Proposal for OAM and Layer Management

To IEEE 802.17

Edited by

Italo Busi, Alcatel

Constantinos Bassias, Lantern Communications

Change history

The following table shows the change history for this document.

Version 0.1 (27/07/2001)

Original version.

Version 0.2 (20/08/2001)

Category	Description
Editorial	Adapted to the common template

Version 0.3 (24/08/2001)

Category	Description
Editorial	Merging between the OAM&P and Layer Management documents

Version 0.4 (27/08/2001)

Category	Description
Editorial	Update of the assumptions made in the document. Restructure of section 2.
Technical	The loopback operation can be required by the management system through the SME. The proper primitives in the SME-MLME SAP are defined. It was added the RPR specific meaning of the generic objects defined in the IF-MIB.

Version 0.5 (27/08/2001)

Category	Description
Editorial	Update the Diagram in Chapter 3.
Technical	Added More MIB Tables

Version 0.7 (4/09/2001)

Category	Description
Editorial	Changed to common format and common terminology.
Technical	Added More MIB Tables

Abbreviations

MAC Medium Access Control

MAU Medium Attachment Unit

PHY Physical Interface

SAP Service Access Point

References

[B1] IEEE 802.3 – 2000 Edition

Carrier sense multiple access with collision detection (CSMA/CD) MAC and physical layer specification.

[B2] ITU-T G.774 Series

SDH Management Information Model for the Network Element View

[B3] ITU-T G.783

Characteristics of Synchronous Digital Hierarchy (SDH) Equipment Functional Blocks

[B4] ITU-T G.gfp

Generic Framing Procedure

[B5] RFC 2863

The Interfaces Group MIB

1 Introduction

The OAM&P (Operation, Administration, Maintenance and Provisioning) and Layer Management functionalities

[Editor's note – Add a brief introduction on what are the OAM&P functions.]

OAM&P and Layer Management usually covers the following functional management areas:

- Configuration management
- Fault management
- Performance management

The configuration management handles the NE configuration provisioning as well as checking and reporting configuration anomalies.

The fault management is responsible to detect and process any faults as well as to report it to the management system.

The performance management is responsible to monitor the system performance and to report statistics information to the management system.

In order to improve the fault and performance management capability, e.g. to allow fault detection, some in-band OAM functions are envisaged.

1.1 Overview of RPR systems

The IEEE 802.17 MAC is a single MAC layer supporting two physical interfaces on the ring: the east interface and the west interface (see Figure 1.1 and Figure 1.2).

Physical interfaces are usually bi-directional interfaces thus each span interface receives from one ringlet and transmits on the opposite ringlet. With a reference to Figure 1.1, the west span interface receives frames from the counterclockwise ringlet and transmits frames on the clockwise ringlet; the opposite applies to the east interface.

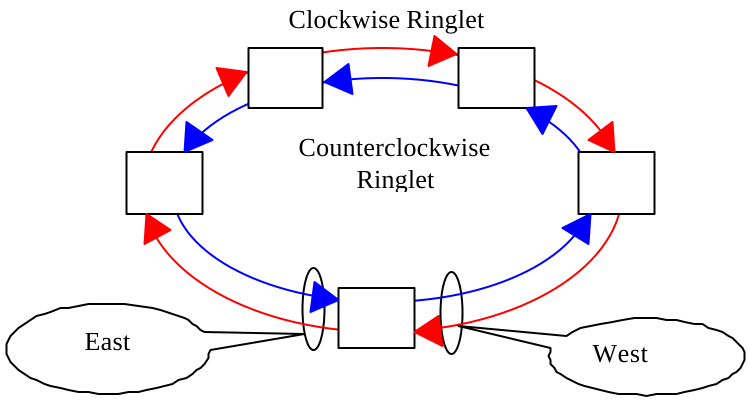

Figure 1.1 RPR Ring View

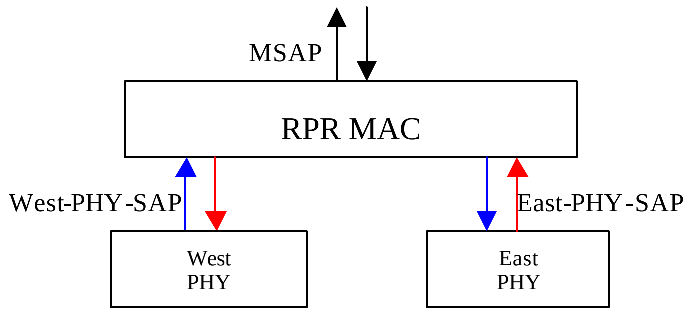

Figure 1.2 RPR Functional Model

The system has at least three interfaces: two (i.e. east and west) span interfaces (PHY-SAPs) and one RPR interface (MSAP) to the upper layers. The OAM&P requirements for the east and west span interfaces depend on the medium (i.e. Ethernet or Sonet/SDH) used while the OAM&P requirements of the RPR interface are independent on the physical medium.

