IEEE P802.11
Wireless Access Method and Physical Layer Specifications

Title: **Changes to the Infrared Baseband PHY in draft IEEE p802.11-93/20b2**

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Abstract:

What's Wrong:

1. The Infrared Baseband Phy, Section 11 in the current draft IEEE p802.11-93/20b2, refers to PHY service primitives which do not correspond to the text in section 8.

2. The Infrared Baseband Phy adopted a PLCP header format in IEEE p802.11-94/153 after the drafting of IEEE p802.11-94/152 (152 was incorporated into IEEE p802.11-93/20b2). The content of 153 is not reflected in the current draft.

3. The current draft IEEE p802.11-93/20b2 contains no information on how to perform the CCA function. The Infrared Baseband Phy adopted a CCA methodology at the September meeting, and this is not reflected in the current draft.

4. The current draft IEEE p802.11-93/20b2 contains no PHY-related MIB parameters.

5. The current draft IEEE p802.11-93/20b2 contains no information on the allowable radiation pattern for conformant devices. The Infrared Baseband Phy adopted the radiation pattern described in IEEE p802.11-93/173, at the September meeting, and this is not reflected in the current draft.

How To Fix It:

1. Rewrite Section 11 to correspond to Section 8.

2. Incorporate the changes to the PLCP from 153 into 20b2, section 11

3. Add the adopted CCA functions to 20b2, section 11

4. Add the adopted PHY-related MIB parameters to sections 7 and 11.

5. Add the adopted radiation pattern to 20b2, section 11

Motions:

Resolved, that the proposed text changes in 11-94/0182 be incorporated into the draft standard IEEE p802.11-93/20b2, Sections 7 and Section 11 in it's next revision by the editors.

7.4. Management Information Definitions

7.4.1.3. *Phy Attributes*

7.4.1.3.1. *agPhyOperation_grp*

aCCA_Rise_Time,
aCCA_Fall_Time,
aRxTx_Turnaround_Time,
aTxRx_Turnaround_Time,
*aRx_*Propagation*_Delay,*
*aTx_*Propagation*_Delay,*
aPHY_SAP_Delay,
aPLCP_Time,
aCCA_Watchdog_Timer_Max,
aCCA_Watchdog_Count_Max,
aCCA_Watchdog_Timer_Min,
aCCA_Watchdog_Count_Min,
aChannel_Transit_Delay,
aChannel_Transit_Variance,
aMPDU_Maximum,
aMPDU_Minimum,
aMPDU_Current_Maximum;

7.4.1.3.2. *agPhyRate_grp*

aSupported_Rx_Rates,
aSupported_Tx_Rates,
aBSS_Basic_Rate_Set,
aStation_Basic_Rate,
aExtended_Rate_Set,
aPLCP_Rate,
aPreferred_Tx_Rate,
aPreferred_Rx_Rate;

7.4.2.3. *PHY Object Class*

PHY MANAGED OBJECT CLASS
DERIVED FROM "ISO/IEC 10165-2":top;
CHARACTERIZED BY
pPHY_base PACKAGE
BEHAVIOR
bPHY_base BEHAVIOR
DEFINED AS "The PHY object class provides the necessary support for the timing information and rate change information which may vary from PHY to PHY and from STA to STA to be communicated to upper layers."
ATTRIBUTES

aCCA_Rise_Time	*GET,*
aCCA_Fall_Time	*GET,*
aRxTx_Turnaround_Time	*GET,*
aTxRx_Turnaround_Time	*GET,*
aRx_Propagation_Delay	*GET,*
aTx_Propagation_Delay	*GET,*
aPHY_SAP_Delay	*GET,*
aPLCP_Time	*GET,*
aCCA_Watchdog_Timer_Max	*GET-REPLACE,*
aCCA_Watchdog_Count_Max	*GET-REPLACE,*
aCCA_Watchdog_Timer_Min	*GET,*
aCCA_Watchdog_Count_Min	*GET,*
aChannel_Transit_Delay	*GET,*
aChannel_Transit_Variance	*GET,*
aMPDU_Maximum	*GET,*
aMPDU_Minimum	*GET,*
aMPDU_Current_Maximum	*GET-REPLACE,*
aSupported_Rx_Rates	*GET,*
aSupported_Tx_Rates	*GET,*
aBSS_Basic_Rate_Set	*GET,*
aStation_Basic_Rate	*GET-REPLACE,*
aExtended_Rate_Set	*GET,*
aPLCP_Rate	*GET,*
aPreferred_Tx_Rate	*GET-REPLACE,*
aPreferred_Rx_Rate	*GET-REPLACE;*

ATTRIBUTE GROUPS
agPhyOperation_grp,
agPhyRate_grp;
ACTIONS
acPHY_init,
acPHY_reset;
NOTIFICATIONS
REGISTERED AS { iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) };

7.4.3.3. *PHY Attribute Group Templates*

7.4.3.3.1. *agPhyOperation_grp*

PhyOperation_grp ATTRIBUTE GROUP
GROUP ELEMENTS
aCCA_Rise_Time,
aCCA_Fall_Time,
aRxTx_Turnaround_Time,
aTxRx_Turnaround_Time,
aRx_Propagation_Delay,
*aTx_*Propagation*_Delay,*
aPHY_SAP_Delay,
aPLCP_Time,
aCCA_Watchdog_Timer_Max,
aCCA_Watchdog_Count_Max,
aCCA_Watchdog_Timer_Min,
aCCA_Watchdog_Count_Min,
aChannel_Transit_Delay,
aChannel_Transit_Variance,
aMPDU_Maximum,
aMPDU_Minimum,
aMPDU_Current_Maximum;
REGISTERED AS { iso(1) member-body(2) us(840) ieee802dot11(xxxx) phy(3) PhyOperation_grp(0) };

7.4.3.3.2. *agPhyRate_grp*

PhyRate_grp ATTRIBUTE GROUP
GROUP ELEMENTS
aSupported_Rx_Rates,
aSupported_Tx_Rates,
aBSS_Basic_Rate_Set,
aStation_Basic_Rate,
aExtended_Rate_Set,
aPLCP_Rate,
aPreferred_Tx_Rate,
aPreferred_Rx_Rate;
REGISTERED AS { iso(1) member-body(2) us(840) ieee802dot11(xxxx) phy(3) PhyRate_grp(1) };

7.4.4.4. *PHY Attribute Templates*

7.4.4.4.1. *aCCA_Rise_Time*

CCA_Rise_Time ATTRIBUTE
WITH APPROPRIATE SYNTAX
integer;
BEHAVIOR DEFINED AS
"Time (in hundreds of nanoseconds) from the disappearance of a transmission in the medium to the assertion of Clear Channel. The decay time of the CCA detector is included in this value.";
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) CCA_Rise_Time(1) };

7.4.4.4.2. *aCCA_Fall_Time*

CCA_Fall_Time ATTRIBUTE
WITH APPROPRIATE SYNTAX
integer;
BEHAVIOR DEFINED AS
"Time (in hundreds of nanoseconds) from the appearance of a transmission in the medium to the assertion of Busy Channel. The attack time of the CCA detector is included.";
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) CCA_Fall_Time(2) };

7.4.4.4.3. *aRxTx_Turnaround_Time*

RxTx_Turnaround_Time ATTRIBUTE
WITH APPROPRIATE SYNTAX
integer;
BEHAVIOR DEFINED AS
"Minimum required time (in hundreds of nanoseconds) between the PHY_DATA.indicate(END_OF_ACTIVITY) and the earliest possible transmission of a new packet. This does not include any recovery time required by the receiver.";
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) RxTx_Turnaround_Time(3) };

7.4.4.4.4. *aTxRx_Turnaround_Time*

TxRx_Turnaround_Time ATTRIBUTE
WITH APPROPRIATE SYNTAX
integer;
BEHAVIOR DEFINED AS
"Minimum required time (in hundreds of nanoseconds) between the transmission of the last symbol of an outgoing frame and the recovery of the receiver to within 3 dB of its nominal gain and noise performance parameters.";
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) TxRx_Turnaround_Time(4) };

7.4.4.4.5. *aRx_*Propagation*_Delay*

*Rx_*Propagation*_Delay ATTRIBUTE*
WITH APPROPRIATE SYNTAX
integer;
BEHAVIOR DEFINED AS
"The electronic delay time (in hundreds of nanoseconds) in the receiver from the reception of a signal at the antenna to a PHY_DATA.indicate. Includes the conversion of eight bits from a serial stream to an octet. Startup delays introduced by the PLCP header are not included in this value."
REGISTERED AS
*{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) Rx_*Propagation*_Delay(5) };*

