IDC PERSPECTIVE

Software-Defined Industrial Automation: An Update

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EXECUTIVE SNAPSHOT

FIGURE 1

Executive Snapshot: Software-Defined Industrial Automation — An Update

This IDC Perspective provides insight into software-defined automation (SDA) trends and recent developments. It contains a definition of software -defined automation and the drivers behind this trend. It also provides guidance for enterprises on best practices for preparing for what will be a significant shift in the approach to automation in the future.

Key Takeaways

- Past approaches to defining and executing automation systems are becoming incompatible with the data-driven future.
- There have been recent market announcements by major OT providers, indicating the availability of SDA technologies.
- Software-defined automation will result in significant disruption to both technology users and providers, as well as services providers that interact with OT systems.
- A confluence of significant market trends are making the shift to software-defined automation inevitable.

Recommended Actions

- Incorporate consideration of a future where SDA is a commonplace into talent and workforce initiatives.
- Participate in consortia and industry ecosystems that are developing SDA technologies.
- Evaluate legacy systems and road maps for compatibility with SDA approaches to ensure a smooth transition.

Source: IDC, 2023

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SITUATION OVERVIEW

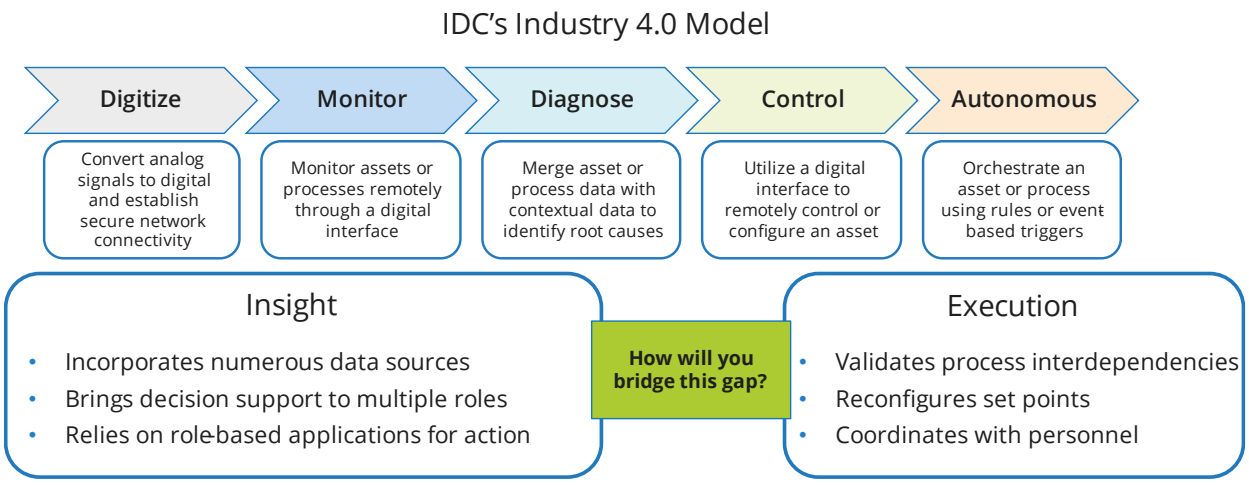
Operations technology (OT) control systems have followed vertically integrated development principles for decades. Industrial operations require reliability and consistency, and users have historically sought very specific functional capabilities with up-front customization and infrequent major changes thereafter. Providers of OT systems such as Rockwell Automation, Honeywell, Schneider Electric, Emerson, and Siemens have developed both the hardware and software components of discrete automation systems, utilizing relatively proprietary approaches and architectures. There has been reliance on OT services providers of many types to build out automation and control systems to meet operational requirements with operators refining processes within relatively fixed prebuilt systems. The skills to program automation systems in certain languages such as ladder logic or interacting with specific brands of OT have been scarce and noteworthy on workers' resumes. The cost of changeovers in terms of both time and capital expense has been high, with many organizations opting for suboptimal business outcomes as a better choice than making changes to adjust to current market conditions.

