Information Bulletin

Instrumentation

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HART Communications Protocol

What's new in WirelessHART?

Wired HART has become the industry standard for digital communications to field instruments. With over 26 million installed instruments, HART has maintained its dominance in the face of competition from the two main fieldbus protocols, Profibus and Foundation.

HART is based on a simple command response relationship between a HART master (hand-held communicator or system) and the field instrument. HART version 5 became available in 1990 and, since then, there have been just two updates to bring us to the current version supporting wireless connectivity. Each update of the HART standard adds new features – nothing is taken away. The result is a standard that is both stable and backward compatible.

The most common application for wired HART is during instrument commissioning and calibration. However, less than 10% of the installed HART instruments have a direct communications link back to a host system. The addition of low-cost wireless connectivity provides a pathway for remote host systems to read process and maintenance information from field instruments, both old and new.

ABB Limited
Howard Road, St. Neots
Cambridgeshire
PE19 8EU
UK
Tel: +44 (0)1480 475321
Fax: +44 (0)1480 217948

WirelessHART

WirelessHART is a part of the recent HART 7 update and, as the name implies, it adds wireless capability. Fig. 1 shows how HART 7 has evolved from the early (1990) HART 5 version. It is clear from this diagram that HART 7 is built from HART 5 by adding new features and not taking anything away.

The WirelessHART aspects of HART 7 describe the additional commands and features to provide a secure and robust wireless network. This document identifies and describes the headline features that are included in HART 7 for wireless.

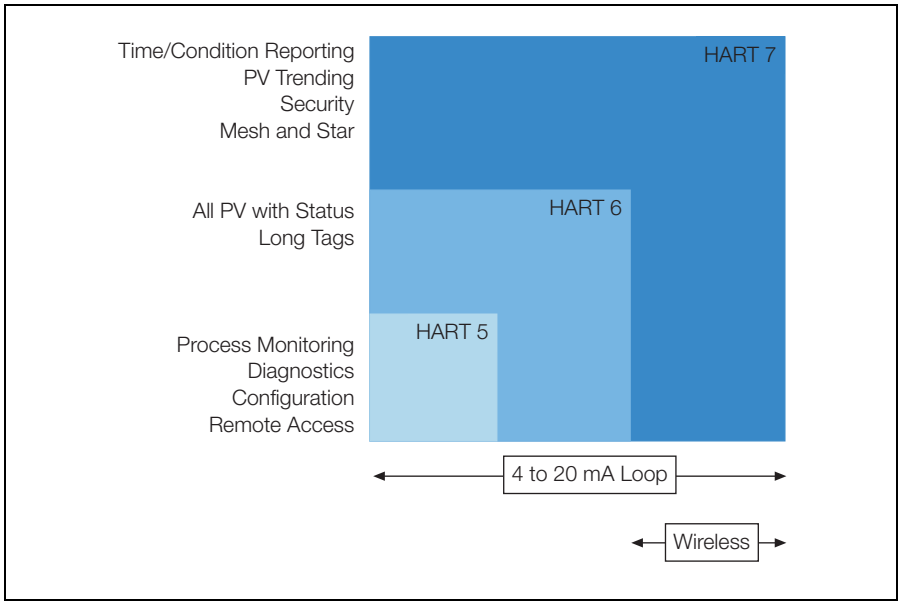

Fig. 1. HART evolution

What's New in WirelessHART

Many of the new functions included here are required to satisfy end user requirements to ensure that the wireless network is secure and reliable. These features also support the new applications and power management to extend battery life.

1. **Wireless Mesh**

   The wireless mesh network is employed by WirelessHART to provide a robust and self-healing network. Fig. 2 shows a wireless gateway connected to the host network (north side) and to the mesh (south side).

   The mesh network provides multiple pathways as data is transmitted between the instruments and the gateway. If one pathway is blocked, the transmission can use one of the alternative (redundant) pathways.

   It is the role of the network manager (typically software residing in the gateway) to manage and maintain the mesh automatically. Switching to a redundant path is automatic with no engineer input required.

   As instruments join the mesh, a new graph of redundant pathways is built automatically. Just tell the new instrument how often you need the process data, which network to join and a password – the rest is automatic.

