



FIELDCOMM GROUP™

*Connecting the World of
Process Automation*

HART Technology



**LEADING THE
DIGITAL TRANSFORMATION**

HART[®]
COMMUNICATION PROTOCOL

CONNECTING THE WORLD OF PROCESS AUTOMATION

Leading the Digital Transformation

Manufacturers are using digital advances such as analytics and smart embedded devices to improve their use of traditional technologies and enhance customer relationships, internal processes, and value propositions. Industrial systems that interface the digital world to the physical world through sensors and actuators are commonly known as cyber-physical systems. These systems solve complex control problems and when combined with "Big Data" solutions, provide deeper insight into the data and analytics.

Current developments such as the Industrial Internet of Things (IIoT) and Industrie 4.0 are focused on digital transformation of

the field device network. This digital transformation will help industrial organizations transition from reactive to predictive maintenance and optimize asset management strategies to improve operations and reduce costs.

HART Technology and the IIoT

HART technology has been driving the digital transformation for more than two decades by making plant operations smarter. It is embedded in millions of intelligent devices and systems and has enabled end users to make better and faster decisions, increase productivity, reduce costs, and minimize risk while raising the level of awareness of plant operations from instrument technicians all the way to executive officers.

A Global Open Network Standard

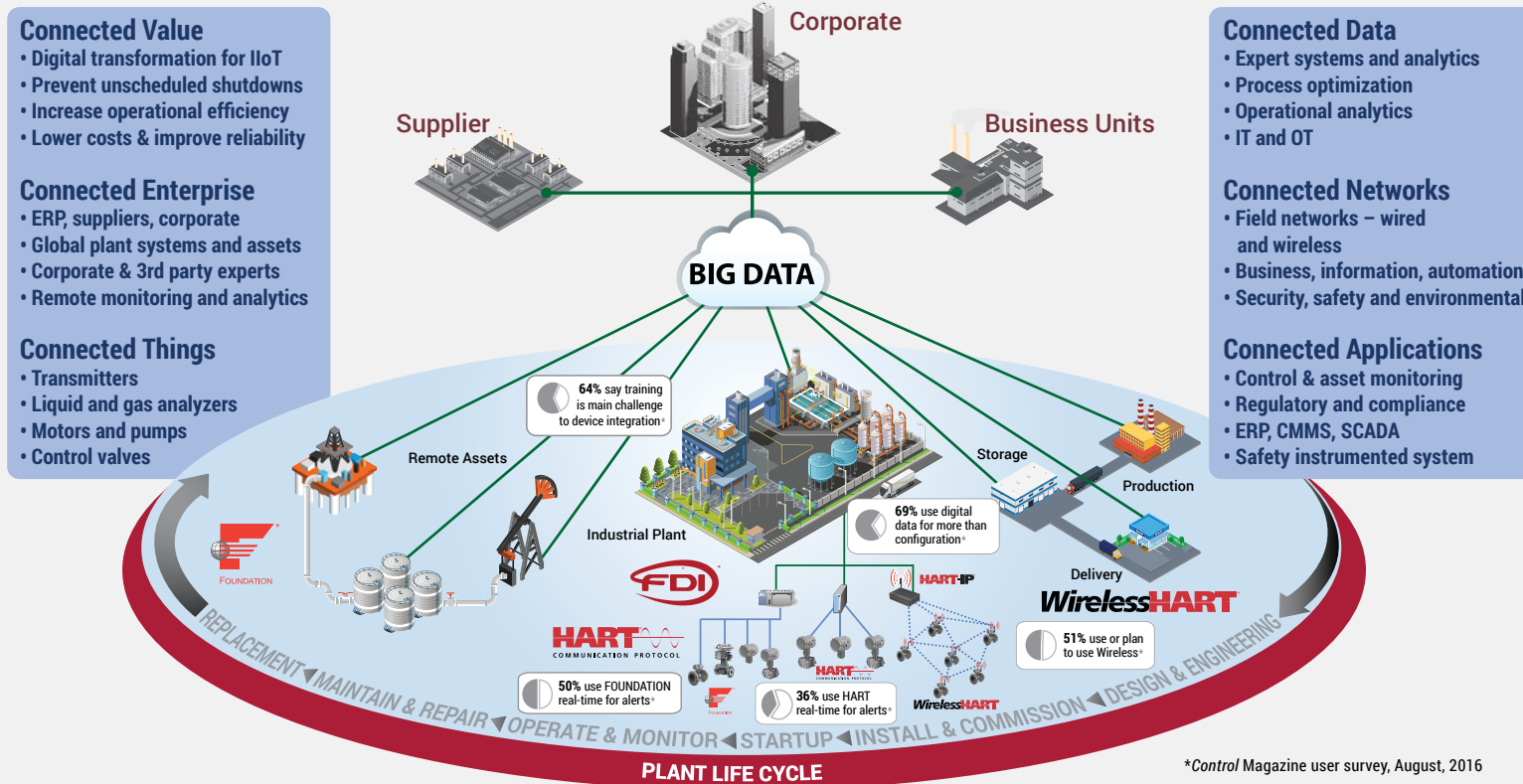
Proprietary protocols were eliminated years ago and for many reasons. Devices today are able to integrate with intelligent asset management, control, safety, SCADA, ERP and other enterprise applications, in an open, interoperable way.

