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Abstract	The document contains clarification for FBSS functionality
Purpose	This document should be considered during comment resolution procedure
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FBSS Clarification

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1. Background

There are some unclear elements in specification of FBSS. Suggested update fixes most of them, but do no touch SHO.

1. Combining all definitions related to SHO and FBSS in a single section is not justified as applicability conditions for SHO and FBSS are different
2. Section 6.3.20.2.6 says "When operating in FBSS, the MSS only communicates with the Anchor BS for UL and DL messages and traffic". Seems reasonable to clarify that in FBSS MSS communicates only to current Anchor BS.
3. Section 6.3.20.2 says: "The section defines the HO process in which an MSS migrates from the air-interface provided by one BS to the air-interface provided by another BS. The HO process consists of the stages:

   ….

   — Network Re-entry

   …..

   — Termination of Service

   This definition obviously is not applicable to FBSS. So the question is whether FBSS is really a particular case of HO as defined in the rest of 6.3.20.2? Seems that proper answer is "No, it is a different procedure though they have something in common". Suggested remedy calls FBSS just a "FBSS procedure", NOT a particular case of HO.
4. It is not clear from the text at which BS the MSS is registered while in SHO/FBSS state, what happens with connections etc. So clarification added

2. Suggested remedy

[Move the following text from 6.3.20.2, p. 130, line 40 to the beginning of new section 6.3.20.3]

6.3.20.3 Soft Handover and Fast BS Switching

In addition to the HO procedures specified in 6.3.20.3, there are two similar procedures, SHO and FBSS. The SHO or FBSS capability can be enabled or disabled in the REG-REQ/RSP message exchange. With SHO or FBSS enabled, when working in a SHO or FBSS mode, the MSS shall perform the following stages:
— SHO Decision - A SHO begins with a decision for an MSS to transmit to and receive from multiple BSs at the same time interval. A SHO can be triggered by start with either MOB_MSSHO-REQ or MOB_BSHO-REQ messages.
— FBSS HO Decision - A FBSS handover begins with a decision for an MSS to monitor and be synchronized

with receive / transmit data from / to multiple BSs at the same time while transmits/receives from the Anchor BS that may change within Active Set. A FBSS handover can be triggered by either MOB_MSSHO-REQ or MOB_BSHO-REQ messages.
— Active Set Selection/Update - An MSS is required may to scan the neighbor BS and select BSs that are suitable to be included in the active set. The MSS shall report the selected BSs and the active set update procedure shall be performed by the BS and the MSS.
— -Anchor BS Selection/Update - An MSS is required to continuously monitor the signal strength of the BSs that are included in the active set. The MSS shall select one BS from its current Active Set to be the Anchor BS and reports the selected Anchor BS on CQICH or MOB-_MSSHO-REQ message.

If MOB_BSHO-RSP specifies another HO type value than requested by MOB_MSSHO-REQ (for example, MSS requested HHO and BS prescribe SHO/FBSS), then MSS should perform procedure specified by BS.

MSS should perform procedure specified by BS in HO Type field of MOB_BSHO-REQ.

When an Active Set and an Anchor BS are maintained at the MSS and the BS, the BS can decide to put the MSS SHO or FBSS on a per burst allocation basis, based on factor such as QoS of a particular service flow being transmitted.

[Move the following text from 6.3.20.2.6 to new section 6.3.20.3.1 with changes according to markup]
6.3.20.3.1 SHO Decision and Initiation

Support of SHO is optional for both MSS and BS.

For MSS and BS that support SHO, the MSS and the BS shall maintain a list of BSs that are involved in SHO with the MSS. The list is called the Active Set. Among the BSs in the Active Set, an Anchor BS is defined. Regular operation when MSS is registered at a single BS is a particular case of SHO with Active Set consisting of single BS, which in this case shall be the Anchor BS.When operating in SHO, the MSS communicates with all BSs in the Active Set for UL and DL unicast messages and traffic.

