Consistently digital
The Internet of Things revolutionizes automation
Realizing the benefits of the digitized world

The Internet of Things (IoT), the Industrial Internet of Things (IIoT), Industrie 4.0, Smart Factories, Smart Cities, and Smart Infrastructure are all popular and exciting buzzwords that generally intend to describe a highly connected and digitized world. But is it really that simple of an explanation? And what does it mean for industrial automation?

When you consider the basic headlines of IIoT to be distributed intelligence, networked communications, machine-to-machine communication, smart sensor technology, and data analytics, the industrial automation world has implemented many forms of these for quite some time. With the technologies in place, the real value of IIoT concepts can only be realized with application, industry knowledge, and experience. That’s why at Phoenix Contact, we’ve invested not only in the technology areas to drive the coming IIoT revolution, but also in the industry and solution engineering expertise to help our customers realize the full potential of an Industrial Internet of Things.

In this edition of Update, we’ll highlight how IIoT technologies and concepts are being applied to smart infrastructure applications and safe and intelligent machinery for smart factories. These stories highlight how automation and IT technologies are merging to form the IIoT backbone needed to safely and efficiently realize the many business benefits of a digitized and interconnected industrial world.

We hope the articles in this edition give you insight into both the “big picture” technology behind the IIoT and the practical ways it is becoming a reality.
The Industrial Internet of Things (IIoT)

Number of “things” being connected every day.
5.5 million

Number of connected things worldwide by 2020.
20.8 billion

Number of connected devices per person (as of 2010).
1.84

Expected to grow 2-3 times more than consumer IoT.

References:
1 http://www.gartner.com/newsroom/id/3165317 (This study includes both consumer and industrial)
So that the flood plains stay dry

Automation technology from Phoenix Contact ensures efficient and reliable flood protection

As part of its modernization measures, the Dutch water authority, Rivierenland, has replaced obsolete technology with automation components from Phoenix Contact. The new equipment helps contribute to cross-border flood protection. It also helps reduce engineering expenditure while increasing system availability.

As part of a project by the International Water Association (IWA), a total of 165 weirs and 135 channel pumping stations will be converted to modern technologies. This also affects the landmark pumping station in Nijmegen, built in 1932 and operated by Rivierenland in Tiel.

The authority is responsible for the water regime of an area roughly located between the Rhine/Lek and Maas rivers, extending from the German border to Kinderdijk, 15 kilometers southeast of Rotterdam.

One hundred ninety-four pumping stations maintain the water level in the river basin ditches at the desired level. The larger pumping stations can pump up to 60,000 liters of water per second from a lower waterway to a higher one. This permits precise coordination of the water demand required by the individual regions.

In Nijmegen’s pumping station, the relay technology used previously has been replaced by automation technology from Phoenix Contact. The centrally installed RFC 470 PN 3TX controller regulates up to three large pumps with a total capacity of up to 16 cubic meters of water per minute. This corresponds to about 80 filled bathtubs per second. The central controller reads the big frequency inverters of the various pumps via the Profinet protocol, so that the power units are constantly monitored.

Profinet bus couplers distributed across the system permit various sensors and actuators to be connected via digital and analog signals. The bus system used here permits all signals that occur in the system to be read, processed, and output again quickly. Simple diagnostic options assist employees during a fault when troubleshooting.

Convenient visualization and operation via touch panel

In addition to making a quick diagnosis, employees must be able to intervene at any time in the process during operation. To help accomplish this, a panel with touch capabilities, built into the control cabinet door, permits continuous operation and surveillance of the building and the power units on site. This easy-to-read display shows all measurement and operating data at all times, and the staff can change it manually when required.

At Rivierenland, the larger pumping stations can pump up to 60,000 liters of water per second from a lower waterway to a higher one.
Due to the high investment and service costs incurred when using a SCADA system for updates and regular maintenance, the Rivierenland water authority management has opted for the web-based visualization software WebVisit from Phoenix Contact. This reduces costs over the entire service life of the system. In addition, the solution opens up a high degree of flexibility when creating operator-specific visualization interfaces.

