Weidmüller

Why Plug-and-Play PLC Migration is ROI Gold

Update your PLCs quickly, easily and without errors

Whitepaper

Executive summary

Nearly every manufacturing or industrial company is coming to terms with a critical issue: Many programmable logic controllers (PLCs), which largely serve as the brains for every function in their plants, are reaching the end of their viability.

The rewiring between controllers, sensors, actuators and other field devices to replace a PLC is complex, time consuming and labor intensive, leading to potential production downtime and errors. However, Weidmuller's MiBridge solution– which features plug-and-play technology – gives end users and integrators a better way to migrate to new PLCs without a comprehensive replacement. These solutions bring operational gains and savings to a significant trio of benefits:

- **Simplicity:** Plug-and-play solutions demonstrate solid, reliable performance and leverage existing wiring connections and cabinet space. These vendor-agnostic alternatives allow manufacturing companies to pivot from legacy platforms and introduce components from other suppliers, which could bring better functionality to meet their current and future needs.

- **Money:** Ripping out discontinued PLCs and installing new PLCs – commonly referred to as "rip-and-replace" – comes with hefty price tags, both for the time and labor.

- **Time:** A single plant can deploy hundreds of PLCs, adding more layers of complexity to a migration initiative. One PLC migration can be executed in less than half the time for a full replacement, which means a plant can drastically reduce downtime.

This white paper demonstrates how Weidmuller's MiBridge technology provides a streamlined and better approach to installing newer, faster and better functioning PLCs –resulting in improved operational capabilities and efficiencies.

Contents

Introduction

Programmable logic controllers (PLCs) were designed and built to operate reliably for a very long time, but, as with all technology, there comes a time when those components begin to approach their end of life. Many PLCs have operated for decades, and manufacturers historically notify customers when they no longer will support and service those PLCs. With many PLCs approaching their end, businesses must plan for upgrades and replacements now to avoid disruptions in production or unnecessary delays, especially if the worst happens: a PLC fails on the job.

Operating with obsolete components and without technical support at the ready further jeopardizes a business's competitive edge. A proactive migration plan addresses security risks, unexpected downtime, compatibility concerns with other hardware and regulatory compliance.

Additional gains from migrating to new PLCs, for example, include greater communication among controllers across a plant. That interconnectivity required in modern industrial needs enables seamless data exchange and remote input/output (I/O) monitoring.

Migration vs. retrofitting

Many people use these terms interchangeably, but they are two clearly distinguishable processes.

- ***Retrofit*** means the technical upgrade of an outdated PLC, which can be done in various ways. For example, an outdated power supply unit can be replaced by a new one that increases efficiency.

- ***Migration*** means the complete replacement of a PLC with a new control system. For cost and time reasons, the aim is to keep the existing field wiring unchanged.

Why PLC migration is so urgent

Several factors have accelerated the need for PLC migration as a pressing concern for plant managers.

1. End of life

Electronic components historically have a limited life span, due to aging hardware, updated standards and product innovations. For many commonly installed control systems, migration is becoming gradually unavoidable:

- SIMATIC S5 (Siemens; market launch 1979); End of life 2020
- PLC-5 (Allen Bradley; market launch 1980); End of life 2017
- Modicon Quantum (Schneider); End of life 2018
- Honeywell IPC-620; Discontinued 2012

All systems launched more than 35 years ago. Even though they still operate reliably in many industries, every month that passes increases their probability of failure. When that happens, expensive repair and replacement measures are unavoidable. At the same time, those manufacturers likely have already discontinued technical support, making it even more difficult to obtain parts. That alone forces many plant operators to consider PLC migration.

2. Inadequate hardware

Many plants must expand during their operating period, which often pushes the hardware of the PLC used to its limits. For example, modern communication interfaces are missing, the process cycle is too long, or the CPU does not support the additionally required I/O modules. Even in such cases, replacing the PLC cannot be avoided.

3. Insufficient flexibility

Machines and plants are exported worldwide today, which means they often must meet different regional requirements and regulations. Consider that a U.S. company might have to plan and equip its plants with control systems from other manufacturers to serve its international markets. It is, of course, advantageous if only the PLC must be replaced.

Can PLC migration be simplified?

An analysis of different approaches to PLC migrations, which are becoming more critical by the day, shows that less complex approaches deliver reliable, scalable solutions and drastically reduce potential downtime and wiring errors. Remember, the tenet of this white paper is that plug-and-play solutions deliver simplicity and save time and money, offering a much better alternative than a wholesale PLC replacement – contributing to transformational growth for businesses.

