IEEE 802.11
Wireless Access Method and Physical Layer Specifications

Title:

MAC Interaction with a Frequency Hopping PHY.

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Abstract:
This submission was motivated by a discussion at a joint MAC/PHY meeting in January.

It lists some assumptions about frequency hopping, presents an example of MAC/PHY interaction, and concludes that the MAC must control frequency hopping.

Hopefully, we can use this as a discussion vehicle and make some progress on MAC interaction with frequency hopping PHYs at our next meeting.

Issues Addressed:
Many parts of issues 12 and 24. In particular, issue 24.9:
Given a Frequency Hopping (FH) PHY, which protocol entity is responsible for the real time aspect of the PHY?

Assumptions

1. When a frequency hopping PHY is used, the duration of each hop (also known as the dwell time) is fixed and known to every station (STA) in the same domain.

2. Every STA has a table of all of the possible hopping sequences.

3. All STAs in the same Basic Service Set (BSS) use the same hopping sequence.

MAC Layer Support

4. All STAs maintain a timer for hop duration. This is a MAC function.
   The MAC can read the timer directly to determine if there is enough time remaining in the current hop to send a new MPDU.

   Only the MAC knows the length of MPDUs that are pending transmission.

5. There is a field in the MPDU header that identifies the hopping sequence being used by the BSS.

   The field that identifies the BSS in the MPDU header, NetID, could be used for this purpose. The MAC could implement a function that maps NetID into a particular hopping sequence in the hopping sequence table.

   A STA that receives an MPDU on a particular frequency will be able to determine the next frequency that will be used by consulting its hopping sequence table.

6. There is a field in the MPDU that specifies the time remaining on the current hop, HopTime.
   Any STA that receives an MPDU will be able to synchronize with the rest of the STAs in the BSS simply by setting its hop timer to the HopTime of the incoming MPDU.

   This field could be labeled "PHY Specific" and used by other PHYs for a different purpose.

   For a MAC with a Point Coordination Function, these fields could be in the MPDUs themselves or in the "superframe" that defines the timing structure for channel access.

MAC/PHY Interface

The MAC controls the timing of frequency hopping. It must be able to tell the PHY to change frequencies.

7. There is a MAC=>PHY primitive "GoToFrequency(x)".
   This primitive is general enough to be useful for other PHYs.

   When FH is used, the MAC may want to visit frequencies that are not in the predefined hopping sequence. This primitive allows that.

8. There are mechanisms for passing MSDUs from the MAC to the PHY and from the PHY to the MAC. The MSDUs carry information necessary to control frequency hopping.

Initialization

9. When a STA first enters the system; it may listen on any legal frequency for MPDUs containing the desired NetID. As soon as the first matching MPDU is heard, the STA will able to synchronize with the rest of the BSS.

   Gross synchronization comes from the NetID. It maps into a hopping sequence, and given the current frequency the MAC can determine the next frequency.

   Fine synchronization comes from the HopTime field which informs the STA how much time is remaining in the current hop.

10. Waking up from a sleep there are two choices.
    10.1 Revert to the initialization process described in 8.
    10.2 While sleeping the MAC maintains a timer. When the MAC awakes it can determine how much time has elapsed and can immediately go to the proper hop. As soon as the STA hears the first MPDU, it will achieve fine synchronization.

11. When Access Points (APs) are present they periodically send small MPDUs (called announce frames or beacons) that contain the HopTime and NetID fields.
    This accelerates the initialization process and helps speed reassociations during BSS transitions.

12. When APs are not present, the MAC guarantees that some traffic is sent on every hop. If there is no traffic during a hop, a STA will send out a beacon or announce frame.

Issues

13. Drift of hop timers. What policy do STAs use to update their hop timers? ?
    13.1 Copy the HopTime information every time they receive an MPDU.
    13.2 Copy the HopTime information only on initialization.
    13.3 Copy the HopTime information on initialization and when waking from sleep.
    13.4 Copy the HopTime information from Beacon or Announce frames only.

Conclusions

14. The MAC should control frequency hopping.
    Keep the PHY dumb and the complexity in the MAC.

15. Providing a PHY specific field in the MAC header is one way for the MAC to support parameters from different PHYs.

16. A Point Coordination Function is not required to control frequency hopping timing.

17. Sleeping and frequency hopping are unrelated. The only thing they have in common is they both require timers.

18. The PHY dependent sublayer should be in the MAC *not* the PHY.

IEEE P802.11 issues addressed:

12.1 Where is the MAC/PHY interface?
12.3 What is the intelligence level of the MAC/PHY interface?
12.4 Is the layer that provides PHY independence the same as MAC/PHY?
12.8 Does a PHY independence sublayer need to be specified in the MAC?

24.3 How will multiple PHY support for the MAC be specified?
24.5 What are the implications of the complexity of the PHY?
24.6 Does the PHY layer provide the PHY type to the MAC layer?
24.7 Will the MAC standard specify the support of multiple PHYs...?
24.8 What functions are required in the Medium Independent PHY layer?
24.9 Given a Frequency Hopping (FH) PHY, which protocol entity is responsible for the real time aspect of the PHY?