



**IEEE Standard for  
Information technology—  
Telecommunications and information  
exchange between systems—  
Local and metropolitan area networks—  
Specific requirements**

## **Part 17: Resilient packet ring (RPR) access method and physical layer specifications**

### **Amendment 2: Protected inter-ring connection**

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#### **IEEE Computer Society**

Sponsored by the  
LAN/MAN Standards Committee

IEEE  
3 Park Avenue  
New York, NY 10016-5997, USA

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as amended by IEEE Std 802.17b™-2007)



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Information technology—  
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**Part 17: Resilient packet ring (RPR) access  
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**LAN/MAN Standards Committee  
of the  
IEEE Computer Society**

Approved 25 March 2010

**IEEE SA-Standards Board**

**Abstract:** A service provider's use of the architecture and protocols of IEEE 802.17 to support ring interconnection through dual station homing, providing 50 ms protection, loop prevention, and load balancing of traffic between rings, is added by this amendment.

**Keywords:** bridging, fairness, layer management, medium access control, metropolitan area network (MAN), physical layer, protection switching, resilient packet ring (RPR), ring topology, spatial reuse, topology detection

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## Part 17: Resilient packet ring (RPR) access method and physical layer specifications

### Amendment 2: Protected inter-ring connection

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<sup>1</sup>Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the standard.

## 1. Overview

### 1.4 Document structure

*Insert the following item in the list of clauses, after item n). Renumber as necessary.*

- o) Clause 15: Protected inter-ring connection

### 3. Terms, definitions, and notation

#### 3.2 Terms and definitions

*Insert the following definitions in alphabetical order into 3.2, renumbering as necessary.*

**3.2.1 primary protection group member:** The PIRC protection group member with higher protection priority.

**3.2.2 protected inter-ring connection (PIRC) mate station:** The other station on the same ring performing the interconnect functionality from that ring to the same destination ring(s).

**3.2.3 protected inter-ring connection (PIRC) station:** A station that provides connectivity between rings and exchanges PIRC messages with other similarly interconnected devices.

**3.2.4 protection group:** A collection of two PIRC stations on the same ring performing the interconnect functionality from that ring to the same destination rings.

**3.2.5 protection group member:** One of the PIRC stations in a protection group.

**3.2.6 secondary protection group member:** The PIRC protection group member with lower protection priority.



## 4. Abbreviations and acronyms

*Insert the following abbreviations in alphabetical order into Clause 4:*

|      |                                 |
|------|---------------------------------|
| PG   | protection group                |
| PGM  | protection group member         |
| PIRC | protected inter-ring connection |



## 5. Architecture overview

*Insert a new subclause 5.19 after 5.18.*

### 5.19 Protected inter-ring connection

Protected inter-ring connection (PIRC) is an optional sublayer of the MAC datapath sublayer. PIRC functionality provides 50 ms protection of traffic between interconnected rings through dual-station homing. The PIRC sublayer is applicable only to interconnect stations. Non-interconnect stations require no changes in order for PIRC to function correctly.



## 6. Medium access control (MAC) service and reference model

### 6.2 Terminology and variables

*Insert the following variable in alphabetical order into 6.2. Renumber as necessary.*

**6.2.1 *enablePirc*:** A boolean variable determining whether PIRC functionality is enabled. A value of FALSE causes all data frames to bypass PIRC and ignores all received PIRC status messages.

### 6.4 MAC services to the client layer

#### 6.4.1 MA\_DATA.request

##### 6.4.1.4 Effect of receipt

*Change 6.4.1.4 as follows:*

The receipt of the MA\_DATA.request primitive causes the MAC entity to create a data frame or an extended data frame, fill in the fields whose values are given or determined by the parameters of this request, and pass the properly formed frame to the transmit state machines by placing it on Q\_TX\_SASPIRC (see Figure 6.2), for transfer to the peer MAC sublayer entity or entities.

### 6.6 MAC reference model

*Change the first paragraph of 6.6 as follows:*

As illustrated in Figure 6.1, the MAC comprises the MAC control sublayer and the MAC datapath sublayer. The MAC datapath sublayer comprises the protected inter-ring connection sublayer, spatially aware sublayer, the ringlet selection entity and the datapaths for the two ringlets. These components and their interconnections are illustrated in Figure 6.4 within the context of a single station view of the MAC architecture.

*Replace Figure 6.4 with the following figure:*

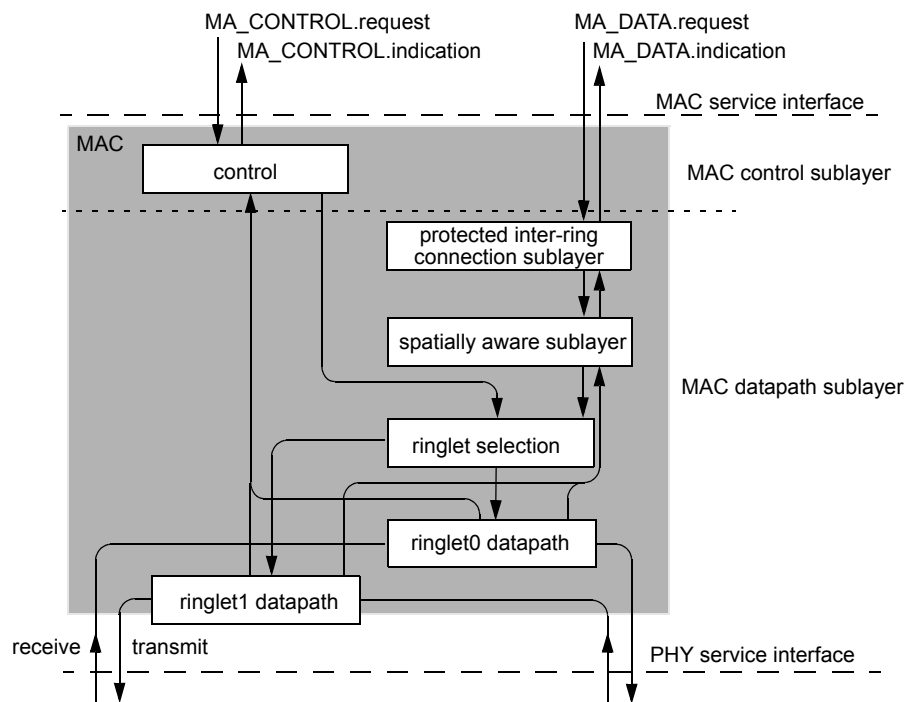


**Figure 6.4—Single station view of MAC architecture**

### 6.6.1 MAC control sublayer

Replace Figure 6.5 with the following figure:

