Enhancements to the Frequency Hopping PHY Layer Proposal (Document IEEE P802.11-92-127r)

Juan Grau
295 N. Bernardo Av.
Mt. View, CA 94043

proxim

Abstract

In this contribution we provide suggestions on how to improve the draft proposal for the Frequency Hopping PHY Standard.

Introduction

This contribution builds on Nathan Silberman's proposal for a 4FSK Frequency Hopping PHY and later contributions by IBM and Motorola. Our comments are based on our experience designing and manufacturing wireless LANs and we hope to improve the current proposed standard by pointing out practical issues of implementation and how these issues may affect the standard's performance, cost and functionality.

Additions to the Specifications

• In addition to a full channel switching time specification, a separate switching time specification for a 1 MHz step should be included. A significantly tighter specification can be placed on a small frequency change. This fact can be used to one's advantage when addressing the issue of synchronization by allowing the receiver to scan much faster than would be possible otherwise .

• Valid Data Detect: The current specification does not have a maximum BER the PHY will allow to pass to the MAC layer. This will put undue hardship on the MAC. Among the possible problems, high BER will generate false opening/closing framing symbols (e.g. FLAGS) flooding the MAC with undesired packets. In addition, integrity of CRCs as an error control mechanism could be compromised. RSSI is sometimes used for this purpose but BER is a function of signal-to-noise ratio (for a given modulation/demodulation) and RSSI is a measure of signal-plus noise.

> A Valid Data Detect signal should be specified at the PHY layer. This signal would become active when the BER is < x (where x should be in the 10^{-4} to 10^{-5} range). This signal can be derived fairly simply from signals in the clock or data recovery circuits.

Changes to the Specifications

17) Channel Nominal Data Rate: 1.6 Mbps. The 20 dB BW for a 4CFSK signal at 1.6 Mbps, a modulation index of .5 (p-p) and a Gaussian pre-modulation filter with BbT factor of .5 is approximately 900 KHz. These parameters allow for effective demodulation without excessive complexity.

18) Fallback data Rates: Should be the nominal data rate divided by powers of two: 1.6 Mbps, 800 Kbps, 400 Kbps and 200 Kbps. This will simplify implementation while still providing the desired flexibility. Fallback data rates specifications should be optional and need to be accompanied by specification on associated receive BW and transmit pulse shape.

21) Pre-amble length: pre-amble length needs to be long enough to allow all of the receiver loops and filters to settle prior to supplying valid data to the MAC. 32 bits is certainly sufficient for clock recovery but does not allow margin for other important functions.

- Scrambler flushing (7 bits-as proposed)
- Data recovery (some data recovery techniques elect to observe the incoming demodulated signal for several bits before making a decision for improved detection.
- Valid Data Detect (described above) is typically derived from the recovered data. This signal requires a few bits beyond the point when the data is being cleanly detected to go active.
- Pre-amble length should be specified in symbols and not in bits (consider 4CFSK case)

We feel that a pre-amble of 64 symbols provides the margin necessary to perform all of the PHY's receiver functions.

22) Clock Recovery: There should be a specification indicating maximum period the clock recovery circuit needs to hold timing information for. Maximum packet length specification from the MAC group will be required.

26) Switching time Tx to RX: Three of the most popular transceiver architectures are Heterodyne transmitter and receiver, Homodyne receiver and transmitter and Homodyne transmitter and Heterodyne receiver. In some of the lower cost implementations, a single VCO is shared between the transmitter and the receiver and needs to switch frequencies between the transmit and receive modes. A 100 µsec Tx to Rx switching time all but rules out the use of this architecture particularly since it already includes a 32 bit pre-amble period leaving less than 70 µsec for VCO switching.

This specification should be relaxed to at least 200 µsec (and possibly 300 µsec) to ensure that very low cost architectures can be used. It will be a lot more economical to deal with the limitation this number imposes in the MAC layer.

(Fall back data rates will require a mechanism to adjust timing parameters correspondingly. One possible approach is to send control packets with the slowest timing paramenters until it is determined that the faster timing can be supported)

27) Switching time Rx to Tx: A number of MAC protocols require, at some point, a quick data exchange between two nodes (such as RTS,CTS and ACK packets). In such cases the latency between transmissions will be the greater of the Tx to Rx and Rx to Tx switching times (one node is switching into Tx while the other is switching into Rx).

The Rx to Tx switching time specification should be stated in a way that the result is a symmetrical channel. Consequently, the Rx-to-Tx settling time (time from full sensitivity at the receiver to full power transmitter availability) should be equal to the Tx-to-Rx settling time minus the pre-amble time.

. . Rx	Go to Tx	Tx Settling	pre-amble	Opening Flag	Tx Data . . . .

<----Rx-to-Tx settling ---->

. . Tx	Go to Rx	Rx settling	Ck recov.	Data recov	Valid Sig.	Opening Flag	Rx Data . . . .

<----------Tx-to-Rx settling ---------->

Other

• Specifying transmit diversity places undue burden on general implementations and would be difficult to specify and regulate (e.g. how much angle difference would qualify as an allowable polarization diversity?).

• We would like to reiterate comments made by other members of the group in asserting that the maximum transmit power level or the receiver sensitivity need not be part of the standard. This will allow more implementation flexibility without affecting interoperability.

• Hopping Synchronization - Even though synchronization may be dealt with outside the physical layer , some characteristics needs to be defined at the PHY. At a minimum, the accuracy of the hopping timers need to be specified so that the group responsible for defining the synchronization algorithms be able to determine parameters such as Sync Hold Periods and Guard Bands.

Conclusion

Practical implementations of a standard dictate that care be given to specifying only those parameters that are required to ensure interoperability between conformant stations from different manufacturers. In order to address the wide range of applications for this standard, flexibility should be given a high priority. The changes suggested in this contribution are intended to help the standard to allow for flexible implementations. Manufacturers know best the needs of their customers. They should be given the flexibility to make the choices between performance and cost as they see fit.