

Demo Abstract: A Complete *WirelessHART* Network

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ABSTRACT

WirelessHART is the first open wireless standard for the process control industry. Previously we demonstrated a three-node prototype network based on an early release of the protocol stack. In this demonstration we build a fully operational *WirelessHART* sensor network of multiple nodes. We show the creation of the network and the execution of process monitoring applications on the network. This new demonstration network serves as a proof of concept for the revised *WirelessHART* standard and as a platform for our future research and experiments.

Categories and Subject Descriptors

C.3 [Special-Purpose and Application-based Systems]: Process Control Systems, Real-time and embedded systems.

General Terms

Design, Experimentation.

Keywords

WirelessHART, Process Control.

1. INTRODUCTION

Wireless sensor technology is being introduced to the process control industry. However, one major roadblock, among others, is the miss of an open standard. Many customers are reluctant to adopt wireless technology for fear of locking into proprietary products for life. *WirelessHART*, released in September, 2007 is the first public standard in the process control industry. Many companies have announced various products based on the standard and customers are eager to try the new standard out. It is expected that 2008 will see the first deployment of such products.

As one of the many supporting teams for the standard, we have been developing prototypes for the proof of concepts. We have demonstrated in [2] a three node network communicating with *WirelessHART* protocol.

In this paper, we demonstrate a complete *WirelessHART* network one year after the standard is published. The demonstration shows the creation of a *WirelessHART* network, the join process of a

new device, the scheduling of the whole network, and the flow of process data for a process monitoring application. The demonstration illustrates how various wireless technologies are integrated to implement real world process control applications.

The rest of the paper is organized as follows: Section 2 gives a brief introduction to the *WirelessHART* standard; Section 3 discusses our implementation of the standard; the demonstration application is described in Section 4 and Section 5 concludes this paper.

2. THE *WirelessHART* STANDARD

WirelessHART is a secure networking protocol operating in the 2.4GHz ISM radio band. On the physical layer, *WirelessHART* utilizes IEEE 802.15.4 compatible DSSS radios. On the data link layer, *WirelessHART* defines a secure and reliable MAC protocol. The *WirelessHART* network layer supports mesh networking technology. In addition, a central network manager is responsible for the configuration of the network and scheduling of all activities in the network.

WirelessHART networks support a wide variety of devices from different manufactures. Figure 1 illustrates some typical network device types.

Some of the key features are summarized in the following subsections.

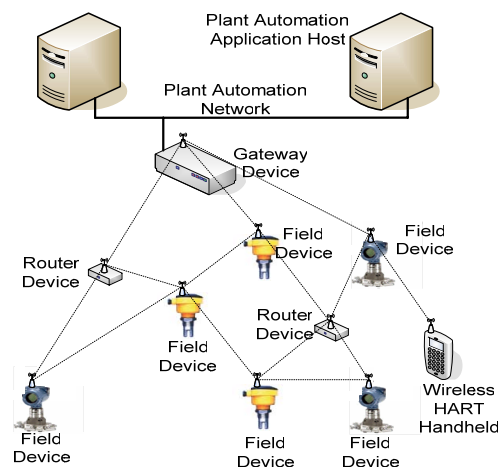


Figure 1. A Sample *WirelessHART* network

2.1 Mesh Network Topology

A *WirelessHART* network is a flexible ad-hoc mesh network. Every device is a router that can both source and sink packets.

This flexibility supports self re-organization and self healing of *WirelessHART* networks. Large geographic coverage is also made possible. Each device in a network reports traffic statistics to the network manager, such as signal levels, packet loss rate for each neighbor, and discovery of new neighbors. The network manager grooms connections and routes data traffics dynamically. By utilizing the capabilities of the network manager, *WirelessHART* can create networks with high reliability, low power and real-time support.

