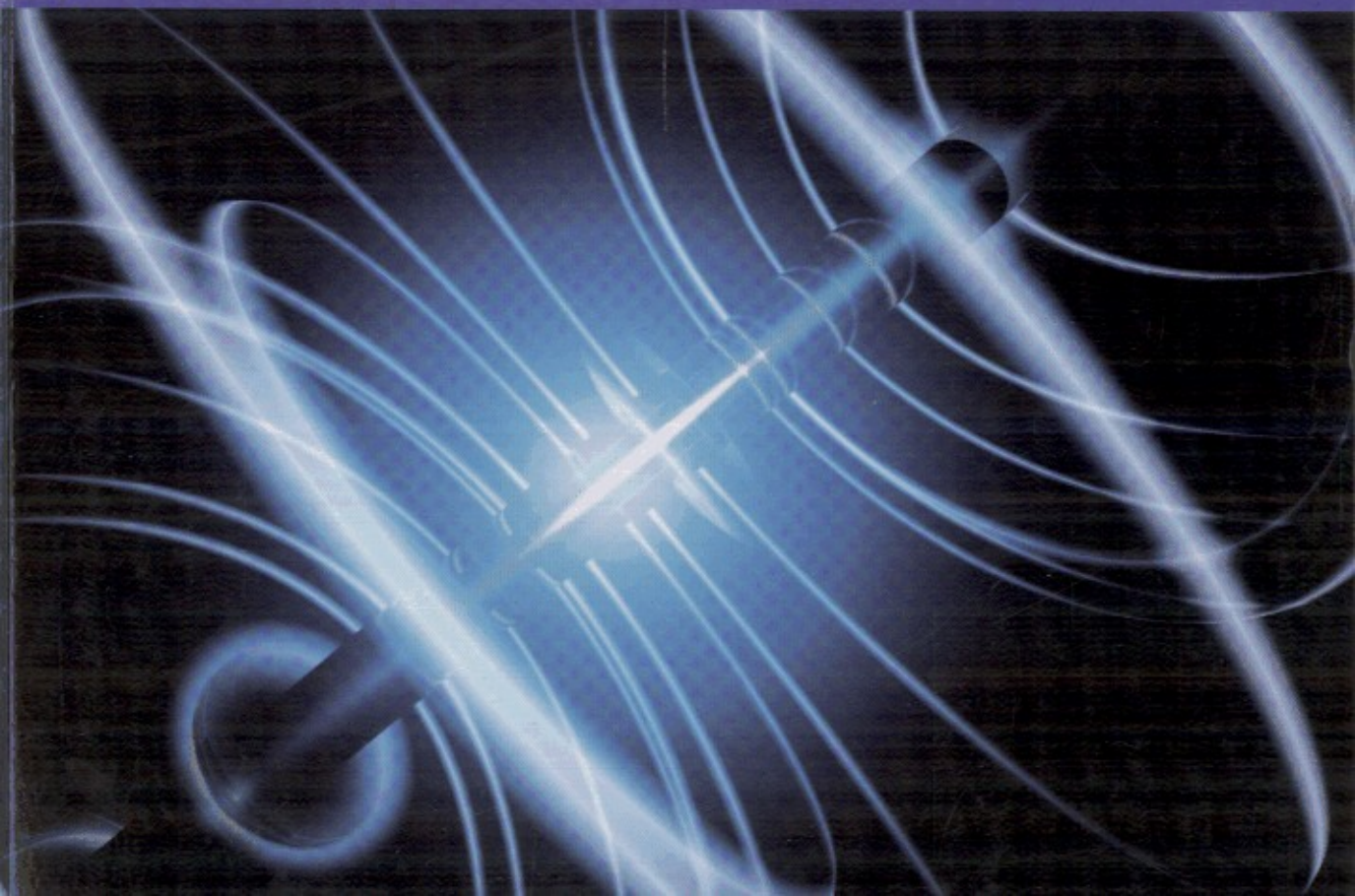


Mobile Communications

Second Edition

JOCHEN SCHILLER



Contents

<i>About the author</i>	xiv
<i>Preface</i>	xv
<i>Acknowledgements</i>	xix

1 Introduction 1

1.1	Applications	3
1.1.1	Vehicles	3
1.1.2	Emergencies	4
1.1.3	Business	4
1.1.4	Replacement of wired networks	5
1.1.5	Infotainment and more	5
1.1.6	Location dependent services	6
1.1.7	Mobile and wireless devices	7
1.2	A short history of wireless communication	9
1.3	A market for mobile communications	15
1.4	Some open research topics	16
1.5	A simplified reference model	18
1.6	Overview	20
1.7	Review exercises	23
1.8	References	23

