Project	IEEE 802.16 Broadband Wireless Access Working Group <**http://ieee802.org/16**>
Title	A compact MAP message to provide a virtual multi-frame structure for a periodic fixed bandwidth assignment scheme.
Date Submitted	2004-08-~~18~~29
Source(s)	Yongjoo Tcha, Min-Sung Kim, Seong-Choon Lee KT 17 Woomyeon-dong, Seocho-gu, Seoul, 137-792, Korea Jung-Hwan Lee Korea University 1.5-ka, Anam-dong, Sungbuk-ku, Seoul 136-701, Korea Voice: +82-2-3290-3236 Fax: +82-2-3290-3691 yjtcha@kt.co.kr lsc@kt.co.kr
Re:	802.16REVe/D5 Sponsor Ballot
Abstract	This contribution introduces a new compact-map type to provide a virtual multi-frame structure for periodic resource allocation.
Purpose	The document is contributed to support certain comment on 802.16REVe/D4 Sponsor Ballot.
Notice	
Release	
Patent Policy and Procedures	

A compact MAP message to provide a virtual multi-frame structure for a periodic fixed bandwidth assignment scheme.

Yongjoo Tcha, Min-Sung Kim, Seong-Choon Lee

KT

Jeong-Hwan Lee

Korea University

1. References

[1] IEEE P802.16e/D3-2004 Amendment for Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Band.

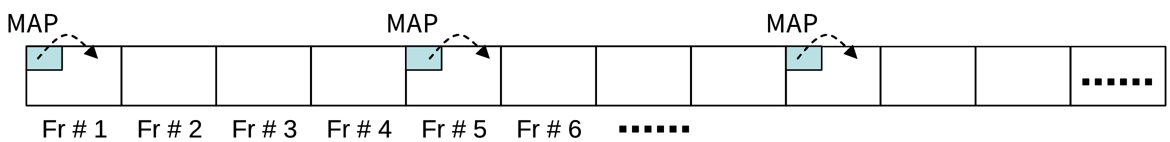
[2] IEEE P802.16-REVd/D5-2004 Air Interface for Fixed Broadband Wireless Access Systems

2. Document Goal

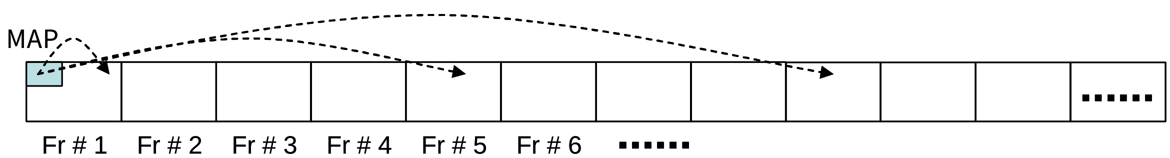
This document introduces a new type of compact MAP message to facilitate a periodic resource allocation for the UGS-type of service classes, e.g., VoIP. By defining a virtual multi-frame structure, it shall allow for designating the fixed bandwidth assignment frames in an efficient manner. The objective of the current proposal is to reduce the MAP overhead inherent to the current specification, especially when the number of connections increases.

3. Problem

In the current specification, MAP message is required for dynamic bandwidth allocation, i.e., MAP message required for every frame in which the bandwidth is allocated. In general, it may suffer from an enormous overhead associated with the dynamic bandwidth allocation, especially when the number of connections increases. In particular, when a payload size is relatively small, the overhead problem becomes critical. One particular example is a VoIP service, which generates a small payload in a periodic manner, e.g., 20 byte payload generated every 20ms for G.729 codec. In fact, any type of CBR service is faced with the same problem. As all these types of services require a periodic resource allocation, it may not be necessary to resort to the MAP message in every frame. In other words, it is sufficient to notify an MSS of the bandwidth allocation information only once with the corresponding allocation period in terms of the number of frames. The same resource allocation information is used implicitly for the later frames until the session is over. Figure 1 illustrates the dynamic bandwidth assignment and fixed bandwidth assignment when a bandwidth reservation is required for every 4 frames. The obvious advantage of the fixed bandwidth assignment is that only a single MAP message is needed at the beginning of each session, which eliminates an overhead associated with individual MAP every time a bandwidth is reserved. In case that a channel condition is changed to incur the different PHY mode during a session, however, old MAP information is not valid any more, which makes the fixed assignment useless. To remedy this problem, new allocation information for the MSS subject to a PHY mode change can be included in the subsequent MAP message. Therefore, all MSS's subject to the fixed assignment still have to listen to all MAP messages in every frame, which makes sure that a new allocation is addressed. We note that the fixed bandwidth allocation can be implemented without changing the current specification, simply because the compact MAP identifies every CID allocated in the corresponding frame. As long as no allocation information for the MSS subject to the fixed assignment is found in the MAP message in a frame, it simply assumes that the previous allocation is still valid. In other words, the fixed assignment is maintained until a channel condition changes.



