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The Path Forward

Migrating Legacy Plant Automation to Advanced PLCs

White Paper | December, 2013

Abstract

This white paper explains the increasing opportunity costs of legacy automation systems based on decades-old technologies, while describing compelling capabilities that advanced PLC technologies have brought modern automation systems. Three specific scenarios illustrate how plant operators with outdated automation systems can migrate to new systems with minimum, if any, disruption. Annual returns on an investment in modernized automation can be as much as 30 percent, paying for the upgrade in a very short time while positioning the plant to be more efficient, profitable and competitive for years to come.

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Time to migrate from legacy control systems to newer, more innovative technology?

Thirty years ago IBM's PC was in its infancy, 300-baud dial-up modems were the norm and hardwired distributed control systems (DCSs) ran much of the world's manufacturing. Back then, our handheld smartphones with their touchscreens, voice recognition, video calling and GPS mapping capabilities would be considered science fiction.

Likewise, today's most advanced programmable logic controllers (PLCs) and the automation infrastructures supporting them are driving production lines in what might once have been called "factories of the future." Indeed, their powerful capabilities are at the fore of a dramatic worldwide transformation in how goods are made, a shift so fundamental that slow adopters risk getting left behind.

In fact, many of those DCSs are still operating, as are early-generation PLC systems, all despite the inevitability of manufacturers phasing out their components. At the same time, the expertise that developed and maintained them is fast disappearing along with the availability of spare parts. Even worse for plants still using them, their obsolescence has created growing opportunity costs as production increasingly suffers shortcomings such as:

- Lack of integrated functionality, especially regarding controls, safety, security and communications;
- Limited diagnostic and alarming capabilities, causing time-consuming troubleshooting;
- Slow data speeds and consequent input/output (I/O) latencies;
- Inability to share data with higher-level manufacturing execution systems (MESs) and enterprise resource planning (ERP) systems that may span different plants and geographies;
- Limited configuration flexibility to adapt or expand plants and production lines to new market opportunities

These aren't just symptoms of obsolescence; they're also factors that cause costly production shutdowns, gross inefficiencies affecting profit margins, lack of operational agility and an overall erosion of competitiveness. No business can afford these costs for long in today's demanding, need-it-now markets.

While obsolete automation infrastructure will inevitably force a plant to update or close, there's good news: *the latest PLC technology can provide a quicker return on investment (ROI) of up to 30 percent, that can pay for the upgrade costs in a very short time.*

Business-builders. New efficiencies, for example, can substantially reduce costs associated with inventory, labor, waste and energy. With wireless communications like PROFINET, remote diagnostics and standardized, plug-and-play components, savings in wiring, maintenance and spare parts can add up fast. Engineering time-savings can be as much as 50 percent or more. And a new product's time-to-market can be shortened by that much, as well.

What's more, these gains don't include the incalculable benefits of having improved safety and security, more production flexibility, and greater operating visibility throughout a plant and enterprise visibility across any number of plants anywhere in the world.

Time to act – with confidence. Many plant operators may recognize the need to upgrade their production infrastructures, but may still hesitate for a variety of reasons. Their machine applications may seem too small to warrant the expense and disruption; and, as such, their older DCS or PLC systems are "good enough." Others may have lots of independent machines supported by a fragmented, multivendor infrastructure, so it's difficult to know where to start. Still others may have limited in-house technical expertise and fear interrupting production, making costly mistakes and supporting the new infrastructure after it's commissioned.

Siemens understands these concerns, and we stand ready to help in addressing them. With our Totally Integrated Automation architecture, SIMATICS S7 portfolio of advanced PLC technology and automation experience going back decades, we've helped hundreds of thousands of customers across just about every industry worldwide overcome them and successfully upgrade their automation systems.

The good news: the latest PLC technology can provide a quicker return on investment of up to 30 percent that can pay for upgrade costs in very short time.

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In the following pages, we suggest ways you can think about migrating to the latest PLC technology and provide answers to the two key questions you may have:

- What are the principal capabilities of today's advanced PLC systems and how do you leverage them to ensure your competitive advantage?
- How do you migrate your plant to a modern PLC system without disrupting productivity?

Our goal is to help you gain the knowledge – and with it, the confidence – to be better prepared to set your plant's production capabilities on course to greater profitability and competitiveness for many years to come.

