The Advantages of Implementing Wireless IO over Wired Alternatives

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Historically, regardless of the industry, hardwiring has been the only option available for users to connect remote instrumentation assets in the field. However, new technology enabling greater use of spread spectrum radios gives companies the ability to connect remote instrumentation in the field without the need for a costly wired infrastructure. In fact, asset information is now available from applied and embedded sensory points enabling sophisticated diagnostics, remote monitoring and control and plant optimization. As a result, companies can now realize the true potential of their production assets with the emergence of this wireless field infrastructure by having dependable access to timely information to establish and maintain excellent situational awareness of their operations.

With the prospect of being able to solve virtually any remote monitoring or control application, many people throughout the industry are viewing wireless I/O as an exciting innovation for addressing issues previously deemed cost prohibitive, not technically feasible, or lacking in sufficient reliability. This excitement is well-justified with the expectation that having additional knowledge about the operation will lead to a safer and more profitable enterprise.

What is Wireless IO?

Wireless I/O (input/output) is basically a mechanism by which analog (4-20mA, 1-5VDC, etc.), discrete and other raw signals are transmitted via radio to and from a central processing device, such as a Distributive Control System (DCS), Programmable Logic Controller (PLC), or other Remote Terminal Unit (RTU). Specifically, the data transmitted includes level, pressure, flow, temperature, alarms and signals generated to actuate final control elements, such as valves.

In the simplest of terms, wireless I/O is wire replacement, where the wireless communication link emulates wire in an existing application. No changes are required to the system architecture. Rather, wireless links are used to transmit the same data that the physical wire once carried.

Consider a level transmitter connected by a twisted pair of wire to a control system. Wireless I/O replaces the twisted pair as the physical layer to carry the analog pressure data to the control system, requiring no physical changes to the instrument, the control system or the underlying control architecture. The figure below illustrates a typical tank level installation using wireless I/O.

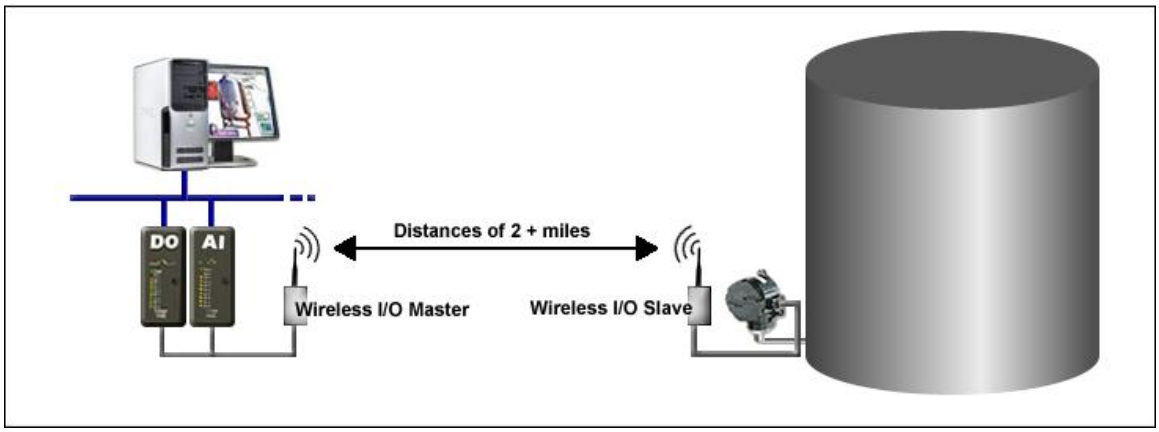

Figure 1. Typical Tank Level Wireless I/O Architecture

In this illustration, the cable is taken away and the transmitter is physically connected to an analog input of the wireless I/O slave device and the wireless I/O master is physically connected to the control system's analog input. Neither the control system nor the instrument can tell that it is not using a cable.

In addition to remote monitoring, remote control functionality also may be utilized using wireless I/O. For example, the illustration above illustrates how the level in a tank was being monitored using a single analog input on the wireless I/O slave radio. The same wireless I/O master and slave may be used and logic is written within the control system where the level is being monitored using the analog value from the level transmitter. Once it reaches a defined low level, the control system generates a digital output to open a valve allowing the tank to be filled. As illustrated in Figure 2, the only modification to the existing system was to connect the valve to the digital output of the I/O slave.