The visualization solution on site in the pumping station communicates via an Ethernet connection directly to the RFC 470 PN 3TX central controller. It displays the current state of the power units as well as metrics and operational data via web pages on the panel. Internet access lets the staff retrieve the current values of all pumping stations and weirs via a secured virtual private network (VPN) tunnel.

Another advantage for the staff is the uniform design of the individual websites, which permits intuitive operation. Likewise, a similar standard was developed for programming the controllers and the documentation. Doing so lowered the engineering costs for Rivierenland.

**Reliable data transmission**

Constant monitoring of remote distributed outdoor systems requires a connection to a superordinate control system. That’s why a permanently manned control room was set up in the control room of the Rivierenland water authority. The most important measurement and operational data are now exchanged in a fail-safe and reliable manner via a special remote control protocol. Communication between the decentralized buildings and the control room is via secure ADSL Internet connections. With IEC 60870-104, the Rivierenland water authority uses a standard specialized in requirements relating to remote control that permits safe and loss-free data exchange between the individual stations and the central control system.
The central controller installed in the pumping station processes the control commands, which are prompted by the control room staff, and sends the current operating data via the VPN connection to the control room. Should data transmission be interrupted, all information is issued with a time stamp and is stored in the memory of the RFC 470 PN 3TX. Once communication is restored, the controller transmits the data in the correct order to the control room. This way, no event that has occurred in the remote stations is lost, and the staff is able to view all of the operating data.

Resource-saving supply of smaller external buildings

Besides modernizing the relay technology, which was previously installed in the pumping stations and weirs, the Rivierenland water authority is seeking a neutral energy balance by 2030. To achieve this goal, renewable energy sources, for example, are being used on smaller weirs. Solar panels and small wind turbines locally produce the energy necessary to supply the external buildings. In order to have enough renewable energy to operate each system, electrical components with low power consumption are required. Built-in equipment that is less energy-efficient is replaced by economical automation products from Phoenix Contact. This kind of swap permits the resource-efficient operation of all weirs and thus contributes to protecting the environment.

Joel Stratemann
www.phoenixcontact.com

Resource-saving supply of smaller external buildings

Phoenix Contact offers robust and reliable operation and monitoring, starting with human machine interfaces (HMIs) and powerful industrial PCs right through to customized solutions for specific industrial requirements. The requirements placed on the user interface, functionality, and system coupling determine the right visualization system and HMI device – from the simple operational data indicator up to high-end visualization. Industrial PCs are indispensable in industrial environments.

Touchscreen monitors and attractive panel and tablet PCs are also part of the portfolio, as well as powerful 19-inch box and rack PCs.

For use under extreme environmental conditions, Phoenix Contact offers devices for marine and outdoor applications specifically designed to meet these requirements.
Safe without safety PLC
Plastics manufacturer discovers easy safety solution

The MGS Manufacturing Group, located in Germantown, Wisc., serves the plastics industry through its core competencies: engineering, design, product and process development, tooling, injection molding, automation systems, turnkey manufacturing cells, and multi-shot technologies. With more than 30 years of experience, MGS has developed a reputation for providing innovative manufacturing solutions.

The MGS Automation division of the MGS Mfg. Group provides custom automation systems as well as design, development, and validation for numerous market sectors including medical, consumer products, energy, and electronics. While many automation companies focus on one style of service or product, MGS Automation specializes in and provides many types of automation services to offer solutions for assembly, packaging, and testing/validation of product.

Tougher safety requirements
When it comes to functional safety, today’s machine builders have more options than in the past, but these choices can be confusing. In the past, MGS Automation used a central safety logic controller with all safety input and output devices wired directly to that unit. As part of an automation upgrade, MGS wanted to distribute safety I/O across the machine without running wires or upgrading to an expensive safety PLC. The project called several remote substations from the main control panel requiring both local and global safety control.

Solution: Bridging the safety gap
MGS Automation implemented Phoenix Contact SafetyBridge technology. This allowed remote safety inputs/outputs that communicate over Ethernet.

