Media Redundancy Protocol

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Media Redundancy Protocol

Media Redundancy Protocol (MRP), defined in International Electrotechnical Commission (IEC) standard 62439-2, provides fast convergence in a ring network topology for Industrial Automation networks. MRP Media Redundancy Manager (MRM) defines its maximum recovery times for a ring in the following range: 200 ms and 500 ms.

Note The default maximum recovery time on the Cisco IE switch is 200 ms for a ring composed of up to 50 nodes. You can configure the switch to use the 500 ms recovery time profile as described in Configure MRP Auto-Manager, on page 15. The 10 ms and 30 ms recovery time profiles are not supported.

MRP operates at the MAC layer and is commonly used in conjunction with the PROFINET standard for industrial networking in manufacturing.

MRP Mode

MRP is supported on the switches.

MRP CLI mode is managed by the Cisco IOS XE CLI and WebUI, a web-based user interface (UI).

Note When managing the switch in MRP CLI mode, you cannot download the MRP configuration from Siemens STEP7/TIA.

Protocol Operation

In an MRP ring, the MRM serves as the ring manager, while the Media Redundancy Clients (MRCs) act as member nodes of the ring. Each node (MRM or MRC) has a pair of ports to participate in the ring. The MRM initiates and controls the ring topology to react to network faults by sending control frames on one ring port over the ring and receiving them from the ring over its other ring port, and conversely in the other direction. An MRC reacts to received reconfiguration frames from the MRM and can detect and signal link changes on its ring ports.

On the switch, certain nodes or all nodes in the ring can also be configured to start as a Media Redundancy Automanager (MRA). MRAs select one MRM among each other by using a voting protocol and a configured priority value. The remaining MRAs transition to the MRC role.

All MRM and MRC ring ports support the following states:

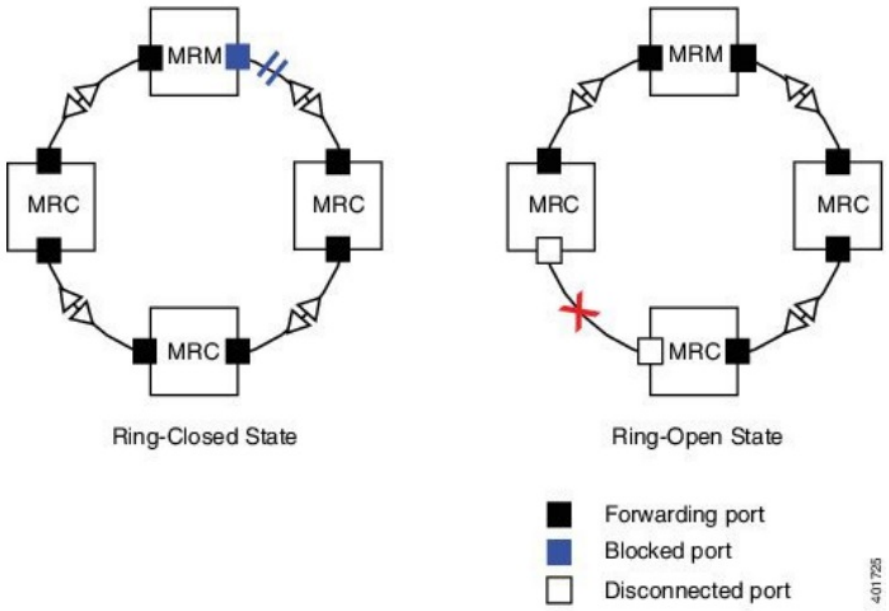
- Disabled: Ring ports drop all received frames.
- Blocked: Ring ports drop all received frames except MRP control frames and some standard frames, for example, LLDP.
- Forwarding: Ring ports forward all received frames.
- Not Connected: The link is physically down or disconnected. (This state differs from the Disabled state, in which the MRP Port is manually disabled through software.)

During normal operation, the network operates in the Ring-Closed state (see figure below). To prevent a loop, one of the MRM ring ports is blocked, while the other port is forwarding. Most of the time, both ring ports of all MRCs are in the forwarding state. With this loop avoidance, the physical ring topology becomes a logical stub topology.

In the figure, note the following details about the two rings, left and right:

- Left Ring: The connection (small blue square, top) on the MRM is in a blocked state (as shown by the two parallel lines) because no ports are disconnected.
- Right Ring: Two MRC connections (left and center small white squares) are in the disabled state because the link between them is broken, as marked by a red “x”.

Figure 1: MRP Ring States



If a network failure occurs:

- The network shifts into the Ring-Open state.
- In the case of failure of a link connecting two MRCs, both ring ports of the MRM change to the forwarding state, the MRCs adjacent to the failure have a disabled and a forwarding ring port, and the other MRCs have both ring ports forwarding.

In the Ring-Open state, the network logical topology becomes a stub.

Layer 2 Ethernet frames will be lost during the time required for the transition between these two ring states. The MRP protocol defines the procedures to automatically manage the switchover to minimize the switchover time. A recovery time profile, composed of various parameters, drives the MRP topology convergence performance. The 200 ms profile supports a maximum recovery time of 200 ms.

MRP uses three types of control frames:

- To monitor the ring status, MRM regularly sends test frames on both ring ports.
- When MRM detects failure or recovery, it sends TopoChange frames on both ring ports.
- When MRC detects failure or recovery on a local port, it sends LinkChange subtype frames, Linkdown and Linkup, to the MRM.

Media Redundancy Automanager

If configured to start as a Media Redundancy Automanager (MRA), the node or nodes select an MRM using a voting protocol and configured priority value. The remaining MRAs transition to the MRC role. All nodes must be configured as MRA. A manually configured MRM and MRA in the same ring is not supported.

Note

- You can activate MRA through the CLI. See the section Configuring MRP CLI Mode, on page 15 in this guide.
- Although MRAs transition to the MRC role after an MRM is selected, you cannot explicitly configure an MRC.

The MRA role is not an operational MRP role like MRM or MRC. It is only an administrative, temporary role at device startup, and a node must transition to the MRM role or the MRC role after startup and the MRM is selected though the manager voting process.

