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Bell Communications Research Specification of Signalling System Number 7

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FOREWORD

"Bell Communications Research Specification of Signalling System No. 7" is intended to be compatible with the "American National Standard Specification of Signalling System No. 7" that is being drafted by the T1X1.1 Working Group on U.S. Standards for Common Channel Signalling. This document uses (as far as possible) the same terminology, annotation rules and technical information as the T1 draft, yet it is being issued ahead of the official standard because it supplies timely information necessary for Bell Operating Company applications.

An Asterisk (*) in the right margin signals a change from the 1984 CCITT protocol for U.S. network use, and a vertical bar in the margin indicates changes in subsequent issues. The following abbreviations are employed throughout:

CCITT SS#7 or SS#7 = International Signalling System No. 7, and
SS7 = the T1 version of Signalling System No. 7.

This document is largely congruent with SS7 which is, in turn, based on and compatible with the 1984 Red Book specification of SS#7 issued for international use by CCITT Study Group XI (Vol. VI, Fascicles VI.7 and VI.8). The objectives for CCITT SS#7 implementation in U.S. networks exceed basic circuit switched call control signalling and place major emphasis on advanced capability support, such as: Integrated Services Digital Network (ISDN) signalling, Operations Administration and Maintenance (OA&M) applications, Transaction Capabilities, and others yet undefined. National versions of the 1984 Red Book Telephone User Part (TUP) and Data User Part (DUP) are not included and will not be supported; rather, descriptions of additional protocol capabilities and new applications are provided. Subsequent information on new applications will appear as detailed definition proceeds within CCITT and the ECSA T1 body.

The CCITT document has been modified by the T1X1.1 Working Group for use within and between U.S. networks to meet the anticipated needs and applications of those entities. These modifications — which coincide with current and projected CCITT activity — assume two general categories: (1) the specification of options designated by the CCITT for national use; and (2) addenda to the 1984 protocol providing for new applications of the SS#7 protocol. Although the T1 specification is a U.S. standard published by ANSI, several Canadian entities participate in the Working Group to ensure compatibility with American standards.

This issue covers the Transport parts of SS7, including the Message Transfer Part (MTP) and the connectionless features of the Signalling Connection Control Part (SCCP). A second issue will cover the Application parts of SS7, including the connection-oriented features of the SCCP, the ISDN User Part, and the Transaction Capabilities Application Part.

The contents of this document correspond to the Red Book specification and, when appropriate, use the same Q numbers and chapter titles. The following appear in the same order as the Red Book:

a. Q.701-Q.708, MTP;
b. Q711-Q.714, SCCP (to provide an OSI network layer over the MTP);
c. Q761-Q.766, for ISDN call control; and
d. Q.791-Q.795, for OA&M capability.

Chapters Q.7TX supplement the Red Book and provide transaction capabilities that specify OSI compatible layers for appropriate applications (a subject for further study in CCITT). The Glossary and Abbreviations amend those in the Red Book, and the Annotation section details the rules used to indicate diversions from the Red Book.

The control of future additions to this document — e.g., protocol evolution, new applications and operational requirements — resides with Bell Communications Research based on the interests of the Bell Operating Companies, and based on the work of the ANSI T1 Committee, which will promote compatibility among U.S. networks. Such additions will be incorporated with due attention to CCITT layered model principles, conventions and boundaries.

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FUNCTIONAL OVERVIEW OF THE SIGNALLING SYSTEM

1. GENERAL[1]

1.1 Objectives and Fields of Application

The overall objective of Signalling System No.7 is to provide an internationally standardized general purpose Common Channel Signalling (CCS) system:

— optimized for operation in digital telecommunications networks in conjunction with stored program controlled exchanges;

— that can meet present and future requirements of information transfer (circuit and non-circuit related) for inter-processor transactions within telecommunications networks for call control, remote control, network data base access, and management and maintenance signalling;

— that provides a reliable means of information transfer in correct sequence, without loss or duplication.

The signalling system meets the requirements of call control signalling for telecommunication services, such as the telephone and circuit switched data transmission services. It can also be used as a reliable transport system for other types of information transfer between exchanges and specialized centers in telecommunications networks (e.g., for management and maintenance purposes). The system is thus applicable for multipurpose uses in networks that are dedicated for particular services and in multiservices networks. The signalling system is intended to be applicable in international and national networks.

The signalling system is optimized for operation over 56 or 64 kbit/s digital channels. The system * is suitable for use on point-to-point terrestrial and satellite links. It does not include the special features required for use in point-to-multipoint operation but can, if required, be extended to cover such an application.

