JUNE 2024

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ISA100 Wireless Moves Forward

On Board with Marine HMI/SCADA

Industrial 5G: Wireless Lessons from Construction Sites

Transforming Remote Monitoring with Advanced Analytics

Digital Twins for the Energy Transition

InTech
DIGITAL MAGAZINE

JUNE 2024

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Wireless communications and remote asset management are the themes of this issue of *InTech* digital magazine, the official publication of the International Society of Automation (ISA). Written for engineers, managers, and other automation decision-makers, *InTech* serves ISA members and the wider automation community with practical, in-depth coverage of automation technologies, applications, and strategies that help automation professionals succeed.

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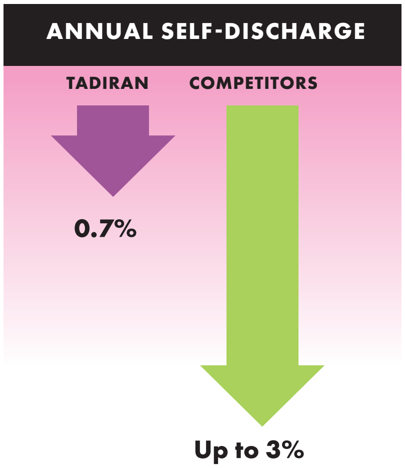

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Remote Asset Management in the Extreme

By Renee Bassett, *InTech* Chief Editor

Remote asset management—the monitoring, control and maintenance of machines or equipment without using a physical wired connection—may be the single most important collection of industrial wireless applications. Secure remote operations address many industrial challenges, from lack of technical personnel to inhospitable/inaccessible areas to 24/7 lights-out production. Underlying these operations are interconnected and layered wireless technologies creating systems of systems.

This June issue of *InTech* digital magazine focuses on wireless communications, from the technologies that enable it to the applications made better by it. We're also taking inspiration from the maritime industry to explore remote asset management there and its lessons for industrial operations.

Open, standards-based wireless networks, such as those supported by ISA100.11a and *Wireless*HART, provide secure, reliable, and scalable communications for industrial applications. Along with private 5G cellular and other technologies, wireless networks enable remote monitoring, control, maintenance, asset tracking, workforce safety, and improved plant efficiency.

Providers of global satellite connectivity and shipboard communications are meeting the needs of extremely remote communications. From lunar rovers to arctic cargo vessels to luxury superyachts, their wireless communication systems are supporting the business and operational needs of assets with always-on connectivity—from anywhere on Earth regardless of environmental conditions.

AST Networks worked with a UK-based crew transfer vessel company providing support to offshore windfarms. The company wanted a communications system and onboard connectivity solution that would improve security and empower the crew and offshore teams with onboard Internet connectivity. AST Networks engineers crafted a secure, custom, onboard solution for dual service: business-Internet access and crew Wi-Fi access.

Each vessel now benefits from a firewall and router that secure the traffic passing between the satellite and all connected devices. These filter and block certain applications to protect against security risks or breaches and ensure continuous communications. Voice over Internet (VOIP) phones enable business communications and an onboard switch connects to additional devices as needed.

While satellite communication is useful for open ocean coverage, 5G cellular technology provides connectivity near coastlines and ports through hybrid connectivity solutions that combine satellite links with fiber optics, microwave links or terrestrial cellular networks. This explosion of wireless technology is meeting the needs of industry by providing improved performance, greater security, lower latency and higher bandwidths, which enables remote asset management in the extreme.

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ISA100 Wireless Moves Forward

By Jack Smith

Wireless communication facilitates better data analytics, decreased downtime and more—with ISA100 often the best option for industrial applications.

As reported in the August 2023 issue of *InTech*, the first global end user to use ISA100 wireless technology for real-time oil-field monitoring was Romania-based OMV Petrom, the largest oil and gas producer in Southeast Europe. The project proved interoperability among ISA100 wireless certified devices from multiple technology providers, and it showed how a company could further its digitalization and production goals with an ISA100 wireless network and instrumentation. Interoperability among the instruments was of vital importance, as was cybersecurity.

OMV Petrom chose ISA100 wireless over other Industrial Internet of Things (IIoT) technologies because it not only met, but exceeded, the requirements for oil field real-time monitoring. Part of the reason is because ISA100 wireless is the only IIoT standards-based solution that can cover a large geographic area using a single wireless mesh, IPv6-addressable network. But industrial plants around the world are choosing ISA100 wireless for other reasons as well. The technology continues to evolve, and certified suppliers are furthering its reach and usefulness with new applications and devices.

In addition, wireless applications are not only trusted but sought after.

"ISA100 can be an important driver for Industry 4.0 and [for] getting stranded data from the edge to main systems. It also gives operators an easy and flexible way of increasing their flexibility to absorb changes in the future," said Ådne Baer-Olsen, global business development lead for wireless safety at Dräger, one of the world's largest suppliers of fixed fire and gas detection solutions. "Using wireless gas detection—the application we use ISA100 for—helps [our customers] increase their onsite safety without having to compromise on cost."

Flint Hills Resources (FHR), another ISA100 wireless user, operates a couple of large refineries, and chemical and fertilizer plants. Robert Boyer, wireless systems administrator at FHR, said, "We use wireless technology for machine learning, stranded data, analytics, and more."

FHR also has a large installation of *Wireless*HART and LoRa devices. It has used ISA100 technology for about 12 years and the other wireless protocols for about 18 years. According to Boyer, data analytics and decreased downtime are definitely at the top of the list of what wireless technology can help FHR accomplish, "but the real end goal is more autonomous operations and fewer shifts."

ISA100 evolves

ISA100 wireless, also known as international standard ANSI/ISA-100.11a-2011 (IEC 62743), is a plant-wide wireless infrastructure technology for industrial environments. Its development was led by the International Society of Automation and sprang from a 2002 DOE study revealing the potential benefits of open, standards-based wireless applications at industrial sites.

ISA100 wireless helps make the industrial Internet of Things (IIoT) a reality by being the only industrial wireless protocol to incorporate IPv6 directly as part of its network layer and transport layer. IPv6, which stands for Internet Protocol Version 6, helps to identify and locate devices on the network.

As of 18 August 2023, the next generation of ISA100 wireless field devices began supporting Bluetooth Low Energy (BLE) as a second radio while the established ISA-100 (IEC 62734) protocol could continue to be used for field reporting. BLE enables provisioning and commissioning of ISA100 wireless field devices by Bluetooth-enabled handhelds, particularly mobile phones.

In addition, ISA100 wireless gateways are also adopting a new OPC-UA data model, based on the PA-DIM specification. Developers will be able to build a single set of applications that work end-to-end with all ISA100 wireless systems using the OPC-UA model. These ISA100 wireless enhancements will improve interoperability and the overall user experience.

Certifying for interoperability

The ISA100 Wireless Compliance Institute (WCI) is the body that brings together users, suppliers, and other stakeholders to support adoption of the ISA100 wireless standard. WCI also ensures interoperability of ISA100 wireless devices and systems by:

- conducting independent testing of ISA100 wireless devices and systems
- certifying that ISA100 wireless devices and systems meet specifications
- providing education, tools, and technical support to users and suppliers.

Lists of certified ISA100 wireless devices and suppliers can be found on the ISA100 Wireless Compliance Institute (WCI) website. Dräger has provided products using ISA100 for more than 10 years. (The company also uses both *Wireless*HART and LoRa wireless communications, but only for monitoring.) "Our ISA100 safe wireless is the only safety-performance-certified wireless solution in the market, giving us a large advantage compared to our competitors," said Baer-Olsen.

Yokogawa has been involved in the development of the ISA100 standard from the beginning and today provides multiple types of ISA100-compliant products (Figure 1). These include field devices such as temperature, pressure, flow, level, and other transmitters; wireless adapters that can convert analog signals to ISA100 wireless; and gateways and access points. In addition, Yokogawa has developed a unique product

Figure 1. ISA100 wireless technology can be found in a wide variety of products certified to be compliant.
Courtesy: Yokogawa

with a wireless module inside of an antenna, helping minimize the lead time and complexity for ISA100 wireless product development and implementation.

Toshi Hasegawa, senior expert, Marketing Headquarters External Affairs and Marketing Technology Center, for Yokogawa Corporation explained how ISA100 supports both developers and users: “ISA100 wireless is constantly being updated and improved to keep up with the latest technology developments, and it is expanding its application portfolio together with ISA100 WCI member companies.”

ISA100 WCI is developing OPC-UA implementation specifications as a higher-level interface for ISA100 wireless gateway products, supporting more open and secure connectivity. Working with ISA100 WCI member companies, Yokogawa and others can provide multi-vendor solutions with interoperability, allowing customers to choose best-in-class equipment to meet different needs.

Hasegawa said Yokogawa, for example, is:

- Supporting sustainable plant operations by reducing energy losses through monitoring of numerous steam traps on

ISA100 Wireless Training and Other Resources

The need to understand how to use and implement ISA100 differs with each company. Luckily, the ISA100 Wireless Compliance Institute (WCI) has a wealth of resources: webinars, training classes, certified consultants, and more. “The Complete Brochure” is more than 100 pages of explanations, implementation procedures, case studies and device descriptions for end users and developers.

“For end users,” Hasegawa said, “ISA100 WCI-sponsored webinars showcase wireless application success stories. These webinars provide tips for deploying wireless technology in their own plants or factories. Also, ISA100 WCI has organized face-to-face training events to introduce ISA100 wireless from basics to their applications for end users.”

Boyer said FHR’s training and resource requirements are focused on instrument techs for installation purposes. “We typically learn on our own using vender data sheets and information,” he said.

Baer-Olsen said that Dräger has the need for its R&D team, product management, engineering teams, and service engineers to be educated on ISA100 and that his company will have internal training classes.

Interested end users or suppliers should consider becoming a member of the WCI or joining the ISA100 Standards Committee to further work on the standard and its implementation.

steam pipelines. ISA100 wireless supports numerous device connections and flexible network configurations.

- Ensuring safe and secure plant operations through gas leak detection sensors. ISA100 wireless provides deterministic response and redundant communication with Duo-cast (a redundancy technology for the wireless path specified in the ISA100.11a standard) for these and other critical applications.
- Reducing downtime and minimizing required maintenance by detecting and analyzing abnormalities proactively in motors and pumps with vibration sensors.

"Recently, one ISA100 WCI member company released its ISA100 wireless valve actuator control product in Japan, which can support business continuity plan measures for mission-critical pipelines as a backup for wired valve actuators. This is a new type of application for ISA100 wireless, and there are many other possibilities," Hasegawa said.

Alternatives to ISA100

ISA100 is not the only wireless technology being adopted by industry. No single wireless technology performs best across all dimensions because there are some design tradeoff limitations among transmission data rate, transmission range, battery life (power consumption), and other factors, according to Hasegawa.

"That's why even the widely available wireless technologies—such as Wi-Fi; Bluetooth; low-power, wide-area (LPWA); and cellular—are designed for specific target applications since there is not a one-size-fits-all solution due to tradeoffs," Hasegawa said.

"The ISA100 wireless standard was developed with end users to provide a good balance among each of the three main tradeoffs previously listed for specific target application requirements in the process automation industry," Hasegawa explained. "So far, we cannot see any alternatives to ISA100 wireless to meet our customer requirements—such as redundancy, flexible network design (mesh/star/hybrid topology), openness (IP-based), strong security measure, long battery life, SIL2 compliance, and other factors—for mission-critical applications in the process automation industry."

Dräger and FHR are using both *Wireless*HART and LoRa for purposes that match their capabilities, but it's ISA100 wireless technology that does the heavy lifting for both these companies and many others.

Although ISA100 is just one interoperable choice among a few wireless approaches, according to Hasegawa, end users should choose ISA100 wireless products due to their multi-vendor interoperability for process monitoring, device diagnostics, environmental monitoring and safety, as well as for the productivity, efficiency, and maintenance benefits of wireless technology overall.

How the ISA100 standard might evolve

The WCI and its member suppliers and end users are continually working to improve ISA100 wireless. FHR's Boyer said that providing feedback to vendors to further their product lines is one way to build on the

ISA100 standard. Dräger's Baer-Olsen said, "I would consider lifting it [the ISA100 standard] from the constraints of 2.4 GHz and see if we could use it on different frequencies to give us other profiles and possibilities."

