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Wireless Cuts Operating Expenses in Capital-Constrained Environments

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Adding points of measurement by installing new instruments in an existing process plant can support operational excellence strategies and reduce operating expenses. But, it can be difficult to justify these automation projects with conventional wired instrumentation due to high cost, lengthy installation time and required downtime.

In a capital-constrained environment, automation projects have to compete with other site initiatives in order to justify funding. This requires a clear case to be made, both financially and to site operations, that the project will deliver value above what already exists on site. Furthermore, stakeholders need assurance that should the project be approved, mitigation strategies are in place to minimize or eliminate any likelihood of cost escalation or slippage.

Many of the difficulties arise due to the complexities and expense of installing wiring and related infrastructure. Installation takes time, and will require work permits and often downtime. Design effort can be substantial, particularly when integrating with an existing system as many different drawings and documents must be reviewed and updated to reflect the addition of new wiring and related infrastructure.

Integrating wireless into the overall solution will conserve footprint and critical marshalling and I/O termination space, which may already be difficult to find. Including wireless can help justify the project as the incremental solutions and applications which can be added to the wireless network can demonstrate benefit beyond the original project scope.

This article will compare wired to wireless installations, and show how wireless provides advantages in many instances.

Wired Instrumentation Design Challenges

Connecting a conventional wired instrument from its installation point in the field back to the automation system can be done with either 4-20mA wiring or via a digital fieldbus such as Foundation Fieldbus. In either case, the connection is usually not directly from the instrument to the automation system, but instead passes through a number of intermediate points.

With 4-20mA wiring, the first step is to make sure there is a spare 4-20mA input at the automation system. In the best case, this requires time-consuming investigation of existing cabinets looking for spare space. If space isn't available, it will be necessary to add an analog input module, often at considerable expense. In the worst case, there will be no space to add the new module in an existing rack or cabinet, necessitating the addition of a new I/O rack or cabinet.

Once a spare 4-20mA input is found or added, wiring must be run from the instrument to the input module. Routing new wiring through existing conduits isn't possible unless all old wiring is replaced. Adding wiring to a cable tray in an existing facility may also be challenging, as there are risks associated with disturbing existing wiring to install new cables (Figure 1).

As noted, wiring from instruments to automation systems very seldom takes a direct path, but instead lands on many intermediate points, primarily marshalling cabinets and junction boxes. In the best case, space is available, but this still requires detailed initial investigation, and modification of a number of drawings. In the worst case, no space is available and extra cabinets and boxes must be designed, purchased and installed.

For fieldbus installations, adding instruments can be simpler than with 4-20mA instruments

Figure 1. Adding new wiring to existing conduit isn't possible without replacing all old wiring, and adding wiring to a cable tray can also present problems.

if capacity is available on existing networks, but detailed engineering analysis must be performed to make sure the new instruments won't overload the existing network. This analysis often reveals the need to add new components to the fieldbus network, greatly increasing design effort, cost and project schedule length.

These design activities typically require putting together a multi-discipline team for even the addition of a few points of measurement, often rendering the proposed project cost-prohibitive, or not feasible due to resource constraints.

A better alternative in many cases is to install wireless instrumentation to add the desired points of measurement.

Wireless Addresses Issues

As the name implies, wireless instruments don't require wiring infrastructure. Connections from the instruments are typically made via a wireless mesh network consisting of the instruments, one or more wireless gateways, and a base station located near the automation system. If the instruments are battery-powered, no power wiring is required (Figure 2). Each wireless gateway will require power wiring, but it's often possible to locate these gateways close to a power source.

This simple architecture eliminates the design and project planning complexities associated with a wholly wired installation (Table). If an existing wireless network infrastructure is in place, then the new instrument can simply be added to this network. In the worst case, a new gateway will be required, but nothing more.

When no wireless network infrastructure exists, one must be installed. But once this network is in place, new wireless instruments can be easily added. In effect, the new wireless network infrastructure greatly increases the capacity to add instrumentation to an existing automation system, and this expanded capability allows plant engineers to focus on developing solutions to overcome operational issues.

Implementation is simple when an existing wireless network is in place, and cost justification is also straightforward. When no wireless network exists, help is available to justify costs and design the network.

Cost Justification

The first justification step is to ensure that a wireless philosophy document is in place, or created if it's not. This document establishes the basis of design for wireless in the project, and aligns all project team members. Emerson Process Management (www.emersonprocess.com) Solution Architects can help end users create this document in the early concept phase of a project through the use of standard templates.

