Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
Title	**Proposed A-MAP Relevance and HARQ Timing for the IEEE 802.16m (Proposed Text for AWD)**
Date Submitted	**2009-03-02**
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Re:	"802.16m AWD" IEEE 802.16m-09/0012, "Call for Contributions on Project 802.16m Amendment Working Document (AWD) Content" • Call for Contributions for P802.16m AWD Proposals: Target topic – HARQ timing
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 TGm for the 802.16m Amendment.
Notice	
Release	
Patent Policy	

Proposed A-MAP Relevance and HARQ Timing for the IEEE 802.16m (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 design principles for A-MAP relevance and HARQ timing, features and benefits of the proposed A-MAP relevance and HARQ timing formula, and illustrations of HARQ timings for various configurations are shown in another input contribution [1]. In the proposed text, the long TTI transmission and frame structures for other than 5, 10, 20 MHz are addressed. For more details of them, see the input contribution [2] and [3], respectively.

2. References

[1] IEEE C802.16m-09/0538, "A-MAP Relevance and HARQ timing for the IEEE 802.16m"

[2] IEEE C802.16m-09/0536, "Long TTI Size in the IEEE 802.16m"

[3] IEEE C802.16m-09/0275r1, "Frame Structures for 7MHz and 8.75MHz Channel Bandwidths"

3. Text proposal for inclusion in the 802.16m amendment

[Insert the following new subcluase into Section 15.2]

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

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

Each transmission timing 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.1. FDD

15.2.x.1.1. Downlink

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

Table 1 – FDD DL HARQ timing

Content	Subframe index	Frame index
Tx of Assignment IE in DL	l	i
Data burst Tx in DL	$m = \begin{cases} l, & \text{for } N_{A-MAP} = 1 \\ l \text{ or } l+1, & \text{for } N_{A-MAP} = 2 \end{cases}$	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 data burst transmission corresponding to a DL Assignment 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 timing for the DL data burst 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.

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

DL HARQ feedback offset z shall be set to 1 only if a time gap from completion of the data burst transmission to its feedback timing derived with z = 0 is shorter than the product of a subframe length and the data burst processing time [in DCD]. Otherwise, z shall be set to 0. This rule shall be also applied to the long TTI transmission. The index m in Table 1 indicates the 1st subframe which a long TTI data burst spans.

Retransmission of a DL data burst shall be indicated by a DL Assignment IE with AI_SN = 0, where the DL Assignment IE is transmitted with the DL data burst in the same subframe.

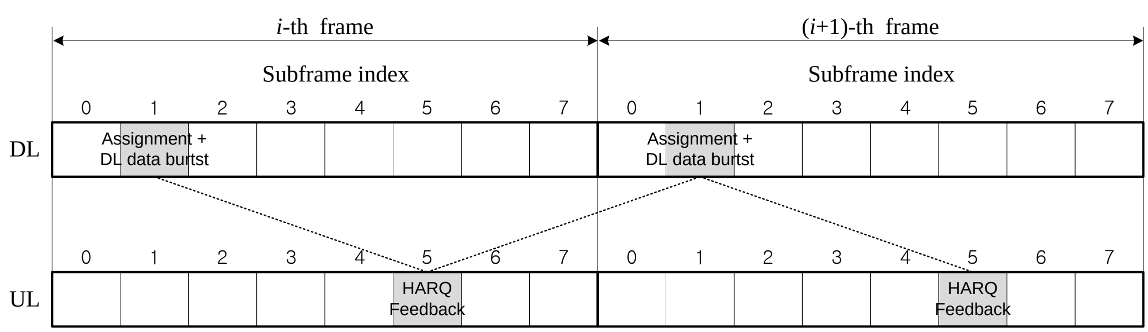

Figure 1 – Example of FDD DL HARQ timing for 5, 10 and 20 MHz channel bandwidths

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

15.2.x.1.2. Uplink

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

Table 2 – FDD UL HARQ timing

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

UL data burst transmission corresponding to a UL Assignment 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 timing for the UL data burst 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 data burst 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.

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

UL HARQ transmission offset v shall be set to 1 only if a time gap from completion of the UL Assignment IE transmission to the data burst transmission timing derived with v = 0 is shorter than the product of a subframe length and the data burst processing time [in DCD]. Otherwise, v shall be set to 0.