Hasegawa said that for equipment vendors, using the WCI ISA100 Wireless Rapid Development Kit is an effective shortcut to developing ISA100 wireless-compliant products. ISA100 WCI provides technical support through its webinars, which explain how to develop an ISA100 wireless product. Also, ISA100 WCI provides certification services to assure multivendor interoperability.

ABOUT THE AUTHOR

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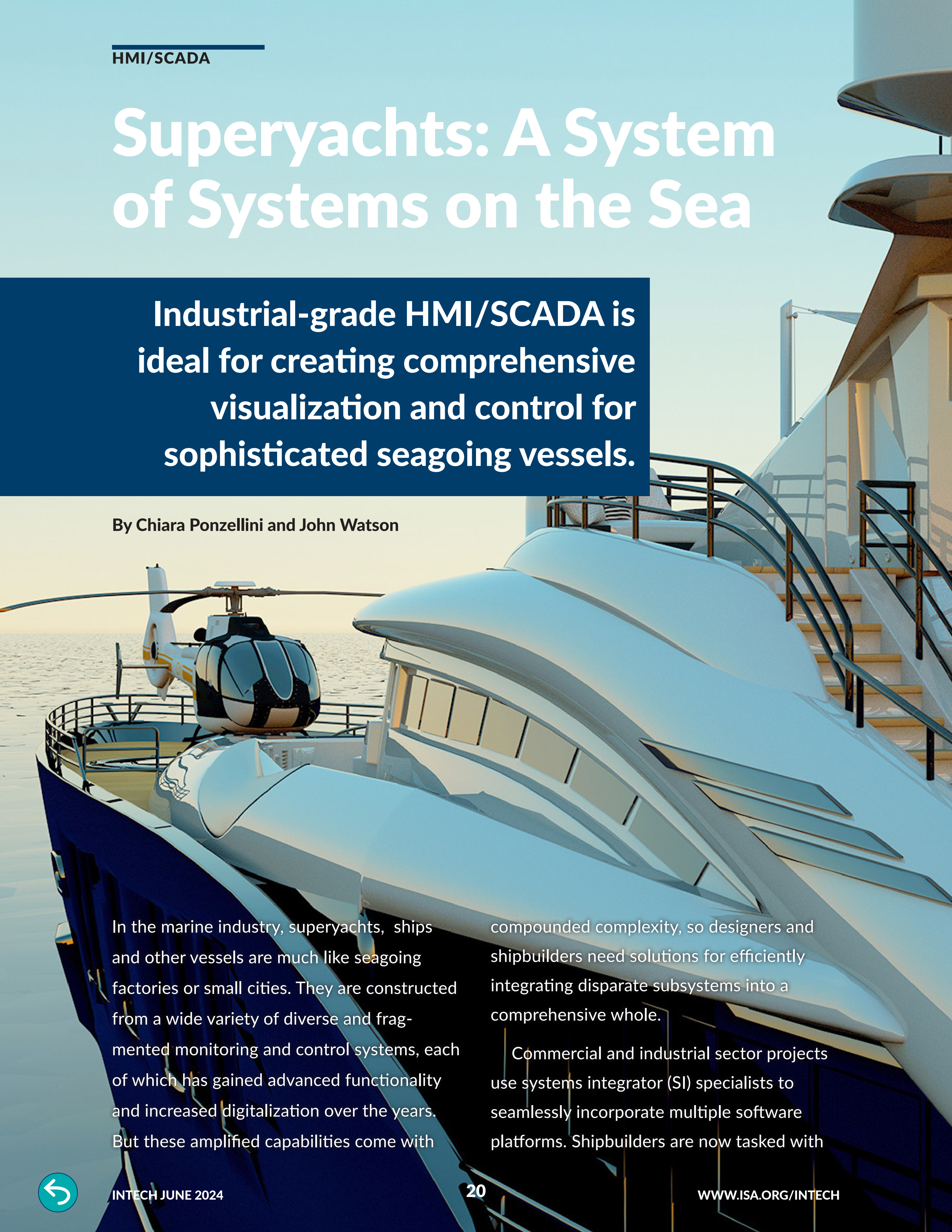

Superyachts: A System of Systems on the Sea

Industrial-grade HMI/SCADA is ideal for creating comprehensive visualization and control for sophisticated seagoing vessels.

By Chiara Ponzellini and John Watson

In the marine industry, superyachts, ships and other vessels are much like seagoing factories or small cities. They are constructed from a wide variety of diverse and fragmented monitoring and control systems, each of which has gained advanced functionality and increased digitalization over the years. But these amplified capabilities come with compounded complexity, so designers and shipbuilders need solutions for efficiently integrating disparate subsystems into a comprehensive whole.

Commercial and industrial sector projects use systems integrator (SI) specialists to seamlessly incorporate multiple software platforms. Shipbuilders are now tasked with doing the same thing, instead of providing multiple parallel and unique interfaces. Lessons can be learned from the harsh environments, control and communication aspects, and visualization needs of maritime vessels. And it might just be pleasing to ponder the comparisons.

Working with major shipbuilder customers, one industrial supplier tailored its industrial human-machine interface (HMI) and supervisory control and data acquisition (SCADA) offerings for this demanding application.

A system of systems

Any large ship is much more than a hull, an engine, a propeller, and a rudder. There are a wide range of subsystems, all important and some critical (Figure 1). These include:

- Engine control (engines will come with specific controls, but it may be necessary to integrate these with a supervisory monitoring system)
- Auxiliary control (thrusters, winches, anchors)
- Electrical power (generation and distribution)
- Machine and other utility control (desalination, water heater, pool)
- Liquid pumping (fuel, ballast, fresh water, waste handling)
- Smoke/fire systems (monitor and alarm)
- Intercoms and other communications
- Environmental control (HVAC, lighting, CCTV, audio/entertainment).

Not only are there a lot of different things going on at once, but each subsystem has

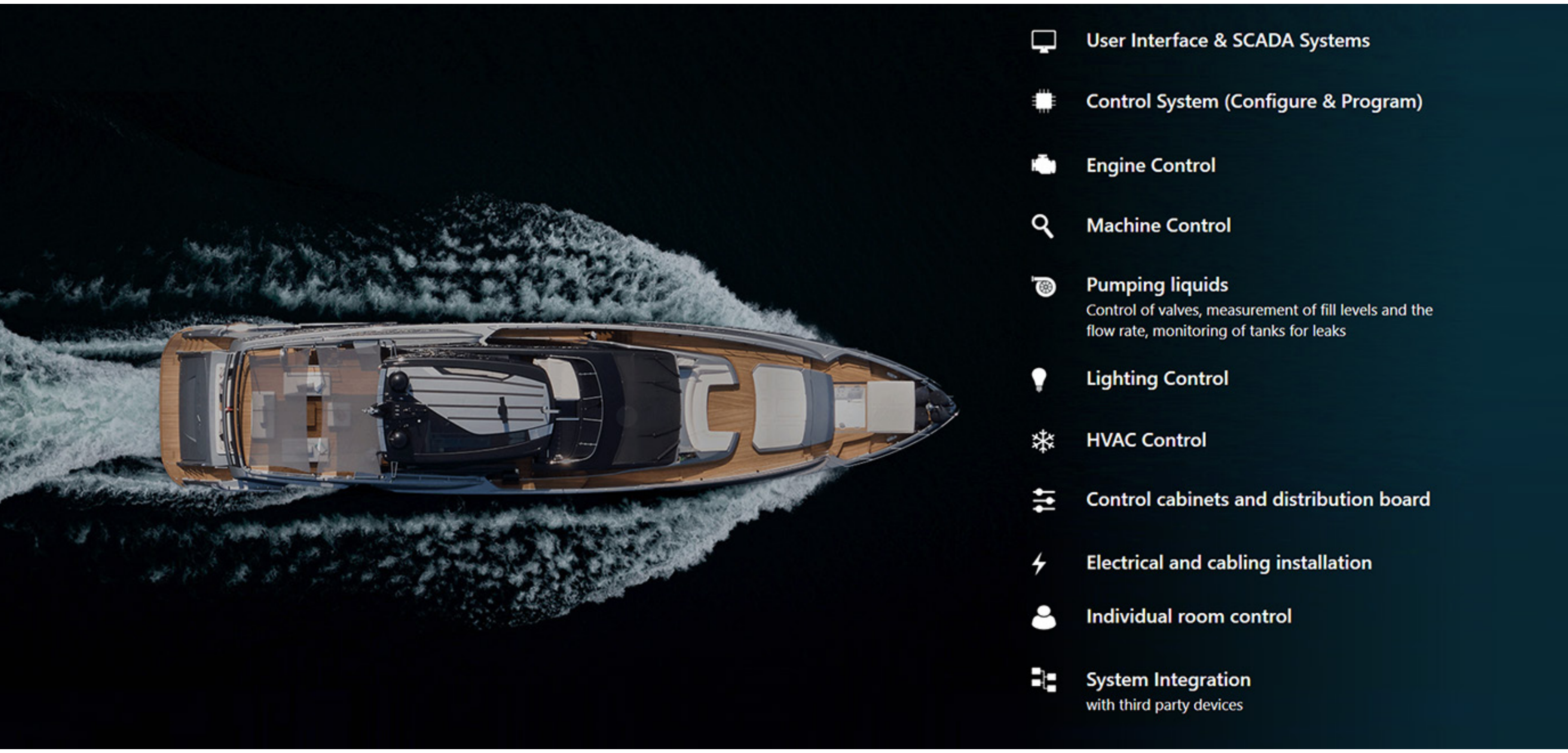

Figure 1. Modern superyachts must integrate a wide variety of critical and auxiliary digitally enabled subsystems so its HMI/SCADA system must support comprehensive communications, computing, control, and visualization.

very unique monitoring and control requirements, and each is likely based on technologies that are dissimilar to other systems, or even proprietary.

With so many fragmented subsystems, integration efforts to achieve basic centralized monitoring is often inefficient. At the very least, this leads to an inconsistent look/feel for user interfaces. In the worst case possible, there could be mistakes during critical interactions, such as dropping anchor. Users may also be hampered by inadequate alarm management and a lack of historical data needed for analysis.

At a bare minimum, any type of centralized HMI/SCADA needs to communicate with each shipboard subsystem to obtain data, visualize it, and log it. While some subsystems may accept remote control commands from HMI/SCADA, the most critical subsystems (direct engine controls, navigation/charting) would need to preserve their independence to a great degree because they are provided by highly specialized suppliers that are domain experts in these areas.

Tough enough for the high seas

Because superyachts and ships share many characteristics with factories, it makes sense that an HMI/SCADA hardware and software platform, built to handle the rigors of industrial-grade production facilities, would be robust enough for shipboard monitoring and control (Figure 2).

Here are just a few of the core competencies an industrial HMI/SCADA platform must deliver to meet essential shipboard requirements.

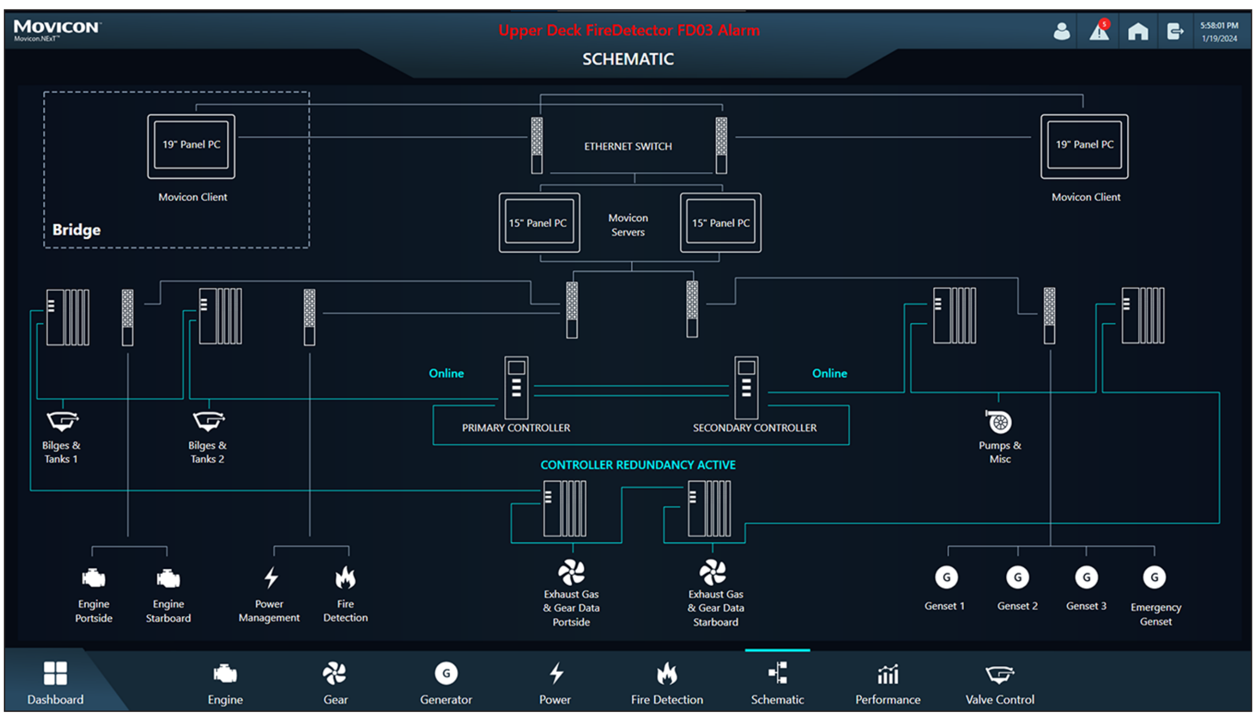

Figure 2. Running on redundantly installed edge controllers and industrial panel PCs, systems like Emerson's PACSystems Movicon HMI/SCADA platform provide an industrial-grade architecture suited for reliable operation for shipboard monitoring and control.

