# Our Presenters

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Automation Specialist
The Reynolds Company

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The Reynolds Company

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Automation Specialist
The Reynolds Company

# Online Technical Seminars
## Register to receive a calendar invite

**THE REYNOLDS COMPANY**
ELECTRICAL SUPPLY

## Tech Talks

| Month | Description |
|---|---|
| January 25th | Grace Technologies – GraceSense |
| February 22nd | Industrial CyberSecurity with Claroty |
| March 29th | CyberSecurity with CrowdStrike |
| April 26th | Automation Weighing Best Practices with Mettler Toledo |
| May 24th | Cable Cleats for Short Circuit Protection with Panduit |
| June 21st | VFD Cables: Essential or Overkill presented by Southwire |
| https://www.reynoldsonline.com/training-and-events/techtalks | |

## Learning Series

| Month | Description |
|---|---|
| January 12th | Automation Update |
| February 23rd | FactoryTalk Design Hub |
| March 16th | Networks and Security Update |
| April 20th | Micro800 Update |
| May 18th | Networking Topologies, Resiliency & Best Practices |
| June 15th | Rockwell Automation Product Selection & Configuration Tools |
| https://www.reynoldsonline.com/training-and-events/learning-series | |

Visit our Resources page on reynoldsonline.com

# Automation Fair 2023
## Boston – November 6th – 9th



## Keynotes

Energize, engage, inspire

Open to all-attendees

Mix of Rockwell leaders, partners, customers and 3rd party speakers

3 days (Tues-Thurs)

## Expo

Show floor built around the customer journey

Heightened focus on new product launches, introduction of discovery theaters

Formalized tour program

2 days (Wed/Thurs)

## Sessions

Industry forums, what's new and info talks, panels, customer stories and partner solutions

Introductory-level technical training and labs

Create your personalized agenda by persona, industry, topic

4 days (Mon-Thurs)

## Advanced Training
(include Professional Development Hour credits)

All sessions that offer PDH certificates

Advanced-level hands-on labs and product & technology training

ROKLive, Process Solutions User Group and Automation Fair technical content

4 days (Mon-Thurs)

Visit our Resources page on reynoldsonline.com

# Agenda

**1** Converged Plantwide Ethernet (CPwE)

**2** Network Segmentation

**3** Network Topologies

**4** Device Level Ring (DLR)

**5** Parallel Redundancy Protocol (PRP)

**6** Network Tools

**Rockwell Automation**

# Network Switch Portfolio Overview

*Supporting secure network infrastructure for a wide range of industrial applications*



Stratix® 2000 switches

Stratix® 2500 switches

Stratix® 5700 ArmorStratix™ 5700* switches

Stratix® 5200 switches

Stratix® 5400 switches

Stratix® 5800 switches

Stratix® 5410 switches

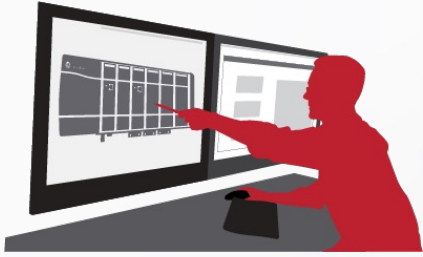100M/1G ←---→ 100M ←---→ 100M/1G ←---→ 1G/10G

**UNMANAGED**

**LIGHTLY MANAGED**

**FULLY MANAGED**

**HIGH PERF MANAGED**

- *End of Life on ArmorStratix™ has been announced
- **End of Life on FTNM has been announced

# Why Stratix Switches?

## Design

**Reduced Engineering & Risk**
- Validated reference architectures (CPwE)
- Custom AOPs & AOI – Premier Integration
- Offline network performance evaluation using the Integrated Architecture Builder tool

**Increase Resiliency**
- Device Level Ring
- Loop detection and prevention
- Security features to achieve uptime

**Consistency in Design**
- Network Address Translation
- Full service local support capabilities
- FactoryTalk HMI Faceplates
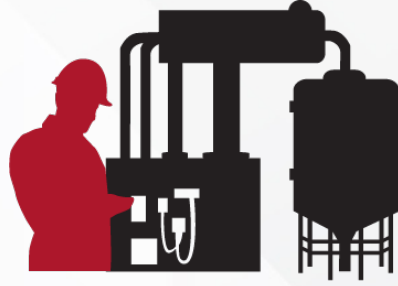
## Operate

**Optimization & Ease of Use**
- OT-centric configuration via express setup

**Reduced Effort, Cost & Downtime**
- Deploy/recover configuration via SD card or Studio 5000
- DHCP per port for automatic end device IP address assignment

**Improved Diagnostics**
- DLR-specific faceplate
- Pre-built switch-specific faceplates with port level diagnostic information to each ring allowing for troubleshooting

## Maintain

**Unit Replacement & Troubleshooting**
- Auto device configuration & replace capabilities
- Plug and play capabilities
- System level support

**Increased Reliability**
- Stratix switches undergo testing within an Integrated Architecture system as part of every new product and firmware update release
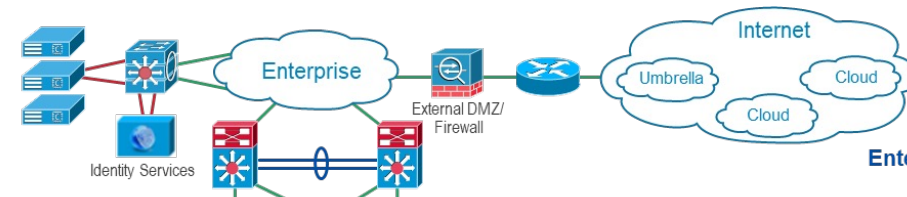
**Lower Total Cost of Ownership**
- Stratix switches automatically included in existing TechConnect℠ agreements
- Updated firmware at No Cost

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# Converged Plantwide Ethernet (CPwE)

Industrial Network Architectures



Industrial Networks Design Guides:

The Design and Implementation guides include plant-wide focused, tested, validated, and documented reference architectures.

- Product Selection and Configuration:
  - Control System Configuration Tools

- Technical Documentation Center
  - CIP Security Application Technique

- Converged Plantwide Ethernet (CPwE) Architectures:
  - Tested and Validated Reference Architectures
  - Industrial Network and Security Whitepapers

# Key Tenets of Converged Plantwide Ethernet (CPwE)

Structured and Hardened Network Infrastructure

## Smart Industrial IoT devices

- EtherNet/IP Industrial IoT technology, hardened, ODVA conformance tested

## Managed Infrastructure – Stratix® Switches

- VLANs, Resiliency, Security, Diagnostics

## Network Segmentation

- Logical model based on standards
- Physical – CIP™ bridge
- Switch hierarchy (L2/L3), VLANs, firewalls
- Software-defined Security Groups

## Resiliency

- Robust Physical Layer
- Redundant paths with Resiliency Protocols
- Redundant Switches, Wireless and Firewalls

## Time-critical data

- Quality of Service (QoS)
- Time synchronization via IEEE 1588 Precision Time Protocol (PTP) and CIP Sync™

## Wireless – Mobility

- Unified and autonomous architectures
- Equipment and personnel

## Holistic Defense-in-depth Security

- Multiple layers, at different IACS levels, with diverse technology, implemented by different personas

## Convergence-ready
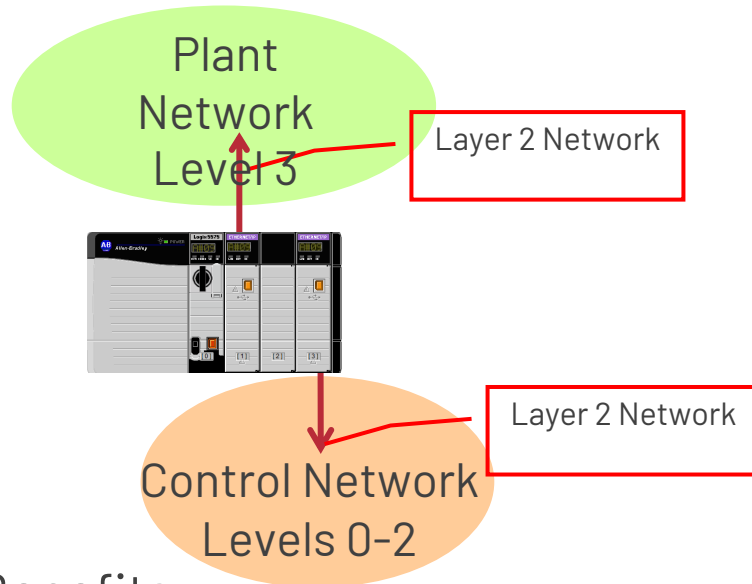
- Network Address Translation (NAT)

# Segmentation

Multiple Network Interface Cards (NICs)

■ Isolated networks – two NICs for physical network segmentation

Plant Network Level 3

Layer 2 Network

Control Network Levels 0-2

Layer 2 Network

■ Benefits
  ▪ Clear network ownership demarcation line
■ Challenges
  ▪ Limited visibility to control network devices for asset management
  ▪ Limited future-ready capability
  ▪ Supported on ControlLogix and 5380's
  ▪ Only CIP bridging

