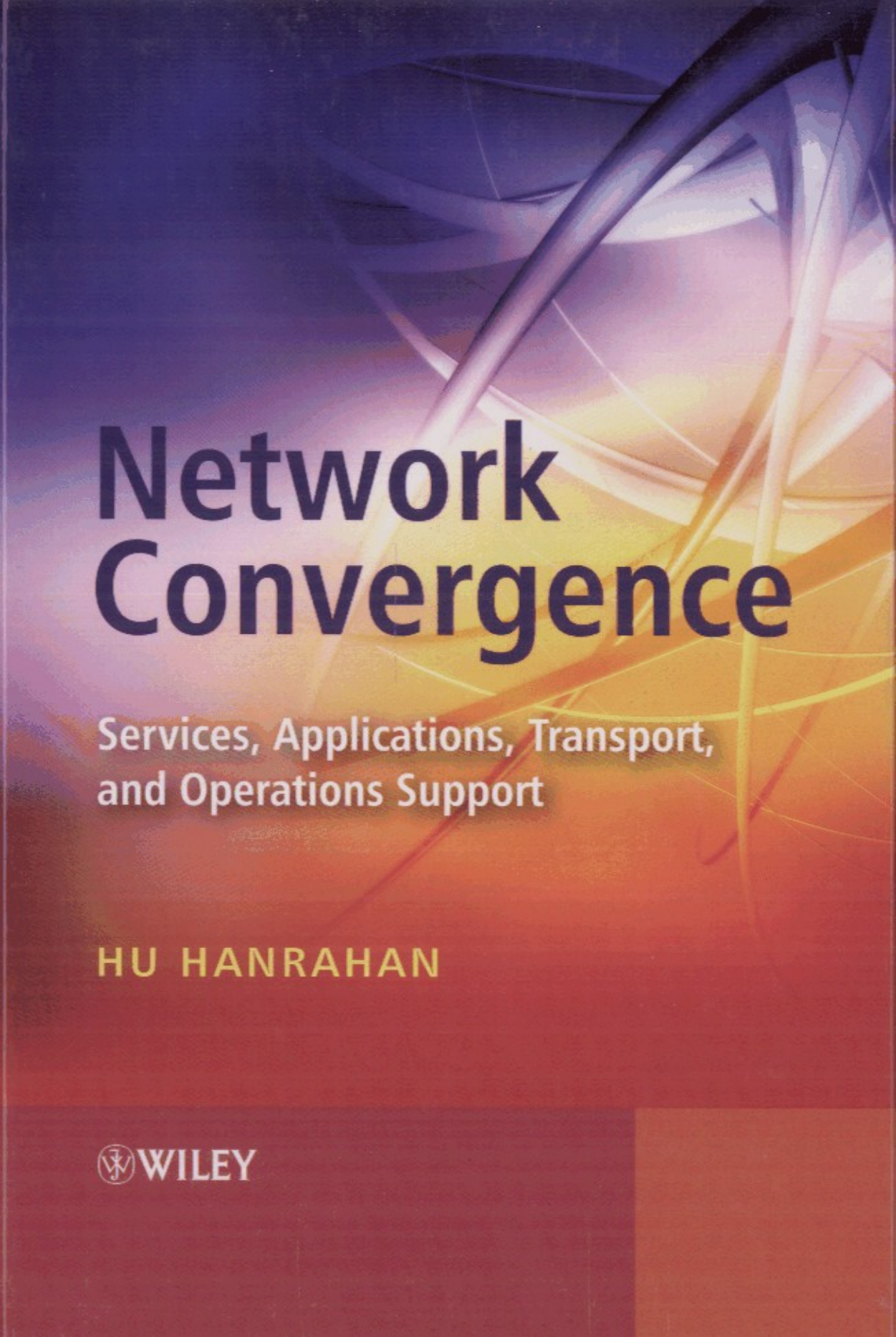




Network Convergence

Services, Applications, Transport,
and Operations Support

HU HANRAHAN

 WILEY

Contents

Preface	xiii
Acknowledgments	xv
Conventions	xv
Companion Website	xvi
Abbreviations	xvii
Principal Graphic Symbols	xxvii
1 Setting the Context for Evolution and Convergence of Networks	1
1.1 Historical Background to Present Networks	2
1.2 Defining Present State Using Reference Models	4
1.2.1 Silo Model for Vertically Integrated Networks	5
1.2.2 Present State: Fixed and Mobile Networks with IN Overlay .	6
1.2.3 Present State: Data Service in Mobile Networks	20
1.2.4 Present State: The Internet	23
1.2.5 Present State: Enterprise Networking	30
1.2.6 Present State: Switched and Leased-line Services	31
1.3 Evolution and Convergence	32
1.3.1 Initial Convergence Examples	33
1.3.2 Features of Convergence	34
1.4 The Next Generation Network Concept	37
1.5 Conclusion	39
2 A Framework for Examining Next Generation Networks	41
2.1 Characteristics of Evolving Networks	41
2.1.1 Proliferation of Terminals and Access Networks	43
2.1.2 Core Network Types	44
2.1.3 Evolution of Service Architectures	45
2.2 Dealing with Complexity	48
2.3 Framework for Evolving Networks	51
2.3.1 Layering	53
2.3.2 Domains	62
2.3.3 Planes	64
2.3.4 Summary of the NGN Framework	67
2.4 Examples of Application of Framework	68
2.4.1 Legacy Networks Elements in the Framework	68

2.4.2	From Circuit Switch to Softswitch	69
2.4.3	Conceptualising Convergence in Layered Model	72
2.4.4	Drawing the Boundary of the Regulated Domains	74
2.4.5	Digital Video Broadcasting in the Framework	74
2.5	Conclusion	76
3	Software Methodologies for Converged Networks and Services	77
3.1	Development of Software Methodologies for ICT	78
3.2	Software Processes in the NGN Framework	79
3.2.1	Software Analysis and Design Requirements	80
3.2.2	Functional Entities as Software Elements	80
3.2.3	Physical Entities in the Framework	82
3.2.4	Specification and Description Requirements	83
3.2.5	Modelling	83
3.3	High-level Analysis and Design Methods	84
3.3.1	The Reference Model of Open Distributed Processing	84
3.3.2	Model Driven Architecture	88
3.3.3	SDL and MSC	90
3.3.4	A Legacy System Method: UFM	92
3.3.5	Generalising High-level Methods	94
3.3.6	Role of Software Architectures	95
3.3.7	Software Modelling Notations	95
3.4	Enterprise and Business Modelling Notation	98
3.4.1	Enterprise Language	98
3.4.2	UML Use Case Diagrams	99
3.5	Object and Data Definition Languages	100
3.5.1	UML Class and Object Diagrams	100
