

# Wireless Process Control Products from ISA 2004

Deji Chen\*, Mark Nixon\*, Tom Aneweer\*, Rusty Shepard\*, Kent Burr\*, and Aloysius K. Mok<sup>1</sup>

*\*Emerson Process Management  
12301 Research Blvd. Bldg. III  
Austin, TX 78759, USA*

*<sup>1</sup>Department of Computer Sciences  
The University of Texas at Austin  
Austin, TX 78712, USA*

## Abstract

*Applying wireless technology in process control is gathering momentum. This is evident from the last ISA Expo. In this paper, we survey the wireless products offered at the ISA Expo. The paper first discusses the process control system and areas where wireless could play a role. It then checks with products that were on display at the Expo. We look at the differentiation these products provide to meet industrial process automation requirements. We conclude with some observations and opinions, including areas that still await the invasion of wireless.*

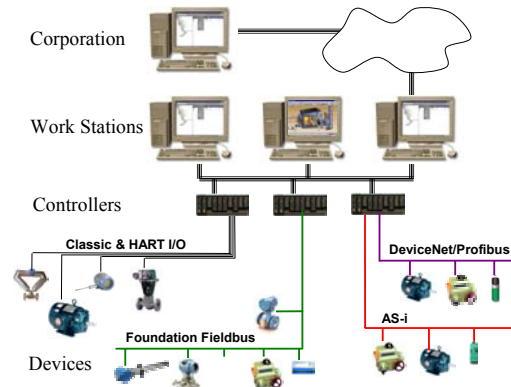
## 1. Introduction

Wireless application in process control industry is much talked about. People are interested what existing wireless products there are for the process control industry. From October 5 to 7, 2004, ISA (the Instrumentation, Systems, and Automation Society) held its annual exhibition and conferences, called ISA Expo, in Houston, Texas. This provided a good venue to checkout the latest offerings from industrial automation companies. In this article we survey the current wireless products based on our visit and the brochures collected from the ISA show. We compare what wireless could be applied and what is already applied.

A process control system, as is shown in Figure 1, controls an industry process. Its core involves some sensor devices measuring the process, actuator devices adjusting the process, and the controller controlling both types of devices. The controller and devices form a control unit wired together by a “control network”. The control network has high real-time requirement. The sensor and control data should be delivered at pre-determined times. A loss of scheduled data normally triggers big costs such as the shut down of the process.

Industry fieldbus network standards are usually employed in the control networks.

In a modern process control systems such control units are further connected in a wider network, the “control area network”. Usually workstations are also on this network serving as the gateway from the controller to the users and the outside world. A user could configure and monitor the control unit from the workstation. The control area network has less strict real-time requirements than the control network.



**Figure 1: A Process Control System**

The workstations in the control area network could also be connected to the office network, or the Internet. The networks involved here are regular ones with no special control requirements.

## 2. Wireless products for a process control system

To distinguish wireless products for process control, we shall call any wireless products that are not specifically targeted for process control “conventional” wireless products.

Let's look at the path that the process data travels from the device all the way to the end user. Wireless products for process control exist from the edge of the devices to the data-receiving workstations. Field devices could have built-in wireless transmitters, or connected by wire to a wireless transmission node, which may talk wirelessly to a controller/workstation, or to another wireless node connected by wire to the controller/workstation. Wireless products could be used to communicate among controllers and workstations. Yet more wireless products could be used to communicate from a control system to the outside world.

The wireless products at the control unit level should serve short distance with high reliability. They have to endure harsh environment. They may have low power requirement. The wireless products at the control area network need to serve high data rate and long distance. It still requires sufficient reliability, although not as high as in the control unit. At this level, security concern starts showing up as the airwave spans a much larger area. Beyond the control system, we assume any conventional wireless products could be used to transmit data to and from the control workstations. Of course, any concern with conventional products maybe an even bigger concern here as we are talking about connected process control system.

Hardware products could be standalone wireless transmitters. They could also be devices and controllers equipped with wireless transmitters. Companies could also sell wireless parts such as antennas and accessories. Software products could be communication stacks, device drivers, and complete systems. Companies could also provide complete solutions or help customers setting up a wireless system.

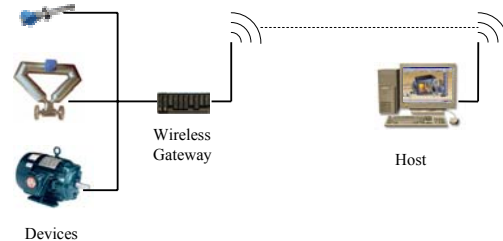
### 3. Wireless products from the ISA Expo

ISA 2004 Expo draws major industrial automation companies. We visited the exhibition floor and collected product brochures from 17 companies and organizations that offer wireless products. Many of them were in the exhibition floor's wireless and network section. Others are scattered in other places. Among the 17 exhibitors, two are organizations, one is a certification lab, the other 14 offer wireless products.