There are two methods for the MSS to monitor DL control information (i.e. DL-MAP, UL-MAP and FCH) and DL broadcast messages. The first method is the MSS monitors only the Anchor BS for DL control information and DL broadcast messages. In this case, the DL-MAP and UL-MAP of the Anchor BS may contain burst allocation information for the non-Anchor Active BS. The second method is the MSS monitors all the BSs in the Active Set for DL control information and DL broadcast messages. In this case, the DL-MAP and UL-MAP of any Active BS may contain burst allocation information for the other Active BSs. The method to be used by MSS is defined during the SBCREG-REQ and SBCREG-RSP handshake.

A SHO begins with a decision for an MSS to transmit/receive unicast messages and traffic from multiple BSs at the same time interval. For DL SHO, two or more BSs provide synchronized transmission of MSS downlink data such that diversity combining can be performed by the MSS. For UL SHO, the transmission from a MSS is

received by multiple BSs such that selection diversity of the information received by multiple BSs can be performed.

The BS supporting SHO shall broadcast the DCD message that includes the H_Add Threshold and H_Delete Threshold. These thresholds are used by the FBSS/SHO capable MSS to determine if MOB_MSSHO-REQ should be sent. When long-term CINR of a serving BS is less than H_Delete Threshold, the MSS shall send MOB_MSSHO-REQ to requires dropping this serving BS from the active set; when long-term CINR of a neighbor BS is higher than H_Add Threshold, the MSS shall send MOB_MSSHOREQ to require adding this neighbor BS to the active set. The decision to update the Active Set or Anchor BS begins with a notification by the MSS through the MOB_MSSHO-REQ MAC management message or by the BS through the MOB_BSHO-REQ management message. Acknowledgement with MOB_BSHO-RSP of a notification is required, but one with MOB_BSHO-RSP is recommended by not required.

If an MSS that transmitted a MOB_MSSHO-REQ message detects an incoming MOB_BSHO-REQ message, it may respond with a MOB_MSSHO-REQ or MOB_HO-IND message and ignore its own previous request. Similarly, a BS that transmitted a MOB_BSHO-REQ message and detects an incoming MOB_MSSHO-REQ or MOB_HO-IND message from the same MSS shall ignore its own previous request.

The BSs involved in SHO with a MSS shall use the same set of CIDs for the connections that are established with the MSS. BS may assign a new set of CIDs to the MSS during Active Set update through MOB_BSHO-REQ message and MOB_BSHO-RSP message

There are several conditions that are required to enable soft handover between MSS and a group of BSs. These conditions are listed below:

—   BSs involving in SHO HO are synchronized based on a common time source
—   The frames sent by the BSs involving in SHO/FBSS HO at a given frametime arrive at the MSS within the prefix interval
—   BSs involving in SHO HO have synchronized frame structures
—   BSs involving in SHO HO have the same frequency assignment
—   BSs involving in SHO HO are required to have full sharing or transfer of MSS related MAC context. Such context includes all information MSS and BS normally exchange during Network Entry, particularly authentication state, so that an MSS authenticated / registered with one of BSs from active set BSs is automatically authenticated / registered with other BSs from the same active set. The context includes also set of Service Flows and corresponding connections associated with MSS (e.g. ARQ state, current authentication and encryption keys, CIDs), state of timers, fragmentation and packing etc.
—   The same MAC/PHY PDUs shall be multicast by the BSs involving in SHO to the MSS

[Add new section]
6.3.20.3.2 FBSS Decision and Initiation

Support of FBSS is optional for both MSS and BS.

For MSS and BS that support FBSS, the MSS and the BS shall maintain a list of BSs that are involved in FBSS with the MSS. The list is called the Active Set. Among the BSs in the Active Set, an Anchor BS is defined. Regular operation when MSS is registered at a single BS is a particular case of FBSS with Active Set consisting of single BS, which in this case shall be the Anchor BS. When operating in FBSS, the MSS only communicates with the Anchor BS for UL and DL messages including management and traffic connections. Transition from one Anchor BS to another ("switching") is performed without invocation of HO procedure described in 6.3.20.2. Anchor update procedure is defined in section 6.3.20.3.4.

