Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Revision of Hand-over Mechanism for Mobility Enhancement**
Date Submitted	**2003-09-06**
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Re:	Response to IEEE 802.16e-03/18 (Call for Contributions on IEEE 802.16e/07r3) Response to Session 26, Comment 66, 'Hand-off ad-hoc to generate specific text for pre-registration.' Response to Session 26, Comment 74, 'Issue call for contributions with regards to mobility agent, role of mobile IP, and applicability of this function to fixed (nomadic) operation, to be coordinated with 802.16d.' Response to Session 26, Comment 100, 'Decide whether parameters can be changed or not during the re-registration process. If not, delete Connection_Info. If they can, delete the last sentence of the CID_update description.' Response to Session 26, Comment 109, 'Call for contributions to add specific text defining the interaction of sleep mode and handoff, and what happening during a "drop" scenario' Response to Session 26, Comment 126, 'Specify what parts of the annex are normative text' Response to Session 26, Comment 130. 'Text should be provide to explain how BS initiates periodic ranging with MSS which is in Sleep Mode; Fix/adapt the general system parameters (section 10) to the mobile context'
Abstract	Clarification, revision, and definition of Hand-over mechanism for Mobility Enhancements
Purpose	Stimulate discussion on a more completely defined, flexible model and mechanism for facilitating mobility functionality
Notice	

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Revision of Hand-over Mechanism for Mobility Enhancement

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Introduction

The mobility enhancements proposed in IEEE 802.16e-03/07r3 provide an initial framework for a robust mechanism to conduct mobility based on the IEEE 802.16 prior art. However, the current definition suffers several significant over-specifications in some areas; and critical omissions in other areas. A systemic review of the model and mechanism provides insight into ways to streamline the solution, eliminate inconsistencies, and fill-in persistent holes.

Systemic Assumptions

Establishing some systemic assumptions grants us an opportunity to create criteria for evaluating the merit of various solution mechanisms. My simple set includes:

- Mobility support for fixed, portable, mobile SS additions/modifications to existing standard
    - Enhancements to existing and proposed fixed standards only
        - Minimize changes to only what is necessary to accomplish task
        - Optional solutions whenever possible; avoid over-specification of new requirements
    - Support of all three multimedia modes of use on the same network seamlessly
        - Minimize performance impact on other modes of operation to support optional modes/multimedia
- Support for multimedia/timing sensitive traffic intrinsic/not just supported
    - Support of all three types of multimedia with adequate service granularity to enable meaningful market models
        - Minimize air interface and network performance impact of changes to support larger concurrent subscriber base with most robust performing multimedia set
        - Network and MSS may perform some activities less efficiently in order to conserve performance in other more critical areas
            - For instance an MSS may elect to temporarily use a course Ranging negotiated value that is moderately inefficient on UL power consumption in order to expedite a soft hand-over
- Support for variety of network configurations, sophistication, relationships

  - Minimize specification that limits configuration, operation, and interaction; only specify what is required to achieve mobility goals
  - Not possible to completely predict all of the forms of successful network configuration; err on the side of flexibility and minimalism
- MSS more sophisticated than fixed device; more sophisticated knowledge, more complex decisions
  - Support for variety of MSS provisioned service profiles
  - MSS may be either use a centrally managed or distributed decision architecture for everything from authentication and service provisioning to hand-over mechanisms
    - MSS may have a great deal of knowledge about operating environment; things that connected network may be insensitive to
  - MSS may have other relationships
    - Private network connections
    - Foreign network connections
  - MSS has requirement to continuously evaluate its operating environment and assess mobility, network, and service options
    - MSS may be out-of-touch from connected network for periods while analyzing and assessing options
  - MSS has power conservation requirements
    - MSS may be out-of-touch from connected network for periods on power conservation
- Network is resource gatekeeper/master control for network resources
  - He who controls the resources has final say on the allocation of those resources
  - Resource conservation, especially air interface conservation, is priority
  - Network or MSS may make decisions that reduce MSS allocated QoS in order to maximize other performance criteria

Observations on Current IEEE 802.16e-03/07r3 Based on Criteria from Assumptions

1. **Neighbor Advertisement, Scanning, and Ranging for Hand-over**

   Problem:

   For mobility, MSS have a consistent periodic need to evaluate their changing operating environment. This requirement exceeds the periodic 6.2.10 proscribed periodic ranging for fixed SS and includes MSS interest in viewing other networks, a concept foreign to fixed SS networks.

In the current proposal, the solution mechanism includes BS neighbor broadcast advisories, MSS scanning and possibly ranging nearby same and foreign network BS.

BS neighbor broadcast currently contains inadequate information for SS to base distributed information hand-over decisions on and would necessitate MSS scanning and possibly ranging, likely with unacceptable frequency, of nearby BS to determine suitability for hand-over, even for BS on the same network. Excessive scanning is undesirable because it results in frequent absence of the MSS from the Serving BS scheduler and unavailability to initiation of timing sensitive DL traffic. Excessive ranging is undesirable because it unnecessarily consumes ranging contention slots and UL/DL scheduler slots on Target BS, impacting effective throughput, service granularity, and support for timing sensitive traffic.

Remedy:

Expand the role and increase the data provided in MOB_NBR-ADV broadcast message. This will decrease the need for MSS to scan and range same network neighbor BS to obtain information useful in making hand-over decisions. Also, MOB_NBR-ADV beacon can be scanned and used by MSS on initial network entry to identify those networks to which it has provisioned affiliation and may be interested in establishing connection without having to scan and range all nearby BS.

Remedy Action 1:

In 1.3.1.2.1.1 Network topology advertisement, replace paragraph 1 in its entirety with:

'A BS may periodically broadcast information about the network topology using the BEA-ADV MAC message. An MSS may decode this message to find out information about the parameters of available networks and neighbor BS. Each MSS will thus be able to assess interest in joining the network and synchronize quickly with neighbor BS.'

Remedy Action 2:

In 6.2.2.3.2 Downlink Map (DL-MAP) message, IEEE 802.16-2001, paragraph 5, Base Station ID defines Operator ID as 'The most significant 24 bits…' of the Base Station ID 48 bit value. This is very restrictive to both the Base Station ID (cannot use MAC address for Base Station ID) and for Operator ID. Need to create a separate 24 bit Operator ID for the network. We can broadcast the Operator ID less frequently using the 6.2.2.3.42 Beacon Network Broadcast Advisory (MOB_BEA-ADV) management message and still get the same benefit of '…a network management hook that can be combined with the Downlink Channel ID of the DCD message for handling edge-of-sector and edge-of-cell situations.'

Replace 6.2.2.3.2, 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.'

Remedy Action 3:

Replace 6.2.2.3.43 Neighbor Advertisement (MOB_NBR-ADV) in its entirety with:

'6.2.2.3.42 Beacon Network Broadcast Advisory (MOB_BEA-ADV) management message

An MOB_BEA-ADV management message may be broadcast by a BS at a periodic interval (BEA-ADV interval, see Table 118a2) to identify the network and define the characteristics of neighbor BS to potential MSS seeking initial network entry or hand-over, and to identify the network to foreign networks. The BS may restrict MOB_BEA-ADV to data covering only BS sharing the same Operator ID.

Table 56ad—MOB_BEA-ADV Beacon Broadcast

Syntax	Size	Notes
MOB_BEA-ADV_Message_Format() {		
Management Message Type=48	8-bits	
BS ID	48-bits	Base station unique identifier (Same number as that broadcasted on the DL-MAP message)
Operator ID	48-bits	Unique Network ID
Network Type	8-bits	0=not specified; 1=managed, restricted; 2=managed, provisional; 3=managed, unrestricted; 4=unmanaged, restricted; 5=unmanaged, provisional; 6=unmanaged, unrestricted; other=reserved
Time Stamp	32-bits	Number of milliseconds since midnight GMT (set to 0xffffffff to ignore)
BS Next Beacon	16-bits	Time interval in frames until next BS beacon event
BS Next Contention Network Entry	8-bits	Time interval in frames until next BS contention based SS network entry interval; value=0 indicates feature not supported
BS Network Managed Handover Supported	1- bit	Binary 0=no; 1=yes
TLV encoded items		See Table 127c

}		

A BS shall generate MOB_BEA-ADV messages in the format shown in Table 56ad. The following parameters shall be included in the MOB_BEA-ADV message,

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

Network Type — defines networks based on service management type and prosecution of non-affiliated MSS connection. The following encodings apply:
0=not specified
1=managed, restricted; ASA function is network managed, MSS access to the network is restricted to affiliated MSS
2=managed, provisional; ASA function is network managed, MSS access to the network is restricted to affiliated MSS, however, limited access may be provided to non-affiliated MSS
3=managed, unrestricted; ASA function is network managed, MSS access to the network is unrestricted
4=unmanaged, restricted; ASA function is either static or unmanaged, MSS access to the network is restricted to affiliated MSS
5=unmanaged, provisional; ASA function is either static or unmanaged, MSS access to the network is restricted to affiliated MSS, however, limited access may be provided to non-affiliated MSS
6=unmanaged, unrestricted; ASA function is either static or unmanaged, MSS access to the network is unrestricted
other=reserved

Time Stamp — number of milliseconds since midnight GMT

BS Next Beacon — time interval in milliseconds until next BS beacon event

BS Next Contention Network Entry — time interval in frames until next BS contention based SS network entry interval

BS Network Managed Handover Supported — binary value indicating support for network managed MSS hand-over at BS

All other parameters are coded as TLV value (see Table 127c).

