CAN EDGE CONTROLLERS BRING BALANCE TO THE INDUSTRIAL IOT?

By Philip Ling | January 19, 2022

Autonomy is part of automation in the Industrial IoT, but how do we put that much control at the edge of the network?

The digitization of automation continues. The earliest examples of automation used steam-driven effort, transferred through linkages and regulated with governors. Control changed with the introduction of electrification. Soon after, electrification also redefined the creation and delivery of mechanical effort.

Today, electronic control systems close the loop between effort and effect in a way that was not possible with pure mechanical systems.

At its simplest, a programmable logic controller (PLC) applies predefined logic to the status of one or more inputs, to set the status of one or more outputs. While the PLC has evolved alongside automation, its predefined nature is becoming more relevant and differentiating. It implies that its design fixes its functionality and so will never change over the service lifetime of the PLC. Connectivity has brought with it an appetite for agile immediacy, which means industrial control is becoming more flexible and responsive.

The simple nature of a classic PLC is intentional. The design intention is for them to function in a monotonous but reliable way. But progress demands more. The internet and, specifically, the IoT, require connected devices to be smarter. They also require a connected solution that operates in a fast, flexible and secure way. These features were not high on the list of must-haves when PLCs were conceived.

Modern PLCs strive to match these demands by adding more connectivity and will continue to meet the needs of many OEMs for years to come. However, the general trend toward putting more processing power at the edge of the network is influencing the way control systems are developing.

The hard edge of the Industrial IoT

It's difficult to think of anything closer to the network's edge than the output stage of an industrial process. It is literally where concept becomes reality. This is the domain of hard real-time control systems that must be robust and reliable.

Conversely, with the increased adoption of connectivity, cloud processing resources are taking on the analysis of data generated at the edge. This highlights an issue. The edge creates a lot of data, which becomes costly to move to the cloud. Also, the cloud is not real-time and is, by comparison, very inconsistent in the time it takes to send and receive data. Technologies like time-sensitive networking (TSN) are now addressing this. See "What does single pair Ethernet bring to the IIoT?" for more information on TSNs. But for many real-time systems, the lack of deterministic latency restricts the value cloud processing adds to industrial processes.

This is where edge processing steps in, by putting the processing capability of the cloud into a device that sits at the network's edge. It is important to differentiate performance and capability. It would not be possible with today's processors to put the same amount of performance accessible in the cloud into an edge device. But when it comes to analyzing data, it is possible to put some of the computational capability needed at the edge.

The edge controller is where the information technology (IT) domain meets the operational technology (OT) domain. While other platforms, such as industrial PCs, are more focused on the IT side, PLCs and programmable automation controllers (PACs) are still more focused on the OT side. This creates an imbalance between IT and OT capabilities.

The edge controller, however, represents a solution that balances both IT and OT. An edge controller is only successful if it achieves this in a way that satisfies the engineers on both sides of the equation.

Edge controllers strike the right balance between IT and OT

There are many ways to achieve this balance. One approach is to develop two separate systems and enable them to exchange data using some form of common protocol. Another might use a single platform with virtualization. This keeps the two halves connected yet separate.

There is no single way of implementing an edge controller. It may involve multiple processors; it will probably use multiple operating systems. On the OT side there will almost definitely be a real-time, deterministic operating system handling the control, with various industrial protocols. The IT side must interface with the cloud and servers using their language, which means it will likely communicate over Ethernet. The mechanisms used to connect the two halves will be critical.

Heterogeneous multicore processing architectures for industrial applications are now available, designed to provide the right platform for edge controllers. These highly integrated devices provide application-class processors for handling the non-deterministic activity, and a capable microcontroller for real-time control.

The RZ/N1 system-on-chip (SoC) family from Renesas is a good example. This SoC group includes versions that feature an Arm Cortex-A7 MPCore sub-system. This sub-system has either a single or dual A7 cores, integrated alongside an Arm Cortex-M3. The RZ/N1 makes an effective platform for systems that employ multiple protocols, which is the case with modern industrial control solutions like gateways and edge controllers.

There is extensive software support for the RZ/N1 from Renesas and its software partners. This includes middleware from the German real-time software specialist, Port GmbH. Port produces the generic open abstraction layer (GOAL) communications middleware for industrial applications. The version of GOAL for the RZ/N1 makes use of the SoC's many features, including the HW-RTOS, a hardware acceleration block for the Cortex-M3's operating system. For more on the HW-RTOS, check out: "Behind the datasheet: HW-RTOS"

Software support also comes from CODESYS and its implementation of Open Platform Communications-Unified Architecture (OPC-UA). This also highlights the shift toward using service-oriented architectures (SOA) in the Industrial IoT. For more insight on how SOA is being adopted in the industrial IoT, read the companion article "Supporting a service-oriented approach in the IIoT."

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