The PHY layers can be either Ethernet or Sonet/SDH media. Some specific OAM&P requirements are already defined in the relevant standard recommendations. This document focuses on the missing requirements.

1.2 Overview of OAM

The Sonet/SDH has already defined an in-band OAM functionality (see G.783), that belongs to the PHY layer. According to G.783 on each span (that is a Sonet SPE or an SDH VC) it is possible to know if there is a Signal Fail (SF).

The IEEE 802.3 standards for 1 GbE (802.3ac) and 10 GbE (802.3ae) LAN PHY interfaces have no in-band OAM functionality defined. The only information that is known is if the physical interface is available or not available. The unavailability of the physical interface directly translates into a Signal Fail (SF) condition for the MAC layer.

The in-band OAM functionality for IEEE 802.3 standard 10 GbE (802.3ae) WAN PHY interface is TBD.

The IEEE 802.17 RPR re-uses the existing in-band OAM mechanisms for the PHY layers it is using.

Some OAM flows in the RPR MAC layer are defined in section 2. These are independent on the PHY technology used.

Other in-band OAM functionality may be needed in the upper layers, but this is outside the scope of the IEEE 802.17 MAC layer.

1.3 Structure of the document

Section 2 defines some OAM flows that are useful to help RPR fault management. In particular it defines a loopback mechanism only because RPR is a connectionless technology. This section will likely become an autonomous clause in the IEEE 802.17 standard.

Section 3 defines the Layer Management requirements for the RPR. It will likely become an autonomous clause in the IEEE 802.17 standard.

Section 4 defines the SNMP MIB objects for the RPR MAC layer. It will likely become an annex to the Layer Management clause in the IEEE 802.17 standard.

2 Operation Administration and Maintenance (OAM)

The IEEE 802.17 RPR MAC is a connectionless technology thus only a very simple in-band OAM can be envisaged: the on-demand in-service reachability check mechanism.

The only OAM frame that can be useful is an RPR ping frame. This frame can be used by any user to check the reachability of a particular destination, like the ping mechanism in the IP networks.

2.1 Generic OAM Frame Format

[Editor's note – The RPR frame format should allow the identification of RPR OAM frames. Some text will be added to recall that mechanism when the frame format group defines it.]

RPR OAM frames are RPR Control frames (with the Payload Type field equal to XXX and the Message Type field equal to XXX), as defined in clause 7.

The format of the control type specific part of the OAM frames is defined as show in Figure 1.3.

OAM Type	Specific Fields
Specific fields	Checksum

Figure 1.3 Generic OAM frame control type specific information

The following fields are defined.

- **OAM Type** – Specifies which type this OAM message is. All the allowed codes are defined in Table 1.2.
- **Specific Fields** – The length and the structure of this part depends on the OAM message type. The format of this structure is defined with the relevant OAM message type.
- **Checksum** – The last 16 bits of the OAM frame payload contain the checksum (CRC-16) calculated on the entire OAM message payload, starting from the OAM type and ending at the last specific field (if present). When an OAM frame is received with a bad checksum, it is silently discarded.

OAM Type	Description
0x00	RPR ping request
0x01	RPR ping reply
All the others	Reserved

Table 1.2 OAM Type values

Note – All the received OAM frames that are addressed to the station and have a reserved OAM Type must be silently discarded.

2.2 RPR Ping function

The IEEE 802.17 allows the management system to request an echo operation to a specified destination in order to check the reachability of an RPR station.

The management system can specify if the request must follow the shortest path (using the topology discovery), the clockwise or the counterclockwise ringlet. By default, if nothing is specified, the RPR ping request is sent on the shortest path.

It can specify also the CoS that should be used to ping the destination. By default, the highest priority CoS will be used.

It can require the addressed station to reply either on the shortest path, or on the same ringlet it received the request, or on the opposite ringlet, or on the counterclockwise or on the clockwise ringlet. By default, if nothing is specified, the addressed station is required to reply on the shortest path.

After the request is made on the source station, it will output an RPR OAM Ping Request frame to the addressed station, together with an indication over which ringlet that station should answer by using the Request Type field (see section 2.2.1).

When an RPR OAM Ping Request message addressed to this station is received, an RPR OAM Ping Reply message is sent as a response to the request's source station. The reply is sent over the ringlet selected in the request message.

When the RPR OAM Ping Reply message is received, the management system is notified about the success of the procedure. If the reply is not received within a pre-defined time interval, either because the request cannot reach the addressed station or because the reply cannot came back to the source station, the ping is declared failed and the management system is notified about this failure.

2.2.1 Ping Request OAM RPR Format

The format of the control type specific part of the Ping Request OAM RPR frame is shown in Figure 1.4.

<table>
<tr><td>OAM Type</td><td>Request Type</td><td>Identifier</td></tr>
<tr><td colspan="2">Sequence Number</td><td>Checksum</td></tr>
</table>

Figure 1.4 RPR Ping Request OAM format

The following fields are defined:

- **OAM Type** – Represents a ping request type (i.e. 0x02 value, as in Table 1.2)
- **Request Type** – It is used to ask the addressed station how to respond, if using the shortest path, the same or the opposite ringlet the request was receive, the counterclockwise or the clockwise ring. Valid values are defined in Table 1.3.
- **Identifier and Sequence Number** – They are used by the application to correlate the requests with the replies. The meaning of these two fields and how they are used to make the correlation are implementation dependent.

