INTERNATIONAL TELECOMMUNICATION UNION

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THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

YELLOW BOOK

VOLUME VI - FASCICLE VI.6

SPECIFICATIONS OF SIGNALLING SYSTEM No. 7

RECOMMENDATIONS Q.701-Q.741

VIITH PLENARY ASSEMBLY
GENEVA, 10–21 NOVEMBER 1980

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[1] "Telematic services" is used provisionally.

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1) "Telematic services" is used provisionally.

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Specifications of Signalling System No. 7

REMARKS

1 The strict observance of the specifications for standardized international signalling and switching equipment is of the utmost importance in the manufacture and operation of the equipment. Hence these specifications are obligatory except where it is explicitly stipulated to the contrary.

The values given in Fascicles VI.1 to VI.6 are imperative and must be met under normal service conditions.

2 The Questions entrusted to each Study Group for the Study Period 1981-1984 can be found in Contribution No. 1 to that Study Group.

CCITT NOTE

In this Volume, the expression "Administration" is used for shortness to indicate both a telecommunication Administration and a recognized private operating agency.

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Recommendations Q.701 to Q.741

SPECIFICATIONS OF
SIGNALLING SYSTEM No. 7

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SPECIFICATIONS OF SIGNALLING SYSTEM No. 7

Preface

Signalling System No. 7 consists of:

- the Message Transfer Part (MTP), specified in Recommendations Q.701 to Q.707
- the Telephone User Part (TUP), specified in Recommendations Q.721 to Q.725
- the Data User Part (DUP), specified in Recommendation X.61 (Q.741).

An overall description of the signalling system and the division of functions and interactions between the Message Transfer Part and the User Parts is given in Recommendation Q.701.

General signalling network considerations are contained in Recommendation Q.705.

The use of Signalling System No. 7 in call control applications of the telephone service is recommended in Recommendations Q.7 [1] and Q.110 [2].

The use of Signalling System No. 7 in call control applications of the circuit switched data transmission service is recommended in Recommendation X.60 [3]. The call control and signalling procedures applicable for international data transmission user facilities and network utilities are defined in Recommendation X.87 [4].

References

[1] CCITT Recommendation *Signalling systems to be used for international automatic and semiautomatic telephone working*, Vol. VI, Fascicle VI.1, Rec. Q.7.

[2] CCITT Recommendation *General aspects of the utilization of standardized CCITT signalling systems on PCM links*, Vol. VI, Fascicle VI.1, Rec. Q.110.

[3] CCITT Recommendation *Common channel signalling for circuit switched data applications*, Vol. VIII, Fascicle VIII.3, Rec. X.60.

[4] CCITT Recommendation *Principles and procedures for realization of international user facilities and network utilities in public data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.87.

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SECTION 1

MESSAGE TRANSFER PART (MTP)

Recommendation Q.701

FUNCTIONAL DESCRIPTION OF THE SIGNALLING SYSTEM (MESSAGE TRANSFER PART)

1 General

1.1 *Objectives and fields of application*

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

- optimized for operation in digital telecommunications networks in conjunction with stored program controlled exchanges;
- that can meet present and future requirements of information transfer 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 and circuit switched data transmission services. It can also be used as a reliable transport system for other types of information transfer between exchanges and specialized 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 applicable in international and national 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 specialized for various types of signalling and information transfer between processors in telecommunications networks.

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

1.3 *Modularity*

The wide scope of the signalling system requires that the total system includes a large diversity of functions and that further functions can be added to cater 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.

System No. 7 is one common channel signalling system. However, as a consequence of its modularity and its intended use as a standard base for national applications the system may be applied in many forms. In general, to define the use of the system in 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.

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 1/Q.701.

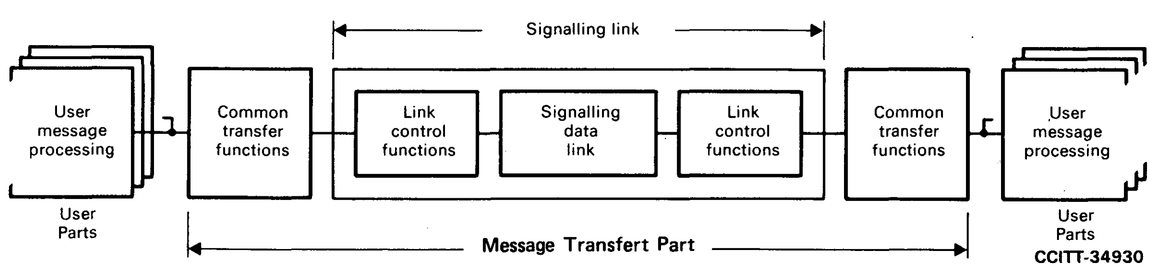


FIGURE 1/Q.701

Functional diagram for the common channel signalling system

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 2/Q.701.

The system structure shown in Figure 2/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 2/Q.701 may be regarded as a possible model of an implementation.

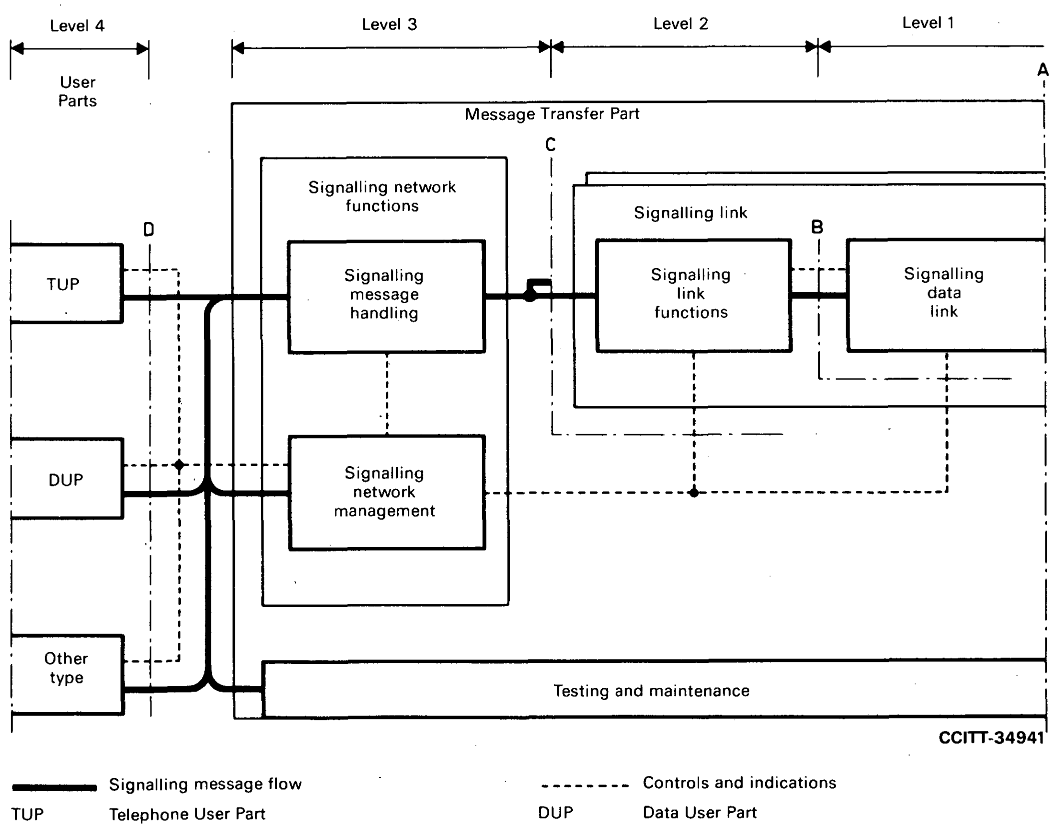


FIGURE 2/Q.701

General structure of signalling system functions

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.

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 2/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 2/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 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* 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 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 3/Q.701) is purely functional and need not appear as such in an implementation of the system.

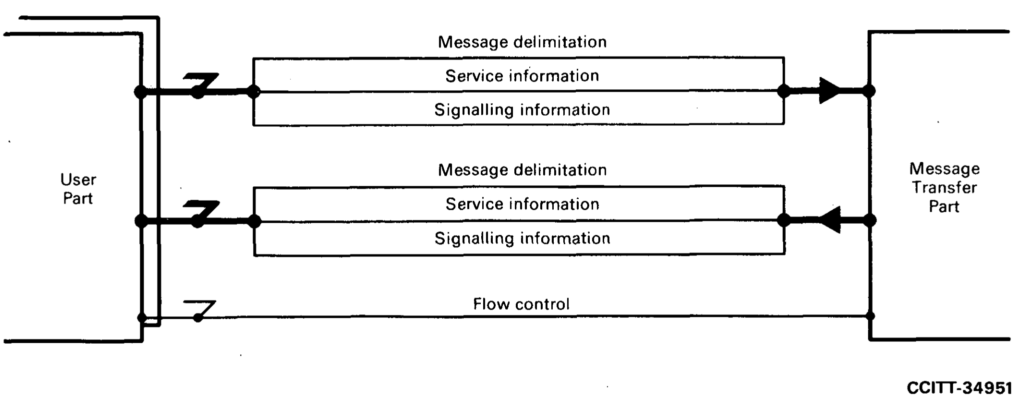


FIGURE 3/Q.701

Functional interface between the message transfer part and the user parts

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 Signalling network

3.1 *Basic concepts and features*

3.1.1 *Signalling network components*

A telecommunication network served by common channel signalling is composed of a number of switching and processing nodes interconnected by transmission links. The nodes in the telecommunication network that are provided with common channel signalling are in the context of signalling referred to as *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 the international and a national signalling network.

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

The corresponding concept for a given User Part is called *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 the common channel signalling system. This communication then constitutes a user signalling relation between the applicable operation and maintenance User Part functions at the telephone exchange and the corresponding functions at the operation and maintenance centre.

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 set 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 *nonadjacent signalling points.*

3.1.2 *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 signalling 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 link sets 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 a message through the signalling network is predetermined 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 4/Q.701.

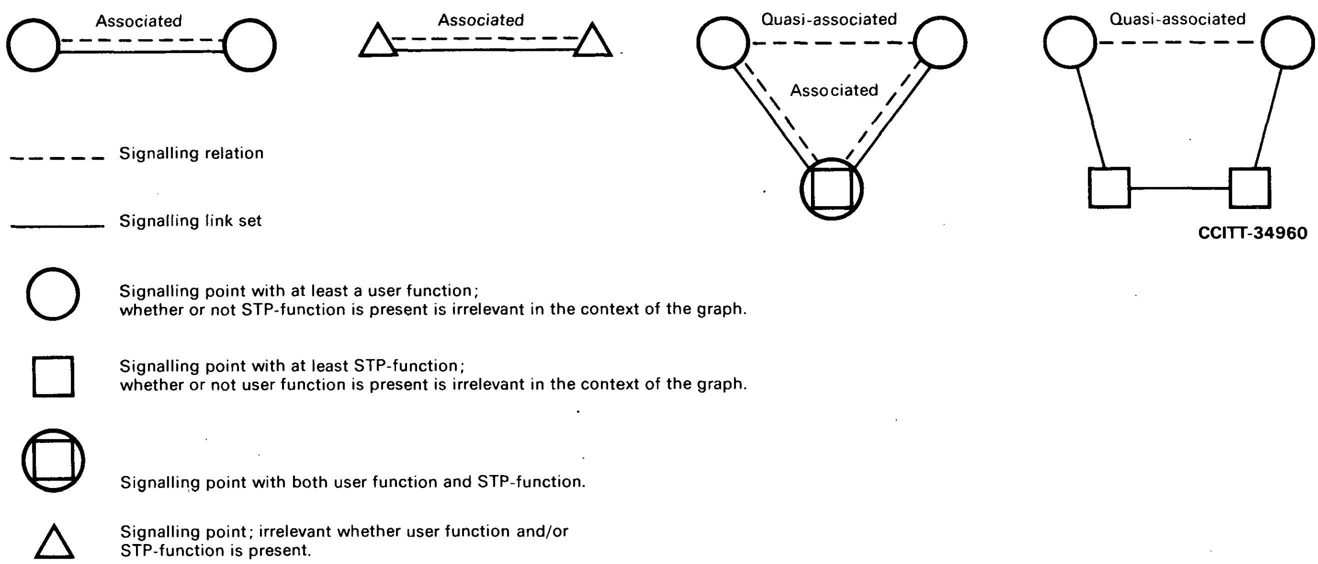


FIGURE 4/Q.701

Examples of associated and quasi-associated signalling modes and definition of signalling network graph symbols

3.1.3 *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 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 *signalling transfer point (STP).*

For a particular signalling relation the two signalling points thus function both 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 a destination point for the messages generated and received by the level 3 function of the Message Transfer Part also in cases when no user functions are present.

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 included in each message.

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

3.2 *Signalling message handling functions*

Figure 5/Q.701 illustrates the signalling message handling functions.

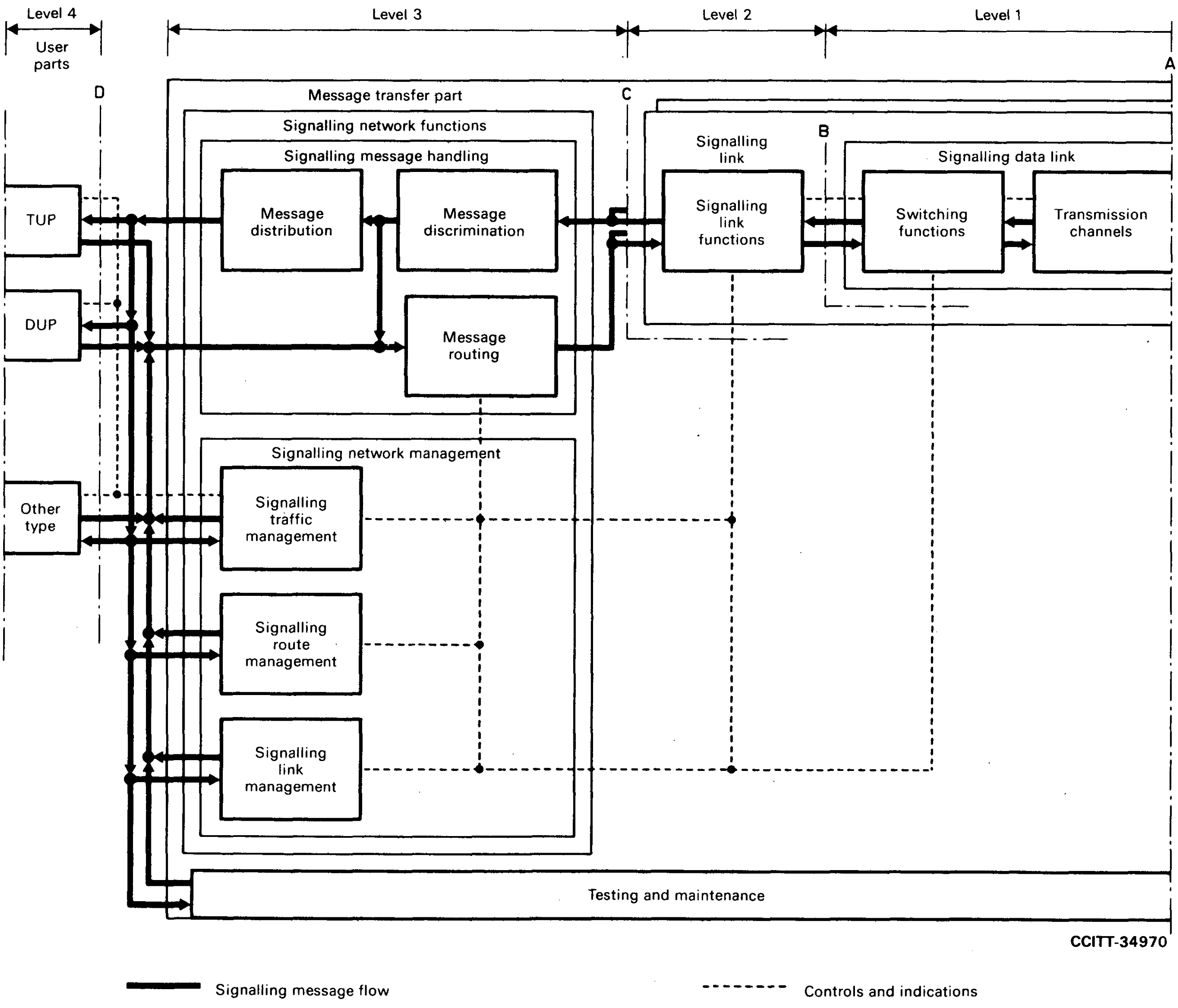


FIGURE 5/Q.701
Detailed structure of signalling system functions

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. 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 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, i.e. in the case when it serves as a signalling transfer point for that message, the message is delivered to the message routing function for further transfer to a signalling link. Message discrimination thus is a function required only at a signalling point that acts as a signalling transfer point.

3.3 *Signalling network management functions*

Figure 5/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* and *signalling route management* functions, 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 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 into an incomplete route.

3.4 *Testing and maintenance functions*

Figure 5/Q.701 illustrates that the signalling system includes some standard testing and maintenance procedures 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 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.

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 for 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 for 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 primarily been determined 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 informationtransfer. 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, § 12.

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; although normally limited to about 60 octets the signalling system can, if required in certain national applications, 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 for 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 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^{-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^{-10}.

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

Recommendation Q.702

SIGNALLING DATA LINK

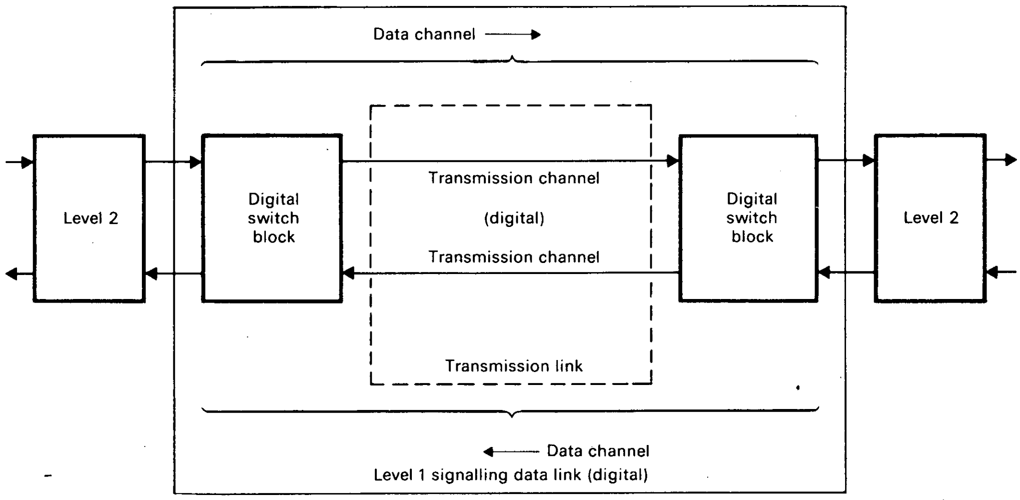
1 General

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.

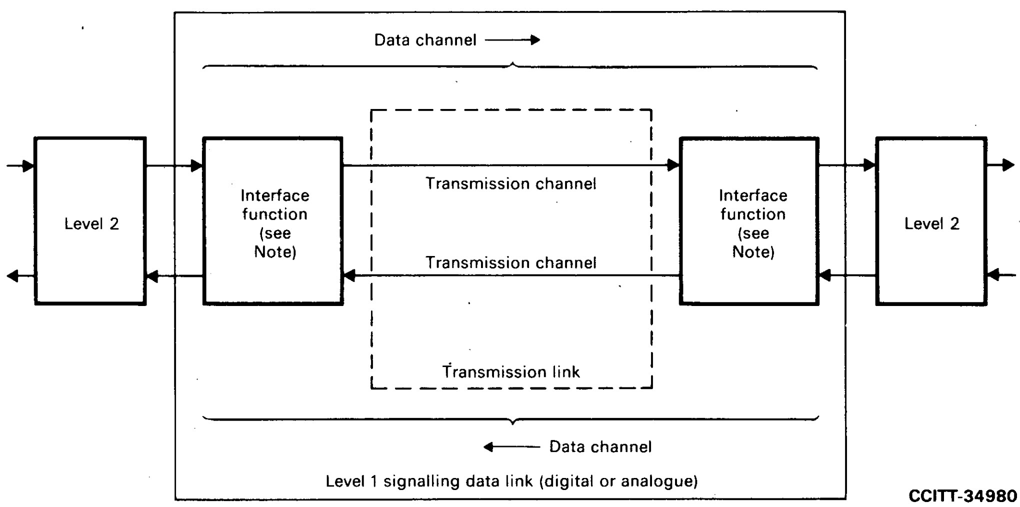
1.2 Functional configuration of a signalling data link is shown in Figure 1/Q.702.

1.3 A digital signalling data link is made up of digital *transmission channels* [1)] and digital switches or their terminating equipment providing an interface to signalling terminals. The digital transmission channels may be derived from a digital stream having a frame structure as specified for digital exchanges and for pulse code modulation multiplex equipment (Recommendations G.732 [1], G.733 [2], G.734 [3], G.744 [4], G.746 [5], G.736 [6], G.737 [7], G.738 [8], G.739 [9], etc.), or from digital streams having a frame structure specified for data circuits (Recommendations X.50 [10], X.51 [11], X.50 *bis* [12], X.51 *bis* [13]).

1) 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.



a) Example 1 – Digital signalling data link via digital switch block



Note – The interface function is provided, for example, by a modem in an analogue signalling data link, a data circuit terminating equipment (DCE) or a time slot access equipment in a digital signalling data link.

b) Example 2 – Signalling data link (digital or analogue) via interface equipment

FIGURE 1/Q.702

Functional configuration of a signalling data link

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* [1)].

[1)] 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.

1.6 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 semipermanent 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 [14]).

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

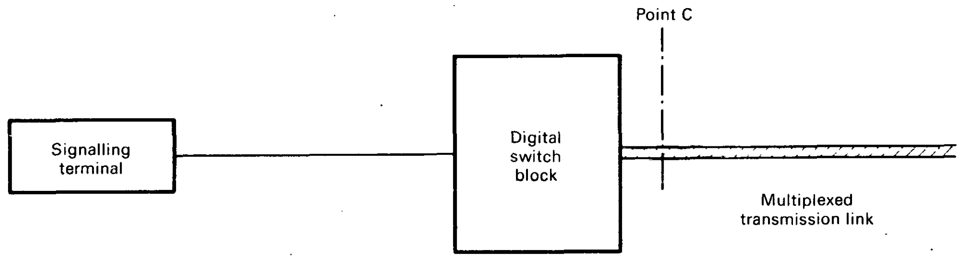
Error characteristics and availability requirements will conform to relevant Recommendations (for example, Recommendation G.821 [15] on digital circuits). No additional characteristics or requirements will be specified in this Recommendation.

4 Interface specification points

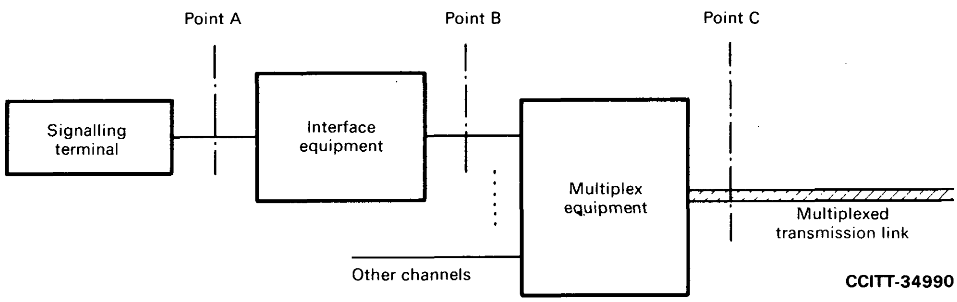
4.1 Interface requirements may be specified at one of three points, A, B or C in Figure 2/Q.702. The appropriate point depends on the nature of transmission links used and the approach toward the implementation of interface equipment adopted by each Administration.

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.)



a) Example 1 – Digital signalling data link via a digital switch block



b) Example 2 – Signalling data link (digital or analogue) via interface equipment

FIGURE 2/Q.702

Interface specification points

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 [16], V.11 [17], V.24 [18], V.28 [19], V.35 [20], V.36 [21], X.24 [22] and G.703 [23] (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.

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 [23] for the electrical characteristics and G.732 [1] and G.734 [3] for other aspects, e.g. for 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 path, 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.744 [4] and G.746 [5] for other aspects, e.g. for 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 (A, μ) encoding laws*

(For further study.)

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 *bis* [12] and X.51 *bis* [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 paths, Recommendations G.736 [6], G.737 [7], G.738 [8] and G.739 [9] 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 [24] and V.27 *bis* [25]. In addition, the following shall apply:

a) Application of either Recommendations V.27 [24] or V.27 *bis* [25] depends on the quality of the analogue transmission channels used. Recommendation V.27 [24] shall apply only to transmission channels conforming to Recommendation M.1020 [26], while Recommendation V.27 *bis* [25] to transmission channels conforming to Recommendation M.1020 [26] 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 [16], V.11 [17], V.24 [18] and V.28 [19], applicable at Point A in Figure 2/Q.702, should be followed as much as possible.

References

[1] CCITT Recommendation *Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s*, Vol. III, Fascicle III.3, Rec. G.732.

[2] CCITT Recommendation *Characteristics of primary PCM multiplex equipment operating at 1544 kbit/s*, Vol. III, Fascicle III.3, Rec. G.733.

[3] CCITT Recommendation *Characteristics of 2048-kbit/s frame structure for use with digital exchanges*, Vol. III, Fascicle III.3, Rec. G.734.

[4] CCITT Recommendation *Second-order PCM multiplex equipment operating at 8448 kbit/s*, Vol. III, Fascicle III.3, Rec. G.744.

[5] CCITT Recommendation *Characteristics of 8448-kbit/s frame structure for use with digital exchanges*, Vol. III, Fascicle III.3, Rec. G.746.

[6] CCITT Recommendation *Characteristics of a digital multiplex equipment operating at 1544 kbit/s*, Vol. III, Fascicle III.3, Rec. G.736.

[7] CCITT Recommendation *Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s and offering synchronous 64-kbit/s digital access options*, Vol. III, Fascicle III.3, Rec. G.737.

[8] CCITT Recommendation *Characteristics of a synchronous digital multiplex equipment operating at 2048 kbit/s*, Vol. III, Fascicle III.3, Rec. G.738.

[9] CCITT Recommendation *Characteristics of an external access equipment operating at 2048 kbit/s and offering synchronous digital accesses at 64 kbit/s*, Vol. III, Fascicle III.3, Rec. G.739.

[10] CCITT Recommendation *Fundamental parameters of a multiplexing scheme for the international interface between synchronous data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.50.

[11] CCITT Recommendation *Fundamental parameters of a multiplexing scheme for the international interface between synchronous data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.51.

[12] 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, Fascicle VIII.3, Rec. X.50 *bis*.

[13] 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, Fascicle VIII.3, Rec. X.51 *bis*.

[14] CCITT Recommendation *Transmission of the answer signal*, Vol. VI, Fascicle VI.1, Rec. Q.27.

[15] CCITT Recommendation *Error performance on an international digital connection forming part of an integrated services digital network*, Vol. III, Fascicle III.3, Rec. G.821.

[16] 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, Fascicle VIII.1, Rec. V.10.

[17] 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, Fascicle VIII.1, Rec. V.11.

[18] CCITT Recommendation *List of definitions for interchange circuits between data-terminal equipment and data circuit-terminating equipment*, Vol. VIII, Fascicle VIII.1, Rec. V.24.

[19] CCITT Recommendation *Electrical characteristics for unbalanced double-current interchange circuits*, Vol. VIII, Fascicle VIII.1, Rec. V.28.

[20] CCITT Recommendation *Data transmission at 48 kbit/s per second using 60-108 kHz group band circuits*, Vol. VIII, Fascicle VIII.1, Rec. V.35.

[21] CCITT Recommendation *Modems for synchronous data transmission using 60-108 kHz group band circuits*, Vol. VIII, Fascicle VIII.1, Rec. V.36.

[22] 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, Fascicle VIII.2, Rec. X.24.

[23] CCITT Recommendation *General aspects of interfaces*, Vol. III, Fascicle III.3, Rec. G.703.

[24] CCITT Recommendation *4800 bit/s per second modems with manual equalizer standardarized for use on leased telephone-type circuits*, Vol. VIII, Fascicle VIII.1, Rec. V.27.

[25] CCITT Recommendation *4800/2400 bit/s per second modem with automatic equalizer standardized for use on leased telephone-type circuits*, Vol. VIII, Fascicle VIII.1, Rec. V.27 *bis*.

[26] CCITT Recommendation *Characteristics of special quality international leased circuits with special bandwidth conditioning*, Vol. IV, Fascicle IV.2, Rec. M.1020.

Recommendation Q.703

SIGNALLING LINK

CONTENTS

1 General

1.1 *Introduction*

1.1.1 This Recommendation describes the functions and procedures for and relating to the transfer of signal messages over one signalling data link. The signalling link functions, together with a signalling data link as bearer, provide a signalling link for reliable transfer of signalling messages between two directly connected *signalling points.*

Signalling messages delivered by superior hierarchical levels are transferred over the signalling link in variable length *signal units.* The signal units include transfer control information for proper operation of the signalling link in addition to the signalling information.

1.1.2 The signalling link functions comprise:

a) signal unit delimitation,

b) signal unit alignment,

c) error detection,

d) error correction,

e) initial alignment,

f) signalling link error monitoring.

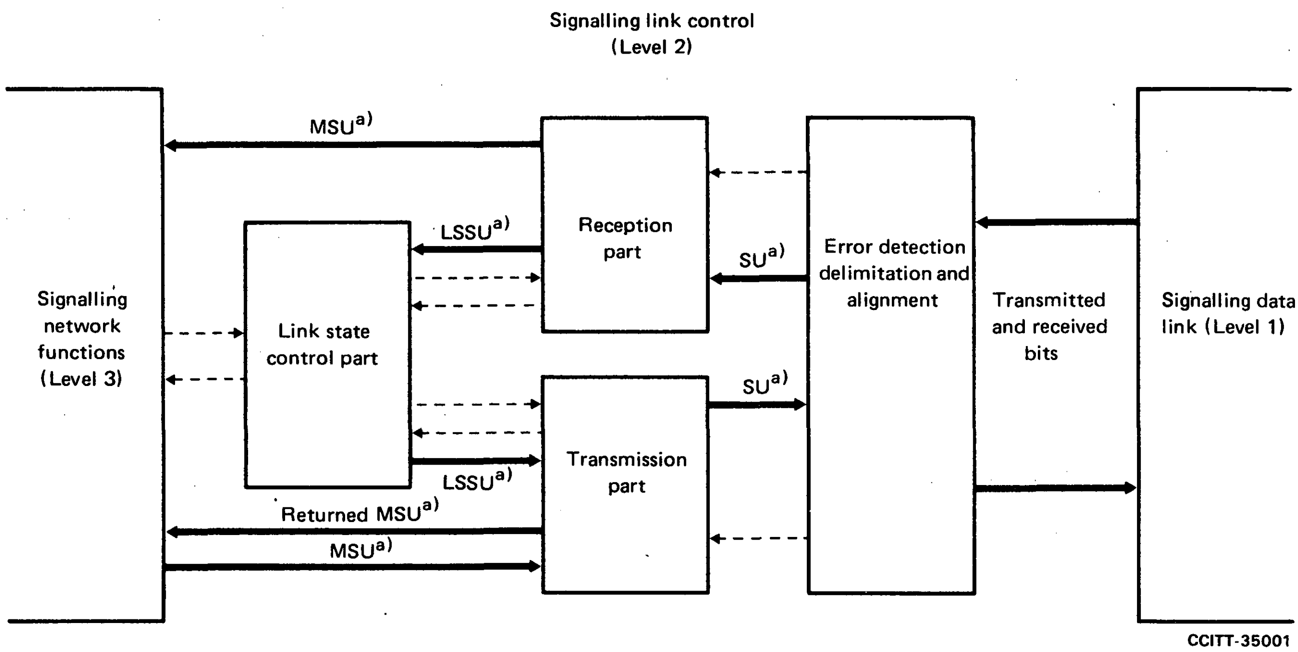
All these functions are coordinated by the *link state control,* see Figure 1/Q.703.

1.2 *Signal unit delimitation and alignment*

The beginning and end of a signal unit are indicated by a unique 8-bit pattern, called the *flag.* Measures are taken to ensure that the pattern cannot be imitated elsewhere in the unit.

Loss of alignment occurs when a bit pattern disallowed by the delimitation procedure (more than six consecutive 1s) is received, or when a certain maximum length of signal unit is exceeded.

Loss of alignment will cause a change in the mode of operation of the *signal unit error rate monitor.*



Signalling message flows
LSSU Link status signal units

----- Controls and indications
MSU Message signal unit
SU Signal unit

a) These signal units do not include all error control information.

FIGURE 1/Q.703

Interactions of the functional specification blocks for signalling link control

1.3 *Error detection*

The error detection function is performed by means of 16 check bits provided at the end of each signal unit. The check bits are generated by the transmitting signalling link terminal by operating on the preceding bits of the signal unit following a specified algorithm. At the receiving *signalling link terminal*[1)] the received check bits are operated on using specified rules, which correspond to that algorithm.

If consistency is not found between the received check bits and the preceding bits of the signal unit, according to the algorithm, then the presence of errors is indicated and the signal unit is discarded.

1.4 *Error correction*

1.4.1 Two forms of error correction are provided, the *basic method* and the *preventive cyclic retransmission method.* The following criteria should be used for determining the international fields of application for the two methods:

a) the basic method applies for signalling links using non-intercontinental terrestrial transmission means and for intercontinental signalling links where the one-way propagation delay is less than 15 ms;

b) the preventive cyclic retransmission method applies for intercontinental signalling links where the one-way propagation delay is greater than or equal to 15 ms and for all signalling links established via satellite.

In cases where one signalling link within an international link set is established via satellite, the preventive cyclic retransmission method should be used for all signalling links of that link set.

1.4.2 The basic method is a non-compelled, positive/negative acknowledgement, retransmission error correction system. A signal unit which has been transmitted is retained at the transmitting signalling link terminal until a positive acknowledgement is received. If a negative acknowledgement is received, then the transmission of new signal units is interrupted and those signal units which have been transmitted but not yet positively acknowledged starting with that indicated by the negative acknowledgement will be retransmitted once, in the order in which they were first transmitted.

1.4.3 The preventive cyclic retransmission method is a non-compelled, positive acknowledgement, cyclic retransmission, forward error correction system. A signal unit which has been transmitted is retained at the transmitting signalling link terminal until a positive acknowledgement for that signal unit is received. During the period when there are no new signal units to be transmitted all the signal units which have not yet been positively acknowledged are retransmitted cyclically.

The *forced retransmission procedure* is defined to ensure that forward error correction occurs in adverse conditions (e.g. high error rate and/or high traffic loading).

When a predetermined number of retained, unacknowledged signal units exist, the transmission of new signal units is interrupted and the retained signal units are retransmitted cyclically until the number of unacknowledged signal units is reduced.

1.5 *Initial alignment*

The initial alignment procedure is appropriate to both first time initialization (e.g. after "switch-on") and alignment in association with restoration after a link failure. The procedure is based on the compelled exchange of status information between the two *signalling points* concerned and the provision of a proving period. No other signalling link is involved in the initial alignment of any particular link, the exchange occurs only on the link to be aligned.

1.6 *Signalling link error monitoring*

Two signalling link error rate monitor functions are provided; one which is employed whilst a signalling link is in service and which provides one of the criteria for taking the link out of service, and one which is employed whilst a link is in the proving state of the initial alignment procedure. These are called the *signal unit*

[1)] A *signalling link terminal* refers to the means of performing all of the functions defined at level 2 regardless of their implementation.

error rate monitor and the *alignment error rate monitor* respectively. The characteristics of the signal unit error rate monitor are based on a signal unit error count, incremented and decremented using the "leaky bucket" principle whilst the alignment error rate monitor is a linear count of signal unit errors. During loss of alignment the signal unit error rate monitor error count is incremented in proportion to the period of the loss of alignment.

1.7 *Link state control functions*

Link state control is a function of the signalling link which provides directions to the other signalling link functions. The interfaces with link state control are shown in Figure 1/Q.703 and Figure 7/Q.703. The split into the functional blocks shown in the figures is made to facilitate description of the signalling link procedures and should not be taken to imply any particular implementation.

The link state control function is shown in the overview diagram, Figure 2/Q.703, and the detailed state transition diagram, Figure 8/Q.703.

2 **Basic signal unit format**

2.1 *General*

Signalling and other information originating from a User Part is transferred over the signalling link by means of signal units.

A signal unit is constituted of a variable length *signalling information field* which carries the information generated by a *User Part* and a number of fixed length fields which carry information required for message transfer control. In the case of link status signal units the signalling information field is replaced by a status field which is generated by the signalling link terminal.

2.2 *Signal unit format*

Three types of signal unit are differentiated by means of the *length indicator* contained in all signal units, i.e.: message signal units, link status signal units and fill-in signal units. Message signal units are retransmitted in case of error, link status signal unit and fill-in signal units are not. The basic formats of the signal units are shown in Figure 3/Q.703.

2.3 *Function and codes of the signal unit fields*

2.3.1 *General*

The message transfer control information encompasses 8 fixed length fields in the signal unit which contain information required for error control and message alignment.

2.3.2 *Flag*

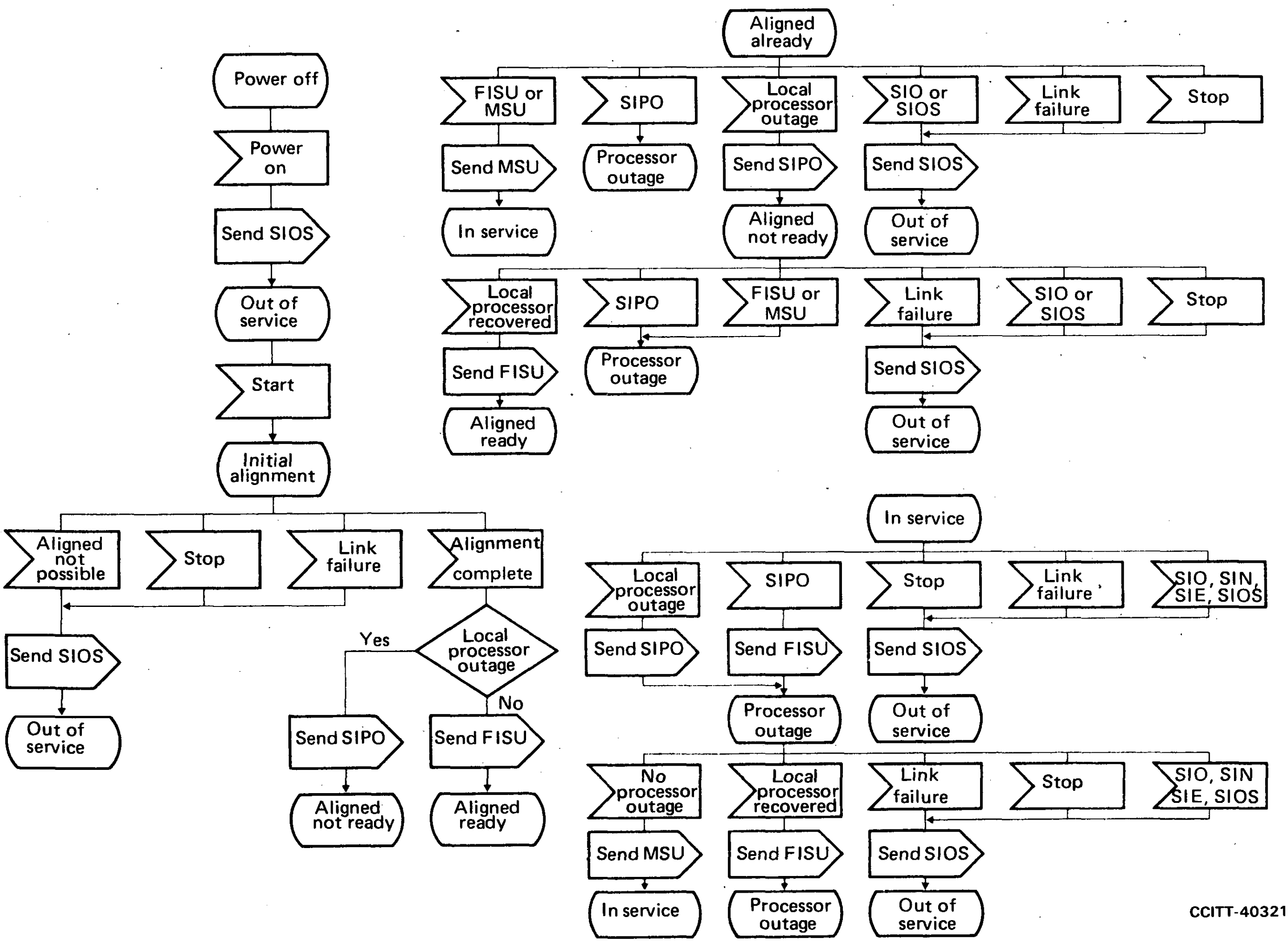
The opening flag indicates the start of a signal unit. The opening flag of one signal unit is normally the closing flag of the preceding signal unit. The closing flag indicates the end of a signal unit. The bit pattern for the flag is 01111110.

2.3.3 *Length indicator*

The length indicator is used to indicate the number of octets following the length indicator octet and preceding the *check bits* and is a number in binary code in the range 0-63. The length indicator differentiates between the three types of signal unit as follows:

Length indicator = 0:	fill in signal unit
Length indicator = 1 or 2:	link status signal unit
Length indicator > 2:	message signal unit

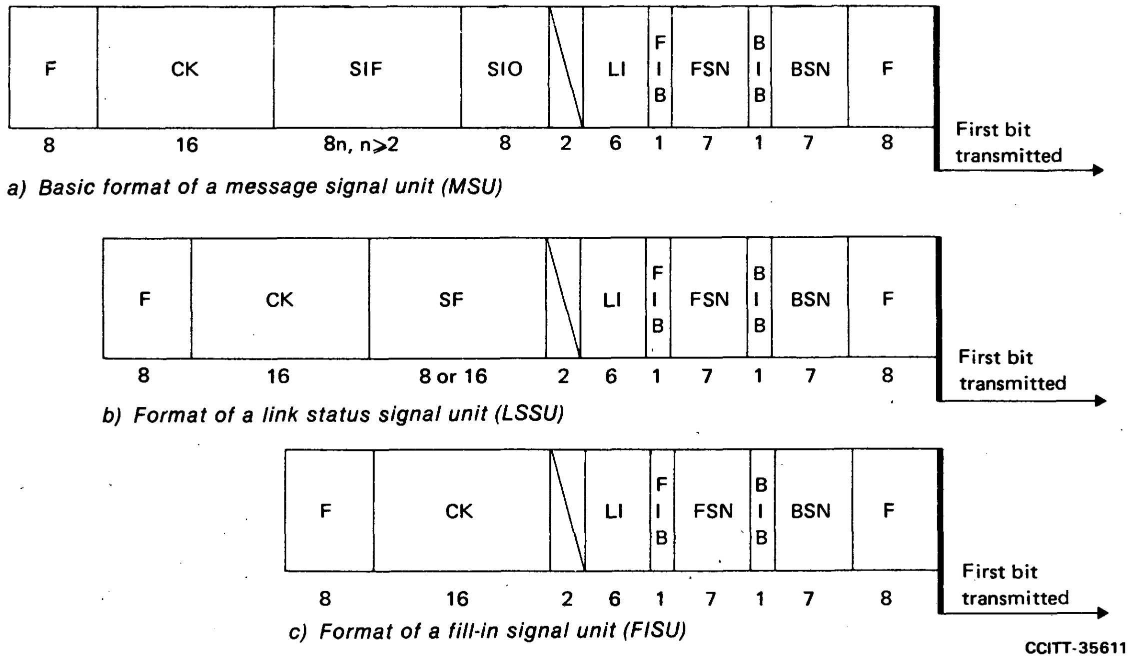
In national signalling networks, in the case that a signalling information field spanning more than 62 octets is included in a message signal unit, the length indicator is set to 63.



FISU Fill-in signal unit
MSU Message signal unit
SIE Status indication "E"
SIN Status indication "N"
SIO Status indication "O"
SIOS Status indication "out of service"
SIPO Status indication "processor outage"

FIGURE 2/Q.703

Overview diagram of link state control



BIB Backward indicator bit
BSN Backward sequence number
CK Check bits
F Flag
FIB Forward indicator bit
FSN Forward sequence number
LI Length indicator
SF Status field
SIF Signalling information field
SIO Service information octet

FIGURE 3/Q.703

Signal unit formats

2.3.4 *Service information octet*

The *service information octet* is divided into the *service indicator* and the *subservice field.* The service indicator is used to associate signalling information with a particular user part and is present only in message signal units.

The content of the subservice field is described in Recommendation Q.704, § 12.2.2.

Note – The Message Transfer Part may handle messages for different users (i.e. messages with different service indicators) with different priorities. These priorities are for further study.

2.3.5 *Sequence numbering*

The *forward sequence number* is the sequence number of the signal unit in which it is carried.

The *backward sequence number* is the sequence number of a signal unit being acknowledged.

The forward sequence number and backward sequence number are numbers in binary code from a cyclic sequence ranging from 0 to 127 (see §§ 5 and 6).

2.3.6 *Indicator bits*

The *forward indicator bit* and *backward indicator bit* together with the forward sequence number and backward sequence number are used in the basic error control method to perform the signal unit sequence control and acknowledgement functions. (See §§ 5.2 and 6.)

2.3.7 *Check bits*

Every signal unit has 16 check bits for error detection. (See § 4.)

2.3.8 *Signalling information field*

The *signalling information field* consists of an integral number of octets, greater than or equal to 2 and less than or equal to 62.

In national signalling networks it may consist of up to 272 octets [2)].

The format and codes of the signalling information field are defined for each user part.

2.3.9 *Status field*

The formats and codes of the *status field* are described in § 10.

2.4 *Order of bit transmission*

Each of the fields mentioned in § 2.3 will be transmitted in the order indicated in Figure 3/Q.703.

Within each field or subfield the bits will be transmitted with the least significant bit first. The 16 check bits are transmitted in the order generated (see § 4).

3 Signal unit delimitation

3.1 *Flags*

A signal unit includes an opening flag (see § 2.2). The opening flag of a signal unit is normally considered to be the closing flag of the preceding signal unit (however, see Note to § 5). In certain conditions (e.g. signalling link overload) a number of flags may be generated between two consecutive signal units.

3.2 *Zero insertion and deletion*

To ensure that the flag code is not imitated by any other part of the signal unit the transmitting signalling link terminal inserts a 0 after every sequence of five consecutive 1s before the flags are attached and the signal unit is transmitted. At the receiving signalling link terminal, after flag detection and removal, each 0 which directly follows a sequence of five consecutive 1s is deleted.

4 Acceptance procedure

4.1 *Acceptance of alignment*

4.1.1 A flag which is not followed immediately by another flag is considered an opening flag. Whenever an opening flag is received the beginning of a signal unit is assumed. When the next flag (a closing flag) is received it is assumed to be the termination of the signal unit.

4.1.2 If seven or more consecutive 1s are received the signal unit error rate monitor enters the "octet counting" mode (see § 4.1.4) and the next valid flag is searched for.

2) The value 272 allows a single message signal unit to accommodate information blocks of up to 256 octets in length accompanied by a label and possible additional housekeeping information which may, for example, be used by level 4 to link such information blocks together.

4.1.3 After deletion of the 0s inserted for transparency the received signal unit length is checked for being a multiple of 8 bits and at least 6 octets. If it is not, then the signal unit is discarded and the signal unit error rate monitor is incremented. If more than $m + 7$ octets are received before a closing flag, the "octet counting" mode is entered (see Figure 11/Q.703) and the signal unit is discarded. m is the maximum length of the signalling information field (in octets) allowed on a particular signalling link. m takes the value 62 or 272 depending on the maximum message length restrictions of the signalling network concerned [3)]. In the case of the basic error control method a negative acknowledgement will be sent, if required, according to the rules set out in § 5.2.

4.1.4 When the "octet counting" mode is entered all the bits received after the last flag and before the next flag are discarded. The "octet counting" mode is left when the next correctly checking signal unit is received, and this signal unit is accepted.

4.2 *Error detection*

The error detection function is performed by means of 16 check bits provided at the end of each signal unit.

The check bits are generated by the transmitting signalling link terminal. They are the ones complement of the sum (modulo 2) of:

i) the remainder of $x^k (x^{15} + x^{14} + x^{13} + x^{12} \ldots + x^2 + x + 1)$ divided (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, where k is the number of bits in the signal unit existing between, but not including, the final bit of the opening flag and the first bit of the check bits, excluding bits inserted for transparency; and

ii) the remainder after multiplication by x^{16} and then division (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$ of the content of the signal unit existing between, but not including, the final bit of the opening flag and the first bit of the check bits, excluding bits inserted for transparency.

As a typical implementation, at the transmitting signalling link terminal, the initial remainder of the division is preset to all 1s and is then modified by division by the generator polynomial (as described above) on all the fields of the signal unit; the 1s complement of the resulting remainder is transmitted as the 16 check bits.

At the receiving signalling link terminal, the correspondence between the check bits and the remaining part of the signal unit is checked; if a complete correspondence is not found the signal unit is discarded.

As a typical implementation at the receiving signalling link terminal, the initial remainder is preset to all 1s, and the serial incoming protected bits including the check bits (after the bits inserted for transparency are removed) when divided by the generator polynomial will result in a remainder of 0001110100001111 (x^{15} through x^0, respectively) in the absence of transmission errors.

5 Basic error correction method

5.1 *General*

The basic error correction method is a noncompelled method in which correction is performed by retransmission. In normal operation the method ensures correct transfer of message signal units over the signalling link, in sequence and with no double delivery. As a consequence, no resequencing or eliminating of the received information is required within the user parts.

Positive acknowledgements are used to indicate correct transfer of message signal units. *Negative acknowledgements* are used as explicit requests for retransmission of signal units received in a corrupt form.

To minimize the number of retransmissions and the resulting message signal unit delay, a request for retransmission is made only when a message signal unit (not another signal unit) has been lost because of, for example, transmission errors or disturbances.

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3) The value 272 may apply in national signalling networks (see § 2.3.8) and it allows a single message signal unit to accommodate information blocks of up to 256 octets in length accompanied by a label and possible additional housekeeping information which may, for example, be used by level 4 to link such information blocks together. It remains for further study to determine if a unique value for the number of octets to be received before entering the "octet counting" mode is acceptable from an operational point of view.

The method requires that transmitted but not yet positively acknowledged message signal units remain available for retransmission. To maintain the correct message signal unit sequence when a retransmission is made, the message signal unit, the retransmission of which has been requested, and any subsequently transmitted message signal units are retransmitted in the order in which they were originally transmitted.

As part of the error correction method each signal unit carries a forward sequence number, a *forward indicator bit*, a backward sequence number and a *backward indicator bit.* The error correction procedure operates independently in the two transmission directions. The forward sequence number and forward indicator bit in one direction together with the backward sequence number and backward indicator bit in the other direction are associated with the message signal unit flow in the first direction. They function independently of the message signal unit flow in the other direction and its associated forward sequence number, forward indicator bit, backward sequence number and backward indicator bit.

The transmission of new message signal units is temporarily stopped during retransmissions or when no forward sequence number values are available to be assigned to new message signal units (due to a high momentary load or corruption of positive acknowledgements) (see § 5.2.2).

Under normal conditions, when no message signal units are to be transmitted or retransmitted, fill-in signal units are sent continuously. In some particular cases link status signal units, continuous fill-in signal units or flags may be sent as described in §§ 7, 8 and 10.

5.2 *Acknowledgements (positive acknowledgement and negative acknowledgement)*

5.2.1 *Sequence numbering*

For the purposes of acknowledgement and signal unit sequence control, each signal unit carries two sequence numbers. The signal unit sequence control is performed by means of the forward sequence number. The acknowledgement function is performed by means of the backward sequence number.

The value of the forward sequence number of a message signal unit is obtained by incrementing (modulo 128, see § 2.3.5) the last assigned value by 1.

This forward sequence number value uniquely identifies the message signal unit until its delivery is accepted without errors and in correct sequence, by the receiving terminal. The forward sequence number of a signal unit other than a message signal unit assumes the value of the forward sequence number of the last transmitted message signal unit.

5.2.2 *Signal unit sequence control*

Information regarding the service information octet, signalling information field, forward sequence number and the length of each message signal unit is retained at the transmitting signalling link terminal until an acknowledgement is received (see § 5.2.3). In the meantime the same forward sequence number cannot be used for another message signal unit (see § 5.2.3).

A forward sequence number value can be assigned to a new message signal unit when a positive acknowledgement concerning that value incremented by at least 1 (modulo 128) is received (see § 5.2.3).

This means that not more than 127 signal units may be available for retransmission.

The action to be taken at the receiving signalling link terminal upon receipt of a correctly checking signal unit is determined by comparison of the received forward sequence number with the forward sequence number of the last previously accepted signal unit and on comparison of the received forward indicator bit with the latest sent backward indicator bit. In addition, as the appropriate action differs for a message signal unit and another signal unit, the length indicator of the received signal unit must be examined.

a) If the signal unit is a fill-in signal unit then:

   i) if the forward sequence number value equals the forward sequence number value of the last accepted message signal unit, the signal unit is processed within the message transfer part;

ii) if the forward sequence number value is different from the forward sequence number value of the last accepted message signal unit, the signal unit is processed within the message transfer part. If the received forward indicator bit is in the same state as the last sent backward indicator bit, a negative acknowledgement is sent.

b) If the signal unit is a link status signal unit then it is processed within the message transfer part.

c) If the signal unit is a message signal unit then:

i) if the forward sequence number value is the same as that of the last accepted signal unit, the signal unit is discarded, regardless of the state of the indicator bits;

ii) if the forward sequence number value is one more (modulo 128 see § 2.3.5) than that of the last accepted signal unit and if the received forward indicator bit is in the same state as the last sent backward indicator bit, the signal unit is accepted and delivered to level 3.

Explicit positive acknowledgements to the accepted signal units are sent as specified in § 5.2.3.

If the forward sequence number is one more than that of the last accepted signal unit and if the received forward indicator bit is not in the same state as the last sent backward indicator bit, then the signal unit is discarded;

iii) if the forward sequence number value is different from those values mentioned in (i) and (ii) above, the signal unit is discarded. If the received forward indicator bit is in the same state as the last sent backward indicator bit, a negative acknowledgement is sent.

Monitoring of the backward sequence number value and backward indicator bit value is performed even for those signal units that are discarded by the signal unit sequence control as described in § 5.3.

5.2.3 *Positive acknowledgement*

The receiving signalling link terminal acknowledges the acceptance of one or more message signal units by assigning the forward sequence number value of the latest accepted message signal unit to the backward sequence number of the next signal unit sent in the opposite direction. The backward sequence numbers of subsequent signal units retain this value until a further message signal unit is acknowledged, which will cause a change of the backward sequence number sent.

The acknowledgement to an accepted message signal unit also represents an acknowledgement to all, if any, previously accepted, though not yet acknowledged, message signal units.

5.2.4 *Negative acknowledgement*

If a negative acknowledgement is to be sent (see § 5.2.2), then the backward indicator bit value of the signal units transmitted is inverted. The new backward indicator bit value is maintained in subsequently sent signal units until a new negative acknowledgement is to be sent. The backward sequence numbers assume the value of the forward sequence number of the last accepted message signal unit.

5.3 *Retransmission*

5.3.1 *Response to a positive acknowledgement*

The transmitting signalling link terminal examines the backward sequence number value of the received message signal units and fill-in signal units that have satisfied the polynomial error check. The previously sent message signal unit, which has a forward sequence number value identical to the received backward sequence number value will no longer be available for transmission.

When an acknowledgement of a message signal unit having a given forward sequence number value is received, all other message signal units which preceded that message signal unit are considered to be acknowledged even though the corresponding backward sequence numbers have not been received.

In the case that the same acknowledgement is consecutively received a number of times no further action is taken.

In the case that a signal unit is received having a backward sequence number value which is not the same as the previous one or one of the forward sequence number values of the signal units available for retransmission, the signal unit is discarded. The following signal unit is discarded.

If any two backward sequence number values in three consecutively received signal units are not the same as the previous one or any of the forward sequence number values of the signal units in the retransmission buffer at the time that they are received, then level 3 is informed that the link is faulty.

In the case of excessive delay in the reception of acknowledgements a link failure indication is given to level 3.

5.3.2 *Response to a negative acknowledgement*

When the received backward indicator bit is not in the same state as the last sent forward indicator bit, all the message signal units available for retransmission are transmitted in correct sequence starting with the signal unit which has a forward sequence number value of one more (modulo 128, see § 2.3.5) than the backward sequence number associated with the received backward indicator bit.

New message signal units can only be sent when the last message signal unit available for retransmission has been transmitted.

At the start of a retransmission the forward indicator bit is inverted, it thus becomes equal to the backward indicator bit value of the received signal units. The new forward indicator bit value is maintained in subsequently transmitted signal units until a new retransmission is started. Thus, under normal conditions the forward indicator bit included in the transmitted signal units is equal to the backward indicator bit value of the received signal units. If a retransmitted message signal unit is lost, then this is detected by a check on the forward sequence number and forward indicator bit (see § 5.2.2) and a new retransmission request is made.

In the case that a signal unit is received having a forward indicator bit value indicating the start of a retransmission when no negative acknowledgement has been sent, then that signal unit is discarded.

If any two forward indicator bit values in three consecutively received signal units indicate the start of a retransmission when no negative acknowledgement has been sent at the time that they are received, then level 3 is informed that the link is faulty.

Note – Repetition of message signal units

The signal unit sequence control makes it possible to repeat a message signal unit which has not yet been acknowledged without affecting the basic error correction procedure. Thus a form of forward error correction by means of repetition of message signal units is possible as a national option (e.g., to reduce the effective signalling link speed in special national applications, and in long loop delay applications to lower the retransmission rate and thus reduce the average message delay). In the case of repetition, each signal unit should be defined by its own opening and closing flags (i.e. there should be at least two flags between signal units) to ensure that the repeated signal unit is not lost by the corruption of only a single flag.

6 Error correction by preventive cyclic retransmission

6.1 *General*

The preventive cyclic retransmission method is essentially a noncompelled forward error correction method, whereby positive acknowledgements are needed to support the forward error correction.

Each message signal unit must be retained at the transmitting signalling link terminal until a positive acknowledgement arrives from the receiving signalling link terminal.

Error correction is effected by preventive cyclic retransmission of the message signal units already sent, though not yet acknowledged. Preventive cyclic retransmission takes place whenever there are no new message signal units or link status signal units available to be sent.

To complement preventive cyclic retransmission, the message signal units available for retransmission are retransmitted with priority when a limit of the number of message signal units or a limit of the number of message signal unit octets available for retransmission has been reached.

Under normal conditions, when no message signal units are to be transmitted or cyclically retransmitted, fill-in signal units are sent. In some particular cases link status signal units, continuous fill-in signal units or flags may be sent as described in §§ 7, 8 and 10.

6.2 *Acknowledgements*

6.2.1 *Sequence numbering*

For the purposes of acknowledgement and signal unit sequence control, each signal unit carries 2 sequence numbers. The signal unit sequence control is performed by means of the forward sequence number. The acknowledgement function is performed by means of the backward sequence number.

The value of the forward sequence number of a message signal unit is obtained by incrementing (modulo 128, see § 2.3.5) the last assigned value by 1. This forward sequence number value uniquely identifies the message signal unit until its delivery is accepted without errors and in correct sequence, by the receiving signalling link terminal. The forward sequence number of a signal unit other than a message signal unit assumes the value of the forward sequence number of the last transmitted message signal unit.

6.2.2 *Signal unit sequence control*

Information regarding the service information octet, signalling information field, forward sequence number and the length of each message signal unit is retained at the transmitting signalling link terminal until the related acknowledgement is received (see § 6.2.3). In the meantime the same forward sequence number value cannot be used for another message signal unit (see § 6.2.3).

A forward sequence number value can be assigned to a new message signal unit to be sent when an acknowledgement concerning that value incremented by at least 1 (modulo 128) is received (see § 6.2.3).

The action to be taken at the receiving signalling link terminal upon receipt of a correctly checking signal unit is determined by comparison of the received forward sequence number with the forward sequence number of the last previously accepted signal unit.

In addition, as the appropriate action differs for a message signal unit and another signal unit, the length indicator of the received signal unit must be examined. The forward indicator bit and the backward indicator bit are not used and are set to 1.

a) If the signal unit is not a message signal unit, then the signal unit is processed within the message transfer part.

b) If the signal unit is a message signal unit then:

   i) if the forward sequence number value is the same as that of the last accepted signal unit, the signal unit is discarded;

   ii) if the forward sequence number value is one more (modulo 128, see § 2.3.5) than that of the last accepted signal unit, the signal unit is accepted and delivered to level 3. Explicit positive acknowledgements for the accepted signal units are sent as specified in § 6.2.3;

   iii) if the forward sequence number value is different from the values mentioned in i) and ii) above, the signal unit is discarded. Monitoring of the backward sequence number value is performed even for those signal units that are discarded by the signal unit sequence control, as described in § 6.3.1.

6.2.3 *Positive acknowledgement*

The receiving signalling link terminal acknowledges the acceptance of one or more message signal units by assigning the forward sequence number value of the latest accepted message signal unit to the backward sequence number of the next signal unit sent. The backward sequence numbers of subsequent signal units retain this value until a further message signal unit is acknowledged, which will cause a change of the backward sequence number sent. The acknowledgement to an accepted message signal unit also represents an acknowledgement to all, if any, previously accepted though not yet acknowledged signal units.

6.3 *Preventive cyclic retransmission*

6.3.1 *Response to a positive acknowledgement*

All message signal units sent for the first time are retained until they have been positively acknowledged.

The transmitting signalling link terminal examines the backward sequence number value of the received message signal units and fill-in signal units that have satisfied the polynomial error check. The previously sent message signal unit, the forward sequence number value of which is the same as the backward sequence number value, will no longer be available for retransmission.

When an acknowledgement for a message signal unit having a given forward sequence number value is received, all other message signal units, if any, having forward sequence number values preceding that value (modulo 128) are considered to be acknowledged, even though the corresponding backward sequence number has not been received.

In the case that the same acknowledgement is consecutively received a number of times no further action is taken.

In the case that a signal unit is received having a backward sequence number value which is not the same as the previous one or one of the forward sequence number values of the signal units in the retransmission buffer, the signal unit is discarded. The backward sequence number of the following signal unit is not used as an acknowledgement to signal units in the retransmission buffer.

If any two backward sequence number values in three consecutively received signal units are not the same as the previous one or any of the forward sequence number values of the signal units in the retransmission buffer at the time that they are received, then level 3 is informed that the link is faulty.

6.3.2 *Preventive cyclic retransmission procedure*

i) If no new signal units are available to be sent, the message signal units available for retransmission are retransmitted cyclically.

ii) If new signal units are available, the retransmission cycle, if any, must be interrupted and the signal units be sent with priority.

iii) Under normal conditions, when no message signal units are to be transmitted or cyclically retransmitted, fill-in signal units are sent continuously. In some particular cases link status signal units, continuous fill-in signal units or flags may be sent as described in §§ 7, 8 and 10.

6.4 *Forced retransmission*

To maintain the efficiency of error correction in those cases where automatic error correction by preventive cyclic retransmission alone is made impossible (by, for example, high signalling load) the preventive cyclic retransmission procedures must be complemented by the forced retransmission procedure.

6.4.1 *Forced retransmission procedure*

Both the number of message signal units available for retransmission (N_1) and the number of message signal unit octets available for retransmission (N_2) are monitored continuously.

If one of them reaches its set limit, no new message signal units or fill-in signal units are sent and all the message signal units available for retransmission are retransmitted once with priority, in the order in which they were originally transmitted. If all message signal units available for retransmission have been sent once and neither N_1 nor N_2 is at its limit value, the normal preventive cyclic retransmission procedure can be resumed. If not, all the message signal units available are sent again with priority.

6.4.2 *Limitation of the values N_1 and N_2*

N_1 is limited by the maximum numbering capacity of the forward sequence number range which dictates that not more than 127 message signal units can be available for retransmission.

In the absence of errors N_2 is limited by the signalling link loop delay T_L. It must be ensured that not more than $T_L/T_{eb} + 1$ message signal unit octets are available for retransmission,

where

T_L is the signalling link loop delay, i.e. the time between the sending of a message signal unit and the reception of the acknowledgement for this message signal unit in undisturbed operation; and

T_{eb} is the emission time of one octet.

7 Initial alignment procedure

7.1 *General*

The procedure is applicable to activation and to restoration of the link. The procedure provides a "normal" proving period for "normal" initial alignment and an "emergency" proving period for "emergency" initial alignment. The decision to apply either the "normal" or the "emergency" procedures is made unilaterally at level 3 (see Recommendation Q.704). Only the signalling link to be aligned is involved in the initial alignment procedure (i.e. no transfer of alignment information over other signalling links is required).

7.2 *Initial alignment status indications*

The initial alignment procedure employs four different alignment status indications:

- status indication "O": out of alignment;
- status indication "N": "normal" alignment status;
- status indication "E": "emergency" alignment status;
- status indication "OS": out of service.

These indications are carried in the status field of the link status signal units (see § 2.2).

Status indication "O" is transmitted when initial alignment has been started and none of the status indications "O", "N" or "E" are received from the link. Status indication "N" is transmitted when, after having started initial alignment, status indication "O", "N" or "E" is received and the terminal is in the "normal" alignment status. Status indication "E" is transmitted when, after having started initial alignment, status indication "O", "N" or "E" is received and the terminal is in the "emergency" alignment status, i.e. it must employ the short "emergency" proving period.

Status indications "N" and "E" indicate the status of the transmitting signalling link terminal; this is not changed by reception of status indications indicating a different status at the remote signalling link terminal. Hence, if a signalling link terminal with a "normal" alignment status receives a status indication "E" it continues to send status indication "N" but initiates the short "emergency" proving period.

Status indication "OS" informs the remote signalling link terminal that for reasons other than processor outage (e.g. link failure) the signalling link terminal can neither receive nor transmit message signal units.

7.3 *Initial alignment procedure*

The alignment procedure passes through a number of states during the initial alignment:

- State 00, the procedure is suspended.
- State 01, "not aligned"; the signalling link is not aligned and the terminal is sending status indication "O". Time-out T_2 is started on entry to State 01 and stopped when State 01 is left [4].
- State 02, "aligned"; the signalling link is aligned and the terminal is sending status indication "N" or "E", status indications "N", "E" or "OS" are not received. Time-out T_3 is started on entry to State 02 and stopped when State 02 is left.

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[4] It must be ensured that the values of this time-out are different at each end of a signalling link (see Recommendation Q.704, § 10).

– State 03, "proving"; the signalling link terminal is sending status indication "N" or "E", status indication "O" or "OS" are not received, the backward indicator bit and the backward sequence number transmitted are set to the received forward indicator bit and forward sequence number, proving has been started.

The procedure itself is described in the overview diagram, Figure 4/Q.703, and in state transition diagram, Figure 9/Q.703.

7.4 *Proving periods*

The values of the proving periods are:

$$P_n = 2^{16} \text{ octets}$$

$$P_e = 2^{12} \text{ octets}$$

for both 64 kbit/s and lower bit rates. These values correspond to times of 8.2 s and 0.5 s respectively at 64 kbit/s, and 110 s and 7 s at 4.8 kbit/s.

8 Processor outage

The procedure for dealing with local and/or remote processor outage is described in Figure 10/Q.703.

A processor outage situation occurs when, due to factors at a functional level higher than level 2, use of the link is precluded.

In this context, processor outage refers to a situation when signalling messages cannot be transferred to functional levels 3 and/or 4. This may be because of, for example, a central processor failure. It may also be due to a manually initiated blocking of an individual signalling link (see Recommendation Q.704, § 3.2.6). A processor outage condition may thus not necessarily affect all signalling links in a signalling point, nor does it exclude the possibility that level 3 is able to control the operation of the signalling link.

When level 2 identifies a local processor outage condition, either by receiving an explicit indication from level 3, (i.e. local signalling link blocking, see Recommendation Q.704, § 3.2.6), or by recognizing a failure of level 3, it transmits link status signal units indicating processor outage. Provided that the level 2 function at the far end of the signalling link is in its normal operating stage (i.e. transmitting message signal units or fill-in signal units), upon receiving link status signal units indicating processor outage it notifies level 3 and begins to continuously transmit fill-in signal units.

When the local processor outage condition ceases, normal transmission of message signal units and fill-in signal units is resumed (provided that no local processor outage condition has arisen also at the remote end); as soon as the level 2 function at the remote end correctly receives a message signal unit or fill-in signal unit, it notifies level 3 and returns to normal operation.

Format and code of link status signal units indicating processor outage (status indication "PO") appear in § 10.

9 Signalling link error monitoring

9.1 *General*

Two link error rate monitor functions are provided; one which is employed whilst a signalling link is in service and which provides one of the criteria for taking the link out of service, and one which is employed whilst a link is in the proving state of the initial alignment procedure (see § 7.3). These are called the signal unit error rate monitor and the alignment error rate monitor respectively.

9.2 *Signal unit error rate monitor*

9.2.1 The characteristics of the signal unit error rate monitor are described by the curve of an orthogonal hyperbola which gives the time to cause a link failure indication to level 3 (expressed in terms of messages) as a function of the signal unit error rate. The two parameters which determine the curve are: the number of consecutive signal units received in error that will cause an error rate high indication to level 3, T (signal units), and the lowest signal unit error rate which will ultimately cause an error rate high indication to level 3, $1/D$ (signal unit errors/signal unit) (see Figure 5/Q.703).

SIE	Status indication "E"
SIN	Status indication "N"
SIO	Status indication "O"
SIOS	Status indication "out of service"

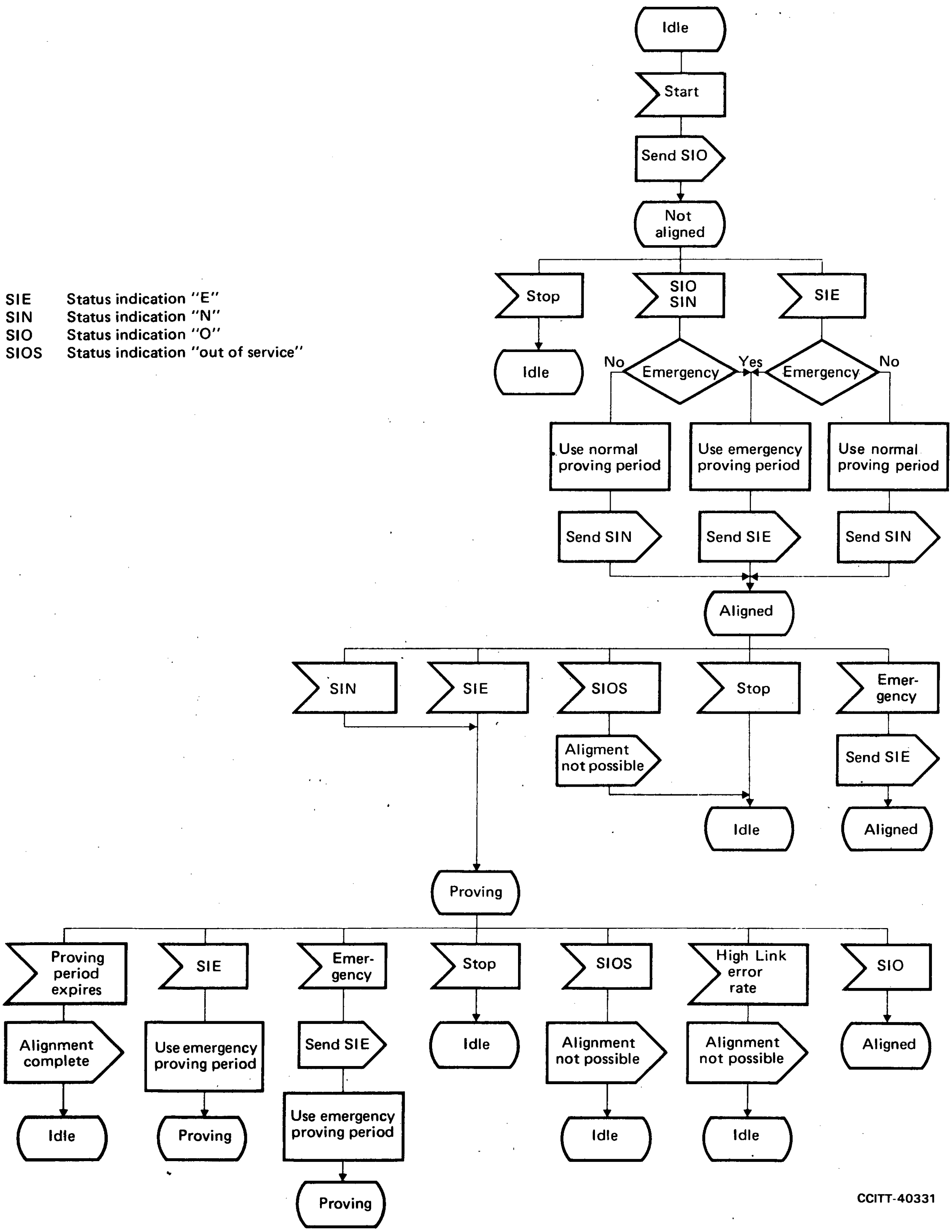


FIGURE 4/Q.703

Overview diagram of initial alignment control

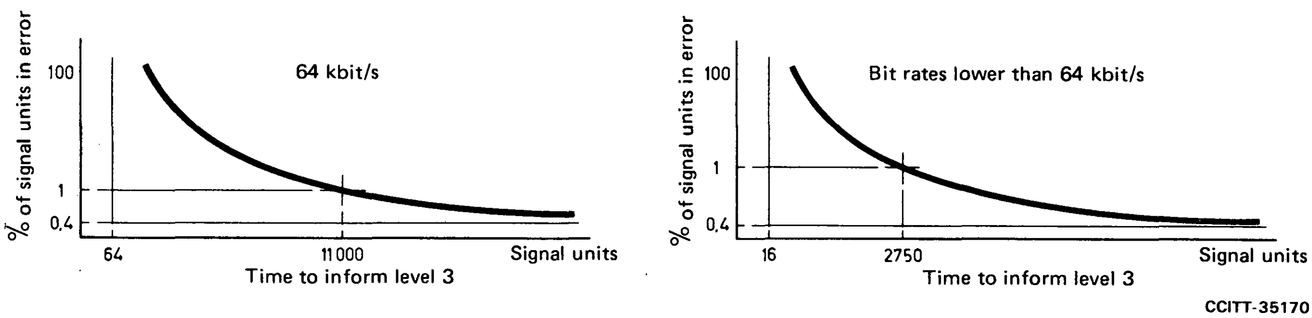


FIGURE 5/Q.703

Orthogonal hyperbola of the signal unit error rate monitor

9.2.2 The signal unit error rate monitor may be implemented in the form of an up/down counter decremented at a fixed rate (for every *D* received signal units or signal unit errors indicated by the acceptance procedure), but not below zero, and incremented every time a signal unit error is detected by the signal unit acceptance procedure (see § 4), but not above the threshold [*T* (signal units)]. An excessive error rate will be indicated whenever the threshold *T* is reached.

9.2.3 In the "octet counting" mode (see § 4.1) the counter is incremented for every *N* octets received until a correctly checking signal unit is detected (causing the "octet counting" mode to be left).

9.2.4 When the link is brought into service the monitor count should start from zero.

9.2.5 The values of the three parameters are:

T	= 64 signal units	For 64 kbit/s
D	= 256 signal units/signal unit error	
N	= 16 octets	
T	= 32 signal units	For lower bit rates
D	= 256 signal units/signal unit error	
N	= 16 octets	

In the case of loss of alignment these figures will give times of approximately 128 ms and 854 ms to initiate changeover for 64 kbit/s and 4.8 kbit/s respectively.

9.3 *Alignment error rate monitor*

9.3.1 The alignment error rate monitor is a linear counter which is operated during normal and emergency proving periods.

9.3.2 The counter is started from zero whenever the proving state (State 03 of Figure 9/Q.703) of the alignment procedure is entered and is then incremented for every signal unit error detected. It is also incremented for every *N* octets received while in the octet counting mode, as described in § 9.2.3.

9.3.3 When the counter reaches a threshold T_i, that particular proving period is aborted; on receipt of a correct signal unit or the expiry of the aborted proving period the proving state is reentered. If proving is aborted *M* times, the link is returned to the out-of-service state. A threshold is defined for each of the two types of proving period (normal and emergency, see § 7). These are T_{in} and T_{ie} and apply to the normal proving period and the emergency proving period respectively.

Proving is successfully completed when a proving period expires without an excessive error rate being detected and without the receipt of status indication "O" or "OS".

9.3.4 The values of the four parameters for both 64 kbit/s and lower bit rates are:

T_{in} = 4

T_{ie} = 1

M = 5

N = 16

10 Level 2 codes and priorities

10.1 *Link status signal unit*

10.1.1 The link status signal unit is identified by a length indicator value equal to 1 or 2. If the length indicator has a value of 1 then the status field consists of one octet; if the length indicator has a value of 2 then the status field consists of two octets.

10.1.2 The format of the one octet status field is shown in Figure 6/Q.703.

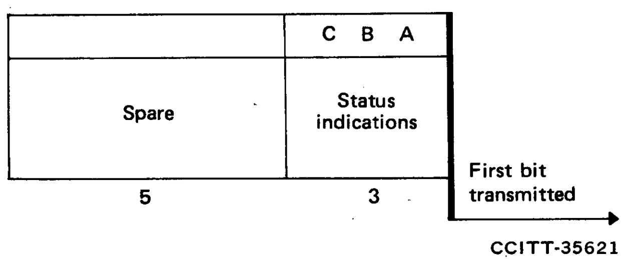


FIGURE 6/Q.703

Status field format

10.1.3 The use of the link status indications is described in § 7; they are coded as follows:

C B A

0 0 0 – Status indication "O"

0 0 1 – Status indication "N"

0 1 0 – Status indication "E"

0 1 1 – Status indication "OS"

1 0 0 – Status indication "PO"

10.2 *Transmission priorities within level 2*

10.2.1 Five different items can be transmitted:

i) new message signal units;

ii) message signal units which have not yet been acknowledged;

iii) link status signal units;

iv) fill-in signal units;

v) flags.

In certain failure conditions it may only be possible to send flags or nothing at all.

10.2.2 For the basic error control method the priorities are:

Highest 1. Link status signal units.

2. Message signal units which have not yet been acknowledged and for which a negative acknowledgement has been received.

3. New message signal units.

4. Fill-in signal units.

Lowest 5. Flags.

10.2.3 For the preventive cyclic retransmission method the priorities are:

Highest 1. Link status signal units.

2. Message signal units which have not yet been acknowledged and which are stored in a retransmission buffer and exceed one of the parameters N_1 and N_2.

3. New message signal units.

4. Message signal units which have not yet been acknowledged.

5. Fill-in signal units.

Lowest 6. Flags.

Note – In the basic error control method, where the repetition of message signal units is employed as a national option, the repeated message signal unit will have a priority immediately below that of link status signal units.

11 State transition diagrams

11.1 § 11 contains the description of the signalling link control functions, described in this Recommendation, in the form of state transition diagrams according to the CCITT Specification and Description Language (SDL). The following list summarizes these diagrams:

- Level 2 – Functional block diagram: Figure 7/Q.703.
- Link state control: Figure 8/Q.703.
- Initial alignment control: Figure 9/Q.703.
- Processor outage control: Figure 10/Q.703.
- Delimitation, alignment and error detection (receiving): Figure 11/Q.703.
- Delimitation, alignment and error detection (transmitting): Figure 12/Q.703.
- Basic transmission control: Figure 13/Q.703.
- Basic reception control: Figure 14/Q.703.
- Preventive cyclic retransmission transmission control: Figure 15/Q.703.
- Preventive cyclic retransmission reception control: Figure 16/Q.703.
- Alignment error rate monitor: Figure 17/Q.703.
- Signal unit error rate monitor: Figure 18/Q.703.

The detailed functional breakdown shown in the following diagrams is intended to illustrate a reference model and to assist interpretation of the text in the earlier sections. The state transition diagrams are intended to show precisely the behaviour of the signalling system under normal and abnormal conditions as viewed from a remote location. It must be emphasized that the functional partitioning shown in the following diagrams is used only to facilitate understanding of the system behaviour and is not intended to specify the functional partitioning to be adopted in a practical implementation of the signalling system.

In the following figures the term *signal unit* refers to units which do not contain all error control information.

11.2 *Abbreviations and timers used in Figure 7/Q.703*

AERM Alignment error rate monitor

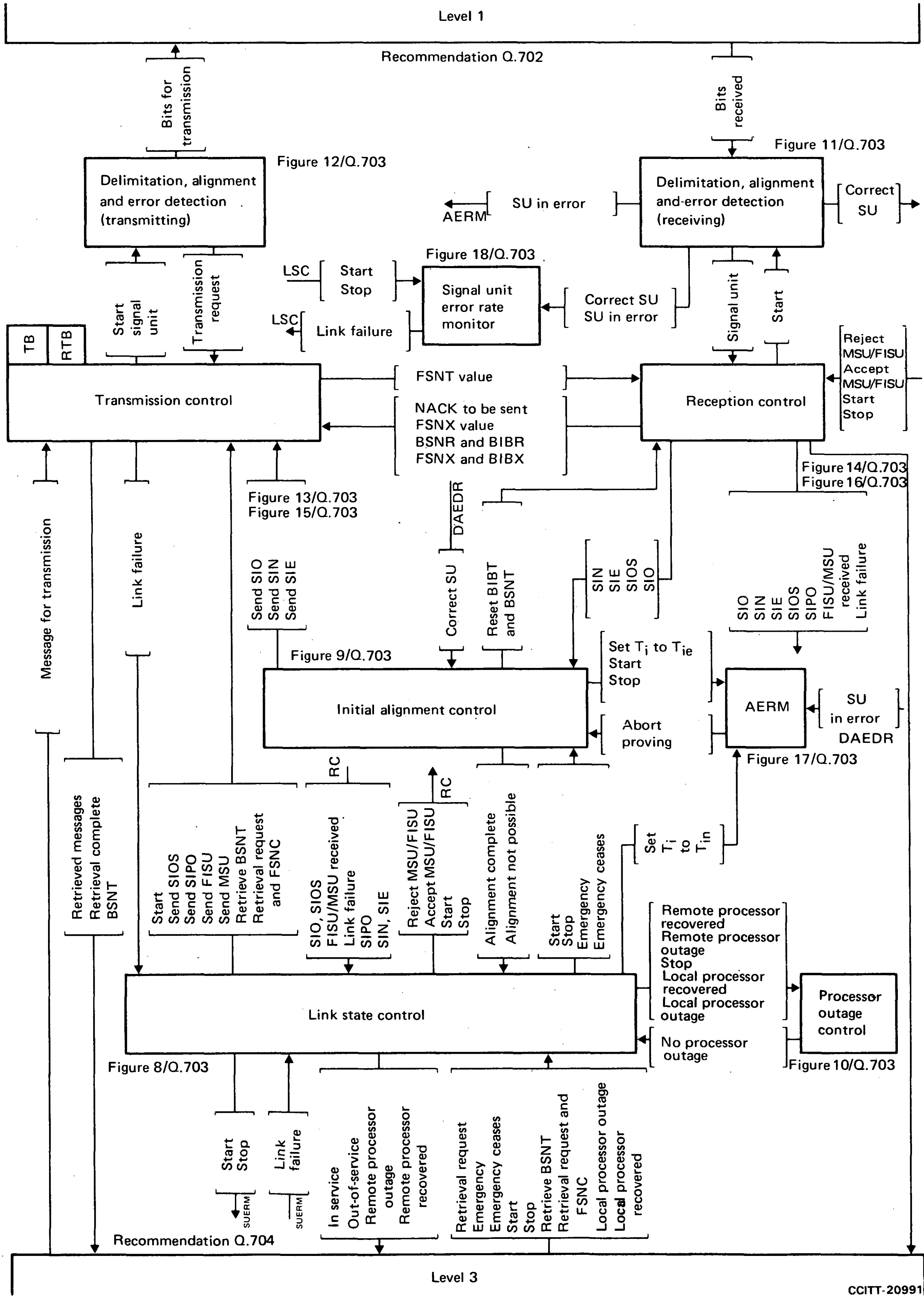
BIB Backward indicator bit

BIBR BIB received

BIBT	BIB to be transmitted
BIBX	BIB expected
BSN	Backward sequence number
BSNR	BSN received
BSNT	BSN to be transmitted
DAEDR	Delimination, alignment and error detection (receiving)
FIB	Forward indicator bit
FISU	Fill-in signal unit
FSN	Forward sequence number
FSNC	Forward sequence number of last message signal unit accepted by remote level 2
FSNT	FSN of the last MSU transmitted
FSNX	FSN expected
LSC	Link state control
MSU	Message signal unit
NACK	Negative acknowledgement
RC	Reception control
RTB	Retransmission buffer
SIE	Status indication "E" ("emergency alignment")
SIN	Status indication "N" ("normal alignment")
SIO	Status indication "O" ("out of alignment")
SIOS	Status indication "out of service"
SIPO	Status indication "processor outage"
SU	Signal unit
SUERM	Signal unit error rate monitor
TB	Transmission buffer
T_i	AERM threshold
T_{ie}	Emergency AERM threshold
T_{in}	Normal AERM threshold

Timers used in Figures 8/Q.703 to 18/Q.703

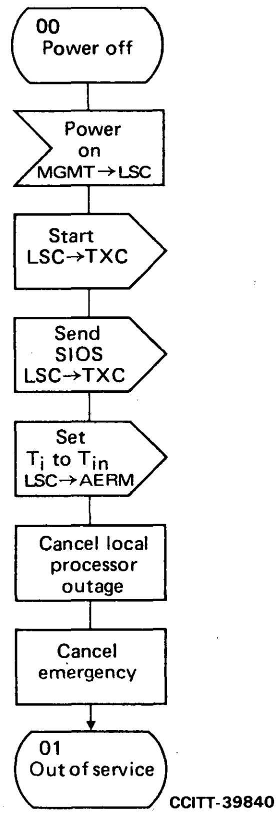
T1	Timer "alignment ready"
T2	Timer "not aligned"
T3	Timer "aligned"
T4	Proving period timer = 2^{16} or 2^{12} octets



Note – Abbreviated message names have been used in this diagram (i.e. origin → destination codes are omitted).

