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Title	**Proposed A-MAP Relevance and HARQ Timing for the IEEE 802.16m Amendment (Proposed Text for AWD)**
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Re:	Category: AWD-DG comments / Area: HARQ Protocol DG "Comments on the Proposed Text of HARQ Protocol DG"
Abstract	This contribution provides the proposed text of A-MAP relevance and HARQ timing for the IEEE 802.16m Amendment.
Purpose	To be discussed and adopted by HARQ Protocol DG and TGm for the 802.16m Amendment.
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Proposed A-MAP Relevance and HARQ Timing for the IEEE 802.16m Amendment (Proposed Text for AWD)

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1. Introduction

This contribution provides the proposed text of A-MAP relevance and HARQ timing for the IEEE 802.16m Amendment. The proposed text is aligned and can be readily combined with HARQ Protocol DG Draft document [1]. The design principles, features and benefits of the proposed A-MAP relevance and HARQ timing, and also illustrations of HARQ timings for various configurations are shown in another input contribution [2].

2. References

[1] IEEE C802.16m-09/0859, " Proposed Text of HARQ Protocol for the 802.16m Amendment"

[2] IEEE C802.16m-09/1131, "Proposed A-MAP Relevance and HARQ Timing for the IEEE 802.16m Amendment (Design Principles and Key Features)"

3. Text proposal

[Insert the following new subcluase into Section 15.2]

---------- Text Start ----------

15.2.x.2.2 A-MAP relevance and HARQ timing

Transmissions of Assignment A-MAP IE, the HARQ subpacket, and the corresponding feedback shall be in accordance to a pre-defined timing. In UL, retransmission of the HARQ subpacket shall also follow a pre-defined timing.

Each transmission time is represented by frame index and subframe index. The frame index shall range from 0 to 3. In FDD, the index of DL or UL subframe shall range from 0 to *F*-1, where *F* is the number of subframes per frame. In TDD, the index of DL subframe shall range from 0 to *D*-1, where *D* is the number of DL subframes per frame, and the index of UL subframe shall range from 0 to *U*-1, where *U* is the number of UL subframes per frame.

15.2.x.2.2.1 FDD

15.2.x.2.2.1.1 Downlink

In DL HARQ transmission, DL Basic Assignment A-MAP IE, the HARQ subpacket, and the corresponding feedback shall follow the timing defined in Table 1.

Table 1 – FDD DL HARQ timing

Content	Subframe index	Frame index
Basic Assignment A-MAP IE Tx in DL	l	i
HARQ Subpacket Tx in DL	$m = l$ or $l + N_{A-MAP} - 1$	i
HARQ feedback in UL	n = ceil(m+F/2) mod F	$j = \left(i + \text{floor}\left(\frac{\text{ceil}(m + F/2)}{F} \right) + z \right) \bmod 4$

DL HARQ subpacket transmission corresponding to a DL Basic Assignment A-MAP IE in l-th DL subframe of the i-th frame shall begin in the m-th DL subframe of the i-th frame. A HARQ feedback for the DL HARQ subpacket shall be transmitted in the n-th UL subframe of the j-th frame. The subframe index m, n and frame index j shall be determined by using l and i, as shown in Table 1.

Note that the subframe index l shall range from 0 to $N_{A\text{-}MAP}$·(ceil(F/$N_{A\text{-}MAP}$) −1) with an increment of $N_{A\text{-}MAP}$. For the case that the A-MAP transmission period is two subframes, i.e. $N_{A\text{-}MAP}$ = 2, m shall be selected between l and l+1. The selection information of m shall be provided in DL Basic Assignment A-MAP IE.

