Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Fast Acknowledgement Method using Subcarrier Set**
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Re:	This document is submitted for a discussion on the "ARQ Algorithm" section of TG 3/4 MAC Document
Abstract	This document proposes a fast acknowledgement method using subcarrier set.
Purpose	The document is submitted as a part development of 802.16a and 802.16b MAC sections. It is for the discussion on the specific details of ARQ Algorithm.
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Fast Acknowledgement Method using Subcarrier Set

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References

[1] IEEE P802.16/D3d2-2001. IEEE Draft. Local and Metropolitan Area Networks – Part 16: Standard Air Interface for Fixed Broadband Wireless Access Systems. 2001-05-03.

1. General

This document suggests a fast acknowledgement method using subcarrier set in the 802.16a and 802.16b MAC sections. It is suggested to support reliable packet delivery especially for real-time traffic services.

2. Acknowledgement for Real-time Traffic Services

Explicit transmission of an acknowledgement is required since, in the wireless medium, a transmitter cannot determine if a packet is successfully delivered.

If the SS has correctly received a data packet in a downlink period, it should acknowledge the successful packet reception. To do this, the transmission opportunity in the uplink period is needed. If the SS has an opportunity to send data in the uplink period, it can send the acknowledgement by using piggy-back mode as shown in figure 1.

Otherwise, the SS requests the transmission opportunity for the acknowledgement in the contention period. In the next frame, if the opportunity is allocated to the SS by UL_MAP message, the SS can send the acknowledgement using the allocated opportunity (see figure 2). In this case, if the bandwidth request message or the acknowledgement message is lost in the wireless interface, additional overhead and delay are added for the retransmission of this message.

Now, Let us consider the worst case. If the BS does not receive the acknowledgement within a specific ACK_Timeout, it retransmits the data packet, as shown in figure 3.

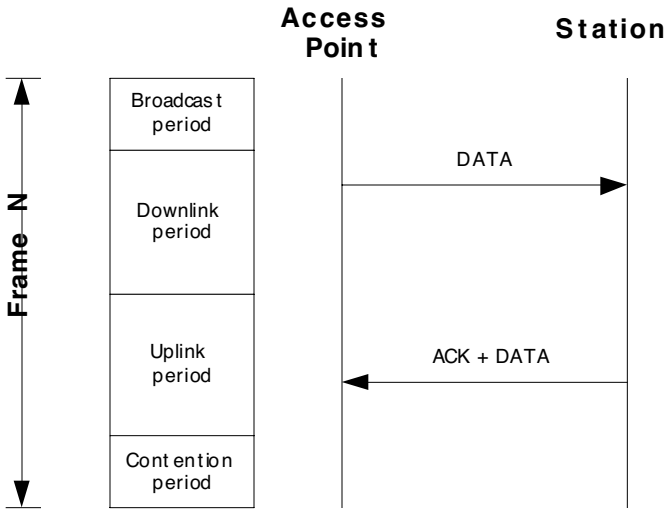

Figure 1.Acknowledgement procedures in case that transmission opportunity is already allocated

