

Contents

Preface	ix
1 CDMA Fundamentals	1
1.1 Spread Spectrum	3
1.1.1 Direct-Sequence Spread Spectrum	3
1.1.2 Frequency-Hopping Spread Spectrum	6
1.2 Code-Division Multiple-Access (CDMA)	7
1.2.1 CDMA Receivers	11
1.3 Classifications	12
1.3.1 Short Codes Versus Long Codes	13
1.3.2 Narrowband Versus Wideband	14
1.4 Spatial Diversity	19
1.5 Scope of This Book	21
2 CDMA With Short Codes: Direct Approaches	25
2.1 Introduction	25
2.2 Constrained Optimization	27
2.3 Decorrelating RAKE Receivers	32
2.3.1 Constrained MOE	33
2.3.2 Adaptive Implementation	37
2.4 Performance Analysis	38
2.4.1 Receiver Optimality	38
2.4.2 Steady-State Behavior	41
2.5 Examples	42
2.6 Conclusion	46

3	CDMA With Short Codes: Indirect Approaches	49
3.1	Introduction	49
3.2	Channel Parameter Estimation	51
3.2.1	Subspace Concept	52
3.2.2	Closed-Form Estimation	53
3.2.3	Overloaded Systems	55
3.2.4	Performance Analysis	56
3.3	Joint Channel and Carrier Estimation	61
3.3.1	Problem Reformulation	63
3.3.2	Decoupling and Closed-Form Solution	66
3.3.3	Performance Analysis	69
3.4	Examples	72
3.5	Conclusion	73
	Appendix 3A: The Existence and Calculation of $\mathbf{G}(z)$	76
	Appendix 3B: First and Second Order Derivatives of the $J(\phi, \mathbf{h}, \mathbf{U}_o)$	78
4	CDMA With Long Codes: Space-Time Processing	81
4.1	Introduction	81
4.2	Uplink	83
4.2.1	Space-Time Receivers	85
4.2.2	Blind 2D Reception	90
4.2.3	Examples	93
4.3	Downlink	101
4.3.1	Constrained Equalization	103
4.3.2	Adaptive Implementation	107
4.3.3	Examples	112
4.4	Conclusion	117
5	Multicarrier CDMA	121
5.1	MC-CDMA Overview	122
5.1.1	Multicarrier and OFDM	122
5.1.2	MC-CDMA	126
5.1.3	MC Direct-Sequence CDMA	130
5.1.4	Multitone-CDMA	134
5.2	Channel and Carrier Offset Estimation	134

5.3	Enabling Codes in MC-DS-CDMA	137
5.4	Carrier Sensitivity Analysis	141
5.4.1	SINR Degradation	143
5.5	Discussion	148
5.6	Conclusion	156
6	Space-Division Multiple-Access	161
6.1	Background	162
6.2	Antenna Array Packet Networks	164
6.2.1	Conventional Spatial-Division Multiple-Access	166
6.3	Scheduling Protocol	170
6.3.1	Terminal Allocation	170
6.3.2	Slot Adjustment	173
6.4	Analysis	176
6.4.1	Upper-Bound and Lower-Bound	176
6.4.2	Asymptotic Optimality	178
6.5	Performance Evaluation	181
6.5.1	Finite Population With Bursty Traffic	181
6.5.2	Infinite Population With Poisson Traffic	184
6.6	Conclusion	186
	About the Author	189
	Index	191