Draft Amendment to IEEE Standard for
Local and Metropolitan Area Networks

Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems —

Amendment for Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands

Sponsor

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Abstract: This Amendment updates and expands IEEE Standard 802.16 to allow for mobile subscrib er stations.

Keywords: Keywords: fixed broadband wireless access (BWA) network, mobile broadband wireless access network, microwave, point-to-multipoint, wireless access systems (WAS), wireless metropolitan area network (WMAN), WirelessMAN™ standards

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NOTE-The editing instructions contained in this amendment/corrigendum define how to merge the material contained herein into the existing base standard IEEE Standard P802.16-REVd/D2-2003.

The editing instructions are shown ***bold italic***. Four editing instructions are used: ***change***, ***delete***, ***insert***, and ***replace***. ***Change*** is used to make small corrections in existing text or tables. The editing instruction specifies the location of the change and describes what is being changed by using strike through (to remove old material) and underscore (to add new material). ***Delete*** removes existing material. ***Insert*** adds new material without disturbing the existing material. Insertions may require renumbering. If so, renumbering instructions are given in the editing instruction. ***Replace*** is used to make large changes in existing text, subclauses, tables, or figures by removing existing material and replacing it with new material. Editorial notes will not be carried over into future editions because the changes will be incorporated into the base standard.

1. Overview

1.3 Frequency Bands

1.3.4 Air interface nomenclature and PHY compliance

[Replace Table 1 in section 1.3.4 with the following:]

Table 1a—Air Interface Nomenclature

Designation	Applicability	PHY specification	Additional MAC requirements	Options	Duplexing alternative
WirelessMAN-SC	10-66 GHz	8.1			TDD FDD
WirelessMAN-SCa	2-11 GHz licensed bands	8.2		AAS (6.4.7.6.1) ARQ (6.4.4) STC (8.2.1) mobile	TDD FDD
WirelessMAN-OFDM	2-11 GHz licensed bands	8.3		AAS (6.4.7.6.1) ARQ (6.4.4) Mesh (6.4.6.6) STC (8.3.7) mobile	TDD FDD
WirelessMAN-OFDMA	2-11 GHz licensed bands	8.4		AAS (6.4.7.6.1) ARQ (6.4.4) STC (8.4.8) mobile	TDD FDD
WirelessHUMAN	2-11 GHz license-exempt bands	[8.2, 8.3 or 8.4] and 8.5	DFS (6.4.14)	AAS (6.4.7.6.1) ARQ (6.4.4) Mesh (6.4.6.6) (with 8.3 only) STC (8.2.1/8.3.7/ 8.4.8)	TDD

[Change 1.4 title to the following:]

~~1.4 Reference Model~~

1.4 Baseline Reference Model

[Insert the following text into Section 1.4.1:]

...

1.4.1 Network Model for Mobile Communications

1.4.1.1 Network reference model

1.4.1.1.1 Entities

The network reference model consists of BS units providing contigious/non-contigious service coverage across a distributed geographic region where the BS units are connected by a backbone network and share network affiliation. Multiple networks, of varying design and performance may coexist in the same geography. Backbone networks may employ centralized AAA (Authorization, Authentication and Accounting), management, provisioning or other specialized servers. Specifically, those servers responsible for authentication and service authorization are collectively referred to as ASA-server(s) and may be single, multiple, centralized or distributed. The operation of these servers with the BS and MSS is specified to the extent of defining the control messages.

Table 1b—Mobility Related Entities

Reference Point	Elements to be Specified by 802.16E
MSS	Mobile Subscriber Station, contains MAC (CS), PHY layers
BS	Base Station Sector: a single MAC entity covers a single sector. BS, at the network side, supports functionality similar to Foreign Agent of Mobile IP (IETF RFC 3344) working in "foreign agent care-of address" mode.
ASA Server(s)	Authentication and Service Authorization Server servicing the whole operatorís network. These servers are optional, and may be implemented as a distributed entity.

Figure 0a shows an example of such a network, where two networks operated by different operators coexist in the same service area. BS #1 is the Serving BS for the depicted MSS. BS #2 and BS #3 are Neighbor BS. Should the depicted MSS move closer to BS #2, as drawn by dotted line BS #2 might be the Target BS for an hand-over (HO). Depending on the configuration of the networks, operational deployment, etc..., MSS may perform hand-overs between BS. Hand-over management may be centrally controlled or employ a distributed decision mechanism. Should the depicted MSS continue movement into the area covered by BS #3, it might perform HO to that base station.

Figure 0a—Network Model Example

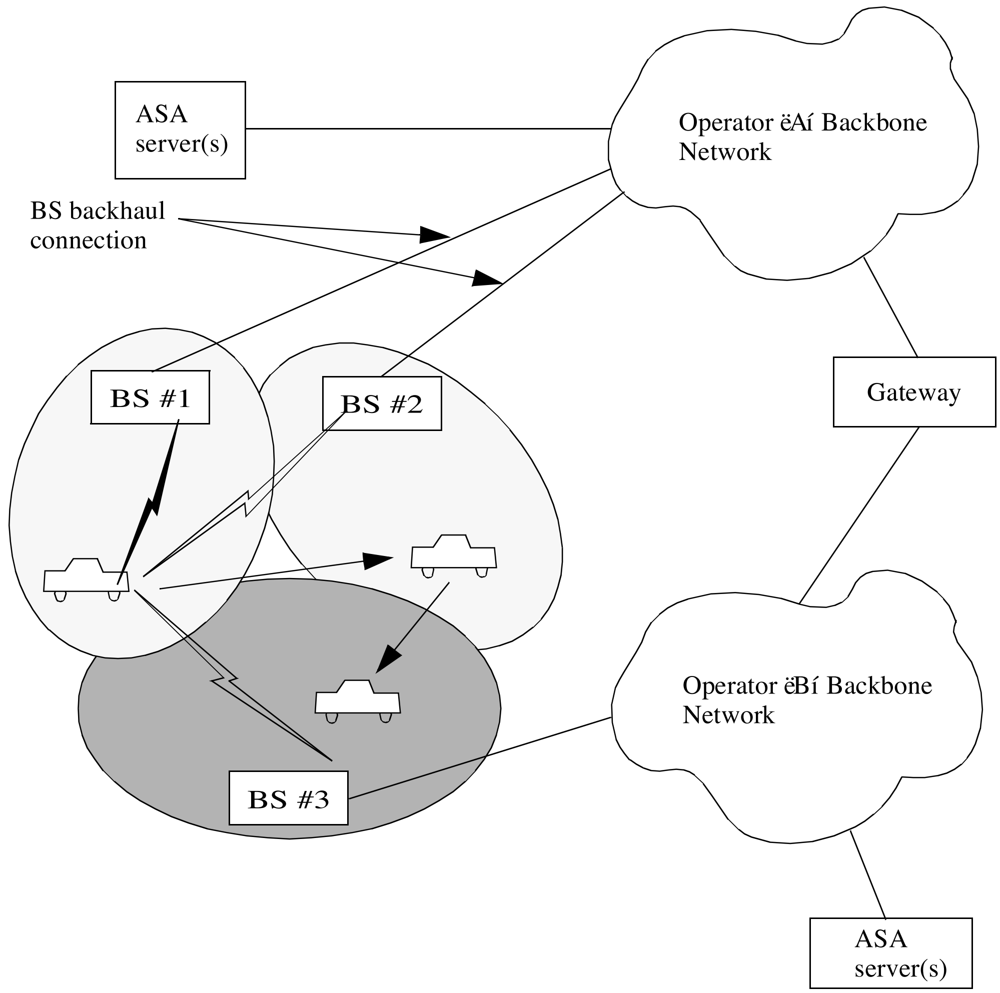
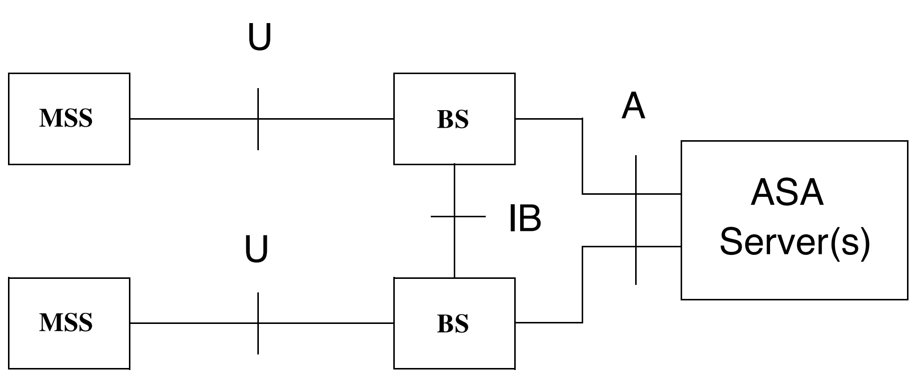


Figure 0b shows the network reference model in the control plane.

Figure 0b—Network Reference Model, Control Plane



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

Table 1c—Reference Points at Control Plane

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

Note: In the case a BS is implemented as a set of BS controlled by a single central controller, IB reference point is located in the controller.

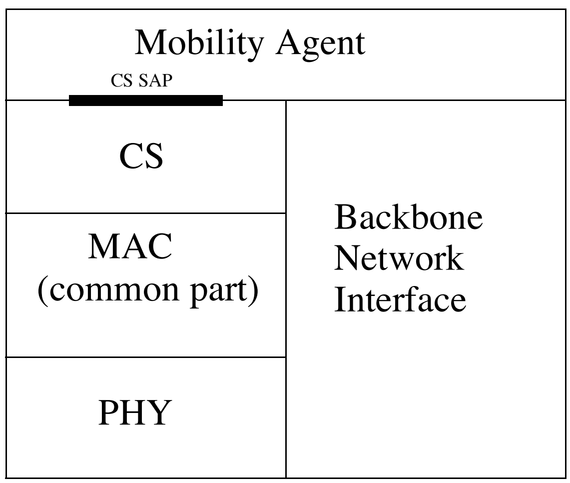
1.4.1.1.2 MSS Protocol Stack

[No difference here compared to the baseline document.]

1.4.1.1.3 BS Protocol Stack

The following picture displays BS protocol stack

Figure 0c—BS Protocol Stack



1.4.1.1.3.1 Mobility Agent (MA) Operations

In addition to regular 802.16 layers, the stack contains a Mobility Agent (MA) layer.

The MA may provide the following functions,

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

1.4.1.1.4 MSS Service Context

In the mobile environment, certain Service Flows are provisioned for each MSS. QoS parameters are provisioned by the operator for each flow and identified by certain Service Class names. Set of Service Classes should be provisioned through upper layers (e.g. network management) at each BS and each MSS.

For each SU certain AuthorizedQoSParamSet shall be provisioned identified by the corresponding Service Class Name. In the initial Network Entry, Ranging and Hand-over processes, MSS shall request from the Target BS certain QoS levels per Active Service Flow, differentiated by Service Class and represented by AuthorizedQoSParamSet. The BS shall respond with name of Service Class available for the Service Flow. This Service Class will become AdmittedQoSParamSet in the case of successful Network Entry/HO.

Network Service is defined as a service provided through the MSS by the network to a single persistent IP address with particular connectivity and air-interface MAC parameters (including QoS properties). Connectivity properties are defined by the service provided through the permanent IP address. The permanent IP address defines the MSS home-network. QoS properties are those of Service Flow associated with the network service, as specified in 6.4.13.

MSS Service Context is defined as a set of network services authorized for a given MSS. It is specified by an MSS Service Context Descriptor composed of the following elements:

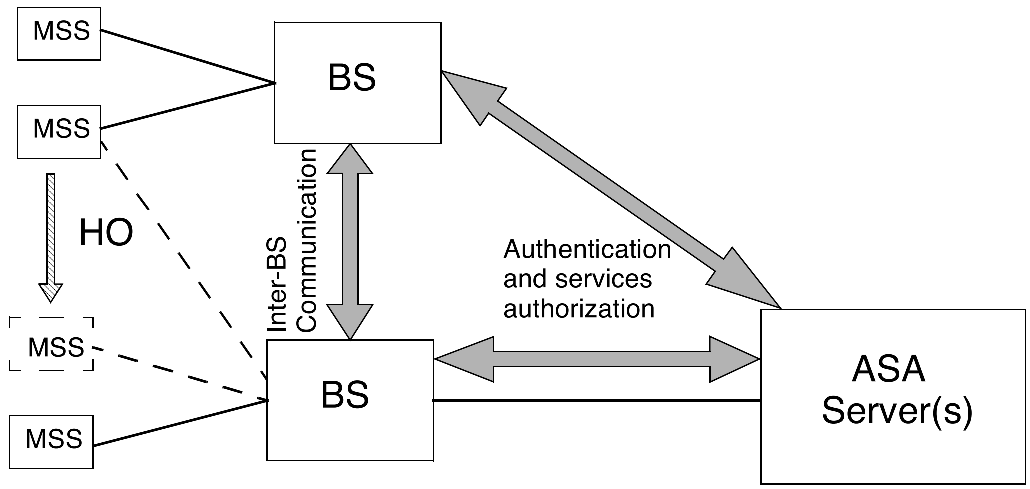
Table 1d—MSS Service Context Descriptor

Context Element	Meaning
MSS 48-bit MAC address unique identifier	48-bit universal MAC address, as specified in 6.4.1.During HO it is used to refer to specific connectivity (addressing) and properties of MAC connections (including QoS properties)
Address of MSS at Home Network	IP address of MSS at its Home Network. This address does not change while MSS travels from one BS to another
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 Association	Number M of Security Associations established for the MSS.
M x SAIE	TBD

Table 1e—Service Information Element(SIE) Contents

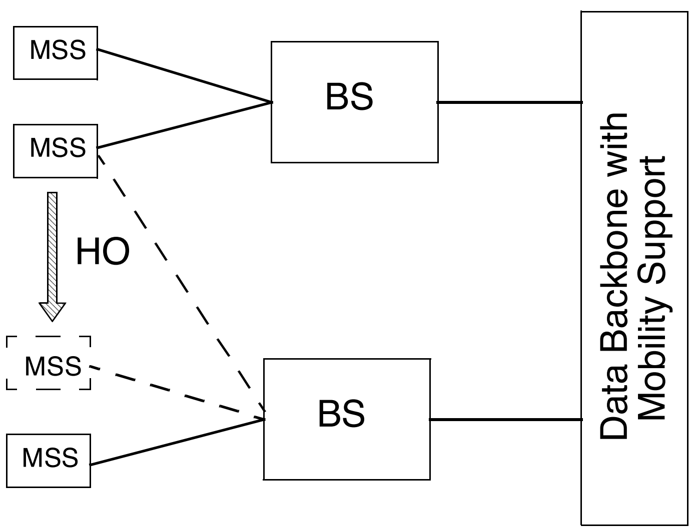
Field	Meaning
Service Flow ID	As specified in 6.4.13.2. Service Flow ID has global meaning; it does not change in the process of hand-over.
MAC Connection Parameters	Connection parameters as specified in section 6.3.1.1
Service Class Name	Specifies AuthorizedQoSParamSet, which is defined globally (while AdmittedQosParamSet is defined each time in the process of hand-over).

Figure 0d—Network Structure (control plane) and HO



1.4.1.1.5 Transfer of Control Information During HO

Figure 0e—Network Structure (data plane) and HO



1.4.1.2 MAC layer HO procedures

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

1.4.1.2.1 Network topology acquisition

1.4.1.2.1.1 Network topology advertisement

A BS may broadcast information about the network topology using the MOB-NBR-ADV MAC message.. An MSS may decode this message to find out information about the parameters of neighbor BS. Each MSS will thus be able to synchronize quickly with neighbor BS.

1.4.1.2.1.2 MSS Scanning of neighbor BS

A BS may allocate time intervals to MSSís for the purpose of seeking and monitoring neighbor BS suitability as targets for HO. Such a time interval will be referred to as a **scanning interval**.

An MSS may request an allocation of a scanning interval using the MOB_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 BS shall respond MOB_SCN-RSP MAC message. The MOB_SCN-RSP MAC message shall either grant the requesting MSS a scanning interval that is at least as long as requested by that MSS, or deny the request.

An MSS, upon detection of a MOB_SCN-RSP MAC message addressed to it in the DL-MAP, shall use the allocated interval to seek for neighbor BS. When neighbor BS are identified, the MSS shall attempt to synchronize with their downlink transmissions, and estimate the quality of the PHY connection.

The BS may buffer incoming data addressed to the MSS during the scanning period, and transmit the data after the scanning period.

1.4.1.2.1.3 Association Procedure

An MSS may use this interval for ranging as well as for the association procedure. When associating with a neighbor BS, the MSS shall not only synchronize with neighbor BS downlink, but shall also perform two additional stages called **association-initial-ranging** and **association-pre-registration**. Association-initial-ranging is performed by transmitting a RNG-REQ MAC message as specified in section 6.4.2.3.5 with the following parameters specified in 11.1.3-11.1.4 for RNG-REQ and RNG-RSP messages:

Serving BS ID

> BS sends RNG-RSP message with the prediction of service level parameter set to 2, only in the case it is ready to accept the MSS after actual HO.

Upon reception of a RNG-RSP message with the **prediction of service level** parameter set to 2, the MSS marks the target BS as Associated. Information on Association may be reported to the Serving BS. The target BS may store information on newly associated MSS. Association state of specific MSS at the BS shall be aged-out after ASC-AGING-TIMER timeout.

1.4.1.2.2 HO process

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 listed below (not necessarily in the order listed):

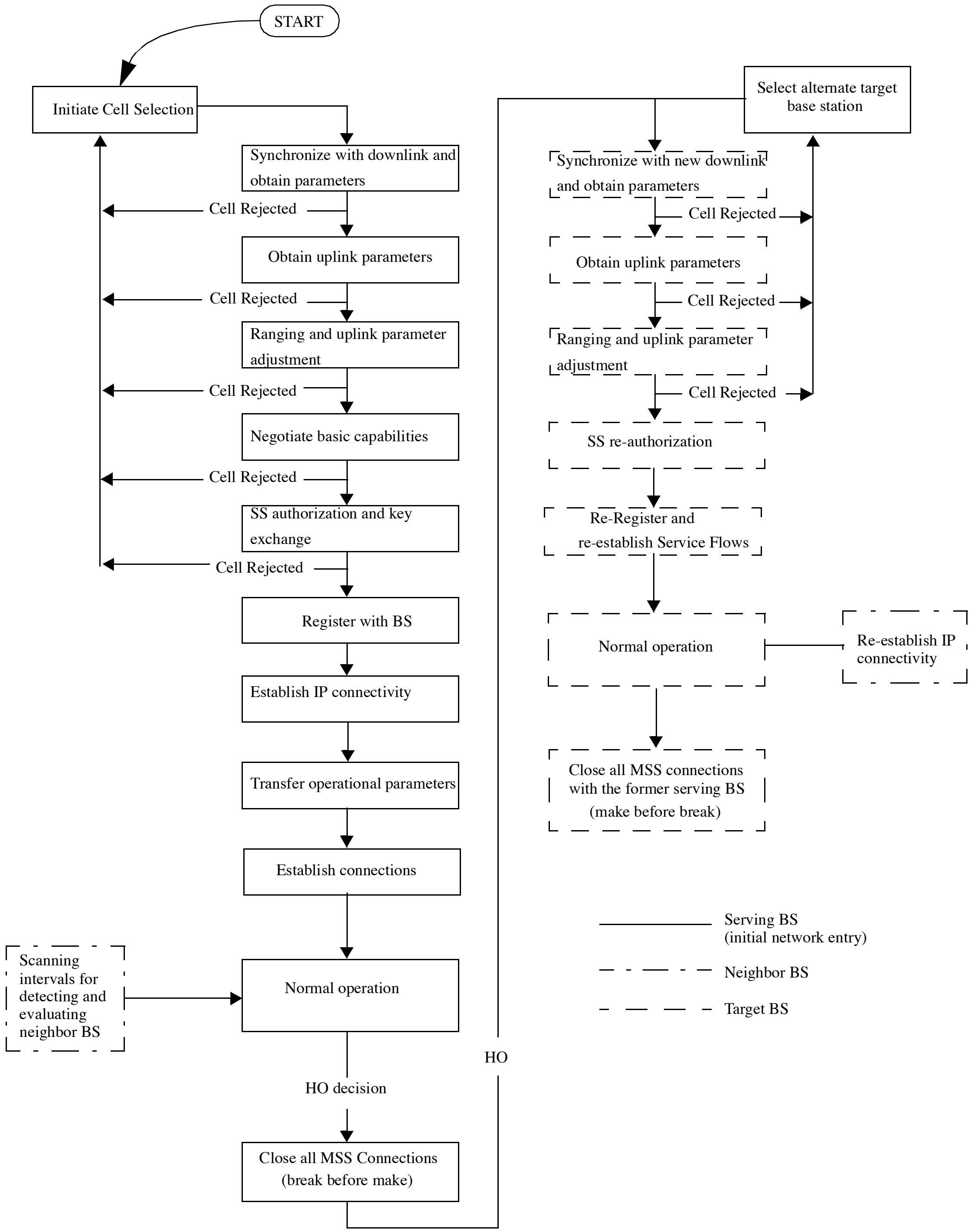
ó HO initiation, the decision to start the process is taken

- Termination of service with the serving BS, 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 or forwarded to the target BS.
- Network re-entry in target BS, where the MSS re-enters the network using a fast network entry procedure. After network re-entry, service flows belonging to the MSS are re-associated with newly established connections. QoS parameters of service flows (AdmittedQoSParamSet) may be different from AuthorizedQoSParamSet, based on the availability of resources in the target BS.

The serving BS may terminate the service with the MSS upon receiving hand-over indication from the MSS, or it may maintain the service with the MSS until receiving network entry indication from the target BS.

The HO process, and its similarity to the initial network entry process, is depicted in Figure 0f.

