Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Inter-BS communication for IEEE 802.16e Handoff**
Date Submitted	**2003-05-13**
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Re:	Call for inputs for the Handoff Ad-hoc group
Abstract	This document is to propose the inter-BS communication for the Handoff ad-hoc group of the IEEE 802.16e group. The document describes a set of messages, parameters and procedures for supporting the HO.
Purpose	Inter-BS communication procedures for Handoff Ad Hoc draft proposal of the IEEE802.16e group.
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Inter-BS Handoff mechanism for IEEE 802.16e

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1   Introduction

The document is to describe the inter-BS communication as an input for call for contribution of the IEEE 802.16e Handoff Adhoc. In this document, we propose the message, a set of parameters and call flow diagram for inter-BS communication in order to provide the inter cell handoff. Actually, the proposal has been introduced at the last meeting held in Dallas and there were positive responses in the meeting. However, current draft does not specify and contain the procedures and a set of parameters previously proposed and introduced. Therefore, here we propose a set of parameters, required message, call flow diagram and some miscellaneous changes in order to make firm the IEEE802.16e specification supporting the mobility.

2   Proposed inter-BS communication

2.1 *Functionality*

2.1.1   Required BW

There have been proposed and introduced the required several preliminary parameters to transmit the packet data services in the generic packet data communication. One of them would be the bandwidth requirement. Particularly, if the target system does not have enough BW for the incoming call or packet transmission, any requests will be rejected and denied. Thus, before handoff the call to the neighbor cell, the serving BS shall double check whether or not the target BS have enough BW, even in the target BS has been ranked as higher power level SNR reported by the MSS. We propose the BW information field on the HO-notification message to be used for inter-BS communication in order to provide the inter cell HO.

- Propose the Required BW(8bit): Bandwidth which is required by MSS in order to guarantee the minimum packet data transmission
- Propose the BW estimated(8bits) :it would be the response to the Required BW from the serving BS (the same logic a s QoS estimated information field)

2.1.2   Required QoS

As described 2.1.1, another critical parameter for supporting packet data transmission, except required BW, would be the QoS control. This required QoS also should be indicated to the target BS before handoff the call. Because the serving BS shall double check whether or not the target BS provide enough QoS level, even in the target BS has been ranked as a higher power level SNR reported by the MSS. We propose the required QoS information field on the HO-notification message to be used for inter-BS communication in order to provide the inter cell HO. Since current specification is mentioning 4 traffic types, we propose the required QoS information field for presenting 4 kinds of QoS level.

- Propose the Required QoS(8bit): QoS level or attribute which is required by the MSS in order to guarantee the packet data transmission in desirable circumstance.
  - Unsolicited Grant Service(UGS)

- Real-time Polling Service(rtPS)
- Non-real time Polling Service(nrtPS)
- Best Effort Service(BE)

2.1.3 ACK/NACK

When the serving BS receives the report message, which includes neighbor BSs signal power, the serving BS may send the HO-notification message to the neighbor BS to be recognized as a target BS. However, the serving BS cannot know the status of the target BS such as supportable QoS and BW and it just can send request message (HO-notification message). Therefore, the neighbor BSs, which receives the HO-notification message from the serving BS, should respond to the serving BS to indicate whether the request from the serving BS can be acceptable or not. We propose the ACK/NACK information field indicating on the HO-notification-response message as followings

- ACK/NACK(1bit)
  - Positive Acknowledgement: the neighbor BS accept the HO-notification message from the serving BS
  - Negative Acknowledgement: the neighbor BS may not accept the HO-notification message from the serving BS

2.2 Primitives

2.2.1 I-am-host of message

No changed and modified

2.2.2 MSS-info-request message

No changed and modified

2.2.3 HO-notification message

The description of the message has been slightly changed. Main reason is that the serving BS does not need to advertise to all neighbor BSs and only target BSs reported from the MSS should be required for the HO. And also, following information fields have been added to this message.