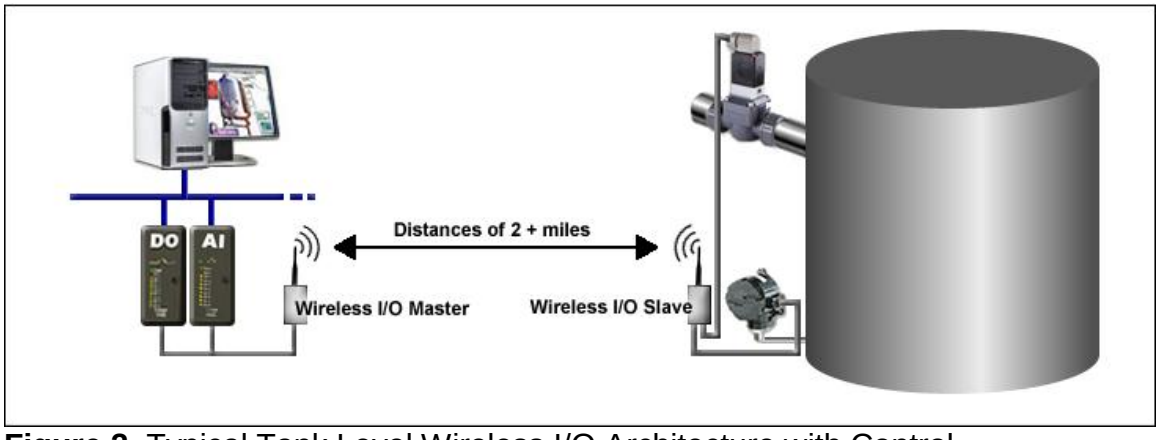

Figure 2. Typical Tank Level Wireless I/O Architecture with Control

Why Wireless I/O?

Frequently, a company has geographically scattered assets and sensor data is needed at a central point. In the past, the only available option included digging trenches and/or running conduit and pulling wire to acquire the signals. Wireless I/O offers substantial and measurable cost savings in terms of engineering, installation and logistics as well as dramatic improvements in the frequency and reliability of field data collection.

Many wireless I/O applications offer simple, cost-effective measurement of monitoring points to eliminate manual collection of field data, thereby improving labor productivity. Alternatively, in more sophisticated applications with a central processing device, wireless I/O enables users to extract full diagnostic data and predictive intelligence from the devices which then will automatically notify the appropriate personnel of the precise problem before a costly asset, unit, or plant shutdown occurs.

As a result, wireless I/O is becoming increasingly popular to help reduce expenditures. Additionally, the majority of wireless I/O systems being deployed today are used for data acquisition, but increasingly more users are utilizing Wireless I/O in control applications as shown in Figure 2. Today, the conventional thinking in automation has shifted from hardwiring to using wireless I/O to create reliable, robust Supervisory Control and Data Acquisition (SCADA) networks.

Foundation of Wireless I/O

The foundation of Wireless I/O is license-free 900MHz spread spectrum radio technology designed specifically for integration into remote assets and SCADA systems. This technology has been widely used in oil and gas field automation for close to 20 years and has proven to be very reliable.

The FCC allows two methods for building a spread spectrum radio: Direct Sequence Spread Spectrum (DSSS) or Frequency Hopping Spread Spectrum (FHSS).

Unlike fixed frequency radio, FHSS radios pseudo-randomly vary carrier frequency, quickly hopping through multiple channels while sending data. Interference is avoided by hopping over different frequencies, each of which has a different interference effect or characteristic. This provides FHSS with collision-free access by allocating a specific time slot and frequency for its transmission. A frequency-hopping scheme, combined with error detection and automatic repeat requests ensures that the data is delivered reliably. Furthermore, since the frequency hopping patterns are proprietary to the radio manufacturer, industrial FHSS radios are inherently secure and less prone to interference. These

characteristics make FHSS the preferable choice for industrial wireless I/O applications, such as simple analog and digital signals.

