

AUTOMATION 2020

Volume 1 | February

IIoT and Smart Manufacturing

- ▶ Digital transformation demystified
- ▶ Cyber-physical system protection
- ▶ ANSI B11.19 for machinery protection



Introduction

IIoT and Smart Manufacturing

Digital transformation can turn industry pressures into opportunities for gaining a competitive advantage. But that transformation requires a lot of knowledge about the possibilities and a focused approach to change management. Find out about smart cyber-physical systems, single-pair Ethernet, low-power wide-area networks, I/O for the IIoT, the latest battery technology for industrial-grade wireless, and more in this edition of **Automation 2020** from [Automation.com](https://www.automation.com).

Formerly called *Advancing Automation*, this ebook series includes sponsored and curated articles from a variety of experts on the latest in smart manufacturing, Industry 4.0 topics, and the Industrial Internet of Things (IIoT).



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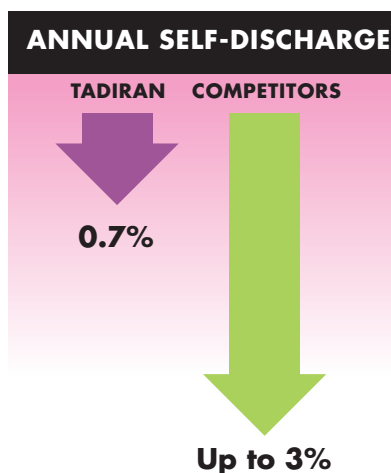
IIoT devices run longer on Tadiran batteries.

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40
YEAR
OPERATING
LIFE*



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Powering the IIoT: Batteries Need Not Be Large and Expensive

Battery technology is evolving and needs to be intelligently designed if the device is to operate maintenance-free for decades

By Sol Jacobs, Tadiran Batteries

By understanding battery technologies, it should be possible to use the smallest and least expensive battery.

When it comes to battery-powered solutions, consumer-grade devices are usually relatively simple, while industrial-grade applications are typically far more challenging. Battery-powered solutions for industrial-grade wireless devices need to be intelligently designed if the devices are intended to operate maintenance-free for decades, especially in remote locations and extreme environments (figure 1).

Not using the right battery technology can lead to unnecessarily large and heavy batteries that may have unforeseen expenses, including more frequent battery replacements, along with the time and labor required to transport and then install these oversized batteries in hard-to-access locations.



Figure 1. Resensys SenSpot structural stress sensors monitor bridges, tunnels, and structures. Bobbin-type LiSOCl_2 batteries offer a long-life, maintenance-free solution.

Source: Resensys

Primary Cell	LiSOCl ₂ Bobbin- type with hybrid layer capacitor	LiSOCl ₂ Bobbin- type	Li metal oxide Modified for high capacity	Li metal oxide Modified for high power	Alkaline	LiFeS ₂ Lithium iron disulfate	LiMnO ₂ CR123A
Energy density (Wh/l)	1,420	1,420	370	185	600	650	650
Power	Very high	Low	Very high	Very high	Low	High	Moderate
Voltage	3.6 to 3.9 V	3.6 V	4.1 V	4.1 V	1.5 V	1.5 V	3.0 V
Pulse amplitude	Excellent	Small	High	Very high	Low	Moderate	Moderate
Passivation	None	High	Very low	None	N/A	Fair	Moderate
Performance at elevated temp.	Excellent	Fair	Excellent	Excellent	Low	Moderate	Fair
Performance at low temp.	Excellent	Fair	Moderate	Excellent	Low	Moderate	Poor
Operating life	Excellent	Excellent	Excellent	Excellent	Moderate	Moderate	Fair
Self-discharge rate	Very low	very low	Very low	Very low	Very high	Moderate	High
Operating temp.	-55°C to 85°C, can be extended to 105°C for a short time	-80°C to 125°C	-45°C to 85°C	-45°C to 85°C	-0°C to 60°C	-20°C to 60°C	0°C to 60°C

Table 1. Comparison of primary lithium cells.

Specifying the right industrial-grade battery starts with understanding the fundamental differences between commercially available (nonrechargeable) chemistries (table 1):

Operating voltage: Basic math tells you that it takes more than two 1.5 V cells to deliver the same voltage as a single 3.6 V cell. Choosing a battery with a higher voltage can reduce the size and weight of the wireless device and can lead to additional savings if fewer cells are required.

Cold and hot temperatures: Exposure to extreme temperatures reduces battery voltage under pulse. If a battery with a limited temperature range is deployed in a harsh environment, oversized batteries may be required to compensate for an expected drop in voltage under pulsed load. This problem can be avoided by using a bobbin-type lithium thionyl chloride (LiSOCl₂) battery that has extremely high energy density and the ability to handle high pulses at extreme temperatures, thus eliminating the need for all that extra capacity or voltage (figure 2).

Self-discharge rate: Certain battery technologies suffer from high self-discharge rates of up to 8 percent per month, thus requiring a larger battery to compensate for the expected capacity losses. Most battery chemistries also experience accelerated self-discharge when exposed to extreme temperatures. With long-term deployments, it often makes sense to specify a battery that features an exceptionally low annual self-discharge rate, which may enable the use of a smaller battery and possibly eliminate the need for future battery replacements over the lifetime of the device.

For example, a superior quality bobbin-type LiSOCl₂ battery has a self-discharge rate of 0.7 percent per year, retaining more than 70 percent of its original capacity after 40 years. By

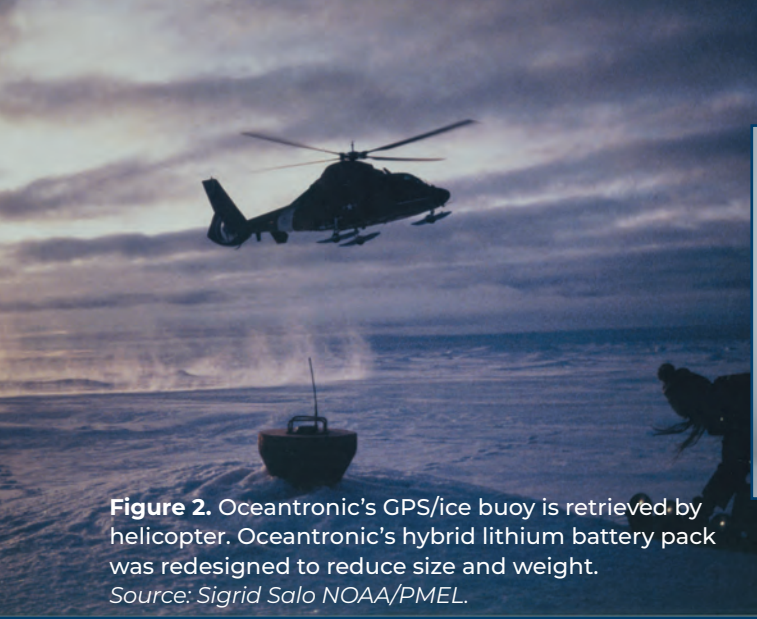


Figure 2. Oceanantronic's GPS/ice buoy is retrieved by helicopter. Oceanantronic's hybrid lithium battery pack was redesigned to reduce size and weight.
Source: Sigrid Salo NOAA/PMEL.



The original (left) used 380 alkaline D cells (54 kg). The improved battery pack (right) uses 32 bobbin-type LiSOCl₂ D cells and four HLCs (3.2 kg).

contrast, a lesser-grade battery using the exact same chemistry can experience a much higher self-discharge rate of 3 percent per year, exhausting 30 percent of its original capacity every 10 years, making 40-year battery life unachievable.

Do not confuse power with energy:

The need for battery power (a measure of short-term energy consumed) is often confused with the total amount of energy required (total battery capacity). Certain wireless devices require relatively high amounts of power (high pulses) for short bursts without exhausting a large amount of total energy. Common examples include surgical power tools that may operate for a few minutes, industrial actuation devices, and certain military applications.

Most commercially available battery technologies are not designed to deliver a high power-per-energy ratio, thus requiring a greater number of cells to compensate for their low pulse design. This often results in compromise solutions that require added space and unneeded cell capacity.

Long-life rechargeable cells: If your application calls for a rechargeable battery, be aware that consumer-grade rechargeable lithium-ion (Li-ion) cells have inherent limitations, including a maximum battery life of approximately three years and 300 full recharge cycles, a relatively narrow temperature range with no ability to discharge or recharge at extremely cold temperatures, and the inability to generate high pulses to power two-way wireless communications (table 2).

		TLI-1550 (AA) Industrial grade	Li-ion 18650
Diameter (max)	[cm]	1.51	1.86
Length (max)	[cm]	5.30	6.52
Volume	[cc]	9.49	17.71
Nominal voltage	[V]	3.7	3.7
Max discharge rate	[C]	15C	1.6C
Max continuous discharge current	[A]	5	5
Capacity	[mAh]	330	3000
Energy density	[Wh/l]	129	627
Power [RT]	[W/liter]	1950	1045
Power [-20C]	[W/liter]	> 630	< 170
Operating temp.	deg. C	-40 to +90	-20 to +60
Charging temp.	deg. C	-40 to +85	0 to +45
Self-discharge rate	[%/year]	<5	<20
Cycle life	[100% DOD]	~5000	~300
Cycle life	[75% DOD]	~6250	~400
Cycle life	[50% DOD]	~10000	~650
Operating life	[Years]	>20	<3

Table 2. Comparison of consumer versus industrial Li-ion rechargeable batteries.

If the rechargeable device needs to operate for more than 300 recharge cycles, then extra consumer-grade Li-ion cells may be required to reduce the average depth of discharge per cell. Choosing a battery with a higher cycle life could reduce the total number of cells needed. Fortunately, industrial-grade rechargeable Li-ion batteries are now available that can operate for up to 20 years and 5,000 recharge cycles while delivering the high pulses (15 A pulses and 5 A continuous current) required to power two-way wireless communications. These industrial-grade batteries also have an extended temperature range (-40°C to 85°C) that allows them to be charged and discharged at extremely cold temperatures (figure 3).



Figure 3. IPS solar-powered parking meters use TLI Series rechargeable lithium-ion batteries to ensure long-life reliability at extreme temperatures.

Handling high pulse requirements: The growth of the Industrial Internet of Things (IIoT) has expanded demand for remote wireless devices that require high pulses to power two-way communications and other advanced functionality. Alkaline batteries are ideal for delivering high pulses due to their high rate design, but have major limitations, including low voltage (1.5 V), a limited temperature range (0°C to 60°C), a high self-discharge rate that reduces life expectancy, and crimped seals that may leak. Alkaline batteries may also need to be replaced every few months due to a very high self-discharge rate, causing long-term maintenance and reliability concerns, especially for remote applications.