1.2 General Characteristics

Common channel signalling is a signalling method in which a single channel conveys, by means of labeled messages, signalling information relating to, for example, a multiplicity of circuits, services provided by network data bases, or, other information, such as that used for network management. Common channel signalling can be regarded as a form of data communication that is specialized for various types of signalling and information transfer between processors in telecommunications networks.

The signalling system uses signalling links for transfer of signalling messages between exchanges or other nodes in the telecommunication network served by the system. Arrangements are provided to ensure reliable transfer of signalling information in the presence of transmission disturbances or network failures. These include error detection and correction on each signalling link. The system is normally applied with redundancy of signalling links, and it includes functions for automatic diversion of signalling traffic to alternative paths in case of link failures. The capacity and reliability for signalling may thus be dimensioned by provision of a multiplicity of signalling links according to the requirements of each application.

1.3 Modularity

The wide scope of the signalling system requires that the total system includes a large diversity of functions and that further functions can be added to cater to extended future applications. As a consequence, only a subset of the total system may need to be used in an individual application.

An asterisk (*) indicates a change from the CCITT Red Book, Vol. VI.

[1] This section has been moved from section 1 of Q.701 to provide a general overview of the signalling system.

FUNCTIONAL OVERVIEW OF THE SIGNALLING SYSTEM

A major characteristic of the signalling system is that it is specified with a functional structure to ensure flexibility and modularity for diverse applications within one system concept. This allows the system to be realized as a number of functional modules that could ease adaptation of the functional content of an operating Signalling System No.7 to the requirements of its application.

The CCITT specifications of the signalling system specify functions and their use for international operation of the system. Many of those functions are also required in typical national applications. Furthermore, the system, to some extent, includes features that are peculiar to national applications. The CCITT specifications thus form an internationally standardized base for a wide range of national applications; such as this U.S. standard application of common channel signalling. *

Signalling System No. 7 is one common channel signalling system. However, as a consequence of its modularity and its intended use as a standard base for national applications, the system may be applied in many forms. In general, to define the use of the system in this application, a selection of the CCITT specified functions has been made, and the necessary additional national functions have been specified based on the nature of the application. This document represents the set of features specified for Signalling System No.7 operation in U.S. networks. * * *

2. *SIGNALLING SYSTEM STRUCTURE*

2.1 Basic Functional Division

The fundamental principle of the signalling system structure is the division of functions into separate modules or entities.

Figure 1 Q.701 of the Red Book has been deleted. *

2.2 Functional Levels *

The following sections describe the protocol model used to specify the SS7 protocol as specified by TI. The first section provides background information on the layered reference model developed by CCITT, and the second section describes how SS7 has been layered to conform with this CCITT standard.

2.2.1 OSI Reference Model

The purpose of the Reference Model of Open Systems Interconnection for CCITT Applications (Recommendation X.200) is to provide a well-defined structure for modeling the interconnection and exchange of information between users in a communications system. This approach allows standardized procedures to be defined not only to provide an open systems interconnection between users over a single network, but also to permit interworking between networks to allow communication between users over several networks in tandem.

The approach taken in the OSI reference model is to partition the model used to describe this interconnection and exchange of information between users in a communications system into seven layers. The characteristics of each layer are described below and comments are included to further clarify the purpose of each of the seven layers.

1. **PHYSICAL LAYER** - The Physical layer (layer 1) provides transparent transmission of a bit stream over a circuit built in some physical communications medium. It furnishes the interface to the physical media and is responsible for relaying bits (i.e. interconnects data-circuits). A 56/64 kbps link is assumed for the SS7 Physical layer.

2. **DATA LINK LAYER** - The Data Link layer (layer 2) overcomes the limitations inherent in physical circuits and allows errors in transmission to be detected and recovered, thereby masking deficiencies in transmission quality. In SS7, the Data Link layer uses positive and negative acknowledgments to indicate when a signal unit has been correctly received or to request retransmission of corrupted signal units.

3. **NETWORK LAYER** - The Network layer (layer 3) transfers data transparently by performing routing and relaying of data between end users. One or more subnetworks may interwork at the Network layer to provide an end user-to-end user network service. A connectionless network provides for the transfer of data between end users, making no attempt to guarantee a relationship between two or more data packets from the same user. Nevertheless, the SS7 Message Transfer Part which is connectionless, does provide strategies for correctly sequencing packets between users. A connection-oriented Network layer provides a means to establish, maintain, and terminate network connections between end users and a means to transfer data over the network connections. That is, a connection-oriented Network layer offers virtual circuit service, while a connectionless Network layer offers datagram-like service.