■ Converged networks – logical segmentation

Shared Layer 2 Network

Plant Network Level 3

VLAN 102

Converged Network

Control Network Levels 0-2
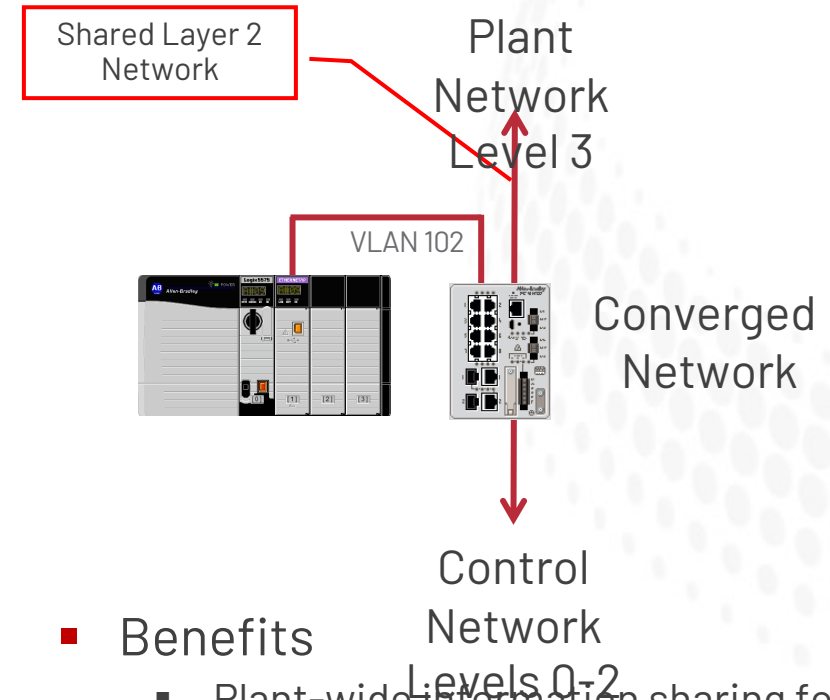
■ Benefits
  ▪ Plant-wide information sharing for data collection and asset management
  ▪ Future-ready
■ Challenges
  ▪ Blurred network ownership demarcation line

# Segmentation

Multiple Network Interface Cards (NICs) – ControlLogix & CompactLogix 5380 Limitations
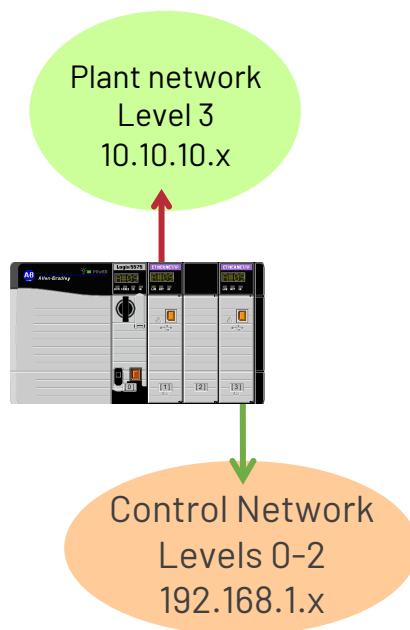
- Isolated networks – two or more NICs for physical network segmentation

Plant network
Level 3
10.10.10.x

Control Network
Levels 0-2
192.168.1.x

- Segment Networks – Enable Dual IP Mode (>= V29)

Plant network
Level 3
10.10.10.x

Control Network
Levels 0-2
192.168.1.x
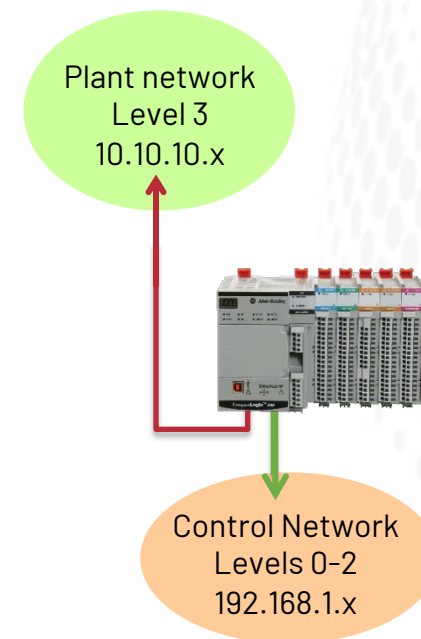
ControlLogix & 5380 controllers do not support the following functions:

- TCP routing or switching between networks.
- CIP bridging of Class 0/1 packets between networks.

ControlLogix & 5380 will support the following functions:

- CIP bridging for Class 3 CIP messages between networks.
- CIP bridging for Unconnected CIP messages between networks.
- Bridging for HMI communications (class 3) between networks.

# Segmentation
VLANs – Virtual Local Area Network



Control Room
VLAN17
Subnet 10.17.10.0/24

Stratix 5400

I/O

I/O

VFD Drive

Controller

Servo Drive

VFD Drive

HMI

HMI

I/O

Controller

I/O

Servo Drive

Skid 1
VLAN10
Subnet 10.10.10.0/24

Skid 2
VLAN20
Subnet 10.10.20.0/24
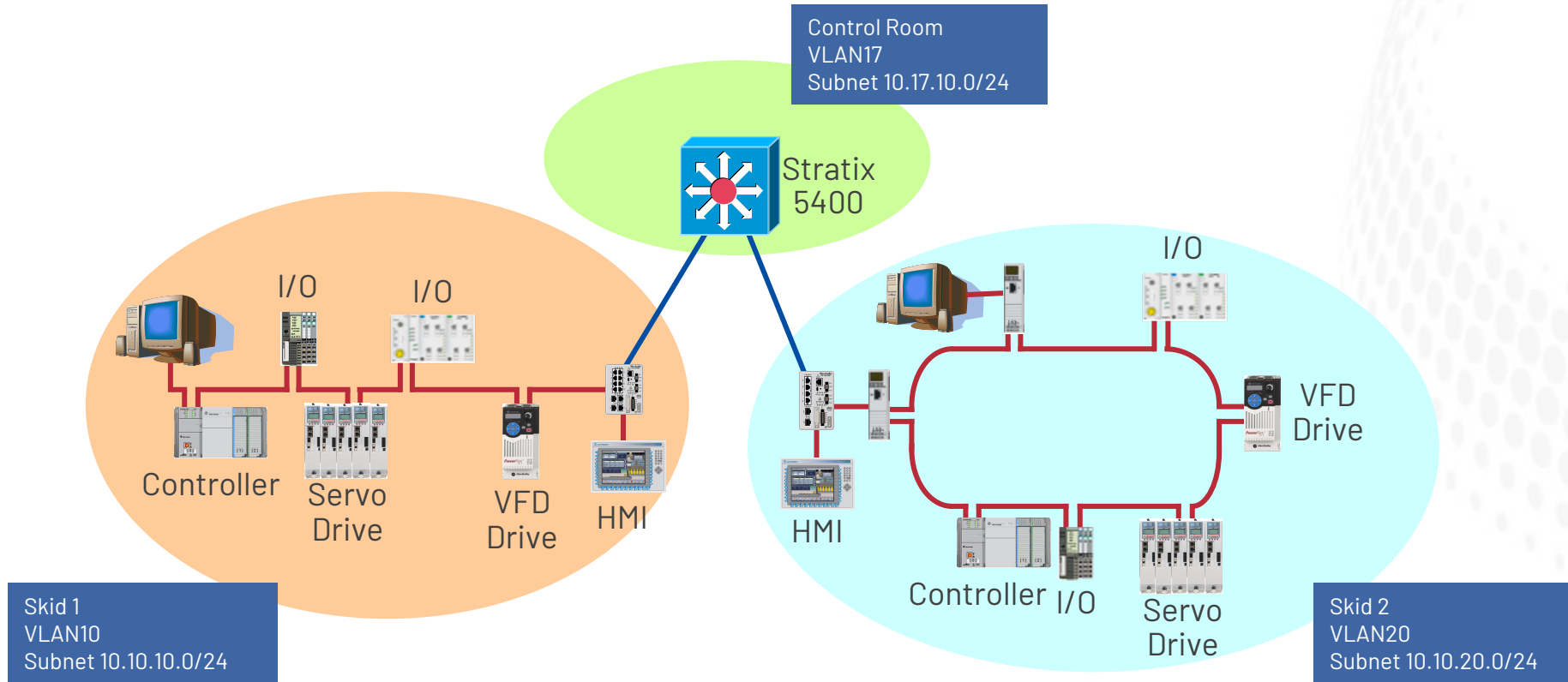
# Segmentation

InterVLAN Routing with Layer 2 switch – Configuration



Network  |  **Routing**

Enable Routing :  ☑

Add    Edit    Delete

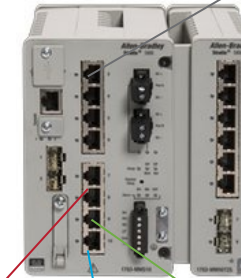| | VLAN ID | Name | Ports | VLAN Status | Operational Mode | IP address |
|---|---|---|---|---|---|---|
| ○ | 1 | default | Gi1/1, Gi1/2, Gi1/4, Gi1/5, Gi1/6 | Active | up | 10.10.10.54 |
| ○ | 10 | Controller | Gi1/9 | Active | up | 172.16.10.1 |
| ○ | 20 | EOI | Gi1/10 | Active | up | 172.16.20.1 |
| ○ | 30 | Drive | Gi1/11 | Active | up | 172.16.30.1 |
| ○ | 40 | PASS | Gi1/3 | Active | up | 172.16.40.1 |

PASS

VLAN 40
IP:  172.16.40.2/24
GW: 172.16.40.1

VLAN 10
IP:  172.16.10.2/24
GW: 172.16.10.1

VLAN 20
IP:  172.16.20.2/24
GW: 172.16.20.1

VLAN 30
IP:  172.16.30.2/24
GW: 172.16.30.1

# Network Topology

# Representative IACS deployments
Plant-wide/site-wide Industrial IoT architectures

EtherNet/IP™

- Examples
  - Isolated LANs
  - Equipment builder solution (Machine or process skid)

