

McGraw-Hill Telecommunications

Signaling System #7

SECOND EDITION

- Local Number
Portability
- Protocol
Standard updates
- Telecommunication
Act updates

A mobile phone is shown in the lower right, with colorful concentric arcs representing signal waves emanating from it. The background is a collage of binary code (0s and 1s) and a barcode.

Travis Russell

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Preface

It has been several years since I wrote the first edition of *Signaling System #7*. Since then there have been many changes in our industry. The most sweeping change to affect all of telecommunications was the Telecommunications Act of 1996. With this new legislation came many new changes that have and will continue to have an impact on SS7.

In this second edition, I have captured many new changes made to the SS7 protocol. You will see these changes in virtually every chapter. New parameters in TCAP, ISUP, and SCCP have been defined. I expanded on the ISUP chapter as both ANSI and Bellcore have further defined BISUP.

I have also made some corrections from readers who have written to me over the last few years. Some of these readers were involved in development of SS7 products, some involved in standards bodies defining various portions of the SS7 protocols and their functions.

I added a new chapter in this edition, titled "Local Number Portability (LNP)." This chapter provides an overview of what LNP is and how SS7 is impacted. It is my hope in future editions to add other applications to this chapter, and provide explanations of various real world uses for SS7 and Intelligent Networks.

Each chapter in this book has been arranged to provide a three-step approach to learning. In the beginning of the chapters discussing SS7 protocol, I provide an overview of the topic, getting you familiar with the topic before discussing specifics. This is ideal for students learning SS7 for the first time, or those just wanting to understand more about what SS7 is.

This is followed by a more detailed discussion about the functions of the various parts of the protocol, identifying the various procedures and operations of the SS7 network as they relate to the protocol being discussed. This is useful to those who need to understand the functions of SS7 and its various protocols.

The last section of these chapters provides a bit level description of the protocol, identifying the message formats, parameter values, and parameter descriptions. This section of the chapter is useful to those involved in the development of SS7 products.

The audience for this book is broad. Students studying telecommunications should learn SS7, because they will be involved with this technology in some form or fashion if they choose a career in telecommunications. Engineers will find this book useful as a reference. I have seen this book on the shelves of many engineering firms developing SS7 products. Sales, marketing, management; all will benefit from this book.

Acknowledgments

First, thank you to my beautiful wife. So many nights were spent typing away while she sat alone watching movies, or reading books. Thank you Deb for being so understanding and endearing throughout this project.

Once again, I have my friends at Tekelec to thank for all of their support for this book. Special thanks to Mr. Allan Toomer, retired CEO of Tekelec. Alan has promoted this book all along, and his encouragement has been much appreciated. Also thanks to Mr. Gord Werner, GM of the Network Switching Division at Tekelec. Being part of a cutting edge company like Tekelec has been a great benefit to me, learning about new advances in SS7 before they are implemented in our nation's networks.

I also must thank my family for their patience while I worked on this second edition. For those interested, I am finally taking the family to Disney World as promised in the first edition. A little late, but a well-deserved vacation for all of us.

I also want to thank the many readers who took the time to send e-mail and provide comments and inputs, and for buying the first edition. I never thought this book would sell as well as it has, only because SS7 is such an obscure and specialized subject matter. You the readers proved me wrong and provided confirmation that SS7 is a technology that everyone is gaining interest in.

Travis Russell

Introduction

First there was ISDN. Then came “portable” 800 numbers. Soon, cellular providers were talking of tying their networks together so that subscribers could roam from one cellular network to another without special roaming numbers. And, of course, we now have the Information Highway and all of the talk behind its many features and intrinsic value to the public.

But during all of these discussions, nothing (or at least very little) has been mentioned about how all of this is possible. How is it possible that many networks can communicate with one another, and what control mechanism is used to maintain the connections and data communications?

