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SIGNALLING SYSTEM NUMBER 7 STANDARDIZATION

JUNE 1998

OFFICE OF THE MANAGER
NATIONAL COMMUNICATIONS SYSTEM
701 SOUTH COURT HOUSE ROAD
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FOREWORD

Among the responsibilities assigned to the Office of the Manager, National Communications System, is the management of the Federal Telecommunications Standards Program. Under this program, the NCS, with the assistance of the Federal Telecommunications Standards Committee identifies, develops, and coordinates proposed Federal Standards which either contribute to the interoperability of functionally similar Federal telecommunications systems or to the achievement of a compatible and efficient interface between computer and telecommunications systems. In developing and coordinating these standards, a considerable amount of effort is expended in initiating and pursuing joint standards development efforts with appropriate technical committees of the International Organization for Standardization, the International Telecommunication Union-Telecommunications Standardization Sector, and the American National Standards Institute. This Technical Information Bulletin presents an overview of an effort which is contributing to the development of compatible Federal and national standards in the area of Signalling System Number 7. It has been prepared to inform interested Federal and industry activities. Any comments, inputs or statements of requirements which could assist in the advancement of this work are welcome and should be addressed to:

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PREFACE

This Bulletin reviews the Recommendations of the International Telecommunication Union - Telecommunication Standardization Sector (ITU-T) for Signalling System Number 7. It adheres to the conventions of the ITU-T with respect to spelling and terminology. For instance, the Recommendations refer to SS No. 7, and “signalling” is the consistent spelling within the Recommendations, whereas the national standards, published by the American National Standards Institute (ANSI) Accredited Standards Committee T1, refer to both SS7 and SS No. 7 as well as signaling and signalling. (In fact, the Recommendations are not consistent, especially where the text appears to have been contributed by T1.) The ITU-T terminology such as “clear down,” which refers to the U.S. action known as “tear down,” is also used.

The Bulletin is based on Recommendations current as of September 1997. While there have been revisions to the Recommendations dated in 1998, the revisions are not known to be substantial, and the dates of Recommendations current as of May 1998 are therefore included in the list of effective standards.

Other than the ITU-T Recommendations and the ANSI T1 Standards themselves, the open literature contains little current, detailed information on SS No. 7. The one exception discovered is Russell, Travis, Signaling System #7, McGraw-Hill, 1995. This source, which is based on the T1 Standards, was used as a general check against the tutorial and Recommendation summaries provided in this Bulletin.

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OVERVIEW

1.0 PURPOSE

The purpose of this report is to summarize the characteristics of the Common Channel Signalling System 7 (SS No. 7) and the ITU-T Recommendations that define it. It summarizes ongoing work in developing SS No. 7 Recommendations and the SS No. 7 role in providing access for broadband applications to ATM. It identifies the impact of this new work on National Security/Emergency Preparedness (NS/EP) objectives and signalling areas where work remains to be performed.

1.1 BACKGROUND

The CCITT[1] developed the first generation digital common channel Signalling System 6 (SS No. 6) in the mid 1960s. This digital, common channel (out-of-band) system responded to a variety of needs:

- Faster call setup times. The alternative signalling method, using in-band multi frequency analogue tones, was slow.
- The potential for more efficient use of voice circuits.
- Support for services which depend on network elements outside voice trunks, such as the databases used to control “800" number and other Intelligent Network services.
- Improved control over fraudulent network usage. Since the signalling occurs over non-voice circuits, voice connections are no longer accessible to fraudulent users until the called party answers.

SS No. 6 was found to be too slow and inflexible. CCITT almost immediately started work on an improved system depending on higher speed data links and variable message lengths. This system was specifically designed to include support for an intelligent network of software controlled switches; it became known as SS No. 7. Telecommunication carriers started deploying interoffice SS No. 7 networks in the mid 1980s, with conversion of local offices somewhat later. ITU-T Recommendations covering SS No. 7 have been published since 1980 as part of the Q series between Q.700 and Q.783. T1 SS7 Standards (to use T1 terminology) are published as T1.110 through T1.116. T1 Standards are designed to be consistent with the ITU-T

[1] The International Telecommunication Union - Telecommunication Sector (ITU-T) was known as the International Telegraph and Telephone Consultative Committee (CCITT) when Common Channel Signalling Recommendations were first written in the 1970s.

Recommendations; differences between the two exist primarily in the implementation of the national options permitted in the Recommendations. These differences are resolved at the gateways between U.S. national networks and other national or international implementations of the Recommendations, a procedure envisioned by the Recommendations. For instance, a unique internal addressing scheme used in the U.S. is translated at the international gateway. However, there are some fields in the T1 Standards which do not appear in the Recommendations. These differences may affect interconnectivity and are summarized in this Report. A third set of references, Bellcore's two volume technical report, TR-NWT-000246, is closely aligned with the T1 series and forms the basis for North American telecommunications carriers' SS No. 7 implementations.

SS No. 7 represents the latest signalling system used to support telephony and other circuit switched telecommunications. The ITU-T Recommendations define a system that has proven to be flexible enough to support other telecommunication signalling needs. These emerging needs include support for Narrowband Integrated Services Digital Network (ISDN) signalling and Intelligent Network services. On other networks, related standards like IS-41 support mobile wireless services and provide access to data bases on SS No. 7 networks through gateways. In addition, other Recommendations specify elements of the SS No. 7 protocol suite to support Broadband ISDN services at the Network Node Interface (NNI). This last does not imply any interconnectivity or interoperability between broadband and narrowband networks.

It is useful to remember that telecommunication service providers have implemented SS No. 7 so universally that it is easy to lose sight of the fact that the standards (whether T1 Standards or ITU-T Recommendations) and the implementations may not be the same things. The networks that have actually been implemented reflect only a portion of the standardized capabilities. This report generally describes the capabilities specified in the ITU-T Recommendations. Where the nature of SS No. 7 implementation in the U.S. does not support this approach (for instance in the case of the Telephone User Part, which is not even included in the T1 Standards), this Bulletin is guided by network implementations. The Bulletin alludes to, but does not review, connection-oriented SS No. 7 service, even though it is thoroughly described in both the Recommendations and the T1 Standards, since SS No. 7 networks in the U.S. have never implemented it and service providers show no intention of doing so.

1.2 STRUCTURE OF THE REPORT

This report is divided into five additional sections: Section 2 describes in general terms the system architecture and messages, protocol stack, and network operation which provide this signalling. Section 3 describes ITU-T Study Group activity in advancing SS No. 7 capabilities. Section 4 describes the ITU-T Recommendations that define the architecture and message protocols. Section 5 summarizes the differences between the ITU-T Recommendations and the T1 Standards. The final Section addresses the ability of SS No. 7 to meet NS/EP telecommunications objectives and the impact of the ITU-T Work Plan on any shortcomings.

SECTION 2

SURVEY OF SIGNALLING SYSTEM 7

2.0 INTRODUCTION

The ITU-T SS No. 7 Recommendations define a packet switched network that provides circuit switched network control by carrying both circuit related and non-circuit related signalling.

- "Circuit related"[2] signalling controls circuit set up and clear down. This signalling is customarily performed link by link, traffic node by traffic node as defined by bearer circuit routing tables outside the scope of SS No. 7. Circuit related signalling therefore does not require the complex addressing capabilities provided by network services.

- "Non-circuit related" signalling provides transport for a data query and response capability which applications use to communicate with databases and invoke features independent of the call set up and clear down function. Unlike the users of circuit related signalling which are internal to the signalling system, users of non-circuit related signalling are actually applications defined outside of the signalling system. SS No. 7 non-circuit related signalling therefore depends on the addressing capabilities provided by the network services function.

- In addition to providing circuit control and information transport in support of the bearer network, the SS No. 7 protocols provide internal automatic link and network management, and support a dedicated internal signalling network operation, administration, and maintenance function. Management capabilities are built into all the protocol Levels. As a result of these management features, the SS No. 7 protocols define a robust and stand-alone CCS network that has proven to be a flexible and powerful tool for ISDN, Intelligent Network, and related applications such as Mobile Service support.

SS No. 7 protocols support both connectionless and connection-oriented service. Connection-oriented service has been defined, but not implemented, for non-circuit related signalling. Connection oriented transmission has not yet been defined for circuit related signalling. SS No. 7 connectionless service is robust, and alternative means have been developed to emulate connection-oriented transmission where required. Connection-oriented transmission probably will not be implemented until end-to-end signalling requirements exceed the capabilities of the presently defined connectionless protocols.

Since the SS No. 7 serves the signalling needs of the network, independent of the transport network, its users are network processes not end user customers. The initial user of the SS No. 7 protocols was the circuit switched call set up and clear down process. Subsequently, when it became apparent that some generic non-call related signalling method was necessary to support

[2] All SS No. 7 signalling is actually related to circuits since it controls circuit switched bearer networks. However, the term "Circuit Related," as used here, refers to *circuit control* signalling passed between switching nodes, whereas other SS No. 7 services are termed "non-circuit related" in the sense that they *transport information* between SS No. 7 nodes and thus are not directly tied to circuit control.

800-number Wide Area Telephone Service, the SS No. 7 Transaction Capabilities protocol (known as an Application Service Element or ASE) was developed. Routing information for 800 numbers was contained in data bases which could not be accessed through customary in-band signalling over voice trunks. Database query-response access provided by Transaction Capabilities has been expanded to support other applications such as routing and billing information for 900 numbers, 911 services, certain custom calling feature instructions, user profiles, mobile user applications, and other Intelligent Network functions. While these user applications are normally carried by the generic Transaction Capabilities, some applications, such as the SS No. 7 Operations Maintenance & Administration Part (OMAP) and the Mobile Application Part (MAP), use additional specific ASEs in addition to the Transaction Capabilities protocol.

The SS No. 7 depends on a well defined network architecture and a flexible set of signalling protocols. Although the ITU-T has continued to develop these protocols to this day, they are now quite stable. Both ITU-T and T1 have continued SS No. 7 development for signalling in support of ISDN supplementary services, interfaces between ISDN and non-ISDN calls, and interfaces with broadband applications.

2.1 SS No. 7 NETWORK ARCHITECTURE

The SS No. 7 provides the means for serving circuit calls between switching nodes. All calls other than those that originate and terminate on the same end office switch are served by the SS No. 7 network which connects these nodes with each other and with databases of information used to control calls.

2.1.1 SIGNALLING POINTS

The SS No. 7 signalling network operates in parallel with the transport network, providing its own packet switching and transport facilities. The SS No. 7 network architecture defines three sets of nodes, also known as signalling points (SPs), connected by (usually multiple) data links, known as linksets. Like the transport network switches, each of these nodes is uniquely identified by a point code by which it is known to the other nodes. This architecture is shown in Figure 2-1.

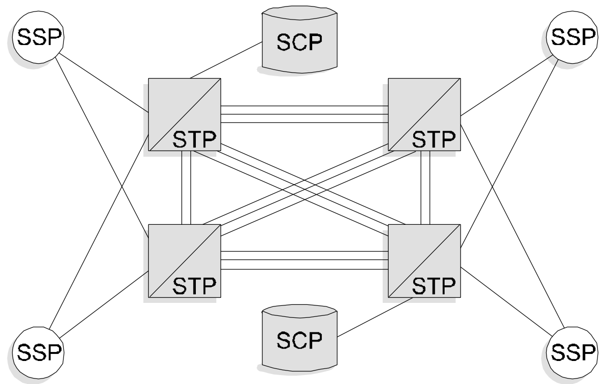

Figure 2-1, SS No. 7 Network Architecture

2.1.1.1 Service Switching Point

Service Switching Points (SSPs)[3] are associated with network transport switches and are the interface between the SS No. 7 network and the transport network. In an SS No. 7-controlled transport network, all the switches, both end office and tandem switches, are connected to the SS No. 7 network through these SSPs. The transport switches access call set up/clear down and data instructions from the SS No. 7 network through the SSPs. An SSP only connects to adjacent nodes and depends network addressing services in other switching points when communications are required to remote switching points. Physically, the SSP is a computer that generates the messages to other elements of the SS No. 7 network and receives their responses.

2.1.1.2 Signal Transfer Point

Signal Transfer Points (STPs) are Switching Points which have the additional capability to translate routing labels and route SS No. 7 network traffic between non-adjacent SPs. STPs also route network traffic to the Service Control Points (SCPs) in which network databases reside. As a practical matter, all SS No. 7 communications are performed through STPs even with adjacent nodes. Finally, STPs provide gateway services, delivering and accepting SS No. 7 calls from other networks, including those of wireless and international service providers which may use differing SS No. 7 implementations. In implementation, redundant STPs are often paired to provide increased system performance and network reliability.

2.1.1.3 Service Control Point

Service Control Points (SCPs) provide access to databases of information required for operation of the network, commonly 800/888 number translation and applications instructions, but increasingly including data required for intelligent and wireless network services. The STPs may access this information over non-SS No. 7 links, such as X.25, and return information for

[3] Both the ITU-T and T1 actually refer to "exchanges (switching centers)" as examples of signalling points located at exchange switches. However, it is common to refer to these points as Service Switching Points to better distinguish the signalling function from the transfer function which resides in the STP.

routing calls between SSPs, associating dialled numbers with physical destinations, providing instructions on how to forward calls, etc. The SCPs provide connection to Intelligent Network components such as the Service Management System and Intelligent Peripherals. In implementation, redundant SCPs are often paired to provide increased system performance and network reliability.

2.1.1.4 Operation, Administration, and Maintenance Centre.

Both the ITU-T Recommendations and the T1 Standards refer to the OA&M Centre as a fourth example of a signalling point, although they are not shown in figures. This signalling point is not strictly speaking an operational point; it offers the network administrator the capability of monitoring and maintaining the network. OA&M Centres may or may not be collocated with other switching points.

2.1.2 SIGNALLING DATA LINKS

Multiple Data Links can be grouped into linksets which connect the signalling points. Linksets provide both increased load bearing capacity and path diversity. However, there is no physical difference between link types. Signalling links are differentiated according to the following types:

A links provide SS No. 7 network “access” to Signalling end points (SSPs and SCPs).
B links “bridge” peer STPs. In the customary configuration, there are four linksets between two sets of mated pairs of STPs.
C links “cross” between a mated pair of STPs. C links are only used when there is no other route between an SSP and the transfer control provided by an STP pair due to, for instance, a link casualty. Although SCPs are also deployed in pairs, no cross link is provided.
D links provide “diagonal” connectivity between subsidiary and primary STPs. As a practical matter, B and D links are so similar that they are often referred to as B/D links.
E links “extend” the connectivity of an SSP to an alternate pair of STPs, when the added reliability justifies the cost.
F links provide a “fully associated,” direct connection between SSPs. Since the whole point of the SS No. 7 network is the flexibility provided by the STPs, fully associated switches are rarely used in networks controlled by SS No. 7.

Figure 2-2 illustrates the relationships between these data links.

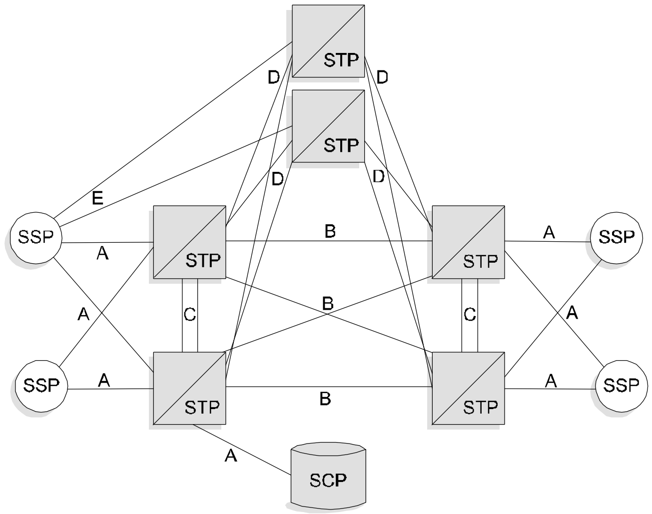

Figure 2-2, Data Link Types

2.1.3 SIGNALLING MODES

Switching Points may be associated in three possible configurations. When two adjacent nodes are connected by a link or linkset, and signalling passes directly from one node to another, they are said to be fully associated. When the signalling path is not fixed, but passes through multiple Signal Transfer Points which provide the network routing service through the SS No. 7 network direct to the destination, then the nodes are said to be non-associated. Limiting the number of transfer nodes has the advantage that the signalling delays are minimized. Although both types of association are defined in the ITU-T Recommendations, non-associated signalling is clearly the choice. However, the ITU-T Recommendations suggest that there be no more than two intervening signalling points in a normal relation, unless the network so stressed that alternative routing is required. The effect is to preserve the flexibility of the non associated mode, but limit the delays introduced by intermediate signalling nodes.

2.1.4 SIGNALLING MESSAGES

SS No. 7 nodes communicate by packet messages referred to as signal units (SUs). These messages provide both the means to support circuit and non-circuit related signalling and automatic internal network management. The messages vary extensively in complexity and flexibility, but all messages have four common fields.

- an 8 bit message separator flag which is considered to be the first field of the ensuing message.
- a series of forward and backward sequence number fields which nodes use to maintain link quality control and orderly flow control
- an information field Length Indicator (LI) which identifies the type of message.

Length Indicator Value	Type of Signal Unit

0	Fill-in Signal Unit (FISU)
1-2	Link Status Signal Unit (LSSU)
3-63	Message Signal Unit (MSU)

- a Frame Check Sequence which carries Cyclic Redundancy Check digits by which nodes identify corrupted messages and thus track link quality.

2.1.4.1 Fill-in Signal Unit

Idle links are not permitted in SS No. 7 networks, and nodes will keep an otherwise inactive link active by sending Fill-in Signal Units (FISUs). Even though there is no other signalling being conducted, nodes perform link management functions through these messages. Since even these fill-in messages contain the CRC field, the network thus maintains a continuous check of link quality by continuously monitoring the CRCs. Since all messages contain backward sequence number and indicator bits, they can be used to acknowledge message receipt, and the forward sequence number and indicator bits can be used to report rejection of a message that failed the CRC. By comparing the forward and backward sequence numbers in a received FISU message, a node can determine which signal units require retransmission.

The FISU is the simplest of the three SS No. 7 message types and exists solely to permit the network to maintain a continuous flow of CRCs and thus a continuous check on link quality. Since there is no information to transmit, the length indicator is set to zero, a unique identifier for the FISU. The FISU is shown in Figure 2-3 below.

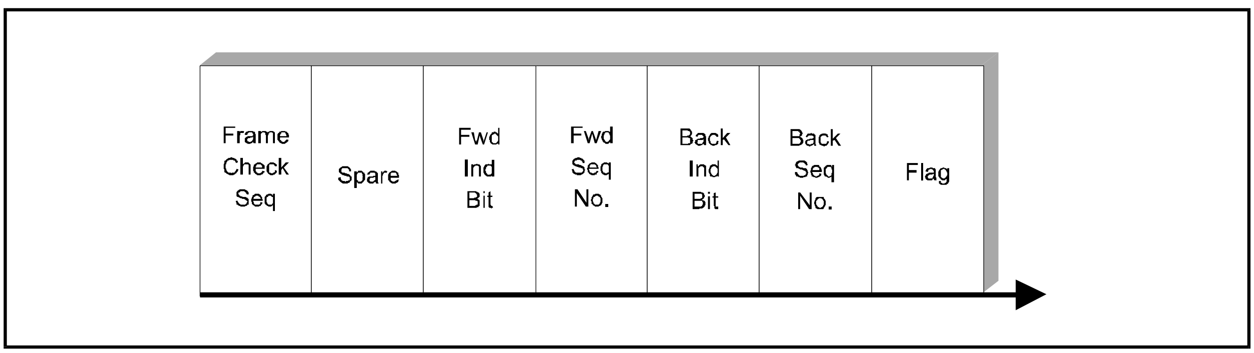

Figure 2-3, Fill-in Signal Unit

2.1.4.2 Link Status Signal Unit

The Link Status Signal Unit (LSSU) is a link management message. When a node detects a link failure, it sends an LSSU to the remote node on that link. These link failures do not involve total loss of communication, but are the result of congestion, poor node processor alignment, or loss of contact with upper protocol Levels. The LSSU advises the remote node on that link to take the link out of service. The affected nodes will trade additional LSSUs to coordinate restoration of the link. Restoration of totally failed links cannot be performed automatically.

