IEEE P802.11  
Wireless LANs

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| Undetected Duplicate Reception Proposed Text | | | | |
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Abstract

This document provides text to resolve the problem of undetected duplicate receptions. See also document 11-11-0834-00-000m-undetected-duplicate-reception.pptx.

**Revision notes:**

R2:

Added language to deal with false positive duplicate detection events.

R1:

Corrected reference to accompanying power point document.

Added reference at end of document pointing to accompanying power point document.

Slightly modified language regarding admission control interaction with management frames.

Added a couple more lines in the discussion section regarding the issue of backwards compliance and the choice of recommendation vs requirements for behaviour.

R0:

initial revision

**Discussion of proposed changes:**

The standard includes rules for sequence number assignment at the transmitter and caching of those sequence numbers at the recipient for the purpose of identifying duplicate receptions. The original sequence number and duplicate detection rules were modified by the 11e QoS amendment. The QoS modifications inadvertently created a problem wherein some frames could be retransmitted without being detected as duplicates. The problem most commonly arises when a QoS transmitter sends a non-QoS DATA frame to a non-QoS recipient using the AC\_BE queue and the ACK frame is lost. The recipient stores the sequence number from the received frame (e.g. seq=N). Following that transmission attempt, the transmitter’s AC\_VO EDCF wins the next backoff and sends a Management frame with seq=N+1 and this frame is received by the same recipient who then replaces his most recently received cache entry for this transmitter with the value N+1. Subsequent to this successful exchange, the transmitter attempts a retransmission of the original seq=N non-QoS Data frame. This frame is received by the recipient and is NOT recognized as a duplicate.

The problem can be fixed by:

1. Having the transmitter send individually addressed management frames for non-QoS destinations using the AC\_BE queue which also contains the Data frames for that same STA, hence, the out-of-order delivery problem is not created
2. Having the recipient track received sequence numbers per received type (i.e. introducing additional caching)

An additional problem arises with the introduction of some immediate-response management transmissions, such as the CSI Feedback Action frame, which also creates an order-of-delivery problem with respect to sequence numbers. This version of the problem can be fixed by eliminating sequence numbers obtained from these frames from the cache at a recipient, or by including those sequence numbers in a different cache to allow duplicate detection on those frames.

An additional problem has existed from the earliest days of the standard and persists today. That problem is due to the sharing of a single sequence number counter at a transmitter by more than one RA. It is possible for a transmitter to draw a sequence number N from the counter for use in a transmission to RA=STA1, and then use the next 4095 sequence numbers for transmissions to other RA values. If the next transmission is again to RA=STA1, then the next sequence number, which is N, will be the same sequence number as was last used for transmission to this RA. If the new transmission fails the first time, then the next attempt will include RETRY=1 in the FC of the MAC header, and the recipient might discard the reception as a duplicate based on a match with the last received sequence number for this TA as is stored in the recipient’s cache.

This problem can be fixed if the transmitter maintains a cache of sequence numbers that were used per RA and avoids sending the same sequence number in successive frames to the same RA as can be determined by examining the cache contents.

A detailed description of the problems can be found in 11-11-0835-01-000m-undetected-duplicate-reception.pptx.

The text changes shown in this document are intended to implement the proposed solutions for these problems.

To avoid problems of making existing implementations non-compliant, the proposed changes are all recommendations instead of requirements.

In addition to the proposed changes, a few errors in the text have been corrected.

**Proposed changes:**

**3.2 Definitions specific to IEEE 802.11**

***TGm Editor: Insert the following new definition into the appropriate location within subclause 3.2 “Definitions specific to IEEE 802.11”:***

**Special Management frame:** a frame of Type Management that is transmitted outside of the normal MAC queuing process. The following frames are defined to be Special Management frames:

* + - PSMP
    - Set PCO Phase
    - CSI
    - Noncompressed Beamforming
    - Compressed Beamforming
    - ASEL Indices Feedback

**9.2.4.2 HCF contention-based channel access (EDCA)**

***TGm Editor: Change the text in the second to last paragraph of subclause 9.2.4.2 “HCF contention-based channel access (EDCA)” as shown:***

A QoS STA should send individually addressed Management frames that are addressed to a non-QoS STA using the access category AC\_BE and shall send all other management frames using the access category AC\_VO. A QoS STA that does not send individually addressed Management frames that are addressed to a non-QoS STA using the access category AC\_BE shall send them using the access category AC\_VO. Management frames are exempted from any and all restrictions on transmissions arising from admission control procedures. A QoS STA shall also send management frames using the access category AC\_VO before associating with any BSS, even if there is no QoS facility available in that BSS. BlockAckReq and BlockAck control frames shall be sent using the same EDCA parameters as the corresponding QoS data frames. PS-Poll control frames shall be sent using the access category AC\_BE to reduce the likelihood of collision following a Beacon frame. When the first frame in a frame exchange sequence is an RTS or CTS, the RTS or CTS frame shall inherit the UP of the data frame(s) or the AC of the management frame(s) that are included in the frame exchange sequence.