### Linear
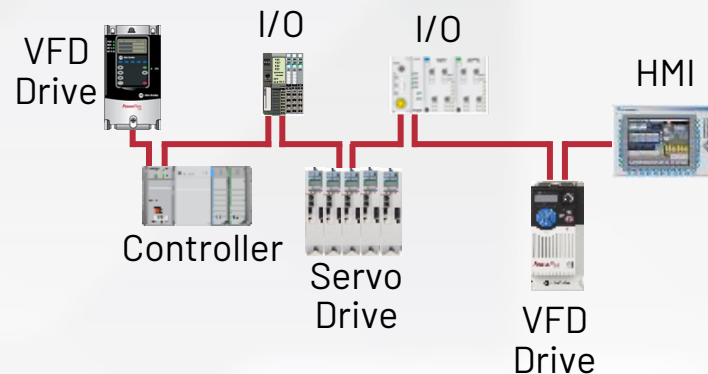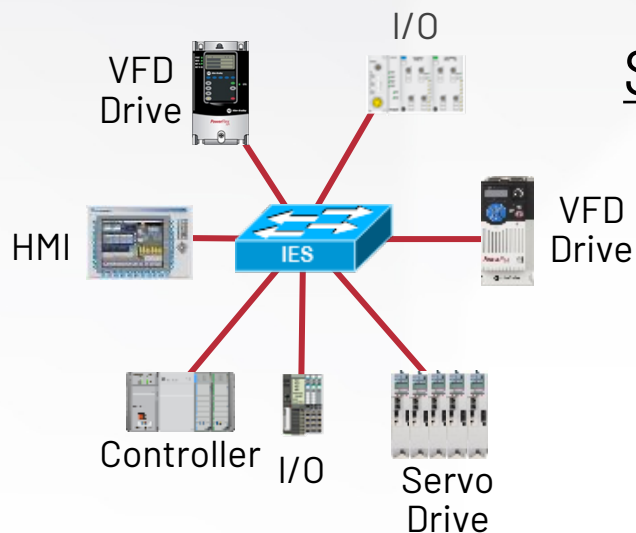
VFD Drive — I/O — I/O — HMI

Controller — Servo Drive — VFD Drive

### Star

VFD Drive — I/O — IES — VFD Drive — HMI — Controller — I/O — Servo Drive

### Ring

Instrumentation — I/O — HMI — VFD Drive — Controller — I/O — Instrumentation
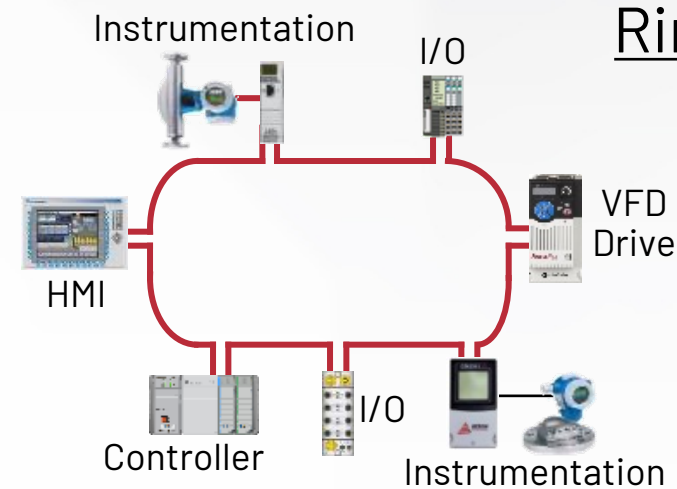
# Representative IACS deployments
Plant-wide/site-wide Industrial IoT architectures

**EtherNet/IP™**

- Examples
  - Connected LANs
  - Integrated equipment builder solutions
  - Single cell/area zone, multiple machines/lines or skids/areas



Star

VFD Drive    I/O

HMI    IES    VFD Drive

Controller    I/O    Servo Drive

Stratix® Switch

Linear

VFD Drive    I/O    I/O

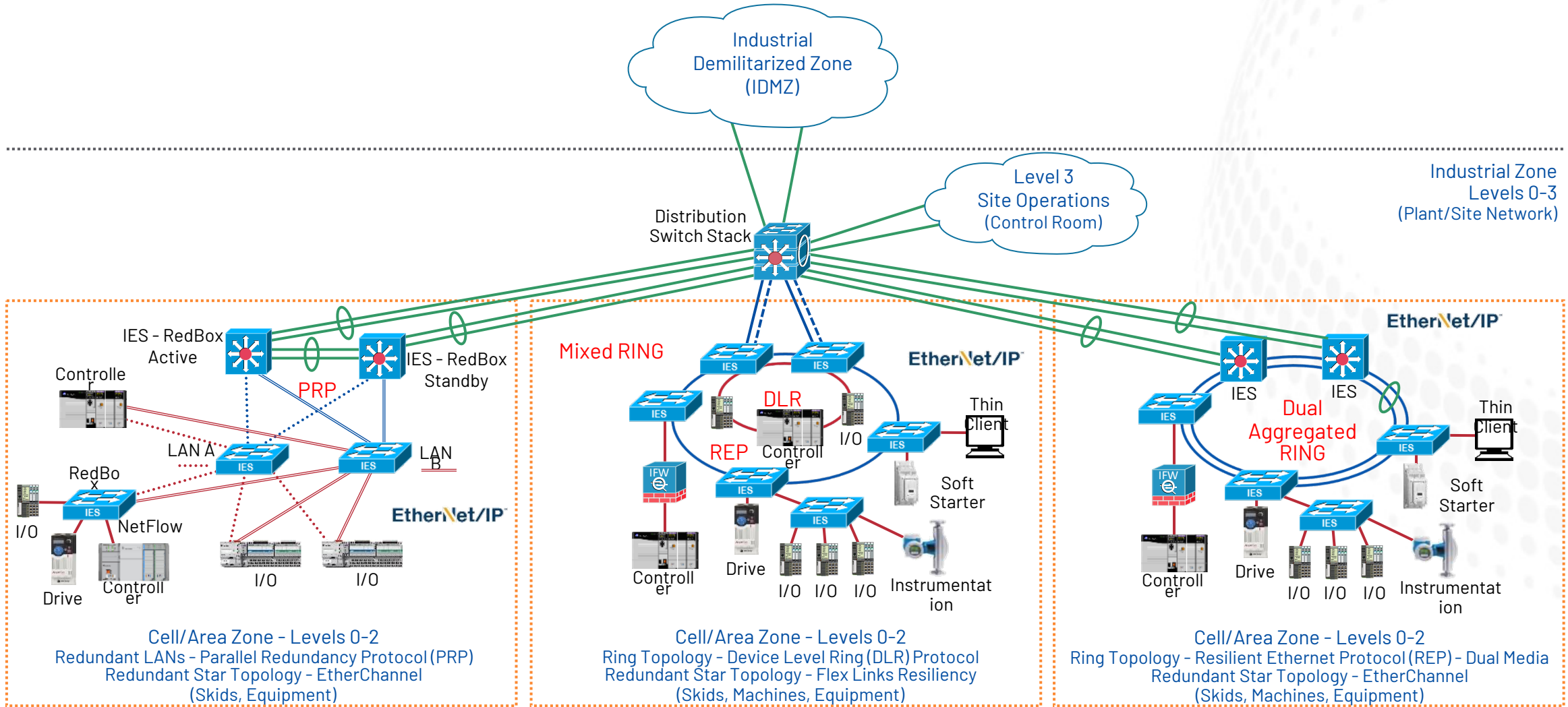Controller    Servo Drive    VFD Drive    IES

IES    HMI

Ring

I/O    VFD Drive

Controller    I/O    Instrumentation
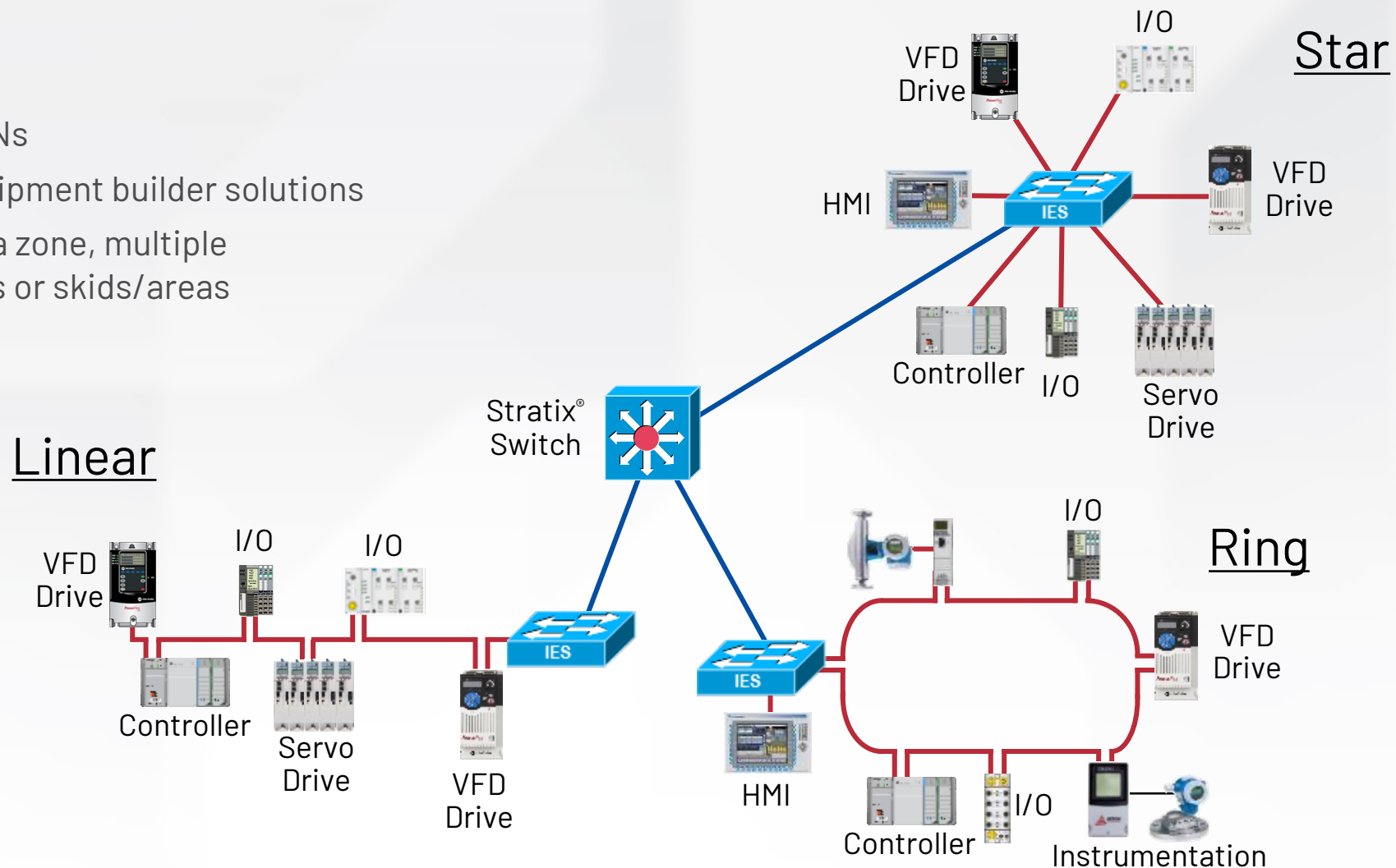
# Representative IACS deployments

