CHAPTER 30

Configuring IEEE 802.17b Resilient Packet Ring on the ML-MR-10 Card

This chapter describes the IEEE 802.17b-based resilient packet ring (RPR-IEEE) and how to configure it on the ML-MR-10 card.

This chapter contains the following major sections:

- Understanding RPR-IEEE, page 30-1
- Configuring RPR-IEEE Characteristics, page 30-6
- Configuring RPR-IEEE Protection, page 30-8
- Configuring QoS on RPR-IEEE, page 30-14
- Verifying and Monitoring RPR-IEEE, page 30-16
- Monitoring RPR-IEEE in CTC, page 30-24

Understanding RPR-IEEE

RPR, as described in IEEE 802.17, is a metropolitan area network (MAN) technology supporting data transfer among stations interconnected in a dual-ring configuration. The IEEE 802.17b spatially aware sublayer amendment is not yet ratified but is expected to add support for bridging to IEEE 802.17. Since the amendment is not yet ratified, no equipment is currently IEEE 802.17b compliant. The ML-MR-10 card's RPR-IEEE is based on the expected IEEE 802.17b based standard.

The ML-MR-10 card supports RPR-IEEE. RPR-IEEE is well suited for transporting Ethernet over a SONET/SDH ring topology and enables multiple ML-MR-10 cards to become one functional network segment. When used in this role, RPR-IEEE overcomes the limitations of earlier schemes, such as IEEE 802.1D Spanning Tree Protocol (STP), IEEE 802.1W Rapid Spanning Tree Protocol (RSTP), and SONET/SDH.

Note Throughout this book, Cisco proprietary RPR is referred to as Cisco proprietary RPR, and IEEE 802.17b-based RPR is referred to as RPR-IEEE. This chapter covers RPR-IEEE. Chapter 26, "Configuring Cisco Proprietary Resilient Packet Ring" covers Cisco proprietary RPR.

RPR-IEEE Features on the ML-MR-10 Card

See Chapter 3, "ML-Series Card Overview" for a list of the ML-MR-10 card supported features based on the expected IEEE 802.17b.

Note On the ML-MR RPR-IEEE interface, only GFP-F Framing is supported and GFP-FCS will not be transmitted.

Advantages of RPR-IEEE

The ML-MR-10 card supports RPR-IEEE in addition to Cisco proprietary RPR. Some of the advantages of RPR-IEEE include:

- Steering. Ring protection is accomplished through steering instead of wrapping. Steering is a more efficient way of routing around a failure.
- Dual-transit queues. Dual-transit queues offer more control in handling transit traffic.
- Best-effort traffic classifications. "Best Effort" and "EIR" traffic classifications improve distribution of traffic across a best-effort service class.
- Interoperability. Conformance to the expected IEEE 802.17b standard increases interoperability with third-party vendors.
- Built-in service provider support. RPR-IEEE provides built-in operations, administration, and maintenance (OAM) support for service provider environments.
- Fairness. Fairness allows all the stations on the ring to fairly share the RPR-IEEE's best-effort bandwidth.

Role of SONET/SDH Circuits

The ML-MR-10 card in an RPR-IEEE must connect directly or indirectly through point-to-point synchronous transport signal/synchronous transport module (STS/STM) circuits. The point-to-point STS/STM circuits are configured on the ONS node through Cisco Transport Controller (CTC) or Transaction Language One (TL1) and are transported over the ONS node's SONET/SDH topology on either protected or unprotected circuits.

On circuits unprotected by the SONET/SDH mechanism, RPR-IEEE provides resiliency without using the capacity of the redundant protection path that a SONET/SDH protected circuit would require. This frees this capacity for additional traffic. RPR-IEEE also utilizes the bandwidth of the entire ring and does not block segments like STP or RSTP.

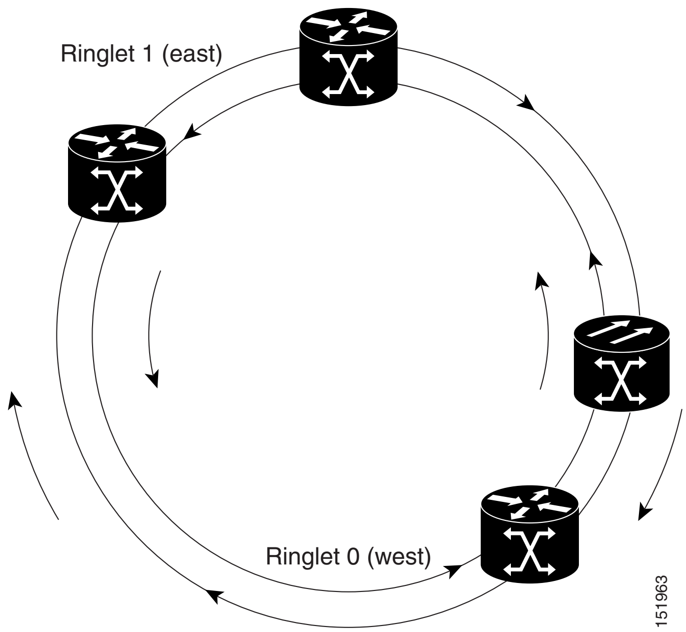
Note A minimum of two members are required to create SW-LCAS based circuit.

Table 30-1 VCAT, SW-LCAS, and HW-LCAS Circuit Sizes Supported by the ML-MR-10 Card

SONET VCAT Circuit Sizes	SDH VCAT Circuit Sizes
STS-1-*n*v (1 <= *n* <= 95)	VC3-*n*v (1 <= *n* <= 95)
STS-3c-*n*v (1 <= *n* <= 31)	VC4-*n*v (1 <=*n* <= 31)

An RPR-IEEE is made up of dual counter-rotating rings (ringlets), one for clockwise or west data traffic and one for counter-clockwise or east data traffic. The ringlets are identified as Ringlet 0 and Ringlet 1 in Figure 30-1. The west ringlet traffic is transmitted out the west interface and received by the east interface. The east ringlet traffic is transmitted out the east interface and received by the west interface. Only east-to-west or west-to-east transmission schemes are allowed.

Figure 30-1 Dual-Ring Structure



RPR-IEEE Framing Process

The RPR frames are encapsulated in a GFP frame and transmitted over SONET on the ML-MR-10 card. There are two types of RPR frames, basic and extended. With POS, the RPR-IEEE frame is encapsulated into the SONET/SDH payload for transport over the SONET/SDH topology. For more information about POS, see Chapter 9, "POS on ONS Ethernet Cards.".

Figure 30-2 illustrates the IEEE 802.17 basic data frame for IP only networks and the expected IEEE 802.17b extended data frame used with bridging. The extended data frame adds an extended destination address and extended source address to the basic data frame.

