Tentative Minutes of the Joint MAC/PHY IEEE P802.11 Working Group

Interim meeting
Atlanta, GA
September 20-23, 1993

10:30 am, Monday

Meeting called to order by chairman Vic Hayes, NCR. Jim Schuessler, NSC, taking minutes.

Submissions

93/115	J	Protocol layering alternatives for practical implementation (M. Fischer)
93/140	J	MAC/PHY Functional Partitioning (Phil Belanger, Xircom, Greg Ennis, Symbol Technologies, and Wim Diepstraten, NCR)
93/146	J	The need for MAC data delimiters in the PHY (Wim Diepstraten, NCR)
93/147	J	The importance of short Rx-Tx turnaround time (Wim Diepstraten, NCR)
93/152	J	Necessary PHY Layer Alternatives for ET band and for "HIPERLAN" (Chandos Rypinski, LACE)
93/162	J	Proposed starting point text for Section 6 of Document P802.11-93/20 (Larry van der Jagt, KII)

Document 93/152 will be presented at the full working group meeting on Thursday afternoon.

Wim D., NCR, presents his paper "The need for MAC Data delimiters in the PHY", doc. 93/146. The delimiter allows automatic speed adaptation if located in the PHY. The delimiter's functional requirements include the hamming distance of 4; an ability to detect up to 3 bit errors. Wim recommend different start and end delimiters due to differing requirements placed on each. He contends that an in-band bit stream delimiter is acceptable for the start delimiter, but not the end delimiter. End delimiters are commonly "end of energy" type and this method could be made more reliable through windowing (i.e. knowing when to expect the end).

So where do these delimiters belong, MAC or PHY? Wim makes a case for including start and end delimiters in the PHY to allow the easy implementation of two features: 1.) automatic speed adaptation and, 2.) possible short preamble in ACK frames for systems with antenna diversity. The paper documents a possible frame format with a PHY specific header preceding MAC "data" (i.e. all MAC related fields such as addressing).

Larry V. makes the comment that the signals outlined in Wim's paper do not appear on our MAC/PHY interface. Perhaps they exist on the DTE/DCE interface.

Wayne M., WiSE, comments that the PHY Specific Field (PSF) does not have a FCS or end delimiter and therefore does not meet the hamming distance requirement. Others comment that 802.3 does not meet this requirement either. Larry V. thinks we have a big problem if we have to meet this requirement because it eliminates the ability to use binary signalling. Comment made that the 48-bit address field improves ability to detect errors, but others disagree. This is not its purpose. Wim comments that Net ID, and Cell ID improve error detection ability.

Wim states that the core requirement of Hamming distance 4 is to insure an undetected error rate. Implication is that how we achieve this is up to the committee. Tom B., Spectrix comments that this requirement was developed for wired systems; we will see many more raw errors. This fact may imply an even more robust error detection technique. Bob Grow, XLNT Designs, makes the point that all the qualifications in all the layers need to be evaluated to determine protection level. He believes a fixed length PHY preamble is a necessity, as well as the addition of an end delimiter.

Kamilo Feher, UCD, cites some theoretical work that with GFSK modulation, an error rate decrease of 10 times can be achieved by dropping the data rate by one half (e.g. 1 Mbit/s/s to 500 kbit/s/s). He is very much in favor of this proposal.

Vic shows a drawing of our 802.11 layered model on the screen to clarify Larry's point of what interface Wim's paper really addresses. Don Johnson says it sounds like you can do what Wim wants with our defined MAC/PHY interface. François Simon, IBM, points out that these MAC/PHY signals could be more specific than MAC_Data_Request, etc. A member points out that the modem world has solved this problem long ago with speed negotiation at the beginning of a connection. This implies speed negotiation occurs at higher levels. Dave B., AMD, cautions that modem analogies do not hold for LANs. We have a multi-point connection model, not point to point. Conversation draws comparison between negotiating speed on a per packet or per connection basis -- large or small granularity. Many favor multiple speed options, but no consensus on how to achieve it.