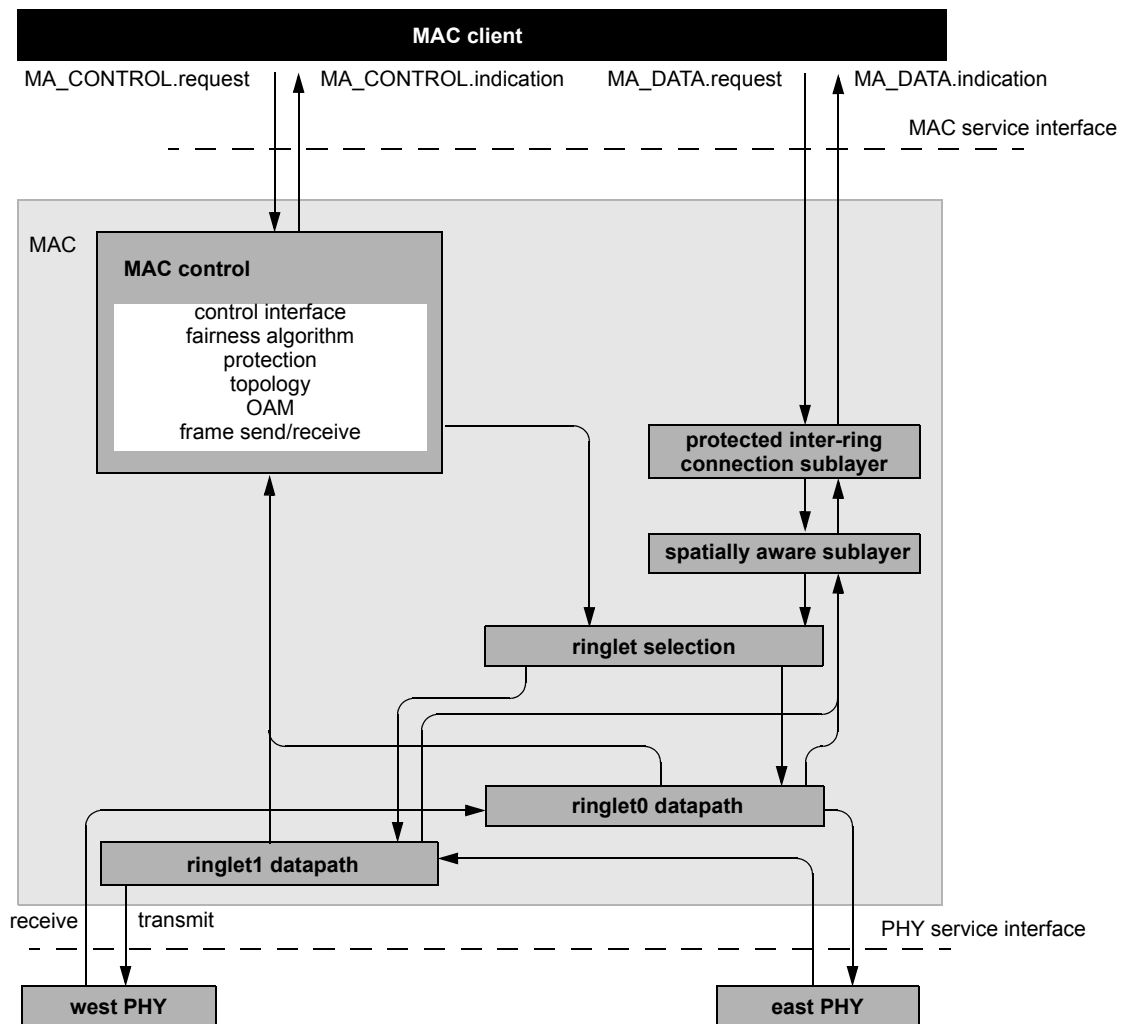


Figure 6.5—MAC control architecture

## 6.6.2 MAC datapath sublayer

Replace Figure 6.6 with the following figure:

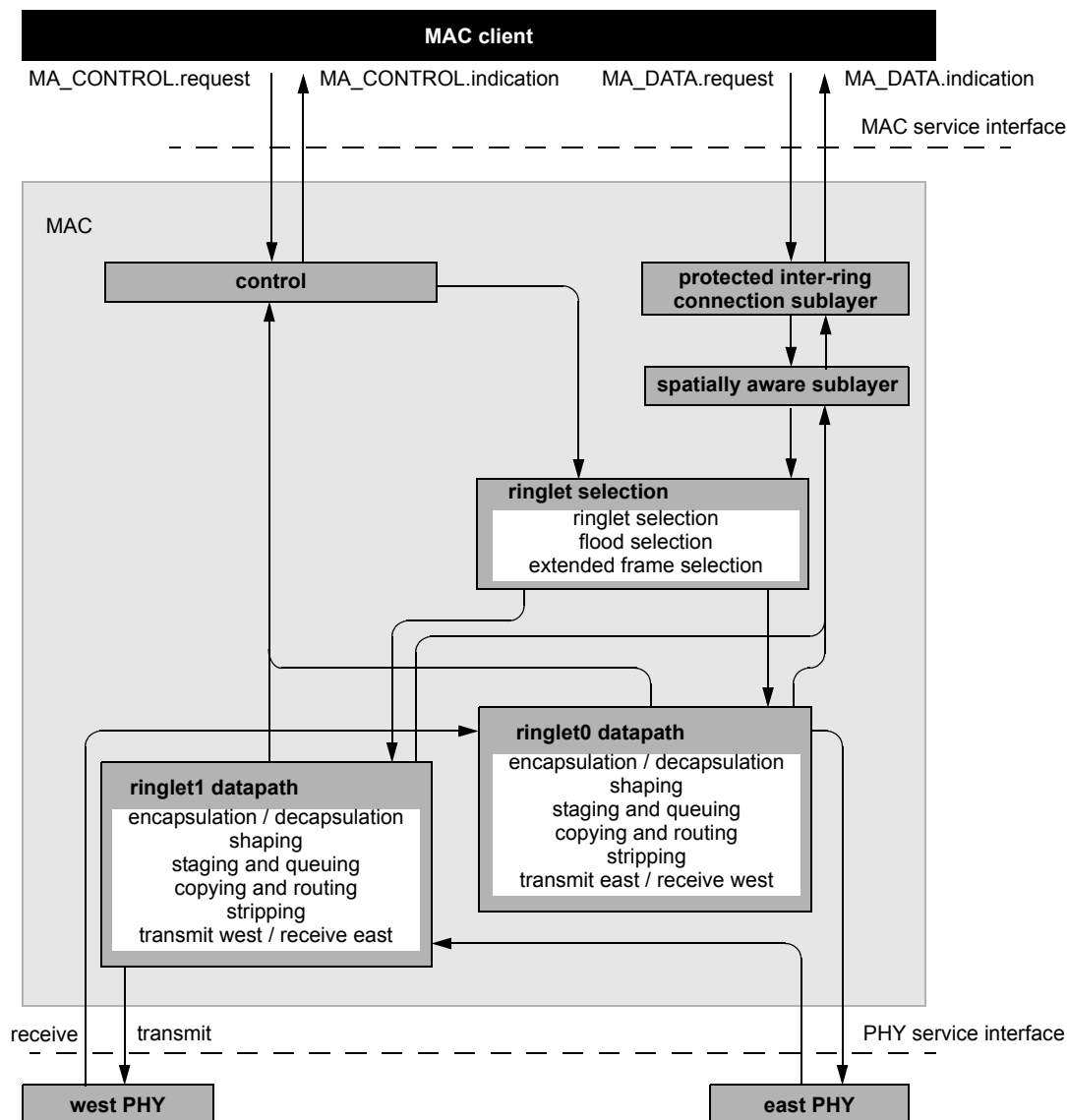


Figure 6.6—MAC datapath architecture

### 6.6.3 Flow of data within the MAC

Replace Figure 6.7 with the following figure:

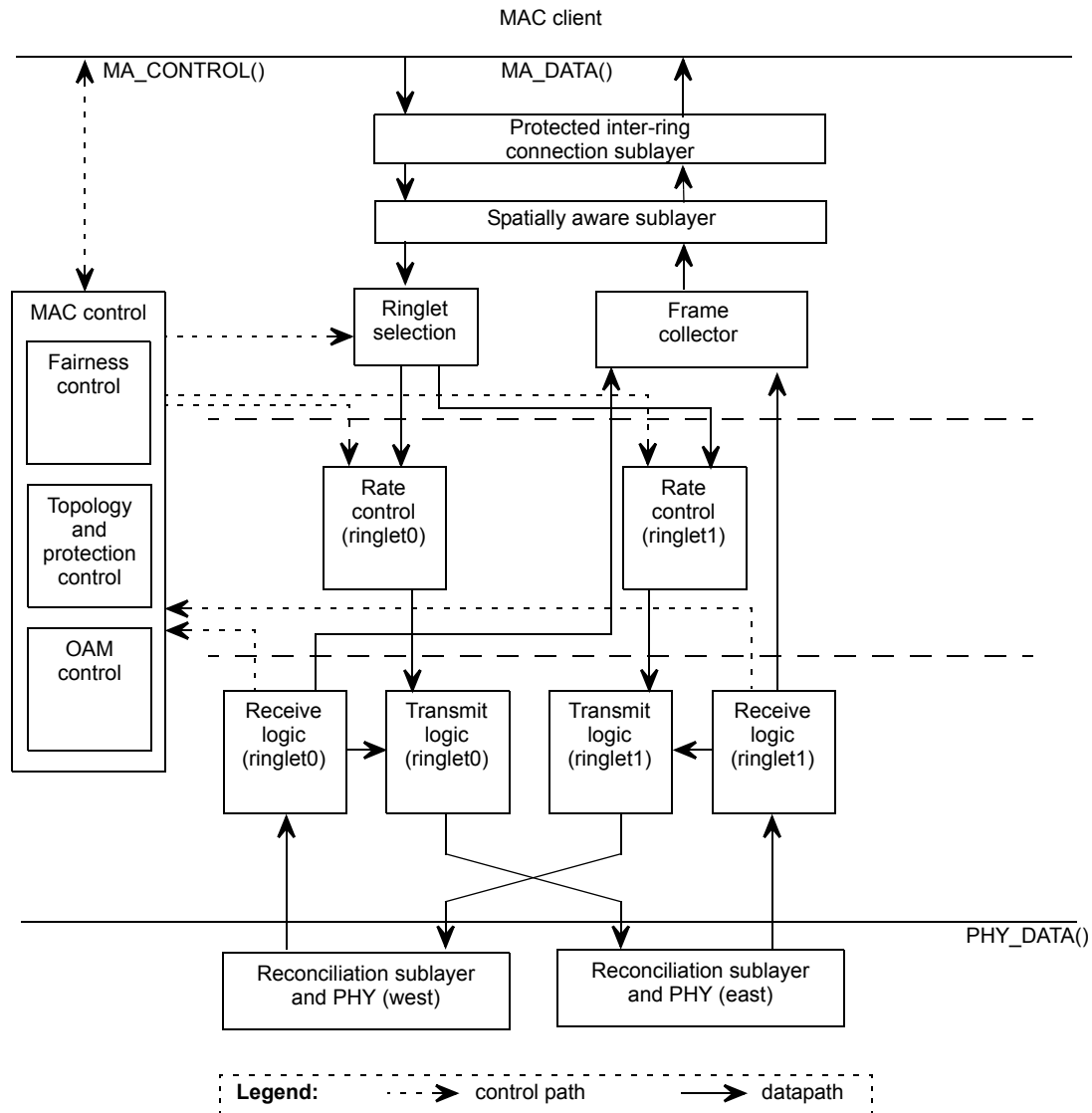


Figure 6.7—MAC reference model, showing internal MAC functions and data paths



## 7. Medium access control datapath

### 7.1 Datapath overview

*Change the second-to-last paragraph of 7.1 as follows:*

The various pieces of the datapath sublayer are tied together through logical queues. For example, an invocation of MA\_DATA.request places input into a queue leading to the ~~SasTransmit~~ PircTransmit state machine. As this and each subsequent state machine processes the input, it takes the input off of one queue and then places it onto another queue. This continues until the last queue leads to a PHY\_DATA.request. Similarly, invocation of PHY\_DATA.indication (by the reconciliation sublayer) provides a frame to each of the receive state machines in turn, via logical queues, and then eventually to one of the transmit state machines, via the transit queue(s), and to MA\_DATA.indication. These relationships are illustrated in a simplified overview in Figure 7.2.

*Replace Figure 7.2 with the following figure:*

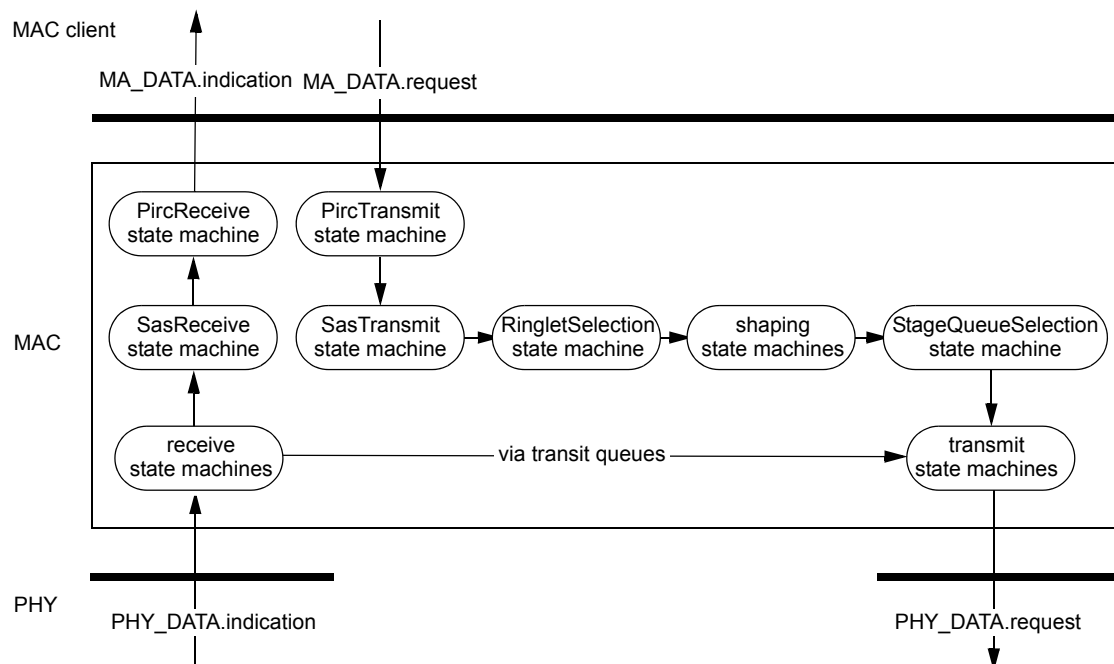


**Figure 7.2—MAC datapath relationships**

## 7.2 Terminology and variables

### 7.2.1 Common state machine definitions

*Insert the following “queue values” in alphabetical order into the existing queue values paragraph of 7.2.1.*

