Digital communication and smart instrumentation increases plant efficiency

With many digital communication options now available, modern instrumentation solutions provide diagnostic information beyond basic process data, empowering informed decision-making and proactive maintenance.

By Fabrício de Andrade, Endress+Hauser

For decades, control system instrument data was constrained to single analog process variables communicated via individual 4-20mA current loops. Modern instrumentation advances, particularly digital communications, now provide a wealth of additional diagnostic and other information, enabling operational insights unachievable with simple 4-20mA measurements alone. This extended data helps plant personnel improve operational efficiency and avoid unplanned shutdowns by empowering them to implement proactive maintenance, and by simplifying calibration procedures.

Modern device-level network media options — like HART® over 4-20mA, WirelessHART®, Ethernet-APL® and Bluetooth® — provide the ability to transmit data bi-directionally between an instrument and its host system. Various communication methods are selected based on the target field devices, depending on the intended application.

For wired installations, plants can implement a combination of HART over 4-20mA and Ethernet-APL, enabling them to update legacy installations and take advantage of newer fully-digital technology, depending on project needs. For instruments in hard-to-reach and hazardous locations, WirelessHART and Bluetooth options enable wireless transmission of multiple process variables and diagnostic data to a wide variety of host systems, providing even more flexibility for handling instrument data.

Traditional instrumentation challenges

There are many factors impacting and even interfering with the accuracy of a traditional instrument's analog output. Operators interpreting such a signal processed by a programmable logic controller, distributed control system, asset management system, or other host system simply have no other information regarding the accuracy. Each analog loop scales a single process value as electrical current, unable to transmit secondary variables such as temperature on a pressure instrument. Additionally, communication is unidirectional only, so there is no way to send commands from a host to the instrument.

Traditional analog instrumentation also lacks diagnostic information, making it nearly impossible to foresee or troubleshoot instrument failure. Malfunctions cause unplanned downtime and costly instrumentation repairs in the best cases, or catastrophic equipment damage and safety hazards in the worst. Bound by analog electronics, traditional instruments must be hardwired to a host system, limiting placement in hard-to-reach areas of a facility, and especially in offsite remote locations.

Digital pathways for enhanced connectivity

Digital communication methods increase data availability, and they provide flexibility for processing the data so plant personnel can make informed operational and maintenance decisions. Plant designs featuring smart instrumentation using digital protocols make facility operation and optimization much more manageable. We will examine four modern protocols and transport media that increase instrumentation value and control system capabilities.

HART over 4-20mA

For retrofitted and new applications where hardwiring transmitters back to a host system is existing or convenient, instruments can use the bi-directional digital HART communication protocol, which is superimposed on a 4-20mA analog current loop, to enable sending and receiving data between an instrument communicator and a host system. The exchanged data includes primary process values, one or more secondary process values, diagnostics, calibration, maintenance, and other information. This

wealth of data makes configuration easy, and it improves operational process insights, compared to traditional analog-only instrumentation.

Because HART-enabled instruments can transmit multiple process values to a controller via a single loop, users gain flexibility to continue using existing analog loops for real-time control, while taking advantage of additional process and diagnostic data to the host system for making data-driven decisions within a facility.

WirelessHART and Bluetooth

Where wired implementations are impossible or inconvenient, wireless smart instruments provide solutions via 2.4 GHz radio wave technologies and protocols, notably WirelessHART and Bluetooth. Many smart instruments provide these connectivity options natively, while adapters can be added to provide this functionality for those that do not (Figure 1). These capabilities can be used to create a mesh network of sensors around a plant and in the field.

WirelessHART and Bluetooth instruments typically send and receive as much or more diagnostic and process data as their wired HART counterparts. While this data can provide immense benefits to a wide range of host systems and applications—such as maintenance management, asset information and health management, inventory control, and enterprise resource planning systems—many facilities do not yet take full advantage of what this data has to offer.

Figure 1: Endress+Hauser's SWA50 WirelessHART/Bluetooth communication adapter enables any HART-compatible instrument to communicate wirelessly.

Ethernet-APL

A more recent development is the Ethernet-APL physical transport layer, which provides the ability to transmit digital data via industrial Ethernet protocols using a single two-wired shielded cable per instrument. With the same cable requirements as HART—though markedly different gateway and termination specifications—Ethernet-APL can simplify retrofits by eliminating the need to pull new wires to instruments (Figure 2).

