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FASCICLE VI.7

Recommendations Q.700 to Q.716

SPECIFICATIONS OF

SIGNALLING SYSTEM No. 7

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SECTION 1

GENERAL

Recommendation Q.700

INTRODUCTION TO CCITT SIGNALLING SYSTEM No. 7

1 General

This Recommendation provides an overview of the Signalling System by describing the various functional elements of CCITT No. 7 and the relationship between these functional elements. This Recommendation provides a general description of functions and capabilities of the Message Transfer Part (MTP), Signalling Connection Control Part (SCCP), Telephone User Part, ISDN User Part (ISDN-UP), Transaction Capabilities (TC), and the Operations, Maintenance and Administration Part (OMAP) which are covered elsewhere in the Q.700 to Q.795 series of Recommendations. However, in the case of contradiction between the specifications and Q.700, the Q.700 to Q.795 specification shall apply.

Supplementary Services in CCITT S.S. No.7 ISDN applications are described in the Q.73x series of Recommendations.

In addition to these functions in the CCITT No. 7 signalling system, the Q.700 to Q.795 series of Recommendations describes the CCITT No. 7 network structure, and also specifies the Tests and Measurements applicable to CCITT No. 7.

This Recommendation is also a specification of those aspects such as CCITT S.S. No. 7 Architecture, Flow Control and general compatibility rule which are not specified in separate Recommendations, and are applicable to the overall scope of S.S. No. 7.

The remainder of this Recommendation describes:

— § 2: Signalling network concepts components and modes;

— § 3: The functional blocks within CCITT Signalling System No. 7 and the services provided by them;

— § 4: CCITT Signalling System No. 7 protocol layering and its relationship to OSI modelling;

— § 5: Node, application entity and user part addressing;

— § 6: Operations, administration and maintenance aspects of CCITT S.S. No. 7;

— § 7: Performance aspects of the functional blocks within CCITT S.S. No. 7;

— § 8: Flow control for both the signalling network and within nodes;

— § 9: Rules for evolving CCITT S.S. No. 7 protocols while preserving compatibility with earlier versions;

— § 10: A cross-reference to a glossary of terms.

1.1 *Objectives and fields of application*

The overall objective of Signalling System No. 7 is to provide an internationally standardised general purpose common channel signalling (CCS) system:

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

— that can meet present and future requirements of information transfer for inter-processor transactions within telecommunications networks for call control, remote control, and management and maintenance signalling;

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

The signalling system meets requirements of call control signalling for telecommunication services such as the telephone, ISDN and circuit switched data transmission services. It can also be used as a reliable transport system for other types of information transfer between exchanges and specialised centres in telecommunications networks (e.g. for management and maintenance purposes). The system is thus applicable for multipurpose uses in

networks that are dedicated for particular services and in multiservices networks. The signalling system is intended to be be applicable in international and national networks.

The scope of CCITT S.S. No. 7 encompasses both circuit related and non-circuit related signalling.

Examples of applications supported by CCITT S.S. No. 7 are:

— PSTN,

— ISDN,

— Interaction with Network Databases, Service Control Points for service control,

— Mobiles (Public Land Mobile Network),

— Operations Administration and Maintenance of Networks.

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

1.2 *General characteristics*

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

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

1.3 *Components of CCITT S.S. No. 7*

CCITT S.S. No. 7 consists of a number of components or functions which are defined as a series of Q.700 to Q.795 Recommendations.

CCITT S.S. No. 7 function	*Recommendations*
Message Transfer Part (MTP)	Q.701-Q.704, Q.706, Q.707
Telephone User Part (TUP)	Q.721-Q.725
(including supplementary services)	
Supplementary services	Q.730
Data User Part (DUP)	Q.741 (note 1)

ISDN User Part (ISDN-UP)	Q.761-Q.764, Q.766
Signalling Connection Control Part (SCCP)	Q.711-Q.714, Q.716
Transaction Capabilities (TC)	Q.771-Q.775
Operations Maintenance and Administration Part (OMAP)	Q.795

Note 1 — Functions of the DUP are fully specified in Recommendation X.61.

Other Q.700 to Q.795 series Recommendations which describe other aspects of the signalling system but not part of the CCITT S.S. No. 7 signalling interfaces are:

Title	*Recommendations*
Signalling Network Structure	Q.705
Numbering of International Signalling Point Codes	Q.708
Hypothetical signalling reference connection	Q.709
PABX application	Q.710
CCITT S.S. No. 7 Test Specification (General)	Q.780
MTP Level 2 Test Specification	Q.781
MTP Level 3 Test Specification	Q.782
TUP Test Specification	Q.783
Monitoring and measurements for the CCITT S.S. No.7 network	Q.791

§ 3 of Q.700 describes the relationship between these components.

1.4 *Description techniques in the Q.700 to Q.795 series of Recommendations*

The CCITT S.S. No. 7 Recommendation series define the signalling system using prose description which is complemented by SDL diagrams and state transition diagrams. Should any conflict arise between the text and the SDL definition, the textual description is taken as definitive.

Message sequence charts or arrow diagrams are used to illustrate examples of signalling procedures, but are not considered definitive.

2 **CCITT S.S. No. 7 signalling network**

2.1 *Basic concepts*

A telecommunications network served by common channel signalling is composed of a number of switching and processing nodes inter-connected by transmission links. To communicate using CCITT No. 7, each of these nodes requires to implement the necessary ‘‘within node’’ features of CCITT S.S. No. 7 making that node a signalling point within the CCITT S.S. No. 7 network. In addition, there will be a need to interconnect these signalling points such that CCITT S.S. No. 7 signalling information (data) may be conveyed between them. These data links are the signalling links of CCITT S.S. No. 7 signalling network.

The combination of signalling points and their interconnecting signalling links form the CCITT S.S. No. 7 signalling network.

2.2 *Signalling network components*

2.2.1 *Signalling points*

In specific cases there may be a need to partition the common channel signalling functions at such a (physical) node into logically separate

entities from a signalling network point of view; i.e., a given (physical) node may be defined as more than one signalling point. One example is an exchange at the boundary between international and national signalling networks.

Any two signalling points, for which the possibility of communication between their corresponding User Part function exists, are said to have a signalling relation.

The corresponding concept for a given User Part is called a user signalling relation.

An example is when two telephone exchanges are directly connected by a bundle of speech circuits. The exchange of telephone signalling relating to these circuits then constitutes a user signalling relation between the Telephone User Part functions in those exchanges in their role as signalling points.

Another example is when administration of customer and routing data in a telephone exchange is remotely controlled from an operation and maintenance centre by means of communication through a common channel signalling system.

Examples of nodes in a signalling network that constitutes signalling points are:

— exchanges (switching centres),

— operation, administration and maintenance centres,

— service control points,

— signalling transfer points.

All signalling points in a CCITT S.S. No. 7 network are identified by a unique code known as a point code (Recommendation Q.704 refers).

2.2.2 *Signalling links*

The common channel signalling system uses signalling links to convey the signalling messages between two signalling points. A number of signalling links that directly interconnect two signalling points which are used as a module constitute a signalling link-set. Although a link set typically includes all parallel signalling links, it is possible to use more than one link set in parallel between two signalling points. A group of links within a link set that have identical characteristics (e.g., the same data link bearer rate) is called a link group.

Two signalling points that are directly interconnected by a signalling link are, from a signalling network structure point of view, referred to

as adjacent signalling points. Correspondingly, two signalling points that are not directly interconnected are non-adjacent signalling points.

2.2.3 *Signalling modes*

The term ‘‘signalling mode’’ refers to the association between the path taken by a signalling message and the signalling relation to which the message refers.

In the associated mode of signalling, the messages relating to a particular signalling relation between two adjacent points are conveyed over a link set, directly interconnecting those signalling points.

In the non-associated mode of signalling, the messages relating to a particular signalling relation are conveyed over two or more linksets in tandem passing through one or more signalling points other than those which are the origin and the destination of the messages.

The quasi-associated mode of signalling is a limited case of the non-associated mode where the path taken by the message through the signalling network is pre-determined and, at a given point in time, fixed.

Signalling System No. 7 is specified for use in the associated and quasi-associated modes. The Message Transfer Part does not include features

to avoid out-of-sequence arrival of messages or other problems that would typically arise in a fully non-associated mode of signalling with dynamic message routing.

Examples of signalling modes are illustrated in Figure 1/Q.700.

Figure 1/Q.700, p.

2.3 *Signalling point modes*

A signalling point at which a message is generated, i.e., the location of the source User Part function, is the originating point of that message.

A signalling point to which a message is destined, i.e., the location of the receiving User Part function, is the destination point of that message.

A signalling point at which a message is received on a signalling link is transferred to another link, i.e., neither the location of the source nor the receiving User part function, is a Signal Transfer Point (STP).

For a particular signalling relation, the two signalling points thus function as originating and destination points for the messages exchanged in the two directions between them.

In the quasi-associated mode, the function of a signalling transfer point is typically located in a few signalling points which may be dedicated to this function, or may combine this function with some other (e.g., switching) function. A signalling point serving as a signalling transfer point functions as an originating and destination point for the messages generated and received by the level 3 function of the Message Transfer Point also in cases when no user functions are present.

2.4 *Signalling routes*

The pre-determined path, consisting of a succession of signalling points/signalling transfer points and the interconnecting signalling links, that a message takes through the signalling network between the origination point and the destination point is the signalling route for that signalling relation.

All the signalling routes that may be used between an originating point and a destination point by a message traversing the signalling network is the signalling route set for that signalling relation.

2.5 *Signalling network structure*

The signalling system may be used with different types of signalling network structures. The choice between different types of signalling network structures may be influenced by factors such as the structure of the telecommunication network to be served by the signalling system and administrative aspects.

In the case when the provision of the signalling system is planned purely on a per signalling relation basis, the likely result is a signalling network largely based on associated signalling, typically supplemented by a limited degree of quasi-associated signalling for low volume signalling relations. The structure of such a signalling network is mainly determined by the patterns of the signalling relations.

Another approach is to consider the signalling network as a common resource that should be planned according to the total needs for common channel signalling. The high capacity of digital signalling links in combination with the needs for redundancy for reliability then typically leads to a signalling network based on a high degree of quasi-associated signalling with some

provision for associated signalling for high volume signalling relations. The latter approach to signalling network planning is more likely to allow exploitation of the potential of common channel signalling to support network features that require communication for purposes other than the switching of connections.

The worldwide signalling network is structured into two functionally independent levels, namely the international and national levels. This structure makes possible a clear division of responsibility for signalling network management and allows numbering plans of signalling points of the international network and the different national networks to be independent of one another.

Further considerations about the structure of the signalling network are given in Recommendation Q.705, and the impact on the message transfer part in Recommendation Q.701.

3 CCITT S.S. No. 7 functional blocks

3.1 *Basic functional division*

The Blue Book CCITT Signalling System No. 7 comprises the following functional blocks:

— Message Transfer Part (MTP)

— Telephone User Part (TUP)

— ISDN User Part (ISDN-UP)

— Signalling Connection Control Part (SCCP)

— Transaction Capabilities (TC)

— Application-Entity (AE) *Note 1*

— Application-Service-Elements (ASEs) *Note 1*

Note 1 — The glossary shows these as hyphenated terms but the usual convention used in this Recommendation will be unhyphenated.

The fundamental principle of the signalling system structure is the division of functions into a common Message Transfer Part (MTP) on one hand, and separate User Parts for different users on the other. This is illustrated in Figure 2/Q.700.

The overall function of the Message Transfer Part is to serve as a transport system providing reliable transfer of signalling messages between the locations of communicating user functions.

User functions in CCITT S.S. No. 7 MTP terms are:

— the ISDN User Part (ISDN-UP)

— the Telephone User Part (TUP)

— the Signalling Connection Control Part (SCCP)

— the Data User Part (DUP)

The term ‘‘User’’ in this context refers to any functional entity that utilises the transport capability provided by the Message Transfer Part.

A User Part comprises those functions of, or related to, a particular type of user that are part of the common channel signalling system, typically because those functions need to be specified in a signalling context.

The SCCP also has Users. These are:

— the ISDN User Part (ISDN-UP)

— Transaction Capabilities (TC)

Figure 2/Q.700, p.

