Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Congestion control mechanism for interworking between WLAN and WMAN**
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Re:	Call for contribution IEEE 802.16d-03/45
Abstract	This contribution proposes an enhancement to the service flow change mechanism
Purpose	For inclusion in the 802.16d amendment document
Notice	
Release	
Patent Policy and Procedures	

Congestion Control

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1. References

[1] IEEE 802.16

[2] IEEE 802.16a

2. Problem statement and Discussion

IEEE802.16a is generally being considered as a good technology for WLAN backhaul, both for hot spots and home networking. We therefore studied an interworking scenario composed of an IEEE 802.11e WLAN system, and a IEEE802.16 WMAN system. The WLAN provides high data rates and mobility to several end-users while the WMAN provides fixed broadband wireless access to the WLAN base station.
Now, if the link capacity in one system is temporarily degraded due to a high traffic load in the WLAN system (congestion) or due to interference, two effects could occur:
loss of data due to buffer overflow and therewith unnecessary retransmissions
waste of bandwidth due to unused reserved transmission opportunities
To avoid the above-mentioned effects a congestion control mechanism needs to be worked out to dynamically adapt the QoS demands of a connection during runtime for a specifically defined period of time.
We studied the interference/congestion situations of the WLAN within the tandem system. Figure 1 shows the case of a MAC management message requesting the base station to reduce the downlink traffic for a connection. Figure 2 shows the case of an UGS connection where the SS requests the BS to allocate less uplink bandwidth for this specific connection.

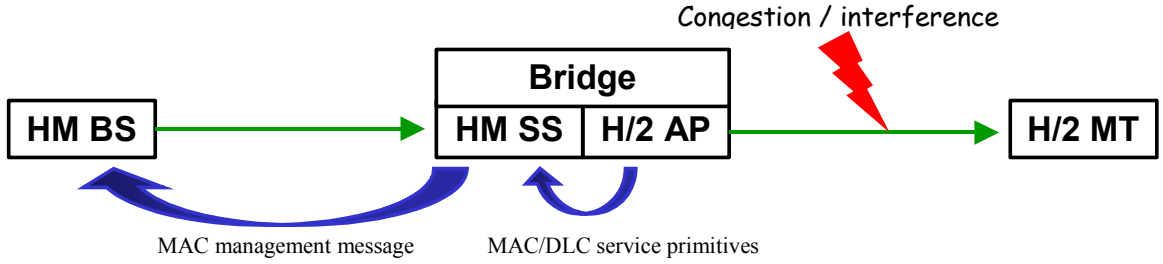

Figure 1 : Congestion in WLAN Downlink

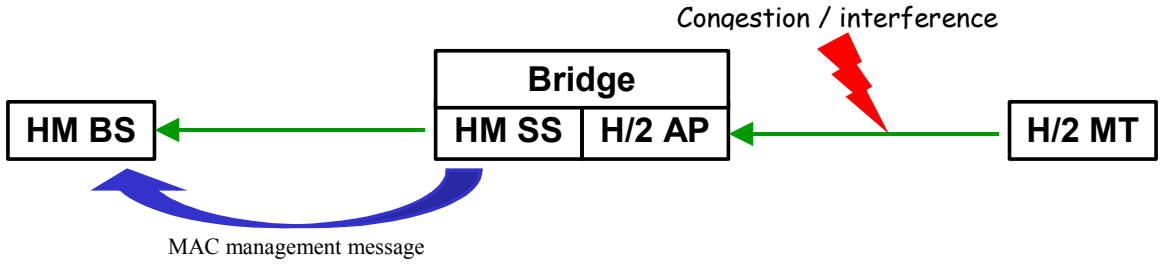

Figure 2 : Congestion in WLAN Uplink

It turned out that no method is available in the IEEE 802.16a standard that is able to temporarily adapt QoS parameters of a service flow during the connection runtime.
There is an existing mechanism to dynamically change a connection respectively a service flow. It is called Dynamic Service Change (DSC). This method permanently modifies the service flow. But the addressed congestion or interference situation is only temporary. After the degradation of the link capacity has disappeared, the same procedure has to be proceeded to undo the changes to the service flow. Thus the existing mechanism provides the wrong functionality (permanent instead of temporary change) and it is too slow (.request, .indication, .response, .confirm and .acknowledge).
The newly proposed method defines a new MAC service primitive MAC_REDUCE_TEMP and an associated MAC management message RED-TEMP. This primitive and message are used by the subscriber station (SS) to trigger the base station (BS) to temporarily reduce the bandwidth for the corresponding connection.
The method might be invoked by the WLAN system when there is congestion/interference on the wireless LAN link. With the service primitive MAC_REDUCE_TEMP.indication the WMAN system can even inform higher layer applications to reduce the bandwidth, e.g. video codecs to reduce the quality (vertical protocol control) or a WMAN SS can trigger other transmission systems, e.g. the WLAN AP in our scenario, to reduce its transmission capability for a particular connection.

