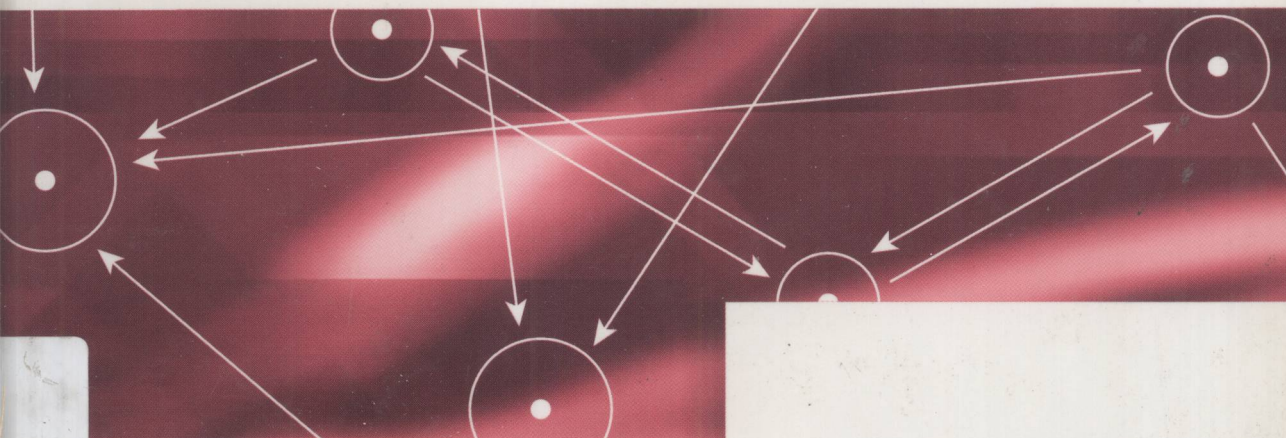




mobile communications series

Arnaud Henry-Labordère  
Vincent Jonack

# **SMS and MMS** **Interworking** **in Mobile Networks**



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# SMS and MMS Interworking in Mobile Networks

Arnaud Henry-Labordère  
Vincent Jonack



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# **SMS and MMS Interworking in Mobile Networks**

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# Introduction

In December 2002, an invitation to lecture at the Belgacom Corporate University (Brussels) offered the opportunity to put together several years of research on the subject of short message service. The *Global System for Mobile Communications* (GSM) includes a large number of beautifully specified standards, with visionary ideas. Comparatively, IS-41 (the U.S.-originated mobile standard specifications for CDMA and TDMA) is much less developed. The GSM specifications are a wonderful reference but they give only a canonical description of the subject.

*Short message service* (SMS) is a very clever and economical resource that was designed back in the 1980s when GSM specifications were taken from CNET (the research center of France Telecom) and redeveloped as a worldwide standard. These services have been tremendously successful and *multimedia messaging* (MMS) will have the same success. For the same network resources as a telephone call, SMS services provide about 100 times more revenue to the operators.

I have been interested in the subject of SMS and now MMS for several years. Currently, when a telephone call is made to any number in the world, the called party is reached. For SMS, this is not yet the case by far because of a lack of connections, lack of commercial agreements, and differences in standards among GSM, IS-41 (CDMA, TDMA), and others, including Japanese standards. While developing solutions to interwork SMS and later MMS, several nonstandard (noncanonical) procedures were implemented to provide termination and two-way SMS, such as the dynamic reply path procedure.

When I was working at FERMA, a French voice mail manufacturer, we received in 1995 our first order from Telkomsel (Indonesia) for a distributed *voice mail system* (VMS) covering 22 provinces. It was also to be equipped with 22 simplified *SMS centers* (SMSCs) for SMS notification: Each time a message was left on one of the VMSs, its associated SMSC would send the called party the information that they had one new message. It was very basic and we did not anticipate the future interest in sending SMS to other networks. I left FERMA at the end of 1998; after 15 years as chairman-founder-CEO, I thought that I had given everything to voice processing, and wanted to do something completely different.

