Clarification on MIMO Feedback Measurement and Report (P80216m/D3-16.3.6.5.2.4.5)

IEEE 802.16 Presentation Submission Template (Rev. 9)

Document Number: IEEE C802.16m-09_2822r1
Date Submitted: 2010-01-13

Source:
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Re : IEEE 802.16-09/0073, “IEEE 802.16 Working Group Letter Ballot#30b”
Target topic: “IEEE P802.16m/D3 section 16.3.6.5.2.4.5 ”.

Base Contribution:

Purpose: To be discussed and adopted by TGm.

MIMO Feedback Requirements

- **What will be the MIMO feedback delay for AMS ?**
  - AMS processing time to perform measurement of MIMO feedback information such as PMI, CQI, etc. and report them to the ABS should be considered.
  - Intuitively, applying the MIMO feedback as early as possible from the MIMO midamble transmission time, from which the AMS will carry out MIMO feedback measurements, will be optimum in performance.
  - However, AMS may suffer from short of processing time if too stringent timing requirement is imposed on.
- **What will be the timing delay at the ABS to reflect MIMO feedback to its scheduling ?**
  - Though up to ABS implementation, ABS applying the MIMO feedback at the proximity of the time to which the recommended MIMO feedback refers will show the optimum performance (maybe, as early as possible after receiving MIMO feedback from the AMS).
  - However, ABS may suffer from short of processing time to schedule MIMO allocation with reference to the MIMO feedback.

MIMO Feedback Considerations

- **What should be taken into account ?**
  - MIMO midamble location within a frame
  - Feasible AMS processing time to report MIMO feedback information
  - Nominal ABS scheduling delay to apply MIMO feedback (though might be further delayed as per the scheduling at the ABS's discretion)
  - Possible trade off between processing time vs. MIMO performance
  - Channel variation during the delay
- **How to enhance MIMO performance ?**
  - AMS performing MIMO measurements with predicting the channel variation will mitigate the impact of channel variation during the feedback/scheduling delay and give better performance.
  - Moreover, AMS and ABS can have relaxed processing time requirement while enjoying enhanced MIMO performance.
  - With the knowledge of prediction, the ABS can apply the MIMO feedback at the frame at the proximity of the time to which the prediction is made, hence resulting in enhanced performance.
  - Can have more freedom in determining MIMO midamble location within the frame.

Channel Variation Effect

- **Impact of time varying channels on MIMO Feedback Measurements**

❖ The channel correlation between frames may be deteriorated due to channel variation in association with the speed.
❖ The tolerable delay for acceptable channel prediction and MIMO feedback measurement performance is about 2 frames.