Figure 30-2 RPR-IEEE Data Frames

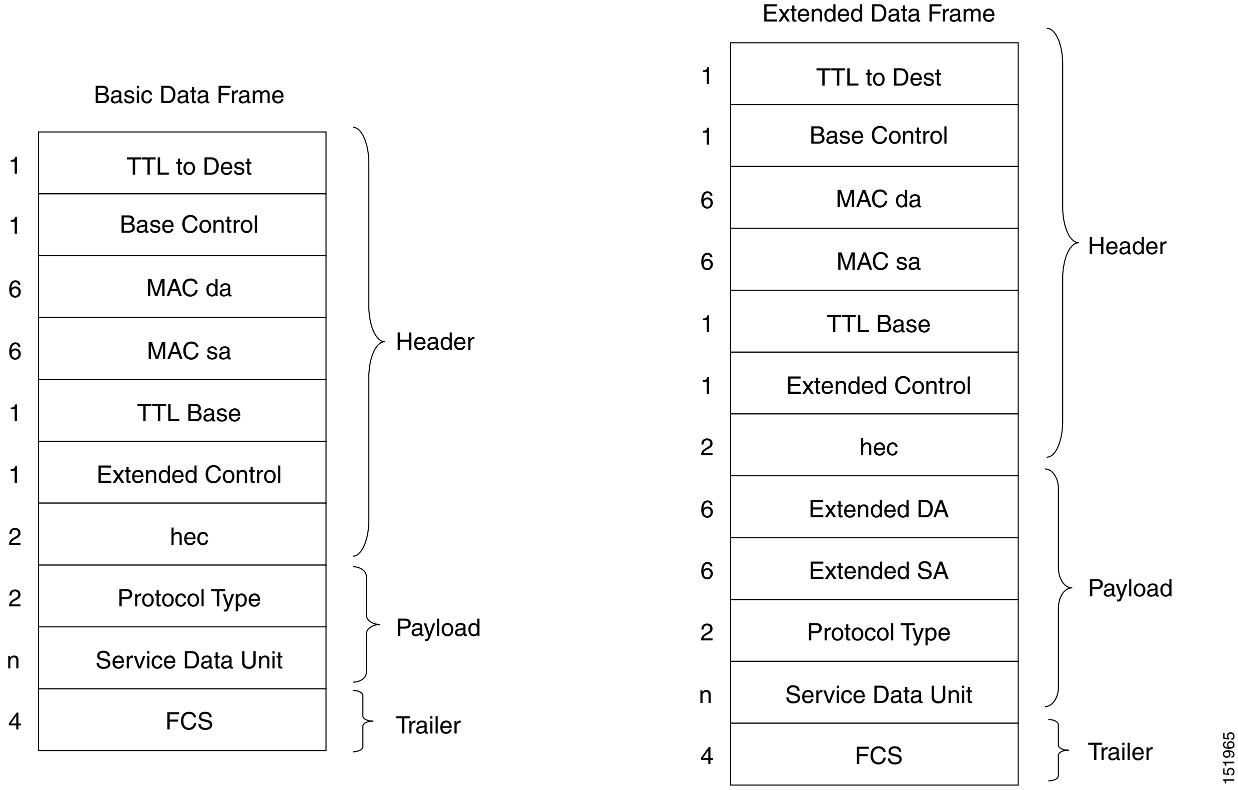


Table 30-2 defines the most important fields in the RPR-IEEE data frame.

Table 30-2 Definitions of RPR-IEEE Frame Fields

Field	Definition
MAC Destination Address (MAC da)	A forty-eight-bit field specifying the destination as a multicast MAC address or the MAC address of a specific ML-MR-10 card in the RPR-IEEE.
MAC Source Address (MAC sa)	A fourth-eight-bit field specifying the MAC address of a specific ML-MR-10 card in the RPR-IEEE as the source.
Base Control	A field that includes the ring indicator bit, the fairness eligible (FE) bit, the frame type (FT) bit, and the service class (SC) bit.
TTL Base	A field that contains the time to live (TTL) setting. The sending station sets the TTL, which remains unchanged for the life of the packet.
Extended Control	A field that contains the flood indicator (FI) bit and the strict order (SO) bit.
Extended DA	A forty-eight-bit field specifying the MAC address of the ultimate destination.
Extended SA	A forty-eight-bit field specifying the MAC address of the ultimate source.

Figure 30-3 illustrates the RPR-IEEE topology and protection control frame. Topology and protection (TP) frames are usually sent to the broadcast address.

Figure 30-3 Topology and Protection Control Frame Formats

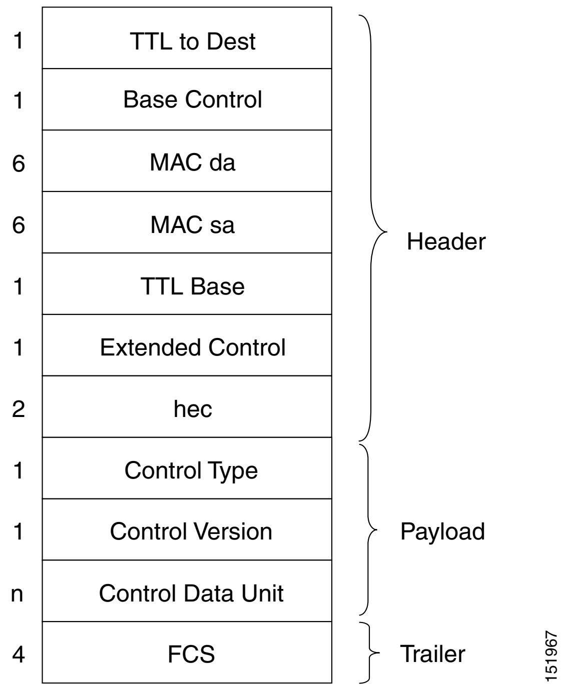
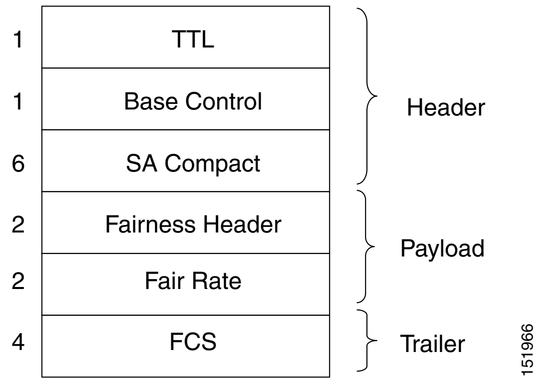


Figure 30-4 illustrates the RPR-IEEE fairness frame. Fairness frames are sent either to all stations or only the nearest neighbor depending on whether it is a single-choke fairness frame (SCFF) or multi-choke fairness frame (MCFF). Fairness frames are included in the total bandwidth of the QoS A0 service class. This eliminates the need for a destination address (DA). The MCFF type also includes an additional frequency division duplexing (FDD) frame to help smooth the fairness variation. The field SA Compact is the address of the station providing the fair rate.

Note The ML-MR-10 card do not generate multi-choke fairness frames but support multi-choke fairness frames generated from other stations on the RPR-IEEE.

Figure 30-4 Fairness Frame Format



For comparison of RPR-IEEE frames and Cisco proprietary RPR frames, see the "Cisco Proprietary RPR Framing Process" section on page 26-5 for Cisco proprietary RPR framing information.