HART technology has been an open standard since 1990 (an IEC standard since 2006). An open standard eliminates single vendor dependency and allows the use of "best-in-class" solutions from multiple suppliers. End users can choose the best available instruments for their application and replace them as needed.

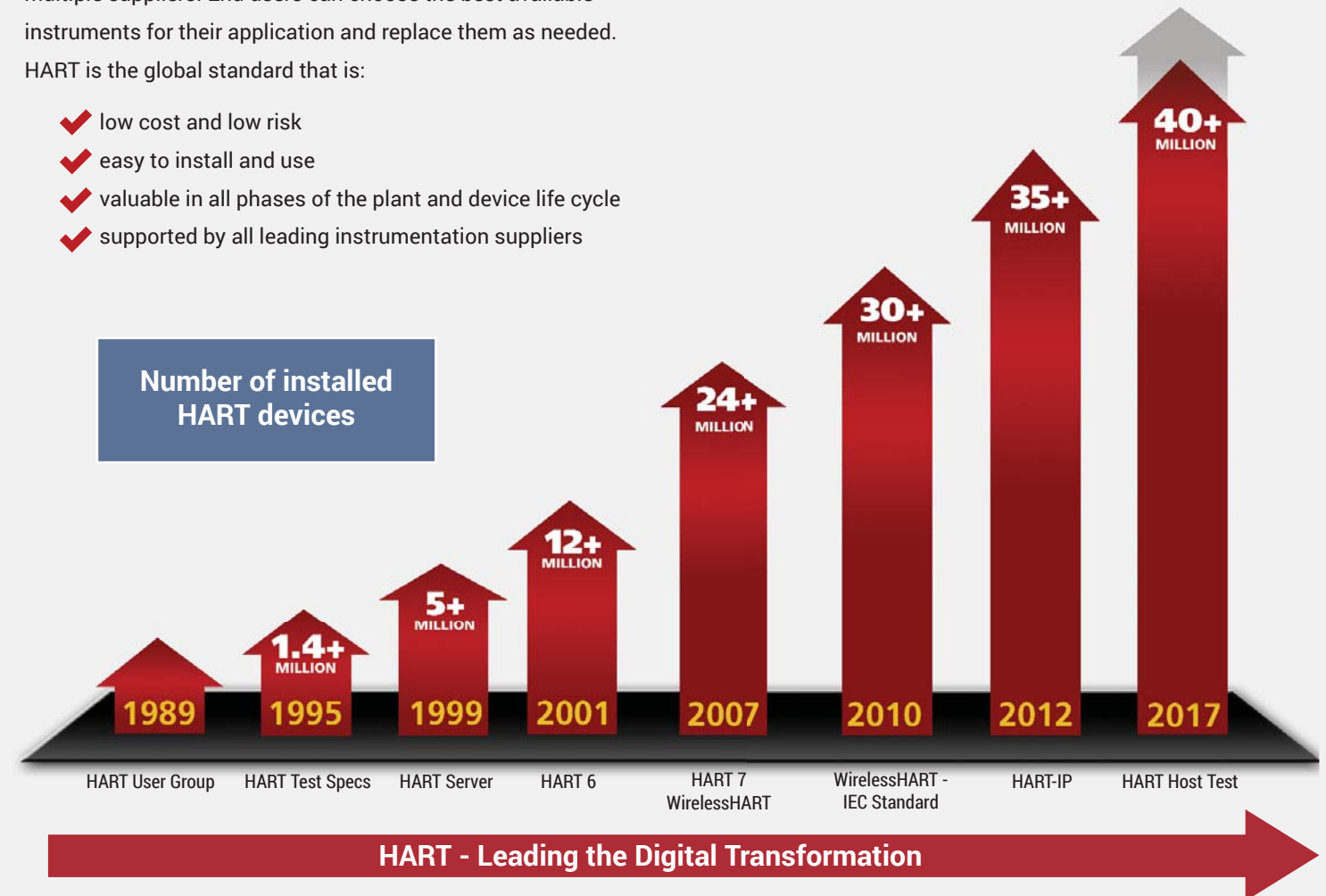
HART is the global standard that is:

- ✓ low cost and low risk
- ✓ easy to install and use
- ✓ valuable in all phases of the plant and device life cycle
- ✓ supported by all leading instrumentation suppliers

HART is the most used digital communications technology deployed in the process automation industry, with an estimated 40+ million installed field instruments worldwide. For nearly 25 years the HART Protocol has delivered value to the bottom line. From device setup and commissioning, to device diagnostics and troubleshooting, users have experienced the many benefits of getting connected to the smart information in their ever-increasing intelligent measurement devices. A reported 75% of users rely on HART technology to save time and money.



*Control Magazine user survey, August, 2016



HART - EXPANDING THE POSSIBILITIES

From Wired to Wireless to Ethernet - HART Expands the Possibilities

Regardless of the application type (new construction or an upgrade), age of the system or the type of process, HART offers a wide variety of solutions – wired, wireless or IP-enabled! Today's business environment requires maximizing the installed assets in all phases of the plant life cycle. Working together, these solutions enable a digital transformation that delivers the right information to the right place at the right time so that informed decisions can be made and appropriate actions taken.

WIRED

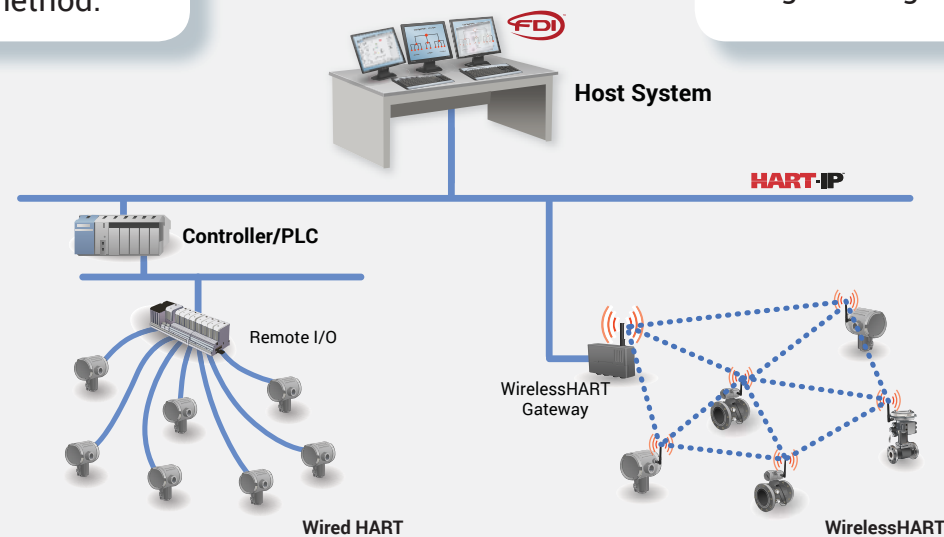
HART Communication is built on the industry standard 4-20mA signal which is the most widely used communication method.

WIRELESS

A WirelessHART device can be installed anywhere in the plant, significantly reducing the cost of engineering, cabling and installation.

IP-ENABLED

HART-IP allows host systems to access measurement information from HART-enabled field devices using existing IP networks.