3.2 *CCITT S.S. No. 7 architecture*

3.2.1 *General*

Figure 2/Q.700 shows the Architecture of CCITT S.S. No. 7 and illustrates the functional relationship between the various functional blocks of the Blue Book CCITT S.S. No. 7. Figure 5/Q.700 shows the relationship between CCITT No. 7 levels and the OSI Reference Model Layers. This level/layer relationship is described in the following sections.

The initial specification of CCITT No. 7 was based on circuit-related telephony control requirements. To meet these requirements, CCITT No. 7 was specified in four functional levels, the Message Transfer Part comprising levels 1-3, and the User Parts as level 4.

Figure 3/Q.700 shows the Functional Levels of CCITT S.S. No. 7. As new requirements have emerged, e.g., for non-circuit related information transfer, CCITT S.S. No. 7 has also evolved to meet these new requirements. There has been a need to align certain elements in CCITT No. 7 to the OSI 7 Layer Reference Model.

The result of this evolution is that Functional Levels and OSI layers co-exist in CCITT No. 7. For example, the SCCP is a level 4 User Part in MTP terms, but also provides an OSI Network layer 3 service. Subsequent sections describe the various functional elements of CCITT S.S. No. 7 in terms of levels and layers.

Figure 3/Q.700, p.

It should be noted that the approach proposed for ISDN architecture is to define two orthogonal planes, User and Control, each of which has its own 7-layer protocol reference model.

From the perspective of an end user, the service provided by a telecommunications network may be regarded as a Network Layer Service (User Plane).

Within the telecommunications network, the techniques of the ISDN Protocol Reference Model are applied, and the 7-layer protocol structure of the OSI Model can also be used for inter-nodal communication to the end user.

3.2.2 *Message Transfer Part (MTP) levels 1-3*

An overview of the MTP is given in Recommendation Q.701. The MTP is defined in Recommendations Q.701-Q.704, Q.706 and Q.707.

3.2.2.1 *Signalling data link functions (level 1)*

Level 1 defines the physical, electrical and functional characteristics of a signalling data link and the means to access it. The level 1 element provides a bearer for a signalling link.

In a digital environment, 64-kbit/s digital paths will normally be used for the signalling data link. The signalling data link may be accessed via a switching function, providing a potential for automatic reconfiguration of signalling links. Other types of data links, such as analogue links with modems, can also be used.

The detailed requirements for signalling data links are specified in Recommendation Q.702.

3.2.2.2 *Signalling link functions (level 2)*

Level 2 defines the functions and procedures for and relating to the transfer of signalling messages over one individual signalling data link.

The level 2 functions together with a level 1 signalling data link as a bearer, and provides a signalling link for reliable transfer of signalling messages between two points.

A signalling message delivered by the higher levels is transferred over the signalling link in variable length signal units. For proper operation of the signalling link, the signal unit comprises transfer control information in addition to the information content of the signalling message.

The detailed requirements for signalling functions are given in Recommendation Q.703.

3.2.2.3 *Signalling network functions (level 3)*

Level 3 in principle defines those transport functions and procedures that are common to and independent of the operation of individual signalling links. These functions fall into two major categories:

a) Signalling message handling functions — These are functions that, at the actual transfer of the message, direct the message to the proper signalling link or User Part.

b) Signalling network management functions — These are functions that, on the basis of predetermined data and information about the status of the signalling network, control the current message routing and configuration of the signalling network facilities. In the event of changes in the status, they also control the reconfigurations and other actions to preserve or restore the normal message transfer capability.

The detailed requirements for signalling network functions are given in Recommendation Q.704.

3.2.3 *Level 4: MTP User functions*

Level 4 consists of the different User Parts. Each User Part defines the functions and procedures of the signalling system that are particular to a certain type of user of the system. the following entities are defined as User Parts in CCITT S.S. No. 7.

3.2.3.1 *Signalling Connection Control Part (SCCP)*

The SCCP is defined in Recommendations Q.711-Q.716. This Recommendation series defines the SCCP capabilities, layer interfaces to MTP

and SCCP users signalling messages, their encoding and signalling procedures, and cross-office performance. The SCCP provides additional functions to the Message Transfer Part to provide such connectionless and connection-oriented network services to transfer circuit-related, and non-circuit-related signalling information.

The SCCP provides the means to:

— control logical signalling connections in a CCITT No. 7 network;

— Transfer Signalling Data Units across the CCITT No. 7 network with or without the use of logical signalling connections.

SCCP provides a routing function which allows signalling messages to be routed to a signalling point based on, for example, dialled digits. This capability involves a translation function which translates the global title (e.g., dialled digits) into a signalling point code and a subsystem number.

SCCP also provides a management function, which controls the availability of the ‘‘subsystems’’, and broadcasts this information to other nodes in the network which have a need to know the status of the ‘‘subsystem’’.

The combination of the MTP and the SCCP is called ‘‘Network Service Part’’ (NSP). The Network Service Part meets the requirements for layer 3 services as defined in the OSI-Reference Model, CCITT Recommendation X.200.

3.2.3.2 *Telephone User Part (TUP)*

The CCITT S.S. No. 7 Telephone User Part is defined in Recommendations Q.721-725. The TUP Recommendations define the necessary telephone signalling functions for use of S.S. No. 7 for international telephone call control signalling. This Recommendation series defines the telephone signalling messages, their encoding and signalling procedures, and cross-office performance.

Supplementary Services handled by the CCITT S.S. No. 7 TUP applications are described in Recommendation Q.724, § 10. These supplementary services embody TUP signalling messages and procedures.

3.2.3.3 *Data User Part (DUP)*

The Data User Part is defined in Recommendation Q.741, and the functionality fully defined in Recommendation X.61. It defines the protocol to control interexchange circuits used on data calls, and data call facility registration and cancellation.

3.2.3.4 *ISDN User Part (ISDN-UP)*

The ISDN User Part is defined in Recommendations Q.761-Q.764 and Q.766. This Recommendation series defines the ISDN network signalling messages, their encoding and signalling procedures, and cross-office performance. This Recommendation series deals with the basic services only.

The ISDN-UP encompasses signalling functions required to provide switched services and user facilities for voice and non-voice applications in the ISDN.

The ISDN-UP is also suited for application in dedicated telephone and circuit-switched data networks and in analogue, and mixed analogue/digital networks.

The ISDN-UP has an interface to the SCCP (which is also a level 4 User Part) to allow the ISDN-UP to use the SCCP for end-to-end signalling.

Supplementary Services handled by the CCITT S.S. No. 7 ISDN application are described in Recommendation Q.730. These supplementary services embody ISDN-UP signalling messages and procedures. In some cases these services also include application protocol which uses TC and SCCP, as, for example, centralised Closed User Group (CUG).

3.2.3.5 *Transaction Capabilities*

Transaction Capabilities is defined in Recommendations Q.771-Q.775. This Recommendation series defines the Transaction Capabilities signalling messages, their encoding and signalling procedures.

Transaction Capabilities consists of two elements. These are:

— Transaction Capabilities Application Part (TCAP);

— Intermediate Service Part (ISP) [The ISP is for further study (see Note 1, Figure 5/Q.700)].

The TCAP entity is a functional block residing above the ISP in layer 7. TCAP consists of two sub-layers: the Transaction sub-layer, and the Component sub-layer. Further details are given in Recommendation Q.771.

TC, as currently specified, provides services based on a connectionless network service. In this case, no ISP layers 4-6 functions are involved. Connection-oriented TC services, and the layer functions of layers 4-6 are for further study.

TC provides the means to establish non-circuit-related communication between two nodes in the signalling network.

TC provides the means to exchange operations and replies via a dialogue. The X.229 Remote Operations protocol has been extended to provide added functionality in order to accommodate specific user needs. The operations and parameters are part of the Application protocol between TC users.

3.2.3.6 *Application Entities and Application Service Elements*

In an OSI environment, communication between application processes is modelled by communication between ‘‘Application Entities (AEs)’’. An Application Entity represents the communication functions of an Application process. There may be multiple sets of OSI communication functions in an application process, so a single application process may be represented by multiple AEs. However, each Application Entity is a set of communication capabilities whose components are ‘‘Application Service Elements’’. An Application Service Element (ASE) is a coherent set of integrated functions.

3.2.3.6.1 *Application Entities in a CCITT S.S. No. 7 environment*

Figure 4/Q.700 shows the relationship between Application Processes and Application Entities, and Application Service Elements.

An ‘‘Application Process’’ is considered to be a range of functions and features which support a particular network requirement. For example, an application process in the context of CCITT S.S. No. 7 provides the co-ordination across circuit-related protocols where required.

An Application Process can be considered as:

a) a co-ordinator of specific aspects of network operation (e.g., ISDN Call Control, Mobiles, OA&M);

b) an individual service or supplementary service control function (e.g., CUG).

In the CCITT S.S. No. 7 context, the various functional elements of the signalling system provide the signalling protocols (information elements, messages, and procedures) necessary to support the service between nodes.

In a CCITT No. 7 environment, Application Entities (AEs) are the elements representing the communication functions of the application process, which are pertinent to inter-nodal communication using layer 7 application protocols.

The options for the relationship between an application process, AEs and ASEs can take several forms at a CCITT No. 7 signalling point. Some examples are shown in Figure 4/Q.700.

Figure 4/Q.700 , p.

3.2.3.6.2 *Application Service Elements in a CCITT No. 7 environment*

Application Service Elements (ASEs) reside in the CCITT S.S. No. 7 Architecture Model within layer 7 above TCAP. In the context of OSI, TCAP could also be considered to be an ASE.

OMAP has an Application Entity currently containing the TCAP ASE and one other ASE. Other ASEs are under study. OMAP is described further in § 6.

The Mobile Application Part (MAP) is another example of an Application Entity (AE) (see Recommendation Q.1051).

An ASE can include a number of signalling procedures for a single service (e.g., Freephone), where this single service is the application.

Alternatively, an ASE can include a number of signalling procedures for any number of services or functions, encompassed by an application (e.g., MAP, OMAP).

Thus, an ASE can define an individual service protocol (e.g., CUG), or a complete application protocol (e.g., MAP).

An ASE can only communicate with a compatible peer ASE. The operations defined in an ASE may be either symmetrically invoked by each entity involved in the dialogue, or asymmetrically invoked by one entity only (i.e., on a

‘‘client/server’’ basis). An example of the former is a ‘‘look ahead if free’’ procedure; an example of the latter is a database enquiry.

3.2.3.6.3 *Addressing for Application Entities (AEs)*

The SCCP provides a mechanism for addressing ‘‘subsystems’’ using Subsystem Numbers (SSNs). The Application Entity is considered, in the connectionless mode, equivalent to an SCCP subsystem.

3.2.3.6.4 *Management of AEs*

The SCCP provides a mechanism for managing ‘‘subsystems’’ and signalling points and informing other nodes of relevant availability status.

4 OSI layering and CCITT S.S. No. 7

4.1 *General*

Evolution of the CCITT Signalling System No. 7 architecture has been based on the Open Systems Interconnection (OSI) Reference Model.

The purpose of the Reference Model of Open Systems Interconnection for CCITT Applications (Recommendation X.200) is to provide a well-defined structure for modelling the interconnection and exchange of information between users in a communications system. This approach allows standardised procedures

to be defined not only to provide an open systems interconnection between users over a single network, but also to permit interworking between networks to allow communication between users over several networks in tandem.

At present, OSI only considers connection-oriented protocols, that is, protocols which establish a logical connection before transferring data. In CCITT S.S. No. 7, the ISDN-UP uses the SCCP connection-oriented protocol. The CCITT S.S. No. 7 Network Service Part (NSP) provides both connectionless and connection-oriented protocol.

The approach taken in the OSI reference model is to partition the model used to describe this interconnection and exchange information between users in a communications system into seven layers.

From the point of view of a particular layer, the lower layers provide a ‘‘transfer service’’ with specific features. The way in which the lower layers are realised is immaterial to the next higher layers. Correspondingly, the lower layers are not concerned with the meaning of the information coming from higher layers or the reasons for its transfer.

The characteristics of each layer are described below.

