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<th><strong>Project</strong></th>
<th>IEEE 802.16 Broadband Wireless Access Working Group</th>
<th><a href="http://ieee802.org/16">http://ieee802.org/16</a></th>
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<tbody>
<tr>
<td><strong>Title</strong></td>
<td>Fixes for Loss of Handover Messages</td>
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<tr>
<td><strong>Date</strong></td>
<td><strong>Submitted</strong></td>
<td><strong>2008-01-16</strong></td>
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<td><strong>Source(s)</strong></td>
<td>Chi-Chen Lee, I-Kang Fu, Kelvin Chou, Paul Cheng</td>
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<td>MediaTek Inc.</td>
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<td>Hsinchu, Taiwan 300</td>
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<td><strong>Re:</strong></td>
<td>IEEE 802.16 Working Group Letter Ballot Recirc #26a</td>
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<tr>
<td><strong>Abstract</strong></td>
<td>The behavior of MS/BS in response to the loss of MOB_HO-IND messages during a HO has not been defined in P802.16Rev/D2, which leads to asynchronization between MS and its Serving BS and potential insecurity. A remedy is proposed to address this issue.</td>
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<tr>
<td><strong>Purpose</strong></td>
<td>Accept the proposed specification changes in IEEE P802.16Rev2/D2</td>
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<tr>
<td><strong>Notice</strong></td>
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Fixes for Loss of Handover Cancellation Messages  
*Chi-Chen Lee, I-Kang Fu, Kelvin Chou and Paul Cheng*  
*MediaTek Inc.*

**Problem Statement**

According to IEEE Std 802.16Rev2/D2, an MS shall transmit a MOB_HO-IND message for final indication that it is about to perform a HO. When the MS cancels or rejects the HO, the MS shall transmit a MOB_HO-IND message with appropriate HO_IND_type field. However, the HO cancellation described in Section 6.3.22.2.3 or HO reject does not define the behavior of MS/BS in response to the loss of MOB_HO-IND messages during a HO, which leads to asynchronization between MS and its Serving BS and potential insecurity. The loss of MOB_BSHO-REQ message also leads to asynchronization between MS and BS.

As shown in Figure 1, during the HO handshake, both MS and its SBS will not be notified the loss of MOB_HO-IND message since there is no Ack for the MOB_HO-IND message. If the MOB_HO-IND message with HO_IND_type being 0b00 (SBS release) is lost, SBS may still learn the HO of MS through the notification from target BSs. However, the loss of MOB_HO-IND message with HO cancel, which contains the HMAC/CMAC Tuple, makes MS and SBS have different perception of the MS status, i.e. MS considers the HO has been canceled while SBS considers the HO has been performed. Furthermore, if the MOB_HO-IND with HO cancel, which contains the HMAC/CMAC Tuple, is lost and SBS still accepts subsequent BW requests, a malicious MS may attack or steal the BW from the SBS by sending BW requests to it.

Possible problematic scenarios are enumerated below:

**Scenario 1 (MS initiated HO):** MS decides to cancel HO right after it sent the MOB_MSHO-REQ message, and the following MOB_HO-IND with HO cancel is lost. MS will consider that the HO is canceled, while SBS will consider that MS continues HO and may stop DL&UL scheduling for the MS, as illustrated in Figure 2.
Scenario 2 (MS initiated HO): MS decides to cancel or reject HO right after it received the MOB_BSHO-RSP message, and the following MOB_HO-IND with HO cancel or HO reject is lost. MS will consider that the HO is canceled or rejected, while SBS will consider that MS continues HO and may stop DL&UL scheduling for the MS, as illustrated in Figure 3.

Scenario 3 (MS initiated HO): MS decides to cancel HO right after it sent the MOB_HO-IND message with SBS release, and the following MOB_HO-IND with HO cancel is lost. MS will consider that the HO is canceled, while SBS will consider that MS continues HO and will stop DL&UL scheduling for the MS, as illustrated in Figure 4.
Scenario 4 (BS initiated HO): MS decides to cancel or reject HO right after it received the MOB_BSHO-REQ message from SBS, and the following MOB_HO-IND with HO cancel or HO reject is lost. MS will consider that the HO is canceled or rejected, while SBS will consider that MS continues HO and may stop DL&UL scheduling for the MS, as illustrated in Figure 5.