Standard bobbin-type LiSOCl_2 batteries are the preferred choice for delivering long-life power to remote wireless devices. However, these cells are not designed to deliver high pulses, as they can experience a temporary drop in voltage when first subjected to a pulsed load: a phenomenon known as transient minimum voltage (TMV). Consumer electronic devices often use supercapacitors to minimize TMV. However, supercapacitors are infrequently used in industrial applications due to major drawbacks, including bulkiness, a high annual self-discharge rate, and a limited temperature range. Solutions involving multiple supercapacitors also require the use of expensive balancing circuits that draw additional current, which further increases self-discharge.

A more practical solution may be to combine a standard bobbin-type LiSOCl_2 cell with a patented hybrid layer capacitor (HLC). The battery and HLC work in parallel: the battery supplies long-term, low-current power in the 3.6 to 3.9 V nominal range, while the single-unit HLC acts like a rechargeable battery to deliver periodic high pulses, thus avoiding the need for supercapacitors. This hybrid battery design has an added bonus: a unique end-of-life voltage curve plateau that can be interpreted to deliver low-battery status alerts (figure 4).



Figure 4. Bobbin-type LiSOCl_2 batteries use a patented hybrid layer capacitor to run up to 40 years with high pulses for two-way wireless communications.

Reducing solar panel and battery sizes in energy harvesting systems

Solar panels and their companion rechargeable batteries have to be designed oversized to consider worst-case scenarios, such as periods of no sun for up to five days, which is rare but could happen. Primary (non-rechargeable) bobbin-type LiSOCl_2 cells can provide a backup energy source to charge the rechargeable battery on days when there is no sun, which could enable the use of smaller solar panels and smaller batteries. This backup energy source ensures greater product reliability, powering the device during months of extended darkness (polar winters) or up to years of storage.

Cheaper is often more expensive. Application-specific requirements dictate whether you can think short term and attempt to achieve the lowest initial purchase cost, or whether you need to think long term and be concerned about long-term product reliability and the total cost of ownership over the lifetime of the device.

If a wireless device is intended for long-term deployment in a highly remote and inaccessible location, then you need to be extremely wary about solutions that involve future battery replacement, as the downtime, cost of labor, and loss of data integrity could be far greater than the initial savings achieved with a low-cost battery.

You must also be aware of the hidden costs associated with excessive battery size and weight. For example, a compact and lightweight power supply could be especially valuable to research scientists conducting experiments in frigid Arctic conditions, as they have limited dexterity and need to conserve energy. Solutions that reduce battery size and weight also serve to minimize transportation costs, as the shipment of lithium batteries has become more expensive due to increasingly restrictive United Nations and International Air Transport Association shipping regulations.

Generally, if the device is easy to access and operates at ambient room temperature, then think seriously about specifying a consumer-grade battery. Conversely, if the application involves a remote location or extreme environment, then think long-term and pay a little more initially for an industrial-grade lithium battery that can operate for the life of your wireless device, reducing your total cost of ownership.



More rugged than consumer-grade rechargeable li-ion batteries, TLI Series cells offer up to 20-year service life, a wider operating temperature range, and high pulse capabilities to power two-way wireless communications.

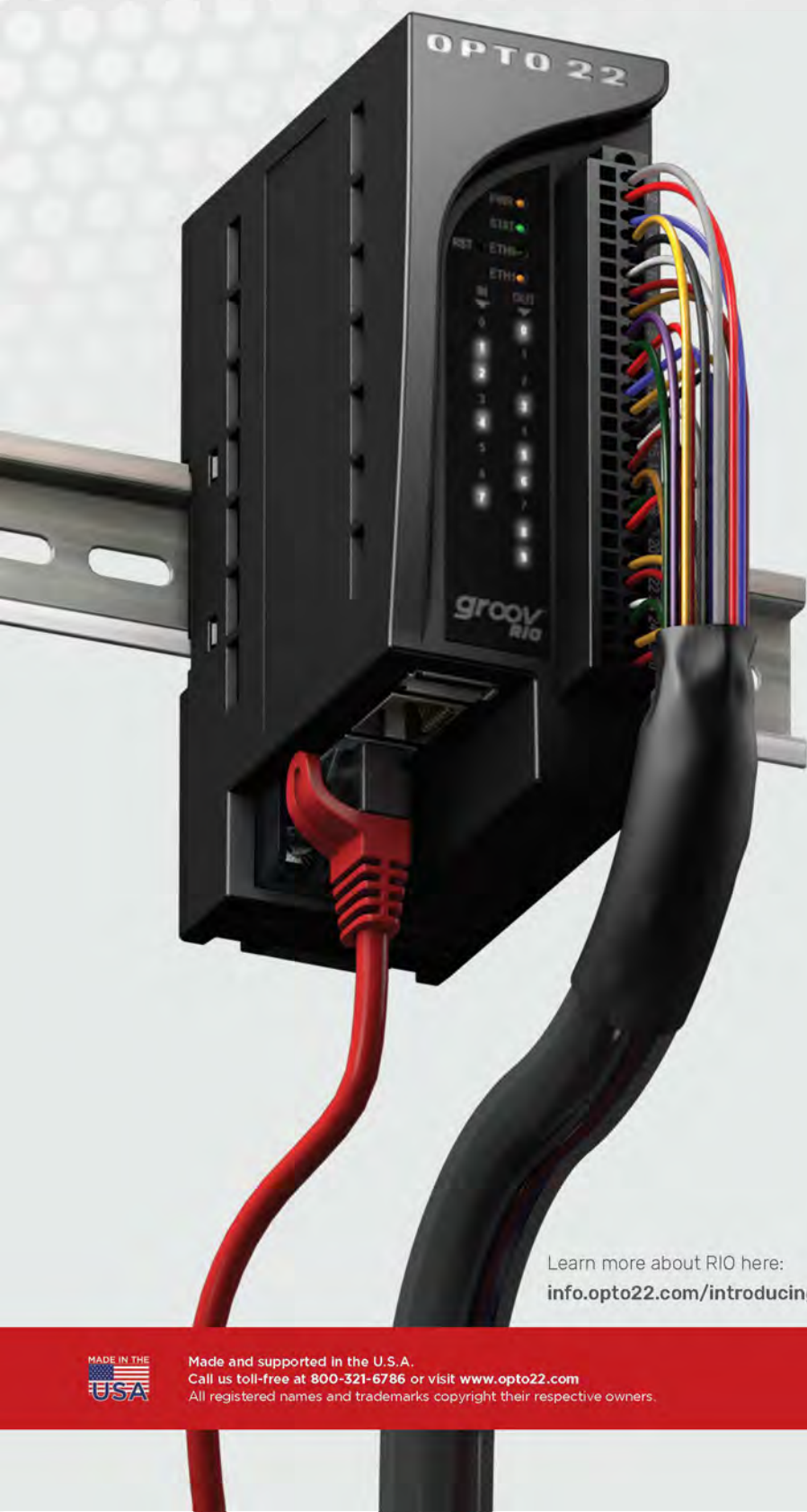
ABOUT THE AUTHOR



Sol Jacobs is vice president and general manager at Tadiran Batteries. Jacobs has more than 30 years of experience in powering remote devices. His educational background includes a BS in engineering and an MBA.

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I/O for the IIoT

A simpler way to meet the input/output needs of today's Industrial Internet of Things applications

By Josh Eastburn, Opto 22

In an era of increasing connectivity and technical capabilities, it seems like simple ideas should be, well, simple to achieve. Suppose you need to:

- ▶ log temperature data from a refrigeration unit into a database
- ▶ receive a text message if a warehouse door is opened after hours
- ▶ send an air compressor's total running time to a cloud analytics system
- ▶ publish process flow and pressure data into a supervisory control and data acquisition (SCADA) system
- ▶ control a security light with your smartphone

Simple ideas, right? They are all achievable, but in practice, they are difficult and expensive and require special skills.

IIoT projects are too complex

Even today, implementing these ideas is typically a complex task. While smart wireless devices are becoming more available, the majority of signals in the real world come from basic switches, sensors, and transmitters that need wired connections. Sending their data where you want it to go is more complicated than it should be.

To log temperature data into a database, for example, you first need to specify and procure all the numerous components of an I/O or programmable logic controller (PLC) system that will work with a temperature sensor. Then you must assemble, install, and power up the PLC,

programmable automation controller (PAC), or other system enclosure. Next, you will need to install a temperature sensor in the refrigeration unit and connect it to a suitable input channel on a temperature input module mounted on the PLC rack. That controller needs to be programmed using the vendor's proprietary software to configure the input channel for the correct signal type and to acquire and log the data.

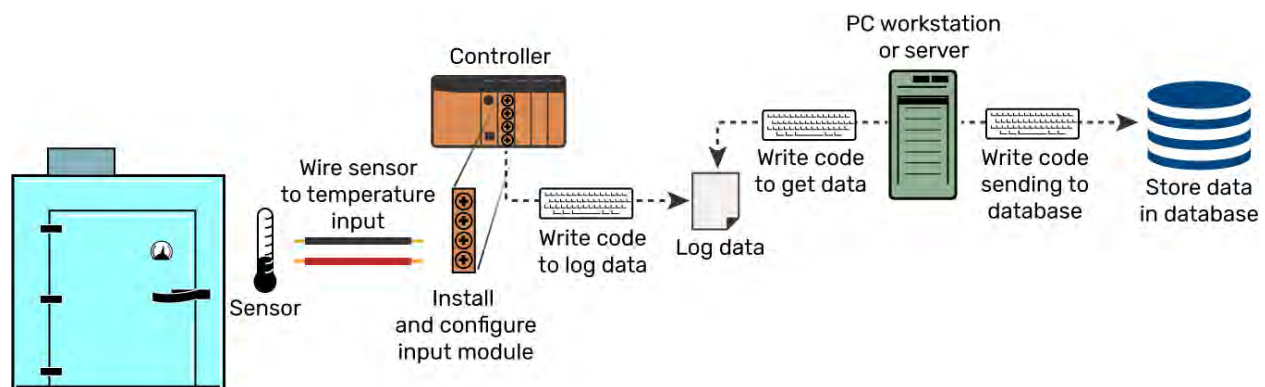
Then, you will likely need a PC with a software application that can read the controller's memory for the logged data and translate the data into a format the database can understand. Finally, some other software will need to connect to the database, and post, or insert, the logged, translated data. And if the database is not on premises, or in the cloud somewhere, you will need even more equipment to create that connection.

