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Re:	This is a response to a Call for Comments IEEE 802.16e-03/58 on IEEE 802.16e-03/07r5
Abstract	This document contains more efficient downlink and uplink resource allocation method in OFDMA-PHY for mobility support applications.
Purpose	The document is submitted for review by 802.16e Working Group members.
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Release	
Patent Policy and Procedures	

Changes on Downlink Resource Allocation in OFDMA-PHY for Mobility Support

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1. Background

In IEEE P802.16-REVd/D2-2003 OFDMA-PHY, Data Region is allocated by rectangle of contiguous group of symbols, in a contiguous group of subchannels. Since the downlink resource allocation is provided by two dimensional rectangle of symbols and subchannels, downlink bursts are not guaranteed the order by the robustness of the burst profiles.

Except the OFDMA-PHY, other PHY specifications in IEEE 802.16d provide the order of the downlink bursts by the robustness of the burst profiles. The most robust burst is appeared first in the downlink subframe and then the next robust one, and finally the least robust burst is transmitted at the last of the downlink subframe. Therefore, each SS can decode all the burst up to its operational burst profile, and can ignore the subsequent bursts. Thus the SS can save the power consumption by not processing the unwanted bursts.

Since the current OFDMA-PHY can not provide the order of the burst by robustness, every awaking SSs should potentially decode every downlink bursts to check the MAC headers whether they have the data addressed to it. It causes some serious power consumption issues to the battery-powered SSs.

To provide an efficient power saving capability to the MSSs, it is very important to check earlier the presence of data addressed to them in the downlink subframe. There are two possible alternatives:

The first one is to provide the Basic CID fields in the DL-MAP-IE( ) to address the MSSs for the specific downlink burst. MSSs addressed in the DL-MAP_IE( ) can only decode the specific downlink burst addressed to them, and skipping all the other bursts. But this methodology will increase the signaling overhead in the DL-MAP_IE( ) by providing the Basic CID fields. And the identifiers of the MSSs, i.e., the Basic CIDs, may be transmitted in duplication on inband (at the CID field in the MAC header) and outband (at the DL-MAP_IE( )).

The second one is to allocate and transmit the downlink bursts in order by the robustness of the burst profiles. Then MSSs in the awake mode can save its processing power by decoding the every downlink bursts up to the burst having its operational burst profile, and ignoring the following bursts. This method requires every awakening MSSs should decode the downlink bursts up to its operational burst, but it has lots of advantages. It does not impose any additional overhead to the DL-MAP_IE( ), and even reduces the signaling overhead for addressing the downlink bursts. Since the order of the downlink bursts are guaranteed, it only needs the information about its burst profile and the size of the burst. Therefore it can reduce the DL-MAP signaling overhead.

If we can apply the DL-MAP information to decode the burst following the DL-MAP message, several number of symbol periods, namely the pipeline delay, are required to process DL-MAP information. Therefore, when the MSSs have the more robust operational burst profiles, the additional power consumption may negligible than the former method.

To transmit data in the uplink for a specific user the preambles are preceded before the data. It is general to allocate the uplink resources to the user by all the symbols in a specific subchannel in the case of the two dimensional rectangle allocation method. Therefore, we propose to allocate the uplink resources by the number of uplink slots (namely, one subchannel by all the symbols cofiguring the corresponding uplink subframe), because it reduces significantly the signaling overhead for the UL-MAP_IE( ).

2. Proposed changes on IEEE 802.16e-03/07r5

[Change the text in the P802.16-REVd/D2-2003 to the followings and add these texts in IEEE 802.16e-03/07r5.]

8.4.3.1 Data region

A slot in the OFDMA PHY requires both a time and subchannel dimension for completeness (subchannels are defined in 8.4.6).

On the downlink allocation, an OFDMA slot is one subchannel by one OFDMA symbol for a regular subchannels, and one mini-subchannel by three OFDMA symbols for mini-subchannels. On the uplink allocation, an OFDMA slot is one subchannel (or minisubchannel) by the number of OFDMA symbols configuring the uplink subframe.

In OFDMA, a Data Region is an allocation of a group of contiguous sequence of slots, such as the block in Figure 208.