Connectivity and security. In an industrial plant, the operational technology (OT) domain includes all the instruments, devices, and subsystems throughout a production area, while the information technology (IT) area consists of the higher-level controllers and PCs gathering and using data. Each area depends on a variety of specialized communications protocols—OT protocols generally require determinism but lower bandwidth, while IT protocols must accommodate higher throughput and can tolerate slight delays.

The OT/IT concept is similar on a ship. An HMI/SCADA architecture must incorporate all common OT protocols, and even be capable of adapting to specialized marine industry protocols so it can communicate with any conceivable shipboard system. It also needs IT protocols suitable for transmitting greater volumes of data amongst PCs for historizing, alarming, and visualization.

Communications security is an obvious concern for any modern production plant which could be internet-connected, but satellites and other means make it equally possible for shipboard systems to be remotely accessed. Therefore, designers should specify shipboard HMI/SCADA solutions with IEC 62443-3-3 certification, just as with industrial systems.

Redundancy. For any industrial or shipboard HMI/SCADA system, redundancy at all implementation levels is essential to provide resiliency for ensuring continued operation in the event of failures. Redundant edge controllers should be capable of working with a self-healing PROFINET ring for accessing remote I/O from devices. Redundant OT network switches and ring networks preserve uninterrupted communications amongst edge controllers and other Ethernet-capable shipboard systems, while redundant IT network switches and ring networks do the same for HMI/SCADA redundant servers and remote panel PCs.

Computing. A complete HMI/SCADA solution encompasses more computing than just what is needed for visualization. Programmable logic controllers (PLCs) and Linux-based edge controllers are best suited for installing close to shipboard equipment. Redundant servers host the HMI/SCADA core application and handle centralized data logging, alarming, and analytics. Most users will interact with the HMI/SCADA via industrial panel PCs, each of which can be remotely located on the bridge and other essential locations as needed to provide a rich variety of graphical interfaces.

Single pane of glass possibilities

To enable the most effective user interaction and visualization with digital systems, many modern transportation systems—such as planes, trains, automobiles, and even the SpaceX Dragon crew capsule—have shifted away from numerous individual specialized control interfaces. Instead, they now use a consolidated single pane of glass interface approach, where multiple systems are depicted on a unified digital display.

The auto industry in particular is an example of where this has been very prominent. Some new cars have almost no physical buttons, and just a few displays to represent the vehicle status, and to control the HVAC, accessories, and entertainment subsystems. Apple CarPlay and Android Auto are further examples of standardized HMI/SCADA interfaces integrated into autos for streamlined connectivity with almost any type of personal mobile device.

In fact, the dashboard of a car is a good metaphor for the type of interface a ship needs. As with a person using a car, the crew on a ship should have ready access to essential information, along with the capability to dive into deeper details as needed (Figure 3).

The following outline represents a hierarchy of the types of visualization and integration functionality:

- Dashboard provides overview of all systems
- Engine Room
  - Propulsion (engine, exhaust gas, and gear data)
  - Diesel generator and electrical power management
  - Valve controls and tank volumes
  - Schematics and performance indicators
  - Fire detection
- Bridge
  - Exterior/navigation lighting
  - Interior lighting
  - Marex control head (propulsion controls)
  - Tank volumes
  - CCTV
  - HVAC
  - Pool
- General
  - Alarms
  - Data logging

Marine designers can accelerate and standardize their efforts by using as a starting point for implementing their specific requirements.

Applications set sail

Here are two examples of industrial-grade HMI/SCADA hardware and software applications for marine use developed using Movicon.NExT from Emerson.

Figure 3. These HMI/SCADA dashboards and displays are developed as templates to provide a quick start for marine designers.

One marine contractor already had an established vessel dynamic positioning system (DPS) for use on a floating production storage and offloading vessel, but the system did not quickly dispatch alarms or provide an overview of functionality. By supplementing their existing subsystems with Movicon.NExT, alarms were rapidly transmitted, leading to improved data displays and physical safety.

A redundant architecture with two servers and four clients prevents interruptions and downtime. This high-performance HMI/SCADA improved the accuracy of vessel positioning during transfers, enhancing response time and decision-making based on the increased visibility, which in turn throughput, reliability, and profitability.

In a second case, a marine industry systems integrator realized that technology integration for superyacht projects was often characterized by inflexible products and high costs. Therefore, they set out to create a comprehensive and cost-effective solution that would be easily usable, even by a small crew. By basing their design on Movicon. NExT, they were able to reduce the time, cost, and complexity for developing marine automation applications due to the use of a standardized and proven platform.

The resulting system is now used on 100+ vessels as a standard automation and visualization solution. End users benefit from simplified operation due to the integration of a wide range of highly disparate systems into a single interface. Builders realized decreased costs and complexity by reducing electrical cabling due to improved OT and IT network connectivity.

Modern HMI/SCADA platforms designed to be tough and capable enough for industrial use are often the best solution for integrating the wide range of digital systems found on today's superyachts and ships. Such comprehensive and robust visualization solutions can consolidate vessel operations into a single, effective interface.

All figures are supplied by Emerson Discrete Automation.

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Wireless Lessons from Construction Sites

NIST research on private 5G service classes can help tailor next-generation wireless networks to industry needs.

By Richard Candell, Mohamed Kashef (Hany), Jing Geng, and Karl Montgomery

Construction sites, especially industrial or commercial construction, can be highly dynamic environments characterized by heavy machinery, tools, and people in constant motion. Activities within the construction environment must be coordinated and monitored to efficiently achieve daily goals, monitor the health of equipment, monitor the ambient environment, and assure the safety of the people working within the construction environment. As with the industrial plants that will ultimately be built, reliable and rapid wireless communication is a key requirement for construction sites and the 5G network is a lead contender in supporting its mix of applications. Exploring private 5G service classes enriches our understanding of tailoring next-generation wireless communications networks to industry needs.

At the Communications Technology Laboratory of the National Institute of Standards and Technology (NIST) in Gaithersburg, MD, USA, we've been addressing the challenges of integrating 5G networks and exploring ways to test and predict wireless network performance in dynamic environments. This is an excerpt of our recently published whitepaper in which we explore deploying wireless communication networks within construction projects, introduce a comparison approach to assessing deployment difficulty at each project phase, and discuss our plans for a testbed for 5G communications that can help shape the future of wireless communications.

Physical environment considerations

During our investigation, we discovered that the key elements affecting the viability of a construction network and simplified them to three principal considerations relating to the physical environment:

- the geometry of the work zone,
- the number and materials of the walls being constructed, and
- the types of materials used to construct floors and ceilings.

Much research has been undertaken to characterize the propagation characteristics of construction spaces primarily focusing on the finished industrial spaces. While it is important to understand all of the impacting factors of a work zone, we must be careful to capture the factors such that they minimally overlap in their impacts on wireless system performance. This approach is synonymous with maintaining the linear independence of variables in a system of linear equations, and we attempt to maintain this independence throughout this work.

We should also note that the focus so far has been on the physical environment, yet construction has other factors that can otherwise degrade the performance of the construction network such as radio frequency interference from welding, unshielded power electronics, and co-existing network traffic. Additionally, the impact attributes for each scenario were assigned a value for three stages of construction: Early-Stage, Mid-Stage, and Late-Stage.

5G service categories

Exploring 5G service classes for construction enriches our understanding of tailoring next-generation wireless communications networks to industry needs. Why consider 5G at all? Its versatile wireless technology accommodates diverse communication needs and deployment structures, making it suitable for various construction applications. While other wireless solutions are viable, we opt for 5G stand-alone (SA) private networks for several reasons:

- Firstly, 5G's built-in determinism, leveraging time and frequency diversity supports channel resource allocation. Spatial diversity is enhanced with multiple-input multiple-output (MIMO) antennas, including massive MIMO systems for optimal device support and beam directionality, ensuring a higher quality of service.
- Secondly, 5G offers quality of service (QoS) support and flexibility in enforcing reliability policies through different service classes and network slicing.
- Additionally, it supports licensed and unlicensed deployment options, expanding available RF bands, and is progressing

towards supporting various industrial protocols for improved interoperability in automation systems.

There are three main 5G service categories: enhanced mobile broadband (eMBB), massive machine type communication (mMTC), and ultra-reliable low-latency communication (URLLC). A new service class, reduced capability (RedCap) is emerging that offers reduced capabilities compared to that of URLLC class with less stringent latency and reliability requirements. This makes it more cost-effective and energy efficient.

URLLC, with 1 ms latency and reliability exceeding 99.999%, is particularly relevant for construction applications. However, considering cost and battery life, RedCap may become a preferred choice for some applications. URLLC achieves low latency by allowing transmissions to interrupt lower-priority ones through the mini-slot concept and periodic grant-free transmission. URLLC can support connectivity for automated guided vehicles, mobile robots, teleoperated heavy machinery, and safety equipment in various construction scenarios.

The eMBB category, with peak data rates up to 10 Gbit/s, benefits high-data-rate applications like augmented reality and remote operation video feedback. The mMTC category, with a node density of up to 100 nodes/m2, is suitable for massive wireless sensor networks, site 11 asset management, and various monitoring applications.

A 5G network is not confined to a specific service category, as these categories represent network performance limits from different perspectives. Generally, a 5G implementation can meet specific communication demands through QoS guarantees enforced by the user plane function (UPF) in the 5G core network.

Specific capabilities introduced for industrial wireless support in 5G include 5G-time-sensitive networking (TSN) integration and OPC UA support.

5G Enabling Capabilities

Various 5G releases offer capabilities to meet diverse service category demands, including those vital for construction communication networks. Key features such as network slicing, QoS support, software-defined networking (SDN), and network function virtualization (NFV) enable dynamic resource allocation and separation of user and control plane functions. Network slices, tailored to specific QoS requirements, span core network to radio access network (RAN) domains, while multi-access edge computing (MEC) places computing resources closer to the RAN and within construction sites for low-latency applications.

Specific capabilities introduced for industrial wireless support in 5G include

5G-time-sensitive networking (TSN) integration and Open Platform Communications Unified Architecture (OPC UA) support. In release 18, 5G-TSN integration achieved centralized TSN implementation, ensuring time synchronization and timely data delivery through traffic shaping and scheduling. The generic precision time protocol (gPTP) facilitates time synchronization between nodes.

Additionally, OPC UA (IEC 62541-1) standardizes data communications in industrial automation, enabling vendor-neutral interoperability. Integrating 5G with OPC UA allows construction applications to operate over 5G, facilitating coexistence and communication with legacy systems. Interaction with OPC UA devices can occur through TSN middleware or directly via the network exposure function (NEF) introduced in release-16.