Behind the scenes is a quiet, highly reliable, fault-tolerant data communications network that links the world’s telephone networks together and allows them to share vital signaling and control information. This one network, which controls telecommunications networks around the world, is being prepared to control the broadband networks that will form the framework for tomorrow’s “Information Highway.”

This data communications network is so robust, so sophisticated, that few really know much about it. Only recently has anything been written about this network, and what information does exist has been sparse and ambiguous. The very standards that define the network are written to answer the needs of so many different audiences that they remain ambiguous and reliant on self-interpretation.

This network, often dubbed the world’s largest data communications network, is known as Signaling System #7 (SS7). It started as a way to access 800 databases here in the United States, although its functions provide much more. Soon SS7 was being used to send signaling information from exchange to exchange. Today, the same network is being used to control central office switching equipment from remote locations.

SS7 is really a *control* network, as well as a signaling network. This is important to understand, because as the Information Highway rolls

out, and as the Advanced Intelligent Network (AIN) is implemented, SS7 will be relied on almost exclusively as a means for telephone companies and other service providers to share database information and switching control without human intervention.

Already we are seeing SS7 play an important role in Local Number Portability (LNP), a new requirement for all telephone service providers (both wireline and wireless) defined in the Telecommunications Act of 1996. SS7 continues to grow in use and function, as the industry discovers new uses for this powerful technology.

Without SS7, AIN is not possible. Cellular roaming is not seamless. 800 numbers are not portable. And the many features and services we take for granted today (such as caller ID) would not be feasible.

When someone asks me how to break into the telecommunications field, I often provide one suggestion. Learn SS7. Every telephone company needs it. Every manufacturer develops around it. Yet there is a lack of expertise in SS7 in this country. That is what this book is all about.

As I began studying SS7 protocols, and began providing seminars around the country, I came to the conclusion that there is no reference material available that provides a comprehensive view of SS7. Nothing to explain the various acronyms and the true applications of this network.

Hence the reason for this book. If you are looking for more than a reference book—a tutorial on SS7, a text book which provides real-world applications, and a futuristic look at the telephone networks—read on.

The intent of this book is to provide a comprehensive introduction to this fascinating network and its protocols, as well as a reference for those already familiar with SS7. While the various standards are always the best source for specific details, this book provides something the standards do not: explanations as to when and why procedures are used and what they mean to the network, the subscriber, and the service provider.

Although it is based on ANSI and Bellcore standards, the text is of value to anyone seeking knowledge about SS7 networks. While the message types and the protocol parameters may be different between countries, the principles and applications are universal.

I hope you find this to be as fascinating as I did while writing this book. Truly, we are at an exciting period for the telecommunications industry, as new services and applications are defined almost monthly. Keeping up with all of the new technologies and advances can be a dizzying experience. Yet the future is today, and this technology is a key player in making it all happen.

Travis Russell

Acronym List

A-links	Access links
AAL	ATM adaptation layer
ABOM	A-bis Operations and Maintenance
AC	authentication center
ACD	automatic call distribution
ACG	Automatic Code Gap
ACM	address complete message (message)
AE	application entity
AERM	alignment error rate monitor
AIN	Advanced Intelligent Networks
AK	data acknowledgment
AMI	alternate mark inversion
ANI	automatic number identification
ANM	answer message (message)
ANSI	American National Standards Institute
ASE	application service element
ASN-1	Abstract Syntax Notation One
ASP	Application Service Part
ATM	asynchronous transfer mode

B-links	bridge links
BIB	backward indicator bit
BISDN	broadband ISDN
BISUP	broadband ISUP
BITS	building integrated timing system
BLA	blocking acknowledgment (message)
BLO	blocking (message)
BOP	bit-oriented protocol
BRI	basic rate ISDN
BSC	base station controller
BSDB	business service database
BSN	backward sequence number

