MAKING WIRELESS PART OF YOUR INDUSTRIAL NETWORK DEPENDS ON STANDARDS AND THE RIGHT HARDWARE

How Wireless Works

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WHETHER YOUR WIRELESS INDUSTRIAL DATA communications involves local area networks (LANs), simple point-to-point solutions, or emerging technologies such as Bluetooth or cellular network systems, hardware and standards are the essential building blocks.

It's becoming clear that more of you are looking to wireless for factory-floor solutions. A 2002 market research study from Venture Development (www.vdc-corp.com) forecasts annual growth rates of more than 25% for wireless LAN hardware through 2005, although that includes all end-use segments, not just factory automation or control. Unit shipments are expected to grow at a healthier 35% a year, providing evidence of price erosion in this category.

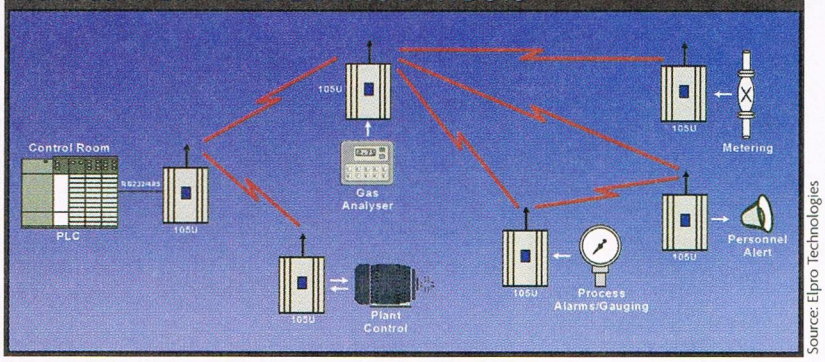
"There's a broad set of solutions in the industrial space," says Harry Forbes, senior analyst with ARC Advisory Group (www.arcweb.com), who also sees huge potential in this technology. "There are a lot of applications for sensor and wire replacement that make sense."

STANDARDS ARE BUILDING BLOCKS

The foundation of this technology is the Institute of Electrical and Electronics Engineers' Project 802, which was initiated in the 1980s to develop standards for compatibility of then-emerging wired local area network technology. The IEEE 802.3 standard was among the first standards developed and is the overall Ethernet standard. The 802.11 standards were developed later for wireless LAN technology.

Efforts to increase data rates later resulted in the addition of 802.11b and 802.11a standards. 802.11b makes use of the same radio frequency designated by the original 802.11 standard while 802.11a uses the FCC's more recently designated Unlicensed National Information Infrastructure or UNII band, making it incompatible with the earlier version.

FIG. 1: CONNECT THE OPERATING DATA DOTS



Source: Elpro Technologies

Wireless access points are often transceivers, transmitting and receiving signals for control or to retransmit what another access point has sent along the network. By wire or via short-range wireless connection, they are coupled with a device or sensor, sending data along on the wireless network.

The 802.11 standard designated two ways of communicating between devices at speeds up to 2 Mbps: direct-sequence spread spectrum (DSSS) and frequency-hopping spread spectrum (FHSS). Spread spectrum means data is sent in small pieces over a number of the frequencies available in the specified range.

Devices using DSSS split each byte of data into several parts and send them simultaneously on different frequencies. Devices using FHSS send a short burst of data, shift (or hop) frequencies, and then send another batch of data. Since the FHSS devices that are communicating agree on which frequencies to hop to, and use each frequency for a brief period of time (less than 400 msec.) before moving on, several independent FHSS networks can exist in the same physical area without interfering with each other.

Wireless networking is based on spread-spectrum radio waves currently at 900 MHz, 2.4 GHz, and 5 GHz. The 900 MHz frequency has been in use for mainly point-to-point, unlicensed industrial, scientific, and medical applications for many years.

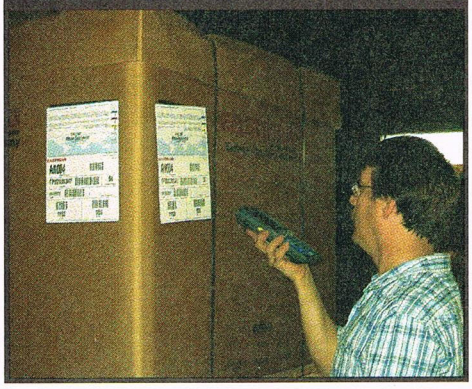
The 2.4 GHz radio band was limited to military applications until about a decade ago when it was made available for wireless networking. The 2.4 GHz band offers greater bandwidth than the 900 MHz range, is considered appropriate for roaming and longer-range fixed wireless communications, and is seen as more suitable for data-centric commercial and industrial applications.