In early 1999, at NILCOM (Paris), I started working on SMS interworking, that is, the ability to use SMS with anyone in the mobile world. We conducted several experiments with cell phones that could be controlled (with a V24 data cable) by an outside PC, which could change the service center address. We found that many SMSCs accepted the SMSs (with a French operator's originating address) and sent the SMS to their own subscribers along with the true originating addresses. We naively thought that if this was made general, we would have a "worldwide" sys-

tem. We then attempted to build a “worldwide numbering plan” so that from a destination number, we would get the service center number. This prompted our interest in building an accurate numbering plan with *mobile number portability* (MNP, whose first appearance was in Hong Kong in 1999), but this was just part of the problem. We then created a start-up company to commercialize this PC software.

At the beginning of 1999, we found that when sending an SMS (for a French operator’s number) to a Luxembourg SMSC, the SMS reached this French operator with the real originating number! We therefore got the wrong idea that the Luxembourg SMSC was copying the SMS to the French operator’s SMSC, using a SMS-MO procedure, to an open SMSC.

By mid-1999, we had created our first SMS interworking gateway, based on the above method. This first gateway was installed in Taipei for a Taiwan operator with my friend Alain Lardenois. The routing strategy was to relay the SMS to the destination SMSC (over an SS7 roaming agreement), the *SMS mobile originated* (SMS-MO) method. It worked well because (although we did not know this at the time) most of the SMSCs were open and SMS-MOs were not charged. From these Taiwanese roaming agreements, we could reach about 70 networks by July 1999, 470 by September 2000, 530 by December 2002, and more than 600 by the end of July 2003.

We had started using the standard *SMS message terminated* (SMS-MT) procedure immediately after the Taiwan experiment: Address the *home location register* (HLR) to get the routing information and send the SMS-MT. We thought, however, that we needed the real HLR address for each addressed mobile number. Hence we began to research the process of HLR finding. Understanding came in September 1999 from a discussion with an expert colleague at France Telecom about *mobile station international ISDN number* (MSISDN) addressing. However, many mobile networks had not implemented a translation facility in the gateway MSC of their network, so direct HLR addressing was kept as backup.

Our full understanding of the subject came in April 2000, after we had installed another SMS interworking gateway in Singapore and conducted extensive tests with our partner. That was when we discovered all of the billing issues. Our backup SMS-MO procedure (we were forcing the originating address to equal the destination address whenever it was rejected) was creating complaints because the recipient was charged! This was because the call detail records of the SMSC were being used for billing in certain Asian countries. From then on, we knew that only SMS-MT standard (or derived) procedures could be used. As a result, we discovered all the procedures associated with the “*network destination code* (NDC) not opened” situation so that our backup direct HLR addressing procedure had to be used and was very useful.

At the beginning of 2000, we also installed an SMS gateway in Indonesia and one of our partners asked us if we could provide two-way SMS; that is, provide a way to receive SMS from another network. This was the demand behind the automatic reply path technique, which we first implemented in March 2000. With these other nodes, we could materialize the relaying techniques, where one node sends to another node, which roams with the destination network. In an important effort to make the software stable, one can say that by the end of 2000, all the ideas concerning the SMS interworking had been identified.



In mid-2000, we also discovered HLR barring with my friends at Chungwha Telecom (Taiwan) who pointed out the effect in SMS-MT *called detail records* (CDRs) at the receiving *mobile switching center* (MSC) of the wrong originating SC addresses.

We had signed a SMS interworking contract with Scancom (Ghana), which had a talented group of engineers, and they asked us if we could provide an *unstructured supplementary service data* (USSD) platform for value-added services, such as registration on a portal for breaking news or demands for weather forecast. USSD allows conversational services, using text, with a server. It exists in GSM 2G, 2.5G, and 3G and is somewhat ignored. USSD is a better alternative to SMS in conversational application cases such as chat, service registration, and customer provisioning.

