

Early attempts to use wireless modems for industrial communications had many challenges. Has technology improved to the point of true reliability for industrial applications?

Industrial Wireless Modems Come of Age

From Tesla and Marconi's electric coils and arcs to the youngster's model car that speeds or stops at the nudge of the controls, we've had a fascination with wireless control and communication.

And with the explosion over the last 25 years of wireless from cell phones to Internet, interest in industrial uses has grown. This could easily afflict anyone from refinery or public works managers to manufacturing techs with equipment monitoring and control needs.

Regardless of the potential, early attempts to adapt wireless technology to industrial applications met with limited success.

There was equipment that couldn't withstand the demands of industrial environments. Radio frequency (RF) noise from large motors, high voltage power and welders hindered reception in industrial settings. Echoes from metal buildings and tanks confused signals. A crowded radio spectrum and inadequate security standards were problems.

For industrial settings high standards of reliability apply. Productivity, profits and safety are on the line, and plant managers can't afford to be early adopters of unproven equipment and standards.

So when did industrial wireless become so practical?

1. Defining the Devices: Industrial Wireless / Radio Modems

A modem was originally a device to send (modulate) and receive (demodulate) digital signals over standard phone lines. This definition is at risk of passing into history, as cable, DSL and other modems replace the older technology.

The terms *wireless modem*, *radio modem* or *RF modem* all describe key equipment of any wireless technology, from cellular to satellites. Wireless modems convert data to and from RF signals, and send and receive RF signals between other modems and devices.

Wireless modems may also function as repeaters, receiving RF signals from one wireless modem and relaying it to another. Each repeater adds to the potential distance.



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2. Finding the Right Solution

Each wireless solution has its uses and champions. Finding which of these makes sense in a given industrial setting starts with the best match of distance, data rates, number of devices, cost, power required, and especially reliability. Here are some of the more popular options: Bluetooth applies for short distances (to 100 M) and a small number of devices (up to 8). Often defined as “personal networks,” these have real but limited industrial applications.

WiFi (802.11) is the standard for fixed shorter distance (to 160 M) commercial applications. It receives much development support because of bandwidth (to 1 gigabits per second). Even so, for industrial applications it has more bandwidth than typically needed and only limited range. It also uses the most computing resources and electrical power and has the largest physical footprint. Industrial WiFi installations should always have added security measures, as most laptops are otherwise potential access points.

Zigbee is the latest entrant to the field and is a proprietary technology, as standards are not finalized. It has low power needs (batteries may last for years) and forms a mesh network with multiple data channels to extend range. Devices take the least space, and up to 64,000 nodes can be connected. Drawbacks include relatively short distances reached by a single link (as low as 20 meters), low bandwidth (720 kilobits per second) and limited interoperability with other systems. Most important in industrial settings – as a new technology it’s not supported by a long history of reliable applications.

Cellular devices for industrial applications can reach anywhere that has adequate cellular service. These may make sense over long distances where multiple cellular service towers are within range. However, cell service isn’t always available or guaranteed, and the potential conflicts with metal structures and need to pay for cellular service for each node may be limiting factors.

Proprietary RF is the standard for much of industrial communications. Distance alone (up to 40 miles with high gain antennas) makes it a superior choice for many situations.

The advantages of proprietary RF are reliable applications, stability, convenience and security. Most significant, these are backed up by the history of successful installations in a wide variety of industrial settings.

The security of proprietary RF starts off at higher levels than other systems. Where Bluetooth, WiFi (802.11), and Zigbee are designed for easy universal access, by definition proprietary is more private, as it doesn’t work with universally available wireless protocols. Any spy



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would have to use identical core technology, compression, packet and frequency transmission patterns. To enhance security, limiting access to equipment and configuration information, directional antennas that limit access to RF signals, data encryption and periodic changes to configurations may all be considered.

Other wireless system frequencies are now crowded by the non-industrial world, and there's less competition at lower frequencies often used by proprietary installations. These frequencies also have greater range and penetration.

But the real advantages of proprietary RF for industrial applications are the proven applications, stability, reliability and convenience. These relate to experience, advanced development cycle, number of devices, rugged designs for industry and the success of many installations in a wide variety of settings.

For proprietary systems a drawback may be "lock in" with a single manufacturer. Finding a stable company that has great technical support, is competitive on price and performance and satisfies customers in a wide range of industries avoids potential problems.

3. Proprietary RF/Wireless Modem Applications

"Experts" predicted just a few years ago that serial technology for industrial I/O and Modbus would disappear. Today we find the use of serial technology, including wireless applications, has not decreased. Instead, applications, amounts and types of serial equipment produced have accelerated.

Water Treatment Plant - A water district with 30 remote Programmable Logic Controllers (PLCs) covering 31 square miles previously connected to these through leased phone lines. As an added expense, when phone lines went down technicians had to be dispatched to monitor conditions on-site.

