Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Comments on IEEE 802.16e Handoff Draft**
Date Submitted	**2003-03-11**
Source(s)	Changhoi Koo Jungje Son Sohyeon Kim Panyuh Joo Samsung Elec. IT center 21st fl. Maetan 3 dong, Paldalgu Suwon, Kyungido Korea Voice: +82-31-279-5091 Fax: +82-31-279-5130 chkoo@samsung.com Junje.son@samsung.com binde.kim@samsung.com panyuh@samsung.com
Re:	Call for inputs for the Handoff Ad-hoc group
Abstract	This documents is to make a set of comments and modifications on Handoff AdHoc document.
Purpose	Some of comments would be adopted into Draft Handoff proposal generated by HO AdHoc group.
Notice	
Release	
Patent Policy and Procedures	

HO mechanism for IEEE 802.16e

1 HO parameters and definitions

1.1 Definitions

Mobile Subscriber Station (MSS) – IEEE 802.16e based SS that supports mobile functionality. [This terms requires its own definition. It is suggested that we revise this definition in a later stage].

Base Station Sector (BSS) – Part of an IEEE 802.16e BS, which provides a single instance of the IEEE802.16e air-interface on a single radio frequency channel. [This definition may be superfluous, if we don't have any entity operating at the multi-sector level. It is suggested that we revise this definition in a later stage].

Base Station (BS) - A fixed station used for communicating with Mobile Subscriber Stations. Depending upon the context, the term Base Station may refer to a cell, a sector within a cell or other part of the wireless system. (CHKOO : The term Sector depends on implementation and does not need to be specified in the document. Actually, the operator wants to deploy the system as multi-sector, the term BSS will not be suitable anymore. If AdHoc group agree with this changes, the term BSS shall be changed to BS)

Handoff (HO) – The process in which a MSS migrates from the air-interface provided by one BSS to the air-interface provided by another BSS. Two HO variants are defined,

- Hard HO - A HO where service with the new BSS starts after a disconnection of service with the old BSS.
- Soft HO - A HO where service with the new BSS starts before disconnection of the service with the old BSS.

Serving BSS – For any MSS, the serving BSS is the BSS with which the MSS has performed the registration stage of the network-entry process.

Served MSS – For any BSS, these are all the MSS it is the serving BSS of.

Target BSS – The BSS that a MSS intends to be registered with at the end of a HO.

Neighbor BSS(or selected BSS) – For any MSS, a set of ~~neighbor~~ BSS ~~is a BSS~~ whose ~~downlink transmission~~ sufficient signal strength can be demodulated by the MSS.

(CHKOO: Depending upon the HO type(Soft HO or Hard HO), number of neighbor(or selected) BSS shall be defined. In case of soft HO, Neighbor shall be multiple and single in case of hard HO)

HO Triggering ~~Scanning Interval~~ – A triggering operation ~~A time period intended~~ for detecting ~~monitoring~~ neighbor BSS by the MSS, to determine their suitability as targets for HO. HO Triggering is achieved by reporting of the periodic scanning and/or signal strength rank ordering)
(CHKOO : There can be a couple of scanning schemes to trigger the HO. Scanning Interval would be one of such schemes. For example, periodic scanning or event wise triggering, etc.)

Monitored BSS(or Candidate BSS) – A set of BSS that is monitored by the MSS during HO ~~its scanning interval.~~

~~**Selected BSS** – A subset of Monitored BSS, which is selected as potential Target BSS.~~
(CHKOO : this definition can be merged into a concept of Neighbor BSS)

2 Network reference model

2.1 Entities

The network reference model consists of BSS units covering a certain area, and connected by a backbone network. Several such networks, owned by different operators may coexist in the same service area. Each backbone network may contain centralized AAA, management, provisioning or other specialized servers, but the operation of these servers with the BSS and MSS is outside the scope of this specification.

Reference Point	Elements to be Specified by 802.16E
MSS	Mobile Subscriber Station, contains MAC (CS), PHY layers
BSS	Base Station Sector: a single MAC entity covers a single sector. BSS, at the network side, supports functionality similar to Foreign Agent of Mobile IP working in "foreign agent care-of address" mode.
ASA Server(s)	Authentication and Service Authorization Server servicing the whole operator's network. These servers are optional, and may be implemented as a distributed entity. The servers provide functions such as AAA (Authorization, Authentication, Accounting), management and provisioning

Table 1: Mobility Related Entities

Figure 1 shows an example of such a network, where two networks operated by different operators coexist in the same service area. BSS #1 is the serving BSS for the depicted MSS. BSS #2 and BSS #3 are neighbor BSS. Should the depicted MSS move closer to BSS #2, as drawn by dotted line BSS #2 might be the target BSS for an HO. Should the depicted MSS continue movement into the area covered the by BSS #3, it might perform HO to that BSS.

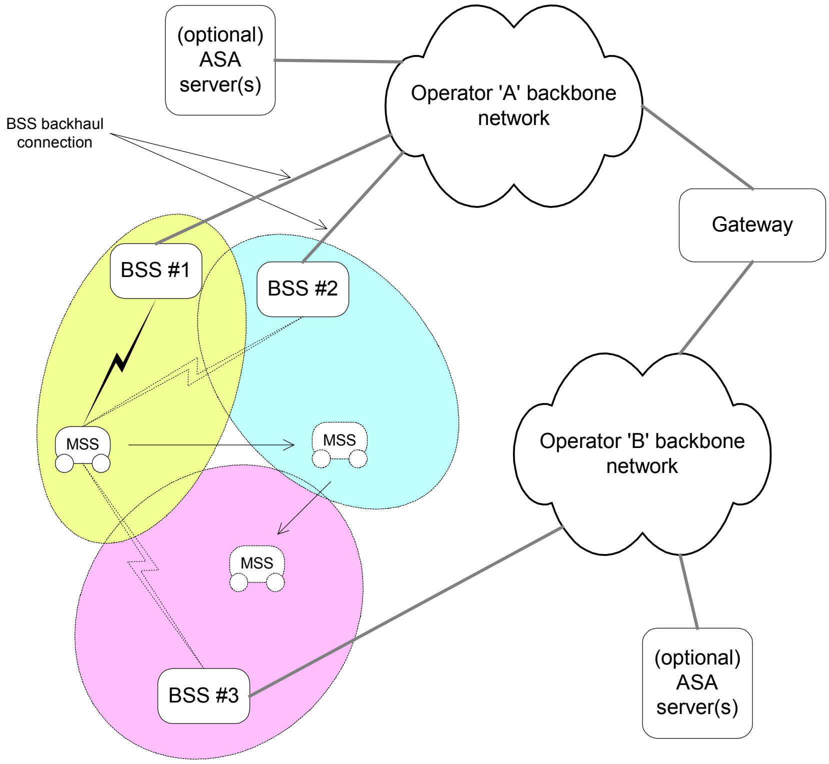


Figure 1: Network model example

Figure 2 shows the network reference model in the data plane.

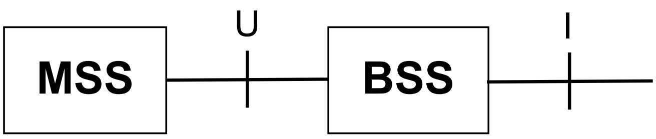


Figure 2: Network reference model, Data Plane

The following reference points are present data plane network model,

Reference Point	Elements to be Specified by 802.16E	Comments
U	PHY, MAC (including CS) operations	
I	None	This point corresponds to data backbone

Table 2: Reference Points at Data Plane

Figure 3 shows the network reference model in the control plane.

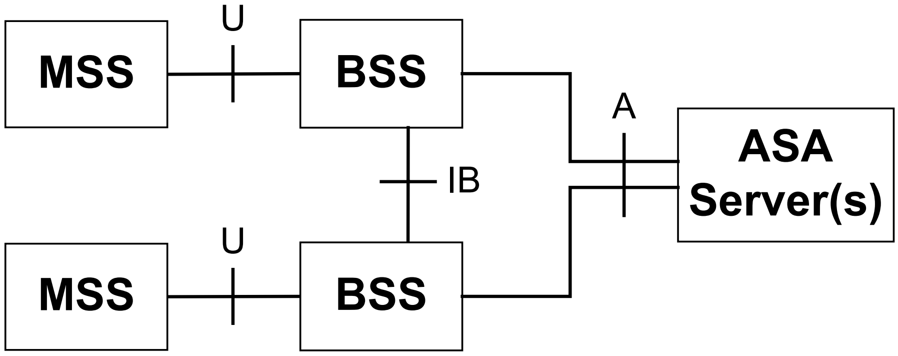


Figure 3: Network reference model, Control Plane

The following reference points are present at the control plane network model

Reference Point	Elements to be Specified by 802.16E	Comments
U	PHY, MAC (including CS) operations, Mobility Sub-layer messages exchange	
IB	BSS-to-BSS messages	Transport protocol is not specified
A	Messages serving MS authentication and service authorization functions	Transport protocol is not specified

Table 3: Reference Points at Control Plane

Note: In the case a BSS is implemented as a set of BSS controlled by a single central controller, IB reference point is located in the controller. This makes inter-cell and intra-cell HO indistinguishable.

(CHKOO : What does mean " a single central controller"? I understand one central controller is connected with a set of BSS and control the BSS during HO. Am I right? If I am correct, how to communicate between BSS and BSS. Do they communicate through a central controller?)

(CHKOO : What does mean "cell"?, I understand that one BSS is a cell which consists of multiple sectors. Am I right? If I am correct, the definition of BSS surely shall be changed. To make firm inter-cell and intra-cell HO, I figure out the diagram as followings.)

(CHKOO : We need to define the role and figure of Central Controller, and the IB interface between BSS and BSS through Controller.)

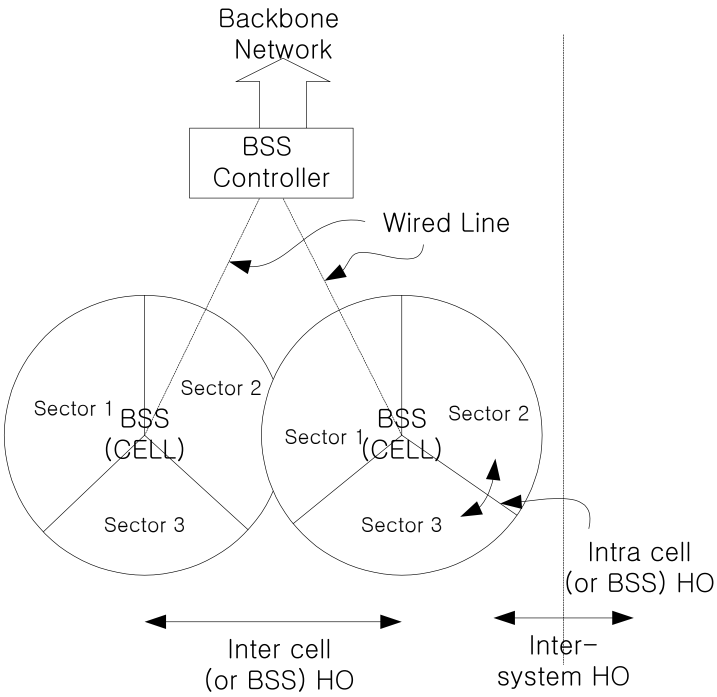


Figure ZZZ. Basic cell concept

2.2 MSS Protocol Stack

No difference here compared to IEEE 802.16a standard.