With Scancom, we also implemented the notion of a private SS7 network with a *signaling transfer point* (STP) in Monaco and the virtual SMSC concept that we had patented. The use of private leased lines was justified by the high traffic and the savings on the volume-dependent charges of the international SS7 carrier. We also acquired a lot of practical experience on the configuration of STPs and SCCP address translation. As a result of teaching operations research for more than 30 years, it was inevitable that many ideas on routing SMS were drawn from this experience. Routing algorithms are instrumental to these nonstandard SMS interworking methods. To implement them easily, one must rely on the SS7 network. The description of the network layer (SCCP and MTP) of SS7 is therefore necessary and is found in Chapter 2.

Working on the standard SMS-MT procedure, we wanted to provide receiving time zone accuracy; that is, when an SMS is received, the time stamp should be that of the receiving region. So we developed a huge MSC database, which today has more than 4,000 entries. The idea of developing a *mobile location center* (MLC) arose very early. The coming of *general packet radio service* (GPRS) and *customized application for mobile network* (CAMEL) made it easy as more and more networks implemented the additional software and hardware facilities that could provide localization data. We delivered our first MLC early in 2002. MLCs use the SMS procedure in the initial phase (gross resolution location). The subject has been included, as well as the original work on the best approximation of the position.

MMS is a very promising topic for future business because 2 years from now, there will not be any costs associated with an MMS-enabled phone. With MNP, it is a key interworking issue. With our work on MNP, we thought that we had a several-years edge for providing MMS interworking as well as MM5 network name resolution.

Also we met in 2002 with the problem of interworking in the fast growing fixed-line SMS market. Our approach with a domain resolution server (which uses the same idea for SMS as a DNS for the Internet) proved well worth pursuing for MMS interworking (described in Chapter 9). You will see that the interworking issue is quite different from the mobile GSM interworking.

Maximizing the operating margin of SMS interworking is a key issue: Optimal routing algorithms will be required to decide the best paths over which to forward the SMS traffic. The algorithm uses the multicommodity flow model described in Chapter 10 and requires linear and nonlinear programming. My goal is for the mod-



eling to be understandable by any reader, although the solution algorithms are for specialists.

Many of the acronyms used in this book are known to people who work in the subject. Those who are unfamiliar with the acronyms will find them defined at the end of the book and detailed explanations in the main text.

This book is aimed at marketing, sales, technical, and operations professionals working with mobile operators or *application service providers* (ASPs) as well as consultants. They will understand the business, billing, and very detailed technical issues associated with SMS and MMS interworking, that is, with the exchange of SMS and MMS among all of the world's mobile operators as well as with content providers. The book will also be useful to SMSC and *multimedia messaging center* (MMSC) manufacturers, because it provides a global view of interworking that they can integrate into their designs.

The text of this book has been used for teaching nonengineer, business graduates and engineering students without difficulty, including its worked-out examples and exercises.

Those who do not have a second-year college level in mathematics can skip the appendixes on the location-based methods (Chapter 13) and the second part of Chapter 15, which is on computation of numbering plans. To understand Chapter 10 (optimal routing algorithms in SMS/MMS interworking networks), you must have studied graph theory and linear/nonlinear programming.

Throughout the book, we assume that the reader has a basic knowledge of graph theory vocabulary, which is common now in many courses. The rest is self-contained including the necessary explanations of the SS7 network (the packet-based network used to exchange data between mobile operators).

