Rockwell Automation

Modernizing from ControlNet to EtherNet/IP

Minimize concerns with modernizing

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Introduction

ControlNet® protocol has been a reliable network solution for Industrial Automation and Control Systems (IACS) for the past 25 years. Moving forward, customers will be able to optimize their asset utilization better using EtherNet/IP™ protocol than with ControlNet. This is, in part, because tools and skilled technicians are more widely available for EtherNet/IP than for ControlNet. In addition, lifecycle management will be more achievable with EtherNet/IP than with ControlNet, as EtherNet/IP products will be available for a much longer time period. Although many ControlNet products will be available for years, new installations should utilize EtherNet/IP because ControlNet products are moving from Active to Active Mature status.

EtherNet/IP is the wired and wireless network technology which enables The Connected Enterprise. New insights that are revealed through enhanced data access can help reduce bottlenecks, implement demand-based decisions and improve maintenance. Greater digitization can help reduce downtime and improve profitability. Digital twins, for example, can be used to optimize machine designs or test production changes before you implement them. Connected products or services can create entirely new revenue streams.

EtherNet/IP takes advantage of many features originally developed for use in the IT field, such as DHCP and switching technologies because it is based on standard, open Ethernet.
Long time users of ControlNet should understand the following topics related to EtherNet/IP and modernization from ControlNet to EtherNet/IP.

Media

Where ControlNet topology options were limited, there are many choices for EtherNet/IP topologies. ControlNet users are familiar with industrial RG-6 coax cable. When moving to EtherNet/IP, there may be questions concerning which copper cable to use. If fiber was used in the ControlNet installation, that same fiber can be reused in the EtherNet/IP installation, although it is likely that new connectors will be required. Specific guidance around Category 5 vs. Category 6, shielded vs. unshielded and other cabling topics can be found in the white paper titled Guidance for Selecting Cables for EtherNet/IP Networks, https://literature.rockwellautomation.com/idc/groups/literature/documents/wp/enet-wp007_-en-p.pdf.

System Sizing

Although there are a few simple rules for sizing a ControlNet system, such as the graph of the number of nodes supported per segment, EtherNet/IP network design is more flexible and more scalable than ControlNet. For example, most Rockwell Automation® products simplify IP addressing with rotary switches that are available on the product. These rotary switches provide for 254 EtherNet/IP addresses compared to the 99 nodes that are available on a ControlNet network. In addition to the simple use of rotary switches, EtherNet/IP can be implemented for larger networks by configuring the addresses statically within software. Optionally, IP addresses can be set dynamically by the Stratix® managed switch, either per port or by position in the DLR ring.

System Validation

By using the RSNetWorx™ for ControlNet application, it was clear that the deployed application would work as designed. To provide confidence that an EtherNet/IP application will perform as designed, the Integrated Architecture® Builder (IAB) tool can be used to lay out and validate the entire control system,

including, but not limited to, the network. Download IAB from the Product Selection Toolbox™ collection or the mobile app. IAB includes many how-to videos that assist in getting started with IAB.

Active Network Components

No active network components are used in ControlNet except for repeaters, which are only required under certain conditions. EtherNet/IP networks often require Ethernet switches. The simplest switches are called unmanaged and do not require configuration. Managed switches allow the user to configure many aspects of the switch, such as security, resiliency, traffic management and prioritization. Managed switches also provide powerful diagnostics, such as broken wire detection, port status and time stamping of network alarms and events. Default configurations in Stratix managed switches simplify the commissioning process and help optimize switch performance.

Switches are at the center of EtherNet/IP star, redundant star, and switch-level ring topologies. Additional information on switches can be found at the Rockwell Automation EtherNet/IP Network webpage. To help select the best switch for your application, see Stratix Industrial Networks Infrastructure At-A-Glance, https://literature.rockwellautomation.com/idc/groups/literature/documents/qr/enet-qr001_-en-e.pdf.

A Device Level Ring topology, enabled by the Device Level Ring protocol (DLR), can limit or eliminate the need for active network components. DLR provides the ability to tolerate a single fault. See Deploying Device Level Ring within a Converged Plantwide Ethernet Architecture, https://literature.rockwellautomation.com/idc/groups/literature/documents/td/enet-td015_-en-p.pdf
Even with the price of the switches included, the bill of materials (BOM) for an EtherNet/IP system is most often less costly than the BOM for ControlNet when taps, media and installation are considered.

Network Performance

In many applications, speed is critical, and it is important that signals are not missed. Scheduling in ControlNet provides higher priority for critical data than for non-critical data.

There are several standard features that allow the most critical data to receive highest priority in an EtherNet/IP network. For example, time-sensitive data such as I/O data is sent using User Datagram Protocol (UDP), which is much more efficient than TCP. As another example, Quality of Service (QoS) is used to prioritize time-sensitive data. Additionally, the speed of EtherNet/IP compared to ControlNet provides a significant advantage. Over the past few decades, Ethernet has evolved from a coaxial cable with a data rate of 10 megabits per second (Mbps) to twisted-pair running typically at 100 Mbps or 1 gigabit per second (Gbps). Higher data rates are becoming common and this trend will continue in the future. ControlNet has a speed of 5 Mbps, which will not increase in the future. This means that, depending on the speed of the EtherNet/IP network, the bandwidth of EtherNet/IP is 20 to 200 times that of ControlNet. This fact in and of itself provides for much higher throughput in an EtherNet/IP system.

