

# Power Loading for MIMO Downlink Transmission

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### Source:

Chih-Yuan Lin ([chihyuan.lin@mediatek.com](mailto:chihyuan.lin@mediatek.com)), Pei-Kai Liao ([pk.liao@mediatek.com](mailto:pk.liao@mediatek.com)), Ciou-Ping Wu ([ciouping.wu@mediatek.com](mailto:ciouping.wu@mediatek.com)), and Paul Cheng ([paul.cheng@mediatek.com](mailto:paul.cheng@mediatek.com))  
MediaTek Inc.

Yih-Guang Jan ([yihjan@ee.tku.edu.tw](mailto:yihjan@ee.tku.edu.tw)) and Yang-Han Lee ([yhlee@ee.tku.edu.tw](mailto:yhlee@ee.tku.edu.tw))  
TKU

Shiann-Tsong Sheu ([stsheu@ce.ncu.edu.tw](mailto:stsheu@ce.ncu.edu.tw))  
NCU

### Venue:

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### Purpose:

Propose to be discussed and adopted by TGM for the use in Project 802.16m SDD

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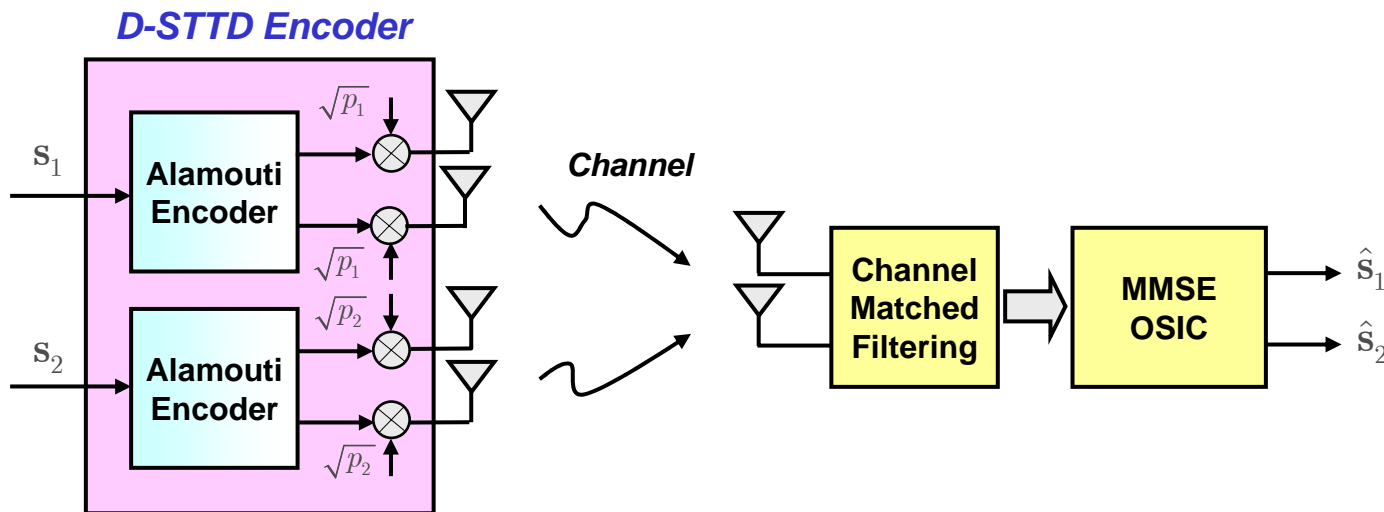
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# Power Loading

- Suggest to include power loading to enhance performance of two-data-stream MIMO systems
- How to get optimal power loading factors at BS?
  - ◆ For two-data-stream case, it is easy to derive optimal loading factors
  - ◆ Only power ratio of the two data streams should be feedbacked
    - ▶ Thus feedback information is quite limited
  - ◆ Performance gain is large as will be shown in following design example

