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Technical article

Make things smart.

How IIoT wireless technologies can connect the unconnected

Technologies connecting the industrial Internet of Things (IIoT) offer manufacturers added value in two ways: (1) greater visibility of end-to-end production; and (2) enabling the processing of field-level plant data via advanced analytics hosted in either on-premise, edge-based platforms or in cloud-based ones. But what about unconnected "things" – material containers, components, work-in-progress, or finished goods – lacking built-in communication features? That's where three backbone wireless technologies from Siemens can come into play.

For machines with existing sensor technology and communication ports, making IIoT connections is relatively simple. But many field devices lack the features needed to connect directly to higher-level OT production systems or to advanced analytic platforms, whether those are hosted on-premise or in the cloud.

Years ago, linking field-level components required various signaling protocols with limited capabilities, such as 4–20 mA current loops and field buses such as PROFIBUS. But, today, most machines come with built-in communication ports that can handle various serial and industrial Ethernet communications protocols, such as PROFINET, that offer much greater bandwidths for a wider range of applications and, critically, determinism – when control commands must have precise, millisecond timings to execute properly.

But why interconnect connect objects, sensors, actuators, and machines at all? One answer is to gain more operational visibility of those types of things that make up the operational technology (OT) landscape of typical plants. Another is to use data analytics to evaluate their individual performances, if relevant, and optimize them to improve overall production performance and cut costs where possible.

Tapping data from PLCs for analysis

In older plants, many things lack smart features, so extracting field-level data from them is hard, if not impossible. To do so, operators must tap into their next higher data-aggregation level, usually a programmable logic controller (PLC). Advanced PLCs, such Siemens SIMATIC S7-1500 models, feature Ethernet ports for gathering data, then processing it via the PLC's CPU.

That capability can be supplemented by a corresponding SIMATIC communication module, which provides security features. For example, the SIMATIC CP1543-1 not only provides an additional communications interface to an S7-1500 PLC and its I/O array, but also provides a built-in firewall.

Of course, sensor data is vital for controls and automation, but analytics with condition-based monitoring of machines and other equipment can support more proactive maintenance models, even predictive ones.

For example, relevant machine data can be drawn continuously or periodically for maintenance planning, sourced from counters of operating hours, temperature gauges, amperage indicators, and other sensors. This data can fuel analytic models with powerful algorithms that search large amounts of data for new patterns, looking for possible anomalous machine behaviors and causal relations.

Using location data to update digital twins

Another IIoT capability that modern factories should want is this: Data about where objects, even personnel, are located can help to update digital production twins – virtual proxies of physical production processes that are modeled in software.

These digital twins can vastly improve plant visibility and be used for applications, such as virtual commissioning of machines and new production lines, saving weeks and months in launching new products.

Such data analyses can also help optimize the use of manufacturing objects, such as feedstock materials and their transport containers, plus components, tools, work-in-progress, and finished goods.

What's more, the paths of objects in motion – forklifts, mobile robots, and automated guided vehicles, among them – can also be optimized.

But for these objects lacking communication interfaces, three backbone wireless technologies are proven to be extremely cost-effective in IIoT applications:

- **Wireless LAN (WLAN)**
- **Radio Frequency Identification (RFID)**
- **Real-Time Locating Systems (RTLS)**

WLAN networks can simultaneously transport information-based, real-time, and mission-critical data – giving top priority to the latter and high priority to real-time data. They offer two key advantages over wired networks:

- **Flexibility:** They offer much more flexibility in factory floor plans and line configurations. Inside factories, in-place cabling infrastructure no longer has to dictate production line configurations and floor plans. Production lines can be reconfigured much faster by removing cabling tasks from such projects' critical paths. WLANs can also be used to relay data in places where cable can't be run.
- **Scalability:** They provide greater scalability at less cost than fixed-wire implementations. WLAN coverage can be easily expanded by adding relatively inexpensive access points (APs). And separate WLANs can be interconnected within buildings and between buildings to form large networks.

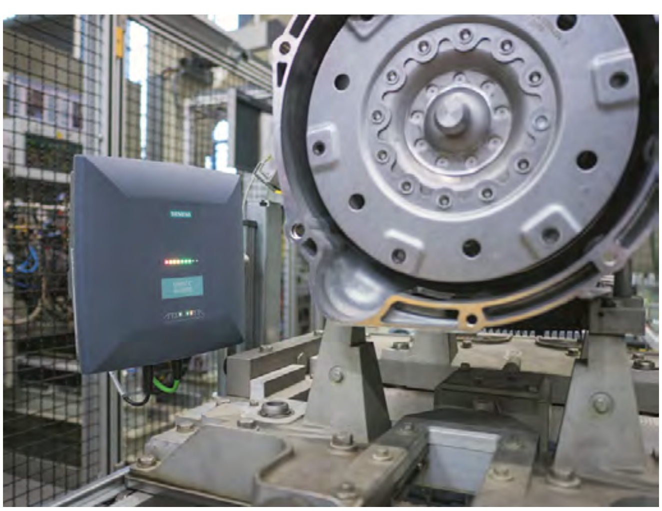


Figure 1. RFID systems are suitable for permanent electronic marking to identify and track products such as this vehicle transmission throughout its manufacture.

