IIoT and Sensing on the Edge

Modern instrumentation provides plenty of information—here's how to get it into IIoT software.

By Ryan Williams, Endress+Hauser

Smart instruments have been available since the mid-1980s when 4-20mA HART devices entered the market, quickly followed by fieldbus-based devices. These digital communication technologies made it possible for instruments to provide more than just a process signal. Using digital interfaces, these devices were now able to send status, diagnostics and other information.

Endress+Hauser estimates that of the 40 million of its process instruments installed worldwide, 90% are digital, smart devices. These smart instruments provide an incredible amount of information at "the Edge" that is of immense benefit to a wide range of host systems and IIoT applications, such as maintenance management, asset management, inventory control, MES, ERP, etc. But one major problem facing industrial plants is: How do we manage all this data?

If a single smart instrument, such as a Coriolis meter, can provide a few dozen items of status and diagnostic information, and a plant has several thousand similar instruments (Figure 1), the host systems have to deal with huge amounts of data arriving in real time.

Because of the immense amount of data, and the problems involved in managing it, Endress+Hauser estimates that 97% of the data is not being used. Instead, automation systems use the flow, pressure, temperature, level and other data needed to control the process, and ignore or discard the status, diagnostic and other data.

Major instrument manufacturers are well aware of the problem, and several are now providing solutions to acquire data from the Edge and provide it to specialized IIoT software—all without affecting or involving the automation system. This article explains how these concepts work.

Figure 1: A process plant may have thousands of smart instruments, all providing status and diagnostic data needed by IIoT software.

Handling Massive Amounts of Data

As noted above, a smart instrument generates a great deal of status, diagnostic and other information. An Endress+Hauser Proline® flowmeter, for example, can detect entrained air, vibration (which could be caused by pump cavitation), coating, corrosion and inhomogeneous or unsuitable media. The flowmeter can detect 125 different

Error code	Error	Actions	Alarm type
843	Process limit	Check process conditions	Alarm
962	Partially filled pipe	Check for gas in process Adjust detection limits	Warning
910	Tubes not oscillating	Check input configuration Check external device or process conditions	Alarm
912	Medium inhomogeneous	Check process condition Increase system pressure	Warning
913	Medium unsuitable	Check process conditions Check sensor	Alarm
948	Oscillation damping too high	Check process conditions	Warning

Figure 2: Typical errors that can be generated by an Endress+Hauser Proline flowmeter.

problems. When process conditions warrant a notification (Figure 2), the flowmeter will generate an event message.

While the automation system is mostly interested in flow values and alarms, IIoT software wants to know about the warnings shown in Figure 2, as well as diagnostics and other data.

Many smart instruments can provide diagnostics to indicate problems with electronics or subcomponents. For example, Proline Coriolis flowmeters can monitor oscillation damping and frequency, temperature, signal asymmetry, exciter current, carrier pipe temperature, frequency fluctuation and other parameters. Changes in these parameters can indicate potential problems.

While every instrument manufacturer's diagnostics differ, each typically monitors internal parameters, observes changes and diagnoses problems. Any further analysis must be done by IIoT maintenance software, which means status and diagnostic data needs to be transmitted to this software.

In many cases, this is accomplished by the automation system, which periodically asks each instrument for the data, then stores it in an online database, such as a process historian. Maintenance management software accesses what it needs from the historian and performs its analysis.

This type of solution presents problems. Networks can be unduly burdened with data transmissions, historians can become bloated, and there can be lags between data collection and recognition by the IIoT software.

Data is collected only periodically because the automation system can't deal with the massive amount of status and diagnostic data from hundreds or thousands of instruments. The data is stored in a database, which has to be accessed from the maintenance software, adding even more delays.

A better solution—now being offered by several major instrument manufacturers—is to provide all the data available at the edge to IIoT software via the cloud, thus bypassing the automation system completely.

Connecting at the Edge

The 30+ million digital instruments currently installed worldwide communicate with their automation systems via different interfaces, including Profibus®, 4-20mA HART, WirelessHART™, EtherNet/IP™, and several others. However, many eventually connect to an Ethernet-based network (Figure 3), where the data can be acquired by a specialized "Edge Device."