The LSSU contains a length indicator set to “one” or “two,” indicating that the message is an LSSU and pointing to a status information (SI) field of one or two octets (some systems built to 1988 SS No. 7 standards can read only one octet). These status information field octets contain the information shown in the following table:

Status Information	Indication
SIO	Out of Alignment
SIPO	Processor Outage
SIOS	Out of Service (other than Processor Outage)
SIB	Busy (Congested)
SIN	Link Returned to Normal Operation
SIE	Emergency (short proving period)

The Link Status Signal Unit is shown in Figure 2-4 below.

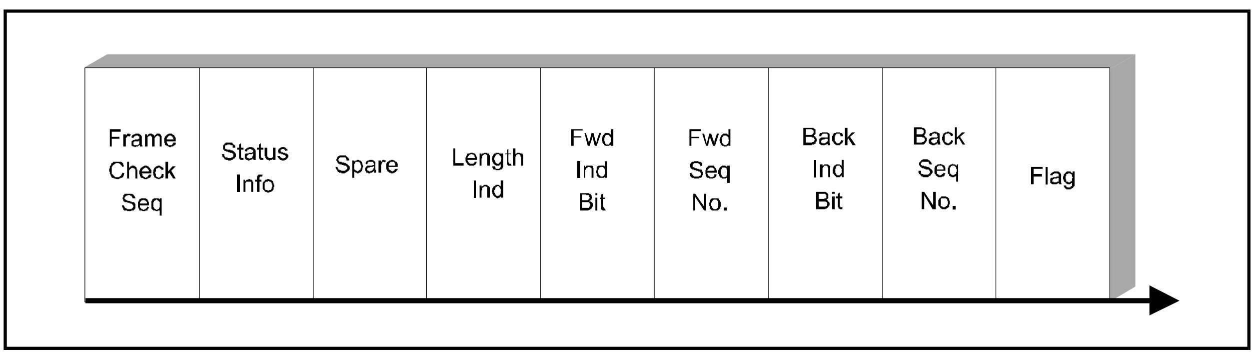

Figure 2-4, Link Status Signal Unit

2.1.4.3 Message Signal Unit

The Message Signal Unit (MSU) is the most complex and variable message of the three types. Unlike the FISU and LSSU which can only be addressed to an adjacent node and thus support the lowest SS No. 7 protocol Levels, MSUs contain routing labels and signalling information fields.

Therefore they provide a vehicle for carrying the circuit control and transaction messages used by the upper Level SS No. 7 protocols. The MSU information field can also carry network management and maintenance information. A Length Indicator value greater than 2 identifies an MSU. The value of LI will lie between 3 and 63, but SS No. 7 does not rely on LI to determine message length (which has been lengthened to a maximum of 272 octets). The general structure of the MSU is shown in figure 2-5.

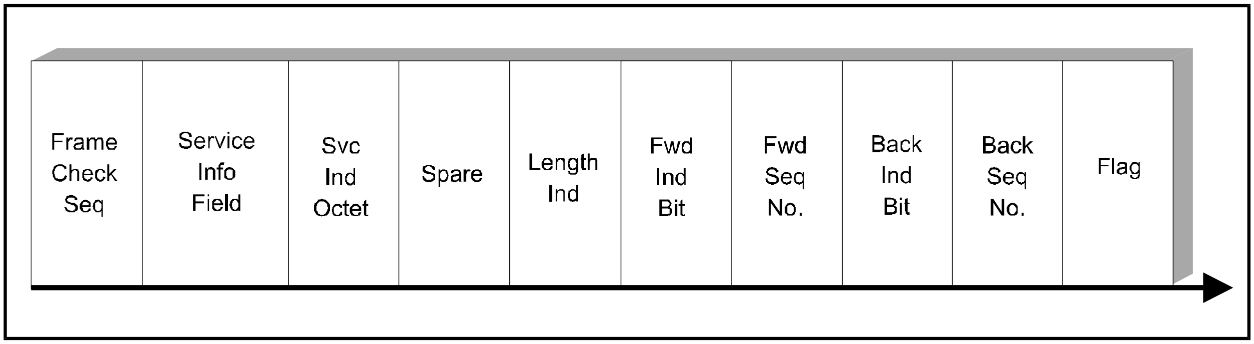

Figure 2-5, Message Signal Unit

In addition to the four fields that are common to all signal units, the MSU contains a Service Information Octet (SIO) and a Signalling Information Field (SIF).

The SIO contains two fields: the subservice field and the service indicator.

- The subservice field contains a network identifier which marks messages requiring access to international links through specifically configured gateways. On the national side of these gateways, SS No. 7 permits certain extensions; translations to other national implementations of SS No. 7 at the gateways are made through the standards published in the ITU-T Recommendations. On the national side of the gateway, standard priority Levels are permitted. In the U.S., T1 has defined four priority Levels. These national standards are described in Section 5, Differences Between ITU-T Recommendations and T1 Standards.

- The other SIO field is the service indicator which provides the information required for message discrimination. On the basis of this field, SS No. 7 identifies the end user or application. There are eight allowed values of the service indicator which identify the messages as various types of management, call control, or information exchange (transaction) messages

The other field unique to the MSU is the Service Information Field (SIF). The SIF makes the MSU the potentially long message of up to 272 octets long.

- The first part of the SIF is the routing label. The routing label provides the network addressing information required for the upper level protocols to forward a message through the network to nodes or applications. Although the ITU-T Recommendation supports four octets in the routing label, the T1 standard contains seven octets which describe the destination and originating point codes in terms of the U.S. network implementations (signal node member, cluster and network identification). The routing label also contains a signalling link circuit identification code (referred to by T1 as a signalling link selection). Depending on the value of this code, the upper level protocols can spread traffic across redundant links to maintain load balance or restrict messages to a certain link if it is required to maintain message delivery order.

- After the routing label is the SIF itself. The SIF is a variable length field containing the upper level user, application, or management information. The construction of the SIF depends on the upper level user, but it always carries a message type code, the mandatory fixed length parameters defined for the message type, the optional fixed length parameters, and the optional variable length parameters. In general, signalling requirements for new services are located in the optional signalling fields in order to avoid the need to redefine the mandatory fields and consequently reprogram the nodes. This field is more completely described in later sections of this report which describe the upper level circuit and non-circuit related protocols.

2.1.4.4 Transmission Hierarchy

SS No. 7 signal units are transmitted according to a hierarchy. This hierarchy indicates the high priority placed on reliability and link management in the SS No. 7 protocols.

Priority	Signal Unit Type
1	Link Status Signal Units
2	Unacknowledged Message Signal Units
3	New Message Signal Units
4	Fill-in Signal Units
5	Flags

2.1.4.5 Primitives

Primitives model the information flows between protocol and application levels. Even though they are defined and referred to (even within this Bulletin) as if they were messages, primitives are not SS No. 7 messages. They are only tools with which to understand the SS No. 7 processes.

While the structure of the SS No. 7 primitive model is standard and consistent with primitive models in other ITU-T Recommendations, the model is only a representation of internal information flows required to execute the SS No. 7 functions and should not be confused with the actual information flows implemented by the equipment vendor. In this regard, when applications are distributed between nodes, the information modelled by the primitives is transported between the peer protocols in the SIF field of Message Signal Units.

The primitive model is composed of four “fields.” The first field identifies the originator protocol, such as a low level protocol or one of the upper level circuit or non-circuit related protocols . The second identifies the type of data provided in the parameter (located in the fourth field). The third field identifies the action being requested or being reported, either a request, a response, or an acknowledgment (that the requested process has been started or completed). The fourth field provides the specific data described in general in the second field.

2.2 SS No. 7 FUNCTIONAL DESCRIPTION

There are four SS No. 7 functions: a basic transport mechanism, circuit related services, non-circuit related services, and management. Circuit related services may make use of non-circuit related services when end-to-end signalling is required (but they currently do not). These functions and relationships are shown in figure 2-6. The basic SS No. 7 function of management is considered to be an internal function and is not customarily displayed on these architectures by either ITU-T or T1.

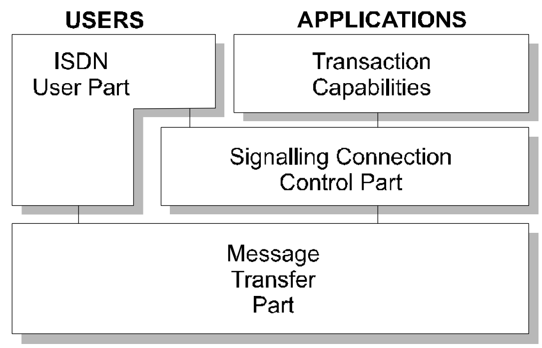

Figure 2-6, SS No. 7 Functional Architecture

2.3 SS No. 7 PROTOCOL STACK

There are four levels to the SS No. 7 Protocol Suite: the three levels of the Message Transfer Part (MTP) which provide a reliable transport system for all users, and a fourth level consisting of MTP Users. There are two MTP Users: one, the ISDN User Part (ISUP) provides basic circuit related call control signalling and supports ISDN Supplementary Services,[4] the other, the Signalling Connection Control Part (SCCP), provides non-circuit related network addressing and routing services through the Transaction Capabilities protocol to SS No. 7 users known as Applications. SS No. 7 Applications characteristically require access to remote databases and nodes, and so require the network addressing capability. The SCCP provides these network services to the complex array of Application Service Elements such as Transaction Capabilities, and Applications (also known as Application Entities).[5] This architecture is shown in Figure 2-7.[6]

[4] The Telephone and Data User Parts (TUP and DUP) are MTP Users defined in the ITU-T Recommendations, but are replaced by the ISDN User Part in US Networks. T1 Standards do not define TUP and DUP.

[5] The term "User" appears to be loosely used by the ITU-T and T1. There are two MTP Users: ISUP and SCCP, but broadband ISUP is sometimes misleadingly included in the list. However, SCCP also has Users: the Application Service Entities such as Transaction Capabilities (TC) and TC has Users, known as SS No. 7 Users. Additionally, ISUP can provide circuit related services to its own Users. To compound the difficulties, readers should be cautious in using the term "Part." The four protocol levels are referred to as Parts, but the Transaction

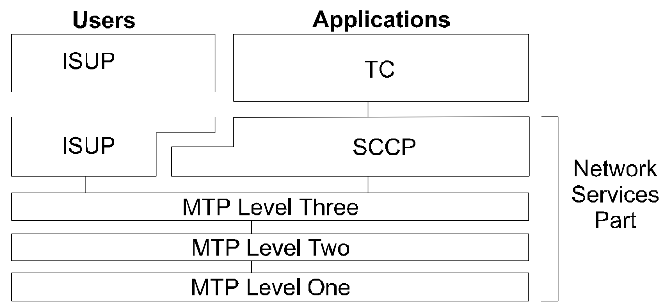

Figure 2-7, SS No. 7 Protocol Architecture

Although the ITU-T defined the SS No. 7 protocol stack before the ISO/OSI described the seven layer protocol model, the four SS No. 7 Levels can be roughly equated to the seven OSI layers as shown in Figure 2-8.

- The combination of the MTP and the addressing capabilities of the SCCP constitute the SS No. 7 Network Services Part which provides OSI layer 3 network addressing and routing services to the Applications.

- OSI layers 4-6 are referred to in the SS No. 7 as the Application Service Part, but are presently undefined. The reliability that these connection oriented protocol OSI layers generally provide is emulated by other means in the SS No. 7 Transaction Capabilities protocols.

- Although the ISUP is usually shown as extending from layer 3 to layer 7, it does not imply that all the intervening layers are defined. In fact, it only implies that the ISUP is involved with translating the end-user's initial call set up signals into the SS No. 7 call set up signalling protocols, and also interacts with the low level message transfer protocols of the MTP.

Capabilities, which looks like a Part is never referred to as a Part, the Operations, Maintenance and Administration Part is rarely shown as a Part, the Mobile Application Part is not a Part but a User, and the INAP which is occasionally shown as an Application Part is really the Intelligent Network Application Protocol.

[6] Unlike either ITU-T or T1 figures, this report shows the ISUP on the left and the SCCP/TC stack on the right and describes the ISUP first. The ISUP is simpler, and describing it first may prepare the reader for the complexities of the SCCP and TC.

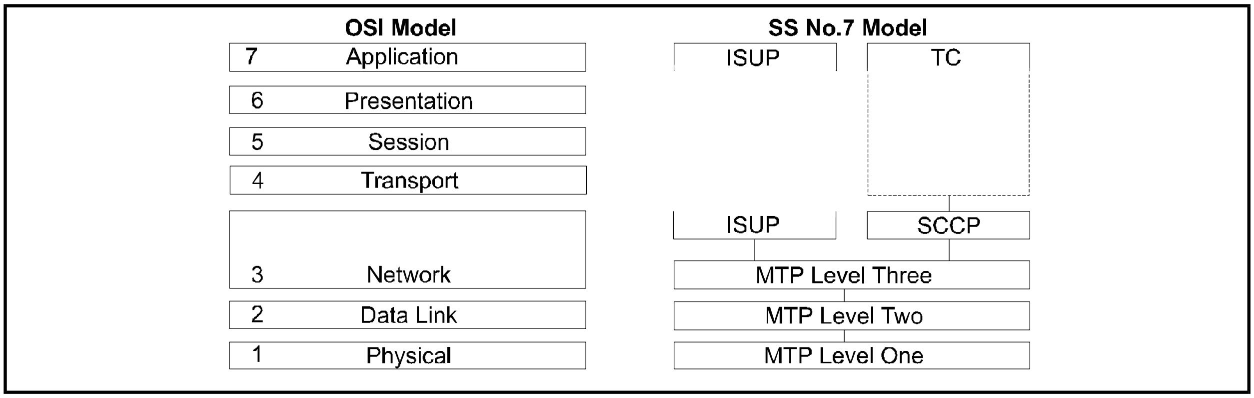

Figure 2-8, SS No. 7 Protocol Stack and the ISO/OSI Reference Model

2.3.1 MTP LEVEL 1

MTP Level 1 is equivalent to the OSI Physical Layer. It defines North American interfaces (DS-1 (1.544 Mbps), DS-0 (64 kbps), and DS-0A (56 kbps)) as well as international interfaces such as V.35 (64 kbps). The MTP Level 1 has been optimized for operation at 56, and 64 kbps, and 1.536 and 1.544 Mbps.[7] Other, lower, speeds are permitted, and their use is for further study.

2.3.2 MTP LEVEL 2

MTP Level 2 is equivalent to the OSI Data Link Layer. It defines the protocols required to detect missing and corrupted messages on the individual data links and to sequence the delivery of data packets. The SS No. 7 Level 2 uses the Fill-in Signal Units to perform error detection and correction and uses Link Service Status Units to control link recovery. Level two maintains itself without disrupting the higher levels.

2.3.3 MTP LEVEL 3

MTP Level 3 is roughly equivalent to the OSI Network Layer. Level 3 is responsible for message handling and network management.

Level 3 performs message handling functions. It discriminates, routes, and distributes messages passed across the data link sets by the Level 2 protocols.

- Level 3 analyzes the addresses of incoming messages and discriminates between messages addressed to the local node and those addressed elsewhere.

[7] The higher signalling transmission rates of 1.536 and 1.544 Mbps in SS No. 7 network backbones would permit the efficient bundling of SS No. 7 signalling links in T1 facilities. The overall signalling rate would remain unchanged. Putting numerous links on a single high speed circuit without the need for channelization would potentially simplify transmission. However, concentrating a significant amount of signalling on a single facility rather than spreading it across a number of 64 kbps channels introduces two vulnerabilities. The loss of a T1 facility dedicated to signalling could be crippling to a network, and, where SS No. 7 networks connect

- Messages addressed to the node are distributed to the process identified by the Service Information Octet in the message.
- If the address of the incoming message is not that of the local node, the Level 3 discrimination function calls on the Level 3 routing function which checks its routing tables, routes the message appropriately, and delivers it back to the Level 2 protocols for retransmission.

MTP Level 3 performs its routing based on the Point Codes contained in the message addresses, which uniquely identify the network location of the originating and destination points. MTP, however, only knows how to route link by link. This is not a problem for circuit related signalling which is performed link by link. However, for non-circuit related signalling to data bases and applications which could reside anywhere in the network, MTP Level 3 at the exchange switch may not have the required routing tables. Consequently, it fills in the unknown fields with zeroes and forwards it to the Signal Transfer Point where routing table resources are centralized. Upper level protocols at the STP then perform a global title translation, enter the necessary routing data, and return the message back to MTP Level 3 for onward transmission.

In addition to discrimination, distributing, and routing messages, MTP Level 3 also performs some management. It controls the use of the LSSU for Level 2 link management. The Level 3 view of link status includes the condition of the end points, such as the network interface cards, so that a link can be operational at Level 2, but out of service at Level 3. The Level 3 link management function normally takes these errored links out of service, performs diagnostics and realignment, and returns them to service without operator intervention. Level 3 management functions also originate upper level traffic and route management messages using MSUs identified as management in the Service Information Octet. When a node becomes either congested or out of service for some reason, Level 3 may either throttle traffic to the node or reroute traffic, in both cases advising adjacent nodes in the network. Level 3 provides maintenance information to the OA&M Centre, so that operators may elect to intervene.

MTP Level 3 protocols can serve broadband applications as well as the narrowband applications discussed so far. When MTP Level 3 is implemented with certain modifications in broadband networks, it is “informally” referred to as MTP-3b (and in this context MTP Level 3 is referred to as MTP-3). The principal difference between MTP-3 and MTP-3b is the length of the SIF payload to be carried: while narrowband implementations of MTP-3 permit a maximum SIF length of 273 octets, the MTP-3b will permit over 4000 octets. When used for broadband applications, MTP-3b provides access to the ATM Signal Application Adaptation Layer (SAAL) and thence to other ATM protocols, rather than MTP Level 2. MTP-3b is an SS No. 7 protocol, but it is defined in the series of Recommendations that specify ATM and Broadband ISDN rather than the SS No. 7 Recommendations.

2.3.4 NETWORK SERVICES PART

The MTP and the Signalling Connection Control Part (SCCP), described below, are referred to as the SS No. 7 Network Services Part (NSP). The NSP uses MTP to route messages from node to node and uses the SCCP to access the network routing function and so provide end-to-end routing through intermediate STPs. SCCP can be considered to be in OSI layer 3, but it provides network Level transport to non circuit-related data messaging protocols (such as Transaction Capabilities), and so it appears in SS No. 7 Level 4.

2.3.5 LEVEL 4, MTP USER FUNCTIONS

SS No. 7 Level 4, MTP User Functions, provides access to MTP Users. There are two MTP Users. One is the ISDN User Part (ISUP) which uses the MTP to carry messages that control circuit set up and clear down link by link. The other is the Signalling Connection Control Part (SCCP) which permits the flexibility of network routing of application transaction messages used by Intelligent Network, mobile service, and operations, maintenance, and administration.

