

Contents

Foreword	xv
Preface	xvii
Acknowledgements	xix
List of Figures	xxi
List of Tables	xxvii

PART I IMS ARCHITECTURE AND CONCEPTS

1 Introduction	3
1.1 What is the Internet Protocol Multimedia Subsystem (IMS)?	3
1.2 Fixed and Mobile Convergence	5
1.3 Example of IMS Services	7
1.4 Where did it come from?	9
1.4.1 3GPP Release 99 (3GPP R99)	9
1.4.2 3GPP Release 4	10
1.4.3 3GPP Releases 5 and 6	10
1.4.4 IMS Development in other Standardization Development Organizations	11
1.4.5 3GPP Release 7 and common IMS	12
1.4.6 Insight to 3GPP Release 8	13
1.5 Why a SIP Solution Based on 3GPP Standards?	13
2 IP Multimedia Subsystem Architecture	15
2.1 Architectural Requirements	15
2.1.1 IP Multimedia Sessions	15
2.1.2 IP Connectivity	16
2.1.3 Ensuring Quality of Service for IP Multimedia Services	17
2.1.4 IP Policy Control for Ensuring Correct Usage of Media Resources	17
2.1.5 Secure Communication	18
2.1.6 Charging Arrangements	18
2.1.7 Support of Roaming	19

2.1.8	<i>Interworking with Other Networks</i>	20
2.1.9	<i>Service Control Model</i>	20
2.1.10	<i>Layered Design and Access Independence</i>	21
2.2	Description of IMS-related Entities and Functionalities	22
2.2.1	<i>Call Session Control Functions (CSCF)</i>	23
2.2.2	<i>Emergency Call Session Control Function (E-CSCF)</i>	25
2.2.3	<i>Databases</i>	26
2.2.4	<i>Service Functions</i>	27
2.2.5	<i>IMS-CS Interworking Functions</i>	29
2.2.6	<i>Support Functions</i>	30
2.2.7	<i>Charging Entities</i>	32
2.2.8	<i>GPRS Entities</i>	32
2.3	IMS Reference Points	33
2.3.1	<i>Gm Reference Point</i>	33
2.3.2	<i>Mw Reference Point</i>	34
2.3.3	<i>IMS Service Control (ISC) Reference Point</i>	35
2.3.4	<i>Ma Reference Point</i>	35
2.3.5	<i>Cx Reference Point</i>	35
2.3.6	<i>Dx Reference Point</i>	38
2.3.7	<i>Sh Reference Point</i>	39
2.3.8	<i>Dh Reference Point</i>	40
2.3.9	<i>Si Reference Point</i>	40
2.3.10	<i>Mi Reference Point</i>	42
2.3.11	<i>Mj Reference Point</i>	43
2.3.12	<i>Mk Reference Point</i>	43
2.3.13	<i>Mg Reference Point</i>	43
2.3.14	<i>Mm Reference Point</i>	43
2.3.15	<i>Mr Reference Point</i>	43
2.3.16	<i>Mp Reference Point</i>	43
2.3.17	<i>Mn Reference Point</i>	44
2.3.18	<i>Gx Reference Point</i>	44
2.3.19	<i>Rx Reference Point</i>	45
2.3.20	<i>Charging Reference Points</i>	45
2.3.21	<i>Mx, Ix and Iq Reference Point</i>	45
2.3.22	<i>Ml Reference Point</i>	45
2.3.23	<i>Ut Reference Point</i>	46
3	IMS Concepts	47
3.1	Overview	47
3.2	Registration	48
3.3	Mechanism to Register Multiple User Identities at a Go	49
3.4	Session Initiation	50
3.5	Identification	51
3.5.1	<i>Public User Identity</i>	51
3.5.2	<i>Private User Identity</i>	52
3.5.3	<i>Relationship between Private and Public User Identities</i>	52
3.5.4	<i>Identity Generation Without ISIM</i>	53
3.5.5	<i>Identification of Services (Public Service Identities)</i>	55