FIGURE 7/Q.703

Level 2 – functional block diagram



AERM	Alignment error rate monitor
LSC	Link state control
MGMT	Management system
TXC	Transmission control
T_i	Monitor threshof
T_{in}	Normal monitor threshold

FIGURE 8/Q.703 (Sheet 1 of 7)

Link state control

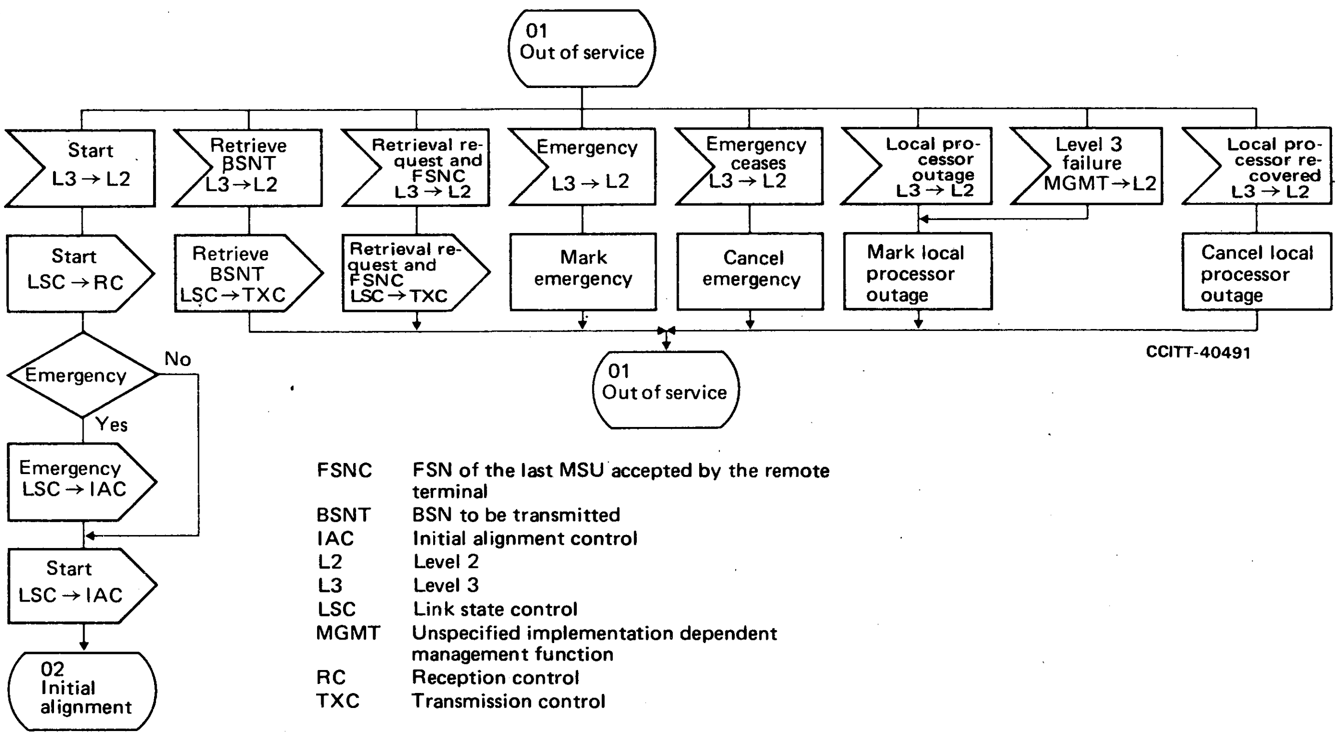


FIGURE 8/Q.703 (Sheet 2 of 7)

Link state control

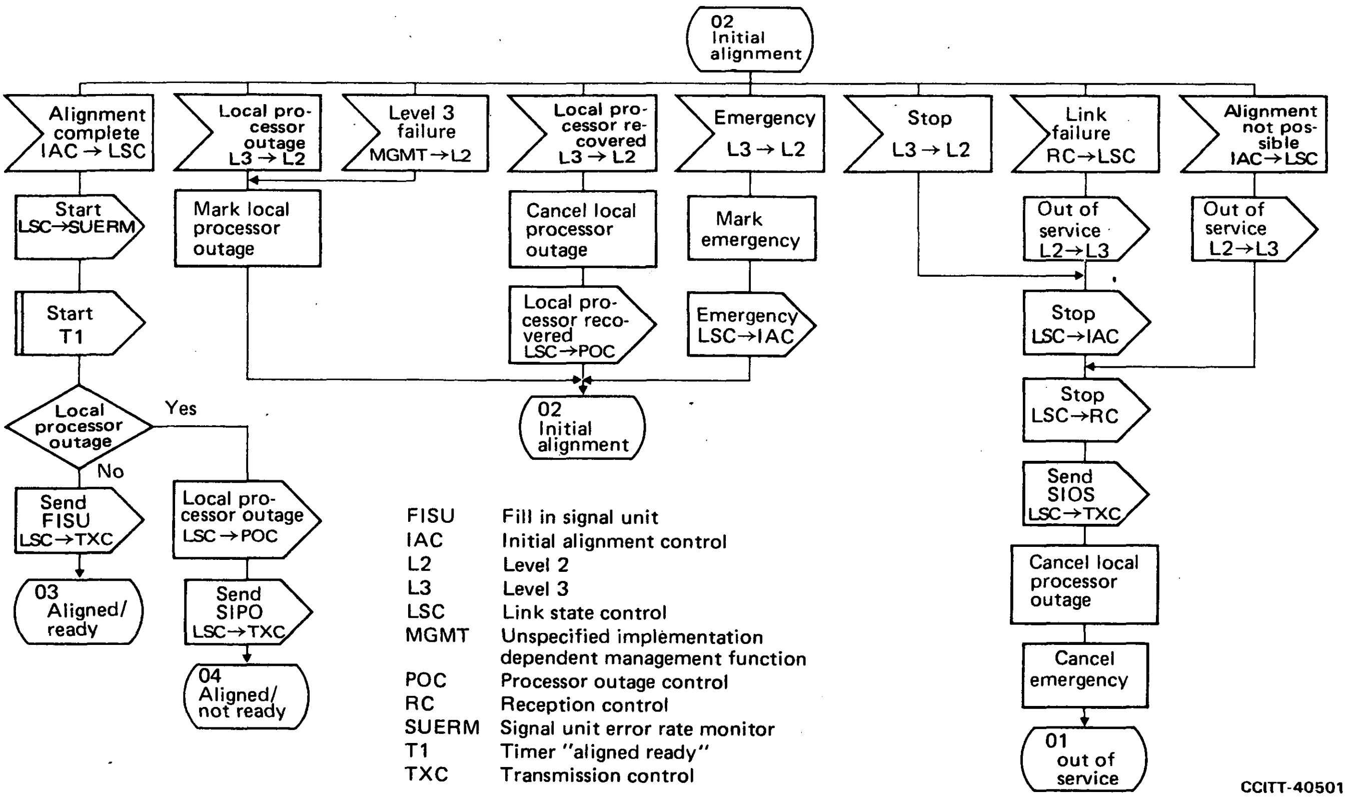
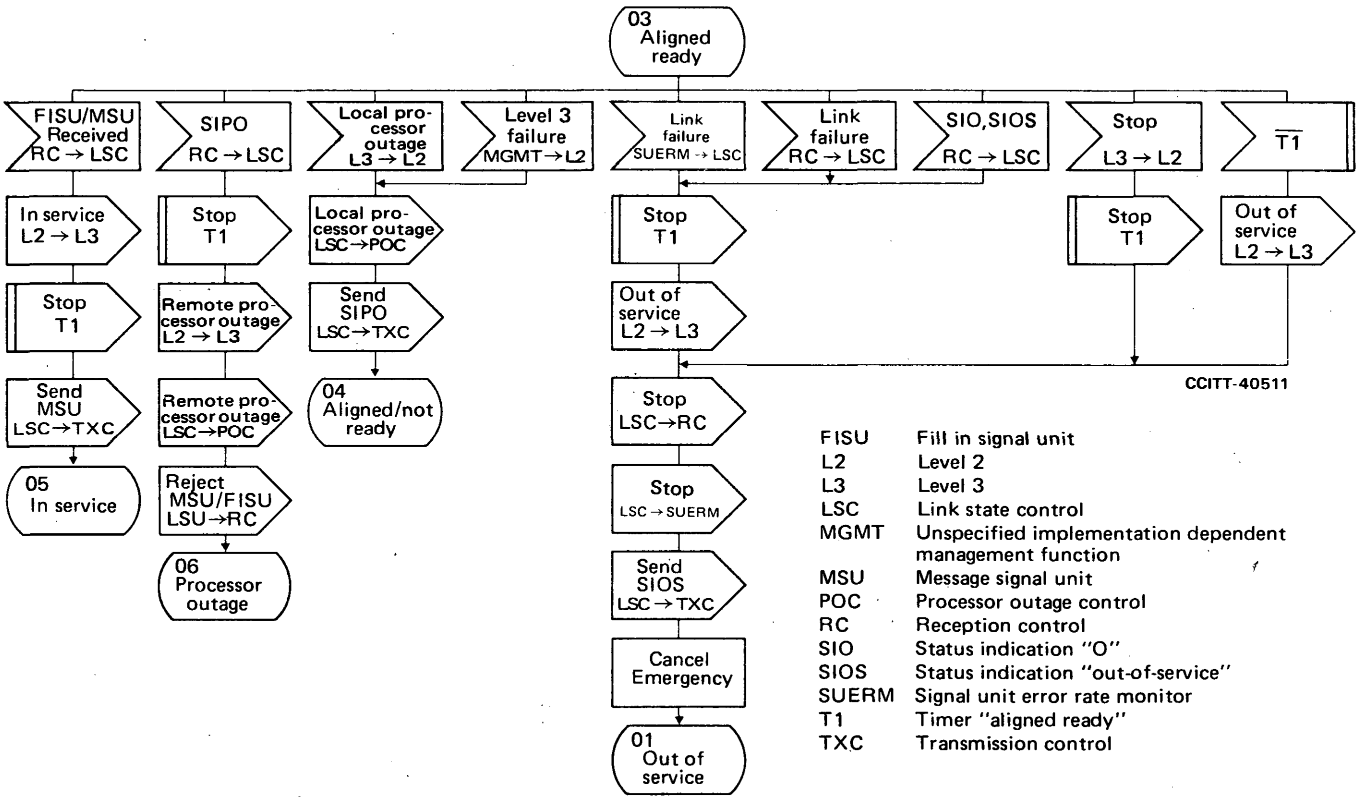


FIGURE 8/Q.703 (Sheet 3 of 7)

Link state control



FISU	Fill in signal unit
L2	Level 2
L3	Level 3
LSC	Link state control
MGMT	Unspecified implementation dependent management function
MSU	Message signal unit
POC	Processor outage control
RC	Reception control
SIO	Status indication "O"
SIOS	Status indication "out-of-service"
SUERM	Signal unit error rate monitor
T1	Timer "aligned ready"
TXC	Transmission control

FIGURE 8/Q.703 (Sheet 4 of 7)

Link state control

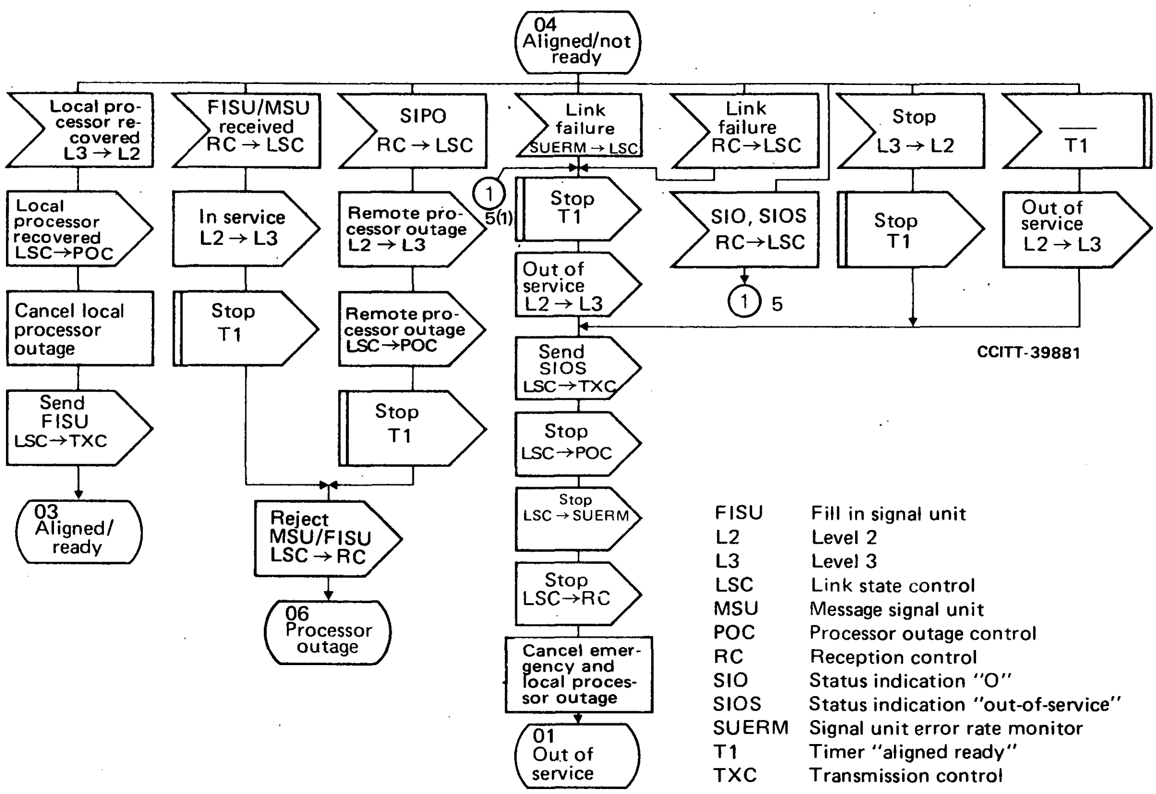


FIGURE 8/Q.703 (Sheet 5 of 7)

Link state control

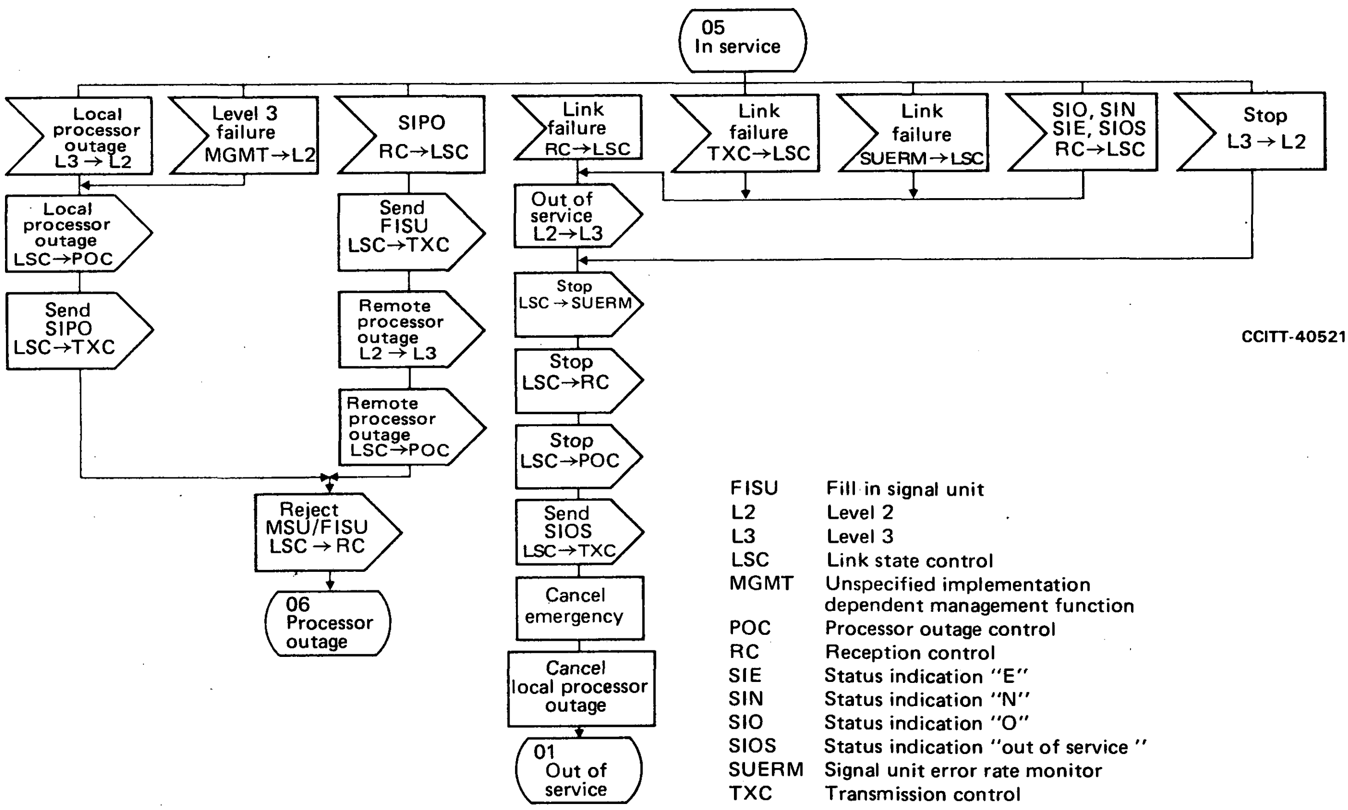
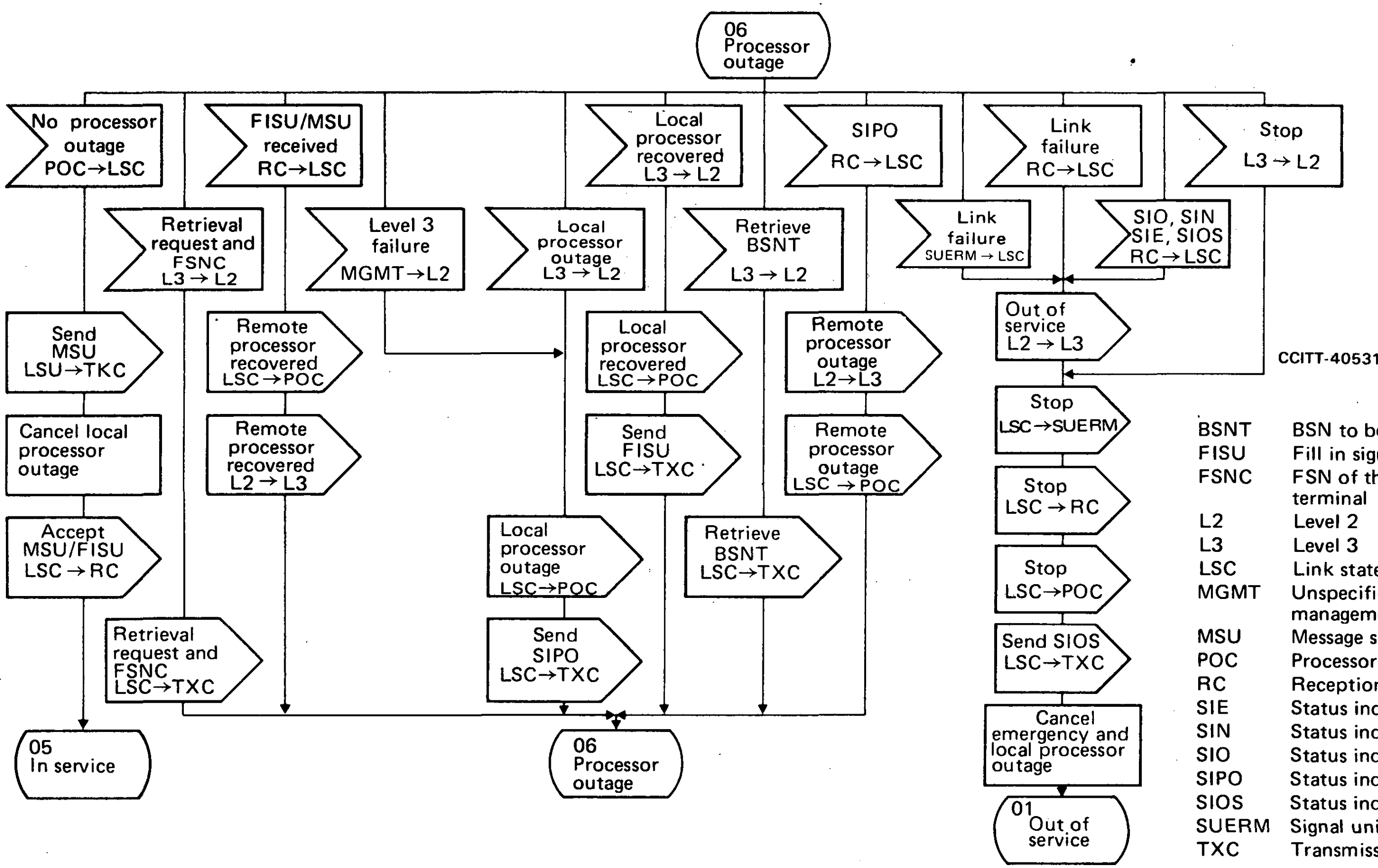


FIGURE 8/Q.703 (Sheet 6 of 7)

Link state control



BSNT	BSN to be transmitted
FISU	Fill in signal unit
FSNC	FSN of the last MSU accepted by the remote terminal
L2	Level 2
L3	Level 3
LSC	Link state control
MGMT	Unspecified implementation dependent management function
MSU	Message signal unit
POC	Processor outage control
RC	Reception control
SIE	Status indication "E"
SIN	Status indication "N"
SIO	Status indication "O"
SIPO	Status indication "processor outage"
SIOS	Status indication "out-of-service"
SUERM	Signal unit error rate monitor
TXC	Transmission control

FIGURE 8/Q.703 (Sheet 7 of 7)

Link state control

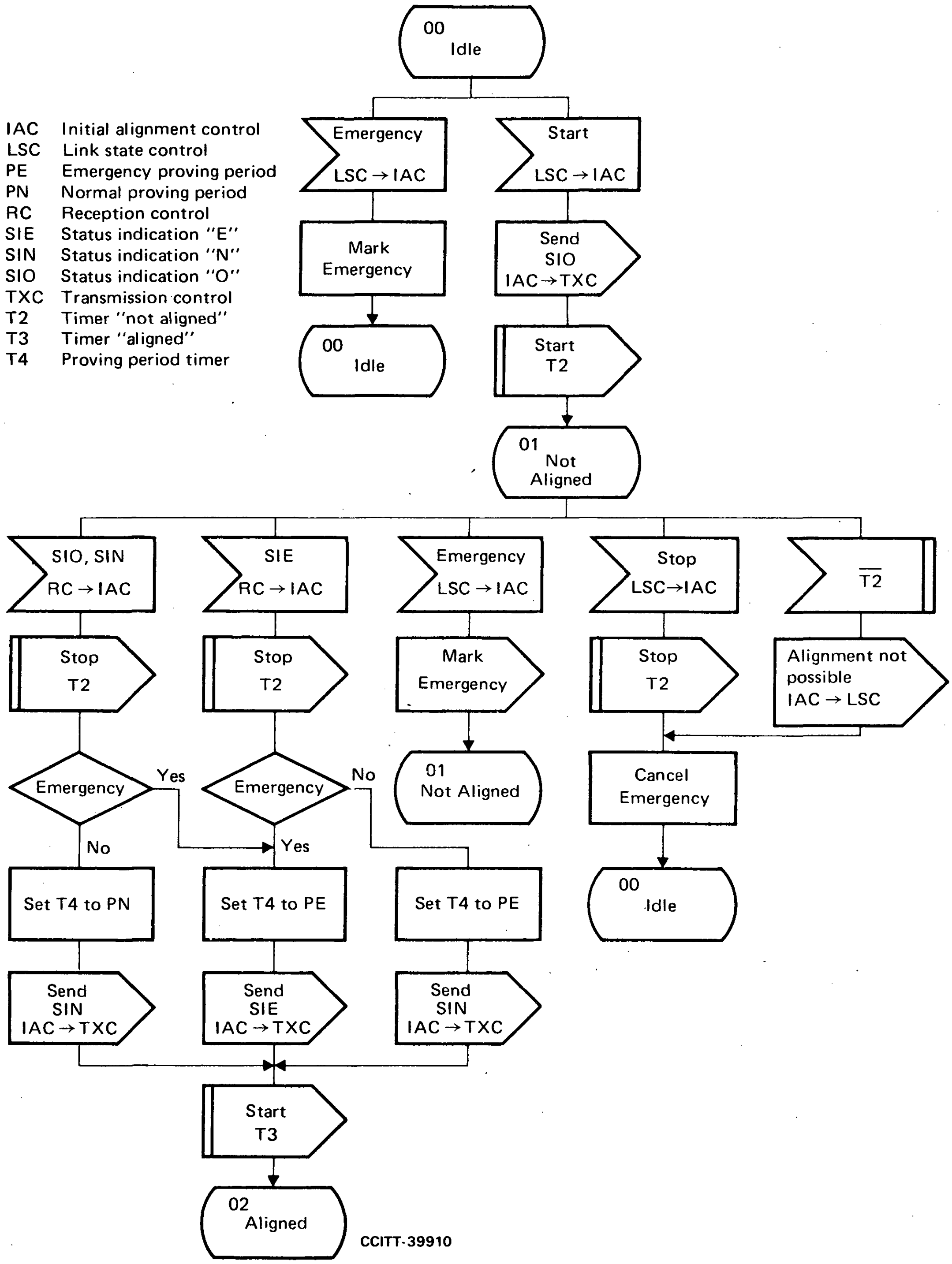
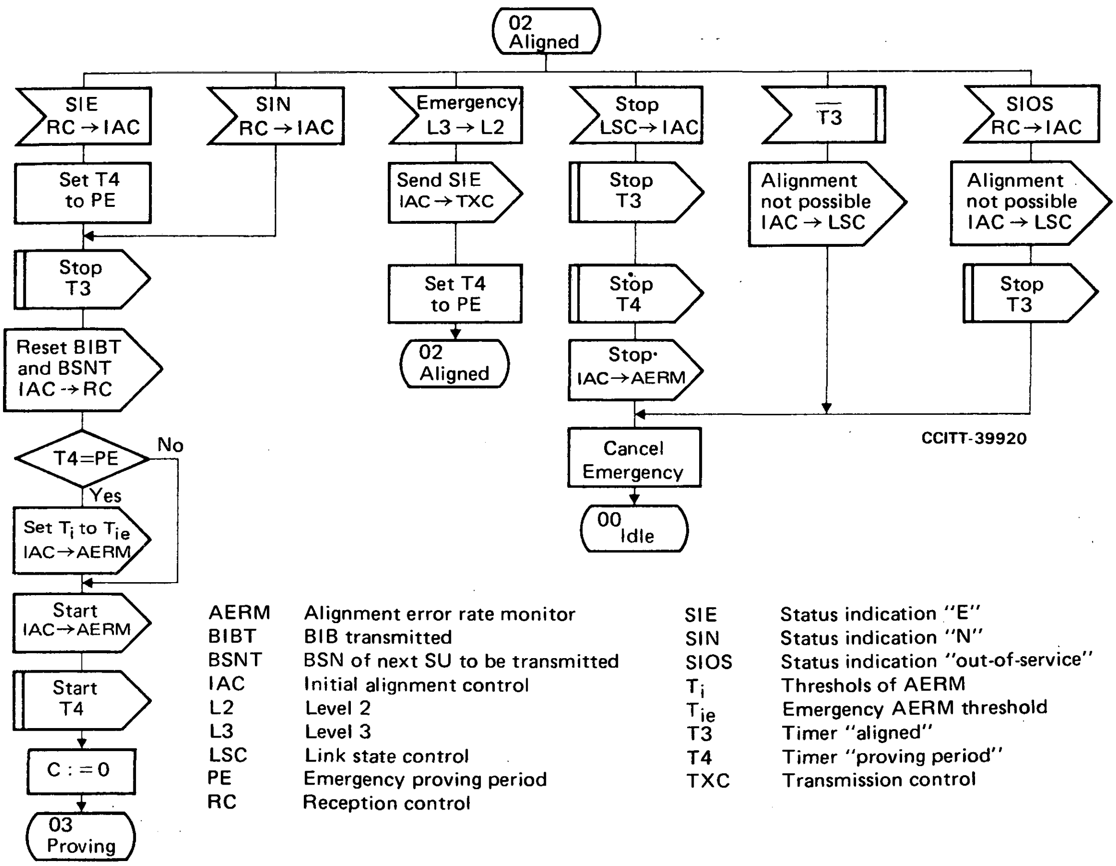


FIGURE 9/Q.703 (Sheet 1 of 3)

Initial alignment control



AERM	Alignment error rate monitor	SIE	Status indication "E"
BIBT	BIB transmitted	SIN	Status indication "N"
BSNT	BSN of next SU to be transmitted	SIOS	Status indication "out-of-service"
IAC	Initial alignment control	T_i	Threshols of AERM
L2	Level 2	T_{ie}	Emergency AERM threshold
L3	Level 3	T3	Timer "aligned"
LSC	Link state control	T4	Timer "proving period"
PE	Emergency proving period	TXC	Transmission control
RC	Reception control		

FIGURE 9/Q.703 (Sheet 2 of 3)

Initial alignment control

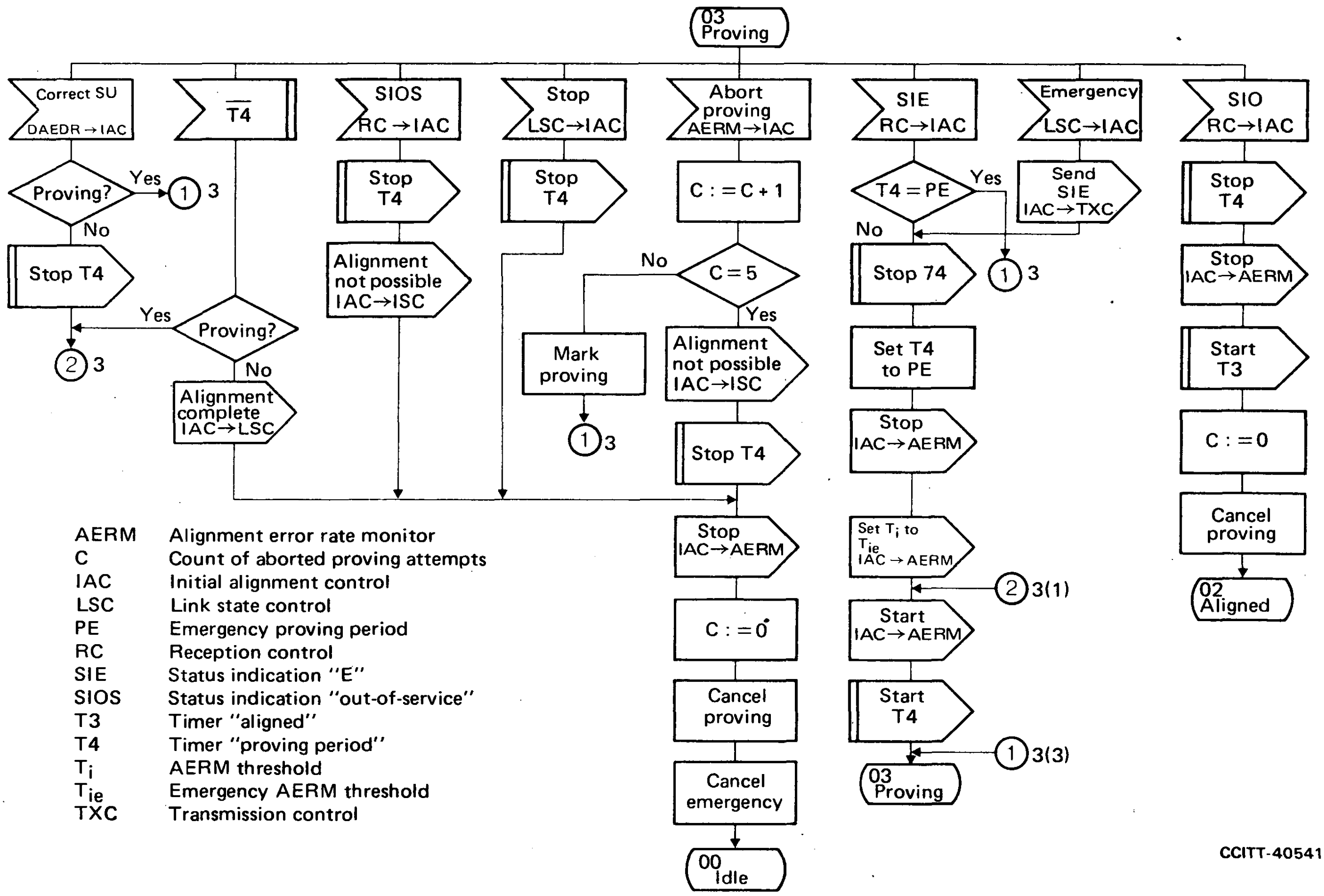
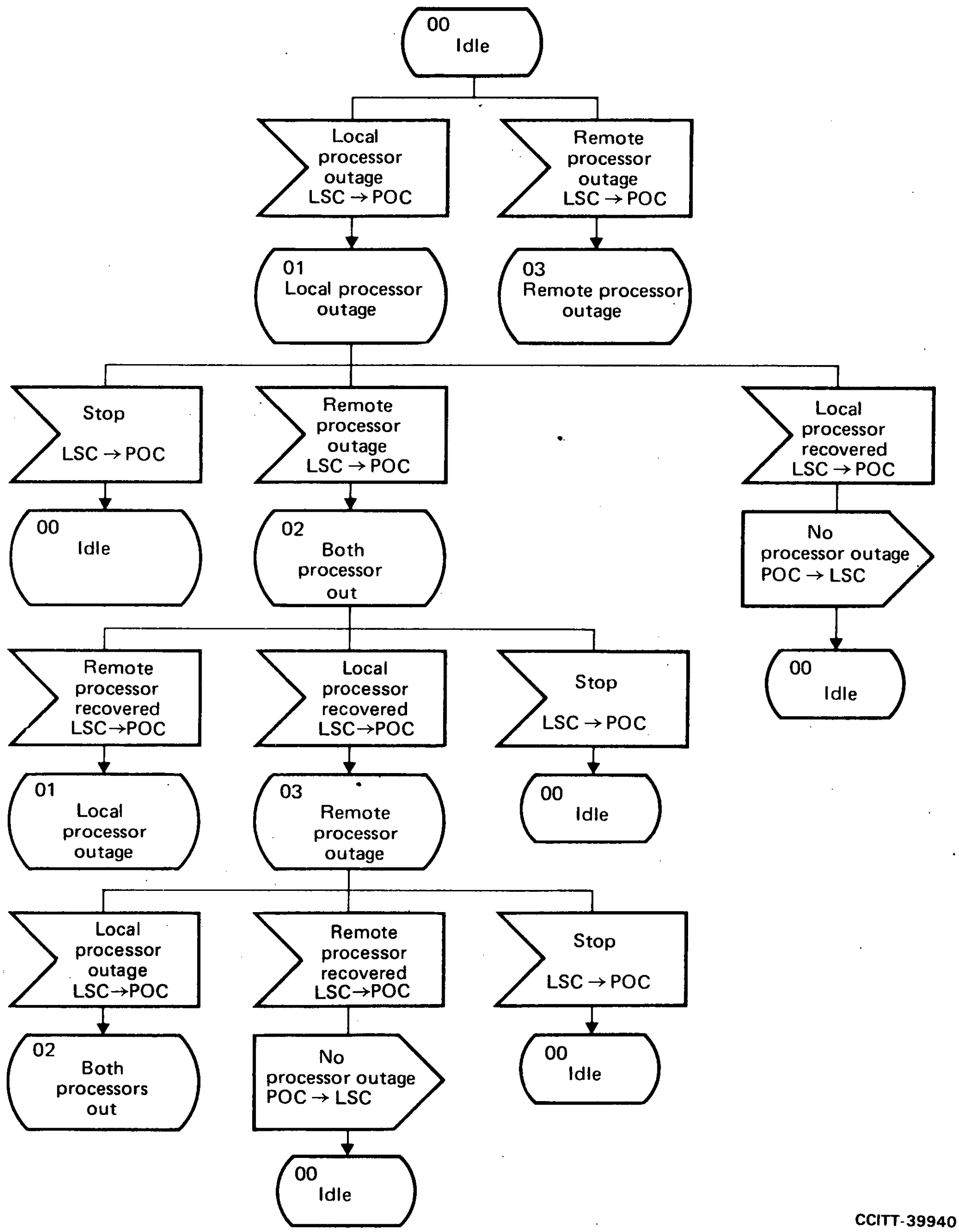


FIGURE 9/Q.703 (Sheet 3 of 3)

Initial alignment control



LSC Link state control
POC Processor outage control

FIGURE 10/Q.703

Processor outage control

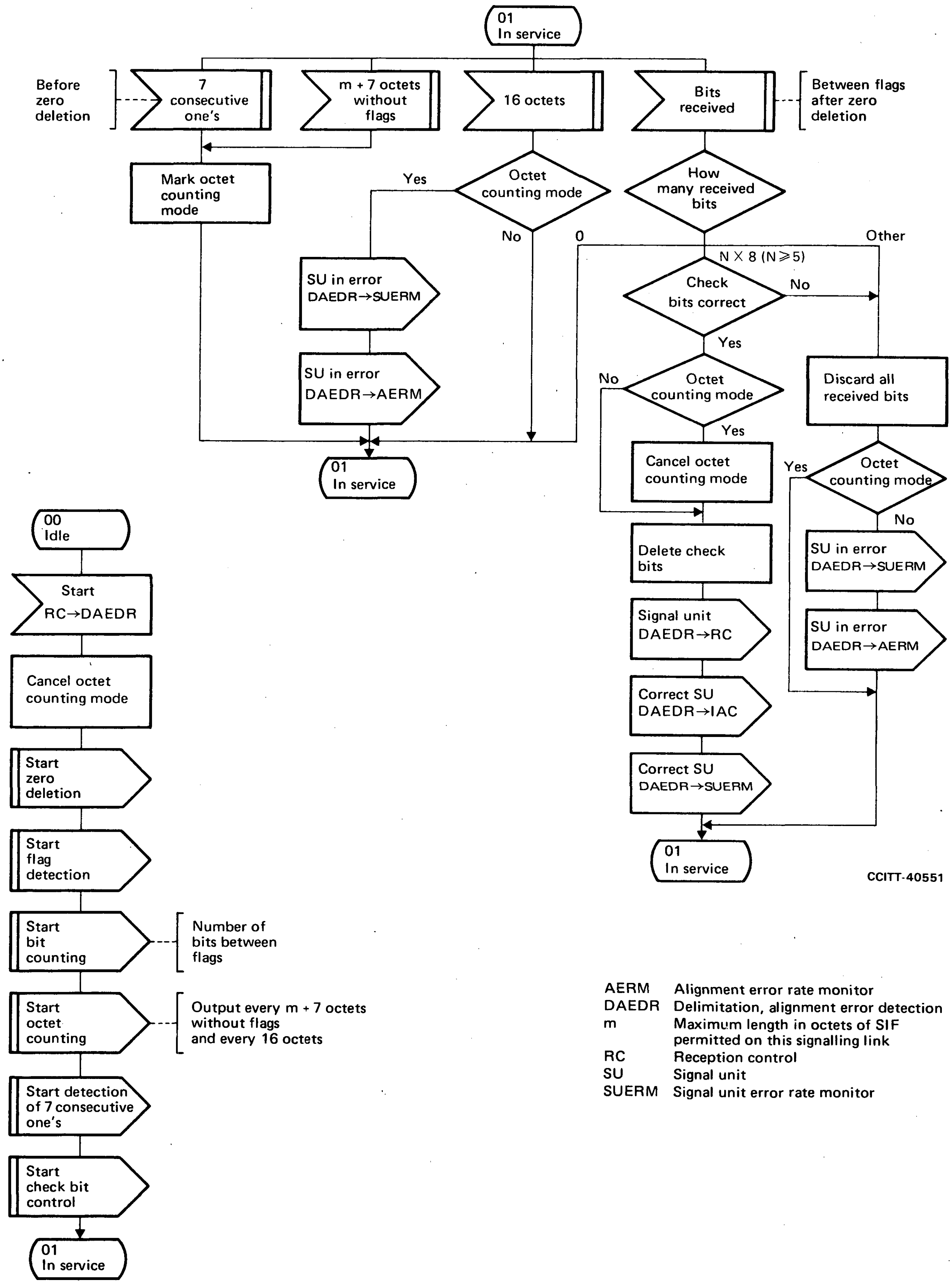
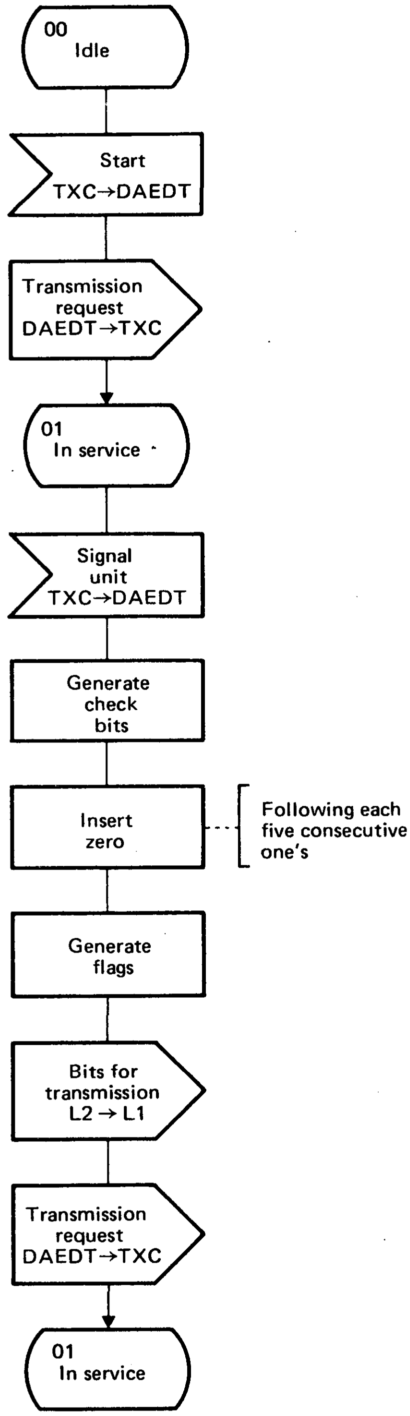


FIGURE 11/Q.703

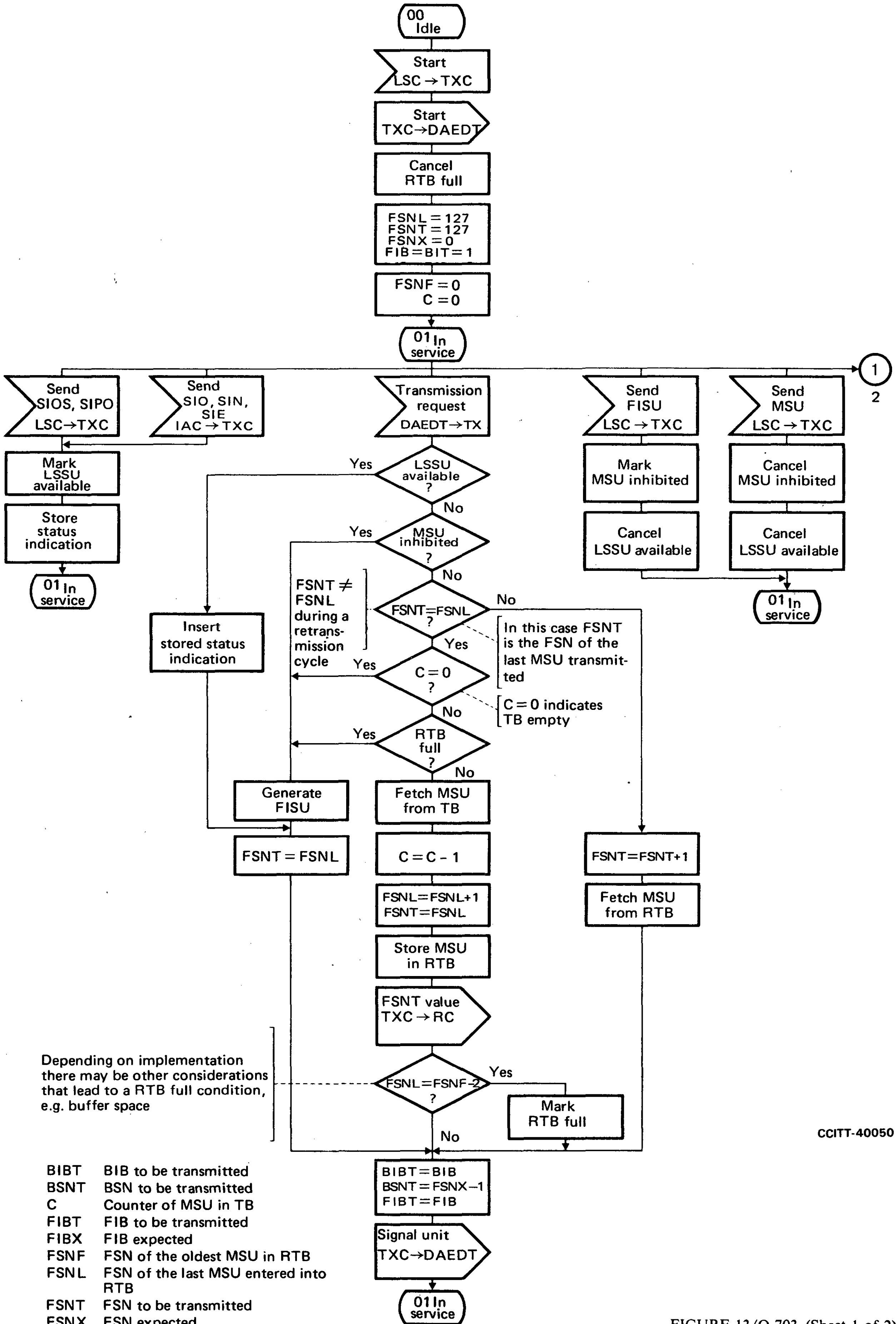
Delimitation, alignment and error detection (receiving)



DAEDT Delimitation, alignment, error detection
TXC Transmitting control

FIGURE 12/Q.703

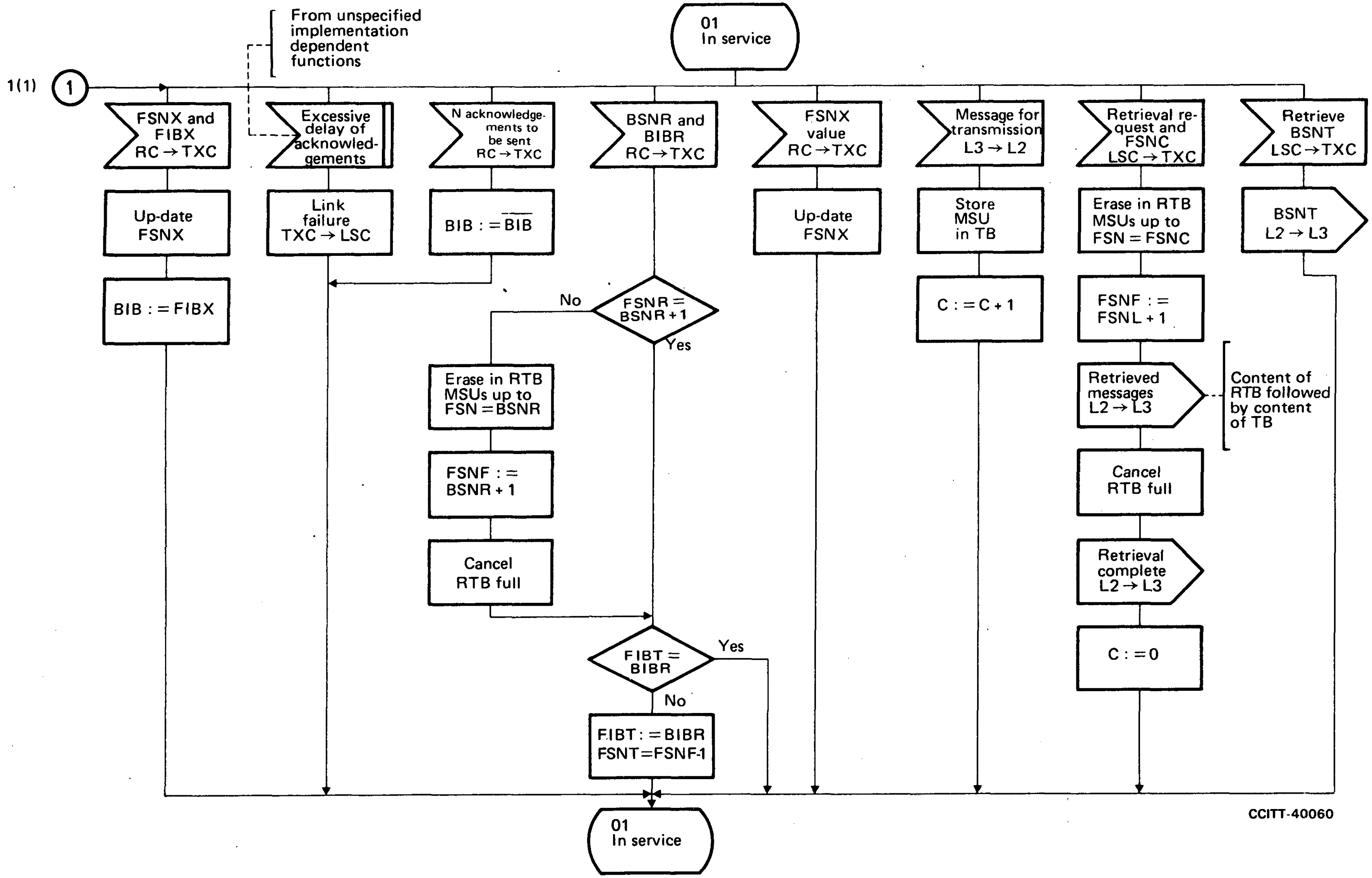
Delimitation, alignment and error detection (transmitting)



BIBT	BIB to be transmitted
BSNT	BSN to be transmitted
C	Counter of MSU in TB
FIBT	FIB to be transmitted
FIBX	FIB expected
FSNF	FSN of the oldest MSU in RTB
FSNL	FSN of the last MSU entered into RTB
FSNT	FSN to be transmitted
FSNX	FSN expected
RTB	Retransmission buffer
TB	Transmission buffer

FIGURE 13/Q.703 (Sheet 1 of 2)

Basic transmission control



BIBR BIB received
BSNR BSN received
FIBR FIB received

FIBX FIB expected
FSNC FSN of the last MSU accepted by the remote terminal (received in the changeover message)
FSNR FSN received

FIGURE 13/Q.703 (Sheet 2 of 2)

Basic transmission control

FIBR FIB received
FIBX FIB expected
FSNF FSN of the oldest MSU in RTB
FSNR FSN received
FSNT FSN of the last MSU transmitted
FSNX FSN expected
RTB Retransmission buffer
RTR If = 1 means retransmission expected
UNB Counter of unreasonable BSN
UNF Counter of unreasonable FIB

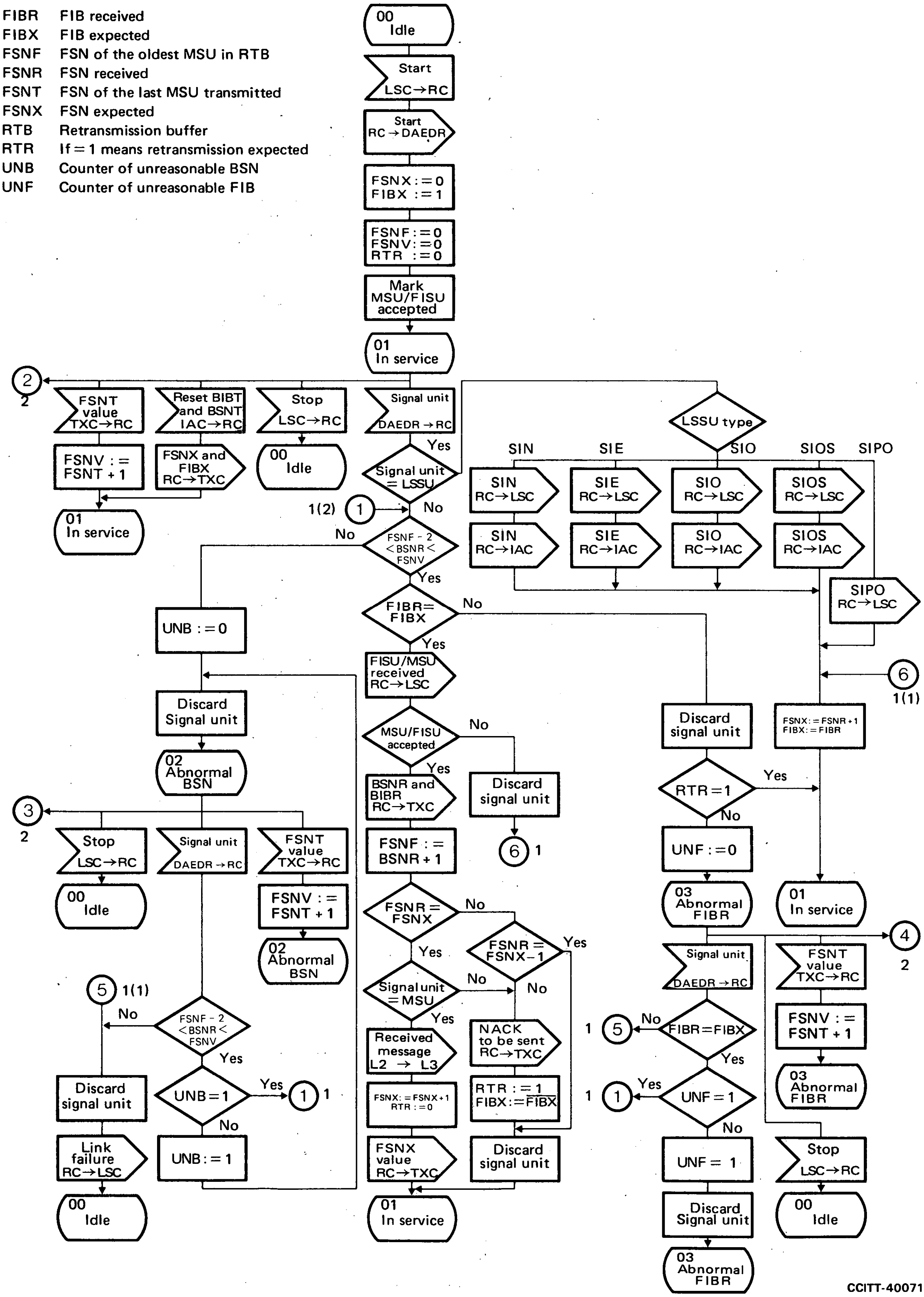


FIGURE 14/Q.703 (Sheet 1 of 2)

Basic reception control

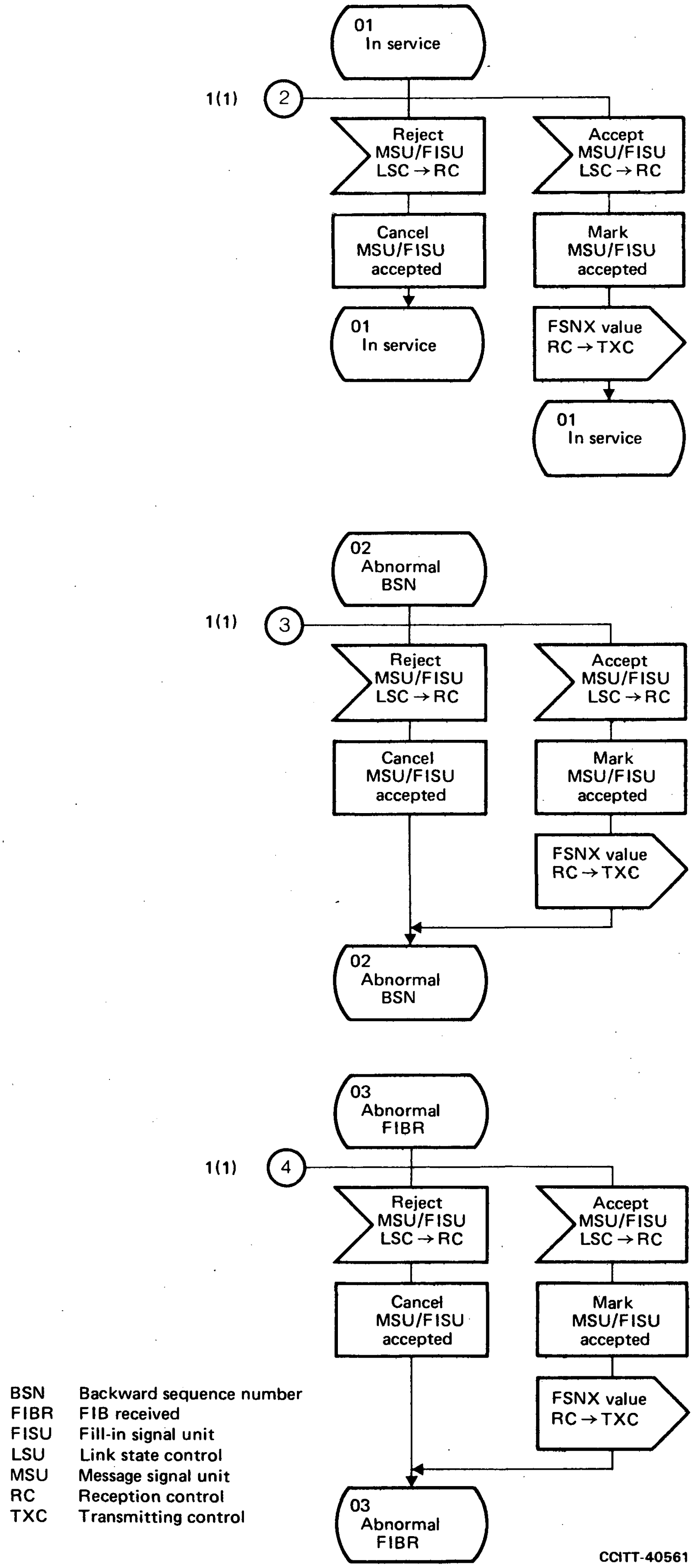
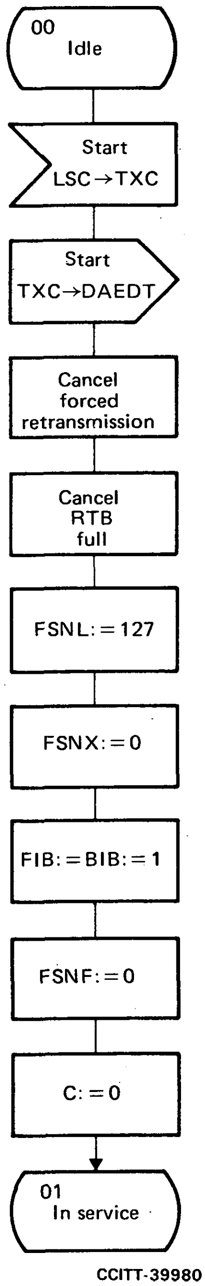


FIGURE 14/Q.703 (Sheet 2 of 2)

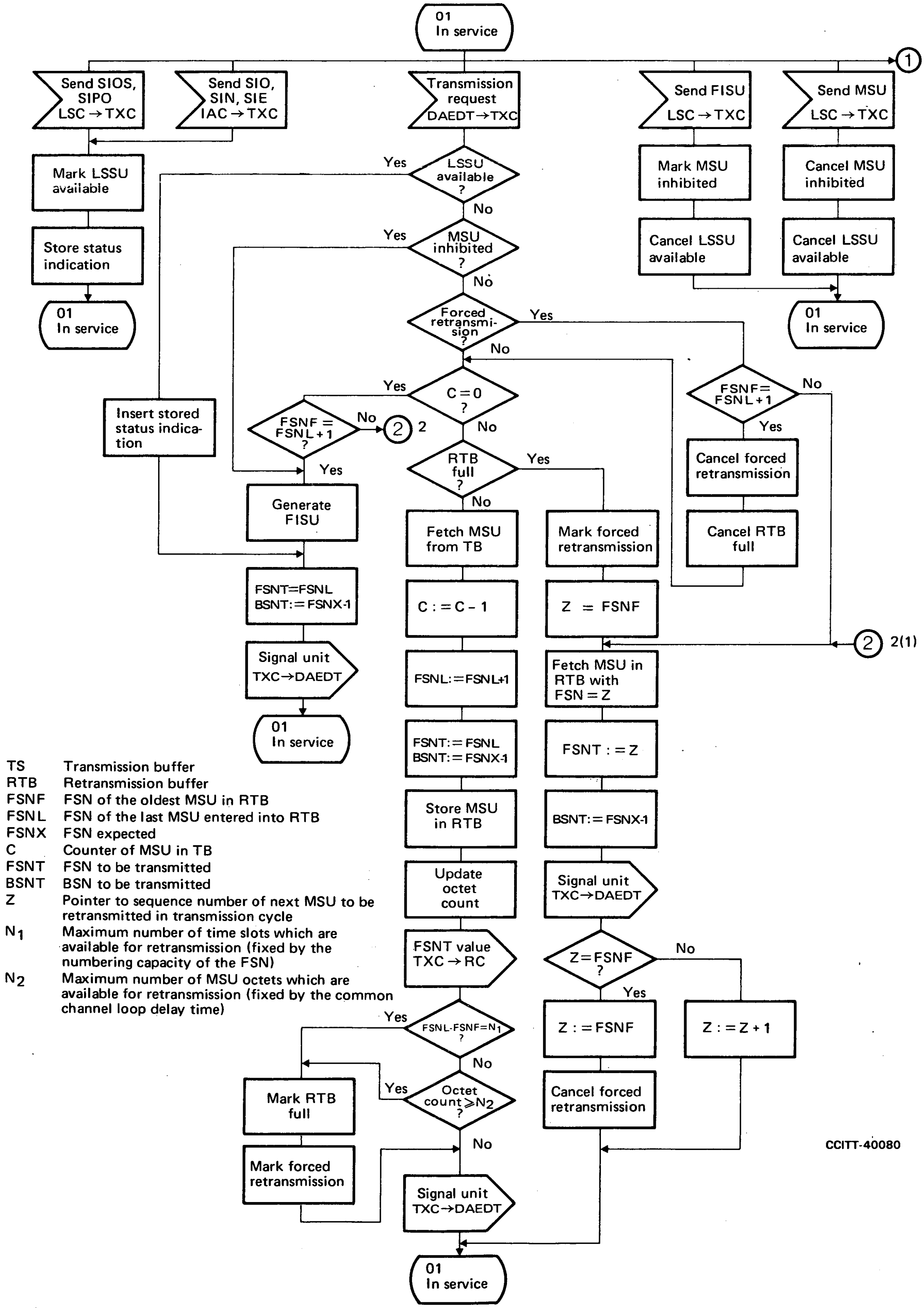
Basic reception control



BIB	Backward indicator bit
DAEDT	Delimitation, alignment error detection
FIB	Forward indicator bit
FSNF	FSN of the oldest MSU in RTB
FSNL	FSN of the last MSU entered into RTB
FSNX	FSN expected
LSC	Link state control
RTB	Retransmission buffer
TXC	Transmission control

FIGURE 15/Q.703 (Sheet 1 of 3)

Preventive cyclic retransmission – transmission control



TS	Transmission buffer
RTB	Retransmission buffer
FSNF	FSN of the oldest MSU in RTB
FSNL	FSN of the last MSU entered into RTB
FSNX	FSN expected
C	Counter of MSU in TB
FSNT	FSN to be transmitted
BSNT	BSN to be transmitted
Z	Pointer to sequence number of next MSU to be retransmitted in transmission cycle
N_1	Maximum number of time slots which are available for retransmission (fixed by the numbering capacity of the FSN)
N_2	Maximum number of MSU octets which are available for retransmission (fixed by the common channel loop delay time)

FIGURE 15/Q.703 (Sheet 2 of 3)

Preventive cyclic retransmission – transmission control

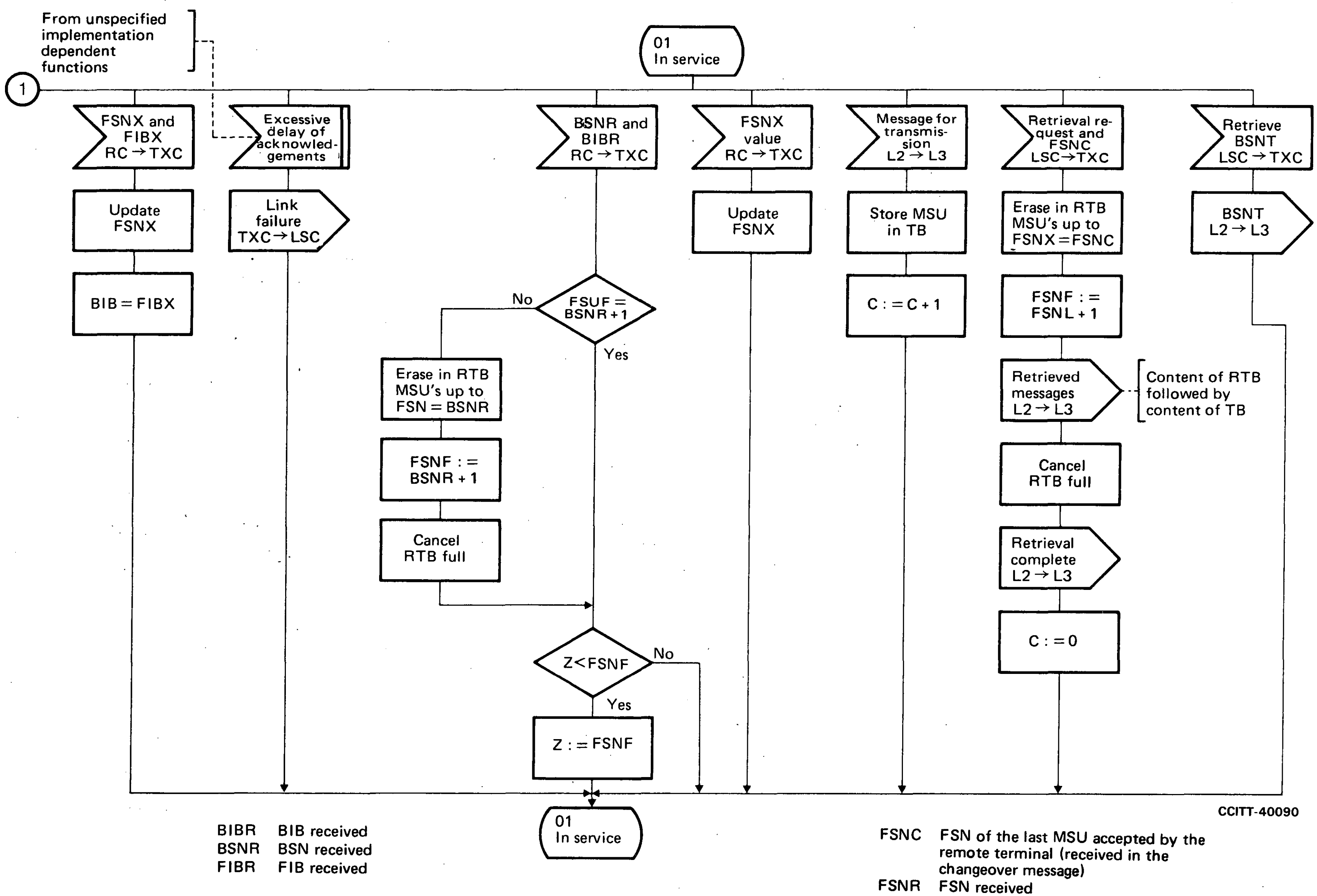
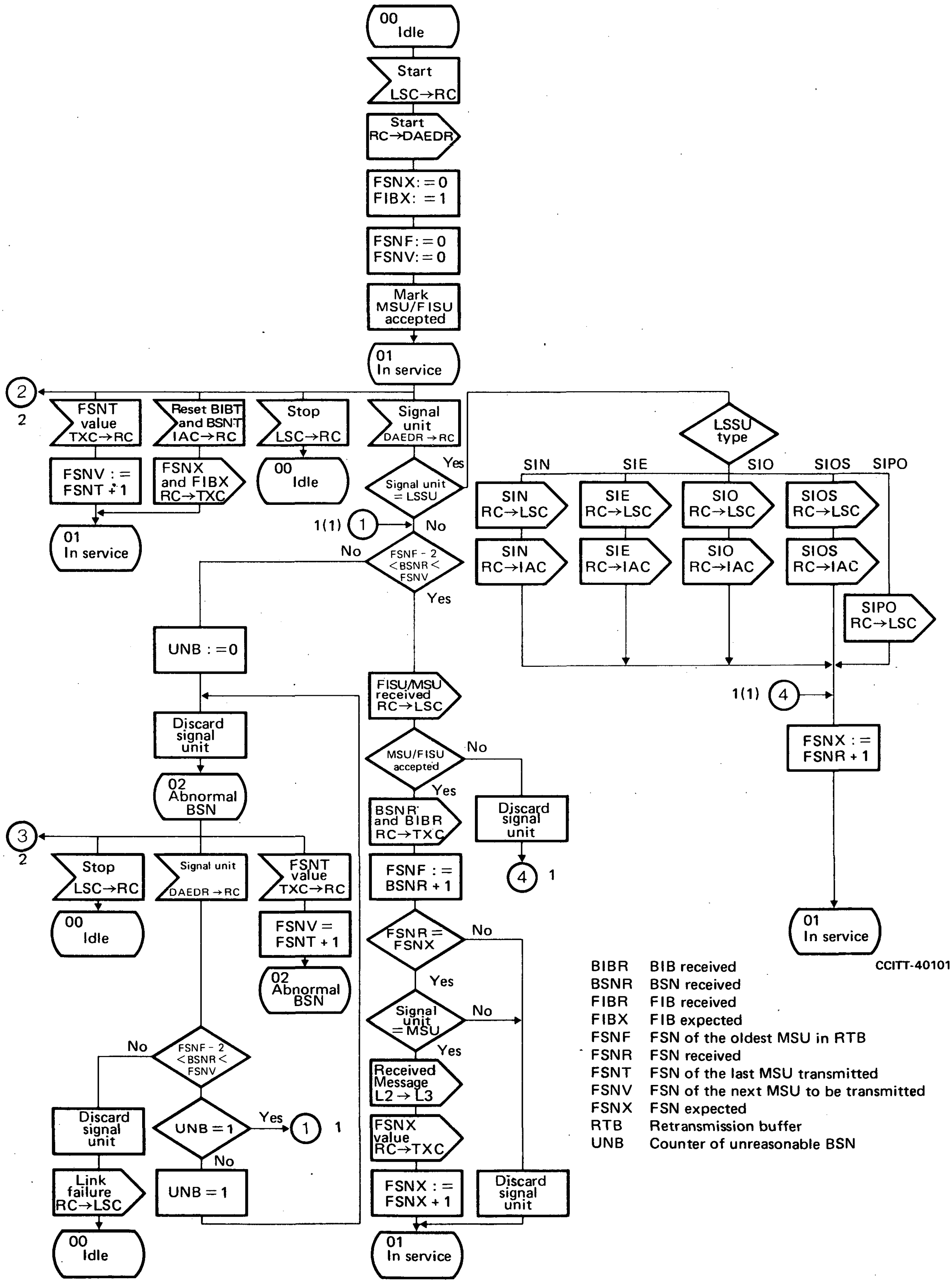


FIGURE 15/Q.703 (Sheet 3 of 3)

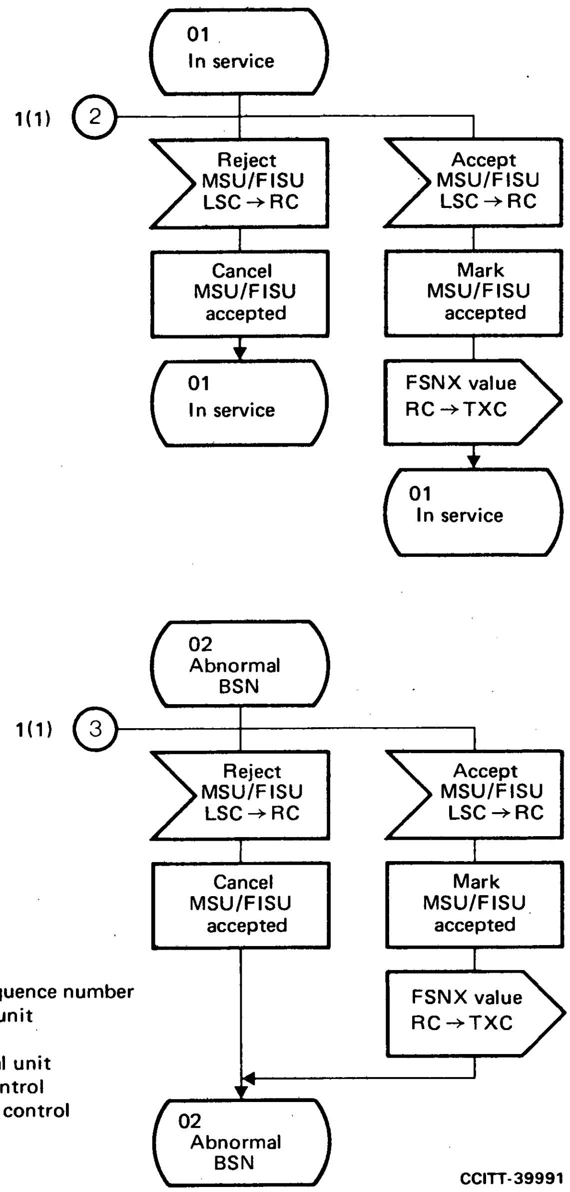
Preventive cyclic retransmission – transmission control



BIBR	BIB received
BSNR	BSN received
FIBR	FIB received
FIBX	FIB expected
FSNF	FSN of the oldest MSU in RTB
FSNR	FSN received
FSNT	FSN of the last MSU transmitted
FSNV	FSN of the next MSU to be transmitted
FSNX	FSN expected
RTB	Retransmission buffer
UNB	Counter of unreasonable BSN

FIGURE 16/Q.703 (Sheet 1 of 2)

Preventive cyclic retransmission reception control



BSN	Backward sequence number
FISU	Fill-in signal unit
LSU	Link state
MSU	Message signal unit
RC	Reception control
TXC	Transmission control

FIGURE 16/Q.703 (Sheet 2 of 2)

Preventive cyclic retransmission reception control

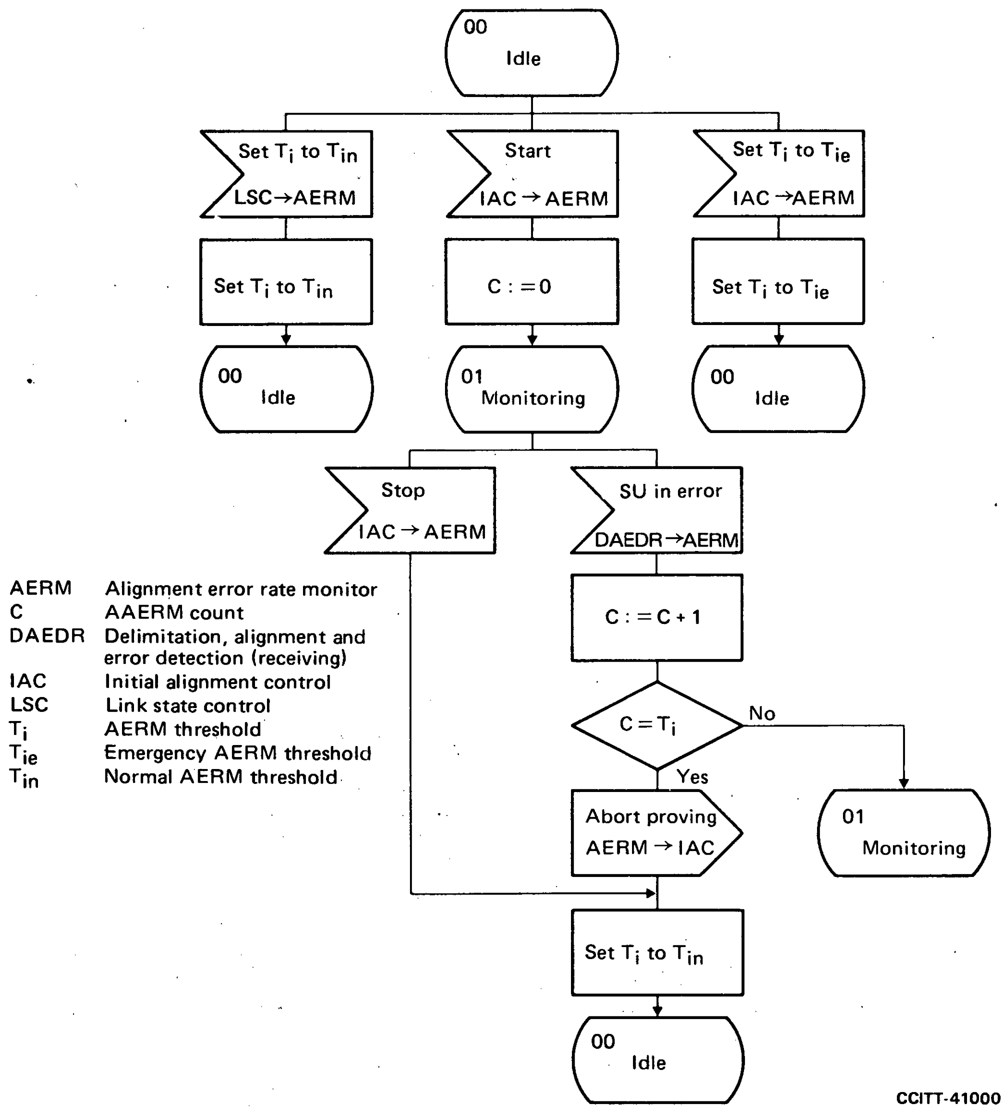
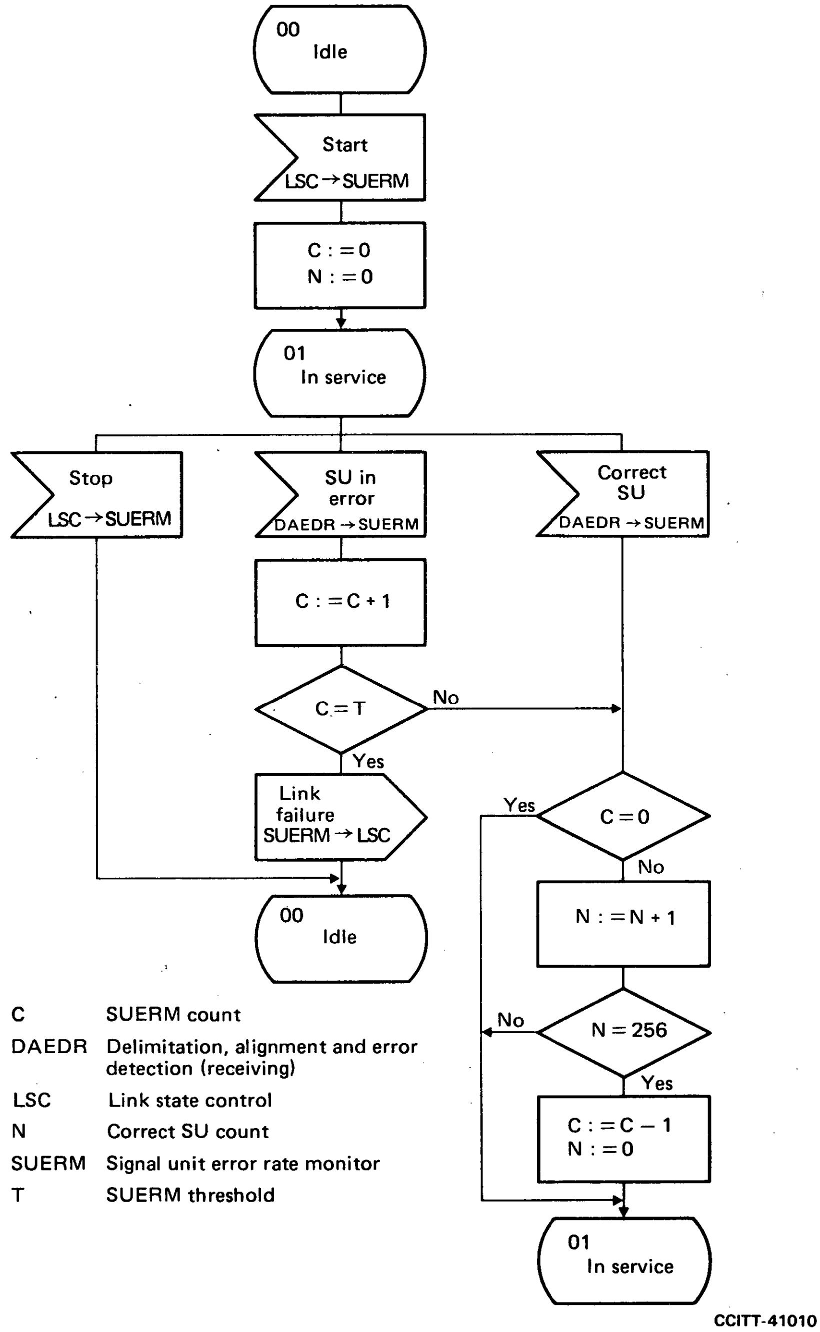


FIGURE 17/Q.703

Alignment error rate monitor



C	SUERM count
DAEDR	Delimitation, alignment and error detection (receiving)
LSC	Link state control
N	Correct SU count
SUERM	Signal unit error rate monitor
T	SUERM threshold

FIGURE 18/Q.703

Signal unit error rate monitor

SIGNALLING NETWORK FUNCTIONS AND MESSAGES

CONTENTS

1 Introduction

1.1 *General characteristics of the signalling network functions*

1.1.1 This Recommendation describes the functions and procedures for and relating to the transfer of messages between the signalling points, which are the nodes of the signalling network. Such functions and procedures are performed by the Message Transfer Part at level 3, and therefore they assume that the signalling points are connected by signalling links, incorporating the functions described in Recommendations Q.702 and Q.703. The signalling network functions must ensure a reliable transfer of the signalling messages, according to the requirements specified in Recommendation Q.706 even in the case of the failure of signalling links and signalling transfer points; therefore they include the appropriate functions and procedures necessary both to inform the remote parts of the signalling network of the consequences of a fault, and to appropriately reconfigure the routing of messages through the signalling network.

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

– *signalling message handling*, and
– *signalling network management.*

The signalling message handling functions are briefly summarized in § 1.2, the signalling network management functions in § 1.3. The functional interrelations between these functions are indicated in Figure 1/Q.704.

1.2 *Signalling message handling*

1.2.1 The purpose of the signalling message handling functions is to ensure that the signalling messages originated by a particular User Part at a signalling point (originating point) are delivered to the same User Part at the destination point indicated by the sending User Part.

Depending on the particular circumstances, this delivery may be made through a signalling link directly interconnecting the originating and destination points, or via one or more intermediate signalling transfer points.

1.2.2 The signalling message handling functions are based on the label contained in the messages which explicitly identifies the destination and originating points.

The label part used for signalling message handling by the Message Transfer Part is called the *routing label*; its characteristics are described in § 2.

1.2.3 As illustrated in Figure 1/Q.704, the signalling message handling functions are divided into:

- the *message routing* function, used at each signalling point to determine the outgoing signalling link on which a message has to be sent towards its destination point;
- the *message discrimination* function, used at a signalling point to determine whether a received message is destined to the point itself or has to be transferred to the message routing function (i.e. when the concerned point acts as a signalling transfer point);
- the *message distribution* function, used at each signalling point to deliver the received messages (destined to the point itself) to the appropriate User Part.

The characteristics of the message routing, discrimination and distribution functions are described in § 2.

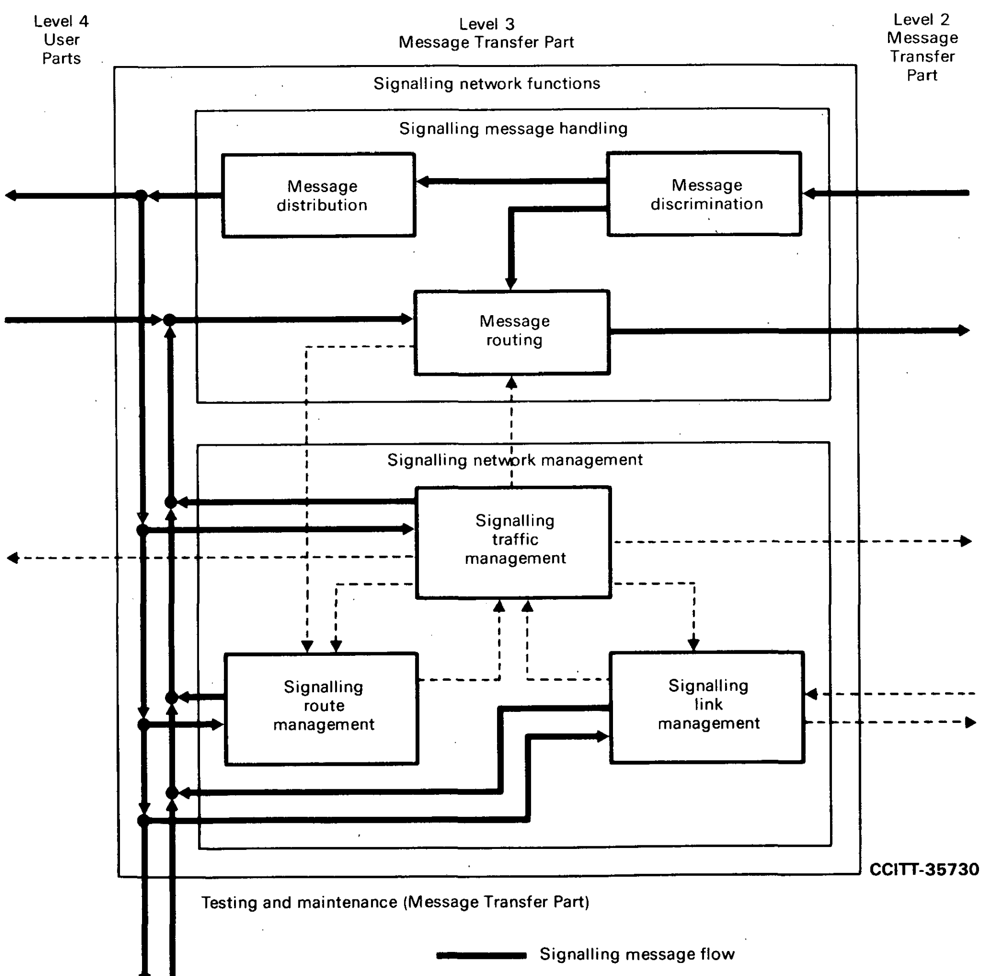


FIGURE 1/Q.704
Signalling network functions

1.3 *Signalling network management*

1.3.1 The purpose of the signalling network management functions is to provide reconfiguration of the signalling network in the case of failures. Such a reconfiguration is effected by use of appropriate procedures to change the routing of signalling traffic in order to bypass the faulty links or signalling points; this requires communication between signalling points (and, in particular, the signalling transfer points) concerning the occurrence of the failures. Moreover, in some circumstances it is necessary to activate and align new signalling links, in order to restore the required signalling traffic capacity between two signalling points. When the faulty link or signalling point is restored the opposite actions and procedures take place, in order to reestablish the normal configuration of the signalling network.

1.3.2 As illustrated in Figure 1/Q.704, the signalling network management functions are divided into:

- *signalling traffic management*,
- *signalling link management*, and
- *signalling route management.*

These functions are used whenever an event (such as the failure or restoration of a signalling link) occurs in the signalling network; the list of the possible events and the general criteria used in relation to each signalling network management function are specified in § 3.

1.3.3 §§ 4 to 9 specify the procedures pertaining to signalling traffic management. In particular, the rules to be followed for the modification of signalling routing appear in § 4. The diversion of traffic according to these rules is made, depending on the particular circumstances, by means of one of the following procedures: *changeover*, *changeback*, *forced rerouting* and *controlled rerouting.* They are specified in §§ 5 to 8 respectively. Moreover, in the case of congestion at signalling points, the signalling traffic management may need to slow down signalling traffic on certain routes by using the *signalling traffic flow control* procedure specified in § 9.

1.3.4 The different procedures pertaining to signalling link management are: *restoration*, *activation* and *inactivation* of a signalling link, *link set activation* and *automatic allocation* of signalling terminals and signalling data links. These procedures are specified in § 10. An alternative to these procedures which may be used within national networks is described in Annex A.

1.3.5 The different procedures pertaining to signalling route management are: the *transfer-prohibited*, *transfer-allowed* and *signalling-route-set-test* procedures specified in § 11.

1.3.6 The format characteristics, common to all message signal units which are relevant to the Message Transfer Part, level 3, are specified in § 12.

1.3.7 Labelling, formatting and coding of the signalling network management messages are specified in § 13.

1.3.8 The description of signalling network functions in the form of state transition diagrams according to the CCITT Specification and Description Language (SDL) is given in § 14.

2 Signalling message handling

2.1 *General*

2.1.1 Signalling message handling comprises message routing, discrimination and distribution functions which are performed at each signalling point in the signalling network.

Message routing is a function concerning the messages to be sent, while message distribution is a function concerning the received messages. The functional relations between message routing and distribution appear in Figure 2/Q.704.

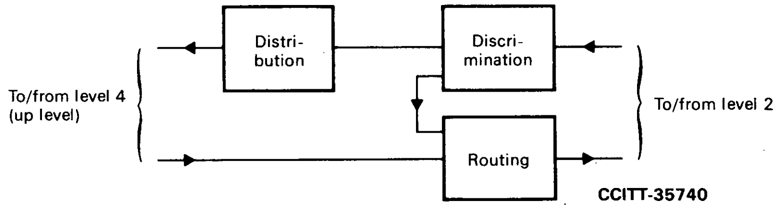


FIGURE 2/Q.704

Message routing, discrimination and distribution

2.1.2 When a message comes from level 4 (or is originated at level 3, in the case of Message Transfer Part level 3 messages), the choice of the particular signalling link on which it has to be sent is made by the message routing function. When two or more links are used at the same time to carry traffic having a given destination, this traffic is distributed among them by the load sharing function, which is a part of the message routing function.

2.1.3 When a message comes from level 2, the discrimination function is activated, in order to determine whether it is destined to this signalling point (acting as a destination point), or is destined to another signalling point in which case it has to be transmitted on an outgoing link according to the routing function (signalling point acting as a signalling transfer point).