CTM and RPR-IEEE

Cisco Transport Manager (CTM) is an element management system (EMS) designed to integrate into an overall network management system (NMS) and interface with other higher level management tools. CTM supports RPR-IEEE provisioning on ML-MR-10 cards. For more information, refer to the *Cisco Transport Manager User Guide* at:

http://www.cisco.com/en/US/products/sw/opticsw/ps2204/products_user_guide_list.html

Configuring RPR-IEEE Characteristics

Configuration tasks for RPR-IEEE characteristics are presented in the following sections:

- General characteristics:
  - Configuring the Attribute Discovery Timer, page 30-7
  - Configuring the Reporting of SONET Alarms, page 30-7
  - Configuring BER Threshold Values, page 30-7
- Protection characteristics:
  - Configuring the Hold-off Timer, page 30-8
  - Configuring Jumbo Frames, page 30-9
  - Configuring Forced or Manual Switching, page 30-10
  - Configuring Protection Timers, page 30-11
  - Configuring the Wait-to-Restore Timer, page 30-12
  - Configuring a Span Shutdown, page 30-13
  - Configuring Keepalive Events, page 30-13
  - Configuring Triggers for CRC Errors, page 30-14

- QoS characteristics:
  - Configuring Traffic Rates for Transmission, page 30-15
  - Configuring Fairness Weights, page 30-15
  - Verifying and Monitoring RPR-IEEE, page 30-16

Configuring the Attribute Discovery Timer

Because station attributes are communicated separately from topology and protection packets, there is a separate timer to control the frequency at which these packets are sent. Attribute propagation is therefore determined by the attribute discovery (ATD) timer. The default rate is one packet per second for each ringlet.

Note Configure both ringlets with the same value.

To enable and configure the ATD, perform the following procedure, beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)#` **`interface rpr-ieee 0`**	Activates interface configuration mode to configure the RPR-IEEE interface.
Step 2	`Router(config-if)#` **`rpr-ieee atd-timer`** *`seconds`*	Specifies the time, in seconds, within which one station attributes packet is sent for each ringlet. The default is one packet for each ringlet per second.
Step 3	`Router(config)#` **`no shut`**	Enables the RPR-IEEE interface and changes the mode from the default passthrough.
Step 4	`Router(config)#` **`end`**	Returns to privileged EXEC mode.
Step 5	`Router#` **`copy running-config startup-config`**	(Optional) Saves configuration changes to the TCC2/TCC2P flash database.

Configuring the Reporting of SONET Alarms

The ML-MR-10 card reports SONET/SDH alarms through the CTC alarm panel in the same manner as other ONS cards. The ML-MR-10 card can also report SONET/SDH alarms through the Cisco IOS command-line interface (CLI). Configuring CTC reporting does not affect Cisco IOS CLI reporting or vice versa. See Chapter 33, "Configuring Ethernet Virtual Circuits and QoS on the ML-MR-10 Card," for more details about configuring the reporting of SONET Alarms.

Configuring BER Threshold Values

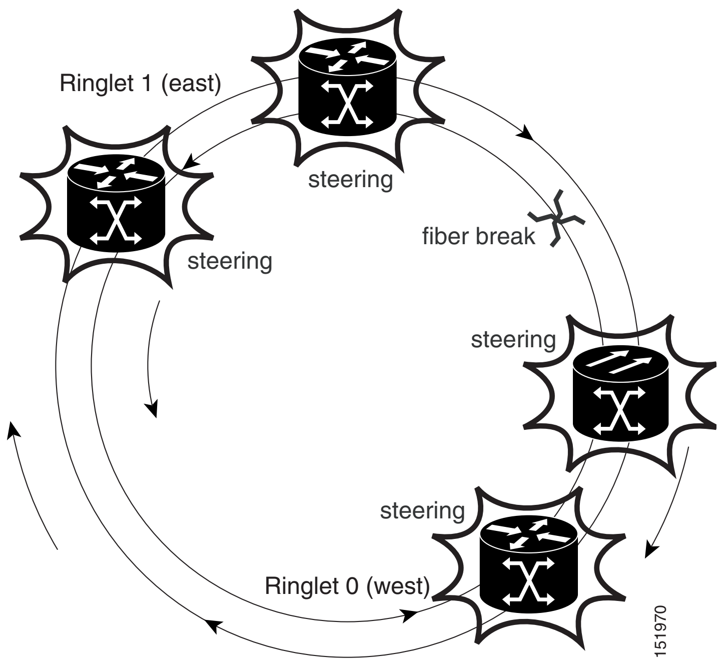
To configure bit error rate (BER) threshold values for various alarms on an RPR-IEEE interface, refer to the "DLP-A533 Create Ethernet RMON Alarm Thresholds" task in the *Cisco ONS 15454 Procedure Guide* or to the "DLP-D441 Create Ethernet RMON Alarm Thresholds" task in the *Cisco ONS 15454 SDH Procedure Guide*.

Configuring RPR-IEEE Protection

RPR-IEEE has three protection states:

- Closed—This is the normal steady state. Data traffic is traveling around the RPR-IEEE on both Ringlet 0 and Ringlet 1. Figure 30-1 on page 30-3 illustrates this state.
- Open—This is the state after a protection event. A protection event, such as a fiber cut or node failure, triggers a change in the ring topology. Each node responds to the new topology by steering. Steering forwards data traffic so that it avoids the failure. Based on the type of failure, it will avoid either a specific span or a node and its two adjoining spans. Figure 30-5 illustrates this state.
- Passthrough—This is the initial state of the RPR-IEEE node. It does not participate in the topology and blindly forwards frames.

Figure 30-5 Each RPR-IEEE Node Responding to a Protection Event by Steering



You can modify many of the RPR-IEEE protection characteristics with the procedures in the following sections.

Configuring the Hold-off Timer

You can delay the protection response to a failure event, such as a signal failure or signal degradation, with the hold-off timer. Setting a longer timer can help avoid link errors that last long enough for detection, but do not last long enough to warrant the costs of protecting the span. This delay can result in higher traffic loss, however. The default value for this timer is 0 milliseconds.

To enable and configure the hold-off timer, perform the following procedure, beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)#` **`interface rpr-ieee 0`**	Activates interface configuration mode to configure the RPR-IEEE interface.
Step 2	`Router(config-if)#` **`rpr-ieee protection sonet holdoff-timer`** *`time`* `[`**`east`** `|` **`west`**`]`	Specifies the delay before a protection response is sent. Values range from 0 to 20, in units of 10 milliseconds. The default is 0. (Optional) You can also specify the east or west ringlet. **Caution** The number of milliseconds for the keepalive timer must be higher than the number of milliseconds for the holdoff timer. **Caution** When using SW-LCAS on the RPR-IEEE, the addition or deletion of a SW-LCAS member circuit causes a traffic hit with a maximum of 50 ms. The holdoff timer requires a value greater than 5 (50 ms) or the SW-LCAS addition or deletion triggers a protection response.
Step 3	`Router(config)#` **`no shut`**	Enables the RPR-IEEE interface and changes the mode from the default passthrough.
Step 4	`Router(config)#` **`end`**	Returns to privileged EXEC mode.
Step 5	`Router#` **`copy running-config startup-config`**	(Optional) Saves configuration changes to the TCC2/TCC2P flash database.

Configuring Jumbo Frames

You can configure the interface to support jumbo frames. The **jumbo** setting specifies that the station support a maximum transfer unit (MTU) of up to 9100 bytes.

Caution For jumbo frame support, you must configure all the stations on the ring to support jumbo frames.