Figure 2. Through the SIMATIC RTLS data channel, it is possible to display data derived from the actual position and status of material containers.

If higher-level systems need field-level data, sensors with WLAN connectivity are required, unless the data is drawn from PLCs. Sensors with WLAN features eliminate cabling costs, which can be substantial, especially if no communication infrastructure exists to connect them in a plant yet, especially outdoors.

For switches, routers, and other components to build a highly secure WLAN communications infrastructure, the Siemens SCALANCE portfolio provides many options designed for the generally demanding conditions of industrial OT environments.

On the machine side, for data collection and aggregation, Siemens offers many other varied options. SIMOTICS IQ, for example, is an easy-to-deploy sensor device that can collect the data from various parameters of a motor drive without interfering with its operation. It can then transmit the data over a facility's WLAN to higher-level, on-premise systems, such as an MES (manufacturing execution system) or an ERP (enterprise resource planning) system, or to cloud-based applications.

Alternatively, consider the RUGGEDCOM RX1400, a compact Layer 3 integrated switch and router. This appliance can serve as a WLAN access point to relay plant data to premised-based systems or to applications hosted on cloud-based platforms, such as Siemens MindSphere, the IOT operating system, for analytics or use in other applications.

RFID is an IIoT technology proven in production control and logistics applications for many years. These systems equip objects with small radio transponders, also called tags, that fixed-positioned RFID readers can read and write to wirelessly as the objects move through their wireless fields.

RFID tags have become so inexpensive that they can be affixed to pallets and cartons of goods, as well as on or inside the goods themselves. These tags provide unique identifiers that can be updated as the goods move through the supply chain. This makes RFID systems particularly suitable for the acquisition of data across departments inside manufacturing operations and even between companies for cloud-based tracking and tracing functions of goods in transit.

Siemens can also provide RFID transponders in heat-resistant versions, which means they can stay on products throughout harsh processes, such as painting lines where they are subject to the high temperatures of drying ovens.

RTLS is the latest IIoT networking technology to help manufacturers and logistics operators track objects and even production personnel throughout their facilities. It's exceptionally easy to deploy.

Using ultra-wideband (UWB) wireless technology and triangulation techniques, a RTLS system can locate objects and personnel with attached battery-powered UWB transponders. The transponders emit UWB signals that are read by fixed anchor point devices. The latter relays the data to a locating server with software that calculates the transponder's position. Location precision is to within a few inches or centimeters of a transponder's actual position with latencies of less than 1 second.

The system's ability to track personnel with transponders affixed to their attire or employee badges, can help improve safety and also enable faster responses to safety incidents. Employees without access privileges to dangerous areas, such as high-voltage electrical panels, can be prevented from entering.

If an accident occurs, the RTLS system can indicate the specific number and location of workers as well as whether a worker is still standing or has fallen. This can offer first responders a better idea of the accident's seriousness, so they can anticipate where they need to provide the most effective first-aid.

Location and more. RTLS can also detect and report a transponder's motion, acceleration, elevation, and orientation. It can immediately relay all this positioning data for any number of objects to higher-level systems in real time, making the location data available for a variety of plant applications.

For example, by comparing a tool's position data with a product's digital image, machining steps can be documented and a particular tool precisely controlled. The resolution in the centimeter range makes it possible to adjust the torque and angle of power screwdrivers automatically, without manual interventions.