2.3.5.1 The ISDN User Part

The ISDN User Part (ISUP) provides the signalling functions required to support basic bearer services and supplementary services for voice and non-voice applications. It controls voice and data call set up and clear down for both ISDN and non-ISDN calls directly through the MTP. The ISUP Recommendations not only specify the signalling that supports ISDN, but also contain the signalling procedures for call set up and clear down. The basic ISUP task is to set up a transport circuit connection between nodes, leading to the called party according to standard routing tables located at the Switching Points. ISUP also supports ISDN supplementary services, by carrying feature or caller information associated with calls being established as part of the ISUP Service Information Field.[8]

ISUP accepts ISDN and non-ISDN call set up messages, mapping them onto its own ISUP Initial Address Message. Consequently, the ISUP is normally pictured as reaching to the OSI application layer where these call set up messages are originated (Layer 7).

ISUP message formats are carried in the SIF of an ISUP message signalling unit. The ISUP SIF contains a routing label, a circuit identification code, and the signalling information. The routing label provides the point codes for the originating and destination addresses. The Circuit Identification Code is a code (undefined in the ITU-T Recommendations) which identifies the bearer circuit which is the subject of the message. The Signalling Information includes the message type and mandatory/optional parameters defined for that type.[9] There are 43 ISUP message types defined in the ITU-T Recommendations, nearly all of them also implemented in the T1 Standards. Message types include, for example, the Initial Address Message (IAM) on which the entire call set up process is based, and call management messages such as call progress (CPG). The structure of the ISUP SIF is shown in figure 2-9.

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[8] Not all ISDN supplementary services can be serviced by the ISUP alone. For instance, call forwarding involves a circuit to the number being forwarded to, which must be set up by another SS No. 7 protocol (TC).

[9] Message types have not been entirely standardized between T1 and the ITU-T and there are many that are not defined in one or the other. There are other differences, particularly in the definition of failure cause codes.

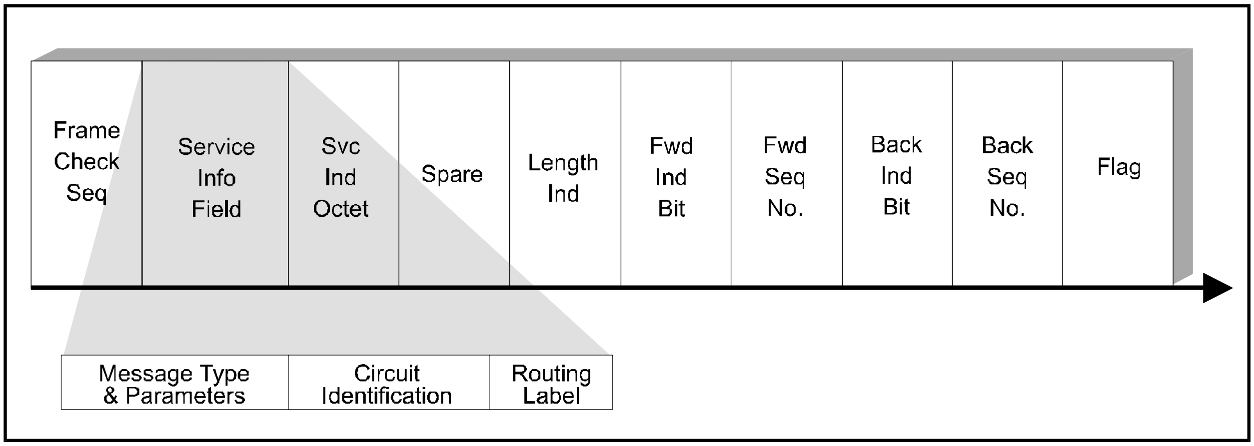

Figure 2-9, ISUP SIF Components

2.3.5.2 Signalling Connection Control Part (SCCP)

Unlike ISUP which is devoted to setting up and clearing down physical bearer circuits, SCCP exists to carry traffic for SS No. 7 User Applications and management. Since it carries application information between two points which may not be related to any bearer circuit, SCCP must be able to interpret and provide more flexible addressing and routing information across the interface to MTP. SCCP performs Global Translation and Routing for destination and originating point codes not associated with physical originations and destinations (such as “800" and credit card numbers), as well as subsystem numbers which provide the logical address for the separate application subsystems within the node being addressed. SCCP also controls MTP Level 3 load sharing between redundant signalling points.

There are four functions of the SCCP protocol as shown in Figure 2-10. The most important is the SCCP Routing Control (SCRC) which translates between the unique node and subsystem addressing point code and the simplified global title contained in most SCCP messages. Based on this translation capability, SCCP performs message discrimination, distributing those messages addressed to its node to the affected subsystems, and passing those not addressed to it back to the MTP. The SCCP routes messages to one of the other three functions for delivery to the addressed subsystem: the SCCP connectionless control (SCLC) function, the SCCP management (SCMG) function, and the SCCP connection-oriented control (SCOC) function (not implemented). The SCCP is defined for both connection-oriented and connectionless service, although connection-oriented service has not been implemented. SCCP connectionless service is robust and can sufficiently emulate the characteristics of connection-oriented service that query and response transactions can be performed reliably.

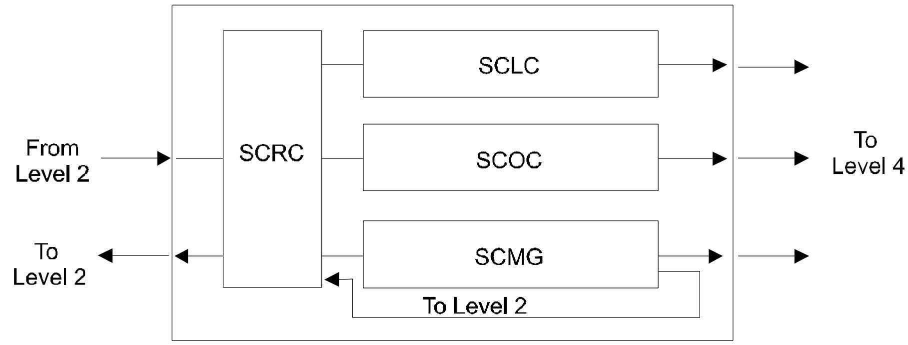

Figure 2-10, SCCP Functions

SCCP provides two levels of connectionless service: class 0 is basic datagram service, and class 1 is sequenced. When a user specifies class 0 service, SCCP distributes messages at random over any available redundant links as a management tool to maintain load balance. Class 1 is chosen when the length of a single transaction may be greater than the 273 octets permitted in the Signalling Information Field of a single MSU, and the data must be segmented over a series of SCCP messages. When Class 1 SCCP detects the fact that a transaction has been segmented, it requires all the segments to be passed over the same physical route, thereby guaranteeing that the addressee receives all the segments in the order transmitted.[10]

Besides the sequence control offered by the choice of two service classes, SCCP offers two other Quality of Service parameters. The return option permits MTP to discard a message on error (e.g. it cannot deliver it) or requires it to return the message to SCCP on error. The message priority is assigned by MTP to SCCP messages according to externally developed guidelines, as described in paragraph 2.1.4.3 (Message Signal Unit, above), and Section 5, Differences Between the ITU-T Recommendations and the T1 Standards.

SCCP provides automatic network traffic and route management. Unlike MTP management which is responsible only for individual links connecting nodes, SCCP management supports subsystems and applications which may be distributed over several nodes. SCCP accepts node status primitive information directly from the MTP signalling point as well as messages indicating subsystem status from remote node. Based on this information, SCCP can reconfigure the signalling network; SCCP throttles traffic or routes messages around nodes that have announced themselves as congested, and manages the routing differences between service classes 0 and 1. Additionally, SCCP can be used to advise the OMAP of alarm conditions.

Like ISUP, SCCP messages are carried in the message signal unit SIF. The Service Information Field in the SCCP message carries a routing label like that of the ISUP which identifies the originating and destination calling points. The second part of the SCCP SIF, known as the SCCP message, contains the message type (management or transport) and the mandatory/optional parameters defined for that message type. Unlike the ISUP, the SCCP exists to provide a transport service and the third field contains any message being transported, usually a

[10] Service classes 2-4 are also defined, but are for the unimplemented connection-oriented service.

Transaction Capabilities message, discussed below. The structure of the SCCP SIF is shown in figure 2-11.

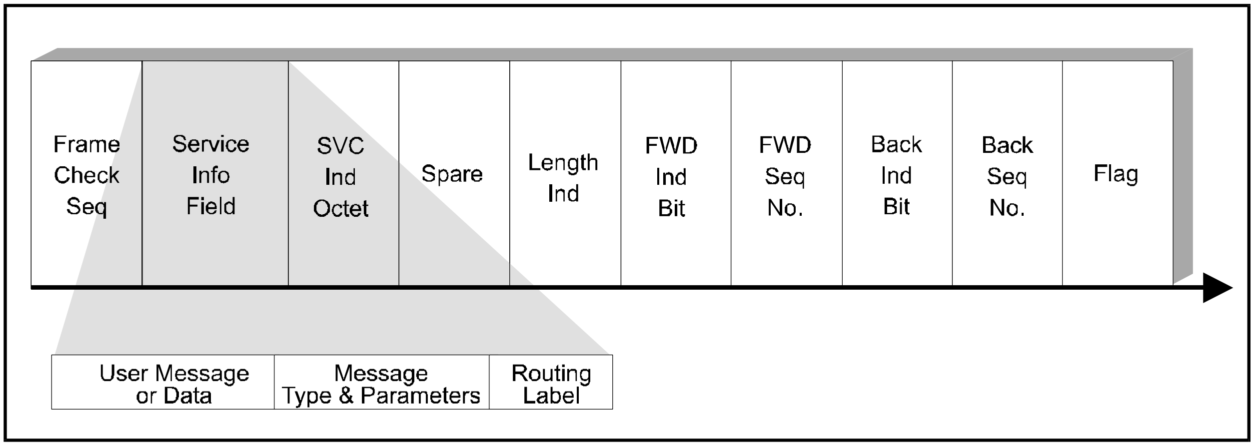

Figure 2-11, SCCP SIF Components

2.3.6 SS No. 7 USERS

The SS No, 7 Users referred to here are those that exist in OSI layer 7 (Application Layer). These SS No. 7 Users can be grouped into two classes:

- those application users that support circuit related traffic (User Parts that control circuits) which use the ISUP to access MTP, and
- those application users which access MTP through SS No. 7 Transaction Capabilities and the SCCP that support non-circuit related query and response transactions with Service Control Point databases and that provide transport of application data.

2.3.6.1 ISDN User Part

ISUP, which controls circuit set up and clear down as an SS No. 7 Level 4 protocol, also is an OSI application layer protocol. Since ISUP treats an end user’s call set up message as an application message to be translated into its own ISUP format, ISUP is customarily shown on SS No. 7 functional architecture graphics as a simple stovepipe extending from Level 4 up to the Level occupied by circuit related applications.

2.3.6.2 Transaction Capabilities

Transaction Capabilities (TC) supports non-circuit related OSI layer 7 application processes. These processes depend on an SS No. 7 capability to carry query and response, feature and Intelligent Network service invocation, or data transfer messages, all of which may be regarded as transactions. All these transactions require messages to be routed between the users and data bases or between user instances. This information does not apply to circuit control, and routing is not accomplished by the same link-to-link method used by ISUP. TC is a generic Application Service Element (ASE) which can support a number of SS No. 7 Applications. However, most applications, such as the Operations, Maintenance, & Administration Application Part (OMAP), require specific additional ASE functionality which is not covered by SS No. 7. In this case, OMAP is served by both the OMASE and TC.

ITU-T defines TC as a generic Application Service Element (ASE) lying between TC-Users (over OSI layer 7) and the SCCP. TC consists of the Application Part (TCAP) and the undefined Application Services Part (ASP).[11]

TCAP consists of three sub-layers, the Transaction, Dialogue, and Component sub-layers. The Transaction portion identifies and distributes traffic to specific transaction and application sub elements, thus assisting in the emulation of connection-oriented service. The Dialogue and Component portions support the differing query/response and unidirectional data transmission traffic needs of the applications.

Like all the upper-Level SS No. 7 messages, TCAP depends on the MSU, contributing a TCAP field to the SCCP SIF consisting of the Transaction identification and the data (component, data, or dialogue) required for the Transaction. The transaction identification defines the message type and parameters required. The structure of the TCAP field in the SCCP SIF is shown in figure 2-12.

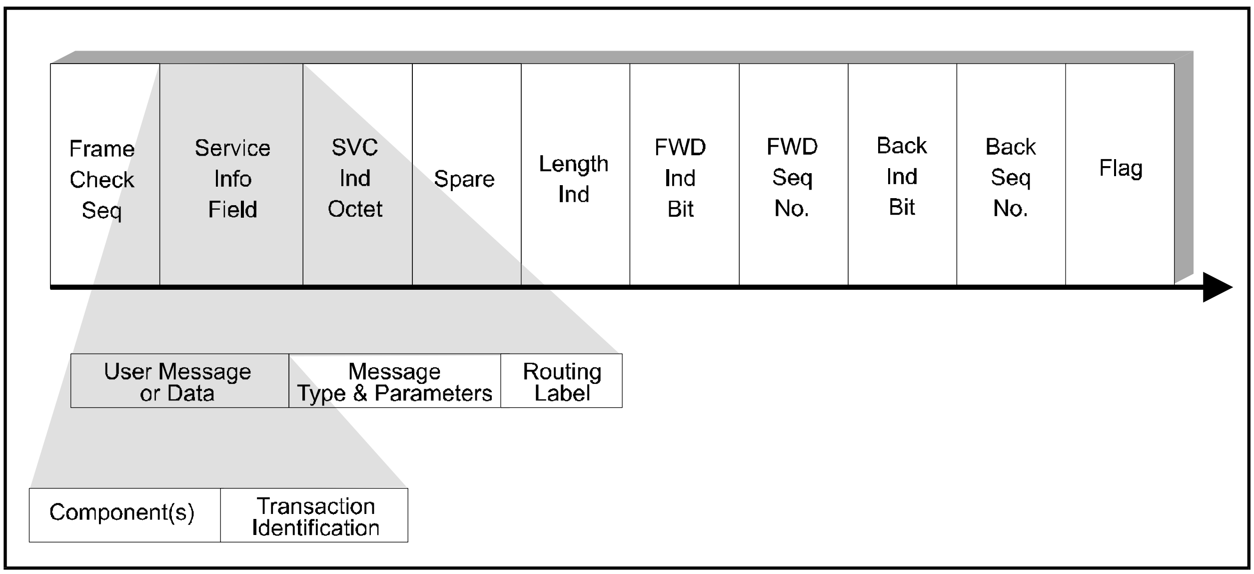

Figure 2-12, The TCAP Field in the SCCP SIF

11 The ASP would implement OSI layers 4-6 and support connection-oriented service. Although both the ITU-T Recommendations and the T1 Standards recognize that the ASP might be needed to be implement connection oriented service, they both leave the subject to further study. In light of the fact that ASP is undefined, both the Recommendations and Standards consider TC to be synonymous with TCAP and use the terms more or less interchangeably. In this report, they are not used synonymously.

2.3.5.3 Operations, Maintenance, & Administration Part (OMAP)

The OMAP provides the means by which the network operator maintains the network. Maintenance includes management outside the scope of the automated management performed by the SS No. 7 protocols themselves described above. The OMAP depends heavily on the ITU-T Telecommunication Management Network (TMN) Recommendations as a means of standardization of the network-wide management approach and implementation.

The OMAP fulfills three main requirements on the SS No. 7 protocols and the associated signalling network.

- It provides an interface between the operator and the network using standard concepts defined in the ITU-T TMN Recommendations.
- It provides the means of standardizing the approach to the entire telecommunication network (including the bearer channels and other networks); this means that the OMAP managed objects are consistent with TMN-defined managed objects. The OMAP exerts control over these objects using a TMN Management Information Base (MIB), through an undefined interface. Each protocol Level contains some Layer Management Entity (LME) in which the managed objects virtually reside.

- OMAP extends the automatic management functions of the SS No. 7 protocols into a consistent network-wide system.

The OMAP provides fault, configuration, and performance management, providing the network operator with the capability for monitoring the performance of the network, the success of the SS No. 7 automatic management procedures, and the option of intervening manually to maintain the network.

The OMAP operates through three functions known as the MTP Routing Validation Test, the SCCP Routing Validation Test, and the Circuit Validation Test. These tests reside conceptually in the OMAP Application Service Element-User (OMASE) which resides in OMAP. The OMASE communicates with SCCP and MTP through the specialized OMASE and generalized ASE, TC (both of which reside within SS No. 7).

SECTION 3

SS No. 7 STANDARDIZATION

3.1 PRINCIPAL STANDARDS ORGANIZATIONS INVOLVED IN SS No. 7

3.1.1 STRUCTURAL OVERVIEW.

At the international Level, the Telecommunication Standardization Sector of the International Telecommunications Union (ITU-T) is the pre-eminent standards body for developing international telecommunication standards (referred to as Recommendations) for voluntary use by member countries. The U.S. input to this process is coordinated through the Department of State's International Telecommunications Advisory Committee (ITAC).

On a national Level, ANSI Accredited Standards Committee T1-Telecommunications (variously referred to as Committee T1, ASC-T1, or just T1) is the Standards Development Organization that has overseen the implementation of SS No. 7 standards, working closely with Bellcore. As a practical matter, the SS No. 7 Transaction Capabilities standards were initially developed in the U.S. and for a while were inconsistent with the ITU-T Recommendations which while they were based on the U.S. experience, included improvements. T1 and ITU-T standards are now closely aligned, with the exception of national differences permitted in the international standards, except that the U.S. Transaction Capabilities includes a Network Security Function which is absent from the ITU-T Recommendations.

3.1.2 STANDARDS GROUPS

3.1.2.1 International Telecommunication Union (ITU)

The ITU is a formal treaty organization, consisting of over 160 member nations, established and operated under the auspices of the United Nations. Its objectives are to maintain and extend international cooperation in the use of telecommunications of all kinds, to promote development of technical facilities and their efficient operation, and to coordinate member's actions in the attainment of these goals. In the achievement of these goals, the ITU allocates radio frequencies, coordinates efforts to eliminate radio interference between nations, helps developing nations use telecommunications technology, advises members on rate setting so that they are fiscally viable while serving their communities, and looks at interoperability and other service issues as they relate to telecommunications between nations. The ITU also undertakes studies, makes regulations, adopts Recommendations (voluntary standards), and collects and publishes information on a wide variety of telecommunications matters. The United States is represented in the ITU by the Department of State.

The ITU is organized into three major sectors: the Telecommunication Standardization Sector (ITU-T, formerly the CCITT), the Radiocommunication Sector (ITU-R, formerly the CCIR), and the Development Sector (ITU-D). Each Sector is supported by a Bureau headed by a Director with general administrative support provided by the ITU General Secretariat.

The ITU-T publishes Recommendations which are determined by the consensus of the member nations and are effectively voluntary standards. These Recommendations are written by the 15 Study Groups, one of which is Study Group 11.

Study Group 11, Signalling Requirements and Protocols. This Study Group is responsible for studies leading to Recommendations relating to signalling requirements and protocols for telephone, N-ISDN, B-ISDN, UPT, mobile and multimedia communications. SG11 is the Lead Study Group on the Intelligent Network and the IMT-2000.

3.1.2.2 ANSI Accredited Standards Committee T1-Telecommunications (T1)

T1 develops technical standards and reports regarding interconnection and interoperability of telecommunications networks at interfaces with end-user systems, other carriers, information and enhanced service providers, and customer premises equipment. Topics addressed include switching, Signalling, transmission, performance, operation, and administration aspects. T1 is also concerned with procedural matters at points of interconnection, such as maintenance and provisioning methods and documentation, for which standardization would benefit the telecommunications industry. This work is concentrated in nine areas, one of which is Signalling.

