IEEE P802.11

Wireless Access Method and Physical Layer Specification

Minutes of the MAC/PHY Interface Ad–hoc Group July, 1994

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Minutes from session held July 11, 1994 (8:30PM – 11:55PM)

The attendees assembled gradually between 8:00PM and 8:30PM, in part due to the late adjournment of the afternoon session and in part due to uncertainty about the starting time.

The meeting was called to order at approximately 8:30PM by Bob O'Hara, who presented the following agenda proposal:

1) Select an interim chair, because the chair (Jim Schuessler) and vice–chair (Kerry Lynn) are both absent.
2) Select a secretary
3) MAC/PHY papers whose authors are present:
   - 94/163: A Pragmatic PHY Proposal, Barry Dobyns
   - 94/157: Proposed Changes to Draft Standard to Support Multi–Rate PHYs Pablo Brenner
   - 94/98a: Update to Knobs, Sliders, and Dials, Bob O'Hara
4) MAC/PHY papers whose authors are not (yet) present
   - 94/203: Text Changes to MAC/PHY Interface, Ed Geiger & Dean Kawaguchi
   - 94/132 & 94/132r1: Elaborate CCA Mechanism, Larry Zuckerman
   - 94/149: Strategic Implication of the HS IR PHY, Peter Bloymeyer

This agenda was accepted without objection. Bob O'Hara was selected to continue as interim chair. Michael Fischer volunteered to take the minutes and there was no objection.

Presentation & Discussion of paper 94/163:
A Pragmatic PHY Proposal, Barry Dobyns, Photonics

This presentation concerned the fact that, to date, each of the PHY working groups have been working independently on their own PHY SAP definitions, PHY principles of operation, and their own flavor of PLCP. However, we need a single PHY layer SAP and common PHY Principles of Operation for use by MAC and MAC management. Then each PHY group can do a PLCP to implement compliance with each of these two common definitions. The need for such commonality was stated to not have been obvious, at least within the IR PHY group(s).

The proposed solution to this problem is to define explicitly that the PHY SAP and Principles of Operation be defined by a single body, and that the various PHY groups focus on defining the relevant PLCPs. The alternatives of making the responsible body the full PHY sub–group or the MAC/PHY Interface ad–hoc group. Consensus was that the proper body was the MAC/PHY Interface ad–hoc group because the items being defined pertained directly to the functionality of the MAC/PHY interface.

Summary of discussion:

(Paul S., Ed. G.) The definition of PLCPs is a subset of what the various PHY groups need to do, and to explicitly list this as their responsibility is overly restrictive. Each PHY needs to do rather different things to acquire the signal and synchronize to the network.
{... heated agreement }

(Barry D.) The key issue is that things like PHY_DATA.indicate need to mean the same thing to the MAC from each of the PHYs.

(Ed G.) At the MAC layer there is the MAC, which sends data, and MAC management, which controls operation of the PHY. The difference from the other 802–LANs is that we don't have the same concept as the wire for PHY. The MAC management entity must provide the concept of the "kind of wire" to the (wireless) LAN. The MAC entity itself must be the same for all PHYs. However, there will be as many MAC management entities as their are PHY types.

(Barry D.) I don't necessarily agree that there are as many different MAC management types as there are PHY types.

(Ed G, Paul S.) The PHY layer service primitives have been taken out of the most recent updates to documents 94/68 (FH) and 94/50 (DS).
{... heated agreement }

(Greg E.) MAC management differences for different PHYs are more what the parameter ranges (and static vs. dynamic) apply, not the existence of the services and parameters. This has major impact on the MAC management to PHY management interface.

(Bob O., Wayne M., Michael F., et. al.) … discussion of whether or not there are two paths (data & management) between MAC and PHY. Some opinions that two paths are simpler to describe. A major reason to use a single path is that, if two paths are used, there needs to be synchronization primitives to ensure that frame–specific control and status apply to the correct frame. This synchronization is implicit if the management information is passed over the same path as the MPDU.

Motion #1:

Resolved that responsibility for the production of the Physical Layer Service Access Point definition rests exclusively with the MAC/PHY Interface group of the 802.11 and Physical Layer Principles of Operation definition rests exclusively with the PHY subcommittee of 802.11

- Moved by Barry Dobyns (w/ friendly amendments from Bagby, O'Hara, Moyers)
- Seconded by Ed Geiger
- VOTE: 28–0–0, motion carries

Motion #2:

Resolved that the medium–specific PHY {working} groups shall halt additional individual work on Physical Layer Service Access Point definition or Physical Layer Principles of Operation definitions. Medium–specific PHY {working} groups are directed to turn over their work in progress to the responsible body

- Moved by Barry Dobyns
- Motion dies for lack of second

Motion #3:

Resolved that each PHY {working} group is directed to concentrate it's efforts on the production of a unique PLCP in conformance with the standard Physical Layer Service Access Points definitions and Physical Layer Principles of Operation definition.

