THE REYNOLDS COMPANY
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TRC Tech Talks

Online Seminars

Resilient Networks – Device Level Ring (DLR)

June 4th, 2020

Introductions

Brandon Singh
Presenter
Network Specialist
The Reynolds Company – Dallas / Fort Worth

Mike Masterson
Panelist
Automation / Network Specialist
The Reynolds Company – Houston

Joe Belaschky
Panelist
Automation / Network Specialist
The Reynolds Company – Houston

Mark McGinnis
Panelist
Automation Specialist
The Reynolds Company – Dallas / Fort Worth

2020 Online Events - Register to receive a calendar invite

User Group

Thursday, June 18
ControlLogix Redundancy
10:00 am

Tech Talks

Tuesday, June 16th
Industrial Networking Series Part 4: Resilient Networks – Parallel Redundancy Protocol (PRP)
10:00 am

Wednesday, June 17th
Industrial Networking Series Part 5: Connected Plantwide Ethernet Architectures
10:00 am

Tuesday, June 23rd
Industrial Networking Series Part 6: Securing Control System Network with CIP Security
10:00 am

https://www.reynoldsonline.com/eventsUnit.action

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Deploying Switch-Level DLR rings within CPwE Reference Architectures

PUBLIC

Allen-Bradley • Rockwell Software

Rockwell Automation

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Deploying Device Level Ring within a Converged Plantwide Ethernet Architecture

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- Publications
  - Design Guide – ENET-TD015
  - White Paper – ENET-WP016
- What's covered
  - Switch-Level Device Level Ring (DLR)
  - Unsupported Topologies
  - DLR Configuration
  - DLR Troubleshooting

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Agenda

Rockwell Automation

- Network Topologies
- DLR Overview
- DLR Design Considerations

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Agenda

Rockwell Automation

Network Topologies

DLR Overview

DLR Design Considerations

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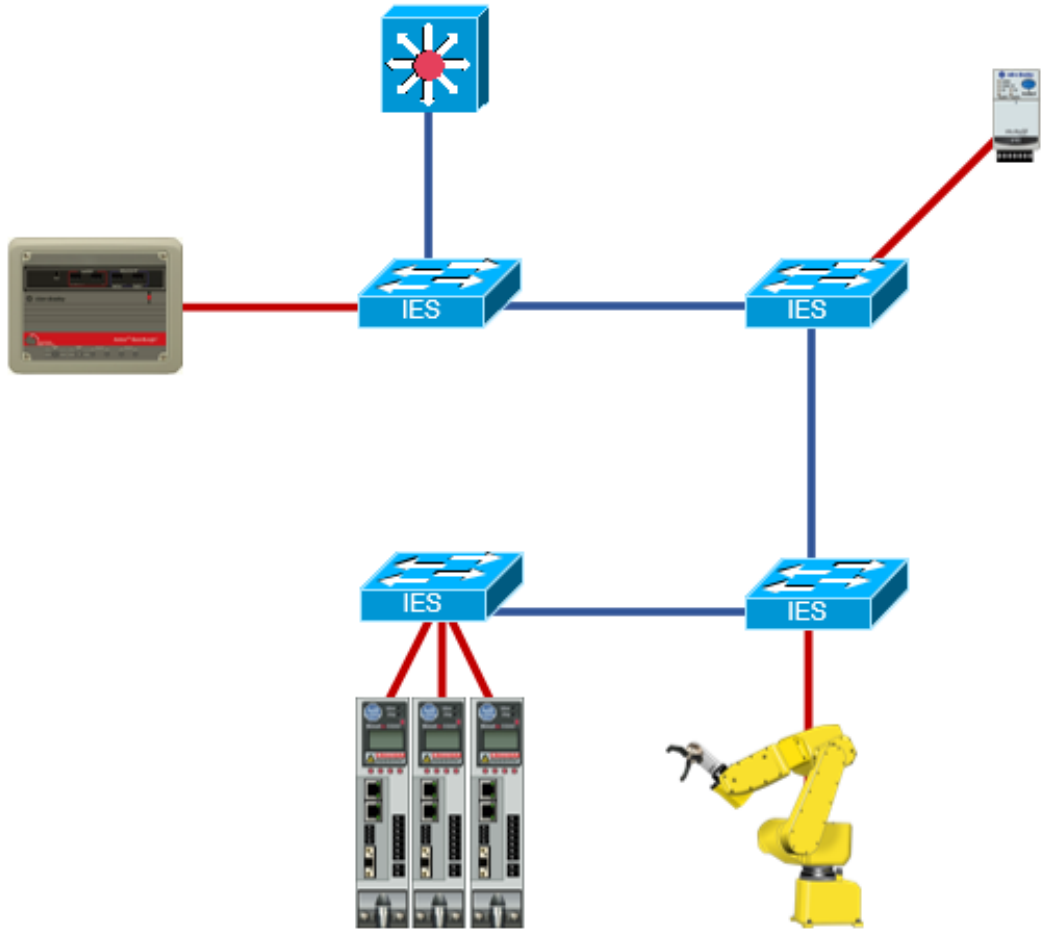
Network Topologies – Linear

- Advantages
  - Easy to design, configure and implement
  - Least amount of cabling and associated cost
- Disadvantages
  - Loss of network service in case of connection failure (no resiliency)
  - Potential to create bottlenecks on the links closest to Layer 3 devices
  - Varying number of hops makes it more difficult to produce reliable performance



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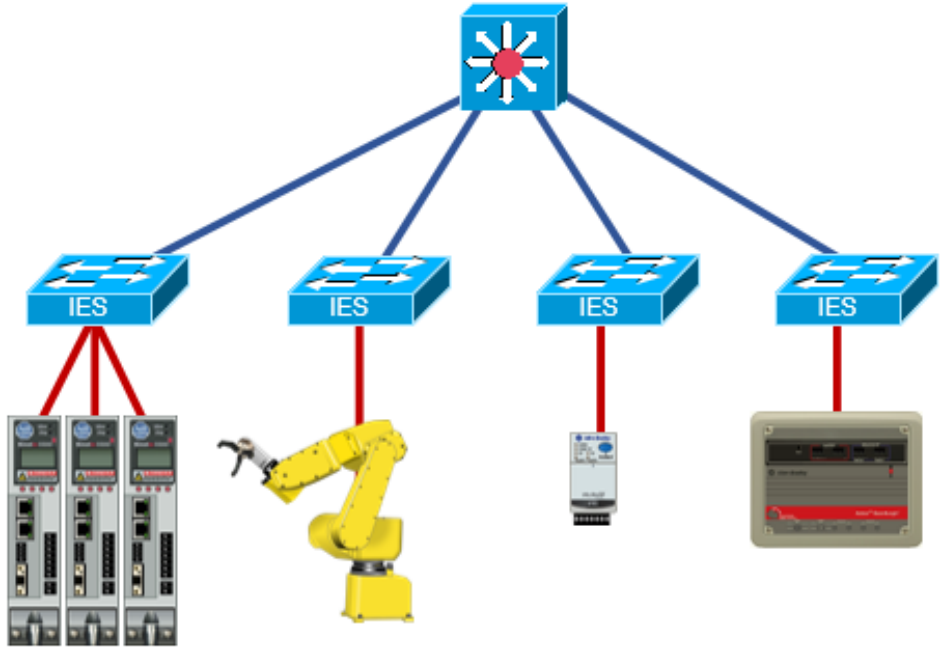
Network Topologies – Star

- Advantages
  - Easy to design configure and implement
  - Least amount of cabling and associated cost
- Disadvantages
  - Loss of network service in case of connection failure (no resiliency)



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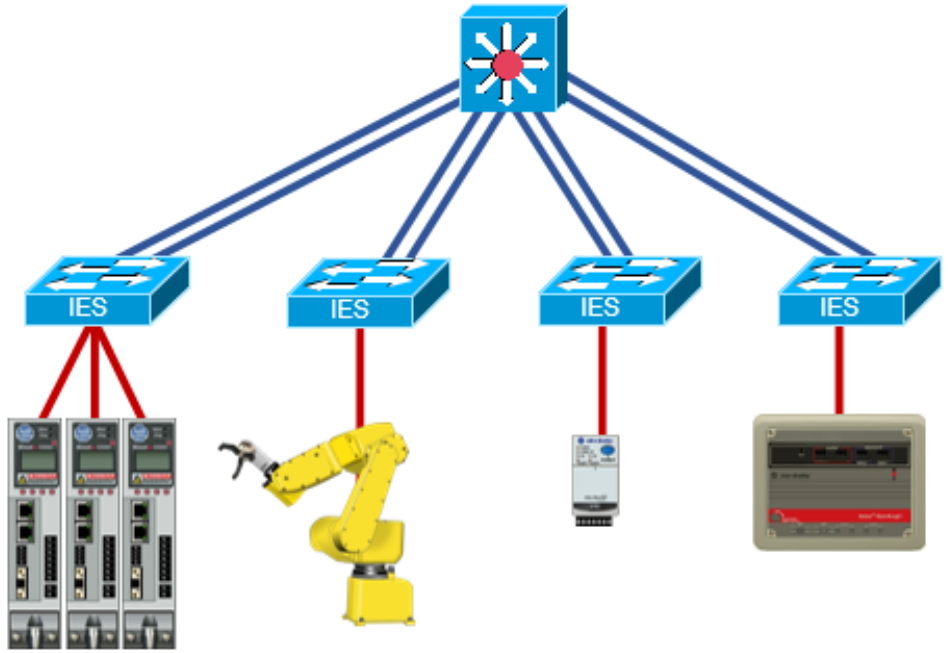
Network Topologies – Redundant Star

- Advantages
  - Resiliency from connection failure
  - Fast convergence to link loss
  - Consistent number of hops
  - Fewer bottlenecks
- Disadvantages
  - Additional wiring and costs required to connect switches
  - Additional configuration complexity



