldwide: >75

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# **Analog Devices: Accelerating the Path to Industry 4.0**

Stay ahead of what's possible with innovative solutions that solve the most complex, important, and impactful industrial automation challenges.



ANALOG DEVICES (ADI) IS A GLOBAL LEADER in the design and manufacturing of analog, mixed signal, and DSP integrated circuits. We intelligently bridge the physical and digital worlds with a cutting-edge portfolio of technologies that sense, measure, interpret, connect, power, and secure.

ADI is, however, not a typical semiconductor company. It pushes the boundaries of silicon technology, investing heavily in software, systems expertise, and domain knowledge within its key markets such as industrial automation.

The combination of this knowledge with that unmatched set of analog-to-digital capabilities enables ADI to approach challenges at the system-level and help its customers get to market faster, create and capture more value, and make sound investments with a roadmap to tomorrow.

#### Industry-leading, scalable Ethernet – timed to perfection

We turn your vision of connected factories into reality. ADI Chronous<sup>TM</sup>, Analog Devices´ family of compatible and interoperable Industrial Ethernet connectivity products, enables bestin-class industrial automation solutions for the connected factory of tomorrow. From complete Time Sensitive Networking solutions for high-performance motion control in factory automation to innovative 10Base-T1L concepts for robust field instrument connectivity in process control – our market-leading Ethernet portfolio of combined software and hardware solutions are scalable and timed to perfection.

ADI Chronous encompasses a range of advanced Industrial Ethernet technologies from real-time Ethernet switches to physical transceivers and network interface solutions that include protocol stacks. Designed to support scalable and flexible system development, the ADI Chronous portfolio offers multiple port count, low power consumption, and flexible bandwidth. Being multiprotocol, these solutions are compatible with the majority of existing industrial protocols while also providing the ability to future-proof for TSN networks.

ADI Chronous solutions are designed and verified for robust operation in harsh industrial environments and offer effective security at each node point within a system. Our suite of Industrial Ethernet products includes technologies, solutions, software, and security capabilities designed to connect the real world to factory networks and beyond to the cloud.

#### WHY ADI?

Our long and rich industrial expertise and system design knowledge coupled with advanced technologies deliver seamless and secure connectivity across the automation network, turning your vision of the connected factory into reality. ADI ensures your timecritical automation and control data is delivered perfectly on time, every time. Get to market fast by using ADI's complete solutions that provide predictable, trusted results you can depend on every time. For deterministic, verified robust, scalable and flexible solutions that simplify system design and reduce the development burden, look no further than Analog Devices.

#### **Analog Devices**

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# Shaping the future of open, autonomous industry

TTTech Industrial aspires to unlock the incredible potential of industrial automation. It combines transformative technologies with hands-on experience to offer customers flexibility, reliability, and choice.

TTTECH INDUSTRIAL WORKS WITH ITS customers to achieve their goals of smarter automation, better data access and more flexible manufacturing with industrial IoT solutions. TTTech Industrial delivers simple and effective ways to bring IoT to industrial systems by providing product platforms that combine traditional automation functionality with secure access to IT services and deterministic connectivity.

### Increasing flexibility and efficiency in manufacturing

Edge computing allows manufacturers to gain in-depth insights into machine performance thanks to real-time data collection and processing. With this data, they can not only improve their own production, but also offer new services to their customers.

TTTech Industrial's edge computing platform Nerve enables manufacturers to connect and manage their machines worldwide. Nerve is an open solution that can host applications from different vendors and visualize data in an intuitive user interface at the edge or in the cloud. This Management System also allows for easy updates and deployment of software to machines installed worldwide.

TTTech Industrial even provides a free trial of Nerve so customers can easily familiarize themselves with the features supporting shop floor digitalization.



TTTech Industrial integrates open, standard technologies to offer flexible platforms for connecting, controlling and managing machines.

Time Sensitive Networking (TSN) is an open standard for industrial communication that offers a range of new features for Ethernet. With its deterministic networking platform Slate, TTTech Industrial provides comprehensive TSN solutions, which enable users to quickly integrate TSN features and easily build TSN networks. Customers can choose from different components that can be combined in different ways within a TSN architecture: TSN Device Solutions enable quick integration of TSN features into FPGAs and ASICs, TSN Device Software offers extended features for TSN implementations, and TSN Network Software allows for planning and dynamical configuration of TSN networks. For those just getting started, TTTech Industrial offers a handy TSN starter kit to immediately implement and test TSN with their applications.



Nerve is an open, flexible edge computing platform providing connectivity from the shop floor to the cloud.

### Reliable communication for smart grid networks

Smart grid networks are key to coping with the challenges of today's energy market. Highly efficient and reliable networks require increased automation capabilities for remote services, repairs and voltage management.

TTTech Industrial offers robust and reliable communication for substation automation and energy management. Flexibilis is a redundant networking product portfolio that includes FPGA IP cores and software for delivering high-availability seamless redundancy for a wide range of industrial applications.

#### TTTech Industrial Automation AG

#### Social Media:

www.linkedin.com/company/tttech-industrial/

# **Industrial networks:** the basis for digitalization

Setting trends, opening up new areas, breaking down barriers – industrial communication is the basis for automation and digitalization today and in the future. Siemens is the specialist for small, medium and large industrial network infrastructures.

SIEMENS OFFERS CUSTOMER INDIVIDUAL network solutions including professional services, trainings as well as products for this purpose. Developing field-proven technology even further, breaking new ground connecting industrial networks with enterprise IT.

#### Setting trends

Today Siemens fully relies on Industrial Ethernet and PROFINET, the open Industrial Ethernet Standard of PROFIBUS & PROFINET International (PI), almost 40 million installed nodes in the field already today.

This is demonstrated by Siemens by means of a comprehensive range of products for PROFINET such as automation systems, drive systems, identification systems, and network components such as Industrial Ethernet Switches, Industrial modems and routers, Industrial Security Appliances as well as Industrial Wireless LAN (IWLAN) Access Points.

The latest innovation with industry routers for 5G shows the time to market activities of Siemens for their customers around the world. Future trends and technologies like OPC UA and Time-sensitive Networking (TSN) will contribute to this successful development.

With approved aggregation and backbone network concepts Siemens realizes the basis for an integrated communication from field level up to the cloud.

Siemens is driving the development of Industrial 5G. An own Automotive Showroom and Test Center in Nuremberg, Germany shows a private standalone 5G network in an industrial environment that is based on Siemens prototypes.

#### **Future proof network solutions**

Siemens designs and implements industrial network infrastructures to master both today's challenges and future customer requirements. Data networks for rough environments, high availability and redundancy, connectivity to existing enterprise IT are Siemens' daily business.

Whether on-site service and support, design and consulting, integration and implementation or training services are customer requirements, Siemens is the reliable partner for industries and for realization of secure collaboration between Operational Technology (OT) and Information Technology (IT). In addition, a wide selection of solution



partners all over the world supports locally.

#### **Breaking down barriers**

Industrial Wireless LAN (IWLAN) replaces obsolete communication paths via contact conductors or tow chains and permits applications such as mobile operation with integrated emergency stop functionality. Experience with Industrial Wireless LAN devices has shown that time critical, cyclical communication is possible.

Even safety signals can be exchanged wirelessly. The new Wi-Fi 6 standard permits higher data rates, improved performance, greater efficiency, and future viability.

#### Integrated communication

PROFINET and Industrial Ethernet permit a unique integration from the field level through the cell aggregations, the industrial backbone all the way up to the enterprise level. And enable the secure connection to a cloud system like MindSphere (the cloud-based, open IoT operating system from Siemens).

For example, the SCALANCE M industry router and the SCALANCE S Industrial Security Appliances permit secure access to a plant network via mobile radio and the internet. The plant's Industrial Ethernet is connected by means of SCALANCE X switches and thus permits access to controllers and PROFINET field devices, for example via web servers. Specific tools for efficient network management, e.g. the SINEC software family, complement the portfolio.

#### **Rugged communications**

RUGGEDCOM is a product line of network components for Industrial Ethernet for mission-critical applications even in the harshest environments. The highly specialized, robust RUGGEDCOM switches and routers fully comply with industry standards, e.g. IEC 61850-3 and IEEE 1613. They meet the toughest EMC, shock and vibration resistance standards, while operating at a temperature range from -40°C to +85°C.

In addition, new PC-based products like the RUGGEDCOM APE and the local processing engine SCALANCE LPE are prepared for applications in Industrial Edge environments.

#### SIEMENS AG

Phone: +49 911 895-0

# **Opto 22: Your Edge in Automation**

Let the engineers at Opto 22 help you build your connected automation system.

Opto 22's *groov*<sup>®</sup> family of industrial edge controllers and I/O is designed from the ground up with integrated control, connectivity, and security tools to help you connect automation, enterprise, and cloud data.

With *groov* EPIC and RIO, you can bring your brownfield systems into the next generation of industrial automation. Unify multi-vendor automation networks into cohesive OT data systems with embedded protocol conversion and OPC UA connectivity. Then secure PLC, I/O, and equipment data with mandatory user authentication, configurable device firewalls, and SSL/TLS encryption.

Whether from new systems or legacy devices, you can publish data directly into on-premise and cloud-based applications like databases, CMMS, and ERP. The included Node-RED IoT programming environment, REST APIs, and MQTT publish-subscribe communication options allow you to collect, process, transform, and transmit operational data efficiently. Store-and-forward capability and fault-tolerant file systems support highly scalable infrastructure for IIoT.

groov devices also reinvigorate traditional industrial control applications with innovative tools that reduce complexity. Develop real-time control programs in a language you know: ladder logic, function block diagram,



An edge programmable industrial controller, groov EPIC<sup>®</sup> is much more than a PLC or a PAC. It can simplify and secure automation and lloT projects, while reducing cost and complexity.

flowcharts, Python, C/C++, and more. Build dynamic operator HMI screens directly from your controller and publish to embedded or external touchscreens, mobile devices, and



groov RIO<sup>®</sup> revolutionizes remote I/O by offering over 200,000 unique software-configurable I/O combinations in a single, compact, PoE-powered industrial package.

browsers.

Replace costly, high-maintenance Windows PCs for HMI, OPC, and data processing with these Linux-based edge devices. The suite of free, web-based tools and software-configurable intelligent I/O allow you to rapidly prototype innovative designs for secure, connected systems and go straight into production with the click of a button.

Built on decades of field-proven experience, groov products are backed by lifetime guarantees on solid-state I/O, UL Hazardous Locations approval, ATEX compliance, and a wide -20 to 70 °C operating temperature range.

Count on free pre-sales engineering help and product support as well. All Opto 22 products are developed, manufactured, and supported in the U.S.A.

With 45+ years as a trusted automation manufacturer, we understand your projects and speak your protocols. Contact our engineers today. Let's talk about what you want to do.

#### Opto 22

www.opto22.com

## **Contemporary Controls: Your Trusted Partner**

Providing innovative and reliable solutions to the industrial automation industry for more than 45 years, Contemporary Controls has been a leader in innovative solutions for industrial automation.

Contemporary Controls' CTRLink products are designed for unattended operation in environments not conducive to office-grade equipment. The products provide convenient DIN-rail mounting in control panels, 24VAC/DC power, UL 508, improved EMC compliance and reliability. Contemporary Controls' repeating hub, switches, media converters and IP routers adhere to IEEE 802.3 standards and more. Specialty regulatory needs are addressed in selected models.

#### **Rugged Ethernet Switches**

Whatever the Ethernet infrastructure need, a solution is available from CTRLink products. For simple systems, plug-and-play unmanaged switches provide a costeffective method for expanding Ethernet networks. Most models include features such as auto-MDIX and auto-negotiation. For more

demanding applications, managed switches provide advanced features such as VLANs, SNMP, Quality of Service, port security, port mirroring, alarming and cable redundancy.

#### **Innovative Diagnostic Switches**

For troubleshooting, diagnostic switches allows a network sniffer to attach to an



CTRLink – Networking for Automation Unmanaged Switches, Managed Switches and IP Routers.

unused port on a switch and observe all traffic on the network.

#### **Cost-Effective, Trusted IP Routers**

Contemporary Controls' Skorpion series of IP routers eases the integration of new machines into the existing network. Each machine consisting of multiple IP devices



connects to the LAN side while keeping the same IP settings for the devices and the application, lowering installation cost and eliminating trouble shooting. The IP address for the WAN port on the IP router is the only setting that requires modification allowing multiple machines to reuse the same configuration on the LAN side. Skorpion routers have been used in Robotics, Automated Guided Vehicles, Packaging and Scientific Equipment.

#### Secure Remote Communication

CONTEMPORARY CONTROLS

SOURCE:

RemoteVPN is a service offered by Contemporary Controls that allows systems integrators remote access to systems from the convenience of the systems integrator's home or office. A cloud-based VPN server hosted by Contemporary Controls provides the critical connection between two VPN clients—one

installed on the systems integrator's PC and the other permanently installed on Contemporary Controls' EIPR/EIGR VPN router located at the remote location. Using this approach, two secure VPN tunnels are created with no concern for intervening firewalls.

#### Solutions You Can Depend On

With automation systems, applications vary and can require a special product or need. Contemporary Controls has worked with OEMs in obtaining UL 864 compliance with some CTRLink switches, and can help in other areas such as private-labeling, unique packaging or extreme environmental design.

Contemporary Controls' customers are systems integrators, contractors and OEMs seeking simple, reliable networking and control products from a dependable source. With headquarters based in the US, Contemporary Controls also has operations in the UK, Germany and China and is well suited to fulfil your application needs.

#### Contemporary Controls www.ccontrols.com

Visit <u>Website</u>

# When Complete Visibility for OT Security Is Mission Critical

Garland Technology believes secure network visibility should be an easy, seamless experience. Since 2011, this U.S. based manufacturer has helped industrial companies with their network visibility needs.

With a deep understanding of the unique challenges and requirements typical of OT environments, Garland provides the industry's most reliable Network TAP, Data Diode, and Network Packet Brokers. Garland's visibility products are developed to ensure OT security solutions receive the packet-level visibility necessary for a properly secured network.

