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Innovation's New Frontier

Over the past 30 years, the automation industry has made incredible strides in technology. The capability and functionality of today's digital automation systems arguably have advanced to a point where they have outpaced the ability of many end users to take full advantage of the technology they already have in place.

So it is, says Peter Zornio, Emerson Process Management chief strategic officer, that the next step change in automation innovation will come, not from adding new features and functionality, but from subtracting complexity—making automation technology easier to use; easier to implement and manage; easier to bring to bear for business benefit.

Control recently caught up with Zornio to discuss Emerson's commitment to human-centered design (HCD) and how it continues to reshape the company's offerings, notably its new DeltaV S-series digital automation system architecture, and what the company calls "I/O on Demand," which is intended to do nothing less than reinvent how I/O gets done in the process industries.

Q: How did Emerson identify human-centered design as an important driving force in the company's development efforts?

A: We actually identified "usability" as a key strategic imperative about five years ago. We conducted surveys of our customers and found that their challenges increasingly revolve around people. The "old" challenges of the past—global competition, optimizing production and complying with regulations—are all still there, but the people challenge has come into focus for our customers as key to running safe, reliable and highly productive plants.

Users face a productivity paradox: There's more technology than ever, and plants are trending toward larger and more complex processes. Meanwhile, experienced worker are retiring; fewer, less experienced

workers are coming in; and what specialists are left are stretched ever more thinly. Further, new plants are coming online in rapidly growing markets in far-away places where the operators may have little familiarity with computers and electronics. HCD principles can make it easier for them to come up to speed and help them operate with fewer errors.

Anecdotally, we had a customer come to Austin and say, "Your technology must pass the 20/20 rule for it to be useful to me." He explained that to solve any particular problem, he may have to "pick from 20 people," and whoever is picked must be able to solve the problem "in 20 minutes." Only technology built for ease-of-use can solve this problem.

Q: How has human-centered design changed Emerson's development process?

A: As we investigated how to improve usability, we began to work with Carnegie Mellon University, the leader in human-centered design for industrial applications—which itself has only been around as a discipline for the past 15 to 20 years. We developed a better understanding of what we needed to do. We made organizational changes and investments, such as creating our own Human-Centered Design Institute. And today, we've put more than 60 key staffers through immersion training in HCD principles.

From an Emerson product development perspective, human-centered design has meant that instead of interviewing customers only to understand how they use or interact with a product, we interview and observe them to understand what they do in their work and how they interact with others. We've created personas for various positions to illustrate how people actually use and interface with the technology. This has helped us better understand how to design the technology around them.

In the end, our HCD goals became three-fold: to eliminate work, to remove complexity and to embed knowledge.

'I/O on Demand is all about affording customers the greatest degree of flexibility with the least amount of effort and risk.'

We used to talk to our customers about the need to change their work practices to get the maximum benefit from technology—but as it turns out, no one's available to rewrite those work processes. So step one is making things easier by engineering the work out of the process. Second, for the work that cannot be eliminated, we're striving to remove complexity: Make it simple as possible, and make the technology do the hard part. Our third aim is to embed within the technology the knowledge of those experienced people who are leaving—or who perhaps were never there in the first place.

Q: One recent outcome of Emerson's focus on human-centered design is "I/O on Demand," a concept revealed at last fall's Emerson Exchange in conjunction with the DeltaV S-series launch. Can you explain more about what makes this new approach to input/output so revolutionary?

A: At its core, I/O on Demand is all about affording customers the greatest degree of flexibility in their I/O decisions with the least amount of effort and risk. Regardless of I/O type chosen—traditionally wired, bussed or even redundant wireless—users can add and begin using input and output points natively and with far less engineering, design and field work than previously possible.

But it's not just choice of I/O type. On demand means flexibility in time and place too. Our electronic marshalling solution, for example, allows users to execute projects far more quickly—gracefully accommodating those inevitable last minute changes and reducing time-to-production. Our SmartWireless offering essentially allows incremental "wireless I/O" to be distributed seamlessly throughout the plant, wherever and whenever the need for a new measurement point is identified.

We've also used HCD principles to change the game in Foundation fieldbus—streamlining segment engineering and installation effort, as well as eliminating many of the potential installation problems having to do with



power, grounding and termination issues. Another way in which we allow users to further leverage their I/O investment is in the seamless communication of DeltaV SIS (safety instrumented system) information to the basic process control system (BPCS). In this way, information from safety I/O can be used to allow the BPCS to make more informed control decisions.

More than a collection of HCD-driven enhancements, I/O on Demand represents a fundamental transformation of Emerson's PlantWeb architecture. An integrated, wireless infrastructure gives plants a flexibility to respond to changing needs during its entire life cycle. Fieldbus has become easier to implement and even more cost-effective. And electronic marshalling has revolutionized how conventionally wired projects get done. It's the first real update to a 35-year-old engineering practice. ■

The New Paradigm

Ever since the first direct digital control system was applied some half-century ago, input/output (I/O) has been essential to process automation system architecture. And for just as long, the engineering of that I/O has been complex, and the fruits of that labor rigid and inflexible.

First, take the specification of conventional rack-mounted I/O cards, each of which uses shared circuitry to deal with a specific number of similar input or output channels. Then add to that the design of associated controllers, marshalling cabinets, junction boxes and wire runs, and it's no surprise that the typical project incurs significant change-order expenses as inevitable late-stage design tweaks wreak havoc on delivery schedules.

Foundation fieldbus and other bus technologies essentially moved some I/O functionality out into the field devices themselves—easing the need for conventional I/O—but fieldbus segments are complex, and little reduction in engineering effort has been realized relative to conventional I/O practices.

The American Heritage Dictionary defines paradigm as “a set of assumptions, concepts, values and practices that constitutes a way of viewing reality for the community that shares them.” And in the case of I/O, the prevailing paradigm is that I/O is hard; I/O is inflexible.

But what if it wasn't so difficult? What if constant revisions to I/O specs didn't hamstring your project schedule? What if existing I/O spares didn't limit your ability to deploy new measurement points? What if I/O was more readily available, in any flavor needed, anywhere you needed it, and at any stage during a project—even after you're up and running?

That's the essential value proposition of I/O on Demand, Emerson Process Management's new way of thinking about I/O.

THE PROCESS LANDSCAPE

To better understand the genesis of the I/O on Demand offering, it's useful to first consider the broader context of the process industries and the increasingly global business environment in which they compete.

Across the process industries, sustainability and related environmental concerns show no sign of abating, especially as they relate to conserving increasingly expensive energy and limiting greenhouse gases. New regulations are being extended to include the protection of personnel and equipment. Control system security also is becoming more important, as the perceived threat of cyber incidents mounts.

Meanwhile, increasing scale and complexity constitute a growing challenge. On the one hand, plants are getting larger. Petrochemical plants, for instance, have become petrochemical complexes. This makes sense for efficiency reasons, but the entire operation becomes more complex because of unit interdependencies. Projects, too, are getting bigger and schedules are getting compressed. Hence more engineering work is getting pushed onsite for completion, sometimes with a marked effect on final project timing, cost and quality.

Against this backdrop are a record number of industry professionals at retirement age, who as they leave are taking a wealth of experience with them. Further, some industries are pursuing strategic workforce reductions. Centralized facilities, for example, are being developed in order to move more people out of hazardous or unsafe areas. The oil and gas industry is particularly adept at creating unmanned facilities, so when someone is sent onsite to troubleshoot, a true generalist—not a specialist—is required. And in growth markets, plants often are being built where there is essentially no ready-trained work force. Further complicating matters, few experienced people are interested in relocating to these remote locales.

So, we're left with fewer, less experienced people dealing with ever more complex processes and technologies. “It's a perfect storm,” said Steve Sonnenberg, Emerson Process Management CEO, in his keynote address to the Emerson Global Users Exchange late last year in Orlando as he prepared to unveil the latest iteration (version 11) of the company's DeltaV digital automation system, the S-series.

‘One of the goals of human-centered design is to eliminate unnecessary work.’

FROM HCD TO ‘I/O ON DEMAND’

Emerson Process Management decided some years ago that human-centered design (HCD) had to be a major part of the answer to this conundrum and set out to ensure that its process automation offering helps to accomplish three primary goals: eliminate work (where possible), reduce complexity for its users (let technology do the hard part), and embed knowledge (where needed).

“Frankly, automation suppliers have not designed products built around the actual ways projects are executed and the ways plants are run,” says Sonnenberg. “Advancing products features is important, but designing products around how people use them is critical.”