3.5.6	<i>Identification of User's Device</i>	55
3.5.7	<i>Identification of Network Entities</i>	56
3.6	IP Multimedia Services Identity Module (ISIM)	57
3.7	Sharing a Single User Identity between Multiple Devices	57
3.8	Discovering the IMS Entry Point	58
3.9	S-CSCF Assignment	59
3.9.1	<i>S-CSCF Assignment during Registration</i>	60
3.9.2	<i>S-CSCF Assignment to Execute Services for an Unregistered User</i>	60
3.9.3	<i>S-CSCF Assignment in Error Cases</i>	61
3.9.4	<i>S-CSCF De-Assignment</i>	61
3.9.5	<i>Maintaining S-CSCF Assignment</i>	61
3.10	Mechanism for Controlling Bearer Traffic	61
3.10.1	<i>Introduction</i>	61
3.10.2	<i>Gating and QoS Control</i>	63
3.10.3	<i>Traffic Plane Event Reporting</i>	71
3.10.4	<i>Network Initiated Bearer Activation</i>	71
3.10.5	<i>Usage of Rx Reference Point</i>	73
3.11	Charging	75
3.11.1	<i>Introduction</i>	75
3.11.2	<i>Charging Architecture</i>	76
3.11.3	<i>Offline Charging</i>	77
3.11.4	<i>Online Charging</i>	79
3.11.5	<i>Flow-Based Charging</i>	80
3.11.6	<i>Charging Reference Points</i>	80
3.11.7	<i>Charging Information Correlation</i>	85
3.11.8	<i>Charging Information Distribution</i>	85
3.12	User Profile	86
3.12.1	<i>Introduction</i>	86
3.12.2	<i>Public Identification</i>	87
3.12.3	<i>Core Network Service Authorization</i>	88
3.12.4	<i>Service-Triggering Information</i>	89
3.13	Service Provision	90
3.13.1	<i>Introduction</i>	90
3.13.2	<i>Creation of Filter Criteria</i>	91
3.13.3	<i>Selection of AS</i>	93
3.13.4	<i>AS Behaviour</i>	93
3.14	Connectivity between Traditional CS Users and IMS Users	94
3.14.1	<i>Introduction</i>	94
3.14.2	<i>IMS-Originated Session Toward a User in the CS Core Network</i>	94
3.14.3	<i>CS-Originated Session Toward a User in IMS</i>	95
3.15	IMS Transit	96
3.16	Support for Local Dialling Plans	98
3.17	IMS Emergency Sessions	100
3.17.1	<i>Introduction and Architecture</i>	100
3.17.2	<i>Emergency Registration</i>	101
3.17.3	<i>Emergency Session Setup</i>	101
3.18	SIP Compression	102
3.18.1	<i>Introduction</i>	102
3.18.2	<i>SigComp Architecture</i>	103
3.18.3	<i>Compressing a SIP Message in IMS</i>	104

3.19	Combination of CS and IMS Services – Combinational Services	105
	3.19.1 <i>Introduction</i>	105
	3.19.2 <i>Capability Exchange</i>	105
	3.19.3 <i>Parallel CS and IMS Services</i>	107
3.20	Voice Call Continuity	107
	3.20.1 <i>Introduction</i>	107
	3.20.2 <i>Voice Call Continuity Functionality</i>	108
	3.20.3 <i>Voice Call Continuity Session Initiation and Termination</i>	108
	3.20.4 <i>Voice Call Continuity Domain Transfer Procedure</i>	111
	3.20.5 <i>Supplementary Services</i>	113
3.21	Security Services in the IMS	113
	3.21.1 <i>IMS Security Model</i>	114
	3.21.2 <i>Authentication</i>	114
	3.21.3 <i>Network Domain Security (NDS)</i>	118
	3.21.4 <i>IMS Access Security for SIP-Based Services</i>	121
	3.21.5 <i>IMS Access Security for HTTP-Based Services</i>	125
3.22	Interworking between IPv4 and IPv6 in the IMS	126
	3.22.1 <i>Introduction</i>	126
	3.22.2 <i>Network Address Translation</i>	127
	3.22.3 <i>IPv6-Only Versus Dual Stack</i>	132
	3.22.4 <i>Interworking Scenarios</i>	133
	3.22.5 <i>Intra-Domain Scenarios</i>	133
	3.22.6 <i>Inter-Domain Scenarios</i>	133
	3.22.7 <i>Configuration and Bootstrapping</i>	133
	3.22.8 <i>IPv4-Only Access Networks</i>	134

