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Title	**Method for Supporting Near-seamless Frequency Assignment Change**
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Re:	Call for inputs for the Handoff Ad-hoc group
Abstract	This contribution describes method for supporting near-seamless frequency assignment change.
Purpose	Handoff Ad Hoc draft proposal for the IEEE802.16e group.
Notice	
Release	
Patent Policy and Procedures	

Method for Supporting Near-seamless Frequency Assignment Change

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1. Problem Statements

Vendors may choose to offer multiple channels (or frequency assignments (FAs)) within one base station (BS). In case of BS with support for multiple FAs, it needs to make an (M)SS transit from one FA to another FA in order to facilitate load sharing among FAs.

According to current IEEE P802.16REVd/D4-2004, however, there is the only way, that is, of using DREG-CMD message in changing FA. The message, DREG-CMD which is used in different usage from its very beginning, has no indication of the target FA. In addition, when an (M)SS receives the message, it shall restart the initial network re-entry sequence after cell selection. The former limit makes impossible the load sharing among FAs, and the latter inefficiency causes too long disruption of service.

In the handover scheme according to the current IEEE P802.16e/D2-2004, there are three major disadvantages because of the poor concern about the inter-FA handover.

- No indication of the target FA

Although the current IEEE P802.16e/D2-2004 says that a BS may be the initiator of a handover to facilitate load sharing among BS, the practical objective of the BS-initiated handover is to distribute the traffic load through the FAs in the cellular multiple-FA system. However, the efficient load sharing is not possible in the current 802.16e version because the BS cannot indicate the target FA to the MSS through the MOB_BSHO-REQ message explicitly. In the inter-FA handover the target FA is determined by the MSS after FA scanning procedure. Even if the BS recommends just one target FA to the MSS, the MSS shall scan the FA through the prescribed procedures and then it determines whether it can accept the BS's recommendation or not.

- Too long disruption for the reliable scanning

If the MSS wants to scan the other FA, it sends a MOB_SCN-REQ message to the BS to grant permission for the scanning. After receiving the MOB_SCN-RSP message with the BS's approval, the MSS changes its center frequency, synchronizes with the downlink of the FA, and obtains PHY parameters. If the MSS wants to scan actively, it will obtain the uplink parameters and send a RNG-REQ message to the BS through the FA. The scanning results are reliable only if the MSS receives the RNG-RSP message respective to the RNG-REQ message. According to the random access characteristic of the sending a RNG-REQ message, the scanning causes a sizable amount of latency. Since the MSS shall scan one or more FAs, the total disruption time of the scanning processes causes significant service degradation. If the MSS wants to apply the MOB_NBR-ADV message to reduce this disruption before it starts the scanning, it must wait until it collects sufficient and reliable information through the message. Therefore, this method may degrade the effectiveness of the inter-FA handover.

- Inefficient network re-entry procedure

On the inter-FA handover in the present standard, the MSS has to send the MOB_MSSHO-RSP message, receive the MOB_BSHO-RSP, and send the MOB_HO-IND message. When the MSS proceeds the inter-FA handover, the MSS and BS shall perform the normal handover by exchanging MAC messages and then the network re-initialization procedures. Although the MSS handovers to another FA using fast network re-entry procedure, the network re-entry procedure is still long and slow due to heavy message exchanges (ranging, capability negotiation, re-authorization, registration). Unfortunately, all service flows may be interrupted during this network re-entry.

To address these problems, this contribution introduces the powerful message which is concentrated in the inter-FA handover and presents the enhanced inter-FA handover procedures.

2. Summary of Solutions

2.1 Support of Multiple FAs

According to the current IEEE P802.16REVd/D4-2004 and IEEE P802.16e/D2-2004, some MAC management messaged contain Channel IDs, which implies that a BS may provide multiple FAs. Table 1 lists MAC management messages that contain Channel IDs.

Table 1 – MAC Messages with Channel IDs

MAC management message	Downlink Channel ID	Uplink Channel ID
DCD	Yes	No
UCD	No	Yes
UL-MAP	No	Yes
RNG-REQ	Yes	No
RNG-RSP	No	Yes

The role of the BS with multiple FAs would be to manage the traffic load to all served (M)SS, and balance the traffic between the multiple FAs by dynamically moving the (M)SSs based upon their resource needs and the resources available. For the purpose, we propose new MAC management messages, Dynamic Frequency Assignment Change Request (DFAC-REQ), Dynamic Frequency Assignment Change Response (DFAC-RSP), and Dynamic Frequency Assignment Change Acknowledge (DFAC-ACK). These messages will be added to Table 1.

