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Re:	IEEE802.16j-06/034: “Call for Technical Proposals regarding IEEEP802.16j”
Abstract	This contribution proposes a practical design for the synchronous multicast and broadcast service (MBS) transmission to achieve macro diversity in the MR networks.
Purpose	To propose design and text for MBS transmission synchronization in the MR networks.
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Synchronous MBS Transmission for Macro Diversity in MR Networks

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Introduction

This contribution proposes a practical design for the synchronous multicast and broadcast service (MBS) transmission to achieve macro diversity in the WiMAX MR networks.

All the related RS(s) defined in [1] are expected to be synchronized to achieve the macro diversity in the MBS transmission. Previous work in [2] reveals MBS transmission synchronization may be achieved by previously transmitting data on the relay link to all the RS(s) while informing the RS(s) how long they should wait. The waiting time is the maximum of the all the RSs' processing delays. The processing delay is reported to MR-BS via SBC-REQ. However, there are several issues regarding this synchronization method:

- Processing delay is the only factor used in determining the total delay over the relay path, other delays are not considered, such as transmission delay (propagation delay, network delay, etc) and queuing delay.
- The total delay at each RS can be impacted by many factors, such as loading, channel condition of the RS, etc. Using the current method alone as defined in [2], a RS needs to report a "maximum" delay possible in SBC-REQ to ensure on-time MBS data delivery. However, using a "maximum" delay causes unnecessary latency in MBS transmission and over-engineering of the system (such as the size of buffer).
- As defined in [2], when a RS enters or exits the network (or due to other change at RS), the wait time can change and the MR-BS sends unsolicited SBC-RSP to all RS with the modified wait time. Since there is no acknowledgment of SBC-RSP message, MR-BS has no information on whether any RS has received the SBC-RSP message and when the wait time will be changed at the RS. This can cause synchronization problem that can not be corrected until next wait time change.

To solve the issues as stated above, an enhancement to the current standard is necessary to ensure the synchronized delivery of MBS data in a MBS zone.

Proposed Solution

In this contribution, an adaptive method is introduced to provide synchronized transmission of MBS data in a MBS zone. The following section provides a detail description of this method.

As defined in IEEE802.16j-06/026r2, each RS still reports its delay in SBS-REQ message to MR-BS. MR-BS determines cumulative delay based on information received from RS. When MBS data is scheduled, the transmission time of the MBS data is determined based on cumulative delay calculated by MR-BSs. The synchronization among multiple MR-BSs is outside the scope of this standard.

To synchronize data transmission for all RSs and MR-BSs in a MBS zone, the MR-BS is required to pre-transmit MBS data to each RS involved in MBS service. When pre-transmitting MBS MAC PDU to each RS, MR-BS attaches a frame number to the MAC PDU. This frame number indicates the target transmission frame of the MAC PDU. RS is required to transmit the MBS MAC PDU at the target transmission frame.

If a RS receives a MBS MAC PDU after its target transmission frame or a RS is not able to process the MAC PDU at its transmission time, the RS should ignore the MBS MAC PDU and sends a NACK indication to MR-BS. Included in the NACK indication, the RS should inform MR-BS the number of addition frames that MR-BS should pre-transmit the MAC PDU to meet the target transmission time. In addition, the RS may also optionally send a NACK indication when a MBS MAC PDU arrives too early at the RS.

When MR-BS receives one or more NACKs, it should re-adjust the pre-transmission time with respect to the target transmission time to ensure all RS successfully transmits MBS data synchronously. Similarly, when a RS enters or exits the network, MR-BS should re-adjust the pre-transmission time based on reporting in SBC-REQ message or the processing of NACKs received that may be triggered by the RS entry or exit event..

Figure 1 shows an example message for this method. The MBS scheduler shown in Figure 1 is for illustration purpose only. Its functionality and physical location is outside the scope of this standard and not discussed in this contribution.