The BS supporting FBSS shall broadcast the DCD message that includes the H_Add Threshold and H_Delete Threshold. These thresholds may be used by the FBSS capable MSS to determine if MOB_MSSHO-REQ should be sent to request switching to another Anchor BS or changing Active Set. When mean CINR of a BS is less than H_Delete Threshold, the MSS may send MOB_MSSHO-REQ to request dropping this BS from the active set; when mean CINR of a neighbor BS is higher than H_Add Threshold, the MSS may send MOB_MSSHO-REQ to request adding this neighbor BS to the active set. In each case Anchor BS responds with MOB_BSHO-RSP with updated Active Set.

Process of updating Active Set begins with MOB_MSSHO-REQ from MSS or MOB_BSHO-REQ from the Anchor BS. Process of Anchor BS update may also begin with MOB_MSSHO-REQ from MSS or MOB_BSHO-REQ from the Anchor BS or it may begin with Anchor switching indication via Fast Feedback channel.

If an MSS that transmitted a MOB_MSSHO-REQ message detects an incoming MOB_BSHO-REQ message, it may respond with a MOB_MSSHO-REQ or MOB_HO-IND message and ignore its own previous request. Similarly, a BS that transmitted a MOB_BSHO-REQ message and detects an incoming MOB_MSSHO-REQ or MOB_HO-IND message from the same MSS shall ignore its own previous request.

There are several conditions that are required to enable Fast BS Switching handover between MSS and a group of BSs. These conditions are listed below:

—   BSs involving in FBSS are synchronized based on a common time source
—   The frames sent by the BSs from Active Set arrive at the MSS within the prefix interval
—   BSs involving in FBSS have synchronized frames
—   BSs involving in FBSS operate at same frequency channel
—   BSs involving in FBSS are also required to share or transfer MAC context. Such context includes all information MSS and BS normally exchange during Network Entry, particularly authentication state, so that an MSS authenticated / registered with one of BSs from active set BSs is automatically authenticated / registered with other BSs from the same active set. The context includes also set of Service Flows and corresponding mapping to connections associated with MSS, current authentication and encryption keys associated with the connections.

[Move sections 6.3.20.2.6.1-2 to new section 6.3.20.3 with following changes]
6.3.20.3.3. 2.6.1 Active Set Update for SHO/FBSS

When MOB_MSSHO-REQ is sent by an MSS, the MSS may provide ~~indicate~~ possible list of BSs to be included in the MSS' Active Set. The MSS may evaluate the possible list of BSs through the received MOB_NBR-ADV MAC management message, and previously performed signal strength measurement, propagation delay measurement, scanning, ranging, and association activity. When MOB_BSHO-RSP is sent by the ~~serving~~ Anchor BS or BSs in the MSS' current Active Set, the BSs may ~~indicate~~ provide list of BSs ~~the~~ recommended ~~list of BSs to be~~ for incorporation into ~~included in~~ the MSS' Active Set.

When MOB_BSHO-REQ is sent by the ~~serving~~ Anchor BS or BSs in the MSS' current Active Set, the BSs may ~~indicate~~ provide ~~the~~ recommended list of BSs to be included in the MSS' Active Set. The ~~BSs~~ criteria for the recommendation may be based on ~~include factors such as~~ expected ~~recommended BSs~~ QoS performance, to MSS requirements and list of BSs that can be involved in SHO/FBSS as broadcast in MOB_NBR-ADV. ~~When MOB_MSSHORSP is sent by the MSS, the MSS may indicate the recommended list of BSs to be included in the MSS' Active Set. The MSS criteria for the recommendation may include factors such as previously performed signal strength measurement, propagation delay measurement, scanning, ranging, and association activity.~~ MSS actual ~~pursuit of handover with the~~ update of Active Set, ~~BSs~~ as listed in MOB_BSHO-RSP ~~MOB_xxxHO-RSP~~ is recommended, but not required. However, the actual Active Set chosen by the MSS shall be a subset of those listed in MOB_BSHO-RSP ~~MOB_xxxHO-RSP~~ and shall be indicated in MOB_HO-IND, with SHOFBSS_IND_type field in MOB_HO-IND set to '00'(confirm Active Set update). The MSS may reject the ~~SHO/FBSS instruction~~ Active Set recommended by the Anchor BS ~~by the BS,~~ by setting the SHOFBSS_IND_type field in MOB_HO-IND to '10' (Active Set update reject). The BS may reconfigure the Active Set ~~BSs~~ list and retransmit MOB_BSHO-RSP message to the MSS.

