ISA100 Wireless Standard Review
Control & Instrument Manufacturer Perspective

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ISA100 Wireless Standard, Control & Instrument Manufacturer Friendly
Control and instrument manufacturers are rapidly meeting the growing demand for industrial wireless devices by leveraging the ISA100 standard. Adding ISA100 to products is a way to reliably and quickly deliver industrial wireless controls and instruments.

Wireless is a growing reality.
Industrial wireless is proving valuable to users every day as indicated by an expanding portfolio of new products and applications that automation professionals are deploying for more effective operations. People are comfortable with wireless since they use it in their daily lives with cell phones, personal computers, and other devices. There is a high return on investment on wireless applications, and adopters are more competitive in the marketplace. Wireless sensor networks provide a low cost means for monitoring hard to reach locations and rolling out new innovative applications. Examples include connecting far distant sensors that are too expensive to wire such as for tank farm monitoring. Other wireless applications include condition monitoring, environmental monitoring, emissions monitoring, asset tracking, continuous commissioning, and acquisition of data previously logged manually. Wireless is also convenient for temporary installations to diagnose problems in a process. Many plants are encouraging their engineers to try wireless data acquisition to learn how these technologies work. ISA100 was designed with major users to address these applications reliably and quickly.

Opportunity
A difficult call in business is determining the opportunity cost of not adopting a new technology before your competitors leverage it against you. If you adopt too early the solutions may not be stable and if you adopt too late your competitors gain business advantages that result in locking you out of opportunities, losing existing customers, and lost sales. More than the immediate loss you have the potential of the loss of ongoing business with a customer for a number of years.

ISA100 provides a way to reliably and quickly add wireless to your controls and instruments. Control and instrument manufacturers have the opportunity to meet the growing demand for industrial wireless devices by leveraging the ISA100 standard. Adding ISA100 is a way you can confidently provide products for these applications reliably and quickly.

User Concerns
Users are learning that industrial plant wireless requires a systems approach like any other aspect of automation and ISA100 addresses these concerns. There are a number of important system level issues with industrial wireless networking that can impact plant operation.
For example, wireless has been growing at a fast rate which has the potential to create performance issues at a plant site without proper system level management. If you have ever been in an internet café and frustrated because you cannot get email because there are too many people using the Wi-Fi, you have experienced what can happen in an unmanaged wireless network. While this is frustrating for an internet café user, an unmanaged network with the potential for the loss of data communications in a wireless industrial plant application could become catastrophic. ISA100 solves this problem since it is designed to manage communications traffic for performance.

It is easy to think of wireless communication as limitless but it has limitations similar to wired industrial networks. Automation people configuring wired industrial networks know there is a finite bandwidth available for communications and overloading the network will create performance problems. Wired industrial networks are in a closed system making them inherently more deterministic than unmanaged wireless communications. Wireless networks also have limitations on communications bandwidth and response issues if not managed. Fortunately, ISA100 provides the structure to manage industrial wireless networks.

Open, Managed Solution
The ISA100 committee is part of ISA and was formed in 2005 to establish standards and related information for industrial wireless. One of the first ISA100 activities was to create the ISA100.11a open wireless networking technology standard developed by the International Society of Automation (ISA) to deploy managed wireless networks in industrial plants. ISA100 achieves the goal of deploying managed wireless industrial networks in plants that meet data integrity and response requirements using a systems approach for orderly communications.

ISA100 Application Framework
Control and instrument manufacturers can add wireless to their products with confidence since ISA100 is a complete proven applications framework for industrial wireless. The ISA100 application framework provides a systems approach for industrial wireless deployment and application. For example, ISA100 provides a secure connection between a field device and automation systems.

The ISA100 standard, without any extensions, is sometimes called the “Native” application layer. The native application layer supports a basic level of services including reporting of analog data, such as temperature, binary data, and blocks of data, such as waveforms. Wireless communication services transmit this data to a gateway or some other remote location.
The entire ISA100 communication stack is shown as a UDP connection that provides a secure connection between a field device and a gateway.

ISA100 defines a communications stack that reliably and securely communicates application data between a device application and a gateway.

