

Controlling the IIoT

How the Industrial Internet of Things is changing the role of the control engineer

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Executive summary

Realizing the potential of the Industrial Internet of Things (IIoT) rests in large part on how well companies can manage and ultimately control the complex interfaces among connected industrial assets, which is the bailiwick of the control engineer. Their traditional skill set is expanding and being supported by evolving tools, including a new generation of IIoT-ready process automation controllers (PACs). These augment traditional programmable logic controller (PLC) functionality with the processing power, connectivity, and security necessary to meet the edge control challenges of the IIoT, equipping control engineers to become real-time business decision-makers who can add millions to operational profitability.

Get acquainted with IIoT

While the concept of IIoT is still relatively new, ubiquitous interconnectivity is already becoming a reality. Having so many more elements in play means more assets and variables to control, plus exponentially more opportunities to help increase production value and reduce operating expenses — especially raw material, energy, and security costs.

Essentially, it's a control issue. So who better to come to the rescue than the control engineer?

Traditionally, process engineers and chemical engineers focused at the process level, applying PID control and advanced optimization software to solve processes across multiple assets. But as industry dynamics become faster-paced, more complex, and larger in scale, solving problems at the process level becomes increasingly challenging. The complexity of a process control strategy increases exponentially with the number of inputs/outputs (I/Os). Imagine the complexity when you ramp up beyond the asset to the unit, area, plant, and enterprise levels.

Controlling processes within assets

For process engineers, there's ultimately only one way to deal with this rising complexity. Don't try to control the entire process; control the asset.

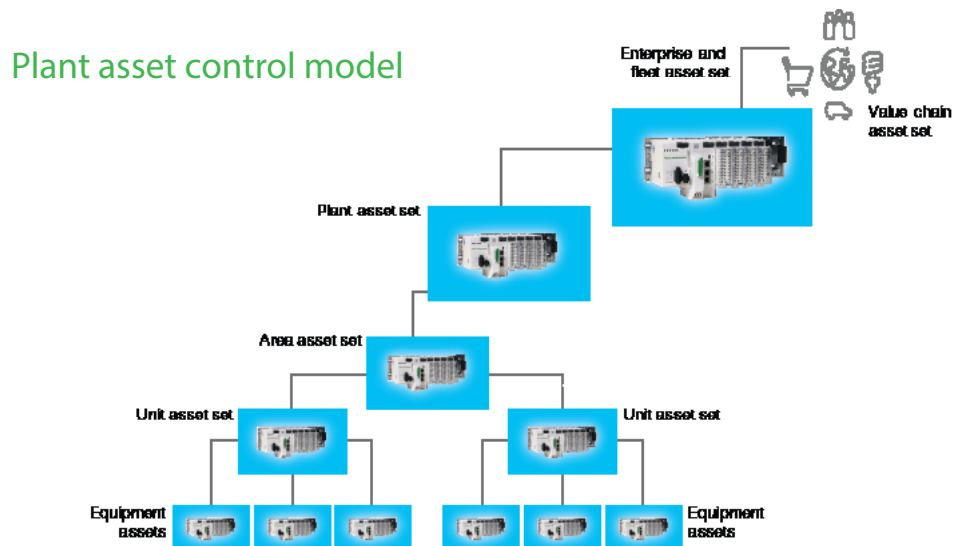
But that requires a fundamental shift in understanding assets.

Information technology (IT) programmers once faced similar problems as they attempted to integrate an entire enterprise's business information. The solution: Structured analysis — breaking the complexity into a number of small functional entities, solving each entity, and combining all into an overall solution.

In industry, the equivalent functional entities are operating assets (equipment, units, areas, plants, and enterprises). Start by building a comprehensive strategy for each equipment asset (pump, motor, compressor, evaporator, etc.). This is relatively simple due to the small number of I/Os associated with each asset.

Once each piece of equipment is autonomously controlled, moving to the unit level is an incremental control and communications issue, not a process issue. Control strategies for each equipment asset are already in place. Where we once talked about process control and manufacturing control separately, the next generation of industrial advancement will be characterized everywhere by *real-time asset control*.

Figure 1



For manufacturing engineers, IIoT presents a different challenge. They've always been asset-centric, applying PLC running ladder logic to solve control algorithms asset by asset, thus controlling pumps, motors, compressors, evaporators, and so on. But now, these assets are expected to do more and to take on a broader scope of work. The critical challenge is controlling them within the context of how other assets and variables are performing — which means balancing safety/environmental risk, reliability, efficiency, and profitability.

The right tools

Process and manufacturing engineers are under pressure to realize quick returns on their IIoT investments. Their companies expect paybacks to start rolling in within two years of implementation. To achieve those ambitions, they should give serious consideration to modernizing the technologies that control their processing lines, especially the lines that are most critical to their businesses' success. For those in the hybrid industries, which combine continuous, batch, and discrete operations, the need is even more pressing.