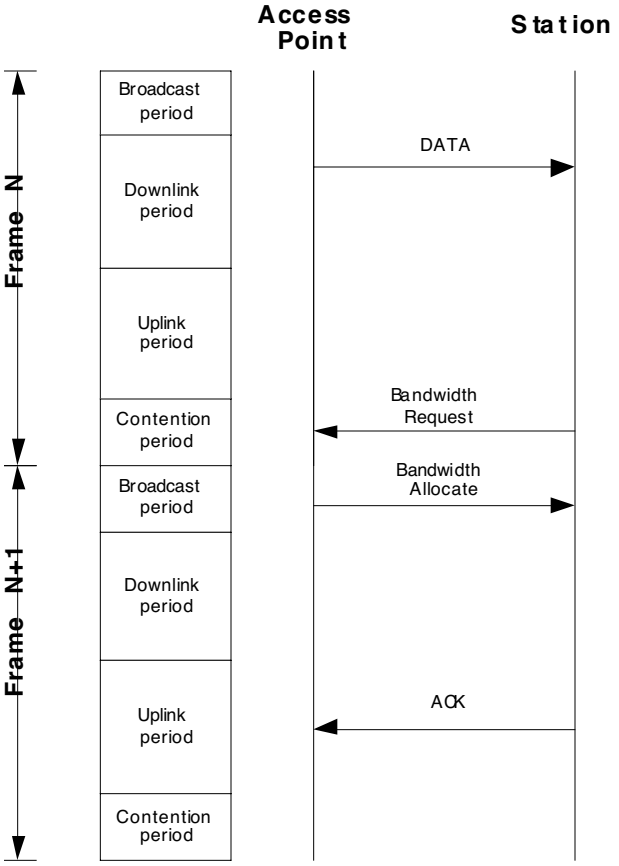

Figure 2. Acknowledgement procedures in case that transmission opportunity is not allocated

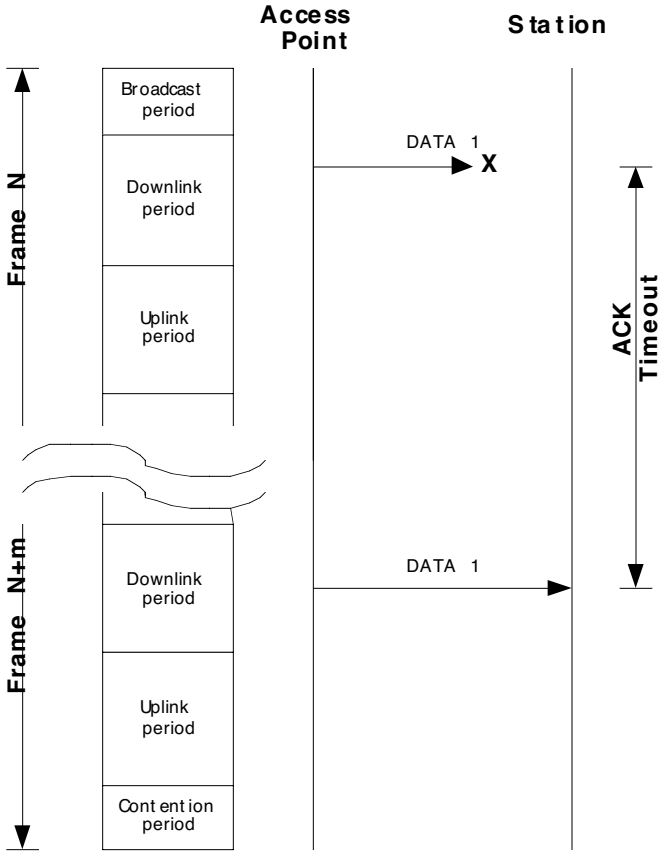

Figure 3. ACK Timeout

3. Fast Acknowledgement Method using Subcarrier Set

In OFDM/OFDMA, there are many subcarriers in a slot (e.g. 512, 1024). Using this property, we suggest a fast acknowledgement mechanism that may be suitable for real-time traffic services. First, we add an ACK period to uplink as shown in figure 4. This period is one-slot size.

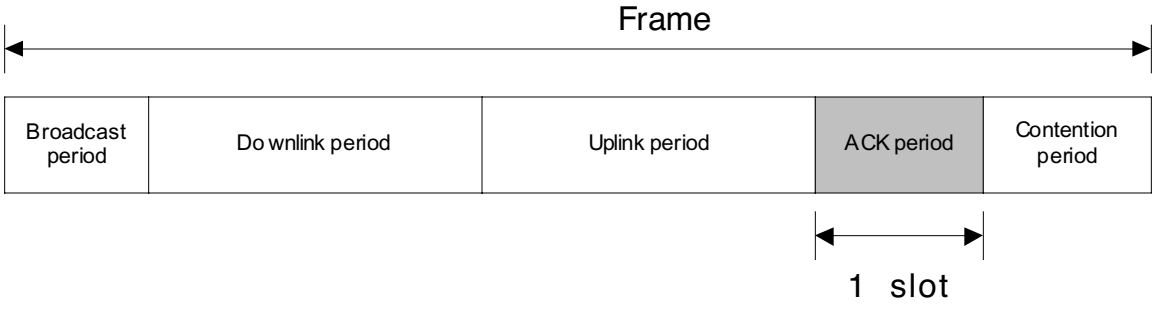

Figure 4. Frame Structure

When one SS establishes a connection with BS, it sends the service profile to the BS. According to the service profile, the BS decides if it is a real-time traffic service. If so, the BS assigns a subcarrier set, which can be used only during the ACK period, to the connection. A subcarrier set may consist of several subcarriers in order to cope with multipath fading. The number of subcarriers in a set depends on wireless channel state. And then, the SS is informed of the subcarrier set that will be used for acknowledgment during the ACK period.

