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# CONTENTS

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<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>06</td>
<td>Drones and Industry 4.0</td>
</tr>
<tr>
<td>12</td>
<td>Predictive Maintenance With Industrial Networks</td>
</tr>
<tr>
<td>18</td>
<td>5G and the Smart Supply Chain</td>
</tr>
<tr>
<td>27</td>
<td>CC-Link IE TSN: Accelerate Smart Factory With TSN Technology</td>
</tr>
<tr>
<td>36</td>
<td>The Challenges of Making the Digital Transformation</td>
</tr>
</tbody>
</table>

**Keywords:**
- Ethernet
- Sensors
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- Interoperability
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Drones and Industry 4.0

BY CHRIS CORFIELD
Technical writer, Control Techniques

Though drones might still seem to be more of a hobby than a critical piece of the IIoT puzzle, numerous applications and new technology developments are being explored that will better position drones as important data collection devices for industry.

The growth in the profile of drones has surely by now moved out of the folder marked “Fad.” Where once flying model aircraft was seen as a fairly niche hobby, enjoyed by men with sensible jackets and thick-rimmed glasses, now seemingly everyone wants to get in on the drone act.

Drones are now used extensively to carry out inspections or survey and map terrain in harsh or hazardous environments. For work on power lines or oil rigs, the benefits to the health and safety of human workers are clear. After all, why would you send a human up
Drones and Industry 4.0

a tower to assess a fault when it takes a camera-equipped drone 10 seconds to get there?

Industry 4.0, the Industrial Internet of Things (IIoT), Big Data and drones are all emerging technology stories destined to find ways to complement one another. When you consider a drone as just another sensor, the same as you’d find installed in factories and machines anywhere, you can begin to see where it fits in the automation ecosystem.

For example, it’s not difficult to imagine using a thermal-imaging device connected to a drone to track high levels of heat coming from an area in a factory and autonomously activate the sprinkler system or notify emergency services.

A good demonstration of how technology companies are adapting drones for use in industry is the new offering from Israeli firm Airobotics. Its Optimus drone-in-a-box package arrives in something resembling a small shipping container. Inside, robotic arms change the drone’s batteries, install different payloads (e.g. cameras and winches) and extract the data provided from the aircraft for subsequent analysis. Everything—from programming flight paths to takeoff and landing—is completely automated. It can truly run in the background without any human intervention.
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As new and interesting potential applications are dreamed up for drone use in industry, drones will be fitted with ever heavier and more complex payloads. It's not beyond the realm of possibility to see robotic arms fitted to drones, or even apparatus for carrying humans—all of which requires more power and better range.
The issue of powering the drone remains a critical consideration for anyone looking to deploy drones for industrial purposes. At the moment, operators need to balance the weight of the payload vs. the required flight-time. Higher-powered (or more efficient) batteries that mitigate against this are surely on the horizon, either in the form of improvements to existing lithium polymer (LiPo) batteries or via new technologies.

Though drone power and payload concerns continue to develop, what is clear is how drone use will continue to grow. The Association for Unmanned Vehicle Systems International (AUVSI) in the U.S. believes drones and drone-related technologies could be responsible for the creation of up to 100,000 new jobs and contribute an extra $82 billion to the U.S. economy by 2025.

However you look at it, drones are here to stay. The examples of drones being used to increase productivity or to make work a safer place far outnumber the negative examples that often capture the biggest headlines. Regulation of drones will, of course, evolve over time to meet the ever-changing drone landscape, and safety will be paramount to these developments.

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As its name implies, predictive maintenance is a prediction of early failure that guides your maintenance schedule and reduces downtime. In the past, predictive maintenance was merely a hypothesis in many plants and usually resulted in reactive maintenance instead of the proactive approach. Today, we take the guesswork out of predictive by basing our decisions on sound facts—on data we gather and process to drive our conclusions. Thanks to Industry 4.0 and advancements in industrial products, we’re now armed with the data to make better decisions.