Critical infrastructure is in Garland's DNA. CTO and Co-Founder Jerry Dillard started his career over 35 years ago developing instruments for fighter jets, including work for defense companies General Dynamics and Lockheed Martin. CEO and Co-Founder Chris Bihary started in IT over 25 years ago building out 9-1-1 call center network infrastructures, ensuring everything was implemented in a way that was fault tolerant, had redundancy and was available 100% of the time. "For us, whether it's 9-1-1 facilities, fighter jets, a power facility or water processing plant, we always take the approach that everything we do is absolutely critical and crucial to a company's success," states Chris Bihary.

#### OT Security Success Begins with Complete Visibility

Protecting your network is the ultimate goal. To accomplish this goal, teams utilize ICS security solutions to properly identify, detect, and respond to security threats and breaches with threat detection and asset visibility management. All of these tools rely on network data to successfully protect the company. Providing complete packet level visibility to these tools has become a very important step in the architecture.

A common access point for network visibility in OT environments has been from the SPAN port on a network switch, which mirrors the traffic from the switch. If available, an engineer will often connect intrusion detection systems (IDS) or network monitoring tools directly to the SPAN. In modern ICS networks there is a more reliable option to quarantee 100% complete network packets for security and monitoring solutions to properly analyze threats and anomalies - network TAPs (test access point). As SPAN ports are known to drop packets, create duplicate packets and even introduce bidirectional traffic, network TAPs are a better option. SPAN wasn't developed for continuous monitoring and is not the foundation we encourage for OT networks.



CEO and Co-Founder Chris Bihary affirms that Garland Technology's mission is to help customers achieve their goals by ensuring complete visibility of the organization's OT Security solution.

#### Packet Visibility Designed for Unique Environments

Many Network TAP vendors offer products designed for IT architectures with ICS teams trying to incorporate these as they can. Garland Technology has spent years working with OT customers and government agencies to design specialized network TAPs to work in their unique environments and requirements, providing small rugged metal form factors, environmentally and temperature resistant, including unidirectional data diode design to protect and aggregate TAP and SPAN traffic.

Garland Technology takes these environmental challenges seriously, as we understand what's at stake. Having worked alongside government agencies for both critical infrastructure and military projects, Garland Technology understands that both industries rely on complete packet visibility.

Garland has also pioneered TAP visibility for extreme temperatures, with Copper OT Network TAPs that provide 100% full duplex traffic visibility and are engineered for temperature variations between -40C and +85C up to -40F and +185F, well beyond standard TAP options.

That's why, along with rugged steel products and high quality standards, industrial teams turn to Garland Technology to ensure their security and monitoring solutions are able to see every bit, byte, and packet, even in the most extreme environments.

Following critical infrastructure's guiding principles — you want your network to be built to last, while ensuring minimal to no network downtime. These concepts rest on solid network infrastructure and visibility



architecture. Garland Technology's mission is to help you achieve your goals by ensuring complete visibility for your OT Security solution.

Garland Technology www.garlandtechnology.com

SOURCE: PROCENTEC

# **Diagnostic and monitoring solutions for industrial automation**

**PROCENTEC**<sup>®</sup> is a member of the HMS Group, and the global leader in network communication diagnostics for industrial protocols such as PROFINET, EtherCAT, Ethernet/IP and PROFIBUS.

Procentec is an independent Dutch company that supplies products, training and consultancy to the Industrial Automation market. Our primary focus is the development and manufacturing of automation products for PROFINET, Industrial Ethernet and PROFIBUS. Some of our products are the most recognized solutions on the market today.

#### 24/7 remote network monitoring

There has been a growing acceptance of Industrial Ethernet over the past few years. Systems have grown increasingly complex, therefore a solution needed to be designed to create clarity. Atlas2 is a proven solution for Industrial Ethernet Diagnostics and permanent monitoring.

One of its main features is the dynamic interactive topology. This is a graphical and hierarchical overview of your complete network. Atlas2 will also provide valuable information about the quality of the network. Getting this information used to be very complicated, but the Q-Factor (Quality Factor) simplifies this using a weighted algorithm, which is built up from all connected devices in the network.

### OT-security tools: find, fix and prevent costly threats!

The importance of IT-security has been acknowledged by experts for years whereas securing Industrial Control Systems seems to have been overlooked. Whilst attacks on Operational Technology (OT) environments are becoming more frequent, companies are looking for ways to strengthen their industrial cybersecurity strategy and bridge the gap between OT and IT.

Each of Procentec's solutions fulfils different security tasks. Uniquely, they tackle both external and internal breaches. This will be welcome news to those concerned about threats not only from hackers and malware but also from those with legitimate access to their networks.

#### **Training & support**

Our training facility, the Procentec Academy, has certified over thousands of engineers to implement and maintain their industrial networks to the highest standards available.

The Procentec Competence Centre has established itself as the leading consultancy



Atlas2 is a proven solution for Industrial Ethernet diagnostics and permanent monitoring.

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The first line of defence for your industrial networks.

on PROFIBUS and Industrial Ethernet projects worldwide, advising on architecture, engineering, training and commissioning. Once a network is commissioned, we have experts available 24/7 to answer questions with maintenance or help with troubleshooting.

#### Procentec

www.procentec.com +31(0)174-671 800 info@procentec.com

# **Get Connected – Stay Connected**

#### Do you want to take advantage of the benefits that seamless networking of IT and OT offers?

Regardless of whether you want to integrate existing or new plants in Industry 4.0 applications or transfer production data to Industrial IoT clouds or Big Data applications, Softing products and solutions ensure a smooth data flow and guarantee a secure and stable network. Based on global standards, they can be integrated seamlessly. In this way, they bridge technological gaps and create the framework for implementing Industry 4.0 and IIoT applications to streamline production processes.

#### **Accessing Control Data**

While plants in discrete and process manufacturing often comprise both legacy and new equipment, they still need to be controlled and managed effectively. This requires a modern communication architecture that can aggregate their heterogeneous data. Softing gateways and links enable the coupling of various Ethernet-based and serial industrial bus systems as well as access to OT networks from the IT level. Designed to allow direct connection of different protocols and field devices, they reduce engineering costs by using existing assets, expand the scope of network management, and open the way for IIoT use cases.

#### IT/OT Integration / IIoT Solutions

As traditional industrial automation software applications move to new IIoT solutions, the



Softing products and solutions create the framework for implementing Industry 4.0 and IIoT applications.

requirements for IT/OT integration change. Previously, the focus was on low maintenance and ease of use of specialized gateways. Now, flexible, and automatable configuration, interface abstraction and IT security are needed. Softing OPC Servers, OPC Middleware and flexible IT/OT integration solutions based on OPC UA, offer flexible deployment options. They ensure seamless information flow between devices and software applications and provide secure data transfer to IIoT clouds.

For OPC UA and OPC Classic communication



Digital communication that enables data exchange between machines, integration into the IT level, and cloud connection is the key to improving production processes.

and cloud connection, we provide the data integration software dataFEED OPC Suite Extended. It enables access to the controllers of all leading manufacturers via an integrated OPC UA server. To IIoT Cloud or Big Data applications Production data is transferred via the MQTT and REST protocols.

The integration of aggregated product and machine data is possible with Softing's Secure Integration Server (SIS), which has a powerful OPC UA data integration layer. And to connect production lines and machines securely and scalably via the Industrial Edge to the Cloud, we offer Docker containers. They enable connection with IIoT applications, e.g. from Siemens PLCs and CNCs and Modbus controllers.

#### **Stable Communication Networks**

Robust digital communication is fundamental for the reliable provision of data which is needed to increase flexibility and efficiency in Industry 4.0 applications. With our network management tools and diagnostic solutions, commissioning and monitoring of devices, and troubleshooting in the event of failures becomes easy. They guarantee a high-performance network and maximum plant availability.

#### Softing Industrial Automation GmbH info.automation@softing.com

# Phoenix Contact: Automation for the future

Phoenix Contact is the worldwide market leader of components, systems and solutions in the area of electrical engineering, electronics and automation. The product range comprises components and system solutions for energy supply including wind and solar, device and machine engineering as well as control cabinet engineering.

Today, the family-owned company employs 17,100 people worldwide and had a turnover of 2.4 billion Euros in 2020. The corporate headquarters is located in Blomberg in North Rhine-Westphalia. The Phoenix Contact Group has eighteen companies in Germany, as well as more than 55 sales subsidiaries. Internationally Phoenix Contact is on site in more than 100 countries. service features according to their specific demands.

Product innovations and specific solutions for individual customer requests are developed at the locations in Germany, China and the United States. Numerous patents underline the fact that many developments from Phoenix Contact are unique in their own.

In close cooperation with universities and

company, which work in combination with the security functions of other components, contribute to the creation of secure networks. From the secure development process to the continuous vulnerability management of Phoenix Contact PSIRT (Product Security Incident Response Team), security is anchored in the complete life cycle of the products and solutions.



Phoenix Contact produces with a high vertical range of manufacture all over the world. Besides screws, plastic and metal parts, highly automated assembly machines are also built in-house.

#### Wide product range

A diverse product range of modular terminal blocks and special-purpose terminals, printed circuit terminal blocks and plug connectors, cable connection technology and installation accessory offers innovative components.

Electronic interfaces and power supplies, automation systems on the basis of Ethernet and Wireless, safety solutions for man, machine and data, surge protection systems as well as software programs and tools provide installers and operators of systems as well as device manufacturers with comprehensive systems.

The automotive, renewable energy and infrastructure markets are supported with holistic solution concepts including engineering and training services and further science, future technologies like e-mobility and environmental technologies are explored and integrated into products, systems and solutions for the market. Phoenix Contact supports the digital transformation with products, systems and solutions. Based on the experience in the in-house machine building, the company knows the requirements of the digitalization and integrated data flow from the engineering through the production and furthermore along the whole product life cycle.

#### 360° Security

Phoenix Contact supports its customers throughout the entire process chain with standardized security. For risk assessment and threat analysis of existing or planned systems, individual service offers form the basis for implementing security concepts.

In addition, secure automation solutions are provided for various industries. Last but not least, the corresponding security components such as firewalls and secure controls of the This wide-ranging competence of Phoenix Contact is also reflected in certifications: Phoenix Contact was one of the first companies in Germany to be certified by TÜV Süd according to the series of standards for IT security IEC 62443-4-1, -2-4 and -3-3.

These certifications underline Phoenix Contact's strategy of offering standardized security in products, industrial solutions and consulting services to enable futureproof operation of machines, systems and infrastructures.



**Phoenix Contact GmbH & Co. KG** Email: info@phoenixcontact.com Phone: +49 52 35 300 www.phoenixcontact.com

# **Enabling real-time data visibility that drives productivity**

Anything In. Anything Out. Anywhere. From industrial automation to networking, Red Lion provides comprehensive solutions across numerous industries and applications.

Red Lion develops products and solutions that enable customers to communicate, control, and monitor their operations from anywhere while yielding tangible results. Our longstanding customer relationships help drive future innovation.

#### **Communicate to Virtually Anything**

Equipment communication in a factory floor setting has never been more important than today. Thanks to an extensive driver list, an organization's operational infrastructure can flow more.

Combined with Red Lion's advanced networking solutions, one can move information to the cloud using MQTT protocol for greater visibility.

#### **Control Your Equipment.**

Disparate assets and equipment connect through Red Lion's powerful programming software, Crimson. With Crimson's large protocol conversion library, legacy equipment upgrade costs and concerns about manufacturer compatibility are no longer a concern. "Anything in and anything out" is achieved within the same operational environment.



#### **Monitor Your Data**

Monitoring data remotely and securely is crucial to any operation. Red Lion's solutions use dashboards, or virtual HMIs, to access this data—no matter the distance! Being able to remotely and securely access data can mean the difference in costly downtime errors, maintenance calls, worker safety, and even profitability of an organization. Critical decisions increase productivity and profitability, regardless of new or legacy equipment infrastructure.

Besides security and reliability, choosing Red Lion products can make all the difference, especially when it comes to product communications, monitoring, and controls in the most hazardous locations. Factory optimization is important when driving profitability and effectiveness on a factory floor.

Red Lion's vast product portfolio of automation products and services means customer-driven solutions anytime, anywhere. That is our commitment to all our customers because that's excellence redefined.



EXCELLENCE. REDEFINED.

*Red Lion* www.redlion.net

Visit Website



SOURCE: RED LION

# Leading the way in Time-Sensitive Networking

The CC-Link Partner Association (CLPA) is an international organization dedicated to the technical development and promotion of the CC-Link family of open automation networks.

The CLPA was founded over 20 years ago in November 2000, when it introduced CC-Link, its highly respected industrial fieldbus technology. This was followed in 2007 with the widely adopted CC-Link IE, the first open industrial Ethernet to offer gigabit bandwidth. CLPA has since grown to be an acknowledged industrial automation network technology leader globally.

Today, CLPA's key technology is CC-Link IE TSN, the world's first open industrial Ethernet that combines gigabit bandwidth with Time-Sensitive Networking (TSN), making it the leading solution for Industry 4.0 applications and providing the foundation of the converged network architecture necessary to address the ever-changing challenges of 21st century manufacturing.

In order to meet demanding productivity and quality targets, current production trends demand cost effectiveness, better process insights, the shortest cycle times and the management of large amounts of process data. Complying to IEEE 802.1 standards, CC-Link IE TSN provides this capability by combining gigabit performance with the integration of control, safety and motion data along with general TCP/IP traffic **on a single network architecture**, all without compromising performance. This is the key to future industrial network convergence and only CC-Link IE TSN offers this functionality



today. This translates to key business benefits:

- Simpler, more cost-effective network architectures and system designs
- Greater process transparency and better management
- Higher productivity

• Better integration of OT and IT systems

Currently the CLPA has over 3,900 member companies worldwide, and more than 2,400 certified products available from over 340 manufacturers. Together, these form a global installed base of 32 million devices. The CLPA's technologies have found application in a wide variety of industries including but not limited to automotive, consumer electronics, semiconductor, food & beverage, packaging, material handling, water treatment and more.

