To Be Wired or Not to Be?
That is the Engineering Question

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Introduction

How many engineers have really sat down to compare the value added to a wireless solution versus a wired solution? Many would compare only the cost factor as the savings in wiring, conduit, design, integration and installation. But can the value go deeper? Is there a return that hasn’t been discussed that can have more significant rewards?

There are millions upon millions of 4-20mA transmitters in the industrial marketplace being used for high level control yet there is no certainty that the measurement is valid. The only time there is certainty of the device is if it is using an online form of deterministic communication like Foundation Fieldbus, DE or some other form of non-deterministic protocol like Profibus, HART or others.

People often refer to smart devices as devices with true certainty of what is being measured in the field. However, if the smart data is not being used in a continuous feed to the system, then more than likely it is only being used as a maintenance tool during periodic calibrations, configuration or troubleshooting exercises. If this is once per year for one hour, what is that device doing the other 8,759 hours it is operating throughout the year? No one knows for sure.

The other issue is what other hiccups can happen to a 4-20mA device that you cannot see at the system? Technicians have seen it all:

- Water or moisture buildup in the conduit
- Corrosion at the wiring
- Wires grounded out altogether or intermittently
- Power supplies insufficient to support all the loop signal lags
- Voltage too low to support the loop
- Transmitter in the field is improperly configured
- Oil in the conduit
- Upon installation wires were marshaled improperly
- Wires labeled incorrectly
- Wrong size resister on input
- Wrong field device attached to loop

What if you had a device that could eliminate all of these questions and installation errors, and reduce startup time and installation costs in upwards of 80 percent or greater? Not only that, a device that could increase the security of the data coming into your alerting/control loop or system at the same time so that you know the data is real and repeatable. This is happening and the data is real.
This table offers comparison between wired and wireless technologies. In the last two columns you record the score for each technology. See how the value adds up.