DL HARQ feedback offset z shall be set to 1 only if a time gap from completion of the HARQ subpacket transmission to its feedback time derived with z = 0 is shorter than the data burst processing time T_{proc}. Otherwise, z shall be set to 0. This rule shall be also applied to the long TTI transmission:

$$z = \begin{cases} 0, & \text{if } (\text{ceil}(F/2) - N_{TTI} \geq T_{proc}) \\ 1, & \text{else} \end{cases}$$

where N_{TTI} is the number of subframes which a HARQ subpacket spans; i.e. 1 for the default TTI and 4 for the long TTI in FDD. The index m in Table 1 indicates the 1st subframe which a long TTI subpacket spans.

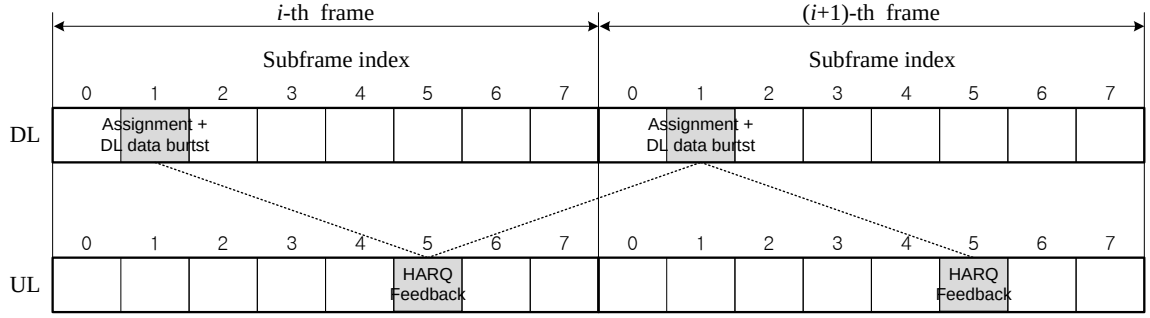

Figure 1 – Example of FDD DL HARQ timing for 5, 10 and 20 MHz channel bandwidths

Figure 1 shows an example of the timing relationship between a DL Basic Assignment A-MAP IE with $N_{A\text{-}MAP}$ = 1, a DL HARQ subpacket with the default TTI, corresponding HARQ feedback, and retransmission in FDD frame structure, for 5, 10 and 20 MHz channel bandwidths. In this example, T_{proc} is 3.

15.2.x.2.2.1.2 Uplink

In UL HARQ transmission, UL Basic Assignment A-MAP IE, the HARQ subpacket, the corresponding feedback, and retransmission of the HARQ subpacket shall follow the timing defined in Table 2.

Table 2 – FDD UL HARQ timing

Content	Subframe index	Frame index
Basic Assignment A-MAP Tx IE in DL	l	i
HARQ Subpacket Tx in UL	$m = n$ or $n + N_{A-MAP} - 1$ where n =ceil(l+F/2) mod F.	$j = \left(i + \text{floor}\left(\frac{\text{ceil}(l + F/2)}{F} \right) + v \right) \bmod 4$
HARQ feedback in DL	l	$k = \left(j + \text{floor}\left(\frac{m + F/2}{F} \right) + w \right) \bmod 4$
HARQ Subpacket ReTx in UL	m	$p = \left(k + \text{floor}\left(\frac{\text{ceil}(l + F/2)}{F} \right) + v \right) \bmod 4$

UL HARQ subpacket transmission corresponding to a UL Basic Assignment A-MAP IE in l-th DL subframe of the i-th frame shall begin in the m-th UL subframe of the j-th frame. A HARQ feedback for the UL HARQ subpacket shall be transmitted in the l-th DL subframe of the k-th frame. When the UL HARQ feedback indicates a negative-acknowledgement, retransmission of the UL HARQ subpacket shall begin in the m-th UL subframe of the p-th frame. The subframe index m, n and frame index j, k, p shall be determined by using l and i, as shown in Table 2.

Note that the subframe index l shall range from 0 to $N_{A\text{-}MAP}\cdot(\text{ceil}(F/N_{A\text{-}MAP}) - 1)$ with an increment of $N_{A\text{-}MAP}$. For $N_{A\text{-}MAP}$ =2, m shall be selected between n and n+1. The selection information of n shall be provided in UL Basic Assignment A-MAP IE.