As organizations expand the connectedness of their industrial operations and the technology is built to new architectures such as cloud-native software and more sophisticated and open-embedded device computing, they are extracting increasing amounts of data that describes and provides opportunities to optimize industrial processes and outcomes. Through this quest to become data driven and capitalize on new analytics capabilities such as AI, organizations are looking to IT paradigms to improve interoperability and central orchestration of these data and information systems for more scalable and predictive analytics outcomes.

It is IDC's belief that presently most industrial organizations have two digital advancement tracks — one for information and data-oriented capabilities that support human decision making and one for mechanical process execution and orchestration that achieve functional capabilities to improve throughput and quality. Closed-loop process control is the bedrock of automation, and it always has been. However, as the systems for measuring and predicting operational outcomes based on more complex and integrated data models evolve, the methods of closing that loop must evolve as well. To achieve upper ends of maturity in either domain will require a merging of the two (see Figure 2). Companies are seeking to capitalize on their data more effectively in operations, and the logical progression of this requires them to use AI-driven data models to close the loop of automation processes.

FIGURE 2

The Convergence of Insight and Execution



Source: IDC, 2023

To achieve this next generation of dynamic, system-level automation orchestration requires a new approach to automation – and the breaking of vertically integrated automation stacks to ones which are open, modular, and software defined across multiple hardware assets. This concept, which IDC describes as software-defined automation (SDA), looks to the datacenter and IT worlds where such phenomena have already driven significant cost savings and optimization of IT environments by utilizing a mix of hardware solutions being orchestrated and executed by a unified virtualized software stack. These same technology trends are now on the cusp of revolutionizing the way industrial automation systems are built.

Today we are seeing an explosion of data-oriented apps, which are orchestrated in the cloud and deployed and run at the edge. We believe this virtualization will extend to control systems soon, and that when it does, it will mark the next wave of digital industrial innovation. According to IDC research, most industrial enterprises report having a significant amount of control systems that were implemented in the 1980s, which are due for updates and replacement. With the alignment of this market requirement and the availability of new virtual PLC and DCS functionality, OT operators should prepare for changes to the hardware, software, services, and skills necessary to remain competitive.

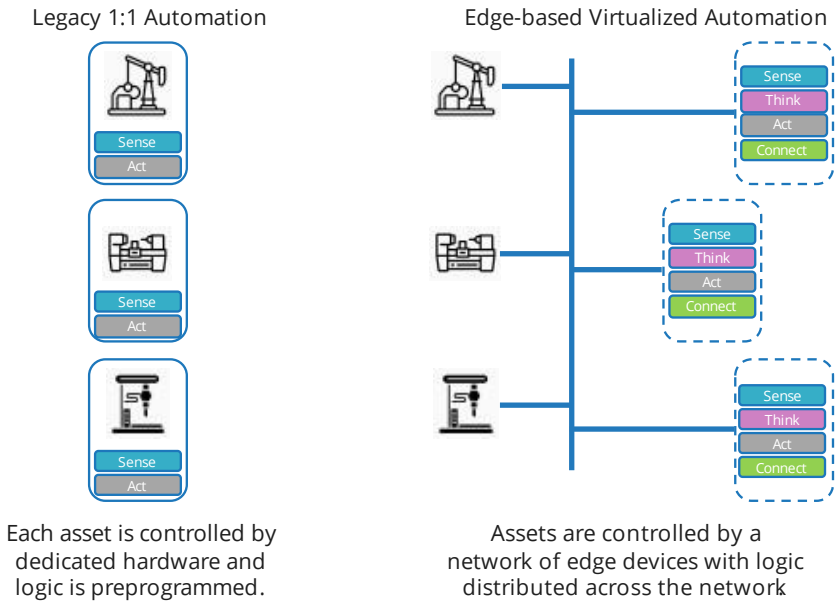
IDC has written on this concept of SDA in years past, making ambitious predictions about its timeline to mainstream adoption. Indeed, for those coming from a traditional OT background, it is difficult to imagine such a shift. Nevertheless, some of the largest industrial automation providers like Siemens and Schneider Electric have made significant investments and announced general availability on such virtualized control and automation system capabilities over the past two years. Significantly, both of these providers made announcements at Hannover Messe 2023 that mark the general availability of SDA capabilities. In discussions with industrial enterprises, the acceptance of such a technology shift has advanced as well and is now a more near-term prospect. IT and OT technology providers, service providers, and industrial enterprises all need to be aware of and incorporate the virtualized automation phenomenon into their road maps to best capitalize on it in the coming years.