PART II IMS SERVICES

4	Presence	139
4.1	Who will use the Presence Service?	139
4.2	Presence-Enhanced Services	140
4.3	Presence Contributing to Business	140
4.4	What is Presence?	141
4.5	Presence Service in IMS	142
4.6	Publishing Presence	144
4.7	Subscribing Presence	145
4.8	Watcher Information	147
4.9	Setting Presence Authorization	149
5	Group Management	151
5.1	Group Management's Contribution to Business	152
5.2	What is Group Management?	152
5.3	What is XML Configuration Access Protocol?	153
5.4	What is Common Policy?	153
	5.4.1 <i>Model and Rule Structure</i>	154

5.4.2	<i>Data Types and Permission Processing</i>	155
5.5	Resource List	156
5.6	XCAP Usage for Resource Lists	156
5.7	Open Mobile Alliance Solution for Group Management	159
5.7.1	<i>Service Specific XML Document Management Servers</i>	159
5.7.2	<i>Shared XML Document Management Servers</i>	168
5.8	Multimedia Telephony and Service Management	171
5.8.1	<i>Communication Barring</i>	172
5.8.2	<i>Communication Diversion</i>	172
5.8.3	<i>Originating Identification Services</i>	172
5.8.4	<i>Terminating Identification Services</i>	173
5.8.5	<i>Multimedia Telephony Service Management Example</i>	173
6	Push to Talk Over Cellular	175
6.1	PoC Architecture	176
6.1.1	<i>PoC Server</i>	177
6.1.2	<i>PoC Client</i>	178
6.2	PoC Features	178
6.2.1	<i>PoC Communication</i>	178
6.2.2	<i>Simultaneous PoC Sessions</i>	180
6.2.3	<i>PoC Session Establishment Models</i>	181
6.2.4	<i>Incoming PoC Session Treatment</i>	183
6.2.5	<i>Instant Personal Alerts</i>	186
6.2.6	<i>Group Advertisement</i>	187
6.2.7	<i>Barring Features</i>	188
6.2.8	<i>Participant Information</i>	188
6.3	User Plane	189
6.3.1	<i>Talk Bursts</i>	189
6.3.2	<i>Talk Burst Control</i>	190
6.3.3	<i>Quality Feedback</i>	191
6.4	PoC Service Settings	192
7	Messaging	195
7.1	Overview of IMS Messaging	195
7.2	Immediate Messaging	195
7.3	Session-Based Messaging	197
7.4	Messaging Interworking	198
7.5	Instant Messaging by Open Mobile Alliance	201
7.5.1	<i>OMA IM Architecture</i>	202
7.5.2	<i>IM Communication</i>	203
7.5.3	<i>Conversation History</i>	211
7.5.4	<i>Deferred Messaging</i>	213
7.5.5	<i>IM Service Settings</i>	215
7.5.6	<i>IM User-Plane</i>	217
7.5.7	<i>Delivery Reports</i>	218

8	Conferencing	221
8.1	IMS Conferencing Architecture and Principles	221
8.1.1	<i>SIP Focus/Conferencing AS/MRFC</i>	221
8.1.2	<i>Conference Mixer–MRFP</i>	221
8.1.3	<i>Conference Participant</i>	222
8.1.4	<i>Conference Moderator, Floor Control and Conference Policy Control</i>	222
8.1.5	<i>Sidebars</i>	223
8.2	IMS Conferencing Procedures	223
8.2.1	<i>Conference Creation</i>	223
8.2.2	<i>Joining a Conference</i>	226
8.2.3	<i>Conference State Event Package</i>	228
8.2.4	<i>Floor Control</i>	230
9	Multimedia Telephony	233
9.1	Introduction	233
9.2	Multimedia Telephony Communication	234
9.2.1	<i>SIP and IMS Multimedia Telephony</i>	234
9.2.2	<i>IMS Communication Service Identification (ICSI) and Telephony Application Server (TAS)</i>	234
9.3	Supplementary Services	235
9.3.1	<i>Communication Barring</i>	235
9.3.2	<i>Communication Diversion</i>	236
9.3.3	<i>Communication Hold</i>	238
9.3.4	<i>Conference</i>	239
9.3.5	<i>Message Waiting</i>	240
9.3.6	<i>Originating Identification Presentation</i>	242
9.3.7	<i>Originating Identification Restriction</i>	243
9.3.8	<i>Terminating Identification Presentation (TIP)</i>	244
9.3.9	<i>Terminating Identification Restriction (TIR)</i>	244
9.3.10	<i>Explicit Communication Transfer</i>	245
 PART III DETAILED PROCEDURES		
10	Introduction to Detailed Procedures	249
10.1	The Example Scenario	249
10.2	Base Standards	251
11	An Example of IMS Registration	253
11.1	Overview	253
11.2	Initial Parameters and IMS Management Object	255
11.3	Signalling PDP Context Establishment	256
11.4	P-CSCF Discovery	257
11.4.1	<i>Overview</i>	257
11.4.2	<i>SIP and DNS Server Configuration via DHCPv6</i>	258
11.4.3	<i>DNS Naming Authority Pointer (NAPTR) Resolving</i>	259
11.4.4	<i>Transport Protocol Selection and DNS Service (SRV) Resolving</i>	259
11.4.5	<i>DNS IPv6 Address Resolving</i>	260

