Software-defined control is (AI)ready now

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EMERSON

Omdia
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Introduction

"It's like moving from a pneumatic controller to an electric controller or from an electric controller to a DCS. It's basically a quantum shift in controller."

Head of Process Control

A New Inflection Point for Industrial Control

Industrial control systems stand at an inflection point—comparable to the universal accessibility and scalability brought by cloud technologies for enterprise applications or the transition to commercial off-the-shelf (COTS) solutions in various industries. For control engineers who have spent careers mastering distributed control system (DCS) and programmable logic controller (PLC) architectures, this shift demands attention.

Today's process and hybrid manufacturers face **fundamentally different challenges than a decade ago**. Dynamic global markets, tightening regulatory requirements, and sustainability targets demand unprecedented flexibility and operational agility. Yet most plants operate control systems designed for reliability and stability—not for the rapid adaptation that modern business conditions require.

The increasingly limited compute horsepower of traditional systems, their distributed nature that increases installation and maintenance costs, and the challenges of multi-vendor control with limited integration (e.g., PLCs within a DCS architecture) are emerging as key obstacles to progress, contributing to higher operational costs.

The challenge intensifies as new technologies like **Ethernet Advanced Physical Layer (Ethernet APL)** are unlocking bandwidth-intensive information from the intelligent field—video, acoustic monitoring, and advanced diagnostics that will push current control hardware to its limits.

Organizations need an artificial intelligence (AI)-ready architecture capable of supporting this next-generation data. Yet legacy control technologies are more likely to silo this data than to enable its use.

Traditional modernization approaches offer limited relief. Expansion or upgrading projects remain complex, expensive, and constrained by purpose-built hardware decisions made years in advance. Omdia's 2025 study estimated that hardware-based closed manufacturing systems cost 7.5% of medium-sized companies revenues and 4.5% for large enterprises, mainly due to modernization and upgrade expenses.

Organizations need a different approach.

Software-defined control provides that approach.

Software-defined control (SDC) virtualizes and containerizes controllers on COTS servers. This approach consolidates hardware, reduces commissioning effort, and delivers the flexibility and scalability required for modern operations.

Unlike traditional systems, SDC enables control strategies to execute on virtualized instances rather than dedicated hardware, allowing capacity adjustments through software configuration rather than physical redesign.

The benefits are:

Dramatically reduced footprint, simplified commissioning, and—critically—the flexibility and scalability that modern operations demand

Control strategies executed on virtualized instances rather than dedicated hardware, enabling **capacity adjustments and updates through software configuration with zero downtime**

Compute power to execute **advanced AI and machine learning applications on the same hardware as real-time control**, providing improved optimizations with no added latencies or compromising deterministic performance

Resilience beyond traditional hardware redundancy, as redundant instances can be deployed on separate servers and distributed across different locations

The technology building blocks supporting SDC have matured over the years, but automation users and suppliers are only now adapting their environments to leverage them fully.

Forward-thinking manufacturers are already integrating these capabilities—preparing for a software-defined future while preserving existing investments through hybrid architectures.

The purpose of this white paper is to assess the current state and pain points of industrial control systems, explain how SDC addresses these challenges, discuss implementation considerations, and outline practical paths toward adoption.

To ground these insights in real-world experience, we surveyed 200+ control engineers, operations personnel, and plant managers across process and hybrid industries and conducted in-depth interviews with decision-makers responsible for control system strategy.

Our findings reveal **high awareness of SDC**—only 6% are unfamiliar with the technology, while apply some form of SDC functionalities in their plants.

How familiar are you with the concept of software-defined control or software-defined automation?

6%

Somewhat familiar, know the term, but not clear on its implications

36%

Familiar, understand core concepts and potential benefits

36%

Very familiar, actively evaluating for implementation

21%

Using in current set up

Source: Omdia

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Most significantly, 68% express interest to participate in pilot projects, signaling strong momentum toward **adoption within the next 6–12 months**.

When would your organization be interested in beginning a pilot?