2.3 BS Protocol Stack

[Should 802.16e specify data backbone protocols and features that support mobility at the backbone? Some reasons to avoid this are,

1) It is out of scope of 802.16E project
2) It would make our work dependent on choices that are yet to be taken by the industry

Instead, certain assumptions could be taken on the nature of the backbone that allows specifying primitives for communication between MAC (CS) and mobility function located at BSS. It might be worthwhile to detail these assumptions in a separated informative section (addendum?) and include examples of specific IP mobility technologies (Mobile IP or Mobile IP/HAWAII etc.)]

The following picture displays BSS protocol stack

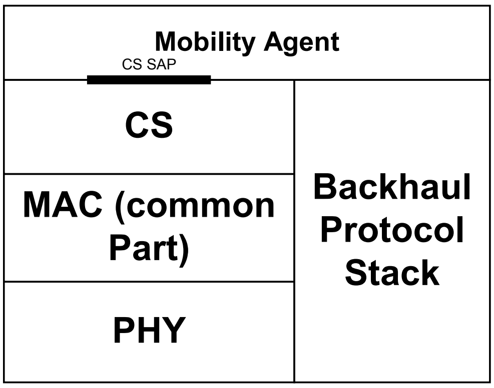


Figure 4: BS Protocol Stack

2.3.1 Mobility Agent (MA) Operations

In addition to regular 802.16 layers, the stack contains Mobility Agent (MA) layer. The functions of MA are similar to functions of Foreign Agent of Mobile IP working in "foreign agent care-of address" mode. Nevertheless, we avoid direct specification of Mobile IP as a protocol that implements mobility features from the backbone side.

MA provides the following functions,

- Termination of tunnel carrying data from MSS home network including de-capsulation of incoming data units
- Communication to CS about
    - After arrival of new MSS to the cell, creation of new connections. This includes
        - Creation of new classifier(s) to forward data to the connections
        - Specification of proper QoS per connection
    - After MS departure, deletion of connections and classifiers

2.3.2 Primitives for Communication Between CS and MA

2.3.2.1 MA to CS: CS_CREATE_CONNECTION.request/response

Generated to trigger creation of new connection servicing a newly arrived MSS; specifies classifier(s) to forward data to the connections and QoS parameters for the connection

[TBD Parameters]

2.3.2.2 MA to CS: CS_TERMINATE_CONNECTION.request/response

Generated to trigger termination of connection(s) after a MSS leaves the cell

[TBD Parameters]

2.3.2.3 MA to CS: CS_SDU.request

Generated to send an SDU to backbone connection

[TBD Parameters]

2.3.2.4 CS to MA: CS_MSS_ARRIVAL.indication

Signals MSS arrival at the cell

[TBD Parameters]

2.3.2.5 CS to MA: CS_MS_DEPARTURE.indication

Signals MSS departure from the cell

[TBD Parameters]

2.3.2.6 CS to MA: CS_SDU.indication

Generated to signal arrival of an SDU from the backhaul connection

[TBD Parameters]

2.4 MSS Service Context

Network Service is defined as a service provided to the MSS by the network through a single MAC connection with particular connectivity and MAC parameters (including QoS properties). Connectivity properties are defined by specification of MSS network address in its Home Network [This term is undefined].

MSS Service Context specifies the set of network services authorized for a given MSS. It is composed of the following elements:

Context Element	Meaning
MSS 48-bit MAC address unique identifier	48-bit unique identifier used by MSS on initial network. This ID does not change while MSS passes from one BSS to another. During HO it is used to refer to specific connectivity (addressing) and properties of MAC connections (including QoS properties)
Number N of Network Service Ies	Number of Network Service Information Elements (NSIEs). Each SIE corresponds to a single data connection
N x NSIE	The structure of SIE is specified below
Number M of Security Associations	Number M of Security Associations established for the MSS.
M x Security Association Descriptor	*TBD*

Table 4: MAC service context

Field	Meaning
Address of MSS at Home Network	IP address of MSS at its Home Network. This address does not change while MSS travels from one BSS to another
MAC Connection Parameters	Connection parameters as specified in [1], section 6.1.1.1.2

Table 5: Service Information Element (SIE) contents

2.5 Transfer of Control Information During HO

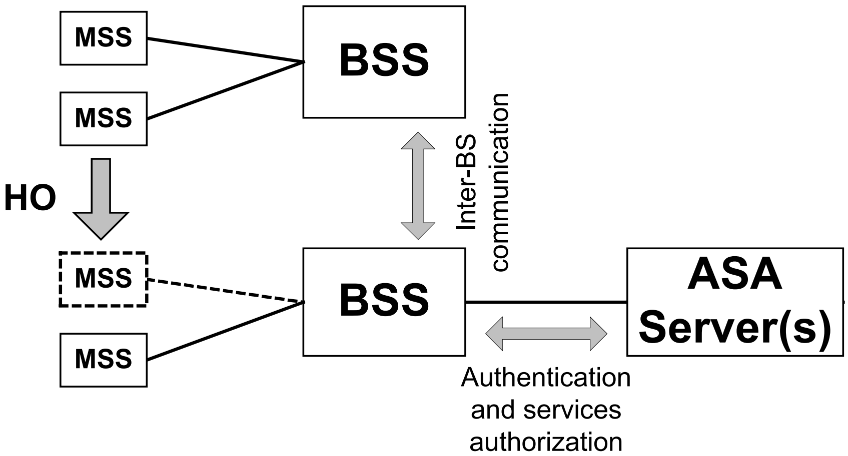


Figure 5: Network Structure (Control Plane) and HO

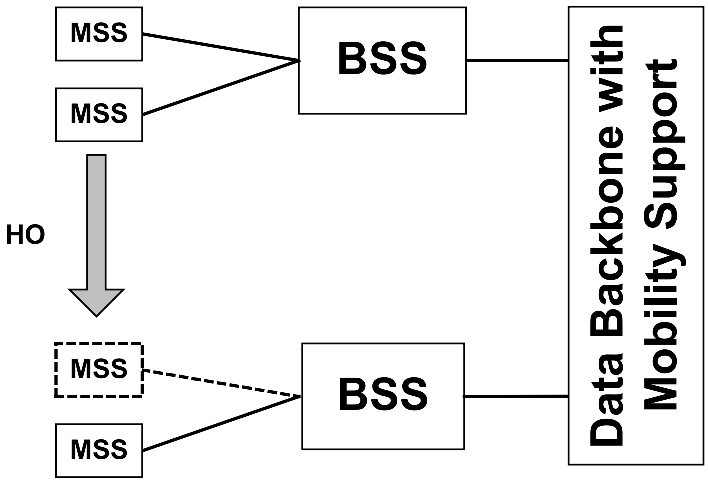


Figure 6: Network Structure (Data Plane) and HO

3 MAC layer HO procedures

This section contains the procedures performed during HO on the air-interface.

3.1 Network topology acquisition

3.1.1 Network topology advertisement

A BSS shall broadcast information about the network topology using the NBR-ADV MAC message. MSS may decode this message to find out information about the parameters of neighbor BSS. Each MSS will thus be able to synchronize quickly with neighbor BSS. [It should be noted in this respect that the neighbor BSS are defined as those a MSS could receive. This means that a BSS does not know its neighbors unless told by its MSS or by the management layer. We should define how the BSS is told who are its neighbors].

3.1.2 MSS Triggering ~~Scanning~~ of neighbor BSS

A BSS may ~~allocate time intervals~~ indicate the triggering scheme to MSS for the purpose of seeking and monitoring neighbor BSS suitability as targets for HO in the DL_MAP (or NBR_ADV). Such a time interval and signal strength will be referred to as a **scanning interval** **and strength rank ordering, respectively**. The BSS may indicate a scanning interal based triggering and/or strength rank ordering for the purpose of seeking and monitoring neighbor BSS suitability as targets for HO. If the BSS indicates the scanning interval based triggering, the MSS shall monitor neighbor BSS based on the allocated scanning interval. If the BSS indicates the strength rank ordering based triggering, the MSS shall monitor the strength measurement changes its relative order with respect to all other signal strength measurements. If the BSS indicates the both, the MSS shall monitor neighbor BSS based on the combination of two triggering schemes. (Note : the flag for indicating the triggering scheme shall be defined in the DL_MAP or NBR_ADV MAC message)

(CHKOO : MSS does not request the any triggering scheme and it could be indicated by the BSS. Furthermore, triggering scheme can be achieved according to MSS's PHY capability)

~~A MSS may request an allocation of a scanning interval using the SCN-REQ MAC message. The MSS indicates in this message the duration of time it requires for the scan, based on its PHY capabilities.~~

~~Upon reception of this message, the BSS shall respond with placement of a Scanning_IE in the DL-MAP. The Scanning_IE shall either grant the requesting MSS a scanning interval that is at least as long as requested by that MSS, or deny the request. The BSS may also place unsolicited Scanning_IE.~~
A MSS, upon detection of a Triggering~~Scanning~~_IE addressed to it in the DL-MAP(or NBR_ADV), shall use the allocated interval and/or rank ordering based on the power level (the signal which should be measured and power level which should be compared : TBD) to seek for neighbor BSS. When neighbor BSS are identified, the MSS shall attempt to synchronize with their downlink transmissions, and estimate the quality of the PHY connection.

A MSS may use HO triggering ~~this interval~~ for UL ranging as well to in a procedure is called **association**. When associating with a neighbor BSS, the MSS shall not only synchronize with neighbor BSS downlink, but shall also perform two additional stages called **association-initial-ranging** and **association-pre-registration**.

The association-initial-ranging shall be performed as described in [1] section 6.2.9.5, except the following,

- Downlink Channel ID shall *differ* from the one specified in UCD message of the target BSS
- SS MAC Address (48-Bit) is required at RNG-REQ/RSP
- CID at MAC Header of RNG-REQ/RSP messages is always the Initial Ranging CID
- Basic CID and Primary Management CID are not assigned to MSS
- BSS may return in RNG-RSP additional TLV parameter: prediction of service level (0 = no service possible for this MSS, 1 = connectivity requested (as determined by the 48-bit MSS MAC address) is available, 2 = connectivity + QoS requested are available). In the latter case MSS marks the target BSS as Associated. Information on Association is reported to the Serving BSS. The target BSS may store information on newly associated MSS. Association state of specific MSS at the BSS shall be aged-out after TBD timeout. [Part of this text should be moved to section 4 and be defined formally].