MRA functions as follows:

1. At power on, all MRAs begin the manager voting process. Each MRA begins to send MRP_Test frames on both ring ports. The MRP_Test frame contains the MRA's priority value. The remote manager's priority value contained in the received MRP_Test frames are compared with the MRA's own priority. If its own priority is higher than the received priority, the MRA sends a negative test manager acknowledgment (MRP_TestMgrNAck) frame, along with the remote manager's MAC address.
2. If the receiving MRA receives an MRP_TestMgrNAck with its own MAC address, the receiving MRA initiates the transition into the client (MRC) role.
3. The MRP_TestPropagate frame informs other MRA devices in the client role about the role change and the new higher priority manager. The clients receiving this frame update their higher priority manager information accordingly. This ensures that clients remain in the client role if the monitored higher priority manager role changes.

Licensing

You do not need a feature license to use MRP with Switches. MRP works with either base license—Network Essentials or Network Advantage.

To find information about platform support and to know which license levels a feature is available with, use Cisco Feature Navigator. To access Cisco Feature Navigator, go to https://www.cisco.com/go/cfn. An account on cisco.com is not required.

Multiple MRP Rings

In an Industrial Ethernet network, an MRP ring in a cell/area is a sub-ring of the access layer. You can connect multiple MRP rings, which you can then aggregate into the distribution layer.

You can configure up to 3 rings. The MRP switch can be configured only as an auto-manager.

MRP-STP Interoperability

MRP works with Spanning Tree Protocol (STP) to prevent unwanted broadcast loops in the event that a user accidentally connects a device that does not participate in the MRP ring. In a network operating with MRP

and STP, spanning tree bridge protocol data units (BPDUs) are not sent on MRP-enabled ports. If ports are unconfigured from an MRP ring, then the ports are added to the spanning tree.

MRP-STP interoperability is supported in MRP CLI mode, and functions without additional CLI configuration.

Prerequisites

- Because MRP is deployed in a physical Ring topology, before configuring or unconfiguring the MRP feature, it is advised to leave one physical connection between two nodes in each ring open by either issuing a **shut** command on the connecting interfaces or physically removing the cable to avoid any network storms. After you have properly configured all MRMs, issue a **no shut** command on the port or re-connect the cable between the nodes.

Guidelines and Limitations

General Guidelines and Limitations

- To avoid Smart License registration failure, ensure that the NTP configuration and the device clock are in sync.
- Support for multiple MRP rings is available only through the CLI or WebUI.
- The switch supports up to 50 MRCs per ring.
- MRP cannot run on the same interface (port) as Resilient Ethernet Protocol (REP), Device Level Ring (DLR), Spanning Tree Protocol (STP), Flex Links, macsec, or Dot1x.
- For access ports, you must specifically configure **switchport mode access** and **switchport access vlan** *x* commands in the MRP interface.
- MRP interfaces come up in a forwarding state and remain in a forwarding state until notified that it is safe to block. The MRP ring state changes to Ring-Closed.
- MRP ports cannot be configured as any of these port types: SPAN destination port, Private VLAN port, or Tunnel port.
- MRP is not supported on EtherChannels or on an individual port that belongs to an EtherChannel.
- Each MRP ring can have one MRP VLAN. The VLAN must be different for each ring in a device to avoid traffic flooding.

MRP CLI Mode Guidelines and Limitations

- After using the CLI to configure the MRP ring, you must attach the MRP ring to a pair of ports that support MRP.
- Both MRP ports must have the same interface mode (access or trunk).
- To change an existing MRP ring's configuration (mode), or to change the interface mode of the ring ports between access and trunk, you must first delete the ring and then recreate it with the new configuration.

- When both MRP ports are in access mode, the access VLANs should match. If the configured MRP VLAN does not match the ports' access VLAN, the MRP VLAN is automatically changed to the MRP ports' access VLAN.
- In an MRP ring with two access ports, if the ports do not belong to the same access VLAN when you create the MRP ring or you change the access VLAN for only one of the ports after the MRP ring is created, the MRP ring operation is suspended and a message similar to the following is displayed:

```
ERROR% The ring 1 ports don't belong to the same access VLAN. The MRP ring will not
function until the issue has been fixed
```

  Resolve the issue by configuring the access VLAN to be the same for the two ring ports.
- The 200 ms standard profile and 500 ms profile are supported. The 10 ms profile and 30 ms profile are not supported.
- You can activate MRA through the CLI.
- Although MRAs transition to the MRC role after an MRM is selected, you cannot explicitly configure an MRC.

Default Settings

- MRP is disabled by default; MRP CLI is the default mode when MRP is enabled.
- The default VLAN is 1.

Note Create the non-default VLAN before you assign it to MRP ring 1.

Guidelines and limitations to PROFINET MRP mode configuration

Before configuring the Cisco switch with PROFINET MRP through Siemens TIA or STEP7, ensure the following:

- PROFINET MRP feature doesn't support MRC role.
- Use the TIA portal to configure or modify MRA role.
- Avoid using CLI for configuration when TIA is in use. MRP CLI mode and PROFINET MRP mode are mutually exclusive.
- If the IE3500 switch is connected to the PROFINET PLC, the output of **show profinet status | include Connected** should display **Yes**. If it displays **No**, the switch is not connected to the PROFINET PLC.
- Ensure that the GSD file version matches the Cisco IOS release to avoid compatibility issues. For detailed configuration steps, refer to the PROFINET Protocol Configuration Guide.

Install the PROFINET GSD File

The PROFINET MRP GSD file is bundled with the Cisco IOS XE software release. After the switch boots at least one time, the GSD files for the switch are located in a directory called "ProfinetGSD". In this directory, there is a zip file containing all the GSDs for all the switch SKUs. Use the GSD file bundled with the release and included in the ProfinetGSD directory.

Note Remove the older GSD XML file from TIA 15 or STEP 7 to ensure compatibility with the Cisco IOS software.

Configure PROFINET MRP

This task guides you through configuring PROFINET MRP to ensure proper network operation and redundancy.

Before you begin

Disconnect an MRP Ethernet port from the ring (open ring) to discover all neighboring devices using the LLDP protocol. Perform this step before deploying PROFINET MRP to the network. This approach prevents unnecessary flooding if configuration issues occur.

- (Optional) Verify **Neighbor Discovery** with LLDP.

  Use the command **show lldp neighbor** to confirm all neighbor devices are correctly discovered before continuing with PROFINET MRP setup.

- Check that the PROFINET status indicates a **connected-state**.