To enable and configure Jumbo frames, perform the following procedure, beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)#` **`interface rpr-ieee 0`**	Activates interface configuration mode to configure the RPR-IEEE interface.
Step 2	`Router(config-if)#` **`rpr-ieee protection pref jumbo`**	Enables jumbo frame capability on the RPR-IEEE interface: **jumbo**—Enables handling of frames in excess of the standard size, up to a maximum size of 9100 bytes. A jumbo-enabled station changes the interface MTU to 9100 bytes if all stations in the ring are jumbo enabled. A message is generated to indicate that the ring supports jumbo frames when all stations are configured for this preference. The default is to not support jumbo frames.
Step 3	`Router(config)#` **`no shut`**	Enables the RPR-IEEE interface and changes the mode from the default passthrough.
Step 4	`Router(config)#` **`end`**	Returns to privileged EXEC mode.
Step 5	`Router#` **`copy running-config startup-config`**	(Optional) Saves configuration changes to the TCC2/TCC2P flash database.

Configuring Forced or Manual Switching

You can request certain protection states to take effect manually on either span of the interface to avoid link usage or in anticipation of failures.

To enable and configure forced or manual switching, perform the following procedure, beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)#` **`interface rpr-ieee 0`**	Activates interface configuration mode to configure the RPR-IEEE interface.
Step 2	`Router(config-if)#` **`rpr-ieee protection request`** `{`**`forced-switch`** `|` **`manual-switch`**`}` `{`**`east`** `|` **`west`**`}`	Specifies that a switch take place on the interface: **forced-switch**—Precedes all other failure events on a ring for the span on which it is configured. The operation protects the span indicated by the command. In the case of steering, forwarding uses only the topology list for the opposite span. A forced switch is saved in the configuration. **manual-switch**—Behaves similarly to a forced switch, in that it coerces a reaction from the protection system. The difference is that this configuration can be usurped by higher-level requests detected on the configured or the opposite span. A manual switch is not saved in the configuration. Configuring a manual switch on a span that has a forced switch configured will clear the forced switch. **Note** When a manual switch is configured, it will neither display in the running configuration nor save to the startup configuration. You must specify whether the switch is to take place on the east or west ringlet.
Step 3	`Router(config)#` **`no shut`**	Enables the RPR-IEEE interface and changes the mode from the default passthrough.
Step 4	`Router(config)#` **`end`**	Returns to privileged EXEC mode.
Step 5	`Router#` **`copy running-config startup-config`**	(Optional) Saves configuration changes to the TCC2/TCC2P flash database.

Configuring Protection Timers

Protection messages are sent based on the intervals of two timers. These timers apply under different circumstances:

- Fast timer—Immediately after a protection event occurs, a fast protection timer is used. This timer is configured between 1 and 20 milliseconds to cause a rapid acknowledgement of the protected state on the ring. A finite number of packets are sent at this frequency after the event. The default for this timer is 10 milliseconds.
- Slow timer—Between protection events, the slow timer communicates the current protection state of the ring. This timer is configured from 1 to 10 in units of 100 milliseconds. The default is 10, which represents 100 milliseconds.

The protection timers are configured the same on both spans of an interface.

To enable and configure the protection timers, perform the following procedure, beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)#` **`interface rpr-ieee 0`**	Activates interface configuration mode to configure the RPR-IEEE interface.
Step 2	`Router(config-if)#` **`rpr-ieee protection timer`** {**`fast`** *`time`* | **`slow`** *`time`*}	Specifies the value of the fast or slow protection timer: **fast**—Ranges from 1 to 20 milliseconds. The default is 10. **slow**—Ranges from 1 to 10 in units of 100 milliseconds. The default is 1 (100 milliseconds).
Step 3	`Router(config)#` **`no shut`**	Enables the RPR-IEEE interface and changes the mode from the default passthrough.
Step 4	`Router(config)#` **`end`**	Returns to privileged EXEC mode.
Step 5	`Router#` **`copy running-config startup-config`**	(Optional) Saves configuration changes to the TCC2/TCC2P flash database.

Configuring the Wait-to-Restore Timer

When the failure is fixed, a wait-to-restore timer defines how long before the span reverts to its original state. This timer protects against false negatives in the detection of the failure status, which can avoid protection-flapping through the use of larger values. Smaller values result in faster recovery times, however. This timer can be configured between 0 and 1440 seconds, or configured to not recover automatically. The default for the timer is 10 seconds.

To enable and configure the wait-to-restore timer, perform the following procedure, beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)#` **`interface rpr-ieee 0`**	Activates interface configuration mode to configure the RPR-IEEE interface.
Step 2	`Router(config-if)#` **`rpr-ieee protection wtr-timer`** {*`time`* | **`never`**}	Specifies the value of the wait-to-restore timer: *time*—Ranges from 0 to 1440 seconds. The default is 10. **never**—Specifies that protection is never restored (no revert mode).
Step 3	`Router(config)#` **`no shut`**	Enables the RPR-IEEE interface and changes the mode from the default passthrough.
Step 4	`Router(config)#` **`end`**	Returns to privileged EXEC mode.
Step 5	`Router#` **`copy running-config startup-config`**	(Optional) Saves configuration changes to the TCC2/TCC2P flash database.

Configuring a Span Shutdown

The **rpr-ieee shutdown** command performs the same task as the **rpr-ieee protection request forced-switch** command.

To cause a forced switch on the span of the interface, perform the following procedure, beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)#` **`interface rpr-ieee 0`**	Activates interface configuration mode to configure the RPR-IEEE interface.
Step 2	`Router(config-if)#` **`rpr-ieee shutdown`** `{`**`east`** `|` **`west`**`}`	Causes a forced switch on a specified span of the interface.
Step 3	`Router(config)#` **`end`**	Returns to privileged EXEC mode.
Step 4	`Router#` **`copy running-config startup-config`**	(Optional) Saves configuration changes to the TCC2/TCC2P flash database.

Configuring Keepalive Events

A station receives fairness messages from a link to determine its status. When the number of milliseconds that pass without receiving a fairness message from the neighboring stations exceeds a specified timer, a keepalive event is triggered. The keepalive event generates a protection event.

The timer can have a different value on each span and must be greater than or equal to the hold-off timer. This feature is independent of the fairness algorithm itself, but is still a function performed by the fairness machine.

To enable and configure the keepalives, perform the following procedure, beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)#` **`interface rpr-ieee 0`**	Activates interface configuration mode to configure the RPR-IEEE interface.
Step 2	`Router(config-if)#` **`rpr-ieee keepalive-timer`** *`milliseconds`* `[`**`east`** `|` **`west`**`]`	Specifies the amount of time that can pass before a keepalive event is triggered after not receiving a fairness message from a neighboring station. Values range from 2 to 200 milliseconds. The default is 3 milliseconds. (Optional) You can also specify the east or west ringlet. **Caution** The number of milliseconds for the keepalive timer must be higher than the number of milliseconds for the holdoff timer.
Step 3	`Router(config)#` **`no shut`**	Enables the RPR-IEEE interface and changes the mode from the default passthrough.

	Command	Purpose
Step 4	`Router(config)#` **`end`**	Returns to privileged EXEC mode.
Step 5	`Router#` **`copy running-config startup-config`**	(Optional) Saves configuration changes to the TCC2/TCC2P flash database.

Configuring Triggers for CRC Errors

You can configure a span shutdown when the ML-MR-10 card receives cyclic redundancy check (CRC)errors at a rate that exceeds the configured threshold and configured soak time. See Chapter 32, “Configuring Ethernet Vitrual Circuits and QoS on ML-MR-10 Card,” for details about configuring triggers for CRC errors.