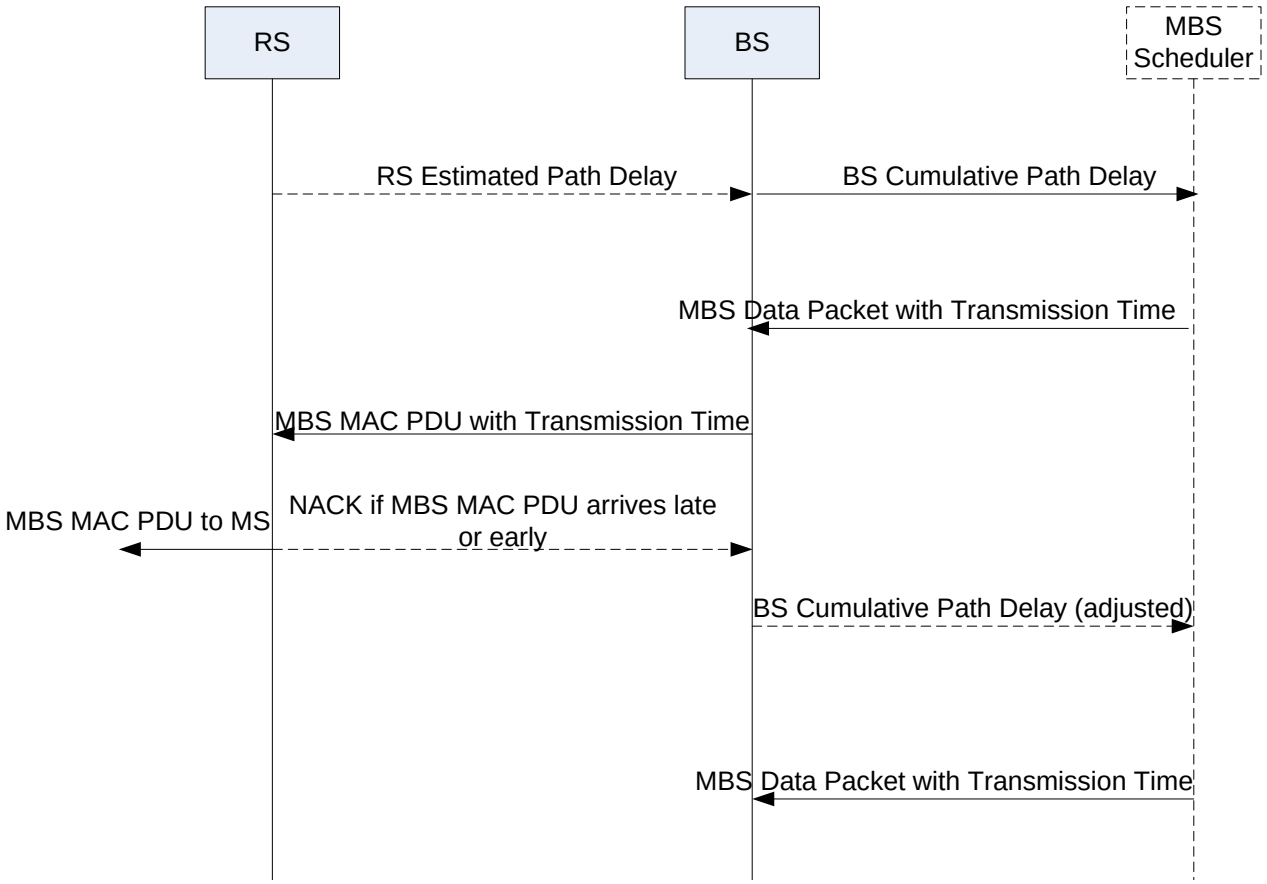

Figure 1 MBS Data Synchronization

Using this method, the MR-BS can adapt to the changes of delay at each RS in a timely manner. When the cumulative delay changes, there is no need to inform each RS of the change. Instead, the RS only needs to transmit the MAC PDU based on the target transmission time specified.

Specified Text Changes

[Insert new section 6.3.2.2.8 in 6.3.2.2]

6.3.2.2.8 Relay MAC Subheader

Relay MAC Subheaders shall only be included in Relay MAC PDU with Relay MAC PDU header.