FHSS is very different from DSSS, which spreads its signal over a larger spectral segment and maintains error-free transmission of its data until the interferer goes over the top of its jamming margin, at which point the throughput of the DSSS quickly drops to zero making it inappropriate for mission-critical, industrial wireless I/O.

Figure 3 illustrates the difference between Frequency Hopping and Direct Frequency Spread Spectrum in terms of signal. FHSS, the image on the left, has short bursts of data and quickly hops (50-1000/second) pseudo-randomly to another frequency within the band. Whereas DSSS, the image on the right, combines its information signal with a spreading signal which occupies a much wider bandwidth.

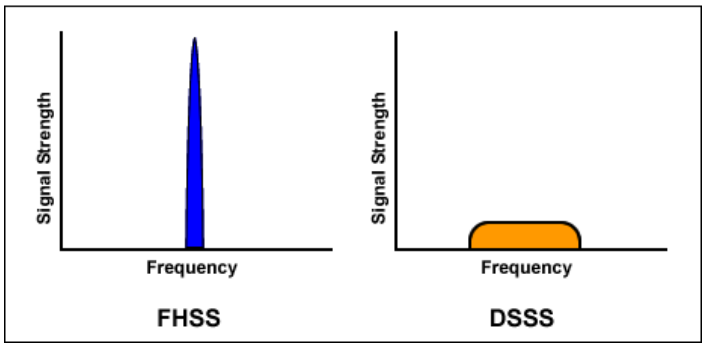

Figure 3. FHSS vs. DSSS signal strength

Advantages over wired alternatives

Installation Savings

The most intuitive of all the advantages is the reduction of labor and material costs required to hardwire the remote assets. Installation costs are a growing concern for company managers as labor rates continue to rise. Furthermore, if these applications are located in hazardous environments, isolation would be required from potential contact with chemicals and run inside of conduit with the necessary seals to reach the instrumentation deployed throughout the facility or field.

In addition to the sheer costs associated with hardwiring instrumentation, one of the other advantages with respect to installation is the speed of deployment. Wired systems can take days or weeks to be properly installed, isolated and commissioned. Wireless I/O networks generally require only the end points to be

installed and configured, saving substantial time for projects with aggressive schedules.

Economies of Scale

Any network, wired or wireless, should scale gracefully as the number of endpoints increases. Following installation savings, scalability is the next biggest advantage of wireless I/O over hard-wired alternatives.

Deploying additional points in a wireless I/O network is incremental. Instead of installing spare conductors, additional I/O slaves may share a common I/O master (as shown in Figure 4). Capacity is increased as required by simply installing additional I/O slaves. In effect, this is a “pay-as-you-go” architecture instead of a difficult tradeoff between initial cost and installed spare capacity.

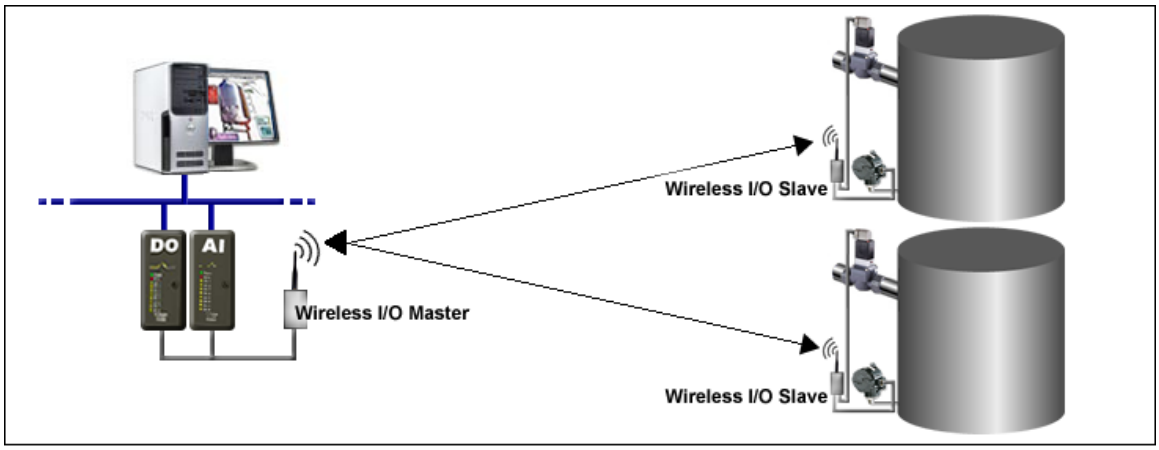

Figure 4. Utilizing a single wireless I/O master for multiple wireless I/O slaves

Fail Safe

No system is completely immune to signal loss. Wired systems are prone to having wires cut during construction or even routine maintenance. Rust, corrosion, steam, dirt, dust and water all can affect a wired instrumentation system. The difference is that wire can not alert a user of a problem.

