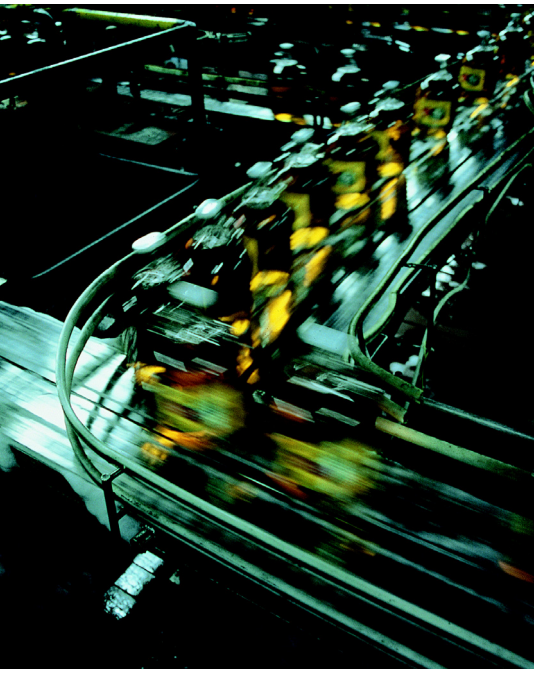

Resilient Ethernet Protocol in a Converged Plantwide Ethernet (CPwE) Architecture White Paper

October 2014

Rockwell Automation and Cisco Four Key Initiatives:

- Common Technology View:
  A single system architecture, using open, industry standard networking technologies, such as Ethernet and IP, is paramount for achieving the flexibility, visibility, and efficiency required in a competitive manufacturing environment.
- Converged Plantwide Ethernet Architectures:
  These manufacturing focused reference architectures, comprised of the Rockwell Automation Integrated Architecture™ and Cisco's Ethernet to the Factory, provide users with the foundation for success to deploy the latest technology by addressing topics relevant to both engineering and IT professionals.
- Joint Product and Solution Collaboration:
  Stratix 5700™ and 8000™ Industrial Ethernet switches incorporating the best of Cisco and the best of Rockwell Automation.
- People and Process Optimization:
  Education and services to facilitate Operational Technology (OT) and IT convergence and allow successful architecture deployment and efficient operations allowing critical resources to focus on increasing innovation and productivity.

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Introduction

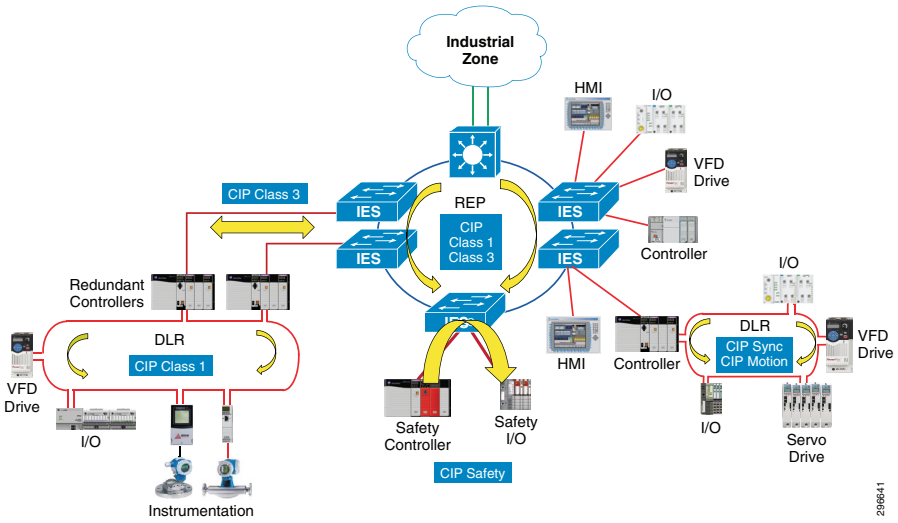
The Converged Plantwide Ethernet (CPwE) architecture now includes a Resilient Ethernet Protocol (REP) architecture, which supports switch ring topology resiliency for Industrial Automation and Control System (IACS) devices and equipment. The REP release of CPwE is a collaborative effort of Cisco Systems, Inc. and Rockwell Automation, Inc., reflecting the Information Technology (IT) and IACS knowledge and expertise of both companies.

REP is suitable for many IACS applications that require a switch ring topology to meet application availability requirements (Figure 1). IACS applications that can tolerate up to a 100 ms network convergence recovery time are suitable for REP:

- Controller to Human Machine Interface (HMI)
- Controller to Controller
- Controller to Input/Output (I/O)
- Controller to Variable Frequent Drives (VFDs)
- Controller to Motor Control Centers (MCCs)

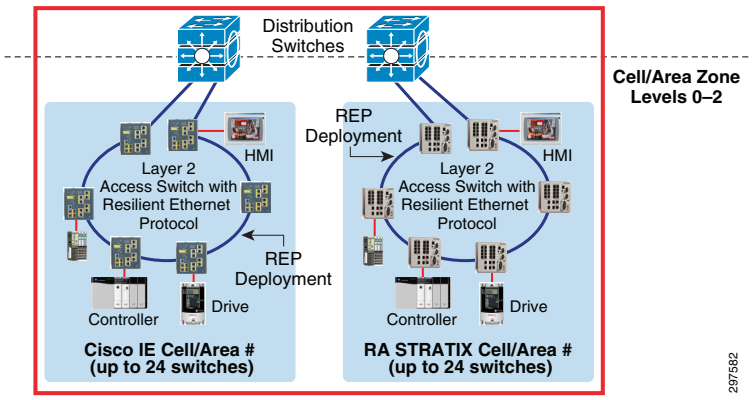
For IACS applications that require a faster network convergence recovery time, Cisco and Rockwell Automation recommend either a redundant star switch topology with the Flex Links resiliency protocol or a device-level ring topology, such as the Open DeviceNet Vendors Association (ODVA) Device Level Ring (DLR) (Figure 1).