7.4.4.4.6. aTx_Propagation_Delay

*Tx_*Propagation*_Delay ATTRIBUTE*
WITH APPROPRIATE SYNTAX
integer;
BEHAVIOR DEFINED AS
"The electronic delay time (in hundreds of nanoseconds) in the transmitter from the reception of a PHY_DATA.indicate to the generation of a signal at the antenna. Startup delays introduced by the PLCP header are not included in this value."
REGISTERED AS
*{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) Tx_*Propagation*_Delay(6) };*

7.4.4.4.7. aPHY_SAP_Delay

PHY_SAP_Delay ATTRIBUTE
WITH APPROPRIATE SYNTAX
integer;
BEHAVIOR DEFINED AS
"The delay introduced (in hundreds of nanoseconds) from PHY_DATA.request(class DATA) to PHY_DATA.indicate(class DATA) in a peer PHY. This includes propagation *delays, channel delays, and paallel-serial-parallel conversion of information."*
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) PHY_SAP_Delay(7) };

7.4.4.4.8. aPLCP_Time

PLCP_Time ATTRIBUTE
WITH APPROPRIATE SYNTAX
set-of integer;
BEHAVIOR DEFINED AS
"The set of times required (in hundreds of nanoseconds) by the PHY to construct and transmit the PLCP header and the PLCP corresponding to each aPLCP_Rate. Does not include aTx_Propagation_Delay. The receive time is assumed to be identical to or less than the transmit time."
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) PLCP_Time(8) };

7.4.4.4.9. aCCA_Watchdog_Timer_Max

CCA_Watchdog_Timer_Max ATTRIBUTE
WITH APPROPRIATE SYNTAX
integer;
BEHAVIOR DEFINED AS
"The time (in hundreds of nanoseconds) at which the watchdog timer in the PMD CCA mechanism generates an alarm. The product of aCCA_Watchdog_Timer_Max and the aCCA_Watchdog_Count_Max must be set to match the length of the maximum length undecoded packet that is to be allowed time to operate.[1] "
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) CCA_Watchdog_Timer_Max(9) };

[1] *A default product of 22 msec allows time for 802.11 type maximal length packets.*

7.4.4.4.10. *aCCA_Watchdog_Count_Max*

CCA_Watchdog_Count_Max ATTRIBUTE
WITH APPROPRIATE SYNTAX
integer;
BEHAVIOR DEFINED AS
"The count of alarms which the watchdog counter in the PMD CCA is permitted to generate before an undecoded energy detection in the medium is ignored."
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) CCA_Watchdog_Count_Max(10) };

7.4.4.4.11. *aCCA_Watchdog_Timer_Min*

CCA_Watchdog_Timer_Min ATTRIBUTE
WITH APPROPRIATE SYNTAX
integer;
BEHAVIOR DEFINED AS
"The minimum time (in hundreds of nanoseconds) to which the aCCA_Watchdog_Timer_Max may be set."
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) CCA_Watchdog_Timer_Min(11) };

7.4.4.4.12. *aCCA_Watchdog_Count_Min*

CCA_Watchdog_Count_Min ATTRIBUTE
WITH APPROPRIATE SYNTAX
integer;
BEHAVIOR DEFINED AS
"The minimum time (in hundreds of nanoseconds) to which the aCCA_Watchdog_Count_Max may be set."
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) CCA_Watchdog_Count_Min(12) };

7.4.4.4.13. *aChannel_Transit_Delay*

Channel_Transit_Delay ATTRIBUTE
WITH APPROPRIATE SYNTAX
integer;
BEHAVIOR DEFINED AS
"Antenna to antenna signal transit time measured in hundreds of nanoseconds."
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) Channel_Transit_Delay (13) };

7.4.4.4.14. *aChannel_Transit_Variance*

Channel_Transit_Variance ATTRIBUTE
WITH APPROPRIATE SYNTAX
integer;
BEHAVIOR DEFINED AS
"Expected variance in the channel transit time, measured in hundreds of nanoseconds."
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) Channel_Transit_Variance(14) };

7.4.4.4.15. *aSupported_Rx_Rates*

Supported_Rx_Rates ATTRIBUTE
WITH APPROPRIATE SYNTAX
set-of integer;
BEHAVIOR DEFINED AS
"This attribute shall be a set of all the reception rates supported by the PHY. The values of the numbers for the reception rates are defined by each PHY."
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) Supported_Rx_Rates (15) };

7.4.4.4.16. *aSupported_Tx_Rates*

Supported_Tx_Rates ATTRIBUTE
WITH APPROPRIATE SYNTAX
set-of integer;
BEHAVIOR DEFINED AS
"This attribute shall be a set of all the transmission rates supported by the PHY. The values of the numbers for the reception rates are defined by each PHY."
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) Supported_Tx_Rates (16) };

7.4.4.4.17. *aBSS_Basic_Rate_Set*

BSS_Basic_Rate_Set ATTRIBUTE
WITH APPROPRIATE SYNTAX
set-of integer;
BEHAVIOR DEFINED AS
"This attribute shall be a set of all the reception rates that must be supported by all PHY in the BSS of which the STA is a member. The values of the numbers for the reception rates are defined by each PHY."
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) BSS_Basic_Rate_Set (17) };

7.4.4.4.18. *aStation_Basic_Rate*

Station_Basic_Rate ATTRIBUTE
WITH APPROPRIATE SYNTAX
integer;
BEHAVIOR DEFINED AS
"This attribute shall be the transmission rate, preferred by the PHY in this STA. This rate must be a member of aBSS_Basic_Rate_Set. The values of the numbers for the reception rates are defined by each PHY."
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) Station_Basic_Rate (18) };

7.4.4.4.19. *aExtended_Rate_Set*

Extended_Rate_Set ATTRIBUTE
WITH APPROPRIATE SYNTAX
set-of integer;
BEHAVIOR DEFINED AS
"This attribute shall be a set of all the reception rates supported by the PHY, which rates are not also a member of the aBSS_Basic_Rate_Set."
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) Extended_Rate_Set (19) };

7.4.4.4.20. *aPLCP_Rate*

PLCP_Rate ATTRIBUTE
WITH APPROPRIATE SYNTAX
set-of integer;
BEHAVIOR DEFINED AS
"This attribute shall be the set of rates at which the PHY in this STA will always transmit the PLCP header. These values must be members of the aBSS_Basic_Rate_Set. The values of the numbers for the rates are defined by each PHY."
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) PLCP_Rate (20) };

7.4.4.4.21. *aPreferred_Tx_Rate*

Preferred_Tx_Rate ATTRIBUTE
WITH APPROPRIATE SYNTAX
integer;
BEHAVIOR DEFINED AS
"This attribute shall be the distinguished rate at which the PHY in this STA would prefer to transmit in the data phase. This value is not constrained to be a member of the aBSS_Basic_Rate_Set. The values of the numbers for the reception rates are defined by each PHY."
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) Preferred_Tx_Rate (21) };

7.4.4.4.22. *aPreferred_Rx_Rate*

Preferred_Rx_Rate ATTRIBUTE
WITH APPROPRIATE SYNTAX
integer;
BEHAVIOR DEFINED AS
"This attribute shall be the distinguished rate at which the PHY in this STA would prefer to receive in the data phase. This value is not constrained to be a member of the aBSS_Basic_Rate_Set. The values of the numbers for the reception rates are defined by each PHY."
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) Preferred_Rx_Rate (22) };

7.4.4.4.23. *aMPDU_Maximum*

MPDU_Maximum ATTRIBUTE
WITH APPROPRIATE SYNTAX
integer;
BEHAVIOR DEFINED AS
"This attribute shall be the maximum MPDU, in octets, that the PHY shall ever be capable of accepting. This maximum MPDU is distinguished from the maximum size which is currently acceptable to the PHY."
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) MPDU_Maximum (23) };

7.4.4.4.24. aMPDU_Minimum

MPDU_Minimum ATTRIBUTE
WITH APPROPRIATE SYNTAX
integer;
BEHAVIOR DEFINED AS
"This attribute shall be the Minimum MPDU, in octets, that the PHY shall ever be capable of accepting. "
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) MPDU_Minimum (24) };

7.4.4.4.25. aMPDU_Current_Maximum

MPDU_Current_Maximum ATTRIBUTE
WITH APPROPRIATE SYNTAX
integer;
BEHAVIOR DEFINED AS
"This attribute shall be the current maximum MPDU, in octets, that the PHY is capable of accepting at the time the object is inspected. The value shall always be greater than or equal to aMPDU_Minimum, and less than or equal to aMPDU_Maximum. The PHY shall replace this value at it's discretion as the maximum deliverable MPDU changes."
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(3) attribute(7) MPDU_Current_Maximum(25) };

11.1. Introduction

11.1.1. Scope

This document describes the physical layer services provided by the 802.11 wireless LAN MAC for the Baseband Infrared (IR) system. The Baseband IR PHY layer consists of two protocol functions as follows:

1. A physical layer convergence function which adapts the capabilities of the physical medium dependent system into the Physical Layer service. This function is supported by the Physical Layer Convergence Procedure (PLCP) which defines a method of mapping the 802.11 MAC layer Protocol Data Units (MPDU) into a framing format suitable for sending and receiving user data and management information between two or more nodes using the associated physical medium dependent system.
2. A Physical Medium Dependent (PMD) system whose function defines the characteristics of, and method of transmitting and receiving data via wireless media between two or more nodes.

