

Why **WirelessHART**[™]? The Right Standard at the Right Time

October 2007

The **WirelessHART**[™] standard provides a robust wireless protocol for the full range of process measurement, control, and asset management applications. Based on the proven and familiar HART protocol, it enables users to quickly and easily gain the benefits of wireless technology while maintaining compatibility with existing devices, tools, and systems.

The industry leaders who developed *WirelessHART* designed it to meet the unique requirements of wireless networks operating in process plants. Key capabilities include:

- **Reliability** even in the presence of interference, thanks to technology like mesh networking, channel hopping, and time-synchronized messaging. *WirelessHART* coexistence with other wireless networks is assured.
- **Security** and privacy for network communications through encryption, verification, authentication, key management, and other open industry-standard best practices.
- **Effective power management** through Smart Data Publishing and other techniques that make batteries, solar and other low-power options practical for wireless devices.

These capabilities, among others, make *WirelessHART* the best approach to meeting users' wireless process automation network needs within the future ISA100 family of standards.

This paper summarizes key aspects of *WirelessHART*, including several of the design decisions that make it the right choice for wireless process automation. More detailed information is available at www.hartcomm.org.

Introduction

The September 2007 publication of the *WirelessHART* standard as part of the HART 7.0 Specification marks an important milestone in the rapid acceptance of wireless technology for process operations. *WirelessHART* provides not only a robust wireless protocol specifically designed for process-related applications, but also an industry-accepted standard to give users the confidence that they're making the right decision as they put wireless to work in their plants.

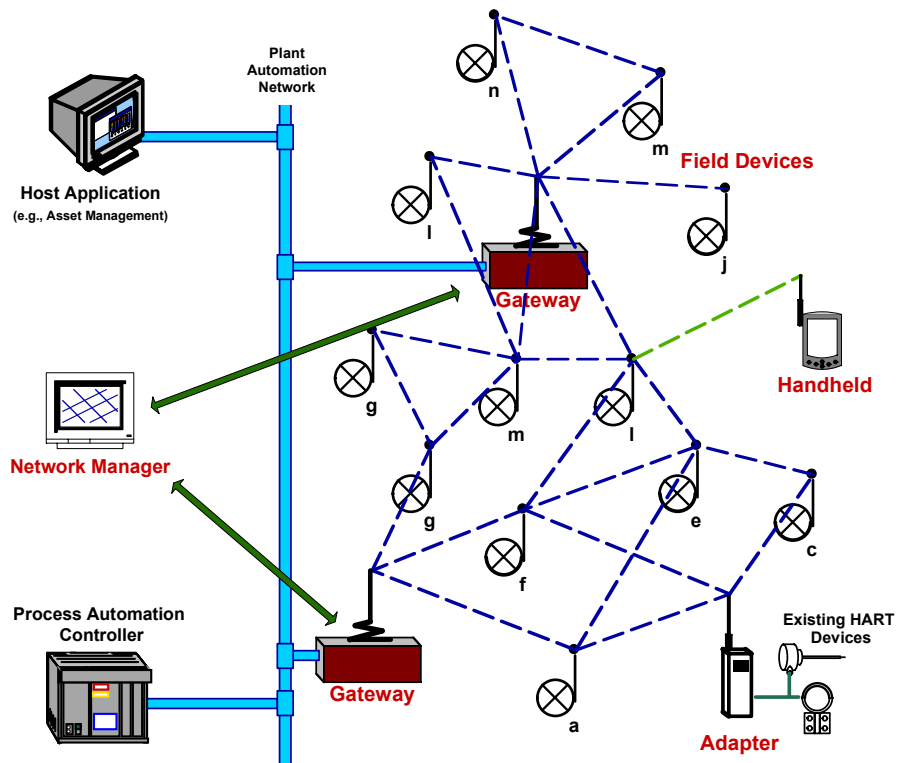


What is *WirelessHART*?

WirelessHART is a wireless mesh network communications protocol for process automation applications. It adds wireless capabilities to the HART Protocol while maintaining compatibility with existing HART devices, commands, and tools.

Each *WirelessHART* network includes three main elements:

- **Wireless field devices** connected to process or plant equipment.
- **Gateways** that enable communication between these devices and host applications connected to a high-speed backbone or other existing plant communications network.
- **A Network Manager** responsible for configuring the network, scheduling communications between devices, managing message routes, and monitoring network health. The Network Manager can be integrated into the gateway, host application, or process automation controller.



The network uses IEEE 802.15.4 compatible radios operating in the 2.4GHz Industrial, Scientific, and Medical radio band. The radios employ direct-sequence spread spectrum technology and channel hopping for communication security and reliability, as well as TDMA synchronized, latency-controlled communications between devices on the network. This technology has been proven in field trials and real plant installations across a broad range of process control industries.