In case of TDD, the uplink and downlink transmissions share the same frequency. In case of FDD, the uplink and downlink channels which are on separate frequencies are mapped one-to-one. So we propose using a FA ID instead of Downlink/Uplink Channel ID.

Figure 1 presents an example of a BS with 4 FAs in TDD mode.

2.2 Dynamically Changing of FAs in a BS with Multiple FAs

At any time after network entry, the BS may direct the (M)SS to change its FA, which may be done for traffic balancing. In general, we are in due consideration of changing FAs under the following two cases:

- In failure of DSA-REQ or DSC-REQ due to resource shortage
- In failure of satisfying QoS for existing service flow because of resource shortage caused by degradation of channel quality

When the FA is changed, the change may be within a MAC domain, or between MAC domains. If the (M)SS is being moved within a MAC domain, then a network re-entry may not be required. If the (M)SS is being moved between MAC domain, then a network re-entry may be required.

Upon entering into the new FA channel, the (M)SS must use the technique specified in the DFAC-REQ Initialization Mode field to determine if it should perform network re-entry, only ranging, or neither.

Figure 2 shows an example of the use of DFAC and its relation to the other IEEE 802.16 MAC messages. Both T_a and T_b timers are used to retransmit the related messages.

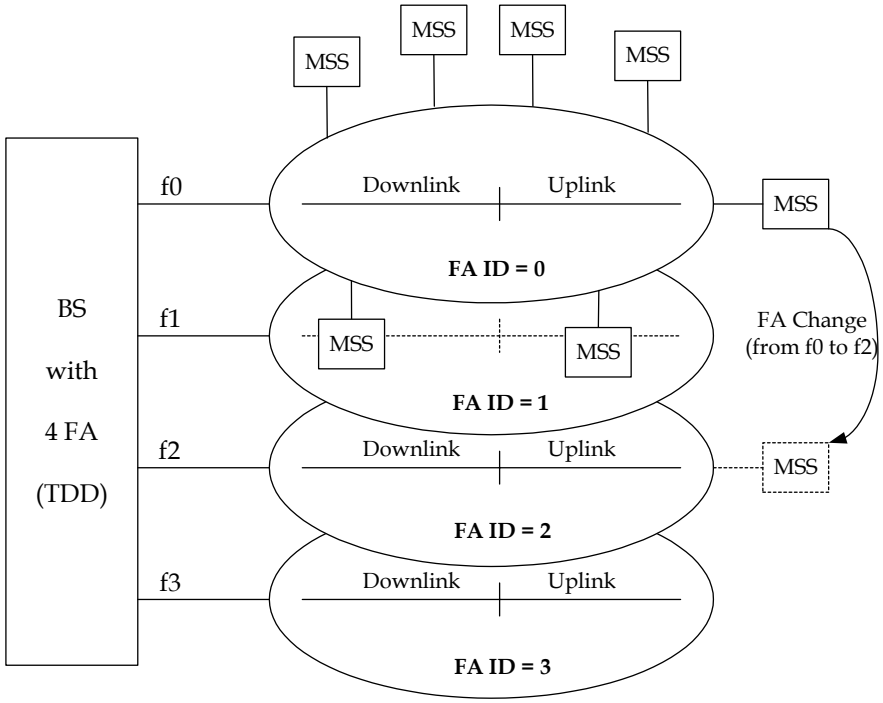

Figure 1 – An example of a BS supporting TDD mode with 4 FAs

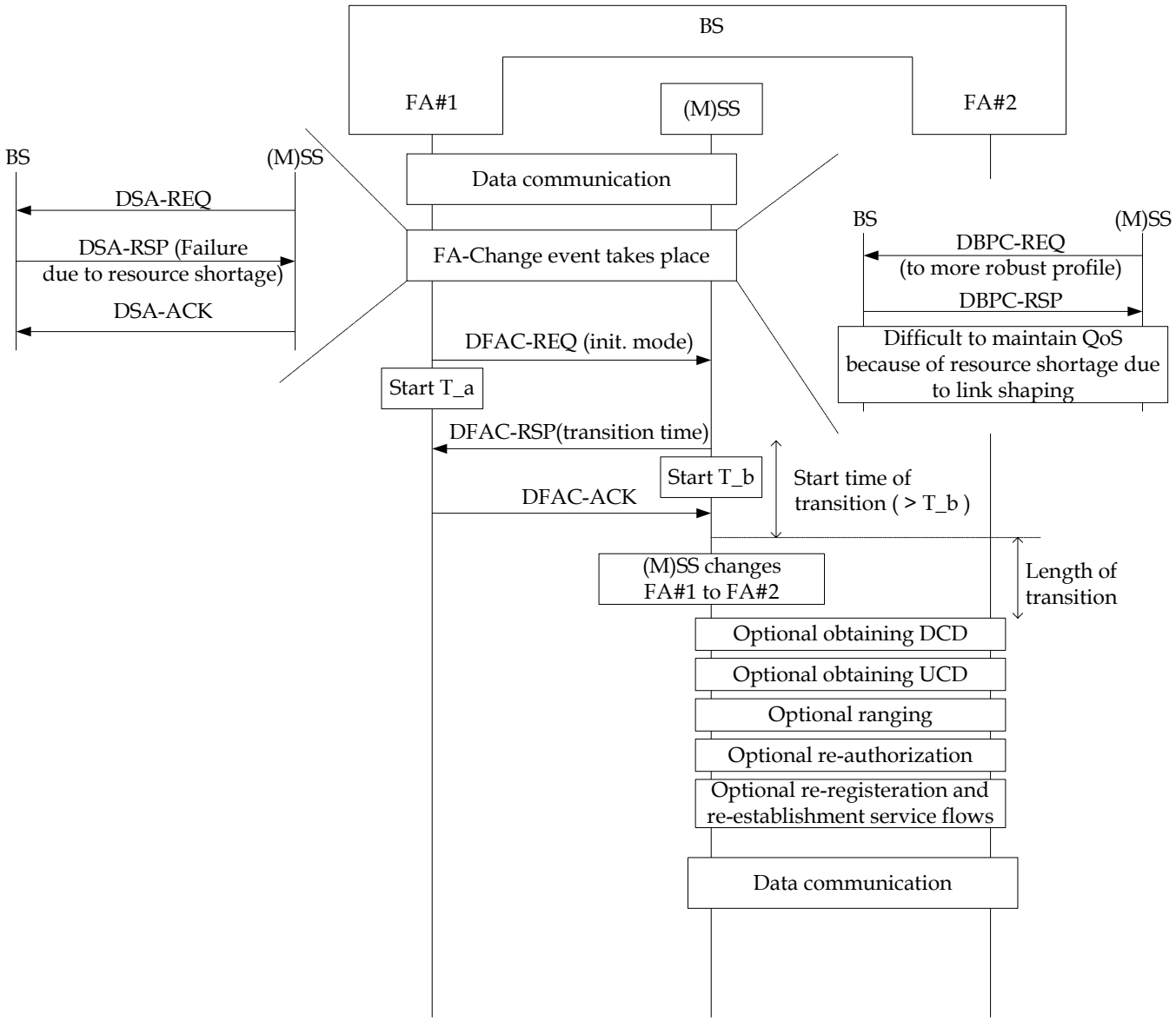

Figure 2 – DFAC Example Operational Flow

2.3 Inter-FA and Inter-BS Handover

TBD

3. Specific Text Change