Dave B. points out that all MAC proposals assume that multiple stations hear a single message. If nodes associated with a single access point at multiple data rates are allowed, multiple messages would be required. The committee is admonished to consider the system implications of this decision. Wim agrees that this proposal has system consequences. Simon Black, Symbionics, points out that a lowest common denominator speed could be used for broadcast data. John McKown agrees. Diversity also presents this problem to the MAC and we have embraced this complexity.

Closed meeting at 11:30 am. for lunch. Reconvene at 1 pm as separate MAC and PHY Working Groups.

Wednesday, September 22, 1993, PM

Objectives:

1. Deal with issues regarding the MAC/PHY Interface
2. Communicate between the MAC and PHY Groups

Announcements

Copying: No courier service needed.

Financial: LXE will accept payments from 2:30 to 3:30 for meeting fee.

Submissions

See earlier table.

Michael Fischer presents document 93/115. Discussion is postponed until 93/140 is presented due to their similarity. Michael's objective is to clarify functions in layers of our model and believes that our current model can unnecessarily constrain our progress. It is mainly a labelling problem. (Presents diagram of current and proposed models on screen.) He proposes a new label, Physical Medium Adaptation (PMA) Layer above the DCE/DTE interface.

Kerry asks whether Michael agrees that "MAC Management" contains medium dependent functions? He does. The "Service Interface" could also be parameterized to accommodate our current range of PHYs.

Larry V. clarifies that the MAC/PHY interface was never intended to be exposed. Michael thought this was intended. Larry makes the point that the reference model says nothing about implementation. It does not force us into more work, more complexity or more cost. Michael feels more explanation is required from those people who created it. The context is whether you can interpret MPDUs in the PHY. Controversy seems to be whether medium dependent information needs to transition the MAC/PHY boundary.

Greg Ennis presents document 93/140. MAC/PHY Functional Partitioning (Phil Belanger, Greg Ennis, Wim Diepstraten) Real point is to develop a model that will allow us to fit all our functional needs into appropriate layers. Our problem seems to be that there are PHY dependencies that belong in the MAC. Greg contends there has been little description of what functions belong in each layer of our model, and little agreement on what has been presented.

The authors identified three categories of PHY level deppendencies that effect the "MAC":

1. PHY Control:
    - "Generic" Functions: bit transmission and reception, and preamble gen.
    - PHY Specific: Frequency, Chipping Sequence

    Their approach to address this is to support PHY specific functions by means of a general command / indication interface with parameters.
2. MAC State Machine
    - Retransmission scheduling in FHSS
    - Use of antenna diversity
    - Scanning for new access point

PHY Independent MAC state machine responsible for most MAC functions such as Medium allocation, Deferral and backoff, Association, CRC, addressing, ACKs, etc.

The MAC management entity is a "submachine" responsible for PHY Dependent actions. (bullets listed above) This entity has different actions for each PHY. These are dynamic actions to a minimum granularity of one frame (per frame)

Greg explains a "Scanning for Access Point" example. This function naturally fits in the MAC, even though PHY dependent since it involves the exchange and interpretation of frames.

3. PHY Dependent Information Exchange

Some information may need to be exchanged between PHYs. Information best handled by the MAC since you can take advantage of the error protection and data processing facilities. Parameters that may need to be exchanged include Tx. Power Level, Channel IDs, Hop Times, etc.

The PHY-Dependent MAC Sub layer cleanly separates dependent and independent functions. This new layer is located above our current Medium Independent layer in the current PHY. The authors propose we amend our model to include this new layer. Greg contends the MAC/PHY interface is PHY independent and exposable. Reasoning includes:

PHY dependencies in MAC are primarily how bits are interpreted, not how they are passed down to PHY

Generic (universal for all PHYs) command / indication interface.

