Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Low Latency Handover**
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Re:	This contribution is in response to the call for comments on Project 802.16g Baseline Task Group Document IEEE 802.16g-04/03r3
Abstract	The document proposes a reduced latency handover procedure with the help of primitives exchanged by the BSs through NCMS. It suggests text for section 14.5.9.7.
Purpose	The document should be considered during the resolution of comments on the baseline document.
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Low Latency Handover

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Problem Description

During handover procedure the MSS breaks the link with the serving BS, when it starts network re-entry procedure. The data traffic is not resumed with the MSS until after the completion of the network re-entry procedure and the data path switchover in the network. This causes latency or break in the data traffic exchange, which is not acceptable for certain real time services, e.g. VoIP. The problem is more aggravated in terms of latency, if a full authentication procedure is performed during network re-entry. Handover latency requirement for MAC layer is 50 msecs in other wireless technology, e.g. IEEE 802.11r.

Table-1 provides an analysis on the handover latency during the network re-entry procedure with all of its optimizations. The following are the assumptions in the above analysis:

- TDD is assumed with 5 msec frame size
- HARQ is assumed with average 3 retransmission per frame

Table-1: Handover Latency Analysis

Network Re-entry Steps	Num of frames	Cumulative Time (msecs)	Notes
Delay in the first UL MAP for the MS		10	UL MAP may not be available right away as soon as the MS switches to the target BS

UL MAP+RNG-REQ	3	25	_
RNG-RSP	3	40	
RNG-RSP Delay		45	Assume 5 msec. Max is 10 msecs for processing this info
2nd instance of Ranging		80	2 msgs (2*3 frames) RNG-RSP Delay
3-way handshake (2 frames)	2*3	110	SA Challenge in RNG-RSP
REG-RSP	3	125	

The handover latency will go much beyond 125 msecs, if we consider the following realistic factors:

- MAC layer timer expiry, in case of a network re-entry message loss. For example, T3 timer waiting on RNG-RSP has a default of 50 msecs. A loss of RNG_RSP will easily add 50 msec in the overall procedure.
- Latency in network path switching from the serving to the target BS
- Delay in scheduling of the messages.
- Full authentication. Simple authentication case is assumed, where only 3 way handshake is performed instead of full authentication

Solution Summary

This contribution proposes a low latency HO procedure that virtually removes the data traffic break duration during network re-entry procedure.

Using the sleep mode feature of 802.16e, an MSS negotiates active/idle period from the BS. During the idle period the MSS can communicate with the other BSs. In the low latency handover procedure, the serving BS transfers the idle period to the target BS, as the available schedule for the target BS with the

MSS. The MSS and the target BS performs network re-entry signaling during the available schedule. In this way it completes the network re-entry signaling with the target-BS, while exchanging data frames with the serving BS. Thus, achieves almost no latency during handover.

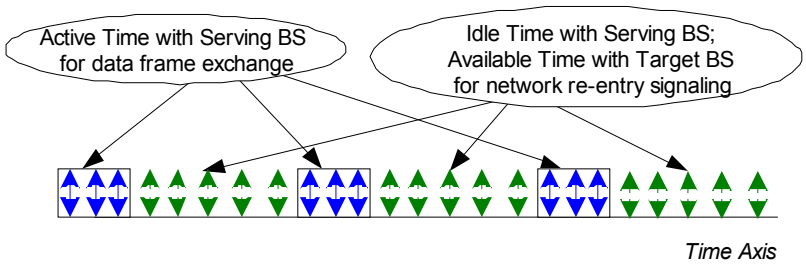


Figure-1: Low Latency Handover Principle

The low latency handover procedure exactly follows the regular handover procedure signaling steps over the air interface. This gives the advantage of selectively applying low latency handover only to certain real time Service Flows, e.g. UGS, ertPS, while the other Service Flows follow the regular handover procedure. This is achieved by applying the proposed solution only to Power Saving Class Type 2. In this way, if an MSS doesn't have a Power Saving Class Type 2~~real time service flow,~~ it will follow the existing Figures 6 and 7 of 802.16g-04/03r3, without any changes. The procedure assumes that the BSs are synchronized with a common time source, so they can interpret the time schedule from each other.

Contribution Overview

This contribution proposes text for section 14.5.9.7. It only adds a parameter in the existing HO request and HO indication primitives for low latency handover.

