Karlsruher Institut für Technologie

Development of a Single-Carrier SM-MIMO Transceiver

System Concept
Literature Research

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System Model SC-SM

SM with N_t=2, BPSK

Bits-to-Symbol Mapping		
Input bits	Active antenna	BPSK symbol
00	1	-1
01	1	+1
10	2	-1
11	2	+1

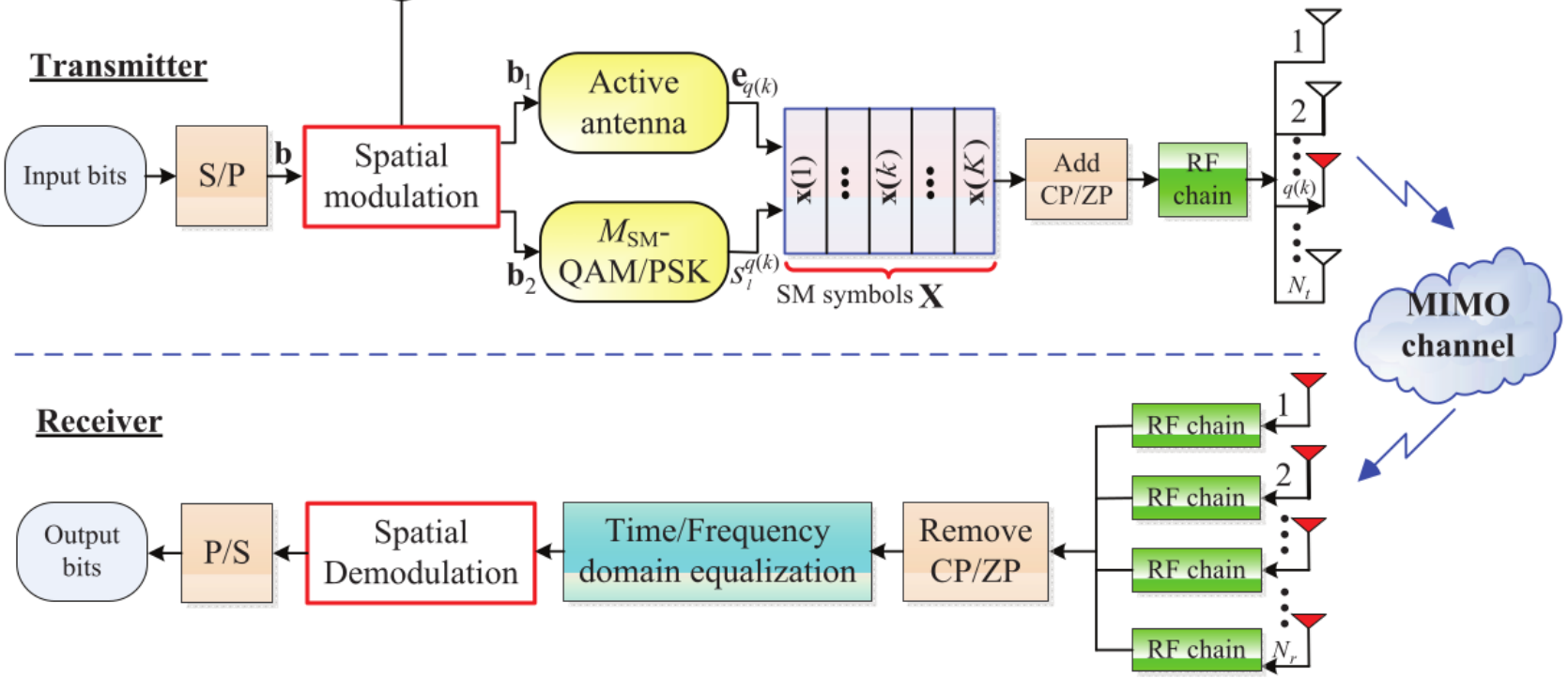

Figure 1: General transceiver structure of SC-SM systems [**1**]