Another point to consider if that within certain industries, including water supply and oil and gas facilities, migration must be incorporated within limited and designated shutdown periods. Those plant operators need confidence that they can execute this mission-critical initiative in the fastest, most-reliable way possible.

Let's look more closely at each of the available options and the opportunities they present:

1. Migration solutions simplify PLC exchange

Well-thought-out migration solutions save time and reduce the workload considerably. A distinction is made between bridge and card (rack in place) solutions. Using pre-assembled cables can generate even more efficiency.

2. PLC transfer elements and pre-assembled cables avoid the risks of rip-and-replace

PLC transfer elements increase system flexibility, provide versatility and facilitate future PLC migration. Returning to pre-assembled cables, these save time in installation and troubleshooting, which increases system availability. In fact, that can drive time savings of up to 95%, even in small systems.

3. Plant control systems become more flexible with PLC transfer elements

Due to their high flexibility, PLC transfer elements can be used worldwide in change and plant control systems for various applications. Global companies can now design systems that aren't dependent on the controller's hardware. Within a short time, the sensor/actuator level can be connected to I/O modules of PLC systems from different manufacturers simply by choosing the right cables.

Now, it's time to prove these points.

Note: This white paper only covers hardware migration. Software migration is the responsibility of system integrators.

1. Migration solutions simplify PLC exchange

Plug-and-play solutions offer unparalleled precision and accuracy in configuration, eliminating the risks associated with misplacement of connections during migration.

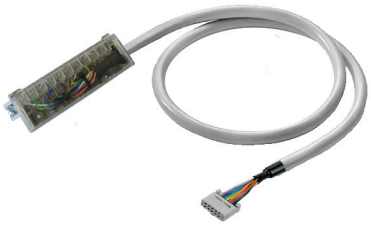
If a connection is designated to travel from Terminal A to Terminal A, it is guaranteed to follow that route. This precision eliminates any potential deviations or complications. Plug-and-play also streamlines the transition by starting with a pre-qualification of connections through an analysis of current and incoming systems, effectively eradicating unexpected issues.

Pre-assembled Cables
Pre-assembled cables are an essential component of any migration solution that can be implemented quickly, easily, and without errors. Cables are available in different lengths and in both standard (LIYY) and shielded (LIYCY) versions. They come with a manufacturer-specific PLC adapter on one side and an IDC (IEC 60603-13), RSV or Sub-D connector on the other. The following manufacturers and control systems are supported:

- Siemens: S7 300, S7 400, S7 1200, S7 1500
- Schneider Electric: Micro Premium, Twido, Quantum 340
- Rockwell Automation: SLC500, CompactLogix, ControlLogix
- GEFANUC: 90-30, RX3I
- Alstom: C80-35
- Omron: CQM1, CJ1W
- Moeller: XIOC
- ABB: S800
- Emerson: Delta-V
- Mitsubishi: MELSEC Q

To ensure 100% quality, all cables are automatically tested for continuity and insulation.

(a) Pre-assembled cables for Siemens S7-1500



(b) Pre-assembled cables for Schneider Premium

Fig. 5.3: Examples of pre-assembled cable

2. PLC transfer elements and pre-assembled cables avoid the risks of rip-and-replace

The length of a complete PLC exchange runs extremely high with conventional individual wiring. Let's look at what might be expected in migrating an AB PLC-5 to a newer-generation PLC. A PLC-5 can be equipped with six digital I/O modules. Each module could have 32 signal connection points, which means 192 wires must be connected. Each wire must be individually released from its terminal point, adjusted in length, stripped, crimped with ferrule and connected to the new I/O modules. Experienced specialists need about 10 minutes per wire for these steps, adding up to total assembly time of about 32 hours. With time built in for error analysis and a loop check, the total working time runs to about 40 hours.

For larger systems, a conversion generally drives several days of lost production. Considering the financial aspect, a skilled electrician costs an average of $180 per hour. For this this small plant, $360 of labor costs are already incurred. Further costs for the acquisition of new hardware, the breakdown of the plant or the time for troubleshooting are added. In this way, the total costs of rip-and-replace increases quickly.

Business leaders who opt to attempt a rip-and-replace strategy during a scheduled shutdown often end up facing unforeseen challenges after removing. Discovery of unexpected issues adjustments prolong the shutdown duration. Furthermore, the installation process for rip-and-replace typically demands at least twice the time. In one recent MiBridge installation, the facility converted fourteen 16-slot racks in only five days, which would have required 10 to 15 days with rip-and-replace.