# Contents

## Introduction

xiii

### CHAPTER 1

Standard Procedures for SMS in GSM Networks	1
1.1 GSM Network Architecture and Principle of the SMS Procedure	1
1.2 Implementation of SMS Services	3
1.2.1 SMS-MO Implementation	3
1.2.2 The SMS-MT Implementation	6
1.2.3 Sending Commands to the SMSC	14
1.2.4 Addressing the Foreign Network HLRs for SMS-MT	15
1.2.5 Summary of the Network Equipment Model for SMS	16
1.3 MAP Dialogue Models at the Application Level	16
1.3.1 Request and CNF (Simple) Dialogue	17
1.3.2 Concatenated SMS Dialogue: More Message to Send	17
1.3.3 Update Location Dialogue	17
1.3.4 Send Routing Information for SM Dialogue	18
1.4 SCCP Addresses: The Tool for Flexible International Roaming	18
1.5 Mobility Procedures	19
1.5.1 Update Location Procedure	20
1.5.2 Making a Telephone Call to a Mobile	22
1.6 GPRS Procedures: The Gc Interface	23
1.7 SMS Billing Records and Methods	23
1.7.1 SMS-MO CDRs	25
1.7.2 SMS-MT CDRs	26
1.8 Load Test of an SMSC	26
1.8.1 SMS-MT Test Configuration	26
1.8.2 Results and Performance Model	26
Exercises	28
References	28

### CHAPTER 2

SS7 Network and Protocol Layers	29
2.1 History	29
2.2 Efficient and Secure Worldwide Telecommunications	29
2.3 MTP Protocol (OSI Layers 1–3)	30
2.3.1 MTP Layer 1: Signaling Data Link Level	31

2.3.2	MTP Layer 2: Signaling Link Functions	31
2.3.3	MTP Layer 3: Signaling Network Functions	34
2.4	Signaling Connection Control Part	37
2.4.1	SCCP Message Format	38
2.4.2	SCCP Layer Architecture	38
2.4.3	SCCP Routing	39
2.5	Transaction Capability Application Part (TCAP)	42
2.5.1	Main Features of TCAP	43
2.5.2	TCAP Architecture	43
2.5.3	TCAP Operation Invocation Example	44
2.6	User-Level Application Parts: MAP, INAP, CAMEL	45
2.6.1	User Part Mapping onto TCAP: MAP Example	45
2.6.2	Routing Design	48
2.6.3	Service-Oriented Design: Application to an SS7-Based Fault-Tolerant System	50
2.7	SS7 and VoIP Interworking Overview SIGTRAN	51
2.7.1	SCTP	51
2.7.2	Interworking with SS7	52
2.7.3	M3UA Layer	52
2.7.4	M2UA Layer	52
2.7.5	SUA Layer	52
2.7.6	TUA Layer	52
2.8	Conclusions	52
2.8.1	Powerful, Efficient Network Architecture	52
2.8.2	Application to a Worldwide SMS Service Network	53
	References	54

### CHAPTER 3

	Standard Procedures for SMS in IS-41 Networks	57
3.1	Introduction	57
3.1.1	IS-41 Networks	57
3.1.2	Inefficient Handover Chain Procedure	57
3.1.3	MIN and IMSI for IS-41 Networks	59
3.2	Implementation of SMS Services	61
3.2.1	SMS-MO Implementation	61
3.2.2	SMS-MT Implementation	63
3.3	IS-41 Procedure for SMS	63
3.3.1	Functional Description of IS-41 SMS Services	64
3.3.2	IS-41 SMS Protocol Description	68
3.3.3	Specification of the SMS Interworking Network IS-41 SMS Router	70
3.4	Interworking Between IS-41 and GSM	75
3.4.1	GSM Specifications of User Information	75
3.4.2	Mapping GSM to IS-637	76
3.4.3	Mapping GSM to IS-136-710	78
3.4.4	SMS Delivery from IS-41 SME to MAP SME	78
3.4.5	SMS Delivery from MAP SME to IS-41 SME	82

3.4.6 IS-41 Numbering for SMS Delivery	83
3.5 Addressing HLRs in TDMA and CDMA Networks for SMS Interworking: Updating Point Code-Based Addressing Information	83
References	84