- Moved by Barry Dobyns
- Seconded by Paul Strushaker
- Friendly amendment to delete "single" and add "s" on "Points" and "definitions"
- Discussion focused on whether this is necessary, appropriate, overly restrictive, etc.
- Question called by Dean K., seconded by Sarosh V., approved
- VOTE: 12–12–2, motion fails

Presentation & Discussion of paper 94/157:
Proposed Changes to Draft Standard in order to Support MultiRate PHYs, (Pablo Brenner is absent) — paper presented by Michael Rothenberg

An opening statement identified that this presentation was an update to Pablo's proposal, refined on Monday AM in an ad–hoc discussion of 18 people representing the FH, IR, and DS PHYs. This presentation is on the basic mechanism and concepts, but the submission also includes some very specific text changes for the standard prose and state machines.

The objective of the proposal is to facilitate the use of MultiRate PHYs by the MAC on a frame–by–frame basis. Assumptions of the originators of this proposal are that, for any PHY with MultiRate capability:

- All stations in an ESS shall support a PHY–specific Default_rate.
- All Control and Multicast frames are sent at the Default_rate.
- All Unit_data messages are sent at the Default_Rate

The basis of the mechanism is to add new fields to RTS frames (Requested_rate) and CTS frames (Granted_rate). These frames are control frames, and therefore are able to be received by all stations because they are sent at the Default_rate. If the Requested_rate is acceptable for the receiving station's PHY, the Granted_rate is equal to the Requested_rate; otherwise the Granted_rate is equal to the Default_rate. In either case the data frame is sent at the Granted_rate in the CTS frame.

- Subsequent presentation introduced the concept of a Basic_rate_set that is the set of rates that all PHYs of a given type are able to handle, and that the Default_rate in use can be any rate of the Basic_rate_set.
- The "duration" field in MAC headers is replaced by a "data length" under this proposal.
- The basis under which PHYs select the rate to indicate in the Granted_rate is likely to vary by PHY type. RF PHYs are likely to use channel quality criteria, whereas IR PHYs are likely to use power consumption considerations.

Summary of discussion:

Some interchange clarifying that the MAC, not the PHY, makes the decision on the Granted_rate, but that this decision is made by the MAC receiving the RTS using information provided by the PHY.

(Dave B.) This mechanism relies on the RTS/CTS exchange, but this exchange is not always used, so how will this work? What rate do you listen at?

(Mike R.) The relevant information for rate selection and NAV updates is in preambles that have uniform headers and control frames that are sent at a Basic_rate. This may create retransmissions in cases without RTS/CTS exchange is not used and where there are not known capabilities at the recipient. Communication can still occur by retransmission of non–acknowledged frames at a Basic_rate.

(Michael F.) What about for PHYs with more than 2 rates, fallback to intermediate levels?

(Mike R.) This proposal says to use the Basic_rate due to simplicity.

The issue of rate selection strategy, and whether this creates an implicit retry strategy (or creates a need for a new, explicit retry strategy) was discussed by a number of people with no clear resolution. There was apparent disagreement on the results of the Monday AM discussions over whether the Default_rate was the lowest rate or just a member of the Basic_rate_set (a rate at which all stations in the ESS can receive). There was reference (by Michael R.) of a compromise on the lowest rate and objection from the baseband IR PHY, in which all stations can receive at 2Mbps, although not all stations can transmit at 2Mbps.

> *EDITORIAL COMMENT BY MINUTE TAKER: The baseband IR PHY is the first instance of an 802.11 PHY with asymmetric data rate for transmission and reception. This is likely to occur in other PHYs in the future. This should be considered as part of any MultiRate support mechanism for the MAC.*

(Tom T.) The duration information in the RTS/CTS is very important for power management, but in the case of from–AP traffic, the CTS may not be heard by all stations.

(Michael R.): The solution is to put the duration and rate information into the data frame.

(Tom T.) But the station might {want to} go to sleep after hearing the RTS or RTS/CTS, and not wait to hear the data, so this does not work unless you put a new constraint and higher power consumption on the power managed station. This information in MAC frame is very difficult to use at a low power station, because the MAC information cannot be used until the FCS is validated, which could be a long time in the case of a 2KB MPDU.