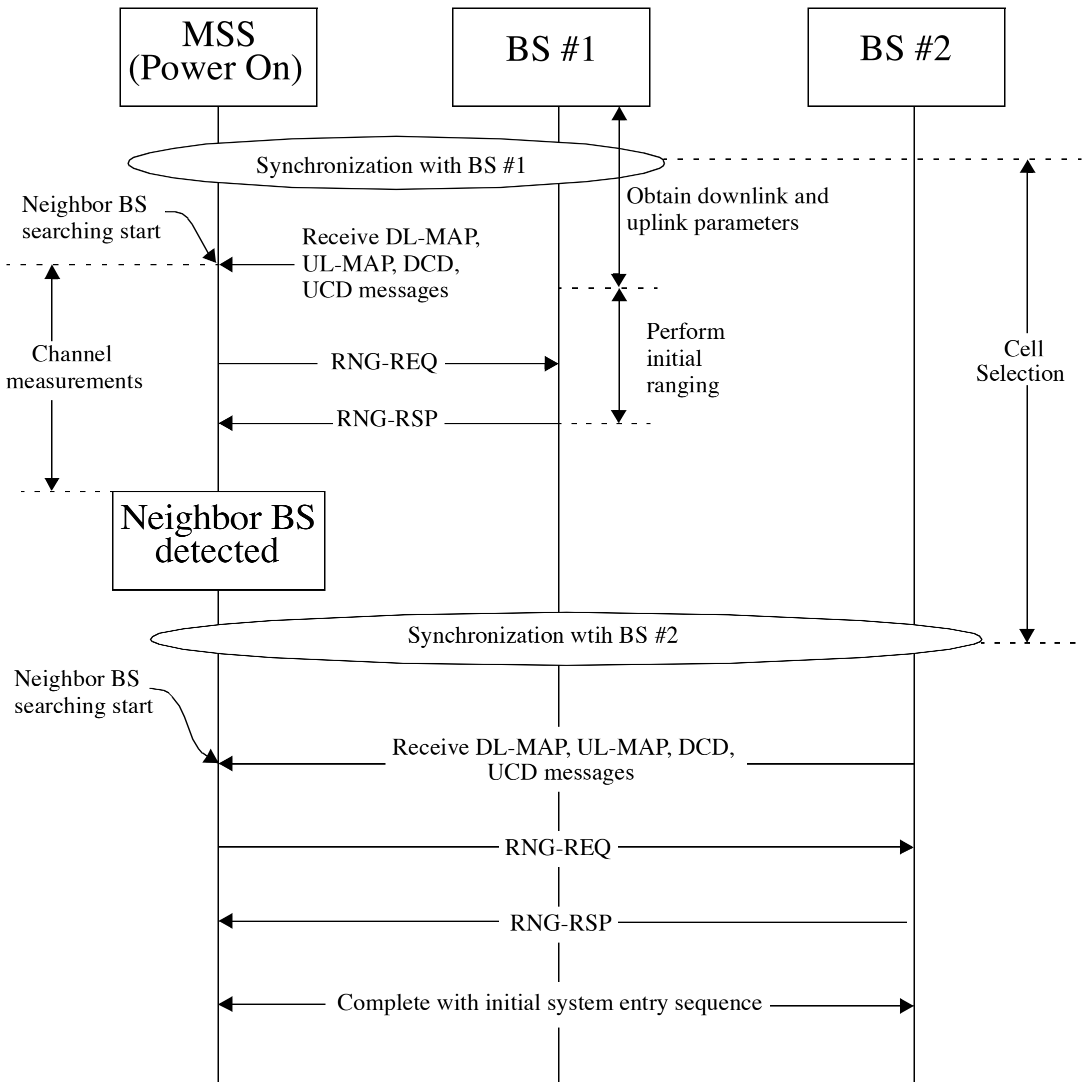
Figure 0f—HO and Initial Network Entry



1.4.1.2.2.1 Cell Selection

Cell selection is a terminology used to refer to situations where an MSS leaves a BS before getting to the normal-operation state. Such procedure does not involve termination of existing connections, nor does it change the status of any existing connections, or establish new ones. An MSS may perform a cell selection if such an action is necessary with respect to its PHY signal quality. In such a case the MSS shall restart the initial re-entry sequence or the HO sequence as applicable. No action is required from the BS during an cell selection.

Figure 0g—Example of cell selection procedure



1.4.1.2.2.2 HO initiation

Either an MSS or a BS may initiate a HO by transmitting the MOB_MSSHO-REQ or MOB_BSHO-REQ MAC messages. It is anticipated that in most situations the MSS will be the initiator of the HO, but sometimes a BS may be the initiator of a HO to facilitate load sharing among BS or because of uplink connection quality.

An MSS may scan neighbor BS presented in the MOB_NBR-ADV message before transmitting MOB_MSSHO-REQ message. When MOB_MSSHO-REQ is sent by an MSS, the MSS may indicate possible target BS (from signal quality point of view). When MOB_BSHO-REQ is sent by a BS, the BS may indicate the recommended target BS (based on their capability to meet the MSS QoS requirements). The MOB_MSSHO-REQ message may include an indication of the estimated time for performing the HO.

At the BS side, before sending MOB_BSHO-REQ or after receiving a MOB_MSSHO-REQ message, the BS may acquire from the neighbor BS information regarding their capability of serving the requesting MSS. The BS may further choose to notify neighboring BS (through the backbone) of the impending hand-over. See Annex A for specifications of the communication through the backbone network, and the information exchanged between BSs.

After receiving MOB_MSSHO-REQ or MOB_BSHO-REQ message, the receiving party shall respond with a MOB_BSHO-RSP or MOB_MSSHO-RSP MAC message. When sent by a BS, the MOB_HO-RSP message may indicate a recommended target BS. The MOB_HO-RSP message may also includes an estimation of the time when the HO would take.

1.4.1.2.2.3 HO cancellation/rejection

After the MSS or BS have initiated an HO using MOB_MSSHO/BSHO-REQ, the MSS may cancel or reject HO at any time through transmission of the MOB_HO-IND. The rejection shall be made through transmission of a MOB_HO-IND with the HO reject option (HO Type = 10). If the HO_type field has the value of 10 (HO reject option), the BS may reconfigure target BS list and retransmit MOB_BSHO-RSP message including new target BS list. The cancellation shall be made through transmission of a MOB_HO-IND with the HO cancel option (HO Type = 01).

1.4.1.2.2.4 Termination with the serving BS

After the [MSS/BS]MOB_HO-REQ/MOB_HO-RSP handshake is completed, the MSS may begin the actual HO. This is done by sending a MOB_HO-IND MAC message with the serving BS release option (HO_type=00).

If the HO_type field has the value of 00 (serving BS release option), the BS may either close all connections and discard MAC state machines and MAC PDUs associated with the MSS or it may retain the connections, MAC state machine and PDU associated with the MSS to be forwarded to the target BS for service continuation, or to be discarded upon reception of hand-over indication from the target BS.

1.4.1.2.3 Drops and corrupted HO attempts

A drop is defined as the situation where an MSS has stopped communication with its serving BS (either in the downlink, or in the uplink) before the normal HO sequence outlined in Cell Selection and Termination with the serving BS has been completed.

An 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 BS can detect a drop by exceeding the RNG-REQ retries limit allowed for the periodic ranging mechanism.

When the MSS has detected a drop, it shall attempt network re-entry with its preferred target BS as outlined in section Re-entry with the target BS. When the BS has detected a drop, it shall react as if a MOB_HO-IND MAC message has been received with HO_type 00.

1.4.1.2.4 Re-entry with the target BS

At re-entry, the MSS performs the steps as shown in Figure 0f.

1.4.1.2.4.1 Synchronize with downlink and obtain parameters

For MSS that have used their scanning interval to synchronize with target BS and have decoded the MOB_NBR-ADV message in the serving BS, this stage should be immediate. In other situations this procedure defaults to the one specified for initial network entry.

1.4.1.2.4.2 Obtain uplink parameters

For MSSís that have decoded the MOB_NBR-ADV message, this stage should be immediate. In other situations this procedure defaults to the one specified for initial network entry.

1.4.1.2.4.3 Ranging and uplink parameters adjustment

An MSS may perform an initial network entry as specified in 6.4.9. During this stage the MSS is assigned a new basic and primary management CID in the target BS. If the MSS has used scanning interval(s) to do preliminary ranging with target BS, and if the target BS received HO-pre-notification message that contains the MAC address of the MSS, (see Section Annex C, Backbone network HO procedures) the BS may choose, instead of waiting for initial ranging request in Initial Ranging Interval, to allocate a non-contention ranging opportunity for the MSS.

As opposed to regular network entry, where initial ranging is performed on contention basis, here the ranging opportunity may be allocated individually based on an MSSís 48-bit MAC address assuming this identifier was forwarded to the target BS via the backbone network. Allocation of non-contention ranging opportunity is done using the Fast_UL_ranging_IE() (see Fast ranging (Paging) Information Element) in the UL-MAP.

1.4.1.2.4.4 MSS re-authorization

During this stage the MSS performs the re-authorization part of the PKM protocol used at initial network entry (see IEEE Standard P802.16-REVd/D2-2003, section 7.2). The BS authenticates the user and as the security context has not changed (it is transferred from the old BS via backbone, see Section Annex C, Backbone network HO procedures) the security sub-layer can continue in normal operation.

1.4.1.2.4.5 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 BS, and receives on the registration response a conversion table that maps the connections it had with its pervious serving BS to a new set of connections on the current serving BS. 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 provided its 48-bit MAC address identifier, and the BS can recognize that the MSS is performing a HO. The BS REG-RSP shall therefore include TLV values for re-establishing the active provisioned Service Flows (see Section 11.1.1.1, UCD channel encodings).

1.4.1.2.4.6 Commence Normal Operation

At this stage, normal operation commences. The MSS shall re-establish its IP connectivity as specified at initial network entry. Figure <TBD> shows how a complete HO process might look like in the time domain.

1.4.1.2.5 HO completion

[TBD This section should discuss the following:]

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

1.4.1.3 Setup and negotiations

[TBD This section should discuss the following:]

ó Setup and negotiation procedures related to the HO
ó PHY dependent parameters and associated handshake
ó The model for coexistence of fixed and mobile-SS on the same air-interface instance

3. Definitions

3.5 Base Station

[Add the follwoing text to section 3.5:]

3.5.1 Serving BS

For any mobile subscriber station (MSS), the serving BS is the BS with which the MSS has recently performed registration at initial network-entry or during an HO.

3.5.2 Target BS

The BS that an MSS intends to be registered with at the end of a HO.

3.5.3 Neighbor BS

For any MSS, a neighbor BS is a BS whose downlink transmission can be demodulated by the MSS.

3.69 Mobile Subscriber Station (MSS)

A subscriber station that supports communications while in motion.

3.70 Hand-over (HO)

The process in which an MSS migrates from the air-interface provided by one BS to the air-interface provided by another BS. Two HO variants are defined:

ó break-before-make HO: A HO where service with the new BS starts after a disconnection of service with the old BS.
ó make-before-break HO: A HO where service with the new BS starts before disconnection of the service with the old BS.

3.71 Scanning Interval

A time period intended for monitoring neighbor BS by the MSS, to determine their suitability as targets for HO.

3.72 Mobility Agent (MA):

A higher layer agent which is responsible for mobility.

6. MAC Common Part Sublayer

6.3 MAC Service Definition

[Add the following text to section 6.3.3:]

6.3.3 MAC Service Definition for Mobility Support

6.3.3.1 Primitives for Communication Between CS and MA

6.3.3.1.1 MA to CS: CS_CREATE_CONNECTION.request

6.3.3.1.1.1 Function

6.3.3.1.1.2 Semantics of the service primitive

6.3.3.1.1.3 When generated

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

6.3.3.1.1.4 Effect of receipt

[TBD Parameters]

6.3.3.1.2 MA to CS: CS_CREATE_CONNECTION.response

6.3.3.1.2.1 Function

6.3.3.1.2.2 Semantics of the service primitive

6.3.3.1.2.3 When generated

6.3.3.1.2.4 Effect of receipt

[TBD Parameters]

6.3.3.1.3 MA to CS: CS_TERMINATE_CONNECTION.request/response

6.3.3.1.3.1 Function

6.3.3.1.3.2 Semantics of the service primitive

6.3.3.1.3.3 When generated

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

6.3.3.1.3.4 Effect of receipt

[TBD Parameters]

6.3.3.1.4 MA to CS: CS_SDU.request

6.3.3.1.4.1 Function

6.3.3.1.4.2 Semantics of the service primitive

6.3.3.1.4.3 When generated

Generated to send an SDU to MAC

6.3.3.1.4.4 Effect of receipt

[TBD Parameters]

6.3.3.1.5 CS to MA: CS_MSS_ARRIVAL.indication

6.3.3.1.5.1 Function

Signals MSS arrival at the cell

6.3.3.1.5.2 Semantics of the service primitive

6.3.3.1.5.3 When generated

6.3.3.1.5.4 Effect of receipt

[TBD Parameters]

6.3.3.1.6 CS to MA: CS_MS_DEPARTURE.indication

6.3.3.1.6.1 Function

Signals MSS departure from the cell.

6.3.3.1.6.2 Semantics of the service primitive

6.3.3.1.6.3 When generated

6.3.3.1.6.4 Effect of receipt

[TBD Parameters]

6.3.3.1.7 CS to MA: CS_SDU.indication

6.3.3.1.7.1 Function

6.3.3.1.7.2 Semantics of the service primitive

6.3.3.1.7.3 When generated

Generated to signal arrival of an SDU from the backhaul connection

6.3.3.1.7.4 Effect of receipt

[TBD Parameters]

6.4 Data/Control Plane

[Modify the existing text in section 6.4.1.1 as shown below:]

[Replace:]

~~ìFinally, the Secondary Management Connection is used by the BS and MSS to transfer delay tolerant, standard based [Dynamic Host Configuration Protocol (DHCP), Trivial File Transfer Protocol (TFTP), SNMP, etc.] management messages.î~~

[with:]

ìFinally, the Secondary Management Connection is used by the BS and MSS to transfer delay tolerant, standard based [Dynamic Host Configuration Protocol (DHCP), Mobile IP, Trivial File Transfer Protocol (TFTP), SNMP, etc.] management messages. These management messages are terminated at the BS and the MSS.î

6.4.2.3.2 Downlink Map (DL-MAP) message

[In section 6.4.2.3.2 Downlink Map (DL-MAP) message, change paragraph 5 with:]

Base Station ID
The Base Station ID is a 48 bit long field uniquely identifying the BS. The Base Station ID shall be programmable.

6.4.2.3.5 Ranging Request (RNG_REQ) message

[Modify the existing text in section 6.4.2.3.5 as shown below:]

The CID field in the MAC header shall assume the following values when sent in an Initial Maintenance interval:

a) Initial ranging CID if SS is attempting to join the network.

b) Initial ranging CID if SS has not yet registered and is changing downlink (or both downlink and uplink) channels as directed by the downloaded SS Configuration File (9.2).

c) Basic CID (previously assigned in RNG-RSP) if SS has not yet registered and is changing uplink channel as directed by the downloaded SS Configuration File (9.2).

d) Basic CID (previously assigned in RNG-RSP) if SS is registered and is changing uplink channel.

e) Initial ranging CID if SS is an MSS registered on one downlink channel and is currently in the process of pre-registration on another channel.

f) In all other cases, the Basic CID is used as soon as one is assigned in the RNG-RSP message.

The following parameters may be included in the RNG-REQ message:

Serving BS ID

For MSS during hand-over or network re-entry, the BS ID of the BS to which the MSS is currently connected (has completed complete registration cycle and is in Normal Operation). Serving BS ID shall not be included if interval timer is timed-out (Serving BS ID AGING-TIMER, see Table 275a-Parameters and Constants). Inclusion of Serving BS ID in the RNG-REQ message signals to the Target BS that the MSS is currently connected to the network through Serving BS and is in the process of either a hand-over or network re-entry.

6.4.2.3.6 Ranging Response (RNG-RSP) message

[Add the following to section 6.4.2.3.6:]

When a BS sends a RNG-RSP message in response to a RNG-REQ message containing Serving BS ID, the BS may include the following TLV parameter in the RNG-RSP message:

Service Level Prediction _ This value indicates the level of service the MSS can expect from this BS. The following encodings apply:

0 = No service possible for this MSS.
1 = Some service is available for one or several Service Flow authorized for the MSS.
2 = For each authorized Service Flow, a MAC connection can be established with QoS specified by the AuthorizedQoSParamSet.
3 = No service level prediction available.

Service Level prediction may be accompanied by a number of Service Flow Encodings as specified in 11.4.9 with the following parameters only:

ó Service Class Name
ó Service Flow Identifier

Service class name may refer either to AuthorizedQoSParamSet (then Service Level Prediction should be encoded as ë2í) or to a subset of it (then Service Level Prediction should be encoded as ë1í).

6.4.2.3.8 Registration Response (REG-RSP) message

[Append to section 6.4.2.3.8 Registration Response (REG-RSP) message:]

For mobile networks, Target BS may include CID_update TLVs in the REG-RSP for MSS recognized by the Target BS as performing HO or network re-entry by the presence of an unexpired Serving BS ID in the RNG-REQ.

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 previous Serving BS. The TLVs specify CID in the Target BS that shall replace active CID used in the previous Serving BS. Multiple iterations of these TLVs may occur in the REG-RSP suitable to re-creating and re-assigning all active Service Flows for the MSS from its previous Serving BS 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 transferred in this manner.

These TLVs enable the Target BS to renew connections used in the previous Serving BS, but with different QoS settings.

[Add the following to sections to the end of 6.4.2.3:]

6.4.2.3.42 Sleep Request message (MOB_SLP-REQ)

MSS supporting sleep-mode uses the MOB_SLP-REQ message to request permission from the BS to enter sleep-mode. The MOB_SLP-REQ message is sent from the SS to the BS on the MSSís basic CID.

Table 85a—Sleep-Request (MOB_SLP-REQ) message format

Syntax	Size	Notes
SLP-REQ_Message_Format() {		
Management message type = 45	8 bit	
initial-sleep window	6 bit	
final-sleep window	10 bit	
listening interval	8 bits	
}		

Parameters shall be as follows:

Initial-sleep window
Requested start value for the sleep interval (measured in frames).
Final-sleep window
Requested final value for the sleep interval (measured in frames).
Listening interval
Requested listening interval (measured in frames) to the MOB_SLP-REQ.

6.4.2.3.43 Sleep Response message (M0B_SLP-RSP)

TThe MOB_SLP-RSP message shall be sent from BS to a MSS on the MSSís basic CID in response to an MOB_SLP-REQ message, or may be sent unsolicited. The MSS shall enter sleep-mode using the parameters indicated in the message. In the case where sleep is denied (After-REQ-action=1), it is recommended that the BS provide unsolicited MOB_SLP-RSP message.

Table 85b—Sleep-Response (MOB_SLP-RSP) message format

Syntax	Size	Notes
MOB_SLP-RSP_Message_Format() {		
Management message type = 46	8 bit	
Sleep-approved	1 bit	0: Sleep-mode request denied 1: Sleep-mode request approved
If (Sleep-approved == 0) {		

After-REQ-action	1 bit	0: The MSS may retransmit the MOB_SLP-REQ message after the time duration (REQ-duration) given by the BS in this message 1: The MSS shall not retransmit the MOB_SLP-REQ message and shall await the MOB_SLP-RSP message from the BS
REQ-duration	4 bit	Time duration for case where After-REQ-action value is 001.
else {		
Start frame	7 bit	
initial-sleep window	6 bit	
final-sleep window	10 bit	
listening interval	8 bit	
SLPID	16 bits	Allowed range: 0..1023
}		
}		

Parameters shall be as follows:

Sleep approved
The activation indication of the MSS when the MSS receives this message from the BS.

After-REQ-duration
On MSS request to enter sleep mode rejected by the BS, indicate recourse action.

REQ-duration
Waiting value for the MOB_SLP-REQ message re-transmission (measured in MAC frames)

Start-frame
Lower byte of the frame number in which the MSS shall enter into sleep mode.

Initial-sleep window
Start value for the sleep interval (measured in frames).

Final-sleep window
Final value for the sleep interval (measured in frames).

Listening interval
Requested listening interval (measured in frames) to the MOB_SLP-REQ.

SLPID
This is a number assigned by the BS whenever an MSS is instructed to enter sleep-mode. This number shall be unique in the sense that it is assigned to a single MSS that is instructed to enter sleep-mode. No other MSS shall be assigned the same number while the first MSS is still in sleep-mode.

6.4.2.3.44 Traffic Indication message (MOB_TRF-IND)

This message is sent from BS to MSS on the broadcast CID. The message is intended for SSís that are in sleep-mode, and is sent during those MSSís listening-intervals. The message indicates whether there has been traffic addressed to each MSS that is in sleep-mode. An SS that is in sleep-mode during its listening-interval shall decode this message to seek an indication addressed to itself.

When an MSS awakens, it will check the frame number to ensure that it did not lose frame synchronization with the BS, if it does not find any positive indication in the MOB_TRF-IND message, it will consider this as a negative indication and shall return to sleep mode.

Table 85c—Traffic-Indication (MOB_TRF-IND) message format

Syntax	Size	Notes
TRF-IND_Message_Format() {		
Management message type = 47	8 bits	
SLPID bit-map	Variable	
}		

Parameters shall be as follows:

SLPID bit-map

The SLPID bit-map field is a variable length field (that is it's length is determined by the number of SLPID currently assigned by the BS). The least-significant bit of the first byte in this field relates to SLPID=0, and subsequent bits relate to SLPID=1, etc.

The MSS that has been assigned SLPID=n by the SLP-RSP message shall interpret bit n (bn) in the SLPID bit map in the following manner:

b_n = 0 means negative indication, MSS shall return to sleep mode

b_n = 1 means positive indication, MSS shall awake

6.4.2.3.45 Neighbor Advertisement (MOB_NBR-ADV) message

An MOB_NBR-ADV management message may be broadcast by a BS at a periodic interval (NBR-ADV interval, see Table 275a) to identify the network and define the characteristics of neighbor BS to potential MSS seeking initial network entry or hand-over.

