



# Device Level Ring within a Converged Plantwide Ethernet Architecture

## Rockwell Automation and Cisco Four Key Initiatives:

- **Common Technology View:**  
A single scalable architecture, using open EtherNet/IP™ standard networking technologies, is paramount to enable the Industrial Internet of Things for achieving the flexibility, visibility, and efficiency required in a competitive manufacturing environment.
- **Converged Plantwide Ethernet Architectures:**  
Collection of tested and validated architectures developed by subject matter authorities at Cisco, Panduit, and Rockwell Automation. The content of CPwE is relevant to both Operational Technology (OT) and Information Technology (IT) disciplines and consists of documented architectures, best practices, guidance, and configuration settings to help manufacturers with design and deployment of a scalable, reliable, safe, secure, and future-ready plant-wide industrial network infrastructure.
- **Joint Product Collaboration:**  
Stratix® 5950 industrial firewall, FactoryTalk® Network Manager™ software, Stratix 5700, Stratix 5400, Stratix 5410, and Stratix 5800 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 Information Technology (IT) convergence, which can assist with successful architecture deployment, and helps to enable efficient operations that allow critical resources to focus on increasing innovation and productivity.

## White Paper

February 2020

## Device Level Ring within a Converged Plantwide Ethernet Architecture

The prevailing trend in Industrial Automation and Control System (IACS) networking is the convergence of technology, specifically IACS operational technology (OT) with information technology (IT). Converged Plantwide Ethernet (CPwE) helps to enable IACS network and security technology convergence, including OT-IT persona convergence, by using standard Ethernet, Internet Protocol (IP), network services, security services, and EtherNet/IP. A reliable and secure converged plant-wide IACS architecture helps to enable the Industrial Internet of Things (IIoT).

Business practices, corporate standards, policies, industry standards, and tolerance to risk are key factors in determining the degree of resiliency and application availability required within an IACS plant-wide or site-wide architecture, e.g., non-resilient LAN, resilient LAN, or redundant LAN. A resilient network architecture within an IACS application plays a pivotal role in helping to minimize the risk of IACS application shutdowns while helping to maximize overall plant or site uptime.

A holistic resilient plant-wide or site-wide network architecture is made up of multiple technologies (logical and physical) deployed at different levels within the plant or site. When selecting a resiliency technology, various plant or site application factors should be evaluated, including the physical layout of IACS devices (geographic dispersion), recovery time performance, uplink media type, tolerance to data latency and jitter, and future-ready requirements. For more information on resiliency technology, refer to *Deploying a Resilient Converged Plantwide Ethernet Architecture (CPwE Resiliency) Design and Implementation Guide (DIG)*.

The ODVA, Inc. Device Level Ring (DLR) resilient LAN technology is optimized to provide ring topology resiliency for time critical IACS applications. DLR supports fast ring convergence (single-fault tolerant) in the event of an IACS device or link failure. DLR also supports flexible topologies such as IACS device-level (embedded switch), switch-level (Layer 2, IES only), hybrid topologies for OEM (equipment, skid, machine) and plant-wide or site-wide IACS deployments. DLR is standard Ethernet (OT-IT convergence) with standard network services such as quality of service (QoS) and IEEE 1588 PTP (Precision Time Protocol).

Deploying Device Level Ring within a Converged Plantwide Ethernet Architecture Design Guide (CPwE DLR) outlines several use cases for designing and deploying DLR technology with IACS device-level, switch-level, and mixed device/switch-level ring topologies across OEM and plant-wide or site-wide IACS applications. CPwE DLR is an extension to CPwE Resiliency and was architected, tested and validated by Cisco Systems and Rockwell Automation with assistance by Panduit.

## CPwE Overview

CPwE is the underlying architecture that provides standard network and security services for control and information disciplines, devices, and equipment found in modern IACS applications. The CPwE architectures (Figure 1) were architected, tested and validated to provide design and implementation guidance, test results, and documented configuration settings. This can help to achieve the real-time communication, reliability, scalability, security, and resiliency requirements of modern IACS applications. The content and key tenets of CPwE are relevant to both OT and IT disciplines.