Spatial Modulation System Design

- Use ZP-aided SC-SM
  - BER performance
  - Only 1 Tx-RF chain
- Channel matrix might be rank deficient
- Trade-off amongst detection complexity, BER, achievable transmission rate and power efficiency

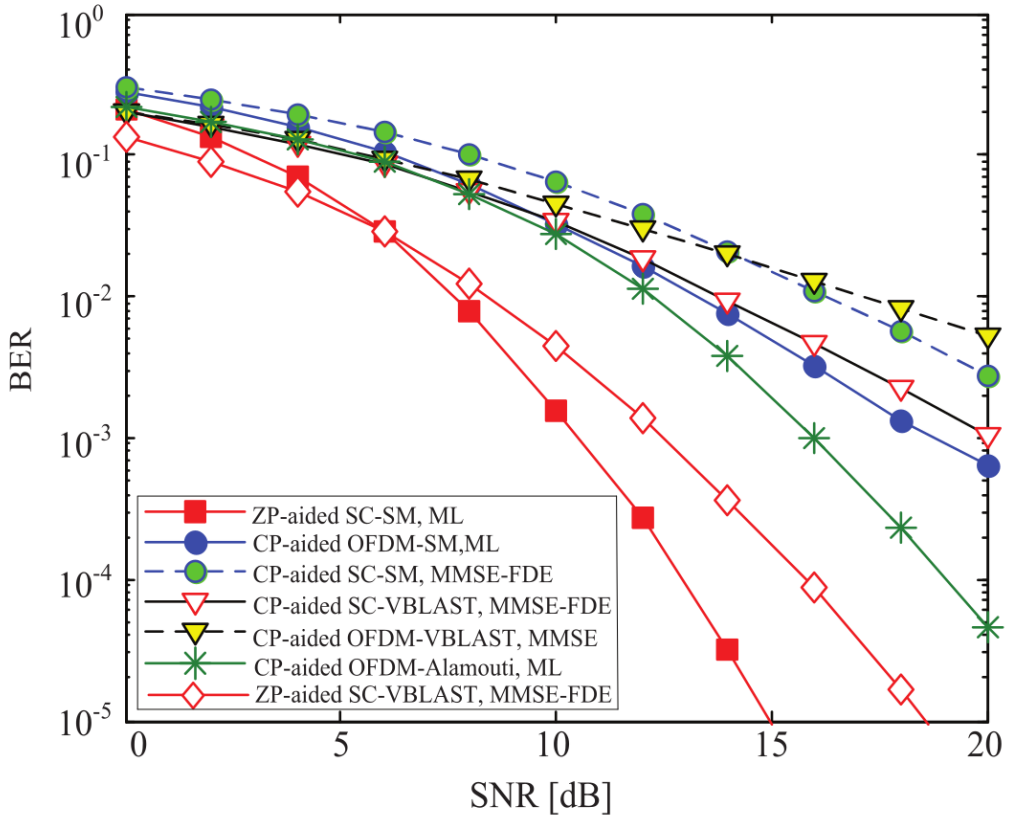

Figure 2: BER comparison of the ZP-aided SC-SM scheme over its CP-aided counterpart and various CP-aided classic MIMO transmission schemes [**1**]