BS Air Interface Advertised Bandwidth — calculated value

BS Air Interface Available Bandwidth — calculated value

BS Backhaul Advertised Bandwidth — calculated value

BS Backhaul Available Bandwidth — calculated value

N_QoS_Records — Number of AuthorizedQoSParamSet Records

Service Class Code — Code of Service Class in AuthorizedQoSParamSet

N_Neighbors – Number of advertised neighbor BS

For each advertised 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

Neighbor Operator ID — the unique network ID shared by an association of BS; may be omitted if same as for transmitting BS

Neighbor Network Type — defines networks based on service management type and prosecution of non-affiliated MSS connection. The following encodings apply:
0=not specified
1=managed, restricted; ASA function is network managed, MSS access to the network is restricted to affiliated MSS
2=managed, provisional; ASA function is network managed, MSS access to the network is restricted to affiliated MSS, however, limited access may be provided to non-affiliated MSS
3=managed, unrestricted; ASA function is network managed, MSS access to the network is unrestricted
4=unmanaged, restricted; ASA function is either static or unmanaged, MSS access to the network is restricted to affiliated MSS
5=unmanaged, provisional; ASA function is either static or unmanaged, MSS access to the network is restricted to affiliated MSS, however, limited access may be provided to non-affiliated MSS
6=unmanaged, unrestricted; ASA function is either static or unmanaged, MSS access to the network is unrestricted
other=reserved

Neighbor Physical Frequency – DL center frequency (kHz).

Neighbor Time Stamp — number of milliseconds since midnight GMT when neighbor info created for transfer to Serving BS

Neighbor BS Next Beacon — time interval in milliseconds from Time Stamp until next BS beacon event

Neighbor BS Next Contention Network Entry — time interval in frames until next BS contention based SS network entry interval

Neighbor BS Network Managed Handover Supported — binary value indicating support for network managed MSS hand-over at Neighbor BS

Neighbor DCD_Settings — 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.

Neighbor UCD_Settings — 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.

Neighbor BS Air Interface Advertised Bandwidth — calculated value

Neighbor BS Air Interface Available Bandwidth — calculated value

Neighbor BS Backhaul Advertised Bandwidth — calculated value

Neighbor BS Backhaul Available Bandwidth — calculated value'

Remedy Action 4:

Replace 11.1.7 in its entirety with:

'11.1.7 BEA-ADV Message Encodings

Table 127c—BEA-ADV Encodings

Name	Type (1 byte)	Length (1 byte)	Value (Variable-length)
BS Air Interface Advertised Bandwidth	?	32-bits	In bits per second
BS Air Interface Available Bandwidth	?	32-bits	In bits per second
BS Backhaul Advertised Bandwidth	?	32-bits	In bits per second

BS Backhaul Available Bandwidth	?	32-bits	In bits per second
N_QoS_Records	?	8-bits	Number of AuthorizedQoSParamSet Records
For (j=0 ; j<N_QoS_Records ; j++) {			
Service Class Code	?	8-bits	Code of Service Class in AuthorizedQoSParamSet
}			
N_Neighbors	?	8-bits	Number of advertised BS neighbors
For (j=0 ; j<N_Neighbors ; j++) {			
Neighbor BS-ID	?	48-bits	
Neighbor Operator ID	?	48-bits	Unique Network ID
Neighbor Network Type	?	8-bits	0=not specified; 1=managed, restricted; 2=managed, provisional; 3=managed, unrestricted; 4=unmanaged, restricted; 5=unmanaged, provisional; 6=unmanaged, unrestricted; other=reserved
Neighbor Time Stamp	?	32-bits	Number of milliseconds since midnight GMT (set to 0xffffffff to ignore)
Neighbor BS Next Beacon	?	16-bits	Time interval in frames until next neighbor BS beacon event
Neighbor BS Next Contention Network Entry	?	16-bits	Time interval in frames until next neighbor BS contention based SS network entry interval; value=0 indicates feature not supported
Neighbor BS Network Managed Handover Supported	?	1 -bit	Binary 0=no; 1=yes
Neighbor DCD_Settings	?	Variable	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.
Neighbor UCD_Settings	?	Variable	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.
Neighbor BS Air Interface Advertised Bandwidth	?	32-bits	In bits per second
Neighbor BS Air Interface Available Bandwidth	?	32-bits	In bits per second
Neighbor BS Backhaul Advertised Bandwidth	?	32-bits	In bits per second
Neighbor BS Backhaul Available Bandwidth	?	32-bits	In bits per second
N_QoS_Records	?	8-bits	Number of AuthorizedQoSParamSet Records
For (h=0 ; h<N_QoS_Records ; h++) {			
Service Class Code	?	8-bits	Code of Service Class in AuthorizedQoSParamSet
}			
}			

‘

Remedy Action 5:

In order to partially compensate for the increased DL data load introduced by the more extensive MOB_BEA-ADV broadcast management message, change references from ‘NBR-ADV’ to ‘BEA-ADV’ in Table 118a2 and extend the MAX interval for BEA-ADV interval to 5 seconds. Devices moving 120kph would only move 167 meters at MAX interval, so should not pose too much of a problem extending interval. Could dynamically reduce interval based on cell characteristics and transient MSS requirements.

Remedy Action 6:

One useful mechanism for building neighbor BS relationships for reporting in MOB_BEA-ADV is to have MSS periodically provide scanning results to the Serving BS. The advantages of this solution type are that 1) the MSS can provide information about BS on both affiliated and foreign networks that may impact MSS hand-over decisions, that the Serving network might otherwise be unaware; and 2) that this model allows for dynamic neighbor BS table creation and maintenance thus not requiring static programming or centralized management. This solution requires the creation of INF-REQ and INF-RSP MAC management messages. SS_INF-REQ/RSP provides some similar information to REP-REQ/RSP but far less detailed and for a much broader frequency domain. We can also provide other useful information about the MSS like Home Network ID, Authentication Server Address (that holds the MSS provisioned service profile and account status), Mobility Support Type (0=none, 1=portable, 2=mobile, SS managed hand over, 3=mobile, network managed hand over), Power Type (A/C, battery), Power

Status (10% increments), other?? We also need to add a timer to expire aged Neighbor BS from the Neighbor BS table. And we need to add the relevant backbone messages to maintain neighbor relationships between affiliated BS and pass the relevant information for reporting in MOB_BEA-ADV.

Add new MAC Data/Control Plane sub-section:

Add 6.2.2.3.50 SS_INF-REQ management message-

‘6.2.2.3.50 SS_INF-REQ message

A BS may transmit an SS_INF-REQ message to an SS at any time to obtain SS operating information and neighbor and foreign network BS measurements. The message shall be transmitted on the MSS basic CID.

Table 56ak—SS_INF-REQ message format

Syntax	Size	Notes
SS_INF-REQ _Message_Format() {		
Management Message Type = 55	8-bits	
}		

A BS shall generate SS_INF-REQ messages in the format shown in Table 56ak.’

Add 6.2.2.3.51 SS_INF-RSP management message-

‘6.2.2.3.51 SS_INF-RSP message

A MSS may transmit an SS_INF-RSP message to a BS at any time in response to an SS_INF-REQ or unsolicited. The message shall be transmitted on the basic CID.