11.4.6	<i>Related Standards</i>	260
11.5	SIP Registration and Registration Routing Aspects	260
11.5.1	<i>Overview</i>	260
11.5.2	<i>Constructing the REGISTER Request</i>	262
11.5.3	<i>From the UE to the P-CSCF</i>	263
11.5.4	<i>From the P-CSCF to the I-CSCF</i>	264
11.5.5	<i>From the I-CSCF to the S-CSCF</i>	264
11.5.6	<i>Registration at the S-CSCF</i>	266
11.5.7	<i>The 200 (OK) Response</i>	268
11.5.8	<i>The Service-Route Header</i>	269
11.5.9	<i>The Path Header</i>	270
11.5.10	<i>Third-Party Registration to Application Servers</i>	271
11.5.11	<i>Updating the User Profile</i>	272
11.5.12	<i>Related Standards</i>	273
11.6	Authentication	273
11.6.1	<i>Overview</i>	273
11.6.2	<i>HTTP Digest and 3GPP AKA</i>	275
11.6.3	<i>Authentication Information in the Initial REGISTER Request</i>	275
11.6.4	<i>S-CSCF Downloads the Authentication Vector (AV) from the HSS</i>	276
11.6.5	<i>S-CSCF Challenges the UE</i>	277
11.6.6	<i>UE's Response to the Challenge</i>	278
11.6.7	<i>Integrity Protection and Successful Authentication</i>	279
11.6.8	<i>Related Standards</i>	279
11.7	Access Security – IPsec SAs	279
11.7.1	<i>Overview</i>	279
11.7.2	<i>Establishing an SA During Initial Registration</i>	280
11.7.3	<i>Handling of Multiple Sets of SAs in the Case of Re-authentication</i>	282
11.7.4	<i>SA Lifetime</i>	284
11.7.5	<i>Port Setting and Routing</i>	285
11.7.6	<i>Related Standards</i>	288
11.8	SIP Security Mechanism Agreement	289
11.8.1	<i>Why the SIP Security Mechanism Agreement is Needed</i>	289
11.8.2	<i>Overview</i>	289
11.8.3	<i>Sip-Sec-Agree-Related Headers in the Initial REGISTER Request</i>	290
11.8.4	<i>The Security-Server Header in the 401 (Unauthorized) Response</i>	291
11.8.5	<i>Sip-Sec-Agree Headers in the Second REGISTER</i>	292
11.8.6	<i>Sip-Sec-Agree and Re-Registration</i>	292
11.8.7	<i>Related Standards</i>	294
11.9	IMS Communication Service Identification and other Callee Capabilities	294
11.9.1	<i>Overview</i>	294
11.9.2	<i>Feature Tags: Callee Capabilities</i>	295
11.9.3	<i>IMS Communication Service Identification (ICSI) and IMS Application Reference Identification (IARI)</i>	295
11.9.4	<i>Related Standards and Links</i>	297
11.10	Compression Negotiation	297
11.10.1	<i>Overview</i>	297
11.10.2	<i>Indicating willingness to use SigComp</i>	298
11.10.3	<i>comp=SigComp Parameter During Registration</i>	298
11.10.4	<i>comp=SigComp Parameter in Other Requests</i>	299
11.10.5	<i>Related Standards</i>	300