What Is Software-Defined Automation and Why Is It Becoming Viable?

Software-defined automation is the integration of open source technologies and standards in industrial processes to control multiple hardware assets from a variety of containerized software running on shared hardware resources (see Figure 3). These hardware resources could be next-generation PLCs, or they could be more IT-like hardware such as ruggedized microservers or advanced networking equipment. SDA is daunting to any industrial operation with longevity because it introduces a series of justifiable concerns. It is also worth noting the significant headwind of traditional OT providers not wanting to accept the business risk and transformation imperative that would come along with such a shift. Indeed, for those OT providers with traditionally architected software and hardware capabilities, they may see entire product lines collapse as companies standardize to best-of-breed solutions across their entire environment. This contrasts with approaches utilizing a heterogeneous mix of software as they do today out of necessity, because the hardware and software are vertically integrated. This was observed in the IT and datacenter worlds when virtualization first took hold – hardware providers could no longer command price premiums and instead had to shift their focus to software, for example.

FIGURE 3

What Is Software-Defined Automation?



Source: IDC, 2023

Despite some challenges and the potential disruption it could bring, a variety of trends are aligning that suggest the market shift to SDA is inevitable:

- **Digital thread and digital twin:** According to IDC research, the bulk of organizations' transformation efforts in operations relate to optimizing the operational data life cycle. Today, they are building out layers of data abstraction and life-cycle management, which enable more complex and multidisciplinary operational data analytics. The goal is to make the use of AI more tangible and reliable and support more predictive decision making. These models, once

sufficiently comprehensive, will serve as the simulation layer that not only predicts and optimizes future operational scenarios but will eventually become closed loop in their ability to effectuate immediate and direct optimization to the automation systems themselves. To cross this bridge will require open automation approaches for that integration to be possible and practical. Once there is confidence in these models, there will be significant industry demand for these models to be capable of interacting directly with OT systems rather than in parallel (refer back to Figure 2).

- **Edge and cloud computing:** Edge computing utilizes cloud-enabled hardware assets in operations to establish a secure connection to the cloud while running processes locally for speed and reliability. In the cloud, mass amounts of operational data can be analyzed at scale while the edge computing elements can act and react to the outcomes of those analytics locally. Companies today are implementing extraneous technology to retrofit existing local automation assets to get data to the cloud. This extra layer limits management and administration capabilities and creates challenges in contextualizing and utilizing OT data. Over time, all OT hardware and software assets will be natively cloud enabled.
- **Open source software:** A key enabler of SDA is the availability and broader trend of open source software and platforms. The goal of many open source systems today is to bridge across numerous proprietary systems. Open source standards in operations have already resulted in meaningful simplification of communication and data protocols, increasing data utilization. It is not a far leap to imagine such open source capabilities moving from the data communication domain (such as OPC UA, MQTT, and ROS) to direct automation capabilities for executing different types of equipment and processes.
- **Standardization efforts:** The Industrial Internet Consortium (IIC), Universal Automation, and several other standards groups are driving ecosystem efforts to build universal and open automation standards. More recently, these organizations have been more end-user driven (versus technology provider driven), indicating the market demand for such a shift that will ultimately pressure the OT providers to play nice and advance toward this goal.
- **Collaborative ecosystems:** This has become a significant trend in the world of operations. Notably, these ecosystems include not only OT providers and OT systems integrators and services but also IT providers and IT systems integrators. These ecosystems incorporating IT and OT technology providers are more likely to produce open and interoperable architectures and protocols for greater speed, repeatability, and leverage across the different technology elements.
- **Generational shift in engineers:** Industrial operations faced skills-based challenges in the recent years. This is not for lack of capable and competent workers. Rather, it is that the workforce possessing archaic skills such as programming control systems in ladder logic is retiring and the next-generation workforce has focused skills development on more modern digital capabilities such as low-code development on platforms. In automation, the approaches to orchestrating assets will need to meet the next generation of workers where they are and that means modernizing to standardize on approaches and interfaces that are familiar to the current and future workforce.

