8. MAC Physical Interface

Editors' Notes: *To be removed prior to final publication.*

References:
IEEE Standard 802.3 Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications
IEEE P802.3ae Draft 4.1
ANSI T1.105.02
ITU-T G.707 Network Node Interface for the Synchronous Digital Hierarchy
ITU-T G.783 Characteristics of SDH Equipment Functional Blocks
ITU-T G.709
ITU-T G.7041 Generic Framing Procedure
IETF RFC 1662 PPP in HDLC-like Framing
IETF RFC 2615 PPP over SONET/SDH

Definitions:
None.

Abbreviations:
Various.

Revision History:

Draft, March 2002	Draft for comment resolution for March meeting.

8.1 Overview

8.1.1 Scope

This clause specifies the resilient packet ring (RPR) media access controller (MAC) physical layer interfaces, and describes the physical layer entities (PHYs) specified for use in RPR systems.

This standard does not specify any new PHYs for RPR implementations. Rather, it defines two families of reconciliation sublayers for use with Ethernet and SONET/SDH PHYs. The reconciliation sublayers map the logical MAC physical layer service primitives to and from standard electrical interfaces used by the PHYs.

The Ethernet reconciliation sublayers provide interfaces to standard gigabit Ethernet and ten gigabit Ethernet LAN and WAN PHYs. Although this clause provides interfaces that allow RPR implementations to use standard Ethernet PHYs, these implementations do not provide Ethernet-compliant interfaces. RPR systems using Ethernet PHYs at the MAC physical layer service interface will not interoperate with Ethernet systems.

The SONET/SDH reconciliation sublayers provide interfaces to adaptation sublayers that specify either generic framing procedure (GFP) or byte-synchronous high-level link control (HDLC) -like framing, for SONET/SDH networks and PHYs operating at 155 Mbps to 9.95 Gbps. Although this clause provides interfaces that allow RPR implementations to use standard SONET/SDH PHYs, these implementations may not provide compliant SONET/SDH interfaces. RPR systems using SONET/SDH PHYs at the MAC physical layer service interface may not interoperate with SONET/SDH systems.

A compliant RPR implementation may use either Ethernet or SONET/SDH interfaces and PHYs, and may operate at various data rates. No specific configuration is preferred or recommended over another by this standard.

A compliant RPR MAC implementation requires at least one of the reconciliation sublayers specified in this clause. Implementations may include more than one reconciliation sublayer.

Implementations other than those described in this standard, such as the use of Ethernet reconciliation sublayers to provide SONET/SDH interfaces or SONET/SDH reconciliation sublayers to support Ethernet PHYs, may provide interoperable implementations but are beyond the scope of this standard.

8.1.2 Objectives

The objectives of the RPR physical layer interfaces and PHYs are:

a) Support the resilient packet ring MAC;
b) Support gigabit Ethernet and ten gigabit Ethernet PHYs;
c) Support SONET/SDH PHYs using GFP or byte-synchronous HDLC-like framing and operating at speeds of 155 Mbps to 9.95 Gbps;
d) Support synchronous or asynchronous network applications;
e) Support full duplex operation only.

8.1.3 Relationship to other standards

Figure 8-1 shows the relationship between the RPR MAC, reconciliation sublayers, adaptation sublayers, and physical layers.