3.5.2	Abstract Syntax Notation One	102
3.5.3	Interface Definition Language	106
3.5.4	Classical Telecommunications Protocols	107
3.5.5	Method Calls as Application Protocols	108
3.5.6	IETF Text-based Protocols	108
3.5.7	Hypertext Markup Language	111
3.5.8	Extensible Markup Language	111
3.6	Dynamic Modelling Notations	114
3.6.1	Activity, Communication and Robustness Diagrams	114
3.6.2	Message Sequence Charts	115
3.6.3	State Diagrams	119
3.6.4	Connection Models	121
3.7	Component and Interface Notations	122
3.8	Distributed Systems	124
3.8.1	Network Protocol-based Distributed Systems	125
3.8.2	Remote Method Invocation	125
3.8.3	Web Services Model	126
3.8.4	CORBA-based Systems	127
3.9	Creating a Unified Framework	129

4	An NGN: the Managed Voice over IP Network	131
4.1	Development of Packet Multimedia Standards	132
4.2	Requirements on a Managed Voice Network	133
4.3	Properties of Packetised Voice	134
4.3.1	Key Properties of Speech	134
4.3.2	Digitising Speech	135
4.3.3	Reducing the Bit-rate	135
4.3.4	Speech Quality Metrics	136
4.3.5	Audio Processing for Conferencing	137
4.4	General Concepts of Multimedia Communications	138
4.4.1	Access Configurations	140
4.4.2	Terminology	142
4.4.3	Generalised Softswitched System Configurations	142
4.4.4	Generalised Multimedia Call Signalling	144
4.5	Signalling Plane for Packet Multimedia	145
4.5.1	Real-time Transport Protocol	146
4.5.2	Reliable Signalling Transport in Packet Networks: SCTP	151
4.6	The H.323 Suite	156
4.6.1	Development and Structure of H.323.	156
4.6.2	The H.323 Architecture	157
4.6.3	Gateway Decomposition	158
4.6.4	Addressing in H.323 systems	160
4.6.5	H.323 Protocol Stacks	160
4.7	Media Gateway Functions and Control	166
4.7.1	Media Gateway Entities	166
4.7.2	Media Gateway Control Protocol: Megaco	167
4.7.3	Media Gateway Control Protocol	170
4.8	Multimedia Communications Based on SIP	170
4.8.1	IETF Multimedia Conferencing Protocols	170
4.8.2	Architecture of SIP Multimedia Systems	172
4.8.3	SIP Methods and Modes of Operation	174
4.8.4	Session Description Protocol	178
4.8.5	Use Cases for SIP	179
4.9	Supplementary Services in Packet Telephony	185
4.9.1	Supplementary Services in H.323	185
4.9.2	Call Services in SIP Telephony	187
4.10	ITU-T Evolutionary Protocols: BICC	188
4.11	Voice on the Internet	190
4.12	Conclusion	191
5	Integrated Enterprise ICT Systems	193
5.1	Drivers and Requirements	193
5.1.1	Convergence in the Enterprise Domain	194
5.1.2	Corporate Requirements	195
5.1.3	Modelling Integrated Enterprise ICT Systems	197