What about sending compressor on time to a cloud analytics platform or publishing process data to your SCADA? Even in the age of IIoT, these common scenarios involve many steps that require the skills of many different people. Between an engineer, the purchasing department, and possibly an industrial electrician or system integrator, you can specify, buy, and install the equipment. Then, the system integrator can wire up the signals. After that, another engineer has to program the controller to configure the inputs and process the signals (scaling, totalizing, comparing, and so on) in order to gain useful information about your equipment. And while that is going on, another engineer familiar with information technology (IT) systems configures the layers of additional information processing to read the controller's memory, format the data, secure it, and transmit it to the destination of your choice. Not simple.

Connected applications like text notification and turning on a security light from your phone have also become much easier than they used to be, but still involve many steps. They also involve working with protocols native to IT systems. If your human-machine interface (HMI) program is not mobile ready, you have to send data to another system, which might mean managing duplicate tag databases or writing custom application code.

In just these few examples, we can see that meeting seemingly simple needs today is still a complicated process. In other cases, you already have sensors, contacts, and transmitters in place with the data you need, but that data is locked in proprietary PLC systems behind someone's control program. To access that data, typically you have to:

- ▶ change the program in the PLC, PAC, or other controller to acquire the data you need
- ▶ purchase and activate necessary middleware (hardware and software, including licenses) with the protocols, languages, and translators required for your application
- ▶ configure and program middleware as necessary to move data where it is needed



Problem: Traditional architectures involve many steps and components to get I/O data where you want it to go.

- ▶ understand and configure Internet gateways and network connections, including server firewalls, security certificates, and user accounts
- ▶ establish communications between middleware systems and the data's destination

Moving toward simplicity

The goal we are trying to reach with the Industrial Internet of Things (IIoT) is a simpler process of gathering data, communicating it, and making it available where it needs to be used. Whether you are monitoring remote assets, acquiring data for analysis or regulatory purposes, controlling equipment and processes, or bringing visualization to operators and supervisors, we want to avoid complexity and the time, money, and risk that go with it.

Fortunately, automation manufacturers are introducing newer kinds of remote I/O with features that help streamline IIoT projects. One of these is the *groov RIO*® family from Opto 22.

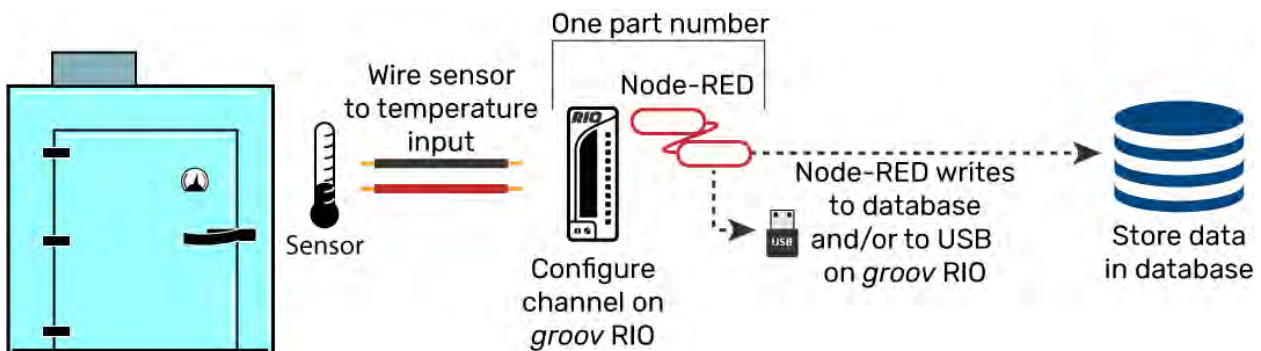
New remote I/O solutions are designed to streamline IIoT integration.

The first product released in this family is a compact, power-over-Ethernet (PoE) remote unit with built-in, mixed-signal I/O channels and a communications processor. Not a controller, the product was designed as an intelligent, distributed I/O device to meet the needs of applications that require data logging or data communications, commonly found in IIoT. It has a standalone, industrial package with

web-based configuration and data processing built in, plus support for multiple operational technology (OT) and IT protocols, which reduces the infrastructure needed for I/O integration from many layers to a single device.

Let's see how a product like *groov RIO* could help with our five examples. With mixed-signal I/O and power over Ethernet, *groov RIO* reduces the difficulty of getting I/O connected. There is only one device to specify, because each I/O channel can be configured for discrete or analog signals, as inputs or as outputs. And installation requires much less setup because you get communication, unit power, and output loop power over the same cable. In fact, with rugged, UL-listed construction, hazardous location and ATEX approvals, and a wide operating temperature (-20°C to $+70^{\circ}\text{C}$), an enclosure is not necessarily required. Attach *groov RIO* to an Ethernet network through one of its two switched, Gigabit interfaces, and the device automatically receives an IP address, just like most other smart devices on an Ethernet network.

Once *groov RIO* is in place, you open a web browser on a PC, tablet, or smartphone, type in the unit's name or IP address, and follow the simple menu options to configure the I/O channels and set up communications for your application. Here is what the remaining steps would look like for each of our example applications.



Solution: Intelligent remote I/O solutions make it easy to bring I/O directly into IIoT and automation applications.

Log refrigeration unit temperature to a database

1. Place a low-cost, two-wire, integrated circuit temperature device (ICTD) temperature sensor in the refrigeration unit, and wire it up to one of the first eight *groov* RIO channels.
2. From a computer or mobile device, log into *groov* RIO with your username and password, and use *groov* Manage to configure the channel as an ICTD input sensor. (You can also find the wiring diagrams for all supported sensors, switches, and transmitters within the same screens.)
3. Still in your web browser, open the included Node-RED editor and use a prebuilt database node (Node-RED function) to create a simple data flow that moves the temperature data to an on-premises or a cloud-based database, like MariaDB, Microsoft SQL Server, or PostgreSQL.
DONE!

You could also write a Node-RED flow to log the temperature to an installed USB memory stick connected directly to *groov* RIO's USB port—which is especially handy if the remote location has no Internet connection.

Receive messages when a warehouse door opens

1. Wire a simple dry contact switch attached to the door to one of the first eight channels on the *groov* RIO.
2. In a web browser, configure the channel for powered switch input. No other external power is required because *groov* RIO provides excitation voltage.
3. Open Node-RED, install the email and scheduling nodes, and create a short program to check the time of day. If it is after hours, have it send an email or text to your mobile device.
DONE!

Send compressor on time to a cloud analytics system

1. Wire the compressor's run/stop dry contact status switch to one of the first two channels on your *groov* RIO.
2. In a web browser, configure the channel as a discrete input with the on-time totalizing feature, and *groov* RIO will automatically total the amount of time the compressor is running.
3. Open Node-RED and create a simple data flow to move totalized data directly to your cloud analytics system (Watson, AWS, Azure) on a chosen interval. No PC or other software is required.
DONE!

Publish data to a SCADA system

1. Wire process instrumentation transmitters (like level, flow, or pressure) to the first four *groov* RIO channels and configure them as analog inputs (voltage or current).
2. In *groov* Manage, configure MQTT (formerly MQ Telemetry Transport) communications to publish channel data to an MQTT broker. SCADA systems can then subscribe to data from the broker.
DONE!

Note: If you have Ignition from Inductive Automation, you can use the Cirrus Link MQTT Distributor module as your broker and publish *groov* RIO's MQTT Sparkplug B data directly into the Ignition platform. An efficient publish-subscribe method of communication like MQTT reduces security concerns by eliminating open network ports and provides a high-performance, two-way communications path for both monitoring and control.

Control a security light via smartphone

1. Wire one of *groov* RIO's two mechanical relay outputs to the security light on/off control.
2. Open Node-RED from your mobile device, download a dashboard user interface node, and create a program with a toggle button in the dashboard that opens or closes the relay, turning the light on or off.

DONE!

Key simplifiers

These scenarios point out some important ways in which a remote I/O product like *groov* RIO can simplify your IIoT projects.

- ▶ **Easy to spec and buy.** A single part number gives you everything you need: networking, processor, I/O, DIN rail or panel mounting, power (PoE), and software. At \$749 USD each, the cost is within many maintenance budgets.
- ▶ **Flexible I/O.** With eight multifunction, multisignal (DI/DO/AI/AO) channels, configurable from included web-based software, and two Form C relay outputs, *groov* RIO supports more than 52,000 field I/O combinations. It also has intelligent features, such as counting, thermocouple linearization, digital totalizing, scaling, ramping, and proportional, integral, derivative (PID) control.
- ▶ **Compact and sturdy.** This small industrial unit can be placed almost anywhere. It takes up little space and does not require a power supply (PoE includes output excitation).
- ▶ **Included software and protocols.** With secure, authenticated web-based management software, it is easy to commission and troubleshoot the unit. Included Node-RED software lets you create simple data flows to connect *groov* RIO with local or cloud-based software and services. Modbus/TCP and MQTT add flexibility for data communications.
- ▶ **Built-in security.** To help you move data securely, RIO includes TLS-encrypted communications, a VPN client, security certificates, and a device firewall configured from the management software, plus user authentication.



Opto 22's *groov* RIO offers flexibility to enable fast, easy integration of traditional I/O into a variety of distributed applications.

Do you have a simple idea you would like to achieve without the complexity and cost of a typical IIoT project? Take a look at newer remote I/O products like *groov* RIO to simplify the technology stack and reduce the skillset you need to get going. For more information, [contact an Opto 22 engineer](#) or visit [groov RIO's webpage](#) at opto22.com.

ABOUT THE AUTHOR



Josh Eastburn is director of technical marketing at Opto 22. After 12 years as an automation engineer working in the semiconductor, petrochemical, food and beverage, and life sciences industries, Eastburn now works with the engineers at Opto 22 to understand the needs of tomorrow's customers. He is a contributing writer at blog.opto22.com.

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Reducing Risk on Industrial Machinery: An Introduction to the Updated ANSI B11.19 Standard

By Chris Soranno, SICK, Inc.

Part 1 of 6 in a series addressing the new (2019) edition of ANSI B11.19

The American National Standards Institute (ANSI) is the United States' national member body to the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC). It coordinates the participation and input of the U.S. in the development of international standards (such as ISO/IEC). ANSI also accredits organizations to develop standards for use within the U.S., according to procedures called essential requirements.

More than 11,000 American National Standards exist in the U.S., with many that apply to the safety of people working with industrial equipment. Of these, one of the most essential, and broadly applicable, is ANSI B11.19 – Performance Requirements for Risk Reduction Measures. This standard is part of the B11 series of machinery safety standards and applies to power-driven industrial machinery that is not portable by hand while working.

This includes “an assembly of linked parts or components (at least one of which moves) with the appropriate actuators, control, and power circuits, etc., that are joined together for a specific application such as, for the processing, treatment, marking, or moving of material.” This standard is developed as a type-B standard applicable across a broad range of industries. (See the previous SICK white paper, [Selecting Safety Standards for Machine Safeguarding Requirements](#), for further description of this stratification system.)