11.11	Access and Location Information	300
	11.11.1 <i>P-Access-Network-Info</i>	300
	11.11.2 <i>P-Visited-Network-ID</i>	300
	11.11.3 <i>Related Standards</i>	301
11.12	Charging-Related Information During Registration	301
11.13	User Identities	301
	11.13.1 <i>Overview</i>	301
	11.13.2 <i>Public and Private User Identities for Registration</i>	302
	11.13.3 <i>Identity Derivation from USIM</i>	303
	11.13.4 <i>Default Public User Identity/P-Associated-URI Header</i>	303
	11.13.5 <i>Assignment of a Globally Routable User Agent URI</i>	304
	11.13.6 <i>UE's Subscription to Registration-State Information</i>	305
	11.13.7 <i>P-CSCF's Subscription to Registration-State Information</i>	308
	11.13.8 <i>Elements of Registration-State Information</i>	309
	11.13.9 <i>Registration-State Information in the Body of the NOTIFY Request</i>	309
	11.13.10 <i>Example Registration-State Information</i>	311
	11.13.11 <i>Multiple Terminals and Registration-State Information</i>	315
	11.13.12 <i>Related Standards</i>	316
11.14	Re-Registration and Re-Authentication	317
	11.14.1 <i>User-initiated Re-registration</i>	317
	11.14.2 <i>Network-Initiated Re-Authentication</i>	317
	11.14.3 <i>Network-Initiated Re-Authentication Notification</i>	318
	11.14.4 <i>Related Standards</i>	319
11.15	De-Registration	319
	11.15.1 <i>Overview</i>	319
	11.15.2 <i>User-Initiated De-Registration</i>	321
	11.15.3 <i>Network-Initiated De-Registration</i>	324
	11.15.4 <i>Related Standards</i>	326
11.16	GPRS-IMS-Bundled Authentication (GIBA)	326
	11.16.1 <i>Example IMS Registration with Fallback to GIBA</i>	326
	11.16.2 <i>GIBA Scenarios</i>	329
12	An Example IMS Multimedia Telephony Session	331
12.1	Overview	331
12.2	Caller and Callee Identities	333
	12.2.1 <i>Overview</i>	333
	12.2.2 <i>From and To Headers</i>	333
	12.2.3 <i>Identification of the Calling User: P-Preferred-Identity and P-Asserted-Identity</i>	334
	12.2.4 <i>Identification of the Called User</i>	335
	12.2.5 <i>Related Standards</i>	337
12.3	Routing	337
	12.3.1 <i>Overview</i>	337
	12.3.2 <i>Session, Dialog, Transactions and Branch</i>	338
	12.3.3 <i>Routing of the INVITE Request</i>	340
	12.3.4 <i>Routing of the First Response</i>	345
	12.3.5 <i>Re-transmission of the INVITE Request and the 100 (Trying) Response</i>	347
	12.3.6 <i>Routing of Subsequent Requests in a Dialog</i>	347
	12.3.7 <i>Standalone Transactions from One UE to Another</i>	349
	12.3.8 <i>Routing to and from ASs</i>	349