5.2	Contributions to Convergence	198
5.2.1	Adoption of Commercial-off-the-Shelf Components	198
5.2.2	The Multimedia Softswitch	199
5.2.3	Computer Telephony Integration	201
5.2.4	Enterprise System Software Architecture	214
5.3	Network Level Convergence	216
5.4	Application and Service Level Convergence	221
5.5	Conclusions	223
6	Legacies and Lessons: Broadband ISDN, TINA and TIPHON	225
6.1	Learning from History	225
6.2	The Broadband ISDN	226
6.2.1	B-ISDN Architecture	226
6.2.2	Asynchronous Transfer Mode	227
6.2.3	Call and Connection Control	229
6.2.4	Routing and Call Control Protocols	230
6.2.5	B-ISDN and IN	231
6.2.6	Appraisal of B-ISDN	231
6.3	TINA Architecture	232
6.3.1	The TINA Architecture	232
6.3.2	TINA Layers	234
6.3.3	Planes: Hiding Physical Resources	235
6.3.4	TINA and RM-ODP	235
6.4	Business Model and Reference Points	236
6.4.1	Generic Business Domains	236
6.4.2	Interdomain Reference Points	238
6.4.3	Business Scenarios	239
6.5	TINA Service Architecture	240
6.5.1	Service Architecture: Information Viewpoint	241
6.5.2	Computational Viewpoint: the Service Components	243
6.6	Network Resource Architecture	254
6.6.1	Use Case 6: Convert Steam Binding to Network Connection	254
6.7	Lessons from TINA for NGNs	256
6.7.1	Achievements of TINA as an NGN	256
6.7.2	Weaknesses of TINA	257
6.8	TIPHON	260
6.8.1	Objectives of TIPHON	260
6.8.2	TIPHON Layered Model	261
6.8.3	TIPHON Business Models	261
6.8.4	TIPHON Domain and Interworking Model	262
6.8.5	TIPHON Functional Architecture	263
6.8.6	Registration and Mobility in TIPHON	266
6.8.7	TIPHON Metaprotocol	267
6.8.8	TIPHON Implementation using Established Protocols	268

6.8.9	TIPHON and Multimedia Services	270
6.8.10	Appraisal of TIPHON	270
6.9	Conclusion	271
7	Important NGNs: Third Generation Mobile Communication Systems	273
7.1	Architectural Concepts	274
7.1.1	Concept of a Public Land Mobile Network	274
7.1.2	Structural Features of a PLNM	275
7.1.3	Geographical Relationships in a PLNM	277
7.2	Mobile Communication System Evolution	277
7.2.1	Baseline: the Second Generation Mobile Network	278
7.2.2	Identification of Mobile Network Generations	280
7.2.3	Evolution of the Radio Access Network	281
7.2.4	Development of the MSC	282
7.2.5	Terminals in the 3G Context	285
7.3	Services in the CS Domain	286
7.3.1	Mobility Management in the CS Domain	286
7.3.2	Call Handling in 3G Systems	287
7.3.3	Setting Up Bearer Connections in the 3G CS Domain	290
7.3.4	CAMEL-based Services in the CS Domain	290
7.4	Packet-switched Domain: GPRS-based Systems	296
7.4.1	GPRS-based Packet-domain Architecture	297
7.4.2	GPRS Support Node Functions	298
7.4.3	Mobility Management in the PS domain	299
7.4.4	Packet Transport in GPRS	300
7.4.5	Protocols Used in GPRS Access and Core	301
7.4.6	GPRS and CAMEL	303
7.5	IP Multimedia Subsystem	306
7.5.1	Origins and Objectives of the IMS	306
7.5.2	IMS Architecture and Components	308
7.5.3	IETF Protocols used in IMS	310
7.5.4	IMS Service Model	312
7.5.5	Session Control	313
7.5.6	Value-added IM Services	320
7.5.7	The 3GPP2 All-IP Approach to 3G Networks	324
7.6	Conclusion	325
8	Opening the Network using Application Programming Interfaces	327
8.1	Closed Network Evolution	327
8.2	Opening the Network	329
8.2.1	Business Models	331
8.3	The OSA/Parlay Architecture	332
8.3.1	Architectural Concepts	332
8.3.2	API Definition Method and Technology Independence	334
8.4	Framework Interfaces and Use Cases	335
8.4.1	Use Case: Provisioning a Gateway Service	335
8.4.2	Use Cases: An Application Gains Access to a Service Manager	337