SafetyBridge technology makes it possible to eliminate the strong dependence between the fail-safe PLC and the safety protocol by achieving two conditions:

1. The safe logic must not be an integrated part of the central PLC, but rather decentralized and separated from the standard PLC, similar to a configurable safety relay.
2. The safe logic must communicate via special protocol over an already installed standard network to read safety input signals from distributed sensors and write safety outputs to actuators.
The logic module is distributed in the network and handles all safety logic processing on site. Processing this safety data is done via internally redundant processors, much like a configurable safety relay can process its own safety program. Unlike a configurable safety relay, however, the distributed logic module can communicate to its associated safe input and safe output signals via a special protocol on the standard network.

This safety protocol does not contain any network or PLC-specific dependencies, but operates on the “black channel” principle, like that of a PROFisafe system. The entire network, including the standard PLC and all infrastructure components located in the data path of the safety signals, is part of the black channel. Safety failure is only implemented at the end points of communication, which can detect failures within the black channel with a residual failure probability for the highest safety levels.

Using this principle, engineers at MGS could maintain centralized safety logic control over the equipment, while reducing the amount of wiring to the main control panel. The safety logic module links to a programmable automation controller (PAC) using EtherNet/IP, so the controller can monitor all safety signals and validate the safety logic.

From the user’s point of view, the safety logic module and its associated safe I/O modules are realized into one configurable safety relay function responsible for all safety functions. Thanks to the black channel communication philosophy, the end user does not need a detailed network view to configure the safety function.

The application also required standard control at each substation. MGS used Phoenix Contact EtherCAT bus couplers that had been previously installed, and installed standard modules alongside the safety modules to control the substation from the central PAC over Ethernet.

**Safe and easy**

MGS Automation liked the ease of distributed I/O across various locations on the machine with a single point of control. Integration with the Rockwell PAC and EtherNet/IP protocols was another advantage. The free SAFECONF configuration tool simplifies the set-up process.

SafetyBridge combined the advantages of programmable and networked fail-safe PLCs with those of configurable safety relays, while meeting all of the required safety specifications.

Zachary Stank, Product Marketing Specialist – Safety, Phoenix Contact USA

[www.phoenixcontact.com/safetybridge](http://www.phoenixcontact.com/safetybridge)
Intelligent production facilities are becoming increasingly networked, which increases the total number of cable connections. Modular and standardized connectors are helping to make automation more flexible and efficient. The industrial connectors Heavycon Modular and M12 circular connectors are central to the Smart Wiring concept.

To modularize machines and systems in a highly integrated way, it makes sense to combine the transmission of data, signals, and power in a single connector. This way, only one connector needs to be connected or disconnected to install or retrofit systems with minimal effort.

**Modular all-rounder: Heavycon**

With Heavycon Modular, Phoenix Contact provides a solution for transmitting power, signals, and data via a single connector. The connector is assembled from a number of modules that are clicked into place in the newly developed snap-in frame with spring.

Depending on the size of the connector, two, three, four, or six modules can be fastened in a single frame. The modules are securely attached in the correct, designated position without becoming loose. Due to the frame, it is impossible to tilt or move the modules. With the variety of usable modules available, the application knows no limits.

The data is transmitted via shielded copper conductors or fiber optics. Modules for attaching RJ45 connectors are available for this purpose. Preassembled and tested RJ45 patch cables may be deployed. For assembly on site, the user can make use of the insulation displacement connection (IDC) connection technology based on RJ Industrial. An additional module can accommodate an RJ45 connector with crimp connection.

In a CAT6 module for gigabit transmission, the wire pairs are also shielded in the connector. Thanks to the full copper shield in the module, interference-free data transmission is ensured even if energy...
is transmitted at the same time. If the EMC load is extremely high, then fiber optics, such as the SC and LC contacts from Phoenix Contact, can also be used. You can use a variety of preassembled fiber optics. The field of application extends from systems to network technology.

Heavycon can also connect signals from sensors and actuators. Individual modules with up to 25 contacts are available. Since a basic signal connector has up to six modules, a packing density of 150 contacts per connector results from 25 contacts per module.