(a) Dynamic Assignment



(b) Fixed Assignment

Fig 1. Dynamic Bandwidth Reservation Schemes for Periodic Allocation

In spite of the advantage of fixed assignment, its implementation is not straightforward in practice. The current specification addresses the bandwidth assignment in terms of the number of subchannels in the order of CID that appears in the MAP. In such a format, a region specified for the fixed assignment can be overwritten by another MSS, which makes the fixed assignment useless.

4. The Proposed Approach

To remedy the overwritten problem discussed in the previous section, we propose to use the *periodic* fixed bandwidth assignment scheme, which allows for refreshing the MAP message in a periodic manner. For a given period, a special update MAP message is used to announce that a currently designated region reserved for the fixed assignment must not be overwritten by all other MSS's while updating a change in the PHY mode if necessary. Whenever an MSS listens to the update MAP message transmitted in a given period, it finds the fixed assignment region, which must not be used by itself during that period.

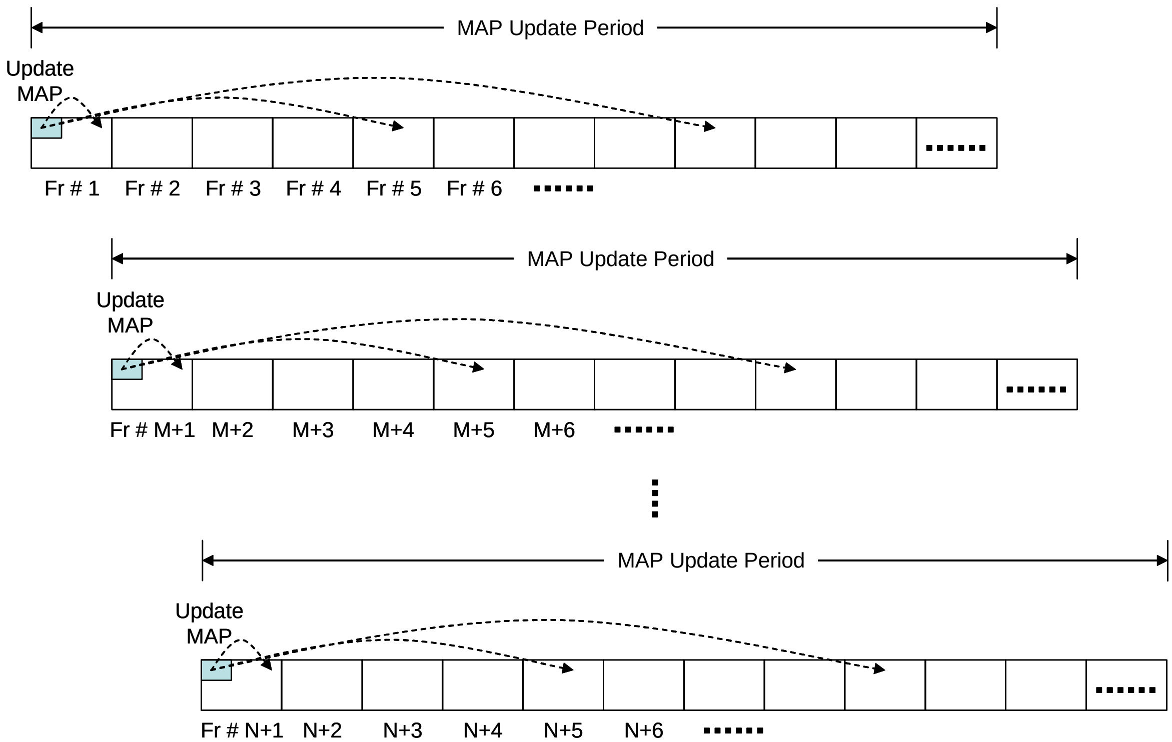


Fig 2. Periodic Fixed Bandwidth Assignment

Given a MAP update period for the fixed assignment, the update MAP message at the beginning of each period must indicate a specific frame in which a fixed assignment is applied per connection (See Figure 2). One possible way of indicating the frames of the fixed assignment is to use a bit map. In this case, as the update period increases, a size of bit map becomes excessive. In this contribution, we consider a notion of a multi-frame structure, which can be implemented in a virtual sense. As shown in Figure 3, three different types of frames are defined in a hierarchical structure: hyper-frame, super-frame, and multi-frame. Each multi-frame is composed of 4 frames. Each super-frame is composed of 4 multi-frames. Finally, each hyper-frame is composed of 4 super-frames. The frames with the fixed assignment