The Ping Request OAM RPR frame header fields are defined as follow:

- The destination address is filled with the value passed by the upper layer representing the station to be echoed.
- The Payload Type field is set to XXX (RPR Control Frame), as defined in clause 7.
- The CoS field is filled with the value requested by the upper layer.

Request Type	Description
0x00	The addressed station replies on the ringlet chosen by the shortest path (via topology discovery)
0x01	The addressed station replies on the counterclockwise ringlet
0x02	The addressed station replies on the clockwise ringlet
0x03	The addressed station replies on the same ringlet it has received the request
0x04	The addressed station replies on the opposite ringlet it has received the request
All the others	Reserved

Table 1.3 Request Type values

Note – Only the 0x00 request type value must be supported, all the other types are optional. All the requests that are received with an unsupported or a reserved request type value must be discarded.

2.2.2 Loopback Reply OAM message

The format of the control type specific part of the Ping Reply OAM RPR frame is shown in Figure 1.5.

OAM Type	Reserved	Identifier
Sequence Number		Checksum

Figure 1.5 RPR Reply OAM format

The following fields are defined:

- **OAM Type** – Represents a ping reply type (i.e. 0x03 value, as in Table 1.2)
- **Reserved** – This field is not used. It must be fixed to 0x00 in transmission and ignored in reception.
- **Identifier and Sequence Number** – They are copied from the request message and used by the application to correlate the requests with the replies. The meaning of these two fields and how they are used to make the correlation are implementation dependent.

The Ping Reply OAM RPR frame header fields are defined as follow:

- The destination address copied from the request's source address.
- The Payload Type field is set to XXX (RPR Control Frame), as defined in clause 7.
- The CoS field is copied from the loopback request frame.
- The Ringlet ID field represents the ringlet over which the OAM frame is sent. This ringlet is chosen according to the information in the Request Type field of the loopback request OAM message.

3 Layer Management

3.1 Overview of the management model

Both RPR MAC and all applicable PHY layers conceptually include management entities, called MAC sub layer management and PHY layer management entities (MLME and PLME, respectively). These entities provide the layer management service interfaces through which layer management functions may be invoked.

In order to provide correct RPR MAC operation, a station management entity (SME) must be present. The SME is a layer-independent entity that may be viewed as residing in a separate management plane. The exact functions of the SME are not specified in this standard, but in general this entity may be viewed as being responsible for such functions as the gathering of layer-dependent status from the various layer management entities, and similarly setting the value of layer-specific parameters. SME would typically perform such functions on behalf of general system management entities and would implement standard management protocols. Figure 1.6 depicts the relationship among management entities.

The management SAPs within this model are the following:

— SME-MLME SAP

--- SME-PLME SAP

In this fashion, the model reflects what is anticipated to be a stackable implementation approach in which PLME functions are controlled by SME. In particular, different PHY implementations are required to have separate interfaces with the SME. The interfaces of the SME with the different PHYs are not part of this standard and are specified in the respective standard documents that specify the management primitives and MIBs for the different PHYs.

=

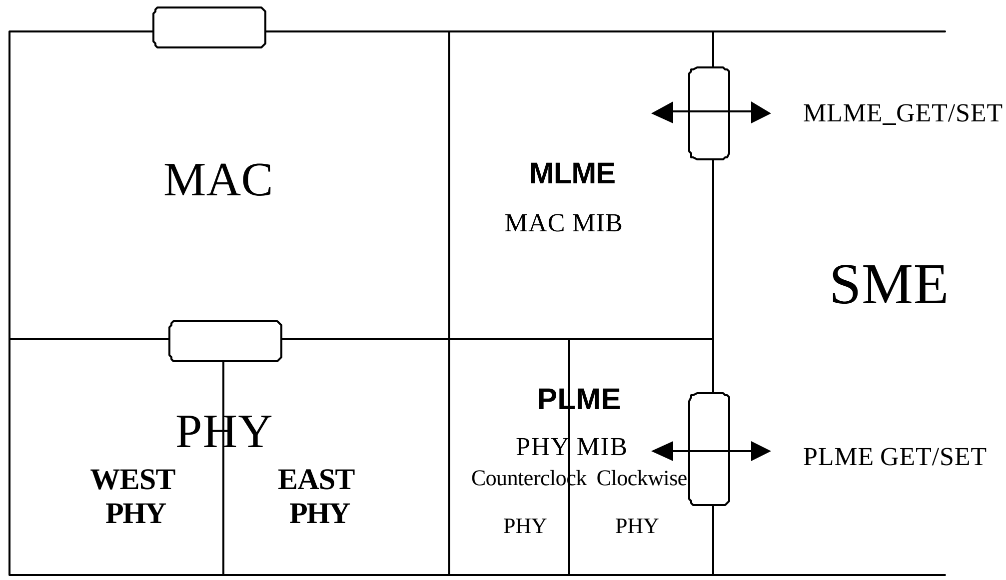

Figure 1.6 – RPR MAC Management SAPs

3.2 Generic management primitives

The management information specific to each layer is represented as a management information base (MIB) for that layer. The MAC and PHY layer management entities are viewed as "containing" the MIB for that layer. The generic model of MIB-related management primitives exchanged across the management SAPs is to allow the SAP user-entity to either GET the value of a MIB attribute, or to SET the value of a MIB attribute. The invocation of a SET.request primitive may require that the layer entity perform certain defined actions.