[Replace the Figure 208 to the following Figure 208a and 208b:]

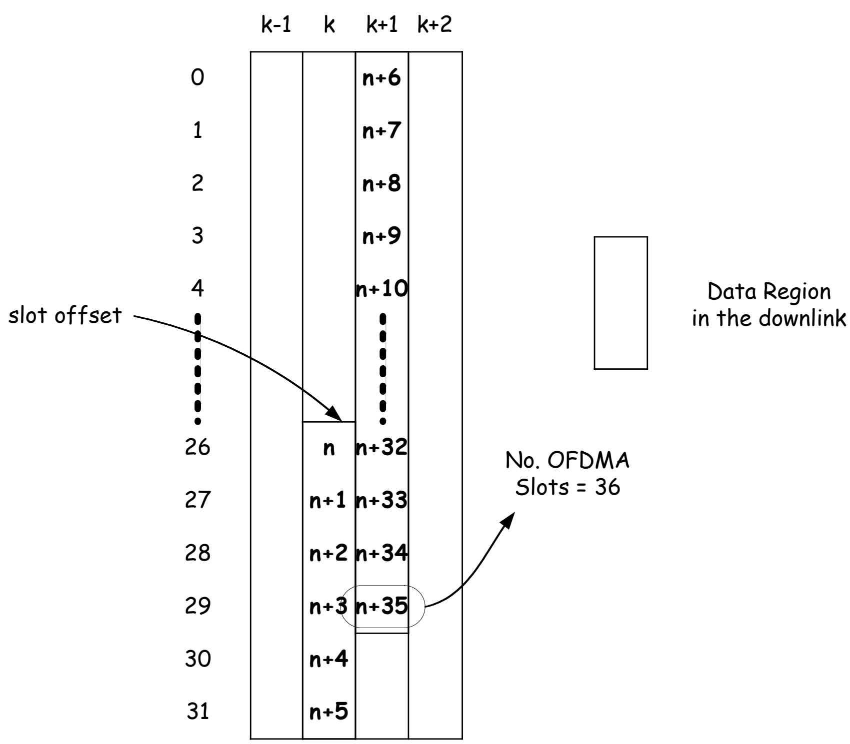


Figure 208a Example of the data region which defines the OFDMA allocation in the downlink

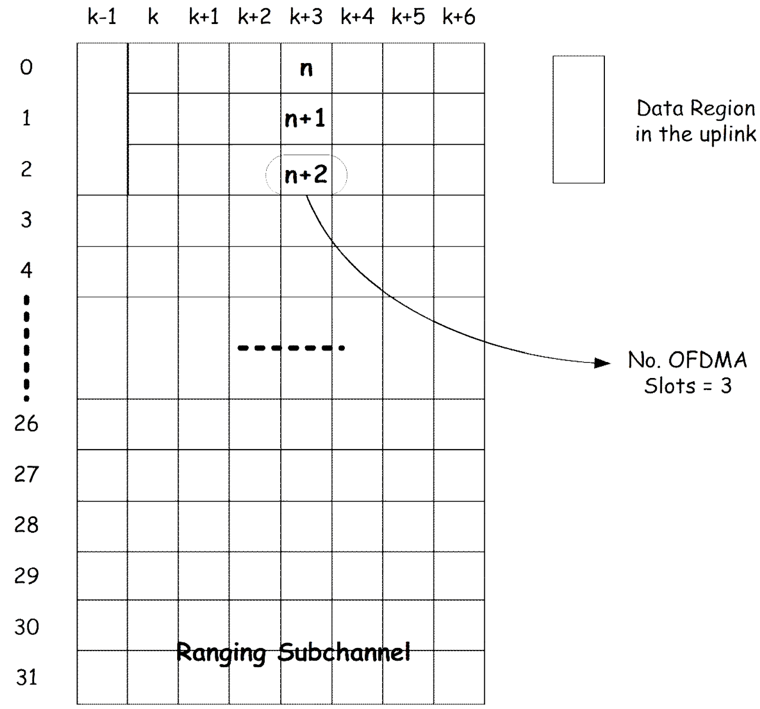


Figure 208b Example of the data region which defines the OFDMA allocation in the uplink

