EtherNet/IP Provides a Single Network for Complete Machine Control

VFD and servo drives benefit from simplified design, operation and maintenance

Bob Hirschinger, principal engineer for motion controller/software products, Rockwell Automation

Machine builders are enjoying a new level of machine design flexibility through the use of a single network for their entire machine, including VFD and servo drives for integrated motion control. That’s because advancements to EtherNet/IP, the world’s leading industrial network, enable it to deliver the speed, sophistication and precision demanded by motion control applications. This eliminates the need for a dedicated motion network and provides a simplified network solution.

The game changer occurred recently when ODVA extended the CIP network specifications to include CIP Motion technology. Soon after, Rockwell Automation introduced new motion control products including servos and VFDs, which provided high-performance, closed- and open-loop drive control using CIP Motion technology on EtherNet/IP. Built on the Common Industrial Protocol, EtherNet/IP uses a single version of Ethernet to handle a wide variety of applications, ultimately helping users manage real-time control and information flow throughout the manufacturing and IT enterprise.

Unlike some Ethernet-based networks, EtherNet/IP uses the same Ethernet and TCP/IP standards as e-mail, the Internet and many other popular commercial & business protocols, without modification. By using standard Ethernet and TCP/IP, EtherNet/IP users can seamlessly connect machines and their motion applications with an end user’s production and business enterprise. Plus, it enables machine builders and their customers to take advantage of commercial and business technologies, ranging from products like routers, switches and cameras to capabilities like voice, video and telephony. It also opens new doors enabling machine builders to offer value-added services by adding secure remote access through their user’s standard business infrastructure.

An open network protocol enables vendors to develop interoperable products, which helps simplify design, programming and integration into new and legacy systems. Today, over 250 vendors supply over 850 product lines and several million installed devices on EtherNet/IP. This allows machine builders to easily integrate an ever-growing list of products into their motion application through an EtherNet/IP network. Products range from commonly networked devices like I/O and HMIs (human-machine interfaces) to robotic and vision systems to smaller devices such as feedback sensors.
One Network, Two Roles

Over the years, the need for different networks has disappeared as machine builders rapidly expanded Ethernet’s usage to include most, if not all, of the space occupied by traditional field busses. This began with information systems, led to I/O control and safety and now has extended to include integrated motion control. To address motion control, ODVA added CIP Motion and CIP Sync technologies to the CIP network specification.

CIP Sync is a time synchronization extension to CIP, based on and fully compliant with the IEEE-1588 Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems. CIP Sync provides the increased control coordination needed for demanding events sequencing, distributed motion control and other highly distributed applications, where absolute time synchronization of devices is vital. With this technology, synchronization down to 100 nanoseconds can be achieved using unmodified, standard Ethernet hardware.

Meanwhile, CIP Motion provides deterministic, real-time, closed loop motion control over the standard, unmodified Ethernet of EtherNet/IP. With the addition of CIP Sync, multiple axes can be coordinated for precise, coordinated motion control applications. CIP Motion's use of time-stamped data along with its simple timing model eliminates any hard synchronization constraints between the drive and the controller. Real-time data values are adjusted at the end device at the time the data is applied, no need to hard schedule the network traffic. CIP Motion delivers an open, high bandwidth, high performance solution for multi-axis, distributed motion control.

Now, thanks to these motion control advancements to standard networking technology, new VFD and servo drive solutions can be used on machines with a single network architecture. For example, the Allen-Bradley® Kinetix® 6500 servo drive and the enhanced Allen-Bradley PowerFlex® 755 AC drive from Rockwell Automation offer integrated motion capabilities on EtherNet/IP. These products offer high-performance, closed- and open-loop drive control using standard Ethernet and IP technology. This marks an industry first: machine builders can now unite both drive technologies on a standard, unmodified network.

The benefits go beyond connectivity – using a single EtherNet/IP network creates a common platform for a machine’s configuration, programming, commissioning, diagnostics and maintenance. This helps enable machine builders to precisely coordinate the control of multiple axes for both VFD and servo drives. In turn, this provides tighter integration while giving OEMs the simplified architecture they need to streamline design and development. Using a common network, they can meet all of their machine’s control and information needs, connect to the end-user’s infrastructure and provide secure remote access for value-added monitoring.

Minus the Limitations

Many other networks fall short due to network topology limitations. An EtherNet/IP network with EtherNet/IP drive hardware in place, however, allows machine builders to deploy any Ethernet topology. In addition, many EtherNet/IP products include embedded dual port switch support for implementing a linear (daisy chain), or device-level ring (DLR) topology without the need for an external switch.

Designed to increase installation flexibility, DLR delivers the resiliency needed for high-speed, high-performance applications. When a DLR detects a break in the ring, it executes alternate routing of the data to help recover the network at extremely fast speeds – less than 3 milliseconds for a 50-node device-level ring. That means the machine continues operating without interruptions. In addition, diagnostics information is provided to pinpoint the location of the failure for quick recovery.