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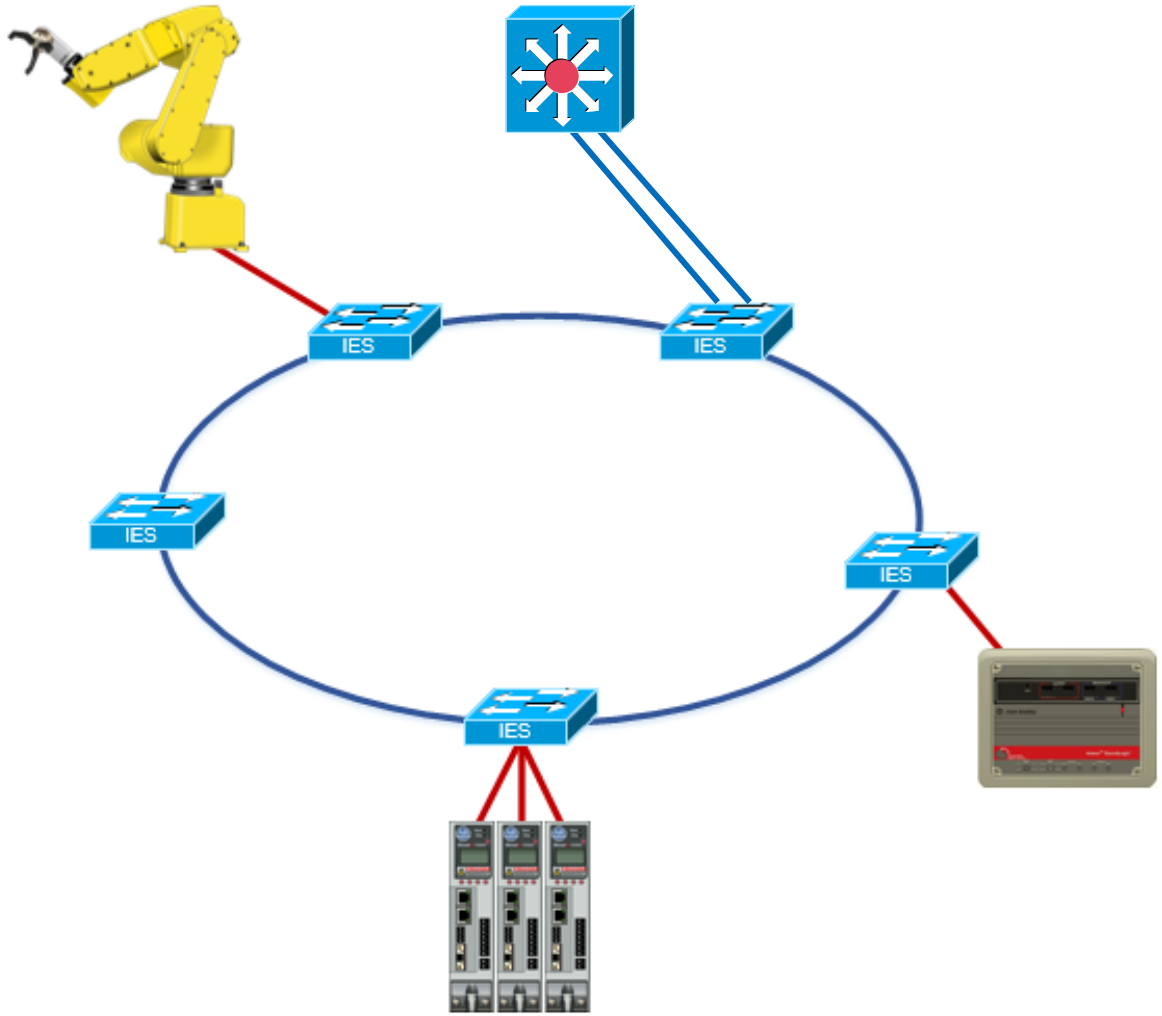
Network Topologies – Ring – DLR

- Advantages
  - Resiliency from single connection failure
  - Faster convergence to connection loss
  - Less cabling complexity in some plant floor layouts
- Disadvantages
  - Additional configuration complexity
  - Potential to create bottlenecks on the links closest to Layer 3 devices
  - Varying number of hops makes it more difficult to produce reliable performance



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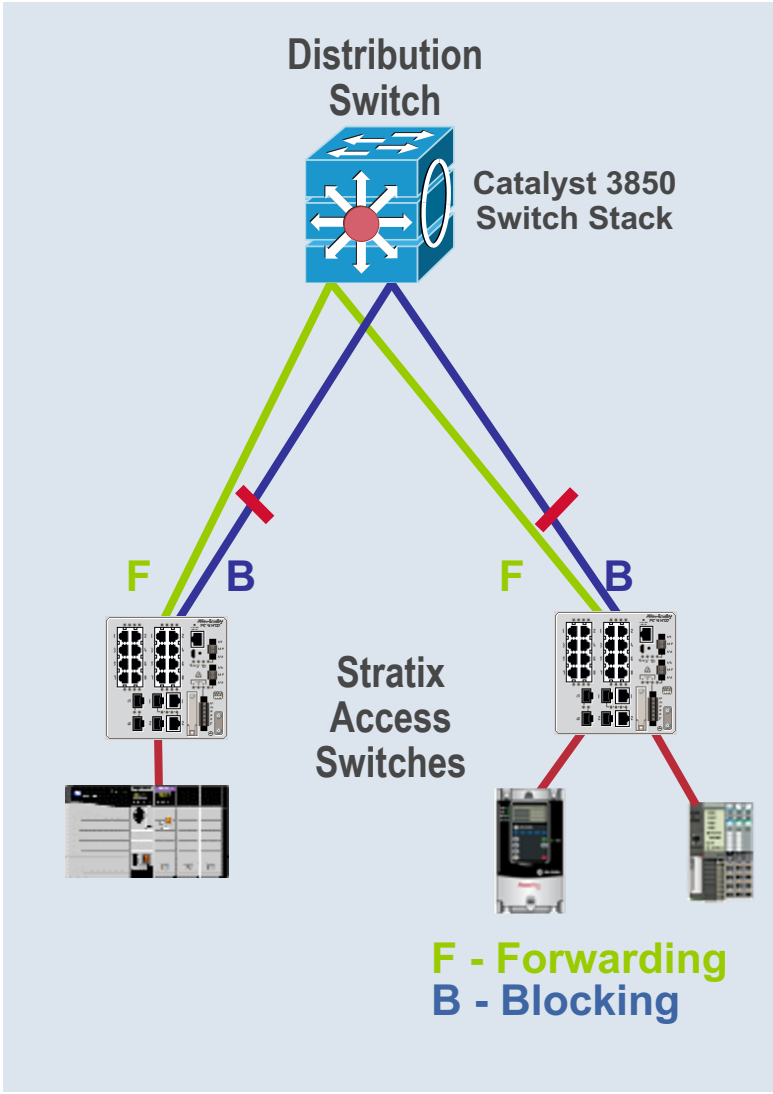
Spanning Tree Protocol(MSTP)

- MSTP is an IEEE standard
- Ring and redundant star topology
- Built into Stratix 5410/5400/5700/8000/8300
- Provides:
  - Loop-free network
  - Redundancy in case of failure
- Distribution is the root bridge
- Operates in a plug-and-play fashion
- Coordinate with IT before implementing



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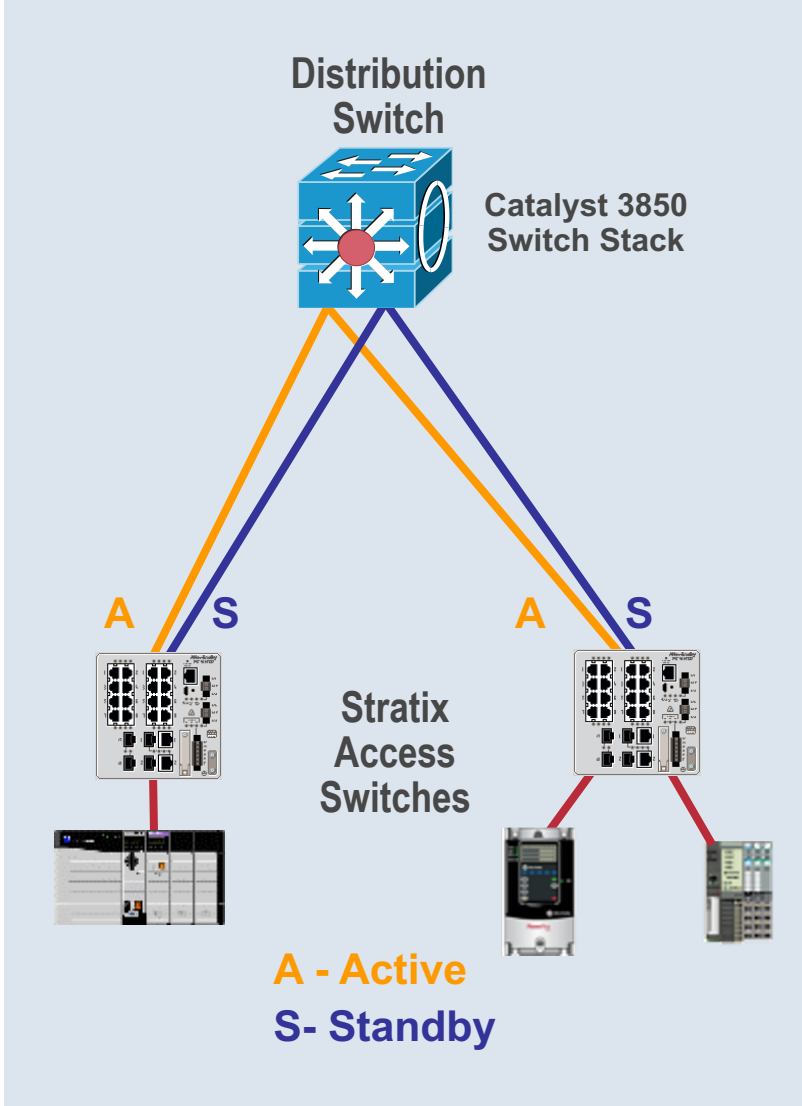
Flex Links