Today's PLC systems are transformative

Faster. Smaller. Cheaper. That mantra has driven the microprocessor industry ever since the 1971 introduction of the Intel 4004, a 4-bit CPU design with 2,300 transistors and a 740 kHz clock speed that cost about $350 in today's dollars. Progress soon followed, in accord with "Moore's Law"– a keen observation by Intel's co-founder Gordon Moore that the number of transistors on integrated circuits doubles about every two years. Today's top-end 64-bit chips may cost 12 times more than the 4004's adjusted price, but they have roughly a million times more transistors and clock speeds about 100,000 times faster.

Moore's Law has also driven advancements in PLC electronics and supporting automation infrastructure. Their power and capabilities are far beyond the microprocessors in DSCs and early PLCs deployed several decades ago. At the same time, industry has made huge improvements in software and firmware engineering that's helped to harness all this computing power into the automation of just about every production process known.

Compelling benefits. Despite all this innovation, many plants around the world have been slow to adopt advanced PLC technologies. That's because for decades their control systems and supporting infrastructure have worked well enough and the pain of changing them never surpassed the apparent gains of doing so. Until now. With early generations of PLCs reaching their end-of-life phases, these plants may seem to have no choice but to upgrade. But, more importantly – and strategically – they also have the opportunity to carefully choose how to best invest in advanced PLC technologies. Their decisions are strategic because, with PLCs offering so many more capabilities than before, operators are making long-term, technology commitment that can truly transform their production processes in many ways.

Among those transformative capabilities are:

- **Open yet common architecture for plug-and-play interoperability** – In the early days of PLCs, proprietary, closed technologies made a lot of sense – mostly for vendors. Sure, many industry standards were still being set, and the sole-sourcing that usually came along with proprietary solutions also made sense for plant operators, to help simplify deployments, parts procurement, maintenance and support. But then, as companies were bought and sold over time (along with their production facilities), plants with different vendor PLC solutions became islands to be bridged with the help of third-party gateways, consultants and sub-optimal workarounds.

  In the mid-90s, Siemens decided to break away from this norm. First, it developed what's called Totally Integrated Automation (TIA). As a common core intelligence, TIA is embedded in over 100,000 automation products including control and safety PLCs, drives, motor control centers, energy management and control, PROFINET/PROFIBUS networking and much more. Second, Siemens renewed its commitment to actively participate in the world's standards-setting bodies to support open standards and interoperability.

  TIA is the foundation for open, flexible technology applications and maximum, plug-and-play interoperability across multiple devices, Siemens and others, to create totally integrated automation systems. TIA, when synchronized with a company's requirements, helps to optimize factory, machine and process operations allowing it to produce more and do so more efficiently. Maintenance, for example, is much easier, because technicians only need to connect and power replacement components; the PLC's intelligence will then identify the type of device, assign it an Internet Protocol (IP) address and other network information, with no programming required. This "self-healing" network also significantly reduces plant downtime when component replacements are needed.

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- **Framework engineering –** Years ago, the relative novelty of microprocessor-based automation concepts and applications required industrial and process engineering to take a piecemeal approach to developing new production methods or reconfiguring existing ones for new purposes. As they did, complexities grew on top of complexities. Even with the advent of software-assisted engineering, project details were a lot to keep track of. Eventually the need to integrate MES and ERP overlays, along with enterprise IT integration, complicated everything even more.

  That's why Siemens developed and refined the TIA Portal, an integrated engineering development and support framework for TIA. It has the software tools needed for all the steps involved in designing, commissioning, operating, maintaining and upgrading automation systems, from simple to complex. Two examples show how development, configuration and deployment can be cut from weeks to days, if not even less:
  - With the TIA Portal framework's extensive library of functional PLC code blocks and using object-oriented programming via an easy-to-use, drag-and-drop interface, plant engineers can quickly develop and deploy the control logic and configurations for any number of PLCs, human-machine interfaces (HMIs) and motor drives. These are all key components of a PLC system, together with their input/output (I/O) connections. The TIA Portal tools do all the work that used to require advanced software development skills such symbolic programming, editing, compiling and debugging, saving hundreds of hours of work while reducing errors to a small fraction of more manual programming approaches.
  - The TIA Portal's library feature also lets plant engineers mix-and-match code for various production lines and recipes, so they don't have to start from scratch when they need to create a new production line or process or reconfigure existing ones. For example, an engineer can select the objects representing the code that dictates how an existing overhead conveyor behaves, drag it into a folder with a new recipe, and all the logic, code, configuration parameters and documentation for the PLCs, HMIs, I/Os automatically follow. Need drawings? Click "Print." Another example – and a distinctive TIA Portal feature – is being able to save to one archive all the code and configurations for an entire production line (all the PLCs, HMIs and drives) and reuse all or part of it for new processes or recipes whenever necessary.

