# Explanation of the PHY Layer Template Document

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The attached document has been generated in an effort to provide a self-consistent framework in which to cast PHY-layer proposals. It is based on an architectural model in which each PHY layer proposal will be considered as a document detailing two sublayers.

1) A Physical Layer Covergence Sublayer - This sublayer takes a MAC-PHY interface definition that is common to all PHY layers and adapts that interface to a specific Medium Dependent Interface

2) A Medium Dependent Interface Sublayer - This sublayer provides definition as to exactly how the output of the Physical Layer Covergence Sublayer is imposed on the medium. This includes but is not limited to mechanical and electrical specifications of the medium interface.

This document assumes that a section of the overall standard will be written that defines a MAC-PHY interface that is required if it is an exposed interface. It also assumes that there are sections of the document that define and parameterize specific instances of medium that are considered conformant.

It is our hope in presenting this document that the architectural structure can be adopted rather quickly and without controversy. In our view this structure does not in any way limit the functionality of any proposal that might come before the committee and it is one that is relatively common in standards of this type.

It is also our hope that the sections of the document that are largely boilerplate and required by the PAR or the IEEE 802 Functional Requirements can be incorporated without significant revision into proposals that are to be considered for standardization. The sections of the document that we consider to be of this type are printed in the **New Century Schoolbook Style that is common to IEEE 802 standards.**

The other sections of the document are intended to provide a guideline to writers of proposals as to the type of information that will ultimately be required in a final document. This is intended both to stimulate thought in particular areas and to encourage standardization of submissions. Sections of the document of this type are printed in the **Helvetica font.**

It is not our intention as part of this presentation to make any attempt to formalize a requirement that proposals be submitted in this format. As has been noted many times in the forum of IEEE 802.11 any attempt to force a standard or even a format through

the committee is destined for failure. All we ask at this time is that you consider the document carefully when you generate PHY proposals.

As an aid in encouraging submissions of serious proposals in this format we would be happy to provide this document to proposers in soft format. Anyone preparing a PHY layer for consideration that would like to take us up on this offer only need contact me and I will make arrangements with you to get an appropriate diskette to you.

# XX. Physical Layer Specification for Use with (Single, Multi) Channel, (Modulation Method) , (Electromagnetic (Band) , Sonic ( Band)) Medium Dependent Interface

The functional, electrical, and mechanical characteristics of one specific form of the Physical Layer of the standard is specified in this section. This standard specifies the Physical Layer Entity (PLE) only in so far as necessary to ensure:

(1) The interoperability of implementations conforming to this specification

(2) The protection of the local area network and those using it.

The relationship of this section to other sections of this standard and to the reference model in use for this standard is illustrated in Figure XX.1.