After an MSS or BS has initiated an Active Set update using MOB_MSSHO/BSHO-REQ, the MSS may cancel the Active Set update at any time. The cancellation shall be made through transmission of a MOB_HO-IND with SHOFBSS_IND_type field set to '01'.
~~If the MSS is operating in SHO or FBSS, when adding a new BS to the MSS' Active Set, the network entry procedures as depicted in Figure 0a are not required and shall not be performed by the MSS.~~ If the MSS is operating in FBSS, when adding a new BS to the MSSs' Active Set, the MSS may initiate ~~optionally perform~~ ranging with newly added BS.
~~but shall not perform the rest of the procedures in Figure 0a, namely, perform re-authorization, reregister/ re-establish service flows, and re-establish IP connectivity.~~

6.3.20.3.4 ~~2.6.2~~ Anchor BS Update for SHO/FBSS

There are two mechanisms for the MSS and BS to perform Anchor BS update. The first mechanism is by using the HO MAC management messages. The second mechanism is by using the fast Anchor BS selection feedback ~~mechanism~~. The preferred Anchor BSs shall be within the current Active Set of the MSS. The MSS may select the preferred Anchor BS through the previously performed signal strength measurement. The BS decides the target Anchor BS based on the MSS report. MSS and BS supporting SHO or FBSS shall ~~use~~ implement one of the two mechanisms to perform Anchor BS update. ~~A BS need not use the same mechanism for each MSS supported in this manner.~~

[Move sections 6.3.20.2.6.2.1, 6.3.20.2.6.2.2 to 6.3.20.3 with no changes to form 6.3.20.3.4.1, 6.3.20.3.4.2]

[Modify section 6.3.2.3.51:]

6.3.2.3.51 BS HO Request (MOB_BSHO-REQ) message

Syntax	Size	Notes
MOB_BSHO-REQ_Message_Format() {		
Management Message Type = 56	8 bits	
Network Assisted HO supported	1 bit	Indicates that the BS supports Network Assisted
Mode	3 bits	000: HHO request 001: SHO/FBSS request: Anchor BS update with CID update 010: SHO/FBSS request: Anchor BS update without CID update 011: SHO/FBSS request: Active Set update with CID update 100: SHO/FBSS request: Active Set update without CID update 101: SHO/FBSS request: Active Set update with CID update for newly added BS 110: SHO/FBSS request: Active Set update with CID update and CQICH allocation for newly added BS 111: reserved
If (Mode == 0b000) {		
…..		
}		
else if (Mode == 0b001) {		
……		
}		
else if (Mode == 0b011) {		
…….		
}		
else if (Mode == 0b100) {		
N_new_BSs	3 bits	Number of new BSs which are recommended to be added to the Active Set of the MSS
For (j=0 ; j<N_new_BSs ; j++) {		
Neighbor BSID	48 bits	
Temp BSID	3 bits	Active Set member ID assigned to this BS
~~Service level prediction~~	~~8 bits~~	
}		
N_current_BSs	3 bits	Number of BSs currently in the Active Set of the MSS, which are recommended to be remained in the Active Set
…….		
}		
else if (Mode == == 101) {		
N_new_BSs	3 bits	Number of new BSs which are recommended to be added to the Active Set of the MSS
N_CIDs	8 bits	Number of CIDs needed to be reassigned
for (i= 0; i < N_new_BSs; i++) {		
Neighbor BS_ID	48 bits	
TEMP_BS_ID	3 bits	Active Set member ID assigned to this BS
~~Service level prediction~~	~~8 bits~~	
for (j= 0;j<N_CIDs;j++) {		
………		