Task analysis, notes Peter Zornio, Emerson chief strategic officer, confirms that automation design is engineering-intensive (Figure 1). “That’s all work,” he says, “and one of the goals of HCD is to eliminate unnecessary work.”

I/O on Demand (Figure 2) is essentially the result of Emerson’s HCD development approach applied to I/O. It consists of a collection of new technologies as well as a range of HCD improvements all aimed at affording customers the greatest degree of flexibility in their I/O decisions with the least amount of effort and risk.

“I/O on Demand is ‘what you want, where you want it, when you want it,’” continues Zornio. “This is an automation breakthrough that eliminates the intensive pre-engineered work associated with I/O.”

ELECTRONIC MARSHALLING STREAMLINES WORK

While I/O on Demand promises usability and labor-saving improvements for almost any choice of I/O approach, perhaps the most transformative innovation for project work is the practice of electronic marshalling.

For conventionally wired instrumentation, electronic marshalling allows users to land field cabling wherever there is an available terminal block in the marshalling cabinet—regardless of signal type or control strategy. Each terminal block is set up to receive a single-channel characterization module, or CHARM, which includes the A/D converter and associated signal characterization for that point’s particular type of analog or digital I/O signal. Each I/O point is then digitally communicated via the marshalling cabinet’s DeltaV backplane—and can be associated with any control strategy in any of the system’s DeltaV controllers.

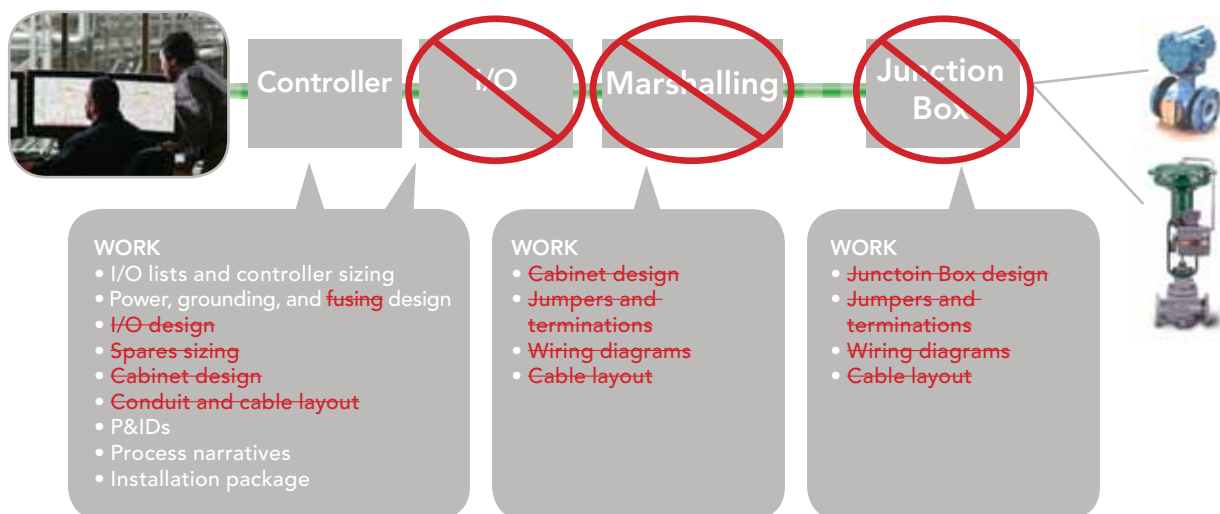


Figure 1. The traditional approach to engineering and installing input/output points is a complex, time-consuming and inflexible process.

I/O ON DEMAND

The effort and cost savings potential is enormous, because the manual cross-referencing of each incoming pair of wires with the appropriate I/O card is effectively eliminated—along with the requisite “spaghetti” wiring, extra terminal blocks and cabinet space. Further, because signal characterization is done on a single-channel basis, flexibility to accommodate late stage design changes is greatly enhanced. On a typical capital project, Emerson estimates that electronic marshalling could result in 32% reduction in

“44% of process control inputs can be wireless with no difficulty, and for a greenfield plant that’s a savings of 7% overall,” says Duncan Schleiss, Emerson vice president of platform strategy. “Getting rid of wires eliminates most activities associated with wiring design and installation,” Schleiss adds. “Poof! Cabinets, wire, terminations, cable tray design, fusing, installation drawings and a host of other activities are simply gone.” (For more details on the wireless aspects of I/O on Demand, see article on p 14.)

‘Advancing product features is important, but designing products around how people use them is critical.’

DeltaV controllers, a 40% reduction in cabinet footprint, and a whopping 90% reduction in intra-cabinet wiring relative to conventional I/O practices. (For more details on the electronic marshalling aspects of I/O on Demand, see article on p 10.)

REDUNDANT WIRELESS BOOSTS FLEXIBILITY

A second important aspect of Emerson’s I/O on Demand approach is the addition of redundancy to the company’s Smart Wireless infrastructure offering. Redundancy will allow an increasing number of traditionally wired I/O points to go wireless—for incremental monitoring as well as for closed-loop control, Emerson believes. This will have a profound impact on the design of new facilities as well as the ability of brownfield plants to easily implement new measurement points and asset management strategies.

REDUCING FIELDBUS EFFORT AND COST

Emerson’s HCD effort also took a hard look at Foundation fieldbus and found that substantial improvements could be made in how fieldbus is done. “Foundation technology requires third-party power supplies and power conditioners—along with the necessary engineering and wiring and cabinet space,” Schleiss explains. “And if you wanted to get at the bus diagnostics, you had to jump through OPC and RS485 hoops in order to get the information into the control system.”

“With DeltaV S-series and I/O on Demand, we’ve integrated the power circuitry with the H1 card itself,” Schleiss says. “Third-party power conditioners and dedicated power supplies—and the engineering that went with them—are a thing of the past.”

Citing a recently completed project consisting of

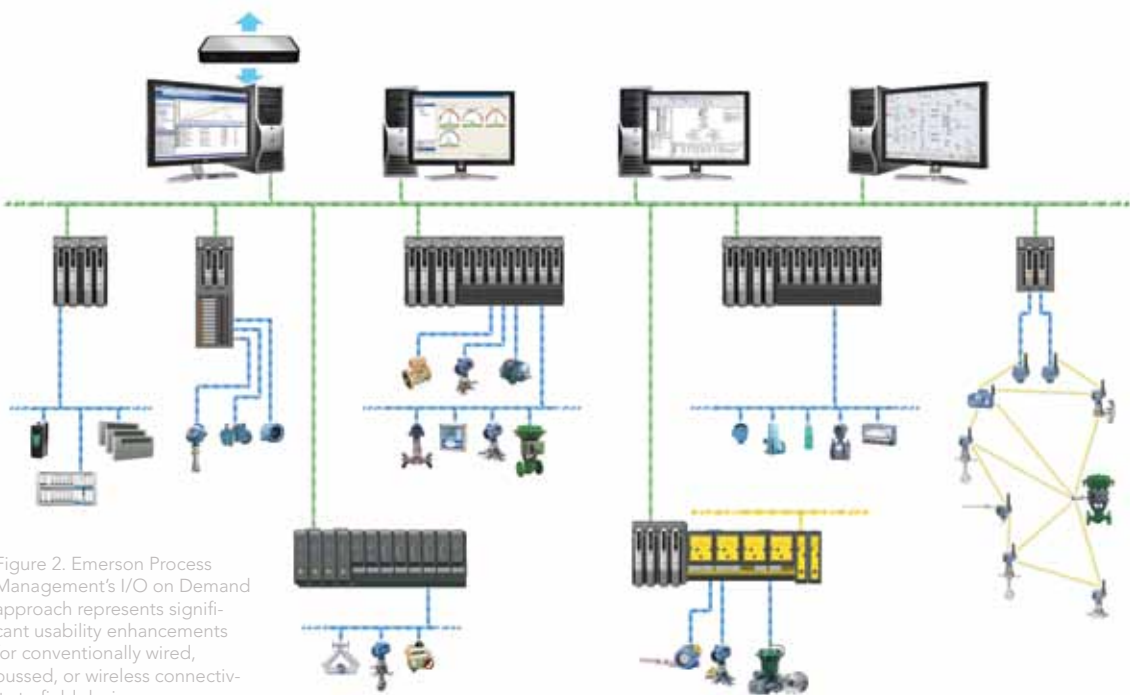


Figure 2. Emerson Process Management's I/O on Demand approach represents significant usability enhancements for conventionally wired, bussed, or wireless connectivity to field devices.

some 2,500 Foundation fieldbus segments, Emerson estimates that total project cost could have been reduced by some 7% using the new I/O on Demand approach. "Five thousand H1 power conditioners, 32 H1 power cabinets, along with their design and documentation, and all that factory and on-site wiring," lists Schleiss. "All gone!