8.5	The OSA/Parlay Gateway	339
8.5.1	Standard Service Capability Features	339
8.5.2	Interface Definition Design Pattern	340
8.5.3	Interaction in Communication-oriented SCFs	342
8.6	Communication-orientated Use Cases	344
8.6.1	Call Control and User Interaction Interfaces	344
8.6.2	Concept of a Call in OSA Parlay	344
8.6.3	Interfaces and Interactions	348
8.6.4	Network Event Detection and Reporting	348
8.6.5	Call, Call Leg and Callback Object Creation	350
8.6.6	User Interaction	352
8.6.7	Handling a Triggered Notification	353
8.6.8	Call Supervision	354
8.6.9	Multimedia Media Stream Control	356
8.6.10	Conference Control	357
8.6.11	Data Session Control	360
8.6.12	Generic Messaging	361
8.6.13	Mobility, Account Management and Terminal Capabilities . .	363
8.6.14	Presence and Availability	364
8.6.15	Charging and Account Management	365
8.6.16	Connection Management	365
8.6.17	OSA/Parlay Data Structures	365
8.6.18	Sample Service	366
8.7	Parlay X Web Services	368
8.7.1	The Case for a Simpler API	368
8.7.2	The Parlay X Web Services Architecture	369
8.7.3	Parlay X Web Service Example: Audiocall	372
8.7.4	Parlay X Implementation via OSA/Parlay	374
8.8	OSA/Parlay API Implementation Issues	374
8.8.1	Gateway-to-Network Interface	374
8.8.2	Abstraction Revisited	377
8.8.3	Service Deployment Scenarios	378
8.8.4	Service Creation	379
8.9	Other Approaches to Open Networks	380
8.9.1	JAIN	380
8.9.2	Open Mobile Alliance Service Environment	381
8.9.3	The Service Delivery Platform Concept	383
8.10	Conclusion	384
9	Operations Support Systems	385
9.1	Relationship of OSS/BSS to ICT Systems	386
9.2	Evolution of OSS/BSS	388
9.2.1	The OSI Network Management Model	389
9.2.2	IETF Network Management Standards	391
9.2.3	The Telecommunications Management Network	395
9.3	The Telecommunications Operations Map	398
9.4	Enhancement of the TOM: eTOM	401

9.5	New Generation OSS	402
9.6	Conclusion	405
10	Migration from Legacy to Next Generation Networks	407
10.1	Retrospect	407
10.2	Reflecting on Evolution and Convergence	408
10.2.1	The Evolution Metaphor, with Hindsight	408
10.2.2	Market-oriented Objectives	410
10.2.3	Promoting Convergence	411
10.3	Technology Migration	411
10.3.1	The Migration Process	412
10.4	Is There a Target NGN?	415
10.4.1	Whither Fixed Networks?	416
10.4.2	Are Fixed and Mobile Networks Distinct?	417
10.4.3	Fourth Generation Mobile Communication Systems	417
10.5	Managing Complexity: Avoiding Pitfalls	418
10.5.1	Do Not Forget the Principles	419
10.5.2	Be Aware of Leaky Abstractions	419
10.5.3	Silos May Still be Created	420
10.5.4	Be Aware of Hype	420
10.5.5	Handling The Great Debates	421
10.5.6	Evolution is an Ongoing Process	421
10.5.7	Revisit the Treasure House	422
10.6	A Last Word	422
	Glossary	423
	References	431
	Index	447