- Required BW(8bit): refer to 2.1.1
- Required QoS(8bit): refer to 2.1.2

2.2.4 HO-notification-response message

Following information fields have been added to this message.

- BW estimated(8bit): refer to 2.1.1
- ACK/NACK(1bit): refer to 2.1.3

2.2.5 HO-notification-confirm message

We propose this message in order to provide the confirmation to the neighbor BS to be selected as the target BS. This message is sent from one serving BS to target BS, typically in response to a *HO-notification-response* message. The message serves to provide the BS that sent the *HO-notification-response* message with information about the level of service and capability.

2.2.6 Association-notification message

This message should be removed because the I-am-host-message can be used instead of this message. In addition to, I-am-host-message and Association-notification message have the same information element fields and meaning exactly. Therefore, this Association-notification message would be surplus and should be deleted from the current draft document..

2.3 Call Flows

To assist understanding HO operation and its related overall operation for supporting HO operation, including over-the-air interface and inter-BS communication, a kind of call flow diagram should be depicted and presented in the standard. We have added the examples of the HO call flow.

3   Text to be inserted into standard

6. 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
]

6.1 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 1Table 1Table 1 shows a list of services provided to the BS through backbone network. Some of these services may be provided by other means (highlighted).

Service	Possible methods for providing service	Comments
Backhaul for traffic	-	Transport protocol is not specified
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

Table 1: Backbone network services

As evident from Table 1Table 1Table 1, 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.

6.2 Backbone network communication primitives

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

6.2.1 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,

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
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

Table 232: I-am-host-of message

6.2.2 MSS-info-request message

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

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
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

Table 343: MSS-info-request message

6.2.3 MSS-info-response message

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

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
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
}		
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
}		
Security field	TBD	A means to authenticate this message
CRC field	32-bit	IEEE CRC-32

Table 454: MSS-info-response message

6.2.4 HO-notification message

This message is sent by a BS to advertise a MSS intention to perform HO. The message is typically sent to all neighbor BS to be referred in BSHO-REQ message or MSSHO-REQ message. The message serves to alert the neighbor BS that a HO event is going to happen. The message contains the following information.

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
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, value 0 of this parameter indicates that no actual HO is pending
Required BW	8-bit	Bandwidth which is required by MSS (to guarantee minimum packet data transmission)
Required QoS	8-bit	Quality of Service level - Unsolicited Grant Service (UGS) - Real-time Polling Service (rtPS)

		- Non-real time Polling Service (nrtPS) - Best Effort Service (BE)
}		
Security field	TBD	A means to authenticate this message
CRC field	32-bit	IEEE CRC-32

Table 565: HO-notification message

6.2.5 HO-notification-response message

This message is sent from one BS to another BS, typically in response to a *HO-notification* message. The message serves to provide the BS that sent the *HO-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,

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

Table 676: HO-notification-response message

6.2.6 HO-notification-confirm message

This message is sent from one BS to another BS, typically in response to a *HO-notification-response* message. The message serves to provide the BS that sent the *HO-notification-response* message with information about the level of service and capability. The message contains the following information

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
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)
QoS Estimated	8-bit	Bandwidth which is provided by BS (to guarantee minimum packet data transmission) TBD(how to set this field)
BW Estimated	8-bit	Quality of Service level - Unsolicited Grant Service (UGS) - Real-time Polling Service (rtPS) - Non-real time Polling Service (nrtPS) - Best Effort Service (BE)
}		
Security field	TBD	A means to authenticate this message
CRC field	32-bit	IEEE CRC-32

6.2.6 Association-notification message

This message is sent from one BS to another BS, to report an association of a MSS. The message contains the following information,

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
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)
}		
Security field	TBD	A means to authenticate this message
CRC field	32-bit	IEEE CRC-32