Advantages & Disadvantages

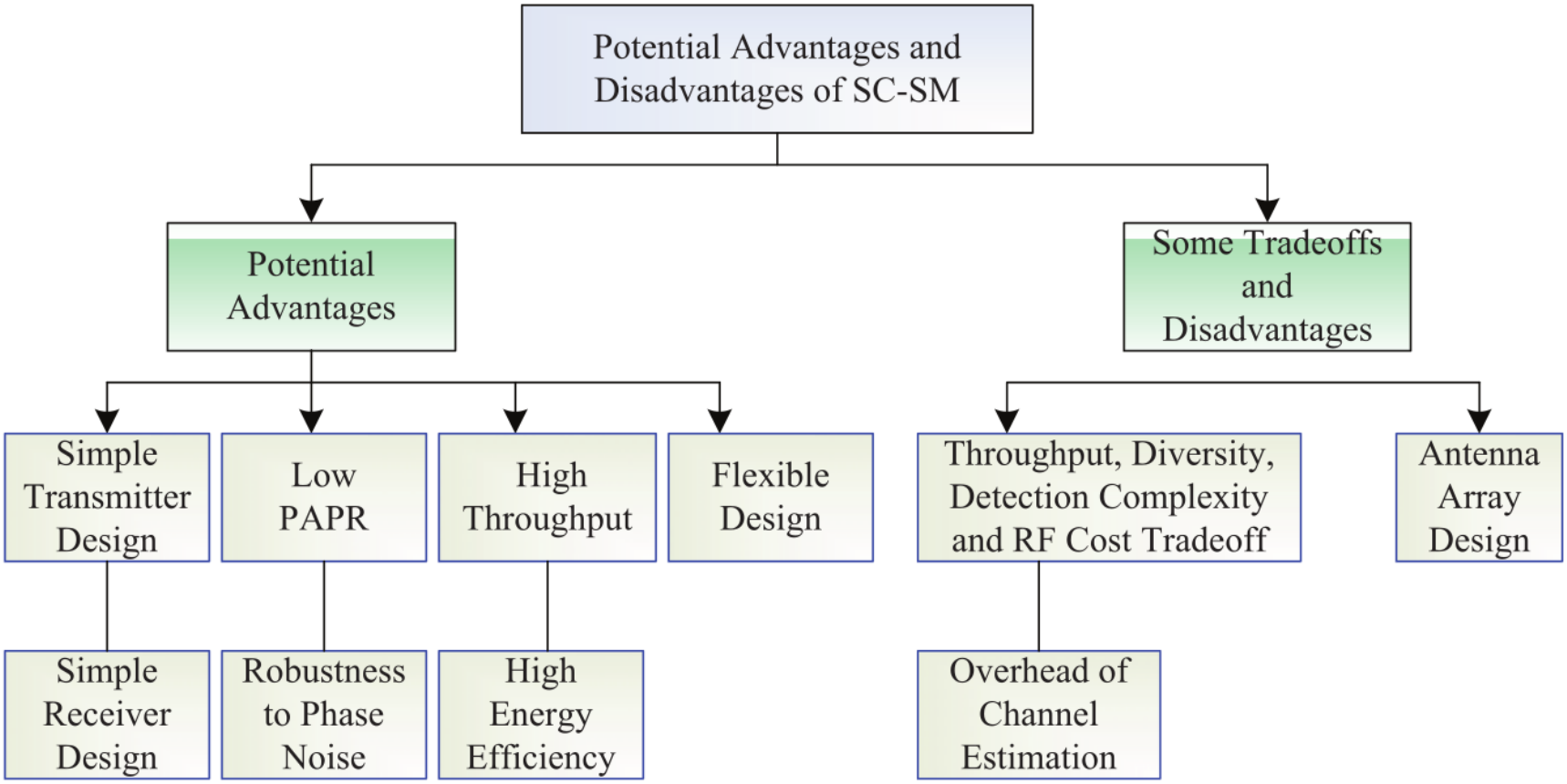

Figure 3: A summary of main advantages and disadvantages of the SC-SM scheme [**1**]

Detector Design

- Conventional SM detectors focus on TA index, ignore ISI
- Conventional MIMO detectors assume N_r > N_t
- BER performance of GSM dominated by the detectors
- Receiver architectures:
  - Frequency-Domain Equalization
  - Time-Domain Equalization
  - Turbo Equalizer
- TDE-type detectors more attractive in context of SC-SM
- TDE detection schemes:
  - ML-based
  - Sphere decoding based
  - PIC-R-SIC
  - LSS