3. Plant control systems become more flexible with PLC transfer elements

Expanding on its benefits, advanced plug-and-play solutions can extend beyond the boundaries of specific brands. For instance, if a facility desires to transition from brand A to brand B, advanced plug-and-play solutions can be tailor made to accommodate this, offering unprecedented flexibility for industrial plants.

The upside is that businesses now have greater access to hardware components that deliver a more comprehensive range of capabilities and functionality, allowing them to expand the brainpower of every PLC exponentially. Furthermore, a well-designed and well-engineered strategy to blend brands to harness those expanded opportunities ensures that reliability and scalability are built in before execution even begins.

For instance, Weidmuller's MiBridge solutions cover a range of existing legacy platforms. The company meticulously designed and prototyped numerous MiBridge adapters to cater to diverse customers, industries, and installed bases across the nation. In fact, these migration solutions possess a distinct capability to seamlessly integrate across various brands, even for scenarios not previously encountered, Weidmuller can engineer the right solutions, which sets it apart from other major PLC manufacturers that typically facilitate migrations only within their brand.

Solution approaches for an efficient PLC migration

Leveraging existing sensor/actuator wiring can minimize time and financial investments for a PLC replacement. Beyond saving installation and testing times, this approach increases plant availability.

1. Bridge solution: Using a new mounting rack

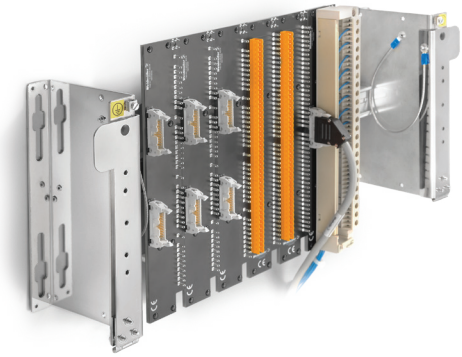


Fig. 4.1: Migration rack for a bridge solution (example)

Fig. 4.2: Front adapter/FAD (example)

Bringing efficiency to the table, mounting racks for PLC migration require no additional space in the control cabinet. They fit in the exact footprint of the former PLC. First the existing PLC is completely disassembled, and only the front connectors of the input and output modules are removed, so the wiring remains unchanged. Next, a suitable mounting rack is placed in place of the PLC*.

The front adapters (FADs) – suitable to the type of I/O card and added to the mounting rail in the cabinet or a rack – then are mounted to the migration rack. The front connector of the I/O card to be migrated can be adapted directly, and signals are routed via the printed circuit board to industrial standard connectors.

The mounting rack is extended by a TS35 standard or manufacturer-specific mounting rail. Finally, the front adapters are connected to the PLC's new I/O cards using pre-assembled cables equipped with the manufacturer-specific PLC connector, along with a universal connector for contacting the front adapters.

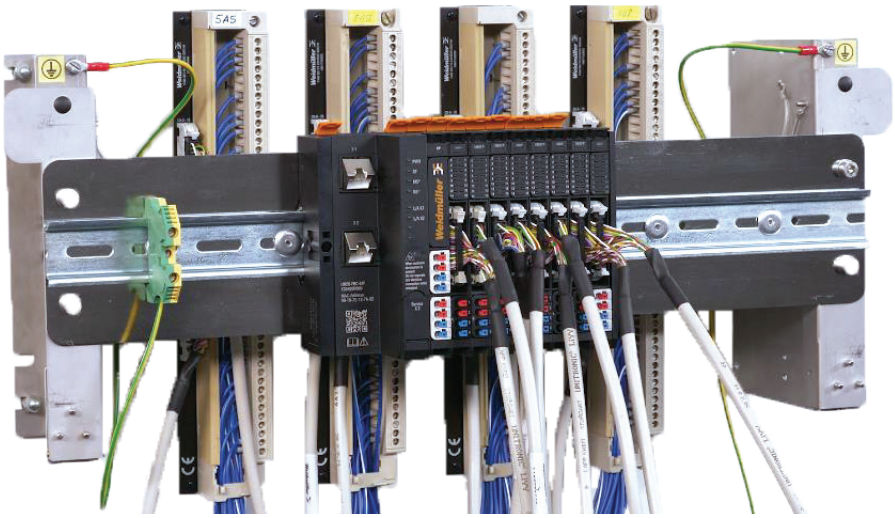


Fig. 4.3: Bridge solution Siemens S5-115 to Weidmuller u-remote. The value "plant availability" considers the downtimes of a plant. Production time and downtime are put into relation. For economic reasons, maximum plant availability is aimed for. During migration or replacement, however, a plant failure is to be expected, which reduces plant availability.

