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| Normative Text for Deterministic Backoff |
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Abstract

This submission contains possible normative text changes for Deterministic Backoff. Changes are relative to REVmd draft 0.2. Changes are for AC\_BE.

**Text changes relative to REVmd draft 0.2.**

* EDCA backoff procedure

Each EDCAF except AC\_BE when dot11DeterministicBackoff is true shall maintain a state variable CW[AC], which shall be initialized to the value of the parameter CWmin[AC], for that EDCAF’s AC.

When dot11DeterministicBackoff is true, AC\_BE shall maintain state variables RetryCount, InterruptionCount, DeterministicBackoff and RandomBackoff, which shall be initialized at 0.

For the purposes of this subclause, transmission failure of an MPDU is defined as follows:

* After transmitting an MPDU (even if it is carried in an A‑MPDU or as part of a VHT (11ah)or S1G MU PPDU that is sent using TXVECTOR parameter NUM\_USERS > 1) that requires an immediate response:
* The STA shall wait for a timeout interval of duration aSIFSTime + aSlotTime + aRxPHYStartDelay, starting when the MAC receives a PHY-TXEND.confirm primitive. If a PHY-RXSTART.indication primitive does not occur during the timeout interval, the transmission of the MPDU has failed.
* If a PHY-RXSTART.indication primitive does occur during the timeout interval, the STA shall wait for the corresponding PHY-RXEND.indication primitive to recognize a valid response MPDU (see Annex G) that either does not have a TA field or is sent by the recipient of the MPDU requiring a response. If anything else, including any other valid frame, is recognized, the transmission of the MPDU has failed.
* The nonfinal (re)transmission of an MPDU that is delivered using the GCR unsolicited retry retransmission policy (ref) is defined to be a failure.
* In all other cases, the transmission of the MPDU has not failed.

The TXNAV timer is a single timer, shared by the EDCAFs within a STA, that is initialized with the duration from the Duration/ID field in the frame most recently successfully transmitted by the TXOP holder, except for PS-Poll frames. The TXNAV timer begins counting down from the end of the transmission of the PPDU containing that frame. An HT STA may retransmit unacknowledged MPDUs within the same TXOP or in a subsequent TXOP. The Reservation Allocation Vector (RAV) timer for a mesh STA that has dot11MCCAActivated true is initialized with the MCCAOP Duration in the MCCAOP Reservation field at the start of an MCCAOP reservation. The RAV timer begins counting down from the start of an MCCAOP reservation (see ref).

The backoff procedure shall be invoked by an EDCAF when any of the following events occurs:

* An MA-UNITDATA.request primitive is received that causes a frame with that AC to be queued for transmission such that one of the transmit queues associated with that AC has now become non-empty and any other transmit queues associated with that AC are empty; the medium is busy on the primary channel as indicated by any of the following:
* physical CS;
* virtual CS;
* a nonzero TXNAV timer value;
* a mesh STA that has dot11MCCAActivated true and a nonzero RAV timer value, and the backoff timer has a value of 0 for that AC.
* The transmission of the MPDU in the final PPDU transmitted by the TXOP holder during the TXOP for that AC has completed and the TXNAV timer has expired, and the AC was a primary AC. (See ref).
* The transmission of an MPDU in the initial PPDU of a TXOP fails, as defined in this subclause, and the AC was a primary AC.
* The transmission attempt collides internally with another EDCAF of an AC that has higher priority, that is, two or more EDCAFs in the same STA are granted a TXOP at the same time.
* The transmission attempt of a STA coordinated by an MM-SME collides internally with another STA coordinated by the same MM-SME (see 11.34 (MMSL cluster operation)), which is indicated to the first MAC entity with a PHY-TXBUSY.indication(BUSY) primitive as response to the PHY-TXSTART.request primitive.

In addition, the backoff procedure may be invoked by an EDCAF when:

* The transmission by the TXOP holder of an MPDU in a non-initial PPDU of a TXOP fails, as defined in this subclause.