Table 56al—SS_INF-RSP message format

Syntax	Size	Notes
SS_INF-REQ _Message_Format() {		
Management Message Type = 56	8-bits	
Home Network ID	48-bits	Operator ID of default network to which MSS is associated

Authentication Server Address	48-bits	Address of ASA network device that holds the MSS provisioned service profile and account status for the MSS
Mobility Support Type	4-bits	What, if any, type of mobility functionality the MSS supports. 0=none; 1=portable; 2=mobile, MSS managed hand over; 3=mobile, network managed hand over; other=reserved
Power Type	4-bits	Disclosure of what power source the MSS employs. 0=line power; 1=battery power; other=reserved
Power Status	4-bits	Disclosure of current MSS power supply status. Value provided as whole number representing the tens grouping of percentage of power remaining, in 10% increments, rounded up
N_Neighbors	8-bits	Number of discovered neighbor BS
For (j=0 ; j<N_NEIGHBORS ; j++) {		
Neighbor BS-ID	48-bits	Same as the Base Station ID parameter in the DL-MAP message of neighbor BS
Neighbor Operator ID	48-bits	the unique network ID shared by an association of BS
Neighbor Physical Frequency	32-bits	DL center frequency (kHz).
BS S/(N + I)	8-bits	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	8-bits	This value indicates the level of service the MSS can expect from this BS. 0 = No service possible for this MSS/service level undetermined; 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
}		
}		

A BS shall generate SS_INF-RSP messages in the format shown in Table 56al. The following parameters shall be included in the SS_INF-REQ message,

Home Network ID — Operator ID of default network to which MSS is associated

Authentication Server Address — Address of ASA network device that holds the MSS provisioned service profile and account status for the MSS

Mobility Support Type — Disclosure of what, if any, type of mobility functionality the MSS supports. The following encodings apply:

0=none

1=portable

2=mobile, MSS managed hand over

3=mobile, network managed hand over

other=reserved

Power Type — Disclosure of what power source the MSS employs. The following encodings apply:

0=line power

1=battery power

other=reserved

Power Status — Disclosure of current MSS power supply status. Value provided as whole number representing the tens grouping of percentage of power remaining, in 10% increments, rounded up (i.e. 18% power remaining would report a value of 2; 31% power remaining would report a value of 4; 97% power remaining would report a value of 0).

N_Neighbors – Number of discovered neighbor BS

For each 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

Neighbor Operator ID — the unique network ID shared by an association of BS

Neighbor Physical Frequency – DL center frequency (kHz).

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; service level undetermined.

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.'

Note: I will look at converting some of this to TLV later; could probably remove some redundancy in Neighbor Operator ID and cut down on the payload a bit.

Remedy Action 7:

To support dynamic neighbor table administration, need to add Neighbor_Notification.request, Neighbor_Notification.response, and Neighbor_Notification.confirmation backbone messages to Annex C.1. Also, need to add Neighbor_Info backbone message to C.1 to periodically transfer Neighbor BS information between neighbor associated BS regardless of the mechanism employed to build the Neighbor BS table.

In Table C1, data row 2 'Provide a BS with the identity of its neighbors', in column 2 'Possible Method for Providing service', add third option '(3) Build list from SS_INF-RSP obtained from MSS'

In Table C1, append the following rows to the end of the table:

Service	Possible Method for Providing service	Comments
Provide Neighbor	Sending BS notifies affiliated BS that Sending BS considers	Message format and transport protocol need to be specified for

Notification request	affiliated BS a Neighbor for Neighbor BS purposes	interoperability.
Provide Neighbor Notification response	Affiliated BS response to Sending BS request for Neighbor BS designation	Message format and transport protocol need to be specified for interoperability.
Provide Neighbor Notification confirmation	Sending BS confirmation of Affiliated BS response to Sending BS request for Neighbor BS affiliation	Message format and transport protocol need to be specified for interoperability.

Add new sub-section:

‘C.2.9 Neighbor_Notification.request message

An originating BS may send a Neighbor_Notification.request to another BS indicating it considers the BS a Neighbor BS.

Table C9—Neighbor_Notification request message

Field	Size	Notes
Global Header	152-bits	
Security Field	TBD	A means to authenticate this message
CRC Field	32-bits	IEEE CRC-32

‘

Add new sub-section:

‘C.2.10 Neighbor_Notification.response message

A notified BS shall respond with a Neighbor_Notification.response message confirming or denying a Neighbor_Notification request. If the neighbor relationship is affirmed, both BS shall place each other on their dynamic Neighbor BS tables and begin aging timer (Neighbor-Aging-Timer, see Table 118a2).

Table C10—Neighbor_Notification response message

Field	Size	Notes

Global Header	152-bits	
ACK/NACK	1-bit	Acknowledgement or Negative acknowledgement. 0=Negative acknowledgement which means that the notified BS refuses to accept neighbor association with the originating BS 1=Acknowledgement which means that the notified BS accepts neighbor association with the originating BS
Security Field	TBD	A means to authenticate this message
CRC Field	32-bits	IEEE CRC-32

‘

Add new sub-section:

‘C.2.11 Neighbor_Notification confirmation message

The originating BS shall confirm acknowledgement of receipt of the Neighbor_Notification.response using a Neighbor_Notification confirmation message.

Table C11—Neighbor_Notification confirmation message

Field	Size	Notes
Global Header	152-bits	
Security Field	TBD	A means to authenticate this message
CRC Field	32-bits	IEEE CRC-32

‘

Add new sub-section:

‘C.2.12 Neighbor_Info message

Each BS shall send a Neighbor_Info message on periodic intervals (Neighbor_Info interval, see Table 118a2) to each other BS on its Neighbor BS table. Also, immediately following sending of a positive

Neighbor_Notification.response message, the notified BS shall send a Neighbor_Info message to the originating BS of the Neighbor_Notification request message.

Table C12—Neighbor_Info message

Field	Size	Notes
Global Header	152-bits	
BS ID	48-bits	Base station unique identifier (Same number as that broadcasted on the DL-MAP message)
Operator ID	48-bits	Unique Network ID
Network Type	8-bits	0=not specified; 1=managed, restricted; 2=managed, provisional; 3=managed, unrestricted; 4=unmanaged, restricted; 5=unmanaged, provisional; 6=unmanaged, unrestricted; other=reserved
Time Stamp	32-bits	Number of milliseconds since midnight GMT (set to 0xffffffff to ignore)
BS Next Beacon	16-bits	Time interval in frames until next BS beacon event
BS Next Contention Network Entry	8-bits	Time interval in frames until next BS contention based SS network entry interval; value=0 indicates feature not supported
BS Network Managed Handover Supported	1- bit	Binary 0=no; 1=yes
BS Air Interface Advertised Bandwidth	32-bits	In bits per second
BS Air Interface Available Bandwidth	32-bits	In bits per second
BS Backhaul Advertised Bandwidth	32-bits	In bits per second
BS Backhaul Available Bandwidth	32-bits	In bits per second
N_QoS_Records	8-bits	Number of AuthorizedQoSParamSet Records
For (j=0 ; j<N_QoS_Records ; j++) {		
Service Class Code	8-bits	Code of Service Class in AuthorizedQoSParamSet
}		

Security Field	TBD	A means to authenticate this message
CRC Field	32-bits	IEEE CRC-32

‘

Append to table 118a2:

System	Name	Time Reference	Min. Value	Default Value	Max. Value
BS	Neighbor_Info interval	Nominal time between transmission of Neighbor_Info messages			600s
BS	Neighbor-Aging-Timer	Nominal time for aging of BS neighbor association and removal from the dynamic Neighbor BS table	3600s		

2. **Association**

Problem:

I am not sure I see an important reason to keep Association as a distinct concept in the doc. The adoption of the changes to max power/initial power setting (this is a mandatory use item) in IEEE 802.16d/r2 6.2.9.5 provides a good shortcut method for curtailing lengthy Ranging negotiation--exactly Association's proposed function. Certainly, given that you would be using the IEEE 802.16d/r2 6.2.9.5 method during Ranging to get Association to begin with, IEEE 802.16d/r2 6.2.9.5 likely provides as good of a shortcut mechanism to minimize the Ranging negotiation interval during actual handover as Association is likely to provide.

Remedy:

Remove all references to ‘Association’. Replace instances of language reference to ‘Association’ with ‘Ranging’. Delete relevant section dedicated to Association. Also, change MSS Association Channel ID TLV item for RNG-REQ to be Serving BS ID. As currently defined, MSS Association Channel ID requires ASA to implement and manage; unnecessary to maintain uniqueness.

Remedy Action 1:

Delete 1.3.1.2.1.3 in its entirety.

Remedy Action 2:

Remove row containing ASC-AGING-TIMER from Table 118a2.

Remedy Action 3:

In 6.2.2.3.6, page 18, line 25, change reference from 'MSS Association Channel ID TLV' to 'Serving BS ID TLV'

In 6.2.2.3.5, page 12, lines 25&26, delete current lines and replace with:

'**Serving BS ID** — 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 exceeded (ServingBS-Aging-Timer, see Table 118a2).'