Configuring QoS on RPR-IEEE

The ML-MR-10 card implements RPR-IEEE QoS. You can configure the different priorities of traffic with rate limiters and specific bandwidths. The configuration for each span might be identical (default) or the configuration might vary from the other span.

The highest-priority traffic, known as service class A0, can reserve a portion of total ringlet bandwidth using the **reserved** keyword. This reservation is propagated throughout the ringlet, and all stations recognize the bandwidth allocation cumulatively. Reserved A0 bandwidth can be used only by the station that reserves it. The default allocation is 0 Mbps.

Service class A1 is configured as high-priority traffic in excess of the A0 bandwidth reservation, and can be rate-limited using the high tx-traffic rate limiter. The default allocation is 10 Mbps.

The medium transmit traffic rate limiter allows a certain amount of traffic to be added to the ringlet that is not subject to fairness eligibility, but must compete for the unreserved bandwidth with other traffic of the same service class. This traffic is committed information rate (B-CIR) traffic. The default allocation is 10 Mbps.

Class C is the lowest traffic priority. Class C cannot allocate any ring bandwidth guarantees.

Configuring Traffic Rates for Transmission

To enable and configure the traffic rates, perform the following procedure, beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# `**`interface rpr-ieee 0`**	Activates interface configuration mode to configure the RPR-IEEE interface.
Step 2	`Router(config-if)# `**`rpr-ieee tx-traffic rate-limit`**` {`**`reserved`**` | `**`high`**` | `**`medium`**`} `*`rate`*` [`**`east`**` | `**`west`**`]`	Specifies a rate limit on a traffic queue. The allowable rate depends on the speed of the interface. **reserved**—Reserves bandwidth for the highest priority traffic, known as service class A0. The default allocation is 0 Mbps. **high**—Limits the rate of service class A1. The default allocation is 10 Mbps. **medium**—Limits the rate of service class B-CIR. The default allocation is 10 Mbps. (Optional) Specify the east or west ringlet.
Step 3	`Router(config)# `**`no shut`**	Enables the RPR-IEEE interface and changes the mode from the default passthrough.
Step 4	`Router(config)# `**`end`**	Returns to privileged EXEC mode.
Step 5	`Router# `**`copy running-config startup-config`**	(Optional) Saves configuration changes to the TCC2/TCC2P flash database.

Configuring Fairness Weights

RPR-IEEE has a configurable fairness system, used to control congestion on each ringlet. This feature moderates bandwidth utilization of the ringlet to minimize and potentially eliminate starvation of any station. Each station has two instances of the fairness machine, to control traffic that is being transmitted and transited out of each span of the interface. Each fairness machine is devoted to a particular ringlet, and controls the traffic that is destined to that ringlet.

Each ringlet in an unwrapped ring is independent, and the fairness configuration can differ for each direction. The default is to configure both directions, but you can optionally specify east or west in the configuration.

The local station weight impacts how congested the station appears relative to other stations in the ringlet. It also affects how much more bandwidth a station can use. A higher weight gives the local station a greater share of the ringlet bandwidth. A lower weight decreases the bandwidth share of the local station. The default value is 0 configured as an exponent of 2, which yields an effective weight of 1.

To enable and configure the fairness weight, perform the following procedure, beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)#` **`interface rpr-ieee 0`**	Activates interface configuration mode to configure the RPR-IEEE interface.
Step 2	`Router(config-if)#` **`rpr-ieee fairness weight`** *`weight`* `[`**`east`** `|` **`west`**`]`	Specifies the weight for a station on the ringlet. Values can range from 0 to 7 and are configured as an exponent of 2, which results in weights ranging from 1 to 128. The default value is zero. (Optional) Specify the east or west ringlet.
Step 3	`Router(config)#` **`no shut`**	Enables the RPR-IEEE interface and changes the mode from the default passthrough.
Step 4	`Router(config)#` **`end`**	Returns to privileged EXEC mode.
Step 5	`Router#` **`copy running-config startup-config`**	(Optional) Saves configuration changes to the TCC2/TCC2P flash database.

Verifying and Monitoring RPR-IEEE

After RPR-IEEE is configured, you can use the following commands to verify setup and monitor its status:

- The **show interface rpr-ieee** *interface-number* command (Example 30-1) displays the following for an interface:
  - Primary or secondary status (if RI is activated)
  - Active or standby mode (if RI is activated)
  - Up or down (pass-through mode) status
  - Monitoring status and by extension, general protection status
- The **show interface rpr-ieee fairness detail** command (Example 30-2) displays the following for an interface:
  - Total bandwidth
  - Traffic class configured transmission rates
  - Fairness weight settings for the interface
  - Instances of congestion
- The **show rpr-ieee protection** command (Example 30-3) displays the following for an interface:
  - Station and neighbor interface MAC addresses
  - Protection timer settings
  - Ring protection status
  - Span failures
- The **show rpr-ieee topology detail** command (Example 30-4) displays the following for the ring:
  - Station names and neighbor MAC addresses of all stations on the ring
  - Traffic class configured transmission rates for all stations on the ring

- Fairness weight settings for all stations on the ring
- Jumbo frame status (on or off) for all stations on the ring
- ATD information for all stations on the ring
- Protection mode for all nodes on the ring
- Secondary MAC addresses for all stations on the ring

Example 30-1 show interface rpr-ieee 0 Output

```
router# show interface rpr-ieee 0
    RPR-IEEE0 is up, line protocol is up
    Hardware is RPR-IEEE Channelized SONET, address is 000e.8312.bcf0 (bia 000e.8312.bcf0)
    MTU 1500 bytes, BW 145152 Kbit, DLY 100 usec,
    reliability 255/255, txload 105/255, rxload 99/255

Encapsulation: RPR-IEEE,
    West Span: loopback not set
    East Span: loopback not set
    MAC passthrough not set
    RI: primary,active peer mac 000e.8312.b870
    ARP type: ARPA, ARP Timeout 04:00:00
    Last input 00:00:00, output never, output hang never
    Last clearing of "show interface" counters never
    Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
    Queueing strategy: fifo
    Output queue: 0/40 (size/max)

West Span:  5 minutes output rate 57872638 bits/sec, 25307 packets/sec
            5 minutes input rate 57786924 bits/sec, 25268 packets/sec
East Span:  5 minutes output rate 2765315 bits/sec, 1197 packets/sec
            5 minutes input rate 0 bits/sec, 0 packets/sec
    26310890 packets input, 3230040117 bytes
    Received 0 broadcasts (0 IP multicast)
    0 runts, 0 giants, 0 throttles
    3 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
    0 watchdog, 0 multicast
    0 input packets with dribble condition detected
    32138811 packets output, 601868274 bytes, 0 underruns
    0 output errors, 0 collisions, 0 interface resets
    0 babbles, 0 late collision, 0 deferred
    0 lost carrier, 0 no carrier
    0 output buffer failures, 0 output buffers swapped out
```