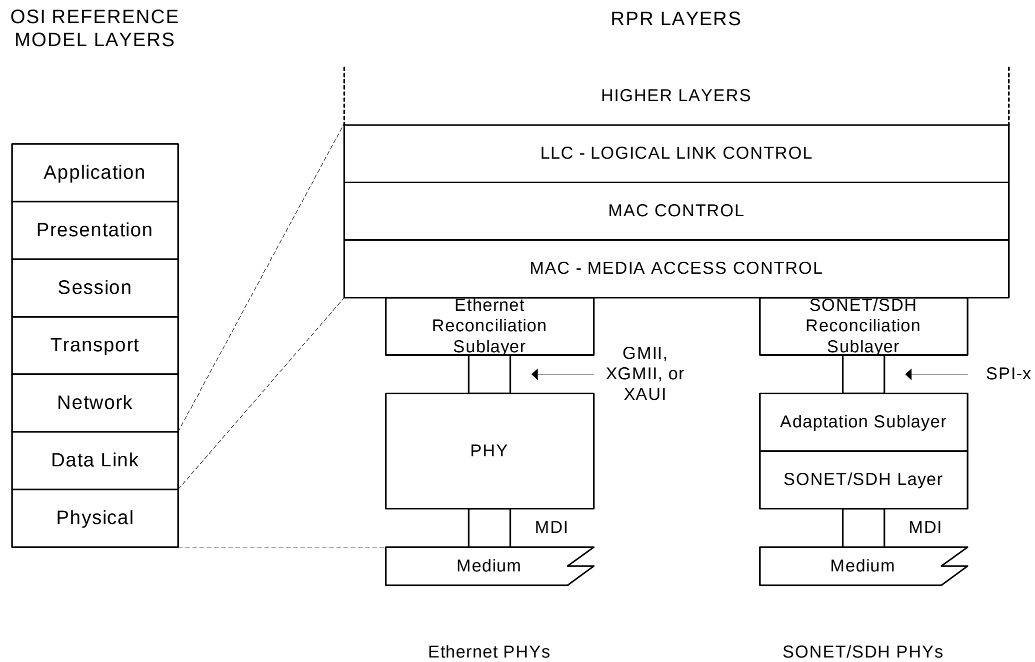

Figure 8–1—RPR RS and PHY relationship to the ISO/IEC Open Systems Interconnection (OSI) reference model

8.2 MAC physical layer service interface

The MAC physical layer service interface allows the MAC to transfer information to and from the reconciliation sublayer and PHYs through logical service primitives. The following primitives are defined:

PHY_DATA.request
PHY_DATA.indicate
PHY_DATA_VALID.indicate
PHY_LINK_STATUS.indicate
PHY_READY.indicate.

8.2.1 PHY_DATA.request

8.2.1.1 Function

This primitive defines the transfer of data from the MAC to the reconciliation sublayer.

8.2.1.2 Semantics of the service primitive

PHY_DATA.request (OUTPUT_FRAME, LENGTH)

The OUTPUT_FRAME parameter either takes the value of a complete RPR frame or NO_FRAME, and represents the transfer of a complete RPR frame from the MAC to the reconciliation sublayer. The value NO_FRAME indicates that the MAC has no frame for transfer.

The LENGTH parameter is optional, and is used by some reconciliation sublayers to indicate the length of the RPR frame. The value of this parameter represents the length of the associated OUTPUT_FRAME, or may be undefined if not used by the reconciliation sublayer.

8.2.1.3 When generated

This primitive is generated by the MAC sublayer to request the transmission of a frame on the physical medium, or to indicate that no frame is available for transmission.

8.2.1.4 Effect of receipt

The effect of receipt of this primitive and a detailed mapping of this primitive to specific electrical interfaces are described in Annexes C and D.

8.2.2 PHY_DATA.indicate

8.2.2.1 Function

This primitive defines the transfer of data from the reconciliation sublayer to the MAC.

8.2.2.2 Semantics of the service primitive

PHY_DATA.indicate (INPUT_FRAME, LENGTH)

The INPUT_FRAME parameter either takes the value of a complete RPR frame or NO_FRAME, and represents the transfer of a complete RPR frame from the reconciliation sublayer to the MAC. The value NO_FRAME indicates that the reconciliation sublayer does not have a frame for transfer.

The LENGTH parameter is is optional, and is used by some reconciliation sublayers to indicate the length of the RPR frame. The value of this parameter represents the length of the associated INPUT_FRAME, or is null if not used by the reconciliation sublayer.

8.2.2.3 When generated

The definition of when this primitive is generated and a detailed mapping of specific electrical interfaces to this primitive are described in Annexes C or D.

8.2.2.4 Effect of receipt

The effect of receipt of this primitive by the MAC sublayer is unspecified.

8.2.3 PHY_DATA_VALID.indicate

8.2.3.1 Function

This primitive indicates whether the parameter of PHY_DATA.indicate contains valid data.

8.2.3.2 Semantics of the service primitive

PHY_DATA_VALID.indicate (DATA_VALID_STATUS)

The DATA_VALID_STATUS parameter can take one of two values: DATA_VALID or DATA_NOT_VALID. The DATA_VALID value indicates that the INPUT_FRAME parameter of the PHY_DATA.indicate primitive contains a valid frame. The DATA_NOT_VALID value indicates that the

INPUT_FRAME parameter of the PHY_DATA.indicate primitive does not contain valid data of a received frame.

8.2.3.3 When generated

The PHY_DATA_VALID.indicate service primitive shall be generated by the reconciliation sublayer whenever the DATA_VALID_STATUS parameter changes from DATA_VALID to DATA_NOT_VALID or vice versa.

Additional requirements for this primitive and a detailed mapping of specific electrical interfaces to this primitive are described in Annexes C or D.

8.2.3.4 Effect of receipt

The effect of receipt of this primitive by the MAC sublayer is unspecified.