2.1.4 In the case that the message is destined to the receiving signalling point, the message distribution function is activated in order to deliver it to the appropriate User Part (or to the local Message Transfer Part level 3 functions).

2.1.5 Message routing, discrimination and distribution are based on the part of the label called the routing label, on the service indicator and, in national networks, also on the national indicator. They can also be influenced by different factors, such as a request (automatic or manual) obtained from a management system.

2.1.6 The position and coding of the service indicator and of the national indicator are described in § 12.2. The characteristics of the label of the messages pertaining to the various User Parts are described in the specification of each separate User Part and in § 13 for the signalling network management messages. The label used for signalling network management messages is also used for testing and maintenance messages (see Recommendation Q.707). Moreover the general characteristics of the routing label are described in § 2.2.

A description of the detailed characteristics of the message routing function, including load sharing, appears in § 2.3; principles concerning the number of load shared links appear in Recommendation Q.705.

A description of the detailed characteristics of the message discrimination and distribution functions appears in § 2.4.

2.2 *Routing label*

2.2.1 The label contained in a signal message, and used by the relevant User Part to identify the particular task to which the message refers (e.g. a telephone circuit), is also used by the Message Transfer Part to route the message towards its destination point.

The part of the message label that is used for routing is called the *routing label* and it contains all the information necessary to deliver the message to its destination point.

Normally the routing label is common to all the services and applications in a given signalling network (national or international) (however, if this is not the case, the particular routing label of a message is determined by means of the service indicator).

The standard routing label is specified in the following. This label should be used in the international signalling network and is applicable also in national applications.

Note – There may be applications using a modified label having the same order and function, but possibly different sizes, of subfields as the standard routing label.

2.2.2 The standard routing label has a length of 32 bits and is placed at the beginning of the Signalling Information Field. Its structure appears in Figure 3/Q.704.

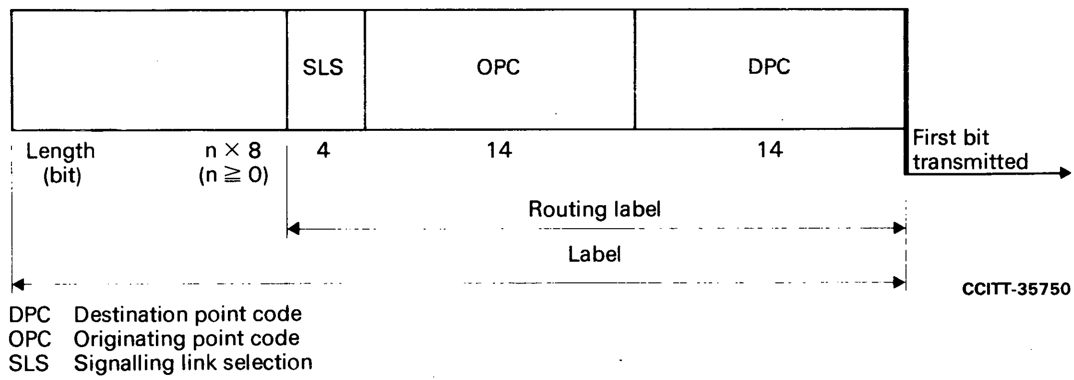


FIGURE 3/Q.704

Routing label structure

2.2.3 The *destination point code* (DPC) indicates the destination point of the message. The *originating point code* (OPC) indicates the originating point of the message. The coding of these codes is pure binary. Within each field the least significant bit occupies the first position and is transmitted first.

A unique numbering scheme for the coding of the fields will be used for the signalling points of the international network, irrespective of the User Parts connected to each signalling point.

2.2.4 The *signalling link selection* (SLS) field is used, where appropriate, in performing load sharing, see § 2.3. This field exists in all types of messages and always in the same position. The only exception to this rule is some Message Transfer Part level 3 messages (e.g. the changeover order), for which the message routing function in the signalling point of origin of the message is not dependent on the field: in this particular case the field does not exist as such, but it is replaced by other information (e.g. in the case of the changeover order, the identity of the faulty link).

In the case of circuit related messages, the field contains the least significant bits of the circuit identification code (or bearer identification code, in the case of the Data User Part), and these bits are not repeated elsewhere.

In the case of Message Transfer Part level 3 messages, the signalling link selection field exactly corresponds to the *signalling link code* (SLC) which indicates the signalling link between the destination point and originating point to which the message refers.

2.2.5 From the rule stated in § 2.2.4 above it follows that the signalling link selection of messages generated by any User Parts will be used in the load sharing mechanism. As a consequence, in the case of User Parts which are not specified (e.g. transfer of charging information) but for which there is the requirement to maintain the order of transmission of the messages, the field should be coded with the same value for all messages belonging to the same transaction, sent in a given direction.

2.2.6 The above principles should also apply to modified label structures that may be used nationally.

2.3 *Message routing function*

2.3.1 The message routing function is based on information contained in the routing label, namely on the destination point code and on the signalling link selection field; moreover, in some circumstances the service indicator may also need to be used for routing purposes.

Note – A possible case for the use of the service indicator is that which would arise from the use of messages supporting the signalling route management function (i.e. transfer-prohibited, transfer-allowed and signalling-route-set-messages) referring to a destination more restrictive than a single signalling point (e.g. an individual User Part) (see § 11). Another case may be in relation to signalling-route-test procedures which may be defined for testing and maintenance purposes (see Recommendation Q.707).

The number of such cases should be kept to a minimum in order to apply the same routing criteria to as many User Parts as possible.

Each signalling point will have routing information that allows it to determine the signalling link over which a message has to be sent on the basis of the destination point code and signalling link selection field and, in some cases, of the national indicator (see § 2.4.3). Typically the destination point code is associated with more than one signalling link that may be used to carry the message; the selection of the particular signalling link is made by means of the signalling link selection field, thus effecting load sharing.

2.3.2 Two basic cases of load sharing are defined, namely:

a) load sharing between links belonging to the same link set,

b) load sharing between links not belonging to the same link set.

The capability to operate in load sharing according to both these cases is mandatory for any signalling point in the international network.

In case a) the traffic flow carried by a link set is shared (on the basis of the signalling link selection field) between different signalling links belonging to the link set. An example of such a case is given by a link set directly interconnecting the originating and destination points in the associated mode of operation, such as represented in Figure 4/Q.704.

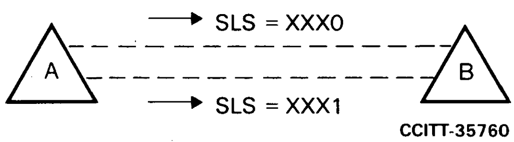


FIGURE 4/Q.704

Example of load sharing within a link set

In case b) traffic relating to a given destination is shared (on the basis of the signalling link selection field) between different signalling links not belonging to the same link set, such as represented in Figure 5/Q.704. The load sharing rule used for a particular signalling relation may or may not apply to all the signalling relations which use one of the signalling links involved (in the example, traffic destined to B is shared between signalling links DE and DF with a given signalling link selection field assignment, while that destined to C is sent only on link DF, due to the failure of link EC).

As a result of the message routing function, in normal conditions all the messages having the same routing label (e.g. call set-up messages related to a given circuit) are routed via the same signalling links and signalling transfer points.

Principles relating to the number of load shared links appear in Recommendation Q.705.

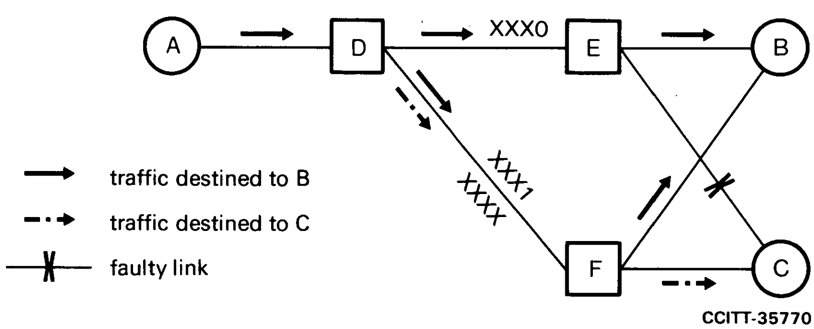


FIGURE 5/Q.704

Example of load sharing between link sets

2.3.3 The routing information mentioned in § 2.3.1 should be appropriately updated when some event happens in the signalling network, which is relevant to the concerned signalling point (e.g. failure of a signalling link or unavailability of a signalling route). The updating of the routing information is made according to the particular event (see § 3) and to the signalling routing modification rules specified in § 4.

2.4 *Message discrimination and distribution functions*

2.4.1 The routing criteria and load sharing method described in § 2.3 imply that a signalling point, sending messages pertaining to a given signalling transaction on a given link, should be able to receive and process messages pertaining to that transaction, e.g. in response to the sent ones, coming from any (but only one) link.

The destination point code field of the received messages is examined by the discrimination function in order to determine if they are destined to the receiving signalling point or, in the case of a signalling point having the signalling transfer point capability, they are not; in the latter case they are directed to the routing function, as described in the previous sections, in order to be sent on the appropriate outgoing link towards the message destination point.

When a signalling transfer point detects that a received message cannot be delivered to its destination point, it sends in response a transfer-prohibited message as specified in § 11.2.

2.4.2 If the destination point code of the message identifies the receiving signalling point, the service indicator is examined by the message distribution function and the message is delivered to the corresponding User Part (or to the Message Transfer Part level 3).

2.4.3 In the case of a signalling point handling both international and national signalling traffic (e.g. an international gateway exchange) the national indicator is also examined in order to determine the relevant numbering scheme (international or national) and possibly the label structure. Moreover, within a national network the national indicator may be examined to discriminate between different label structures or between different signalling point numbering if dependent on the network levels (see § 12.2).

3 Signalling network management

3.1 *General*

3.1.1 The signalling network management functions provide the actions and procedures required to maintain signalling service and to restore normal signalling conditions in the event of disruption in the signalling network, either in signalling links or at signalling points. For example, in the case of a link failure the traffic conveyed over the faulty link should be diverted to one or more alternative links. The link failure may also result in unavailable signalling routes and this, in turn, may cause diversion of traffic at other signalling points in the signalling network (i.e. signalling points to which no faulty links are connected).

3.1.2 The occurrence of or recovery from failures generally results in a change of the status of the affected signalling link(s) and route(s). A signalling link may be considered by level 3, either as "available" or "unavailable" to carry signalling traffic; in particular, an available signalling link becomes unavailable if it is recognized as "failed", "deactivated" or "blocked" [1] and it becomes once again available if it is recognized as "restored", "activated" or "unblocked" respectively. A signalling route may be considered by level 3 as "available" or "unavailable" too. The detailed criteria for the determination of the changes in the status of signalling links and routes are described in §§ 3.2 and 3.4 respectively.

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1) The "blocked" condition arises when the unavailability of a signalling link does not depend on a failure in the link itself, but on other causes, such as a "processor outage" condition in a signalling point.

3.1.3 Whenever a change in the status of a signalling link or route occurs, the three different signalling network management functions (i.e. signalling traffic management, link management and route management) are activated, when appropriate, as follows:

a) The signalling traffic management function is used to divert signalling traffic from a link or route to one or more different links or routes, or to temporarily slow down signalling traffic in the case of congestion at a signalling point; it comprises the following procedures:

- changeover (see § 5),
- changeback (see § 6),
- forced rerouting (see § 7),
- controlled rerouting (see § 8),
- signalling traffic flow control (see § 9).

b) The signalling link management function is used to restore failed signalling links, to activate idle (not yet aligned) links and to deactivate aligned signalling links; it comprises the following procedures (see § 10):

- signalling link activation, restoration and deactivation,
- link set activation,
- automatic allocation of signalling terminals and signalling data links.

c) The signalling route management function is used to distribute information about the signalling network status, in order to block or unblock signalling routes; it comprises the following procedures:

- transfer-prohibited procedure (see § 11.2),
- transfer-allowed procedure (see § 11.3),
- signalling-route-set-test procedure (see § 11.4).

3.1.4 An overview of the use of the procedures relating to the different management functions on occurrence of the link and route status changes is given in §§ 3.3 and 3.5 respectively.

3.2 *Status of signalling links*

3.2.1 A signalling link is always considered by level 3 in one of two possible major states: available and unavailable. Depending on the cause of unavailability, the unavailable state can be subdivided into three possible cases as follows (see also Figure 6/Q.704):

- unavailable, failed or inactive,
- unavailable, blocked,
- unavailable, failed or inactive and blocked.

The concerned link can be used to carry signalling traffic only if it is available. Six possible events can change the status of a link: signalling link failure, restoration, deactivation, activation, blocking and unblocking; they are described in §§ 3.2.2 to 3.2.7.

3.2.2 *Signalling link failure*

A signalling link (in service or blocked, see § 3.2.6) is recognized by level 3 as failed when:

a) A link failure indication is obtained from level 2. The indication may be caused by:

- intolerably high signal unit error rate (see Recommendation Q.703, § 9);
- excessive length of the realignment period (see Recommendation Q.703, §§ 4.1 and 7);
- excessive delay of acknowledgements (see Recommendation Q.703, §§ 5.3 and 6.3);
- failure of signalling terminal equipment;
- two out of three unreasonable backward sequence numbers or forward indicator bits (see Recommendation Q.703, §§ 5.3 and 6.3);
- reception of consecutive link status signal units indicating out of alignment, out of service, normal or emergency terminal status (see Recommendation Q.703, § 1.7).

The first two conditions are detected by the *signal unit error rate monitor* (see Recommendation Q.703, § 8).

b) A request (automatic or manual) is obtained from a management or maintenance system.

Moreover a signalling link which is available (not blocked) is recognized by level 3 as failed when a changeover order is received.

3.2.3 *Signalling link restoration*

A signalling link previously failed is restored when both ends of the signalling link have successfully completed an initial alignment procedure (see Recommendation Q.703, § 7).

3.2.4 *Signalling link deactivation*

A signalling link (in service, failed or blocked) is recognized by level 3 as deactivated (i.e. removed from operation) when:

a) a request is obtained from the signalling link management function (see § 10);

b) a request (automatic or manual) is obtained from an external management or maintenance system.

3.2.5 *Signalling link activation*

A signalling link previously inactive is recognized by level 3 as activated when both ends of the signalling link have successfully completed an initial alignment procedure (see Recommendation 703, § 7).

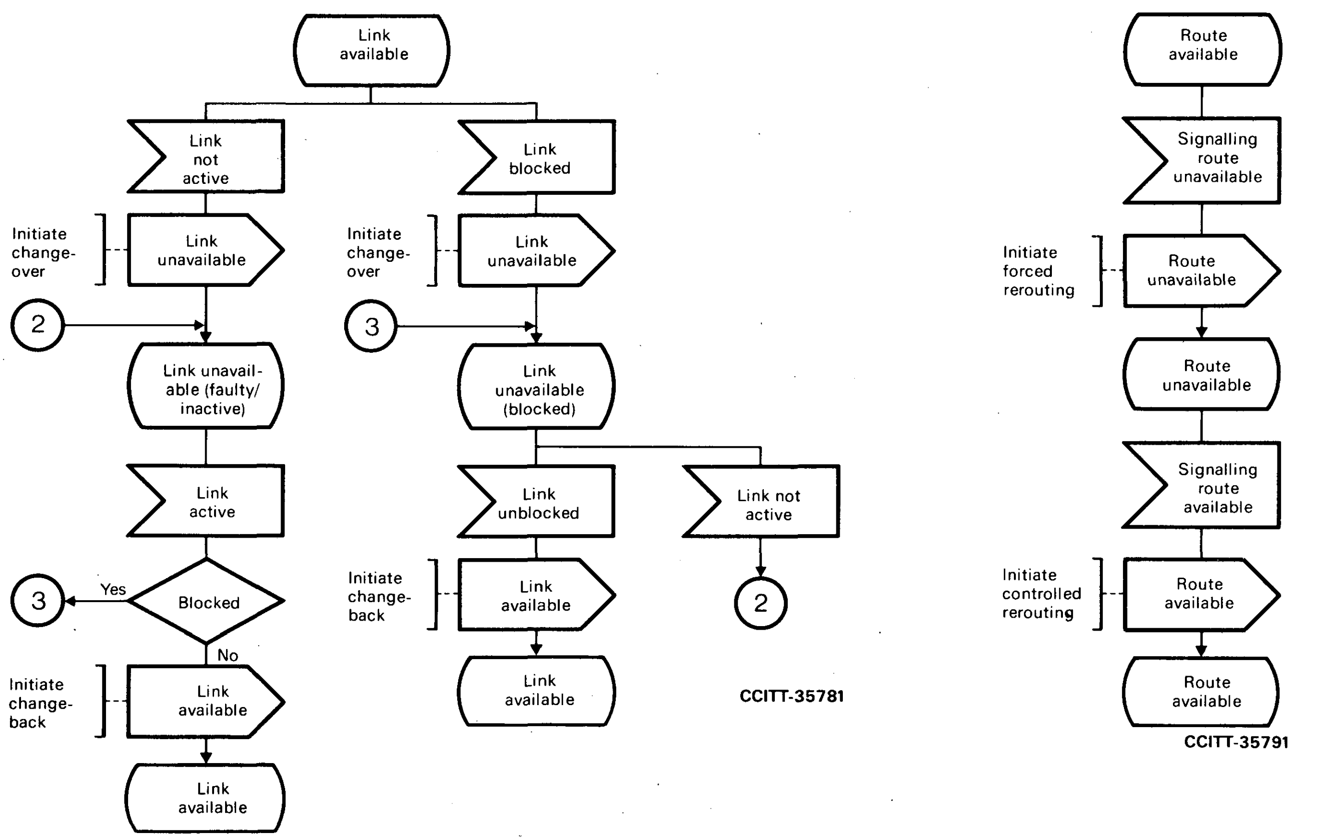
3.2.6 *Signalling link blocking*

A signalling link (which is not failed or inactive) is recognized as blocked when:

a) an indication is obtained from the signalling terminal that a processor outage condition exists at the remote terminal (i.e. link status signal units with processor outage indication are received, see Recommendation Q.703, § 8);

b) a request (automatic or manual) is obtained from a management system.

Note – A link becomes unavailable when it is failed or deactivated and/or blocked (see Figure 6/Q.704).

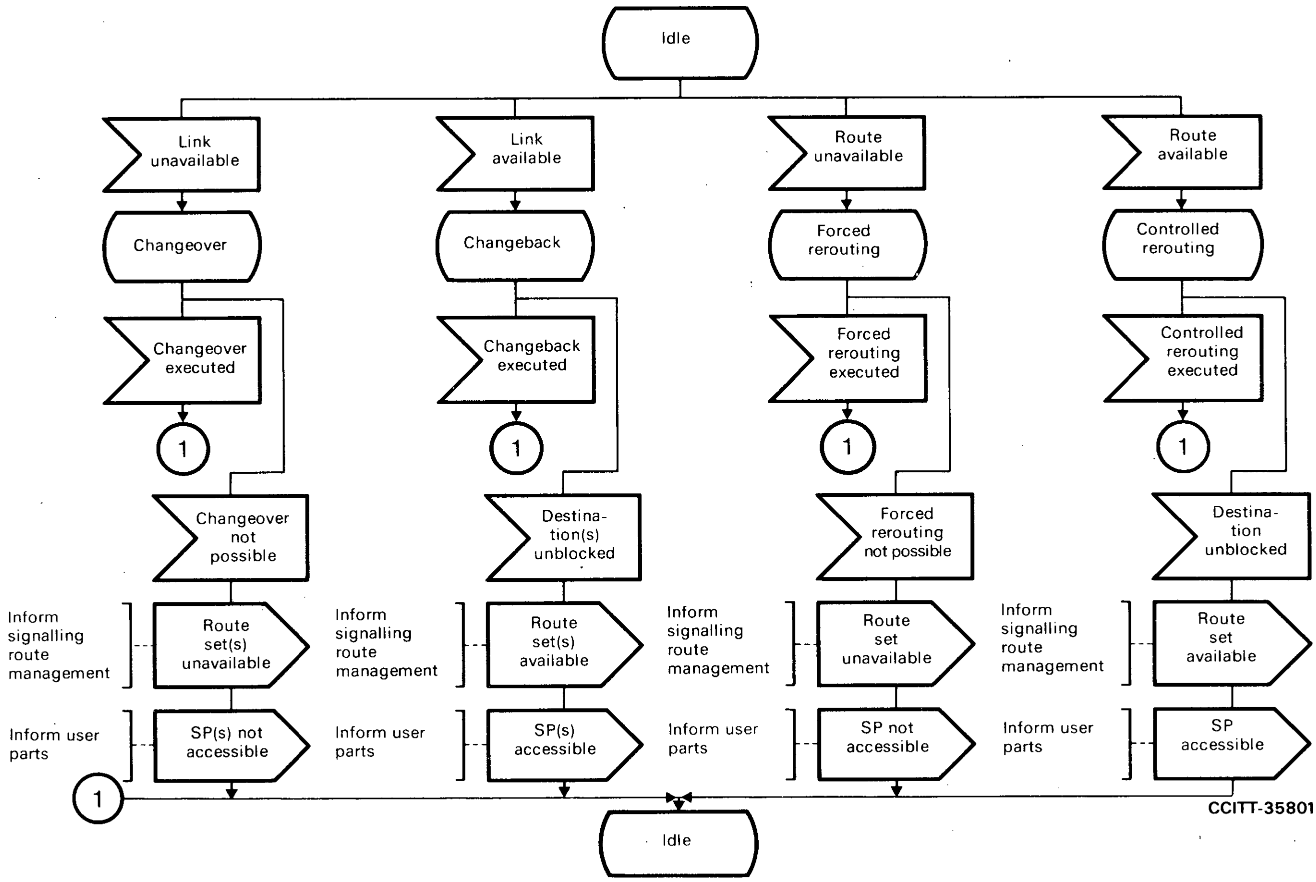


a) Signalling link availability

b) Signalling route availability status

FIGURE 6/Q.704 (sheet 1 of 2)

Signalling traffic management overview diagrams



c) Signalling traffic reconfiguration and flow control

FIGURE 6/Q.704 (sheet 2 of 2)

Signalling traffic management overview diagrams

3.2.7 *Signalling link unblocking*

A signalling link previously blocked is unblocked when:

a) an indication is obtained from the signalling terminal that the processor outage condition has ceased at the remote terminal. (Applies in the case when the processor outage condition was initiated by the remote terminal.);

b) a request from a management system is obtained. (Applies in the case when the blocking was initiated by the management system.)

Note – A link becomes available when it is restored or activated and/or unblocked (see Figure 6/Q.704).

3.3 *Procedures used in connection with link status changes*

In § 3.3 the procedures relating to each signalling management function, which are applied in connection with link status changes, are listed. (See also Figures 6/Q.704, 7/Q.704 and 8/Q.704.) Typical examples of the application of the procedures to the particular network cases appear in Recommendation Q.705.

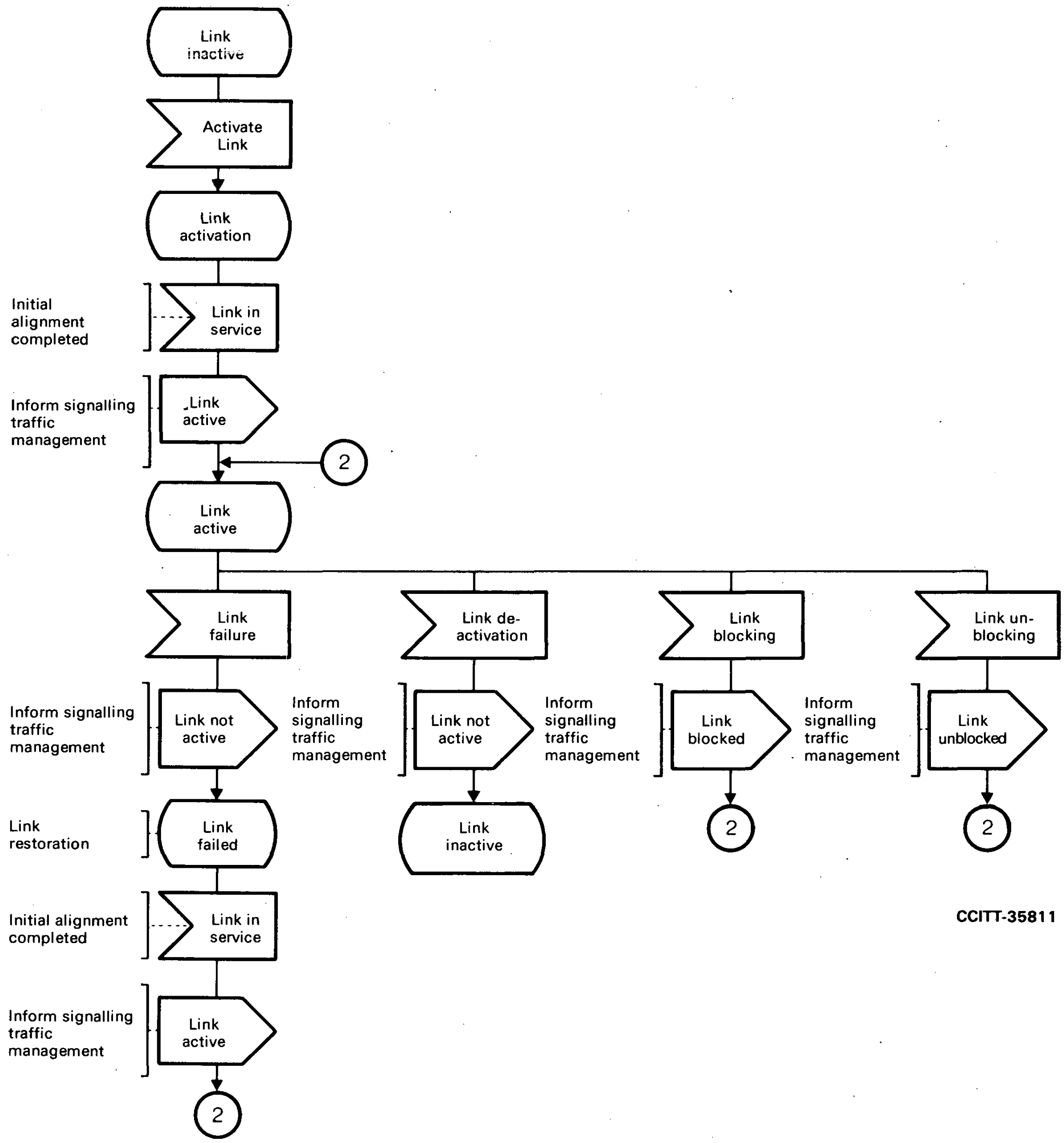


FIGURE 7/Q.704

Signalling link management overview diagram

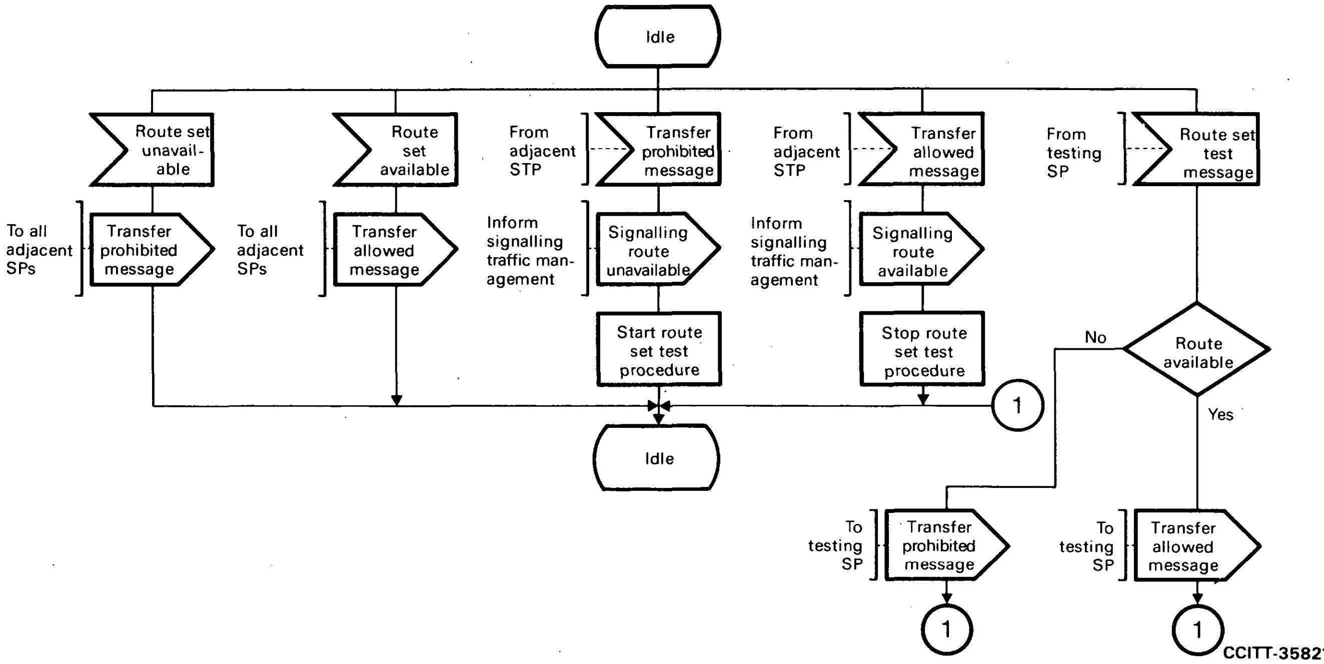


FIGURE 8/Q.704

Signalling route management overview diagram

3.3.1 *Signalling link failed*

3.3.1.1 Signalling traffic management: the changeover procedure (see § 5) is applied, if required, to divert signalling traffic from the unavailable link to one or more alternative links with the objective of avoiding message loss, repetition or mis-sequencing; it includes determination of the alternative link or links where the affected traffic can be transferred and procedures to retrieve messages sent over the failed link but not received by the far end.

3.3.1.2 Signalling link management: the procedures described in § 10 are used to restore a signalling link and to make it available for signalling. Moreover, depending on the link set status the procedures can also be used to activate another signalling link in the same link set to which the unavailable link belongs and to make it available for signalling.

3.3.1.3 Signalling route management: in the case when the failure of a signalling link causes a signalling route set to become unavailable, the signalling transfer point which can no longer route the concerned signalling traffic applies the transfer-prohibited procedures described in § 11.

3.3.2 *Signalling link restored*

3.3.2.1 Signalling traffic management: the changeback procedure (see § 6) is applied, if required, to divert signalling traffic from one or more links to a link which has become available; it includes determination of the traffic to be diverted and procedures for maintaining the correct message sequence.

3.3.2.2 Signalling link management: the signalling link deactivation procedure (see § 10) is used if during the signalling link failure another signalling link of the same link set was activated; it is used to assure that the link set status is returned to the same state as before the failure. This requires that the active link activated during the link failure is deactivated and considered no longer available for signalling.

3.3.2.3 Signalling route management: in the case when the restoration of a signalling link causes a signalling route set to become available, the signalling transfer point which can once again route the concerned signalling traffic applies the transfer-allowed procedures described in § 11.

3.3.3 *Signalling link deactivated*

3.3.3.1 Signalling traffic management: as specified in § 3.3.1.1.

Note – The signalling traffic has normally already been removed when signalling link deactivation is initiated.

3.3.3.2 Signalling link management: if the number of active signalling links in the link set to which the deactivated signalling link belongs has become less than the normal number of active signalling links in that link set, the procedures described in § 10 may be used to activate another signalling link in the link set.

3.3.3.3 Signalling route management: as specified in § 3.3.1.3.

3.3.4 *Signalling link activated*

3.3.4.1 Signalling traffic management: as specified in § 3.3.2.1.

3.3.4.2 Signalling link management: if the number of active signalling links in the link set to which the activated signalling link belongs has become greater than the normal number of active signalling links in that link set, the procedures described in § 10 may be used to deactivate another signalling link in the link set.

3.3.4.3 Signalling route management: as specified in § 3.3.2.3.

3.3.5 *Signalling link blocked*

3.3.5.1 Signalling traffic management: will be the same as in § 3.3.1.1.

3.3.5.2 Signalling route management: if the blocking of the link causes a signalling route set to become unavailable, the signalling transfer point which can no longer route the concerned signalling traffic applies the transfer-prohibited procedures described in § 11.

Note – In the case when the blocking is initiated by a management system, an indication should be given to the signalling terminal in order to stop transmission of Message Signal Units and start contiguous transmission of link status signal units indicating processor outage (see Recommendation Q.703, § 8).

3.3.6 *Signalling link unblocked*

3.3.6.1 Signalling traffic management: the actions will be the same as in § 3.3.2.1.

3.3.6.2 Signalling route management: if the link unblocked causes a signalling route set to become available, the signalling transfer point which can once again route the signalling traffic in that route set applies the transfer-allowed procedures described in § 11.

Note – In the case when the blocking and thus the unblocking was initiated by a management system, an indication should be given to the signalling terminal in order to stop any transmission of link status signal units indicating processor outage.

3.4 *Status of signalling routes*

A signalling route can be either available or unavailable, for signalling traffic having the concerned destination (see also Figure 6/Q.704).

3.4.1 *Signalling route unavailability*

A signalling route becomes unavailable when a transfer-prohibited message, indicating that signalling traffic towards a particular destination cannot be transferred via the signalling transfer point sending the concerned message, is received (see § 11).

3.4.2 *Signalling route availability*

A signalling route becomes available when a transfer-allowed message, indicating that signalling traffic towards a particular destination can be transferred via the signalling transfer point sending the concerned message, is received (see § 11).

3.5 *Procedures used in connection with route status changes*

In § 3.5 the procedures relating to each signalling management function which in general are applied in connection with route status changes are listed. (See also Figures 6/Q.704 and 8/Q.704.) Typical examples of the application of the procedures to particular network cases appear in Recommendation Q.705.

3.5.1 *Signalling route unavailable*

3.5.1.1 Signalling traffic management: the forced rerouting procedure (see § 7) is applied; it is used to transfer signalling traffic to the concerned destination from the link set, belonging to the unavailable route, to an alternative link set which terminates in another signalling transfer point. It includes actions to determine the alternative route.

3.5.1.2 Signalling route management: because of the unavailability of the signalling route the network is reconfigured; in the case that a signalling transfer point can no longer route the concerned signalling traffic, it applies the procedures described in § 11.

3.5.2 *Signalling route available*

3.5.2.1 Signalling traffic management: the controlled rerouting procedure (see § 8) is applied; it is used to transfer signalling traffic to the concerned destination from a signalling link or link set belonging to an available route, to another link set which terminates in another signalling transfer point. It includes the determination of which traffic should be diverted and procedures for maintaining the correct message sequence.

3.5.2.2 Signalling route management: because of the restored availability of the signalling route the network is reconfigured; in the case that a signalling transfer point can once again route the concerned signalling traffic, it applies the procedures described in § 11.

4 Signalling traffic management

4.1 *General*

4.1.1 The signalling traffic management function is used, as indicated in § 3, to divert signalling traffic from signalling links or routes, or to temporarily reduce it in quantity in the case of congestion.

4.1.2 The diversion of traffic in the cases of unavailability or availability of signalling links and routes is typically made by means of the following basic procedures, included in the signalling traffic management function:

- signalling link unavailability (failure, deactivation or blocking): the changeover procedure (see § 5) is used to divert signalling traffic to one or more alternative links (if any);
- signalling link availability (restoration, activation or unblocking): the changeback procedure (see § 6) is used to divert signalling traffic to the link made available;
- signalling route unavailability: the forced rerouting procedure (see § 7) is used to divert signalling traffic to an alternative route (if any);
- signalling route availability: the controlled rerouting procedure (see § 8) is used to divert signalling traffic to the route made available.

Each procedure includes different elements of procedure, the application of one or more of which depends on the particular circumstances, as indicated in the relevant sections. Moreover, these procedures include a modification of the signalling routing, which is made in a systematic way, as described in §§ 4.2 to 4.6.

4.1.3 The signalling traffic flow control procedures are used in the case of signalling traffic congestion in a signalling point, in order to request a temporary interruption of the signalling traffic sent to it by one or more adjacent signalling points. These procedures are specified in § 9.

4.2 *Normal routing situation*

4.2.1 Signalling traffic to be sent to a particular signalling point in the network, is normally routed to one or, in the case of load sharing between link sets, two links sets. Within a link set, a further routing may be performed in order to load share the traffic over the available signalling links (see § 2).

To cater for the situations when signalling links or routes become unavailable, alternative routing data are defined.

For each destination which may be reached from a signalling point, one or more alternative link sets are allocated. The possible link sets appear in a certain priority order. The link set having the highest priority is used whenever it is available. It is defined as the normal link set for traffic to the concerned destination. In case of load sharing between link sets, a normal link set exists for each portion of the divided signalling traffic.

For each signalling link, the remaining signalling links in the link set are alternative links. The signalling links of a link set are arranged in a certain priority order. Under normal conditions the signalling link (or links) having the highest priority is used to carry the signalling traffic.

These signalling links are defined as normal signalling links, and each portion of load shared traffic has its own normal signalling link. Signalling links other than normal may be active standby or inactive signalling links, see § 10.

4.2.2 Message routing (normal as well as alternative) is in principle independently defined at each signalling point. Thus, signalling traffic between two signalling points may be routed over different signalling links or paths in the two directions.

4.3 *Signalling link unavailability*

4.3.1 When a signalling link becomes unavailable (see § 3.2) signalling traffic carried by the link is transferred to one or more alternative links by means of a changeover procedure. The alternative link or links are determined in accordance with the following criteria.

4.3.2 In the case when there is one or more alternative signalling links available in the link set to which the unavailable link belongs, the signalling traffic is transferred within the link set to:

a) an active and unblocked signalling link, currently not carrying any traffic. If no such signalling link exists, the signalling traffic is transferred to

b) one or possibly more than one signalling link currently carrying traffic. In the case of transfer to one signalling link, the alternative signalling link is that having the highest priority of the signalling links in service.

4.3.3 In the case when there is no alternative signalling link within the link set to which the unavailable signalling link belongs, the signalling traffic is transferred to one or more alternative link sets in accordance with the alternative routing defined for each destination. For a particular destination, the alternative link set is the link set in service having the highest priority.

Within a new link set, signalling traffic is distributed over the signalling links in accordance with the routing currently applicable for that link set; i.e. the transferred traffic is routed in the same way as the traffic already using the link set.

4.4 *Signalling link availability*

4.4.1 When a previously unavailable signalling link becomes available again (see § 3.2), signalling traffic may be transferred to the available signalling link by means of the changeback procedure. The traffic to be transferred is determined in accordance with the following criteria.

4.4.2 In the case when the link set, to which the available signalling link belongs, already carries signalling traffic on other signalling links in the link set, the traffic to be transferred is the traffic for which the available signalling link is the normal one.

The traffic is transferred from one or more signalling links, depending on the criteria applied when the signalling link became unavailable (see § 4.3.2).

4.4.3 In the case when the link set, to which the available signalling link belongs, does not carry any signalling traffic (i.e. a link set has become available), the traffic to be transferred is the traffic for which the available link set has higher priority than the link set currently used. However, in the case of load sharing between link sets, traffic is not transferred from a normal link set.

The traffic is transferred from one or more link sets and from one or more signalling links within each link set.

4.5 *Signalling route unavailability*

When a signalling route becomes unavailable (see § 3.4) signalling traffic carried by the unavailable route is transferred to an alternative route by means of forced rerouting procedure. The alternative route (i.e. the alternative link set) is determined in accordance with the alternative routing defined for the concerned destination (see § 4.3.3).

4.6 *Signalling route availability*

When a previously unavailable signalling route becomes available again (see § 3.4) signalling traffic may be transferred to the available route by means of a controlled rerouting procedure. This is applicable in the case when the available route (link set) has higher priority than the route (link set) currently used for traffic to the concerned destination (see § 4.4.3).

The transferred traffic is distributed over the links of the new link set in accordance with the routing currently applicable for that link set.

5 Changeover

5.1 *General*

5.1.1 The objective of the changeover procedure is to ensure that signalling traffic carried by the unavailable signalling link is diverted to the alternative signalling link(s) as quickly as possible while avoiding message loss, duplication or mis-sequencing. For this purpose, in the normal case the changeover procedure includes buffer updating and retrieval, which are performed before reopening the alternative signalling link(s) to the diverted traffic. Buffer updating consists of identifying all those messages in the retransmission buffer of the unavailable signalling link which have not been received by the far end. This is done by means of a hand-shake procedure, based on changeover messages, performed between the two ends of the unavailable signalling link. Retrieval consists of transferring the concerned messages to the transmission buffer(s) of the alternative link(s).

5.1.2 Changeover includes the procedures to be used in the case of unavailability (due to failure or blocking) of a signalling link, in order to divert the traffic pertaining to that signalling link to one or more alternative signalling links.

These signalling links can be carrying their own signalling traffic and this is not interrupted by the changeover procedure.

The different network configurations to which the changeover procedure may be applied are described in § 5.2.

The criteria for initiation of changeover, as well as the basic actions to be performed, are described in § 5.3.

Procedures necessary to cater for equipment failure or other abnormal conditions are also provided.

5.2 *Network configurations for changeover*

5.2.1 Signalling traffic diverted from an unavailable signalling link is routed by the concerned signalling point according to the rules specified in § 4. In summary, two alternative situations may arise (either for the whole diverted traffic or for traffic relating to each particular destination):

i) traffic is diverted to one or more signalling links of the same link set, or

ii) traffic is diverted to one or more different link sets.

5.2.2 As a result of these arrangements, and of the message routing function described in § 2, three different relationships between the new signalling link and the unavailable one can be identified, for each particular traffic flow. These three basic cases may be summarized as follows:

a) the new signalling link is parallel to the unavailable one (see Figure 9/Q.704);

b) the new signalling link belongs to a signalling route other than that to which the unavailable signalling link belongs, but this signalling route still passes through the signalling point at the far end of the unavailable signalling link (see Figure 10/Q.704);

c) the new signalling link belongs to a signalling route other than that to which the unavailable signalling link belongs, and this signalling route does not pass through the signalling point acting as signalling transfer point, at the far end of the unavailable signalling link (see Figure 11/Q.704).

Only in the case of c) does a possibility of message mis-sequencing exist: therefore its use should take into account the overall service dependability requirements described in Recommendation Q.706.

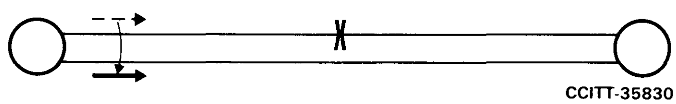


FIGURE 9/Q.704

Example of changeover to a parallel link

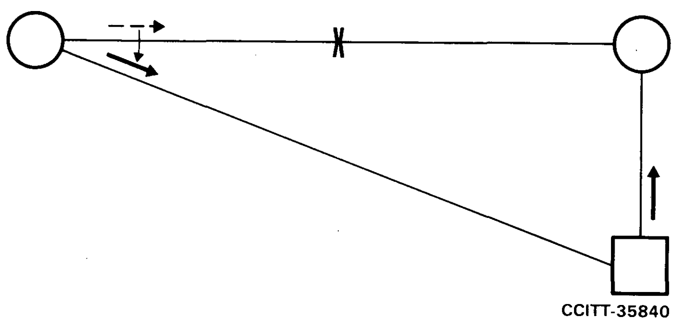


FIGURE 10/Q.704

Example of changeover to a signalling route passing through the remote signalling point

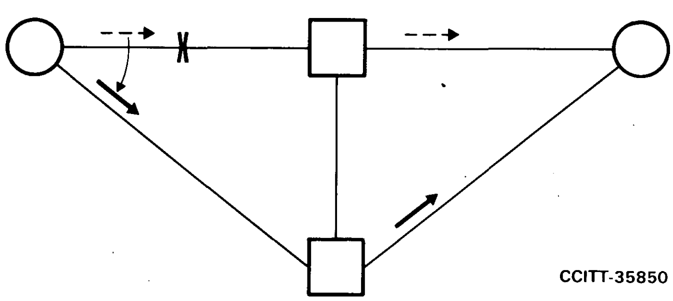


FIGURE 11/Q.704

Example of changeover to a signalling route not passing through the remote signalling point

5.3 *Changeover initiation and actions*

5.3.1 Changeover is initiated at a signalling point when a signalling link is recognized as unavailable according to the criteria listed in §§ 3.2.2 and 3.2.6.

The following actions are then performed:

a) transmission and acceptance of message signal units on the concerned signalling link is terminated;

b) transmission of link status signal units or fill in signal units, as described in Recommendation Q.703, § 5.3, takes place;

c) the alternative signalling link(s) are determined according to the rules specified in § 4;

d) a procedure to update the content of the retransmission buffer of the unavailable signalling link is performed as specified in § 5.4 below;

e) signalling traffic is diverted to the alternative signalling link(s) as specified in § 5.5 below.

In addition, if traffic toward a given destination is diverted to an alternative signalling link terminating in a signalling transfer point not currently used to carry traffic toward that destination, a transfer-prohibited procedure is performed as specified in § 11.2.

5.3.2 In the case when there is no traffic to transfer from the unavailable signalling link action, b) only of § 5.3.1 is required.

5.3.3 If no alternative signalling link exists for signalling traffic towards one or more destinations, the concerned destination(s) are declared inaccessible and the following actions apply:

i) the routing of the concerned signalling traffic is blocked and the concerned messages already stored in the transmission and retransmission buffers of the unavailable signalling link, as well as those received subsequently, are discarded; [2)]

ii) a command is sent to the User Part(s) (if any) in order to stop generating the concerned signalling traffic;

iii) the transfer-prohibited procedure is performed, as specified in § 11.2;

iv) the appropriate signalling link management procedures are performed, as specified in § 10.

5.3.4 In some cases of failures or in some network configurations, the normal buffer updating and retrieval procedures described in §§ 5.4 and 5.5 cannot be accomplished. In such cases, the emergency changeover procedures described in § 5.6 apply.

Other procedures to cover possible abnormal cases appear in § 5.7.

5.4 *Buffer updating procedure*

5.4.1 When a decision to changeover is made, a changeover order is sent to the remote signalling point. In the case that the changeover was initiated by the reception of a changeover order (see § 5.2) a changeover acknowledgement is sent instead.

A changeover order is always acknowledged by a changeover acknowledgement, even when changeover has already been initiated in accordance with another criterion.

No priority is given to the changeover order or changeover acknowledgement in relation to the normal traffic of the signalling link on which the message is sent.

5.4.2 The changeover order and changeover acknowledgement are signalling network management messages and contain the following information:

- the label, indicating the destination and originating signalling points and the identity of the unavailable signalling link;
- the changeover-order (or changeover-acknowledgement) signal; and
- the forward sequence number of the last message signal unit accepted from the unavailable signalling link.

Formats and codes of the changeover order and the changeover acknowledgement appear in § 13.

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2) The adequacy of this procedure to meet the acceptable dependability objective in terms of loss of messages requires further study.

5.4.3 Upon reception of a changeover order or changeover acknowledgement, the retransmission buffer of the unavailable signalling link is updated (except as noted in § 5.6), according to the information contained in the message. The message signal units successive to that indicated by the message are those which have to be retransmitted on the alternative signalling link(s), according to the retrieval and diversion procedure.

5.5 *Retrieval and diversion of traffic*

When the procedure to update the retransmission buffer content is completed the following actions are performed:

- the routing of the signalling traffic to be diverted is changed;
- the signal traffic already stored in the transmission buffers and retransmission buffer of the unavailable signalling link is sent directly towards the new signalling link(s), according to the modified routing.

The diverted signalling traffic will be sent towards the new signalling link(s) in such a way that the correct message sequence is maintained. The diverted traffic has no priority in relation to normal traffic already conveyed on the signalling link(s).

5.6 *Emergency changeover procedures*

5.6.1 Due to the failure in a signalling terminal it may be impossible for the corresponding end of the faulty signalling link to determine the forward sequence number of the last message signal unit accepted over the unavailable link. In this case, the concerned end accomplishes, if possible, the buffer updating procedure described in § 5.4 but it makes use of an emergency changeover order or an emergency changeover acknowledgement instead of the corresponding normal message; these emergency messages, the format of which appears in § 13, do not contain the forward sequence number of the last accepted message signal unit. Furthermore, the signalling link is taken out of service, i.e. the concerned end initiates, if possible, the sending of *out-of-service* link status signal units on the unavailable link (see Recommendation Q.703, § 5.3).

When the other end of the unavailable signalling link receives the emergency changeover order or acknowledgement, it accomplishes the changeover procedures described in §§ 5.4 and 5.5, the only difference being that it does not perform either buffer updating or retrieval. Instead it directly starts sending the signalling traffic not yet transmitted on the unavailable link on the alternative signalling link(s).

The use of normal or emergency changeover messages depends on the local conditions of the sending signalling point only, in particular:

- an emergency changeover order is acknowledged by a changeover acknowledgement if the local conditions are normal; and
- a changeover order is acknowledged by an emergency changeover acknowledgement if there are local fault conditions.

5.6.2 It may happen that no signalling path exists between the two ends of the unavailable link, so that the exchange of changeover messages is impossible.

When the concerned signalling point decides to initiate changeover in such circumstances, after the expiry of a time T1 = 1 s (provisional value) it starts signalling traffic not yet transmitted on the unavailable signalling link on the alternative link(s); the purpose of withholding traffic for the time T1 is to reduce the probability of message mis-sequencing.

An example of such a case appears in Recommendation Q.705, Annex A.

In the abnormal case when the concerned signalling point is not aware of the situation, it will start the normal changeover procedure and send a changeover order; in this case it will receive no changeover message in response and the procedure will be completed as indicated in § 5.7.2. Possible reception of a transfer-prohibited message (sent by an involved signalling transfer point on reception of the changeover order, see § 11.2) will not affect changeover procedures.

5.6.3 Due to failures, it may be impossible for a signalling point to perform retrieval even if it has received the retrieval information from the far end of the unavailable signalling link. In this case, it starts sending new traffic on reception of the changeover message (or on time-out expiry, see §§ 5.6.2 and 5.7.2); no further actions in addition to the other normal changeover procedures are performed.

5.7 *Procedures in abnormal conditions*

5.7.1 The procedures described in this section allow the completion of the changeover procedures in abnormal cases other than those described in § 5.6.

5.7.2 If no changeover message in response to a changeover order is received within a time-out T2 = 1 s (provisional value), new traffic is started on the alternative signalling link(s).

5.7.3 If a changeover order or acknowledgement containing an unreasonable value of the forward sequence number is received, no buffer updating or retrieval is performed, and new traffic is started on the alternative signalling link(s).

5.7.4 If a changeover acknowledgement is received without having previously sent a changeover order, no action is taken.

5.7.5 If a changeover order is received relating to a particular signalling link after the completion of changeover from that signalling link, an emergency changeover acknowledgement is sent in response, without any further action.

6 Changeback

6.1 *General*

6.1.1 The objective of the changeback procedure is to ensure that signalling is diverted from the alternative signalling link(s) to the signalling link made available as quickly as possible, while avoiding message loss, duplication or mis-sequencing. For this purpose (in the normal case), changeback includes a procedure to control the message sequence.

6.1.2 Changeback includes the basic procedures to be used to perform the opposite action to changeover, i.e. to divert traffic from the alternative signalling link(s) to a signalling link which has become available (i.e. it was restored or unblocked). The characteristics of the alternative signalling link(s) from which changeback can be made are described in § 5.2. In all the cases mentioned in § 5.2 the alternative signalling links can be carrying their own signalling traffic and this is not interrupted by the changeback procedures.

Procedures necessary to cater for particular network configuration or other abnormal conditions are also provided.

6.2 *Changeback initiation and actions*

6.2.1 Changeback is initiated at a signalling point when a signalling link is restored or unblocked and therefore it becomes once again available, according to the criteria listed in §§ 3.2.3 and 3 2.7. The following actions are then performed:

a) the alternative signalling link(s) are determined, to which traffic normally carried by the signalling link made available was previously diverted (e.g. on occurrence of a changeover);

b) signalling traffic is diverted (if appropriate, according to the criteria specified in § 4) to the concerned signalling link by means of the sequence control procedure specified in § 6.3; traffic diversion can be performed at the discretion of the signalling point initiating changeback, as follows:

   i) individually for each traffic flow (i.e. on destination basis);

   ii) individually for each alternative signalling link (i.e. for all the destinations previously diverted on that alternative signalling link);

   iii) at the same time for a number of or for all the alternative signalling links.

On occurrence of changeback, it may happen that traffic towards a given destination is no longer routed via a given adjacent signalling transfer point, towards which a transfer-prohibited procedure was previously performed on occurrence of changeover (see § 5.3.1); in this case a transfer-allowed procedure is performed, as specified in § 11.3.

In addition, if traffic towards a given destination is diverted to an alternative signalling link terminating in a signalling transfer point not currently used to carry traffic toward that destination, a transfer-prohibited procedure is performed as specified in § 11.2.

6.2.2 In the case when there is no traffic to transfer to the signalling link made available, none of the previous actions are performed.

6.2.3 In the case that the signalling link made available can be used to carry signalling traffic toward a destination which was previously declared inaccessible, the following actions apply:

i) the routing of the concerned signalling traffic is unblocked and transmission of the concerned messages (if any) is immediately started on the link made available;

ii) a command is sent to the User Part(s) (if any) in order to restart generating the concerned signalling traffic;

iii) the transfer-allowed procedure is performed, as specified in § 11.3.

6.2.4 If the signalling point at the far end of the link made available currently results inaccessible at the signalling point initiating changeback, the sequence control procedure specified in § 6.3 (which requires communication between the two concerned signalling points) does not apply; instead, the time-controlled diversion specified in § 6.4 is performed. This is made also when the concerned signalling points are accessible, but there is no signalling route to it using the same outgoing signalling link(s) (or one of the same signalling links) from which traffic will be diverted.

6.3 *Sequence control procedure*

6.3.1 When a decision is made at a given signalling point to divert a given traffic flow (towards one or more destinations) from an alternative signalling link to the signalling link made available, the following actions are performed if possible (see § 6.4):

i) transmission of the concerned traffic on the alternative signalling link is stopped; such traffic is stored in a *changeback buffer*;

ii) a changeback declaration is sent to the remote signalling point of the signalling link made available via the concerned alternative signalling link; this message indicates that no more message signal units relating to the traffic being diverted to the link made available will be sent on the alternative signalling link.

6.3.2 The concerned signalling point will restart diverted traffic over the signalling link made available when it receives a changeback acknowledgement from the far signalling point of the link made available; this message indicates that all signal messages relating to the concerned traffic flow and routed to the remote signalling point via the alternative signalling link have been received. The remote signalling point will send the changeback acknowledgement to the signalling point initiating changeback in response to the changeback declaration; any available signalling route between the two signalling points can be used to carry the changeback acknowledgement.

6.3.3 The changeback declaration and changeback acknowledgement are signalling network management messages and contain:

- the label, indicating the destination and originating signalling points, and the identity of the signalling link to which traffic will be diverted;
- the changeback-declaration (or changeback-acknowledgement) signal, and
- the changeback code.

Formats and codes of the changeback declaration and changeback acknowledgement appear in § 13.

6.3.4 A particular configuration of the changeback code is autonomously assigned to the changeback declaration by the signalling point initiating changeback; the same configuration is included in the changeback acknowledgement by the acknowledging signalling point. This allows discrimination between different changeback declarations and acknowledgements when more than one sequence control procedures are initiated in parallel, as follows.

6.3.5 In the case that a signalling point intends to initiate changeback in parallel from more than one alternative signalling link, a sequence control procedure is accomplished for each involved signalling link, and a changeback declaration is sent on each of them; each changeback declaration is assigned a different configuration of the changeback code. Stopped traffic is stored in one or more changeback buffers (in the latter case, a changeback buffer is provided for each alternative signalling link). When the changeback acknowledgement relating to that alternative signalling link is received, traffic being diverted from a given alternative signalling link can be restarted on the signalling link made available, starting with the content of the changeback buffer; discrimination between the different changeback acknowledgements is made by the changeback code configuration, which is the same as that sent in the changeback declaration.

This procedure allows either reopening the recovered signalling link to traffic in a selective manner (provided that different changeback buffers are used) as soon as each changeback acknowledgement is received, or only when all the changeback acknowledgements have been received.

6.4 *Time-controlled diversion procedure*

6.4.1 The time-controlled diversion procedure is used in the case when the remote signalling point is inaccessible at the signalling point initiating changeback, i.e. communication between the two ends of the signalling link made available is not possible via a signalling route other than that signalling link; the sending of changeback declaration is therefore impossible. An example of such a case appears in Figure 12/Q.704.

In this example, on failure of signalling link AB, traffic towards the destination was diverted to signalling link AC. When signalling link AB is made available, sending of changeback declaration from A to B is impossible, since no signalling link exists between C and B.

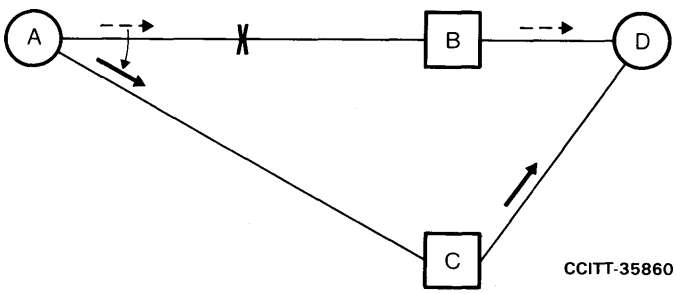

FIGURE 12/Q.704

Example of time-controlled diversion procedure

6.4.2 When changeback is initiated, a signalling point unable to send a changeback declaration stops traffic to be diverted from the alternative signalling link for a time T3 = 1 s (provisional value) after which it reopens traffic on the signalling link made available. The time delay minimizes the probability of out of sequence delivery to the destination point(s).

6.4.3 In the abnormal case when the concerned signalling point is not aware of the situation it will start a normal changeback procedure and send a changeback declaration; in this case it will receive no changeback acknowledgement in response and the procedure will be completed as indicated in § 6.5.3. Reception of a transfer prohibited message (sent by C, in the figure, on reception of the changeback declaration from A, see § 11.2) will not affect the above procedures.

6.5 *Procedures in abnormal conditions*

6.5.1 If a changeback acknowledgement is received by a signalling point which has not previously sent a changeback declaration, no action is taken.

6.5.2 If a changeback declaration is received after the completion of the changeback procedure, a changeback acknowledgement is sent in response, without taking any further action. This corresponds to the normal action described in § 6.3.2 above.

6.5.3 If no changeback acknowledgement is received in response to a changeback declaration within a time T4 = 1 s (provisional value), the changeback declaration is repeated and a new time-out T5 = 1 s (provisional value) is started. If no changeback acknowledgement is received before the expiry of T5, the maintenance functions are alerted and traffic on the link made available is started. The changeback code contained in the changeback acknowledgement message makes it possible to determine in the case of parallel changebacks from more than one reserve path, which changeback declaration is unacknowledged and has therefore to be repeated.

7 Forced rerouting

7.1 *General*

7.1.1 The objective of the forced rerouting procedure is to restore, as quickly as possible, the signalling capability between two signalling points towards a particular destination, in such a way as minimize the consequences of a failure. However, since the unavailability of a signalling route is in general caused by the fact that the concerned destination has become inaccessible to a signalling transfer point, a probability of message loss exists (see § 5.3.3). Therefore the structure of the signalling network should be such as to reduce the probability of signalling route unavailability to limits compatible with the overall dependability requirements (see Recommendation Q.706).

7.1.2 Forced rerouting is the basic procedure to be used in the case where a signalling route towards a given destination becomes unavailable (due to, for example, remote failures in the signalling network) to divert signalling traffic towards that destination to an alternative signalling route outgoing from the concerned signalling point. Signalling links pertaining to the alternative signalling route can be carrying their own signalling traffic (relating to different signalling routes) and this is not interrupted by the forced rerouting procedure.

7.2 *Forced rerouting initiation and actions*

7.2.1 Forced rerouting is initiated at a signalling point when a transfer-prohibited message, indicating a signalling route unavailability, is received.

The following actions are then performed:

a) transmission of signalling traffic towards the concerned destination on the link set(s) pertaining to the unavailable route is immediately stopped; such traffic is stored in a *forced rerouting buffer*;

b) the alternative route is determined according to the rules specified in § 4;

c) as soon as action b) is completed, the concerned signalling traffic is restarted on a link set pertaining to the alternative route, starting with the content of the forced rerouting buffer;

d) if appropriate, a transfer-prohibited procedure is performed (see § 11.2.2).

7.2.2 In the case when there is no signalling traffic to be diverted from the unavailable route, action b) and d) only apply.

7.2.3 If no alternative route exists for signalling traffic towards the concerned destination, that destination is declared inaccessible and the actions specified in § 5.3.3 apply.

8 Controlled rerouting

8.1 *General*

8.1.1 The objective of the controlled rerouting procedure is to restore the optimal signalling routing and to minimize mis-sequencing of messages. Therefore controlled rerouting includes a time-controlled traffic diversion procedure, which is the same as that used in some cases of changeback (see § 6.4).

8.1.2 Controlled rerouting is the basic procedure to be used in the case where a signalling route towards a given destination becomes available (due to, for example, recovery of previous remote failures in the signalling network), to divert back signalling traffic towards that destination from the alternative to the normal signalling route outgoing from the concerned signalling point. Signalling links pertaining to the alternative signalling route can be carrying their own signalling traffic (relating to different signalling routes) and this is not interrupted by the normal rerouting procedure.

8.2 *Controlled rerouting initiation and actions*

8.2.1 Controlled rerouting is initiated at a signalling point when a transfer-allowed message, indicating that the signalling route has become available, is received. The following actions are then performed:

a) transmission of signalling traffic towards the concerned destination on the link set pertaining to the alternative route is stopped; such traffic is stored in a *controlled rerouting buffer*; a time out T6 = 1 s (provisional value) is started;

b) a transfer-prohibited message is sent on the route made available and a transfer-allowed message on the alternative one (see §§ 11.2.2 and 11.3.2 respectively);

c) at the expiry of T6, the concerned signalling traffic is restarted on an outgoing link set pertaining to the signalling route made available, starting with the content of the controlled rerouting buffer; the aim of the time delay is to minimize the probability of out of sequence delivery to the destination point(s).

8.2.2 When there is no signalling traffic to be diverted back to the route made available, the above actions are not performed and the signalling point notes the availability of the route, which therefore may be used if necessary.

8.2.3 If, the destination was inaccessible, when the route is made available, then the destination is declared accessible and the actions specified in § 6.2.3 apply.

9 Signalling traffic flow control

9.1 *General*

The purpose of the signalling traffic flow control functions is to limit signalling traffic at its source in the case when the signalling network is not capable of transferring all signalling traffic offered by the User Parts because of network failures or overload situations.

Flow control actions may be taken as a consequence of a number of events; the following cases have been identified:

– Failures in the signalling network (signalling links or signalling points) have resulted in route set unavailability.

– Overload of a signalling link or signalling point has resulted in a situation where reconfiguration of traffic is not possible or appropriate.

– Failure or overload of a User Part has made it impossible for the User Part to handle all messages delivered by the Message Transfer Part.

When the normal transfer capability is restored, the flow control functions initiate resumption of the normal traffic flow.

9.2 *Flow control indications*

The need for the following indications has been identified; however, other indications are likely to be required (e.g. for User Part overload or User Part failure).

9.2.1 *Signalling route set unavailability*

In the case when no signalling route is available for traffic towards a particular destination (see §§ 5.3.3 and 7.2.3), an indication is given from the Message Transfer Part to all User Parts, informing them that signalling messages destined to the particular signalling point cannot be transferred via the signalling network. Each User Part then takes appropriate actions in order to stop generation of signalling information destined for the inaccessible signalling point.

9.2.2 *Signalling route set availability*

In the case when a signalling route becomes available for traffic to a previously blocked destination (see §§ 6.2.3 and 8.2.3), an indication is given from the Message Transfer Part to the User Parts, informing them that signalling messages destined to the particular Signalling Points can be transferred via the signalling network. Each User Part then takes appropriate actions in order to start generation of signalling information destined for the now accessible signalling point.

10 Signalling link management

10.1 *General*

10.1.1 The signalling link management function is used to control the locally connected signalling links. The function provides means for establishing and maintaining a certain predetermined capability of a link set. Thus, in the event of signalling link failures the signalling link management function controls actions aimed at restoring the capability of the link set.

Three sets of signalling link management procedures are specified in the following sections. Each set corresponds to a certain level of automation as regards allocation and reconfiguration of signalling equipment. The basic set of signalling link management procedures (see § 10.2) provides no automatic means for allocation and reconfiguration of signalling equipment. The basic set includes the minimum number of functions which must be provided for international application of the signalling system.

The two alternative sets of signalling link management procedures are provided as options and include functions allowing for a more efficient use of signalling equipment in the case when signalling terminal devices have switched access to signalling data links.

Note – In Annex A a modified set of signalling link management functions are defined, being an alternative for national applications to those functions specified in § 10.4.

10.1.2 A signalling link set consists of one or more signalling links having a certain order of priority as regards the signalling traffic conveyed by the link set (see § 4). Each signalling link in operation is assigned a signalling data link and a signalling terminal at each end of the signalling data link.

The signalling link identity is independent of the identities of the signalling data link and signalling terminals which it comprises. Thus, the identity referred to by the Signalling Link Code (SLC) included in the label of messages originated at Message Transfer Part level 3 is the signalling link identity and not the signalling data link identity or the signalling terminal identity.

Depending on the level of automation in an application of the signalling system, allocation of signalling data link and signalling terminals to a signalling link may be made manually or automatically.

In the first case, applicable for the basic signalling link management procedures, a signalling link includes predetermined signalling terminals and a predetermined signalling data link. To replace a signalling terminal or signalling data link, a manual intervention is required. The signalling data link to be included in a particular signalling link is determined by bilateral agreement (see also Recommendation Q.702).

In the second case for a given signalling point, a signalling link includes any of the signalling terminals and any of the signalling data links applicable to a *link group.* As a result of, for example, signalling link failure, the signalling terminal and signalling data link included in a signalling link, may be replaced automatically. The criteria and procedures for automatic allocation of signalling terminals and signalling data links are specified in §§ 10.5 and 10.6 respectively. The implementation of these functions requires that for a given link group any signalling terminal can be connected to any signalling data link.

Note – A link group is a group of identical signalling links directly connecting two signalling points. A link set may include one or more link groups.

10.1.3 When a link set is to be brought into service, actions are taken to establish a predetermined number of signalling links. This is made by connecting signalling terminals to signalling data links and for each signalling link performing an initial alignment procedure (see Recommendation Q.703, § 5.3). The process of making a signalling link ready to carry signalling traffic is defined as *signalling link activation.*

Activation of a signalling link may also be applicable, for example when a link set is to be extended or when a persisting failure makes another signalling link in the link set unavailable for signalling traffic.

In the case of signalling link failure, actions should be taken to restore the faulty signalling link, i.e. to make it available for signalling again. The restoration process may include replacement of a faulty signalling data link or signalling terminal.

A link set or a single signalling link is taken out of service by means of a procedure defined as *signalling link deactivation.*

The procedures for activation, restoration and deactivation are initiated and performed in different ways depending on the level of automation applicable for a particular implementation of the signalling system. In the following, procedures are specified for the cases when:

a) no automatic functions are provided for allocation of signalling terminals and signalling data links (see § 10.2);

b) an automatic function is provided for allocation of signalling terminals (see § 10.3);

c) automatic functions are provided for allocation of signalling terminals and signalling data links (see § 10.4).

10.2 *Basic signalling link management procedures*

10.2.1 *Signalling link activation*

10.2.1.1 In the absence of failures, a link set contains a certain predetermined number of active (i.e. aligned) signalling links. In addition, the link set may contain a number of inactive signalling links, i.e. signalling links which have not been put into operation. Predetermined signalling terminals and a signalling data link are associated with each inactive signalling link.

The number of active and inactive signalling links in the absence of failures, and the priority order for the signalling links in a link set, should be identical at both ends of the link set.

Note – In the typical case, all signalling links in a link set are active in the absence of failures.

10.2.1.2 When a decision is taken to activate an inactive signalling link, initial alignment starts. If the initial alignment procedure is successful, the signalling link is active and ready to convey signalling traffic. In the case when initial alignment is not possible, as determined at Message Transfer Part level 2 (see Recommendation Q.703, § 7), new initial alignment procedures are started on the same signalling link until the signalling link is activated or a manual intervention is made.

10.2.2 *Signalling link restoration*

After a signalling link failure is detected, signalling link initial alignment will take place. In the case when the initial alignment procedure is successful, the signalling link is regarded as restored and thus available for signalling.

If initial alignment is not possible, as determined at Message Transfer Part level 2 (see Recommendation Q.703, § 7), new initial alignment procedures may be started on the same signalling link until the signalling link is restored or a manual intervention is made, e.g. to replace the signalling data link or the signalling terminal.

10.2.3 *Signalling link deactivation*

An active signalling link may be made inactive by means of a deactivation procedure, provided that no signalling traffic is carried on that signalling link. When a decision has been taken to deactivate a signalling link the signalling terminal of the signalling link is taken out of service.

10.2.4 *Link set activation*

A signalling link set not having any signalling links in service is started by means of a link set activation procedure.

Two alternative link set activation procedures are defined:

- link set normal activation,
- link set emergency restart.

10.2.4.1 *Link set normal activation*

Link set normal activation is applicable when a link set is to be put into service for the first time (link set initial activation) or when a link set is to be restarted (link set normal restart); the latter is applicable for example in the case when:

- all signalling links in a link set are faulty,
- a processor restart in a signalling point makes it necessary to reestablish a link set,
- a signalling point recognizes other irregularities concerning the interworking between the two signalling points,

provided that none of the above events create an emergency situation.

When link set normal activation is initiated, signalling link activation starts on as many signalling links as possible. (All signalling links in the link set are regarded as being inactive at the start of the procedure.)

The signalling link activation procedures are performed on each signalling link in parallel as specified in § 10.2.1 until the signalling links are made active.

Signalling traffic may, however, commence when one signalling link is successfully activated.

10.2.4.2 *Link set emergency restart*

Link set emergency restart is applicable when an immediate reestablishment of the signalling capability of a link set is required, (i.e., in a situation when the link set normal restart procedure is not fast enough). The precise criteria for initiating link set emergency restart instead of normal restart may vary between different applications of the signalling system. Possible situations for emergency restart are, for example:

- when signalling traffic that may be conveyed over the link set to be restarted is blocked,
- when it is not possible to communicate with the signalling point at the remote end of the link set.

When link set emergency restart is initiated, signalling link activation starts on as many signalling links as possible, in accordance with the principles specified for normal link set activation. In this case, the signalling terminals will have emergency status (see Recommendation Q.703, § 7) resulting in the sending of status indications of type "E" when applicable. Furthermore, the signalling terminals employ the emergency proving procedure and short time-out values in order to accelerate the procedure.

When the emergency situation ceases, a transition from emergency to normal signalling terminal status takes place resulting in the employment of normal proving procedure and normal time-out values.

10.2.4.3 *Time-out values*

The initial alignment procedure (specified in Recommendation Q.703, § 7.3) includes time-outs the expiry of which indicates the failure of an activation or restoration attempt. The values of the time-outs are for further study.

10.3 *Signalling link management procedures based on automatic allocation of signalling terminals*

10.3.1 *Signalling link activation*

10.3.1.1 In the absence of failures a link set contains a certain predetermined number of active (i.e. aligned) signalling links. The link set may also contain a number of inactive signalling links.

An inactive signalling link is a signalling link not in operation. A predetermined signalling data link is associated with each inactive signalling link; however, signalling terminals may not yet be allocated.

The number of active and inactive signalling links in the absence of failures, and the priority order for the signalling links in a link set, should be identical at both ends of the link set.

10.3.1.2 Whenever the number of active signalling links is below the value specified for the link set, actions to activate new inactive signalling links should be taken automatically. This is applicable, for example, when a link set is to be brought into service for the first time (see § 10.3.4) or when a link failure occurs. In the latter case, activation starts when the restoration attempts on the faulty link are considered unsuccessful (see § 10.3.2).

The signalling link(s) to activate is the inactive link(s) having the highest priority in the link set.

Generally, if it is not possible to activate a signalling link, an attempt to activate the next inactive signalling link (in priority order) is made. In the case when an activation attempt performed on the last signalling link in the link set is unsuccessful, the "next" signalling link is the first inactive signalling link in the link set (i.e. there is a cyclic assignment).

Activation of a signalling link may also be initiated manually.

Activation shall not be initiated automatically for a signalling link previously deactivated by means of a manual intervention.

10.3.1.3 When a decision is taken to activate a signalling link, the signalling terminal to be employed has to be allocated at each end.

The signalling terminal is allocated automatically by means of the function defined in § 10.5.

In the case when the automatic allocation function cannot provide a signalling terminal the activation attempt is aborted.

The predetermined signalling data link which may be utilized for other purposes when not connected to a signalling terminal must be removed from its alternative use (e.g. as a speech circuit) before signalling link activation can start.

10.3.1.4 The chosen signalling terminal is then connected to the signalling data link and initial alignment starts (see Recommendation Q.703, § 7).

If the initial alignment procedure is successful, the signalling link is active and ready to convey signalling traffic.

If initial alignment is not possible, as determined at Message Transfer Part level 2 (see Recommendation Q.703, § 7), the activation is unsuccessful and activation of the next inactive signalling link (if any) is initiated. Successive initial alignment attempts may, however, continue on the previous signalling link until it is activated or its signalling terminal is disconnected (see § 10.5).

In the case when activation attempts take place at both ends of a link set, it may be that the two ends attempt to activate different signalling links, thus making initial alignment impossible. By initiating activation of the next signalling link when an activation attempt fails, and by having different lengths of the initial alignment time-outs at the two ends of the link set (see § 10.3.4.3) it is ensured that eventually a signalling data link will be provided with signalling terminals at both ends at the same time.

10.3.2 *Signalling link restoration*

10.3.2.1 After a signalling link failure is recognized, signalling link initial alignment will take place (see Recommendation Q.703, § 7). In the case when the initial alignment is successful, the signalling link is regarded as restored and thus available for signalling. If the initial alignment is unsuccessful, the signalling terminals and signalling link may be faulty and require replacement.

10.3.2.2 The signalling terminal may be automatically replaced in accordance with the principles defined for automatic allocation of signalling terminals (see § 10.5). After the new signalling terminal has been connected to the signalling data link, signalling link initial alignment starts. If successful, the signalling link is restored.

If initial alignment is not possible or if no alternative signalling terminal is available for the faulty signalling link, activation of the next signalling link in the link set (if any) starts. In the case when it is not appropriate to replace the signalling terminal of the faulty signalling link (e.g. because it is assumed that the signalling data link is faulty) activation of the next inactive signalling link (if any) is also initiated. In both cases successive initial alignment attempts may continue on the faulty signalling link until a manual intervention is made or the signalling terminal is disconnected (see § 10.5).

Note – In the case when a signalling terminal cannot be replaced, activation of the next signalling link is only initiated if the link set includes an alternative link group having access to other signalling terminals than the signalling link for which restoration is not possible.

10.3.3 *Signalling link deactivation*

In the absence of failures a link set contains a specified number of active (i.e. aligned) signalling links. Whenever that number is exceeded (e.g. as a result of signalling link restoration), the active signalling link having the lowest priority in the link set is to be made inactive automatically provided that no signalling traffic is carried on that signalling link.

Deactivation of a particular signalling link may also be initiated manually, for example in conjunction with manual maintenance activities.

When a decision has been taken to deactivate a signalling link, the signalling terminal and signalling data link may be disconnected.

After deactivation, the idle signalling terminal may become part of other signalling links (see § 10.5).

10.3.4 *Link set activation*

A signalling link set not having any signalling links in service is started by means of a link set activation procedure. The objective of the procedure is to activate a specified number of signalling links for the link set. The activated signalling links should, if possible, be the signalling links having the highest priority in the link set. Two alternative link set activation procedures are defined:

- link set normal activation,
- link set emergency restart.

10.3.4.1 *Link set normal activation*

Link set normal activation is applicable when a link set is to be put into service for the first time (link set initial activation) or when a link set is to be restarted (link set normal restart); the latter is applicable, for example, in the case when:

- all signalling links in a link set are faulty;
- a processor restart in a signalling point makes it necessary to re-establish a link set;
- a signalling point recognizes other irregularities concerning the interworking between the two signalling points, e.g. that a certain signalling data link is associated with different signalling links at the two ends of the link set;

provided that none of the above events create an emergency situation.

When link set normal activation is initiated, signalling link activation starts on as many signalling links as possible. (All signalling links in the link set are regarded as being inactive at the start of the procedure.) If activation cannot take place on all signalling links in the link set (e.g., because a sufficient number of signalling terminals is not available), then the signalling links to activate are determined in accordance with the link priority order.

Note – All idle signalling terminals may not necessarily be made available for link set activation. Thus making possible, for example, restoration of faulty signalling links in other link sets at the same time.

The signalling link activation procedures are performed as specified in § 10.3.1.

If the activation attempt for a signalling link is unsuccessful (i.e. initial alignment is not possible), activation of the next inactive signalling link, if any, in the priority order is initiated [3]. According to the principles for automatic allocation of signalling terminals defined in § 10.5, the signalling terminal connected to the unsuccessfully activated signalling link will typically be connected to the signalling data link of that signalling link for which the new activation attempt is to be made.

When a signalling link is successfully activated, signalling traffic may commence.

After the successful activation of one signalling link, the activation attempts on the remaining signalling links continue in accordance with the principles defined in § 10.3.1, in such a way that the signalling links having the highest priorities are made active. This is done in order to obtain, if possible, the normal configuration within the link set. Signalling link activation continues until the predetermined number of active signalling links is obtained.

10.3.4.2 *Link set emergency restart*

Link set emergency restart is applicable in the case when the link set normal restart procedure is not fast enough. Emergency restart is performed in the same way as link set normal activation except that, in the case of emergency restart, the emergency proving procedure and the short emergency time-out values (cf Recommendation Q.703, § 7) are employed in order to accelerate the procedure (see further § 10.2.4.2).

10.3.4.3 *Time-out values*

The values of the time-outs included in the initial alignment procedure (see Recommendation Q.703, § 2) should be different at the two ends of the link set. These values are for further study.

10.4 *Signalling link management procedures based on automatic allocation of signalling data links and signalling terminals*

10.4.1 *Signalling link activation*

10.4.1.1 In the absence of failures a link set contains a certain predetermined number of active (i.e. aligned) signalling links. The link set may also contain a number of inactive signalling links.

An inactive signalling link is a signalling link currently not in operation. It is not associated with any signalling terminal or signalling data link (i.e. the signalling link is only identified by its position in the link set).

The number of active and inactive signalling links (in the absence of failures), and the priority order for the signalling links in a link set, should be identical at both ends of the link set.

10.4.1.2 Whenever the number of active signalling links is below the value specified for the link set, actions to activate new inactive signalling links should be taken automatically. This is, for example, applicable when a link set is to be brought into service for the first time (see § 10.4.4) or when a link failure occurs. In the latter case, activation starts when the restoration attempts on the faulty link are considered unsuccessful (see § 10.4.2).

The signalling link(s) to activate is the inactive link(s) having the highest priority in the link set.

If it is not possible to activate a signalling link an attempt to activate the next inactive signalling link (in priority order) is made. In the case when an activation attempt performed on the last signalling link in the link set is unsuccessful, the "next" signalling link is the first inactive link in the link set (i.e. a cyclic assignment).

Note – Activation of the next signalling link is only initiated if the link set includes an alternative link group, having access to other signalling terminals and/or other signalling data links than the signalling link for which activation is not possible.

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[3] Inactive links exist in the case when the number of signalling terminals available is less than the number of signalling links defined for the link set.

Activation of a particular signalling link may also be initiated upon receiving a request from the remote signalling point, or by a manual request.

Activation shall not be initiated automatically for a signalling link previously inactivated by means of a manual intervention.

10.4.1.3 When a decision is taken to activate a signalling link, the signalling terminals and signalling data link to be employed have to be allocated.

A signalling terminal is allocated automatically by means of the function defined in § 10.5.

The signalling data link is allocated automatically by means of the function defined in § 10.6. However, in conjunction with link set activation the identity of the signalling data link to use may be predetermined (see further § 10.4.4). A signalling data link which is not connected to a signalling terminal may be utilized for other purposes, e.g., as a speech circuit. When the data link is to be employed for signalling, it must be removed from its alternative use.

In the case when the automatic allocation functions cannot provide a signalling terminal or a signalling data link, the activation attempt is aborted.

10.4.1.4 When the signalling data link and signalling terminal to be used for a particular signalling link are determined, the signalling terminal is connected to the signalling data link and signalling link initial alignment starts (see Recommendation Q.703, § 7). If the initial alignment procedure is successful, the signalling link is active and ready to convey signalling traffic.

If initial alignment is not possible, as determined at Message Transfer Part level 2 (see Recommendation Q.703, § 7), alternative signalling data links are automatically connected to the signalling terminal, until an initial alignment procedure is successfully completed. In the case when the function for automatic allocation of signalling data links cannot provide an alternative signalling data link, the activation is regarded as unsuccessful and activation of the next inactive signalling link (if any) is initiated (see, however, the Note to § 10.4.1.2 above). Successive initial alignment attempts may continue on the previous signalling link until it is activated or its signalling terminal is disconnected (see § 10.5).

10.4.2 *Signalling link restoration*

10.4.2.1 After a signalling link failure is recognized, signalling link initial alignment will take place (see Recommendation Q.703, § 7). In the case when the initial alignment is successful, the signalling link is regarded as restored and thus available for signalling.

If the initial alignment is unsuccessful, the signalling terminal and signalling data link may be faulty and require replacement.

10.4.2.2 The signalling data link may be automatically replaced by an alternative, in accordance with the principles defined in § 10.6. After the new signalling data link has been connected to the signalling terminal signalling link, initial alignment starts. If successful, the signalling link is restored. If not, alternative data links are connected to the signalling terminal, until an initial alignment procedure is successfully completed.

If the automatic allocation function cannot provide a new signalling data link, activation of the next inactive signalling link (if any) is initiated (see, however, the Note to § 10.4.1.2). Successive initial alignment attempts may, however, continue on the faulty signalling link until it is restored or its signalling terminal is disconnected.

10.4.2.3 The signalling terminal may be automatically replaced in accordance with the principles defined in § 10.5. After the new signalling terminal has been connected to the signalling data link, signalling link initial alignment starts. If successful, the signalling link is restored. If not, activation of the next signalling link in the link set (if any) starts (see, however, the Note to § 10.4.1.2).

Successive initial alignment attempts may, however, continue on the faulty signalling link until it is restored or, for example, the signalling terminal or signalling data link is disconnected.

Note – Activation of the next signalling link in the link set should not be initiated as long as one of the activities described in §§ 10.4.2.2 and 10.4.2.3 above is taking place.

10.4.3 *Signalling link deactivation*

In the absence of failures, a link set contains a specified number of active (i.e. aligned) signalling links. Whenever that number is exceeded (e.g. as a result of signalling link restoration) the active signalling link having the lowest priority in the link set is to be made inactive automatically, provided that no signalling traffic is carried on that signalling link.

Deactivation of a particular signalling link may also be initiated manually, e.g. in conjunction with manual maintenance activities.

When a decision has been taken to deactivate a signalling link, the signalling terminal and signalling data link may be disconnected. After deactivation, the idle signalling terminal and signalling data link may become parts of other signalling links (see §§ 10.5 and 10.6).

10.4.4 *Link set activation*

Link set activation is applicable in the case when a link set not having any signalling links in service is to be started for the first time or after a failure (see § 10.3.4). The link set activation procedure is performed as specified in § 10.3.4, also as regards the allocation of signalling data links; i.e., signalling data links are allocated in accordance with a predetermined list assigning a signalling data link to some or all of the signalling links in the link set. This is made in order to cater for the situation when it is not possible to communicate with the remote end of the link set (c.f. § 10.6). However, when a signalling link has become active, signalling data link allocation may again be performed automatically (i.e. activation of a signalling link takes place as specified in § 10.4.1).

10.5 *Automatic allocation of signalling terminals*

In conjunction with the signalling link activation and restoration procedures specified in §§ 10.3 and 10.4, signalling terminals may be allocated automatically to a signalling link. A signalling terminal applicable to the link group is allocated in accordance with the following principles:

a) an idle signalling terminal (i.e. a signalling terminal not connected to a signalling data link) is chosen if possible;

b) if no idle signalling terminal is available, a signalling terminal is chosen which is connected to an unsuccessfully restored or activated signalling link.

Note – Activation and restoration is regarded as unsuccessful when it is not possible to complete the initial alignment procedure successfully (see §§ 10.3 and 10.4).

Measures should be employed to ensure that signalling terminals to be allocated to signalling links are able to function correctly (see Recommendation Q.707).

A link set may be assigned a certain number of signalling terminals. A signalling terminal may be transferred from a signalling link in one link set to a signalling link in another link set [in accordance with b) above] only when the remaining number of signalling terminals in the link set is not below the specified value.

Note – From a link set with a minimum number of signalling terminals, only one signalling terminal and signalling data link may be removed at a time (e.g. for testing, see Recommendation Q.707).

10.6 *Automatic allocation of signalling data links*

10.6.1 In conjunction with the signalling link activation and restoration procedures specified in § 10.4, signalling data links may be allocated automatically. Any signalling data link applicable to a link group may be chosen for a signalling link within that link group.

The signalling data links applicable to a link group are determined by bilateral agreement and may, for example, include all speech circuits between two exchanges. A signalling data link may also be established as a semipermanent connection via one or more intermediate exchanges.

When a potential signalling data link is not employed for signalling, it is normally used for other purposes (e.g. as a speech circuit).

The identity of the signalling data link to be used for a particular signalling link is determined at one of the two involved signalling points and reported to the remote end by a signalling data link connection order message. The signalling point controlling the choice of signalling data link is the signalling point initiating the activation or restoration procedure or, in the case when both ends initiate the procedure at the same point in time, the signalling point having the highest signalling point code (included in the label of the message).

10.6.2 When a signalling data link has been chosen at a signalling point, the data link is made unavailable for other uses (e.g. as a speech circuit) and an order to connect the appointed signalling data link to a signalling terminal is sent to the signalling point at the remote end of the signalling link.

The signalling-data-link-connection-order contains:

- the label, indicating the destination and originating signalling points and the identity of the signalling link to activate or restore;
- the signalling-data-link-connection-order;
- the identity of the signalling data link.

Formats and codes for the signalling-data-link-connection-order message appear in § 13.

10.6.3 Upon reception of the signalling-data-link-connection-order, the following applies:

a) In the case when the signalling link to which a received signalling-data-link-connection-order refers is inactive as seen from the receiving signalling point, the message is regarded as an order to activate the concerned signalling link, resulting in, for example, allocation of a signalling terminal. The signalling data link indicated in the signalling-data-link-connection-order is then connected to the associated signalling terminal and signalling link initial alignment starts. An acknowledgement is sent to the remote signalling point.

   In the case when it is not possible to connect the appointed signalling data link to a signalling terminal (e.g. because there is no working signalling terminal available), the acknowledgement contains an indication informing the remote signalling point whether or not an alternative signalling data link should be allocated to the concerned signalling link.

b) In the case when the signalling point receives a signalling data link connection order when waiting for an acknowledgement, the order is disregarded in the case when the signalling point code of the receiving signalling point is higher than the signalling point code of the remote signalling point. If the remote signalling point has the highest signalling point code, the message is acknowledged and the signalling data link referred to in the received message is connected.

c) In the case when a signalling-data-link-connection-order is received in other situations (e.g. in the case of an error in procedure), no actions are taken.

The signalling-data-link-connection-acknowledgement contains the label, indicating the destination and originating signalling points and the identity of the signalling link to activate or restore, and one of the following signals:

- connection-successful signal, indicating that the signalling data link has been connected to a signalling terminal;
- connection-not-successful signal, indicating that it was not possible to connect the signalling data link to a signalling terminal, and that an alternative signalling data link should be allocated;
- connection-not-possible signal, indicating that it was not possible to connect the signalling data link to a signalling terminal, and that no alternative signalling data link should be allocated.

Formats and codes for the signalling-data-link-connection-acknowledgement message appear in § 13.

10.6.4 When the signalling point initiating the procedure receives a message indicating that signalling data link and signalling terminal have been connected at the remote end, the signalling data link is connected to the associated signalling terminal and initial alignment starts (see § 10.4).

In the case when the acknowledgement indicates that it was not possible to connect the signalling data link to a signalling terminal at the remote end, an alternative signalling data link is allocated and a new signalling data link connection order is sent (as specified above). However, if the acknowledgement indicates that no alternative signalling data link should be allocated, the activation or restoration procedure is terminated for the concerned signalling link.