are designated by a bit map organized in a hierarchical frame structure. First of all, the update period is specified in terms of the different frame types. More specifically, the update period is given by a multiple of 4 frames, i.e., 4 frames (1 multi-frame), 8 frames (2 multi-frames), 16 frames (1 super-frame), 32 frames (2 super-frames), 64 frames (1 hyper-frame), and 128 frames (2 hyper-frames), which can be represented by a 3-bit long update period field in a MAP message. Once the update period is given, the fixed assignment is specified by the bit map for the different frame type in a hierarchical structure. There exist three different bit maps, each one for multi-frame, super-frame, and hyper-frame, respectively. The length of each bit map is 4. A bit-map for the multi-frame represents which one of four frames is for the fixed assignment in the corresponding multi-frame. A bit-map for the super-frame represents which multi-frame includes a frame of the fixed assignment. In other words, '1' in the super-frame bit-map indicates that one of the frames in the corresponding multi-frame is subject to the fixed bandwidth region. Finally, the hyper-frame bit map represents which super-frame includes a frame of the fixed assignment. Note that the fixed frame position must take an integer in [1,2^n], n = 1,2,….,7, under the current proposal. Figure 3 illustrates the proposed bit-map structure for the fixed assignment with a period of 8 frames.

To accommodate the virtual frame structure addressed in the above, a new type of compact DL-MAP message is introduced, i.e., DL_MAP Type = 6 in Compact_DL-MAP_IE. The difference from the existing compact DL-MAP is to include the update period and frame position for the fixed assignment.

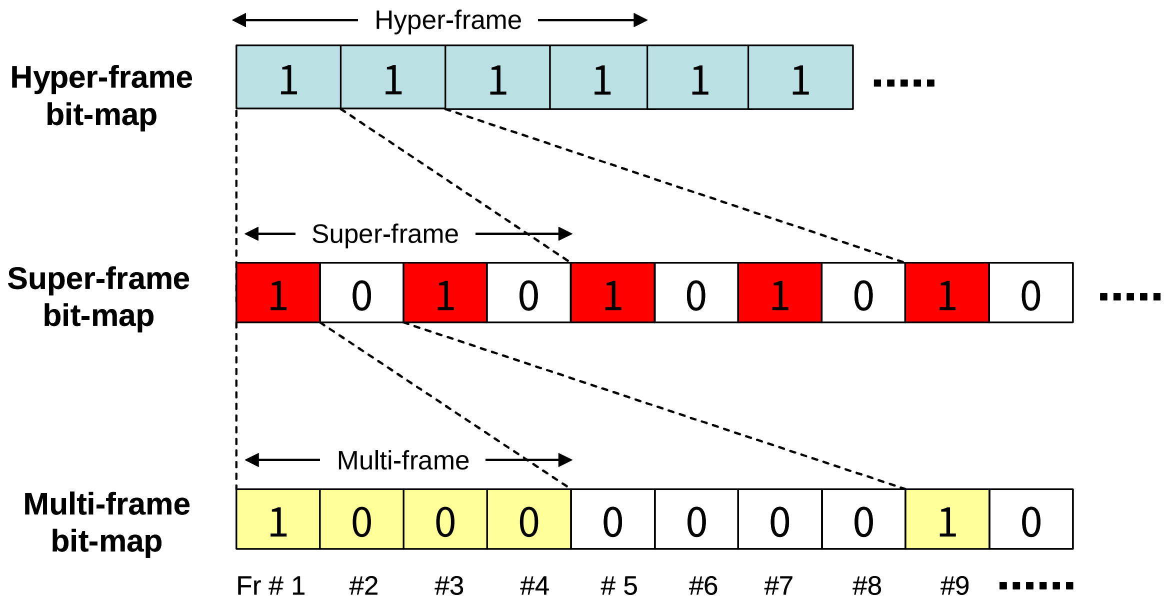


Fig 3. Multi-frame Bit-Map: Illustration for Fixed Assignment with a Period of 8 Frames

5. Specific Text Changes in the Standard

Remedy 1:

[Add the following tables to "the baseline document Section 6.3.2.3.43.6 Compact DL-MAP IE in page 118."]