**Evaluation Matrix: Wired vs. Wireless**

<table>
<thead>
<tr>
<th>Function</th>
<th>4-20mA Wired</th>
<th>Wireless</th>
<th>WIRED</th>
<th>WIRELESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital data for diagnostics of the transmitter</td>
<td>NA – Some units will go to a default scale in the event of failure</td>
<td>Complete data on status and potential diagnostics of unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smart diagnostics that include up to 85% of the data FF provides</td>
<td>NA</td>
<td>Complete diagnostics including radio health and battery life</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal alarm points to flag the system that it has gone beyond a specific high level or low level or both</td>
<td>4-20mA is a single inferred input to a process variable</td>
<td>The sensor network is true raw digital data. Most units have alarm points that can be transmitted on the data stream without another device</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notification of the output is limited due to moisture in the conduit, corrosion in the line or insufficient power supply</td>
<td>Cannot be seen until unit has a hard fail or the error results in a process upset</td>
<td>As all the data is digital you never have to worry about this. If by chance the data is interrupted the system will notify you immediately and allow for immediate options.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response time from sensor to 4-20mA input on system/controller</td>
<td>250 msec or less in many cases</td>
<td>One second response in a solid wireless sensor network. Typically faster response may shorten battery life to 3-5 years at that rate.</td>
<td></td>
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</tr>
<tr>
<td>Ability to historically record all events in a separate database and reference back to any changes in the event of a recorded process upset</td>
<td>4-20mA is a single inferred input to a process variable</td>
<td>Diagnostics data, sensor data, alarm points can all be sent to a separate database as it is in “e” form and can be integrated to a location that you want the data installed.</td>
<td></td>
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</tr>
<tr>
<td>Scalability options</td>
<td>Only to the amount of analog inputs available on the control system</td>
<td>As the data is brought in on network bus like Ethernet, modbus, modbus/tcp or OPC it is all dependent on each base/gateway capability. They range typically from 100 to 30,000 points.</td>
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</tr>
<tr>
<td>Security on the data coming to the system</td>
<td>There is no proof of the data coming into the system and therefore no protection</td>
<td>Typically protected by individual RFID signatures, encryption, CRC checking, channel selection, hopping sequencing, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Function</td>
<td>4-20mA Wired</td>
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<td>--------------------------------------------------------------------------</td>
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<tr>
<td>Ability to use smart data for determining health of instrument 24 hours a day, 365 days a year</td>
<td>Only available if system is designed to do online asset management monitoring</td>
<td>Available all the time and can be segmented at the system to store to any database the owner desires</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ranging the 0-100% data to a specific range, i.e. 0-150 °C or 0-15 PSIG</td>
<td>Yes, it has that capability</td>
<td>This can be set up in the system but is really not needed. As the data is digital it will read whatever the sensor is indicating in the field over its entire range.</td>
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<td></td>
</tr>
<tr>
<td>Ability to discern at the system if the transmitter connected to that input is scaled 0-50 H2O or 0-50 PSID</td>
<td>No ability. The input side of the loop is only designed to read in 4-20mA. If the replacement is made it cannot distinguish.</td>
<td>Immediate indication of the unit installed in the field. This would allow for immediate correction before a process upset occurs.</td>
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<tr>
<td>Plant power loss affecting field units</td>
<td>If the transmitters do not have a UPS on their power supply they will drop out altogether</td>
<td>Batter backup can be supplied to the base station/gateway. The field units are all individually powered and require no additional source.</td>
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</tr>
<tr>
<td>Redundancy on field units</td>
<td>Yes, you can wire a separate transmitter into the system and bring it back to the control room if there is an available twisted pair in the field. Permitting will be required if it is a classified hazardous area.</td>
<td>Just program and stick in the field. No permitting required as the units are all Class 1 Div 1 A-G.</td>
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<tr>
<td>What about HART?</td>
<td>Yes, if purchased with that protocol option. However currently in the field there are millions of HART devices. Only 1-2% are actually being monitored full time. The rest of the time HART is only used as a configuration aid.</td>
<td>Seeing as the data is already in a digital format it can then be transferred to any asset management system. This would include Profibus, FF, HART or others. It is not limited as the data is in a “smart” format.</td>
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<tr>
<td>What about lightning?</td>
<td>Very susceptible. When lightning strikes the energy is dispersed over several hundred feet. It often is a nightmare for tank farms and open plants due to all the conduit run across the ground.</td>
<td>All technologies are susceptible. However wireless has proven to be more enduring as it is a single device. If not mounted at the highest point with a ground path it is very tolerant. If there is a lightning arrester in the path of the antenna it will eliminate or minimize any impact.</td>
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</table>

The matrix is a very realistic representation of technology that is often feared by many. Like any technology shifts it will take some time for the industrial world to embrace it.
The weaknesses in the 4-20mA technology are common in the industry. The following is an excerpt from a white paper drafted by Tom Wallace of Emerson Process Management called “Functional Comparison of HART and FOUNDATION Fieldbus” (June 2007).

The 4–20 mA signal is considered robust, but this can be a misconception. Since the signal is sent and received continuously, it provides excellent response for process control. The 4–20 mA signals have trouble detecting when communication errors take place or the information is faulty. If the signal is between 4–20 mA, it is assumed valid. Issues such as grounding, ground loops, and electrical interference from high current or electromagnetic sources can impose an undetectable bias on the 4–20 mA signal. Since the entire control signal is 16 mA total, a bias of the current of only 1 mA represents an error of over 6 percent in the process variable received by the control host. In addition, on-scale failures of devices are generally undetectable, and if a process variable goes significantly above or below the calibrated range of the device, the analog signal saturates and the operator has no idea what the actual process variable is. Often the actual process variable is within the range of the transmitter and would be available on a digital protocol.

So it is fair to assume from the above that this is truly a known problem and the summary line clearly describes the goal, "Often the actual process variable is within the range of the transmitter and will be available on a digital protocol."

In a nutshell digital data is bringing the actual field data into the control room without any fear of the data being watered down. It is as close to sensing the real physical properties and process changes that you can achieve. In addition it provides information that allows you to react immediately if there is something wrong with the field device without second guessing.