To help, control engineers have many automation tools at their disposal, including *PLCs*, *PACs*, and *DCSs*. Technically all have similar control functionality, but each has its own strengths, and it's important to use the right tool for the right job. As industry luminary Dennis Brandl puts it: "You can build a house with a chainsaw, but the result won't likely be ideal."

Whether you are a process control engineer taking an asset-centered approach or a manufacturing control engineer looking to optimize for the challenges of a world where IIoT is ubiquitous, you are probably going to need a faster, better connected, and more reliable PAC — one that has been specifically IIoT-enhanced. And to meet management expectations for greater agility in adapting to market dynamics and improving product availability, you'll increasingly need a PAC that's more powerful, more integrated, and more secure.

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— Dennis Brandl
Founder and Chief Consultant
BR&L Consulting

A future-proof PAC should have at least the following features:

- A high-performance CPU, greater onboard memory, and faster scan times to handle complex processing and to compress steps in industrial operations
- Ethernet connectivity to make production information available to other applications in real time
- Built-in cybersecurity protection to obtain the benefits of open computing while minimizing risk of cyberattack



Such systems will be most effective when implemented within a flexible, open, object-based engineering environment. In addition, to take maximum advantage of new features with minimum risk and cost, a fast-track migration approach is essential.

Over the years, controller technology has strongly advanced in this direction. PACs are increasingly being implemented using preprogrammed application libraries and open, advanced, object-oriented engineering environments. These have allowed PACs to gain some traction in the market, primarily as low-end DCS alternatives.

In recent years, PACs have evolved still further. For instance, the Modicon™ M580 ePAC adds embedded Ethernet communications and updated cybersecurity protection.

Whether you call them advanced PLCs, IIoT-ready PACs, or ePACs, modern controllers with the characteristics mentioned above are enabling engineers to control their most important risks whether they are in a process, batch, or hybrid operation. It's happening already.

Driving real business values

Modern process controllers are already demonstrating that they can drive significant increases in business value as industry transforms — improving operational profitability and safety in ways that directly impact the organization's bottom line. They are helping to:

- Increase manufacturing productivity
- Improve operational visibility
- Achieve efficient energy management
- Speed time to market
- Strengthen cybersecurity

The increases in business value to be derived from this new generation of controllers make upgrading easy to justify, even in times of continuing downward pressure on capital costs. With the right models, companies involved in brownfield or greenfield modernization automation projects may see 100 percent returns on their controller investment in as little as three months.

Increased productivity

The IIoT is driving greater customer expectations for everything from faster delivery and more customization to higher quality. All at lower prices.

It's surprising how much help even relatively modest automation upgrades can be in satisfying these demands. For example, making significant improvements in the pace of production usually requires eliminating steps in the manufacturing process. Conventionally, this may demand a wholesale process redesign.

Recent developments in controller technology point to a simpler approach: Just speed up the steps. For example, new ePACs deliver speedier performance than ever before, with scan times up to 5X faster than previous models, plus up to 8X more memory. These aren't just technical advances. They generate immediate impacts on the factory floor, adding value to products and accelerating time to market.

Consider a typical case in a hybrid or discrete manufacturing plant turning out a high-value product. The product requires six manufacturing process steps, with two scans between each step.

But with its significantly faster scan times (6 milliseconds per scan, compared to 30 ms for older controllers), an ePAC can get to each step more rapidly — ultimately producing 969 cycles per shift, versus only 960 using a previous model. Assuming eight-hour shifts, five days a week for 50 weeks a year, the new controller could help produce nine extra products per shift. That's 2,250 more products per year. And if each finished product were valued at \$1,000, the plant could gain \$2.25 million in annual production. Thus, simply improving controller scan times can make a real difference to bottom-line productivity.

In one real-world example, a feed mill in Vietnam used ePACs to achieve 3X faster feed production. And by standardizing on one control product family, it has cut cabling costs significantly. Overall, the mill has increased production by 3 percent and reduced costs by 30 percent.

The lesson: For some discrete-industry applications especially, an automation project that adds the right IIoT-ready PACs can greatly speed up your production line.

Faster time to market

In addition to streamlining production operations, modern controllers help meet new market requirements and pressures. By shortening the time it takes to adapt processes, they can help users take advantage of new business opportunities, expand operations, and even implement automation on greenfield projects.

Typically, these require teams of programmers to write custom code for each new installation. But newer controllers often offer comprehensive libraries of preprogrammed software for many common applications. This can greatly speed project time and substantially cut costs. Project engineers using modern controllers within open programming environments can integrate them with the rest of the enterprise via open backplane and embedded standard Ethernet connectivity, featuring architecture that's transparent from top to bottom with easy plug-in configuration.