T1 is sponsored by the Alliance for Telecommunications Industry Solutions (ATIS) and accredited by ANSI to develop American National Standards in its area of expertise. Membership is open to any organization, company, government agency, or individual having a direct and material interest in the activities of the Committee. Members are classified into four interest groups: Exchange, Interexchange, Manufacturing, and User and General Interests. In compliance with ANSI policy, no group is allowed to achieve a dominant in T1 activities.

T1 is divided into six Technical Subcommittees which are advised and managed by a Technical Advisory Group (T1AG) consisting of the Officers of Committee T1, a designated representative of the Secretariat, and the Chair and Vice-Chair of each of the subcommittees. Each Technical Subcommittee develops draft standards and technical reports in its designated areas of expertise. They also review and recommend positions on matters under consideration by other national and international standards bodies, with particular emphasis on the ITU-T.

Technical Subcommittee T1S1 - Performance and Signal Processing: T1S1 develops standards and technical reports related to new telecommunications services and their supporting architectures and enabling signalling protocols, of which ISDN, Intelligent Networks, Signalling System No.7, and Broadband ATM are the most prominent. This work is primarily focused on the development of international standards in ITU-T and JTC1, and the identification of any unresolved differences between these standards and the needs of North American industry. Significant liaison is also maintained with the North American ISDN Users Forum (NIUF), the ATM Forum, and the Frame Relay Forum, as well as counterparts in the European Telecommunications Standards Institute (ETSI). T1S1 is divided into the following Working Parties

- T1S1.1 ISDN Architecture and Services;
- T1S1.3 Common Channel Signalling;
- T1S1.5 Broadband ISDN
- T1S1.6 Standardization and Program Management for Local Number Portability

3.2 STANDARDS UNDER DEVELOPMENT

This section summarizes the Work Programs of ITU-T Study Group 11.

3.2.1 ITU-T STUDY GROUP 11 RECOMMENDATIONS UNDER DEVELOPMENT OR REVISION

The latest Study Group 11 Work Programme is dated 20 April 1998. The following list of SS No. 7 related elements was drawn from that programme. The elements are ordered by question number, as they are in the ITU-T list.

Question/ Priority	Timing	Rec	Subject	Reference
none/H	none	Q.725	TUP Performance	none
none/H	none	Q.766	ISUP Performance	none
2/none	none	Q.751.0	Overview of SS No. 7 managed objects series	none
2/none	none	Q.751.1	Network element information model for the MTP	White Book 10/95 COM-11-R65 App 2
2/none	98-05	Q.751.4	ISUP Managed Objects	COM11-R71
2/none	after 99	Q.751.5	MTP Network Managed Object Model	none
2/none	after 99	Q.751.6	SCCP Network Managed Object Model	none
2/none	none	Q.751.t-w	Network information model for the TC, ISUP, MTP, & SCCP	none
2/none	after 99	Q.751.x-z	SS N0. 7 managed objects for IN, UPT, & Mobile	none
2/none	after 99	Q.755	SS7 Protocol Tests	none
2/none	98-05	Q.755.1	SS No. 7 Protocol testers - MTP tester	COM11-R72
2/none	none	Q.780	SS No. 7 test specs - General description	White Book 10/95
2/none	none	Q.78x	SS No. 7 Test Specs: OMAP	none

Question/ Priority	Timing	Rec	Subject	Reference
2/none	after 99	Q.2751. series	Overview of SS No. 7 managed objects for B-ISDN	White Book 10/95
12/H	00-02	Q.761	Functional description of the ISUP of SS No. 7	none
12/H	00-02	Q.762	General function of messages and signals, SS7 ISUP	none
12/H	00-02	Q.763	Formats & codes, SS7, ISUP	none
12/H	00-02	Q.764	Signalling procedures, SS7, ISUP	none
12/H	98-05	Q.765	Application Transport Mechanism	TD PL/11-80
16/H, M, none[12]	none[12]	Q.70x series	MTP definition	Blue & White Books, COM11-R66
16/none	none	Q.71x series	SCCP definition	Blue & White Books, COM11-R6 Ann 3
16/none	none	Q.781	MTP Level 2 test specification	White Book
16/none	none	Q.782	MTP Level 3 test specification	White Book
16/M	none	Q.786	SCCP test specification	Blue Book

3.2.2 STUDY GROUP 11 WORK PROGRAMME

Study Group 11 is responsible for studies relating to signalling requirements and protocols for telephone, N-ISDN, B-ISDN and others. The Work Program for 1997-2000 is (not necessarily in the order of priority):

1) telephone and N-ISDN basic and supplementary services
2) B-ISDN and multimedia services
3) user mobility and terminal mobility
4) access and network security
5) control of transmission equipment (e.g. echo controllers) using technologies such as
    1) intelligent network
    2) Signalling System No. 7, including MTP, ISUP, B-ISUP, SCCP, and TC
    3) DSS1 for N-ISDN
    4) DSS2

3.2.3 SPECIFIC STUDY GROUP 11 SS No. 7 WORK QUESTIONS[13]

[12] Not of all the Recommendations in this series has any completion date except Q.708 which is timed for completion in 99-03. The Recommendations are evenly split between High, Medium, and no priority.

[13] This list does not match the contents of the Work Programme exactly. In particular, there is no reference to Question 18 (Reliability) in the table. These descriptions are formatted the same way the ITU-T questions are formatted. There are some formatting inconsistencies between questions.

Question 2/11 Signalling System No. 7 - Management (OMAP)

Reasons for the Question

Experience with Signalling System No. 7 management procedures and protocols is evolving. Increased SS No. 7 traffic volume and changing characteristics of that traffic will require control and management procedures.

The Study of SS No. 7 ,management requires close coordination between studies of evolving SS No. 7 protocols and the evolving TMN.

New technologies (e.g. ATM) will require new functions in the management plane.

Performance objectives of SS No. 7 should be defined.

TMN will provide management functions supporting SS No. 7 signalling network management requirements,

Using new calculation potential of the TMN, the large set of non-obligatory measurements for SS No. 7 usage and performance should be reduced to a smaller set of obligatory basic ones.

Enhancements are required to the existing Recommendations Q.750 to Q.755.

Task objectives, each leading to one or more Recommendations for implementation.

Measurements:

Identify the basic set of measurements for the SS No. 7 broadband signalling, reduce and refine the existing set of SS No. 7 measurements and complete the measurements for SCCP accounting.

Object Models:

Complete the definition of managed objects.

Testing:

Additions to descriptions of protocol testers in Q.755 and development of additional tests.

Question 16/11 Common Channel Signalling System No, 7 - Network Service Part (MTP and SCCP)

Reasons for the Question

While the Recommendations on the existing Signalling System No.7 (SS No.7) message transfer part (MTP and signalling connection control part (SCCP) have reached stability and form a stable basis for the upper layers of SS No.7, the following should be considered:

- there is a large and increasing implementation of signalling networks using SS No.7 with MTP and SCCP in both national and international networks.
- Minimal revisions to the MTP Recommendations Q.701 to Q.707 resulting from experience in the field may need to be addressed.

Such a signalling network has the capability to serve as a transfer system for a multitude of networks and services at an NNI, such as ISDN, broadband ISDN, IN, mobile networks, and virtual private networks.

The ITU-T has recommended SS No.7 for use at 64 kbps and higher speeds in digital networks.

Guidelines and criteria to be used in the assignment of international signalling point codes as it relates to Recommendation Q.708 need to be considered.

New capabilities have been defined in Q.2210 allowing the use of MTP using the services specified in Q.2140

There is a need to identify MTP and SCCP performance, reliability and security requirements of the signalling networks, given that these are fundamental for its continuing operation.

There is a continuous need to specify international SCCP addressing and formats.

New applications and services may impose some additional requirements on SCCP.

Further study is required for MTP and SCCP to complete and enhance the specifications for:

SCCP:

- connection-oriented and connectionless SCCP capabilities using the services of Recommendation Q.2210;
- SCCP management including congestion handling by SCCP and SCCP restart global identification of SCCP relay nodes interaction between OMAP and SCCP management;
- routing and addressing for existing and new envisaged services;
- possible alignment with X.2T3 and OSI addressing;
- performance aspects; security aspects.

MTP:

- interworking between an MTP according to Q.704 and an MTP according to Q.2210;
- performance aspects of MTP according to Q.2210.

Testing:

- testing of Q.2210;
- testing of connection-oriented and connectionless SCCP (Q.786 completion).

Questions

What minimal revisions of the existing MTP Recommendations (Q.701 to Q.707 and Q.781 to Q.782) are required, taking into account that any further changes to MTP procedures should minimize difficulties of interworking with systems that are built to earlier MTP specifications?

What additions, revisions to or clarifications of Recommendation Q.708 are required?

What new Recommendations, additions, revisions or clarifications of MTP according to Q.2210 are required, taking into account performance aspects and compatibility and interworking procedures with Q.704?

What additions, revisions or clarifications of Q.711 to Q.716 are required?

What additions, revisions or clarifications of Recommendation Q.786 are required?

What new Recommendations are required for specifying the testing of MTP according to Q.2210?

Question 18/1

1 Reliability Aspects of Signalling System No. 7

Reasons motivating the proposed Question

The reliability of Signalling System No. 7 networks is important to meet telecommunication service objectives.

Network configuration, architecture, protocol, and testing are key factors in signalling.

Desirability of administrations to share information on network outages and to provide feedback on remedial and preventative steps.

The action plan to implement the collection, evaluation and distribution of information on network outages has been developed.

Question

Based on historical data, what enhancements to existing Recommendations and new Recommendations are required for signalling networks (including SS No. 7 networks)?

3.2.4 STUDY GROUP 11 QUESTIONS RELATED TO SS No. 7

Question 3/11 Access and Network Security Requirements

Reasons for the Question

[In summary, the question addresses security aspects of:]

IN and relationships between network operators, service providers and end users.

user authorizations services based on other technologies (e.g. Internet) and commercial transactions.

user information stored or transferred in the network.

Specific Task objectives [among other objectives]:

Identification of service related security requirements, e.g. **Identify inter- and intra-network security requirements and define guidelines for the embedding of internal network security procedures in the SS No. 7 protocols**, i.e. description of mechanisms, identification of most appropriate protocol Level, and identification of network addresses and identities to be linked to cryptologic keys.

Question 8/11 Signalling requirements for emerging land mobile and satellite mobile networks

Task Objectives (among others)

Identification of interface points associated with access and network signalling requirements including call control, radio resource management and mobility management (e.g. input for (among others**) ISUP/B-ISUP**.):

Question 10/11 Common Upper Layer Protocols to Support Signalling Applications

Reasons motivating the proposed Question
[With respect to TC, use of Remote Operations Systems Elements (ROSE, X.880), use of ASN.1 and basic encoding rules:]

Additional common upper layer capabilities may be needed to support new capabilities such as security mechanisms

Alternative encodings may need to be supported which would require functions to negotiate and/or announce presentation contexts.

New efficient upper layer protocols are being defined for OSI applications which may be useful in a signalling environment

There is a need to develop common signalling application protocols that may be used in a variety of environments.

Task Objectives [among others]
Maintenance of the Q.77x-series [TC] and Q.1400 Recommendations

Question 17/11 Updating of Q-Series Recommendations

Reasons motivating the proposed Question

Systems based on ITU-T standards [*sic*] are generally implemented over relatively long periods of time after standards definition.

There is a need for ongoing maintenance of existing Q-series Recommendations.

SECTION 4

SUMMARIES OF ITU-T RECOMMENDATIONS WHICH DEFINE THE SS No. 7

4.0 INTRODUCTION

The ITU-T Recommendations defining the SS No. 7 fall naturally into groups defining the various protocols. The list below is grouped into those that introduce and summarize the entire system, define the Message Transfer Part, the Telephone and Data User Parts, the ISDN User Part (including Supplementary Services), the Signalling Connection Control Part, Transaction Capabilities (a Part), and the Operations Maintenance and Administration Part.

Not all these Recommendations are summarized here. The series of Recommendations specifying the Telephone and Data User Parts, which have not been implemented by any U.S. network, are not summarized. Additionally, only the basic Recommendation defining ISDN Supplementary Services is summarized here; the other Recommendations in this series only provide Stage 3 descriptions and define the parameters to be carried in otherwise standard ISDN User Part messages. Testing Specifications do not define the SS No. 7 protocol and are not summarized here.

The list of SS No. 7 Recommendations below includes those that are customarily included as those that define the Signalling System. There are others which define the use of SS No. 7 in broadband applications, generally following the same numbering scheme as the narrowband series but with a leading 2, making them part of the Q.2xxx Broadband series. In addition, there are those that define the Broadband ISDN User Part (B-ISUP) and the interactions between MTP Level 3 and the B-ISUP, that relate to the interfaces between SS No. 7 and other signalling protocols (such as those that address the interaction between SS No. 7 and ISDN/non-ISDN access signalling), and those that address the support provided to Intelligent Network and other applications by SS No. 7 Transaction Capabilities.

4.1 LIST OF ITU-T SS NO. 7 RECOMMENDATIONS.

The list below includes all the ITU-T Recommendations needed to define the SS No. 7 protocols in the International Plane. Those that are not summarized are marked with an asterisk.

SS No. 7 Introduction

Q.700 Specifications of Signalling System No. 7

Message Transfer Part

Q.701 Functional Description of the Message Transfer Part (MTP)
Q.702 Signalling Data Link
Q.703 Switching and Signalling
Q.704 Signalling Network Functions and Messages

Q.705 Signalling Network Structure
Q.706 Message Transfer Part Signalling Performance
Q.707 Testing and Maintenance
Q.708* Numbering of International Signalling Point Codes
Q.709* Hypothetical Signalling Reference Connection
Q.710* Simplified MTP Version for Small Systems [PABXs]

ISDN User Part
Q.761 Functional Description of the ISDN User Part
Q.762 General Function of Messages and Signals
Q.763 Formats and Codes of the ISDN User Part
Q.764 ISDN User Part Signalling Procedures
Q.766 Performance Objectives in the ISDN Application

ISDN Supplementary Services
Q.730 ISDN Supplementary Services
Q.731 Series* Number Identification Supplementary Services
Q.732 Series* Call Offering Supplementary Services
Q.733 Series* Call Completion Supplementary Services
Q.734 Series* Multiparty Supplementary Services
Q.735 Series* Community of Interest Supplementary Services
Q.736 Series* Charging Supplementary Services
Q.737 Series* Additional Information Supplementary Service

Telephone User Part*
Q.721 Functional Description of TUP
Q.722 General Function of Telephone Messages and Signals
Q.723 Formats and Codes
Q.724 Signalling Procedures
Q.725 Signalling Performance in the Telephone Applications

Data User Part*
Q.741 SS No. 7 Data User Part

Signalling Connection Control Part
Q.711 Functional Description of the Signalling Connection Control Part
Q.712 Definition and Function of Signalling Connection Control Part Messages
Q.713 Signalling Connection Control Part Formats and Codes
Q.714 Signalling Connection Control Part Procedures
Q.716 Signalling Connection Control Part Performance

Transaction Capabilities
Q.771 Functional Description of Transaction Capabilities
Q.772 Transaction Capabilities Information Element Definitions
Q.773 Transaction Capabilities Formats and Encoding
Q.774 Transaction Capabilities Procedures
Q.775 Guidelines for Using Transaction Capabilities

Management

Q.750 Overview of Signalling System No. 7 Management
Q.751 Network Element Management Information Model for the Message Transfer Part
Q.752 Monitoring and Measurements for Signalling System No. 7 Networks
Q.753 Management Functions MRVT, SRVT and CVT and Definition of the OMASE-User
Q.754 Management Application Service Element (ASE) Definitions
Q.755 Protocol Tests

Testing Specifications*

Q.780 SS No. 7 Test Specification (General)
Q.781 MTP Level 2 Test Specification
Q.782 MTP Level 3 Test Specification
Q.783 TUP Test Specification
Q.784 ISUP Test Specification
Q.785 ISUP Supplementary Services Test Specification
Q.786 SCCP Test Specification
Q.787 TCAP Test Specification

Broadband Related SS No. 7 Recommendations

Q.2140 B-ISDN ATM Adaptation Layer - Service Specific Coordination Function for Signalling at the Network Node Interface
Q.2210 M.P. Level 3 Functions and Messages Using the Services of ITU-T Recommendation Q.2140
Q.2660 Broadband integrated services digital network (B-ISDN) - interworking between Signalling System No. 7 - Broadband ISDN user part (B-ISUP) and narrow-band ISDN user part (N-ISUP)

4.2 SUMMARIES OF ITU-T SS No. 7 RECOMMENDATIONS

Q.700 INTRODUCTION TO CCITT SIGNALLING SYSTEM No. 7

Published March 1993

This is the SS No. 7 Overview Recommendation. It describes the functions of SS No. 7: circuit related (control) signalling, non-circuit related service signalling, and network management. It provides a list of the Recommendations which constitute the description of the SS No. 7 signalling interfaces. It describes the network elements (nodes and links), the functions of the four Levels of protocols and architecture that implements the relationships between the functional Levels. It summarizes system performance and flow control, and ends with a discussion of compatibility between protocol enhancements and backward compatibility.

THE MESSAGE TRANSFER PART

The Q.70X series of Recommendations specifies the lowest Level protocols, the Message Transfer Part, which transports circuit-related call set up messages, non-circuit related data transfer messages, and management messages for the entire SS No. 7 network. Q.702 describes the level 1 signalling data link. Q.703 describes the level 2 signalling link functions. Q.704 describes the level 3 message handling and signalling network management functions and messages. Q.705 (which is not listed in Q.701) addresses the Signalling Network Structure. Q.706 addresses MTP performance parameters, and Q.707 describes MTP testing and maintenance.

Q.701 FUNCTIONAL DESCRIPTION OF THE MESSAGE TRANSFER PART (MTP)

Published March 1993

This Recommendation summarizes the objectives of the MTP: to provide the means for reliable transport and delivery of User Part signalling information, to take necessary action to ensure that system and network failures do not affect that transport and delivery. It is the only place that the SS No. 7 Recommendations refer to the testing function separately as the Testing User Part (“for further study”).

It provides the general description of the MTP as a sequenced connectionless transfer mechanism over individual links that carries SS No. 7 user messages; it is also a means for taking action to address network and system failures. It details the message transfer capability of the MTP, the services provided by the MTP to the users, and the interactions between the three MTP levels. The basic functional division between the common transport capability of MTP in

serving the individual users is described as a principal feature of the SS No. 7 and shown in a functional diagram, simplified and repeated in figure 4-1 below.

