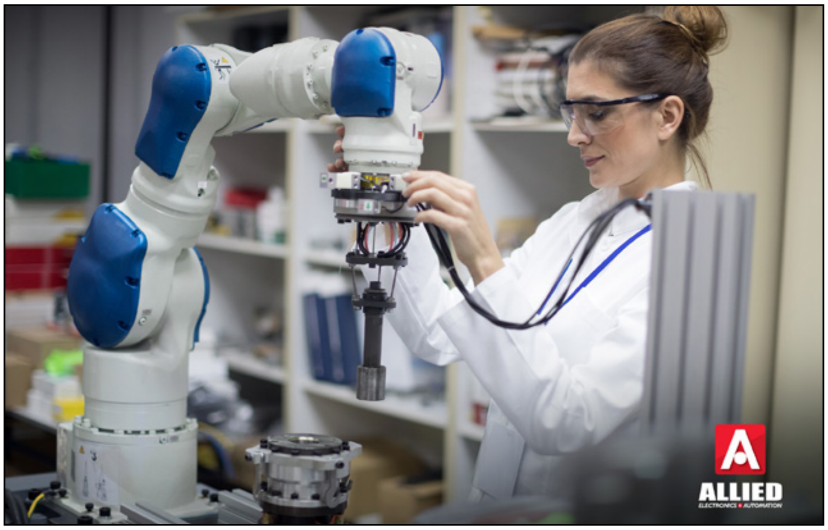
Unlocking Industry 4.0 for Industrial Communications and Control Platforms

Introduction

The concept of Industry 4.0, given all the benefits promised by its implementation, has been a popular topic for years among the companies that want to make that future a reality for their production enterprises. The reality of the new industrial revolution has yet to fully take hold, however, leading to a major question: What does it take to unlock the full potential of Industry 4.0? For industrial communications, this looks like pure, seamless data transfer, regardless of communications protocol, location, or device.

Most industrial automation systems today utilize centralized control strategies with a programmable logic controller (PLC) at the core. Such PLC-centric solutions provide limited remote access, no security, separated safety control and no machine-to-machine communication. In a scanner/adapter system, autonomous devices can hardly coexist; all the inputs and outputs from sensors and actuators must be wired to or from a PLC directly, or through some active or passive devices.

In contrast to today's separated PLC systems, the long-term goal of Industry 4.0 is to create a truly connected plant floor, from sensor to cloud, including such infrastructure as device-level internet connections. To get there, technology will need to continue improving, not just in theory or in specific consortiums but also in



Within their respective consortiums, the technologies are defined by their specifications, like speed of the network and interoperability of the network, and by their integration with devices that are designed to sit on those networks.

Design engineers must ensure that any device to be incorporated into a control system architecture meets the requirements for interoperability with current control platforms. Equally important is ensuring that the integration effort brings value through such results as long-term reductions in hardware deployments and maintenance costs. All efforts must be compliant with respective consortium standards, such as Ethernet/IP, PROFINET and CC-Link IE, as well as other standardized industrial protocols. Beyond these factors, engineers are aware of the increasing need to bridge the gap between information technology and operational technology, including ensuring the security of data transfer, data mining, and storage.

practice within individual manufacturing plants. Participants in this future will learn to shift how they think, jumping cultural hurdles and updating business models on the way. The shift will take time because of deeply rooted, widely used legacy technology and existing employee skill sets specific to those technologies. Upgrading software, hardware and training is costly, and that is a barrier to transition.

Because of the time, cultural, and mental model shifts necessary to make fundamental business changes, legacy technologies tend to keep their hold until an application finally faces financial or technological pressure for change, such as the need to remotely yet securely gather data from the plant floor. Even though surveyed manufacturing professionals seem to universally agree they will benefit from the capabilities Industry 4.0 promises,[1] the reality of evolving to new technology across an application can be daunting, and solid technology support will be necessary throughout the seasons of change ahead.

Industrial communication protocols, among the issues that need to evolve for Industry 4.0 to become a reality, are still shifting from legacy protocols to Ethernet-based versions, and from non-safe to functionally safe variants. Beyond those changes, there is a long way to go to reach the ideals of Industry 4.0: Communication must develop to a point where the specific protocol simply doesn't matter anymore.

Bridging Diverse Communication Protocols

The major communication protocols in use right now, despite all being Ethernet based, cannot communicate with one another.

In today's industrial environment, the lack of cross-compatibility ties each application to a single protocol. This can create problems because manufacturers build devices that work more easily with one communication protocol but not another, leading to unwanted limitations. In the long term, manufacturers will need to change this siloed approach or there must be a clear means of bridging protocols seamlessly. Large regional bases of different legacy protocols and a need to standardize communication in order to optimize next-generation technology will require a nonproprietary communication method that will allow seamless bridging of data from device to device and from device to controller in both non-safe and functionally safe states.

This data bridge seems to be in sight. Technologies designed to eliminate the need to support specific protocols are now rising. These new networking layers create the needed bridge between existing protocols, so devices that previously could not communicate with one another will now gain that coveted interoperability. After all, protocols are a means for transmitting data, and the data itself is what matters.

From Functional Safety to Open Architecture and Beyond

The mere existence of technology that creates bridges between protocols is not enough; it must be adopted across applications for its potential benefits to be realized. Such a shift will take time. Functional safety as a derivative of control within plant architecture is still being implemented in some plant locations. Though the benefits of functional safety are clear—it keeps humans safe, improves quality and efficiency, and reduces the need for expensive mechanical barriers—it is represented in only about 15%–20% of input/output blocks on plant floors.