4.1.1 *Physical Layer*

The Physical Layer (layer 1) provides transparent transmission of a bit stream over a circuit built in some physical communications medium. It furnishes the interface to the physical media and is responsible for relaying bits (i.e., interconnects data-circuits). A 64 kbit/s link is assumed for the CCITT S.S. No. 7 Physical Layer.

4.1.2 *Data Link Layer*

The Data Link Layer (layer 2) overcomes the limitations inherent in the physical circuits and allows errors in transmission to be detected and recovered, thereby masking deficiencies in transmission quality.

4.1.3 *Network Layer*

The Network Layer (layer 3) transfers data transparently by performing routing and relaying of data between end users. One or more of the sub-networks may interwork at the Network Layer to provide an end user to end user network service. A connectionless network provides for the transfer of data between end users, making no attempt to guarantee a relationship between two or more data messages from the same user.

4.1.4 *Transport Layer*

The Transport Layer (layer 4) provides end user to end user transfer optimising the use of resources (i.e., network service) according to the type and character of the communication, and relieves the user of any concern for the details of transfer. The Transport Layer always operates end-to-end, enhancing the Network Layer when necessary to meet the quality of service objectives of the users.

4.1.5 *Session Layer*

The Session Layer (layer 5) co-ordinates the interaction within each association between communicating application processes. Full and half duplex dialogues are examples of possible Session Layer modes.

4.1.6 *Presentation Layer*

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

4.1.7 *Application Layer*

The Application Layer (layer 7) specifies the nature of the communication required to satisfy the users' needs. This is the highest layer in the Model and so does not have a boundary with a higher layer. The Application Layer provides the sole means for the application processes to access the OSI environment.

4.2 *Relationship between CCITT S.S. No. 7 layering and the OSI model*

Layers 1-3 comprise functions for the transportation of information from one location to another, possibly via a number of communication links in tandem. These functions provide the basis on which a communication network can be built.

— The SCCP provides, with the MTP, OSI layer services 1-3.

Layers 4-7 define functions relating to end-to-end communication. These layers are so defined that they are independent of the internal structure of the communication network.

— Transaction Capabilities provides layer 4-7 services.

Layer 7 represents the semantics of a communication, whereas layers 1-6 comprise the means by which the communication may be realised.

— Application Entities/Application Service Elements provide the appropriate Application Layer Protocols in layer 7.

Figure 5/Q.700 shows the relationship between SCCP, TC, and ASEs to the OSI 7 Layer Reference Model.

Figure 5/Q.700, p.

The aspect of the SMAP which is then involved with communication is the Systems Management Application Entity (SMAE). The SMAE is also known as the OMAP AE.

4.3 *Primitive Interfaces between CCITT No. 7 Functions*

4.3.1 *General*

Interfaces between the functional elements of CCITT S.S. No. 7 are specified using interface primitives. Primitive interface definition does not assume any specific implementation of a service.

4.3.2 *OSI service primitives*

Where the functional element of CCITT No. 7 is modelled on the OSI 7 layer reference model, e.g., SCCP, TC, service primitives are defined in line with Recommendation X.210.

In line with Recommendation X.210, Figure 6/Q.700 illustrates the relationship between the terms ‘‘service’’, ‘‘boundary’’, ‘‘service primitives’’, ‘‘peer protocol’’ and ‘‘peer entities’’. The term ‘‘boundary’’ applies to boundaries between layers, as well as to boundaries between sub-layers.

Figure 6/Q.700, p.

4.3.2.1 *Service primitives*

The user of primitives does not preclude any specific implementation of a service in terms of interface primitives.

A service primitive consists of a name and one or more parameters which are passed in the direction of service primitive.

The name of a service primitive contains three elements, as defined in Recommendation X.210:

a) a type indicating the direction of the primitive flow. Four types of service primitives are identified (Figure 7/Q.700):

— request a primitive issued by a service user to invoke a service element,

— indication a primitive issued by a service provider to advise that a service element has been invoked by the service user at the peer service access point or by the service provider,

— response a primitive issued by the service user to complete at a particular service access point some service element whose invocation has been previously indicated at that service access point,

— confirmation a primitive issued by a service provider to complete at a particular service access point some service element previously invoked by a request at that service access point.

Not all four types can be associated with all service names.

b) a name which specifies the action to be performed;

c) An initial (or initials) which specifies the (sub-)layer providing the service:

— OM for the Operations Management primitives associated with OMAP;

— TC for the TCAP Component sub-layer,

— TR for the TCAP Transaction sub-layer,

— P, S, T, respectively for the Presentation, Session, and Transport layers in the ISP,

— N for the Network Service Part (MTP + SCCP), as defined in Recommendation Q.711.

Figure 7/Q.700, p.

Figure 8/Q.700 provides an overview of the primitives used between the various functional elements of CCITT No. 7.

The MTP primitives apply to all level 4 users of the MTP.

Similarly, the SCCP Management Primitives N-STATE, N-COORD, N-PCSTATE apply to all SCCP subsystems/AEs via TC.

The TC primitives between the ASE and TC provide control of connectionless TCAP transactions. Service primitives for connection-oriented TC transactions are for further study.

Figure 8/Q.700, p.

5 Addressing

Addressing of CCITT S.S. No. 7 messages has to be considered on a number of levels. For example, the message transfer part uses the destination point code to route the message to the appropriate signalling point. The called party address field in TUP, or ISUP called party number field, in the Initial Address Message is used to route the call to the appropriate called destination. The capabilities of the various CCITT S.S. No. 7 addressing mechanisms are illustrated by the signalling message structure.

5.1 *Signalling message structure*

A signalling message is an assembly of information, defined at level 3 or 4, pertaining to a call, management transaction, etc., that is transferred as an entity by the message transfer function.

Each message contains service information including a service indicator identifying the source User Part and possibly additional information such as an indication whether the message relates to international or national application of the User Part.

The signalling information of the message includes the actual user information, such as one or more telephone or data call control signals, management and maintenance information, etc., and information identifying the type and format of the message. It also includes a label that provides information enabling the message to be:

— routed by the level 3 functions and thorugh a signalling network to its destination; and (This part of the label is known as the Routing label. This is shown in Figure 9/Q.700.)

— directed at the receiving User Part to the particular circuit, call, management or other transaction to which the message is related.

Further details are given in Q.700, § 5.2.

Figure 9/Q.700 [T1.700], p. (Traiter comme tableau MEP)

There are four types of label:

— type A for MTP management messages;

— type B for TUP;

— type C for ISDN-UP (circuit related) messages;

— type D for SCCP messages.

These are shown in Figure 10/Q.700.

The circuit identification code is used as a label for circuit related signalling messages, e.g., TUP or ISDN-UP. The least significant 4 bits of this field (in the TUP) is the Signalling Link Selection (SLS) field, which is used, where appropriate, to perform load sharing (see Q.704). In the ISDN-UP, the SLS is a separate field to the circuit identification code.

The CCITT No. 7 MTP signalling messages at level 2, which carry user information, are called Message Signal Units (MSUs). Figure 11/Q.700 shows the basic format of the MSU (refer also to Q.703) and the breakdown of the MSU. Signalling Information Field (SIF) when transporting circuit-related (ISDN-UP, TUP) messages and non-circuit-related messages (SCCP, TC based). Further details are given on message formats in

Recommendations Q.704, Q.713, Q.723, Q.763, Q.773.

Figure 10/Q.700, p.10

Figura 11/Q.700, p.

5.2 *MTP addressing*

There is a two part addressing mechanism in the MTP, one part of the mechanism uses the point code which is incorporated in the routing label of every message signal unit, the other part of the mechanism makes use of the service indicator and network indicator within the service information octet. The point code is used for inter-node addressing and the SIO addresses signalling system users on an intra-node basis.

5.2.1 *Point codes*

Every signalling point (SP) and signalling transfer point (STP), when integrated in an SP, will be allocated its own unique point code. This is used by the MTP routing function to direct outgoing messages towards their destination in the network as indicated by the inclusion of the appropriate point code in the routing label. This point code is known as the destination point code (DPC). The routing label also contains the point code of the SP originating the message signal unit, therefore, the combination of this

originating point code (OPC) and DPC will determine the signalling relation (i.e., the network points between which MTP ‘‘User’’ information is exchanged). The DPC is used by the receiving SP/STP discrimination function to determine whether the message is addressed to that SP or requires to be onward routed by means of the signal transfer capability of the STP.

The DPC will always be determined and inserted in the routing label by the level 4 MTP ‘‘User’’. This will also generally be the same for the OPC but it is possible that since the OPC might be constant it could be inserted by the MTP.

5.2.2 *Service indicator and network indicator*

The 4 bit service indicator (SI) and 2 bit network indicator (NI) are included in the service information octet (SIO) and are used within an SP’s distribution function to determine the ‘‘User’’ the incoming message should be delivered to.

The SI will determine the ‘‘User’’, e.g., TUP, SCCP, ISUP and the NI will determine which network is concerned, e.g., international or national.

The NI will also in conjunction with the OPC/DPC determine whether a national or international signalling relation/routing is involved.

The NI, together with the standard 14 bit point code, allows for a max 16 **|** 84 point codes to be allocated in a signalling network.

5.3 *SCCP addressing*

Addressing within the SCCP of S.S. No. 7 makes use of three separate elements:

— DPC

— Global Title (GT)

— Sub-System Number (SSN)

One, two or all of the elements may be present in the Called and Calling Party Address, the main options are:

H.T. [T2.700]

GT DPC + SSN When transferring SCCP messages }	{
SSN GT SSN + GT When receiving messages from MTP }	{

{
DPC
DPC + (SSN or GT or both)
GT
GT + SSn
}
When receiving messages from connectionless or connection-orientated control for SCCP Routing.
}
	{

Table [T2.700], p.

The form of address used will depend on the service, application and underlying network.

5.3.1 *Global Title (GT)*

The Global Title (GT) may comprise of dialled digits or another form of address that will not be recognized in the S.S. No. 7 network, therefore, if the associated message requires to be routed over the S.S. No. 7 network, translation is required.

Translation of the GT will result in a DPC being produced and possibly also a new SSN and GT. A field is also included in the address indicator to identify the format of the global title.

5.3.2 *Destination Point Code (DPC)*

The DPC in an address requires no translation and will merely determine if the message is destined for that in SP (incoming message) or requires to be routed over the S.S. No. 7 signalling network via the MTP. For outgoing messages this DPC should be inserted in the MTP routing label. On an incoming message the DPC in the MTP routing label should correspond to the DPC in the called address.

5.3.3 *Subsystem Number (SSN)*

The SSN will identify a subsystem accessed via the SCCP within a node and may be a User Part, e.g., ISUP, SCCP management or an AE via TC. TC, however, will be invisible to the SCCP.

When examination of the DPC in an incoming message has determined that the message is for that SP, examination of the SSN will identify the concerned SCCP ‘‘User’’. The presence of an SSN without a DPC will also indicate a message which is addressed to that SP.

The SSN field has an initial capacity of 255 codes with an extension code for future requirements.

5.4 *User Part addressing*

5.4.1 *Telephone User Part addressing*

The Telephone User Part is capable of handling E.164 (incorporating E.163) addresses in the calling and called party address information elements.

5.4.2 *ISDN User Part addressing*

The ISDN User Part address structure is capable of handling E.164 addresses in the calling and called number, and re-directing address information elements.

5.4.3 *Signalling connection control part addresses*

The signalling connection control part is capable of handling E.164 (incorporating E.163), X.121, F.69, E.210, E.211, E.212, E.213, addresses, and the mobile hybrid E.214 address in the calling and called party address information elements.

The handling of OSI NSAP addresses in SCCP is for further study.

5.5 *Labelling*

A variety of methods to label signalling messages is used to allow the signalling system and users of the signalling system to relate a received message to a particular call or transaction.

For circuit-related messages, (e.g., on a simple telephone call), the TUP (and the ISUP) use the circuit identification code (CIC) to label the message.

For certain ISUP procedures, call reference are used to associate messages with calls.

SCCP also uses local references on connection oriented protocols.

Transaction capabilities use transaction and invoke identities to associate transaction messages and components respectively.