- Cisco technology
- Redundant star only
- Built into Stratix 5410/5400/5700/8000/8300
- Active/Standby port scheme
  - Provides alternate path in case of failures, avoiding loops
  - No bandwidth aggregation
  - Applied to the Stratix Access Switch
  - Recommend using equal speed ports
  - Provides fast fail over for multicast traffic



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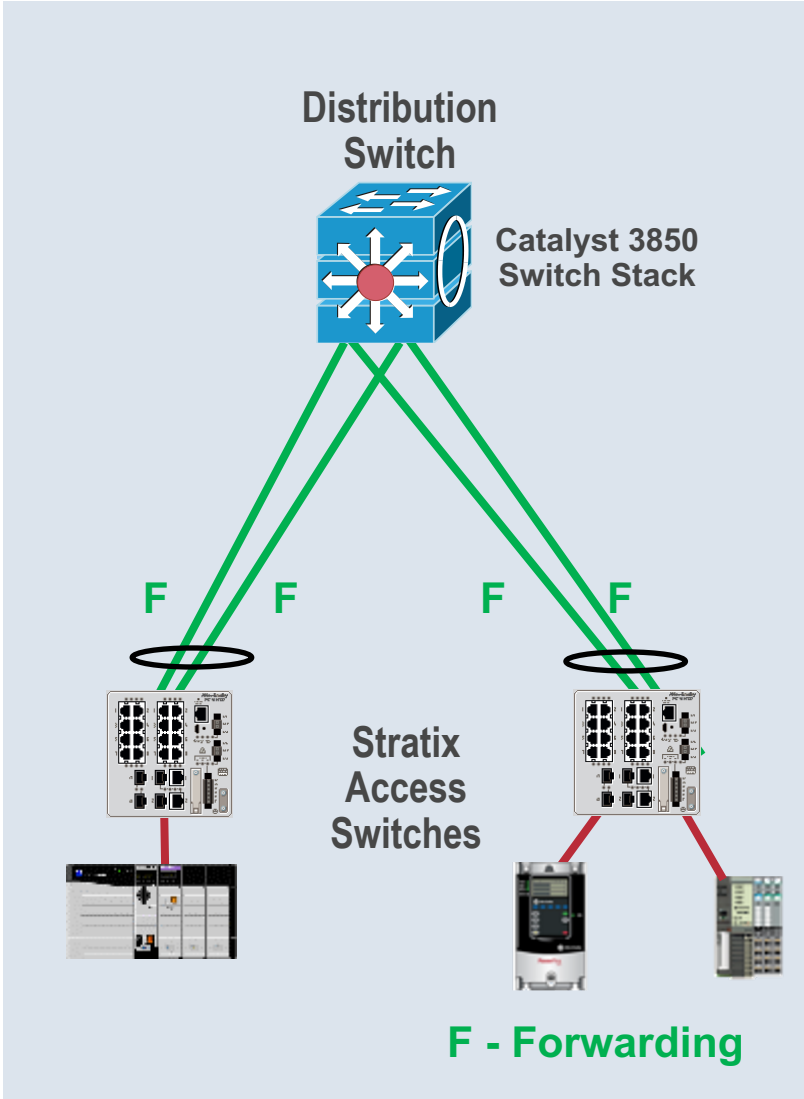
EtherChannel

- Link Aggregation Control Protocol (LACP) port aggregation – IEEE 802.3ad
- Redundant Star Topology
- Built into Stratix 5410/5400/5700/8000/8300
- Aggregates multiple physical links into one logical link
- Provides resiliency between connected switches if a connection is broken



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Agenda

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Network Topologies

DLR Overview

DLR Design Considerations

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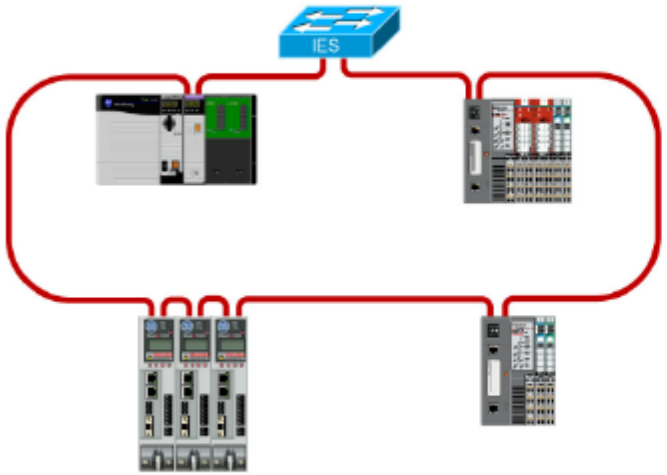
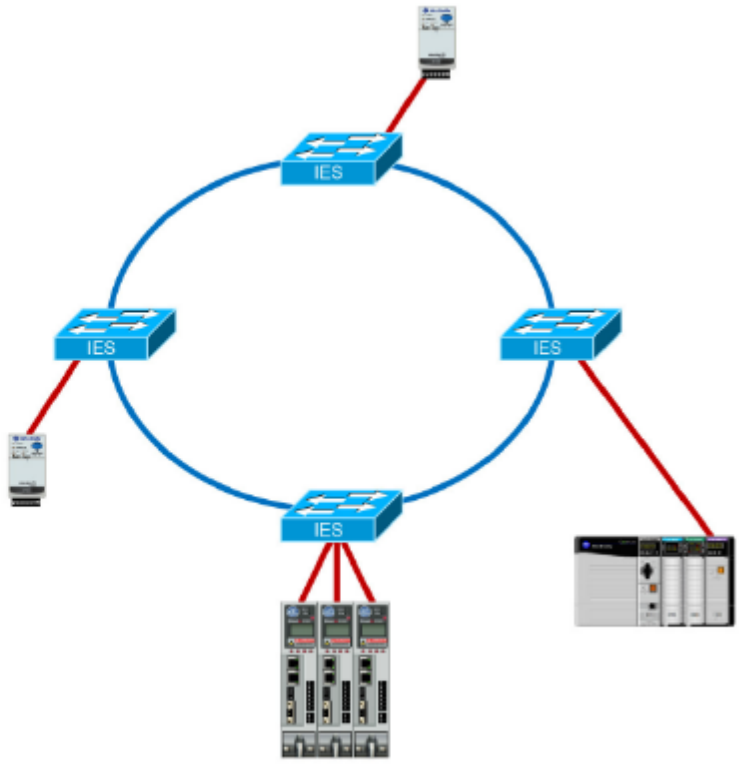
DLR Ring Implementations

- DLR can be implemented in both device-level and switch-level ring topologies
- Device-level and mixed switch/device-level topologies are out of the scope of this CPwE





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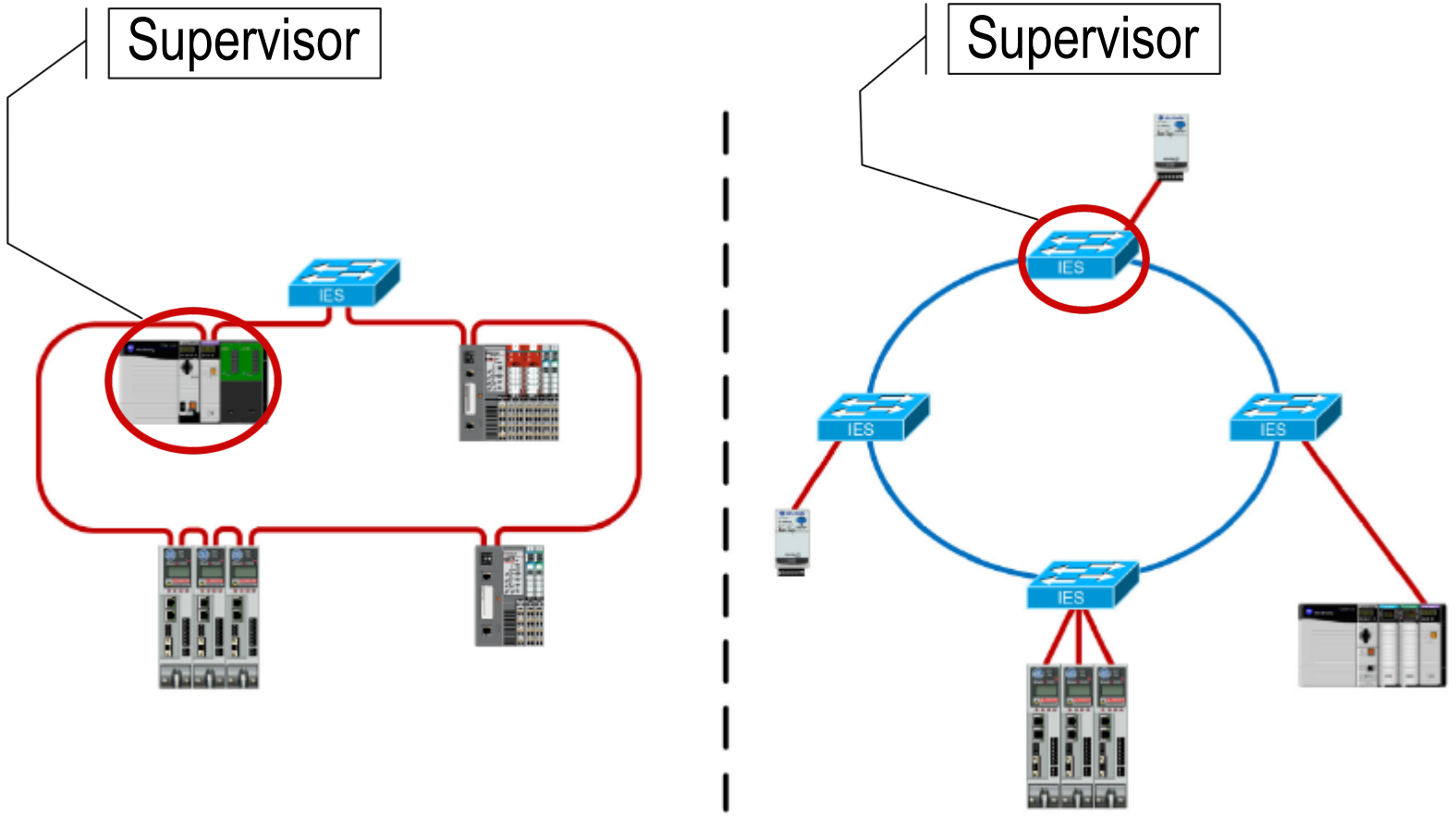
DLR Protocol Overview