# Design Example

- Double space-time transmit diversity (D-STTD) system
  - ◆ MMSE ordered successive interference cancellation (MMSE-OSIC) receiver is adopted to decouple data
  - ◆ Goal: adjust  $p_1$  and  $p_2$  to achieve optimal BER under a total power constraint  $p_1 + p_2 = P$



- Analysis: when is average BER minimized?
  - ◆ It can be proven that when respective BERs of two data streams are equal, system average BER is minimized [1]

$$Q(SINR_{stream1}) = Q(SINR_{stream2}) \Rightarrow \frac{1}{2} (Q(SINR_{stream1}) + Q(SINR_{stream2}))$$

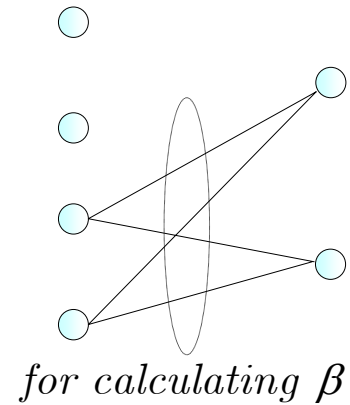
**is minimized**

- ▶ Find  $p_1$  and  $p_2$  to let  $SINR_{stream1} = SINR_{stream2}$

[1] D. P. Palomar, J. M. Cioffi, and M. A. Lagunas, "Joint Tx-Rx beamforming design for multicarrier MIMO channels: A unified framework for convex optimization," IEEE Trans. Signal Processing, vol. 51, no. 9, pp. 2381-2401, Sept. 2003

- By some manipulations, we have following power ratio

$$\begin{aligned}
 &\text{If } \alpha < \beta \\
 &p_1 : p_2 = 1 : \frac{\alpha^2}{(\alpha\beta - \gamma)} \\
 &\qquad \qquad \qquad < 1 \\
 &\text{elseif } \alpha > \beta \\
 &p_1 : p_2 = \frac{\beta^2}{(\alpha\beta - \gamma)} : 1
 \end{aligned}$$



- ▶  $\alpha = |h_{11}|^2 + |h_{12}|^2 + |h_{21}|^2 + |h_{22}|^2$
- ▶  $\beta = |h_{13}|^2 + |h_{23}|^2 + |h_{14}|^2 + |h_{24}|^2$
- ▶  $\gamma = |h_{11}^*h_{13} + h_{12}^*h_{14} + h_{21}^*h_{23} + h_{22}^*h_{24}|^2 + |h_{12}^*h_{13} - h_{11}^*h_{14} + h_{22}^*h_{23} - h_{21}^*h_{24}|^2$

- For D-STTD, optimal power loading (in term of BER) only requires the following **real value**