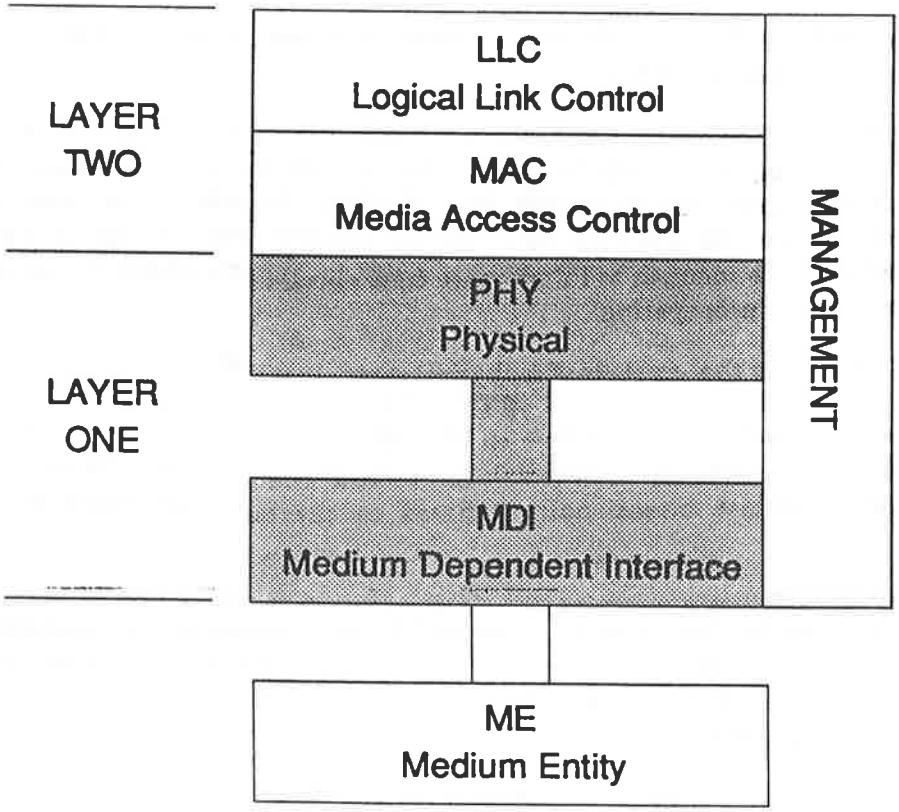


Figure XX.1

**XX.1 Nomenclature.** Terms used in this section that have a specific definition within the context of this section of the requirements document.

**signal.** A detectable disturbance.

**good signal.** A signal that passes all the tests that an IEEE 802.11 PHY Layer Entity can perform on it to assure that the signal has been generated by an IEEE 802.11 conformant PHY Layer Entity.

**infared signal.** A signal that consists of an electromagnetic disturbance with a wavelength in the range from 750 nm to 1 mm. This corresponds to frequencies between 40000 GHz and 300 GHz.

**microwave signal.** A signal that consists of an electromagnetic disturbance with a wavelength in the range from 1 mm to 30 cm. This corresponds to frequencies between 300 GHz and 1 GHz.

**radio frequency signal.** A signal that consists of an electromagnetic disturbance with a wavelength in the range from 10 m to 1 cm. This corresponds to frequencies between 30 MHz and 30 GHz. (Note: This definition deliberately excludes signals that might be considered radio frequency in other environments in order to maintain a reasonable relationship between the physical size of objects in the environments in which the IEEE 802.11 standard is expected to operate and the wavelength of a signal)

**medium.** Anything upon which a signal is impressed or from which a signal is received. The term media is used only as the plural of medium.

**conformant medium.** A medium that exhibits the characteristics detailed in one of the Medium Definition sections of the IEEE 802.11 standard.

**guided medium.** A medium that consists of a physical waveguide that confines signals impressed upon it to propagate only in the physical space occupied by the waveguide. A guided medium can only deliver signals to stations that are physically located along the path of the waveguide. Examples of guided media are coaxial and fiber optic cables. Signals propagating on a guided medium can be considered to be immune to interference from signals not intentionally imposed on the medium on which they are propagating.

**restricted medium.** A medium that consists of a physical cavity in which all signals that originate within the cavity are contained and from which all signals that originate outside of the cavity are excluded. A room without openings through which infared signals can pass is an example of a restricted medium. Signals propagating on a restricted medium can be considered to be immune to interference from signals not intentionally imposed on the medium on which they are propagating.

**directed medium.** A medium that propagates signals along a path that is primarily (although not entirely) confined to a solid angle that is small compared to $4\pi$ steradians. An example of a directed medium is a point-to-point microwave link. Signals propagating on a directed medium cannot be considered to be immune to interference from signals not intentionally imposed on the medium on which they are propagating.

**undirected medium.** A medium that propagates signals in a manner that is not confined to a known physical path. An example of an undirected medium is cluttered free space in the vacinity of radio frequency signals emitted from common dipole antennae. Signals propagating on undirected medium cannot be considered to be immune to interference from signals not intentionally imposed on the medium on which they are propagating.

**station.** Any entity that imposes signals that conform to the IEEE 802.11 PHY specification on a medium in a manner that conforms to the IEEE 802.11 MAC specification and receives signals

that conform to the IEEE 802.11 PHY and MAC specifications from a medium is considered a station whether or not it has any functionality beyond the reception and transmission of signals.

**channel.** An instance of medium use that can coexist with other instances of medium use with each instance of medium use providing service to a separate set of stations.