CLPA offers development support and certification for device makers and product developers wanting to take advantage of CC-Link IE TSN's advanced capabilities in their own compatible products.

The CLPA has also been active in forming relationships with other industry leading associations such as the OPC Foundation and PROFIBUS & PROFINET International.

#### SERVICES

- Open industrial Ethernet
- Time-Sensitive Networking
- Gigabit & 100Mbit bandwidth
- Support for Industry 4.0
- Open fieldbus
- Safety networks
- Motion control networks
- Product certification
- Product development support
- Product promotion opportunities
- PROFINET interoperability
- OPC UA compatibility

#### **CC-Link Partners Association** Email: partners@eu.cc-link.org Website: eu.cc-link.org

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# **Optimize power consumption using remote monitoring**

The Industrial Internet of Things (IIoT) generates a tremendous amount of data that also needs to be stored. Consequently, more and more data centers are needed to fulfill this growing demand for data storage management, increasing energy consumption in the process.

DATA CENTER OPERATORS AND APPLICATION owners need to operate numerous servers and power-hungry equipment while optimizing power consumption. Power distribution units (PDUs) are used to control and distribute power to various equipment. Nowadays, intelligent PDUs that feature metering and switching capabilities from remote sites have seen significant market growth due to increasing remote monitoring demands.

In fact, a recent report identifies the increasing demand for data center monitoring solutions as the key driver of PDU market growth. Monitoring PDUs in an application not only helps optimize energy usage, by recording daily power consumption for payment calculation and energy management, but also allows collection of data about the status of PDUs for device maintenance.

According to Moxa to reap the benefits of monitoring PDUs, an energy management system (EMS) needs to collect meter data from PDUs so that operators can control, monitor, and optimize the performance of the PDUs. In addition, remote power panels (RPPs) may also be used as an extension of PDUs to increase the power distribution capacity by providing extra circuits. Thus, it's also important to monitor the circuit breakers and current transformers to ensure that power distribution through different circuits is under control.

It takes reliable connectivity between the EMS and power devices, such as PDUs and RPPs, to ensure smooth and optimized power distribution. Here are tips to consider to ensure reliable connectivity in between.

#### **Retrofitting or building new?**

Once a user decides to monitor the PDUs and RPPs in an application environment, the question about enabling connectivity depends on the implementation plan. Besides connecting power meters, circuit breakers, and current transformers that might use different protocols and interfaces than your EMS, ask the following questions.

Is the goal to retrofit existing PDUs or deploy a new one? Is there enough space for wiring design? How many PDUs will be connected to the network?

Answers to the above questions will reveal the need for a single-port or high port-density connectivity solution. For example, if you have



Typical system diagram.

limited space for retrofitting your existing PDUs in a relatively small-scale application, a single-port connectivity solution may be the ideal option due its compact design. In contrast, high port-density connectivity solutions can help save on costs if there is sufficient space to deploy multiple new PDUs.

Choosing an easy-to-use connectivity solution can save significant time and effort. In the installation stage, wiring can be painful when you are connecting dozens of PDUs to the same network. Check if the selected connectivity solution has features such as Ethernet cascading, which provides an efficient wiring solution across several PDUs and RPPs to the EMS located in the control center. When PDUs and RPPs are up and running, networking devices will still require backups and updates from time to time. meter data loss can lead to miscalculation of power consumption data, resulting in incorrect billing and incomplete power data for analytics. To enhance power monitoring system reliability, consider backup mechanisms from different angles. Start from the networking devices.

Dual-power inputs and high EMI immunity are features that can protect networking devices from electrical interference. Next, develop a redundancy mechanism for network transmissions. There are various network redundancy features in the market. When considering these options, see if their recovery times are acceptable for the needs of the power monitoring application.

Application article by Moxa.

Visit Website

When unexpected network failures occur,

# Open and highly adaptable automation machine concept

As the pioneer in 3D laser processing technology, Trumpf offers complete machines and systems with optimally coordinated components in addition to beam sources and beam components. New solutions relied on Industrial PC technology and EtherCAT components to drive new levels of performance.



Interior of the TruLaser Cell 8030. Picture: © Trumpf GmbH + Co. KG/Oliver Graf Fotostudio GmbH

THE ADVANCED TRULASER CELL SERIES machines from Trumpf, a leader in 3D laser processing technology, utilize Industrial PC technology and EtherCAT I/O components from Beckhoff Automation. The current, second-generation TruLaser Cell 8030 combines maximum production reliability and productivity for 3D laser cutting.

The TruLaser Cell 8030 is designed for the automotive sector and can be flexibly configured. A large version for cutting drawings and complete side parts is available along with a smaller variant for manufacturing individual parts and segments of the bodyshell.

The high-speed rotary changer provides a 20% shorter turning time of only 1.8 seconds, minimizing non-productive times and increasing the overall performance. In comparison to the predecessor model, the machine cuts a hot-formed vehicle cross member, for example, with 10% higher machine dynamics, 10% lower non-productive times and 30% faster slug control.

#### Flexible control systems

The TruLaser Cell 8030 can process large series parts cost-effectively and with high flexibility. The NC programming offers maximum flexibility in terms of the component geometry, which can also be subsequently modified to address new requirements using the variable laser tool.

The same applies to the automation specialist chosen for the project, as Thomas Brauchle, Service Quality Assurance Manager at Trumpf in Michigan, USA, and former TruLaser Cell 8030 project manager, explained: "With Beckhoff we have a partner who supplies us with state-of-the-art automation technology and also has the flexibility to address the special requirements of a laser processing system. The broad portfolio offers almost all of the required components. In rare cases, in which the standard range could not provide a solution, they quickly developed the ideal product."

Another key factor behind the decision to choose Beckhoff technology was the

underlying EtherCAT communication system. Thomas Brauchle confirms this: "We utilize EtherCAT with all TruLaser Cell machines. The key factor here was that EtherCAT provides an optimal fieldbus system for modular control cabinet equipment. This enabled us to implement our concept for compact control cabinet modules in an ideal way – only a few I/O signals combined with the secure signals in a single module.

The EK1914 EtherCAT Coupler is the concrete result of these requirements. It combines the functions of the EK1100 EtherCAT Coupler with standard and secure digital I/Os in an exceptionally compact design and can be expanded to include additional EtherCAT Terminals as needed. Using the EtherCAT I/O system, we significantly reduced the space required in the control cabinet compared to other fieldbus systems."

Another differentiator for the TruLaser Cell is the high performance of EtherCAT for controlling a highly dynamic laser optic axis



The TruLaser Cell 8030 laser cutting machine can be conveniently operated via the customer-specific Control Panel built by Beckhoff (left).

while also supplying the servo amplifiers with setpoints fast enough.

EtherCAT offers a number of essential features to the TruLaser Cell, as Brauchle added: "The available bandwidth perfectly matches the requirements of a laser processing system. This enables us to utilize EtherCAT for all of the installation technology and we do not have to make any compromises. In addition, there is the advantage of a worldwide communication standard with its widespread use. The transmission of signals to a rotating axis is an essential function in a 5-axis machine and we have developed a contactless and wear-free system for EtherCAT transmission together with a supplier."

Brauchle also values the extensive EtherCAT diagnostic options as a means of locating the causes of any faults. For example, in one case study a service technician remotely identified a fault in a cable for the power supply: "After the right spare part was received and replaced by the machine user, the system was back up, running smoothly again and the customer was impressed with the service."

For some systems, space-saving control components are important to reduce footprint requirements. As such, the Beckhoff system as a whole provides the assurance that the systems are state-of-the-art, flexible, very reliable, highly productive and cost-effective.

#### **Demands on machine HMI**

According to Brauchle, Trumpf machine control panels have extremely demanding requirements, which ultimately led to the decision to use a customized Control Panel from Beckhoff: "On one hand, the HMI has to be uniformly suitable for diverse machine technologies. On the other hand, our high demands regarding ergonomics and design also have to be fulfilled. This is only possible with a specifically developed Control Panel.

Beckhoff's high flexibility regarding the design was a particular advantage. For example, we were able to specify the supplier for the integrated pushbuttons. We also quickly received a fully functional prototype for our own testing. The compatibility of the 'open frame' variant with the design operating panel is another advantage as it enables the new operating panel design to be integrated into an existing machine series."

The C6930 control cabinet Industrial PC with 2 SSDs and the C9900-U330 battery pack is used as the control computer in the TruLaser Cell 8030. According to Brauchle, Trumpf had numerous selection criteria and considered the IPC and Control Panel package as a whole. In addition to the high performance, the flexible installation on the highest possible number of different machines was a decisive factor. The ability to place the Control Panel in any desired location using the CP-Link 4 singlecable solution was another contributing factor.

#### **Openness and system consistency**

A wide variety of fieldbus systems have to be considered, given that Trumpf's OEM customers, in particular, integrate the laser sources into production lines. According to Brauchle, Beckhoff offers the right solution because of the open-system design of PC-based control combined with a wide range of different fieldbus controllers, enabling the machines to flexibly adapt to each production environment. For example, PROFINET RT is connected via the EL6631 controller/device terminal as well as EtherNet/IP (EL6652), DeviceNet (EL6752) or PROFIBUS (EL6731).

The TruLaser Cell machines and the laser devices also utilize further EtherCAT I/O components. These include standard I/O terminals, including the high-density (HD) design, the compact EK1818 and EK1914 EtherCAT Couplers, IO-Link Box modules (with IP67 protection class) for connecting diverse sensors (temperature, pressure, level) as well as the EP9214 24 V voltage distribution for EtherCAT Box modules. Machine safety is also integrated consistently across diverse TwinSAFE Terminals and Box modules.

The logical links are implemented in the EL6910 TwinSAFE Logic terminal. Brauchle added: "TwinSAFE has replaced numerous electromechanical components with wear-free software. This has significantly reduced the number of conventional components and also the amount of wiring required. All non-drive safety functions were implemented via the TwinSAFE Editor and we truly value its graphical overview of the logical links. The ability to show and hide safety functions is essential for standard machines with expansions."

Application article by **Beckhoff Automation**.

# **Strategies for modernizing and optimizing legacy DCSs**

Plants with an aging DCS will require an upgrade to a modern automation system at some point. Selecting the right upgrade strategies and the right project management team are critical to success. A third-party service provider can often assist in project management and the development of the upgrade strategies.



A modern automation system provides tight integration among various controllers and computing systems, allowing for integrated monitoring and control of the entire plant.

MANY INDUSTRIAL MANUFACTURERS TODAY have aging distributed control systems (DCS) in place. These legacy systems may work fine, yet as time goes on, there is increased potential for exposure to risks, which may prevent them from capitalizing on productivity benefits from state-of-the-art technologies. As a DCS reaches the end of its useful life, modernizing to a new automation system is essential.

Once the decision to modernize DCS systems has been made, there are four main strategic decisions that need to be considered:

- Replication vs. Innovation
- Horizontal Approach vs. Vertical Approach
- Rip and Replace vs. Phased Migration
- Hot Cutover vs. Cold Cutover

If you or your operation are considering converting an existing DCS to a new

automation system, learn how each of these decisions can impact your overall strategy, minimize cost and reduce potential risk.

#### Decision 1: Replication vs. Innovation

One of the key decisions to make when modernizing a legacy DCS is determining whether it should be merely replicated or enhanced by implementing a more innovative, modern DCS system.

Replication is a replacement of existing automation hardware with new components, keeping all functionality identical to the greatest extent possible. The main benefit of replication is that the new automation system components will be supported by the supplier for decades — particularly important when the DCS is reaching the end of its useful life. Some improvement is typically realized, as the new controllers often have superior algorithms for loop control, and new hardware brings more memory and CPU power, so some consolidation is possible.

However, any existing HMI-related problems with poor process adjustments, alarm handling, and identification/resolution of issues will still exist. I/O may be replaced one for one, with no upgrade to distributed I/O via digital networks. Changes are only made to I/O to resolve any compatibility issues among I/O and field devices.

Conversely, innovation means improving the existing system to perform optimally with a new automation system. These improvements may lead to increased production and throughput, quality of product and increased safety performance.

New controller configuration and code can be developed to automate existing manual

SOURCE: ROCKWELL AUTOMATION

operations to improve and optimize process control. These changes result in better quality, less scrap, and more throughput. Substantial return-on-investment (ROI) can often be made by upgrading to smart and distributed I/O and high-speed digital networks, particularly as modern digital I/O networks accommodate both smart I/O and smart field instruments.

In addition to readily quantifiable benefits — such as better quality, increased production, and less unplanned downtime — plants can also expect to experience fewer safety-related incidents and substantially improve security and regulatory compliance.

This first decision might be considered more philosophical, but it can be crucial to providing financial justification to move forward with modernization. With improvement, each upgrade area is examined strategically, with investments made where return is greatest. Replication is cheaper up front but becomes more expensive over the entire life cycle of the new automation system, as many of the benefits of a modern DCS are forfeited.

#### Decision 2: Horizontal Approach vs. Vertical Approach

When developing a DCS modernization strategy, the user must determine if the conversion or upgrade will be done vertically or horizontally. A vertical upgrade means that one specific process area slice is converted at one time, including the human-machine interface (HMI), controllers and I/O. Conversely, a horizontal upgrade means all similar DCS equipment is replaced at one time across multiple (some or all) process units.

To give an example: A plant might have 10 boilers, with each one supplying process steam to a process area. In a horizontal upgrade, a portion of the automation system for all boilers (typically HMI first, controllers later) would be replaced over a single period before going down to the next layer.

In a vertical upgrade, the automation system for the boiler would be replaced in conjunction with an upgrade to its associated process unit's automation system.

Horizontal versus vertical upgrade decisions are often driven by specific plant process configurations. For example, if two boilers supplied steam to five process areas each, it would likely necessitate a horizontal upgrade approach.