**For a universal connection: circular connectors**

M8 and M12 circular connectors offer an integrated solution to reliably connect automated production communication participants. Thanks to their versatility, they are suitable for the modular and scalable automation concepts of Industrie 4.0. They can be conveniently adapted to different applications and simultaneously transmit signals, data, or power.

The M12 circular connector in particular has become the leading connection system for sensors and actuators. The components are robust and user-friendly, the pin assignments are internationally standardized, and special internationally harmonized coding prevents incorrect insertion. The time-saving concept behind the connectors speeds up initial startup. System diagnostics in case of failure is simplified, due to clearly arranged installations.

The M12 connector has evolved not only for data transmission – many new application possibilities arise when it comes to voltage and current. Thanks to its small designs and simple locking mechanism, the M12 is suitable where space is limited.

The new internationally standardized coding means that even more types of applications are possible. The K- and S-coded versions of the M12 power connector are designed for an AC power supply with 630 V AC and 16 A. They permit the space-saving connection of AC motors and drives as well as frequency inverters, motor starters, power supplies or lighting systems. The L- and T-coded M12 power connectors were designed for the low-voltage DC power supply up to 63 V and 16 A. These reliably supply I/O modules, networking devices, or motors with power.

Hybrid connectors for transmitting signals, data, and power reduce the number of interfaces in the field. The optional fast-locking system Speedcon minimizes cabling times.

Hartmut Schwettmann/Thomas Wolting

[phoenixcontact.com/heavycon](http://phoenixcontact.com/heavycon)

[phoenixcontact.com/m12competence](http://phoenixcontact.com/m12competence)

**Heavycon Modular is the modular connector system for data, signals, and power.**
Lighting the way
Safer tunnels, thanks to automated LED lighting system

The simple act of driving in to or out of a tunnel can be more dangerous than you might have thought. Traveling from bright sunlight into a darker environment at high speeds doesn’t give the eye enough time to properly adjust to the interior luminescence of the tunnel.

If tunnel traffic has a sudden slowdown, for example, drivers may not be able to react to that congestion in time, causing the situation to quickly turn serious.

With the U.S. highway infrastructure due for upgrades, LED lighting has become the solution of choice. Phoenix Contact’s expertise in control and automation is joined with Schréder Lighting to provide intelligent lighting solutions.

Our solutions go beyond simply adapting the light levels with a luminance meter. We provide intelligent control systems that can be easily integrated into the main tunnel network and existing infrastructure.

Phoenix Contact’s Advanced Tunnel System (ATS) makes it easy to automate, control, and monitor the LED lighting within a tunnel. The system measures the intensity of the light conditions outdoors, and then automatically adjusts the tunnel lights to a luminance level that matches outside conditions. This minimizes dangerous driving conditions within tunnels.

In addition to LED lights being more than 70 percent efficient than traditional lights, this
The system communicates with the luminaire via RS-485 communication and adjusts the brightness level within the tunnel based on:

- Traffic speed and volume
- Tunnel length
- Geometrical and approach characteristics
- Dust buildup on the panels
- Entrance zone road conditions
- Unidirectional and bidirectional traffic

The system can be configured to detect reductions in traffic speed within the tunnel and automatically initiate speed reduction warnings. In the event of an accident blocking one side of the tunnel, cameras can be activated that will feed live images to the control room, where the operator can initiate an emergency sequence to redirect oncoming traffic. In this scenario, the luminance can be set to the maximum level to provide better visibility to emergency response teams.

The Phoenix Contact LUMGATE is the RS-485-capable interface between the control system and the luminaires. The LUMGATE enables the communication of various LED luminaire drivers to the Phoenix Contact fieldbus system.

This intuitive system also accommodates for luminosity control in the “adaptation zone,” allowing the luminosity to attenuate gradually, so that drivers can adjust to the tunnel’s interior luminosity level. The luminaires communicate with the control system via the RS-485 communication, ensuring the appropriate luminance for different road, weather, and traffic conditions.

If communication fails, three designed-in failure settings ensure continued operation:

- Emergency highest: The brightest setting
- Emergency off: Turns the lights off
- Last state: Returns the system to the previous setting

The ATS meets the Tunnel Lighting guidelines for the ANSI RP-22-11.