2 Wireless transmission 25

2.1	Frequencies for radio transmission	26
2.1.1	Regulations	27
2.2	Signals	31
2.3	Antennas	32
2.4	Signal propagation	35
2.4.1	Path loss of radio signals	36
2.4.2	Additional signal propagation effects	37
2.4.3	Multi-path propagation	39

Mobile communications

2.5	Multiplexing	41
2.5.1	Space division multiplexing	41
2.5.2	Frequency division multiplexing	43
2.5.3	Time division multiplexing	44
2.5.4	Code division multiplexing	45
2.6	Modulation	46
2.6.1	Amplitude shift keying	48
2.6.2	Frequency shift keying	49
2.6.3	Phase shift keying	49
2.6.4	Advanced frequency shift keying	50
2.6.5	Advanced phase shift keying	51
2.6.6	Multi-carrier modulation	53
2.7	Spread spectrum	54
2.7.1	Direct sequence spread spectrum	56
2.7.2	Frequency hopping spread spectrum	59
2.8	Cellular systems	61
2.9	Summary	64
2.10	Review exercises	65
2.11	References	66
3	Medium access control	69
3.1	Motivation for a specialized MAC	70
3.1.1	Hidden and exposed terminals	70
3.1.2	Near and far terminals	71
3.2	SDMA	72
3.3	FDMA	72
3.4	TDMA	73
3.4.1	Fixed TDM	74
3.4.2	Classical Aloha	75
3.4.3	Slotted Aloha	76
3.4.4	Carrier sense multiple access	76
3.4.5	Demand assigned multiple access	77
3.4.6	PRMA packet reservation multiple access	78
3.4.7	Reservation TDMA	79
3.4.8	Multiple access with collision avoidance	79
3.4.9	Polling	82
3.4.10	Inhibit sense multiple access	82
3.5	CDMA	82
3.5.1	Spread Aloha multiple access	87

Contents

3.6	Comparison of S/T/F/CDMA	89
3.7	Review exercises	91
3.8	References	92
4	Telecommunications systems	93
4.1	GSM	96
4.1.1	Mobile services	98
4.1.2	System architecture	100
4.1.3	Radio interface	105
4.1.4	Protocols	110
4.1.5	Localization and calling	113
4.1.6	Handover	117
4.1.7	Security	120
4.1.8	New data services	122
4.2	DECT	130
4.2.1	System architecture	131
4.2.2	Protocol architecture	132
4.3	TETRA	134
4.4	UMTS and IMT-2000	136
4.4.1	UMTS releases and standardization	141
4.4.2	UMTS system architecture	142
4.4.3	UMTS radio interface	143
4.4.4	UTRAN	149
4.4.5	Core network	151
4.4.6	Handover	154
4.5	Summary	156
4.6	Review exercises	158
4.7	References	160
5	Satellite systems	165
5.1	History	165
5.2	Applications	166
5.3	Basics	169
5.3.1	GEO	173
5.3.2	LEO	174
5.3.3	MEO	175

Mobile communications

5.4	Routing	175
5.5	Localization	176
5.6	Handover	176
5.7	Examples	177
5.8	Summary	179
5.9	Review exercises	180
5.10	References	181

6 Broadcast systems 183

6.1	Overview	183
6.2	Cyclical repetition of data	185
6.3	Digital audio broadcasting	186
6.3.1	Multi-media object transfer protocol	190
6.4	Digital video broadcasting	191
6.4.1	DVB data broadcasting	193
6.4.2	DVB for high-speed internet access	194
6.5	Convergence of broadcasting and mobile communications	195
6.6	Summary	196
6.7	Review exercises	198
6.8	References	198