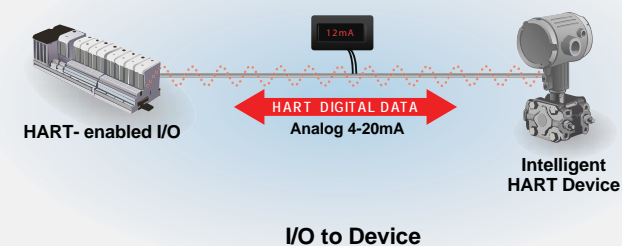
HART technology provides benefits to both the user and the supplier:

- ✓ Based on industry standard 4-20mA signal
- ✓ Simultaneous analog and digital communication
- ✓ Easy to configure and troubleshoot without special tools
- ✓ Wired, wireless and Ethernet communication options
- ✓ Interoperability makes device replacement fast and easy
- ✓ Smart devices can be configured for a specific application
- ✓ Reduces the amount of replacement inventory
- ✓ Uses standard wiring and wiring practices

How It Works

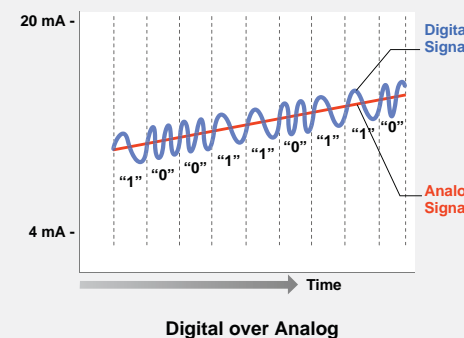
The HART Communication Protocol provides two-way communication between intelligent field instruments and host systems. HART supports a wide range of hosts from a technician's hand-held configurator to a plant's process control, asset management, safety and SCADA systems or cloud-based data historian applications.

In traditional 4-20mA installations, HART technology provides two simultaneous communication channels: one analog and the other digital.



The 4-20mA signal powers the device and communicates the Primary Variable (measurement value or setpoint) as an analog value. The 4-20mA signal is then converted to a numeric value based on the configured Upper and Lower Range settings. For example, a measurement of 7mA = 80 degrees F or a setpoint of 12mA = 50% open.

The two-way digital communication channel utilizes an audio signal that encodes and communicates the digital device information, using a technique known as Frequency Shift Keying.

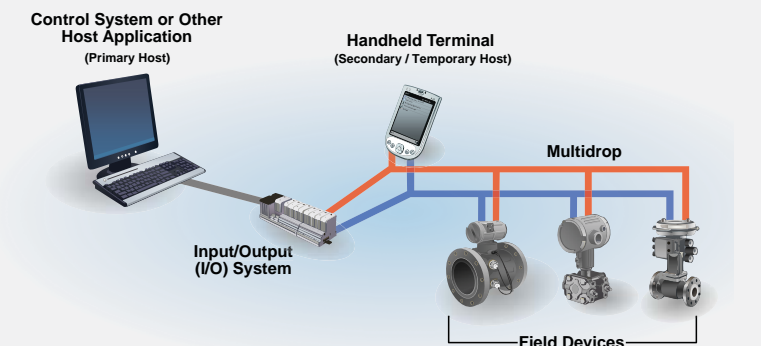


Two-way communication enables access to a wealth of device information including multiple digital process values, device status, diagnostics and device parameters. This communication also allows the integrity and accuracy of the 4-20mA current loop itself to be monitored. Together, the two communication channels provide a complete field communications solution that is easy to design, simple to use, low cost and extremely reliable.

Acyclic and Cyclic Communications

HART Protocol supports both acyclic and cyclic communications. Acyclic request-response communication enables access-on-demand to all device information. For acyclic operation, the smart field device responds to the host only when it receives a request.

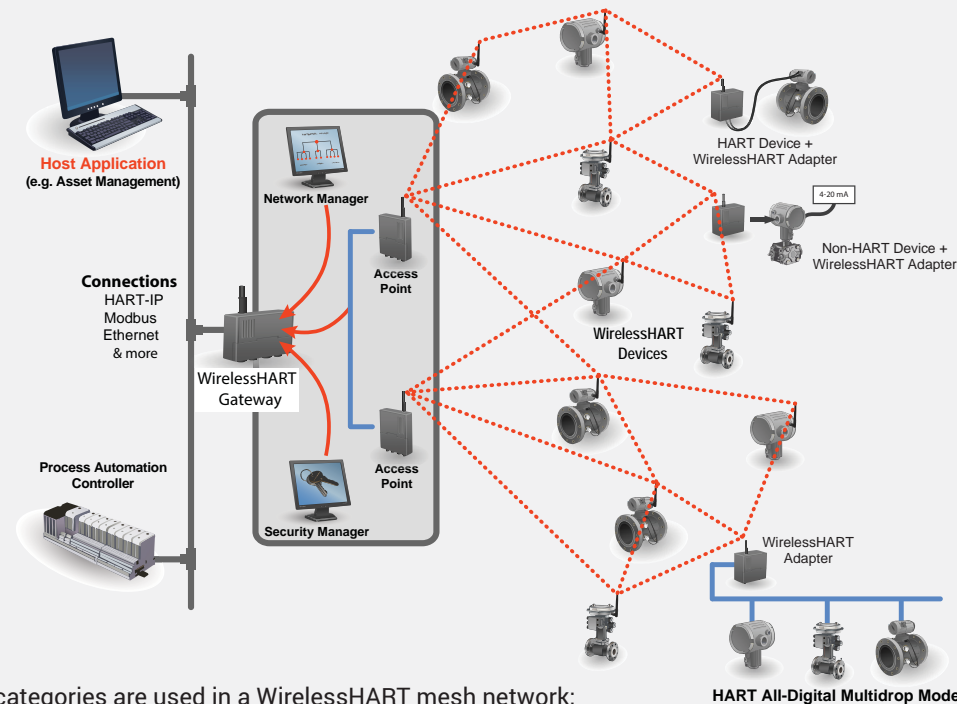
HART also supports cyclic publishing of runtime data and device status. This allows multiple hosts to continuously acquire digital process values. HART supports smart data publishing where data can be published when, for example, the values exceed a setpoint or the value is changing quickly. Smart data publishing enables efficient use of communication resources.



