CONTROL LEVEL NETWORK RESILIENCY USING RING TOPOLOGIES

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Introduction

Many Ethernet applications require some level of network resiliency – such as a critical operation or an installation with a vulnerable cabling system. Spanning Tree Protocol (STP), Link Aggregation and proprietary Ring protocols are all technologies available to build a fault-tolerant network on Ethernet. Each solution provides a different level of fault tolerance and deciding which to use depends on the application requirements and installation practicability.

Resilient Ring Network

For automation systems, a ring solution is the most commonly used method for control level network resiliency. This is mainly due to its installation simplicity and speedy network recovery performance. Unlike a more complex resilient topology, such as a redundant-star, the ring topology simplifies the network design and requires less cabling which helps reduce wiring and installing costs. In addition, its relatively responsive network recovery time helps minimize system downtime.

In a typical ring network, a series of Ethernet switches are connected to one another through designated ports to form a ring topology. Automation devices are then connected to these switches to establish communications on the network (see Figure 1). This topology guarantees a single fault-tolerant network in which communications between devices continue even if a link within the ring is broken. For example, Device A would continue communication to Device B with a cable break at Link X.

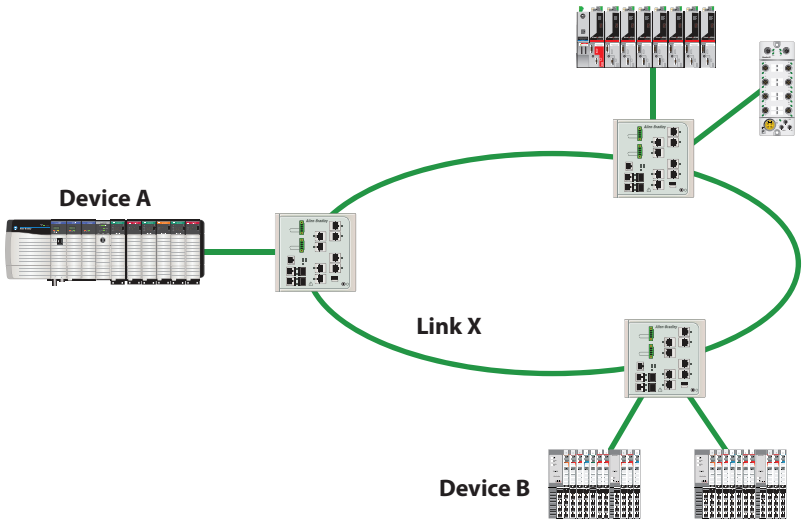

Figure 1 – Switch Ring Topology

Device-Level Ring Protocol

As industrial applications become more complex and data sensitive, the need for a reliable and robust network infrastructure increases. This is pushing control engineers to be more diligent in designing high-performance resilient networks while keeping implementation costs down. The Device-Level Ring (DLR) solution, which ODVA introduced in 2009, was developed to meet those requirements. Unlike typical ring solutions, DLR is designed to be deployed at the end devices instead of the switches. The protocol enables EtherNet/IP™ devices, equipped with dual network ports, to connect directly to neighboring nodes to form a ring topology (see Figure 2). A ring topology at the device level greatly reduces the number of wires on the network, as well as the number of needed industrial Ethernet switches. The flexibility of the solution allows connectivity between a DLR network and other external networks regardless of their network topologies. All DLR-compliant products are assured interoperability, making this protocol a great network solution for multi-vendor EtherNet/IP systems.

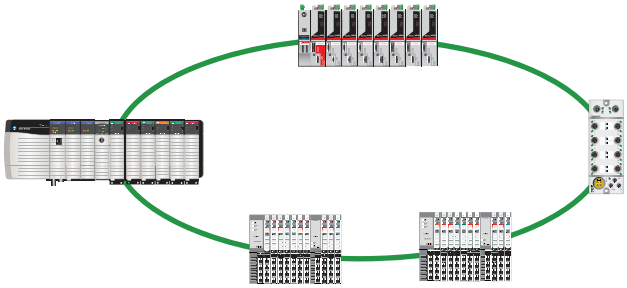

Figure 2 – Device-Level Ring Topology

DLR Operation

The fundamental operation of the DLR protocol is similar to that of other ring protocols. A ring node is designated as the "active supervisor" on the network. The core function of the active-supervisor node is to prevent data from traveling in loops by logically blocking one of its ports. Furthermore, the active supervisor continuously transmits beacon packets through both of its ports at a pre-configured interval. The detection of the returning beacon packets allows the supervisor to determine the state of the network. If a network fault is detected, diagnostic information is readily available at the active supervisor. Users can manipulate this information in a controller program or display it on HMI screens.

For example, if a cable break occurs, the exact location of the break can be obtained from the active-supervisor node to help an engineer quickly remedy the issue. In addition, backup supervisors can be configured on the network to provide redundant supervisory support in case of a failure at the active-supervisor node.

DLR Performance

The DLR protocol offers a solution for applications that require extremely fast recovery times. The typical recovery time for a 50-node ring is less than 3 ms. This represents the time it takes to detect a ring fault until the time the network is restored, allowing communications to continue. From a system point of view, the quick recovery time means ring failures are essentially transparent to the devices on the network. This transparency allows the system to continue operations without any interruptions. By leveraging the diagnostic capability in the protocol, break points are easily identified and maintenance can be scheduled at a convenient time.

In addition, DLR supports standard IEEE 802.3 and is fully compatible with all EtherNet/IP applications, including advanced solutions such as CIP Safety™ and CIP Motion™. Switch services, such as QoS (802.1Q/D), are embedded into DLR to help prioritize data transmission to ensure critical data can be delivered in a timely fashion on the ring network.

DLR Versus Other Ring Protocols

The following table provides a snapshot comparison between the DLR and other ring solutions available today.

	Device-Level Ring	Other Ring Solutions
Topology	• Ring topology connected at the end devices • Supports connection to other network topologies, i.e. star, tree, linear	• Ring topology connected at the switch level • Supports connection to other network topologies, i.e. star, tree, linear
Network Recovery	• < 3 ms for a 50-node system	• Performance varies based on vendor, could range from 30 ms – 500 ms
Resiliency	• Single fault tolerant at the device level	• Single fault tolerant at the switch level
Installation	• Cabling needed only for the ring • Switch embedded into the end devices; no external switches required	• Cabling needed for the ring and also cabling from switches to devices • External switches required

Summary

The DLR solution from ODVA helps simplifies network architectures and reduce installation costs. Furthermore, the protocol's superior network recovery performance significantly reduces downtime for even the most demanding applications.

In automation applications, the ring topology remains the most practical option for network resiliency. DLR provides control engineers with a viable solution that pushes resiliency down another network layer, further increasing the application's reliability and robustness.

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