5G uses cases in construction

Many 5G use cases in the construction industry are being considered at other industrial sites and each makes use of specific 5G service categories described in our paper. As shown at the top of Figure 1, streaming video would utilize the eMBB service category. Streaming video enables situational awareness of construction activities as well as security monitoring of the work zone. Additionally, streaming video has become an essential part of the teleoperation of machinery and drone-based inspection. Streaming video is,

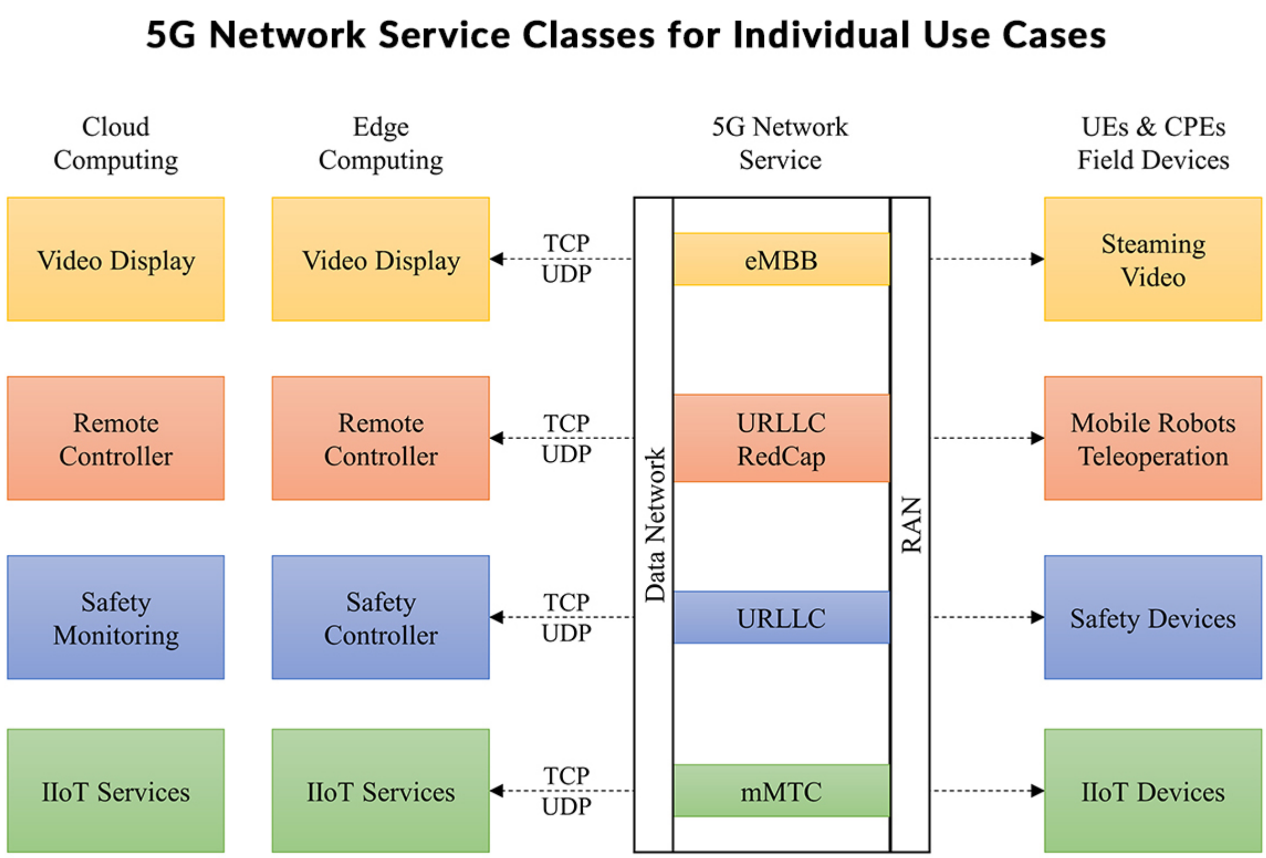


Figure 1. Individual 5G use cases employ specific 5G service categories, often simultaneously.

therefore, an essential component of most, if not all, construction projects.

Streaming high-definition (HD) video at a rate of 60 frames per second equates to a minimum of 5 Mbps with a peak bit rate of 10 Mbps. The high video quality may seem excessive, but it's likely necessary for teleoperating heavy machinery around people in the work zone and for drone-based inspections. Furthermore, several of these activities operating concurrently would have a multiplying effect on the 5G system.

Teleoperation and mobile robotic platforms, apart from video-based observation, require a service category that guarantees latency and reliability targets. As an example, teleoperation requires that control messages reach the vehicle being controlled by recurring deadlines on the scale of milliseconds. Every type of remotely operated machine is different, therefore, the service category may be either URLLC or RedCap.

A teleoperated front loader requires the ability to move forward, and backward, turn left and right, raise and lower its bucket, and control the orientation of its front, rear, and side cameras. A heavy-grade mobile manipulator would need similar control mechanisms and more degrees of freedom to control its end-effector. Additionally, haptic and audible feedback which are also latency and reliability sensitive are required as these signals provide important sensory feedback to the remote driver.

Safety mechanisms such as fall detection, emergency stops, alarms, or the ability to stop or slow a nearby vehicle while a human is crossing in its path in a loud and confusing environment require strict latency and reliability requirements. Hence, the URLLC service category is indicated. It is expected that actual safety execution be controlled at the edge, at the construction site itself, to minimize latency concerns. General safety conditions could be monitored remotely through the cloud.

Streaming video enables situational awareness of construction activities, security monitoring, the teleoperation of machinery, and drone-based inspection. Several of these activities operating concurrently would have a multiplying effect on the 5G system.

Machine and environmental condition monitoring through Industrial Internet of Things (IIoT) devices indicates the use of the mMTC service category. The mMTC service category was specified in the 5G standard to support IIoT use cases such as environment sensing and machine health monitoring. Generally, within a construction site, mMTC would be used to monitor environmental conditions within and around the structure being built and the machines that are being used and left on-site. Depending on the scenario, the mMTC use cases could scale from a few to hundreds of sensors.

Given these use cases and the requirements for each, one must also consider that the use cases would exist concurrently such that video, teleoperation, safety, and monitoring would be operating simultaneously. The deployment architecture, type of service provider, and RF band or bands should be selected carefully to support the requirements of the construction project. The requirements of each scenario would then determine if a 5G private network could be deployed locally, a large service provider would need to be employed, or a combination of both. We recommend that the selection of deployment architectures be an area of study for construction activities.

5G Testbed for Construction

To enhance our understanding and practical application of expertise in 5G construction environments, we conducted a literature review for applicable testbeds and channel measurements. Despite finding various experiments on 5G propagation in indoor and outdoor settings, we did not identify a suitable 5G testbed specifically designed for construction environments.

The literature highlighted limitations in current wireless communication capabilities in construction, and discussed the need for 5G applications in construction. Given the lack of comprehensive coverage for construction scenarios, we recommend and plan to develop a dedicated 5G testbed for researching construction-specific concerns.

Unlike conducting wireless network tests directly in an actual construction environment, our testbed would offer enhanced flexibility for system validation and testing. It allows emulation of real-world environments without affecting operational settings, easily adapts to diverse use cases, and provides more accurate results than simulations.

The testbed includes 5G system hardware, various 5G-compatible user equipment (UEs) from different vendors, PCs, industrial collaborative robotic manipulators, and networking devices. Our current focus is establishing a remote operation control scenario with different IIoT traffic and interference, a common use case in construction.

More about the design of the testbed can be found in our whitepaper.

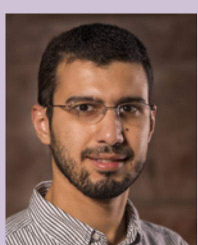
Looking ahead

The advancement of wireless communications in the construction industry presents a myriad of exciting research opportunities that can shape the future of infrastructure development. These research opportunities offer a road map for research engineers and industry practitioners to collaborate and contribute to the evolution of wireless communication technologies tailored to the unique demands of construction and industry.

Our whitepaper addresses complex wireless communication challenges in the construction industry and provides a way forward for further research and development. It introduces a systematic scoring system to assess wireless connectivity difficulty throughout construction phases, incorporating a comprehensive set of attributes. We also present a novel testbed design for deploying and exploring strategies in a simulated construction environment.

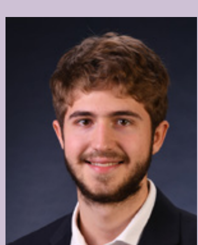
ABOUT THE AUTHOR

Dr. Richard Candell has over 20 years of experience in the design and evaluation of wireless communications systems for commercial and defense applications. He joined the National Institute of Standards and Technology (NIST) in the US in 2014 where he leads the Industrial Wireless Systems research laboratory. Previously, he served as the lead systems engineer in developing spread spectrum interference cancellation and performance evaluation strategies for satellite ground stations and mobile phased array transceivers, and holds patents in successive interference cancellation and transmission burst detection applied to spread-spectrum satellite communications signals. He holds a Ph.D. in Computer Science from the University of Burgundy, Dijon, France and BS and MS degrees in electrical engineering from the University of Memphis. Dr Candell was the primary contributing author of the Guide to Industrial Wireless Systems Deployments (NIST AMS 300-4) and he serves as the Chair of the IEEE P3388 Wireless Performance Assessment and Measurement Working Group and the NIST Industrial Wireless System technical interest group.

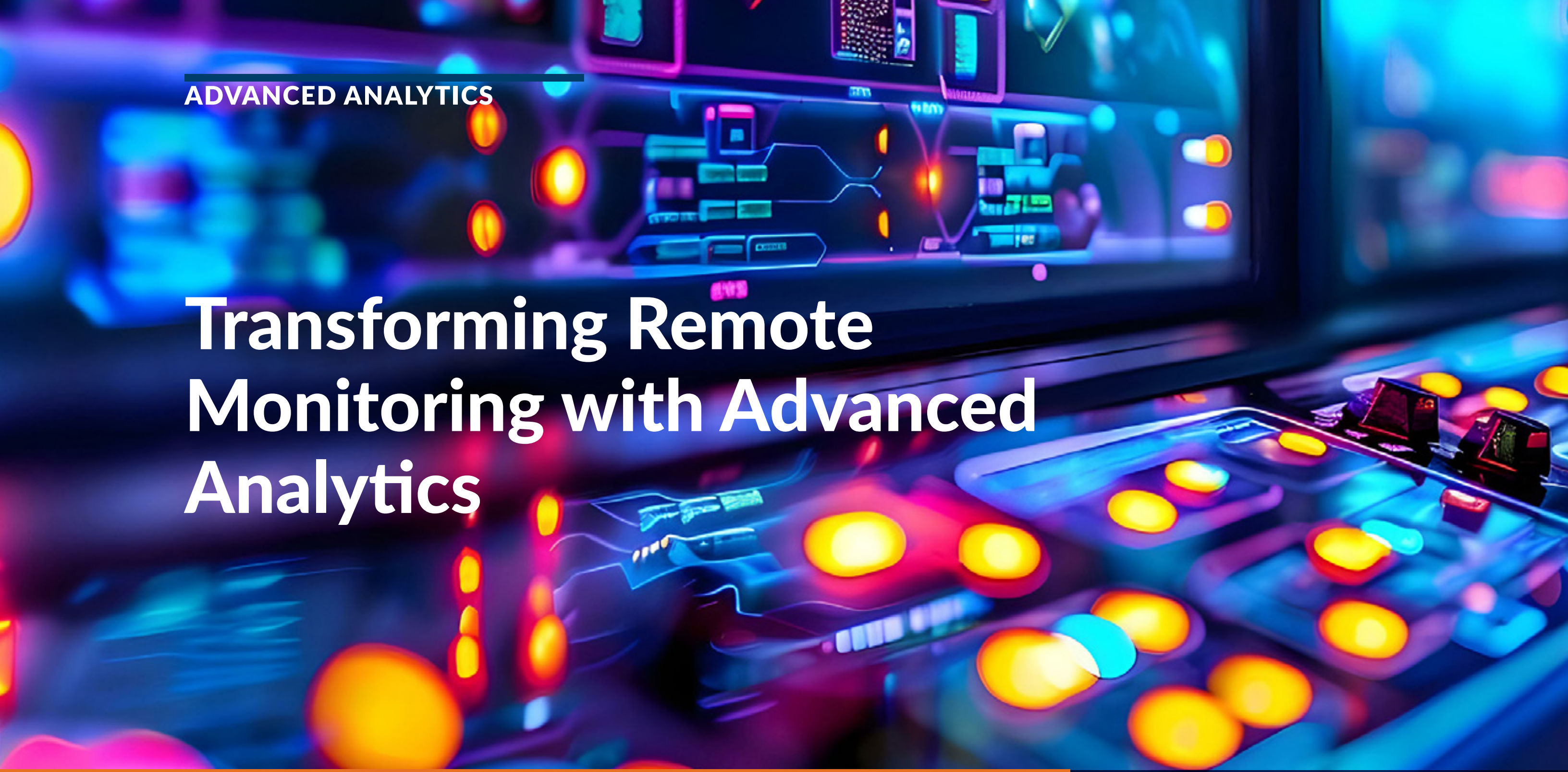


Mohamed Kashef (Hany) holds BS and M.S. degrees (with Hons.) in electronics and electrical communications engineering from the Cairo University and a PhD in electrical engineering from the University of Maryland. He is currently a Research Scientist at the National Institute of Standards and Technology (NIST) with a focus is on industrial wireless networks deployment, channel modeling, applying artificial intelligence for data analysis and test methods for industrial wireless networks.