- Inspect the MRP ring port status:

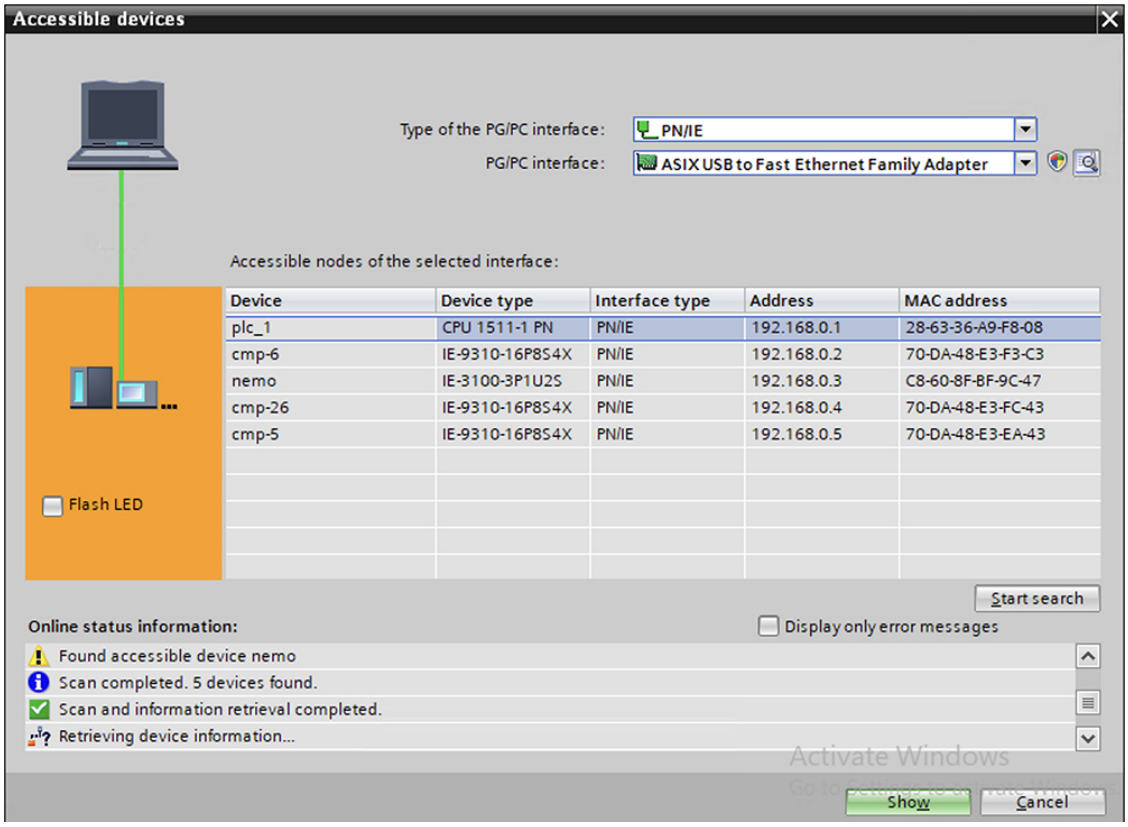
  Use the **profinet mrp ring 1** command.

Procedure

Step 1 Access the PROFINET Device Discovery (DCP) window.

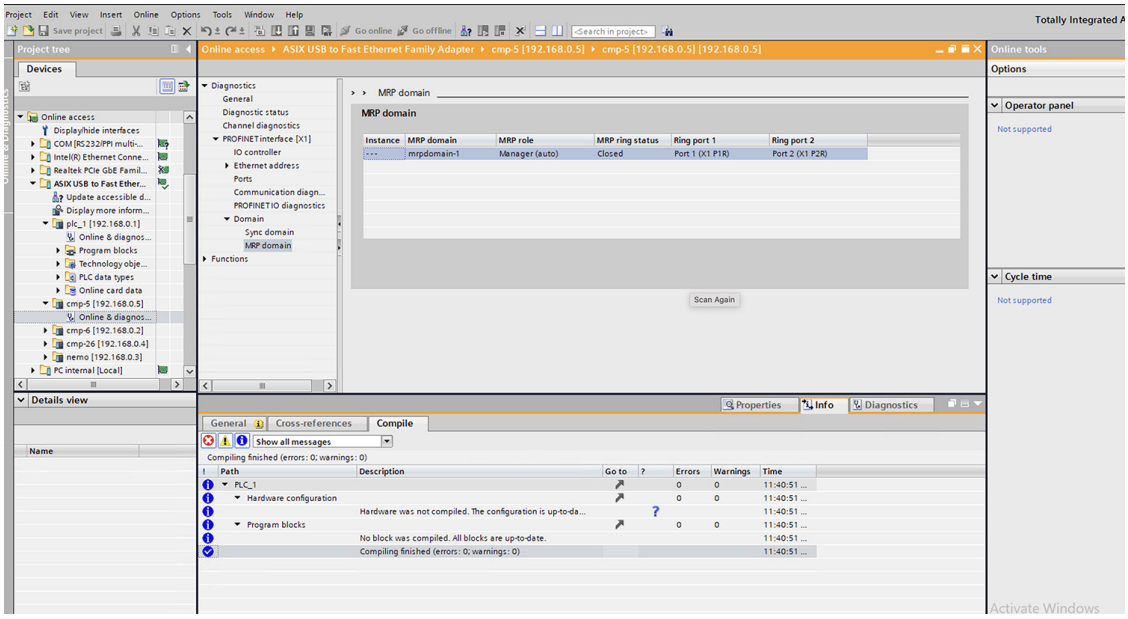
Open the PROFINET DCP window to identify and manage devices in the network.