- Q\_RX\_PIRC—The queue identifier associated with PIRC receive processing of frames.
- Q\_RX\_PIRC\_STATUS—The queue identifier associated with received PIRC status frames.
- Q\_TX\_PIRC—The queue identifier associated with PIRC transmit processing of frames.

## 7.2.4 Variables and literals defined in other clauses

*Insert the following literal in alphabetical order in the “literals defined in Clause 9” list.*

CT\_OAM\_PIRC\_STATUS

## 7.2.5 Flow count variables

*Insert the following flow count variables in alphabetical order in the “fromCtrlFrames” list.*

*fromCtrlOamPircStatusFrames*  
*toCtrlOamPircStatusFrames*

## 7.6 Receive operation

### 7.6.3 Receive operation state machines

#### 7.6.3.1 Receive entity

*Replace Figure 7.8 with the following figure:*

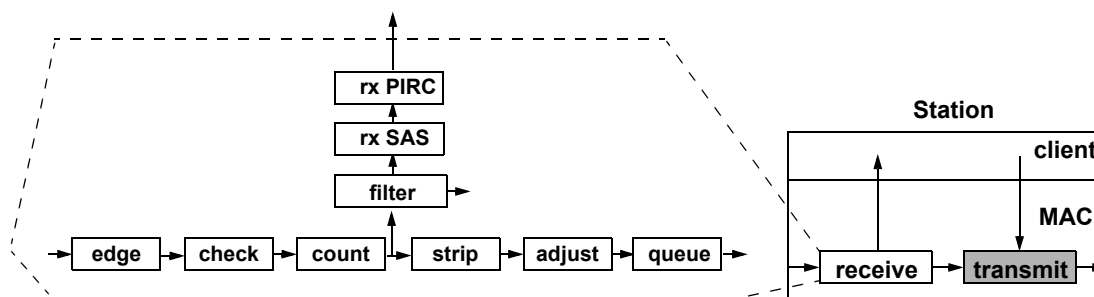


**Figure 7.8—Receive subentities**

*Add the following list item i) to the end of the list of subentities:*

- i) Rx PIRC (see 15.5.1): Frames destined to the client are processed by PIRC.

#### 7.6.3.13 ReceiveFilterControlCount state machine

##### 7.6.3.13.1 ReceiveFilterControlCount state machine definitions

*Insert the following definition in alphabetical order into 7.6.3.13.1.*

CT\_OAM\_PIRC\_STATUS

##### 7.6.3.13.2 ReceiveFilterControlCount state machine variables

*Insert the following variable in alphabetical order in 7.6.3.13.2.*

*toCtrlOamPircStatusFrame*

7.6.3.13.4 ReceiveFilterControlCount state table

Insert the following row into Table 7.26 between rows 14 and 15 and renumber rows:

|  |                                            |    |                                                                      |  |
|--|--------------------------------------------|----|----------------------------------------------------------------------|--|
|  | frame.controlType ==<br>CT_OAM_PIRC_STATUS | 15 | toCtrlOamPircStatusFrames += 1;<br>Enqueue(Q_RX_PIRC_STATUS, frame); |  |
|--|--------------------------------------------|----|----------------------------------------------------------------------|--|

Insert the following row comment below Table 7.26 after 7.26-14 and renumber:

Row 7.26-15: Count the number of PIRC status frames.

7.7 Transmit operation

Replace Figure 7.10 with the following figure:

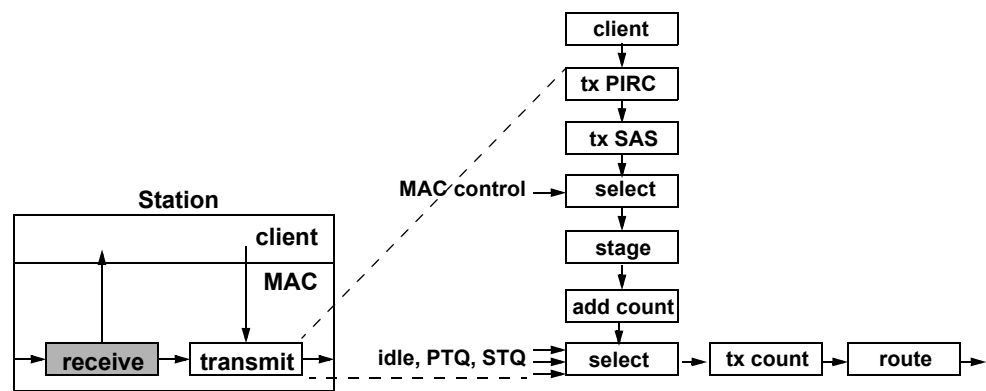


Figure 7.10—Transmit subentities

Insert the following subentity description at the beginning of the list. Renumber the list as necessary.

- a) protected inter-ring connection sublayer (see 15.5.2)

7.7.3 Setting of ttl and ttlBase

7.7.3.1 Definitions for use with setting of ttl and ttlBase

Insert the following definition in alphabetical order.

CT\_OAM\_PIRC\_STATUS

7.7.3.4 Initial ttl field values

Insert the following text into Table 7.30 between rows 12 and 13 and renumber rows:

|  |                                            |    |                                                  |  |
|--|--------------------------------------------|----|--------------------------------------------------|--|
|  | frame.controlType ==<br>CT_OAM_PIRC_STATUS | 13 | ttl >= numStations - 1 &&<br>ttl <= MAX_STATIONS |  |
|--|--------------------------------------------|----|--------------------------------------------------|--|

*Insert the following row comment below Table 7.30 after 7.30-12 and renumber:*

**Row 7.30-13:** PIRC status frames are capable of traveling the known size of the ring.

**7.7.6 ControlAddCount state machine**

**7.7.6.1 ControlAddCount state machine definitions**

*Insert the following definition in alphabetical order in 7.7.6.1.*

CT\_OAM\_PIRC\_STATUS

**7.7.6.2 ControlAddCount state machine variables**

*Insert the following variables in alphabetical order in 7.7.6.2.*

*fromCtrlOamPircStatusFrames*

**7.7.6.4 ControlAddCount state table**

*Insert the following text into Table 7.33 between rows 13 and 14 and renumber rows:*

|  |                                            |    |                                   |  |
|--|--------------------------------------------|----|-----------------------------------|--|
|  | frame.controlType ==<br>CT_OAM_PIRC_STATUS | 14 | fromCtrlOamPircStatusFrames += 1; |  |
|--|--------------------------------------------|----|-----------------------------------|--|