The automated lighting, control, and monitoring solution offers complete control and diagnostics. It is also scalable and has retrofit capability. Operators can change the settings, adjust brightness levels, and turn the lights on or off manually, remotely, or with a web-based HMI screen.

Haroon Rashid, Industry Manager – Transportation Infrastructure, Phoenix Contact USA

www.phoenixcontact.com/transportation

https://www.youtube.com/watch?v=Gm_goM3gms
5G: The road to the Internet of Things (IoT)

Lower cost, lower battery consumption, and lower latency than 4G

Telecom analysts have predicted that by 2020, 50 billion devices will be connected to mobile networks worldwide. To help meet the bandwidth to support these devices, the telecom industry is rapidly moving towards its fifth generation (5G). 5G is the proposed set of standards for mobile communications beyond the current 4G/IMT-Advanced standards. Besides empowering the network to download seemingly unlimited data quantities, 5G will support the rapidly growing machine-to-machine communication sector, also known as the Internet of Things (IoT), offering lower cost, lower battery consumption, and lower latency than 4G equipment.

Though today’s 4G networks incorporate the latest technologies and continue to offer faster data access, the road beyond 4G is far from clear. The rapid consumption of wireless data continues to outpace the industry’s ability to meet demand. However, faster data and greater access are only part of the picture.

Connecting devices unleashes potential

5G will transform our lives yet again and unleash enormous economic potential. 5G networks must accommodate many more users and devices, while delivering more data to each user in real time. Moreover, not only will the 5G network deliver unprecedented data rates and mobile access, but also an opportunity to redefine the network to accommodate a multitude of new and diverse connected devices.

The road to 5G will require new spectrum and new technologies to send more bits to users beyond today’s allocated spectrum. Embedded devices sending bits of information to other devices, servers, or the cloud will account for a large percentage of the 50 billion connected devices experts predict. Much of the hype around the IoT has focused on future low-latency applications, such as autonomous vehicles and traffic control.

In the industrial markets, however, the focus is on the Industrial Internet of Things (IIoT). Industry analyst claim the IIoT market is expected to reach $151 billion by 2020 and to grow at a CAGR of 8.03% between 2015 and 2020. IIoT is expected to generate many opportunities for markets such as manufacturing, smart grid, transportation, and healthcare. Many different businesses could benefit by enabling optimal utiliza-
tion of resources, smart decision-making capabilities, improved asset monitoring, effective collaboration, and most important, new opportunities to develop and test innovative technologies.

IIoT devices may incorporate sensors to measure pressure, temperature, or stress. They might include controllers to turn devices on and off, or make adjustments in real time. For example, rail track heaters are no longer simply set to run for continuously for six to eight months, but are instead connected and controlled remotely based on the temperature and weather conditions. This prevents the tracks from freezing, while also conserving energy. HVAC systems at cell sites are being automated to control air flow to conserve and reduce HVAC run times by more than 30 percent. Regulatory operators could use air-pollution monitoring data to regulate emissions and apply corrective action.

New spectrum and technologies

Machine-to-machine connectivity through wireless or wired networks forms the base for IIoT. The rising adoption of IIoT is expected to boost the market for networking technologies, especially 5G wireless networks and the cloud. These networks not only provide mobility to the equipment, but also offer greater scalability and ease of integration to the network.

Network operators must address network response times (latency). Control without deterministic response times limits the utility and adoption of these technologies. It’s estimated that latency on current networks is on average in the tens of milliseconds range. To reduce latency, the cloud itself will need to move closer to improve determinism that control applications.

Devices with sensors, actuators, and so on could be controlled and operated remotely or autonomously in the cloud. 5G will provide the connectivity to bind these devices to the cloud in a seamless web to accommodate more users with increased efficiency.

Network providers have already started to upgrade their current 4G networks to 4.5G and 4.9G through densification, which means increasing the number of access points, including macro cells, small cells, and pico cells, deployed in a geographic region. Densification relies on the theory that adding more access points to a served area divides the spectrum by geography rather than the spectrum itself. In addition to densification, new network topologies such as Cloud RAN enable service operators to locate their equipment in the cloud, which significantly reduces the heating and cooling costs of locally deployed equipment as well.

