ARC WHITE PAPER

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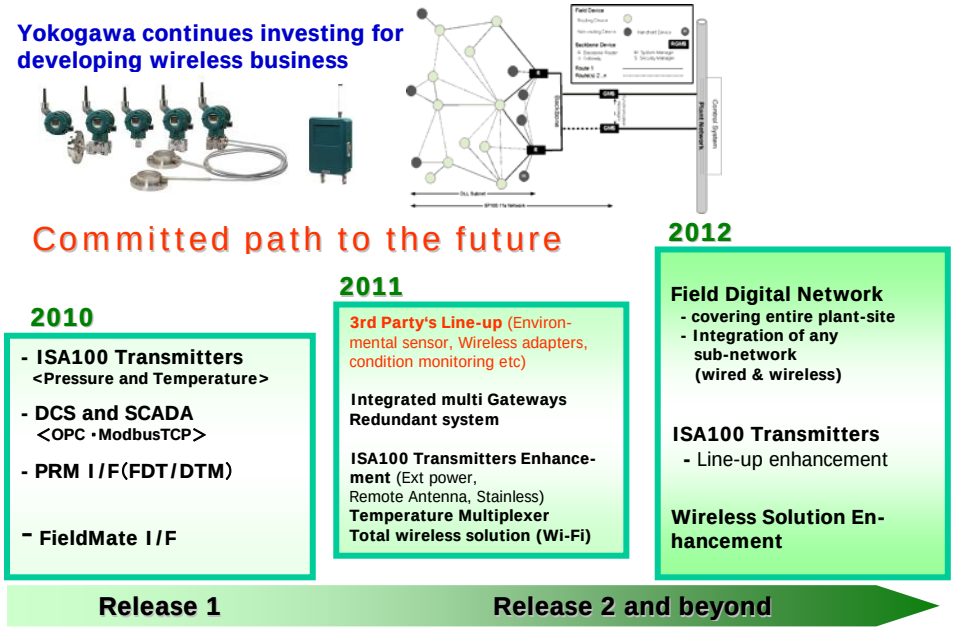
Yokogawa's Wireless Solutions Show a Long-Term Commitment to ISA100 Standard



Yokogawa's Field Digital Roadmap

Requirements		Implementations
Real-time Response Availability Deterministic Security	Reliability	Full Redundant Architecture Duo Cast, Peer to Peer, Subnet Authentication & Encryption End to End Security & TAI for Nonce Reliable Radio High Speed Data Update(1Sec)
Easy Battery Maintenance Maintainability in Hazardous Area Retail-Base Battery (Storage) Long life Power solution Battery Interchangeability	Battery	Star Topology (Not Mesh) Non-Routing Nodes Long Battery Life(D-cell Battery) Exchangeable Battery Case Exchange in Hazardous area Power Harvesting
Plant Level Scalability Future Proof Network Investment Protection Supports legacy protocols Total Wireless Solution	Future	IP-base Technology (IPv6) Application I/F Sub-Layer Protocol Mapping and Tunneling Integration with other systems ex. Wi-Fi

Yokogawa's Field Wireless Solution Supports Real Time Control Requirements, Sustainable Power, and is "Future Proof"

Executive Overview

Standards provide many benefits to the automation end user. Standards promote choice, interoperability, transparency and ensure that things work as they should (at least insofar as the standard is defined). The influx of wireless technology into the world of process automation has brought forth its own standard – ISA100 -- a major standards initiative managed by the International Society of Automation (ISA).

Using the ISA100 standard, Yokogawa's strategy is to develop a new field digital network platform that enhances productivity by eliminating the difficulties users currently face with incompatible wireless communication protocols, making the systematic integration of wired and wireless technologies possible.

While Yokogawa embraces multiple protocols for field instrumentation and for wireless sensors, it is focused on ISA100 as the primary vehicle for developing its Field Wireless network architecture. Using the ISA100 standard, Yokogawa's strategy is to develop a new field digital network platform that enhances productivity by eliminating the difficulties users currently face with incompatible wireless communication protocols, making the systematic integration of wired and wireless technologies possible.

Yokogawa is supporting ISA100 for several reasons. Aside from the overall benefits provided by standards, ISA100 encompasses the work of other standards and industry organizations. ISA100 also incorporates some of the best technologies from the IT world, including IP technology, Security, and reliable radio technologies.

Yokogawa introduced its first ISA100 compatible devices and solutions in 2010 and plans to accelerate development of its new offerings through 2011, when the company will incorporate the next iteration of the ISA100 standard. In addition to expanding its wireless offerings, it plans to begin to offer wireless for control applications.