Table 7: Association-notification message

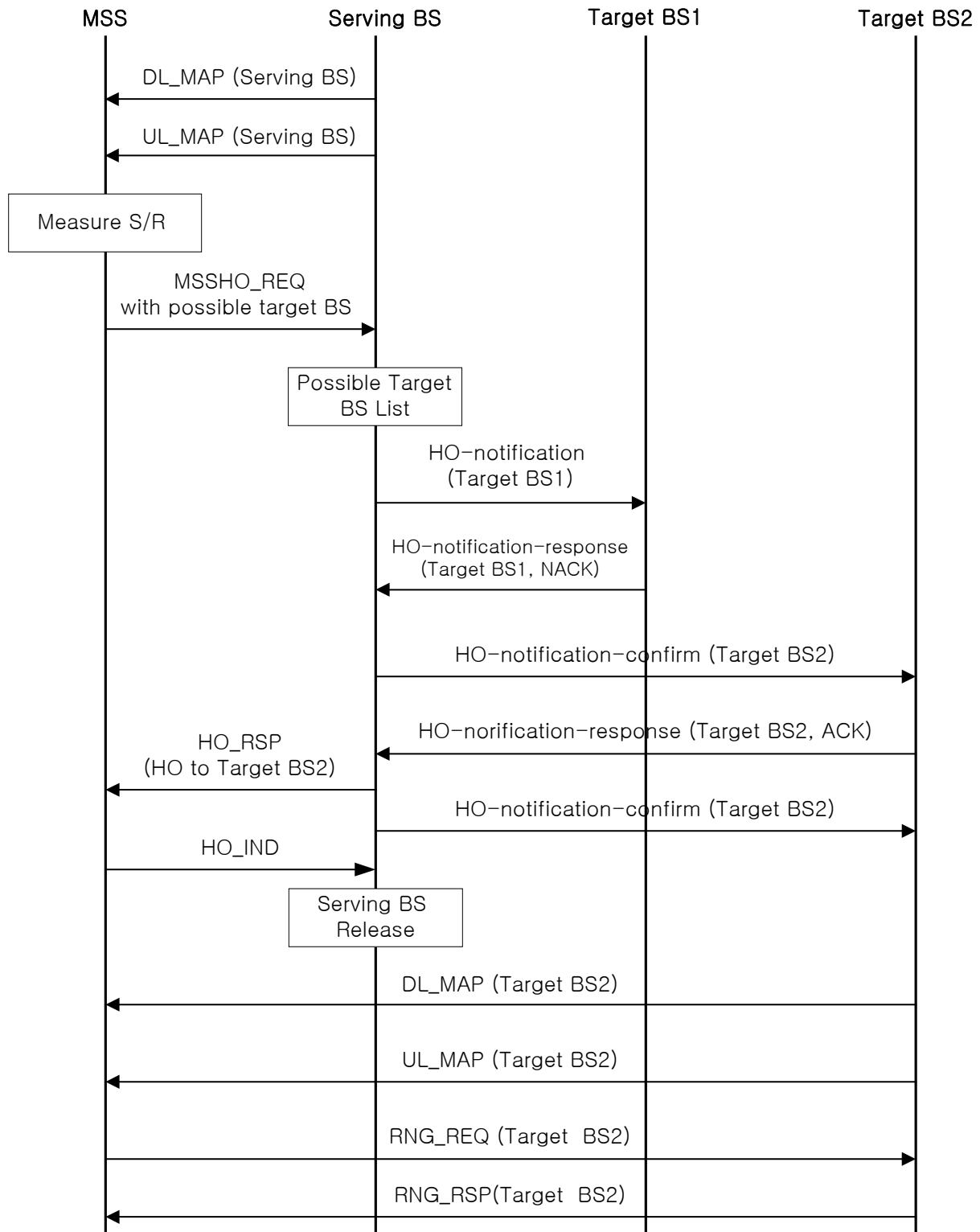## 6.2.6 Example of Backbone network HO procedure