27%	41%	23%	1%	8%
Within the next 6 months	6–12 months	13–24 months	Beyond 24 months	Depends on the specific application and terms

Source: Omdia

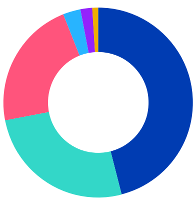
The following sections present the survey findings and technology capabilities and provide practical guidance for control engineers evaluating SDC for their operations.

Assessment of Current SDC Deployment

Heterogeneous Hardware-based Architecture with Modern Elements

Today's control installed base is highly heterogeneous: In terms of age, most sites run a mixed-age control environment, with a large mid-life core supplemented by both legacy islands that have outlived their intended lifecycle and newer, recently upgraded segments. As a result, engineers are managing multiple generations of hardware, software, and networks in parallel, which increases integration effort and makes system-wide upgrades difficult.

What is the average age of your core operational control systems (DCS/PLC)?



- **45%** 6–10 years
- **25%** 3–5 years
- **22%** 11–15 years
- **3%** More than 15 years
- **2%** Less than 3 years
- **1%** Don't know

Source: Omdia

The same heterogeneity applies to the control systems architecture. Modern elements coexist with traditional legacy deployments:

- **54% and 52%** of DCS computers run on IPC hardware and DCS, another **40%** and **29%** of respondents are running control logic traditional PLC-based and proprietary systems, respectively.
- At the same time, on the more modern side, **47%** are using embedded edge controllers next to the DCS to handle equipment-near functions or add new capabilities.
- A large portion **(50%)** of current control systems inherits cloud-connected elements.

Yet almost all of these "modern hardware-based" DCS deployments are based on traditional, non-software-defined architectures. Moving control logic from a proprietary DCS rack to an IPC, edge controller, or supervisory cloud instance improves hardware flexibility, but it does not change the fundamental constraints of traditional DCS design.

These architecture limitations translate directly to the day-to-day operational challenges and pain points for control teams, outlined in the next section.

The Challenges of Current Control Systems

> "Right now, if you look at most sites, we need to put the controller very close to where we have the inputs and outputs, and we end up having multiple controllers... So, we end up with more hardware, more equipment to maintain and upgrade... It costs a lot of money to upgrade a system, especially with hardware controllers. You have to flash, take your site down, and it takes a lot of time and a lot of planning."
>
> Head of Process Control

For project and engineering teams, **the most immediate pain points relate to delivery timelines**: respondents report excessive engineering effort, extended commissioning cycles, and repeated rework when deploying new or updating existing control logic.

A lack of reusable, modular, and scalable control logic amplifies these delivery challenges, while also limiting production line flexibility: most teams cannot quickly reconfigure assets to support smaller batch sizes, new product variants, or changing customer demands.

Ranked second, but no less significant, are running operational challenges when **integrating multi-vendor hardware and software systems, and costly vendor lock-in**.

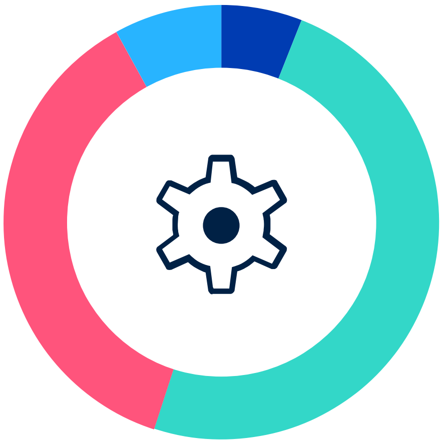
For teams running high-speed or safety-critical process applications, respondents also flag significant, ongoing difficulties maintaining reliable determinism and timing synchronization across hardware assets of different ages, vendors, and generations.

What are your top 3 pain points in managing your organization's control systems?

Source: Omdia

To address these pain points, many companies are launching frequent modernization and upgrading initiatives—but these projects are often lengthy, resource-intensive, and disruptive, competing with day-to-day production priorities, and costly:

How often do you deploy updates to control systems?



