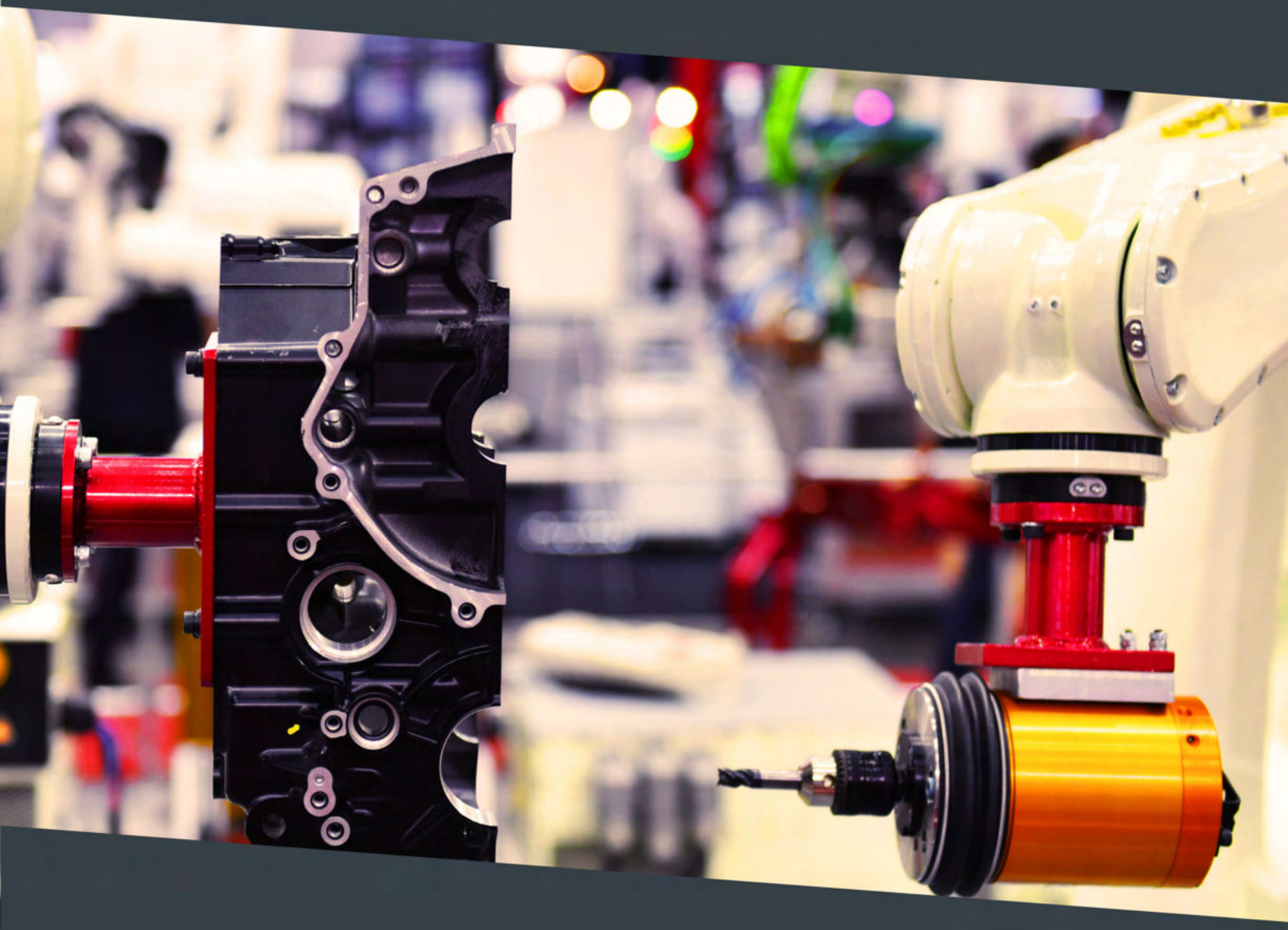
Industrial Gateways

Bridging the Communication Gap



Authored By: Spectrum Controls
Date: March, 2024

Sections

01 | Introduction

In today's swiftly evolving automation landscape, the transition towards smart factories is both a goal and a challenge, fueled by an ever-growing demand for data accessibility. This journey is complicated by the prevalence of mixed-protocol environments, featuring both serial and Ethernet communications, each with its own set of variations and complexities. This exploration aims to shed light on the dynamic landscape of industrial communication protocols, underscoring the indispensable role of gateways in facilitating modern automation in mixed-protocol environments.

