

Development of a Single-Carrier SM-MIMO Transceiver

Detector Design
MIMO Implementation

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System Model SC-SM

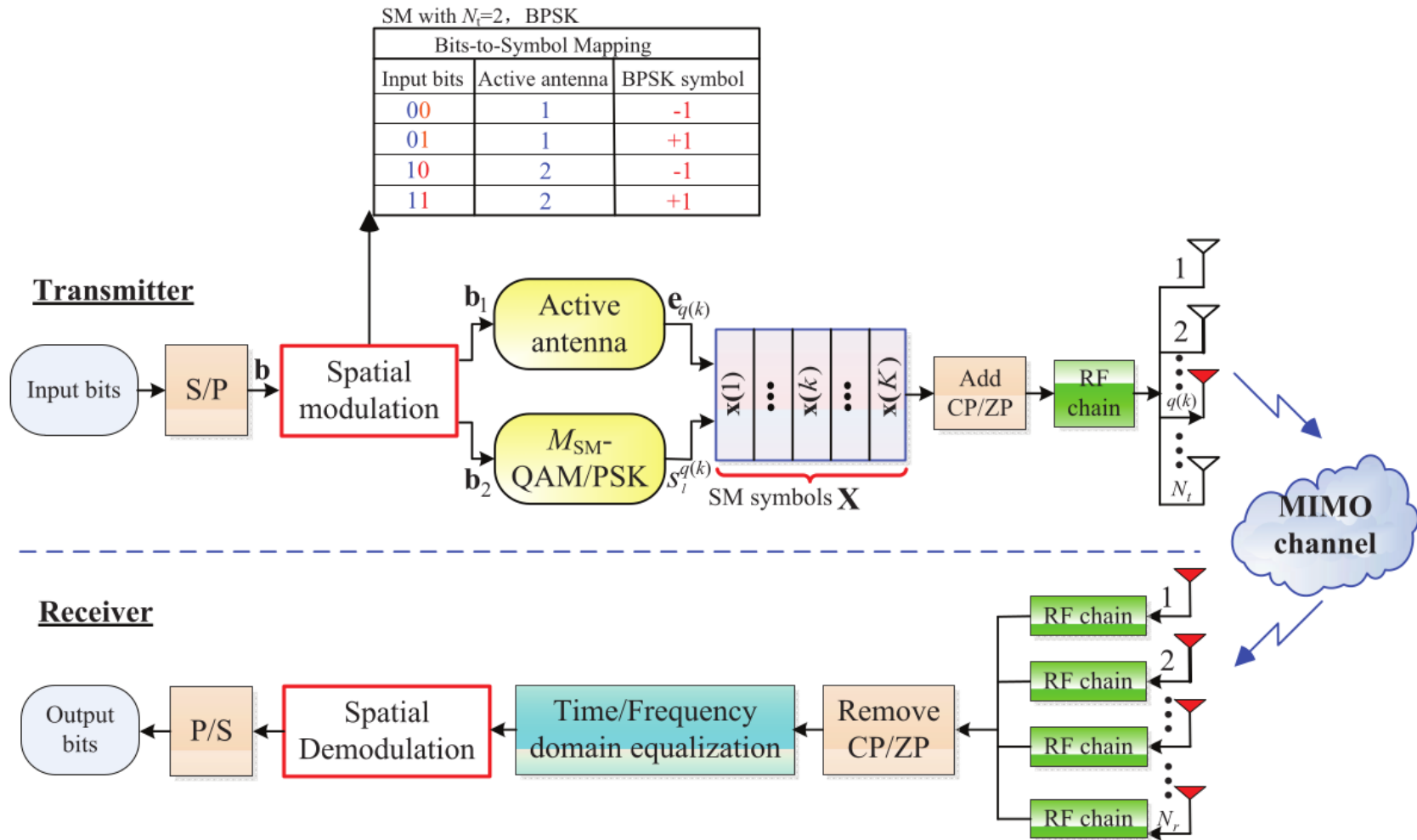


Figure 1: General transceiver structure of SC-SM systems [1]

Low-Complexity Detection Scheme for GSM-SC

- Based on M-algorithm
- Single stream ML detection
- Avoids QR-decomposition
- Balanced trade-off:
performance & complexity
- Scheme approaches ML
detector with increasing M
- Efficient operation even in
rank-deficient channel
scenarios