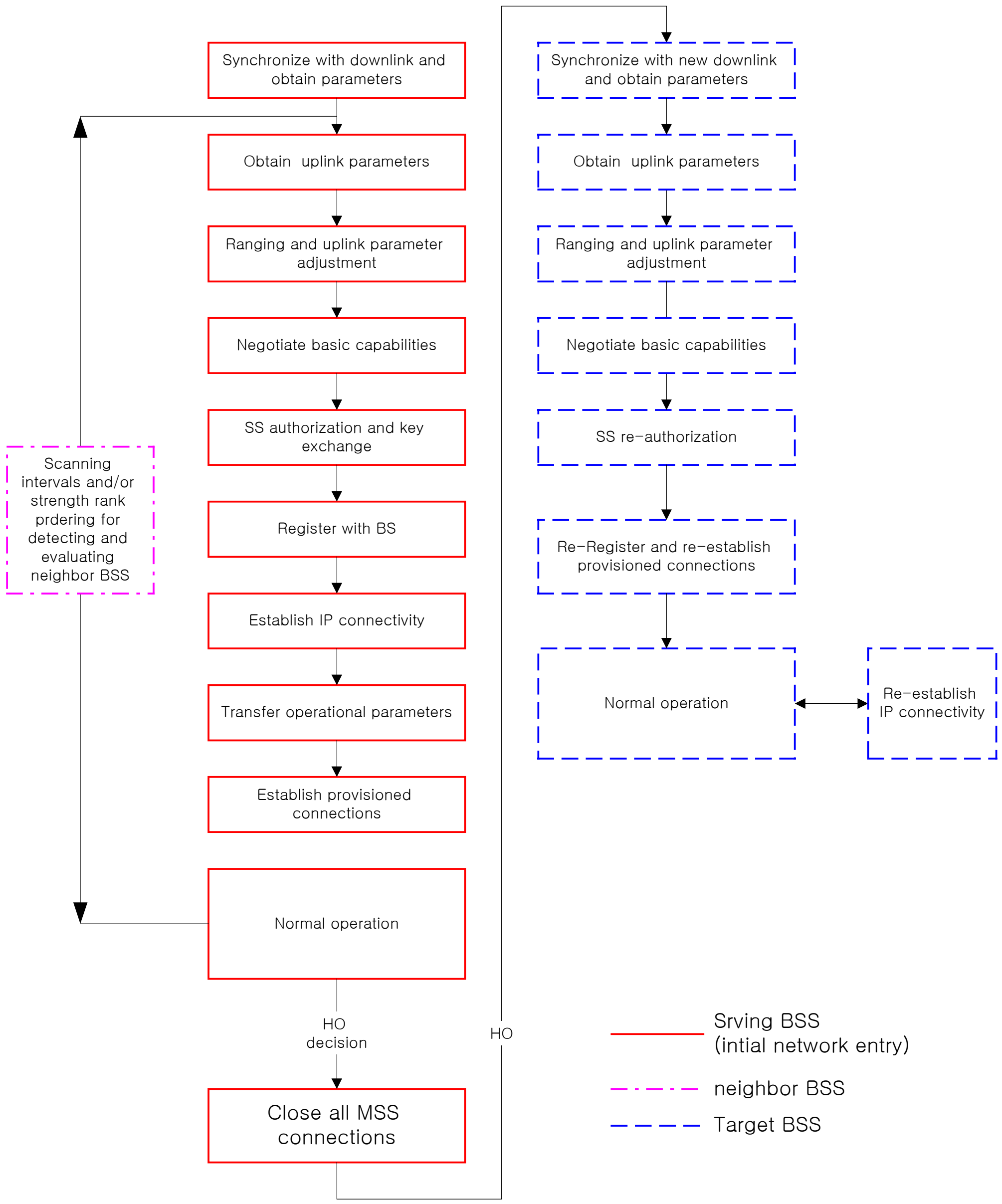
3.2 HO process

The section defines the HO process in which a MSS migrates from the air-interface provided by one BSS to the air-interface provided by another BSS. (CHKOO : Upon receiving the Triggeirng_IE through the DL_MAP and NBR_ADV MAC message, the MSS can starts the monitoring neighbor BSS. So the figure 7 and following procedures should be slightly modified) The HO process belongs to the break-before-make type and consists of the following stages:

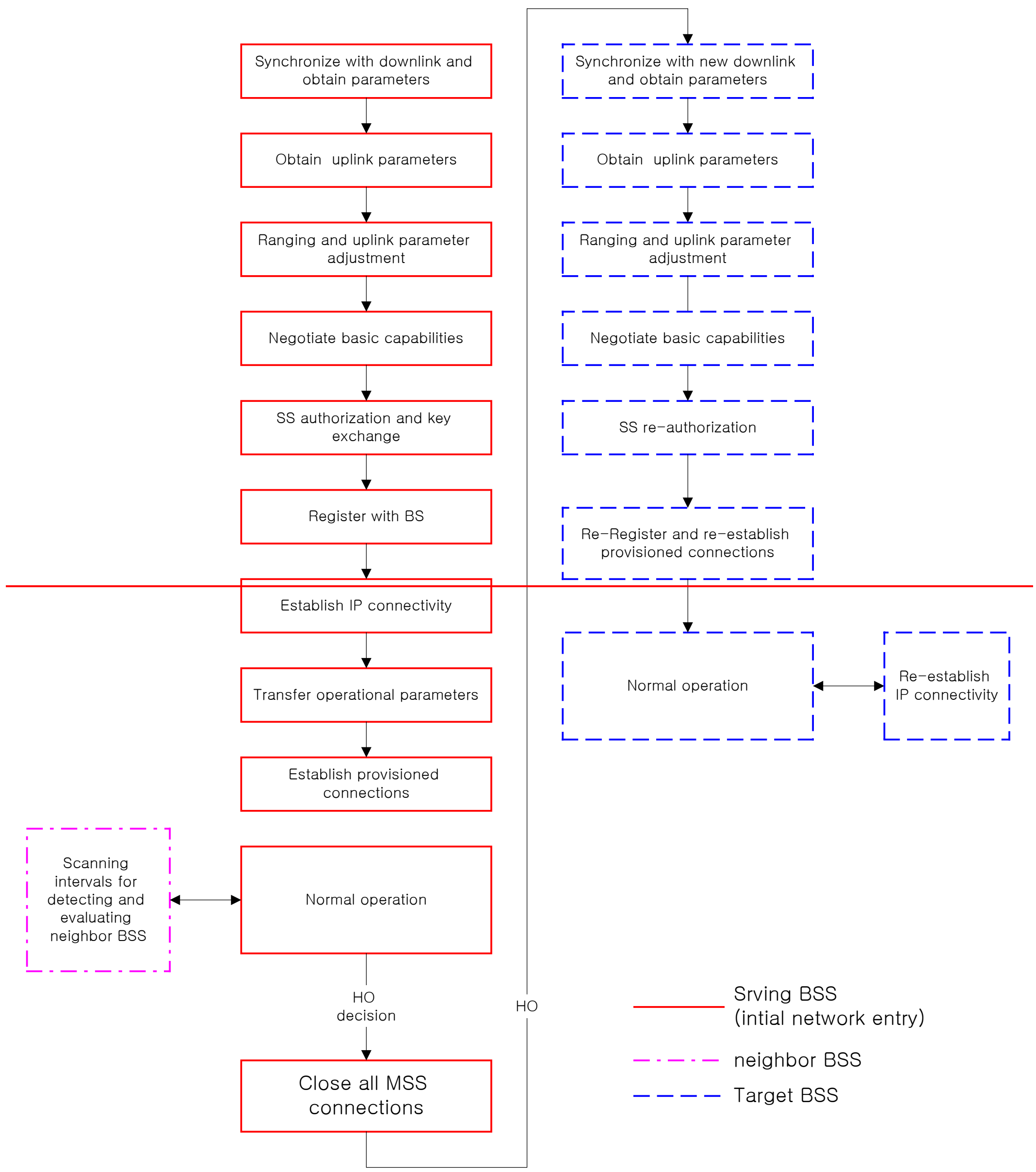
1. System detection and determination, monitoring the neighbor BSS
~~1.~~2. HO initiation, the decision to start the process is taken
~~2.~~3. Termination of service with the serving BSS, where all connections belonging to the MSS are terminated, and the context associated with them (i.e. information in queues, ARQ state-machine, counters, timers, etc.) is discarded
~~3.~~4. Network re-entry in target BSS, where the MSS re-enters the network using a fast network entry procedure. After network re-entry, connection belonging to the MSS are re-established based on the availability of resources in the target BSS.

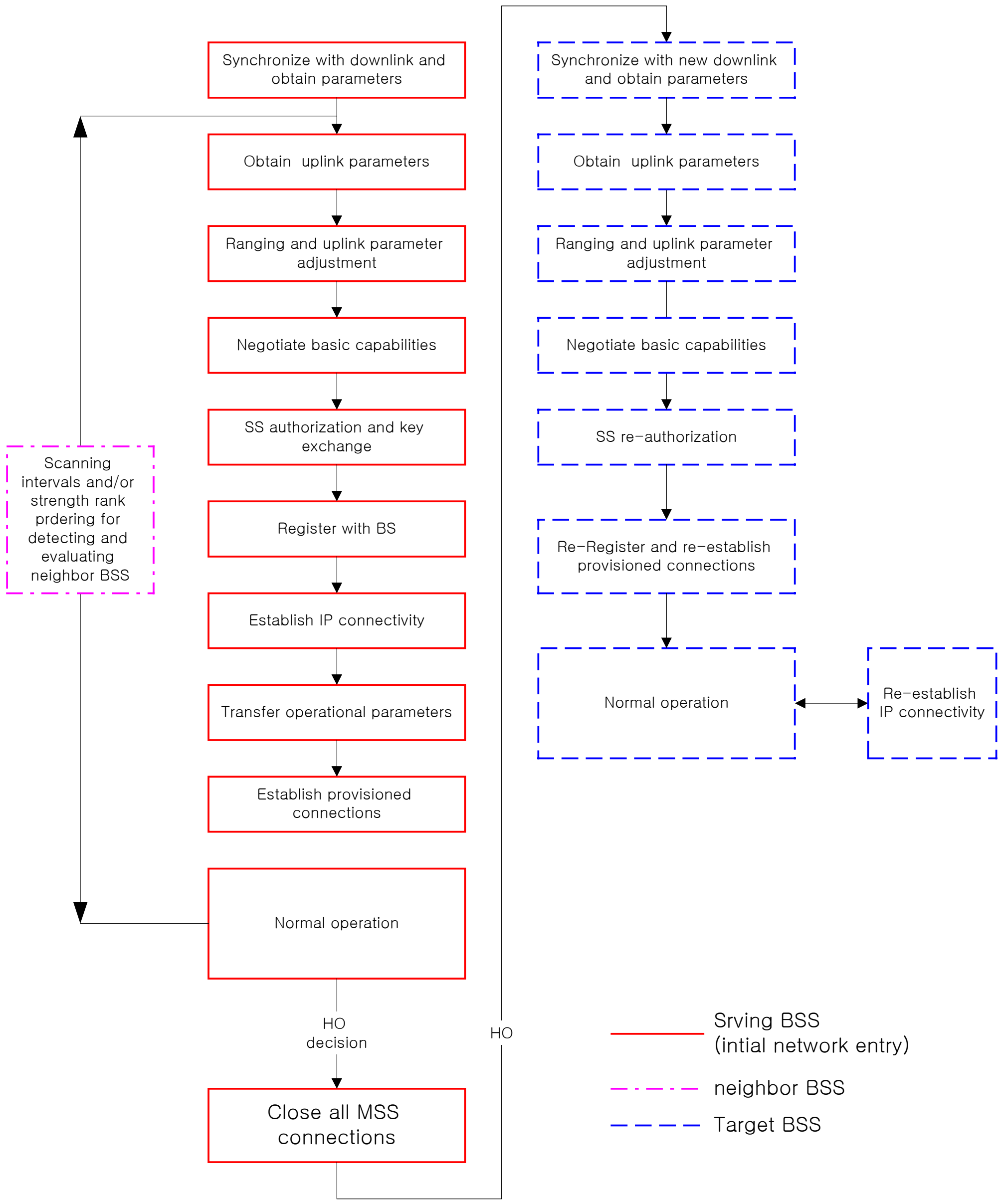
(CHKOO : The HO process is performed during transmitting the user packet data(In-traffic HO on the dedicated channel) and non-transmitting the user packet data(Idle HO on the common channel). Furthermore, those procedures are really different and should be defined separately. In my understanding, the overall HO including points of the Idle and In-traffic HO is depicted in figure 7)

The HO process, and its similarity to the initial network entry process, is depicted in



.