CPwE key tenets include:

- **Smart IIoT devices**—Controllers, I/O, drives, instrumentation, actuators, analytics, and a single IIoT network technology (EtherNet/IP)
- **Zoning (segmentation)**—Smaller connected LANs, functional areas, and security groups
- **Managed infrastructure**—Managed Allen-Bradley® Stratix industrial Ethernet switches (IES), Cisco Catalyst distribution/core switches, FactoryTalk Network Manager software, and Stratix industrial firewalls
- **Resiliency**—Robust physical layer and resilient or redundant topologies with resiliency protocols
- **Time-critical data**—data prioritization and time synchronization via CIP Sync™ and IEEE-1588 Precision Time Protocol (PTP)
- **Wireless**—Unified wireless LAN (WLAN) to enable mobility for personnel and equipment
- **Holistic defense-in-depth security**—Multiple layers of diverse technologies for threat detection and prevention, implemented by different persona (e.g., OT and IT) and applied at different levels of the plant-wide or site-wide IACS architecture
- **Convergence-ready**—Seamless plant-wide or site-wide integration by trusted partner applications

**Wide Area Network (WAN)**

Data Center - Virtualized Servers

- ERP - Business Systems
- Email, Web Services
- Security Services - Active Directory (AD), Identity Services (AAA), TLS Proxy
- Network Services - DNS, DHCP
- Call Manager

**Enterprise Zone Levels 4-5**

**Physical or Virtualized Servers**

- Patch Management
- AV Server, TLS Proxy
- Application Mirror, Reverse Proxy
- Remote Desktop Gateway Server

**Plant Firewalls**

- Active/Standby
- Inter-zone traffic segmentation
- ACLs, IPS and IDS
- VPN Services
- Portal and Remote Desktop Services proxy

**Industrial Demilitarized Zone (IDMZ)**

**Core Switches**

**NetFlow**

**Distribution Switch Stack**

**Access Switches**

**Cell/Area Zone Levels 0-2 (Plant-wide Network)**

**Level 3 - Site Operations (Control Room)**

**Cell/Area Zone - Levels 0-2**

Redundant LAN - Parallel Redundancy Protocol  
Enhanced Interior Gateway Routing Protocol - EtherChannel  
Hot Standby Router Protocol - Active/Standby (Skids, Equipment)

**Cell/Area Zone - Levels 0-2**

Ring Topology - Device Level Ring (DLR) Protocol  
Redundant Star Topology - Flex Links Resiliency  
Unified Wireless LAN (Lines, Machines, Skids, Equipment)

**Cell/Area Zone - Levels 0-2**

Linear/Bus/Star Topology  
Redundant Star Topology - EtherChannel Resiliency  
Unified Wireless LAN (Lines, Machines)

This release of the CPwE architecture focuses on EtherNet/IP, which uses the ODVA, Inc. Common Industrial Protocol (CIP™) and is ready for the Industrial Internet of Things (IIoT). For more information on EtherNet/IP, CIP Sync, CIP Motion™, CIP Safety™, and DLR, see [odva.org](http://odva.org) at the following URL:

- <http://www.odva.org/Technology-Standards/EtherNet-IP/Overview>

## CPwE Device Level Ring Solution Use Cases

An IACS is deployed in a wide variety of industries such as automotive, pharmaceuticals, consumer packaged goods, pulp and paper, oil and gas, mining, and energy. IACS applications are made up of multiple control and information disciplines such as continuous process, batch, discrete, and hybrid combinations. One of the challenges facing industrial operations is the industrial hardening of standard Ethernet and IP-converged IACS networking technologies to take advantage of the business benefits associated with IIoT. A resilient network architecture (Figure 2) can help to increase the overall equipment effectiveness (OEE) of the IACS by helping to reduce the impact of a failure and speed recovery from an outage, which lowers Mean-Time-to-Repair (MTTR).

CPwE DLR outlines the concepts, requirements, and technology solutions for reference designs developed around a specific set of priority use cases. These use cases were tested for solution functional validation by Cisco Systems and Rockwell Automation with assistance by Panduit. This helps support a resilient converged plant-wide or site-wide EtherNet/IP IACS architecture.

