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WirelessHART signals a change at plants

This open approach promises many benefits

Wireless technology is so much a part of our lives that we use words like Blue-tooth and WiFi systems with confidence and familiarity. So why has it taken so long for the chemical industry to take advantage of the benefits a wireless network can offer?

Some things that we can tolerate as consumers — such as signal loss when driving through a tunnel or occasional interference from other wireless networks — are unacceptable at plants. The chemical industry requires reliable and secure transmission of information via a technique that's easy to set up and flexible enough to adapt to changing conditions. WiFi, Bluetooth and others simply don't meet these basic requirements. The result is that wireless networking has found a few specialized applications at plants but hasn't been widely deployed.

The wireless instruments available to date are either proprietary or early pilot developments that only can exist within a single vendor network. However, an open approach is emerging.

In September 2007, the Hart Communication Foundation (HCF), Austin, Texas, released its latest specification, HART 7, which included wireless connectivity. HART 7 provides the chemical industry with a wireless network that can support instruments from multiple vendors in an industrial environment. This WirelessHART specification was demonstrated at last year's ISA show in Houston, where a multi-vendor network of instruments worked together within the same wireless network connection to asset management applications running on computer workstations (Figure 1).

HART 7 gives plants a real incentive to consider wireless. So, we'll examine the advantages and typical applications of a wireless instrument network, whether now is the right time to consider a wireless project, and how a WirelessHART instrument network works.

The advantages

Traditional 4–20-mA field instruments have been using the extremely successful HART protocol to assist during commissioning and scheduled maintenance work; in fact, more than 24 million such instruments have been installed to date. However, some 20 years since HART 5 became available we're still not making the best use of the remote access HART offers — instrument information remains locked away for the vast majority of users. WirelessHART can provide the key to unlock this information and allow us to install instruments at a very much lower cost.

Retrieving stranded instrument and process information. The vast majority of 4–20-mA instruments installed have no mechanism to allow remote access to the information they hold. If you wish to retrofit a communications path back to an asset management system, then you typically would need to break into the field wiring to insert a HART multiplexer. This poses some risk and cost. The use of a WirelessHART plug-in instrument adapter (Figure 2) offers a more convenient, lower risk and lower cost alternative.

Reducing installation and planning costs. The need to run cabling around a plant makes installation and commissioning

>> **Successful demonstration**

Figure 1. At last year's ISA show WirelessHART effectively linked instruments from multiple vendors.

>> **Instrument adapter**

Figure 2. A plug-in adapter can provide a simple, low cost way to get information from instruments.

costly for traditional 4–20-mA analog and fieldbus (Foundation Fieldbus H1 and Profibus PA) networks. When you consider routing the cable, mounting cable trays, cutting holes and tunnelling, and generating the work permits, expenses can run to $5,000 per point. Wireless networks clearly can reduce these costs as there are no (or fewer) cables to run with instruments often being self-powered.

During the planning phase for traditional wired instrument loops, it's common to add up to 20% spare capacity to account for future plant modifications because wired systems are expensive to modify and expand later. However, frequently much of this spare capacity isn't actually used five or 10 years down the line. A wireless network offers a very scalable solution that can reduce the need for building in and paying for such spare capacity at the onset.

The intrinsic low-cost nature of wireless technology now allows you to tackle some of those process problems that only can be solved by measuring new process data or by monitoring device condition.

Target applications

The chemical industry historically has been cautious in adopting new technologies. Hopefully WirelessHART will jump-start the use of wireless instrument networks at plants. End-user surveys provide a good guide to likely wireless applications.

Upgrading existing instruments. Adding WirelessHART to an existing HART instrument in the field is very simple. Connect the adapter to the instrument at either a spare cable gland or even at a junction box. (The adapter could be self-powered or powered via the loop.) Add the network ID and password to the adapter and it will automatically join the existing WirelessHART mesh network. The original 4-20-mA signal remains intact and you now have remote access to the instrument information. This permits:

- Calibration check and over-range reading. For a pressure transmitter you can monitor the instrument process value and compare it to the 4–20-mA value. This can help confirm the instrument calibration status or provide a value when the 4–20-mA signal is out of range. (The WirelessHART value doesn't depend upon the 4–20-mA value — it comes straight from the digital value.)
- Valve condition monitoring. For a positioner you now have access not only to valve position feedback but also to other data to help analyze the valve's condition.
- Advanced diagnostics. You have remote access to instrument information such as asset signatures, level echo trace and other advanced diagnostics.
- Full use of complex multivariable instruments. For multivariable instruments (mass flow, for example), you now can read the process values previously hidden away.

