Application Guide

Allen-Bradley

EtherNet/IP Embedded Switch Technology

Linear and Device-level Ring Topologies

Important User Information

Solid-state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.rockwellautomation.com/literature/) describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
	**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

This manual contains new and updated information. Changes throughout this revision are marked by change bars, as shown to the right of this paragraph.

New and Updated Information

This table contains the changes made to this revision.

Topic	Page
Revised Studio 5000® Environment description.	7
Removed the chapter titled 'Troubleshoot a Linear or DLR Network'. See Troubleshoot EtherNet/IP Networks Application Techniques, publication ENET-AT003-EN-P, for comprehensive EtherNet/IP troubleshooting information.	
Removed catalog-number specific information.	
Updated the History of Changes.	81

Notes:

This manual describes how to install, configure, and maintain linear and device-level ring (DLR) networks that use Rockwell Automation EtherNet/IP devices with embedded switch technology.

Studio 5000 Environment

The Studio 5000 Automation Engineering & Design Environment™ combines engineering and design elements into a common environment. The first element is the Studio 5000 Logix Designer™ application. The Logix Designer application is the rebranding of RSLogix™ 5000 software and will continue to be the product to program Logix5000™ controllers for discrete, process, batch, motion, safety, and drive-based solutions.

The Studio 5000 environment is the foundation for the future of Rockwell Automation® engineering design tools and capabilities. The Studio 5000 environment is the one place for design engineers to develop all of the elements of their control system.

IMPORTANT Where appropriate, the software screens shown throughout this publication reflect the use of the Studio 5000 Logix Designer application.

However, you can continue to use RSLogix 5000 software in DLR applications.

For more information on the Rockwell Automation software applications that you can use in a DLR application, see Configure Supervisor Nodes on a DLR Network on page 30.

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

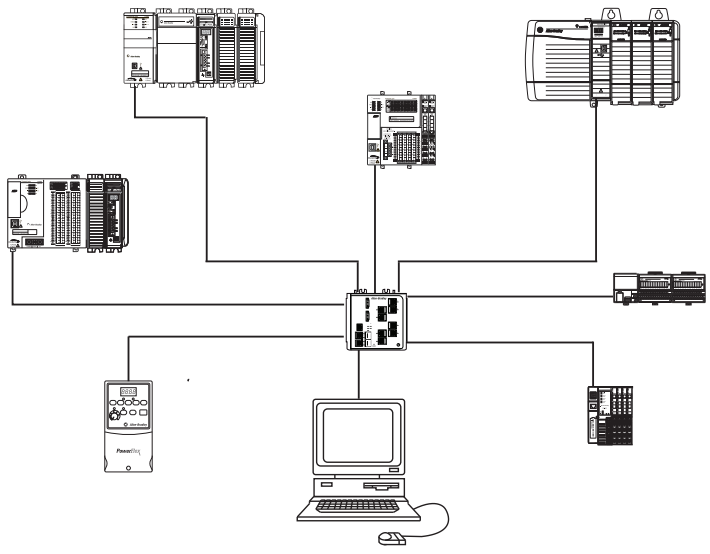
Resource	Description
EtherNet/IP Communication Modules installation Instructions, publication ENET-IN002	Provides information about how to complete these tasks with EtherNet/IP communication modules in a Logix5000 control system: • Install the module • Configure initial application setup • Troubleshoot application anomalies related to EtherNet/IP communication module use
EtherNet/IP Embedded Switch Technology Application Guide, publication ENET-AP005	Provides details about how to install, configure, and maintain linear and Device-level Ring (DLR) networks by using Rockwell Automation EtherNet/IP devices equipped with embedded switch technology.
Embedded Switch Technology Reference Architectures Reference Manual, publication ENET-RM003	This publication provides design recommendations for connecting device-level topologies to larger, switch networks comprised of Layer 2 access switches
Ethernet Design Considerations Reference Manual, publication ENET-RM002	Provides explanation of the following Ethernet concepts: • Overview • Network layout and components • Network infrastructure devices • Network infrastructure features • Protocol
EtherNet/IP Network Configuration User Manual, publication ENET-UM001	This publication describes how you can use EtherNet/IP communication modules with your Logix5000 controller and communicate with various devices on the Ethernet network.
EtherNet/IP Secure Communication Module User Manual, publication ENET-UM003	Provides information on setting up authentication, encryption, and firewalls, typical architectures, and diagnostics for modules equipped with secure communication functionality.
EtherNet/IP Media Planning and Installation Manual (available from ODVA, the Open DeviceNet Vendor Association, at http://www.odva.org)	Provides details about how to use the required media components and how to plan for, install, verify, troubleshoot, and certify your EtherNet/IP network.
Integrated Motion on the EtherNet/IP Network Reference Manual, publication MOTION-RM003	Reference descriptions of the AXIS_CIP_DRIVE attributes and the Studio 5000 Logix Designer application Control Modes and Methods
Integrated Architecture and CIP Sync Configuration Application Technique, publication IA-AT003	Provides information on CIP Sync and the IEEE 1588-2008 Precision Time Protocol.
Troubleshoot EtherNet/IP Networks Application Technique, publication ENET-AT003	Provides troubleshooting techniques for Integrated Architecture products on EtherNet/IP networks.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Network Technology Web page	Provides information on reference architectures and white papers on networking.
Product Certifications website, http://www.ab.com	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at http://www.rockwellautomation.com/literature/. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

EtherNet/IP Embedded Switch Technology Overview

The traditional EtherNet/IP network topology has been a star, where end devices are connected and communicate with each other via a switch. The diagram below shows an EtherNet/IP star configuration.

Figure 1 - Example EtherNet/IP Star Topology



The EtherNet/IP embedded switch technology offers alternative network topologies for interconnecting EtherNet/IP devices by embedding switches into the end devices.

EtherNet/IP Embedded Switch Technology

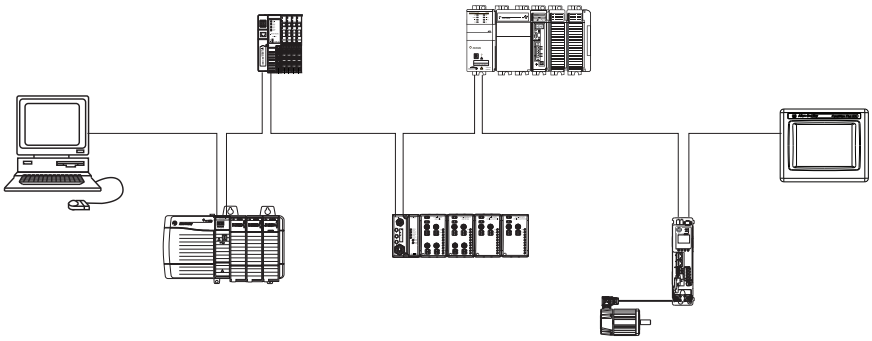
Embedded switch technology is designed to enable end devices to form linear and ring network topologies.

IMPORTANT	Products with EtherNet/IP embedded switch technology have two ports to connect to a linear or DLR network in a single subnet. You cannot use these ports as two Network Interface Cards (NICs) connected to two different subnets.

Linear Network

A linear network is a collection of devices that are daisy-chained together. The EtherNet/IP embedded switch technology lets you implement this topology at the device level. No additional switches are required.

Figure 2 - Example Linear Network



The following are advantages of a linear network.

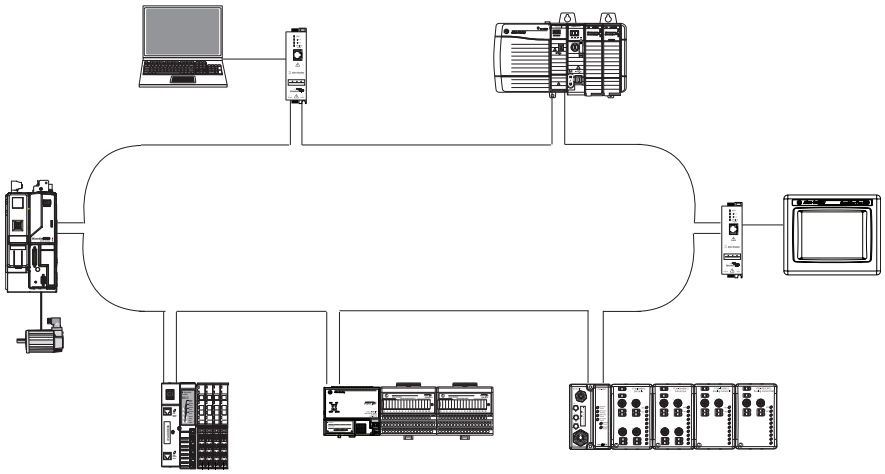
- Simple installation
- Reduced wiring and installation costs
- No special software configuration required
- Improved CIP Sync application performance on linear networks

The primary disadvantage of a linear network is that any break of the cable disconnects all devices downstream from the break from the rest of the network.

Device-level Ring (DLR) Network

A DLR network is a single-fault tolerant ring network intended for the interconnection of automation devices. This topology is also implemented at the device level. No additional switches are required.

Figure 3 - Example DLR Network



The following are advantages of the DLR network:

- Simple installation
- Resilience to a single point of failure on the network
- Fast recovery time when a single fault occurs on the network

The primary disadvantage of the DLR topology is the additional effort required to set up and use the network as compared to a linear or star network.

Check your device specifications to determine whether the device supports the DLR network and whether the device can act as a supervisor.

Features Common to Products with Embedded Switch Technology

Typically, products with embedded switch technology have the following features. Exceptions can exist in which a product that has embedded switch technology does not support **all** of the following features:

- Support for the management of network traffic to ensure timely delivery of critical data, that is, QoS and IGMP protocols, are supported
- Product design that meets the ODVA specification for EtherNet/IP

  Because of this design, third-party products can be designed, according to the ODVA specification, to operate on a DLR or linear network. For more information on the ODVA specification, use the following link:

  http://www.odva.org/

- For DLR networks, ring recovery time is less than 3 ms for a 50 node network. For more information about recovery time, see Appendix B, Network Recovery Performance on page 79.

- IEEE 1588 transparent clock for Integrated Motion over the EtherNet/IP network and CIP Sync applications

  CIP Sync technology can be used in Logix control systems to synchronize clocks across a system operating on the EtherNet/IP network. This technology supports highly distributed applications that require such functions as timestamping, sequence of events recording, distributed motion control, and increased control coordination.

  For example, with CIP Sync technology, a single ControlLogix® controller can establish a master time and then, by using ControlLogix Ethernet modules, propagate that time to all necessary devices on the network.

  For more information on how to use CIP Sync technology, see the Integrated Architecture and CIP Sync Configuration Application Solution, publication IA-AP003.

- Two ports to connect to linear or DLR networks in a single subnet

  You cannot use these ports as two network interface cards (NICs) connected to two different subnets.

- Cut Through Forwarding that limits communication latency as it passes through the embedded switch

- Broadcast rate limiting for DLR devices when the broadcast traffic is excessive

  This feature prevents end devices from becoming overwhelmed by network noise.

- Filtering of incoming unicast and multicast frames to the DLR device

  This feature prevents data that is not directed to the end device, but is passing through the embedded switch, from being processed by the device.

- Support for Auto-Negotiation device port configuration

  When you enable the Auto-Negotiation feature, device ports determine the optimal speed and duplex settings for network communication.

  You can use this feature on one or both of the device ports.

- Support for the Auto-MDIX feature

  The Auto-MDIX feature detects and, if necessary, corrects crossover or straight-through cabling between devices. The Auto-MDIX feature makes installation easier.

IMPORTANT	Some devices with embedded switch technology also support EtherNet/IP QuickConnect functionality. If a device is used in an EtherNet/IP QuickConnect environment, you can disable the Auto-Negotiate and Auto-MDIX features to obtain the fastest connection speeds possible. For more information on EtherNet/IP QuickConnect functionality, see the EtherNet/IP QuickConnect Application Technique, publication ENET-AT001.

DLR Network Elements

A DLR network is made up of the following devices:

- Supervisor Node
  - Active Supervisor Node
  - Back-up Supervisor Node (optional)
- Ring Node

These device types are described in the following sections. The following graphics show devices connected to a DLR network with copper connections (maximum of 100 m), fiber-optic connections (maximum of 2 km), or a mix of media.

Figure 4 - Example DLR Network with Copper Connections

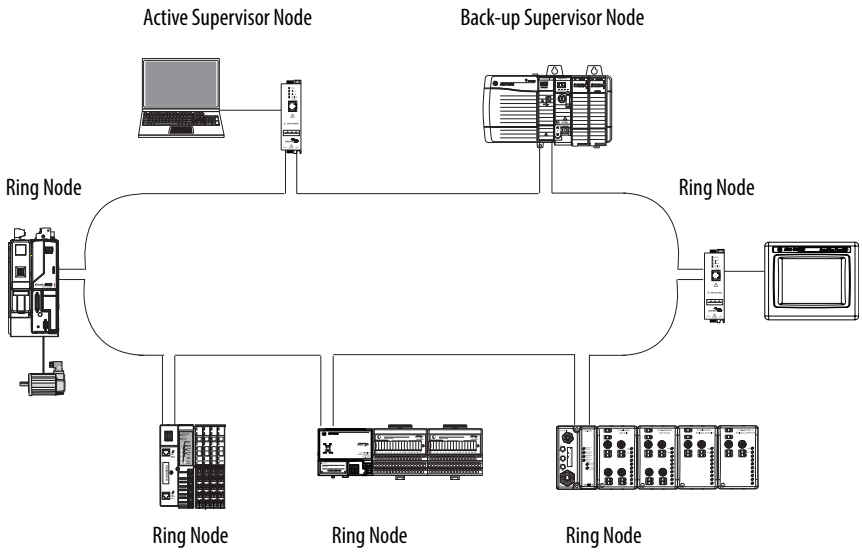


Figure 5 - Example DLR Network with Fiber-optic Connections

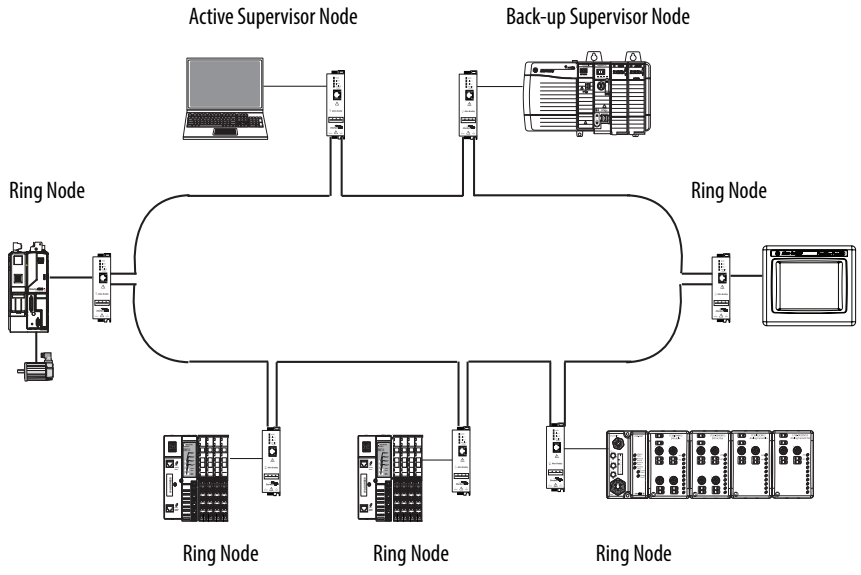
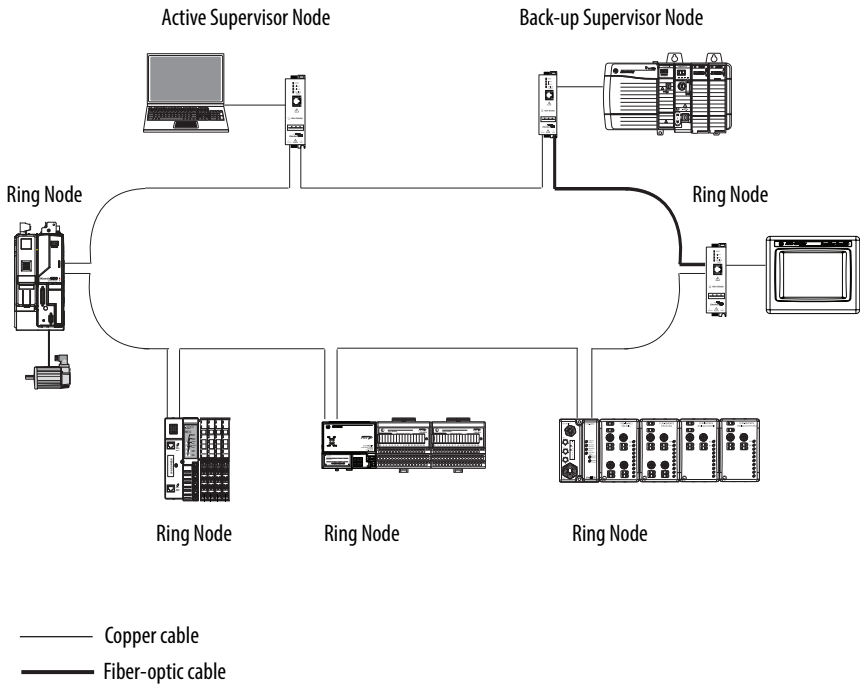


Figure 6 - Example DLR Network with Mixed-media Connections



Supervisor Node

A DLR network requires at least one node to be configured as ring supervisor.

IMPORTANT	Out of the box, the supervisor-capable devices have their supervisor function disabled so they are ready to participate in either a linear/star network topology, or as a ring node on an existing DLR network. In a DLR network, you must configure at least one of the supervisor-capable devices as the ring supervisor before physically closing the ring. If not, the DLR network does not work. You can use the DIP switches on a 1783-ETAP tap so the tap functions as a supervisor at power-up. For more information on how to use the 1783-ETAP DIP switches, see Use DIP Switches on page 56.

Active Ring Supervisor

When multiple nodes are enabled as supervisor, the node with the numerically highest precedence value becomes the active ring supervisor; the other nodes automatically become back-up supervisors.

The ring supervisor provides the following primary functions:

- Verifies the integrity of the ring
- Reconfigures the ring to recover from a single fault
- Collects diagnostic information for the ring

Back-up Supervisor Node

At any point in time, there is one active supervisor on a DLR network. We recommend that you can configure at least one other supervisor-capable node to act as a back-up supervisor.

During normal operation, a back-up supervisor behaves like a ring node. If the active supervisor node operation is interrupted, for example, it experiences a power-cycle, the back-up supervisor with the next numerically highest precedence value becomes the active supervisor.