- **6%** Less than once per year
- **49%** 1–2 times per year
- **37%** 3–6 times per year
- **8%** Monthly or more frequently

Source: Omdia © 2026 Omdia

How long does it typically take to deploy an update to your control systems?

Source: Omdia © 2026 Omdia

In practice, traditional upgrade approaches tend to refresh or add hardware and software without resolving the underlying structural issues: limited performance, modularity, scalability, and reuse, brittle integration across vendors, constrained flexibility, and persistent dependence on tightly coupled legacy platforms.

These challenges highlight the urgent need for a more flexible, scalable, and future-proof approach to industrial control.

The Case for SDC

> "I could add controllers whenever I want. I could swap them. Those to me are massive benefits. I can even create, for example, a simulation controller, and run it right there, do all of my testing, and move it over without having to have a separate development system."
>
> Director of Process Control Technology

SDC offers several compelling benefits that address the pain points identified in the survey.

Resiliency:

- Beyond traditional one-to-one redundancy, SDC enables N+1 or better redundancy.
- Rapid failover ensures continuous operation, even in the event of hardware failure.
- Critical applications can fail over to hosts in another physical location.

Scalability:

- Add capacity by spinning up additional controller instances without redesigning cabinets or re-engineering I/O.
- High-performance compute platforms provide substantial processing headroom for future control, analytics, and optimization workloads.

Flexibility:

- Adjust control logic, add I/O points, or reallocate controller capacity through software configuration.
- Eliminate the constraints of hardware decisions made months in advance.
- Supports adding automation workloads without requiring facility shutdowns.

Extensibility:

- Adopt new control system features with reduced disruption by updating control function instances without interrupting production (i.e., update one instance while another continues operations).
- Enables a data-centric system ready for future data-heavy workloads, such as AI, APC, and Edge.

The SDC advantages outlined in this section are not hypothetical benefits: they align with the outcomes survey respondents expect to achieve with adopting the technology, reflecting the high level of awareness of SDC and its potential observed in our research.

Which software-defined control capabilities and benefits are most compelling to your organization?

- 40% Improved availability and reliability of operations
- 40% Improved security and centralized governance
- 38% Better data accessibility and integration with IT systems (MES, ERP, Cloud)
- 35% Easier scaling and centralized software updates
- 31% Higher system optimization and efficiency via ML
- 31% Access to latest technologies without hardware changes
- 29% Reduced project and commissioning time
- 27% Centralized management and orchestration of distributed control functions
- 25% Over-The-Air (OTA) updates for control software and security patches, remote feature activation
- 22% Dynamic reconfiguration of production processes/ lines via software
- 19% Hardware-agnostic (runs on various hardware platforms)
- 18% Simpler deployment of modular or hybrid facilities
- 18% Plug-and-play device onboarding
- 18% Predictive maintenance or energy efficiency via edge analytics
- 17% Lower TCO through OPEX models
- 14% Digital twin integration

Source: Omdia

Addressing Concerns

Notably, the top adoption concerns mirror the expected benefits: respondents want the flexibility and scalability of Software-defined control, but they will only accept it if it also delivers DCS-grade or improved resiliency and secure operation (i.e., high availability/fault tolerance and seamless and secure deployment with guaranteed data privacy and IP protection).

What are your organization's primary concerns when considering the adoption of software-defined control technologies?

44%	Data privacy and intellectual property concerns with cloud/edge components
41%	Reliability and real-time performance guarantees
38%	Cybersecurity risks with increased connectivity and software definition
36%	Integration complexity with existing legacy systems
36%	Meeting regulatory compliance
32%	Upfront cost of migration and new infrastructure
28%	Vendor support, long-term commitment, and ecosystem maturity
23%	Lack of internal skilled personnel/training requirements for new paradigms
23%	Perceived complexity of managing software-defined systems compared to hardware-centric

Source: Omdia

The top concern about **data privacy** is understandable: SDC increases data accessibility. Yet the risk depends on the chosen deployment architecture; it is not an inherent weakness of SDA itself. *For example, on-premise solutions, such as Emerson's DeltaV IQ Controller running on local compute infrastructure, ensure that sensitive data remains within the plant's secured environment.*

Reliability and deterministic real-time performance—critical for 52% of respondents—are among the most frequently raised concerns for SDA. In software-defined architectures, these requirements are addressed through proven control runtimes on redundant virtualized or distributed server-based platforms, with execution placed where timing is needed and availability ensured via high availability and rapid failover.