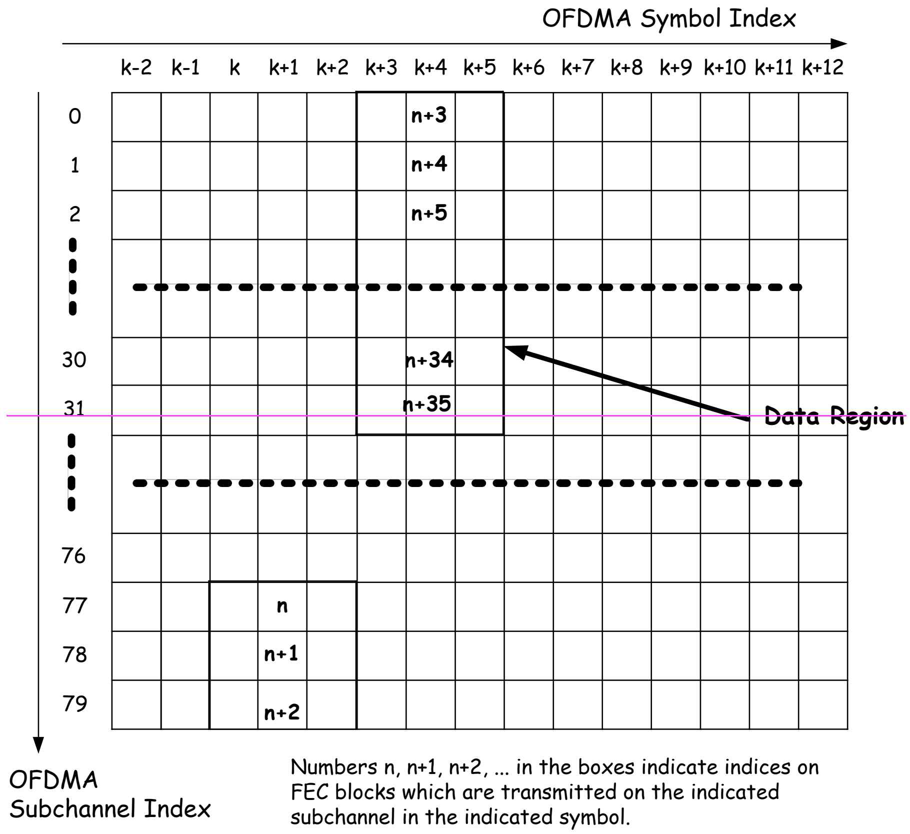
8.4.3.2 OFDMA data mapping

MAC data shall be processed as described in 8.4.9 and shall be mapped to an OFDMA Data Region in 8.4.3.1 using the following algorithm:

1) Segment the data into blocks sized to fit into one FEC block.
2) Each FEC block spans one subchannel in the subchannel axis and one OFDMA symbol in the time axis (see figure 210). In addition, when mini-subchannels are employed for the uplink direction, each FEC block spans three OFDMA symbols in the time axis (see Figure 209). Map the FEC blocks such that the lowest numbered FEC block occupies the lowest numbered subchannel in the lowest numbered OFDMA symbol.
3) Continue the mapping such that the subchannel index is increased for each FEC block mapped. When the edge of the Data Region is reached, continue the mapping from ~~the lowest numbered~~ subchannel number 0 in the next OFDMA symbol.

[Replace the Figure 209 and Figure 210 to the following Figure 209~~a, Figure 209b~~ and Figure 210a, Figure 210b:]

Figure 209 and Figure 210 illustrate the order in which FEC blocks are mapped to subchannels and OFDMA symbols.