Table 85d—MOB_NBR-ADV Message Format

Syntax	Size	Notes
MOB_NBR-ADV_Message_Format() {		
Management Message Type = 48	8 bits	
Operator ID	24 bits	Unique ID assigned to the operator
Configuration Change Count	8 bits	
N_NEIGHBORS	8 bits	
For (j=0 ; j<N_NEIGHBORS ; j++) {		
Neighbor BS-ID	48 bits	
Physical Frequency	32 bits	
TLV Encoded Neighbor information	Variable	TLV specific
}		
}		

A BS shall generate MOB_NBR-ADV messages in the format shown in Table 84d. The following parameters shall be included in the MOB_NBR-ADV message unless otherwise noted as an optional item in which case they may be included,

BS ID - same as the Base Station ID parameter in the DL-MAP message

Operator ID - the unique network ID shared by an association of BS

Configuration Change Count - Incremented by one (modulo 256) whenever any of the values relating to any included data element changes. If the value of this count in a subsequent MOB_NBR-ADV message remains the same, the MSS can quickly disregard the entire message.

All other parameters are coded as TLV values (see Table 292a). All TLV items are optional.

N_Neighbors - Number of advertised neighbor BS

For each advertised Neighbor BS, the following TLV parameters may be included,

Neighbor BS-ID - Same as the Base Station ID parameter in the DL-MAP message of Neighbor BS

Physical Frequency - DL center frequency (kHz).

DCD_settings - The DCD_settings is a compound TLV value that encapsulates a DCD message that may be transmitted in the advertised BS downlink channel. This information is intended to enable fast synchronization of the MSS with the advertised BS downlink. The DCD settings fields shall contain only neighbor's DCD TLV values which are different from the serving BS corresponding values. For values that are not included, the MSS shall assume they are identical to the serving BSs corresponding values.

UCD_settings - The UCD_settings is a compound TLV value that encapsulates a UCD message that may be transmitted in the advertised BS downlink channel. This information is intended to enable fast synchronization of the MSS with the advertised BS uplink. The UCD settings fields shall contain only neighbor's UCD TLV values which are different from the serving BS's corresponding values. For values that are not included, the MSS shall assume they are identical to the serving BS's corresponding values.

6.4.2.3.46 Scanning Interval Allocation Request (MOB_SCN-REQ) message

A MOB_SCN-REQ message may be transmitted by an MSS to request a scanning interval for the purpose of seeking neighbor BS, and determining their suitability as targets for HO.

An MSS shall generate MOB_SCN-REQ messages in the format shown in Table 85e:

Table 85e—MOB_SCN-REQ Message Format

Syntax	Size	Notes
MOB_SCN-REQ_Message_Format() {		
Management Message Type = ?	8 bits	
Scan Duration	12 bits	Units are frames.
Start Frame	4 bits	
}		

The following parameters shall be included in the MOB_SCN-REQ message,

Scan Duration

Duration (in units of frames) of the requested scanning period.

Start Frame

Measured from the frame in which this message was received. A value of zero means that it will start in the next frame.

6.4.2.3.47 Scanning Interval Allocation Response (MOB_SCN-RSP) message

A MOB_SCN-RSP message shall be transmitted by the BS in response to an MOB_SCN-REQ message sent by an MSS. In addition, BS may send an unsolicited MOB_SCN_RSP. The message shall be transmitted on the basic CID.

The format of the MOB_SCN-RSP message is depicted in Table 85f.

Table 85f—MOB_SCN-RSP Message Format

Syntax	Size	Notes
MOB_SCN-RSP_Message_Format() {		
Management Message Type = ?	8 bits	
For (i=0 ; i<num_CIDs; i++) {		num_CIDs can be determined from the length of the message (found in the generic MAC header).
CID	16 bits	basic CID of the MSS
Duration	12 bits	in frames
Estimated time for hand-over	8 bits	
Start Frame	4 bits	
}		
}		

The following parameters shall be included in the MOB_SCN-RSP message:

CID

Basic CID of the MSS that have sent MOB_SCN-REQ message.

Duration

Duration (in units of frames) where the MSS may scan for neighbor BS.

Estimated time for hand-over

Timing (in frames) for the hand-over. A value of zero indicates unknown, a value of one indicates the next frame relative to the frame in which this message is received.

Start Frame

Measured from the frame in which this message was received. A value of zero means that it will start in the next frame.

6.4.2.3.48 BS HO Request (MOB_BSHO-REQ) message

The BS may transmit a MOB_BSHO-REQ message when it wants to initiate an HO. An MSS receiving this message may scan recommended neighbor BSs in this message. The message shall be transmitted on the basic CID.

Table 85g—MOB_BSHO-REQ Message Format

Syntax	Size	Notes
MOB_BSHO-REQ_Message_Format() {		
Management Message Type = 51	8 bits	
N_Recommended	8 bits	
For (j=0 ; j<N_Recommended ; j++) {		
Neighbor BS-ID	48 bits	
Service level prediction	8 bits	
}		
}		

A BS shall generate MOB_BSHO-REQ messages in the format shown in Table 85g. The following parameters shall be included in the MOB_BSHO-REQ message:

N_Recommended
Number of recommended neighbor BS

For each recommended neighbor BS, the following parameter shall be included:

Neighbor BS-ID
Same as the Base Station ID parameter in the DL-MAP message of neighbor BS. This may include the Serving BS.

Service level prediction
This value indicates the level of service the MSS can expect from this BS. the following encodings apply:
1 = Some service is available for the MSS.
2 = Service is available with the current QoS.

6.4.2.3.49 MSS HO Request (MOB_MSSHO-REQ) message

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

Table 85h—MOB_MSSHO-REQ Message Format

Syntax	Size	Notes
MOB_MSSHO-REQ_Message_Format() {		
Management Message Type = 52	8 bits	

N_Recommended	8 bits	
For (j=0 ; j<N_Recommended ; j++) {		
Neighbor BS-ID	48 bits	
BS S/(N+I)	8 bits	
Service level prediction	8 bits	
}		
}		

An MSS shall generate MOB_MSSHO-REQ messages in the format shown in Table 85h. The following parameters shall be included in the MOB_MSSHO-REQ message,

N_Recommended – Number of recommended neighbor BS

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

Neighbor BS-ID
Same as the **Base Station ID** parameter in the DL-MAP message of neighbor BS
BS S/(N + I)
This parameter indicates the signal to noise and interference ratio measured by the MSS from the particular BS. The value shall be interpreted as an unsigned byte with units of 0.25dB.
Service level prediction
This value indicates the level of service the MSS can expect from this BS. the following encodings apply:
0 = No service possible for this MSS.
1 = Some service is available for the MSS.
2 = Service with current QoS level is available.
3 = No service level prediction available.

6.4.2.3.50 BS HO Response (MOB_BSHO-RSP) message

The BS shall transmit an MOB_BSHO-RSP message upon reception of MOB_HO-REQ message. The message shall be transmitted on the basic CID.

Table 85i—MOB_HO-RSP Message Format

Syntax	Size	Notes
MOB_HO-RSP_Message_Format() {		
Management Message Type = 53	8 bits	
Estimated HO time	8 bits	
N_Recommended	8 bits	
For (j=0 ; j<N_Recommended ; j++) {		Neighbor base stations shall be presented in an order such that the first presented is the one most recommended and the last presented is the least recommended.
Neighbor BS-ID	48 bits	

service level prediction	8 bits	
}		
}		

A BS shall generate MOB_BSHO-RSP messages in the format shown in Table 85i. The following parameters shall be included in the MOB_BSHO-RSP message,

Estimated HO time
Estimated number of frames starting from the frame following the reception of the MOB_BSHO-RSP message until the HO may take place. A value of zero in this parameter signifies that this parameter should be ignored.

N_Recommended
Number of recommended neighbor BS

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

Neighbor BS-ID
Same as the **Base Station ID** parameter in the DL-MAP message of neighbor BS. This may include the Serving BS.

Service level prediction
This value indicates the level of service the MSS can expect from this BS. the following encodings apply:
0 = No service possible for this MSS.
1 = Some service is available for the MSS.
2 = Service with QoS specified at ASA server (for the MSS identified by the 48-bit MAC address) is available.
3 = No service level prediction available.

6.4.2.3.51 MSS HO Response (MOB_MSSHO-RSP) message

An MSS shall transmit an MOB_MSSHO-RSP message upon reception of MOB_BSHO-REQ message. The message shall be transmitted on the basic CID.

Table 85j—MOB_MSSHO-RSP Message Format

Syntax	Size	Notes
MOB_MSSHO-RSP_Message_Format() {		
Management Message Type = 54	8 bits	
Estimated HO time	8 bits	
N_Recommended	8 bits	
For (j=0 ; j<N_Recommended ; j++) {		
Neighbor BS-ID	48 bits	
BS S/(N+1)	8 bits	
}		
}		

When MSS receives a MOB_BSHO-REQ message from serving BS, it may select a target BS according to the result of SINR measurements for each neighbor BS recommended in the MOB_BSHO-REQ message. If a target BS selection has been made, the MSS may include in its response message the parameter ìN_Recommended = 1î.

An MSS shall generate MOB_MSSHO-RSP messages in the format shown in Table 85j. The following parameters shall be included in the MOB_MSSHO-RSP message:

Estimated HO time – Estimated number of frames starting from the frame following the reception of the MOB_MSSHO-RSP message until the HO may take place. A value of zero in this parameter signifies that this parameter should be ignored.

N_Recommended – Number of recommended neighbor BS

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

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

6.4.2.3.52 HO Indication (MOB_HO-IND) message

An MSS shall transmit a MOB_HO-IND message for final indication that it is about to perform a HO. When MSS cancel or reject the HO, the MSS also shall transmit a MOB_HO-IND message with appropriate HO_IND type field. The message shall be transmitted on the basic CID.

Table 85k—MOB_HO-IND Message Format

Syntax	Size	Notes
MOB_HO_IND_Message_Format() {		
Management Message Type = 54	8 bits	
reserved	6 bits	Reserved; shall be set to zero
HO_IND_type	2 bits	00: Serving BS release 01: HO cancel 10: HO reject 11: reserved
Target_BS_ID	48 bits	This field will be enabled when HO_IND-type is set to 00.
HMAC Tuple	21 bytes	See 11.4.11
}		

An MSS shall generate MOB_HO-IND messages in the format shown in Table 85k. If Privacy is enabled, the MOB_HO-IND message shall include the following TLV value,

HMAC Tuple (see 11.4.11 in IEEE Standard P802.16-REVd/D2-2003) – The HMAC Tuple Attribute contains a keyed Message digest (to authenticate the sender).

[Prepend section 6.4.9.10 with the following:]

"If mobile IP is being used, it may secure it's address on the secondary management connection."

[At the end of the paragraph in 6.4.9.10, add:]

"The IP version paramater shall be included in the TLV described in section 11.4.2.7."

6.4.13 Quality of Service

[At the end of the paragraph in 6.4.13.2, add:]

The BS may send the unsolicited RNG-RSP as a reaction to a CDMA-based bandwidth request.

When the MSS receives an unsolicited RNG-RSP message after transmitting the bandwidth-request code, it shall reset the periodic ranging timeout, adjust the parameters (timing and power, etc.) as notified in the RNG-RSP message.

[add to section 6.4.14.4:]

6.4.13.4 Detecting primary users

In a mobile environment, pre-provisioned Service classes shall be used by an operator to identify a set of QoS parameters, which are assigned to certain Service Flows by provisioning. When MSS passes from BS to another, it negotiates with the new BS desired level of QoS in the terms of Service Classes.

[Add to the end of section 6.4:]

6.4.16 Data Delivery Services

Data delivery service is associated with certain predefined set of QoS-related Service Flow parameters. For example, Continuing Grant Service has the following parameters:

SDU Size
SDU Inter-arrival Interval
Time Base
Maximum Latency
Minimum Tolerable Traffic Rate

Note that definition of Data Delivery Service does not include assignment of specific values to the parameters.

6.4.16.1 Types of Data Delivery Services

Type of Data Delivery Service identifies specific set of QoS parameters – see Table 108a.

Table 108a—Type of Data Delivery Services

Type	Symbolic Name of Service Type	Meaning
0	CG	Continuing Grant Service For UL connections should be supported by UGS Scheduling Service

Type	Symbolic Name of Service Type	Meaning
1	RT-VR	Real Time - Variable Rate Service For UL connections should be supported by rtPS Scheduling Service
2	NRT-VR	Non-Real Time - Variable Rate service For UL connections should be supported by nrtPS Scheduling Service
3	BE	Best Efforts Service For UL connections should be supported by BE Scheduling Service

See below detailed definitions for the data delivery services of different types.

6.4.16.1.1 Continuing Grant (CG) Service

This type of service is to support real-time applications generating fixed-size data packets on a periodic basis. The following are the parameters of the service:

Table 108b—Continuing Grant Service Parameters

Parameter	Meaning
SDU Size	According to 11.4.9.16
SDU Inter-arrival Interval	Interval between arrivals of consequent SDUs to MAC SAP of the transmitter
Time Base	Parameter T as specified in 11.4.9.9; should be much larger than Maximum Latency
Maximum Latency	As specified in 11.4.9.14
Minimum Tolerable Traffic Rate	Optional parameter described in 11.4.9.10. This value should be less than (SDU Size)*8/(SDU Inter-arrival Interval). The difference between these two values reflects SDUsí loss rate. Default = 0.

<u>**Description of the service**</u>

The BS is supposed during each time interval of the length (Time Base) to grant to the connection resources sufficient for transferring at least N SDUs of the given size where N = (Time Base) / (SDU Inter-arrival Interval) so that each SDU shall be delivered within time interval (Maximum Latency). If the data rate at the connection falls below (Minimum Tolerable Traffic Rate), the BS may close the connection releasing resources to other services.

6.4.16.1.2 Real-Time Variable Rate (RT-VR) Service

This service is to support real-time data applications with variable bit rates which require guaranteed data rate and delay. The following are the parameters of the service:

Table 108c—Real-Time Variable Rate Service Parameters

Parameter	Meaning
Maximum Latency	As specified in 11.4.9.15

Parameter	Meaning
Time Base	Parameter T as specified in 11.4.9.9; should be much larger than Maximum Latency
Minimum Reserved Traffic Rate	As defined according to 11.4.9.9 wth time base = T
Minimum Tolerable Traffic Rate	As specified in 11.4.9.10, with time base = T. This value should be less than Minimum Reserved Traffic Rate. The difference between these two values reflects SDUsí loss rate
Maximum Sustained Traffic Rate	Optional parameter; see 11.4.9.7. If specified, should be greater than Minimum Tolerable Traffic Rate. If not specified, the default is equal to Minimum Tolerable Traffic Rate

Description of the service

Let S denote the amount of data arrived to the transmitterís MAC SAP, during time interval T = Time Base; R = Minimum Reserved Traffic Rate. Then the BS is supposed during each time interval of the length (Time Base) to grant to the connection resources sufficient for transferring amount of data at least min {S, R * T}. Any SDU should be delivered within time interval D = Maximum Latency. In the case when the amount of data submitted to the transmitterís MAC SAP exceeds (Maximum Sustained Traffic Rate) * T, delivery of each specific SDU is not guaranteed.

6.4.16.1.3 Non-Real-Time Variable Rate (NRT-VR) Service

This QoS profile shall support applications that require a guaranteed data rate but are insensitive to delays. It is desirable in certain cases to limit the data rate of these services to some maximum rate. The QoS profile is defined by the following parameters defined as in the ***Table DDD*** (note absence of Maximum Latency parameter):

ó Time Base
ó Minimum Reserved Traffic Rate
ó Minimum Tolerable Traffic Rate
ó Maximum Sustained Traffic Rate

Description of the service

Let S denote the amount of data arrived to the transmitterís MAC SAP, during time interval T = Time Base; R = Minimum Reserved Traffic Rate. Then the BS is supposed during each time interval of the length (Time Base) to grant to the connection resources sufficient for transferring amount of data at least min {S, R * T}. In the case when the amount of data submitted to the transmitterís MAC SAP exceeds (Maximum Sustained Traffic Rate) * T, delivery of each specific SDU is not guaranteed

6.4.16.1.4 Best Effort (BE) Service

This service is for applications with no rate or delay requirements. The following are the parameters of the service:

Table 108d—Best Effort Service Parameters

Parameter	Meaning
Maximum Sustained Traffic Rate	As specified in 11.4.9.7

Description of the service

In the case when the amount of data submitted to the transmitterís MAC SAP exceeds (Maximum Sustained Traffic Rate) * T, delivery of each specific SDU is not guaranteed.

6.4.17 Sleep-mode for mobility-supporting SS

6.4.17.1 Introduction

Sleep-mode is a mode in which SSís supporting mobility may power down. Sleep-mode is intended to enable mobility-supporting SSís to minimize their energy usage while staying connected to the network. Implementation of sleep-mode is optional.

An SS that supports sleep-mode can be in one of two modes:

ó Awake
ó Sleep

When an MSS is in awake-mode, it can receive and transmit PDUs in a normal fashion. When the SS is in a sleep-mode, it does not send or receive PDUs. In sleep-mode the SS may power down.

Two intervals are defined:

Sleep-interval
A time duration, measured in whole frames, where the SS is in sleep-mode. During consecutive sleep periods the sleep-interval shall be updated using an exponentially increasing algorithm with adjustable minimum and maximum limits.

Listening-interval
Length, measured in whole frames, of the listening interval. During this interval the SS shall decide whether to stay awake or go back to sleep based on an indication from the BS.

Before entering sleep-mode the SS shall inform the BS and obtain its approval. The BS may buffer (or it may drop) incoming PDUs addressed to the sleeping SS, and shall a send notification to the SS in itís awakening periods about whether data has been addressed for it.

An SS shall awake according to the sleep-interval and check whether there were PDUs addressed for it. If such PDUs exist, it shall remain awake. An SS may terminate sleep-mode and return to awake-mode anytime (i.e. there is no need to wait until the sleep-interval is over). If the BS receives an MPDU from an SS that is supposed to be in sleep-mode, the BS shall assume that the SS is no longer in sleep-mode.

Traffic indication message (MOB_TRF-IND) shall be sent by the BS on the broadcast CID when there an MSS in listening interval of sleep-mode. If the number of positive indications is zero, the BS sends an empty indication message, that is, TRF-IND message with num-positive=0.

When its sleep-interval timer expires, the MSS shall awake to listen to the DL transmissions. If, during the listening interval, the MSS receives a TRF-IND message with a positive indication to the MSS, it shall remain awake. If the listening interval passed but the MSS didn't receive any TRF-IND message, it should return to awake state. If, during the listening interval, the MSS received at least one TRF-IND message but there is no positive indication for the MSS, it may return to its sleep-mode. The listening-interval parameter defines the maximum number of frames the SS shall remain awake waiting for the TRF_IND message.

Figure 108h shows the SDL for the SS in the awake state.

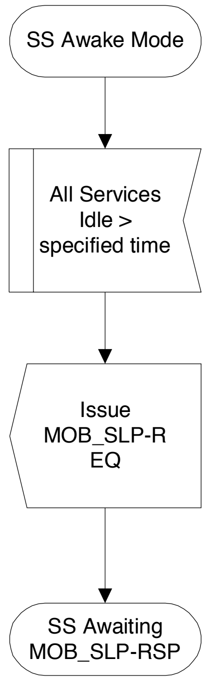


Figure 108h—SS Awaiting Sleep Response SDL Diagram

Figure 108i shows the SDL for the SS after it has sent an MOB_SLP-REQ message and is awaiting a response.

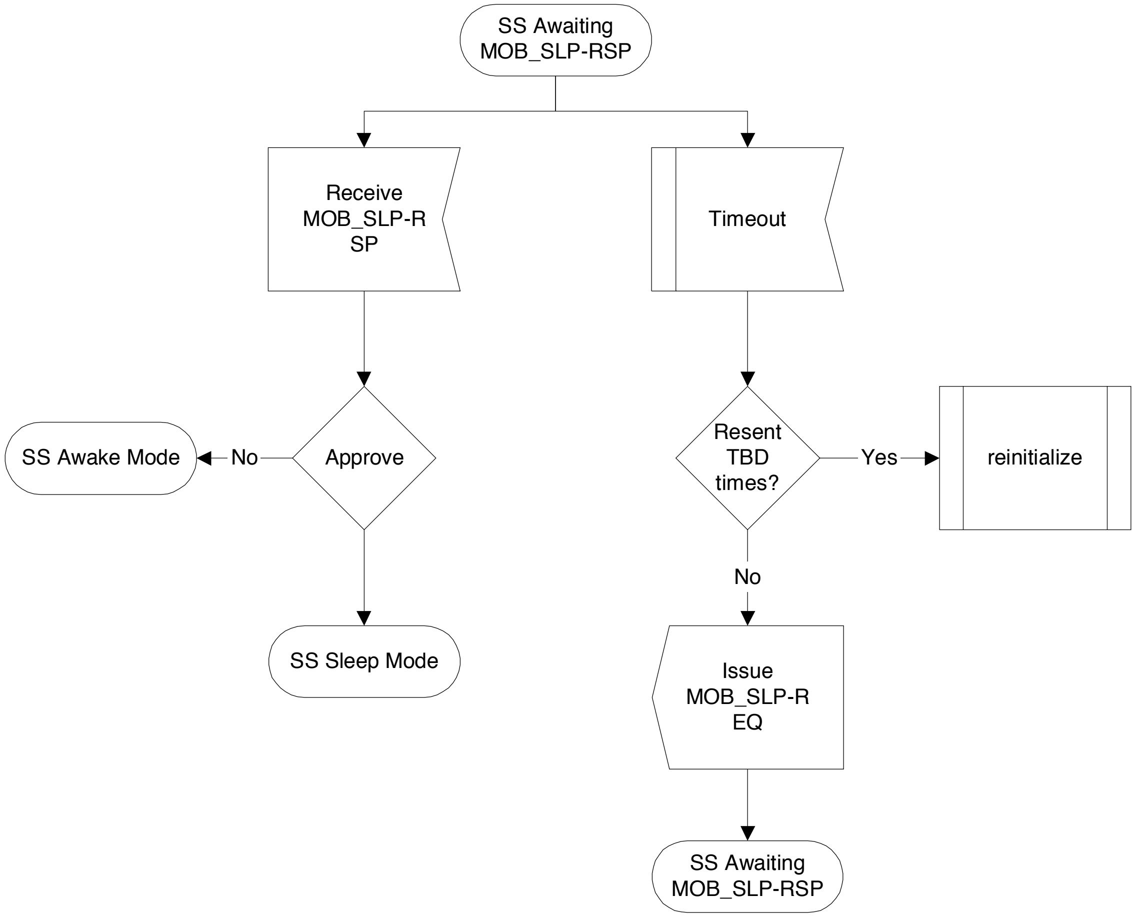


Figure 108i—SS Sleep Mode SDL Diagram

Figure 108j shows the SDL for the SS while in sleep-mode.