#### 3.1. Wireless Gateway

Interestingly, the main products of the majority of the companies are "gateways" acting as the intermediaries between the devices and the outside as

is shown in Figure 2. The wireless gateway connects to the devices by wire using existing serial network protocols such as RS-232, RS-485, or RS-422. The gateway in turn communicates wirelessly to the host or another gateway connected to the host. The transmission distance ranges from hundreds of feet to miles.



**Figure 2: Wireless Gateway**

Nine companies have such products as their major offering. Among the other five companies, one offers gateway between hosts only; two offer complete solutions that include such gateway; one sells antennas only; and the last one is a mesh network player.

The gateway could be as simple as a modem that translates data from one protocol to another. There are wireless Ethernet modems, wireless serial modems, and wireless I/O modems. The gateway could also be a data access point that combines several devices together and acts as a single wireless source. More sophisticated gateways are called wireless bridges, node modules, or remote terminals. They run software, could be configured, and process data. They provide product designer with a transparent and easy to design in wireless serial communication link.

While the gateway connects to the devices through standard serial network protocols, the wireless communication from the gateway varies. Some are proprietary; most use wireless standards, such as 802.11b/g (Wi-Fi), at the lower level and wireless Ethernet at the higher level. Some products use Bluetooth. One company sells GSM (Global System for Mobile Communication) modems with text message SMS (Short Message Service) and GPRS (General Packet Radio Service).

Referring to Figure 1, we can tell the gateway network is the combination of control network and area control network. Devices could be connected to

controllers or PLCs (Programmable Logic Controllers) through the wireless gateway, but unless they use proprietary protocol, Wi-Fi is not good enough for rigorous control network requirement. One gateway product actually builds routing tables using Allen-Bradley and MODBUS ([www.modbus.org](http://www.modbus.org)) addresses, enables the radio to further assure communications between PLC's and devices in a system for both inbound and outbound messages. One product even supports 802.11i with AES (Advanced Encryption Standard) and dynamic key distribution. Products using Wi-Fi also boast enhanced security and reliability of Wi-Fi. Almost all Wi-Fi products mention the advantage of its underlying technology. Proprietary products advertise the frequency hopping spread spectrum (FHSS) technology with low data rate and high reliability vs direct sequence frequency hopping (DSSS) technology used in Wi-Fi. Still, the majority of the products apply to sensing and monitoring rather than controlling.

### 3.2. Other wireless products

Besides gateway products, we did not see many other wireless products.

Antenna is the essential part of the wireless network. Four companies sell antenna as major offerings. One company dedicated in selling different kinds of antennas for different purposes, reliability, hostile environment, and heavy duties. It "established an enviable and proven track record of supplying robust antennas for use in mission critical situations."

Some companies sell wireless sensors as combined products. Those products are wireless video server, wireless RFID data point, and many kinds of small sensors.

Few companies also sell hardware parts such as cables, accessories, PC-based wireless cards, remote sensor interface, etc.

Companies selling hardware also provide some software or services. Some companies go beyond that. They provide complete wireless data solutions such as radio frequency site survey, installation, start-up & commissioning, and training. One company claims to be the "leading provider of most secure wireless infrastructure and applications utilizing FIPS (Federal Information Processing Standards) 140-2 validated wireless products, 802.11 wireless network solutions, condition-based and location-based telemetric solutions, and Bluetooth networking solutions." It "has proven technology leadership in the areas of remote monitoring, highly secure wireless networking, integrated sensor networks, and systems integration." Another sensor company also provides sensors and

data collection tools for diagnostics, condition-based maintenance, asset management, situation awareness, operational readiness, and security. It provides PC-based remote sensor interfaces.

### 3.3. Organizations

Although they did not have dedicated exhibition booths, three wireless organizations could be heard during the show. ZigBee and Bluetooth were covered each in four company brochures. WINA, the Wireless Industrial Networking Alliance was also present.

**ZigBee** The mission of the ZigBee Alliance is "to create specifications that leverage existing standards and implement qualification programs that enable reliable, wirelessly networked, cost-effective, low-power consuming, and secure, monitoring and control products." The existing standard is IEEE 802.15.4. The initial markets are home control and building automation, although it is also believed that it is the best candidate for process control market. No specification had been published at the time. Several companies already are ZigBee members or have pledged ZigBee support. Although no real ZigBee product exists yet, we expect many of the companies will come up with some. Interestingly, ZigBee is already promoted by TUV whose service is product testing and certification.