8.2.4 PHY_LINK_STATUS.indicate

8.2.4.1 Function

This primitive conveys the status of the physical link as detected by the PHY to the MAC.

8.2.4.2 Semantics of the service primitive

PHY_LINK_STATUS.indicate (LINK_STATUS)

The LINK_STATUS parameter takes the value of OK, FAIL or DEGRADE, and signifies the status of the link as detected by the PHY. OK indicates the absense of link degradation or fault conditions. DEGRADE indicates a link degradation condition. FAIL indicates a link fault condition. Detection and signaling of OK and FAIL are supported by all reconciliation sublayers. Detection and signaling of DEGRADE is not supported by all reconciliation sublayers.

8.2.4.3 When generated

The PHY_DATA_VALID.indicate service primitive shall be generated by the reconciliation sublayer whenever the value of the LINK_STATUS parameter changes.

Additional requirements for this primitive and a detailed mapping of specific electrical interfaces to this primitive are described in Annexes C or D.

8.2.4.4 Effect of receipt

The effect of receipt of this primitive by the MAC sublayer is unspecified.

8.2.5 Mapping of PHY_READY.indicate

8.2.5.1 Function

This primitive indicates whether the reconciliation sublayer is ready to accept a new MAC frame.

8.2.5.2 Semantics of the service primitive

PHY_READY.indicate (READY_STATUS)

The READY_STATUS parameter takes the value of READY or NOT_READY, and signifies whether the reconciliation sublayer is able to accept a frame from the MAC for transmission on the PHY.

8.2.5.3 When generated

The definition of when this primitive is generated and a detailed mapping of specific electrical interfaces to this primitive are described in Annexes C or D.

8.2.5.4 Effect of receipt

The effect of receipt of this primitive by the MAC sublayer is unspecified.

8.3 Ethernet physical layer interfaces and PHYs

8.3.1 Ethernet reconciliation sublayers

Two Ethernet reconciliation sublayers are defined to provide interfaces to Ethernet PHYs. The first is the Gigabit Ethernet Reconciliation Sublayer (GERS) that provides a standard interface for use with gigabit Ethernet PHYs. The second is the Ten Gigabit Ethernet Reconciliation Sublayer (XGERS) that provides a standard interface for use with ten gigabit Ethernet PHYs.

8.3.1.1 Gigabit Ethernet Reconciliation Sublayer (GERS)

The Gigabit Ethernet Reconciliation Sublayer (GERS) maps the MAC physical layer service primitives to and from the Gigabit Media Independent Interface (GMII) specified in Clause 35 of IEEE Standard 802.3. The requirements for the GERS are specified in Annex C.

8.3.1.2 Ten Gigabit Ethernet Reconciliation Sublayer (XGERS)

The Ten Gigabit Ethernet Reconciliation Sublayer (XGERS) maps the MAC physical layer service primitives to and from the Ten Gigabit Media Independent Interface (XGMII) specified in Clause 46 of IEEE P802.3ae. The XGMII is an optional interface. An XGMII Extender Sublayer (XGXS) may be used to provide a Ten Gigabit Attachment Unit Interface (XAUI) as defined in Clause 47 of IEEE P802.3ae. The XGERS shall provide the XGMII, or implement an XGXS and provide the XAUI. The requirements for the XGERS are specified in Annex C.

8.3.2 Ethernet physical layer entities (PHYs)

8.3.2.1 Gigabit Ethernet PHYs

The following gigabit Ethernet PHYs are supported:

a) 1000BASE-SX short wavelength optical PHY;
b) 1000BASE-LX long wavelength optical PHY.

Each of these PHYs consists of a Physical Coding Sublayer (PCS) and Physical Medium Attachment (PMA) sublayer specified in Clause 36 of IEEE Standard 802.3, and a Physical Medium Dependent (PMD) sublayer specified in Clause 38 of IEEE Standard 802.3.

The 1000BASE-CX PMDs specified in Clause 39 and the 1000BASE-T PMDs specified in Clause 40 of IEEE Standard 802.3 for use with copper cabling are not supported for RPR networks.

8.3.2.2 Ten gigabit Ethernet PHYs

The following ten gigabit Ethernet LAN PHYs are supported:

a) 10GBASE-SR short wavelength serial LAN PHY;
b) 10GBASE-LR long wavelength serial LAN PHY;
c) 10GBASE-ER extra-long wavelength serial LAN PHY;
d) 10GBASE-LX4 WDM LAN PHY.