The 5 GHz frequency used by the

UNII band and the IEEE 802.11a standard has not yet been adopted by other countries and is currently used in only a limited selection of products. However, congestion in the heavily used 900 MHz and 2.4 GHz ranges is expected to make future use of the 5 GHz range more attractive.

A key point to remember is wireless devices that are 802.11-compliant are by definition also compliant to IEEE standard 802.3, which defines wired 10BaseT Ethernet. After all, at some point these radio signals have to come back to some hardware, and often to a wired network. "Basically, the architecture of the wireless network is an access point tied to a wired network," says Tim Cutler, vice president of sales and marketing for Cirronet (www.cirronet.com). The unique 802.11 specifications apply only to the standard's over-the-air protocol.

FIG. 2: UNTETHERED DATA COLLECTION



Source: Eastman

Wireless technology at Eastman mostly involves data collection with handheld units, but the company is considering wireless access points so workers can look at the whole process while in the area.

HARDWARE CUTS THE CORD

Perhaps the simplest kind of wireless technology is single or multi-conductor cable replacement, where a signal or set of signals can be transmitted without requiring power at both ends. In this case, "You don't have a network, you have a wire replacement technology," says Forbes.

Wire replacement is good for sensors that cannot be wired easily. Product examples, according to Forbes, are the MCR-RAD wireless I/O interface transmitter/receiver set from Phoenix Contact (www. phoenixcon.com) and similar products from Cirronet. The Phoenix product has a range of 600-1,000 ft. and operates license free on the 902-928 MHz frequency spectrum.

Cutler describes his company's products as allowing legacy devices to be tied together wirelessly and capable of taking unformatted data and formatting it for transmission on a wired network. "It looks like an Ethernet device to the wired network," he says.

But the wireless network essentially has two hardware elements: wireless access points and interface connections into mobile or fixed equipment.

Wireless access points are always transmitters and usually are also receivers. As transceivers, they can both transmit signals and receive them, for purposes of control or merely

Bluetooth Comes to America

Bluetooth technology is much more common in Europe than in North America, but it is beginning to catch on here with product vendors and end users alike.

The initial uses for Bluetooth (www.bluetooth.com) are to enable devices such as phones, laptops, PDAs, and other devices to communicate with each other at close range without the need for line-of-sight or additional communication protocols.

It is anticipated by some industry analysts that Bluetooth will be a truly ubiquitous network used by consumer, medical, scientific, and industrial products.

Bluetooth technology operates at 2.4 GHz with a range of about 30 ft.—a pretty short range, but ample enough for a technician with a PDA or a wireless HMI to walk around an area of a plant and take readings from machines. Goals include extending its range to 300 ft. in the future. In its first incarnation, Bluetooth will use frequency-hopping, spread-spectrum technology with data transmission rates up to 784 Kbps.

Crossbow Technology Inc. (www.xbow.com) recently announced a wireless sensor architecture that makes wireless data connections to the Internet using Bluetooth. Among its products is a wireless measurement node to collect data from up to four sensor channels and transmit the data to a computer, handheld, or other network access point.

Wilcoxon Research Inc. (www.wilcoxon.com) released a cable replacement for connecting an accelerator or 4-20 mA sensor with a junction box or online data acquisition system, and Oceana Sensor Technologies (www.oceanasensor.com) offers a Bluetooth-based data acquisition and processing module designed for machinery monitoring and impact detection, among other applications.

"Bluetooth is particularly suited to wireless sensor applications due to its lower costs and power consumption," says Simon Harris, senior analyst for England's IMS Research (www.imsresearch.com). He predicts the net cost to sensor manufacturers of adding Class 1 Bluetooth, including radio and baseband components, should fall below $10 this year. "Its low power consumption means that the wired power supply can be replaced by a local source of power, such as batteries, enabling full wireless mobility," says Harris.

But Bluetooth does not have a lot of bandwidth and should be viewed only as a point-to-point replacement technology, says ARC Advisory Group's Harry Forbes.

While not seeing any immediate uses for Bluetooth, Dave Hrivnak says Eastman Chemical Co. is replacing numerous laptops this summer with units that have Bluetooth built in. "We're hedging our bets and believe Bluetooth will be coming but we don't have any [applications] slated right now," he says.

to retransmit what another access point has sent along the network. By wire or via short-range wireless connection, they are coupled with a device or sensor, sending data along on the wireless network (Figure 1).