The edge device is programmed to extract instrument data from the network and transmit it to IIoT software in the cloud.

An edge device can also be installed on a smaller system, such as a pumping station, that may or may not be connected to a plant's Ethernet network, or to instruments that are connected to an older, non-Ethernet system. In that case, each instrument is wired to a nearby "Edge Gateway" device which collects data from devices and transmits it to the cloud.

Once the instruments are connected to an ethernet-based network that is ready for IoT connection, the appropriate edge device is selected. Various edge devices are available from instrument manufacturers to handle expected data rates.

For example, Endress+Hauser has multiple approaches to select the right edge device for the right quantity of instruments transmitting information to the cloud. At a site where there are 100s of instruments, the edge device has high speed data acquisition to push the information to the IoT cloud. Conversely, Endress+Hauser also offers instrument-based edge devices that run at basic speed, transmitting small amounts of information to the IoT cloud.

All data transmission is one way from the device to the cloud. Cybersecurity is deployed within data transmission, edge devices, and cloud services connectivity.

Inside the Cloud

Major instrument manufacturers provide software that uses data from the edge to diagnose problems, schedule maintenance activities, analyze processes, predict problems and so on.

Using Endress+Hauser as an example, cloud software consists of several components:

- **Instrument diagnostics** – Software built into modern instruments monitors device status and process conditions, and provides data needed for further analysis. Endress+Hauser embeds Heartbeat Technology® into its instruments to provide status and diagnostic information, and to perform vital functions such as condition monitoring and in-situ verification.

  During verification, the current conditions of various parameters are compared with their reference values, thereby determining the device status. Heartbeat Technology produces a "pass" or a "fail" statement based on the tests, which is performed by traceable and redundant internal references. The individual tests and results are automatically recorded and used to print a verification report.

- **Cloud connection** – Software and hardware are needed to extract data from the plant's Ethernet network or from individual devices and transmit it to the cloud-based software. At Endress+Hauser, this is accomplished with Netilion Connect, which consists of edge devices which acquire the data, a cloud platform that hosts the IIoT software and an application programmable interface (API).

The API provides a way to connect cloud-to-cloud or cloud-to-apps in a simplified way. It enables customers to use IoT in a simple and efficient way without the complexity of IT computer science.

Netilion is Endress+Hauser's brand name for its IoT ecosystem. The ecosystem is based on an open source technology platform that is common in our industry and — like other vendor's ecosystems — offers these functions:

- **Analytical software** — Analytics processes data generated by Heartbeat Technology to assess instrument health, analyze and predict problems, schedule maintenance, etc.
- **Process Health** — Health software analyzes instrumentation at the edge to determine if the process is getting more difficult to control, if external influences are having a detrimental effect on performance, or if changes