Figure 2. A battery-powered wireless instrument requires no signal or power wiring, and can operate for up to ten years before the battery needs replacement.

Table: Wired versus Wireless Instrumentation

	Wired	Wireless
Design	Extensive investigation required, and often substantial redesign of existing wired infrastructure	Minimal once wireless infrastructure is in place, much less than with wired designs even when new infrastructure is required
Scalability	Constrained by infrastructure	Highly scalable into multiple applications
Installation Time	Time consuming, typically weeks or months, even for just a few instruments	Typically a few hours per instrument
Downtime	Often required	Seldom required
Maintenance	Periodic integrity checks of the physical infrastructure. For classified areas, mandatory periodic inspections of wiring infrastructure to ensure compliance with required protection levels.	Minimal, only requires power module change every 10 years or less.

Secondly, the plant must identify areas which could benefit from wireless measurement. Wireless measurement points are often added for applications which ensure regulatory compliance, improvement asset efficiency, and/or enable predictive diagnostics to provide early alerts regarding equipment degradation. Once again, Emerson experts can assist, in this case by using pre-defined engineering processes to help design engineers quickly identify solutions and capitalize on savings in project implementation.

Assuming there is no existing wireless network infrastructure in place, a preliminary design must be produced to estimate costs. At the same time, the benefits of adding wireless measurement points can be quantified. Comparing benefits and costs yields project justification.

Emerson, as well as other leading providers of wireless instrumentation and infrastructure, has solution architects who routinely perform value analysis and can help an end user put together a project justification.

Some suppliers also have tools to aid in preliminary design, such as Emerson's Basis of Design tool, which provides a detailed analysis of the comparative benefit of introducing wireless to a project I/O infrastructure versus conventional 4-20mA or fieldbus installations (Figure 3).