If multiple supervisors are configured with the same precedence value (the factory default value for all supervisor-capable devices is 0), the node with the numerically highest MAC address becomes the active supervisor.

IMPORTANT	While a back-up supervisor is not required on a DLR network, we recommend that you configure at least one back up ring supervisor for your ring network.

We recommend the following when configuring your Supervisor nodes:

- Configure at least one back-up supervisor node.
- Configure your desired active ring supervisor with a numerically higher precedence value as compared to the back-up supervisors.
- Keep track of your network's supervisor-precedence values for all supervisor-enabled nodes.

For more information about how to configure a supervisor, see Chapter 2, Construct and Configure a Device-level Ring Network on page 29.

Ring Node

A ring node is any node that operates on the network to process data that is transmitted over the network or to pass on the data to the next node on the network. When a fault occurs on the DLR network, these reconfigure themselves and relearn the network topology. Additionally, ring nodes can report fault locations to the active ring supervisor.

IMPORTANT	**Do not connect non-DLR devices** directly to the network. Non-DLR devices must be connected to the network through 1783-ETAP, 1783-ETAP1F, or 1783ETAP2F taps.

DLR Network Operation

During normal network operation, an active ring supervisor uses beacon, and other DLR protocol frames to monitor the health of the network. Back-up supervisor nodes and ring nodes monitor the beacon frames to track ring transitions between Normal, that is, all links are working, and Faulted, that is, the ring is broken in at least one place, states.

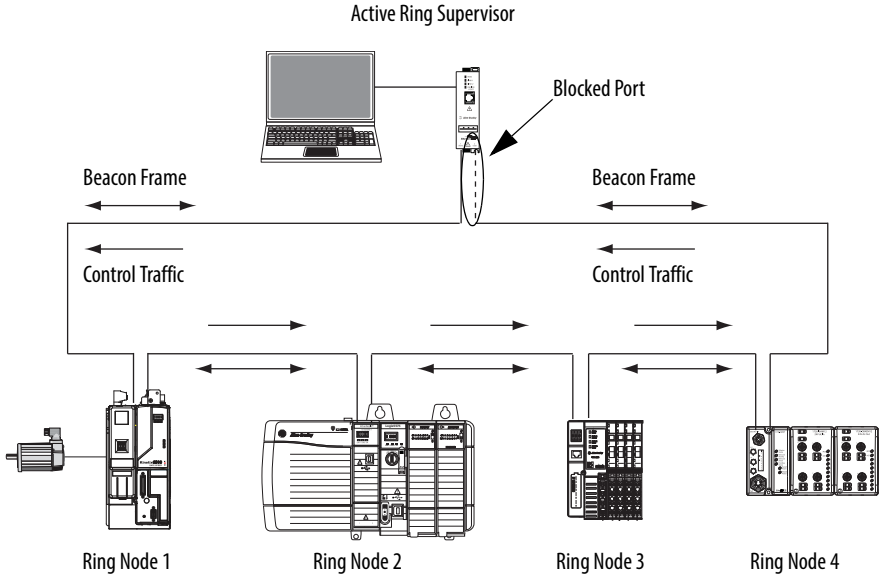
You can configure the following beacon-related parameters:

- Beacon interval - Frequency the active ring supervisor uses when transmitting a beacon frame through both of its ring ports.
- Beacon timeout - Amount of time that supervisor or ring nodes wait before timing out the reception of beacon frames and taking appropriate action.

These parameters impact network recovery performance. For information on recovery performance times, see page 79. For information on how to set these parameters, see Chapter 2, Construct and Configure a Device-level Ring Network on page 29.

During normal operation, one of the active supervisor node's network ports is blocked for DLR protocol frames. However, the active supervisor node continues to send beacon frames out of both network ports to monitor network health. The graphic below shows the use of beacon frames sent from the active ring supervisor.

Figure 7 - Normal DLR Network Operation



A second category of ring nodes, known as announce frame ring nodes, can be designed to participate in a DLR network. The active supervisor sends announce frames out one of its ports once per second or on detection of a ring fault. DLR networks with announce frame ring nodes have slightly longer recovery times than beacon frame nodes.

Number of Nodes on a DLR Network

We recommend that you use no more than 50 nodes on a single DLR or linear network. If your application requires more than 50 nodes, we recommend that you segment the nodes into separate, but linked, DLR networks.

The following advantages exist with smaller networks:

- Better management of traffic on the network.
- Networks are easier to maintain.
- Lower likelihood of multiple faults.

Additionally, on a DLR network with more than 50 nodes, network recovery times from faults are higher than those listed in Appendix B, Network Recovery Performance on page 79.

DLR Network Fault Management

Your network can occasionally experience faults that prevent the normal transmission of data between nodes. Your DLR network can protect your application from interruptions resulting from a single fault.

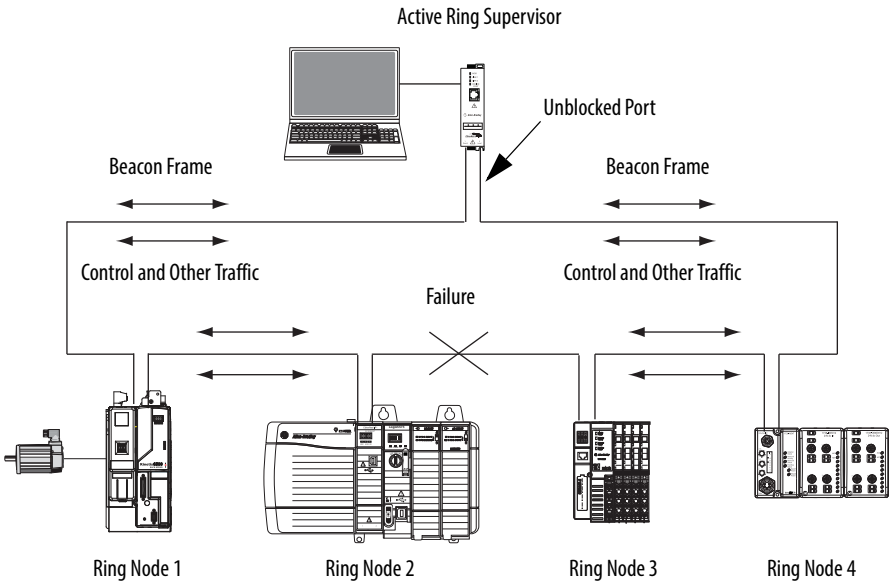
To maintain the resiliency of your ring, configure your application so that it monitors the health of the ring itself, as the ring can be faulted while all higher-level network functions, such as I/O connections, are operating normally.

You can obtain fault location information from the active supervisor. For more information on how to obtain fault location information, see Chapter 3, Monitor a DLR Network on page 41.

After a fault occurs, the active supervisor reconfigures the network to continue sending data on the network.

The following graphic shows the network configuration after a failure occurs, with the active ring supervisor passing traffic through both of its ports, thus, maintaining communication on the network.

Figure 8 - Network Reconfiguration After Fault



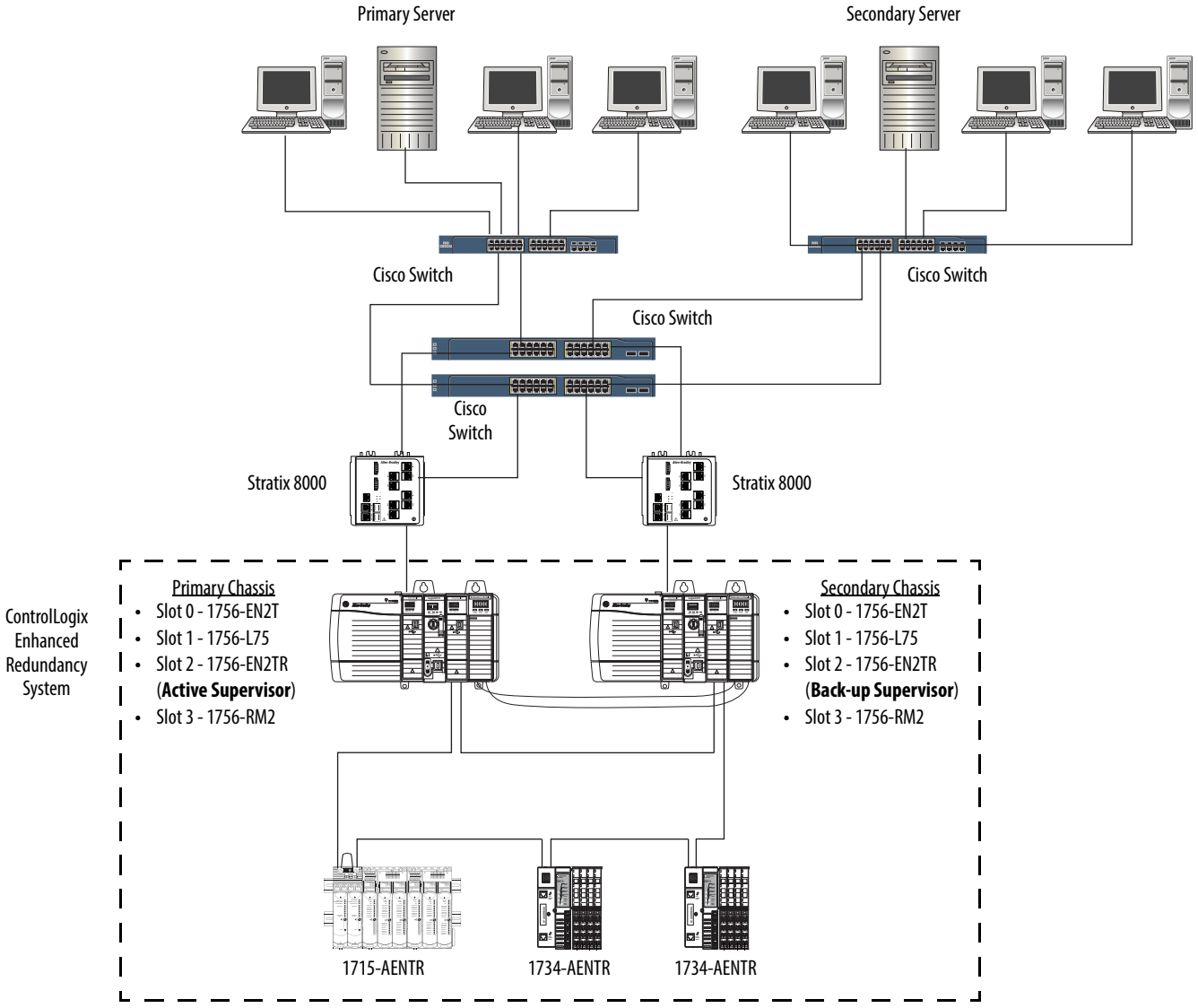
Using ControlLogix Enhanced Redundancy System with the DLR Topology

You can use ControlLogix Enhanced Redundancy in conjunction with the DLR topology as shown in Figure 9 in the context of an overall high-availability architecture.

The following DLR network configuration parameters apply:

- The 1756-EN2TR module in the primary chassis is the DLR network's Active Supervisor node.
- The 1756-EN2TR module in the secondary chassis is the DLR network's Back-up Supervisor node.

Figure 9 - High-availability Architecture That Includes a ControlLogix Enhanced Redundancy System Using DLR Topology for Network Resiliency



ControlLogix Enhanced Redundancy Crossload, Synchronization, and Switchover

A ControlLogix Enhanced Redundancy system uses the following functionality:

- **Crossloading and synchronization** transfer data from the primary controller to the secondary controller so the secondary controller can assume control in the event of a switchover.

  IMPORTANT Crossloading and synchronization transfer DLR network configuration parameters. The active supervisor role is independent of ControlLogix Redundancy and does not directly follow the primary chassis. That is, it is possible the active supervisor role does not transfer.

  We recommend that you verify that the active supervisor role transferred in conjunction with an enhanced redundancy system data transfer from a primary controller to a secondary controller.

- **Switchovers** swap chassis and controller roles, that is, the primary chassis and controller become the secondary chassis and controller. The secondary chassis and controller become the primary chassis and controller.

  When the switchover occurs, partnered sets of EtherNet/IP communication modules swap IP addresses.

  Switchovers result in a network break only if the primary chassis is no longer online. If a break occurs, the DLR supervisor switchover, that is, the changing of the active supervisor role, takes less than 3 ms.

  Keep in mind, the 3 ms time does not represent the time to change the primary and secondary chassis in the enhanced redundancy system.

Switchover That Does Not Break the DLR Network

If the switchover does not break the DLR network, the following occurs:

- The Active and Back-up supervisor roles remain with the same nodes, that is, the same physical devices, despite the chassis changing roles from primary to secondary and secondary to primary.
- The Active and Back-up supervisors swap IP addresses, but the MAC ID values remain the same. This is a function of Enhanced redundancy.

  The swapping of IP addresses does not break the DLR ring and does **not** cause Active supervisor status to switch to the Back-up supervisor.

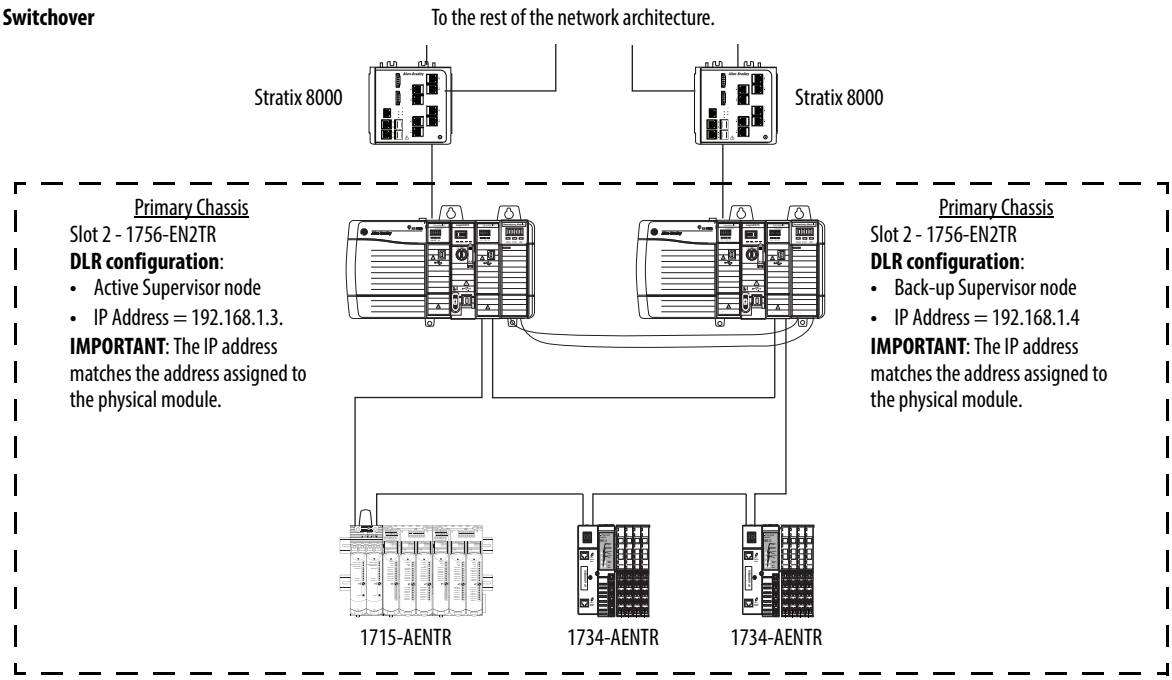
You can programmatically monitor the Active Supervisor node for status, as described in Retrieve All Ring Diagnostic Information on page 50. In this case, we recommend the following:

- Write your application code so it switches over to monitoring the Active Supervisor node at its new IP address.
- Write application code that monitors the Active Supervisor node and Back-up Supervisor node.

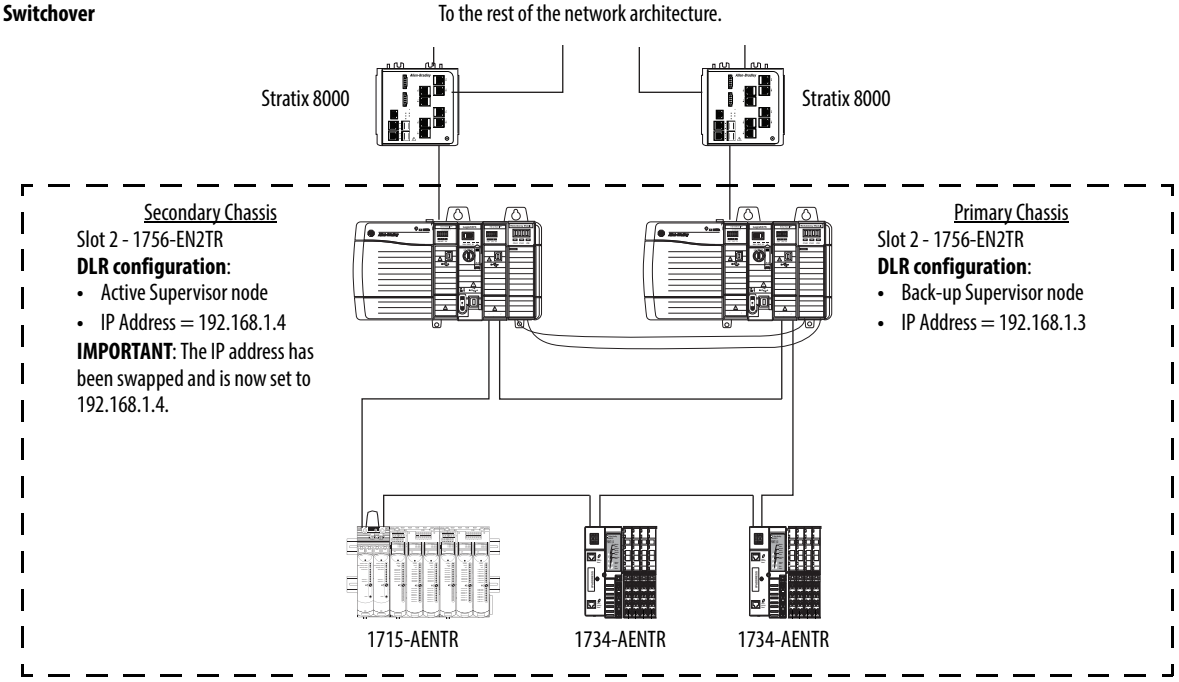
  The application code checks the Ring Supervisor status of the Active Supervisor node and Back-up Supervisor node to determine from which node to read diagnostic information.

