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-03/83
Abstract	This contribution proposes an enhancement to the service flow change mechanism
Purpose	For inclusion in the 802.16-REVd_D2 amendment document
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Congestion Control

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1. References

[1] IEEE 802.16

[2] IEEE 802.16a

2. Problem statement and Discussion

IEEE 802.16d 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 an IEEE 802.16d 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, leading to inefficiency on the IEEE 802.16d link, 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. In this system, the IEEE 802.16 SS and WLAN AP are integrated into one physical device, which provides a communication path for the congestion indication. Figure 1 shows the case of a MAC management message requesting the base station to reduce the downlink traffic for a connection.

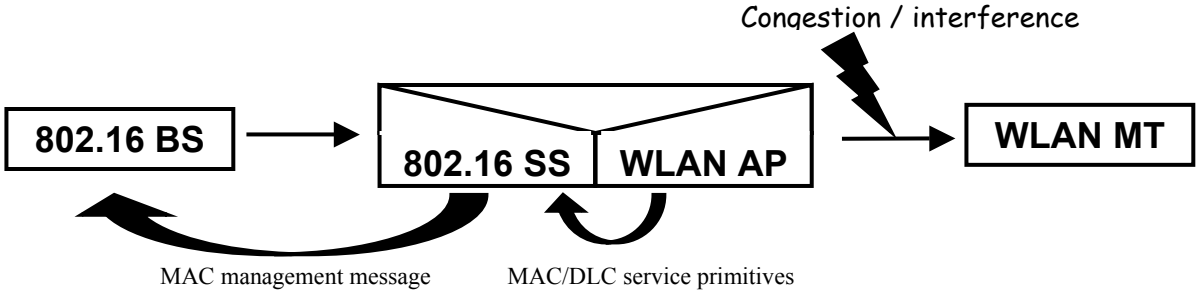

Figure 1 : Congestion in WLAN Downlink

Figure 2 shows the case of an UGS connection where the SS requests the BS to allocate less uplink bandwidth for this specific connection.

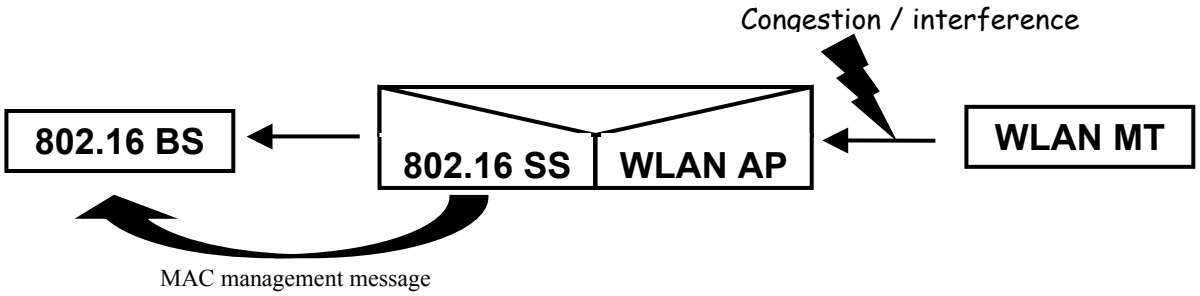

Figure 2 : Congestion in WLAN Uplink

It turned out that no method is available in the IEEE 802.16d 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) and it is sufficient when the IEEE 802.16d link is seen as a simple pipe replacing a wire. 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).
The newly proposed method defines a new MAC service primitive MAC_DSC_TEMP and an associated MAC management message DSC-TEMP. This message will be sent on the fast basic connection. The 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.
This congestion control mechanism could also prove to be very useful to support the Explicit Congestion Notification mechanism in future deployment of TCP (IEEE Comm. Mag. Oct. 2003, p.75).

3. Changes in 802.16-REVd_D1

Add below line 57 p.33

MAC_DSC_TEMP.request
MAC_DSC_TEMP.indication

Change line 24 p.34
For actions other than ~~DATA.request and DATA.indication~~ DATA.request/indication and MAC_DSC_TEMP.request/indication,…

Add new paragraphs line 47 p.42

6.3.1.1.12 MAC_DSC_TEMP.request

6.3.1.1.12.1 Function

This primitive is generated by the CS to request a temporary reduction of traffic for a downlink or uplink (UGS) transport connection.

6.3.1.1.12.2 Semantics of the service primitive

The parameters of the primitive are as follows :

MAC_DSC_TEMP.request
(
SFID (mandatory),
Maximum sustained traffic rate (optional),
Maximum traffic burst (optional),
Minimum reserved traffic rate (optional),
Time indicator (mandatory)
)

The Serviceflow ID parameter specifies the transport connection for which the reduction is meant.

One or more of the traffic parameters (Maximum sustained traffic rate, Maximum traffic burst, Minimum reserved traffic rate) specify the reduced traffic rate.

The time indicator specifies the duration of the period during which the traffic is reduced in ms.

6.3.1.1.12.3 When generated

This primitive is generated when the CS is triggered that the traffic rate for a specific transport connection is temporarily reduced.

6.3.1.1.12.4 Effect of receipt

The MAC reduces the capacity of the indicated connection by changing the corresponding QoS parameter set temporarily for the specified duration and sends the DSC_TEMP to the MAC entity of the other station.

6.3.1.1.13 MAC_DSC_TEMP.indication

6.3.1.1.13.1 Function

This primitive indicates the temporary reduction of the corresponding downlink or uplink (UGS) transport connection.