*Insert the following row comment below Table 7.33 after 7.33-13 and renumber:*

**Row 7.33-14:** Count the number of PIRC status frames.

9. Frame formats

9.3 Control frame format

9.3.2 Control frame fields

*Insert the following value 0C<sub>16</sub> information field in Table 9.4, after the 0B<sub>16</sub> entry.*

|                  |                     |                               |
|------------------|---------------------|-------------------------------|
| 0C <sub>16</sub> | CT_PIRC_MATE_STATUS | PIRC mate status notify frame |
|------------------|---------------------|-------------------------------|



## 11. Topology discovery and protection

### 11.2 Terminology and variables

#### 11.2.3 Common state machine variables

*Insert the following field values in alphabetical order into 11.2.3.*

##### *pircTopologyChange*

Indicates that a topology change has occurred requiring an update of the PIRC protection status.

TRUE—A topology change has occurred requiring an update of the PIRC protection status.

FALSE—(Otherwise.)

#### 11.2.5 *myTopoInfo* fields

*Insert the following field values in alphabetical order into 11.2.5.*

##### *pircUser*

Indicates whether the station is PIRC capable, based on the value of the *enablePirc* variable.

TRUE—The station is PIRC capable.

FALSE—(Otherwise.)

#### 11.2.6 *topoEntry[rid][hops]* fields

*Insert the following field values in alphabetical order into 11.2.6.*

##### *pircGroupMember*

Indicates whether the station is PIRC capable, based on the value of the *enablePirc* variable.

TRUE—The station is PIRC capable.

FALSE—(Otherwise.)

#### 11.2.9 Defect indications

*Insert the following defect definitions in alphabetical order into 11.2.9.*

##### *pircLbDefect*

A critical severity defect indicating the PIRC protection group members have conflicting PIRC load-balancing provisioning.

TRUE—A conflicting PIRC load-balancing provisioning defect is present.

FALSE—(Otherwise.)

##### *pircPrDefect*

A critical severity defect indicating the PIRC protection group members have conflicting PIRC priority protection group provisioning.

TRUE—A conflicting PIRC priority protection group provisioning defect is present.

FALSE—(Otherwise.)

## 11.4 Defined ATT encodings

### 11.4.3 Station settings ATT

*Replace Figure 11.18 with the following figure:*

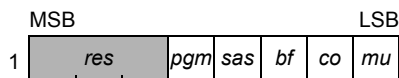


**Figure 11.18—Station settings *attDataUnit* format**

*Replace item 11.4.3.1 with the following text.*

**11.4.3.1 *res*:** A 3-bit reserved field.

*Insert the following station setting immediately following item 11.4.3.1. Renumber as necessary.*

**11.4.3.2 *pgm*:** A (PIRC group member) bit that is set to 1 if the station is a member of a PIRC protection group. Otherwise, this bit has a default 0 value.

*Change the last paragraph of 11.4.3 as follows.*

When received, this information is copied to the *pircGroupMember*, *sasUser*, *badFcsUser*, *conservativeMode*, and *multichokeUser* fields in the topology database (see 11.5).

## 11.5 Topology database

### 11.5.1 Topology database structure

#### 11.5.1.1 Logical representation of topology database

*Insert the following entry, in Table 11.10, before the “SAS is enabled” entry.*

|                                              |                 |      |
|----------------------------------------------|-----------------|------|
| station is member of a PIRC protection group | pircGroupMember | TRUE |
|----------------------------------------------|-----------------|------|

*Insert the following entry, in Table 11.11, before the “sasUser” entry.*

|                        |      |       |      |
|------------------------|------|-------|------|
| <i>pircGroupMember</i> | TRUE | FALSE | TRUE |
|------------------------|------|-------|------|

## 11.6 State machines

### 11.6.6 TopologyValidation state machine

#### 11.6.6.3 TopologyValidation state machine variables

*Insert the following variable in alphabetical order into 11.6.6.3.*

*pircTopologyChange*  
See 11.2.3.

**11.6.6.5 TopologyValidation state table**

*Insert the following depicted row in Table 11.16, before the existing row 12. Renumber subsequent rows.*

|       |                                              |    |                            |       |
|-------|----------------------------------------------|----|----------------------------|-------|
| VALID | myTopoInfo.pircGroupMember &&<br>topoChanged | 12 | pircTopologyChange = TRUE; | START |
|-------|----------------------------------------------|----|----------------------------|-------|

*Insert the following row description below Table 11.16, before existing the 11.16-12 description. Renumber subsequent rows.*

**Row 11.16-12:** A topology change forces a rechecking of the topology. If the station is a PIRC protection group member, set indication for pircControl state table.



## 12. Operations, administration, and maintenance (OAM)

### 12.1 Overview

*Insert the following item to the end of the list.*

- f) Provide a mechanism to interconnect rings with fast failure recovery.

#### 12.1.2 OAM functions supported by RPR

*Insert the following additional OAM frame type supported to the end of the list.*

- e) PIRC management—For status exchange and notification between the mate stations.

*Insert the following new subclause 12.1.8 after 12.1.7.*

#### 12.1.8 PIRC management operations

A PIRC frame allows one interconnected station to notify its status and characteristic to its mate station in the same protection group. The PIRC frame is broadcast over the ring with a service class of subclassA0. PIRC frames are received by all stations and processed by the inter-ring stations.

### 12.3 OAM frame formats

*Insert the following new subclause 12.3.5 after 12.3.4.*

#### 12.3.5 PIRC frame

The PIRC frames are identified by the *controlType* field value of CT\_OAM\_PIRC\_STATUS and a *controlVersion* value of 0. The PIRC frame is sent only by the inter-ring station. The PIRC frame contents include information about the sending station's status and characteristics. Figure 12.13 illustrates the PIRC frame payload with the *controlDataUnit* portion of the frame indicated.

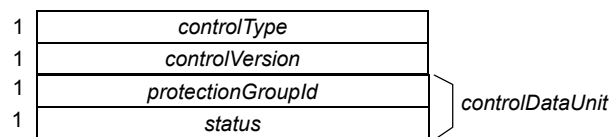


**Figure 12.13—PIRC frame payload format**

The header fields (specified in 9.3, but not illustrated here) are additionally constrained as shown in Table 12.5.