Let’s examine how condition-based data, condition monitoring and diagnostics have all changed our world in the networked environment.
Predictive Maintenance With Industrial Networks

**Condition-based data** is gathering of information in real time on the state of affairs occurring on a machine. This data comes typically from low-level sensor devices on the plant floor and then, in the Industry 4.0 world, is fed back to the programmable logic controller (PLC) via IO-Link (a rapidly growing communication protocol). Such data can also come from the valve driver used on a pneumatic valve manifold, where process and parameter data is collected by the valve driver, also known as the network node.

Process data (also called cyclic data) is fed back to the PLC at regular intervals. This is your need-to-know-in-a-hurry data that you want to monitor, such as temperate warnings, over-voltages and shorts.

Parameter data (also called acyclic data) is nice-to-have data embedded in the electronics and must be retrieved if needed. Examples of parameter data include cycle counting and specific information such as which valve coil is shorting out.

Every manufacturer offers different amounts and types of process and parameter data. Therefore, a sound understanding of the diagnostics available on your in-plant equipment is essential to building your Industry 4.0 predictive maintenance strategy.
Condition monitoring is distinct from condition-based data because condition monitoring searches for a change of state over a given period of time. Condition monitoring of plant equipment is often defined by a change of state in heat, acoustics and vibration. If it’s louder and running hotter, you know its condition has changed—a likely indicator of wear. In industrial networks, condition monitoring can include cycle counting, cycle time changes and temperature rise for potential signs of impending failure.

To make data acquisition work effectively, two areas that should not be overlooked are sensors and machine safety.

Sensors provide data. For example, continuous position sensors lend themselves well to diagnosing a cylinder with leakage and wear. Sensors provide great data at low cost and can literally be a lifesaver in hard-to-reach areas. With so many cost-effective sensors on the market, why not integrate a few into your predictive maintenance plans? Consider flow and pressure sensors, continuous-position sensors and even simple analog sensors. This way you’ll get a warning through the network that something has malfunctioned, along with the exact address of that sensor, which makes things much easier.
Safety tells us a great deal about our equipment. How many times has the light curtain tripped? Why? Do production line workers hit the e-stop button frequently? Why? All of these things point to larger problems that result in wasted time, higher scrap yields and potential injury. Companies that monitor safety can uncover the underlying issues. Gathering cycle count data for a light curtain, for example, might bring surprising results. By determining the root cause of the
breached light curtain, you can shed further light on production issues. Putting safety on the network allows you to monitor and manage such activity. Some manufacturers offer safe power-capable devices that apply safe power to components so that in the event of an emergency, power can be disconnected but communication remains on. There’s a great deal of value in thinking about safety on machine and over network. Gathering diagnostics can also ease some of the regulatory compliance requirements for reporting as required in larger facilities when the Occupational Safety and Health Administration (OSHA) wants to validate your compliance.

The Industrial Internet of Things (IIoT) brings with it many great functional and diagnostic tools. Manufacturers are building integrated smarts into valve drivers and network nodes. Integrated sensing is now available in many products or as add-on options. Ensure that you understand the function of these diagnostic capabilities to incorporate their use and don’t forget to look at your safety network for hidden problems that can be turned into big cost savings with little expense or effort. Think big picture on how you can incorporate the technologies available across your existing equipment for a quick IIoT upgrade.

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In recent years, enterprises have made great strides forward in supply chain efficiency as automated Industrial Internet of Things (IIoT) devices proliferate across the supply chain. These devices rely on data to perform effectively. As a result, companies in every industry are emphasizing data collection and analysis, giving rise to edge computing, which gathers and processes data directly where data is generated—at the network edge.

Edge computing has helped supply chains transition from a series of independently managed locations to an increasingly connected network of devices, sharing knowledge in real time. Enabling greater communication for devices throughout the supply chain provides

As 5G network capabilities become available in 2019, it’s important to understand how they can be used to expand edge computing accessibility and use cases.
businesses the knowledge and flexibility to automate key decisions and maximize efficiency.

**The cost of computing**

Though enterprises have implemented edge computing and are yielding the benefits of smarter supply chains, the productivity gains and cost savings have largely eluded smaller-scale businesses. Edge computing can powerfully upgrade a business’s ability to gather and analyze key supply chain data, but hardware can be expensive.

