
Contents

List of Abbreviations	xii
Introduction	xxiii
Chapter 1. Architecture Based on Wi-Fi Access	1
1.1. Functional architecture	1
1.1.1. Architecture based on the S2a interface	1
1.1.2. Architecture based on the S2b interface	4
1.1.3. Architecture based on the S2c interface	7
1.2. Tunnel establishment	8
1.2.1. Architecture based on the S2a interface	8
1.2.2. Architecture based on the S2b interface	12
1.2.3. Architecture based on the S2c interface	13
1.3. DIAMETER protocol	14
1.3.1. AAA server interfaces	15
1.3.2. PCRF interfaces	20
Chapter 2. MAC Layer	23
2.1. Frame structure	23
2.1.1. Frame header	23
2.1.2. Structure of control frames	25
2.1.3. Structure of management frames	26
2.2. Procedures	30
2.2.1. Timers	30
2.2.2. Mobile registration	30
2.2.3. Data transfer	32

2.2.4. Clear channel assessment	34
2.2.5. Frame fragmentation	36
2.2.6. Standby management	36
2.3. Security	38
2.3.1. Security mechanism	38
2.3.2. Security policies	39
2.3.3. MAC header extension.	39
2.4. Quality of service	46
2.4.1. EDCA mechanism	46
2.4.2. Impact on the MAC header	48
Chapter 3. 802.11a/g Interfaces	49
3.1. 802.11a interface.	49
3.1.1. PLCP sub-layer	49
3.1.2. PMD sub-layer	51
3.2. 802.11g interface	58
3.2.1. PLCP sub-layer	58
3.2.2. PMD sub-layer	61
Chapter 4. 802.11n Interface	63
4.1. MAC layer evolution	63
4.1.1. Management frames	64
4.1.2. Structure of the MAC header	66
4.1.3. Frame aggregation	68
4.1.4. Control frames	70
4.2. PLCP sub-layer	72
4.3. PMD sub-layer	75
4.3.1. Transmission chain	75
4.3.2. Frequency plan	78
4.3.3. Frequency multiplexing	78
4.3.4. Space multiplexing	79
4.3.5. Modulation and coding scheme	81
Chapter 5. 802.11ac Interface	85
5.1. MAC layer	85
5.1.1. Management frame evolution.	85
5.1.2. Control frames	89
5.1.3. MAC header structure	90
5.2. PLCP sub-layer	92

5.3. PMD sub-layer	94
5.3.1. Transmission chain	94
5.3.2. Frequency plan	99
5.3.3. Frequency multiplexing	100
5.3.4. Spatial multiplexing	101
5.3.5. Modulation and coding scheme	102
Chapter 6. Mutual Authentication	105
6.1. 802.1x mechanism	105
6.1.1. EAPOL protocol	107
6.1.2. EAP	109
6.1.3. RADIUS messages	111
6.1.4. Authentication procedure	112
6.2. Key management	114
6.2.1. Key hierarchy	114
6.2.2. Four-way handshake procedure	115
6.2.3. Group Key Handshake procedure	116
6.3. Application to the 4G mobile network	117
6.3.1. EAP-AKA method	117
6.3.2. Mutual authentication procedure	118
6.3.3. Procedure for rapid renewal of authentication	121
6.3.4. Application to the MIPv4 FA mechanism	122
Chapter 7. SWu Tunnel Establishment	125
7.1. IPsec mechanism	125
7.1.1. Header extensions	127
7.1.2. IKEv2 protocol	131
7.1.3. Procedure	137
7.2. Application to the 4G mobile network	142
7.2.1. SWu tunnel establishment procedure	142
7.2.2. Procedure for rapid renewal of authentication	145
Chapter 8. S2a/S2b Tunnel Establishment	147
8.1. PMIPv6 mechanism	147
8.1.1. Mobility extension	148
8.1.2. Procedures	149
8.1.3. Application to the 4G mobile network	151
8.2. GTPv2 mechanism	155
8.2.1. Trusted Wi-Fi access	156
8.2.2. Untrusted Wi-Fi access	158

8.3. MIPv4 FA mechanism	158
8.3.1. Components of mobility	158
8.3.2. Foreign agent discovery	159
8.3.3. Registration	160
8.3.4. Procedure	160
8.3.5. Application to the 4G mobile network	162
Chapter 9. S2c Tunnel Establishment	165
9.1. MIPv6 mechanism	165
9.1.1. IPv6 header extensions	166
9.1.2. ICMPv6 messages	169
9.1.3. Procedures	171
9.2. DSMIPv6 mechanism	177
9.3. Application to the 4G mobile network	178
9.3.1. Trusted Wi-Fi access	178
9.3.2. Untrusted Wi-Fi access	179
9.3.3. IFOM function	180
Chapter 10. Network Discovery and Selection	183
10.1. Mechanisms defined by 3GPP organization	183
10.1.1. ANDSF function	183
10.1.2. RAN assistance	191
10.2. Mechanisms defined by IEEE and WFA organizations	192
10.2.1. Information elements provided by the beacon	194
10.2.2. Information elements provided by the ANQP server	195
Chapter 11. Carrier Aggregation	201
11.1. Functional architecture	201
11.2. Protocol architecture	202
11.2.1. LWA	202
11.2.2. LWIP aggregation	205
11.2.3. LAA aggregation	207
11.3. Procedures	207
11.3.1. LWA	207
11.3.2. LWIP aggregation	211
11.3.3. LAA aggregation	212
11.4. PDCP	214

Chapter 12. MPTCP Aggregation	217
12.1. Functional architecture	217
12.2. TCP.	218
12.2.1. TCP header.	218
12.2.2. Opening and closing a connection	220
12.2.3. Data transfer	221
12.2.4. Slow Start and Congestion Avoidance mechanisms.	221
12.2.5. Fast Retransmit and Fast Recovery mechanisms.	222
12.2.6. ECN mechanism.	224
12.3. MPTCP	226
12.3.1. Establishment of MPTCP connection	227
12.3.2. Adding a TCP connection	227
12.3.3. Data transfer	229
12.3.4. Closing an MPTCP connection	231
12.3.5. Adding and removing an address.	233
12.3.6. Return to the TCP connection.	234
Bibliography	235
Index	239