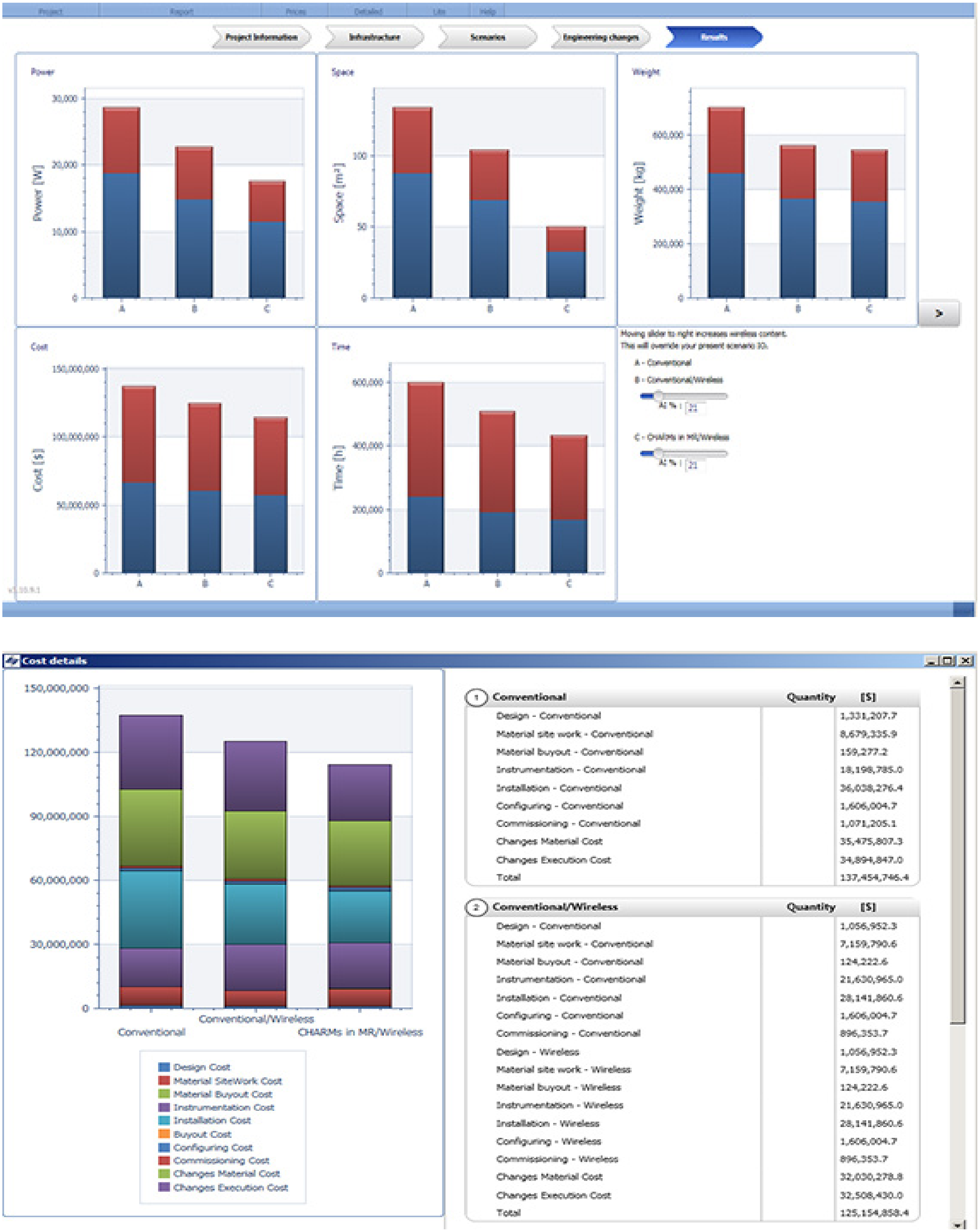

Figure 3. Emerson Process Management's Basis of Design tool enables an end user to analyze the comparative benefit of introducing wireless technology as a strategy in the overall I/O infrastructure.

The Basis of Design tool is used during the early design phase to assess the comparative benefit of including wireless in the overall I/O solution. This design tool helps engineer teams to quantify the relative benefit of moving individual or groups of points across from those traditionally allocated as wired to wireless. The tool can quantify the infrastructure impact and allow a determination of the potential benefit in terms of the following project design and management parameters:

- Space – Impact on cabinet space (marshalling, I/O, barriers, etc.) associated with infrastructure
- Weight – Impact on total weight, particularly important in modular construction builds or offshore modifications.
- Time – Impact to overall project schedule
- Cost – Impact on cost, with a detailed breakdown of items
  Power – impact on project power use, particularly important in installations where available power budget may be limited, such as offshore installations, or installations heavily reliant on renewable energy sources.

Past analysis has shown savings from using wireless instead of wired I/O in the range of 22% to 67%, with higher numbers found for complex installations in arduous environments.

Once project justification is complete, the next step is implementation.

Implementation Effort

Implementation starts with a project philosophy document, which ensures all design stakeholders are aligned and understand the implementation plan and the application. The next step is a detailed project plan and schedule, which defines all project tasks and assigns people to these tasks. The main project tasks will be design, procurement, installation and software configuration.

Wireless projects include fewer activities than wired equivalents due to the elimination of wired infrastructure. The main activities will be installing the instruments, gateways and the base station. Once installed, these items must be connected together in a wireless network. Finally, the base station must be connected to the DCS or another control and monitoring system, and these systems must be configured to read and act upon the information supplied by the wireless instruments.

Through all of these activities, wireless must be an implicit part of the design process, as it's fundamentally different from traditional wired installations. Tools, documentation and processes should be set up to not only facilitate the current project, but also the future addition of wireless instruments. A section should be added to the DCS or control system specification describing integration options, an area where the wireless supplier can often provide assistance by providing pre-built spec sheets.

Conclusion

This is the first of a five-article series on wireless instrumentation and infrastructure. This article gives an overview of wired versus wireless installations, and also discusses justification and implementation.

The next four articles in this series will be published in the upcoming issues of automation.com's Wireless Quarterly as follows:

- Article 2, Oct 2015, Field Network Planning and Design. Describes how the design process changes with wireless as compared to wired installations. Includes design best practices
- Article 3, Jan 2016, Wireless Configuration. Describes alarm configuration practices and integration options for gateways. Discusses host integration, wireless PID control, and redundant and secondary measurements.
- Article 4, Apr 2016, Reliability and Maintenance of Wired versus Wireless Networks. Discusses reliability and maintenance of wireless networks as compared to their wired equivalents.
- Article 5, Jul 2016, Adding to Existing Wireless Networks. A detailed discussion of 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 for capital improvement and operational efficiency projects.

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