- DLR ring nodes contain the following roles:
  - Supervisor ●



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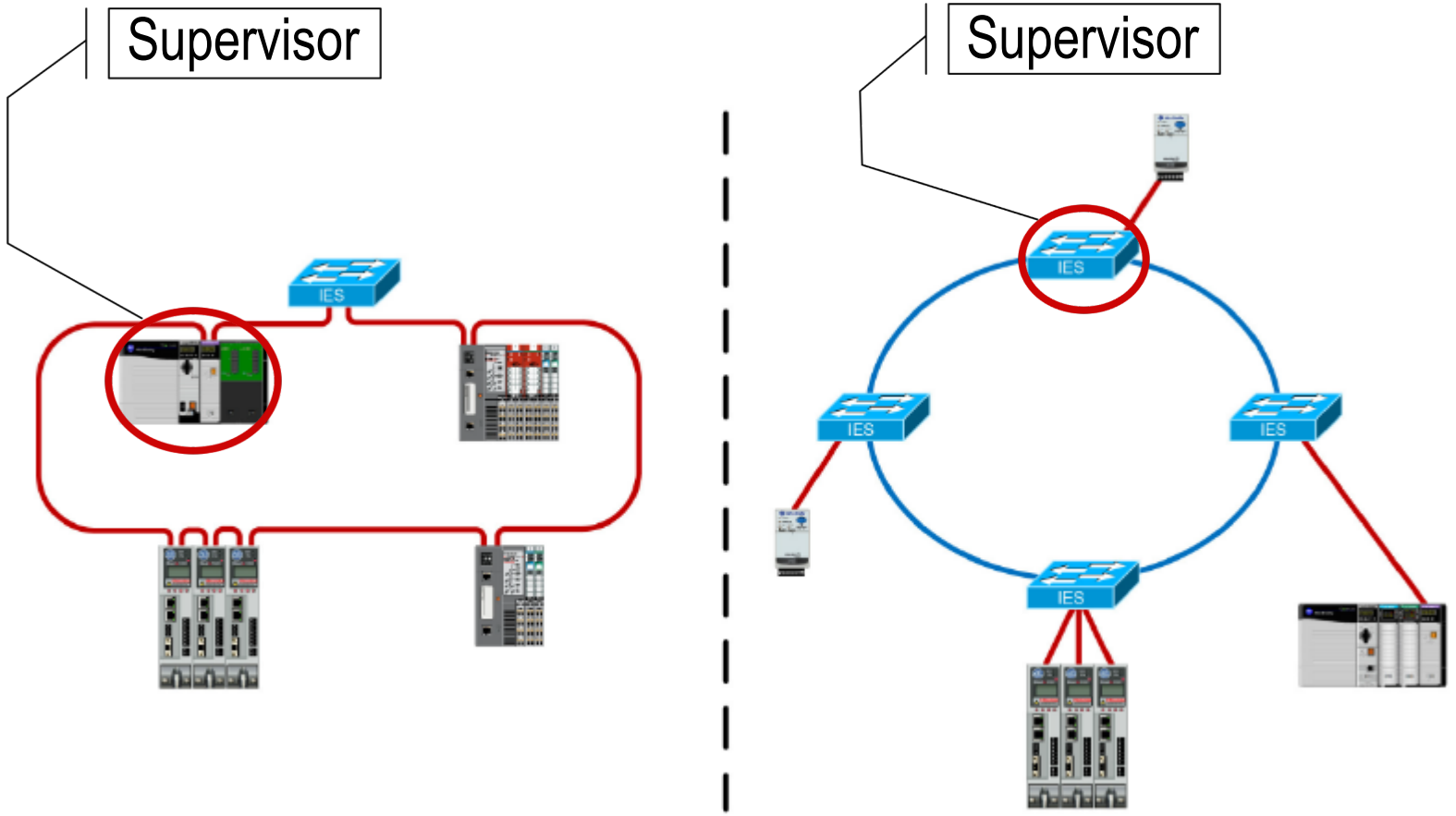
DLR Protocol Overview - Supervisor

- DLR ring supervisors are responsible for the following:
  - Network Loop Prevention
  - Active/Backup Status
  - Ring Integrity
  - Fault Recovery
  - Diagnostics
  - DLR DHCP Server (Stratix only)



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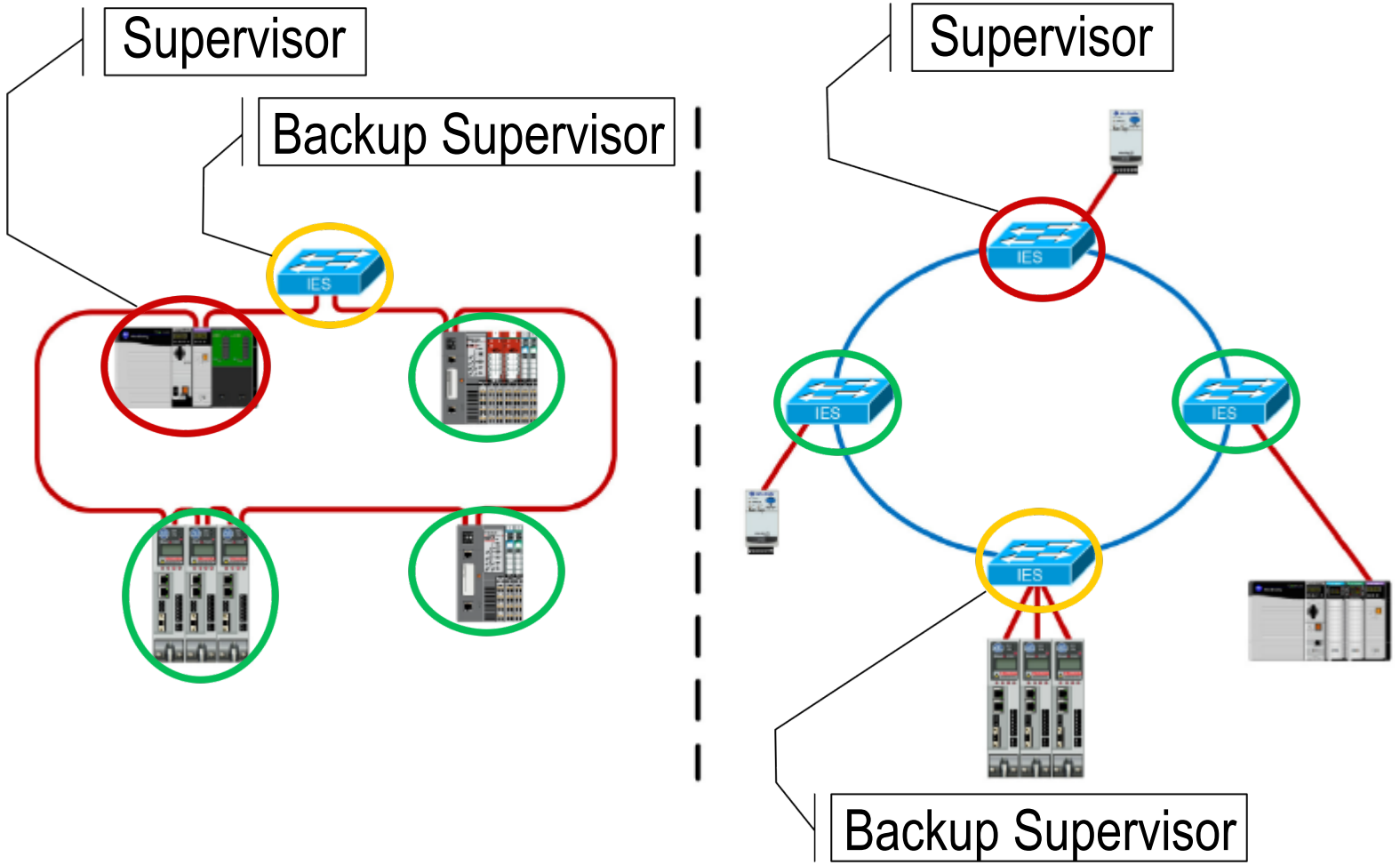
DLR Protocol Overview

- DLR ring nodes contain the following roles:
  - Supervisor ●
    - Backup Supervisor ●
  - Participant ●



