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Re:	IEEE 802.16-08/028: “IEEE 802.16 Working Group Letter Ballot Recirc #28d: Announcement”
Abstract	This contribution proposes the condensed DL-MAP IE
Purpose	Text proposal for 802.16j Draft Document.
Notice	
Release	
Patent Policy	

Condensed DL-MAP IE for Efficient DL-MAP Transmission

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Introduction

In the current definition of the allocation of downlink data in WirelessMAN-OFDMA, each allocation (i.e. a burst) is described as a two-dimensional rectangle with time axis (OFDMA symbol) and frequency axis (sub-channel). In order to specify the burst with the 2-D allocation scheme, the existing DL-MAP IE, defined in P802.16Rev2/D5, utilizes four parameters, that are, a “OFDMA symbol offset” and a “OFDMA sub-channel offset” to locate the coordinate of the left-top point of the allocated rectangular, plus, “number of OFDMA symbols” and “number of OFDMA sub-channels” to indicate its length and width, respectively. This approach is intuitive, but carries 27-bit overhead.

In order to reduce the MAP overhead, this contribution proposes a condensed DL-MAP IE that uses two parameters, which are “number of OFDMA symbols” and “number of sub-channels”, to describe the allocation of the bursts with 13-bit overhead. In addition, the pseudo code for encoding and decoding are provided in the annex, which are based on a proven theory that with the above two parameters the 2-D allocations of a DL zone can be uniquely determined as long as the sequence of Condensed DL-MAP IEs are ordered along the time axis in a frequency first manner.

Two Examples of Encoding and Decoding Procedures with Condensed DL-MAP IE

Two examples of the decoding procedure with the proposed condensed MAP IE are illustrated as follows. Without loss of generality, we consider a DL subframe with one zone in the following examples since they can be easily extended to cases of multiple zones.

Figure 1 shows a DL subframe. This DL subframe consists of one FCH, one DL-MAP, and 6 data bursts (the first data burst is UL-MAP). For the convenience of illustration, we assume that there are 6 OFDMA symbols and 6 subchannel in the DL subframe and 1 slot is defined as a rectangular resource comprised by 1 OFDMA symbol and 1 subchannel. Thus, there are total 36 slots. Obviously, for a slot i, its location can be identified by a 2-D coordinate (symbol_i, subchannel_i), where symbol_i is the OFDMA symbol offset and subchannel_i is the subchannel offset of this burst. Then we define a 1 to 1 mapping function

F(symbol_i,subchannel_i)= 6(OFDMA symbol_i)+subchannel_i*

which maps the coordinate of each slot into an unique index. Essentially, this mapping function is equivalent to map the slots (coordinates) into unique indexes 0~35 where the coordinate with smaller OFDMA symbol offset is mapped to a smaller index and for the slots with the same OFDMA symbol offset, the index of the one with smaller subchannel offset is smaller. Furthermore, define the left-top of each data burst is the start point of this burst. Then the data bursts can be indexed into burst 1, burst 2,… to burst 6 by sorting the index of their start point in increasing order. Figure 1 shows the index mapping of the bursts and the slots.

When composing MAP messages, the MR-BS or RS encode the condensed DL-MAP IE in the sequence of the ascending order of burst indexes. Instead of using four parameters to describe the location of a data IE, the condensed DL-MAP IE consists of only the number of OFDMA symbols and the number of subchannels. Although only partial information is carried in condensed DL-MAP IE, with the knowledge of the sequence of each condensed IE, and the location of FCH and DL-MAP, it is sufficient for an RS to uniquely identify all the starting point of each burst. Then, the 2-D allocation is re-constructed by applying the decoding procedure described in the annex. Conceptual steps of re-construction are as follows:

1. Since the allocation region of FCH and DL-MAP is already known, the start point of the first burst (the data burst with the smallest index) can be easily obtained
2. By the information of the number of OFDMA symbol and the number of subchannel carried in the first condensed DL-MAP IE (corresponding to the first burst), the allocation region of the first burst is identified
3. Once the first burst is re-constructed. The second burst could also be identified in a similar manner. The remaining burst could then be re-constructed in the sequence of the burst indexes.

In the annex, the pseudo codes for the encoding procedure and the decoding procedure of proposed condensed DL-MAP IE are described. It can be shown that the worst case time complexity of the decoding algorithm is $O(NC)$. Where N is the total number of bursts (IEs), C is the total number of subchannels.

