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Title	**Proposal on DLFP Format Change for 802.16 OFDM**
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Re:	Supporting document for Letter Ballot #13a
Abstract	The document suggests DLFP Format Change for 802.16 OFDM. Such change allows to fix problem of DL-MAP overhead (that also decreases penalties of certain STC solution), to eliminate special case when MAC PDU is crossing boundary between two PHY bursts and to relax real time problems in DL-MAP parsing
Purpose	The document is intended for consideration within comments resolution process
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Proposal on DLFP Format Change for 802.16 OFDM

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1. Rationale

Similarly to what was mentioned in [2] for OFDMA PHY, current format of the DL-MAP message under certain conditions is inefficient and inconvenient for implementation also for OFDM PHY. According to the current version of the standard [1] (8.3.4 Frame structure), DL-MAP starts within FCH burst, immediately after DLFP (DL Frame Prefix, 3 bytes). FCH transmitted at QPSK ½ so the payload is 23 bytes (1 byte goes for FEC tail). Size of DL-MAP is 22 + 4N bytes where N = number of DL PHY bursts. Obviously the DL-MAP message cannot fit completely into FCH and spills out to the following PHY burst ("burst #1"). This is the only case when a MAC message crosses boundary of PHY burst and therefore in implementation it must be a special case design.

One more implementation problem is that information on modulation/coding for bursts #2 (following burst #1) is available only after DL-MAP completely received and processed. Processing delay in this case may be essential if software is involved in DL-MAP parsing, which is typically a case for all MAC messages. Burst #2 might start in the air before the processing of burst #1 and parsing of DL-MAP are finished. Then burst #2 information should be accumulated and stored for the whole period of DL-MAP reception and parsing, in the form of digital samples, which may require considerable amount of memory.

Essential part of DL-MAP message does not contain useful information. For example, Generic MAC Header contains the following fields:

Field	Value	Comment
HT	0	
EC	0	
Type	000000	
CI	1	CRC is appended
EKS	00	
LEN	Variable	Message length = 22 + 4N
CID	0xFFFF	Broadcast

It is clear from the above table that all fields except Length (and HCS) are constants so they don't carry any useful information. As FCH is using the lowest possible modulation, wasted airtime is expensive.

2. New Format of DLFP

Solution for abovementioned problems is to modify the format of DLFP. Currently DLFP contains the following information:

Field	Comment

Field	Comment
Rate_ID	Field that defines the burst profile of the following burst. Encoding is specified in Table 195.
Length	Number of OFDM symbols (PHY payload) in the burst immediately following the FCH burst.
HCS	An 8-bit Header Check Sequence used to detect errors in the DL Frame Prefix

It is suggested to change format of DLFP to the following: DLFP contains one or several DLFP IEs followed by HCS:

	Field	Size, bits	Comment
DLFP IE	Last	1	'1' if the IE is the last in FCH, otherwise '0'
	Rate_ID/DIUC	3	For the first information element it shall be Rate_ID encoded according to the Table 195. For following IEs this field is DIUC that defines the burst profile of the corresponding burst. Only DIUC values in the range 0-7 will be used.
	Midamble present	1	If '1', midamble is placed before the burst
	Length	11	Number of OFDM symbols in the burst
	HCS	8	An 8-bit Header Check Sequence

Figure 1. Format of FCH Payload

FCH payload length is 23 bytes, so up to 11 DLFP IEs of above format may be placed. Adding CID (16 bits) with the same sense as in DL-MAP would decrease the number of DLFP IEs to 7.

If in the future the FCH rate will be decreased to BPSK ½, there still will be space for 5 elements of this format.

