IEEE 802.11
Wireless Access Method and Physical Specification

Element Requirements for BSS Synchronization

Greg Ennis
Symbol Technologies
1101 S. Winchester Blvd., Suite B-110
San Jose, CA USA 95128
Tel: (408) 356-4775
Fax: (408) 356-4775
Email: gennis@netcom.com

Abstract

When an ad hoc network is formed, it cannot be assumed that all stations will be within transceiver range of each other. For power management and PHY-management reasons (in the case of FHSS), it is necessary for all stations in the ad hoc network to be synchronized. Such synchronization is achieved through the exchange of periodic beacons which include a timestamp. If not all stations are within range of each other, there is the possibility that clusters may form in which different clusters are separately synchronized. 20B3 includes some mechanisms which address this situation, but it is not fully defined and is overly complex. This paper describes a simplification of the current mechanism.

Cluster Resolution in 20B3

The mechanism to be used to resolve clusters is not defined in detail in 20b3. However, certain elements are included ("Weight" and "Channel Sync Information") which had their origin in a scheme originally proposed in Document 93/190.

This scheme addresses the following basic problem: if different clusters form and then come together, we must somehow select one of the clusters as the "better" of the two and force the stations within the other cluster to resynchronize. It would be nice if the selection of the "better" cluster was based on some objective measure of goodness. For example, if one cluster consisted of ten stations and the other consisted of one station, we would want to select the larger cluster as the better of the two, thereby minimizing the resynchronization impact on the total system.

The weight concept was intended as a way of introducing such a measure of cluster goodness into the cluster selection algorithm. The idea was that a station within a better cluster would have a higher weight, and this weight would be transmitted within beacons. A variety of heuristics could be considered to calculate a station's weight, such as "number of stations from which I have received a beacon". Another part of the scheme was a "channel sync" element which would indicate to the other stations whether or not the transmitting station is currently synchronized with other stations.

Another possible factor which could be included within a weight calculation is the age of the cluster. However, this approach founders if the field used to indicate the age is of a relatively small finite length, causing a wraparound problem which makes it difficult to determine the "correct" age.

The following simplication of the ad hoc synchronization mechanism eliminates these complications by increasing the size of the timestamp field within ad hoc beacons so as to guarantee that it is always a real measure of the cluster's age.

Proposed Simplified Approach

The key components of the proposed approach are as follows:

- The weight and channel sync elements are eliminated.
- Increase the size of the timestamp field to eight bytes (still indicating time in microseconds). A time of many years can be indicated by such a field, which is more than adequate to represent the lifespan of any single incarnation of an ad hoc network. Such a large timestamp would not be required for infrastructure networks.
- Whenever a station is first attempting to join an ad hoc network (with a particular BSSID), it scans (actively probing or listening for beacons) to determine if some other station has already created this network. If so, it adopts that station's timestamp value and thereby synchronizes with the existing network. Otherwise, the station assumes that it is the first to join, sets it timer to 0 and begins broadcasting beacons as usual.

- All stations within an ad hoc network periodically scan for other clusters.
- Timestamps are included in beacons, probes and probe responses.
- In the case of FHSS, the hop sequence information is included within all beacons, probes, and probe responses.
- If a station receives a beacon, probe or probe response from another station within the ad hoc BSS which has a larger timestamp, it acts as follows:

  1. adopt the new (larger) timestamp
  2. generate one or more beacons to the other stations within the current cluster, including the new (larger) timestamp and the new hopping information (if necessary)
  3. resynchronize with the new cluster

Cluster resolution is thereby accomplished as follows: if multiple clusters form, one will form before the other. This one will always have the larger timestamp, assuming no cluster lives longer than the timestamp field's wraparound value. The stations within the other cluster will detect that an older cluster exists (by receiving a beacon, probe or probe response from the other cluster) and will resynchronize. Each resynchronization by an individual station will be preceded by a flurry of beacons during which other stations are informed of the need to resynchronize.

Beacon Contents in Various Situations

The elements discussed in this paper may or may not appear in Beacons depending upon the specific circumstance. In particular:

- Ad hoc beacons include long timestamp
- Infrastructure beacons include short timestamp and TIM
- FHSS beacons (ad hoc and infrastructure) include hop control elements

Similar differences would pertain to probes and probe responses.

Acknowledgment

Thanks to Allesandro Bolea (Raytheon) for a useful email discussion regarding some basic problems in this area.

Specific Recommendations

It is recommended that the element descriptions be changed as follows:

Short Time Stamp

This field shall represent the value of the TSFTIMER of a frame's source. ~~The most significant bit, when set, shall indicate that the station is synchronized within its BSS~~. The element-specific field length is four octets.

Long Time Stamp

This field shall represent the value of the TSFTIMER of a frame's source. The element-specific field length is eight octets.

~~Weight~~

~~This field shall indicate the degree to which a station is synchronized within its BSS. Larger values shall indicate a greater degree of synchronization. The element-specific field length is two octets.~~

~~Channel Sync Information~~

~~This field shall contain the information necessary for a station to be able to remain synchronized with a particular BSS that is using a multi-channel PHY. The element-specific field length is a variable number of octets.~~

The editors should place text describing the synchronization approach described in this paper into Section 7 of the draft specification.