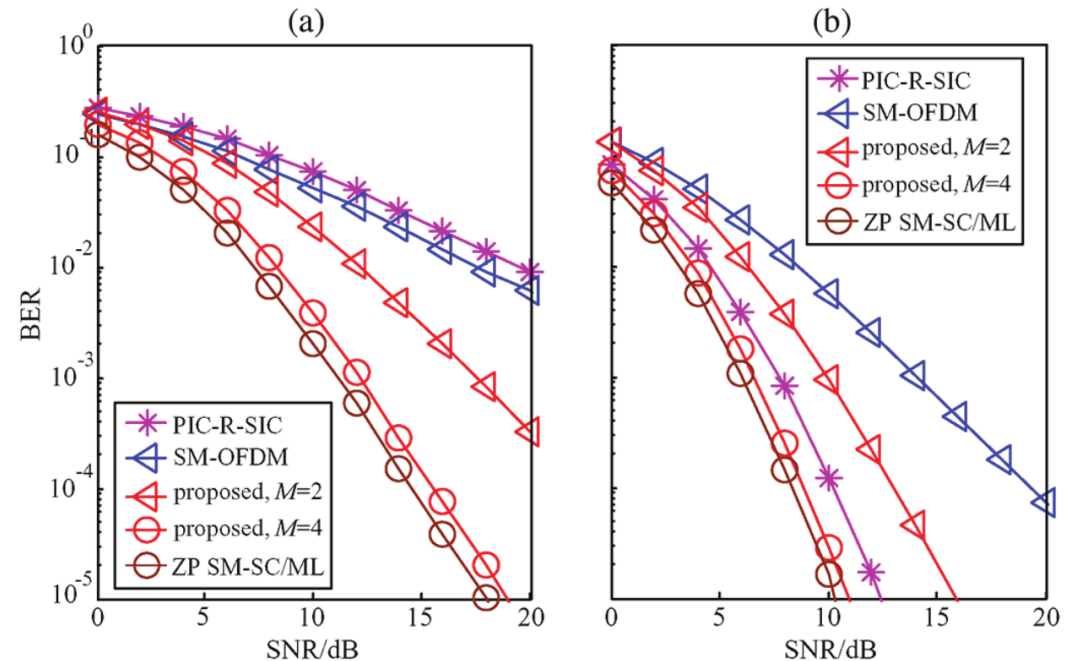


Figure 4: BER of ZP-aided SM-SC and SM-OFDM with different receiver antennas: (a) $N_r = 1$; (b) $N_r = 2$ [1]

- $$\underbrace{\begin{bmatrix} \mathbf{Y}_1 \\ \mathbf{Y}_2 \\ \vdots \\ \mathbf{Y}_{K+P-1} \end{bmatrix}}_{\mathbf{Y} \text{ of size } (K+P-1)N_r \times 1} = \underbrace{\begin{bmatrix} \mathbf{H}_0 & \mathbf{O} & \dots & \mathbf{O} & \mathbf{O} \\ \mathbf{H}_1 & \mathbf{H}_0 & \dots & \mathbf{O} & \mathbf{O} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ \mathbf{H}_{P-1} & \mathbf{H}_{P-2} & \dots & \mathbf{H}_0 & \mathbf{O} \\ \mathbf{O} & \mathbf{H}_{P-1} & \dots & \mathbf{H}_1 & \mathbf{H}_0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ \mathbf{O} & \mathbf{O} & \dots & \mathbf{H}_{P-1} & \mathbf{H}_{P-2} \\ \mathbf{O} & \mathbf{O} & \dots & \mathbf{O} & \mathbf{H}_{P-1} \end{bmatrix}}_{\mathbf{H} \text{ of size } (K+P-1)N_r \times KN_t} \underbrace{\begin{bmatrix} \mathbf{x}_1 \\ \mathbf{x}_2 \\ \vdots \\ \mathbf{x}_K \end{bmatrix}}_{\mathbf{x} \text{ of size } KN_t \times 1} + \underbrace{\begin{bmatrix} \mathbf{n}_1 \\ \mathbf{n}_2 \\ \vdots \\ \mathbf{n}_{K+P-1} \end{bmatrix}}_{\mathbf{n} \text{ of size } (K+P-1)N_r \times 1}$$

- Channel Matrix scales according to N_t, N_r :

[illegible]

Current Detector Design

■ Working MIMO implementation ($N_t \times N_r$):

■ 1×2

■ 2×2

$$e_2^m = \left\| \hat{\mathbf{Y}}_2 - \begin{pmatrix} \mathbf{H}_0 & 0 \\ \mathbf{H}_1 & \mathbf{H}_0 \end{pmatrix} \begin{pmatrix} \mathbf{x}_1^m \\ \mathbf{x}_2 \end{pmatrix} \right\|_F^2$$

$$= \tilde{e}_1^m + \left\| \mathbf{Y}_2 - (\mathbf{H}_1 \quad \mathbf{H}_0) \begin{pmatrix} \mathbf{x}_1^m \\ \mathbf{x}_2 \end{pmatrix} \right\|_F^2, \mathbf{x}_2 \in C_{GSM}$$

■ M smallest metrics are chosen by M-algorithm:

■ $M = 1$

■ No final detection yet: $\hat{\mathbf{x}}_{proposed} = \arg \min_{m \in (1, 2, \dots, \hat{M})} \|\mathbf{Y} - \mathbf{H}\mathbf{D}_K^m\|_F^2$

■ Script to test the detector:

■ If every sent symbol is correctly detected: True

■ ~45% of the time this is the case (SNR = 10 dB)

Prospects

- Adjust sent symbols
- Generalize for number of multi-path links (P)
- Generalize for M (starting with $M = 2$)
- Compare BER performance with results in paper
- MIMO schemes to implement:
 - 2×1
 - $N_t \times N_r$
- Fuse scripts: class based SISO transmission and MIMO detector scheme
- Addition of spatial modulation / spatial modulation symbols
- Proof of concept with GNU Radio

Any questions?

■ Sources

- [1] L. Xiao, D. Lilin, Y. Zhang, Y. Xiao, P. Yang and S. Li, “**A low-complexity detection scheme for generalized spatial modulation aided single carrier systems,**” *IEEE Commun. Lett.*, vol. 19, no. 6, pp. 1069-1072, Jun. 2015
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