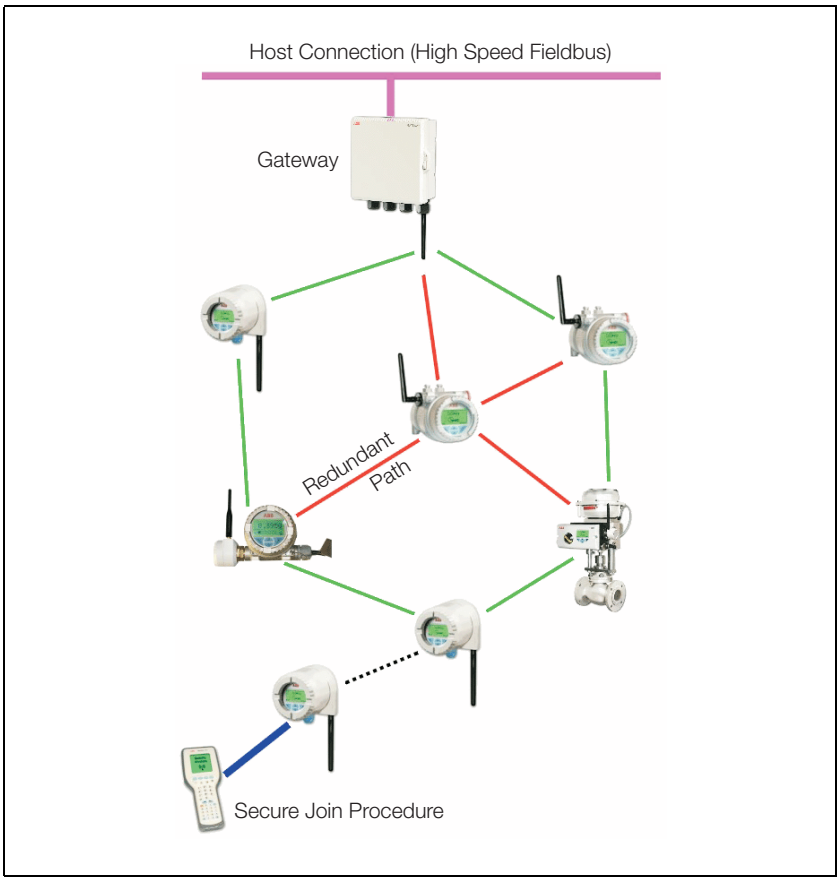

Fig. 2. The wireless mesh

2. **Time Synchronization**

Wireless instruments transmit data on a wireless channel back to the wireless gateway and, eventually, the host system. All transmissions are synchronized to avoid collisions and loss of data. WirelessHART employs a fixed time duration (often called a slot) of 10 ms for each transmission – see Fig. 3. These time slots are configured automatically (based on the data update rate required) to ensure instruments can report process data and other data back to the gateway.

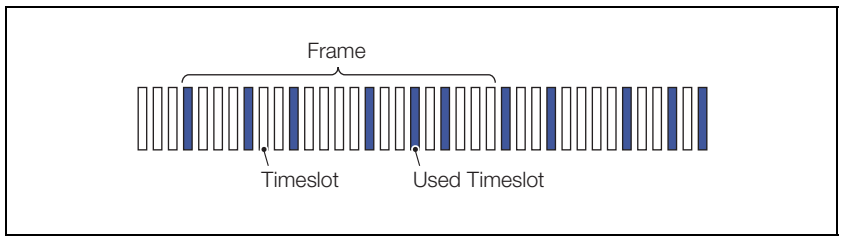

Fig. 3. Time slots and frames

3. **Report by Exception – Time- and Condition-based Alerts**

Every time the radio transmitter is on, a significant amount of energy is used. This results in frequent transmissions that shorten battery life. WirelessHART offers several features to maximize battery life.

The concept is to transmit process data only if it has changed or if an event requires transmission.

Smart reporting provides a method to change the data rate based on the process value. Fig. 4 shows the reporting rate increase if the Process Variable (PV) crosses an alert level, offering the operator faster update times.

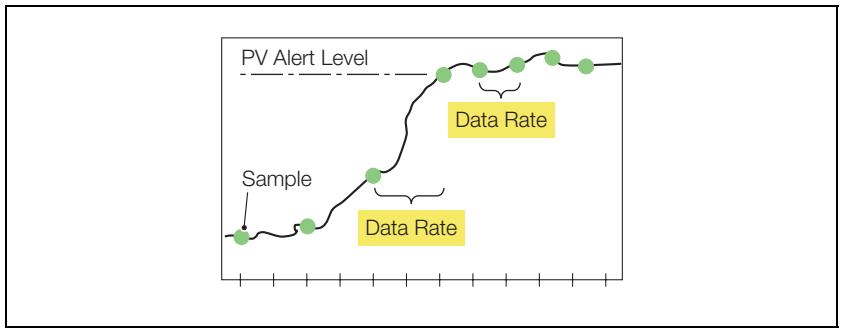

Fig. 4. Smart reporting

Another version of smart reporting transmits data only if the process changes by a preset amount (for example, 5%) or if a time period expires (for example, 10 minutes). The process data transmitted has a time and date stamp added by the instrument.