If no signalling-data-link-connection-acknowledgement or -order is received from the remote signalling point within a time-out T7 = 2 s (provisional value), the signalling-data-link-connection-order is repeated.

10.6.5 When a signalling data link is disconnected in conjunction with signalling link restoration or deactivation, the signalling data link is made idle (and available, e.g. as speech circuit).

11 Signalling route management

11.1 *General*

The purpose of the signalling route management function is to ensure a reliable exchange of information between the signalling points about the availability of the signalling routes.

The unavailability and availability of a signalling route is communicated by means of the transfer-prohibited and transfer-allowed procedure respectively, specified in §§ 11.2 and 11.3.

Recovery of signalling route status information is made by means of the signalling-route-set-test procedure specified in § 11.4.

11.2 *Transfer-prohibited*

11.2.1 The transfer-prohibited procedure is performed at a signalling point acting as a signalling transfer point for messages relating to a given destination, when it has to notify one or more adjacent signalling points that they must no longer route the concerned messages via that signalling transfer point.

The transfer-prohibited procedure makes use of the transfer-prohibited message and of the transfer-prohibited-acknowledgement message which contain:

- the label, indicating the destination and originating points;
- the transfer-prohibited (or transfer-prohibited-acknowledgement) signal; and
- the destination for which traffic transfer is no longer possible [4].

Formats and codes of these messages appear in § 13.

11.2.2 A transfer-prohibited message relating to a given destination *X* is sent from a signalling transfer point *Y* in the following cases:

i) When signalling transfer point *Y* starts to route (at changeover, changeback, forced or normal rerouting) signalling traffic destined to signalling point *X* via a signalling transfer point *Z* not currently used by signalling transfer point *Y* for this traffic. In this case the transfer-prohibited message is sent to signalling transfer point *Z*.

ii) When signalling transfer point *Y* recognizes that it is unable to transfer signalling traffic destined to signalling point *X* (see §§ 5.3.3 and 7.2.3). In this case a transfer-prohibited message is sent to all accessible adjacent signalling points.

iii) When a message destined to signalling point *X* is received at signalling transfer point *Y* and signalling transfer point *Y* is unable to transfer the message. In this case the transfer-prohibited message is sent to the adjacent signalling point from which the concerned message was received.

If no transfer-prohibited-acknowledgement is received in response to a transfer-prohibited message within T8 = 1 s (provisional value) the transfer-prohibited message is repeated. During this time, the transfer-prohibited message will not be sent according to criterion iii) above.

Examples of the above situation appear in Recommendation Q.705.

11.2.3 When a signalling point receives a transfer-prohibited message from signalling transfer point *Y* it sends in response to signalling transfer point *Y* a transfer-prohibited-acknowledgement; moreover, it performs the actions specified in § 7 (since reception of transfer-prohibited message indicates the unavailability of the concerned signalling route, see § 3.4.1).

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4) The possibility of referring to a more general destination than a single signalling point (e.g. a signalling region), or more restrictive than a single signalling point (e.g. an individual User Part) is for further study.

11.2.4 In some circumstances it may happen that a signalling point receives either a repeated transfer-prohibited message or a transfer-prohibited message relating to a nonexistent route (i.e. there is no route from that signalling point to the concerned destination via signalling transfer point *Y*, according to signalling network configuration) or to a destination which is already inaccessible, due to previous failures; in this case a transfer-prohibited-acknowledgement is sent, without further actions.

11.3 *Transfer-allowed*

11.3.1 The transfer-allowed procedure is performed at a signalling point, acting as signalling transfer point for messages relating to a given destination, when it has to notify one or more adjacent signalling points that they may start to route to it, if appropriate, the concerned messages.

The transfer-allowed procedure makes use of the transfer-allowed message and of the transfer-allowed-acknowledgement which contain:

- the label, indicating the destination and originating points;
- the transfer-allowed (or transfer-allowed-acknowledgement) signal; and
- the destination for which transfer is now possible [4].

Formats and codes of these messages appear in § 13.

11.3.2 A transfer-allowed message relating to a given destination *X* is sent from signalling transfer point *Y* in the following cases:

i) When signalling transfer point *Y* stops routing (at changeback or normal rerouting) signalling traffic destined to signalling point *X* via a signalling transfer point *Z* (to which the concerned traffic was previously diverted as a consequence of changeover or forced rerouting). In this case the transfer-allowed message is sent to signalling transfer point *Z*.

ii) When signalling transfer point *Y* recognizes that it is again able to transfer signalling traffic destined to signalling point *X* (see §§ 6.2.3 and 8.2.3). In this case a transfer-allowed message is sent to all accessible adjacent signalling points.

If no transfer-allowed-acknowledgement is received in response to a transfer-allowed message within T9 = 1 s (provisional value), the transfer-allowed message is repeated.

Examples of the above situations appear in Recommendation Q.705.

11.3.3 When a signalling point receives a transfer-allowed message from signalling transfer point *Y*, it sends in response a transfer-allowed-acknowledgement to signalling transfer point *Y*; moreover, it performs the actions specified in § 8 (since reception of a transfer-allowed message indicates the availability of the concerned signalling route, see § 3.4.2).

11.3.4 In some circumstances it may happen that a signalling point receives either a repeated transfer-allowed message or a transfer-allowed message relating to a nonexistent signalling route (i.e. there is no route from that signalling point to the concerned destination via signalling transfer point *Y* according to the signalling network configuration); in this case a transfer-allowed-acknowledgement is sent, without further actions.

11.4 *Signalling-route-set-test*

11.4.1 The signalling-route-set-test procedure is used at a signalling point to test whether or not signalling traffic towards a certain destination may be routed via an adjacent signalling transfer point.

The procedure makes use of the signalling-route-set-test message, and the transfer-allowed and the transfer-prohibited procedures.

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[4] The possibility to refer to more general destination than a single signalling point (e.g. a signalling region), or more restrictive than a single signalling point (e.g. an individual User Part) is for further study.

The signalling-route-set-test message contains:

- the label, indicating the destination and originating points;
- the signalling-route-set-test signal; and
- the destination, the accessibility of which is to be tested [4].

Format and coding of this message appear in § 13.

11.4.2 A signalling-route-set-test message is sent from a signalling point in the following cases:

a) When a transfer-prohibited message is received from an adjacent signalling transfer point. In this case a signalling-route-set-test message is sent to that signalling transfer point referring to the destination declared inaccessible by the transfer-prohibited message every 30 seconds (provisional value) until a transfer-allowed message, indicating that the destination has become accessible, is received.

b) When a previously unavailable link set, directly connecting the signalling point with a signalling transfer point, becomes available. In this case signalling-route-set-test messages sent to the signalling transfer point refer to all destinations which in the absence of failures are accessible via the signalling transfer point.

c) When the route status information at a signalling point is to be updated, for example in conjunction with processor restart. In this case signalling-route-set-test messages, referring to all destinations which in the absence of failures are accessible from the signalling point, are sent. For a certain destination a signalling-route-set-test message is sent to each adjacent signalling transfer point which under normal conditions is capable of routing signalling traffic to the destination.

In case a) above, the procedure is used in order to recover the signalling route availability information that may not have been received because of some signalling network failure.

In cases b) and c) above, the positive or negative responses to the test messages (i.e. the reception of transfer-allowed messages or transfer-prohibited messages) are used to update route status information in the signalling point.

11.4.3 A signalling-route-set-test message is sent to the adjacent signalling transfer point as an ordinary signalling network management message.

11.4.4 At the reception of a signalling-route-set-test message, a signalling transfer point will send in response:

- a transfer-allowed message, referring to the destination the accessibility of which is tested, if the signalling transfer point can reach the indicated destination via a signalling link not connected to the signalling point from which the signalling-route-set-test message was originated;
- a transfer-prohibited message in all other cases (including the inaccessibility of that destination).

11.4.5 At the reception of the transfer-allowed or transfer-prohibited message, the signalling point will perform the procedures specified in §§ 11.2.3 and 11.3.3 respectively.

12 Common characteristics of message signal unit formats

12.1 *General*

The basic signal unit format which is common to all message signal units is described in Recommendation Q.703, § 2. From the point of view of the Message Transfer Part level 3 functions, common characteristics of the message signal units are the presence of:

- the service information octet;
- the label, contained in the signalling information field, and, in particular, the routing label.

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[4] The possibility to refer to more general destination than a single signalling point (e.g. a signalling region), or more restrictive than a single signalling point (e.g. an individual User Part) is for further study.

12.2 *Service information octet*

The service information octet of message signal units contains the service indicator and the sub-service field. The structure of the service information octet is shown in Figure 13/Q.704.

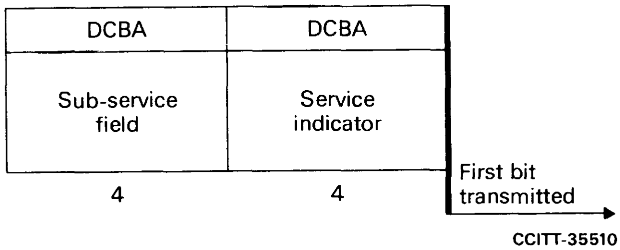


FIGURE 13/Q.704

Service information octet

12.2.1 *Service indicator*

The service indicator is used by signalling handling functions to perform message distribution (see § 2.4) and, in some special applications, to perform message routing (see § 2.3).

The service indicator codes are allocated as follows:

bits D C B A	
0 0 0 0	Signalling network management messages
0 0 0 1	Signalling network testing and maintenance messages
0 0 1 0 0 0 1 1	Spare for international allocation
0 1 0 0	Telephone User Part
0 1 0 1	Spare for international allocation
0 1 1 0	Data User Part (call and circuit related messages)
0 1 1 1	Data User Part (facility registration and cancellation messages)
1 0 0 0 1 0 0 1 1 0 1 0 1 0 1 1	Spare for international allocation
1 1 0 0 1 1 0 1 1 1 1 0 1 1 1 1	For national use

12.2.2 *Sub-service field*

The sub-service field contains the national indicator (bits C and D) and two spare bits (bits A and B). The national indicator is used by signalling message handling functions (e.g. in order to determine the relevant signalling point numbering scheme); see §§ 2.3 and 2.4.

The two spare bits, coded 00, are available for possible future needs that may require a common solution for all international User Parts.

The national indicator provides for discrimination between international and national messages. In the case of national messages it can be used, for example, for discrimination between different label structures. The national indicator codes are allocated as follows:

bits D C	
0 0	International message
0 1	Spare (for international use only)
1 0	National message
1 1	Reserved for national use

The international spare code (01) should not be used for implementing features which are to be provided both internationally and nationally.

In national applications when the discrimination provided by the national indicator is not used, the whole sub-service field can be used independently for different User Parts.

12.3 *Label*

The structure and content of the label is defined for each User Part and is defined in the relevant specification. The common part of the label used for signalling message handling, the routing label, is specified in § 2.2.

13 Formats and codes of signalling network management messages

13.1 *General*

13.1.1 The signalling network management messages are carried on the signalling channel in message signal units, the format of which is described in § 12 and in Recommendation Q.703, § 2. In particular, as indicated in § 12.2 these messages are distinguished by the configuration 0000 of the service indicator (SI). The sub-service field (SSF) of the messages is used according with the rules indicated in § 12.2.2.

13.1.2 The signalling information field consists of an integral number of octets and contains the label, the heading code and one or more signals and indications. The structure and function of the label, and of the heading code, are described in §§ 13.2 and 13.3 respectively; the detailed message formats are described in the following sections. For each message the sequence of fields is shown in the corresponding figure, including fields that may or may not be present.

In the figures, the fields are shown starting from the right to the left (i.e. the first field to be transmitted is at the right). Within each field the information is transmitted least significant bit first. Spare bits are coded 0 unless otherwise indicated.

13.2 *Label*

For signalling network management messages the label coincides with the routing label and indicates the destination and originating signalling points of the message; moreover, in the case of messages related to a particular signalling link, it also indicates the identity of the signalling link among those interconnecting the destination and originating points. The standard label structure of Message Transfer Part level 3 messages appears in Figure 14/Q.704; the total length is 32 bits.

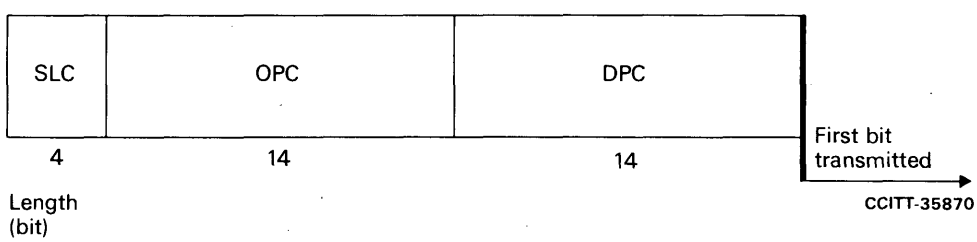


FIGURE 14/Q.704
Standard label structure

The meaning and use of the destination point code (DPC) and of the originating point code (OPC) fields are described in § 2. The signalling link code (SLC) indicates the signalling link, connecting the destination and originating points, to which the message is related. If the message is not related to a signalling link, or another particular code is not specified, it is coded 0000.

13.3 *Heading code (H0)*

The heading code (H0) is the 4 bit field following the label and identifies the message group.

The different heading codes are allocated as follows:

0000 Spare
0001 Changeover and changeback messages
0010 Emergency changeover message
0011 Spare (reserved for signalling-traffic-flow-control messages)
0100 Transfer-prohibited and -allowed messages
0101 Signalling-route-set-test messages
0110 Spare
0111 Spare
1000 Signalling-data-link-connection messages

The remaining codings are spare.

The synopsis of signalling network management messages is given in Table 1/Q.704.

13.4 *Changeover message*

13.4.1 The format of the changeover message is shown in Figure 15/Q.704.

0		DCBA	0001		
	FSN of last accepted MSU	Heading code H1	Heading code H0	Label	First bit transmitted →
1	7	4	4	32	

CCITT-35880

FIGURE 15/Q.704
Changeover message

13.4.2 The changeover message is made up of the following fields:

- Label (32 bits): see § 13.2.
- Heading code H0 (4 bits): see § 13.3.
- Heading code H1 (4 bits): see § 13.4.3.
- Forward sequence number of last accepted message signal unit (7 bits).
- A filler bit coded 0.

13.4.3 The Heading code H1 contains signal codes as follows:

bit D C B A
0 0 0 1 Changeover order signal
0 0 1 0 Changeover acknowledgement signal

13.5 *Changeback message*

13.5.1 The format of the changeback message is shown in Figure 16/Q.704.

	DCBA	0001		
Changeback code	Heading code H1	Heading code H0	Label	First bit transmitted →
8	4	4	32	

CCITT-35580

FIGURE 16/Q.704
Changeback message

13.5.2 The changeback message is made up of the following fields:

- Label (32 bits): see § 13.2.
- Heading code H0 (4 bits): see § 13.3.
- Heading code H1 (4 bits): see § 13.5.3.
- Changeback code (8 bits): see § 13.5.4.

13.5.3 The Header code H1 contains signal codes as follows:

bit C D B A	
0 1 0 1	Changeback declaration signal
0 1 1 0	Changeback acknowledgement signal

13.5.4 The changeback code is an 8-bit code assigned by the signalling point which sends the message according to the criteria described in § 6.

13.6 *Emergency changeover message*

13.6.1 The format of the emergency changeover message is shown in Figure 17/Q.704.

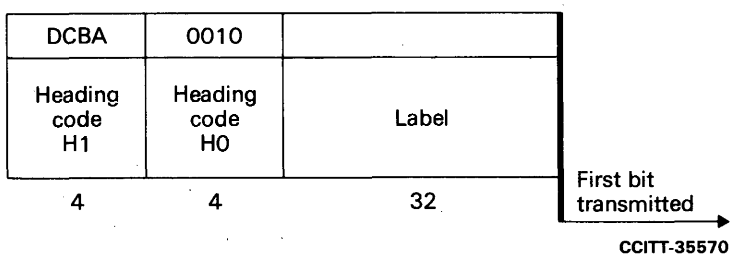


FIGURE 17/Q.704

Emergency changeover message

13.6.2 The emergency changeover message is made up of the following fields:

- Label (32 bits): see § 13.2.
- Heading code H0 (4 bits): see § 13.3.
- Heading code H1 (4 bits): see § 13.4.3.

13.7 *Transfer-prohibited message*

13.7.1 The format of the transfer-prohibited message is shown in Figure 18/Q.704 [4)].

4) The possibility to refer to more general destination than a single signalling point (e.g. a signalling region), or more restrictive than a single signalling point (e.g. an individual User Part) is for further study.

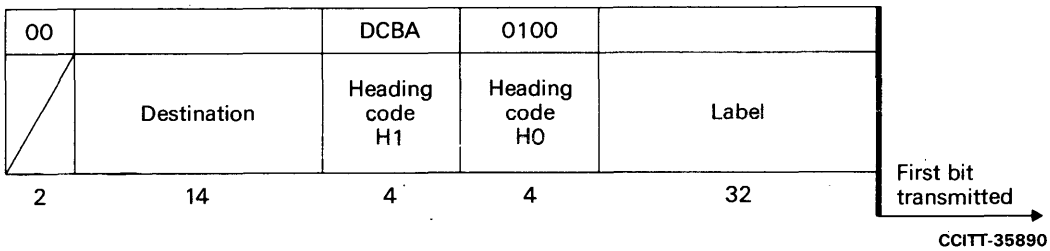


FIGURE 18/Q.704
Transfer-prohibited message

13.7.2 The transfer-prohibited message is made up of the following fields:

- Label (32 bits): see § 13.2.
- Heading code H0 (4 bits): see § 13.3.
- Heading code H1 (4 bits): see § 13.7.3.
- Destination (14 bits): see § 13.7.4.
- Spare bits (2 bits) code 00.

13.7.3 The heading code H1 contains signal codes as follows:

bit DCBA	
0 0 0 1	Transfer-prohibited signal
0 0 1 0	Transfer-prohibited-acknowledgement signal

13.7.4 The destination field contains the identity of the signalling point to which the message refers.

13.8 *Transfer-allowed message*

13.8.1 The format of the transfer-allowed message is shown in Figure 19/Q.704 [4].

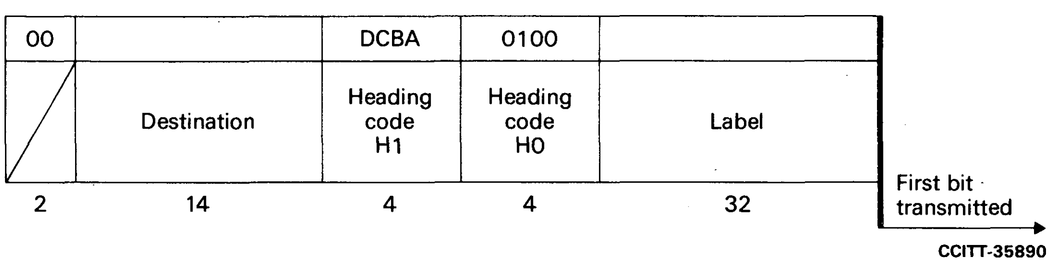


FIGURE 19/Q.704
Transfer allowed message

[4] The possibility to refer to a more general destination than a single signalling point (e.g. a signalling region), or more restrictive than a single signalling point (e.g. an individual User Part) is for further study.

13.8.2 The transfer-allowed message is made up of the following fields:

- Label (32 bits): see § 13.2.
- Heading code H0 (4 bits): see § 13.3.
- Heading code H1 (4 bits): see § 13.8.3.
- Destination (14 bits): see § 13:7.3.
- Spare bits (2 bits) coded 00.

13.8.3 The heading code H1 contains signal codes as follows:

bit D C B A
0 1 0 1 Transfer-allowed signal
0 1 1 0 Transfer-allowed-acknowledgement signal

13.9 *Signalling-route-set-test message*

13.9.1 The format of the signalling-route-set-test message is shown in Figure 20/Q.704 [4].

00		0001	0101		
	Destination	Heading code H1	Heading code H0	Label	
2	14	4	4	32	First bit transmitted →

CCITT-35890

FIGURE 20/Q.704
Signalling-route-set-test message

13.9.2 This message is made up of the following fields:

- Label (32 bits): see § 13.2.
- Heading code H0 (4 bits): see § 13.3.
- Heading code H1 (4 bits): is coded 0001.
- Destination (14 bits): see § 13.7.3.
- Spare bits (2 bits), coded 00.

13.10 *Signalling data link connection order message*

13.10.1 The format of the signalling data link connection order message is shown in Figure 21/Q.704.

0000		0001	1000		
	Signalling data link identity	Heading code H1	Heading code H0	Label	
4	12	4	4	32	First bit transmitted →

CCITT-35900

FIGURE 21/Q.704
Signalling-data-link-connection-order message

[4] The possibility to refer to more general destination than a single signalling point (e.g. a signalling region), or more restrictive than a single signalling point (e.g. an individual User Part) is for further study.

13.10.2 The signalling-data-link-connection-order message is made up of the following fields:

- Label (32 bits): see § 13.2.
- Heading code H0 (4 bits): see § 13.3.
- Heading code H1 (4 bits): is coded 0001.
- Signalling data link identity (12 bits): see § 13.10.3.
- Spare bits (4 bits) coded 0000.

13.10.3 The signalling data link identity field contains the circuit identification code (CIC), or the bearer identification code (BIC) in case of a 64-kbit/s channel used to carry submultiplexed data streams, of the transmission link corresponding to the signalling data link.

13.11 *Signalling-data-link-connection-acknowledgement message*

13.11.1 The format of the signalling data link connection acknowledgement message is shown in Figure 22/Q.704.

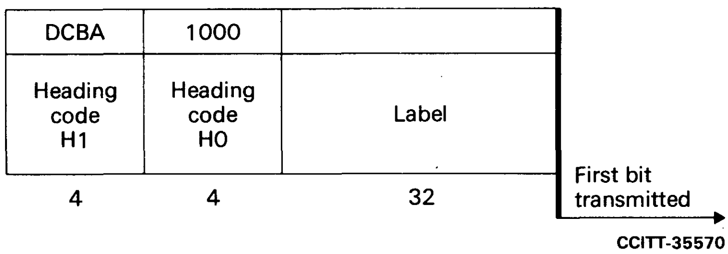


FIGURE 22/Q.704

Signalling-data-link-connection-acknowledgement message

13.11.2 The signalling-data-link-connection-acknowledgement message is made up of the following fields:

- Label (32 bits): see § 13.2.
- Heading code H0 (4 bits): see § 13.3.
- Heading code H1 (4 bits): see § 13.11.3.

13.11.3 The heading code H1 contains signal codes as follows:

bit	D C B A	
	0 0 1 0	Connection-successful signal
	0 0 1 1	Connection-not-successful signal
	0 1 0 0	Connection-not-possible signal

14 State transition diagrams

14.1 *General*

§ 14 contains the description of the signalling network functions described in §§ 2 to 11 in the form of state transition diagrams according to the CCITT Specification and Description Language (SDL).

A set of diagrams is provided for each of the following major functions:

a) signalling message handling (SMH), described in § 2;

b) signalling traffic management (STM), described in §§ 4 to 9;

c) signalling route management (SRM), described in § 10;

d) signalling link management (SLM), described in § 11.

TABLE 1/Q.704

Heading code allocation of signalling network management messages

Message Group	H1 / H0	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
	0000																
CHM	0001		COO	COA			CBD	CBA									
ECM	0010		ECO	ECA													
FCM	0011																
TFM	0100		TFP	TPA			TFA	TAA									
RSM	0101		RST														
	0110																
	0111																
DLM	1000		DLC	CSS	CNS	CNP											
	1001																
	1010																
	1011																
	1100																
	1101																
	1110																
	1111																

CBA – Changeback-acknowledgement signal
CBD – Changeback-declaration signal
CHM – Changeover and changeback messages
CNP – Connection-not-possible signal
CNS – Connection-not-successful signal
COA – Changeover-acknowledgement signal
COO – Changeover-order signal
CSS – Connection-successful signal
DLC – Signalling-data-link-connection-order signal
DLM – Signalling-data-link-connection-order message
ECA – Emergency-changeover-acknowledgement signal
ECM – Emergency-changeover message
ECO – Emergency-changeover-order signal
FCM – Signalling-traffic-flow control messages
RSM – Signalling-route-set-test message
RST – Signalling-route-set-test signal
TAA – Transfer-allowed-acknowledgement signal
TFA – Transfer-allowed signal
TFM – Transfer-prohibited and transfer-allowed messages
TFP – Transfer-prohibited signal
TPA – Transfer-prohibited-acknowledgement signal

For each major function a figure illustrates a subdivision into functional specification blocks, showing their functional interactions as well as the interactions with the other major functions. In each case this is followed by figures showing state transition diagrams for each of the functional specification blocks.

The detailed functional breakdown shown in the following diagrams is intended to illustrate a reference model and to assist interpretation of the text in the earlier sections. The state transition diagrams are intended to show precisely the behaviour of the signalling system under normal and abnormal conditions as viewed from a remote location. It must be emphasized that the functional partitioning shown in the following diagrams is used only to facilitate understanding of the system behaviour and is not intended to specify the functional partitioning to be adopted in a practical implementation of the signalling system.

14.2 *Drafting conventions*

14.2.1 Each major function is designated by its acronym (e.g. SMH = signalling message handling).

14.2.2 Each functional block is designated by an acronym which identifies it and also identifies the major function to which it belongs (e.g. HMRT = signalling message handling-message routing; TLAC = signalling traffic management-link availability control).

14.2.3 External inputs and outputs are used for interactions between different functional blocks. Included within each input and output symbol in the state transition diagrams are acronyms which identify the functions which are the source and destination of the message, e.g.:

L2→ L3	indicates that the message is sent between functional levels from: functional level 2 to: functional level 3
RTPC→ TSRC	indicates that the message is sent within a functional level (3 in this case) from: signalling route management-transfer prohibited control to: signalling traffic management-signalling routing control

14.2.4 Internal inputs and outputs are only used to indicate control of time-outs.

14.3 *Signalling message handling*

Figure 23/Q.704 shows a subdivision of the signalling message handling (SMH) function into smaller functional specification blocks and also shows the functional interactions between them. Each of these functional specification blocks is described in detail in a state transition diagram as follows:

a) message discrimination (HMDC) is shown in Figure 24/Q.704;

b) message distribution (HMDT) is shown in Figure 25/Q.704;

c) message routing (HMRT) is shown in Figure 26/Q.704.

14.4 *Signalling traffic management*

Figure 27/Q.704 shows a subdivision of the signalling traffic management (STM) function into smaller functional specification blocks and also shows functional interactions between them. Each of these functional specification blocks is described in detail in a state transition diagram as follows:

a) link availability control (TLAC) is shown in Figure 28/Q.704;

b) signalling routing control (TSRC) is shown in Figure 29/Q.704;

c) changeover control (TCOC) is shown in Figure 30/Q.704;

d) changeback control (TCBC) is shown in Figure 31/Q.704;

e) forced rerouting control (TFRC) is shown in Figure 32/Q.704;

f) controlled rerouting control (TCRC) is shown in Figure 33/Q.704;

g) signalling traffic flow control (TSFC) is shown in Figure 34/Q.704.

14.5 *Signalling link management*

Figure 35/Q.704 shows a subdivision of the signalling link management function (SLM) into smaller functional specification blocks and also shows functional interactions between them. Each of these functional specification blocks is described in detail in a state transition diagram as follows:

a) link set control (LLSC) is shown in Figure 36/Q.704;

b) signalling link activity control (LSAC) is shown in Figure 37/Q.704;

c) signalling link activation (LSLA) is shown in Figure 38/Q.704;

d) signalling link restoration (LSLR) is shown in Figure 39/Q.704;

e) signalling link deactivation (LSLD) is shown in Figure 40/Q.704;

f) signalling terminal allocation (LSTA) is shown in Figure 41/Q.704;

g) signalling data link allocation (LSDA) is shown in Figure 42/Q.704.

14.6 *Signalling route management*

Figure 43/Q.704 shows a subdivision of the signalling route management (SRM) function into smaller functional specification blocks and also shows functional interactions between them. Each of these functional specification blocks is described in detail in a state transition diagram as follows:

a) transfer prohibited control (RTPC) is shown in Figure 44/Q.704;

b) transfer allowed control (RTAC) is shown in Figure 45/Q.704;

c) signalling route set test control (RSRT) is shown in Figure 46/Q.704.

14.7 *Abbreviations and timers used in Figures 23/Q.704 to 46/Q.704*

BSNT	Backward sequence number of next signal unit to be transmitted
DPC	Destination point code
FSNC	Forward sequence number of last message signal unit accepted by remote level 2
HMDC	Message discrimination
HMDT	Message distribution
HMRT	Message routing
L1	Level 1
L2	Level 2
L3	Level 3
L4	Level 4
LLSC	Link set control
LSAC	Signalling link activity control
LSDA	Signalling data link allocation
LSLA	Signalling link activation
LSLD	Signalling link deactivation
LSLR	Signalling link restoration
LSTA	Signalling terminal allocation
MGMT	Management system
RSRT	Signalling route set test control
RTAC	Transfer allowed control
RTPC	Transfer prohibited control
SLM	Signalling link management
SLS	Signalling link selection
SMH	Signalling message handling
SRM	Signalling route management
SLTC	Signalling link test control
STM	Signalling traffic management
TCBC	Changeback control
TCOC	Changeover control
TCRC	Controlled rerouting control
TFRC	Forced rerouting control
TLAC	Link availability control
TSFC	Signalling traffic flow control
TSRC	Signalling routing control

Timers

T1	Delay to avoid message mis-sequencing on changeover
T2	Waiting for changeover acknowledgement
T3	Time controlled diversion – delay to avoid mis-sequencing on changeback
T4	Waiting for changeback acknowledgement (first attempt)
T5	Waiting for changeback acknowledgement (second attempt)
T6	Delay to avoid message mis-sequencing on controlled rerouting
T7	Waiting for signalling data link connection acknowledgement
T8	Waiting for transfer prohibited acknowledgement
T9	Waiting for transfer allowed acknowledgement
T10	Waiting to repeat signalling route set test message

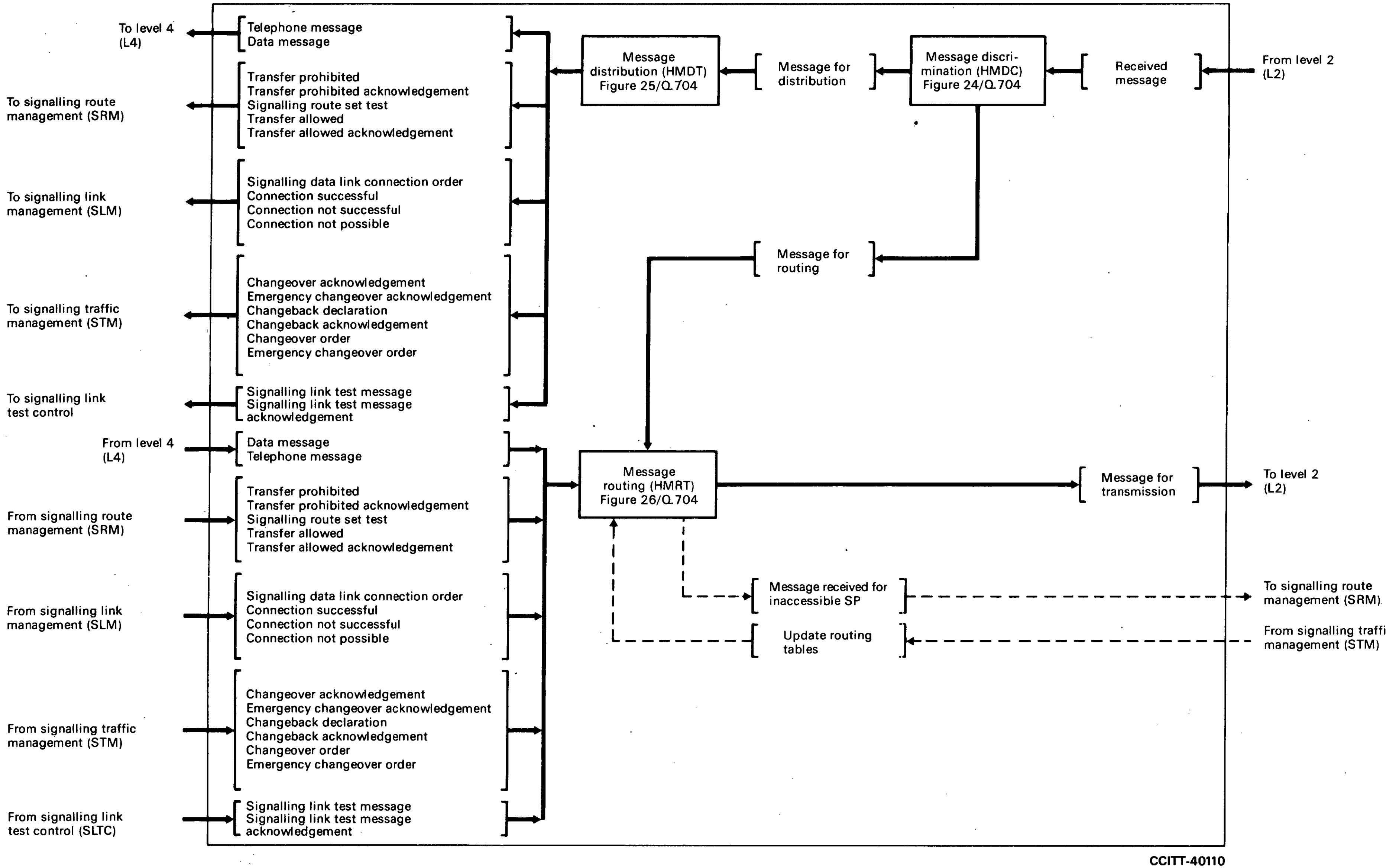


FIGURE 23/Q.704

Level 3 – signalling message handling (SMH); functional block interactions

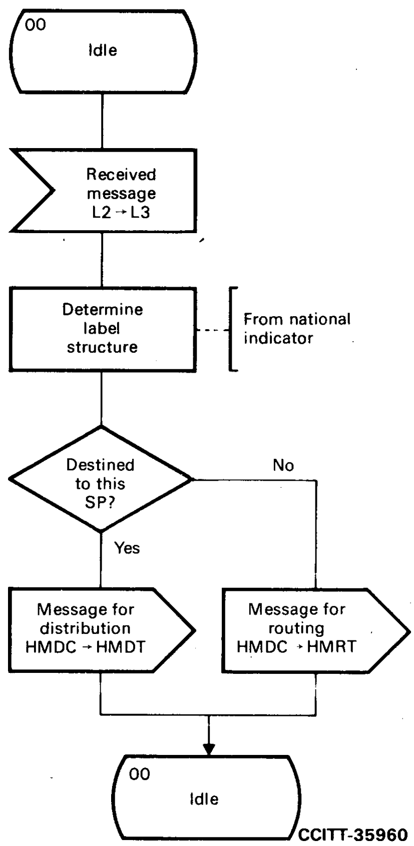


FIGURE 24/Q.704

Signalling message handling; message discrimination (HMDC)

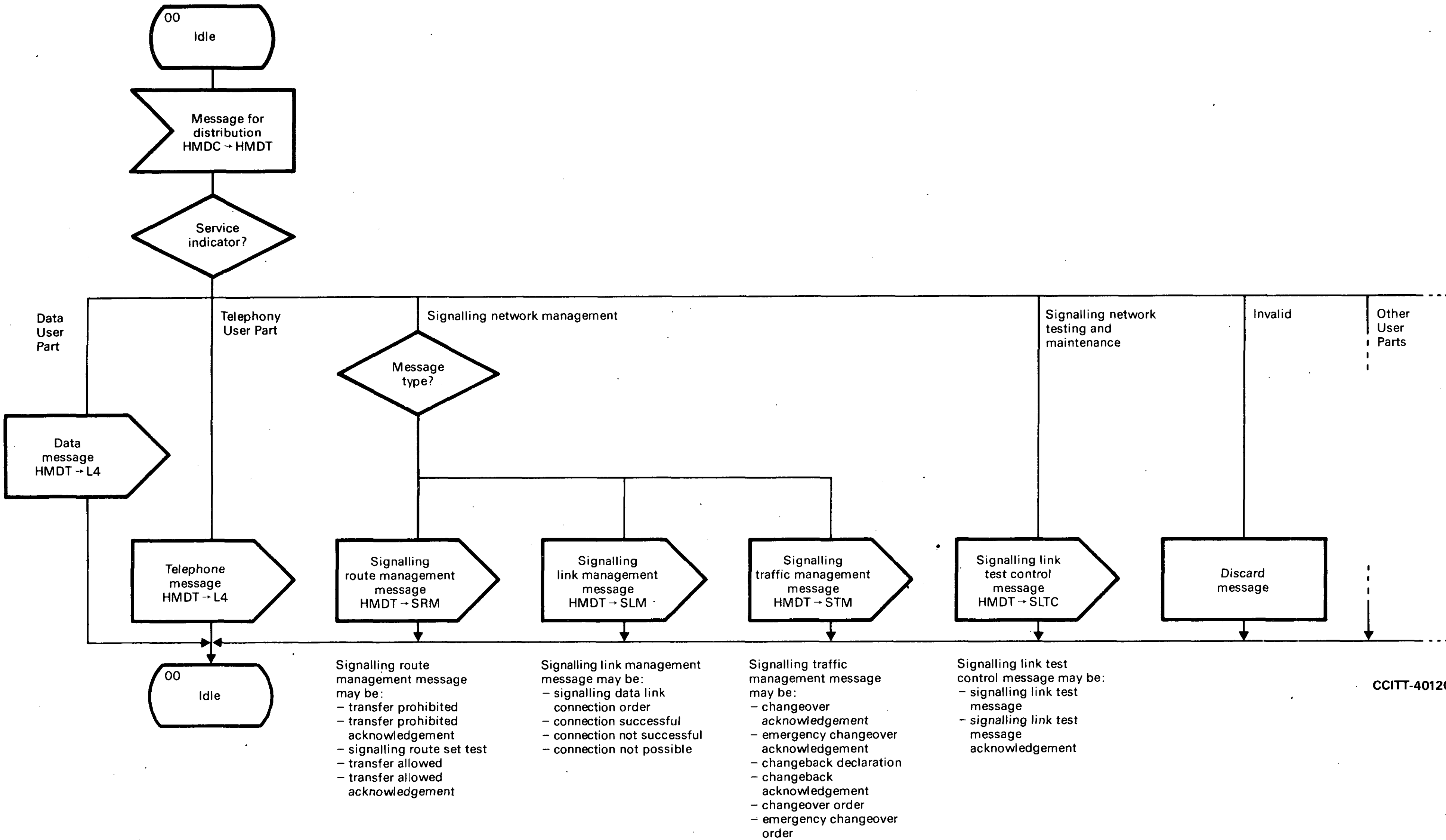


FIGURE 25/Q.704

Signalling message handling; message distribution (HMDT)

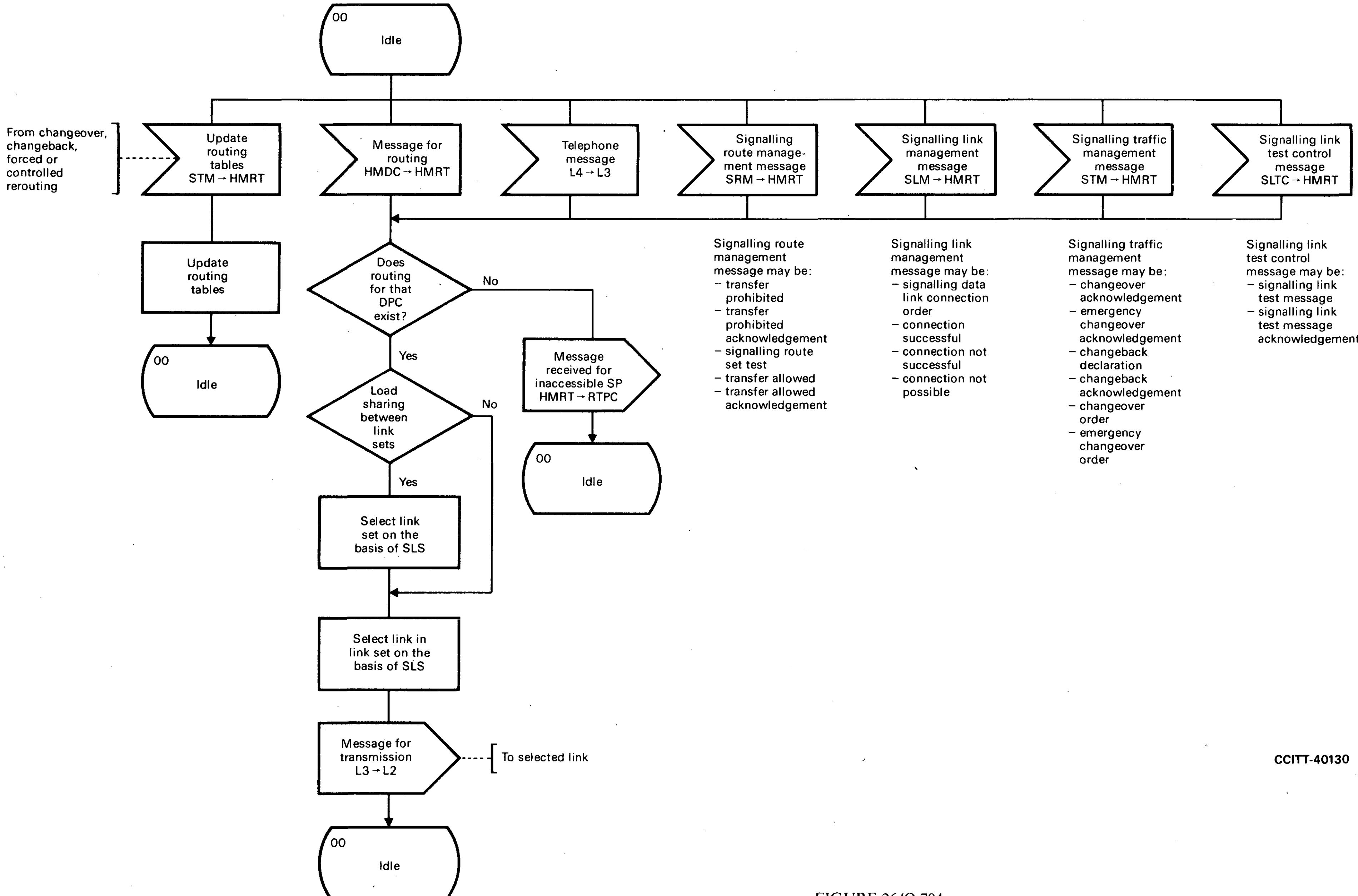
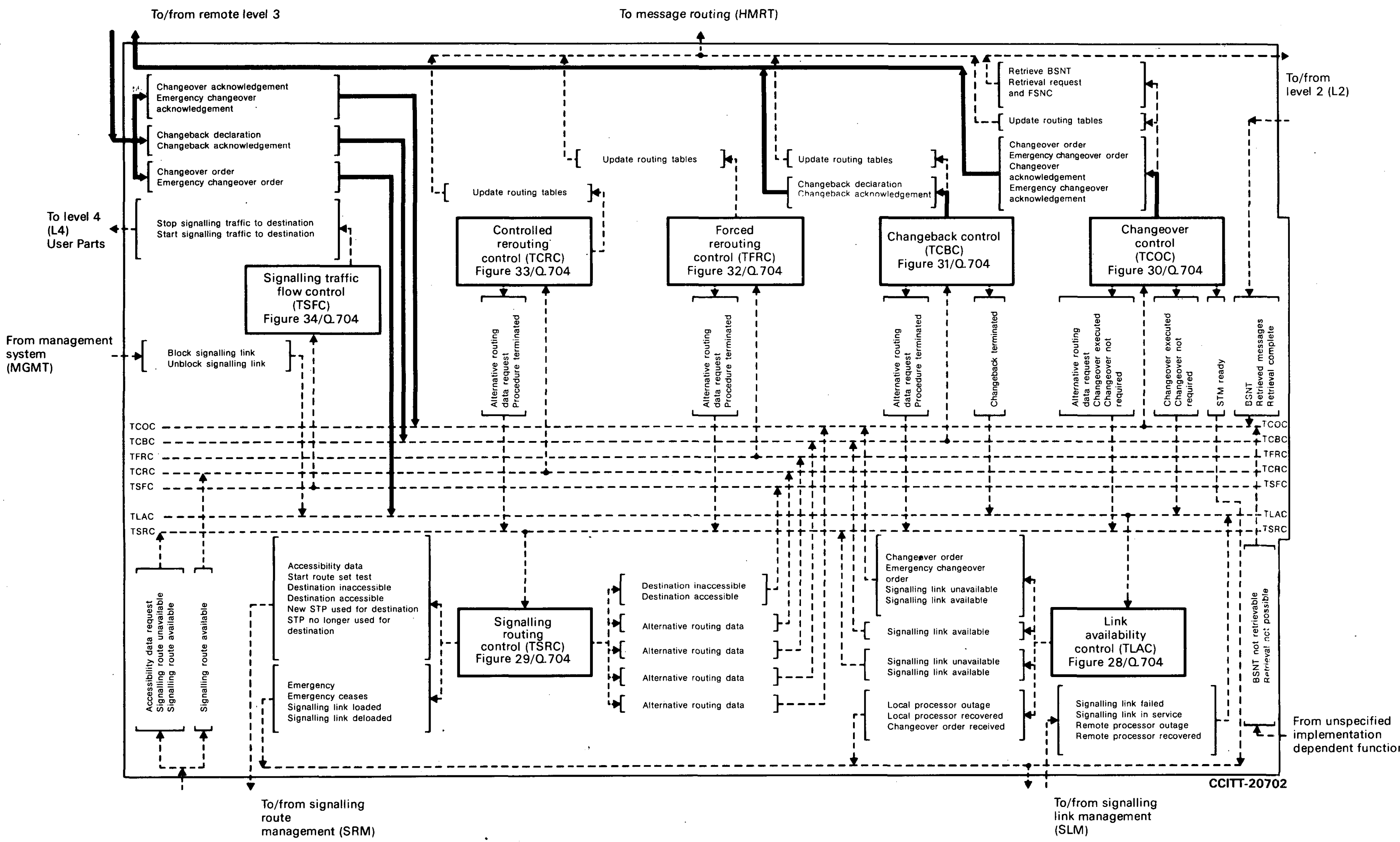


FIGURE 26/Q.704

Signalling message handling; message routing (HMRT)



Note – Abbreviated message names have been used in this diagram (i.e., origin → destination codes are omitted).

FIGURE 27/Q.704

Level 3 – Signalling traffic management (STM); functional block interactions

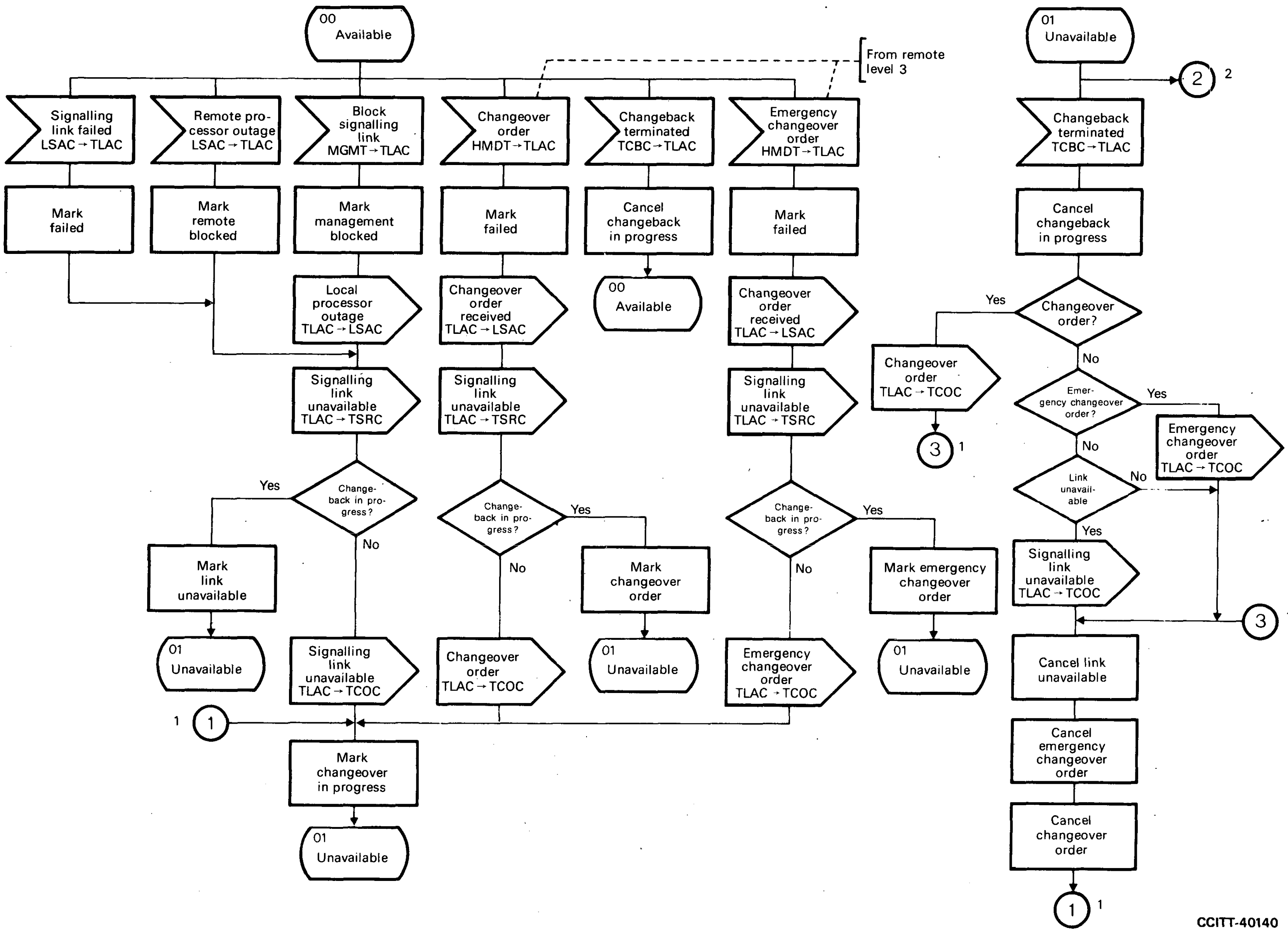


FIGURE 28/Q.704 (sheet 1 of 2)

Signalling traffic management; link availability control (TLAC)

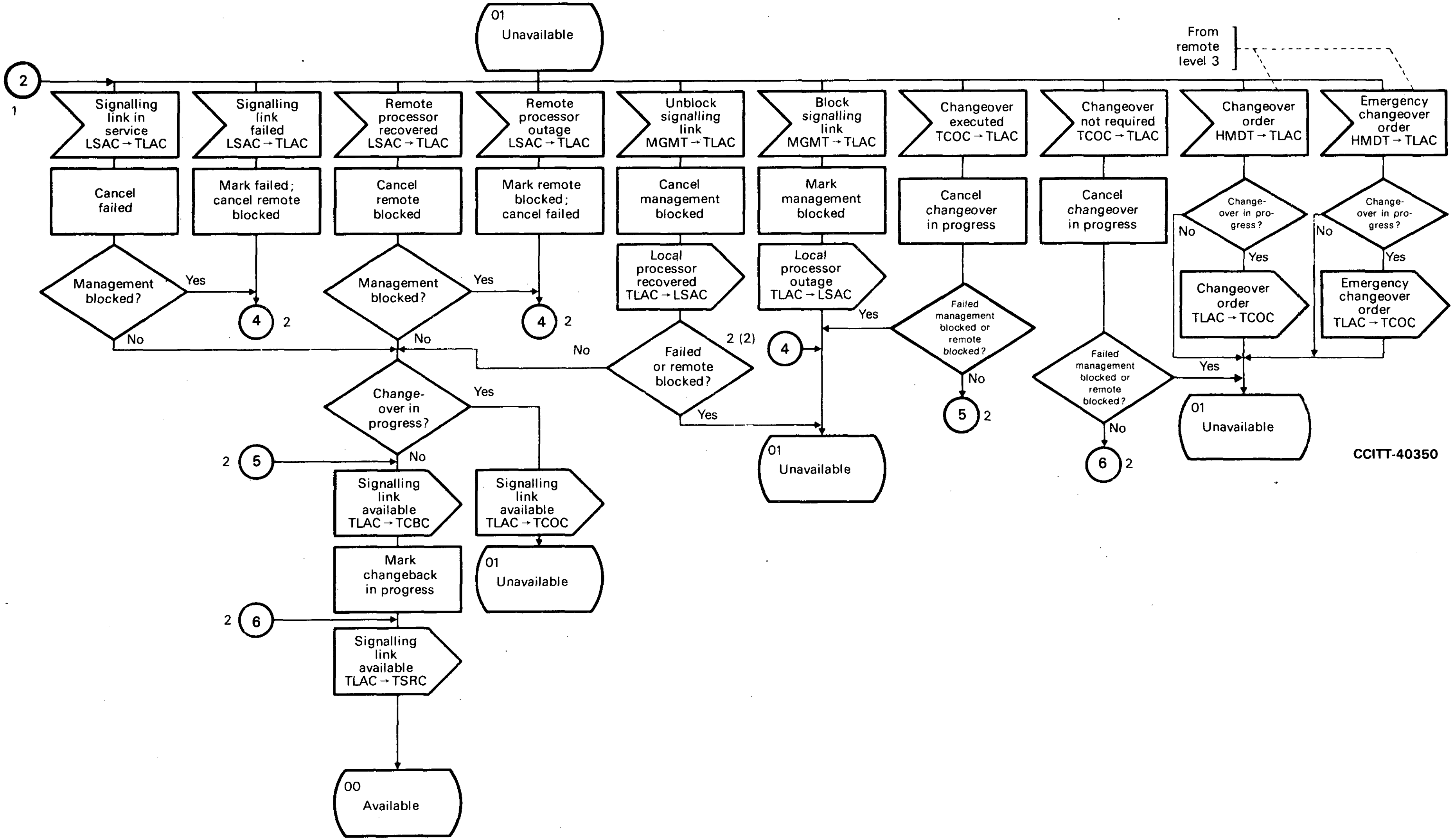


FIGURE 28/Q.704 (sheet 2 of 2)

Signalling traffic management; link availability control (TLAC)

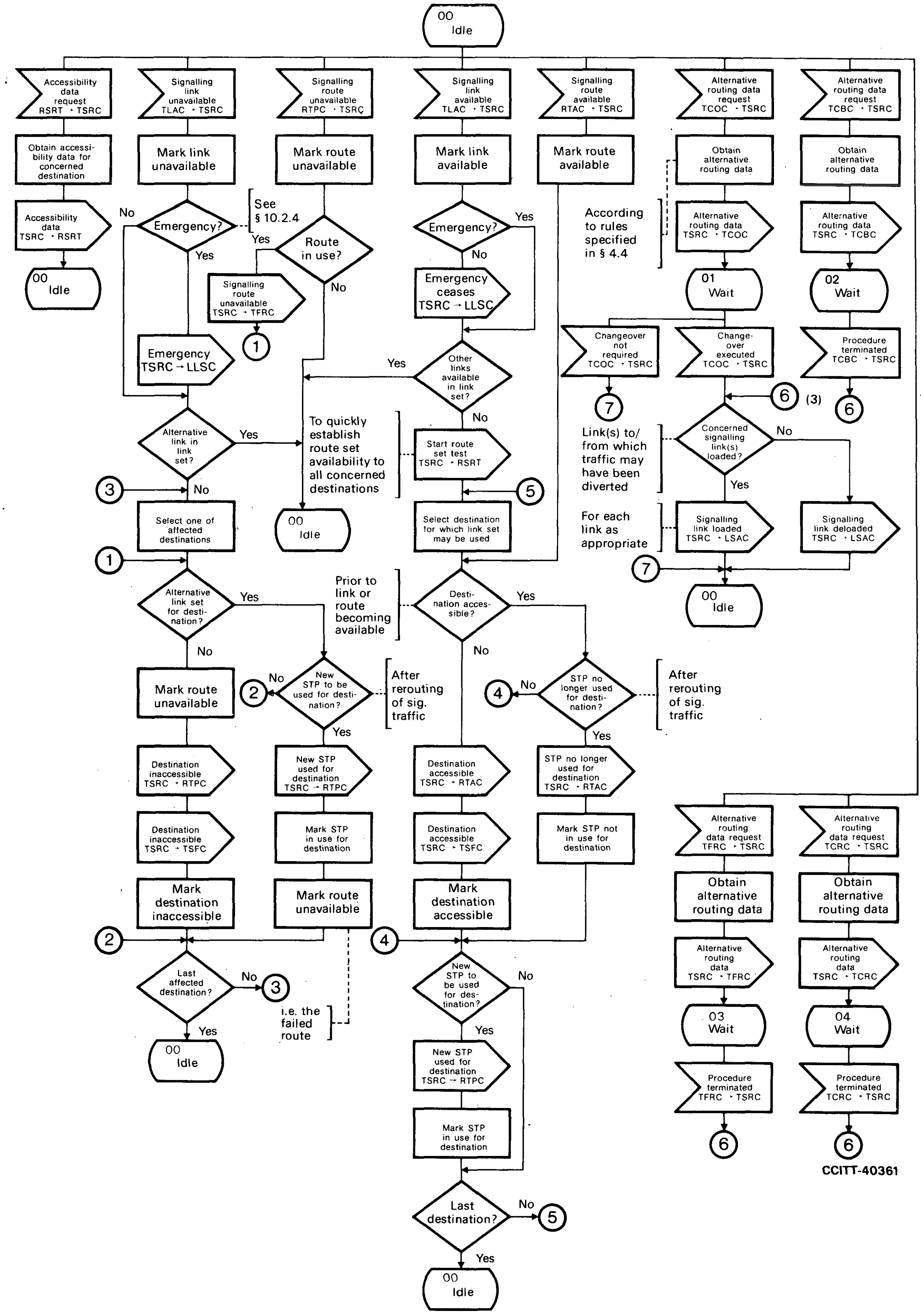


FIGURE 29/Q.704

Signalling traffic managements; signalling routing control (TSRC)

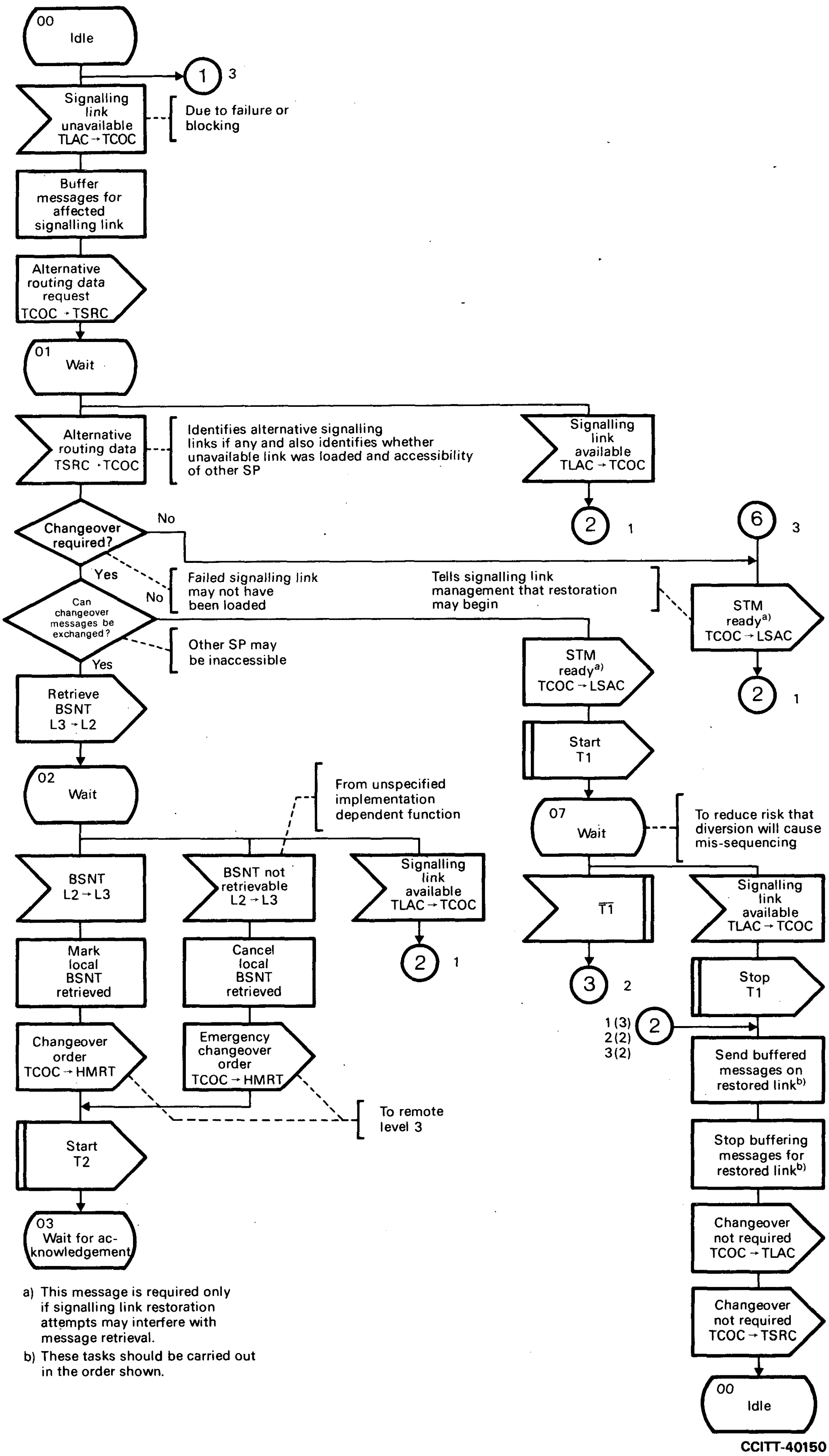


FIGURE 30/Q.704 (sheet 1 of 3)

Signalling traffic management; changeover control (TCOC)

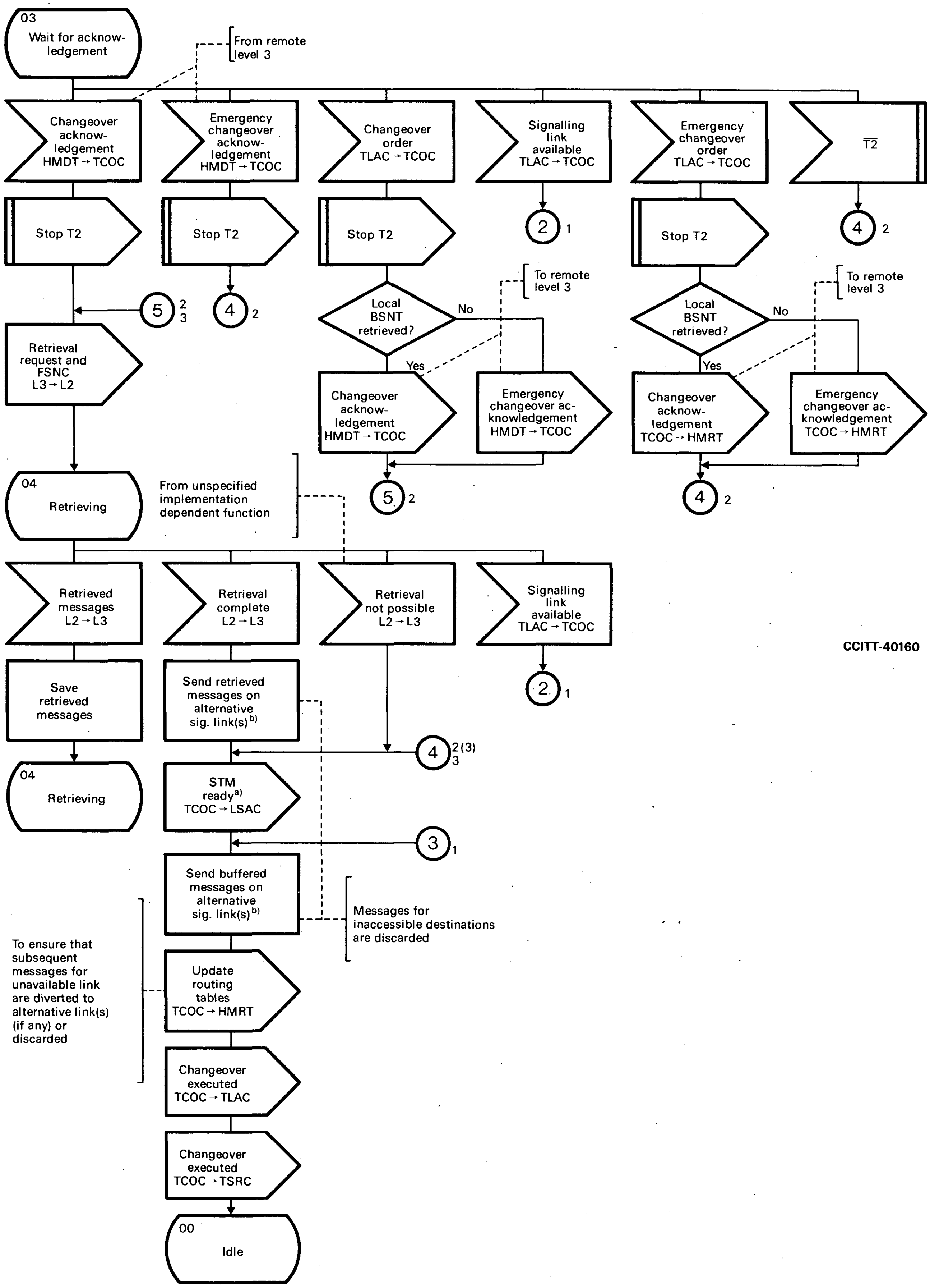


FIGURE 30/Q.704 (sheet 2 of 3)

Signalling traffic management; changeover control (TCOC)

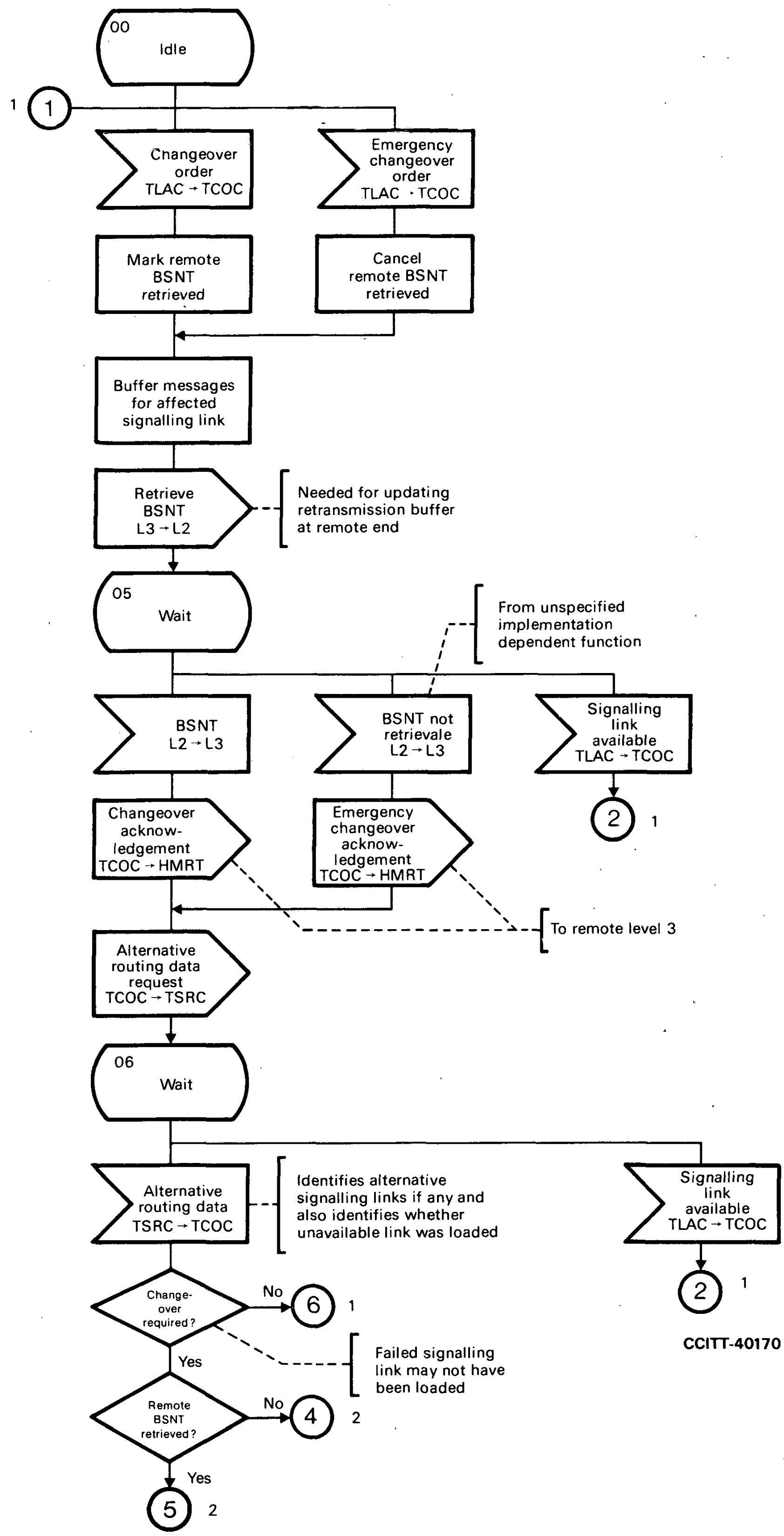
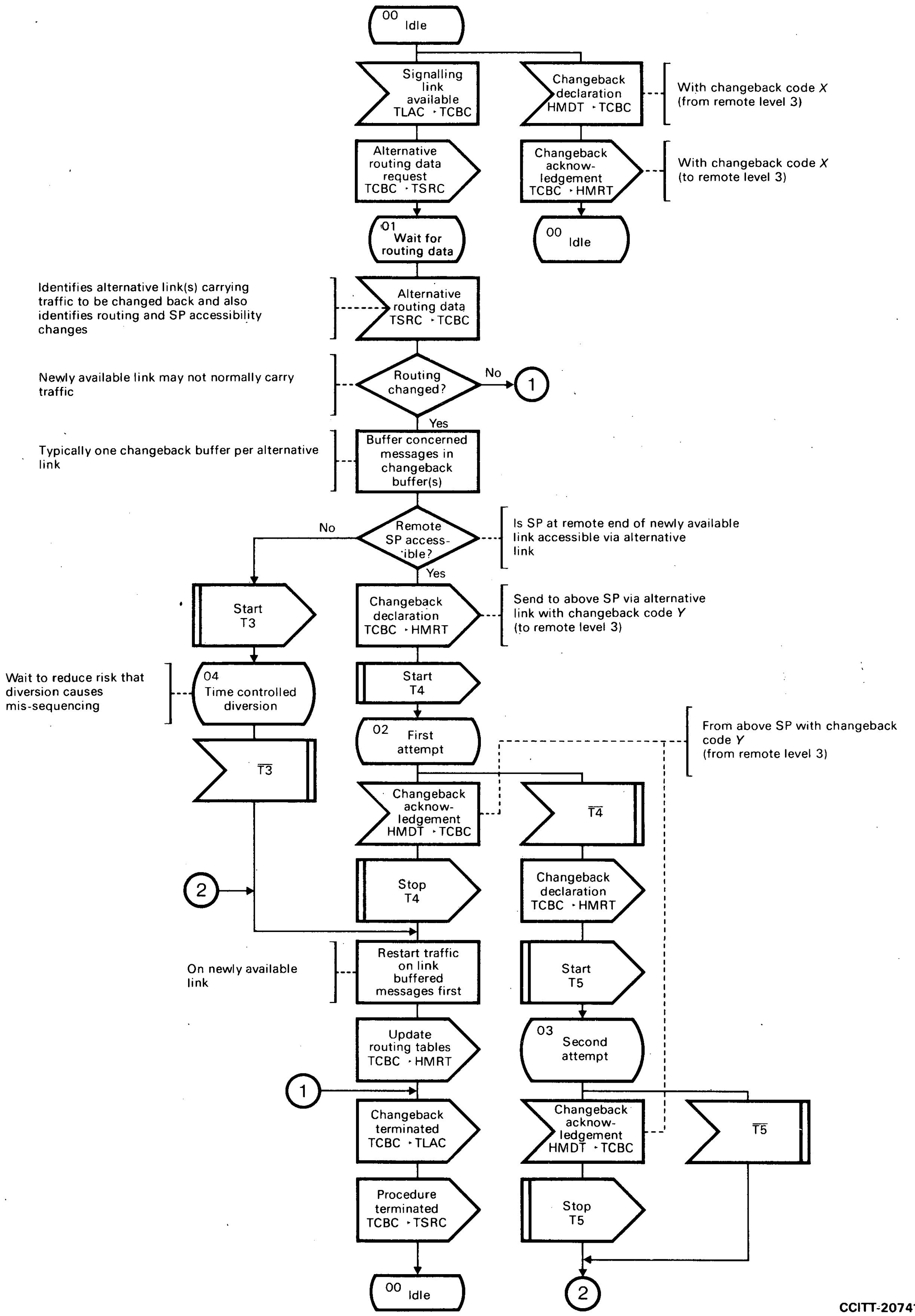


FIGURE 30/Q.704 (sheet 3 of 3)

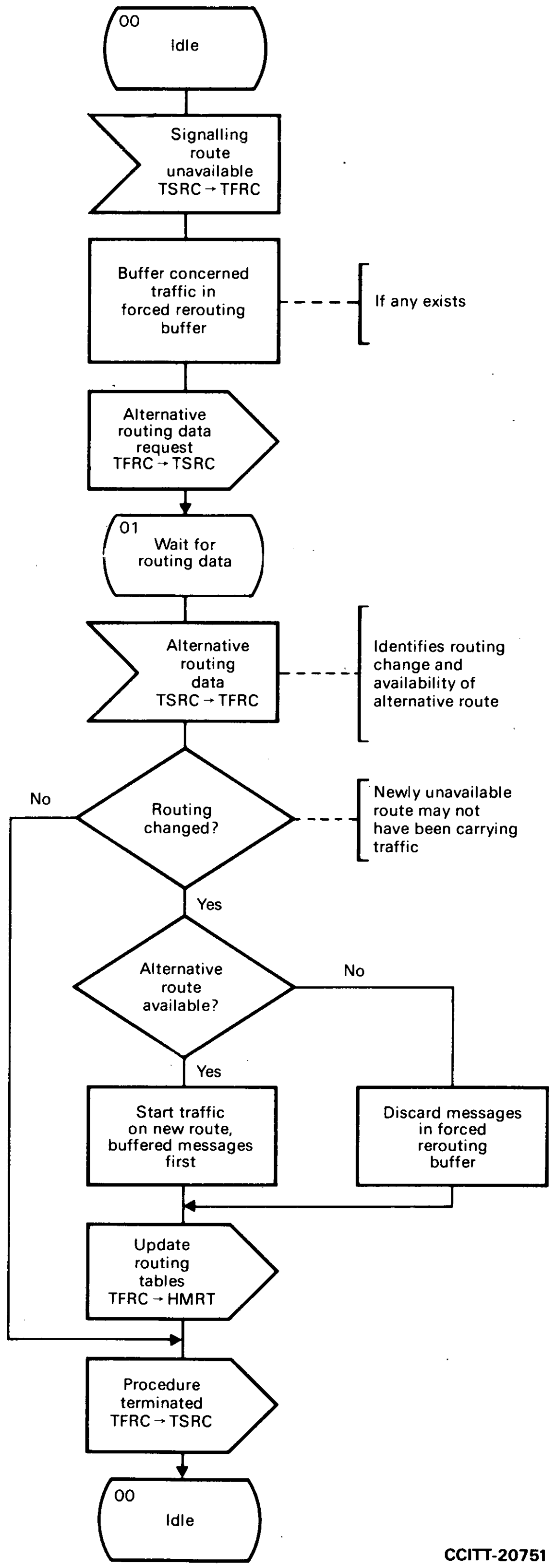
Signalling traffic management; changeover control (TCOC)



Note – For simplicity, changeback from only one alternative link is shown.

FIGURE 31/Q.704

Signalling traffic management; changeback control (TCBC)



CCITT-20751

FIGURE 32/Q.704

Signalling traffic management; forced rerouting control (TFRC)

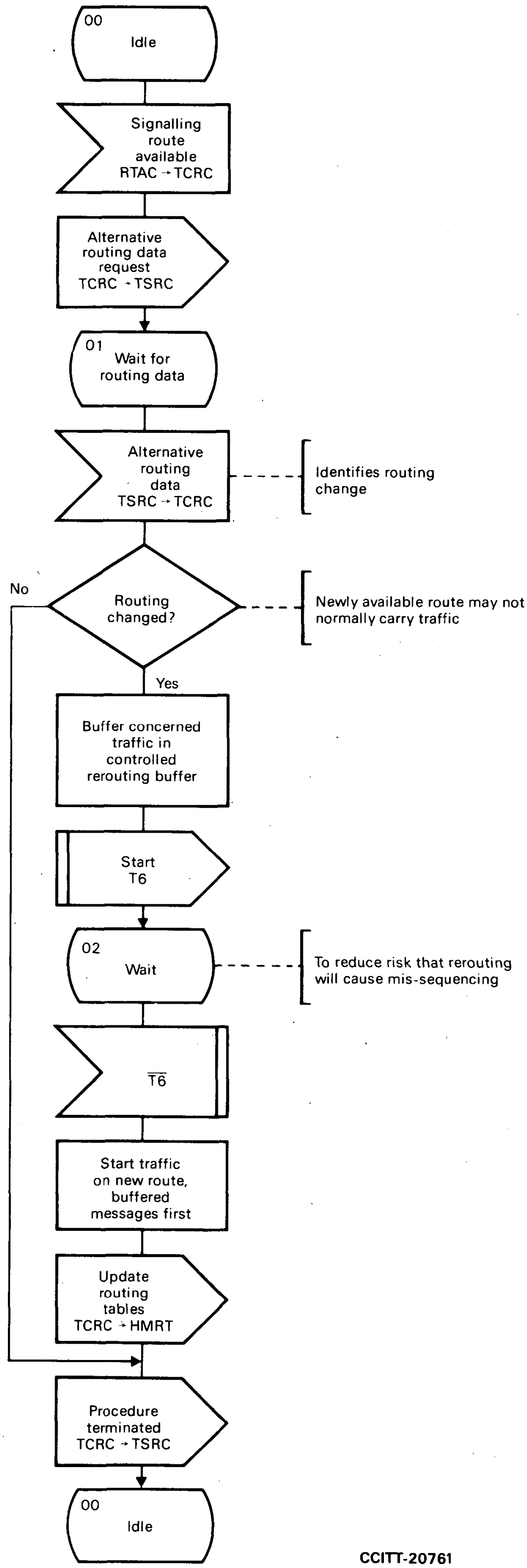


FIGURE 33/Q.704

Signalling traffic management; controlled rerouting control (TCRC)

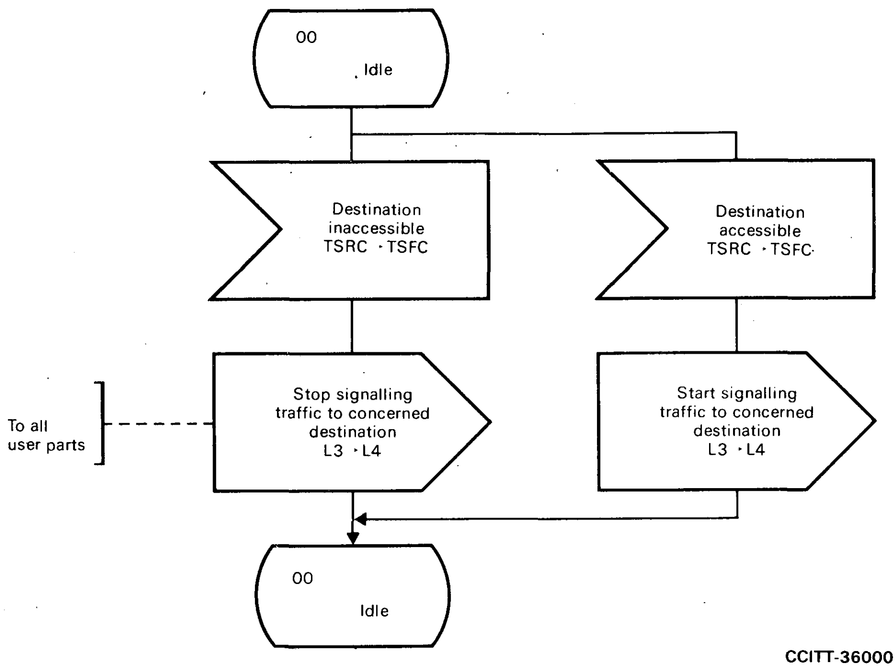
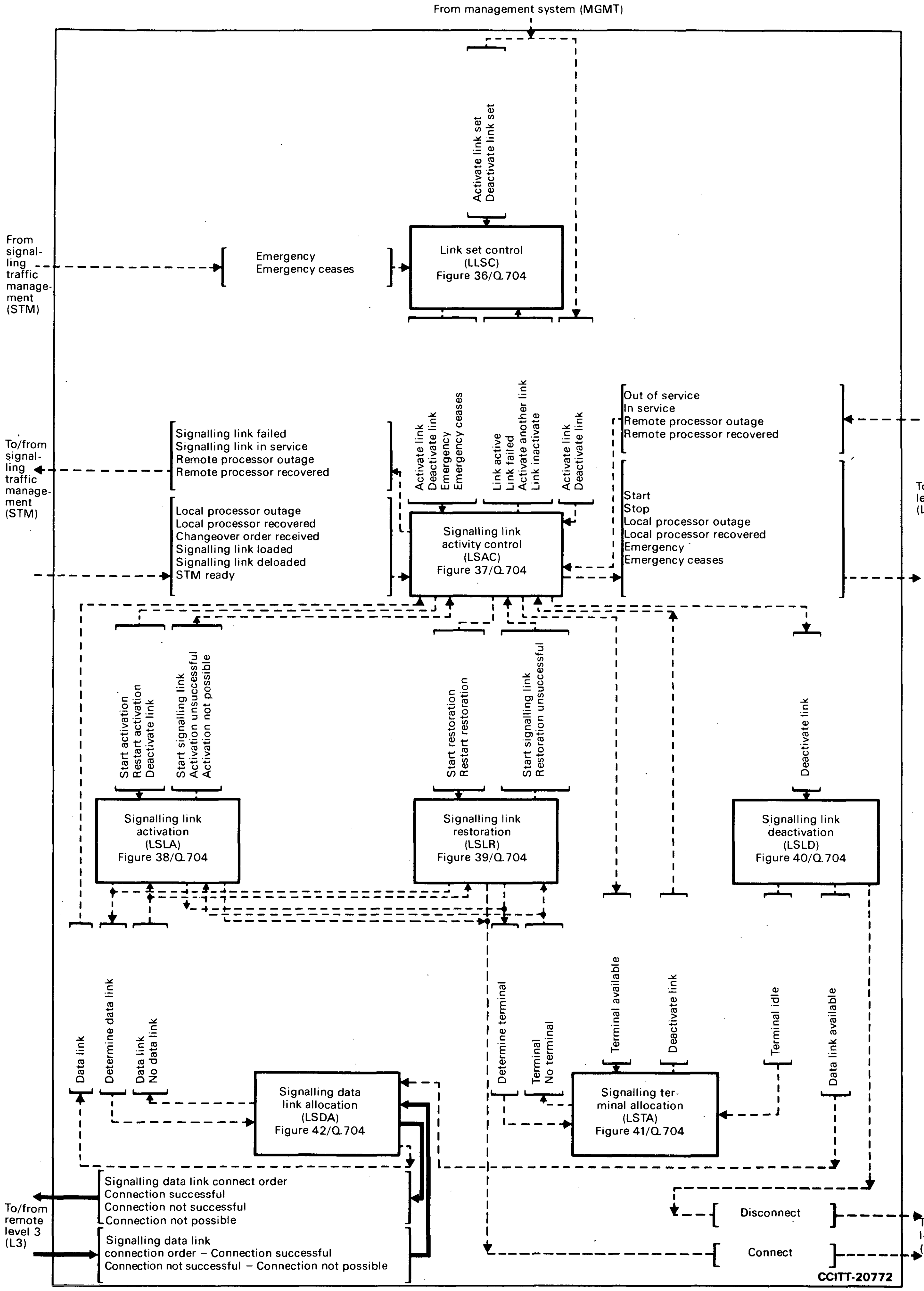


FIGURE 34/Q.704

Signalling traffic management; signalling traffic flow control (TSFC)



Note – Abbreviated message names have been used in this diagram (i.e. origin → destination codes are omitted).

FIGURE 35/Q.704

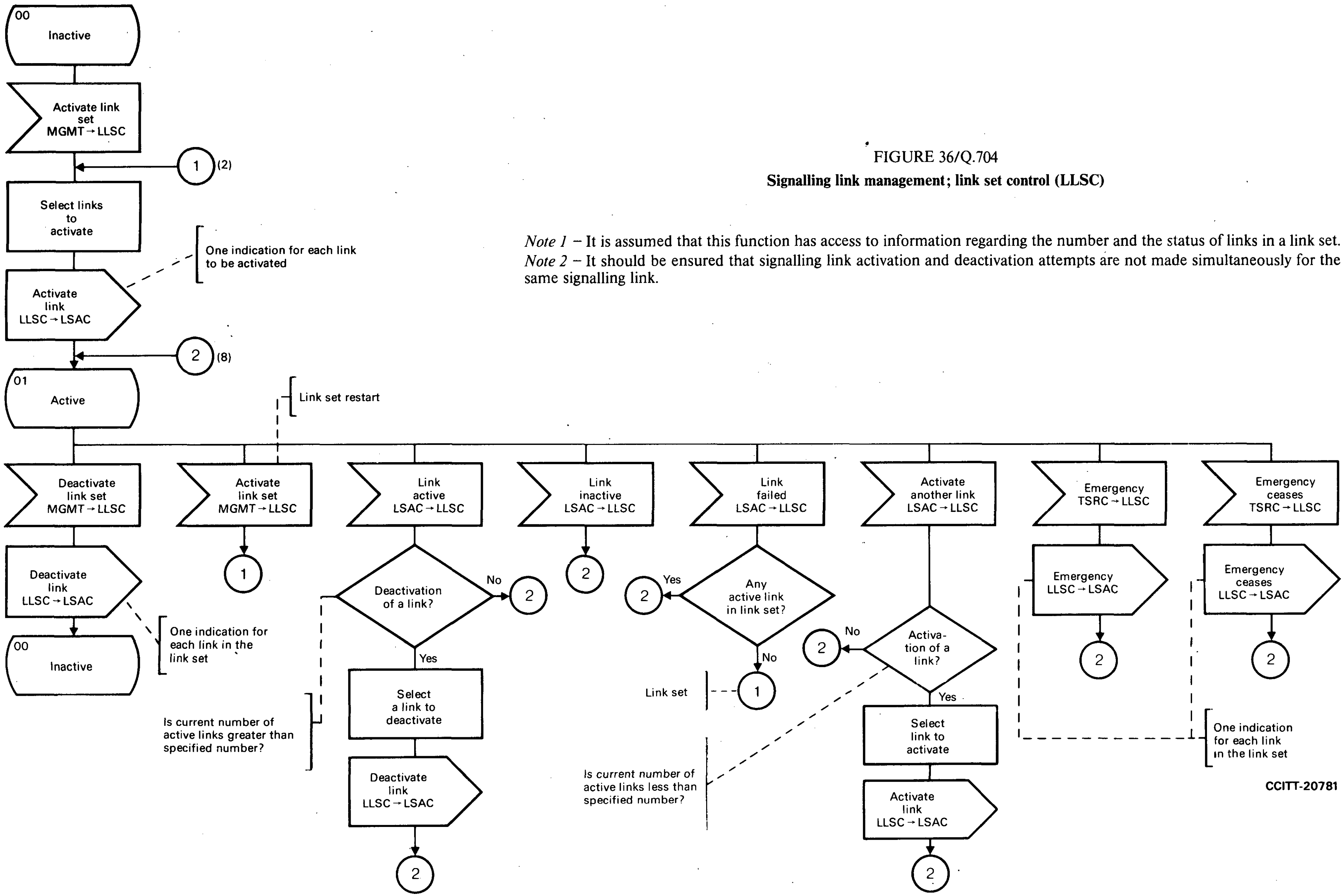
Level 3 – Signalling link management (SLM); functional block interactions

FIGURE 36/Q.704

Signalling link management; link set control (LLSC)

Note 1 – It is assumed that this function has access to information regarding the number and the status of links in a link set.