HART can operate in several modes – analog plus digital, all digital or multidrop mode allowing multiple device to be connected on a single pair of wires.

WirelessHART - SIMPLE, RELIABLE, SECURE.

WirelessHART is a highly reliable, easy to deploy wireless communication protocol for process automation applications. It adds wireless capabilities to HART technology while maintaining compatibility with existing HART devices, commands and tools. WirelessHART uses license-free 2.4GHz communication band, IEEE 802.15.4 standard and mesh networking technology, which means each device serves as a router for messages to/from other devices. This extends the range and geographic coverage of the network and provides redundant communication routes to increase reliability to 99.99% (4 Sigma) even in a difficult radio environment found in some process facilities.



Three device categories are used in a WirelessHART mesh network:



WirelessHART Gateway

- Contains an access point, network manager and security manager
- Interoperable with all HART devices and systems
- System integration via HART-IP, Modbus RTU/TCP and others



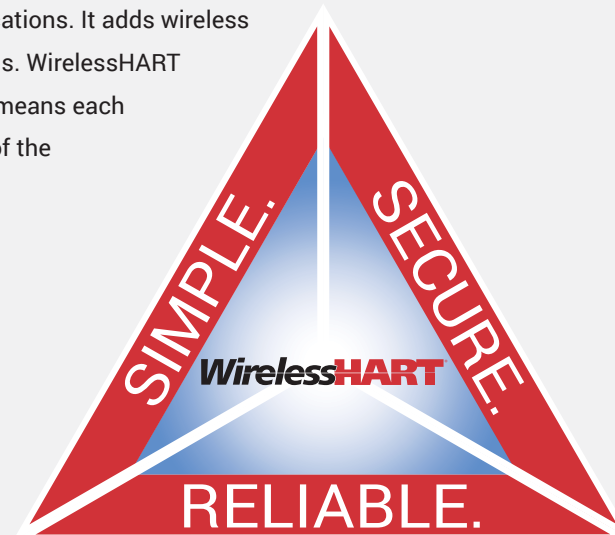
WirelessHART Adapter

- Allows a wired HART device to communicate wirelessly
- Attaches to a device or taps anywhere on the 4-20mA current loop
- One adapter for multiple wired devices reduces project and installation costs



WirelessHART Device

- Standard device with wireless communication
- Smart reporting for long battery life
- Battery, line, loop or energy harvesting power options



SIMPLE.

- Easy network and device setup
- Self-organizing adaptable mesh network
- Coexistence with other wireless networks

RELIABLE.

- Channel hopping to avoid interference
- Time-synchronized communication
- Redundant self-healing network

SECURE.

- Robust, multi-tiered, always-on security
- Device authentication and passwords
- Standard AES128 bit data encryption

Benefits and Applications

There are many benefits to using WirelessHART technology:

- ✓ Lower cost and reduced engineering time when adding new measurements
- ✓ Access to remote and difficult to reach process areas
- ✓ Improve plant reliability by monitoring the health of critical devices, reducing unplanned shutdowns

WirelessHART technology is field proven worldwide, with an estimated 20,000+ networks operating in both new and existing plants. It is low-risk, low-cost, interoperable and uses the same tools and skills as wired HART. WirelessHART provides a cost-effective solution for integrating additional measurements in control systems that are near capacity.