Plant-wide/site-wide Industrial IoT architectures based upon CPwE

**EtherNet/IP™**

Industrial Demilitarized Zone (IDMZ)

Level 3 Site Operations (Control Room)

Industrial Zone Levels 0–3 (Plant/Site Network)

Distribution Switch Stack

**EtherNet/IP™**

IES – RedBox Active

IES – RedBox Standby

PRP

Controller

LAN A

LAN B

RedBox

NetFlow

I/O

Drive

Controller

I/O

I/O

**EtherNet/IP™**

Mixed RING

IES    IES

**EtherNet/IP™**

DLR

REP

IFW

Controller

IES

Drive

I/O   I/O   I/O

Instrumentation

Thin Client

Soft Starter

IES

IES

Dual Aggregated RING

IFW

Controller

Drive

I/O   I/O   I/O

Instrumentation

Thin Client

Soft Starter

Cell/Area Zone – Levels 0–2
Redundant LANs – Parallel Redundancy Protocol (PRP)
Redundant Star Topology – EtherChannel
(Skids, Equipment)

Cell/Area Zone – Levels 0–2
Ring Topology – Device Level Ring (DLR) Protocol
Redundant Star Topology – Flex Links Resiliency
(Skids, Machines, Equipment)

Cell/Area Zone – Levels 0–2
Ring Topology – Resilient Ethernet Protocol (REP) – Dual Media
Redundant Star Topology – EtherChannel
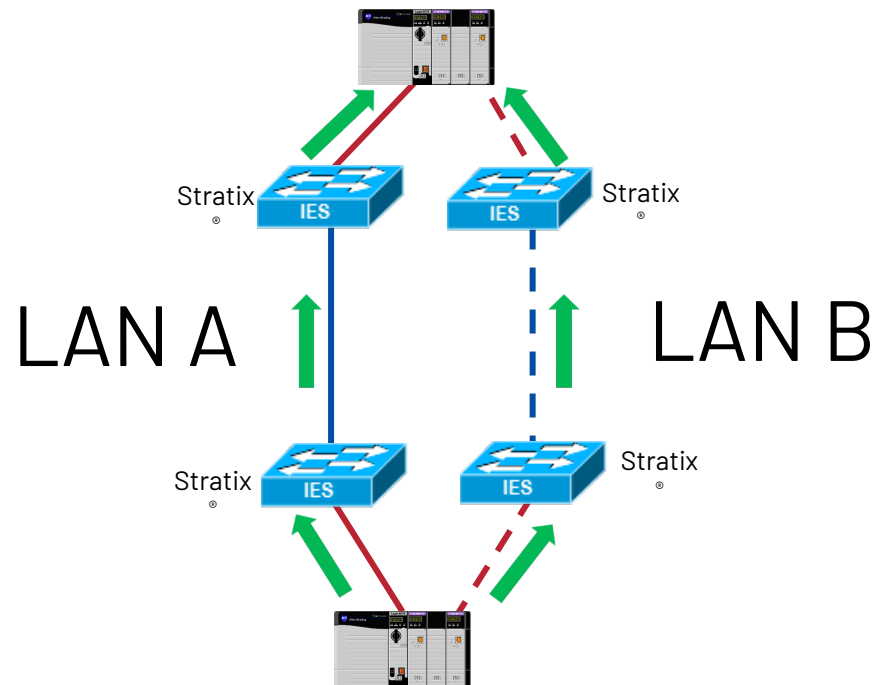(Skids, Machines, Equipment)

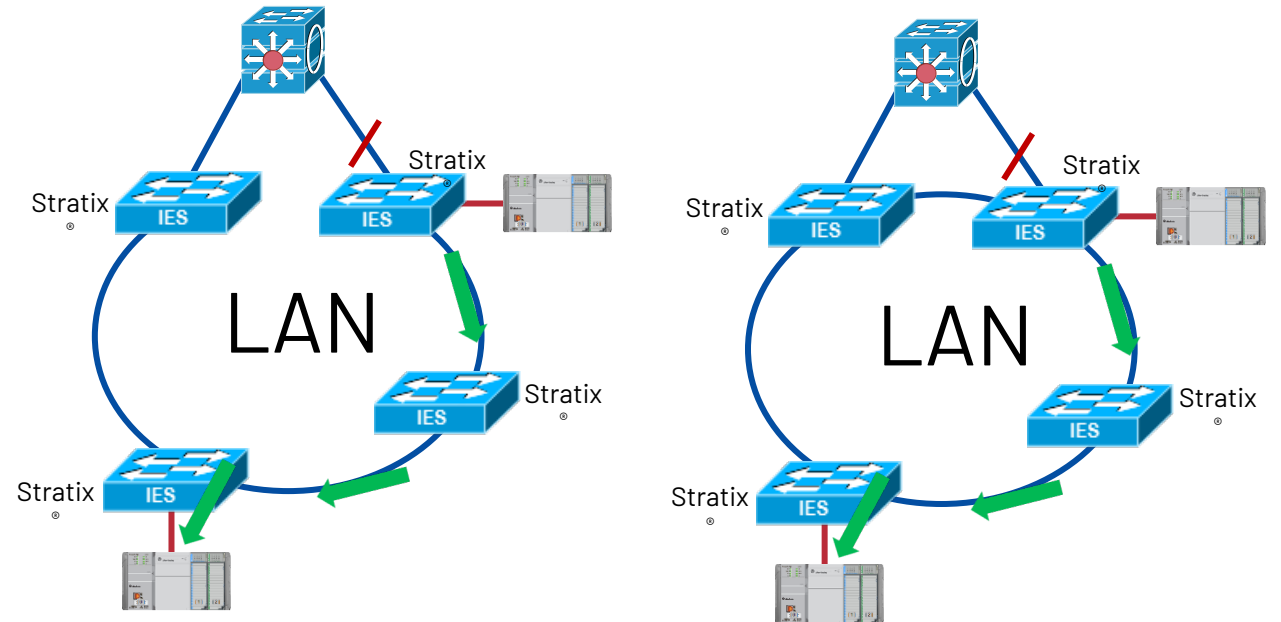# Networking Design Considerations – Redundant vs. Resilient

Resiliency

- **Redundant Ethernet Networks**
  - Independent Local Area Networks (LANs)
  - Independent Paths
  - Zero Recovery Time

- **Resilient Path Ethernet Network**
  - Common (single) LAN
  - Redundant Paths
  - Resiliency Protocol
  - Network Convergence Recovery Time

Device Level Ring
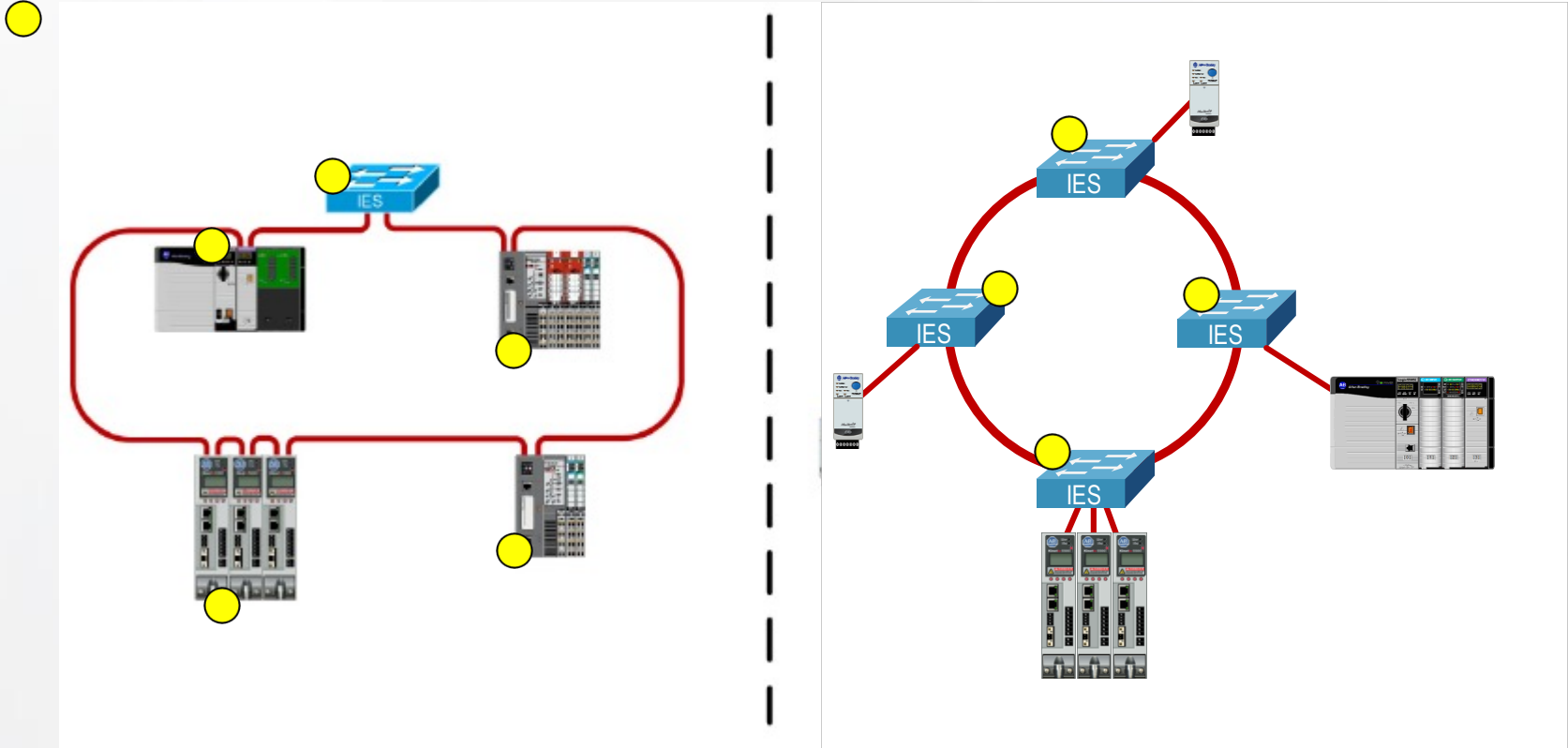
# Resilient Network Design
## Device Level Ring (DLR) Overview