There are two basic services namely publication and alerts. Publication is used to configure a device to transmit data at periodic time intervals, for example every 20 seconds. Alerts allow messages to be sent based on trigger points defined by users; this is sometimes referred to as management by exception reporting. When the value crosses a trigger threshold, the device goes into an alarm condition and immediately sends an alarm message. When the value crosses the threshold in the opposite direction, the alarm clears and another message is transmitted. This conserves communications bandwidth to increase the effectiveness of the wireless network. Consider an application that needs to report exceptions within 10 seconds. Using the publication approach would require a transmit message every 10 seconds even when the data is almost exactly the same consuming battery and network resources. Appropriately using publication and alert types provides an optimal balance between energy, data freshness, and fast alarms. These are native functions in the standard supporting a basic level of functionality.

For more sophisticated applications, the ISA100 Wireless Compliance Institute (WCI) has defined extensions to the standard with more added over time to support existing common industrial applications. In 2009, the ISA Automation Standards Compliance Institute (ASCI) established the ISA100 Wireless Compliance Institute also known as WCI. The ISA100 Wireless Compliance Institute owns the ‘ISA100 COMPLIANT’ certification scheme and provides independent testing of ISA100 based products to ensure that they conform to the ISA100 standard (www.isa100wci.org). The committee consists of over 400 automation professionals from nearly 250 companies worldwide. The committee represents end users, wireless suppliers, system integrators, research firms, consultants, government agencies, and industry consortia.

Gateways are included in the standard as a bridge to various networks and standards including Modbus, OPC, and FDT. WCI General Client Interface sets the baseline design that can be used as the basis to create other gateways.
WCI Device Side Extensions
WCI extensions to the ISA100 standard include some codes that link the device to its certification and diagnostics recommended by NAMUR NE 107. The initial extensions also include basic data modeling, especially related to alarms, and profiles for temperature, and pressure.

Device Descriptors (DD)
WCI has adopted Device Description files based on conventions established by Foundation Fieldbus. Device Descriptions are files that describe the capabilities and data structure of devices. This is accomplished by providing an extended description of each application object in the device, which might include proprietary objects that are not covered by any standard. For example, there might be an LCD display on the device that is not standardized. A device description can be used to give the user access to that proprietary display. Device Descriptions enable users to understand the meaning of a device’s data and to access all of its functions. DDs enable the system to be configured without having the device online, which is a real benefit to system integrators. And, generally, a DD opens up host-device communication without custom programming, even if the device has custom features. Foundation Fieldbus device descriptors can be used with ISA100 as illustrated with a number of ISA100 conforming products. User interfaces are automatically generated based on the information provided in Device Descriptor files. For example, there is a selection list on the user interface, and the available selections are determined by the device descriptor. This is very familiar to people who are versed in Foundation Fieldbus.

Communications Abstraction
The ISA100 standard is designed to abstract the communications so that users are freed from any wireless details. The ISA100 System Manager, while not involved in the data flow of information between gateways and wireless nodes is the “brains” of the network that orchestrates all network devices through policy controlled network configurations. Each wireless device has a unique profile defined with a Device Descriptions that specifies the capabilities and internal structure of the device to the host.

ISA100 Stack
ISA100 is built on the Internet Protocol, indicated as UDP/IP in the picture. This is exactly as standardized by the Internet gurus at the Internet Engineering Task Force, generally known as IETF.
ISA100 adds end-to-end security above UDP and below the device application using established Internet Protocol. The developer can treat the whole stack and its security as a magic cloud that just works. That is possible because the ISA100 application layer is well segregated from communication details. Below IP is a radio mesh, with another layer of security that is designed to protect the integrity of radio communications. The core concept is that applications do not need to be aware or perform special functions to communicate with wireless devices. The wireless aspects are all encapsulated at lower layers of the stack.

Service Contracts
ISA100 uses, “Service Contracts”, to define quality of service for wireless nodes to deliver desired network performance. A service contract needs to be established before an application starts transmitting data. For example, an application is configured to publish data every 5 seconds. The application needs to negotiate with the network to set up a service contract, to reserve communication capacity. When a contract is granted, the application knows it can publish every 5 seconds. The service contract approach preserves layer independence, and makes it much easier to add new radios to ISA100 in the future. All the other details that make communications happen are completely transparent to the user. The user does not even need to know what type of communications is being deployed over IP (802.15.4 radio, Wi-Fi, Ethernet, Infrared, etc.) and the user can rely on the service contract feature to help manage the wireless communications bandwidth.