~~Figure 209a Example of mapping FEC blocks to subchannels and symbols in the downlink when using mini-subchannels~~

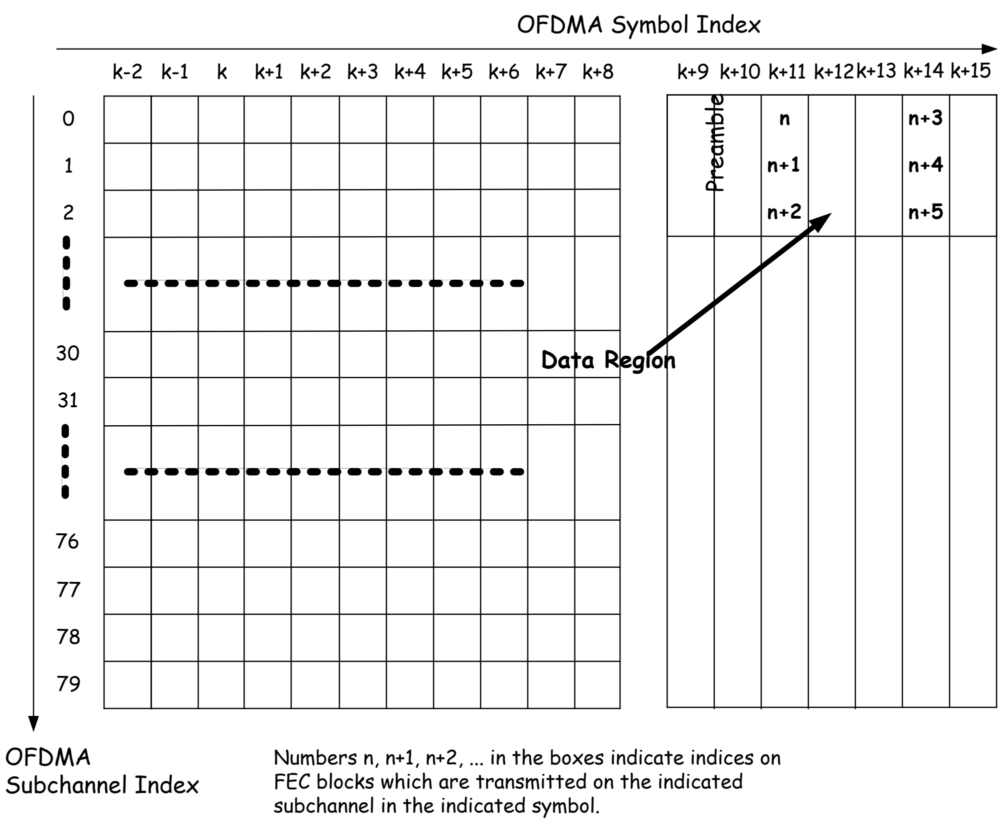


Figure 209~~b~~ Example of mapping FEC blocks to subchannels and symbols in the uplink when using mini-subchannels

