IEEE P802.11
Wireless LANs

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| Bufferable Unit Additions |
| Date: 2012-10-02 |
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Abstract

Proposed additions to the definition of a bufferable unit = the block ack req and block ack frames.

**Revision Notes**

**R1:**

Added CID 265 as reference.

**R0:**

Initial.

**No CID**

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| **CID** | **Commenter** | **Page** | **Clause** | **Comment** | **Proposed Change** | **Resolution** |
| - | Matthew Fischer | 989.50 | 10.2.1.6 | There are additional frames that can become BUs – these need to be added to the definition and accounted for in the STA and AP PS behavioral descriptions. | As in the comment. | Revise – Tgm editor to make changes to the draft as shown in document 11-12-1369r0 under the heading “No CID”. |
| 265 | MARK RISON |  | 10.2.1.1 | "The STAs that currently have buffered BUs within the AP are identified in a TIM, which shall be included as an element within all Beacon frames generated by the AP. A STA shall determine that a BU is buffered for it by receiving and interpreting a TIM." -- not true e.g. if some but not all ACs are delivery-enabled. | Fix. | REVISED (GEN: 2013-01-15 00:51:27Z) At 984.35, after "The STAs that currently have buffered Bus", insert "(excluding those BUs for a STA associated with ACs that are U-APSD delivery-enabled when not all ACs are delivery-enabled by that STA)" |

**Discussion**

Note that as might be expected because of parallel constructs in the standard, there are in fact, no changes needed to 10.2.1.7 “*AP Operation during the CFP*” because the language in that subclause is more generic than the language in its parallel subclause 10.2.1.6 “*AP Operation during the CP*”. 10.2.1.7 never refers to DATA or Management, but only to BUs.

There is at least one open issue, which might have already existed anyway:

What about the issue that EOSP that cannot be set in a BU that is a control frame?

For APSD, is the EOSP needed anyway, when the BU is the last allowable transmitted frame? E.g. if the limit per SP is 4 frames, then why does the 4th frame need to have EOSP=1? I suppose it helps the recipient, so that the recipient does not need to track the number of frames received in order to know when it may return to sleep. But then, this creates a problem when the 4th frame is a control frame. Does the AP need to send a 5th frame with EOSP=1? Does the control frame really count anyway, since it is not going to use normal RX buffer space? But if there are no DL DATA frames, but there is a pending DL BAR frame, then the TIM bit would be set, because the BAR is a BU, so it should count, shouldn’t it?

One could always follow the transmission of a BU which is either an AMPDU or a Control frame with a QOS NULL which contains the EOSP=1 indication (and never set EOSP to 1 within an AMPDU and infer that the lack of existence of an EOSP bit within an control frame is the equivalent of EOSP=0.)

There is a note in 10.2.1.6:

NOTE—An AP that transmits an A-MPDU containing data MPDUs in which the EOSP field is set to 1 and that receives a BlockAck that does not acknowledge all of those MPDUs, cannot transmit any missed data MPDUs within the current service period because the destination STA might now be asleep.

This answers questions about AMPDU EOSP setting, but there is still the open question for EOSP in control frames.

A solution for control frame EOSP=1 might be to send a NULL DATA frame with EOSP=1. No text needs to change to support this – however, for the case of a limited number of MSDUs per SP for U-APSD operation, one must ask whether either the Control frame or the NULL DATA frames is included in the count of allowed frames.

**Proposed changes**

***TGm editor: Modify the following definitions in subclause 3.2. Definitions specific to IEEE 802.11 as shown:***

**3.2 Definitions specific to IEEE 802.11**

**bufferable unit (BU):** An MSDU, A-MSDU (HT STAs only), BlockAckReq frame, BlockAck frame or bufferable MMPDU that is buffered to operate the power saving protocol.

***TGm editor: Modify Figure 8-12 – Frame Control field subfield values within control frames in subclause 8.3.1.1 Format of control frames by removing the “(0)” in bit 13, More Data***

***TGm editor: Change the first, second and fifth paragraphs of subclause 8.2.4.1.8 More Data field as shown:***

**8.2.4.1.8 More Data field**

The More Data field is 1 bit in length and is used to indicate to a STA in PS mode that more BUs are

buffered for that STA at the AP. The More Data field is valid in individually addressed BUstransmitted by an AP to a STA in PS mode. A value of 1 indicates that at least one additional

buffered BU is present for the same STA.

The More Data field is optionally set to 1 in individually addressed BUs transmitted by a CFPollable STA to the PC in response to a CF-Poll to indicate that the STA has at least one additional buffered MSDU available for transmission in response to a subsequent CF-Poll.

The More Data field is 1 in individually addressed BUs transmitted by a mesh STA to a peer mesh STA that is either in light sleep mode or in deep sleep mode for the corresponding mesh peering, when additional BUs remain to be transmitted to this peer mesh STA.