The GET and SET primitives are represented as REQUESTs with associated CONFIRM primitives. These primitives are prefixed by MLME or PLME depending upon whether the MAC or PHY layer management SAP is involved.

In the following, XX denotes MLME or PLME:

XX-GET.request (MIBattribute)

Requests the value of the given MIBattribute.

XX-GET.confirm (status, MIBattribute, MIBattributevalue)

Returns the appropriate MIB attribute value if status = "success," otherwise returns an error indication in the Status field. Possible error status values include "invalid MIB attribute".

XX-SET.request (MIBattribute, MIBattributevalue)

Requests that the indicated MIB attribute be set to the given value. If this MIBattribute implies a specific action, then this requests that the action be performed.

XX-SET.confirm (status, MIBattribute)

If status = "success," this confirms that the indicated MIB attribute was set to the requested value, otherwise it returns an error condition in status field. If this MIBattribute implies a specific action, then this confirms that the action was performed. Possible error status values include "invalid MIBattribute" and "attempt to set read-only MIB attribute."

Additionally, there are certain requests (with associated confirms) that may be invoked across a given SAP that do not involve the setting or getting of a specific MIB attribute. Each SAP supports one of these, as follows:

— XX-RESET.request: where XX is MLME or PLME as appropriate

— XX-RESET.confirm

This service is used to initialize the management entities, the MIBs, and the data path entities. It may include a list of attributes for items to be initialized to non-default values. The corresponding.confirm indicates success or failure of the request.

Other SAP-specific primitives are in the following sections.

3.3 MLME SAP interface

The services provided by the MLME to the SME are specified in this section. These services are described in an abstract way and do not imply any particular implementation or exposed interface. MLME SAP primitives are of the general form ACTION.request followed by ACTION.confirm. The SME uses the services provided by the MLME through the MLME SAP.

According to the IETF layering principles, the RPR interface should be stacked over the two west and east span interfaces.

3.3.1 RPR interface configuration

The RPR ring interface can be activated/deactivated for administrative purposes. Its activation/deactivation allows/forbids the upper layers to send packets on the ring. It can be activated if and only if at least one of the underlying span interfaces is activated.

The RPR interface has its own operational state that goes down when both the span interfaces go down.

The RPR MAC entity requires the MAC address. This is fixed by the vendor and can be only read for maintenance purposes.

3.3.2 Topology discovery monitoring

The configuration management should allow monitoring, for maintenance purposes, the state of the auto-configuration and topology discovery protocols. It should also allow disabling the support of some features, even if supported by all the stations on the ring.

The detailed configuration requirements for the auto-configuration and topology discovery protocols depend from the actual mechanism that will be used and are now for further study.

If some misconfiguration condition is detected, a notification is sent to the management system for maintenance purposes. For example, the topology discovery mechanism can discover that two stations on the ring have the same MAC address.

3.3.3 Protection switching

The protection management mechanisms that will be defined in this standard are based on information known to the MAC entity. PHY layer protection mechanisms are independent and are addressed in the appropriate PHY specifications.

The configuration management should allow monitoring, for maintenance purposes, the state of the protection switching.

It should also allow activating/deactivating the RPR protection as well as activating/deactivating the usage of the Signal Degrade condition as switching criteria.

When the RPR protection is deactivated, the RPR MAC never switches under failure conditions. When the usage of the SD as a switching criteria is disabled, the RPR MAC never switches because of a signal degrade condition detected on the physical interface.

In order to support multi-layer protection mechanisms, a hold-off timer should be configured for each span interface, because it highly depends on the kind of physical network you have between two adjacent RPR nodes, if any.

In order to ensure robustness against unstable alarms, a wait time to restore (WTR) should be configured for each node, because there is no need to have a granular configuration of it.

The usage of the hold-off timer and of the wait to restore is specified in the protection switching section.

It should be possible to force a switching event for operational purposes.

This mechanism deals with the modes under which an RPR MAC switches to protection.

3.3.3.1 MLME- SWITCHTOPROTECTION.request

This primitive requests a change in the protection mode of an RPR ring.

The primitive parameters are as follows:

MLME-SWITCHTOPROTECTION.request (

ReversionMode,

Side

)

This primitive is generated by the SME to implement a user request for a node to switch to protection at the east or the west side.