Enterprises also rightly have some concerns about the use of SDA principles and adopting this technology in their operations. First, there are concerns about cybersecurity. As operations become more interconnected and internet connected, cybersecurity is top of mind. If one segment of a system becomes compromised with greater levels of integration, it may mean the entire system may be compromised. The peer scrutiny and openness of open source systems in the IT world have demonstrated that if anything, open source systems are more secure than proprietary systems. Organizations are worried about legacy systems integration. Indeed, there will be a long period where

custom integrations and translations will have to take place to bridge legacy equipment and control systems with these new SDA systems. When we look at the advancement of industrial data protocol translation by companies like PTC Kepware and now an entire ecosystem of such data connectivity solutions, this has a proven track record of being a problem that can be solved in a scalable way. Last, and this is likely the most difficult obstacle to overcome, is human resistance to change. The resistance on the technology provider side is to not give up monopolies on hardware and software, as well as the fear of being disrupted by more digitally savvy upstarts and competitors. The resistance on the technology user side is to not cause disruption to operations and to continue to use the skills and staffing and approaches that have worked in the past. Yet for each, the potential upside of this technology shift is far too great to be ignored, and IDC predicts a significant competitive advantage gap between leaders and laggards as adoption accelerates.

ADVICE FOR THE TECHNOLOGY BUYER

Imagining the transition to SDA will be an extension of transformation journeys that enterprises are already on. To prepare for this change effectively, some advice to technology buyers are:

- **Focus on workforce transformation.** This includes education and training in IT-like disciplines, helping them understand the benefits and inevitability of the transition and fostering a culture of innovation and participation. This will improve willingness and ability to adopt SDA as more of the technological capabilities arrive.
- **Participate in the consortia and working groups around SDA.** With this input, organizations can be confident that the standards and approaches will fit with their environment and not create too many new challenges or disruptions. It is a great way to ensure providers develop products that fit market needs, rather than products optimized for revenue and service revenue generation.
- **Evaluate your legacy systems to determine which areas may require entire overhauls or retrofitting to be interoperable with an SDA-controlled environment.** Instrumentation continues to rise, and organizations sound ensure that when they do so, the instrumentation will be capable of standing up to the demands of SDA or even running SDA capabilities on the devices.
- **Fit SDA into your long-term and comprehensive technology road map.** For example, ask yourself how you might make decisions about data integration and modeling systems and approaches today, if you knew these data models will eventually become the closed-loop control systems of tomorrow. What types of providers and tools would you trust to make that transition simple and effective? What types of capabilities and users would you want these systems to cater to?

SDA capabilities have evolved significantly in the past 24 months, offering a more confident vision of a future that is highly data driven, modeled, simulated, and dynamically controlled and orchestrated in real time for optimization around different business metrics. For example, a company may be able to optimize operations for energy efficiency or throughput on a day-to-day basis based on fluctuating energy pricing. Companies may be able to adjust production goals daily based on weather patterns or available staffing. Once AI and comprehensive data modeling and simulation capabilities can eliminate lengthy and costly changeovers, there are few limits to the ways organizations could adapt for competitive advantage. However, challenges such as cybersecurity concerns, heterogeneous legacy systems integration, and interoperability issues should not be ignored. By planning a road map carefully; collaborating with ecosystems and consortia; and embracing the enabling technologies like

data life-cycle management, edge and cloud computing, and open source standardization, organizations can position themselves well to take advantage of the many potential benefits without opening themselves up to risk.

Note: All numbers in this document may not be exact due to rounding.

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Related Research

- *Advancing Digital Twins Beyond Time Series Data: A Framework for Defining and Categorizing Operational Data* (IDC #US50446923, March 2023)
- *Three Key Considerations to Frame the Industrial Operations Software Architecture* (IDC #US49886122, December 2022)

Synopsis

This IDC Perspective provides an update on the state of software-defined industrial automation. There have been many transformational shifts in industrial operations over the years. The current shift has been largely about extraction and use of operational data for human decision making. Software-defined or virtualized automation and control systems that are fueled by AI-driven data models represent the next significant advancement of the use of technology in physical-world operations.

"We've talked about this idea of software-defined automation for a few years," says Jonathan Lang, research director for IDC's Worldwide IT/OT Convergence Strategies research program. "We are now starting to see general availability of some of this technology, which means we have to speak more practically and prescriptively about the impact to organizations and how to best prepare for it."

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