Each physical medium dependent sublayer for the Baseband IR PMD may require the definition of a unique PLCP. If the PMD sublayer already provides the defined Physical Layer services, the physical layer convergence function might be null.

11.1.2. Baseband IR Physical Layer Functions

~~The Baseband IR PHY architecture is shown in Figure 1-1.~~ The Baseband IR physical layer contains three functional entities: the physical medium dependent function, the physical layer convergence function, and the layer management function. Each of these functions is described in detail in the following subsections.

The Baseband IR Physical Layer service is provided to the Media Access Control entity at the node through a Service Access Point (SAP) *as described in Section 8, Physical Service Specification.* ~~as shown in Figure 1-1 called the PHY_SAP. A set of primitives will also be defined to describe the interface between the physical layer convergence protocol sublayer and the physical medium dependent sublayer called the PMD_SAP.~~ *For a visual guide to the relationship of the Baseband IR Physical Layer to the remainder of a system, refer to figure 2-11, Portion of the ISO Basic Reference Model Covered in this Standard.*

~~**Figure 1-1 Protocol Reference Model**~~

11.1.2.1. Physical Layer Convergence Procedure Sublayer

In order to allow the 802.11 MAC to operate with minimum dependence on the PMD sublayer, a physical layer convergence sublayer is defined. This function simplifies the physical layer service interface to the 802.11 MAC services. *The PHY specific preamble is normally associated with this convergence layer.*

11.1.2.2. Physical Medium Dependent Sublayer

The physical medium dependent sublayer provides a *clear channel assessment mechanism,* transmission *mechanism and reception mechanism which are used by the MAC via the PCLP* to send or receive data between two or more nodes.

11.1.2.3. Physical Layer Management Entity (LME)

The Physical LME performs management of the local Physical Layer Functions in conjunction with the MAC Management entity.

11.1.3. Definitions

This section defines the terms used in this standard. Words in *italics* indicate terms that are defined elsewhere in the lists of definitions

11.1.4. Acronyms

~~**AMF**~~	~~=~~	~~Available MAC Frame (transmit)~~
CRC	=	Cyclic Redundancy Check
FCS	=	Frame Check Sequence
IR	=	Infrared
LME	=	Layer Management Entity
MAC	=	Media Access Control
~~**MDA**~~	~~=~~	~~MAC Data Available (receive)~~
MPDU	=	MAC Protocol Data Unit
PDU	=	Protocol Data Unit
PHY_SAP	=	Physical Layer Service Access Point
PLCP	=	Physical Layer Convergence Procedure
PMD	=	Physical Medium Dependent
PMD_SAP	=	Physical Medium Dependent Service Access Point
PPM	=	Pulse Position Modulation
SAP	=	Service Access Point
~~**TXE**~~	~~=~~	~~Transmit Enable~~

11.1.5. Service Specification Method and Notation

The models represented by figures and state diagrams are intended as the illustrations of functions provided. It is important to distinguish between a model and a real implementation. The models are optimized for simplicity and clarity of presentation, the actual method of implementation is left to the discretion of the 802.11 Baseband IR PHY compliant developer. *Conformance to the standard is not dependent on following the model, and an implementation which follows the model closely may not be conformant.*

The service of layer or sublayer is a set of capabilities that it offers to a user in the next higher layer (or sublayer). Abstract services are specified here by describing the service primitives and parameters that characterize each service. This definition is independent of any particular implementation. *In particular, the PHY_SAP operations are defined and described as instantaneous, however, this may be difficult to achieve in an implementation.*

~~11.1.6. Baseband IR Physical Layer Service Specifications11.1.6. Scope and Field of Application~~

~~This section specifies the services provided by the Baseband IR Physical Layer to the 802.11 MAC. These services are described in an abstract way and do not imply any particular implementation or exposed interface.~~

~~11.1.7. Overview of the Service~~

~~The Baseband IR Physical Layer function is separated into two sublayers: the Baseband IR PLCP sublayer and the Baseband IR PMD sublayer as shown in Figure 1-1. The function of the PLCP sublayer is to provide a mechanism for transferring MAC Protocol Data Units (MPDUs) between two or more nodes over the Baseband IR PMD sublayer. This is accomplished by the PLCP sublayer in the transmit direction by converting MPDUs into Protocol Data Units (PDUs). The formation of the PDU is covered in section 3. In the receive direction, the PLCP is responsible for converting PDUs back into MPDUs. The PLCP is also responsible for adding a Preamble and a Postamble to the PDU at the transmitting node which is used by the receiving nodes for recovering the PDU.~~

~~A number of PLCP services and parameters are passed directly to the PMD. These provide direct control of the PHY by the MAC without any translation at the PMD_SAP.~~

~~11.1.8. Overview of Interactions~~

~~The primitives associated with the 802.11 MAC sublayer to the Baseband IR PHY layer fall into two basic categories:~~

1. ~~Service primitives that support MAC peer-to peer interactions (i.e. data transmission and reception)~~
2. ~~Service primitives that have local significance and support sublayer-to-sublayer interactions~~

~~11.1.9. Basic Service and Options~~

~~All the service primitives described in this section are considered mandatory unless otherwise specified. In some cases, the provisions for multiple choices for a given parameter are provided for future expansion where only a single default choice will be required.~~

~~11.1.9.1. PHY_SAP Peer-to-Peer Service Primitives~~

~~Primitive~~	~~Request~~	~~Indicate~~	~~Confirm~~	~~Response~~
~~PHY_DATA~~	~~X~~	~~X~~		

~~Table 1. PHY_SAP Sublayer-to-Sublayer Service Primitives~~

~~11.1.9.2. PHY_SAP Sublayer-to-Sublayer Service Primitives~~

~~The following table indicates the primitives for sublayer-to-sublayer interactions.~~

~~Primitive~~	~~Request~~	~~Indicate~~	~~Confirm~~	~~Response~~
~~PHY_INFO~~	~~X~~			
~~PHY_CS~~		~~X~~		
~~PHY_RXBUSY~~		~~X~~		
~~PHY_TXBUSY~~		~~X~~		

~~Table 2. PHY_SAP Sublayer-to-Sublayer Service Primitives~~

11.1.9.3. PHY_SAP Service Primitive Parameters.

The following table shows the parameters used by one or more of the PMD_SAP Service Primitives.

Parameter	Associated Primitive	Value
LENGTH	PHY_DATA.indicate PHY_DATA.response	16 bit unsigned integer 0 - TBD MAX octets
TXDATA	PHY_DATA.request	0 - TBD data octets
RXDATA	PHY_DATA.indicate	0 - TBD data octets
RATE	PHY_DATA.indicate PHY_DATA.request	16 bit unsigned integer -see section 3
TYPE	PHY_INFO.request	Radio type: Baseband IR, IR, FH

Table 3. PHY_SAP Service Primitive Parameters

11.1.10. PHY_SAP Detailed Service Specification

The following sections describe the services provided by the peer-to-peer and sublayer-to-sublayer primitives listed in section 2.4.

11.1.10.1. PHY_DATA.request

11.1.10.1.1. Function

This primitive defines the transfer of data from the MAC sublayer to the local PHY entity

11.1.10.1.2. Semantic of the Service Primitive

This primitive shall provide the following parameters:

PHY_DATA.request(TXDATA, RATE)

TXDATA. The TXDATA parameter is the list of 0 to LENGTH octets which comprises the MPDU the MAC is requesting to transmit.

RATE. The RATE parameter specifies the data rate (modulation) which will be used to transmit the MPDU portion of the PDU on a per packet basis. The Baseband IR PHY rate change feature is described in section 3.4. The RATE is indicated at the PMD with the PMD_RATE primitive described in section 4.5.5.

11.1.10.1.3. When Generated

This primitive is generated by the MAC sublayer to request the transmission of an MPDU.

11.1.10.1.4. Effect of Receipt

The receipt of this primitive initiates the transmission of a PDU. The PLCP state machine will generate and transmit the Baseband IR PHY Preamble, as described in section 3, transmit the MPDU defined by TXDATA and generate and transmit the Baseband IR PHY Postamble, as described in section 3.

11.1.10.2. PHY_DATA.indicate

11.1.10.2.1. Function

This primitive indicates to the local MAC entity that the PHY sublayer has completed receiving the MPDU. This primitive defines the transfer of data from the PHY sublayer to the local MAC entity. In addition, this primitive provides the MAC entity a method of updating receive specific parameters to the PHY entity to be applied to subsequent receive operations.