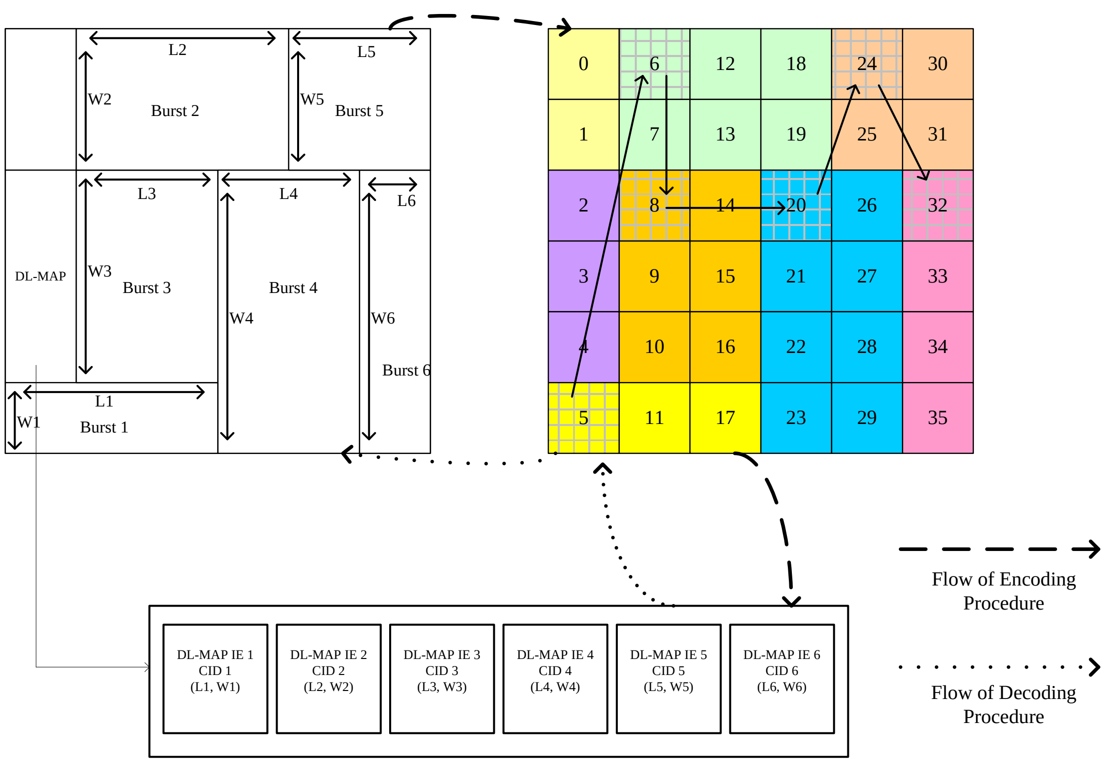

Figure 1 An example of indexes mapping of slots and burst in a general DL zone

Figure 2 shows another example. In figure 2, there are allocation holes in which no burst is allocated in a DL subframe. In such case, we can regard the holes as one or more rectangular "null burst" and perform the same process described in the first example.