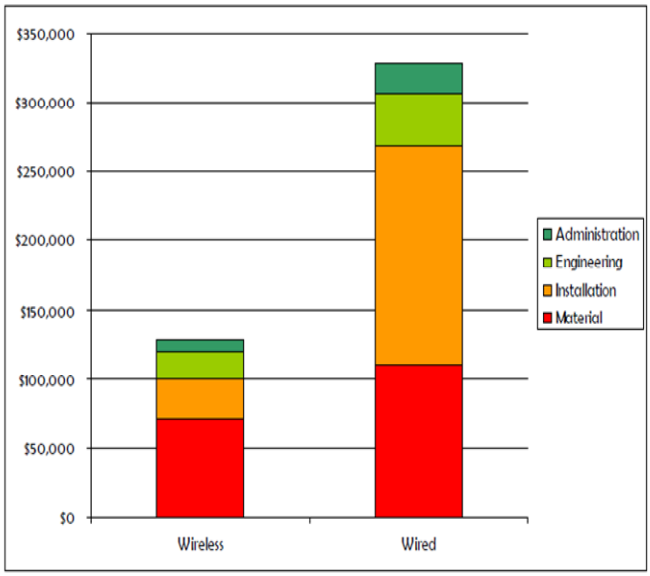
Yokogawa's strategy is to provide a long-term roadmap for its Field Wireless Systems that is "future proof" and provides a consistent migration path, much in the same way that it has done with its CENTUM process control system. Yokogawa is also focused on providing a solution that can incorporate both wired and wireless technologies as required.

The Value Proposition of Wireless Sensors for Process Automation

Wireless networks for process sensors and actuators present a real business value proposition for a wide range of industries. Wireless sensors allow you to add monitoring points in hard to reach places and harsh environments. Wireless sensors can also be placed on moving or rotating assets, providing measurements that were previously impossible. The ways in which these new measurements can improve manufacturing processes are still being discovered, and in many cases, production processes are being completely transformed. If you are an oil producer, for example, wireless devices on your wellheads can help you fulfill your digital oilfield strategy.

Installed Cost Reductions are Significant

The significantly reduced installed cost of wireless devices over wired devices also means that you can install a lot more of them, resulting in a better overall measurement picture of your entire plant and process. The cost of a field transmitter is a fraction of the installed cost paid by a process manufacturer to bring a new measurement live. The other costs represent design, procurement, installation and commissioning of the required support infrastructure including:



Installed Cost of Wireless vs. Wired Process Field Devices
Source : Apprion survey "Wireless Economics"

- Physical: Process connection(s), racks, conduit, wiring, termination areas
- Engineering: New and updated plant engineering design documents
- Back End Applications: Updates to other plant systems such as DCS, plant historians, alarm management, HMI, plant asset management, enterprise asset management, compliance applications, etc.

Wireless devices still require some of this supporting infrastructure (process connections, for example), but much of it becomes simpler or even unnecessary and thus can be achieved at lower cost when using them. Integration of "back end" applications is also simpler, because the integration point (typi-

cally a device gateway) is able to support multiple devices and a limited number of standardized interfaces.

Wireless Devices Enable Predictive Asset Management

The installed cost benefits of wireless devices are significant, but the operational cost benefits are also substantial, and any implementation of a field wireless system must provide an operational perspective. Wireless devices enable a more predictive asset management strategy. Wireless devices provide easy access to diagnostic data about themselves and the processes they are controlling. With peer-to-peer communications, these devices can also talk to each other, enabling a completely new level of diagnostic capability. With this avalanche of data, however, comes the requirement to organize it in a way that enables a predictive asset management strategy. The plant asset management platform decision in this case is just as important as deciding which devices to purchase and which wireless network to use.

Wireless Improves Plant Safety

The remote data access capabilities of wireless devices eliminates the need to send personnel into potentially dangerous situations. Wireless sensors can also be used to track personnel in the plant. Eyewash and other safety stations can be equipped with wireless sensors to warn of their activation. Even video surveillance can be improved.