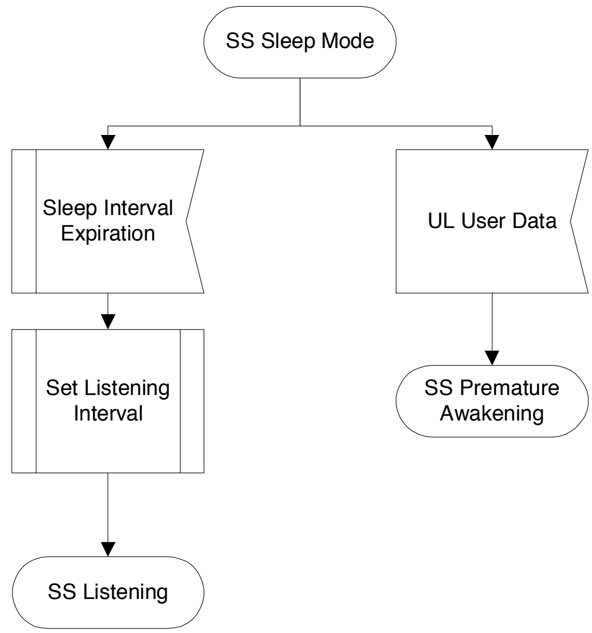


Figure 108j—SS Await Poll SDL Diagram

Figure 108k shows the SDL for when the SS is listening for an MOB_TRF-IND message from the BS.

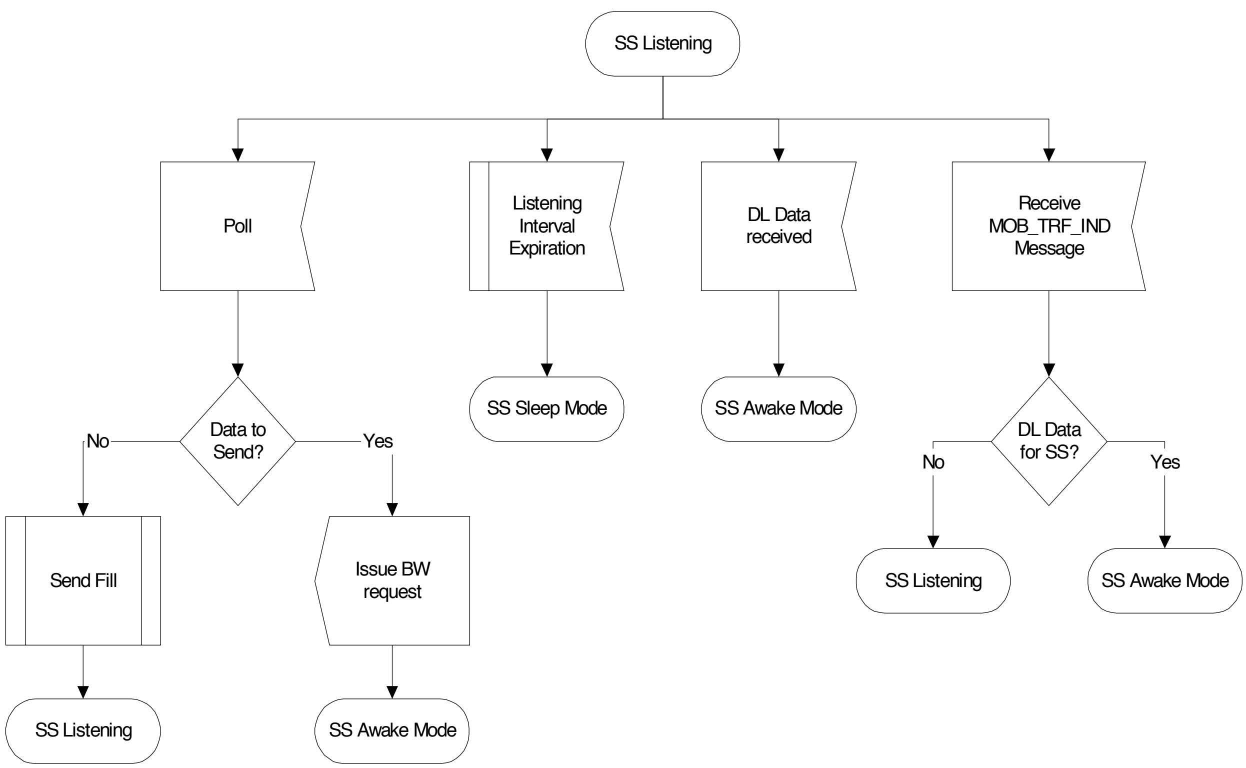


Figure 108k—SS Listening SDL Diagram

Figure 108l shows the SDL for when the SS has awakened prematurely.

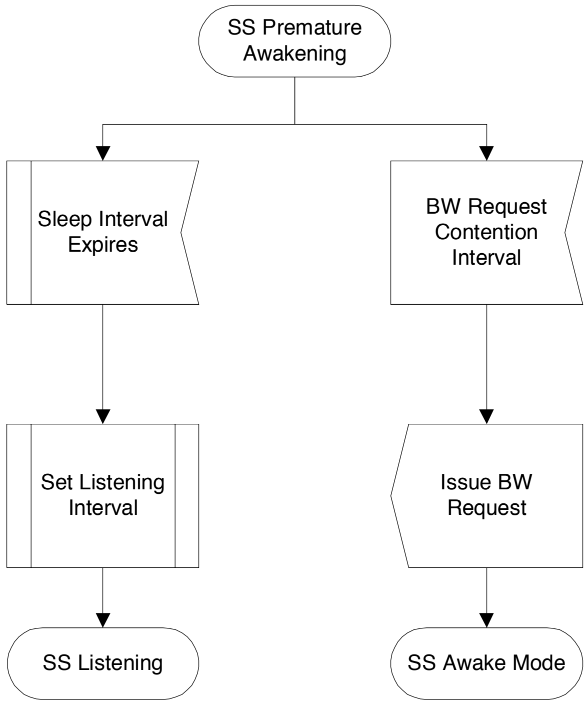


Figure 108l—SS Premature Awakening SDL Diagram

Figure 108m shows the SDL for the BS when an SS is in awake mode.

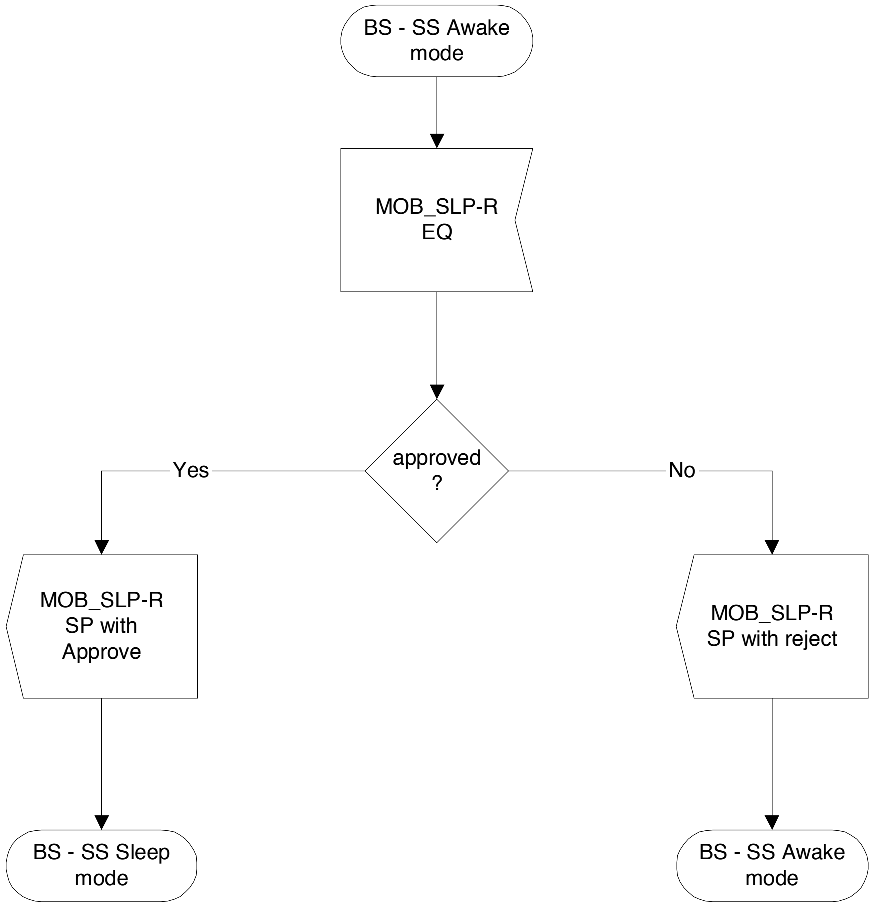


Figure 108m—BS – SS Awake Mode SDL Diagram

Figure 108n shows the SDL for the BS when the SS is in sleep mode.

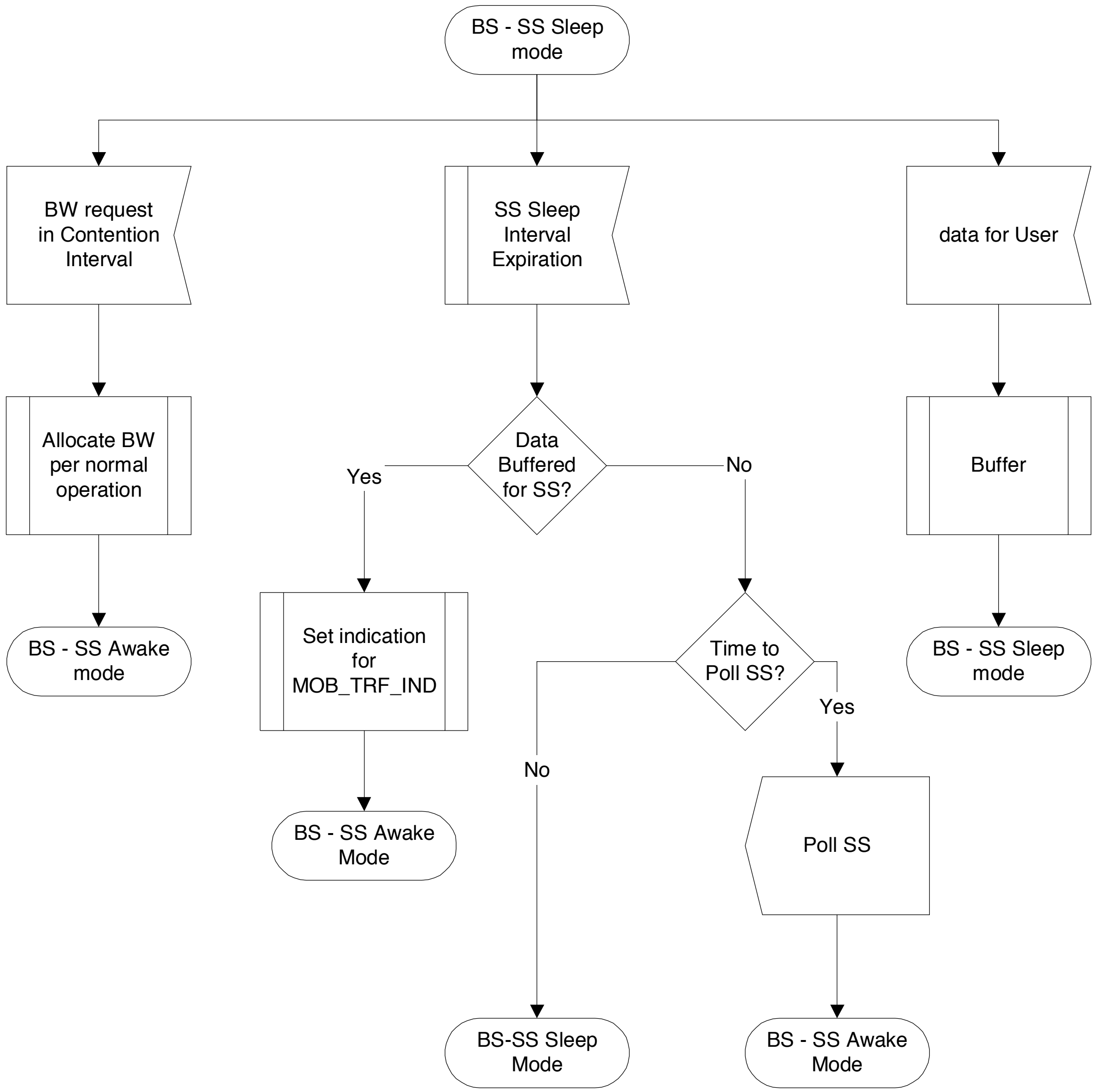


Figure 108n—BS – SS Sleep Mode SDL Diagram

Figure 108o shows the BS SDL for when the SS is awakening.

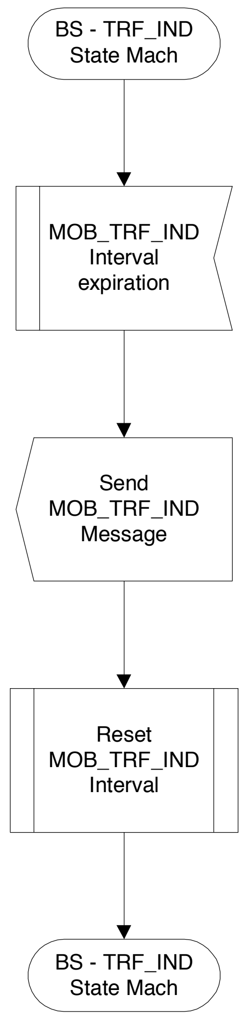


Figure 108o—BS – SS Awakening SDL Diagram

6.4.17.2 Sleep-interval update algorithm

An MSS shall enter sleep-mode after receiving an SLP-RSP message from the BS. In the first time it enters sleep-mode, it shall use the initial-sleep window value for the sleep interval. If during the following listening interval the BS has not signaled that traffic has been addressed for the MSS, the MSS shall re-enter sleep-mode an double the duration of the sleep-interval. This procedure shall be repeated as long as the resulting sleep-interval does not exceed the final-sleep window value. The following formula defines the claculation of the duration of k^{th} sleep-interval - I_k:

$$\begin{cases} I_0 = \text{initial-sleep window} \\ I_k = min\{2 \cdot I_{k-1}, \text{final-sleep window}\} \qquad k > 0 \end{cases} \tag{1}$$

When the MSS has reached the final-sleep window size, it shall continue in sleep mode without further increasing the sleep-interval. The next sleep interval window shall start from the end of the previous one.

6.4.17.3 Traffic indication signaling

A BS shall notify each SS in sleep-mode, during its listening-interval, if traffic has been addressed to it.. The indication is sent on the TRF-IND broadcast message. The SS shall examine the frame number from the PHY Synchronization Field and shall verify its synchronization with the BS. If the expected frame number is different than found frame number, the SS shall return into awake mode.

If the SS recives a TRF-IND message with ëenum-positiveí field = 0, or no CID in the TRF-IND message matches the SSís basic CID, it shall consider this as a negative indication and shall continue in sleep mode. For an example of sleep mode operation, see Annex D.

8. Physical layer

8.2 WirelessMAN-SCa PHY Layer

8.2.1.5.5.3 UL Information Element formats

[Add the following text under section 8.2.1.5.5.3:]

8.2.1.5.5.3.3 Fast ranging (Paging) Information Element

A Fast_UL_ranging_IE may be placed in the UL-MAP message by a BS to provide a non-contention based initial-ranging opportunity. The Fast_UL_ranging_IE shall be placed in the extend UIUC (extension code = TBD) within a UL-MAP IE.

The format of the IE is PHY dependent as shown in Table 180a.

Table 180a—Fast Ranging Format IE: SCa PHY

Syntax	Size	Notes
Fast_UL_ranging_IE {		
CID		= initial ranging (0x0000)
UIUC		= 15
Extention UIUC code		= TBD
MAC address	48 bits	MSSís 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 off-sets are the transmission times of the first symbol of the burst including preamble.
Reserved	4 bits	
}		

8.3 WirelessMAN-OFDM PHY Layer

8.3.6.3 Bandwidth Requesting

[Insert the following after section 8.4.6.3.3:]

8.3.6.3.4 Fast ranging (Paging) Information Element

A Fast_UL_ranging_IE may be placed in the UL-MAP message by a BS to provide a non-contention based initial-ranging opportunity. The Fast_UL_ranging_IE shall be placed in the extend UIUC (extension code = TBD) within a UL-MAP IE.

The format of the IE is PHY dependent as shown in Table 218a.

Table 218a—Fast Ranging Format IE: OFDM PHY

Syntax	Size	Notes
Fast_UL_ranging_IE {		
CID		= initial ranging 0x0000
UIUC		= 15
Extention UIUC code		= TBD
MAC address	48 bits	MSSís 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	
}		

8.4 WirelessMAN-OFDMA PHY Layer

[Insert the following after section 8.4.5.3.4:]

8.4.5.3.5 Fast ranging (Paging) Information Element

A Fast_UL_ranging_IE may be placed in the UL-MAP message by a BS to provide a non-contention based initial-ranging opportunity. The Fast_UL_ranging_IE shall be placed in the extend UIUC (extension code = TBD) within a UL-MAP IE.

The format of the IE is PHY dependent as shown in Table 231a.

Table 231a—Fast Ranging Format IE: 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	
}		

8.4.5.3.6 UL-MAP Fast tracking indication

The UL-MAP Fast Indication in an UL-MAP entry used to provide fast power, time and frequency indications\corrections to SSís that have transmitted in the previous frame.

The extended UIUC=15 shall be used for this IE with sub-code 0x03

The CID used in the Information Element should be a broadcast CID.

Table 231b—UL fast tracking Information Element

Syntax	Size	Notes
UL_Fast_tracking_IE() {		
extended UIUC	4 bits	Fast-Indication = 0x03
Number of Elements	8 bits	Number of Fast Indication bytes
for (*i* = 1; *i* <= *n*; *i*++) {		For each Fast Indication bytes 1 to n (n=Number of Element field)

Power correction	2	Power correction indication, 00: no change; 01: +2dB; 10: -1dB; 11: -2dB
Frequency correction	4	Frequency correction. Units are PHY-specific For OFDM/OFDMA: The correction is 0.1% of the carrier spacing multiplied by the 4-bit number interpreted as a signed integer (i.e. 1000: -8; Ö 0000: 0; Ö 0111: 7)
Time correction	2	Time offset correction. Units are PHY-specific For OFDM/OFDMA: The correction is floor(2 / F_s) multiplied by, 00: 0; 01: 1; 10: -1; 11: Not used
}		
}		

The UL Fast tracking IE is an optional field in the UL_MAP. When this IE is sent it provides an indication about corrections that should be applied by SSís that have transmitted in the pervious UL frame. Each Indication byte shall correspond to one unicast allocation-IE that has indicated an allocation of an uplink transmission slot in the previous UL_MAP. The order of the indication bytes shall be the same as the order of the unicast allocation-IE in the UL-MAP.

9. Configuration file

9.1 SS IP addressing

[Insert the following after section 9.1.1:]

9.1.2 Mobile IP fields used by the MSS

The following fields shall be present in the Mobile IP registration request from the MSS and shall be set as described below and encoded according to IETF RFC 3344.

a) When the MSS (or Mobile Node (MN)) attempts to obtain an IP address dynamically, home address field shall be set to ì0.0.0.0î.

b) When the MSS (or MN) attempts to obtain an IP address in the visited network, the home agent address field shall be set to ì0.0.0.0î. On the other hand, when the MSS (or MN) attempts to obtain an IP address in the home network, the home agent address field shall be set to ì255.255.255.255î.

c) The Network Access Identifier (NAI) extension [IETF RFC 2789] shall be included for identifying the Mobile IP user.

d) The Challenge extension shall be included [IETF RFC 3012], if the Challenge extension is included in the Agent Advertisement message.

e) A 128-bit key may be shared between an MSS (or MN) and an AAA server during the initial Mobile IP registration, and the MSS (or MN)-AAA Authentication extension may be generated based on the shared key [IETF RFC 3012].

The following fields are expected in the Mobile IP registration response returned to the MSS. The MSS shall configure itself based on the Mobile IP registration response

a) The home address to be used by the MSS;

b) The MSSís NAI extension to identify a Mobile IP user [IETF RFC 2789];

c) The challenge extension if the foreign agent supports more strong security;

d) The MSS (or MN) and home agent authentication extension for authenticating the home agent;

e) The key reply extensions for security between the MSS and the HA, and between the MSS and FA, if the MSS requests keys between the MSS and the HA, and between the MSS and the foreign agent.

