Wireless and Wired Network Reliability and Maintenance

Using both wired and wireless field device networks increases reliability and reduces required maintenance.

By Moazzam Shamsi MSc, BEng, CEng, MinstMC;
Global Solutions Architect with Emerson Process Management

Process plants must connect up to thousands of field devices to automation systems. These field devices are primarily instruments, analyzers and valves. Wired or wireless networks can be used to make these connections. Wired networks are typically some type of digital fieldbus, with 4-20mA wiring not considered a network for the purpose of this article. Wireless networks can be either WirelessHART or ISA 100.

Automation systems are highly reliant on accurate information in order for control algorithms and operators to make informed decisions. Furthermore, as data from field devices is consolidated, plant operations personnel gain access to timely knowledge regarding plant throughput, availability and product quality.

At the heart of these process plants is the physical infrastructure which interconnects the automation system to the field devices. This article discusses the maintenance and reliability aspects of wired and wireless infrastructure, and the mechanisms employed to ensure sustained performance of wired and wireless field networks

Fieldbus Networks

Compared to traditional 4-20mA wiring, Foundation Fieldbus and other fieldbus technologies save wiring costs, simplify expansion, and are easier to make redundant because they allow multiple instruments to use a single cable called a trunk or segment (Figure 1). A trunk or segment begins at an interface device at the automation system.

Figure 1, Multiple Foundation Fieldbus instruments can be installed on a trunk line.
One of the main advantages of fieldbus networks over 4-20mA connections is the reduction in the amount of wiring and connections. Each wire and connection point is a possible point of failure, so reducing wiring increases reliability. It also reduces the damage which would be caused by a catastrophic event which could affect an entire wire bundle.

With fieldbus networks, wiring is reduced, and good design practices can minimize the possibility of damage. Wire reliability is determined by the reliability of the physical wire itself. Wire has the lowest complexity level of the fieldbus network components, and usually the lowest failure rate. Thus the major concern with cabling is not failure of the media itself, but external factors affecting the wiring.

Wire reliability can be greatly enhanced by following installation and maintenance procedures to avoid accidental shorting or grounding as these are the most common causes of wiring failures. Reliability can also be enhanced by selecting wire, routing and connectors that shield exposed media from physical contact with electrical discontinuities.

Despite the generally high reliability of wired fieldbus networks, there is still a possibility of failure due to corrosion, wear and tear, and other factors. To maintain reliable wired network operation, the IEC 60079 standard recommends periodic inspections to ensure safe and reliable operations (Reference 1). The standard is lengthy and comprehensive, but in summary recommends periodic inspections, particular for those installations in classified areas.

If a problem should occur with fieldbus network wiring, service interruption is managed through robust error checking and retransmission mechanisms. The digital signal will thus reflect bad status, unlike a 4-20mA signal which may indicate an erroneous and not detectable measurement caused by external factors such as induced interference.

The trend for both brownfield and greenfield projects is to look at ways to eliminate or reduce the amount of required wiring along with its corresponding required inspections. WirelessHART can help plants reach this goal by minimizing required wired infrastructure, thus creating greater resilience and flexibility.

Before we look at wireless network reliability and required maintenance, it's instructive to examine WirelessHART network specifics.

**WirelessHART Details**

WirelessHART is a self-organizing mesh technology in which field devices form robust wireless networks to dynamically mitigate obstacles in the process environment (Figure 2). Other wireless technologies employ similar strategies.

WirelessHART and other wireless technologies don’t require signal wiring to and from the automation system. Some wireless devices require power wiring, but the vast majority of deployments use integral power modules, some with energy harvesting modules, and thus operate completely without wires.

A WirelessHART installation requires, first of all, a wireless field device transmitting data according to the IEC 62591 WirelessHART standard (Figure 3). If a field device does not have WirelessHART capability, a WirelessHART adapter can be installed to convert the device’s output.

With WirelessHART, each wireless device transmits to a gateway managing a specific wireless field network. Typically, the gateway is...
assigned to a process unit. Each gateway will manage its own wireless field network, and can have an assigned HART Tag like any HART device. Each wireless field network in a plant has a unique Network ID to prevent devices from attempting to join the wrong network.

WirelessHART devices can communicate through each other to send messages to the gateway, forming a self-organizing “mesh.” The mesh extends the range of a device beyond that of its own radio. For example, a wireless device may be several hundred feet away from the gateway with obstacles between, but power-efficient “hops” through neighboring devices closer to the gateway ensure a reliable, extended range.

The gateway connects to the DCS via a wired or wireless high-speed link, typically Ethernet.

**Wireless Network Reliability**

As can be surmised from the previous discussion of WirelessHART, the main reliability and maintenance advantage of wireless field networks as compared to fieldbus networks is the greatly reduced amount of wiring.