**9.3.2.11 Duplicate detection and recovery**

***TGm Editor: Change the text in subclause 9.3.2.11 “Duplicate detection and recovery, beginning with the third paragraph, as shown:***

Non-QoS STAs, as well as QoS STAs operating as non-QoS STAs because they are in a non-QoS BSS or non-QoS IBSS, assign sequence numbers to management frames and data frames (QoS subfield of the Subtype field is equal to 0) from a single modulo-4096 counter, starting at 0 and incrementing by 1, for each MSDU or MMPDU. Transmitting STAs should cache the last used sequence number per RA for frames that are assigned sequence numbers from this counter and should ensure that the sequence numbers for successively transmitted frames to a single RA do not have the same value by incrementing the counter by 2, if incrementing by 1 would have produced the same sequence number as is found in the cache for that RA.

A STA operating as a QoS STA maintains one modulo-4096 counter, per <Address 1, TID>, for individually addressed QoS Data frames. Sequence numbers for these frames are assigned using the counter identified by the Address 1 field and the TID subfield of the QoS Control field of the frame, and that counter is incremented by 1 for each MSDU or A-MSDU corresponding to that <Address 1, TID> tuple. Sequence numbers for management frames, QoS data frames with a group address in the Address 1 field, and all non-QoS data frames transmitted by QoS STAs are assigned using an additional single modulo-4096 counter, starting at 0 and incrementing by 1 for each such MSDU, A-MSDU, or MMPDU. Transmitting STAs should cache the last used sequence number per RA for frames that are assigned sequence numbers from this counter and should ensure that the sequence numbers for successively transmitted frames to a single RA do not have the same value by incrementing the counter by 2, if incrementing by 1 would have produced the same sequence number as is found in the cache for that RA. Sequence numbers for QoS (+)Null frames may be set to any value.

Each receiving STA shall keep a cache of recently received <Address 2, sequence-number, fragment-number> tuples from frames that are not QoS Data frames. The receiving STA shall keep at least the most recent cache entry per <Address 2> value in this cache. Each receiving QoS STA shall also keep a cache of recently received <Address 2, TID, sequence-number, fragment-number> tuples from QoS Data frames from all STAs from which it has received QoS data frames. The receiving QoS STA shall keep at least the most recent cache entry per <Address 2, TID> pair in this cache. Each receiving STA should maintain two additional caches containing entries of recently received <Address 2, sequence-number, fragment-number> tuples from received management frames and from received Special Management frames and should not include the entries in these caches in any other caches. In each of these two caches, the receiving STA should keep at least the most recent cache entry per <Address 2> value. A receiving STA should omit tuples obtained from group addressed and ATIM frames from all caches.

A receiver STA shall reject as a duplicate frame any frame that is not a QoS Data frame in which the Retry bit in the Frame Control field is 1 and that matches an <Address 2, sequence-number, fragment-number> tuple of an entry in the cache that contains tuples of that format, unless the frame is a management frame and the STA is maintaining separate caches for <Address 2, sequence-number, fragment-number> tuples from received management frames. A receiver QoS STA shall also reject as a duplicate frame any QoS Data frame in which the Retry bit in the Frame Control field is 1 and that matches an <Address 2, TID, sequence-number, fragment-number> tuple of an entry in the cache that contains tuples of that format. A STA that is maintaining separate caches for <Address 2, sequence-number, fragment-number> tuples from received management frames shall reject as a duplicate frame any management frame that is not a Special Management frame in which the Retry bit in the Frame Control field is 1 and that matches an <Address 2, sequence-number, fragment-number> tuple of an entry in the management cache that contains tuples from frames that are not Special Management frames. A STA that is maintaining separate caches for <Address 2, sequence-number, fragment-number> tuples from received management frames shall reject as a duplicate frame any Special Management frame in which the Retry bit in the Frame Control field is 1 and that matches an <Address 2, sequence-number, fragment-number> tuple of an entry in the cache that contains tuples from Special Management frames.

There is a small possibility that a frame may be improperly rejected due to such a match; however, this occurrence would be rare and simply results in a lost frame (similar to an FCS error in other LAN protocols).

**References:**

11-11-0835-01-000m-undetected-duplicate-reception.pptx