<Add the following in section 14.5.9.7.1>

14.5.9.7.1 HO Control Primitives

14.5.9.7.1.1 HO request

<Add the following parameter at the end>

Available Schedule t-BS

Start Timestamp (4 bytes) – The absolute time from which the Source BS Active Interval is counted.

Serving BS Active Interval (1 byte) – The number of msecs after the start timestamp in a time period, when MSS is linked to the serving BS.

Target BS Available Interval (1 byte) – The number of msecs after the Serving BS Active Interval in a time period, when MSS is linked to the target BS.

14.5.9.7.1.2 HO indication

<Add the following parameter at the end>

Available Schedule t-BS

Start Timestamp (4 bytes) – The absolute time from which the Source BS Active Interval is counted.

Serving BS Active Interval (1 byte) – The number of msecs after the start timestamp in a time period, when MSS is linked to the serving BS.
Target BS Available Interval (1 byte) – The number of msecs after the Serving BS Active Interval in a time period, when MSS is linked to the target BS.

14.5.9.7.2 Hard Handoff Procedures

<Add the following figures before Figure 8 >

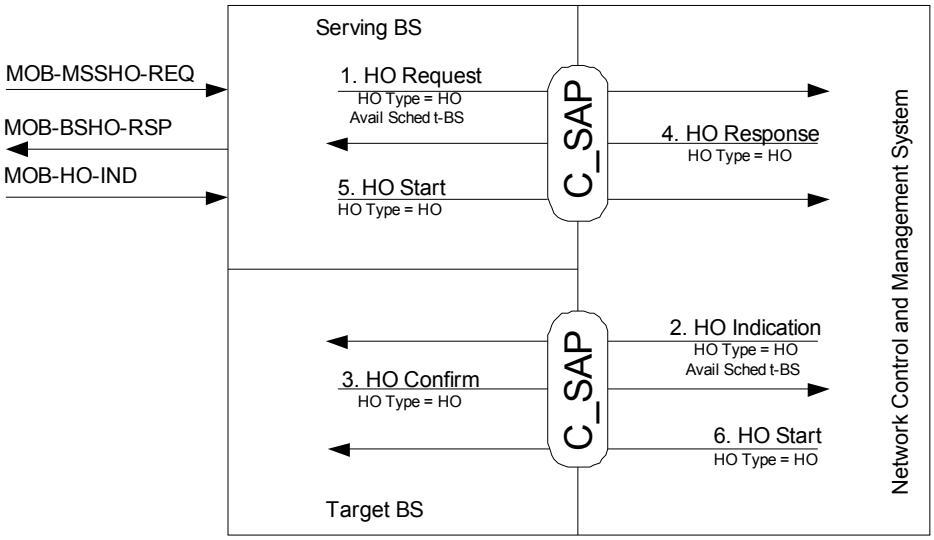


Figure xy.1 – Example Primitive Flow of Low Latency HO Initiated by MSS

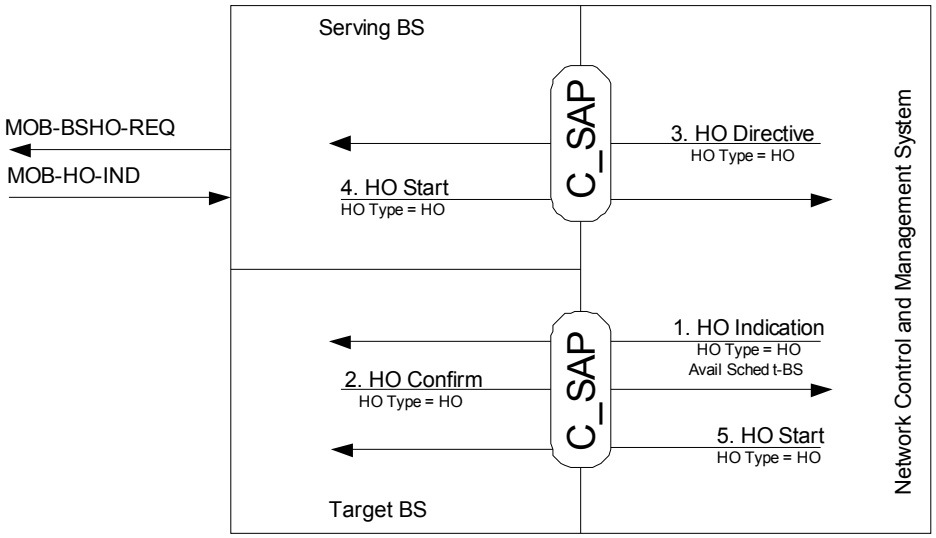


Figure xy.2 – Example Primitive Flow of Low Latency HO Initiated by BS

<The following description of low latency handover can be added in an annex as an informative text to describe the overall procedure>

Annex H: Overall Procedure for Low Latency Handover

H.1 MSS Initiated Handover

Figure h.1 shows the handover procedure initiated by MSS. The specifics for the low latency handover are identified in the steps.