4. **TRANSPORT LAYER** - The Transport layer (layer 4) provides end user-to-end user transfer, optimizing the use of resources (i.e. network service) according to the type and character of the communication, and relieves the user of any concern for the transfer details. The Transport layer always operates end-

to-end, enhancing the Network layer, when necessary, to meet the quality of service objectives of the users. The Transport layer is similar to the Data Link layer in that the performance of the Physical and Network layers are improved by the Data Link and Transport layers, respectively. Sequencing and error control are functions found in the Transport layer to guarantee, when necessary, delivery of packets between end users in-sequence.

5. **SESSION LAYER** - The Session layer (layer 5) coordinates the interaction within each association between communicating application processes. Full and half duplex dialogue are examples of possible Session layer modes.

6. **PRESENTATION LAYER** - The Presentation layer (layer 6) transforms the syntax of the data that is to be transferred into a form recognizable by the communicating application processes. For example, the Presentation layer may convert a data stream from ASCII to EBCDIC.

7. **APPLICATION LAYER** - The Application layer (layer 7) specifies the nature of the communication required to satisfy the user's needs. This is the highest layer in the model and, therefore, does not have a boundary with a higher layer. The Application layer provides the sole means for application processes to access the OSI environment.

2.2.2 SS7 Layered Model

Figure 1 depicts the SS7 Layered Reference Model in terms of major protocol components. It illustrates the relationship between the OSI 7-layer protocol model and the CCITT SS#7 4-level protocol model. It should be noted that OSI layers 1 and 2 directly correspond with SS#7 levels 1 and 2; layer 3 (the OSI network layer) is subdivided into two sub-layers, which correspond to levels 3 and 4 respectively; and layers 4 - 7 do not currently correspond with specific levels. The view presented here provides further sub-layering of level 4 to provide the advantages of functional partitioning — such as call processing — for users of the signalling system. It should be noted that the architecture of SS7 is an area for further study.

Levels 1, 2 and 3 are known as the Message Transfer Part (MTP). The overall function of the Message Transfer Part is to serve as a connectionless transport system providing reliable transfer of signalling messages between the locations of communicating user or application functions. The term "user," in this context, refers to any functional entity that utilizes the basic transport capability provided by the Message Transfer Part. The Service Indicator (SI) is used to distribute between the MTP and its users.

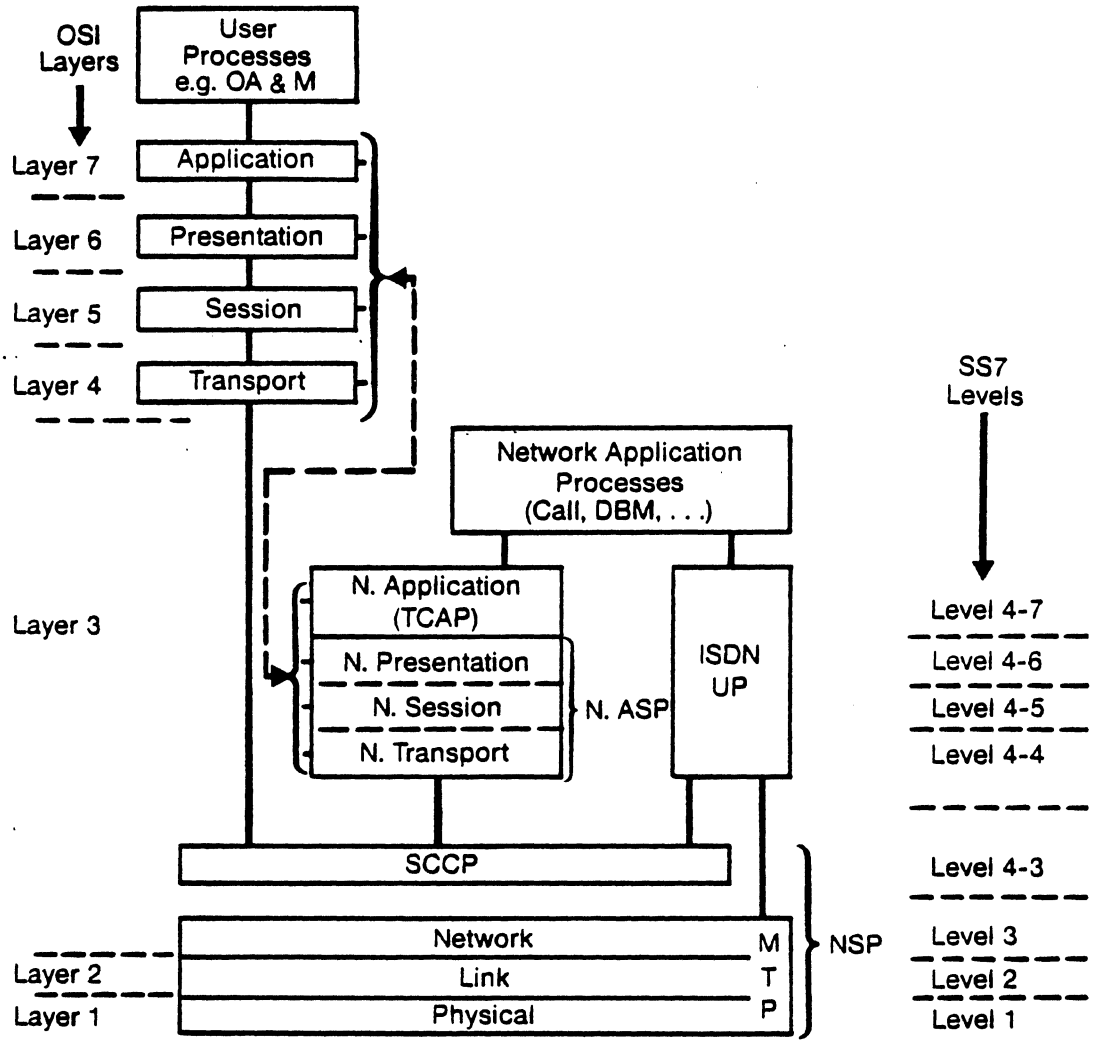
A functional block is defined which, starting from the MTP service, will provide a connectionless and connection-oriented network service according to the OSI-CCITT definition. The functional block, called the Signalling Connection Control Part (SCCP), will be available to users of the MTP.