  This kind of plant engineering work used to take weeks; now it can take as little as a few days or less. For plant engineers used to the laborious old ways of doing their work, plant engineering done via the TIA Portal can be truly a transformative experience.

- **Real time and remote diagnostics** – With advanced PLC systems having solid-state electronics and fewer moving parts than legacy automation systems, problems like faults, shutdowns and other issues that could plague older systems are much less frequent. TIA's modular automation system components like PLCs, HMIs, drives, network switches and so forth have integrated diagnostic functions. This enables operators to have 24x7 plant-wide system diagnosis for reliably detecting, automatic reporting and clearing faults quickly. Technicians, for example, can troubleshoot issues inside motor control cabinets from a safe distance, without having to bother with personal protective equipment (PPE) to protect them from arc flash dangers.

  In legacy automation systems, HMIs would continually poll so-called "trigger tags." If operating conditions exceeded their parameters, these code blocks would execute a simple binary response to register with the HMI's next round of polling. Today's PLCs dispense with the inherent latency of that mechanism by issuing to their HMIs direct messages to invoke a response in real time and therefore much faster than trigger tags. What's more, plant engineers using the TIA Portal tools can program PLCs to deliver easily understood alerts such as "Brew kettle over-temperature: 101°."

  Advanced PLC systems offer integrated 24x7 diagnostics for reliably detecting, automatic reporting and clearing faults quickly.

  In complex plants, the TIA maintenance station delivers on a single screen a standardized view of relevant status information for all components, providing greater visibility of current system health and past history. Alerts can be sent automatically to the mobile devices of responsible parties, who can then securely log into the system, if necessary, to assess and correct the situation. On the one hand,

faster and remote diagnostics help to reduce costs associated with unexpected shutdowns because troubleshooting and repair is much easier; on the other hand, this boosts the overall equipment efficiency (OEE) and capacity utilization.

- **Highly scalable, high-speed communications** – Modern PLCs and their supporting infrastructure components typically have built-in switching with two or more data ports, so if wired, they can be daisy-chained, saving long wiring runs back to a central switch. In addition, they also can communicate via industrial Ethernet at speeds up to 1 Gbps, thousands of times faster than the 56 Kbps speeds of legacy automation systems. Wireless implementations can save expensive cabling and offer tremendous flexibility and scalability in configuring plant layouts – and speed when reconfiguring them.

  While all industrial Ethernet is based on the global IEEE 802.11 standard, Siemens supports the independent PROFINET implementation for industrial automation. It's the most advanced Industrial Ethernet solution available for interconnecting: (a) production assets like sensors, actuators, sub-systems, including safety, and production modules at the I/O level; (b) automation assets such as PLCs and (with gateways) legacy DCSs at the control level; and (c) higher-level manufacturing execution systems and enterprise resource planning systems (ERP) at the IT level.

  Also, while PROFINET is fully compatible with the wired and wireless 802.11 Ethernet protocols used in offices, homes and cafés, it can also meet the real-time performance that industrial automation demands for sake of minimizing and eliminating latencies in controls and safety.

- **Multilayered security –** Security across a plant's production network – at I/O, control and MES levels – is as critical as the IT network and must be protected from hackers, viruses and other malware. The costs and safety hazards from compromised networks can be huge. TIA enables plant engineers using the TIA Portal to establish several layers of security with relatively little administrative effort.

  Firewalls, VPNs, encryption, role-specific authentication are just some of the security features that can be deployed in a multilayered security architecture, as best practices would suggest, and managed from a single, easy-to-use interface, onsite or remotely. TIA's administrative granularity is remarkable. Specific PLCs can be authorized to communicate only with specific HMIs and vice-versa. When the TIA Portal sends code to a PLC, the code is encrypted to thwart "man-in-the-middle" attacks in which hackers try to intercept control code using network analyzers commonly found on the Internet.