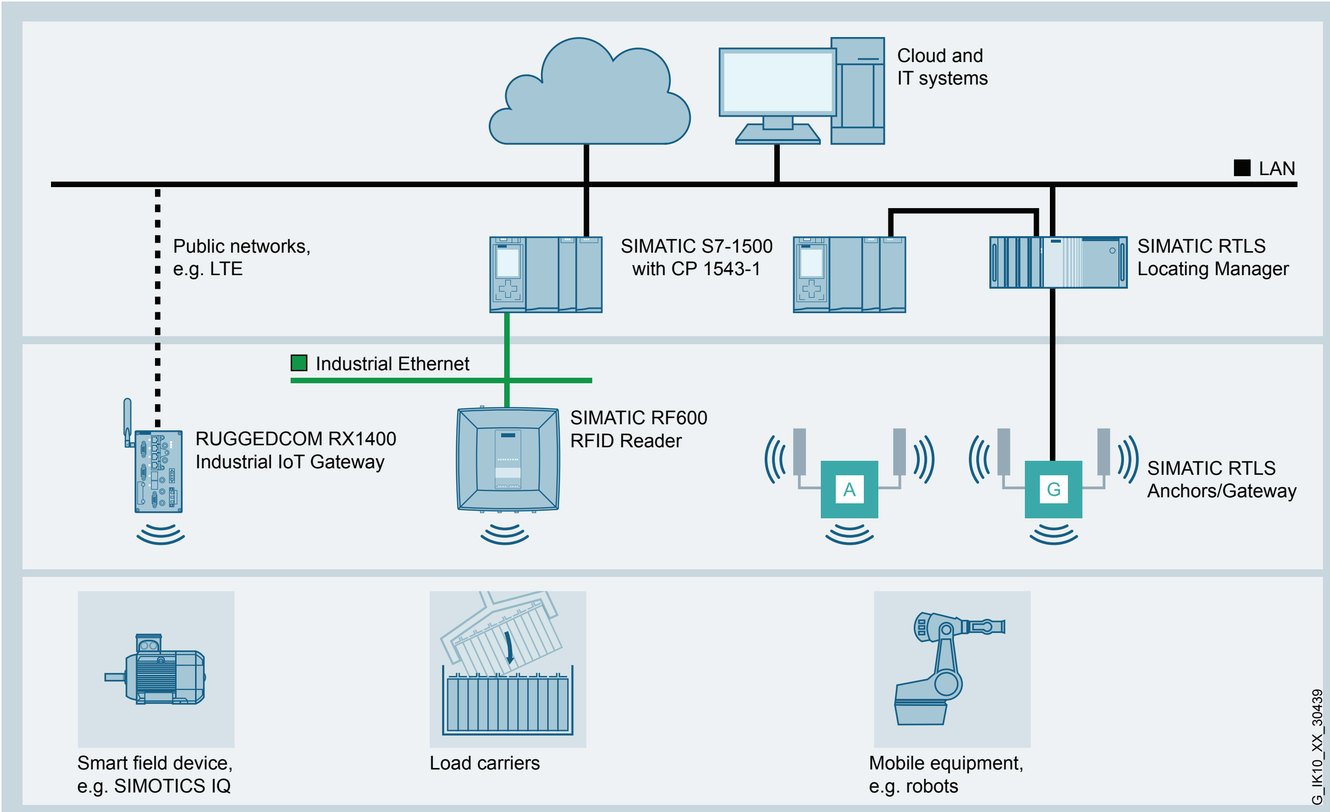
Commercial analyses are also feasible: By automatically knowing the usage frequency and duration of material handling containers, their inventory can be optimized to save costs without shortchanging the processes that depend on them.

Another application, specific to Siemens SIMATIC RTLS solutions, is a special line of UWB transponders with small, low-power information displays. These mimic ink-on-paper to provide workers with relevant details about a container and its contents, turning an otherwise unconnected "dumb box" into a "smart transport container."

All of these IIoT wireless technologies – WLAN, RFID, and RTLS – can provide industrial environments with the communications backbone they need to cost-effectively engage the IIoT, while also prioritizing the highly secure delivery of their data, depending on whether it's information-based, real-time, or mission-critical.

This is accomplished by the rugged design, engineering, and manufacture of the various Siemens components and the reliability of their communication paths.

Importantly, all Siemens components are designed and engineered with security built-in, not added on. The SCALANCE S family of WLAN components offers even greater security safeguards.



Wireless communication bridges the gap between production objects and the IIoT.

Specific supplements to the standards ensure that the special demands arising from the industrial applications are covered. One, for example, is the Siemens **iPRP (Industrial Parallel Redundancy Protocol)** function of the SCALANCE W family. It's a high-performance adaptation of the PRP standard that ensures uninterrupted communications if a component fails by providing immediate and transparent failover to a second, identical network topology as an alternative data pathway.

Another example is the Siemens **iPCF (industrial Point Coordination Function).** Because data transmission latencies can cause control problems, Siemens developed an exclusive, patented way to minimize those to as little as 16 milliseconds, small enough to effectively provide for real-time communications. As a highly deterministic algorithm, it's well-suited for the fast communications required by industrial control, especially fast roaming and safety applications.

Both iPRP and iPCF are pioneering examples of Siemens championing the use of wireless systems in industrial applications. Long ago, we recognized that reliable, fast, and highly deterministic communications provide the necessary backbone for production automation and controls, greater operational visibility, and now IIoT connectivity in manufacturing and logistics enterprises. That fact will continue to be true for today's operators and tomorrow's "factories of the future."

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