In a vertical example, each process area might have its own automation system, meaning that the boiler's automation system would be upgraded in conjunction with its associated process unit's automation system in a vertical fashion. In a third example, one automation system might control the entire plant, making the vertical versus horizontal decision purely strategic, as either option would be feasible.

Either vertical or horizontal upgrades can be

#### Table 1: Reasons for improvement rather than replication

Superior ROI

Easier to maintain the software and configuration code

**Tighter Process Control** 

Better quality -- less scrap and re-work

Improved operator interface screens

Better alarm handling

Faster troubleshooting and identification of root causes of alarms

Increased throughput

executed with a phased migration approach, minimizing downtime and risk when managed properly.

#### **Decision 3: Rip and Replace vs. Phased Migration**

One conversion method is to replace the entire DCS at once, including the HMIs, controllers, and I/O. This method is simple to execute and often results in lowest overall purchase and installation costs, but downtime can be excessive, coming all in one continuous period. Breaking up the total required downtime into multiple periods is often advantageous, and this can be accomplished with a multi-phase conversion strategy. This strategy also spreads conversion costs out over a longer period and minimizes risk for each phase.

With a multi-phase conversion, the most obsolete components — generally the HMIs — might be converted first, usually requiring little or no downtime. In the next phase, controllers are replaced. This will usually necessitate some downtime, but it can be kept to a minimum by using the methods explained below. In a later phase, the I/O is replaced.

There are methods to minimize required downtime during this multi-phased approach.

*HMI Phase:* In this phase, old HMIs are replaced with modern PC-based HMI components. Once the new HMIs are configured, they can be tested using software that simulates connection to an actual automation system. Benefits and costs generally increase with the accuracy of the simulation.

Once the HMIs are configured and the simulation software is active, the HMIs can be installed in the process plant control room. Viewing these simulated HMI screens next to existing HMIs is a low-risk and low-cost method to train plant operators on the new HMIs. Once operators are comfortable with the new HMIs, the simulation software can be uninstalled from the HMI PCs, and the PCs can be connected to the existing controllers. This may require some downtime and configuration to integrate the new HMIs with the existing controllers.

*Controller Phase:* In this phase, legacy controllers are replaced with modern controllers featuring higher speeds, more memory and process optimization technologies such as multi-variable control, model-based control and other advanced process control methodologies. Depending on the vintage of the old DCS and other factors, new controller configuration may be generated from scratch or imported from existing DCS programs.

Once the new automation system controller code is generated, the new controllers and software can be run and tested in a simulated environment to minimize issues when the new controllers go live on actual plant processes. As the new HMIs are already in place, the HMI software can often be installed on the same PC as the simulation software, adding to the veracity of the simulation.

Technologies such as I/O scanners can also be deployed at this point to simulate connections between the new controllers and the legacy I/O.

As with the HMIs, benefits and costs increase with the accuracy of the simulation. But unlike with HMIs, controller simulation is much more critical as mistakes in controller configuration can cause downtime, and it's much harder to change controller configuration online as compared to HMI configuration. For these reasons, it's generally a good idea to invest in controller simulation to the greatest extent possible, as this will go a long way towards ensuring a smooth switchover from the old DCS to the new automation system.

I/O Phase: Once the new HMIs and the new controllers are in place, the final step in a multi-phased conversion strategy — I/O replacement — can take place.

In this step, software simulation is not required, but hardware simulation often is. Hardware simulation for I/O consists of connecting new I/O modules to field sensors, actuators and instruments of the same models as those found in the existing plant. This simulation is generally performed in a test area where it is feasible to stage and interconnect all the required components.

Once hardware testing is performed and compOleted, the new I/O can be installed and connected. As with HMI/controller connections, the connection between the new I/O and the controllers is very straightforward, as both sets of components will typically be supplied by one vendor, or by two vendors adhering to a standard open communications protocol such as EtherNet/IP.

Connections among I/O points and existing field sensors, actuators and instruments are more complex, but many automation suppliers have wiring solutions that minimize downtime when replacing and connecting I/O.

With a phased approach, users have the flexibility to choose specific subsets of the legacy system to replace, and this often means replacing HMI, controllers and I/O separately. The phased approach takes longer to complete but requires less downtime and incurs less risk.

#### Decision 4: Hot Cutover vs. Cold Cutover

The decision between hot and cold cutover is a key tipping point, setting the strategic focus for all conversion activities.

With hot cutover, some or all of the old DCS and the new automation system operate simultaneously, with one control loop at a time converted from the old DCS to the new automation system.

- If a phased approach was selected, hot cutover occurs at the I/O level as the HMI and the controllers have already been replaced. The old and the new I/O systems are both in place and running simultaneously, with old I/O replaced by new I/O as each loop is put into service.
- If a phased approach was not selected, then the old and the new HMI, controllers and I/O are kept up and running simultaneously. As new loops are put into service, the associated I/O is moved to the new controller. Old HMI and controllers are retired as the I/O associated with them is converted, until the entire automation system is replaced.

#### Table 2: Hot cutover versus cold cutover

Less downtime	More expensive over time
Reduced risk	Requires more space
Easier to troubleshoot potential issues	Takes longer to complete
Simpler to implement on-the-job training	Both old and new systems must operate concurrently

With cold cutover, the legacy DCS is replaced en masse by the new automation system, with the entire process being restarted at once. There is no simultaneous operation of the old DCS and the new automation system.

Hot cutover has advantages over cold cutover, but also some drawbacks. The chief advantages are decreased downtime and reduced risk. Because the old DCS is kept running while the new automation system is being cutover one control loop at a time, only one control loop at a time is down. In most plants, this can be managed with little or no downtime.

With hot cutover, risk is very low as control of each loop can be transferred back to the old DCS in the event of problems controlling the loop with the new automation system. Troubleshooting is very simple as any problems are isolated to one loop.

However, there are also corresponding drawbacks. A hot cutover is more expensive overall as some or all of both the legacy DCS and the new automation system have to be up and running simultaneously. More space is required in the control room and rack rooms, adding to the complexity of project management.

Most plants opt for hot cutover, unless there are special circumstances that would allow the entire plant to be shut down for an extended period. The hot cutover choice may seem more expensive in terms of pure upgrade costs, but when Total Cost of Operations (TCO) are considered — which includes the cost of lost production due to the extensive downtime and increased risk during startup — it is generally the best choice.

### Project management plans for success

No matter what strategies are selected for a modernization, project management will be a key factor in determining successful implementation. Depending on the size and scope of the upgrade project, project management will require varying numbers of staff, with staffing numbers often changing throughout the project. At every stage of implementation, there is simply no substitute for experience. But for many plants and organizations, there is simply insufficient in-house staff and expertise to manage large capital projects internally, particularly for specialized tasks performed infrequently, such as a DCS upgrade or conversion.

This tends to be the reason why many plants turn to outside service providers to manage these projects.

When selecting a service provider, the main criteria should be experience with the desired upgrade path, in terms of strategy and plant processes, and the new automation system hardware and software. Ideally, the service provider will have successfully executed multiple similar upgrades, with an opportunity for plant personnel to speak with past customers to verify service provider claims.

### Make the right decisions for your DCS modernization

To summarize, four strategic decisions must be made before proceeding with a modernization plan:

- Determine whether you prefer innovation or select simple DCS replication
- Select either a horizontal or vertical approach to replace like equipment
- Choose between a phased approach or a rip-and-replace strategy
- Establish whether a hot or cold cutover strategy will guide your modernization approach

Plants with an aging DCS will require an upgrade to a modern automation system at some point. Selecting the right upgrade strategies and the right project management team are critical to the success of the upgrade. If a third-party service provider is brought in, they can often assist in not only project management, but also in the development of the upgrade strategies.

Chris King, PlantPAx Migration Business Development Manager, **Rockwell Automation**.

SOURCE: CISCO

# **Safeguarding PTP Protocol with Parallel Redundancy Protocol**

This article shares a high-level view into PRP, PTP, and how one safequards the other. The complex nature of today's industrial networks relies on a deep understanding of protocols' specifications and network design best practices.



Figure 1. PTP Network

INDUSTRY IS EMBRACING INDUSTRIAL automation to bring new and better services and to protect their critical infrastructures. In the process, they are quickly realizing the need for a secure and resilient industrial grade network. One of the key requirements from this network is to achieve time synchronization with high accuracy across crucial functions. The network needs to deliver the robust protocols that can handle both unexpected and planned events while shielding the complex systems and services that it supports.

Two key protocols answer the call for high precision time synchronization and enhanced redundancy - Precision Time Protocol (PTP) and Parallel Redundancy Protocol (PRP). PTP establishes a dynamic packet-based time synchronization mechanism that achieves sub-microsecond accuracy. PRP increases infrastructure reliability by providing lossless failure redundancy using two parallel networks and packet duplication.

Each of these protocols brings enormous value to industrial use-cases. Both integrate their operation over Local Area Networks (LANs). Both protocols utilize Local Area Networks, lower the cost of deployments and reduce overall network complexity. Industry verticals that can most benefit include telecommunications, financial, manufacturing, and energy sectors, among others. All of these require high availability, reliability, and highly accurate time synchronization to ensure services consistency.

Implementing PTP over a PRP environment isn't as simple as combining both protocols. PRP's redundancy works on packet duplication over parallel ethernet networks. PTP time synchronization accuracy relies on a clear understanding of path and transit delays.

Duplicating PTP packets would complicate the delivery of accurate timing information. potentially confusing end devices. Standards bodies introduced protocols' modifications that eliminate these challenges, ensure their smooth coexistence, and help to highlight the advantages of their combined strengths.

This article shares an overview of how PRP

interoperates with PTP and vice versa. Let's start with a high-level view of PTP and PRP to set a baseline.

#### Precision Time Protocol (PTP)

Precision Time Protocol (PTP) is a time precision and synchronization protocol standardized by the IEEE in IEEE Std. 1588. PTP, a message-based protocol, runs on packet networks, such as Ethernet networks. It enhances the time synchronization mechanisms (phase, frequency, absolute time) from older, less accurate implementations to one that takes advantage of a Local Area Network where data and synchronization would use the same network infrastructure while providing sub-microsecond accuracy.

PTP automatically establishes a timing hierarchy. This allows network devices to protect timing accuracy by participating in its measurement and adjustment. Other older, less accurate time synchronization methods relied on their own dedicated infrastructures for analog and serial mechanisms, e.g., PPS



Figure 2. PRP Network (Traffic Duplication Flow)

(pulse per second) and IRIG-B used pulsed electrical signals or serial data grams. In the realm of data packet networks NTP (Network Time Protocol), also works over Ethernet and provides packet-based timing, but with lower precision. Its distributed implementation doesn't account for the timing impact of network elements in the path between timing source and destination – PTP does.

#### Why is PTP important?

PTP integrates time synchronization services into the same industrial data Ethernet network where industrial devices communicate. The benefits of using PTP in an Ethernet network include low cost, ease of implementation, and the reduction of overall network complexity. It enhances support and serviceability and makes the infrastructure more reliable and secure.

The timing precision that PTP provides, aligns with the stringent requirements demanded by industrial automation and modernization efforts. It's sub-microsecond precision is a critical component of automation and control systems, measurement and test systems, power generation, transmission and distribution systems, etc. PTP is uniquely positioned to satisfy the need for these critical infrastructures (manufacturing, utilities, oil & gas, transportation, others) to accurately monitor their network, predict and protect from critical situations, and measure the delivery and consumption of services.

#### **PTP inner workings**

The standard defines a Master-Slave hierarchy with roles, port states, and related behaviors. As a side note, there is an ongoing effort by the standard bodies (IEEE, IEC, others) to find alternate terms to the controversial Master-Slave terminology. In this document we will use Master-Follower.

During and after the Master-Follower hierarchy is established, PTP timing synchronization messages traverse the network to calculate time delay differences on the path from the Master to the Follower Clocks and PTP entities in between, Figure 1. These time delay calculations provide PTP devices with an accurate way to update their local clocks. The result is PTP's sub-microsecond time synchronization precision. A PTP network consists of PTP-capable

devices, Clocks, and often, devices not using PTP. Though PTP communication happens between Master Clock(s) and Follower Clock(s), these are executed in a variety of roles providing key functionality along the way.

The following are roles in a PTP network (Clock types):

Grandmaster Clock (GM): primary time source for the hierarchy with either an external time source (e.g., GPS) or a very high accuracy internal time source. Could be a LAN switch.

Boundary Clock (BC): clock source that has more than one network port - normally a LAN switch. One or more ports receiving timing while others (one or more) sending time out. Follower to the Grandmaster Clock.

Ordinary Clock (OC): End-client device. Typically, with one network port to receive time. Industrial devices, sensors, relays, monitoring and metering systems (e.g., IEDs) Follower to the Grandmaster Clock.

Transparent Clock (TC): more than one network port - normally a switch, it updates the time interval field within the PTP event messages. This compensates for any switches in the path giving the timing messages accuracy within one picosecond. Follower to the Grandmaster Clock.

Each of these PTP-capable devices engage in establishing the Master-Follower hierarchy. Ports are not only used to connect these devices to the network but play an important part in the PTP state machine. There are three PTP port states:

*Master (M) Port:* port used to source clock information and messaging to downstream PTP devices (e.g., Followers)

Follower (F) Port: port used to receive the clock synchronization messages and update the Follower local clock after computing the delay of the link, time offset, frequency offset, and drift error parameters.

Passive Follower (PF) Port: port used to receive the clock synchronization messages but doesn't update the local clock.

At a high-level, PTP dynamics can be grouped in two areas: Master Clock selection into the Grandmaster Clock role and ongoing

#### Basic PRP packet handling at DAN (non-PTP vs. PTP):

Non-PTP Packets	PTP Packets
Upper layers (application) to generate 1 frame.	Separate PTP process per port (LAN A and LAN B). Time processing to be handled per port.
PRP logic to duplicate each upper layer frames into packets to be sent out each port (LAN A and LAN B).	PRP Stack will not duplicate PTP messages as those will bypass the stack.
Each duplicated packet to be appended with a Redundancy Control Trailer	No RCT to be appended to any PTP packet.