Coping with aging infrastructure. The maintenance and support of aging plant often can be a problem, especially when new measurements are required and the spare capacity within cable runs and its condition are unclear. A WirelessHART solution can overcome many of these issues because a wired infrastructure isn't required and the mesh network overcomes many of the problems of point-to-point wireless topologies. Some examples:

- Replacing local gauge indicators. A wireless instrument can provide a low cost way to report process information back to the control room, reducing operator rounds to read local indicators and improving visibility of the process.
- Supplanting obsolete field instruments. Installing wireless instruments can obviate difficulties in keeping old instruments working as spares become harder to find. Self-

powered or loop-powered, the wireless network provides an information pathway without other major changes to wiring or control system hardware.

Short-term monitoring. The low cost nature of wireless technology allows you to consider temporary measurements to help diagnose process problems. This could be as simple as using a strap-on temperature transmitter or replacing a local pressure gauge with a new pressure transmitter.

To get a sense of how wireless can change the way you troubleshoot, consider the following issues raised at a refinery operations morning meeting:

Operator A: "We have a problem in the PP splitter column (Figure 3). I just don't have enough information to isolate and diagnose the problem. What I really need is a new pressure measurement at the top of the column."

Traditionally, the engineer responsible for the unit might reply:

"I'll call a meeting with Instruments and Electrical. We might have some spare cable pairs and trays up there, but we probably don't. We'll have to call in the construction subcontractors. I'll look into it and get back to you later in the week."

Instead, with WirelessHART, the engineer might say:

"No problem. We have a wireless pressure transmitter. We'll stick the transmitter on the piping vent up there and have it running by lunch time. Just give me the tag and how often you want the data updated."

Operator B: "We seem to have more fouling in the pre-heat exchangers again and I'm not sure which ones to clean. We're measuring a few of the temperatures, and there're even some spare thermowells, but there aren't any real data to help me with this problem."

Here, the conventional response might be:

"I'll call a meeting. We're going to need some new cable trays in there as we used the last of the spare cable pairs during the 'little learning event' we had last year. We can probably find a few spare slots in the input modules but they'll be spread out a bit. I don't like these spaghetti solutions, though, because they make for trouble later on."

With WirelessHART, the engineer might instead say:

"I've got seven wireless temperature instruments and thermocouples in stock. I could even borrow some more from another unit for a few days. They're all WirelessHART, so there's no problem with compatibility. We just need the mobile platform for access and a list of which ones to fit first. If you want, I can leave some up there permanently. Let me know when I can have the ones you don't need back."

Closed loop control? One of the clear messages from customers is that they won't consider closed loop control using wireless for at least five years — they want to get experience with the technology first. While it's possible to transmit process data from a measuring device over the mesh to a positioner/valve, this requires care in setting up the network topology to reduce time delays. Plus, the positioner would be constantly modulating the valve and would need significant power, thus perhaps ruling out a self/battery-power option. Given that the measuring instrument typically isn't far away, a local controller using wired connection to the instrument and positioner would be a good solution when coupled with instrument WirelessHART connectivity back to the host.

Meshing efforts

Early adopters of wireless instrument networks have been using either proprietary solutions (e.g., for tank level or safety shower operation) or running early pilots of WirelessHART. The proprietary networks often relied on a *star* configuration with single line-of-sight connection to a wireless hub/gateway.

Process plants have steel vessels, exchangers, piping, structural steel work, reinforced concrete, etc. So, it's tough to set up a star wireless network with clear lines of sight from the gateway to each instrument. Then, what happens in the future as the plant is modified and maintained with scaffolding being erected near the wireless network?

WHY USE WIRELESSHART?

Besides providing an open solution for an instrument wireless network, it:

- Builds upon the existing HART specification used by more than 24 million installed instruments;
- Unlocks information stranded inside existing 4–20-mA intelligent field instruments by adding a WirelessHART adapter;
- Uses existing software tools to configure and maintain instruments;
- Offers simple and low cost installation, reducing cabling and hookup expenses;
- Allows measuring of points that were uneconomical to get at in the past; and
- Features a self-building and self-healing mesh network.

>> Troublesome splitter

Figure 3. Wireless pressure transmitter offers a quick and simple way to get necessary data.