Figure 2: PROFINET Device Discovery (DCP) window before configuring MRP



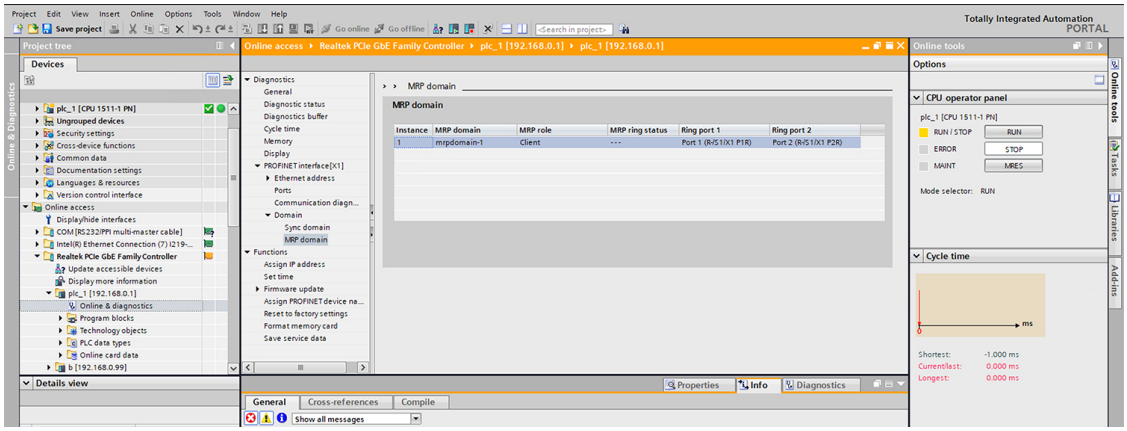
Step 2 Assign PROFINET MRP Manager role and domain name on MRM device.

Figure 3: PROFINET MRP Manager role and MRP domain name



Step 3 Define the PROFINET MRP client and MRP domain name on client devices.

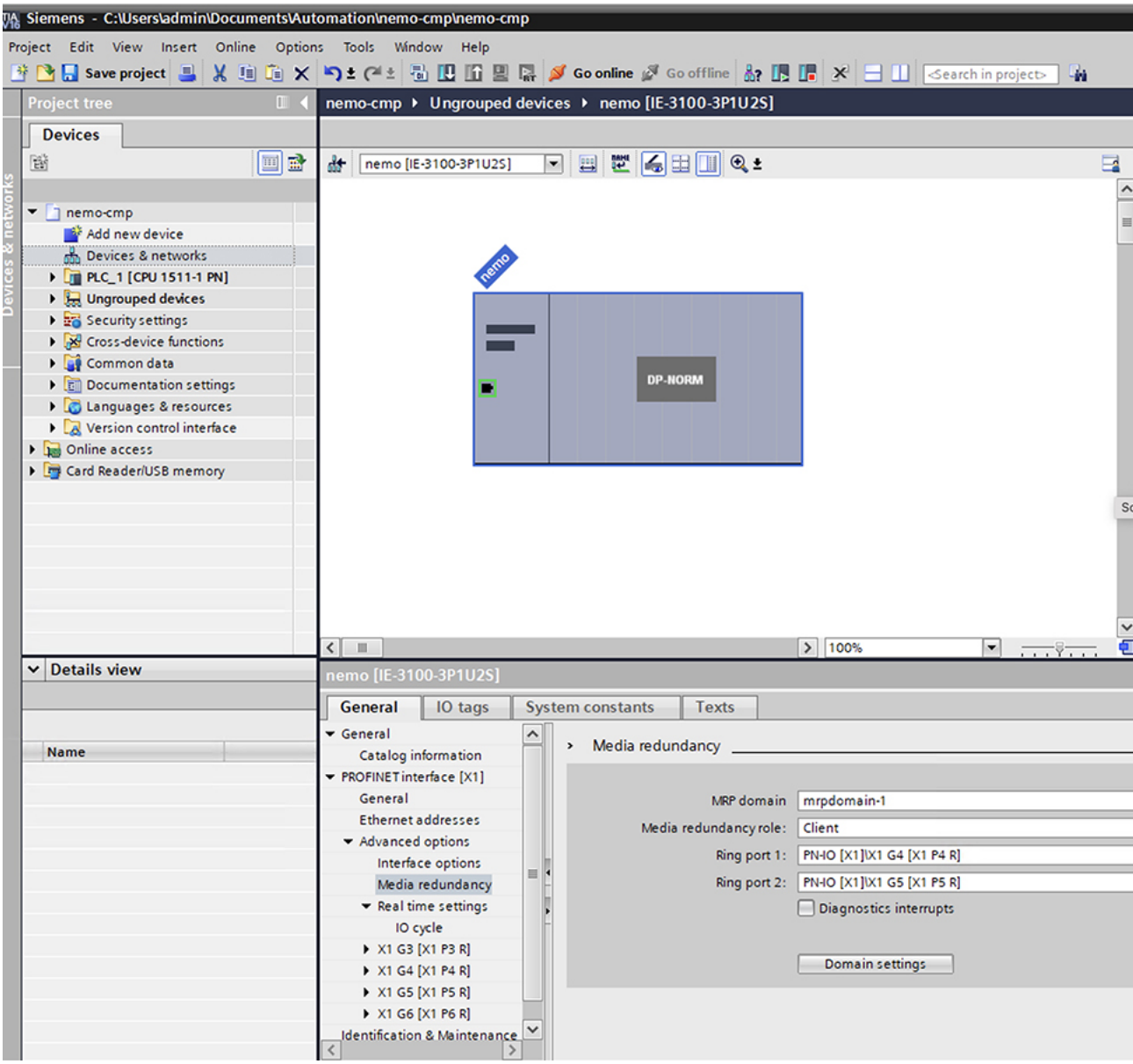
Figure 4: PROFINET MRP and MRP domain on client



Step 4 When using MRA mode, configure all devices and domain details.

Step 5 Configure the PROFINET MRP interfaces on all devices participating in the ring.