6 Operations administration and maintenance

6.1 *Management*

Management within S.S. No. 7 is partitioned into two main areas:

— Signalling network management;

— Signalling system management.

6.1.1 *Signalling network management*

These are functions contained within the MTP and SCCP which, by means of automatic procedures, maintain the required signalling network performance (e.g., changeover of faulty links, forced re-routing, subsystem availability, etc.).

6.1.2 *Signalling system management*

This may be considered as the actions taken by the operator (or by an external automatic mechanism) to maintain the signalling system performance when problems are identified.

6.1.3 *Signalling System No. 7 and TMN*

The TMN concept identifies CCITT S.S. No. 7 as a candidate to act as a data communications network (DCN) for some TMN functions. The protocols that will be needed for this purpose are intended to be defined as ASEs, as part of OMAP. This topic is for further study.

6.1.4 *Signalling System No. 7 and OSI management*

This subject is for further study.

6.2 *Maintenance and testing*

The maintenance administration and management functions of the signalling system themselves use the signalling system as a data carrying mechanism. When regarded in the data transport mode, however, any management or maintenance information is regarded as signalling traffic. Those functions having direct impact on S.S. No. 7 are included in OMAP Recommendation Q.795.

Testing within Signalling System No. 7 is:

— instigated automatically as a part of a signalling system management procedures (e.g., signalling route set test in MTP) or

— applied as a result of external activity, e.g., human-machine (MMI).

The first form is described in the appropriate Q.700 to Q.795 Recommendation dealing with MTP or SCCP, etc. The second form includes some MMI initiated procedures (initiation of MRVT (Q.795)), and also pre-in service testing using test cases specified in Recommendations for S.S. No. 7 tests (Q.780 to Q.783). A testing user part has been agreed to be necessary for pre-in service testing, this topic is for further study.

6.2.1 *Operations Maintenance and Administration Part (OMAP)*

Recommendation Q.795 provides procedures and protocols related to operations and maintenance information. These procedures and protocols use TCAP and are invoked by the system management application process (SMAP). Recommendation Q.795

includes the following:

— MTP Routing Verification Test (MRVT)

— SCCP Routing Verification Test (SRVT) — for further study

— Circuit Validation Test

The protocol for the MRVT contained in Q.795 forms part of the OMAP AE which in turn uses the services provided by transaction capabilities.

ASEs needed to support the TMN functions are for further study.

6.2.2 *Testing*

Test specifications for Signalling System No. 7 are contained in Recommendations Q.780-783 and cover MTP level 2, level 3 and the TUP together with an overview of testing.

A Testing User Part is for further study.

6.3 *CCITT S.S. No. 7 measurements*

Recommendation Q.791 specifies the monitoring and measurements appropriate to the MTP and SCCP.

7 Signalling system performance

The performance requirements of Signalling System No. 7 must take account of the performance requirements of the services that are being supported. Each functional component of Signalling System No. 7 has its performance criteria specified in a self-contained Recommendation. An overall performance target is specified in the form of a Hypothetical Signalling Reference Connection (HSRC).

7.1 *Hypothetical Signalling Reference Connection (HSRC)*

The HSRC for Signalling System No. 7 (Recommendation Q.709), identifies components that are used in a signalling relation between signalling end points, signalling points, signalling transfer points, and signalling points with SCCP relay functions, and gives the values for the signalling delays and unavailability parameters. The values used are derived from the figures contained in the individual performance Recommendations for MTP, TUP, SCCP and ISUP.

7.2 *MTP*

The MTP signalling performance requirements are specified in Recommendation Q.706. This Recommendation includes:

— the parameters route-set unavailability, MTP malfunction (loss of messages and mis-sequencing), and message transfer times;

— factors affecting performance, for example signalling traffic characteristics (e.g., loading potential, security, etc.) and parameters related to transmission characteristics (e.g., bit rates of signalling data links);

— those parameters which have greatest influence on the signalling network queueing delays for example, error control, security arrangements, failures and priorities.

It should be noted that management functions affect MTP performance.

7.3 *SCCP*

The SCCP signalling performance requirements are contained in Recommendation Q.716. Parameters identified are signal connection delays (establishment, unsolicited reset, reset and release signalling connection, reset and release failure probability, data message transmit delay, data message delay failure and error probability and SCCP unavailability).

It should be noted that management functions affect SCCP performance.

7.4 *TUP*

The TUP signalling performance requirements are contained in Recommendation Q.725. Parameters contained in this Recommendation are cross office performance for TUP supported circuit connection control application under normal and abnormal traffic loads. Also specified is the probability of failure of calls due to signalling malfunction.

7.5 *ISDN-UP*

The ISDN-UP signalling performance requirements are contained in Recommendation Q.766. Parameters contained in this Recommendation are cross office performance for ISDN-UP supported circuit connection control under normal and abnormal traffic loads. Also specified is the probability of failure of an ISDN call due to signalling function.

8 Flow control

Signalling System No. 7 in common with other transport mechanisms, needs to limit the input of data when congestion onset is detected. Failure to do so can create overload situations. The nature of CCITT S.S. No. 7 will lead to SP/STP overload congestion being spread through the signalling network if no action is taken. This will result in impaired signalling performance. In addition to signalling network congestion within a node, congestion will also require action to prevent signalling performance from deteriorating. There is thus a need for flow control within the signalling system to maintain the required signalling performance.

8.1 *Signalling network flow control*

This is achieved by incorporating a flow control mechanism in the MTP. On detection of congestion, MTP ''Users'' are informed by the means of a special primitive; the ''User'' should then reduce signalling traffic towards the congested part of the network. If the User is at a remote SP, the information is carried across the network in an appropriate signalling network management message.

8.2 *Signalling node (congestion) flow control*

In addition to network congestion, nodal congestion also requires the remedial action of flow control to prevent the signalling performance from being impaired. Nodal congestion can occur both within the MTP and the MTP ''User''.

8.2.1 *MTP nodal flow control*

A similar activity to that to combat signalling network congestion is required, i.e., on detection, the ''User'' is informed so that traffic can be reduced.

8.2.2 *''User'' flow control*

As well as taking action to reduce MTP congestion, mechanisms are also required within the User to detect the onset of congestion and to take appropriate action.

8.3 *Automatic congestion control*

The ISUP and TUP provide signalling procedures which aim to reduce the new calls offered to an exchange which is experiencing processor overload.

Automatic congestion control provides the means to inform adjacent exchanges of the current workload, and to request that only priority calls are offered to the exchange experiencing overload.

9 Compatibility mechanisms and rules in CCITT S.S. No. 7

9.1 *Modularity*

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

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

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

CCITT S.S. No. 7 is one common channel signalling system. However, as a consequence of its modularity and its intended use as a standard base for national applications the system may be applied in many forms. In general, to define the use of the system in a given national application, a selection of the CCITT specified functions must be made and the necessary additional national functions must be specified depending on the nature of the application.

CCITT S.S. No. 7 is an evolutionary signalling system which has undergone a number of enhancements. To allow ease of evolution it has been necessary to incorporate a number of compatibility mechanisms in various functional elements of CCITT No. 7, and to apply a number of compatibility rules to protocol enhancement. Detailed specification of the compatibility mechanisms in each functional element of CCITT S.S. No. 7 are given in the appropriate Q.700 to Q.795 Recommendations. Hence an overview is given in this Recommendation.

Compatibility rules which apply to all functional elements of CCITT S.S. No. 7 are detailed in the following text.

9.2 *Evolutionary requirements*

In application protocols (e.g., ISDN-UP, ASEs), the main evolutionary requirement is the ability to add new subscriber services, new administration and network services to the protocol.

In the SCCP and MTP, the evolutionary requirements are different in that initial versions provide basic transport functions which are generally stable. The main enhancements have been in the management protocols.

Although the evolutionary requirements are different across the elements of CCITT S.S. No. 7, it is possible to incorporate certain common mechanisms in the various functional elements.

9.3 *Forward and backward compatibility*

Compatibility mechanisms can be considered as being either:

— Forward compatibility mechanisms

— Backward compatibility rules

Forward compatibility mechanisms are defined as a scheme to enable a version of a protocol to communicate effectively and interwork with future versions of the protocol.

Backward compatibility rules are defined as a scheme to ensure that future versions of the protocol will be able to send protocol messages to the previous version which will be understood and fully processed by the node supporting the previous version.

9.4 *Compatibility rules for CCITT S.S. No. 7*

The following compatibility rules are applied to each element of CCITT S.S. No. 7 (e.g., ISDN-UP) when protocols are enhanced.

9.4.1 *Addition of a new value to an existing field (e.g., a cause value)*

New values to an existing field can be added. The processing of these new values at nodes supporting an earlier version of the protocol will be defined in their version specifications.

9.4.2 *Addition of a new parameter to an existing message*

Any new parameters added to an existing message must not be added as mandatory parameters. If a new parameter, must be added, and it must be a mandatory parameter, then a new message type must be created.

9.4.3 *Handling of unrecognized information*

When a new protocol, message or information element is created, a rule is required on a per message and information element basis, to define the action on receipt of unrecognized information. This rule needs to be applied to both unrecognized messages, unrecognized information elements within messages, and unrecognized values within recognized information elements.

The actions defined for receipt of an unrecognized message/information element could be:

— Discard message/information element.

— Discard/ignore information element within a recognized message.

— Default to a known general value (e.g., on receipt of an ISDN-UP IAM with an unrecognized calling party category could be defaulted to ‘‘Unknown’’).

— Send a ‘‘Confusion’’ message.

— Terminate the call/transaction.

— Information management.

9.4.4 *Increase in the length of optional parameters*

If a parameter is used as an optional parameter in all messages that it appears, the length of the parameter can be increased. The older version of the protocol would be able to function as it does today, assuming it ignores the extra bits or a suitable extension method has been defined. The newer version would have to check the length of the parameter to determine if the added information was present.

Protocols which use coding rules which are based on X.409 (e.g., TC) are not subject to this rule.

9.4.5 *Processing of messages with unrecognized SIO information*

To enable signalling points implemented to the Blue Book to interwork with signalling points implemented to earlier Recommendations when a message containing an unrecognized service information octet (see Q.704, § 14.2) is received, the message is discarded.

9.4.6 *Unacknowledged messages*

Where a function requires an acknowledgement to a message in order to continue, if no response is received the function sends the message for only a limited number of times. The sending signalling point should assume that the function is not available, and inform local management.

9.4.7 *Processing of spare fields*

For those CCITT S.S. No. 7 functions which define fields or sub-fields in signalling messages as spare or reserved, the following rules for processing of these fields apply.

At a node generating a signalling message, all spare and reserved fields are set to zero. At transit nodes, spare or reserved fields may be passed on transparently. At the destination node, the spare and reserved fields are not examined.

10 Glossary

A Glossary of terms in CCITT S.S. No. 7 is contained at the back of the Fascicles VI.7, VI.8 and VI.9.

BLANC

SECTION 2

MESSAGE TRANSFER PART (MTP)

Recommendation Q.701

FUNCTIONAL DESCRIPTION OF THE

MESSAGE TRANSFER PART (MTP) OF SIGNALLING SYSTEM No. 7

1 Introduction

1.1 *General*

The Message Transfer Part (MTP) provides the functions that enable User Part significant information passed to the MTP to be transferred across the Signalling System No. 7 network to the required destination. In addition, functions are included in the MTP to enable network and system failures that would affect the transfer of signalling information to be overcome. This constitutes a sequenced connectionless service for the MTP user.

The Message Transfer Part together with one of its ‘‘users’’, the Signalling Connection Control Part (SCCP), described in Recommendations Q.711-716, forms the Network Service Part (NSP).

The Network Service Part meets the requirement for Layer 3 services as defined in the OSI — Reference Model CCITT Recommendation X.200. The relationship of the MTP with this model and to other parts of S.S. No. 7 is described in Recommendation Q.700.

1.2 *Objectives*

The overall objectives of the Message Transfer Part are to provide the means for:

a) the reliable transport and delivery of ‘‘User Part’’ signalling information across the S.S. No. 7 network.

b) the ability to react to system and network failures that will affect a), and take the necessary action to ensure that a) is achieved.