Figure 10 - Effects of Switchover That Does Not Break the DLR Network

Before Switchover



After Switchover



Switchover That Breaks the DLR Network at the Active Supervisor Node

If the switchover breaks the DLR network at the Active Supervisor node, the following occurs:

- The DLR network ring faults and transitions to a linear network.
- The Back-up Supervisor node becomes the Active Supervisor node.
- Convergence time on the network is less than 3 ms, making the switchover seamless for the application.
- The partnered pair of EtherNet/IP modules that function as Active and Back-up Supervisor nodes swap IP addresses.

  The new Active Supervisor node uses the same IP address as the previous Active Supervisor node. This IP address swap is part of the Enhanced Redundancy system operation.

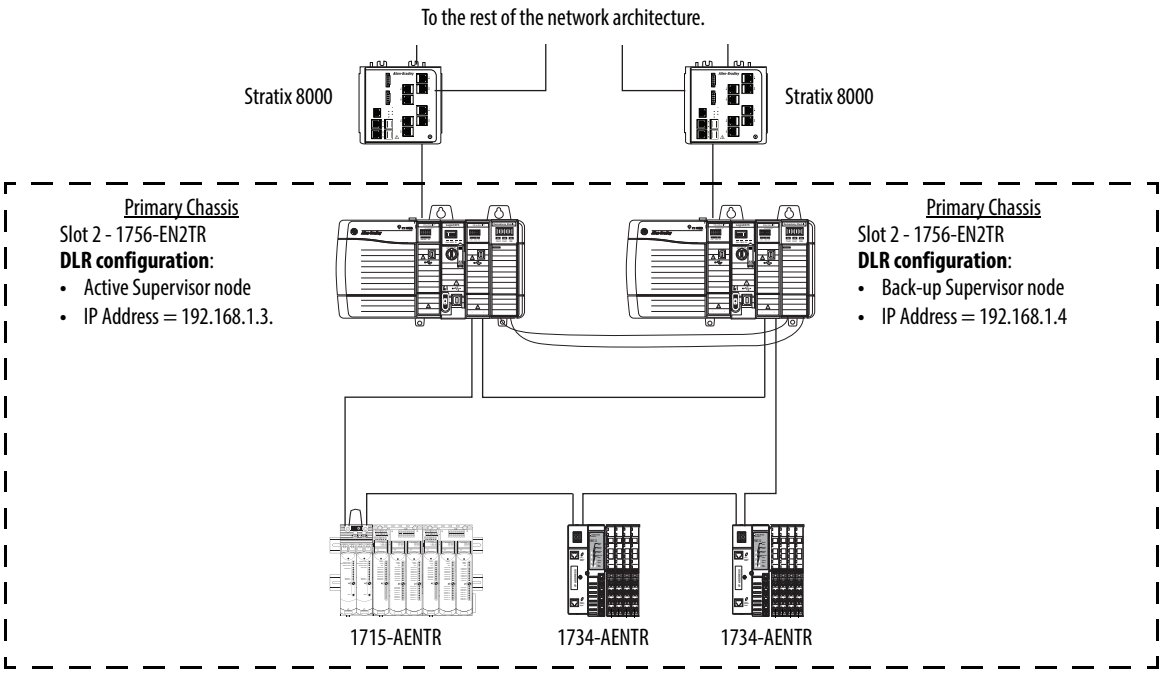
  In this case, the MAC ID values remain the same.

If your application code is monitoring the Active Supervisor node for network status information, as described in Retrieve All Ring Diagnostic Information on page 50 continues to read that information from the same network address despite the fact that the Active Supervisor node is now a different physical node.

Figure 11 - Effects of Switchover That Breaks the DLR Network at the Active Supervisor Node

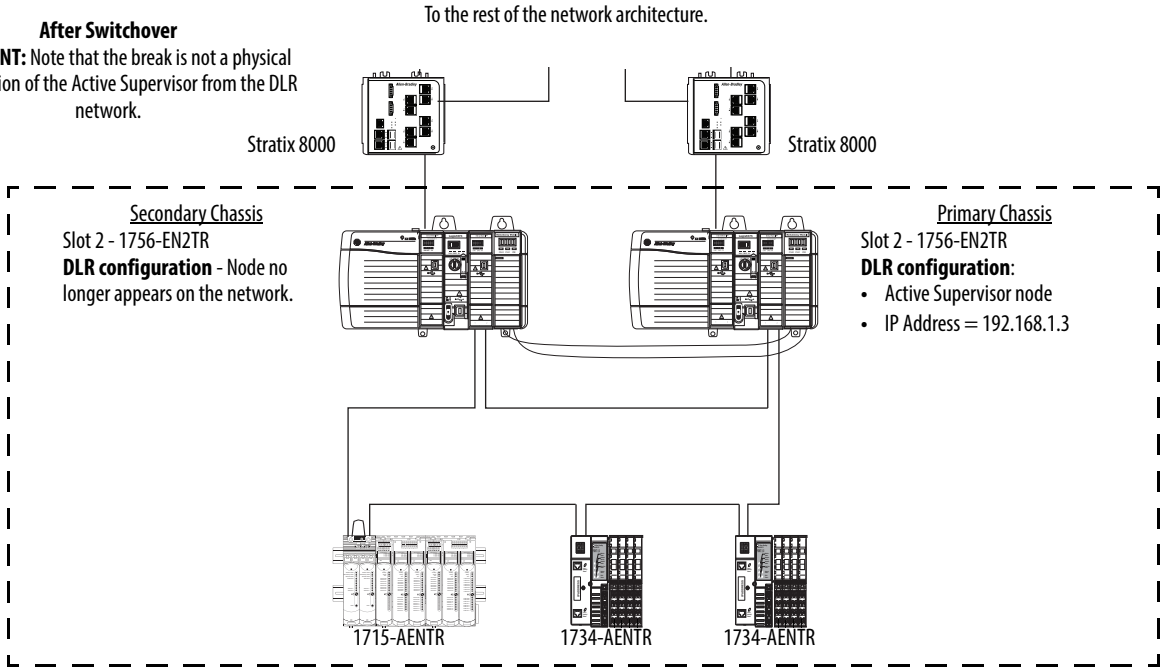
IMPORTANT Note that in this example, the break in the DLR network at the Active Supervisor node is not a physical disconnection from the network.

Before Switchover



After Switchover

IMPORTANT: Note that the break is not a physical disconnection of the Active Supervisor from the DLR network.



For more information, see the following Knowledgebase articles:

- #502155, 1756-EN2TR in Redundant ControlLogix Chassis as the DLR Supervisors
- #532359, 1756-EN2TR DLR Active Supervisor IP Address might not get updated in Redundancy System

You can access the Rockwell Automation Knowledgebase at:
https://rockwellautomation.custhelp.com/app/answers/list.

Notes:

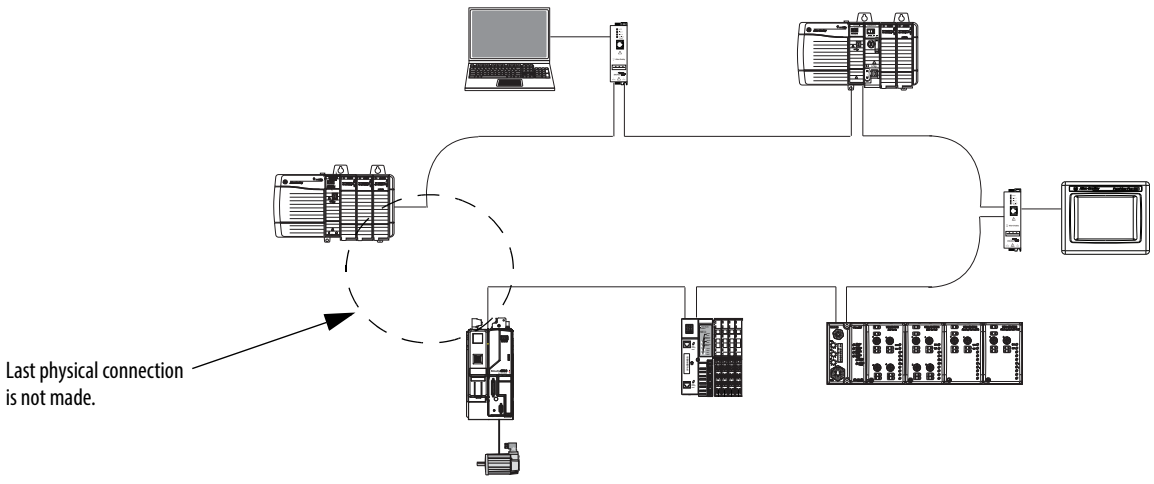
Construct and Configure a Device-level Ring Network

Install Devices on a DLR Network

The first step to configuring a DLR network is to connect all devices to the network. Leave at least one connection unmade, that is, temporarily omit the physical connection between two nodes on the ring network, because the factory default settings of DLR devices are set to operate in linear/star mode or as ring nodes on existing DLR networks.

IMPORTANT If you fully connect your DLR network without a supervisor configured, a network storm can result, rendering the network unusable until one link is disconnected and at least one supervisor is enabled.

Figure 12 - Example Device-level Ring Topology with One Connection Left Unmade



Use the installation instructions for each device to connect it to the network. You can view or download Rockwell Automation publications at http:/www.rockwellautomation.com/literature/.

Configure Supervisor Nodes on a DLR Network

After you have installed your devices on the DLR network, you must configure at least one supervisor node. Ring nodes do not require any DLR network configuration.

Depending on your application configuration, you can use the following to configure and enable a Supervisor node:

- Logix Designer application - Required with Logix5000 controllers that use firmware revision 21.*xxx* and later
- RSLogix 5000 software - Required with Logix5000 controllers that use firmware revision 20.*xxx* and earlier
- RSLinx® Classic software

Device specifications, for example, firmware revision, dictate the software application options to configure a supervisor node, as described in Table 1.

Table 1 - Software Applications Used to Enable a Ring Supervisor

Supervisor-capable Device(1)	Firmware Revision	Software IMPORTANT: You use only one of the software applications listed with your device.		
		Logix Designer Application	RSLogix 5000	RSLinx Classic
1756-EN2TR module	2.001	Version 21.00.00 or later	Version 17.00.01…20.*xx.xx*	Version 2.55.00 or later
	3.*xxx* or later			Version 2.56.00 or later
1756-EN3TR module	3.*xxx* or later		Version 18.*xx.xx*…20.*xx.xx*	Version 2.56.00 or later
1783-ETAP tap	1.001		Version 17.00.01…20.*xx.xx*	Version 2.55.00 or later
	2.*xxx* or later(2)			Version 2.56.00 or later
1783-ETAP1F tap	2.*xxx* or later(2)			Version 2.56.00 or later
1783-ETAP2F tap				
CompactLogix™ 5370 controller	20.*xxx*	N/A	Version 20.*xx.xx*	Version 2.59.00 or later
	21.*xxx* or later	Version 21.00.00 or later	N/A	Version 3.51.00 or later

(1) **IMPORTANT**: The list of products is complete as of the publication date. For the most current list of the Allen-Bradley® products available for DLR or linear network use, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

(2) You can use DIP switch 3 on the 1783-ETAP, 1783-ETAP1F or 1783-ETAP2F taps, firmware revision 2.*xx.xx* or later, to enable the taps as ring supervisors instead of by using the software. For more information, see Use DIP Switches on page 56.

IMPORTANT The examples in this publication use Logix Designer application or RSLinx Classic software.

Add-on Profiles

If your application uses RSLogix 5000 software, version 17.00.01, to configure the active and back-up supervisor nodes, you must download an Add-on Profile (AOP) to make devices supervisor-capable.

For more information on what AOP revision your application requires and to download the AOP, go to: http://support.rockwellautomation.com/controlflash/LogixProfiler.asp.

Configure a Ring Supervisor in Logix Designer Application

IMPORTANT

The following example shows how to configure the 1756-EN2TR module.

Consider the following guidelines before configuring a ring supervisor:

- The steps to configure a ring supervisor via software are basically the same for all supervisor-capable devices with some variations in the dialog boxes.
- You only configure the 1783-ETAP, 1783-ETAP1F, and 1783-ETAP2F taps in your I/O Configuration if you plan to enable the tap as a ring supervisor.

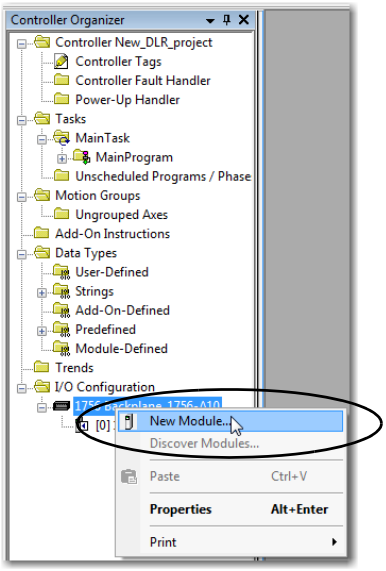
  If you do not plan to use the tap as a ring supervisor, we recommend that you do not add it to your I/O Configuration.
- If you plan to configure a 1783-ETAP, 1783-ETAP1F, or 1783-ETAP2F tap as a supervisor via software, you must first assign it an IP address.

  The tap does not require an IP address if it is used as a ring node or has its supervisor function enabled by DIP switches.

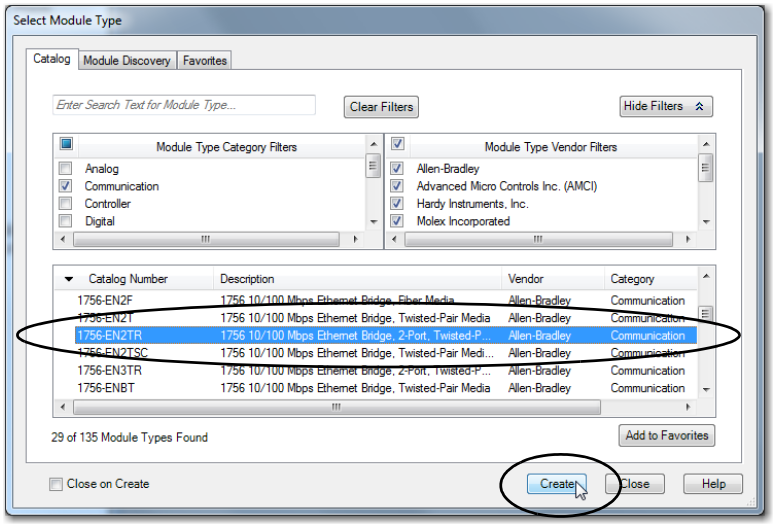
  For more information on how to use a tap's switch to configure it as a ring supervisor, see Chapter 4, Additional EtherNet/IP Tap Features on page 55.

Complete the following steps.

1. Confirm that your controller is in Program mode.
2. Right-click 1756 Backplane and choose New Module.

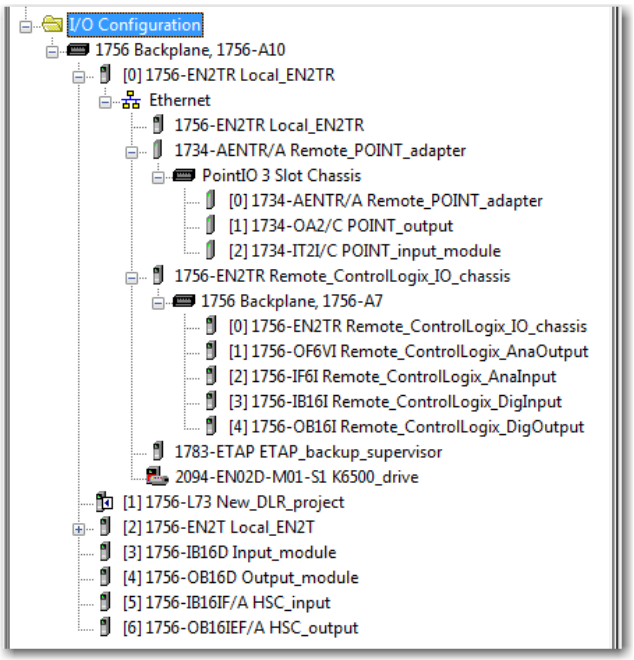


3. Select the module and click Create.



4. Configure the module and the rest of the project.

   The following graphic shows an example DLR network I/O configuration.



5. Download the project to your Logix controller.
6. Go online with the controller and leave it in Program mode.

Enable Ring Supervisor in Logix Designer Application

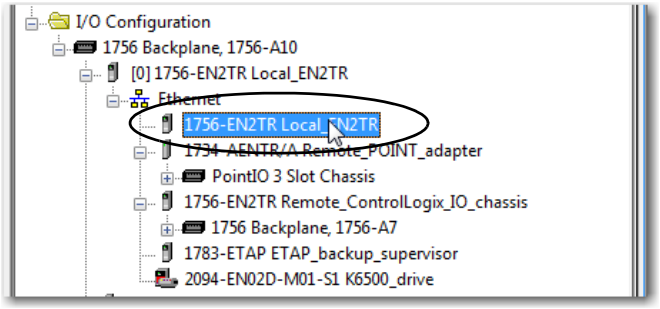
After you have added your 1756-EN2TR module or 1783-ETAP, 1783-ETAP1F, or 1783-ETAP2F taps to your Logix Designer application project, you must enable the ring supervisor mode.

IMPORTANT	If you are using Logix Designer application to configure your ring supervisor and monitor diagnostics on your DLR network, you must be online with your controller.

Complete these steps.

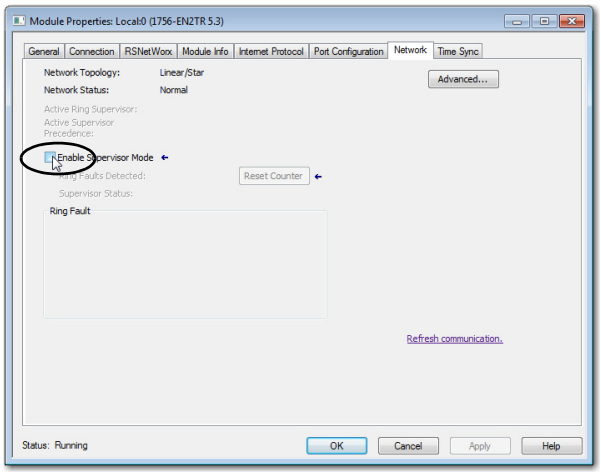
IMPORTANT	The steps to enable a ring supervisor are basically the same for both the 1756-EN2TR module or 1783-ETAP, 1783-ETAP1F, or 1783-ETAP2F taps. This example shows how to do it for the 1756-EN2TR module.

1. With your project online with the controller, double-click a supervisor-capable device in the I/O configuration tree.



The module properties dialog box opens.