**local area network (LAN).** A group of stations that can communicate with each other through the use of a common medium.

**premises local area network (PLAN).** A group of stations under the control of a single administration that desires the ability to communicate exclusively with members of this group of stations.

**infrastructure.** Equipment that is placed into a geographical area serviced by a PLAN in order to enhance communciation service in that area.

**basic coverage area (BCA).** The geographic area that has communication service available at more than the minimum percentage of its area during more than the minimum percentage of the time specified in the PAR for conformance to IEEE 802.11 without the support of infrastructure.

**extended coverage area (ECA).** The geographic area that has communciation service available at more than the minimum percentage of its area during more than the minimum percentage of the time specified in the PAR for conformance to IEEE 802.11 with the support of infrastructure.

**total coverage area.** The geographic area served by a local area network. It has communication service available at more than the minimum percentage of its area during more than the minimum percentage the time specified in the PAR for conformance to IEEE 802.11 with the support of all equipment installed including (if it is present) pre-installed infrastructure.

**PLAN user.** An entity that desires access to the services of a specific PLAN.

**native station.** A station that is a member of the specific instance of a premises local area network of concern to a specific PLAN user.

**off premises local area network (OPLAN).** A group of stations not under the administrative control of the specific instance of a PLAN of concern to a specific PLAN user.

**alien station.** A station that is a member of an instance of an off premises local area network in the view of a specific PLAN user.

**obsequious station.** A station that cooperates with alien stations for the purposes of sharing a single medium.

**recalcitrant station.** A station that does not cooperate with alien stations for the purposes of sharing a single medium.

**jammer.** An entity that places signals that are observable by entities implementing an IEEE 802.11 PHY Layer Entity but do not conform to the IEEE 802.11 PHY Layer Specification.

**pernicious jammer.** An entity that places signals that conform to the IEEE 802.11 PHY Layer Specification but do not conform to the IEEE 802.11 MAC Layer Specification.

**Euclidean distance.** The classical measure of spatial separation that is calculated as $Sqrt[x^2+y^2+z^2]$ and is denominated in meters.

**attenuation distance.** The path loss between stations experienced by a signal that conforms to the IEEE 802.11 PHY specification as it propagates between a transmitter and a receiver. This distance is measured in dB and it is typically a time varying quantity.

**XX.2 Object.** The object of this specification is to:

(1) Provide the physical means necessary for communication between native staions employing the IEEE P802.11 media access control method defined in this standard and one of the media defined in this standard,

(2) Define a physical interface that can be implemented independently among different manufacturers of hardware and achieve the intended level of interoperability when connected of a common medium,

(3) Provide a communication channel capable of high bandwidth and low error rate over a usable coverage area,

(4) Provide for ease of installation and service in a wide range of environments,

(5) Provide for a low level of outage over a usable coverage area,

6) Use a medium that can be shared by totally unrelated applications and conserve the capacity of that medium.

**XX.3 Compatibility Considerations.** This standard applies to Physical Layer Entities that can be broken down into a Physical Layer Convergence Sublayer and a Medium Dependent Sublayer.

This combined Physical Layer Entity will impose conformant signals onto an instance of a medium. If this instance of a medium is a conformant medium as defined in the Medium Entity Definition section of this standard for the particular medium required by the Medium Dependent Sublayer Entity, communciation service with the minimum quality specified for conformance to this standard should be achieved between combinations of like entities within the defined coverage area of that medium.

The Physical Layer Entity defined in this Section will provide this communications service to an IEEE 802.11 conformant Media Access Control Entity at the MAC Service Interface. This communications service will be provide in a manner that conforms to the MAC-PHY Interface Specification Section of this standard if the MAC-PHY interface is exposed. If in a specific implementation the MAC-PHY interface is not exposed there is no requirement that the MAC-PHY Interface specified in this document be implemented.

**XX.4 Operational Overview of a Network Without Infrastructure.** This section of the document should provide a brief description of how the proposed system will implement basic coverage without a distribution system (infrastructure). This is intended to be general overview that gives an impression of the intraction of the MAC, PHY, and Medium.