Each device in the mesh network can serve as a router for messages from other devices. In other words, a device doesn't have to communicate directly to a gateway, but just forward its message to the next closest device. This extends the range of the network and provides redundant communication routes to increase reliability. The Network Manager determines the redundant routes based on latency, efficiency and reliability. To ensure the redundant routes remain open and unobstructed, messages continuously alternate between the redundant paths. Consequently, like the Internet, if a message is unable to reach its destination by one path, it is automatically re-routed to follow a known-good, redundant path with no loss of data.

The mesh design also makes adding or moving devices easy. As long as a device is within range of others in the network, it can communicate.

For flexibility to meet different application requirements, the *WirelessHART* protocol supports multiple messaging modes including one-way publishing of process and control values, spontaneous notification by exception, ad-hoc request/response, and auto-segmented block transfers of large data sets. These capabilities allow communications to be tailored to application requirements thereby reducing power usage and overhead.

Building on a Standard

As a standards-based technology, *WirelessHART* reflects the efforts of the best minds in the process automation and industrial wireless industries, working together to ensure multi-vendor interoperability of intelligent measurement and control devices in process industry applications.

The first decision was whether to invent a new protocol or to build on the well-established HART Protocol. The members of the HART Communication Foundation (HCF) quickly realized that enhancing the HART Protocol to include wireless communication capabilities was the fastest, easiest, and least risky approach—a wireless solution that end users could readily understand and implement.

- **Suitability.** HART technology was developed to help users solve process measurement and control problems – problems that are the same whether the solution is wired or wireless. The broad range of wired HART devices available today shows that there are few, if any, process applications that HART Communication can't handle.

The HART Protocol fundamentally supports on-demand and as-needed communication, making it a good choice for wireless applications where long battery life is important. Other bus protocols require continuous communications that drain batteries quickly.

- **Familiarity.** With more than 24 million HART devices installed around the world, users already have HART tools, training, and work practices in place. Far fewer changes are needed than with an entirely new wireless protocol.

- **Simplicity.** The popularity of HART technology is due in part to how easy it is to implement and use – qualities that will help users quickly gain the benefits of wireless technology.
- **Support & stability.** The large installed base and number of suppliers selling HART devices, as well as the organizational strength of the HCF, provide assurance of ongoing support for the protocol.
- **Timing.** Adding wireless capabilities to an established protocol, rather than starting from scratch, greatly shortens the time required to develop and gain acceptance for a wireless standard. It will also speed the availability of wireless devices because manufacturers can adapt existing wired HART product lines to also support *WirelessHART*.
- **Low Risk.** Starting with an established, proven protocol reduces the risk of unforeseen problems with the technology or development process, enabling users to begin using wireless technology sooner and with greater confidence.

Adapting HART Communication for wireless communication also offers a benefit not available with a new standard or with other protocols. The onboard diagnostics in millions of installed HART devices currently go unused because their host systems can't access digital HART data. *WirelessHART* adapters unlock this “trapped” data by providing a new communication path to asset-management systems, historians or other tools. Pent-up demand for such a solution encourages manufacturers to quickly develop *WirelessHART* products and users to adopt them—eliminating the “chicken-or-egg” problem that can plague new technologies.

The Right Tool for the Job

Wireless technology offers opportunities for a wide range of applications—from adding measurements where they were previously out of physical or economic reach, to enabling plant-wide functions such as asset and people tracking, security, and worker productivity.

However, the *WirelessHART* specification team recognized that no one technology is right for every application. Their approach was to focus on core process-automation functions where no appropriate wireless standard existed.

Like wired HART, *WirelessHART* therefore supports the full range of process monitoring and control applications, including

- Equipment and process monitoring
- Environmental monitoring, energy management, regulatory compliance
- Asset management, predictive maintenance, advanced diagnostics
- Closed-loop control (when appropriate)

Real-world use cases—developed by HCF member companies based on inputs from end-users—helped the team ensure the final specification provides this broad support.

Wireless technology will complement rather than replace wired instrumentation, and plants will often have both operating side-by-side. *WirelessHART* technology’s backward compatibility, including the HART command structure and Device Description Language, makes it easy to support both wired and wireless devices using the same tools.