Append row to table 118a2:

System	Name	Time Reference	Min. Value	Default Value	Max. Value
MSS	ServingBS-Aging-Timer	Nominal time for aging of Serving BS association. Timer recycles on successful Serving BS DL-MAP read	500ms		

In 11.1.3, replace Table 126a with:

'Table 126a—RNG-REQ Message Encodings

Name	Type (1 byte)	Length (1 byte)	Value (Variable-length)
Serving BS ID	4	1	the BS ID of the BS to which the MSS is currently connected (has completed complete registration cycle and is in Normal Operation)

'

3. **Scanning, Ranging, and Sleep**

Problem:

The fact that we have created a logical separation/use distinct between 'sleep' mode and 'scanning' mode seems unnecessary. When determining whether differentiating mechanically, I think it best to look at impact on the Serving BS and network when assessing the importance of maintaining a logical distinction. All the network cares is that the SS is 'unavailable' during the described interval, for whatever reason, and that the Serving BS should not schedule any DL/UL slots addressed to the SS. What the SS does during that interval of absence is irrelevant to the Serving BS and network and does not affect the mechanics of the standard.

There is benefit to unifying the two concepts for performance reasons, as well as conceptually. We spent some time at the last meeting talking about re-synchronization on timing for SS returning from 'sleep' mode. We did not make similar correction for SS returning from 'scanning' mode. By combining the allocation mechanism for both under the 'sleep' mode rules we effectively eliminate that problem for 'scanning', and any other logical use, as well.

Finally, we also made changes to SLP-REQ allowing for single iteration 'sleep' intervals which, in instances were a single 'sleep' interval is specified, eliminates the need for a TRF-IND.

Remedy:

Delete the separate rules allocation for Scanning. Expand the definition and rules for ‘Sleep’ mode to be more flexible and generalized as an MSS ‘Unavailable’ period. Create an appropriate aging timer for Serving BS to consider connection to MSS in ‘Sleep’ mode lost.

Remedy Action 1:

Delete 1.3.1.2.1.2 in its entirety.

Remedy Action 2:

Delete 6.2.2.3.44 in its entirety.

Remedy Action 3:

Delete 6.2.2.3.45 in its entirety.

Remedy Action 4:

In 1.3.1.2.3.1.1, paragraph 1, replace current paragraph with:

‘For MSS that have decoded the Serving BS BEA-ADV message including Target BS information and/or used a sleep interval to scan and synchronize with a Target BS DL-MAP, this stage should be immediate. In other situations this procedure defaults to the one specified in IEEE 802.16-2001 sections 6.2.9.1 and 6.2.9.2.’

Remedy Action 5:

In 6.2.2.3.40, replace Table 56aa with:

‘Table 56aa—Sleep-Request (MOB_SLP-REQ) message format

Syntax	Size	Notes
MOB_SLP-REQ_Message_Format() {		
Management Message Type=45		
initial-sleep window	6-bits	
sleep-window factor	4-bits	
final-sleep window	12-bits	
sleep-window iterations	8-bits	
}		

‘

In 6.2.2.3.40, paragraph 2, replace current paragraph with:

‘Parameters shall be as follows:

initial-sleep window

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

sleep-window factor

Multiplying factor for increasing the sleep-window value through multiple sleep-window iterations

final-sleep window

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

sleep-window iterations

Number of iterations of sleep-window to perform prior to completing sleep-interval’

In 6.2.2.3.41, replace Table 56ab with:

‘Table 56ab—Sleep-Request (MOB_SLP-RSP) message format

Syntax	Size	Notes

MOB_SLP-RSP_Message_Format() {		
Management Message Type=46		
Sleep approved	1-bit	0: Sleep-mode request denied 1: Sleep-mode request approved
If (Sleep-approved == 0) {		
reserved	7-bits	
} else {		
start frame	7-bits	lower byte of the frame number in which the SS shall enter into sleep mode
initial-sleep window	6-bits	
sleep-window factor	4-bits	
final-sleep window	12-bits	
sleep-window iterations	8-bits	
listening interval	8-bits	
}		
}		

‘

In 6.2.2.3.41, paragraph 2, replace current paragraph with:

‘Parameters shall be as follows:

Sleep approved

Defines whether or not the request to enter sleep-mode has been approved by the BS.

start frame

lower byte of the frame number in which the SS shall enter into sleep mode.

initial-sleep window

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

sleep-window factor

Multiplying factor for increasing the sleep-window value through multiple sleep-window iterations

final-sleep window

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

sleep-window iterations

Number of iterations of sleep-window to perform prior to completing sleep-interval

listening interval

Duration in frames for SS to listen prior to begin next sleep window iteration'

In 6.2.16.1, paragraph 1, replace current paragraph with:

'Sleep-mode is a mode in which SS's supporting mobility may power down, scan neighbor and foreign network BS, range neighbor and foreign network BS, or perform other activities for which the MSS will be unavailable to the Serving BS for DL or UL traffic. Sleep-mode is intended to enable mobility-supporting SS's to minimize their energy usage and facilitate hand-over decision and operation while staying connected to the network, but sleep-mode use should not be narrowly interpreted. Implementation of power-save mode is optional.'

In page 27, line 1, section 6.2.16.1, paragraph 3, replace current paragraph with:

'When an SS is in awake-mode, it is receiving and transmitting PDUs as in normal operation. When the SS is in sleep-mode, it does not send or receive PDUs. When an SS is in sleep-mode it has no obligation to listen to DL traffic and may power down one or more physical operation components.'

In page 27, line 7, section 6.2.16.1, paragraph 4, replace current paragraph with:

'**Sleep-interval**

A time duration, measured in whole frames, where the SS is in sleep-mode. The sleep-interval is constructed of one or more variable-length, consecutive sleep-windows, with interleaved listening intervals, through one or more iterations. During consecutive sleep-windows comprising a single sleep-interval, sleep-window may be updated using an increasing algorithm with an adjustable maximum limit.'

In page 27, line 18, section 6.2.16.1, paragraph 6, replace current paragraph with:

'Before entering sleep-mode the SS shall inform the BS using SLP-REQ and obtain its approval. Serving BS shall respond with a SLP-RSP message. Serving BS may send an unsolicited SLP-RSP to SS to initiate SS sleep-interval. Upon Serving BS transmittal of an affirming SLP_RSP, Serving BS shall initiate aging timer (MSSSleep-Aging-Timer, see Table 118a2) to coincide with initiation of sleep-interval at start-frame. The BS may buffer (or it may drop) incoming PDUs addressed to the sleeping SS, and shall send notification to the SS in its listening periods about whether data has been addressed for it.'

In page 27, line 29, section 6.2.16.1, paragraph 8, replace current paragraph with:

‘A traffic indication message (TRF-IND) shall be sent by the BS on the broadcast CID during each appropriate MSS listening interval. If the number of positive indications is zero, the BS sends an empty indication message, that is, TRF-IND message with num-positive=0.’

In page 27, line 33, section 6.2.16.1, paragraph 9 & 10, replace current paragraphs with:

‘Upon completion of sleep-interval, the SS shall awaken and return to normal operations. Any UL message from the SS to the Serving BS shall interrupt the sleep-interval, shall signal the Serving BS that the SS is still active and connected and has not dropped connection during its sleep-interval, and the Serving BS shall terminate the aging timer (MSSSleep-Aging-Timer, see Table 118a2). If the intervening interval of MSS absence exceeds the aging timer, then the Serving BS shall assume loss of connection to the MSS and process as if it had received a backbone message announcing another BS becoming the Serving BS for the specified MSS (see section Backbone network HO procedures).

The interval between two TRF-IND messages sent by the BS is the maximum listening interval for all SS’s supporting sleep-mode. Listening interval shall be sent in the SLP-RSP message only.’

Append row to table 118a2:

System	Name	Time Reference	Min. Value	Default Value	Max. Value
BS	MSSSleep-Aging-Timer	Nominal time for aging of MSS Sleep disconnect.			10500s

In page 27, line 48, section 6.2.16.2, paragraph 1, replace current paragraph with:

‘An SS shall enter sleep-mode, at the appropriate frame proscribed by start frame, after receiving an SLP-RSP message from the BS. The MSS shall use the following algorithm for calculating and performing the sleep-interval:

```
For (j=0 ; j<sleep-window iterations ; j++) {
    sleep-window = initial-sleep window + initial-sleep window * (sleep-window factor * (j – 1))
    If (sleep-window > final-sleep window) {
        sleep-window = final-sleep window
    }
    Process SS sleep for sleep-window duration
```

```
        If (sleep-window iterations > 1) {
            Process SS listening for listening interval duration
        }
    }
```

Upon completion of sleep-interval, SS and BS shall return to normal operation.'