This white paper series is intended as an overview of the standard. True value can only be gained by obtaining and thoroughly reviewing the standard's content. The standard is available now from various technical document providers, including directly from the [ANSI webstore](#). While interpretation and application of the many standards may be cumbersome at times, qualified consultants, including [SICK services](#), are available to assist for each unique application.

History of ANSI B11.19

In October of 1980, the B11.19 subcommittee was established to fill a need for a standard outlining the construction, care, and use of guards, devices, and methods for safeguarding the point of operation of machine tools. The development of the first edition was complicated by the wide variety and size of machinery existing in industry. Almost a decade was required to develop the first edition in order to meet the demands for a general descriptive organization of safeguards. However, the edition was proven to be well worth the effort, as it was reaffirmed in 1996 without change.

By the end of the 1990s, an update to the standard was necessary in order to implement new research and keep up with changes in the environmental health and safety (EH&S) profession. Of these, the concept of safety distances based upon anthropomorphic data had been updated by Liberty Mutual based on a larger population survey, which included both women and minorities in the workplace. The first revision of the standard resulted in the 2003 edition of ANSI B11.19.

Following the ANSI requirement for a five-year review cycle, the standard was found to be in need of another revision. As part of the third edition, a number of new topics were added, as well as concepts from another widely used safety standard, ANSI/ASME B15.1 – *Safety Standard for Mechanical Power Transmission Apparatus*, which had recently been withdrawn. Furthermore, the 2010 edition placed a greater emphasis on the risk assessment process. The intent was to allow safety solutions commensurate with the required level of risk reduction that could be reasonably justified through the process of a documented risk assessment.

Upon the next mandatory review cycle, it was again determined that additions and modifications to the standard could further support and advance safety efforts. The new fourth edition (2019) of ANSI B11.19 is the result of an extensive, four-and-a-half-year revision process containing substantial and significant changes—many of which will be highlighted in this white paper series.

First resource for risk reduction

Throughout its history, ANSI B11.19 has not provided the requirements for the *selection* of the risk reduction measures, as this selection is part of the risk assessment process (See SICK white paper, [The Risk Assessment Process](#), for further information). Instead, ANSI B11.19 is only intended to address the *implementation* of a risk reduction measure once chosen.

One of the goals of the subcommittee was to develop a document that could be used hand in hand with the risk assessment process of ANSI B11.0 – *Safety of Machinery*. ANSI B11.0 has also been recently revised, with a new fourth edition developed in parallel to B11.19 that is now available. In order for ANSI B11.19 to be a true counterpart to ANSI B11.0, the standard needed to be a guidance document providing the most comprehensive resource for various types of risk reduction measures.



ANSI B11.19 allows engineers to apply the risk reduction process to industrial machinery.

Building upon the existing content, the experts included guidance for additional measures, as well as references to external documents providing a thorough overview of specific topics. As a result, the 2019 edition effectively complements the risk assessment process by providing a nearly complete list of risk reduction measures, including requirements—or resources where such requirements can be found in other U.S. standards—to achieve the desired level of risk reduction. An overview of the risk reduction measures added to ANSI B11.19 in the fourth edition will be addressed in detail in the next white paper in this series, [Newly Added Risk Reduction Measures in the Updated ANSI B11.19 Standard](#).

A result of this revision is a standard that has more than doubled in size from the previous edition, but that at the same time provides a comprehensive resource unequalled by any other standard available at this time. An outline of domestic and international standards addressing similar risk reduction measures is included in the new edition in “Annex O – Risk Reduction Measures in Use.”

Modified structure

The risk assessment process is not complete until adequate risk reduction is achieved. While ANSI B11.0 addresses the risk evaluation process and selection of appropriate measures, ANSI B11.19 is meant to describe how to apply the risk reduction measures once selected. To further achieve the aim of creating a companion document for ANSI B11.0, the subcommittee also implemented modifications to the organizational structure of the content.

As discussed in a previous SICK white paper, [The Risk Reduction Process Utilizing a Hierarchy of Controls](#), the “hierarchy of controls” provides a rational approach to risk reduction. This approach is based on the understanding that measures independent of human action or behavior are more effective, and therefore preferred. An equivalent approach is described in ISO 12100 that is called the “three-step method.”

In order for ANSI B11.19 to assist engineers and safety professionals with the application of risk reduction measures, it was only logical that the document should also follow the organization structure of the hierarchy of controls. Therefore, the measures included in the new standard now follow the same three-step method. However, since the second step of risk reduction—often called “safeguarding” or “engineering controls”—includes such a large variety of techniques, the measures were further partitioned into additional clauses with a more specific focus for each subset.

As with previous editions of the standard, the first few clauses address universal topics applicable throughout the entire document. In the fourth edition, clauses 1 through 5 represent the universal concepts. Additionally, it was recognized that there are a number of elementary requirements that are fundamental to all risk reduction measures. Rather than repeating the same underlying concepts, the subcommittee agreed to extract these principles into a central location, preceding all the specifications of the techniques addressed in the standard, resulting in a new “general requirements for ALL risk reduction measures” in clause 6.



The standard is a counterpart to ANSI B11.0, providing a resource for various types of risk reduction measures.

The remainder of the clauses (7 through 11) address the hierarchy of controls and also have common expectations that must be applied. For each major clause addressing a new group of risk reduction measures, the first subclause always addresses those general requirements that apply to all of the subsequent measures addressed within each grouping, as represented in table 1.

To the reader intending to implement the requirements of the new ANSI B11.19, this means the entire document must be read and applied in context. For example, to understand all of the technical requirements for a safety light curtain (addressed specifically in clause 10.7.2), the reader must also apply the following generalized requirements:

- ▶ General requirements for risk reduction measures (clause 6.1)
- ▶ General requirements for engineering controls – devices (clause 10.1)
- ▶ General requirements for presence sensing devices (clause 10.7.1)

This “stratified” approach repeats for each of the risk reduction measures discussed.

To assist the reader with the new format of the standard, especially for readers familiar with the previous 2010 edition, a new annex was introduced to provide a cross-reference: “Annex P – Cross-Reference Mapping of ANSI B11.19: 2010 vs. 2019.” This annex provides both old-

1 Scope												
2 References												
3 Definitions												
4 Responsibilities												
5 Risk Assessment Process												
6 Risk Reduction Measures												
6.1 General Requirements for Risk Reduction Measures												
STEP 1				STEP 2					STEP 3			
7 Inherently safe by design				8 Engineering controls – guards					9 Engineering controls – control functions			
7.1 General requirements for inherently safe by design measures				8.1 General requirements for engineering controls – guards					9.1 General requirements for engineering controls – control functions			
7.2 Prevention through design				8.2 Fixed guards					9.2 Performance of safety functions			
7.3 Safe-opening safeguarding method				8.3 Movable guards					9.3 Monitoring functions			
7.6 Maximum gaps to avoid exposure to hazards				8.10 Shields					9.12 Span of control			
7.10 Awareness means				8.13 Trapped (captive) key systems					9.13 Interlock devices			
7.13 Slide locks				8.15 Awareness means					9.15 Information for use (human & organizational)			
7.18 Personal protective equipment (PPE)				8.18 Information for use (human & organizational)					9.18 Awareness means			

Table 1. Structure of new ANSI B11.19-2019 (all subclauses not listed).

to-new and new-to-old comparisons of the 2010 and 2019 editions, and also highlights topics newly introduced in the latest edition. It also provides a visual structure tree of the new format.

While the reorganization of the standard was fairly straightforward, there was one existing measure that struggled to find a location deemed acceptable to everyone. The concept of the safe-opening safeguarding method has been in use for a long time and has appeared in every edition of ANSI B11.19 starting in 1990. This solution is a mixture of all three steps of the hierarchy:

- ▶ Maximum gap to prevent exposure (inherently safe by design, see clause 7.6)
- ▶ Prevention of cycling when workpiece is not present (engineering controls – control function, see clause 9.3)
- ▶ Supervision of adjustable guards (administrative controls, see clause 11.5)

This methodology of reducing risk, as exemplified in SICK's Safeguard Detector system for packaging applications, had no clear “home” in the standard. After much deliberation, it was placed in “Inherently Safe by Design (Step 1)”; however, it is clear that additional measures from both Steps 2 and 3 are still required in order for the solution to adequately reduce risk.

Amended terminology

Another outcome realized in the fourth edition is terminology changes used within the document. While seemingly inconsequential at first, a number of “commonly used” phrases by safety professionals are no longer in the document. In part, it was determined that many of the expressions used frequently are—unfortunately—not used consistently. While a standard may not change the vocabulary used by engineers and EH&S professionals overnight, it was important that the new standard not perpetuate the habit of using similar root terms or phrases to represent very different concepts.

Safeguard

The biggest example of such a change is to the title of ANSI B11.19. Previously referred to as *Performance Criteria for Safeguarding*, the title is now *Performance Requirements for Risk Reduction Measures*. To aid those familiar with the previous editions, the standard also includes a subtitle *Safeguarding and other Means of Reducing Risk*.

In the ever-growing global market, it is now more common for engineers to be familiar with standards used outside of the United States—especially international standards that are applied in many countries around the world. ISO 12100 – *Safety of machinery – General principles for design – Risk assessment and risk reduction* is a pervasive document in the realm of industrial safety. Therefore, it was imperative to both acknowledge the issues and present solutions that, at a minimum, would not continue to spread conflict between standards.

In ISO 12100, the steps of the three-step method are listed as follows:

- ▶ Inherently safe design measures
- ▶ Safeguarding and complementary protective measures
- ▶ Information for use

As noted above, however, the previous editions of ANSI B11.19 all included “safeguarding” in the title. The predicament this caused, especially for global organizations, is that ANSI B11.19 has always included techniques that are not confined to only Step 2 of the hazard control hierarchy. Therefore, the consensus of the experts was to replace the term “safeguard” (and its derivatives) with more accurate terms.

Upon review of the document, most occurrences were either in reference to:

- ▶ *all* measures used to reduce risk, which have been replaced with the term “risk reduction measures” or
- ▶ measures *specifically* within Step 2, which are now referred to as “engineering controls,” and where necessary, specific subgroups.

Some instances of the term still exist, but only where it was part of an existing phrase used to name a specific concept or measure (e.g., safeguarded space, safeguarding method).

Complementary measures

Conversely, the subcommittee also found instances where alignment with ISO 12100 was not compelling. As noted above, Step 2 of the risk reduction process in ISO is listed as “safeguarding and *complementary protective measures*.” This concept was first represented as “auxiliary equipment” in the first edition of B11.19, but then was modified to “complementary measures” starting in 2003 and continuing into the 2010 version.