Figure 1 REP IACS Applications



The REP architecture aligns with previous CPwE systems from an overall architecture framework (Figure 2) perspective and with general design and implementation recommendations in order to continue to align with industry standards. The REP architecture utilizes EtherNet/IP™ network communications, which are driven by the ODVA Common Industrial Protocol (CIP).

Figure 2 REP Ring in CPwE



Business Value of Resiliency in Converged Networks

Increasing numbers of devices are being connected on the plant floor. Such devices are being connected using the same network technology as the Internet. Devices such as sensors embedded in manufacturing devices that collect data are now used as tools to understand complex processes better. With real-time data, manufacturers can respond to changes quickly. REP-based architectures enhance the production network's resilience and ability to support systems that connect people, processes, and data to real time applications, even during a network disruption. In manufacturing, IP-based networks like EtherNet/IP drive a new generation of connected, intelligent machines with improved network visibility into the plant—supported by the Connected Enterprise vision from Rockwell Automation and Cisco's Internet of Everything (IoE).

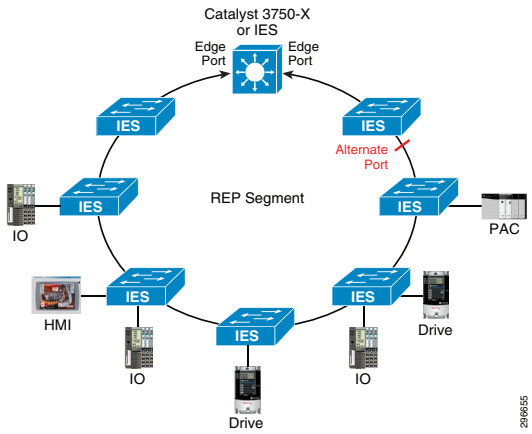
- **Lower Costs**—Placing network intelligence, such as REP, deeper into plants with ruggedized but standard industrial internet protocol (IP) networks increases critical information access from machines, resiliency for some applications, bandwidth, and troubleshooting abilities.
- **Improved Machine Uptime**—Improved uptime of end-to-end IP networks can speed up the troubleshooting of issues with plant floor machines. By leveraging improved network uptime, visibility down to the machine can be improved while troubleshooting time can be greatly reduced.

Unique Capabilities, Solving Manufacturing Challenges

Using REP, network resiliency is established within the manufacturing environment at the network protocol level, forming a switch-level ring redundant path topology. Because REP is distributed across the switch ring, the protocol does not rely on a master node or master switch to control the ring's status or state. Because of the nature of a ring topology, segment failures are detected locally through loss of signal (LOS) or loss between connected neighbors. REP, when used in combination with a ring topology, provides simple and effective redundancy. The CPwE architecture utilizes the Industrial Ethernet Switch (IES) models, including the Allen-Bradley Stratix 5700™ and Stratix 8000™ series, and the Cisco Industrial Ethernet (IE) 2000 and 3000 switches, all of which support REP. The Cisco Catalyst 3750-X supports REP as the distribution switch, as shown in Figure 3.

- **Efficient Network**—REP utilizes a Layer 2 ring topology utilizing up to 24 Allen-Bradley Stratix 5700 / Stratix 8000 Series switch devices in a given ring. REP allows for efficient network re-convergence times, when compared to more traditional methods such as the Spanning Tree method. Moreover, this mechanism for resilient failovers remains flexible and supports fast convergence when scaling the ring's size.
- **Redundancy in a Ring Topology**—By definition, a REP segment is a chain of ports connected together. Each end of a network segment terminates at a neighboring switch or at the Distribution Catalyst 3750X Series switch. Figure 3 illustrates a simple REP segment.

Figure 3 REP Segment Example



REP intelligence prevents the creation of a traffic loop condition when a ring of the Stratix 5700/8000 series switches is utilized. If a cable breaks or switch service disrupts, REP allows CIP traffic to continue to reach the edge of the ring topology for IACS, monitoring, and management continuity.

Summary

REP establishes a resilient network architecture that goes beyond previously explored resiliency protocols. REP is the only ring switch-level resiliency protocol applicable to both Industrial Automation and IT applications. As plant network convergence drives significant change in manufacturing organizations, systems, and networks, REP improves network convergence. In the event of a network disruption, REP networks support continued IACS functionality and reduced downtime costs, while preserving throughput productivity and sustained operations. Applications deployed in a REP environment support a wide variety of manufacturing disciplines, including batch, discrete, process, and hybrid manufacturing. Cisco Systems and Rockwell Automation's test and validation of REP within the CPwE architecture builds upon established standards, while expanding network resiliency functionality.

The Cisco Validated Design (CVD) for Deploying a Resilient Ethernet Protocol in a Converged Plantwide Ethernet System is accessible from:

- http://www.cisco.com/c/en/us/td/docs/solutions/Verticals/CPwE/REP/CPwE_REP_DG.html
- http://literature.rockwellautomation.com/idc/groups/literature/documents/td/enet-td005_-en-p.pdf

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