In page 27, line 55, section 6.2.16.3, paragraph 1 & 2, replace current paragraphs with:

'A BS shall notify each SS in sleep-mode, during its listening-interval, if traffic has been addressed to the SS during any sleep-window iteration. The indication shall be sent on the TRF-IND broadcast message. The SS shall examine the frame number from the PHY Synchronization Field during each listening interval and shall verify synchronization with the BS. If the expected frame number is different than the discovered frame number, the SS shall return to awake mode, normal operation. Similarly, if the SS does not find the expected TRF-IND broadcast message, the SS shall return to awake mode, normal operation.

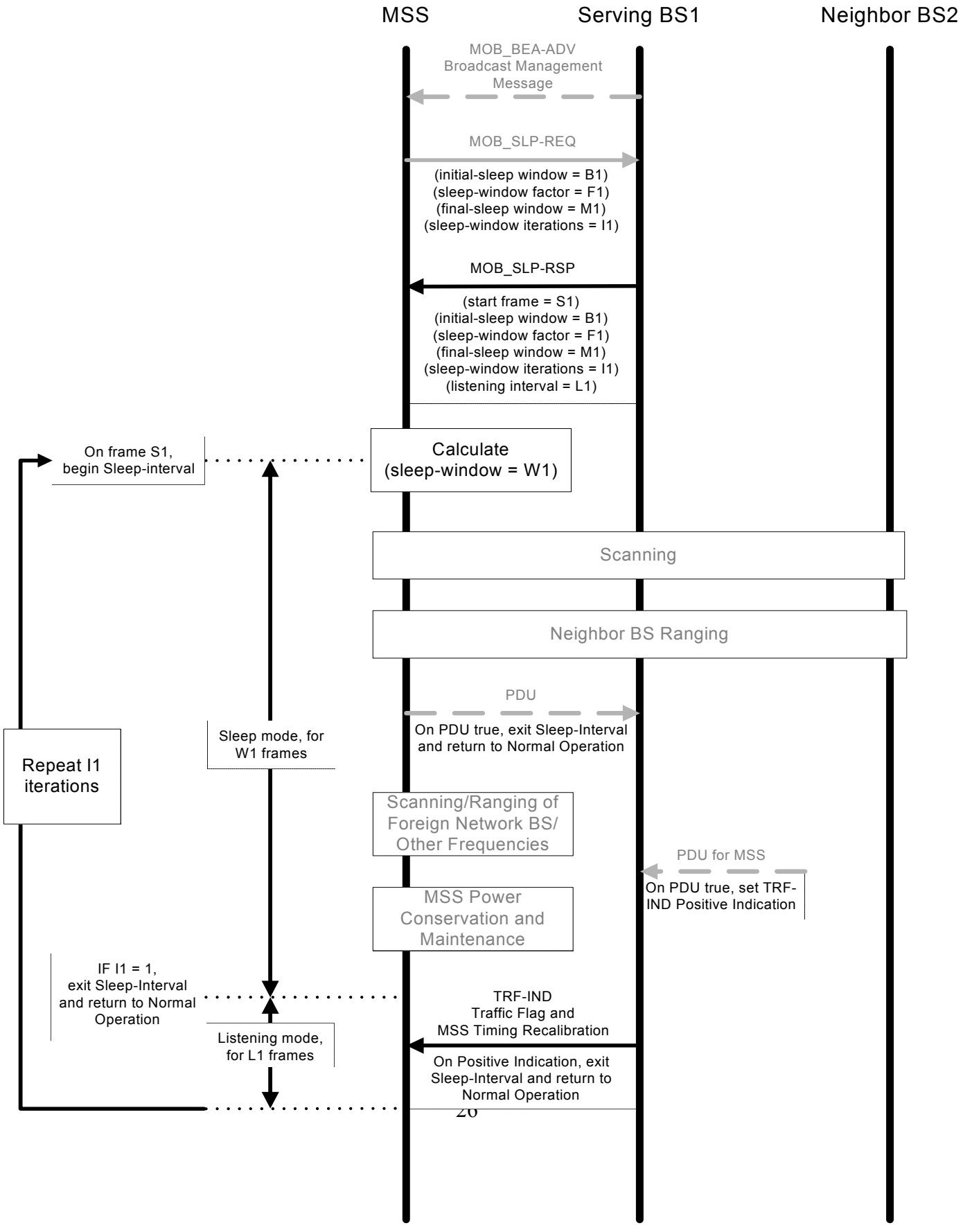
If the SS does not find any positive indication with its CID in the TRF-IND message, it shall consider this as a negative indication and shall continue in sleep mode through the next iteration. For an example of sleep mode operation, see Annex D.'

In page 39, line 25, section 10.1, Table 118a1, delete the second row of data entirely. Max_sleep_interval is appropriately constrained by virtue of the max values of its constituent variables. Max_sleep_interval calculates as 1,038,592 frames under current constraints. This will probably equal to about 5,193 seconds, which should be acceptable. Should this number be seen as too high, it is far preferable to reduce the bit size of some of the constituent variables to reduce Max_sleep_interval.

In page 39, line 25, section 10.1, Table 118a1, modify the third row of data:

Set Minimum Value for Listening_Interval to 4 frames.

In page 54, Annex D.2, Replace Figure D.5 with:


MSS
Serving BS1
Neighbor BS2
MOB_BEA-ADV
Broadcast Management
Message
MOB_SLP-REQ
(initial-sleep window = B1)
(sleep-window factor = F1)
(final-sleep window = M1)
(sleep-window iterations = I1)
MOB_SLP-RSP
(start frame = S1)
(initial-sleep window = B1)
(sleep-window factor = F1)
(final-sleep window = M1)
(sleep-window iterations = I1)
(listening interval = L1)
On frame S1,
begin Sleep-interval
Calculate
(sleep-window = W1)
Scanning
Neighbor BS Ranging
PDU
On PDU true, exit Sleep-Interval
and return to Normal Operation
Repeat I1
iterations
Sleep mode, for
W1 frames
Scanning/Ranging of
Foreign Network BS/
Other Frequencies
PDU for MSS
On PDU true, set TRF-
IND Positive Indication
MSS Power
Conservation and
Maintenance
IF I1 = 1,
exit Sleep-Interval
and return to Normal
Operation
TRF-IND
Traffic Flag and
MSS Timing Recalibration
Listening mode,
for L1 frames
On Positive Indication, exit
Sleep-Interval and return to
Normal Operation

In pages 55 & 56, Annex D.2, Delete Figures D.6 and D.7 entirely.

4. **Hand-over**

Problem:

As currently defined, mechanics for hand-over are incomplete or poorly defined. Elements are out of order.

Remedy:

Revise hand-over process.

Remedy Action 1:

The language in the introductory paragraph for Network Reference Model for Mobile Communications is unnecessarily restrictive.

It is entirely possible to have smaller private mobile networks, say, using Mobile IP to facilitate a campus mobile network. Also, these networks may be partially or completely 'unmanaged', that is to say not a sophisticated AAA support system on the backbone, not a sophisticated hand-over management infrastructure. And there should be some discussion of the core concept that defines a 'mobile' network, that is MSS peforming intra- or inter-network hand-overs.

In page 2, line 63, section 1.3.1.1.1, paragraph 1, replace paragraph with:

‘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. The reference network may be public or private, managed or unmanaged, restricted entry or open connection. Multiple networks, of varying design and performance and operated by disparate operators may coexist in the same geography. Depending on the relationship of the varying operators, cofiguration of the networks, operational deployment, etc..., MSS may perform uninterrupted service flow hand-over (soft hand-over) or interrupted service flow hand-over (hard hand-over) between BS on the same or disparate networks. Hand-overs may be intra- or inter-network. Hand-over management may be centrally controlled or employ a distributed decision mechanism, or some combination thereof. Back-bone networks may employ sophisticated 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.’

Remedy Action 2:

Language problems with paragraph. Correct reference to Association.

In page 6, line 54, section 1.3.1.1.4, paragraph 2, sentences 2 & 3, replace with:

'In the initial Network Entry, Ranging and Hand-over processes, MSS shall request from the target BS certain QoS level per Service Flow, differentiated by Service Class and represented by AuthorizedQoSParamSet. The BS shall respond with name of Service Class available for the Service Flow.'

Remedy Action 3:

In page 6, line 54, section 1.3.1.1.4, paragraph 3, lines 1, 2, 3, and 4, and Table 0b3

Inappropriate references to 'permanent IP address' and association of a 'permanent IP address' with the MSS home attachment point for Mobile IP.