2. On the Network tab, check the Enable Supervisor Mode checkbox.

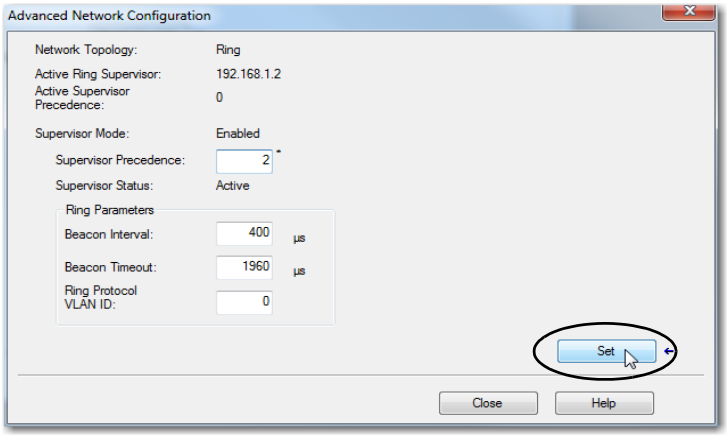


Configuration takes effect immediately; you do not need to click Apply or OK.

3. Click the Advanced button.
4. Configure supervisor-related parameters.

IMPORTANT	For Beacon Interval, Beacon Timeout and Ring Protocol VLAN ID, we recommend that you use the default values.

5. Click Set.



Functionality	Description	Default Setting
Supervisor Precedence	You can configure a supervisor precedence number for each device configured as a ring supervisor. The highest possible supervisor precedence value is 255. When multiple nodes are enabled as supervisor, the node with the highest precedence value is assigned as the active ring supervisor; the other nodes automatically become back-up supervisors. We recommend the following: • Configure at least one back-up supervisor node. • Set your desired Active Ring Supervisor with a relatively high supervisor-precedence value compared to the back-up node(s). • Keep track of your network's supervisor-precedence values. If multiple supervisors are configured with the same precedence value (the factory default value for all supervisor-capable devices is 0), the node with the numerically highest MAC address becomes the active supervisor.	0
Beacon Interval	Frequency of the active ring supervisor transmitting a beacon frame through both of its Ethernet ports. This parameter is user configurable for any time between 200µS and 100000µS. For more information on how this parameter relates to network performance, see page 79.	400 µS
Beacon Timeout	The beacon timeout is amount of time nodes wait before timing out the reception of beacon frames and taking appropriate action. Supervisors support a range of 400µS to 500000µS. For more information on how this parameter relates to network performance, see page 79.	1960 µS
Ring Protocol VLAN ID	Reserved for future use.	0

Configure and Enable a Ring Supervisor in RSLinx Classic Software

You can configure and enable a ring supervisor for your DLR network through RSLinx Classic software. This example is for the 1783-ETAP tap.

IMPORTANT Depending on the firmware revision of your product, you must use specific versions of RSLinx Classic software. For more information, see Table 1 on page 30.

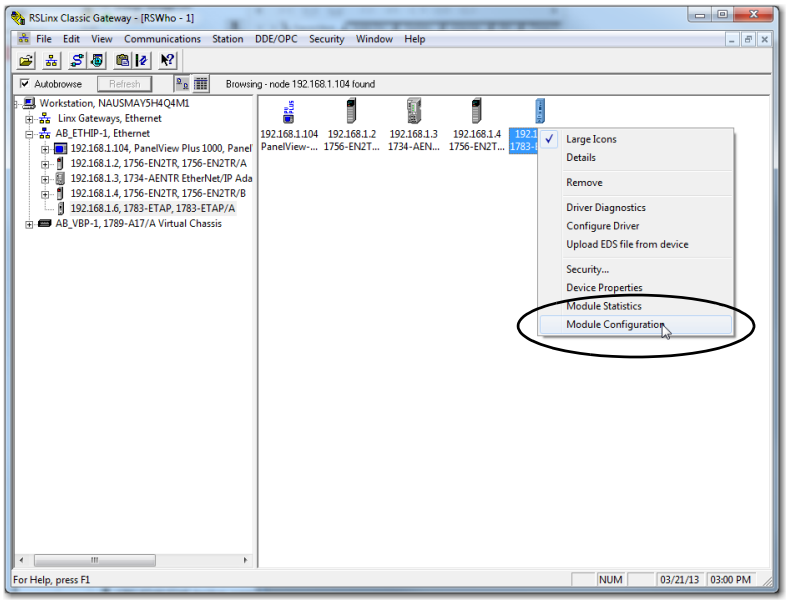
Complete the following steps.

1. Launch RSLinx Classic software.
2. Browse to the DLR network.

TIP If you do not have the Electronic Data Sheet (EDS) file installed on the module configured to be the ring supervisor, it appears with a question mark (?). To obtain and use the EDS file, take one of the following actions:

- Right-click the module and choose to upload the EDS file from the device.
- Download the EDS file from: http://www.rockwellautomation.com/resources/eds/.

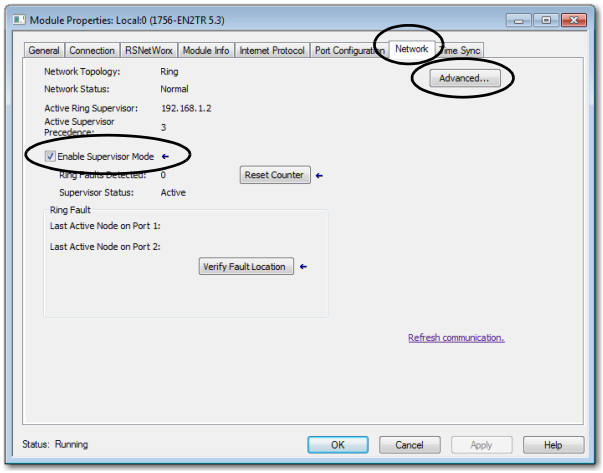
3. Right-click the supervisor-capable node's properties and choose Module Configuration.



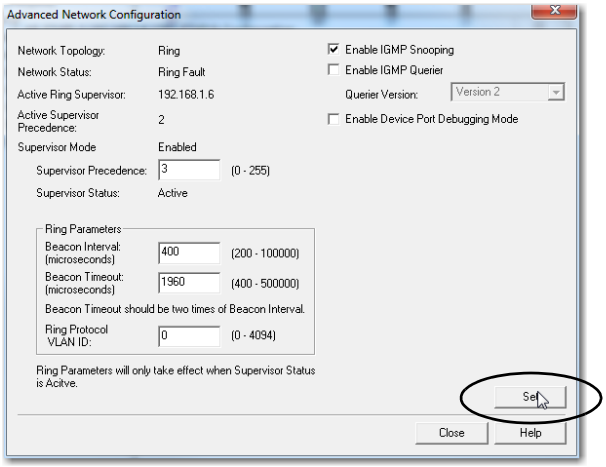
4. On the Network tab, check the Enable Supervisor Mode checkbox.

   Configuration takes affect immediately; you do not need to click Apply or OK.

5. Click Advanced.



6. Configure supervisor-related parameters as needed.



7. Click Set.

IMPORTANT For Beacon Interval, Beacon Timeout and Ring Protocol VLAN ID, we recommend that you use only the default values.

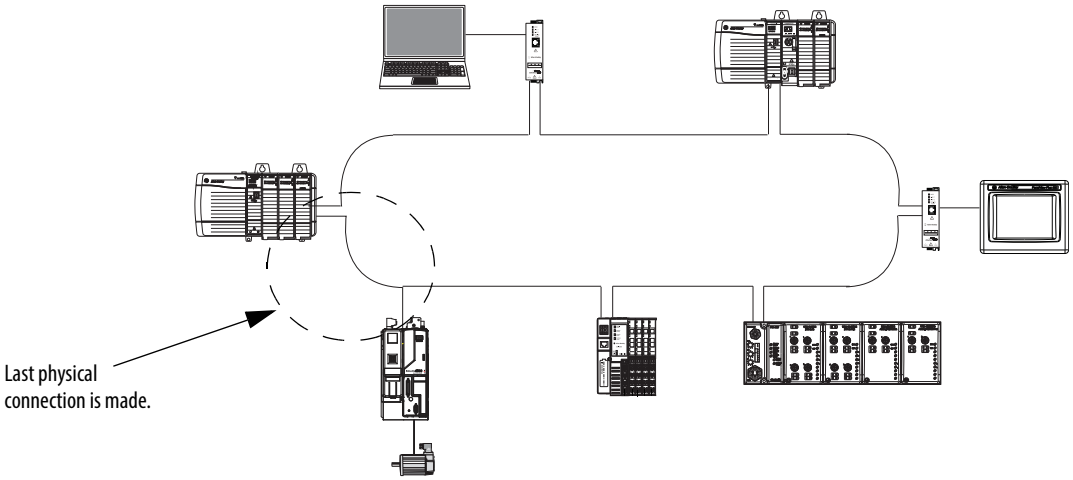
Functionality	Description	Default Setting
Supervisor Precedence	You can configure a supervisor precedence number for each device configured as a ring supervisor. The highest possible supervisor precedence value is 255. When multiple nodes are enabled as supervisor, the node with the highest precedence value is assigned as the active ring supervisor; the other nodes automatically become back-up supervisors. We recommend the following: • Configure at least one back-up supervisor node. • Set your desired Active Ring Supervisor with a relatively high supervisor-precedence value compared to the back-up node(s). • Keep track of your network's supervisor-precedence values. If multiple supervisors are configured with the same precedence value (the factory default value for all supervisor-capable devices is 0), the node with the numerically highest MAC address becomes the active supervisor.	0
Beacon Interval	Frequency of the active ring supervisor transmitting a beacon frame through both of its Ethernet ports. This parameter is user configurable for any time between 200µS and 100000µS. For more information on how this parameter relates to network performance, see page 79.	400 µS
Beacon Timeout	The beacon timeout is amount of time nodes wait before timing out the reception of beacon frames and taking appropriate action. Supervisors support a range of 400µS to 500000µS. For more information on how this parameter relates to network performance, see page 79.	1960 µS
Ring Protocol VLAN ID	Reserved for future use.	0
Enable IGMP Snooping	For more information on IGMP Snooping, see Chapter 4, Additional EtherNet/IP Tap Features on page 55.	Enabled
Enable IGMP Querier	For more information on IGMP Querier, see Chapter 4, Additional EtherNet/IP Tap Features on page 55.	Disabled
Enable Device Port Debugging Mode	For more information on Device Port Debugging Mode, see Chapter 4, Additional EtherNet/IP Tap Features on page 55.	Disabled

Complete the Physical Connections of the Network

After you configure and enable your ring supervisor nodes, you must complete the physical connection of your network to establish a complete and fully functioning DLR network.

The figure below shows an example DLR network with all physical connections complete.

Figure 13 - Example Device-level Ring Topology with All Connections Complete



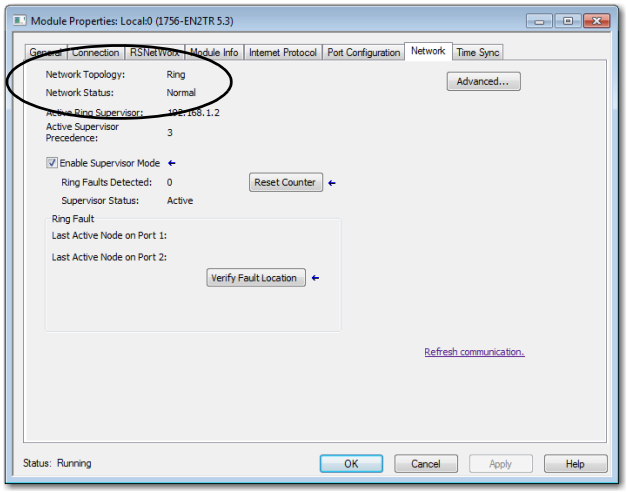
Verify Supervisor Configuration

You can verify your configuration and overall DLR network status in either Logix Designer application or RSLinx Classic software.

Complete the following steps.

1. Access the supervisor node's properties as shown previously in this chapter.
2. Click the Network tab.
3. Check the Network Topology and Network Status fields.

If	there
the Network Topology = Linear/Star	is no supervisor configured for the network.
the Network Topology = Ring	is at least one node configured as a supervisor.
the Network Status = Normal	are no faults on the network.



You can also verify the supervisor configuration through the module's diagnostic web pages, if available. For more information on monitoring diagnostics via an EtherNet/IP module's web pages, see Monitor Diagnostics via MSG Instructions on page 47.

Notes:

Monitor a DLR Network

Use this chapter to learn how to monitor your DLR network.

Methods to Monitor a DLR Network

You can retrieve network diagnostic information from the ring supervisor-capable devices by using the following:

- Logix Designer Application Status Pages
- RSLinx Classic Software Status Pages
- Device Web Pages
- Programmatically Through the Use of a MSG Instruction

IMPORTANT See Troubleshoot EtherNet/IP Networks Application Technique, publication ENET-AT003, for information about troubleshooting techniques for Integrated Architecture products on EtherNet/IP networks.

Logix Designer Application Status Pages

Logix Designer application, version 21.00.00 and later, provide status pages to monitor the network.

RSLinx Classic Software Status Pages

To monitor the network with this method, you must use RSLinx Classic software, version 2.55.00 or later.

Device Web Pages

The 1783-ETAP1F and 1783-ETAP2F taps support device web pages out-of-the-box.

IMPORTANT	A 1783-ETAP tap, firmware revision 1.1, does not support device web pages. You must upgrade the tap's firmware to revision 2.x or later, to use device web pages.

Programmatically through the Use of a MSG Instruction

For more information on how to monitor your DLR network via MSG Instructions, see page 47.

Monitor Status Pages

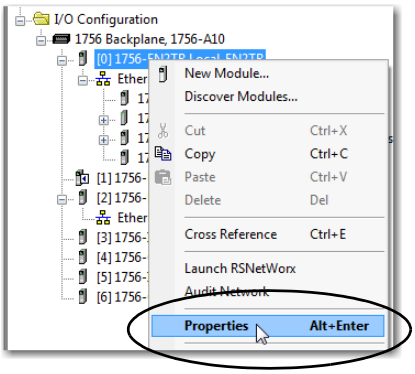
Both Logix Designer application and RSLinx Classic software offer status pages that you can use to monitor your network's performance.

Logix Designer Application Status Pages

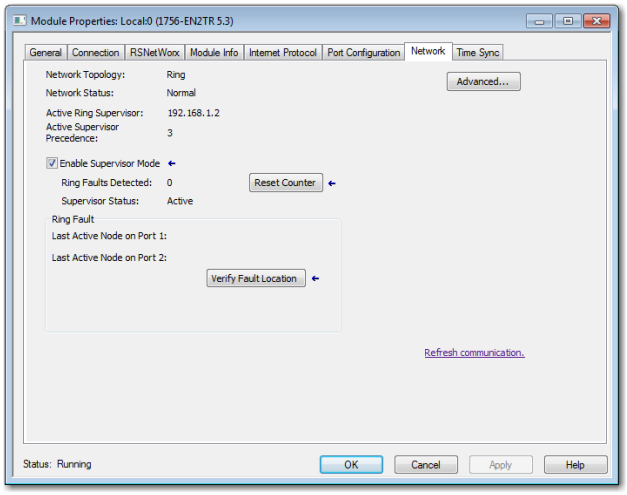
You can monitor your network's diagnostic information through the Logix Designer application when the software is online.

Complete the following steps.

1. Verify that your project is online.
2. Right-click the active supervisor node and choose Properties.



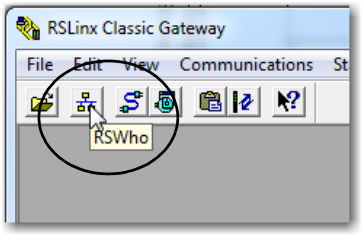
3. Use the Network tab to monitor diagnostics.



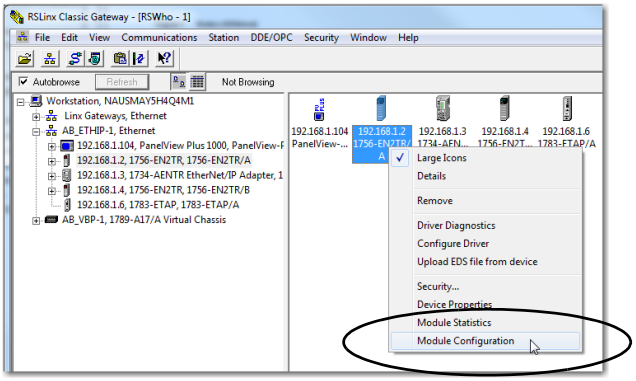
RSLinx Classic Software

Complete the following steps.

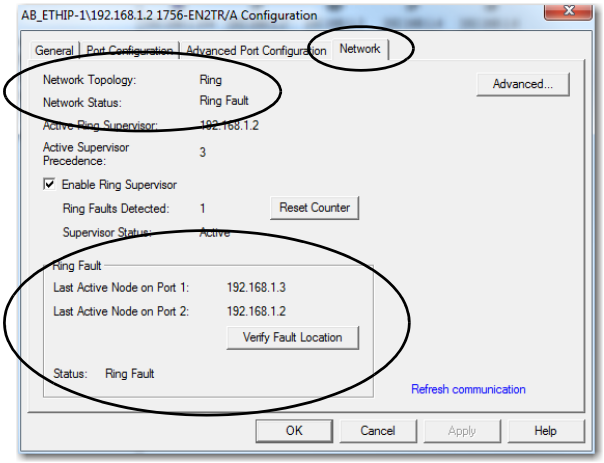
1. Browse the network.



2. Browse to the active supervisor node.
3. Right-click the node and choose Module Configuration.



The Module Configuration dialog box appears with multiple tabs. Each tab displays configuration information. The example graphic shows a ring fault between nodes at IP addresses 192.168.1.3 and 192.168.1.2.



There are multiple fields that you can use to monitor network diagnostics.

Field	Definition
Network Topology	Possible values here can be Linear or Ring.
Network Status	Displays if the network is operating normally (Normal) or has experienced a fault (Ring Fault), as shown in the example screen above.
Active Ring Supervisor	Displays the IP address or MAC address of the active ring supervisor.
Active Supervisor Precedence	For more information on this field, see Active Ring Supervisor on Active Ring Supervisor on page 16.
Enable Ring Supervisor	Configurable field that lets you to set the node as a ring supervisor.
Ring Faults Detected	Number of faults detected on the network since the last module power cycle or counter reset.
Supervisor Status	Displays whether this node is the active ring supervisor (Active), a back-up supervisor (Back-up), a ring node, or part of a linear network.
Last Active Node on Port 1	The last node the active ring supervisor can communicate with on Port 1. This value is an IP address or a MAC ID and remains latched until the Verify Fault Location button is clicked.
Last Active Node on Port 2	The last node the active ring supervisor can communicate with on Port 2. This value is an IP address or a MAC ID and remains latched until the Verify Fault Location button is clicked.
Status	Displays whether a fault exists on the ring.