6.3.2.3.43.6.7 Compact DL-MAP IE format for normal subchannel with multi-frame structure

The format of Comapct DL-MAP IE for normal subchannel with multi-frame structure is presented in Table xx.

Table xx. H-ARQ Compact DL-MAP IE format for normal subchannel with multi-frame structure

Syntax	Size	Notes
Compact_DL-MAP_IE () {		
DL-MAP Type = 6	3 bits	

UL-MAP append	1 bits	
RCID_IE	variable	See Reduced CID section
Update Indicator	1 bits	1: Fixed assignment not updated 0: Fixed assignment updated or PHY mode changed or deallocated
If (Update Indicator == 0) {		
Update type	3 bits	000: 1 Multi frame 001: 2 Multi frames 010: 1 Super frame 011: 2 Super frames 100: 1 Hyper frame 101: 2 Hyper frames 110, 111: Reserved
Frame Position	4 bits	Multi Frame Bit Map
if (Allocation type != 000,001) {		
Multi Frame Position	4 bits	Super Frame Bit Map
if (Allocation type != 010,011) {		
Hyper Frame Position	4 bits	Hyper Frame Bit Map
}		
}		
}		
Nep code	4 bits	Code of encoder packet bits (see 8.4.2.3.5)
Nsch code	4 bits	Code of allocated subchannels (see 8.4.2.3.5)
H-ARQ_Control_IE	variable	See H-ARQ section
CQICH_Control_IE	variable	See CQICH section
if (UL-MAP append){		
Update Indicator	1 bits	1: Not updated for fixed assignment 0: Updated for fixed assignment
If (Update Indicator == 0) {		
Update type	3 bits	000: 1 Multi frame 001: 2 Multi frames 010: 1 Super frame 011: 2 Super frames 100: 1 Hyper frame 101: 2 Hyper frames 110, 111: Reserved
Frame Position	4 bits	Multi Frame Bit Map
if (Allocation type != 000,001) {		
Multi Frame Position	4 bits	Super Frame Bit Map
if (Allocation type != 010,011) {		
Hyper Frame Position	4 bits	Hyper Frame Bit Map
}		
}		
}		
Nep code for UL	4 bits	Code of encoder packet bits (see 8.4.2.3.5)
Nsch code for UL	6 bits	Code of allocated subchannels (see 8.4.2.3.5)
H-ARQ_Control_IE for UL	variable	
CQICH_Control_IE for UL	variable	See CQICH section
}		
}		

Remedy 2:

[Add the following tables to "the baseline document Section 6.3.2.3.43.6 Compact DL-MAP IE in page 118."]

6.3.2.3.43.6.8 Compact DL-MAP IE format for band AMC subchannel with multi-frame structure

The format of Comapct DL-MAP IE for band AMC subchannel with multi-frame structure is presented in Table xx.

Table xx. H-ARQ Compact DL-MAP IE format for band AMC subchannel with multi frame stucture

Syntax	Size	Notes
Compact_DL-MAP_IE () {		
DL-MAP Type = 7	3 bits	
UL-MAP append	1 bits	
RCID_IE	variable	See Reduced CID section
Update Indicator	1 bits	1: Fixed assignment not updated 0: Fixed assignment updated or PHY mode changed or deallocated
If (Update Indicator == 0) {		
Update type	3 bits	000: 1 Multi frame 001: 2 Multi frames 010: 1 Super frame 011: 2 Super frames 100: 1 Hyper frame 101: 2 Hyper frames 110, 111: Reserved
Frame Position	4 bits	Multi Frame Bit Map
if (Allocation type != 000,001) {		
Multi Frame Position	4 bits	Super Frame Bit Map
if (Allocation type != 010,011) {		
Hyper Frame Position	4 bits	Hyper Frame Bit Map
}		
}		
Nep code	4 bits	Code of encoder packet bits (see 8.4.2.3.5)
Nsch code	4 bits	Code of allocated subchannels (see 8.4.2.3.5)
Nband	Nb-Band bits	Number of bands, 0 = use BITMAP instead
if (Nband == 0) {		
Band BITMAP	Nb-BITMAP bits	n-th LSB is 1 if n-th band is selected
}else {		
for (i=0;i< Nband ; i++)		
Band Index	Nb-Index bits	Band selection.