BSS	base station subsystem
BSSMAP	Base Station Subsystem Mobile Application Part
BTA	basic trading area
BTS	base transceiver station
BTSM	Base Transceiver Station Management
C-links	cross-links
CAE	Communications Applications Environment
CBA	changeback acknowledgment (message)
CBD	changeback declaration (message)
CC	connection confirmed (message)
CCE	consistency check end (message)
CCEA	consistency check end acknowledgment (message)
CCR	continuity check request (message)
CCRA	consistency check request acknowledgment (message)
CCS	common channel signaling
CD	carrier detect
CESID	Callers Emergency Service Identification
CFN	confusion (message)
CGB	circuit group blocking (message)
CGBA	circuit group blocking acknowledgment (message)
CGU	circuit group unblocking (message)
CGUA	circuit group unblocking acknowledgment (message)
CIC	circuit identification code
CLLI	COMMON LANGUAGE™ Location Identifier
CMC	call modification completed (message)
CMR	call modification request (message)
CMRJ	call modification reject (message)
CMSDB	call management services database (message)
CON	connect (message)
COO	changeover order (message)
COT	continuity test (message)
CPG	call progress (message)
CPU	central processor unit
CQM	circuit query message (message)
CQR	circuit query response (message)
CR	connection request (message)
CRA	circuit reservation acknowledgment (message) <i>also</i> consistency check request (message)
CRC	cyclic redundancy check
CREF	connection refusal (message)
CRG	charge information (message)
CRM	circuit reservation message (message)

CRST	cluster-route-set-test (message)
CSA	Canadian Standards Association
CTIA	Cellular Telecommunication Industry Association
CTS	clear to send
CVM	circuit validation test (message)
DCE	data communications equipment
DN	directory number
DPC	destination point code
DPNSS	Digital Private Network Signaling System
DRS	delayed release (message)
DSR	data set ready
DSU	data service unit
DTAP	Direct Transfer Application Part
DTE	data terminal equipment
DTMF	dual-tone multifrequency
DTR	data terminal ready
DT1	data form 1
DT2	data form 2
DUP	Data User Part
EA	expedited data acknowledgment (message)
EAS	exchange access signaling
ED	expedited data (message)
EIA	Electronic Industries Association
EIR	equipment identification register
ERR	error (message)
FA	Framework Advisory
FAA	facility accepted (message)
FAR	facility request (message)
FCC	Federal Communications Commission
FDDI	Fiber Distributed Data Interface
FIB	forward indicator bit
FISU	fill-in signal unit
FOT	forward transfer (message)
FR	Family of Requirement
FRJ	facility rejected (message)
FSN	forward sequence number
GMT	Greenwich Mean Time
GPS	Global Positioning System
GRA	circuit group reset acknowledgment (message)

GRS	circuit group reset (message)
GSM	Groupe Special Mobile
GUI	graphical user interface
HLR	home location register
IAA	IAM acknowledgment (message)
IAM	initial address message (message)
IAR	IAM reject (message)
IN	Intelligent Network
INA	information network architecture
INF	information (message)
INR	information request (message)
IP	intelligent peripheral
ISDN	integrated services digital network
ISDNUP	Integrated Services Digital Network User Part
ISNI	Intermediate Signaling Network Identification
ISO	International Standards Organization <i>or</i> International Organization for Standardization
ISUP	ISDN User Part
IS-41	Interim Standard-41
IT	inactivity test (message)
ITU	International Telecommunications Union
ITU-D	ITU Telecommunication Development Sector
ITU-RS	ITU Radiocommunication Sector
ITU-TS	International Telecommunications Union Telecommunications Standardization Sector
LAN	local area network
LAPD	Link Access Procedure on the D Channel
LATA	Local Access Transport Area
LI	length indicator
LIDB	Line Information Database
LLI	logical link identifier
LPA	loopback acknowledgment (message)
LSB	least significant bit
LSSU	link status signal unit
MAP	Mobile Application Part
MF	multifrequency
MIN	mobile identification number
MLPP	Multi-Level Precedence and Preemption
MSC	mobile switching center