3. Proposal

3.1 MAC service primitive

The proposed format of the MAC service primitive is outlined in Figure 3.

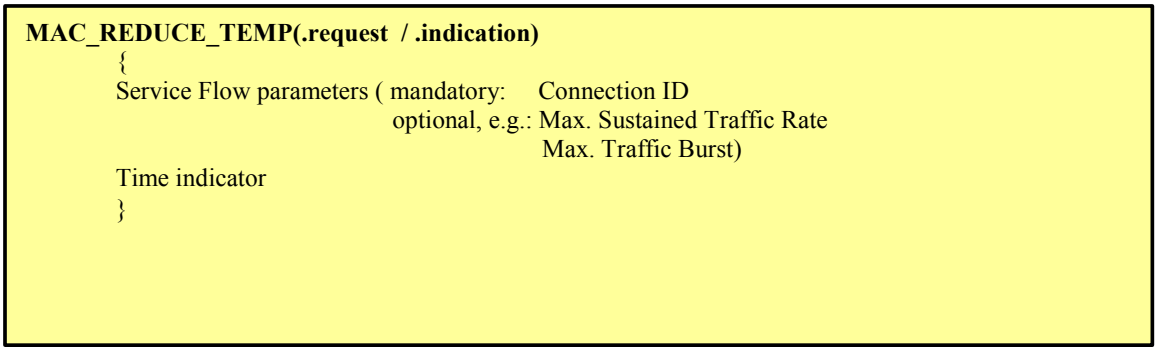

Figure 3 : Proposed format of MAC primitive MAC_REDUCE_TEMP

The service flow parameters include details on the QoS parameters that need to be temporarily downgraded. These parameters are the same as those in the dynamic service change request management message. The transport connection ID (CID) of the connection to be downgraded is mandatory. The time indicator specifies the estimated duration of the congestion/interference situation in ms.

3.2 MAC management message

The MAC service primitive is transformed into a MAC management message that is transmitted to the BS on the primary management connection. The parameters of the primitive and the management message are identical. The proposed format of the MAC management message, which is called “RED_TEMP”, is outlined in Figure 4 and Figure 5.

Typ	Message Name	Message Description	Connection
17	RED-TEMP	Temporary reduction of transmission capacity e.g. bandwidth association in DL direction	Primary Management

Figure 4: MAC management message (to be added to table 13 / 13a [2])

A RED_TEMP management message is sent by a SS to temporarily reduce the level of QoS on a particular transport connection (CID) for a specified duration. The involved service flow parameters are therefore downgraded by the BS. After the duration of the invoked reduction is over, the involved service flow parameters are automatically upgraded to the original level without signalling this to the SS.

RED_TEMP_message_format()	Size	Notes
Management Message Type = 19	8 bit	
Transaction ID	16 bit	
TLV encoded information	variable	TLV Specific
		including Connection ID (mandatory)
Reduction Duration	16 bit	in ms (0…65535)

Figure 5 : RED_TEMP message format

A SS shall generate RED_TEMP messages as shown in Figure 5, including the following parameters:

- **CID (in the Generic MAC Header) :** SS's primary management CID.
- **Transaction ID** : unique identifier for this transaction assigned by the sender.
- **Reduction Duration** : duration of the requested downgrade. After the duration has ended the service flow is upgraded without signaling.

All other parameters are coded as TLV tuples.

- **Service Flow Parameters (see 11.4.8 [1],[2]):** Specification of the service flow's temporary (downgraded) traffic characteristics. Additionally the transport connection ID (CID; see 11.4.8.2 [1]) of the connection is mandatory.

3.3 Other chapters involved

The proposed mechanism should also be included in a new chapter *6.2.13.7.2.4 Temporary service flow* [2] *reduction* and into the state transition diagrams of *6.2.13.8 Dynamic service* [1].
The proposed method has also to be integrated into chapter *6.11.4.8 Service flow encodings* [2].