Adding Process Control to a PLC-based System: Challenges and Opportunities

Are We There Yet?

The history of the automation industry has been a history of engineering and technical advances, yet sometimes these advances seem to barely keep pace with the increased demands from the corporations and organizations that use them. New field devices, more complex processes, a need to feed data into corporate computer networks—all these requirements and more can be a source of frustration for busy control engineers.

As automation applications grow and change at an increasing pace, systems that once seemed powerful and future-proof gradually begin to look less capable. Even advanced control systems that have worked well for years are nonetheless limited by the design assumptions and manufacturing capabilities at the time they were specified.

A Little History

Automation systems of the past were often developed to serve a specific purpose in a specific industry. For example, programmable logic controllers (PLCs) were originally developed to replace banks of physical relays that controlled and monitored discrete machines and equipment, such as the on/off controls in a bottling plant. These relays were essentially switches that were either open or closed, and the ladder logic programming within the PLC was designed to mimic the action of the original relays.

In a largely discrete system such as this, the job of the central controller is to systematically read the states of all input/output (I/O) points, solve the logic, and then write back to the I/O, repeating this pattern over and over again very, very quickly. PLCs are fast.

Enter Analog

In contrast, many complex processes such as oil refining and wastewater treatment use smaller quantities of on/off digital signals. These processes involve large numbers of variable analog signals for temperatures, pressures, variable pumps, and the like. A different type of system, the Distributed Control System (DCS), was developed to accommodate them.

In a DCS, the reading, writing, and logic solving is not concentrated in the central controller. Instead, much of it is distributed to smaller intelligent units, usually located near the device being monitored or controlled. The central controller provides overall supervision.

Distributed intelligence was essential for process control because analog signals and the logic needed for them require much greater processing power. Converting electrical signals into degrees Celsius, as just one example, involves a complex mathematical formula. One controller simply could not handle all these analog tasks at once; but a division of labor enabled even very large systems to run smoothly.

Now for Today's Challenges

Today's automation applications are less narrowly defined than in the past. Today, both discrete control and process control are often required to get the job done. We can see this trend toward hybrid systems in the offerings of some of the largest DCS manufacturers, for example Emerson's DeltaV® and ABB's Freelance®.

Adding Process Control to a PLC-based System

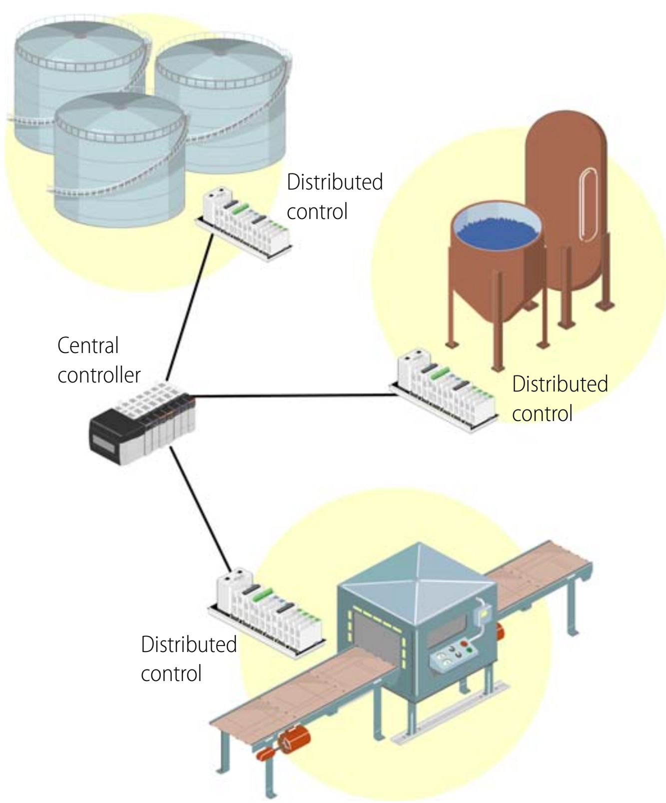
Control engineers who have spent most of their time developing and running discrete systems may now need to add process control for the first time. Because of the architectural differences between a PLC-based system and a DCS, approaching a hybrid system from the PLC side can offer some challenges.

Alternatives for Process Control

Adding process control to a PLC-based system presents problems of cost, integration, and system performance. A full DCS is hard to justify due to its size, expense, and the complexity of learning such a system. For companies doing small- to medium-sized process control, for example in pharmaceuticals, the food and beverage industry, or water and wastewater, a full DCS is, frankly, overkill.

Using one of the newer hybrid systems from a DCS manufacturer may mean abandoning an existing system that's working fine. Conversely, integrating a DCS with your existing system is difficult because these systems are proprietary; traditionally they were designed as closed systems, both for manufacturing and marketing reasons.

A DCS Distributes Processing Power



PC-based process control is a possibility, but operating system reliability and the cost for industrially hardened hardware are concerns. Integration may also be difficult, involving engineering time and expense.

What about simply using the PLC for process control as well as discrete manufacturing? Newer PLCs offer analog functions, and PLC manufacturers have added functionality to meet process control needs.