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

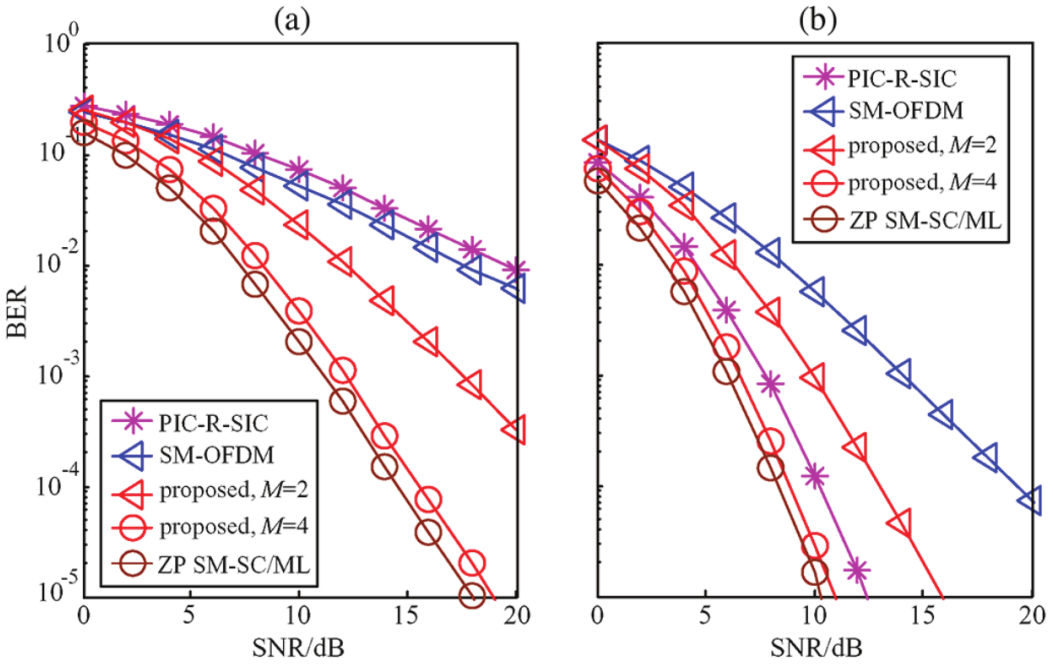

Figure 4: BER of ZP-aided SM-SC and SM-OFDM with different receiver antennas: (a) N_r = 1; (b) N_r = 2 [**2**]