12.3.9	<i>IMS Communication Service Identification</i>	352
12.3.10	<i>Related Standards</i>	360
12.4	Compression Negotiation	360
12.4.1	<i>Overview</i>	360
12.4.2	<i>Compression of the Initial Request</i>	360
12.4.3	<i>Compression of Responses</i>	361
12.4.4	<i>Compression of Subsequent Requests</i>	362
12.4.5	<i>Related Standards</i>	362
12.5	Media Negotiation	362
12.5.1	<i>Overview</i>	362
12.5.2	<i>Reliability of Provisional Responses</i>	364
12.5.3	<i>SDP Offer/Answer in IMS</i>	365
12.5.4	<i>Related Standards</i>	373
12.6	Resource Reservation	373
12.6.1	<i>Overview</i>	373
12.6.2	<i>The 183 (Session in Progress) Response</i>	374
12.6.3	<i>Are Preconditions Mandatorily Supported?</i>	374
12.6.4	<i>Preconditions</i>	376
12.6.5	<i>Establishing the Media Resources and PCC Related Actions</i>	381
12.6.6	<i>Media Policing</i>	382
12.6.7	<i>Related Standards</i>	383
12.7	Charging-Related Procedures During Session Establishment for Sessions	383
12.7.1	<i>Overview</i>	383
12.7.2	<i>Inter-Operator Identifier Exchange of ICID for a Media Session</i>	384
12.7.3	<i>Correlation of GCID and ICID</i>	385
12.7.4	<i>Distribution of Charging Function Addresses</i>	386
12.7.5	<i>Related Standards</i>	387
12.8	Release of a Session	387
12.8.1	<i>User-Initiated Session Release</i>	387
12.8.2	<i>P-CSCF Performing Network-Initiated Session Release</i>	388
12.8.3	<i>S-CSCF Performing Network-Initiated Session Release</i>	389
12.9	Alternative IMS Session Establishment Procedures	389
12.9.1	<i>Overview</i>	389
12.9.2	<i>Session with a Uni-Directional Media Stream and Available Resources on A Side</i>	390
12.9.3	<i>Session with a Uni-Directional Media Stream and Resources Need to be Reserved on A and B Side</i>	395
12.9.4	<i>Resources Available on B Side Only</i>	398
12.9.5	<i>Network Initiated Resource Reservation, Resources Available Only at A-Side</i>	400
12.9.6	<i>Network Initiated Resource Reservation at A Side</i>	404
12.9.7	<i>Resources Available on A Side and B Side</i>	406
12.9.8	<i>Early Media and Reliable Ring-Back Tone</i>	408
12.9.9	<i>Session Towards a Non-IMS SIP Terminal</i>	410
12.9.10	<i>Session From Non-IMS SIP Terminal</i>	414
12.9.11	<i>Related Standards</i>	415
12.10	Routing of GRUUs	415
12.10.1	<i>Theresa Registers her Laptop</i>	415
12.10.2	<i>REFER Request in Order to Transfer the Ongoing Call to Theresa's Laptop</i>	416
12.10.3	<i>Setting up the New Call to Theresa's Laptop</i>	417

12.11	Routing of PSIs	418
	12.11.1 Scenario 1: Routing From a User to a PSI	418
	12.11.2 Scenario 2: Routing From a PSI to a User	419
	12.11.3 Scenario 3: Routing From a PSI to Another PSI	420
12.12	A Short Introduction to GPRS	420
	12.12.1 Overview	420
	12.12.2 Packet Data Protocol (PDP)	421
	12.12.3 PDP Context Types	422
13	An example IMS Voice Call Continuity Procedures	425
13.1	Overview	425
13.2	Configuring the Clients with Communication Continuity Configuration Parameters	427
13.3	Setting up the Initial Call and Call Anchoring	429
	13.3.1 Tobias Sets up a CS Call Towards Theresa	429
	13.3.2 Anchoring Decision and Routing the CS Call to the MGCF	429
	13.3.3 Interworking the CS Call to IMS at the MGCF	431
	13.3.4 Forwarding the IMS call to the VCC Application Server (resolving and direct routing of PSI)	436
	13.3.5 Anchoring the Call in Tobias's Domain	437
	13.3.6 Forwarding the Call to Theresa's Domain	441
	13.3.7 Anchoring the call in Theresa's Domain	447
	13.3.8 Delivering the Call to Theresa	452
	13.3.9 Establishing the End-to-End Call	453
	13.3.10 Scenario After Anchoring	456
13.4	Domain Transfer: CS to IMS	457
	13.4.1 Tobias's Phone Invokes VCC Procedures	457
	13.4.2 Routing to Tobias's VCC AS	459
	13.4.3 Tobias's VCC AS Performs the CS to IMS Domain Transfer	460
	13.4.4 Scenario after CS to IMS Domain Transfer	462
13.5	Theresa adds Video to the Call	463
13.6	Domain Transfer: IMS to CS	465
	13.6.1 Theresa's Phone Starts VCC Procedures	465
	13.6.2 From Theresa's Phone to Theresa's VCC AS	466
	13.6.3 Performing the IMS to CS Domain Transfer	466
	13.6.4 Scenario after IMS to CS Domain Transfer	467
13.7	Related Standards	468
	References	471
	List of Abbreviations	477
	Index	487