**XX.5 Operational Overview of a Network With Infrastructure.** This section of the document should provide a brief description of how the proposed system will implement extended coverage with a distribution system (infrastructure). This is intended to be a general overview that gives an impression of the interaction of the MAC, PHY, and Medium.

**XX.6 General Overview of Physical Layer**

**XX.6.1 General Description of Functions.** In general, a Physical Layer Entity accepts PHY-service primitives from the MAC that specify the transmit signal that the MAC wishes to send. The Physical Layer Convergence Entity accepts these signals and performs any transformation required to map these signals onto the set of signals required at the Medium Dependent Sublayer Interface. The protocol function that accomplishes this is called the Physical Layer Convergence Protocol (PLCP) . The Medium Dependent Sublayer Entity accepts PLCP-service primitives and provides the actual means by which the signals required by these primitives are imposed onto the medium. In the Physical Layer Entity at the receiver the process is reversed. The combined function of the transmitting and receiving PLEs results in the provision of communication service to their respective MACs.

**XX.6.1.1 Symbol Transmission and Reception Functions.** This section of the document should define the set of symbols that can appear at the MAC service interface and detail what transformations must be applied to those symbols to meet the needs of the specific Medium Dependent Sublayer Entity under consideration. Next information should be provided describing in general terms about the action that the Medium Dependent Sublayer takes in getting the signals onto the medium. Details should then be provided regarding the inverse of these transformations and how any ambiguities that may develop in the transformation process will be resolved.

**XX.6.1.2 Jabber-Inhibit Functions.** To protect the local area network from most faults in a station, each PLE shall implement a jabber-inhibit function. This function serves as a "watchdog" on the transmitter; if the station does not turn off its transmitter after a prolonged time (roughly one-half second), then the transmitter output shall be disabled automatically. Reset of the jabber-inhibit function is implementation dependent, but in no case should the transmitter be reenable for the remainder of that transmission.

**XX.6.1.3 Quality of Service Indication Functions.** This section should indicate what measures of quality of service are generated by the specific implementation being described.

**XX.6.1.4 Local Administrative Functions** This section should indicate what Station managment functions are available to the Layer Management entity with this implementation.

**XX.6.1.5 Basic Functions and Options.** Symbol transmission and reception functions and jabber-inhibit functions are required in all implementations. Next a descripition the other aspects of this implementation that are considered required and the aspects that are considered optional.

**XX.7 Application of Management.** The following constraints are imposed on the parameters and actions allowable under the Station and Layer Managment Specification Section of this document:

(1-N) List limitations on allowable station management options that are specific to this implementation.

**XX.8 Functional, Electrical, and Mechanical Specifications.** Unless otherwise stated, all voltages are in rms and dBmV, based on transmission of random data patterns. Unless otherwise stated all power levels are rms and dBmW, based on transmission of random data patterns.

**XX.8.1 Data Signaling Rates.** Specify the data signalling rate or rates that are supported by this implementation. A statement regarding the tolerance on these signaling rate is required. This tolerance is typically ±.01% unless there is a specific reason why this tolerance needs to be higher or lower.

**XX.8.2 Symbol Encoding.** This section should describe in excruciating detail the translations performed by the PLE on the MAC symbols in order to prepare them for presentation to the MDI. In that we do not have a specification from the MAC subgroup of what the required symbol set will be I suggest that as a minimum the set {Silence, Zero, One, and Pad_Idle} be documented. Any proposed implementation should give serious thought to the impact on the implementation of needing to support an additional symbol in this set for the transmission of a non_data symbol.

**XX.8.3 Transmitted Signals.** This section of the document should describe in excruciating detail the nature of the signals that will be generated by the MDI on the medium. It should start with a n basic statement of the modulation technique in this introductory paragraph and continue with more detail in a series of subparagraphs. Suggested subparagraph titles and general contents are as follows.

**XX.8.3.1 Signal Representation.** This section might describe how the various symbols generated by the PLEs Medium Dependent Convergence Protocol are to be generated. For instance, a particular baseband modulation waveform might be frequency shifted and filtered. The necessary detail required to assure that the signals could be generated by multiple implementors using this representation needs to be provided.