But both PC-based control and PLC-based systems lack the distributed intelligence that is the main advantage of a DCS. So any substantial amount of analog logic will slow down scan times, increase network traffic, and adversely affect system throughput. While slower scan times for analog devices may be acceptable, a PLC also running digital control can't afford to slow down critical digital response time.

Supercharging Your PLC System

What if you didn't have to choose between a PLC-based system and distributed intelligence for process control, but could have the best features of both? What if you could supercharge your PLC system for process control?

Here's a way to do just that, by adding intelligent remote I/O to your existing PLC-based system.

EtherNet/IP™ for Communication

Like a DCS, PLC-based systems used to be closed and proprietary. But today many such systems—for example, Allen-Bradley® ControlLogix® and CompactLogix® PLCs—use a common communication platform consisting of an Ethernet network and EtherNet/IP, an industrial protocol developed by A-B and currently supported by ODVA (Open DeviceNet Vendors Association).

Challenges and Opportunities

The major advantage of EtherNet/IP is that it provides a widely used, standard conduit for communication between products from various vendors. So a PLC that uses the EtherNet/IP protocol can communicate easily with devices from other manufacturers. And this interoperability gives you choices.

Like your Information Technology (IT) department, which may use Microsoft® software and Dell® computers but chooses printers and peripherals from other vendors, you as a control engineer can use EtherNet/IP-capable hardware and software, such as Allen-Bradley CompactLogix and ControlLogix PLCs and RSLogix, but choose I/O for specific purposes from another vendor.

New Choices

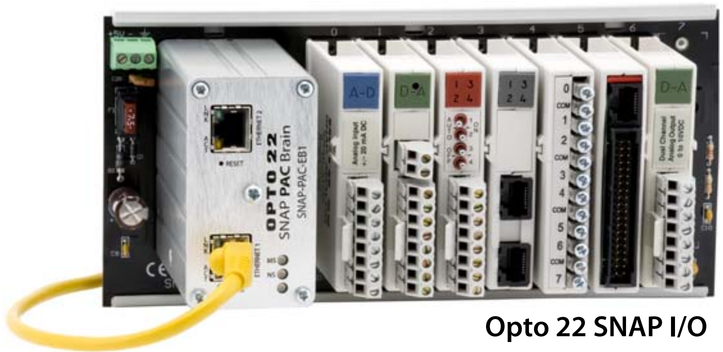
PLC systems by their very nature do not include distributed control. As you are well aware, when you add analog I/O, you must also add new ladder logic to process that I/O. But additional logic and more I/O points eat up processing power, impacting overall system performance by increasing network traffic and slowing scan times.

One of the more exciting choices EtherNet/IP presents, however, is the possibility of augmenting a PLC-based system with I/O that's designed for process control. You can choose to add the distributed intelligence of a DCS to a PLC-based system.

SNAP I/O™ from Opto 22 can augment an A-B ControlLogix or CompactLogix system—or another PLC system that uses EtherNet/IP (such as MicroLogix 1100/1400)—by doing exactly that: providing intelligent remote I/O that offloads many I/O functions, especially those involving the heavy analog signal processing required by most process control applications. With remote I/O that handles such functions as ramping, thermocouple linearization, analog scaling, and proportional-integral-derivative (PID) loop control, the PLC can continue to do its normal job with little impact.

The No-Programming Alternative

In a PLC-based system, communication with most remote I/O is through a bus coupler. In the past, putting intelligence at the I/O level meant buying another PLC and programming it, either in ladder logic or by learning a new programming language. Both require development time and expense.



Opto 22 SNAP I/O

The advantage of Opto 22 SNAP I/O is that it does not require programming. All I/O functions are built into the I/O, in a device called a *brain*. The brain provides communications, like a bus coupler, but it also provides automatic I/O processing. As soon as the I/O is configured, the brain immediately begins processing. Compatibility with A-B PLCs is guaranteed because SNAP I/O is EtherNet/IP conformance tested by ODVA.

Built-in Remote I/O Functions

For process control applications, the following built-in analog functions in SNAP I/O are especially useful:

- PID loop control (up to 96 loops per brain)
- Minimum and maximum values
- Analog scaling
- Calibration
- Ramping
- Totalizing
- Engineering unit conversion
- Thermocouple linearization
- Temperature conversion
- Watchdog timeout
- Output clamping

In addition, SNAP I/O offers these serial and digital functions on the same I/O rack:

- Multiple serial device control (RS 232/485)
- Input latching
- Digital filtering
- Quadrature counting
- High-speed counting

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- Watchdog timeout
- Pulse generation
- Pulse measurement
- Time-proportional output
- Frequency and period measurement

The ability to add all these functions in remote I/O with no programming and little impact on the overall system may well be the supercharger your system needs to succeed with new process control tasks.

Who Is Opto 22?

Opto 22 was started in 1974 by one of the co-inventors of the solid-state relay (SSR), who discovered a way to make SSRs more reliable. The company developed the red-white-yellow-black color-coding system for input/output (I/O) modules and the open Optomux® protocol, and pioneered Ethernet-based I/O.

Opto 22 is probably best known for its high-quality SSRs and I/O, both of which are manufactured and supported in the U.S.A. and guaranteed for life. In a time of financial uncertainty and increasing budget restraints, the company is especially attractive for its continuing policy of providing free product support, free training, free documentation, and free pre-sales engineering.

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