Example 30-2 show rpr-ieee fairness detail Output

```
router# show rpr-ieee fairness detail
IEEE 802.17 Fairness on RPR-IEEE0:
   Bandwidth: 96768 kilobits per second
   Station using aggressive rate adjustment.
Westbound Tx (Ringlet 1)
   Weighted Fairness:
      Local Weight: 0  (1)
   Single-Choke Fairness Status:
      Local Congestion:
         Congested? No
            Head? No
         Local Fair Rate:
            Approximate Bandwidth: 64892 Kbps
            25957 normalized bytes per aging interval
```

```
51914 bytes per ageCoef aging interval
      Downstream Congestion:
        Congested? No
             Tail? No
          Received Source Address: 0000.0000.0000
Received Fair Rate:
             Approximate Bandwidth: FULL RATE
65535 normalized bytes per aging interval

Reserved Rate:
0 Kbps
      0 bytes per aging interval
   Unreserved Rate:
      96768 Kbps
      4838 bytes per aging interval
Allowed Rate:
      Approximate Bandwidth: 96000 Kbps
      4800 bytes per aging interval
   Allowed Rate Congested:
      Approximate Bandwidth: 96000 Kbps
      4800 bytes per aging interval
      TTL to Congestion: 255
      Total Hops Tx: 4
   Advertised Fair Rate:
      Approximate Bandwidth: FULL RATE
65535 normalized bytes per aging interval
      8191 bytes per aging interval
Eastbound Tx (Ringlet 0)
   Weighted Fairness:
      Local Weight: 0  (1)
   Single-Choke Fairness Status:
      Local Congestion:
         Congested? No
            Head? No
         Local Fair Rate:
            Approximate Bandwidth: 0 Kbps
            0 normalized bytes per aging interval
            0 bytes per ageCoef aging interval
      Downstream Congestion:
         Congested? No
            Tail? No
         Received Source Address: 0000.0000.0000
         Received Fair Rate:
            Approximate Bandwidth: FULL RATE
            65535 normalized bytes per aging interval

   Reserved Rate:
0 Kbps
      0 bytes per aging interval
   Unreserved Rate:
      96768 Kbps
      4838 bytes per aging interval
   Allowed Rate:
      Approximate Bandwidth: 96000 Kbps
      4800 bytes per aging interval
   Allowed Rate Congested:
      Approximate Bandwidth: 96000 Kbps
      4800 bytes per aging interval
      TTL to Congestion: 255
      Total Hops Tx: 4
   Advertised Fair Rate:
      Approximate Bandwidth: FULL RATE
      65535 normalized bytes per aging interval
      8191 bytes per aging interval
```

Example 30-3 show rpr-ieee protection Output

```
router# show rpr-ieee protection
Protection Information for Interface RPR-IEEE0
 MAC Addresses
   West Span (Ringlet 0 RX) neighbor 000b.fcff.9d34
   East Span (Ringlet 1 RX) neighbor 0013.1991.1fc0
   Station MAC address 0005.9a3c.59c0
 TP frame sending timers:
fast timer: 10 msec
     slow timer: 1x100 msec (100 msec)
Protection holdoff timers:
     L1 Holdoff                        Keepalive Detection
     West Span  0x10 msec (  0 msec)    West Span   5 msec
     East Span  0x10 msec (  0 msec)    East Span   5 msec
 Configured protection mode: STEERING
 Protection Status
   Ring is IDLE
   Protection WTR period is 10 sec. (timer is inactive)
     Self Detected Requests              Remote Requests
     West Span IDLE                      West Span IDLE
     East Span IDLE                      East Span IDLE
     Distant Requests
     East Span IDLE                      West Span IDLE
   West Span Failures: none
   East Span Failures: none
```