The ‘‘Users’’ of MTP are the SCCP, Telephone User Part (TUP) [Recommendation Q.721-725 Data User Part (DUP) [Recommendation Q.741] and ISDN User Part (ISUP) [Recommendation Q.761-766]. The MTP Testing User Part is for further study.

1.3 *General characteristics*

1.3.1 *Method of description*

— functions provided by each level within the MTP

— services provided by the MTP

— interaction with the signalling network

— interaction with the MTP ‘‘User’’

— the message transfer capability of the MTP

The functions of each level of the MTP are performed by means of the level protocol between two systems which provides a ‘‘level service’’ to the upper levels, (i.e., Level 1 Signalling Data Link, Level 2 Signalling Link and Level 3 Signalling network) as described in Recommendations Q.702, 703 and 704 respectively.

The service interface to the Level 4 ‘‘User’’ of MTP is described by means of primitives and parameters.

1.3.2 *Primitives*

Primitives consist of commands and their respective responses associated with the services requested of the SCCP and of the MTP, see Figure 1/Q.701. The general syntax of a primitive is shown below:

H.T. [T1.701]

X	Generic name	Specific name	Parameter

Table [T1.701], p.

— ‘‘X’’ designates the functional block providing the service (‘‘MTP’’ for MTP).

— ‘‘Generic name’’ describes the action that should be performed by the addressed layer.

— ‘‘Specific name’’ indicates the direction of the primitive flow.

— ‘‘Parameters’’ are the elements of information which are to be transmitted between layers.

Four Specific Names exist in general:

— request

— indication

Not all generic names contain all four specific names (Figure 2/Q.701).

— response

— confirmation

Figure 1/Q.701, p.

Figure 2/Q.701, p.

Primitives and parameters of the Messsage Transfer Part service are listed and described in Section 8 of this Recommendation.

1.3.3 *Peer-to-peer communication*

Exchange of information between two peers of the MTP is performed by means of a protocol. The protocol is a set of rules and formats by which the control information and MTP ‘‘User’’ data is exchanged between the two peers. The protocol caters for

— the transfer of ‘‘User’’ data in Message Signal Units (MSUs);

— level 2 control by use of Link Status Signal Units (LSSUs);

— testing and maintenance of signalling links by means of the signalling link test message carried in an MSU.

1.3.4 *Contents of Recommendations Q.701 to Q.707 Series relating to the MTP*

Recommendation Q.701 contains a functional description and overview of the Message Transfer Part of CCITT S.S. No. 7.

Recommendation Q.702 details the requirements of a signalling data link to support CCITT S.S. No. 7.

Recommendation Q.703 describes the signalling link functions.

Recommendation Q.704 describes signalling network functions and messages.

Recommendation Q.706 defines and specifies values for MTP performance parameters.

Recommendation Q.707 describes the testing and maintenance functions applicable to the MTP.

2 Signalling system structure

2.1 *Basic functional division*

The fundamental principle of the signalling system structure is the division of functions into a common Message Transfer Part (MTP) on one hand and separate User Parts for different users on the other. This is illustrated in Figure 3/Q.701.

Figure 3/Q.701 p.

The overall function of the Message Transfer Part is to serve as a transport system providing reliable transfer of signalling messages between the locations of communicating user functions.

The term *user* | in this context refers to any functional entity that utilizes the transport capability provided by the Message Transfer Part. A User Part comprises those functions of, or related to, a particular type of user that are part of the common channel signalling system, typically because those functions need to be specified in a signalling context.

The basic commonality in signalling for different services resulting from this concept is the use of a common transport system, i.e., the Message Transfer Part. Also, a degree of commonality exists between certain User Parts, e.g., the Telephone User Part (TUP) and the Data User Part (DUP).

2.2 *Functional levels*

2.2.1 *General*

As a further separation, the necessary elements of the signalling system are specified in accordance with a level concept in which:

— the functions of the Message Transfer Part are separated into three functional levels, and

— the User Parts constitute parallel elements at the fourth functional level.

The level structure is illustrated in Figure 4/Q.701. The system structure shown in Figure 4/Q.701 is not a specification of an implementation of the system. The functional boundaries B, C and D may or may not exist as interfaces in an implementation. The interactions by means of controls and indications may be direct or via other functions. However, the structure shown in Figure 4/Q.701 may be regarded as a possible model of an implementation.

2.2.2 *Signalling data link functions (level 1)*

Level 1 defines the physical, electrical and functional characteristics of a signalling data link and the means to access it. The level 1 element provides a bearer for a signalling link.

In a digital environment, 64-kbit/s digital paths will normally be used for the signalling data link. The signalling data link may be accessed via a switching function, providing a potential for automatic reconfiguration of signalling links. Other types of data links, such as analogue links with modems, can also be used.

The detailed requirements for signalling data links are specified in Recommendation Q.702.

Figure 4/Q.701, p.17

2.2.3 *Signalling link functions (level 2)*

Level 2 defines the functions and procedures for and relating to the transfer of signalling messages over one individual signalling data link. The level 2 functions together with a level 1 signalling data link as a bearer provides a signalling link for reliable transfer of signalling messages between two points.

A signalling message delivered by the higher levels is transferred over the signalling link in variable length *signal units* . For proper operation of the signalling link, the signal unit comprises transfer control information in addition to the information content of the signalling message.

The signalling link functions include:

— delimitation of signal unit by means of flags;

— flag imitation prevention by bit stuffing;

— error detection by means of check bits included in each signal unit;

— error correction by retransmission and signal unit sequence control by means of explicit sequence numbers in each signal unit and explicit continuous acknowledgements;

— signalling link failure detection by means of signal unit error rate monitoring and signalling link recovery by means of special procedures.

The detailed requirements for signalling link functions are given in Recommendation Q.703.

2.2.4 *Signalling network functions (level 3)*

Level 3 in principle defines those transport functions and procedures that are common to and independent of the operation of individual signalling links. As illustrated in Figure 4/Q.701 these functions fall into two major categories:

a) signalling message handling functions — these are functions that, at the actual transfer of a message, direct the message to the proper signalling link or User Part;

b) signalling network management functions — these are functions that, on the basis of predetermined data and information about the status of the signalling network, control the current message routing and configuration of signalling network facilities. In the event of changes in the status they also control reconfigurations and other actions to preserve or restore the normal message transfer capability.

The different level 3 functions interact with each other and with the functions of other levels by means of indications and controls as illustrated in Figure 4/Q.701. This figure also shows that the signalling network management as well as the testing and maintenance actions may include exchange of signalling messages with corresponding functions located at other signalling points. Although not User Parts these parts of level 3 can be seen as serving as ‘‘User Parts of the Message Transfer Part’’. As a convention in these specifications, for each description, general references to User Parts as sources or sinks of a signalling message implicitly include these parts of level 3 unless the opposite is evident from the context or explicitly stated.

A description of the level 3 functions in the context of a signalling network is given in § 3 below. The detailed requirements for signalling network functions are given in Recommendation Q.704. Some means for testing and maintenance of the signalling network are provided and the detailed requirements are given in Recommendation Q.707.

2.2.5 *User Part functions (level 4)*

Level 4 consists of the different User Parts. Each User Part defines the functions and procedures of the signalling system that are particular to a certain type of user of the system.

The extent of the User Part functions may differ significantly between different categories of users of the signalling system, such as:

— users for which most user communication functions are defined within the signalling system. Examples are telephone and data call control functions with their corresponding Telephone and Data User Parts;

— users for which most user communication functions are defined outside the signalling system. An example is the use of the signalling system for transfer of information for some management or maintenance purpose. For such an ‘‘external user’’ the User Part may be seen as a ‘‘mailbox’’ type of interface between the external user system and the message transfer function in which, for example, the user information transferred is assembled and disassembled to/from the applicable signalling message formats.

2.3 *Signalling message*

A signalling message is an assembly of information, defined at level 3 or 4, pertaining to a call, management transaction, etc., that is transferred as an entity by the message transfer function.

Each message contains *service information* | ncluding a *service indicator* | dentifying the source User Part and possibly additional information such as an indication whether the message relates to international or national application of the User Part.

The *signalling information* | f the message includes the actual user information, such as one or more telephone or data call control signals, management and maintenance information, etc., and information identifying the type and format of the message. It also includes a *label* | hat provides information enabling the message:

— to be routed by the level 3 functions and through a signalling network to its destination; and

— to be directed at the receiving User Part to the particular circuit, call, management or other transaction to which the message is related.

On the signalling link, each signalling message is packed into Message Signal Units (MSUs) which also includes transfer control information related to the level 2 functions of the link.

2.4 *Functional interface*

The following functional interface between the Message Transfer Part and the User Parts can be seen as a model illustrating the division of functions between these parts. The interface (see Figure 5/Q.701) is purely functional and need not appear as such in an implementation of the system.

Figure 5/Q.701, p.

The main interaction between the Message Transfer Part and the User Parts is the transfer of signalling messages across the interface, each message consisting of service information and signalling information as described above. Message delimitation information is also transferred across the interface with the message.

In addition to the transfer of messages and associated information, the interaction may also include flow control information, e.g., an indication from the Message Transfer Part that it is unable to serve a particular destination.

A description of the characteristics of the Message Transfer Part as seen from the functional interface and the requirements to be met by potential users of the message transfer function is given in § 4.

3 Message transfer part and the signalling network

3.1 *General*

Since the Message Transfer Part forms the interface at a node with the rest of the signalling network, the signalling network will have significant impact on the MTB. The MTP must however be independent of the signalling network in that it has to be capable of performing its set functions and attaining its objectives no matter what network structure or status prevails.

The MTP has therefore to contain the necessary functions to ensure any impact that the network has does not impair MTP performance.

3.1.1 *Signalling network components*

A full description of signalling network components is contained in Recommendation Q.700, the components that must be considered by the MTP are:

— signalling points (including signalling transfer points);

— signalling relations between two signalling points;

— signalling links;

— signalling link sets (including link groups);

— signalling routes;

— signalling route-sets.

3.1.2 *Signalling modes*

Signalling modes are described in Recommendations Q.700 and Q.705 (signalling network structures). The modes applicable to CCITT S.S. No. 7 MTP are:

— associated mode;

— quasi-associated mode.

3.1.3 *Signalling point modes*

A signalling point can be an originating point, a destination point or a signalling transfer point in a signalling relation. All three modes must be considered in the MTP.

3.1.4 *Message labelling*

Each message contains a label. In the standard label the portion that is used for routing is called the *routing label* . This routing label includes:

a) explicit indications of destination and originating points of the message, i.e., identification of the signalling relation concerned;

b) a code used for load sharing which may be the least significant part of a label component that identifies a user transaction at level 4.

The standard routing label assumes that each signalling point in a signalling network is allocated a code according to a code plan, established for the purpose of labelling, that is unambiguous within its domain. Messages labelled according to international and national code plans are discriminated by means of an indication in the service information octet included in each message.

The standard routing label is suitable for national applications also. However, the signalling system includes the possibility for using different routing labels nationally.

3.2 *Signalling message handling functions*

Figure 6/Q.701 illustrates the signalling message handling functions.

Figure 6/Q.701, p.

3.2.1 *Message routing*

Message routing | is the process of selecting, for each signalling message to be sent, the signalling link to be used. In general, message routing is based on analysis of the routing label of the message in combination with predetermined routing data at the signalling point concerned.

Message routing is destination-code dependent with typically an additional load-sharing element allowing different portions of the signalling traffic to a particular destination to be distributed over two or more signalling links. This traffic distribution may be limited to different links within a link set or applied to links in different link sets.

Each succession of signalling links that may be used to convey a message from the originating point to the destination point constitutes a *message route* . A signalling route is the corresponding concept for a possible path referring to a succession of link sets and signalling transfer points, between a given signalling point and the destination point.

In Signalling System No. 7, message routing is made in a manner by which the message route taken by a message with a particular routing label is predetermined and, at a given point in time, fixed. Typically, however, in the event of failures in the signalling network, the routing of messages, previously using the failed message route, is modified in a predetermined manner under control of the signalling traffic management function at level 3.

Although there are in general advantages in using a uniform routing of messages belonging to different User Parts, the service indicator included in each message provides the potential for using different routing plans for different User Parts.