- Monitoring Spaces
  - Env. Monitoring, Conservation biology, …
  - Precision agriculture,
  - Built environment comfort & efficiency …
  - Alarms, security, surveillance, EPA, OSHA, treaty verification …
- Monitoring Things
  - Automated meter reading
  - Condition-based maintenance
  - Disaster management
  - Civil infrastructure
- Interactions of Space and Things
  - Manufacturing, asset tracking, fleet & franchise
  - Context aware computing, non-verbal communication
  - Assistance - home/elder care
- Action and control
  - Optimizing processes
  - Automation

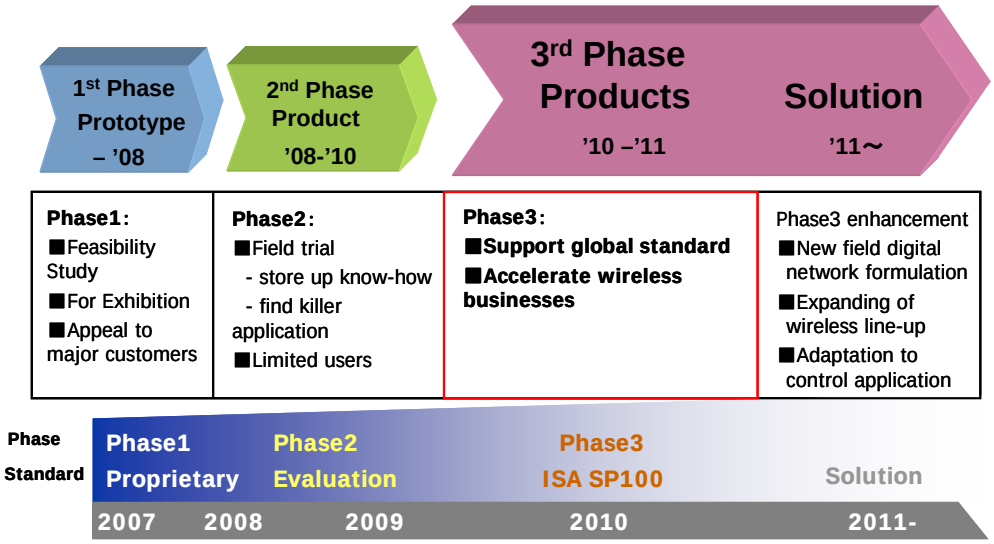
Wireless Technology is Already Being Used in Many Industrial Applications

Wireless Applications Already have Widespread Acceptance

Wireless devices in process automation already have a considerable installed base. Applications include remote areas of the plant, such as tank gauging, to terminal automation, monitoring of wellheads, environmental monitoring applications, and more. The overall size of the wireless market for process automation is already approaching half a billion dollars and is growing rapidly.

Wireless is Key Part of Yokogawa's VigilantPlant Strategy

Yokogawa's vision for field wireless systems is part of its new VigilantPlant strategy, which is guiding every aspect of the company's overall process business. VigilantPlant is based on three core principles – to enable end users to "See Clearly, Know in Advance and Act with Agility". It is Yokogawa's embodiment of a philosophy for operational excellence and continuous improvement in the process industries.



Yokogawa's Wireless History and Roadmap

Yokogawa's Field Wireless System conforms to the three principles of See, Know and Act. Yokogawa has a portfolio of wireless devices that enable the user to see clearly and eliminate many of the existing blind spots in today's plants. Combining the remote diagnostic capability of wireless devices with the predictive capability of a plant asset management system such as Yokogawa's Plant Resource Manager allows user to know of any potential problems in advance. Acting with agility is possible through Yokogawa's lifecycle approach to Field Wireless Systems, which incorporates lower total cost of ownership and continuous evolution.

Yokogawa's strategy is to provide a long-term roadmap for its Field Wireless Systems that is "future proof" and provides a consistent migration path, much in the same way that it has done with its CENTUM process control system. Yokogawa is also focused on providing a solution that can incorporate both wired and wireless technologies as required. Yokogawa has been researching reliable wireless communication infrastructure for many years. Yokogawa's research has shown that radio reliability is one of the most important and fundamental features for constructing reliable indus-

trial wireless systems. This is why Yokogawa has based their wireless solution on reliable radio.