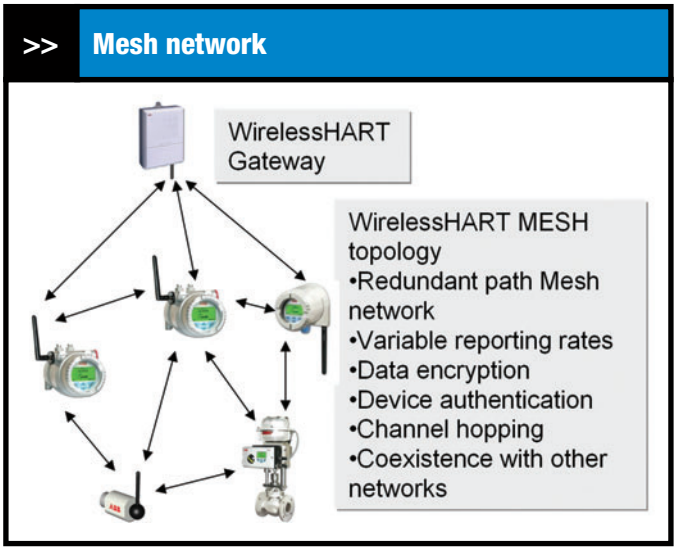

Figure 4. Self-building and self-healing mesh adapts to plant changes, even temporary ones for maintenance.

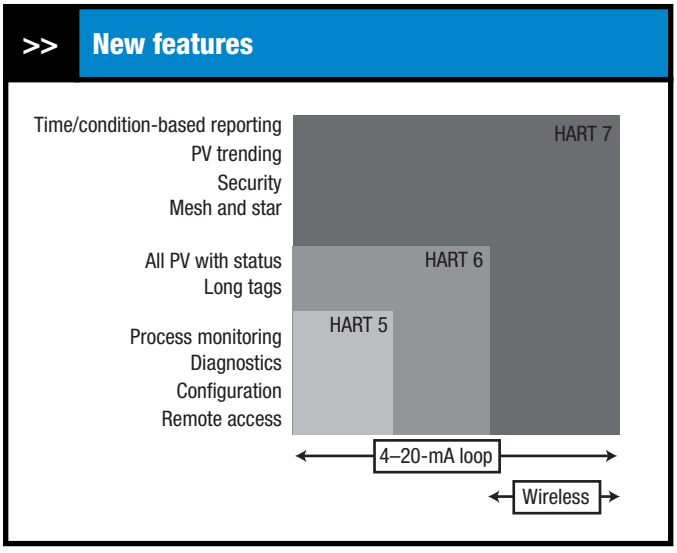

Figure 5. The HART 7 specification adds wireless connectivity and other features.

A self-healing *mesh* network with redundant pathways that can adapt to changing plant environments avoids such issues (Figure 4). ABB and other vendors have tested such mesh networks within plants and observed the mesh adapting to the changing environment and effectively coping with other interference sources.

As often is the case with emerging technology, other groups — here, ISA (via the SP100 Committee) and Foundation Fieldbus and Profibus — have similar efforts underway. This does seem to send a confusing message to end users who are looking for a single standard. (Incidentally, instrument vendors also would like a single standard and development path.) However, these groups have made huge strides in working together to allow us to obtain a successful wireless instrument network.

HART 7 and ISA. HCF has provided the WirelessHART specification to SP100 — a joint analysis team has already identified a pathway forward to use WirelessHART at the instrument level. Don't forget that ISA SP100 is a family of protocols; WirelessHART would fit in very well at the instrument level.

HART 7 and Fieldbus. The Wireless Cooperation Team (WCT) is working towards a topology where WirelessHART can be used at the instrument level with Foundation Fieldbus or Profibus as the backbone to the host system. The WCT meets regularly and includes experts from all three protocols.

With such cooperative efforts progressing and end-user pilots complete, there's no reason to wait much longer to consider a WirelessHART project.

Evolution not revolution

The HART 7 specification has built upon the existing HART specification by adding wireless connectivity and other features to ensure reliability, security and simplicity of operation (Figure 5). So, yes, we can employ existing software tools including HART hand-held configurators; yes, the network is self-building and self-healing; and, yes, existing instruments can be used via a WirelessHART adapter.