Table 12.5—PIRC frame header field-value restrictions

| Field              | Sub-field | Value             | Description                                           |
|--------------------|-----------|-------------------|-------------------------------------------------------|
| <i>ttl</i>         | —         | MAX_STATIONS      | Allows PIRC frames to propagate through all stations. |
| <i>baseControl</i> | <i>sc</i> | CLASS_A0          | Sent as subclassA0.                                   |
|                    | <i>fe</i> | FALSE             | Not fairness eligible.                                |
| <i>da</i>          | —         | FF-FF-FF-FF-FF-FF | Allows PIRC frames to be received by any station.     |

**12.3.5.1 Protection Group ID:** A one-byte field identifying a protection group.

**12.3.5.2 Status:** The status field consists of multiple sub-fields, as illustrated in Figure 12.14:

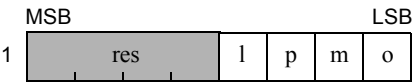


Figure 12.14—PIRC frame status field

**12.3.5.2.1 *res*:** Reserved (4 bits).

**12.3.5.2.2 *lb*:** A one-bit field for marking that this PIRC station works in load-balancing mode.

**12.3.5.2.3 *pr*:** A one-bit field for marking that this PIRC station is provisioned as the primary protection group member.

**12.3.5.2.4 *ms*:** A one-bit field for marking that this PIRC station is in the PIRC protection state of PIRC\_MANUAL\_SWITCH.

**12.3.5.2.5 *ok*:** A one-bit field for marking that this PIRC station is capable of interconnecting functionality.

12.5 OAM state machines

12.5.1 OamFrameTransmit state machine

12.5.1.1 OamFrameTransmit state machine definitions

*Insert the following definition in alphabetical order into 12.5.1.1.*

OAM\_PIRC\_STATUS

12.5.1.3 OamFrameTransmit state machine routines

Insert the following routine in alphabetical order in 12.5.1.3.

PircStatusFrame(frame)  
Formats the remaining frame field values for a PIRC status frame (see 12.3.5).

12.5.1.4 OamFrame transmit state table

Insert the following entry in Table 12.3 after row 6 and renumber remaining rows.

|  |                                      |   |                                 |  |
|--|--------------------------------------|---|---------------------------------|--|
|  | frame.controlType == OAM_PIRC_STATUS | 7 | frame = PircStatusFrame(frame); |  |
|--|--------------------------------------|---|---------------------------------|--|

Insert a new row description below Table 12.3 after row 12.3-6 as follows. Renumber as necessary.

Row 12.3-7: If the client opcode indicates PIRC status, generate a PIRC status frame.

12.5.2 OamFrameReceive state machine

12.5.2.3 OamFrameReceive state machine routines

Insert the following routine definition in alphabetical order into 12.5.2.3.

PircMateMsgReceive()  
Processes received PIRC status message from the PIRC mate (see 15.4.2).

12.5.2.4 OamFrameReceive state table

Insert the following entry in Table 12.4 after row 5 and renumber remaining rows.

|  |                                               |   |                              |  |
|--|-----------------------------------------------|---|------------------------------|--|
|  | (rxFrame = Dequeue(Q_RX_PIRC_STATUS)) != NULL | 6 | PircMateMsgReceive(rxFrame); |  |
|--|-----------------------------------------------|---|------------------------------|--|

Change the numbering of Row 12.5-5 to 12.4-5 as shown.

Row 12.4-5 ~~12.5-5~~: Purge selected entries found in the SBD associated with the source address of the frame.

Insert a new row description after Row 12.4-5 as follows. Renumber as necessary.

Row 12.4-6: Process received PIRC status frame.

## 12.7 Protocol Implementation Conformance Statement (PICS) proforma for Clause 12<sup>1</sup>

### 12.7.3 PICS tables for Clause 12

#### 12.7.3.6 SAS notify

*Insert the following new subclause 12.7.3.7 after 12.7.3.6.*

#### 12.7.3.7 PIRC

| Item | Feature      | Subclause | Value/Comment                                      | Status | Support                                                         |
|------|--------------|-----------|----------------------------------------------------|--------|-----------------------------------------------------------------|
| PS1  | PIRC support | 15.1      | Protected inter-ring connection sublayer supported | O      | Yes [ <input type="checkbox"/><br>No [ <input type="checkbox"/> |

<sup>1</sup> Copyright release for PICS proformas: Users of this standard may freely reproduce the PICS proforma in this clause so that it can be used for its intended purpose and may further publish the completed PICS.

14. Spatially aware sublayer

14.5 SAS operations

14.5.4 SAS receive operation

14.5.4.1.1 SasReceive state machine definitions

Replace the text of 14.5.4.1.1 with the following:

FLOOD\_NONE  
See 14.2.3.  
NULL  
See 14.2.3.  
Q\_RX\_SAS  
Q\_RX\_PIRC  
See 7.2.1.  
SAS\_GROUP\_ADDRESS  
See 14.2.3.

14.5.4.1.4 SasReceive state table

Replace the text of row 8 in Table 14.9 with the following:

|       |   |   |                            |       |
|-------|---|---|----------------------------|-------|
| FINAL | — | 8 | Enqueue(Q_RX_PIRC, frame); | START |
|-------|---|---|----------------------------|-------|

Replace the text of row 14.9-8 below Table 14.9 with the following:

Row 14.9-8: Pass the frame to the PIRC sublayer.



*Insert the following new Clause 15 after Clause 14.*

## 15. Protected inter-ring connection

### 15.1 Overview

Protected inter-ring connection (PIRC) is an optional sublayer of the MAC that may be implemented. PIRC supports rings interconnected through dual-station homing, providing fast recovery, loop prevention, and load-balancing features. The interconnecting stations may be a discrete network element on each ring with back-to-back connections or a single network element with multiple stations on each of the rings.

PIRC provides protection from interconnect station failures in less than 50 ms. Non-interconnect stations benefit from this fast recovery without any need to implement the optional PIRC sublayer. PIRC also provides maintenance commands (e.g., manual switch-over) to facilitate servicing of interconnect stations with no user impact.

PIRC always prevents loops in steady-state operation. Temporary loops might occur during the transient process between normal and failure states.

An active/standby algorithm is the mandatory method for forwarding across an interconnect. PIRC defines several load-balancing options for an operator. Optionally, load-balancing algorithms based upon VLAN hash, static VLAN assignments, or other methods are allowed but not specified in this standard. These methods must follow several defined constraints. All load-balancing designs shall allow unicast traffic to be forwarded without persistent flooding or loss of connectivity. Any hashing required will not be based on MAC addresses.

#### 15.1.1 PIRC stations

A pair of PIRC stations are shown in Figure 15.1. PIRC mate stations (Stations A and B) are stations on the same interconnected ring. Alternatively, Stations C and D can also be PIRC mate stations (instead of Stations A and B). In a topology of multiple rings, all the rings should have protection group members with the exception of one of the rings, in order to provide connectivity between the stations without loops.