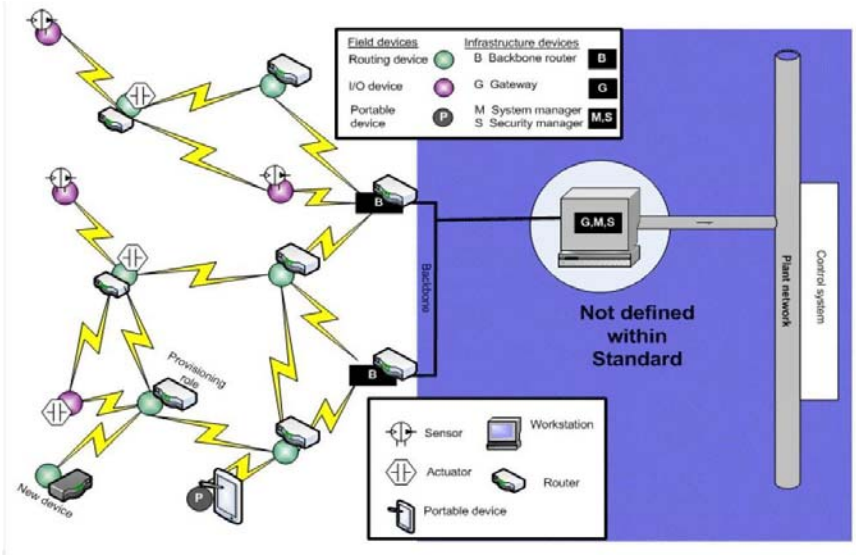
Yokogawa's Wireless Roadmap

Yokogawa's Wireless Roadmap began with first phase prototypes in 2007. The second phase of Yokogawa's Field Wireless strategy began around 2008. Yokogawa conducted field trials of wireless devices in promising applications with a limited number of beta users.

Yokogawa introduced its first ISA100 compatible devices and solutions in 2010 and plans to accelerate development of its new offerings through 2011, when the company will incorporate the next iteration of the ISA100 standard. In addition to expanding its wireless offerings, the company plans to begin to offer wireless for control applications.

A Single Global Standard

Yokogawa's strategy to support ISA100 is based on the need to embrace a single global standard for wireless sensing. The ISA100.11a standard is focused on field devices in process manufacturing applications. ISA100.11a has defined specific classes of automation and a number of roles for field devices and networks, though these roles are not restricted to dedicated devices.



The Scope of the ISA100.11a Standard
Source: ISA100

The ISA100.11a standard defines an OSI protocol stack (Physical, Data Link, Network, Transport, and Application layers) along with system management and security functionality. It does not specify any "backbone" or backhaul network, or any higher-level automa-

tion. It presumes that gateway, system management, and security functionality may reside outside the field networks, but ISA100.11a specifies the interfaces between these remote functions and the field network.

The Value of Standards

Standards provide many benefits. The largest benefits to users are certainty in terms of operation and commercial benefits, because standardization reduces supplier's costs. Users also realize productivity improvements from standards. The productivity benefits extend from functional scoping through start-up and beyond. With standards, one-of-a-kinds can be eliminated, technology widely reused, and documentation and training costs minimized. Standards also promote choices.

Drawing from Existing Standards

While comprehensive, the ISA100 standard often incorporates existing standards and technologies. ISA100 functionality specifies technology that meets the end user convergence requirements outlined in NAMUR report NE 133, which prescribes:

- Sensor node network connectivity
- Host node network connectivity
- Multi-vendor device interoperability among field devices
- Multi-vendor device interoperability between routers and field devices
- Multi-vendor device interoperability between gateways and devices
- Data flows for sensor data
- Network health metrics, metric collection, and presentation
- Field device parameterization/configuration.

Integration with Existing Systems

Integration with existing systems and protocols poses a challenge for any new industrial standard. Radio coexistence is provided by using a common radio technology at the Physical Layer. However, no standard can specify the integration path for each potential network and protocol encountered in the field. ISA100.11a provides informative material pertaining to the integration of HART, Profibus, Foundation Fieldbus, and MODBUS protocols through device adapters, network protocol pass-through tunneling, via mapping using interface objects, or a combination of the above. The challenge here is that any timing-sensitive behavior of a protocol may be difficult or even impossible to guarantee when it is encapsulated and carried as a payload by another network.

Wireless Compliance Institute Provides Interoperability

In addition to standards development, a new organization, the ISA100 Wireless Compliance Institute (WCI), is charged with delivering compliance certification services for the work of ISA100. The ISA100 committee establishes standards, recommended practices, technical reports, and related information for implementing wireless systems in the automation and control environment, with an initial focus on the field level. Given the committee's broad scope, they have formed a number of working groups to pursue specific tasks. The primary deliverable from the Committee thus far is the standard ISA100.11a, "Wireless Systems for Industrial Automation: Process Control and Related Applications". However, a quick glance at the list of working groups shows that several other topics will be addressed by future ISA100 deliverables.