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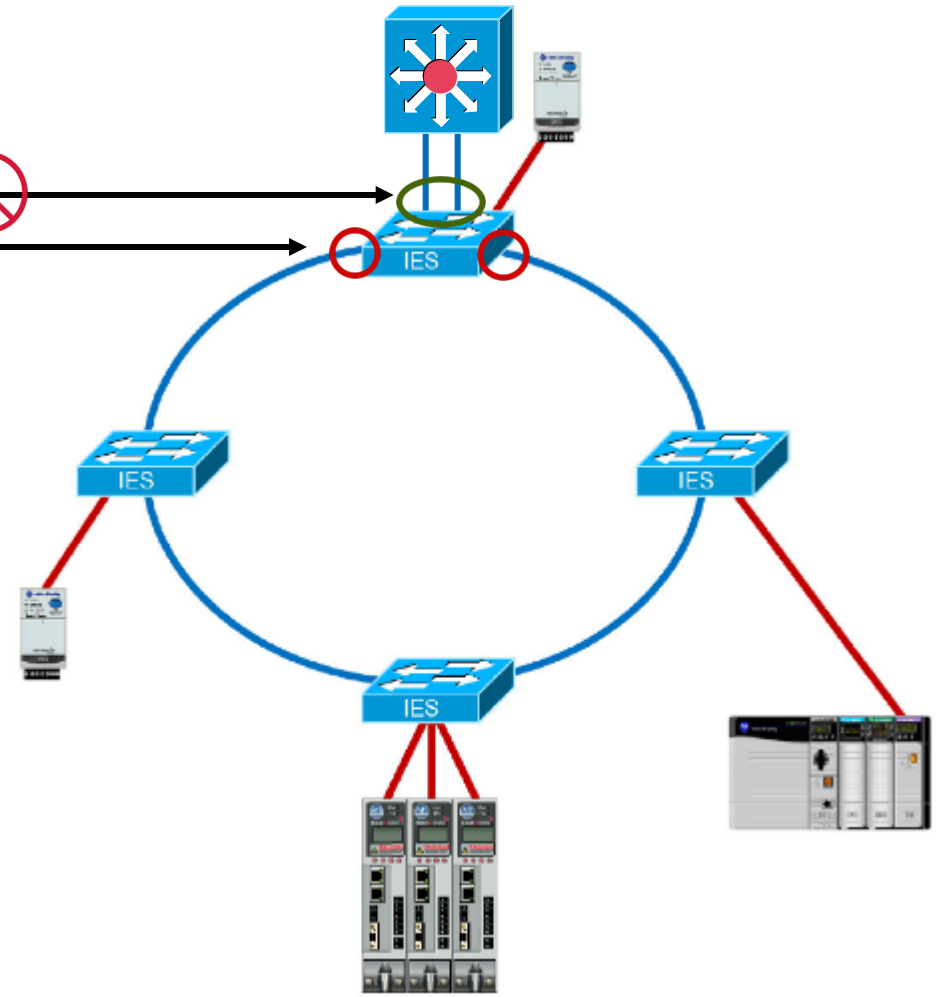
DLR Protocol Compatibility

- DLR ring ports are not compatible with the following:
  - EtherChannels
  - Network Address Translation (NAT)
  - REP
  - STP
  - Flex Links
  - 802.1x Security
  - Multiple VLANs (Trunking)
  - Smartport roles except for Multiport Automation Device



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DLR Design Consideration

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Network Capacity

- Network capacity is a critical metric in DLR ring planning
- DLR ring nodes all share bandwidth on a ring network
  - Too many devices connected to switches in a DLR ring can create bottlenecks and inconsistent network behavior

- All CPwE DLR Proof of Concept testing utilized the following:
  - 128 I/O connections at varying RPIs (20-40ms)
  - IXIA traffic generation of approximately 32,000 packets per second sized at 70 bytes

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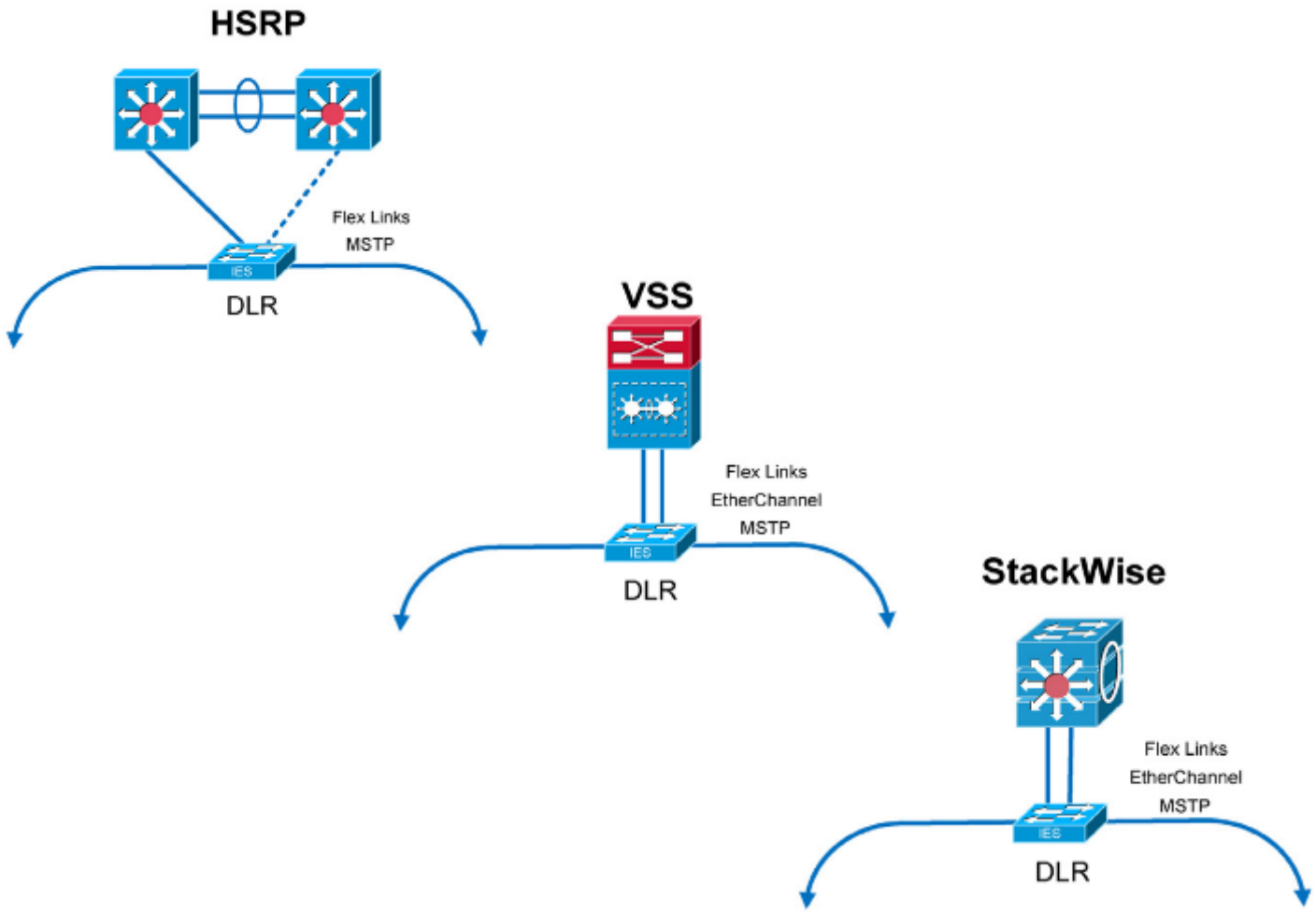
DLR Switch-Level Reference Architectures

- Multiple distribution and resiliency protocol combinations
- No more than 24 switches per DLR ring
  - Larger rings introduce more risk
- No more than 254 hosts per DLR ring
  - Network capacity should be strictly reviewed
- Single VLAN



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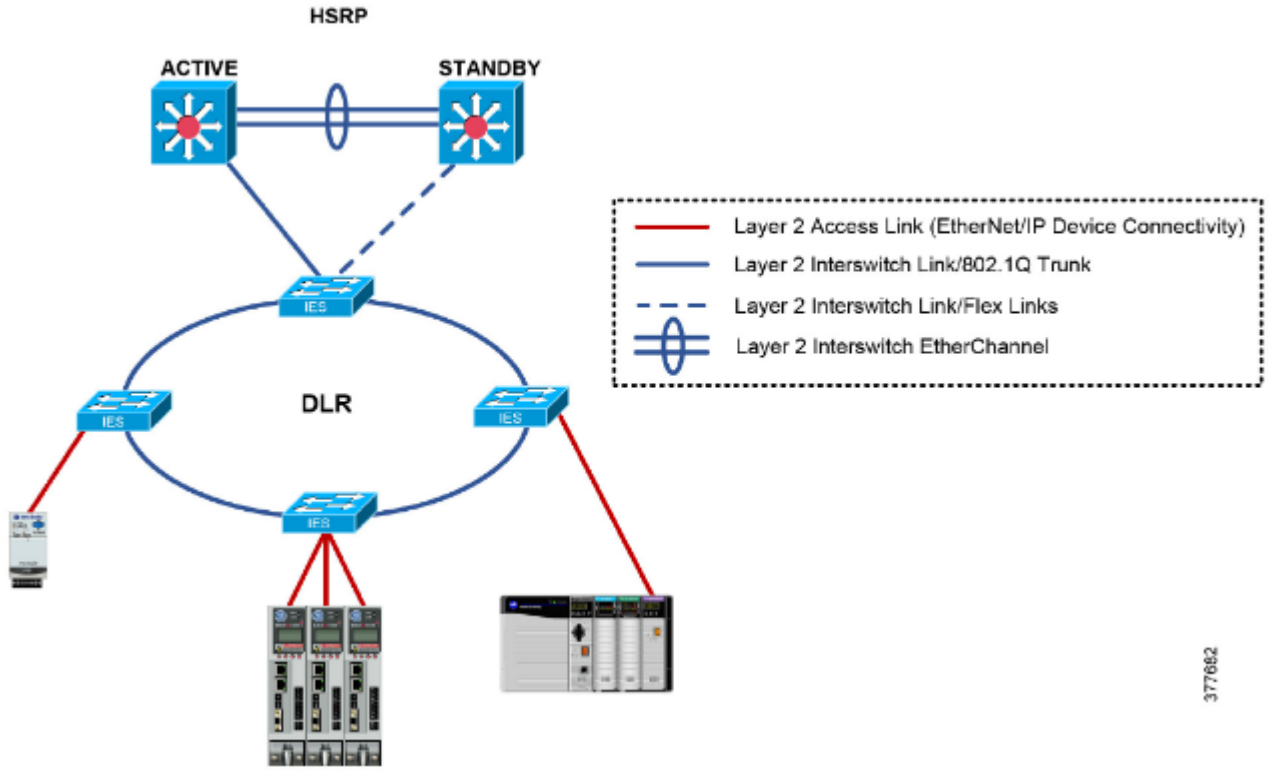
DLR Switch-Level Reference Architectures