New base station technologies such as multiple input, multiple outputs (MIMO) promise more bandwidth and energy efficiency. Massive MIMO base stations incorporate hundreds of antenna elements to focus the energy per user, which increases data rates and improves the quality of the communications link particularly at the cell edges. MIMO has the capacity to increase data rates by 100 times or more. New spectrum frontiers in the millimeter wave (mmWave) frequency range are being deployed in frequencies from 28 GHz to 76 GHz. Nokia Networks has introduced an mmWave communication link achieving data rates 100 times above current 4G rates with low latency.

Internet of everything

The road to 5G is already underway, and its impact will be truly transformational. Network densification, 5G waveforms, massive MIMO, and mmWave communications will be deployed concurrently to provide the innovations to realize this transformation. These 5G technologies are moving forward, and by 2020 the vision of an Internet for everyone and everything will become a reality.

Paul McClusky, Industry Manager – Telecommunications, Phoenix Contact USA

www.phoenixcontact.com
Energy-efficient industrial PCs

The new Valueline 2 (VL2) industrial PCs from Phoenix Contact have increased performance power and energy efficiency, compared with the legacy Valueline IPCs. The VL2’s design improves usability, incorporates fourth-generation Intel® Core processors, and has an interactive user interface.

The VL2 has a unique gull-wing access door, which reduces maintenance time and also provides easy access to the PCI/PCle card. The IPCs have DisplayPort++ for high-resolution images and streaming over a single connector. The 10-point capacitive multi-touch screen allows a more interactive user interface.

www.phoenixcontact.com/vl2

Configurable power supplies

The newest generation of QUINT POWER power supplies gives control engineers improved configuration and diagnostics to ensure reliable power to the control system. Phoenix Contact has added near-field communications (NFC), real-time monitoring, coordinated surge protection, and a configurable DC output characteristic to the proven QUINT Power line.

With secured NFC, the power supplies can be configured while still in the box. User-definable settings allow monitoring of real-time DC current, power, or voltage using a 4-20 mA analog output.

www.phoenixcontact.com/quintpower

Handheld printer for fast marking

Thermofox from Phoenix Contact is an easy-to-operate, handheld printer for small labeling projects in the field or around the industrial panel shop. Thermofox makes it easy to swap material cartridges for terminal block markers, shrink sleeves, self-laminating wire wraps, and indoor/outdoor vinyl tape. For power, the Thermofox accepts standard AA batteries, or a rechargeable lithium-ion battery is available.

www.phoenixcontact.com/handheld

Direct connection to the PCB

Phoenix Contact’s new SDC 2.5 connectors plug directly into the PCB via through-contacted bore holes. This eliminates the need for an additional header and the soldering process, reducing component and process costs.

The connectors feature Phoenix Contact’s “SKEDD” plug-in technology for easy PCB mounting without tools.

www.phoenixcontact.com/skedd
Global Automation and Manufacturing Summit

Jack Nehlig gives keynote presentation at IMTS event

Jack Nehlig, president of Phoenix Contact USA, recently gave the keynote address at the Global Automation and Manufacturing Summit, part of the 2016 IMTS in Chicago.

Nehlig discussed Phoenix Contact’s initiatives around the Industrial Internet of Things, both as an industry supplier and as a manufacturer.

Read Jack’s insight on IIoT [here](#).

Industrie 4.0 in practice

Work out the benefits of digital production for the customer

In order to test components, systems, and solutions for Industrie 4.0, Phoenix Contact opened a digitization lab in June 2016. The technology and technology know-how surrounding digitization are to be learned and applied in practice on 130 square meters in the newly inaugurated Phoenix Contact Training Center in Schieder, Germany. The focus is on transferring, applying, and testing results from various committees and working groups for Industrie 4.0.

The objective is to also test scenarios where Industrie 4.0 can be used, which serve to digitalize the value creation networks of customer applications. The benefits can thus be validated and demonstrated.

The Industrie 4.0 Demonstrator is used to test application scenarios.
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