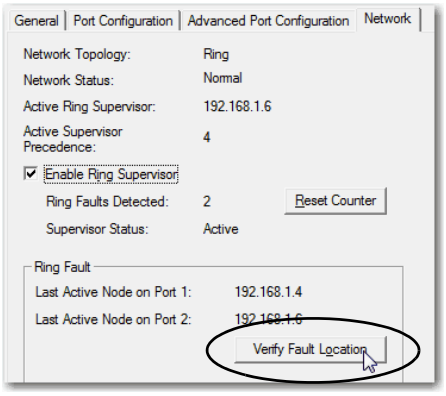
IMPORTANT

Once a fault is cleared and the network restored to normal operations, the Network tab displays the following:

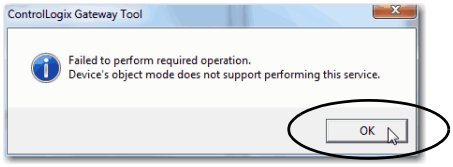
- Network Topology field = Ring
- Network Status field = Normal
- Last Active Node on Port 1 = Appropriate IP address
- Last Active Node on Port 2 = Appropriate IP address

The Last Active Node fields display the last fault information even though it has been corrected.

To clear the last fault information from these fields, click Verify Fault Location, as shown.



When the dialog box appears that indicates the supervisor is no longer in fault mode and the fields are cleared, click OK.



Monitor Device Web Pages

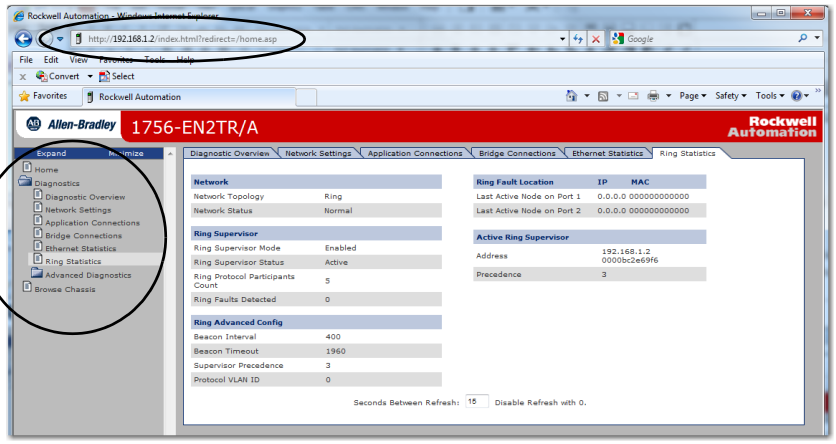
Another method to monitor network diagnostic information with supervisor-capable nodes is to use the module's diagnostic web pages. This example uses a 1756-EN2TR module.

IMPORTANT	A 1783-ETAP tap that uses firmware revision 1.1 does not support diagnostic web pages. You must upgrade the tap to firmware revision 2.x or later, to use diagnostic web pages. Keep in mind, though, that upgrading your 1783-ETAP tap to firmware revision 1.1 also requires that you upgrade your RSLinx Classic software to version 2.56.00 or later.

Complete the following steps.

1. Open your web browser and enter your module's IP address.

   Use the links on the left-most navigation bar to see each available web page. The screen below shows Ring Statistics for a 1756-EN2TR module that uses IP address 192.168.1.2.



Monitor Diagnostics via MSG Instructions

You can obtain network diagnostic information programmatically via MSG instructions in the Logix Designer application. For example, you can execute the following:

- Request all ring diagnostic information
- Request a ring participant list
- Request the active supervisor information
- Clear rapid ring faults
- Verify a fault location
- Reset a fault counter
- Enable and configure a ring supervisor
- Initiate the Restart_Sign_On service

This information can be displayed on an HMI device or manipulated in your project code.

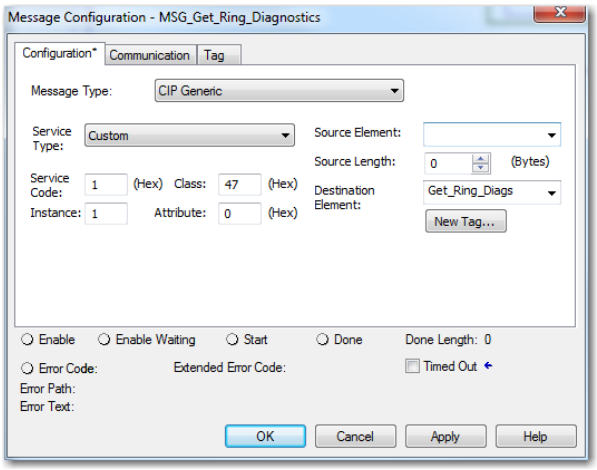
Example Use of MSG Instruction

The following steps describe how to retrieve diagnostic information.

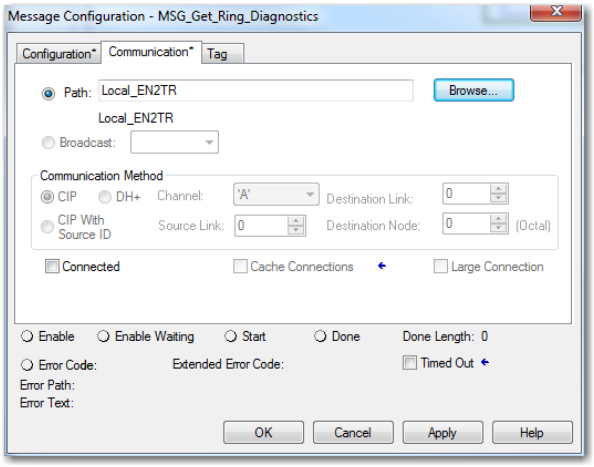
1. Enter a MSG instruction into your rung of logic.
2. Configure the MSG instruction to retrieve ring diagnostic information service, as shown in the following screen shots.

IMPORTANT Make sure the tag you create is sized appropriately to hold all of the data you are reading or writing.

For more information, see page 49.



3. Configure the MSG instruction's communication path to point to the active supervisor node.



IMPORTANT

When you use the Custom Get_Attributes_All (01) service, if you point to an active supervisor node, you retrieve all of the attributes listed in Retrieve All Ring Diagnostic Information on page 50.

If you point to a non-supervisor node, you retrieve the Network Topology and Network Status attribute information only.

If you point to backup supervisor node, you can retrieve the current active supervisor's IP address.

TIP

An EtherNet/IP Device Level Ring Network Diagnostics Faceplate is available from the Rockwell Automation Sample Code website. The diagnostics faceplate contains logic code (add-on instruction) that allows a controller to retrieve real-time DLR network status information, and HMI faceplate graphics to allow the data to be visualized on an operator interface.

Use Specific Values on the Configuration Tab

Use the values on the Configuration tab of your MSG instruction to perform specific services.

TIP Sample DLR network diagnostic application code, for example, Add-on Instruction or HMI faceplate graphics, is available on the Rockwell Automation Sample Code Library.

For more information about the Rockwell Automation Sample Code Library, see: http://www.rockwellautomation.com/solutions/integratedarchitecture/resources5.html

Request	Description	Message Type	Service Type	Service Code (HEX)	Class (HEX)	Instance	Attribute (HEX)	Source Element	Source Length (Bytes)	Destination	Destination Length (bytes)
Retrieve All Ring Diagnostic Information	Information for this request is listed in Retrieve All Ring Diagnostic Information on page 50.	CIP Generic	Custom	1	47	1	NA	Left blank	0	Tag	50 or 54(2)
Request Ring Participant List(1)	Information for this request is listed in Request the Ring Participant List on page 52	CIP Generic	Get Attribute Single	e	47	1	9	NA	NA	Tag	10/node
Get Active Supervisor	Obtain the IP address and MAC ID of the active supervisor on the DLR network	CIP Generic	Get Attribute Single	e	47	1	a	NA	NA	Tag	10
Acknowledge Rapid Ring Faults Condition	Request supervisor to resume normal operation after encountering a rapid ring fault condition	CIP Generic	Custom	4c	47	1	NA	NA	NA	NA	
Verify a Fault Location	Request supervisor to update Last Active Node values	CIP Generic	Custom	4b	47	1	NA	NA	NA	NA	NA
Reset the Ring Fault Counter	Reset the number of ring faults detected on the DLR network	CIP Generic	Set Attribute Single	10	47	1	5	Tag	2	NA	NA
Enable and Configure a Ring Supervisor	Information for this request is listed in Enable and Configure a Ring Supervisor on page 52.	CIP Generic	Set Attribute Single	10	47	1	4	Tag	12	NA	NA
Restart_Sign_On Service	Refresh the supervisor node's participants list	CIP Generic	Custom	4d	47	1	NA	NA	NA	NA	

(1) This request works only if there are fewer than 40 nodes on the network. If there are more nodes than fit in a single message, an error is returned.

(2) You can use a Destination Length of 54 bytes if you use firmware revision 3.x or later for the 1756-EN2TR module or firmware revision 2.x or later for the 1783-ETAP, 1783-ETAP1F, or 1783-ETAP2F taps.

Retrieve All Ring Diagnostic Information

When you perform the Retrieve All Ring Diagnostic Information request on an active supervisor, the MSG instruction returns the following information.

Destination Tag	Need in Implementation	Access Rule	Attribute Name	Data Type	Description	Possible Values
SINT [0]	Required	Get	Network Topology	USINT	Current network topology mode	0 = Linear 1 = Ring
SINT [1]	Required	Get	Network Status	USINT	Current status of the network	0 = Normal 1 = Ring Fault 2 = Unexpected Loop Detected 3 = Partial Network Fault 4 = Rapid Fault/Restore Cycle
SINT [2]	Conditional(2)	Get	Ring Supervisor Status	USINT	Ring supervisor active status flag	0 = Node is functioning as a backup 1 = Node is functioning as the active ring supervisor 2 = Node is functioning as a normal ring node 3 = Node is operating in a non-DLR topology 4 = Node cannot support the currently operating ring parameters, that is, Beacon Interval and/or Beacon Timeout
	Conditional(2)	Set	Ring Supervisor Config	Structure of:	Ring Supervisor configuration parameters	
SINT [3]			Ring Supervisor Enable	BOOL	Ring supervisor enable flag	0 = Node is configured as a normal ring node (default configuration) 1 = Node is configured as a ring supervisor
SINT [4]			Ring Supervisor Precedence	USINT	Precedence value of a ring supervisor(3)	Valid value range = 0…255 0 = Default value
SINT [5-8]			Beacon Interval	UDINT	Duration of ring beacon interval	Valid value range = 200 μs…100 ms Default = 400 μs
SINT [9-12]			Beacon Timeout	UDINT	Duration of ring beacon timeout	Valid value range = 400 μs…500 ms Default value = 1960 μs
SINT [13-14]			DLR VLAN ID	UIINT	Valid ID to use in ring protocol messages	Valid value range = 0…4094 Default value = 0
SINT [15-16]	Conditional(2)	Set	Ring Faults Count	UINT	Number of ring faults since power up(3)	
	Conditional(2)	Get	Last Active Node on Port 1	Structure of:	Last active node at the end of the chain through port 1 of the active ring supervisor during a ring fault	
SINT [17-20]				UDINT	Device IP address(3)	Any valid IP address value A value = 0 indicates no IP address has been configured for the device. The default configuration is no IP address configured for the device.
SINT [21-26]				ARRAY of 6 USINTs	Device MAC address(3)	Any valid Ethernet MAC address

Destination Tag	Need in Implementation	Access Rule	Attribute Name	Data Type	Description	Possible Values
	Conditional[2]	Get	Last Active Node on Port 2	Structure of:	Last active node at the end of the chain through port 2 of the active ring supervisor during a ring fault	
SINT [27-30]				UDINT	Device IP address[3]	Any valid IP address value A value = 0 indicates no IP address has been configured for the device. The default configuration is no IP address configured for the device.
SINT [31-36]				ARRAY of 6 USINTs	Device MAC address[3]	Any valid Ethernet MAC address
SINT [37-38]	Conditional[2]	Get	Ring Protocol Participants Count	UINT	Number of devices in the ring protocol participants list	
	Required	Get	Active Supervisor Address	Structure of:	IP and/or Ethernet MAC address of the active ring supervisor	
SINT [39-42]				UDINT	Supervisor IP address	Any valid IP address value A value = 0 indicates no IP address has been configured for the device.
SINT [43-48]				ARRAY of 6 USINTs	Supervisor MAC address	Any valid Ethernet MAC address
SINT [49]	Conditional[2]	Get	Active Supervisor Precedence	USINT	Precedence value of the active ring supervisor	
SINT [50-53][1]	Required	Get	Capability Flags	DWORD	Alerts you that the device is capable of operating as a supervisor and beacon-based ring node.	0x22

(1) This destination tag is available with the 1756-EN2TR module, firmware revision 3.x or later, or the 1783-ETAP, 1783-ETAP1F, and 1783-ETAP2F taps, firmware revisions 2.x or later, only. If you use the 1783-ETAP tap, firmware revision 1.x, your program does not include this destination tag.

(2) This attribute is implemented only for devices that can function as the ring supervisor.

(3) Logix Designer application can display the value in this field as negative numbers. To better understand the value, we recommend you view it in HEX format.

Request the Ring Participant List

When you request the Ring Participant List service on your DLR network, the MSG instruction returns the following information.

Destination Tag	Need in Implementation	Access Rule	Attribute Name	Data Type	Description	Possible Values
	Conditional[1]	Get	Ring Protocol Participants List[2]	ARRAY of:	List of devices participating in ring protocol	
				Structure of:		
SINT [0-3]				UDINT	Device IP address[3], [4]	Any valid IP address value A value = 0 indicates no IP address has been configured for the device.
SINT [4-9]				ARRAY of 6 USINTs	Device MAC address[4], [5]	Any valid Ethernet MAC address

(1) This attribute is implemented only for devices that can function as the ring supervisor.

(2) This attribute returns an array of the data shown, one entry for each node. The Ring Protocol Participants Count attribute determines the number entries.

(3) This tag displays IP addresses only for ring participants that have been configured with one. For example, you can have a 1783-ETAP tap connected to the network that has not been assigned an IP address. In that case, no address is shown for the 1783-ETAP tap.

(4) Logix Designer application can display the value in this field as negative numbers. To better understand the value, we recommend you view it in HEX format.

(5) Unlike destination tag SINT [0-3], where IP addresses are displayed **only** for ring participants configured with an IP address, this tag displays MAC addresses for **all** ring participants because every ring participant has a MAC address.

Enable and Configure a Ring Supervisor

When you perform the Enable and Configure a Ring Supervisor request on a supervisor-capable device, configure the MSG instruction with the following information.

Source Tag	Need in Implementation	Access Rule	Attribute Name	Data Type	Description	Possible Values
	Conditional[1]	Set	Ring Supervisor Config	Structure of:	Ring Supervisor configuration parameters	
SINT [0]			Ring Supervisor Enable	BOOL	Ring supervisor enable flag	0 = Node is configured as a normal ring node (default configuration) 1 = Node is configured as a ring supervisor
SINT [1]			Ring Supervisor Precedence	USINT	Precedence value of a ring supervisor[2]	Valid value range = 0…255 0 = Default value
SINT [2-5]			Beacon Interval	UDINT	Duration of ring beacon interval	Valid value range = 200 μs…100000 μs Default = 400 μs
SINT [6-9]			Beacon Timeout	UDINT	Duration of ring beacon timeout[2]	Valid value range = 400 μs…500000 μs Default value = 1960 μs
SINT [10-11]			DLR VLAN ID	UINT	VLAN ID to use in ring protocol messages[2]	Valid value range = 0…4094 Default value = 0

(1) This attribute is implemented only for devices that can function as the ring supervisor.

(2) Logix Designer application can display the value in this field as negative numbers. To better understand the value, we recommend you view it in HEX format.

Restart_Sign_On Service

The Sign_On process builds the ring participant list. The process occurs automatically whenever the ring transitions from Fault mode to Run mode. The Restart_Sign_On service is a request to start the Sign_On process again.

The following requirements must be met before you can use the Restart_Sign_On service:

- The ring must be in Normal mode.
- The previous Sign_On process must be complete.

If you attempt to use the Restart_Sign_On service without meeting the requirements, an error occurs.

After the Restart_Sign_On service refreshes the ring participant list, you must issue a Request Ring Participant List service to retrieve the list.

TIP We recommend that you wait at least one second after receiving a response that the Restart_Sign_On service was successful before issuing a Request Ring Participant service request.

IMPORTANT When using the Restart_Sign_On service, consider the following:

- Typically, you issue a Restart_Sign_On service request to update the list of IP addresses for all devices in the ring participant list.

  This can be necessary if any ring participant list devices were in the process of obtaining an IP address when the most recent Sign_On service request was completed.
- Network functionality is not affected if the active supervisor has an inaccurate list.

Notes:

Additional EtherNet/IP Tap Features

The 1783 EtherNet/IP taps connect devices that do not support embedded switch technology to a linear or DLR network. For example, 2711P PanelView Plus terminals connect to a linear or DLR network only through a 1783 EtherNet/IP tap.

Previous sections in this publication describe how to use 1783 EtherNet/IP taps for general tasks, such as the physical connection to the network and how to configure the tap to operate on the network. This chapter explains the additional features of the 1783-ETAP, 1783-ETAP1F, and 1783-ETAP2F EtherNet/IP taps.

IMPORTANT Always use 1783-ETAP, 1783-ETAP1F, and 1783-ETAP2F EtherNet/IP taps to connect non-DLR devices to a linear or DLR network.

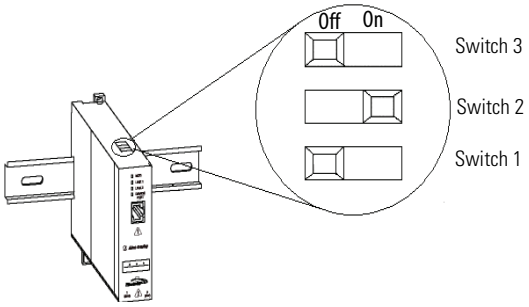
Do not connect non-DLR devices, for example, third-party devices with multiple EtherNet/IP network ports, directly to the network.