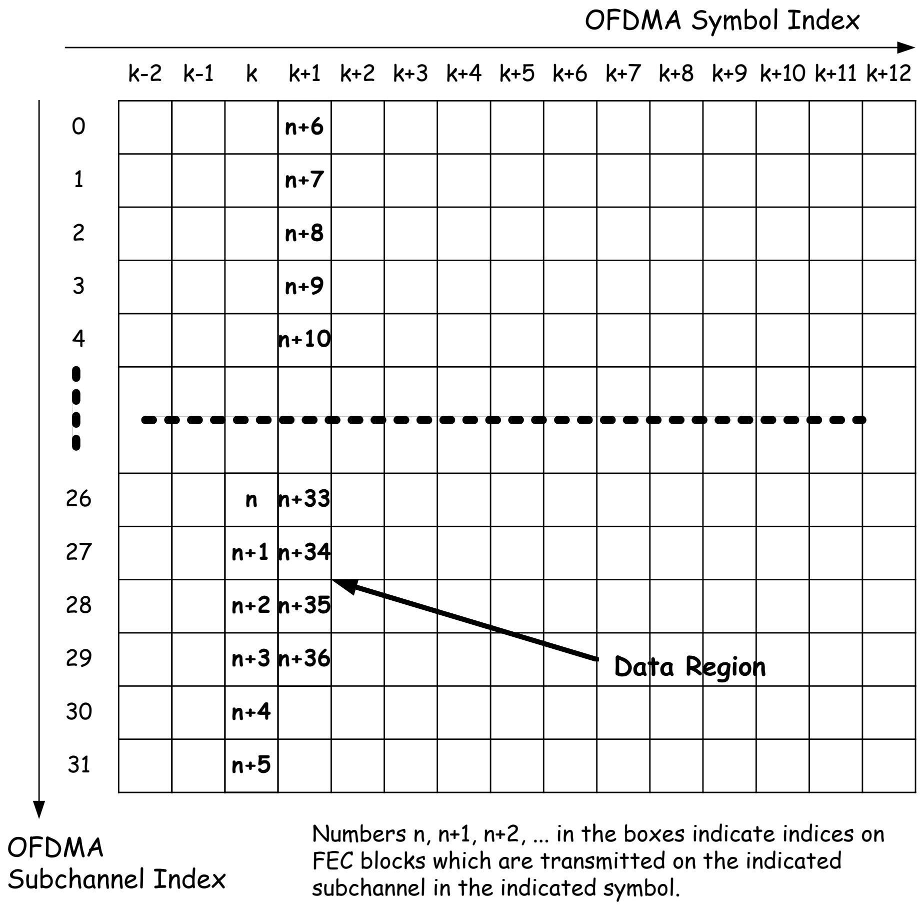


Figure 210a Example of mapping FEC blocks to subchannels and symbols in the downlink.

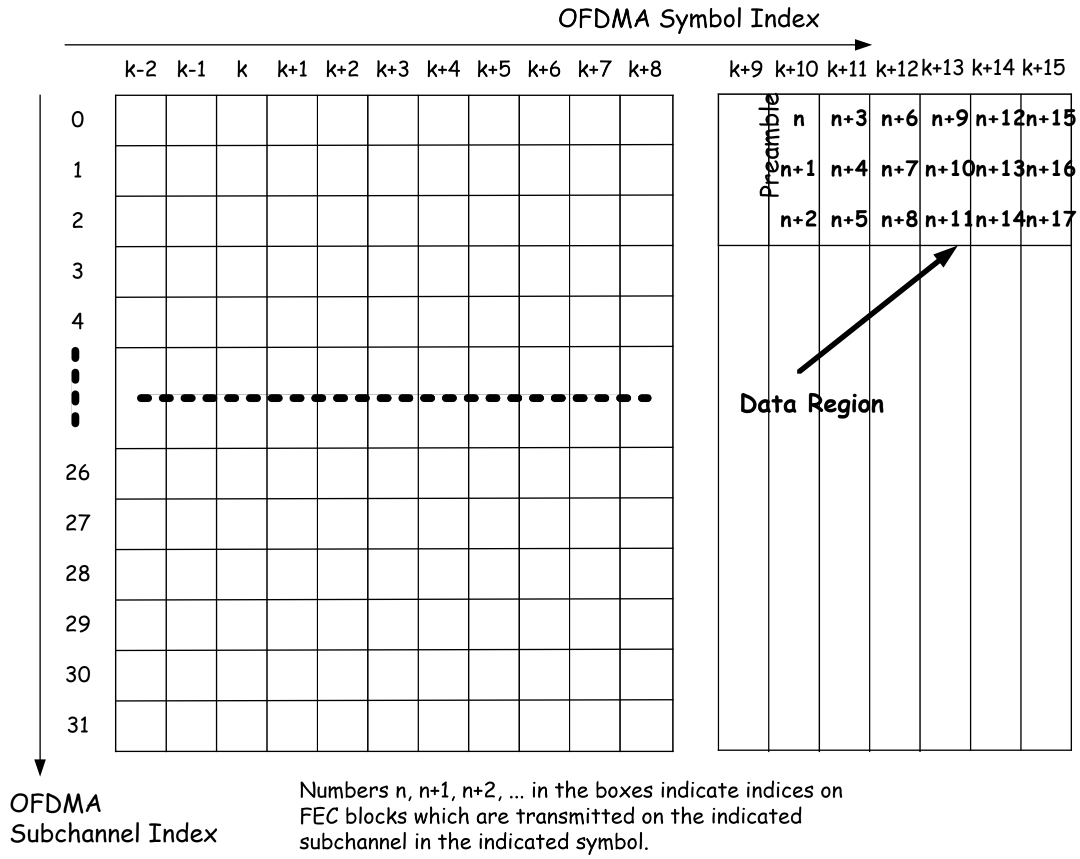


Figure 210b Example of mapping FEC blocks to subchannels and symbols in the uplink.