Synchronize with downlink and obtain parameters
Obtain uplink parameters
Ranging and uplink parameter adjustment
Negotiate basic capabilities
SS authorization and key exchange
Register with BS
Establish IP connectivity
Transfer operational parameters
Establish provisioned connections
Scanning intervals for detecting and evaluating neighbor BSS
Normal operation
HO decision
Close all MSS connections
HO
Synchronize with new downlink and obtain parameters
Obtain uplink parameters
Ranging and uplink parameter adjustment
Negotiate basic capabilities
SS re-authorization
Re-Register and re-establish provisioned connections
Normal operation
Re-establish IP connectivity
Srving BSS (intial network entry)
neighbor BSS
Target BSS



~~Figure 7: HO and initial network entry~~ Figure 8: MSS procedures with HO triggering operation

3.2.1 Idle HO

The section defines the Idle HO process in which a MSS migrates from the air-interface provided by one BSS to the air-interface provided by another BSS during non-transmitting user packet data between MSS and BSS. Idle HO can be achieved once receiving the Triggering_IE through the downlink MAC message. Because the dedicated channel, which can send the user packet data, is not allocated to the MSS, Idle HO may be achieved on the contention based access channel. Preliminary Idle HO can be achieved during the access procedures in idle state as depicted in figure XXX. If the MSS detect the neighbor BSS as a Target BS during the searching period based on scanning interval and/or strength rank ordering, the MSS is synchronized with Target BS and receive the downlink MAC message from the Target BSS. Upon receiving information the MSS sends an access probe with initial power level defined in UL_MAP MAC message and waits a response. If not received the response from the Target BS, the MSS enters the general backoff operation for re-sending an access probe.

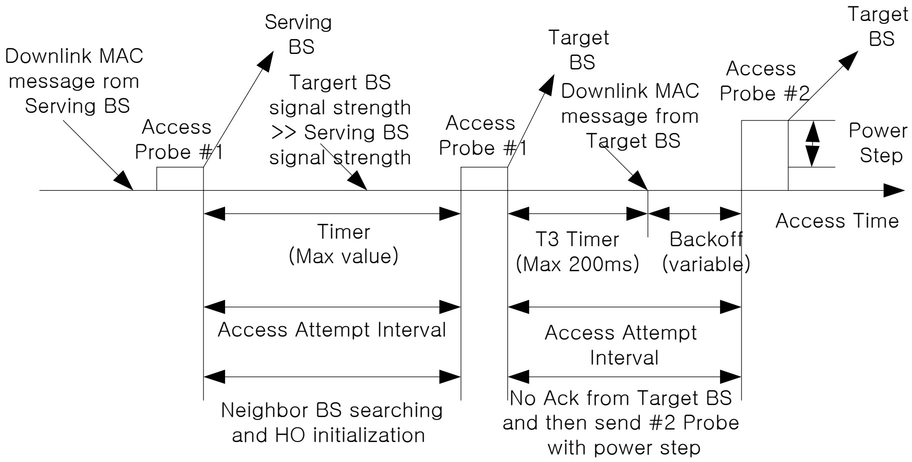


Figure. XXX Idle HO operation

Overall call flow for idle HO based on Figure XXX is depicted in Figure YYY. A couple of state and substate are present in figure. The specific operation description for each state would be described(TBD). (CHKOO: Actually, to assist understanding, it is required that this kind of call flow diagram.

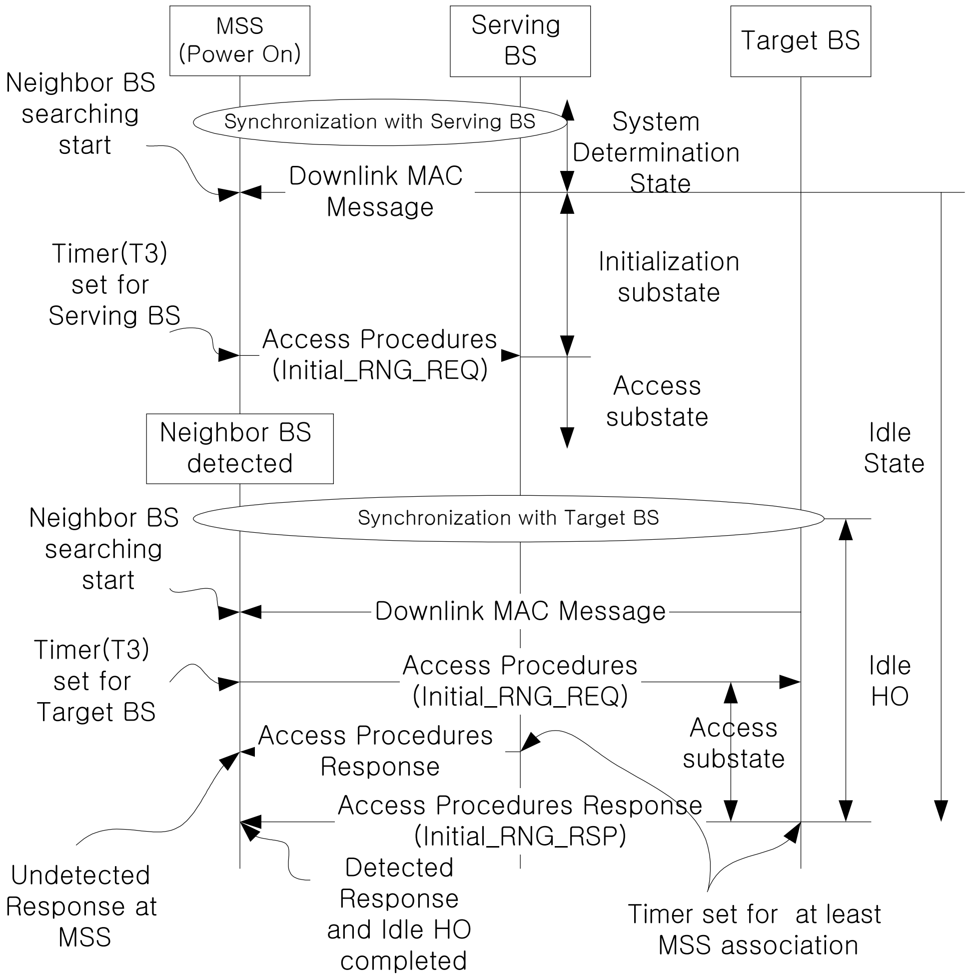


Figure YYY. Call Flow for Idle HO

3.2.1.1 HO initiation

A MSS may initiate a HO by monitoring and detecting the neighbor BSS. It is anticipated that in most situations the MSS will be the initiator of the HO. The MSS receive a set of neighbor BSS information through downlink MAC message.

At the MSS side, upon receiving information of a set of monitor BSS received, the MSS starts search and monitor a set of monitor BSS. If the MSS have something to send on the access channel based on contention period, the MSS enters the access substate to achieve the access procedures. During these access procedures with timer value setting, the MSS may search and monitor a set of monitor BSS and perform the idle HO. And if the MSS detects the neighbor BSS with enough signal quality (strength), based on HO triggering scheme indicated by BS, as a target BSS for HO, the MSS starts to synchronize with the BSS. After HO, the MSS perform the general operation and enter the access substate again to achieve the access procedures. At this moment, the MSS transmits the access probe with initial power level and set the timer for response from target BSS.

At the BSS side, upon receiving the access probe from the MSS, the BSS shall send an access procedure response with timer value setting. In this idle HO, the serving BSS does not recognize that the MSS is moving to other BSS and sends a response. When the BSS sends a response to the MSS, the BSS sets the timer for confirming the association of the MSS to the BSS itself. If the BSS recognize that the MSS is not correctly associated to the BSS itself, the BSS clear the air resource assigned to the MSS.

3.2.1.2 Termination with the serving BS

When the serving BSS does not recognize the MSS that is correctly associated to the BSS itself until the timer expired, the BSS clear the air resource assigned to the MSS. Therefore, the connection with the serving BS is automatically terminated and all resources to be assigned to the MSS is discarded.

3.2.1.3 Drops and corrupted HO attempts

A drop is defined as the situation where a MSS has stopped communication with its serving BSS (either in the downlink, or in the uplink) before the normal HO sequence outlined in 3.2.1.1 and 3.2.1.2 has been completed. A MSS can detect a drop by its failure to demodulate the downlink, or by exceeding the RNG-REQ retries limit allowed for the periodic ranging mechanism. A BSS can detect a drop by exceeding the RNG-REQ retries limit allowed for the periodic ranging mechanism. [Figures 56 and 55 in IEEE 802.16-2001 and the associated timers should be amended in this context to allow faster drop detection].

When the MSS has detected a drop, it shall attempt network re-entry with its preferred target BS as outlined in section 3.2.1.4. When the BSS has detected a drop, it shall remove all air resources to be assigned to the MSS.

3.2.1.4 Re-entry with the target BSS

When re-entry with the target BSS takes place, the target BSS as well as all neighbor BSS are aware of the HO in progress (except in a drop situation). At re-entry, the MSS performs the steps as shown in figure XXX and figure YYY. At the re-entry stage, the MSS transmits the RNG_REQ with the initial power level to the target BSS.

3.2.1.5 Synchronize with target BSS and obtain all parameters

For MSS that have used their HO triggering scheme to synchronize with target BSS and have decoded the downlink MAC messages, this stage should be immediate. In other situations this procedure defaults to the one specified for initial network entry. [Should we mandate a limit here? The limit would have to consider DCD-Interval parameter].

3.2.1.6 Ranging and uplink parameters adjustment

For MSS that have used HO triggering scheme to do UL ranging with target BSS this stage should be immediate. Otherwise, this stage is similar to the one performed at initial network entry. During this stage the MSS is assigned a new basic and primary management CID in the target BSS.

As opposed to initial network entry, where this stage is performed on contention basis, here the ranging opportunity may be allocated individually by the BSS based on a MSS 48-bit MAC address identifier. This identifier is forwarded to the target BSS via the backbone network (see section 5) or central controller(see figure ZZZ). This is done using the Fast_UL_ranging_IE() (see 4.6) in the UL-MAP. When an initial ranging opportunity is not allocated individually, this procedure defaults to the one specified for initial network entry.

3.2.1.7 Negotiate basic capabilities

This stage is identical to the one performed during initial network entry. [This handshake could be skipped if we could agree on a set of capabilities that are met by all MSS implementing the mobile profile. This would reduce flexibility, but would reduce HO time by at-least two frames].

3.2.1.8 MSS re-authorization

During this stage the MSS performs the re-authorization part of the PKM protocol used at initial network entry (see [1] section 7.2). The BSS authenticates the user and as the security context has not changed (it is transferred from the old BS via backbone or central controller, see section 5) the security sub-layer can continue in normal operation.