Communication link alarms let the user know that data is no longer being received from the instrument due to a loss of signal between an I/O slave and the I/O master. Additionally, in the event of a communication failure, the I/O slave will control its outputs based on the fail-safe default condition that was pre-programmed in the radio during the configuration of the system. In other words, should the link between the wireless I/O master and slave be compromised, the outputs of the I/O slave will default to its pre-programmed fail-safe position of on, off, or remaining in the last position.

Flexibility

Wireless I/O also means that users are not required to replace existing legacy infrastructure. Wireless I/O can be implemented slowly and integrated into existing systems.

In terms of flexibility, another benefit is the ease of reconfiguration and expansion. Should the need arise to relocate instruments, there is no expensive conduit to be demolished, relocated, or added. Moreover, if mobile instrumentation is to be used within the company. wireless I/O offers an attractive solution.

Creating even more flexibility is the advent of Modbus wireless I/O. Whereas traditional wireless I/O is limited by the I/O count on the master radio, Modbus wireless I/O delivers data to a central control point via a serial port, exponentially increasing the I/O count and thus eliminating the need for hardwiring the I/O master to the control system's I/O.

With Modbus wireless I/O, each Modbus I/O slave is given a unique Modbus device ID and the central control system is configured to poll Modbus registers of the specific Modbus address for a given slave. Typically, a Modbus register map is provided by each vendor for their device.

Reliability

For industrial applications, reliability is crucial: wireless systems must be just as reliable as traditional copper wire. Depending on the specific application, corrupted data can result in anything from a disruptive glitch to a devastating failure.

Three factors determine the signal reliability: path loss, RF interference, and transmit power. In order to identify and ultimately maximize signal reliability, it is recommended that an RF site survey or path study be performed. Although extremely useful, one of the major drawbacks has been the cost associated with the process as it requires highly skilled labor. However, certain manufacturers now are providing this as a value-added service helping customers realize precise and accurate network designs in a multitude of applications.

Diagnostic Monitoring

Another advantage is the diagnostic monitoring of the signal reliability within the radio system. The diagnostic activity occurs outside the normal transmission of

I/O data and can be fed into a diagnostics software package which will notify the system user of any abnormal operation of the system.

In the case of wireless I/O, an additional signal is extracted and analyzed during the course of normal operation of the sensor. As the sensor operates, the signal is monitored for abnormalities in terms of signal, noise, voltage, temperature, reflected power, etc. The user may determine at what levels a warning occurs and at what levels an alarm is triggered.

Low Power Consumption

Although not necessarily a specific advantage over wired alternatives, but one of the most important considerations for remote site operation, is low DC power consumption. Low power consumption translates into smaller batteries and solar panels making remote site deployment feasible in areas previously considered impractical for monitoring and control.

Typical I/O kit hardware consists of a weather tight enclosure with an antenna and solar panel. The enclosure houses a battery, battery charger and the wireless I/O slave. An example of this configuration is shown in Figure 5. These types of kits provide up to 14 days of autonomy with multiple readings per second.

Figure 5. Wireless I/O Kit

Conclusion

Wirelessly enabled I/O solutions offer an evolutionary opportunity to turn more information into knowledge across geographically dispersed assets, leading to optimized productivity, improved safety and asset reliability. This information is vital to companies who want to create and maintain a significant competitive advantage.

As the advantages defined here have illustrated, wireless I/O is positioned to meet specific challenges beyond just wiring costs. As a result, companies can make better decisions with real-time information. In fact, suffice it to say that those who ignore embracing the technology risk are missing an enormous opportunity. Shedding the wires provides unmatched freedom and flexibility to creatively solve difficult challenges and allows adopters to deliver a major, positive impact to their respective company’s bottom line.