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Title	**Link-to-System Performance Mapping based on Effective SNR**
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Re:	IEEE 802.16m-07/005r2, “Call for Contributions on Evaluation Methodology and Key Criteria for P802.16m – Advanced Air Interface”
Abstract	This contribution introduces the mutual information (MI) link quality model to perform link-to-system performances mapping in OFDM based IEEE 802.16m system.
Purpose	Propose the MI based link quality model for 16m Evaluation Methodology
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Link-to-System Performance Mapping based on Effective SNR

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I. Introduction

This contribution proposes the mutual information (MI) based link quality model for evaluating the effective link quality of the sub-channel.

In IEEE 802.16 OFDMA system, the frequency selectivity caused by the multipath channel may introduce large SNR variations across the whole band. It makes the SNR of each subcarrier in a sub-channel may be different. In addition, for systems supporting adaptive hybrid ARQ or supporting coding block with mixed modulations, a coded block may have very different SNR values in different portions of the block with multiple retransmissions, and the modulation order may change from one sub-block to another.

In order to efficiently collect the accurate performance metric of a sub-channel with frequency selectivity or H-ARQ/mixed modulation schemes during the system level simulation, defining a simple and accurate link-to-system interface for performance mapping is very critical.

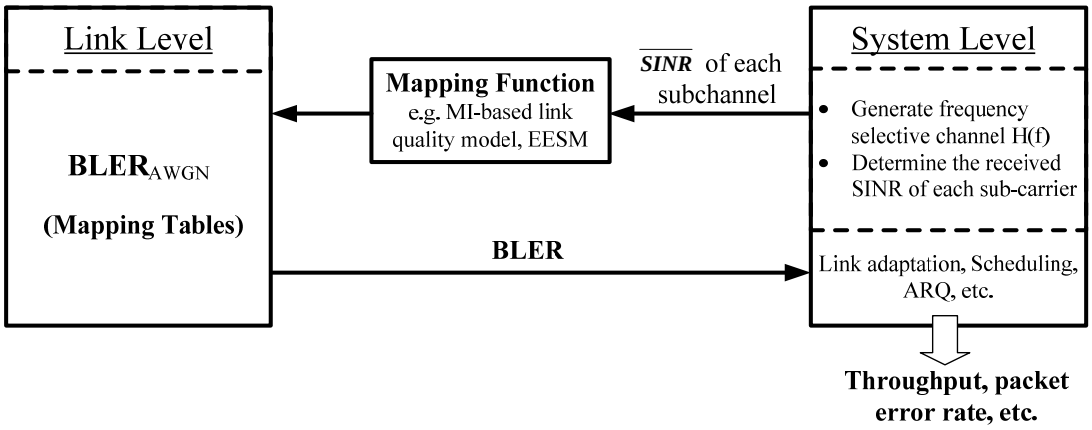

Figure 1 The structure of link-to-system level performance mapping

Figure 1 shows the structure of link-to-system level performance mapping. There are several popular mapping functions proposed in literatures, such as linear average over the frequency selective fading channel, Exponential Effective SINR Mapping (EESM) [1], Mutual Information (MI) based link quality model [2, 3], etc. Conventional SNR calculation for sub-channel based on linear averaging over the frequency selective channel cannot reflect the real situation, previous researches [1-3] show that its accuracy need to be further improved. When applying the EESM method, two adjusting factors, one for different modulation order and the other for various code rates, are needed to fine-tune jointly[1, 2]. A mutual-information-based (MI-based) link quality model is proposed here to determine the block error rate (BLER) of the sub-channel in the frequency selective channels [2].

According to previous researches [2, 3], it shows that the MI-based link quality model can outperform EESM method by its suitability when simulating the HARQ or the coding block with mixed modulation.

II. Text Proposal

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Add the following text to the evaluation methodology document

Link-to-System Performance Mapping based on Effective SNR

The MI-based link quality model contains a modulation model and a coding model separately [2]. The modulation model maps the received SNR of each state/each subcarrier into the mutual information symbol by symbol. The coding model first normalizes the accumulated mutual information of the total coded bits within the block to get the received bit information rate (RBIR), and then maps it to the quality indicators, e.g. BLER (block error rate), based on the simulated AWGN performance. The MI-based link quality model structure is shown in Figure 2.