Meanwhile, edge computers are only as powerful as the network connections they rely on. Currently, many smaller-scale businesses and manufacturers struggle more with connectivity than computing. Establishing sufficient bandwidth, latency and security at the network edge to support next-level data computing can be extremely expensive. For businesses without excessive technology budgets, patches of Wi-Fi linked by Ethernet are the norm. These networks might not be powerful enough to support a full range of edge computing applications, limiting the consistency of IIoT in the supply chain.

**How 5G changes the picture**

Thankfully, the expected advances of 5G connectivity will make connected, IIoT-enabled supply chains accessible to more businesses
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than ever before. 5G will offer a significant performance upgrade to existing 4G and LTE networks but, more importantly, 5G technology will greatly simplify network management. By building centrally controlled, unified networks on 5G signals, companies will decrease their spending on networking devices. By limiting hardware endpoint vulnerabilities, companies will also benefit from increased and greatly simplified cybersecurity.
As 5G technology proliferates, cheaper, more effective connectivity will create new computing and automation possibilities for businesses of all sizes, especially those without billion-dollar technology budgets. 5G will allow companies to view far more data, while edge computing technology will allow companies to analyze this data with greater speed and confidence. In effect, expected advances in network technology will bring automation and IIoT capabilities to businesses that previously only dreamed of them.

The benefits of 5G at the edge

Improved connectivity will deliver vast improvements to businesses looking to optimize their supply chains through automation. 5G will dramatically improve data collection and analysis at both the “near edge” (within a business facility) and the “far edge” (where an OEM IIoT device is deployed after the sale).

At the near edge, IIoT devices on the shop floor will be able to collect and share data more easily with the help of 5G bandwidth. Meanwhile, edge computers used to analyze IIoT-collected data will run faster thanks to 5G connectivity, providing logistics and manufacturing teams with the information they need to make critical decisions.
5G technology also offers notable benefits at the far edge of a production cycle, after IIoT devices have left a business facility. Private 5G networks can help IIoT devices quickly and securely transmit data from far-flung, remote locations.

Transportation is another key opportunity for supply chain teams to use edge computing to optimize their logistics decisions. Powered by a 5G network, businesses can host applications on small appliances...
5G and the Smart Supply Chain

and track critical data and adjust transit routes to deliver product more efficiently. In-transit data transmissions are a key challenge today for automated technology in the supply chain. With 5G connectivity, this ability will grow significantly stronger.

Use cases

To illustrate the potential of 5G at the near and far edge, consider the example of a brewery. On-site, at the near edge, 5G technology can help brewers collect and analyze additional data about their beer during production, allowing them to adjust their ingredient mix and processes as needed. After a shipment of beer leaves the brewery, 5G-enabled trucks can automatically transmit their locations and traffic patterns, allowing the brewery’s logistics team to reroute shipments and avoid delay. 5G can also help logistics teams track the temperature of the beer in real time, ensuring their product maintains its quality before delivery.

Though the supply chain benefits of 5G will trickle into every industry, a few key verticals stand out as ripe for disruption. The oil and gas industry, for example, is marked by complex material processing and long-distance transport that 5G can help organize. In discrete manufacturing of consumer goods, 5G can link distributed edge systems to connect distant, small-scale supply partners via a private
Preparing for the 5G revolution

As 5G technology develops rapidly, OT, IT and supply chain teams can prepare by monitoring their internal processes to determine where their existing automation and analytics operations are not performing adequately. Businesses can also closely examine their existing hardware spending to ensure supply chains are positioned to make the most of expected gains in connectivity. Supply chain teams should identify the aspects of their operations that are most in need of change, so that they can integrate 5G effectively in the years ahead.

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CC-Link IE TSN: Accelerate Smart Factory With TSN Technology

BY JOHN F. WOZNIAK, P.E.
Manager, CLPA-Americas

The CC-Link Partner Association has created a new industrial open network specification, CC Link IE TSN, as the next-generation CC-Link IE network.

The new CC-Link IE TSN specification is the first to combine Gigabit Ethernet bandwidth with Time-Sensitive Networking (TSN). TSN is the addition to the IEEE Ethernet related standards that is starting to become popular for industrial networks. TSN’s key benefit is that it allows the combining of real-time control communication with non-real-time information communication while maintaining deterministic performance. This is not possible with conventional general-purpose industrial Ethernet.