11.1.10.2.2. Semantic of the Service Primitive

This primitive shall provide the following parameters:

PHY_DATA.indicate(RXDATA, RATE)

RXDATA. The RXDATA parameter is the list of 0 to LENGTH octets which comprises the MPDU the MAC is receiving from the PHY.

RATE. The RATE parameter specifies the data rate (modulation) which was used to transmit the MDPU portion of the PDU. The Baseband IR PHY rate change feature is described in section 3.4.

11.1.10.2.3. When Generated

This primitive is generated by the PHY sublayer to inform the MAC that the reception of an MPDU is complete.

11.1.10.2.4. Effect of Receipt

The receipt of this primitive indicates the termination of reception of a PDU.

11.1.10.3. PHY_INFO.indicate

11.1.10.3.1. Function

This primitive allows the local MAC entity to query and receive a list of capabilities from the PHY sublayer.

11.1.10.3.2. Semantic of the Service Primitive

This primitive shall provide the following parameters:

PHY_INFO.request(TYPE)

TYPE. The TYPE parameter indicates the PHY type: DS, FHSS, Baseband IR, Carrier IR, or high speed FHSS.

~~11.1.10.3.3. When Generated~~

~~This primitive is generated by the MAC sublayer during system initialization to query the PHY entity's capabilities and set MAC parameters to make use of these capabilities.~~

~~11.1.10.3.4. Effect of Receipt~~

~~The PHY responds to the MAC entities query with the information parameters list.~~

~~11.1.10.4. PHY_CS.indicate~~

~~11.1.10.4.1. Function~~

~~This primitive generated by the PHY entity directly informs the MAC entity that a Baseband IR Preamble was detected (carrier sense) and that data reception is in progress.~~

~~11.1.10.4.2. Semantic of the Service Primitive~~

~~This primitive indicates a binary PHY entity status of ENABLED or DISABLED. The ENABLED condition indicates that a Preamble was detected and the PHY entity has a data reception in progress. The DISABLED condition indicates that the PHY entity does not currently have valid data reception in progress.~~

~~11.1.10.4.3. When Generated~~

~~This primitive is generated by the PHY sublayer whenever the PHY Baseband IR Preamble is detected.~~

~~11.1.10.4.4. Effect of Receipt~~

~~The receipt of this indicator by the MAC entity indicates that the media is busy, and that any pending MPDU transmission should be deferred.~~

~~11.1.10.5. PHY_RXBUSY.indicate~~

~~11.1.10.5.1. Function~~

~~This primitive, generated by the PHY entity, directly informs the MAC entity that MPDU data is available.~~

~~11.1.10.5.2. Semantic of the Service Primitive~~

~~The PHY_RXBUSY is associated with the PMD_MDA (Mac Data Avaliable) primitive. PHY_RXBUSY indicates a binary PHY entity status of ENABLED or DISABLED. PHY_RXBUSY is ENABLED when the first data bit of the MPDU is available from the PHY entity for use by the MAC entity. MDA is DISABLED when the last data bit has been processed by the PHY entity.~~

~~11.1.10.5.3. When Generated~~

~~This primitive is generated by the PHY sublayer when the PHY is receiving the MPDU portion of the PDU.~~

~~11.1.10.5.4. Effect of Receipt~~

~~This indicator is provided to the MAC for information purposes. No specific action is required by the MAC entity upon receipt of this indicator.~~

~~11.1.10.6. PHY_TXBUSY.indicate~~

~~11.1.10.6.1. Function~~

~~This primitive, generated by the PHY entity, directly informs the MAC entity that the transmission of the MPDU is underway.~~

~~11.1.10.6.2. Semantic of the Service Primitive~~

~~The PHY_TXBUSY is associated with the PMD_AMF (Avaliable MAC Frame) primitive. PHY_TXBUSY indicates a binary PHY entity status of ENABLED or DISABLED. PHY_TXBUSY is ENABLED when the PLCP Preamble transmission is complete and transmission of the MPDU is underway. PHY_TXBUSY is DISABLED when the PLCP Postamble has been transmitted by the PHY entity.~~

~~11.1.10.6.3. When Generated~~

~~This primitive is generated by the PHY sublayer when the PHY is transmitting the MPDU portion of the PDU.~~

~~11.1.10.6.4. Effect of Receipt~~

~~This indicator is provided to the MAC for information purposes. No specific action is required by the MAC entity upon receipt of this indicator.~~

~~11.1.11. MPHY_SAP Sublayer Management Primitives~~

~~The following messages may be sent between the PHY sublayer entities and the interlayer or higher Layer Management Entities (LME).~~

~~Primitive~~	~~Request~~	~~Indicate~~	~~Confirm~~	~~Response~~
~~MPHY_RXRESET~~	~~X~~		~~X~~	
~~MPHY_TXRESET~~	~~X~~		~~X~~	

~~Table 4. MPHY_SAP Sublayer Management Parameters~~

~~11.1.11.1. MPHY_SAP Management Service Primitive Parameters~~

~~The following table shows the parameters used by one or more of the MPHY_SAP Sublayer Management Primitives.~~

~~Parameter~~	~~Associate Primitive~~	~~Value~~
~~none at this time~~		

~~Table 5. PHY_SAP Service Primitive Parameters~~

11.1.12. MPHY_SAP Detailed Service Specifications

The following section describes the services provided by each MPHY_SAP Service Primitive.

11.1.12.1. MPHY_RXRESET.request

11.1.12.1.1. Function

This primitive is a request by the LME to reset the PHY sublayer receive state machine.

11.1.12.1.2. Semantic of the Service Primitive

The primitive shall provide the following parameter:

MPHY_RXRESET.request

There are no parameters associated with this primitive.

11.1.12.1.3. When Generated

This primitive is generated at any time to reset the receive state machine in the PHY sublayer.

11.1.12.1.4. Effect of Receipt

Receipt of this primitive by the PHY sublayer will cause the PHY entity to reset the receive state machine to its idle state.

11.1.12.2. MPHY-RSRESET.confirm

11.1.12.2.1. Function

This primitive is a confirmation by the PHY layer to the local LME that the PLCP receive state machine was successfully reset.

11.1.12.2.2. Semantic of the Service Primitive

The primitive shall provide the following parameter:

MPHY_RXRESET.confirm

There are no parameters associated with this primitive.

11.1.12.2.3. When Generated

This primitive is generated as a response to the MPHY_RXRESET.request primitive once the PLCP has successfully completed reset of the receive state machine.

11.1.12.2.4. Effect of Receipt

The effect of receipt of this primitive by the LME is unspecified.

11.1.12.3. MPHY_TXRESET.request

11.1.12.3.1. Function

This primitive is a request by the LME to reset the PHY sublayer transmit state machine.

11.1.12.3.2. Semantic of the Service Primitive

The primitive shall provide the following parameter:

MPHY_TXRESET.request

There are no parameters associated with this primitive.

11.1.12.3.3. When Generated

This primitive is generated at any time to reset the transmit state machine in the PHY sublayer.

11.1.12.3.4. Effect of Receipt

Receipt of this primitive by the PHY sublayer will cause the PHY entity to reset the transmit state machine to its idle state.

11.1.12.4. MPHY_TXRESET.confirm

11.1.12.4.1. Function

This primitive is a confirmation by the PHY layer to the local LME that the PLCP transmit state machine was successfully reset.

11.1.12.4.2. Semantic of the Service Primitive

The primitive shall provide the following parameter:

MPHY_TXRESET.confirm

There are no parameters associated with this primitive.

11.1.12.4.3. When Generated

This primitive is generated as a response to the MPHY_TXRESET.request primitive once the PLCP has successfully completed reset of the transmit state machine.

11.1.12.4.4. Effect of Receipt

The effect of receipt of this primitive by the LME is unspecified.

11.2. Baseband IR Physical Layer Convergence Procedure Sublayer

While the Physical Layer Convergence Procedure (PLCP) sublayer and the Physical Medium Dependent (PMD) sublayer are described separately, the separation and distinction between these sublayers is artificial, and is not meant to imply that the implementation must separate these functions. This distinction is made primarily to provide a point of reference from which to describe certain functional components and aspects of the PMD. The functions of the Physical Layer Convergence Procedure can be subsumed by a Physical Medium Dependent sublayer: In this case, the PMD will incorporate the PHY_SAP as it's interface, and will not offer a PMD_SAP.

11.2.1. Introduction

This section provides a convergence procedure in which MPDUs are converted to and from PDUs. During transmission, the MPDU is appended with a PLCP Preamble *and PLCP Header* ~~and with a PLCP Postamble~~ to create the PDU. At the receiver, the PLCP Preamble is processed and the internal data fields are processed to aid in demodulation and delivery of the MPDU.