One user of the MTP and the SCCP is the ISDN User Part (ISDN-UP). The ISDN User Part provides inter-exchange signalling to support trunk setup (analog and digital), ISDN access signalling, and specialized subscriber facilities.

Another use of the MTP and SCCP is to provide for services, through an equivalent OSI layered model, for Network Application Processes. Levels 4-4, 4-5 and 4-6 may be specified and developed in a common way for all such applications. These 3 levels of the protocol are termed the Application Service Part within the network layer (N.ASP) and will use the equivalent of the OSI Transport, Session, and Presentation layer protocols (as shown by the dashed arrow in figure 1). In this way, the N.Application Service Part builds on the service of the MTP and SCCP by providing additional functions to meet the needs of the users of the signalling network. The term "application" refers to an entity that utilizes the capabilities of the MTP, SCCP, and the N.ASP. One example of such an application is the Transaction Capabilities Application Part (TCAP), which is intended to support such non-circuit related activities as 800 or Calling Card Service.

Another use of the MTP provides interworking with other protocols. For this application, the MTP provides a transport service for messages formulated within a different protocol domain. The special functions required to provide such a capability may include message modification; e.g. byte alignment and network management interpolation.

Figure 1. Signalling system No. 7 layered reference model



NSP = Network Service Part
DBM = Data Base Management

3. SPECIFICATION GUIDE

3.1 Message Transfer Part (MTP)

The first division of this specification following this overview describes the Message Transfer Part of SS7. Specifically, Q.701 describes the overall MTP, Q.702 describes the Physical Layer (level 1), Q.703 describes the Link Layer (level 2), Q.704 describes the connectionless Network Layer (level 3), Q.705 describes the signalling network structure, Q.706 describes the performance of the MTP, Q.707 describes MTP testing, and Q.708 describes the numbering plan.

3.2 Signalling Connection Control Part (SCCP)

The second division of this specification describes the Signalling Connection Control Part of SS7. Specifically, Q.711 describes the overall part, Q.712 defines the individual messages, Q.713 identifies the message encoding, and Q.714 specifies the procedures.

3.3 Integrated Services Digital Network (ISDN) User Part

The third division describes the call control for the ISDN. It begins with the Q.761 overall description and continues with Q.762 on messages, Q.763 on encoding, Q.764 on procedures and Q.766 on performance.

3.4 Operations, Administration, and Maintenance (OA&M)

Two sections have been defined in the OA&M series of specification: Q.791 on measurements for the SS7 MTP, and Q.795 for the Operations and Maintenance Application Part (OMAP).

3.5 Application Service Part (ASP)

The next section of the specification describes the overall Application Service Part, and each of the individual layers — Transport (4), Session (5), Presentation (6) — of the ASP, and ASP performance.

3.6 Transaction Capabilities

The last division covers the Transaction Capabilities Application Part with an overall description, messages, encoding, and procedures.

3.7 Support Information

The concluding support chapters cover the annotation rules used in producing this specification, and the glossary of new terms and abbreviations used.