The following changes should be done in Table 202—OFDM DIUC values

DIUC	Usage
0-11	Burst Profiles
12	Reserved
13	Gap
14	End of Map
15	Extended DIUC

3. DLFP and Regular DL-MAP

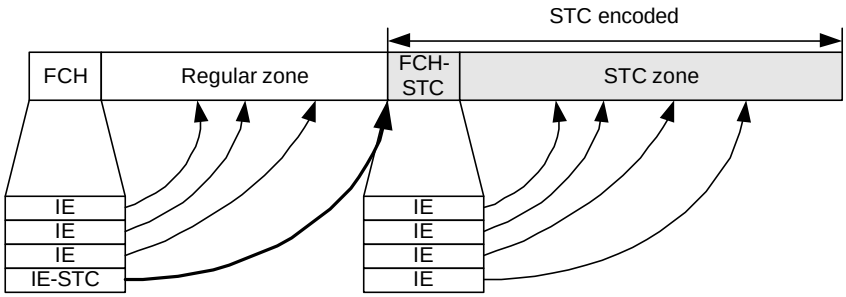
DL-MAP message will still be used, but it will not cross the boundary between FCH and burst #1. Format of DL-MAP is not changed. Bursts specified by DLFP will not be specified in DL-MAP and opposite.

In most cases there will not be more than 5 bursts in the DL, then the only information left to DL-MAP is PHY Sync information (particularly frame number), BS ID etc.

4. STC Support in DLFP

One of possible solutions for STC is to transmit FCH at lower modulation (BPSK ½) that makes it possible for reception even to those SSs that otherwise would need additional STC gain. Thus FCH is transmitted to all SSs including STC-enabled SSs.

One of DIUC values (e.g. DIUC = 12) may be reallocated to mean STC zone. So the corresponding FCH IE marks the start of STC zone. The STC zone ends at the end of the frame. STC zone starts from preamble and STC encoded FCH-STC burst (one symbol with the same payload format as specified in Figure 1). FCH-STC burst is followed by one or several STC encoded PHY bursts. The first burst in STC zone may contain DL-MAP and UL-MAP that are applicable only to STC zone.



Such implementation eliminates the need to transmit the whole DL-MAP at BPSK that would increase the overhead.

5. Specific Changes in 802.16-REVd/D2-2003 to Change DLFP Format

[Change in 8.3.4.1]

A downlink PHY PDU starts with a long preamble, which is used for PHY synchronization. The preamble is followed by a FCH burst. The FCH burst is one OFDM symbol long and is transmitted using QPSK rate ½ with the mandatory coding scheme. The FCH contains DL_Frame_Prefix to specify ~~the~~ burst profile and length of one or several ~~the~~ downlink bursts immediately following the FCH #1. ~~The Rate_ID encoding is defined in Table 195.~~ A DL-MAP message shall be the first MAC PDU in the burst following the FCH. ~~immediately follow the DL_Frame_Prefix~~. An UL-MAP message shall immediately follow the DL-MAP message. ~~Note that in the case of the remainder of the FCH being smaller than the size of the two messages combined they will 'spill' over into downlink Burst #1.~~ If UCD and DCD messages are ~~be~~ transmitted in the frame, they shall immediately follow~~ing~~ the DL-MAP and UL-MAP messages. Although ~~the downlink are~~ burst #1 contains broadcast MAC control

messages, it is not necessary to use the most robust well-know modulation/coding. A more efficient modulation/coding may be used if it is supported and applicable to all the SSs of a BS. ~~With exception of the maps, no MAC PDUs shall be split over multiple consecutive bursts with different burst profiles~~.

The FCH is followed by one or multiple downlink bursts, each transmitted with different burst profiles. Each downlink burst consists of an integer number of OFDM symbols. Location and profile of the first downlink burst and optionally several following bursts are specified in Downlink Frame Prefix (DLFP). Location and profile of other bursts are specified in DL-MAP. ~~and its burst p~~Profile~~s~~ are specified by either a 4 bit Rate_ID (for the first DL burst) or by DIUC ~~in the DL-MAP~~. The DIUC encoding is defined in the DCD messages.