*All migration rack components must be connected to the protective equipotential bonding, according to current regulations.

2. Card solution: using the existing chassis/rack

The card solution keeps the chassis in the cabinet of the PLC to be migrated.

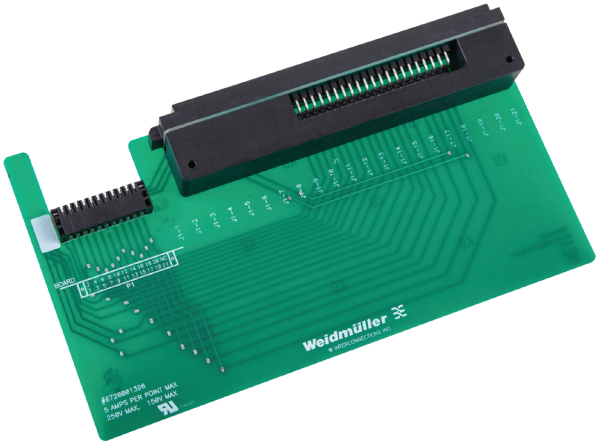


Fig. 4.4.: Example adapter card

When rebuilding, the front connectors or terminal blocks/swingarms of the I/O cards are removed first, and the wiring stays the same. I/O cards are then removed from the chassis and replaced by suitable Weidmuller card adaptors, which have a connector to the I/O cards to be migrated. After those cards have been mounted in the rack, the previously dismounted front connectors – which carry the sensor/actuator wiring – are plugged in. The PLC being migrated to is installed in a control cabinet either nearby or remote, and adapter cards are connected to the PLC using longer lengths of pre-assembled cables.

$$\textit{Plant availability} = \frac{\textit{Total time - Downtime}}{\textit{Total time}} \quad X\ 100\%$$

3. Weidmuller system cabling solutions with PLC interface modules

To simplify any future migration process, the right choice is PLC interface modules (IMs), the go-between from the control-side system line to the field-side connections of the sensor-actuator level. On these modules, all electrical connections are routed via a single printed circuit board, whose standard industrial connector bundles a direct connection of all pre-assembled cables and PCB terminals for connecting field components. As a result, PLC migration can be carried out within a few minutes by simply plugging in a new connector.

Wire to Wire
- I/O connected wire by wire to PLC

System Wiring
- I/O connected to an interface
- Interface connected by one or two Pre-assembled cable (PAC) to PLC

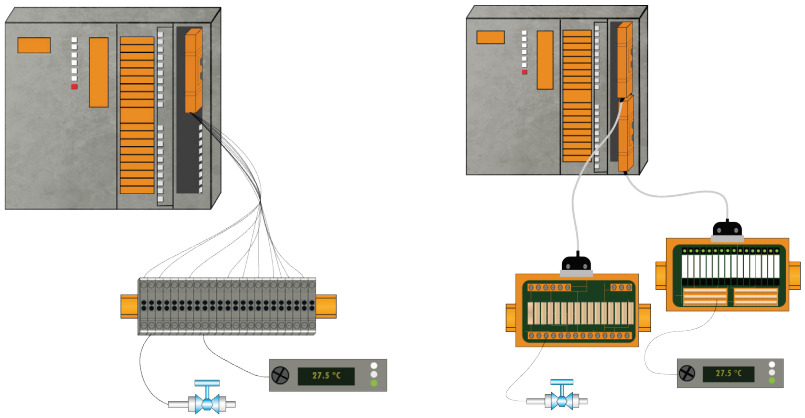


Fig. 4.5.: System wiring based on PLC transfer elements and pre-assembled cables ensures a considerable acceleration of the migration process. This is particularly evident when compared to conventional point-to-point wiring.

IMs can be used universally and independently of the respective control system. On the control side, modules come equipped with these standard connectors:

- IDC (IEC60603-13) DIN41651 male connector, 20-pin, for digital signals up to 60V DC or 75 V AC@1 A
- RSV plug connector 24/36-pole for digital signals > 60 V DC / 75 V AC)
- D-Sub IEC 807-2/DIN 41652 / 15- or 25-pole male connector for analog signals/shielded cable

Using pre-assembled cables, the digital and analog I/O modules of the respective PLC can be easily and quickly adapted to IMs. The field-side connection of sensors and actuators is ensured on the interface modules via PCB terminals with screw connection, tension spring or a PUSH IN connection. Standard plus-or-minus potentials can be optionally bridged via the printed circuit board for all input and output terminals, and an external supply voltage can be fed in via separate connections. In the control cabinet, PLC IMs are usually mounted on standard mounting rails.