- The recommended usage of the DLR protocol in the CPwE is limited to switch-level DLR with uplinks to distribution
- DLR capable Stratix have specific ports for which DLR can be implemented
- This CPwE does not include the usage of the Redundant Gateway (RG) feature
  - Multicast convergence times have shown to be higher than expected, this type of traffic should be limited from using the RG. This type of traffic may include the following:
    - Multicast I/O (examples are ControlLogix Redundancy I/O and IEEE 1588 CIP Sync traffic)
    - Multicast produced/Consumed Tags



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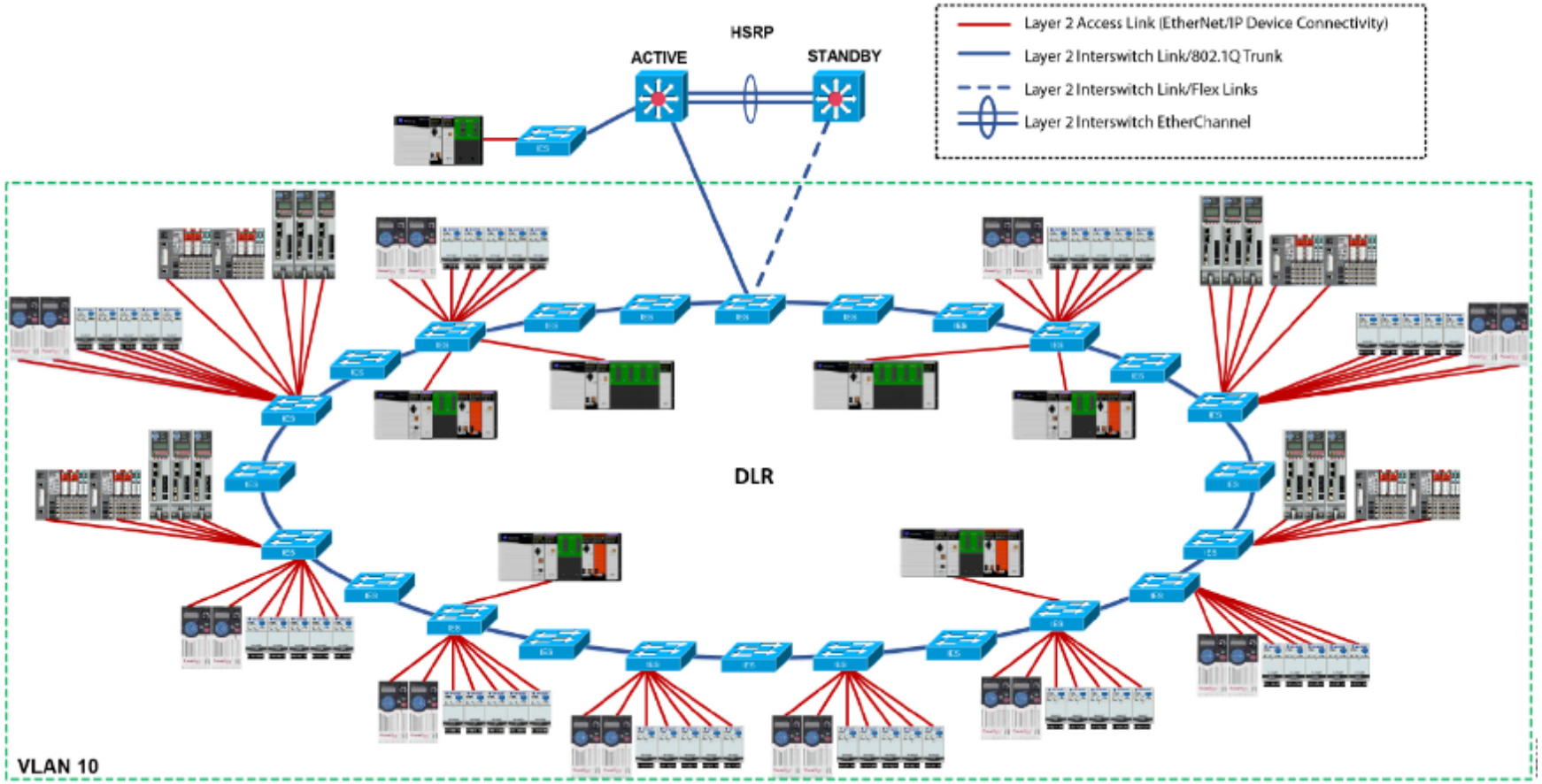
DLR Switch-Level Reference Architectures

Switch-Level Ring

- Up to 24 switches
- Mixed Stratix 5400 and 5700 switches
- 100 Mbps or 1 Gbps but not mixed
- Single VLAN



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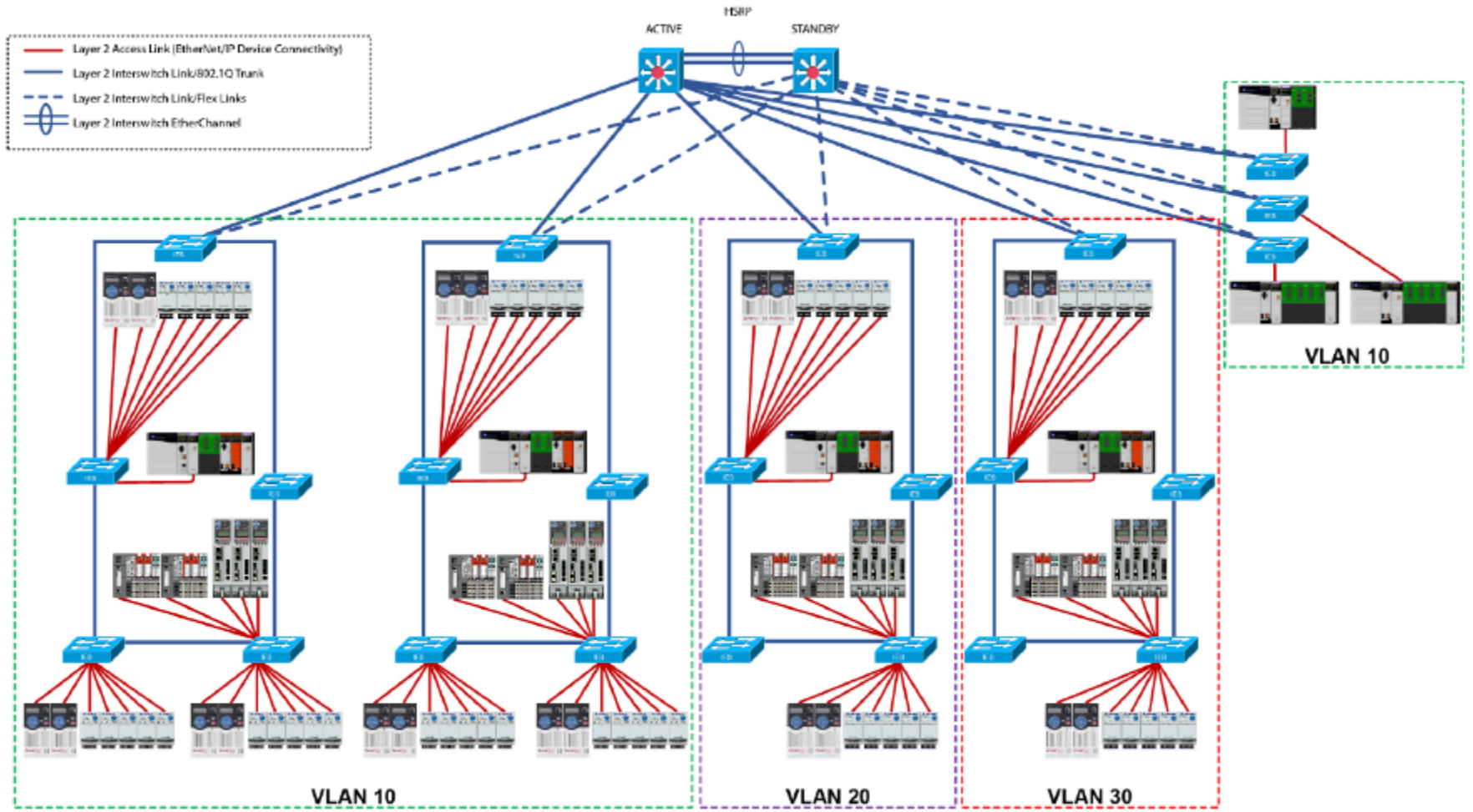
DLR Switch-Level Reference Architectures

Multi-VLAN Segmentation

- Mixed Stratix 5400 and 5700 switches
- 100 Mbps or 1 Gbps but not mixed
- Single VLAN per ring
- Single VLAN spanned across multiple rings



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DLR Switch-Level Reference Architectures

- Testing results were consistent with CPwE Resiliency Redundant Star results

		Redundant Star		
Distribution switch	L2 Protocol / L3 Protocol	MSTP	Flex Links	EtherChannel
Catalyst 4500-X	HSRP	✓	✓	×
	VSS	×	✓	✓
Catalyst 3850	HSRP	○	○	×
	Stack	✓	✓	✓
IE 5000 / Stratix 5410	HSRP	✓	✓	×
IE 4000 / Stratix 5400	HSRP	×	×	×