02 | Understanding Communication Protocols

In industrial environments, Programmable Logic Controllers (PLCs) play a crucial role in controlling and monitoring various processes. Essentially specialized computers that are designed to control manufacturing processes, PLCs serve as the brain of the automation system. They receive input data from sensors, process it using programmed logic, and then send commands to actuators, motors, valves, and other output devices to control the process. At the heart of this process is the exchange of data and thus, communication protocols. Communication protocols are essential for enabling communication between PLCs, associated devices, sensors, and other components within the industrial system; however, various communication protocols are used depending on the specific requirements of the application. Looking solely at a Rockwell Automation factory, some common protocols include:

DF1: Developed by Allen-Bradley, DF1 is a serial communication protocol that operates over RS-232 or RS-485 and typically used for point-to-point communication

Modbus RTU: Known for its simplicity, Modbus RTU is a serial communication protocol, transmitted in a binary format over RS-232 or RS-485 communication lines.

Modbus TCP: An adaptation of the Modbus protocol that operates over Ethernet networks and leverages the TCP/IP protocol suite for higher-speed communications and scalability.

EtherNet/IP: Similar to Modbus TCP, EtherNet/IP operates over Ethernet networks, leveraging TCP/IP for communication, but is built upon the Common Industrial Protocol (CIP) which offers greater scalability, real-time communication and device flexibility.

These protocols facilitate seamless communication between PLCs, devices. and sensors. allowing for efficient control and monitoring of industrial processes. The choice of protocol depends on factors such as speed, reliability, real-time requirements. and compatibility with existing equipment.

03 | Different Applications Bring Different Needs

Given the various communication protocols and their differing physical medium, creating and/or expanding an automation system can quickly become complicated, as different applications have different needs. Consider the four protocols previously mentioned (DF1, Modbus RTU, Modbus TCP and EtherNet/IP), and there are six possible communication scenarios: (1) DF1 to Modbus RTU, (2) DF1 to Modbus TCP, (3) DF1 to EtherNet/IP, (4) Modbus RTU to Modbus TCP, (5) Modbus RTU to EtherNet/IP, and (6) Modbus TCP to EtherNet/IP. Things only get more complicated when accounting for differences like RS-232 or RS-485, half-duplex or full-duplex, and serial or Ethernet. While the existence of multiple protocols in industrial automation is nothing new, it's worth exploring the factors that create these multi-protocol environments.

04 | A Change in Technology and Protocols Over Time

In the past, data exchange was dominated by serial communications with DF1 and Modbus RTU as leading protocols. Modbus RTU, developed in the late 1960s by Modicon, quickly became a standard for its simplicity and open protocol nature. Meanwhile, Allen Bradley's preference for DF1 solidified its footprint in North America. Despite their durability and efficacy, these protocols were not without speed limitations, where higher speeds meant less reliability.

Everything changed with Ethernet's rise as the predominant communication medium over the past two decades. Innovations by Allen Bradley and Schneider in developing Ethernet protocols have met the speed and throughput demands of end-users. Allen Bradley's introduction of "EtherNet/IP" and Schneider's adaptation of Modbus into "Modbus/TCP" reflect this evolution. Both use a “Client/Server” setup, but EtherNet/IP is more complex and allows devices to take on different roles more flexibly than Modbus/TCP, which is more straightforward but sticks closely to how the original Modbus worked.

05 | Expanding an Existing Application

This complex backdrop reveals the myriad of bridging requirements in industrial communication, such as connecting different protocol environments within modular process skids or upgrading legacy systems. The challenges faced by skid manufacturers and municipalities illustrate the broader issue: the impracticality of a single universal protocol and the enduring presence of mixed protocol environments. This reality prompts engineers to seek solutions for efficient data integration, skid equipment integration, and the modernization of obsolete equipment with minimal disruption.

06 | Replacing and/or Upgrading

Upgrading systems that rely on outdated or legacy equipment presents a notable challenge, primarily due to financial constraints. Consider a scenario where a municipal water treatment facility operates with 30 cells, each equipped with an Allen Bradley SLC5/03 PLC using the DF1 port for communication. The plan is to modernize the plant by adopting ControlLogix PLCs as the new standard, switching to EtherNet/IP for communication. This upgrade involves replacing the SLC5/03s with CompactLogix PLCs across all cells. However, the financial burden of updating all 30 PLCs simultaneously is significant. A phased approach, replacing five PLCs every six months and employing gateways to bridge DF1 and ControlLogix communications, offers a financially viable solution by distributing costs more evenly over time.