Used as connection interfaces for input and output signals of the controller, PLC IMs offer the possibility of directly connecting field devices in single-, two- or three-wire technology. In addition, active multi-relay couplers for electrical isolation, power amplification or voltage level adjustment of I/O signals are available in different versions. The optional equipment of the PLC transfer elements with components such as LED displays, diodes, fuses, isolating switches and test sockets increase the functional range in the respective applications.

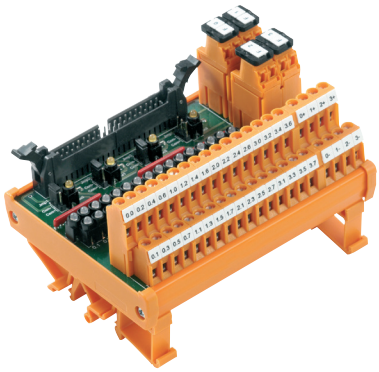


Fig. 4.6.: Example of a PLC transfer element

How a plug-and-play PLC migration delivers compelling ROI

Going back to the earlier example of a complete PLC replacement, a deeper dive into different approaches will help showcase plug-and-play's benefits.

This cost comparison evaluates the decision of rip-and-replace versus the MiBridge solution. This scenario looks at an obsolete PLC with six digital input I/O modules to be replaced by a new PLC with the same number of modules at 32 points each. The below table compares the possible migration methods with work steps and approximate times respectively.

How different PLC migration investments compare

This comparison shows that bridge and migration card solutions are considerably more economical than conventional point-to-point wiring. The benefits for this alternative are twofold: First, this offers a more gradual and cost-effective way to modernize control systems by leveraging existing infrastructure and maximizing the return on previous investments. Second, it positions a facility for expanded automation, leading to greater output at lower operational costs – all while staying competitive.

(see next page for comparison table)

Cost comparison of migration methods

No.	Work Steps	Rip-and-Replace Single Wiring	MiBridge Solution	Rack-in-Place Solution
One-off steps				
1	Mount the new PLC	15 min	4 min	15 min
2	Assemble and mount the adapter chassis	NA	10 min	NA
	Total working time for one-off operations	15 min	14 min	15 min
Work steps per 32-channel I/O module				
3	Measure and cut field wiring to length	5 min	NA	NA
4	Strip and crimp wires	5 min	NA	NA
5	Remove the legacy front connectors (swing arm/ terminal block)	NA	10 sec	10 sec
6	Connect to and test the new PLC	8 min	NA	NA
7	Attach MiBridge adapter and re-connect the front connector of the legacy PLC	NA	35 sec	NA
8	Replace the legacy I/O module with rack-in-place adapter card	NA	NA	43 sec
9	Connect the new connector end of the MiBridge assembly to the new PLC mounted on the front of the adapter chassis	NA	20 sec	NA
	Total working time per module	18 min	1 min 5 sec	53 sec
Total working time for 6, 32-point I/O modules				
Working time for 6, 32-point modules		1hrs 48 min	6 min 30 sec	5 min 30 sec
Working time for one-off work steps		15 min	14 min	15 min
Total working time for the migration		2hrs 3 min	20 min	20 min
Plant or system availability during time of migration		0%	96.8%	96.4%
Troubleshooting		Several hours	NA	NA
Total working time for 12, 32-point I/O modules				
Working time for 12, 32-point modules		3hrs 36 min	18 min	12 min
Working time for one-off work steps		15	14 min	15 min
Total working time for the migration		3hrs 51 min	32 min	27 min
Plant or system availability during time of migration		0%	96.8%	96.4%
Troubleshooting		Several hours	NA	NA

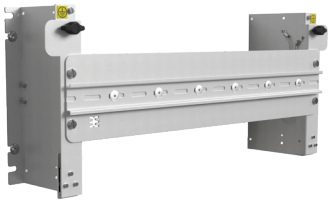
Source:

$180/hour labor rate + $100,000/hour plant downtime (6-slot PLC)
$360 labor and $200,000 downtime for one, 6-slot, **rip-and-replace method**
$180 labor and $33,333.33 downtime costs for one, 6-slot, **MiBridge solution**

$180/hour labor rate + $100,000/hour plant downtime (12-slot PLC)
$630 labor and $400,000 downtime for one, 12-slot, **rip-and-replace method**
$180 labor and $33,333.33 downtime costs for one, 12-slot, **MiBridge solution**

Retrofitting made easy –
The migration process

Step 1
The bridge takes the place of the old control system so that no additional space is required in the panel.