SOURCE: CISCO



PTP execution through the network to maintain full understanding (synchronization) of time and timing differences.

Multiple devices could be capable of becoming Master clocks. A mechanism to select the best Master Clock is known as Best Master Clock Algorithm (BMCA). During the execution of BMCA, clocks will evaluate the quality, stability, logical distance to the clock source and determine the top or best Master Clock (i.e., Grandmaster Clock).

In its simplest form, PTP exchanges can be summarized as follows:

- PTP messages sent between Master and Follower devices to determine delay.
- PTP measures the exact time messages are transmitted and received. It uses this information to determine the delay between devices to calculate an average path delay.
- Follower devices will adjust the received time based on the calculated path delay

Users can configure PTP in a multi-vendor environment. Cisco Industrial Ethernet products support multiple variations of PTP (e.g., profiles, versions) in all roles and combinations (hybrid modes). Cisco IE switches have a rich feature set with solid PTP support covering many industrial use-cases. Key platforms like the Cisco IE5000 can operate as a Grandmaster Clock thanks to its internal GPS receiver and accurate internal Oven-controlled crystal oscillator (OCXO). It also supports hybrid modes, e.g., Grandmaster Clock and Boundary Clock simultaneously. This allows for the convergence of services in a highly reliable industrial platform.

The use-cases and strict requirements of

a critical network infrastructure will dictate the best option to support stringent time synchronization and precision needs. PTP is considered the most vital modern timing protocol for its flexibility, automation, and precision. Providing a reliable and resilient infrastructure is critical. This topic opens the door to our PRP conversation.

#### Parallel Redundancy Protocol (PRP)

PRP is defined by the International Standard IEC 62439-3. The protocol is designed to provide lossless or hitless redundancy across Ethernet networks for industrial applications. This zero-recovery time after failures sets PRP apart from traditional Ethernet network redundancy protocols such as Spanning Tree, where a network failure results in topology changes that disrupt traffic flow momentarily.

PRP provides a different approach to traditional data network redundancy. Redundancy is implemented at the PRP-node level instead of relying entirely on the data network devices. PRP lossless resiliency is achieved by connecting to two separate, independent, Local Area Networks (LANs) and duplicating traffic across said networks. A PRP dually attached node (DAN) transmits two packets simultaneously across LAN A and LAN B. At the receiving PRP endpoint a discard algorithm is in place to eliminate the duplication and deliver a single packet to the upper layers – to the applications.

Each PRP-frame, duplicated across LANs, is appended with a Redundancy Control Trailer (RCT) containing a sequence number, LAN ID, etc. This RCT enables the receiving node to identify and discard the duplicated messages. Important point to highlight is that PRP redundancy is implemented at a PRP-node level. PRP-nodes are defined as follows:

*Dually Attached Node (DAN):* PRP node with two interfaces connecting to LAN A and LAN B respectively. PRP duplicates packets on transmission and removes duplication on receival.

Singly Attached Node (SAN): non-redundant endpoint, attaches to LAN A or LAN B. Needs to rely on other methods for PRP protection (e.g., RedBox) or remain unprotected.

Redundancy Box (RedBox): PRP device used to connect non-PRP endpoints into LAN A and LAN B thus providing PRP protection on behalf of the device. RedBox handled duplication for the devices behind it. The RedBox is a DAN.

Virtual DAN (VDAN): non-PRP endpoint connected into a RedBox appears as a "DAN" to other nodes in the PRP network. These are known as Virtual DANs (VDAN).

During a failure, LAN A in Figure 2 goes down or is impaired, the path for red packets is disrupted. This leads to red packet loss or extreme delays. However, the unaffected path, LAN B, will allow for the other duplicated packets, green, to arrive uninterrupted. The applications in the upper layer will not detect or "feel" any impacts due to the failure.

Cisco IE switches support a scalable and top performing deployment of PRP. The switches implement RedBox functionality allowing for a scalable number of VDANs (non-PRP endpoints) to be protected by PRP's lossless redundancy.

#### **PTP over PRP**

Precision Time Protocol (PTP) can operate over Parallel Redundancy Protocol (PRP). PRP

provides high availability through redundancy by parallel transmission over two independent networks. PTP and PRP can coexist in network devices and end-nodes. This coexistence allows PTP to take advantage of the redundant connections of PRP-nodes thus increasing its resiliency and reliability.

Why is this important? Precise time synchronization is a key foundational requirement for many industrial critical infrastructures. It drives precision alignment for key management, control, and serviceability functions. A failure could result is business, services, revenue, or quality of life disruptions. Safeguarding PTP with PRP protects business continuity. PTP over PRP is a practice that has generated a lot of interest in the industry.

#### The Original Challenge

The PRP method of achieving redundancy by connecting to two parallel networks (e.g., LAN A and LAN B) and duplicating each packet, one for each LAN does not work for PTP as it does for other traffic. Challenges included:

- The delay experienced by a frame is not the same in LAN A as in LAN B. Each LAN could have different topologies, traffic loads, types of network nodes.
- Some frames are modified in the Transparent Clocks (TCs) while transiting through the LAN.
- A Dually Attached Node (DAN) does not receive the same PTP message from both ports even when the source is the same.
- Boundary Clocks (BCs) present in the LAN are not PRP-aware and would generate their own PTP messages with no Redundancy Control Trailer (RCT) appended.
- Transparent Clocks are not PRP-aware and not obliged to forward the RCT, the message part after the payload.

#### **The Solution**

For PTP to take advantage of the redundancy benefits offered by the underlying PRP infrastructure, PTP packets need to be handled differently from other traffic types. The behavior required is detailed in IEC 62439-3:2016 standard, Annex A.

Cisco IE switches follow this IEC standard and implement an approach that overcomes the challenges mentioned above. Two high-level changes accomplish this:

- 1. PTP packets are not to be appended with PRP's RCT (Redundancy Control Trailer)
- PTP packets bypass PRP's duplication and discarding logic (i.e., no duplication of PTP messages).

PTP will follow the standard specifications for timing and synchronization over redundant ports which applies to PRP-nodes and makes the integration a valuable architectural foundation for industrial networks. In simple terms, PTP redundant ports will run separate PTP processes that listen for timing information from the Grandmaster Clock (i.e., Follower and Passive Follower ports). These will determine PTP communication status and local clock synchronization based on Grandmaster's timing qualities.

These differences in regular vs. PTP packet handling dig into PRP's actual behavior and the adjustments needed for timing and synchronization operations. The combination allows for concurrent protection of end-to-end services and the required timing precision that PTP offers. Next, a high-level example will expand on the cooperative behaviors.

#### **Behavior**

PRP nodes participating in timing synchronization will execute a separate virtual clock process (PTP process) per LAN A and LAN B port that needs to synchronize to the Grandmaster Clock. As mentioned earlier, this is one of the necessary modifications to PRP – eliminating duplication and discarding of said duplicate PTP packets.

On the other hand, all other traffic will be handled as defined by PRP's standard in PRP-capable nodes (duplication, discarding of the second packet copy on arrival, appending RCT providing PRP with required information).

Figure 3 shows the different PTP processes that will run a simple PRP network. The yellow arrows represent the PTP messages behind the RedBoxes (Boundary Clocks in this example) towards the VSANs. Each redundant port on the RedBoxes will run a separate PTP instance / state-machine which will traverse each LAN. PTP in LAN A is represented by blue arrows and in LAN B by green arrows.

RedBox1 and 2 are Dually Attached Nodes (DANs). Each transmits and receives PTP information over both PRP ports connected to LAN A and LAN B. This behavior separates PTP communications, LAN A and LAN B, represented by green and blue arrows. FYI, ports where the DANs, SANs, and RedBoxes are acquiring GM's timing information as labeled Master(M). Other ports transmitting timing information (PTP messages) to endpoints down the line are labeled Follower(F).

We remember that PRP's redundancy is based on packet duplication across two parallel LANs. However, PTP operates outside of said duplication and relies on the protocol's behavior over redundant links. PTP port status towards the Grandmaster clock is either Follower(F), in the case of a single PTP port (e.g., PTP capable SAN) or Follower(F) and Passive Follower(PF) when two PTP and PRP ports are connected to separate LANs.

#### Protection during a failure

In a failure, the second most noticeable change in PTP over PRP's behavior becomes critical. Following Figure 3, RedBox1 and 2 elected LAN A ports as the PTP Follower ports from which they are synchronizing their clocks with the Grandmaster (GM) Clock (VDAN1).

Ports connected to LAN B are in a Passive Follower status (listening to PTP messages from the GM but not synchronizing their local clocks). If LAN A goes down, the LAN B ports in the DANs and RedBoxes take over as Follower (from Passive Follower state) and start to synchronize the local clock. VDANs (e.g., VDAN2) continue to receive PTP synchronization from their corresponding Redbox before the failure – slight operational difference if the Redbox is a Boundary vs. Transparent Clock. Note that for SANs, redundancy is not available. In this example, SAN 1 will lose synchronization if LAN A goes down.

Due to the change, VDAN2 may experience an instantaneous shift in its clock due to the offset between the LAN A port's virtual clock and the LAN B port's virtual clock. The magnitude of the change should only be a few microseconds at the most because both virtual clocks are synchronized to the same GM. In recovery, a shift occurs when the LAN A port comes back as Follower and the LAN B port becomes Passive Follower.

This scenario can be considered the baseline of PTP over PRP operations. Different use-cases will call for higher complexity levels depending on scalability and performance needs. Cisco Industrial solutions offer best practices for many viable industrial scenarios while keeping PRP, PTP, and their coexistence a simple configuration step. Cisco IE products provide top performance, market-leading resiliency options, practical support, and serviceability for industrial scenarios that increase infrastructure efficiencies while reducing operational expenses.

#### **Closing words**

PRP's enhanced redundancy mechanisms establish a paradigm in network resiliency where lossless communication during failures safeguards the end-to-end transport of industrial services. These critical infrastructures rely on high levels of business continuity where resiliency and security are paramount, but so is the unquestionable dependency on high precision timing synchronization. PTP is the protocol that robustly provides dependable time precision.

That is why standards bodies like IEC have established detailed specifications on the integration of PRP and PTP. It is also why Cisco Industrial Ethernet products deliver proper support for both protocols with unrivaled solutions for end-to-end industrial critical infrastructures implementations.

Carlos Gonzalez, IoT Technical Marketing Engineer, **Cisco.** 

# What manufacturing looks like with (and without) ERP software

Learn how ERP turns overweight, inefficient manufacturing into a lean, fit and supercharged manufacturing machine. Manufacturing is a complex process, no matter what products you make or what processes you use. ERP simplifies manufacturing by providing real-time data visibility at every step of the production process.

ERP PROVIDES A COMPLETE SOLUTION FOR what ails a manufacturing business. Created to efficiently run the entire organization from quote to cash, it touches all critical aspects of the business, allowing users to manage everything from one central location.

The power of ERP lies in its ability to provide the data needed to make smart decisions for a business. When you know what's happening in every corner of the shop, everything gets better. People and processes become more efficient and productive. Communication between departments improves. Costs and waste go down while sales, margins and product quality go up. Users can promise due dates to customers with confidence. On-time delivery becomes a way of life.

#### Manufacturing before ERP

Manufacturing without ERP generally looks like a mess. Some of the top signs of an unhealthy manufacturing business include the following.

#### Data can't be trusted

Manufacturing companies without ERP generally use volumes of paper documents and spreadsheets to manage production. What software they do use consists of disparate programs that can't communicate with each other. This creates a system rife with manual errors, and inaccurate, outdated information. When you can't trust the data guesswork prevails, and often leads to low quality decisions.

#### Hit or miss scheduling

With no true accounting of labor and machine capacity, rough estimations drive the scheduling process. Manual scheduling can take days to complete. Making changes to jobs in progress becomes a nightmare of complexity and uncertainty. All of which result in missed due dates and dissatisfied customers. It's no wonder many manufacturers rank scheduling as the most stressful job in the business.

#### Inaccurate job costing

Few manufacturing tasks are more important than precise job costing. Without ERP, few tasks are more difficult. Manual time sheets often contain errors. Incorrect inventory counts make it hard to identify true material



The power of ERP lies in its ability to provide the data needed to make smart decisions for a business.

costs. Lack of real-time data makes job costing historical rather than current. Estimating and quoting frequently miss the mark due to imprecise and unreliable data. Not a good recipe for knowing true costs.

#### Incorrect work orders and routers

In a "before" ERP environment, work order and routing information often consists of tribal knowledge that resides in the heads of a few people. Jobs often start late because the work orders and routers don't get to the shop floor on time. Large, complex work orders can take days or weeks to construct. Human error causes shop floor mistakes that lead to costly rework and missed due dates.

#### Poor inventory management

Manual inventory management creates a drag on virtually every aspect of production. Parts and materials get lost or misplaced. Purchasing often buys too much or too little due to imprecise inventory data. Poorly designed number structures can result in duplicate inventory.

Material shortages cause jobs to start late and lead to expedited shipping costs. Inventory carrying costs go up, on-time delivery goes down.

#### Inefficient material movement

Inaccurate inventory is a major cause of shop floor bottlenecks. Manually tracking material movements with handwritten bin cards makes getting the right parts to the right jobs even more difficult. Bin cards get lost. Material movers sometimes forget to record their transactions. Incorrect part numbers deliver the wrong part to the job. Inventory counts for a part or material may not get updated for days after a transaction.

#### Excess purchasing costs

When the purchasing function can't communicate with inventory, buyers often don't know when to order parts, how many, or how much to pay. Incorrect inventory counts can cause overbuying to avoid potential part stockouts. Researching vendors for the best price and delivery times can take hours. Purchasing inefficiencies cause material costs to go up while inventory accuracy goes down.

#### Financial disconnect

When the finance function doesn't reside in an ERP system, it must produce the financial reporting with a different system – a slow, cumbersome and inefficient process. The lack of integration with production makes the data historical rather than real-time. The numbers become out of date as soon as the next transaction occurs. Manual data entry inevitably results in human error and can take days or weeks to close the books at the end of the month.