[More details should be provided here]

3.2.1.9 Re-register and re-establish provisioned connections

This stage is equivalent to several stages performed during initial network entry. In this stage the MSS re-registers with the target BSS, and receives on the registration response a conversion table that maps the connections it had with its pervious serving BSS to a new set of connections on the current serving BSS. In doing so, the MSS skips the **establish-IP-connectivity** stage, where it is assigned an IP address for management purposes. This stage is not really skipped during HO, instead it is postponed until the normal-operation stage is reached. The **transfer-operational-parameters** and the **time-of-day establishment** stage are skipped as none of the information contained in the configuration file, nor the time-of-day is expected to change.

The MSS attempts the re-registration by sending the normal REG-REQ MAC message. At this stage the MSS has already provides its 48-bit MAC address identifier, and the BSS can recognize that the MSS is performing a HO. The BSS REG-RSP shall therefore include TLV values for re-establishing the provisioned connections (see section 4.7).

3.2.1.10 Commence normal operation

At this stage normal operation commences. The MSS shall re-establish its IP connectivity as specified at initial network entry. **Figure 10** shows how a complete HO process might look like in the time domain.(see also figure YYY) (CHKOO : no need parameter “Time to HO 7frames” and message DEL-ALL)

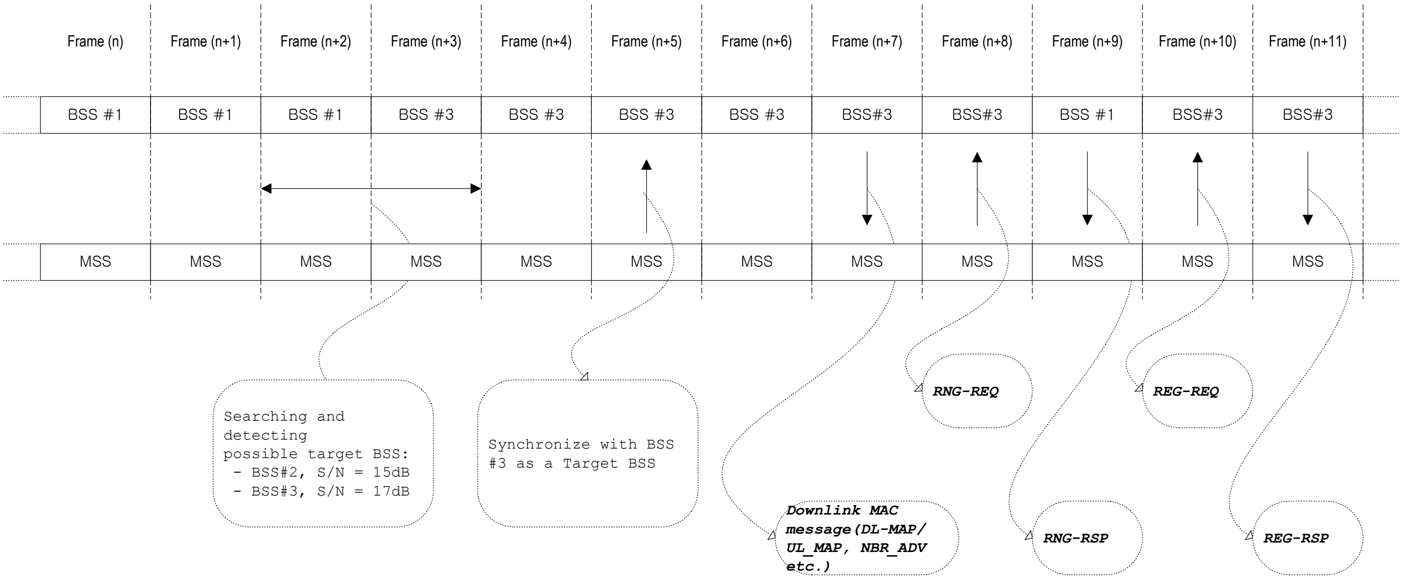


Figure 9: View of a Idle HO process in the time domain

3.2.1.11 HO completion

[This section should discuss the following:

Post HO operations (mostly applicable if make-before-break HO is supported)

3.2.2 In-traffic HO

3.2.13.2.2.1 HO initiation

Either a MSS or a BSS may initiate a HO by transmitting the HO-REQ MAC message. It is anticipated that in most situations the MSS will be the initiator of the HO, but sometimes a BSS may be the initiator of a HO to facilitate load sharing among BSS.
When HO-REQ is sent by a MSS, the MSS may indicate possible a set of target BSSs (from signal quality point of view). When sent by a BSS, the BSS may indicate the recommended target BSS (based on their capability to meet the MSS QoS requirements). The HO-REQ(in case of BS initiated HO) and HO-RSP(in case of MS initiated HO) messages may include an indication of the activation time estimated time for starting performing the HO.
At the BSS side, before sending or after receiving a HO-REQ message, the BSS shall notify neighboring BSS through the backbone or central controller of the HO request.(CHKOO : Actually, it would be surplus that the term backbone and/or central controller mentioned here. Because it could be the implementation issues whether using backbone, central controller or any other BSS) The BSS shall further acquire from the neighbor BSS information regarding their capability of serving the requesting MSS. See section 4.3 for specification of the communication through the backbone network, and the information exchanged between BSS.

After receiving HO-REQ message, the receiving party shall respond with a HO-RSP MAC message. When sent by a BSS, the HO-RSP message may indicate a recommended target BSS. (CHKOO : The MSS already the HO-REQ message with a prefer set for the HO to the BSS, thus the MSS shall follow the recommendation from the BSS because the BSS will not recommend any other BSS which is not included in the HO-REQ message sent from the MSS) The MSS, at the risk that if it chooses an alternative target BSS, it might receive a degraded level of service, may ignore this recommendation (this includes staying with its serving BSS, i.e. skipping the HO). The HO-RSP message may also includes an estimation of the time when the HO would take.
(CHKOO : Estimation time is not required but activation time which indicates the actual HO operation to receive the data from the target BSS)

3.2.23.2.2.2 Termination with the serving BS

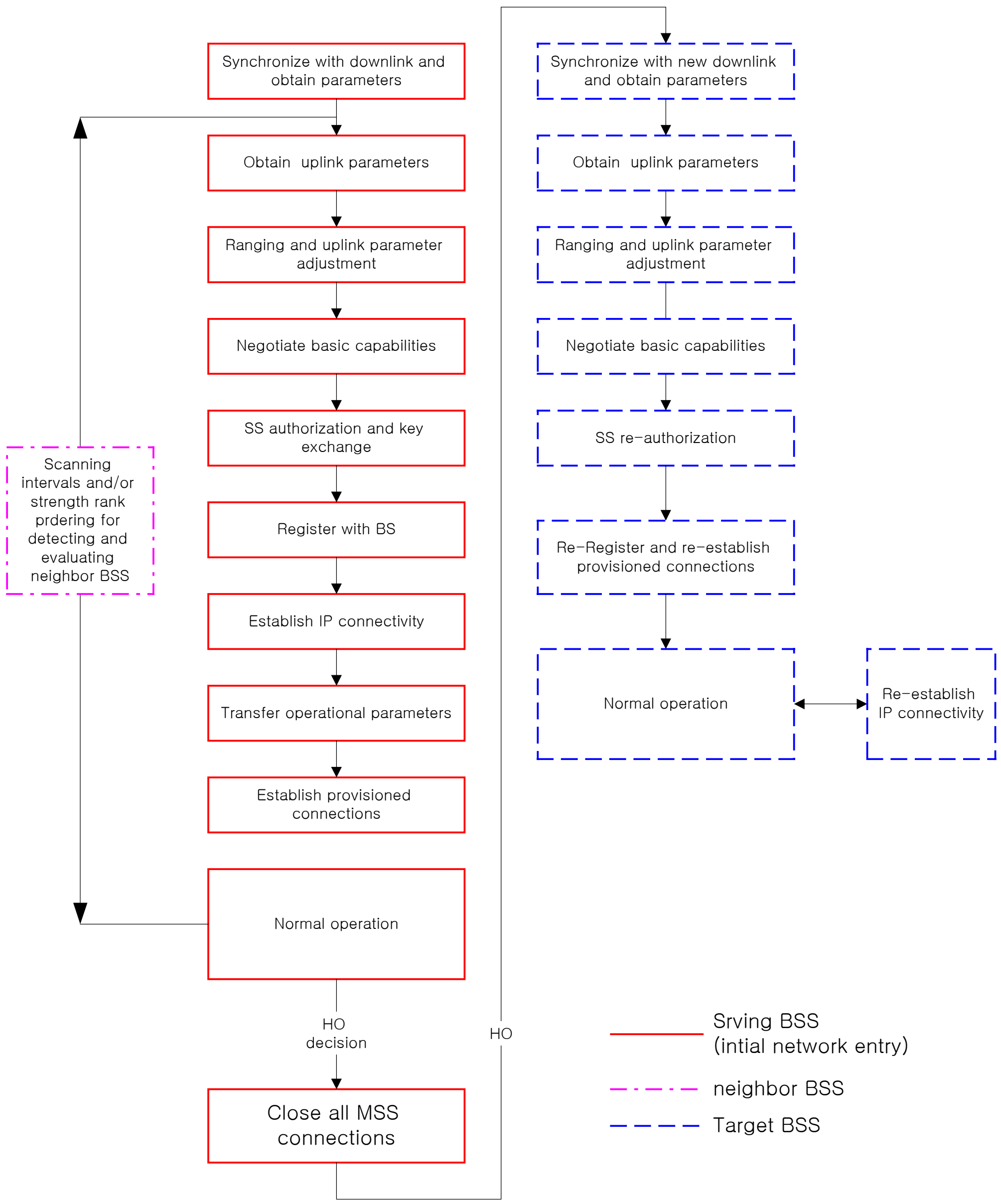
After the HO-REQ/RSP handshake is completed, the MSS may begin the actual HO by closing all connections to the serving BSS. (CHKOO : The BSS and MSS enough close the all connection using the channel supervision and timer so that MSS does not need to send DEL-ALL MAC message to the BSS. Furthermore, in hard HO, the MSS has to do transition to the different frequency band in order to send DEL-ALL MAC message and it will give a not good performance on the communication with target BSS.) This mass destruction act is done by sending a DEL-ALL MAC message.
Upon reception of a DEL-ALL MAC message, the BSS may close all connections and discard MAC state machines and MPDUs associated with the MSS. [Note the BSS does not HAVE to close or discard anything, this enables a make-before-break HO] .

3.2.33.2.2.3 Drops and corrupted HO attempts

A drop is defined as the situation where a MSS has stopped communication with its serving BSS (either in the downlink, or in the uplink) before the normal HO sequence outlined in 43.2.1 and 3.2.2.2 has been completed.
A MSS can detect a drop by its failure to demodulate the downlink, or by exceeding the RNG-REQ retries limit allowed for the periodic ranging mechanism. A BSS can detect a drop by exceeding the RNG-REQ retries limit allowed for the periodic ranging mechanism. [Figures 56 and 55 in IEEE 802.16-2001 and the associated timers should be amended in this context to allow faster drop detection].
When the MSS has detected a drop, it shall attempt network re-entry with its preferred target BS as outlined in section 3.2.2.4. When the BSS has detected a drop, it shall remove all air resources to be assigned to the MSSreact as if a DEL-ALL MAC message has been received from the dropped MSS.

3.2.43.2.2.4 Re-entry with the target BSS

When re-entry with the target BSS takes place, the target BSS as well as all neighbor BSS are aware of the HO in progress (except in a drop situation). At re-entry, the MSS performs the steps as shown in



.