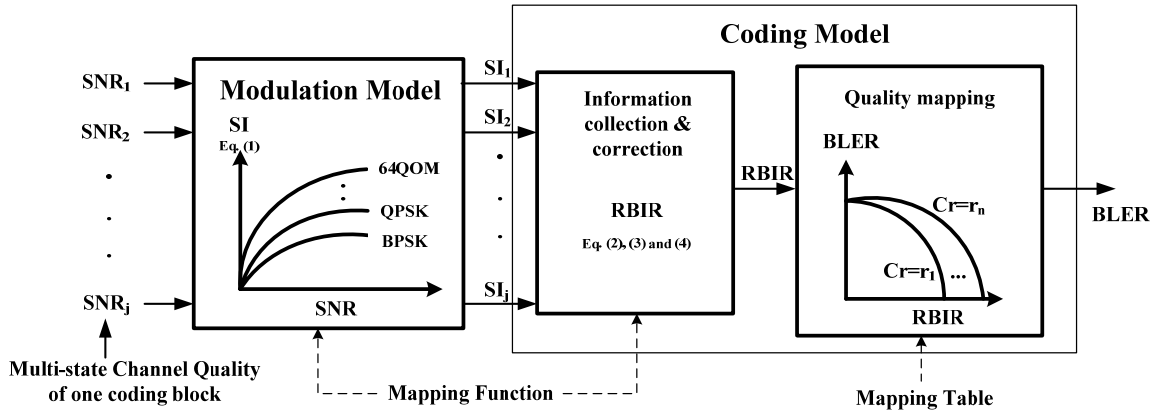

Figure 2 MI-based link quality model structure

Modulation model

For modulation order m, the symbol information (SI) of the channel symbol SNR value γ is defined as

$$SI(\gamma, m) = E_{xy}\{\log_2 \frac{P(Y \mid X, \gamma)}{\sum_X P(X)P(Y \mid Y, \gamma)}\} \quad (1)$$

where Y is the complex-value channel output symbol with SNR equal to γ, and $P(Y|X,\gamma)$ is the AWGN channel transition probability conditioned on the noise-free channel symbol X.

For the j^{th} symbol with modulation order m_j and channel state SNR γ_j, the symbol information $SI(\gamma_j, m_j)$ can be obtained by a modulation model look-up table.

Coding model

After gathering SI of each channel state, the information passes to the coding model. The coding model consists two parts: the SI collection/correction unit and the quality mapping unit.

The SI collection/correction unit first collects the received coded bit information (RBI) among the J symbols with SNR values $\{\gamma_1, \gamma_2, \ldots, \gamma_J\}$ and modulation order $\{m_1, m_2, \ldots, m_J\}$:

$$RBI = \sum_{j=1}^{J} SI(\gamma_j, m_j) \quad (2)$$

The RBI value is normalized by the number of total coded bits to obtain the received bit information rate (RBIR):

$$RBIR = RBI \Big/ \sum_{j=1}^{J} M_j \quad (3)$$

The RBIR is equivalent to the sample average of normalized SI over the received block for code blocks with single modulation mode with the value ranging from 0 to 1.

There is an adjusting factor γ_{cod} applying to the SI values before they are combined into RBIR when considering the practical coding loss from the Shannon limit.

$$RBI_0 = \sum_{j=1}^{J} SI(\gamma_j / r_{cod}, m_j) \quad (4)$$

The γ_{cod} can be obtained by training based on simulation results over a set of pre-defined channel realizations that covers amount of different channel variations.

The channel quality measurement, e.g. BLER, based on the simulated AWGN performance can be obtained by a RBIR-to-BLER mapping.

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III. Summary

An MI-based link quality model is introduced in this contribution to evaluate the effective channel quality for the sub-channel in IEEE 802.16 OFDMA system. By transforming multiple-state SNR into the mutual information domain, and then calculating the received bit information rate (RBIR), the BLER of the effective channel can be obtained through a RBIR-to-BLER mapping. From [2, 3], the performance of MI-based link quality model is with high accuracy compared with other existing quality models. Meanwhile, the MI-based link quality model is simpler and easier to be applied in system level simulation when the modulation and H-ARQ schemes may be time variant. Based on the proposed MI-based link quality model, the results collected by system level simulation will be more accurate and closer to real situation.

References

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[2] L. Wan, S. Tsai, and M. Almergn, “A fading-Insensitive Performance Metric for a Unified Link Quality Model,” IEEE WCNC, Vol.4, pp. 2110-2114, Apr 2006

[3] S. Tsai and A. Soong, “Effective-SNR Mapping for Modeling Frame Error Rates in Multiple-state Channels,” 3GPP2-C30-20030429-010, Apr 2003