ISA100 Working Group	Working Group Focus
WG1	Integration
WG2	RFP Evaluation Criteria
WG3	ISA100.11a
WG5	RF co-existence
WG6	Interoperability
WG7	Networking
WG8	Users
WG9	User Guide
WG10	Marketing
WG12	Standards Convergence
WG14	Trustworthy Wireless
WG15	Backhaul/Backbone
WG16	Factory Automation
WG17	ZigBee
WG18	Power Sources
WG21	People/Asset Tracking

ISA100 Working Groups

In 2006, at about the same time ISA100 was forming, the ISA also created the non-profit Automation Standards Compliance Institute (ASCI). This organization manages certification, conformance, and compliance assessment activities in the ISA's automation domain. ASCI extends the standards work of ISA by facilitating the effective implementation and independent testing of ISA standards. It creates a vital link between the development of standards and industries' implementation of the standards. The ISA100 Wireless Compliance Institute (WCI) functions as an operational group within ASCI. Operating the ISA100 Wireless Compliance Institute within ASCI allows it to leverage the infrastructure of ASCI, which in addition to WCI, is shared by several ASCI compliance programs.

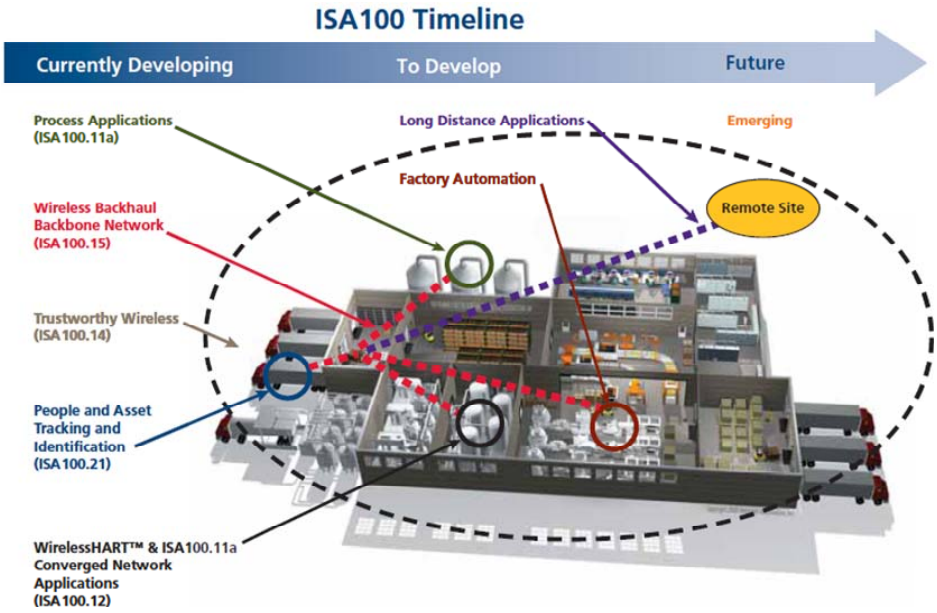
The WCI is tasked to:

- Conduct independent testing/certification of devices and systems to the ISA100 family of standards
- Provide education, tools, and technical support to users and suppliers
- Certify that devices and systems meet a common set of specifications
- Assure interoperability via standards, tests, and conformance processes

The most important aspect of ACSI and WCI from the end user's standpoint is that important future ISA standards will be provided with independent certification testing services for conformance to the standards. This is a critical advantage, which provides assurances of product interoperability. Standards that lack effective independent compliance services are of little value to end users, regardless of their origin.