** See summary of recommendations for multi-ring topology

✓	Validated and recommended
✓	Validated
○	Not tested
×	Invalid / Not recommended

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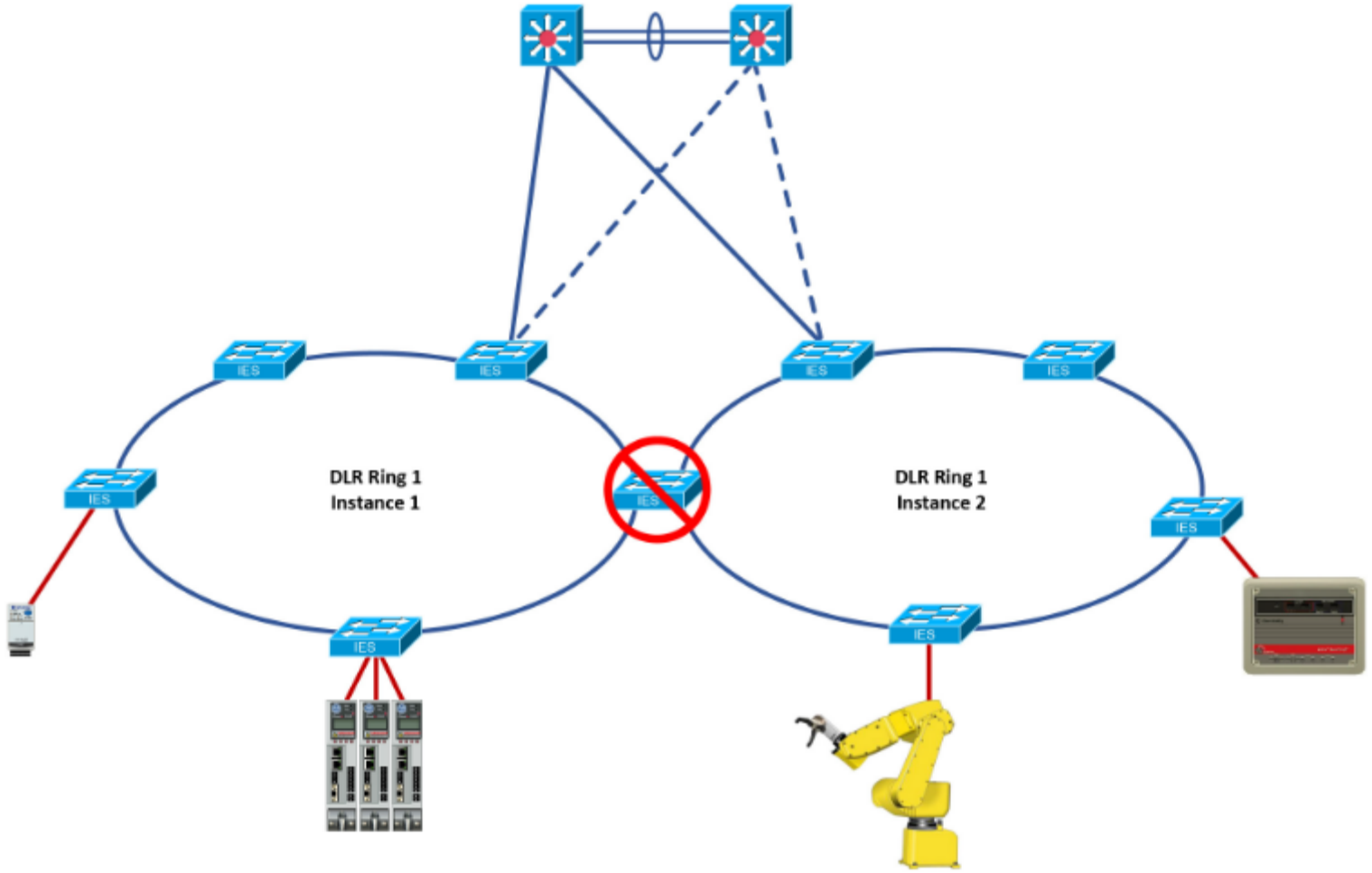
DLR Design Considerations

Unsupported Topologies

- The DLR protocol does not support sharing the same ring between two nodes
- This is not to be confused with the Stratix 5400 multi-ring feature



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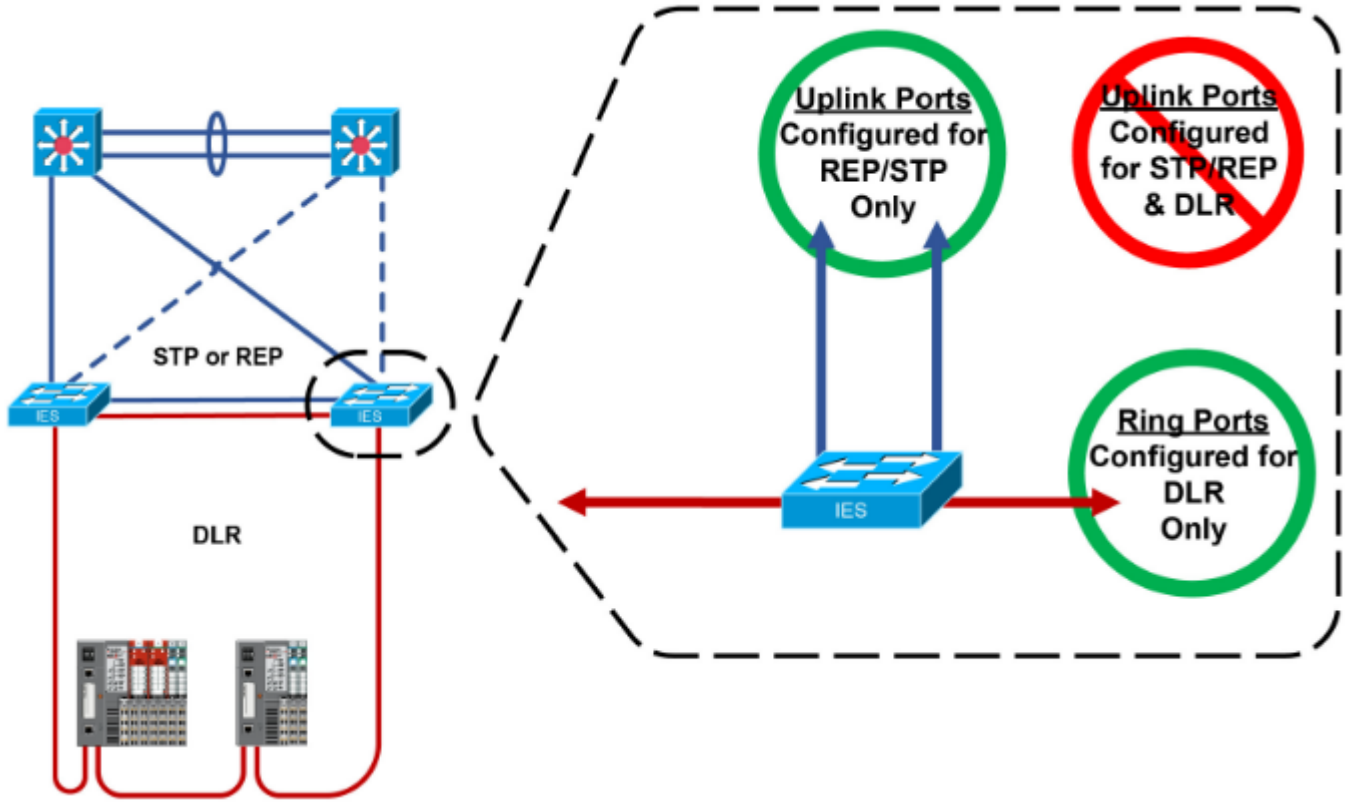
DLR Design Considerations

Unsupported Topologies

- The DLR protocol cannot be implemented on the same ports as other resiliency protocols

- For example:
  - Uplink ports cannot be configured for STP/REP and DLR
  - Ring ports cannot be configured for STP/REP and DLR



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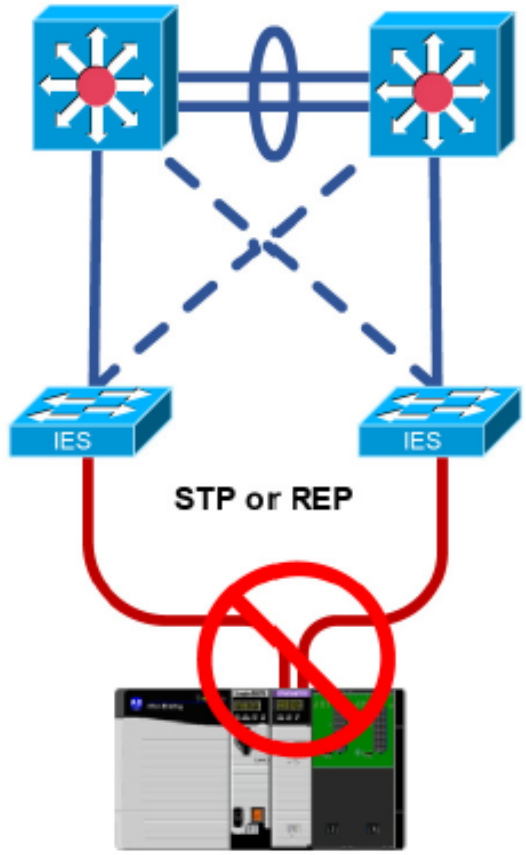
DLR Design Considerations

Unsupported Topologies

- Embedded switch devices cannot have each port connected to a Stratix switch without implementing the DLR protocol