This approach can get new projects (brownfield modernization or greenfield) up, running, and making money much sooner.

For example, using IIoT-ready PACs as described can cut up to three weeks from a typical three-month automation project. Assuming 120 production hours, at \$20,000 per hour, a plant can typically save more than \$2 million of extra production at launch — increasing its time to market by 25 percent.

Improved operational visibility

Small problems that aren't detected can add up to large profit shortfalls. More connected devices means more chances for problems to sneak through. For example, in a typical discrete/hybrid manufacturing plant, information on the performance of an asset such as a pump or motor is confined to the control level. Granular results are not available on all levels of the plant. So engineers and managers alike frequently lack the insight into operational performance they need to make faster, better decisions.

Estimates say that lacking precise data on asset location, process status, and so on can cost up to 3 percent of yearly revenues. That can create a significant margin shortfall for the typical plant. The impact on the bottom line can be substantial.

Fortunately, advanced PAC technology can help make granular production details available to interested users. The resulting operational visibility aids in stopping losses and delivering increased profitability.

IIoT-ready PACs with built-in Ethernet allow seamless access to advanced collaborative and integrated automation architectures, and to object-oriented integration environments. It's easy to link up controllers with other networks, and make any needed information visible throughout smart connected manufacturing enterprises.

For example, if a controller reading exceeds preset parameters, the engineer or operator receives a text message alert on his or her smartphone or tablet. He or she can then click through to the affected pump, motor, etc. Its location, coding, and full documentation are instantly available — without time-consuming trips to the control room or plant floor PLC/PAC — for fast, efficient problem identification, investigation, and resolution. And fewer trips to the plant floor decrease the likelihood of adverse incidents and bring greater control of safety variables.

With this technology, engineers are also able to offer top management the fruits of today's most sophisticated real-time accounting measures and tools. So a quite technical feature — transparent, open native networks embedded in an IIoT-ready PAC — can translate directly into real-world business improvements.

Cost-efficient energy management

“Controllers are connected to power meters on machines and other assets across the plant ... Active energy management is built into the process. So managers can take maximum advantage of fluctuating energy costs. And assets can achieve optimum productive efficiency for the energy consumed.”

— Sylvain Thomas
Director, M580 Product Marketing
Process Automation,
Industry Business
Schneider Electric

Just a decade or so ago, the price of energy supplied to a U.S. manufacturing plant traditionally would change only once a year, with each new utility contract. Today, a plant's price of energy can change every 15 minutes. It's typically only one element in a complex relationship among assets, raw materials, and utility costs.

This complexity is one reason for a dawning realization among engineers and executives: It may be a false economy to try to cut energy consumption across the board. Because you can cut consumption and still have your electricity bill go *up* — if you consume that lower amount mostly during peak-priced times of day. And meanwhile, expensive manufacturing capital assets can't perform whenever required for peak efficiency.

Don't shut your machines off. Instead, build in better visibility.

New technology means IIoT-ready controllers can be integrated within collaborative and integrated automation architectures utilizing built-in Ethernet.

“Using these new IIoT-ready controllers, data is visible whenever and wherever it's needed,” says Sylvain Thomas of Schneider Electric. “Controllers are connected to power meters on machines and other assets across the plant. Their data can be gathered into a central point; integrated connections make data flows visible to whatever users need it. That includes sending information up to IT networks at the business level, and benchmarking all relevant results.

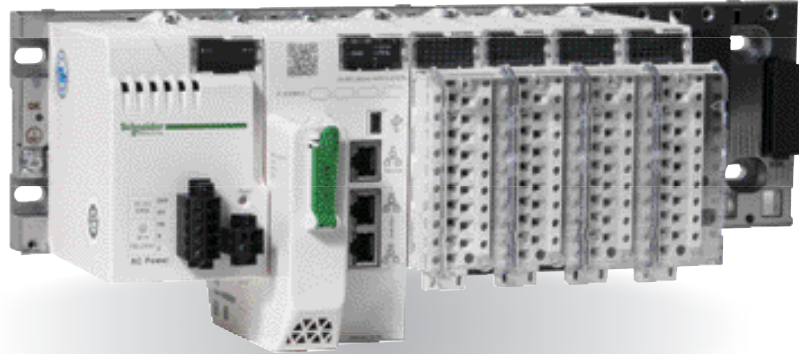
“Active energy management is built into the process. So managers can take maximum advantage of fluctuating energy costs. And assets can achieve optimum productive efficiency for the energy consumed.”

Using this advanced controller approach, typical plants can reduce their annual energy expenditures by as much as 30 percent. And remember, that includes 100 percent returns on the controller investment in fewer than three months.