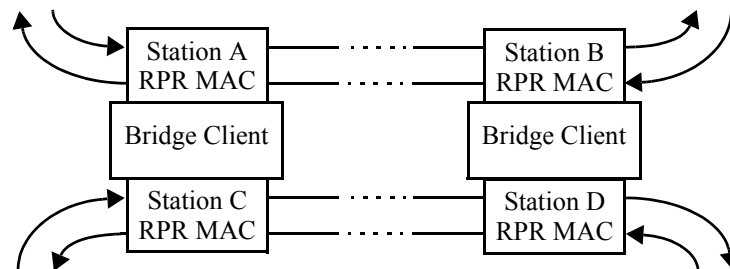


**Figure 15.1—PIRC station types**

#### 15.1.1.1 PIRC information communication between PIRC mate stations

PIRC messages are exchanged between PIRC mate stations and consist of the following information:

- a) ok—indication that the station is alive, the operational status is up, no misconfiguration has been detected, and the protection status is not in a failure, forced switch, or wait-to-restore condition.
- b) ms—indication that the station is in a manual switch protection state.
- c) pr—indication that the station is provisioned as the primary protection group member.
- d) lb—indication that the station is provisioned in PIRC load-balancing mode.

These mate messages are also used as a keep-alive to detect the existence of a provisioned PIRC mate station.

#### 15.1.2 PIRC load balancing

By default there is no load balancing. If load balancing is implemented, it is implementation specific.

NOTE—The ATD organization-specific ATT defined in 11.4.8 could be used to provide information on implementation-specific load balancing.

##### 15.1.2.1 Load balancing based on VLAN hashing

VLAN-based hashing is one of the possible methods for the vendor-specific load-balancing implementations. In this method, the function `pireMyFlow()` (see 15.4.1) is implemented as a comparison of the result of a bit-wise-xor of the VID of the forwarded frame to '1'.

##### 15.1.2.2 Load balancing based on static VLAN assignments

VLANs are assigned to one of the PIRC interconnecting stations by manual configuration to achieve load balancing. On each PIRC interconnecting station, the suitable VLAN range is configured, and it must be guaranteed that the intersection of the VLAN ranges configured at different interconnecting stations is empty. It is judged by the PIRC interconnecting stations based on the VLAN carried, whether the copy of the broadcast traffic is forwarded to the inter-ring. Each PIRC interconnecting station only forwards the broadcast traffic from VLANs assigned to it. The unicast traffic is forwarded along the path learned through the broadcast traffic.

#### 15.1.3 PIRC misconfiguration detection

There are two possible misconfigurations that can be detected:

- a) In a protection group both members are primary or both members are secondary.
- b) The members of a group have different settings for load balancing or not.

#### 15.1.4 PIRC failure conditions

The following PIRC failure conditions are applicable for a PGM:

- a) Detection of PIRC misconfiguration.
- b) Loss of connectivity with PIRC mate station.

### 15.1.5 PIRC maintenance commands

The following PIRC maintenance commands are applicable for a PGM:

- a) PIRC forced switch command—A management directive that forces the PGM to deactivate inter-ring connectivity.
- b) PIRC manual switch command—A management directive that (if not overridden) deactivates the PGM inter-ring connectivity.
- c) PIRC idle command—A management directive that (if not overridden) activates PGM inter-ring connectivity.

### 15.1.6 PIRC reversion mode

A mode of operation of a PIRC station in which, upon clearing of PIRC failures, the station remains in a wait-to-restore protection state until the wait-to-restore condition is preempted by a higher priority protection condition elsewhere on the protection group, or PIRC\_IDLE administrative request.

### 15.1.7 PIRC protection hierarchy

The effect of the protection condition and commands depends on the severity order, listed as follows, where the top-through-bottom conditions are listed in order of most-through-least severity.

- a) PIRC\_FORCED\_SWITCH—The PIRC state following PIRC creation or subsequent to a PIRC forced switch administrative command.
- b) PIRC\_FAILURE—The PIRC state during PIRC misconfiguration condition or loss of ring interface.
- c) PIRC\_PROTECTING—The PIRC state while PIRC mate station deactivates inter-ring connectivity.
- d) PIRC\_MANUAL\_SWITCH—The PIRC state following PIRC manual switch administrative command.
- e) PIRC\_WTR—The PIRC state after PIRC\_FAILURE, the PIRC wait-to-restore timer improves stability in the presence of transient failures.
- f) PIRC\_CONTAINMENT—The PIRC state preceding PGM activation of inter-ring connectivity, the PIRC containment timer prevents frame duplication during PIRC transient events.
- g) PIRC\_NO\_REQUEST—The PIRC state while PIRC is not deactivated using management directive or other failure condition.

NOTE—The value of the containment timer should be provisioned to the sum of: the PIRC mate message forwarding delay + the message processing and protection update delay + ring transit latency.

### 15.1.8 PIRC ring-interconnection forwarding states

Three ring interconnection forwarding states are supported as follows:

- a) Forward all—The PIRC station disables the PIRC filtering in the inter-ring connection. This forwarding state is engaged while the PIRC protection status is PIRC\_PROTECTING. In addition, for non-load-balancing primary protection group members, this forwarding state is engaged while the PIRC protection status is PIRC\_NO\_REQUEST.
- b) Forward mine—The PIRC station enables the PIRC selective filtering in the inter-ring connection. This forwarding state is applicable only to PIRC load-balancing stations. This forwarding state is engaged while the PIRC protection status is PIRC\_NO\_REQUEST or PIRC\_CONTAINMENT state if preceded by PIRC\_NO\_REQUEST state.

- c) Forward none—The PIRC station deactivates the inter-ring connection. This forwarding state is engaged while the PIRC protection status is PIRC\_FORCED\_SWITCH, PIRC\_FAILURE, PIRC\_WTR, PIRC\_MANUAL\_SWITCH, or PIRC\_CONTAINMENT unless preceded by PIRC\_NO\_REQUEST state. In addition, for non-load-balancing secondary protection group members, this forwarding state is engaged while the PIRC protection status is PIRC\_NO\_REQUEST or PIRC\_CONTAINMENT.

## 15.2 Terminology and variables

### 15.2.1 Common definitions

This subclause uses the following terms:

primary protection group member  
See 3.2.1.  
protection group  
See 3.2.4.  
protection group member  
See 3.2.5.  
protection inter-ring connection (PIRC) mate station  
See 3.2.2.  
protection inter-ring connection (PIRC) station  
See 3.2.5.  
secondary protection group member  
See 3.2.6.

### 15.2.2 Common state machine variables

*adminPircReq()*

An administrative PIRC protection request, with the following values:

PIRC\_FS—Indicates a PIRC forced switch command.  
PIRC\_MS—Indicates a PIRC manual switch command.  
PIRC\_IDLE—Indicates the clearing of PIRC\_WTR state or a PIRC forced switch or PIRC manual switch command.  
NULL—No PIRC administrative protection request is available.

### 15.2.3 Common state machine routines

*pircConfigDefect()*

Determines if a configuration defect exists.

TRUE—A configuration defect exists.  
FALSE—(Otherwise.)

(pircLbDefect || pircPrDefect)

*pircWtrExpired()*

Determines if the protection state is PIRC\_WTR state and the timer expired.

TRUE—protection state is PIRC\_WTR state and the timer expired.

FALSE—(otherwise.)