10. Parameters and Constants

10.1 Global Values

[Add the following values to table 264:]

Table 264a—Parameters and Constants

System	Name	Time Reference	Minimum Value	Default Value	Maximum Value
MSS	Min_Sleep_Interval	Minimum sleeping time allowed to SS	2 Frames		
MSS	Max_Sleep_Interval	Maximum sleeping time allowed to SS			1024 Frames
MSS	Listening_Interval	The time duration during which the SS, after waking up and synchronizing with the DL transmissions, can demodulate downlink transmissions and decides whether to stay awake or go back to sleep			
BS	NBR-ADV interval	Nominal time between transmission of NBR-ADV messages			1s

BS	ASC-AGING-TIMER	Nominal time for aging of MSS associations	0.1s		

11. TLV Encodings

11.1.1.1 UCD channel encodings

[Add the following rows to table 268:]

Table 268a—UCD channel encodings

Name	Type (1 byte)	Length (1 byte)	Value (Variable-length)	PHY scope
HO_ranging_start	19	1	Initial backoff window size for MSS performing initial ranging during hand-over processs, expressed as a power of 2. Range: 0-15 (the highest order bits shall be unused and set to 0).	All
HO_ranging_end	20	1	Final backoff window size for MSS performing initial ranging during hand-over process, expressed as a power of 2. Range: 0-15 (the highest order bits shall be unused and set to 0).	

11.1.3 RNG-REQ message encodings

[Add the following rows to table 278:]

Table 278a—RNG-REQ Message Encodings

Name	Type (1 byte)	Length	Value (Variable-length)
MSS Association Channel ID	5	1	An identifier of the downlink channel on which the MSS is currently registered. The downlink channel identifier is the downlink channel ID field from the DCD message. This TLV may be sent by the MSS only when it is attempting association with foreign BS.
Serving BS ID	4	6	The unique identifier of the former serving BS

11.1.4 REG-RSP TLVs for re-establishment of Service Flows

[Add the following rows to table 279:]

Table 279a—RNG-REQ Message Encodings

Name	Type (1 byte)	Length	Value (Variable-length)

Service Level Prediction	17	1	This value indicates the level of service the MSS can expect from this BS. The following encodings apply: 0 = No service possible for this MSS. 1 = Some service is available for the MSS. 2 = Service with QoS specified at ASA server (for the MSS identified by the 48-bit MAC address) is available. 3 = No service level prediction available.

[Add the following rows to table 280:]

Table 280a—REG-RSP Encodings

Name	Type (1 byte)	Length (1 byte)	Value (Variable-length)
New CID	TBD	2	New CID after hand-over to new BS.
Old CID	TBD	2	Old CID before hand-over from old BS.
Connection_Info	TBD	Variable	The Connection_Info is a compound TLV value that encapsulates the **Service Flow Parameters** and the **CS Parameter** that have changed for the service. All the rules and settings that apply to the parameters when used in the DSC-RSP message apply to the contents encapsulated in this TLV.

[Insert the following section after 11.1.7:]

11.1.8 NBR-ADV Message Encodings

Table 282a—NBR-ADV Parameters

Name	Type (1 byte)	Length (1 byte)	Value (Variable-length)
Encoded Neighbor Information TLV	**1**	**Compound**	**TLVs from Table 292a**

Table 282b—NBR-ADV Encodings

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.

[Add 11.1.10 REG-RSP Message Encodings (add table number):]

Table 282c—REG-RSP Message Encodings

Name	Type (1 byte)	Length (1 byte)	Value (Variable-length)
CID_update	2	Compound	TLVs from Table 282d

Table 282d—TLVs

Name	Type (1 byte)	Length (1 byte)	Value (Variable-length)
New_CID	2.1	2	New CID after hand-over to new BS.
Old_CID	2.2	2	Old CID before hand-over from old BS.
Connection Info	2.3	Variable	If any of the service flow parameters change, then those service flowparameters and CS parameter encoding TLVs that have changed will be added.Connection_Info is a compound TLV value that encapsulates the Service Flow Parameters and the CS Parameter that have changed for the service. All the rules and settings that apply to the parameters when used in the DSC-RSP message apply to the contents encapsulated in this TLV.

11.4 Common encodings

[Add to Table 295]

Table 295a—SS Capability encodings

Type	Parameters
23	Method for allocating IP address
24	Mobility parameters support

[Apply the following changes to section 11.4.2:]

11.4.2 SS Capabilities encoding

11.4.2.12 Method for allocating IP address

Table 0—Method for allocating IP address

Type	Length	Value	Scope
5.23	**1**	**bit #0: DHCP** **bit #1: Mobile IPv4** **bit #2-7: reserved; shall be set to zero**	**REG-REQ** **REG-RSP**

[Insert new section 11.4.2.13:]

...

11.4.2.13 MSS Mobility parameters support

This field defines the parameters associated with the mobility support capabilities of the MSS.

Type	Length	Value
5.24	n	-

11.4.2.13.1 Sleep-mode supported

This field indicates whether the MSS supports sleep-mode. A bit value of 0 indicates ìnot supportedî while 1 indicates Ïsupported.

Type	Length	Value	Scope
5.24.1	1	Bit #0: Sleep-mode support Bits #1-7: *Reserved*, shall be set to zero	REG- REQ

11.4.2.13.2 Sleep-mode recovery time

This field indicates the time requires for an MSS which is in a sleep-mode to return to awake-mode. This parameter is optional and may be used by the BS to determine the sleep interval windows sizes when initiating sleep-mode with an MSS.

Type	Length	Value	Scope
5.24.2	1	Number of freames required for the MSS to switch from sleep-mode to awake-mide	REG- REQ

11.4.9.9 Minimum reserved traffic rate

This parameter specifies the minimum rate reserved for this service flow.

Minimum Reserved Traffic Rate = R (bits/sec) with time base T(sec) means the following: Let S denote additional demand accumulated at the MAC SAP of the transmitter during an arbitrary time interval of the length T. Then the amount of data forwarded to PHY (in bits) during this interval should be not less than min {S, R * T}.

The BS should be able to satisfy bandwidth requests for a service flow up to its Minimum Reserved Traffic Rate. If less bandwidth than its Minimum Reserved Traffic Rate is requested for a service flow, the BS may reallocate the excess reserved bandwidth for other purposes. The aggregate Minimum Reserved Traffic Rate of all service flows may exceed the amount of available bandwidth. The value of this parameter is calculated from the byte following the MAC header HCS to the end of the MAC PDU payload. If this parameter is omitted, then it defaults to a value of 0 bits per second (i.e., no bandwidth is reserved for the flow by default).

11.4.9.10 Minimum Tolerable Traffic Rate

ìMinimum Tolerable Traffic Rate = R (bits/sec) with time base T(sec)î means the following. Let S denote additional demand accumulated at the MAC SAP of the transmitter during an arbitrary time interval of the length T. Then the amount of data forwarded at the receiver to CS (in bits) during this interval should be not less than min {S, R * T}.

In the case of DL connection, Minimum Tolerable Traffic Rate should be monitored by the BS to make decisions on rate change or deletion of the connection in the case SDUsí loss ratio is too high. So SS has to measure and report certain parameters to BS as specified in NNN .

HMAC Tuple

[Insert into Table 298 -- HMAC Tuple definition (Scope field):]

ìMOB_HO-INDî

[Insert new sections 11.4.14:]

11.4.14 Mobility support capabilities

This field defines common parameters for mobility support..

Type	Length	Value
44	n	-

11.4.14.1 Listening Interval

This field indicates the length in frames of listening interval for sleep-mode operation.

Type	Length	Value	Scope
44.1	1	Length in frames of listening interval	REG- RSP

[Add the following Annexes:]

Annex C Backbone network HO procedures

[This section should contain the procedures performed on 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

]

C.1 Backbone network services

The backbone network provides a backhaul transmission path to the BS, and may provide other services at the control plane level. Table C1 shows a list of services provided to the BS through backbone network. Some of these services may be provided by other means (highlighted).

Table C1—Backbone Network Services

Service	Possible methods for providing service	Comments
Backhaul for traffic	-	Default transport protocol is UDP.
Provide a BS with the identity of its neighbors	(1) Get info from ASA server (2) Configuration (network management)	Options (1) and (2) are really the same, the only difference is where the configuration is done
Provide a BS with the identity of the ASA server	(1) ASA server publishes its presence (2) Configuration (network management)	Message format and transport protocol need to be specified for interoperability
Advertise the fact that a certain MSS has registered with a certain BS	(1) BS notifies ASA server (2) BS notifies neighbor BS	Message format and transport protocol need to be specified for interoperability
Provide a BS information about a certain MSS	(1) ASA server provides information (2) Serving BS provides information (or network management if serving BS cannot be found)	Message format and transport protocol need to be specified for interoperability
Information exchange during HO	(1) ASA server is in the middle (2) BS to BS direct exchange	Message format and transport protocol need to be specified for interoperability

As evident from Table C1, it is possible to exchange information between BS directly or through the ASA server. In that respect the protocol used for information exchange on the backbone can regard the ASA server as another BS, and therefore no special message will be required with regards to the ASA server.

C.2 Inter-base station message formats

The message formats described in this section may be used for communication with peer BS or with an ASA server through the backbone.

C.2.1 Global Message Header

The global message header is a collection of fields required by all inter-base station messages. The header is defined in Table C2.

Table C2—Global Message Header

Field	Size	Notes
Message Type = ?	8-bit	
Sender BS-ID	48-bit	Base station unique identifier (Same number as that broadcasted on the DL-MAP message)
Target BS-ID	48-bit	Base station unique identifier (Same number as that broadcasted on the DL-MAP message)
Time Stamp	32-bit	Number of milliseconds since midnight GMT (set to 0xffffffff to ignore)
Num Records	16-bit	Number of MSS identity records

C.2.2 I-am-host-of message

This message is sent by a BS to notify other BS (or the ASA server) that a certain MSS is registered with it. The message shall be sent upon MSS registration, and periodically (TBD period). The message might trigger a neighbor BS to request more information on the MSS (either directly from the sender BS, or from the ASA server). The message contains the following information,

Table C3—I-am-host-of Message

Field	Size	Notes
Global Header	152-bit	
For (j=0; j<Num Records; j++) {		
MSS unique identifier	48-bit	48-bit unique identifier used by MSS on initial network entry
}		
Security field	TBD	A means to authenticate this message
CRC field	32-bit	IEEE CRC-32

C.2.3 MSS-info-request message

This message may be sent from one BS to another (or to the ASA server) to request information about an MSS. Typically the message will be sent as a reaction to reception of an *I-am-host-of* message, or in cases where an MSS is trying to re-enter the network after a HO. The message contains the following information,

Table C4—MSS-info-request Message

Field	Size	Notes
Global Header	152-bit	
For (j=0; j<Num Records; j++) {		

MSS unique identifier	48-bit	48-bit unique identifier used by MSS (as provided by the MSS or by the *I-am-host-of* message)
}		
Security field	TBD	A means to authenticate this message
CRC field	32-bit	IEEE CRC-32

C.2.4 MSS-info-response message

This message may be sent from one BS to another (or from the ASA server) to provide information about an MSS. Typically the message will be sent in response to an *MSS-info-request* message. The message contains the following information,

Table C5—MSS-info-response Message

Field	Size	Notes
Global Header	152-bit	
For (j=0; j<Num Records; j++) {		
MSS unique identifier	48-bit	48-bit unique identifier used by MSS (as provided by the MSS or by the *I-am-host-of* message)
N_NSIE		Number of Network Service Information Elements
For (k=0; k<N_NSIE; k++) {		
Field Size	16-bit	Size of TLV encoded information field below
TLV encoded information	Variable	TLV information as allowed on a DSA-REQ MAC message
}		
N_SAIE		Number of Security Association Information Elements
For (k=0; k<N_SAIE; k++) {		
Field Size	16-bit	Size of TLV encoded information field below
TLV encoded information	Variable	TLV information as allowed on a PKM-xxx MAC messages
}		
N_SS_CAP		Number of SS Capabilities
For (k=0; k<N_SS_CAP; k++) {		
Field Size	16-bit	Size of TLV encoded information field below
TLV encoded information	Variable	TLV information as allowed on a SBC-REQ MAC message
}		
TLV encoded information	Variable	TLV information as allowed on a SBC-REQ MAC message
}		
Security field	TBD	A means to authenticate this message

CRC field	32-bit	IEEE CRC-32

C.2.5 HO-pre-notification message

This message is sent by a BS to advertise an MSS intention to perform HO. The message is typically sent to neighbor BS referenced in the MOB_BSHO-REQ or MOB_MSSHO-REQ message. The message serves to query the target BS whether it can serve the HO requesting MSS. The message contains the following information:

Table C6—HO-pre-notification Message

Field	Size	Notes
Global Header	152-bit	
For (j=0; j<Num Records; j++) {		
MSS unique identifier	48-bit	48-bit unique identifier used by MSS (as provided by the MSS or by the *I-am-host-of* message)
Estimated Time to HO	16-bit	In milliseconds, relative to the time stamp. A value of 0 indicates that the estimated time is unknown.
Required BW	8-bit	Bandwith which is required by MSS (to gurarantee minimum packet data transmission)
Required OoS	8-bit	Name of Service Class representing AuthorizedQoSParamSet
}		
Security field	TBD	A means to authenticate this message
CRC field	32-bit	IEEE CRC-32

C.2.6 HO-pre-notification-response message

This message is sent from one BS to another BS, typically in response to a *HO-pre-notification* message. The message serves to provide the BS that sent the *HO-pre-notification* message with information about the level of service the MSS could expect if it transitions to this BS. The message contains the following information,

Table C7—HO-pre-notification-response Message

Field	Size	Notes
Global Header	152-bit	
For (j=0; j<Num Records; j++) {		
MSS unique identifier	48-bit	48-bit unique identifier used by MSS (as provided by the MSS or by the *I-am-host-of* message)

BW Estimated	8-bit	Bandwidth which is provided by BS (to guarantee minimum packet data transmission) TBD how to set this field
QoS Estimated	8-bit	Quality of Service level ó Unsolicited Grant Service (UGS) ó Real-time Polling Service (rtPS) ó Non-real-time Polling Service (nrtPS) ó Best Effort
ACK/NACK	8 bits	Acknowledgement or Negative acknowledgement ó 1 is Acknowledgement which means that the neighbor BS accepts the HO-pre-notification message from the serving BS ó 0 is Negative acknowledgement which means that the neighbor BS may not accept the HO-pre-notification message from the serving BS
}		
Security field	TBD	A means to authenticate this message
CRC field	32-bit	IEEE CRC-32

C.2.7 HO-confirm message

This message is sent from the serving BS to the neighbor BS, which is selected as recommended target BS. The message serves to notify the neighbor BS that HO event is estimated to happen after "Estimated time to HO" indicated in the HO-pre-notification message. The message contains the following information:

Table C8—HO-confirm Message

Field	Size	Notes
Global Header	152-bit	
For (j=0; j<Num Records; j++) {		
MSS unique identifier	48-bit	48-bit universal MAC address of the MSS (as provided to the BS on the RNG-REQ message)
BW Estimated	8-bit	Bandwidth which is provided by BS (to guarantee minimum packet data transmission) TBD how to set this field
QoS Estimated	8-bit	Quality of Service level ó Unsolicited Grant Service (UGS) ó Real-time Polling Service (rtPS) ó Non-real-time Polling Service (nrtPS) ó Best Effort Service (BE)
}		
Security field	TBD	A means to authenticate this message
CRC field	32-bit	IEEE CRC-32

C.2.8 Example of Backbone Network HO procedure

Figure C.1—Example of HO call flow by MS

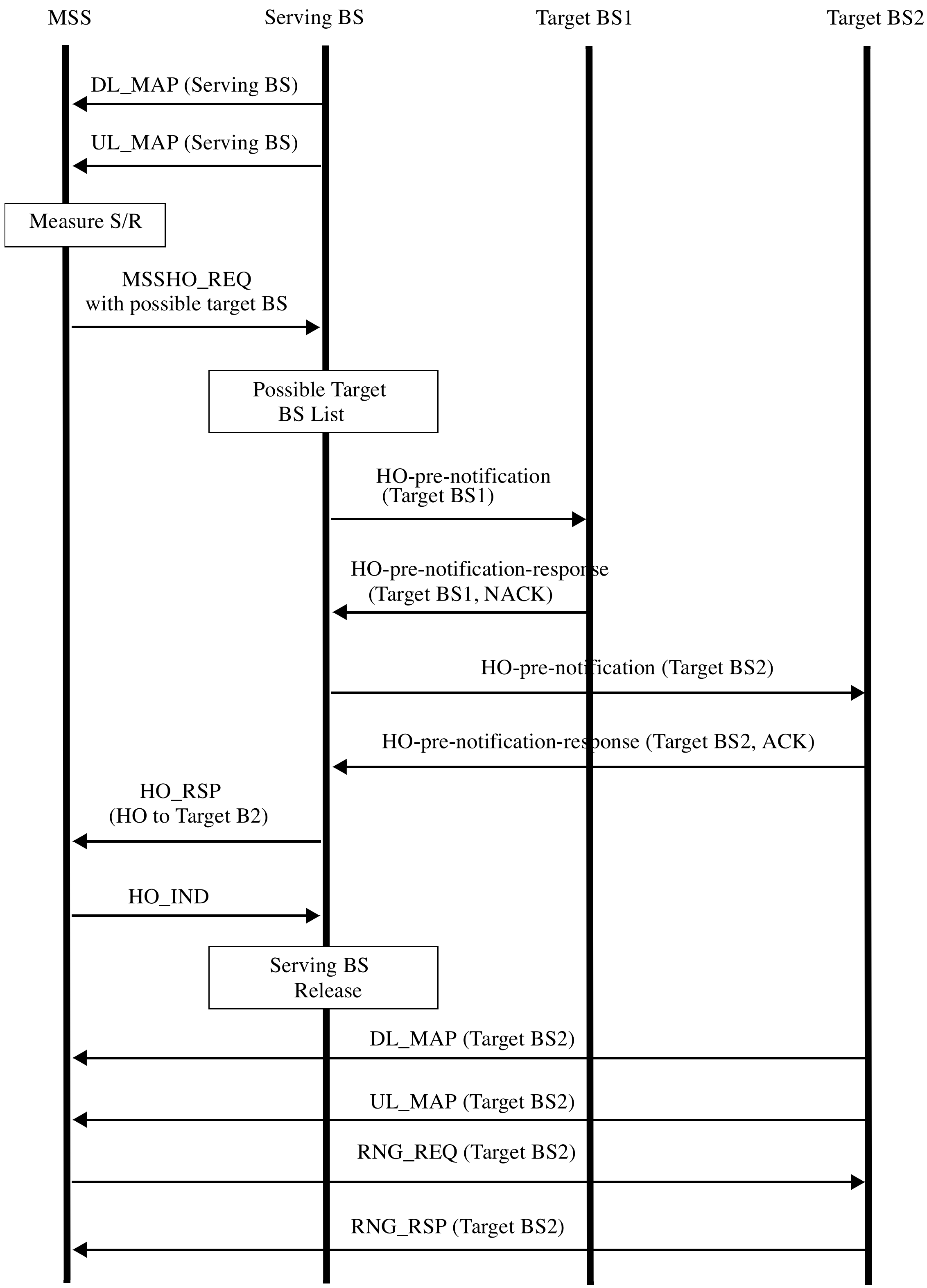
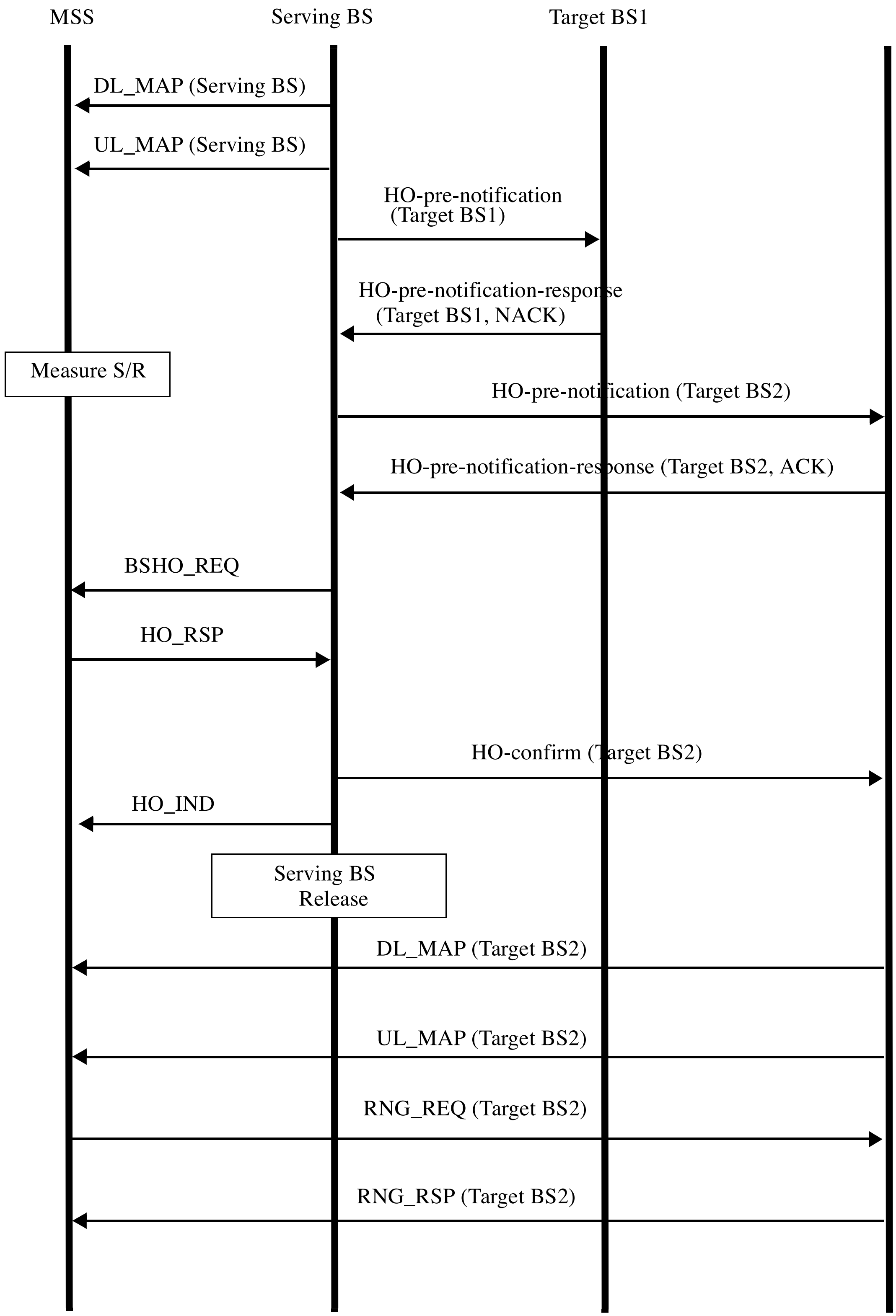


Figure C.2—Example of HO call flow by BS



C.3 Backbone network communication protocol

[TBD]

C.4 Convergence sub-layer HO procedures

C.4.1 Supported convergence sub-layers

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

C.4.2 SAP for higher layer protocols

This section defines the services between the MAC and higher layers for supporting the HO process. In some scenarios the higher layers may use information provided by the MAC layer HO process to optimize their HO process and reduce the overall HO duration.