Elpro Technologies (www.elprotech.com) calls this network a Wireless Instrument Backbone, with its telemetry modules picking up and forwarding signals along the network until they're interfaced with a control computer or a wired network. Gateways usually are used for the connection back to a physical network.

What Forbes describes as clipboard-oriented tasks are especially well suited to wireless networking using extended networks or LANs. For example, Eastman Chemical Co., Kingsport, Tenn., is considered a leader in implementation of digital technology and has also been one of the most aggressive companies in the chemical industry in

Phone It in

Cellular telephone companies are demonstrating some interest in industrial applications in the wake of recent slippage in the growth of other sectors of their user base.

Most of these early uses of cellular networks in industrial applications are using SMS (short message service) and WAP (wireless application protocol) mobile Internet to allow a standard mobile phone to be used to receive alarm messages, request data from controllers, and modify data within controllers, according to Simon Harris, IMS Research (www.imsresearch.com).

"Cellular is not really what you would want to use in a point-to-point application, but all you need is a modem for a wireless LAN-type application," he says, noting that Sweden-based Ericsson and Finland-based Nokia have introduced rugged modems for industrial applications.

Nokia recently partnered with Opto 22 (www.opto22.com), one of the first companies to market a wireless I/O module with open wireless technology when it launched its Snap wireless LAN line in 2001. It's aimed at enabling machines to communicate with each other.

Among the uses of the machine-to-machine product coming from the Nokia-Opto 22 partnership are expected to be dealer-managed inventory systems, supply chain activities, and remote monitoring systems, says Benson Hougland, director of technical marketing for Opto 22. "Cellular works anywhere in the world and this works for any type of machine connectivity," he adds. "With this, communication should become a non-issue."

Programmable logic controllers with open wireless cellular communication capability have also been introduced by Germany's Beck IPC GmbH and a joint marketing team of Finland's Klinkmann and Israel's Unitronics.

implementing wireless networking.

Dave Hrivnak, associate analyst for Eastman and project manager for the company's mobile projects, says the use of wireless technology mostly involves data collection with handheld units (Figure 2). But, he says the company is studying the possibility of putting wireless access points into an area so workers can look at the whole process while in the area.

One production area where wireless has been installed involves vibration data analysis from large and heavy rotating equipment that needs to be on Eastman's Ethernet. "We'll put accelerometers on to see if we can reduce that vibration," Hrivnak says. "In the past, we've always had to run Ethernet to where the machine sits, which was quite expensive. What we've done is now set up an access point and a wireless bridge, and we also use directional antennas to get a longer range."

Hrivnak says engineers are normally able to find Ethernet wiring somewhere within a building so that they can set up an access point, direct the antennas, and make the connections to communicate wirelessly.

NOT WITHOUT PROBLEMS

There are considerable hurdles preventing a proliferation of wireless technology in Hrivnak's plant. "Wireless access points don't have a very great range—normally about 150 ft—and they don't transmit well through concrete or steel," he says. "And most of our manufacturing buildings have a lot of concrete and steel, so it takes a lot of access points to cover a production building."

He also has to deal with a lot of brick walls and a lot of metal tanks that do a lot of reflecting and bouncing of the signals. "So a typical building will take three [wireless access points] per floor, times eight floors," he notes. "That's a lot of wireless access points. There's just not that much benefit right now to warrant that many access points being put in."

However, Hrivnak notes that wireless has been installed for about half the cost of wired networks when new wiring is required.

On the other hand, short-range applications such as inventory management have been quite successful. Eastman helped Symbol Technologies Inc. (www.symbol.com) develop a rugged handheld computer that the two companies claim is the first Pocket PC to be certified for use in hazardous locations. It has been certified intrinsically safe for use in Class I, Div. 1, nonincendive for use in Class I, Div. 2, and internationally to the ATEX directive II 2 G, EEx ib IIC T4.

Although Symbol only began shipping the computers in January, Eastman has been using them in the inventory system since last summer.

Hrivnak notes the wireless inventory management system has resulted in substantial improvements in inventory accuracy and timeliness, as well as inventory data improvements.

In another short-range solution, the Cryovac Div. of Sealed Air Corp., Simpson, S.C., selected a wireless DeviceNet solution for a contact sensor that monitors a rotating machine used in the manufacture of packaging materials.

"The rotation of the contact tends to wear out wiring and cables," says Judith Byerley, electrical/controls engineer, who noted repairs had been required every two weeks with a wired system. That maintenance can cause as much as eight hours of

Faster WLANs Coming This Summer

Products are rushing to market even before the Institute for Electrical and Electronics Engineers (IEEE) fully approves its 802.11g amendment to the IEEE 802.11 wireless LAN standard, which would increase the speed of wireless networks to 54 Mbps from the current 11 Mbps.