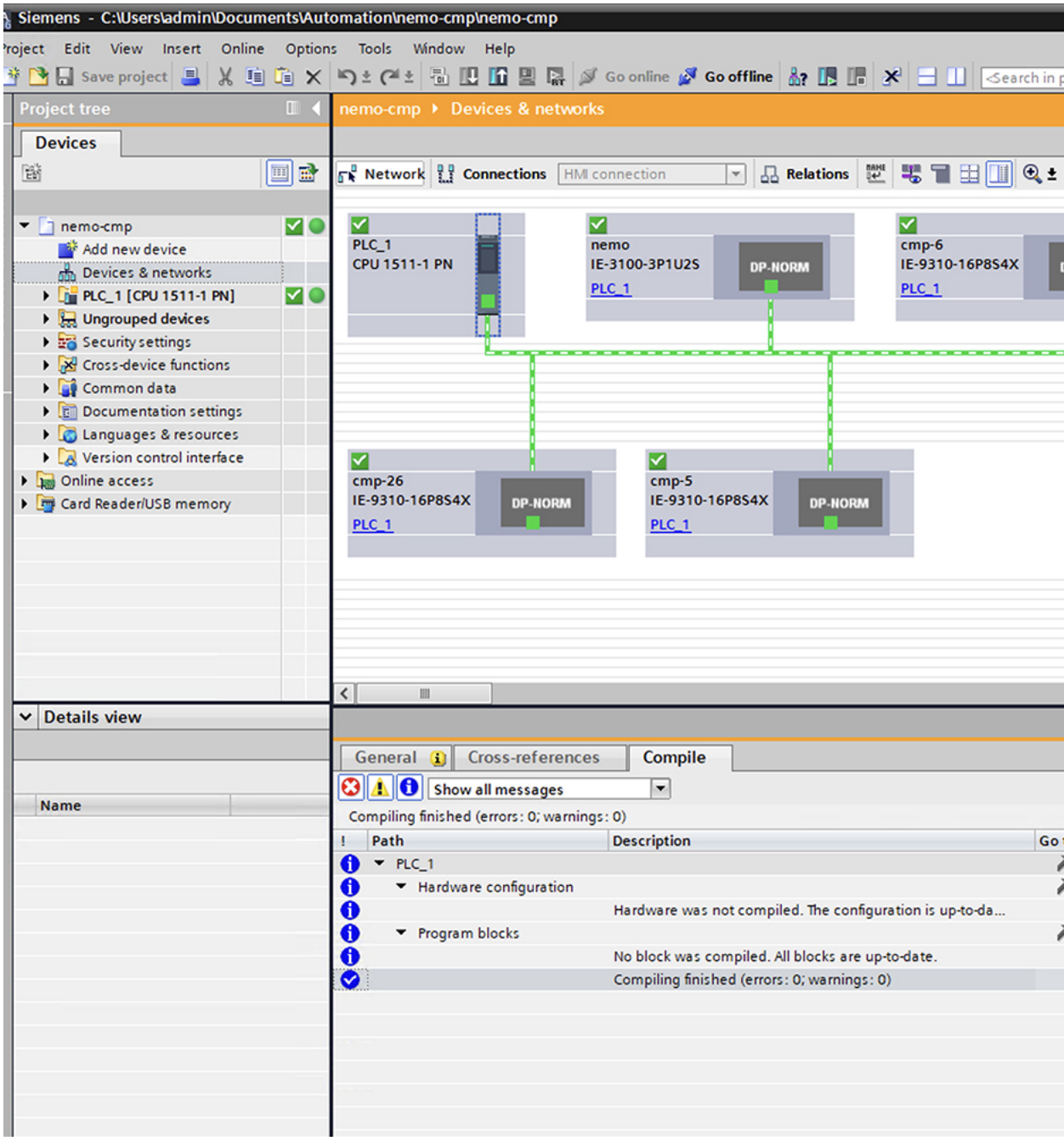
Figure 5: PROFINET MRP inerfaces



Step 6 Compile the configuration, and then download it to the PLC device.

Step 7 Verify that all devices are connected and the MRP ring is closed.

Figure 6: PROFINET MRP network configuration diagram



Step 8 Verify on the devices that the MRP ring is closed by using the **show profinet mrp ring 1** command:

Ensure that one port is in the **Blocked** state and the other port is in the **Forwarding** state.

Managing PROFINET Using Simatic Step 7 or TIA 15 Portal

This section provides an overview of key screens within the TIA portal. It does not provide any configuration details. For details on using the TIA portal, refer to the Siemens Simatic STEP7 user documentation.

Note MRP automanager in PROFINET mode is supported only in TIA V15.