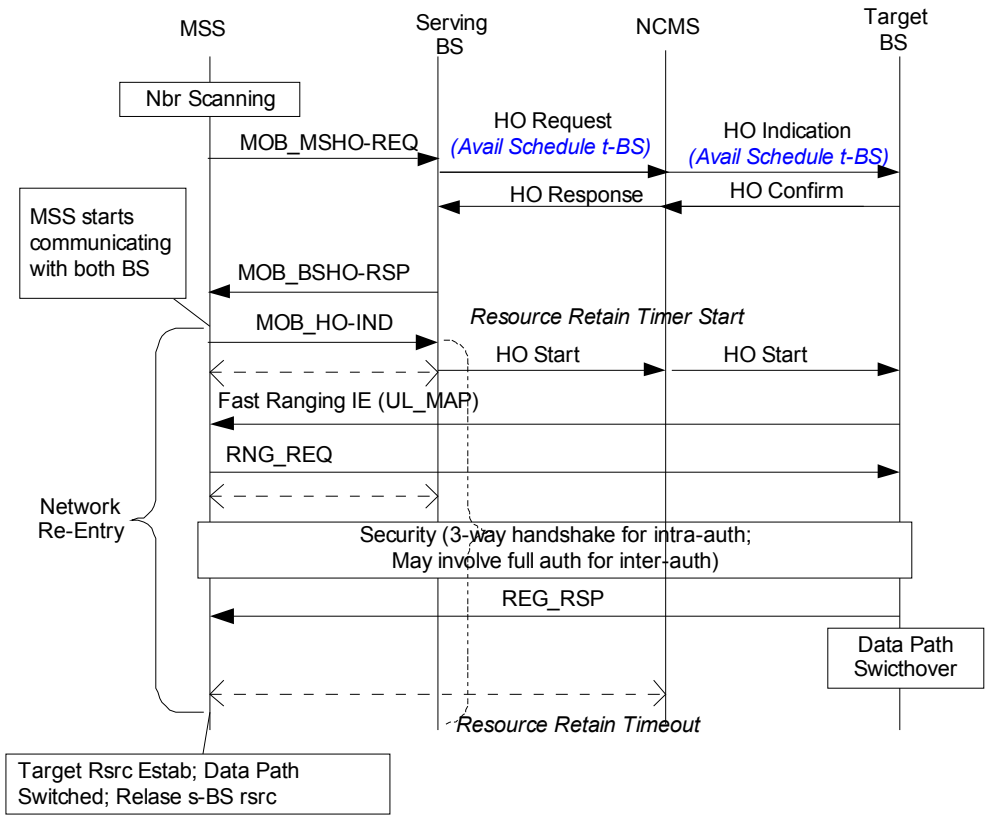


Figure h.1 MSS Initiated Low Latency Handover

1. An MSS performs scanning/association with the neighbor BSs, and sends radio measurement

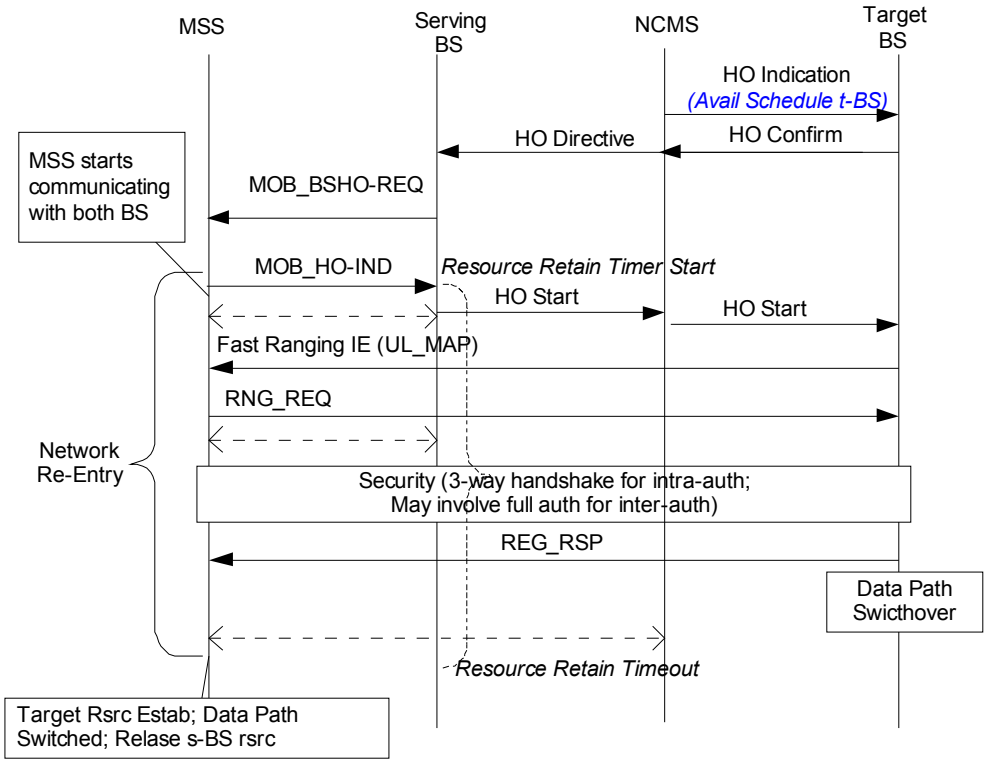
reports to the serving BS.

2. The MSS initiates handoff preparation by sending MOB_MSHO_REQ message to the serving BS, with a list of recommended target BSs.
3. The serving BS sends *HO Request* primitive to NCMS through C_SAP. The serving BS includes *Available Schedule t-BS* parameter by considering the active schedule with the MSS. This can be sent for a certain set of Service Flow Scheduling Type, e.g. UGS, and ertPS.
4. The NCMS sends *HO Indication* primitive to the candidate BSs for permission to handover a MSS. The primitive carries the *Available Schedule t-BS* parameter for the MSS with the target BS.
5. The candidate BSs respond back with the *HO Confirm* primitive.
6. The NCMS informs the serving BS with *HO Response*, indicating the candidate target BS list.
7. The MSS receives MOB_BSHO-RSP with the list of recommended target BSs.
8. The MSS selects a target BS and sends MOB_HO_IND to the serving BS. For low latency handover, it uses HO_IND_Type=0b00 and Resource Retain Type= 1 for indicating that the serving BS resources should not be released and continue to be used for the Resource Retain Timer value.
9. The MSS starts the network re-entry procedure. It performs signaling with the target BS according to its available schedule with the target BS. It continues exchanging data frames with the serving BS using its active schedule with the serving BS. Network re-entry also involves security procedure. If the handover is intra-authenticator, the security procedure involves 3-way handshake for re-keying. If the handover is inter-authenticator, the security procedure may involve full authentication with AAA server.