## **CHAPTER 4**

Implementation of Mobile Number Portability and GSM-to-IS-41 Conversion	85
4.1 Business Model	85
4.2 Basics of Roaming Agreement Implementation	85
4.3 Implementations of Number Portability	86
4.3.1 MNP Handled by Each Individual Operator (Level N)	87
4.3.2 MNP Handled by the Entry International SCCP Gateway (Level N – 1)	90
4.3.3 Unregulated Countries' MNP Process Must Be Handled by the SMS Interworking Network	91
4.4 SMS Routing Strategies for an SMS Interworking Operator to a Regulated MNP Country	91
4.5 MNP for SMS in Countries That Have Both GSM and IS-41 Operators	92
4.5.1 SMS-MT GSM to an IS-41 Destination	92
4.5.2 SMS-MT from an IS-41 Network to a GSM Destination	95
4.6 Identification of the Destination Network	96
4.6.1 MMS Interconnection	96
4.6.2 Fixed-Line SMS Interconnection	96
4.6.3 MMS and Fixed-Line SMS Interconnection Business	97
References	99

## **CHAPTER 5**

Barring Inbound SMS-MT	101
5.1 Barring Inbound SMS-MT: An Important Business Issue	101
5.1.1 Filtering Service Offered by IGP's at the SCCP Level	101
5.1.2 Selective E164 Translation Facility Barring of the SMS-MT at the GMSC's SCCP Level	102
5.1.3 HLR Barring	103
5.1.4 Origin Address Type Barring at the MSC Level	103
5.1.5 MAP Barring by the GMSC	103
5.2 Barring or Restricting the SMS-MO of One's Own Subscribers	104
5.3 Intelligent Barring of SMS-MT	104
5.3.1 Origin Address-Based Barring	104
5.3.2 Filtering Based on Content of Incoming SMS-MT	105

## **CHAPTER 6**

Virtual SMSC Implementation and Transit Agreements	109
6.1 Business Model	109
6.2 Principle of the Virtual SMSC: Architecture and Billing of SMS-MO	109
6.2.1 Architecture	109
6.2.2 Payment Issues	110

6.2.3	Billing Coherence: Dynamic Originating SMSC GT	111
6.2.4	Use of a Local Virtual SMSC GT in the SIM Card	111
6.3	Detailed Implementation of the Virtual SMSC	112
6.3.1	Half-SCCP Roaming for SMS-MO	112
6.3.2	Failure of Half-SCCP Roaming for SMS-MO	113
6.3.3	Solving This Failure Case	113
6.4	Implementation of Transit Agreements (SMS-MT)	114
6.4.1	Cases When a Virtual SMSC Has All Roaming Agreements of the Operator	114
6.4.2	Optimization of the Implementation of a Transit Agreement	118
6.4.3	Use of an International Point Code: The Solution in Difficult Setup Cases	118
6.5	Super-Routing Gateway and Multiple Virtual SMSCs in the Same Equipment	120
	Reference	121

## CHAPTER 7

	Connecting Mobile Operators for SMS-MO	123
7.1	Business Need for an SMS Interworking Operator to Connect Multiple Mobile Operators	123
7.2	Principle of the Virtual HLR/MSC Approach	123
7.2.1	Relay Mode	123
7.2.2	Transparent Mode	125
7.2.3	Direct Interrogation of the HLR by the Client Operator	126
7.2.4	SMS Interworking Network and the Status Report	127
7.3	Configuration the SMSC or GMSC to Route to the Third Party	127
7.3.1	GT Address Translation in the GMSC	127
7.3.2	Doing the Address Translation in the SMSC	130
7.3.3	Use of a Private Conversion Unit	131
7.3.4	Intelligent SCCP Routing by Your IGP	133
7.4	Creating Third-Party SCCP Routing When a GT Translation Is Unavailable	134
7.4.1	Case in Which Connected Operator Acts as Its Own SCCP Gateway	134
7.4.2	Case in Which Connected Operator Uses an International SCCP Gateway Service: No Solution	135
7.4.3	Case in Which GT Translation Is Not Possible and the Operator Is Not Its Own SCCP Provider: Use a Conversion Unit	135
7.4.4	Transmission of Signaling Between a GSM and an IS-41 Network	136
7.5	Conclusion	136
	Reference	136