UL HARQ transmission offset v shall be set to 1 only if a time gap from completion of the UL Basic Assignment A-MAP IE transmission to the HARQ subpacket transmission time derived with v = 0 is shorter than the data burst processing time T_{proc}. Otherwise, v shall be set to 0:

$$v = \begin{cases} 0, & \text{if } (\text{ceil}(F/2) - 1 \geq T_{proc}) \\ 1, & \text{else} \end{cases}$$

UL HARQ feedback offset w shall be set to 1 only if a time gap from completion of the HARQ subpacket transmission to its feedback time derived with w = 0 is shorter than the data burst processing time T_{proc}. Otherwise, w shall be set to 0. This rule shall be also applied to the long TTI transmission:

$$w = \begin{cases} 0, & \text{if } (\text{floor}(F/2) - N_{TTI} \geq T_{proc}) \\ 1, & \text{else} \end{cases}$$

where N_{TTI} is the number of subframes which a HARQ subpacket spans; i.e. 1 for the default TTI and 4 for the long TTI in FDD. The index m in Table 2 indicates the 1st subframe which a long TTI subpacket spans.

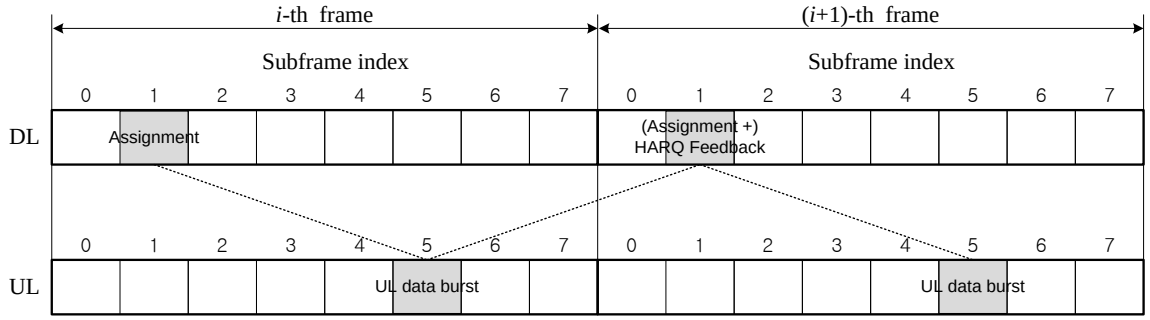

Figure 2 – Example of FDD UL HARQ timing for 5, 10 and 20 MHz channel bandwidths.

Figure 2 shows an example of the timing relationship between a UL Basic Assignment A-MAP IE with $N_{A\text{-}MAP}$ = 1, a UL HARQ subpacket with the default TTI, corresponding HARQ feedback and retransmission in FDD frame structure, for 5, 10 and 20 MHz channel bandwidths. In this example, T_{proc} is 3.

15.2.x.2.2.2 TDD

15.2.x.2.2.2.1 Downlink

In DL HARQ transmission, DL Basic Assignment A-MAP IE, the HARQ subpacket, and the corresponding feedback shall follow the timing defined in Table 3.

Table 3 – TDD DL HARQ timing

Content	Subframe index	Frame index
Basic Assignment A-MAP IE Tx in DL	l	i
HARQ Subpacket Tx in DL	$m = l$ or $l + N_{A-MAP} - 1$	i
HARQ feedback in UL	For $D > U$, $n = \begin{cases} 0, & \text{for } 0 \le m < K \\ m - K, & \text{for } K \le m < U + K \\ U - 1, & \text{for } U + K \le m < D \end{cases}$	$j = (i+z) \bmod 4$
	For $D \le U$, $n = m - K$	