8.4.4.2 PMP frame structure

[Replace the Figure 211 to the following:]

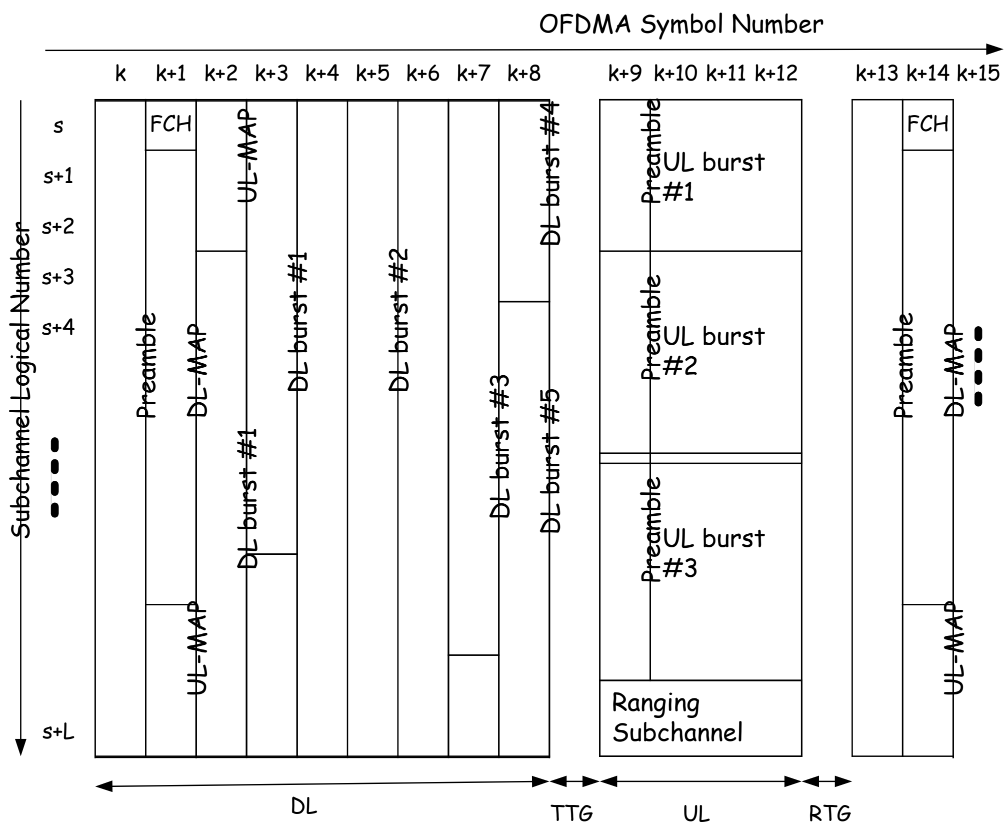


Figure 211 Time plan – one TDD time frame

The downlink bursts are transmitted in order of decreasing robustness. For example, with the use of a single FEC type with fixed parameters, data begins with QPSK modulation, followed by 16-QAM, followed by 64-QAM.

8.4.5.3 DL-MAP IE format

The OFDMA DL-MAP IE defines the allocation of OFDMA slots in Table 227.

Table 227 OFDMA DL-MAP_IE format

Syntax	Size	Notes
DL-MAP_IE ( ) {		
DIUC	4 bits	
if (DIUC == 15) {		
Extended DIUC dependent IE	variable	AAS_DL_IE( ) or STC_IE( )
} else {		
No. DL OFDMA slots	12 bits	Allocated number of OFDMA slots (one subchannel by one symbol for regular subchannels.
}		
}		

8.4.5.4 UL-MAP IE format

The OFDMA UL-MAP IE defines a two-dimensional allocation pattern for the uplink bursts. IEs define uplink bandwidth allocations. Each UL-MAP message shall contain at least one IE that marks the end of the last allocated burst. ~~The IEs shall be strict chronological order within the UL-MAP.~~ The CID represents the assignment of the IE to either a unicast, multicast, or broadcast address. A UIUC shall be used to define the type of uplink access and the burst type associated with that access. A Burst Descriptor shall be specified in the UCD for each UIUC to be used in the UL-MAP. The format of the UL-MAP IE is defined in Table 232.