- A DLR network is a single-fault tolerant ring network intended for the interconnection of automation devices:

- Advantages include:
  - Simple installation
  - Resilience to a single point of failure on the network
  - Fast recovery (3ms) time when a single fault occurs on the network
  - Comprehensive diagnostics



Active Supervisor Node

Back-up Supervisor Node

Ring Node

Ring Node

Ring Node
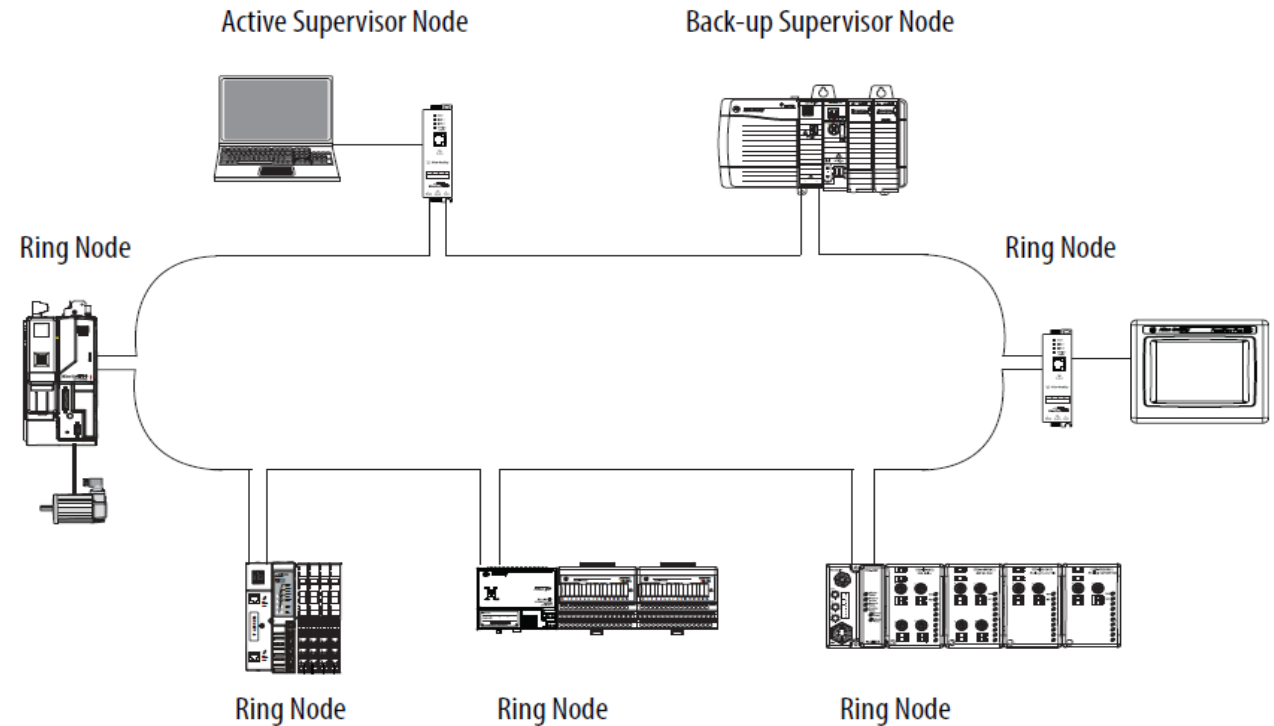
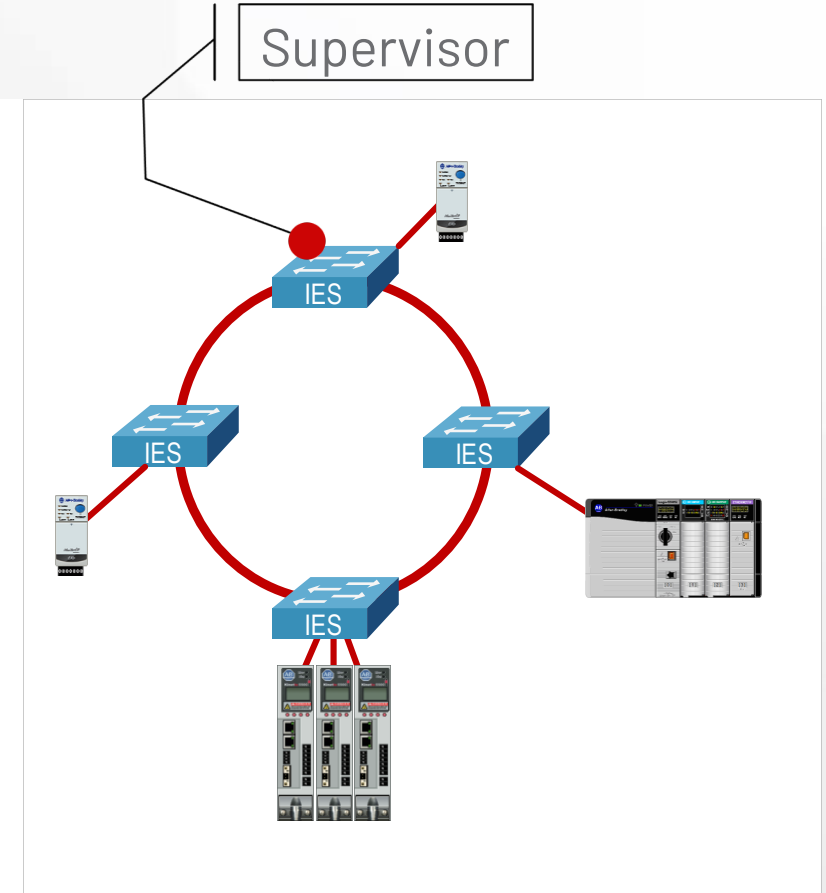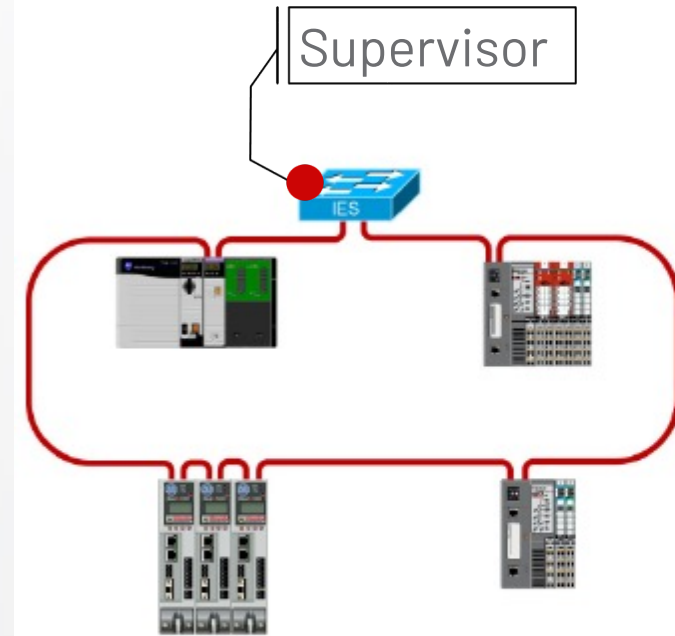Ring Node

Ring Node

# DLR Overview

DLR capable devices directly in the ring are called Ring Nodes.

# DLR Overview

DLR ring nodes contain the following roles:
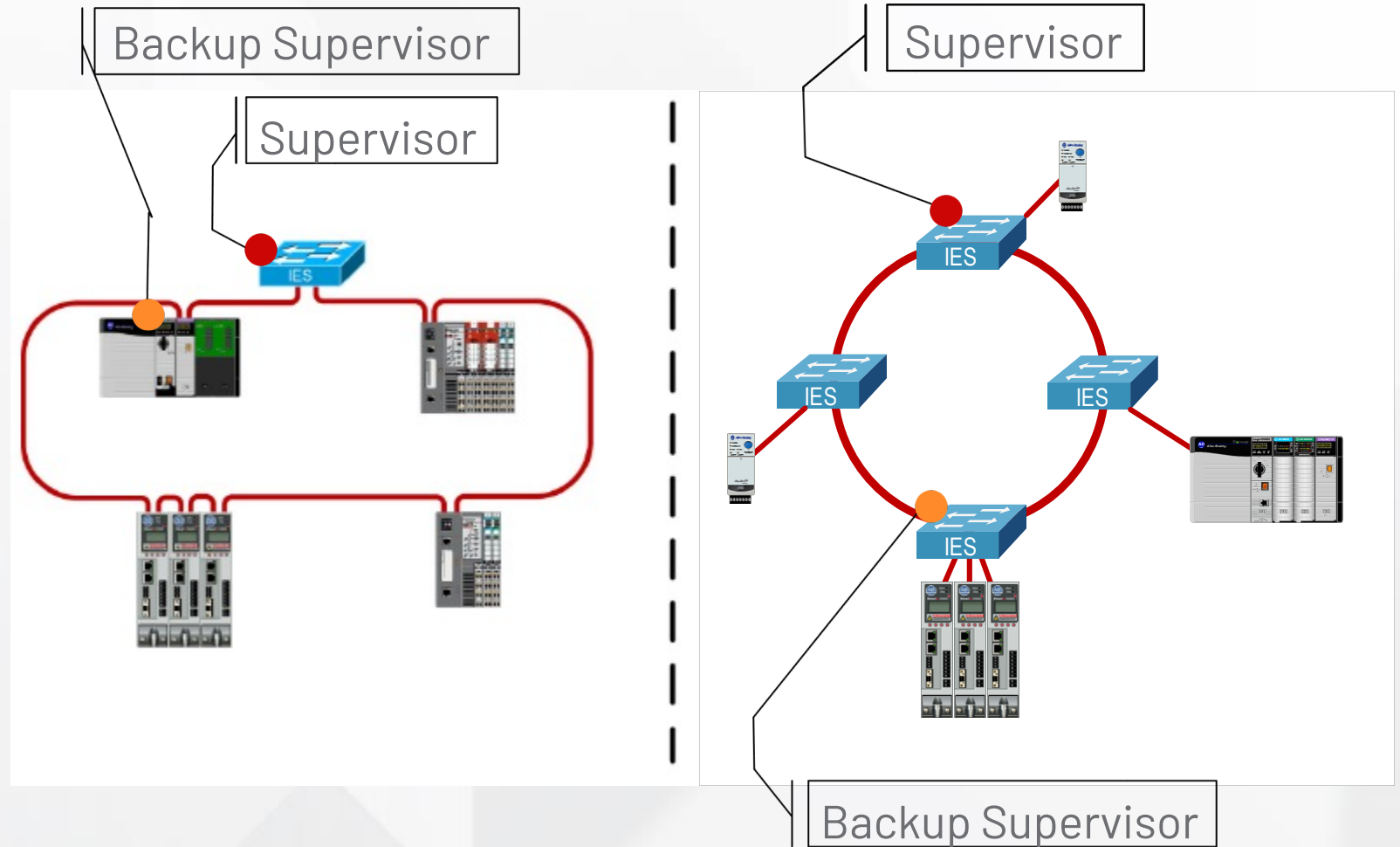
- Supervisor (required)