11.2.2. Physical Layer Convergence Procedure Frame Format

Figure 11.3.1 shows the format for the PDU including the PLCP Preamble, the PLCP Header and the MPDU. The PLCP Preamble contains the following fields: Synchronization (SYNC) and Start Frame Delimiter (SFD). The PLCP Header contains the following fields: Data Rate (DR), DC Level Adjustment (DCLA), Length (LENGTH) and CRC. Each of these fields will be described in detail in section 11.3.3.

~~Figure 3.1 shows the format for the PDU including the PLCP Preamble, the MPDU and the PLCP Postamble. The PLCP Preamble contains the following fields: Synchronization (Sync), Start Frame Delimiter (SFD), Data Rate (DR) and DC Level Adjustment (DC LA). Each of these fields will be described in detail in section 3.3. The PLCP postamble is the End Frame Delimiter (EFD).~~

PLCP Preamble		PLCP Header				
SYNC	SFD	DR	DCLA	LENGTH	CRC	MPDU
57-73 slots	4 slots	3 slots	32 slots	16 bits	16 bits	variable number of octets

Figure *11*.3.1. PLCP Frame Format

11.2.3. PLCP Modulation and Rate Change

The PLCP Preamble shall be transmitted using the basic pulse defined ~~in section 4.8.2. The Data Rate field will indicate the data rate which will be used to transmit the MPDU. The 1 Mbps data rate will use 16-PPM and the 2 Mbps data rate will use 4-PPM. The transmitter and receiver will initiate the modulation or demodulation indicated by the DR field starting with the first symbol (4 bits for 16-PPM and 2 bits for 4-PPM) of the MPDU. The MPDU transmission rate is set by the RATE parameter in PHY_DATA.request primitive. Any conformant Baseband IR PHY shall be capable of receiving at 1 Mbps and 2 Mbps. Transmission at 2 Mbps is optional. All PLCP fields will be transmitted using the same basic pulse as defined~~ *in section 11.4.8.2. The MPDU, LENGTH and CRC fields are transmitted using Pulse Position Modulation (PPM). PPM maps words into symbols: a word with n bits is mapped into one of the $L=2^n$ positions of a symbol (L-PPM). The basic L-PPM time unit is the slot. A slot corresponds to one of the L positions of a symbol and has a 250ns duration. The MPDU, LENGTH and CRC fields are transmitted in one of two bit rates: 1MBPS and 2MBPS. The Data Rate field indicates the data rate which will be used to transmit the MPDU, LENGTH and CRC fields. The 1 MBPS data rate uses 16-PPM (Basic Access Rate) and the 2 MBPS data rate uses 4-PPM (Enhanced Access Rate). The transmitter and receiver will initiate the modulation or demodulation indicated by the DR field starting with the first 4 bits in 16-PPM or 2 bits in 4-PPM of the LENGTH field. The MPDU transmission rate is set by the RATE parameter in PHY_DATA.request primitive specifying START-OF-ACTIVITY. Any conformant Baseband IR PHY shall be capable of receiving at 1 MBPS and 2 MBPS. Transmission at 2 MBPS is optional.*

11.2.4. PLCP Field Definitions

~~The entire PLCP Preamble and Postamble shall be transmitted using the basic pulse defined in section 4.8.2.~~ In all fields the *left* ~~right~~ most bit is transmitted first.

11.2.4.1. PLCP Synchronization (*SYNC* ~~Sync~~)

The *SYNC* ~~Sync~~ field consists of a sequence of alternated presence and absence of a pulse in consecutive slots. The *SYNC* ~~Sync~~ field has a minimum length of 57 slots and a maximum length of 73 slots and shall terminate with an empty slot. This field is provided so that the receiver can perform clock recovery *(slot synchronization)*, automatic gain control (optional), signal-to-noise ratio estimation (optional) and diversity selection (optional).

11.2.4.2. PLCP Start Frame Delimiter (SFD)

The SFD field length is 4 slots and consists of the binary sequence `1001`. The SFD field is provided to indicate the start of the *PLCP Preamble* ~~MPDU~~ and to perform bit and symbol synchronization.

11.2.4.3. PLCP Data Rate (DR)

The DR field indicates to the PHY the data rate which will be used for the transmission or reception of the MPDU, *LENGTH and CRC fields. The transmitted value is provided by the PHY_DATA.request primitive specifying START_OF_ACTIVITY as described in section 8.* The DR field has a length of 3 slots. The Baseband IR PHY currently supports two data rates defined by the following binary words:

1 MBPS: 000
2 MBPS: 001

This field allows for the future introduction of a maximum of 8 different data rates.

11.2.4.4. PLCP DC Level Adjustment (*DCLA* ~~DC LA~~)

The *DCLA* ~~DC LA~~ field is required to allow the receiver to *stabilize*~~stabilise~~ the DC level after the *SYNC* ~~Sync~~ ,~~and~~ SFD *and DR* fields. The length of the *DCLA* ~~DC LA~~ field is 32 slots and consists of the binary words:

1 MBPS:	00000000100000000000000010000000
2 MBPS:	00100010001000100010001000100010

~~11.2.4.5. PLCP End Frame Delimiter (EFD)~~

~~The EFD field is provided to indicate the end of the MPDU. The EFD length is 16 slots and consists of the binary word 0000011011011011.~~

11.2.4.6. *PLCP LENGTH*

The LENGTH field is an unsigned 16 bit integer which indicates the number of octets to be transmitted in the MPDU. The transmitted value is provided by the PHY_DATA.request primitive specifying START_OF_ACTIVITY as described in section 8. The LSB (least significant bit) shall be transmitted first in time. This field is sent in L-PPM format. This field is protected by the CRC16 Frame Check Sequence described in next section.

11.2.4.7. *PLCP CRC*

The LENGTH field shall be protected by a CCITT CRC16 FCS (Frame Check Sequence). The CRC16 FCS is the ones compliment of the remainder generated by the module 2 division of the LENGTH field by the polynomial:

$$x^{16}+x^{12}+x^5+1$$

The protected bits will be processed in transmit order. This field is sent in L-PPM format. All FCS calculations shall be made prior to L-PPM encoding on transmission and after L-PPM decoding on reception.

11.2.4.8. *PLCP Transmit Procedure*

All commands issued by the MAC require PHY_DATA.confirm primitives to be issued by the PHY. The PHY_DATA.confirm primitives provide flow control between the MAC and the PHY.

Based on the status of CCA the MAC will assess that the channel is clear. If the channel is clear, transmission of the MPDU is initiated by a PHY_DATA.request specifying START-OF-ACTIVITY with DATA parameters LENGTH and RATE.

The PHY entity will immediately initiate transmission of the PLCP preamble and PLCP header based on the LENGTH and RATE parameters passed in the PHY_DATA.request primitive. Once the PLCP preamble and PLCP header transmission is completed the PHY entity issues a PHY_DATA.indicate specifying END-OF-ACTIVITY. Data is then exchanged between the MAC and the PHY by a series of PHY_DATA.request specifying DATA. At the PHY layer each octet is divided into symbols (2 or 4 bits). Transmission is terminated by the MAC through the primitive PHY_DATA.request specifying END-OF-DATA-AND-ACTIVITY.

11.2.4.9. *PLCP Receive Procedure*

All commands issued by the MAC require PHY_DATA.confirm primitives to be issued by the PHY. The PHY_DATA.confirm primitives provide flow control between the MAC and the PHY.

Reception is initiated by a PHY_DATA.indicate specifying START_OF_ACTIVITY indicating that the medium is busy. This will occur during the SYNC field of the PLCP preamble. The PHY entity will then begin searching for the SFD field. Once the SFD field is detected the PHY entity will receive the PLCP header. After receiving the DR and DCLA fields the CRC processing is initiated and LENGTH field is received. The change indicated in the DR field is initiated with the first symbol of the LENGTH field. The CRC16 FCS will be processed. If the CRC16 FCS check fails or no match is found for DR field a PHY_DATA.indicate specifying END-OF-ACTIVITY will be issued.

If the PLCP preamble and PLCP header reception is successful, the received MPDU bits are assembled into octets and presented to the MAC using a series of PHY_DATA.indicate specifying DATA. The first PHY_DATA.indicate specifying DATA will include the parameters RATE and LENGTH. The PHY proceeds with MPDU reception. Reception is terminated after the reception of the final bit of the last MPDU octet indicated by the PLCP header LENGTH field. Depending on the CCA status, either a PHY_DATA.indicate specifying END-OF-DATA or a PHY_DATA.indicate specifying END-OF-DATA-AND-ACTIVITY is issued to the MAC.