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- **Integrated safety** – For the most part, older automation systems lack safety integration capabilities, so over the years, plant engineers have had to hardwire standard safety features like e-stops, door and gate interlocks, light curtains and safety PLCs as "bolt-on" accessories to a separate safety system. This approach is widespread. In a December 2012 survey of its readers, *Control Design* magazine found 62 percent of respondents reporting their safety systems were separate and hardwired. This is costly in many ways: extra wiring, controls, maintenance, and spare parts, to name a few.

  In contrast, modern PLC technology like the TIA portfolio makes safety integration easy. Greater integration of control and safety systems simplifies complexity by reducing the issues related to different programming procedures and languages; installation and configuration requirements; maintenance; and, last but not least, human errors. All this also translates into lower total cost of ownership (TCO), because less engineering, hardware, training and spare parts are needed.

  Control and safety integration provides greater system availability, thanks to improved diagnostics and trouble shooting. Less downtime for maintenance and repair – not to mention accidents – translates to greater productivity. Plant operators gain greater operational flexibility, too, as they can reconfigure their floor layouts and machine placements much more easily by having just one integrated system to move instead of two.

Migration strategies to minimize or eliminate disruptions

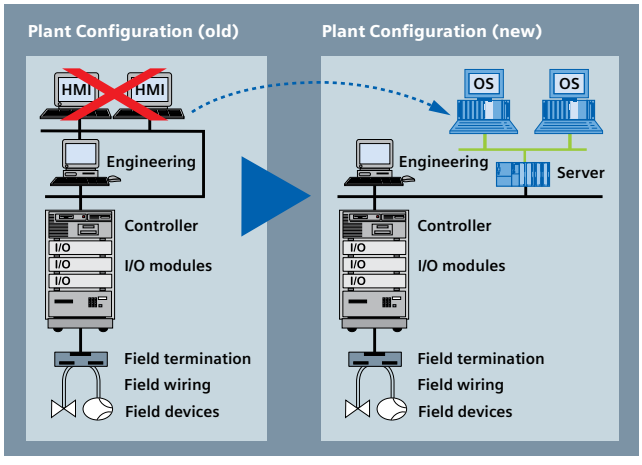
With proper planning, experienced assistance and a phased approach, plant operators can update their production capabilities with the latest PLC technology and infrastructure with little or no disruption to current production runs. The following three scenarios will help explain how that's done. Do upgrades take long? Not necessarily. A small to medium size plant with a small number of production lines can upgrade inside a month, with little or no disruption if planned right and executed with care.

Scenario 1: Replace HMI systems

Given the rapid changes in PC technology, legacy automation systems' HMIs are likely outdated technically, with spare parts prohibitively expensive or even obsolete. New requirements, such as integration of the control network with the corporate network, improved network security, or other functional expansions may also dictate an HMI upgrade. In these cases, a new HMI can be installed, such as one from the Siemens TIA portfolio, which will protect existing investments in PLCs, I/O, process graphics and their application engineering and code. Conversion tools in the TIA Portal enable existing process graphics to be redrawn in readable symbolic code at a fraction of their original engineering cost and in much less time.

Major benefits:

- Extends the life of existing control systems while providing new operational capabilities
- Minimizes migration cost impacts
- Enables connectivity to MES and ERP systems, plys tighter IT integration
- Provides operating personnel with an easier transition to new HMI technology
- Allows system upgrades to be performed online with out unplanned downtime
- Minimizes TCO by reducing design, installation and startup costs



Scenario 1: HMI replacement

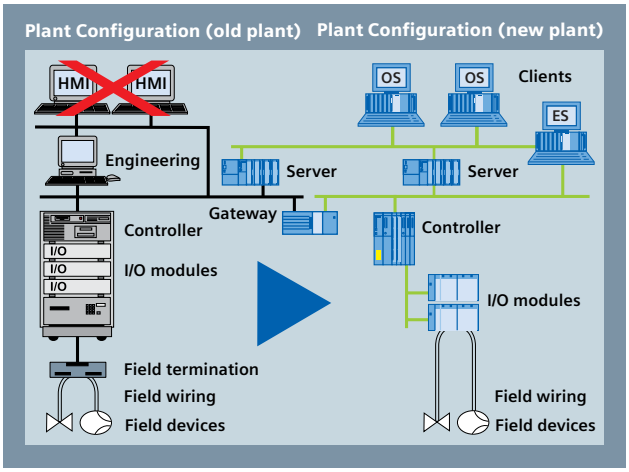
Scenario 2: Overlay legacy system overlays or expand with new systems

In this case, a new automation system like a TIA system overlays a plant's legacy system. Or if a plant expansion is needed, the new automation system is installed to co-exist plant with the legacy system. Either path calls for coordinated operation between new and old, while enabling a smooth transition to new technology. For example, if the old and new systems are united under a common new HMI, then their integrated system architecture can offer operating personnel the same look and feel for both systems.