3.2.4.13.2.2.5 Synchronize with target BSS downlink and obtain all parameters

For MSS that have used their HO triggering scanning interval to synchronize with target BSS and have decoded the downlink MAC messages, NBR-ADV message, this stage should be immediate. In other situations this procedure defaults to the one specified for initial network entry. [Should we mandate a limit here? The limit would have to consider DCD-Interval parameter].

~~3.2.4.2Obtain uplink parameters~~

~~For MSS that have decoded the NBR-ADV message, this stage should be immediate. In other situations this procedure defaults to the one specified for initial network entry. [Should we mandate a limit hear? The limit would have to consider UCD-Interval parameter].~~

~~3.2.4.3~~3.2.2.6 Ranging and uplink parameters adjustment

For MSS that have used their HO triggering scheme ~~scanning interval~~ to do UL ranging with target BSS this stage should be immediate. Otherwise, this stage is similar to the one performed at initial network entry. During this stage the MSS is assigned a new basic and primary management CID in the target BSS.

As opposed to initial network entry, where this stage may ~~is~~ be performed on contention basis or contention free (CHKOO : In traffic HO, the communication path between MSS and BSS is already assigned as a dedicated channel so that the MSS may send everything on the contention free environment.), here the ranging opportunity may be allocated individually by the BSS based on a MSS 48-bit MAC address identifier. This identifier is forwarded to the target BSS via the backbone network (see section 5) or central controller. This is done using the Fast_UL_ranging_IE() (see 4.6) in the UL-MAP. When an initial ranging opportunity is not allocated individually, this procedure defaults to the one specified for initial network entry.

~~3.2.4.4~~3.2.2.7 **Negotiate basic capabilities**

This stage is identical to the one performed during initial network entry. [This handshake could be skipped if we could agree on a set of capabilities that are met by all MSS implementing the mobile profile. This would reduce flexibility, but would reduce HO time by at-least two frames].

~~3.2.4.5~~3.2.2.8 MSS re-authorization

During this stage the MSS performs the re-authorization part of the PKM protocol used at initial network entry (see [1] section 7.2). The BSS authenticates the user and as the security context has not changed (it is transferred from the old BS via backbone or central controller, see section 5) the security sub-layer can continue in normal operation.

[More details should be provided here]

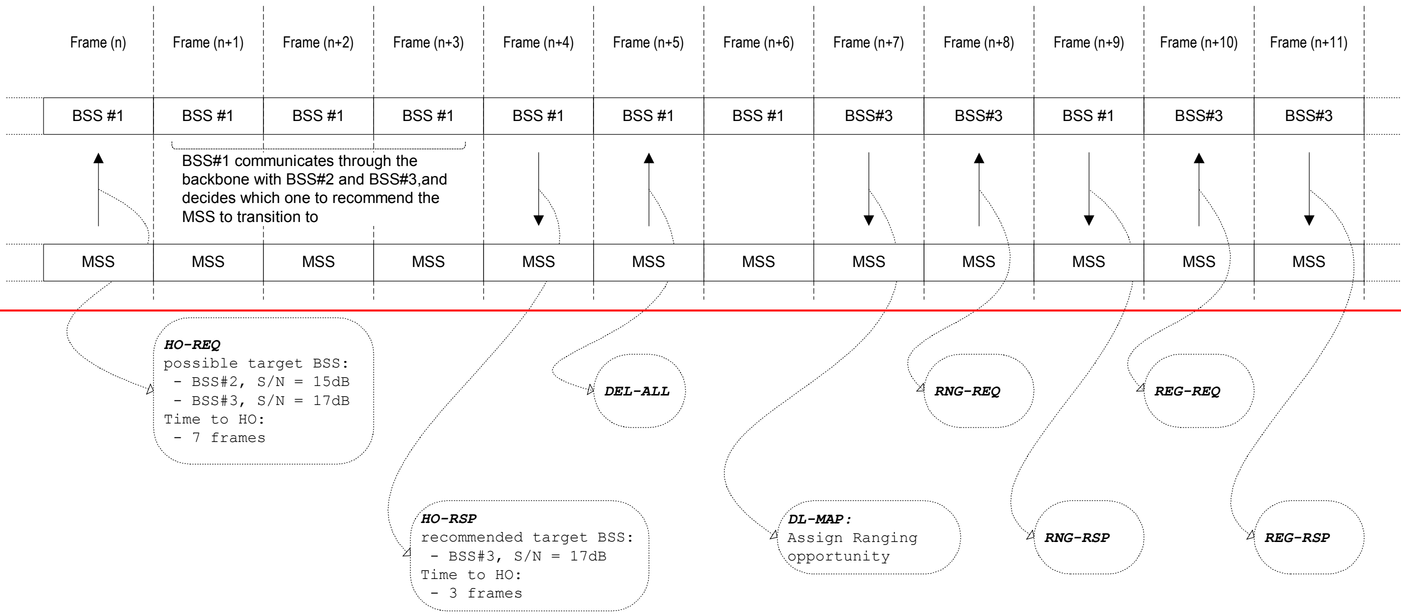
~~3.2.4.6~~3.2.2.9 Re-register and re-establish provisioned connections

This stage is equivalent to several stages performed during initial network entry. In this stage the MSS re-registers with the target BSS, and receives on the registration response a conversion table that maps the connections it had with its pervious serving BSS to a new set of connections on the current serving BSS. In doing so, the MSS skips the **establish-IP-connectivity** stage, where it is assigned an IP address for management purposes. This stage is not really skipped during HO, instead it is postponed until the normal-operation stage is reached. The **transfer-operational-parameters** and the **time-of-day establishment** stage are skipped as none of the information contained in the configuration file, nor the time-of-day is expected to change.

The MSS attempts the re-registration by sending the normal REG-REQ MAC message. At this stage the MSS has already provides its 48-bit MAC address identifier, and the BSS can recognize that the MSS is performing a HO. The BSS REG-RSP shall therefore include TLV values for re-establishing the provisioned connections (see section 4.7).

~~3.2.4.7~~3.2.2.10 Commence normal operation

At this stage normal operation commences. The MSS shall re-establish its IP connectivity as specified at initial network entry. **Figure 10** shows how a complete HO process might look like in the time domain. (CHKOO : no need parameter "Time to HO 7 frames" and message DEL-ALL)



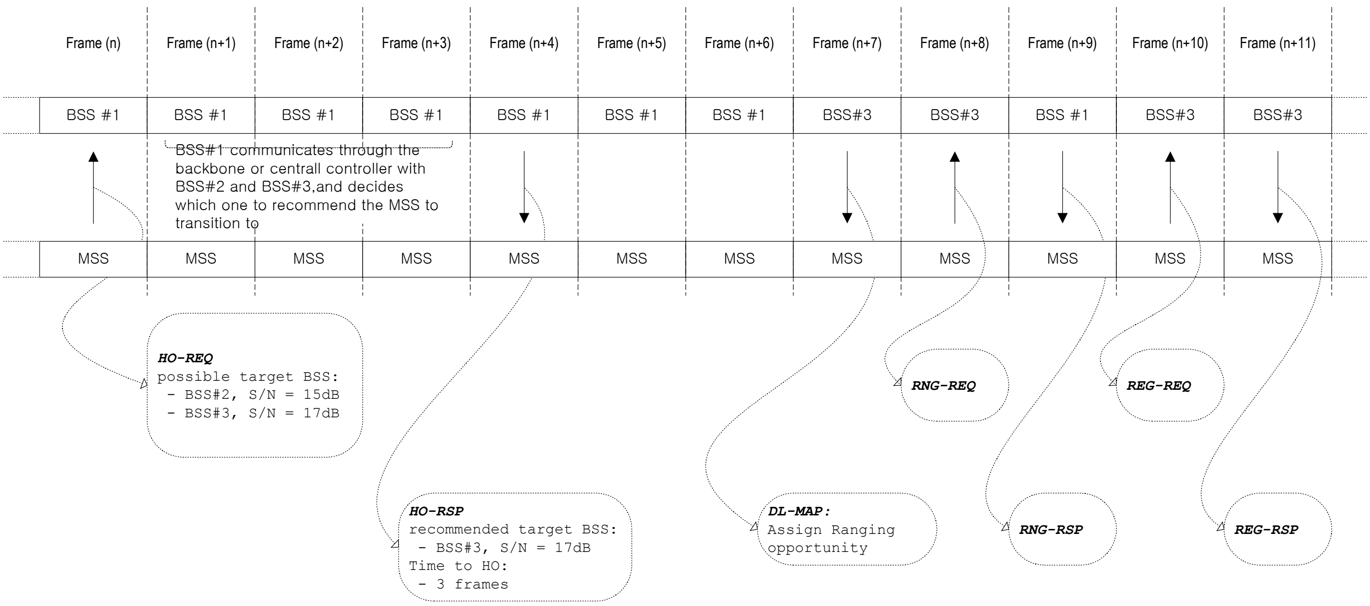


Figure 10: View of a HO process in the time domain

(CHKOO : Estimation time is not required but activation time(time to HO in figure 10) which indicates the actual HO operation to receive the data from the target BSS)

~~3.2.5~~3.2.2.11 HO completion

[This section should discuss the following:

- Post HO operations (mostly applicable if make-before-break HO is supported)

]

4 MAC messages for HO

[This section should contain the formal definition of the MAC messages used for the HO, and associated state-machines.]

4.1 Neighbor Advertisement (NBR-ADV) message

An NBR-ADV message shall be broadcasted by a BSS at a periodic interval (Table 16) to define the characteristics of neighbor BSS.
The message parameters following the configuration change count shall be encoded in a TLV format in which the type and length fields are each 1 byte long.

Syntax	Size	Notes
NBR-ADV_Message_Format() {		
Management Message Type = ?	8 bits	
N_NEIGHBORS	8 bits	
For (j=0 ; j<N_NEIGHBORS ; j++) {		
Neighbor BSS-ID	48 bits	
Configuration Change Count	8 bits	
Physical Frequency	16 bits	
TLV Encoded Neighbor information	Variable	TLV specific
}		
}		

Table 6: NBR-ADV message format

A BSS shall generate NBR-ADV messages in the format shown in Table 6. The following parameters shall be included in the NBR-ADV message,

N_Neighbors – Number of advertised neighbor BSS
(CHKOO : There is ambiguity between neighbor BSS and monitored BSS. According to the definition of the "Monitored BSS", N_Neighbor would be Monitored BSS indicated by the BSS. So the name of the IE should be taken carefully)

For each advertised neighbor BSS, the following parameters shall be included,

Neighbor BSS-ID – Same as the **Base Station ID** parameter in the DL-MAP message of neighbor BSS

Configuration Change Count – Incremented by one (modulo 256) whenever any of the values relating to this neighbor BSS change. If the value of this count in a subsequent NBR-ADV message remains the same, the MSS can quickly to disregard the TLV encoded information

Physical Frequency – Physical frequency in multiples of 0.1MHz

All other parameters are coded as TLV value (see Table 17).
For each advertised neighbor BSS, the following TLV parameters may be included,

DCD_settings – The DCD_settings is a compound TLV value that encapsulates a DCD message that may be transmitted in the advertised BSS downlink channel. This information is intended to enable fast synchronization of the MSS with the advertised BSS downlink.

UCD_settings – The UCD_settings is a compound TLV value that encapsulates a UCD message that may be transmitted in the advertised BSS downlink channel. This information is intended to enable fast synchronization of the MSS with the advertised BSS uplink.