Use DIP Switches

Use the DIP switches on the tap to do the following:

- Specify the method for configuring IP settings, such as the IP address.
- Enable the Ring Supervisor mode with its current parameters.
- Restore the factory default settings.

Refer to this figure to understand DIP switch On and Off positions.



Use this procedure to set the DIP switches.

1. Move the switches to the desired position, and then cycle power to the tap.

IMPORTANT The switch settings take effect only at powerup. The tap's behavior is not modified by switch changes until the tap is power cycled.

Power-up Behavior		Switch 1	Switch 2	Switch 3
Internet Protocol settings	Uses the IP settings configured by software[1] or Uses the default IP address of 169.254.1.1 if settings have not been configured by software	Off	Off	The position of switch 3 does not affect IP settings.
	Uses the IP settings acquired by a BOOTP server	On	Off	
	Uses the IP settings acquired by a DHCP server	Off	On	
Ring Supervisor mode	Enables Ring Supervisor mode with the current supervisor-related parameters[2]	The positions of switches 1 and 2 do not affect Ring Supervisor mode		On[3], [4]
	Lets Ring Supervisor mode and supervisor-related parameters be enabled and configured by software			Off
Restores the factory default settings and then suspends operation		On	On	On or Off

(1) RSLinx Classic software, Logix Designer application, or RSLogix 5000 software is required. Logix Designer application, version 21.*xx.xx* or later, is required if your controller uses firmware revision 21.011 or later. RSLogix 5000 software, version 20.*xx.xx* or earlier, is required if you controller uses firmware revision 20.*xxx* or earlier.

(2) For information about supervisor-related parameters, refer to Supervisor Node on page 15.

(3) A tap must use firmware revision 2.001 or later, for Switch 3 to control the Rung Supervisor mode as described.

(4) **IMPORTANT**: If you use the tap in a linear network, make sure switch 3 is set to the **Off** position.

2. Observe these guidelines when you use the DIP switches:
   - Out of the box, all three switches are in the Off position. In this state, the tap is configured to be a non-supervisor ring node and responds to the default IP address of 169.254.1.1.
   - If your application does not require access to the tap's diagnostic information or configuration, no further action is required.

     Otherwise, use alternate DIP switch settings or use the software to configure the tap.
   - When a switch is pushed to the left, it is in the Off position.
   - When a switch is pushed to the right, it is in the On position.
   - To use BOOTP, move switch 1 to the On position and switch 2 to the Off position.
   - To use DHCP, move switch 1 to the Off position and switch 2 to the On position.
   - To enable Ring Supervisor mode with the current supervisor-related parameters, move switch 3 to the On position.
   - To restore the factory default settings and suspend operation, move both switch 1 and 2 to the On position.

     When both switch 1 and 2 are in the On position, the position of switch 3 is ignored.
   - When operation is suspended, the OK status indicator blinks red.

     To resume normal operation, move the switches to the desired positions and then cycle power to the tap.

Internet Group Management Protocol (IGMP) Configuration Parameters

The 1783-ETAP, 1783-ETAP1F, and 1783-ETAP2F taps support two Internet Group Management Protocol (IGMP) functions.

- IGMP Snooping - Enabled by default
- IGMP Querier - Disabled by default

You can use either Logix Designer application or RSLinx Classic software to configure these parameters.

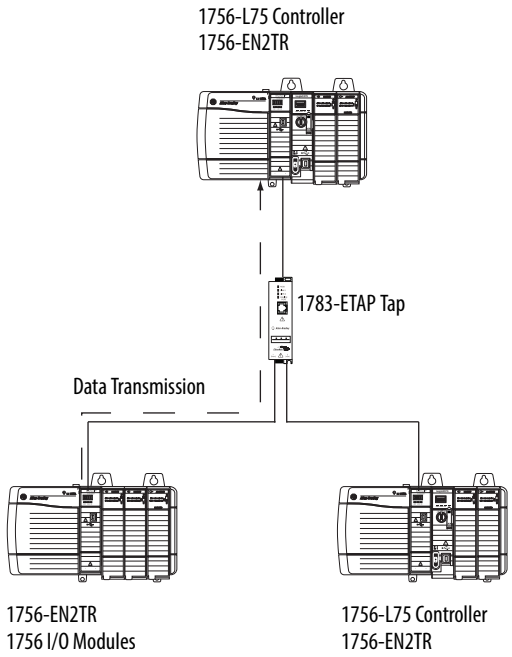
IGMP Snooping

This functionality is enabled by default in the 1783-ETAP, 1783-ETAP1F, and 1783-ETAP2F taps, and is commonly used to manage multicast traffic on the network. When in use, this functionality lets the tap multicast data to those devices and not to all devices connected to the network.

IMPORTANT	For snooping to work, there must be a device present that is running a querier. Typically, the device is a router or a switch, such as the Stratix 6000™, Stratix 8000™, or Stratix 8300™ managed switch.

The graphic below shows a ControlLogix controller receiving multicast data from I/O modules via a 1783-ETAP tap. The second ControlLogix controller does not receive unwanted multicast traffic.

Figure 14 - IGMP Snooping



IGMP Querier

This functionality is disabled by default. The IGMP Querier functionality enables a 1783-ETAP, 1783-ETAP1F, or 1783-ETAP2F tap or switch, such as a Stratix managed switch, to send out a query to all devices on the network to determine what multicast addresses are of interest to a specific node or a group of nodes.

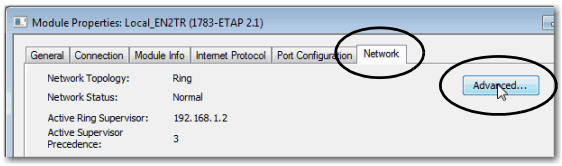
IMPORTANT	We recommend that you enable the IGMP Querier functionality for at least one node on the network. The 1783-ETAP, 1783-ETAP1F, or 1783-ETAP2F taps, managed switches, and routers are examples of devices that support IGMP Querier functionality. If you do not enable the IGMP Querier functionality for at least one node on the network, multicast traffic on the network can eventually create network performance issues.

However, for all devices that you configure on the network with the IGMP Querier parameter enabled, you must also set an IP address other than the factory default value for those devices. If multiple devices on the network enable this functionality, the node with the lowest IP address becomes the active IGMP Querier node.

IGMP Version

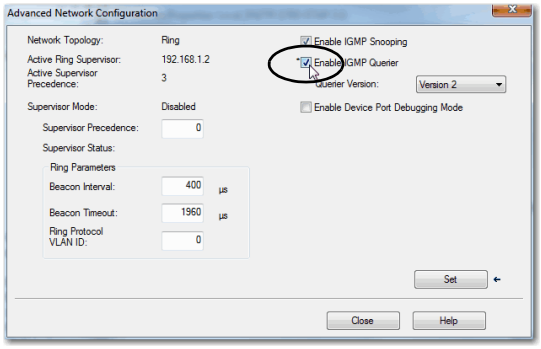
Complete the following tasks to access the Port Diagnostics tab.

- **Logix Designer application**, version 21.00.00 or later.
  a. Double-click the device in the I/O Configuration.
  b. On the Module Properties dialog box, click the Network tab.
  c. Click Advanced.

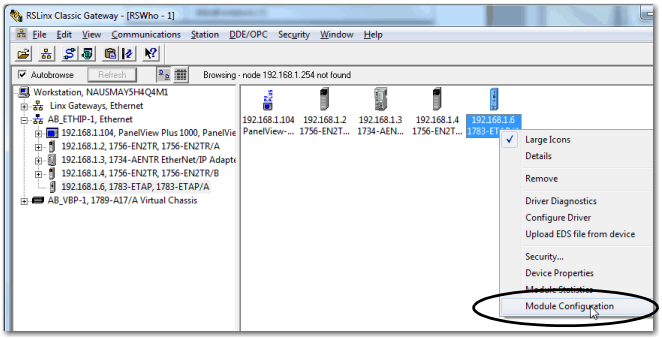


d. Make configuration changes as necessary.

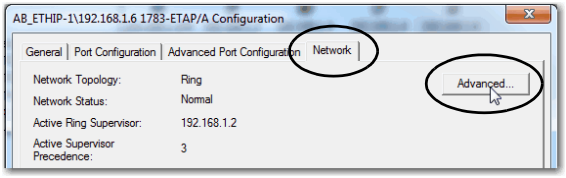
IMPORTANT If you enable IGMP Querier, you must select a Querier version. The default version is 2.



- **RSLinx Classic software**, version 3.51.00 or later.
  a. Browse the network.
  b. Right-click the device and choose Module Configuration.

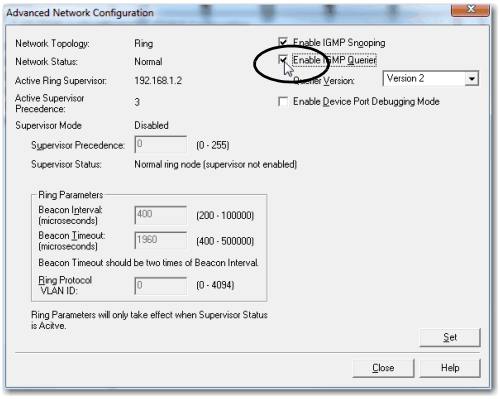


c. On the Configuration dialog box, click the Network tab.
d. Click Advanced.



e. Make configuration changes as necessary.

IMPORTANT If you enable IGMP Querier, you must select a Querier version. The default version is 2.



Device Port Debugging Mode

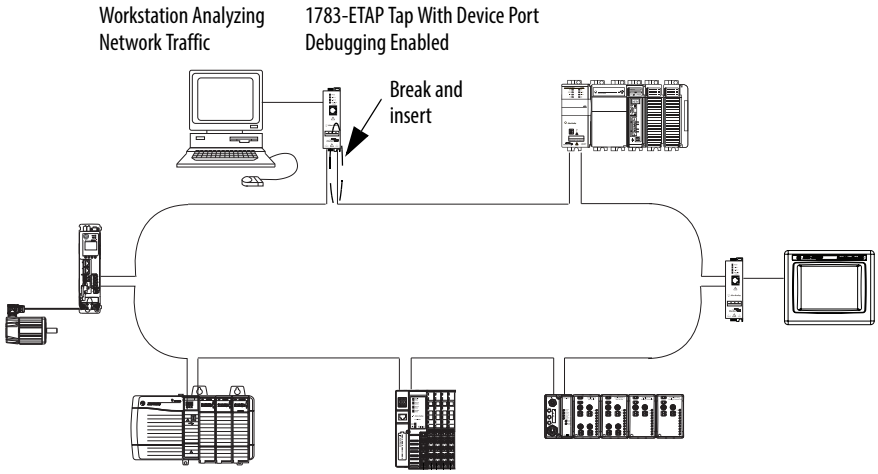
This functionality is disabled by default. You can use Device Port Debugging mode, which is similar to port mirroring, to monitor data received on the 1783-ETAP, 1783-ETAP1F, or 1783-ETAP2F tap's two network ports over the device port to a device, such as a personal computer running a protocol analyzer application for advanced network debugging or analysis.

IMPORTANT We **strongly recommend** that you use this functionality when troubleshooting the network only and not in normal network operation.

When device port debugging is used on a 1783-ETAP, 1783-ETAP1F, or 1783-ETAP2F tap, the device connected to the 1783-ETAP tap's front port receives all of the data traversing the ring (both directions).

When you use the Device Port Debugging mode functionality, you insert the 1783-ETAP, 1783-ETAP1F, or 1783-ETAP2F tap, with the network analyzer connected to the device port, at the spot on the ring network where the node in question is installed. The following graphic shows a 1783-ETAP tap inserted in the network.

Figure 15 - Device Port Debugging Example Network



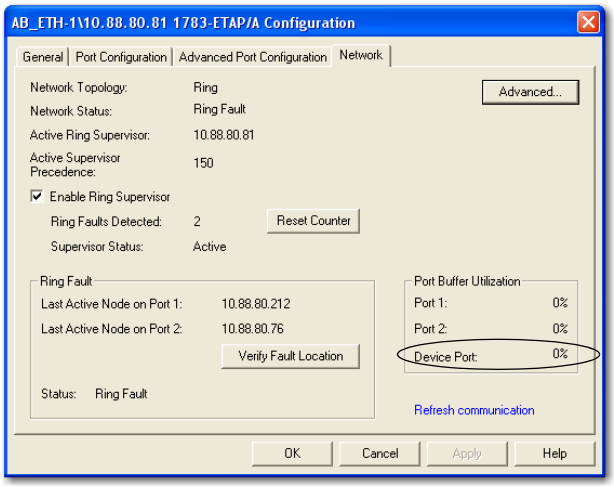
Combined total network bandwidth of the traffic received on the two 1783-ETAP, 1783-ETAP1F, or 1783-ETAP2F tap's ports connected to the network must not exceed the tap's device port capacity. The speed setting determines the device port's capacity.

You can configure the device port on a 1783-ETAP, 1783-ETAP1F, or 1783-ETAP2F tap to either of the following speed settings:

- 100 Mbps - default setting
- 10 Mbps

If the bandwidth exceeds the capacity of the tap's device port, some frames from the ring are dropped before reaching the device port. These dropped frames do not impact the traffic on the rest of the DLR network.

The device port setting determines how much network traffic the 1783-ETAP, 1783-ETAP1F, or 1783-ETAP2F tap can handle before dropping frames. The circled section in the graphic below shows the Port Buffer Utilization. In this example the value is zero because a ring fault exists on the network.

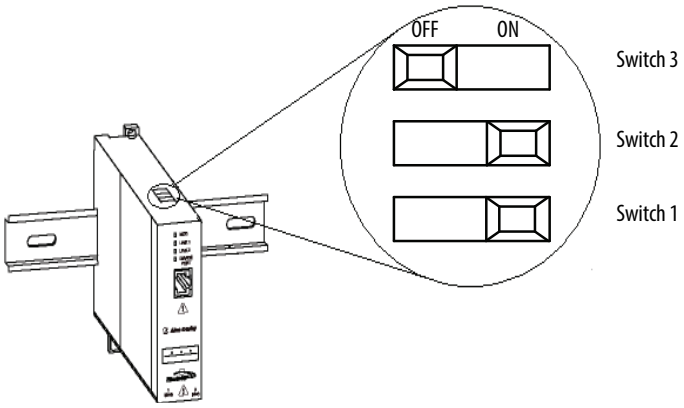


Replace a Tap on the Network

There can be times when you need to replace a 1783-ETAP, 1783-ETAP1F, or 1783-ETAP2F tap on your network. In these instances, we recommend that you use a tap that is set to factory default settings. If you are unsure of a replacement tap's configuration, we recommend that you return the tap to its factory default configuration.

The following example shows how to return a 1783-ETAP tap to its factory default configuration. Complete these steps.

1. Power up the 1783-ETAP, 1783-ETAP1F, or 1783-ETAP2F tap with switches 1 and 2 set to On and switch 3 to Off as shown below.



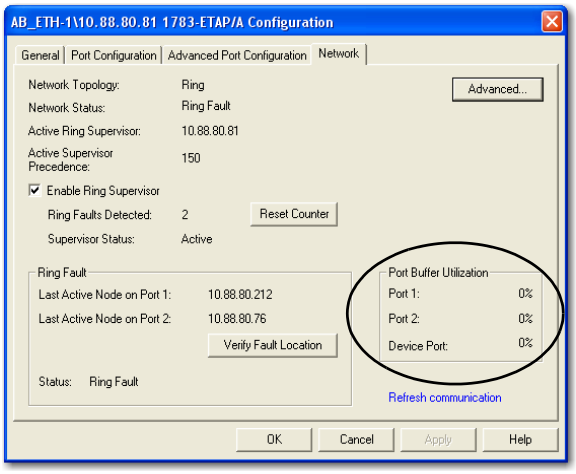
2. Power off the tap.
3. Adjust the switches back to necessary setting to set the IP address. For more information on switch settings, see Use DIP Switches on page 56.
4. Power up the tap.

Port Buffer Utilization

When you monitor the Port Buffer Utilization values on a 1783-ETAP, 1783-ETAP1F, or 1783-ETAP2F tap, you can monitor the following:

- Port 1
- Port 2
- Device Port

You can monitor these fields from the Network tab for a 1783-ETAP, 1783-ETAP1F, or 1783-ETAP2F tap, as shown in the screen shot below.



If the values for any of these fields exceed 90% consistently, we recommend that you analyze and adjust your network design.

Do not use a single 1783-ETAP, 1783-ETAP1F, or 1783-ETAP2F tap to connect a large number of nodes, for example, hundreds of nodes, on each port with a large amount of traffic flowing through this single tap. Doing so significantly impacts the tap's ability to transmit the data between nodes.

We recommend the following:

- Use managed switches to connect a large number of devices.
- Do not use more than 50 nodes on a single DLR network.

For more information on topology recommendations, see Chapter 5, Common Network Topologies on page 67.

Notes:

Common Network Topologies

Multiple common network topology combinations are shown in this chapter.

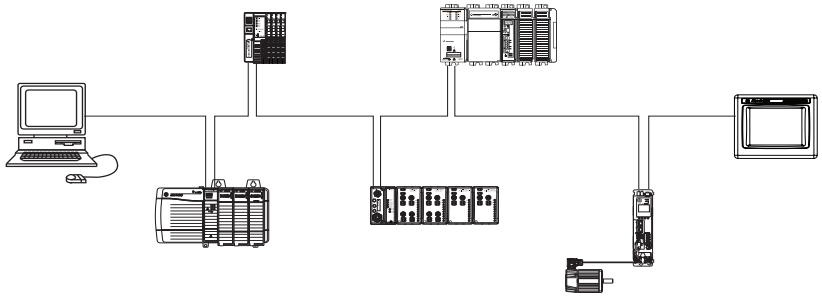
This chapter shows a series of common topologies. Your use of these networks/topologies is not limited to these examples.

For more information about EtherNet/IP topologies, see Embedded Switch Technology Reference Architectures, publication ENET-RM003.

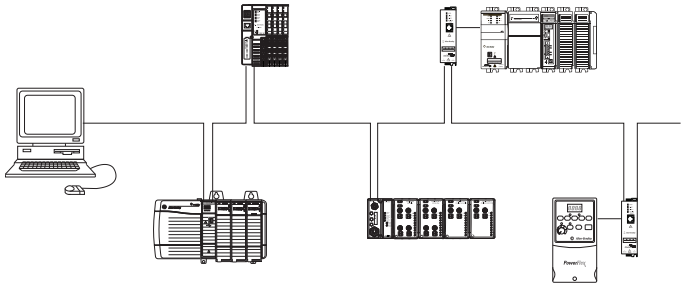
Standalone Linear Networks

The following graphics show example standalone linear networks. We recommend that you do not use more than 50 nodes on a single linear network.