The 10GBASE-SR, -LR, and -ER serial PHYs consist of a Physical Coding Sublayer (PCS) specified in Clause 49, a Physical Medium Attachment (PMA) sublayer specified in Clause 51, and a Physical Medium Dependent (PMD) sublayer specified in Clause 52 of IEEE P802.3ae.

The 10GBASE-LX4 WDM PHY consists of a Physical Coding Sublayer (PCS) and Physical Medium Attachment (PMA) sublayer specified in Clause 48, and a Physical Medium Dependent (PMD) sublayer specified in Clause 53 of IEEE P802.3ae.

Additionally, the following ten gigabit Ethernet WAN PHYs are supported:

a) 10GBASE-SW short wavelength serial WAN PHY;
b) 10GBASE-LW long wavelength serial WAN PHY;
c) 10GBASE-EW extra-long wavelength serial WAN PHY.

The 10GBASE-SW, -LW, and -EW PHYs consist of a Physical Coding Sublayer (PCS) specified in Clause 49, a WAN Interface Sublayer (WIS) specified in Clause 50, a Physical Medium Attachment (PMA) sublayer specified in Clause 51, and a Physical Medium Dependent (PMD) sublayer specified in Clause 52 of IEEE P802.3ae.

8.4 SONET/SDH physical layer interfaces and PHYs

SONET/SDH physical layer interfaces and PHYs consist of the following elements:

a) A reconciliation sublayer that maps the logical service primitives at the MAC physical layer service interface to and from standard electrical interfaces;
b) A GFP or byte-synchronous HDLC-like framing adaptation sublayer;
c) A SONET/SDH layer.

Two types of reconciliation sublayers are defined. One is the SONET/SDH Reconciliation Sublayer (SRS) that can be used with either adaptation sublayer. The other is the GFP Reconciliation Sublayer (GRS) that is intended for use only with a GFP adaptation sublayer. The two reconciliation sublayers are identical, except that the GRS conveys packet length information to the GFP adaptation sublayer to optionally eliminate the need to calculate this parameter.

Both types of reconciliation sublayers are specified with 8-bit SPI-3, 32-bit SPI-3, SPI-4.1, and SPI-4.2 interfaces for various operating speeds.

The GFP and HDLC adaptation layers are built over the SONET/SDH path layer and not directly over a SONET/SDH medium. Because of the multiplexing capacity of SONET/SDH and of the virtual concatenation feature, there is not a one-to-one relationship between the PHY's bit rate seen by the RPR MAC sublayer and the speed of the physical media.

The interface between the SONET/SDH layer and the adaptation layer (either the GFP or the SONET/SDH) is the standard interface between the SONET/SDH path sublayer and any upper layer as defined in ITU-T G.707 and G.783, and is not defined in this standard.

The functionality performed in the SONET/SDH layer is beyond the scope of this specification. The implementations must be compliant with ITU-T G.707 and G.783. The higher-layer paths (VC4), all the possible contiguous concatenated paths (VC4-4Nc) and all the possible virtual concatenated paths (VC4-Nv) are supported by the standard IEEE 802.17 RPR MAC.

8.4.1 SONET/SDH reconciliation sublayers

8.4.1.1 SONET/SDH Reconciliation Sublayer (SRS)

The SONET/SDH Reconciliation Sublayer (SRS) maps the logical primitives at the MAC physical layer service interface to and from the following electrical interfaces:

a) SPI Level 3 (SPI-3) using 8-bit transmit and receive data paths and operating at 155 Mbps to 622 Mbps;
b) SPI Level 3 (SPI-3) using 32-bit transmit and receive data paths and operating at 155 Mbps to 2.5 Gbps;
c) SPI Level 4 Phase 1 (SPI-4.1) operating at 622 Mbps to 10 Gbps;
d) SPI Level 4 Phase 2 (SPI-4.2) operating at 622 Mbps to 10 Gbps.

Four versions of the SRS using these four interfaces are specified in Annex D.

8.4.1.2 GFP Reconciliation Sublayer (GRS)

> ***Editors' Notes:*** *To be removed prior to final publication.*
>
> ***The text does not currently define the format in which the PLI information is conveyed on the SPI interface, and does not specify how the PLI is originally generated. The MAC physical layer service interface has provisions to transfer the PLI as an optional field but doesn't specify where it originates.***

The GFP Reconciliation Sublayer (SRS) maps the logical primitives at the MAC physical layer service interface to and from the following electrical interfaces:

a) SPI Level 3 (SPI-3) using 8-bit transmit and receive data paths and operating at 155 Mbps to 622 Mbps;
b) SPI Level 3 (SPI-3) using 32-bit transmit and receive data paths and operating at 155 Mbps to 2.5 Gbps;
c) SPI Level 4 Phase 1 (SPI-4.1) operating at 622 Mbps to 10 Gbps;
d) SPI Level 4 Phase 2 (SPI-4.2) operating at 622 Mbps to 10 Gbps.