(Barry D.) Observes that an ESS that contains no old equipment may have a Basic_rate_set that includes speeds that the older units may not support.

(Greg E.) Believes that this discussion is attacking the least important part of the problem, which is AP–to–station communication (for client/server applications). In this case the preponderance of the traffic is outbound. W need to solve the issue of efficient handling of outbound traffic (from AP) in an environment that does not use (depend on) RTS.

(Mike R.) What is the traffic model? Is the model static? The standard cannot assume an optimization for a particular traffic model. This proposal allows non–RTS traffic at any of the rates in the Basic_rate_set. Also, simulation shows that the biggest benefits are to stations which operate at the lowest rates because they get more opportunities to transmit with gear shifting is used.

(Paul S.) In the DS PLCP header there is a CRC–protected length (in octets) and the data rate in the PHY header, so for the DS PHY the duration info is available immediately, not after MPDU validation. *{editorial observation — this is available to PHY, there needs to be a way to get this to MAC in a timely manner}*
Also, strongly supports the need for gear shifting because RF conditions at any site dictate that some communication will be at a fallback rate to maintain any sort of link. The alternative is very short range, and customers do not want pico–cell architectures, they want LESS infrastructure, not more, and other schemes require more APs and/or smaller cells. "Use gear shifting, it's what your military has been using for 25–30 years."

(Dean K.) Are there any IP issues on this mechanism?

(Mike R.) No, No, No (at least not from my company)

(Wayne M.) No, this proposal came from a consortium of people.

(Sarosh V.) What about the case of new stations with a new, higher rate and not using RTS/CTS, don't they have to send twice in each communication with older stations?

(Mike R.) You will find that you want to use RTS/CTS for improved data rate.

(Sarosh V.) So you are requiring RTS/CTS mandatory if the new rate is in the extended set rather than in the basic set.

(Mike R.) Yes

(Arthur C., Mike R., Dave B., et. al) Discussion on NAV updates with and without RTS/CTS. The basic mechanism is the inclusion of rate and length information, protected by a 16–bit CRC, in the PHY header.

Discussion on the use of a Basic_rate_set per ESS rather than BSS is to support roaming, and that it may be necessary to slow down after a handoff. In this discussion the statement was made that broadcasts and multicasts are sent at the Default_rate, which is "probably" the highest rate in the Basic_rate_set.

(Dave B.) Keep in mind that in the case of an ad–hoc network, if the MultiRate mechanism requires tables, each station will have to maintain the one–to–many like an AP does in the infrastructure network case.

(Wim D.) Multiple bit rate support is important, but this solution is inadequate, as is any solution that is dependent on RTS/CTS.

(Mike R.) Any solution is acceptable to me as long as the issue of selectively upgrading the network is provided for.

(Ed G.) Keep in mind that the best gain (from gear shifting) you will ever get is 12X, even for infinite data rate. {Bob O. displays a table that he presented in Oshawa to support this.} Also, don't bother with an 8–bit CRC on RTS & CTS frames (from 94/20b1), either use no checking or use 16–bit or 32–bit checking polynomials, since in the RF environment a 1:256 error check is not worth using.

Minutes from meeting held July 12, 1994 (8:00PM – 10:00PM)

Continuation of the discussion of paper 94/157:

Michael Rothenberg begins by summarizing the concerns expressed last night.

- How to switch between rates without RTS/CTS
- How to handle AP–generated traffic without RTS/CTS
- How to perform NAV–update calculations at stations hidden from CTS

- Is the RTS/CTS rate transaction mandatory for new rates in the Extended_rate set?

A summary of his understanding of the initial Basic, Default, and Extended Rate Sets:

	Baseband IR	High–speed IR	Direct Sequence	Frequency Hop
Basic_rate set	1Mbps, 2Mbps	4Mbps	1Mbps, 2Mbps	1Mbps
Default_rate	1Mbps	4Mbps	1Mbps	1Mbps
Extended_rate set	? (4Mbps)	? (10Mbps)	? (4Mbps, 8Mbps)	2Mbps

General comments on the concerns:

How to deal with switching between rates in the Basic_rates set?

- Try high(er) Basic_rate; if unsuccessful, retry a low(er) rate.
- This is an implementation approach (strategy), not a required approach.
- Enhanced solution (especially for APs) is to keep tables, but this is not appropriate for inclusion in the standard.