- Products used to construct a copper linear network



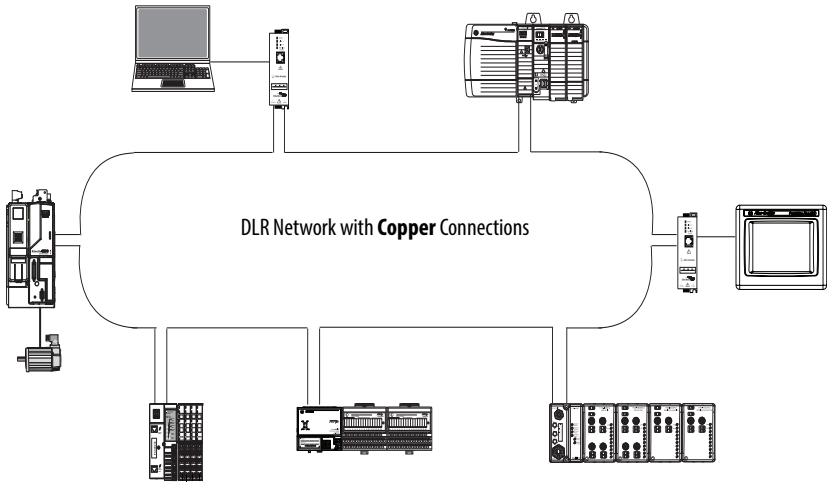
- Products used to connect copper and fiber-optic sections of a linear network



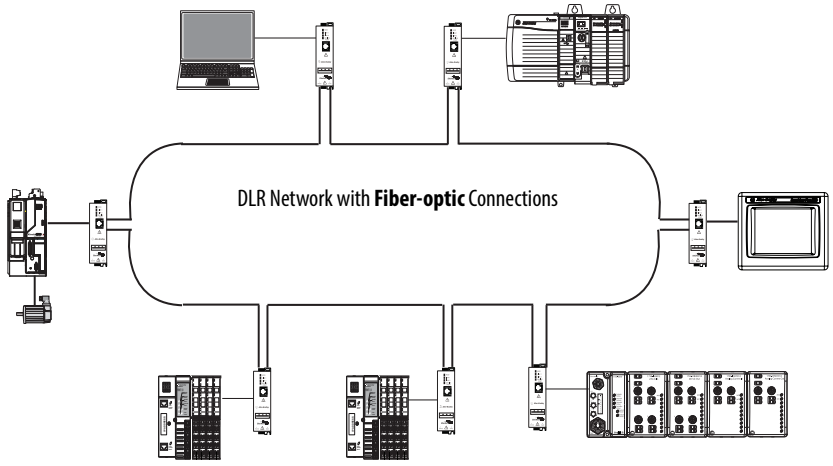
Standalone DLR Networks

The following graphics show standalone DLR networks. We recommend that you do not use more than 50 nodes on a single DLR network.

- Products used to construct a copper DLR network



- Products used to construct a fiber-optic DLR network



Expanding Beyond Simple Linear or DLR Networks

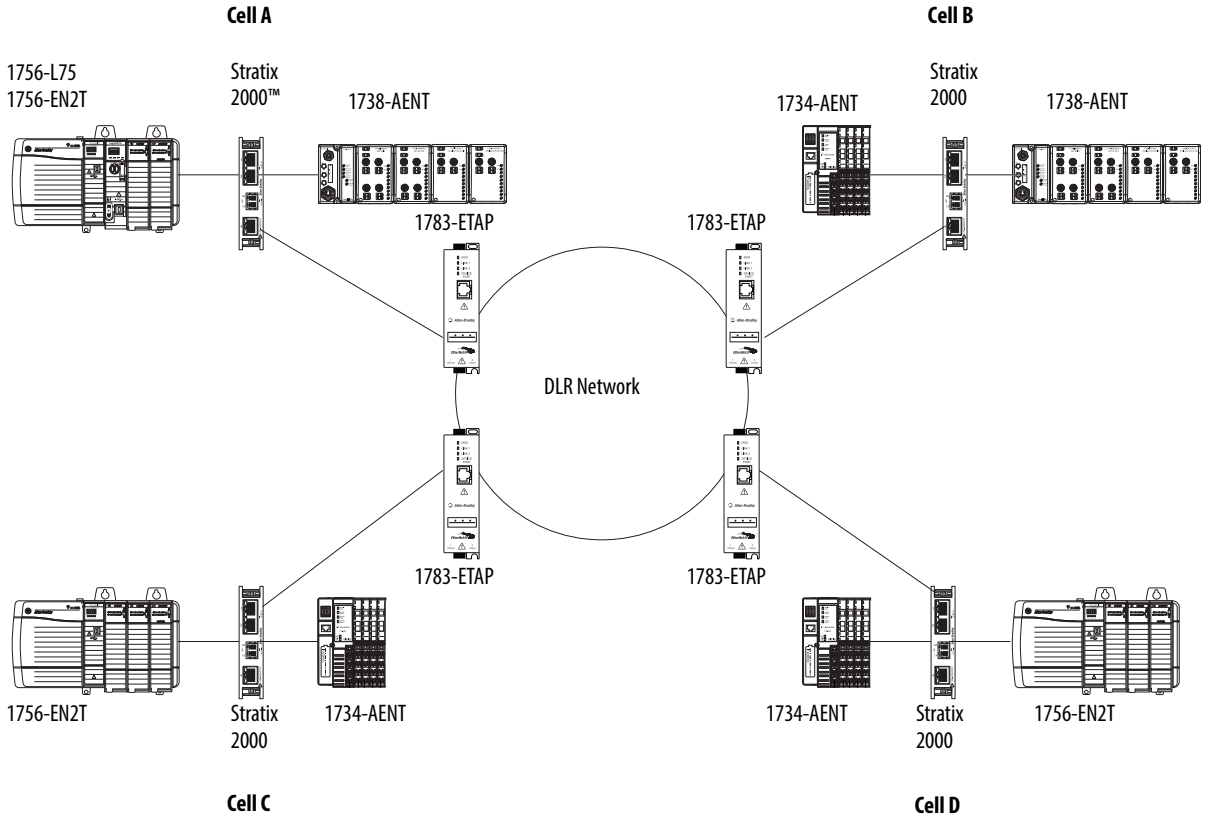
This section shows complex example DLR topologies.

Connecting to External Switches

In this example, the 1783-ETAP taps on the DLR network can be connected to managed or unmanaged switches with star or linear topologies.

Make sure you segment your network properly and limit the traffic sent between 1783-ETAP taps. For example, limit the traffic from cell A to cell B.

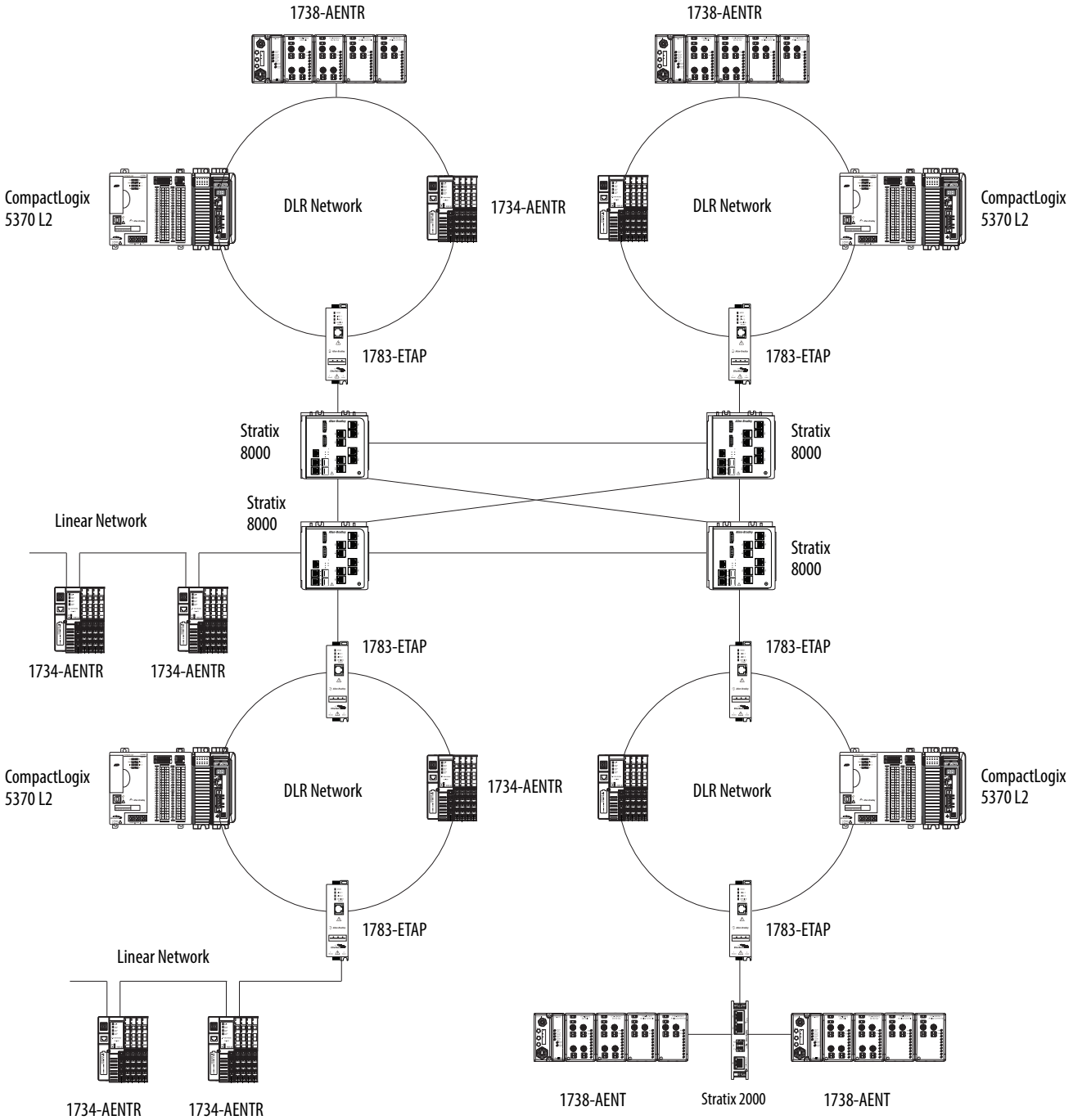
To monitor how much of a 1783-ETAP tap's port capacity, the network traffic is using, check the Port Buffer Utilization values. For more information on Port Buffer Utilization, see page 65.



Working with STP, RSTP, or MSTP

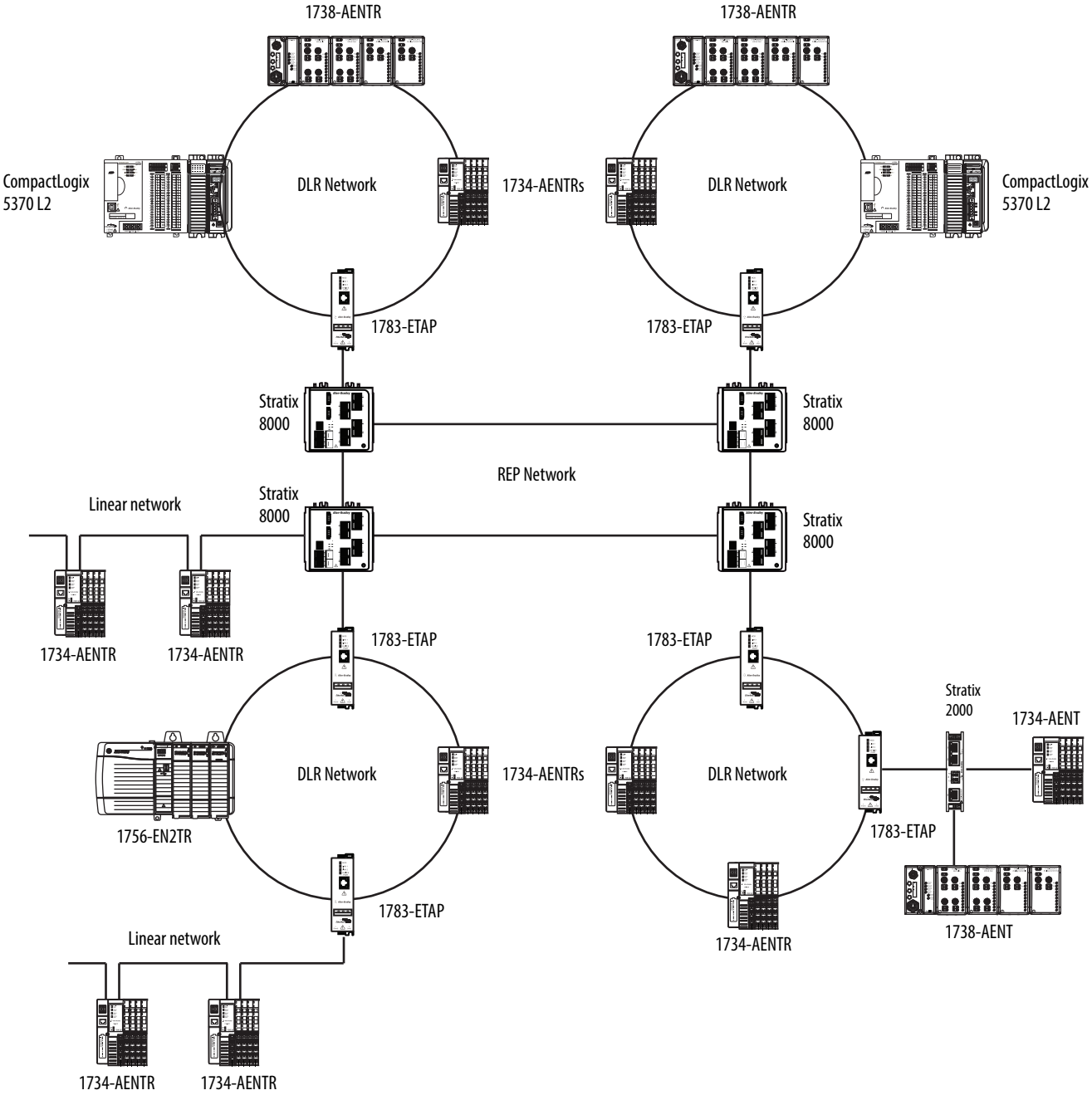
In this example, the managed switches that are used must support Spanning Tree Protocol (STP), Rapid Spanning Tree Protocol (RSTP) or Multiple Spanning Tree Protocol (MSTP) and have the protocol enabled.

If a fault occurs on any of the redundant links between the managed switches, the recovery time is dependent on the protocol being used on the managed switches.



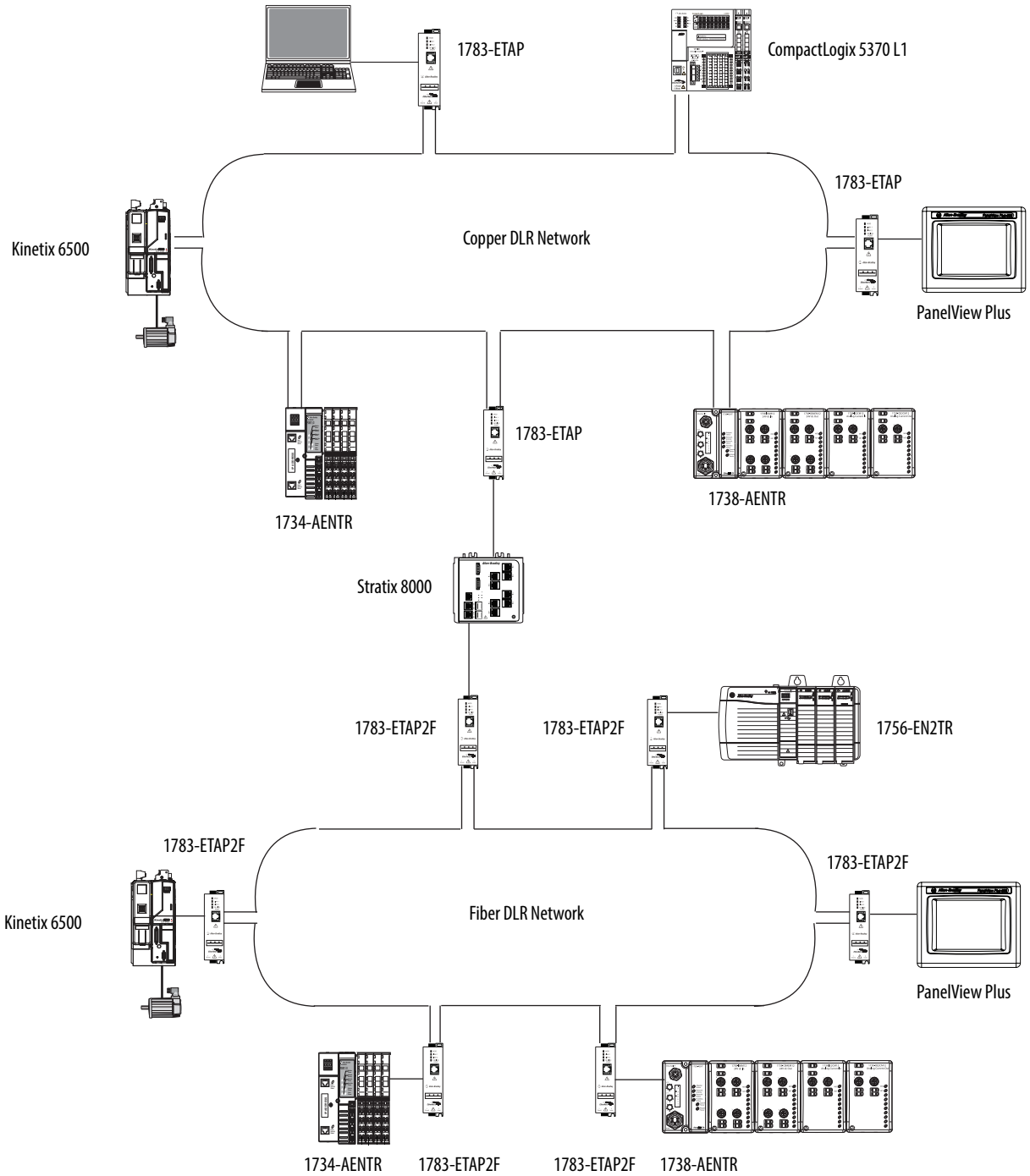
Working with Other Rings (Resilient Ethernet Protocol)

If a fault occurs on a non-DLR ring network, the recovery time is protocol-dependent.