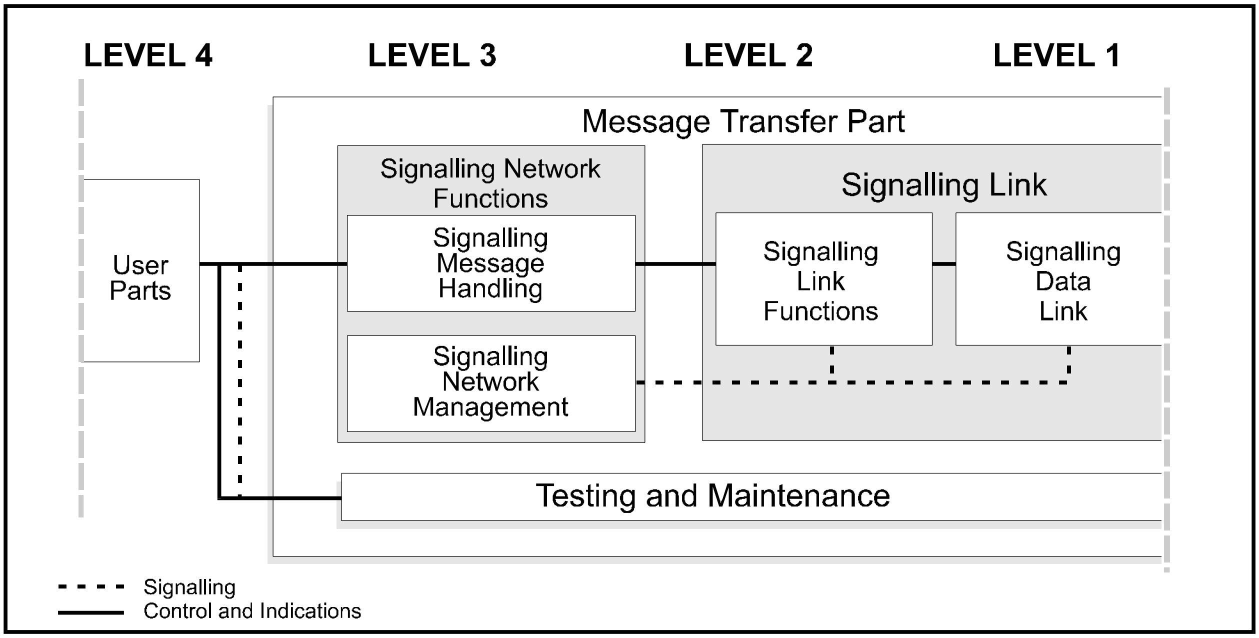

Figure 4-1, General Structure of MTP Signalling System Functions

This Recommendation summarizes signalling message structure. It refers to the Level 2 transfer control information and defines the payload structure of the Message Signalling Unit which carries information across the interface between the MTP and the Users:

- service information (source User Part) and service indicator, and
- signalling information (identification of message type and format, and actual user control or management information) and routing label.

The functional interface between the MTP and User Parts is shown in simplified form in Figure 4-2, below.

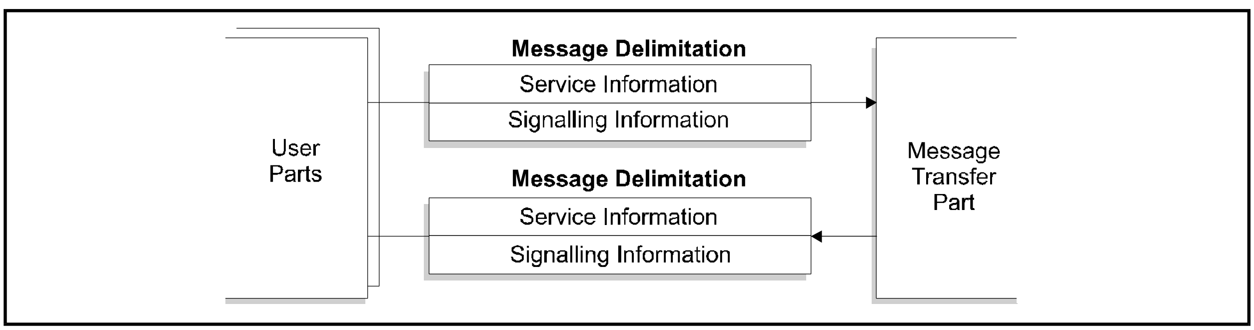

Figure 4-2, Functional Interface Between the MTP and User Parts

The Recommendation ends with definitions of MTP Primitives.

Since network implementation is outside the scope of the Recommendations, only the MTP signalling functions and component relationships are defined. Message handling functions are described in detail and summarized below in Figure 4-3.

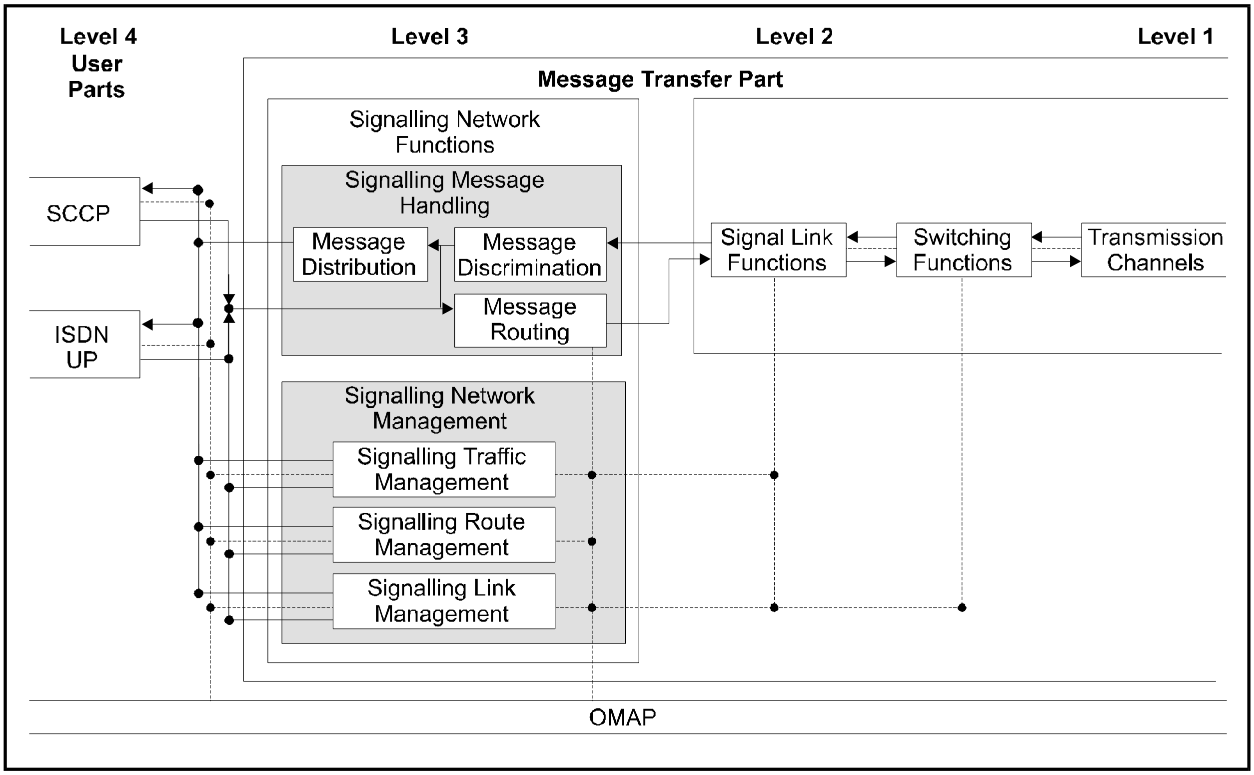

Figure 4-3, Detailed Structure of Signalling System Functions

Q.702 SIGNALLING DATA LINK

Published 1988 (Blue Book)

This Recommendation defines the Level 1 Signalling Data Link as a bidirectional transmission path consisting of two data channels operating at the same data rate. The standard is written for a standard bit rate of 64 kbps, although lower rates are permitted. Higher data rates (1.5 and 2.0 Mbps) are specified in Annex A to Recommendation Q.703, published subsequently.

Q.703 SWITCHING AND SIGNALLING

Published July 1996

This Recommendation describes SS No. 7 Level 2: the functions and procedures for transferring messages over a signalling data link. It defines three Level 2 functions:

- error detection, message delimitation, and link alignment
- link state control functions, and
- congestion (flow) control.

The relationship between these three functions is summarized in Figure 4-4 below.

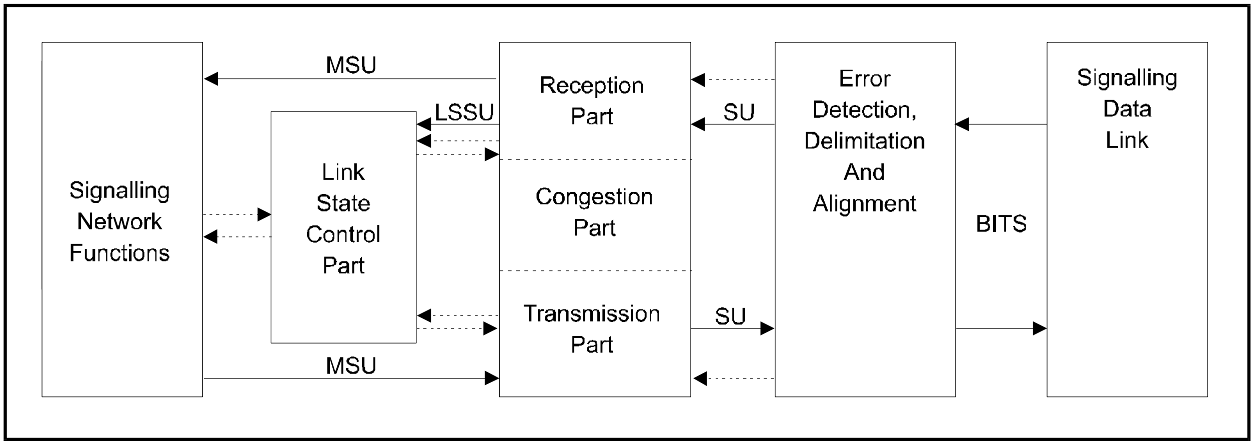

Figure 4-4, Interactions of the Functional Specification Blocks for Signalling Link Control

There is an extensive discussion of error detection, control, and recovery as well as the role of the Link Status Signal Unit (LSSU) in managing link control. LSSUs always have the highest priority in transmission. The means of detection of congestion and the traffic levels which constitute congestion are implementation-dependent functions and are not specified in the Recommendation.

Detection of errors is performed by the Signal Unit Error Rate Monitor (for links in service) and the Alignment Error Rate Monitor (for links in the alignment recovery state). Values for the timers used for error control and recovery are defined, and Level 2 link state diagrams are presented.

The Recommendation also defines the basic signal unit format of the three types of signal unit: Fill-In, Link Status, and Message Signal Unit. These definitions are repeated below in Figure 4-5.

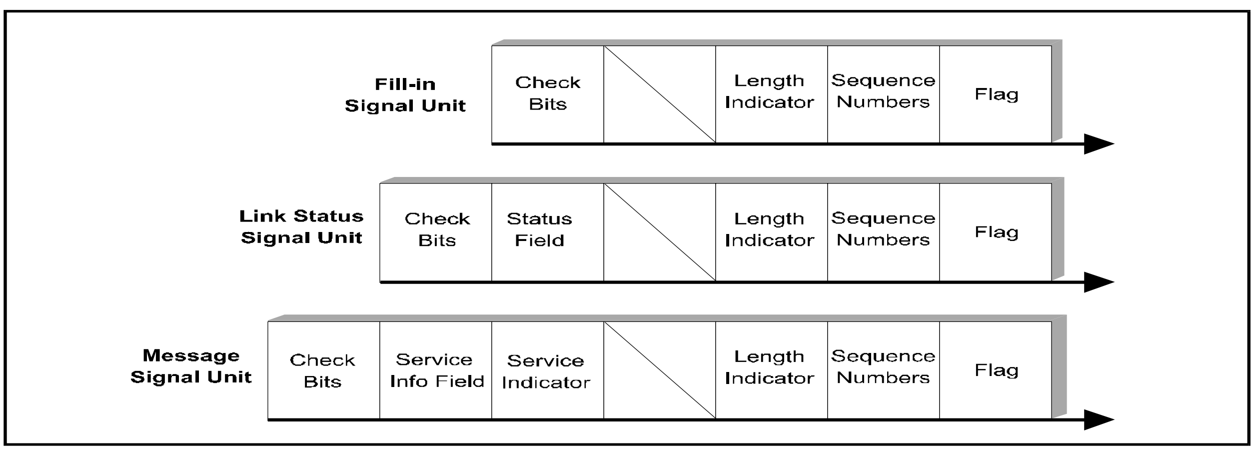

Figure 4-5, Signal Unit Formats

Annex A provides additions to support enhanced MTP Level 2 functions and procedures that are suitable for the operation and control of signalling links at data rates of 1.5 and 2.0 Mbps as a national option. In this regard, the length of the Sequence Number field is increased to permit extended sequence numbers, and the length of the check field has been increased. The error monitor is based on measurement over an interval rather than an error rate. The Level 2 timers are lengthened.

Q.704 SIGNALLING NETWORK FUNCTIONS AND MESSAGES

Published July 1996

This long Recommendation describes functions and procedures for transferring messages between signalling points which may not be adjacent nodes of the signalling network. Such functions and procedures are performed by the Message Transfer Part Level 3, and assume that the signalling points are connected by signalling links incorporating the functions described in Recommendations Q.702 (Level 1) and Q.703 (Level 2). The signalling network functions are defined to ensure reliable transfer of signalling messages, according to the requirements specified in Recommendation Q.706 (MTP Performance), even when individual signalling links and signalling transfer points fail. Therefore, Level 3 definitions include the appropriate functions and procedures necessary both to inform the remote parts of the signalling network of the consequences of a fault (traffic management), and to appropriately reconfigure the routing of messages through the signalling network (route management).

The 1996 edition includes modifications to permit use of the Broadband ISDN User Part in the narrow-band environment, and the Satellite ISDN User Part.

According to these principles, the signalling network functions can be divided into two basic categories:

- signalling message handling; and
- signalling network management.

The signalling message handling function ensures that the messages originated by a user are delivered to the same user function at the destination; the signalling network management function reconfigures and restores network routing. The interrelations between these functions are summarized in Figure 4-6.

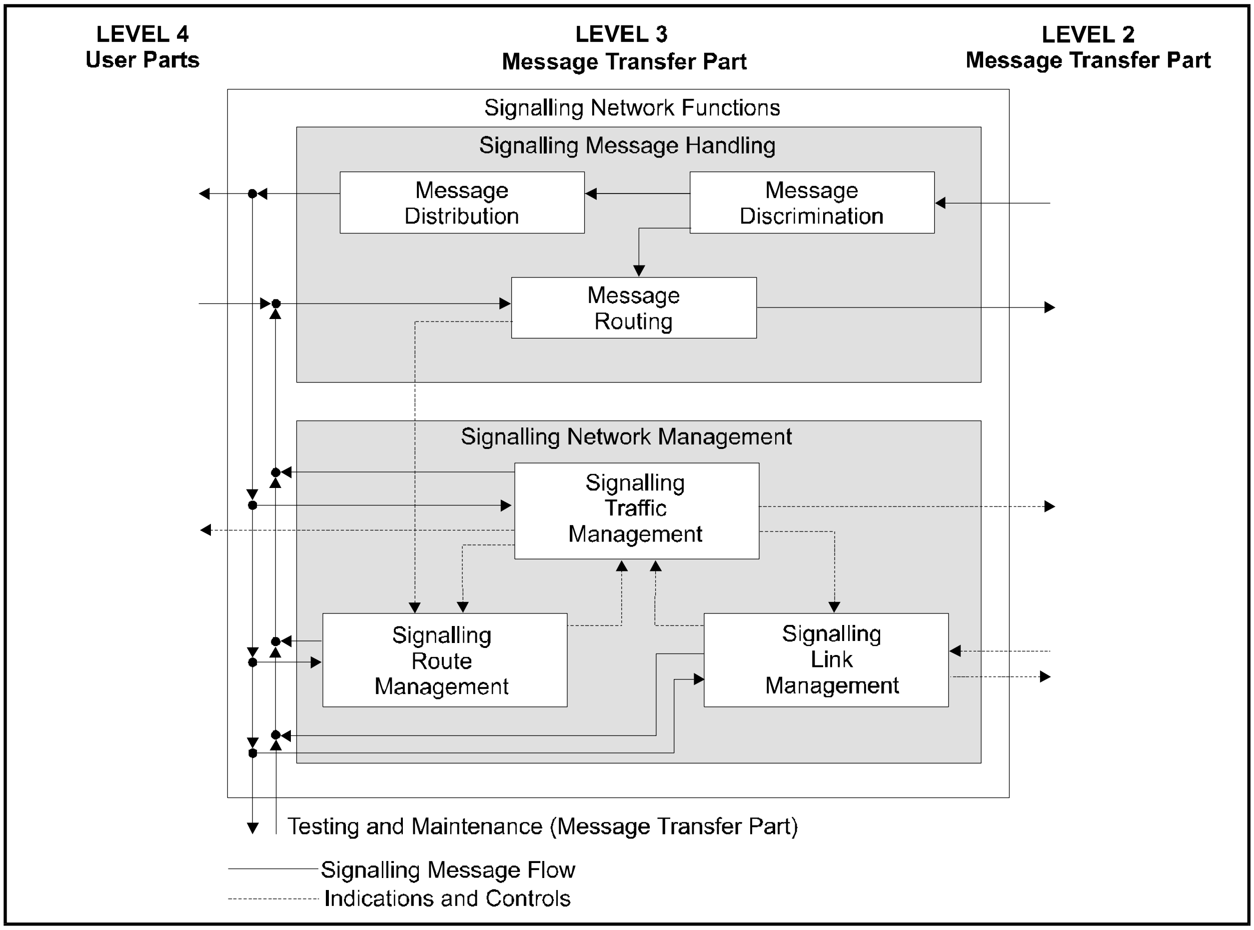

Figure 4-6, Level 3 Signalling Network Functions

This Recommendation specifies the Service Information Octet (SIO) which is common to all Message Signal Units. The Service Indicator portion of the SIO permits definition of 16 User Parts (i.e. services) and now specifies the Broadband ISDN User Part and the Satellite ISDN User Part, as well as management, testing, Level 4 SCCP, and [Narrowband] ISDN User Parts. There is great detail in definitions of Routing Labels and their use in load sharing and congestion control as well as routing to nodes and applications. In addition to routing, Level 3 performs congestion control based on priorities generated by the User Parts. The priorities are assigned to types of messages, not content. Three levels of priority are specified for international use, with the highest priority reserved for network management messages. The message routing labels are defined for international and national networks, but modified label structures may be used nationally. The T1 standards implement a modified label.

MTP Level 3 is a primary source of network management, and the bulk of the Recommendation is used to define how this function is actually performed.

Q.705 SIGNALLING NETWORK STRUCTURE

Published March 1993

This Recommendation describes aspects to be considered when designing international and national SS No. 7 networks. Some aspects are dealt with for both international and national networks (e.g. the impact of mixing satellite and terrestrial signalling links on transmission diversity and timers), others are discussed in the context of the international network only (e.g. the maximum number of signal transfer points in a signalling relation). A number of aspects require further study for national networks. Annex A gives examples of how the signalling network procedures may be applied to a mesh network representation.

Alternatives for interconnecting national networks are described. In addition to connecting through an international network (gateway), the Recommendation acknowledges the unique characteristics of cross-border traffic which may be addressed through some other means (such as an integrated numbering plan) than through a gateway using the international SS No. 7 Recommendations.

Q.706 MESSAGE TRANSFER PART SIGNALLING PERFORMANCE

Published March 1993

This Recommendation details the MTP design objectives and basic performance parameters which permit it to operate as the joint signalling transport system for different users. In order for the MTP to satisfy the individual requirements of each user, it was designed to meet the most stringent of the User Part requirements envisaged at the time of specification (telephone service, data transmission service, and signalling network management). It was assumed that a signalling performance which satisfies the requirements mentioned above will also meet those of future users.

In order to achieve a proper signalling performance, the Recommendation takes three groups of parameters into account:

- The first group covers the objectives derived from the requirements of the different users. The aims are limitation of message delay, protection against all kinds of failures, and guarantee of availability.
- The second group covers the features of the signalling traffic, such as the loading potential and the structure of the signalling traffic.
- The third group covers the given environmental influences, such as the characteristics (e.g. error rate and proneness to burst) of the transmission media.