How to (accurately) update the NAV without receiving the CTS?

- Include rate and length information in the MPDU.
- The use of length is perceived by the authors as an improvement; however, this is not an organic requirement and the proposal will work even if duration is used for the NAV calculation.
- The use of RTS/CTS is not mandatory, but the result is suboptimal from a performance gain point of view if this mechanism is not used.

Motion:

Adopt 94/157 as the foundation for the support of multiple rates and instruct the editors to create and include text {in the draft standard} using 94/157 as a reference without precluding rate shifts when RTS/CTS is not used in the MPDU exchange.

- Moved by Mike Rothenberg
- Seconded by Wayne Moyers
- The original motion did not refer to explicitly using text from 94/157 and did not include "... without precluding ...," friendly amendments from Tom T. and Wim D. produced the wording above.
- VOTE: 15–16–9, motion fails

Discussion of Motion:

(Dean K.) What is cost of using this mechanism? We discussed the benefits, but what are the costs?

(Rui V.) From point of view of baseband IR PHY, the current text of 94/157 does not reflect our needs. This approach requires us to always transmit broadcasts and multicasts at 1Mbps, which will degrade our performance substantially.

(Tim P.) Objects to motion due to complexity of this solution. Observes that FH does not benefit from more than one rate in the same BSS. Prefers using different channels/BSSes at different rates as a simpler to implement.

(Paul S.) Does not like RTS/CTS, but if you use RTS/CTS this proposal is a good use for the mechanism. Support for multiple and higher bit rates are mandatory and will be implemented outside of the standard if we do not put them in the standard. If we reject this mechanism, we must keep working toward another mechanism.

(Mike R.) This is not too complex (to implement in the real world. Tim's approach is easier to document, but not easier to implement.

(Dave B.) This is better, but is still incomplete, as a multirate mechanism, so believes the motion is premature. Also wishes the chair to rule on whether the motion is in order (should this motion be in MAC or Joint?)

(Chair) The motion is in order.

(Michael F.) Strongly opposes this motion because this proposal does not cover the needs of CF–async, power management, and the proposed text is for 94/20b0 (not b1). This motion is premature as worded, the mechanism is a good start, but the result of taking this path is just as likely to add even more complexity.

(Wayne M.) Indicates this is a foundation, which should be adopted as such.

Presentation and discussion of paper 94/203 , Text Changes ..., Ed Geiger

In Oshawa, we decided (at the MAC/PHY Interface meetings) to accept a set of frame–based service primitives for the MAC/PHY interface. This proposal is an attempt to provide this new service primitive set as a replacement.

Background:

How do other ISO standards deal with this interface?

- ISO/IEC 8802.3 uses a bit–by–bit interface.
- ISO/IEC 8802.4 uses a byte–by–byte interface
- The physical Layer of 802.6 (DQDB) uses a byte–by–byte interface that, if not for the MAC processing of the state of the frame could have been in 53–byte units.

What is the general specification methodology?

- define function

- define semantics, including calling sequence
- state when generated
- state effect of receipt

Summary of changes being suggested:

- Defines that each PHY will include a PMD
- Defines that each PHY will include a PLCP (which could be null)
- Uses a reference model with 2 SAPs at MAC/PHY interface
- Defines semantics based primarily on 802.3
- Defines a new set of primitives & parameters
- Includes PLME (PHY Layer Management Entity) and PLME–parameter list that is PHY–type specific.

Motion:

That we take the text from 94/203 as a replacement text for the current PHY Layer service primitives .

- Moved by Ed Geiger
- Seconded by Dean Kawaguchi

Discussion:

(Larry V.) < ... strongly opposed to new primitives, PLME_SAP, frame–based interface primitives, etc. just prior to the motion... >

(Paul S.) Vitally important to make this decision on service primitives so that we can get on with the work of editing PHY standard drafts.

(Dean K.) FH PHY has state machines that are functions of multiple bytes, so this interface specification is the simplest manner to do the primitives.

(Dave B.) Thinks this document includes good work, although not necessarily complete. Some of the decisions from Oshawa have not been adequately brought forward due to Schuessler & Lynn not being here. This seems to be a fair reflection of the spirit in Oshawa. Recommends that we take this to full working group in the joint MAC/PHY for discussion.

Motion:

To postpone the main motion to a specific time, that being the joint MAC/PHY session on Wednesday PM.

- Moved by Dave Bagby

- Seconded by Dave Roberts
- Vote: 23–3–1, main motion postponed

The meeting was adjourned without objection at 10:00PM