Example 30-4 show rpr-ieee topology detail Output

The IP address field in the output of **show rpr-ieee topology detail** is populated only by the IP address of the main interface, rpr-ieee 0. It is not populated by the IP address of any of the subinterfaces.

```
router# show rpr-ieee topology detail
802.17 Topology Display
  RX ringlet0->West spanRX ringlet1->East span
Number of nodes on
      ringlet0: 5ringlet1: 5
======================================================================
Local Station Topology Info
======================================================================
Topology entry:
  Station MAC address: 0005.9a3c.59c0
   West Span (Outer ringlet RX) neighbor 000b.fcff.9d34
   East Span (Inner ringlet RX) neighbor 0013.1991.1fc0
  Ring Topology: CLOSED (STABLE)
  Containment Active: NO
  A0 class reserved rate:
      ringlet0: 0 (mbps)ringlet1: 0 (mbps)
  Ringlet reserved rate:
      ringlet0: 0 (mbps)ringlet1: 0 (mbps)
  Ringlet unreserved rate:
      ringlet0: 96 (mbps)ringlet1: 96 (mbps)
  Ringlet effective unreserved rate:
      ringlet0: 95.9 (mbps)ringlet1: 95.9 (mbps)
  Advertised Protection requests:
      ringlet0: IDLEringlet1: IDLE
  Active Edges:
      ringlet0: NO ringlet1: NO
  Configured protection mode: STEERING
  Jumbo preference: NOT SET (ring doesn't support JUMBOS)
  Is revertive: YES
  Measured LRTT: 0
```

```
  Sequence Number: 3
ATD INFO:
  ATD timer: 1 sec
  Station Name: ML100T-481
  A0 reserved Bandwidth:
      ringlet0: 0 mbpsringlet1: 0 mbps
  SAS enabled: YES
  Weight:
      ringlet0: 1ringlet1: 1
  Secondary Mac Addresses:
        MAC 1: 0000.0000.0000 (UNUSED)
        MAC 2: 0000.0000.0000 (UNUSED)

=======================================================================
Topology Map for Outer ringlet
=======================================================================

=======================================================================
Topology entry at Index 1 on ringlet 0:
  Station MAC address: 000b.fcff.9d34
  Valid on ringlet0: YES
  Entry reachable: YES
  Advertised Protection requests:
      ringlet0: IDLEringlet1: IDLE
  Active Edges:
      ringlet0: NO ringlet1: NO
  Preferred protection mode: STEERING
  Jumbo preference: NOT SET (ring doesn't supports JUMBOS)
  Measured LRTT: 0
  Sequence Number: 3
ATD INFO:
  Station Name: ML100X-491
  A0 reserved Bandwidth:
      ringlet0: 0 mbpsringlet1: 0 mbps
  SAS enabled: YES
  Weight:
      ringlet0: 1ringlet1: 1
  Secondary Mac Addresses:
        MAC 1: 0000.0000.0000 (UNUSED)
        MAC 2: 0000.0000.0000 (UNUSED)
=======================================================================

Topology entry at Index 2 on ringlet 0:
  Station MAC address: 0011.2130.b568
  Valid on ringlet0: YES
  Entry reachable: YES
  Advertised Protection requests:
      ringlet0: IDLEringlet1: IDLE
  Active Edges:
      ringlet0: NO ringlet1: NO
  Preferred protection mode: STEERING
  Jumbo preference: NOT SET (ring doesn't supports JUMBOS)
  Measured LRTT: 0
  Sequence Number: 3
ATD INFO:
  Station Name: ML1000-491
  A0 reserved Bandwidth:
      ringlet0: 0 mbpsringlet1: 0 mbps
  SAS enabled: YES
  Weight:
      ringlet0: 1ringlet1: 1
  Secondary Mac Addresses:
        MAC 1: 0000.0000.0000 (UNUSED)
        MAC 2: 0000.0000.0000 (UNUSED)
```

```
======================================================================

Topology entry at Index 3 on ringlet 0:
  Station MAC address: 0005.9a39.7630
  Valid on ringlet0: YES
  Entry reachable: YES
  Advertised Protection requests:
      ringlet0: IDLEringlet1: IDLE
  Active Edges:
      ringlet0: NO ringlet1: NO
  Preferred protection mode: STEERING
  Jumbo preference: NOT SET (ring doesn't supports JUMBOS)
  Measured LRTT: 0
  Sequence Number: 3
ATD INFO:
  Station Name: ML1000-492
  A0 reserved Bandwidth:
      ringlet0: 0 mbpsringlet1: 0 mbps
  SAS enabled: YES
  Weight:
      ringlet0: 1ringlet1: 1
  Secondary Mac Addresses:
        MAC 1: 0000.0000.0000 (UNUSED)
        MAC 2: 0000.0000.0000 (UNUSED)
======================================================================

Topology entry at Index 4 on ringlet 0:
  Station MAC address: 0013.1991.1fc0
  Valid on ringlet0: YES
  Entry reachable: YES
  Advertised Protection requests:
      ringlet0: IDLEringlet1: IDLE
  Active Edges:
      ringlet0: NO ringlet1: NO
  Preferred protection mode: STEERING
  Jumbo preference: NOT SET (ring doesn't supports JUMBOS)
  Measured LRTT: 0
  Sequence Number: 3
ATD INFO:
  Station Name: ML100T-482
  A0 reserved Bandwidth:
      ringlet0: 0 mbpsringlet1: 0 mbps
  SAS enabled: YES
  Weight:
      ringlet0: 1ringlet1: 1
  Secondary Mac Addresses:
        MAC 1: 0000.0000.0000 (UNUSED)
        MAC 2: 0000.0000.0000 (UNUSED)
======================================================================

Topology entry at Index 5 on ringlet 0:
  Station MAC address: 0005.9a3c.59c0
    Valid on ringlet0: YES
  Entry reachable: YES
  Advertised Protection requests:
      ringlet0: IDLEringlet1: IDLE
  Active Edges:
      ringlet0: NO ringlet1: NO
  Preferred protection mode: STEERING
  Jumbo preference: NOT SET (ring doesn't supports JUMBOS)
  Measured LRTT: 0
  Sequence Number: 3
ATD INFO:
  Station Name: ML100T-481
```

```
  A0 reserved Bandwidth:
      ringlet0: 0 mbpsringlet1: 0 mbps
  SAS enabled: YES
  Weight:
      ringlet0: 1ringlet1: 1
  Secondary Mac Addresses:
        MAC 1: 0000.0000.0000 (UNUSED)
        MAC 2: 0000.0000.0000 (UNUSED)
=======================================================================
Topology Map for Inner ringlet
=======================================================================

=======================================================================
Topology entry at Index 1 on ringlet 1:
  Station MAC address: 0013.1991.1fc0
  Valid on ringlet1: YES
  Entry reachable: YES
  Advertised Protection requests:
      ringlet0: IDLEringlet1: IDLE
  Active Edges:
      ringlet0: NO ringlet1: NO
  Preferred protection mode: STEERING
  Jumbo preference: NOT SET (ring doesn't supports JUMBOS)
  Measured LRTT: 0
  Sequence Number: 3
ATD INFO:
  Station Name: ML100T-482
  A0 reserved Bandwidth:
      ringlet0: 0 mbpsringlet1: 0 mbps
  SAS enabled: YES
  Weight:
      ringlet0: 1ringlet1: 1
  Secondary Mac Addresses:
        MAC 1: 0000.0000.0000 (UNUSED)
        MAC 2: 0000.0000.0000 (UNUSED)
=======================================================================

Topology entry at Index 2 on ringlet 1:
  Station MAC address: 0005.9a39.7630
  Valid on ringlet1: YES
  Entry reachable: YES
  Advertised Protection requests:
      ringlet0: IDLEringlet1: IDLE
  Active Edges:
      ringlet0: NO ringlet1: NO
  Preferred protection mode: STEERING
  Jumbo preference: NOT SET (ring doesn't supports JUMBOS)
  Measured LRTT: 0
  Sequence Number: 3
ATD INFO:
  Station Name: ML1000-492
  A0 reserved Bandwidth:
      ringlet0: 0 mbpsringlet1: 0 mbps
  SAS enabled: YES
  Weight:
      ringlet0: 1ringlet1: 1
  Secondary Mac Addresses:
        MAC 1: 0000.0000.0000 (UNUSED)
        MAC 2: 0000.0000.0000 (UNUSED)
=======================================================================

Topology entry at Index 3 on ringlet 1:
  Station MAC address: 0011.2130.b568
  Valid on ringlet1: YES
```

```
  Entry reachable: YES
  Advertised Protection requests:
      ringlet0: IDLEringlet1: IDLE
  Active Edges:
      ringlet0: NO ringlet1: NO
  Preferred protection mode: STEERING
  Jumbo preference: NOT SET (ring doesn't supports JUMBOS)
  Measured LRTT: 0
  Sequence Number: 3
ATD INFO:
  Station Name: ML1000-491
  A0 reserved Bandwidth:
      ringlet0: 0 mbpsringlet1: 0 mbps
  SAS enabled: YES
  Weight:
      ringlet0: 1ringlet1: 1
  Secondary Mac Addresses:
        MAC 1: 0000.0000.0000 (UNUSED)
        MAC 2: 0000.0000.0000 (UNUSED)
======================================================================

Topology entry at Index 4 on ringlet 1:
  Station MAC address: 000b.fcff.9d34
  Valid on ringlet1: YES
  Entry reachable: YES
  Advertised Protection requests:
      ringlet0: IDLEringlet1: IDLE
  Active Edges:
      ringlet0: NO ringlet1: NO
  Preferred protection mode: STEERING
  Jumbo preference: NOT SET (ring doesn't supports JUMBOS)
  Measured LRTT: 0
  Sequence Number: 3
ATD INFO:
  Station Name: ML100X-491
  A0 reserved Bandwidth:
      ringlet0: 0 mbpsringlet1: 0 mbps
  SAS enabled: YES
  Weight:
      ringlet0: 1ringlet1: 1
  Secondary Mac Addresses:
        MAC 1: 0000.0000.0000 (UNUSED)
        MAC 2: 0000.0000.0000 (UNUSED)
======================================================================

Topology entry at Index 5 on ringlet 1:
  Station MAC address: 0005.9a3c.59c0
  Valid on ringlet1: YES
  Entry reachable: YES
  Advertised Protection requests:
      ringlet0: IDLEringlet1: IDLE
  Active Edges:
      ringlet0: NO ringlet1: NO
  Preferred protection mode: STEERING
  Jumbo preference: NOT SET (ring doesn't supports JUMBOS)
  Measured LRTT: 0
  Sequence Number: 3
ATD INFO:
  Station Name: ML100T-481
  A0 reserved Bandwidth:
      ringlet0: 0 mbpsringlet1: 0 mbps
  SAS enabled: YES
  Weight:
      ringlet0: 1ringlet1: 1
```

```
Secondary Mac Addresses:
      MAC 1: 0000.0000.0000 (UNUSED)
      MAC 2: 0000.0000.0000 (UNUSED)
```

Monitoring RPR-IEEE in CTC

You can display the IEEE-RPR topology from a network map in CTC. If there are circuits that make a logical ring, CTC can trace the ring and display the complete topology. The network map has a granularity going down to the ML-MR-10 card, because multiple ML cards within a single node can be used to make a RPR topology. The display shows all the ML-MR-10 cards as individual entities in the topology.