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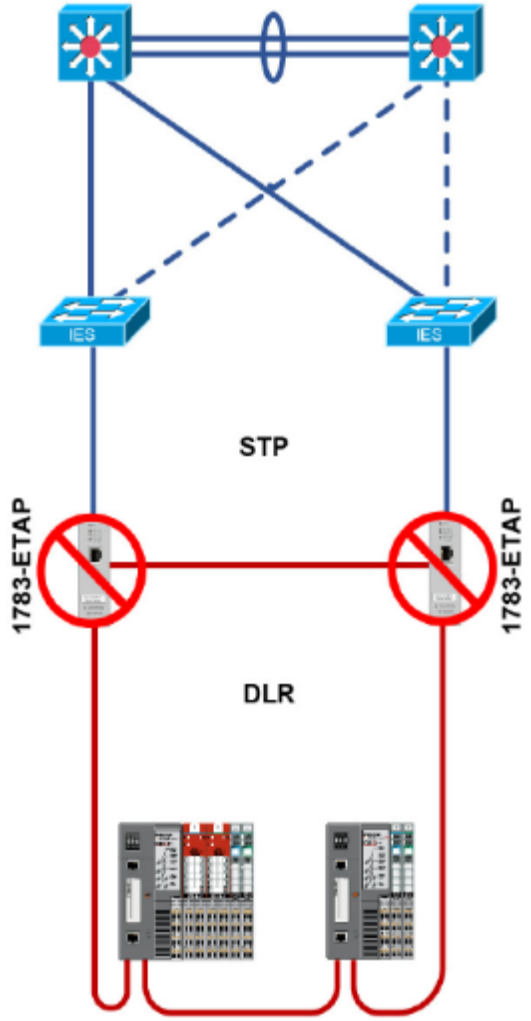
DLR Design Considerations

Unsupported Topologies

- Connecting multiple 1783-ETAPs from a DLR topology to a common network or switch
  - 1783-ETAP does not support Redundant Gateway uplinking



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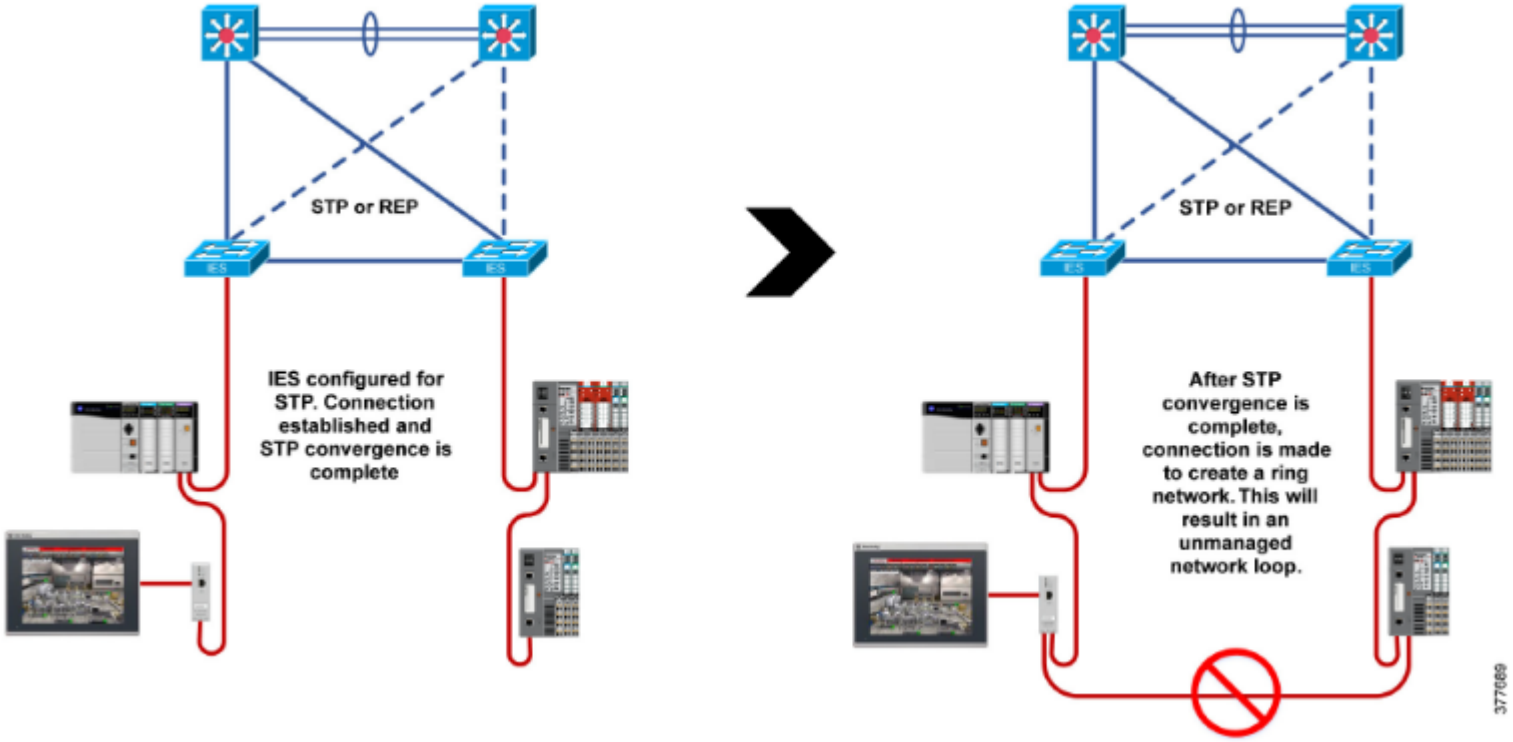
DLR Design Considerations

Unsupported Topologies

- Two separately configured linear topologies cannot be connected together without the DLR protocol



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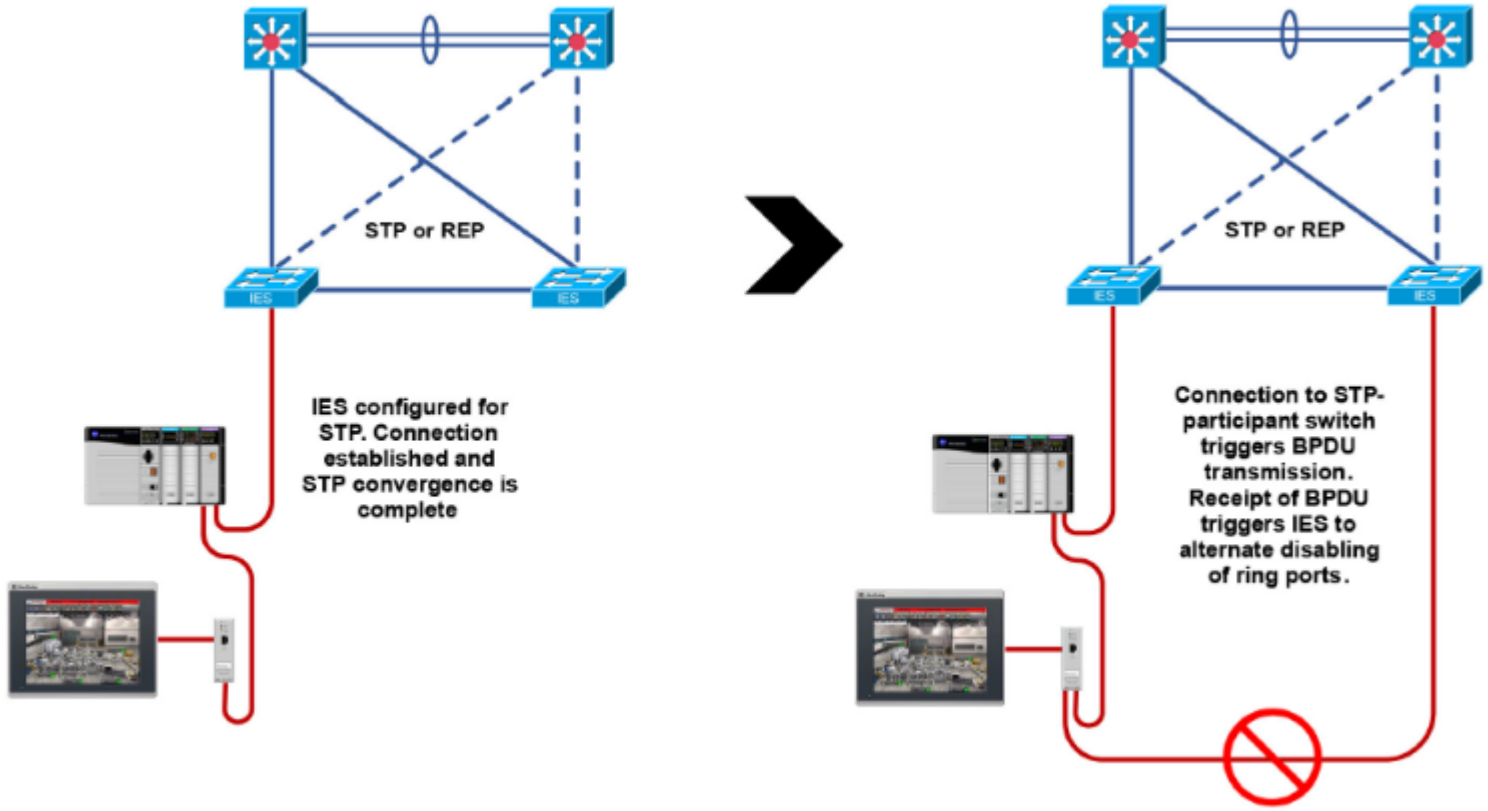
DLR Design Considerations

Unsupported Topologies

- A linear topology cannot be connected into a ring without the DLR protocol



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Summary

- In a single ring, Commercial Engineering tested up to 24 Stratix switches
  - Traffic loading should be strictly reviewed and Ethernet capacity calculated
  - Star device connections to Stratix switches should be less than class C size network (254 devices)
- Redundant Gateway testing showed challenges that are documented in the Design Guide
- Multiple segmented rings to a single distribution switch was tested for scalability
- Test results for both Reference Architectures consistent with CPwE Resiliency Redundant Star results

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Summary

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Questions?

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