Note 2 – It should be ensured that signalling link activation and deactivation attempts are not made simultaneously for the same signalling link.



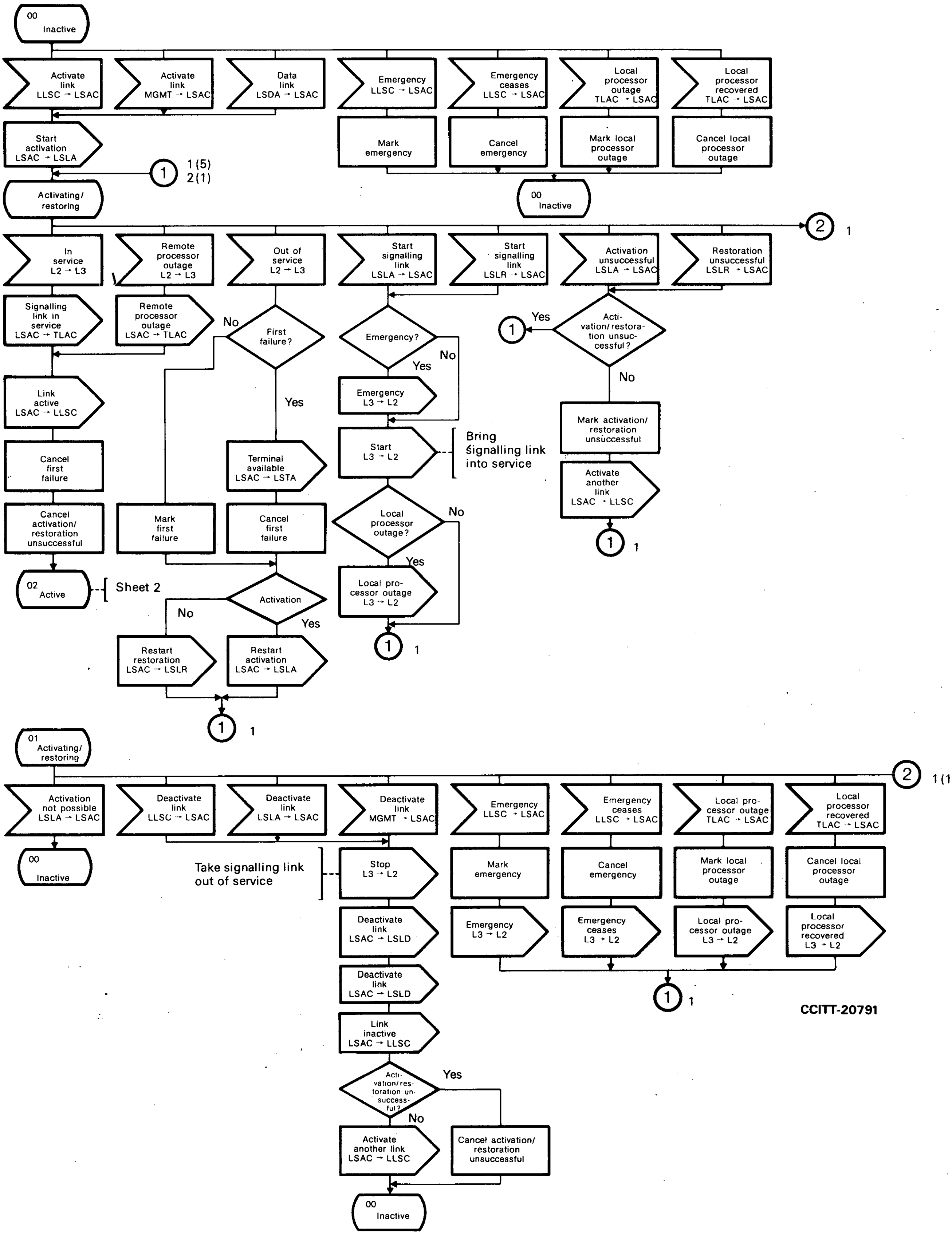


FIGURE 37/Q.704 (sheet 1 of 2)

Signalling link management; signalling link activity control (LSAC)

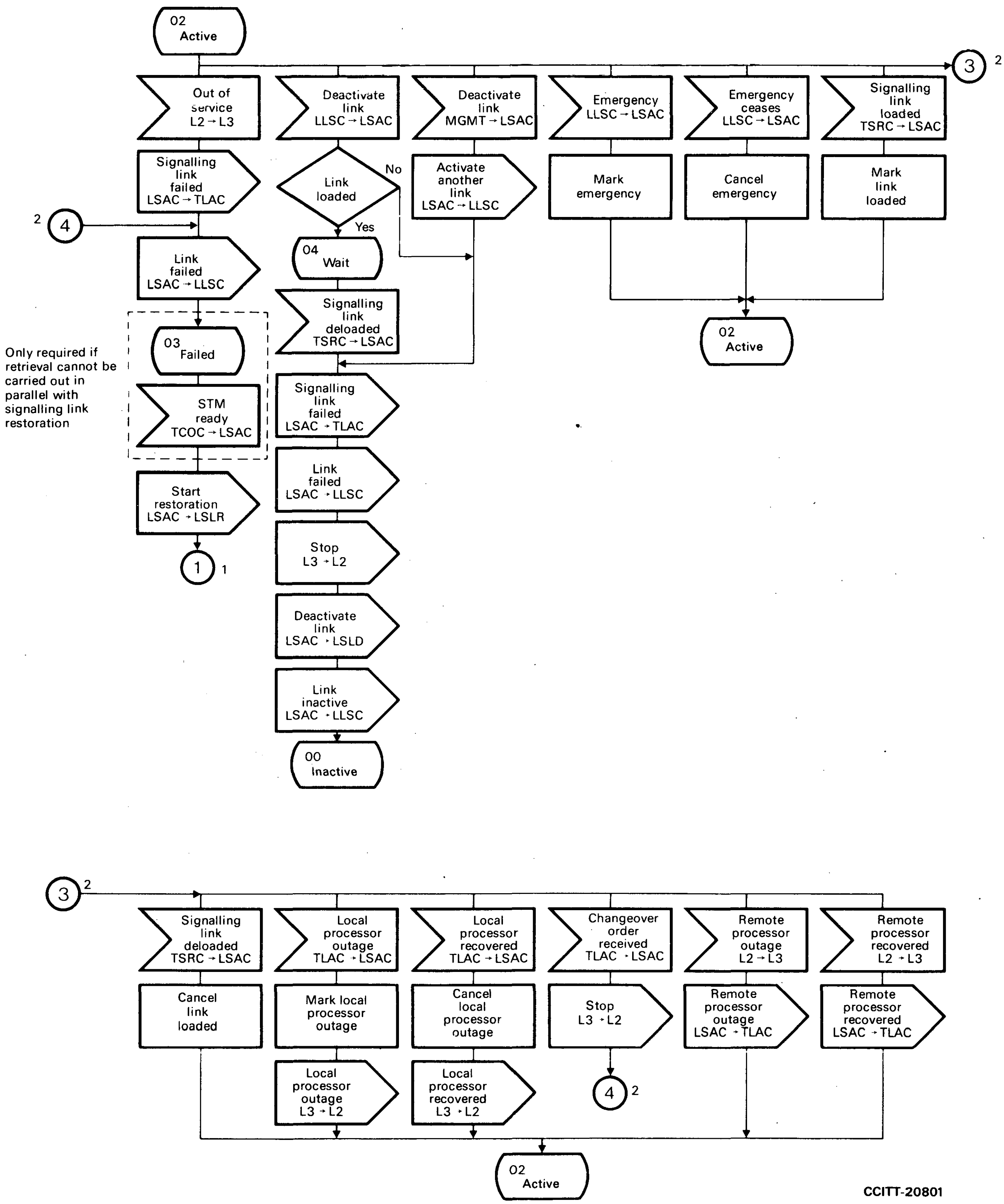


FIGURE 37/Q.704 (sheet 2 of 2)

Signalling link management; signalling link activity control (LSAC)

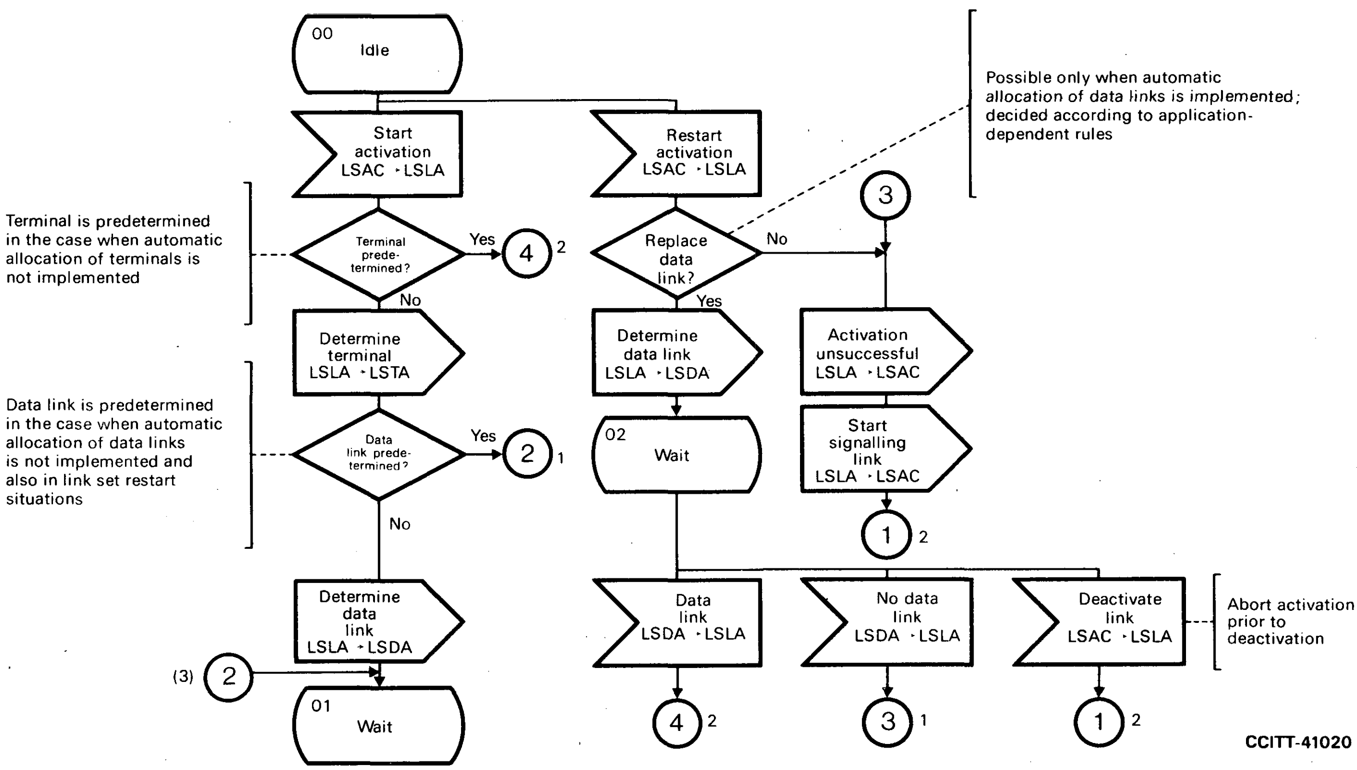


FIGURE 38/Q.704 (sheet 1 of 2)

Signalling link management; signalling link activation (LSLA)

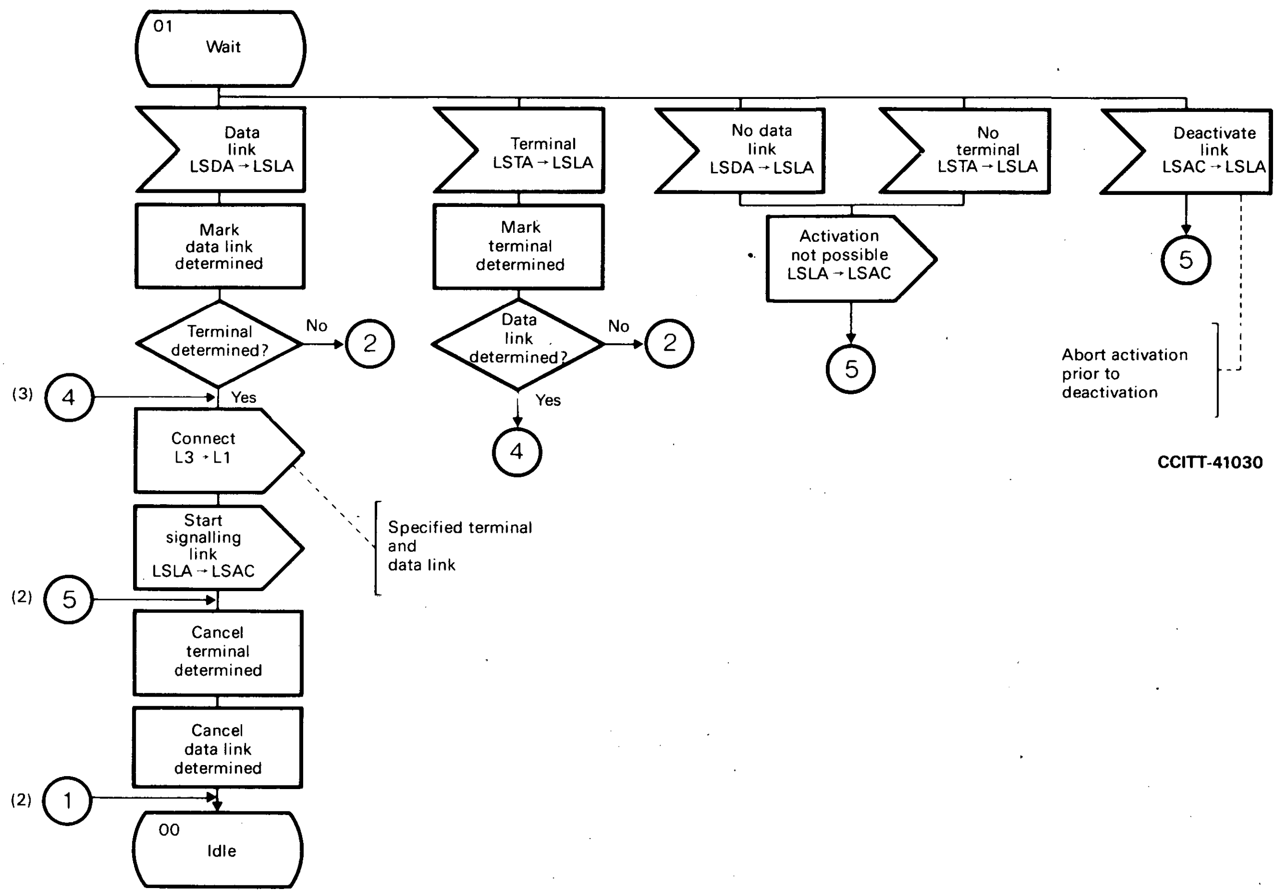


FIGURE 38/Q.704 (sheet 2 of 2)

Signalling link management; signalling link activation (LSLA)

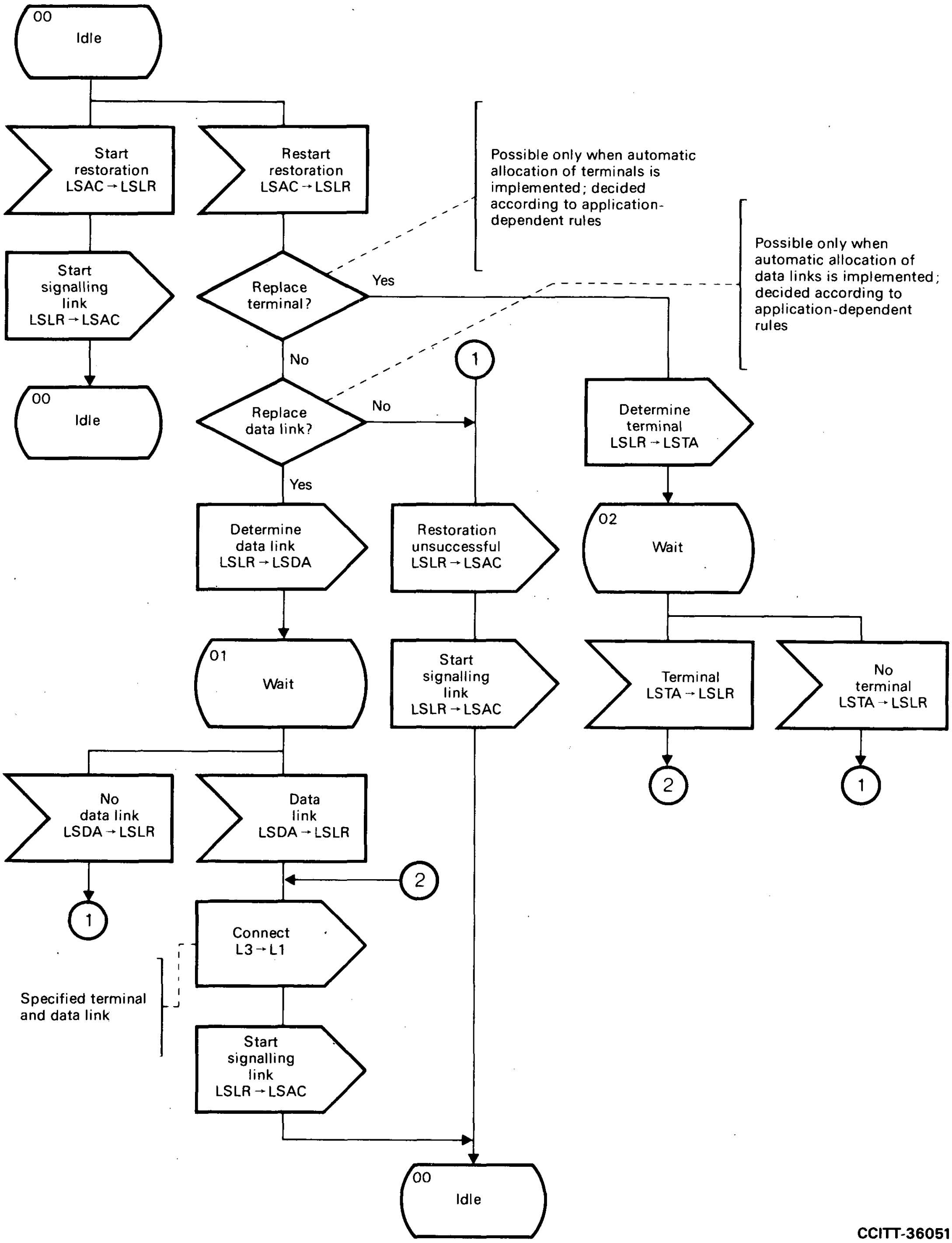


FIGURE 39/Q.704

Signalling link management; signalling link restoration (LSLR)

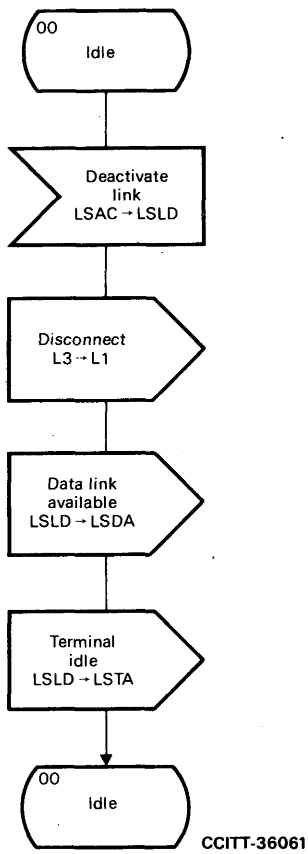


FIGURE 40/Q.704

Signalling link management; signalling link deactivation (LSLD)

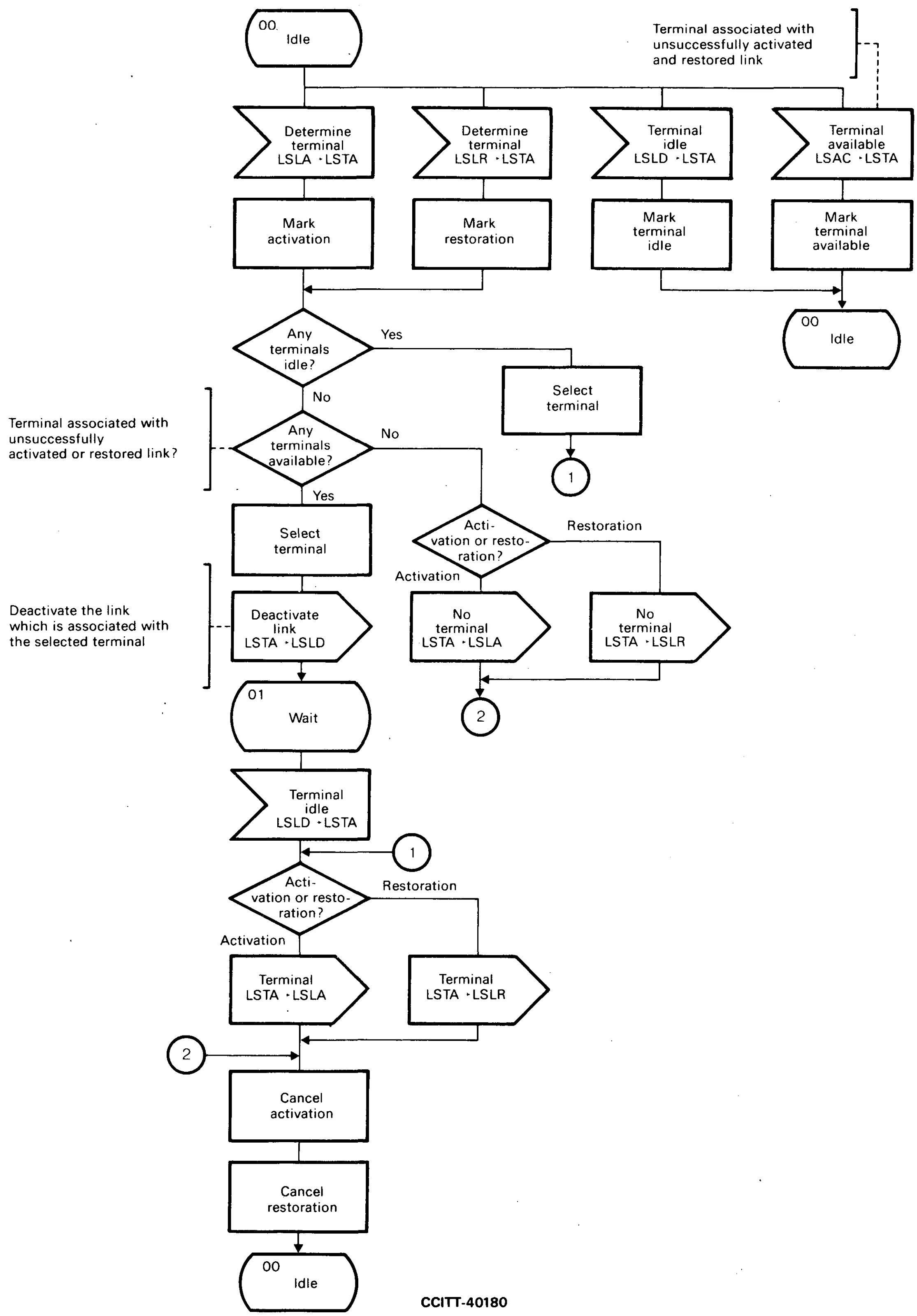
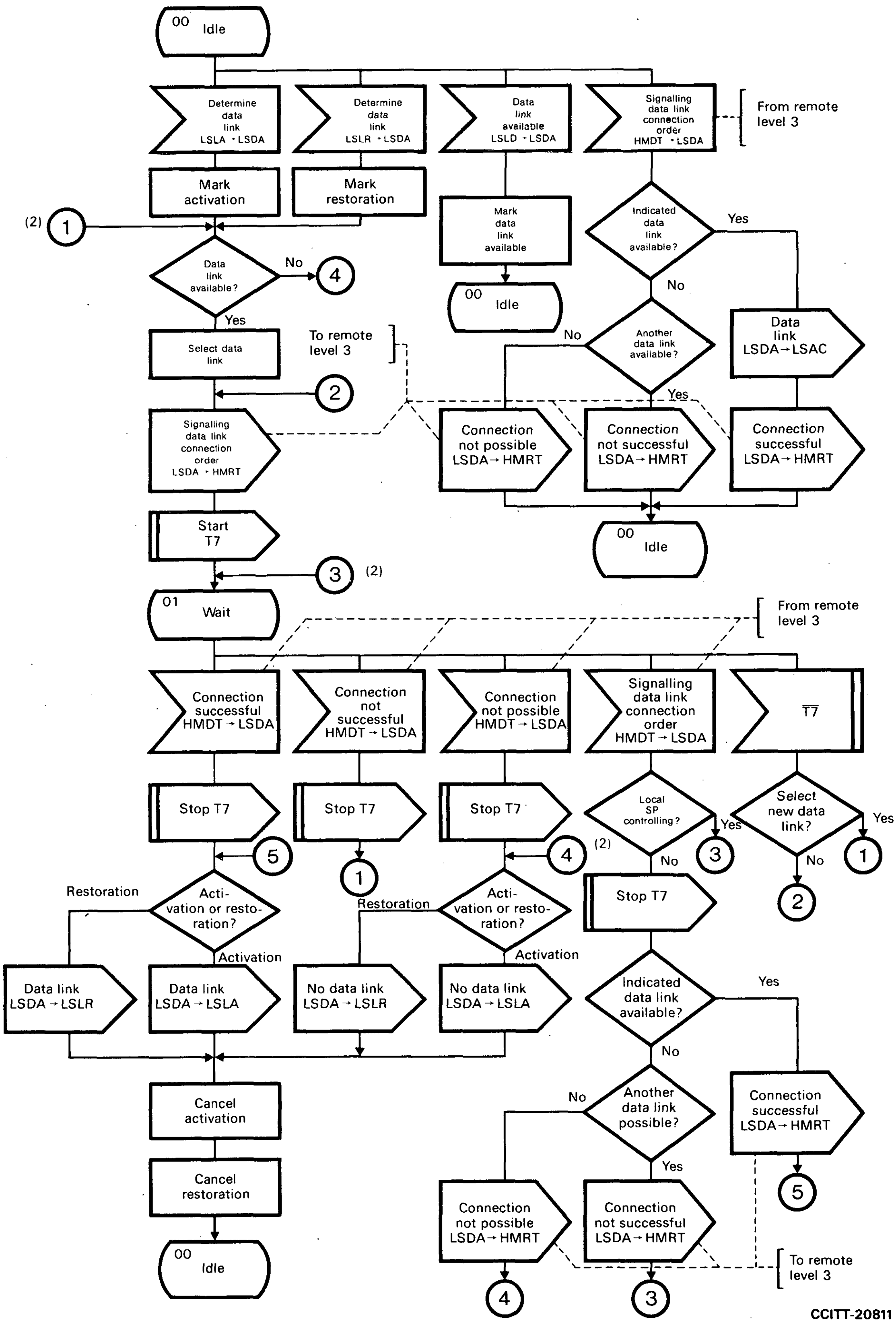


FIGURE 41/Q.704

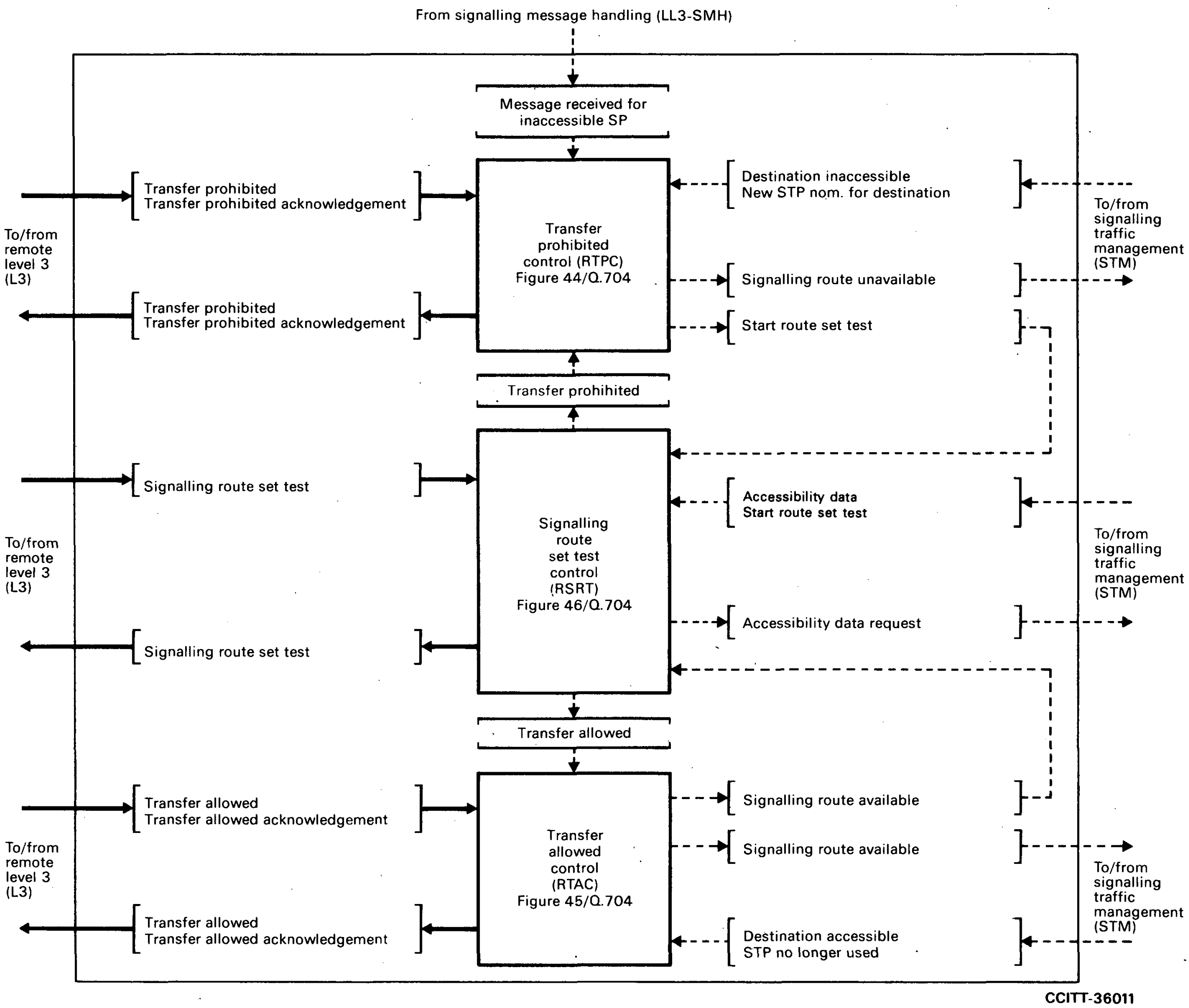
Signalling link management; signalling terminal allocation (LSTA)



CSS Connection successful
CNS Connection not successful
CNP Connection not possible

FIGURE 42/Q.704

Signalling link management; signalling data link allocation (LSDA)



Note – Abbreviated message names have been used in this diagram (i.e. origin → destination codes have been omitted).

FIGURE 43/Q.704

Level 3 – signalling route management (SRM); functional block interactions

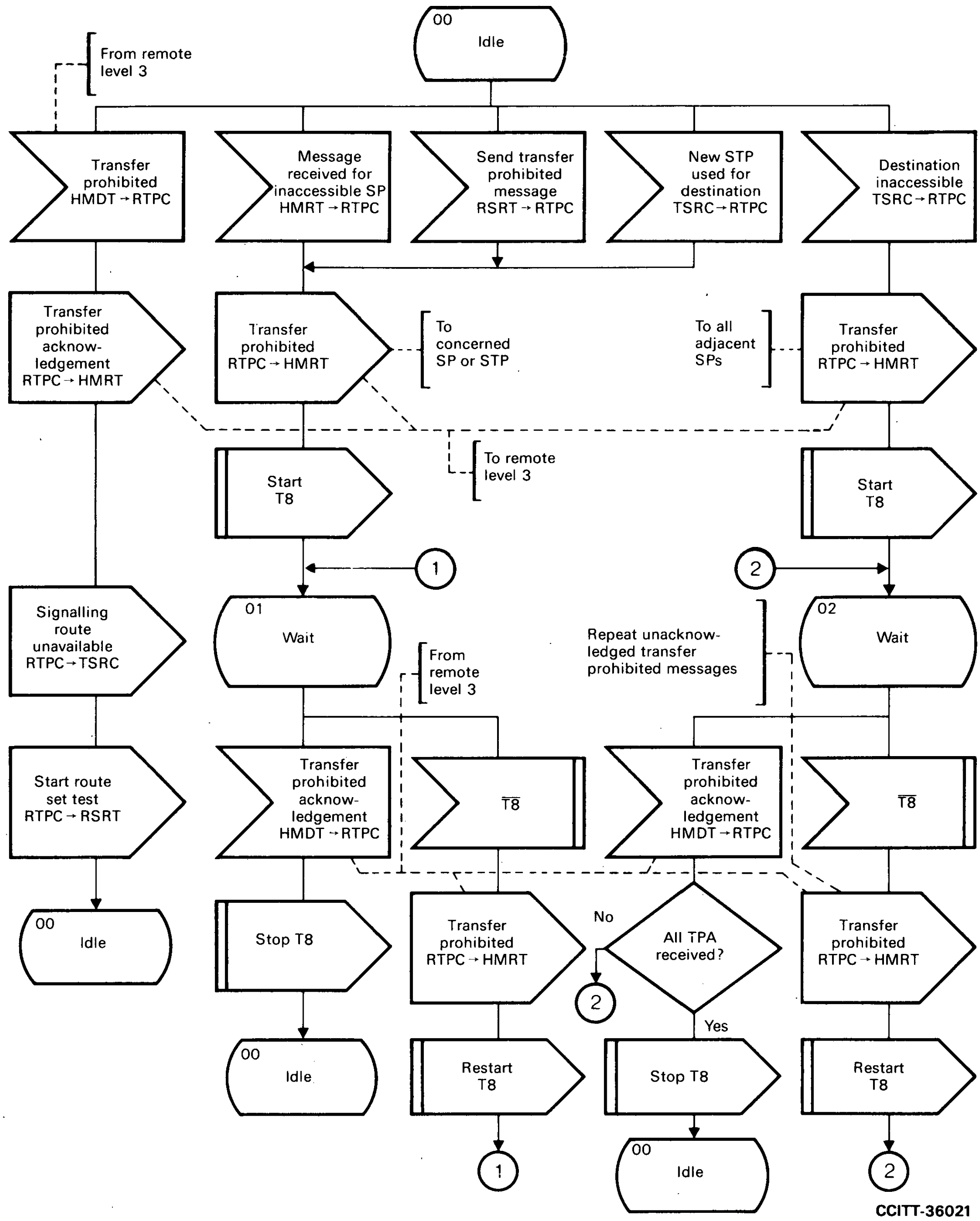


FIGURE 44/Q.704

Signalling route management; transfer prohibited control (RTPC)

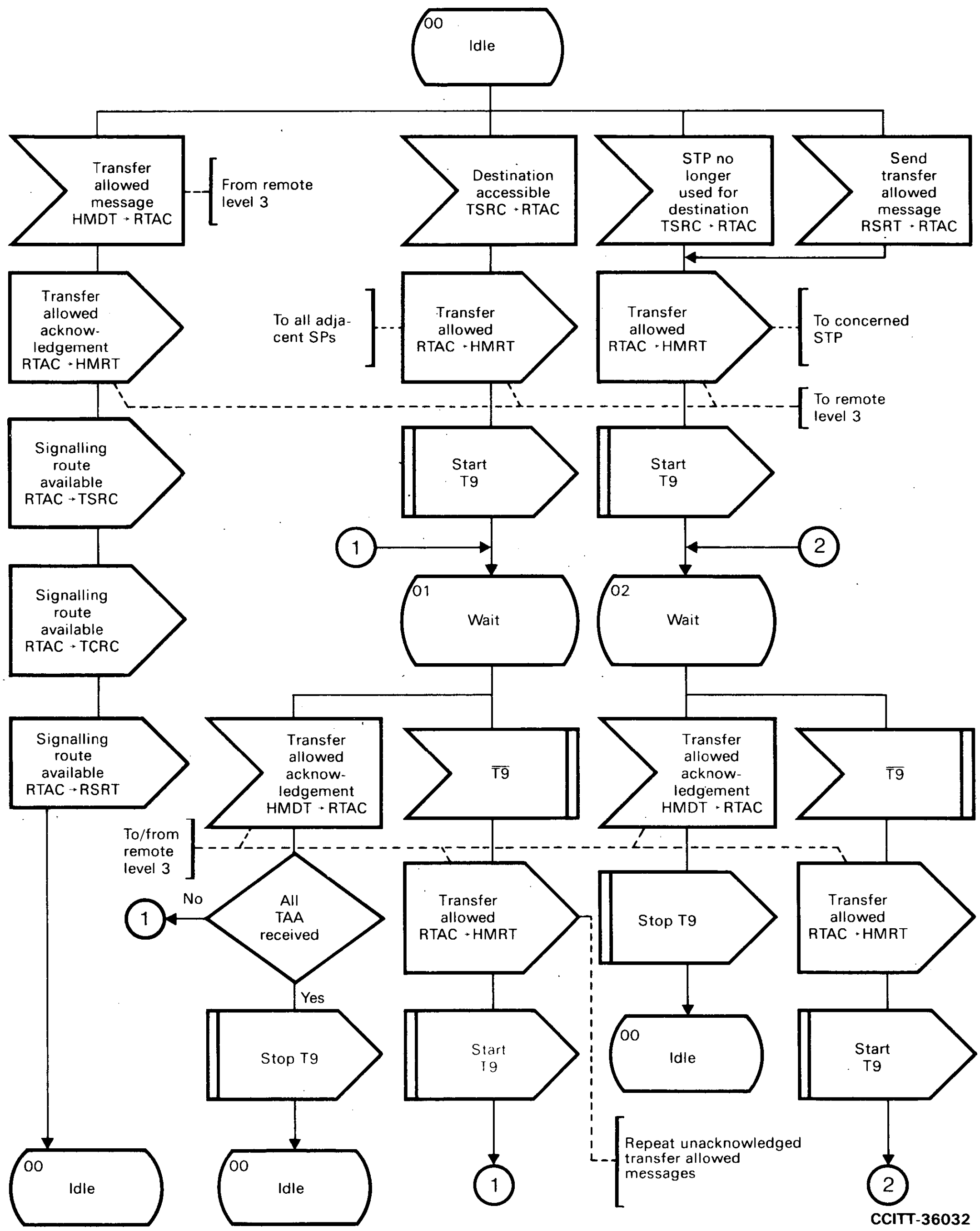


FIGURE 45/Q.704

Signalling route management; transfer allowed control (RTAC)

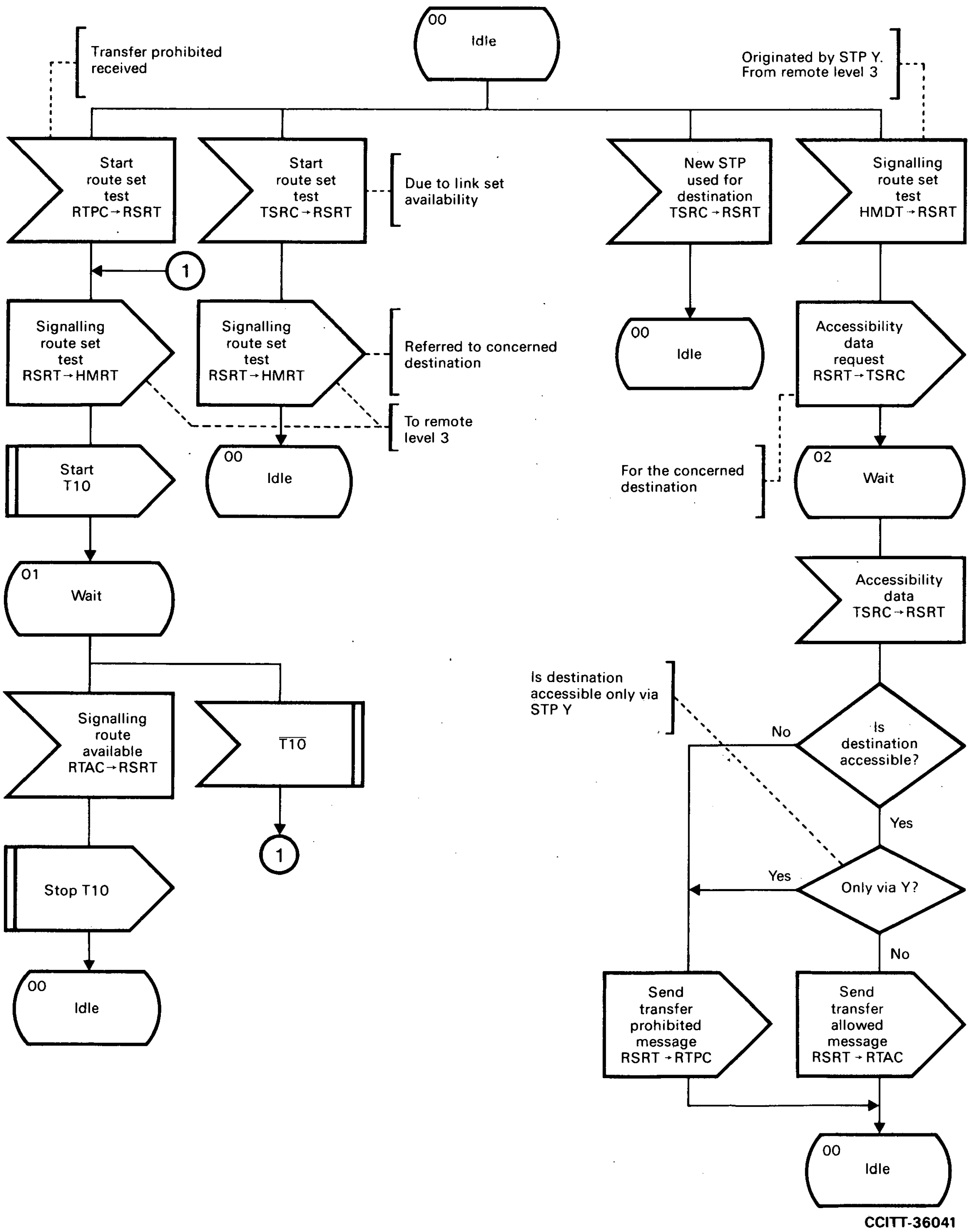


FIGURE 46/Q.704

Signalling route management; signalling route set test control (RSRT)

ANNEX A

Signalling Link Management and Signalling Traffic Management by the Switchover Method

A.1 *General*

A.1.1 This annex describes a set of actions and procedures for signalling link management which is an alternative to some of the procedures specified in § 10, and which is intended for use within national integrated digital networks, in particular for local exchange networks. Alternative signalling traffic management actions to those specified in § 5 are also described.

A.1.2 The *switchover method* is characterised by its response to signalling link failure in that before changeover of signalling traffic is initiated, an attempt is made to restore the failed signalling link using the *switchover* procedure to rapidly connect a new signalling data link between the signalling terminals of the failed signalling link. Changeover of the affected signalling traffic takes place only if the signalling link has not been restored within a specified time interval. Since the latter case is expected to be encountered in only a small proportion of failure situations, and since the introduction of a delay before diversion of signalling traffic reduces the probability of message sequence errors, a subset of the emergency changeover procedures is employed in conjunction with the method.

A.1.3 The functions described in this annex are consistent with and are accommodated within the functional organization shown in Figure 1/Q.704.

A.1.4 Apart from additions and modifications to signalling link management itself, no further modifications are necessary in level 3 procedures. It should be noted, however, that within signalling traffic management, only a subset of the changeover procedure is needed by the switchover method (see § A.6).

A.1.5 In addition to the above, the switchover method requires that some additions be made to the level 2 procedures and that provision be made for monitoring the error performance of *standby signalling data links* which are not connected to signalling terminals (see § A.6).

A.2 *Principles of the switchover method*

The switchover method is intended for application within signalling network configurations in which all, or some large fraction, of the signalling points are interconnected by non-duplicated signalling links. The basic principles of the switchover method may be described with reference to the simple configuration shown in Figure A-1/Q.704.

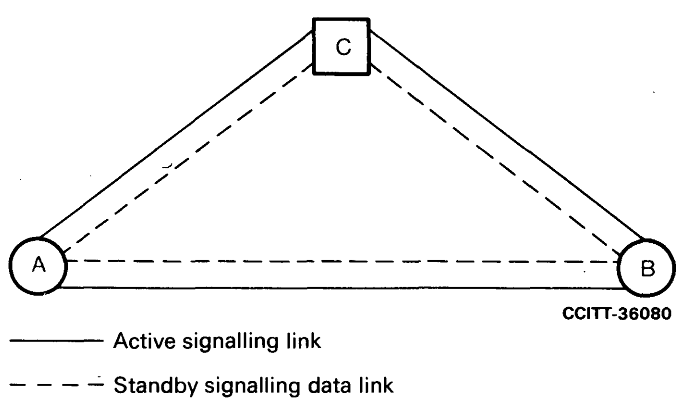


FIGURE A-1/Q.704

Simple network configuration to illustrate the switchover method

A.2.1 *Actions on detection of a failure*

Failure of the signalling data link between signalling points A and B will normally be detected by level 2 functions at each end of the signalling link and level 3 will be notified before each level 2 function automatically goes out of service. As soon as it is notified of the failure, signalling traffic management at each end initiates buffering of messages destined for the failed link. At this point, instead of performing the normal changeover procedure with exchange of changeover messages and retrieval of unacknowledged messages from level 2, it begins a time-out which is inherent in the emergency changeover procedures described in § 5.6.2. At the same time, signalling link management initiates replacement of the failed signalling data link by a predetermined standby signalling data link, using the switchover procedure in an attempt to rapidly restore the failed signalling link. Having been connected to the new signalling data link, the signalling terminals resume normal operation starting at the points in the transmission (or retransmission) procedure at which they were interrupted at the time of failure. Provided that this signalling link restoration attempt is successful, no messages are lost, duplicated or sent out of sequence. The switchover procedure is described in more detail in § A.3.

No initial alignment of the signalling link is initiated, instead signalling traffic management is notified of the recovery of the failed signalling link, and provided that recovery is completed within the above mentioned time-out interval, the buffered signalling traffic is released onto the recovered signalling link followed by subsequent signalling messages. If, however, signalling traffic management completes the time-out without being notified of recovery of the failed signalling link, signalling traffic is diverted onto one or more alternative signalling routes (e.g. ACB in Figure A-1/Q.704) without exchange of changeover signals or retrieval of messages from level 2 of the failed signalling link, the latter messages being discarded.

Once the signalling link has been satisfactorily restored to service, signalling link management initiates a *standby data link selection* procedure to automatically select a new standby signalling data link. This procedure is described in more detail in § A.4.

In order to allow the signalling terminals to resume normal operation at the point where they were interrupted by signalling data link failure, it is necessary to avoid performing the initial alignment procedure on the signalling link prior to restarting signalling traffic on it. Therefore a means has to be provided to continuously monitor the error performance of a standby signalling data link prior to its connection to a level 2 function. The details of such an error monitor require further study (see § A.6).

Note – The above description outlines only the normal flow of signalling traffic and signalling link management actions which would follow a typical signalling link failure caused by failure of the signalling data link. Signalling link management actions taken in the event of more complex failure situations (e.g. signalling terminal failure) are identical to those described in § 10.4.

A.2.2 *Actions resulting from management blocking of a signalling link*

Consider the events following the blocking of the signalling link between signalling link points A and B in Figure A-1/Q.704 as a result of management system action (automatic or manual) at signalling point A. Such an action may, for example, precede the removal of the affected signalling link from service for maintenance or other purposes.

As already stated above, the switchover method employs a subset of the emergency changeover procedures in which no retrieval of message signal units from the concerned signalling link is attempted. In order to avoid message signal units being lost when changeover results from management system blocking, it is necessary to ensure that the transmission and reception of message signal units, by the level 2 functions over the concerned signalling link, continues for some time after the emergency changeover procedure (described in § 5.6.2) has been initiated by level 3. This allows all of the message signal units contained in the level 2 transmission and retransmission buffers, at signalling points A and B, to be transmitted and acknowledged before the signalling link is taken out of service. The above capability is made possible by introducing a time-out procedure within level 2. This is described in detail in § A.5.

A.3 *Switchover procedure*

A.3.1 *General*

The objective of the switchover procedure is to recover a failed signalling link as quickly as possible without introducing message loss, duplication or sequence errors.

Higher level recovery measures employed when the switchover procedure is unable to recover the failed signalling link, are described in § 10.4.

A.3.2 *Criteria for initiation of the switchover procedure*

Switchover is the first measure employed by the signalling link restoration procedure following the detection of signalling link failure. The criteria which initiate switchover (as part of signalling link restoration) are identical to those which are described in § 3.2.2 and which would normally cause signalling link initial alignment to be initiated (see § 10.4.2) in parallel with the normal changeover procedure.

A.3.3 *Actions following signalling link failure*

A.3.3.1 Following signalling link failure, signalling link restoration is initiated and its first signalling link restoration attempt is based upon the use of the switchover procedure, to switch the standby signalling data link to the signalling terminal of the failed signalling link. Following the above action, level 2 begins to continuously transmit fill-in signal units. Level 2 then proceeds to the *aligned/ready* state as soon as it correctly receives one fill-in signal unit.

A.3.3.2 If level 3 receives an *in service* or *remote processor outage* indication from level 2, the signalling link restoration attempt is considered successful, the signalling link is once more considered to be active and signalling traffic management is informed. Finally the standby data link selection procedure is initiated. This procedure will select a new error monitored standby signalling data link for the recovered signalling link.

A.3.4 *Procedures for abnormal conditions*

A.3.4.1 If the initial signalling link restoration attempt cannot be completed (because no standby data link is allocated) or is unsuccessful (because level 2 indicates *out of service* or a level 2 failure is suspected), further signalling link restoration and/or activation measures are performed. These measures are exactly as specified in § 10.4.2 for the case when the initial signalling link restoration attempt (based on attempted initial alignment of the failed signalling link) is not successful.

A.3.4.2 When a failed signalling link is restored (or an alternative signalling link is activated) signalling traffic management is informed and the standby data link selection procedure is initiated in order to select a standby signalling data link for the restored (or activated) signalling link.

A.4 *Standby data link selection procedure*

A.4.1 *General*

The standby data link selection procedure is used by signalling link management to determine a new standby data link which can be used for switchover purposes (see § A.3.3.2) and which is dedicated to a particular signalling link.

The procedure is dependent on at least one other signalling data link being available between two signalling points in addition to the active signalling data link (i.e., the signalling data link which is in use as part of the working signalling link for which the standby data link will be selected).

The signalling data link chosen to become a standby should be selected in such a way as to take advantage of transmission facility diversity with respect to the active signalling data link, in order to minimize the chances of the same fault disabling both the active and standby signalling data link. The procedure makes use of the automatic signalling data link allocation procedure described in § 10.6.

A.4.2 *Criteria for initiation of standby data link selection*

The following events result in the initiation of the standby data link selection procedure:

a) An intolerable error rate is recognized on the standby signalling data link (by a standby data link error monitor, see § A.6) while the signalling link, to which it is assigned, is still active.

b) Restoration or activation of a signalling link (see § 10.4) is completed.

A.4.3 *Standby data link selection*

A.4.3.1 If standby data link selection is initiated at the local end of the signalling link, as a result of either of the criteria identified in § A.4.2, the automatic signalling data link allocation procedure described in § 10.6 is used to allocate a signalling data link for the signalling link concerned. Provided that the signalling data link is allocated successfully, the data link is identified as being the new standby data link for the concerned signalling link and error monitoring of the new standby link is initiated.

A.4.3.2 If standby data link selection is initiated at the remote end of the concerned signalling link, a signalling data link is allocated using the procedure above. Provided the concerned signalling link is active (i.e. not out of service or in the process of initial alignment), the allocated signalling data link is recognized as being a new standby data link (as distinct from a signalling data link to be used in a restoration or activation attempt currently in progress) and error monitoring of the new standby data link is initiated.

A.4.4 *Procedures for abnormal conditions*

A.4.4.1 If standby data link selection is initiated at the local end of the concerned signalling link but no signalling data link is available, further attempts to select a signalling data link are repeated at intervals of TA2 (value for further study) until either an attempt is successful or the signalling link ceases to be active (as the result of signalling link failure or signalling link deactivation).

A.5 *Procedure for management blocking of a signalling link*

As noted in § A.2.2, when blocking of a signalling link is initiated by a management system action, it is necessary to ensure that transmission and reception of message signal units by the level 2 function on the concerned link continues for some time after emergency changeover has been initiated. This is achieved by level 2, which, while it is in the in-service state, responds to indications of local or remote processor outage (received from level 3 or remote level 2 respectively) as described below.

In Figure A-1/Q.704, at signalling point A, i.e., at the signalling point where blocking of the signalling link AB is initiated, level 3 sends a local processor outage indication to level 2 which starts a time-out TA4 = 100 ms (provisional value) but remains in service, sending and receiving message signal units normally. At the expiry of the time-out interval, if the level 2 transmission and retransmission buffers are empty, level 2 begins to continuously transmit link status signal units indicating processor outage as specified in § 3.3.3. If, however, the level 2 buffers are not empty, the time-out is restarted.

At signalling point B, upon receiving a link status signal unit indicating processor outage on the signalling link AB, level 2 immediately notifies level 3 of the remote processor outage condition and starts a time-out TA4 as above, meanwhile remaining in service. At the expiry of the time-out interval, if the level 2 transmission and retransmission buffers are empty, level 2 begins to continuously transmit fill-in signal units. If however, the level 2 buffers are not empty, the notification of remote processor outage to level 3 is repeated and the time-out is restarted.

Note — In the above procedure it is an implicit assumption that level 2 at signalling point A continues to accept and acknowledge message signal units received over the concerned signalling link from signalling point B while simultaneously sending link status signal units indicating processor outage.

A.6 *Impact on MTP functions*

The impact of the switchover method on Message Transfer Part functions is summarized in Table A-1/Q.704.

A.6.1 *Level 3 — Signalling link management*

A.6.1.1 In order to accommodate the switchover and standby data link selection procedures, the following changes are required to the standby set of signalling link management functions. No standard functions are replaced, one new function (standby data link selection) is added, additional logic is inserted into one standard function (signalling link activity control) and additional logic replaces one portion of another standard function (signalling link restoration). The overall impact of the switchover method on the functional structure of signalling link management is illustrated in Figure A-2/Q.704.

TABLE A-1/Q.704

Impact of the switchover method on Message Transfert Part functions — summary

Functional level	Function	Impact	
		Type	Figure
3	Signalling link management:		A-2/Q.704
	– signalling link activity control	additional logic	A-5/Q.704
	– signalling link restoration	additional logic	A-3/Q.704
	– standby data link selection	new function	A-4/Q.704
	Signalling traffic management:		
	– link availability control	slightly simplified	A-7/Q.704
	– changeover control	considerably simplified	A-6/Q.704
2	Link state control	additional logic	A-8/Q.704
1	Signalling data link	error monitor required	–

A.6.1.2 The switchover procedure is incorporated into the signalling link restoration procedure defined in § 10.4.2. It replaces the first signalling link initial alignment attempt in the normal signalling link restoration procedure as described in § A.3. The impact on the signalling link restoration function is illustrated in Figure A-3/Q.704.

A.6.1.3 Standby data link selection is a new procedure which is defined in addition to the standard signalling link management procedures. The operation of the procedure is described in § A.4 while the logic of the procedure is illustrated in Figure A-4/Q.704 in the form of a new functional element, standby data link selection, which is activated by signalling link activity control.

A.6.1.4 In order to accommodate the standby data link selection procedure some additions are necessary to the signalling link activity control function as illustrated in Figure A-5/Q.704.

A.6.2 *Level 3 – Signalling traffic management*

A.6.2.1 The only impact of the switchover method on signalling traffic management is within the changeover control function and the link availability control function. Since changeover messages are never exchanged in the switchover method, the changeover control function reduces to a subset of the standard changeover control function as illustrated in Figure A-6/Q.704. Similarly some simplification of the link availability control function is possible as illustrated in Figure A-7/Q.704. No other changes are necessary within signalling traffic management.

A.6.3 *Level 2 – Signalling link control*

Modifications required to functional level 2 are restricted to the link state control function (see Recommendation Q.703). The modifications relate to the addition of 2 new states to the link state control function.

The first new state is one in which level 2 emits and receives fill-in signal units only. This forms part of a logical path via which level 2 can pass from the out of service state to the in service state without performing initial alignment (as described in § A.2.1).

The second new state is a wait state in which level 2 awaits the expiry of a time-out interval TA4 before proceeding to the processor outage state (as described in § A.5 above).

The required additions are illustrated in Figure A-8/Q.704.

A.6.4 *Level 1 – Signalling data link*

In order to provide for error monitoring of a standby signalling data link, some additions may be required to functional level 1. An error monitor is required which would give an early indication of standby data link failure, thus enabling a new standby data link to be rapidly assigned if necessary. The means by which such error monitoring should be performed requires further study.

Note – As an alternative to monitoring the error rate on each individual standby signalling data link (e.g., by using a signal unit error rate monitor similar to that employed by functional level 2), it may be possible to monitor the error performance of a primary digital PCM multiplex system using the synchronization channel (i.e., time slot 0 in the case of Recommendation G.732 [1] based systems or the framing bit in the case of Recommendation G.733 [2] based systems).

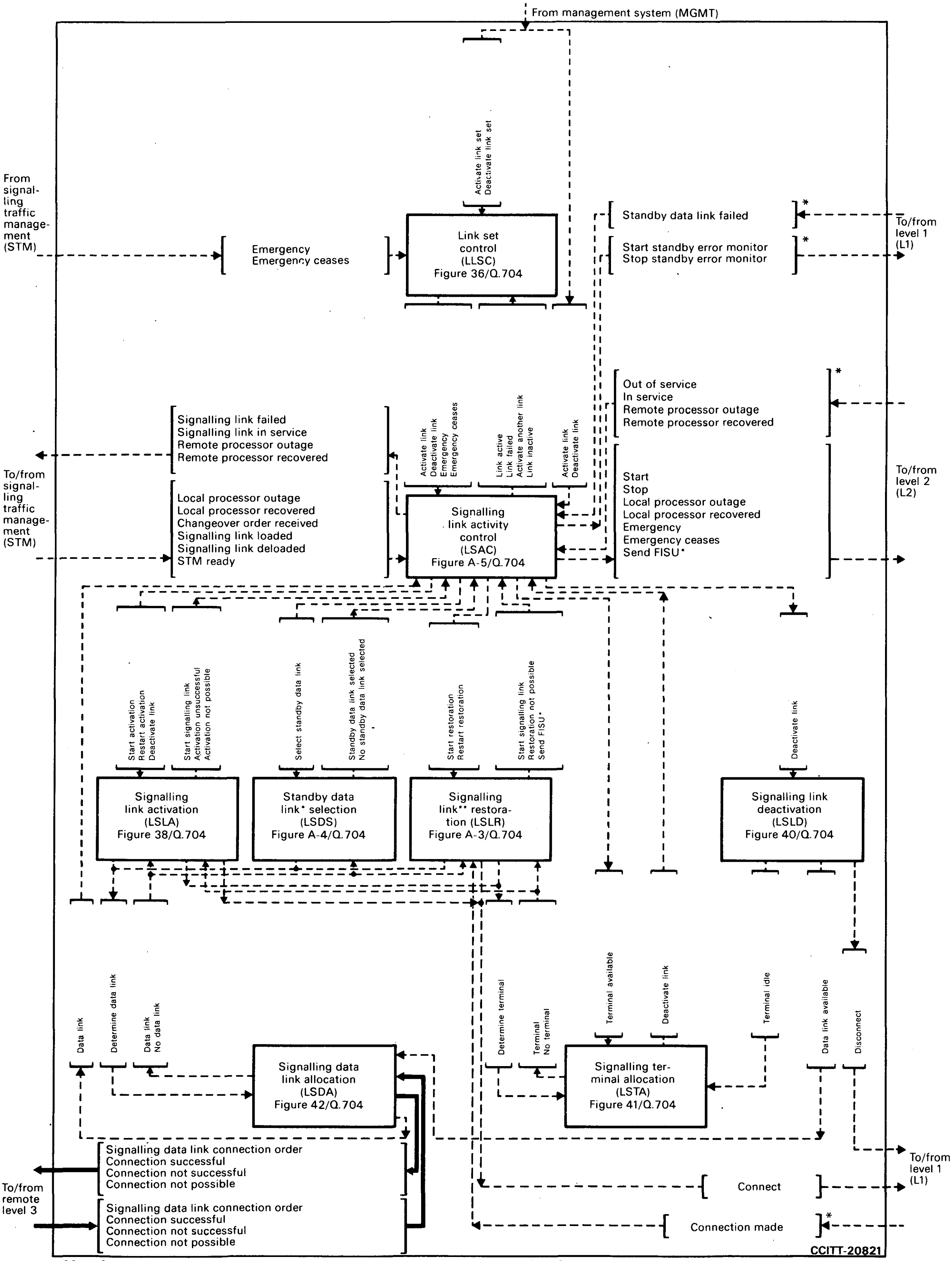
A.6.5 *Abbreviations and timers used in Figures A-2/Q.704 to A-8/Q.704*

BSNT	Backward sequence number of next signal unit to be transmitted
FISU	Fill-in signal unit
FSNC	Forward sequence number of last message signal unit accepted by remote level 2
HMDT	Message distribution
HMRT	Message routing
IAC	Initial alignment control
L1	Level 1
L2	Level 2
L3	Level 3
LLSC	Link set control
LSAC	Signalling link activity control
LSC	Link state control
LSDA	Signalling data link allocation
LSDS	Standby data link selection
LSLA	Signalling link activation
LSLD	Signalling link deactivation
LSLR	Signalling link restoration
LSTA	Signalling terminal allocation
MGMT	Management system
MSU	Message signal unit
POC	Processor outage control
RC	Reception control
SIE	Status indication "emergency"
SIN	Status indication "normal"
SIO	Status indication "out of alignment"
SIOS	Status indication "out of service"
SIPO	Status indication "processor outage"
SLM	Signalling link management
STM	Signalling traffic management
SUERM	Signal unit error rate monitor
TCBC	Changeback control

TCOC	Changeover control
TLAC	Link availability control
TSRC	Signalling routing control
TXC	Transmission control

Timers

TA1	Waiting for connection of new signalling data link (during switchover)
TA2	Delay to limit frequency of standby data link selection attempts
TA3	Waiting for indication of FISU reception (confirming successful switchover)
TA4	Delay to allow transmission and retransmission buffers (level 2) to empty before initiating processor outage action
T1	(level 3) Delay to avoid message mis-sequencing on changeover
	(level 2) Waiting for indication of FISU/MSU reception
T2	(level 3) Waiting for changeover acknowledgement

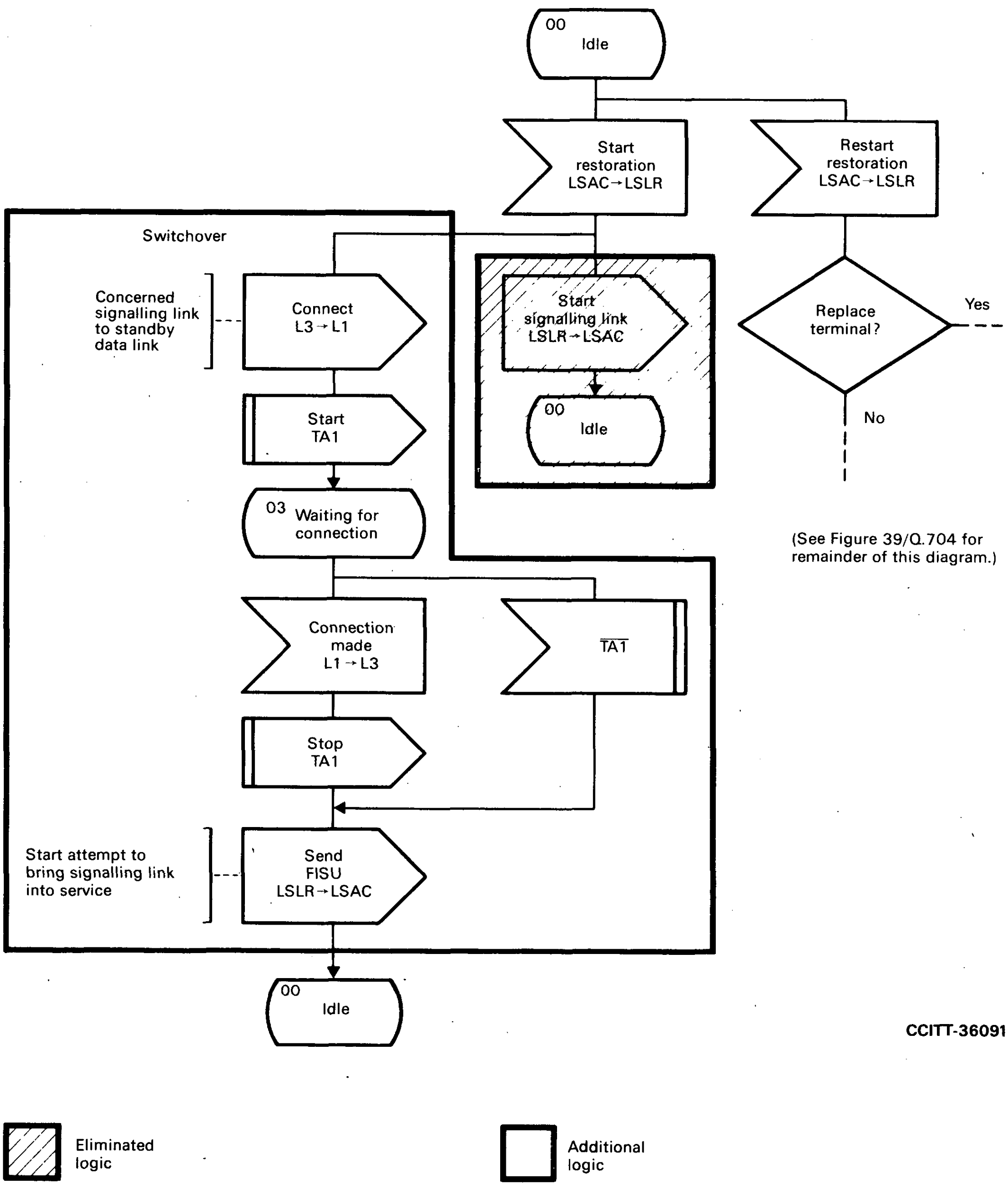


* New function or message. ** Modified function or message.

Note – See also Figure 35/Q.704.

FIGURE A-2/Q.704

Level 3 – signalling link management (SLM); functional block interactions (impact of switchover method)



Note – See also Figure 39/Q.704.

FIGURE A-3/Q.704

Level 3 – signalling link management; signalling link restoration (LSLR) (impact of switchover method)

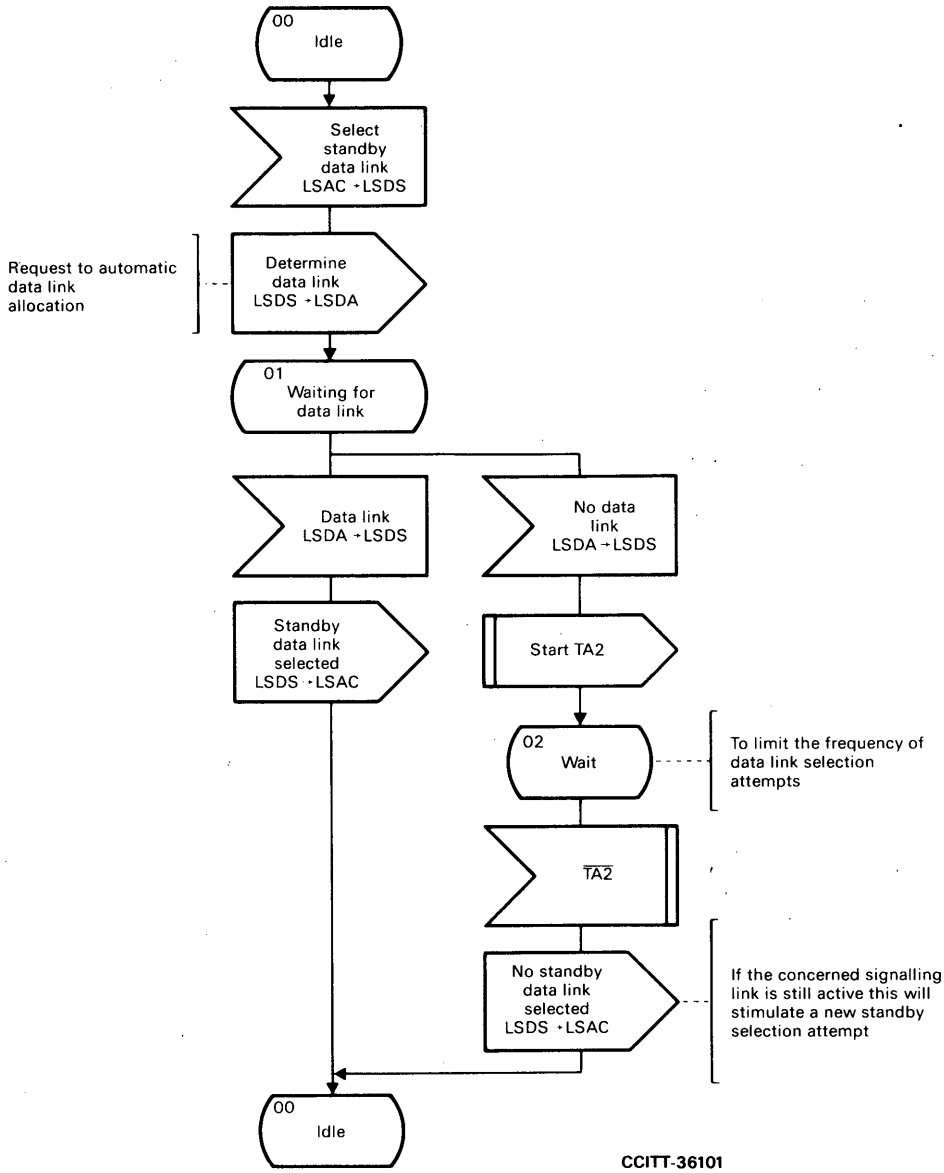
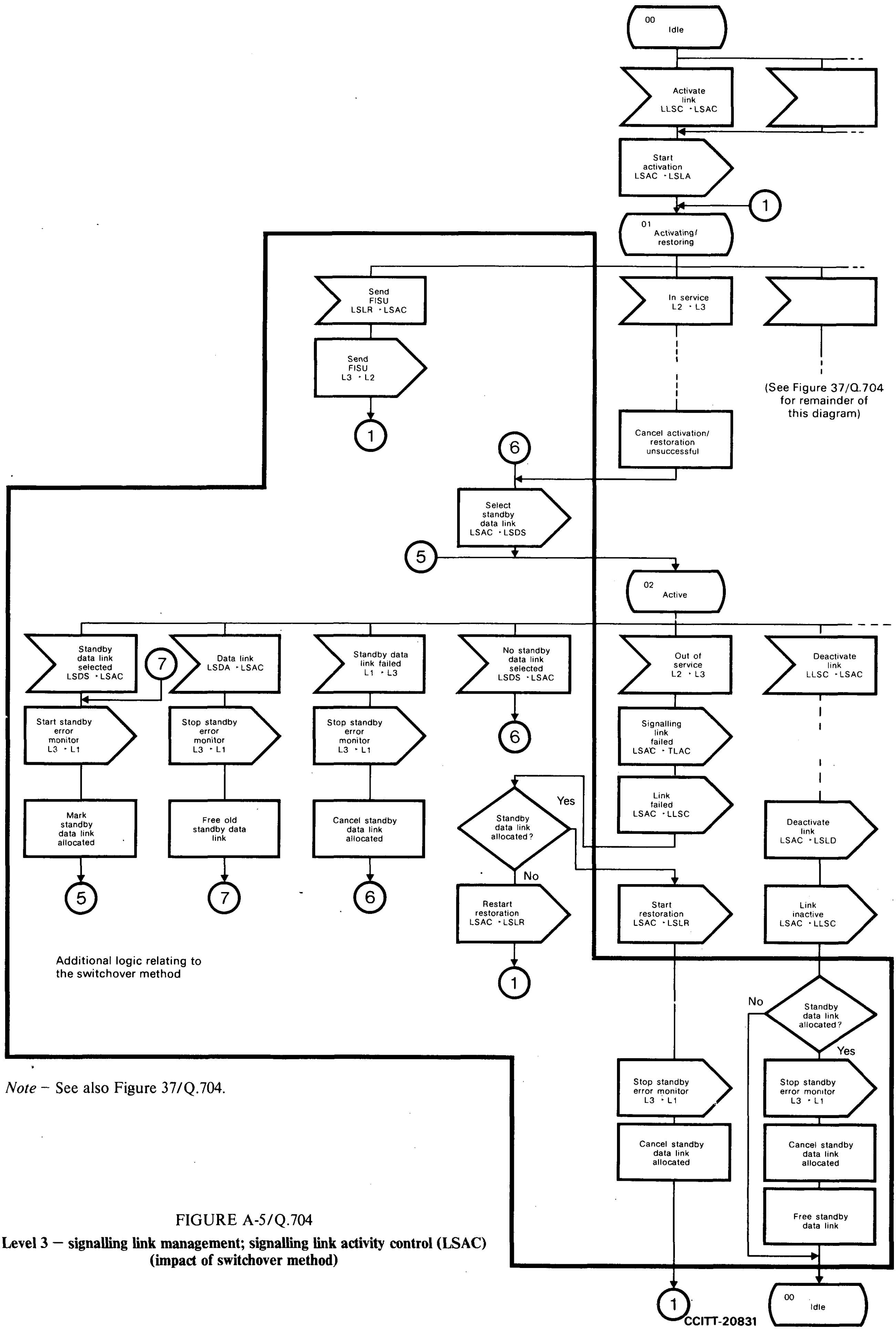


FIGURE A-4/Q.704

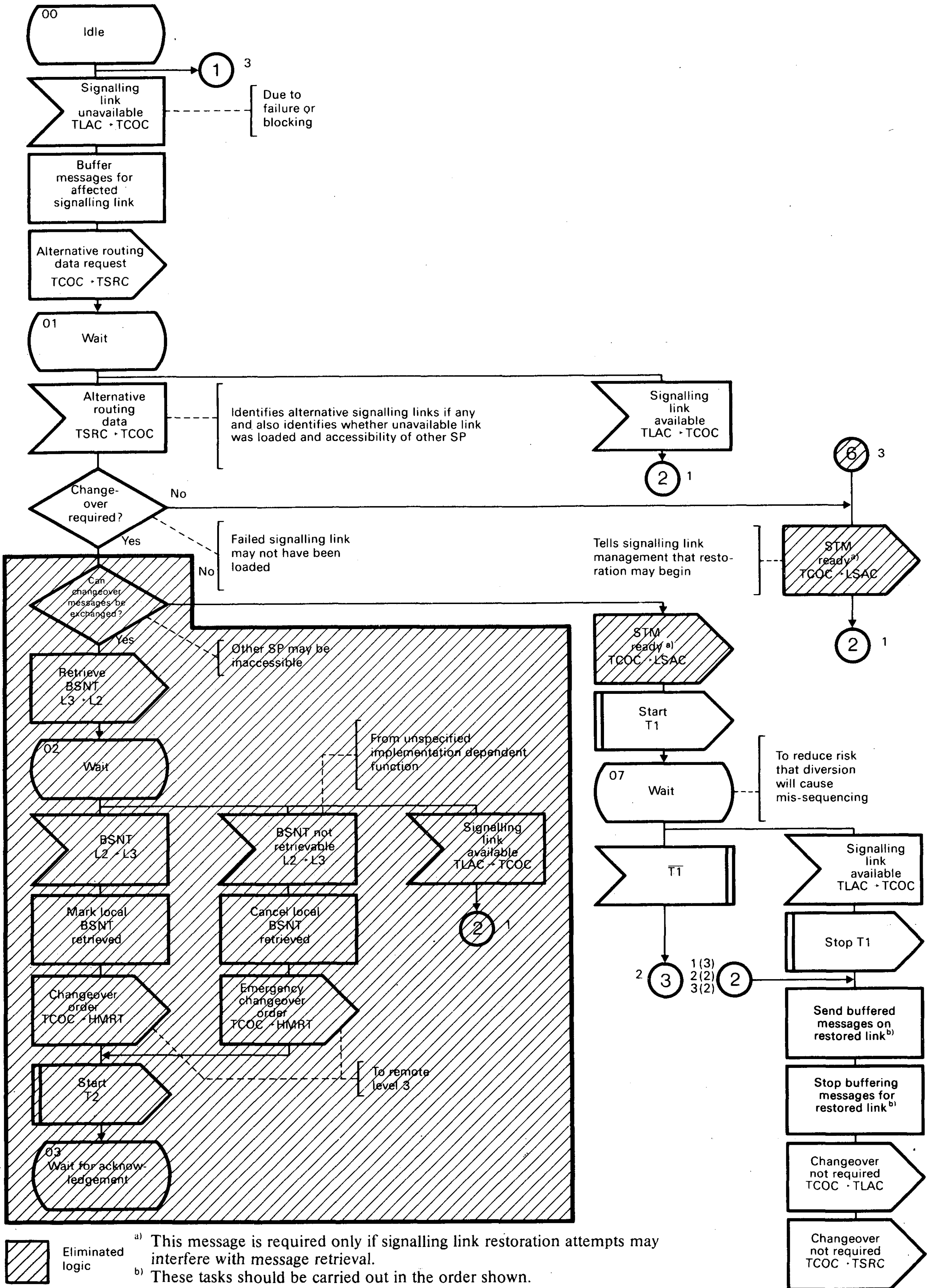
Level 3 – signalling link management; standby data link selection (LSDS) (new function required for the switchover method)



Note – See also Figure 37/Q.704.

FIGURE A-5/Q.704

Level 3 – signalling link management; signalling link activity control (LSAC) (impact of switchover method)



a) This message is required only if signalling link restoration attempts may interfere with message retrieval.

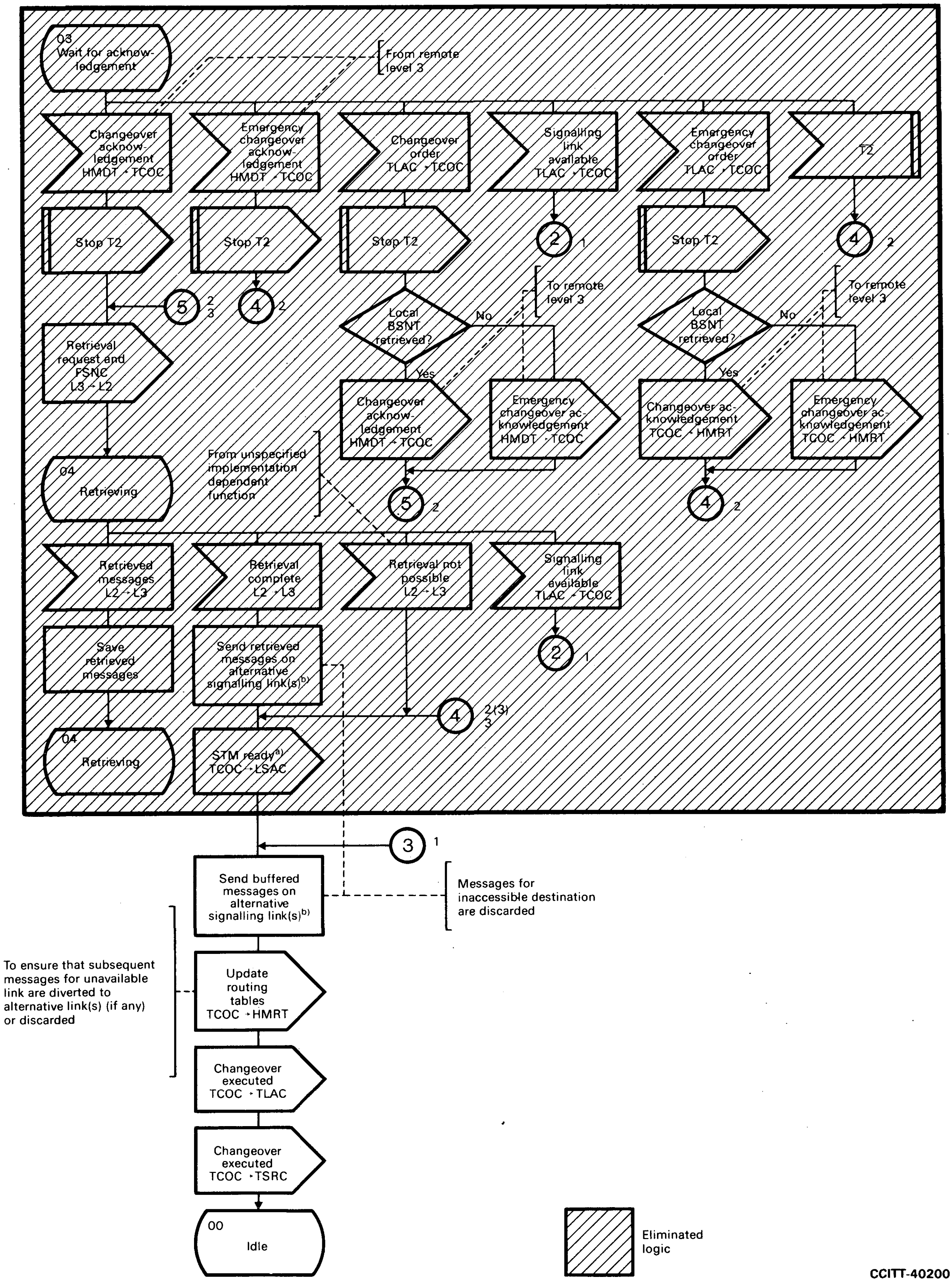
b) These tasks should be carried out in the order shown.

Note 1 – See also Figure 30/Q.704.

Note 2 – All of the logic corresponding to sheet 3 of Figure 30/Q.704 is eliminated.

FIGURE A-6/Q.704 (sheet 1 of 2)

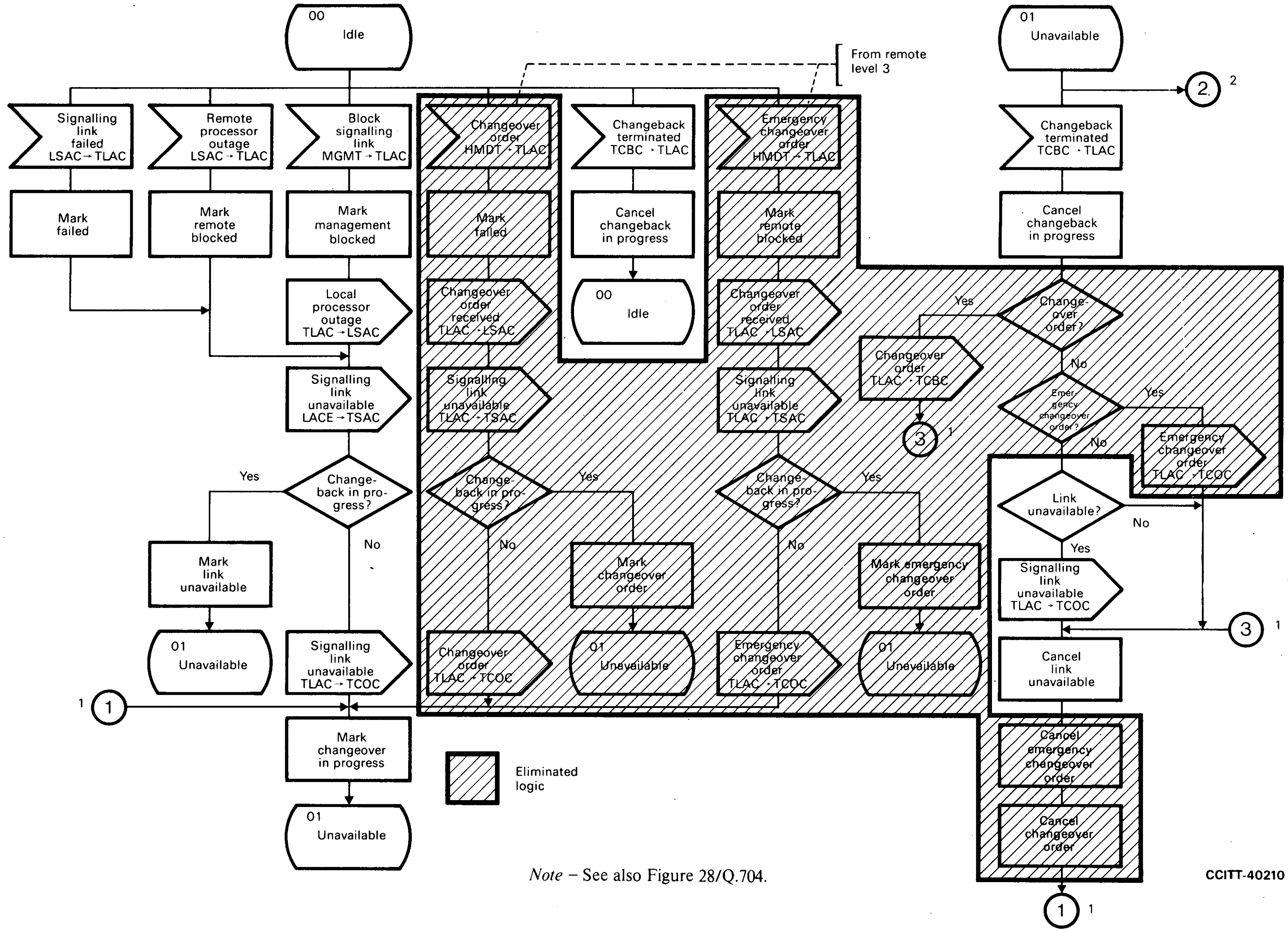
Level 3 – signalling traffic management; changeover control (TCOC) (impact of switchover method)



Note – See also Figure 30/Q.704.

FIGURE A-6/Q.704 (Sheet 2 of 2)

Level 3 – signalling traffic management; changeover control (TCOC) (impact of switchover method)



Note – See also Figure 28/Q.704.