Jing Geng received his BS degree in electrical engineering from National Taiwan University and his PhD in electrical and computer engineering from the University of Maryland at College Park. He is currently a research scientist in the Industrial Wireless System Lab at NIST working mainly on designing and constructing a 5G smart manufacturing testbed, and real-time wireless communication simulations for industrial networks.



Karl Montgomery is an electronics engineer in the Networked Control Systems Group at NIST. He has an M S in electrical and computer engineering from the Johns Hopkins Whiting School of Engineering, with a focus on communications and networking. At NIST, he performs research with wireless communications for typical industrial automation applications by conducting experiments using the NIST industrial wireless testbed.



Transforming Remote Monitoring with Advanced Analytics

Analytics are revealing hidden plant insights that drive operational efficiency and profitability.

By Kin How Chong

In the age of information, remote monitoring technologies offer countless benefits for manufacturers. Using data generated by sensors installed throughout industrial processes, engineers and operators glean valuable insights into real-time critical process parameters, equipment performance, and environmental conditions, helping teams optimize plant operations and reduce expenditures. Additionally, remote monitoring enables early detection of potential safety hazards, prompting plant personnel to act swiftly and prevent upsets.

With effective monitoring and centralized control at remote operations centers, subject matter experts (SMEs)—collectively process engineers and data scientists—can proactively keep tabs on every operational unit throughout the enterprise, minimizing unplanned downtime and equipment failures. However, there are challenges to implementing remote monitoring effectively.

Smart process surveillance

Today's manufacturers rely heavily on sensors and equipment that generate massive amounts of data. Complex petrochemical and refining operations, for example, require data collection and subsequent analysis from numerous geographically-dispersed sources, often in harsh environments, to ensure efficient and safe production.

Operational data is often housed in various locations—such as process historians, data lakes, and other databases—varying by equipment type and manufacturer. As a result, it can be difficult to standardize and deploy a centralized remote monitoring solution. This creates delays in identifying and addressing critical issues, which can impact production and pose safety risks.

Moreover, dispersed operations often lack the necessary software tools to analyze time-series data effectively. This creates the common industrial paradigm of "data-rich, information-poor," and despite significant investments in storage, the return on investment is minimal when data remains unused.

These issues are further compounded by the complexities of integrating many modern monitoring systems with existing legacy infrastructure, including:

- Challenges connecting the two systems, relying on outdated and unsupported communications protocols.
- The need to upgrade some legacy sensors for compatibility with the new monitoring software.
- High costs and time-consuming commissioning to align both systems.

Historically, extracting value from remote monitoring systems required specialized skillsets. In most cases, effectively deriving insights from data requires coordination between engineers—who understand the process operation—and data scientists, who are trained in coding. However, not all plant personnel possess the skillsets required to perform these tasks.

Unlock powerful insights

Advanced analytics platforms bridge the gap between skillset limitations and operational insights, providing extensive support for connecting to and extrapolating meaning from data spread among different locations, regardless of the format or structure. This is accomplished with alignment algorithms and protocols that ensure data consistency and accuracy.

Extensibility features allow users to operationalize custom calculations.

By automating data alignment and alleviating manual efforts, these software platforms provide significant advantages for remote monitoring, which frees up valuable SME resources and reduces the potential for human error.

Modern advanced analytics platforms offer a range of powerful tools for data contextualization, calculation, and asset scaling, facilitating extraction of valuable insights from consolidated data. These accessible platforms require no coding skills, empowering users to quickly become proficient in the software, even those with limited technical expertise.

Beyond ease of use, these platforms provide advanced features for complex analysis and calculations, including predictive analytics, machine learning, and statistical modeling. Additionally, extensibility features allow users to operationalize custom calculations, empowering them to not only analyze historical data, but to also predict future outcomes and optimize processes accordingly.

Better monitoring across industries

In recent years, industrial organizations are increasingly leveraging advanced analytics platforms to remotely monitor their operations. This approach is providing positive benefits in many industries, improving efficiency, reducing costs, and increasing profitability, as demonstrated in the following cases.

Improved furnace decoke performance. Decoking—the removal of coke deposits from the internal surfaces of furnaces and reactors—is a vital process for maintaining efficient and safe operations. Although it varies based on the furnace and on organizational practice, some of the most commonly monitored parameters include furnace temperature, furnace pressure, steam and gas flow rates, decoking duration, effluent composition, coke removal rates, and coke quality.

Poor decoking has several negative consequences, such as reduced heat transfer efficiency, which decreases furnace capacity and production rates. Additionally, lower performing furnaces result in higher energy consumption, requiring more fuel to reach optimal temperature and maintain target production rates. Poor decoking also causes frequent maintenance shutdowns, resulting in unplanned downtime and production schedule disruptions.

One global oil and gas company deployed Seeq, an advanced analytics platform, to closely monitor its decoke procedures, reducing engineering time spent creating dashboards by 20% and improving furnace decoke performance by 10%. The solution enabled engineers to:

- Establish conditions for each furnace decoke parameter and assign scores based on a stringent performance matrix, using tools in the software.
- Calculate overall decoke quality by synthesizing all scores.
- Visualize performance using built-in tools, such as Histogram, which incorporates an adjustable display range for viewing specific time periods of interest (Figure 1).

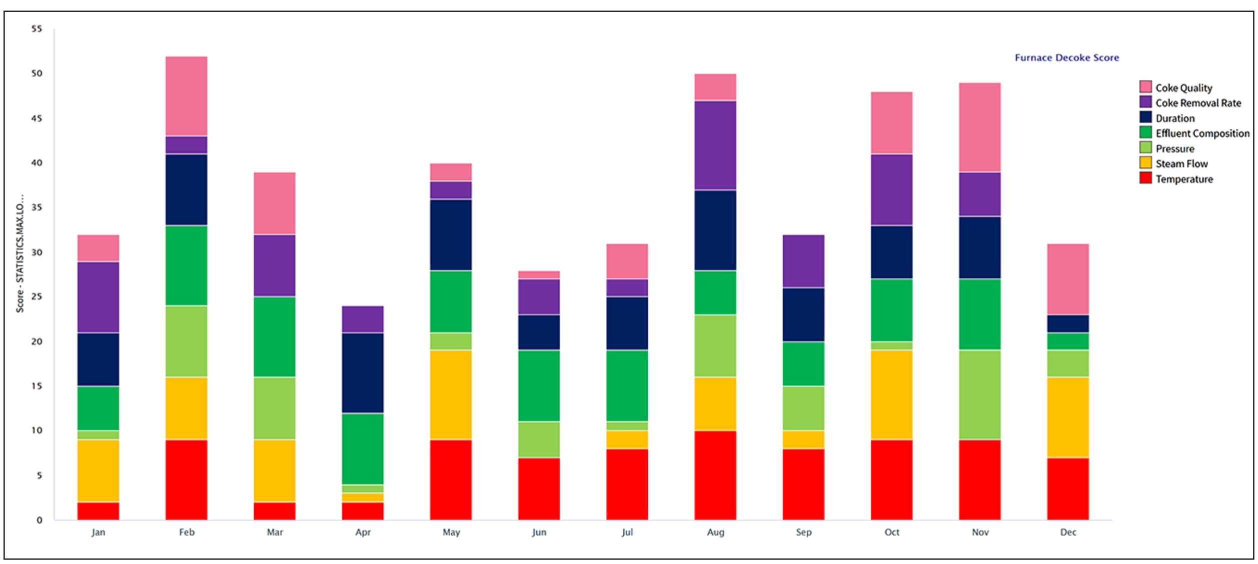


Figure 1: Analytics can reveal monthly furnace decoke performance parameters by category in Seeq software using Histogram.

Efficient distillation column operation. Differential pressure (DP) is an important parameter in distillation columns that provides valuable information about the column's state and efficiency. This term refers to the pressure difference between two points within the column, which is usually measured across the trays or packing.

When differential pressure climbs significantly above expected values, it is usually a sign of flooding, a critical situation that can arise in various processes where liquid holdup becomes excessive, hindering vapor flow and reducing separation efficiency. This can severely tarnish final product quality and overall production.

Monitoring DP closely can enable early detection and alerting prior to flooding, prompting corrective action to minimize damage when equipment malfunctions, feed compositions change, or blockages occur. It also helps reduce plant downtime and operational expenditures.

Setting up a DP monitoring dashboard is usually challenging because readings are highly prone to noise or fluctuations. As a result, developers must implement signal filtering to differentiate between meaningful changes and random variations. While a sudden increase in DP usually indicates flooding, there are other factors that can cause fluctuations, such as changes in feed composition or vapor flow. To distinguish between flooding and normal variations, additional data analysis and experience are required.

At a global petrochemical and refining company's remote monitoring center, process engineers adopted a modern advanced analytics platform to monitor the performance of multiple distillation columns. As a critical data cleansing step, the engineers applied signal smoothing to remove random variation from noisy DP signals, excluding downtime data. The team closely monitored the cleansed DP signal along with the reflux flow rate of the distillation column in an XY plot (Figure 2).

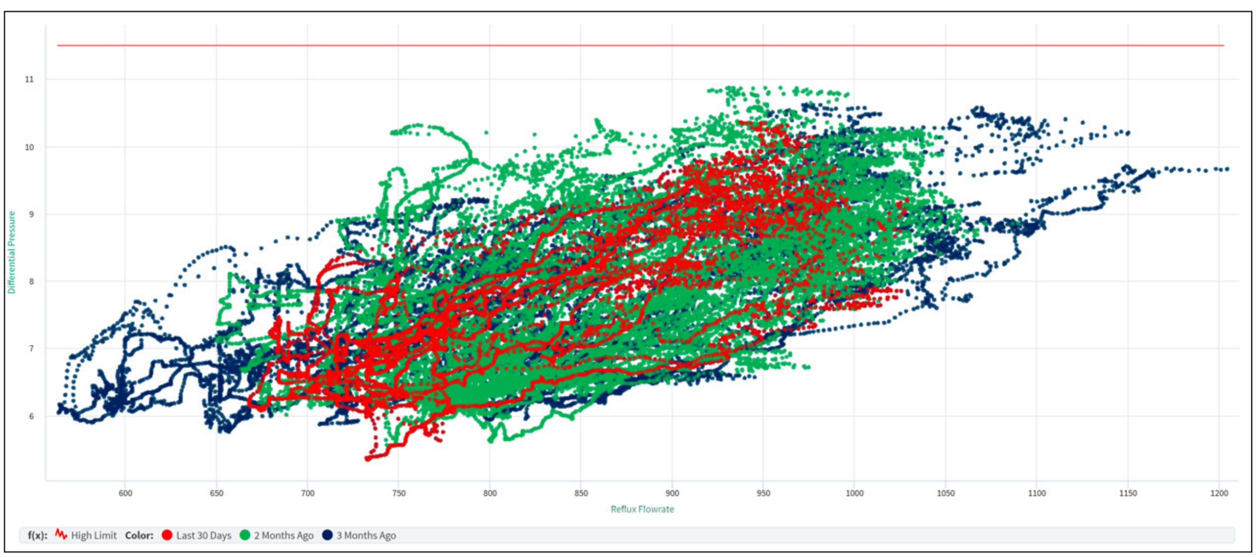


Figure 2: A global petrochemical and refining company's historical and recent distillation column DP trends are visualized on an XY plot.