Name	Type	Valid range	Description
ReversionMode	Enumeration	FORCED, AUTOMATIC-REVERTIVE, AUTOMATIC-NONREVERTIVE	An enumerated type that describes the desired way to revert from protection
Side	Enumeration	WEST, EAST	An enumerated type that describes the side of the ring relative to the station that will switch

Effect of receipt

This request sets the reversion mode of the protection switch that occurs at the specified side. The MLME subsequently issues a MLME- SWITCHTOPROTECTION.confirm that reflects the results of the protection switch request.

3.3.3.2 MLME- SWITCHTOPROTECTION.confirm

This primitive confirms the change in protection switching mode.

The primitive parameters are as follows:

MLME- SWITCHTOPROTECTION.confirm (

ResultCode

)

Name	Type	Valid range	Description
ResultCode	Enumeration	SUCCESS, INVALID_PARAMETERS, NOT_SUPPORTED	Indicates the result of the MLME-SWITCHTOPROTECTION.request

This primitive is generated by the MLME as a result of an MLME-SWITCHTOPROTECTION.request by the SME. It is not generated until the switch is completed.

Effect of receipt

The SME is notified of the protection switch.

3.3.4 Performance and Accounting Measurements

The following statistics should be kept for the RPR interface.

1. RCF performance monitoring.
2. How many frames/octets have been inserted on the ring (by the upper layer)
3. How many frames/octets have been delivered to the upper layer
4. How many frames, received from the west interface, have been stripped because originated by the node itself
5. How many frames, received from the east interface, have been stripped because originated by the node itself
6. How many pass-through frames, received from the west interface, have been discarded because of the TTL expiration

7. How many pass-through frames, received from the east interface, have been discarded because of the TTL expiration
8. How many frames, received from the west interface, have been discarded because of a bad FCS (this counter is fixed to 0 when the cut-through method is implemented)
9. How many frames, received from the east interface, have been discarded because of a bad FCS (this counter is fixed to 0 when the cut-through method is implemented)
10. How many frames addressed to the node have been discarded because of a bad FCS (this counter is fixed to 0 when the store and forward method is implemented)
11. How many frames, addressed to the node, have been discarded because of an unknown or unsupported protocol.
12. How many frames addressed to the node have been discarded even if no error has been detected (e.g. because of buffer congestion). This counter has an implementation specific meaning and in some implementations it may be always equal to 0.
13. How many frames originated by the node have been discarded (e.g. because of buffer congestion). This counter has an implementation specific meaning and in some implementations it may be always equal to 0.
14. How many frames, received from the west interface, correctly passed-through the MAC entity.
15. How many frames, received from the east interface, correctly passed-through the MAC entity.
16. How many pass-through frames, received from the west interface, have been discarded even if no error has been detected (e.g. because of buffer congestion). This counter has an implementation specific meaning and in some implementations it may be always equal to 0.
17. How many pass-through frames, received from the east interface, have been discarded even if no error has been detected (e.g. because of buffer congestion). This counter has an implementation specific meaning and in some implementations it may be always equal to 0.

For the counters defined in points 1, 2, 9, 11, 12, 13, 14, 15 and 16, there is one counter for each QoS class and a global counter.

3.3.4.1 Topology Discovery statistics

The exact requirements depend on the mechanism that is used and then are for further study.

3.3.5 Notifications and Fault Management

TBD

3.3.6 RPR Ping Management

3.3.6.1 MLME-PING.request

This primitive requests the station to loopback another station on the RPR ring.

The primitive parameters are as follows:

MLME-PING.request (

Addressed Station,

Ringlet,

Request Type,

CoS,

Timer

)

This primitive is generated by the SME to implement a user request for a node to perform a ping operation.

Name	**Type**	**Valid range**	**Description**
Addressed Station	MAC Address	Any valid unicast MAC address	The MAC address of the RPR station to be ping
Ringlet	Enumeration	SHORTEST, COUNTERCLOCKWISE, CLOCKWISE	The ringlet over which the RPR ping request message should be sent (see section 2)
Request Type	Enumeration	SHORTEST, SAME, OPPOSITE, COUNTERCLOCKWISE, CLOCKWISE	The ringlet over which the addressed station should send the RPR ping reply message (see section 2)
CoS	Integer	(0…7)	The CoS to be used in the RPR OAM frames carrying the RPR ping request and reply messages.
Timer	Integer	(0..65535)	The number of seconds the source station should wait for the reply before declaring the ping

			failed.

Effect of receipt

This requests causes the station to send an OAM RPR ping request message.

3.3.6.2 MLME- PING.confirm

This primitive notifies the success or the failure of a ping operation.

The primitive parameters are as follows:

MLME- PING.confirm (

ResultCode

)

Name	Type	Valid range	Description
ResultCode	Enumeration	SUCCESS, INVALID_PARAMETERS, FAILURE	Indicates the result of the MLME- PING.request

This primitive is generated by the MLME as a result of an MLME- PING.request by the SME. It is not generated until the OAM RPR ping reply frame is received or the timer expires.

Effect of receipt

The SME is notified of the success or of the failure of the ping procedure.