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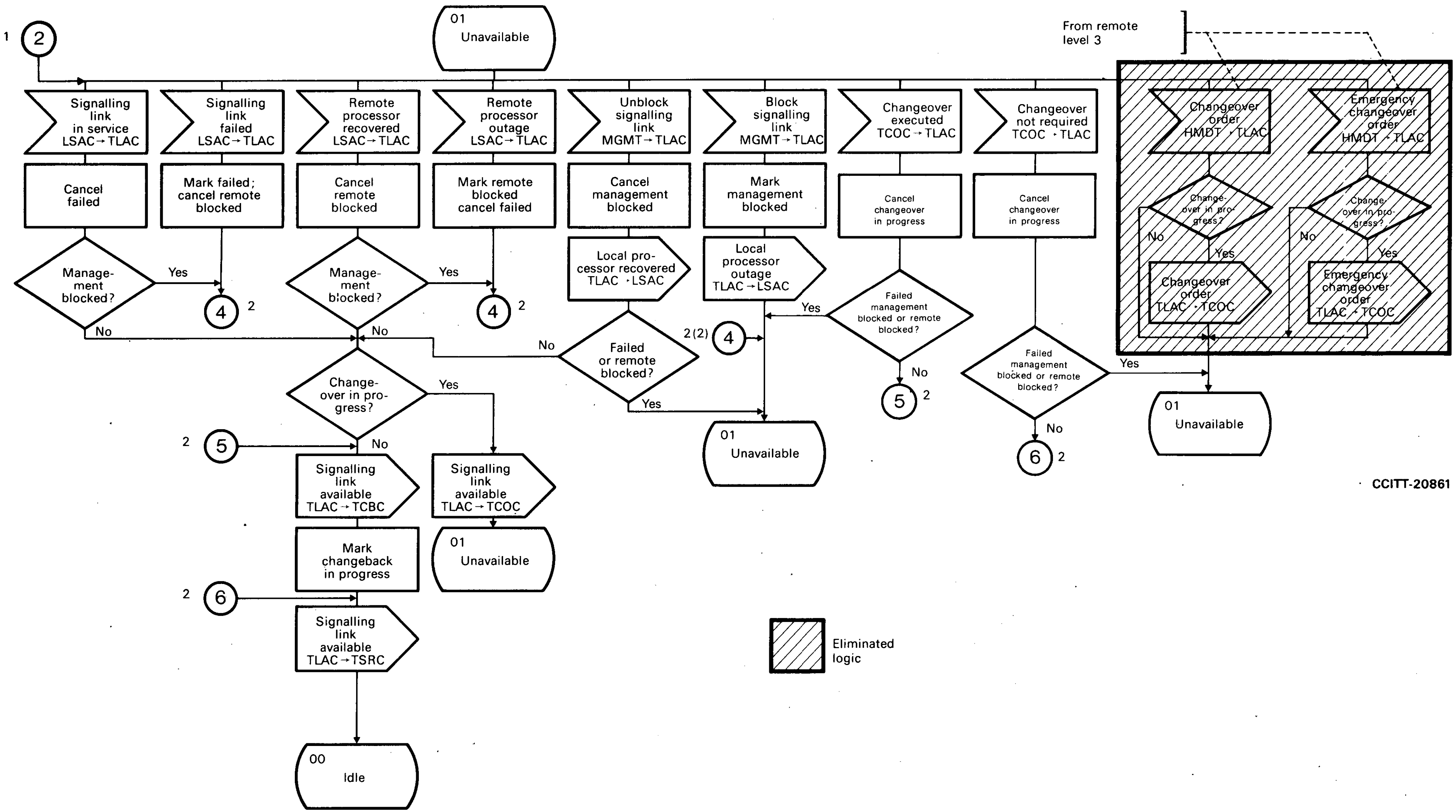
FIGURE A-7/Q.704 (Sheet 1 of 2)

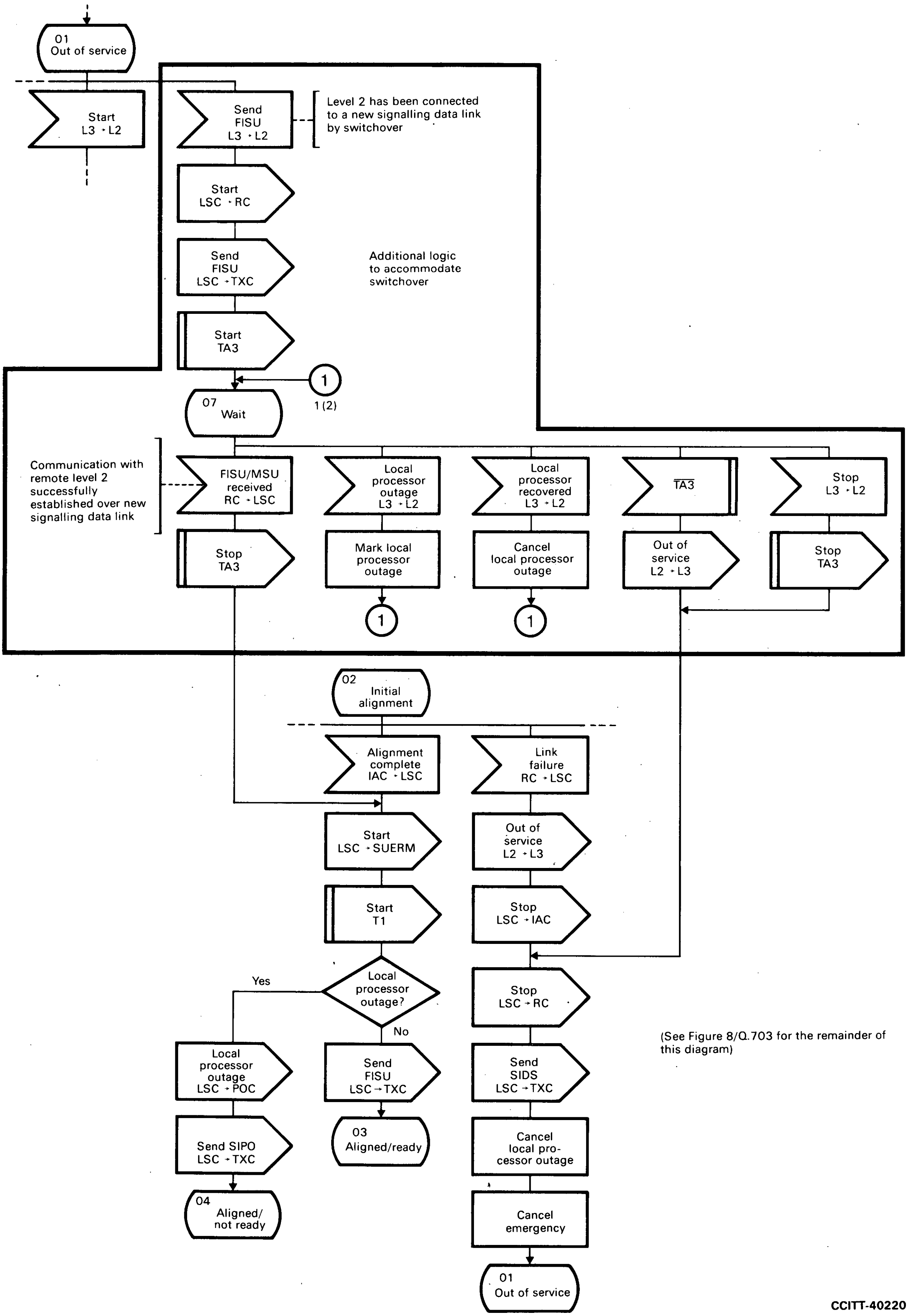
Level 3 – signalling traffic management; link availability control (TLAC) (impact of switchover method)



Note – See also Figure 28/Q.704.

FIGURE A-7/Q.704 (Sheet 2 of 2)

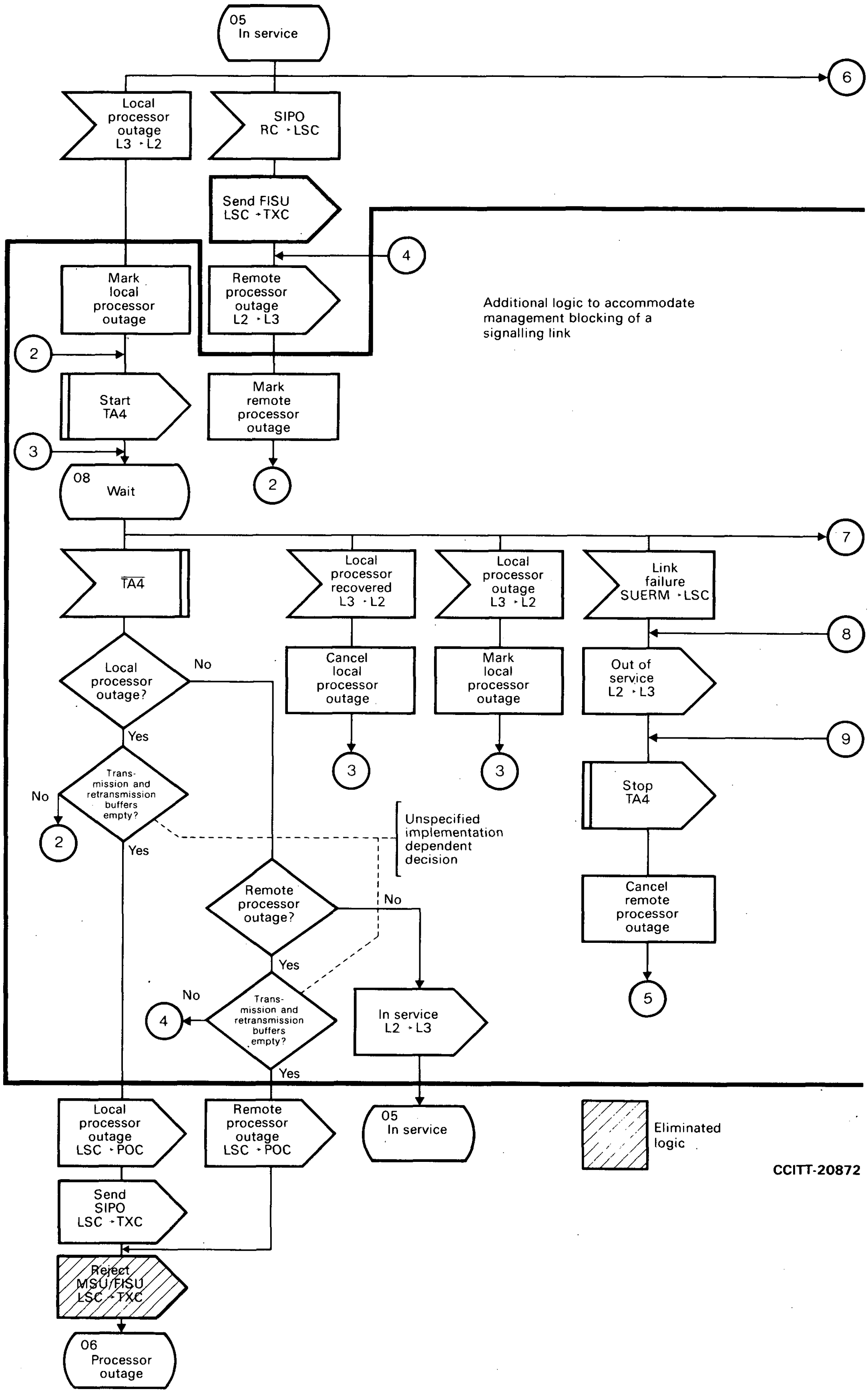
Level 3 – signalling traffic management; link availability control (TLAC) (impact of switchover method)



Note – See also Figure 8/Q.703.

FIGURE A-8/Q.704 (Sheet 1 of 3)

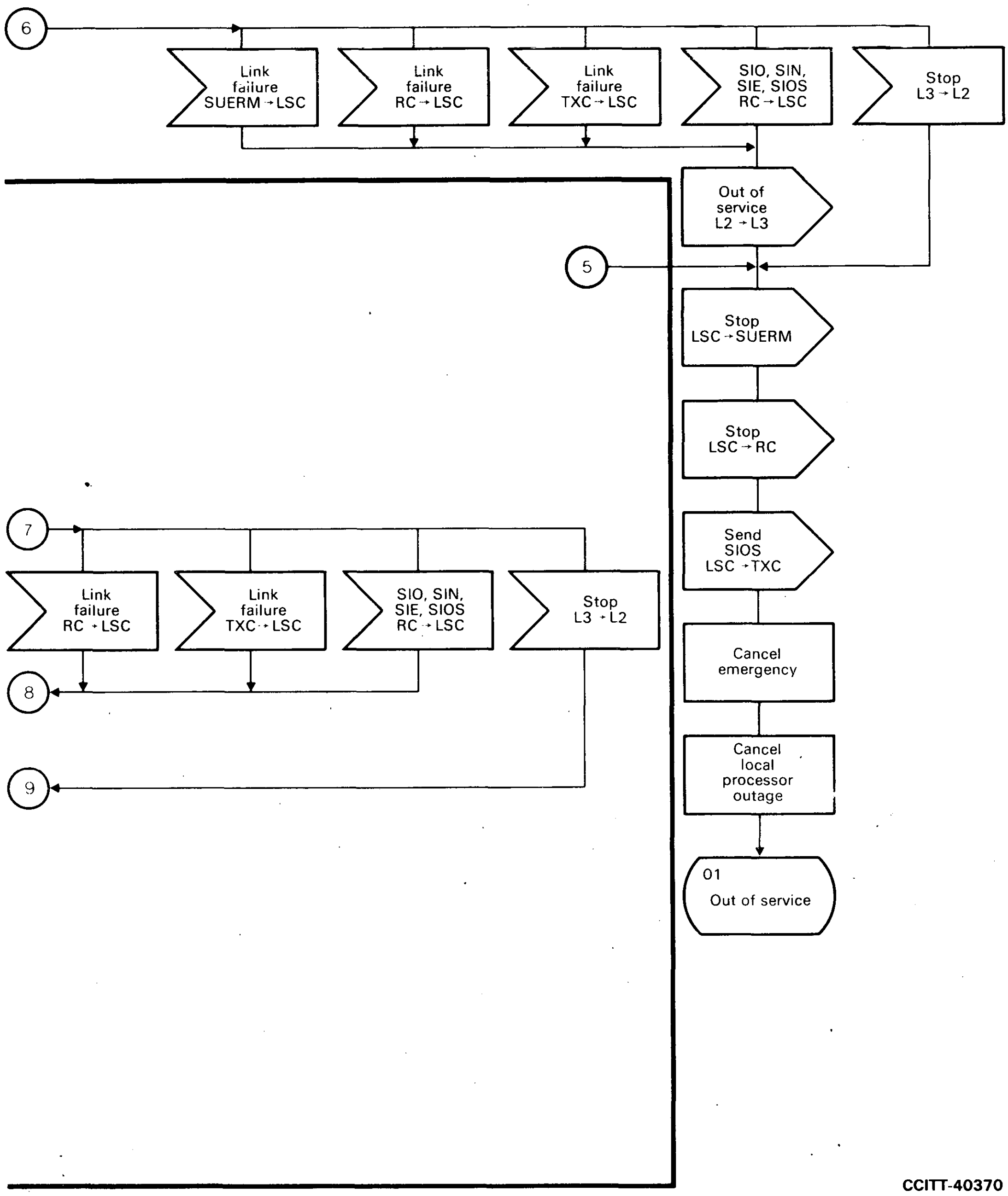
Level 2 – link state control (LSC) (impact of switchover method)



Note – See also Figure 8/Q.703.

FIGURE A-8/Q.704 (Sheet 2 of 3)

Level 2 – link state control (LSC) (impact of switchover method)



Note – See also Figure 8/Q.703.

FIGURE A-8/Q.704 (Sheet 3 of 3)

Level 2 – link state control (LSC) (impact of switchover method)

References

[1] CCITT Recommendation *Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s*, Vol. III, Fascicle III.3, Rec. G.732.

[2] CCITT Recommendation *Characteristics of primary PCM multiplex equipment operating at 1544 kbit/s*, Vol. III, Fascicle III.3, Rec. G.733.

SIGNALLING NETWORK STRUCTURE

CONTENTS

1 Introduction

This Recommendation describes aspects which are pertinent to and should be considered in the design of international signalling networks. Some or all of these aspects may also be relevant to the design of national networks. Some aspects are dealt with for both international and national networks (e.g. availability), others are discussed in the context of the international network only (e.g. number of *signalling transfer points* in a signalling relation). A number of aspects require further study for national networks. This Recommendation also gives in Annex A examples of how the signalling network procedures may be applied to the mesh network representation.

The national and international networks are considered to be structurally independent and, although a particular *signalling point* may belong to both networks, signalling points are allocated *signalling point codes* according to the rules of each network.

The signalling network procedures are provided in order to effectively operate a signalling network having different degrees of complexity. They provide for reliable message transfer across the network and for reconfiguration of the network in the case of failures.

The most elementary signalling network consists of *originating and destination signalling points* connected by a single *signalling link*. To meet availability requirements this may be supplemented by additional links in parallel which may share the signalling load between them. If, for all signalling relations, the originating and destination signalling points are directly connected in this way in a network then the network operates in the *associated mode*.

For technical or economic reasons a simple associated network may not be suitable and a *quasi-associated network* may be implemented in which the information between originating and destination signalling points may be transferred via a number of signalling transfer points. Such a network may be represented by a *mesh network* such as that given in Annex A, as other networks are either a subset of the mesh network or are structured using this network or its subsets as components.

2 Network components

2.1 *Signalling links*

Signalling links are basic components in a signalling network connecting together signalling points. The signalling links encompass the *level 2* functions which provide for message error control (detection and subsequent correction). In addition, provision for maintaining the correct message sequence is provided (see Recommendation Q.703).

2.2 *Signalling points*

Signalling links connect signalling points at which signalling network functions such as message routing are provided at *level 3* and at which the user functions may be provided at *level 4* if it is also an originating or destination point (see Recommendation Q.704, § 2.4).

A signalling point that only transfers messages from one signalling link to another at level 3 serves as a signalling transfer point (STP).

The signalling links, signalling transfer points, and signalling (originating or destination) points may be combined in many different ways to form a *signalling network.*

3 Structural independence of international and national signalling networks

The worldwide signalling network is structured into two functionally independent levels, namely the international and national levels, as illustrated in Figure 1/Q.705. 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.

A signalling point (SP), including a signalling transfer point (STP), may be assigned to one of three categories:

- national signalling point (signalling transfer point) which belongs to the national signalling network only (e.g. NSP_1) and is identified by a signalling point code (OPC or DPC) according to the national numbering plan of signalling points;
- international signalling point (signalling transfer point) which belongs to the international signalling network only (e.g. ISP_3) and is identified by a signalling point code (OPC or DPC) according to the international numbering plan of signalling points;
- a node that functions both as an international signalling point (signalling transfer point) and a national signalling point (signalling transfer point) and therefore belongs to both the international signalling network and a national signalling network and accordingly is identified by a specific signalling point code (OPC or DPC) in each of the signalling networks.

If a discrimination between international and national signalling point codes is necessary at a signalling point, the national indicator is used (see Recommendation Q.704, § 12.2).

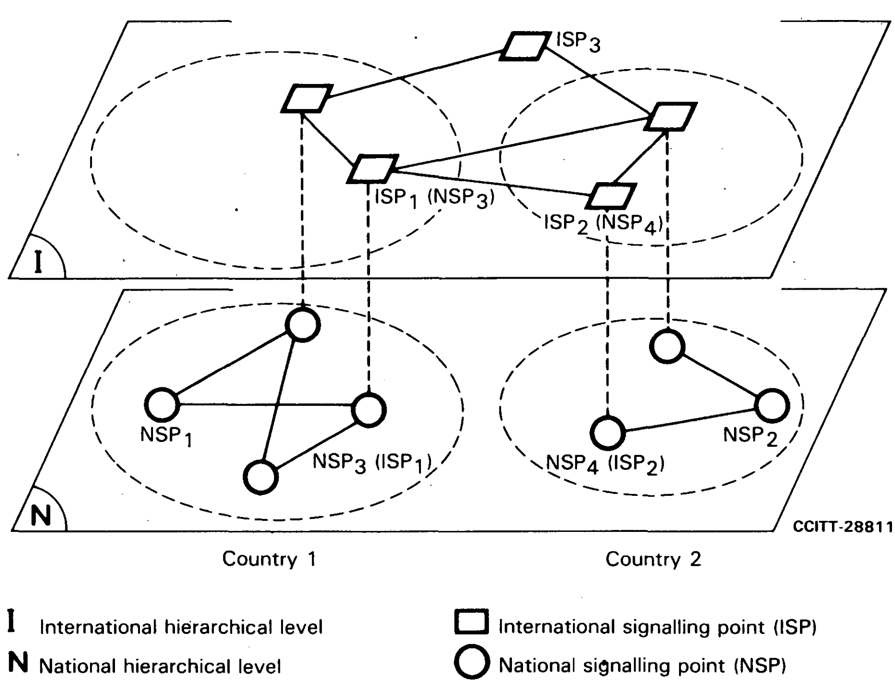


FIGURE 1/Q.705

International and national signalling networks

4 Considerations common to both international and national signalling networks

4.1 *Availability of the network*

The signalling network structure must be selected to meet the most stringent availability requirements of any User Part served by a specific network. The availability of the individual components of the network (signalling links, signalling points, and signalling transfer points) must be considered in determining the network structure.

4.2 *Message transfer delay*

In order to take account of signalling message delay considerations regard should be given, in the structuring of a particular signalling network, to the overall number of signalling links (where there are a number of signalling relations in tandem) related to a particular user transaction (e.g. to a specific call in the telephone application).

4.3 *Message sequence control*

For all messages for the same transaction (e.g. a telephone call) the Message Transfer Part will maintain the same routing provided that the same *signalling link selection* code is used in the absence of failure. However, a transaction does not necessarily have to use the same signalling route for both forward and backward messages.

4.4 *Number of signalling links used in load sharing*

The number of signalling links used to share the load of a given flow of signalling traffic typically depends on:

- the total traffic load,
- the availability of the links,
- the required availability of the path between the two signalling points concerned, and
- the bit rate of the signalling links (see Recommendation Q.706, § 5.4).

Load sharing requires at least two signalling links for all bit rates, but more may be needed at lower bit rates.

When two links are used, each of them should be able to carry the total signalling traffic in case of failure of the other link. When more than two links are used, sufficient reserve link capacity should exist to satisfy the availability requirements specified in Recommendation Q.706.

5 International signalling network

5.1 *General*

The international signalling network will use the procedures to be defined in the Signalling System No. 7 Recommendations. The international network structure to be defined can also serve as a model for the structure of national networks.

5.2 *Number of signalling transfer points in signalling relations*

In the international signalling network the number of signalling transfer points between an originating and a destination signalling point should not exceed two in a normal situation. In failure situations, this number may become three or even four for a short period of time. This constraint is intended to limit the complexity of the administration of the international signalling network.

5.3 *Numbering of signalling points*

A 14-bit code is used for the identification of signalling points. The allocation of individual signalling point codes requires further study.

5.4 *Routing rules*

(Requires further study.)

5.5 *Structures*

(Requires further study.)

5.6 *Procedures*

(Requires further study.)

6 National signalling networks

(Requires further study.)

ANNEX A

(to Recommendation Q.705)

Mesh signalling network examples

A.1 *General*

This Annex is provided to demonstrate the procedures defined in Recommendation Q.704. While the example uses a specific *mesh* network to demonstrate the procedures, it is not the intent of this annex to recommend either implicitly or explicitly the network described.

The *mesh* network is used to demonstrate the Message Transfer Part level 3 procedures because it is thought to be a possible international network implementation as shown or it, or subsets of it, may be used to construct other network structures.

A.2 *Basic network structures (example)*

Figure A-1/Q.705 shows the basic mesh network structure, while three simplified versions derived from this basic network structure are shown in Figure A-2/Q.705. More complex signalling networks can be built, using these as building components.

In the following, the basic mesh network Figure A-1/Q.705 is taken as an example to explain the procedures defined in Recommendation Q.704.

In this network, each signalling point with level 4 functions is connected by two link sets to two signalling transfer points. Each pair of signalling transfer points is connected to each other pair by four link sets. Moreover, there is a link set between the two signalling transfer points of each pair.

The simplified versions (a), (b) and (c) of the basic signalling network are obtained by deleting respectively:

a) two out of four intersignalling transfer point link sets;

b) link sets between signalling transfer points of the same pair; and

c) a) and b) together.

It should be noted that for a given signalling link availability, the more signalling link sets removed from the basic signalling network [e.g. in going from Figure A-1/Q.705 to Figure A-2c)/Q.705], the lower the availability of the signalling network. However, an increase in the availability of the simplified signalling networks may be attained by adding one or more parallel signalling links to each of the remaining signalling link sets.

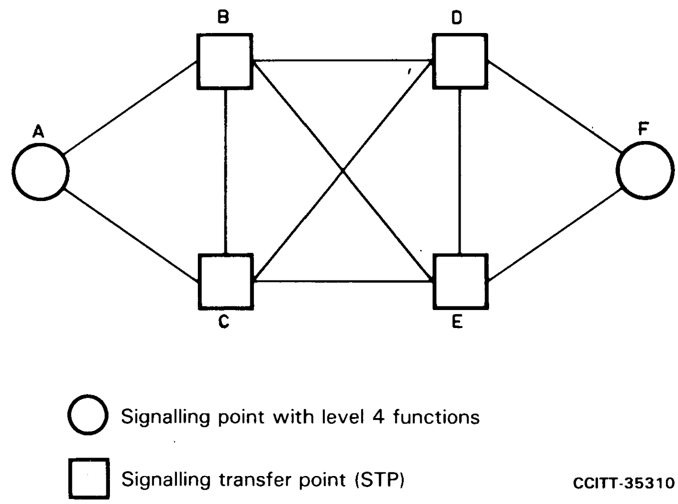


FIGURE A-1/Q.705

Basic mesh network

A.3 *Routing*

A.3.1 *General*

This section gives some routing examples in the basic mesh network in Figure A-1/Q.705. Routing actions required to change message routes under failure conditions are described in § A.4. The following routing principles are assumed for the examples in § A.3:

- Message routes should pass through a minimum number of intermediate signalling transfer points.
- Routing at each signalling point will not be affected by message routes used up to the concerned signalling transfer points.
- When more than one message route is available, signalling traffic should be load-shared by such message routes.
- Messages relating to a given user transaction and sent in a given direction will be routed over the same message route to ensure correct message sequence.

A.3.2 *Routing in the absence of failures*

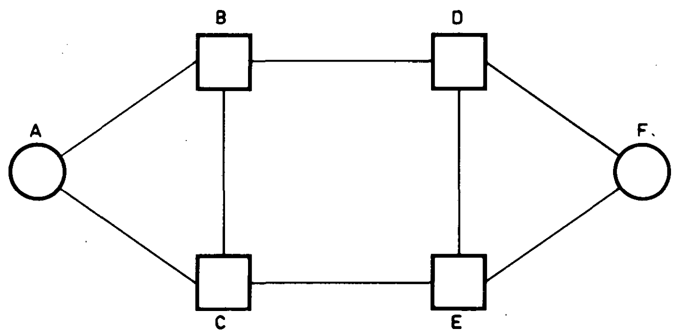
Figure A-3/Q.705 illustrates an example of routing in the absence of failures for messages from signalling point A to signalling point F.

The following points are worthy of note:

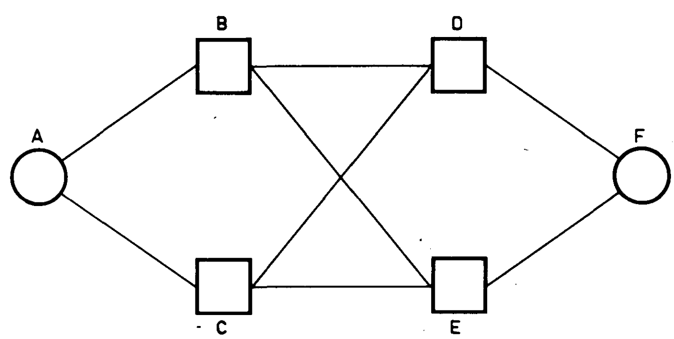
a) In distributing traffic for load-sharing at the originating signalling point and intermediate signalling transfer points, care should be taken in the use of signalling link selection (SLS) codes so that traffic will be distributed over four available routes evenly. In the example, originating signalling point A uses the second least significant bit of the signalling link selection code, and signalling transfer points B and C the least significant bit.

b) Other than that described above, the choice of a particular link for a given signalling link selection code can be made at each signalling point independently. As a result, message routes for a given user transaction (e.g. SLS = 0010) in two directions may take different paths (e.g. A → C → D → F and F → E → B → A).

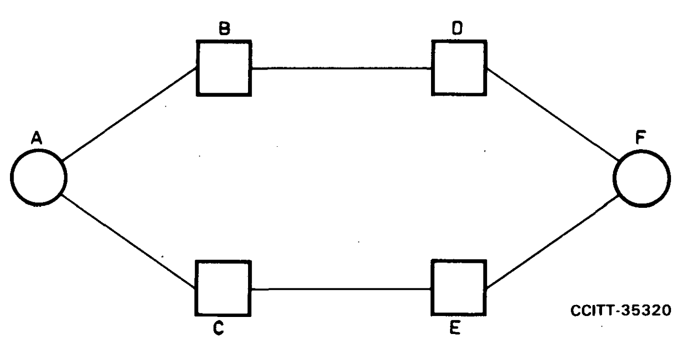
c) Links BC and DE are not used in the absence of failures. They will be used in certain failure situations described in § A.4.



a) Two out of four inter-STP link sets deleted



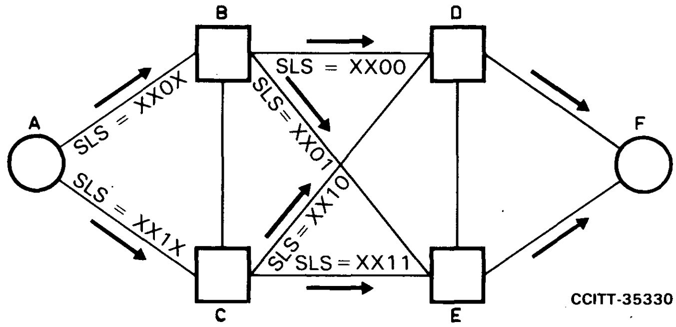
b) Link sets between STPs of the same pair deleted



c) Two out of four inter-STP link sets and link sets between STPs of the same pair deleted

FIGURE A-2/Q.705

Simplified versions of the basic mesh network



Normal message routes from A to F

— A → B → D → F (SLS = XX00)
— A → C → D → F (SLS = XX10)
— A → B → E → F (SLS = XX01)
— A → C → E → F (SLS = XX11)

SLS Signalling link selection code in the routing label
Assumption: There is only one link between adjacent signalling points

FIGURE A-3/Q.705

An example of routing in the absence of failures

A.3.3 *Routing under failure conditions*

A.3.3.1 *Alternative routing information*

In order to cope with failure conditions that may arise, each signalling point has alternative routing information which specifies, for each normal link set, alternative link set(s) to be used when the former become(s) unavailable (see Recommendation Q.704, § 4.2).

Table A-1/Q.705 gives, as an example, a list of alternative link sets for all normal link sets at signalling point A and at signalling transfer point B. In the basic mesh network, all link sets except those between signalling transfer points of the same pair are normal links which carry signalling traffic in the absence of failures. In case a normal link set becomes unavailable, signalling traffic formerly carried by that link set should be diverted to the alternative link set with priority 1. Alternative link sets with priority 2 (i.e. link sets between signalling transfer points of the same pair) will be used only when both the normal link set and alternative link set(s) with priority 1 become unavailable.

§§ A.3.3.2 to A.3.3.5 present some typical examples of the consequences of faults in signalling links and signalling points on the routing of signalling traffic. For the sake of simplicity, link sets are supposed to consist of only one link each.

TABLE A-1/Q.705

List of alternative link sets at signalling points A and B

	Normal link set	Alternative link set	Priority[a]
Signalling point A	AB	AC	1
	AC	AB	1
Signalling transfer point B	BA	BC	2
	BC	None	
	BE	BD	1
		BC	2
	BD	BE	1
		BC	2

[a] *Priority 1* — used with normal link set on load-sharing basis in the absence of failures.
Priority 2 — used only when all the link sets with priority 1 become unavailable.

A.3.3.2 *Single link failure examples*

Example 1: Failure of a link between a signalling point and a signalling transfer point (e.g. link AB) (see Figure A-4/Q.705).

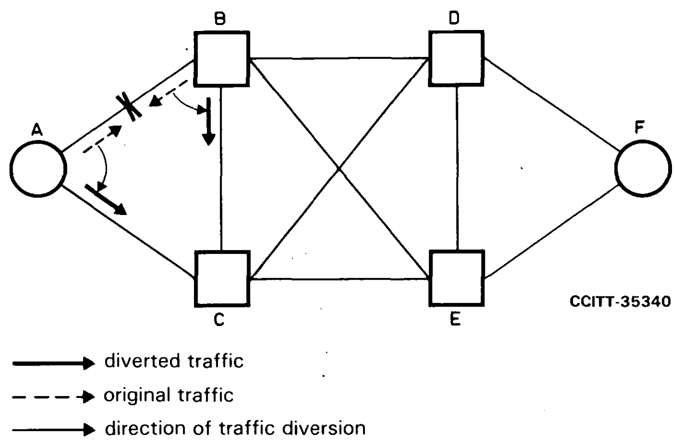


FIGURE A-4/Q.705
Failure of link AB

As indicated in Table A-1/Q.705, A diverts traffic formerly carried by link AB to link AC, while B diverts such traffic to link BC. It should be noted that the number of signalling transfer points traversed by signalling messages from F to A which passes through B is increased by one and becomes three in this case.

The principle to minimize the number of intermediate signalling transfer points in § A.3.1 is applied in this case at signalling transfer point B to get around the failure. In fact, the procedures defined in Recommendation Q.704 assume that traffic is diverted at a signalling point only in the case of a signalling link being unavailable on the route outgoing from that signalling point. Therefore, the procedures do not provide for sending an indication that traffic routed via signalling transfer point B will traverse a further signalling transfer point.

Example 2: Failure of an intersignalling transfer points link (e.g. link BD) (see Figure A-5/Q.705).

As indicated in Table A-1/Q.705, B diverts traffic carried by link BD to link BE. In the same sense, D diverts traffic carried by link DB to link DC.

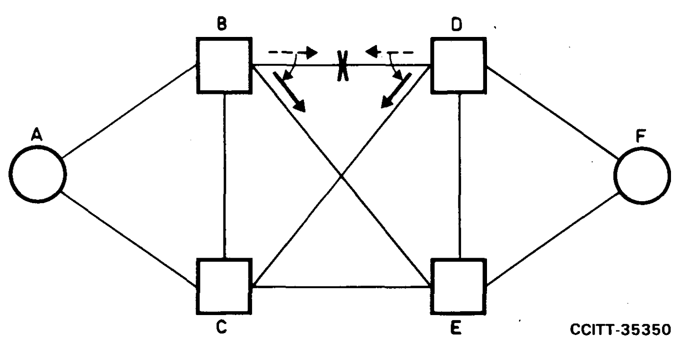


FIGURE A-5/Q.705
Failure of link BD

Example 3: Failure of a link between signalling transfer points of the same pair (e.g. link BC) (see Figure A-6/Q.705).

No routing change is required as a result of this kind of failure. Only B and C take note that the link BC has become unavailable.

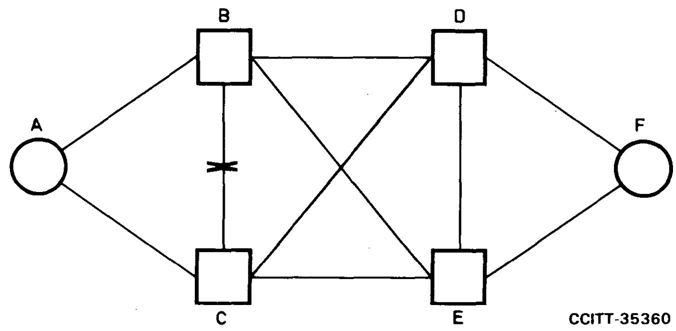


FIGURE A-6/Q.705
Failure of link BC

A.3.3.3 *Multiple link failure examples*

As there are a variety of cases in which more than one link set becomes unavailable, only some typical cases are given as examples in the following.

Example 1: Failure of a link between a signalling point and a signalling transfer point, and of the link between that signalling transfer point and that of the same pair (e.g. links DF, DE) (see Figure A-7/Q.705).

B diverts traffic destined to F from link BD to link BE, because destination F becomes inaccessible via D. It should be noted that only the traffic destined to F is diverted from link BD to link BE, and not all the traffic on link BD. The same applies to C, which diverts traffic destined to F from link CD to link CE. F diverts all the traffic formerly carried by link FD to link FE in the same way as the single link failure example in § A.3.3.2.

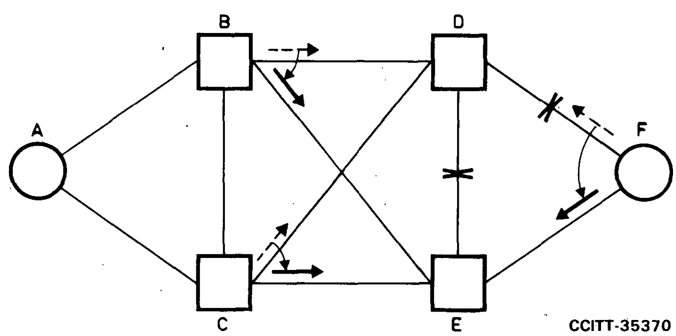


FIGURE A-7/Q.705
Failure of links DE and DF

Example 2: Failure of two intersignalling transfer point links (e.g. links BD, BE) (see Figure A-8/Q.705).

B diverts traffic formerly carried by link BD to link BC, because its alternative link set with priority 1, i.e. link BE, is also unavailable. The same applies to traffic formerly carried by link BE, and B diverts it to link BC. D and E divert traffic formerly carried by links DB and EB respectively to links DC and EC in the same way as the single link failure example in § A.3.3.2.

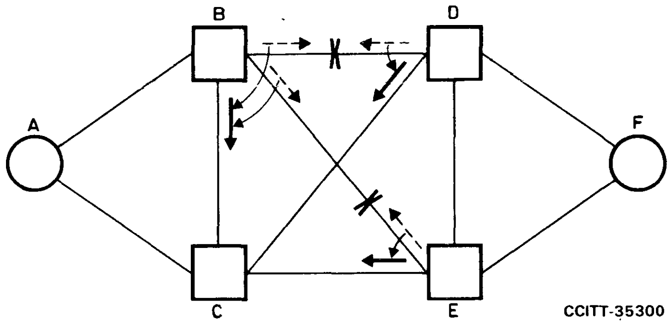


FIGURE A-8/Q.705

Failure of links BD and BE

Example 3: Failure of a link between a signalling point and a signalling transfer point, and of an intersignalling transfer point link (e.g. links DF and BD) (see Figure A-9/Q.705).

This example is a combination of Examples 1 and 2 in Section A.3.3.2. D diverts traffic formerly carried by link DF to link DE, while F diverts it to link FE. Moreover D diverts traffic formerly carried by link DB to link DC (this traffic will be that generated by signalling points other than F connected to D). In the same sense, B diverts traffic carried by link BD to link BE.

It should be noted that in this case only the portion of traffic sent by C to F via D traverses three signalling transfer points (C, D and E), while all the other portions continue to traverse two.

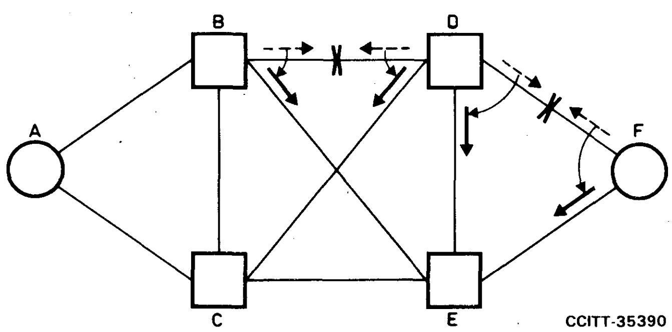


FIGURE A-9/Q.705

Failure of links BD and DF

Example 4: Failure of the two links between a signalling point and its signalling transfer points (e.g. DF and EF) (see Figure A-10/Q.705).

In this case the signalling relations between F and any other signalling point of the network are blocked. Therefore F stops all outgoing signalling traffic, while A stops only traffic destined to F.

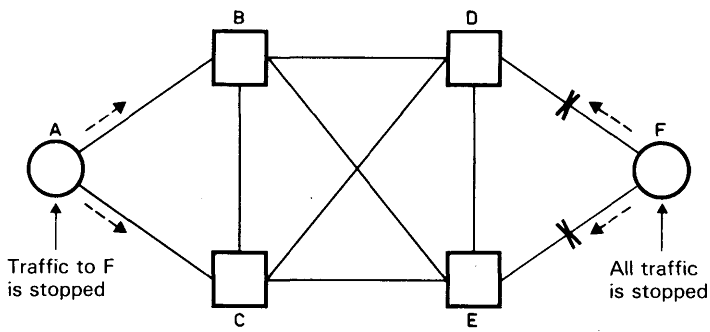


FIGURE A-10/Q.705

Failure of links DF and EF

A.3.3.4 *Single signalling point failure examples*

Example 1: Failure of a signalling transfer point (e.g. D) (see Figure A-11/Q.705).

B diverts all the traffic formerly carried by link BD to link BE. The same applies to C which diverts all the traffic carried by link CD to link CE. Originating point F diverts all the traffic carried by link FD to link FE as in the case of the link FD failure (see Example 1 in § A.3.3.2).

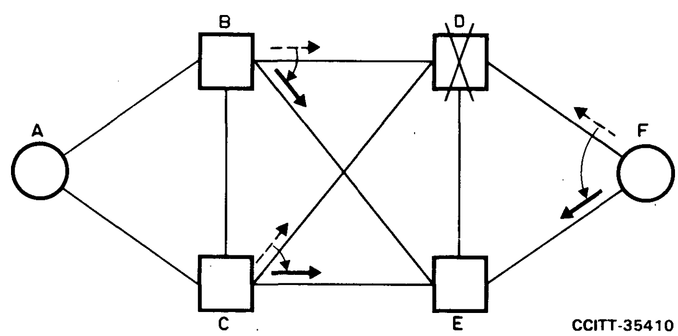


FIGURE A-11/Q.705

Failure of signalling transfer point D

Attention is drawn to the difference to Example 1 in § A.3.3.3 where only a part of the traffic previously carried by links BD and CD was diverted.

Example 2: Failure of a destination point (e.g. F) (see Figure A-12/Q.705).

In this case A stops all the traffic to F formerly carried on links AB and AC.

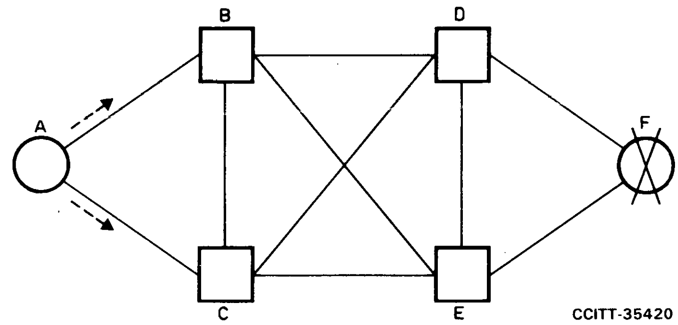


FIGURE A-12/Q.705

Failure of signalling point F

A.3.3.5 *Multiple signalling transfer point failure examples*

Two typical cases of two signalling transfer points failing together are presented in the following examples.

Example 1: Failure of two signalling transfer points not pertaining to the same pair (e.g. B and D) (see Figure A-13/Q.705).

As a result of the failure of B, A diverts traffic formerly carried by link AB to link AC, while E diverts traffic formerly carried by link EB to link EC. Similarly as a result of the failure of D, F diverts traffic formerly carried by link FD to link FE, while C diverts traffic formerly carried by link CD to link CE.

It should be noted that, in this example, all the traffic between A and F is concentrated on only one intersignalling transfer point link, since failure of a signalling transfer point has an effect similar to a simultaneous failure of all the signalling links connected to it.

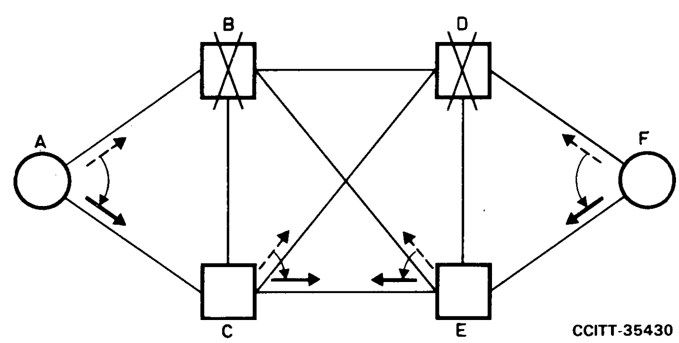


FIGURE A-13/Q.705

Failure of signalling transfer points B and D

Example 2: Failure of two signalling transfer points pertaining to the same pairs (e.g. D and E) (see Figure A-14/Q.705).

This example is equivalent to Example 4 in § A.3.3.3 as far as the inaccessibility of F is concerned, but in this case any other signalling point connected by its links to D and E also becomes inaccessible. In this case A stops signalling traffic destined to F, while F stops all outgoing signalling traffic.

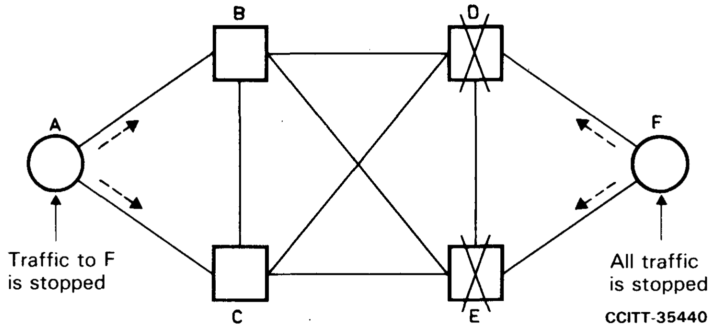


FIGURE A-14/Q.705

Failure of signalling transfer points D and E

A.4 *Actions relating to failure conditions*

In the following, four typical examples of the application of signalling network management procedures to the failure cases illustrated in § A.3.3 are shown. In the case of multiple failures, an arbitrary failure (and restoration) sequence is assumed for illustrative purpose.

A.4.1 *Example 1: Failure of a link between a signalling point and a signalling transfer point (e.g. link AB)* (see Figure A-15/Q.705)

(Same as § A.3.3.2, Example 1.)

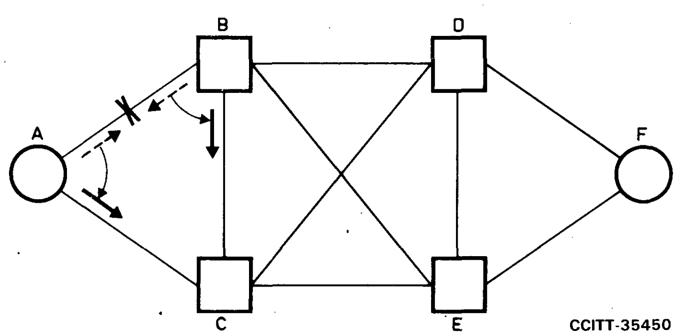


FIGURE A-15/Q.705

Failure of link AB

A.4.1.1 *Failure of link AB*

a) When the failure of link AB is detected in A and in B, they initiate the changeover procedure, by exchanging changeover messages via C. Once buffer updating is completed, A restarts the traffic originally carried by the failed link on link AC; similarly, B restarts traffic destined to A on link BC.

b) In addition, B sends a transfer-prohibited message to C referred to destination A (according to the criterion indicated in Recommendation Q.704, § 11.2.2).

c) On the reception of the transfer-prohibited message, C sends a transfer-prohibited acknowledgement and starts the periodic sending of signalling-route-set-test messages, referred to A, to B (see Recommendation Q.704, § 11.4.2).

A.4.1.2 *Restoration of link AB*

When the restoration of link AB is completed, the following applies:

a) B initiates the changeback procedure, by sending a changeback declaration to A via C. Once it has received the changeback acknowledgement, it restarts traffic on the restored link. Moreover, it sends to C a transfer-allowed message, referred to destination A (see Recommendation Q.704, § 11.3.2). When C receives the transfer-allowed message, it stops sending signalling-route-set-test messages to B.

b) A initiates the changeback procedure, by sending a changeback declaration to B via C; once it has received the changeback acknowledgement, it restarts traffic on the normal link. The only traffic to be diverted is that for which link AB is the normal link set according to the load sharing rule (see § A.3.3.1). Moreover A sends to B signalling-route-set-test messages, referred to the destination points that it normally accesses via B.

A.4.2 *Example 2: Failure of signalling transfer point D* (see Figure A-16/Q.705)

(Same as § A.3.3.4, Example 1.)

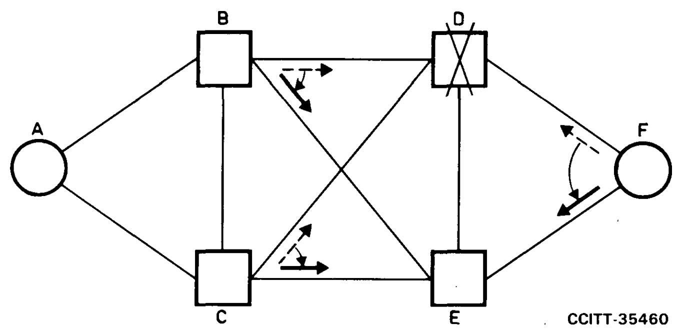


FIGURE A-16/Q.705
Failure of signalling transfer point D

A.4.2.1 *Failure of signalling transfer point D*

a) Changeover is initiated at signalling points B, C and F from blocked links BD, CD and FD to the first priority alternative links BE, CE and FE respectively. Due to the failure of D, the concerned signalling points will receive no changeover message in response, and therefore they will restart traffic on alternative links at the expiry of the time T2 (see Recommendation Q.704, § 5.7.2). In addition, E will send to B, C and F transfer-prohibited messages referred to destination D. These signalling points (B, C and F) will thus start periodic sending to E of signalling-route-set-test messages referred to D.

b) When B receives a transfer-prohibited message from E referred to D, it updates its routing information so that traffic to D will be diverted to C, thus sending a transfer-prohibited message to C referred to D. The same applies to C, and C sends a transfer-prohibited message to B.

c) So, when B receives a transfer-prohibited message from C, it finds that destination D has become inaccessible and sends a transfer-prohibited message to A. The same applies to C and thus C also sends a transfer-prohibited message to A. Having received transfer-prohibited messages from both B and C, A recognizes that D has become inaccessible and stops traffic to D.

d) In the same manner, i.e. link-by-link transmission of transfer-prohibited messages referred to D, other signalling points B, C, E and F will finally recognize that destination D has become inaccessible. Each signalling point will, therefore, start periodic sending of signalling-route-set-test messages referred to D to their respective adjacent signalling points.

A.4.2.2 *Recovery of signalling transfer point*

a) Changeback at signalling points B, C and F from the alternative to the normal links is performed. In all the three cases changeback includes the time-controlled diversion procedure (see Recommendation Q.704, § 6.4), since D is still inaccessible via E at B, C and F (as a result of previous reception of transfer-prohibited message from E).

b) E sends to B, C and F transfer-allowed messages referred to destination D. These signalling points will thus send transfer allowed messages to their respective adjacent signalling points. Thus, the link-by-link transmission of transfer-allowed messages will declare to all signalling points that destination D has become accessible.

c) On reception of a transfer-allowed message, each signalling point stops periodic sending of signalling-route-set-test messages to their respective adjacent signalling points.

d) On recovery of previously unavailable links BD, CD and FD, B, C and F will send a signalling-route-set-test message to D, referred to the destination points that they normally access via D.

A.4.3 *Example 3: Failure of link between a signalling point and a signalling transfer point, and of the link between that signalling transfer point and that of the same pair (e.g. links DF, DE)* (see Figure A-17/Q.705.)

(Same as § A.3.3.3 Example 1.)

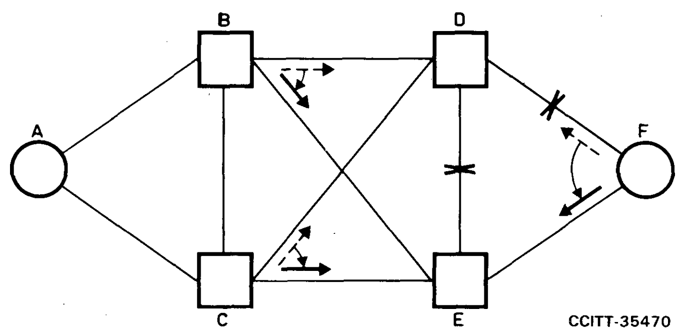


FIGURE A-17/Q.705

Failure of links DE and DF

A.4.3.1 *Failure of link DE*

On failure of link DE, this link is marked unavailable at both signalling transfer points D and E. Since in the absence of failures, link DE does not carry signalling traffic, no change in message routing takes place at this time.

However, D and E send to signalling points B, C and F transfer-prohibited messages referred to destination E or D respectively. These signalling points will thus start periodic sending of signalling-route-set-test messages, referred to D or E, to E and D respectively.

A.4.3.2 *Failure of link DF in the presence of failure of link DE*

a) On failure of link DF the following actions occur:

   i) Signalling point D which no longer has access to signalling point F indicates this condition to signalling transfer points B and C by sending transfer-prohibited messages. B and C will thus start the periodic sending of signalling-route-set-test messages referred to F, to D.

   ii) Emergency changeover from link FD to link FE is initiated at signalling point F, since D becomes inaccessible to F due also to the previous failure.

b) On receiving the transfer-prohibited messages forced rerouting is initiated at points B and C. This causes traffic destined to F to be diverted from links terminating on D to links terminating on E. Forced rerouting thus permits recovery from a failure condition caused by a fault in a remote part of the network.

A.4.3.3 *Restoration of link FD in the presence of failure of link DE*

a) On recovery of link FD the following actions occur:

i) Signalling point D sends a transfer-allowed message to B and C to indicate that D once again has access to F. B and C will thus stop the sending of signalling-route-set-test messages referred to F to D.

ii) F initiates changeback with time controlled diversion from link FE to link FD. This procedure permits changeback to be executed at one end of a link, when it is impossible to notify the other end of the link (in this example, because link DE is unavailable). Traffic in this case is not diverted from the alternative link until the time interval T4, tentatively set at one second, has elapsed, in order to minimize the danger of mis-sequencing of messages (see Recommendation Q.704, § 6.4. In addition, F sends to D a signalling-route-set-test message referred to the destinations that it normally accesses via D.

b) On receiving the transfer-allowed message, controlled re-routing of traffic from the alternative routes (BEF, CEF) to the normal routes (BDF, CDF) is initiated at points B and C. Controlled rerouting involves diversion of traffic to a route which has become available after a time interval (see Recommendation Q.704, § 8.2.1 provisionally set at one second to minimize the danger of mis-sequencing messages.

A.4.3.4 *Restoration of link DE*

On recovery of link DE it is marked available at signalling transfer points D and E. Signalling points D and E send to B, C and F transfer-allowed messages referred to destination E or D respectively. These signalling transfer point will thus stop sending of signalling-route-set-test messages.

A.4.4 *Example 4: Failure of links DF and EF* (see Figure A-18/Q.705)

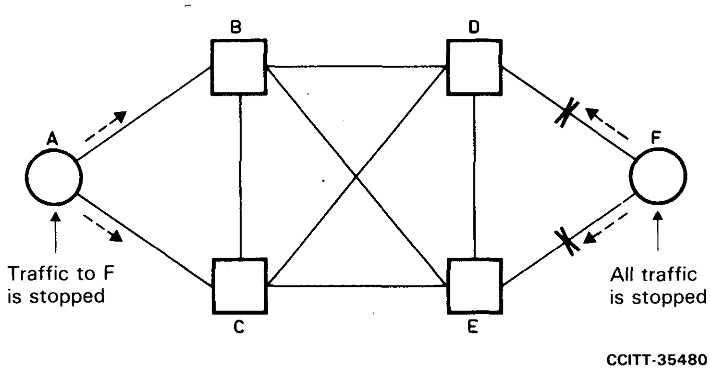


FIGURE A-18/Q.705

Failure of links DF and EF

A.4.4.1 *Failure of link DF*

When the failure of link DF is detected, D and F perform the changeover procedure; D diverts traffic, destined to F, to link DE, while F concentrates all the outgoing traffic on link FE.

In addition, D sends to E a transfer-prohibited message, referred to destination F; E will thus start sending of signalling-route-set-test messages, referred to F, towards D (see also § A.4.1.1).

A.4.4.2 *Failure of link EF in the presence of failure of link DF*

a) When the failure of link EF is detected, the following applies:

i) Since all destinations become inaccessible F stops sending all signalling traffic.

ii) E sends to B, C and D a transfer-prohibited message, referred to destination F. B, C and D start periodic sending of signalling-route-set-test messages referred to F to E.

b) When D receives the transfer-prohibited message, it sends to B and C a transfer-prohibited message, referred to destination F (see Recommendation Q.704, § 11.2.2). B and C start periodic sending of test messages referred to F to D.

c) When B receives the transfer-prohibited messages from D and E, it sends a transfer-prohibited message to C; the same applies for C (it sends the message to B). As soon as B and C have received the transfer-prohibited messages from all the three possible routes (BD, BE and BC, or CD, CE and CB respectively), they send a transfer-prohibited message to A.

Note – Depending on the sequence of reception of transfer-prohibited messages at B or C, they may start a forced rerouting procedure on a route not yet declared to be unavailable; such procedure is then aborted as soon as a transfer-prohibited message is received also from that route.

d) As soon as A receives the transfer-prohibited messages from B and C, it declares destination F inaccessible and stops sending traffic towards it. Moreover, it starts the periodic sending of signalling-route-set-test messages, referred to F, to B and C.

A.4.4.3 *Restoration of link EF in the presence of failure on link DF*

a) When restoration of link EF is completed, the following applies:

i) F sends to E a signalling-route-set-test message, referred to the destination points it can normally access via E, and it restarts traffic on link EF.

ii) E sends a transfer-allowed message, referred to destination F, to B, C and D; moreover it restarts traffic on the restored link.

b) When B and C receive the transfer-allowed message, they send a transfer-allowed message to A and C or A and B, respectively and they stop sending signalling-route-set-test messages to E; moreover, they restart the concerned traffic on link BE or CE respectively.

c) When D receives the transfer-allowed message from E, it sends transfer-allowed messages to B and C and stops sending signalling-route-set-test messages to E; moreover, it starts the concerned traffic on link DE. On receipt of the transfer-allowed message, B and C will divert to links BD and CD, by means of a controlled rerouting procedure, traffic carried by links BE and CE for which they are the normal links (see § A.3.3). Moreover, they will stop sending signalling-route-set-test messages to D.

Note – According to the rules stated in Recommendation Q.704, § 11.3.2, on receipt of transfer-allowed messages from E [phase b) above], B and C should send transfer-allowed messages also to D and E. However, this is not appropriate in the network configurations such as the one here considered, taking into account that:

– there is no route, for example, from D (or E) to F via B (or C) and therefore the transfer-allowed messages would be ignored (although acknowledged) by D and E;

– on restarting traffic to F on links BD, BE, CD and CE it would anyway be necessary that B and C send transfer-prohibited- messages to D and E, which would contradict the previous transfer-allowed messages.

d) As soon as A receives a transfer-allowed message from B or C, it restarts signalling traffic to B and C. If traffic has already been restarted on one link when the transfer-allowed message is received on the other link, a changeback procedure is performed to establish the normal routing situation on both links (i.e. to divert part of the traffic on the latter link).

A.4.4.4 *Restoration of link DF*

When the restoration of link DF is completed, the following applies:

a) D initiates the changeback procedure to link DF; moreover, it sends to E a transfer-allowed message, referred to destination F,

b) F sends a signalling-route-set-test message to D referred to the destination points it normally accesses via D. It initiates the changeback procedure to link DF; this procedure refers only to the traffic for which link DF is the normal one, according to the routing rules.

A.5 *Explanatory note from the implementors forum for clarification of load sharing*

A.5.1 In general, to improve the distribution of traffic, load sharing at a particular signalling point (amongst link sets to a given destination) will be on the basis of a part of the signalling link selection field which is different than that part used for load sharing amongst signalling links within a selected link set. In the example represented in Figure 5/Q.704, if link set DF contains more than one signalling link, then the least significant bit of the signalling link selection field is not used in sharing traffic within link set DF amongst the signalling links. Similar considerations can apply to link set DE.

A.5.2 At an originating signalling point it is assumed that for a given signalling relation, signalling link selection field values are evenly distributed and traffic is shared over the appropriate link sets and signalling links within each link set on this basis. In general, to achieve this a different load sharing rule is needed for each number of link sets, and each number of signalling links within a link set, over which traffic is to be shared. The intention is to attain, for a given signalling relation, as even as possible a traffic balance over the link sets, and the signalling links within each link set, based on the signalling link selection field and the numbers of link sets and signalling links within each link set; such an even traffic balance may result if the fixed part of the signalling link selection field is not excluded from consideration by the load sharing rules.

A.5.3 At a signalling transfer point, for a given signalling relation, signalling link selection field values may not be evenly distributed (see Figure 5/Q.704, signalling transfer point E). A different set of load sharing rules to those for originating signalling points may be provided to deal with this possibility. These are again based on the signalling link selection field and the numbers of link sets and signalling links within each link set, but assume that a particular part of the signalling link selection field is fixed. The fixed part of the signalling link selection field may be different at different signalling transfer points. Where signalling messages for different signalling relations arriving at a particular signalling transfer point do not have the same part of the signalling link selection field fixed, an uneven sharing of traffic for a particular signalling relation amongst the relevant link sets and signalling links within each link set may result.

Recommendation Q.706

MESSAGE TRANSFER PART SIGNALLING PERFORMANCE

The message transfer part of Signalling System No. 7 is designed as a joint transport system for the messages of different users. The requirements of the different users have to be met by the Message Transfer Part. These requirements are not necessarily the same and may differ in importance and stringency.

In order to satisfy the individual requirements of each user the Message Transfer Part of Signalling System No. 7 is designed in such a way that it meets the most stringent User Part requirements envisaged at the time of specification. To this end, the requirements of the telephone service, the data transmission service and the signalling network management, in particular, were investigated. It is assumed that a signalling performance which satisfies the requirements mentioned above will also meet those of future users.

In the light of the above, signalling system performance is understood to be the capability of the Message Transfer Part to transfer messages of variable length for different users in a defined manner. In order to achieve a proper signalling performance, three groups of parameters have to be taken into account:

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

The three groups of parameters are considered in the specification of the procedures to enable the Message Transfer Part to transfer the messages in such a way that the signalling requirements of all users are met and that a uniform and satisfactory overall signalling system performance is achieved.

1 Basic parameters related to Message Transfer Part signalling performance

Signalling performance is defined by a great number of different parameters. In order to ensure a proper signalling performance for all users to be served by the common Message Transfer Part, the following design objectives are established for the Message Transfer Part.

1.1 *Unavailability of a signalling route set*

The unavailability of a signalling route set is determined by the unavailability of the individual components of the signalling network (signalling links and the signalling points) and by the structure of a signalling network.

The unavailability of a signalling route set should not exceed a total of 10 minutes per year.

The unavailability of a signalling route set within a signalling network may be improved by replication of signalling links, signalling paths and signalling routes.

1.2 *Unavoidable message transfer part malfunction*

The Message Transfer Part of Signalling System No. 7 is designed to transport messages in a correct sequence. In addition, the messages are protected against transmission errors. However, a protection against transmission errors cannot be absolute. Furthermore, mis-sequencing and loss of messages in the Message Transfer Part cannot be excluded in extreme cases.

For all User Parts, the following conditions are guaranteed by the Message Transfer Part:

a) *Undetected errors*

On a signalling link employing a signalling data link which has the error rate characteristic as described in Recommendation Q.702 not more than one in 10^{10} of all signal unit errors will be undetected by the message Transfer Part.

b) *Loss of messages*

Not more than one in 10^7 messages will be lost due to failure in the message transfer part.

c) *Messages out-of-sequence*

Not more than one in 10^{10} messages will be delivered out-of-sequence to the User Parts due to failure in the message transfer part. This value also includes duplication of messages.

1.3 *Message transfer times*

This parameter includes:

- handling times at the signalling points (see § 4.3);
- queueing delays including retransmission delays (see § 4.2);
- signalling data link propagation times.

1.4 *Signalling traffic throughput capability*

Needs further study (see § 2.2).

2 Signalling traffic characteristics

2.1 *Labelling potential*

The design of Signalling System No. 7 provides the potential for labels to identify 16 384 signalling points. For each of the 16 different User Parts a number of user transactions may be identified, e.g. in the case of the telephone service up to 4096 speech circuits.

2.2 *Loading potential*

Considering that the load per signalling channel will vary according to the traffic characteristics of the service, to the user transactions served and to the number of signals in use, it is not practicable to specify a general maximum limit of user transactions that a signalling channel can handle. The maximum number of user transactions to be served must be determined for each situation, taking into account the traffic characteristics applied so that the total signalling load is held to a level which is acceptable from different points of view.

When determining the normal load of the signalling channel, account must be taken of the need to ensure a sufficient margin for peak traffic loads.

The loading of a signalling channel is restricted by several factors which are itemized below.

2.2.1 *Queueing delay*

The queueing delay in absence of disturbances is considerably influenced by the distribution of the message length and the signalling traffic load (see § 4.2).

2.2.2 *Security requirements*

The most important security arrangement is redundancy in conjunction with changeover. As load sharing is applied in normal operation, the load on the individual signalling channels has to be restricted so that, in the case of changeover, the queueing delays do not exceed a reasonable limit. This requirement has to be met not only in the case of changeover to one predetermined link but also in the case of load distribution to the remaining links.

2.2.3 *Capacity of sequence numbering*

The use of 7 bits for sequence numbering finally limits the number of signal units sent but not yet acknowledged to the value of 127.

In practice this will not impose a limitation on the loading potential.

2.2.4 *Signalling channels using lower bit rates*

A loading value for a signalling channel using bit rates of less than 64 kbit/s will result in greater queueing delays than the same loading value for a 64-kbit/s signalling channel.

2.3 *Structure of signalling traffic*

The Message Transfer Part of Signalling System No. 7 serves different User Parts as a joint transport system for messages. As a result, the structure of the signalling traffic largely depends on the types of User Parts served. It can be assumed that at least in the near future the telephone service will represent the main part of the signalling traffic also in integrated networks.

It cannot be foreseen yet how the signalling traffic is influenced by the integration of existing and future services. The traffic models given in § 4.2.4 have been introduced in order to consider as far as possible the characteristics and features of different services within an integrated network. If new or more stringent requirements are imposed on signalling (e.g. shorter delays) as a consequence of future services, they should be met by appropriate dimensioning of the load or by improving the structure of the signalling network.

3 **Parameters related to transmission characteristics**

No special transmission requirements are envisaged for the signalling links of Signalling System No. 7. Therefore, System No. 7 provides appropriate means in order to cope with the given transmission characteristics of ordinary links. The following items indicate the actual characteristics to be expected – as determined by the responsible Study Groups – and their consequences on the specifications of the Signalling System No. 7 Message Transfer Part.

3.1 *Application of Signalling System No. 7 to 64-kbit/s links*

The Message Transfer Part is designed to operate satisfactorily with the following transmission characteristics:

a) a long-term bit error rate of the signalling data link of less than 10^{-6} [1];

b) a medium-term bit error rate of less than 10^{-4};

c) random errors and error bursts including long bursts which might occur in the digital link due to, for instance, loss of frame alignment or octet slips in the digital link. The maximum tolerable interruption period is specified for the signal unit error rate monitor (see Recommendation Q.703, § 8.2).

3.2 *Application of Signalling System No. 7 to links using lower bit rates*

(Needs further study.)

4 **Parameters of influence on signalling performance**

4.1 *Signalling network*

Signalling System No. 7 is designed for both associated and nonassociated applications. The reference section in such applications is the signalling route set, irrespective of whether it is served in the associated or quasi-associated mode of operation.

For every signalling route set in a signalling network, the unavailability limit indicated in § 1.1 has to be observed irrespective of the number of signalling links in tandem of which it is composed.

4.1.1 *International signalling network*

(Needs further study.)

4.1.2 *National signalling network*

(Needs further study.)

4.2 *Queueing delays*

The Message Transfer Part handles messages from different User Parts on a time-shared basis. With time-sharing, signalling delay occurs when it is necessary to process more than one message in a given interval of time. When this occurs, a queue is built up from which messages are transmitted in order of their times of arrival.

There are two different types of queueing delays: queueing delay in the absence of disturbances and total queueing delay.

4.2.1 *Assumptions for derivation of the formulas*

The queueing delay formulas are basically derived from the $M/G/1$ queue with priority assignment. The assumptions for the derivation of the formulas in the absence of disturbances are as follows:

a) the interarrival time distribution is exponential (M);

b) the service time distribution is general (G);

c) the number of server is one (1);

d) the service priority refers to the transmission priority within level 2 (see Recommendation Q.703, § 10.2); however, the link status signal unit and the independent flag are not considered;

e) the signalling link loop propagation time is constant including the process time in signalling terminals; and

f) the forced retransmission case of the preventive cyclic retransmission method is not considered.

In addition, for the formulas in the presence of disturbances, the assumptions are as follows:

g) the transmission error of the message signal unit is random;

h) the errors are statistically independent of each other;

i) the additional delay caused by the retransmission of the erroneous signal unit is considered as a part of the waiting time of the concerned signal unit; and

j) in case of the preventive cyclic retransmission method, after the error occurs, the retransmitted signal units of second priority are accepted at the receiving end until the sequence number of the last sent new signal unit is caught up by that of the last retransmitted signal unit.

Furthermore, the formula of the proportion of messages delayed more than a given time is derived from the assumption that the probability density function of the queueing delay distribution may be exponentially decreasing where the delay time is relatively large.

4.2.2 *Factors and parameters*

a) The notations and factors required for calculation of the queueing delays are as follows:

Q_a mean queueing delay in the absence of disturbances

σ_a^2 variance of queueing delay in the absence of disturbances

Q_t mean total queueing delay

σ_t^2 variance of total queueing delay

$P(T)$ proportion of messages delayed more than T

a traffic loading by message signal units (MSU) (excluding retransmission)

T_m mean emission time of message signal units

T_f emission time of fill-in signal units

T_L signalling loop propagation time including processing time in signalling terminal

P_u error probability of message signal units

$$k_1 = \frac{\text{2nd moment of message signal units emission time}}{T_m^2}$$

$$k_2 = \frac{\text{3rd moment of message signal units emission time}}{T_m^3}$$

Note — As a consequence of zero insertion at level 2 (see Recommendation Q.703, § 3.2), the length of the emitted signal unit will be increased by approximately 1.6 percent on average. However, this increase has negligible effect on the calculation.

b) The parameters used in the formulas are as follows:

$$t_f = T_f / T_m$$

$$t_L = T_L / T_m$$

for the basic method,

$$E_1 = 1 + P_u t_L$$

$$E_2 = k_1 + P_u t_L (t_L + 2)$$

$$E_3 = k_2 + P_u t_L (t_L^2 + 3t_L + 3k_1)$$

for the preventice cyclic retransmission (PCR) method,

$a_3 = \exp(-a t_L)$: traffic loading caused by fill-in signal units

$$a_z = \frac{a_3}{1-a}$$

$$t_{aL} = \frac{at_L}{1-a}$$

$$F = 1 + \frac{P_u t_{aL}}{2}$$

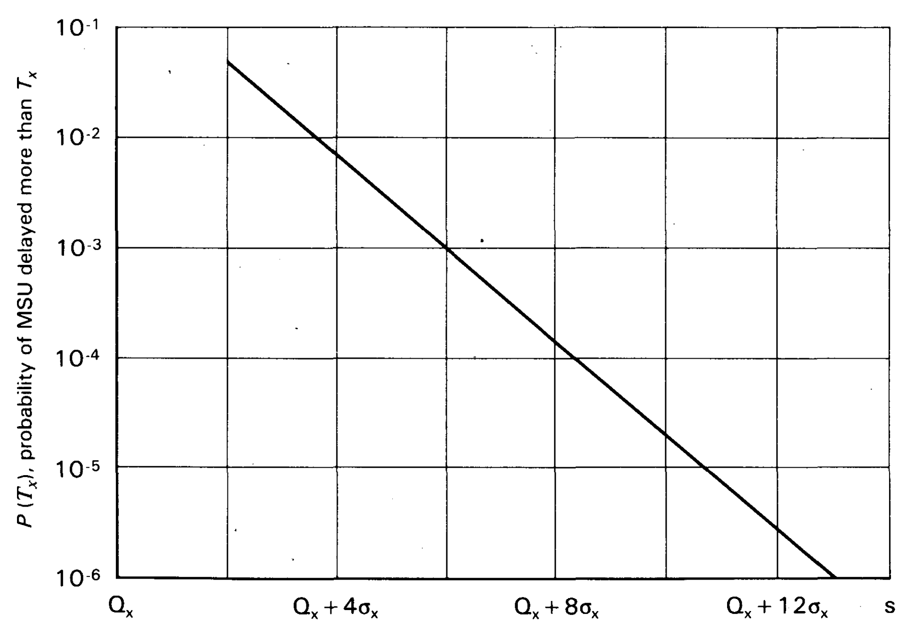
$$\varepsilon = P_u \frac{Fa^3}{(1-2a)(1-2aF)} t_L$$

4.2.3 *Formulas*

The formulas of the mean and the variance of the queueing delays are described in Table 1/Q.706. The proportion of messages delayed more than a given time T_x is:

$$P(T_x) \simeq \exp\left(-\frac{T_x - Q_x + \sigma_x}{\sigma_x}\right)$$

where Q_x and σ_x denote the mean and the standard deviation of queueing delay, respectively. This approximation is better suited in absence of disturbances. In presence of disturbances the actual distribution may be deviated further. Relation between $P(T_x)$ and T_x is shown in Figure 1/Q.706.



Q_x Mean queueing delay (see Figure 2/Q.706)
σ_x Standard deviation (see Figure 3/Q.706)

FIGURE 1/Q.706

Probability of message signal unit delayed more than T_x

TABLE 1/Q.706

Queueing delay formula

Error correction method	Disturbance	Mean Q	Variance σ^2
Basic	Absence	$\frac{Q_a}{T_m} = \frac{t_f}{2} + \frac{ak_1}{2(1-a)}$	$\frac{\sigma_a^2}{T_m^2} = \frac{t_f^2}{12} + \frac{a[4k_2 - (4k_2 - 3k_1^2)a]}{12(1-a)^2}$
	Presence	$\frac{Q_t}{T_m} = \frac{t_f}{2} + \frac{aE_2}{2(1-aE_1)} + E_1 - 1$	$\frac{\sigma_t^2}{T_m^2} = \frac{t_f^2}{12} + \frac{a[4E_3 - (4E_1E_3 - 3E_2^2)a]}{12(1-a)^2} + P_u(1-P_u)t_L^2$
Preventive cyclic retransmission	Absence	$\frac{Q_a}{T_m} = \frac{k_1 + a_z(t_f - k_1)}{2} + \frac{ak_1}{2(1-a)}$	$\frac{\sigma_a^2}{T_m^2} = \frac{4k_2 - 3k_1^2}{12} + a_z\left(\frac{4-3a_z}{12}t_f^2 + \frac{a_z - 1}{2}k_1t_f + k_1^2\frac{2-a_z}{4} - \frac{k_2}{3}\right) + \frac{a[4k_2 - (4k_2 - 3k_1^2)a]}{12(1-a)^2}$
	Presence	$\frac{Q_t}{T_m} = \frac{1+\varepsilon}{2(1-aF)}\left[\frac{aP_ut_{aL}}{6}(2t_{aL} + 3k_1) + k_1\right] + F - 1$	(For further study)

4.2.4 *Examples*

Assuming the traffic models given in Table 2/Q.706, examples of queueing delays are calculated as listed in Table 3/Q.706.

TABLE 2/Q.706

Traffic model

Model	A	B	
Message length (bits)	120	104	304
Percent	100	92	8
Mean message length (bits)	120	120	
k_1	1.0	1.2	
k_2	1.0	1.9	

TABLE 3/Q.706

List of examples

Figure	Error control	Queueing delay	Disturbance	Model
2/Q.706	Basic/PCR	Mean	Absence	A and B
3/Q.706	Basic/PCR	Standard deviation	Absence	A and B
4/Q.706	Basic	Mean	Presence	A
5/Q.706	Basic	Standard deviation	Presence	A
6/Q.706	PCR	Mean	Presence	A

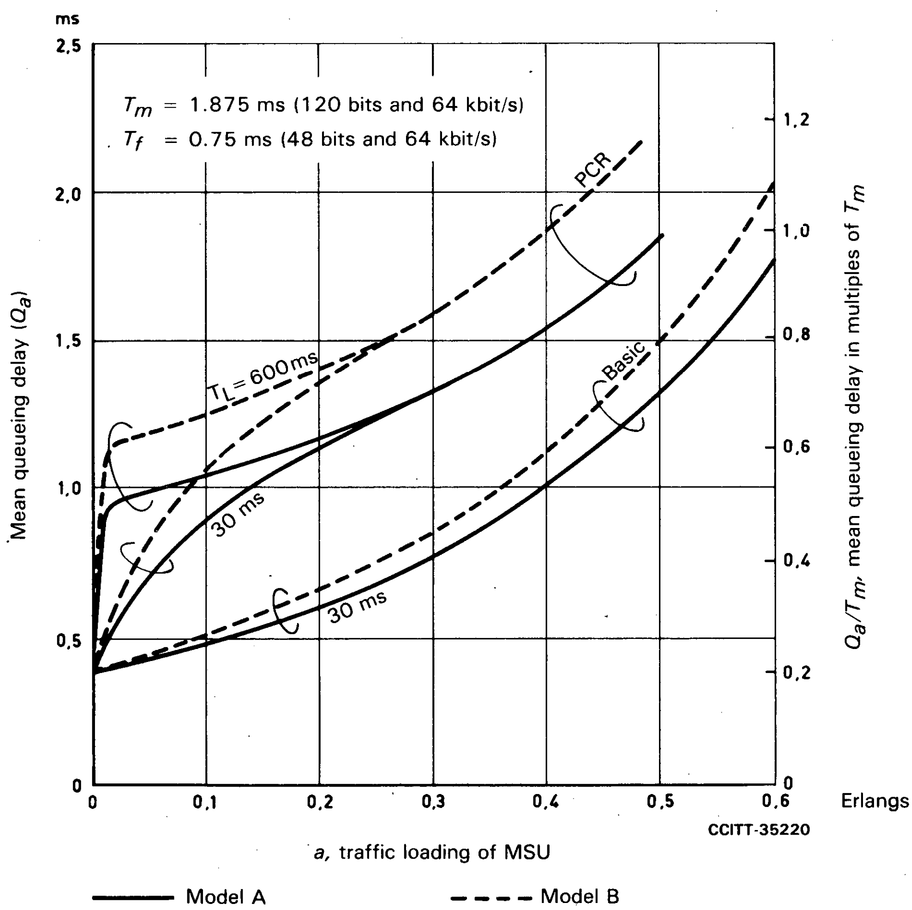


FIGURE 2/Q.706

Mean queueing delay of each channel of traffic in absence of disturbance

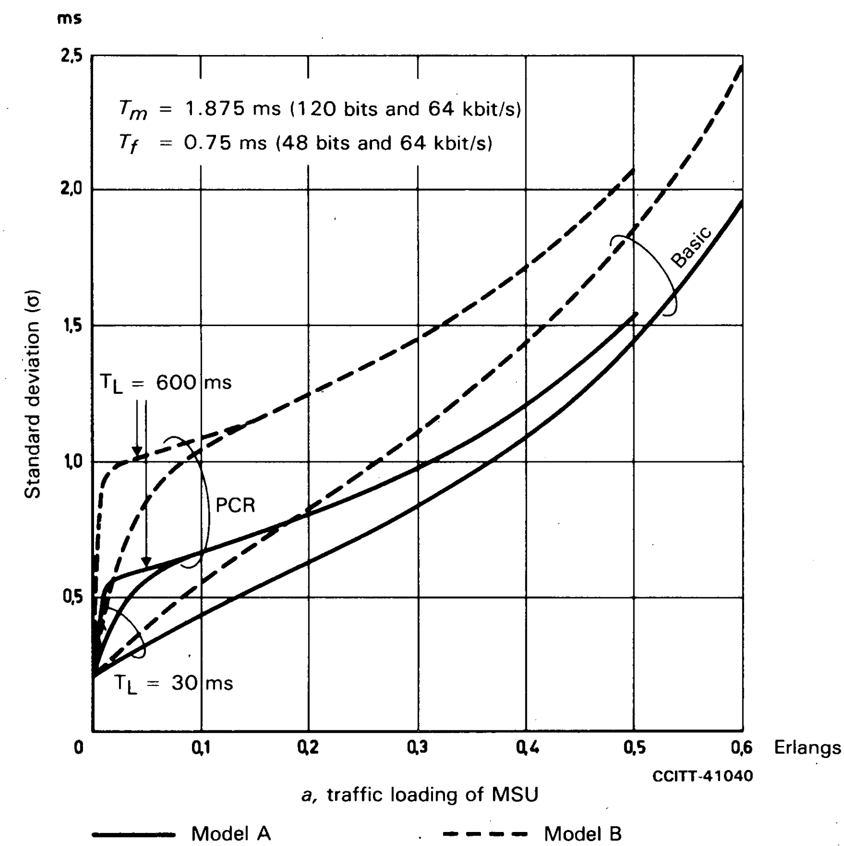


FIGURE 3/Q.706

Standard deviation of queueing delay of each channel of traffic in absence of disturbance

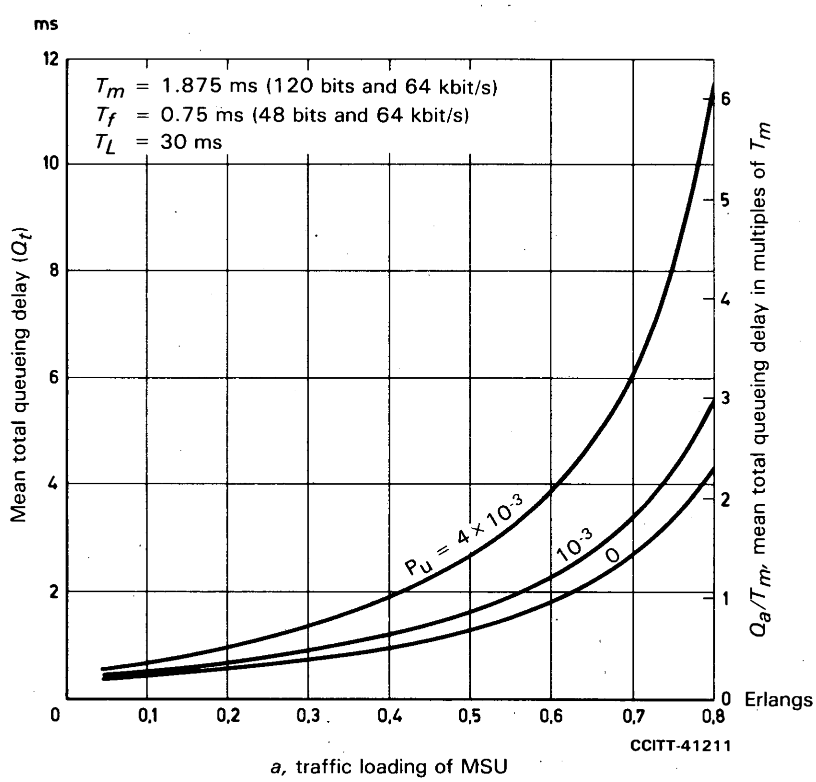


FIGURE 4/Q.706

Mean total queueing delay of each channel of traffic; basic error correction method

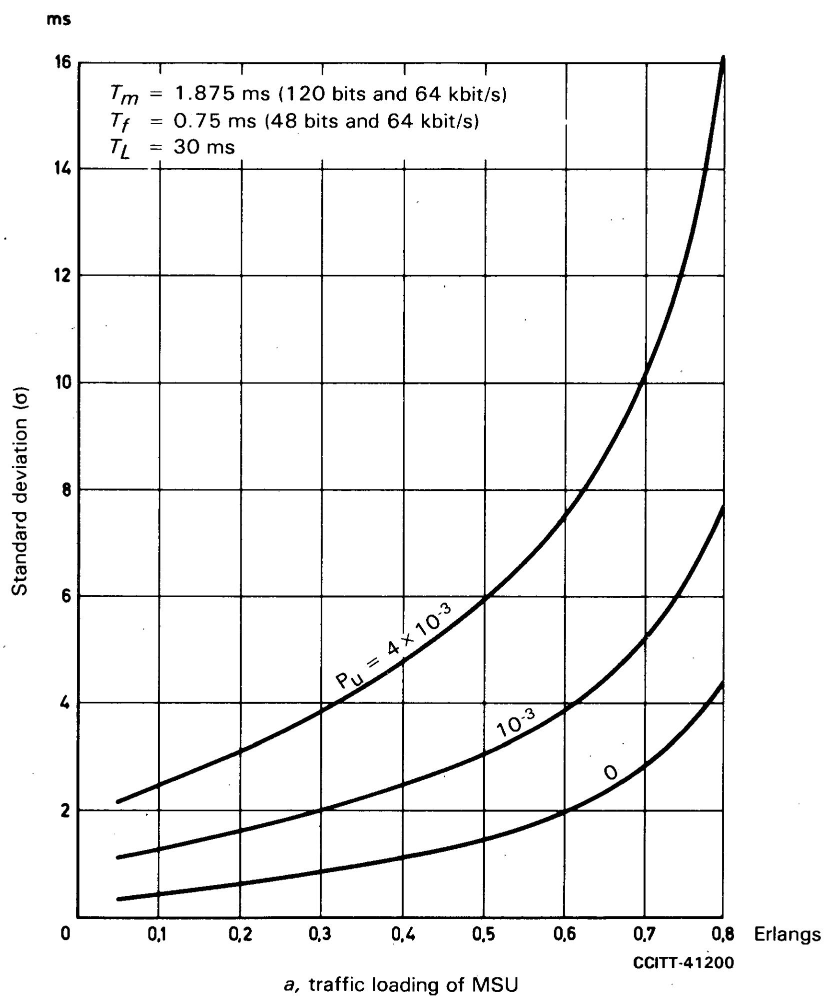


FIGURE 5/Q.706

Standard deviation of queueing delay of each channel of traffic; basic error correction method

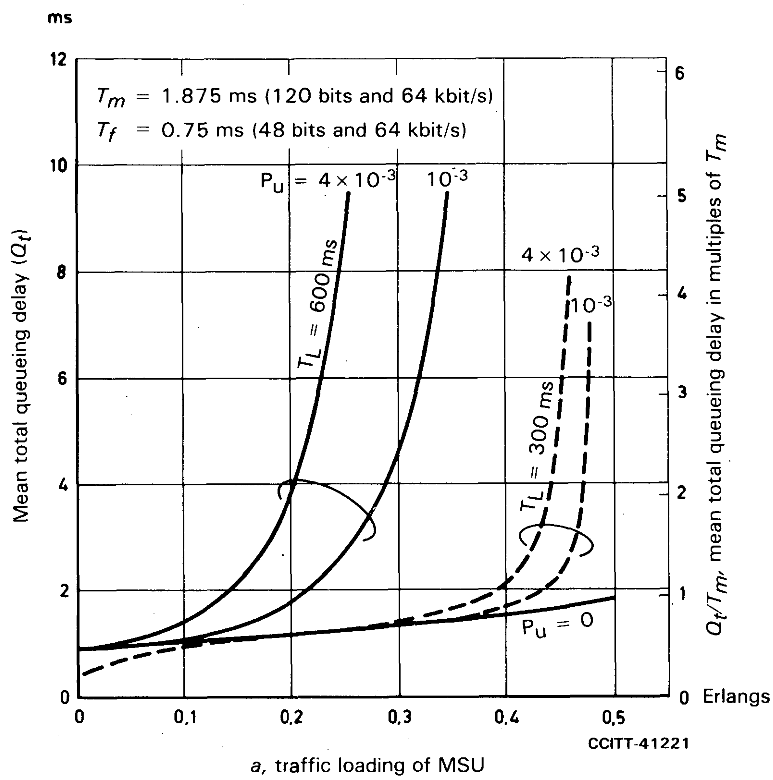


FIGURE 6/Q.706

Mean total queueing delay of each channel of traffic; preventive cyclic retransmission error correction method

4.3 *Message transfer times*

Within a signalling relation, the Message Transfer Part transports messages from the originating User Part to the User Part of destination, using several signalling paths. The overall message transfer time needed depends on the message transfer time components (a) to (e) involved in each signalling path.

4.3.1 *Message transfer time components and functional reference points*

A signalling path may include the following functional signalling network components and transfer time components.

a) Message Transfer Part sending function at the point of origin (see Figure 7/Q.706).

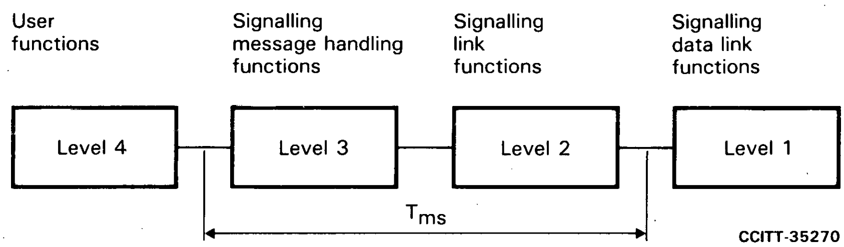
b) Signalling transfer point function (see Figure 8/Q.706).

c) Message Transfer Part receiving function at the point of destination (see Figure 9/Q.706).

d) Signalling data link propagation time (see Figure 10/Q.706).

e) Queueing delay.

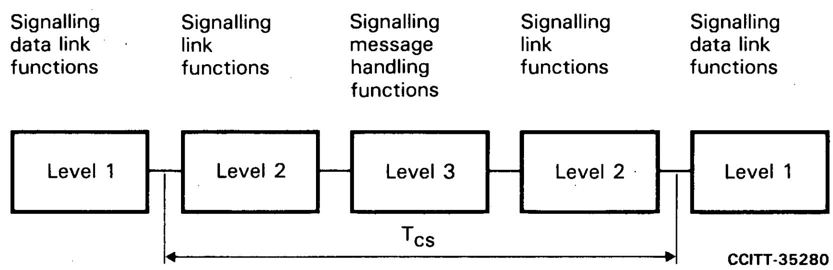
An additional increase of the overall message transfer times is caused by the queueing delays. These are described in § 4.2.