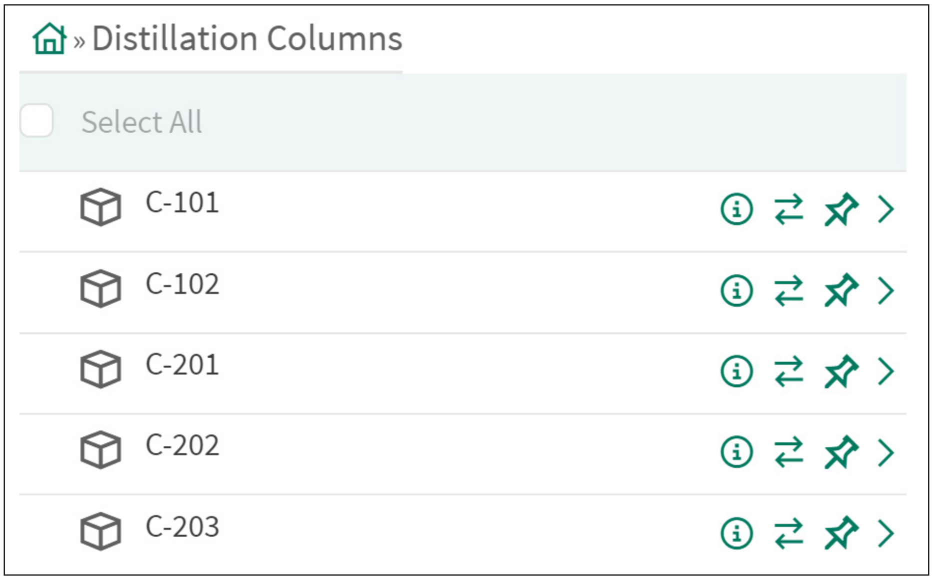


Figure 3: The engineers created an asset tree for analysis scaling. This enabled scaling DP monitoring to over 100 columns, and it standardized the workflow across a large monitoring center.

To gain additional insight and compare the characteristics of the DP versus reflux profile over time, the engineers color-coded the plot based on fixed time period conditions. They also added a high limit to the plot to detect anomalies, such as abnormally high DP readings.

However, the task did not end here. The team scaled the same analysis to multiple distillation columns by creating asset trees and swapping the asset from one distillation column to another (Figure 3). This enabled scaling DP monitoring to over 100 columns, and it standardized the workflow across a large monitoring center with more than 200 engineers.

Optimized valve maintenance. Valves play a crucial role in many industrial applications by regulating the flow of fluid or gas through pipes and equipment. However, valve performance can be difficult to predict in real-time, making it challenging to maintain these assets effectively.

Maintenance is critical to keep valves operating optimally and to prevent unplanned downtime. On one hand, pre-scheduled preventive maintenance is costly and time-consuming because preexisting valve conditions are not considered. However, on the other hand, it reduces unexpected downtime, which has the potential to hamper production, reduce revenue, and potentially damage ancillary equipment or harm the environment.

Obtaining the best of both worlds, an oil and gas company implemented an advanced analytics platform to conduct condition-based valve health analysis. The solution continuously monitors valve parameters—including apparent stiction, cycle duration, rate of travel, and cycle count—to generate a health score and preemptively detect valve failures.

These key performance indicators (KPIs) are amalgamated and displayed using Treemaps, which show overall valve health at a glance so maintenance teams can easily prioritize their efforts (Figure 4).

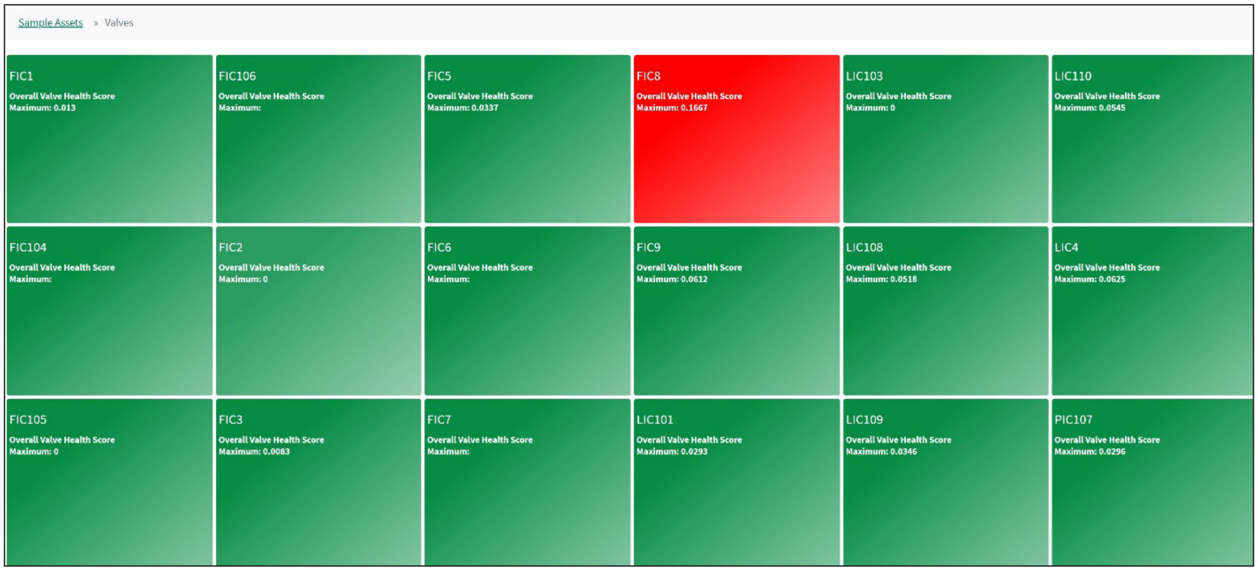


Figure 4: An oil and gas company monitors valve health using Treemaps in Seeq to prioritize maintenance.

Subsequent dashboards show detailed trends of all valve health KPIs, helping identify patterns and trends impacting valve performance. This also helps identify when corrective actions are required, and it ensures limited maintenance resources are utilized effectively.

One leading agriculture company used this same approach to reduce fugitive emissions by monitoring nitrogen blanket control valves, saving an estimated $120k per year in wasted nitrogen per faulty valve.

A future of smart remote monitoring

In today's connected landscape, remote monitoring is increasingly becoming a cornerstone of manufacturing, allowing SMEs to collaborate and innovate from anywhere in the world. However, implementing effective monitoring is not without its challenges.

Advanced analytics platforms accelerate the time to value, automating data aggregation from multiple locations, as well as providing operation-wide context and optimization insights. These solutions are improving process safety and efficiency, empowering manufacturers to increase uptime, produce more product, and maximize profitability to remain competitive in continuously-evolving markets.

All figures courtesy of Seeq

ABOUT THE AUTHOR

Kin How Chong is a Senior Analytics Engineer at Seeq. He has an engineering background with a BS in chemical engineering from Universiti Kebangsaan Malaysia and an MS in data science from the University of Malaya. Kin How has more than a decade of experience working for and with chemical manufacturing companies to solve high-value business problems. In his current tole, Kin How enjoys supporting industrial organizations as they maximize value from their time series data.

Digital Twins for Complex Power Gen Operations

By Rick Kephart

Modern simulation technology is critical to incorporating renewables into the electrical grid.

With all the recent focus on electrification of human lifestyles across the globe, it can feel as though the energy industry has changed overnight. Today, the global public is hearing more about photovoltaic solar, wind generation, and battery storage than ever before. Businesses and residences are installing solar panels at an unheard-of pace, while expanding solar and wind farms become visible reminders that the grid is changing rapidly.

Though in the past they did not enjoy the market share they do today, solar, wind, and battery systems have existed for a long time. These technologies have been understood and improving for decades. It simply took a cultural shift—increased pressure and incentives from governments and the public—to bring renewable energy generation technologies into the spotlight.

With such a change comes increased complexity. Power generation companies must now run their operations differently. As these organizations incorporate renewables, they must navigate continual changes, both in weather and in energy markets, to be profitable and efficient. Simultaneously, many of these companies face severe workforce shortages. They can't find people with the expertise necessary to run generation facilities—renewable or traditional dispatchable—at peak operational efficiency.

Fortunately, a critical technology the energy industry has relied upon for decades—digital twin simulation—has continued to evolve to support transitions in generation portfolios. Modern digital twins provide a way for users to navigate a changing industry. As a result, as power generation operations increase in complexity, the business case for digital twin simulation continues to improve.

What is a digital twin simulation?

Digital twins come in many different forms, but for the power industry, one of the most valuable is a virtual simulated replica of a control system that duplicates the monitoring and control of plant, process, and system operations in a secure, risk-free environment. Key components of a digital twin include:

- Simulation models that accurately reflect the operation and interaction of plant equipment and processes.
- Virtual controllers, which replicate plant controllers to execute simulated models.
- An instructor station that controls the simulation for operator training.
- Standard control system software for operations and engineering.
- Replica control system logic and graphics.

There are many different use cases for digital twin simulations, with the most common use case being operator training. With increasing turnover in industry and a shortage of experienced workers available to backfill a retiring workforce, companies need to train operators quickly, safely, and effectively. Best-in-class digital twins use the same automation platform as the plant control system for this training. An operator training on such a system gains real-world experience, interacting with controls, graphics, and tools that are identical to the ones they use when operating the physical plant. Moreover, systems using a single set of

Power generation companies must now run their operations differently. As these organizations incorporate renewables, they must navigate continual changes, both in weather and in energy markets, to be profitable and efficient.

common tools help organizations realize cost savings through less maintenance, training, and service required to maintain a single platform for both the digital twin and plant controls, versus individualized platforms for each (Figure 1).

In addition, companies using a digital twin for training can take snapshots of certain operational states, allowing them to quickly return to critical training exercises repeatedly. Trainees can test a wide variety of mitigation strategies and control options, and see how the results cascade across the automation system, making it easy to evaluate best practices.

Digital twin simulation is also commonly used for engineering. For teams looking to test new control strategies, or to develop new automation algorithms, a digital twin provides a testing environment that is both realistic and safe. The best digital twin systems have the capability to mix and match the fidelity of each module. Such a solution not only saves cost and time during deployment—high fidelity models are more complex and costly

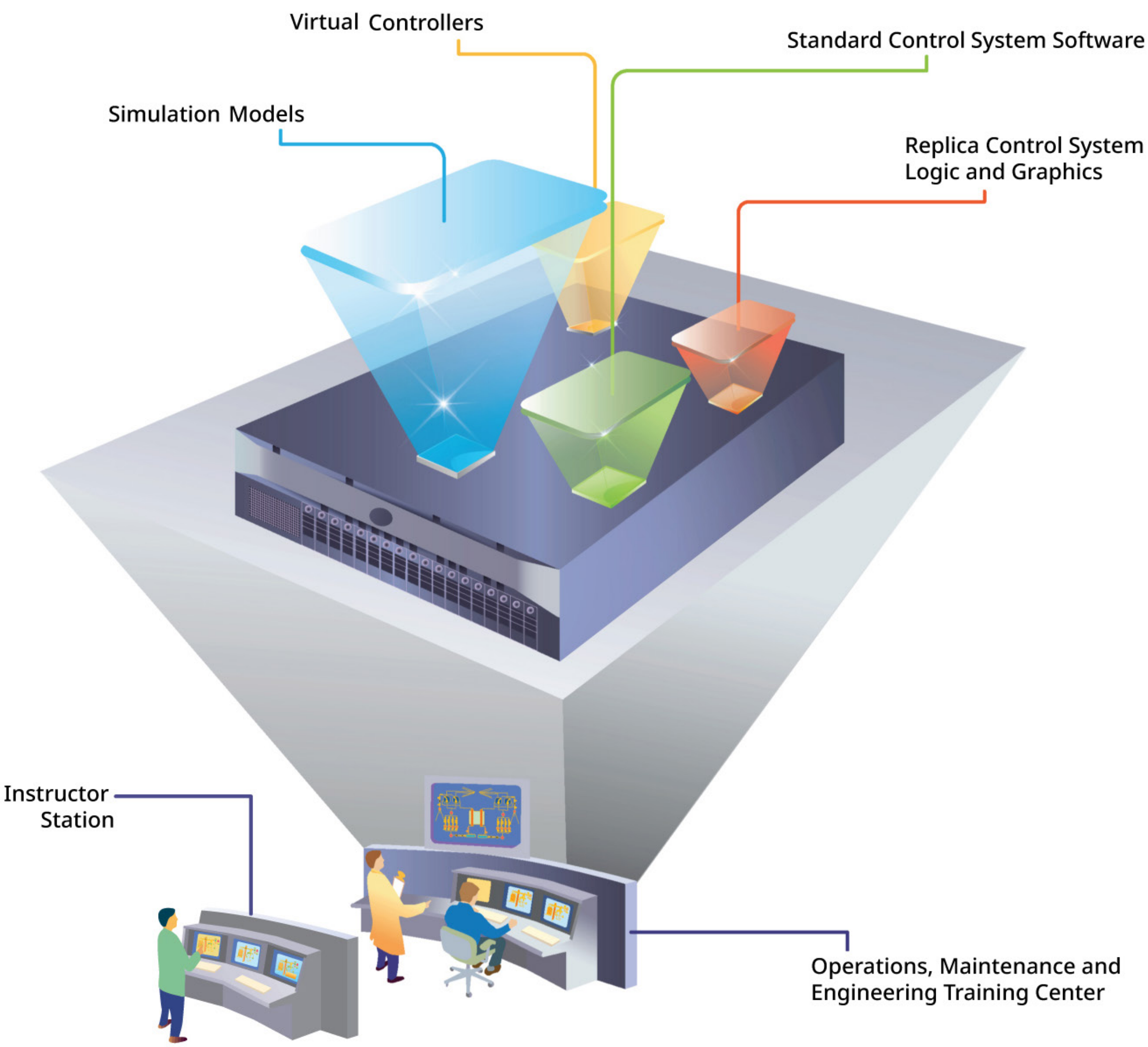


Figure 1: The best digital twin tools are based on the same platform as a control system to eliminate the complexity and cost of maintaining separate modeling software, and to make it easy for in-house staff to update plant models and training scenarios.

to develop—but also provides flexibility for modernization across the lifecycle of the system. A team can start with a low fidelity digital twin simulation, and then upgrade specific elements to higher fidelity as needed.