[Add MAC Management messages to 6.4.2.3 MAC Management messages; editor will make appropriate allocation of numbering for subsection and Management Message Type, and set appropriate Table number nn]:

6.4.2.3.?? Dynamic Frequency Assignment Change Request (DFAC-REQ) Message

A Dynamic Frequency Assignment Change Request may be transmitted by a BS to cause a (M)SS to change the FA on which it is transmitting and receiving. The DFAC-REQ message shall be sent on the primary CID.

Table xxx— DFAC-REQ Message Format

Syntax	Size	Notes
DFAC-REQ_Message_Format() {		
Message Type = ??	8 bits	
Transaction ID	16 bits	
FA ID	8 bits	
Initialization Mode	8 bits	0x00 = Perform network re-entry 0x01 = Perform contention-based initial-ranging 0x02 = Perform non-contention based initial-ranging 0x03 = Perform either contention-based initial-ranging or non-contention based initial-ranging 0x04 = Use the new FA directly without network re-entry 0x05 – FF = reserved
TLV Encoded Information	Variable	TLV specific
}		

A BS shall generate DFAC-REQ message in the form shown in Table xxx, including the following parameters:

Transaction ID

Unique Identifier for this transaction assigned by the sender.

FA ID

The identifier of the FA to which the (M)SS is to switch.

Initialization Mode

This field allows the BS to indicate the MSS as to what level of re-initialization, if any, it should perform before it can resume data communications on the new FA.

Initialization mode value:

0x00 = Perform network re-entry

0x01 = Perform contention-based initial-ranging on new FA before normal operation

0x02 = Perform non-contention based initial-ranging on new FA before normal operation. In this mode, the BS shall place a Fast_UL_ranging_IE in the UL-MAP message.

