Proposal for IEEE 802.16m Handover Schemes

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Re: IEEE 802.16m-08/024 – Call for Contributions on Project 802.16m System Description Document (SDD), on the topic of "Upper MAC – Mobility"

Purpose: Adopt the proposal into the IEEE 802.16m System Description Document

Introduction

- This contribution proposes the handover schemes that address the following TGm SRD (IEEE 802.16m-07/002r4) requirements:
  - Section 6.2.1 Data latency:
    - As shown in Table 2, the maximum allowable data latency is 10ms
  - Section 6.2.3 Handover interruption time:
    - As shown in Table 4, the maximum interruption time is 30ms and 100ms for intra-frequency and inter-frequency handover respectively
  - Section 6.10 System overhead:
    - “Overhead, including overhead for control signalling as well as overhead related to bearer data transfer for all applications shall be reduced as far as feasible without compromising overall performance and ensuring proper support of system features”
  - Section 7.3 Mobility:
    - As shown in Table 12, mobility of up to 350km/h shall be supported with the different performance level given in the table.

Issues with Handover in the 802.16e (1/2)

- There are several issues with optimized handover mechanism in 802.16e:
  - There is no notion of active set. BS cannot pre-populate data to neighbor BSs to expedite the data delivery after the MS handover to the target BS. In addition, the system configuration information of neighbor BS cannot be selectively unicast to the MS based on the active set membership.
  - Even in full optimized handover, MS still has to perform handover ranging with the target BS if association level 1 or 2 is not performed prior to handover. Although association level 1 or 2 can be performed prior to handover, it causes unavailable time of the MS at the serving BS
  - Large MAC management messages are used to perform the signaling handshake between MS and BS for handover. There are two issues: 1) the heavy weight MAC management messages reduce the agility of handover between different BSs for MS at cell edge; 2) MS at the cell edge that needs to perform handover usually has poor SNR. The large MAC management messages further burden the reception reliability of these messages.

Issues with Handover in 802.16e (2/2)

- There are several issues with fast BS switching (FBSS) mechanism in 802.16e:
  - There is no mechanism to allow expedited ranging in FBSS. Although MS can optionally perform ranging after switching to the target anchor BS, this increases the HO interruption time.
  - BS does not explicitly acknowledge the MS' indication of anchor BS switching. If the UL SNR at the serving BS is very low, the serving BS may not receive the switch indication and the MS will proceed to switch to the target anchor BS. This causes unnecessary latency as the target anchor BS is not aware of the MS presence and will not proactively assign UL fast feedback control resource.
- Overall, full optimized handover and FBSS are very similar in terms of the required layer 2 context information sharing/transfer between BSs. The main differences are how the handover signaling is performed, as well as whether handover ranging is performed at the target BS. These two schemes can be effectively combined for 802.16m as proposed in subsequent slides.

Overview of the Proposed Handover Schemes

- Two types of handover schemes are proposed:
  - Soft handover to support multi-BS SFN transmission and multi-BS MIMO
  - Enhanced fast BS switching
- From an MS perspective, it doesn’t need to be aware of whether there is one BS or multiple BSs transmit/receive traffic to/from it. The MS only needs to know the corresponding permutation zone that the BS uses to assign DL/UL resource to it. The following operations are the same for both SHO and enhanced FBSS:
  - Active Set management
  - Anchor BS switching
  - Exchange DL/UL control information with the Anchor BS. An MS may be allocated additional UL control channels for transmission to other non-anchor BS in the active set for the purpose of interference mitigation.

Multi-BS Ranging

- Periodic ranging resource (ranging code and ranging region) is pre-allocated to the MS by the Anchor BS. The serving BS notifies the neighbor BSs in the active set of the assigned ranging resource to the MS.
- All BSs in the active set including the neighbor BSs detect the ranging code transmission from the MS.
- For the case of SHO, BSs within the active set may exchange the ranging detection performance and coordinate the joint ranging adjustment parameters. The Anchor BS transmits the ranging adjustment parameters to the MS through the MAC management message.
- For the case of enhanced FBSS, neighbor BSs send ranging adjustment parameters to the serving BSs through the backhaul. The Anchor BS transmits the ranging adjustment parameters of the neighbor BSs to the MS via MAC management message
  - As the MS keeps track of the updated ranging adjustment parameters from neighbor BSs, when it switches to a target anchor BS, handover ranging is not required.

Anchor BS Switching

- MS sends Anchor BS switching request to the current Anchor BS, using the UL fast feedback control channel or as piggy-back lower MAC signaling with data traffic. After sending the Anchor BS switching request, the MS waits for current Anchor BS' response. If no response is received after a configured timeout period, the MS retransmit the Anchor BS switching request.
- The current Anchor BS acknowledges the reception of the Anchor BS switching request from the MS by transmitting lower MAC signaling (e.g. MAC header) to the MS. The current Anchor BS can approve or reject MS' request. If approved, the following information are included in the lower MAC signaling:
  - Action time, i.e., when the MS shall switch to the target Anchor BS (this value is determined by the BS based on the required backbone latency to coordinate the context information exchange and data flow synchronization). The action time aligns with the superframe boundary.
  - Assignment of UL fast feedback control channel and other UL resource for bandwidth request, ARQ sequence number etc., at the target Anchor BS
- MS switches to the target Anchor BS at the specified action time. MS decodes the superframe header of the target Anchor BS. MS transmits UL fast feedback control information (e.g. CQI etc.) and additional lower MAC signaling (e.g. bandwidth request, ARQ sequence number etc.) on the pre-assigned UL resource on the sub-frame following the superframe header.

Neighbor BS System Configuration Information

- Neighbor BS system configuration information (SCI) has two purposes:
  - Helps an MS to decides whether to add a BS to the active set
  - Helps an MS to decide which neighbor BSs' preamble to scan to measure signal strength
  - Expedite the handover process since after switching to the target BS, the MS does not have to wait until it successfully decoded the target BS system configuration information
- Neighbor BS SCI does not have to be broadcast to all MSs in a cell since it is only relevant to MSs in cell edge.
- The serving BS unicast the preamble indices of its neighbor BSs to an MS during or after the MS performs network entry procedure. Since this information is static, it doesn't have to be sent to the MS again. When a MS handover to another BS, the target BS unicast the preamble indices of its neighbor BSs to the MS. The information on preamble indices facilitates the MS in performing scanning.
- The following steps are used to provide efficient neighbor BS SCI transmission and active set management:
  - MS measures the signal strength of neighbor BSs. The MS may use the preamble indices previously sent by the serving BS to expedite the preamble scanning and signal strength measurement procedure.
  - MS sends neighbor BS signal strength measurement report to the Anchor BS. The signal strength measurement report includes signal strength from neighbor BSs that are higher than a pre-defined threshold
  - The Anchor BS responds with the list of neighbor BSs recommended to be in the Active Set
  - The serving BS may choose to unicast the neighbor BS SCI to the MS for those neighbor BS within the MS' active set, or multicast the neighbor BS SCI to a group of MSs' whose active set contain the neighbor BS.

Proposed Text for SDD

- Section 10.x: Mobility Support and Handover
- Section 10.x.1: Handover
  - [*Copy the content in slides 5, 6, 7, 8 into this section*]
- Section 10.x.2: Neighbor BS System Configuration Information
  - [*Copy the content of slide 9 into this section*]