}		
Allocation Mode	2 bits	Indicates the subchannel alocation mode. 00 = same number of subchannels for the selected bands 01 = different number of ubchannels for the selected bands 10 = total number of subchannels for the selected bands determined by Nsch code and Nep code 10, 11 = reserved
Reserved	2 bits	Shall be set to zero
If (Allocation Mode == 00){		
No. Subchannels	8 bits	
} else if (Allocation Mode == 01) {		
for (i=0;i< band count ;i++) {		If Nband is 0, band count is the number of '1' in Band BITMAP. Otherwise band count is Nband.
No. Subchannels	8 bits	
}		
}		
H-ARQ_Control_IE for UL	variable	
CQICH_Control_ IE for UL	variable	
}		
if (UL-MAP append){		
Update Indicator	1 bits	1: Not updated for fixed assignment 0: Updated for fixed assignment
If (Update Indicator == 0) {		
Update type	3 bits	000: 1 Multi frame 001: 2 Multi frames 010: 1 Super frame 011: 2 Super frames 100: 1 Hyper frame 101: 2 Hyper frames 110, 111: Reserved
Frame Position	4 bits	Multi Frame Bit Map
if (Allocation type != 000,001) {		
Multi Frame Position	4 bits	Super Frame Bit Map
if (Allocation type != 010,011) {		
Hyper Frame Position	4 bits	Hyper Frame Bit Map
}		
}		
Nep code for UL	4 bits	Code of encoder packet bits (see 8.4.2.3.5)
Nsch code for UL	4 bits	Code of allocated subchannels (see 8.4.2.3.5)
Nband	Nb-Band bits	Number of bands, 0 = use BITMAP instead
if (Nband == 0) {		
Band BITMAP	Nb-BITMAP bits	n-th LSB is 1 if n-th band is selected
}else {		
for (i=0;i< Nband ; i++)		
Band Index	Nb-Index	Band selection.

	bits	
}		
Allocation Mode	2 bits	Indicates the subchannel alocation mode. 00 = same number of subchannels for the selected bands 01 = different number of ubchannels for the selected bands 10 = total number of subchannels for the selected bands determined by Nsch code and Nep code 10, 11 = reserved
Reserved	2 bits	Shall be set to zero
If (Allocation Mode == 00){		
No. Subchannels	8 bits	
} else if (Allocation Mode == 01) {		
for (i=0;i< band count ;i++) {		If Nband is 0, band count is the number of '1' in Band BITMAP. Otherwise band count is Nband.
No. Subchannels	8 bits	
}		
}		
H-ARQ_Control_IE for UL	variable	
CQICH_Control_ IE for UL	variable	
}		
}		

6. Conclusion

Table 1 illustrates the MAP size reduced by the proposed approach for band AMC MAP IE when bandwidth is periodically allocated every 4 frames for N MSS's. While the MAP IE is generated at a rate of N MAP IE's/4 frames with the dynamic assignment, we assume that the MAP IE is updated at a period of 128 frames, i.e., MAP IE generation rate of N MAP IE's/128 frames. Assuming that No. band = 1 and N = 70, the existing MAP IE incurs an overhead of 16% for a frame structure with DL:UL = 24:12, while it can be reduced to about 4% with the proposed MAP IE. In general, the overhead reduction increases with the number of MSS's.

Table 1. Comparison of MAP size for the existing and proposed MAP IE: Band AMC MAP IE

	Existing MAP IE	**Proposed MAP IE**
MAP size: UL+ DL (A)	136 + 16 * No. band	148 + 16 * No. band
MAP IE Rate (B)	N MAP IE's/4 frames	N MAP IE's/128 frame
MAP Size (bits)/frame: (A) * (B)	(136 + 16 * No. band) * N bits / 4 frames	(148 + 16 * No. band) * N bits / 128 frames