CC-Link IE TSN adds TSN to increase openness while further strengthening performance and functionality. It supports more development methods, enabling easier implementation on a wider
range of equipment and increasing the number of compatible products. It is expected to accelerate the construction of smart factories using the Industrial Internet of Things (IIoT).

As customer needs grow more diverse and advanced, there is a growing trend in manufacturing industry toward automation, reducing total cost of ownership and improving quality, together with embracing new manufacturing methods. The information-driven society fueled by IT-based data continues to grow with the development of sensing technology, higher-speed networks, the spread of cloud/edge computing and other advanced technologies.

We are seeing the global megatrends moving toward the use of the IIoT in manufacturing industry, such as Industry 4.0 in Europe, the Industrial Internet Consortium (IIC) in the U.S., Intelligent Manufacturing in China, and others. All of these share a common goal: the creation of smart factories in which everything is connected, data is used to the fullest, and optimized manufacturing takes place autonomously.

To create smart factories, essential issues include gathering real-time information from production processes, processing it and then transmitting it seamlessly to IT systems. Toward that end, one crucial need when making the most of production site data is a network
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capable of high-speed, stable control communication as well as large-volume information transmission to IT systems. In other words, it is important to combine industrial networks at production sites with IT system networks.

A wide variety of industrial networks are currently in use. However, it is difficult to achieve interoperability between them, leading to islands of automation that decrease process transparency. Demand for TSN support will increase, since this technology makes it possible to mix different networks on the same line and provide real-time communication through time synchronization.

CC-Link IE TSN was developed to meet this demand. The new specification enables seamless, smooth connection from upper-level IT systems to operations technology (OT) systems at production sites, allowing the expanded use of a wide variety of applications in manufacturing industry.

Created as a next-generation industrial open network to accelerate the construction of smart factories, CC-Link IE TSN builds on the benefits of CC-Link IE by improving communication functions and synchronization accuracy, as well as significantly enhancing motion control capabilities.
CC-Link IE TSN offers multiple features:

Integration of control communication and information communication. By giving a high priority to cyclic communication for device control and by allocating bandwidth preferentially over information communication, CC-Link IE TSN offers a network environment that communicates information with IT systems while controlling system devices with real-time cyclic communication. This mixture with information communication means that devices using UDP or TCP communication (such as machine vision systems) can be connected to the network for high-accuracy monitoring, diagnostics and analysis.

Rapid system setup and advanced predictive maintenance. CC-Link IE TSN is also compatible with SNMP, enabling easier diagnosis of network devices. Until now, special tools were required when collecting device status information. However, general-purpose SNMP monitoring tools can now be used to gather and analyze data from devices compatible with either CC-Link IE TSN or IP communication (such as switches and routers). This allows quicker system startup times and can reduce the amount of time and effort spent on system administration and checking the operating status of devices during maintenance.
The time synchronization protocol regulated by TSN is used to calibrate time differences between devices compatible with CC-Link IE TSN, keeping them synchronized with high accuracy. Time information stored in devices is kept synchronized to the microsecond. If a network error occurs, this makes it possible to check operation.
logs and accurately trace events up to the error in chronological order. This can help to identify problems and can lead to quicker recovery. It is also possible to provide production site information and accurate time information to IT systems. This will allow artificial intelligence (AI) enabled data analysis to provide further process improvement via predictive maintenance.

Maximize the performance of motion control and reduce cycle times. CC-Link IE TSN uses a time-sharing method with time trigger and bidirectional simultaneous communication to achieve microsecond or less cycle times. Adding sensors or increasing the number of servo amplifier axes required for control to expand a production line has minimal effect on overall cycle time in systems operated with CC-Link IE TSN. Cycle times might even be reduced compared with systems operated with conventional networks.

CC-Link IE TSN allows equipment with different communication cycles to be used together according to the performance of each device. Until now, devices connected to the same master station had to be operated using the same cyclic communication cycle (link scan time) throughout the entire network. CC-Link IE TSN allows for multiple communication cycles to be used within the same network.
This makes it possible to optimize communication cycles depending on the characteristics of each device.