# DLR Overview

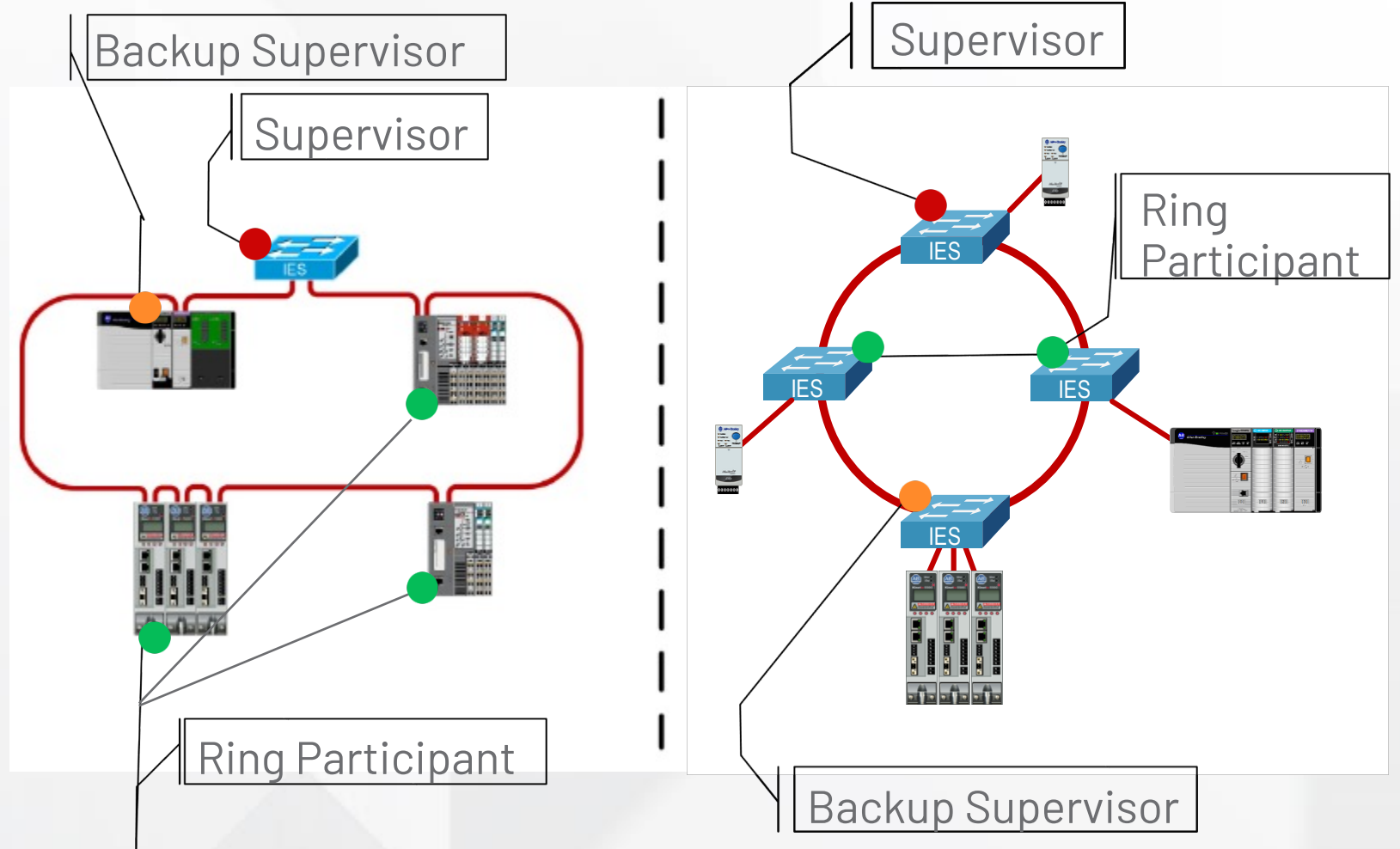DLR ring nodes contain the following roles:

- 🔴 Supervisor (required)
  - 🟠 Backup Supervisor (optional)

Backup Supervisor

Supervisor

Supervisor

Backup Supervisor

# DLR Overview

DLR ring nodes contain the following roles:

- 🔴 Supervisor (required)
  - 🟠 Backup Supervisor (optional)
- 🟢 Ring Participant(s)

Backup Supervisor

Supervisor

Ring Participant

Supervisor

Ring Participant

Backup Supervisor

# DLR Overview

DLR ring nodes contain the following roles:

🔴 Supervisor (required)

🟠 Backup Supervisor (optional)

▪ DLR ring supervisors are responsible for the following:

   ▪ Network Loop Prevention

   ▪ Active/Backup Status

   ▪ Ring Integrity

   ▪ Fault Recovery

   ▪ Diagnostics

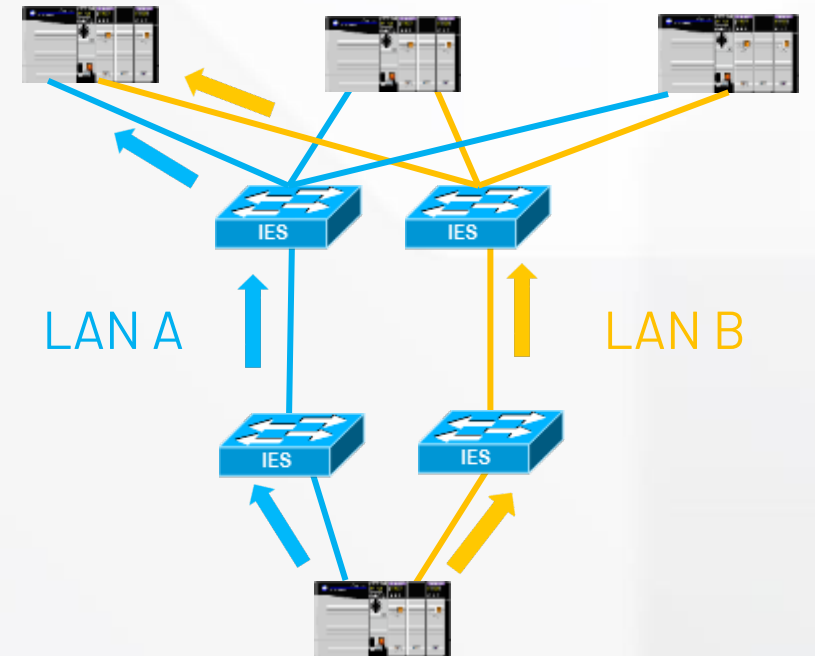   ▪ DLR DHCP Server (Stratix only)