#### Low product quality

Without ERP, quality control is a historical rather than in-the-moment process. Incorrect part numbers on work orders or routers can result in production errors. Manual scrap counts tend to be unreliable. Jobs often continue after engineers issue a stop order because some people don't receive the notification. All of which leads to rework, increased job costs, and dissatisfied customers.

#### Double data entry

Without ERP, customer specs, drawings, engineering documents, bills of materials (BOMs) and other job data typically require double manual entry – once by the customer and once on your end. This time-consuming process invites human error that increases labor costs and leads to mistakes on the job.

The inability to integrate with CAD/ CAM, nesting, and other software programs increases the time and cost required to set up and complete jobs. With a reliable ERP software, none of the above need to happen in your business.

#### Manufacturing after ERP

What does the after ERP photo look like? Generally speaking, companies that implement or convert to an ERP system with a reputation for quality and service will experience many of the following improvements.

#### One source of truth

Imagine being able to trust the data you collect. Not just some of it, but all of it – including production schedules and promised due dates. ERP makes it happen by tracking, organizing and providing quick access to information users can count on to be accurate and up to date. Manual spreadsheets, redundant processes, and stand-alone silos of information disappear as users discover what your business can achieve with data you can trust.

#### Fully integrated scheduling

The toughest job in the plant becomes far less stressful with ERP. Instantly identify your true labor and resource capacities. Engage in "what-if" scenario planning to see how potential schedule changes will affect other jobs.

Use finite and infinite scheduling to make long-term scheduling decisions. When you get the schedule right, shop floor personnel always know what to be working on now and what to work on next.

#### Precise job costing

ERP gives you certainty in your job costing by providing detailed cost breakdowns for inventory, jobs sequences and cost of goods sold. It tracks every cost that goes into a project – from labor and parts to setup times, tool and equipment usage, indirect labor, outside work, and more – with remarkable precision. Estimate and quoting become more accurate. Cost overruns are easy to spot. Comparing actual to estimate becomes a powerful tool for identifying problems and areas for improvement. When a job is finished you know the total cost down to the penny.

#### Accurate work orders and routers

Work orders act as the architectural blueprint for each job; routers provide the road map to get there. ERP electronically sends these critical documents to the shop floor, ensuring the correct versions get there on time, every time. Large, complex routers and BOMs can be built in a few hours rather than days or weeks. Work orders and routers become trusted tools that speed the production process rather than causing bottlenecks.

#### Digital inventory management

Accurate inventory injects a new level of speed and efficiency into the entire production process. With a few clicks of a mouse you can see how much of a part or material you have on hand, where it is, how much is already allocated to jobs, and when ordered parts will arrive. In short, everything you need to know to accept a due date or get a job started on time. Cycle times become simple to track. Physical counts often take hours rather than days or weeks. Inventory stockouts become a thing of the past.

#### Mobile material movement

ERP transforms material movement by seamlessly aligning with mobile technology. Using handheld scanners and mobile devises, part movers can make material transactions from anywhere on the shop floor. Every transaction is instantly recorded in inventory, keeping the location and number of parts always up to date. Movers no longer waste hours looking for misplaced inventory, and the right materials get to the right jobs when operators need them.

#### A new level of financial accountability

ERP systems with fully integrated accounting modules save time and money while leaning the entire accounting function. AR and AP management take less time. Eliminating duplicate data entry dramatically reduces human error. The system recognizes most accounting data as soon as new transactions are recorded, enabling in-the-moment financial decisions. Month-end closing of the books shrinks from weeks or days to hours. You get more done in less time while creating a culture of financial accountability throughout the business.

#### Purchasing as a competitive advantage

ERP purchasing consolidates all work order and inventory data so you can make smart purchasing decisions. Purchases can be automated, giving buyers time to research vendors and negotiate better deals. Buyers can forecast future purchases based on customer history. The system even identifies when new purchasing actions are required due to job changes. ERP purchasing does all this and more – all from one screen.

#### Real-time quality

ERP provides a robust array of tracking, statistical analysis, and reporting tools, including complete traceability of every part that moves through the shop floor. Live production data lets you measure quality by part, employee, machine, defect code and other criteria. The system automatically alerts you to non-conforming parts while jobs are in progress. Producing documentation for ISO and other quality certifications can be accomplished in minutes. When employees are held accountable for scrap, the cost of quality declines.

#### Third-party software interfaces

Electronic Data Integration (EDI), nesting and other software interfaces allow your ERP system to seamlessly exchange information with third-party software programs. This eliminates the need for duplicate data entry on the receiving end and prevents double entry mistakes.

CAD/CAM interfaces save hours of high-cost engineer time by directly importing CAD/CAM drawings and data in digital format. Nesting interfaces send designs directly to cutting machines to optimize material usage. Payroll interfaces automatically send hours, pay rates, and other data to your payroll vendor for rapid processing. The possibilities for how much time, money and effort integrations and interfaces can save you are endless.

#### Lean and fit with ERP

Manufacturing is a complex process, no matter what products you make or what processes you use. ERP simplifies manufacturing by providing real-time data visibility at every step of the production process. Knowing what you need to know to eliminate waste, reduce costs, and get quality parts out the door on time every is only a few mouse clicks or keystrokes away, whenever you need it.

Mike Melzer, VP of Operations & Service, Global Shop Solutions.

## **Digital water management provides pumping solutions**

SCADA solution helps monitor and analyze daily flow consumption patterns, thereby identifying possible leaks and sending the information in real-time to the central control room. This helps to avert water loss because it means that leaks are identified and can be repaired swiftly.

END-TO-END DIGITAL SOLUTIONS HELP THE local water authority to track, measure and optimize water use in a drought-stricken region of southwest India, as well as pump and distribute clean treated river water to village homes. The solution includes 635 digital flowmeters and technologies to improve control at pumping stations and reservoirs.

With a population of around one million people, the Koppal district is regularly challenged by water shortages. Until now, responses have ranged from preserving ancient wells to following age-old water conservation practices, but thanks to digital technologies, the Kushtagi and Yelburga villages will soon benefit from ABB's digital water management solutions as part of a multi-village clean drinking water scheme.

Koppal needed solutions that could effectively monitor water flow and manage leaks to reduce non-revenue water and achieve overall productivity improvement in a widely dispersed water distribution network set-up. L&T Construction Water & Effluent Treatment IC, the lead contractor for the project, chose ABB Ability Symphony Plus SCADA and ABB's AquaMaster 4 flowmeters for the project.

ABB's engagement spans the end-to-end automation and instrumentation of the project, from the pumping station at the river to the treatment of clean drinking water. The route comprises 620 overhead tanks and 16 reservoirs. The project involves putting in place a network of RTUs (remote terminal units) for remote locations and pumping stations and ABB Ability Symphony Plus SCADA to supervise and control the operation. ABB Ability Symphony Plus SCADA is designed to maximize reliability and availability of water plants and networks through integrated information management, integration of equipment, and process optimization based on the entire water network data for safer and enhanced operations.

The SCADA solutions help monitor and analyze daily flow consumption patterns thereby identifying possible leaks and sending the information in real-time to the central control room. This helps to avert water loss because it means that leaks are identified and can be repaired swiftly.

ABB's AquaMaster 4 electromagnetic flowmeters, running on battery power, will



Elctromagnetic flowmeters offer reliability even in low flow conditions, in areas where most mechanical flowmeters would fail.

offer reliability even in low flow conditions, in areas where most mechanical flowmeters would fail. They offer measurement accuracy down to flow velocities lower than 0.1m/s where most meters struggle to even detect flow. As the vast majority of leaks are small but continuous, the ability of AquaMaster to detect small variations in flow is crucial in combating the water shortage challenge.

The AquaMaster 4 is a first of its kind digital flowmeter that is easy to install and use. Its unique Velox Mobile App interface saves time and resources by eliminating the requirement for special cables, tools or the input of a trained engineer to set up the meter or read data on it. The device is largely self-sufficient in operation, with automatic self-health check and auto calibration features. ABB Velox App uses near-field communication (NFC), protected by strong encryption to avoid eavesdropping or tampering.

With inbuilt tamper-proof datalogging, self-diagnostics, and a smart integrated GPRS communication module, AquaMaster 4 facilitates automated meter reading (AMR) and links to an automatic billing system, providing transparency in consumption data, with user-specific tags and access control. GIS (geographical information systems) enable preventive maintenance and permit easy navigation to the site of a potential leak, thanks to Google Maps GPS assistance. The meters can be verified by the ABB Ability Verification for measurement devices solution, which extends the lifecycle of the product, validates accuracy, and provides the customer with a health-check report in accordance with the ISO9001 standard. This makes AquaMaster 4 a perfect choice for Advance Metering Infrastructure (AMI) projects.

G Srinivas Rao, Head of ABB Measurement & Analytics in India, said: "As India moves swiftly towards smart and sustainable villages, towns and cities, one of the key challenges is water management. This project shows how ABB's digital water management solutions can be deployed not only in cities but also to provide clean, drinking water in the villages that are crucial to our agrarian economy."

ABB flowmeters are also in operation in cities across India, including Delhi, Bangalore, Surat, Ranchi, Kolkata, Udaipur, Chennai, and in semi urban and rural areas like Gadag in Karnataka and Jawai in Rajasthan. As Koppal looks at growth in industries and agriculture, this major water management project will ensure the availability of infrastructure facilities for the district to forge ahead.

Application article by ABB.

# Technology

# **SFP, QSFP or CFP? Which transceiver is best?**

Optical transceivers are widely used in networking hardware installations, with different modules used for specific applications. While they allow a switch to support different types of transmissions formats, it can sometimes be confusing to make out which transceiver is best for a specific application.

WITH THE ADVANCE OF TECHNOLOGY, transceivers have become an essential part of any network hardware configuration and they have improved over time to respond to the changing needs of the telecommunication industry.

Transceivers are often perceived as one of the simplest pieces of hardware in a network, but this is actually not the case. There are a great number of transceivers and possible configurations, and their quality and reliability can change from brand to brand.

Choosing the wrong transceiver or ignoring any quality verification means that at the end of day, system administrators might have to deal with unexpected issues caused by poor quality transceivers. So, what are the three main categories of transceivers and how are they best used in different applications?

#### SFP transceivers

Small Form-Factor Pluggable (SFP) transceivers are the most popular optical transceiver format. As the name suggests, they come in a small and compact size, which allows them to be used in different applications, including in tight networking spaces to provide fast communication between switches. SFP transceivers are also greatly flexible and can be used with both copper and fibre optics. Lastly, SFP modules benefit from being hot swappable, which means the transceiver can expand the capacity of existing networks without the need to redesign the entire cable infrastructure.

SFP+ transceivers are an advanced version of SFP. SFP+ benefits from being faster and supporting speeds up to 10Gbps, but it works across shorter distances than SFP. Recently, two new advanced versions of SFP transceivers have been developed, the SFP28, which supports a speed of up to 28.1Gbps, and SFP56, which is capable of double the capacity of SFP28, if set up with a PAM4 modulation.

SFP- type transceivers are mainly used in Ethernet switches, routers and firewalls. In copper networks, they are ideal for bridging communication between switches on a distance of up to 100 metres. However, when it comes to fibre optics, the network range is



Optical transceivers are available in three main categories.

anywhere from around 500 meters to over 100 km. Furthermore, SFP modules support both singlemode and multimode fibre and transmit data over a pair of optical fibres (duplex) or over a single optical fibre (simplex), and also in CWDM/DWDM technology.

Their flexibility allows these transceivers to be used in almost all applications that require high-speed and long-range cables, from high-definition audio transmission and reception, passive optical networks (PON), to multiplexing and simplex networking.

#### **QSFP transceivers**

QSFP stands for Quad (four channel) Small Form-Factor Pluggable transceiver, and it is used for 40 Gigabit Ethernet (40GbE) data communications applications. The 40G QSFP optical module is a compact hot-swappable light module that provides four transmission channels in one pluggable interface, each with a data rate of 10Gbps. Compared to SFP+ optic modules, the QSFP modules can increase the port-density by four times.

Further demand for higher data rates has led to the development of QSFP28, which supports 28Gbps data rates on each of its four channels. This transceiver supports both Singlemode and MultiMode applications for distances of up to 100 kilometres. It also uses 4 wavelengths, some of which can be enhanced using CWDM technology, with each channel carrying up to 28Gbps. On the other hand, LanWDM technology is used when the distance between the channels is less than 5 nanometres to allow for a longer distance reach.

A popular configuration of the transceiver

is the 100G QSFP28 DWDM PAM4 solution in QSFP28 form factor, which is able to connect multiple data centres within 80km distance. The advantage of this solution is that clients can build an embedded DWDM network by using this transceiver directly in the switch.

Similarly, an advanced version of QSFP is QSFP-DD (dual density), which has 8 channels and allows for double speed on a single channel and is able to carry 400G over just one transceiver.

#### **CFP transceivers**

The CFP module is a hot pluggable form factor transceiver that serves 100G interfaces. Different types of this module, such as CFP2, CFP4 or CFP8 can support ultra-high bandwidth requirements of data communication networks, including nextgeneration High-Speed Ethernet. The most recent module, the CFP8, provides support for a broad range of PMD's at 400G and is futureproof for supporting 800Gb/s.

Similarly, the 100G CFP Coherent module supports a range of applications from 80km client interfaces up to 2,500km DWDM links and can also be configured to optimise power dissipation for a given application.

These transceivers are primarily used in WAN, Metro, wireless base-stations, video and other telecommunication networks systems. They have widely been implemented in enterprise data centres, High Performance Computing and Internet provider systems due to their long-distance transmission and fast speeds.

With different applications requiring unique solutions, there is definitely at least one type of transceiver suitable for each of them. Whether network owners are looking for higher bandwidth at the expense of distance transmission or they need strong connectivity over tens of kilometres, they can choose from a wide selection of modules. At Salumanus, we have delivered over 500,000 optical modules in the last few years and offered our expert technical support to clients worldwide to make the most of their optical networks.