3.2.2 *Message distribution*

Message distribution | is the process which, upon receipt of a message at its destination point, determines to which User Part or level 3 function the message is to be delivered. This choice is made on analysis of the service indicator.

3.2.3 *Message discrimination*

Message discrimination | is the process which, upon receipt of a message at a signalling point, determines whether or not the point is the destination point of that message. This decision is based on analysis of the destination code in the routing label in the message. If the signalling point is the destination point the message is delivered to the message distribution function. If it is not the destination point, and the signalling point has the transfer capability, the message is delivered to the routing function for further transfer on a signalling link.

3.3 *Signalling network management functions*

Figure 6/Q.701 illustrates the signalling network management functions.

3.3.1 *Signalling traffic management*

The tasks of the *signalling traffic management* | function are:

a) to control message routing; this includes modification of message routing to preserve, when required, accessibility of all destination points concerned or to restore normal routing;

b) in conjunction with modifications of message routing, to control the resulting transfer of signalling traffic in a manner that avoids irregularities in message flow;

c) flow control.

Control of message routing is based on analysis of predetermined information about all allowed potential routing possibilities in combination with information, supplied by the *signalling link management* | nd *signalling route management* | unctions, about the status of the signalling network (i.e., current availability of signalling links and routes).

Changes in the status of the signalling network typically result in modification of current message routing and thus in transfer of certain portions of the signalling traffic from one signalling link to another. The transfer of signalling traffic is performed in accordance with specific procedures. These procedures — *changeover, changeback, forced rerouting and controlled rerouting* — are designed to avoid, as far as the circumstances permit, such irregularities in message transfer as loss, mis-sequencing or multiple delivery of messages.

The changeover and changeback procedures involve communication with other signalling point(s). For example, in the case of changeover from a failing signalling link, the two ends of the failing link exchange information (via an alternative path) that normally enables retrieval of messages that otherwise would have been lost on the failing link. However, as further explained later, these procedures cannot guarantee regular message transfer in all circumstances.

A signalling network has to have a signalling traffic capacity that is higher than the normal traffic offered. However, in overload conditions (e.g., due to network failures or extremely high traffic peaks) the signalling traffic management function takes flow control actions to minimize the problem. An example is the provision of an indication to the local user functions concerned that the Message Transfer Part is unable to transport messages to a particular destination in the case of total breakdown of all signalling routes to that destination point. If such a situation occurs at a signalling transfer point, a corresponding indication is given to the signalling route management function for further dissemination to other signalling points in the signalling network.

3.3.2 *Signalling link management*

The task of the signalling link management function is to control the locally connected link sets. In the event of changes in the availability of a local link set it initiates and controls actions aimed at restoring the normal availability of that link set.

The signalling link management function also supplies information about the availability of local links and link sets to the signalling traffic management function.

The signalling link management function interacts with the signalling link function at level 2 by receipt of indications of the status of signalling links. It also initiates actions at level 2 such as, for example, initial alignment of an out-of-service link.

The signalling system can be applied with different degrees of flexibility in the method of provision of signalling links. A signalling link may for example consist of a permanent combination of a signalling terminal device and a signalling data link. It is also possible to employ an arrangement in which any switched connection to the remote end may be used in combination with any local signalling terminal device. It is the task of the signalling link management function in such arrangements to initiate and control reconfigurations of terminal devices and signalling data links to the extent such reconfigurations are automatic. In particular, this involves interaction, not necessarily direct, with a switching function at level 1.

3.3.3 *Signalling route management*

Signalling route management is a function that relates to the quasi-associated mode of signalling only. Its task is to transfer information about changes in the availability of signalling routes in the signalling network to enable remote signalling points to take appropriate signalling traffic management actions. Thus a signalling transfer point may, for example, send messages indicating inaccessibility of a particular signalling point via that signalling transfer point, thus enabling other signalling points to stop routing messages to an incomplete route.

3.4 *Testing and maintenance functions*

Figure 6/Q.701 illustrates that the signalling system includes some standard testing and maintenance functions that use level 3 messages. Furthermore, any implementation of the system typically includes various implementation-dependent means for testing and maintenance of equipment concerned with the other levels.

3.5 *Use of the signalling network*

3.5.1 *Signalling network structure*

The signalling system may be used with different types of signalling network structures. The choice between different types of signalling network structures may be influenced by factors such as the structure of the telecommunication network to be served by the signalling system and administrative aspects.

In the case when the provision of the signalling system is planned purely on a per-signalling relation basis, the likely result is a signalling network largely based on associated signalling, typically supplemented by a limited degree of quasi-associated signalling for low volume signalling relations. The structure of such a signalling network is mainly determined by the patterns of the signalling relations. International signalling is an example of an application for which this approach is suitable.

Another approach is to consider the signalling network as a common resource that should be planned according to the total needs for common channel signalling. The high capacity of digital signalling links in combination with the need for redundancy for reliability, typically leads to a signalling network based on a high degree of quasi-associated signalling with some provision for associated signalling for high-volume signalling relations. The latter approach to signalling network planning is more likely to allow exploitation of the potential of common channel signalling to support network features that require communication for purposes other than the switching of connections.

Further considerations about the use of a signalling network are given in Recommendation Q.705.

3.5.2 *Provision of signalling facilities*

In general, the most important factor in the dimensioning of the signalling network is the need for reliability by means of redundancy. Depending on the signalling network structure and the potential for reconfiguration of signalling equipment, the required redundancy may be provided by different combinations of:

— redundancy in signalling data links (e.g., nominated reserves or switched connections);

— redundancy in signalling terminal devices (e.g., a common pool of terminals for the whole signalling point);

— redundancy of signalling links within a link set (typically operating with load sharing);

— redundancy in signalling routes for each destination (possibly operating with load sharing).

The loading capacity of a digital signalling link is high in relation to the signalling traffic generated for call control signalling. Therefore, in many typical applications the links will be lightly loaded and signalling traffic volume will be a secondary factor in the dimensioning of the signalling network. However, in high signalling traffic applications or when analogue links with lower speeds are used, it may be necessary to dimension the traffic capacity by provision of additional signalling links. The message routing principles adopted for the signalling system allow partitioning of the total signalling traffic into different portions based on load sharing, destination point code and service information. Such partitioning provides a useful means of controlling the load and dimensioning of the capacity of different sections of a signalling network as it allows distribution of different portions of the signalling traffic. It can also be used to dedicate certain parts of a signalling network to signalling traffic related to a particular user.

3.5.3 *Application of signalling network functions*

The signalling network functions provided by the signalling system are designed to cater for a range of signalling network configurations. It is

not necessary that all of those functions be present at all signalling points. The necessary functional content at level 3 at a particular signalling point depends for example on what signalling mode(s) are used, whether or not it is a signalling transfer point, what type of signalling equipment redundancy is employed, etc. It is thus feasible to implement level 3 functions with modularity for different capabilities corresponding to different signalling network configurations. As a special case, it is even possible to apply the signalling system without using the level 3 element at all, e.g., in a small exchange or private automatic branch exchange which can only be reached via one primary pulse code modulation system.

4 Message transfer capability

4.1 *General*

The Message Transfer Part recommendations specify methods by which different forms of signalling networks can be established. The requirements for the Message Transfer Part have been determined primarily by the requirements of call control signalling for the telephone and circuit switched data transmission services. However, the Message Transfer Part is also intended to have the ability to serve as a transport system for other types of information transfer. The following summarises the typical characteristics of the transport service that may be offered by the Message Transfer Part to a potential user of this ability.

All information to be transferred by the Message Transfer Part must be assembled into messages. The linking of the source and sink of a message is inherent in the label in combination with the signalling routes existing between the two locations. From a transportation point of view each message is self-contained and handled individually. The nature of the transport service offered by the Message Transfer Part is therefore similar to that offered by a packet switched network. In addition, all messages containing the same label constitute a set of messages that is handled in a uniform manner by the Message Transfer Part, thus ensuring, in normal circumstances, regular delivery in the correct sequence.

4.2 *User location in system structure*

A potential user of the transport service is typically included in the system structure by provision of a separate User Part. This requires allocation of a service indicator code, the specification of which is part of both the Message Transport Part and User Part concerned.

As an alternative, a potential user may be catered for, together with other similar users, by an already existing or new User Part. In such a case the discrimination between messages belonging to this potential user and the other similar users is an internal matter within the User Part concerned. It then follows that all messages belonging to such a User Part are necessarily handled, e.g., as regards routing, in a uniform manner by the Message Transfer Part.

4.3 *Message content*

4.3.1 *Code transparency*

Information with any code combination generated by a user can be transferred by the Message Transfer Part provided that the message respects the requirements described below.

4.3.2 *Service information*

Each message must contain service information coded in accordance with the rules specified in Recommendation Q.704, § 14.

4.3.3 *Message label*

Each message must contain a label consistent with the routing label of the signalling network concerned. See also Recommendation Q.704, § 2.

4.3.4 *Message length*

The information content of a message should be an integral number of octets.

The total amount of signalling information transferable in one message is limited by some parameters of the signalling system; the signalling system can accept transfer of user information blocks in the order of 256 octets in single messages.

Depending on the signalling traffic characteristics of a user and of other users sharing the same signalling facilities, there may be a need to limit message lengths below the system limit based on queueing delay considerations.

In the case when information blocks generated by a user function exceed the allowed message length, it is necessary to implement means for segmentation and blocking of such information blocks within the User Part concerned.

4.4 *User accessibility*

The accessibility of user functions through a signalling network depends on the signalling modes and routing plan employed in that network.

In the case when only the associated mode of signalling is employed, only user functions located at adjacent signalling points may be accessed.

In the case when quasi-associated signalling is employed, user functions located at any signalling point may be accessed provided that the corresponding message routing data is present.

4.5 *Transport service performance*

Further detailed information is provided in Recommendation Q.706.

4.5.1 *Message transfer delay*

The normal delay for transfer of messages between user locations depends on factors such as distance, signalling network structure, signalling data link type and bit rate and processing delays.

A small proportion of messages will be subject to additional delay because of transmission disturbances, network failures, etc.

4.5.2 *Message transfer failures*

The Message Transfer Part has been designed to enable it to transfer messages in a reliable and regular manner even in the presence of network failures. However, inevitably some failures will occur the consequences of which cannot be avoided with economic measures. The types of failures

that may occur and some typical probabilities of their occurrence are described below. Recommendation Q.706 provides further detailed information that can be used to estimate failure rates for particular cases.

In the case when a potential user function requires a reliability of the transport service that cannot be guaranteed by the Message Transfer Part, the reliability of that user may be enhanced by adoption of appropriate level 4 procedures, possibly including some means of supplementary end-to-end error control.

The following types of message transfer failures are possible, and the expected probabilities for such failures in typical applications are indicated (see also Recommendation Q.706).

a) Unavailability of the transport service to one or more locations — the availability of the message transfer capability depends on the redundancy provided in the signalling network; the availability can therefore be dimensioned.

b) Loss of messages — the probability of loss of messages mainly depends on the reliability of signalling equipment; typically it is expected to be lower than 10^{D}lF261^{7}.

c) Mis-sequencing of messages — may in certain configurations of quasi-associated signalling occur with rare combinations of independent failures and disturbances. The probability, in such configurations, of a message being delivered out-of-sequence depends on many factors but is expected to be lower than 10^{D}lF261^{10}.

d) Delivery of false information — undetected errors may lead to the delivery of false information; the possibility of an error in a message delivered is expected to be lower than 10^{D}lF261^{10}.

5 Differences from the Red Book

The ongoing development of the MTP during this study period has resulted in a number of differences occurring between the Recommendations as documented in the Red Book and these current Recommendations (Blue Book). In order to limit interworking problems, a backwards compatibility mechanism is required (see § 6). As an initial step towards producing such a mechanism, this section identifies the new items and items changed because of operational considerations, that have been included in the Blue Book. This section does not consider editorial or technical corrections.

5.1 *Signalling Information Field length*

The maximun length of the Signalling Information Field has been increased to 272 octets. This was previously a National only option. Networks using both signalling terminals with 62 octet maximum SIF length handling capability and signalling terminals with 272 octet maximum SIF length handling capability must ensure that messages with SIFs longer than 62 octets cannot be routed to signalling links that are unable to handle them (see § 7).