Step 2
Front adapters are added so that the existing field wiring signal can be carried with pre assembled cables to the new PLC/DCS.

Step 3
Lastly, the rail with the new PLC/DCS is positioned and the pre-assembled cable from the FAD is connected to the appropriate new I/O card.

Uniquely designed solution
The key to our migration platform is the design. It permits your existing field wiring to remain in place and undisturbed on the front panel adapter, and eliminates the need to wire-trace or ring-out.

Compatibility means flexibility
Weidmuller's migration solution includes several versions of card adapters and cable types enabling you to seamlessly migrate to any control system.

Minimal components maximize migration efficiency
The assembly is a universal conversion/ migration system for main legacy PLC/DCS systems, enabling you to seamlessly migrate to any new control system.

Quick and efficient
Time savings up to 95% thanks to reduced cabling combined with a reduction in the testing and marking workload.

Safe and reliable
Convenient plug-and-play solution without the error sources typically seen in conventional cable processing and point-to-point wiring.

Equipped for the future
The control system can be updated and retrofitted without having to re-wire the sensors and actuators in the field.

Paving the path for a successful migration

Even though plug-and-play solutions are simplified, that's not to say that these kinds of infrastructure changes aren't without challenges. However, an upfront approach weighs those factors and related risks to ensure a seamless installation. These key steps should include:

1. Meticulous migration planning

With a complete understanding of the task, build out a comprehensive migration plan that establishes guardrails for the work and accounts for potential pitfalls that might surface. A detailed migration planning workbook becomes a step-by-step guide that balances the migration initiative with each plant's ongoing and unique needs. With these insights, product managers formulate the optimal solution tailored to each plant's individual needs and requirements, and the process then advances to custom "engineered" drawings, including engineered custom cable lengths.

2. Adapting existing infrastructure

Hardware takes up physical real estate, and existing plant control boxes often operate in a confined space. That makes accommodating new PLC systems more complicated, creating potential disruptions and the need for custom-engineered solutions. Much as using existing wiring makes plug-and-play a more attractive option, this approach allows plants to use the same rack space. This simplicity in design translates to maximum migration efficiency, allowing electricians to focus on the upgrade itself rather than being consumed with intricate wiring arrangements.

3. Compatibility across diverse industrial setups

Every plant will approach PLC migration differently: Some will carve out time, moving from controller to controller, only taking a line out of production for a short time. Leaning into their business's seasonality, others operate with scheduled full-facility shutdowns, such as once a year, when all technology maintenance and upgrades are performed. In any case, plant operators need trusted, reliable and efficient migrations. Plug-and-play can quickly adapt and be compatible for different industrial needs, further demonstrating its versatility and reliability. This is critical because escalating consumer demand for plant outputs reinforces the necessity for migration, as it emphasizes the paramount importance of increasing production efficiency and automation.

Conclusion

Between a tighter economy and increased supply-chain pressures, businesses are looking for every opportunity to operate more efficiently to maintain – and advance – their competitive edge.

PLC migration is emerging as a high-priority Industry 4.0 initiative, and all industry sectors will allocate significant financial resources to upgrade their legacy systems. The economic advantages of enhanced security, productivity, efficiency and sustainability drive serious manufacturers to opt for smart and sophisticated migration solutions. Ultimately, PLC migration is a "must do," as existing controllers are hobbling amid a sea of state-of-the-art advancements where they simply can't keep up – and shouldn't be expected to. Facilities that don't prioritize this migration will rapidly lose ground.

But this doesn't have to be a technology project that stops business. Instead, the right modern solution – which uses plug-and-play components – allows plants to significantly reduce downtime, which means they are best protecting their output and ongoing revenues. They also are better positioned within their organizations to seize better capabilities and new functionalities available through modern PLCs.

Technology allows businesses to be flexible and scalable: two key ingredients in industrial automation application. These advantages contribute to more efficient and adaptable control processes – no matter the industry.

The accelerating pace of technological advancements further underscores the necessity of adaptable systems that can evolve. The migration from legacy PLCs to advanced solutions with networking capabilities is a pivotal step toward securing the future of industrial automation.

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