ISA 100 and WirelessHART Convergence

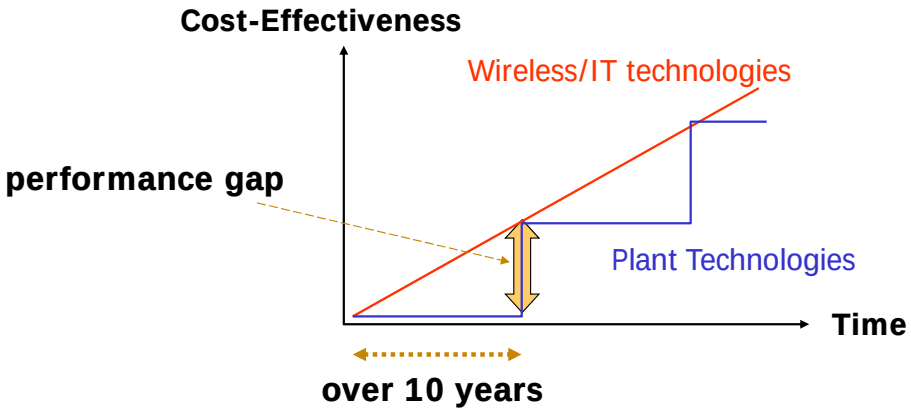
Recognizing the scope overlap between ISA100.11a and IEC 62591 (WirelessHART), ISA100 formed the ISA100.12 convergence subcommittee. Charged with convergence of ISA100 and IEC 62591, this team has independently solicited input from end users regarding their needs and priorities. End user input was solicited through a "Convergence User Requirements Team" (CURT). The CURT made its recommendations available to both ISA100 and the NAMUR organization. Likewise, ISA100 has also accepted convergence recommendations from NAMUR and incorporated them into the requirements produced by CURT. The ISA100.12 convergence work thus far has developed an RFP (request for proposals). These proposals must define a roadmap for convergence of these global wireless standards. The RFP went out for ballot and passed on November 8, 2010. Now that it is approved by the ISA100 Committee, convergence proposals will be submitted to ISA100 in 1Q2011.



Source : ISA100

ISA100 Incorporates Industry Standard and Mainstream Technologies

Yokogawa has many reasons for supporting ISA100 and making it the linchpin of its Field Wireless strategy. The ISA100 standard is written to incorporate existing, proven technology rather than create its own. Users have made it clear that they wanted the ISA100 standard to provide a common network structure that will afford the greatest diversity of field sensor applications. Other key user requirements for ISA100 include the ability to support thousands of devices, support of control functionality, no single point of failure, low latency, and high reliability.



Adoption of Standard IT Technologies in Automation Provides Cost Effective Solutions with Increased Performance

A key example of incorporating open technologies with ISA100 is the use of IEEE 802.15.4 standard radio as its physical layer. This "layering" approach is critical, because it allows a degree of independence between layers. Defined interfaces between layers allow the standard to adapt to technology changes. This allows any layer within the standard to be modified without disturbing the others. IP, Radio, and industry standard security approaches are all mainstream technologies that are well suited to industrial wireless networks.

There are several advantages to incorporating mainstream technologies to industrial applications, where they are appropriate of course. Many of these technologies are already based on proven industry standards and many engineers and technicians are familiar with the technology. This makes the systems easier to maintain. Incorporating industry standard technologies is also at the heart of Yokogawa's "Future Proof" approach to

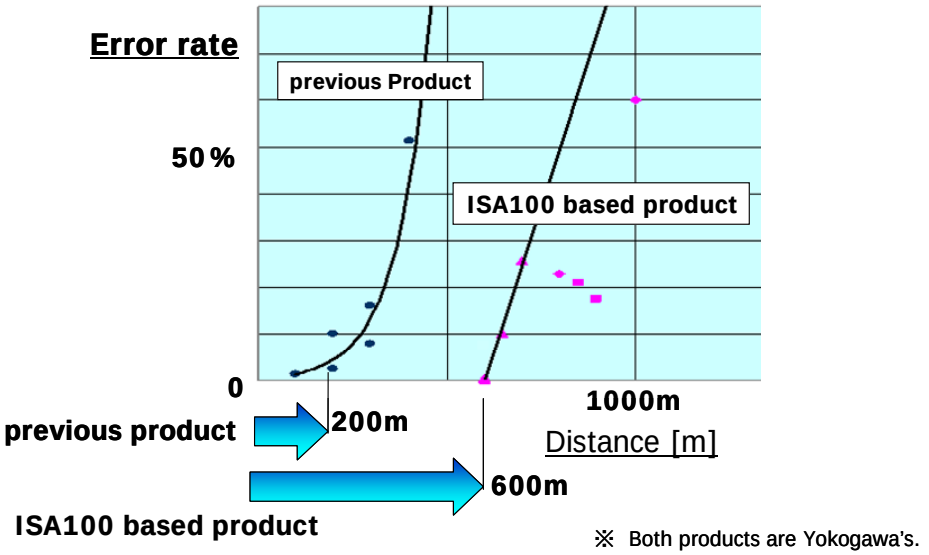
wireless that can adapt to new technologies as they emerge and incorporate improvements to existing technologies.