NOTE—A STA can perform a PIFS recovery, as described in **Error! Reference source not found.**, or perform a backoff, as described in the previous paragraph, as a response to transmission failure within a TXOP. How it chooses between these two is implementation dependent.

A STA that performs a backoff within its existing TXOP shall not extend the TXNAV timer value (see ref).

NOTE—In other words, the backoff is a continuation of the TXOP, not the start of a new TXOP.

For all ACs, except AC\_BE when dot11DeterministicBackoff is true:

If the backoff procedure is invoked for reason a) above, the value of CW[AC] shall be left unchanged. If the backoff procedure is invoked for reason b) above, the value of CW[AC] shall be reset to CWmin[AC].

If the backoff procedure is invoked for reason c), d), e), or f) above, or the transmission failure of a non-initial frame by the TXOP holder, the value of CW[AC] shall be updated as follows before invoking the backoff procedure:

* If the QSRC[AC] or the QLRC[AC] has reached dot11ShortRetryLimit or dot11LongRetryLimit respectively, CW[AC] shall be reset to CWmin[AC].
* If dot11RobustAVStreamingImplemented is true and either the QSDRC[AC] or the QLDRC[AC] has reached dot11ShortDEIRetryLimit or dot11LongDEIRetryLimit, respectively, CW[AC] shall be reset to CWmin[AC].
* Otherwise,
* If CW[AC] is less than CWmax[AC], CW[AC] shall be set to the value (CW[AC] + 1) × 2 – 1.
* If CW[AC] is equal to CWmax[AC], CW[AC] shall be left unchanged.

For AC\_BE when dot11DeterministicBackoff is true:

If the backoff procedure is invoked for reason a), RetryCount shall be left unchanged.

If the backoff procedure is invoked for reason b), RetryCount shall be set to 0.

If the backoff procedure is invoked for reason c), d), e), or f), or the transmission failure of a non-initial frame by the TXOP holder, RetryCount shall be incremented modulo 7.

* EDCA TXOPs

There are three modes of EDCA TXOP defined: initiation of an EDCA TXOP, sharing an EDCA TXOP, and multiple frame transmission within an EDCA TXOP. Initiation of the TXOP occurs when the EDCA rules permit access to the medium. Sharing of the EDCA TXOP occurs when an EDCAF within an AP that supports DL-MU-MIMO has obtained access to the medium, making the corresponding AC the primary AC, and includes traffic from queues associated with other ACs in VHT (11ah)or S1G MU PPDUs transmitted during the TXOP. Multiple frame transmission within the TXOP occurs when an EDCAF retains the right to access the medium following the completion of a frame exchange sequence, such as on receipt of an Ack frame.

* Obtaining an EDCA TXOP

Each EDCAF shall maintain a backoff timer, which has a value measured in backoff slots as described below.

When the backoff procedure is invoked for any AC except AC\_BE when dot11DeterministicBackoff is true, the backoff timer is set to an integer value chosen randomly with a uniform distribution taking values in the range 0 to CW[AC].

When the backoff procedure is invoked for AC\_BE when dot11DeterministicBackoff is true:

* when RetryCount is less than 2, the backoff timer shall be set to DeterministicBackoff, and RandomBackoff shall be set to 0
* otherwise, the backoff timer shall be set to an integer value chosen randomly with a uniform distribution taking values in the range 0 to 6, and RandomBackoff shall be set to 1.

The duration AIFS[AC] is a duration derived from the value AIFSN[AC] by the relation

AIFS[AC] = AIFSN[AC] × aSlotTime + aSIFSTime.