DL HARQ subpacket transmission corresponding to a DL Basic Assignment A-MAP IE in *l*-th DL subframe of the *i*-th frame shall begin in the *m*-th DL subframe of the *i*-th frame. A HARQ feedback for the DL HARQ subpacket shall be transmitted in the *n*-th UL subframe of the *j*-th frame. The subframe index *m*, *n* and frame index *j* shall be determined by using *l* and *i*, as shown in Table 3. In the table, if the sum of *D* and *U* is an odd number and *D* is less than $U/N_{A\text{-}MAP}$, K = ceil((*D*-*U*)/2) for $D \ge U$, and K = –ceil((*U*-*D*)/2) for $D < U$. Otherwise, K = floor((*D*-*U*)/2) for $D \ge U$, and K = –floor((*U*-*D*)/2) for $D < U$.

Note that the subframe index *l* shall range from 0 to $N_{A\text{-}MAP}$·(ceil($D/N_{A\text{-}MAP}$) –1) with an increment of $N_{A\text{-}MAP}$. For $N_{A\text{-}MAP}$ =2, *m* shall be selected between *l* and *l*+1. The selection information of *m* shall be provided in DL Assignment A-MAP IE.

DL HARQ feedback offset *z* shall be set to 1, only if a time gap from completion of the HARQ subpacket transmission to its feedback time derived with z = 0 is shorter than the data burst processing time T_{proc}. Otherwise, *z* shall be set to 0. This rule shall be also applied to the long TTI transmission:

$$z = \begin{cases} 0, & \text{if } (D - m - N_{TTI} + n \geq T_{proc}) \\ 1, & \text{else} \end{cases}$$

where N_{TTI} is the number of subframes which a HARQ subpacket spans; i.e. 1 for the default TTI and D for the long TTI in TDD DL. The index m in Table 3 indicates the 1st subframe which a long TTI subpacket spans.

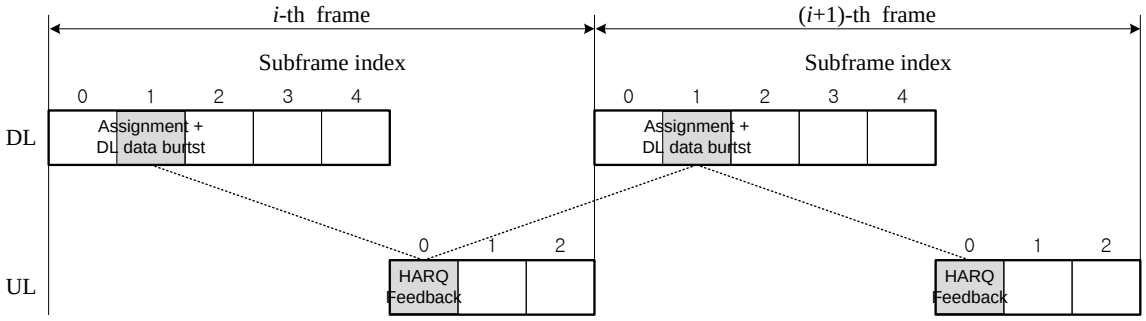

Figure 3 – Example of TDD DL HARQ timing for 5, 10 and 20 MHz channel bandwidths.

Figure 3 shows an example of the timing relationship between a DL Basic Assignment A-MAP IE with $N_{A\text{-}MAP}$ = 1, a DL HARQ subpacket with the default TTI, corresponding HARQ feedback and retransmission in TDD frame structure, for 5, 10 and 20 MHz channel bandwidths. In this example, T_{proc} is 3.

15.2.x.2.2.2.2 Uplink

In UL HARQ transmission, UL Basic Assignment A-MAP IE, the HARQ subpacket, the corresponding feedback, and retransmission of the HARQ subpacket shall follow the timing defined in Table 4.

