IEEE 802.11

Wireless Access Method and Physical Layer Specifications

Title: **Solution for Frame Reordering Issues**

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Abstract: **This paper provides suggested text changes to P802.11/D3.1 to
                    provide for the delivery of broadcast/multicast MSDUs across the
                    MAC Data SAP in the exact sequence in which they were
                    generated within a stream of unicast MSDUs from the same
                    source. This ability if desired in a station is controlled by a MIB
                    variable. The MIB variable would be set to TRUE to support
                    higher level protocols which were sensitive to this type of frame
                    ordering.**

Action: **Adopt the text changes proposed in this paper for inclusion in
                    P802.11/D4.0**

Introduction

The issue has been raised that we must provide for the case where frame misordering between broadcast/multicast frames and unicast frames is unacceptable to the upper layers. This need is perceived to be rare, so the offered approach puts most of the burden onto those stations that need this type of service, while providing minimal impacts on the all other station in the BSS and on the AP. The implementation impact is also small. This approach does allow power saving to be used in conjunction with strict ordering.

The basic approach is to provide a flag that indicates that frame misordering is occurring and using the MSDU sequence numbers to allow a mobile station to reorder the frames if necessary before passing them up through the MAC data SAP. A station that does reordering will have to buffer received frames till the rules allow it to forward them. A MIB variable enables the reordering. Stations that do not have their a Strict Order MIB variable set to TRUE, do not need to buffer frames and operate as in Draft 3.1. The AP always follows the rules identified below, but these are to allow stations to effect any necessary reordering. APs need never reorder their frames and essentially operate exactly as in Draft 3.1.

Overview of the Basic Approach

The basic approach involves:

1.   Ensuring that the sequence numbers assigned to MSDUs reflects their "true" order.
2.   Allowing stations to temporarily store received MSDUs so as to reorder them if necessary before passing them up to through the MAC Data SAP.

The main issue is this: how does a station know that it can forward a set of MSDUs across the Data SAP without the potential subsequent receipt of an MSDU from the AP which will now be out of order? This is handled by providing the AP with a means by which it can signal to the station that a potential misordering situation exists with queued broadcasts. A set of rules defined below for both the AP and station ensure that the station can then determine when it can forward frames up through the Data SAP.

The AP Rules

AP1.   AP shall assign sequence numbers to MSDUs so as to reflect the order in which they are received across the Data SAP.

This rule allows stations to know the "true" order of their received frames.

AP2.   AP shall set SID bits in DTIM for all stations (including non-power-saving stations) if a unicast frame for that station is queued.

This allows all stations to know that subsequent broadcasts from the AP following the DTM may need to be reordered after receiving the AP-buffered unicast frames, and hence must be temporarily buffered in station.

AP3.   AP shall indicate within every unicast frame whether or not there is a queued broadcast./multicast which arrived prior to this data frame. Call this the "broadcast pending indication" (BPI).

This informs stations that a received unicast frame may need to be reordered with a subsequent set of broadcast frames, and hence must be temporarily buffered in the station.

AP4.   Following a DTIM, and AP shall transmit only those broadcast/multicast frame which arrived prior to the transmission of the DTIM.
This prevents the AP from transmitting a broadcast which arrived after a unicast, unless the station has been already informed (in the DTIM) that such a unicast is buffered.

Station Rules

If a non-AP station is required to deliver received MSDUs from a given source in the same strict order in which they were received by the AP, then the following rules shall be obeyed regarding the forwarding of received MSDUs across the MAC Data SAP:

STA1: Each received unicast MSDU with BPI O may be forwarded, those with BPI 1 are stored temporarily in a reordering buffer..

> This rule ensures that if the station receives a unicast frame which may be misordered with respect to buffered broadcasts in the AP, it will wait before forwarding it across the Data SAP until it knows that this is proper.

STA2: If no unicast MSDUs are stored in the reordering buffer, and the station's SID is not set in a received DTIM, then each received broadcast/multicast MSDU may be forwarded. Otherwise, received broadcast/multicast MSDUs are stored in the reordering buffer.

> This rule states what the station will do in response to received broadcasts which can only be transmitted by the AP following a DTIM. Depending on the state of the station's SID in the DTIM, there may or may not be a potential misordering problem, and the station can take the appropriate action.

STA3: If the station's SID is not set in a received DTIM, then when the last broadcast/multicast MSDU is received, all stored MSDUs may be reordered and forward.

> This rule is proper since if the station's SID is not set in the DTIM, there are no unicast frames buffered for the station within the AP, hence upon receipt of all broadcasts the station can reorder whatever it has temporarily stored and forward the frames across the SAP.

STA4: If the station's SID is set in a DTIM, then when the first unicast data frame with a larger sequence number than the last broadcast/multicast sequence number is received, all stored frames may be reordered and forwarded.

> This rule governs the following situation: a unicast frame if buffered in the AP for this station, and it may need to be reordered with respect to the subsequent broadcast frames transmitted from the AP after the DTIM.

Proposed Text Changes

7.1.3.1.
Update the figure and text to reflect use of B15 and Broadcast Pending Indicator

7.1.3.1.10

Add the following new text:
> The Broadcast Pending Indication (BPI) field shall be one bit in length and shall be set to a 1 by an AP in any Data Type frame that contains an MSDU of fragment thereof whenever the AP is currently buffering a broadcast or multicast frame which arrived earlier than this data frame.

7.1.3.4.1
Add the following sentence at the end:
> An AP shall assign sequence numbers to MSDUs so as to reflect the order in which they are received across the Data SAP.

9.2.11 New Section
Insert new section 9.2.11

9.2.11 Frame Reordering

If a Strict Ordering is TRUE, then the following rules shall be obeyed regarding the forwarding of received MSDUs across the MAC Data SAP.

Each received unicast MSDU with BPI 0 may be immediately forwarded.

Each received unicast MSDU with BPI 1 is stored temporarily in a reordering buffer.

If no unicast MSDUs are stored in the reordering buffer, and the station's SID is not set in a received DTIM, then each received broadcast/multicast MSDU may be immediately forwarded. Otherwise, received broadcast/multicast MSDUs are stored in the reordering buffer.

If the station's SID is not set in a received DTIM, then when the last broadcast/multicast MSDU is received, all stored MSDUs shall be reordered and forwarded. The reordering shall ensure that the MSDUs are forwarded across the Mac Data SAP according to their original sequence, as shown by their sequence numbers.

If the station's SID is set in a DTIM, then when the first unicast data frame with a larger sequence number than the last broadcast sequence number is received, all stored frames may be reordered and forwarded as described in ST4 above.

11.2.1.4.
Remove "in the PS Mode" in list item (c), so that the AP shall set SID bits in DTIM for all stations (including non-power-saving stations) if a unicast frame for that station is queued. (Note: 7.3.2.1 already says this)

In item (e), add to end of first sentence "which arrived prior to the transmission of the DTIM".

11.4.4.1.32
New Section

11.4.4.1.32 a_Strict_Order
Strict Order ATTRIBUTE

WITH APPROPRIATE SYNTAX

boolean;

BEHAVIOUR DEFINED AS

"This attribute shall be true to indicate that the MAC shall deliver MSDUs across the MAC Data SAP from a given source address in the same order n which they were generated".

REGISTERED AS

{iso(1) member-body(2) us (840) ieee802dot11(10036)
SMTattribute(7)Strict Order(32)}