Marcin Bala, CTO at telecommunications networks specialist, **Salumanus Ltd.** 

# Digital retrofitting in pharmaceutical manufacturing

The pace of change in the pharmaceutical industry is faster, fiercer and often more urgent than ever before. When deployment of new physical equipment is out of the question, digital tools can be considered to retrofit production lines and equip them with greater flexibility, dexterity and, in turn, possibility.

PHARMACEUTICAL MANUFACTURERS ARE FACED with a complex juxtaposition. Medicines are developing at a rapid rate, while physical production lines are lagging behind.

The global vaccine effort in response to the COVID-19 pandemic is a clear example of the change of pace in pharmaceutical manufacturing. Vaccines aside, time-to-market is an increasingly important factor for the development of all types of pharmaceutical products. Not only is increased agility crucial to beating competitors to market, but also to keep production as streamlined as possible and enhance the throughput of a facility.

Throughput capacity is particularly important for today's market. Unlike facilities of several decades ago, which may have focused on producing just a handful of medicines, typically of the same form such as tablets, liquid medicines, or vaccines, today's manufacturing lines are expected to adapt for multiple different products. This expands to accommodating the manufacture of personalised medicines and small batches.

#### Pharma's inflexibility problem

One of the greatest barriers to achieving this level of agility is the inflexibility of current pharmaceutical manufacturing facilities. As many of these factories operate with legacy machinery that is several decades old, producing new, novel medicines at the drop of a hat often is not feasible. At least, not without significant investment.

That said, the cost of introducing new equipment to a site can be colossal. From the initial cost of the machine through to programming and integration, facilities managers can rack up millions in costs for the sake of a small batch. When considering the factory footprint required for some pharmaceutical equipment too, this option is often impractical.

#### **Digitalization for agility**

Implementing digital tools is one method to overcome this challenge. Legacy equipment can often be retrofitted with software to prepare it for the introduction of new product lines, or to allow it to communicate with other pieces of equipment.

Consider a 1990s liquid vial filling machine as an example. This could be updated to



To share data effectively from multiple protocols, independent software that is suitable for facilities with multiple equipment types is essential.

communicate seamlessly with a conveyor despite being manufactured 30 years ago and coming from a different original equipment manufacturer (OEM).

Using the right software platform, allows these machines to continue to provide value and they can be updated and designed to move and fill vials in a choreographed manner. What's more, by adding more machinery to the mix, the entire process can be completed in a faster way than would be possible independently.

To achieve this, manufacturers must consider the communication protocol of the equipment and whether this is compatible with the software in question. To share data effectively from multiple protocols, independent software that is suitable for facilities with multiple equipment types is essential.

#### Modular pharma

In addition to enhancing equipment communication, many pharmaceutical manufacturers are implementing modular production to meet demand for personalised and small batch medicines.

Modular production describes a production line that is broken into smaller modules,

allowing manufacturers to isolate or combine specific modules to create new lines.

Digitalisation software can also make this possible, even with legacy equipment. What's more, Module Type Packages (MTPs) can make modular production more straightforward. In the case of COPA-DATA's zenon, a software platform for pharmaceutical manufacturing facilities, the tool can map out modular automation while maintaining full connectivity and control of the facility. For pharmaceutical manufacturers using zenon, this allows them to make otherwise inflexible production lines far more agile.

The pace of change in the pharmaceutical industry is faster, fiercer and often more urgent than ever before. While R&D teams are storming ahead, manufacturing facilities themselves cannot adapt at the same rate. When deployment of new physical equipment is out of the question, digital tools must be considered to retrofit production lines and equip them with greater flexibility, dexterity and in turn, possibility.

Alexandra Hughes, Industry Sales Manager, COPA-DATA UK.

### **OPC Suite data preprocessing features**

Extended Version V5.15 makes provision of production data for various IT systems easier and more flexible.

With data type conversion and LUA script support, the new V5.15 version of Softing's dataFEED OPC Suite Extended offers new data pre-processing capabilities.

The new dataFEED OPC Suite Extended Version V5.15 makes the provision of production data for various IT systems even easier and more flexible. The data type conversion offers various options for the conversion of strings to other data types, such as integer or Boolean.

Furthermore, thanks to the support of LUA scripts, extensive and complex operations can be performed. This includes, for example, the splitting of arrays into individual elements or their processing as well as the merging or splitting of strings.

Previously, it was already possible to perform mathematical and logical calculations, such as converting a temperature value from Celsius to Fahrenheit. In addition, users could combine multiple values into a single data point using simple mathematical operations, extract bits from an integer, and perform logical operations (AND, OR, NOT, ...) with multiple data points.

dataFEED OPC Suite Extended is an



Thanks to the extensive data preprocessing functionality, data can be adjusted easily and flexibly.

all-in-one package for OPC communication and cloud connectivity. The suite can be used for accessing the controllers of leading manufacturers and for the integration of automation devices in IoT cloud applications.

Using the MQTT and REST protocols, production data can be transferred to IoT Cloud or Big Data applications on Microsoft Azure, Amazon AWS, Google Cloud, Bosch PPM and Siemens Mind-Sphere platforms.

A free trial version of dataFEED OPC Suite Extended V5.15 is available for download.

#### Softing

Visit Website

### **New Flexible Automation Modules**

Accelerated path to Industry 4.0 with expanded industrial automation solutions and modules (FAMs).

Advances and the introduction of Flexible Automation Modules (FAMs) extend Molex's Industrial Automation Solutions (IAS4.0) by empowering supply chain stakeholders to build software-defined machines, robots and production lines that meet escalating demands for connected, secure, scalable and efficient operations.

Modular, connected automation solutions (IAS4.0) and new Flexible Automation Modules (FAMs) drive production-line innovations and operational efficiencies.

As the core building blocks, the FAMs offer highly customizable connectivity, distributed control and IIoT apps to speed the development of flexible, modular and connected manufacturing machines. Pre-certified and custom FAM functionality encompasses distributed control, embedded safety and security, multi-directional communications, provisioning and device management, as well as remote configuration and programming services.

Critical manufacturing data can be collected and shared seamlessly—from sensors or complex devices, as well as between devices,



Modular FAM building blocks enable software-defined functionality and connected IIoT apps for manufacturing.

machine-to-machine or to edge devices and the cloud. Feeding this data to artificial intelligence and analytics solutions will help expedite the delivery of actionable operational insights. Additionally, real-time data capture can help pinpoint potential issues to elevate predictive maintenance and decrease downtime while seamless integration with critical business systems and services supports effective decision making.

#### Molex

### **SINAMICS enclosed drive series**

New drive for industrial pump, fan and compressor use in harsh environments and heavy-duty positioning.

Siemens has announced immediate availability of a new enclosed drive system, the SINAMICS G120XE, designed specifically for the demands of industrial pump, fan and compressor applications in a wide variety of markets. Built around the popular SINAMICS G120X infrastructure drive, this new enclosed system is ideal for fast design and commissioning in industries such as oil-and-gas/petrochemical, water/wastewater, power plants, industrial climate control, refrigeration and chillers in harsh environments.

A NEMA 1 enclosure is standard, with a NEMA 12 version optional, featuring appropriate ventilation and air filters. The base enclosure is suitable for wall-mounting to 75 hp applications, while the free-standing floor module accommodates uses to 200 hp.

Standard electrical characteristics of the drive system also include a UL508A listing, SCCR rating to 65kA, circuit breaker disconnect with flange-mounted operator handle and mechanical door interlock, plus control power transformer for internal power control and power module with PWM IGBT inverter. Overload ratings allow operation in either light or high overload duty conditions.



Siemens offers wall-mounted or free-standing versions of its new SINAMICS G120XE enclosed drive system.

The enclosure ventilation fans on the SINAMICS G120XE are controlled via a relay and run only as needed, a significant energy saver and noise reduction feature. Optional features on the enclosure include output filters and reduced voltage soft start (RVSS) bypass.

In addition to the door-mounted IOP-2

keypad / display, the drive can also be commissioned, setup or modified using any Wi-Fi-enabled laptop, tablet or smartphone by installing the Smart Access Module.

Siemens

Visit Website

### **Fiber-rich managed switches**

Antaira launches an update to its 20-port fiber rich managed Industrial Ethernet switches.

Antaira's LMP-2012G-SFP and LMX-2012G-SFP series are industrial-grade equipment that is Ethernet-ready to fulfill various markets' edge-level networking applications in harsh and outdoor environments, such as manufacturing automation, security surveillance, power/utility, water wastewater treatment plants, oil/gas/mining-density Ethernet port connectivity, wide bandwidth, long-distance data transmission, and have a superb reliability factor.

Antaira's LMP-2012G-SFP Series industrial PoE switch provides eight PoE ports (30 Watts) for security applications and 12 fiber optic interfaces for long-range connectivity (1 meter to 100 KM), that is, from 3 feet to over 60 miles. The SFP port will allow connectivity beyond the 100 meters/300-foot limitation of copper cable and permits connectivity through areas where electromagnetic interference may cause issues found on factory floors.

With the enhancement of the Antaira management software and the redesign from the predecessor (LNX-2012GN-SFP Series), these switches help monitor, react, and troubleshoot applications to reduce the cost



Support for12~48VDC provides a power input for applications where only low volts of DC power are readily available.

of maintenance and downtime. Features such as SNMP Traps, Syslog, and port mirroring can be priceless when maintaining a system and reducing issues causing outages. Additional features that were not included in the predecessor like the ERPS (both LMP and LMX-2012G-SFP Series) and PoE functionality (LMP-2012G-SFP Series only) give this improved high-port count managed Ethernet switches more versatility for your applications.

Antaira Technologies

Visit Website

SOURCE: ANTAR/

### **Ultrasonic sensors for safety applications**

Unit is a 2-channel ultrasonic sensor, featuring two transducers connected to a control interface.

A new ultrasonic sensor system brings safety to applications where it was not possible before. Whether in very tight installation spaces, in dusty environments, or outdoors with the USi®-safety, safe protection can now be achieved anywhere.

Pepperl+Fuchs is expanding its factory automation portfolio with the all-new USi-safety ultrasonic sensor. Suitable for use in harsh environments and outdoor applications, this small but mighty sensor requires only a small amount of installation space.

With safety certification in accordance with EN ISO 13849 category 3 PL d and as the only sensor of its kind in the world, the new USi-safety reinforces Pepperl+Fuchs' position as a market leader in ultrasonic sensors and safety applications. The unit is a 2-channel ultrasonic sensor, featuring two transducers connected to a control interface. On each of the two independent channels, objects can be detected via an elliptical sound beam within ranges of up to 2500 mm. Two safe OSSD outputs are provided for signal output.

Due to the special "wide and shallow" shape of the detection field, the system can be successfully used just above the floor or close



The new ultrasonic sensor requires only a small amount of installation space.

to a wall. Perfected for monitoring in threedimensional space, the optimal protection of machines, vehicles, and persons is therefore ensured. This is made possible by the special shape of the sound beam: while conventional ultrasonic sensors emit acoustic signals in the form of a radially symmetrical sound beam, the USi-safety does so in an elliptical sound field. Due to the opening angle of  $\pm$  17°/ $\pm$  5°, a particularly wide detection range is generated in one plane and a narrow detection range in the other plane.

Pepperl+Fuchs

Learn More

### **Unmanaged switches: IP 67protection**

#### FL SWITCH 1000 and 1100 series is the company's latest generation of unmanaged Ethernet Switches.

These new unmanaged switches for field installation expand the product range of Ethernet switches from Phoenix Contact.

The new 1608 and 1708 variants of the FL SWITCH 1000 family feature IP65/IP66/ IP67 degrees of protection and make it easier to integrate distributed sensors, actuators, cameras, and I/O stations into the network.

The rugged housing design provides nearly unlimited options for choosing a mounting position. The flexible M12 connection technology lets the user choose between using classic M12 connectors with screw connection and the M12 PUSH-PULL fast locking system from Phoenix Contact. The unmanaged switches support the Quality of Service (QoS) functionalities of the FL Switch 1000 product series for customary use of automation protocol prioritization.

A unique mounting accessory allows users to mount the FL SWITCH 1000 and 1100 series devices flat on the DIN rail. As a result, the switches can also be used in small or flat control cabinets where space is at a premium. Users are free to choose the outlet direction of the connections. This not only makes the



The new Unmanaged Switch series features enhanced data traffic prioritization for automation protocols.

switches very flexible to use, but the smaller number of product variants also helps reduce inventory costs.

The new Unmanaged Switch series features enhanced data traffic prioritization for automation protocols. The real-time properties of PROFINET and EtherNet/IP™ automation networks are supported, resulting in more stable networks and increased system availability.

#### Phoenix Contact

SOURCE: PEPPERL + FUCHS

### **Multi-speed mega PoE injector**

Hardened multi-speed mega PoE injector enables diverse infrastructure applications.

Advantech's new compact, industrial grade solution delivers Wi-Fi 6 network infrastructure, power over Ethernet (PoE) and advanced connectivity to out-of-date, extant infrastructure. It supports multiple data rates (10M/100M/1G/2.5G/5G) and IEEE802.3bt 90W PoE output; and is an excellent choice for obsolete infrastructure applications requiring heavy network connectivity.

Advantech's EKI-2701MPI-5G supports downward compatible 2.5 and 5Gbps data rates to deliver Wi-Fi 6 capabilities to existing wireless infrastructure. It further serves as a PoE PSE, delivering up to 90W output to IP cameras, Wi-Fi 6 access points, and other connected devices. This injector's PoE standard is downward compatible for 15, 30, and 60W PoE PD devices, easing network infrastructure upgrades. Using this solution to upgrade infrastructure saves manpower while reducing cabling weight and cost.