Chip sets, WLAN access points, cards, and other products already are being marketed, largely as a result of seemingly final changes made to the standard in January, but IEEE doesn't expect to certify the standard revision until June at the earliest. Also, there remain some thorny issues, according to some press reports, including some concerns over the backward-compatibility of the new standard with 802.11b. The new standard also may conflict with Bluetooth devices, which operate in the same 2.4 GHz band.

Nevertheless, the independent Wi-Fi Alliance, announced it will begin to certify products based on the new standard within weeks of IEEE's final approval. The alliance (formerly called WECA) is a nonprofit organization in Mountain View, Calif., formed in 1999 to certify interoperability of IEEE 802.11 products and to promote them as the global, wireless LAN standard across all market segments.

The alliance has instituted a test suite that defines how member products are tested to certify that they are interoperable with other Wi-Fi-certified products. These tests are conducted at an independent laboratory. This will be the fourth Wi-Fi certification test that has been developed for 802.11 standards since the program began in March of 2000. To date, over 600 products from 100 companies have received Wi-Fi certification.

"Wireless LAN product interoperability is fundamental to a good user experience," says Dennis Eaton, chairman of the alliance.

Network designers who want higher data rates can opt for the 802.11a standard, which offers the same 54 Mbps data rate as "g" but in the 5-GHz unlicensed frequency bands. However, 802.11a hardware isn't compatible with 802.11b hardware.

downtime. The installation of a wireless connection with a stationary control panel six months ago eliminated the scheduled downtime. "With the wireless DeviceNet system, we don't wear out wiring and contacts," she says. "I think it has been a really good solution."

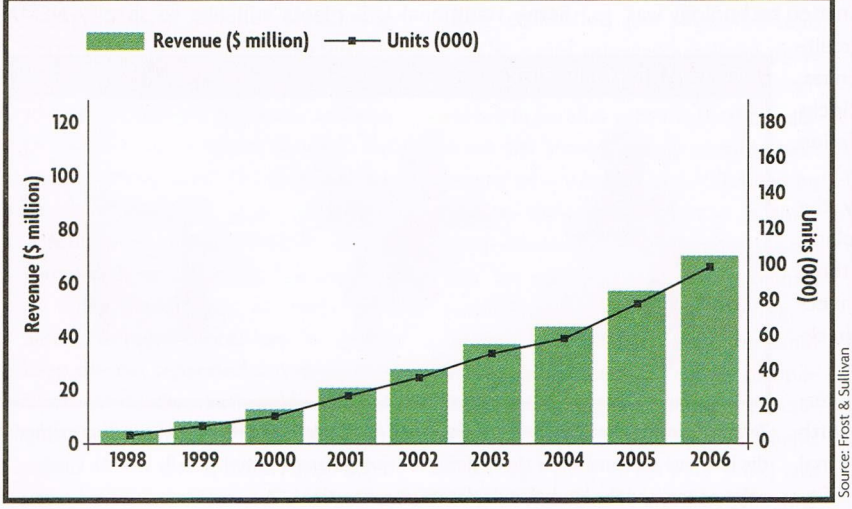
The DeviceNet product is designed specifically for indoor and short-range industrial use, says Bill Arnold, product marketing manager for networking, Omron Electronics (www.info.omron. com). "We tend to be fairly conservative about what we

"Congestion in the heavily used 900 MHz and 2.4 GHz ranges is expected to make future use of the 5 GHz range more attractive."

recommend this for," he says, noting that there are limitations on the ability of any wireless device to deliver messages. "Wireless DeviceNet has limitations on how you lay out the cable branch drops and how many nodes are connected," he warns.

The longest branch off the main trunk of the wireless DeviceNet is 20 ft., but it is also designed to establish new DeviceNet subnetworks and can talk to up to 64 wireless slaves within a 200 ft. radius. Arnold notes that clear and non-overlapping radio channels are required in this configuration.

FIG. 3: NORTH AMERICAN WIRELESS SENSORS MARKET



Source: Frost & Sullivan

Wireless sensors have gained the confidence of scientific reseachers and industry consultants, but are still in the "early adopters" stage among end users, says a Frost & Sullivan (www.sensors.frost.com) report. The market research firm predicts 23% annualized growth through 2008 for the segment.

Hrivnak says he can foresee a day when manufacturing will rip out wires and replace them with wireless networks, although that day has not yet arrived. "It's going to be several years before that happens," he says. "A wired network is faster and, for now, superior for most things. But as wireless gets faster, more range, and better coverage, we'll be moving towards that." ●

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