As a practical matter, none of the actual performance parameters are defined in relation to this list. The basic parameters that define performance are route set availability, MTP malfunctions (transmission errors, message loss, and mis-sequencing), transfer time, and throughput capability (listed as needing further study). Values for these parameters are defined and related to each other.

Q.707 TESTING AND MAINTENANCE

Published 1988 (Blue Book)

In order to realize the performance requirements described in Recommendation Q.706, means and procedures for signalling network testing and maintenance are required in addition to the means defined in Recommendations Q.703 and Q.704. This Recommendation specifies the test to be conducted over a Signalling Data Link, that is, one with signalling link functions at both ends.

THE ISDN USER PART

One of the two principal SS No. 7 users of the Message Transfer Part is the ISDN User Part (ISUP). The Q.76x Series of Recommendations describes the SS No. 7 ISDN User Part. The protocol which supports basic bearer service is described in Q.761, a general description of ISDN User Part signals and messages is provided in Q.762, message formats and field codings are defined in Q.763, signalling procedures for set-up and cleardown of national and international ISDN connections are described in Q.764, Q.766 deals with ISDN User Part performance objectives. Additionally, the Q.73x series (Stage 3 Descriptions of ISDN User Part protocol elements required to support Supplementary Services).

Q.761 FUNCTIONAL DESCRIPTION OF THE ISDN USER PART OF SIGNALLING SYSTEM NO. 7

Published March 1993 Revised edition approved September 1997

This Recommendation provides the basic definition of the ISDN User Part (ISUP) signalling procedures, capabilities, primitives which support services assumed from MTP, and end-to-end signalling.

Basic call procedures are established for both basic telephone and ISDN service, using either the link-by-link or end-to-end method. The link-by-link method is defined primarily for messages that need to be examined by all exchanges involved in call set up and clear down and accesses the MTP directly. The end-to-end method is defined primarily for supplementary service messages of end point significance, although link-by link is defined for this use also. End-to-end signalling may be accomplished either using SCCP services, or by the pass-along method (using MTP only). Although end-to-end services are defined, end-to-end services for the ISUP are not known to be used at present.

The requirements of interworking and backward compatibility are defined for all ISUP versions 1988 and later.

A list of basic call, supplementary services, and supplementary service signalling functions and services are specified for National and International use. The only difference between the list of National and International functions and services is in certain of the Generic Signalling Procedures for supplementary services which are not supported over the International boundary.

The Recommendation defines the primitives by which the ISUP and the MTP communicate. These primitives are the means by which ISUP passes signalling information to the MTP: the originating and destination point codes, signalling link selection code, service information octet, and parameters to be used in the SIF mandatory and optional parts. Primitives are also defined so the MTP can advise the calling ISUP when the called number is unavailable for some reason.

Q.762 GENERAL FUNCTION OF MESSAGES AND SIGNALS OF THE ISDN USER PART OF SIGNALLING SYSTEM NO. 7

Published March 1993 Revised edition approved September 1997

This Recommendation describes the elements of signalling information used by the ISUP protocol and their functions. There are 49 signalling messages defined, and 155 elements of signalling information, some of which are defined for national use only.

Q.763 FORMATS AND CODES OF THE ISDN USER PART OF SIGNALLING SYSTEM NO. 7

Published March 1993 Revised edition approved September 1997

This Recommendation specifies the coding for the ISUP Message Signal Unit Service information field (SIF). As specified in Q.704, the SIF contains the following parts in any message signal unit:

Routing Label
Circuit Identification Code
Message Type Code
Mandatory (parameter) Fixed Part
Mandatory (parameter) Variable Part
Optional (parameter) Part

The Recommendation provides naming and coding instructions for the contents of these parts.

Annex A describes interpretations which can be applied when a recognized parameter containing codes indicated as “spare” in this Recommendation is received at a node. Some default interpretations are provided. Actions to be taken on default are contained in Q.764. Annex B offers a general description of component encoding rules. Components are made up of information elements consisting of a tag, length indicator, and contents. Both Annexes are integral parts of the Recommendation.

Q.764 ISDN USER PART SIGNALLING PROCEDURES

Published July 1997

This Recommendation describes the ISDN-User Part basic call control and signalling procedures for the set-up and cleardown of national and international ISDN connections. It builds on Recommendation Q.761 which provides an overview of the complete ISUP signalling capabilities, but this Recommendation addresses basic calls only (unique features of supplementary ISDN service calls are described in Q.73x). Actions common for all types of exchanges are described; these actions include successful and unsuccessful call set-up, call release, fallback, echo control, congestion control, and others. Actions required at the outgoing exchange, intermediate national or international exchange, outgoing or incoming international exchange, and destination exchange are all described in similar detail. Unique actions required in an exchange node are specified in a separate subclause applicable to that type of exchange or action.

There are seven Annexes, all of which are integral parts of the Recommendation.

- Annex A provides a consolidated list of details on the timers T1 through T39 associated with the ISUP, some of which are actually specified in other Recommendations. Time out values, initiation and termination criteria, and follow-on actions are all specified.
- Annex B summarizes basic call control signalling procedures in a series of figures (arrow charts).
- Annex C provides figures of examples of echo control signalling procedures.
- Annex D provides figures of examples of signalling procedures for connection type allowing fallback.
- Annex E describes the sending sequence of forward address information for test calls based on bilateral agreements.
- Annex F points to Q.850 for cause values and handling location indicators on the international interface.
- Annex G details the start up procedures for placing ISUP circuits into service. Two types of exchange switch are acknowledged: Type A do not require any preparation before a test call, responding to a reset or group reset message with a release or acknowledgment message. Type B exchanges require an acknowledgment message cycle before the test can be performed. The two different types of exchanges are illustrated.

Q.766 PERFORMANCE OBJECTIVES IN THE INTEGRATED SERVICES DIGITAL NETWORK APPLICATION

Published March 1993

This Recommendation gives the requirements of the ISDN application call control service supported by SS No. 7. Whereas previous Recommendations in this series viewed the basic call set-up and cleardown ISUP services, this Recommendation takes a broader view of ISDN services, including telephone conferencing and non-circuit related connections for terminal-to-terminal control. The Recommendation therefore considers such factors as signalling network availability, dependability, and signalling delay (in terms of MTP and ISUP performance). It also addresses signalling system limitations caused by the potentially large number of ISDN signalling points and the number of ISDN call identities at a given signalling point.

The Recommendations also refers to E.721 (Network Grade of Service parameters and target values for circuit-switched services in the evolving ISDN) and I.352 (Network performance objectives for connection processing delays in an ISDN) in reference to ISDN performance.

Q.730 ISDN SUPPLEMENTARY SERVICES

Published March 1993

This Recommendation describes the format for supplementary services contained in Recommendations Q.731 to Q.737, and is supported by the Recommendations that define the ISDN User Part (Q.761 to Q.764) and Q.767, Application of the ISDN User Part for International ISDN Interconnections.

Each type of supplementary service is defined in separate sections, each containing the complete procedures encompassing both the ISDN User Part and the procedures to be used on top of Transaction Capabilities, where appropriate.

Each section contains a general paragraph giving details of the specific service defined in the ISDN series. Signalling aspects of the call set-up procedures and the actions taken at concerned exchanges are defined.

Candidate methods for end-to-end signalling are defined: pass-along and SCCP methods.

The list of Supplementary Services envisioned in 1993 is included, with the proviso that more services might be added in the future.

A non-normative Appendix provides Contents of the Interface Elements Between the ISDN User Part and the SCCP.

THE SIGNALLING CONNECTION CONTROL PART

The other principal SS No. 7 user of the Message Transfer Part is the Signalling Connection Control Part (SCCP). Unlike the ISUP which relies primarily on the link by link method of routing, the SCCP provides SS No. 7 with an end-to-end network routing service capability. Q.711 provides a functional description of SCCP services. Q.712 defines the function of SCCP messages, and the set of SCCP protocol elements. Q.713 defines message formats and codes. Q.714 defines SCCP procedures. Q.715 is a handbook which gives guidance on incorporation of SCCP in actual networks; the guidelines are not normative. Q.716 defines SCCP performance requirements.

Q.711 FUNCTIONAL DESCRIPTION OF THE SIGNALLING CONNECTION CONTROL PART

Published July 1996

This Recommendation defines the overall objectives of the SCCP: it defines additional functionality to MTP to support both connectionless and connection-oriented network services to transfer circuit related and non-circuit related signalling information and other types of information. The Recommendation defines the Network Services Part as consisting of the MTP and the SCCP, providing a subset of OSI layer 3 services. Although the connection-oriented service is fully defined, it is not known to have been implemented and is not reviewed here.

There are two classes of connectionless service defined; basic (class 0) and in-sequence (class 1). Connectionless service is routed to the destination using the routing function of MTP 3. When in-sequence delivery is of primary importance (as when the SCCP message must be segmented), SCCP is required to use the same Signalling Link Selection code for each segment. Although the segments reach their destination in sequence, the load sharing capacity of assigning SLS codes at random is lost.

SCCP management is summarized.

The SCCP is defined to provide network services both through the MTP as defined in Q.704 (MTP 3) and as specified in Q.2210 (broadband service through MTP 3b). The principal difference between access through narrowband and broadband MTP Service Access Points is that the maximum permissible size of the service data unit (including the routing label) increases from 272 octets to 4095 octets. Additionally, the list of user data to be transported over the interface is redefined in Q.2210. With this exception, the Recommendation defines the two services as equivalent.

Q.712 DEFINITION AND FUNCTION OF SIGNALLING CONNECTION CONTROL PART MESSAGES

Published July 1996

This Recommendation describes the message signalling units used by the peer-to-peer SCCP protocol. The descriptions consist of lists of message type codes, parameter fields, and association of parameters with the various message types.

Q.713 SIGNALLING CONNECTION CONTROL PART FORMATS AND CODES

Published July 1996

This Recommendation expands on Q.712 and specifies the SCCP message formats and codes for the support of the three SCCP services (connection-oriented, connectionless, and SCCP management services). The four parts of the SCCP message are defined: the (mandatory) message type code, the mandatory (parameters) fixed part, the mandatory (parameters) variable part and the optional (parameters) part. All these parts when preceded by the MTP routing label constitute the SCCP Signal Information Field. National message types and parameters are permitted.

SCCP management messages are formatted like other SCCP messages, but have their own set of codes. The Recommendation acknowledges that Congestion Control may be improved after further analysis of congestion control procedures.

Annex A provides Mapping for Cause Parameter Values (connection release, refusal, and reset). Annex B provides International SCCP Addressing and Format Specifications.

Q.714 SIGNALLING CONNECTION CONTROL PART PROCEDURES

Published July 1996

This long and instructive Recommendation describes the procedures performed by the SCCP to provide connection-oriented and connectionless network services, as well as SCCP management services as defined in Recommendation Q.711. These procedures make use of the messages and information elements defined in Recommendation Q.712, whose formatting and coding aspects are specified in Recommendation Q.713.

SCCP is described in terms of a data transfer service. The data is the collection of mandatory and optional parameters delivered as network service data unit (NSDU) primitives to SCCP by the using applications for delivery to remote peer applications. When the NSDU exceeds the size limits of SS No. 7 message service units, the NSDUs are segmented depending on whether the service is provided according to narrowband specifications or supports the long format NSDUs according to Q.2210.

The four classes of SCCP protocol services are defined and described. Classes 0 (basic connectionless) and 1 (sequenced connectionless) are defined for both narrowband and the long network service data unit used by broadband as defined in Recommendation Q.2210. Classes 2 (connection-oriented) and 3 (includes flow control) are defined only for narrowband; broadband long network service data units are not yet supported in connection-oriented service. The Recommendation specifies procedures for nodes which do not recognize parameters being passed through them.

The basic structure of the SCCP itself is described in terms of its four functions:

- Routing Control (SCRC) provides routing to messages received either from MTP below or Users above.
- Connection-Oriented Control (SCOC) controls establishment and release of signalling connections and provides for data transfer on signalling connections.
- Connectionless Control (SCLC) provides User and SCCP management with a data transfer mechanism.
- Management (SCMG) provides additional data transfer for control of SCCP failures outside the scope of MTP flow control.

The concept of the Global Title as an addressing alternative to Destination Point Code and Sub System Number is introduced. Methods of translating the Global Title into the corresponding DPC are specified.

This structure is described in a figure, simplified below:

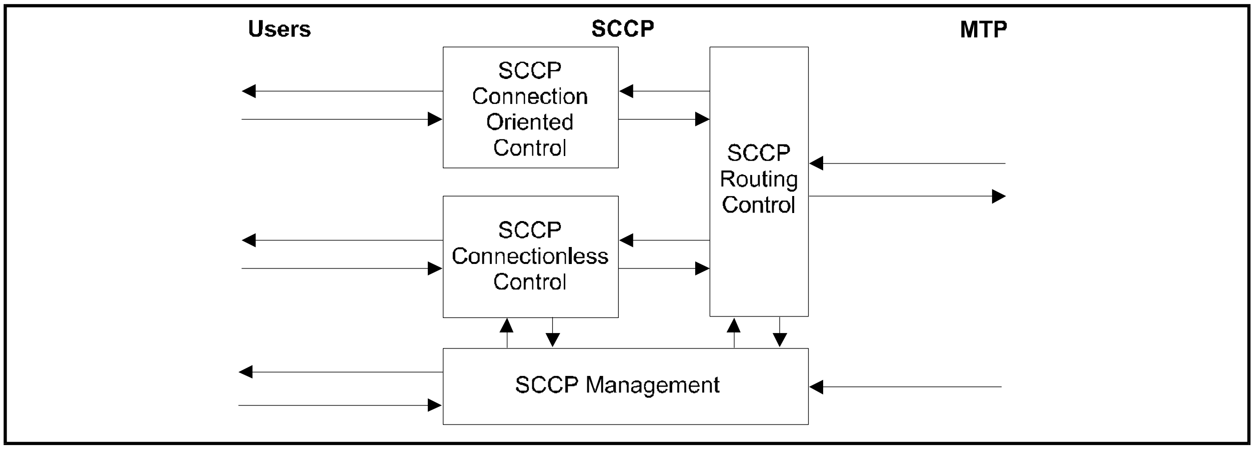

Figure 4-7, SCCP Basic Structure

The Recommendation ends with four normative Annexes:

Annex A is State Diagrams for SCCP.
Annex B is Action Tables for Connection-oriented Control (SCOC)
Annex C is State Transition Diagrams for SCCP
Annex D is State Transition Diagrams for SCCP Management Control (SCMG).

Q.716 SIGNALLING CONNECTION CONTROL PART PERFORMANCE
Published March 1993

This Recommendation describes SCCP performance based on the requirements of the ISDN User Part (ISUP), the Operations & Maintenance Application Part (OMAP), and the dialogue between an exchange and a Service Control Point (using the Transaction Capabilities). These services are assumed to be the most stringent.

SCCP performance is defined by parameters of two kinds:

- quality of service parameters as seen by a user of the SCCP, and
- internal parameters which are not seen by the user but which contribute to a quality of service parameter, for example, the transfer delay in a relay point which contributes to the total transit delay of messages as seen by the user.

These internal parameters and allowed values are defined. (Values for other quality of service parameters are given in Recommendation Q.709.) Consideration is also given to performance degradation attributable to satellite links and new SS No. 7 applications such as longer messages and higher link loading.

TRANSACTION CAPABILITIES

Accessing the SS No. 7 through the SCCP, Transaction Capabilities (TC) is a set of capabilities that provide an interface between the applications and a network layer service, such as that provided by SCCP and MTP. The Q.77x Series of Recommendations describes the SS No. 7 Transaction Capabilities. A functional description of the service and the service expected from SCCP below is in Q.771, Functional Description of Transaction Capabilities. Q.772 provides Transaction Capabilities Information Element Definitions and functions. Formats and encoding are defined in Q.773. Q.774 defines TC Procedures. Q.775 provides guidelines for defining applications and their use of Transaction Capabilities.

Q.771 FUNCTIONAL DESCRIPTION OF TRANSACTION CAPABILITIES

Published March 1993 revision approved June 1997

This Recommendation contains introductory information on Transaction Capabilities (TC), referring to a set of communication capabilities that provide a generic interface between applications and a network layer service. TC is defined in two sub-layers: the Component Sublayer and the Transaction Sublayer.

- The component sub-layer deals with the component primitives which constitute operation invocations and responses and with the optional dialogue portion protocol which conveys the parameters related to the application context or user information. More than one component may be included in a single message.
- the transaction sub-layer deals with addressing and transaction tagging to permit the unique identification of the operations being invoked by the components and parameters being passed between remote TC users.

This structure is shown in Figure 4-8.

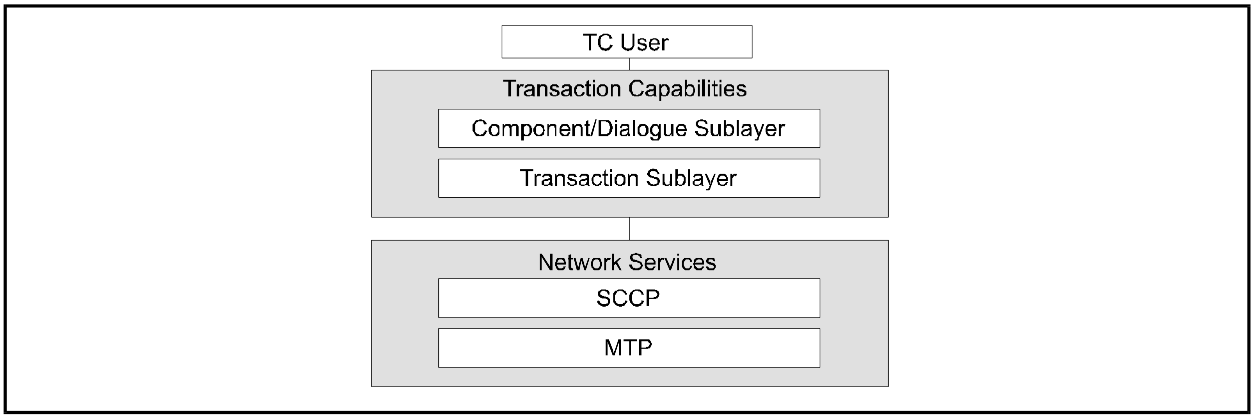

Figure 4-8, Structure of Transaction Capabilities

Since TC supports control of remote operations in the network, the Recommendation reviews alignment of TC with the Remote Operation Service (X.219), Remote Operation Service Element (ROSE, X.229), and Association Control Service Element (ACSE, X.217 and X.227). TC is only in partial alignment with all of them.

TC depends on the addressing options supported by SCCP, but the Recommendation acknowledges that other network layer service providers could be used.

Two types of TC dialogues are defined: structured and unstructured. When TC components do not require replies from the peer TC, there is no explicit association between the TC users and the dialogue is unstructured. Structured dialogues require a TC user to indicate the beginning , continuation, and end of the dialogue, as well as to identify a dialogue ID. Consequently, a TC user may conduct several structured dialogues simultaneously.

Q.772 TRANSACTION CAPABILITIES INFORMATION ELEMENT DEFINITIONS

Published March 1993 revision approved June 1997

This Recommendation describes the individual information elements and parameters used within TC messages. Encoding and formatting is covered in Recommendation Q.773.

The meaning and format of information elements is described in general terms for each of the three portions defined in Q.771, the transaction portion, the dialogue portion, and the component portion. The TC architecture is defined in terms of only two parts, the component and transaction parts; both parts make use of the dialogue portion to carry information concerned with the application context and user information (data which are not components). The TC message is contained in the as part of the Signalling Information Field of the SCCP message signal unit

Transaction Portion Message and transaction ID types are defined as the means for tracking multiple transactions simultaneously.