"But we also integrated diagnostics. So now the maintenance staff can wait for the DeltaV H1 card to notify them of a problem on the physical layer, such as low voltage or high current. Easy! It's all integrated!" (For more details on the fieldbus aspects of I/O on Demand, see article on p 18.)

SAFETY I/O LEVERAGES HART DATA

Emerson also has addressed flexible I/O considerations in the modular, distributed architecture of its safety instrumented system, DeltaV SIS. Fully configurable I/O for any type of signal, the ability to add incremental logic solvers at any time, and scalability from 16 to 30,000 I/O points all contribute to increased flexibility, improved robustness and the elimination of single points of failure.

Further, the integration of DeltaV SIS with the

DeltaV basic process control system (BPCS), allows users to leverage SIS I/O information to make better operations decisions. (For more details on the safety aspects of I/O on Demand, see article on p 20.)

ERROR-PROOFING CONVENTIONAL I/O

Even the DeltaV system's "conventional" I/O hardware has evolved to make life easier with the new S-series. Heat dissipation technology allows for a completely enclosed shell (no vents). This prevents particles—or an errant screw—from entering a card and short-circuiting electronics.

And the new S-series hardware also offers "easy-on-hard-off" installation, which means there are no screws needed to install a card onto the backplane, yet releasing one requires pushing an out-of-the-way release button on top of the card. (For more details on how conventional I/O practices have been improved using HCD principles, see article on p 14.)

In the final analysis, I/O on Demand spans both revolutionary new technologies as well as the sum-total of myriad human-centered design innovations—all in the name of shifting the I/O paradigm. Now, I/O doesn't seem quite so hard, does it? ■

Redefining the Project Path

A cornerstone of I/O on Demand is electronic marshalling, a new approach to an industry practice that until now has changed little over the past several decades.

Indeed, classical marshalling is at the heart of a labor-intensive, relatively inflexible work practice that also is subject to the whims of late-stage process design modifications. Changes in process design drive changes in control system inputs and outputs required, and proceed to cascade through all that detailed engineering work—from reworking drawings to control system partitioning to building new cabinets. Late design changes are inevitable, but they add cost, time, and most important, risk to any project. The practice of wired marshalling only intensifies these problems.

But what if the nature of any single I/O channel could be changed at will, at any time during a project? What if a new pair of wires needed only a place to land and could be digitally bound to any controller in the system? What if all marshalling cabinets and junction boxes were of a “standard” design and

need not be engineered beyond knowing an approximate total I/O count?

Electronic marshalling does all these things. As a result, it effectively removes I/O from the critical path of many projects—decoupling process design from I/O architecture decisions, as well as eliminating the rework costs and project delays that were once the inevitable consequence of late-stage design modifications.

“The new I/O on Demand capability of Emerson’s DeltaV S-series allows users to add or change I/O types whenever they make project design changes, no matter where the I/O is located,” notes Larry O’Brien, analyst for the ARC Advisory Group. “This reduces project costs and, even more important, reduces time to startup.”

OUT WITH THE OLD

In the typical project of today, field home run wires are landed on the right-hand terminal strips in the marshalling cabinet shown in Figure 1. The terminal blocks then must be cross-marshalled to the appropriate I/O card and controller on the left-hand side of the diagram,

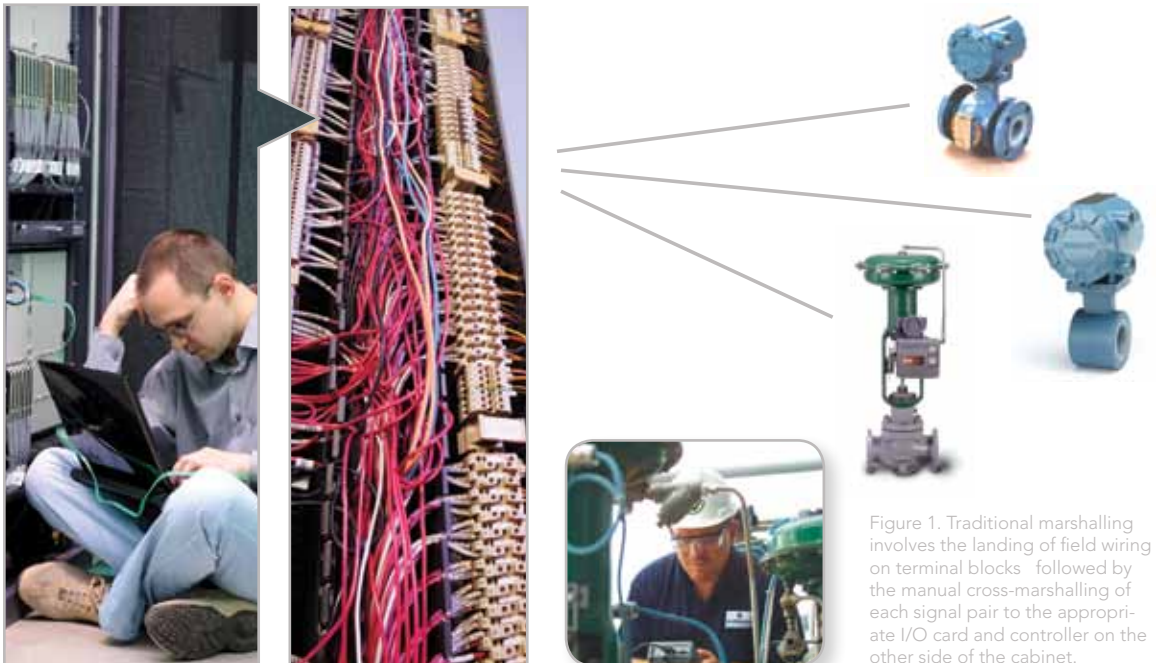


Figure 1. Traditional marshalling involves the landing of field wiring on terminal blocks followed by the manual cross-marshalling of each signal pair to the appropriate I/O card and controller on the other side of the cabinet.



24V DC field power injection

Hidden digital bus provides electronic marshalling

Figure 2. Electronic marshalling allows field wiring to be landed on any available terminal block in the cabinet; each channel is then individually characterized and digitally mapped to the desired controller.

Single-channel A/D converter with character (CHARM - characterization module)



resulting in a rat's nest of wiring that is both difficult to manage and difficult to modify.

With electronic marshalling, wires from the field still are landed on the right-hand set of terminal blocks as shown in Figure 2. But there are no cross wires. All of that work, design and engineering simply goes away. That's because with electronic marshalling, each individual channel is characterized to become the appropriate I/O type— analog input, digital output, etc.— simply by plugging in the appropriate A/D converter module called a characterization module, or CHARM.

So when it comes to instrumentation installation, land the wires anywhere, characterize the signal with a CHARM, drag and drop it to the appropriate controller in the host system and off you go! Any I/O can be used with any controller in the system— meaning that all of the I/O can be bound to the control system much later in the project. Overall system costs are lower because internal cabinet cross-wiring is eliminated, cabinet footprint is reduced, I/O channel

assignments are simplified and factory-acceptance test (FAT) activities are trimmed.

AN INSIDE LOOK

The DeltaV CHARM IO card (CIOC) itself has been designed for ease of use, both in physical installation (Figure 3) and its software tools. Components snap together with secure DIN-rail latches and interlocking carrier connectors; a series of 96 I/O channels can be connected to a DIN-rail in a matter of minutes. Each I/O card can serve I/O signals to any four controllers in the system with 50 ms updates for fast, reliable control.

The CIOC architecture is fully redundant, starting with the two I/O cards on a carrier. The carrier has redundant communication modules for primary and secondary network connections. There are two 24-VDC input power connections. The carrier connects to the CHARMS base plates and provides redundant power and communication buses to the CHARMS. Everything is redundant down to the individual channel.