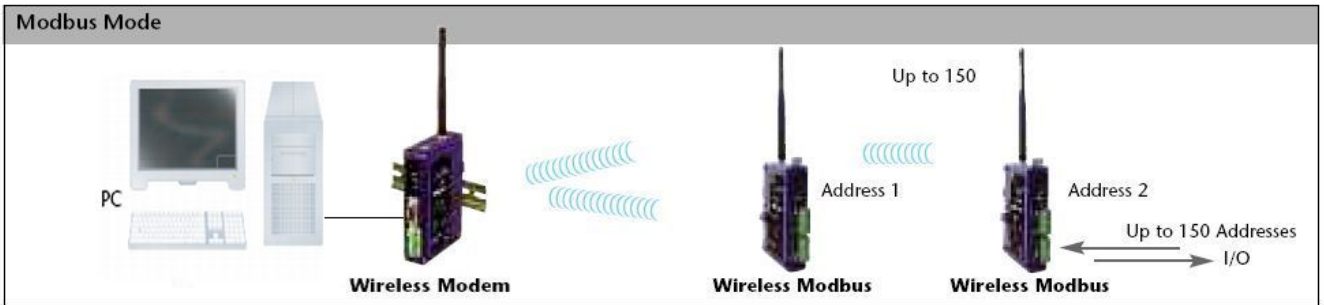
In changing to wireless modems, two radio modem base stations and four repeaters were installed to communicate across the hilly terrain. There were concerns about a nearby military base producing lots of RF interference, but these proved groundless. The system has functioned without problem, saving thousands of dollars every year.

Modbus Applications – Modbus is superior in practice for many industrial networks. It links easily to the huge installed base of serial devices. Forgiving of slow data responses, it tolerates up to a 1 second delay. Existing software usually needs no changes. And as extended by Ethernet links, the use of Modbus including wireless appears endless – single and even multiple Modbus networks may be connected as below:



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For example, wireless Modbus improved operations at a backhoe assembly plant with Automated Guide Vehicles (AGVs) moving assemblies from station to station. The AGVs needed lots of human monitoring to monitor “the big picture” of quality and production status. This increased costs and decreased quality and safety.

Installing radio modems in a wireless Modbus configuration allowed a PLC to monitor and control the AGVs from a single location. Quality control and manufacturing status were better coordinated, production times went down, profits and safety went up.

Here are some other application examples:

- The remote operator of a mobile loader at a feed mill in Saskatchewan uses a toggle switch, a pair of wireless modems and an I/O module. These open the receiver as a loader approaches, the simple means to great labor savings.
- At a Bureau of Reclamation site in Colorado, wireless modems and repeaters send water level, temperature and wind velocity data across mountains and lakes to be read by a PLC back at the office.
- In Maine an energy management/recycling company replaced outdoor cabling with wireless modems, for more reliable processing of recycled material and energy generation.
- A Canadian traffic controller uses wireless modems to digitally control traffic control devices.
- Radio modems regulate tank levels, pumps and pipe flows at a department of public works in South Carolina.

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- Solar panels owned by a solar technology firm in Colorado are coordinated through wireless modems, moving the panels to maximize exposure to the sun.

4. Industrial Wireless Checklist

After the type of technology to use is settled, some other issues are:

- Does distance or obstacles require added repeater(s)?
- Are available power sources supported on the wireless modem?
- How will placement for signal strength be determined?
- Is a high gain antenna needed, and is a standard antenna connector built in?
- Does it have the rugged build needed for industrial applications?
- Is industry standard Modbus supported?
- Is DIN rail placement supported?
- Does the system allow for future expansion?

5. Progress and Projections

Progress in technology and equipment allows wireless modems to monitor a wide range of tanks, pipes, and machinery. Applications are many, and today's technology turns the potential that was envisioned for years into real world solutions.

The problems that plagued early industrial wireless are increasingly resolved. RF interference is handled by newer digital technologies that transmit smaller data packets and check and resend data in case of errors.

Wireless was once reserved for the most extreme situations due to cost. Over the last five years, with the recognition that industrial RF is ready, economies of scale for engineering and manufacturing have kicked into gear. Capabilities climbed and prices dropped. As cable costs grow, wireless installations often cost less than wired ones.

Another factor is ease of use and installation. Wireless installation and maintenance once required engineer or programmer expertise. Many of today's wireless modems can be installed with far less adjustment in the field.

The future of industrial wireless is bright. There's a "critical mass" of engineering talent focusing on wireless modem technology. The



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Industrial wireless modems, especially using proprietary RF, have benefited from the "critical mass" of recent technical developments.

For most industrial situations the best time to consider wireless is now.

increasing momentum of equipment, programming, distance and security has led to a growing number of successful installations. It's a practical reality – there are more reasons than ever to consider wireless technologies as reliable solutions to industrial needs.

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