((pircInfo.protState == PIRC\_WTR) && pircProv.pircRevertive &&  
((currentTime-pircInfo.startTime) >= pircProv.wtrTimeout))

*pircContainmentExpired()*

Determines if the protection state is PIRC\_CONTAINMENT state and the timer expired.

TRUE—protection state is PIRC\_CONTAINMENT state and the timer expired.

FALSE—(otherwise.)

((pircInfo.protState == PIRC\_CONTAINMENT) && ((currentTime-pircInfo.startTime)  
>= pircProv.pcTimeout))

**15.2.4 Variables and routines defined in other clauses***ifOperStatus*

See D.5.2.

*Reachable(address, ringlet)*

See 14.2.3.

**15.2.5 Defect indications***pircLbDefect*

See 11.2.9.

*pircPrDefect*

See 11.2.9.

**15.3 PIRC database**

The PIRC database is partitioned into multiple components, as described in Figure 11.25 and listed as follows:

- a) Provisioning information (see 15.3.1)
- b) Dynamic information (see 15.3.2)
- c) Mate information (see 15.3.3)

**15.3.1 pircProv provisioning database**

The pircProv database consists of all the PIRC administrative provisioning for the PIRC station. See Table 15.1.

**Table 15.1—PIRC pircProv database**

| Variable              | Description                                                                                             | Values                                                             |
|-----------------------|---------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|
| pircRevertive         | See PIRC                                                                                                | Range: [TRUE, FALSE]<br>Default: FALSE                             |
| pircLoadBalancing     | See PIRC                                                                                                | Range: [TRUE, FALSE]<br>Default: FALSE                             |
| fastMateMsgRpt        | Number of times a PIRC mate message should be retransmitted after PIRC status change                    | Range: [1, 10]<br>Resolution: 1<br>Default: 3                      |
| fastMateMsgInterval   | Time interval between PIRC mate message retransmission after PIRC status change                         | Range: [1 ms, 1000 ms]<br>Resolution: 1 ms<br>Default: 10 ms       |
| slowMateMsgInterval   | Time interval between periodic PIRC mate message                                                        | Range: [10 ms, 10 000 ms]<br>Resolution: 10 ms<br>Default: 100 ms  |
| wtrTimeout            | PIRC WTR time-out interval                                                                              | Range: [0 s, 100 s]<br>Resolution: 1 s<br>Default: 10 s            |
| pcTimeout             | PIRC containment time-out interval                                                                      | Range: [0 ms, 1000 ms]<br>Resolution: 10 ms<br>Default: 50 ms      |
| mateKeepAliveInterval | Time interval without reception of any PIRC mate message for determining of PIRC mate connectivity loss | Range: [30 ms, 100 000 ms]<br>Resolution: 10 ms<br>Default: 350 ms |
| pircPrimary           | Indicates this station is the primary station in the protection group                                   | Range: [TRUE, FALSE]<br>Default: TRUE                              |

**15.3.2 pircInfo dynamic information database**

The pircInfo database consists of all the PIRC dynamic information for the PIRC station. See Table 15.2.

**Table 15.2—PIRC pircInfo database**

| Variable     | Description                                                                                                                              | Values               |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| protState    | PIRC protection state (see 15.1.8)                                                                                                       | —                    |
| startTime    | Triggering time of the WTR or containment timer                                                                                          | —                    |
| ifOperStatus | The station ifOperStatus at the time of the last PIRC status update                                                                      | —                    |
| active       | Indicates if the PIRC station could perform ring-interconnection functionality                                                           | Range: [TRUE, FALSE] |
| pcFwd        | Relevant only for load-balancing PIRC stations—indicates if the PIRC station should forward its PIRC flows during PIRC containment state | Range: [TRUE, FALSE] |
| pircMateLoss | Indicates loss of communication with the PIRC Mate                                                                                       | Range: [TRUE, FALSE] |

**15.3.3 pircMateMsg mate information database**

The pircMateMsg database consists of all the parameters related to PIRC mate messages for the PIRC station. See Table 15.3.

**Table 15.3—PIRC pircMateMsg database**

| Variable      | Description                                                                               | Values                       |
|---------------|-------------------------------------------------------------------------------------------|------------------------------|
| fastMsgCnt    | Number of fast PIRC mate messages remained to be retransmitted (after PIRC status change) | Range: [0, 10] Resolution: 1 |
| lastTimeStamp | The time of the last received PIRC mate message                                           | —                            |
| macAddress    | MAC address of last received PIRC mate message                                            | —                            |
| ok            | The ok field from the last received PIRC mate message                                     | Range: [TRUE, FALSE]         |
| ms            | The ms field from the last received PIRC mate message                                     | Range: [TRUE, FALSE]         |
| pr            | The pr field from the last received PIRC mate message                                     | Range: [TRUE, FALSE]         |
| lb            | The lb field from the last received PIRC mate message                                     | Range: [TRUE, FALSE]         |

## 15.4 State machines

### 15.4.1 State machine functions

#### *pircFwdNone()*

Determines if the protection group member should not forward all data frames (see 15.1.8).

TRUE—The protection group member should not forward all data frames.

FALSE—(Otherwise.)

((pircInfo.protState == PIRC\_FS) || (pircInfo.protState == PIRC\_FAILURE) ||  
(pircInfo.protState == PIRC\_MS) || (pircInfo.protState == PIRC\_WTR) || !pircInfo.pcFwd  
&& (pircInfo.protState == PIRC\_CONTAINMENT) || !pircProv.pircLoadBalancing &&  
!pircProv.pircPrimary && (pircInfo.protState == PIRC\_NO\_REQUEST))

#### *pircFwdAll()*

Determines if the protection group member should forward all data frames (see 15.1.8).

TRUE—The protection group member should forward all data frames.

FALSE—(Otherwise.)

((pircInfo.protState == PIRC\_PROTECTING) || !pircProv.pircLoadBalancing &&  
pircProv.pircPrimary && (pircInfo.protState == PIRC\_NO\_REQUEST))

#### *pircMyFlow(frame)*

Performs load-balancing forwarding decision. Implementation is vendor specific (see 15.1.2).

TRUE—The protection group member should forward the data frame.

FALSE—(Otherwise.)

### 15.4.2 PircMateMsgReceive state machine

#### 15.4.2.1 PircMateMsgReceive state machine overview

This subclause specifies the state machine for processing PIRC mate messages.

#### 15.4.2.2 PircMateMsgReceive state machine definitions

There are no state machine definitions defined within this subclause.

#### 15.4.2.3 PircMateMsgReceive state machine variables

##### *enablePirc*

See 6.2.1.

##### *currentTime*

See 10.2.4.

##### *pircProv*

See 15.3.1.

##### *pircInfo*

See 15.3.2.

##### *pircMateMsg*

See 15.3.3.

##### *pircLbDefect*

See 15.2.5.

##### *pircPrDefect*

See 15.2.5.

#### 15.4.2.4 PircMateMsgReceive state machine routines

There are no state machine routines defined within this subclause.