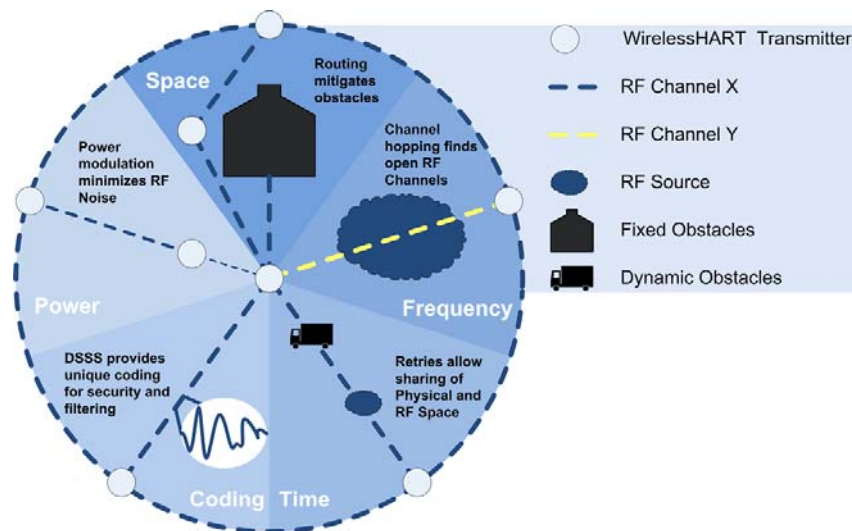
WirelessHART also goes beyond promising device "interchangeability" to provide true **interoperability**. This means users can select the best *WirelessHART* devices regardless of manufacturer, with the assurance that compliant devices can work together in a system and be substituted for one another without loss of functionality at the host system level – just as HART devices can today.

The Fieldbus Foundation (FF) and PROFIBUS Nutzerorganisation (PNO) have signed an agreement with the HCF to develop a specification for a common interface to a wireless gateway. The goal is to ensure complete compatibility with the existing wired versions of each participant's technology.

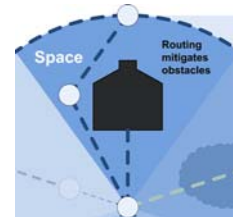
Virtually every process automation requirement is supported by one or more of the wired HART products available today. WirelessHART simply adds another way to communicate with HART devices.

Reliability

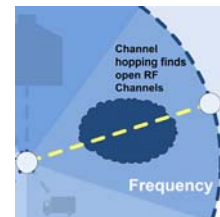
WirelessHART includes several features to provide reliable communications in plant environments where dense infrastructures, the movement of large vehicles or equipment, changing conditions and numerous sources of radio-frequency (RF) or electromagnetic interference could cause problems.



Redundant mesh routing (space diversity). *WirelessHART* mesh topology with self-organizing and self-healing characteristics enables the network to maintain long-term, hands-off reliability and robustness. When interference or other obstacles interrupt a communication path, the network immediately (and automatically) re-routes transmissions to avoid the problem. And because *WirelessHART* uses an path optimized, redundant mesh topology, this benefit is available across the complete network.

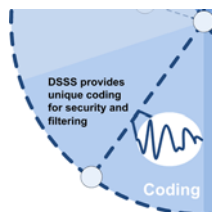


Channel hopping (frequency diversity). Like other technologies that use the 2.4GHz band, *WirelessHART* could be subject to interference from several other sources, such as other networks. To solve this problem *WirelessHART* "hops" across the 16 channels defined by the IEEE 802.15.4 radio standard – overcoming interference with agility rather than brute force.

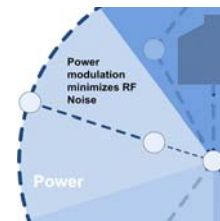


Automatic clear-channel assessment before each transmission and channel "blacklisting" can also be used to avoid specific areas of interference and minimize interference to others.

Time synchronized communication (time diversity). All device-to-device communication is done in a pre-scheduled time window, which enables very reliable (collision-free), power-efficient, and scalable communication, promoting interoperability and ease of use. Each message has a defined priority to ensure appropriate Quality of Service (QoS) delivery. Fixed time slots also enable the Network Manager to create the optimum network for any application without user intervention. The alternate approach of using flexible time slots or unsynchronized communication can lead to significant user configuration, poor QoS, high power use, and unreliable communications.



Additional techniques such as DSSS technology (**coding diversity**) and adjustable transmission power (**power diversity**) also help *WirelessHART* provide reliable communication even in the midst of other wireless networks.



WirelessHART was specifically designed to coexist with other wireless networks, including those that don't comply with IEEE 802 standards. It is both **tolerant** and **considerate** of other networks – carrying out its functions even in the presence of interference, and using bandwidth efficiently to avoid causing problems for others.

Security

WirelessHART employs robust security measures to ensure the network and data are protected at all times. These measure include:

- **Encryption.** 128-bit encryption prevents sensitive data from being intercepted.
- **Verification.** Message Integrity Codes verify each packet.
- **Robust Operation.** Channel hopping and the mesh infrastructure mitigate effects of jamming and denial-of-service attacks.
- **Key Management.** Rotating keys can prevent unauthorized devices from joining or communicating on the network.
- **Authentication.** Devices aren't allowed onto the network without authorization.