ELECTRONIC MARSHALLING

No tools are needed to remove a CHARM or CHARM terminal block from the CIOC (Figure 3). Upon initial insertion, CHARMs are sensed by the system, automatically creating the I/O definition in the DeltaV configuration database. Also, upon initial insertion of a CHARM, each terminal block is “self-keyed” so that the wrong type of CHARM cannot be

mistakenly inserted. CHARMs also can be partially ejected to a locked position, disconnecting the field wiring from the system to perform field maintenance actions or to remove power to a field device. Activating the CHARM latch ejects the CHARM to the stand-by position. Closing the latch locks the CHARM in place and isolates the field wiring for field work.

‘Emerson’s DeltaV S-series allows users to add or change I/O types whenever they make project design changes.’

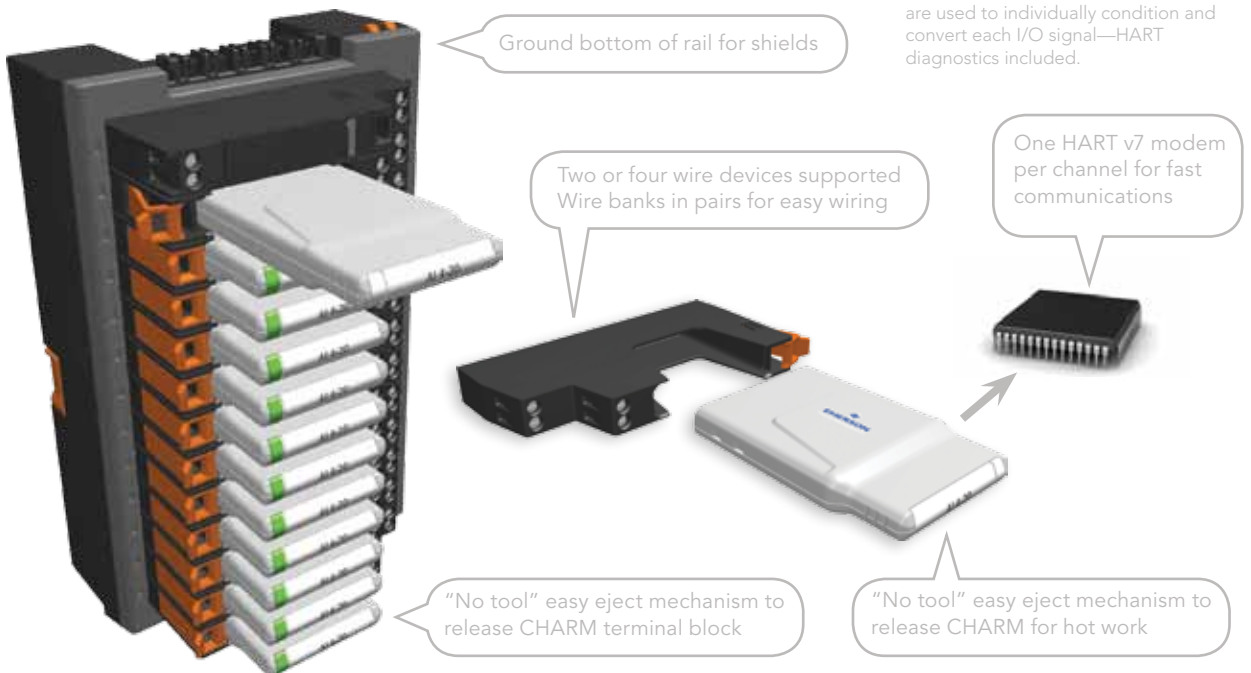
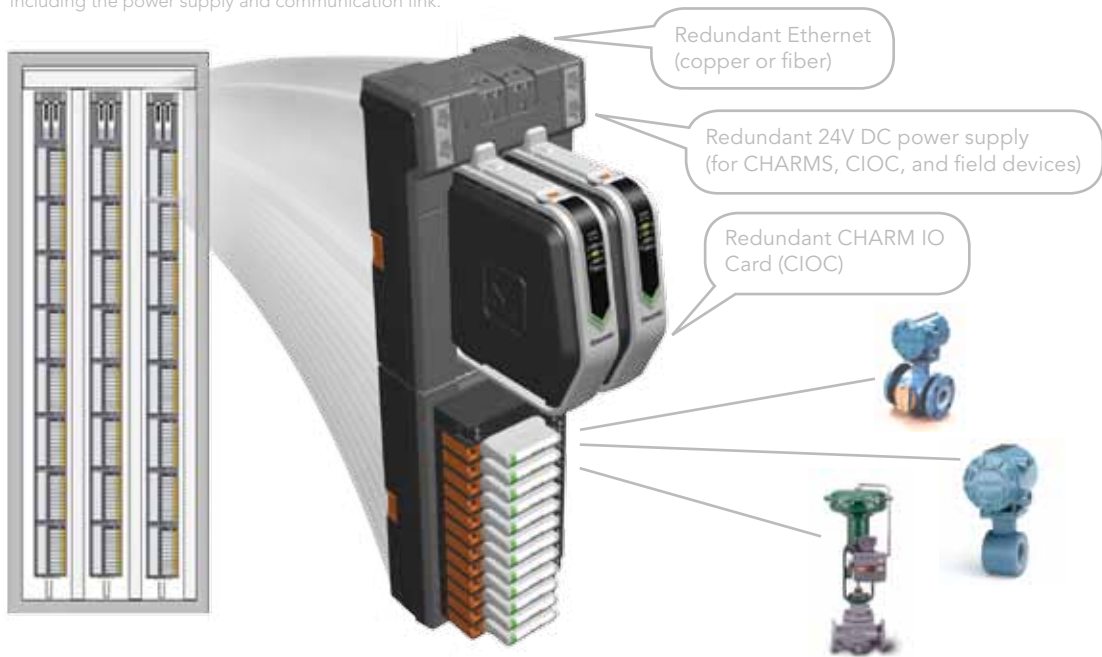


Figure 3. Detail shows how a series of characterization modules, or CHARMs, are used to individually condition and convert each I/O signal—HART diagnostics included.

‘The electronic marshalling junction boxes come in a one-size-fits-all design.’

Figure 4. Redundancy is built into each CHARM IO card, including the power supply and communication link.



WHAT CABINET DESIGN?

Because electronic marshalling senses the individual character of each I/O channel to its plug-in CHARM, the design of marshalling cabinets can be greatly simplified. Indeed, Emerson's standard electronic marshalling cabinet comes with no options (none are required) and with all rails and components installed. The only missing parts are the CHARMS and corresponding CIOCs, which means that I/O from field can be wired up at any time—and be electronically marshalled later.

And because all components of the CIOC are rated for installation in Class 1/Division 2 or Zone 2 hazardous locations and feature extended operating temperature ranges and G3 environmental ratings, electronic marshalling can be done in field-mounted junction boxes. Using standard Ethernet infrastructure hardware, I/O can be added to a remote enclosure located miles away from the controllers and control room. This further reduces the footprint of the central equipment room

as well as reducing the overall wiring infrastructure of traditional multi-core instrumentation cable.

Like its electronic marshalling cabinets, Emerson's electronic marshalling junction boxes also come in a one-size-fits-all design: Simply run a CAT5 or fiber-optic Ethernet back to the controller cabinet, and now the marshalling cabinets disappear altogether. This means even fewer design tasks, less footprint, less wire and fewer wiring problems.

All told, the use of electronic marshalling in junction boxes has the potential to eliminate scores of hours of engineering, design and installation work while improving the ability of a project to accommodate late-stage engineering changes while minimizing rework and schedule impacts. The traditional marshalling cabinets and I/O cabinets are effectively gone, along with design and installation tasks related to such tedious details as fuses, spares, jumpers and terminations, wiring diagrams and cable layout—not to mention the design of the cabinets and junction boxes themselves. ■

CONVENTIONAL I/O

Redesigned for How You Work

Even as it has helped I/O to escape its old constraints, the practice of human-centered design has been used to make important usability enhancements to conventional I/O as well.

In the Emerson DeltaV architecture, HCD is embodied in the new DeltaV S-series I/O cards, which carry forth the electronic functionality of the company's proven M-series I/O, but are re-engineered to deliver a new level of easy, error-proof installation and operational robustness.

"The S-series I/O cards use the same electronics and software that has been proven for more than a decade in the M-series hardware," says Duncan Schleiss, Emerson vice president of platform strategy. "And, by the way, customers can upgrade to the DeltaV version 11 without needing to upgrade to S-series I/O."