The WirelessHART topology. Every WirelessHART network has three main elements:

1. A gateway: It connects the control system (via Ethernet, Profibus, etc.) to the wireless network;
2. A network manager: This normally is part of the gateway and automatically builds the wireless network and manages its operation; and
3. Field instruments and devices: These usually consist of pressure, temperature, position or other instruments but also can include adapters.

WirelessHART is an instrument level network using existing and new HART commands to access information. The instrument network connects to a WirelessHART gateway that builds the mesh topology and also connects to the host system via standard high-speed backbones such as Ethernet.

How often is the information updated? The rate at which process information is transmitted over a wireless network directly impacts battery life for those instruments using battery power. WirelessHART offers several mechanisms to maximize battery life and use of the network capacity:

- Transmit measurements at different rates for different instruments — for instance, level every 20 or 30 seconds, and flow every 1 or 2 seconds;
- Send when data change — deliver alarm or alert messages only when they are triggered (time stamp within the instrument); and
- Change measurement rates based upon alarm limits —

i.e., increase the rate when a value approaches a set limit.

Building a WirelessHART network. Once the gateway is commissioned (connected to the host and asset management system), you're ready to build the WirelessHART network. It's really a very simple procedure that involves entering three variables into the wireless instrument. This is one example of a commissioning procedure:

- Obtain the wireless network name/identity (which would be a value set in the gateway);
- Connect the instrument to the process;
- Power up the instrument (which could be externally or battery powered); and
- Attach a HART hand-held configurator to the maintenance port (terminals within the instrument that look like 4–20-mA connectors). Follow the menu on the hand-held and enter the following:
    1. The network name/ID;
    2. The instrument refresh rate (i.e., how often the PV is updated); and
    3. The network join password.

Monitor the instrument as it automatically synchronizes to the network, is authenticated, and successfully joins the network.

The gateway automatically optimizes the mesh network and redundant pathways. It continues to monitor the mesh and adapts it as new devices join or the radio environment changes. This self-building and self-healing feature provides the reliability of data communications industry requires.

How are the issues of security addressed? Security at chemical plants is a huge topic in its own right (see, e.g., www.ChemicalProcessing.com/articles/2008/046.html, www.ChemicalProcessing.com/articles/2007/152.html and www.ChemicalProcessing.com/articles/2007/095.html). Wireless HART makes security of data transmitted a key part of its core technology. For WirelessHART, security is always switched on. Built-in features address the issues of data security and outside interference. Some of the security methods used include:

- Keeping data transmission bursts short (10-msec time slots) (Figure 6). This makes it hard to synchronize and read messages.
- Authenticating devices as they try to join the network (join key, device key) and monitoring attempted joins. This will help to stop unauthorized devices joining the network.
- Encrypting each message. WirelessHART also allows the user to rotate encryption keys to make it difficult to identify the keys and decode messages.

>> Data security

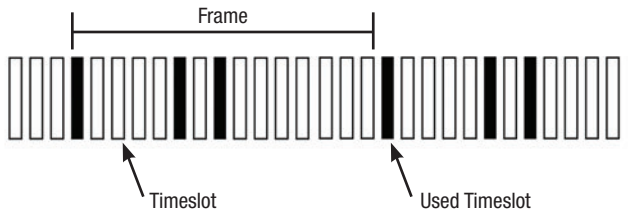

Figure 6. Use of short and varying-interval time slots for sending data enhances security.

- Authenticating that the data haven't been altered as they pass through the mesh network.
- Changing the transmitted channel after each message is sent, making it hard to snoop at data.
- Requiring a physical connection to the instrument (via a HART hand-held) for the instrument join procedure.

Time to act

Vendor testing and end user trials have shown that WirelessHART provides the reliability, security and simplicity that the chemical industry demands from a wireless network. You can take advantage of the technology today to improve your vision of the process and to unlock valuable information hidden within existing instruments.

It's clear that WirelessHART will complement not displace 4–20-mA loops. We've cited some applications, such as short-term diagnostic measurements, condition checking via adapters and instrument replacement, worth considering.

The WirelessHART specification is available now. Many significant instrument vendors (e.g., ABB, Emerson, Siemens and Yokogawa) are at an advanced stage of product development. Indeed, WirelessHART instruments and devices will start to reach the market in the middle of 2008 and the selection will widen during 2009.

Don't wait. An open solution for an instrument wireless network is here. Find a local seminar to build you knowledge and identify the benefits a WirelessHART solution can provide for your process. **CP**

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