~~11.2.5. PLCP Transmit Procedure~~

~~The PLCP transmit procedure is shown in figure 3.3. Based on the status of PHY_CS the MAC will assess that the channel is clear and initiate the PHY_DATA.request primitive. The PLCP will enable the PMD_TXE (TX mode) and the PHY entity will immediately initiate transmission of the PLCP Preamble based on the parameters passed in the PHY_DATA.request primitive. Once the PLCP Preamble transmission is completed, PMD_AMF is enabled which in turn enables the PHY_TXBUSY primitive to the MAC. The rate change, if any, is initiated at this same time as described in section 3.4. The PHY proceeds with MPDU and PLCP Postamble transmission. Transmission is terminated by disabling the PMD_TXE primitive. The termination occurs after the transmission of the final slot of the PLCP Postamble. Coincident with the termination of PMD_TXE, the PHY_TXBUSY is disabled. The packet transmission is completed and the PHY entity enters the default receive state (PMD_TXE is disabled).~~

~~Figure 3.3 PLCP Transmit Procedure~~

~~11.2.6. PLCP Receive Procedure~~

~~The PLCP receive procedure is shown in figure 3.4. In order to receive data, PMD_TXE must be disabled so that the PHY entity is in the default receive state. Upon detecting the transmitted Preamble the PMD will enable PMD_CS and the PLCP will enable PHY_CS. The PHY entity begins searching for the SFD field. Once the SFD field is detected the DR and DC LA fields are received. After the last slot of the DC LA field has been received, the PMD_MDA is enabled which in turn enables the PHY_RXBUSY primitive to the MAC. The rate change indicated in the DR field is initiated at this same time as described in section 3.5. The PHY starts immediately searching for the EFD and also proceeds with MPDU reception. Reception is terminated after the reception of the final slot of the EFD. Coincident with the termination PMD_MDA is disabled, PHY_RXBUSY is disabled and a PHY_DATA.indicate primitive is issued. The receiver returns to the default receive state.~~

~~Figure 3.4 PLCP Receive Procedure~~

11.3. Baseband IR Physical Medium Dependent *Sublayer*

The Baseband IR Physical Medium Dependent Sublayer does not define PMD Service Access Primitives. The mechanism for communications between the PLCP and PMD sublayers, as well as the distinction between these two sublayers, if any, are left to the implementors. In particular, it is possible to design and implement in a conformant way a single sublayer which subsumes the functions of both the PLCP and PMD, presenting only the PHY_SAP.

11.3.1. *Introduction* ~~Scope and Field of Application~~

This section describes the PMD ~~services provided to the PLCP for the Baseband IR Physical Layer. Also defined in the section are the~~ functional, electrical, and optical characteristics required for interoperability of implementations conforming to this specification. The relationship of this specification to the entire Baseband IR PHY Layer is shown in figure 11.4.1

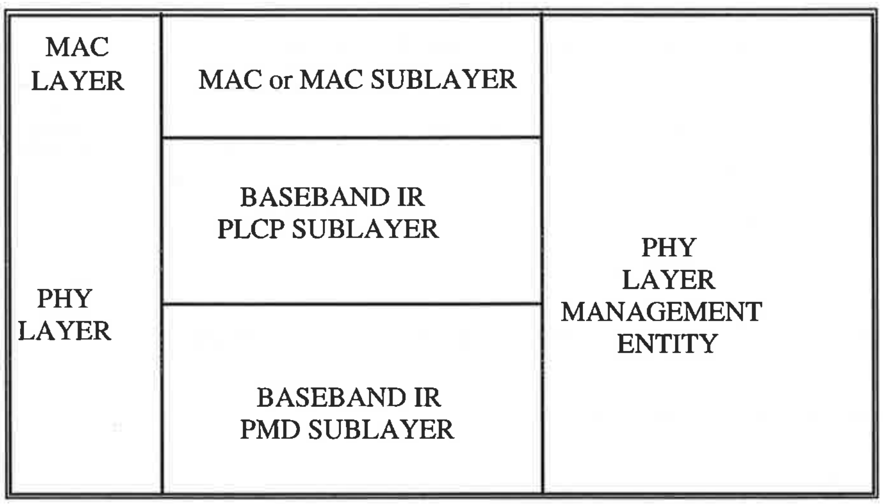

Figure 11.4.1 PMD Layer Reference Model

~~11.3.2. Overview of Service~~

The Baseband IR Physical Medium Dependent Sublayer ~~accepts Physical Layer Convergence Procedure sublayer service primitives and~~ provides the actual means by which data is transmitted or received from the media. ~~The combined function of Baseband IR PMD sublayer primitives and parameters for the receive function results in a data stream, timing information, and associated received signal parameters being delivered to the PLCP sublayer. A like functionality is provided for data transmission.~~

~~11.3.3. Overview of Interactions~~

~~The primitives associated with the 802.11 PLCP sublayer to the Baseband IR PMD falls into two basic categories:~~

~~1. Service primitives that support PLCP peer-to-peer interactions~~

2. Service primitives that have local significance and support sublayer-to-sublayer interactions.

11.3.4. Basic Service and Options

All of the service primitives described in this section are considered mandatory unless otherwise specified.

11.3.4.1. PMD_SAP Peer-to-Peer Service Primitives

The following table indicates the primitives for peer-to-peer interactions.

Primitive	Request	Indicate	Confirm	Response
PMD_DATA	X	X		

Table 4.1 PMD_SAP Peer-to-Peer Service Primitives

11.3.4.2. PMD_SAP Sublayer-to-Sublayer Service Primitives

Primitive	Request	Indicate	Confirm	Response
PMD_TXE	X			
PMD_RATE	X	X		
PMD_AMF		X		
PMD_MDA		X		
PMD_CS		X		

Table 4.2 PMD_SAP Sublayer-to-Sublayer Service Primitives

PMD_SAP Service Primitive Parameters

Parameter	Associate Primitive	Value
TXD_UNIT	PMD_DATA.request	One, Zero
RXD_UNIT	PMD_DATA.indicate	One, Zero
IR_STATE	PMD_TXE.request	Receive, Transmit
RATE	PMD_RATE.indicate PMD_RATE.request	0 for 1 MBPS 16-PPM 1 for 2 MBPS 4-PPM

Table 4.3 List of Parameters for the PMD Primitives

11.3.5. PMD_SAP Detailed Service Specification

The following section describes the services provided by each PMD primitive.

11.3.5.1. PMD_DATA.request

11.3.5.1.1. Function

This primitive defines the transfer of data from the PLCP sublayer to the PMD entity.

11.3.5.1.2. Semantic of the Service Primitive

The primitive shall provide the following parameters:

PMD_DATA.request(TXD_UNIT)

The TXD_UNIT parameter takes on the value of ONE or ZERO. This parameter represents a single data bit.

11.3.5.1.3. When Generated

This primitive is generated by the PLCP sublayer to request transmission of a data bit. The data clock for this primitive is supplied by PMD layer.

11.3.5.1.4. Effect of Receipt

The PMD performs transmission of the data.

11.3.5.2. PMD_DATA.indicate

11.3.5.2.1. Function

This primitive defines the transfer of data from the PMD entity to the PLCP sublayer.

11.3.5.2.2. Semantic of the Service Primitive

The primitive shall provide the following parameters:

PMD_DATA.indicate(RXD_UNIT)

The RXD_UNIT parameter takes on the value of ONE or ZERO. This parameter represents a single data bit which has been recovered from the received signal by the PMD entity.

11.3.5.2.3. When Generated

This primitive is generated by the PMD entity forward received data to the PCLP sublayer. The data clock for this primitive is supplied by PMD layer based on the recovered clock.

11.3.5.2.4. Effect of Receipt

The PLCP sublayer either interpretates the data bit as part of the PLCP convergence procedure or pass the data to the MAC layer as part of the MPDU.

11.3.5.3. PHY_TXE.indicate

11.3.5.3.1. Function

This primitive, generated by the PHY PLCP sublayer, initiates PDU transmission by the PMD layer.

11.3.5.3.2. Semantic of the Service Primitive

The primitive shall provide the following parameters:

PMD_TXE.request(IR_STATE)

IR_STATE. The IR_STATE parameter indicates one of two possible PHY operating conditions: Receive or Transmit. This primitive is a Transmit Enable. The default PHY state is receive.

11.3.5.3.3. When Generated

This primitive is generated by the PLCP sublayer to initiate the PMD layer transmission of the PDU. The PHY_DATA.request primitive must be provided to the PLCP sublayer prior to setting IR_STATE = transmit within the PMD_TXE command.

11.3.5.3.4. Effect of Receipt

PMD_TXE initiates or terminates transmission of a PDU by the PMD sublayer.

11.3.5.4. PMD_RATE.request

11.3.5.4.1. Function

This primitive, generated by the PHY PLCP sublayer, selects the data RATE which will be used by the Baseband IR PHY for transmission.

11.3.5.4.2. Semantic of the Service Primitive

The primitive shall provide the following parameters:

PMD_RATE.request(RATE)

RATE. RATE selects which of the Baseband IR PHY data rates will be used for MPDU transmission. Section 4.7.1 provides further information on the Baseband IR PHY data rates. The Baseband IR PHY rate change capability is fully described in section 3.4.