Reporting of alarms or alerts can be on exception; in other words they are transmitted only when triggered. A process alarm is transmitted when it is triggered and includes a time and date stamp.

4. **Time Stamp**

   Each instrument contains a synchronized clock enabling it to transmit data at the correct time. This clock is also used to stamp a time and date code to each sample of process data. The time stamp is important if data is transmitted with long intervals between samples.

5. **Process Variable (PV) Trending**

   Another WirelessHART feature to maximize battery life and process resolution (faster updates) is to sample the process data in the instrument and send the data in a burst back to the host system. The host system can then build a trend based on the data bundle and relevant time stamps.

6. **Wireless Co-existence**

   HART 7 uses a standard radio (802.15.4) and an unlicensed frequency band (Instrument Medical Scientific [ISM]) of 15 channels to transmit over. The problem with the ISM band is that anyone can use it (WiFi) and so we need to minimize collisions to ensure both networks operate at a satisfactory level.

   WirelessHART uses channel assessment and short message sizes to coexist with neighboring networks – see Fig. 5. As each message is prepared for sending, the instrument checks the channel it intends to transmit on to establish if it is being used. If the channel is being used, the instrument waits for the next time slot and uses a new channel.

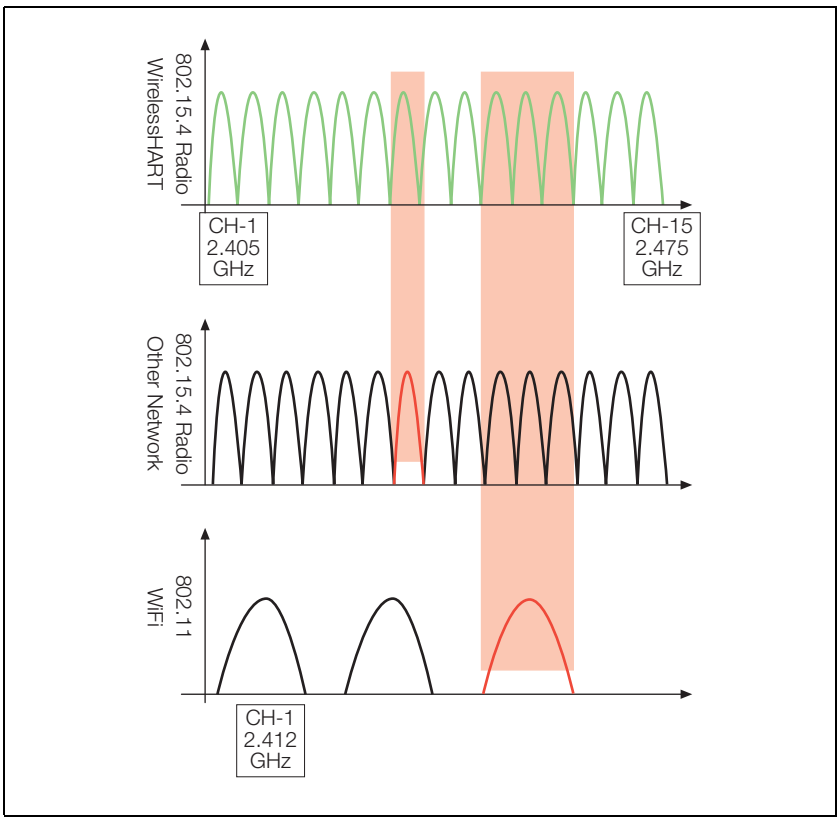

Fig. 5. WirelessHART and co-existence

7. **Wireless Diagnostics**

   It is important to monitor wireless network diagnostics to ensure the health of the network and its security status. These diagnostics are built into the HART standard and include indicators of battery life remaining, devices present, network join attempts and other network management indicators.

8. **Wireless Security**

   Security is one of the top three wireless requirements (the others are robustness and simplicity) and is handled at several levels:

   – The system must verify if a joining instrument has the right credentials to join (is expected and has the join key – see Fig. 6).

   – Wireless messages each contain a unique Message Integrity Code (MIC) to ensure that the content of the message has not been altered as it passes through the mesh network.

   – At the end of each message the channel is changed to make it difficult to read the data.

   – Messages are encrypted to keep the content secure.

