PCTEL®
Performance Critical

APPLICATION NOTE

Industrial Process Automation

Process Automation and the Industrial Internet of Things (IIoT)

We are in the midst of a radical transformation in industrial production, enabled by the Industrial Internet of Things (IIoT). The IIoT consists of numerous industrial devices, connected primarily over wireless networks. IIoT networks leverage technologies associated with the internet, such as big data and machine learning. Processes that once required significant human oversight can now be fully monitored and controlled by a relatively small number of humans from a remote location. Machines connected on the IIoT can continually monitor and report output levels, detect potential problems, and autonomously adjust input variables, allowing for the automation of entire industrial processes. With location tracking technology, even safety procedures can be partially automated. A wide variety of wireless technologies are available to support these applications. For every IIoT network, however, reliable network connectivity is crucial.

IIoT networks should be built using wireless technologies that match the specific needs of the industrial environment and application. Although wired data sharing is possible for some fixed IIoT devices, most IIoT network connections are wireless. Wireless networks enable mobile device connections and can be installed more easily in space-constrained industrial environments. They are also less expensive and easier to maintain than their wired counterparts. However, with wireless networks, coverage, latency, and throughput levels must all meet the needs of the specific application and environment. For example, a crowded factory floor may require a mesh network for reliable coverage. Most forms of process automation require low latency levels, while real-time video streaming for monitoring or remote control of devices requires high throughput levels. Meanwhile, location tracking has its own specific technological requirements. A single IIoT network may require more than one wireless technology to meet all of its needs.

Wireless networks are only as reliable as their antennas. Wireless data sharing for IIoT requires a high-performing antenna at every point in the communications link. Antennas in industrial applications may need to communicate over long distances, in severe conditions, or in obstructed pathways, depending on the facility. Antenna failures can result in failure of the entire wireless network, negating efficiency gains and disrupting any operations that depend on the IIoT. A 2017 survey reveals that 53% of industrial companies have either already invested significantly in IIoT or plan to do so this year.[1] Proper wireless network deployment will be a critical factor as to whether those investments pay off.

Wireless IIoT Technologies

Process automation and related IIoT applications require advanced wireless network technologies. While wireless Supervisory Control and Data Acquisition (SCADA) systems have been around for a long time, advanced process automation places higher demands on wireless networks. The IIoT requires ubiquitous connectivity on both a machine-to-machine (M2M) and a machine-to-person (M2P) level. For most SCADA applications, including advanced process automation, low latency is also crucial. Video monitoring and future applications such as cyber-physical systems also require much higher data throughput levels than are supported by traditional UHF and VHF-based SCADA networks. Finally, location tracking requires its own specialized wireless network technology.

For IIoT applications that don't require much bandwidth, traditional VHF and UHF networks operating over ISA100 or GSM are fast being replaced by LPWAN technologies such as NB-IoT, LoRA, and SigFox. LPWAN combines low latency and low power requirements with coverage for a wide area, such as a factory floor. Some LPWAN technologies can also support remote monitoring applications that involve data transmission over long distances.

However, LPWAN doesn't always overcome the connectivity challenges of a crowded industrial environment. For that, mesh networks may be required. A mesh network consists of nodes, or intermediary antennas, which receive transmissions from otherwise isolated antennas and relay those signals to one or more third locations within the network. This facilitates reliable communication between local technologies in automated processes like self-healing. Zigbee and WirelessHART are among the most popular wireless protocols for mesh networks.

Data-intensive activities like video monitoring require wideband wireless standards that accommodate large amounts of data at fast rates, such as Wi-Fi or LTE. Wi-Fi is frequently the technology of choice for deployments on unlicensed spectrum. LTE has relatively low latency and can be deployed on spectrum leased from carriers, or on privately held spectrum. MulteFire could also make LTE deployments possible using exclusively unlicensed spectrum. Soon, 5G networks are expected to support even higher data throughput rates and lower latency, on both traditional wireless and millimeter-wave spectrum.

Wireless technology also allows for tracking of goods through the production process. Real-time locating applications also require specialized wireless protocols such as active RFID or Bluetooth Low Energy (BLE). Using wireless RFID tags or Bluetooth beacons, supervisors can monitor the location of any good, device, worker, or mobile machine. Location tracking can alert supervisors of flow disruptions, enable increased automation, and even enable cyber-physical systems. When on-site personnel are involved in an accident, responders can also use wireless tracking technology to locate the employees and provide necessary assistance.

Antenna Selection for IIoT Applications

Antennas can be found everywhere in a modern production environment, from line sensors to relay nodes to access points to backhaul to mobile machines. Antenna properties such as coverage patterns determine whether a transmission will successfully reach a receiver, as well as the

1 "Make the IIoT and Digital Transformation a Reality." LNS Research. 2017.

amount of data that can be transmitted. The design and placement of antennas is therefore critical to the overall performance of the network. Maximizing propagation is not always ideal, since overlapping coverage areas can result in interference. Antennas for IIoT must be designed to provide coverage where it's needed, transmit large volumes of data, minimize interference, conserve space, and withstand severe conditions.