WirelessHART security uses today's industry-standard best practices and allows for future enhancements as open industry standards for security evolve.

Power

WirelessHART allows users and device designers to select the power option that best meets their needs. Example options include long-life batteries, solar power, line power, and loop power.

Devices that are "truly wireless" – with no wired power source – offer the greatest flexibility as well as lower installation costs, but gaining these benefits requires minimal

energy usage to extend battery life or take advantage of other "unwired" low-power sources such as solar energy.

That's why the *WirelessHART* team carefully balanced every potential requirement and feature against the power it would demand. As a result, low-power operation is engrained throughout the protocol. Two examples are Smart Data Publishing and Notification by Exception.

Smart Data Publishing. The HART Protocol has always had the ability to publish process data using "Burst Mode." Smart Data Publishing enhances this by enabling transmission only when process conditions change or the information is needed by the user's application -- greatly improving communication and power efficiency.

Notification by Exception. Users can be notified automatically when equipment needs maintenance, a device configuration changes, or another event occurs that could jeopardize operations. Because the information is "pushed" to users only if such an event occurs, systems no longer need to poll each device just to check on its health -- a major savings in energy usage when every message packet costs battery life.

***WirelessHART* and SP100**

It's not unusual for multiple standards to address different aspects of a technology, or even for one standard to incorporate another. While *WirelessHART* was designed specifically for process measurement and control applications, it will be used in plants and other process operations that also employ wireless technology for other functions (e.g., WiFi-based backbones, RF Identification, plant security).

It therefore makes sense that the HCF and ISA are collaborating to investigate the incorporation of *WirelessHART* into the ISA100's family of standards. In fact, the *WirelessHART* and SP100 teams include many of the same members. That's not surprising because both share the goal of helping users gain the benefits of wireless.

It also makes sense that the SP100 team would take advantage of the work already done on *WirelessHART* by including it in the broader ISA100 wireless standard. Because ISA100 has such broad objectives, the SP100.11a team has narrowed their near-term focus to the wireless process automation networks. To date, their decisions about technical requirements for robust application of wireless in process operations are largely consistent with the technical specification of the approved *WirelessHART* standard.

Including *WirelessHART* in ISA100's family would give users all the benefits of *WirelessHART* and accelerate ISA100 development by enabling team members to focus their efforts on tools and best practices for plant-wide applications such as wireless physical-security monitoring, voice communications, and support for mobile workers.

WirelessHART provides the best approach to meeting users' needs for wireless process automation networks within the ISA100 family of standards. The *WirelessHART* team examined other approaches, such as tunneling data across other wireless networks, but realized that those methods had substantial drawbacks in terms of energy usage, complexity, and reduced functionality. Tunneling is an inefficient way to provide an interface between wired and wireless protocols because packaging a message within a message consumes much more power and requires the user to learn and support two protocols.

Wireless versions of other digital bus protocols, such as FOUNDATION fieldbus or PROFIBUS, are unlikely and would require a major redesign of those protocols. If access to devices based on other protocols is required, their communication could be tunneled over a *WirelessHART* network. As mentioned earlier, the HCF, FF and PNO have agreed to develop a specification for a common interface to a wireless gateway. The planned approach is to use efficient translations between protocols rather than tunneling, and to perform the translations in the gateway, where electrical and computational power is abundant.

Support

Founded in 1993, the HART Communication Foundation is the technology owner and central authority on the HART Protocol and provides global support for application of the HART technology. The HCF manages and controls the HART standards including new technology developments and enhancements that benefit and support the needs of the industry. End users can implement *WirelessHART* with the confidence that the technology will continue to be maintained and enhanced by the Foundation.

There are many requirements to support and maintain a standard in a multi-vendor industrial environment, and the HCF has well-developed policies, procedures, and processes for doing this. For example, the HCF has a very strict Intellectual Property policy so that no supplier can patent technology that precludes open, royalty-free implementation of the standard. There are also processes for testing, interoperability, core technology sourcing, and tool development.

The Right Time to Get Started

New technology has no value until users can put it to work. The more quickly, easily, and cost-effectively they can put it work, the greater the value.

The *WirelessHART* standard is available today. It reflects countless hours of focused effort by dozens of experts from the HART Communication Foundation and its member companies – from formal creation of a wireless working group in 2005 through development, review, and approval of the complete specification in September 2007.

The standard has now been released to the industry, and commercially available products are expected in Spring 2008.

In short, the wait is over. *WirelessHART* is here – the right standard at the right time.

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