Inappropriate reference to 6.2.14 Dynamic Frequency Selection

Two requirements here that are being improperly bound and creating confusion:

1) No requirement for a 'permanent IP address' in 6.2.9; don't need it for mobility

2) Need network 'MSS Home Network address' referencing the home address attachment point for Mobile IP and other traffic forwarding mobility models

In page 6, line 60, section 1.3.1.4, paragraph 3, sentences 1 thru 4 & Table 0b3, replace with:

'*Network Service* is defined as a service provided to the MSS by the network through a single, persistent IP address with particular connectivity and air-interface MAC parameters (including QoS properties). A MSS persistent IP address is defined as an MSS network connection address as allocated in 6.2.9.10 for as long as it remains persistent on the network. Connectivity properties, including Home Network address, are defined by specification in the MSS Configuration file in 6.2.9.12. QoS properties are those of Service Flow associated with the network service, as specified in 6.2.13.'

In page 7, section 1.3.1.4, Table 0b3, row 2, change reference:

Replace 'Address of MSS at Home Network' with 'MSS Home attachment address'

Replace 'IP address of MSS at its Home Network. This address does not change while MSS travels from one BS to another' with 'MSS static configured home attachment point address for traffic forwarding mobile addressing model.'

Add TLV to 11.3:

‘11.3.10 MSS Home Attachment address:

For mobile enabled networks, MSS Home Attachment address defines the static reference address location for traffic forwarding mobility models

Type	Length	Value
??	4 or 16	IP Address

‘

Remedy Action 4:

Adding to, correcting language and structure for hand-over.

In page 9, line 44, section 1.3.1.2.2, paragraphs 1 thru 4, replace with:

‘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:

Cell Selection — MSS may use Neighbor BS information acquired from a decoded BEA-ADV message, or may make uninformed decision, to schedule sleep-intervals to scan, and possibly range, Neighbor BS for the purpose of evaluating MSS interest in hand-over to potential Target BS. MSS may provide results of its scanning and ranging activity to Serving BS through SS_INF-RSP.

HO Decision — a hand-over begins with a decision for an MSS to hand-over its air interface, service flow, and network attachment from a Serving BS to a Target BS. The decision may originate either at the MSS, the Serving BS, or on the network. The HO Decision consummates with a notification of MSS intent to hand-over through HO-REQ. The HO notification is recommended, but not required. The HO notification may originate with either the Serving BS or MSS. Acknowledgement with HO-RSP of a notification is required.

Backbone HO Notification — Serving BS may notify Target BS over the backbone network of MSS intent to hand-over to Target BS (see section Backbone network HO procedures). Serving BS may also send MSS information over the backbone that can expedite hand-over. If Target BS receives a backbone notification message, subsequent backbone HO notification response and confirmation messages are recommended, but not required.

Sleep — the MSS shall use sleep-interval to establish a working 'unavailable' service window with Serving BS to conduct network re-entry with Target BS. This mechanism permits continued service with the Serving BS should the hand-over attempt fail or be aborted. The MSS shall send a SLP-REQ sleep request message, or Serving BS may send an unsolicited SLP-RSP sleep response message. The burden for message origination lies with the party that originated HO-REQ hand-over request. If MSS sends SLP-REQ, then Serving BS SLP-RSP is required. An MSS may continue the HO process even if the Serving BS fails to respond to a SLP-REQ, but not if SLP-RSP denies the sleep request. If denied, the MSS may re-attempt a SLP-REQ at the appropriate interval. If an MSS operational parameter changes after HO-REQ but prior to start-frame of an approved sleep-interval, MSS must abort the hand-over attempt, return to HO Decision, and re-notify the Serving BS of intent to hand-over.

Target BS Scanning — MSS shall scan Target BS for downlink channel & synchronization and uplink channel & synchronization. If MSS had previously decoded a BEA-ADV message including Target BS ID, Physical Frequency, DCD and UCD, then the scanning and synchronization process may be shortened. If the Target BS had previously received HO notification from Serving BS over the backbone (see section Backbone network HO procedures), then Target BS may place a non-contention based Fast_UL_ranging_IE MSS maintenance opportunity in the UL-MAP. MSS shall scan Target BS for UL-MAP that includes either a contention or non-contention based SS maintenance opportunity.

Network Re-entry — MSS and Target BS shall conduct Ranging per 6.2.9.5 to begin network re-entry. If MSS RNG-REQ includes an unexpired Serving BS ID and Target BS had not previously received MSS information over the backbone (see section Backbone network HO procedures), then Target BS may make an MSS information request of Serving BS over the backbone network and Serving BS may respond. Regardless of having received MSS information from Serving BS, Target BS may request MSS information from an Authorizing Station via the backbone network. Network re-entry proceeds per 6.2.9.5 except as may be shortened by Target BS possession of MSS information obtained from Serving BS over the backbone network. Network re-entry process completes with establishment of MSS normal operations.

Termination of Service — The final step in hand-over is any termination of MSS services with previous Serving BS. If Target BS had received a HO notification from Serving BS over the backbone (see section Backbone network HO procedures), or MSS RNG-REQ included an unexpired Serving BS ID, then Target BS may send a HO complete/Serving BS notification message over the backbone network to the Serving BS and any Authorizing Station. HO acknowledgement is recommended, but not required. Upon receipt of a HO complete/Serving BS notification message, Serving BS shall terminate all connections belonging to the MSS and the context associated with them (i.e. information in queues, ARQ state-machine, counters, timers, etc…, is discarded). Target BS now becomes the new Serving BS for all purposes.'

In page 11, line 4, section 1.3.1.2.2.1, paragraph 1, replace with:

'Cell Selection refers to the process of an MSS Scanning and/or Ranging one or more BS in order to determine suitability, along with other performance considerations, for network connection or hand-over. MSS may incorporate information acquired from a BEA-ADV message to give insight into available Neighbor BS for cell selection consideration. If currently connected to a Serving BS, an MSS shall schedule sleep-intervals to conduct Cell Selection for the purpose of evaluating MSS interest in hand-over to potential Target BS. Such procedure does not involve termination of existing connections to a Serving BS and their re-opening in a Target BS. If ranging a Target BS for hand-over, any newly assigned basic and primary CIDs are specific to the Target BS and do not replace or supplant the basic and primary CIDs the MSS employs in its communication with its Serving BS. MSS may provide results of its scanning and ranging activity to Serving BS through SS_INF-RSP.'

In page 11, line 4, section 1.3.1.2.2.2, paragraph 1 thru 4, replace with:

'Either an MSS or a BS may initiate a HO by transmitting the MSSHO-REQ or BSHO-REQ MAC messages. Transmission of the HO-REQ MAC message is recommended, but not required.

When MSSHO-REQ is sent by an MSS, the MSS may indicate possible Target BS. MSS cell selection criteria for Target BS may include factors like expected signal quality. When BSHO-REQ is sent by a Serving BS, the Serving BS may indicate the recommended Target BS. Serving BS criteria for recommendation of Target BS may include factors like expected Target BS QoS performance to MSS requirements. The HO-REQ message may include an indication of the estimated time for performing the HO. Acknowledgement with HO-RSP of a HO-REQ notification is required. MSS actual pursuit of hand-over to Target BS in HO-RSP is recommended, but not required. MSS may elect to attempt hand-over to a different Target BS with the understanding that the different Target BS will not receive notification of the pending hand-over from the Serving BS over the backbone network (see section Backbone network HO procedures).

Serving BS may notify Target BS over the backbone network of MSS intent to hand-over to Target BS (see section Backbone network HO procedures). Serving BS may also send MSS information over the backbone that can expedite hand-over. If Target BS receives a backbone notification message, subsequent backbone HO notification response and confirmation messages are recommended, but not required.'

In page 12, line 31, section 1.3.1.2.2.3, replace entire section with:

'1.3.1.2.2.3 Sleep and Hand-over

The MSS shall use sleep-interval to establish a working 'unavailable' service window with Serving BS to conduct scanning and network re-entry with Target BS. This mechanism permits continued service with the Serving BS should the hand-over attempt fail or be aborted. The MSS shall send a SLP-REQ sleep request message, or Serving BS may send an unsolicited SLP-RSP sleep response message. The burden for message origination lies with the party that originated HO-REQ hand-over request. If no HO-REQ message was issued, then the requirement falls to the MSS. If MSS sends SLP-REQ, then Serving BS SLP-RSP is required. An MSS may continue the HO process even if the Serving BS fails to respond to a SLP-REQ, but not if SLP-RSP denies the sleep request. If denied, the MSS may re-attempt a SLP-REQ at the appropriate interval.

If an MSS operational parameter changes after HO-REQ but prior to start-frame of an approved sleep-interval, MSS must abort the hand-over attempt, return to HO Decision, and re-notify the Serving BS of intent to hand-over.

MSS may abort the hand-over attempt at any time, for any reason, by aborting the sleep-interval and returning to normal operation with its Serving BS.'