The number of functionally safe nodes being sold at Molex, as of January 2022, increased tenfold over just six months, and while the average ratio of functionally safe I/O blocks to non-safe blocks in plants used to be about one in 10, it's now closer to one in four[2] in areas or applications where functional safety is deployable. At this time, adoption is increasing rapidly, but it has taken many years to reach this apparent tipping point. The total redesign needed for devices that did not support functional safety has been costly and time-consuming, and, as with all steps into the future, there have been psychological hurdles to overcome as well.

It is reasonable that cost-effective, timely deployment of functional safety is the first step on the path to the desired revolutionary efficiency of Industry 4.0. Functional safety makes it possible for humans to work directly with robots, which is vital for many dynamic automation scenarios, and functional safety-based communication includes certain efficiencies and is more cost-effective once implemented.

Eventually, there will be no difference between a functionally safe sensor and a non-safe sensor, or a functionally safe block and a non-safe I/O block. Each will be able to communicate and meet the requirements for both. From there, the expected next step will entail transitioning to a network that allows all devices to communicate with each other regardless of manufacturer or communication protocol, as described earlier in this document.

The goal of Industry 4.0 is, in essence, to break down the need for centralized controls, boundaries between traditional domains and other historical limitations, and to move forward to something more distributed. Smartphones, for example, have become not only useful but also necessary for millions of people because they replace a variety of single-use tools, like GPS devices, calculators, cameras, and laptops. They accept myriad applications, and can send, receive, create, and act on data without the user taking any extra steps. The user never has to consider whether a photo taken or edited with a particular application can be sent to a person via a particular messaging platform; with some exceptions, all data can be sent through all channels. That level of connectivity in the industrial environment is the dream of Industry 4.0.

The agility inherent at this level of connection — or the comparative clumsiness of its absence — touches every level of the traditional control pyramid. At the same time, the nature of the control pyramid is that each area depends on another, and for that reason, change will not be quick. The earliest changes will likely be in areas of complex machine application where free expression or full cell-based ownership exists, such as a complex machine that can manage all areas of control and logic while still maintaining a connection to the enterprise network.

There are certainly obstacles to this in development and deployment. However, it is expected that the market will align as the benefits of new efficiencies outweigh the challenges of upgrading infrastructure and training people. Consider, for instance, the electric car, which has developed from an interesting idea to an increasingly commonplace reality. Sales of electric cars in 2021 were more than double what they were the previous year.[3] It has taken more than a decade to reach this point from almost zero all-electric vehicles on the road. Hybrid cars have helped bridge the gap as infrastructure, battery technology and consumer expectations align, leading into a future where all-electric vehicles are the norm.

Once it becomes typical for industrial devices to support both functionally safe and non-safe connections, focus will shift to

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distributed control in islands of adoption, where each machine can function as its own control island that can make some independent decisions, building flexibility into industrial control system architecture.

Perfectly Connected

Open, interoperable networks are necessary for dynamic automation and the industrial internet of things (IIoT). The proprietary and semi-open solutions inherent in the current PLC-centric model will not be sufficient.

In an open ecosystem, every device would be interconnected, with no limitations from the communication protocol or any other proprietary piece of the system. Open architectures will give machine builders and their customers the freedom to customize and use the latest technologies, and to more easily add or decommission devices within the ecosystem.

A challenge of converging information technology (IT) and operational technology (OT) is ensuring a safe, efficient, and secure connection between machines, where interfaces can securely distribute, control, transmit, and analyze data points from machine to machine. To gain the advantages of storing data on remote servers when so many critical operations rely on wireless communication, systems that will handle potential failures must be built and implemented. These steps are necessary for digital transformation and will make it possible to successfully integrate IT and OT, laying the foundation for more of the benefits of Industry 4.0, including flexible manufacturing, digital twins and the ability to configure software through enterprise applications.

Getting from Here to There: The Long Road to Industry 4.0

At the current pace of industrial development, it may be 10–20 years before fully connected plants, with a single communication layer, are typical. For now, industry needs to continue moving from legacy protocols to Ethernet-based ones, and adopting and integrating functional safety, whether that is CIP Safety, PROFIsafe, CC-Link IE Safety or Safety over EtherCat.

Together with Allied Electronics & Automation, Molex sees an opportunity to help complex machine manufacturers successfully make those transitions as well as the transitions to come. In the meantime, while islands of specific industrial protocols remain, Molex and Allied will continue supporting the connection to these technologies for both adapters and scanners.

Molex and Allied are committed to providing solutions through every step of the evolution to a fully connected plant floor, including existing solutions as well as custom integrated options, and supporting current Ethernet-based protocols in both non-safe and functionally safe variants. The path forward requires support of current, in-use legacy protocols, as well as a strategy to move into the future of Industry 4.0.

Allied's long-standing relationship with Molex ensures the company is particularly reliable at carrying core Molex products, especially within the industrial space, such as for food processing manufacturers, automotive manufacturing, oil and gas producers, mining companies, and commercial transport. Allied is rapidly increasing its stocked Molex offerings, expecting to double them by the end of 2022.

References

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Dean Donnelly is Director of Products, Industrial Communications, at Molex.

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