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}		
…….		
}		
else if (Mode == 110) {		
N_new_BSs	3 bits	Number of new BSs which are recommended to be added to the Active Set of the MSS
N_CIDs	8 bits	Number of CIDs needed to be ~~reassigned~~ allocated
for (i= 0; i < N_new_BSs; i++) {		
Neighbor BS_ID	48 bits	
TEMP_BS_ID	3 bts	Active Set member ID assigned to this BS
~~Service level prediction~~	~~8 bits~~	
…..		
}		
Action time	8 bits	~~Recommended action time when the Active Set shall be updated~~
padding	variable	Padding bits to ensure byte aligned
HMAC Tuple	21 bytes	See 11.1.2

~~New CID - New CIDs are enumerated by the ascending order of corresponding current CIDs. The MSS shall store the CIDs associated with the newly added BS and using the CIDs when the newly added BS becomes the anchor BS.~~

A BS shall generate MOB_BSHO-REQ messages in the format shown in Table 106j. The following parameters shall be included in the MOB_BSHO-REQ message:
…..

Mode
indicates which HO mode is for this handover request.
0b000: HHO request
0b001: SHO/FBSS request: Anchor BS update with CID update
0b010: SHO/FBSS request: Anchor BS update without CID update
0b011: SHO/FBSS request: Active Set update with CID update
0b100: SHO/FBSS request: Active Set update without CID update
0b101: SHO/FBSS request: Active Set update with CID update for newly added BS
0b110: SHO/FBSS request: Active Set update with CID update and CQICH allocation for newly added BS
0b111: reserved

Resource ~~Remain~~ Retain Type
The Resource ~~Remain~~ Retain Type flag indicates whether the serving BS will retain or delete the connection information of the MSS upon receiving MOB_HO-IND with HO_IND_type=00. If the flag is set to 1, the serving BS will retain the MSS's connection information during the time in Resource Retain Time field. If Resource ~~Remain~~ Retain Type=1 and Resource Retain Time is not included as a TLV item

in the message, then the serving BS and MSS shall use the System Resource Retain Time timer. If the flag is set to 0, the serving BS will discard the MSS's connection information.

Action Time

For HHO, this value is defined as number of frames until the Target BS allocates a non-contention based ranging opportunity for the MSS. For SHO/FBSS, this is the time of update of Anchor BS and/or Active Set. A value of zero in this parameter signifies that this parameter should be ignored.

HMAC Tuple (see 11.1.2)

The HMAC Tuple Attribute contains a keyed Message digest (to guarantee the origin and integrity of the message). The HMAC Tuple shall be the last item in the message

…..
[Insert the following to Page 92 line 32:]

For Mode != 0b000, the following parameters shall be included:

N_new_BSs - Number of new BSs which are recommended to be added to the Active Set of the MSS

N_CIDs - Number of CIDs needed to be allocated

TEMP BSID – Index to active set for active BS ranging from 0 to 7

[Modify the following section:]
6.3.2.3.53 BS HO Response (MOB-_BSHO-RSP) message

Syntax	Size	Notes
MOB-_BSHO-RSP_Message_Format() {		
Management Message Type = 58	8 bits	
Mode	3 bits	0b000: HHO request 0b001: SHO/FBSS request: Anchor BS update with CID update 0b010: SHO/FBSS request: Anchor BS update without CID update 0b011: SHO/FBSS request: Active Set update with CID update 0b100: SHO/FBSS request: Active Set update without CID update 0b101: SHO/FBSS request: Active Set update with CID update for newly added BS 0b110: : SHO/FBSS request: Active Set update with CID update and CQICH allocation for newly added BS 0b111: reserved
If (Mode == 0000) {		
…..		
}		
……		
else if (Mode == 0b011) {		
N_new_BSs	3 bits	Number of new BSs which are recommended to be added to the Active Set of the MSS
For (j=0 ; j<N_new_BSs ; j++) {		
Neighbor BSID	48 bits	
Temp BSID	3 bits	Active Set member ID assigned to this BS
Service level prediction	8 bits	
}		
….		
}		
else if (Mode == 0b100) {		
N_new_BSs	3 bits	Number of new BSs which are recommended to be added to the Active Set of the MSS
For (j=0 ; j<N_new_BSs ; j++) {		
Neighbor BSID 48 bits		
Temp BSID	3 bits	Active Set member ID assigned to this BS
Service level prediction		
…..		
}		