0x03 = Perform either contention-based initial-ranging or non-contention based initial-ranging on new FA before normal operation

0x04 = Use the new FA directly without network re-entry

0x05 – FF = reserved

The DFAC-REQ may include the following parameters encoded as TLV tuples:

DCD_setting

The DCD_settings is a compound TLV value that encapsulates a DCD message that may be transmitted in the new FA. This

information is intended to enable fast synchronization of the MSS with the new FA. The DCD settings field shall contain only new FA's DCD TLV values which are different from the current FA corresponding values. For values that are not included, the MSS shall assume they are identical to the current FA's corresponding vlaues.

UCD_setting

The UCD_settings is a compound TLV value that encapsulates a UCD message that may be transmitted in the new FA. This information is intended to enable fast synchronization of the MSS with the new FA. The UCD settings field shall contain only new FA's UCD TLV values which are different from the current FA corresponding values. For values that are not included, the MSS shall assume they are identical to the current FA's corresponding vlaues.

SAID Substitution

A pair of Security Association Identifiers (SAID) which containthe current SAID and the new SAID for the new FA. This TLV occurs if the SAID requires substitution.

CID_update

The CID_update is a compound TLV value that provides a shorthand method for renewing active connections used by the MSS in its current FA. The TLVs specify CID in the new FA that shall replace active CID used in the current FA. Multiple interations of these TLVs may occur in the DFAC-REQ suitable to re-creating and re-assigning all active Service Flows for the MSS from its current FA including Basic, Primary and Secondary CIDs. If any of the Service Flow parameters change, then those Service Flow parameters and CS parameter encoding TLVs that have changed will be added. Only active Service Flows are transfered in this manner.

If Privacy is enabled, the DFAC-REQ message shall include the following TLV value:

HMAC Tuple

The HMAC Tuple attribute contains a keyed Message digest (to authenticate the sender). The HMAC Tuple attribute must be the final attribute in the DFAC message's attribute list.

6.4.2.3.?? Dynamic Frequency Assignment Change Response (DFAC-RSP) Message

A Dynamic Frequency Assignment Change Response shall be generated in response to a received DFAC-REQ message. The DFAC-RSP message shall be sent on the primary CID.

Table xxx— DFAC-RSP Message Format

Syntax	Size	Notes
DFAC-RSP_Message_Format() {		
Message Type = ??	8 bits	
Transaction ID	16 bits	
Confirmation Code	8 bits	
Start Time of Transition	8 bits	In unit of frame
Length of Transition	8 bits	In Unit of frame

HMAC Tuple	168 bits	
}		

A MSS shall generate DFAC-RSP message in the form shown in Table xxx, including the following parameters:

Transaction ID

A transaction ID from corresponding DFAC-REQ.

Confirmation Code

The appropriate Confirmation Code (CC) for the corresponding DFAC-REQ. Confirmation Codes for DFAC should be added in Table 338.

Start Time of Transition

This field allows the MSS to indicate to the BS when the MSS plans to perform its transition and be disconnected from the current FA. With this information, the BS may take preventative measures to minimize or to eliminate packet drops in the downlink due to the FA change.

Length of Transition

This field indicates to the BS the length of the transition from the current FA to the new FA. It represents the length of time that the MSS will not be able to receive data in the downlink. With this information, the BS may take preventative measures to minimize or to eliminate packet drops in the downlink due to the FA change.

If Privacy is enabled, the DFAC-REQ message shall include the following field:

HMAC Tuple

The HMAC-Digest attribute contains a keyed Message digest (to authenticate the sender). The HMAC-Digest attribute must be the final attribute in the DFAC message's attribute list.

6.4.2.3.?? Dynamic Frequency Assignment Change Acknowledge (DFAC-ACK) Message

A Dynamic Frequency Assignment Change Acknowledge shall be transmitted by a BS in response to a received DFAC-RSP message. The DFAC-ACK message shall be sent on the primary CID.

Table xxx— DFAC-ACK Message Format

Syntax	Size	Notes
DFAC-ACK_Message_Format() {		
Message Type = ??	8 bits	
Transaction ID	16 bits	
HMAC Tuple	168 bits	
}		

A BS shall generate DFAC-ACK message in the form shown in Table xxx, including the following parameters:

Transaction ID

A transaction ID from corresponding DFAC-RSP.

If Privacy is enabled, the DFAC-REQ message shall include the following field:

HMAC Tuple

The HMAC Tuple attribute contains a keyed Message digest (to authenticate the sender). The HMAC Tuple attribute must be the final attribute in the DFAC message's attribute list.