Benefits for traditional dispatchable power generators

Power generation operations are changing. Plants built decades ago were typically designed to run continuously, supplying as much power to the grid as possible. However, with the rise of renewables, such plants are seeing the need for more dynamic operation, which increases the number of complex activities operators must perform. Improved operational efficiency is highly reliant on the organization's ability to tap into the knowledge of industry veterans to reskill current staff, and to teach a new generation of digital natives how to operate plants safely and efficiently.

However, traditional dispatchable base load power plants typically have a lot more moving parts than most renewable facilities, with more severe consequences for failure. Consequently, it is difficult, if not impossible, to train new personnel on complex activities, such as startup and shutdown, on live equipment. New operators in these plants have likely had few or no opportunities to start up and shut down the plant. Moreover, they will have had even fewer opportunities to experience abnormal conditions, such as when a boiler feed pump fails.

These new personnel not only need to know what to do in such situations, they also need to know what not to do. For example, if the plant has a failure on a critical piece of equipment, the automation might initiate a runback, bringing the power output back to a level it can support. A system running back looks very different from a system in normal operating mode, and operators need to recognize such a status and understand the normal mitigation strategies common in abnormal operations. The only way to accomplish this is to let operators see such situations themselves, and the best way to let them do that safely is via a digital twin simulation.

Consolidation of multiple plant operations into a single, remote operations center is a common strategy power generators are using to improve reliability, reduce costs, and increase operational flexibility.

In addition, as dispatchable base load generators experience more startups and shutdowns, it becomes more important to ensure that those operations occur in the same, optimal manner regardless of who is on shift at the facility. For example, as soon as a system starts burning fuel, the team needs to close a breaker as soon as possible, without violating equipment constraints, but doing so requires expertise. Digital twin simulation training allows teams to score operators based on ideal responses, then train and retrain them until they can optimize operation without creating undue mechanical stress on equipment.

Benefits for renewable power generators

Companies with renewables operations are seeing the most benefit from using digital twin simulations when they use them as test beds for engineering and improving operation. A digital twin can be used to test and validate new control strategies before starting commercial operation. This capability is particularly beneficial to organizations investigating microgrids—a collection of assets that presents itself as a single entity for energy distribution. Using a digital twin simulation, teams can more easily build and manage their portfolio of assets, modeling loads and determining the capability of electrical components.

Teams can also use a digital twin to more easily model the way distributed energy resources (DERs) interact with each other. As Federal Energy Regulatory Commission (FERC) order number 2222 gains more traction, allowing DERs to compete more easily in energy markets, new players in the industry will likely use digital twins to build virtual power plants, aggregating all their disparate DERs into larger, more easily controllable generation assets.

Many companies are also extending their digital twin capabilities outside of the plant with smart grid extensions. These tools are used with grid-level simulation packages to provide simulation of an organization's total power system. Such a solution can help organizations understand the grid's varying conditions, while managing communications and data flows to optimize production across the total power system, from generation to distribution.

Predicting the future

One of the most significant trends in the power industry is the shift toward control room consolidation. The historical footprint for power generation is far less applicable to renewables sites, many of which maintain few or no personnel on premises. Even traditional plants have been forced to cut back on their on-site personnel. As these changes occur, the way the fleets are being controlled and monitored is also changing. Consolidation of multiple plant operations into a single, remote operations center is a common strategy power generators are using to improve reliability, reduce costs, and increase operational flexibility.

As power companies centralize operations, digital twin simulations help them cross-train co-located experts to remotely monitor, operate, and maintain a wider variety of assets. Technicians, engineers, and operators in a centralized control facility can also use the digital twin as they collaborate to improve maintenance strategies and develop improved operations across the enterprise.

Another increasing trend in power generation is the use of artificial intelligence (AI) to improve efficiency and productivity. Under the right circumstances, a digital twin could be used in a predictive capacity, incorporating real-time plant data and running at faster than real time to identify potential flaws, bottlenecks, or other problems that will occur in the future.

Today, accomplishing this predictive capability on a digital twin is a difficult task. First principles models are hard to run faster than real time due to the complexity of their calculations and the computing overhead necessary to accomplish such a task. As tools improve, however, AI components could exercise digital twin models to learn the dynamics of a system, enabling them to build lightweight surrogate AI models that could be run faster than real time. Coupled with a generative AI-driven copilot, these tools could make a predictive digital twin more approachable, empowering personnel to simply ask the AI to predict the results of any changes to standard operations.

Building a flexible foundation

The rise of renewable power has brought increased complexity for generation and distribution organizations. Operations teams need to be much more flexible, which requires them to lock in best practices to ensure peak safety and operational efficiency. Digital twin simulation is a critical enabler of that flexibility, helping teams not only teach all their personnel to operate at their best, but also providing a test bed for the increasing number of operational changes necessary to compete in a more complex, hybrid environment.

The best digital twin tools will be based on the same platform as a control system designed specifically for the power industry. Such solutions eliminate the complexity and cost of maintaining separate modeling software, and they make it easy for in-house staff to update plant models and training scenarios using familiar—and often, automated—tools. Moreover, implementing a built-for-purpose system today will provide the foundation necessary for the smart grid extensions, centralized control, and AI technologies that will help organizations navigate the even more complex dynamic operations just over the horizon.

All figures courtesy of Emerson

ABOUT THE AUTHOR

Rick Kephart has over 30 years of automation experience in the power and water/wastewater industries. Over his career, he has become an expert in control systems and theory, embedded systems and real-time systems. Rick currently serves as the vice president of technology for Emerson's power generation and water solutions business. Previously, Rick was the vice president of software solutions and responsible for the software portion of the Ovation™ automation platform. He holds a B.S. in electrical engineering from Penn State University and an M.S. in electrical engineering from the University of Pittsburgh.

ISA Hosts Leading OT Cybersecurity Summit in London

At its second-annual OT Cybersecurity Summit in London this month, ISA treated 260 attendees—a 117% increase in attendance year over year—to 34 sessions, 44 speakers and 14 technology-rich sponsor exhibits.

"This is only the second year that ISA has hosted the OT Cybersecurity Summit, but already this event is recognized as the leading venue for conversations about operational technology and industrial cybersecurity," said Claire Fallon, ISA CEO and executive director. "As developers of the ISA/IEC 62443 series of standards, ISA is uniquely positioned to provide thought leadership, training and certification on these critical standards that are used the world over to ensure that industrial facilities are safe and secure."

The event included two tracks on intelligence evolution and Internet of Things (IoT) cybersecurity, as well as an exclusive cybersecurity escape room experience designed specifically for ISA.

In addition, ISA offered its most popular training courses—Using the ISA/IEC 62443 Standards to Secure Your Control Systems (IC32) and Assessing the Cybersecurity of New Existing IACS Systems (IC33)—as well as a workshop on the ISA/IEC 62443 series of standards.

ISA's second-annual OT Cybersecurity Summit enjoyed increased year-over-year attendance. The 2025 event will be held in Brussels, Belgium.

Attendees shared their positive feedback:

- "Cybersecurity is really a team sport, so there needs to be more ongoing collaboration between product vendors and asset owners. This event provides just the right environment for these conversations."
- "Being part of ISA is all about knowledge sharing, community and collaboration. The collaborative community sets ISA events apart—the event doesn't 'end' because we stay in touch and continue to work throughout the year to help solve some of the big challenges in cybersecurity."
- "I love ISA events! The people are awesome—they are warm-hearted, intellectual and passionate about engineering. They are people that definitely know their stuff, but they aren't know-it-alls, so it's a really cool environment."

The next OT Cybersecurity Summit will take place in Brussels, Belgium, on 17-19 June 2025. For more information about the event and to view photos, visit otcs.isa.org.

What It Means To Become an ISA Fellow

The International Society of Automation (ISA) sat down with Deji Chen to find out what it means to him to be one of four automation professionals elevated to the distinguished grade of ISA Fellow in 2024. He is recognized as among the first people who pioneered bringing wireless technology to industrial automation and is an expert on *Wireless*Hart and industrial Internet of Things (IIoT) technology.

Chen: It means a lot! During my work at Emerson, I have observed that many colleagues I looked up to became ISA Fellows, including Terry, Marty, Willy, Eric, and of course my manager/mentor Mark Nixon. It has become my dream to be recognized among them. It still feels like a dream to me right now.

ISA: What contribution to the automation industry got you nominated?

Chen: I am recognized as among the first people who pioneered bringing wireless technology to industrial automation.

*Wireless*HART is the first international standard on industrial wireless communication in the plant. It was initiated by Emerson. While Mark Nixon and Eric Rotvold were busy co-writing the standard text with Wally Pratt who is from the HART communication Foundation, I led a team of Ph.D. students of Professor Al Mok at the University of Texas at Austin for the literature research and technical verification. The code we wrote was later developed into the testing system for the *Wireless*HART certification by the HART communication Foundation. The text we wrote was later developed into a definitive book on industrial wireless sensor networks.

OPC was also pioneered by Emerson [among others]. My first job at Emerson was developing this standard with Mark Nixon's team. In the meantime, I participated in coding OPC software in the DeltaV system. OPC-UA has become the mainstream standard for IIoT.

After coming back to China, I was invited to work on IEC 30141, the IoT architecture standard. During this period, I initiated and chief-edited the IEC30165 standard (Real-Time IoT Framework) to emphasize the real-time aspect of an IoT system.

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ISA: How has being an ISA member and now Fellow positively impacted your career?

Chen: My daily task at Emerson mainly was of product development. My association with ISA fulfills my craving for exploration and innovation. Some highlights of my career with ISA are receiving from ISA the Excellence in Documentation Award for the paper I co-wrote, "Improving PID Control with Unreliable Communications"; receiving from ISA the Raymond D. Molloy Award for the book I co-authored "Wireless Control Foundation—Continuous and Discrete Control for the Process Industry"; and the translation into Chinese of three ISA award-winning books "Control Loop Foundation," "Advanced Control Foundation" and "Wireless Control Foundation."

Learn more about Chen in the April 2024 issue of InTech, where he also authored an article, "The Case for DIPS and Distributed, Intelligent Automation." —*Liz Niemann*

Nominations Open for 2025 ISA Fellows

ISA members can now nominate a peer or colleague for the prestigious recognition of ISA Fellow. The Fellows designation recognizes senior members who have made exceptional (significant) contributions to the automation profession, in practice or in academia. For more information, contact the ISA Membership department here. Nominations close August 1st.