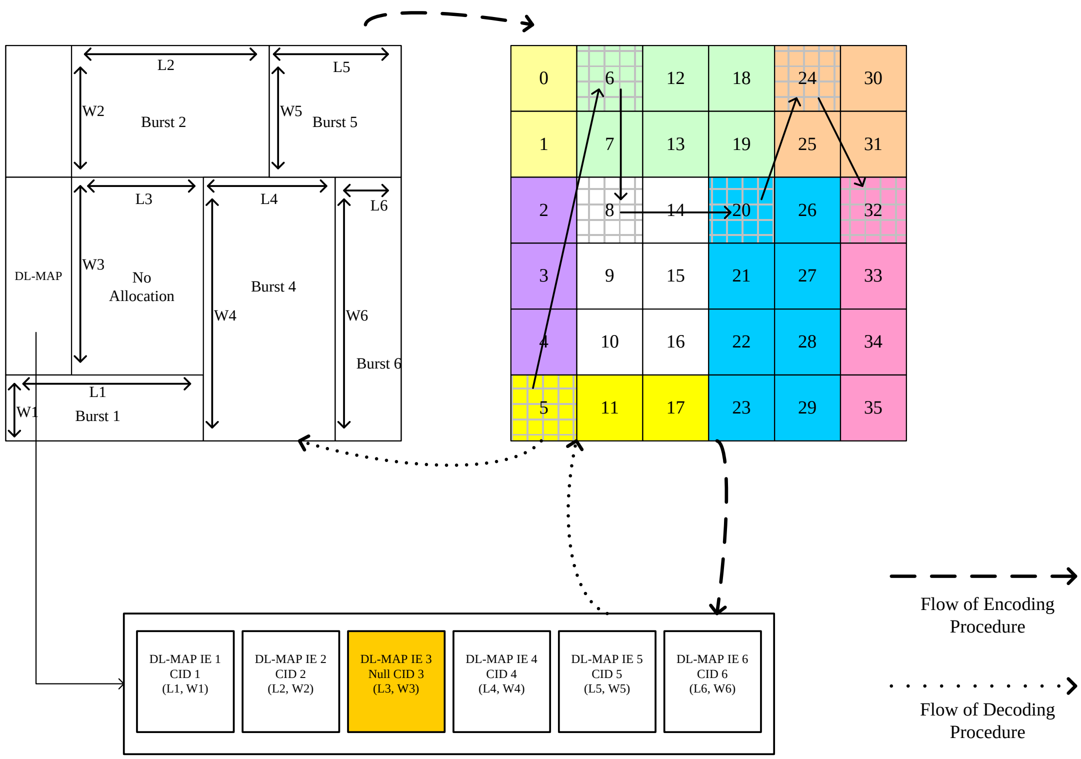

Figure 2 An example of indexes mapping of slots and bursts with allocation hole in DL zone

In order to facilitate the incorporation of this proposal into IEEE 802.16j standard, specific changes to the draft standard P802.16j/D5 are listed below.

Spec changes

8.4.5.3 DL-MAP IE format

[Insert the following table at the end of 8.4.5.3 DL-MAP IE format:]
MR-BS and RS may transmit Condensed DL-MAP IE to describe the data burst or the null burst (unused data burst) on the DL relay link. The CID of the null burst should be padding CID. The sequence of Condensed DL-MAP IEs in the MAP, if present, are ordered along the OFDMA symbol number (in a ascending order) in a subchannel logical number (in a ascending order) first manner. (see Annex N)

Table 380a Condensed DL-MAP IE

Syntax	Size	Notes
Condensed_DL-MAP_IE() {	-	-
DIUC	4 bits	
if (DIUC == 14 {	-	-
Extended-2 DIUC dependent IE	*variable*	
} else if (DIUC == 15) {	-	-

Extended DIUC dependent IE	*variable*	See subclauses following 8.4.5.3.1
} else {	-	
if (INC_CID == 1) {	-	The DL-MAP starts with INC_CID =0. INC_CID is toggled between 0 and 1 by the CID-SWITCH_IE() (8.4.5.3.7)
N_CID	8 bits	Number of CIDs assigned for this IE
for (n=0; n< N_CID; n++) {	-	-
RCID_IE()	*variable*	For R-MAP, RS_Access-MAP and RS_Relay-MAP, reduced CID format is used
}	-	-
}	-	-
Boosting	3 bits	000: normal (not boosted); 001: +6dB; 010: -6dB; 011: +9dB; 100: +3dB; 101: -3dB; 110: -9dB; 111: -12dB;
if (Permutation = 0b11 and (AMC type is 2x3 or 1x6)) {	-	-
No. OFDMA triple symbol	5 bits	Number of OFDMA symbols is given in multiples of 3 symbols
} else {	-	-
No. OFDMA Symbols	7 bits	
}	-	-
No. Subchannels	6 bits	
Repetition Coding Indication	2 bits	0b00 – No repetition coding 0b01 – Repetition coding of 2 used 0b10 – Repetition coding of 4 used 0b11 – Repetition coding of 6 used
}	-	-
Padding	variable	Shall be set to 0
}	-	-

6.3.2.3.87 RS access MAP (RS_Access-MAP) message

Table 183z—RS Access MAP message format

[Modify line 45 of page 75 in Table 183z as indicated:]

DL_IE count	8 bits	Number of DL_IE in the burst
DL-MAP IE format	1 bit	0: Normal DL-MAP IE, 1: Condensed DL-MAP IE
For (i = 0; i < DL IE count; i++) {	-	-

[Modify line 53 of page 75 in Table 183z as indicated:]

If(DL-MAP IE format == 0b0) {		
DL-MAP_IE()	*variable*	“DL-MAP” in DL-MAP or Compressed DL-MAP
} else {		
Condensed_DL-MAP_IE()	*variable*	
}		

6.3.2.3.88 RS relay MAP (RS_Relay-MAP) message

Table 183ad—RS relay MAP message format

[Modify line 18 of page 80 in Table 183ad as indicated:]