Table 4 – TDD UL HARQ timing

Content	Subframe index	Frame index
Basic Assignment A-MAP IE Tx in DL	l	i
HARQ Subpacket Tx in UL	For $\text{ceil}(D/N_{A\text{-}MAP}) \geq U$, $m = \begin{cases} 0, & \text{for } 0 \leq l < K \\ l-K, & \text{for } K \leq l < U+K \\ U-1, & \text{for } U+K \leq l < D \end{cases}$	$j = (i+v) \bmod 4$
	For $1 < \text{ceil}(D/N_{A\text{-}MAP}) < U$, $m = \begin{cases} 0, \cdots, \text{or } l-K+N_{A-MAP}-1, & \text{for } l = 0 \\ l-K \text{ or } l-K+N_{A-MAP}-1, & \text{for } 0 < l < l_{\max} \\ l-K, l-K+1, \cdots, \text{or } U-1, & \text{for } l = l_{\max} \end{cases}$ where $l_{\max} = N_{A\text{-}MAP} \cdot (\text{ceil}(D/N_{A\text{-}MAP}) - 1)$.	
	For $\text{ceil}(D/N_{A\text{-}MAP}) = 1$, $m = 0, 1, \ldots, \text{or } U\text{-}1$ for $l = 0$	
HARQ feedback in DL	l	$k = (j+1+w) \bmod 4$
HARQ Subpacket ReTx in UL	m	$p = (k+v) \bmod 4$

UL HARQ subpacket transmission corresponding to a UL Basic Assignment A-MAP IE in *l*-th DL subframe of the *i*-th frame shall begin in the *m*-th UL subframe of the *j*-th frame. A HARQ feedback time for the HARQ subpacket shall be transmitted in the *l*-th DL subframe of the *k*-th frame. When the UL HARQ feedback indicates a negative acknowledgement, retransmission of the UL HARQ subpacket shall begin in the *m*-th UL subframe of the *p*-th frame. The subframe index *m*, *n* and frame index *j*, *k*, *p* shall be calculated as shown in Table 4.

In the table, if the sum of *D* and *U* is an odd number and *D* is less than $U/N_{A\text{-}MAP}$, K = ceil((*D*-*U*)/2) for $D \geq U$, and K = –ceil((*U*-*D*)/2) for $D < U$. Otherwise, K = floor((*D*-*U*)/2) for $D \geq U$, and K = –floor((*U*-*D*)/2) for $D < U$. Note that the subframe index *l* shall range from 0 to $N_{A\text{-}MAP}$·(ceil($D/N_{A\text{-}MAP}$) –1) with an increment of $N_{A\text{-}MAP}$.

For ceil($D/ N_{A\text{-}MAP}$) <*U*, *m* for a certain range of *l* shall be selected one of multiple values. The selection information of *m* shall be provided in UL Basic Assignment A-MAP IE.

UL HARQ transmission offset *v* shall be set to 1 only if a time gap from completion of the UL Assignment A-MAP IE transmission to the HARQ subpacket transmission time derived with $v = 0$ is shorter than the data burst processing time T_{proc}. Otherwise, *v* shall be set to 0:

$$v = \begin{cases} 0, & \text{if } (D - l - 1 + m \geq T_{proc}) \\ 1, & \text{else} \end{cases}$$

UL HARQ feedback offset *w* shall be set to 1 only if a time gap from completion of the HARQ subpacket transmission to its feedback time derived with $w = 0$ is shorter than the data burst processing time T_{proc}. Otherwise, *w* shall be set to 0. This rule shall be also applied to the long TTI transmission:

$$w = \begin{cases} 0, & \text{if } (U - m - N_{TTI} + l \geq T_{proc}) \\ 1, & \text{else} \end{cases}$$

where N_{TTI} is the number of subframes which a HARQ subpacket spans; i.e. 1 for the default TTI and *U* for the long TTI in TDD UL. The index *m* in Table 4 indicates the 1st subframe which a long TTI subpacket spans.