The Ethernet-APL physical layer is protocol agnostic, and supports industrial protocols such as PROFINET®, EtherNet/IP™, Modbus® TCP, HART-IP, OPC® UA, and other higher-level network protocols (Figure 3).

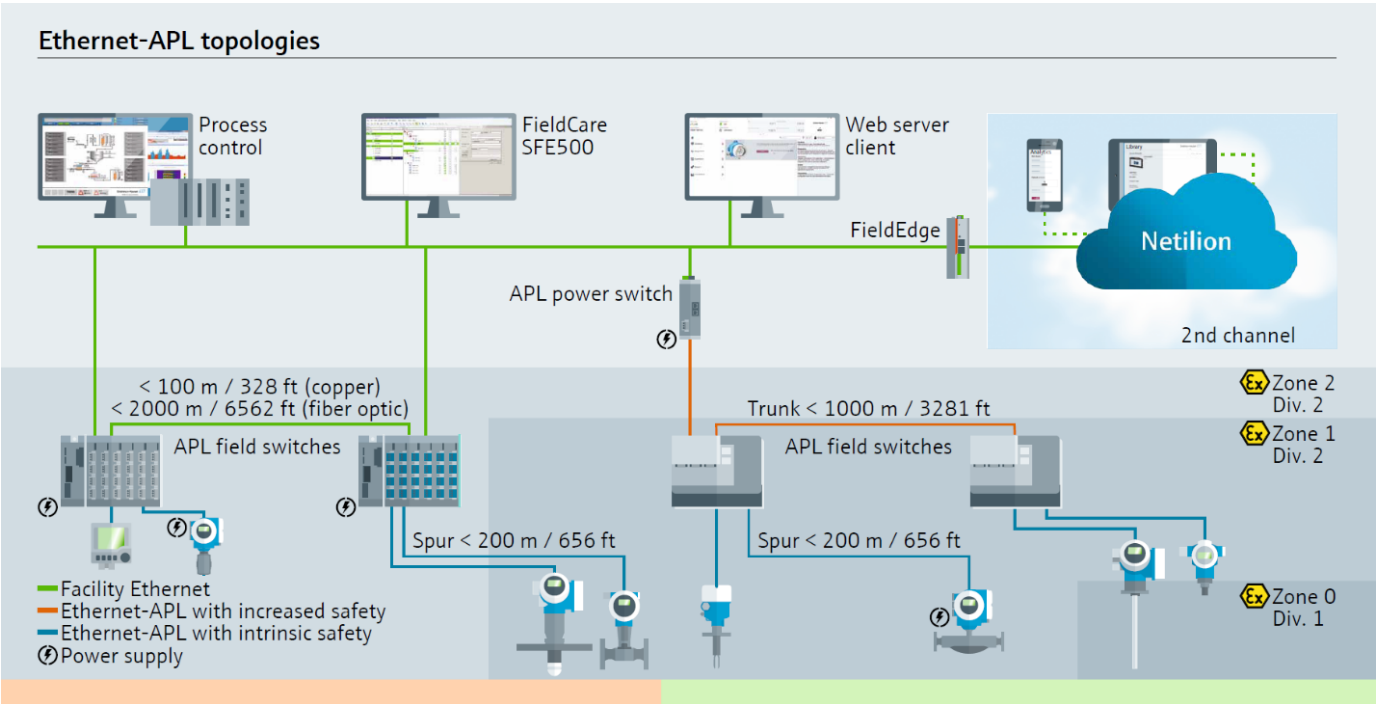

Figure 2: Ethernet-APL architecture is highly customizable, requiring only a gateway and power supply to enable data transfer among a wide range of instruments and various host systems using a single two-wire shielded cable per instrument. In many cases, cables are already present in plants with existing analog instrumentation.