Figure 7: PROFINET Device Discovery (DCP) Window Before Configuring MRP

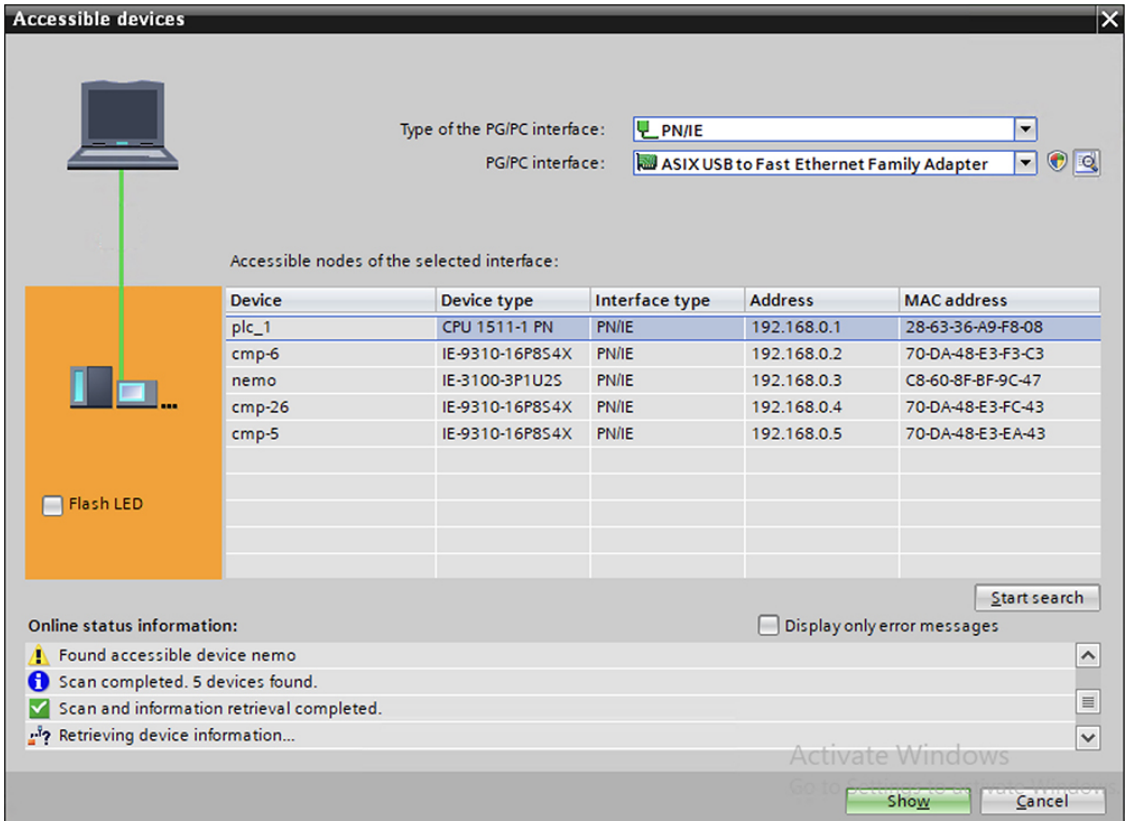


Figure 8: Define PROFINET MRP Manager and MRP domain

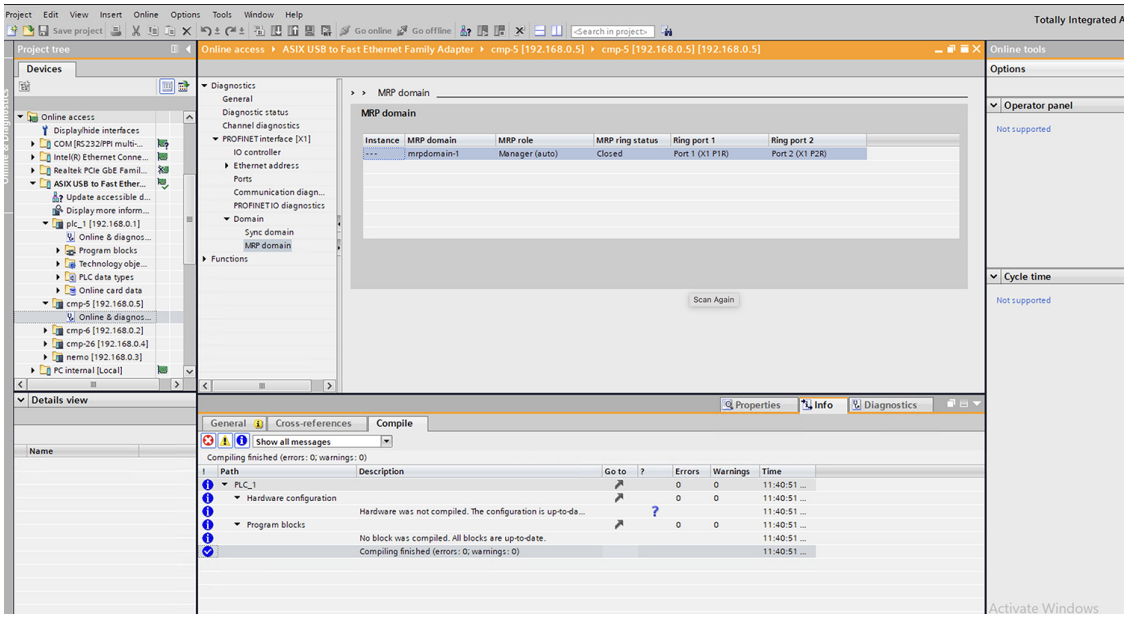


Figure 9: Define PROFINET MRP Client and MRP Domain

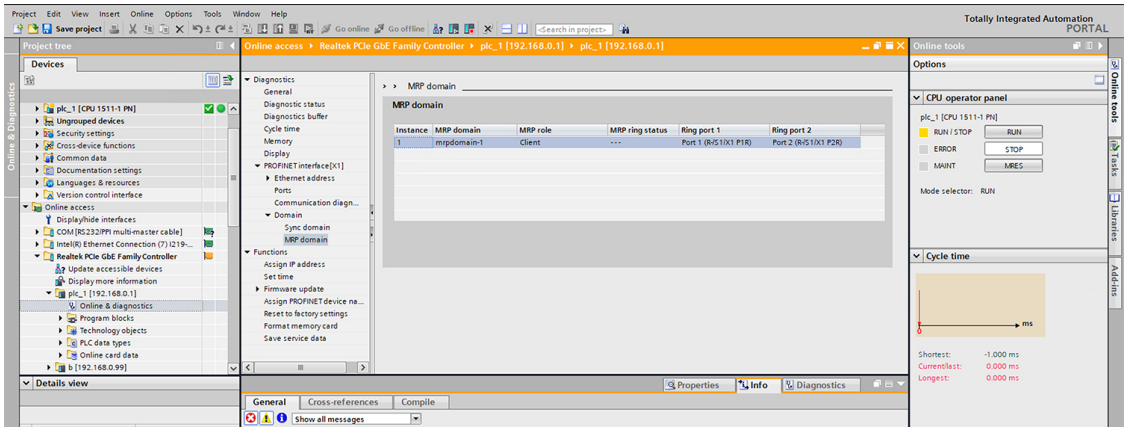


Figure 10: Define PROFINET MRP Interfaces

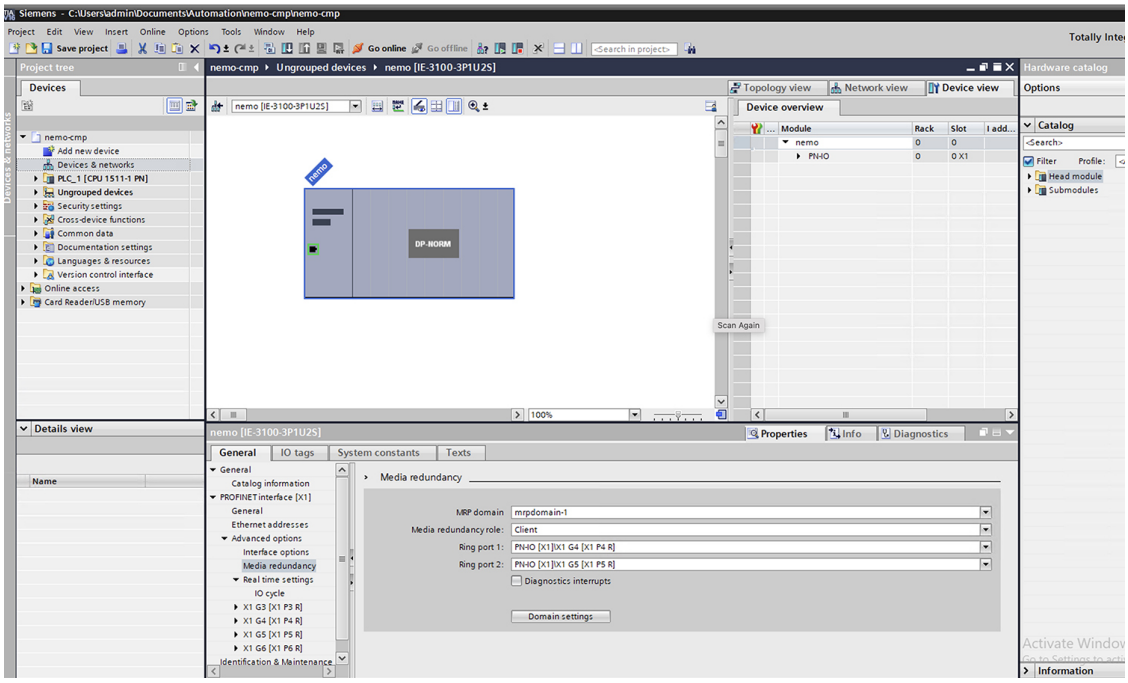
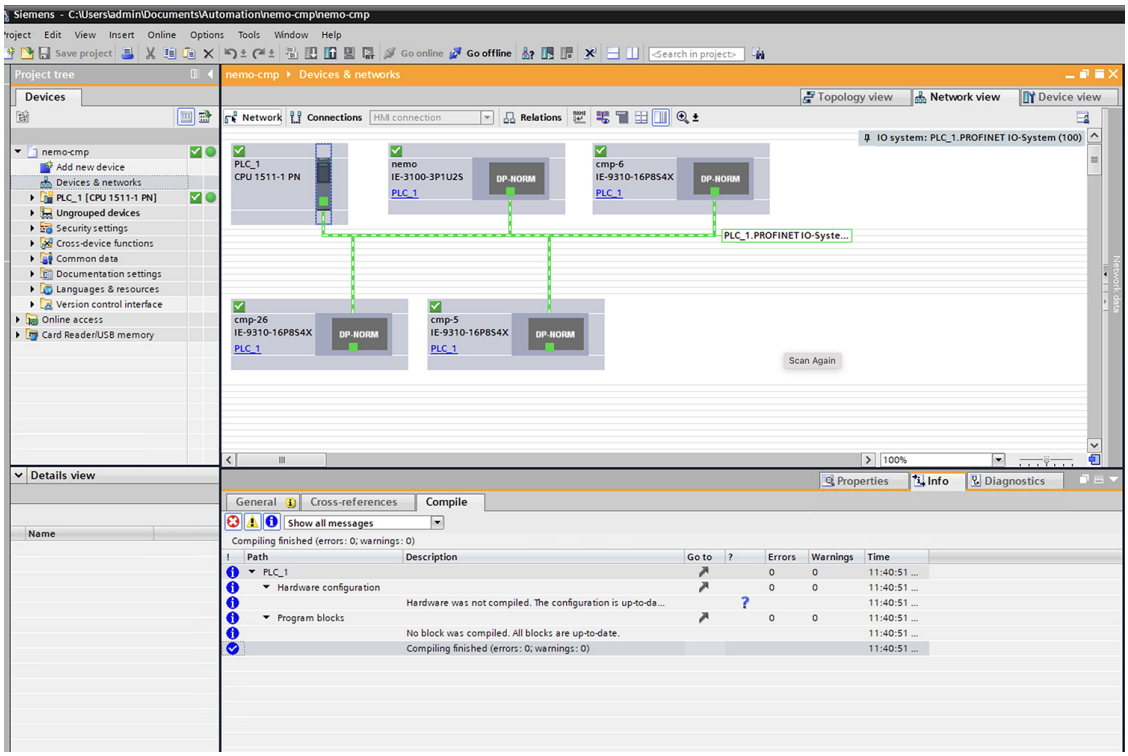


Figure 11: PROFINET MRP Network Configuration Diagram



Configuring MRP CLI Mode

To configure MRP, configure the node as MRA and specify the two MRP ports. You can configure up to 3 rings on the device (the device can be manager or client) with a manager instance for each ring and one manager per device.

The following MRP configuration parameters are optional:

- domain-id: A unique ID that represents the MRP ring.
- domain-name: Logical name of the configured MRP domain-ID.
- profile: 200 ms (the default)
- vlan-id: VLAN for sending MRP frames.

Configure MRP Auto-Manager

Follow this procedure to configure the switch as MRA in MRP CLI mode, which is the default.

Note If the device is connected to a PLC module, please make sure “no device in the ring” is selected for MRP.

Procedure

Step 1 Enable MRP:

mrp ring *mrp_id*

MRP supports up to 3 rings.

Step 2 Configure MRP auto-manager mode on the switch:

mode auto-manager

Step 3 (Optional for single MRP ring) Configure the domain ID:

domain-id *value*