WirelessHART technology opens the door for enhanced performance of a process plant and increased productivity by providing plant transparency through:

- ✓ Process monitoring and control including remote locations and pipelines
- ✓ Asset management via remote access for all phases of the device life-cycle
- ✓ Temporary measurements for testing and troubleshooting

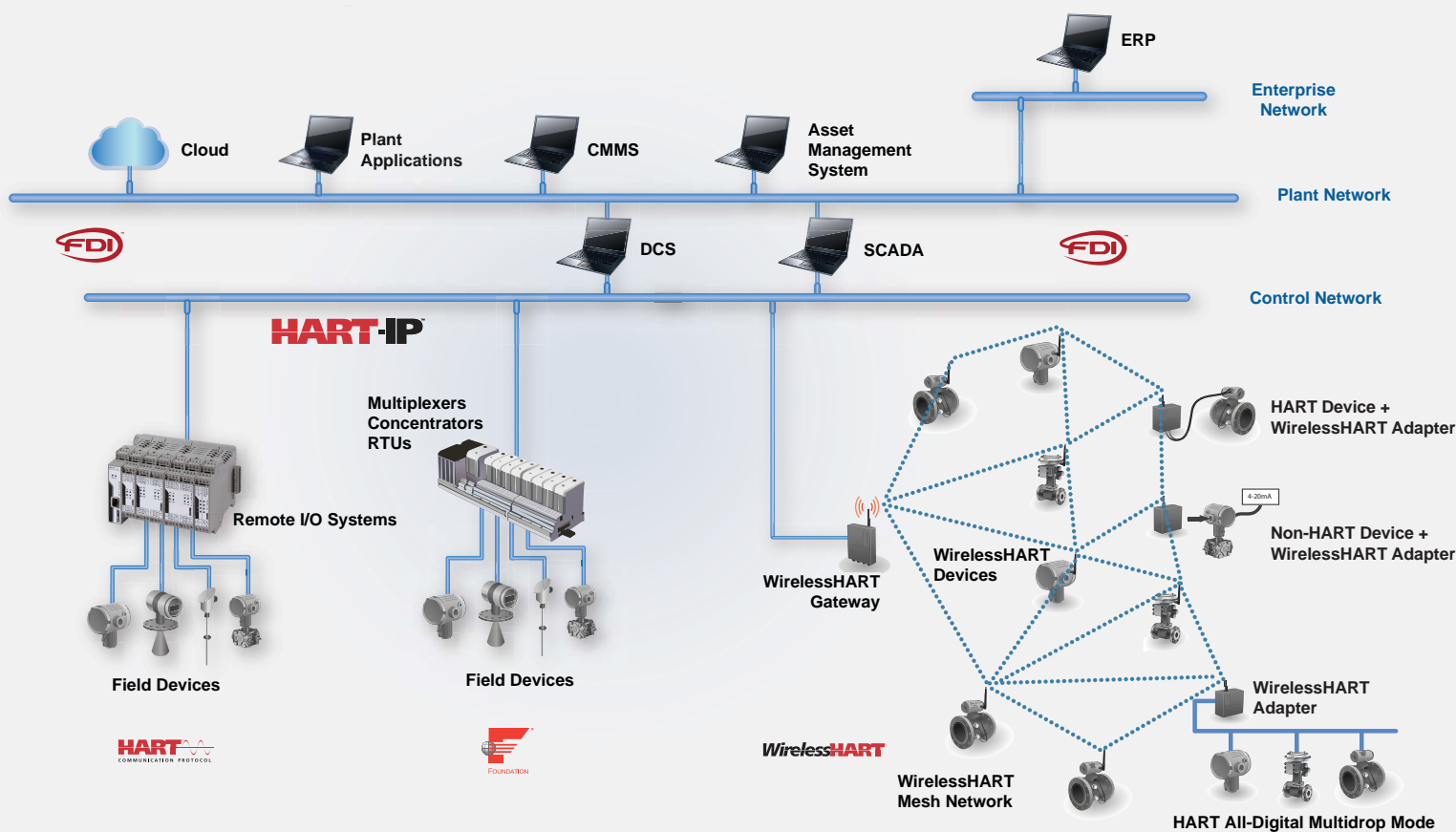


HART-IP - HART AT THE SPEED OF ETHERNET

Ethernet networks have been pervasive in office environments for decades, but in process facilities 2-wire, 4-20mA wiring has been the norm. Slowly, Ethernet and IP networks are growing towards the process plant floor. To address this growth HART-IP, an Internet protocol (IP) enabled version of HART, was developed. HART-IP gives enterprise level systems and applications access and integration of runtime measurement and device diagnostics information from HART devices through existing plant IP networks using Ethernet, Wi-Fi, fiber optic, packet-radio, satellite or 3G/4G cellular.