Potential Design Issues

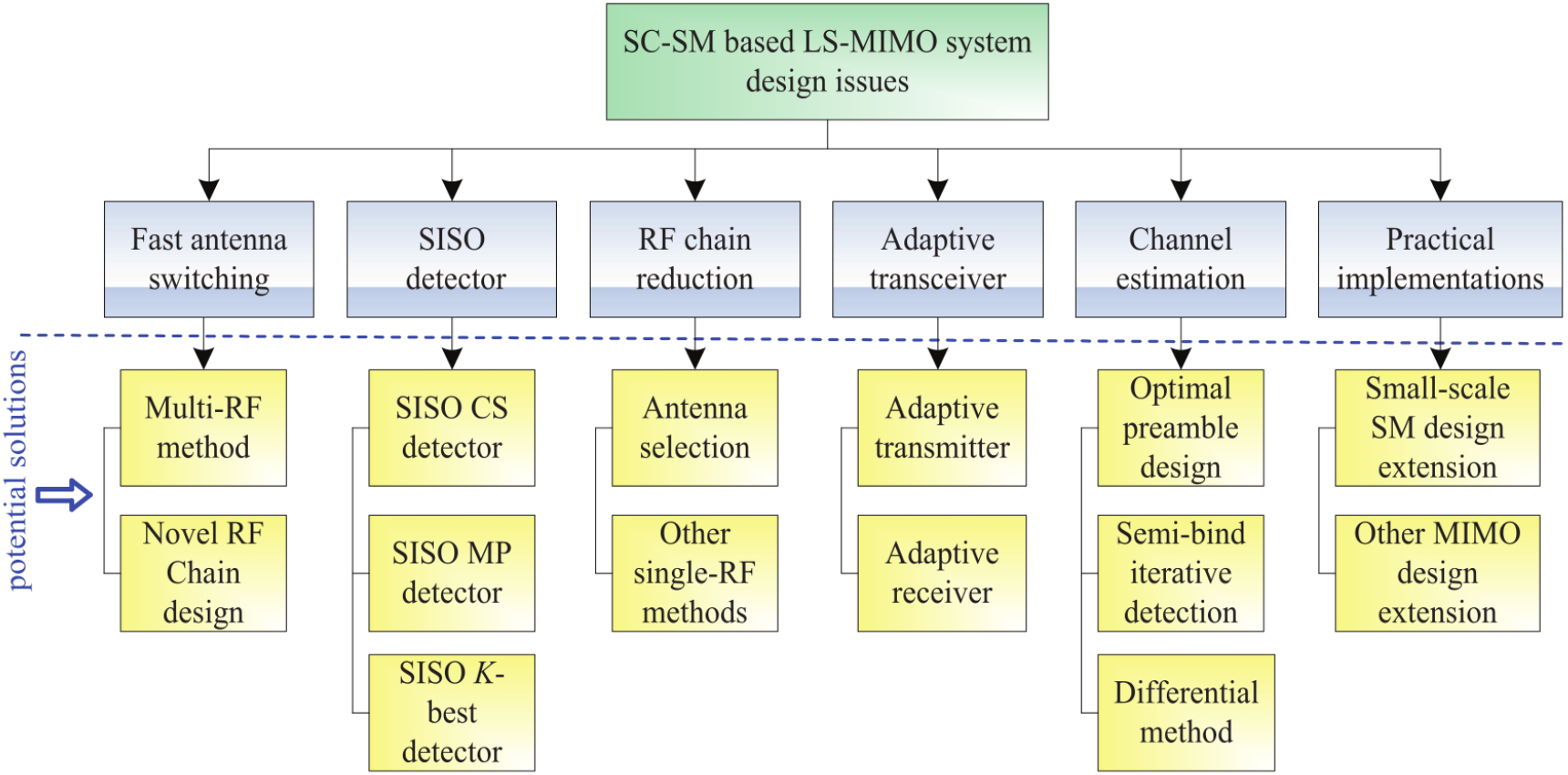

Figure 5: Potential future design issues and potential solutions [**1**]

Prospects

- Simulation of a single-carrier transmission system
- Addition of MIMO
- Addition of spatial modulation
- Proof of concept with GNU Radio

Any questions?

- Sources
  - [1] P. Yang, Y. Xiao, Y. L. Guan, K. V. S. Hari, A. Chockalingam, S. Sugiura, H. Haas, M. Di Renzo, C. Masouros, Z. Liu, L. Xiao, S. Li and L. Hanzo, "**Single-Carrier SM-MIMO: A Promising Design for Broadband Large-Scale Antenna Systems**," *IEEE Commun. Surveys & Tutorials*, vol. 18, no. 3, pp. 1687-1716, August 2016
  - [2] 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
  - [3] Z. Tian, Z. Li, M. Zhou and X. Yang, "**M-Algorithm-Based Optimal Detectors for Spatial Modulation**," *Journal of Commun.*, vol. 10, no. 4, April 2015
  - [4] L. Wei, c. Ming and S. Cheng, "**An Improved QRD-M Algorithm in MIMO Communications**," *Global Telecommunications Conference, 2007, IEEE GLOBECOM '07*, November 2007