An alternative exposed interface is to leave it where it is now (between medium independent and convergence). This would put some more functions in the Medium Independent Layer (MIL) he recommends however to make the MAC/PHY interface exposed.

From the MAC Management entity, the per frame functions needed include:

- Support for variable preamble length
- TX and RX control -- bit level data transfer
- Indication of Status information on each frame such as:
    - Receive signal level
    - signal quality
    - silence / interference level
    - bit rate received.
- Support for short training (e.g. for ACKs)
- Dynamic Bit rate selection
- Dynamic power control
- Diversity option
- ...others.

All the static interface functions should go into the Station Management layer or entity.

The authors MAC/PHY interface approach, which may be exposed, include data with synchronous clock, command lines from MAC to PHY and status lines from PHY to MAC. François Simon believes that "exposed" does not necessarily mean it is physical. Others disagree claiming that if "exposed" it must be testable, and a 'service interface" is what François is speaking of.

Larry argues that some functions that travel across the exposed interface are implicit. Certainly the information transitions the MAC/PHY interface, but not necessarily the exposed interface. Greg's model makes these interfaces one and the same.

See the paper for all the functions the authors recommend are conveyed across the MAC / PHY interface.

The authors conclude that it is possible for a single MAC to support multiple PHYs with parameterization. The MAC state machine is conditional and the management component is responsible for PHY dependent actions. PHY dependent sub layer is defined within the MAC. PHY independent exposed interface between the MAC and PHY. Finally, the MAC controls frequency selection.

Kerry Lynn, suggests this is really a matter of where you draw the line of where the MAC and PHY are demarcated.. Greg agrees. Phil states that an intelligent PHY was a less than optimal

solution. It is not just a matter of where you draw the line because it implies intelligence of the PHY.

Bob Grow argues for a management field which could be in every frame to accommodate the functionality Greg describes. He basically agrees, but cautions that many functions are intimately involved with MAC operation.

Leon believes we have just moved our line. Line was just to demarcate what subgroup worked on each layer. Doesn't believe our model is broken.

Wayne asks about the exposed versus unexposed interface. Concerned about the implementation of our exposed interface; won't it be too wide? Scared of so many functions making interface unrealistic.

Dave Bagby addresses where we put an exposed interface. Likes proposal. Does not agree that intelligent is necessarily complex or expensive -- equates it to utility.

Discussion of procedure.

Jim S: Didn't think I would be able to bring history back to this group, but... Could have substituted text from previous meetings into this one. Moving the line. Semantics. Need more work on functions in our current layers. (as Leon stated)

Kerry L. struggled to fit existing implementation into this model. When Ed Geiger presented in the PHY group many argued it was MAC specific. Agrees with Michael's simplification of the model. Believe current PHY must be interpreted as "intelligent". Arguing about where line should be.

Michael states that as PHY worked up from the bottom and MAC worked down from the top, this was the grey area in the middle. Makes the point that much care should be taken with the exposed interface. If no exposed interfaces are present, how is one to know if we have a single MAC or not? The exposed interfaces expose this issue. The most important aspect of the model is descriptive.

Nathan Silberman commends work done by authors. If our model is constraining our progress, change it. It looks like the model doesn't help us. It should not set boundaries to our thought process. Where we place these lines is irrelevant given current chip integration technology.

Dave Bagby moves that and Tom B. seconds:

1.) We revise our reference model as proposed in 92/140 without the PHY Convergence Layer, and

2.) adopt the described approach to refine the mac/phy interface, and

3.) that we not specify and exposed DTE/DCE interface, and

4.) close issue 1.5 by referring to the adopted reference model.

Michael offers an amendment that is accepted as friendly.

Jim motions to amend point one to read:

1.) We revise our reference model as proposed in 92/140 without the PHY Convergence Layer, and without the Medium Independent Layer.

20, 8, 22 passes.