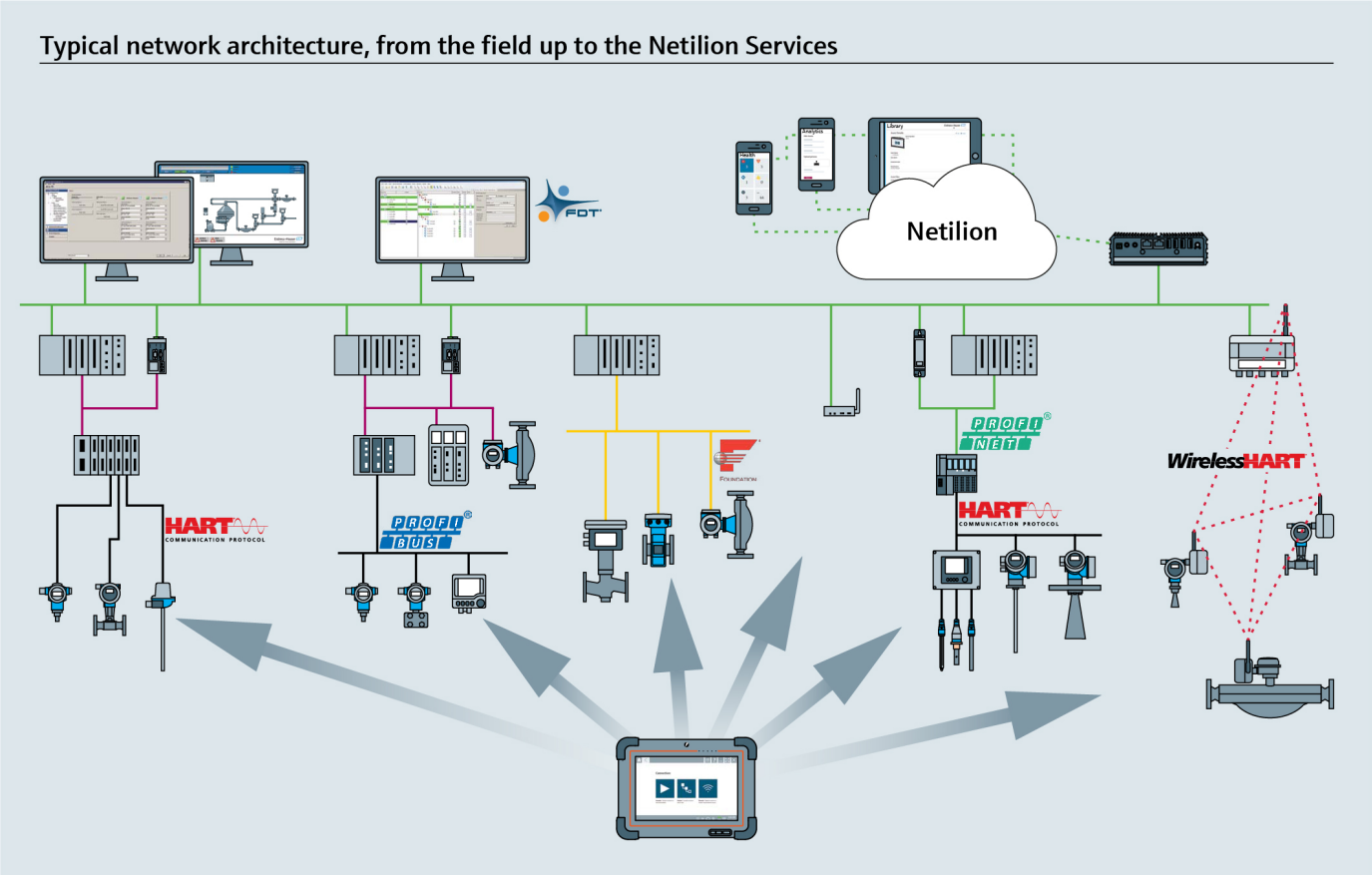

Figure 3: An edge device (upper right) takes instrument data from the plant's Ethernet network and sends it to Endress+Hauser Netilion IIoT software in the cloud.

need to be made. For example, Netilion Smart System for Surface Water can be used by water treatment plants to monitor incoming surface water. The system monitors conductivity, pH, dissolved oxygen and other parameters, and issues warnings to operators.

- **Equipment documentation** – Maintenance technicians need access to equipment manuals, troubleshooting instructions and other materials describing each instrument. Library software logs in all pertinent information and makes it available to technicians on request.

Getting Started

Implementing a system like Netilion might appear challenging, but several factors help simplify the effort.

First, few plants are exclusive to a single instrument vendor. All this instrumentation has to be identified and entered into the system, along with their manuals, error codes, diagnostic information, etc. This is normally done during an installed base analysis.

Fortunately, modern instruments typically are identified with bar codes or labels that can be scanned to identify the vendor and product. Then, the necessary data can easily be downloaded from the vendor's web site.

Second, there's no need to implement a plant-wide system right away. Most vendors provide a "startup kit" that allows a plant to try out the concept. For example, Endress+Hauser offers a free trial version for up to 15 assets with a typical plant introductory IoT package that can connect up to 500 instruments to its cloud software.

Summary

Modern instruments provide a wealth of information about their health and the process they're monitoring, but few plants use all that data. Today, major instrument manufacturers are providing hardware and software solutions that bring all the data available at the edge to IIoT software for analysis and corrective actions.

About the Author

Ryan Williams is the national product manager for services and solutions at Endress+Hauser. Ryan graduated from Purdue University in 2005 with his degree in Electrical & Computer Engineering Technology. He came to Endress+Hauser in 2018 with more than 14 years of experience at Rockwell Automation.