Mode Selection based on Effective CINR.

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Venue:

IEEE C802.16m-08/024 - Call for Comments and Contributions on Project 802.16m System Description Document (SDD)

Target topic:

“Link adaptation”.

Base Contribution:

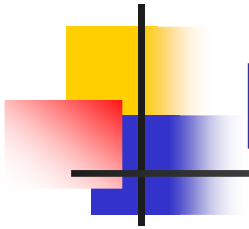
none.

Abstract:

We propose a new explicit technique for efficient MIMO mode selection.

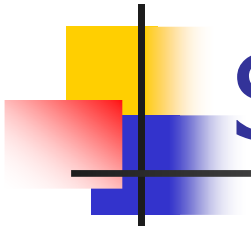
Purpose:

Discussion and approval by TGm for the 802.16m SDD



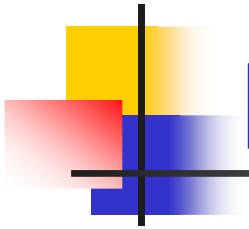
Motivation

- In the 16e, MIMO mode selection is implementation specific.
- This means that it is difficult for BS vendors to rely on it for link adaptation.
- Many BS vendors rather rely on PCINR which is better defined (but does not fully reflect the link condition).
- Therefore mode selection should be well defined in the 16m.



Scope

- We introduce a new mode selection technique, which provides an efficient and accurate means for selecting the optimal MIMO mode and MCS in various channel conditions.
- This method is based on the effective CINR concept applied to the per-tone MIMO PCINR.



Preliminaries - ECINR

- It is known that average PCINR provides a loose link error prediction for fading channels .

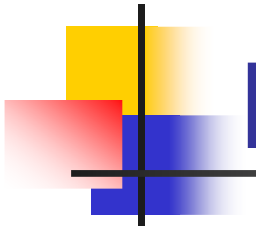
- To overcome this difficulty, the PCINR may be replaced with the effective CINR (ECINR), which is defined as the AWGN-equivalent CINR that results in the same error rate.

Preliminaries - ECINR

- ECINR may be evaluated by the exponential effective SINR method (EESM).

$$ECINR\,[dB] = 10\log 10\left[-\beta \ln\left(\frac{1}{N}\sum_{i=1}^{N} e^{-\frac{PCINR_i}{\beta}}\right)\right],$$

where β is a parameter for each MCS and FEC size (see [1],[2] for β values for various MCSs).



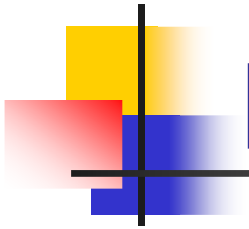
Preliminaries – MIMO PCINR

- The per-tone MIMO PCINR is well defined in the 802.16e for most MIMO modes.

- Some of the 16e PCINR formulas are given in the next slide.

Preliminaries – MIMO PCINR Examples

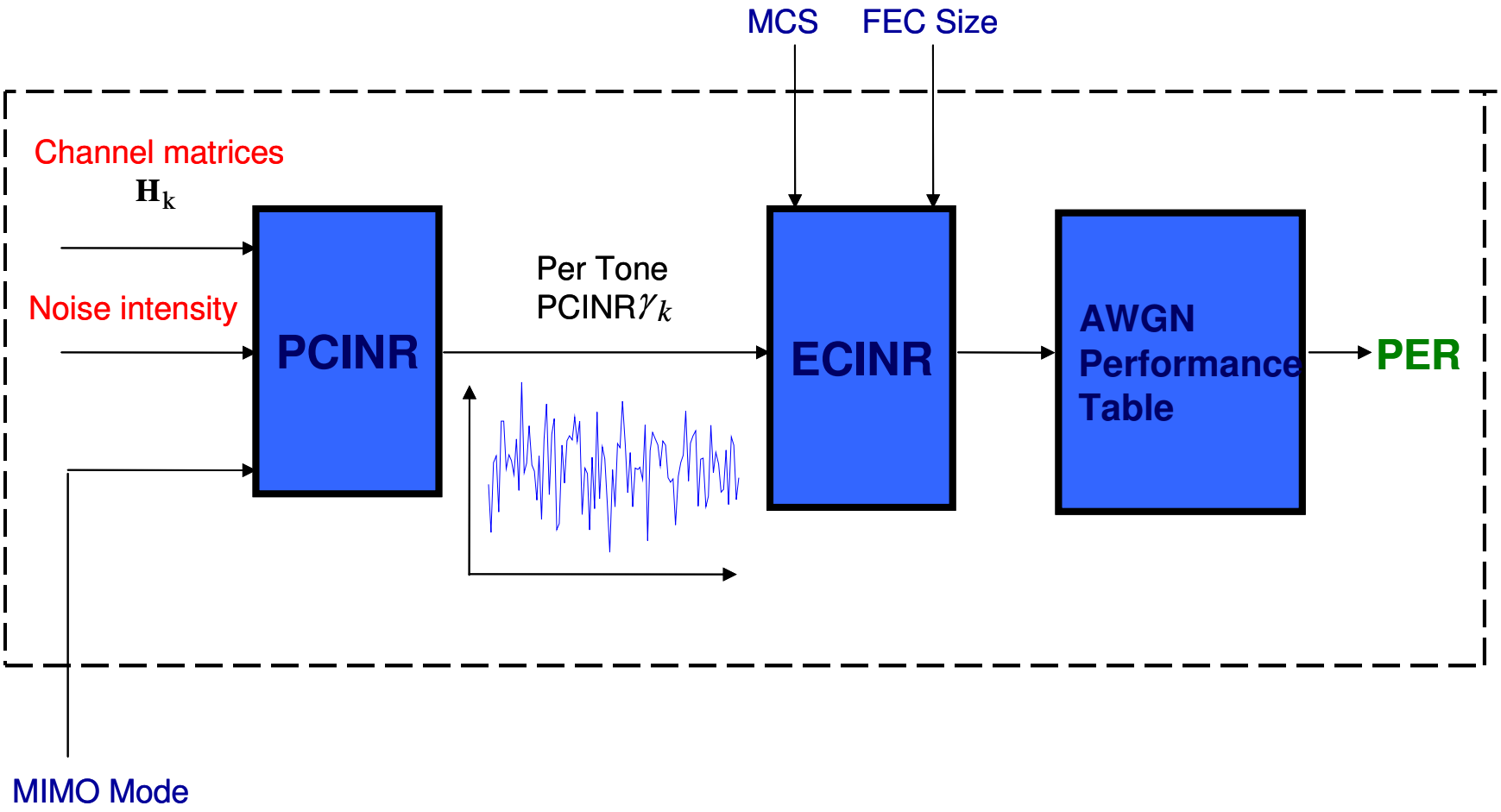
MIMO Modes	PCINR
SISO	$\lvert h\rvert^2/\rho^2$, ρ -noise intensity.
MRC	$\lVert \mathbf{h} \rVert / \rho^2$, $\mathbf{h} = (h_{1,\ldots,} h_m)^T$
STC 2X1	$\lVert \mathbf{h} \rVert / 2\rho^2$, $\mathbf{h} = (h_1, h_2)^T$
STC 2X2	$\lVert \mathbf{H} \rVert_F / \rho^2$, $\mathbf{H} = \begin{pmatrix} h_{00} & h_{10} \\ h_{01} & h_{11} \end{pmatrix}$
Matrix B ML	$\det\left(I + \mathbf{H}\mathbf{H}^* / \rho^2\right) - 1$