**Bluetooth** In contrast, Bluetooth has been around for a while. While the companies mentioning ZigBee pledged alliance; companies mentioning Bluetooth have products already. One sensor company uses Bluetooth as its only wireless offering. Bluetooth, however, is created for personal area network. The question remains if it will become a major player in process control.

**WINA** WINA is not a standard committee. Rather, as a coalition, it promotes advancement of wireless solutions for industry. Its charter is: identify, recommend, and certify appropriate wireless technologies; focus on customer requirements; promote effective standards, regulations, and practices; quantify and communicate the benefits and potential impacts of wireless technologies.

**Magazines** Wireless is relatively new in process control. And it is not surprising that the most you hear about it is from trade magazines. These include InTech magazine ([www.isa.org/InTechTemplate.cfm](http://www.isa.org/InTechTemplate.cfm)), Sensors magazine ([www.sensorsmag.com](http://www.sensorsmag.com)), Control magazine ([www.controlmag.com](http://www.controlmag.com)), Control Engineering magazine ([www.controleng.com](http://www.controleng.com)), etc.

## 4. Observations

Of all the companies surveyed, only one looks like a pure wireless company. One company only sells antennas and accessories. All other companies on the wireless bandwagon have non-wireless offerings as well. Many of them sell network gears and wireless products are part of their series of network products. One sensor company introduced wireless sensors on top of their sensor offerings.

Without one wireless standard for process control, the communication protocols used by the gateways vary. This presents the problem of product interoperability. Products from a single company are required at both ends of a wireless communication. Even for products using Wi-Fi, some of them build wireless Ethernet on top, some use proprietary software.

The majority wireless products are wireless gateways. Few of them provide wireless process control systems.

One company showed a demo in which the audience could update and view the value in an instrument mounted in its east coast office through computer, cell phone, or other digital assistance gadget. The graphical user interface displays the pictures and real-time value. It is questionable if this system could endure the rigid requirement of process control.

Wireless is also a major topic in the accompanying technical conferences. One company presentation talked about its experimentations installing wireless control system for its customers where a mobile truck is able to track and control oil tanks. Some form of customized wireless gateway is used in the experiment.

#### *4.1. Mesh Networks*

Sensor network or mesh network has good promise. It connects small sensors through low power, low data rate wireless communication. By collecting endless environment data, it provides great potential for enhancing process control. ZigBee as the low power high reliable network standard could be the underlying engine driving its success.

Three companies provide mesh network products, all embrace ZigBee. One has a full suite of mesh network products, from sensors to network software to complete systems. With low sampling rate and outdoor environment, its wireless sensors could scatter over several acres or more and operate on battery for at least one year.

#### *4.2. Customer perspective*

Wireless is relatively new. Customers may have trouble selecting the best products. Wireless also has inherent risk such as security, attenuation, reliability, noise, etc. It is interesting to see how vendors distinguished among themselves. Some of the promoting phrases we collected are: "Network solutions that maximize industrial productivity", "simply output serial data from any microcontroller RS-232 port into the ... to send FCC (Federal Communications Commission) and ETSI (European Telecommunications Standards Institute) approved FHSS data", "peer-to-peer, point-to-point, and point-to-multipoint networks", "e-device, e-infrastructures, e-applications", "world leader in manufacturing of industrial data communications", "Products designed specifically to perform in the harshest environments and to protect your data transmissions, reducing errors and downtimes", "Galvanic isolation, transient protection, superior components, industrial level EMC (Electromagnetic Compatibility) immunity", "rapid and cost-effective integration, FCC certification".

For customers, the main selecting criteria would be if the product suits the need. Others are product cost, development cost, power consumption, transmission distance, communication reliability (mesh vs. peer to peer), bandwidth, business maturity, project risk, network protocol, handheld support, large system deployment, interoperability, installation tool support, troubleshooting tool support, international support, etc. Once the market settles on a few stable vendors, the customer will be in a better position to select products. Can we predict that the eventual market winner may not necessarily have the best technology?

#### *4.3. Missing wireless products*

For the market to mature, a diversity of products must emerge. It is interesting to see what product is not present at the ISA Expo.

First of all, the wireless gateway connects to devices through serial standards. More and more process control systems connect up devices with fieldbuses. We do not see any wireless gateway that supports fieldbuses other than the one supporting MODBUS.