Advantech's EKI-2701MPI-5G is PoE and data rate downward compatible. It helps extend extant device lifecycles and maximizes return on investment by futureproofing infrastructure from different generations. The unit features a compact, palm-sized form factor adaptable



5G solution supports compatible 2.5 and 5Gbps data rates to deliver Wi-Fi 6 to existing wireless infrastructure.

to network infrastructure upgrade applications with limited space. Despite space constraints, EKI-2701MPI-5G is capable of delivering network service without overheating. Indeed, it supports wide operating temperatures (-40  $\sim$  75 °C/-40  $\sim$  167 °F) found in harsh working environments.

Highlighted features include support for

Data in and PoE out; IEEE 802.3af/at/bt compliant; amd force mode power support for up to 90W by DIP switch.

multi data rate 10M/100M/1G/2.5G/5G for

Advantech

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### **PHYs enable multidrop bus architecture**

Ethernet PHYs are first to implement 10BASE-T1S single-pair Ethernet standard for industrial networks.

Smart manufacturing is driving efficiencies in automation as digital networks increasingly connect machines, production line equipment and robotics. Operation and information technology networks that are critical to the Industrial Internet of Things (IIoT) rely on Ethernet for interoperability and to speed data transmission and ensure security.

The LAN867x family of 10BASE-T1S PHYs, a new solution available today from Microchip Technology Inc. (Nasdaq: MCHP), expands Ethernet connectivity to the very edges of industrial networks, simplifying architectures and reducing risk for designers.

Microchip's LAN867x Ethernet Physical Layer (PHY) transceivers are high-performance, small-footprint devices enabling connections to standard system devices including sensors and actuators that previously required their own communication systems.

With the LAN867x devices, all-Ethernet infrastructures in OT and IT systems can be expanded to the edges of the network. These devices eliminate the need for gateways that in the past were needed to interconnect incompatible communication systems. The



All-Ethernet infrastructures simplify architectures by using well-known communication and security mechanisms.

single pair of wires reduces cost, while the multidrop bus architecture reduces the need for expensive switches and enhances scalability. Several nodes can operate on the same bus line with high data throughput.

The Ethernet PHYs are the first designed and

validated to the new 10BASE-T1S standard for single-pair Ethernet released by IEEE.

#### Microchip

### **Compact 7-inch multi-touch panel**

Panel comes with EDGE2 technology processor, 256 MB internal program and data memory (DDR3 RAM).

A new addition to SIGMATEK's HMI product range, the ETT 7321, is designed for VESA75 carrier arm mounting and can be placed more flexibly on the machine or system.

Equipped with a 7-inch TFT LCD color display with 800 x 480 pixels and LED backlight, the compact multi-touch operating panel (PCT) comes standard with EDGE2 technology processor, 256 MB internal program and data memory (DDR3 RAM), as well as 512 MB NAND flash.

A USB 2.0 and an M12 interface for power supply and Ethernet are integrated. Like all SIGMATEK HMIs with a processor, this multi-touch panel also supports OPC UA communication.

On the front side, the ETT 7321 is designed in protection class IP65, on the back side it complies with IP54. The advantage of the carrier arm mounting is that the operator can align the panel to always keep his application in view.

With the elegant glass display enclosed by a 5 mm aluminum frame in black and thus more robust, the fanless HMI also has a lot to offer visually. The creation of the visualization is comfortable and very flexible by using the



The ETT 7321 from SIGMATEK is a modern 7-inch multi-touch panel for the carrier arm.

object-oriented engineering tool LASAL.

SIGMATEK human-machine interfaces are compactly designed and fanless. Users have the choice between operating panels with and without a processor, resistive or capacitive touch screen – and of course, different formats and models. Units are fast and reliable: data and fit for the digital factory. All SIGMATEK HMIs with a processor also support OPC UA communication.

#### SIGMATEK

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### **Rail-mount terminal block**

#### Rail-mount terminal block range offers new mini variant for maximum performance in minimum space.

As devices become smaller and smaller, less and less space is available for connecting them, so the connection components need to be small too. WAGO added a miniature version to its range of rail-mount terminal blocks last year, and its Mini Rail-Mount Terminal Blocks are also now available with a nominal cross-section of 2.5 mm<sup>2</sup>. This second variant supplements the 1 mm<sup>2</sup> model already available.

WAGO'S TOPJOB® S Mini Rail-Mount Terminal Blocks are especially compact, making them suitable for wiring work in cramped terminal boxes of motors, pumps or devices in control cabinets, for example. Despite a compact design, the new 2.5 mm<sup>2</sup> version (max. 4 mm<sup>2</sup> without ferrule) can be used in applications up to 24 A (max. 32 A without ferrule) and 800 V (IEC)/ 600 V (UL). Motors, pumps and devices are often connected close to production lines, in industrial environments where Mini Rail-Mount Terminal Blocks offer the additional advantage of reliable, vibration-resistant connections, thanks to spring pressure connection technology.

Both versions of the WAGO Mini Rail-Mount



By using GOT Mobile, operators can monitor the screen from computers and tablets in a remote location.

Terminal Blocks  $(1 \text{ mm}^2 \text{ and } 2.5 \text{ mm}^2)$  offer tremendous flexibility: They can be mounted on a 15 x 5 mm DIN-rail or on a mounting plate with snap-in feet or mounting flanges. The terminal blocks are equipped with either an intuitive push-button or an operating slot – both versions also allow direct push-in connection. Both the 1 mm<sup>2</sup> and 2 mm<sup>2</sup> Mini Rail-Mount Terminal Blocks carry CCA, UL, CSA, IECEx and ATEX, AEX approvals.

#### WAGO

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SOURCE: WAGO

### **FactoryTalk Logix Echo**

New software transforms machine design as engineers can fully test control code in a virtual environment.

Machine designers can save time and costs, optimize machine performance, and get to market faster using the new FactoryTalk Logix Echo controller emulation software. The software is now available for use with the ControlLogix 5580 family of controllers from Rockwell Automation.

Using the emulation software, engineers can fully test control code in a virtual environment. With support for up to 17 emulated controllers, the software can emulate a machine, production line or even an entire plant.

Emulated controllers can also be paired with other software for a wide range of uses. For example, by connecting an emulated controller to a mechanical system model via the Emulate3D digital twin software, users can perform testing and experimentation without large physical equipment.

And by connecting an emulated controller to training simulator software, operators can be trained on a new machine and learn its real-time responses before the machine arrives on site.

The FactoryTalk Logix Echo software is designed with a modern user interface and



New software enables users to take the next step towards comprehensive digital engineering.

a simpler overall experience than existing emulation software. Switching between design and emulation, for example, is effortless and requires no program changes.

The FactoryTalk Logix Echo software is the latest addition to the FactoryTalk DesignSuite portfolio.

The portfolio brings together engineering

and design elements into a standard framework, allowing engineers to use the same tools, language, and resources to build or modify their systems.

**Rockwell Automation** 

Visit Website

### **Open-source wireless GPS/GNSS**

mowi is an open-source reference design for Septentrio's highly accurate GNSS module, mosaic.

Septentrio announced open-source resources for its GPS/GNSS module receivers: mosaic<sup>™</sup> wireless or mowi. It combines the Septentrio mosaic-X5 or mosaic-H module receiver with a dual-mode Bluetooth and integrated Wi-Fi from the ESP32-WRover programmable module by Espressif Systems. It is an addition to the already existing mosaicHAT board, designed on the Raspberry Pi platform.

The mowi project facilitates accurate and reliable GNSS positioning for robotic and autonomous devices, on a hardware level. Numerous engineers use the ESP32 and the multiple libraries available for Internet-of-Things (IoT) prototyping. The mowi board is an easy way for integrators to get started with Septentrio's mosaic-X5 or mosaic-H heading module receivers. The mowi board can be used on its own or plugged into a mobile computer such as Raspberry Pi or Arduino to deliver high-accuracy positioning with high update rates, ideal for machine navigation, monitoring or control. The internet connection via Wi-Fi or Bluetooth enables numerous industrial IoT applications, simplifying the connectivity to mobile data for the delivery



The mowi board is an easy way for integrators to get started with mosaic-X5 or mosaic-H heading module receivers.

of GNSS corrections needed for cm-level RTK positioning.

On top of the wireless communication, the small board can host IoT applications in its internal memory. It has onboard logging and exposes interfaces such as USB, serial communication, and general-purpose pins. The schematic's reference design, PCB layout and documentation are openly available for prototyping or further customization.

Septentrio

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SOURCE: SEPTENTRIO

### **KBox Industrial PCs**

#### The Kontron Box PC KBox B-202-CFL is now available in two new versions.

The KBox variants 'Smart Performance' and 'Smart Storage' meet the demand for higher computing performance and additional, internal storage options Kontron has added two new model variants to its KBox B-202-CFL industrial PC.

In addition to the high processor performance with Intel Core processors of the 8th or 9th generation, the new KBox B-202-CFL variant 'Smart Performance' is equipped with an even more powerful 270 W power supply, which enables the use of high-performance graphics cards with up to 120 W enables.

The 'Smart Performance' variant offers impressive graphics performance and image quality for graphics-intensive applications. With the 'Smart Storage' variant's additional hard drive capacities, the focus is on memoryintensive processes that require a high level of reliability.

Thanks to the 9th generation of Intel Core processors and up to eight processor cores, the KBox B-202-CFL easily handles computationally intensive processes and large amounts of data. In addition to its high performance, the compact Embedded Box PC is characterized by maximum expandability and a



The KBox B-202-CFL easily handles computationally intensive processes and large amounts of data.

low noise level. Graphics or network cards (full height, half-length PCIe) can be added via the PCIe interface, making the KBox B-202-CFL suitable for demanding desktop and control room applications. In addition to the basic equipment with a 2.5-inch SATA SSD and an M.2 SSD, the 'Smart Storage' variant offers the option of storing data using two additional 2.5-inch SSD hard drives (fixed or removable) in the to save so-called RAID level 1 mirrored. Alternatively, a 3.5-inch HDD hard drive with up to 12 TB can be integrated.

#### Kontron

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### Harnessing data to meet alarm needs

#### Cloud-based applications provide opportunities for more resilient and flexible network management options.

Technology provider Ovarro is working in partnership with several companies across a range of sectors to develop software tools that enables them to gain clearer insights into what is happening in their processes and internal networks. In many cases the new tools are utilising data that has already been captured, but has not been streamlined or managed effectively.

One example is AlarmVision, a softwareas-a-service (SaaS) application that presents real-time dashboards, which analyses the stream of alarms coming into a control room from telemetry systems. SaaS applications are cloud-based and can be accessed via any device with an internet connection, as opposed to a software product that is entirely installed on a device or network.

AlarmVision dashboards give a measure of control over alarms, based on internationally recognised key performance indicators, and allow action to be taken to help operators maintain or gain control. The ability to gain real-time, or backwards-looking, analysis of how the control room is operating against the standards provides an insight into whether



New software solutions are enabling optimum use of existing alarm data.

there is a risk of critical alarms being missed. Users can also identify the root cause of the largest proportion of alarms being generated on their system – for example, a faulty piece of equipment could be causing 10 per cent of total alarms on a given day. Ovarro wants to enable companies to be fully predictive and to

#### **O**varro

### **New wireless 5G gateway**

ELTEC Elektronik complements router family for railway technology with new wireless 5G gateway.

CyBox GW 2-P offers five slots for various 5G/ LTE and Wi-Fi module combinations as well as two Gigabit Ethernet interfaces to optimize connectivity and improve performance.

With the new unit, ELTEC is launching its first mobile 5G and Wi-Fi 5 Wave 2 gateway for high-speed communication especially for use in trains. The CyBox GW 2-P was developed in compliance with the (German) railway standard EN 50155 and designed for an operating temperature range from -40 °C to +70 °C.

Compared to the LTE version, the new CyBox GW 2-P enables significantly higher transmission rates of up to 2.4 Gbit/s download and 500 Mbit/s upload for each 5G modem. The CyBox GW 2-P offers 5 slots for communication modules, of which up to 3 can be equipped with 5G modems.

Four SIM card slots per modem support the use of different providers and, thus, ensure cost-effective, location-based routing and always the best network coverage. The CyBox GW 2-P is available in different configuration variants with a 4-core CPU (1.4 GHz) or alternatively 8-core CPU (1.8 GHz), with



Via the gateway, passengers with mobile Wi-Fi-capable devices in a passenger train can easily communicate.

integrated mass storage and two slots for I/O extensions. It can, thus, be flexibly adapted to the respective performance requirements.

With the Cybox GW 2-P, ELTEC is expanding its successful family of compact and robust 5G wireless routers. It combines the functions of a Wi-Fi access point and a communication server in a compact and maintenance-free system solution and serves as a particularly fast wireless interface to the Internet.

ELTEC

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### **Single-chip network synchronization**

#### Solution provides ultra-precise timing for 5G radio access equipment.

5G technology requires time sources to be synchronized throughout a packet-switched network ten times more accurately than 4G requirements. Microchip now makes it possible to achieve 5G performance with a single-chip, highly integrated, low-power, multi-channel integrated circuit (IC) coupled with its widely adopted IEEE® 1588 Precision Time Protocol (PTP) and clock recovery algorithm software modules.

Microchip's measure, calibrate and tune capabilities ensure 5G systems achieve International Telecommunication Union – Telecommunication (ITU-T) Standard G.8273.2 Class C (30ns max|TE|) and the emerging Class D (5ns max|TEL]) time error requirements.

The architecture provides flexibility, offering up to five independent Digital Phase Locked Loop (DPLL) channels while consuming only 0.9W of power in a compact 9 x 9-millimeter package that simultaneously reduces board space, power and system complexity.

With five ultra-low-jitter synthesizers, this latest platform offers 100 femtosecond (fs) root mean square (rms) jitter performance required by high-speed interfaces in the latest



Low-power device supported by 1588 Precision Time Protocol and synchronization algorithm software modules.

5G RU, DU and CU systems.

Microchip's network synchronization platform software includes its ZLS30730 high-performance algorithm coupled with its ZLS30390 IEEE 1588-2008 protocol engine. Both are widely deployed in 3G, 4G and 5G networks with precise timing capabilities. The platform combined with its 5G oscillators offers 5G network operators a total system solution.

#### Microchip