IP technology

One of the key standard technologies embraced by ISA100 and Yokogawa is the IP or Internet Protocol suite of technologies. The IP suite of applications is probably one of the best known in the industry and is embraced worldwide. ISA100.11a supports 6LoWPAN, which means that the ISA100.11a devices can communicate with devices that support IPv6. 6LoWPAN has been developed by the Internet Engineering Task Force as a method to adopt Internet Protocol Version 6 (IPv6) on low power, low-data rate Personal Area Networks (PAN) – hence the Working group's exotic name. ISA100.11a incorporated 6LoWPAN in 2009. Incorporation of 6LoWPAN makes connecting sensor networks connect to the IP world much simpler. Characteristics of 6LoWPAN include small packet size, with header compression, low bandwidth, and low power consumption.

Security

ISA100.11a supports cyber security technologies such as device authentication, encryption and integrity checking and so on. Standard cipher technologies such as AES and MMO hash are also used. These security technologies can also add scalability to system design.



Next Generation ISA100-Based Products from Yokogawa Provide Much Greater Distance Range with Reduced Error Rate

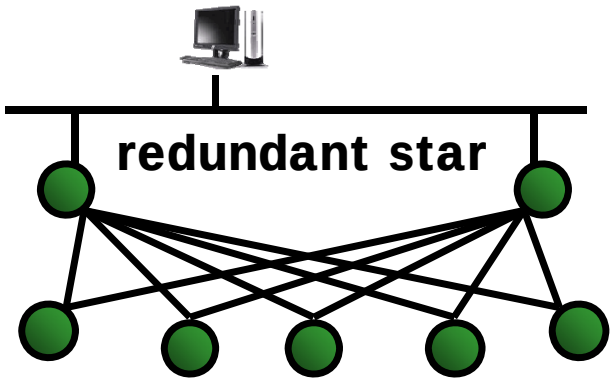
Radio

Radio is another well accepted, mainstream technology, and a fundamental component of system reliability. System performance increases in step with radio technology improvement, and radio providers continue to improve their functionality day by day. As a result, higher receiver sensitivity is developing. Yokogawa has radio features that provide long range communication, reliability in the "pipe jungle" of industrial plants, and coexistence with Wi-Fi technology.

Yokogawa's Field Wireless: Control Proof, Power Proof, Future Proof

The latest release of CENTUM® VP supports integrated ISA100 wireless functionality. These wireless products include an EJX-B series differential pressure and pressure transmitter, a YTA series temperature transmitter, and an integrated field wireless gateway for field sensor networks. The company also has multiple applications to assist with configuration and ongoing maintenance of wireless networks. The Field Wireless Configurator software performs network setting, maintenance, and other tasks. The Field Wireless Management Tool manages the field wireless network and field wireless devices and checks operating conditions.

Many of Yokogawa's other application offerings can be used in conjunction with wireless technology to provide operational benefits. For example, Yokogawa customers are using the Exapilot procedural automation application with a wireless LAN for fieldwork support to improve maintenance work scheduling. End users improve efficiency and quality by sharing work schedule and progress information on the Exapilot system through wireless mobile terminals.



Yokogawa's Redundant Star Topology

Through ISA100, Yokogawa's roadmap calls for building a Field Wireless solution that is "Control Proof, Power Proof, and Future Proof". Control Proof means that the wireless architecture meets the requirement for real time control applications. Power Proof refers to the ability of Yokogawa's wireless solution to provide

reliable and long lasting power, while Future Proof refers to the ability of the solution to keep up with the rapid changes taking place in the world of IT.

Control Proof

To be suitable for control applications, wireless networks must possess the necessary reliability and deterministic data transfer capabilities. ISA100 supports reliable radio technology and offers coexistence with Wi-Fi and duocast technology. With bidirectional digital wireless networks based on ISA100, the production, device diagnostic, and parameter data transferred between a control system and field devices are securely encrypted. This wireless technology is ideal for control applications in addition to status monitoring, device diagnostics, and control applications. Yokogawa also supports full redundancy and one-second data transfer.

Network topology also affects performance and reliability. Yokogawa's Field Wireless strategy calls for a redundant star topology network. In Yokogawa's view, redundant star topology provides the best determinism, low latency, and multiple route communications needed to provide the level of reliability needed for process control applications.