Greg is not convinced we need an exposed interface but believes the model in 93/140 could support an exposed interface between the MAC and the PHY. Does not support the motion due to point 3. Motions to amend point 3 to:

3.) Leave open the sub-issue of to have or not have an exposed DTE/DEC interface at the MAC/PHY boundary.

Don Johnson seconds.

Bob Grow speaks against the amendment. Believes the model we are discussing improves on current model, but needs work yet. Would support motion if we would just leave the issue open. He moves to amend the amendment to read:

3.) Leave open.

Bob withdraws the motion.

François says we have a closed issue 12.2.A that says the MAC/PHY interface could be exposed.

Ron Bjorklund speaks in agreement with the amendment. It allows an IR PHY to plug into the same connector as an RF PHY -- a good thing.

Kerry points out that issue 12.3 appear closed. How can we proceed? Dave points out that voting for it automatically opens and closes the issue in an atomic operation.

Dave moves to call the questions: 31, 0, 8 passes

Vote on amendment 26, 9, 9 passes. Now the main motion reads:

> **1.) We revise our reference model as proposed in 92/140 without the PHY Convergence Layer and Medium Independent Layer, and**
>
> **2.) adopt the described approach to refine the mac/phy interface, and**
>
> **3.) Leave open the sub-issue of to have or not have an exposed DTE/DEC interface at the MAC/PHY boundary, and**
>
> **4.) close issue 1.5 by referring to the adopted reference model.**

Discussion on main motion now.

Bob _____: Discussion centers around boundary of MAC and PHY layers. This may not be what we want to discuss. Maybe the two are indistinguishable. We have worked on a common controller to an IR and RF PHY.

Tom B. moves to call the question. Dave seconds. 34, 3, 1 passes

Vote on main motion: 30, 6, 6 passes. (4:30 pm)

Wim presents doc. 93/147, "The Importance of Short Tx/Rx Turnaround Times". Refers to doc 93/109 by Pablo Brenner. Many reasons why this effects our standards effort.

Chan: Glad to hear this emphasis.

Vic: what should we do with this paper?

Wim: recommendations to PHY group. Doc. 93/147 recommends to open new issue to specify parameters the MAC needs.

Nathan: Antenna slot time analysis seems too simplistic. Joint issue is what probability of Carrier Sense can the MAC live with? Antenna decision making is not simply on strongest signal. Wim thinks he agrees.

Tom B: Suggests this a PHY issue.

Jim: Agree with most of your reasons why Tx/Rx turnaround time is important and furthermore, for FH systems, the hop time is also an important parameter effecting throughput. Disagree that

short time is important for Migration (backward compatibility) issue however. The time is not the only parameter effecting product migration (performance improvement) -- there are perhaps a hundred others. Migration will be handled by "old" mode, "new" mode in new products. Point is that there is a balance between turnaround time and cost / power / etc.

Michael thanks Wim for quantifying these effects. If these slot times have to be long, it is a message to look at differing protocols that do not depend (as much) on this turnaround time.

John McKown states that it is the nature of the old PHY contending with the new PHY limits performance. Does this mean a new MAC is needed for a each new PHY?

Larry: Saying one particular MAC will cause this difficulty. Both PHY and MAC will cost money. Not all MACs are equally effected by this parameter. Wim says Pablo's paper states this.

Tom B: Never thought he would commend Wim's protocol, but certainly this parameter is just as important in a deterministic protocol.

Michael states that, yes, all MAC protocols are sensitive to this and he has done an analysis of this some time ago. He will try to adapt his effort to this committee and bring the work to the next meeting.

Bill Stevens charges us to remember that co-located LANs effect our MAC evaluation and some protocols are perceived as handling this better (especially in single channel environment)

Larry presents doc. 93/162 on service primitives. "Proposed starting point text for Section 6 of the Document P802.11-93/20" These primitives were started in 92/96, 92/119, 92/125. Suggest we recover this information. The paper deals with the MAC and PHY interface service primitives. (Now between the PHY-Dependent sub layer in the MAC and the PHY)

Michael: If there is an LBT MAC, how is this indicated in PHY_Data_Confirm. Larry says it's not. When these were defined, were they considered sufficient to accommodate frame priorities? Larry says this is irrelevant to the PHY. Also could we add "time" as a parameter. Bob Grow says you could add a _____.