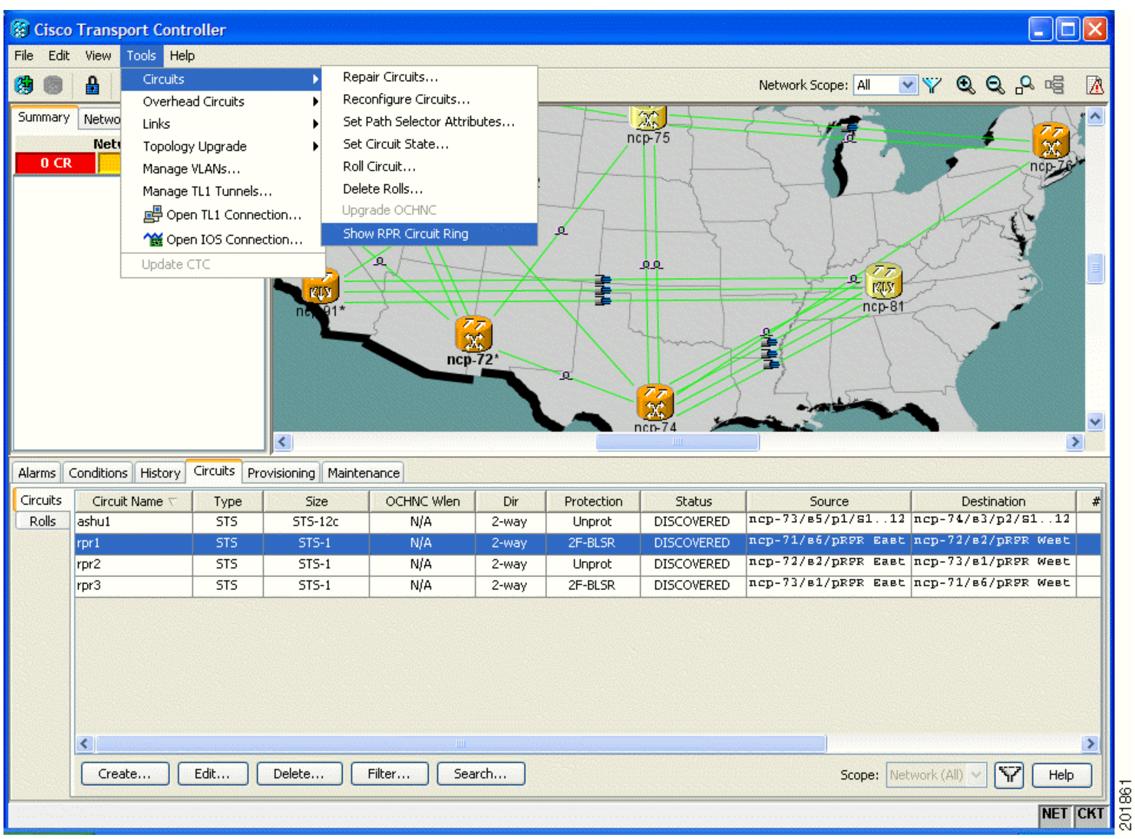
To display an RPR, proceed as follows:

Step 1 Launch CTC and select the network view. A screen similar to Figure 30-6 on page 30-24 is displayed.

Step 2 Click the **Circuits** tab in the lower pane and select an RPR circuit that you want to display.

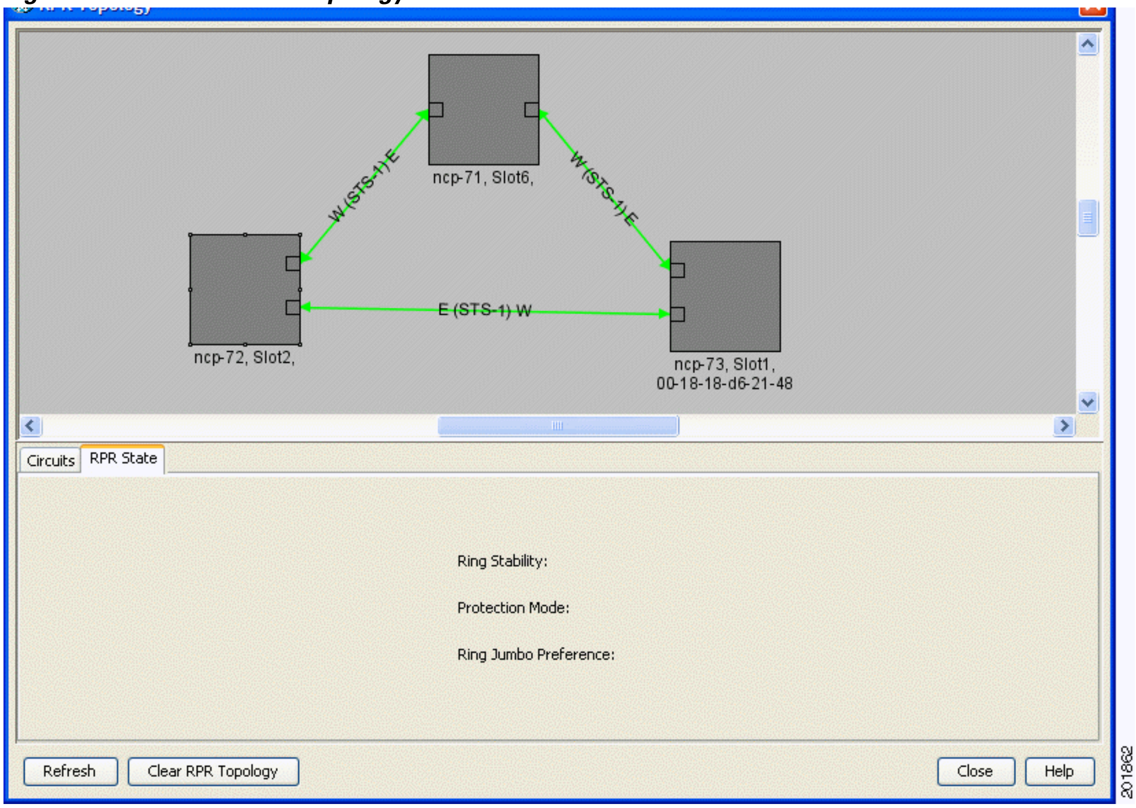
Step 3 Click Tools > Circuits > Show RPR Circuit Ring.

Figure 30-6 CTC Network Map View



CTC displays the RPR Topology window, shown in Figure 30-7 on page 30-25, showing the complete topology of the ring. Click the **RPR State** tab to see the status of the displayed ring.

Figure 30-7 CTC RPR Topology Window



The links on the RPR topology display are shown as between east port and west port. The display also shows the slot number occupied by each ML-MR-10 card on its respective node.

The RPR-IEEE ring display is based only on the provisioned circuit state, since CTC is not updated with RPR-IEEE failure cases or ML-MR-10 card in passthrough mode.

CTC also displays incomplete RPR-IEEE topologes so you can identify which segment of the RPR-IEEE topology you need to create. A maximum number of 254 ML-MR-10 cards are supported in one RPR-IEEE topology.