T_{ms} Message Transfer Part sending time

FIGURE 7/Q.706

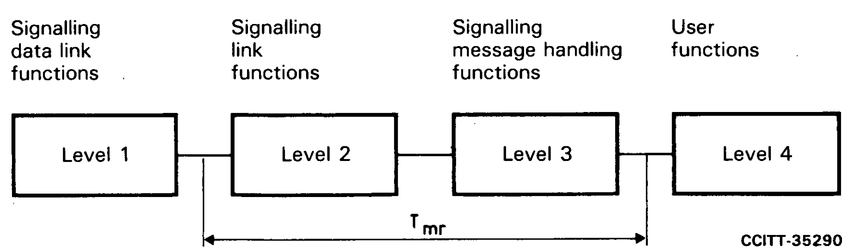
Functional diagram of the Message Transfer Part sending time



T_{cs} Message transfer time at signalling transfer points

FIGURE 8/Q.706

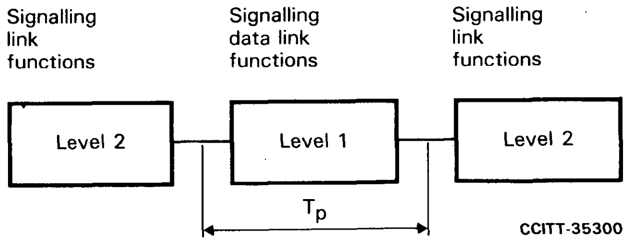
Functional diagram of the message transfer time at signalling transfer points



T_{mr} Message Transfer Part receiving time

FIGURE 9/Q.706

Functional diagram of the Message Transfer Part receiving time



T_p Propagation time of the data channel

FIGURE 10/Q.706

Functional diagram for the propagation time

4.3.2 *Definitions*

4.3.2.1 **Message Transfer Part sending time T_{ms}**

F: temps d'émission du Sous-système Transport de Messages T_{ms}

S: tiempo de emisión de la parte de transferencia de mensajes T_{ms}

T_{ms} is the period which starts when the last bit of the message has left the User Part and ends when the last bit of the signal unit enters the signalling data link for the first time. It includes the queueing delay in the absence of disturbances, the transfer time from level 4 to level 3, the handling time at level 3, the transfer time from level 3 to level 2, and the handling time in level 2.

4.3.2.2 **message transfer time at signalling transfer points T_{cs}**

F: temps de transfert des messages aux points de transfert sémaphore, T_{cs}

S: tiempo de transferencia de mensajes en los puntos de transferencia de la señalización T_{cs}

T_{cs} is the period, which starts when the last bit of the signal unit leaves the incoming signalling data link and ends when the last bit of the signal unit enters the outgoing signalling data link for the first time. It also includes the queueing delay in the absence of disturbances but not the additional queueing delay caused by retransmission.

4.3.2.3 **Message Transfer Part receiving time T_{mr}**

F: temps de réception du Sous-système Transport de Messages T_{mr}

S: tiempo de recepción de la parte de transferencia de mensajes T_{mr}

T_{mr} is the period which starts when the last bit of the signal unit leaves the signalling data link and ends when the last bit of the message has entered the User Part. It includes the handling time in level 2, the transfer time from level 2 to level 3, the handling time in level 3 and the transfer time from level 3 to level 4.

4.3.2.4 **data channel propagation time T_p**

F: temps de propagation sur la voie de données, T_p

S: tiempo de propagación del canal de datos T_p

T_p is the period which starts when the last bit of the signal unit has entered the data channel at the sending side and ends when the last bit of the signal unit leaves the data channel at the receiving end irrespective of whether the signal unit is disturbed or not.

4.3.3 *Overall message transfer times*

The overall message transfer time T_o is referred to the signalling relation. T_o starts when the message has left the user part (level 4) at the point of origin and ends when the message has entered the user part (level 4) at the point of destination.

The definition of the overall message transfer time and the definitions of the individual message transfer time components give rise to the following relationships:

a) In the absence of disturbances

$$T_{oa} = T_{ms} + \sum_{i=1}^{n+1} T_{pi} + \sum_{i=1}^{n} T_{csi} + T_{mr}$$

b) In the presence of disturbances

$$T_o = T_{oa} + \Sigma (Q_t - Q_a)$$

Here

T_{oa} overall message transfer time in the absence of disturbances

T_{ms} Message Transfer Part sending time

T_{mr} Message Transfer Part receiving time

T_{cs} Message transfer time at signalling transfer points

n number of STPs involved

T_p data channel propagation time

T_o overall message transfer time in the presence of disturbances

Q_t total queueing delay (see § 4.2)

Q_a queueing delay in the absence of disturbances (see § 4.2)

Note – For $\Sigma (Q_t - Q_a)$, all signalling points in the signalling relation must be taken into account.

4.3.4 *Estimates for message transfer times*

(Needs further study.)

The estimates must take account of:

– the length of the signal unit,

– the signalling traffic load,

– the signalling bit rate.

The estimates for T_{mr}, T_{ms} and T_{cs} will be presented in the form of:

– mean values,

– 95% level values.

The estimates for T_{cs} for a signalling transfer point are given in Table 4/Q.706.

TABLE 4/Q.706

STP signalling traffic load	Message transfer time at an STP (T_{CS}) in ms[a)]	
	Mean	95%
Normal	20	40
+ 15%	40	80
+ 30%	100	200

a) Provisional values

These figures are related to 64-kbit/s signalling bit rate. The normal signalling traffic load is that load for which the signalling transfer point is engineered. A mean value of 0.2 Erlang per signalling link is assumed. The message length distribution is as given in Table 2/Q.706.

4.4 *Error control*

During transmission, the signal units are subject to disturbances which lead to a falsification of the signalling information. The error control reduces the effects of these disturbances to an acceptable value.

Error control is based on error detection by redundant coding and on error correction by retransmission. Redundant coding is performed by generation of 16 check bits per signal unit based on the polynomial described in Recommendation Q.703, § 4.2. Moreover, the error control does not introduce loss, duplication or mis-sequencing of messages on an individual signalling link.

However, abnormal situations may occur in a signalling relation, which are caused by failures, so that the error control for the signalling link involved cannot ensure the correct message sequence.

4.5 *Security arrangements*

The security arrangements have an essential influence on the observance of the availability requirements listed in § 1.1 for a signalling relation.

In the case of Signalling System No. 7, the security arrangements are mainly formed by redundancy in conjunction with changeover.

4.5.1 *Types of security arrangements*

In general, a distinction has to be made between security arrangements for the individual components of the signalling network and security arrangements for the signalling relation. Within a signalling network, any security arrangement may be used, but it must be ensured that the availability requirements are met.

4.5.1.1 *Security arrangements for the components of the signalling network*

Network components, which form a signalling path when being interconnected, either have constructional security arrangements which exist from the very beginning (e.g. replication of the controls at the exchanges and signalling transfer points) or can be replicated, if need be (e.g. signalling data links). For security reasons, however, replication of signalling data links is effected only if the replicated links are independent of one another (e.g. multipath routing). In the case of availability calculations for a signalling path set, special care has to be taken that the individual signalling links are independent of one another.

4.5.1.2 *Security arrangements for signalling relations*

In quasi-associated signalling networks where several signalling links in tandem serve one signalling relation, the security arrangements for the network components, as a rule, do not ensure sufficient availability of the signalling relation. Appropriate security arrangements must therefore be made for the signalling relations by the provision of redundant signalling path sets, which have likewise to be independent of one another.

4.5.2 *Security requirements*

In the case of 64-kbit/s signalling links, a signalling network has to be provided with sufficient redundancy so that the quality of the signalling traffic handled is still satisfactory. (Application of the above to signalling links using lower bit rates needs further study.)

4.5.3 *Time to initiate changeover*

If individual signalling data links fail, changeover is initiated by signal unit error monitoring (see Recommendation Q.703, § 8). With signal unit error monitoring, the time between the occurrence of the failure and the initiation of changeover is dependent on the message error rate (a complete interruption will result in an error rate equal to 1).

Changeover leads to substantial additional queueing delays. To keep the latter as short as possible, the signalling traffic affected by an outage is reduced to a minimum by the use of load sharing on all existing signalling links.

4.6 *Failures*

4.6.1 *Link failures*

During transmission, the messages may be subject to disturbances. A measure of the quality of the signalling data link is its signal unit error rate.

Signal unit error monitoring initiates the changeover at a signal unit error rate of about $4 \cdot 10^{-3}$.

The error rate, which Signalling System No. 7 has to cope with, represents a parameter of decisive influence on its efficiency.

As a result of error correction by retransmission, a high error rate causes frequent retransmission of the message signal units and thus long queueing delays.

4.6.2 *Failures in signalling points*

(Needs further study.)

4.7 *Priorities*

Priorities resulting from the meaning of the individual signals are not envisaged. Basically, the principle "first-in – first-out" applies.

Although the service indicator offers the possibility of determining different priorities on a user basis, such user priorities are not yet foreseen.

Transmission priorities are determined by Message Transfer Part functions. They are solely dependent on the present state of the Message Transfer Part and completely independent of the meaning of the signals (see Recommendation Q.703, § 10.2).

5 Performance under adverse conditions

5.1 *Adverse conditions*

(Needs further study.)

5.2 *Influence of adverse conditions*

(Needs further study.)

Reference

[1] CCITT Recommendation *Error performance on an international digital connection forming part of an integrated services digital network*, Vol. III, Fascicle III.3, Rec. G.821.

Recommendation Q.707

TESTING AND MAINTENANCE

1 General

In order to realize the performance requirements described in Recommendation Q.706, means and procedures for signalling network testing and maintenance are required in addition to the means defined in Recommendations Q.703 and Q.704.

2 Testing

2.1 *Signalling data link test*

As defined in Recommendation Q.702, § 1, the signalling data link is a bidirectional transmission path for signalling. Testing and maintenance functions can be initiated independently at either end.

The signalling data link and the constituent parts of the digital and analogue versions are described in Recommendation Q.702, § 1.

They must be tested before being put into service to ensure that they meet the requirements of Recommendation Q.702, § 3.

Since interruptions of the signalling data link will affect many transactions, they must be treated with the utmost care. Appropriate special measures should be taken to prevent unauthorized maintenance access which could result in interruptions to service. These special measures may include marking or flagging the equipment and indications on distribution frames or test bays where access is possible (see Recommendation M.1050 [1]).

The signal unit error rate monitor and the alignment error rate monitor described in Recommendation Q.703, § 9, also provide means for detecting deterioration of a signalling data link.

Further studies are required with reference to Recommendation V.51 [2].

2.2 *Signalling link test*

As defined in Recommendation Q.703, § 1.1.1 and illustrated in Figure 1/Q.701, the signalling link comprises a signalling data link with signalling link functions at either end.

In the following, an on-line signalling link test procedure is specified which involves communication between the two ends of the concerned signalling link. This procedure is intended for use while the signalling link is in service. In addition, local failure detection procedures should be performed at either end; these are not specified in this Recommendation.

The test procedure is intended to be applied periodically on each operational signalling link with a sufficient frequency to ensure that the signalling link performance requirements are met. The signalling link test message is sent at regular intervals [1]. The testing of a signalling link is performed independently from each end.

The ability to send a signalling test acknowledgement, defined below, must always be provided at a signalling point but the provision for transmission of the signalling test message is at the discretion of the signalling points.

The signalling point initiating the tests transmits a signalling link test message on the signalling link to be tested. This message includes a test pattern which is chosen at the discretion of the end initiating the test. After receiving a signalling link test message, a signalling point responds with a signalling link test acknowledgement message on the same signalling link within $T = 100$ ms (provisional value). The test pattern included in the signalling link test acknowledgement message is identical to the test pattern received. In the case that a test pattern in a received signalling link test acknowledgement is the same as that sent in a signalling link test message, no further action is taken.

In the case when:

a) a signalling link test acknowledgement message is not received on the link being tested within T1 = 1 s (provisional value), after the signalling link test message has been sent, or

b) a signalling link test acknowledgement message is received with a test pattern that is different from the last pattern sent in a signalling link test message,

the test is considered to have failed and is repeated once. In the case when also the repeated test fails, a management system must be informed and further action is for further study.

The formats and codes of signalling link test and signalling link test acknowledgement messages used for signalling link testing are specified in § 5.4.

2.3 *Signalling route test*

In addition to the procedures specified in the Recommendation Q.704, § 10, the need for, and form of other line procedures are for further study.

3 **Fault location**

Fault location operations, employing particular manual or automatic internal test equipment are left to the discretion of the individual signalling points.

Tests requiring provision of messages are for further study. See [3].

4 **Signalling network monitoring**

In order to obtain information on the status of the signalling network, monitoring of the signalling activity must be provided (for example measures of the signalling load on the signalling data link). The specification of such means and procedures is for further study.

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[1] The definition of the lower limit of these intervals is for further study. This must be defined, taking into account the need to ensure that a received signalling link test acknowledgement is in response to the last sent signalling link test message.

5 Formats and codes of signalling network testing and maintenance messages

5.1 *General*

The signalling network testing and maintenance messages are carried on the signalling channel in message signal units, the format of which is described in Recommendation Q.703, § 2. As indicated in Recommendation Q.704, § 12.2, these messages are distinguished by the configuration 0001 of the service indicator (SI). The Sub Service Field (SSF) of signalling network testing and maintenance messages is used in accordance with Recommendation Q.704, § 12.3.

The Signalling Information Field (SIF) consists of an integral number of octets and contains the label, the heading code and one or more signals and indications.

5.2 *Label*

For signalling network testing and maintenance messages, the label has the same structure as the label of signalling network management messages (see Recommendation Q.704, § 13.2).

5.3 *Heading code H0*

The heading code H0 is the 4-bit field following the label and identifies the message group. The different heading codes are allocated as follows:

0000 Spare

0001 Test messages

The remaining codes are spare.

5.4 *Signalling link test messages*

The format of the signalling link test messages is shown in Figure 1/Q.707.

			DCBA	0001	
Test pattern	Length indicator	Spare	Heading code H1	Heading code H0	LABEL
n[a] × 8	4[a]	4[a]	4	4	32

First bit transmitted →

[a] Provisional value.

CCITT-35550

FIGURE 1/Q.707

The signalling link test messages, are made up of the following fields:

- Label: (32 bits), see § 5.2
- Heading code H0: (4 bits)
- Heading code H1: (4 bits)
- Spare bits: (4 bits) [2)]
- Length Indicator: (4 bits) [2)]
- Test pattern: ($n \times 8$ bits with $n < 16$) [2)]

In the label, the signalling link code identifies the signalling link on which the test message is sent.

The heading code H1 contains signal codes as follows:

bits D C B A
- 0 0 0 1 signalling link test message
- 0 0 1 0 signalling link test acknowledgement message

The length indicator gives the number of octets which the test pattern comprises.

The test pattern is an integral number of octets and is chosen at the discretion of the originating point.

6 State transition diagram

The state transition diagram is intended to show precisely the behaviour of the signalling system under normal and abnormal conditions as viewed from a remote location. It must be emphasized that the functional partitioning shown in the following diagram is used only to facilitate understanding of the system behaviour and is not intended to specify the functional partitioning to be adopted in a practical implementation of the signalling system.

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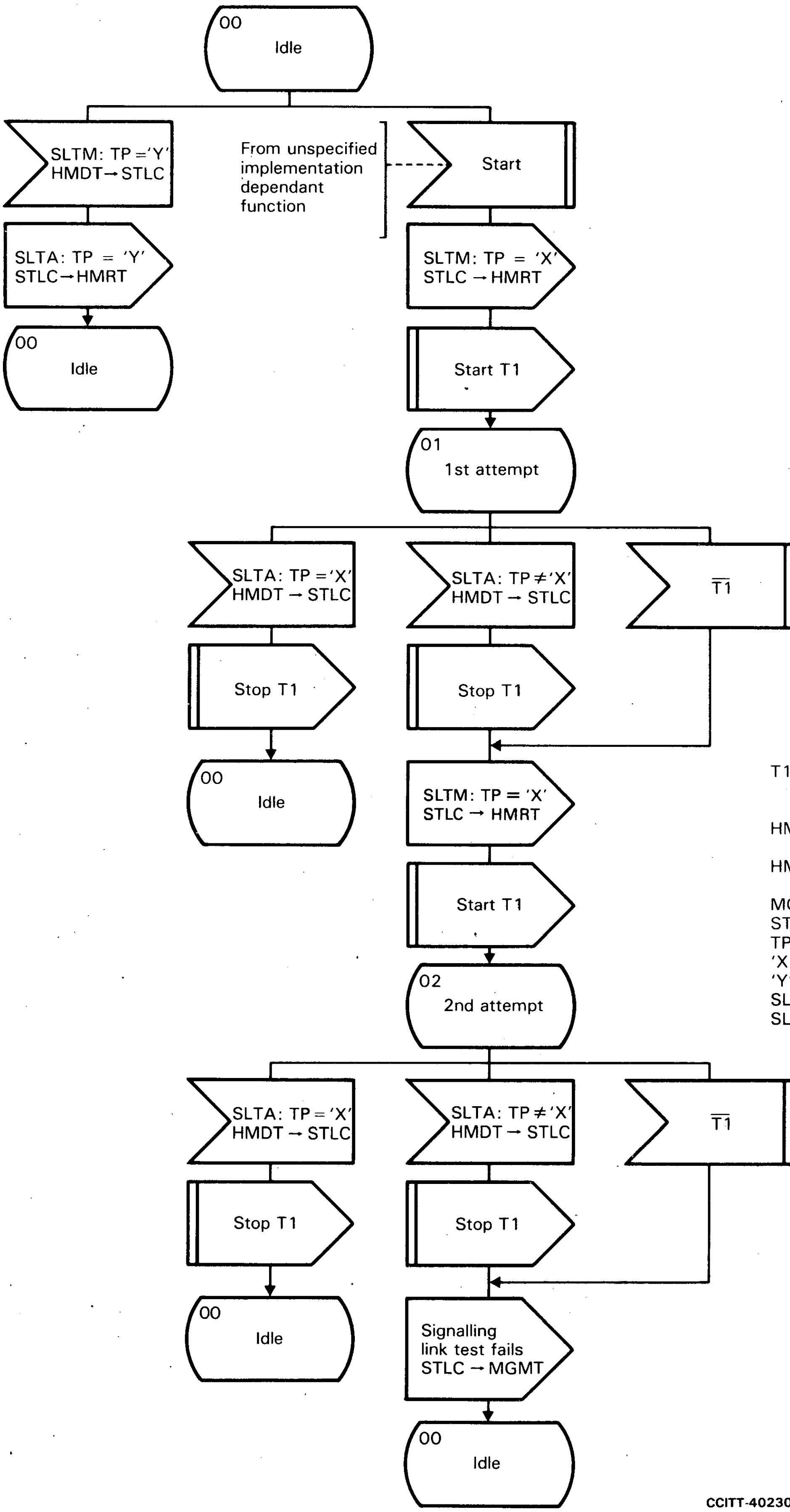
2) Provisional value.



T1	1s (provisional value) — time out for waiting for the test message acknowledgement
HMDT	Signalling message handling. Message distribution
HMRT	Signalling message handling. Message routing
MGMT	Management system
STLC	Signalling link test control
TP	Test pattern
'X' } 'Y' }	Particular test patterns
SLTM	Signalling link test message
SLTA	Signalling link test message acknowledgement

FIGURE 2/Q.707

Signalling link test control

References

[1] CCITT Recommendation *Lining up an international point-to-point leased circuit*, Vol. IV, Fascicle IV.2, Rec. M.1050.

[2] CCITT Recommendation *Organization of the maintenance of international telephone-type circuits used for data transmission*, Vol. VIII, Fascicle VIII.1, Rec. V.51.

[3] *Ibid.*, § 5.

Recommendation Q.721

FUNCTIONAL DESCRIPTION OF THE SIGNALLING SYSTEM TELEPHONE USER PART (TUP)

1 General

Use of Signalling System No. 7 for telephone call control signalling requires:

- application of *Telephone User Part* (TUP) functions, in combination with
- application of an appropriate set of *Message Transfer Part* (MTP) functions.

A general description of the signalling system is given in Recommendation Q.701. That Recommendation also defines the division of functions and the requirements of interaction between the Message Transfer Part and the Telephone User Part.

2 Telephone User Part

The Telephone User Part specified in these specifications defines the necessary telephone signalling functions for use of Signalling System No. 7 for international telephone call control signalling. It is specified with the aim of providing the same features for telephone signalling as other CCITT telephone signalling systems.

Signalling System No. 7 can be used to control the switching of all types of international circuits to be used in a worldwide connection, including circuits with speech interpolation and satellite circuits.

The system meets all requirements defined by the CCITT concerning the service features for worldwide international semiautomatic and automatic telephone traffic. It is designed for the bothway operation of speech circuits.

When used with homogenous digital telephone circuits the continuity of these circuits is ensured by the means for transmission quality supervision and failure detection that are inherent in the digital systems providing these circuits. However, the system includes means for link-by-link assurance of continuity check of the speech path when used with analogue telephone circuits.

The signalling system is suitable for national telephone applications. Most telephone signalling messages types and signals specified for international use are also required in typical national applications. In addition to these, national applications typically require additional signalling message types and signals; the system provides ample spare capacity for such additions.

The standard label structure specified for telephone signalling messages requires that all exchanges using the signalling system are allocated codes from code plans established for the purpose of unambiguous identification of signalling points. The principles to apply to the international signalling network are for further study.

3 Message Transfer Part

The Message Transfer Part of Signalling System No. 7 is specified in separate Recommendations. An overview description of the Message Transfer Part is contained in Recommendation Q.701.

The Message Transfer Part defines a range of functions by which different signalling modes and different signalling network configurations may be realized. Any application of Signalling System No. 7 requires that an appropriate selection of these functions is applied depending on the intended use of the system and the characteristics of the telecommunications network concerned.

Recommendation Q.722

GENERAL FUNCTION OF TELEPHONE MESSAGES AND SIGNALS

This Recommendation describes the general function of telephone signalling messages and the telephone signals and other information components contained in those messages. The requirements relating to the use of the signalling messages and their signal content are specified in Recommendations Q.723 and Q.724.

1 Telephone signalling messages

The definition of formats and codes for telephone messages is based on a functional grouping as indicated in the following. It is expected that national application of the signalling system typically will require further message types in addition to the internationally defined message types indicated in the following. As a result of the criteria on which the grouping of message types are based some groups as yet only contain one message type.

1.1 *Forward address message group*

This message group includes messages sent in the forward direction containing address information. Signals from § 3.3 may be included. Messages so far specified are as follows.

1.1.1 *Initial address message*

A type of message sent first in the forward direction at call set-up. It contains address information and other information relating to the routing and handling of the call.

1.1.2 *Subsequent address message*

A type of message sent in the forward direction subsequent to the initial address message and containing further address information.

1.2 *Forward set-up message group*

This message group includes messages sent in the forward direction, subsequent to address messages containing further information for call set-up. Signals from § 3.3 may be included. Messages so far specified are as follows.

1.2.1 *Calling-line-identity message*

A type of message containing the identity of, and possibly other information relating to, the calling line.

1.2.2 *Calling-line-identity-unavailable message*

A type of message containing the information that the identity of the calling line is not available.

1.2.3 *Continuity message*

A type of message containing a continuity signal.

1.3 *Backward set-up request message group*

This message group includes messages sent in the backward direction requesting further information for call set-up. Signals from § 3.4 may be included. Messages so far specified are as follows.

1.3.1 *Calling-line-identity-request message*

A type of message containing a signal requesting transfer of the identity of, and possibly other information relating to, the calling party.

1.4 *Successful backward set-up information message group*

This message group includes messages sent in the backward direction containing information relating to a successful call set-up. Signals from § 3.4 may be included. Messages so far specified are as follows.

1.4.1 *Address-complete message*

A type of message containing a signal indicating that the call has been connected to the called party and giving additional information relating to this.

1.4.2 *Charging message*

A type of message containing charging information.

1.5 *Unsuccessful backward set-up information message group*

This message group includes messages sent in the backward direction containing information relating to an unsuccessful call set-up. Signals from § 3.4 may be included. Messages so far specified as follows.

1.5.1 *Unsuccessful-call-attempt message*

A message containing a signal, from § 3.4, relating to an unsuccessful call set-up.

1.6 *Call supervision message group*

A message containing a signal, from § 3.5, relating to the supervision of the call.

1.7 *Circuit supervision message group*

A message containing a signal, from § 3.6, relating to the supervision of the circuit.

2 Service information

The service information provides the highest level of discrimination between different sets of signalling messages. It contains the following components.

2.1 *Service indicator*

Information used to identify the User Part to which the signalling message belongs.

2.2 *National indicator*

Information used for discrimination between international and national messages. In case of national messages, it may for example also be used for discrimination between different label alternatives for national use.

3 Signalling information

3.1 *Label components*

In the case of the telephone signalling messages the label is used for message routing and, in general, identification of the concerned telephone circuit. The standard label structure consists of the following components.

3.1.1 *Destination point code*

Information identifying the signalling point to which the message is to be routed.

3.1.2 *Originating point code*

Information identifying the signalling point from which the message has been originated.

3.1.3 *Circuit identification code*

Information identifying the telephone circuit among those interconnecting the destination point and originating point.

3.2 *Message format identifiers*

3.2.1 *Heading*

Information discriminating, as applicable, between different groups or individual types of messages within the set of messages identified by the service information. The heading is split into two levels. The first level discriminates between different groups. The second level either discriminates between different message types or contains a signal.

3.2.2 *Field length indicator*

Information associated with and indicating the length of a variable length field.

3.2.3 *Field indicator*

Information associated with and indicating the presence or absence of an optional field.

3.3 *Forward set-up telephone signals*

3.3.1 *Address signal*

A call set-up signal sent in the forward direction containing one element of information (digit 0, 1, 2, ... 9, Code 11 or Code 12) about the called party's number or the end-of-pulsing (ST) signal.

For each call, a succession of address signals is sent.

3.3.2 *End-of-pulsing (ST) signal*

An address signal sent in the forward direction indicating that there are no more address signals to follow.

3.3.3 *Nature-of-address indicator*

Information sent in the forward direction indicating whether the associated address or line identity is an international, national significant or subscriber number.

3.3.4 *Nature-of-circuit indicator*

Information sent in the forward direction about the nature of the circuit or any preceding circuit(s) already engaged in the connection:

- a satellite circuit, or
- no satellite circuit.

An international exchange receiving this information will use it (in combination with the appropriate part of the address information) to determine the nature of the outgoing circuit to be chosen.

3.3.5 *Echo suppressor indicator*

Information sent in the forward direction indicating whether or not an outgoing half-echo suppressor is included in the connection.

3.3.6 *Calling-party's-category indicator*

Information sent in the forward direction about the category of the calling party and, in case of semiautomatic calls, about the service language to be spoken by the incoming, delay and assistance operators.

The following categories are provided:

- operator,
- ordinary calling subscriber,
- calling subscriber with priority,
- data call,
- test call.

3.3.7 *Continuity-check indicator*

Information sent in the forward direction indicating whether or not a continuity check will be performed on the circuit concerned or is being (has been) performed on a previous circuit in the connection.

3.3.8 *Calling line identity*

Information sent in the forward direction indicating the national significant number of the calling party.

3.3.9 *Calling-line-identity-unavailable signal*

A signal sent in the forward direction indicating that the identity of the calling line is not available.

3.3.10 *Continuity signal*

A signal sent in the forward direction indicating continuity of the preceding System No. 7 speech circuit(s) as well as of the selected speech circuit to the following international exchange, including verification of the speech path across the exchange with the specified degree of reliability.

3.3.11 *Continuity-failure signal*

A signal sent in the forward direction indicating failure of continuity of the System No. 7 speech circuit.

3.4 *Backward set-up telephone signals*

3.4.1 *Calling-line-identity-request signal*

A signal sent in the backward direction requesting transfer of the calling line identity from the originating exchange.

3.4.2 *Address-complete signal*

A signal sent in the backward direction indicating that all the address signals required for routing the call to the called party have been received and that no called-party's-line-condition signals (electrical) will be sent.

3.4.3 *Address-complete signal, charge*

A signal sent in the backward direction indicating that all the address signals required for routing the call to the called party have been received, that no called-party's-line-condition signals (electrical) will be sent and that the call should be charged on answer.

3.4.4 *Address-complete signal, no-charge*

A signal sent in the backward direction indicating that all the address signals required for routing the call to the called party have been received, that no called-party's-line-condition (electrical) will be sent and that the call should not be charged on answer.

3.4.5 *Address-complete signal, coin-box*

A signal sent in the backward direction indicating that all the address signals required for routing the call to the called party have been received, that no called-party's-line-condition (electrical) will be sent, that the call should be charged on answer and that the called number is a coin (box) station.

3.4.6 *Subscriber-free indicator*

Information sent in the backward direction indicating that the called party's line is free.

3.4.7 *Switching-equipment-congestion signal*

A signal sent in the backward direction indicating the failure of the call set-up attempt due to congestion encountered at international switching equipment.

3.4.8 *Circuit-group-congestion signal*

A signal sent in the backward direction indicating the failure of the call set-up attempt due to congestion encountered on an international circuit group.

3.4.9 *National-network-congestion signal*

A signal sent in the backward direction indicating the failure of the call set-up attempt due to congestion encountered in the national destination network [excluding the busy condition of the called party's line(s)].

3.4.10 *Address-incomplete signal*

A signal sent in the backward direction indicating that the number of address signals received is not sufficient for setting up the call. This condition may be determined in the incoming international exchange (or in the national destination network):

- immediately after the reception of an ST signal, or
- on timeout after the latest digit received.

3.4.11 *Call-failure signal*

A signal sent in the backward direction indicating the failure of a call set-up attempt due to the lapse of a timeout or a fault not covered by specific signals.

3.4.12 *Unallocated-number signal*

A signal sent in the backward direction indicating that the received number is not in use (e.g. spare level, spare code, vacant subscriber's number).

3.4.13 *Subscriber-busy signal (electrical)*

A signal sent in the backward direction indicating that the line(s) connecting the called party with the exchange is (are) engaged. The subscriber-busy signal will also be sent in case of complete uncertainty about the place where the busy or congestions are encountered and in the case where a discrimination between subscriber-busy and national-network congestion is not possible.

3.4.14 *Line-out-of-service signal*

A signal sent in the backward direction indicating that the called party's line is out-of-service or faulty.

3.4.15 *Send-special-information-tone signal*

A signal sent in the backward direction indicating that the special information tone should be returned to the calling party. This tone indicates that the called number cannot be reached for reasons not covered by other specific signals and that the unavailability is of a long-term nature (see also Recommendation Q.35 [1]).

3.5 *Call supervision signals*

3.5.1 *Forward-transfer signal*

A signal sent in the forward direction on semiautomatic calls when the outgoing international exchange operator wants the help of an operator at the incoming international exchange. The signal will normally serve to bring an assistance operator (see Recommendation Q.101 [2]) into the circuit if the call is automatically set up at the exchange. When a call is completed via an operator (incoming or delay operator) at the incoming international exchange, the signal should preferably cause this operator to be recalled.

3.5.2 *Answer signal, charge*

A signal sent in the backward direction indicating that the call is answered and subject to charge.

In semiautomatic working, this signal has a supervisory function. In automatic working, the signal is used:

- to start metering the charge to the calling subscriber (Recommendation Q.28 [3]), and
- to start the measurement of call duration for international accounting purposes (Recommendation E.260 [4]).

3.5.3 *Answer signal, no charge*

A signal sent in the backward direction indicating that the call is answered but is not subject to charge. It is used for calls to particular destinations only.

In semiautomatic working, this signal has a supervisory function. In automatic working, the reception of this signal shall not start the metering to the calling subscriber.

3.5.4 *Clear-back signal*

A signal sent in the backward direction indicating that the called party has cleared.

In semiautomatic working this signal has a supervisory function. In automatic working, the arrangements specified in Recommendation Q.118 [5] apply.

3.5.5 *Re-answer signal*

A signal sent in the backward direction indicating that the called party, after having cleared, again lifts his receiver or in some other way reproduces the answer condition, e.g. switch-hook flashing.

3.5.6 *Clear-forward signal*

A signal sent in the forward direction to terminate the call or call attempt and release the circuit concerned. This signal is normally sent when the calling party clears but also may be a proper response in other situations as, for example, when reset circuit is received.

3.6 *Circuit supervision signals*

3.6.1 *Release-guard signal*

A signal sent in the backward direction in response to a clear-forward signal, or if appropriate to the reset-circuit signal, when the circuit concerned has been brought into the idle condition.

3.6.2 *Reset-circuit signal*

A signal that is sent to release a circuit when, due to memory mutilation or other causes, it is unknown whether, for example, a clear-forward or clear-back signal is appropriate. If at the receiving end the circuit is blocked, this signal should remove that condition.

3.6.3 *Blocking signal*

A signal sent for maintenance purposes to the exchange at the other end of a circuit to cause engaged conditions of that circuit for subsequent calls outgoing from that exchange. An exchange receiving the blocking signal must be capable of accepting incoming calls on that circuit unless it also has sent a blocking signal. Under conditions covered later, a blocking signal is also a proper response to a reset circuit signal.

3.6.4 *Unblocking signal*

A signal sent to the exchange at the other end of a circuit to cancel in that exchange the engaged conditions of that circuit caused by an earlier blocking signal.

3.6.5 *Blocking-acknowledgment signal*

A signal sent in response to a blocking signal indicating that the speech circuit has been blocked.

3.6.6 *Unblocking-acknowledgment signal*

A signal sent in response to an unblocking signal indicating that the speech circuit has been unblocked.

3.6.7 *Continuity-check-request signal*

A signal sent requesting an independent circuit continuity test.

References

[1] CCITT Recommendation *Characteristics of the dial tone, ringing tone, busy tone, congestion tone, special information tone and warning tone*, Vol. VI, Fascicle VI.1, Rec. Q.35.

[2] CCITT Recommendation *Facilities provided in international semiautomatic working*, Vol. VI, Fascicle VI.1, Rec. Q.101.

[3] CCITT Recommendation *Determination of the moment of the called subscriber's answer in the automatic service*, Vol. VI, Fascicle VI.1, Rec. Q.28.

[4] CCITT Recommendation *Basic technical problems concerning the measurement and recording of call durations*, Vol. II, Fascicle II.2, Rec. E.260.

[5] CCITT Recommendation *Special release arrangements and indication of congestion conditions at transit exchanges*, Vol. VI, Fascicle VI.1, Rec. Q.118.

FORMATS AND CODES

1 Basic format characteristics

1.1 *General*

The telephone user messages are carried on the signalling data link by means of signal units the format of which is described in Recommendation Q.703, § 2.2.

The signalling information of each message constitutes the signalling information field of the corresponding signal unit and consists of an integral number of octets. It basically contains the *label*, the *heading code* and one or more *signals* and/or *indications*. Structure and function of the label are described in § 2; the heading codes and detailed message formats are described in § 3.

1.2 *The Service information octet*

The *service information octet* comprises the *service indicator* and the *subservice field*.

The service indicator is used to associate signalling information with a particular User Part and is only used with message signal units (see Recommendation Q.704, § 12.2).

The information in the subservice field permits a distinction to be made between national and international signalling messages. In national applications when this discrimination is not required possibly for certain national User Parts only, the subservice field can be used independently for different User Parts.

The format of the service information octet is shown in Figure 1/Q.723.

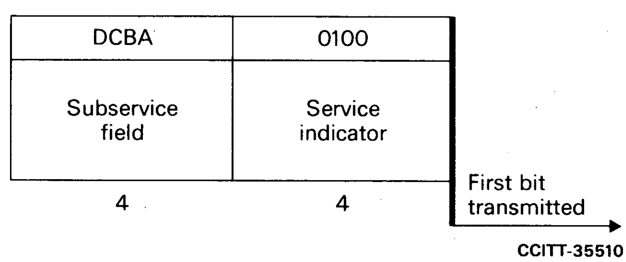


FIGURE 1/Q.723
Service information octet

The following codes are used in the fields of the service information octet:

a) The service indicator is coded 0100.

b) Subservice field

bits B A Spare (see Note)

bits D C National indicator
0 0 International message
0 1 Spare (for international use only)
1 0 National message
1 1 Reserved for national use

Note – The two unused bits in the service information octet are spare for possible future needs that may require a common solution for all international User Parts and Message Transfer Part level 3. The bits are coded 00.

1.3 *Format principles*

The user generated information in the signalling information field is, in general, divided into a number of subfields which may be either of fixed or variable length. For a given message type identified by a unique message heading, the presence of a given subfield may be either mandatory or optional. The various types of subfields are further defined below.

1.3.1 *Mandatory subfields*

Subfields which have been declared mandatory for a given message type appear in all messages of that type.

1.3.2 *Optional subfields*

Subfields which have been declared optional for a given message type only appear when required in messages of that type. The presence or absence of each optional field is indicated by the state of a field indicator located in an indicator field, which in this case is a mandatory subfield.

1.3.3 *Fixed length subfields*

Subfields which have been declared fixed length for a given message type, contain the same number of bits in all messages of that type.

1.3.4 *Variable length subfields*

For subfields which have been declared variable length for a given message type, the number of bits may vary between messages of that type. The size of a variable length subfield is indicated in an immediately preceding fixed length subfield in terms of a predefined unit such as bits, octets or half-octets.

1.3.5 *Order of subfield transmission*

For a given type of message the various types of subfields are transmitted in the following order:

a) mandatory subfields,

b) Optional subfields.

Within each of these two classes, the order of subfield transmission is, in general, as follows:

1) fixed length subfields (with the exception of the indicator field and subfields indicating the size of a variable length subfield),

2) variable length subfields.

1.3.6 *Order of bit transmission*

Within each defined subfield the information is transmitted least significant bit first.

1.3.7 *Coding of spare bits*

Spare bits are coded 0 unless indicated otherwise.

2 Label

2.1 *General*

The *label* is an item of information which forms part of every signalling message and is used by the message routing function at Message Transfer Part level 3 to select the appropriate signalling route and by the User Part function to identify the particular transaction (e.g. the call) to which the message pertains.

In general, label information encompasses an explicit or implicit indication of the message source and destination and, depending on the application, various forms of transaction identification.

For messages which are related to circuits or calls, the transaction is conveniently identified by including the corresponding circuit identity in the label. In future the introduction of new subscriber services may require the transfer of call related messages between exchanges at a time when no circuit is associated with the call. The type of call identification to be used in that case is for further study.

One standard label format is specified (§ 2.2) for international use. The same standard label is applicable for national use; admitted deviations from the format of the standard label are described in § 2.3.

2.2 *Standard telephone label*

2.2.1 *Label format*

The *standard label* has a length of 40 bits and is placed at the beginning of the signalling information field. The label structure is as shown in Figure 2/Q.723.

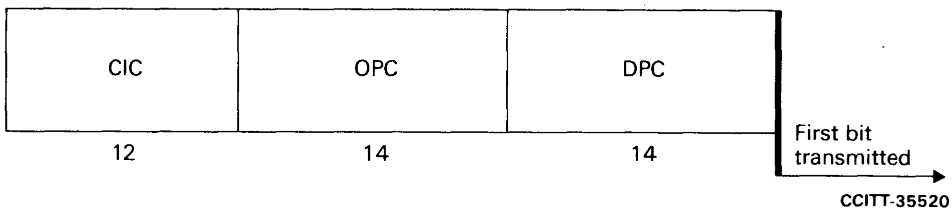


FIGURE 2/Q.723

Standard telephone label structure

The *destination point code* (DPC) indicates the signalling point for which the message is intended, while the *originating point code* (OPC) indicates the signalling point which is the source of the message. The *circuit identification code* (CIC) indicates one speech circuit among those directly interconnecting the destination and the originating points.

The portion of the label that consists of the destination point code and originating point code fields and of the four least significant bits of the circuit identification code field corresponds to the standard routing label specified in Recommendation Q.704, § 13.2.

2.2.2 *Destination and originating point codes*

The standard label structure requires that each telephone exchange in its role as signalling point is allocated a code from code plans established for the purpose of unambiguous identification of signalling points.

Separate code plans will be used for the international signalling network and for different national signalling networks.

The principles of code allocation which apply to the international signalling network are for further study.

The destination point code will be the code applicable to the telephone exchange to which the message is sent. The originating point code will be the code applicable to the telephone exchange from which the message is sent.

2.2.3 *Circuit identification code*

The allocation of circuit identification codes to individual telephone circuits is determined by bilateral agreement and/or in accordance with applicable predetermined rules.

Allocation rules for certain applications are defined below:

a) 2048 kbit/s digital path

   For circuits which are derived from a 2048-kbit/s digital path (Recommendations G.732 [1] and G.734 [2]) the circuit identification code contains in the 5 least significant bits a binary representation of the actual number of the time slot which is assigned to the speech circuit. The remaining bits in the circuit identification code are used where necessary, to identify one among several systems interconnecting an originating and destination point.

b) 8448 kbit/s digital path

   For circuits which are derived from a 8448-kbit/s digital path (Recommendation G.744 [3] and G.746 [4]) the circuit identification code contains in the 7 least significant bits an identification of the channel which is assigned to the speech circuit. The codes in Table 1/Q.723 are used.

   The remaining bits are used, where necessary, to identify one among several systems interconnecting an originating and destination point.

c) Frequency division multiplex (FDM) systems in networks using the 2048-kbit/s pulse code modulation standard

   For frequency division multiplex systems existing in networks that also use the 2048-kbit/s pulse code modulation standard, the circuit identification code contains in the 6 least significant bits the identification of a channel within a group of 60 channels carried by 5 basic frequency division multiplex groups which may or may not be part of the same supergroup.

   The codes in Table 2/Q.723 are used.

TABLE 1/Q.723

0000000	channel 1
0000001	channel 2
|	|
0011111	channel 32
0100000	channel 33
|	|
1111110	channel 127
1111111	channel 128

TABLE 2/Q.723

000000	unallocated	
000001	channel 1	1st basic (FDM) group
|	|	
001100	channel 12	
001101	channel 1	2nd basic (FDM) group
001110	channel 2	
001111	channel 3	
010000	unallocated	
010001	channel 4	
|	|	
011001	channel 12	
011010	channel 1	3rd basic (FDM) group
|	|	
011111	channel 6	
100000	unallocated	
100001	channel 7	
|	|	
100110	channel 12	
100111	channel 1	4th basic (FDM) group
|	|	
101111	channel 9	
110000	unallocated	
110001	channel 10	
110010	channel 11	
110011	channel 12	
110100	channel 1	5th basic (FDM) group
|	|	
111111	channel 12	

2.3 *Optional national labels*

For the purpose of satisfying the requirements imposed by specific characteristics of some national signalling networks, field sizes different from those specified for the standard label are admitted for the destination point code, originating point code and circuit identification code fields in national labels.

3 Telephone signal message formats and codes

3.1 *General*

All telephone signal messages contain a *heading* consisting of two parts, heading code H0 and heading code H1. Code H0 identifies a specific message group (see Recommendation Q.722, § 3.2.1) while H1 either contains a signal code or in case of more complex messages, identifies the format of these messages. The allocation of the H0 and H1 code is summarized in Table 3/Q.723.

TABLE 3/Q.723

Heading code allocation

Message group	H0 \ H1	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
	0000	Spare, reserved for national use															
FAM	0001		IAM	IAI	SAM	SAO											
FSM	0010		CLI	CLU	COT	CCF											
BSM	0011		CIR														
SBM	0100		ACM	CHG													
UBM	0101		SEC	CGC	NNC	ADI	CFL	SSB	UNN	LOS	SST						EUM
CSM	0110		ANC	ANN	CBK	CLF	RAN	FOT									EAM
CCM	0111		RLG	BLO	BLA	UBL	UBA	CCR	RSC								
	1000	Spare, reserved for international and basic national use															
	1001																
	1010																
	1011																
	1100	Spare, reserved for national use															
	1101																
	1110																
	1111																

CCITT-35590

Abbreviations used

ACM Address complete message
ADI Address incomplete signal
ANC Answer signal, charge
ANN Answer signal, no charge
BLA Blocking-acknowledgement signal
BLO Blocking signal
BSM Backward set-up message
CBK Clear-back signal
CCF Continuity-failure signal
CCM Circuit supervision message
CCR Continuity-check-request signal
CFL Call-failure signal
CGC Circuit-group-congestion signal
CHG Charging message
CIR Calling-line-identity-request signal
CLF Clear-forward signal
CLI Calling-line-identity message
CLU Calling-line-identity-unavailable signal
COT Continuity signal
CSM Call supervision message
EAM Extended answer message indication
EUM Extended unsuccessful backward set-up information message indication
FAM Forward address message
FOT Forward-transfer signal
FSM Forward set-up message
IAI Initial address message with additional information
IAM Initial address message
LOS Line-out-of-service signal
NNC National-network-congestion signal
RAN Reanswer signal
RLG Release-guard signal
RSC Reset-circuit signal
SAM Subsequent address message
SAO Subsequent address message with one signal
SBM Successful backward set-up information message
SEC Switching-equipment-congestion signal
SSB Subscriber-busy signal (electrical)
SST Send-special-information tone signal
UBA Unblocking-acknowledgement signal
UBL Unblocking signal
UBM Unsuccessful backward set-up information message
UNN Unallocated-number signal

3.2 *Heading Code H0*

The *heading code* H0 occupies the 4-bit field following the label and is coded as follows:

0000	spare, reserved for national use
0001	forward address messages
0010	forward set-up messages
0011	backward set-up request messages
0100	successful backward set-up information messages
0101	unsuccessful backward set-up information messages
0110	call supervision messages
0111	circuit supervision messages
1000 to 1011	reserved for international and basic national use
1100 to 1111	reserved for national use

3.3 *Forward address messages*

The following types of *forward address messages* are specified and are each identified by a different heading code H1:

- Initial address message
- Initial address message with additional information (see Note)
- Subsequent address message (with one or more address signals)
- Subsequent address message with one (address) signal

Note – The initial address message with additional information is classified, for the time being, in the basic national category of messages. The use of this message in the international network is for further study.

3.3.1 *Initial address message*

The basic format of the *initial address message* is shown on Figure 3/Q.723.

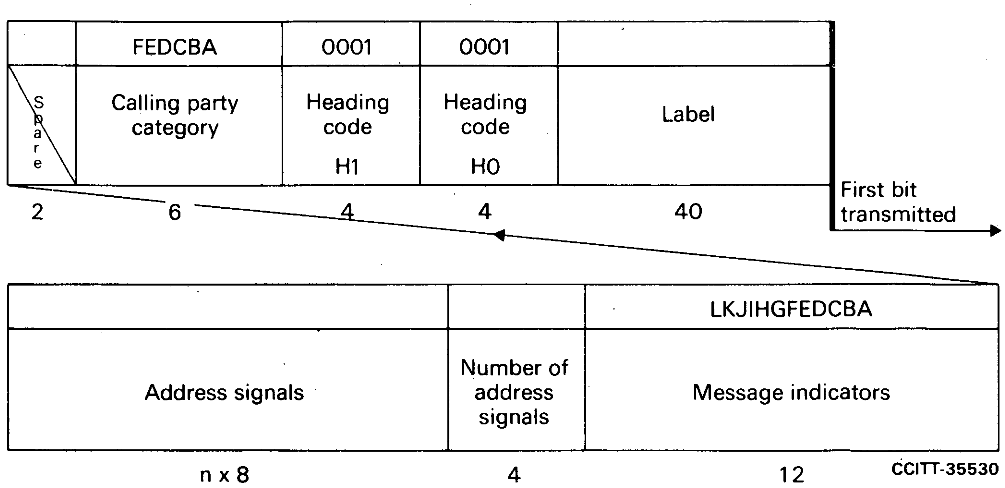


FIGURE 3/Q.723

Initial address message

The following codes are used in the fields of the initial address message.

a) Label: see § 2

b) Heading code H0 is coded 0001

c) Heading code H1 is coded 0001

d) Calling party category indicator

bits F E D C B A	
0 0 0 0 0 0	spare
0 0 0 0 0 1	operator, language French
0 0 0 0 1 0	operator, language English
0 0 0 0 1 1	operator, language German
0 0 0 1 0 0	operator, language Russian
0 0 0 1 0 1	operator, language Spanish
0 0 0 1 1 0 0 0 0 1 1 1 0 0 1 0 0 0	available to Administrations for selecting a particular language provided by mutual agreement
0 0 1 0 0 1	reserved (see Recommendation Q.104 [5]) (note)
0 0 1 0 1 0	ordinary calling subscriber
0 0 1 0 1 1	calling subscriber with priority
0 0 1 1 0 0	data call
0 0 1 1 0 1	test call
0 0 1 1 1 0 to 1 1 1 1 1 1	spare

Note – In national networks code 001001 may be used to indicate that the calling party is a national operator.

e) Spare

The bits in this field are spare for international allocation.

f) Message indicators

bits B A: nature of address indicator
- 0 0 subscriber number
- 0 1 spare, reserved for national use
- 1 0 national (significant) number
- 1 1 international number

bits D C: nature-of-circuit indicator
- 0 0 no satellite circuit in the connection
- 0 1 one satellite circuit in the connection
- 1 0 spare
- 1 1 spare

bits F E: continuity-check indicator
- 0 0 continuity-check not required
- 0 1 continuity-check required on this circuit
- 1 0 continuity-check performed on a previous circuit
- 1 1 spare

bit G: echo-suppressor indicator
- 0 outgoing half echo suppressor not included
- 1 outgoing half echo suppressor included

bits H-L: spare (see Note)

Note – Spare indicators may be used, e.g. to provide the following indications, pending further study:

- incoming international call
- redirected call
- all digital path required
- μ/A law conversion control

g) Number of address signals

A code expressing in pure binary representation the number of address signals contained in the initial address message.

h) Address signals

0000 digit 0
0001 digit 1
0010 digit 2
0011 digit 3
0100 digit 4
0101 digit 5
0110 digit 6
0111 digit 7
1000 digit 8
1001 digit 9
1010 spare
1011 code 11
1100 code 12
1101 spare
1110 spare
1111 ST

The most significant address signal is sent first. Subsequent address signals are sent in successive 4-bit fields.

i) Filler

In case of an odd number of address signals, the filler code 0000 is inserted after the last address signal. This ensures that the variable length field which contains the address signals consists of an integral number of octets.

3.3.2 *Initial address message with additional information*

The basic format of the *initial address message with additional information* is shown on Figure 4/Q.723.

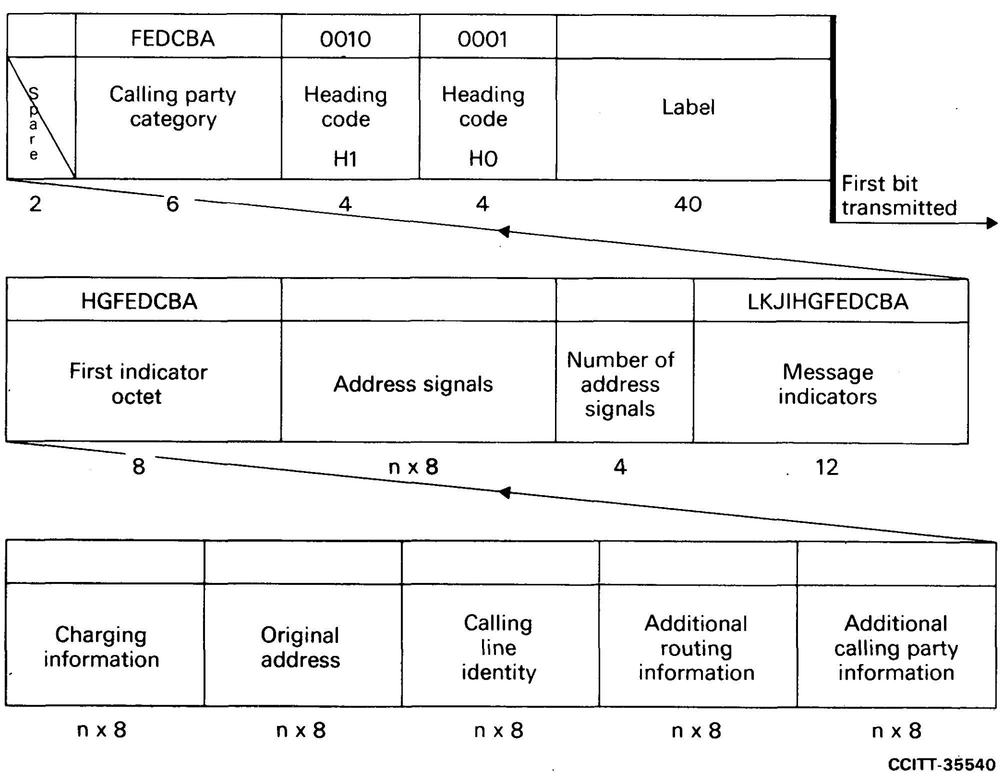


FIGURE 4/Q.723

Initial address message with additional information

The following codes are used in the initial address message with additional information:

a) Label: see § 2

b) Heading code H0 is coded 0001

c) Heading code H1 is coded 0010

d) Calling party category indicator: [see § 3.3.1 d)]

e) Message indicators: [see § 3.3.1 f)]

f) Number of address signals: [see § 3.3.1 g)]

g) Address signals: [see § 3.3.1 h)]

h) First indicator octet

bit A: additional calling party information indicator
- 0 additional calling party information not included
- 1 additional calling party information included

bit B: additional routing information indicator
- 0 additional routing information not included
- 1 additional routing information included

bit C: calling line identity indicator
- 0 calling line identity not included
- 1 calling line identity included

bit D: original address indicator
- 0 original address not included
- 1 original address included

bit E: charging information indicator
- 0 charging information not included
- 1 charging information included

bits F, G: spare

bit H: spare, reserved for indicating the presence or absence of a second indicator octet

i) Additional calling party information: for further study. (This optional field is of fixed length and will indicate additional information concerning the calling party, which is not carried by the calling party's category indicator.)

j) Additional routing information: for further study. (This optional field is of fixed length and will indicate that the call has to be routed in some particular way, due for example to additional customer services.)

k) Calling line identity: for further study. (This optional field is of variable length and will contain the identity of the calling line in a format similar to that used in the calling line identity message, including an explicit indication of the number of address signals and a nature of address indicator.)

l) Original address: for further study. (This optional field is of variable length and will contain the identity of the original destination address to be used in connection with additional subscriber services. Included will be an explicit indication of the number of address signals and a nature of address indicator.)

m) Charging information: for further study. (This optional field will contain information to be sent to a successive exchange for charging and/or accounting purposes.)

3.3.3 *Subsequent address message*

The basic format of the *subsequent address* message is shown in Figure 5/Q.723.

		0000	0011	0001		
Address signals	No. of address signals	Filler	Heading code H1	Heading code H0	Label	
n x 8	4	4	4	4	40	First bit transmitted →

CCITT-35550

FIGURE 5/Q.723

Subsequent address message

The following codes are used in the fields of the subsequent address message (SAM):

a) Label: see § 2

b) Heading code H0 is coded 0001

c) Heading code H1 is coded 0011

d) Address signal is coded as indicated in § 3.3.1 h) (as applicable).

e) Number of address signals: a code expressing in pure binary representation the number of address signals contained in the subsequent address message.

3.3.4 *Subsequent address message with one signal*

The basic format of the *subsequent address message with one signal* is shown in Figure 6/Q.723.

0000		0100	0001	
Filler	Address signal	Heading code H1	Heading code H0	Label
4	4	4	4	40

First bit transmitted →

CCITT-35560

FIGURE 6/Q.723

Subsequent address message with one signal

The following codes are used in the fields of the subsequent address message with one signal:

a) Label: see § 2

b) Heading code H0 is coded 0001

c) Heading code H1 is coded 0100

d) Address signal is coded as indicated in § 3.3.1 h) (as applicable).

3.4 *Forward set-up messages*

The following types of forward set-up messages are specified and are each identified by a different heading code H1:

- calling-line-identity message,
- calling-line-identity-unavailable message,
- continuity-check message.

Unallocated H1 codes in this message group are spare.

3.4.1 *Calling-line-identity message (see Note)*

The basic format of the *calling line identity* message is shown in Figure 7/Q.723.

		DCBA	0001	0010	
Calling line address signals	No. of address signals	Message indicators	Heading code H1	Heading code H0	Label
n x 8	4	4	4	4	40

First bit transmitted →

CCITT-35550

FIGURE 7/Q.723

Calling-line-identity message

The following codes are used in the fields of the calling line identity message:

a) Label: see § 2

b) Heading code H0 is coded 0010

c) Heading code H1 is coded 0001

d) Message indicators

bits B A: nature of address indicator
- 0 0 subscriber number
- 0 1 spare, reserved for national use
- 1 0 national significant number
- 1 1 international number

bits D C: spare

e) Number of address signals

A code expressing in pure binary representation the number of calling line address signals.

f) Calling line address signals

Each signal is coded as indicated in § 3.3.1 h) as applicable.

Note – The calling-line-identity message is classified, for the time being, in the basic national category of messages. The use of this message in the international network is for further study.

3.4.2 *Calling-line-identity-unavailable message*

The basic format of the *calling-line-identity-unavailable* message is shown in Figure 8/Q.723.

0010	0010	
Heading code H1	Heading code H0	Label
4	4	40

First bit transmitted →

CCITT-35570

FIGURE 8/Q.723

Calling-line-identity-unavailable message

The following codes are used in the fields of the calling-line-identity unavailable message:

a) Label: see § 2

b) Heading code H0 is coded 0010

c) Heading code H1 contains the calling-line-identity-unavailable signal and is coded 0010.

3.4.3 *Continuity-check message*

The basic format of the *continuity-check* message is shown in Figure 9/Q.723.

	0010	
Heading code H1	Heading code H0	Label
4	4	40

First bit transmitted →

CCITT-35570

FIGURE 9/Q.723

Continuity-check message

The following codes are used in the fields of the continuity-check message:

a) Label: see § 2

b) Heading code H0 is coded 0010

c) Heading code H1 contains signal codes as follows:

0011 continuity signal
0100 continuity-failure signal

3.5 *Backward set-up request message*

The basic format of the *backward set-up request* message is shown in Figure 10/Q.723.

	0011	
Heading code H1	Heading code H0	Label
4	4	40

First bit transmitted →

CCITT-35570

FIGURE 10/Q.723

Backward set-up request message

The following codes are used in the fields of the backward set-up request message:

a) Label: see § 2

b) Heading code H0 is coded 0011

c) Heading code H1 contains signal codes as follows:

0000 spare
0001 calling-line-identity-request signal

0010 to 1111 } spare

Note – The calling-line-identity-request signal is classified for the time being in the basic national category of messages. The use of this message in the international network is for further study.

3.6 *Successful backward set-up information message*

The following types of successful backward set-up information messages are specified and are each identified by a different heading code H1:

– address-complete message

– charging message

3.6.1 *Address-complete message*

The basic format of the *address-complete* message is shown in Figure 11/Q.723.

HGFEDCBA	0001	0100	
Message indicators	Heading code H1	Heading code H0	Label
8	4	4	40

First bit transmitted →

CCITT-35580

FIGURE 11/Q.723

Address-complete message

The following codes are used in the fields of the address-complete message:

a) Label: see Section 2

b) Heading code H0 is coded 0100

c) Heading code H1 is coded 0001

d) Message indicators

bits B A:	Type of address-complete signal indicators
0 0	address-complete signal
0 1	address-complete signal, charge
1 0	address-complete signal, no charge
1 1	address-complete signal, coin box
bit C:	subscriber-free indicator
0	no indication
1	subscriber-free
bit D:	spare, for international use
bits E-H:	spare, for national use

3.6.2 *Charging message* (see Note)

The basic format of the *charging* message is shown in Figure 12/Q.723.

	0010	0100	
Charging information	Heading code H1	Heading code H0	Label
n x 8	4	4	40

First bit transmitted

CCITT-35585

FIGURE 12/Q.723

Charging message

The following codes are used in the fields of the charging message:

a) Label: see § 2

b) Heading code H0 is coded 0100

c) Heading code H1 is coded 0010

d) Charging information

(The format and codes of the charging information field are for further study.)

Note – The charging message is classified, for the time being, in the basic national category of messages. The use of this message in the international network is for further study.

3.7 *Unsuccessful backward set-up information message*

The basic format of the unsuccessful backward set-up information message is shown in Figure 13/Q.723.

	0101	
Heading code H1	Heading code H0	Label
4	4	40

First bit transmitted

CCITT-35570

FIGURE 13/Q.723

Unsuccessful backward set-up information message

The following codes are used in the fields of the unsuccessful backward set-up information message.

a) Label: see § 2

b) Heading code H0 is coded 0101

c) Heading code H1 contains signal codes as follows:

0000	spare
0001	switching-equipment-congestion signal
0010	circuit-group-congestion signal
0011	national-network-congestion signal
0100	address-incomplete signal
0101	call-failure signal
0110	subscriber-busy signal (electrical)
0111	unallocated-number signal
1000	line-out-of-service signal
1001	send-special-information-tone signal
1010 to 1110	spare
1111	extended unsuccessful backward set-up information message indication

3.8 *Call supervision message*

The basic format of the *call supervision* message is shown in Figure 14/Q.723.

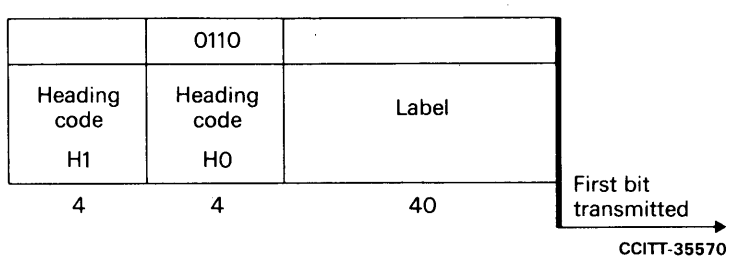


FIGURE 14/Q.723

Call supervision message

The following codes are used in the fields of the call supervision message:

a) Label: see § 2

b) Heading code H0 is coded 0110

c) Heading code H1 contains signal codes as follows:

0000	spare
0001	answer signal, charge
0010	answer signal, no charge
0011	clear-back signal
0100	clear-forward signal
0101	re-answer signal
0110	forward-transfer signal
0111 to 1110	spare
1111	extended answer message indication

3.9 *Circuit supervision message*

The basic format of the *circuit supervision* message is shown in Figure 15/Q.723.

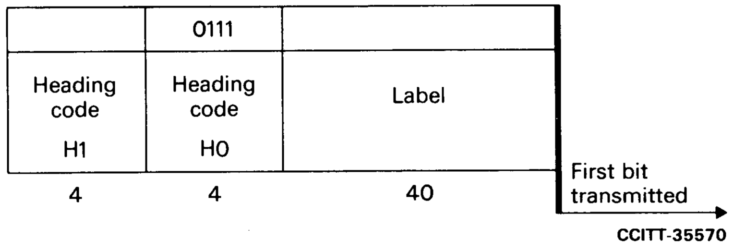


FIGURE 15/Q.723

Circuit supervision message

The following codes are used in the fields of the circuit supervision message:

a) Label: see § 2.

b) Heading code H0 is coded 0111

c) Heading code H1 contains signal codes as follows:

0000	spare
0001	release-guard signal
0010	blocking signal
0011	blocking-acknowledgement signal
0100	unblocking signal
0101	unblocking-acknowledgement signal
0110	continuity-check-request signal
0111	reset-circuit signal
1000 to 1111	spare

References

[1] CCITT Recommendation *Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s*, Vol. III, Fascicle III.3, Rec. G.732.

[2] CCITT Recommendation *Characteristics of 2048-kbit/s frame structure for use with digital exchanges*, Vol. III, Fascicle III.3, Rec. G.734.

[3] CCITT Recommendation *Second order PCM multiplex equipment operating at 8448 kbit/s*, Vol. III, Fascicle III.3, Rec. G.744.

[4] CCITT Recommendation *Characteristics of 8448-kbit/s frame structure for use with digital exchanges*, Vol. III, Fascicle III.3, Rec. G.746.

[5] CCITT Recommendation *Language digit or discriminating digits*, Vol. VI, Fascicle VI.1, Rec. Q.104.

Recommendation Q.724

SIGNALLING PROCEDURES

CONTENTS

1 Normal call set-up

In this Recommendation the signalling procedures are described for the normal call set-up of an international call. The messages and signals are defined in Recommendation Q.722 and the format and content are given in Recommendation Q.723.

1.1 *Initial address message*

An *initial address message* which is sent as the first message of a call set-up generally includes all of the information required by the next international exchange to route the call. The seizing function is implicit in the reception of this initial address message.

The sending sequence of address information will be the country code (not sent to an incoming international exchange) followed by the national (significant) number. For calls to operator positions (code 11 and code 12), refer to Recommendation Q.107 [1].

All digits required for routing the call through the international network will be sent in the initial address message. On calls with a country code in the address (except in the case of calls to special operators), the initial address message will contain a minimum of 4 digits and should contain as many digits as are available. All digits of the address may be included; however, the initial address message can contain one digit in specific circumstances, e.g. national applications.

Selection of the outgoing national circuit normally can start at the incoming international exchange on receipt of the initial address message and signalling can proceed on the first national link.

When no echo suppressor or nature-of-circuit indication is received from a preceding circuit using a signalling system with fewer facilities, the indicators will be considered as received *no* unless positive knowledge is available.

1.2 *Subsequent address message*

The remaining digits, if any, of the address may be sent individually in one-digit messages or in groups in multidigit messages. Efficiency can be gained by grouping together as many digits as possible.

However, to prevent an increase in post-dialling delay in those cases where overlap operation with subscribers' dialling is used, it may be desirable to send the last few digits individually.

Subsequent address messages can be sent on the national network as they are received. If a continuity-check has to be performed on one or more of the international circuits involved in the connection, appropriate measures [e.g. by withholding the last digit(s) of the national number] must be taken at the last common channel exchange to prevent ringing the called subscriber or alerting the operator until the continuity of such speech circuits has been verified.

1.3 *End-of-pulsing (ST) signal*

The *end-of-pulsing* (ST) signal is always sent in the following situations:

a) semiautomatic calls,

b) test calls, and

c) when the end-of-pulsing signal is received from a preceding circuit.

In automatic working, the end-of-pulsing signal will be sent whenever the outgoing international exchange is in a position to know, by digit analysis, that the final digit has been sent. Digit analysis may consist of an examination of the country code and counting the maximum (or fixed) number of digits of the national number. In other cases, the end-of-pulsing signal is not sent and the end-of-address information is determined by the receipt of one of the address-complete signals from the incoming international exchange.

1.4 *Continuity-check of the telephone circuits*

Because the signalling in Signalling System No. 7 does not pass over the speech path, facilities should be provided for making a *continuity-check* of the speech path in the circumstances described below.

The application of the continuity-check depends on the type of the transmission system used for the telephone circuit.

For transmission systems having some inherent fault indication features giving an indication to the switching system in case of fault, a continuity-check is not required. This situation occurs when fully digital circuits are applied.

For analogue circuits with pilot supervision it is sufficient to perform the continuity-check on a statistical basis or by test calls (see § 7.5) [1]. For analogue circuits not using pilot supervision and for mixed circuits, i.e. analogue and digital circuits, the continuity-check should be performed on a per call basis. Within mixed connections, i.e. connections composed of circuits with and without continuity-check on a per call basis, it shall be ensured that the continuity signal be forwarded to the destination point although no continuity-check may have been performed on one or more parts of the end-to-end connection.

The continuity-check is not intended to eliminate the need for routine testing of the transmission path.

The continuity-check of the speech circuit will be done, link-by-link, on a per call basis or by a statistical method prior to the commencement of conversation. Procedures and requirements are specified in § 7.

The actions to be taken when pilot supervision is used are described in § 9.

1.5 *Cross-office check*

For digital exchanges the requirements mentioned in Recommendation Q.504 [2] shall be met. For other exchanges Administrations shall ensure the reliability of a connection through a switching machine (cross-office check) either on a per call basis or by a statistical method. With either method, the probability of the connection being established with an unacceptable speech path transmission quality should not exceed 10^{-5} as the long-term average.

1.6 *Address-complete signals*

An *address-complete* signal will not be sent until the continuity signal has been received and the cross-office check made, if they are applicable.

If the succeeding network does not provide electrical called-party's-line-condition signals, the last Signalling System No.7 exchange shall originate and send an address-complete signal when the end of address signalling has been determined:

a) by receipt of an end-of-pulsing signal;

b) by receipt of the maximum number of digits used in the national numbering plan;

c) by analysis of the national (significant) number to indicate that a sufficient number of digits has been received to route the call to the called party;

d) by receipt of an end-of-selection signal from the succeeding network (e.g. number received signal in Signalling System No. 4); or

e) exceptionally, if the succeeding network uses overlap signalling and number analysis is not possible, by observing that 4 to 6 seconds have elapsed since the last digit was received, and that no fresh information has been received; in such circumstances, transmission to the national network of the last digit received must be prevented until the end of the waiting period which causes an address-complete signal to be sent over the international circuit. In this way, it is ensured that no national answer signal can arrive before an address-complete signal has been sent.

If in normal operation, delay in the receipt of an address-complete or equivalent signal from the succeeding network is expected, the last common channel signalling exchange will originate and send an address-complete signal 15 to 20 seconds after receiving the latest address message. This time-out condition is an upper limit considering the clauses of § 6.4.1 (20 to 30 seconds for outgoing international exchanges in abnormal release conditions).

On receipt of an address-complete signal, the first Signalling System No. 7 exchange will through-connect the speech path of the interconnected circuit [2].

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[1] The application to the international circuits and the quantitative aspects (in particular, the frequency of performing the continuity-check) are for further study.

[2] It is envisaged that in the future evolution of the Telephone User Part (e.g. in the context of an integrated services digital network) the through-connection immediately after sending of the initial address message may become a mandatory requirement.

After an address-complete signal, only the following signals relating to the call set-up may be sent in the backward direction:

a) in normal operation, one of the answer or release-guard signals;

b) call-failure signal; or

c) one of the congestion signals.

Any further information about the called-party's-line-condition will be transmitted to the calling subscriber or operator as audible tones or announcements.

The address-complete signal with the subscriber-free indication is sent when it is known that the called subscriber's line is free (not busy). It must be originated in the called subscriber's exchange, and therefore cannot be followed by one of the unsuccessful backward set-up information signals.

1.7 *Address-incomplete signal*

The determination that the proper number of digits has not been received can be made at once if the end-of-pulsing signal is received or by receipt of an *address-incomplete* signal (or equivalent) from the national network. When overlap working is used and the end-of-pulsing signal has not been received, the address-incomplete signal will be sent by the last Signalling System No. 7 exchange 15 to 20 seconds after receipt of the latest digit.

Each Signalling System No. 7 exchange on receipt of the address-incomplete signal will send the signal to the preceding Signalling System No. 7 exchange, if any, and clear forward the connection. The first Signalling System No. 7 exchange will send a suitable signal on the preceding circuit if the related signalling system permits to do so; otherwise the appropriate tone or announcement for the national network concerned will be sent to the calling party.

1.8 *Congestion signals*

As soon as the congestion condition is detected one of the *congestion* signals (see Recommendation Q.722, § 3.4) is sent without waiting for the completion of a possible continuity-check sequence.

Reception of a congestion signal at any Signalling System No. 7 exchange will cause the clear-forward signal to be sent and cause an appropriate signal to be sent to the preceding exchange if the signalling system allows this or an appropriate tone or announcement to be sent to the originating subscriber or operator.

1.9 *Called-party's-line-condition signals*

The following signals will be sent when the appropriate electrical signals are received at the incoming international exchange from the national network:

- subscriber-busy signal,
- line-out-of-service signal,
- unallocated-number signal,
- send-special-information-tone signal.

The *called-party's-line-condition* signals will be sent without waiting for the completion of a possible continuity check. On receipt of one of these signals, the first Signalling System No. 7 exchange (or the outgoing international exchange) will clear forward the connection and cause an appropriate signal to be sent to the preceding exchange if the signalling system allows this or an appropriate tone or announcement to be sent to the originating subscriber or operator.

Each Signalling System No. 7 exchange on receipt of one of these signals has to clear forward the connection.

1.10 *Answer signals*

The signals *answer, charge* and *answer, no charge* are sent as received from the national network or from the succeeding international link.

The signals answer, charge and answer, no charge are used only as a result of the first off-hook signal from the called party.

1.11 *Clear-back signal*

A *clear-back* signal must not disconnect the speech path at a Signalling System No. 7 exchange. The requirements for the release of a connection in the event that a clear-forward signal is not received are given in Recommendation Q.118 [3].

1.12 *Reanswer and clear-back signal sequences*

Subsequent off-hook, on-hook signals from the called party, such as will result from switch-hook flashing, will cause the following sequence of signals to be sent:

- clear-back,
- reanswer,
- clear-back,
- reanswer,
- etc.

It is necessary that a flashing sequence be retransmitted to the operator (or the preceding link) and that the final condition of the circuit represents the final position of the called party's switch hook.

1.13 *Forward-transfer signal*

The *forward-transfer* signal may be sent in semiautomatic working in either of the following two cases:

a) following a call switched automatically to a subscriber, or following a call established via a special operator, the controlling operator wishes to call in an assistance operator. On receipt of the forward-transfer signal at the incoming international exchange, an assistance operator is called in;

b) following a call via code 11 and 12, the controlling operator wishes to recall the incoming operator at the incoming international exchange. Receipt of the forward-transfer signal at the incoming international exchange recalls the incoming operator on calls completed via the operator positions at the exchange.

1.14 *Clear-forward and release-guard sequence*

The *clear-forward* signal is overriding and all exchanges must be in a position to respond by releasing the circuit and sending a *release-guard* signal at any time during the progress of a call and even if the circuit is in the idle condition. If sent while a circuit is blocked it will not result in unblocking the circuit concerned (see § 5). The fact that the circuit is blocked will not delay the transmission of the release-guard signal.

1.15 *Reset-circuit signal*

In systems which maintain circuit status in memory there may be occasions when the memory becomes mutilated. In such a case the circuits must be reset to the idle condition at both exchanges to make them available for new traffic. Since the exchange with the mutilated memory does not know whether the circuit is idle, busy outgoing, busy incoming, blocked, etc., a *reset-circuit* signal should be sent for each affected circuit. On receipt of a reset-circuit signal the unaffected exchange will:

a) accept the signal as a clear-forward signal and respond by sending a release-guard signal, after the circuit has been made idle, if it is the incoming exchange on a connection in any state of call set-up or during a call;

b) accept the signal as a clear-back or call-failure signal, whichever is appropriate, and respond by sending a clear-forward signal if it is the outgoing exchange on a connection;

c) accept the signal as a clear-forward signal and respond by sending a release-guard signal if the circuit is in the idle condition;

d) if it has previously sent a blocking signal, or if it is unable to release the circuit as described above, respond by the blocking signal. If an incoming or outgoing call is in progress, this call should be disconnected and the circuit returned to the idle (blocked) state. A clear-forward or release-guard signal may be sent. The blocking signal should be acknowledged by the affected exchange. If the acknowledgement is not received, the repetition procedure specified in § 6.4.4 should be followed;

e) if it had previously received the blocking signal, respond by disconnecting any connected call, remove the blocked condition and restore the circuit to the idle state. If an outgoing call had been in progress, respond with a clear-forward or, in all other cases, a release-guard signal;

f) if a reset-circuit signal is received after the sending of an initial address message but before receipt of a backward signal relating to that call, clear the circuit and make an automatic repeat attempt on another circuit if appropriate;

g) if a reset-circuit signal is received after having sent a reset-circuit signal, respond by a release-guard signal. The circuit should be restored to traffic;

h) send an appropriate clearing signal on an interconnected circuit (e.g., clear-forward, or a suitable backward signal).

The affected exchange will then reconstruct its memory according to the received acknowledgement to the reset-circuit signal, and respond to the signals received in the normal way, i.e. release-guard in response to a clear-forward, blocking-acknowledgement in response to a blocking signal.

In addition, an interconnected circuit may be cleared by the use of an appropriate signal. If no acknowledgement to the reset-circuit signal is received before 4-15 seconds, the reset-circuit signal should be repeated. If an acknowledgement for the signal is not received within 1 minute after the sending of the initial reset-circuit signal, maintenance personnel should be notified to permit manual restoration procedures. However, the sending of the reset-circuit signal should continue at 1-minute intervals until maintenance intervention occurs.

1.16 *Diagrams showing signal sequence*

In the following some examples of call set-up sequences are shown diagrammatically (Tables 1/Q.724 and 2/Q.724).

2 Dual seizure with both-way operation

2.1 *Dual seizure*

Since Signalling System No. 7 circuits have the capability of *both-way* operation, it is possible that the two exchanges will attempt to seize the same circuit at approximately the same time.

2.2 *Unguarded interval*

Considering that with Signalling System No. 7:

a) signalling data link propagation time may be relatively long,

b) there may be significant delay due to retransmissions,

c) quasi-associated operation may add extra message transfer time(s) at signalling transfer points,

the unguarded interval during which *dual seizure* can occur may be relatively long in some instances. The exchange must therefore detect dual seizure and take action as defined in § 2.5.

2.3 *Detection of dual seizure*

A dual seizure is detected by an exchange from the fact that it receives an initial address message for a circuit for which it has sent an initial address message (see also § 7.5.1).

2.4 *Preventive action*

Different methods for circuit selection can be envisaged to minimize the occurrence of dual seizure. In the following, two methods are described. Further study is required to determine the field of application of each method and to ensure that the two methods do interwork satisfactorily.

Other methods for circuit selection may also be used provided that they give the same degree of protection against dual seizure also when one of the methods specified is used at the other end.

Method 1

An opposite order of selection is used at each terminal exchange of a both-way circuit group.

Method 2

Each terminal exchange of a both-way circuit group has priority access to the group of circuits which it is controlling (see § 2.5). Of this group the circuit which has been released the longest is selected *(first-in – first-out)*. In addition each terminal exchange of a both-way circuit group has nonpriority access to the group of circuits which it is noncontrolling. Of this group the latest released circuit is selected *(last-in – first-out)*.

TABLE 1/Q.724

Semiautomatic (SA) and automatic (A) terminal traffic

(error-free operation assumed)

Outgoing international exchange		Incoming international exchange
	Normal call to a free subscriber (using continuity-check)	
Address signals from the national network are analysed.		
The outgoing circuit is seized.		
The initial address message is sent: – all address signals including ST in "en bloc" operation, or – all available address signals in overlap operation (a minimum of 4 digits).	Initial address message [a] →	The address message is analysed to determine: – the circuit to be seized – country code not included – nature-of-circuit (satellite or terrestrial) – echo suppressor control – calling-party's-category – continuity-check control.
The echo suppressor, if present, is disabled so that the speech path continuity-check may be performed.		The echo-suppressor, if present, is disabled so that the speech path continuity-check may be performed. The loop for the speech path continuity-check is attached to the incoming circuit.
The transceiver for the speech path continuity-check is attached, and the check-tone is transmitted on the outgoing circuit.	Check-tone [a] → (dotted)	Set-up the call in the national network begins when enough address signals are received for routing (overlap operation).
When the speech path continuity-check and cross-office check have been completed, and if the incoming circuit is used with common channel signalling, when the continuity signal has been received from the national network, the continuity signal is sent, and the transceiver is removed. (When the continuity-check fails, the continuity-failure signal is sent forward. An automatic repeat attempt is made.) The echo suppressor, if present, is enabled as appropriate. The remaining address signals are sent forward in overlap operation.	Check-tone ← (dotted) Continuity → Subsequent address messages →	The check-loop is removed and the echo suppressor, if present, is enabled. Address signals are passed into the national network. The speech path is switched through. The address messages are analysed to determine that all the required address signals have been received (where applicable) [b]. Set-up of the speech path is completed. Subsequent supervisory signals are handled by the processor as appropriate.
On receipt of the address-complete signal, registers (if any) are released and the speech path through-connected, the address signals are erased. Subsequent supervisory signals are handled by the processor as appropriate.	Address-complete ←	
The operator (SA), or the calling subscriber (A) hears ringing tone.	Audible ringing tone ← (dotted)	Ringing tone of the country of destination is sent back.
On receipt of the answer signal, charging [c] measurement of call duration and conversation begin.	Answer ←	Signals from the national network are passed to the outgoing international exchange as follows. The called subscriber answers (charge or no charge).
"Clear-back" is recognized.	Clear-back ←	The called subscriber hangs up.
SA: A clearing supervisory signal to given to the controlling operator. A: After 1–2 min., if there is no clear-forward signal, the international connection is released and charging and measurement of the call duration are ceased.		SA and A: After 2–3 min., if there is no clear-forward signal, the national part of the connection is released.
The outgoing operator (SA) or the calling subscriber (A) clears. When the outgoing equipment is released, the clear-forward signal is sent.	Clear-forward →	"Clear-forward" is recognized. The connection is released, and "clear-forward" is sent to the national network of destination.
"Release-guard" is recognized, and the outgoing circuit is made available for new traffic.	Release-guard ←	When the incoming equipment has released, a release-guard signal is sent back. The circuit is made available for new traffic.

[a] Solid arrows denote common channel signals; dotted arrows are tones sent via the speech path (check-tone and audible tones).

[b] Address-complete signal may come from the national network.

[c] Unless a no-charge answer or address-complete signal has been received.

TABLE 2/Q.724

Semiautomatic (SA) and automatic (A) transit traffic

(error-free operation assumed)

Outgoing international exchange		International transit exchange		Incoming international exchange
		Call to a free subscriber (using continuity-check)		
Address signals from the national network are analysed. The outgoing circuit is seized. The initial address message is sent: – all address signals including ST in "en bloc" operation or – all available address signals in overlap operation.	Initial address message [a)] →	The address message is analysed to determine: – the circuit to be seized – country code included – nature-of-circuit (satellite or terrestrial) – echo suppressor control – calling-party's-category – continuity-check control.		
The echo suppressor, if present, is disabled so that the speech path continuity-check may be performed.			Initial address message →	The address message is analysed to determine: – the circuit to be seized – country code not included – nature-of-circuit (satellite or terrestrial) – echo suppressor control – calling-party's-category – continuity-check control.
The transceiver is attached and the check-tone is transmitted on the outgoing circuit.	Check-tone [a)] - - →	The incoming half-echo suppressor, if present, is disabled; the loop for the speech path continuity-check is attached. When enough address signals have been received to select a route, the outgoing circuit is seized. The address message is sent. The outgoing half-echo suppressor, if present, is disabled.		
	← - - Check-tone			
When the speech path continuity-check and the cross-office check have been completed, the continuity signal is sent and the transceiver is removed. (When the continuity-check fails, the continuity-failure signal is sent forward. An automatic repeat attempt is made.)	Continuity →	The transceiver is attached and the check-tone is transmitted. On receipt of continuity signal, the loop is removed.	Check-tone - - →	The echo suppressor, if present, is disabled and the loop is attached so that the speech path continuity-check may be performed. When enough address signals are received to select the national route, a circuit is seized and the available address signals are passed into the national network (overlap operation).
The echo suppressor, if present, is enabled as appropriate.	Subsequent address messages →	Address signals are passed to the incoming international exchange.	Subsequent address messages →	Address signals are passed into the national network.
		Cross-office check. The transceiver is removed.	← - - Check-tone	

TABLE 2/Q.724 *(continued)*

Outgoing international exchange		International transit exchange		Incoming international exchange
		(When the continuity-check fails, the continuity-failure signal is sent forward. An automatic repeat attempt is made.) The speech path is switched-through.	Continuity →	On receipt of continuity signal, the loop is removed. The echo suppressor, if present, is enabled as appropriate. The last address signal, if withheld, is passed into the national network.
On the receipt of the address-complete signal, registers (if any) are released and the speech path is through-connected. The address signals are erased. Subsequent supervisory signals are handled by the processor as appropriate.	← Address complete	"Address-complete" is passed on to the outgoing international exchange. The address signals are erased. Subsequent supervisory signals are handled by the processor, as appropriate.	← Address complete	The address messages are analysed to determine that all required address signals have been received (where applicable) [b]. On receipt of continuity signal, set-up of the speech path is completed. Subsequent supervisory signals are handled by the processor as appropriate.
The operator (SA) or the calling subscriber (A) hears the audible ringing tone.	← - - -	Audible ringing tone [a] - - -	- - -	Audible ringing tone of the incoming national network is sent back.
				Signals from the national network are passed to the outgoing international exchange as follows:
On receipt of the answer signal, charging [c], measurement of call duration and conversation begin.	← Answer	"Answer" is passed on to the outgoing international exchange.	← Answer	The called subscriber answers (charge or no charge).
"Clear-back" is recognized. SA: A clearing supervisory signal is given to the controlling operator. A: After 1-2 min., if there is no clear-forward signal, the international connection is released and charging and measurement of the call duration are ceased.	← Clear-back	"Clear-back" is passed on to the outgoing international exchange.	← Clear-back	The called subscriber hangs up. SA and A: After 2-3 min., if there is no clear-forward signal, the national part of the connection is released.
The outgoing operator (SA) or the calling subscriber (A) clears. When the outgoing equipment is released, the clear-forward signal is sent.	Clear-forward →	"Clear-forward" is passed on to the incoming international exchange after release of the connection and outgoing equipment.	Clear-forward →	"Clear-forward" is recognized, the connection is released, and "clear-forward" is sent to the national network of destination.
"Release-guard" is recognized and the outgoing circuit is made available for new traffic.	← Release-guard	When the incoming equipment has released, "release-guard" is sent back to the outgoing international exchange. The incoming circuit is made available for new traffic.		
		"Release-guard" is recognized, and the outgoing circuit is made available for new traffic.	← Release-guard	When the incoming equipment has released, the release-guard signal is sent back. The circuit is made available for new traffic.

TABLE 2/Q.274 *(continued)*

Outgoing international exchange		International transit exchange		Incoming international exchange
		Call to a busy subscriber		
The signal sequence is the same as for a call to a free subscriber up to the point where all of the address signals have been passed into the incoming national network.				
SA: A busy indication is given ot the operator. A: The calling subscriber hears the local national busy tone sent by the outgoing (national or international exchange).	Subscriber-busy signal (electrical) ←	"Subscriber-busy" (electrical) is passed back to the outgoing international exchange.	Subscriber-busy signal (electrical) ←	First case: The incoming national network returns the subscriber-busy signal (electrical).
		The circuit is cleared automatically.	Clear-forward →	"Clear-forward" is recognized, the connection is released, and "clear-forward" is sent to the national network of destination.
		"Release-guard" is recognized, and the outgoing circuit is made available for new traffic.	Release-guard ←	When the incoming equipment has released, "release-guard" is sent back. The circuit is made available for new traffic.
The circuit is cleared automatically.	Clear-forward →			
"Release-guard" is recognized and the outgoing circuit is made available for new traffic.	Release-guard ←	When the incoming equipment has released, "release-guard" is sent back to the outgoing international exchange. The incoming circuit is made available for new traffic.		
The operator (SA) or the calling subscriber (A) hears the busy tone of the distant country and clears. The clear-forward sequence follows as above.	← - - -	Busy tone - - -	- - -	Second case: The busy tone of the incoming national network is sent back.
		Congestion (For simplicity, the continuity-check is not shown.)		
Address signal from the national network are analysed. The outgoing circuit is seized. The initial address message is sent.	Initial address message →	When enough address signals have been received to select a route, an attempt is made to seize an outgoing circuit. When blockage occurs in the switching equipment, the switching-equipment-congestion signal is sent backward.		

TABLE 2/Q.724 *(end)*

Outgoing international exchange		International transit exchange		Incoming international exchange
Appropriate action is taken. (For example, an indication is given to the calling subscriber or an automatic repeat attempt is made, etc.)	Switching-equipment-congestion ← Circuit-group congestion ←	When the circuit group is fully occupied, the circuit-group-congestion signal is sent backward (if overflow is inappropriate)		
SA: An indication is given to the operator. A: An indication is given to the calling subscriber.	National-network-congestion ←	The national-network-congestion signal is passed backward. For the other congestion signals, appropriate action is taken. (For example, the congestion signal is sent backward or an automatic repeat attempt is made, etc.)	National-network-congestion ← Switching equipment-congestion ←	If congestion occurs in the national network, the national-network-congestion signal is sent backward. If blockage occurs in the switching equipment at the intenational exchange, the switching-equipment-congestion signal is sent backward.
The outgoing operator (SA) or the calling subscriber (A) clears. Appropriate action is taken. (For example, an indication is given to the calling subscriber, or an automatic repeat attept is made, etc.)	Switching-equipment-congestion ←			

[a] Solid arrows denote common channel signals; dotted arrows are tones sent via the speech path (check-tone, audible tones, busy tone).
[b] The address-complete signal may come from the national network.
[c] Unless a no-charge answer or address-complete signal has been received.

For call control purposes a both-way circuit group can be subdivided into subgroups in an exchange.

It is necessary to take preventive action in cases where Signalling System No. 7 uses a signalling data link with long propagation time.