Component types are defined for the Component Portion. These components types include Protocol Data Units defined in Recommendation X.229 (invoke, return result (last), return error, and reject) as well as a long list of others. [One of the component types is “operation code” which indicates the precise operation to be invoked. The actual operation codes, and the definition of the operations and their associated parameters, are defined in relevant ASE specifications. The component sublayer does not set or examine the operation code value, nor parameters which are present, nor the parameter values.]

Dialogue Control application protocol data units are defined (request, response, abort, and unidirectional), and information elements described.

Q.773 TRANSACTION CABILITIES FORMATS AND ENCODING

Published March 1993 revision approved June 1997

This Recommendation provides the format and encoding of Transaction Capabilities messages. These encoding rules are based on a consistent subset of the encoding rules specified in Recommendation X.209. The Recommendation uses the Abstract Syntax Notation 1 and the description (tabular) method of other Q.700-Series Recommendations.

Maximum message length that may be encoded is constrained by the network service data unit (NSDU) size limitations in the connectionless case. Limitations in the connection-oriented case are for further study.

Q.774 TRANSACTION CAPABILITIES PROCEDURES

Published March 1993 revision approved June 1997

This Recommendation describes the procedures and rules governing the information content and exchange of TC messages between TC-Users using connectionless network service. In general, the descriptions offered by this Recommendation are based on the protocol point of view rather than the service-oriented descriptions offered in Q.771. It establishes two basic guidelines for TC procedures:

- To maximize flexibility in service architecture and implementation style, TC procedures are restricted to supporting exchange of components (with the option of certain user information not governed by component structure). Application-specific procedures (e.g. those directly associated with individual TC-Users) are not part of TC.

- Parameter values not associated with a primitive required by a sub-layer are passed through the primitive interface. Certain dialogue control request primitives can initiate construction of a dialogue control Application Protocol Data Unit.

The Component Sub-layer provides two procedures: component handling and (optional) dialogue handling. Component handling procedures map the component service primitives onto the sub-layer protocol data units. There are four classes of operation invoked by the components: reporting success or failure, reporting failure only, reporting success only, and outcome not reported. The Recommendation defines state machines and transitions for each of the four.

In support of the component sub-layer dialogue handling capabilities, the TC dialogue handling service primitives are mapped onto dialogue control Application primitives, and also onto Transaction Control Primitives. The Recommendation discusses compatibility issues associated with communications between 1988 TC Recommendation instances (which do not support dialogues) and those of later Recommendations.

The Transaction Sub-Layer describes one procedure: associating each TC message with a specific transaction, using the message type and transaction ID. TC messages may contain user data consisting of components or dialogue; however, any user data is only passed through to the next layer. Thus the transaction sub-layer treats all messages the same, except that an unstructured, unidirectional, dialogue is not assigned a transaction ID.

The Recommendation also describes the process by which the TC-user, after having invoked an operation by sending primitives to the TC component sub-layer, may then pass additional primitives requesting their immediate transmission. The resulting flow of components between the two peer TC-users is called a dialogue. If only one message is required for an operation and no response is required, then the dialogue is unstructured; however, if the flow requires responses and simultaneous operations, each dialogue must be identified and the dialogue is referred to as structured.

Annex A, Transaction Capabilities SDLs, is an integral part of the Recommendation. This Annex translates the descriptive text of the Recommendation into SDLs according to specification and description language. It is to be noted that this Annex is one of the few places in the SS No. 7 Recommendations where an alternative Network Service is specifically referenced: the figure calls out X.213 as well as SS No. 7 SCCP.

Q.775 GUIDELINES FOR USING TRANSACTION CAPABILITIES

Published June 1997

This Recommendation provides guidelines to potential users (applications) of Transaction Capabilities (TC-users). It consists of illustrative examples, and the Recommendation is careful to point out that the examples do not indicate how TC must be used. This Recommendation does not form a part of the TC technical basis, which is entirely contained in Q.771 - Q.774.

TC assumes a connectionless service with a very low probability of message loss in the network; if this probability cannot satisfy the reliability requirements for an application, it should use the connection-oriented network service approach. If some protocol information needs an upgraded Quality of Service (e.g. charging information), the application should introduce its own mechanisms to obtain higher reliability for this information.

Finally, the Recommendation summarizes information also found in Recommendation Q.1400 (Architecture Framework for the Development of Signalling and OA&M Protocols Using OSI Concepts) describing how Application Service Elements (ASEs), Application-Contexts and Application Entities (AE) are structured and how an AE is addressed in SS No. 7. TC can be considered an ASE since it provides generic means for all signalling applications to communicate using the remote operations paradigm (X.219 and X.229) over a connectionless network service. The Recommendation makes detailed suggestions for specifying application entities and contexts within this framework.

OPERATIONS, MAINTENANCE, & ADMINISTRATION PART

The series of Recommendations on the Operations, Maintenance and Administration Part (OMAP) defines the functions, procedures and entities for managing a Signalling System No. 7 network. Recommendation Q.750 gives an OMAP summary; Recommendation Q.751 defines the managed objects; Q.752 defines the monitoring and measurements; Q.753 defines the management functions for managed objects that require SS No. 7 communication in the network between themselves and the OMASE-User; Q.754 defines the ASE for OMASE defined in Q.753; Q.755 defines the SS No. 7 testers.

Q.750 OVERVIEW OF SIGNALLING SYSTEM NO. 7 MANAGEMENT

Published March 1993

The Operations, Management, and Administration Part (OMAP) provides the following management parts of an SS No. 7 network:

- Management functions located in the Telecommunication Management Network (TMN) (Network Element Functions (NEFs) and Operations System Functions (OSF). These functions include measurement collection and cover TMN-to-TMN interactions; such management functions are modelled as managed objects at the interface between network elements and operations systems, or between operations systems.

- Management functions defined to enable verification and validation of routing tables, CICs, etc. These functions may require communication within the signalling network, and for this a separate protocol is defined. Such management functions are modelled as managed objects at the interface between the network elements and an operations system.

Management functions within the SS No. 7 protocol itself (e.g. changeover, forced rerouting, sub-system management, etc.) can be modelled as existing within the "Layer Management Entities" of SS No. 7, with the functions defined in the Recommendations pertinent to those layers. OMAP interacts with all SS No. 7 Levels to effect control of the network.

The Recommendation acknowledges three requirements for SS No. 7 management, all based either on sharing a Management Information Base (MIB) with the TMN, or on internal SS No. 7 management functions:

- The OMAP to Administration interface must use TMN-defined concepts.
- OMAP managed objects must be compatible with other TMNs' managed objects.
- OMAP should provide for integrating existing SS No. 7 management functions (as defined in MTP and SCCP Recommendations) into a consistent network-wide OA&M approach.

Based on these requirements, the Recommendation proposes five network management categories for OMAP: fault, configuration, performance, accounting, and security. Nonetheless, only the first three are actually defined.

The functional relationship between OMAP and the functions of an SS No. 7 network are shown in figure 4-9 below.

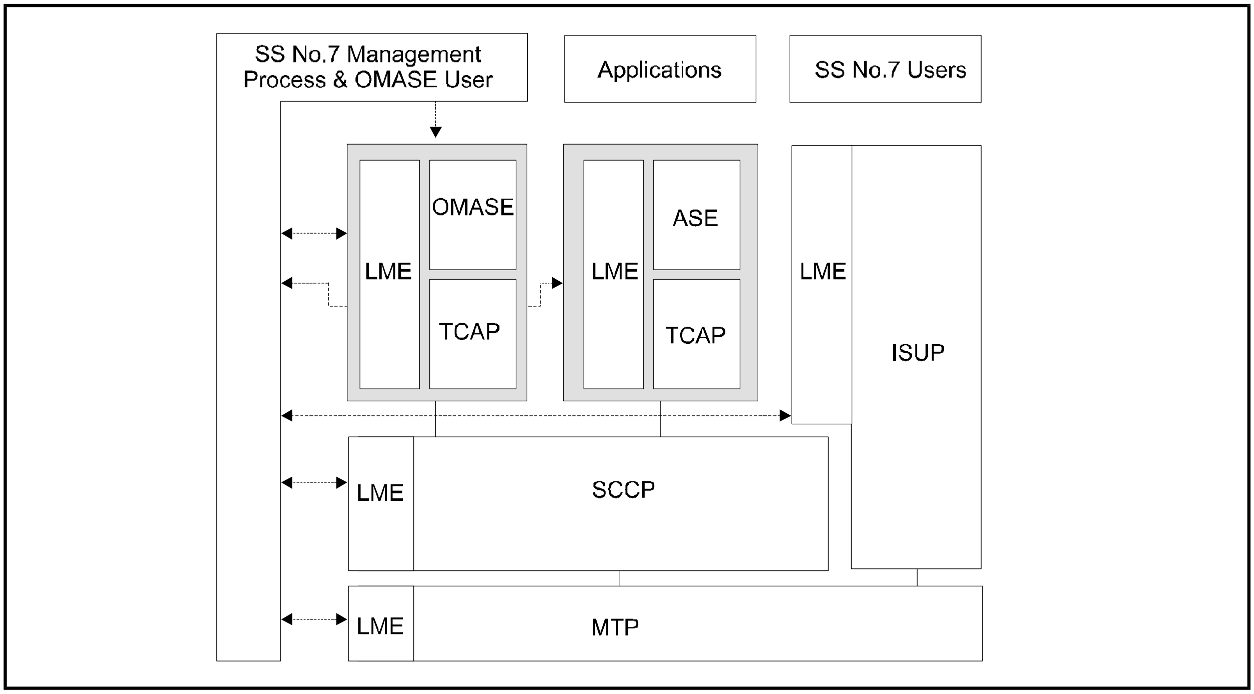

Figure 4-9, SS No. 7 Management and Internal Configuration of a Signalling Point

Q.751.1 NETWORK ELEMENT MANAGEMENT INFORMATION MODEL FOR THE MESSAGE TRANSFER PART (MTP)

Published October 1995

This Recommendation defines Network Element Management of the Message Transfer Part (MTP). It contains the MTP Network Element Management Information Model, that is, the definition of network element managed objects. This formal description is based on an informal but comprehensive analysis of the management relevance of MTP resources in Annex B. The Recommendation describes management of MTP in one SS No. 7 network only and does not address internetworking issues. The Management Information Model is based on the functions needed to initiate and stop measurements.

Each managed object is described in terms of attributes, notifications, and actions (if any), by text, tables, and formal definitions using the Guide to Definitions of Managed Objects (GDMO, X.721) and ASN.1 (X.208).

There are six annexes, all of them integral parts of the Recommendation.

- Annex A is an overview of OMT notation.
- Annex B contains informal entity-relationship diagrams of MTP elements, and forms the basis of the formal descriptions in the body of the Recommendation.

- Annex C contains examples of state mapping between MTP and OSI/TMN managed objects. While the Annex does not show all possible combinations, the examples do show the correct MTP-OSI/TMN-state mapping of the managed objects.
- Annex D describes the relationship between the objects on the Network Management level and those on the Network Element level in terms of SS No. 7 function and management aspects.
- Annex E provides formal descriptions of MTP measurements using GDMO templates based on the measurement descriptions in Q.752.
- Annex F provides an informal and formal description of an MTP route verification test.

Q.752 MONITORING AND MEASUREMENTS FOR SIGNALLING SYSTEM NO. 7 NETWORKS

Published March 1993 revision approved June 1997

This Recommendation identifies "raw" or "primitive" measurements made on the signalling network resources. The recommended primitive measurements (and, at times, other derived measurements, whose computation using the primitive measurements is described) are those required for the effective management of the signalling network resources. OMAP depends on the definition of MTP data points recommended in Q.751 and data management procedures recommended in Q.753, as well as these measurements, to describe the entire OM&A process.

A subset of signalling network measurements (marked as "obligatory" in the tables) is recommended for international networks. This subset should also be useful for national networks; however, national SS No. 7 networks may need additional measurements;

Unlike Recommendation Q.751, this Recommendation defines a series of monitoring and measurement requirements for all the levels of SS No. 7: MTP, SCCP, ISUP, and TC.

Q.753 MANAGEMENT FUNCTIONS MRVT, SRVT AND CVT AND DEFINITION OF THE OMASE-USER

Published March 1993 revision approved June 1997

This Recommendation contains the informal Stage 1 and 2 text descriptions of the following management functions:

Network Routing Management: MTP Routing Verification Test (MRVT), and SCCP Routing Verification Test (SRVT), and
Circuit Management: Circuit Validation Test (CVT).

These management functions require the resource modelled by the managed object at the initiating signalling point (SP) to communicate with similar resources at other SPs, using the SS No. 7 network and protocol, in order to audit certain SS No. 7 data. The network, as well as the network element, is checked on use of this data by these audits.

The Recommendation also includes the Stage 2 semi-formal description of the OMAP Application Service Element (OMASE)-User. The logic in the management functions is assumed to reside in the OMASE-User; the Management Process provides the mapping between the Signalling Point Management and the OMASE-User; the communications functions reside in OMASE. These relationships are shown in the simplified figure 4-10 below.

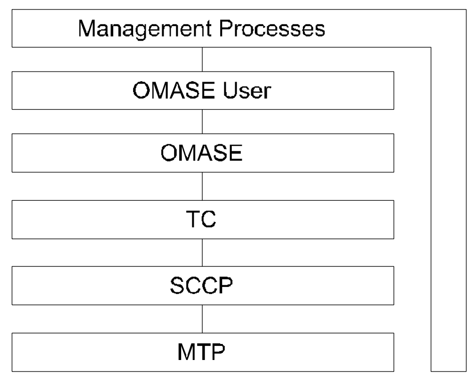

Figure 4-10, Application Layer and Application Process Model

Annex A covers Generic considerations for the SRVT which are in addition to the requirements listed in the body of the Recommendation. Annex A is integral to the Recommendation.

Q.754 MANAGEMENT APPLICATION SERVICE ELEMENT (ASE) DEFINITIONS

Published June 1997

This Recommendation provides the Stage 3 definition of the Operations and Maintenance Application Part Application Service Element (OMAP ASE), known as OMASE. OMASE provides the services invoked using primitives across the OMASE-User to OMASE boundary. (See Figure 4-10 above.) The OMASE services are derived from TMN services defined in CMIP.[14]

OMASE provides operations allowing the network administration, via the OMAP Management Process and the OMASE-User, to perform MTP and SCCP Routing Verification Tests (MRVT and SRVT), and circuit validation tests (CVT).

The arguments used for primitives across the OMAP Management Process to OMASE-User boundary, and for primitives across the OMASE-User to OMASE boundary, and between OMASE and TC are defined in this Recommendation. The TC ASE is for further study.

[14] CMIP is defined in ISO IS 9596 and in Recommendation X.711.

Appendix A, which forms an integral part of the Recommendation, provides examples of the Protocol Data Units which are passed between the TC transaction sublayer and the SCCP in support of these functions.

Q.755 PROTOCOL TESTS

Published March 1993

The protocol testers may be used as an aid when testing the Message Transfer Part (MTP and the Signalling Connection Control Part (SCCP), either when performing validation testing of an implementation or compatibility testing between two implementations. The tester s main function is simulation of an ordinary user part or sub-system, as seen from the MTP or SCCP respectively, for the generation of test traffic. Testers are connected to each SS No. 7 function in the Layer Management Plane as part of the Layer Management Entity. See Figure 4-10.

Q.756 GUIDEBOOK TO OMAP

Published June 1997

The Guidebook, which is not part of the OMAP Recommendations, provides guidelines for development of User Application Service Entities (ASEs).

BROADBAND RELATED SS No. 7 RECOMMENDATIONS

Q.2140 B-ISDN ATM ADAPTATION LAYER - SERVICE SPECIFIC COORDINATION FUNCTION FOR SIGNALLING AT THE NETWORK NODE INTERFACE

This Recommendation specifies a function that is part of the ATM Adaptation Layer (AAL) to support signalling (SAAL) at the Network Node interface of the B-ISDN. This function is used to map the service of the Service Specific Connection-Oriented Protocol (SSCOP) of the AAL to the requirements of the SAAL user at the NNI as defined in Recommendation Q.704 (SS No. 7 MTP). This Recommendation is of importance to relating SS No. 7 and B-ISDN signalling because it specifies the MTP-3 to SSCOP interface and includes a (non-normative) Appendix on the impacts of SAAL on MTP-3.

Q.2210 MTP LEVEL 3 FUNCTIONS AND MESSAGES USING THE SERVICES OF ITU-T RECOMMENDATION Q.2140

This Recommendation specifies MTP Level 3 functions and messages that are suitable for the control of signalling links that provide the service of ITU-T Recommendation Q.2140 (i.e. at the Network Node Interface). If MTP Level 3 is used for the control of these signalling links, this Recommendation applies and takes precedence over Q.701, 704, and 707. The Recommendation informally refers to these functions and messages as MTP-3b, and the term has come into general use. However, the Recommendation acknowledges that there may be other concerns between MTP-3 and MTP-3b, but any additional specifications for their interworking are beyond the scope of the Recommendation.

The MTP-3b makes use of the same primitives defined for MTP-3, except that the User Data carried by the transfer primitive is permitted to be longer. Whereas MTP-3 service data unit (SDU) can only be 272 octets before a message must be segmented, MTP-3b permits SDUs of 4096 octets.

Additional differences between Q.704 MTP-3 and Q.2160 MTP-3b are defined: new changeover procedure, route set allocation and congestion control, additional service indicator for B-ISUP (and Satellite ISUP), and slightly modified coding and message format conventions. Some of the MTP-3 timers are disabled and values for others may be changed based on future experience.

Q.2660 INTERWORKING BETWEEN SS No. 7 BROADBAND ISDN USER PART (B-ISUP) AND NARROW BAND ISDN User Part (N-ISUP [ISUP])

This Recommendation specifies the interworking between the two Parts as a set of arrow diagrams showing message interworking, and tables which map parameters.

SECTION 5

DIFFERENCES BETWEEN THE INTERNATIONAL ITU-T RECOMMENDATIONS AND THE U.S. NATIONAL T1 STANDARDS

5.0 INTRODUCTION

The T1 volumes which standardize the U.S. version of the SS No. 7 system are listed below:

ANSI T1.110-1992	SS7 General Information
ANSI T1.111-1996	SS7 Message Transfer Part (MTP)
ANSI T1.113-1005	SS7 ISDN User Part
ANSI T1.112-1996	SS7 Signalling Connection Control Part (SCCP)
ANSI T1.114-1996	SS7 Transaction Capabilities Application Part (TCAP)
ANSI T1.116-1996	SS7 Operations, Maintenance, and Administration Part (OMAP)

The T1 Standard which provides General Information on SS7 (T1.110-1992) states that SS7 is intended to be generally compatible with that [SS No. 7] standard. It has been appropriately modified for use within and between U.S. networks to meet the anticipated needs and applications of those entities. In general, these modifications fall into two categories:

(1) The specification of options designated by the CCITT for national use;
(2) Extensions to the 1988 protocol to provide for new applications of the SS7 protocol.

This Bulletin summarizes the differences between the ITU-T SS No. 7 Recommendations and the T1 SS7 Standards based on the assertions made in the T1 Standards which are careful to highlight what they consider modifications to the international standards. The T1 standards contain many references to ITU-T features that are not implemented in U.S. standards and networks. They make references to features which are national extensions, but these references may not be complete, especially in the Transaction Capabilities Application Part Standard (T1.114-1996).

It should be noted that T1 does not revise the national standards on the same schedule that ITU-T revises the international Recommendations. The T1 Standards currently date from 1995 and 1996, while the ITU-T Recommendations are dated between 1993 and 1997. Therefore there may be some differences that stem from the fact that they are not synchronized.