Scenario 5 (BS initiated HO): MS decides to cancel HO right after it sent the MOB_HO-IND message with SBS release, and the following MOB_HO-IND with HO cancel is lost. MS will consider that the HO is canceled, while SBS will consider that MS continues HO and will stop DL&UL scheduling for the MS, as illustrated in Figure 6.
**Scenario 6 (BS initiated HO):** MOB_BSHO-REQ message is lost. In this case, MS will remain at normal operation, while SBS will consider that MS continues HO and may allocate unsolicited UL grant for MOB_HO-IND message or may stop DL&UL scheduling for the MS, as illustrated in Figure 7.

![Diagram](image)

**Figure 6 – Loss of HO cancel after MOB_HO-IND with SBS release is sent by MS**

**Figure 7 - Loss of MOB_BSHO-REQ**

**Suggested Remedy**

The suggested remedies are illustrated in Figure 9 to Figure 13. First of all, after SBS sent MOB_BSHO-REQ
or MOB_BSHO-RSP message, it shall stop allocating UL allocations to the MS except the unsolicited grant or contention bandwidth request for the transmission of MOB_HO-IND message. The allocation of unsolicited grant for ertPS and UGS services before the expiration of the HO indication readiness timer should be omitted since the duration between MOB_BSHO-REQ/RSP message and MOB_HO-IND message (2 by default) is very short. If the Serving BS receives MOB_HO-IND message with HO_IND_type being HO cancel or HO reject from the MS, it shall allocate unicast grant to the MS as an acknowledge to the MOB_HO-IND message. The BS shall resume UL scheduling for MS upon receiving one of the following messages: MOB_HO-IND message with HO cancel/reject or MOB_MSHO-REQ message.

Once MS decides to cancel or to reject HO after receiving the BSHO-REQ message or BSHO-RSP message, it shall start a HO-IND retry timer immediately after sending the MOB_HO-IND message with HO cancel or HO reject, and then waits for the unicast grant from Serving BS. If MS does not receive any unicast grant before the expiration of the HO cancel retry timer, it shall retransmit the MOB_HO-IND message to cancel or reject HO; otherwise MS considers that the HO cancellation is successful.

If the maximum retries exceeded on transmission of the HO cancel or HO reject message, the MS shall perform initial network entry or HO with other BS.

If MS sends MOB_HO-IND message with HO cancel or HO reject right after sending MOB_MSHO-REQ, but receives MOB_BSHO-RSP from SBS, it shall consider that its HO cancel or HO reject message has been lost. In this case, it shall retransmit another MOB_HO-IND message with HO cancel or HO reject and start HO-IND retry timer immediately.

![Diagram](image-url)

**Figure 8 - Suggested remedy for scenario 1**
MS decides to cancel HO or reject HO

Stop scheduling UL grant except the unsolicited grant for HO-IND msg

BS receives HO-IND msg and allocate unsolicited grant or resume UL scheduling

HO is canceled or rejected successfully

Figure 9 – Suggested remedy for scenario 2

MS decides to cancel HO

Stop scheduling UL grant except the unsolicited grant for HO-IND msg

BS stops DL&UL scheduling

BS receives HO-IND msg and allocate unsolicited grant or resume UL scheduling

HO is canceled successfully

Figure 10 – Suggested remedy for scenario 3
MS decides to cancel

Stop scheduling UL grant except the unsolicited grant for HO-IND msg

BS receives HO-IND msg and allocate unsolicited grant or resume UL scheduling

Figure 11 – Suggested remedy for scenario 4

MS decides to cancel or reject

Stop scheduling UL grant except the unsolicited grant for HO-IND msg

BS receives HO-IND msg and allocate unsolicited grant or resume UL scheduling

Figure 12 – Suggested remedy for scenario 5 and 6
Suggested Changes in Rev2/D2

Part 1

InRev2/D2, line 13 on page 437, section 6.3.22.2.2, insert the following text:

The serving BS shall stop issuing UL allocations to the MS expect the unsolicited grant for the transmission of MOB_HO-IND message or bandwidth request for Basic CID after sending MOB_BSHO-REQ/RSP message to the MS or after expiration of Handover Indication Readiness Timer if Unsolicited UL Grant for HO-IND flag is set to 1. If the Serving BS receives MOB_HO-IND message from the MS and HO_IND_type field indicates the HO cancel or HO reject, it shall allocate UL allocation to the MS as an acknowledge of reception of MOB_HO-IND message. The BS shall resume issuing DL and UL allocations for MS upon receiving one of the following messages: MOB_HO-IND message that HO_IND_type field indicates HO cancel or HO reject or MOB_MSHO-REQ message. The serving shall start BS HO request retransmission timer after sending MOB_BSHO-REQ message and it shall retransmit the MOB_BSHO-REQ message if it does not receive the MOB_HO-IND message from the MS before the expiration of BS HO request retransmission timer. If the maximum retries exceeded on transmission of the MOB_BSHO-REQ message, the serving BS shall start Resource Retain timer.

Part 2

InRev2/D2, line 27 on page 437, section 6.3.22.2.3, insert the following text:

Once MS decides to cancel HO or reject HO after receiving the MOB_BSHO-REQ/RSP message, it shall start a
HO-IND retry timer immediately after sending the MOB_HO-IND message or after Handover Indication Readiness Timer if Unsolicited UL Grant for HO-IND flag is set to 1 in MOB_BSHO-REQ/RSP message, then waits for the UL allocation as an acknowledge of reception of MOB_HO-IND message. If MS does not receive the UL allocation before the expiration of the HO-IND retry timer, it shall retransmit the MOB_HO-IND message to cancel HO or to reject HO, otherwise MS considers that the HO cancellation or rejection is successful. If the maximum retries exceeded on transmission of the MOB_HO-IND message, the MS shall perform initial network entry or HO with other BS.

If MS sends MOB_HO-IND message with HO cancel right after sending MOB_MSHO-REQ message or MS sends MOB_HO-IND message with HO cancel or HO reject after receiving MOB_BSHO-REQ message, but receives MOB_BSHO-REQ/RSP message from serving BS, it shall consider that the MOB_HO-IND message has been lost. In this case, it shall retransmit the MOB_HO-IND message to cancel HO and start HO-IND retry timer immediately or after Handover Indication Readiness Timer if Unsolicited UL Grant for HO-IND flag is set to 1 in MOB_BSHO-REQ/RSP message.

---End of the Text---

Part 3

---Start of the Text---

[InRev2/D2, line 38 on page 438, section 6.3.22.2.6, change the third paragraph as]

When the MS has detected a drop during network reentry with a target BS, it may attempt network reentry with its preferred target BS as through Cell Reselection (see 6.3.22.2.1), and may include resuming communication with the serving BS by sending MOB_HO-IND message with HO_IND type = 0b01 (HO cancel) and start HO-IND retry timer immediately. If the maximum retries exceeded on contention-based bandwidth request or transmission of the MOB_HO-IND message, the MS shall perform initial network entry or HO with other BS. If the MS fails network reentry with its preferred target BS, the MS shall perform initial entry procedure.

---End of the Text---

Part 4

---Start of the Text---

[InRev2/D2, line 56 on page 438, section 6.3.22.2.6, add the sentence at the end of fourth paragraph]

The serving BS shall ignore the bandwidth request from the MS that resources are not retained by serving BS any more.

---End of the Text---

Part 5

---Start of the Text---

[InRev2/D2, table 525, insert the following text]

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<tr>
<th>System</th>
<th>Name</th>
<th>Time reference</th>
<th>Minimum value</th>
<th>Default value</th>
<th>Maximum value</th>
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<td>MS</td>
<td>HO-IND retry timer</td>
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<td>Same as contention-based reservation timeout value specified in</td>
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<tr>
<td>MS</td>
<td>Maximum MOB_HO-IND message retries</td>
<td>Wait for MOB_HO-IND message from MS after sending MOB_BSHO-REQ message</td>
<td>70 ms or Handover Indication Readiness Timer if Unsolicited UL Grant for HO-IND flag is set to 1 in MOB_BSHO-REQ message</td>
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<td>BS</td>
<td>BS HO retransmission timer</td>
<td>Number of timeout retries on MOB_BSHO-REQ message</td>
<td>5</td>
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---End of the Text---