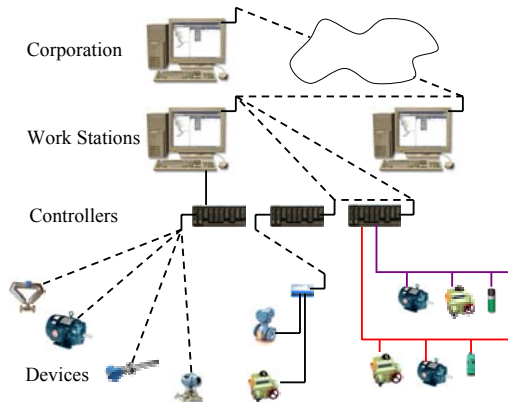
Other than small sensors, we do not see main stream process control devices such as temperature sensors, valves, and motors that are ready-equipped with wireless transmitters.

What is missing is also a common network standard that all products could interoperate with.

Finally, we expect complete wireless process control systems, or process control systems with wireless as an integral part.

One question needs to be answered is how a wireless product meets the hard real-time requirement of a process control system, especially at the control network level.

We showed a typical current process control system in Figure 1. Wireless could appear in any of the three network layers. When wireless becomes fully integrated with process control, we expect the next generation control system looking like something shown in Figure 3.



**Figure 3: Wireless Process Control System**

## 5. Conclusions

In this survey we looked at wireless products displayed at the ISA 2004 Expo. While wireless is much talked about, there are still limited real products for process control. When a new technology comes along, it always goes through an adoption period. We are still at the early stage of wireless in process control. This is evident from the limited products during the ISA Expo. Once the hype is over, we should see steady growth.

The opinions in this paper do not represent any companies. They are of the authors only. We do not endorse or disapprove by mentioning the companies or organizations. Also by only visiting the exhibition booths and reading the brochures, we do not claim to be the authority on those wireless products. We take what is claimed in the brochures by face value. We do not claim to have covered all wireless products from a company, nor have we covered all wireless companies. This is because there are process control companies, especially those outside the USA who did not attend the ISA Expo. Last, we do not have any knowledge of the exact prices of the wireless products offered there.

We only covered real wireless products in the ISA Expo. There should have been a lot of development since then. For example, in December 2004 ZigBee standard 1.0 was published.

## 6. Companies surveyed

We could not guarantee that all ISA exhibition companies that offer wireless products are included. However, we believe the survey presented a rather comprehensive picture.

- Wireless Industrial Networking Alliance (WINA) ([www.wina.org](http://www.wina.org))
- ZigBee Alliance ([www.zigbee.org](http://www.zigbee.org))
- TUV ([www.tuv.com](http://www.tuv.com))
- 3e Technologies International ([www.3eti.com](http://www.3eti.com))
- Atop Technologies ([www.atop.com.tw](http://www.atop.com.tw))
- B&B electronics manufacturing Company ([www.bb-elec.com](http://www.bb-elec.com))
- Bluewave Antenna Systems Ltd. ([www.bluewaveantenna.com](http://www.bluewaveantenna.com))
- Cirronet, Inc. ([www.cirronet.com](http://www.cirronet.com))
- Crossbow Technology ([www.xbow.com](http://www.xbow.com))
- Data-linc group ([www.data-linc.com](http://www.data-linc.com))
- DPAC Technologies Corp ([www.dpactech.com](http://www.dpactech.com))
- Electronic Systems Technology, Inc. ([www.esteem.com](http://www.esteem.com))
- Iconics ([www.iconics.com](http://www.iconics.com))
- MaxStream ([www.maxstream.net](http://www.maxstream.net))
- Oceana Sensor Technologies ([www.oceanasensor.com](http://www.oceanasensor.com))
- RF Neulink ([www.rfneulink.com](http://www.rfneulink.com))
- Westermo Teleindustri AB ([www.westermo.com](http://www.westermo.com))

## 7. References

- [1] D. Culler, D. Estrin, and M. Srivastava, Overview of Sensor Networks, Computer, August 2004
- [2] C. Dick, Wireless Networks for Industrial Automation, The Instrumentation, Systems and Automation Society, 2004
- [3] M. Nixon, R. Shepard, B. Bennett, D. Chen, and A. K. Mok, A Framework to Transmit Process Control Data over Commercial Wireless Networks, ISA Technical Conference, October 2004
- [4] Foundation Fieldbus, <http://www.fieldbus.org/>
- [5] Bluetooth Standard, <https://www.bluetooth.org/>
- [6] IEEE standards, <http://standards.ieee.org/wireless/>