INSTALLATION ERROR-PROOFED

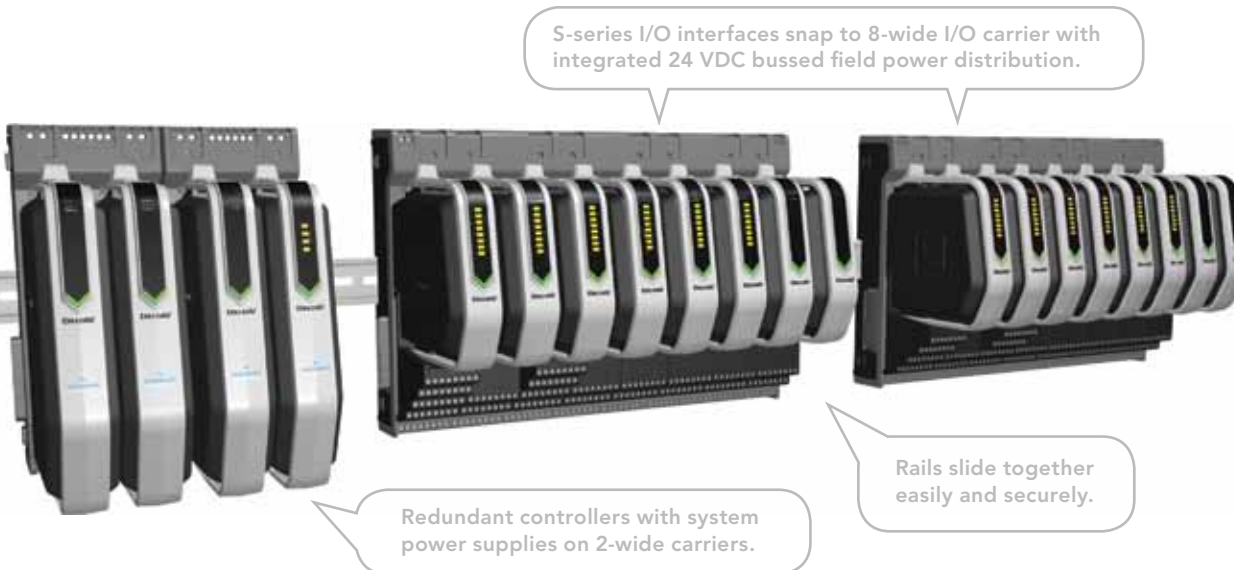
One HCD-driven improvement is the S-series' heat dissipation technology, which features a plastic cover over the top air vents to prevent items from dropping down into the card from above and shorting out the circuitry.

The new cards also offer "easy-on-hard-off" installation, which means there are no screws needed to install a card onto the backplane, yet releasing one requires pushing an out-of-the-way release button on top of the card. Further, S-series I/O cards are automatically "auto-sensed" when added to the system. This helps make maintenance error-proof, ensuring that any replacement I/O card is of the proper type. A guide prevents bent pins and cards easily snap in place.

System availability is addressed with S-series I/O by allowing the online addition of new components without shutting down. Controllers, I/O cards, field devices and workstations can be added while the host system is powered and running—any system can be upgraded or expanded on-the-fly with no downtime. System uptime is also enhanced through the available redundancy of system components, including controllers, control and field interface power supplies, controller Ethernet communications and many field interface cards.

MODULAR AND COMPATIBLE

Importantly, both S-series and M-series I/O hard-





‘Both S-series and M-series I/O hardware can coexist in the same DeltaV system with no trade-offs or incompatibilities.’

ware can coexist in the same DeltaV system with no trade-offs or incompatibilities. And while it doesn't offer the single-channel modularity of Emerson's new electronic marshalling approach (see story, p 10), the S-series does allow users to specify the exact number of I/O cards, 8-wide carriers, power/controllers and 2-wide carriers needed—and the flexibility to add more I/O as the system grows.

The DeltaV system supports a full range of analog, discrete, digital bus, thermocouple and RTD field devices. DeltaV control hardware is built rugged and flexible to mount almost anywhere and

is designed for extreme field installation conditions, including: Class 1/Division 2 areas, CENELEC Zone 2 areas, and ISA-71.04-1985 Airborne Contaminants Class G3.

All DeltaV I/O cards are rated for extreme operating temperature ranges of -40 °C to 70 °C (-40 °F to 158 °F) and can be mounted in field junction boxes, significantly reducing equipment footprint. Shared remote I/O is available for Zone 2 installations. Unlike other remote I/O, DeltaV remote I/O can be shared among several controllers for a greater range of applications and installation flexibility. ■

The Ultimate in Flexibility

The advent of the wireless instrument network—which in effect moves I/O functionality out into the field device itself—offers perhaps the ultimate in I/O on Demand flexibility. Indeed, once a mesh-based wireless infrastructure is in place, incremental I/O points actually lead to a stronger, more robust wireless network.

So not only does the new I/O point come along “for free,” it actually improves the communications reliability of those wireless measurement points around it.

“Wireless has been adopted at thousands of customer sites globally,” notes Bob Karschnia, vice president, wireless, for Emerson Process Management. “Plants using wireless have realized savings and become smarter through simpler engineering and construction, flexible start-up, faster deployment and project completion, and the ability to respond to changing automation needs.”

But customers have been asking for more, relates Peter Zornio, Emerson chief strategic officer. “In particular, they’ve requested gateway redundancy and the ability to install gateways in hazardous areas. We’ve solved both of these issues with the new DeltaV system.”

REDUNDANCY + HAZARDOUS AREA INSTALLATION

Redundancy and hazardous area installation—together with Emerson’s new PID algorithm, which makes possible closed-loop control over Wireless HART—will allow more traditionally wired I/O points to go wireless, Emerson believes. This promises to have a profound impact on the design of new facilities as well as the ability of brown-field plants to implement new measurement points and asset management strategies.

“Full redundancy protects the wireless network from any single point of failure by allowing primary failover to ensure that data always is delivered even if there is a malfunction,” Karschnia says. “The new full redundancy furthers strengthens Smart Wireless technology as a complement to wired and bus approaches on capital projects.”

Wireless redundancy in the new DeltaV architecture takes the form of redundant remote links, which communicate via RS485 with redundant Wireless I/O Cards (WIOCs). The WIOCs, in turn, communicate

redundantly with the DeltaV network (Figure 1). This new approach divides the functionality of the existing 1420 Wireless Gateway into two elements, allowing the remote link to be installed in hazardous environments.

“This gives a lot of benefits by increasing availability, reducing both installed cost and footprint, and is more forgiving,” says Duncan Schleiss, Emerson vice president of platform strategy. “As with our previous wireless solution, it lowers life-cycle costs and removes the need for engineering drawings.”

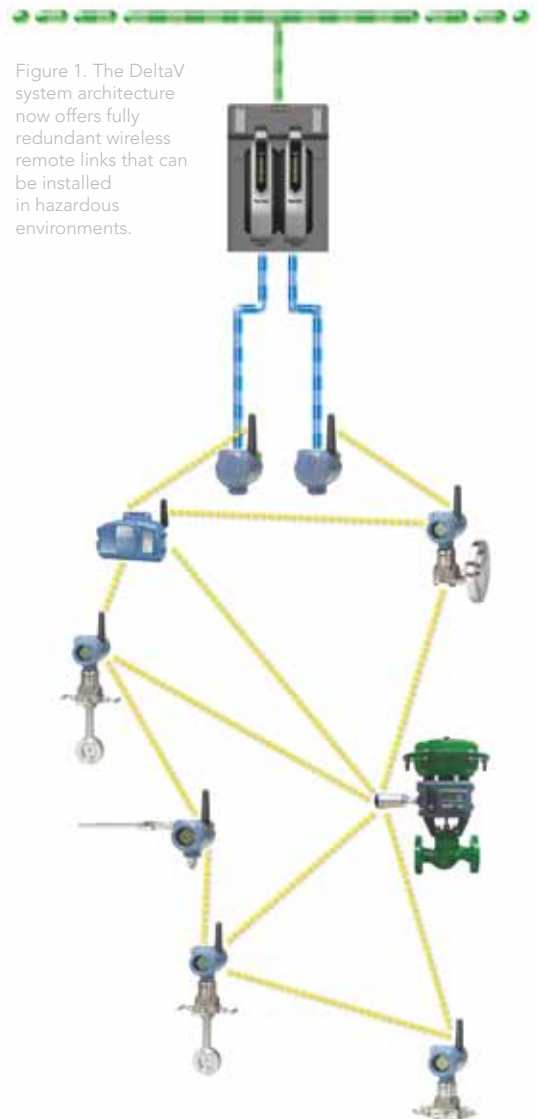


Figure 1. The DeltaV system architecture now offers fully redundant wireless remote links that can be installed in hazardous environments.