value: UUID string of 32 hexadecimal digits in five groups separated by hyphens

Example: 550e8400-e29b-41d4-a716-446655440000

The default domain ID for ring 1 is FFFFFFFF-FFFF-FFFF-FFFF-FFFFFFFFFFFE.

Note
Only change the domain-ID from the default when required.

Step 4 (Optional for single MRP ring) Configure the domain name:

domain-name *name*

name: String of up to 32 characters

Step 5 (Optional) Configure the VLAN ID:

vlan-id *vlan*

Step 6 (Optional) Configure the recovery profile:

profile { |**200** | **500**}

- 200: Maximum recovery time 200 milliseconds
- 500; Maximum recovery time 500 milliseconds

Step 7 (Optional) Configure the MRA priority:

priority *value*

value: Range <36864 – 61440>, lowest: 65535.

The default priority is 40960.

Step 8 (Optional) Configure the interval:

interval *interval*

Note
The Interval field is not displayed in WebUI for MRP.

- 3: 3 milliseconds MRP_Test default interval for 30 ms profile
- 20: 20 milliseconds MRP_Test default interval for 200 ms profile
- 50: 50 milliseconds MRP_Test default interval for 500 ms profile
- <3-10>: Optional faster MRP_Test interval in milliseconds

Note
The optional faster MRP_Test interval can be configured only when the ring is formed with IE3x00 devices.

Step 9 Specify the ID of the port that serves as the first ring port:

interface *port*

Step 10 Configure the interface mode:

switchport mode { **access** | **trunk** }

Note
You must specify **switchport mode access** when configuring MRP in access mode.