6.3.1.1.13.2 Semantics of the service primitive

The parameters of the primitive are as follows :

MAC_DSC_TEMP.indication
(
SFID (mandatory),
Maximum sustained traffic rate (optional),
Maximum traffic burst (optional),
Minimum reserved traffic rate (optional),
Time indicator (mandatory)
)

Parameters : see MAC_DSC_TEMP.request

6.3.1.1.13.3 When generated

This message is generated when the MAC entity receives a DSC-TEMP management message or when the MAC entity detects a congestion situation.

6.3.1.1.13.4 Effect of receipt

The receipt of this primitive indicates the temporary reduction of allocated bandwidth for the corresponding transport connection to the CS.

Add new text line 27 p.44

The sequence of logical MAC SAP events and the associated actual MAC events effecting a CS stimulated temporary traffic reduction are shown in Figure 21.

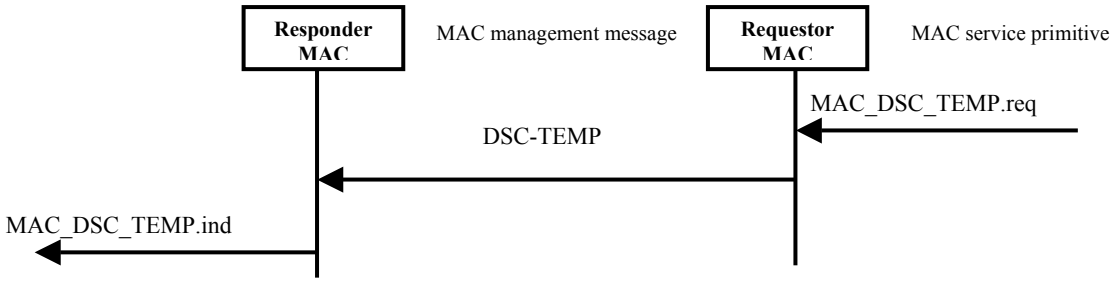

Figure 21—MAC SAP event and MAC event sequence for temporary traffic reduction stimulated by CS

Replace entry 19 in table 13 on page 61 line 31 by :

Type	Message name	Message description	Connection
19	DSC-TEMP	Temporary traffic capacity reduction	Basic

Add on line 20 page 87 the chapter below

6.4.2.3.18 DSC-Temporary Reduction (DSC-TEMP) message

The DSC-TEMP message is sent to a BS to request the temporary traffic reduction of a transport connection. If it is sent to a SS, it indicates the temporary reduction. The format of the message is shown in table 45.

Table 45—DSC-TEMP message format

Management Message Type = 19	8 bit	
SFID	32 bit	1…4 294 967 295
Reduction Duration	16 bit	in ms (0…65535)
TLV encoded information	variable	TLV Specific

Parameters shall be as follows :

CID (in the Generic MAC Header)
basic CID

SFID
Service flow ID of the concerned service flow is mandatory

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

Specification of the service flow's temporary (downgraded) traffic characteristics (Maximum sustained traffic rate, Maximum traffic burst , Minimum reserved traffic rate)

Add on page 250 line 31 the chapter below :

6.4.13.10.6 Temporary traffic reduction

The temporary traffic reduction mechanism is a fast, low overhead mechanism, which realizes a temporary traffic reduction for the concerned transport connection.

Figure 125 shows the State Transition diagram for this mechanism.

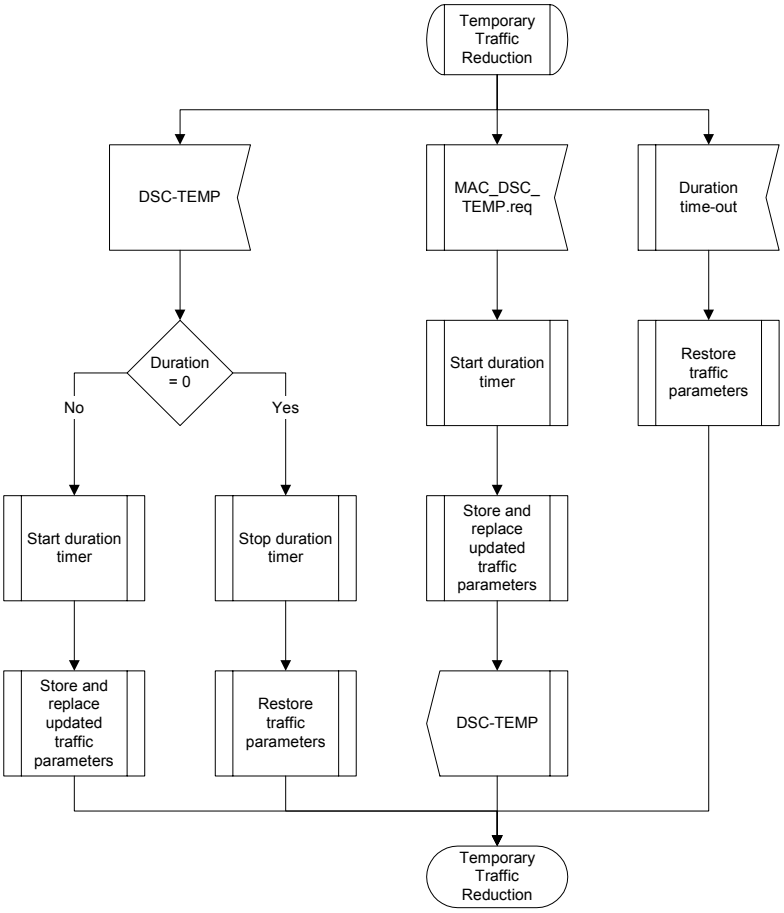

Figure 125 - DSC-TEMP mechanism