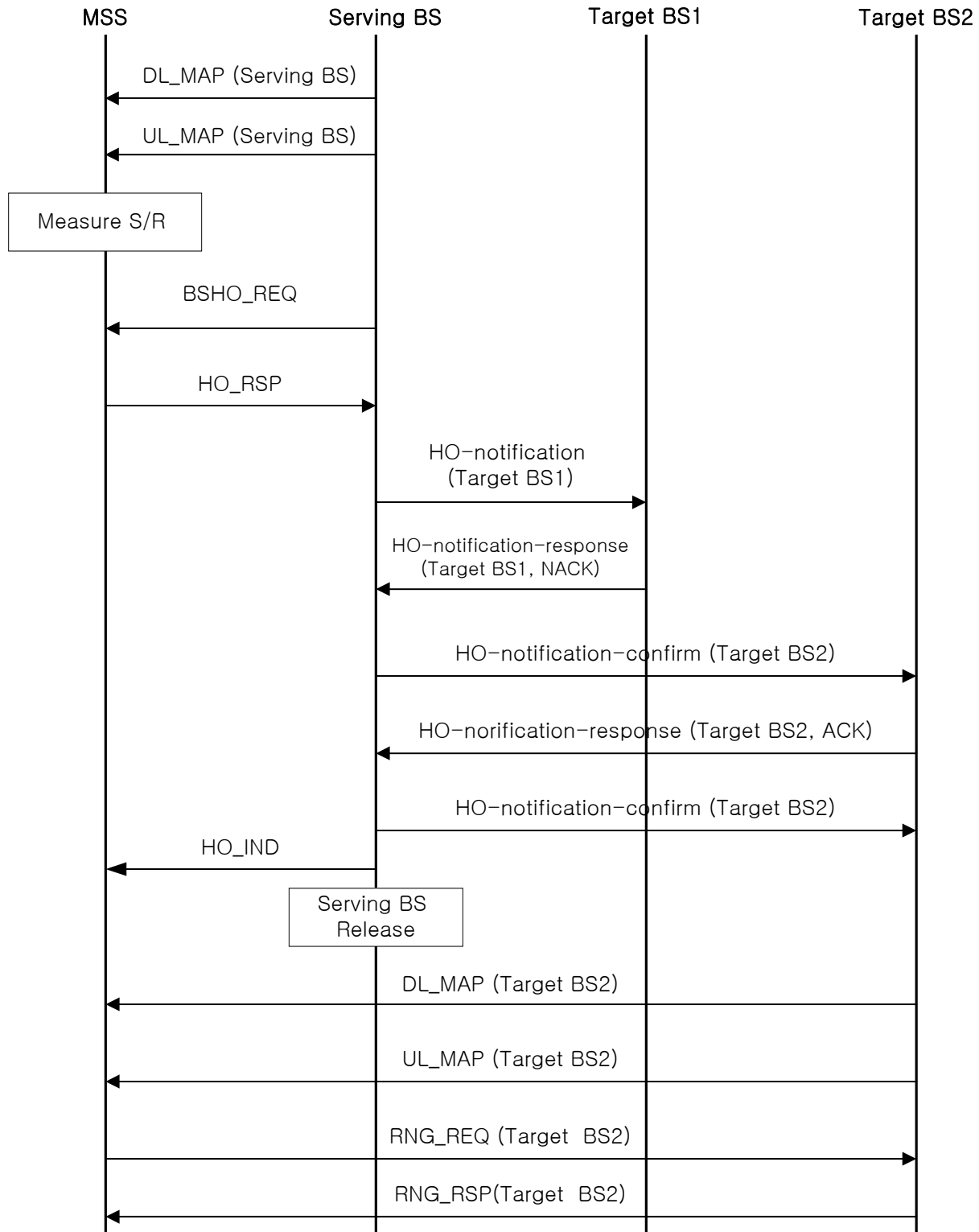

Figure XXX. Example of HO calls flow by MS

Figure XXX. Example of HO calls flow by BS

References

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

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

[3] K. Malki et al. "Low latency Handoffs in Mobile IPv4" Jul 2002