[Changes in Table 196]

Syntax	Size	Notes
DL_Frame_Prefix_Format() {		
for (n=0; n < Number_of_IEs; n++) {		
DL_Frame_Prefix_IE() {		
LAST	1 bit	'1' if the IE is the last in FCH, otherwise '0'
Rate_ID /DIUC	~~4 bits~~ 3 bits	
Midamble present	1 bit	If '1', midamble is placed before the burst
Length	~~12 bits~~ 11 bits	
}		
}		
HCS	8 bits	
}		

[Changes at p. 420, line 1]

Unused space in FCH payload should be filled with padding bytes 0xFF.

The following are the fields of ~~DL Frame Prefix~~ DL_Frame_Prefix_IE:

Rate_ID /DIUC

~~Field that defines the burst profile of the following burst. Encoding is specified in Table 195.~~ For the first IE it shall be Rate_ID encoded according to the Table 195. For following IEs this field is DIUC that defines the burst profile of the corresponding burst. Only DIUC values in the range 0-7 shall be used.

Length

Number of OFDM symbols (PHY payload and midamble if present) in the burst ~~immediately following the FCH burst.~~

[Change in 8.3.4.4.]

DIUC value is used in the DL-MAP message and in DLFP to specify the Burst Profile to be used for a specific downlink burst.

[Change in 8.3.5.2.1]
Table 202 contains the DIUC values used in DL-MAP_IE() and DL_Frame_Prefix_IE.

[Change in Table 202]

DIUC	Usage
~~0~~	~~Reserved~~
~~1-12~~ 0-11	Burst Profiles
12	Reserved
13	Gap
14	End of Map
15	Extended DIUC

6. Specific Changes in 802.16-REVd/D2-2003 to Support STC with New DLFP Format

[It is assumed that all changes specified in Section 6 of this document are already done]
[Change in 8.3.4.1]
A downlink PHY PDU starts with a long preamble, which is used for PHY synchronization. The preamble is followed by a FCH burst. The FCH burst is one OFDM symbol long and is transmitted using ~~QPSK~~ BPSK rate ½ with the mandatory coding scheme.

[After changes specified above for 8.3.4.1]
The DIUC encoding is defined in the DCD messages.

DL Subframe may optionally contain an STC zone where all DL bursts are STC encoded. If STC zone is present, the last IE in DLFP shall have DIUC = 0 (see Table 202). Then the IE contains information on start time of STC zone (see Table 196). The STC zone ends at the end of the frame.

STC zone starts from preamble (see NNN) and STC encoded FCH-STC burst, which is one symbol with the same payload format as specified in Table 196. FCH-STC burst is transmitted at QPSK ½. It is followed by one or several STC encoded PHY bursts. The first burst in STC zone may contain DL-MAP applicable only to STC zone. If DL-MAP is present, it shall be the first MAC PDU in the payload of the burst.

[Changes in Table 196]

Syntax	Size	Notes
DL_Frame_Prefix_Format() {		
for (n=0; n < Number_of_IEs; n++) {		
DL_Frame_Prefix_IE() {		
LAST	1 bit	'1' if the IE is the last in FCH, otherwise '0'
Rate_ID /DIUC	~~4 bits~~ 3 bits	

If (DIUC != 0) {	1 bit	If '1', midamble is placed before the burst
Midamble present	1 bit	If '1', midamble is placed before the burst
Length	~~12 bits~~ 11 bits	
} else {		
Start Time	12 bits	Start time of STC zone in units of symbol duration counted from the beginning of the frame
}		
}		
HCS	8 bits	
}		

[Change in Table 202]

DIUC	Usage
~~0~~	~~Reserved~~
0	STC zone
~~1-12~~ 1-11	Burst Profiles
12	Reserved
13	Gap
14	End of Map
15	Extended DIUC

7. References

[1] IEEE P802.16-REVd/D2-2003 Draft IEEE Standard for local and metropolitan area networks Part 16: Air Interface for Fixed Broadband Wireless Access Systems

[2] IEEE C802.16d-03/63 Compressed DL-MAP format for OFDMA PHY by Itzik Kitroser et al.