Under the common thinking of the 1990s and early 2000s, risk reduction measures were segregated into two basic groups: those used to reduce risk during normal operation, and those used for all other modes (teaching, setup, maintenance, etc.). However, as the methodology of risk assessment has continued to advance through the years, a paradigm shift has begun to permeate through the industry.

Under the risk assessment process, specific tasks are paired with specific hazards, and the combined risk factors are evaluated. When the initial risk is unacceptable, the risk reduction process is applied. For tasks that are nonproduction, the common “primary” measures in Step 2 are often not applicable. Therefore, the measures actually used to reduce risk for some tasks are in fact not complementary to anything; they are, in and of themselves, the only measures in Step 2 that are effective.

A familiar example in the robotic industry is the task of teaching a robot. Most traditional robot cells include perimeter barrier guards combined with either interlocked access doors or presence-sensing devices, such as light curtains or area scanners. For tasks associated with normal operation, these “primary” measures are active and effective.

However, for a task such as teaching the robot, the employee is often required to be inside the robot cell. Therefore, the perimeter measures are deactivated, meaning they do not remove drive power to the robot. Otherwise, the robot would have no power available to perform the teaching functions. Instead, the measures from Step 2 applied to reduce risk for teaching (such as an enabling device combined with a hold-to-run control and speed-monitoring features) are active, *instead of*—not complementary to—the perimeter measures that are active for completely different tasks. Therefore, all measures in Step 2, including guards and all devices that are integrated into the safety-related part of the control system (SRP/CS), are now termed as “engineering controls.”

SICK's Safeguard Detector System for packaging applications exemplifies the concept of the safe-opening safeguarding method in the standard.



Stop

With the improvements in automation technology over the past few decades, machinery is now much more flexible than in the past. Machines of the past only had one condition where personnel could be considered safe from mechanical hazards: when a machine was completely stopped.

However, current advancements now allow reliable control and monitoring of machine conditions, including speed. Newer equipment often uses safety-rated drives to accurately control speed conditions, but when a complete retrofit of existing equipment is not practical, solutions like SICK's FX3-MOC Drive Monitor system and DFS60S Safe Encoder can be used. With reliable detection and control of speed now a reality, equipment can be deemed adequately safe under conditions where velocity is greater than zero.

Due to these new advancements, the standard is needed to transition to alignment with this new paradigm. Therefore, the terminology associated with the result of an action by the SRP/CS is no longer to “achieve a stop,” but rather to “achieve a safe condition” (with the exception of emergency stop conditions). The concept of *achieving a safe condition* is now explored at great length in the new editions of both ANSI B11.19 and ANSI B11.0, including a number of informative annexes added to ANSI B11.19-2019 (addressed in more detail in Part 6 of this white paper series):

- ▶ Annex J – Measurement & Calculation of System Performance to Achieve a Safe Condition
- ▶ Annex K – Achieving a Safe Condition
- ▶ Annex L – Safety Functions for Power Drive Systems
- ▶ Annex M – Supplier Information for Time and Distance to Achieve a Safe Condition



Machine builders can add products like SICK's FX3-MOC Drive Monitor system to control machine speed and ensure safe operations.

Safety blocks, etc.

The means of inserting a prop between opposing machine or tooling members to prevent hazardous motion of one or both members has been in existence for many decades. However, the terminology used to address this concept in previous editions of ANSI B11.19 was quite lengthy; therefore, the phrase “restraint mechanism” is now used in the new edition to refer to safety blocks, chain locks, locking pins, and limiting/blocking pins. This modification was made in order to closely align with other widely used standards, including ISO 12100 (*mechanical restraint device*) and ANSI/ASSE Z244.1 (*restraint devices*).

Restraint devices

In light of the change mentioned above, the term “restraint device,” as used in all previous editions of B11.19, required realignment. This term was used in reference to a device with attachments for the operator’s hands and wrists that prevents the operator from reaching into the hazard zone. Similar to *pull back (pull out) devices*, both measures require a machine operator to be “strapped in” to the machine (typically a press). While a pull-back device is mechanically connected to a moving portion of the machine to withdraw the operator’s hands from the hazard zone during operation, restraint devices were simply anchored to a fixed point, with the length of the attachment cables defined and anchored at a fixed distance.

Because *restraint device* has a very different meaning in other broad industry standards, the goal of the subcommittee was to reduce confusion as much as possible. Therefore, the term “restraint device” as it relates to mechanical attachments for the operator’s hands has been changed to its other widely used and recognized designation of “hold-out device.”

Conclusion

As outlined in this article, the new ANSI B11.19 standard is indispensable to engineers and safety professionals applying the risk reduction process to industrial machinery by fulfilling the goal of complementing the risk assessment process. The new standard has made attempts to align with other widely used standards, both domestically and internationally, by reducing conflicts in terminology and technical requirements. Furthermore, it also introduces requirements for risk reduction measures previously nonexistent in other U.S. standards, as well as new measures or approaches not addressed in any other known standards globally. Therefore, it is highly recommended that the new editions of both ANSI B11.19 and ANSI B11.0 be acquired for immediate implementation to successfully reduce risks and improve worker safety on both new and existing equipment.

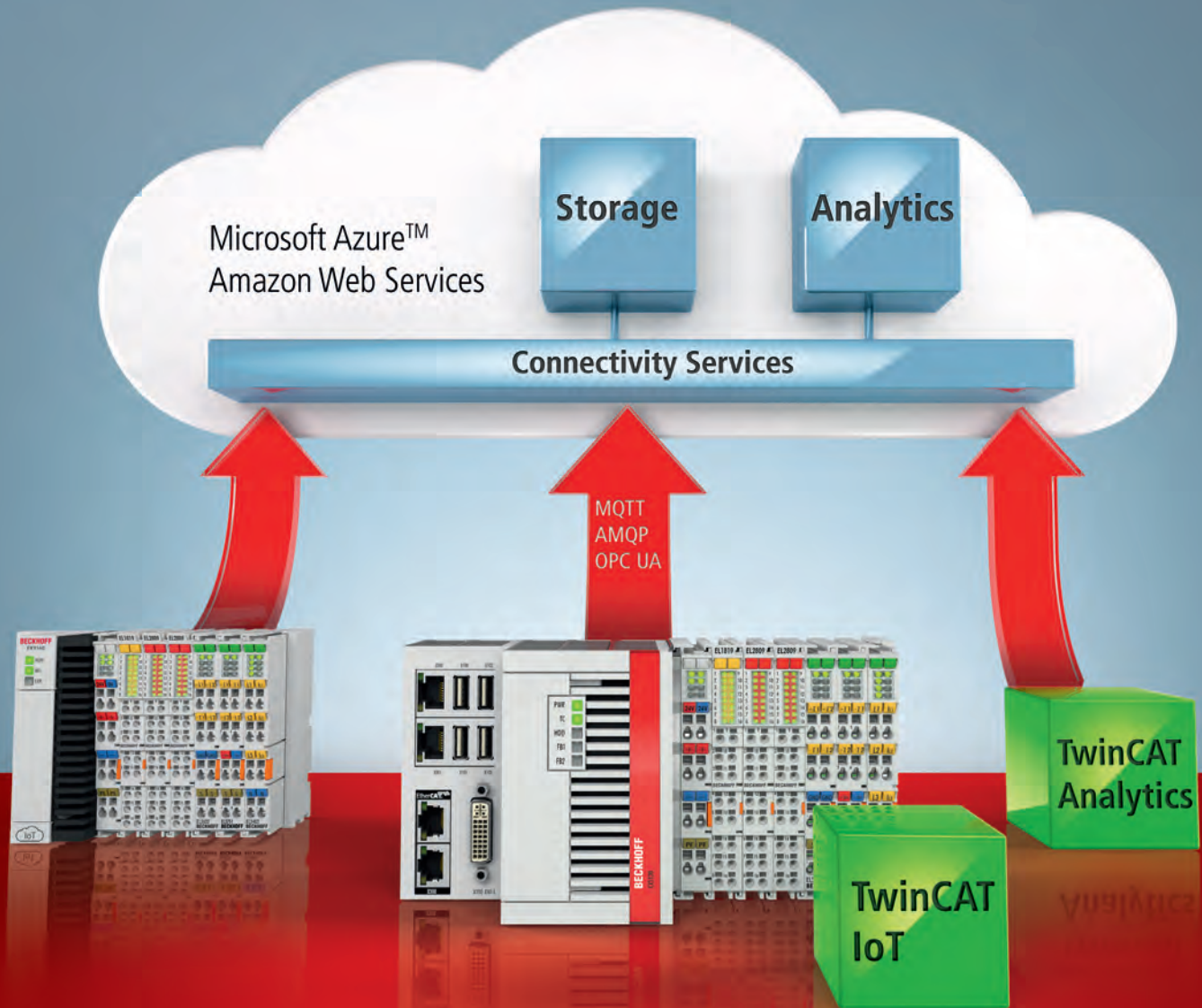
This white paper is meant for guidance only and is accurate as of the time of publication. When implementing any safety measures, we recommend consulting a safety professional.

ABOUT THE AUTHOR



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New Automation Technology **BECKHOFF**

How Smart Cyber-Physical Systems Benefit Machine Builders

Digital simplicity
streamlines all phases
of the life cycle of a
new system

By Philipp Wahl, Festo SE and Co.

Smart cyber-physical systems (CPSs) promise to increase production and future-proof new plants for machine builders and operators alike. Unlike traditional mechatronic processes, these solutions also simplify value chain processes—a phenomenon known as digital simplicity—leading to autonomous production with self-regulating systems. Let's explore the new technology behind CPSs—particularly, how it unites traditional pneumatics with electric automation to propel digital pneumatics further into the age of Industry 4.0.

Mechatronic systems bring together mechanical systems, electronics, control technology, and information technology, enabling them to interact. These systems enable extensive function integration, including greater system adaptability and standardization. Since fewer components need to be selected, procured, assembled, and wired, mechatronic systems lead to significant improvements along the value chain.

Despite all the benefits of modular mechatronic systems, however, there is still room for improvement when it comes to flexibility. This is where smart cyber-physical systems like the Festo Motion Terminal VTEM come in. These systems combine all the benefits of pneumatic and electric automation technology and integrate complex movements, variable positioning, condition monitoring, and many other functionalities into a single component.

Compared to conventional valve terminal platforms, the Festo Motion Terminal enables many complex movements—including various speed profiles and positioning tasks—that were formerly only possible with servo-pneumatics or electrical automation. This CPS solution makes it easier than ever to achieve a wide range of functions, condition monitoring, and preventive maintenance—all while expending less energy. The results are simplified processes, increased productivity, and better process reliability.