Because ControlNet is a bus network, only a single device can transmit at a time. Ethernet started as a bus network, but today the use of switches in EtherNet/IP allows traffic to be confined only to the devices that need to receive that traffic, allowing multiple devices to transmit or receive in parallel, thereby increasing bandwidth.

Concerning motion control, EtherNet/IP leverages IEEE1588:2008 to provide determinism. Signals that require fast responses, like a registration input, are time-stamped (to the nanosecond level) by the motion drive to add determinism. Scheduled outputs, for motion output cam instructions, have resolutions to the nanosecond level. This would not be possible using ControlNet.
ControlNet can guarantee that a signal can arrive (roughly) every so many milliseconds. The fastest time is every 2 milliseconds, but if 2 milliseconds is the network update time, then very few devices will be able to communicate on the network. With EtherNet/IP, there is no network update time to constrain the

network. Signals can arrive in microseconds as can be seen in the scope traces in the Converged Plantwide Ethernet (CPwE) Design and Implementation Guide, https://literature.rockwellautomation.com/idc/groups/literature/documents/td/enet-td001_-en-p.pdf. The fact that real-time motion control can be done on EtherNet/IP but not on ControlNet is just one example of how EtherNet/IP can provide much higher performance.

High Availability

ControlNet provides for high availability in two ways. First, ControlNet is supported in ControlLogix® redundant controllers. Second, ControlNet provides for redundant media. EtherNet/IP also provides for high availability through use of ControlLogix redundant controllers. To address media resiliency, EtherNet/IP offers two options at the device level: Parallel Redundancy Protocol (PRP) or DLR. DLR, as discussed previously, is a ring protocol that provides single fault tolerance. PRP provides for more flexible architectures than ControlNet redundant media because PRP does not require that every node be directly connected to both physical redundant networks the way ControlNet does. The option to implement redundant 1756 I/O adapters is a high availability feature coming soon to EtherNet/IP that will never be available for ControlNet.

EtherNet/IP utilizes standard Ethernet, standard IT redundancy and load balancing protocols, such as EtherChannel and Flex Links which are compatible with EtherNet/IP. This provides for a high degree of IT/OT integration.

Security

ControlNet is a mature technology with no security. There are many security features available with EtherNet/IP and standard Ethernet and IP networking. These features can be used as part of the defense in depth approach to security, which establishes multiple layers of protection that are based on diverse technologies through physical, electronic and procedural safeguards. One of these technologies available through EtherNet/IP is CIP Security™ protocol, which provides for authentication of devices, integrity of data and confidentiality of data.

Safety

Safety application coverage on the EtherNet/IP network provides the ability to mix safety devices and standard devices on the same network or wire for seamless integration and increased flexibility. CIP Safety™ protocol provides fail-safe communication between nodes such as safety I/O blocks, safety interlock switches, safety light curtains and safety PLCs in safety applications up to Safety Integrity Level (SIL) 3 according to IEC 61508 standards. There are no CIP Safety devices that connect directly to the ControlNet network.

Availability of Devices

There are many more devices available from Rockwell Automation for EtherNet/IP than for ControlNet. These devices, which include controllers, switches and many I/O devices, support high data rates, QoS and other features, which provide the high performance of EtherNet/IP. Integrated motion and integrated safety devices, for example, are available on EtherNet/IP but not on ControlNet. There are many more devices available from other vendors for EtherNet/IP than for ControlNet.

Future Development

Development in the future will be focused on EtherNet/IP rather than ControlNet. The integration of Rockwell Automation devices to common standards, such as OPC-UA, will occur through EtherNet/IP.

Expanding Applications

Using EtherNet/IP, the amount of data that can be moved and where it can be moved, is much greater and more flexible. With a converged EtherNet/IP network, ThinManager® software and virtualization can be employed. Applications can include, for example, Ethernet cameras, in which case the cameras can deliver photos to the thin clients as data is being delivered from the control system to the thin clients. The result is an integrated view of live physical assets along with data, providing a rich information set for the user.

Resources

There is a great deal of documentation that exists to assist with the deployment of EtherNet/IP.

ControlNet to EtherNet/IP migration guide can be found at:
https://literature.rockwellautomation.com/idc/groups/literature/documents/rm/cnet-rm001_-en-p.pdf

Ethernet design considerations can be found at:
https://literature.rockwellautomation.com/idc/groups/literature/documents/rm/enet-rm002_-en-p.pdf

Converged Plantwide Ethernet white papers can be found at:
https://www.rockwellautomation.com/en_NA/capabilities/industrial-networks/whitepapers/overview.page

Converged Plantwide Ethernet design guides can be found at:
https://www.rockwellautomation.com/en_NA/capabilities/industrial-networks/technical-data/overview.page

Parallel Redundancy Protocol application technique can be found at:
https://literature.rockwellautomation.com/idc/groups/literature/documents/at/enet-at006_-en-p.pdf

Device Level Ring application technique can be found at:
https://literature.rockwellautomation.com/idc/groups/literature/documents/at/enet-at007_-en-p.pdf

CIP Security application technique can be found at:
https://literature.rockwellautomation.com/idc/groups/literature/documents/at/secure-at001_-en-p.pdf

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Publication ENET-WP003A-EN-P — February 2020