The GRS is identical to the SRS, except that the GRS additionally conveys packet length information to the GFP adaptation sublayer. Four versions of the GRS using the four electrical interfaces are specified in Annex D.

8.4.2 SONET/SDH adaptation sublayers

Two different adaptation sublayers for SONET/SDH interfaces are defined that differ from each other in the way RPR frames are mapped into the SONET/SDH path payload. The first adaptation sublayer uses GFP framing. The second adaptation sublayer uses byte-synchronous HDLC-like framing. These two different adaptation layers do not interoperate with each other.

8.4.2.1 Generic Framing Procedure (GFP) adaptation sublayer

Generic Framing Procedure (GFP) defined by ITU-T G.7041 is a standard method of mapping and delineating variable-length, octet-aligned payloads into octet-synchronous payload envelopes. GFP defines a frame format for protocol data units (PDUs) transferred between GFP initiation and termination points.

GFP framing for RPR shall be performed in accordance with ITU-T G.7041 using a null extension header as defined by the Extension Header Identifier (EXI), no GFP FCS field, and with a User Payload Identifier (UPI) corresponding to an RPR payload.

The GFP Reconciliation Sublayer (GRS) and the MAC sublayer provide an optional capability to propagate the PDU length value to optimize the forwarding of PDUs with minimal delay.

8.4.2.2 Byte-synchronous HDLC-like framing adaptation sublayer

RPR frames may be mapped into the SONET/SDH layer using byte-synchronous HDLC-like framing. This framing method is functionally identical to that defined in IETF RFC 2615 for PPP over SONET/SDH, and in IETF RFC 1662 for PPP in HDLC-like framing, except that:

a) Link Control Protocol (LCP) is not used to negotiate a link. Rather, a set of static link parameters are used;
b) The mapping does not carry PPP frames; it carries only RPR frames;
c) PPP-specific and legacy support is not provided or defined.

Byte-synchronous HDLC-like framing for RPR shall be performed in accordance with IETF RFC 1662 using octet-stuffed framing. The Flag Sequence is hexadecimal 0x7E, and the Control Escape octet is hexadecimal 0x7D. The Link Control Protocol (LCP) is not used. Instead of using LCP for link negotiation, byte-synchronous HDLC-like framing for RPR shall use the following statically-defined link parameters:

a) Address and Control Field compression is always used;
b) The Protocol Field is not used;
c) The FCS is neither computed nor appended to the frame;
d) The Asynchronous Control Character Map (ACCM) is not used.

8.4.3 SONET/SDH physical layer entities (PHYs)

The functionality performed in the SONET/SDH layer is beyond the scope of this specification. The implementations must be compliant with ITU-T G.707 and G.783. The higher-layer paths (VC4), all the possible contiguous concatenated paths (VC4-4Nc) and all the possible virtual concatenated paths (VC4-Nv) are supported by the standard IEEE 802.17 RPR MAC.

All the SONET/SDH speeds, ranging from 150 Mb/s (VC-4) up to 10 Gb/s (VC4-64c), are supported by the IEEE 802.17 Standard. All the intermediate speeds that are a 4x upgrades (VC4-4Nc) are supported. In addition, using virtual concatenation all the intermediate speeds at step of 150 Mb/s (VC4-Nv) can also be supported. Table A.1 summarizes all of the supported speeds.

Note that because of the standard SONET/SDH multiplexing and virtual concatenation features, there is not a one-to-one correspondence between the RPR PHY speed and the speed of the SONET/SDH physical media over which the signal is transmitted. The possible mappings are outside the scope of this specification and already defined in ITU-T G.707 and G.783.

SONET path sublayer	SDH path sublayer	Bit-rate
STS-3c-SPE	VC4	150 Mb/s
STS-12c-SPE	VC4-4c	600 Mb/s
STS-48c-SPE	VC4-16c	2.4 Gb/s
STS-192c-SPE	VC4-64c	9.6 Gb/s
STS-3c-Nv SPE (Note 1)	VC4-Nv (Note 1)	Nx150Mb/s (Note 1)
Note 1 — All of the interger values of X between 2 and 192 are supported. The virtual concatenated paths can support all speeds from 300 Mbps to 9.6 Gbps with a granularity of 150 Mbps.		

Table A.1—Sonet/SDH supported path layers and speeds