MSU	message signal unit
MTA	major trading area
MTP	Message Transfer Part
NISDN	narrowband ISDN
NNI	network-to-network interface
NOF	Network Operations Forum
NRC	Network Reliability Council
NRM	network resource management
NRZ	nonreturn to zero
OAMP	Operations, Administration, Maintenance, and Provisioning
OLM	overload message (message)
OMAP	Operations, Maintenance, and Administration Part
OMC	Operations and Maintenance Center
OOS	out of service
OPC	origination point code
OPDU	Operations Protocol Data Unit
OS	operations system
OSI	Open Systems Interconnections
OSS	Operations Support System
PAM	pass-along message
PBX	private branch exchange
PCR	preventive cyclic retransmission
PCS	Personal Communications Services
PIN	personal identification number
POP	point-of-presence
POTS	Plain Old Telephone Service
PRI	primary rate ISDN
PRS	primary reference source
PSC	PCS switching center
PSTN	Public Switched Telephone Network
PVC	permanent virtual circuit
QoS	Quality of Service
RAO	regional accounting office
RBOC	Regional Bell Operating Company
RD	receive data
REL	release (message)
RES	resume (message)

RJ	registered jack
RLC	release complete (message)
RLSD	released (message)
RSA	regional service area
RSC	reset confirmation (message) <i>also</i> reset circuit (message)
RSR	reset request (message)
RTS	request to send, ready to send
SAM	subsequent address message
SAP	service access point
SAT	supervisory audio tone
SBR	subsystem-backup-routing (message)
SCCP	Signaling Connection Control Part
SCE	service creation environment
SCLC	SCCP connectionless control
SCMG	SCCP management
SCOC	SCCP connection-oriented control
SCP	service control point
SCRC	SCCP routing control
SDLC	signaling-data-link-connection
SDU	service data unit
SF	status field, single frequency
SGM	segmentation message
SIF	service information field
SIO	service indicator octet
SLC	signaling link code
SLS	signaling link selection
SLTA	signaling-link-test-acknowledgment
SLTM	signaling-link-test-message
SMDR	station detailed message recording
SMS	service management system
SNR	subsystem-normal-routing
SOG	subsystem-out-of-service-grant
SONET	Synchronous Optical NETwork
SOR	subsystem-out-of-service-request
SR	Special Reports
SRCT	signaling-route-set-congestion-test
SRST	signaling-route-set-test
SRT	subsystem-routing-status test
SSA	subsystem-allowed
SSP	service switching point <i>also</i> subsystem-prohibited
SST	subsystem-status-test
SS7	Signaling System #7
ST	<i>Science and Technology</i> (publication)
STP	signal transfer point

SUERM	signal unit error rate monitor
SUS	suspend message
SIB	status indicator—busy
SIE	status indicator—emergency
SIN	status indicator—normal
SIO	status indicator—out of alignment
SIOS	status indicator—out of service
SIPO	status indicator—processor outage
TA	Technical Advisory
TCA	transfer-cluster-allowed
TCAP	Transaction Capabilities Application Part
TCP	transfer-cluster-prohibited
TCR	transfer-cluster-restricted
TD	transmitted data
TFA	transfer-allowed
TFC	transfer-controlled
TFP	transfer-prohibited
TFR	transfer-restricted
TIA	Telecommunication Industry Association
TR	Technical Reference
TRA	traffic-restart-allowed
TRW	traffic-restart-waiting
TUP	Telephone User Part
T1A6	T1 Advisory Group
UCIC	unequipped circuit identification code
UBA	unblocking acknowledgment (message)
UDT	Unitdata
UDTS	Unitdata Service
UL	Underwriters Laboratories
UNI	user-to-network interface
UPA	user part available
UPT	user part test
USIS	user-to-user indicators
USR	user-to-user information (message)
VPCI	virtual path connection identifiers
VLR	visitor location register
WATS	Wide Area Telephone Service
XUDT	Extended Unitdata
XUDTS	Extended Unitdata Service