The information is defined as set of messages sent by the MAC layer to the higher layers, providing indication of particular events before and after MAC layer HO.

C.4.2.1 MSS Movement

Occurs at the MSS, indication that the MSS has registered to a new Target BS.

C.4.2.2 Serving BS Pre-HO

Occurs at the Serving BS, indication that a MAC layer HO of a certain MSS is about to take place.

C.4.2.3 Target BS Pre-Ho

Occurs at the Target BS, indication that a MAC layer HO of a certain MSS is about to take place.

C.4.2.4 BS Post-HO

Occurs at the Target BS or MSS, indication that a MAC layer HO between the MSS and the Target BS has been completed.

C.4.2.5 Serving BS-Link Loss

Occurs at the Serving BS, indication that MAC layer link between the Serving BS and a certain MSS has been lost.

Annex D Messages sequence charts (MSCs)

This annex provides MSCs for the procedures of hand-over and sleep mode operations.

D.1 Hand-over MSCs

D.1.1 Neighbors advertisement and scanning of neighbors

The following figures describes the messages flow for neighbors advertisement and scanning of neighbors by the MSS request, BSS request and periodic scanning of neighbors during hand-over.

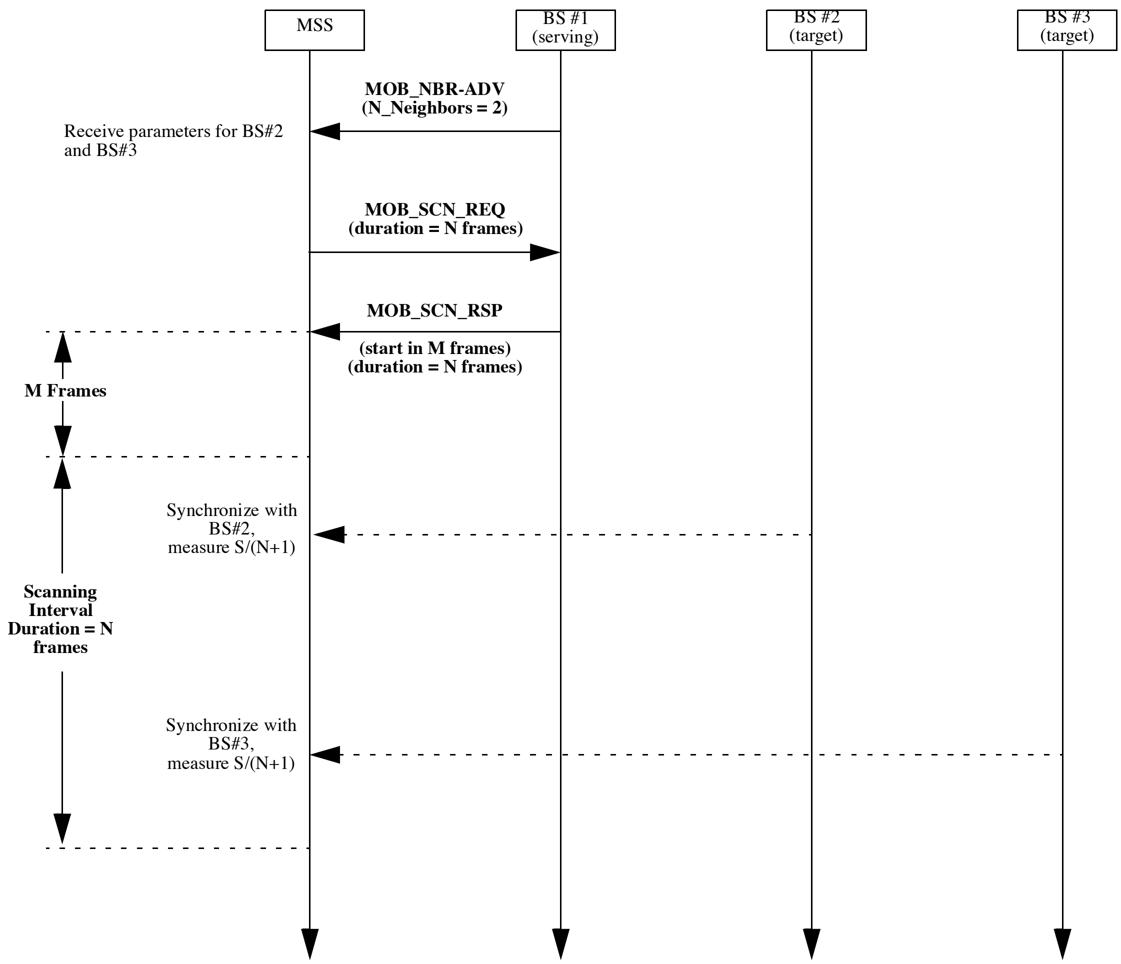


Figure D.1—Example of BS advertisement and scanning (without association)by MSS req

..

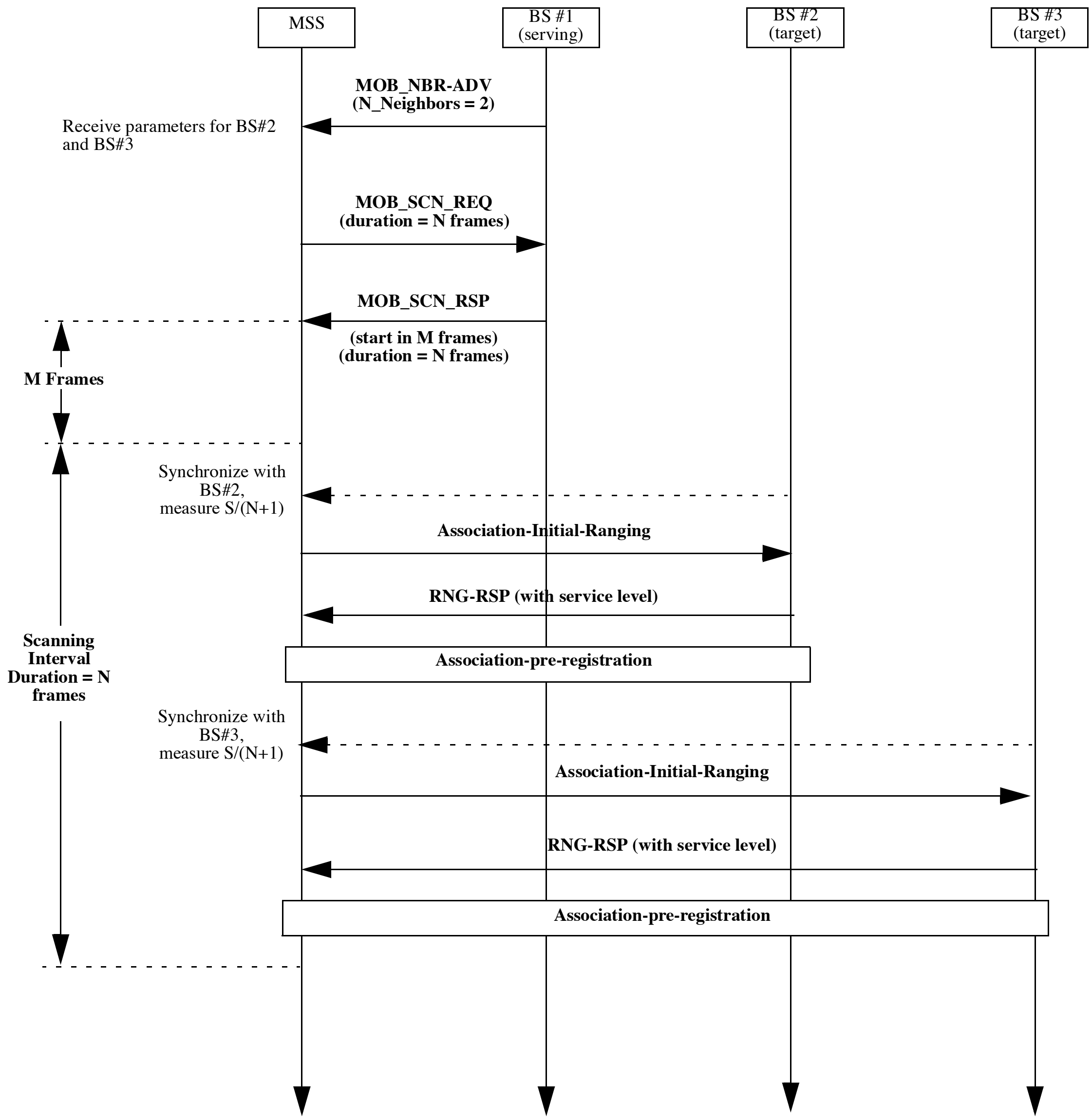


Figure D.2—Example of BS advertisement and scanning (with association) by MSS requ

.

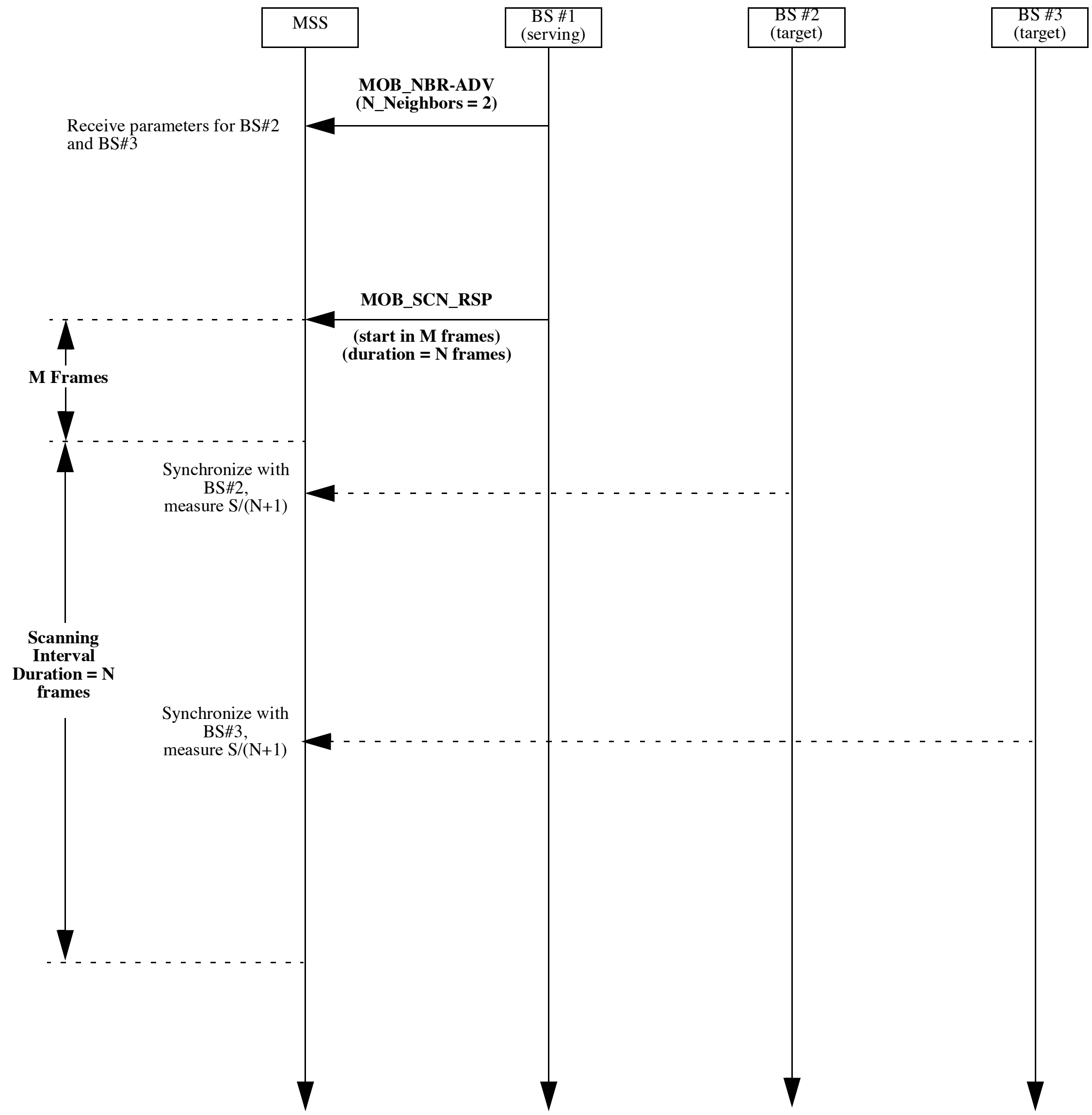


Figure D.3—Example of BS advertisement and scanning (without association) by BSS req

.

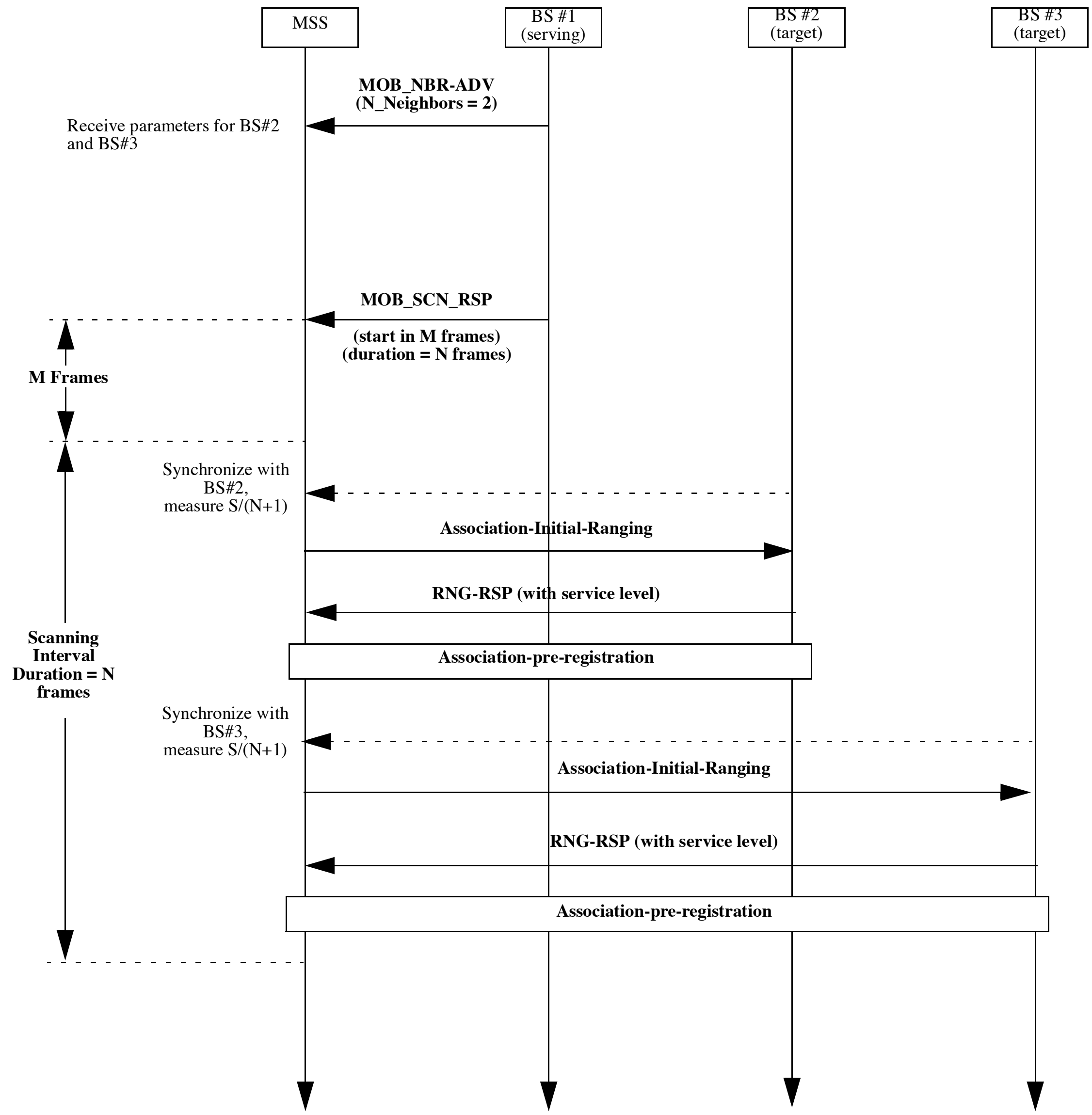


Figure D.4—Example of BS advertisement and scanning (with association) by BSS requ

..

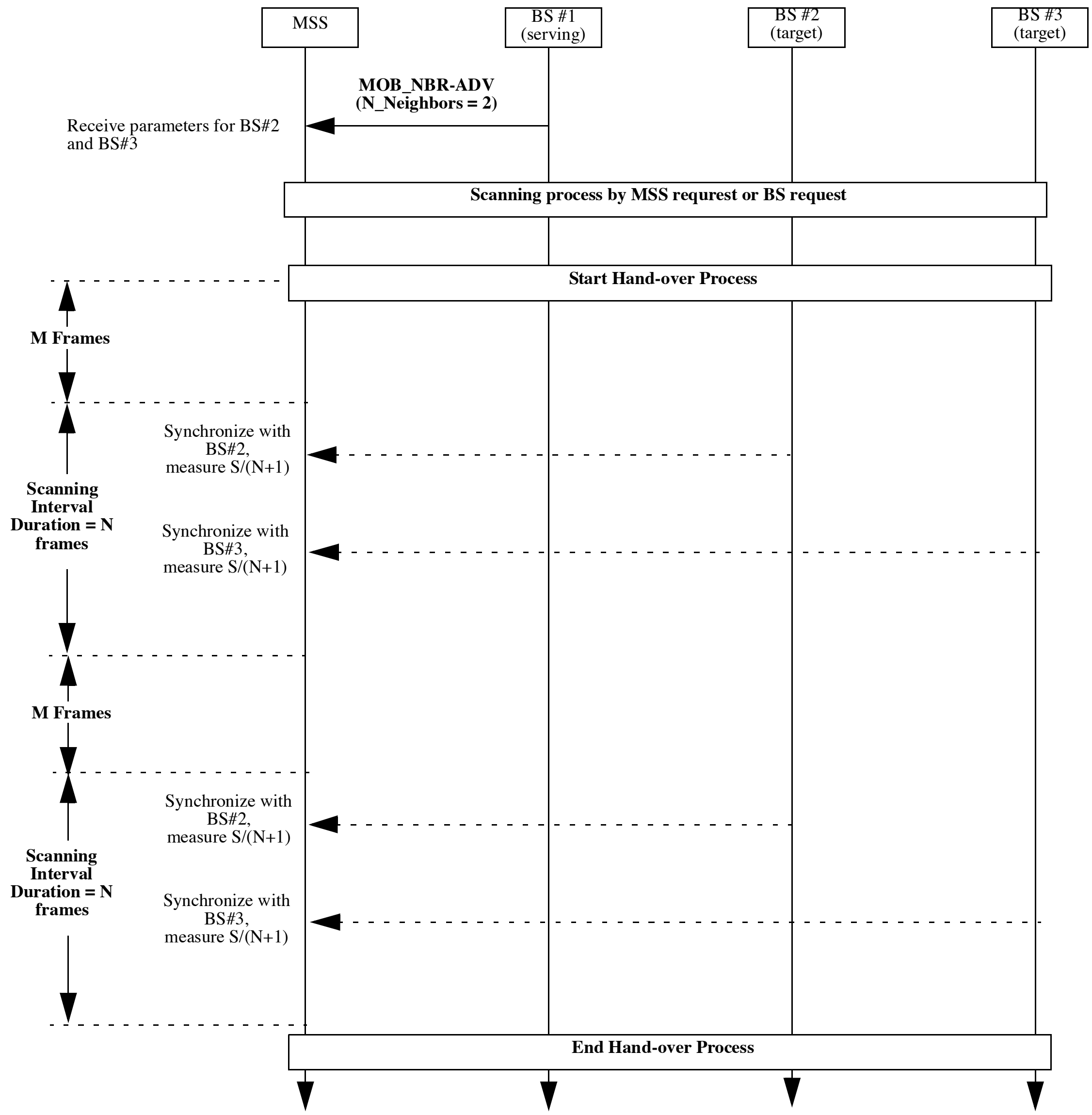


Figure D.5—Example of periodic scanning during Hand-over process

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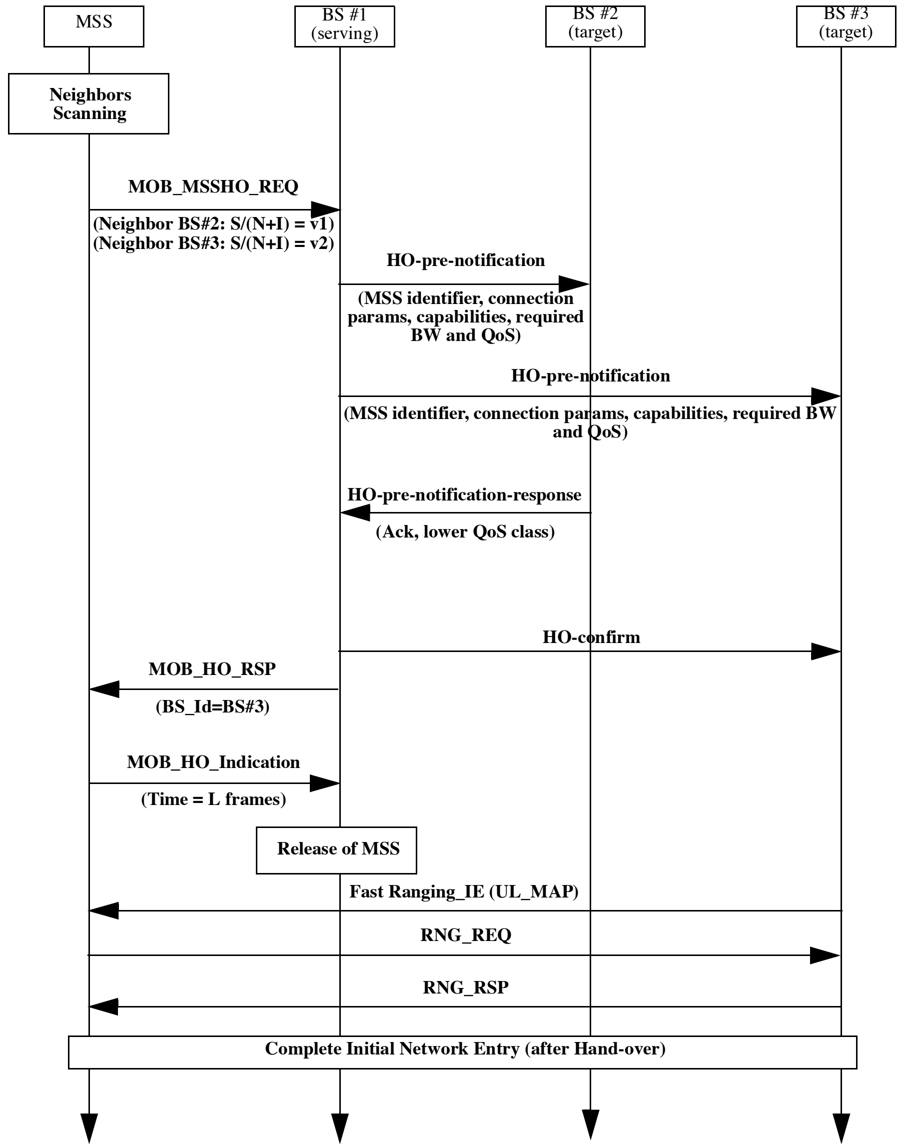