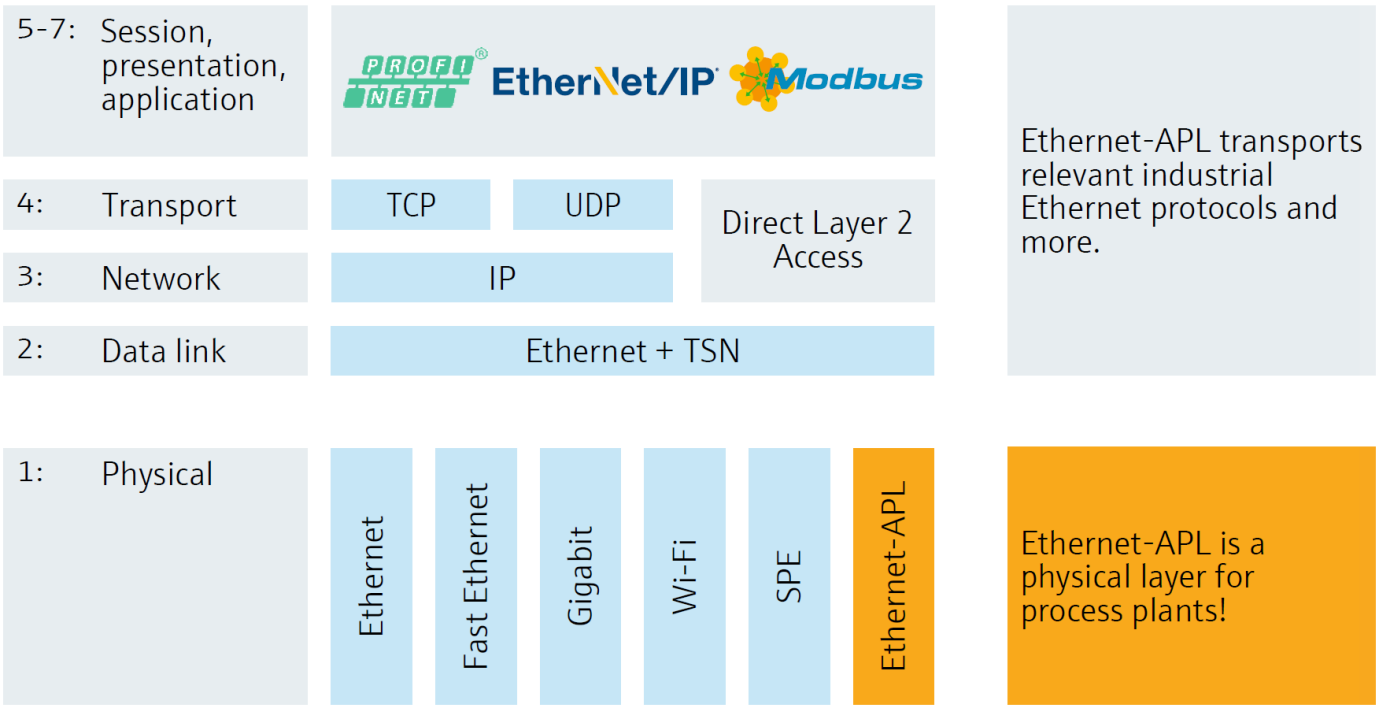

Figure 3: As a foundational transport layer, Ethernet-APL is capable of carrying any industrial Ethernet protocol. Endress+Hauser Ethernet-APL instrumentation currently supports PROFINET traffic, with plans to carry EtherNet/IP, Modbus TCP, and additional protocols in the near future.

Ethernet-APL provides high-speed data transmission at a 10Mbit/s data rate, making it possible to send and receive more data than is possible with older digital methods, providing a robust basis for continuous diagnostics, monitoring, industrial internet of things (IIoT) connectivity, and remote instrumentation verification.

Because communication is handled via standard Ethernet protocols, instrument data routing among process control systems and asset management tools is highly efficient in modern control environments already using these protocols.

Turn enhanced data into operational optimization insights
Control systems regularly use flow, pressure, temperature, level, and other measured values to monitor and control processes, but they often discard or lack access to status and diagnostic data. By not using this supplementary information facilities miss out on opportunities to optimize, simplify, and safeguard their plant operations.

Instead, if this data can be ingested by intelligent plant analysis systems, facilities are able to increase their ratio of proactive to reactive maintenance, reducing unplanned downtime, and minimizing equipment and human safety hazards. For example, instead of waiting for an alert indicating a high-temperature condition, process data can be used to provide a preemptive notification when conditions are detected that would lead to this type of issue if left unmitigated.

Data can also be analyzed to provide advance warning of instrument failure, or troubleshooting insight in the event of failure. Additionally, tracking and managing assets becomes easier throughout plant lifecycles because calibration and nameplate information for many modern smart instruments is also recorded.