For example, consider a typical large water plant processing 220 million gallons per day. The facility might use 1500 kilowatt hours (kWh) per million gallons, 365 days a year, at a cost of \$0.05 per kWh. Annual energy expenditure: \$6 million.

If the plant installs advanced controllers using pluggable programming libraries, the result would be managed consumption of process energy. Making smart decisions based on the transparent data the engineers supplied, managers could cut energy up to 30 percent — saving more than \$1.8 million annually on the plant's electric bill.

The Modicon M580 Ethernet programmable automation controller (ePAC) possesses industry-leading processing speed and memory, plus stronger embedded cybersecurity. Its core Ethernet capabilities allow seamless, faster, enterprisewide access to operating data. For the hybrid industry, it's considered the highest-performing PAC in the marketplace — designed as the right controller for the IIoT and beyond.



Cybersecurity protection

Utilizing open technologies and interconnecting more and more assets plantwide (and worldwide) creates many benefits. But it also points to a possible downside of the IIoT: mounting cybersecurity concerns.

In fact, studies show that manufacturers now have a 32 percent chance of experiencing a hostile cyber event or cyberattack every year. So an average plant will likely experience a successful attack at least once every three years.¹ Severities vary, but a data breach costs its target an average of more than \$3.7 million.² This means an annual risk of at least \$1.2 million for the typical organization. And that risk is only increasing.

Adversaries constantly probe for weak points. The notorious Stuxnet worm, for example, reportedly infected PLCs when introduced via USB flash drives. Now IIoT interconnectivity opens up the possibility of attack via the internet. However they are created, cybersecurity breaches can degrade or shut down machine performance, causing unexpected downtime and lost productivity; threaten the safety of plant personnel or the community; or even trigger catastrophic environmental disasters. High-profile cyberattacks have led to such serious consequences as a pipeline explosion in Turkey, an energy grid blackout in Ukraine, and even disruption of a nuclear plant at an undisclosed location.

The good news? Advanced cybersecurity can now be designed into each controller, right from the start. Cyber-equipped controllers block communications from unauthorized devices; they digitally sign firmware to prevent counterfeiting; they protect application programs to prevent tampering via unauthorized malware; and they can be set up to disable USB ports, require passwords, and so on. If intrusions or mistakes occur, cybersecurity-equipped controllers can refuse action and send alarms.

For comprehensive protection, some suppliers combine all this with advanced services such as cybersecurity assessment, remediation, and maintenance. So plants can take secure advantage of the IIoT to safely improve productivity.

Using IIoT-ready PACs in key roles within comprehensive plantwide cybersecurity strategies can drastically reduce the likelihood of cyberattacks. This can save an average discrete or hybrid plant more than \$1.2 million annually, and help prevent harmful consequences for production, safety, and the environment.

For instance, in the United States, the intellectual property of a ground calcium carbonate production facility is more protected than ever before. The plant's grinding operation is now cybersecure at every level, with no additional training required. Since the operation can't afford any downtime, this advanced IIoT-ready PAC approach helps it run 24/7.

Conclusion

As business and operations leaders respond to and leverage the IIoT, they are evaluating plant automation purchases in new ways. They still start with technical excellence and ease of implementation. But today, they must also make near-heroic efforts to ensure they're advancing critical business activities such as real-time accounting, which draws on the business algorithms running at the control level to track the impact of control decisions on operational profitability and take corrective actions as needed to maintain or increase it.

Taking advantage of IIoT using the most advanced PAC technologies has already been proven to deliver such business benefits.

For example, consider the Modicon M580 Ethernet-enabled programmable automation controller (ePAC) platform from Schneider Electric. It possesses industry-leading processing speed and memory, as well as stronger embedded cybersecurity. Additionally, its core Ethernet capabilities allow seamless, faster, enterprisewide access to operating data. For the hybrid industry, it's considered the highest-performing PAC in the marketplace. Recently named Controller of the Year by *Control Engineering*, the M580 continues Modicon's pioneering half-century-long controller heritage, and is built to sustain it. Its makers designed it as the ideal controller for the IIoT, and beyond.

Recommending these advanced PACs may make a control engineer the hero of the plant's IIoT project. It can also assist the engineer's organization in achieving blazingly fast ROI and, even more importantly, help it realize substantial impacts on overall profitability for years to come.

About the author



John Boville is a marketing manager for Schneider Electric's marketing and innovation group, where he focuses on the Modicon controller line. He has been with Schneider Electric industrial automation for more than 25 years, including implementing market segment strategies for the automotive industry. Prior to joining Modicon, before it became part of Schneider Electric, he served for 12 years in project engineering for CEGELEC Automation as an industrial system designer, installation specialist, and project leader for large automation migration projects. He holds a B.S. in electrical engineering from the University of Bradford, U.K. Keep up with John's latest insight in his blog: <http://blog.schneider-electric.com/author/jboville/>

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