In an infrastructure BSS, AIFSN[AC] is advertised by an EDCA AP in the EDCA Parameter Set element in Beacon and Probe Response frames transmitted by the AP. The value of AIFSN[AC] shall be greater than or equal to 2 for non-AP STAs. The value of AIFSN[AC] shall be greater than or equal to 1 for APs. An EDCA TXOP is granted to an EDCAF when the EDCAF determines that it shall initiate the transmission of a frame exchange sequence. Transmission initiation shall be determined according to the following rules:

EDCAF operations shall be performed at slot boundaries, defined as follows on the primary channel, for each EDCAF:

* Following AIFSN[AC] × aSlotTime – aRxTxTurnaroundTime of idle medium after SIFS (not necessarily idle medium during the SIFS) after the last busy medium on the antenna that was the result of a reception of a frame with a correct FCS (11ah)or of an S1G frame. Note that upon reception of an S1G frame, an S1G STA updates its RID counter based on information obtained from the RXVECTOR as described in ref and this update does not depend on the outcome of the FCS check.
* Following EIFS – DIFS + AIFSN[AC] × aSlotTime + aSIFSTime – aRxTxTurnaroundTime of idle medium after the last indicated busy medium as determined by the physical CS mechanism that was the result of a (11ah)non-S1G frame reception that has resulted in FCS error, or (11ah)of a frame reception that has resulted in PHY-RXEND.indication (-RXERROR) primitive where the value of RXERROR is not NoError.
* When any other EDCAF at this STA transmitted a frame requiring acknowledgment, the earlier of
* The end of the AckTimeout interval timed from the PHY‑TXEND.confirm primitive, followed by AIFSN[AC] × aSlotTime + aSIFSTime – aRxTxTurnaroundTime of idle medium, and
* The end of the first AIFSN[AC] × aSlotTime – aRxTxTurnaroundTime of idle medium after SIFS (not necessarily medium idle during the SIFS, the start of the SIFS implied by the length in the PHY header of the previous frame) when a PHY-RXEND.indication primitive occurs as specified in ref.
* Following AIFSN[AC] × aSlotTime – aRxTxTurnaroundTime of idle medium after SIFS (not -necessarily medium idle during the SIFS) after the last busy medium on the antenna that was the result of a transmission of a frame for any EDCAF and which did not require an -acknowledgment and after the expiration of the TXNAV timer if nonzero, and, if dot11MCCAActivated is true, the expiration of the RAV timer if nonzero.
* Following AIFSN[AC] × aSlotTime + aSIFSTime – aRxTxTurnaroundTime of idle medium after the last indicated busy medium as indicated by the CS mechanism that is not covered by a) to d).
* Following aSlotTime of idle medium, which occurs immediately after any of these conditions, a) to f), is met for the EDCAF.

On these specific slot boundaries, each EDCAF shall make a determination to perform one and only one of the following functions:

* Decrement the backoff timer.
* Initiate the transmission of a frame exchange sequence.
* Invoke the backoff procedure due to an internal collision.
* Do nothing.

NOTE—If an EDCAF gains access to the channel and transmits MSDUs, A‑MSDUs, or MMPDUs from a secondary AC, the EDCAF of the secondary AC is not affected by this operation. If the EDCAF of a secondary AC experiences an internal collision with the EDCAF that gained access to the channel, it performs the backoff procedure regardless of the transmission of any of its MSDUs, A‑MSDUs, or MMPDUs (see ref).

At each of the above-described specific slot boundaries, each EDCAF shall decrement the backoff timer if the backoff timer for that EDCAF has a nonzero value.

At each of the above-described specific slot boundaries, each EDCAF shall initiate a transmission sequence if

* There is a frame available for transmission at that EDCAF, and
* The backoff timer for that EDCAF has a value of 0, and
* Initiation of a transmission sequence is not allowed to commence at this time for an EDCAF of higher UP.

At each of the above-described specific slot boundaries, each EDCAF shall report an internal collision (which is handled in Obtaining an EDCA TXOP) if

* There is a frame available for transmission at that EDCAF, and
* The backoff timer for that EDCAF has a value of 0, and
* Initiation of a transmission sequence is allowed to commence at this time for an EDCAF of higher UP.

If dot11DeterministicBackoff is true:

* AC\_BE shall increment InterruptionCount at slot boundaries a) throuh e)
* if RandomBackoff is 0, AC\_BE shall set DeterministicBackoff to 10 + InterruptionCount - 1 when the transmission of a frame exchange sequence is initiated or when the backoff procedure is invoked due to an internal collision.

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