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Matrix Modulation; 3.8 Summary; 4 Matrix Modulation: Low SNR Aspects; 4.1 Linear Matrix Modulation; 4.2 Examples; 4.3 Heuristic Design Rules at Low SNR; 4.4 Matched Filtering and Maximum Likelihood Metric; 4.5 Mutual Information; 4.6 Expansion around Diagonal Dominance; 4.7 Performance of Examples; 4.8 Summary; 5 Increasing Symbol Rate: Quasi-orthogonal Layers; 5.1 Orthogonal Designs; 5.2 Complexity Issues: Choosing Symbol Rate and Target Tx Diversity

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7.4 Improved Performance by Extending Block 7.5 Comparison of Layered Schemes for Four Tx Antennas; 7.6 Weighted and Multimodulation Non-orthogonal Matrix Modulation; 7.7 Summary; 8 Robust and Practical Open-loop Designs; 8.1 Randomized Matrix Modulations; 8.2 Space-Time Block Code with Rotated Constellations; 8.3 Performance Evaluation; 8.4 Summary; 9 High-rate Designs for MIMO Systems; 9.1 Sets of Frobenius Orthogonal Unitary Matrices; 9.2 Optimizing Rate 2 MIMO-Modulation for $N_{\text{sub}(t)} = T = 2$; 9.3 Four Transmit Antennas, Rate 2; 9.4 Four Transmit Antennas, Rate 3

9.5 Four Transmit Antennas, Rate 4 9.6 The Information Provided by the Schemes; 9.7 Summary; Part III: Closed-loop Methods; 10 Closed-loop Methods: Selected Multi-antenna Extensions; 10.1 Closed-loop Transmit Diversity in WCDMA; 10.2 More than Two Transmit Antennas; 10.3 Performance; 10.4 Summary; 11 Analysis of Closed-loop Concepts; 11.1 Generalized Feedback Signalling Design; 11.2 Analysis of SNR Gain of the Co-phase Algorithm; 11.3 Analysis of SNR Gain of the Order and Co-phase Algorithm; 11.4 SNR Gain in Multipath Rayleigh Fading Channels; 11.5 Errors in Feedback Signalling

11.6 Feedback Latency

Sommario/riassunto

Multi-antenna techniques are widely considered to be the most promising avenue for significantly increasing the bandwidth efficiency of wireless data transmission systems. In so called MIMO (multiple input multiple output) systems, multiple antennas are deployed both at the transmitter and the receiver. In MISO (multiple input single output) systems, the receiver has only one antenna, and the multiple transmit antennas are used for transmit diversity. The key aspects of multiple antenna transceiver techniques for evolving 3G systems and beyond are presented. MIMO and MISO (transmit dive