HART-IP is a simple-to-use, high-level application technology that is independent of the underlying media, thus HART-IP operates with Ethernet media as well as mesh or ring topologies. Similarly, HART-IP can run on Power over Ethernet (PoE) for such infrastructure and devices. Speeds of 10 Mbit/s, 100 Mbit/s, and 1 Gbit/s are supported.

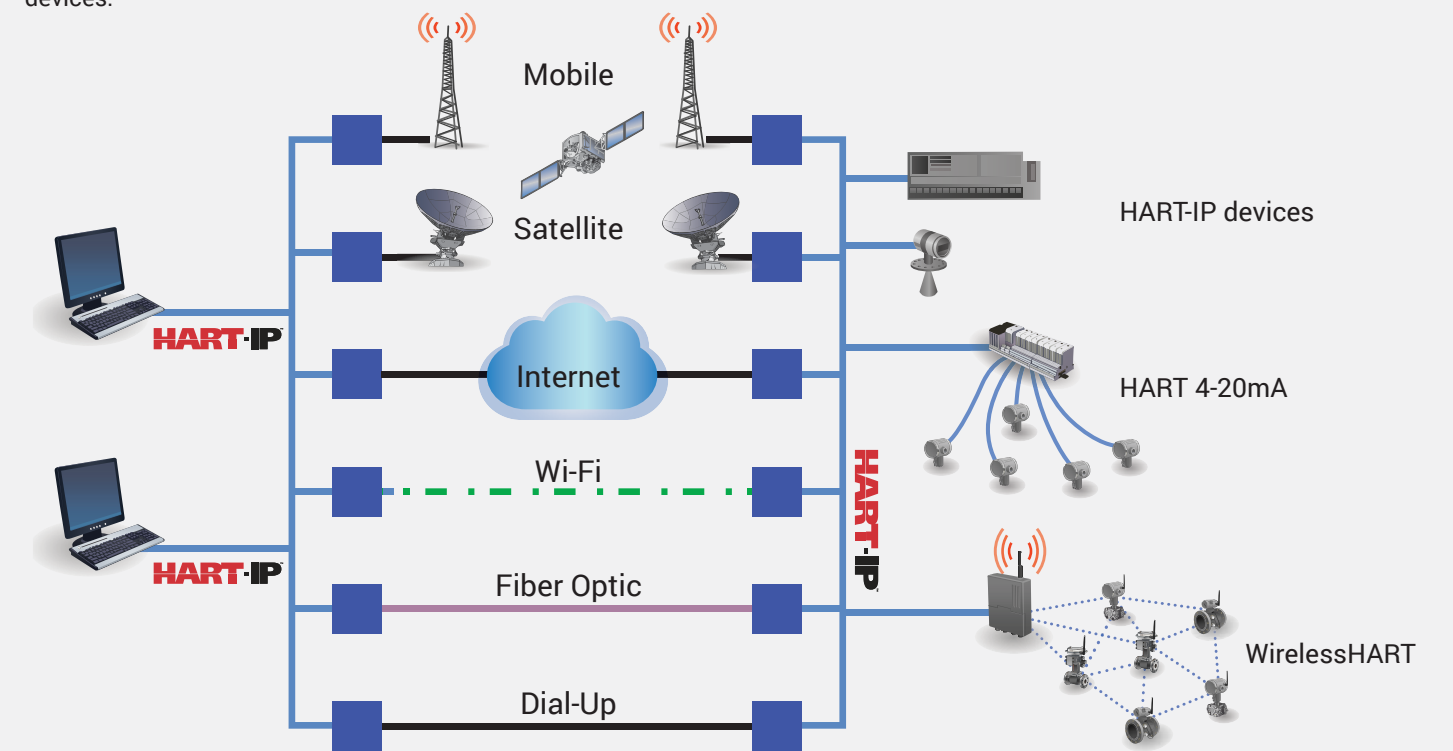
HART-IP enables remote access to device and process information for IIoT Initiatives



Since the application layer is the same for HART field devices as HART-IP, time consuming and error-prone data mapping required by MODBUS RTU is eliminated. Using a simple HART command, HART-IP delivers all requested smart device information - not just the Primary Variable. This makes HART-IP the most simple to use and suitable backhaul network for WirelessHART gateways, wired HART multiplexers, remote I/O and native HART-IP field devices.