Motion apps replace hardware

The Festo Motion Terminal includes four 2/2-way piezo pilot and diaphragm poppet valves with integrated smart sensors. It has the traditional valve functions of 2/2-, 3/2-, 4/2- or 4/3-way valves, as well as proportional technology and servo-pneumatic functions—in one device. Other functions include preset travel time, ECO drive, and leakage diagnostics. Machine builders can perform these and more functions in a single valve design using motion apps.

CPS solutions like this are characterized by maximum flexibility. Even during operation, users can adapt system functions and movements via the software without making major changes to the hardware. They can also implement new functions quickly with a simple software update.



Smart systems can standardize system hardware while allowing fast, flexible changes via software.

Smart systems like this enable machine builders and end users to use one standardized platform for several applications without having to replace any hardware. It also streamlines and simplifies all phases of the life cycle of a new system.

Phase 1: Make contact. Innovative action begins with the right partner. Machine builders should ask themselves: Does your supplier operate globally? Can you count on your supplier to successfully deliver further developments in the future? After all, end customers will only invest in a new technology if it offers potential for the future.

Phase 2: Conceptualize. During this phase, machine designers create the foundation for the plant or system. Smart systems can standardize system hardware while still permitting a fast, flexible response to changes. All functional adaptations are easily accomplished via motion apps without ever changing existing hardware.

Phase 3: Design and program. The design phase is one of the most costly steps in the value chain, accounting for approximately 25 percent to 30 percent of costs. CPSs lead to significant time and cost savings compared to conventional valve terminal platforms. In some cases, the time saved designing and parameterizing a modular valve terminal reaches 70 percent.

Phase 4: Procure. During the procurement phase, a lot of data is processed—including delivery dates, prices, supplier details, and stock locations—and then entered and maintained in the enterprise resource planning (ERP) system. From a cost perspective, this complex task is often included as part of your overhead, which means the costs are not always directly visible.



CPS do not involve complex manual setting processes.

Modular systems like a valve terminal lead to significant savings, because you can order several components with one part number. But a CPS makes data management, logistics, and warehousing even simpler. These solutions open the door to entirely new business models and delivery times. With the Festo Motion Terminal, for example, machine builders only need to buy the appropriate [motion app](#) license to have the functionality they need. The benefits include shorter time to market and higher overall equipment effectiveness (OEE).

Phase 5: Assemble. Because human error is often the cause of system failures, reducing system complexity is becoming more important than ever. Solutions with intelligent function integration and fewer interfaces are therefore ideal for achieving maximum efficiency. These features reduce assembly work, as well as possible errors and queries that may arise. Having just one standardized component also optimizes process sequences for a wide range of functions.

Phase 6: Commission. Coordinating individual process steps, such as setting the travel speeds of cylinders, is a time-consuming process in conventional mechatronic systems. CPS solutions, on the other hand, do not involve complex manual setting processes. They are also self-regulating and self-optimizing in terms of their energy consumption—benefiting machine builders even further.

Phase 7: Operate. When it comes to cutting costs, improving sustainability, and meeting strict legal regulations, the spotlight is increasingly on energy efficiency. CPS solutions address that need. The Festo Motion Terminal, for example, provides an ECO drive app that saves on annual energy costs.

Phase 8: Modernize. Modernization serves many purposes, including increasing system output, expanding the range of products, and reducing operating costs. CPS solutions save energy, improve process efficiency and allow machine builders to easily adjust an entire machine series.

Digitization will profoundly alter the world of production. Cyber-physical systems like the Festo Motion Terminal are uncoupling pneumatic functions from mechanical hardware for the first time, moving a wide range of pneumatic motion tasks that can be performed with just a single valve type. This design offers many measurable benefits along the entire value chain.

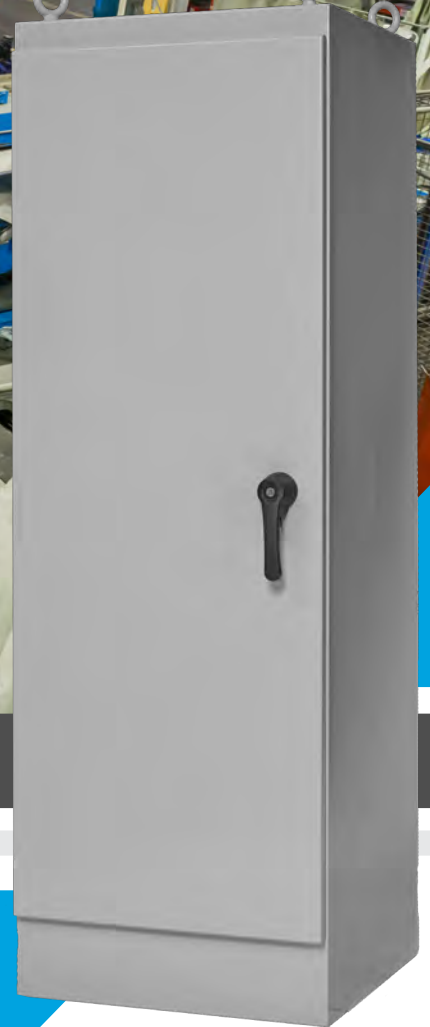
ABOUT THE AUTHOR



Philipp Wahl is part of the strategic marketing team for [Festo SE and Co.](#) Wahl studied mechanical engineering, specializing in production technology at Reutlingen University in Germany and completed his MBA in international marketing management at ESB Reutlingen. Whilst working at Trumpf Inc. (USA), he completed his thesis, which was subsequently patented by Trumpf Inc. He gained experience as a design engineer in automation systems for a number of industries during his time as a project manager for Manz AG, before joining Festo SE and Co.



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Demystifying Digital Transformation in Manufacturing

By Louis Columbus, IQMS/DelmiaWorks

Drivers include workforce changes and customer needs and expectations

To stay competitive, manufacturers must continually reinvent themselves and find new ways to improve—whether by delivering differentiated products, controlling costs, or improving quality. So, it should be no surprise that manufacturers' pragmatic, practical need for results presents a perfect proving ground for digital transformation techniques, technologies, and processes.

New digital technologies that promise to transform manufacturing must provide improved business outcomes if they are going to become engrained in the daily operations of any organization.

Today, three factors are accelerating the adoption of digital transformation techniques, technologies, and processes: the chronic labor shortage of workers in manufacturing, customers' requests for more product quality data on each production run that includes their orders, and customer expectations for price breaks over time.

This article looks at pragmatic strategies for applying digital transformation approaches in order to turn the industry pressures faced by manufacturing into opportunities for gaining a competitive advantage.

It's all about people

It is easy to focus too narrowly on the word "digital." However, real digital transformation is all about empowering people. That is particularly true at the core of manufacturing, where the goal is about improving how people get work done and how information technologies can help employees to streamline and improve the daily processes of producing high-quality products.

In my experience, 80 percent to 90 percent of a given enterprise resource planning (ERP) system implementation's costs are for customizing a system to match how teams work. This includes change management programs, training, and continual support of new technologies that support the core ERP platform. Spending on software is a mere 10 percent of a total implementation.

The same holds true for manufacturing's adoption of the latest digital transformation technologies, including additive manufacturing, analytics, 3D printing, the Internet of Things (IoT), machine learning, and manufacturing intelligence, to name a few. Adopting these new technologies has everything to do with change management, and the first goal is to define how they improve people's ability to get more done in less time while capitalizing on their core strengths as contributors.

The tighter the match of any new technology in the context of strengthening people's ability to contribute and help them excel, the higher the probability that an initiative will succeed. Therefore, giving employees greater training and expertise in using this technology to do their jobs is a compelling and proven business case that delivers results. By coupling years

of experience and expertise with the latest digital technologies and automation, manufacturers can create a winning combination that makes them formidable competitive forces in their markets.

● ● ● ● ● **Adopting new technologies** has everything to do with change management.

A report by McKinsey & Company on how digital manufacturing can escape "pilot purgatory" highlights how addressing the human factor is critical to closing the digital transformation gap that exists in manufacturing today. Although 70 percent of manufacturers told McKinsey that digital manufacturing is a top priority, just 30 percent of organizations have rolled out pilots companywide.

As part of its recommendations for closing this chasm, the McKinsey study recommends "getting ahead of the capability gap: build the skills to achieve impact and the culture to sustain it." At the same time, it emphasizes the importance of manufacturers having their senior management team champion any new digital initiative and model the behaviors needed to make it succeed.

From the CEO to senior executives and line managers, members of the leadership team need to show they have skin in the game and are completely committed. I have seen CEOs dive in to learn new applications and techniques, and even earn certificates in machine learning, so they can serve as role models for their teams. And it works; their efforts inspire others to continually improve.

● ● ● ● ● **Digital transformation** is not about replacing people; it must be about providing people new ways to excel in their jobs while capitalizing on their expertise and experience.

Digital transformation is not about replacing people; it must be about giving people new ways to excel in their jobs while capitalizing on their expertise and experience. The combination of human and tech factors leads to exponential gains in scale, speed, and productivity. McKinsey's excellent report underscores this point with examples and is worth a read.

Business case first, dashboard later

Manufacturing is dominated by professionals with engineering expertise, and many decisions are made with an engineering-driven mindset—one that highly values reliable, true analytics and metrics of performance. That is why many of manufacturers' initial digital transformation pilots are focused first on analytics and manufacturing intelligence.