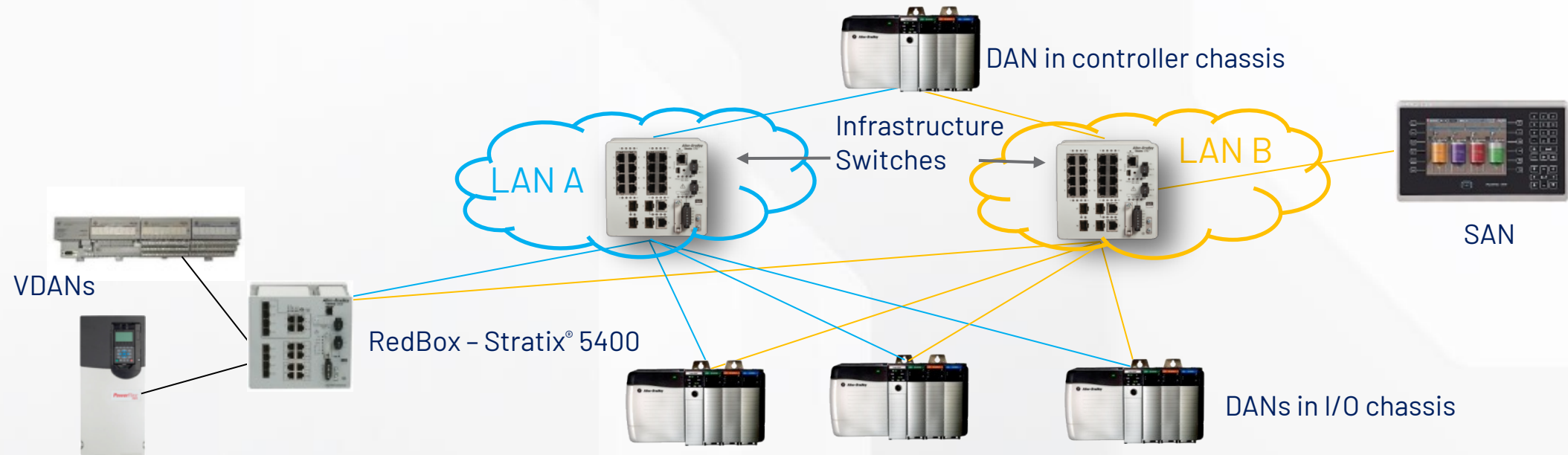🟢 Ring Participant(s)
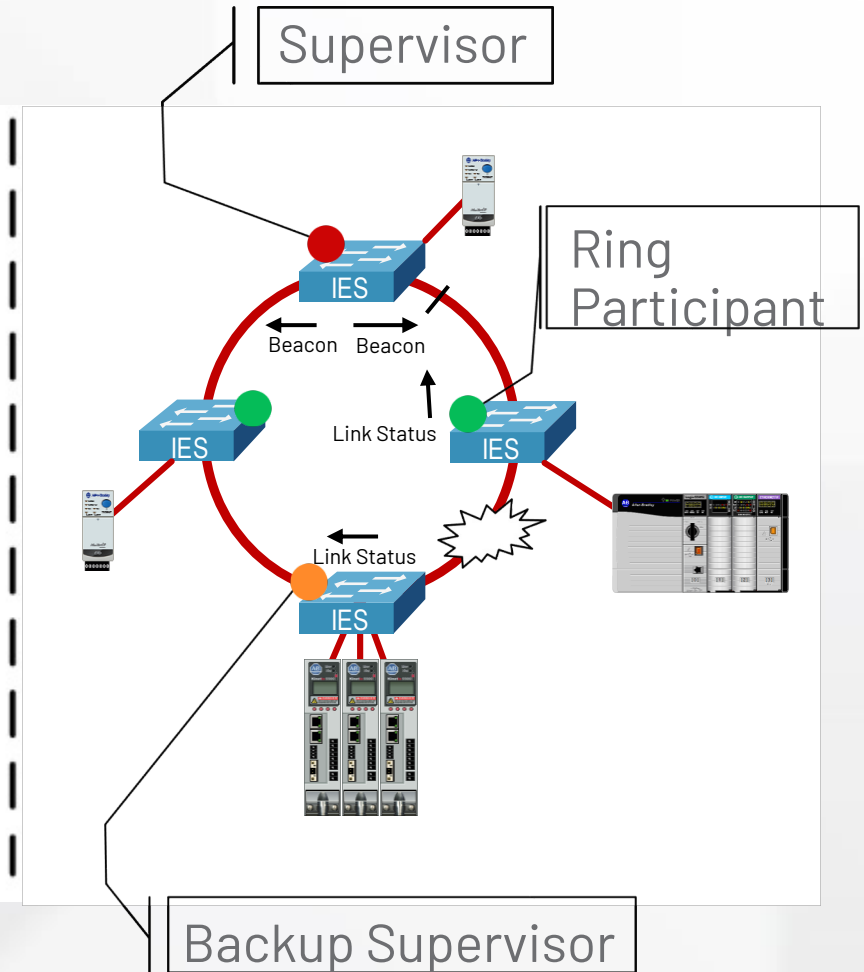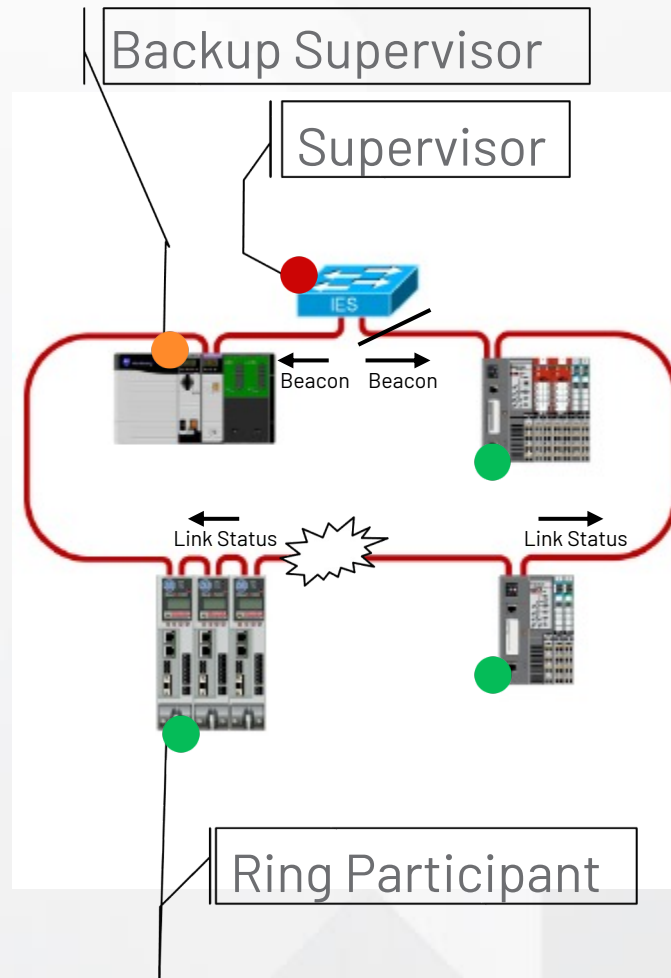
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Parallel Redundancy Protocol

# Parallel Redundancy Protocol (PRP)

- What is PRP?
  - Part of IEC standard [62439-3](#)
  - Supported by ODVA EtherNet/IP (PRP CIP object and attributes)
  - Redundant, fault-independent Ethernet infrastructure at Layer 2
  - Same Ethernet frame is sent on both LANs
  - Zero data loss during a single LAN fault
  - Independent of LAN topology
  - Resiliency protocols like DLR, REP, Spanning Tree or EtherChannel can be used in each LAN
- Typical applications for PRP
  - Where redundant network infrastructure is desired
  - Process applications with 24x7x365 operational requirements
  - ControlNet redundant media migration
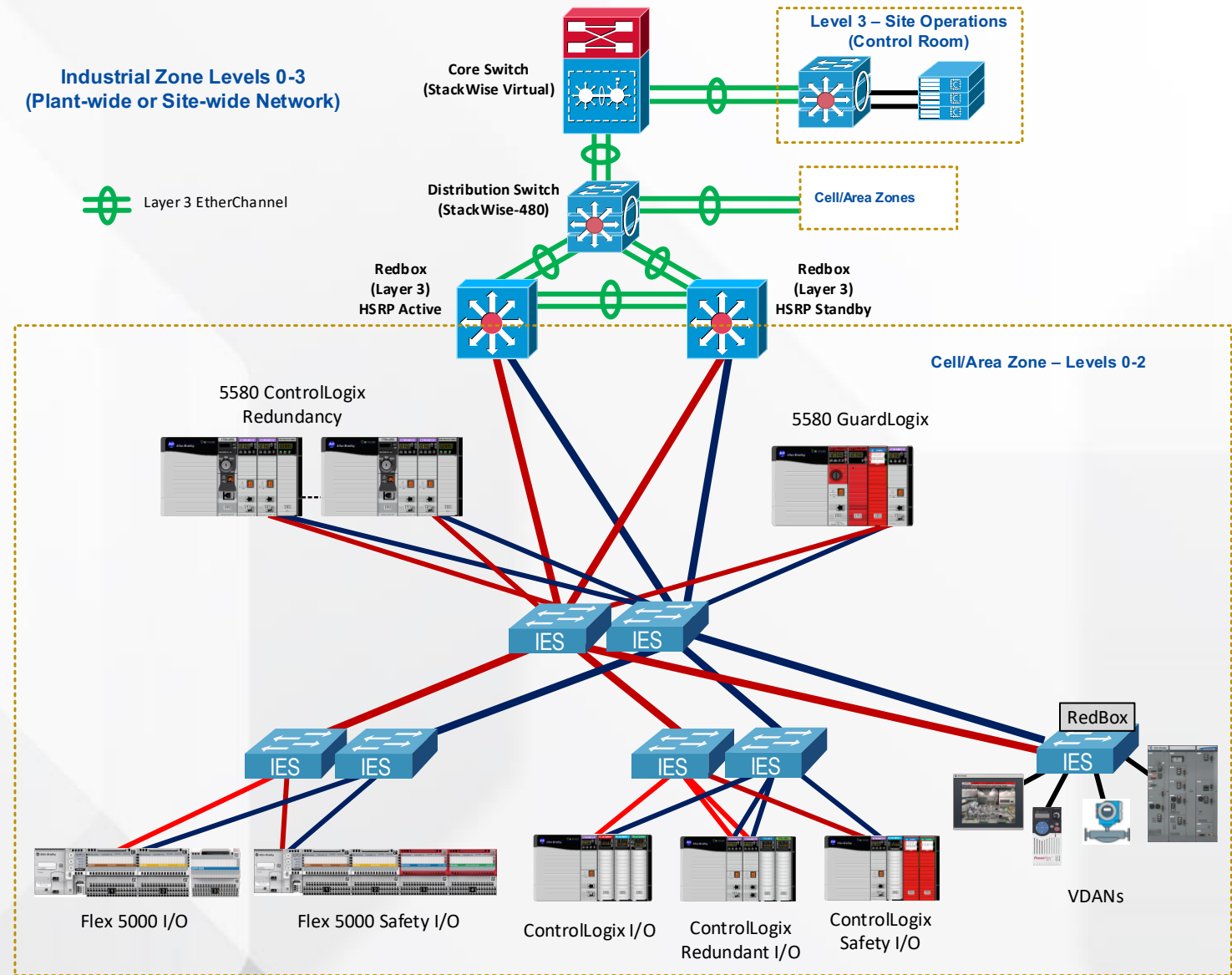  - Parallel data paths (transportation and mining tunnels, dual rings)

# PRP Topology



DAN in controller chassis

Infrastructure Switches

LAN A

LAN B

SAN

VDANs

RedBox – Stratix® 5400

DANs in I/O chassis

- Supports any LAN A/B topology where LANs are fault-independent

- LAN switches pass the PRP-marked frames just like any other Ethernet traffic

- Must be able to configure MTU size 1506 bytes or more (typically managed switches)

- Network monitoring is critical to detect LAN faults

  - Infrastructure devices must have unique IP addresses for monitoring

- Best practices for physical media, network design and security still apply!