WIRELESS PID ENABLES CLOSED-LOOP CONTROL

The latest DeltaV and Smart Wireless offering can also do closed-loop PID control over wireless. At bioprocess technologies supplier Broadley James, wireless pH and temperature transmitters control a single-use disposable bioreactor. “We conducted batch runs using mammalian cell culture,” says Scott Broadley, Broadley James president. “The observed pH and temperature control using wireless measurements was equivalent to that achieved using wired transmitters.”

Similar results were seen at another installation, this one at the University of Texas, Austin, stripper and absorber control is being done using WirelessHART transmitters. Column pressure control and heater stream flow control over wireless provided the same dynamic response and comparable performance as wired transmitters, according to Frank Seibert, technical manager of the UT Austin separations research program. Both installations use the enhanced PID algorithm available with the DeltaV S-series.

What makes this possible, explains Randy Balentine, DeltaV product marketing manager for Emerson Process Management, is the new control algorithm. “We knew WirelessHART devices and the way they do non-periodic updates, and we understood how we could accommodate that in the PID algorithm and function block,” he says. The technology is available to address most control applications, with scan rates as fast as one second, supported by devices, gateway and the DeltaV digital automation system.



Trials at the University of Texas, Austin, have demonstrated the use of WirelessHART devices for closed-loop distillation control.

“Yesterday, you couldn’t do PID wirelessly,” says Balentine. “Today, that’s no longer the case.”

All these wireless enhancements mean that more and more wireless points can be implemented wirelessly—and the savings can add up quickly.

“Up to 44% of process control inputs can be wireless with no difficulty, and for a greenfield plant that’s a savings of 7% overall,” estimates Schleiss. “Getting rid of wires eliminates most activities associated with wiring design and installation—Poof! Cabinets, wire, terminations, cable tray design, fusing, installation drawings and a host of other activities are simply gone.” ■

‘44 % of process control inputs can be wireless with no difficulty and for a greenfield plant that’s a savings of 7% overall.’

The New Game in Fieldbus

While it doesn't obviate the need for wires altogether, Foundation fieldbus and other bus technologies do reduce the need for traditional rack-mounted I/O cards by moving the I/O function into the field devices themselves.

In a typical fieldbus topology, a number of these digitally communicating devices—whether speaking Foundation, Profibus, ASI-bus or any of a number of other protocols—can coexist on a single pair of wires, communicating not only process variable or status information, but a wealth of other secondary information as well. In the case of Foundation fieldbus, up to 16 devices can be daisy-chained along a single pair of wires, and the traditional I/O cards that would have been needed are replaced by a rack-mounted H1 card to manage communications between the control system and the devices along that given segment.

But a funny thing happened on the way to the

reduced wiring costs and better information access promised by fieldbus. While fieldbus reduced the number of I/O cards needed back at the control room or junction box, it still required third-party power supplies and power conditioners. And, if you wanted the ability to access fieldbus diagnostics directly in the control system, more third-party devices, software and integration work were needed. Further, installing fieldbus properly came with its own set of "gotchas." In the end, using fieldbus instead of point-to-point wiring did little to reduce the time and effort needed to engineer and implement I/O points.

HCD MEETS FOUNDATION

Enter Emerson's human-centered design (HCD) initiative, which took a hard look at Foundation fieldbus in the course of its DeltaV S-series development work, and found that substantial improvements could be

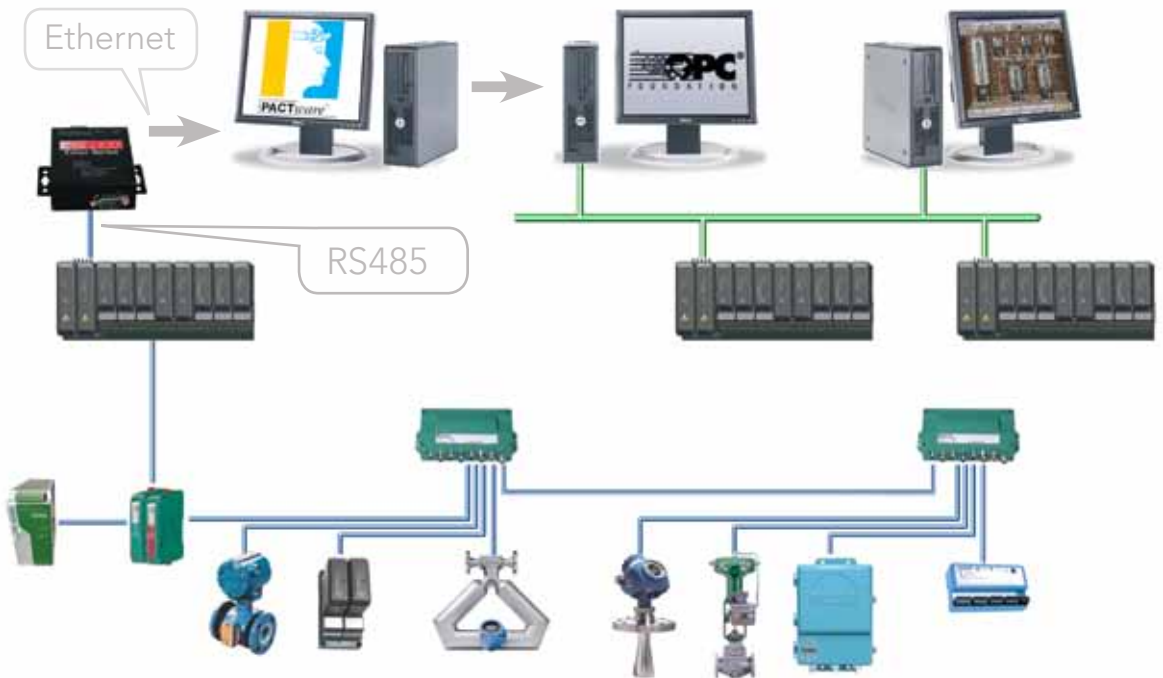


Figure 1. The old way of doing Foundation fieldbus required an array of third-party devices and software.

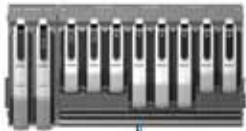
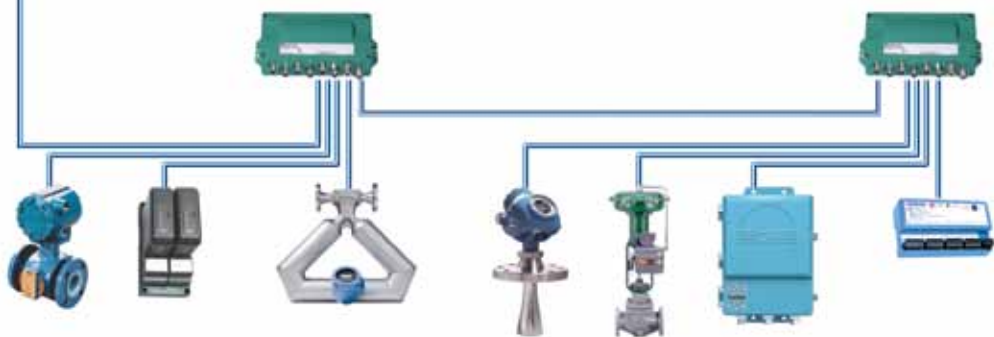


Figure 2. The new way of doing Foundation fieldbus in the DeltaV S-series system includes integrated diagnostics and power circuitry built right into the H1 card.



made in how fieldbus gets done, according to Duncan Schleiss, Emerson vice president of platform strategy. “By applying the principles of HCD, we have changed the game in fieldbus again,” Schleiss says.

Foundation fieldbus technology requires third-party power supplies and power conditioners, engineering, wiring and cabinet space. Also, to get at the bus diagnostics, you have to jump through OPC and RS485 hoops in order to get the information into the control system.

With DeltaV S-series and I/O on Demand, Emerson has integrated the power circuitry within the H1 card itself, explains Schleiss. This eliminates difficult segment power design, installation and troubleshooting tasks. The additional cabinet footprint associated with use of external segment power supplies is also eliminated. Third-party power conditioners and dedicated power supplies and all the engineering that went with them are no longer necessary. They have become a thing of the past.