This example, alongside others, underscores the ideal yet impractical notion of adopting a single, universal communication protocol across all automation equipment. While appealing, the reality is that a vast array of existing equipment would remain incompatible with such a universal standard, highlighting the complexity and diversity of communication needs in industrial settings.

07 | The Solution

For all the reasons listed above, mixed protocol factories are a reality and that leaves engineers asking how to solve these issues. How do they collect data from mixed protocols, how do they integrate skid equipment more effectively, how can they replace obsolete equipment while maintaining communications and minimizing downtime? The solution is communication gateways. But what is a communication gateway and how do you go about selecting one?

08 | What is a Gateway?

A Gateway is a communications device that extracts data from one device and puts it into another device when the devices have dissimilar communications protocols. They have been around for some time now and all operate on the same basic principle; gather data from one device and move it to another.

09 | Benefits of Using Gateways in PLC Networks

The integration of gateways in PLC networks brings several advantages that significantly enhance the performance, reliability, and scalability of industrial automation systems. Key benefits include:

Enhanced Interoperability

Gateways break down communication barriers between devices using different protocols, enabling them to interact seamlessly. This interoperability is crucial for modern industrial environments where equipment from various manufacturers and generations need to work together harmoniously. By facilitating data exchange across disparate systems, gateways contribute to creating a cohesive and efficient automation ecosystem.

Scalability and Flexibility

With gateways, expanding or modifying an industrial network becomes much more manageable. They allow for the easy integration of new devices and technologies without the need for extensive rewiring or system overhaul. This flexibility ensures that industrial systems can evolve over time, adopting new capabilities and adapting to changing operational requirements without significant disruptions or costs.

Improved Data Management and Accessibility

Gateways can consolidate data from multiple sources into a uniform format, simplifying data management tasks. This data harmonization is essential for effective monitoring, analysis, and decision-making processes. Additionally, remote access gateways enable engineers and technicians to access PLCs and other devices from distant locations, enhancing maintenance capabilities and reducing downtime through timely diagnostics and interventions.

10 | Powerful Tools, with Some Caveats

Despite their significant advantages, it's important to acknowledge the challenges associated with typical gateways to appreciate the full spectrum of their application. One notable downside is the inherent limitation related to the principle of "one box, one set of protocols." This specificity can lead to the necessity of multiple devices for diverse protocol needs, potentially escalating the initial financial outlay and physical space requirements. For example, if you need to bridge EtherNet/IP to Modbus RTU, the gateway you get will do only just that, bridge EtherNet/IP to Modbus RTU, and in a lot of cases, unless you purchase an upgraded version, you only get one serial port limiting the number of connections you can make.

Additionally, the setup and configuration process, involving specialized software, can introduce a layer of complexity and require a time investment. This not only involves the initial setup but also ongoing maintenance and updates, which may necessitate specialized knowledge or training. The complexity can be a barrier for some users, potentially leading to underutilization of the gateway's capabilities or reliance on external technical support, thereby increasing operational costs.