6.3.2.2.8.1 MBS Subheader

MBS subheader is a per-PDU subheader and shall be included in all MAC PDUs for MBS transport connections. MBS subheader shall be inserted into MAC PDU immediately following Relay MAC PDU header.

MBS subheader is shown in Table xxx:

Syntax	Size	Notes
MBS Subheader{		
Frame Number	16bits	Indicates the frame which RS shall transmit the MAC PDU to MS
}		

Table XXX MBS Subheader

[Modify section 6.3.2.1.2.2.1, Table7i, insert a new Feedback Type]

6.3.2.1.2.2.1 Feedback header

Feedback Type (binary)	Feedback Contents	Description
1110	Early/Late Indication (1bit) Arrival Delta (8 bits) CID (16bits)	This feedback header is sent by RS to MR-BS to provide NACK for MBS data. Early Late Indication: 0: Early Indication 1: Late Indication Arrival Delta: Number of frames RS received frames early or late based on Early Late Indication CID: CID of MBS connection between RS and MR-BS
~~1110~~ 1111	Reserved for future use	-

[Modify text in 6.3.23.3:]

6.3.23.3 MBS macro diversity Support in MR network

For MR networks, MBS transmission within an MBS zone shall be synchronized. In Multi-MR-BS-MBS case, MR-BSs should be synchronized in network level as described in section 6.3.23.2.

If there is only one RS connecting with the MR-BS, that RS shall report its ~~processing~~ delay (in unit~~s~~ of ~~a~~ frame), DR, to the MR-BS as a capability parameter in the SBC-REQ message. When an MBS transmission is necessary, the MR-BS shall first send the MBS data over the relay downlink as a pre-transmission~~, and then after DR frames, the MR-BS and RS shall synchronously transmit this MBS data over the access link~~.

If there are multiple RSs in the MBS zone at various hop counts from the MR-BS and/or with different ~~processing~~ delays, each RS shall report its ~~processing~~ delay, DR, to the MR-BS as a capability parameter in the SBC-REQ message. The MR-BS shall determine the maximum cumulative delay, DM, of all RSs in the MBS zone based on their positions in the tree and their individual ~~processing~~ delays. ~~The MR-BS shall then calculate the required waiting time, Wi, for each RS based on the value of DM and each RS's cumulative delay and notify each RS of its waiting time via an SBC-RSP message. If the MR-BS detects that the waiting time has changed for a particular RS, it may send an unsolicited SBC-RSP message to that RS to update its waiting time.~~

MR-BS should determine target transmission frame of each MBS MAC PDU based on maximum cumulative delay, DM. In addition, MR-BS shall include relay MAC header and MBS subheader to each MAC PDU sent to RS for MBS data. In MBS subheader, MR-BS shall include frame number of the target transmission frame for the MBS MAC PDU at the RS. When an MBS transmission is necessary, the MR-BS shall forward the MBS data over the relay downlink as a pre-transmission ~~DM frames~~ before transmitting this MBS data over the access link. Each RS in the MBS zone shall forward the MBS data it receives over the relay downlink. ~~Finally, once the MR-BS has waited DM frames and each RS has waited its specified waiting time, Wi, the~~ MR-BS and RSs shall synchronously transmit the MBS data over the access link at target transmission frame.
If a RS fails to transmit a MBS MAC PDU at its target transmission frame, the RS shall provide NACK to MR-BS by sending MBS NACK feedback header (Feedback type 1110). The RS shall include the duration of late arrival for this MBS MAC PDU in unit of frames. In addition, a RS may provide early arrival information to MR-BS by sending MBS NACK feedback header if the RS determines a MBS MAC PDU has arrived too early for its target transmission frame. With early arrival detection, the RS shall include the number of frames the MAC PDU has waited to be transmitted.

Reference:

[1] IEEE 802.16e-2005.
[2] IEEE C802.16j-07/005, "A proposal for synchronous MBS transmission in MR".