11.3.5.4.3. When Generated

This primitive is generated by the PLCP sublayer to change or set the current Baseband IR PHY data rate.

11.3.5.4.4. Effect of Receipt

The receipt of PMD_RATE selects the rate which will be used for all transmissions. This rate will be used for transmission only. The Baseband IR PHY will still be capable of receiving at all the required Baseband IR PHY data rates.

11.3.5.5. PMD_RATE.indicate

11.3.5.5.1. Function

This primitive, generated by the PMD sublayer, indicates which data rate was used to receive the MPDU part of the PDU. The data rate is indicated in the PLCP Preamble 802.11 DATA RATE field.

11.3.5.5.2. Semantic of the Service Primitive

The primitive shall provide the following parameters:

PMD_RATE.indicate(RATE)

RATE. In receive mode, the RATE parameter informs the PLCP layer which of the Baseband IR PHY data rates was used to process the MPDU part of the PDU. Section 4.7.1 provides further information on the Baseband IR PHY modulation rates. The Baseband IR PHY rate change capability is fully described in section 3.4.

11.3.5.5.3. When Generated

This primitive is generated by the PMD sublayer when the PLCP Preamble 802.11 DATA RATE field has been properly detected.

11.3.5.5.4. Effect of Receipt

This parameter is provided to the PLCP layer for information only.

11.3.5.6. PMD_AMF.indicate

11.3.5.6.1. Function

This primitive, generated by the PMD, indicates to the PLCP layer that transmission of the MPDU portion of the PDU is underway.

11.3.5.6.2. Semantic of the Service Primitive

The PMD_AMF (Avaliable MAC Frame) primitive is associated with the PLCP layer PHY_TXBUSY primitive. PMD_AMF indicates a binary PHY entity status of ENABLED or DISABLED. PHY_AMF is ENABLED when the first data bit of the MPDU is required for transmission. PHY_AMF is DISABLED when the last MPDU data bit has been transmitted by the PHY entity.

11.3.5.6.3. When Generated

This primitive is generated by the PMD sublayer when the PHY is transmitting the MPDU portion of the PDU.

11.3.5.6.4. Effect of Receipt

This indicator is provided to the PLCP for forwarding to the MAC entity for information purposes through the PHY_TXBUSY indicator. No specific action is required by the MAC entity upon receipt of this indicator.

11.3.5.7. PMD_MDA.indicate

11.3.5.7.1. Function

This primitive, generated by the PMD, indicates to the PLCP layer that MPDU data is being processed and that data is available.

11.3.5.7.2. Semantic of the Service Primitive

The PMD_MDA (Mac Data Avaliable) primitive is associated with the PLCP layer PHY_RXBUSY primitive. PMD_MDA indicates a binary PHY entity status of ENABLED or DISABLED. PHY_PMD is ENABLED when the first data bit of the MPDU is available from the PHY entity for use by the MAC entity. PHY_MDA is DISABLED when the last data bit has been processed by the PHY entity.

11.3.5.7.3. When Generated

This primitive is generated by the PMD sublayer when the PHY is receiving the MPDU portion of the PDU.

11.3.5.7.4. Effect of Receipt

This indicator is provided to the PLCP for forwarding to the MAC entity for information purposes through the PHY_RXBUSY indicator. No specific action is required by the MAC entity upon receipt of this indicator.

11.3.5.8. PMD_CS.indicate

11.3.5.8.1. Function

This primitive, generated by the PMD, indicates to the PLCP layer that the receiver has detected a valid Preamble.

11.3.5.8.2. Semantic of the Service Primitive

The PMD_CS (Carrier Sense) primitive is associated with the PLCP layer PHY_CS primitive. PMD_CS indicates a binary PHY entity status of ENABLED or DISABLED. PHY_CS is ENABLED when a valid Preamble has been detected and data is being received.

11.3.5.8.3. When Generated

This primitive is generated by the PMD sublayer when the PHY is receiving PDU and a valid Preamble has been detected.

11.3.5.8.4. Effect of Receipt

This indicator is provided to the PLCP for forwarding to the MAC entity for information purposes through the PHY_CS indicator. This parameter indicates that the IR media is busy and occupied by an IR PHY signal. The Baseband IR PHY should not be placed into the transmit state when PMD_CS is ENABLED.

11.3.6. MPMD_SAP Sublayer Management Primitives

No sublayer management primitives are defined for the Baseband IR PHY PMD

11.3.7. PMD Operating Specifications General

The following sections provide general specifications for the Baseband IR Physical Medium Dependent sublayer. These specifications apply to both the receive and transmit functions and general operation of a compliant Baseband IR PHY.

11.3.7.1. Modulation and Channel Data Rates

Two modulation formats and data rates are specified for the Baseband IR PHY: a Basic Access Rate and an Enhanced Access Rate. The Basic Access Rate is based on 1 *MBPS*~~MBPS~~ 16-PPM modulation. The 16-PPM encoding is specified in Table 11.4.6. Each group of 4 data bits is mapped in one of 16-PPM symbols. The Enhanced Access Rate is based on 2 *MBPS*~~MBPS~~ 4-PPM. The 4-PPM encoding is specified in Table 11.4.7. Each group of 2 data bits is mapped into one of 4-PPM symbols.

Data	16-PPM Symbol
0000	1 - 0000000000000001
0001	2 - 0000000000000010
0010	3 - 0000000000000100
0011	4 - 0000000000001000
0100	5 - 0000000000010000
0101	6 - 0000000000100000
0110	7 - 0000000001000000
0111	8 - 0000000010000000
1000	9 - 0000000100000000
1001	10 - 0000001000000000
1010	11 - 0000010000000000
1011	12 - 0000100000000000
1100	13 - 0001000000000000
1101	14 - 0010000000000000
1110	15 - 0100000000000000
1111	16 - 1000000000000000

Table 11.6 1 *MBPS*~~MBPS~~ 16-PPM Basic Rate Mapping Table

Data	4-PPM Symbol
00	1 - 0001
01	2 - 0010
10	3 - 0100
11	4 - 1000

Table 11.7 2 *MBPS*~~MBPS~~ 4-PPM Enhanced Rate Mapping Table

~~11.3.7.2. Transmit to Receive Turnaround Time~~

~~The time from transition of the PMD_TXE control from the TX state to the RX state until the transceiver is in receive mode shall be less than or equal to TBD usec.~~

~~11.3.7.3. Receive to Transmit Turnaround Time~~

~~The time from transition of the PMD_TXE control from the RX state to the TX state until the transceiver is in transmit mode shall be less than or equal to TBD usec.~~

11.3.8. PMD Transmit Specifications

The following sections describe the transmit functions and parameters associated with the Physical Medium Dependent sublayer.

11.3.8.1. Transmitted Peak Optical Power

The peak optical power shall be 2 W ± 20%.

11.3.8.2. Basic Pulse Shape and Parameters

~~The transmitted optical format of the basic pulse is shown in figure 4.1.~~ The basic pulse width measured between the 50% amplitude points, shall be 250 ns ± 10 ns. The pulse rise time, measured between the 10% and 90% amplitude points, shall be lower than or equal to 40 ns. The pulse fall time, measured between the 10% and 90% amplitude points, shall be lower than or equal to 40 ns. The pulse jitter, defined as the absolute deviation in time of the a pulse from its correct position, shall be lower than or equal to 10 ns.

11.3.8.3. *Emitter Radiation Pattern Mask*

The emitter radiation pattern mask is defined in table 11.4.8. Position the conformant device in its recommended attitude. Define the conformant device axis as the axis passing through the emitter center and having the direction of the vertical from the floor. The mask represents the irradiance normalised to the average emitted power, as a function of the angle between the conformant device axis and the axis from the emitter center to the test receiver center (declination angle). The distance between emitter and test receiver is 1 meter. The test receiver normal is always aimed at the emitter center. The azimuth angle is a rotation angle on the conformant device axis.

DECLINATION ANGLE	*NORMALIZED IRRADIANCE*
α £ 60°	*> 3.5e-6*
α ≤ 22°	*≤ 2.2e-5*
29° < α ≤ 43°	*≤ -1.06e-4 + (0.44e-5) α*
43° < α≤ 57°	*≤ -1.15e-4 - (7.1e-7) α*
57° < α≤ 74°	*≤ 2.98e-4 - (3.9e-6) α*
74° < α≤ 90°	*≤ 4.05e-5 - (4.5e-7) α*

Table 11.4.8 Definition of the Emitter Radiation Pattern Mask

Measurements at the following angles shall be made: declination angles from 0° to 90° in steps of 10°; at each declination angle for azimuth angles of 0°, 4°, 11°, 20° and 31°. A device is judged conformant if for all 10 declination angles the average of the irradiance over the 5 azimuth angles falls within the bounds of the emitter radiation pattern mask for any arbitrarily selected initial azimuth angle.