## CHAPTER 8

	Connecting ASPs and ISPs with SMPP	137
8.1	Introduction	137
8.2	SMPP Sessions	137

8.3	SMPP Commands	138
8.4	Example of SMPP Sessions	138
8.5	Example of Message Operations	138
8.5.1	Session Management: Transceiver PDUs	138
8.5.2	Message Submission Operation	139
8.5.3	Other SMPP Operations	143
8.6	GSM IS-41 Interworking Through SMPP	143
	Reference	144

## CHAPTER 9

	MMS Interworking	145
9.1	Introduction	145
9.2	Standard Model for MMS Sending and Receiving	145
9.2.1	MMS Relay/Server	145
9.2.2	MMS User Databases	145
9.2.3	MMS User Agent	146
9.2.4	MMS VAS Applications	146
9.3	Standard Protocols for MMS	147
9.3.1	MM1 Protocol over WAP	147
9.3.2	MM1 over M-IMAP	149
9.3.3	MM4 Protocol	150
9.3.4	MM7 Protocol	151
9.4	MMS Interworking Architectures Using a Third Party	151
9.5	Setting Up the MMS Profile in the Cell Phone	156
9.5.1	Data Access Profile	157
9.5.2	MMSC Profile	159
	References	160

## CHAPTER 10

	Optimal Routing Algorithms for an SMS Interworking Network	161
10.1	Maximizing the Margin of an SMS Interworking Network	161
10.2	Enumerating All Loopless Paths with the Latin Multiplication Algorithms	161
10.3	Shortest Path: Dijkstra Algorithm	165
10.4	Least Cost Path	165
10.5	Least Trouble Path	165
10.6	The Best Flow Problem—Not a Classical Graph Problem	165
10.6.1	Income Model for Customer Charges and Notations	166
10.6.2	Noncontinuous Price Function Paid to the Interworking Network for an Unsatisfied Demand	166
10.6.3	Continuous Concave Price Function	167
10.6.4	Network Model	167
10.6.5	Mathematical Model for Optimization	168
10.6.6	Algorithm to Find the Global Optimum	171
10.6.7	Centralized Network Traffic Regulation Principle	171
10.7	Example: Detailed Modeling of a Real SMS Interworking Network	172
10.7.1	Modeling a Simple SS7 Router or a Relay	172

10.7.2	Modeling Traffic to Subscribers of a Network Hosting an SS7 Router	173
10.7.3	Modeling a Virtual SS7 Router with Several IGPs and Transit Agreements	173
10.7.4	Connection of Hosting Partners	176
10.7.5	Path Valuations	176
	References	176

## CHAPTER 11

	INAP and CAMEL Overview and Other Solutions for Prepaid SMS	177
11.1	Use of CAMEL for SMS Prepaid Services	178
11.1.1	SMS Payment from Prepaid Customers	178
11.1.2	Credit Reloading for Prepaid Customers	179
11.2	Useful Subset of CAMEL Services for Prepaid Customers	179
11.2.1	Example 1: Prepaid SMS	179
11.2.2	Example 2: Simple Prepaid Voice Call	179
11.2.3	Example 3: Voice Call Rerouted to an Announcement Machine	181
11.2.4	Details of Applicable CAMEL Services	182
11.2.5	Specificity of the CAMEL Services	183
11.3	Implementation: Multiple-Protocol Services-Oriented Platform: CAMEL Gateways	184
11.4	Example of Analyzer Traces of a CAMEL Transaction	185
11.5	Other Solutions for Prepaid SMS	187
11.5.1	Prepaid SMS with Service Nodes	187
11.5.2	Prepaid SMS with AoC-Enabled Networks	188
	References	189