ISA Podcast Episode 4 Covers Maritime Cybersecurity

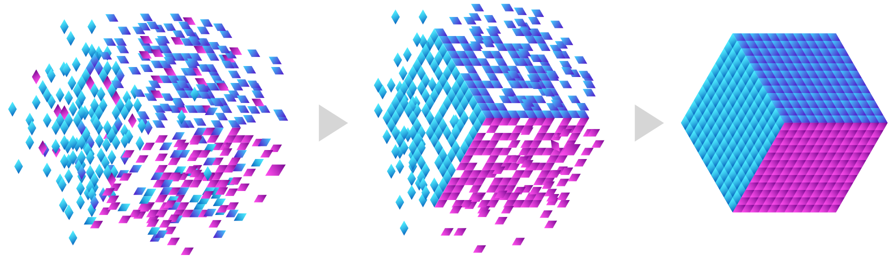
Episode 4 of ISA's podcast, Podomation, is now available on YouTube. Episode 4, titled "Secure Seas: Navigating Maritime Cybersecurity," features four panelists discussing the evolution of maritime cybersecurity and how regulations and standards have been pivotal in guiding the integration of cyber risk management into safety management systems on ships.

Podomation Episode 4 panelists include:

- Sean Plankey, global head of Cybersecurity Software, Willis Towers Watson
- Michael DeVolld, senior principal consultant, American Bureau of Shipping
- Kevin Duffy, CEO, Maritime Imperative
- Marco Ayala, president, Infragard Houston.

How IIoT Enables AI and Big Data

By Arlen Nipper



As industrial companies work to make better use of their data to improve operations and increase efficiency, there are many challenges in the convergence of operational technology (OT) and information technology (IT) systems. Bridging the gap between OT and IT is essential to unlocking the insights that can be achieved through artificial intelligence (AI) and big data analytics.

At the heart of the OT-IT disparity lies the fundamental variance in data requirements. OT data consists of proprietary protocols, multiple data formats, and no contextual information. OT data is of course designed for operations, is directly coupled to applications, often exists over isolated networks, and typically relies on application programming interface (API) endpoints for data retrieval.

On the other hand, IT has very different needs to feed cloud-based AI and big data applications with data. IT needs data objects and modeling, standard data formats, and contextualized information. IT needs data to be decoupled so it can be shared, easily integrated with enterprise systems, and conform to a publish/subscribe methodology.

The key is finding a superior solution that works for OT while being able to share contextualized data to IT.

Bridging the divide: Enabling data connectivity

OT and IT do have some needs in common. Both are looking for secure data movement, both want to put data to use to power use cases that improve the business, and both are typically interested in saving resources (time and/or money). Addressing both the common and disparate needs necessitates robust data connectivity solutions tailored for the plant floor and designed for interoperability. The first step is to choose a protocol—a method for moving data—that is based on open standards and allows for self-discovery of the data.

Message queuing telemetry transport (MQTT) is a lightweight messaging protocol designed for efficient communication between devices in low-bandwidth, high-latency, or unreliable networks. MQTT is secure, ensuring encrypted data transmission to safeguard sensitive data.

MQTT Sparkplug is a specification that builds on the MQTT protocol to define how to use the protocol in a mission-critical, real-time environment. Sparkplug standardizes the format and structure of messages exchanged between industrial devices, sensors, and applications in Industrial Internet of Things (IIoT) environments. It provides the data model needed to define a tag value for use with OT, also providing data to IT, making it 100 percent self-discoverable and easy to consume.

Sparkplug gives users the ability to publish under a well-known OT-centric topic namespace to be able to publish model definitions from the edge, populate them with the contextual data for those process variables, and do all of that with report-by-exception. It's simply a great solution for this OT to IT challenge.

Sparkplug also decouples applications from the underlying data sources, so cloud platforms can efficiently ingest data models and assets, enabling advanced analytics and AI-driven insights. Leveraging open standards like MQTT Sparkplug facilitates data modeling and self-discovery, establishing a source of truth at the edge.

Edge-to-cloud data flow

Decoupling applications from data sources is the real strength of an architecture built around MQTT Sparkplug. Applications can decouple and populate cloud platforms with the data models and assets seamlessly. There are many applications on the market—many vendors call them integrations or bridges—designed to facilitate this movement from edge to cloud.

These bridges exist for the major cloud platforms, making it possible to easily connect OT data models into Azure Digital Twins and AWS IoT SiteWise. Consider sending data to Snowflake, for example, to see how Sparkplug really aids in this type of edge-to-cloud data flow.

The IoT Bride for Snowflake delivers data to the Snowflake Data Cloud Platform, allowing that data to be represented in SQL form and then can be used to run AI and other big data applications to gain insights. IoT Bridge for Snowflake subscribes to MQTT servers to receive manufacturing and OT data in a secure and open standard methodology (Figure 1).

Here's why this open standard is ideal for this use case:

- **Self-learning auto-creation of data models and assets.** Using the Sparkplug standard

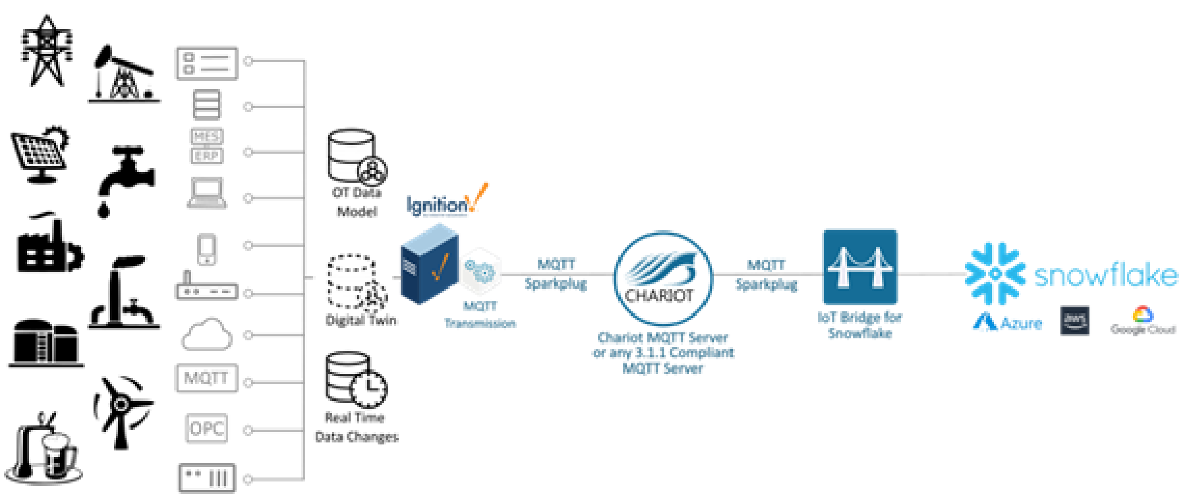


Figure 1. IoT Bridge for Snowflake subscribes to MQTT servers to receive manufacturing and OT data in a secure and open standard methodology.

Leveraging open standards like MQTT Sparkplug facilitates data modeling and self-discovery, establishing a source of truth at the edge.

from the Eclipse Foundation via the bridge Snowflake can atomically learn data assets requiring zero configuration and deliver the data into Snowflake.

- **Efficient ingest of real-time tag data.** Data is only ingested on report-by-exception, meaning values are only updated as it changes, vastly minimizing data storage requirements.
- **No programming or code required.** MQTT Sparkplug provides the open standard protocol that enables edge platforms and devices the native capability to represent OT data requiring only configuration for a zero-code solution.

IIoT serves a crucial role in bridging the gap between OT and IT systems, enabling the application of AI and big data analytics on cloud platforms within industrial settings. Through the adoption of protocols like MQTT Sparkplug, which standardizes message formats and facilitates self-discovery of data, industrial companies can efficiently communicate between devices and cloud platforms. This streamlined data connectivity enables real-time analytics, AI-driven insights, and efficient data flow from the edge to the cloud. By leveraging open standards, such as MQTT Sparkplug, companies can achieve interoperability and integration without extensive programming, ultimately empowering them to optimize operations, increase productivity, and remain competitive in today's data-driven landscape.

ABOUT THE AUTHOR

Arlen Nipper is President and CTO of Cirrus Link. With over 38 years of experience in the SCADA industry, Nipper was one of the early architects of pervasive computing and the Internet of Things and co-inventor of MQTT, a publish-subscribe network protocol. His experience covers a broad range of technology from the design and manufacturing of embedded systems to SCADA system infrastructure implementations. Arlen holds a bachelor's degree in electrical and electronics engineering (BSEE) from Oklahoma State University.

Increasing Manufacturing Capacity with OEE

By Jack Smith

InTech had the opportunity to talk with subject matter experts at LineView Solutions about how the company helped Rugby, UK-based Britvic, a major soft drink bottling company, increase capacity through line balancing optimization.

Teaching line balancing optimization

LineView was tasked with providing the Britvic controls engineering team with the necessary skills and knowledge to identify and implement line balancing optimization opportunities across the business. LineView's industry experts worked in collaboration with the team to implement practical improvements and enable the lines to fulfil market demand for summer can volume.

The line-balancing optimization training equipped eight Britvic team members with skills to effectively balance operator and machine time. LineView experts guided the controls engineering team through improving control, accumulation, speed, startup, and run-out times across Britvic's can lines.

The Britvic project entailed training and coaching its team on the line balancing optimization "perfect flow" methodology, conducting audits on four can lines, and ensuring that the team could continue this process on all other lines. "We established baseline scores and monitored them via our LineView software," said Miguel Ferreira, customer success manager at LineView. "Post-audit, we optimized line control by implementing techniques such as cascade control and dynamic accumulation, which were executed by an automation engineer directly on the line's software."

LineView's involvement went beyond classroom training. "Our approach is comprehensive and hands on," explained Ferreira. "We demonstrated how to conduct audits, set baselines, monitor, and validate. We actively coached the team, identifying opportunities for improvement. In addition, we implemented hands-on improvements on the lines, including modifying sensor positions, code adjustments, and optimizing conveyor speeds."

Ferreira said that LineView is versatile, acting as both a consultant and an integrator depending on the client's needs. "Some clients prefer us to train, coach, assess, and develop an action plan for them to execute. Others require our direct involvement in implementing changes, which is beneficial as we bring extensive experience in line control and provide valuable training for their automation engineers, enhancing their capabilities."

Positive results at Britvic

Britvic is now positioned to unlock additional capacity increases across multiple lines, while fostering sustained production efficiency through a commitment to continuous improvement. The bottling company unlocked £5.4M in capacity increase—an initial capacity increase of £2.9M, followed by further capacity gains of £2.5M through enhanced control optimization. Both LineView and Britvic express the improved capacity in monetary terms because the gains are directly tied to overall equipment effectiveness (OEE).

Paramjeet Pahdi, Rugby site director at Britvic PLC, said "We've unlocked significant capacity for our plant and reduced the impact of minor stoppages on our production lines. Most importantly, we've equipped our people to be able to go hunt down these opportunities throughout our business. LineView ensured we have full understanding and confidence to take ownership of this process moving forward."

Working through the challenges

Ferreira said that the most significant challenge was addressing inadequate line control previously attempted by the original equipment manufacturer (OEM).

The most impressive success was the positive impact on the production line's speed and efficiency. "The faster restart times for each asset and longer running times for the critical machine due to increased accumulation were particularly noteworthy," Ferreira continued. This success changed the team's perspective, leading to widespread buy-in for the methodology. In addition, the project enhanced the team's understanding of their equipment, revealing many more opportunities for further improvements and sparking a proactive approach to continuous optimization."

OEE is the key

OEE is a measure of how well a manufacturing operation is used (facilities, time, and material) compared to its full potential during the periods when it is scheduled to run. It identifies the percentage of manufacturing time that is truly productive. An OEE of 100% means that only good parts are produced (100% quality), at the maximum speed (100% performance), and without interruption (100% availability).

By measuring OEE and the underlying losses, important insights can be gained into how to systematically improve the manufacturing process. The best way for reliable OEE monitoring is to automatically collect data directly from the machines.

OEE allows comparison between manufacturing units in differing industries. It is not an absolute measure and is best used to identify scope for process performance improvement as well as how to get that improvement. OEE measurement is also commonly used as a key performance indicator (KPI) in conjunction with Lean manufacturing efforts.

ABOUT THE AUTHOR

Jack Smith is senior contributing editor for Automation.com and InTech digital magazine, publications of ISA, the International Society of Automation. Jack is a senior member of ISA, as well as a member of IEEE. He has an AAS in Electrical/Electronic Engineering and experience in instrumentation, closed loop control, PLCs, complex automated test systems, and test system design. Jack also has more than 20 years of experience as a journalist covering process, discrete, and hybrid technologies.