# Connecting PRP to the Industrial Zone

- Example: Star LAN topology
- Redundant Layer 3 RedBoxes
  - HSRP active/standby gateways
  - Layer 3 Stratix 5400/5410/5800 catalog numbers (-R)
- Layer 3 routed ports on RedBoxes (except PRP channel ports)
- Dynamic or static routing
  - Tested EIGRP routing protocol in CPwE
- Small / medium networks can combine core and distribution



**Industrial Zone Levels 0-3
(Plant-wide or Site-wide Network)**

Layer 3 EtherChannel

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

**Core Switch
(StackWise Virtual)**

**Distribution Switch
(StackWise-480)**

**Cell/Area Zones**

**Redbox
(Layer 3)
HSRP Active**

**Redbox
(Layer 3)
HSRP Standby**

**Cell/Area Zone – Levels 0-2**

5580 ControlLogix
Redundancy

5580 GuardLogix

IES IES

IES IES

IES IES

RedBox
IES

Flex 5000 I/O

Flex 5000 Safety I/O

ControlLogix I/O

ControlLogix
Redundant I/O

ControlLogix
Safety I/O

VDANs

# PRP Ref Architecture with CIP Security



1756-EN4TR pair with CIP Security for workstation (program upload/download/monitor)

5580 controller pair

PRP LAN B

PRP LAN A

1756-EN4TR Redundant Adapter Pair
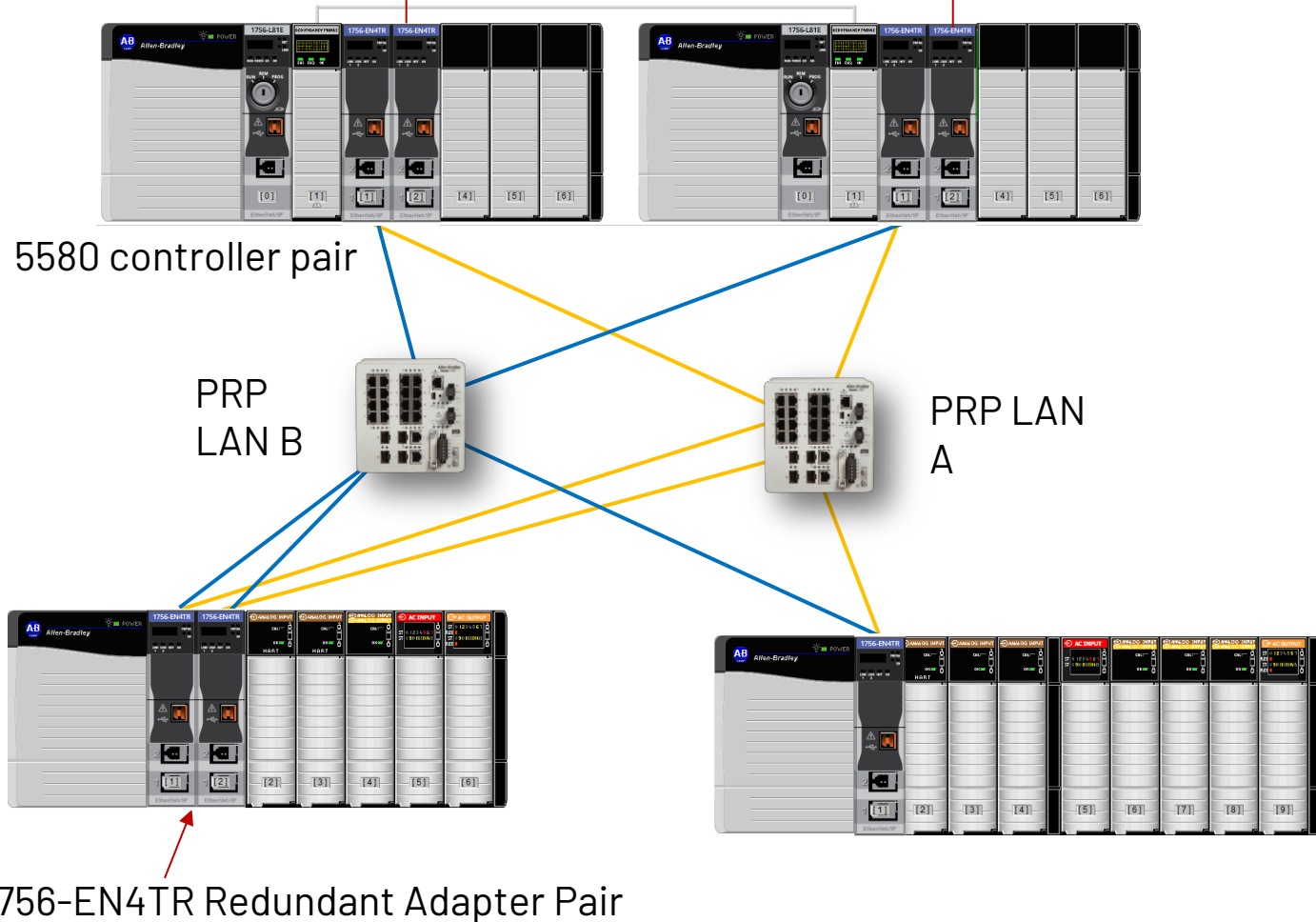
- Previously released in FW 3.001: a pair of 1756-EN4TR can be used as a redundant pair of adapters for I/O

- 1756-EN4TR FW 4.001 supports redundant V34 5580 ControlLogix controllers

- 1756-EN4TR FW 4.001 supports PRP in addition to DLR

- 1756-EN4TR FW 4.001 supports CIP Security with 1756-EN4TR pair with redundant V34 ControlLogix 5580 controllers for program upload/download/monitor (not I/O)

  - This pair must be configured for non-IP address swapping

# PRP Configuration

- No configuration is required for Ethernet modules (other than selecting the PRP mode)

- LAN switches and SANs must have unique IP addresses

- Common steps for infrastructure switches

  - MTU size 1506 bytes

  - Disable IGMP querier

  - BC or TC mode for PTP (CIP Sync)

- Common steps for RedBox switches

  - Enable IGMP querier

  - BC mode for PTP (CIP Sync)

  - HSRP Redundancy for Layer 3 RedBoxes

- Spanning Tree Portfast on ports between RedBoxes and LAN switches

- See CPwE PRP guide and PRP Application Technique for details

2 - Configure a PRP Network
- Device IP Addresses
- Frame Sizes for LAN A and LAN B Devices
- Configuration for LAN A and LAN B Infrastructure Switches
- Spanning Tree Protocol (STP)
- Multicast Traffic and IGMP Querier
- CIP Sync Time Synchronization (Precision Time Protocol)
- Configuration Example

# PRP Monitoring in Studio 5000 Logix Designer

- AOP for Stratix RedBox
- AOP for PRP-enabled modules

Module Properties: Y51 (1783-HMS8TG8EG4CGN 7.001)  ×

- General
- Connection
- Module Info
- Fault/Program Action
- Switch Configuration

**Channel Group 1**

Network Mode:                        Parallel Redundancy Protocol (PRP)

Module Properties: Local:1 (1756-EN2TP 11.001)  ×

- General
- Connection
- RSNetWorx
- Module Info
- Internet Protocol
- Port Configuration
- Network
- Time Sync

**Network**

Network Mode:              Parallel Redundancy Protocol (PRP)

Port B (Gi1/2)

OK

0

**Diagnostics for this node**

| | Port A | Port B | |
|---|---|---|---|
| Network Status | OK | Fault | 2016424 |
| Network Fault Count | 3 | 4 | 2179483 |
| Transmit Count | 1490840616 | 1490840601 | 0 |
| Receive Count | 1609476816 | 1609480780 | |
| Wrong LAN Count | 0 | 0 | 59 |
| Unique Entry Count | 119477 | 123424 | |
| Duplicate Entry Count | 162416098 | 1446941304 | 2133517 |
| Multiple Entry Count | 0 | 0 | |

Reset Counters   ←

0

Last PRP Port A Fault Timestamp    2019-10-02-10:27:59.930_856_568(UTC-05:00)
Last PRP Port B Fault Timestamp    2019-10-07-09:30:29.528_541_393(UTC-05:00)

**Diagnostics for other PRP nodes**

| Address | Node Type | Port A | Port B |
|---|---|---|---|
| 10.22.1.55 | Virtual Double Attached Node | Active | Active |
| 00:1d:9c:c3:9f:a6 | Virtual Double Attached Node | Active | Active |
| 00:1d:9c:d9:46:26 | Double Attached Node | Active | Active |
| ▶ 00:1d:9c:d9:46:63 | Double Attached Node | Active | Inactive |
| 00:1d:9c:d9:46:81 | Double Attached Node | Active | Active |

**Diagnostics for other PRP nodes**

| Address | Node Type | Port A | Port B |
|---|---|---|---|
| 10.22.1.55 | Virtual Double Attached Node | Active | Active |
| 10.22.1.61 | Double Attached Node | Active | Active |
| ▶ 10.22.1.62 | Double Attached Node | Active | Inactive |
| 10.22.1.80 | Virtual Double Attached Node | Active | Active |
| 00:1d:9c:d9:46:26 | Double Attached Node | Active | Active |

Rockwell Automation

# Network Device Library v12.02

Tested, documented and life cycle managed object library. It includes preconfigured status and diagnostic faceplates and AOI sets for Rockwell Automation Stratix 5800, 5700, 5400, 5410, and 2500 Switch Automation Devices and Device Level Ring networks.
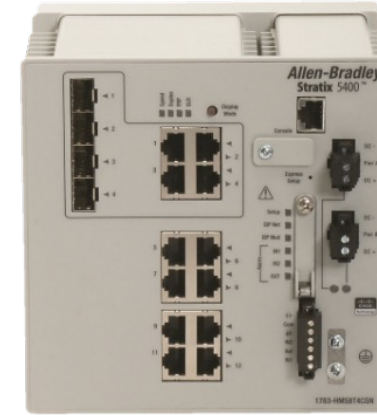
## Supported Devices

Stratix Managed Switches:

- 2500
- 5400/5410
- 5700 (Standard/Armor)
- 5800

Device Level Ring (DLR)

- 1 Ring
- 1 Ring Lite
- 3 Ring/Ring of Switches

## Network Diagnostics

- View port status, configuration, alarms and statistics
- View IP, VLANs and PTP configuration
- Monitor uptime, SD card, and power supply, temperature, I/O
- Check model, serial number, FW version and supported features

## Supported HMI Platforms

- FactoryTalk View SE
- FactoryTalk View ME (PanelView Plus)
- Studio 5000 View Designer (Panelview 5000)