7 Wireless LAN 201

7.1	Infra red vs radio transmission	204
7.2	Infrastructure and ad-hoc network	205
7.3	IEEE 802.11	207
7.3.1	System architecture	208
7.3.2	Protocol architecture	210
7.3.3	Physical layer	211
7.3.4	Medium access control layer	214
7.3.5	MAC management	225
7.3.6	802.11b	231
7.3.7	802.11a	234
7.3.8	Newer developments	238
7.4	HIPERLAN	239
7.4.1	Historical: HIPERLAN 1	240
7.4.2	WATM	244
7.4.3	BRAN	255
7.4.4	HiperLAN2	257
7.5	Bluetooth	269
7.5.1	User scenarios	270
7.5.2	Architecture	271

Contents

7.5.3	Radio layer	276
7.5.4	Baseband layer	276
7.5.5	Link manager protocol	282
7.5.6	L2CAP	285
7.5.7	Security	287
7.5.8	SDP	289
7.5.9	Profiles	290
7.5.10	IEEE 802.15	291
7.6	Summary	293
7.7	Review exercises	297
7.8	References	298
8	Mobile network layer	303
8.1	Mobile IP	304
8.1.1	Goals, assumptions and requirements	304
8.1.2	Entities and terminology	307
8.1.3	IP packet delivery	309
8.1.4	Agent discovery	310
8.1.5	Registration	312
8.1.6	Tunneling and encapsulation	315
8.1.7	Optimizations	319
8.1.8	Reverse tunneling	321
8.1.9	IPv6	323
8.1.10	IP micro-mobility support	324
8.2	Dynamic host configuration protocol	328
8.3	Mobile ad-hoc networks	330
8.3.1	Routing	332
8.3.2	Destination sequence distance vector	335
8.3.3	Dynamic source routing	336
8.3.4	Alternative metrics	339
8.3.5	Overview ad-hoc routing protocols	340
8.4	Summary	343
8.5	Review exercises	345
8.6	References	346
9	Mobile transport layer	351
9.1	Traditional TCP	352
9.1.1	Congestion control	352
9.1.2	Slow start	352

Mobile communications

9.1.3	Fast retransmit/fast recovery	353
9.1.4	Implications of mobility	354
9.2	Classical TCP improvements	355
9.2.1	Indirect TCP	355
9.2.2	Snooping TCP	358
9.2.3	Mobile TCP	360
9.2.4	Fast retransmit/fast recovery	362
9.2.5	Transmission/time-out freezing	363
9.2.6	Selective retransmission	363
9.2.7	Transaction-oriented TCP	364
9.3	TCP over 2.5/3G wireless networks	366
9.4	Performance enhancing proxies	368
9.5	Summary	369
9.6	Review exercises	371
9.7	References	372
10	Support for mobility	375
10.1	File systems	376
10.1.1	Consistency	377
10.1.2	Coda	378
10.1.3	Little work	380
10.1.4	Ficus	380
10.1.5	Mio-NFS	381
10.1.6	Rover	381
10.2	World wide web	381
10.2.1	Hypertext transfer protocol	382
10.2.2	Hypertext markup language	385
10.2.3	Some approaches that might help wireless access	386
10.2.4	System architecture	389
10.3	Wireless application protocol (version 1.x)	392
10.3.1	Architecture	393
10.3.2	Wireless datagram protocol	396
10.3.3	Wireless transport layer security	397
10.3.4	Wireless transaction protocol	400
10.3.5	Wireless session protocol	404
10.3.6	Wireless application environment	412
10.3.7	Wireless markup language	414
10.3.8	WMLScript	416

Contents

10.3.9	Wireless telephony application	419
10.3.10	Push architecture	426
10.3.11	Push/pull services	428
10.3.12	Example stacks with WAP 1.x	429
10.4	i-mode	430
10.5	SyncML	433
10.6	WAP 2.0	434
10.7	Summary	437
10.8	Review exercises	440
10.9	References	441
11	Outlook	449
11.1	The architecture of future networks	449
11.2	References	453
	<i>Appendix 1– Acronyms</i>	455
	<i>Appendix 2 – Glossary</i>	471
	<i>Index</i>	477