4.2Scanning Interval Allocation Request (SCN-REQ) message

An SCN-REQ message may be transmitted by a MSS to request a scanning interval for the purpose of seeking neighbor BSS, and determining their suitability as targets for HO.
(CHKOO : in my understanding, this message is not needed and scanning interval is directly allocated by BSS regardless with MSS's request)

Syntax	Size	Notes
SCN-REQ_Message_Format() {		
Management Message Type = ?	8 bits	
Scan Duration	20 bits	For SCa PHY, units are mini-slots. For OFDM/OFDMA PHY, units are OFDM symbols
}		

Table 7: SCN-REQ message format

A MSS shall generate SCN-REQ messages in the format shown in Table 13. The following parameters shall be included in the SCN-REQ message,

Scan Duration – The requested period of time for the scan. The units are PHY-dependent, as specified in Table 7. [Should scan duration be specified in frames?]

4.34.2 ScanningTriggering_Information Element

A TriggeringScanning_IE shall be placed in the DL-MAP message by a BSS in response to an SCN-REQ message sent by a MSS. The TriggeringScanning_IE shall be placed in the extend DIUC (extension code = ?) within a DL-MAP IE. A value of zero in the Scan Duration field shall be interpreted as denial of the SCN-REQ. A BSS may also send an unsolicited TriggeringScanning_IE.
The format of the IE is PHY dependent as shown in Table 8.

For SCa PHY:		
Syntax	**Size**	**Notes**
Ordering_IE {		
CID	16bits	
Ordering Duration	22bits	Minimum keeping duration(in units of mini-slot) for the changing of rank order when the indicated signal strength measurement difference greater than or equal to XXX power in units of YYYdB,
}		
Scanning_IE {		
CID	16 bits	MSS basic CID
Scan Start	22 bits	Offset (in units of mini-slots) to the start of the scanning interval from the mini-slot boundary specified by the downlink Allocation_Start_Time
Scan Duration	22 bits	Duration (in units of mini-slots) where the MSS may scan for neighbor BSS.
}		

For OFDM PHY:

Syntax	Size	Notes
Ordering_IE {	16bits	
CID	22bits	Minimum keeping duration(in units of OFDM symbols) for the changing of rank order when the indicated signal strength measurement difference greater than or equal to XXX power in units of YYYdB,
Ordering Duration		
}		
Scanning_IE {		
CID	16 bits	MSS basic CID
Scan Start	18 bits	Indicates the scanning interval start time, in units of OFDM symbol duration, relative to the start of the first symbol of the PHY PDU (including preamble) where the DL-MAP message is transmitted.
Scan Duration	18 bits	Duration (in units of OFDM symbols) where the MSS may scan for neighbor BSS.
}		

For OFDMA PHY:		
Syntax	**Size**	**Notes**
Ordering_IE {		
CID	16bits	
Ordering Duration	22bits	Minimum keeping duration(in units of OFDM symbols) for the changing of rank order when the indicated signal strength measurement difference greater than or equal to XXX power in units of YYYdB,
}		
Scanning_IE {		
CID	16 bits	MSS basic CID
Scan Start	18 bits	The offset of the OFDM symbol in which the scanning interval starts. Measured in OFDM symbols from the time specified by the Allocation_Start_time field in the DL-MAP
Scan Duration	18 bits	Duration (in units of OFDM symbols) where the MSS may scan for neighbor BSS.
}		

Table 8: Scanning_IE format

4.3 Candidate HO Request(CH-REQ) message

(CHKOO : there are couple of ambiguities and optional IEs field based on the generator side. To clarify and identify these matter. I propose the new message CH-REQ)

The BSS may transmit an CH-REQ message when the BSS wants to initiate an HO. The message shall be transmitted on the basic CID.

Syntax	Size	Notes
CH-REQ Message Format() {		
Management Message Type = ?	8 bits	
TLV Encoded Information	Variable	TLV specific
}		

Table AAA: CH-REQ message format

4.4 HO Request (HO-REQ) message

~~Either a~~ The MSS ~~or a BSS~~ may transmit an HO-REQ message when the MSS ~~either~~ wants to initiate an HO. And the MSS shall transmit an HO-REQ message upon reception of CH-REQ message. The message shall be transmitted on the basic CID.

Syntax	Size	Notes
HO-REQ_Message_Format() {		
Management Message Type = ?	8 bits	
~~**Estimated HO time**~~	~~8 bits~~	
N_Recommended	8 bits	
For (j=0 ; j<N_NEIGHBORS ; j++) {		
Neighbor BSS-ID	48 bits	
BSS S/(N+I)	8 bits	~~This parameter exists only when the message is sent by the MSS~~ (CHKOO : this message is modified that the MSS only send)
}		
}		

Table 9: HO-REQ message format

~~A BSS or~~ The MSS shall generate HO-REQ messages in the format shown in Table 9. The following parameters shall be included in the HO-REQ message,

~~**Estimated HO time** – Estimated number of frames until the HO will take place. A value of zero in this parameter signifies that this parameter should be ignored.~~
(CHKOO : The BSS only know the actual HO time and the MSS does not send this information)

N_Recommended – Number of recommended neighbor BSS

For each recommended neighbor BSS, the following parameters shall be included,

Neighbor BSS-ID – Same as the **Base Station ID** parameter in the DL-MAP message of neighbor BSS

BSS S/(N + I) – ~~This parameter exists only when the MSS sends the HO-REQ message.~~ The parameter indicates the signal to noise and interference ratio measured by the MSS from the particular BSS. The value shall be interpreted as an unsigned byte with units of 0.25dB. ~~A value of zero in this parameter signifies that this parameter should be ignored.~~ (CHKOO : even in the MSS specifies the S/(N+I), the BSS can ignore the value. Therefore, zero value does not need to be specified here-)

4.5 HO Response (HO-RSP) message

~~Either a MSS or a~~ The BSS shall transmit an HO-RSP message upon reception of HO-REQ message. The message shall be transmitted on the basic CID.

Syntax	Size	Notes
HO-RSP_Message_Format() {		
Management Message Type = ?	8 bits	
~~Estimated~~ Activated HO time	8 bits	
N_Recommended	8 bits	
For (j=0 ; j<N_NEIGHBORS ; j++) {		
Neighbor BSS-ID	48 bits	
BSS rating	8 bits	~~This parameter exists only when the message is sent by the BSS~~
}		
}		

Table 10: HO-RSP message format

A BSS ~~or MSS~~ shall generate HO-RSP messages in the format shown in Table 10. The following parameters shall be included in the HO-RSP message,

> **~~Estimated~~ Activated HO time** – ~~Estimated n~~Number of frames until the HO will actually take place. ~~A value of zero in this parameter signifies that this parameter should be ignored.~~ (See. comments on HO-REQ message)

> **N_Recommended** – Number of recommended neighbor BSS. In case of soft HO, this value can be set to multiple BSS; otherwise this value shall be set to single BSS

For each recommended neighbor BSS, the following parameters shall be included,

> **Neighbor BSS-ID** – Same as the **Base Station ID** parameter in the DL-MAP message of neighbor BSS

> **BSS rating** – ~~This parameter exists only when the BSS sends the HO-RSP message.~~ The parameter indicates the relative level to which the target BSS could meet the MSS QoS requirements [How exactly will this parameter be calculated?]. A value of zero in this parameter signifies that this parameter should be ignored.

~~4.6Delete All Connections (DEL-ALL) message~~

(CHKOO : the BSS can clear the all connection by channel supervising and/or timer value so that this message does not need to be defined)

~~A MSS may transmit a DEL-ALL message for the purpose of closing all its connections with the serving BSS. The message shall be transmitted on the basic CID.~~

~~Syntax~~	~~Size~~	~~Notes~~
~~DEL-ALL_Message_Format() {~~		
~~Management Message Type = ?~~	~~8 bits~~	
~~TLV Encoded Information~~	~~Variable~~	~~TLV specific~~
~~}~~		

~~**Table 11: DEL-ALL message format**~~

~~A MSS shall generate DEL-ALL messages in the format shown in Table 11. If Privacy is enabled, the DEL-ALL message shall include the following TLV value,~~

> ~~**HMAC Tuple** (see 11.4.10 in IEEE 802.16-2001) – The HMAC Tuple Attribute contains a keyed Message digest (to authenticate the sender).~~

~~4.7~~4.6 Fast UL ranging Information Element

A Fast_UL_ranging_IE may be placed in the UL-MAP message by a BSS to provide a non-contention based initial-ranging opportunity. The Fast_UL_ranging_IE shall be placed in the extend UIUC (extension code = ?) within a UL-MAP IE.
The format of the IE is PHY dependent as shown in Table 12.

For SCa PHY:		
Syntax	**Size**	**Notes**
Fast_UL_ranging_IE {		
MAC address	48 bits	MSS MAC address as provided on the RNG_REQ message on initial system entry
UIUC	4 bits	UIUC ≠ 15. A four-bit code used to define the type of uplink access and the burst type associated with that access.
Offset	12 bits	Indicates the start time, in units of minislots, of the burst relative to the Allocation Start Time given in the UL-MAP message. The time instants indicated by offsets are the transmission times of the first symbol of the burst including preamble.
Reserved	4 bits	
}		

For OFDM PHY:		
Syntax	**Size**	**Notes**
Fast_UL_ranging_IE {		
MAC address	48 bits	MSS MAC address as provided on the RNG_REQ message on initial system entry
UIUC	4 bits	UIUC ≠ 15. UIUC ≠ 4. A four-bit code used to define the type of uplink access and the burst type associated with that access.
Duration	12 bits	The Duration indicates the length, in units of OFDM symbols, of the allocation. The start time of the first allocation shall be the Allocation Start Time given in the UL-MAP message.
Reserved	4 bits	
}		

For OFDMA PHY:		
Syntax	**Size**	**Notes**
Fast_UL_ranging_IE {		
MAC address	48 bits	MSS MAC address as provided on the RNG_REQ message on initial system entry
UIUC	4 bits	UIUC ≠ 15. A four-bit code used to define the type of uplink access and the burst type associated with that access.
OFDM Symbol offset	10 bits	The offset of the OFDM symbol in which the burst starts, the offset value is defined in units of OFDM symbols and is relevant to the Allocation Start Time field given in the UL-MAP message.
Subchannel offset	6 bits	The lowest index OFDMA subchannel used for carrying the burst, starting from subchannel 0.
No. OFDM Symbols	10 bits	The number of OFDM symbols that are used to carry the UL Burst
No. Subchannels	6 bits	The number OFDMA subchannels with subsequent indexes, used to carry the burst.
Reserved	4 bits	

CID	16 bits	MSS basic CID
}		

Table 12: Fast_UL_ranging_IE format

4.84.7 REG-RSP TLVs for connection re-establishment

[Add this text to the REG-RSP text in the base standard]
The following TLVs shall be included in the REG-RSP for MSS recognized by the BSS through their 48-bit MAC address (provided in the RNG-REQ message) as MSS that are performing HO,

CID_updtae – The CID_update is a TLV value that provides a shorthand method for renewing a connection used in the previous serving BSS. The TLV specifies a CID in the new serving BSS that shall replace a CID used in the previous serving BSS. All the service flows and parameters associated with the old CID remain unchanged. (See Table 18).