UL HARQ feedback offset w shall be set to 1 only if a time gap from completion of the data burst transmission to its feedback timing derived with w = 0 is shorter than the product of a subframe length and the data burst processing time [in DCD]. Otherwise, w shall be set to 0. This rule shall be also applied to the long TTI transmission. The index m in Table 2 indicates the 1st subframe which a long TTI data burst spans.

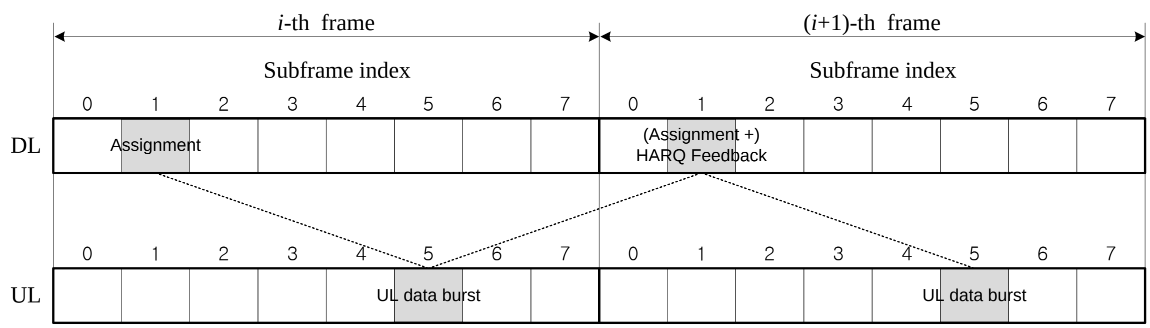

Figure 2 – Example of FDD UL HARQ timing for 5, 10 and 20 MHz channel bandwidths.

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

15.2.x.2. TDD

15.2.x.2.1. Downlink

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

Table 3 – TDD DL HARQ timing

Content	Subframe index	Frame index
Tx of Assignment IE in DL	l	i
Data burst Tx in DL	$m = \begin{cases} l, & \text{for } N_{A-MAP} = 1 \\ l \text{ or } l+1, & \text{for } N_{A-MAP} = 2 \end{cases}$	i
HARQ feedback in UL	For $D \geq U$, $n = \begin{cases} 0, & \text{for } 0 \leq m < K \\ m-K, & \text{for } K \leq m < U+K \\ U-1, & \text{for } U+K \leq m < D \end{cases}$	$j = (i+z) \bmod 4$
	For $D < U$, $n = m - K$	

DL data burst transmission corresponding to a DL Assignment 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 timing for the DL data burst 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, K = ceil((D-U)/2) for $D \geq U$, and K = –ceil((U-D)/2) for $D < U$.

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

DL HARQ feedback offset z shall be set to 1, only if a time gap from completion of the data burst transmission to its feedback timing derived with z = 0 is shorter than the product of a subframe length and the data burst processing time [in DCD]. Otherwise, z shall be set to 0. This rule shall be also applied to the long TTI transmission. The index m in Table 3 indicates the 1st subframe which a long TTI data burst spans.

Retransmission of a DL data burst shall be indicated by a DL Assignment IE with AI_SN = 0, where the DL Assignment IE is transmitted with the DL data burst in the same subframe.

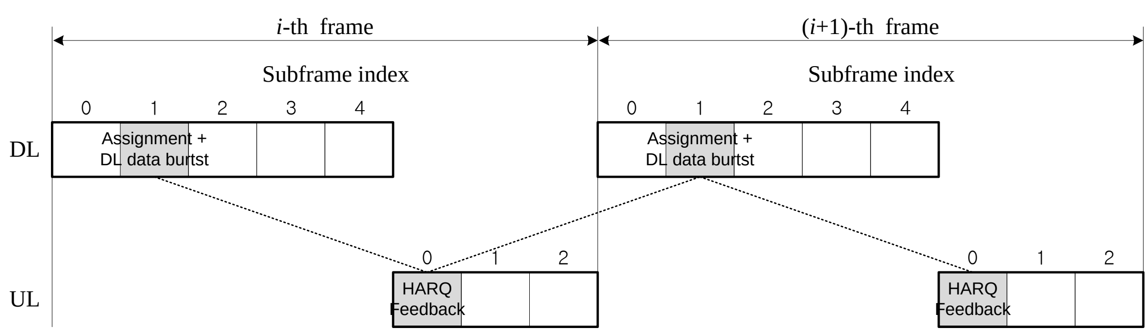

Figure 3 – Example of TDD DL HARQ timing for 5, 10 and 20 MHz channel bandwidths.