*For example, Emerson's DeltaV IQ Controller natively supports **1:1 high availability redundancy deployed on fully separate, independent physical hosts**. Automatic built-in fault tolerance and rapid failover ensure control execution, timing consistency, and production continuity with zero disruption if one host experiences a hardware failure. Control workloads can fail over to server hosts in an entirely separate physical location if required, without loss of deterministic performance.*

Cybersecurity is usually implemented by design in modern SDA platforms, with native zero-trust operational technology (OT) security controls, the ability to apply security patches without production downtime, and centralized management that simplifies access controls for sensitive control logic and operational data.

Integration and management complexity, a pain point for heterogeneous DCS fleets, can be significantly reduced by SDA: *platforms like Emerson's DeltaV IQ Controller use the exact same engineering and operations tools teams already use for traditional controllers, and support seamless, secure integration with existing field assets, historians, and MES.*

SDC does not require a complete overhaul of existing infrastructure. Instead, hybrid deployment models allow organizations to:

- Continue operating existing physical controllers while SDC instances handle new areas or expansions
- Use the same I/O infrastructure (CHARMs, remote I/O, Ethernet I/O) and control network
- Maintain the same engineering and maintenance tools for both physical and virtual controllers; there is no need for upskilling

This approach minimizes risk while enabling gradual adoption of SDC capabilities.

Most vendors' SDA platforms offer some level of legacy system integration, but might require more initial integration efforts and a steeper learning curve. Emerson's approach has a clear practical advantage here.

This approach minimizes risk while enabling gradual adoption of SDC capabilities.

Conclusion and Recommendations

"I've been in this industry for so long, 41 years, and I've been waiting for this moment where we didn't have to embed the controllers out in the field that we could, we had enough bandwidth and speed and reliability that we could basically create a controller farm and have, I would say, the ability to expand my control anywhere I need it. I can mock-up an entire plant. On one server.

Director of Process Control Technology

The momentum for SDC is undeniable, with 87% of companies indicating interest in SDA pilot/POC program participation, 47% of them are ready to start now.

How interested is your organization in participating in a software-defined control pilot or proof-of-concept program?