2.2 Robustness

Security, reliability, safety, and timeliness are all very important for process control. *WirelessHART* is specially designed to meet these requirements. It provides redundant paths between a gateway and field devices. By prioritizing packets, *WirelessHART* ensures the operation of a network and allocates enough bandwidth to monitoring and control applications. *WirelessHART* uses industry-standard AES-128 ciphers and keys at both the MAC and network layers. By introducing channel hopping on top of the IEEE 802.15.4 PHY, *WirelessHART* can support very high reliability and co-exists with other IEEE 802.15.4-based protocols.

2.3 Process Control Oriented

WirelessHART is designed for process control. Simplicity and easy of use is vital for the success of *WirelessHART*. With this in mind, *WirelessHART* provides diagnostics support to assess the overall operation of the network. Network managers can dynamically allocate bandwidth and continuously adapt the network to the changing environment in a plant. Normally, devices need fixed bandwidth for publishing process and control data. They can also request additional bandwidth temporarily (e.g., to transfer a vibration spectra), and ramp up/down bandwidth when maintenance is performed on a field device. Each *WirelessHART* network is created and managed by a network manager. All field devices have the same network capabilities for simplicity. By configuring the network manager properly, customers can choose different network topologies, speeds, and applications.

3. *WirelessHART* IMPLEMENTATION

We implemented our previous demonstration on an 8-bit 40MHz microcontroller with 4KB of RAM. Since a complete *WirelessHART* stack requires more hardware resources, we upgraded the memory and microprocessor capability. Our current demonstration is developed on a 48MHz 32-bit CodeFire V1 processor with a programmable 128K flash and 16KB RAM. The radio board is an IEEE 802.15.4 compatible 2.4GHz transceiver. Fig. 2 shows the actual hardware. In [2], we discussed several challenges in implementing *WirelessHART* protocol on resource-limited hardware. The solutions we proposed prove to be effective.

4. DEMONSTRATION DESCRIPTION

Five boards from Figure 2 will be used in the demonstration. One will serve as the gateway and access point, which is connected to

a laptop. The laptop is the host and runs the network manager. In this demonstration we illustrate how a *WirelessHART* network operates in the following steps.

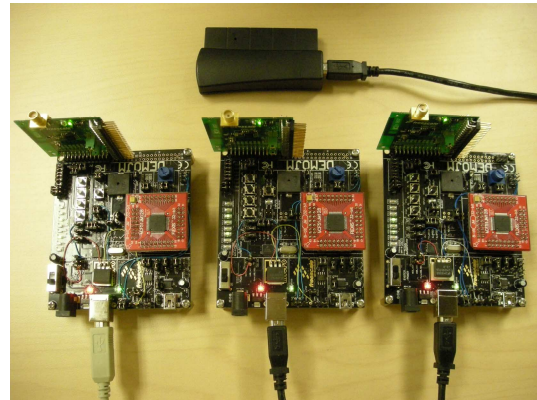


Figure 2. Hardware platform for the demonstration

4.1 Network Creation

A device follows a strict process to join the network. Only after the network manager provisions it can a new device become a part of the network. However, a device has the flexibility to choose any neighbor with the best signal-to-noise ratio (or some other parameters) to join the network. We shall explain the procedure when the other 4 devices join the network.

4.2 Simulated Process Applications

We show the functioning of the *WirelessHART* network with simulated process applications. Once a device is set up it publishes process data to the host periodically. The data will be routed via other neighboring devices. *WirelessHART* is mainly targeted towards monitoring applications in which devices send sensor data to the host. In this demonstration, we shall also show how data is routed from the host to the devices. The on-board peripherals (LEDs) will be used to visually display the application progress.

5. CONCLUSION AND FUTURE WORK

WirelessHART is the first open wireless standard for the process control industry. *WirelessHART*-certified products are expected to hit the market in late 2008. Our demonstration network shows a complete *WirelessHART* network. This demonstration serves to prove the viability of *WirelessHART*. It also serves as a research and experimentation platform for future works.

6. REFERENCES

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