Figure 3 shows an example of the timing relationship between a DL Assignment IE in A-MAP with $N_{A\text{-}MAP} = 1$, a DL data burst with the default TTI, corresponding HARQ feedback and retransmission in TDD frame structure, for 5, 10 and 20 MHz channel bandwidths In this example, the data burst processing time is 3, and K is given by 1 because the ratio of D:U is 5:3.

15.2.x.2.2. Uplink

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

Table 4 – TDD UL HARQ timing

Content	Subframe index	Frame index
Tx of Assignment IE in DL	l	i
Data burst Tx in UL	For ceil(D/ $N_{A\text{-}MAP}$) ≥ U, $m = \begin{cases} 0, & \text{for } 0 \le l < K \\ l-K, & \text{for } K \le l < U+K \\ U-1, & \text{for } U+K \le l < D \end{cases}$ For ceil(D/ $N_{A\text{-}MAP}$) <U, For $N_{A\text{-}MAP} = 1$, $m = \begin{cases} 0 \text{ or } 1, & \text{for } l = 0 \\ l-K, & \text{for } 0 < l < D-1 \\ U-1, & \text{for } l = D-1 \end{cases}$. For $N_{A\text{-}MAP} = 2$, $m = \begin{cases} 0 \text{ or } 1, & \text{for } l = 0 \\ l-K \text{ or } l-K+1, & \text{for } 0 < l < D-1 \\ U-1, & \text{for } l = D-1 \end{cases}$	$j = (i+v) \bmod 4$
HARQ feedback in DL	l	$k = (j+1+w) \bmod 4$
Data burst ReTx in UL	m	$p = (k+v) \bmod 4$

UL data burst transmission corresponding to a UL Assignment 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 timing for the data burst 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 data burst 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, K = ceil((D-U)/2) for $D \ge U$, and K = –ceil((U-D)/2) for $D < U$. Note that the subframe index l for $N_{A\text{-}MAP} = 2$ ranges from 0 to 2·ceil(D/2)-2 with an increment of 2.

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 DL Assignment IE.

UL HARQ transmission offset v shall be set to 1 only if a time gap from completion of the UL Assignment IE transmission to the data burst transmission timing derived with $v = 0$ is shorter than the product of a subframe length and the data burst processing time [in DCD]. Otherwise, v shall be set to 0.

UL HARQ feedback offset w shall be set to 1 only if a time gap from completion of the data burst transmission to its feedback timing derived with $w = 0$ is shorter than the product of a subframe length and the data burst processing time [in DCD]. Otherwise, w shall be set to 0. This rule shall be also applied to the long TTI transmission. The index m in Table 4 indicates the 1st subframe which a long TTI data burst spans.

Figure 4 shows an example of the timing relationship between a UL Assignment IE in A-MAP with $N_{A\text{-}MAP} = 1$, a UL data burst with the default TTI, corresponding HARQ feedback and retransmission in TDD frame structure, for 5, 10 and 20 MHz channel bandwidths. In this example, the data burst processing time is 3, and *K* is given by 1 because the ratio of *D*:*U* is 5:3.