47%
Very interested – we'd like to schedule one immediately

40%
Interested – we'd like to discuss terms and timeline

10%
Somewhat interested – we'd consider it under the right conditions

2%
Not interested at this time

Source: Omdia

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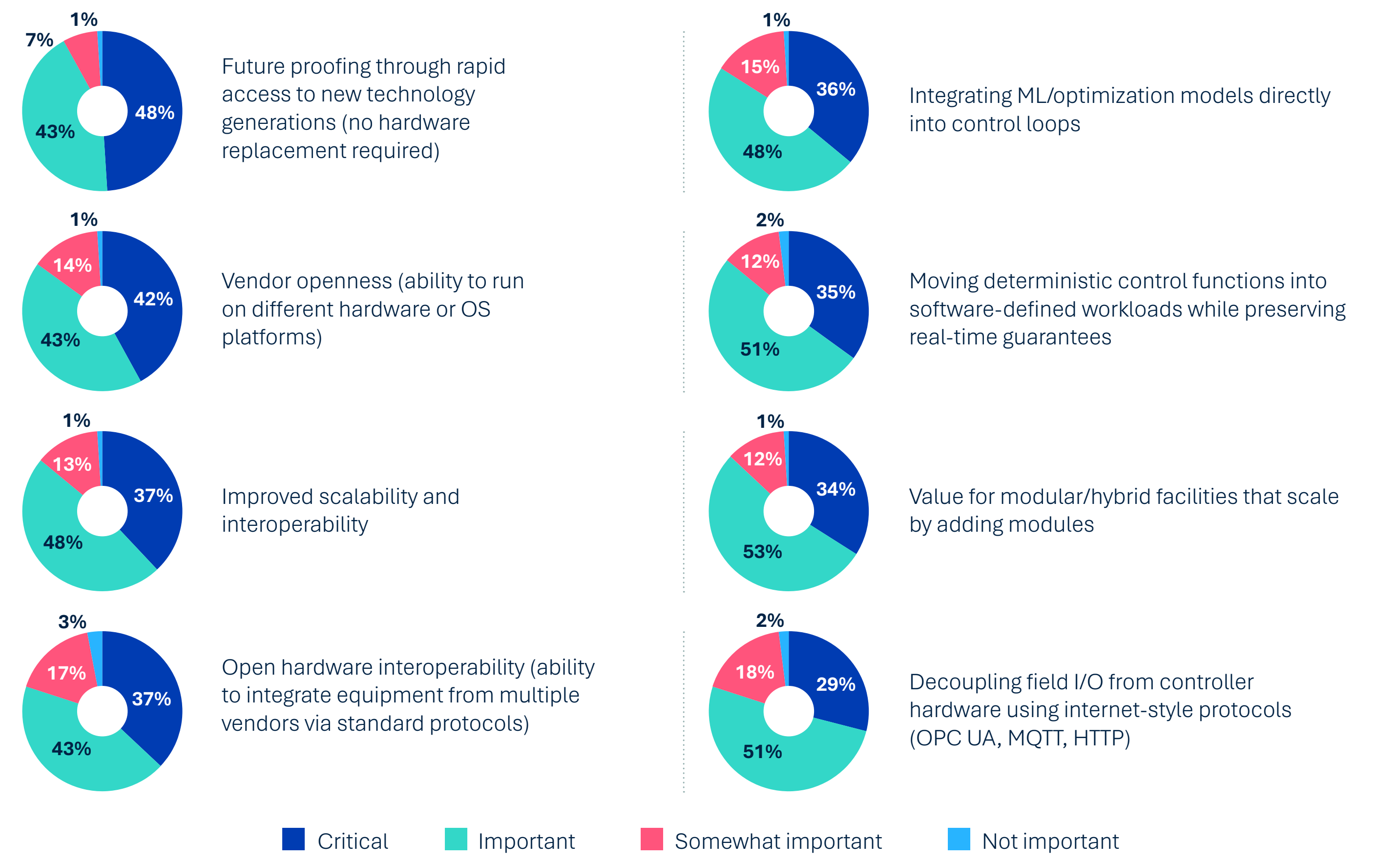
When asked what matters most, companies consistently prioritize futureproofing, vendor independence, scalability, interoperability, modularity, and a stronger digital thread across engineering and operations.

How important are the following software-defined control characteristics?



Source: Omdia

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Recommended Next Steps

The following recommendations translate these priorities into actionable next steps—how to structure pilots, de-risk adoption, and build a credible path from initial deployment to scalable rollout.

1. Establish the foundation: Use a virtualized or distributed server-based platform to host control workloads with built-in high availability and redundancy.
2. Start with a low-risk pilot: Select a non-critical process area for your first deployment. For example, respondents in the survey and our interviews are prioritizing supervisory control or lower-criticality control loops as the initial candidates for implementation.
3. Avoid full rip-and-replace: Deploy SDC incrementally alongside working legacy assets; you can add or upgrade SDC components without production interruptions.
4. Minimize rework: Use native controller virtualization/emulation capabilities to migrate already proven existing control logic to the SDC platform, without rewriting code or re-validating already qualified logic.
5. Use simulation/digital twin to de-risk change: Validate strategies and changes before rollout, and use this to shorten commissioning and reduce rework.
6. Scale gradually through software: Once your pilot is validated, expand deployment to other process areas or sites, and reuse modular control logic to maximize return on engineering investments in critical operations.

Contact your automation vendor to discuss evaluation resources, pilot programs, and next steps. The time to act is now—embrace the future of industrial control with SDC.

Omdia consulting

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