10. After the network re-entry procedure, the data paths are switched in the network and exchanged through the target BS. When the Resource Retain Timer expires, the serving BS resources are released.

H.2 Network Initiated Handover

Figure h.2 shows the handover procedure initiated by BS. The specifics for the low latency handover are identified in the steps.

Figure h.2 Network Initiated Low Latency Handover



1. The mobile control entity in the NCMS initiates handover. It sends *HO Indication* primitive to a list of candidate BSs for permission to handover a MSS. The primitive carries the *Available*

Schedule t-BS parameter for the MSS with the target BS.

2. The candidate BSs respond back with the *HO Confirm* primitive.
3. NCMS informs the serving BS with *HO Directive*, indicating the candidate target BS list.
4. The MSS receives MOB_BSHO-REQ with the list of recommended target BSs.
5. The MSS selects a target BS and sends MOB_HO_IND to the serving BS. For low latency handover, it uses HO_IND_Type=0b00 and Resource Retain Type= 1 for indicating that the serving BS resources should not be released and continue to be used for the Resource Retain Timer value.
6. The MSS starts the network re-entry procedure. It performs signaling with the target BS according to the *Available Schedule t-BS*. It continues exchanging data frames with the serving BS using its active schedule with the serving BS. Network re-entry also involves security procedure. If the handover is intra-authenticator, the security procedure involves 3-way handshake for re-keying. If the handover is inter-authenticator, the security procedure may involve full authentication with AAA server.
7. After the network re-entry procedure, the data paths are switched in the network and exchanged through the target BS. When the Resource Retain Timer expires, the serving BS resources are released.