IIoT networks require a variety of different antenna coverage patterns, depending on the antenna's function and placement in the network. A network may require transmissions directly from one location to another (point-to-point), or to multiple surrounding locations (point-to-multipoint). Simple point-to-point data transmissions generally require directional antennas, whereas point-to-multipoint transmissions are better served with omnidirectional antennas. However, network designers can incorporate omnidirectional antennas in point-to-point applications for greater flexibility. This may be the case in a mesh network with multiple moving parts, where one antenna may technically only transmit point-to-point, but in different directions at different times depending on the availability of nearby antennas. Regardless of whether the antenna is directional or omnidirectional, optimized antenna pattern performance is crucial to ensure reliable coverage and minimize interference.

Antennas for IIoT incorporate a variety of technologies to improve throughput and coverage. Multiple Input, Multiple Output (MIMO) technology enables antennas to differentiate data streams of identical frequencies, allowing for greater levels of automation in data-intensive applications like video monitoring. Many MIMO designs use dual polarization to further solidify network connectivity via de-correlation of RF ports. Networks that use multiple RF frequencies call for multi-band antennas, which feature several antenna elements in one housing. Quality multi-band antennas use port-to-port isolation to minimize interference among frequencies, and have the added benefit of compactness.

When selecting and placing antennas for IIoT networks, it is important to preserve space in a facility for actual production processes. To this end, network designers need high-performing antennas with low-profile, compact designs. A common solution is to embed an antenna within the device it supports. Complex devices like line sensors may contain an entire embedded RF system, whereas routers or access points may simply contain a radio and an antenna. These designs generally save space and simplify the installation process. With both external and embedded antennas, mounting flexibility is an additional consideration. Antennas typically require a metallic ground plane surface, but antennas customized for IIoT can be mounted directly on a wall or whatever surface is most available.

Antennas in certain applications must be ruggedized to withstand severe conditions or human manipulation. For example, sensors that measure temperature in food freezers require antenna housings that can resist cold and moisture, and sensors that monitor violent machine activity need antennas able to withstand extreme vibration. Ruggedized housings are especially essential in outdoor wireless networks, where antennas are exposed to various kinds of severe weather as well as meddling from humans. High quality antenna systems generally feature rugged, low-profile housings to limit ingress from water and dust, as well as vandal-proof mechanisms to prevent removal of any equipment inside the cabinet. Antennas without these ruggedized housings are liable to break or lose connectivity in the event of severe conditions, resulting in failure of the IIoT network.

Conclusion

The fourth industrial revolution has arrived, but those who underestimate the need for quality antenna technology risk getting left behind. With real-time data sharing between machines on the production line and supervisors in the control room, companies can reduce overhead costs and speed up their production lines at. All these benefits, however, depend on quality antennas. Antennas for IIoT must be flexible enough to support a wide range of RF frequencies and applications, robust enough to perform under the most extreme conditions, and compact enough to work in facilities where space is limited. Selection and installation of antennas for industrial applications therefore requires expertise and careful planning.

PCTEL designs and manufactures a full range of antenna products and embedded systems for the IIoT. We leverage our application experience and expertise, advanced testing facilities, and proprietary antenna technology to ensure that our solutions meet the specific needs of each customer and application. We offer a wide variety of directional and omnidirectional antennas. We also create custom engineered antenna solutions for wireless sensors, gateways, and access points. We offer antenna system design, radio integration, testing, modeling, and manufacturing capabilities to our customers.

PCTEL antennas are compatible with the most popular standards for IIoT, including NB-IoT, ISA100, Zigbee, WirelessHART, LTE, and Wi-Fi. PCTEL antennas enable connectivity in a variety of deployment scenarios, including LPWAN, mesh networks, and long range point-to-point communications. Our ruggedized antennas undergo strict environmental testing. Our low profile antennas combine superior installation flexibility with exceptional performance. Models widely deployed for the IIoT include the multi-band omnidirectional Coach series and the hemispherical FDM9023, with a flat 13mm-tall design that is ideal for tight spaces.

PCTEL develops advanced antenna technologies that help our customers successfully deploy process automation technology. Our expertise extends from legacy narrow band technologies to emerging technologies such as LTE-M and 5G. Our proprietary high rejection filtering technology protects Wi-Fi and GPS/GNSS antennas from nearby or co-located LTE transmitters. We continue to develop advanced MIMO and multi-band antenna designs that maximize performance and throughput across multiple wireless technologies. Finally, we are leaders in complex antenna array design, including BLE location tracking arrays.

At PCTEL, we believe that RF performance is critical for process automation and Industry 4.0. That's why we want to be your RF propagation partners in the mission to get real results from the IIoT.

FDM9023 antenna

Coach™ multi-band antenna

Connected Solutions – Services & Capabilities

- Custom antenna design and optimization
- Embedded systems design and integration
- Sophisticated RF modeling and testing
- In-house environmental testing
- Manufacturing in the United States and Asia

PCTEL®
Performance Critical

PCTEL CONNECTED SOLUTIONS

471 Brighton Drive | Bloomingdale, Illinois 60108-3102

Toll-free within the U.S.: 1-800-323-9122
Phone: 1-630-372-6800
Web: www.antenna.com
Nasdaq: PCTI