Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**	
Title	**Revision of Hand-over Mechanism for Mobility Enhancement**	
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Re:	Response to IEEE 802.16e-03/23 (Call for Contributions on IEEE 802.16e/07r4) Response to Session 27 Minutes remand C802.16e-03/54r0 to Ad Hoc Group for refinement and continued revision	
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	
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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-03/07r4 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—notification mechanisms for initiation of hand-over and recovery on failed or terminated hand-over attempts being the most noticeable and objectionable. 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

1. **Change Document in Revision Outline Format**.

*[In **1.4.1.1 Network reference model**, **1.4.1.1.1 Entities**, page 3, paragraph 1, modify paragraph with:]*

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.

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.

*[In **1.4.1.1.4 MSS Service Context**, page 6, modify with:]*

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

*[In IEEE P802.16-REVd/D1-2003 "Part 16: Air Interface for Fixed Broadband Wireless Access Systems", **6.4.2.3.2 Downlink Map (DL-MAP) message**, page 63, 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.

*[In **6.4.2.3.5 Ranging Request (RNG-REQ) message**, page 17, lines 9-12, delete from this location and modify and append to end of IEEE P802.16-REVd/D1-2003 "Part 16: Air Interface for Fixed Broadband Wireless Access Systems" section **6.4.2.3.5 Initial ranging and automatic adjustments**, page 173, as:]*

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.

*[In **6.4.2.3.6 Ranging Response (RNG-RSP) message**, page 17, lines 19&20, change:]*

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,

*[In **6.4.2.3.6 Ranging Response (RNG-RSP) message**, page 17, lines 43-58, modify, relocate and insert as new paragraph after line 21, IEEE P802.16-REVd/D1-2003 "Part 16: Air Interface for Fixed Broadband Wireless Access Systems", **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.

[In 6.4.2.3.44 Neighbor Advertisement (MOB_NBR-ADV), page 20&21, modify as:]

6.4.2.3.44 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 84d—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	
Encoded Neighbor information TLV	Variable	TLV specific, See Table 292a
}		
}		

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.

[In 11.1.8 insert before table 292a]

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

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

Name	Type (1 byte)	Length (1 byte)	Value (Variable-length)
CID_update	2	Compound	TLVs from Table xxx ***[table below]***

Name	Type (1 byte)	Length (1 byte)	Value (Variable-length)
New_CID	2.1	2	New CID after handover to new BS.
Old_CID	2.2	2	Old CID before handover from old BS.

Connection_Info	2.3	Variable	If any of the service flow parameters change, then those service flow parameters 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.