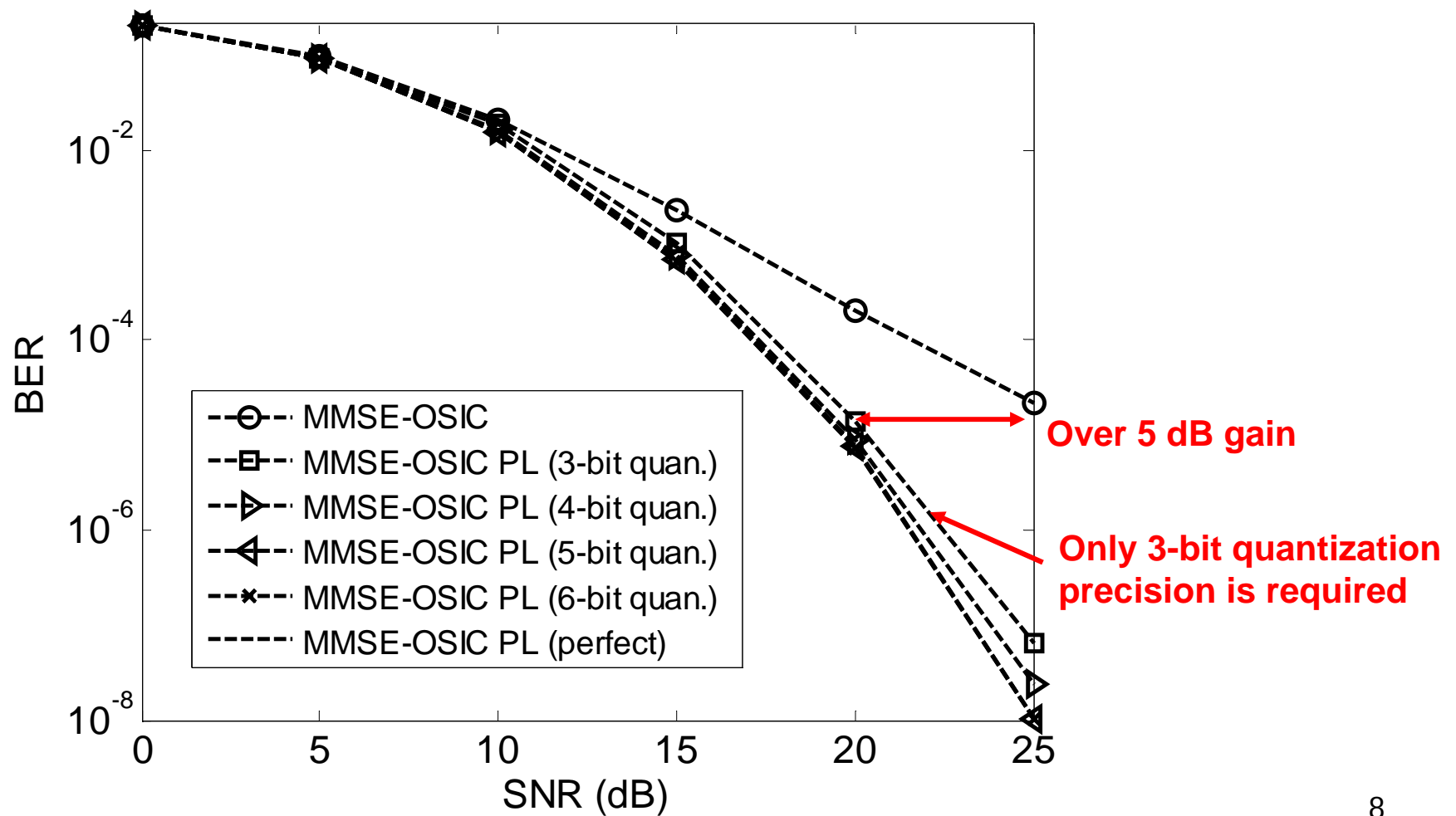
$$\frac{\alpha^2}{(\alpha\beta - \gamma)} \quad \text{or} \quad \frac{\beta^2}{(\alpha\beta - \gamma)}$$

- ◆ MS only requires quantizing the value and sending it back without any codebook being stored

# Simulation Results

- Simulation parameters
  - ◆ D-STTD (4-by-2) MIMO-OFDM system with MMSE-OSIC detector
  - ◆ 512 subcarriers
  - ◆ QPSK modulation
  - ◆ Channel impulse response follows ITU Pedestrian B model
  - ◆ Perfect synchronization and channel estimation are assumed
  - ◆ Comparative methods
    - ▶ MMSE-OSIC with power loading
    - ▶ MMSE-OSIC without power loading

● BER performance comparison





## Conclusion

- Power loading is appealing to two-data-stream MIMO systems
  - ◆ Only a power ratio of the two data streams should be feedbacked
    - ▶ In design example, 3-bit quantization precision is sufficient to get over 5-dB SNR gain
  - ◆ It is beneficial to trade a small feedback overhead for such a large performance gain