Yokogawa's Unique Approach to Batteries Allows for Hazardous Area Replacement and Lower Cost

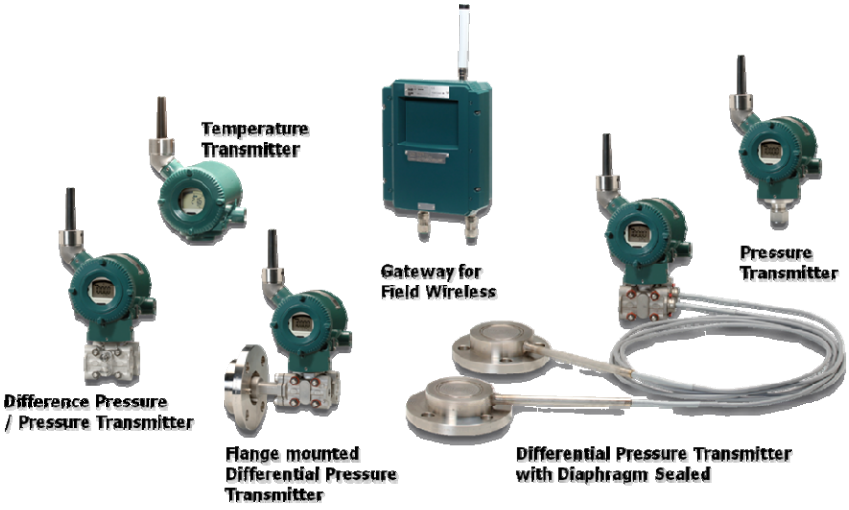
Power Proof

A primary advantage of wireless transmitters is that they do not require wiring for either data transmission or power supply. However, reliable and long lasting power has been a longstanding challenge for wireless process sensor applications. Yokogawa has addressed this issue with its own Open Battery Concept. The company has created its own general-purpose Lithium Thionyl Chloride Battery for their wireless transmitters, and has designed a unique battery case that allows users to replace the battery pack even in a hazardous environment. The redundant star topology network also provides low energy consumption, providing longer battery

life. Yokogawa also plans to develop easy-to-maintain solar batteries for use with these devices.

Future Proof

To make its wireless solution future proof, Yokogawa also plans to support multiple protocols moving forward, including HART and Foundation ™fieldbus and so on. The company also supports many wired protocols from HART to Foundation Fieldbus and Profibus, and the company will replicate this policy with its wireless offerings. Yokogawa will continue to be radio agnostic, and will continue to provide a solution that can incorporate changing IT technologies. Part of being future proof also means providing seamless integration of both wired and wireless technologies, as the two will continue to coexist in process plants for many years in the future. As a partner with its customers, Yokogawa is always looking to develop new technology solutions while working to ensure full compatibility with customer's current assets, thus protecting their investment. These products were designed with this requirement in mind.



Yokogawa Has a Full Range of ISA100 Compatible Wireless Field Devices

Conclusions and Recommendations

As a member of the ISA100 Standards Committee on Wireless Systems for Automation, Yokogawa will continue to engage in a wide range of activities to promote development of the ISA100.11a international standard. Yokogawa's next step in its wireless roadmap is to develop a fully redundant wireless system based on ISA100 and to continue to make enhancements to its wireless devices and its applications such as PRM. The company also plans to incorporate Wi-Fi technology into its offering by the end of 2011. In the longer term, Yokogawa's Field Digital Network will cover the entire

plant site and provide integration of any sub-networks, both wired and wireless.

In ARC's opinion, Yokogawa has a very good record of accomplishment for holding to its development schedule and commitments to customers. This is one of the reasons why the company is so open with its long-term development roadmap. Yokogawa's commitment to providing a wireless solution that meets the requirements of process automation end users and incorporates industry standard technologies such as ISA100 is real. At the same time, Yokogawa is committed to its installed base and will continue to support its installed systems and devices with a wireless architecture that can seamlessly incorporate the full range of wireless and wired networks supported by the company.

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Acronym Reference: For a complete list of industry acronyms, refer to our web page at www.arcweb.com/Research/IndustryTerms/

ASCI	Automation Standards Compliance Institute
B2B	Business-to-Business
BPM	Business Process Management
CAGR	Compound Annual Growth Rate
CAS	Collaborative Automation System
CMM	Collaborative Management Model
CPG	Consumer Packaged Goods
CPM	Collaborative Production Management
CURT	Convergence User Requirements Team
DCS	Distributed Control System
DLL	Data Link Layer
ERP	Enterprise Resource Planning
HMI	Human Machine Interface
IP	Internet Protocol
IT	Information Technology
LAN	Local Area Network
PAN	Personal Area Network
PAS	Process Automation System
PLC	Programmable Logic Controller
PLM	Product Lifecycle Management
RFID	Radio Frequency Identification
ROA	Return on Assets
RPM	Real-time Performance Management
SCM	Supply Chain Management
WMS	Wireless Compliance Institute

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