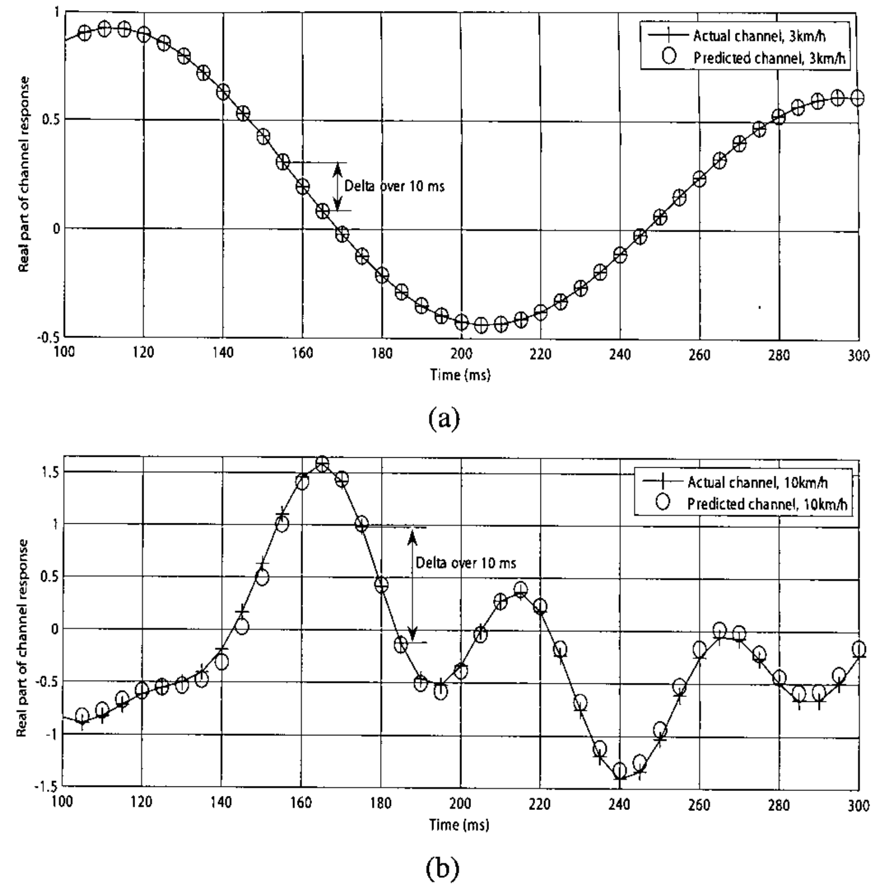


Fig. 2. Time varying fading channels and the predicted channel responses for mobile speeds: (a) 3 km/h, (b) 10 km/h.

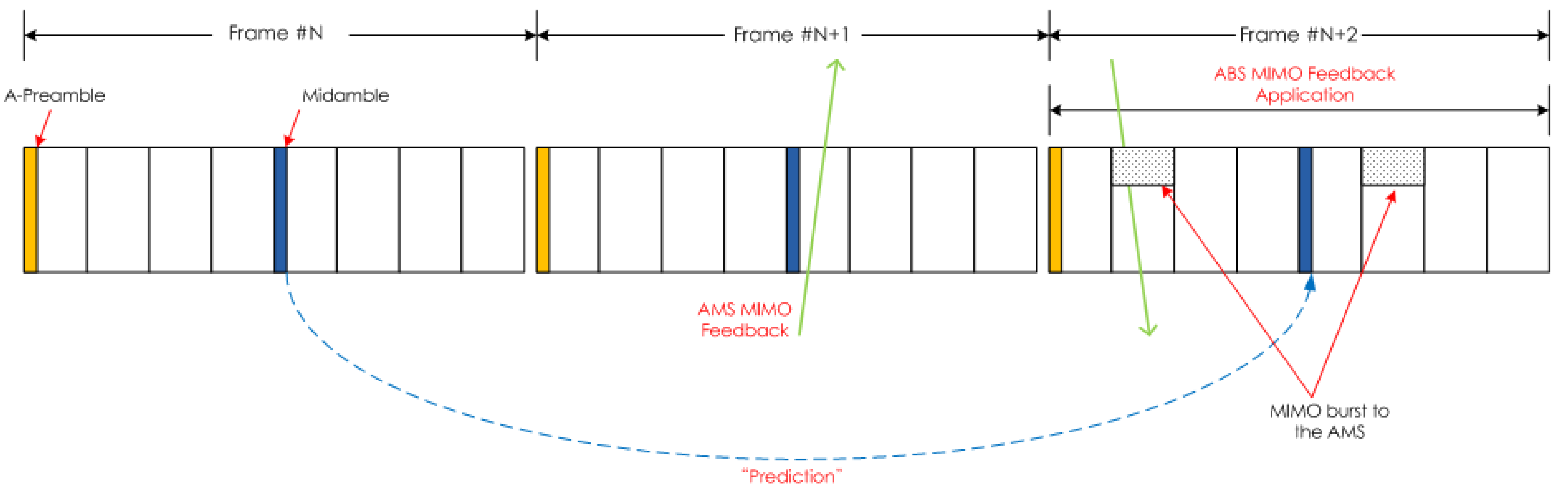
Reference: Q. Li, X. E. Lin, and J. Zhang, *"MIMO Precoding in 802.16e WiMAX"*, Journal of Communications and Networks, vol. 9, No. 2, June 2007

Conclusion (1/2)