Regardless of the topology, use of a standard EtherNet/IP network now allows VFD and servo drives to integrate seamlessly with the rest of the plant’s existing infrastructure, as well as other devices, from distributed I/O and smart actuators to robotic and vision systems. With EtherNet/IP, machines also have the flexibility to use fiber or copper media.
Integrated Motion Gains Momentum

Bringing servo and VFD drives together on the same network gives integrated motion applications a broader power range, from 0.1 to 650 horsepower, along with a wider range of device options. Machine builders can integrate motion devices with other commonly networked devices, like I/O, valve manifolds, weigh scales, temperature controllers, vision, robotics, and HMIs (human-machine interfaces). They also can round out their application with a broad range of rotary/linear motors and linear actuators to help provide the right solution for almost any application. This gives machine builders a common programming, configuration and commissioning environment for all motor control technologies.

In addition to using a single network, integrated motion on EtherNet/IP supports drive configuration, programming, commissioning, diagnostics and maintenance using a single software package. To implement an EtherNet/IP-based motion application, machine builders follow familiar steps for both VFD and servo drives. Standardized operation and consistent behavior creates a common, simplified user experience. They start by picking the best hardware and network topology for their application and then configure, program and commission the drive and application for production.

Optimizing Hardware Selection

The critical first step – choosing the right hardware – is easier when VFDs and servo drives share a network and a single software environment. To avoid over- or under-sizing servo drives at this step, many machine builders utilize the mechatronics design approach. Mechatronics allows engineering teams to collaborate in a virtual environment rather than work independently and manually, to design separate pieces of the overall machine. To help create a common forum, tools like Motion Analyzer software from Rockwell Automation help machine builders more easily gather and develop design input from mechanical, control and electrical engineering teams.

Recent advances take mechatronics to the next level because development software like Motion Analyzer now supports both VFD and servo drives. This makes it possible to address both drive technologies early on and streamline development time and cost while ensuring a tightly integrated architecture that includes control, motion and safety among other capabilities.

Convenient Configuration

Integrating motion capabilities on EtherNet/IP streamlines configuration, as well. Configuration is a simple matter of entering the catalog number of the drive, motor, and actuator. All of the device configuration parameters are automatically set based on the catalog number and mode of operation selections. In most cases, the default parameters result in optimal machine operation and no further actions are required. However, users are able to customize the configuration parameters using integrated commissioning tools like auto tune and manual tune. The configuration parameters and firmware revision are automatically downloaded to the devices on power-up and any time a device is replaced.

Advanced Programming Support

One of the major benefits of the EtherNet/IP integration of VFD and servo drives is access to a common, extensive range of motion functions. Support for pt-pt moves, multi-axis gearing, position/velocity camming (PCAM), multi-axis interpolation and kinematics is common for both drives. It is now easier to program and execute high level position functions like PCAM-ing multiple VFD and servo drives with complex registration phase correction algorithms to a common virtual machine master. The motion functions are supported in multiple languages like ladder, structure text (ST) and sequential function chart (SFC).
Reusable code objects, called Add-On Instructions (AOI), are another new, sharable resource. Designed to help ease reuse, reduce project development time and improve consistency, AOIs allow machine builders to encapsulate commonly used logic as sets of reusable instructions. Furthermore, machine builders can merge existing standardized libraries they’ve created to share programming by bringing VFD and servo drives together on an EtherNet/IP network.

**More Maintainable Machines**

Reducing the number of networks helps ease machine maintenance, as EtherNet/IP provides more powerful diagnostics and troubleshooting capabilities. For example, if a single drive faults, an EtherNet/IP-based application using a software package such as Rockwell Automation RSLogix 5000 can pinpoint the problem drive and gather comprehensive information about the error. It then relays the data to the maintenance team so they can solve the problem.

Meanwhile, the software program time-stamps and logs detailed alarm, fault and status information, providing precise drive-speed and position regulation. This helps end users better understand the status of a machine’s controllers, motors, actuators and other automation devices.

While several software programs offer these capabilities, using a single network for VFD and servo drives creates a tighter troubleshooting process. It simplifies data collection, helping maintenance teams more quickly identify and solve the problem. This brings significant value to motor-intensive machines, some of which have more than 100 drives.

**Smart Machines, More Power**

EtherNet/IP gives machine builders access to other intelligent features as well. For example, many Ethernet/IP devices and drives offer embedded Web pages to provide high-speed access to critical drive data. Operators can monitor real-time performance, safety and network data, as well as alarm and fault history, lost packets and power peaks – all through a Web browser.

This real-time information – along with remote access capabilities – helps keep machines up and running. EtherNet/IP enables machines to relay the condition data back to the machine builder, who can then provide secure, remote diagnostics for a machine, including its critical servo assets. In addition, harnessing EtherNet/IP’s IT capabilities like voice and video gives OEMs the eyes and ears they need to thoroughly understand the machine’s condition. By taking vital action before a machine fails, machine builders and their customers save time and money.

Bringing commonality to the network architecture helps machine builders cut costs and complexity while taking integration to the next level. Ultimately, this helps machine builders sharpen their competitive edge with higher-performance, more flexible machines.

www.rockwellautomation.com