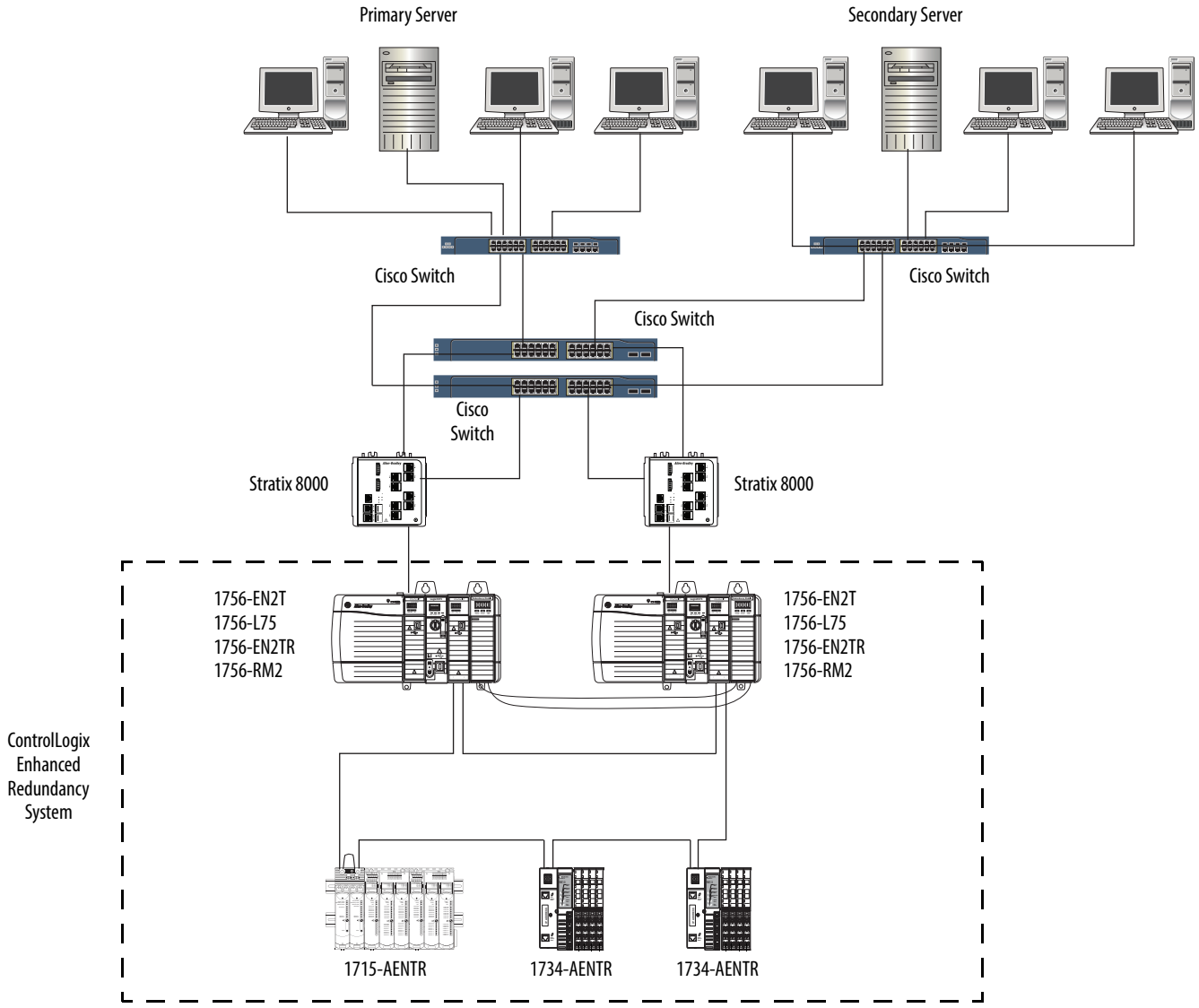
Connecting a Copper DLR Network to a Fiber DLR Network via a Switch

In the following example, a DLR network that uses copper media is connected to a DLR network that uses fiber media via a managed switch.



Using ControlLogix Enhanced Redundancy with DLR Topology

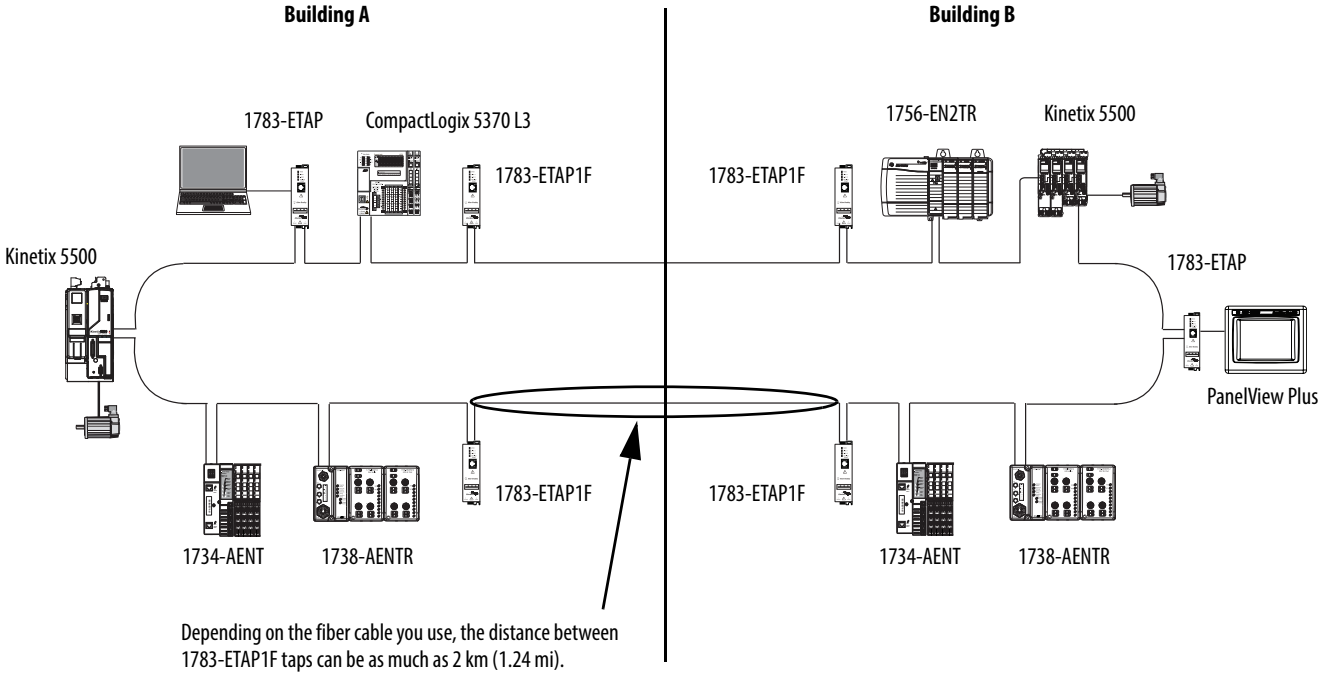
The following example shows ControlLogix Enhanced Redundancy used in conjunction with DLR topology in the context of an overall high-availability architecture.



Extending a DLR Network Across a Long Distance via a Fiber Connection

You can use fiber media to extend a DLR network across long distances, for example, two networks in separate buildings.

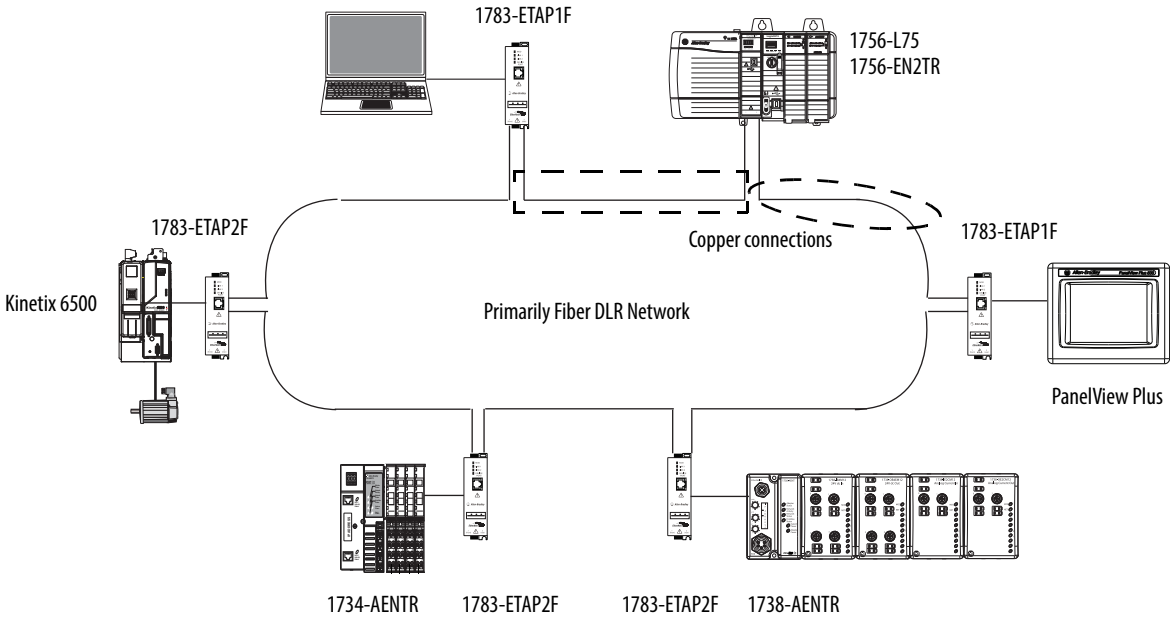
The following example uses copper media for each section of the DLR network in separate buildings and 1783-ETAP1F taps to extend the network across a long distance.



For more information on using fiber media to extend a DLR network across long distances, see Fiber Optic Infrastructure Application Guide, publication ENET-TD003.

Using a 1756-EN2TR ControlLogix EtherNet/IP Communication Module as a Supervisor Node on a Fiber DLR Network

The following example shows how you use a 1756-EN2TR ControlLogix EtherNet/IP communication module as the Active Supervisor node on a primarily fiber DLR network.



Network Usage Guidelines and Recommendations

Consider the guidelines and recommendations in the following table.

Guideline/Recommendation	Explanation
Use fewer than 50 nodes on a single DLR network. If your application requires more than 50 nodes, we recommend that you break the nodes into separate, but linked, DLR networks.	If you use more than 50 nodes on a single DLR network, consider the following: • Your network has a greater chance of multiple faults occurring on the network. • Network recovery times from faulted DLR network are higher.
Do not configure a supervisor on a linear network.	If your linear network includes non-DLR nodes and has a supervisor-enabled node on the network, it can impact communication to non-DLR devices connected to the linear network.
If you must connect a device that is running at 10 Mbps to a DLR or linear network, do so through a 1783-ETAP, 1783-ETAP1F, or 1783-ETAP2F tap device port.	The 1783-ETAP, 1783-ETAP1F, and 1783-ETAP2F taps can operate at 100 Mbps on the DLR network; this is the optimal speed for a network. If you connect a 10 Mbps device directly to the network, instead of through a tap, the linear or DLR network traffic slows to 10 Mbps. Additionally, if the 10 Mbps device is connected to the network without a 1783-ETAP tap, network recovery times are significantly impacted.
Configure multiple supervisor nodes per ring.	If your DLR network has one supervisor only, and the supervisor experiences a fault, none of the other nodes become the active supervisor. In this case, the network becomes a linear network until the fault is corrected and the DLR network restored. Another reason to configure multiple supervisor nodes is that if you need to replace an active supervisor node with an out-of-box replacement, the new device is not enabled as a supervisor (by default) and there is no supervisor on the network.
Connect switches to a DLR network via 1783-ETAP, 1783-ETAP1F, or 1783-ETAP2F taps.	If switches are connected to the DLR network without the use of a 1783-ETAP, 1783-ETAP1F, or 1783-ETAP2F tap, the network can experience unpredictable behavior and network performance is unknown.
Run all nodes on the DLR network at 100 Mbps and in Full-duplex mode.	These configuration values provide the best performance for your network. Additionally, we recommend the following: • Use auto-negotiate for all nodes on the DLR network. • Do not use auto-negotiate on one node and then force speed on the next node linked to it.

Guideline/Recommendation	Explanation
In a linear network, the number of nodes to use is application specific, based on the considerations described in the next box.	When determining the number of nodes to use on a linear network, consider the following: • There is a delay per node as information is transmitted to each successive node used on the network. - The typical delay on a linear network with 100 m copper segments between nodes is 30 μS. - The typical delay on a linear network with 2 kM fiber-optic segments between nodes is 40 μS. The greater the number of nodes on the network, the longer the total time for information to be transmitted across the entire network. **IMPORTANT** The total time for information to be transmitted across the entire network, and its effect on how many nodes to use on a linear network, is related to the Requested Packet Interval (RPI). We recommend that you verify that the total time to transmit information from the first node to the last node on the network is less than the RPI. Make sure the network is not loaded beyond 80% of capacity. You can estimate total delay for a linear network by multiplying the number of nodes by 30 μs for copper and 40 μs for fiber cable. We suggest that you allow a 20% margin for media variability. For example, if your network RPI is 5 ms and uses copper cable, then the maximum number of nodes would be 5000us/30us = 165, less 20% = 132 nodes. • The single point of failure possibility is greater with each additional connection. • Troubleshooting the network can be more difficult with a higher number of nodes.
Do not physically close a DLR network without a supervisor configured on the network.	A DLR network without a supervisor node results in a network storm. If you do close the DLR network without a supervisor configured, break the ring and configure at least one supervisor before physically reconnecting the network. **IMPORTANT** You can use the DIP switches on a 1783-ETAP tap to configure it to function as a supervisor at power-up. This allows you to physically close a powered DLR network before programming the devices on the network. For more information on how to use the 1783-ETAP DIP switches, see Use DIP Switches on page 56.
Use the default values for the following: • Beacon Interval • Beacon Timeout • Ring Protocol VLAN ID	Changing the default values for the parameters Beacon Interval, Beacon Timeout and Ring Protocol VLAN ID, can result in unpredictable network behavior and negatively impacted network performance. The default values are optimized for a network with the following configuration: • 50 or fewer nodes are on the network. • All nodes are operating at 100 Mbps and full-duplex mode. • At least 50% of the network traffic bandwidth being EtherNet/IP traffic If you think you need to change the values of the Beacon Interval, Beacon Timeout or Ring Protocol VLAN ID, for example, if any node on ring is not operating at 100 Mbps and full-duplex mode, we recommend that you first call Rockwell Automation technical support.

Network Recovery Performance

When you measure your network's performance while dealing with fault conditions, we recommend that you consider the network recovery time. Network recovery is the time for all of the following to take place:

1. The supervisor node recognizes that a fault exists on the network.
2. The supervisor node reconfigures the network appropriately because of the fault.
3. The supervisor node communicates to the network nodes that a fault condition exists.
4. The network nodes reconfigure themselves appropriately because of the fault.

With the default beacon interval value of 400 µS and beacon timeout value of 1960 µS, the worst-case time for network recovery times are:

- 2890 µS for a **copper DLR network**. This recovery time is based on 100 m copper segments between nodes on the network.
- 3140 µS for a **fiber-optic DLR network**. This recovery time is based on 2 kM fiber-optic cable segments between nodes on the network.

  When considering the values listed above, keep in mind:
  - Recovery time can actually occur faster than the times listed.
  - The recovery times listed above assume that your network's nodes are operating at 100 Mbps speed and full-duplex mode. We recommend that your nodes generally operate in this mode for DLR networks.
  - If other node conditions exist, such as a node operating at 10 Mbps full-duplex, or 10/100 Mbps half-duplex, the recovery times vary from the times listed above.

    If this is the case for your application, you need to change the beacon interval and beacon timeout. If you think you need to change these parameters, we recommend that you first call Rockwell Automation technical support.
  - The value assumes that the majority of the traffic on your network is EtherNet/IP traffic.

Notes:

History of Changes

Changes to the Manual

This manual has been revised multiple times to include updated information. This appendix briefly summarizes changes that have been made with previous revisions of this manual.

IMPORTANT This appendix does not list the changes that have been implemented with this revision of the publication.

For a list of changes made in this revision of the publication, see Summary of Changes on page 3.

Reference this appendix if you need information to determine what changes have been made across multiple revisions. This is especially useful if you are deciding to upgrade your hardware or software based on information added with previous revisions of this manual.

This table lists the publication revision, publication date, and changes made with the revision.

Publication Revision and Date	Topic
ENET-AP005E-EN-P, August 2013	• Introduction of Studio 5000 Environment • Listing of new products that use embedded switch technology • Listing of additional features that are common to products that use embedded switch technology • Description of how to use a ControlLogix Enhanced Redundancy System with a Device-level ring (DLR) topology • Description of Restart_Sign_On Service • Updated description of 1783 ETAP taps • Additional common DLR network topologies • Introduction of History of Changes appendix
ENET-AP005D-EN-P, August 2011	Provided the most accurate and common topologies currently available with a DLR application.
ENET-AP005C-EN-P, May 2010	
ENET-AP005B-EN-P, January 2010	• Introduction of new EtherNet/IP taps • Features common to products with embedded switch technology • Listing of the product firmware revisions that are compatible with the following software: – RSLogix 5000 software, version 17.01, AOPs – RSLinx Classic software • Additional information on how to monitor a DLR network • Using a 1783-ETAP1F tap in a standalone linear network • Using a 1783-ETAP2F tap in a standalone DLR network • Other non-DLR redundant media topologies • New delay values for linear networks • New network recovery values

Notes:

Numerics

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Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products. At http://www.rockwellautomation.com/support you can find technical and application notes, sample code, and links to software service packs. You can also visit our Support Center at https://rockwellautomation.custhelp.com/ for software updates, support chats and forums, technical information, FAQs, and to sign up for product notification updates.

In addition, we offer multiple support programs for installation, configuration, and troubleshooting. For more information, contact your local distributor or Rockwell Automation representative, or visit http://www.rockwellautomation.com/services/online-phone.

Installation Assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/rockwellautomation/support/overview.page, or contact your local Rockwell Automation representative.

New Product Satisfaction Return

Rockwell Automation tests all of its products to help ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

Documentation Feedback

Your comments will help us serve your documentation needs better. If you have any suggestions on how to improve this document, complete this form, publication RA-DU002, available at http://www.rockwellautomation.com/literature/.

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