**XX.8.3.2 Jitter.** This section can be used to describe the level of timing uncertainty that is allowable on the duration of individual line symbols. It might also be used to describe acceptable levels of phase jitter on local oscillators.

**XX. 8.3.3 Output Level.** This should describe the range of output powers that are to be considered conformant. If sufficent detail has not been provided in the section on line representation to completely specify the distribution of this output power in the frequency domain it may be necessary to provide spectral mask information in this section.

**XX.8.3.4 Transmitter Off State Leakage.** This previous section described limits of transmitter power during transmitter on operation. This section is design to ensure that

implementors reduce the transmitter power to a sufficently low level during transmitter off time.

**XX.8.3.5 Transition Times.** This is intended to describe the rise and fall time characteristics of transitions from one transmitted waveform to another. If the definitions given in the section on line representation totally specify the transmit waveform a section like this may not be necessary. This section should also detail times required to go from active to passive states.

**XX.8.4. Jabber Inhibit.** Each PLE shall have a self-interrupt capability to inhibit modulation from reaching the medium. Hardware within the PLE (with no external message other than the prolonged detection of an output-on condition within the transmitter) shall provide a nominal window of one-half second ±25% during which normal data link transmission may occur. If a transmission is in excess of this duration, the jabber-inhibit function shall operate to inhibit any further output from reaching the medium. Reset of this jabber-inhibit function is implementation dependent but in no case should transmission be resumed prior to the completion of the interrupted transmission.

**XX.8.5 Coupling to the Medium.** This section should describe the physical hardware that is intended to be used to couple signals to the medium. In this section descriptions of antennae or other means of coupling to the media should be detailed.

**XX.8.6 Receiver Characteristics.**

**XX.8.6.1 Receiver Sensitivity and Selectivity.** The PLE shall be capable of delivering MAC Protocol Data Units (MPDU), excluding any preamble, transmitted by one MAC entity to the PHY service interface of a peer MAC entity, with the probability of the MPDU not being reported correctly being less than $4*10^{-5}$ for an MPDU length of 512 octets. This capability shall be met at least 99.9% of the time on a daily basis, in 99.9% of the total geography of the coverage area, when

(1) The received signals are transmitted according to XX.8.3

(2) The received signals are conveyed by a conformant medium as defined in Section YY.Y

(3)After this statement of the functional requirements dictated by the PAR a summary of the receiver operating range and selectivity requirements should be listed.

**XX.8.6.2 Minimum Receiver Off Level and Blanking.** In this section requirements relating to receiver squelch levels and post message blanking if any exist should be documented.

**XX.8.7 Symbol Timing.** In this section requirements relating to what the timing and clock characteristic of information delivered to the MAC service interface are for this implementation. This is where information reagarding clock slip during preamble would be placed if they exist.

**XX.8.8 Symbol Decoding.** This section should include information about the inverse transformation of signals received from the medium to MAC symbols and the conditions under which such things as bad_signal might be reported.

**XX.8.9 Quality of Service Indications.** This section should detail the Quality of Service indications that are proposed for this implementation and the conditions under which those indications are valid.

**XX.8.10 Protection Against Device Failure.** The PLE should be designed such that a single failure in the PLE should not cause more than a transient failure of the network as a whole (except as related to the failed device). The loss of power to any data device should not cause more than a transient failure of the network as a whole. For the purposes of this document, "transient" is defined as an event that has a duration on the order of one second.

**XX.9 Environmental Specifications**

**XX.9.1 Electromagnetic Emanation.** Equipment shall comply with local and national requirements for electromagnetic emanations.

**XX.9.2 Safety Requirements.** All equipment meeting this standard shall comply with relevant local, national, and international safety codes and standards such as IEC Publication 950 (1986).

**XX.10 Labeling.** It is recommended that each embodiment (and supporting documentation) of a PLE conformant to this standard be labeled in a manner visible to the user with at least these parameters:

(1) Data rate capabilities in Mb/s

(2-N) Any inplementation specific labeling issues that may be required.

In addition when an implementation has multiple connectors the role of those connectors should be clearly marked in the vacinity of the connectors.