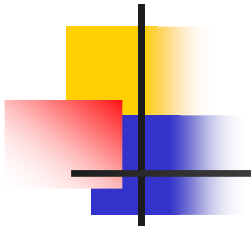


Main Concept

- Fusion between ECINR and Effective MIMO channel
- Decide on the MIMO mode and MCS with maximal throughput subject to QoS.

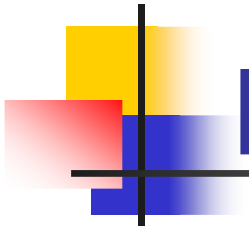
Main Concept: Block Diagram





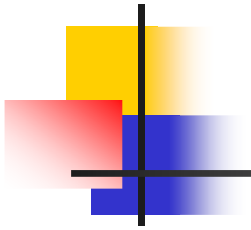
Further Simplifications

- Check Only Relevant Modes
  - Create a list of available MIMO modes based on system capabilities (Mobility will be discussed in the sequel).
  - In case only part of the channel matrix is available, modes that require more information for the computation of the PCINR should not be considered (e.g. MIMO PCINR cannot be based on the channel estimate resulting for single antenna transmission).



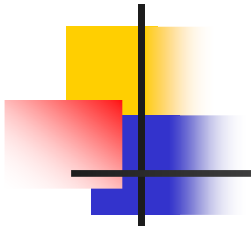
Further Simplifications

- Modes hierarchy
  - Some modes are always superior to others (e.g. MRC is always better than SISO)
  - Thus, when superior modes are available the inferior modes shouldn't be considered.
  - Thus an offline database of modes hierarchy may be constructed.
  - This database doesn't include any information regarding modulation-coding schemes.



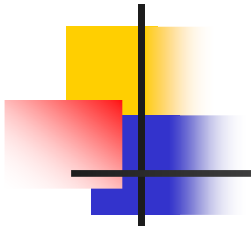
Optimality Criterion

- Based on the resulting PER values, choose the optimal MIMO mode and MCS combination with highest throughput subject to some predefined QoS.



Accounting for Mobility

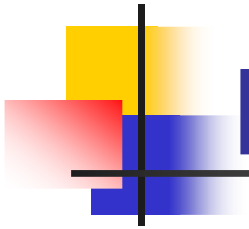
- Some MIMO modes, as closed-loop schemes, are not suitable for employment in high mobility scenarios.
- Thus, such schemes should not be considered when the velocity is above some threshold.
- This issue (and the way channel variations are assessed) requires further study.



Conclusions

- Will provide similar baseline for different vendors
- Calculation of the ECINR is based on PCINR which is already incorporated in the system
- Will enhance system performance and is simple to implement

* This approach as been recently presented in [1] and showed excellent performance.



Proposed changes

- We propose that the specified technique of mode selection based on ECINR calculation will be used by the 16m MS.
- We propose to include a section pertaining to MIMO mode selection in the SDD.

References:

[1] Dachuan Yao, Alfonso Camargo, and Andreas Czylwik, Adaptive MIMO Transmission Scheme for BICM-OFDM Wireless Systems, COST 2100, TD(08)509,2008.

[2] Ericsson, “Effective-SNR Mapping for Modeling Frame Error Rates in Multiple-state Channels,” 3GPP2-C30-20030429-010, Nov., 2003.