Table 232 OFDMA UL-MAP_IE format

Syntax	Size	Notes
UL-MAP_IE ( ) {		
CID	16 bits	
UIUC	4 bits	
if (UIUC == 12) {		
No. UL OFDMA Slots	5 bits	
Ranging Method	3 bits	000 – Initial Ranging over two symbols 001 – Initial Ranging over four symbols 010 – BW Request/Periodic Ranging over one symbol 011 – BW Request/Periodic Ranging over three symbols 100 - 111 – reserved
} else if (UIUC == 14) {		
CDMA_Allocation_IE( )	~~24~~ 32 bits	
} else if (UIUC == 15) {		
Extended UIUC dependent IE	variable	Power_Control_IE( ) or AAS_UL_IE( )
} else {		
No. OFDMA UL Slots	5 bits	
Mini-subchannel index	3 bits	000 – no mini-subchannels used 001 – mini-subchannel 1 is allocated 010 – mini-subchannel 2 is allocated 011 – mini-subchannel 3 is allocated 100 – mini-subchannel 4 is allocated 101 – mini-subchannel 5 is allocated 110, 111 – reserved
}		
}		

CID
Represents the assignment of the IE.
UIUC
UIUC used for the burst.
No. OFDMA UL Slots
The number of OFDMA uplink slots that are used to carry the burst.
Mini-subchannel index
The index of the mini-subchannel for the subchannel indicated by slot offset parameter.

The end of the last allocated burst is indicated by allocating an End of Map burst (CID=0 and UIUC=11) with zero duration. ~~The time instants indicated by the offsets are transmission times of the first symbol of the burst including preamble.~~

A BS supporting the AAS option shall allocate subchannels 30 and 31, during the last 4 symbols of the uplink frame as initial ranging slot for AAS SS that has to initially alert the BS to its presence. This period shall be marked in the UL-MAP as Initial-Ranging (UIUC=12), but shall be marked by an AAS initial ranging CID such that no non-AAS subscriber (or AAS subscriber that can decode the UL-MAP message) uses this interval for Initial Ranging.

8.4.5.4.2 CDMA allocation UL-MAP IE format

Table 234 defines the UL-MAP_IE for allocation bandwidth for a user that has requested bandwidth using Request Code. This IE is identified by UIUC = 14.

Table 234 CDMA Allocation IE format

Syntax	Size	Notes
CDMA_Allocation_IE ( ) {		
Ranging Code	6 bits	
Ranging Symbol	10 bits	
No. OFDMA UL Slots	5 bits	
Ranging subchannel	6 bits	
BW request mandatory	1 bit	1 = yes, 0 = no
Mini-subchannel index	3 bits	000 – no mini-subchannels used 001 – mini-subchannel 1 is allocated 010 – mini-subchannel 2 is allocated 011 – mini-subchannel 3 is allocated 100 – mini-subchannel 4 is allocated 101 – mini-subchannel 5 is allocated 110, 111 – reserved
Reserved	1 bit	
}		

Ranging code
Indicating the CDMA Code sent by the SS.
Ranging symbol
Indicating the OFDMA symbol used by the SS.
No. OFDMA UL Slots
The number of OFDMA uplink slots that are used to carry the burst.
Ranging subchannel
Identifies the Ranging subchannel used by the SS to send the CDMA code.
BW request mandatory
Indicates whether the SS shall include a Bandwidth (BW) Request on the allocation.
Mini-subchannel index
The index of the mini-subchannel for the subchannel indicated by slot offset parameter.

The end of the last allocated burst is indicated by allocating an End of Map burst (CID=0 and UIUC=11) with zero duration. The time instants indicated by the offsets are the transmission times of the first symbol of the burst including preamble.