5.2 *Signalling Point Restart*

The Signalling Point Restart procedure (see Q.704 § 9) has been included together with a definition of Signalling Point availability. This procedure allows a graceful increase in message traffic at a restarting Signalling Point.

5.3 *Management Blocking*

The Management Blocking procedure for Signalling links has been deleted. No interworking problems are foreseen in networks where some Signalling Points still incorporate this procedure and others are implemented in accordance with the Blue Book.

5.4 *Signalling Link Test*

The Signalling Link Test has been enhanced to check that both ends of the link agree as to which signalling link is being tested. No interworking problems are foreseen (see Q.707 § 2.2).

5.5 *Compatibility mechanism*

General principles have been incorporated in the Message Transfer Part that will allow implementations to the Blue Book to be compatible with implementations to Red/Yellow Books and future issues of the Recommendations (see § 6).

5.6 *Timer values*

The values of existing Q.703 and Q.704 Timers have been finalized (see § 7).

5.7 *Processor Outage*

The actions related to Processor Outage have been clarified (see Q.703 § 8 and Q.704 § 4, 5 and 6). No interworking problems are foreseen.

5.8 *User flow control*

Procedures for Message Transfer Part User Flow Control have been adopted for use at a Signalling Point when an MTP user has become unavailable (see Q.704 § 11 and Q.701 § 7).

5.9 *Management Inhibiting and Management Inhibiting test procedure*

The time-controlled changeover procedure is now used to divert traffic from a management inhibited link.

To verify the inhibited status of a link, test procedures have been introduced into management inhibiting (see Q.704 § 10 and Q.701 § 7).

5.10 *Signalling point/signalling transfer point congestion*

Procedures to detect and handle signalling point/signalling transfer point congestion have now been identified (see Q.704 § 11.2.6). No interworking problems are foreseen.

6 Compatibility in the message transfer part

To enable implementations of Signalling System No. 7 to this issue (Blue Book) of the Recommendations to achieve compatibility with implementations to other issues, e.g., Yellow, Red and 1992 Books, a set of appropriate procedures and guidelines has been concluded in Recommendation Q.700. This section identifies the action that is required within the Message Transfer Part to ensure both forward and backwards compatibility. The areas considered are the treatment of spare fields, spare values, lack of acknowledgements and unreasonable information.

6.1 *Unreasonable Information*

The following actions occur in the MTP when messages are received containing unreasonable information.

6.1.1 *Messages containing an unallocated SIO value*

When messages containing an unallocated SIO value are received at either a terminating Signalling Point or an STP that employs message routing based on both DPC and SIO, they should be discarded. If required, a report should be made to management.

6.1.2 *Messages containing an unallocated H0/H1 code*

When messages containing an unallocated H0/H1 code are received at the appropriate functional block within the MTP, they are discarded. There should be no impact on any protocol and, if required, a report should be made to management.

6.1.3 *Messages containing an unallocated value in a recognized field*

When massages are received at an owning function within the MTP containing a field with an unallocated value they are discarded and, if required, a report made to management. There should be no impact on any current protocol.

(An owning function is a function to which a received message pertains.)

6.2 *Treatment of spare fields*

The MTP will handle spare fields in MTP messages in the following manner:

i) Spare fields are set to zero on message creation, and are not examined on reception at the destination owning function.

ii) Spare subfields are set to zero on message creation, and are not examined on reception at the destination owning function.

iii) Implementations of the STP function should transit all messages unchanged, including spare fields and spare subfields.

6.3 *Lack of acknowledgement*

Should a message that requires an acknowledgement not receive one within a specified time, the message will be repeated, unless the protocol specifies otherwise. However, subsequent failures to receive the acknowledgement should not cause indefinite repeat attempts.

7 Interworking of Yellow, Red and Blue MTP implementations

There have been a number of changes introduced into this issue (Blue Book) of Recommendations Q.701-707 from the previous issue (Red Book). The changes have been identified in § 5 and although in the majority of cases there will be no interworking problems between a Signalling Point/STP implemented to the Red Book and one implemented to a Blue Book, there are some instances where problems will arise. This section gives guidance on the appropriate action that can be taken in the MTP to overcome interworking problems and also considers Yellow to Red Book and Yellow to Blue Book interworking.

7.1 *Yellow Book to Red Book interworking*

There were four areas where changes from the Yellow Book to the Red Book introduced interworking problems:

i) Level 2 flow control, LSSU SIB introduced.

ii) Transfer Restricted (TRF) and Transfer Controlled (TFC) messages and procedures were introduced into the Red Book.

iii) Transfer Allowed (TAA) and Transfer Prohibited (TPA) acknowledgements were deleted from the Red Book.

iv) Management inhibiting procedures were introduced into the Red Book.

The suggested action required at the Yellow and/or Red Book SP/STP to enable interworking is contained in the following point items.

7.1.1 *Level 2 Flow control*

The Red Book SP/STP should apply normal level 2 flow control action (i.e., acknowledgements are withheld and SIBs sent). The Yellow Book SP/STP should ignore the LSSU SIB when received. It is recognized that although flow control is not performed in this case, interworking is possible. However, a possible option would be to set the congestion threshold at the Red Book SP/STP, such that flow control is not triggered on that signalling relation.

7.1.2 *Transfer restricted and Transfer controlled procedures*

The Yellow Book SP/STP should ignore TFR and TFC messages when received.

7.1.3 *Transfer allowed/Transfer prohibited acknowledgements*

The Yellow Book SP/STP should limit the repetition of the TFA/TFP message to once only. The Red Book SP/STP should ignore the acknowledgement messages when they are received.

7.1.4 *Management inhibiting procedure*

The Yellow Book SP/STP should ignore the Link Inhibit (LIN) and Link Uninhibit (LUN) messages when received. The Red Book SP/STP should limit the repetition of the LIN/LUN message.

7.2 *Red Book to Blue Book interworking*

The changes in this issue (Blue Book) from the Red Book Q.701-707 Recommendations are identified in § 5. There are five areas where changes have resulted in interworking problems:

i) Signalling Point Restart procedure has introduced the Traffic Restart Allowed (TRA) message.

ii) Timer values have been confirmed in this issue, previous values were provisional.

iii) User Flow Control procedure has introduced the User Part Unavailable (UPU) message.

iv) Signalling Information Field length increase will require action to prevent overlength messages being sent on a link that is not capable of handling them.

v) Management-inhibiting test procedure has introduced Link Local inhibit test message (LLT) and Link Remote inhibit test message (LRT).

The suggested actions required at the Red and/or Blue Book SP/STP to enable interworking are contained in the following point items.

7.2.1 *Signalling Point Restart*

The Red Book SP/STP should ignore the Traffic Restart Allowed messages when received.

7.2.2 *Q.703 and Q.704 timer values*

Where possible, an SP/STP implemented to the Red Book should adopt the timer values specified in the Blue Book when interworking with a Blue Book SP/STP. For timer values (see Q.703 § 12 and Q.704 § 16).

7.2.3 *User flow control*

The Red Book SP/STP should ignore the User Part Unavailable (UPU) message if received.

7.2.4 *Management inhibit test procedure*

The Red Book SP/STP should ignore the Link Local inhibit test (LLT) and Link Remote inhibit test (LRT) messages. A report to local management should also be made.

7.2.5 *SIF length increase*

The SP/STP with 272 octet SIF length handling capability should prevent overlength messages from being routed over signalling links that only have a 62 octet SIF handling capability.

7.2.6 *SIF length increase (National networks option)*

In the international Signalling System No. 7 network, it should be possible to identify signalling links/routes with a limited SIF length handling capability and prevent overlength messages being transmitted over them by administrative action based on the exchange of operational data. However, with some national networks due to the rapid change in status of SP/STP

implementation level (e.g., 62 to 272 SIF capability) and the number of SP/STPs in the network, this administrative action and data exchange may not be adequate. In this situation, a mechanism based on the following MTP activities may be more appropriate.

i) Detection of a link with 272 SIF capability may be achieved by coding the ‘‘D’’ bit of LSSUs sent during alignment as 1 (with 62 octet SIF links it would be 0). On receipt of this LSSU, a Blue Book SP/STP would mark the link/route as having 272 SIF capability. A Red Book SP/STP would ignore the coding of the ‘‘D’’ bit and treat the LSSU in the normal manner.

ii) When a Blue Book SP/STP receives a message for onward routing, it will check if the message (SIF) is greater than 62 octets. If the SIF is greater than 62 octets, it will verify that the link/route can handle a message of this length. Should the link/route not have the SIF length capability, the message will be discarded and an indication sent to the message origin. A Red Book SP/STP should not receive a message with an SIF > 62 octets.

iii) If the message originator is a local MTP User, an MTP PAUSE primitive will be returned by the MTP in response to an overlength message (see § 8). Should the originator be at a remote SP, a TFA coded to indicate that only 62 octet SIF messages can be transferred will be returned by the MTP in response to an overlength message (see Q.704 § 15).

In national networks using an SIF compatibility mechanism, the two spare bits in the TFA (see Q.704 § 15.8.2) may be coded as an SIF compatibility indicator as follows:

bit B A	
0 0	Allow 62 octet SIFs/Prohibit 272, X and Y octet SIFs
0 1	Allow 62 and 272 octet SIFs/Prohibit X and Y octet SIFs
1 0	Allow 62, 272 and X octet SIFs Prohibit Y octet SIFs.
1 1	Allow 62, 272, X and Y octet SIFs.

Note — 272 < X < Y octets, the values of X and Y are for further study.

7.3 *Yellow Book to Blue Book Interworking*

The changes between Yellow and Blue Books have taken place in two stages: Yellow to Red and Red to Blue. Therefore, to achieve interworking between Yellow and Blue Book implementations, the actions specified in §§ 7.1 and 7.2 should be applied. In § 7.1 Red Book SP/STP should be read as Blue Book SP/STP and in § 7.2 Red Book SP/STP should be read as Yellow Book SP/STP.

There is one change from the Red Book in the Blue Book that will have an additional impact on interworking with the Yellow Book, and that is the deletion of the blocking procedure. This means that while a Yellow Book implementation can block a signalling link, a Blue Book node can neither inhibit nor block the link in the opposite direction.

8 Primitives and Parameters of the Message Transfer Part

The primitives and parameters are shown in Table 1/Q.701.

H.T. [T2.701]

TABLE 1/Q.701

Message transfer part service primitives

Primitives Generic Name	Specific Name	Parameters
MTP-TRANSFER OPC (see Q.704 § 2.2) DPC (see Q.704 § 2.2) SLS (see Q.704 § 2.2) (Note 1) SIO (see Q.704 § 14.2) User data (see Q.703 § 2.3.8) }	Request Indication	{
MTP-PAUSE (Stop)	Indication	Affected DPC
MTP-RESUME (Start)	Indication	Affected DPC
MTP-STATUS Affected DPC Cause (Note 2)	Indication	

Note 1 — The MTP users should take into account that this parameter is used for load sharing by the MTP, therefore, the SLS values should be distributed as equally as possible. The MTP guarantees (to a high degree of probability) an in-sequence delivery of messages which contain the same SLS code.

Note 2 — The Cause parameter has, at present, two values:

i) *Signalling network congested (level)*

This parameter value is included if national options with congestion priorities and multiple signalling link states without congestion priorities as in Recommendation Q.704 are implemented.

ii) *Remote User unavailable.*

Table 1/Q.701 [T2.701], p.

8.1 *Transfer*

The primitive ‘‘MTP-TRANSFER’’ is used between level 4 and level 3 (SMH) to provide the MTP message transfer service.

8.2 *Pause*

The primitive ‘‘MTP-PAUSE’’ indicates to the ‘‘Users’’ the total inability of providing the MTP service to the specified destination.

8.3 *Resume*

The primitive ‘‘MTP-RESUME’’ indicates to the ‘‘User’’ the total ability of providing the MTP service to the specified destination.

This primitive corresponds to the destination accessible state as defined in Recommendations Q.704.

8.4 *Status*

The primitive ‘‘MTP-STATUS’’ indicates to the ‘‘Users’’ the partial inability of providing the MTP service specified destination. The primitive is also used to indicate to a User that a remote corresponding User is unavailable (see Q.704 § 11.2.7).