Engineering libraries developed within the TIA Portal can mimic the functionality and behavior of older systems to help minimize technicians' learning curve for the technicians nd the scope of maintenance functions.

Major benefits:

- Adds production capacity and manufacturing flexibility
- Opens doors for introducing new technologies into the plant
- Enables connectivity to MES and ERP systems, plus tighter IT integration
- Allows different automation systems to be brought under control of a common HMI
- Provides operating personnel with an easier transition to new HMI technology
- Improves security



Scenario 2: Overlay legacy system overlays or expand with new systems

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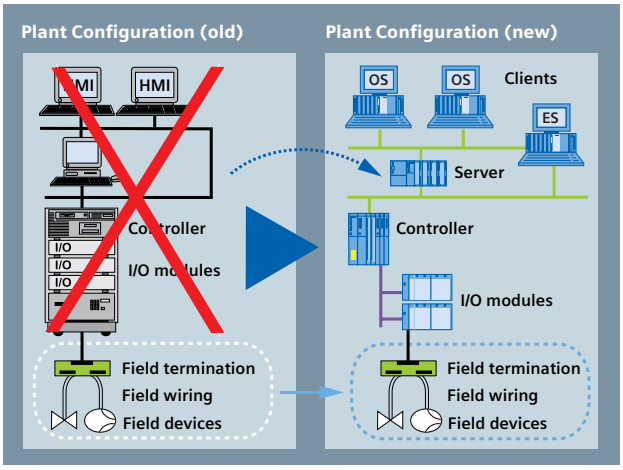
Scenario 3: Replace entire system

More and more, the best choice for plant operators is to replace their legacy automation systems altogether. As mentioned earlier, many manufacturers may soon (if not already) discontinue key components. This will result in a lack of spare parts and technical support. Meanwhile existing system expertise may retire soon. And the old system may be incapable of important functional extensions, such as integrations into MES and ERP systems. In this case, a new automation system using the latest PLC technology like what's in the TIA portfolio is the recommended course of action. If necessary, the legacy system can stay online to en sure production goals are met. In this scenario, the investment in wiring, hardware components, existing I/O and field devices and application engineering can be reused, based on the customer's evaluation of what components hold maximum future value.

Major benefits:

- Provides the maximum lifespan extension of the process automation system
- Removes dependence on existing vendors
- Minimizes TCO by allowing reuse of the most valuable existing assets
- Improves security



Scenario 3: Replace entire system

Conclusion: The time to act is now

Around the world and across every industry, a fundamental and dramatic transformation of manufacturing is taking place. Driving this change is a dynamic interplay between market forces, including increasing competitive stakes, shareholder demands to maximize profits, and the ever more powerful capabilities of PLC technologies that enable plant operators to gain much greater efficiencies while lowering costs. In this paper, we summarized those capabilities as follows:

- Open yet common architecture for plug-and-play interoperability
- Framework engineering
- Real time and remote diagnostics
- Highly scalable, high-speed communications
- Multilayered security

In effect these capabilities can make plants currently using legacy automation systems much more efficient, profitable and competitive. At this point in a plant's life cycle and with all the compelling benefits of advanced, PLC-powered automation systems, operators of outdated plant infrastructures should not be questioning if an upgrade is necessary. Instead they should ask how to best upgrade and when to do it. Good planning and experienced assistance can minimize if not eliminate production disruptions, and stepwise upgrades can be done within a month. With an annual combined system ROI of up to 30 percent, a modernized automation system can pay for itself within a very short time. The time for plant operators to act is now, so their decisions to upgrade today can start paying off sooner rather than later.

By Wayne Cantrell, Consulting Systems Engineer Industry Automation, Siemens Industry, Inc.

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Siemens Industry, Inc.
3333 Old Milton Parkway
Alpharetta, GA 30005

usa.siemens.com/automation

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