Dave asks if there was some handshake between MAC and PHY. Yes.

Kerry asks if End of Activity could be used as a quiet channel indication and start a timer from this? Larry says certainly. So we can assume a fixed delay here? Not unless it is specified. Larry indicates this can be constrained in a specification.

Craig MacKenna: Asks about need for new values in one of the primitives. Also suggests default value of 0.

Vic asks about PhData.request. Confirm is invalid in international standard world. Larry states objective is certainly to get this through ISO.

Bob Grow states this is a good start.

John M. asks if the timing of primitives one to another implies information content. Not intent. Michael agrees and this the reason why he recommends we implement this as a primitive parameter. States that if time is not included in these primitives, a MAC dependent on time could not operate.

Larry moves:

We adopt the service primitives as described in 93/162 as the service primitives for the PhSAP associated with data transference between MAC and PHY. (These primitives have

previously been described in 92/96, and 92/119) This is done to close issue 12.1 and opening 12.1.A and 12.1.B that will define two more SAPs.

This is addressing issue 12.1 What is the MAC/PHY interface? We have two other SAPs we have no issues. MAC Management and Station Management SAPs.

Chan seconds.

Simon Black asserts that we can't close this issue unless you believe you will never change these primitives. They are Done. Consensus agrees that we should not close the issue, but there is much discussion over the entire process. Point made that our procedures are limiting what we want to do here. This is something that will arise again and again and should be solved. Vic asks François to help out.

Dave moves to modify the last sentence to read:

Issue 12.1 be appropriately modified to reflect this decision.

Michael seconds.

Wayne calls the question, Leon seconds, passes by voice vote

Amendment passes by voice vote.

Tom B. calls question on motion, Don seconds, passes by voice vote.

Vote on motion: 42, 0, 0

Final motion reads:

We adopt the service primitives as described in 93/162 as the service primitives for the PhSAP associated with data transference between MAC and PHY. (These primitives have previously been described in 92/96, and 92/119) Issue 12.1 be appropriately modified to reflect this decision.

(6:05 pm)

PHY Input

Kamilo Feher presents five slides on how a lower data rate could increase reliability. Based on 93/138. Problem is that high raw error rate will cause us significant data transmission problems. Solution is to reduce data rate from 1 Mbit/s/s to 500 kbit/s/s. Gain 3 dB immediately by theory. Gain 4 dB through some other method and can then transfer data reliably. The 7 dB improvement takes raw error rate from 10E-3 to 10E-7. Point is that dropping the data rate could make a significant reliability improvement.

Vic points out we have a lower limit of 1 MBit/s..

Chan points out that shorter frames could help too. This is a linear gain. 1 dB gain is 1000% i.e. non-linear. Wim points out that environment is interference limited and not noise limited. Kamilo agrees more study is needed.

Dave objects to subtle message that reducing data rate is our one solution to increase reliability. There are many other "knobs" to turn without decreasing data rate.

Jerry Loraine states some technical problem with the analysis that Kamilo agrees with. Something to do with Gaussian noise and fading. Kamilo believes this analysis is simple "baby

level", and the model could be better. More strongly, the models used in the committee are wrong.

Larry presents some conclusions from the PHY group:

1.) There is a strong majority opinion in the PHY Group that rate switch should be included in standard providing it does not introduce significant performance degradation to basic rate operation.

2.) There is a majority opinion that 802.11 will still be a useful standard without rate switching.

3.) 100 uS preambles are acceptable.

MAC Input

Rate discussion occurred in MAC meeting and report will be later. It definitely effects the MAC in nontrivial way.

Adjourn for MAC and PHY Groups

adjourn at 6:45 pm