Not all the differences affect interoperability. The gateway between the national and international SS No. 7 networks translate many of the differences. However, when users originate calls that passes through a gateway, features that are available on one side may not be available on the other side and no translation will be possible. When differences in the standards prevent a capability on one side from being carried through the gateway, then there is a failure of interoperability which may be of NS/EP concern.

5.1 DIFFERENCES BETWEEN THE T1 AND THE ITU-T MESSAGE TRANSFER PART

A general difference between the T1.111.1996 MTP Standard and the ITU-T MTP Recommendations is that the T1 Standard addresses MTP support to broadband signalling, while the ITU includes MTP support for broadband in its Broadband Recommendations and in much less detail.

The MTP defined by T1.111-1996 contains many of the differences between the international and the national SS No. 7 standards. The differences identified in the T1 standards are listed below.

Signalling Data Link Functions, describe not only the variety of transmission speeds also described by the ITU-T, but makes the distinction between dedicated facilities and links accessed by a switching function. Switching the signals between links provides the potential for automatic reconfiguration of signalling links. While the potential for automatic link reconfiguration may have NS/EP implications on network reconstitution, the distinction between switched and unswitched facilities is not so much a standardization issue as much as it is an implementation issue. (Para 2.2.2, T1.111.1)

Line Signalling Systems (in-band and non-in-band) are not specified in the T1 standards, as they are not applicable to U.S. networks. (Para 2.2.2 & 3, T1.111.2)

Signalling Data Links derived from the 2048 and 8448 kbit/s Digital Paths are not specified for U.S Networks. (Para 5.1 & 2, T1.111.2)

The ITU-T Recommendations permit four different formats for **routing labels**, one specifically for MTP Management Messages. T1 Standards permit the use of a unique label, but rely on SCCP messages to carry the information. (Para 5.2 T1.110.1)

Law Converters other than the A/mu law converter are not specified. (Para 5.4 T1.111.2)

Of the six **signalling route management procedures** permitted in the ITU-T Recommendation (transfer-prohibited, -allowed, -restricted, -controlled; and signalling-route-set-test and -congestion-test), the transfer-restricted procedure is designated as the national standard procedure. (Para 1.3.5, T1.111.4)

The **standard routing label** is defined for U.S. networks. The national routing label lengthens the destination and originating point code fields each from 14 to 24 bits and the signalling link selection field from 4 to 8 bits, so the national label is 56 rather than 32 bits long. While the international point codes are pure binary numbers, the national codes are structured to identify network cluster member, network cluster,[15] and network identifier for both signalling points. Specific rules for construction of the national signalling point codes are specified. (Para 2.2, T1.111.4, & T1.111.8 entire)

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[15] The impact of the differing addressing scheme shows up again in specific managment tools available for linksets to clusters, features that are not covered in the ITU-T Recommendations. (Para 13.5, T1.111.4)

Signalling link congestion procedures for handling signalling messages are defined. These procedures are important because they support NS/EP programs such as High Probability of Completion and Multi-level Precedence and Preemption. The T1 Standard summarizes the international procedures: User Parts (ISUP and SCCP) assign congestion priorities and decide whether a message should be discarded. For the international MTP, the standard asserts that there is no congestion priority and the MTP will only discard a message if there is an extreme resource limitation. However, in U.S. signalling networks, the User Part assigns each message a congestion priority which the MTP uses to determine whether or not the message should be discarded if the link is congested. [Congestion is determined according to the procedure described below: **Signalling network congestion procedures.]** MTP compares the congestion priority assigned to the message submitted by the User Part with the congestion status of the selected link. If the priority is less than the congestion level, MTP compares the message priority with the signalling link discard status. If the priority is less than the discard status, it is discarded; if it is at least equal to the discard status, it is transmitted (e.g. placed in a buffer for transmission). MTP also sends a transfer controlled message to the User Parts which then throttle traffic of lower priority.

The standard permits User Parts to assign one of four priority levels[16] according to tables included in the Standard. The standard assigns the lowest two priority levels for ISUP[17], generally higher priority for SCCP and OMAP messages, and the highest priority to MTP (e.g. MTP management) messages. The tables provide some flexibility in congestion priority assignment, depending on the application, but are designed to support a distribution of roughly 75% of traffic of priority 0 and 1 (lowest) and 25% priority 2 and 3 (highest). (Paras 2.3.5, 3.8, 13.7, & 14.2.2 of T1.111.4 and Annex A to T1.111.5 (tables)).

Management control of signalling links in U.S. networks is performed by the management inhibit procedure. Links can be inhibited by the Level 3 protocol at either end of the link. The T1 inhibit procedures contain a number of national extensions. (Para 3.2.8 & 10, T1.111.4)

Signalling network congestion procedures for U.S. networks permit three rather than one threshold for definition of congestion onset and abatement. These threshold levels define the congestion status which MTP uses to control transmission of signalling messages. Additionally, the standard defines three discard levels, with the discard levels to be placed higher than the congestion onset levels. These levels are implementation dependent. Similar rules are applied to signalling route sets. The congestion status of signalling route sets is updated by the signalling-route-set congestion-test procedure as the national option. (Para 3.8 & 11.2.4, T1.111.4)

Status of local SCCP for Alias Point Code Routing [Global Translation] is determined by the implementation. (Para 3A & B, T1.111.4)

[16] The priority is contained in the Service Information Octet, subservice field which permits an option of national use of the entire national/international discrimination field where the national network can be seen as a closed network and discrimination is not required.

[17] Message priority level 1 is limited to those network services or capabilities that have been approved by T1 (e.g. High Probability of Completion and Multi-level Precedence and Preemption). That leaves Level 2 unassigned.

[Security] Procedures to prevent unauthorized use of an STP (by another Administration/ROA) in the interest of network security are permitted by the T1 Standard. These procedures are in addition to procedures set down in MTP monitoring and measurement procedures. (Para 8, T1.111.5)

5.2 DIFFERENCES BETWEEN THE T1 AND THE ITU-T ISDN USER PART

ISUP messages not specified for U.S. networks. There are 15 ITU-T-defined messages not specified for use in U.S. networks. (Para 1, T1.113.2)

Call Modification Completed
Call Modification Reject
Call Modification Request
Closed User Group Selection & Validation Request
Closed User Group Selection & Validation Response
Connect
Delayed Release
Facility Accepted
Facility Deactivated
Facility Information
Facility Reject
Facility Request
Overload
Subsequent Address
User-to-User Information

Of the 33 **ISUP parameters or indicators** defined by the ITU-T Recommendations, 13 are not specified for U.S. networks. (Para 2, T1.113.2)

Access Barred
Call Forwarding May Occur
Call Modification
Call Rerouting
Called Party Address Request
Called Party Address Response
Called Party Free
Called Party Address Request
Called Party Address Response
Called Party Answer
Calling Party Number Incomplete
Calling Party's Category Request
Calling Party's Category Response
All of the Cause Indicator Values have either unspecified values or additional values specified for U.S. networks.

Circuit Identification Codes are undefined for 2048 FDM and digital paths and 8448 digital paths. There is no allocation scheme standardized for the 1544 kbit/s digital path. (Para 1.2, T1.113.3)

There is a large number of ISUP Parameters that are either not defined for U.S. networks, specific to U.S. networks, or of a different format. For instance there is no procedure specified for the **Address Presentation Restriction Indicator** parameter. Instead, there are three Automatic Congestion levels specified. (Para 3.2 & 3.2A, T1.113.3) The **Circuit State Indicator** parameter field is limited to 24 octets in U.S. networks, but permitted to be 32 octets internationally. (Para 3.11B, T1.113.3) **Egress Service** is recognized as an ISUP parameter, but is permitted to be network specific and therefore not standardized for U.S. networks. (Para 3.16A, T1.113.3)

Basic Call Control and Signalling Procedure Differences include the following (T1.113.4):

Only en bloc operation is permitted for forward address signalling. Overlap operation is not specified. (Para 2.1.2)

There are no procedures for Transfer of User-to-User Information, although access signalling information is permitted. (Para 2.4)

A call can be Suspended or Resumed only by the network; no procedures for suspense of résumé initiated by the calling or called party are specified. (Para 2.5)

Delayed release and In-call modification are not specified. (Para 2.6 & 2.7)

Dynamic echo control procedures described in ISUP 92 Recommendations are not specified for U.S. networks. T1 specifies echo control procedures described in Q.115. (Para 2.7A)

5.3 DIFFERENCES BETWEEN THE T1 AND THE ITU-T SIGNALLING CONNECTION CONTROL PART

The address elements of the **SCCP address indicator** contained in the Routing Label occur in a different order (signalling point code, global title, subsystem number) from that specified by the ITU-T Recommendation (subsystem number, global title, signalling point code). The global title indicator (which directs the message to the appropriate global title translator) is 0001 in the T1 standard, but 0011 in the ITU-T Recommendation. (Para 3.4.2, T1.112.3)

The **rationale for connection-oriented service** is described in this Standard. “The connectionless procedures allow a user of the SCCP to request transfer of up to 3920 octets of user data without first requesting establishment of a signalling connection.” (Para 4, T1.112.4 Further reference is made to Para 2.3.8, T1.111.3, but this appears to be an obsolete reference.

5.4 DIFFERENCES BETWEEN THE T1 AND THE ITU-T TRANSACTION CAPABILITIES APPLICATION PART

The structure of the optional Dialogue Portion is specified in the T1 Standard with more options than in the ITU-T Recommendation. The ITU-T Recommendation only specifies that the optional dialogue part to contain transaction context information. T1 defines some of those contexts, without specifying that they are national extensions. This structure includes three sets of fields of interest to NS/EP applications: **Encoding, Security Context and Confidentiality Context** (identifier, length, and information). Encoding is one of the User Information Fields and describes encoding of TCAP messages. Security Context is application specific, and is not described in the Standard. The Confidentiality Context contains information, as defined in the Security Context, that is used to perform encryption/decryption functions on data concerned with the Transaction. None of these fields are defined with a great deal of detail; in fact the paragraph describing the security information to be included in the field was omitted from the standard. (Para 2.3, 4.10.12, 4.11-15.5, T1.114.3)

SECTION 6

STANDARDIZATION ISSUES & NS/EP IMPLICATIONS

6.0 INTRODUCTION

This Section assesses the impact of continuing ITU-T standardization activities on the NS/EP goals of the OMNCS.

6.1 CONTINUING DEVELOPMENT OF SS No. 7 RECOMMENDATIONS

The Recommendations that govern SS No. 7 are generally accepted as being stable. However, there are areas of continued activity by ITU-T in SS No. 7, primarily in the areas of network management, performance, and reliability. ITU-T also remains active in development of Broadband Recommendations which include references to MTP-3 as an access protocol. All these areas have NS/EP implications.

There are three ITU-T Study Group 11 Questions which apply directly to SS No. 7, and all of them address technical issues which are found on the list of NS/EP Objectives for the OMNCS.

- Operations, Management, and Administration. Network OAM has historically been an internal task of the service provider/network operator. Since these tasks were viewed as internal to the network, standards necessarily left a lot of room for the operators. However, as end users have become more involved with quality of service and have made demands on guarantees of end-to-end service quality, the operators have had to address management interconnection issues. Consequently, the largely advisory or optional aspects of OMAP have become inadequate to support the measure of interconnection required. As a business issue, OMAP must be tightened up.

  In terms of standardization, OMAP must be compatible with the ITU-T Telecommunication Management Network (TMN) which addresses the entire network (bearer as well as signalling). Since TMN is, itself, under the same standardization pressures and in that respect still under development, and since TMN is also facing technology advances (such as advancements in object management), keeping OMAP and TMN aligned is a matter of NS/EP concern.

- Another Study Group 11 SS No. 7 Question deals with concerns over network reliability. While the Question does not imply that there are network outages that are degrading SS No. 7 performance, it does specify that there needs to be some support mechanism for administrations (e.g. operators) to share outage information and provide feedback on remedial and preventative steps. This Question addresses the same communication issues between operators referred to above, but from a different perspective.

- The third Study Group 11 SS No. 7 Question addresses the loose grouping of SS No. 7 protocol levels into the Network Service Part (NSP). While each of the four levels that form the NSP are thoroughly specified in the Recommendations, the NSP itself is only referred to as “for further study.” As long as the bulk of SS No. 7 traffic was generated by the ISDN User Part independent of the NSP, NSP efficiency was not an issue. As the SS No. 7 is required to carry an increasing amount of traffic generated by Transaction Capabilities that depend on the NSP, the ITU-T will have to study the efficiency of the NSP as a single unit.

- The other Study Group 11 Questions which address SS No. 7 peripherally, and those others that address the impact of signalling requirements of new systems and technologies, all impact SS No. 7 at least in terms of the MTP which underlies all the narrowband network signalling. Many of these activities continue to develop the use of MTP-3 modifications to provide a broadband access to the ATM Signalling Application Adaptation Layer.

- There are national SS7 standards which do not implement all the requirements of the ITU-T Recommendations. In general these are areas in which the Recommendations permit unique national implementations. The national SS7 networks are only required to meet the ITU-T Recommendations when they pass through the gateway into the international plane. However, the U.S. T1 Transaction Capabilities standard includes a network security function which is not reflected in the ITU-T Recommendation. It is possible that an originator of traffic in a national SS7 network might anticipate that the security function could be transported into the international network. While it is difficult to imagine that such a user would not check the system capabilities before transmitting information requiring security, such a difference in capabilities would appear to be dangerous. Since the T1 Standard is more recent than the ITU-T Recommendation, it may be that a revised Recommendation will contain this option.

6.2 SS No. 7 STANDARDIZATION ACTIVITIES AND THE IMPACT OF THE CHANGING TELECOMMUNICATIONS ENVIRONMENT

The changing telecommunication and information technology environment will have substantial impact on SS No. 7 as the demands of new bearer services alter the nature, volume, and requirements of signalling traffic.

As the telecommunication environment changes, the loading on the SS No. 7 networks may also change. While the ITU-T Recommendations are silent on the subject, the T1 MTP Standard states that

> It cannot be foreseen yet how the signalling traffic will be influenced by the integration of existing and future services. If new or more stringent requirements are imposed on signalling (e.g. shorter delays) as a consequence of future services, they should be met by appropriate dimensioning of the load or by improving the structure of the signalling network. (Para 3.3, T1.111.6)

The SS No. 7 networks have always appeared to have sufficient bandwidth to serve the ISUP needs and growing TC needs of the networks, while providing connectionless service robust enough to meet the signalling reliability requirements. However, use of TC appears to be growing as new users such as intelligent network and mobile applications are being implemented. In this regard

- TC is a complex protocol and continued growth in its use may increase signalling traffic disproportionately to a point where network operation is affected.
- TC's complexity may also affect its speed. It may not be efficient enough to provide reliable service for call setup when intelligent network information must be accessed in real time.

SS No. 7 performance is a function of network architecture as well as TC's efficiency. Since the Service Switching Point often sends its TC messages through a number of Switching Transfer Points to a Switching Control Point, network architecture and the number of STPs required to pass the TC message to the SCP data base may also influence SS No. 7 responsiveness. While the growing impact of TC traffic could be regarded as a network implementation issue, it could also be regarded as a standardization issue requiring a refinement of the protocol. Study Group 11 Study Question 2/11 (OMAP) addresses performance objectives.

As the telecommunication environment becomes more competitive, the transmission capabilities of SS No. 7 could be viewed as an attractive bearer service. Placing commercial bearer service on the signalling network will have important loading implications, not to mention network security. Another source of additional traffic may come from using the TC transport capabilities to provide a bearer service for end users. Although such a service could conceivably be supported, especially within a single SS No. 7 network where there would be no interconnection complexities, the implications on SS No. 7 network security and resultant implications on the security of the bearer network served by the SS No. 7, are considerable. Operators have historically refused to permit end users access to their signalling networks in order to prevent both hacking and overloading.

6.3 IMPLEMENTATION OF ALL ASPECTS OF THE SS No. 7 PROTOCOLS

The ITU-T Recommendations specify both connection oriented and connectionless services for SS No. 7. However, U.S. networks have only implemented service based on the connectionless service.

> While there are many areas of the SS No. 7 protocols which are left for further study, there are also many areas which appear to have been thoroughly studied but never implemented. In particular, connection oriented service and the end-to-end signalling capability of ISUP through SCCP are specified. In many cases, the connection oriented services are described before the connectionless services (implying an ordering by importance). However, implementation of connection oriented services has not occurred, at least in U.S. networks. It is not clear that the conditions under which connection oriented SS No. 7 services would be implemented, but such a major shift in network design would have tremendous impact on the signalling network structure and thus NS/EP.

APPENDIX A

LIST OF ACRONYMS

AAL	ATM Adaptation Layer
ACSE	Association Control Service Element
AE	Application Entity
ANSI	American National Standards Institute
APDU	Application Protocol Data Unit
ASE	Application Service Element
ASN.1	Abstract Syntax Notation one, X.208
ASP	Application Service Part
ATM	Asynchronous Transfer Mode
B-ISUP	Broadband ISDN User Part
CCITT	International Telegraph and Telephone Consultative Committee
CCS	Common Channel Signalling
CIC	Circuit Identification Code
CMIP	Common Management Information Protocol
CRC	Cyclic Redundancy Check
CVT	Circuit Validation Test
DPC	Destination Point Code
DUP	Data User Part
FDM	Frequency Division Multiplexed
FISU	Fill-in Signal Unit
GDMO	Guide to Definitions of Managed Objects, X.721
ID	identifier
INAP	Intelligent Network Application Protocol
ISDN	Integrated Services Digital Network
ISO/OSI	International Standards Organization Open Systems Interface
ISUP	ISDN User Part
ITAC	International Telecommunication Advisory Committee (U.S. Department of State)
ITU-T	International Telecommunication Union - Telecommunication Standardization
LI	Length Indicator
LSSU	Link Status Signal Unit
MAP	Mobile Application Part
MIB	Management Information Base
MRVT	MTP Routing Verification Test
MSU	Message Signal Unit
MTP	Message Transfer Part
NEF	Network Element Function
N-ISUP	Narrowband ISUP (same as ISUP)
NNI	Network to Node Interface

NSDU	network service data unit primitive
NSP	Network Service Part
NS/EP	National Security and Emergency Preparedness
OA&M	Operations, Administration, and Maintenance
OMAP	Operations and Maintenance Application Part
OMASE	OMAP Application Service Element
OPC	Originating Point Code
OSF	Operations System Function
OSI	Open System Interconnect [model]
PABX	Private Automatic Branch Exchange (obsolete term for PBX)
ROSE	Remote Operation Service Element, X.229
SAAL	Signalling ATM Adaptation Layer
SCLC	SCCP Connectionless Control
SCMC	SCCP Management Control
SCOC	SCCP Connection-Oriented Control
SCRC	SCCP Routing Control
SCCP	Signalling Connection Control Part
SCLC	SCCP Connectionless Control
SCMG	SCCP Management Control
SCOP	SCCP Connection-oriented Control
SCRC	SCCP Routing Control
SDL	Service Definition Language
SDU	Service Data Unit
SI	Status Information [Field]
SIF	Signalling Information Field
SIO	Service Information Octet
SRVT	SCCP Routing Verification Test
SS No. 7	Signalling System Number 7
SS7	Signalling System Number 7
SSCOP	Service-Specific Connection-Oriented Protocol
SCP	Service Control Point
SP	Signalling Point
SSP	Service Switching Point
STP	Signalling Transfer Point
SU	Signal Unit
TC	Transaction Capabilities
TCAP	Transaction Capabilities Application Part
TMN	Telecommunication Management Network
TUP	Telephone User Part