## CHAPTER 12

	USSD: A Still-Relevant Conversational Application Service	191
12.1	USSD Advantages over SMS	191
12.2	How Does Mobile-Initiated USSD Service Work?	191
12.3	Example of USSD Service	194
12.4	USSD Is Free: A Call-Back Application	195

## CHAPTER 13

	Location-Based Services	197
13.1	Location-Based Services: Examples and Revenue Possibilities	197
13.2	Mobile-Originated LBS	197
13.3	Methods	198
13.3.1	MSC Location Method	198
13.3.2	Cell ID Method	198
13.3.3	Extended Cell ID Method	200
13.3.4	Mobile Location Units and BSSAP-LE	200
13.4	Other Methods: Mobile Measured Power Level	201
13.5	3G UMTS Networks	202
13.6	Best Estimate of a Location Using Hyperbolic $n$ -Triangulation	203
13.6.1	Algebraic Equation of a Hyperbola	203



13.6.2	Finding the Best Localization Estimate	204
13.6.3	Exact Solution (True Optimum)	205
13.7	Main Results in the Theory of Resultants and Sturm's Theorem	206
13.7.1	Purpose of the Theory of Resultants	206
13.7.2	Main Result for Two Algebraic Equations	206
13.7.3	Sturm's Theorem	208
13.7.4	Bounds on the Value of Roots	210
13.7.5	Application: Recursive Algorithm to Find All the Real Roots	211
	References	213

## CHAPTER 14

	SMS-MO Premium Number Services and Architectures	215
14.1	The Premium SMS-MO Number Business	215
14.1.1	Use of a GSM Modem: Small Throughput	215
14.1.2	Use of a Direct IP Connection to an SMSC: Negotiation and Setup Tasks	216
14.2	Virtual Roaming Subscriber Architecture	216
14.2.1	Case 1: Omnitel and Third-Party Operator	216
14.2.2	Case 2: Mobile Operator Has a Virtual MSC	217
14.3	SMS-MO with a Real SIM Card	218
14.4	Short Code: A Costly and Time-Consuming Setup	218
14.5	FSG Architecture	219
	References	220

## CHAPTER 15

	Numbering Plan Creation and Maintenance Algorithms	221
15.1	Purpose of Computing Numbering Plans for an SMS Interworking Network	221
15.2	Entropy of a Numbering Plan as a Quality Indicator	222
15.2.1	Avoiding the Multiple Spanning of HLRs	222
15.2.2	Average Entropy of the Numbering Plan	222
15.2.3	Resulting Global Entropy	223
15.3	"Little Prince" Algorithm to Compute an HLR Numbering Plan	223
15.3.1	Numbering Plan After One Try	224
15.3.2	Numbering Plan After Two Tries	224
15.3.3	Numbering Plan After Three Tries	224
15.4	MSC Search Problem	224
15.4.1	Problem 1	225
15.4.2	Problem 2	225
15.5	Definitions and Properties	225
15.6	Problem 1: Average Number of Searches for a Known $N$	228
15.6.1	Case $N = 2$ MSCs	228
15.6.2	Case $N = 3$ MSCs	229
15.6.3	Asymptotic Bound of $M_N$	230
15.7	Problem 2: Estimate of the Probability That the Number of MSCs $N = j$	231
	References	232

**CHAPTER 16**

Worked-Out Examples	233
16.1 Example 1	233
16.2 Example 2	250
16.3 Example 3	268
16.4 Example 4	268
16.5 Example 5	269
16.6 Example 6	270
16.7 Example 7: Connection of a GSM to a Third-Party SMS Network	280
16.8 Example 8: SMS Interworking Between CDMA Networks	294
 Abbreviations and Acronyms	 301
About the Authors	319
Index	321