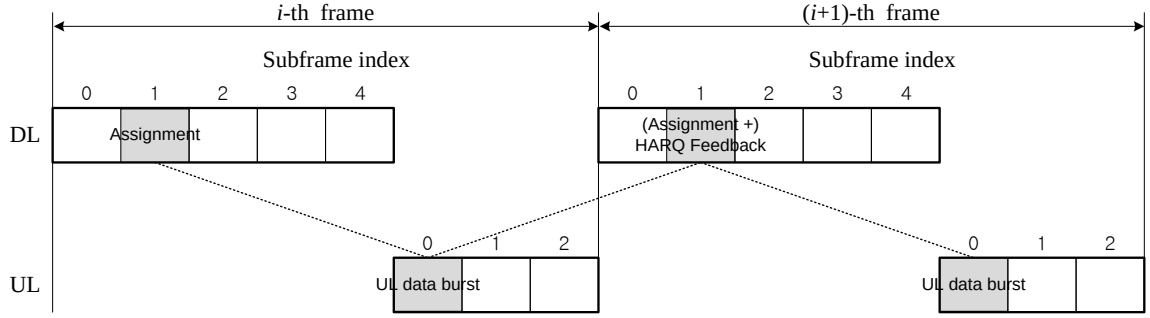

Figure 4 – Example of TDD UL HARQ timing for 5, 10 and 20 MHz channel bandwidths.

Figure 4 shows an example of the timing relationship between a UL Basic Assignment A-MAP IE with $N_{A\text{-}MAP}$ = 1, a UL HARQ subpacket with the default TTI, corresponding HARQ feedback and retransmission in TDD frame structure, for 5, 10 and 20 MHz channel bandwidths. In this example, T_{proc} is 3.

15.2.x.2.2.2.3 HARQ Timing in frame structure supporting the WirelessMAN-OFDMA frames

The A-MAP relevance and HARQ timing defined in 15.2.x.2.2.2 shall be applied to the frame structure supporting the WirelessMAN-OFDMA TDD frames in 15.3.3.4.1.

Subframes in the frame supporting the WirelessMAN-OFDMA TDD frames shall be indexed as follows: the DL subframe index shall range from 0 to *D*-1, where *D* is the number of DL subframes dedicated to the Advanced Air Interface operation in frame. The UL subframe index shall range from 0 to *U*-1, where *U* is the number of UL subframes dedicated to the Advanced Air Interface operation in frame.

Figure 5 shows an example of subframe indexing for 5, 10 and 20 MHz channel bandwidths. In this example, the ratio of whole DL subframes to whole UL subframes, *D'*:*U'* is 5:3. FRAME_OFFSET is 2, and UL subframes of the WirelessMAN-OFDMA and the Advanced Air Interface are frequency-division multiplexed. Then, the ratio of DL to UL subframes for the Advanced Air Interface, *D*:*U* is 3:3. The subframe index, *l*, *m*, and *n* are the renumbered index of *l'*, *m'*, and *n'*, respectively.

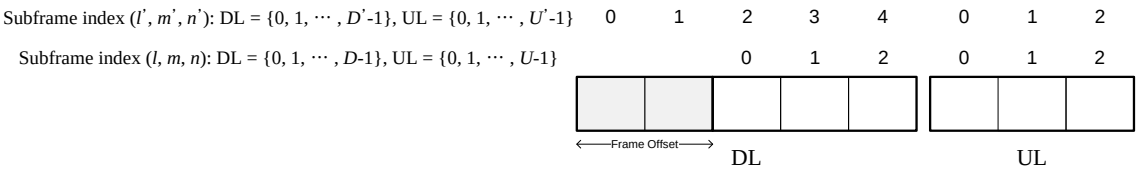

Figure 5 – Example of subframe indexing in frame structure supporting the WirelessMAN-OFDMA frame.