We have to look at other technologies available to the user today that can help bring digital data into the control room and how they compare to wireless technology.

**What Is Really Smart?**

You may have noticed that the table did not include units with digital communications type outputs (FF, HART, Profibus, Device Net, etc.). The largest percentage of field devices (even smart field devices) uses the smart protocols as configuration type inputs. Foundation Fieldbus was the only technology prior to wireless technology that was designed to be control ready and control capable. The only other protocol designed with deterministic input for control prior to that was DE back at the birth of the smart transmitter in 1983.

If you look at the technologies and why they were invented it may shed some additional light as to the possible inherent value of wireless. Rather then breaking this down to any specific open protocol as there are so many globally, we will break it down into configuration and diagnostic software and Foundation Fieldbus. This allows the two areas to be discussed separately as this is really their functional design by nature.

Configuration and diagnostics protocols are generally used for configuration. In a very small percentage of facilities they are used for meaningful online diagnostics. A much smaller percentage of facilities use them for control. Therefore it is difficult to draw a conclusion as to how it would compare as there is no standard format outside of configuration and calibration that users have adopted since the release of smart technology 25 years ago.
It would be impractical to suggest that a plant would rip out its installed base of instrumentation and install new equipment to gain those values that the diagnostics can offer. Furthermore it would be more then idealistic to suggest that they modify their control system to enable control of that technology.

Wireless offers the ability to add the data in a very quick, scalable fashion. You can simply start with a handful of devices at critical points. Integrate them with an age old standard like modbus or some other serial interface. Then grow your network as you see fit from that point. Complete projects of 10-15 points have been initiated, installed, commissioned and integrated in less then three hours. And now they have smart dynamic digital communication out to the sensor location.

**Beyond Conventional Smart**

Foundation Fieldbus is by far the most robust protocol and industrial sensing and control standard built to date. There is a wealth of functional capabilities that are now offered at the sensor than ever before. This was truly a protocol that was designed to be control ready.

One of the main driving forces behind the Fieldbus Foundation was to reduce the amount of wiring. Early in its conception phase communications offered the capability to have multi-drop bidirectional type networks and reduce the overall wiring cost of the project. In many cases this was the immediate ROI engineers needed to justify the change.

They added control and function block programming to the devices at the sensor level as well. However for the largest part of the installed base they are utilizing the deterministic protocol response from the field device and still maintaining control in the operator station.

If you look at wireless, it adds something to the fieldbus network that really empowers a plant.

- Wireless eliminates the need for wires (fieldbus multi-drop) reducing significant project cost.
- The wireless sensor and Ethernet network can now include fieldbus through Ethernet converters (or any bus).
- The network can be meshed or built with multiple redundancy points without the cost of wiring.
- The network can act as your fiber optic points to RTUs for control.

It is not feasible to think that in the future we will see a completely wireless plant. However, when planning the next project, it would make sense to weigh the cost of implementing a project with a number of wireless points over wired points if it could save $20,000 to $100,000 and significantly reduce the installation time. However to say a wireless plant is not feasible would be like the comment Ken Olsen, founder of DEC, made in 1977, “There is no reason anyone would want a computer in their home.” It is proof that technology will expand our limits beyond what we can perceive today.

Wireless is an enabler to your projects, safety and regulatory requirements, your information base in the control room, a rapid response to lost data points without loss in production time and more. It is simply an enabler. You may be surprised at how easy it is to bring data across the plant or into the control room without having to run wiring. This would especially be important if it is a point that you are not sure if the return on investment for the application would ever prove itself worthy of the project.
Wireless will happen to every major process plant operating in America in the next 3-5 years. Whether it’s used for monitoring the environmental sensors for regulatory purposes, enhancing optimization, providing safety information or basic process control, it will happen. It is only a question of when it will happen at your plant.

More Information
For more information about Honeywell’s wireless solutions, visit www.honeywell.com/ps/wireless or contact your Honeywell account manager.

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