Connection_Info – The Connection_Info is a compound TLV value that encapsulates the **Service Flow Parameters** and the **CS Parameter Encodings** TLVs allowed on the DSA-RSP. This TLV enables the new serving BSS to renew a connection used in the previous serving BSS, but with different QoS settings.

5 Backbone nNetwork HO procedures

[This section should contain the procedures performed on inter-BSS and inter-system backbone to support HO such that BS from (different manufacturers are interoperable). The section should address issues such as,

- Centralized HO controller and/or distributed decision
- The information that should be exchanged (Post-HO, Pre-HO and during HO)
- Information exchange model (publishing, on request, combined)
- The transport protocol to use
- Formal definition of the messages

]

5.1 Inter BSS procedures (IB interface)

5.1.1 Ordering target BSSs

If the serving BSS received HO-REQ message, serving BSS shall send an indication for HO request to neighbor BSSs based on the rank of S/(N+I) included in the HO-REQ message. The BSS that has the greatest S/(N+I) may be selected as the first Target BSS

5.1.2 Request HO possibility

After ordering target BSSs, the serving BSS sends the HO-CONNECTION-REQ message to the target BSSs, in order to request handoff possibility. This message may include bandwidth request information and QoS requirement of the MSS to be handoff, and is to decide whether the target BSS can accept the MSS or not. If the target BSS does not have available bandwidth, the BSS may not be the actual Target BSS although the BSS has the greatest S/(N+I).
The serving BSS shall continually send the HO-CONNECTION-REQ message until it finds the actual target BSS which can accept handoff.

5.1.3 Response HO possibility

When the target BSS receives HO-CONNECTION-REQ message, the target BSS shall send the HO-CONNECTION-RSP message. If the target BSS cannot accept the BW and QoS of MSS the target BSS shall send the HO-COONECTION-RSP including NACK; otherwise the target BSS shall send the HO-CONNECTION-RSP including ACK.

5.1.4 Retry to request HO possibility and to receive response

If the serving BSS receives the HO-CONNECTION-RSP with NACK, the serving BSS shall send the HO-CONNECTION-REQ message to remaining BSS until it finds the actual target BSS which can accept handoff.

5.1.5 HO connection fail

The BSS may send the HO refusal indication by HO-RSP message or the BSS may send the resembled BSS information as a target BSS over the air-interface.

5.1.6 Report HO result

Upon receiving the HO-CONNECTION-RSP with ACK from the target BB, the serving BSS shall send the HO-RSP message with neighbor BSS information to the MSS and send the HO-CONNECTION-CFM to the actual target BSS. Then communication path with the serving BSS is release and handoff to the target BSS. Figure AAA shows the overall call flow with inter-BSS communication.

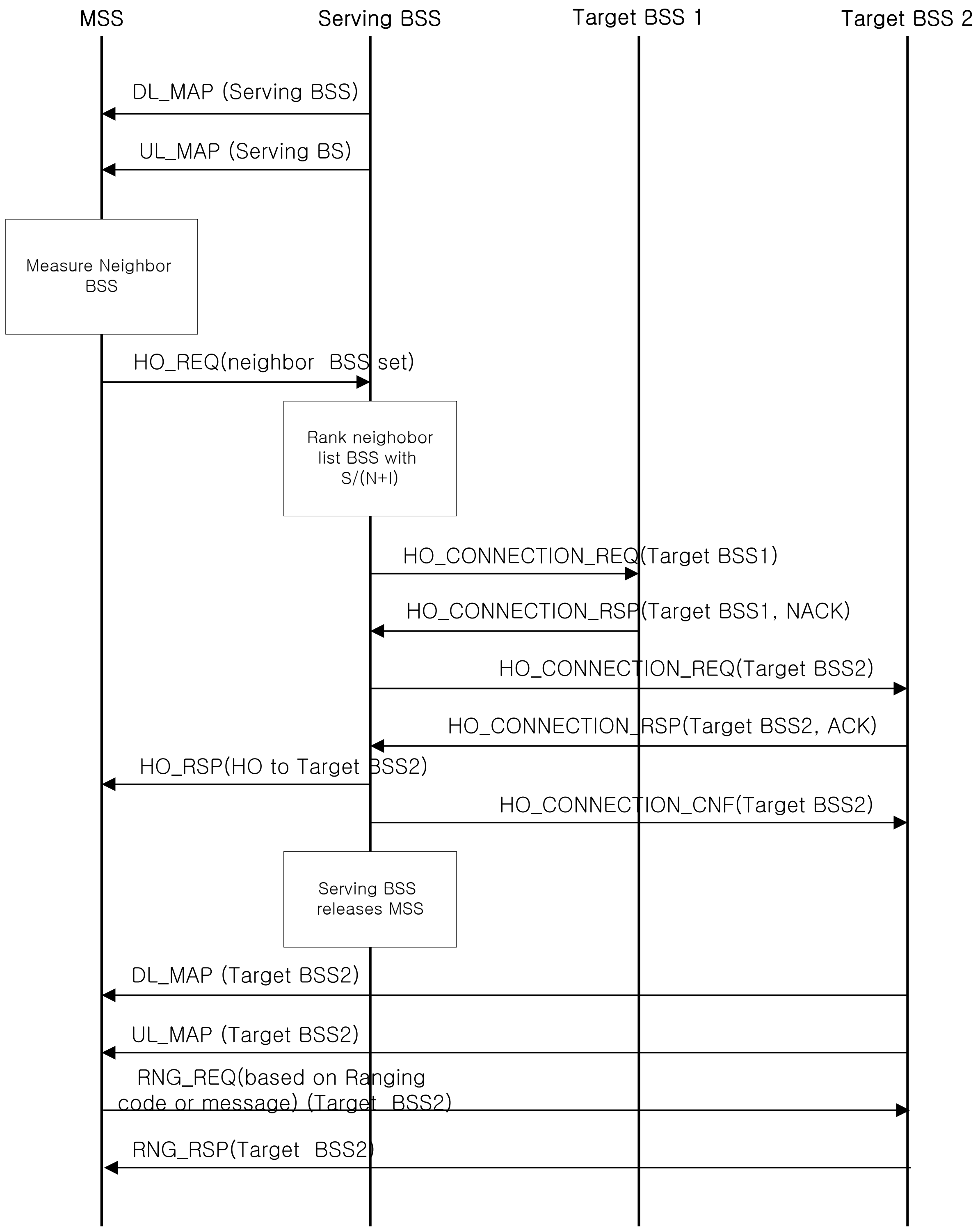


Figure AAA. HO scenario with inter-BSS communication

5.2 MAC messages for HO

5.2.1 HO_CONNECTION_Request (HO-CONNECTION-REQ) message

Upon receiving HO-REQ message from the MSS, the serving BSS sends this message to neighbor BSSs included in HO-REQ message in order to request the HO. The rank ordering of target BSS may be determined by signal quality S/(N+I) of neighbor BSSs.

Syntax	**Size**	**Notes**
HO_CONNECTION_REQ_Message_Format() {		
Management Message Type = ?	8 bits	
Neighbor BSS-ID	48 bits	
CID	16bits	MSS basic CID
BW request	8bits	Bandwidth which is required by MSS.
QoS	8bits	Quality of Service - Unsolicited Grant Service (UGS) - Real-Time Polling Service (rtPS) - Non-Real-Time Polling Service (nrtPS) - Best Effort service(BE)
}		

Table 13 HO-CONNECTION-REQ message format

Neighbor BSS-ID – Same as the **Base Station ID** parameter in the DL-MAP message of neighbor BSS

BW request – Required BW to support minimum guarantee the packet data transmission (How to set this field is TBD)

QoS – Required QoS level. (How to set this field is TBD)

5.2.2 HO_CONNECTION_Response (HO-CONNECTION-RSP) message

Upon receiving HO-CONNECTION-REQ message from the serving BSS, the BSS shall send the HO-CONNECTION-RSP message. The message shall be transmitted on the basic CID

Syntax	**Size**	**Notes**
HO_CONNECTION_RSP_Message_Format() {		
Management Message Type = ?	8 bits	
Neighbor BSS-ID	48 bits	
CID	16bits	MSS basic CID
Response	1 bits	1 is ACK which means that this neighbor BSS accepts the HO-CONNECTION-REQ from the serving BSS. 0 is NACK which means that this neighbor BSS does not accept the HO-CONNECTION-REQ from the serving BSS.
}		

Table 14 . HO-CONNECTION-RSP message format

5.2.3 HO_CONNECTION_Confirm (HO-CONNECTION-CFM) message

Upon receiving HO-CONNECTION-RSP message with ACK from the target BSS, the serving BSS shall send the HO-CONNECTION-CFM message.

Syntax	Size	Notes
HO_CONNECTION_CFM_Message_Format() {		
Management_Message_Type = ?	8 bits	
Neighbor BSS-ID	48 bits	
CID	16bits	MSS basic CID
}		

Table 15. : HO-CONNECTION-CFM message format

6 Convergence sub-layer HO procedures

[This section should contain the procedures performed during HO in the convergence sub-layer. The section should address issues such as,

6.1 Supported convergence sub-layers

[This section should discuss the types of convergence sub-layer that are supported (i.e. IPv4, IPv6, Ethernet, or others)]

6.2 SAP for higher layer protocols

[This section should discuss the following:
- Definition of triggers from the HO process to upper layers (i.e. reporting of events such as 'About to perform HO to BS(k)', 'MS coming from BS(i)', etc.)
- What entity should be the source of such triggers (serving BS, new BS, MS or all three)
- Provision of higher layers information to layer 2 (e.g. network topology, address, etc.)

]

7 Setup and negotiations

[This section should discuss the following:
- Setup and negotiation procedures related to the HO
- PHY dependent parameters and associated handshake
- The model for coexistence of fixed and mobile-SS on the same air-interface instance

]

8 Parameters and constants

System	Name	Time reference	Minimum value	Default value	Maximum value
BSS	NBR-ADV interval	Nominal time between transmission of NBR-ADV messages			1s

Table 16: Parameters and Constants

Name	Type (1 byte)	Length (1 byte)	Value (Variable-length)
DCD_settings	?	Variable	The DCD_settings is a compound TLV that encapsulates an entire DCD message

			(excluding the generic MAC header). All the rules and settings that apply to the DCD message apply to the contents encapsulated in this TLV.
UCD_settings	?	Variable	The UCD_settings is a compound TLV value that encapsulates an entire UCD message (excluding the generic MAC header). All the rules and settings that apply to the UCD message apply to the contents encapsulated in this TLV.

Table 17: NBR-ADV encodings

Name	Type (1 byte)	Length (1 byte)	Value (Variable-length)
CID_update	?	16-bits	CID in the previous serving BSS
		16-bits	Replacement CID in the current serving BSS
Connection_Info	?	Variable	The Connection_Info is a compound TLV value that encapsulates the **Service Flow Parameters** and the **CS Parameter Encodings** TLVs allowed on the DSA-RSP message. All the rules and settings that apply to the TLVs when used in the DSA-RSP message apply to the contents encapsulated in this TLV.

Table 18: REG-RSP encodings

9 References

[1] IEEE Std 802.16-2001 “Part 16: Air Interface for Fixed Broadband Wireless Access Systems”

[2] IEEE P802.16a/D7-2002 “Part 16: Air Interface for Fixed Broadband Wireless Access Systems – Medium Access Control Modifications and Additional Physical Layer Specifications for 2-11 GHz”