Add new section 1.3.1.2.2.4:

'1.3.1.2.2.4 Scanning of Target BS

During its sleep-interval, MSS shall scan Target BS for downlink channel & synchronization and uplink channel & synchronization. If MSS had previously decoded a BEA-ADV message including Target BS ID, Physical Frequency, DCD and UCD, then the scanning and synchronization process may be shortened. If the Target BS had previously received HO notification from Serving BS over the backbone (see section Backbone network HO procedures), then Target BS may place a non-contention based MSS maintenance opportunity using the PHY dependent Fast_UL_ranging_IE() (see 8.3.1.4.5.3.1 Fast ranging (Paging) Information Element, 8.4.4.3.6 Fast ranging (Paging) Information Element, and

8.5.5.3.5 Fast ranging (Paging) Information Element) in the UL-MAP. MSS shall scan Target BS for UL-MAP that includes either a contention or non-contention based SS maintenance opportunity.'

Add new section 1.3.1.2.2.5:

'1.3.1.2.2.5 Network Re-entry

During its sleep interval, MSS and Target BS shall conduct Ranging per 6.2.9.5 to begin network re-entry. If MSS RNG-REQ includes an unexpired Serving BS ID and Target BS had not previously received MSS information over the backbone (see section Backbone network HO procedures), then Target BS may make an MSS information request of Serving BS over the backbone network and Serving BS may respond. Regardless of having received MSS information from Serving BS, Target BS may request MSS information from an Authorizing Station via the backbone network. Network re-entry proceeds per 6.2.9.5 except as may be shortened by Target BS possession of MSS information obtained from Serving BS over the backbone network.

If Target BS had previously received an MSS-Info response message (see section Backbone network HO procedures) containing MSS information, Target BS may use the embedded TLV SBC-REQ information to build and send an unsolicited SBC-RSP message to MSS. Target BS may ignore only the first SBC-REQ message received if it sends an unsolicited SBC-RSP message. MSS is not required to send an SBC-REQ if it receives an unsolicited SBC-RSP prior to MSS attempt to send SBC-REQ.

If MSS RNG-REQ included an unexpired Serving BS ID and Target BS had previously received an MSS-Info response message (see section Backbone network HO procedures) containing MSS information, MSS and Target BS shall use the embedded TLV PKM-REQ information and the re-authorization process as defined in 7.2 PKM protocol.

If Target BS had previously received an MSS-Info response message (see section Backbone network HO procedures), Target BS may use the embedded TLV REG-REQ & DSA-REQ information to build and send an unsolicited REG-RSP message. The REG-RSP message may include the CID_Update and Connection_Info TLVs. Target BS may ignore only the first REG-REQ message received if it sends an unsolicited REG_RSP message. MSS is not required to send an REG-REQ if it receives an unsolicited REG-RSP prior to MSS attempt to send REG-REQ.

If Target BS had previously received an MSS-Info response message (see section Backbone network HO procedures) that included the MSS Network Address in the embedded TLV, Target BS may skip most of the Network Address allocation process and re-provision the same address through an

unsolicited Network Address Response. Target BS may ignore only the first Network Address discover message received if it sends an unsolicited Network Address response message. MSS is not required to send an Network Address discover if it receives an unsolicited Network Address response prior to MSS attempt to send Network Address discover.

If MSS RNG-REQ included an unexpired Serving BS ID, MSS and Target BS may skip Time of day process.

If MSS RNG-REQ included an unexpired Serving BS ID, MSS may skip the SS configuration file download procedure.

If MSS received a REG-RSP message that included the CID_Update and Connection_Info TLVs, MSS and Target BS may skip the establish connections procedure.

Network re-entry process completes with establishment of MSS normal operations.'

Add new section 1.3.1.2.2.6:

'1.3.1.2.2.6 Termination of Service

The final step in hand-over is any termination of MSS services with previous Serving BS. If Target BS had received a HO notification from Serving BS over the backbone (see section Backbone network HO procedures), or MSS RNG-REQ included an unexpired Serving BS ID, then Target BS may send a HO complete/Serving BS notification message over the backbone network to the Serving BS and any Authorizing Station. HO acknowledgement is recommended, but not required. Upon receipt of a HO complete/Serving BS notification message, Serving BS shall terminate all connections belonging to the MSS and the context associated with them (i.e. information in queues, MPDUs, ARQ state-machine, counters, timers, etc…). Target BS now becomes the new Serving BS for all purposes.'

Page 44, section C.2.4, Table C5:

Remove duplicate row references to TLV SBC-REQ MAC messages

Page 44, section C.2.4, Table C5:

Add rows with appropriate references to TLV REG-REQ MAC messages

Page 44, section C.2.4, Table C5:

Add row with appropriate references to MSS Network Address

Page 44, section C.2.4, Table C5:

Is the encoded DSA-REQ TLV info going to give enough information, including final service mappings, to build a useful CID_Update and Connection_Info TLV for the HO REG-RSP?

Add rows with appropriate references to populate CID_Update and Connection_Info TLVs for Target BS REG-RSP to MSS during hand-over.

In page 12, line 40, section 1.3.1.2.3, paragraph 2, append to end of paragraph:

'Serving BS can also detect a drop by MSS failure to communicate exceeding MSSSleep-Aging-Timer.'

In page 12, line 57, section 1.3.1.2.3.1, paragraph 1, sentence 1, replace sentence 1 with:

'Network re-entry is processed using the mechanics for hand-over as detailed in 1.3.1.2.2'

In page 13, line 1, delete sections 1.3.1.2.3.1.1 thru 1.3.1.2.3.1.6 completely

In page 43, line 16, section C.2.1, paragraph 1, replace entire paragraph with:

'C.2.1 HO complete/Serving BS notification 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 primary use is to notify previous Serving BS and/or ASA or other network services access control administrator that MSS has successfully completed network entry or hand over and that the BS originating the HO complete/Serving BS notification message is now the Serving BS for the MSS. The message may be sent upon MSS establishment of normal operation, and periodically on timer interval (MSSRegistration-timer). The message might trigger a Neighbor BS to request more information on the MSS (either directly from the Serving BS, or from an ASA server). The message contains the following information,

Table C3—HO complete/Serving BS notification message'

In page 46, line 20, section C.2.7, replace entire section with:

‘C.2.7 HO complete/Serving BS notification acknowledge message

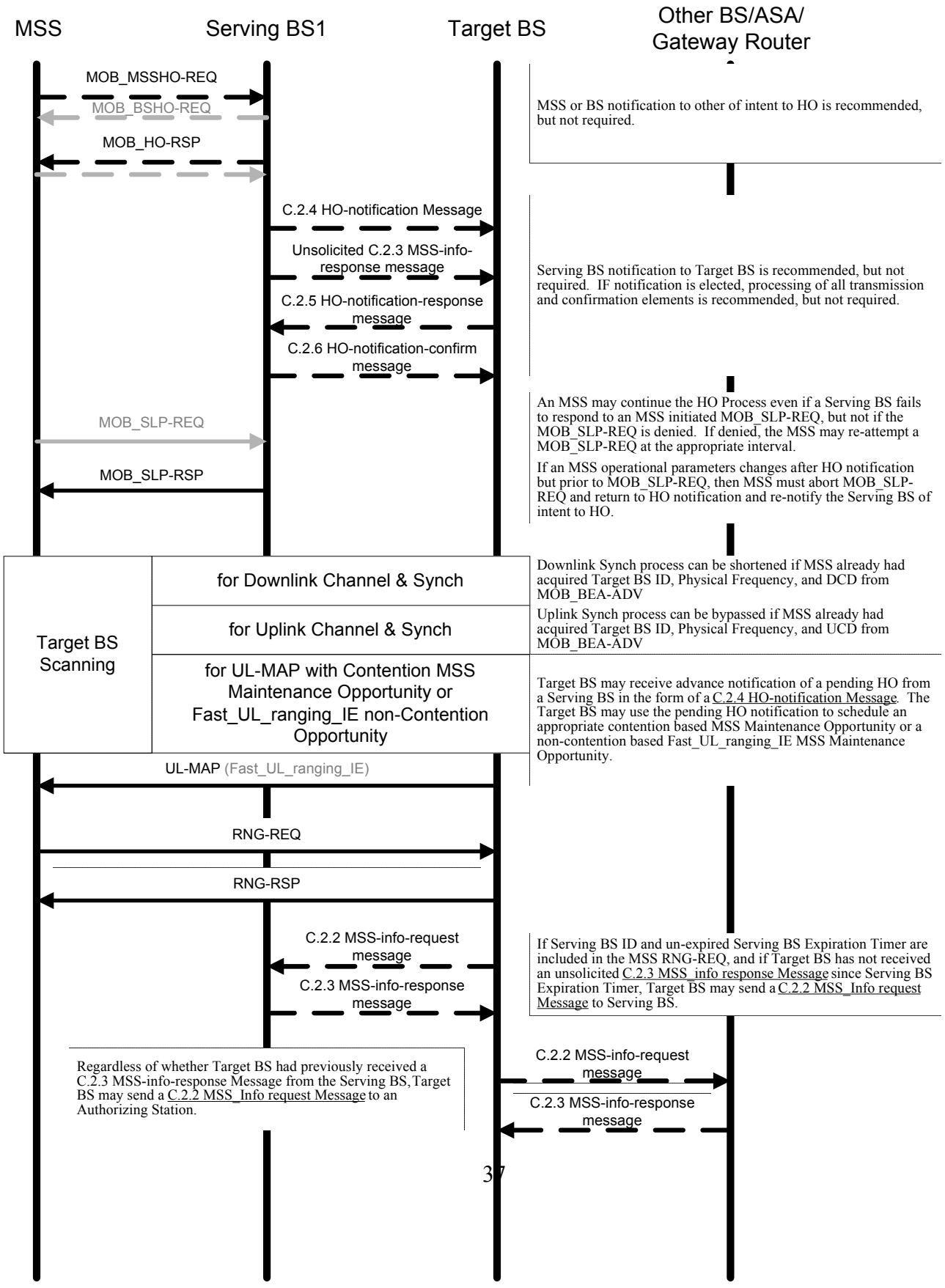
A BS may send a HO complete/Serving BS notification acknowledge message to acknowledge receipt of a HO complete/Serving BS notification message.