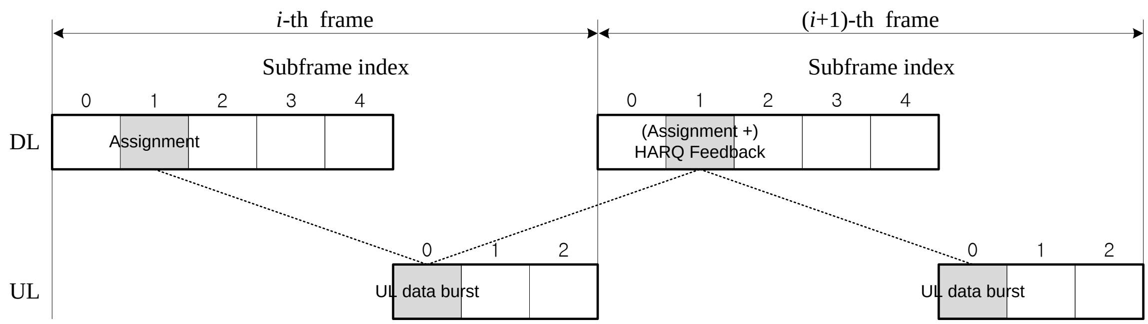

Figure 4 – Example of TDD UL HARQ timing for 5, 10 and 20 MHz channel bandwidths.

15.2.x.2.3. HARQ Timing in frame structure supporting the WirelessMAN-OFDMA frames

The A-MAP relevance and HARQ timing defined in 15.2.x.2.1 and 15.2.x.2.2 shall be applied to the frame structure supporting the WirelessMAN-OFDMA frames in 15.3.3.4.1.

Subframes in the frame supporting the WirelessMAN-OFDMA 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.

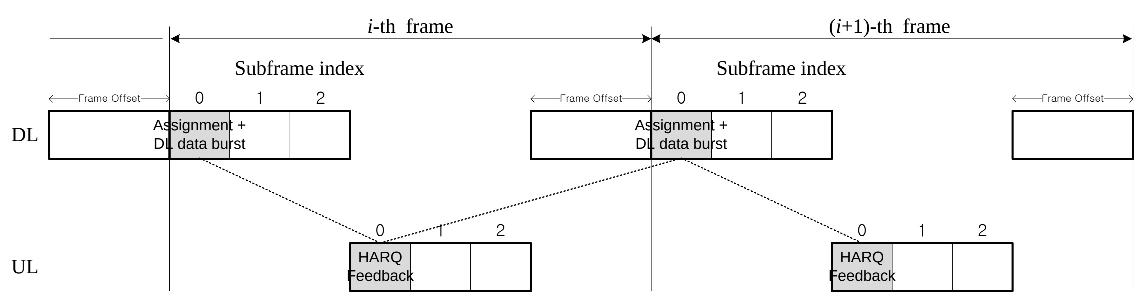

Figure 5 – Example of TDD DL HARQ timing in frame structure supporting the WirelessMAN-OFDMA frames.

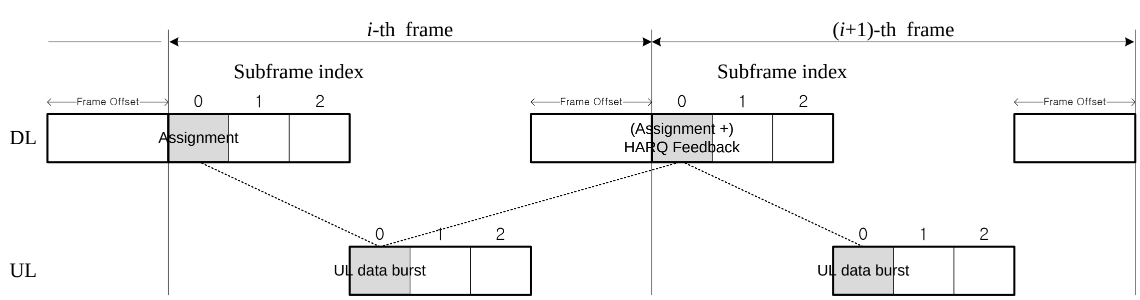

Figure 6 – Example of TDD UL HARQ timing in frame structure supporting the WirelessMAN-OFDMA frames.

Figure 5 and 6 show examples of the DL and UL timing relationships between a Assignment IE in A-MAP with $N_{A\text{-}MAP} = 1$, a data burst with the default TTI, corresponding HARQ feedback and retransmission, for 5, 10 and 20 MHz channel bandwidths. In this example, UL subframes of the WirelessMAN-OFDMA and the Advanced Air Interface are frequency-division multiplexed, the data burst processing time is 2, the ratio of DL to UL symbols in frame is 29:18, and the ratio of DL to UL subframes for the Advanced Air Interface, i.e. D:U, is 3:3.

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