MSS
BS #1 (serving)
BS #2 (target)
BS #3 (target)
Neighbors Scanning
MOB_MSSHO_REQ
(Neighbor BS#2: S/(N+I) = v1)
(Neighbor BS#3: S/(N+I) = v2)
HO-pre-notification
(MSS identifier, connection params, capabilities, required BW and QoS)
HO-pre-notification
(MSS identifier, connection params, capabilities, required BW and QoS)
HO-pre-notification-response
(Ack, lower QoS class)
HO-confirm
MOB_HO_RSP
(BS_Id=BS#3)
MOB_HO_Indication
(Time = L frames)
Release of MSS
Fast Ranging_IE (UL_MAP)
RNG_REQ
RNG_RSP
Complete Initial Network Entry (after Hand-over)

Figure D.6—

.

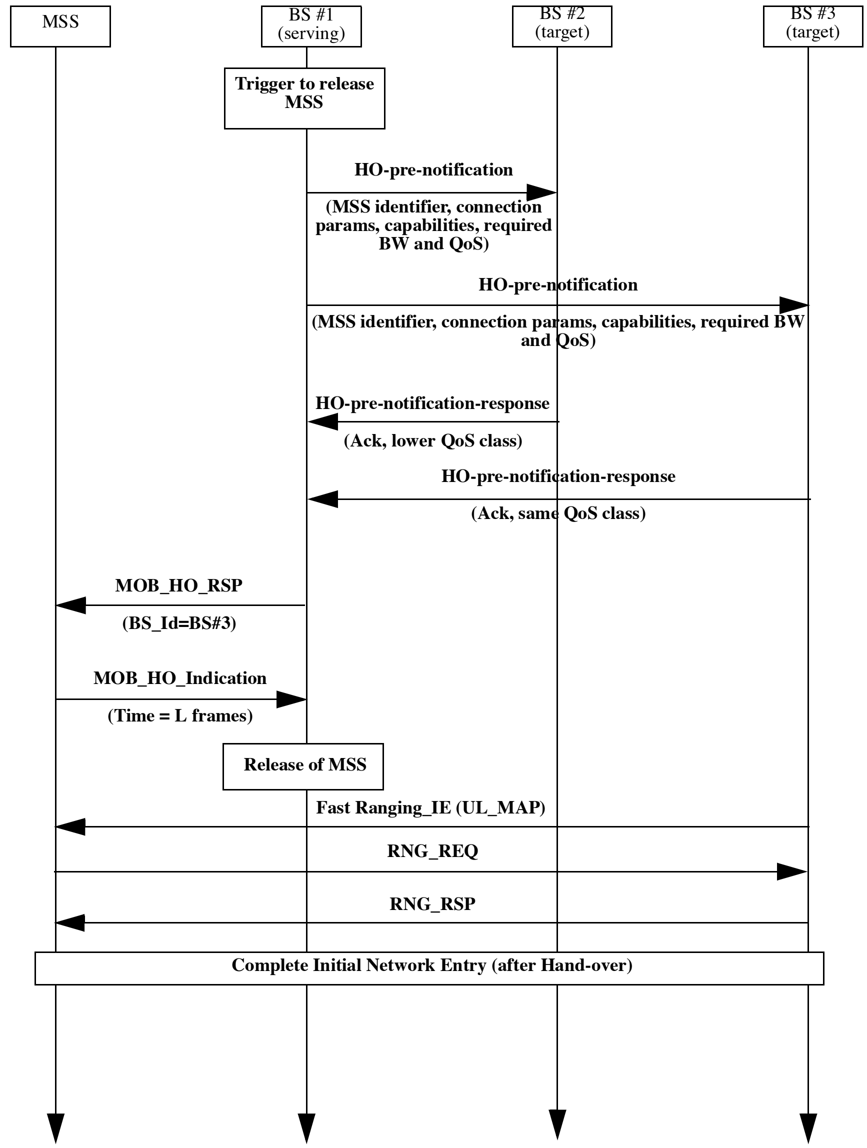

MSS
BS #1 (serving)
BS #2 (target)
BS #3 (target)
Trigger to release MSS
HO-pre-notification
(MSS identifier, connection params, capabilities, required BW and QoS)
HO-pre-notification
(MSS identifier, connection params, capabilities, required BW and QoS)
HO-pre-notification-response
(Ack, lower QoS class)
HO-pre-notification-response
(Ack, same QoS class)
MOB_HO_RSP
(BS_Id=BS#3)
MOB_HO_Indication
(Time = L frames)
Release of MSS
Fast Ranging_IE (UL_MAP)
RNG_REQ
RNG_RSP
Complete Initial Network Entry (after Hand-over)

Figure D.7—

...

.

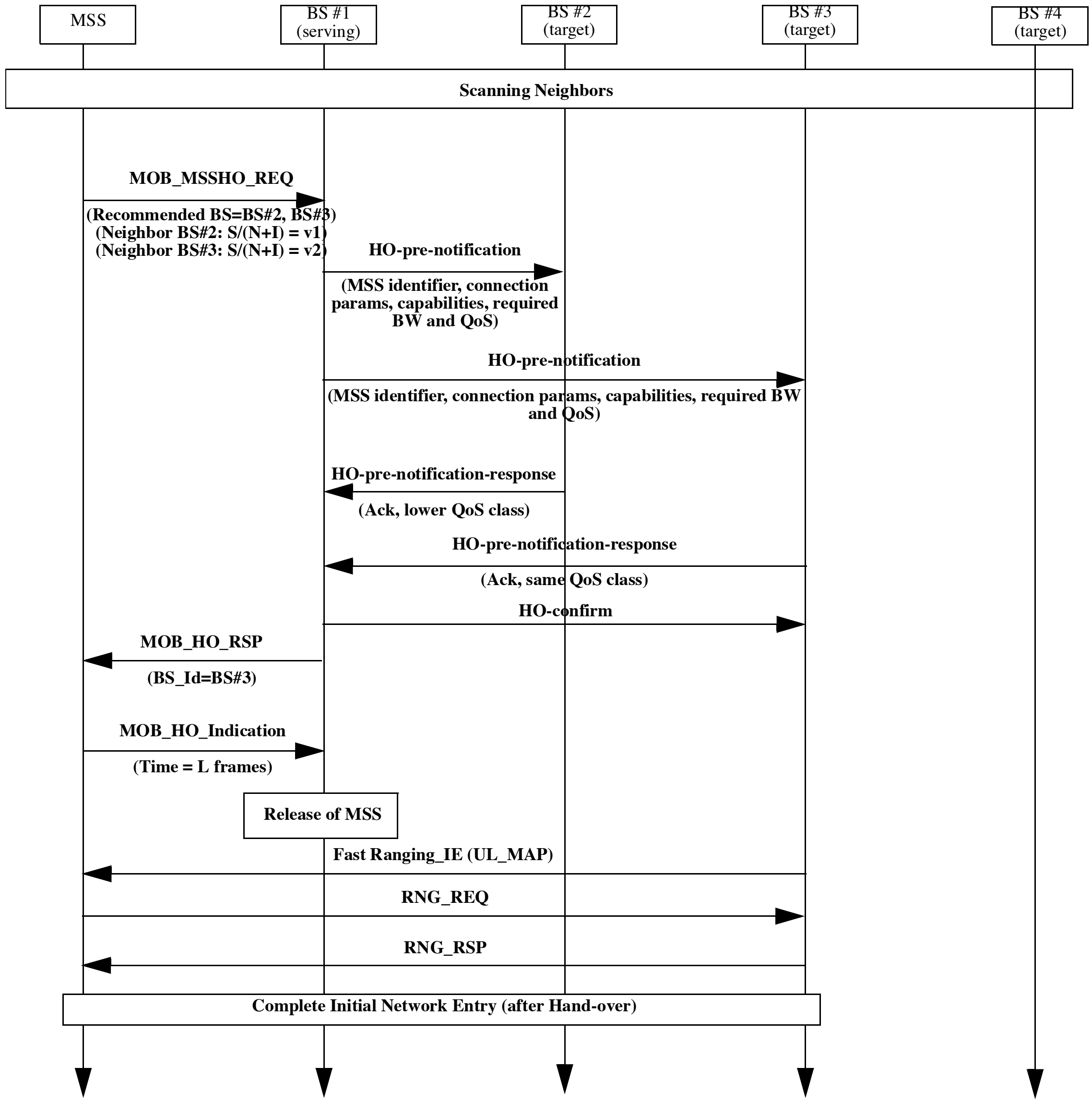


Figure D.8—HO process by MSS request

.

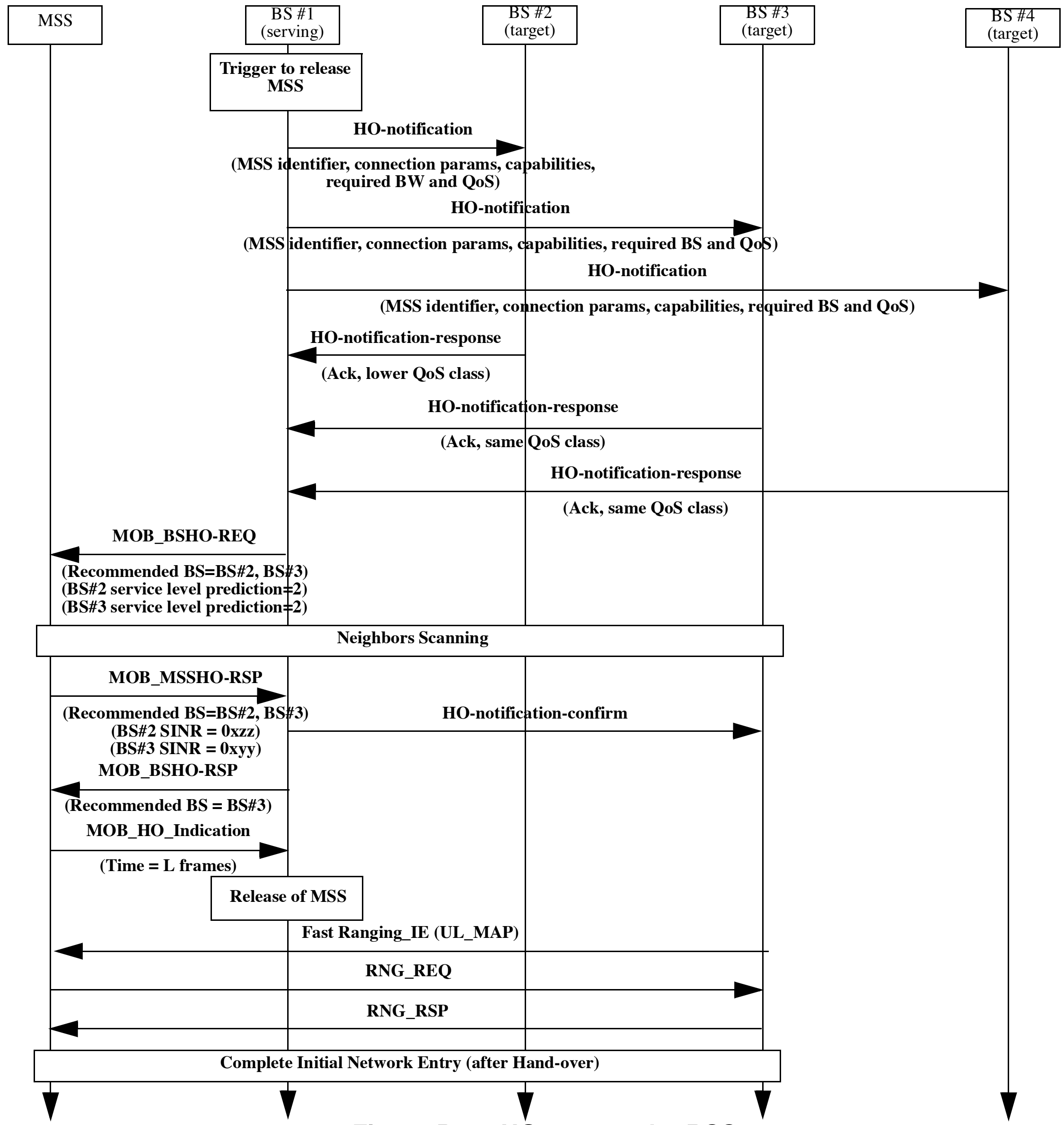


Figure D.9—HO process by BSS request

.