Table C8— HO complete/Serving BS notification acknowledge message

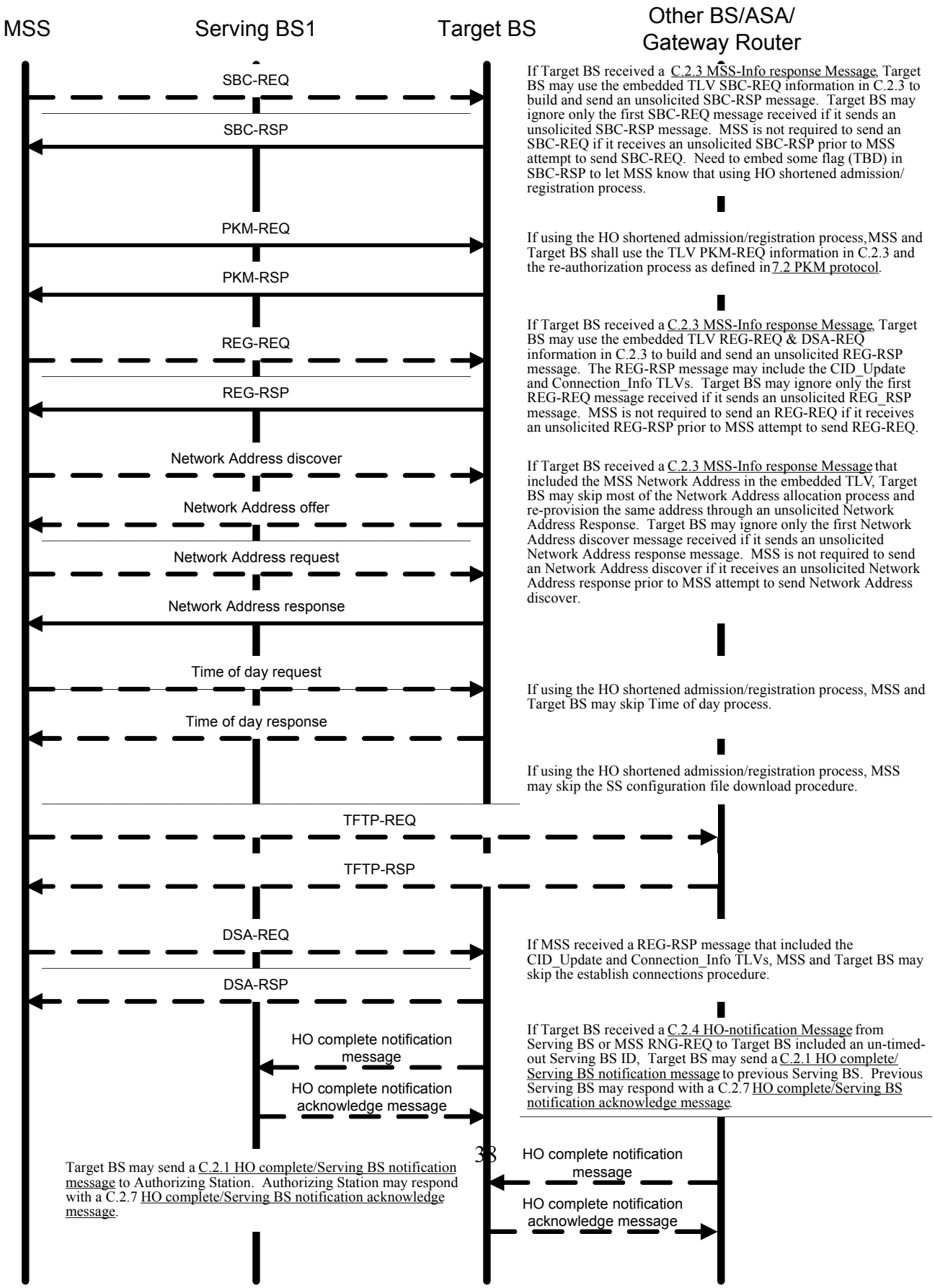
Field	Size	Notes
Global Header	152-bits	
Security Field	TBD	A means to authenticate this message
CRC Field	32-bits	IEEE CRC-32

‘

In page 46, line 57, section C.2.8, delete Figures C.2 entirely and replace Figure C.1 with:



Continued on next page


MSS
Serving BS1
Target BS
Other BS/ASA/
Gateway Router
SBC-REQ
SBC-RSP
PKM-REQ
PKM-RSP
REG-REQ
REG-RSP
Network Address discover
Network Address offer
Network Address request
Network Address response
Time of day request
Time of day response
TFTP-REQ
TFTP-RSP
DSA-REQ
DSA-RSP
HO complete notification message
HO complete notification acknowledge message
HO complete notification message
HO complete notification acknowledge message
If Target BS received a C.2.3 MSS-Info response Message, Target BS may use the embedded TLV SBC-REQ information in C.2.3 to build and send an unsolicited SBC-RSP message. Target BS may ignore only the first SBC-REQ message received if it sends an unsolicited SBC-RSP message. MSS is not required to send an SBC-REQ if it receives an unsolicited SBC-RSP prior to MSS attempt to send SBC-REQ. Need to embed some flag (TBD) in SBC-RSP to let MSS know that using HO shortened admission/ registration process.
If using the HO shortened admission/registration process,MSS and Target BS shall use the TLV PKM-REQ information in C.2.3 and the re-authorization process as defined in 7.2 PKM protocol.
If Target BS received a C.2.3 MSS-Info response Message, Target BS may use the embedded TLV REG-REQ & DSA-REQ information in C.2.3 to build and send an unsolicited REG-RSP message. The REG-RSP message may include the CID_Update and Connection_Info TLVs. Target BS may ignore only the first REG-REQ message received if it sends an unsolicited REG_RSP message. MSS is not required to send an REG-REQ if it receives an unsolicited REG-RSP prior to MSS attempt to send REG-REQ.
If Target BS received a C.2.3 MSS-Info response Message that included the MSS Network Address in the embedded TLV, Target BS may skip most of the Network Address allocation process and re-provision the same address through an unsolicited Network Address Response. Target BS may ignore only the first Network Address discover message received if it sends an unsolicited Network Address response message. MSS is not required to send an Network Address discover if it receives an unsolicited Network Address response prior to MSS attempt to send Network Address discover.
If using the HO shortened admission/registration process, MSS and Target BS may skip Time of day process.
If using the HO shortened admission/registration process, MSS may skip the SS configuration file download procedure.
If MSS received a REG-RSP message that included the CID_Update and Connection_Info TLVs, MSS and Target BS may skip the establish connections procedure.
If Target BS received a C.2.4 HO-notification Message from Serving BS or MSS RNG-REQ to Target BS included an un-timed-out Serving BS ID, Target BS may send a C.2.1 HO complete/ Serving BS notification message to previous Serving BS. Previous Serving BS may respond with a C.2.7 HO complete/Serving BS notification acknowledge message.
Target BS may send a C.2.1 HO complete/Serving BS notification message to Authorizing Station. Authorizing Station may respond with a C.2.7 HO complete/Serving BS notification acknowledge message.

Note: still need to rework all of sections D.1 through D.5 Figures and Diagrams.