With wireless networks, the main reliability concern is based upon the assurance of data transmission from the field device to the WirelessHART gateway. The auto routing meshing capabilities of WirelessHART are automatically managed and result in quick resumption of service in data transmission links in the event of an obstacle being introduced. This auto routing capability minimizes or eliminates data transmission disruption.

Because data transmission is digital, what is measured by or transmitted to the field device reflects values at the automation system. To ensure reliability, digital wireless protocols such as WirelessHART have inherent error checking functions to ensure:

- Signals don’t suffer from drift or spikes
- Any corrupt data is flagged and retransmission is requested

*Figure 3, This WirelessHART 3051S Pressure Gauge is installed in a chemical plant and provides local indication of pressure as well as wireless transmission of its pressure reading.*
• Retransmission mechanisms to resend data if it becomes corrupt

• Reconstruction of partially scrambled data packets

**Redundancy and Network Strategy**

How much redundancy to have in a process plant, and how to provide it, depends on the specific situation and is based on factors such as mean-time-between-failure, system availability and experience. It is also based on how critical particular devices, loops, and processes are to safe and effective plant operation.

Options range from redundant measurements to redundant process streams and everything in between. With wireless technology, inherent mechanisms make use of redundant paths to route data. Wireless repeaters can be added to increase the reliability of a specific wireless network, and reliability can be further enhanced by the use of redundant gateways.

Including WirelessHART as part of the core design of the field device network infrastructure creates inherent design flexibility, which can be used to increase reliability and reduce required maintenance. This allows network design to include the use of wired fieldbus and wireless networks depending on the specific application.

Strategic adoption of wireless networks should look at ways of rationalizing the wired infrastructure by eliminating or reducing the reliance on wired junction boxes. Every wiring termination is a potential risk in terms of design errors, installation issues, and future points of failure. One WirelessHART gateway is potentially capable of providing wireless coverage for an entire process unit (Figure 4). This means the number of junction boxes across the process unit can be reduced to minimize design complexity, eliminate routine reliability inspections of physical infrastructure.

Using wireless field devices and networks as an additional technology will enhance the overall robustness of the field device network architecture. It will also save time in terms of inspections, while eliminating potential for design error and reducing complexity. Fewer wires mean reduced design intervention in terms of routing and terminations, and faster repairs in the event of any incidents.

**Conclusion**

The appropriate use of wireless technology is best summarised in the following table:

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*Figure 4, One WirelessHART gateway can usually cover an entire process unit area, providing connections via a mesh network to all wireless instruments installed within the area.*
Process plants will still retain wired infrastructures for implementing critical control and safety instrumented loops, and for processes requiring high speed (<100ms) communications. These high speed applications may not be suitable for wireless due to potential lags in communications, or asynchronous communications between wireless devices. The recommendation is to use wireless where it is most appropriate to supplement and enhance the overall integrity of the I/O infrastructure.

This is the fourth of a five-article series on wireless instrumentation and infrastructure. This article discussed the reliability and maintenance of wired versus wireless networks. For more detail on these and other subjects listed below, please see Reference 3.

The first article showed how wireless can be used to cut operating expenses in capital-constrained environments. It can be found at: http://www.automation.com/automation-news/wireless-cuts-operating-expenses-in-capital-constrained-environments

The second article covered wireless device system planning, design, test and commissioning. It can be found at: http://www.automation.com/automation-news/todays-featured-news-headlines/wireless-device-network-planning-and-design

The third article covered WirelessHART field device installation and configuration. It can be found at: http://www.automation.com/wirelesshart-field-device-installation-and-configuration

Article 5 will appear in July 2016 and will show how to add instruments to existing wireless networks.

Upon conclusion of this five-article series, the reader will be prepared to justify, design, install and maintain wireless instrumentation and wireless networks.

About the Author

Mr. Shamsi has been an automation professional for 25 years and his career spans a broad range of industries, in roles from technical leader to project management. He presently works for Emerson Process Management where he directs Emerson’s global wireless consulting and execution solutions on large capital projects. He specializes in working with clients and contractors to implement technology solutions to improve operational efficiency.

 Figures

Figures, all courtesy of Emerson Process Management
Figure 1. Multiple Foundation Fieldbus instruments can be installed on a trunk line.

Figure 2. WirelessHART devices combine with a gateway (center of diagram) to create a wireless mesh network.

Figure 3. This WirelessHART 3051S Pressure Gauge is installed in a chemical plant and provides local indication of pressure as well as wireless transmission of its pressure reading.

Figure 4. One WirelessHART gateway can usually cover an entire process unit area, providing connections via a mesh network to all wireless instruments installed within the area.

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