11.3.8.4. *Optical Emitter Peak Wavelength*

The optical emitter peak wavelength shall be between 850 and 950 nm.

~~**Figure 4.1 Basic Pulse Shape**~~

~~11.3.8.5. Optical Radiation Pattern Mask~~

~~The optical radiation pattern mask is TBD.~~

~~11.3.8.6. Transmit Spectrum Mask~~

~~The Transmit Spectrum Mask is TBD.~~

~~**Figure 4.2 Transmit Spectrum Mask**~~

11.3.8.7. PMD Receiver Specifications

The following sections describe the receive functions and parameters associated with the Physical Medium Dependent sublayer.

11.3.8.8. Receiver Sensitivity

The Receiver Sensitivity defined as the minimum irradiance (in dBm/cm^2) at the photodetector plane required for a FER of $4x10^{-5}$ with an MPDU of 512 octets and with an ambient light level of - 10 dBm/cm^2, shall be:

1 *MBPS*~~MBPS~~: - 47 dBm/cm^2
2 *MBPS*~~MBPS~~: - 41 dBm/cm^2

11.3.8.9. Receiver Dynamic Range

The receiver dynamic range, defined as the ratio between the maximum and minimum irradiance at the photodetector plane that assure*s* a FER lower than or equal to $4x10^{-5}$ with an MPDU of 512 octets and with an ambient light level of - 10 dBm/cm^2, shall be greater or equal to 30 dB.

11.3.8.10. Receiver Field-of-View (FOV)

The receiver FOV defined as twice the angle from the normal of the detector surface to the direction at which no more optical power impinges on the detector shall be greater than or equal to 150°.

~~11.3.8.11. Receiver Interference Level Tolerance~~

~~The receiver interference level tolerance from other non-baseband IR PHYs is TBD.~~

~~11.3.8.12. Receiver Carrier Detection Response Time~~

~~The maximum response time from the first transition of the PLCP Sync signal to PMD_CS ENABLE shall be less than or equal to 12 usec.~~

11.3.9. *Clear Channel Assessment, Carrier Detect and Energy Detect Definitions*

11.3.9.1. *Clear Channel Assessment:*

Clear Channel Assessment (CCA) will be asserted "CLEAR" by the PHY when the Carrier Detect Signal (CS) and the Energy Detect Signal (ED) are both false, or when ED has been continuously asserted for a period of time defined by the product of CCA_WATCHDOG_TIMER and CCA_WATCHDOG_COUNT without CS becoming active. When either CS or ED go true, CCA is *indicated as "BUSY" to the MAC via the primitive **PHY_DATA.indicate** of class **START-OF-ACTIVITY.***

*Normally, CCA will be held "BUSY" throughout the period of the PLCP Header. After receiving the last PLCP bit and the first data octet, the PHY will signal **PHY_DATA.indicate** of class **DATA** with the parameters **LENGTH** and **RATE**. CCA will be held "BUSY" until the number of octets specified in the decoded PLCP Header are received. At that time the PHY will signal **PHY_DATA.indicate** of class **END-OF-DATA-AND-ACTIVITY** or **PHY_DATA.indicate** of class **END-OF-DATA** if CCA remains "BUSY", indicating some form of interference. In the latter case, the PHY will signal **PHY_DATA.indicate** of class **END-OF-ACTIVITY** only when CCA goes "CLEAR".*

*The transition of CCA from "CLEAR" to "BUSY" is indicated to the MAC via the primitive **PHY_DATA.indicate**, of class **END-OF-DATA-AND-ACTIVITY**, or **END-OF-ACTIVITY**.*

*If CS and ED go false before the PHY signals **PHY_DATA.indicate** of class **DATA**, CCA is set to "CLEAR" and immediately signaled to the MAC via **PHY_DATA.indicate** of class **END-OF-ACTIVITY.** If CS and ED go false after the PHY has signaled **PHY_DATA.indicate** of class **DATA** implying that the PLCP Header has been properly decoded, then the PHY will not signal a change in state of CCA until the proper interval has passed for the number of bytes indicated by the received PLCP LENGTH. At that time, the PHY will signal **PHY_DATA.indicate** of class **END-OF-DATA-AND-ACTIVITY.***

The transition of CCA from "CLEAR" to "BUSY" resets the timer and counter associated with CCA_WATCHDOG_TIMER and CCA_WATCHDOG_COUNT, respectively. CCA_WATCHDOG_TIMER and CCA_WATCHDOG_COUNT are parameters available via MIB table entries and can be read and set via the LME.

Rise and fall times of CCA relative to the OR'ing of the CS and ED signals will be less than 30 nanoseconds. CS and ED are both internal signals to the PHY and are not available directly to the MAC, nor are they defined at any exposed interface.

11.3.9.2. ***Carrier Detect Signal:***

The Carrier Detect Signal (CS) is asserted by the PHY when it detects and locks onto an incoming PLCP Preamble signal. This signal is not directly available to the MAC. Conforming PHY are required to assert this condition within the first 12 microseconds of signal reception, at a signal level of -47 dBm/cm^2 for 1 MBPS operation and -41 dBm/cm^2 for 2 MBPS operation, with less than -10 dBm/cm^2 of background IR.

The Carrier Detect Signal (CS) is de-asserted by the PHY when the receiving conformant device loses carrier lock.

Note that the 12 microseconds specification is somewhat less than the minimum length of PLCP SYNC interval which is 28.5 cycles at 2 MHz, or 14.25 usec.

11.3.9.3. ***Energy Detect:***

The Energy Detection Signal (ED) is set true when IR energy variations in the band between 1 Mhz and 10 Mhz exceed -30 dBm/cm^2 .

This signal is not directly available to the MAC.

11.4. *PHY Managed Objects*

PHY Managed objects have default values, or allowed values which are PHY dependent. This section describes those values, and further specifies whether they are permitted vary from implementation to implementation.

MIB Object	Default Value	Operational Semantics	Operational Behavior
aCCA_Rise_Time	*5 usec*	*Static*	*Identical for all conformant PHY*
aCCA_Fall_Time	*1 usec*	*Static*	*Identical for all conformant PHY*
aRxTx_Turnaround_Time	*0 usec*	*Static*	*Identical for all conformant PHY*
*aRx_*Propagation*_Delay*	*1.5 usec*	*Static*	*Identical for all conformant PHY*
*aTx_*Propagation*_Delay*	*3.5 usec*	*Static*	*Identical for all conformant PHY*
aPLCP_Time	*60 usec 1mbps* *40 usec 2mbps*	*Static*	*Identical for all conformant PHY*
aPHY_SAP_Delay	*13.6 usec 1mbps* *9.6 usec 2mbps*	*Static*	*Identical for all conformant PHY*
aCCA_Watchdog_Timer_Max	*implementation dependent*	*Dynamic*	*A conformant PHY may set this via the LME*
aCCA_Watchdog_Count_Max	*implementation dependent*	*Dynamic*	*A conformant PHY may set this via the LME*
aCCA_Watchdog_Timer_Min	*22*	*Static*	*Identical for all conformant PHY*
aCCA_Watchdog_Count_Min	*1*	*Static*	*Identical for all conformant PHY*
aChannel_Transit_Delay	*25 nsec*	*Static*	*Identical for all conformant PHY*
aChannel_Transit_Variance	*25 nsec*	*Static*	*Identical for all conformant PHY*
aMPDU_Maximum	*2500 octets*	*Static*	*Identical for all conformant PHY*
aMPDU_Minimum	*0 octets*	*Static*	*Identical for all conformant PHY*
aMPDU_Current_Maximum	*implementation dependent*	*Dynamic*	*A conformant PHY may set this via the LME*
aSupported_Rx_Rates	*implementation dependent*	*Static*	*All conformant PHY must include the value 000 (1 Mbps).*
aSupported_Rx_Rates	*implementation dependent*	*Static*	*All conformant PHY must include the values 000 (1 Mbps) and 001 (2 Mbps).*
aBSS_Basic_Rate_Set	*000, 001*	*Static*	*Identical for all conformant PHY*
aStation_Basic_Rate	*implementation dependent*	*Dynamic*	*A conformant PHY may set this via the LME*

aExtended_Rate_Set	*implementation dependent*	*Static*	*Rates not in the BSS_Basic_Rate_Set which are supported by the PHY*
aPLCP_Rate	*000, 001*	*Static*	*The PLCP rate must be a member of the BSS_Basic_Rate_Set, and if the data rate is also a member of the BSS_Basic_Rate_Set, then the PLCP_Rate is the same.*
aPreferred_Tx_Rate	*implementation dependent*	*Dynamic*	*A conformant PHY may set this via the LME,*
aPreferred_Rx_Rate	*implementation dependent*	*Dynamic*	*A conformant PHY may set this via the LME,*