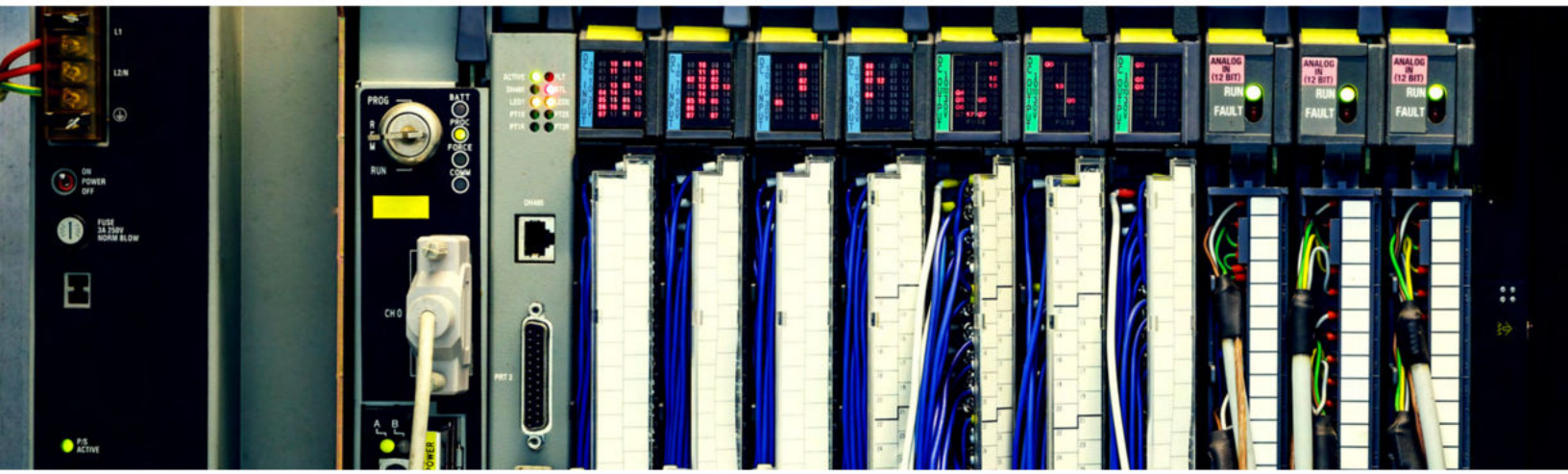
11 | Choosing the Right Gateway for Your Industrial Network

Compatibility and Protocol Support

The foremost consideration is the gateway's compatibility with your existing and anticipated devices and systems. It's essential to choose a gateway that supports a wide range of communication protocols to ensure interoperability among diverse equipment. The Spectrum Controls Universal Industrial Gateway exemplifies this quality by accommodating multiple protocols, both serial and Ethernet based, making it a versatile choice for varied industrial environments.

Configuration and Management Ease

Ease of configuration and ongoing management are critical for minimizing setup times and facilitating maintenance. Browser based vs desktop based user interfaces and user-friendly, intuitive configuration tools with context-sensitive help can significantly reduce the technical burden on your team, enabling quick adjustments and simplifying the integration process.



Advanced Data Handling Capabilities

Consider gateways offering more than just protocol conversion. Advanced data processing features, such as data aggregation, filtering, and routing, can provide significant benefits. They enable more effective data management and pave the way for sophisticated applications like real-time monitoring, analytics, and integration with cloud services or IT systems. This consideration is increasingly important as industries move towards more data-driven decision-making processes.

11 | Choosing the Right Gateway for Your Industrial Network (continued)

Scalability

Your chosen gateway should accommodate future growth and technological advancements. A scalable solution allows for easy updates and reconfiguration to meet evolving needs, ensuring a long-term return on investment. The modular design and software flexibility of the Spectrum Controls Universal Industrial Gateway serve as excellent benchmarks for scalability.

Application-Specific Requirements

Finally, your specific application needs should guide your gateway selection. Consider the environmental conditions, such as temperature extremes or exposure to dust and moisture, and ensure the gateway is suitably ruggedized. Additionally, evaluate the support and warranty services provided, as these can be crucial in maintaining operational continuity. Choosing the right gateway involves balancing these considerations to find a solution that aligns with your technical requirements, operational goals, and budget constraints. The right gateway not only facilitates seamless communication across your industrial network but also enhances data management, supports scalability, and positions your infrastructure for future advancements.

12 | Summary

In this paper, we explored the crucial aspect of communication in factories of the past, particularly focusing on the challenges that arise from needing different systems to interact harmoniously. Imagine a scenario where equipment from various eras had to communicate but found themselves hindered by a language barrier. This is the reality for many environments, stuck navigating a labyrinth of communication methods that don't seamlessly integrate.

We took a closer look at some of the primary communication protocols used in these settings, such as Modbus and EtherNet/IP. Each protocol serves its purpose, but the transition from traditional serial communications to faster Ethernet options introduces a fresh set of challenges, primarily ensuring compatibility and understanding across systems. When it comes to selecting a gateway, it is essential to choose the right tool for a specific job. The ideal gateway needs to complement the existing infrastructure, offer simplicity in management, and possess the ability to scale with future developments. From enhancing manufacturing processes to powering energy sectors or managing water treatment, gateways prove their worth by smoothing out operations, optimizing data utilization, and facilitating the upgrade of outdated systems.

In closing, gateways stand as critical elements in smoothing operational transitions, optimizing data utilization, and updating outdated systems, ultimately positioning industrial setups for future advancements.