If the SS has correctly received a data packet that is related to the real-time connection in a downlink period, it activates the subcarrier set in the ACK period with one-slot size in order to signal the successful packet reception. Otherwise, the SS should not activate the subcarrier set. In the ACK period, the BS detects the activities of all of the subcarriers related to the subcarrier set. If none of the subcarriers is activated, the BS retransmits the data packet in the next frame.

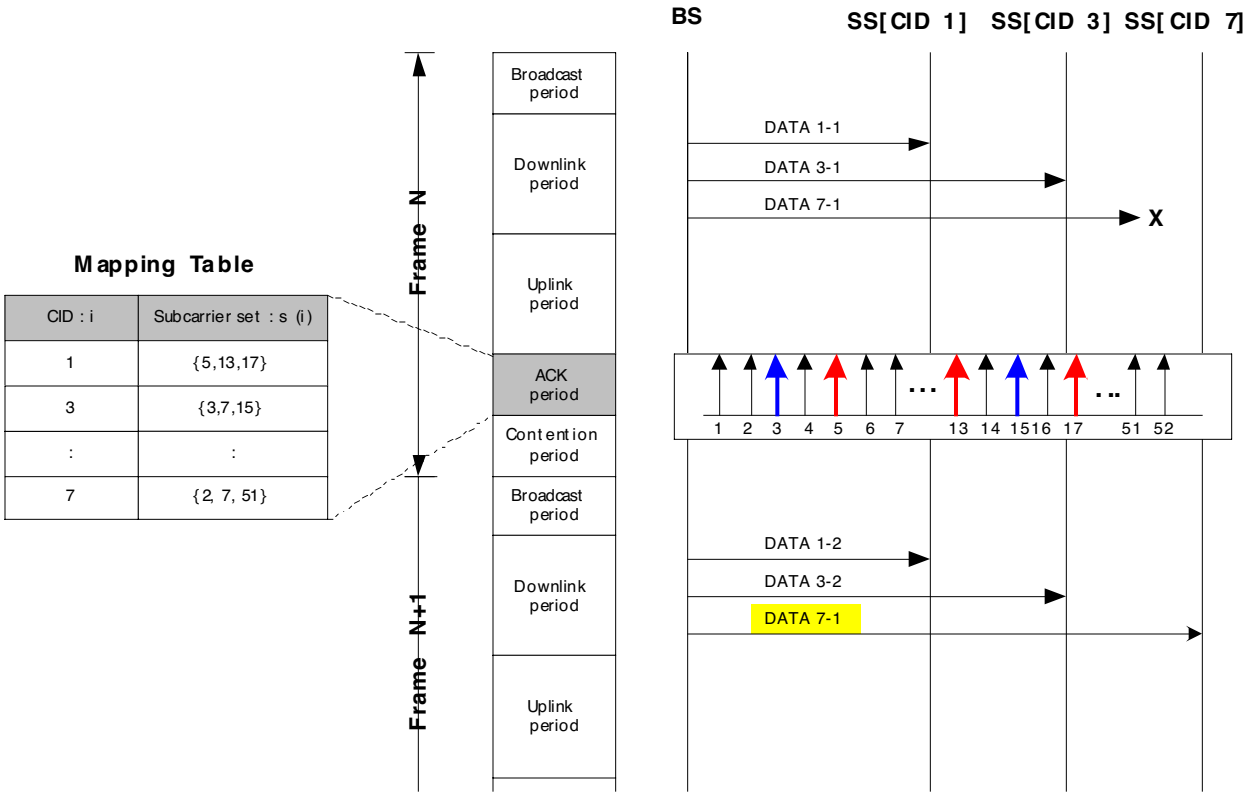

Figure 5. Bandwidth Request and Allocation Mechanism