The CPwE DLR Design Guide includes:

- Device Level Ring technology overview
- Design and configuration considerations for plant-wide IACS device-level, switch-level, and mixed device/switch-level DLR deployments
- Selection of Industrial Ethernet Switches (IES)
  - Allen-Bradley Stratix 5700 and Stratix 5400 managed IES
- The following represent a portion of the DLR application use cases;
  - Single ring of IES
  - Single mixed device/switch-level ring
  - Multiple mixed device/switch-level rings
  - Multiple distribution switch choices
  - DLR support for Dynamic Host Configuration Protocol (DHCP)

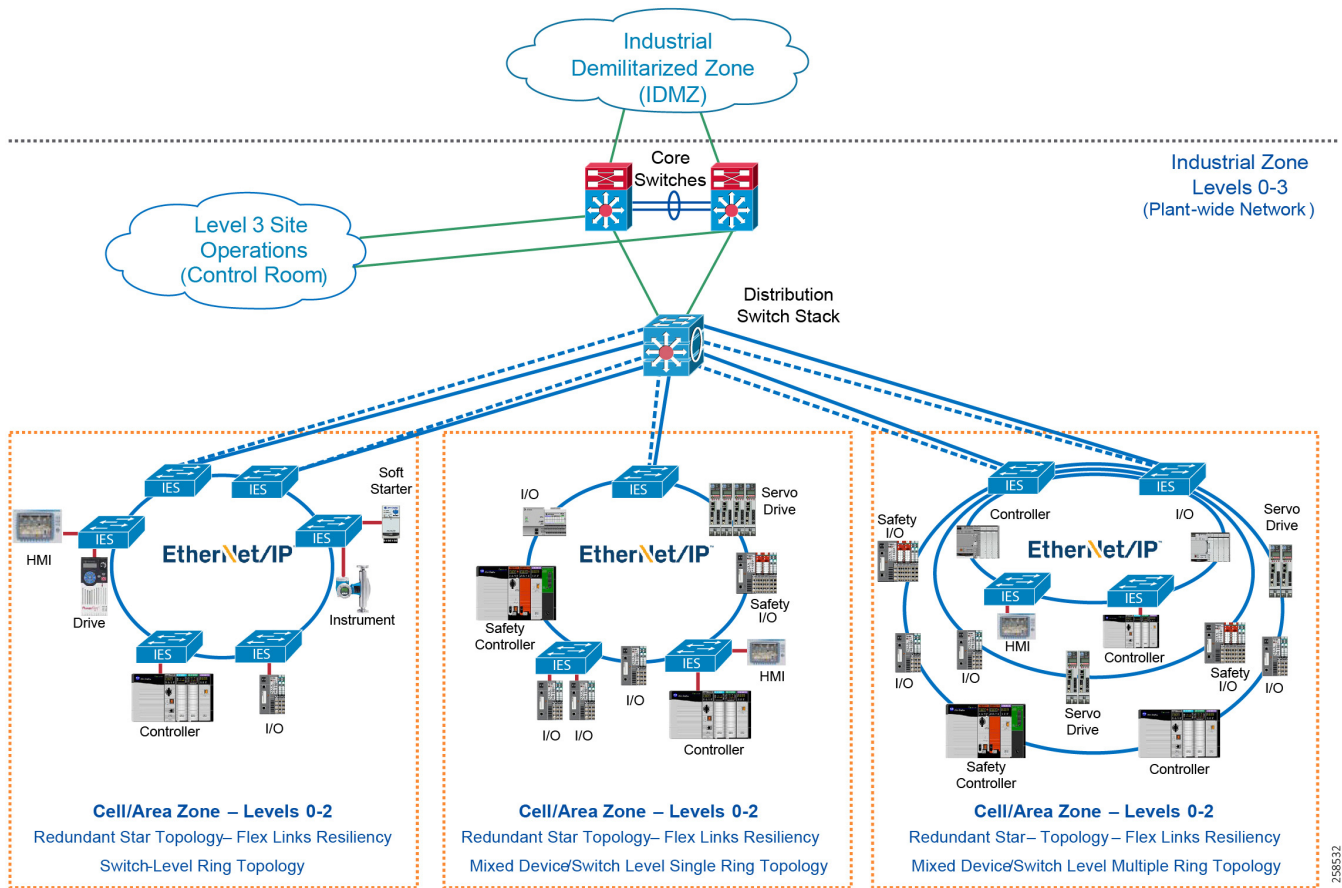
## Release Notes

This section summarizes the extensions to CPwE DLR in the February 2020 release:

- Test Hardware and Software for DLR Reference Architectures
- DLR System Components Overview
- DLR application use cases for single Industrial Ethernet Switch (IES) ring with Redundant Gateway
- DLR application use cases including single mixed IACS device/Industrial Ethernet Switch (IES) ring and multiple mixed IACS device/IES rings with Redundant Gateway
- DLR Monitoring and Troubleshooting with FactoryTalk Network Manager software



Figure 2 Representative Plant-wide or Site-wide Switch-Level and Mixed Device/Switch-Level DLR Deployments



## CPwE Resilient IACS Architectures Overview

Protecting availability for IACS assets requires a defense-in-depth approach where different solutions are needed to address various network resiliency requirements for a plant-wide or site-wide architecture. This section summarizes the existing Cisco, Panduit and Rockwell Automation CPwE Cisco Validated Designs (CVDs) and Cisco Reference Designs (CRDs) that address different aspects of availability for IIoT IACS applications.

*Deploying A Resilient Converged Plantwide Ethernet Architecture Design and Implementation Guide* outlines several use cases for designing and deploying resilient plant-wide or site-wide architectures for IACS applications, utilizing a robust physical layer and resilient topologies with resiliency protocols.

- Rockwell Automation site:  
[https://literature.rockwellautomation.com/idc/groups/literature/documents/td/enet-td010\\_-en-p.pdf](https://literature.rockwellautomation.com/idc/groups/literature/documents/td/enet-td010_-en-p.pdf)
- Cisco site:  
[https://www.cisco.com/c/en/us/td/docs/solutions/Verticals/CPwE/4-0/Resiliency/DIG/CPwE\\_resil\\_CVD.html](https://www.cisco.com/c/en/us/td/docs/solutions/Verticals/CPwE/4-0/Resiliency/DIG/CPwE_resil_CVD.html)

*Deploying Parallel Redundancy Protocol within a Converged Plantwide Ethernet Architecture Design and Implementation Guide* outlines several use cases for designing and deploying Parallel Redundancy Protocol (PRP) technology with redundant network infrastructure across plant-wide or site-wide IACS applications.

- Rockwell Automation site:  
[https://literature.rockwellautomation.com/idc/groups/literature/documents/td/enet-td021\\_-en-p.pdf](https://literature.rockwellautomation.com/idc/groups/literature/documents/td/enet-td021_-en-p.pdf)
- Cisco site:  
<https://www.cisco.com/c/en/us/td/docs/solutions/Verticals/CPwE/5-1/PRP/DIG/CPwE-5-1-PRP-DIG.html>

## Summary

CPwE is a collection of architected, tested, and validated designs. The testing and validation follow the Cisco Validated Design (CVD) and Cisco Reference Design (CRD) methodologies.

The content of CPwE, which is relevant to both operational technology (OT) and informational technology (IT) disciplines, consists of documented architectures, best practices, guidance, and configuration settings to help industrial operations and OEMs with the design and deployment of a scalable, reliable, secure, and future-ready plant-wide or site-wide industrial network infrastructure. CPwE can also help industrial operations and OEMs achieve cost reduction benefits using proven designs that can facilitate quicker deployment while helping to minimize risk in deploying new technology. CPwE is brought to market through an ecosystem consisting of Cisco, Panduit, and Rockwell Automation emergent from the strategic alliance between Cisco Systems and Rockwell Automation.

The *Deploying Device Level Ring within a Converged Plantwide Ethernet Architecture Design and Implementation Guide* outlines several use cases for designing and deploying the ODVA, Inc. Device Level Ring (DLR) technology throughout a plant-wide or site-wide Industrial Automation and Control System (IACS) network infrastructure. CPwE DLR highlights the key IACS application requirements, technology, and supporting design considerations to help with the successful design and deployment of these specific use cases within the CPwE framework. CPwE DLR was architected, tested and validated by Cisco Systems and Rockwell Automation with assistance by Panduit.

More information on CPwE Design and Implementation Guides can be found at the following URLs:

- Rockwell Automation site:  
<http://www.rockwellautomation.com/global/products-technologies/network-technology/architectures.page?>
- Cisco site:  
[http://www.cisco.com/c/en/us/solutions/enterprise/design-zone-manufacturing/landing\\_ettf.html](http://www.cisco.com/c/en/us/solutions/enterprise/design-zone-manufacturing/landing_ettf.html)

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