3.4 Link Aggregation

If Link Aggregation for RPR Links is supported then Link Aggregation Objects and a Link Aggregation MIB will be defined. For this purpose the IEEE 802.3 link aggregation objects defined in the LAG-MIB (IEEE 802.3 – Annex 30C) might serve as a guide.

Link aggregation can be managed as an interface stacked over multiple RPR interfaces

A request for a new ifType for the aggregation should be forwarded to the IANA

3.5 PLME SAP interface

Each span interface can be activated/deactivated separately for administrative purposes. Its activation/deactivation allows/forbids the MAC layer to send packets on that span.

In order to avoid inconsistent configurations, a span interface can be deactivated only if the RPR interface has been deactivated or the other span interface is still active.

Each span interface has its own operational state that can be read for maintenance purposes.

The management of Sonet/SDH PHY as well as of Ethernet physical interfaces are already defined in the relevant standard recommendations. The IEEE 802.17 will reuse the already defined PLME SAP primitives to manage the Sonet/SDH and Ethernet PHY layers.

The number frames that are received or transmitted on each span interface are counted as span interface statistics representing the number of frames that the span interface has delivered or has received from the upper layer.

3.5.1 The Ethernet PHY

For the Ethernet PHY we will use the 802.3ae LAN and WAN PHY primitives. Also we will use the MIB objects that are defined in the MAU-MIB (RFC 2668) for the Ethernet PHY objects and the updated MIB in preparation (draft-ietf-hubmib-mau-mib-v3-00) for management of 10 Gb/s LAN PHY. In addition we will use the MIB objects defined in (draft-ietf-hubmib-wis-mib-00) to manage the10 Gb/s WAN PHY – called ETHER-WIS-MIB.

The Ethernet Reconciliation Sublayer management should be defined in the IEEE 802.17 specification.

According to the IETF layering principles, the RPR interface, when working over Ethernet interfaces, should be stacked over the west and east "Ethernet" interfaces.

An Ethernet span interface can be activated at any time, because it is the lowest level interface on the system. Its operational state goes down when the media is unavailable.

3.5.2 The SONET PHY

Sonet/SDH interfaces are layered interfaces and are managed as a set of stacked interfaces. The physical medium, the section and the line layers are managed as a single layered interface. The recommended IANA ifType is sonet (39). The Path layer is managed as a stacked interface over the Medium/Section/Line interface. The recommended IANA ifType is sonetPath (50). For the SONET PHY the SONET/SDH PHY objects are defined in the SONET-MIB (RFC 2558).

3.5.2.1 The GFP Adaptation Layer

An additional GFP interface might be stacked over the Path interface to represent the GFP adaptation layer.

The GFP management is outside the scope of IEEE 802.17.

According to the IETF layering principles, the RPR interface, when working over Sonet/SDH interfaces, should be stacked over the west and east GFP interfaces.

A GFP span interface can be activated only if the underlying Sonet/SDH interface is activated. Its operational state goes down when a signal fail condition is detected on the Sonet/SDH path or if there is a payload mismatch (the value in the received C2 byte is different than the GFP code, i.e. [TBD] value) or there is a loss of frame alignment.

[Editor's note – The signal label value to be put in the C2 byte of Sonet/SDH interfaces has not yet been assigned by ITU-T.]

4 RPR SNMP MIB Definition

4.1 Introduction

This section defines a portion of the Management Information Base (MIB) for use with network management protocols in the TCP/IP base Internets. In particular it defines objects for managing the IEEE 802.17 RPR interfaces.

This section includes a MIB module that is SNMPv2 SMI compliant.

4.2 The SNMP Management Framework

The SNMP Management Framework presently consists of five major components:

a) An overall architecture, described in RFC 2571 [1].

b) Mechanisms for describing and naming objects and events for the purpose of management. The first version of this Structure of Management Information

(SMI) is called SMIv1 and described in STD 16, RFC 1155, STD 16, RFC 1212 and RFC 1215. The second version, called SMIv2, is described in STD 58, RFC 2578, STD 58, RFC 2579 and STD 58, RFC 2580.

c) Message protocols for transferring management information. The first version of the SNMP message protocol is called SNMPv1 and described in STD 15, RFC 1157. A second version of the SNMP message protocol, which is not an Internet standards track protocol, is called SNMPv2c and described in RFC 1901 and RFC 1906. The third version of the message protocol is called SNMPv3 and described in RFC 1906, RFC 2572 and RFC 2574.

d) Protocol operations for accessing management information. The first set of protocol operations and associated PDU formats is described in STD 15, RFC 1157. A second set of protocol operations and associated PDU formats is described in RFC 1905.

e) A set of fundamental applications described in RFC 2573 and the view-based access control mechanism described in RFC 2575.

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. Objects in the MIB are defined using the mechanisms defined in the SMI.