Field Device
The ISA100 standard provides generic application services that are basic capabilities specified in the ISA100.11a standard. The most fundamental function is publication of process data from a field device to a gateway. Typically most of the actual network traffic will be publications.

Publication is the periodic reporting of specified information across the ISA100 network. For example, a sensor configured to transmit data every 5 seconds. In ISA100, publication is normally accomplished through concentrator objects. A concentrator object assembles various types of data in the device and packages that data together, or concentrates the data.
Bandwidth Utilization
ISA100 improves communications performance using objects to consolidate information into packets. The concentrator object and alarm reporting objects for example assembles information into packets for more efficient communications. There is a symmetrical object on the receive side called a dispersion object to disassemble the publication when it is received. This bundling of information conserves communications bandwidth.

These native functions are part of the standard providing everything that is needed to deliver the basic level of functionality.

ISA100 Unified Field Objects
The ISA100 standard defines a number of objects including the ones described here.

Analog Input Object
This object represents the state of an analog input, and includes a scaled floating-point number, a status, and a few other basics. The 32-bit data uses exactly the same units as Foundation Fieldbus. For example, unit code 1001 is degrees Celsius in both Foundation Fieldbus and ISA100. About 700 different units are defined, allowing for a lot of flexibility. For example, Unit Code 1634 is barrel (US Beer) per second. For example, a temperature sensor in ISA100 would report its data through an Analog Input Object, containing a floating-point number that represents degrees Celsius or some other unit.

Upload/Download Object
The Upload/Download object supports transmission of large blocks of data, kilobytes or even megabytes long. It has two major purposes. Every ISA100 device can receive stack downloads through the Upload/Download object. That means every ISA100 device is required to support stack upgrades over the air in a way that is precisely defined by the standard. Upload/download can also send waveforms in the opposite direction in specialized ISA100 devices. For example, vibration sensors or corrosion sensors can also use the upload/download object to transmit waveforms. Additionally, users don’t need to manually schedule the
upload/download action or worry that the automatic upload or download action might interfere with normal but important process measurement communications since the transmitting device would obtain a service contract to transmit in bulk ensuring that the transmission does not compromise critical functions on the network.

One very important aspect of the ISA100 application layer is that it is object oriented and extensible to accommodate future requirements. WCI has made extensions to the basic ISA100 capabilities for the process industry. The first set of extensions relates to general device information including the device’s manufacturer ID, tag name, and device certification. Device diagnostic extensions have been added following the guidelines provide by NAMUR in NE 107. For example, an electrical fault in a device is reported as recommended by NAMUR 107. Other extensions relate process data that is reported by the device, and also a mechanism for reporting alerts based on trigger values including filtering, and alarms with hysteresis. A simulation capability is incorporated to facilitate test and certification of devices.

WCI is building on ISA100 objects to define a set of profiles for specific types of devices. WCI wrote specifications for temperature and pressure profiles in 2010 and currently are developing a positioner profile.

WCI profiles are modeled on similar Foundation Fieldbus specifications and adjusted as needed to account for the ISA100 object model. The goal is that WCI profiles will be similar to Foundation Fieldbus so that integration is straightforward for systems that already integrate with Foundation Fieldbus. Profiles include things that are specific to the type of device. For example, the temperature profile includes thermo-resistance compensation, which of course is very particular to temperature devices.
**Summary**
ISA100 provides a means to deliver a wireless solution in a competitive world. Developing wireless architecture logic including network management are major design challenges. These complex design issues are handled in the ISA100 standard so product designers simply deal with straightforward interfaces.
ISA100.11 is a well thought out open wireless networking technology standard to deploy managed wireless networks in industrial plants. This achieves the goal of deploying wireless industrial networks in plants that meet data integrity and response requirements users require. The WCI organization is committed to decreasing the time, costs, and risks of developing and deploying industrial wireless devices and systems with a collaborative industry-based program that embraces users, suppliers, and other stakeholders. WCI performs independent testing and certification of wireless devices and systems for the ISA100 Wireless Systems for Industrial Automation standards to assure interoperability of devices.

WCI also is a resource for education, tools, and technical support to users and suppliers in the design, certification, deployment, and management of wireless devices and systems that utilize the ISA100 wireless family of standards. ISA100 provides manufacturers a reliable, low risk, and quick path to add industrial wireless to their control and instrument products with confidence.