Citing a recently completed project consisting of some 2,500 Foundation fieldbus segments, Emerson estimates that total project cost could have been reduced by some 7% using the new I/O on Demand approach. “Five thousand H1 power conditioners,

32 H1 power cabinets, along with their design and documentation, and all that factory and on-site wiring,” lists Schleiss. “All gone!”

ALL THIS AND DIAGNOSTICS, TOO

“But we also integrated diagnostics,” Schleiss says. “So now the maintenance staff can wait for the DeltaV H1 card to notify them of a problem on the physical layer, such as power consumption or a missing terminator. Easy! It’s all integrated!”

The DeltaV digital automation system also works natively with other popular digital communication buses, such as Profibus DP and DeviceNet for integration of motor starters and drives, and AS-i bus for low-cost, simple installation of discrete devices, such as push-buttons, on/off valves and proximity sensors.

“The DeltaV system provides native support for configuring busses with no need for third-party configuration tools,” Schleiss says. “And Ethernet I/O devices are easily connected through virtual I/O modules.”

Further, fieldbus devices are auto-sensed when connected to the DeltaV system network and automatically added to the system configuration, Schleiss adds. “As a result, engineering and commissioning effort is dramatically reduced.” ■

Flexibility Without Compromise

In addition to a fundamental rethinking of how input/output gets done in process control and monitoring applications, Emerson's I/O on Demand approach has transformed the ability of users to flexibly deploy modular, distributed safety applications while ensuring the robust isolation of safety functions and the elimination of single points of failure.

Further, the transparent integration of DeltaV SIS with DeltaV automation systems used for basic process control system (BCPS) applications allows the leveraging of safety I/O data to make better informed process control decisions.

FULLY CONFIGURABLE I/O

Starting with upfront design and engineering tasks, complexity is greatly reduced by the use of fully configurable I/O in DeltaV SIS. This configurable I/O functionality allows users to design application-specific safety instrumented functions (SIFs) without limitations on I/O type per logic solver or the added complexity of I/O card wiring. This simplifies both engineering and maintenance.

Field devices are wired to the logic solver as needed, and the I/O channels are then configured ap-

propriately. Specifying the I/O hardware requires only two pieces of information—the total number of I/O and whether (and where) redundancy is required. Redundancy allows for the on-line replacement, on-line upgrade and on-line proof-testing. However, DeltaV SIS logic solvers are SIL 3-rated in both simplex and redundant configurations. There are no time-out issues should a redundant pair fail.

MODULAR AND SCALABLE

With the DeltaV SIS architecture, users can add I/O capacity in increments of as few as 16 fully configurable I/O points—up to a maximum of 30,000 points in a single system. Because the I/O is directly connected to the logic solver, memory and processing power increase whenever I/O is added; this negates any concerns over the ability to effectively run the configured logic, regardless of system size.

Each DeltaV SIS logic solver is in effect a container for a small number of SIFs, and there can be no unplanned interaction between them. This is very different from the traditional approach where hundreds of SIFs are all placed in a single safety PLC, and the effect of changing a single register or the addition of a SIF could affect all of the logic.

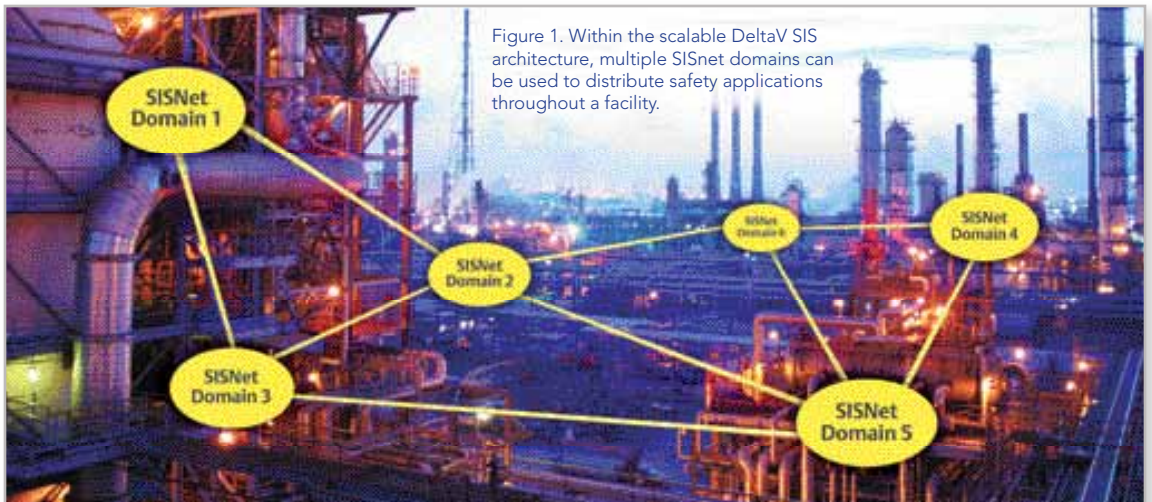


Figure 1. Within the scalable DeltaV SIS architecture, multiple SISnet domains can be used to distribute safety applications throughout a facility.

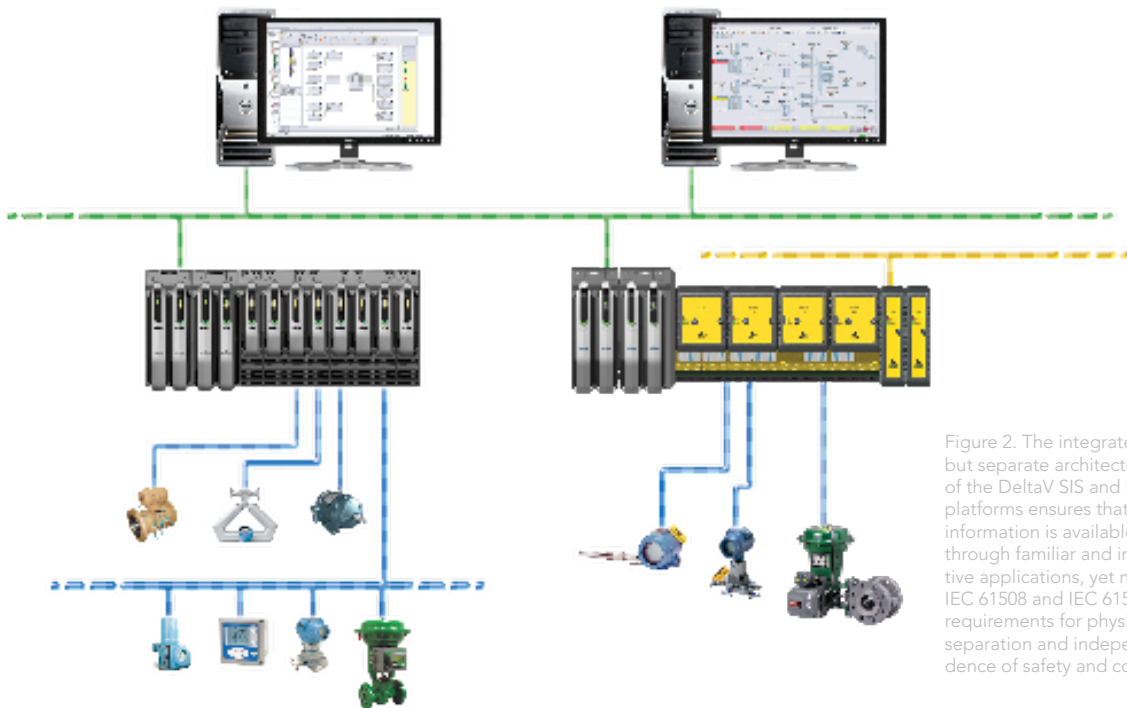


Figure 2. The integrated but separate architecture of the DeltaV SIS and BPCS platforms ensures that safety information is available through familiar and intuitive applications, yet meets IEC 61508 and IEC 61511 requirements for physical separation and independence of safety and control.

For complex applications that may require multiple SIFs acting on the same final element, input data is shared among multiple logic solvers so that cause-and-effect logic can easily be implemented in a single SIS module. Given this flexibility, the DeltaV SIS system is well-suited to the full range of safety applications, from small burner management applications to large emergency shutdown (ESD) and fire and gas applications.

The DeltaV SIS system architecture also enables SIS applications to be geographically distributed in local junction boxes across a plant or facility. This ability is especially appealing for large plant complexes as well as for applications such as distributed oil and gas wellheads and pipelines (Figure 1).