In the case of national option with congestion priorities or multiple signalling link congestion states without priorities as in Recommendation Q.704 are implemented, this ‘‘MTP-STATUS’’ primitive is also used to indicate a change of congestion level.

This primitive corresponds to the destination congested/User Part unavailable state as defined in Recommendation Q.704.

8.5 *Restart*

The MTP indicates to the ‘‘Users’’ at the restarting SP that the MTP is commencing or ending the signalling point restart procedure (see Recommendation Q.704, § 9).

The indication may have the following qualifiers:

i) Begin

ii) End

The qualifier ‘‘Begin’’ indicates to the ‘‘Users’’ that all destinations should be marked as accessible (but that the resumption of signalling traffic must await the reception of MTP-RESUME primitive or MTP restart indication ‘‘End’’).

The qualifier ‘‘End’’ indicates to the ‘‘Users’’ that signalling traffic may be restarted, taking into account any MTP-PAUSE primitives previously received.

The means of conveying the MTP restart indication to the MTP ‘‘Users’’, is for further study.

Recommendation Q.702

SIGNALLING DATA LINK

1 General

1.1 A *signalling data link* | is a bidirectional transmission path for signalling, comprising two *data channels* operating together in opposite directions at the same data rate. It constitutes the lowest functional level (level 1) in the Signalling System No. 7 functional hierarchy.

1.2 Functional configuration of a signalling data link is shown in Figure 1/Q.702.

The terms *transmission channel* | and *transmission link* | are used in Signalling System No. 7 instead of transfer channel and transfer link used in Signalling System No. 6.

1.3 A digital signalling data link is made up of digital *transmission channels* and digital switches or their terminating equipment providing an interface to signalling terminals. The digital transmission channels may be derived from a digital multiplex signal at 1544, 2048 or 8448 kbit/s having a frame structure as defined in Recommendation G.704 [1], or from digital multiplex streams having a frame structure specified for data circuits (Recommendations X.50 [4], X.51 [5], X.50 | fIbis [6], X.51 | fIbis [7]).

1.4 An analogue signalling data link is made up of voice-frequency analogue transmission channels either 4 kHz or 3 kHz spaced, and modems.

1.5 Signalling System No. 7 is capable of operating over both terrestrial and satellite *transmission links* .

Figure 1/Q.702, p.21

1.6 The operational signalling data link shall be exclusively dedicated to the use of a Signalling System No. 7 signalling link between two signalling points. No other information should be carried by the same channel together with the signalling information.

1.7 Equipment such as echo suppressors, digital pads, or A/μ law convertors attached to the transmission link must be disabled in order to assure full duplex operation and bit integrity of the transmitted data stream.

1.8 64-kbit/s digital signalling channels entering a digital exchange via a multiplex structure shall be switchable as semi-permanent channels in the exchange.

2 Signalling bit rate

2.1 *General*

2.1.1 The standard bit rate on a digital bearer will be 64 kbit/s.

2.1.2 Lower bit rates may be adopted for each application, taking into account the User Part requirements and the capability of available transmission links.

2.1.3 The minimum signalling bit rate for telephone call control applications will be 4.8 kbit/s. For other applications such as network management, bit rates lower than 4.8 kbit/s can also be used.

2.2 *Use of bit rates lower than 64 kbit/s*

2.2.1 For national telephone call control applications, use of Signalling System No. 7 at bit rates lower than 64 kbit/s shall take account of the requirement to minimize the answer signal delay when in-band line signalling systems are involved (Recommendation Q.27 [8]).

2.2.2 Signalling System No. 7 can be used for direct international application at bit rates lower than 64 kbit/s between countries which have no in-band line signalling systems in their national extension networks (see § 2.1.3).

2.2.3 The possible use of Signalling System No. 7 at bit rates lower than 64 kbit/s between countries which have in-band line signalling systems in their national extension networks is for further study.

3 Error characteristics and availability

Error characteristics and availability requirements will conform to relevant Recommendations (for example, Recommendation G.821 [9] on digital circuits). No additional characteristics or requirements will be specified in this Recommendation.

4 Interface specification points

4.1 Interface requirements may be specified at one of three points, A, B or C in Figure 2/Q.702. The appropriate point depends on the nature of transmission links used and the approach toward the implementation of interface equipment adopted by each Administration.

4.2 For the international application, interface requirements at either Point B or Point C will apply.

4.3 Interface requirements for an international digital signalling data link will be specified at Point C in accordance with the specific multiplex structure used (see § 5.)

4.4 Interface requirements for an international analogue signalling data link will be specified at Point B on a single channel basis, and thus are independent of multiplex equipment used. (See § 6.)

4.5 Interface at Point A may or may not appear in particular implementations, as each Administration may adopt different approaches towards the implementation of interface equipment. If it does appear in implementations, then the interface requirements specified in Recommendations V.10 [10], V.11 [11], V.24 [12], V.28 [13], V.35 [14], V.36 [15], X.24 [16] and G.703 [17] (for 64-kbit/s interface) should be followed as appropriate.

4.6 Implementations which do not follow all the requirements in the relevant Recommendations cited above should nevertheless take into account those requirements that are specified for testing and maintenance actions which require communication between the two ends of a data link. Interface requirements for testing and maintenance are specified in Recommendation Q.707.

Figure 2/Q.702 p.22

5 Digital signalling data link

5.1 *Signalling data link derived from the 2048-kbit/s digital path*

When a signalling data link is to be derived from a 2048-kbit/s digital path, the following shall apply:

a) The interface requirements, specified at Point C in Figure 2/Q.702, should comply with Recommendations G.703 [17] for the electrical characteristics and G.704 [1] for the functional characteristics, in particular the frame structure.

b) The signalling bit rate shall be 64 kbit/s.

c) The standard channel time slot for the use of a signalling data link is time slot 16. When time slot 16 is not available, any channel time slot available for 64-kbit/s user transmission may be used.

d) No bit inversion is performed.

5.2 *Signalling data link derived from the 8448-kbit/s digital path*

When a signalling data link is to be derived from a 8448-kbit/s digital link, the following shall apply:

a) The interface requirements, specified at Point C in Figure 2/Q.702, should comply with Recommendations G.703 [23] for the electrical characteristics and G.704 [1] for the functional characteristics, in particular the frame structure.

b) The signalling bit rate shall be 64 kbit/s.

c) The standard channel time slots for the use of a signalling data link are time slots 67 to 70 in descending order of priority. When they are not available, any channel time slot available for 64-kbit/s user transmission may be used.

d) No bit inversion is performed.

5.3 *Signalling data link derived from the 1544-kbit/s digital path*

(For further study.)

Note — When a signalling bit rate of 64 kbit/s is adopted, the values of bits should be inverted within the signalling terminal or the interface equipment in order to meet the minimum mark density requirements of the Recommendation G.733 [2] based PCM systems.

5.4 *Signalling data link established over a digital path made up by digital sections based on different digital hierarchies*

When a signalling data link is to be established between networks based on different digital hierarchies and speech encoding laws, the following shall apply:

a) The interface requirements, specified at Point C in Figure 2/Q.702, should comply with Recommendations G.703 [17] for the electrical characteristics and G.802 [3] for other aspects, e.g., for interworking arrangements.

b) The signalling bit rate shall be 64 kbit/s.

c) No bit inversion is performed.

5.5 *Signalling data link established over data circuits*

When a signalling data link is to be established over data circuits derived from a 64-kbit/s digital stream having a frame structure as specified in such Recommendations as X.50 [10], X.51 [11], X.50 | fIbis [12] and X.51 | fIbis [13] the following shall apply:

a) The interface requirements, specified at Point C in Figure 2/Q.702, should comply with relevant requirements in one of the above-mentioned Recommendations, applicable to the environment of the intended use.

b) When 64-kbit/s multiplexed streams are carried on 2048-kbit/s or 1544-kbit/s digital links, Recommendation G.704 [1], should apply.

6 Analogue signalling data link

6.1 *Signalling bit rate*

6.1.1 Applications of the analogue signalling data link must take account of the delay requirements described in § 2.2.

6.1.2 For telephone call control applications, the signalling bit rate over an analogue signalling data link shall be higher or equal to 4.8 kbit/s.

6.2 *Interface requirements*

In case of 4.8-kbit/s operation, interface requirements specified at the interface point B in Figure 2/Q.702 should comply with relevant requirements specified for 4.8-kbit/s modems in Recommendations V.27 [18] and V.27 | fIbis [19]. In addition, the following shall apply:

a) Application of either Recommendations V.27 [18] or V.27 | fIbis [19] depends on the quality of the analogue transmission channels used. Recommendation V.27 [18] shall apply only to transmission channels conforming to Recommendation M.1020 [20], while Recommendation V.27 | fIbis [19] to transmission channels conforming to Recommendation M.1020 [20] or of lower quality.

b) Full duplex operation over a 4-wire transmission link should be adopted.

c) If a separate modem is to be used, the interface requirements specified in Recommendations V.10 [10], V.11 [11], V.24 [12] and V.28 [13], applicable at Point A in Figure 2/Q.702, should be followed as much as possible.

References

[1] CCITT Recommendation *Functional characteristics of interfaces associated with network nodes* , Vol. III, Rec. G.704.

[2] CCITT Recommendation *Characteristics of primary PCM multiplex equipment operating at 1544 kbit/s* , Vol. III, Rec. G.733.

[3] CCITT Recommendation *Interconnection of digital paths using different techniques* , Vol. III, Rec. G.802.

[4] CCITT Recommendation *Fundamental parameters of a multiplexing scheme for the international interface between synchronous data networks* , Vol. VIII, Rec. X.50.

[5] CCITT Recommendation *Fundamental parameters of a multiplexing scheme for the international interface between synchronous data networks* , Vol. VIII, Rec. X.51.

[6] CCITT Recommendation *Fundamental parameters of a 48-kbit/s user data signalling rate transmission scheme for the international interface between synchronous data networks* , Vol. VIII, Rec. X.50 | fIbis .

[7] CCITT Recommendation *Fundamental parameters of a 48-kbit/s user data signalling rate transmission scheme for the international interface between synchronous data networks using 10-bit envelope structure* , Vol. VIII, Rec. X.51 | fIbis .

[8] CCITT Recommendation *Transmission of the answer signal* , Vol. VI, Rec. Q.27.

[9] CCITT Recommendation *Error performance on an international digital connection forming part of an integrated services digital network* , Vol. III, Rec. G.821.

[10] CCITT Recommendation *Electrical characteristics for unbalanced double-current interchange circuits for general use with integrated circuit equipment in the field of data communications* , Vol. VIII, Rec. V.10.

[11] CCITT Recommendation *Electrical characteristics for balanced double-current interchange circuits for general use with integrated circuit equipment in the field of data communications* , Vol. VIII, Rec. V.11.

[12] CCITT Recommendation *List of definitions for interchange circuits between data-terminal equipment and data circuit-terminating equipment* , Vol. VIII, Rec. V.24.

[13] CCITT Recommendation *Electrical characteristics for unbalanced double-current interchange circuits* , Vol. VIII, Rec. V.28.

[14] CCITT Recommendation *Data transmission at 48 kbit/s per second using 60-108 kHz group band circuits* , Vol. VIII, Rec. V.35.

[15] CCITT Recommendation *Modems for synchronous data transmission using 60-108 kHz group band circuits* , Vol. VIII, Rec. V.36.

[16] CCITT Recommendation *List of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) on public data networks* , Vol. VIII, Rec. X.24.

[17] CCITT Recommendation *Physical/electrical characteristics of hierarchical digital interfaces* , Vol. III, Rec. G.703.

[18] CCITT Recommendation *4800 bit/s per second modems with manual equalizer standardized for use on leased telephone-type circuits* , Vol. VIII, Rec. V.27.

[19] CCITT Recommendation *4800/2400 bit/s per second modem with automatic equalizer standardized for use on leased telephone-type circuits* , Vol. VIII, Rec. V.27 | fIbis .

[20] CCITT Recommendation *Characteristics of special quality international leased circuits with special bandwidth conditioning* , Vol. IV, Rec. M.1020.

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