Step 11 Associate the interface to the MRP ring:

mrp ring 1

Step 12 Return to global configuration mode:

exit

Step 13 Specify the ID of the port that serves as second ring port:

interface *port*

Step 14 Configure the interface mode:

switchport mode { **access** | **trunk** }

Note
You must specify **switchport mode access** at this step when configuring MRP in access mode.

Step 15 Associate the interface to the MRP ring:

mrp ring 1

Step 16 Return to privileged EXEC mode:

end

Step 17 (For multiple rings) Repeat step 1 through 14 for each additional ring:

- Assign ring number 2 for the second ring.
- Assign a unique domain ID for Ring 2. The default domain ID for ring 2 is FFFFFFFF-FFFF-FFFF-FFFF-FFFFFFFFFFFD.
- Assign ring number 3 for the third ring.
- Assign a unique domain ID for Ring 3. The default domain ID for ring 3 is FFFFFFFF-FFFF-FFFF-FFFF-FFFFFFFFFFFC.

Note
Each ring should have its own domain ID. No two rings share the same domain ID.

Example

The following example shows configuring MRP automanager:

```
Switch#configure terminal
Switch# no profinet mrp
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#mrp ring 1
Switch(config-mrp)#mode auto-manager
Switch(config-mrp-auto-manager)#domain-id FFFFFFFF-FFFF-FFFF-FFFF-FFFFFFFFFFFF
Switch(config-mrp-auto-manager)#priority 40960
Switch(config-mrp-auto-manager)#end
Switch#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#GigabitEthernet1/1
Switch(config-if)#switchport mode trunk
Switch(config-if)#mrp ring 1
WARNING% Enabling MRP automatically set STP FORWARDING. It is recommended to shutdown all
interfaces which are not currently in use to prevent potential bridging loops.
Switch(config-if)#exit
Switch(config)#GigabitEthernet1/1
Switch(config-if)#switchport mode trunk
Switch(config-if)#mrp ring 1
WARNING% Enabling MRP automatically set STP FORWARDING. It is recommended to shutdown all
interfaces which are not currently in use to prevent potential bridging loops.
Switch(config-if)#exit
Switch(config-if)#end
```

```
Switch# show mrp ring 1
MRP ring 1

Profile : 200 ms
Mode : Auto-Manager
Priority : 40960
Operational Mode: Client
From : CLI
License : Active
Best Manager :
MAC Address : 00:78:88:5E:03:81
Priority : 36864

Network Topology: Ring
Network Status : OPEN
Port1: Port2:
MAC Address :84:B8:02:ED:E8:02 MAC Address :84:B8:02:ED:E8:01
Interface :GigabitEthernet1/1 Interface :GigabitEthernet1/1
Status :Forwarding Status :Forwarding

VLAN ID : 1
Domain Name : Cisco MRP Ring 1
Domain ID : FFFFFFFF-FFFF-FFFF-FFFF-FFFFFFFFFFFF

Topology Change Request Interval : 10ms
Topology Change Repeat Count : 3
Short Test Frame Interval : 10ms
Default Test Frame Interval : 20ms
Test Monitoring Interval Count : 3
Test Monitoring Extended Interval Count : N/A
Switch#show mrp ports

Ring ID : 1
PortName                Status
--------------------------------------
GigabitEthernet1/1         Forwarding
GigabitEthernet1/1         Forwarding
```

Note The **show mrp ring** output shows "License: Not Applicable" in CLI and Profinet mode.

Configuration Example

The following example shows the MRP switch configured as automanager:

```
Switch#configure terminal
Switch# no profinet mrp
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#mrp ring 1
Switch(config-mrp)#mode auto-manager
Switch(config-mrp-auto-manager)#priority 36864
Switch(config-mrp-auto-manager)#end
Switch#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#interface gi1/1
Switch(config-if)#switchport mode trunk
```

```
Switch(config-if)#mrp ring 1
WARNING% Enabling MRP automatically set STP FORWARDING. It is recommended to shutdown all
interfaces which are not currently in use to prevent potential bridging loops.
Switch(config-if)#exit
Switch(config)#interface gi1/1
Switch(config-if)#switchport mode trunk
Switch(config-if)#mrp ring 1
WARNING% Enabling MRP automatically set STP FORWARDING. It is recommended to shutdown all
interfaces which are not currently in use to prevent potential bridging loops.
Switch(config-if)#end

Switch#show mrp ring
MRP ring 1

Profile     : 200 ms
Mode        : Auto-Manager
Priority    : 36864
Operational Mode: Manager
From        : CLI
License     : Active
Best Manager MAC Address    :84:B8:02:ED:E8:01     priority 36864

Network Topology: Ring
Network Status  : OPEN
Port1:                                    Port2:
 MAC Address    :84:B8:02:ED:E8:02          MAC Address    :84:B8:02:ED:E8:01
 Interface      :GigabitEthernet1/1      Interface      :GigabitEthernet1/1
 Status         :Forwarding                 Status         :Forwarding

VLAN ID     : 1
Domain Name : Cisco MRP Ring 1
Domain ID   : FFFFFFFF-FFFF-FFFF-FFFF-FFFFFFFFFFFF

Topology Change Request Interval        : 10ms
Topology Change Repeat Count            : 3
Short Test Frame Interval               : 10ms
Default Test Frame Interval             : 20ms
Test Monitoring Interval Count          : 3
Test Monitoring Extended Interval Count : N/A


Topology Change Request Interval        : 10ms
Topology Change Repeat Count            : 3
Short Test Frame Interval               : 10ms
Default Test Frame Interval             : 20ms
Test Monitoring Interval Count          : 3
Test Monitoring Extended Interval Count : N/A
```

Verifying the Configuration

You can use the following commands to verify the MRP configuration.

Command	Description
show mrp ring? {**1 - 22**}	Display details about the MRP ring configuration.
show mrp ports	Display details about the MRP port states. If MRP is not configured on any ports, display shows N/A.

Command	Description
show mrp ring {**1 - 22**} **statistics** [**all** | **event** | **hardware** | **packet** | **platform**]	Display details about the MRP ring operation.
debug mrp-ring [**alarm**|**cli** | **client** | **license** | **manager** | **packet** | **platform**]	Trace MRP events. **Note** **manager** is available only when the switch is configured as manager or automanager.
show tech-supportmrp	Display all MRP details.