“The DeltaV SIS modular, distributed architecture enables users to custom-fit the system to their SIS application with the flexibility to locate safety logic and I/O near the process,” says Larry O’Brien, ARC Advisory Group analyst. “This SIF-based approach isolates safety instrumented functions, eliminates single points of failure, and simplifies change management.”

INTEGRATED SAFETY AND CONTROL

To facilitate better decision-making, plant operators

have one common operating environment for both the BPCS and SIS when using the DeltaV control and safety platforms. This integrated view (Figure 2) includes alarm handling, time synchronization, user security and device health monitoring. Meanwhile, the DeltaV SIS power supplies, communication channels, hardware and real-time operating systems are physically separate and independent of the control system, maintaining the separation required by IEC 61508 and IEC 61511 standards.

“Not only is DeltaV SIS itself modularly scalable, but it can be transparently integrated with DeltaV systems used for process control,” explains Duncan Schleiss, Emerson vice president of platform strategy.

All DeltaV SIS information is communicated to the control network via the DeltaV controllers. This eliminates work that is traditionally required to map data between the two systems with two different engineering and operations environments. It also eliminates the time and cost of training personnel to use two different systems. “The DeltaV SIS system delivers the benefits of total integration and total separation,” Schleiss adds, “without the tradeoffs associated with the two extremes.” ■

Calculate Your Project Savings

Because I/O on Demand represents a significant shift in how most types of I/O are engineered and implemented, it can be a challenge to decide just what options to use in a particular project. And while plant practices and application requirements may dictate the mix of I/O on Demand platforms chosen, figuring out how much money you could save relative to the traditional way of doing things just got a whole lot easier.

Enter IOonDemandCalculator.com, a new website created by Emerson Process Management to help you estimate project cost savings—and impact on project schedule—based on the mix of electronically marshalled, wireless and fieldbus I/O you expect to deploy.

Also, because certain choices will have different implications for the ability of a project to accommodate late-stage revisions without delaying the schedule, you'll be asked to estimate:

- The number of I/O typically affected by change orders.
- The number of people engaged in the project.

Once these essential project parameters have been entered into the calculator, you can estimate the project costs savings and the impact on delivery schedule for different mixes of I/O on Demand platform options relative to a conventionally wired and marshalled system. The essential options include electronically marshalled in a central control room, electronically marshalled in field junction boxes, fieldbus and wireless.

SAMPLE CALCULATION

Take, for example, a project with a total I/O count of 5,000, 20% spare I/O capacity and average control-room-to-junction-box and junction-box-to-field-device distances of 200 m and 20 m, respectively.

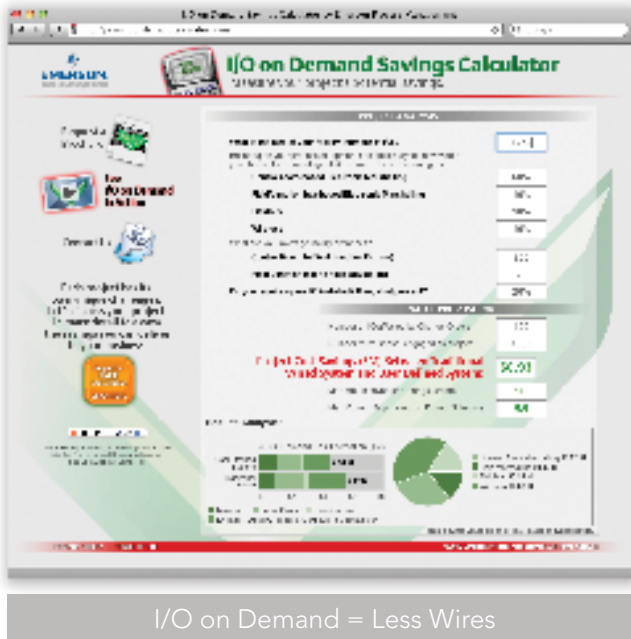
If 20% of I/O are electronic marshalled in the control room, 30% are electronically marshalled in field junction boxes, 30% of I/O points are implemented using wireless and 10% using fieldbus, the I/O on Demand Calculator indicates that you stand to save \$8.11 million in project costs relative to conventional wiring practices.

Further, if 500 I/O points (10% of the total) are estimated to be subject to change orders, and 100 people are working on the project, the I/O on Demand Calculator indicates that this mix of I/O on Demand platforms can potentially eliminate 44.9 man-project days and 1,867 man-hours of work.

While these initial project cost savings are nothing to sneeze at, it's important to note that they do not take into account the longer-term benefits afforded by electronic marshalling and a wireless infrastructure.

Indeed, once a project is done, the I/O on Demand savings have only just begun. ■

Visit IOonDemandCalculator.com to estimate how much you could save on your next capital project.



The essential information you'll need to know includes:

- The total number of I/O required.
- Average facility distances, from the control room to the field junction boxes and from the field junction boxes to the devices.
- Percentage of spare I/O capacity desired.

The Early Reviews Are In

Since it was first introduced at the 2009 Emerson Global Users Exchange, much has been written about I/O on Demand and its potential to revolutionize how the process industries do I/O—especially in the context of project work. Following are excerpts of the articles and reviews that have rolled out over the past several months. Visit ControlGlobal.com/IOonDemand for direct links to the full stories excerpted below.

"EMERSON CHARMS USER GROUP WITH INTRODUCTION OF DELTAV S-SERIES"

"Cabinets, wire, terminations, cable tray design, fusing, installation drawings and a host of other activities are gone! Single-channel CHARMS and controller independence allow the first real updates to 35-year-old engineering practices." Highlights of the 2009 Emerson Global Users Exchange as reported by Walt Boyes and the rest of the editors of *Control*. Visit ControlGlobal.com/IOonDemand for direct link to their full report.

"ELIMINATES MUCH OF THE COST ASSOCIATED WITH INSTALLING CONVENTIONAL I/O"

"I/O on Demand fits well with Emerson's overall theme of making advanced technologies easily accessible and easier to use for a wide range of industries," writes Larry O'Brien, analyst with the ARC Advisory Group. "ARC believes that I/O on Demand and the concept of electronic marshalling can offer cost savings in new projects, but also offers a good solution for control system migration projects. Significantly, it avoids a simple functional replacement of conventional I/O, which can be very difficult to justify in today's world of constrained capital and tight operating budgets. I/O on Demand effectively eliminates much of the cost associated with installing conventional I/O." Visit ControlGlobal.com/IOonDemand for direct link to full story.

"DELTAV S-SERIES IS NO IVORY-TOWER RETHINK"

"By putting usability and productivity at the heart of product design, Emerson meets two vital needs of



Emerson's Duncan Schleiss holds a single-channel Characterization Module, or CHARM, at the company's October 2009 launch of I/O on Demand and its new DeltaV S-series.

today's global environment: skills shortages in emerging markets and an aging experienced workforce in the developed world," writes Jim Pinto, automation industry observer. "DeltaV S-Series is no ivory-tower re-think. Emerson insiders tell me that they worked the design every step of the way with a large petrochemical customer. Bravo, Emerson team, for yet another engineering and market coup!" Visit ControlGlobal.com/IOonDemand for direct link to full story.

"EMERSON OVERTURNS 35 YEARS OF INDUSTRY THINKING ON I/O"

"Selectively previewed at last year's Emerson Exchange in Washington, [electronic marshalling] essentially eliminates the need for a physical path from signal source to controller," writes Andrew Bond of the *Industrial Automation Insider*. "Instead, new single-channel CHARACTERIZATION ModuleS or CHARMS relay I/O information via the Ethernet backbone to any controller and provide single-channel integrity and flexibility down to the channel level. Not only does this approach drastically reduce engineering time, but it also ensures that changes to the original design can be readily accommodated without rewiring." Visit ControlGlobal.com/IOonDemand for direct link to the full story. ■

THE I/O YOU WANT WHEN YOU WANT WHERE YOU WANT IT.



**Last minute project changes?
Forget the pain. Calculate the gain.**



The DeltaV™ system's breakthrough I/O on Demand takes the time, expense and risk out of last minute project changes. Wireless, FOUNDATION fieldbus, Electronically Marshalled or traditional I/O—the choice is yours. I/O on Demand eliminates steps and gives you the flexibility to easily handle unforeseen changes. Prove it to yourself. Plug in your project's parameters and see the savings possible across the life of the project at: IOonDemandCalculator.com



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