This Annex specifies a MIB module that is compliant to the SMIv2. A MIB conforming to the SMIv1 can be produced through the appropriate translations. The resulting translated MIB must be semantically equivalent, except where objects or events are omitted because no translation is possible (use of Counter64). Some machine readable information in SMIv2 will be converted into textual descriptions in SMIv1 during the translation process. However, this loss of machine readable information is not considered to change the semantics of the MIB.

4.3 Structure of the MIB

4.4 Relationship to the Interfaces MIB

The Interface MIB [B5] requires that any MIB, which is an adjunct of the Interface MIB, clarify specific areas within the Interface MIB.

These areas were intentionally left vague in the Interface MIB to avoid over constraining the MIB, thereby precluding management of certain media-types.

Section 3.3 of [B5] enumerates several areas which a media-specific MIB must clarify. Each of these areas is addressed in a following subsection. The implementor is referred to [B5] in order to understand the general intent of these areas.

4.4.1 Layering Model

Any RPR interface is stacked over two lower-layer interfaces, representing the two spans.

The layering relationship between the RPR interface and the lower-layer interfaces is defined by the ifStackTable defined in [B5]. The RPR MIB module should define a way for the management system to designate which of the two span interface is the east and which is the west interface.

4.4.2 ifRcvAddressTable

This table contains all the IEEE 802.17 addresses, unicast, multicast or broadcast, for which this interface will receive packets and forward them up to a higher layer entity for local consumption. The format of the address, contained in the ifRcvAddressAddress object, is the same as for ifPhyAddress.

In the event that the interface is part of a MAC bridge, this table does not include unicast addresses, which are accepted for possible forwarding out some other port. This table is explicitly not intended to provide a bridge address filtering mechanism.

4.4.3 ifPhyAddress

This object contains the IEEE 802.17 address, which is placed in the source-address field of any RPR frames that is originated at this interface. Usually this will be kept in ROM on the interface hardware. Some systems may set this address via software.

If the address cannot be determined, an octet string of zero length should be returned.

The address is stored in binary in this object. The address is stored in "canonical" bit order, that is, the Group Bit is positioned as the low-order bit of the first octet. Thus, the first byte of a multicast address would have the bit 0x01 set.

4.4.4 ifType

This MIB applies to interfaces which have the following ifType value:

ieee80217Rpr (TBA)

A request for a new ifType for the RPR interface should be forwarded to the IANA

4.4.5 Specific Interface MIB Object

Table 1.4 provides specific guidelines for applying the interface group generic objects to the RPR media.

Object	Definitions
ifIndex	A unique value is allocated to each RPR interface by the local system. It is interpreted as defined in [B5].
ifDescr	Refer to [B5].
ifType	Refer to section 4.4.4.
ifMTU	TBD octets. This is the MTU as seen by the MAC client.
ifSpeed	The current operational speed of the interface. Both the east and west span interfaces are assumed to have the same speed.
ifPhysAddress	Refer to section 4.4.3.
ifAdminStatus	Refer to [B5].
ifOperStatus	It goes “down” when both the span interfaces’ operation status is “down”. It is “up” when either one of the span interfaces’ operational status is “up”.
ifLastChange	Refer to [B5].
ifInOctets	Refer to [B5]: the number of octets in valid MAC frames received on this RPR interface, including the MAC header and FCS.This does not include the number of octets in valid MAC control frames received on this interface, because they are not passed to any higher layer protocol.
ifInUCastPkts	Refer to [B5]. This does not include the MAC control frames received on this interface, because they are not passed to any higher layer protocol.
ifInDiscards	Refer to [B5].
ifInErrors	TBD
ifInUnknownProtos	Refer to [B5].
ifOutOctets	Refer to [B5]: the number of octets in valid MAC frames transmitted on this RPR interface, including the MAC header and FCS. This does not include the number of octets in valid MAC control frames transmitted on this interface, because they are not generated by any higher layer protocol.
ifOutUcastPkts	Refer to [B5]. This does not include the MAC control frames transmitted on this interface, because they are not generated by any higher layer protocol.
ifOutDiscards	Refer to [B5].

ifOutErrors	TBD
ifName	Refer to [B5].
ifInMulticastPkts	Refer to [B5]. This does not include the MAC control frames received on this interface, because they are not passed to any higher layer protocol.
ifInBroadcastPkts	Refer to [B5]. This does not include the MAC control frames received on this interface, because they are not passed to any higher layer protocol.
ifOutMulticastPkts	Refer to [B5]. This does not include the MAC control frames transmitted on this interface, because they are not generated by any higher layer protocol.
ifOutBroadcastPkts	Refer to [B5]. This does not include the MAC control frames transmitted on this interface, because they are not generated by any higher layer protocol.
ifHCInOctets ifHCOutOctets	Refer to [B5].
ifHCInUcastPkts ifHCInMulticastPkts ifHCInBroadcastPkts ifHCOutUcastPkts ifHCOutMulticastPkts ifHCOutBroadcastPkts	Refer to [B5].
ifLinkUpDownTrapEnable	Refer to [B5]. Default is 'disabled' because the RPR interface is not the lowest-level one.
ifHighSpeed	Refer to [B5].
ifPromiscuousMode	Refer to [B5].
ifConnectorPresent	This will always be 'false', because it is not a lowest-level interface.
IfAlias	Refer to [B5].
ifCounterDiscontinuityTime	Refer to [B5]. A discontinuity in the Interface MIB counters may also indicate a discontinuity in some or all of the counters in this MIB that are associated with tat interface/
ifStackHigherLayer ifStackLowerLayer ifStackStatus	Refer to section 4.4.1.
ifRcvAddressAddress ifRcvAddressStatus ifRcvAddressType	Refer to section 4.4.2.