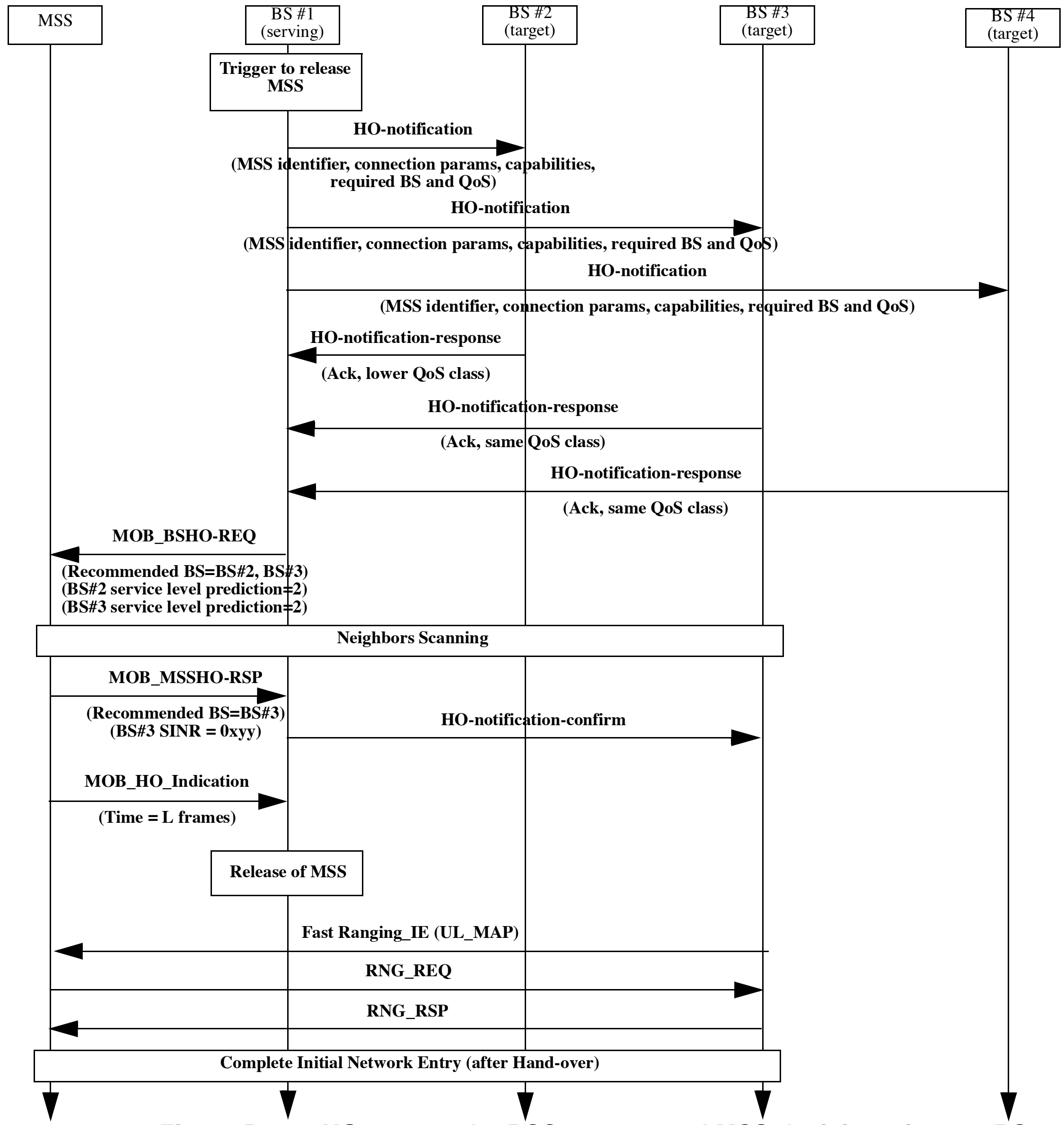


Figure D.10—HO process by BSS request and MSS decision of target BS

D.2 Sleep mode MSCs

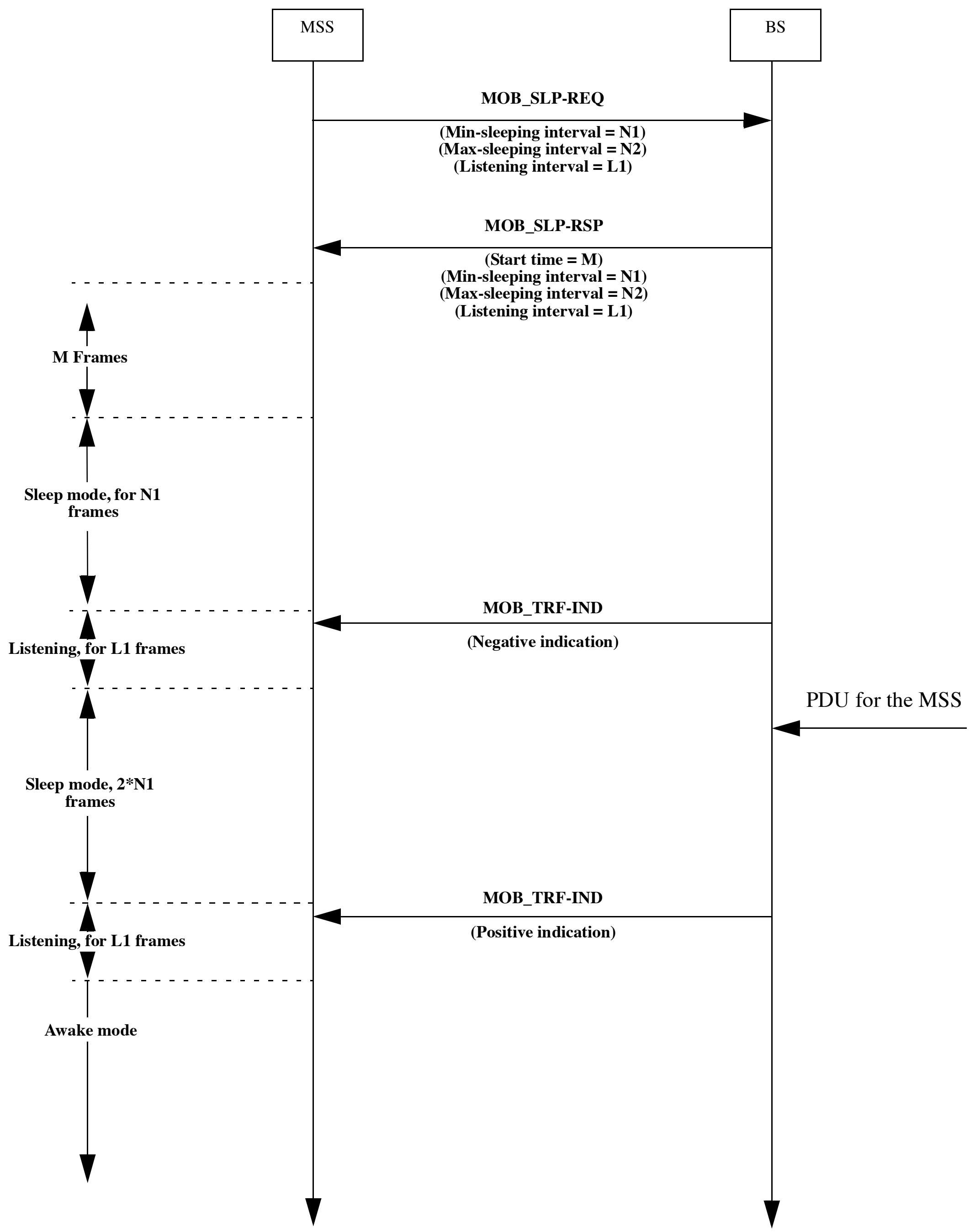


Figure D.11—Example of periodic scanning during Hand-over process

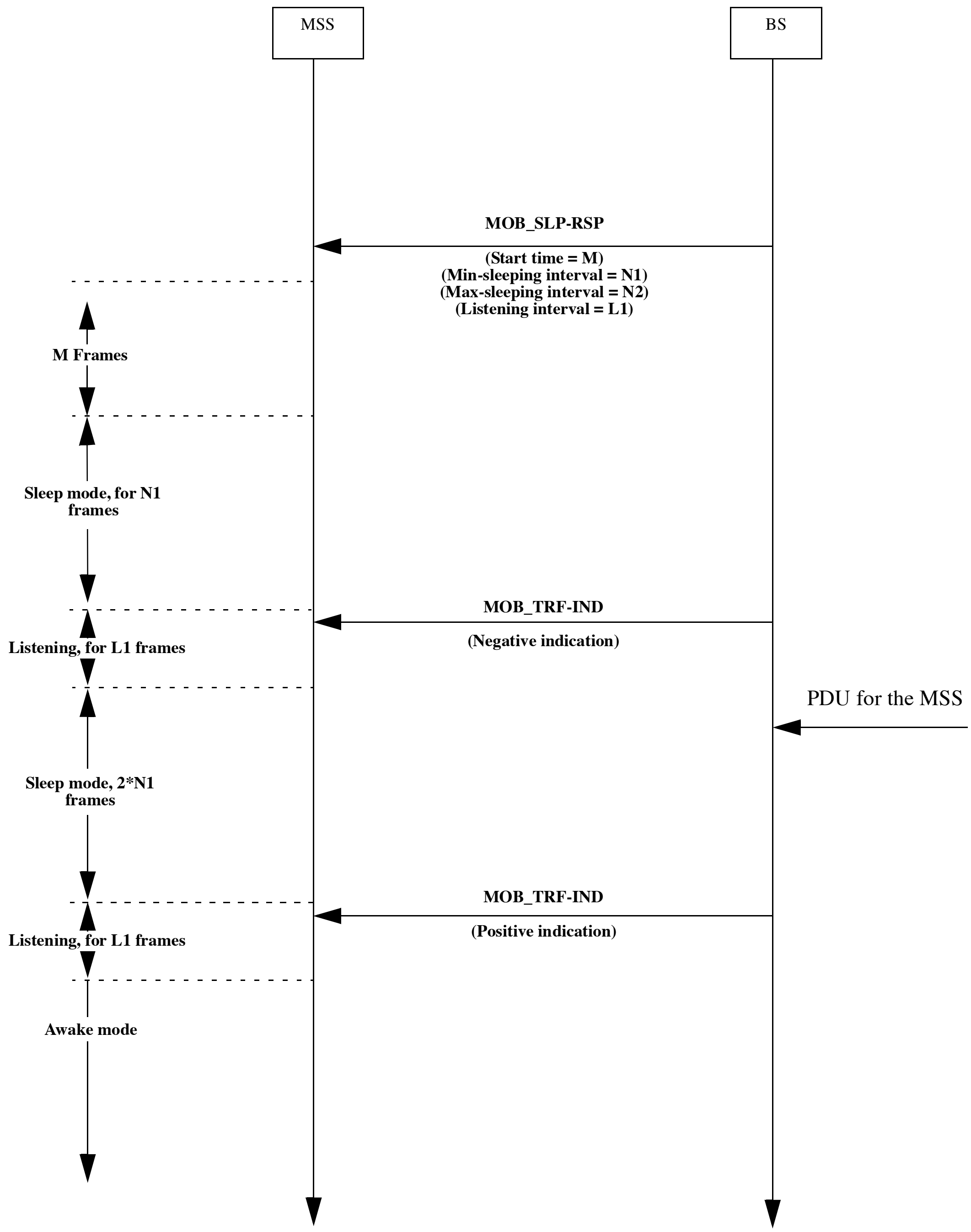


Figure D.12—Sleep mode, BS initiated

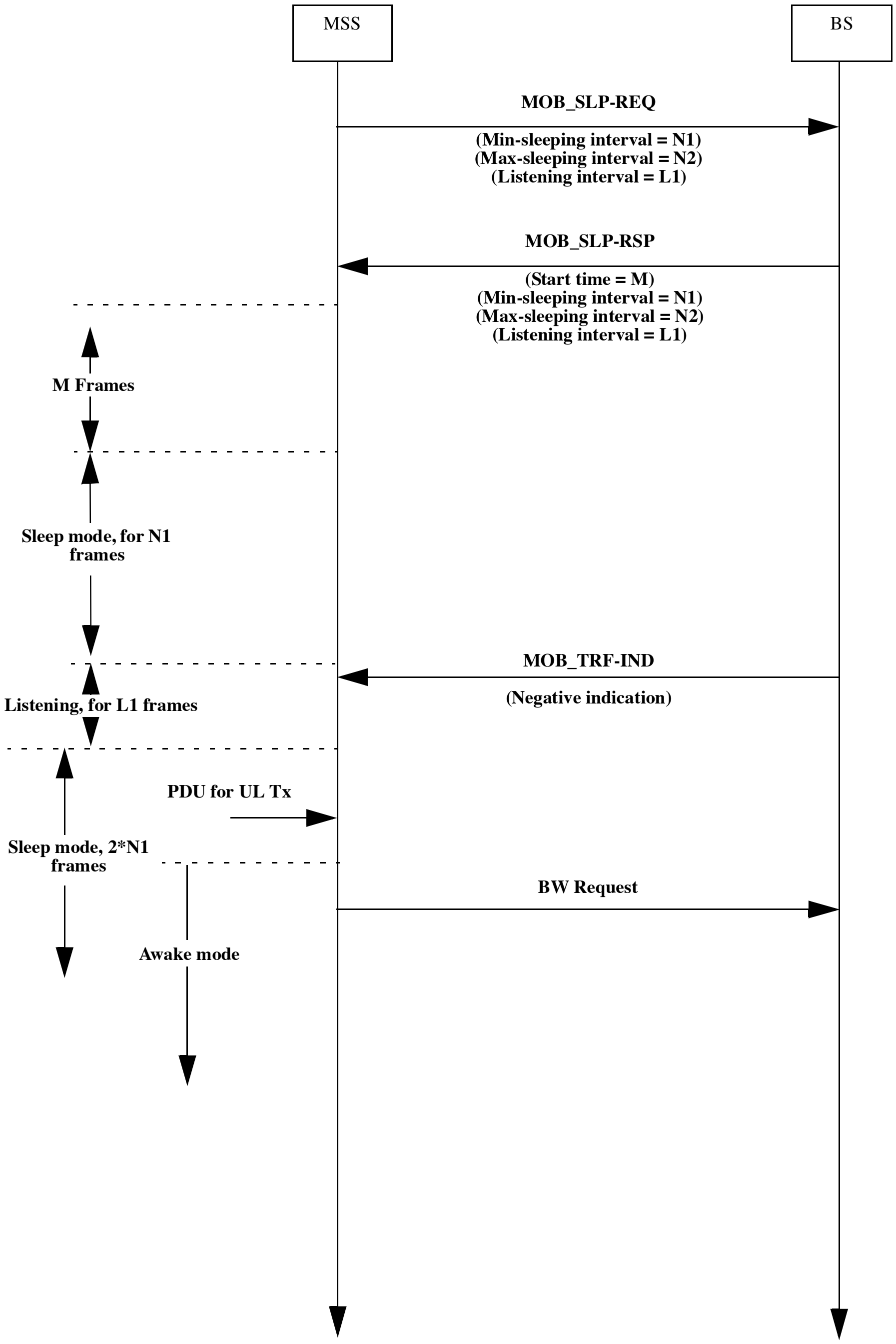


Figure D.13—Sleep mode, MSS initiating awakening

Annex E-Block Diagrams

This annex provides block diagrams for the procedures of hand-over.

E.1 Hand-over Block Diagrams

E.1.1 Hand-over by MSS request

Figure E.1—HO process block diagram in MSS by MSS request

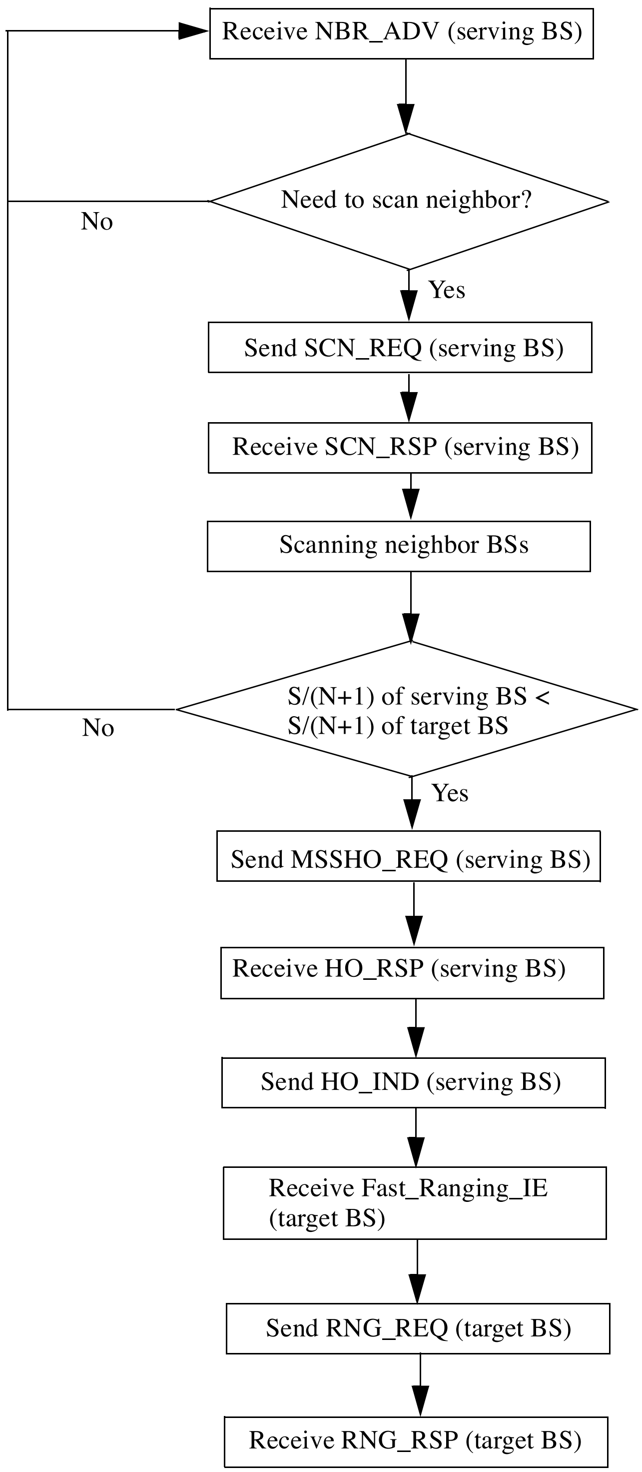


Figure E.2—HO process block diagram in Servicing BSS by MSS request

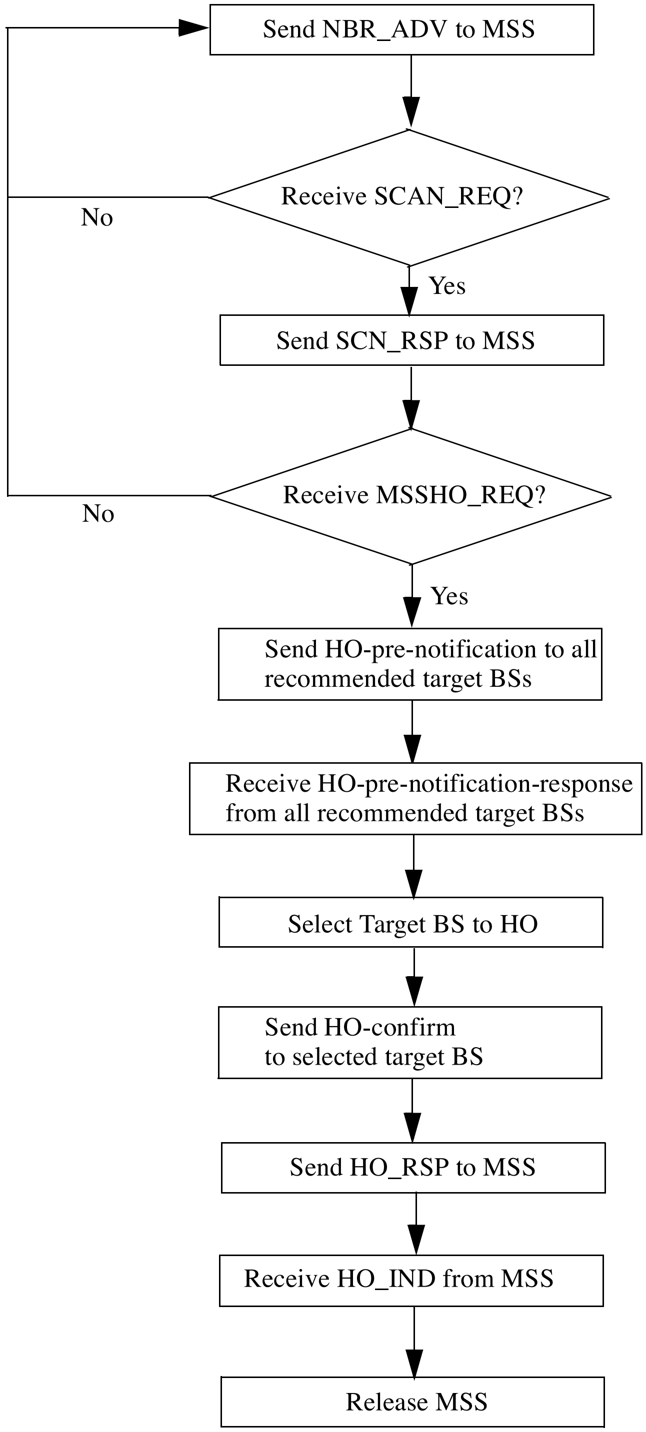
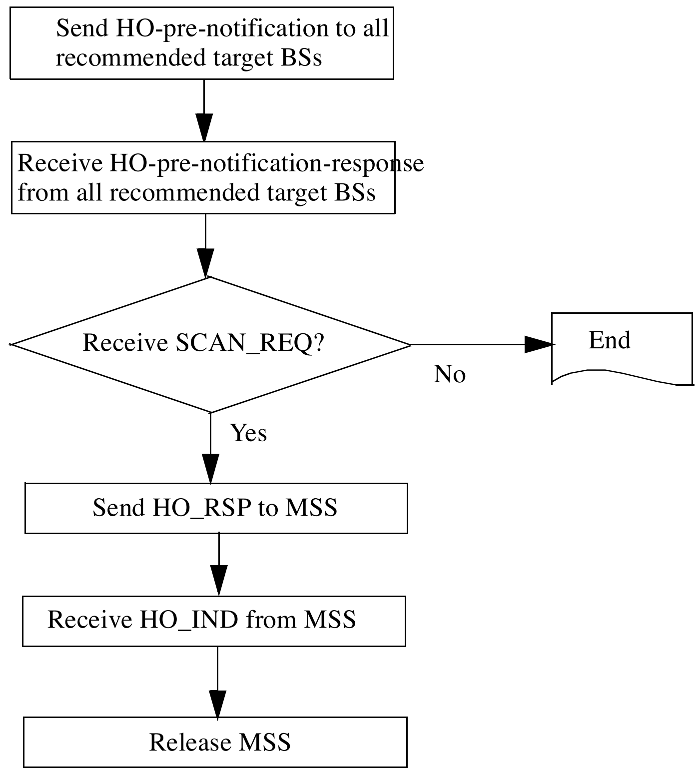


Figure E.3—HO process block diagram in Servicing BSS by MSS request



E.1.2 Hand-over by BSS request

HO process block diagram in Target BSS by BSS request is the same as HO process block diagram in Target BSS by MSS request.

Figure E.4—HO process block diagram in MSS by BSS request

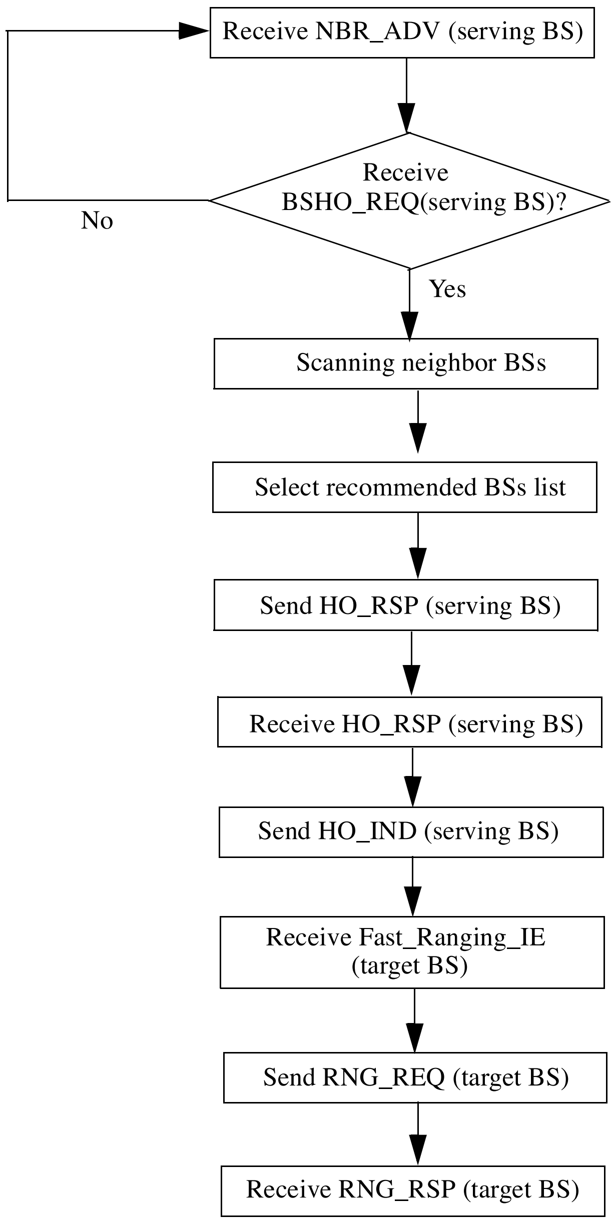
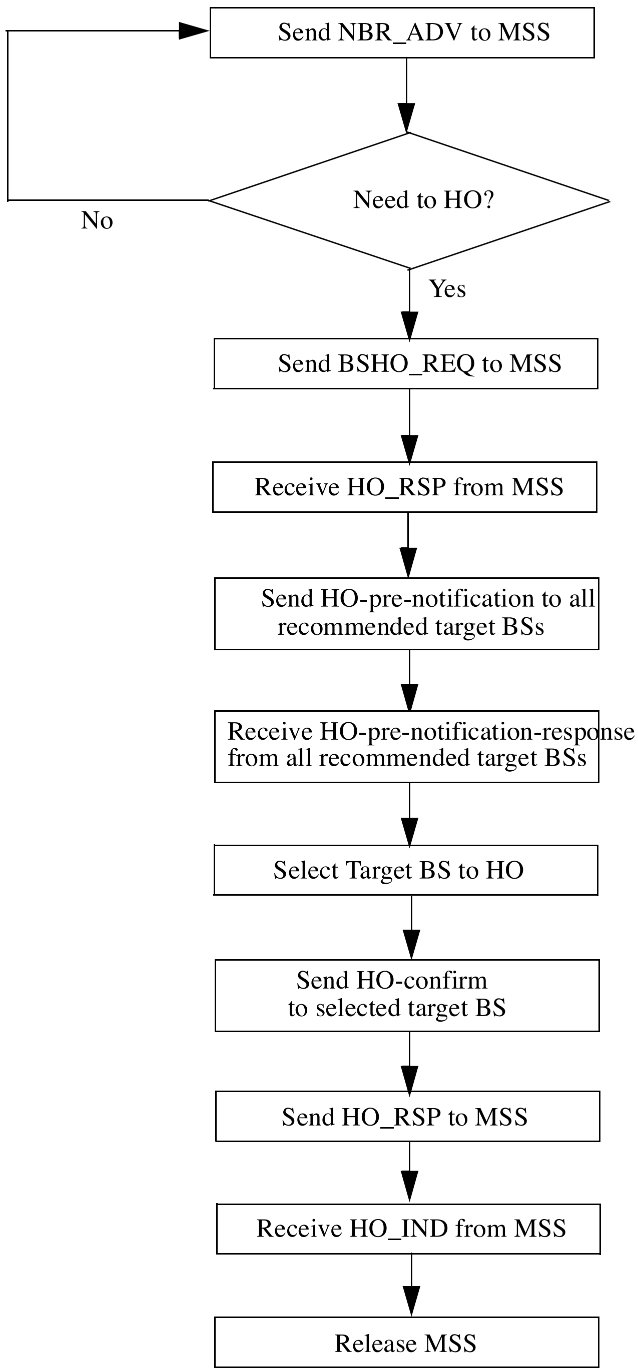


Figure E.5—HO process block diagram in Serving BSS by BSS request



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