The same equations and rule in Table 3 and 4 shall be applied for deciding HARQ timing with *l*, *m*, *n*, *D*, and *U*, except that *l'*, *m'*, *n'*, *D'*, and *U'* shall be used to set *z*, *v*, and *w*, as follows:

$$z = \begin{cases} 0, & \text{if } (D' - m' - N_{TTI} + n' \geq T_{proc}) \\ 1, & \text{else} \end{cases}$$

$$v = \begin{cases} 0, & \text{if } (D' - l' - 1 + m' \geq T_{proc}) \\ 1, & \text{else} \end{cases}$$

$$w = \begin{cases} 0, & \text{if } (U' - m' - N_{TTI} + l' \geq T_{proc}) \\ 1, & \text{else} \end{cases}$$

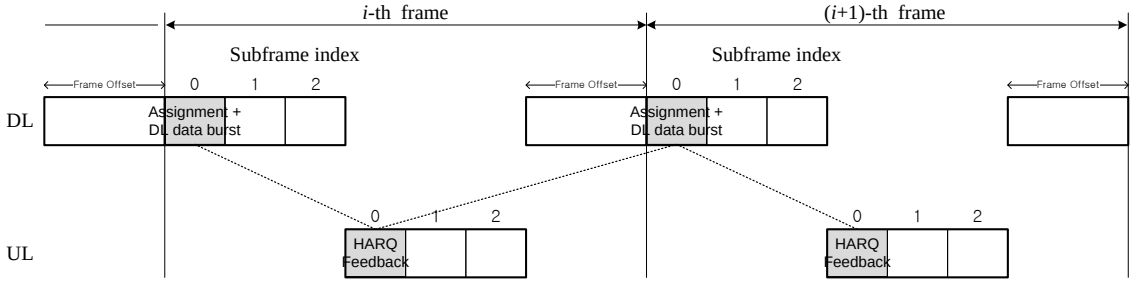

Figure 6 – Example of TDD DL HARQ timing in frame structure supporting the WirelessMAN-OFDMA frame.

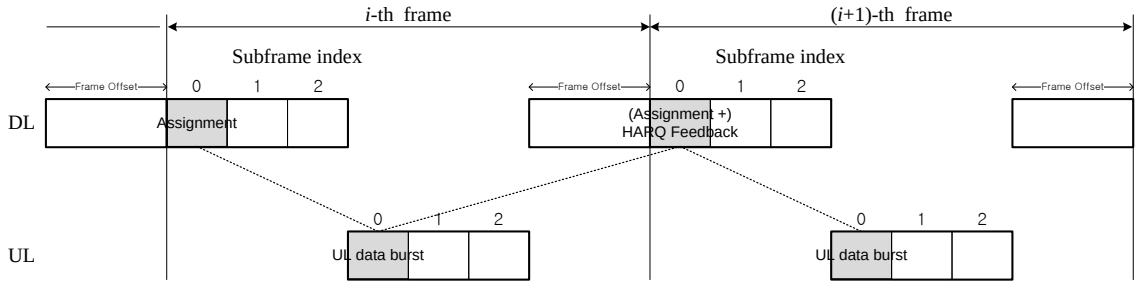

Figure 7 – Example of TDD UL HARQ timing in frame structure supporting the WirelessMAN-OFDMA frame.

Figure 6 and 7 show examples of the DL and UL timing relationships between a Assignment A-MAP IE with $N_{A\text{-}MAP}$ = 1, a HARQ subpacket with the default TTI, corresponding HARQ feedback and retransmission, for 5, 10 and 20 MHz channel bandwidths. The ratio of whole DL subframes to whole UL subframes, *D'*:*U'* is 5:3. In this example, FRAME_OFFSET is 2, UL subframes of the WirelessMAN-OFDMA and the Advanced Air Interface are frequency-division multiplexed, the ratio of DL to UL subframes for the Advanced Air Interface, *D*:*U* is 3:3, and T_{proc} is 3.

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