else if (Mode == 0b101) {		
N_new_BSs	3 bits	Number of new BSs which are recommended to be added to the Active Set of the MSS
N_CIDs	8 bits	Number of CIDs needed to be reassigned
For (j=0 ; j<N_new_BSs ; j++) {		
Neighbor BSID 48 bits		
Temp BSID	3 bits	Active Set member ID assigned to this BS
~~Service level prediction~~	~~8 bits~~	
…..		
}		
else if (Mode == 0b110) {		
N_new_BSs	3 bits	Number of new BSs which are recommended to be added to the Active Set of the MSS
N_CIDs	8 bits	Number of CIDs needed to be reassigned
For (j=0 ; j<N_new_BSs ; j++) {		
Neighbor BSID 48 bits		
Temp BSID	3 bits	Active Set member ID assigned to this BS
~~Service level prediction~~	~~8 bits~~	
…..		
}		
Action time	8 bits	~~Recommended action time when the Active Set shall be updated~~
~~Estimated HO start~~	~~8 bits~~	
Resource Remain Type	1 bit	0: MSS resource release 1: MSS resource retain
padding	Variable	Padding bits to ensure byte aligned
TLV encoded information	Variable	TLV specificpadding
HMAC Tuple	21 bytes	See 11.1.2

~~New CID - New CIDs are enumerated by the ascending order of corresponding current CIDs. The MSS shall store the CIDs associated with the newly added BS and using the CIDs when the newly added BS becomes the anchor BS.~~

A BS shall generate MOB-_BSHO-RSP messages in the format shown in Table 106l. The following parameters shall be included in the MOB_BSHO-RSP message,

~~Estimated HO start~~Action Time
 For HHO, this value is defined as number of frames until the Target BS allocates a non-contention based ranging opportunity for the MSS. For SHO/FBSS, this is the time of update of Anchor BS and/or Active Set.
 A value of zero in this parameter signifies that this parameter should be ignored.

......

[Insert the following to Page 92 line 32:]

For Mode=0b01, the following parameters shall be included:

11

N_new_BSs - Number of new BSs which are recommended to be added to the Active Set of the MSS

N_CIDs - Number of CIDs needed to be allocated

TEMP BSID – Index to active set for active BS ranging from 0 to 7

New CID - New CIDs are enumerated by the ascending order of corresponding current CIDs. The MSS shall store the CIDs associated with the newly added BS and using the CIDs when the newly added BS becomes the anchor BS.

[Add a new feedback type to Feedback Header on Table 7b, to support SHO combined CQI reporting:]

Table 7b. Feedback Type and feedback content.

Feedback Type	Feedback contents	Description
0b0111	Number of feedback types, O (2 bits) + O occurrences of 'feedback type (4bits) + feedback content (variable)'	Multiple types of feedback
0b1000	Combined CQI of Active BSs (5 bits).	Combined CQI value of all Active BSs within the Active Set.
0b10001-0b1111	Reserved for future use	

[Add a new paragraph at the end of section 6.3.20.2.6, to clarify the reporting of anchor BS CQI and the reporting of combined CQI of all active BSs:]

If SHO support is negotiated, the BS may assign UL resource to the MSS to send combined CQI of active BSs using the Feedback header. The BS may also assign Fast Feedback channel or Enhanced Fast Feedback channel for CQI feedback. When such a channel is assigned, the MSS shall report the CQI of the Anchor BS on the channel.

1. References

[1]   IEEE 802.16- 2004 IEEE Standards for local and metropolitan area networks part 16: Air interface for fixed broadband wireless access systems
[2]   IEEE P802.16e-D5a-2004