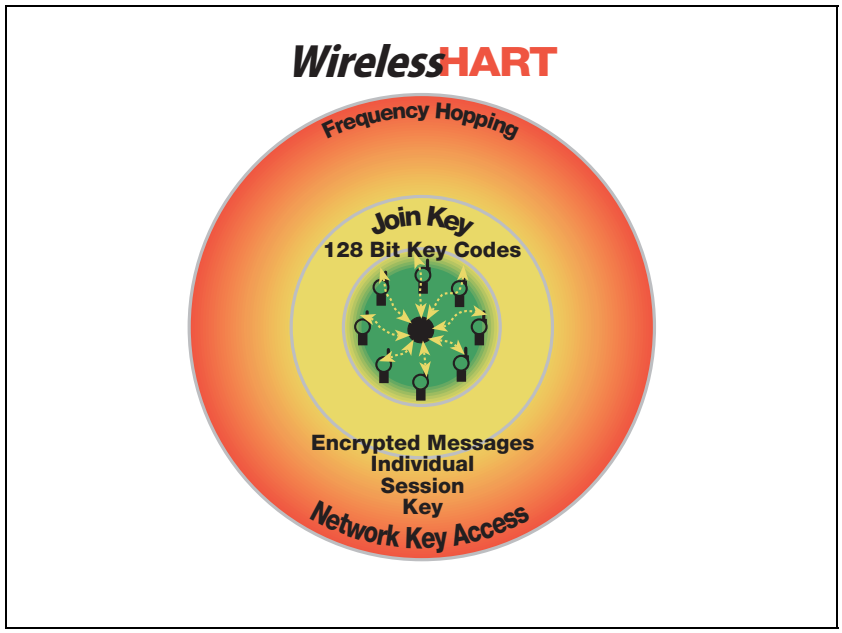

Fig. 6. Wireless security

9. **Loop Testing**

   There is no 4 to 20 mA signal so WirelessHART offers a loop test or simulate command to check that the process data is displayed correctly at the host and to test other control functions.

10. WirelessHART Adapter

This is a new HART device. The adapter can be added to an installed wired HART instrument and provide a WirelessHART connection for remote access. The ABB adapter (see Fig. 7) is loop-powered (no battery required) and small enough for most applications, even if space is an issue.

Remote access to existing wired HART instruments is possible with installation of HART multiplexers; however this involves significant wiring changes. In contrast, the adapter alternative can be added point-by-point to your most valuable asset for condition monitoring.

Fig. 7. ABB WirelessHART Adapter

Conclusion

WirelessHART is part of the HART 7 update to this industry standard communications protocol. It adds functionality to take advantage of low-cost wireless connectivity while addressing concerns of security and robustness.

WirelessHART has also produced a new device type – the WirelessHART adapter. The adapter can be fitted to an existing 4 to 20 mA instrument to provide remote access to asset management applications.

The WirelessHART adapter offers a good starting point for end users to gain experience of this new technology while benefiting from new remote access to existing assets in the field.

	Version		
HART Features	**5**	**6**	**7**
PV with status	✔	✔	✔
Device status	✔	✔	✔
Broadcast message	✔	✔	✔
Instrument configuration	✔	✔	✔
4 to 10 mA loop	✔	✔	✔
Multi-variable read	✔	✔	✔
32-character tag	✔	✔	✔
All variable status		✔	✔
Digital loop check		✔	✔
Enhanced multi-variable support		✔	✔
Local interface lock		✔	✔
Manual ID of device by host		✔	✔
Peer-to-peer messages		✔	✔
Visual ID of device		✔	✔
Report by exception			✔
Synchronized sampling			✔
Time- or condition-based alerts			✔
Time stamp			✔
PV trends			✔
Wireless co-existence			✔
Wireless diagnostics			✔
Wireless mesh and star			✔
Wireless routing			✔
Wireless security			✔

USA

ABB Inc.
125 E. County Line Road
Warminster
PA 18974
USA
Tel:+1 215 674 6000
Fax:+1 215 674 7183

Germany

ABB Automation Products GmbH
Borsigstr. 2
63755 Alzenau
Deutschland
Tel:+49 800 1 11 44 11
Fax:+49 800 1 11 44 22

UK

ABB Limited
Howard Road, St. Neots
Cambridgeshire
PE19 8EU
UK
Tel:+44 (0)1480 475321
Fax:+44 (0)1480 217948

Italy

ABB SACE
a division of ABB S. p. A.
Via Statale 113
22016 Lenno (CO)
Italy
Tel:+39 0344 58111
Fax:+39 0344 56278

China

ABB (China) Ltd.
35th Floor Raffles City
(Office Tower)
268 Xizang Zhong Lu
Shanghai, 200001
Tel:+86 21 61228888
Fax:+86 21 61228892