Cloud-based add-ons

Plant managers can extend digital instrument insights even further by leveraging cloud connectivity and computing for performing advanced analysis, data storage, archival, and retrieval. For example, Endress+Hauser's Netilion Health monitoring service provides insights for past and present conditions of process assets, empowering staff to track instrument health, and then initiate maintenance proactively to keep operations running smoothly.

Comprehensive insights support development of maintenance plans to organize shutdowns, and evolve maintenance procedures from corrective to predictive. Additional cloud-based tools can be used to generate process optimization insights, identifying parameter changes and strategy adjustments that can lead to improved operational efficiency.

Avoiding undesirable conditions

A hazardous waste incineration company leveraged WirelessHART-enabled instruments (Figure 4) and cloud-based analytics to detect and clear pipe scaling in its flue gas

Figure 4: A hazardous waste incineration company added multiple Endress+Hauser pressure and temperature transmitters with SWA50 WirelessHART/Bluetooth communication adapters to detect scaling in its flue gas denitrification unit.

denitrification unit. The unit's heat exchanger experienced severe scaling, reducing its efficiency, and it required extensive periods of downtime to clear the clogs.

By installing additional pressure and temperature transmitters throughout the unit—and integrating the instrument data wirelessly with a Fieldgate SWG70 edge gateway—the company began digitally recording a vast amount of additional process data, which they passed to cloud-based tools for analysis (Figure 5). Using the process and diagnostic data, these cloud tools leveraged artificial intelligence and machine learning to accurately predict pipe scaling accumulation. Equipped with these insights, plant personnel made small adjustments to the process, greatly reducing the rate of scaling.

The company is now expanding their cloud capabilities by preparing their cloud-based computerized maintenance management system to automatically issue workorders when the analytics system detects process issues. It will also connect to the inventory database, keeping tabs on available spare parts, and will digitally issue orders for those in short supply.

Comprehensive correlations

For public utilities, an upgrade to digital communications and smart instrumentation serves to supply edge- or cloud-based tools with water, air, gas, electricity, and steam consumption

Figure 5: Wireless data transmission and collection at Endress+Hauser's Fieldgate SWG70 edge gateway eliminates the need for conduits and wires between instruments and host systems.

data, supporting the creation of correlations with process inputs and outputs. This helps users understand where their facilities are using these resources and guides efforts to reduce waste.

In the chemical industry, environmental contaminants are often a concern, so dedicated systems are installed to mitigate pollutants prior to discharge. These systems are often controlled separately from manufacturing equipment, but efficiency and safety can be increased by installing smart instrumentation at these locations so they can be closely integrated with the central control system. Wireless digital communication protocols make integration much simpler than running costly cables, especially over long distances.

At facilities with manufacturing machinery, continuous asset monitoring is critical to detect impending mechanical equipment failure, so proactive maintenance can be performed to avoid excessive downtime. Leveraging the health monitoring diagnostics of smart equipment, such as actuators, manufacturers can increase productivity and reduce maintenance costs.

Digital advancements

For optimizing plant processes, the implementation of digital protocols and smart instrumentation provides indispensable data for host systems, which can be used to create operational and maintenance insights. Two-way communication from smart instruments to host systems provides multivariable process values and extensive diagnostic information.

Insights derived in this manner help users improve process efficiency and assist in avoiding unplanned shutdowns by aiding the development of proactive maintenance procedures. Data can be reviewed locally at a facility, and expanded to the cloud so insights can be accessed remotely by external support personnel and process experts. This can further increase an organization's productivity and response speed when issues arise.

Whether an organization is well along on their digitalization journey, or just beginning, it is undeniable that industry reliance on digital data and the IIoT is becoming more pronounced. By deploying network infrastructure and smart instrumentation throughout their enterprises, companies are better prepared to continuously optimize their processes and remain competitive in the digital age.

All figures courtesy Endress+Hauser

About the Author

Fabrício de Andrade is an IIoT Business Development Manager at Endress+Hauser Digital Solutions in Switzerland, where he is responsible for IIoT in Latin America, Mexico, Spain and Portugal. He graduated in business management and holds an MBA in Marketing and Digital Business, in addition to a degree in Process Automation and Telecommunication. He has more than 15 years of experience working in big process automation players in Brazil, Germany and Switzerland.

www.addresses.endress.com

WP01200S/24/EN/01.24-00

Endress+Hauser

People for Process Automation