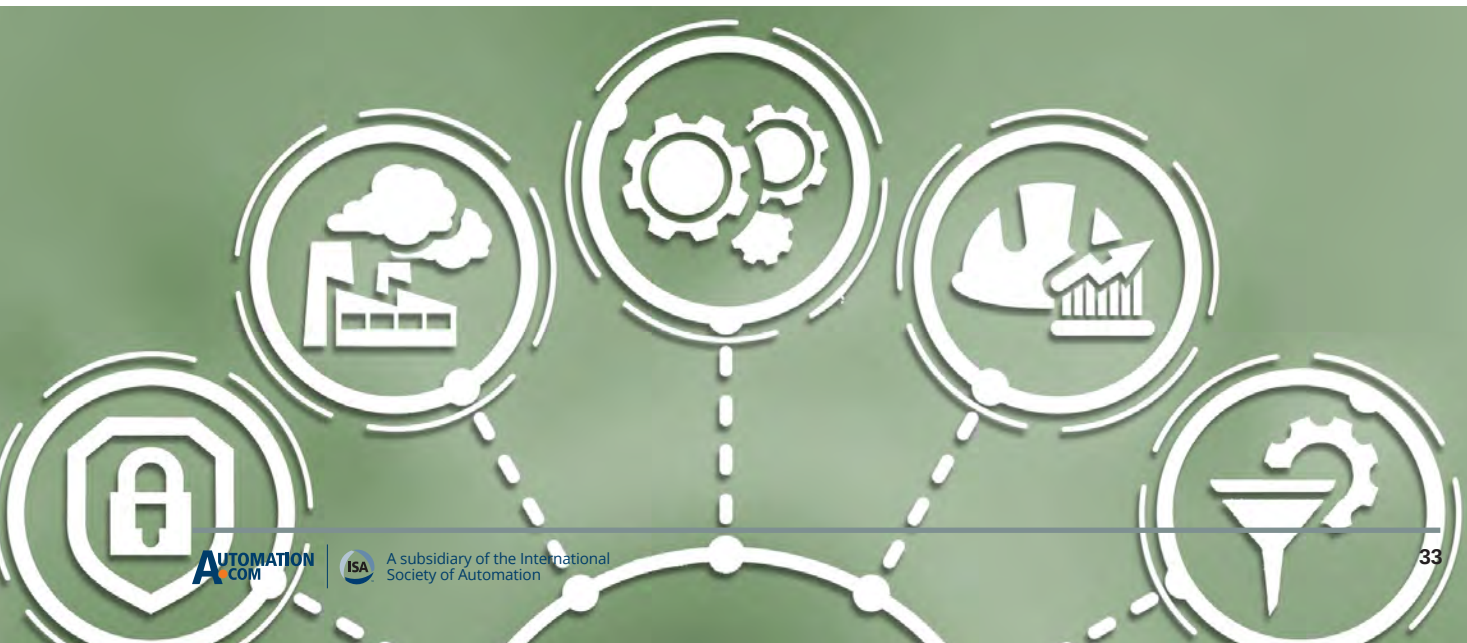
Such insights are highly valuable in the pilot and production phases of a digital transformation initiative. But before manufacturers start thinking about dashboards, they need to put their best engineering and financial minds to work on building a compelling business case if they are to attain the benefits they seek.

In laying the groundwork for their digital transformation, manufacturers need to build out a true business plan complete with financial projections of when, where, how, and why the new technologies are going to drive more revenue and reduce costs. This plan should focus on the incremental revenue gains and cost reductions possible with a new series of technologies, so that the company can recognize and track results early on. Without establishing this framework first, dashboards can quickly become swollen with so many metrics and key performance indicators that they become unusable in directing the digital transformation project.

By thinking about the business case first, manufacturers have a great opportunity to unleash their best minds on the most challenging problems of all: how to keep growing and keep costs down in uncertain times. However, manufacturers need to resist the temptation to trim headcount to get cost savings and instead look at which process areas are costing excess time and revenue.

Manufacturing's labor shortage is not going to end anytime soon, so keeping valuable workers is a prudent idea. Besides, as digital transformation efforts increase the open production hours that can be used to take on additional customer orders, those employees will be needed to build the products.

The best business plans are predicated on improving processes, products, and procedures that involve tight collaboration between personnel in design, investing, manufacturing engineering, sales, marketing, channel marketing, and pricing. Together these teams need to develop the business case and supporting road map of why any given new technology makes sense to adopt. By far the most effective business cases are those that seek to create greater orchestration for new product development across the many functional areas of a manufacturing operation.



Customer-driven manufacturing

One core focus of digital transformation in manufacturing today is tighter orchestration of new product development using product life-cycle management (PLM) with ERP and manufacturing execution system (MES) solutions, and sales and marketing insights from customer relationship management (CRM) software. By orchestrating these systems—which all too often do not communicate effectively with each other—manufacturers aim to respond faster to both customer demands and market conditions.

Real-time monitoring of production processes across different systems is often the first step in digitally transforming a business.

Often real-time monitoring shows the gaps between PLM, ERP, MES, and CRM systems that slow down new product development and make cost visibility a challenge to improve. Through real-time monitoring, manufacturers can access a contextually rich, real-time data stream to benchmark operations and determine the best approach to improve process areas.

For this reason, real-time monitoring of the most essential production processes across different systems is often the first step manufacturers take in digitally transforming their businesses. In taking advantage of real-time monitoring, the overarching goal needs to be providing design engineering with the same data that manufacturing, sales, and marketing teams are using, so all of manufacturing operations speak the same language.

True digital transformation helps teams to understand the constraints and challenges of the functional departments they rely on, and then applies integration to make each department multilingual from the standpoint of speaking the languages of teams they work with daily.

The most successful digital transformation efforts get everyone talking the same language by normalizing performance using real-time product and process monitoring to identify gaps between systems and then putting real-time integration in place to close those gaps. While all this is happening, production team members often remark that they are finally getting the data they need to excel at their jobs.

Most important of all, taking an integrative approach to digital transformation can keep manufacturing on the one true path of being customer-centric—focused on how to solve customer problems with products, delight customers with new product and service experiences, and help their customers grow.

Manufacturers that combine real-time product and process monitoring with system integration can better orchestrate the core enterprise systems they rely on. This, in turn, enables them to find new ways of optimizing production processes while paying attention to customers and how they are using products to help them grow.

Manufacturing trust

All manufacturers are part of a broader supplier network, especially those competing in business-to-business markets. Excelling as a supplier is best achieved by trimming time off the production process while improving quality and understanding tier-one supplier or original equipment manufacturer customers' needs to improve the end product.

Digital transformation selectively applied using a strong business case provides this level of end-to-end visibility for members of the supply chain. This visibility, for example, makes

track and trace functions much easier to accomplish than previous manual methods. Most important, with real-time product and process monitoring, manufacturers know where they are excelling and how they need to improve in supplying products to a final assembler.

The best-performing manufacturers on the planet may not always be the most well-known or those mentioned the most in the media. They are the ones that have a nearly unbreakable bond of trust with their customers, because they have learned how to produce products with integrity, and they are transparent on all aspects of production.

●●●●● **The essence** of a strong digital transformation strategy is the willingness to become collaborators in creation with customers, suppliers, and employees.

It is not that they are perfect and do not ever make mistakes; every manufacturing operation does. It is that they own up to those errors, know how to act with integrity, are not afraid to share product quality data, and in short have earned the trust of their customers through years of operating this way.

The ability to provide transparency and instill trust is where being selective about which digital transformation technologies to use becomes relevant. Real-time monitoring and systems integration combined with predictive analytics, 3D modeling, and robotics are giving manufacturers new insights into how they can improve product quality, streamline fulfillment, improve product configuration options, and respond to the life-cycle requirements of their customers.

In summary, having a digital transformation initiative that is driven by a strong business case—and recognizes that people come first—is the key to succeeding with any new technology that has the potential to drive revenue and reduce costs. The essence of a strong digital transformation strategy is the willingness to become collaborators in creation with customers, suppliers, and employees. It takes the best minds a manufacturer has to make any digital transformation succeed, so paying attention to change management first is an imperative.

The commitment to change management starts at the top with the CEO and the management team. And for manufacturing to stay strong as an industry, true digital transformation is really a commitment to continual self-transformation. That desire and passion to keep learning and improving is the catalyst that ensures new technologies deliver value and dividends for decades to come.

ABOUT THE AUTHOR



Louis Columbus, enterprise software strategist, is currently serving as principal of IQMS/DelmiaWorks. You can reach him on Twitter at @LouisColumbus. His previous positions include product management at Ingram Cloud, product marketing at iBASEt, Plex Systems, and senior analyst at AMR Research (now Gartner). Columbus is also a member of the Enterprise Irregulars. His academic background includes an MBA from Pepperdine University and completion of the Strategic Marketing Management and Digital Marketing Programs at the Stanford University Graduate School of Business. He teaches MBA courses in international business, global competitive strategies, international market research, and capstone courses in strategic planning and market research.

Industrial Cybersecurity is a Global Imperative

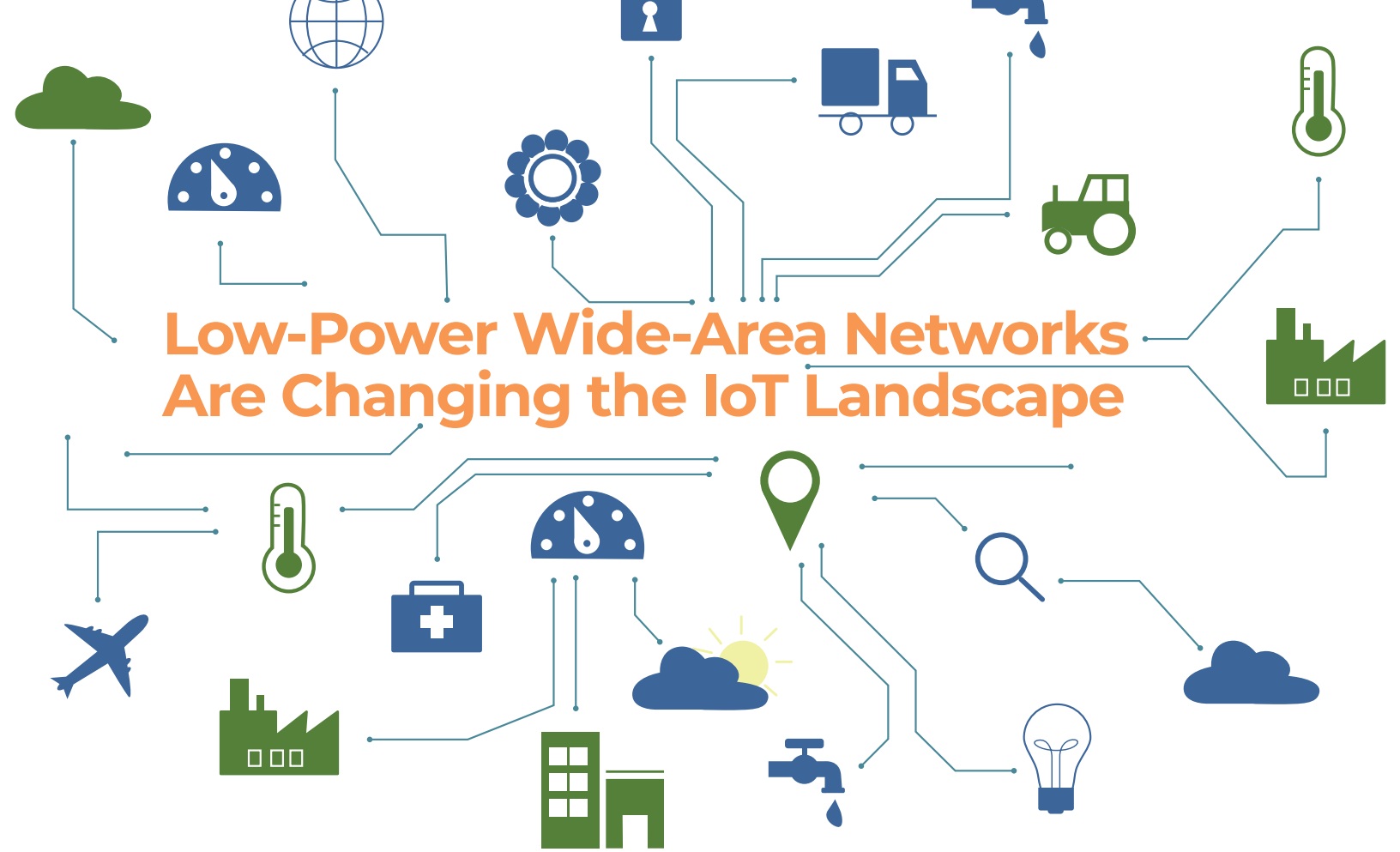
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Low-Power Wide-Area Networks Are Changing the IoT Landscape

Indoors and out, LPWANs handle specific data needed to optimize specific applications

By Ken Lynch, Senet

The prospect of reaching billions of devices connected to the Internet of Things (IoT) is not only coming from expected areas of opportunity such as asset tracking, wireless utility meters, and smart city applications, but from applications that instrument ordinary or hidden business activities with the promise of yielding revolutionary results. Many of these “ordinary” use cases are industrial in nature, and successfully deploying them at scale requires applying transformative enabling technologies and new connectivity models.