***TGm editor: Modify items g) and h) of 10.2.1.6 AP operation during the CP as shown:***

**10.2.1.6 AP operation during the CP**

g) A single buffered BU for a STA in the PS mode shall be forwarded to the STA after a PS-Poll has been received from that STA. For a STA using U-APSD, the AP transmits one BU destined for the STA from any AC that is not delivery-enabled in response to PS-Poll from the STA. When all ACs associated with the STA are delivery-enabled, the AP transmits one BU from the highest priority AC. The AP can respond with either an immediate data or management frame or with an ACK, while delaying the responding data or management frame.

Within a BU transmitted to a STA in PS mode and not using U-APSD, the AP shall set the More Data field to indicate the presence of further buffered BUs for the polling STA. Within a BU transmitted to a STA using U-APSD, the AP shall set the More Data field to indicate the presence of further buffered BUs that do not use delivery-enabled ACs. Within a BU transmitted to a STA in PS mode for which all ACs are delivery-enabled, the AP shall set the More Data field to indicate the presence of further buffered Bus using delivery-enabled ACs. If there are buffered BUs to transmit to the STA, the AP may set the More Data bit in a QoS +CF-Ack frame to 1, in response to a QoS data frame to indicate that it has one or more pending BUs buffered for the PS STA identified by the RA in the QoS +CF-Ack frame. An AP may set the More Data bit in an ACK frame to 1 in response to a QoS data frame to indicate that it has one or more pending BUs buffered for the PS STA identified by the RA in the ACK frame, if that PS STA has set the More Data Ack subfield in the QoS Capability element to 1.

While the AP has at least one BU queued for transmission to a STA in response to a previously received PS-Poll, the AP shall acknowledge any additional PS-Poll frames received from that STA but shall not queue any additional BUs for transmission to that STA in response to the receipt of the additional PS-Poll frames. This prevents a retried PS-Poll from being treated as a new request to deliver a buffered BU.

While the AP has at least one BU queued for transmission to a STA in response to a previously received trigger frame, the AP acknowledges as appropriate, any additional trigger frames received from that STA but shall not queue any additional BUs for transmission to that STA in response to the receipt of the additional trigger frames. This prevents a retried trigger frame from being treated as a new request to deliver buffered BU(s).

h) At each scheduled APSD SP for a STA, the APSD-capable AP (i.e., an AP for which dot11APSDOptionImplemented is true) shall attempt to transmit at least one BU, using admitted TSPECs with the APSD and Schedule subfields both set to 1, that are destined for the STA. At each unscheduled SP for a STA, the AP shall attempt to transmit at least one BU, but no more than the value specified in the Max SP Length field in the QoS Capability element from delivery-enabled ACs, that are destined for the STA.

The More Data bit of the individually addressed BUs transmitted using delivery-enabled ACs and destined for that STA indicates that more BUs are buffered for the delivery-enabled ACs. The More Data bit equal to 1 in BUs transmitted using nondelivery-enabled ACs and destined for that STA indicates that more BUs are buffered for the nondelivery-enabled ACs. For all frames except for the final frame of the SP, the EOSP subfield of the QoS Control field of the QoS data frame shall be set to 0 to indicate the continuation of the SP. An AP may also set the More Data bit to 1 in a QoS +CF-Ack frame in response to a QoS data frame to indicate that it has one or more pending BUs buffered for the target STA identified by the RA in the QoS +CF-Ack frame. If the QoS data frame is using a delivery-enabled AC, the More Data bit in the QoS +CF-Ack frame indicates more BUs for all delivery-enabled ACs. If the QoS data frame is not using a delivery-enabled AC, the More Data bit in the QoS +CF-Ack frame indicates more BUs for all ACs that are not delivery-enabled.

The AP considers an APSD STA to be in Awake state after it has sent a QoS +CF-Ack frame, with the EOSP subfield in the QoS Control field equal to 0, to the APSD STA. If necessary, the AP may generate an extra QoS Null frame, with the EOSP set to 1. When the AP has transmitted an individually addressed frame to the STA with the EOSP subfield set to 1 during the SP except for retransmissions of that frame, the AP shall not transmit any more frames to that STA using this mechanism until the next SP. The AP shall set the EOSP subfield to 1 to indicate the end of the SP in APSD.

***TGm editor: Modify item d) of 10.2.1.8 Receive operation for STAs in PS mode during the CP as shown:***

**10.2.1.8 Receive operation for STAs in PS mode during the CP**

d) If the More Data field in the received BU indicates that more traffic for that STA is buffered, the STA, at its convenience, shall Poll until no more BUs are buffered for that STA.

***TGm editor: Modify item d) of 10.2.1.9 Receive operation for STAs in PS mode during the CFP as shown:***

**10.2.1.9 Receive operation for STAs in PS mode during the CFP**

d) If the More Data field in the Frame Control field of the last BU received from the AP indicates that more traffic for the STA is buffered, then, when the CFP ends, the STA may remain in the Awake state and transmit PS-Poll frames during the CP to request the delivery of additional buffered BUs, or may enter the Doze state during the CP (except at TBTTs for DTIMs expected during the CP), awaiting the start of the next CFP.

**References:**