HART-IP Architecture

HART-IP uses a conventional client-server architecture. A client can be either a host system or a host application while servers can be WirelessHART gateways, HART multiplexers, HART Remote I/O or individual HART devices. Client-server communication utilizes either/both UDP or TCP transport. Servers also support a minimum of two simultaneous client sessions.



HART-IP offers straightforward access to large amounts of stranded HART measurement and diagnostic information from complex or multi-variable devices that concentrate measurements into a single output. It allows the information from these devices to be easily integrated with TCP/IP networks, without the need to go through any translation processes and with no loss of information.

Features and Benefits of HART-IP:

- ✓ Works with existing IP infrastructure
- ✓ Increases safety by reducing trips to the field
- ✓ Provides faster startup and device configuration
- ✓ Improves plant reliability through remote access to diagnostics
- ✓ Easy remote access to valuable device and process information

BENEFITS OF SMART DEVICES

The HART Protocol is a powerful communication technology used to employ the full potential of smart field devices. Preserving the traditional 4-20mA signal, the HART Protocol extends system capabilities for two-way digital communication with smart field instruments.

The HART Protocol offers the most cost-effective solution for smart field device communication and has the widest base of device suppliers and device types of any field device protocol worldwide. More instruments are available with the HART Protocol than any other digital communications technology. Almost any process application can be addressed by one of the products offered by HART-enabled instruments or devices.



Performance Improvements
Real-time process performance and device health information facilitate predictive maintenance strategies improving performance, quality and safety.



Calculated Enhancements
Advanced capabilities like compensated mass flow, multi-variable calculation and valve diagnostics can improve plant operations, product quality and regulatory compliance.



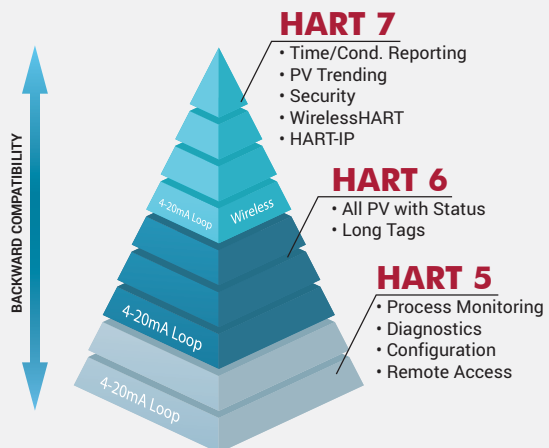
Time Savings
Remote access to device diagnostics reduces trips into the field, saving time and resources since the majority of field service trips report "no problem found".



Bottom-line Improvements
Reducing unplanned shutdowns, faster start-ups and lower maintenance costs improve the bottom-line.

Asset and Investment Protection

As the HART Protocol is upgraded, new functions and capabilities may be added to meet new user requirements. A basic premise of the HART Protocol is that new HART instruments must behave in precisely the same manner as older versions when interfaced with an earlier revision host system. Unlike other digital communication technologies, the HART Protocol provides a unique communication solution that is backward compatible with the installed base of instrumentation in use today. This backward compatibility ensures that investments in existing cabling and current control strategies will remain secure well into the future.



IIoT Ready Using Smart Device Information

Smart HART devices contain several different types of information supporting digital transformation and the IIoT. Smart devices contribute valuable information throughout all of their life cycle phases - engineering, configuration, operation, diagnostics and maintenance. Information can be grouped into 4 types: Setup / Configuration, Health Status, Complex Multivariable Measurements and Predictive / Diagnostic Troubleshooting. The graphic below identifies some of the enhanced functions provided by smart devices that, when used effectively, save time and money.





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FOUNDATION

FOUNDATION™ Fieldbus provides an all-digital infrastructure, with powerful multivariable measurement capabilities, robust device diagnostics, and the ability to integrate wireless devices across multiple networks.



COMMUNICATION PROTOCOL

With over 40 million supported field instruments installed worldwide, HART technology offers a reliable, long-term solution for leveraging benefits of intelligent devices through digital communication.