For years, industries such as agriculture, healthcare, manufacturing, transportation, and utilities have relied on wireless technologies to operate efficiently and, in many cases, deliver new or enhanced services. Organizations in these markets may be leveraging short-range technologies such as Wi-Fi, Bluetooth, or radio frequency identification, or long-range communications technology like cellular or satellite. But many, at some point, will need to implement a long-range connectivity solution that provides low-power consumption and more advantageous customer engagement models to meet their digital transformation goals.

To this end, low-power wide-area networks (LPWANs) are fundamentally changing the IoT landscape. LPWANs are designed for sensors and applications that need to send and receive small amounts of data over long distances a few times per hour or maybe only once a day. The market opportunity for LPWAN-based solutions is rapidly emerging and significant. Because of the unique characteristics of LPWAN technologies, it is expected that more than half of the 80 billion IoT devices in use by 2030 will be connected with low-power wide-area networks.

Unique characteristics

The characteristics of LPWANs distinguish them from other wireless technologies like cellular, which carries more data and uses more power, and from local area networks, which are limited by range and require device provisioning that does not scale. By collecting and transmitting only the data that is needed to optimize specific applications or operations, LPWANs have value that cannot be achieved with other network technologies, including:

- ▶ lower cost in both capital and operational expense
- ▶ the ability to deploy sensor solutions with an extended lifespan of more than 10 years
- ▶ long-range wireless coverage with less infrastructure, both inside buildings and for outdoor applications
- ▶ accelerated time to market for end solution deployments

Of all LPWAN technologies, LoRaWAN (the open LPWAN specification supported by the nonprofit LoRa Alliance) has emerged as the leading technology for the broadest range of in-building and outdoor connected applications.

Short for long range (LoRa), the LoRaWAN specification is differentiated by its open ecosystem, strong security specifications, bidirectional communication, optimization for mobility, and scalability for capacity. The LoRaWAN architecture is a high-availability, fault tolerant, and redundant platform. It is also designed to connect sensors over long distances in harsh environments (over 60 miles line-of-sight) that were previously too challenging or cost prohibitive for cellular or LAN technologies.

The LoRaWAN architecture is a high-availability, fault tolerant, and redundant platform. It is also designed to connect sensors over long distances in harsh environments.

Propane fuel tank example

With LPWANs expanding globally, the opportunity to modernize traditionally nontechnical industries and applications is rapidly growing. As an example, several propane delivery companies across the U.S. have implemented LoRaWAN tank monitoring solutions.

With the large number of propane and fuel oil tanks being used residentially and commercially, a reliable system to monitor fuel levels is essential. Fuel delivery companies are a critical partner in consumer supply chain operations where running out can have detrimental effects. Without the means to remotely measure fuel levels, trucks are often being dispatched inefficiently, driving up operational costs and complicating customer deliveries.

By placing battery-powered LoRaWAN sensors on fuel tanks, fill level and other valuable data is sent over LoRaWAN networks to tank monitoring solutions used by supply companies. These solutions address the market's largest controllable expenses, including delivery labor and vehicle costs, resulting in increased per-delivery margins and a reduction in costly service failures.

With sensors and network connectivity technologies like LoRaWAN driving a more effective ROI, propane distributors are on a path to doubling their tank monitoring deployments from 30 percent of tanks connected with cellular-based systems to more than 60 percent of total tanks connected. Not only are these advancements in technology playing a key role in driving productivity in distribution and improving profitability, but they are increasing the attractiveness of propane to a broader customer base.

Steam trap example

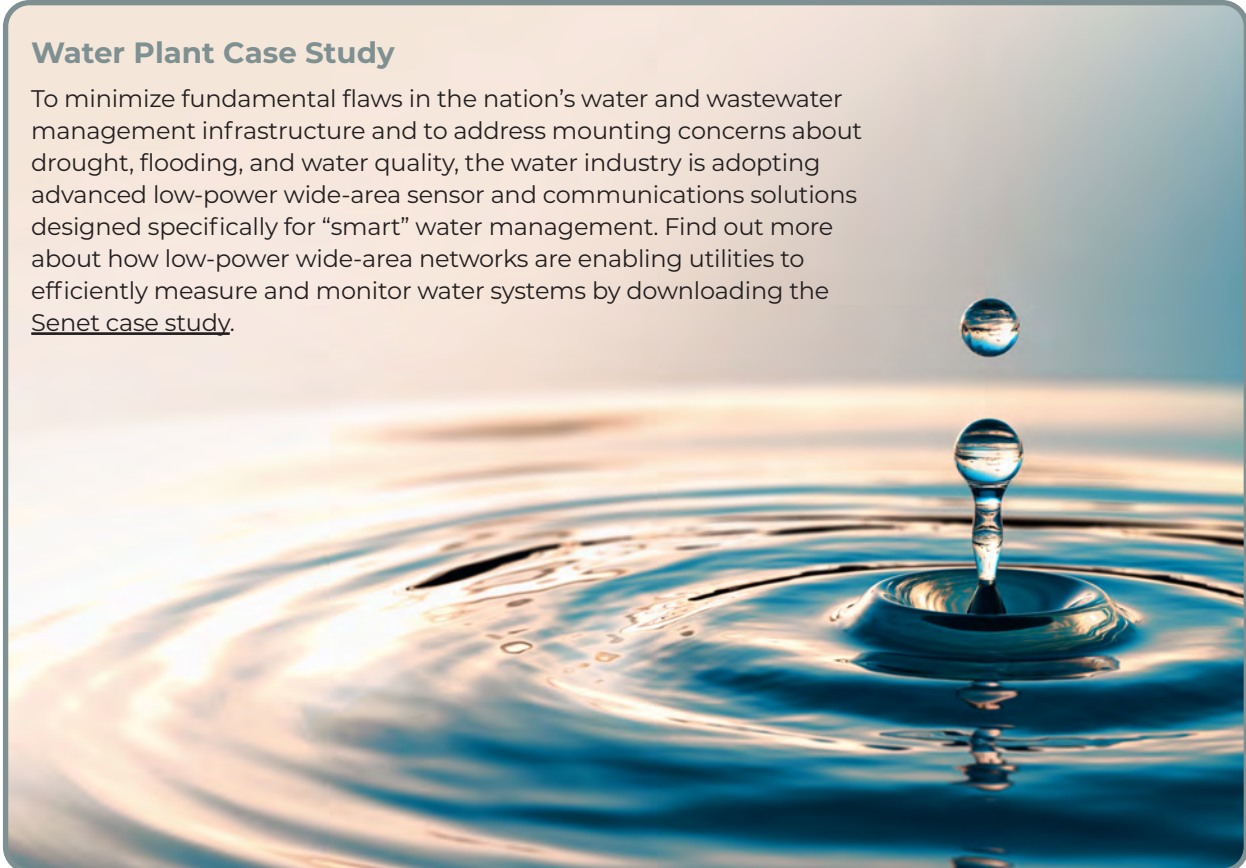
Because of the propagation characteristics of LoRaWAN technology, it also has great potential for use in large-scale indoor industrial applications like steam trap monitoring. Steam traps are a type of automatic valve that filter out condensed steam and noncondensable gases without letting steam escape. Common uses include steam-heated processes in factories and steam-driven turbines in electric power plants.

To address a yearly failure rate of 10 – 30 percent and to modernize labor-intensive test and inspection processes, LoRaWAN steam trap monitoring systems allow enterprises to interrogate their steam trap population frequently to detect failures. In heavy industrial facilities, LoRaWAN has a range of thousands of feet and can traverse multiple concrete walls and floors and even reach subterranean steam vaults. Operational data from LoRaWAN-enabled steam traps is sent securely to an online building management system, providing dashboard visibility and reports on which traps are functioning normally and which need repair.

From tank monitoring and steam trap repair to leak detection, air quality monitoring, and asset tracking, LoRaWAN is rapidly becoming a key enabling technology for autonomous

Water Plant Case Study

To minimize fundamental flaws in the nation's water and wastewater management infrastructure and to address mounting concerns about drought, flooding, and water quality, the water industry is adopting advanced low-power wide-area sensor and communications solutions designed specifically for "smart" water management. Find out more about how low-power wide-area networks are enabling utilities to efficiently measure and monitor water systems by downloading the [Senet case study](#).



industrial sensing, indoor and outdoor monitoring, and process automation across a variety of markets and applications.

Similar to the transformation of industries through the adoption of new technology, traditional one-way service delivery engagements between communication service providers and their customers no longer apply. Today's businesses seek value exchange in order to realize the full potential of their technology investments. This value, and the success of the Industrial Internet of Things, will be driven by cooperation between network operators, end device manufacturers, solution providers, and others looking to proactively expand their role in the services economy.

Importantly, these new engagement models also create opportunities for partnerships between critical infrastructure and service providers such as municipalities, utilities, and large enterprise organizations—and the citizens they serve. Whether it is delivering propane for residential heat, optimizing industrial operations, reducing energy consumption in cities, or reducing water loss through smart metering and water management solutions, an entire ecosystem of partners has the opportunity to provide limitless societal and economic benefit, delivering on the ultimate promise of the Internet of Things.

ABOUT THE AUTHOR



Ken Lynch is director of marketing for Senet. [Senet](#) develops cloud-based software and services used by network operators, application developers and system integrators for the on-demand deployment of Internet of Things networks. Senet offers technology in over eighty countries and owns and operates the largest publicly available LoRaWAN network in North America.