DL_IE count	6 bits	Number of DL_IE in the burst

DL-MAP IE format	1 bit	0: Normal DL-MAP IE, 1: Condensed DL-MAP IE
For (i = 0; i < DL IE count; i++) {	-	-

[Modify line 27 of page 80 in Table 183ad as indicated:]

If(DL-MAP IE format == 0b0) {		
DL-MAP_IE()	*variable*	"DL-MAP" in DL-MAP or Compressed DL-MAP
} else {		
Condensed_DL-MAP_IE()	*variable*	
}		

[Modify line 16 of page 212 in Table 496a as indicated:]

8.4.5.10 R-MAP message

Table 496a—R-MAP message format

Syntax	Size	Notes
RCID_Type	2 bits	0b00 = Normal CID 0b01 = RCID 11 0b10 = RCID 7 0b11 = RCID 3
DL-MAP IE format	1 bit	0b0 = Normal DL-MAP IE 0b1 = Condensed DL-MAP IE
Length	11 bits	Length of R-MAP in bytes
DL_IE count	6 bits	Number of DL_IE in the burst
UL_IE count	6 bits	Number of UL_IE in the burst
for(i=0;i<DL_IE count; i++){		
If(DL-MAP IE format == 0b0) {		
DL_-MAP_IE()	*variable*	
} else {		
Condensed_DL-MAP_IE()	*variable*	
}		
}		

Annex N

(Informative)

Encoding/decoding of Condensed DL MAP for Efficient Transmission

Annex N.1 Data Structure:

/* the size of the DL Subframe is W symbols width and H sub-channels height */

DL-MAP_IE_bursts[0..(N-1)]   /* *N* bursts which are indexed as 0, 1, 2, …, (N-1). For the i-th burst, the location information is a 4-tuple (x_i, y_i, w_i, h_i), where x_i and y_i are the OFDMA symbol offset and subchannel offset, respectively, and w_i and h_i are no. of occupied OFDMA symbols and no. of occupied subchanne */

Condensed_DL-MAP_IE_bursts[0..(N-1)]   /* *N* bursts which are indexed as 0,1,2,…,(N-1). For the i-th burst, the location information is a 2-tuple (w_i, h_i), where w_i and h_i are no. of occupied OFDMA symbols and no.

of occupied subchannel */

Annex N.2 Encoding Procedure

Input
DL-MAP_IE_bursts[0..(N-1)]
Output
Condensed_DL-MAP_IE_bursts[0..(N-1)]

```
/* Pseudo code to encode an array of DL-MAP IE into an array of Condensed_DL-MAP IE */
Encode (DL-MAP_IE_bursts[])
{

Sort the DL-MAP_IE_bursts in ascending order such that the value of H*x_i+y_i of the i-th burst is less than
the i+1-th burst

FOR (i = 0; i < N; i++)
{
   Condensed_DL-MAP_IE_bursts[i].w_i = DL-MAP_IE_bursts[i].w_i;
   Condensed_DL-MAP_IE_bursts[i].h_i = DL-MAP_IE_bursts[i].h_i;
}
RETURN Condensed_DL-MAP_IE_bursts[];
}
```

Annex N.3 Decoding procedure

Input
Condensed_DL-MAP_IE_bursts[0..(N-1)]
Output
DL-MAP_IE_bursts[0..(N-1)]

```
/* Pseudo code to decode an array of Condensed_DL-MAP into an array of DL-MAP IE Complexity : O(N×H)
*/
Decode (Condensed_DL-MAP_IE_bursts[])
{

Symbol_offset[0..(H-1)]=0; /* an array to record all the left most symbol offset of the unallocated space for
each subcarrier */

For (i=0; i<N; i++)
{
   x_i=W-1;
   y_i=H-1;
   For (k=H-1; k>=0; k--)
   {
         If (Symbol_offset[k]<=x_i)
         {
            DL-MAP_IE_bursts[i].x_i = x_i = Symbol_offset[k];
            DL-MAP_IE_bursts[i].y_i = y_i = k;
```

```
            DL-MAP_IE_bursts[i].w_i = w_i = Condensed_DL-MAP_IE_bursts[i].w_i;
            DL-MAP_IE_bursts[i].h_i = h_i = Condensed_DL-MAP_IE_bursts[i].h_i;
        }
  }
  For (k=y_i; k< y_i + h_i ; k++)
        Symbol_offset[k] = x_i + w_i - 1;
}
RETURN DL-MAP_IE_bursts[];
}
```