For example, devices (such as remote I/O) not requiring a high-speed communication cycle can be connected while still maintaining the performance of devices requiring high-performance communication cycles (such as servo amplifiers). This can also maximize the potential of slave devices on the network and improve productivity throughout the entire system.

For more information about CC-Link IE TSN, access the complete white paper at http://awgo.to/tsn.
With the introduction of a cost efficient Industrial Ethernet network node, Parker enables its partners to increase productivity and profitability, while reducing complexity. Connected valve technology enables better machine-to-machine control in a cost-effective way.

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The Challenges of Making the Digital Transformation

BY CHARLIE NORZ
Product manager, Wago

A look at how numerous product enhancements and capabilities enable Wago to support a range of industry initiatives to connect and secure plant floor devices.

Digitalization offers innovative companies a great opportunity to successfully shape the future. However, digital transformation also brings with it many challenges such as real-time data collection, system security, and multi-vendor equipment collaboration. A single blueprint for mastering the digital transformation does not exist today; rather, companies need a variety of tailor-made solutions for their individual requirements.

The good news is that Wago’s open automation architecture provides just that. With a long history of helping industry collect valuable information from the plant floor, Wago continues to develop
advanced technologies that offer users the freedom to quickly bring to market customizable solutions for the emerging digital age.

Through the advancement and development of the Industrial Internet of Things (IIoT), Wago helps enhance manufacturing and industrial processes through data mining and machine learning, and also helps users secure networks from cyber attacks. We have continued to enhance our technologies with tools for the digital transformation age. For example, we have embedded the MQTT protocol in our programmable logic controllers (PLCs) to enable secure data exchange between the plant floor and cloud services such as Microsoft Azure, IBM Cloud, SAP Cloud and others.

This makes it easy to create direct connections from the field level to the cloud. Information like run/stop times, connection status and device information can be communicated to the cloud through decentralized data acquisition processes. Our location-independent visualization helps provide an enterprise-level view, giving users full control over proprietary data. This creates an extension of existing systems via our PFC controller’s IIoT gateway.
The Challenges of Making the Digital Transformation

As digitalization enables users to view their systems remotely from anywhere in the world, it also means those systems need to be protected accordingly. Government and industry organizations have recommendations for industrial security via defense-in-depth strategies. Wago has the means to assist with implementing these tactics through helping to ensure the security and integrity of sensitive information for web access and data transfers. Our PFC platform can encrypt information directly in the controller before sending it to the cloud over VPN connections. In addition, the controllers have an onboard firewall to further help with network security.

As we look to the future, we understand that industrial communication needs to be quick and regulated so that businesses can keep up with these ever-changing challenges of digitalization. Wago is working with a number of manufactures to drive Time-Sensitive Networking (TSN) plus OPC UA communication standards to empower a variety of tomorrow’s cross-platform, vendor-neutral solutions in this regard. The aim is to deliver high-performance, recurring communication, and enable plug-and-serve scenarios by joining communication and information modeling for now and into the future.

“We have embedded the MQTT protocol in our PLCs to enable secure data exchange between the plant floor and cloud services such as Microsoft Azure, IBM Cloud and SAP Cloud.”

CONTINUED
As with all Wago solutions, safety and reliability are at the heart of all of our products, services and technologies. The result has been a portfolio of controllers and fieldbus couplers that are completely independent of protocols, as they support all common fieldbus protocols as well as incorporate Ethernet-based standards to meet the evolving requirements of the market. It is Wago’s vision to continue to be the backbone of a smart connected world.

For more information, visit Wago at www.wago.us.
Technical specifications

- Processor: Intel Core i7, 4 hyperthreaded cores
- System Memory: 32 GB
- Storage: 512 GB SSD
- System I/O: HDMI, Ethernet: 4 x 1 GbE (2 available for user applications), USB: 8 x USB 2.0
- OS: Stratus Redundant Linux (with virtualization)
- Temperature: –40 to +60 °C (0 to +50 °C if using provided AC adapter)
- Humidity: 10% to 95%, non-condensing
- Vibration: 3 Grms (5-500 Hz: X, Y, and Z directions)
- Dimensions: 280 mm (11.02 in) x 190 mm (7.48 in) x 76 mm (2.99 in)
- Weight: 4.6 kg (10.2 lbs.)
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