Table 1.4ifTable element definitions for an RPR interface

4.5 Definitions for the RPR MIB

```
-- *****************************************************************
-- Textual Conventions
-- *****************************************************************

   InterfaceSide ::= TEXTUAL-CONVENTION
       STATUS current
       DESCRIPTION
         "The interface side on the ring."
       SYNTAX INTEGER {
            east (1),
            west (2) }

-- *****************************************************************
-- the RRP MAC Interface group
-- *****************************************************************

   rprIfTable OBJECT-TYPE
       SYNTAX  SEQUENCE OF RprIfEntry
       MAX-ACCESS  not-accessible
       STATUS  current
       DESCRIPTION
         "The RPR interface table."
       ::= { rprMAC 1 }

   rprIfEntry OBJECT-TYPE
       SYNTAX  RprIfEntry
       MAX-ACCESS  not-accessible
       STATUS  current
       DESCRIPTION
         "There exists one such entry for every interface
          in the ifTable which has an ifType of RPR interface.
          Each of these entries are indexed by the value
          of ifIndex as defined in RFC2863."
       INDEX   { ifIndex }
       ::= { rprIfTable 1 }
```

```
   RprIfEntry ::=
    SEQUENCE {
         rprNodesOnTheRing       Integer32,
         rprWaitToRestoreTimer   Integer32,
         rprIfTimeElapsed        Integer32,
         rprProtectionState      INTEGER,
         rprIfValidIntervals     Integer32
  }



-- *******************************************************************
-- The dual counter rotating ring topology map
-- *******************************************************************
   rprRingTopologyMapTable OBJECT-TYPE
       SYNTAX  SEQUENCE OF RprRingTopologyMapEntry
       MAX-ACCESS  not-accessible
       STATUS  current
       DESCRIPTION
            "A list of RPR MACs that form a dual counter rotating ring.
            This list represents the topology of the ring as viewed
            from a specific station."
       ::= { rprMAC  2 }

   RprRingTopologyMapEntry OBJECT-TYPE
       SYNTAX  RprRingTopologyMapEntry
       MAX-ACCESS  not-accessible
       STATUS  current
       DESCRIPTION
         "A topology entry containing information
          specific to a particular station on the ring.
          The distance is computed counterclockwise on the ring."
       INDEX   { ifIndex, rprStationDistance }
       ::= { rprRingTopologyMapTable 1 }

   RprRingTopologyMapEntry ::=
       SEQUENCE {
```

```
        rprStationDistance
                Unsigned32,
        rprStationMACAddress
                MacAddress,
        rprStationMACName
                DisplayString
    }



-- *******************************************************************
-- The PRP MAC to PHY side table
-- *******************************************************************


   rprMACSideTable OBJECT-TYPE
       SYNTAX  SEQUENCE OF rprMACSideEntry
       MAX-ACCESS  not-accessible
       STATUS  current
       DESCRIPTION
         "A table of information about the sides of RPR interfaces."
       ::= { rprMAC  3 }

   rprMACSideEntry OBJECT-TYPE
       SYNTAX  RprMACSideEntry
       MAX-ACCESS  not-accessible
       STATUS  current
       DESCRIPTION
         "A list of information specific to a particular
          side of a particular RPR interface."
       INDEX   { ifIndex, rprMACInterfaceSide }
       ::= { rprMACSideTable 1 }

   RprMACSideEntry ::=
       SEQUENCE {
           rprMACInterfaceSide
                   InterfaceSide,
```

```
        rprMACNeighborAddress
                MacAddress,
        rprMACReversionMode
                ReversionMode,
        rprMACAutoDetectionMode
                DetectionMode,
        rprMACTopologyTimer
                Integer32
    }

-- ******************************************************************
-- The RPR MAC RCF Performance Monitoring Table
-- ******************************************************************


-- ******************************************************************
-- The RPR MAC Protection switch thresholds Table
-- ******************************************************************


-- ******************************************************************
-- The RPR MAC Protection switch thresholds Table
-- ******************************************************************


-- ******************************************************************
-- The RPR MAC Interval Counters
-- ******************************************************************

-- ******************************************************************
-- The RPR MAC Interval Traffic Counters
-- ******************************************************************

-- ******************************************************************
-- The RPR MAC Interval Error Counters
-- ******************************************************************
```

```
-- ******************************************************************
-- The RPR MAC Counters
-- ******************************************************************

-- ******************************************************************
-- The RPR MAC Notifications
-- ******************************************************************
```