- **Conclusion**
  - AMS predicting the channel variation and ABS applying the MIMO feedback at the predicted frame shows much better performance under time varying channel
  - Though the actual timing of reflecting the received MIMO feedback at the ABS may be further delayed as per ABS implementation/scheduling, ABS can still consider the reference point of time that the AMS made MIMO feedback measurement to and further modify/extrapolate the regular MIMO feedbacks from the AMS taking the actual time of allocation into account to enhance MIMO performance (ABS implementation specific)
  - In very slow varying channels the performance of prediction will be at least near the bounds of no prediction case, while showing better performance for most of the cases
  - Channel prediction within the tolerable delay shows similar performance (that is, 1 or 2 frame delay for prediction and MIMO feedback/scheduling doesn’t have large difference in performance)
  - In this context, it is suggested to apply channel prediction at the AMS, to let 1frame for AMS MIMO feedback delay, and to have 1 frame delay for ABS applying the MIMO feedback

Conclusion (2/2)

- **Conceptual Illustration**
  - Note the midamble location is still under discussion
  - Midamble location may change depending on Duplex mode, BW, Mixed mode, etc.
  - → Nevertheless, with the knowledge of the number of frames considered for prediction and the location of midamble, ABS can apply the MIMO feedback at the proper time to have optimal performance (or, in the vicinity of the predicted MIMO midamble location)



Proposed Text (1/2)

Blue/Underline: Text Added

~~Red/Strikeout~~: Text Deleted

[Change 1: Modify the text in the Notes column for the field “Frame offset” in Table 821 Feedback Allocation A-MAP IE, line 48~54, page 424 as follows]

The AMS starts reporting at the frame of which the number has the same 3 LSB as the specified frame offset. If the current frame is specified, the AMS starts reporting in eight frames.

MIMO feedback reported by an AMS in frame ‘N’ pertains to measurements performed up to frame ‘N–1’. The first MIMO feedback report following the Feedback Allocation IE as per the “Frame Offset” may contain invalid MIMO feedback information if the MIMO feedback is sent in the frame immediately following the frame in which the Feedback Allocation IE was received.

[Change 2: Add the following paragraph after the last paragraph in page 437 (section 16.3.6.5.2.4.11)]

MIMO feedback reported by an AMS in frame ‘N’ pertains to measurements performed up to frame ‘N-1’. The first MIMO feedback report following the Feedback Polling A-MAP IE may contain invalid MIMO feedback information if the MIMO feedback is sent in the frame immediately following the frame in which the Feedback Polling A-MAP IE was received.

Proposed Text (2/2)

Blue/Underline: Text Added

~~Red/Strikeout~~: Text Deleted

[Change 3: Modify the text in section 16.3.9.3.1.3, line 44~57, page 549 as follows]

16.3.9.3.1.3 Channel quality indicator (CQI) definition

The CQI feedback together with the rank feedback (when applicable) composes the spectral efficiency value reported by the AMS. This value corresponds to the measured block error rate which is the closest, but not exceeding, a specific target error rate.

The AMS reports the CQI by selecting a nominal MCS index from Table 901. MCS index should be selected assuming 4 LRUs in type-1 AAI subframe as a resource allocation~~,~~ and 10% as a target error rate for the first HARQ transmission and considering varying channel conditions during the delay from the reference signal that the CQI measurement is made on and to the point of time that the CQI is reported . That is, the reported CQI in frame 'N' measured from the reference siganl(s) at least up to frame 'N-1' corresponds to an appropriate MCS index for the frame 'N'. In order to allocate the AMS with MCS level and rank appropriate for the actual requirements, the ABS should make further adjustments to the AMS reported spectral efficiency, by considering parameters values different from the reference ones and by adapting to delay and mobility conditions.

[Change 4: Insert the following paragraph in section 16.3.9.3.1.5 after line 32, page 551]

16.3.9.3.1.5 Feedback Format

…

(Omitted)

…

Wideband PMI, subband PMI and base PMI shall be encoded with 3, 4 or 6 bits according to the codebook size.

Differential PMI shall be encoded with 2, 4 or 4 bits when the ABS has 2, 4 or 8 transmit antennas, respectively.

When the AMS estimates PMI by using the midamble, AMS should consider channel variation and report the PMI with reference to the frame the PMI is reported. That is, the reported PMI in frame 'N' measured from the midamble(s) at least up to frame 'N-1' corresponds to an appropriate value of PMI estimated for the frame 'N'.