2.5 *Action to be taken on detection of dual seizure*

Each exchange will control one half of the circuits in a both-way circuit group. On detection of a dual seizure, the call being processed by the control exchange for that circuit will be completed and the received initial address message will be disregarded.

Under these conditions, the call being processed by the control exchange will be allowed to complete although, when continuity-check has to be performed, the continuity of the circuit may have been checked in the direction from noncontrol to control only. The call being processed by the noncontrol exchange will be backed off, switches released, the continuity-check transceiver removed, and the check-loop connected unless or until a continuity signal has been received from the control exchange. A clear-forward signal will not be sent. The noncontrol exchange will make an automatic repeat attempt on the same or on an alternative route.

For the purpose of resolution of dual seizure on both-way circuits, the exchange with the higher signalling point code will control all even-numbered circuits (circuit identification code) and the other exchange the odd-numbered circuits. The designation of control may also be used for maintenance control purposes.

3 Automatic repeat attempt

Automatic repeat attempt, as defined in Recommendation Q.12 [4], is provided in Signalling System No. 7.

An automatic repeat attempt will be made:

- upon failure of the continuity-check (see § 7.3);
- on detection of dual seizure (at the noncontrol exchange) (see § 2.5);
- on receipt of the blocking signal after sending an initial address message and before any backward signal has been received (see § 6);
- on receipt of a reset-circuit signal after sending an initial address message and before a backward signal has been received.

4 Speed of switching and signal transfer in international exchanges

4.1 *Outgoing international exchange*

At the outgoing international exchange:

- if overlap operation is used, the sending of the initial address message shall take place as soon as sufficient digits are received and analyzed to permit the selection of an outgoing circuit;
- if "en bloc" operation is used, the initial address message should be sent as soon as all the digits of the address including the end-of-pulsing signal are available and the outgoing circuit has been chosen.

4.2 *International transit exchange*

At the international transit exchange, the selection of an outgoing circuit should begin as soon as the digits necessary to determine the routing have been received and analyzed.

4.3 *Incoming international exchange*

At the incoming international exchange:

- if overlap operation is used in the national network, the setting-up of the national part of the connection should start as soon as a sufficient number of digits has been received for routing;
- if "en bloc" operation is used in the national network, the setting-up of the national part of the connection should start as soon as all the digits of the address including the end-of-pulsing signal have been received.

5 Blocking and unblocking sequences

The *blocking (unblocking)* signal is provided to permit the switching equipment or maintenance personnel to remove from (and return to) traffic the distant terminal of a circuit because of a fault or to permit testing. Specific conditions for automatic sending of blocking and unblocking signals by the switching equipment in case of use of the interruption control on FDM-circuits appear in § 9.

Since the circuits served by Signalling System No. 7 have both-way capability, the blocking signal can be originated by either exchange. The receipt of the blocking signal will have the effect of prohibiting calls on the relevant circuit outgoing from that exchange until an unblocking signal is received, but will not in itself prohibit calls incoming to that exchange. Acknowledgement sequences are always required for both the blocking and unblocking signals, using the *blocking-acknowledgement* signal, and the *unblocking-acknowledgement* signal, respectively. The acknowledgement is not sent until the appropriate action, either blocking or unblocking, has been taken. The clear-forward signal should not override the blocking signal and return circuits to service which might be faulty. The blocked circuit will be returned to service on transmission of the unblocking-acknowledgement signal at one exchange and on receipt of the unblocking-acknowledgement signal at the other exchange.

In the event of the receipt of a blocking signal:

– after and initial address message has been sent, and

– before a backward signal relating to that call has been received,

an automatic repeat attempt will be made on another circuit. The exchange receiving the blocking signal should clear forward the original attempt in the normal manner after sending the blocking-acknowledgement signal.

If the blocking signal is sent while the speech circuit is engaged on a call and after at least one backward signal relating to that call has been sent by the exchange receiving the blocking signal, this exchange will not seize that circuit for subsequent outgoing calls.

The fact that the circuit is engaged on a call will not delay transmission of the blocking (unblocking)-acknowledgement signal.

If a blocking signal is sent and subsequently an initial address message is received in the opposite direction, the following action is taken:

– for test calls, the call should be accepted, if possible. In the case where the test call cannot be accepted, the blocking signal must be returned;

– for calls other than test calls, the blocking signal must be returned.

Blocking of a circuit by use of the blocking signal should not exceed five minutes, after which an alarm should be given at each terminal of the circuit. Should a call be in progress on the circuit involved, the five minutes time will commence when that call is cleared. If the work on the circuit must exceed five minutes, the circuit should be withdrawn from service.

6 Release of international connections and associated equipment

6.1 *Normal release conditions*

Connections are normally released in the forward direction as a result of the receipt of a clear-forward signal from the preceding exchange.

In addition, the normal release of connections (or circuits) occurs as follows:

– on continuity-check failure (see § 7.3);

– on receipt of an address-incomplete signal (see § 1.6);

– on receipt of one of the congestion signals (see § 1.7);

– on receipt of one of the called-party's-line-condition signals (see § 1.8);

– on receipt of the blocking signal after sending an initial address message and before a backward signal relating to that call has been received (see § 5).

If the conditions for the normal release of connections as described above are not fulfilled, release is provided as follows:

– in the release under abnormal conditions (see § 6.4);

– on receipt of a call-failure signal (see § 6.3);

– on failure to receive a clear-forward signal after sending a clear-back signal (see § 6.4);

- on failure to receive an answer signal (see § 6.4);
- on receipt of a reset-circuit signal (see § 1.15).

Address and routing information are released from memory in each of the exchanges of a connection as described in the following subsections.

6.1.1 *Outgoing international exchange*

Address and routing information stored at the outgoing international exchanges can be erased on receipt of one of the following backward signals:

a) one of the address-complete signals,

b) the address-incomplete signal,

c) one of the congestion signals,

d) one of the called-party's-line-condition signals,

e) the call-failure signal,

or when the connection is cleared earlier and no automatic repeat attempt has to be made.

6.1.2 *Incoming international exchange*

Address and routing information stored at the incoming international exchange can be erased on receipt of one of the backward signals indicated in § 6.1.1 (or equivalent) from a national signalling system, or when one of the following signals has been originated and sent to the outgoing international exchange:

a) one of the address-complete signals,

b) the address-incomplete signal,

c) one of the congestion signals,

d) the call-failure signal,

e) the reset-circuit signal,

or on receipt of a clear-forward signal.

6.1.3 *International transit exchange*

Address and routing information stored at an international transit exchange can be erased on receipt of one of the backward signals indicated in § 6.1.1, on receipt of a clear-forward signal, or when one of the congestion signals is originated in that exchange.

6.2 *Abnormal release conditions – Clear-forward, release-guard sequences*

6.2.1 *Inability to release in response to a clear-forward signal*

If an exchange is unable to return the circuit to the idle condition in response to a clear-forward signal, it should remove the circuit from service and send the blocking signal. Upon receipt of the blocking-acknowledgement signal, the release-guard signal is sent in acknowledgement of the original clear-forward signal.

6.2.2 *Inability to release in response to a backward signal*

If an exchange is unable to release a circuit in response to an address-incomplete, congestion, called-party's-line-condition or call-failure signal, it should remove the circuit from service by sending the blocking signal. Upon receipt of the blocking-acknowledgement signal, the clear-forward signal should be sent in reply to the original backward signal.

6.2.3 *Failure to receive a release-guard signal in response to a clear-forward signal*

If a release-guard signal is not received in response to a clear-forward signal before 4-15 seconds, the clear-forward signal will be repeated.

If, after sending a clear-forward signal, a release-guard signal is not received within a period of one minute after the first clear-forward signal, the maintenance personnel shall be alerted. The repetition of the clear-forward signal is ceased, the circuit is taken out of service, and the blocking signal is sent.

6.3 *Call-failure signal*

The *call-failure* signal is sent as the result of time-out situations, described in § 6.4 and whenever a call attempt fails and other specific signals do not apply, viz:

- the address-incomplete signal,
- the congestion signals, or
- the called-party's-line-condition signals.

Reception of the call-failure signal at any Signalling System No. 7 exchange will cause the clear-forward signal to be sent and, if the signalling system permits to do so, the appropriate signal to be sent to the preceding exchange or the appropriate tone or announcement to be sent to the national network.

6.4 *Abnormal release condition – other sequences*

If the conditions for normal release as covered in § 6.1 are not fulfilled, release will take place under the following conditions.

6.4.1 *Outgoing international exchange*

An outgoing international exchange shall:

a) release all equipment and clear forward the connection on failure to meet the conditions for normal release of address and routing information as covered in § 6.1.1 before 20-30 seconds after sending the latest address message;

b) release all equipment and clear forward the connection on failure to receive an answer signal within the interval specified in Recommendation Q.118 [3];

c) release all equipment and clear forward the connection on failure to receive a clear-forward signal from the national network after having received a clear-back signal within the interval specified in Recommendation Q.118 [3].

6.4.2 *Incoming international exchange*

An incoming international exchange shall:

a) release all equipment, clear forward the connection into the national network and send back a call-failure signal in the following cases:

   - on failure to receive a continuity or continuity-failure signal if applicable (see Recommendation Q.723, § 3.3.1) before 10-15 seconds after receipt of the initial address message; or
   - on failure to receive one of the backward signals indicated in § 6.1.1 (or equivalent) from a national network (where expected) before 20-30 seconds after receipt of the latest address message, unless the timing for sending the address-incomplete signal (see § 1.7) is provided; or
   - on receipt of an address-incomplete signal after an address-complete signal has been generated;

b) send the call-failure signal on failure to receive a clear-forward signal for the incoming circuit before 4-15 seconds after sending an address-incomplete, congestion, call-failure or a called-party's-line-condition signal indicating inability to complete the call.

   If a clear-forward signal is not received within a period of one minute after sending the call-failure signal, the repetition of the call-failure signal should be ceased, maintenance personnel should be alerted, the circuit should be removed from service, and the blocking signal sent.

c) release all equipment and clear forward the connection into the national network on failure to receive a clear-forward signal after sending a clear-back signal within the interval specified in Recommendation Q.118 [3].

6.4.3 *International transit exchange*

An international transit exchange shall:

a) release all equipment, clear forward the connection and send back the call-failure signal in the following cases:

   - on failure to receive a continuity or continuity-failure signal if applicable (see Recommendation Q.723, § 3.3.1) before 10-15 seconds after receipt of the initial address message; or

- on failure to meet the conditions for normal release as covered in § 6.1.3 before 20-30 seconds after sending the latest address message; or

b) send the call-failure signal on failure to receive a clear-forward signal for the incoming circuit before 4-15 seconds after sending an address-incomplete, congestion, call-failure or a called-party's-line-condition signal indicating inability to complete the call.

If a clear-forward signal is not received within a period of one minute after sending the call-failure signal, the repetition of the call-failure signal should be ceased, maintenance personnel should be alerted, the circuit should be removed from service, and the blocking signal sent.

6.4.4 *Failure in the blocking/unblocking sequence*

An international exchange will repeat the blocking or unblocking signal on failure to receive an acknowledgement signal in response to either the blocking or unblocking signals before 4-15 seconds. (See § 5, for the blocking/unblocking sequence.)

If an acknowledgement signal is not received within a period of one minute after sending the initial blocking or unblocking signal, maintenance personnel should be alerted, the repetition of the blocking or unblocking signal should be ceased and the circuit taken out of the service as appropriate.

6.5 *Receipt of unreasonable signalling information*

The Message Transfer Part of the signalling system will avoid mis-sequencing, or double delivery, of messages with a high reliability (Recommendation Q. 706, § 2). However, undetected errors at the signalling link level and exchange malfunctions may produce signalling information in messages that is either ambiguous or inappropriate.

In order to resolve some possible ambiguities in the state of a circuit when unreasonable signals are received the following will apply:

a) if a clear-forward signal is received relating to an idle circuit it will be acknowledged with a release-guard signal;

b) if a release-guard signal is received relating to an idle circuit it will be discarded;

c) if a release-guard signal is received relating to a busy circuit for which a clear-forward signal has not been sent, the circuit will be released and a clear-forward signal will be sent;

d) if a blocking signal is received for a blocked circuit, a blocking-acknowledgement signal will be sent;

e) if an unblocking signal is received for an unblocked circuit, an unblocking-acknowledgement signal will be sent.

Except in certain cases (see § 2) any other unreasonable signalling information received will be discarded. If the discarding of the information prevents a call from being completed that call will eventually be released by the expiry of a time out [3].

7 Continuity-check for 4-wire speech circuits

7.1 *General*

This specification relates only to that part of a 4-wire connection served by Signalling System No. 7. The part of the speech path to be checked may include a circuit with speech interpolation. As the presence of active echo suppressors in the circuit would interfere with the continuity-check, it is necessary to disable the suppressors during the check and to re-enable them, if required, after the check has been completed.

The *transceiver* (check-tone transmitter and receiver) is connected to the *go* and *return* paths of the outgoing circuit at the first and each succeeding exchange, excluding the last exchange, in that part of the connection served by Signalling System No. 7. The *check-loop* should be connected to the *go* and *return* paths of the incoming circuit at each exchange except the first in that part of the connection served by Signalling System No. 7. A continuity-check is considered successful when a tone is sent on the *go* path and is received on the *return* path within acceptable transmission and timing limits.

[3] Possible further actions to be taken on receiving unreasonable signalling information are for further study.

7.2 *Transmission requirements*

7.2.1 *Transmitting equipment*

The *check-tone* frequency will be 2000 ± 20 Hz. For international application the sending level of the check-tone will be −12 ± 1 dBm0.

7.2.2 *Check-loop*

The check-loop will have a loss of 0 dB, taking into account any difference between the relative levels of the two paths at the point of attachment.

7.2.3 *Receiving equipment*

The check-tone receiver will have the following characteristics:

a) *Operating requirements*

Check-tone frequency: 2000 ± 30 Hz

Check-tone level range for international application:

The absolute power level N of the check-tone shall be within the limits
$(-18 + n) \leqslant N \leqslant (-6 + n)$ dBm

where n is the relative power level at the receiver input.

Recognition time: 30-60 ms

The frequency and level range tolerances allow for variations at the sending end and for variations in line transmission that are considered acceptable.

b) *Non-operating requirements*

Signal frequency: outside the frequency band 2000 ± 200 Hz

Signal level for international application: below or equal to $-22 + n$ dBm.

The limit is 10 dB below the nominal absolute level of the check-tone at the input of the receiver. If the level falls below this point, transmission is considered unacceptable.

Signal duration: shorter than 30 ms

The level range of $(-18 + n) \leqslant N \leqslant (-6 + n)$ dBm will serve as a Go/No-go check on the links in that part of the international connection served by Signalling System No. 7.

c) *Release requirements*

If the receiver is used to test for the removal of check-tone (see § 7.3):

- after recognition of tone, interruptions of up to 15 ms shall be ignored; this will prevent switching through the speech path prematurely;
- the indication of tone removal should not be delayed more than 40 ms; and
- the release level of the receiver should be lower than $-27 + n$ dBm for international application.

7.3 *Continuity-check procedure*

Decision on whether continuity-check should be performed or not on a given circuit should be made by an outgoing exchange according to the criteria described in § 1.4. The outgoing exchange will indicate whether continuity-check is required or not by the continuity-check indicator in the initial address message (Recommendation Q.723, § 3.3.1). If it is required, the outgoing exchange will connect a transceiver to the speech circuit when it sends an initial address message. If continuity-check is not required either on the incoming circuit or on the outgoing circuit, the outgoing exchange can switch-through the speech path immediately after having sent the initial address message.

A description of the procedure using the specification and description language is given in the state transition diagrams in Figures 4/Q.724 and 5/Q.724. The Signalling System No. 7 exchange will send forward the continuity signal after completion of all the following actions:

- the continuity-check performed on the outgoing circuit is completed;
- the speech path across the exchange has been checked and found correct (see § 1.4); and
- if the continuity-check indicator in the received initial address message indicates that continuity-check is being (has been) performed on previous circuit(s), receipt of a continuity signal from the preceding exchange.

The speech path may be switched through at an international transit or incoming exchange and the transceiver disconnected after the continuity-check of the circuit has been successfully completed. However, the switching through of the speech path should be delayed until the residual check-tone has propagated through the return path of the speech circuit.

This determination may be made by timing, or by using the check-tone receiver to test for the removal of the check-tone, or other appropriate means.

On receipt of the continuity signal in the following international exchange, the continuity-check loop will be removed if inserted. Also, any digits of the national number which were withheld may be released (see § 1.2).

At the Signalling System No. 7 exchange, on failure of the outgoing circuit to satisfy the continuity-check:

- the continuity-check transceiver will be removed and an automatic repeat attempt will be made on another circuit,

- a continuity-failure signal will be sent to the following exchange.

A repeat of the continuity-check of the speech path will be made on the failed outgoing circuit within 1-10 seconds of detection of the continuity-check failure.

The second continuity-check will be initiated by the Signalling System No. 7 exchange detecting the failure using the continuity-check-request signal.

If the repeated check passes on this call, the speech circuit will be returned to idle with a clear-forward/release-guard sequence. If the second check fails, the maintenance staff will be alerted that a failure has occurred and the check will be repeated at intervals of 1-3 minutes. The repeated continuity-check will only be finished when continuity is detected.

According to transmission maintenance requirements, Signalling System No. 7 should provide for:

a) a print-out each time a second continuity-check is started. In such cases, the circuit involved should be identified;

b) a print-out each time a continuity-check results is a warning being given to maintenance personnel.

Since a continuity-check failure can be caused by a faulty transceiver, precautions should be taken to ensure a low probability of selecting a faulty one for both the initial continuity-check and the second check, e.g. by ensuring the selection of a different transceiver for each of the checks.

7.4 *Continuity-check timing*

7.4.1 *Time-out period*

The continuity-check is considered to have failed if the receiver has not responded within a period determined by the Administration concerned. This period should not exceed two seconds.

The time-out period of the continuity-check should always exceed the continuity recognition time, T_{CR}, given by:

$$T_{CR} = 2T_P + T_{IAM} + T_{TC} + T_L + T_R - T_T$$

where

T_P One-way propagation time of the speech circuit and the signalling link (where these times are the same),

T_{TC} Speech interpolation clip time for two speech interpolation systems in series (for connections not using speech interpolation $T_{TC} = 0$),

T_R Receiver response time,

T_L Loop connecting time (maximum),

T_T Transceiver connecting time (minimum),

T_{IAM} Emission time of the longest initial address message.

If retransmission of an initial address message is to be included in T_{CR}, the following formula may be used:

$$T_{CR} = 4T_P + 2T_{IAM} + T_{FISU} + 2T_X + T_L + T_R - T_T$$

where

T_{FISU} Emission time of a fill-in signal unit (length of a fill-in signal unit),

T_X Time between receiving an initial address message and emitting a signal unit containing an acknowledgement for that initial address message, or

time between receiving a signal unit asking for retransmission and emitting the initial address message to be retransmitted.

7.4.2 *Switching of continuity-check equipment*

The connection and disconnection of the equipment used for the continuity-check and also the disabling and subsequent enabling of echo suppressors should be related to the following stages of progress in the establishment of the connection:

a) *Preparation at Signalling System No. 7 exchange applying the transceiver* – Action should be initiated when the initial address message is available for transmission in the Message Transfer Part.

b) *Preparation at Signalling System No. 7 exchange connecting the check-loop* – Action should be initiated at the moment of recognition of the initial address message received.

c) *Disconnection at Signalling System No. 7 exchange connecting the check-loop* – Action follows the receipt of the continuity signal, the continuity-failure signal or the clear-forward signal, or the emission of signals indicating that the call cannot be established, e.g. circuit-group-congestion signal.

d) *Disconnection at Signalling System No. 7 exchange applying the transceiver* – Action should be initiated on the successful completion or the failure of the continuity-check.

Exceptionally, if disconnection has not previously occurred, action should be initiated at the moment of recognition of the address-complete signals, the answer signals, signals indicating that the call cannot be established, or on the emission of a clear-forward signal.

It is recommended that the mean time, both for the connection and for the disconnection, is less than 100 ms. A mean time of 200 ms should not be exceeded.

7.5 *Continuity-check test calls*

7.5.1 The following procedure may be used in the cases when continuity-check is performed by test calls. This procedure is used to test a single interexchange circuit, which must be idle when the procedure is initiated.

7.5.2 When the outgoing Signalling System No. 7 exchange intends to initiate the procedure, it sends to the following exchange a continuity-check-request message and it connects the transceiver to the outgoing speech circuit. On receipt of the continuity-check-request message, the following exchange connects the loop to the involved circuit. On detection of the backward tone within the time-out specified in § 7.4.1, the outgoing exchange will disconnect the transceiver and the circuit will be returned to idle with a clear-forward/release-guard sequence.

7.5.3 In the case that no backward tone is detected within the specified time-out, the same actions apply as in the case of continuity-check failure during normal call set-up, see § 7.3 (the clause referring to the repeat attempt is not relevant in this case).

7.5.4 If an exchange will receive an initial address message relating to a circuit for which it has sent a continuity-check-request message (i.e. in case of collision on a both-way operated circuit), it will abort the continuity-check test call, disconnect the transceiver and complete the incoming call.

An exchange receiving a continuity-check-request message after having sent an initial address message, will ignore it and continue the call set-up procedure.

8 Continuity-check for 2-wire speech circuits

In general the same procedure as described in § 7 is used for the continuity-check of 2-wire speech circuits except the check-loop which has to be replaced by a transponder and the fact that in the backward direction the frequency 1780 ± 20 Hz is used. A more detailed specification of this particular case needs further study.

9 Interruption control on FDM circuits

9.1 *General*

Interruption of the pilot in frequency-division multiplex systems corresponds to loss of continuity of speech circuits or a considerable reduction of level. Therefore a switching equipment monitoring this indication (see § 1.4) should inhibit local seizure of the concerned speech circuits in case of interruption. Moreover, seizure by the remote exchange should be prevented, as long as the interruption persists, by sending blocking and unblocking signals as specified in § 9.2 below.

When interruption control is implemented, possible use of the specifications contained in Recommendation Q. 416 [5] could be applied.

9.2 *Blocking and unblocking of speech circuits*

Blocking signals are sent to the other end, with regard to the relevant speech circuits, whenever an interruption is detected which lasts more than 4-15 seconds (provisional values).

When an interruption indicated terminates, unblocking signals are sent to the other end after 4-15 seconds (provisional value), provided that blocking signals were previously sent on occurrence of the interruption.

10 State transition diagrams

10.1 *General*

§ 10 contains the description of the signalling procedures described in this Recommendation in the form of state transition diagrams according to the CCITT Specification and Description language (SDL).

In order to facilitate functional description, the Telephone User Part signalling procedure function is divided into functional blocks, as shown in Figure 1/Q.724; state transition diagrams are provided for each functional block, as shown below:

- Signalling procedure control (SPC): Figure 2/Q.724
- Call processing control (CPC): Figure 3/Q.724
- Continuity-check outgoing (CCO): Figure 4/Q.724
- Continuity-check incoming (CCI): Figure 5/Q.724
- Continuity-recheck outgoing (CRO): Figure 6/Q.724
- Continuity-recheck incoming (CRI): Figure 7/Q.724
- Other functional blocks (for further study).

The detailed functional breakdown shown in the following diagrams is intended to illustrate a reference model and to assist interpretation of the text in the earlier sections. The state transition diagrams are intended to show precisely the behaviour of the signalling system as viewed from a remote location. It must be emphasized that the functional partitioning shown in the following diagrams is used only to facilitate understanding of the system behaviour and is not intended to specify the functional partitioning to be adopted in a practical implementation of the signalling system.

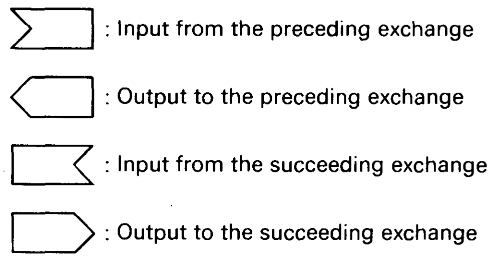
10.2 *Drafting conventions*

a) Acronyms used in Figures 1/Q.724 to 7/Q.724 are listed in § 10.3.

b) External inputs and outputs are used for interactions with different functional blocks. Internal inputs and outputs are used for interactions within each functional block, e.g. to indicate control of time-outs.

c) External inputs and outputs contain as part of their name acronyms of their source and destination functional block names with an arrow in between, e.g. Start CPC→CCO.

d) For interexchange signals or signal messages, external input and output symbols are used as shown below to indicate the direction of each signal on message.



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Note – The functions covered by the present Figures 1/Q.724 to 7/Q.724 are limited in the following points:

- they refer only to call processing functions in international transit exchanges;
- they do not include the blocking and unblocking procedures, the handling of the forward-transfer signal and that of the reset-circuit signal;
- they do not necessarily cover all the abnormal situations.

However, they include operations on receipt of unreasonable signalling information as specified in § 6.5, except the case of the blocking and unblocking signals as mentioned above.

The diagrams for functions not presently covered are for further study.

10.3 *Abbreviations and timers used in Figures 1/Q.724 to 7/Q.724*

General

OGC Outgoing trunk circuit
ICC Incoming trunk circuit
NOK Not OK
CC Continuity-check

Function block names (see Figure 1/Q.724)

SPRC Signalling procedure control
CPC Call processing control
CCO Continuity-check outgoing
CCI Continuity-check incoming
CRO Continuity-recheck outgoing
CRI Continuity-recheck incoming
L3 Level 3 (Signalling network functions)
L4 Level 4 (Telephone user part)

Messages and signals

ACM Address complete message
ADI Address incomplete signal
ANC Answer signal, charge
ANN Answer signal, no charge
CBK Clear-back signal
CCF Continuity-failure signal
CCH Continuity-check indicator:
- 0: CC not required
- 1: CC required on this circuit
- 2: CC is being (has been) performed on a previous circuit

CCR	Continuity-check-request signal
CFL	Call-failure signal
CGC	Circuit-group-congestion signal
CLF	Clear-forward signal
COT	Continuity signal
BLO	Blocking signal
IAM	Initial address message
LOS	Line-out – of-service signal
NNC	National-network-congestion signal
RAN	Reanswer signal
RLG	Release-guard signal
SAM	Subsequent address message
SEC	Switching-equipment-congestion signal
SSB	Subscriber-busy signal (electrical)
SST	Send-special-information-tone signal
UNN	Unallocated-number signal.

Timers

T1	Timer "waiting for continuity or continuity-failure signal" [10-15 seconds, see § 6.4.3 a)]
T2	Timer "waiting for address-complete signal" [20-30 seconds, see § 6.4.3 a)]
T3	Timer "waiting for clear-forward signal after sending unsuccessful message" [4-15 seconds, see § 6.4.3 b)]
T4	Timer "waiting for clear-forward signal after sending call-failure signal" [4-15 seconds, see § 6.4.3 b)]
T5	Timer "stop sending call-failure messages on time out" [1 minute, see § 6.4.3 b)]
T6	Timer "waiting for release-guard signal" (4-15 seconds, see § 6.2.3)
T7	Timer "stop sending clear-forward signal on time out" (1 minute, see § 6.2.3)
T8	Timer "waiting for backward check-tone" (should not exceed 2 seconds, see § 7.4.1)
T9	Timer "delay to start first-time continuity-recheck" (1-10 seconds, see § 7.3)
T10	Timer "delay for multiple retests of continuity" (1-3 minutes, see § 7.3)

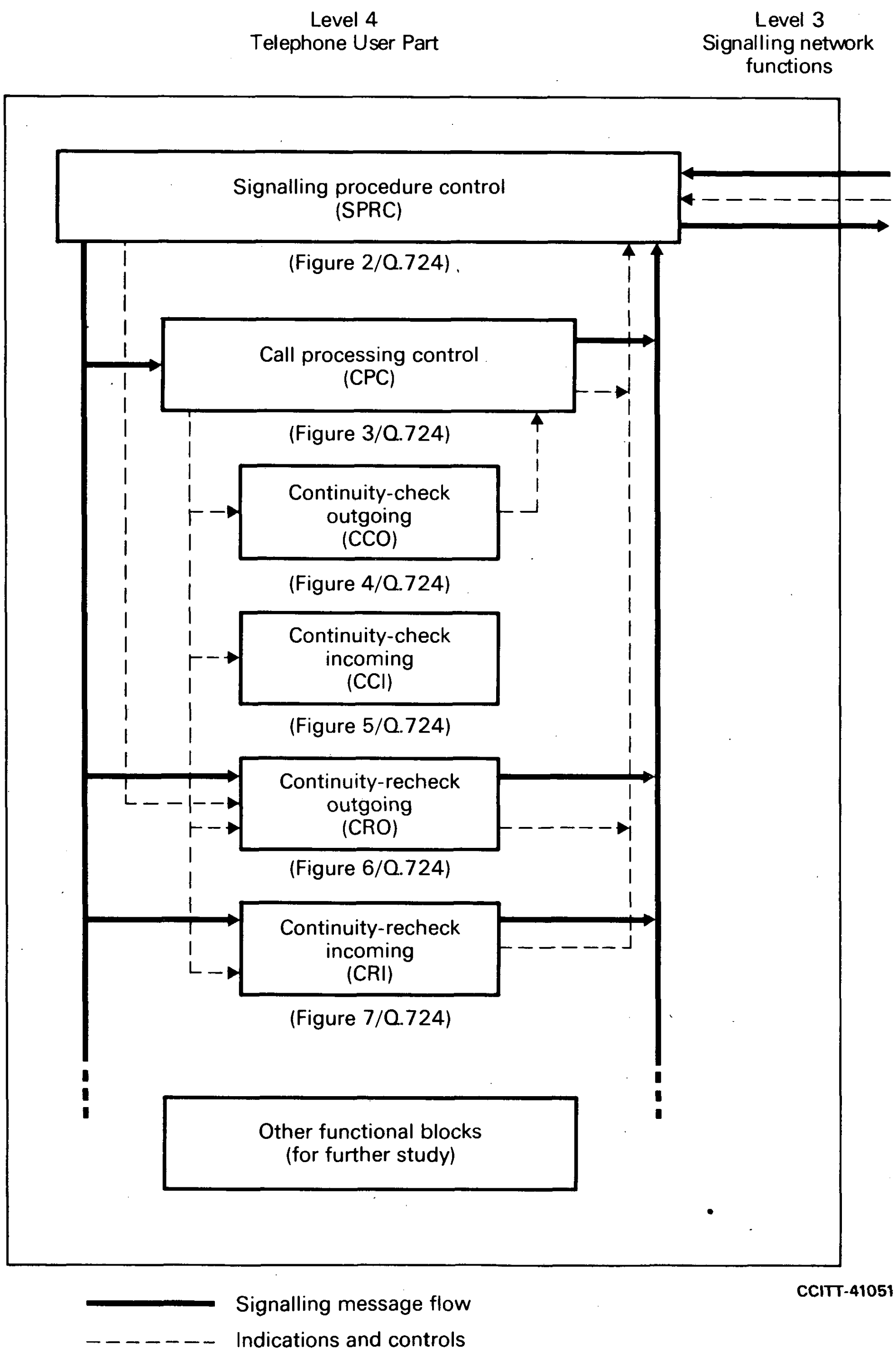
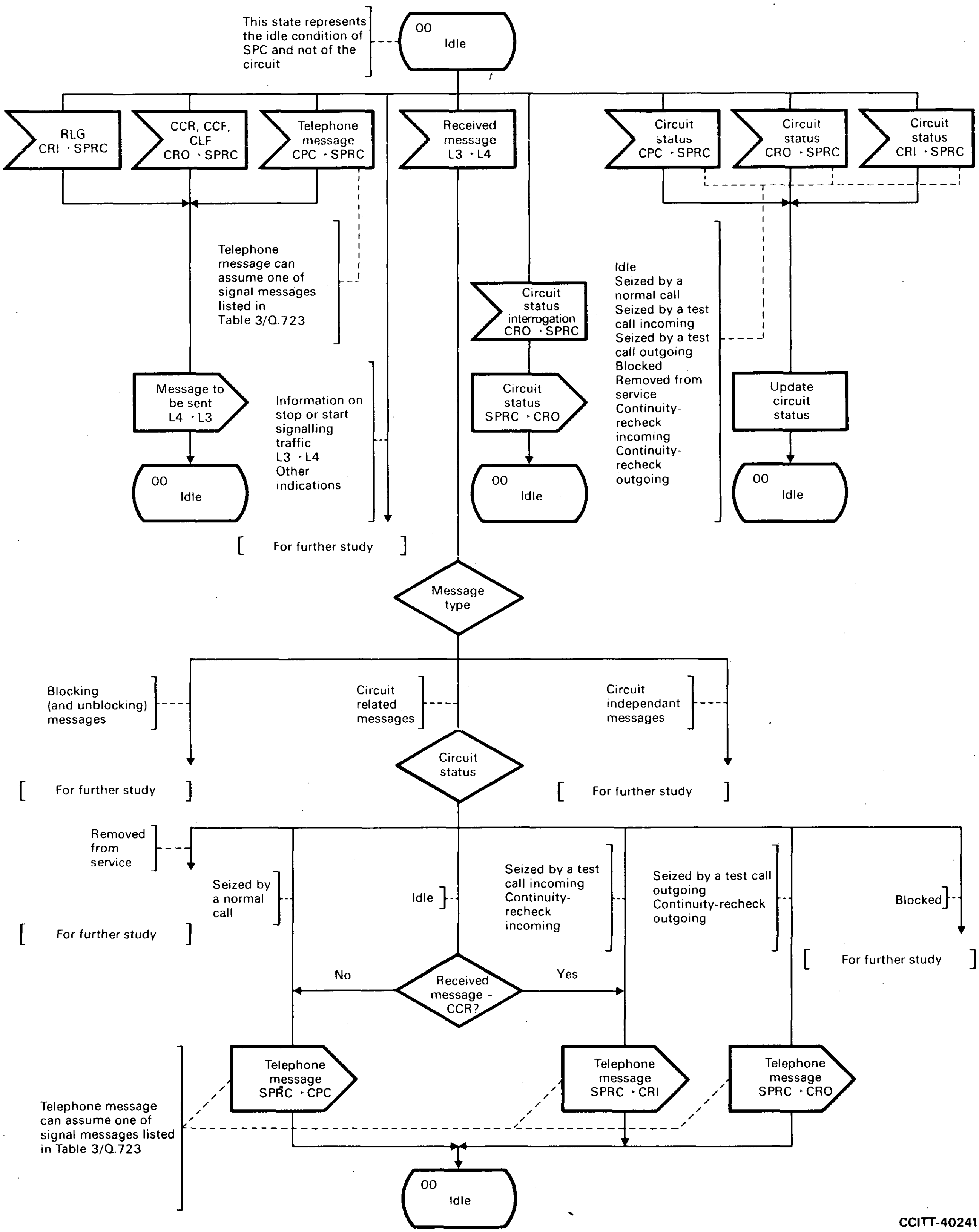


FIGURE 1/Q.724

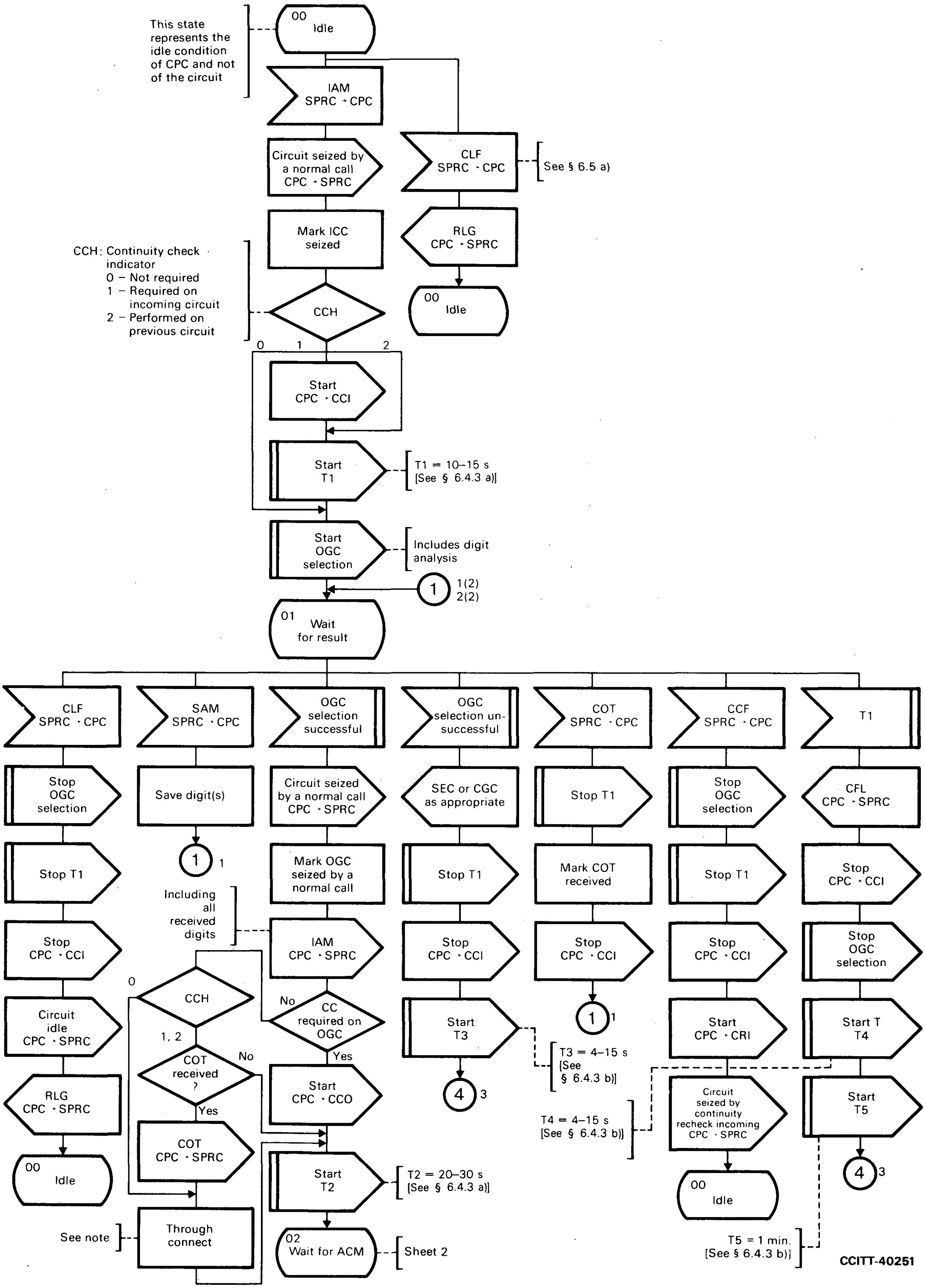
Level 4 – Telephone User Part functions



Note – In this particular figure, the direction of input and output symbols does not necessarily represent the forward or backward direction of messages contained in them.

FIGURE 2/Q.724

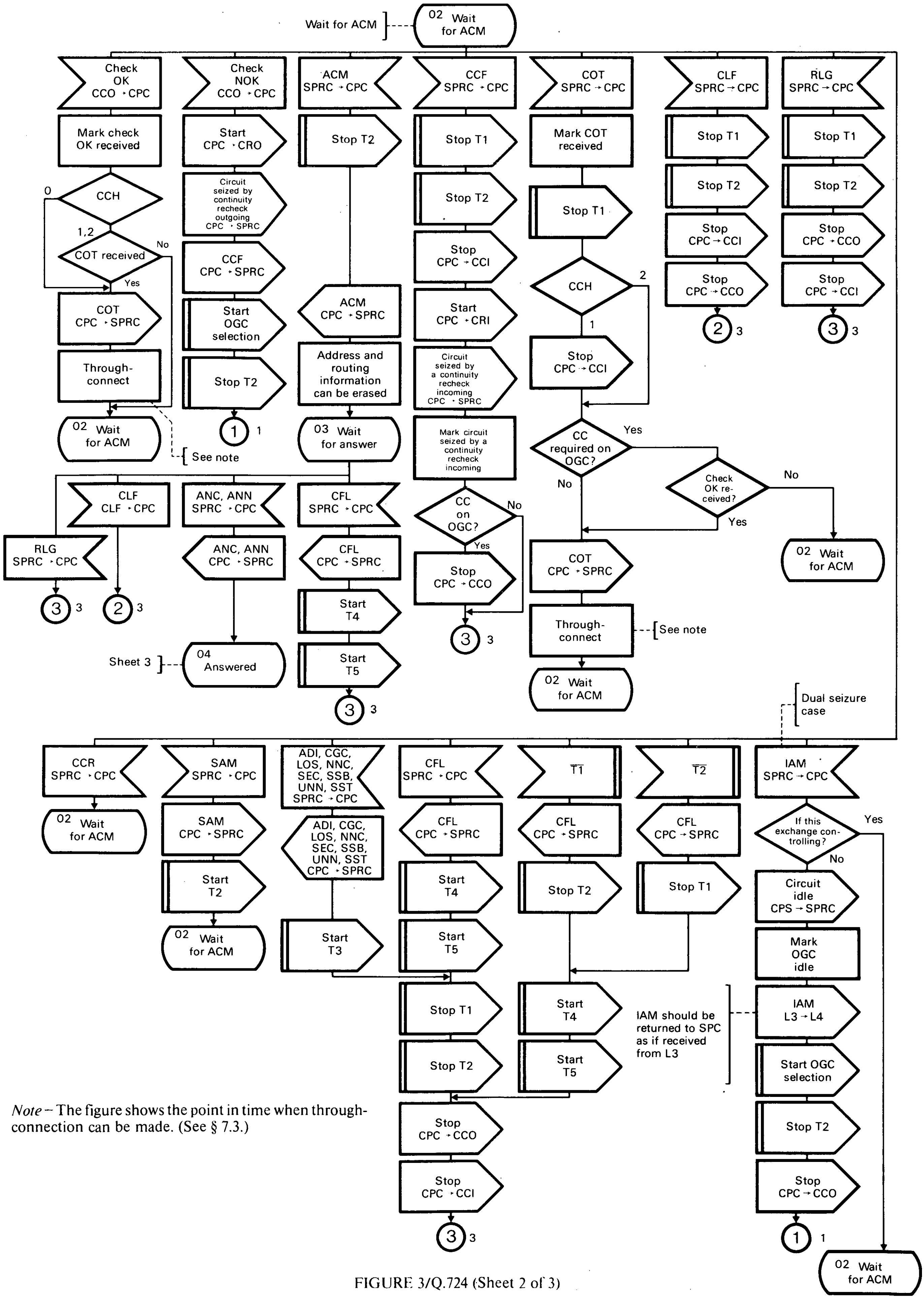
Signalling procedure control (SPC)



Note – The Figure shows the point in time when through-connection can be made (sse § 7.3).

FIGURE 3/Q.724 (sheet 1 of 3)

Call processing control (CPC)



Note – The figure shows the point in time when through-connection can be made. (See § 7.3.)

FIGURE 3/Q.724 (Sheet 2 of 3)

Call processing control (CPC)

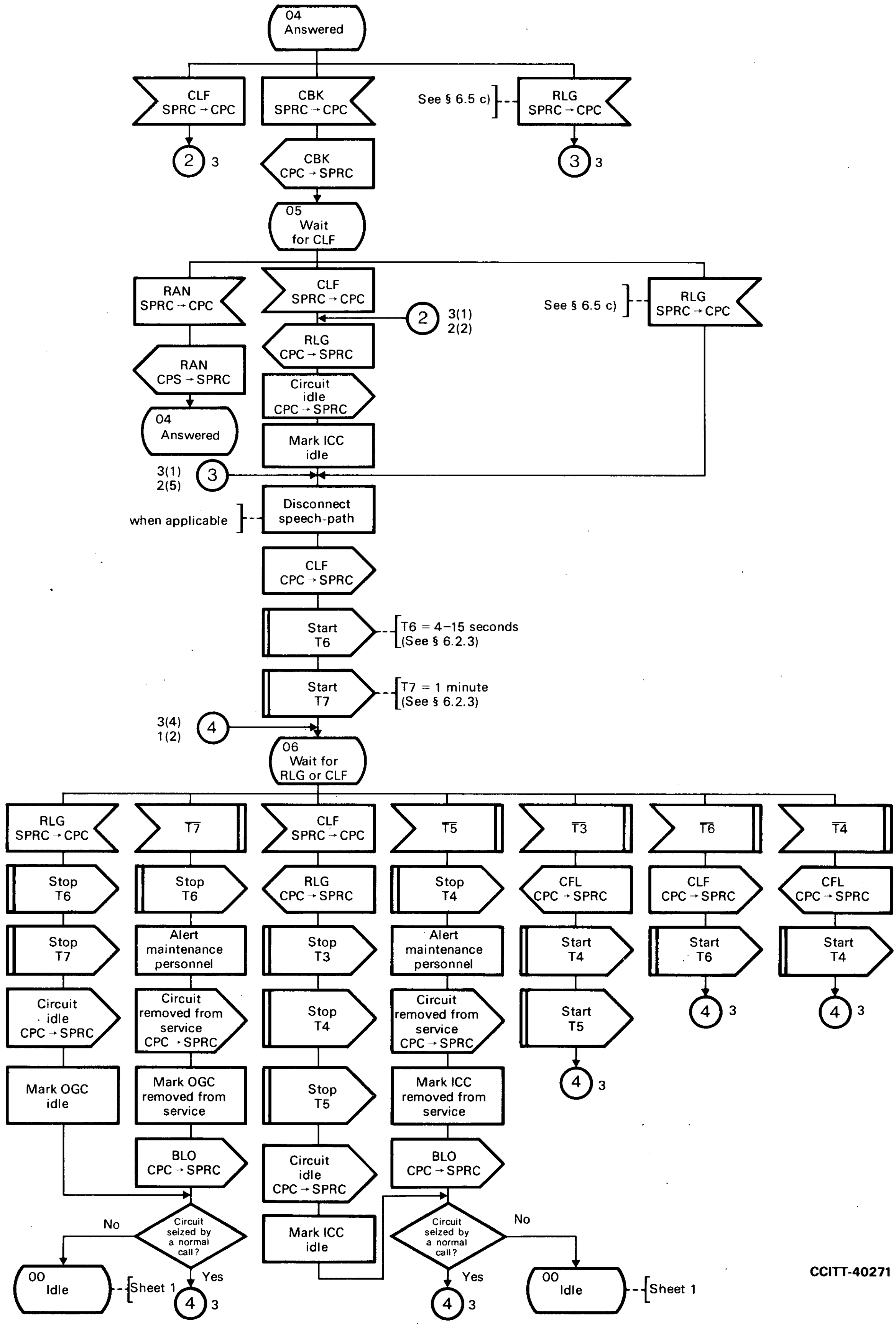


FIGURE 3/Q.724 (Sheet 3 of 3)

Call processing-control (CPC)

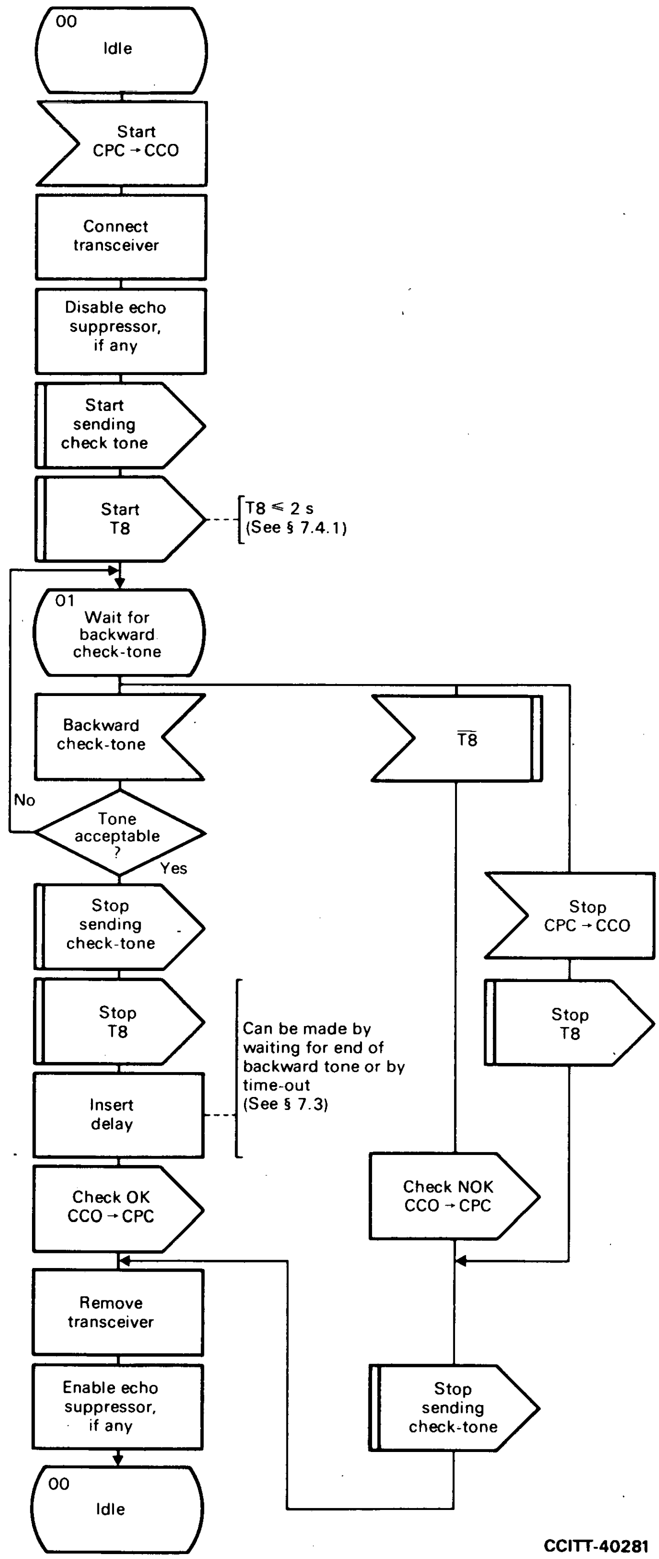


FIGURE 4/Q.724

Continuity-check outgoing (CCO)

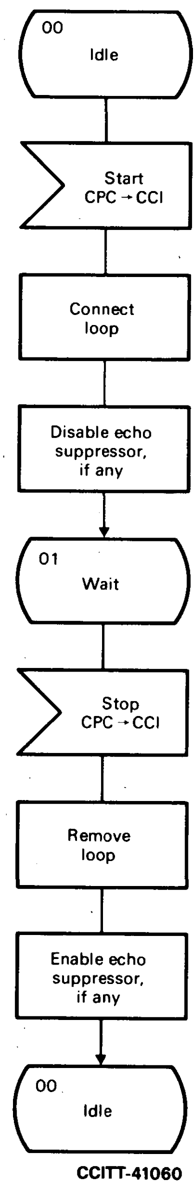


FIGURE 5/Q.724
Continuity-check incoming (CCI)

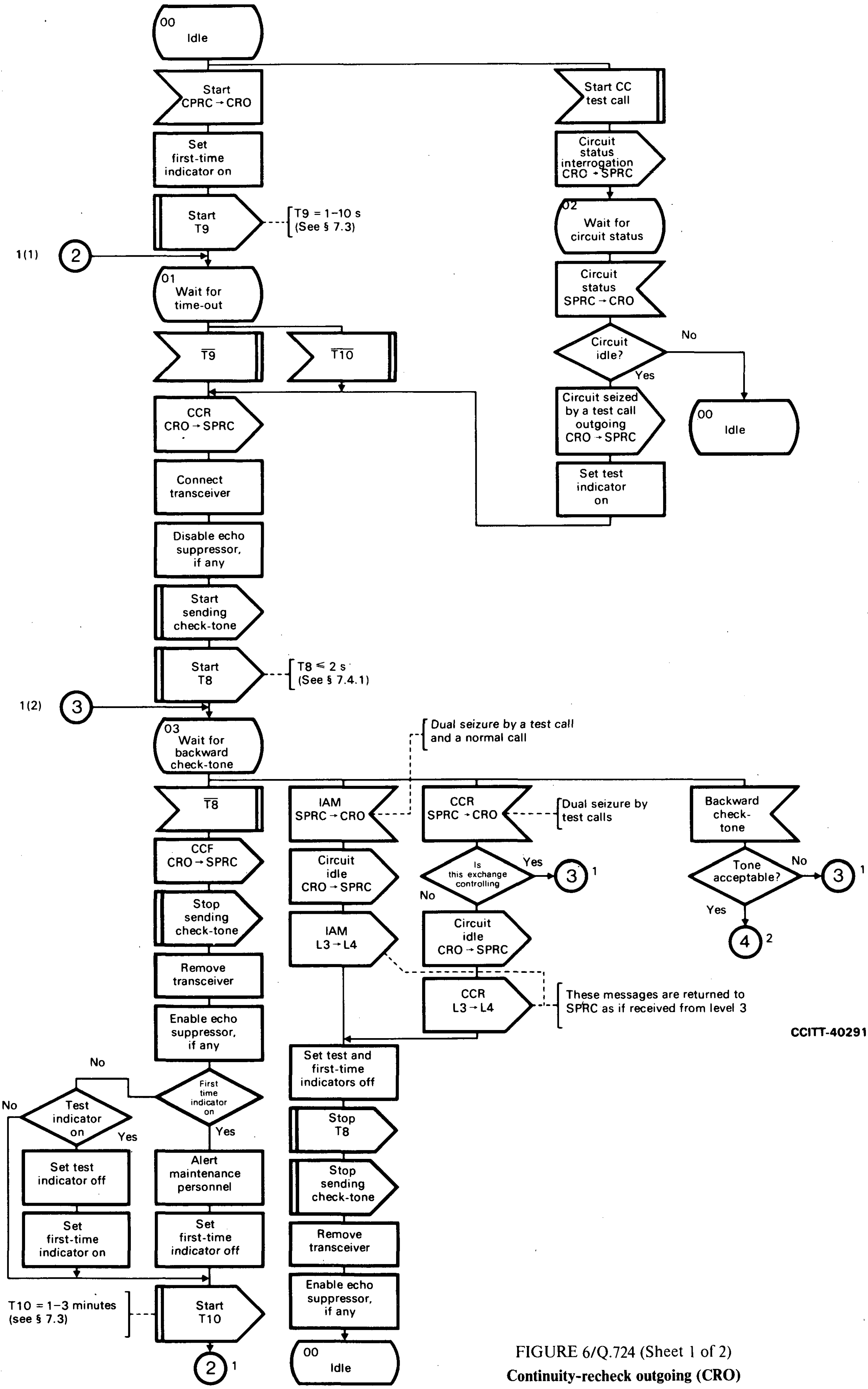


FIGURE 6/Q.724 (Sheet 1 of 2)

Continuity-recheck outgoing (CRO)

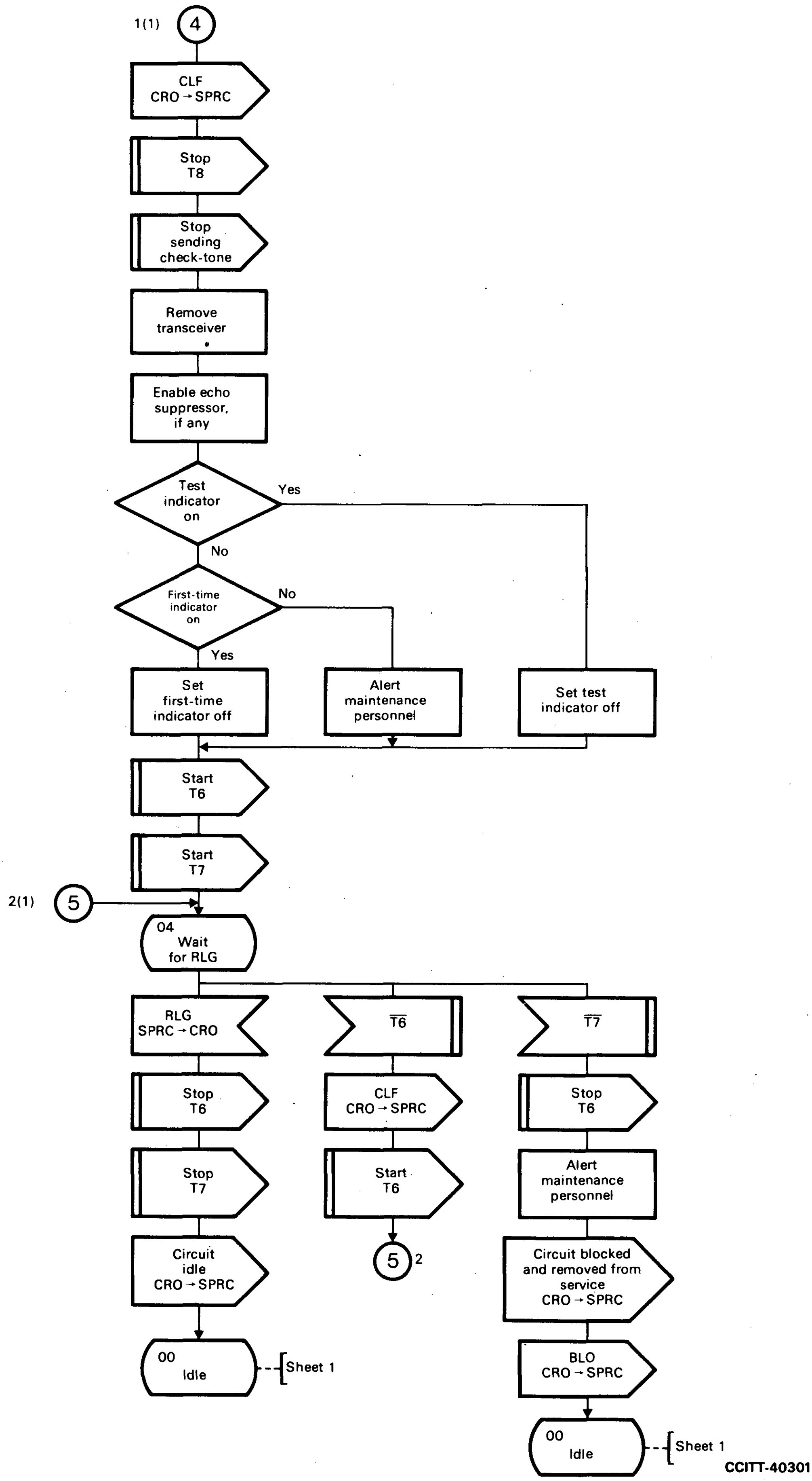


FIGURE 6/Q.724 (Sheet 2 of 2)

Continuity-recheck outgoing (CRO)

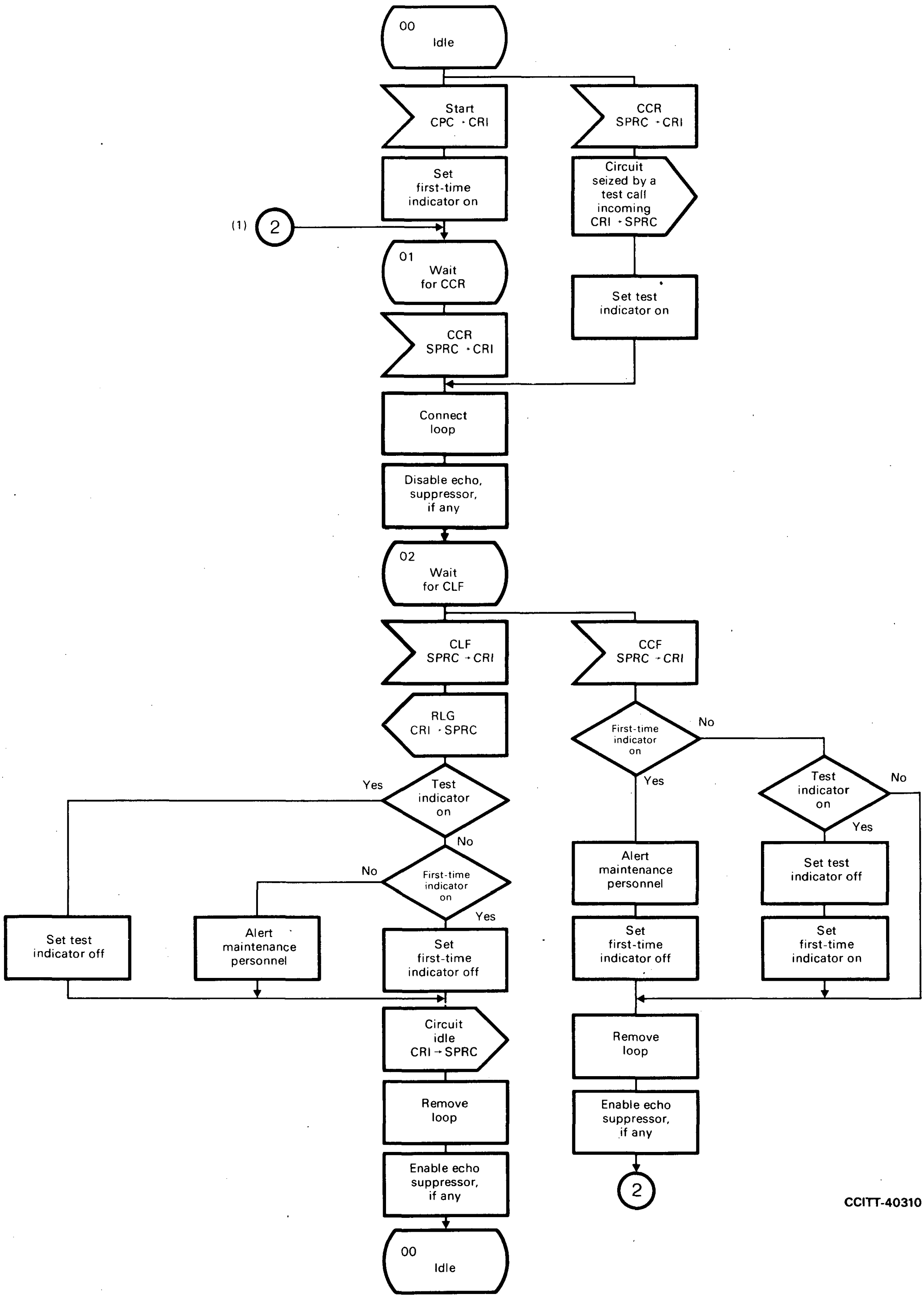


FIGURE 7/Q.724

Continuity-recheck incoming (CRI)

References

[1] CCITT Recommendation *Sending Sequence of numerical (or address) signals*, Vol. VI, Fascicle VI.1, Rec. Q.107.

[2] CCITT Recommendation *Performance requirements*, Vol. VI, Fascicle VI.5, Rec. Q.504.

[3] CCITT Recommendation *Special release arrangements*, Vol. VI, Fascicle VI.1, Rec. Q.118.

[4] CCITT Recommendation *Overflow-alternative, routing-rerouting automatic repeat attempt*, Vol, VI, Fascicle VI.1, Rec. Q.12.

[5] CCITT Recommendation *Interruption control*, Vol. VI, Fascicle VI.4, Rec. Q.416.

Recommendation Q.725

SIGNALLING PERFORMANCE IN THE TELEPHONE APPLICATION

1 Introduction

This Recommendation gives the requirements of the telephone application of Signalling System No. 7.

In Recommendation Q.706, the Message Transfer Part performance is described. The Message Transfer Part is the basis of the telephone application of Signalling System No. 7 and provision of a signalling network to serve the telephone service must take account of the performance of the Message Transfer Part and the requirements of the telephone application. For example, taking account of the message transfer times detailed in Recommendation Q.706 and the requirements for message transfer times between two telephone exchanges, a figure may be derived for the total permissible number of signalling links in signalling relations in tandem for a particular call.

2 Unsuccessful calls due to signalling malfunction

The proportion of calls that are unsuccessful due to signalling malfunction should be less than 1 in 10^5.

By means of error detection (see Recommendation Q.703) as well as transmission fault indication (see Recommendation G.732 [1] and G.733 [2]), it is ensured that, overall, not more than one error in 10^8 of all signal units transmitted is accepted and will cause false operation.

Unsuccessful calls may be caused by undetected errors, loss of messages or messages delivered out of sequence (during emergency situations within the signalling network) and may result in:

- incomplete call set-up,
- misrouted calls (e.g. connection of wrong numbers),
- calls routed correctly but mishandled (e.g. false clearing).

3 Unavailability of a signalling route set

The overall unavailability of a signalling route set causing the unavailability of a signalling relation should not exceed a total of 10 minutes per year.

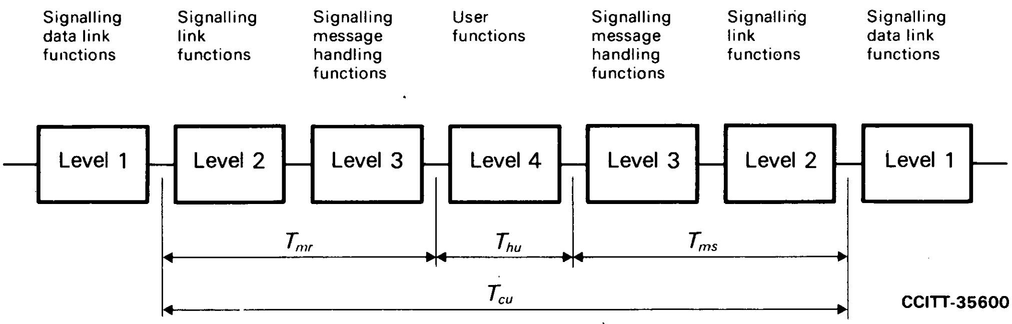
Note – The availability of a signalling route set within a signalling network may be enhanced by replication of signalling links, signalling paths and signalling routes.

4 Labelling potential

The label of the Telephone User Part of Signalling System No. 7 provides the potential to identify 16 384 signalling points and up to 4096 speech circuits for each signalling relation.

5 Cross-office transfer time

5.1 *Functional reference points and transfer time components*



T_{cu} Cross-office transfer time

T_{hu} Telephone User Part handling time

T_{mr} Message Transfer Part receiving time [a)]

T_{ms} Message Transfert Part sending time [a)]

[a)] The definitions of these times are given in Recommendation Q.706.

FIGURE 1/Q.725

Functional diagram of the cross-office transfer time

5.2 *Definitions*

a) *cross-office transfer time, T_{cu}*

T_{cu} is the period which starts when the last bit of the signal unit leaves the incoming signalling data link and ends when the last bit of the signal unit enters the outgoing signalling data link for the first time. It also includes the queueing delay in the absence of disturbances but not the additional queueing delay caused by retransmission.

b) *User handling time, T_{hu}*

T_{hu} is the period which starts when the last bit of the message has entered the Telephone User Part and ends when the last bit of the derived message has left the Telephone User Part.

5.3 *Queueing delay*

The formulae for the queueing delays are described in Recommendation Q.706, § 4.2.

The telephone traffic model assumed is given in Table 1/Q.725, from which the proportion of signal messages may be obtained as shown in Table 2/Q.725. Using Table 2/Q.725, examples of queueing delays are calculated as shown in Figures 2/Q.725 to 5/Q.725, where one call attempt per second per 64-kbit/s signalling data link may yield 0.00577 Erlang of the traffic loading of each channel.

5.4 *Estimates for message transfer time*

The figures in Table 3/Q.725 are related to a signalling bit rate of 64 kbit/s.

5.5 *Effect of retransmission*

As a consequence of correction by retransmission, not more than one in 10^4 signals should be delayed more than 300 ms as a long-term average. This requirement refers to each signalling link.

This requirement is laid down in order to ensure satisfactory answer delays.

TABLE 1/Q.725

Traffic model

Sending procedure			"En bloc"				Overlap			
Type of call			AW	SB	CC	AB	AW	SB	CC	AB
Per cent calls			30	10	5	5	30	10	5	5
Messages per call		Length (bits)								
	12-digit IAM	176	1	1	1	0				
	6-digit IAM	152					1	1	1	1
	3-digit SAM	128					1	1	0	1
	1-digit SAM	112					3	3	0	0
	Address complete	112	1	1	0	0	1	1	0	0
	Others	104	3,5	2	3	0	3,5	2	3	2

Note – AW Answered,
SB Subscriber busy and not answered,
CC Circuit congestion,
AB Abortive.

The assumptions used in this model are chosen for illustrative purposes, and should not be considered to be typical.

TABLE 2/Q.725

Proportion of messages

Length (bits)	176	152	128	112	104	Total
Messages per call in both directions	0.45	0.5	0.45	2.0	2.9	6.3
Percent	7.1	7.9	7.1	31.7	46.0	100
Mean message length (T_m)	117.2 bits					
k_1	1.032					
k_2	1.107					

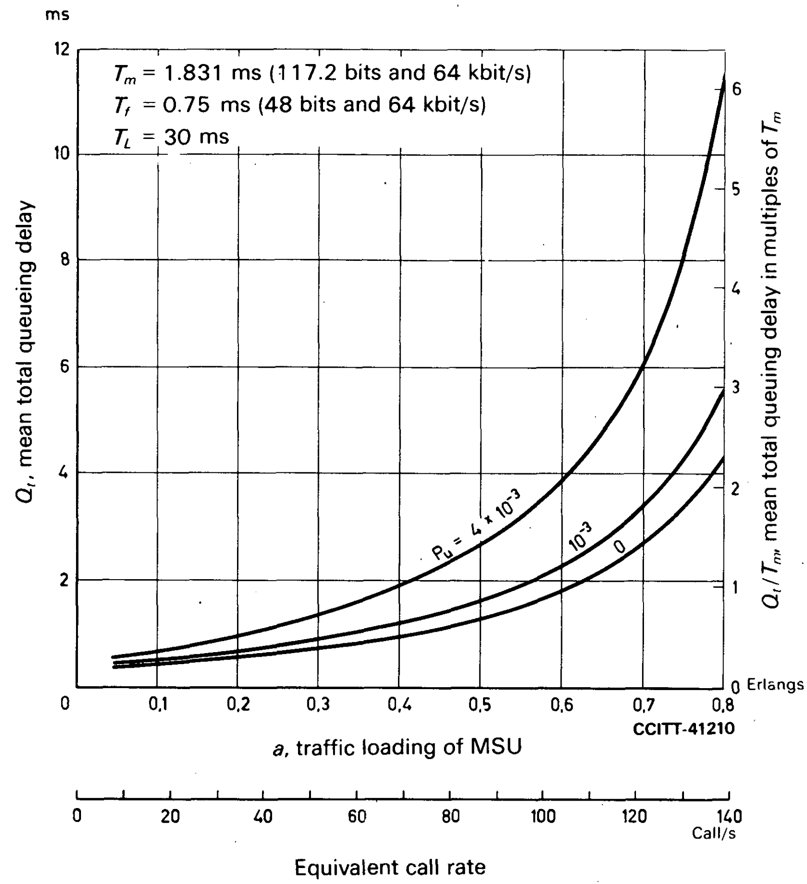


FIGURE 2/Q.725

Mean total queueing delay of each channel of traffic; basic error correction method

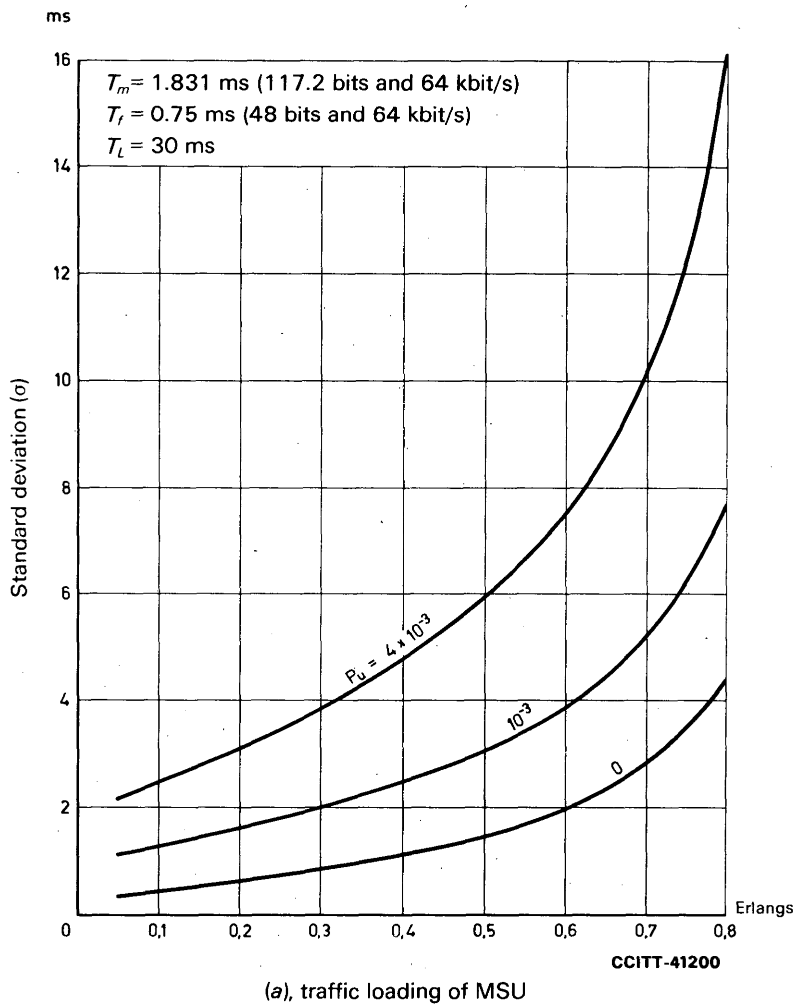


FIGURE 3/Q.725

Standard deviation of queueing delay of each channel of traffic; basic error correction method

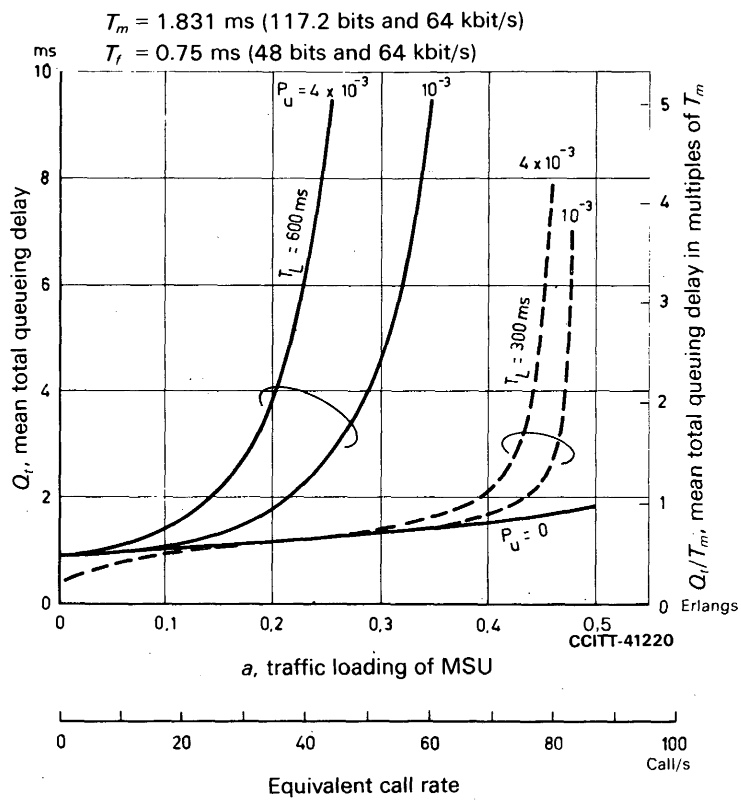


FIGURE 4/Q.725

Mean total queueing delay of each channel of traffic; preventive cyclic retransmission error correction method

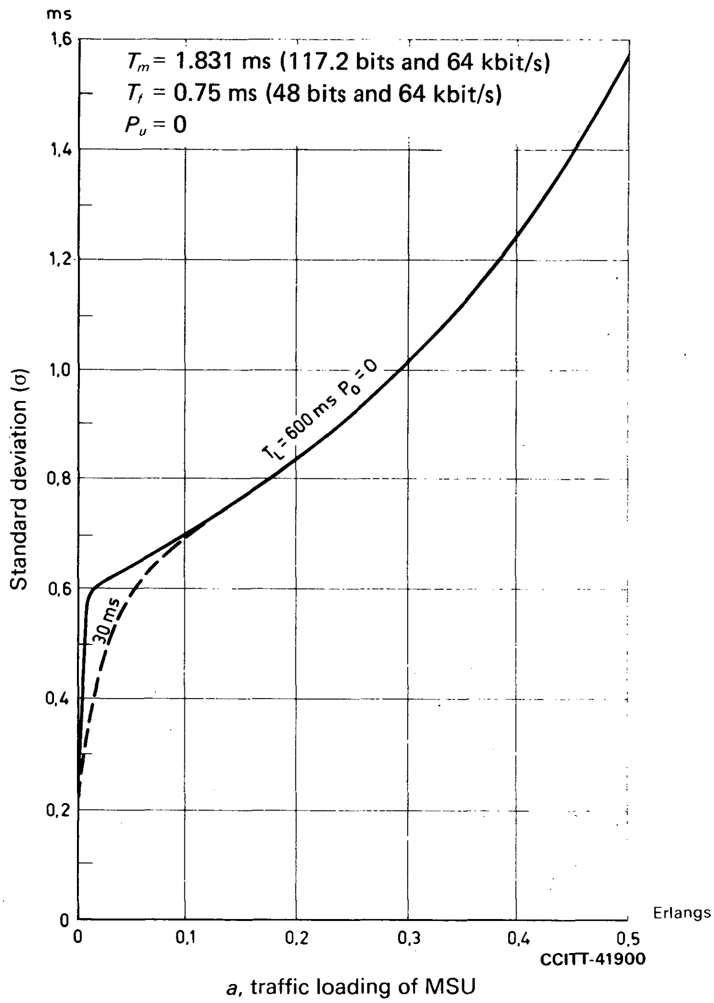


FIGURE 5/Q.725

Standard deviation of queueing delay of each channel of traffic; preventive cyclic retransmission error correction method

TABLE 3/Q.725

Exchange call attempt loading	Cross-office transfer time T_{cu} [a)] (ms)	
	Mean	95%
Normal	50	100
+ 15%	100	200
+ 30%	250	500

[a)] Provisional values.

References

[1] CCITT Recommendation *Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s*, Vol. III, Fascicle III.3, Rec. G.732.

[2] CCITT Recommendation *Characteristics of primary PCM multiplex equipment operating at 1544 kbit/s*, Vol. III, Fascicle III.3, Rec. G.733.

Recommendation Q.741 [1]

SIGNALLING SYSTEM No. 7 – DATA USER PART

(Former Recommendation X.60, Geneva, 1976; amended at Geneva, 1980)

TABLE OF CONTENTS

[1] This Recommendation is also included in the Series X Recommendations under the number Recommendation X.61.

1 Functional description of the signalling system

1.1 *General*

Use of Signalling System No. 7 for call control or for facility registration and cancellation signalling for circuit-switched data transmission services requires:

- application of Data User Part (DUP) functions, in combination with
- application of an appropriate set of Message Transfer Part (MTP) functions.

A general description of the signalling system is given in Recommendation Q.701. That Recommendation also defines the division of functions and the requirements of interaction between the Message Transfer Part and the Data User Part.

1.2 *Data User Part*

The Data User Part specified in this Recommendation defines the necessary call control, and facility registration and cancellation related elements for international common channel signalling by use of Signalling System No. 7 for circuit-switched data transmission services. As regards call control and signalling procedures for international user facilities and network utilities, refer to Recommendation X.87 [1].

The signalling system meets all requirements defined by CCITT concerning service features, user facilities and network utilities for circuit-switched data transmission services.

It can be used to control switching of various types of data circuits, including satellite circuits, to be used in worldwide circuit-switched data connections. It is designed for both-way operation of data circuits.

The signalling system is suitable for national circuit-switched data applications. Most data signalling message types and signals specified for international use are also required in typical national data applications. In addition to these, national data applications typically require additional types of signals; such requirements that have been identified are already provided for. The system provides ample spare capacity to cater for further additions of new message types and signals should such a need arise.

The label structures specified for data signalling messages require that all exchanges using the signalling system are allocated codes from code plans established for the purpose of unambiguous identification of signalling points, see Recommendations Q.701 and Q.704. The principles to apply to the international signalling network are for further study.

1.3 *Message Transfer Part*

The Message Transfer Part of Signalling System No. 7 is specified in separate Recommendations. An overview description of the Message Transfer Part is contained in Recommendation Q.701.

The Message Transfer Part defines a range of functions by which different signalling modes and different signalling network configurations may be realized. Any application of Signalling System No. 7 requires that an appropriate selection of these functions is applied depending on the intended use of the system and the characteristics of the telecommunications network concerned.

2 General function of data signalling messages, signals, indicators, codes and conditions

§ 2 describes general functions of data signalling messages, signals, indicators, codes and conditions which are used to set up a call, to control user facilities and to control and supervise a circuit. The requirements relating to the use of the signalling messages and their signalling information content are specified in §§ 3, 4, and 5.

2.1 *Signalling messages*

2.1.1 *Call and circuit related messages*

Call and circuit related messages are used to set up and clear a call or control and supervise the circuit state.

2.1.1.1 *Address message*

A message sent in the forward direction, containing signalling information required to route and connect the call to the called user. This message contains address information, class of service information, etc., and may also contain additional information such as, for example, calling line identity.

2.1.1.2 *Calling line identity message*

A message sent in the forward direction, containing the calling line identity or the originating network identity. This message is sent subsequently to an address message, which does not contain the calling line identity, when requested by the destination network.

2.1.1.3 *Call accepted message*

A message sent in the backward direction, containing information to indicate that connection of the call is allowed by the destination exchange. It may also contain additional information such as, for example, called line identity.

2.1.1.4 *Call rejected message*

A message sent in the backward direction containing a signal to indicate the cause of the failure of the call set-up as the response to the address message and initiating clearing of the call. The call rejected message will be sent as either the first response, or the second response after sending the call accepted message when the call fails to be completed at the destination exchange, e.g. because no call accepted signal was received from the called user.

2.1.1.5 *Clear message*

A message sent in either direction, containing information about the clearing of the call.

2.1.1.6 *Circuit state message*

A message sent in either direction, containing signals to control and supervise a circuit.

2.1.2 *Facility registration and cancellation related messages*

Facility registration and cancellation related messages are used to exchange information between originating and destination exchanges to register and cancel information related to user facilities. The exchange of this type of message is generally not associated with a call between two users.

2.1.2.1 *Facility registration/cancellation request message*

A message sent in the forward direction to register or cancel a user facility. This message contains information which identifies the user requesting facility registration or cancellation and information relating to the facility concerned.

2.1.2.2 *Facility registration/cancellation request accepted message*

A message sent in the backward direction, containing information that registration or cancellation is completed or accepted at the destination exchange.

2.1.2.3 *Facility registration/cancellation request rejected message*

A message sent in the backward direction, containing information that the registration or cancellation is not completed or accepted at the destination exchange with information indicating a reject cause.

2.2 *Service information*

The service information provides the highest level of discrimination between different sets of signalling messages. It contains the following components.

2.2.1 *Service indicator*

Information used to identify the User Part to which the signalling message belongs.

2.2.2 *National indicator*

Information used for discrimination between international and national messages. In case of national messages, it may for example also be used for discrimination between different label alternatives for national use.

2.3 *Signalling information transferred in the signalling messages*

2.3.1 *Label components*

In the case of call and circuit related messages, the label is used for message routing and, in general, for identification of the data circuit selected for the call. In the case of facility registration and cancellation messages, the label only provides a message routing function. The standard label structure consists of the following components.

2.3.1.1 *Destination point code*

Information identifying the signalling point to which the message is to be routed.

2.3.1.2 *Originated point code*

Information identifying the signalling point from which the message has been originated.

2.3.1.3 *Bearer identification code*

Information identifying the 64-kbit/s bearer among those interconnecting the destination point and originating point.

2.3.1.4 *Time slot code*

Information identifying the submultiplexed circuit at a lower bit rate on the 64-kbit/s bearer which is itself identified by the bearer identification code.

2.3.2 *Message format identifiers*

2.3.2.1 *Heading*

Information discriminating, as applicable, between different groups of individual types of messages within the set of messages identified by the service information. The heading is split into two levels. The first level discriminates between different message groups. The second level either discriminates between different message types or contains a signal.

2.3.2.2 *Field length indicator*

Information associated with and indicating the length of a variable length field.

2.3.2.3 *Field indicator*

Information associated with and indicating the presence or absence of an optional field.

2.3.3 *Basic call set-up address information*

2.3.3.1 *Address signal*

A signal containing an element of a Data Country Code (DCC), Data Network Identification Code (DNIC) or a data number.

2.3.3.2 *Destination address*

Information sent in the forward direction consisting of a number of address signals indicating the complete data number of the called user.

2.3.4 *Basic call set-up indicators*

2.3.4.1 *National/international call indicator*

Information (for national use only) sent in the forward direction indicating whether the call is a national or international call. In the destination network, it may for example be used in connection with user facilities requiring separate handling of international calls.

2.3.4.2 *DCC/DNIC indicator*

Information (for national use only) sent in either direction, associated with a data number, indicating whether the DCC/DNIC is included in that data number.

2.3.4.3 *Alternative routing indicator*

Information sent in the forward direction indicating that the call has been subjected to an alternative routing and which may be used to prevent the call being set up over an alternative route more than once.

Note – This signal is provided provisionally, and will be subject to change when the necessary network capabilities for routing have been determined.

2.3.4.4 *User class indicator*

Information sent in the forward direction, indicating the user class of service of the calling user. This indicator may be used to determine the type of interexchange data circuit to be selected and to verify that the calling and called users belong to the same user class.

2.3.5 *Basic call set-up response signals*

2.3.5.1 *Call accepted signal*

A signal sent in the backward direction, indicating that the call can be completed. At the originating exchange, it results in preparing for data path through-connect and charging.

2.3.5.2 *Transit through-connect signal*

A signal sent in the backward direction, specifically provided for interworking with decentralized signalling (see Recommendation X.80 [2]), indicating that the call can be completed and that through-connection of transit exchanges using decentralized signalling may take place.

2.3.5.3 *Network failure signal*

A signal sent in the backward direction indicating that the call cannot be completed because of a temporary fault condition within the network, e.g. expiry of a time-out or line fault. At the originating exchange it results in sending a *no connection* call progress signal to the calling user and clearing the call.

2.3.5.4 *Number busy signal*

A signal sent in the backward direction, indicating that the call cannot be completed because the called user's access line to the exchange is engaged in another call. At the originating exchange it results in sending a *number busy* call progress signal to the calling user and clearing the call.

2.3.5.5 *Access barred signal*

A signal sent in the backward direction, indicating that the call cannot be completed because a user facility prevents connection of the call to the called user, e.g. as a result of failure of a closed user group validation check. At the originating exchange, it results in sending an *access barred* call progress signal to the calling user and clearing the call.

2.3.5.6 *Changed number signal*

A signal sent in the backward direction, indicating that the call cannot be completed because the called number has been changed recently. At the originating exchange, it results in sending a *changed number* call progress signal to the calling user and clearing the call.

2.3.5.7 *Not obtainable signal*

A signal sent in the backward direction, indicating that the call cannot be completed because the called number is not in use or assigned. At the originating exchange, it results in sending a *not obtainable* call progress signal to the calling user and clearing the call.

2.3.5.8 *Out of order signal*

A signal sent in the backward direction, indicating that the call cannot be completed because either the called user's terminal or the called user's access line is out of service or faulty. At the originating exchange, it results in sending an *out of order* call progress signal to the calling user and clearing the call.

2.3.5.9 *Controlled not ready signal*

A signal in the backward direction, indicating that the call cannot be completed because the called user's terminal is in a *controlled not ready* condition. At the originating exchange, it results in sending a *controlled not ready* call progress signal to the calling user and clearing the call.

2.3.5.10 *Uncontrolled not ready signal*

A signal sent in the backward direction, indicating that the called user's terminal is in an *uncontrolled not ready* condition. At the originating exchange, it results in sending an *uncontrolled not ready* call progress signal to the calling user and clearing the call.

2.3.5.11 *DCE power off signal*

A signal sent in the backward direction, indicating that the called user's DCE is switched off. At the originating exchange, it results in sending a *DCE power off* call progress signal to the calling user and clearing the call.

2.3.5.12 *Network fault in local loop signal*

A signal sent in the backward direction, indicating that a fault has been detected in the local access connection for the called user. At the originating exchange, it results in sending a *network fault in local loop* call progress signal to the calling user and clearing the call.

2.3.5.13 *Call information service signal*

A signal sent in the backward direction, indicating that the called terminal is not available for reasons which have been indicated to the information service, and which are not covered by another specific signal. At the originating exchange, it results in sending a *call information service* call progress signal to the calling user and clearing the call.

2.3.5.14 *Incompatible user class of service signal*

A signal sent in the backward direction, indicating that the called user's terminal is incompatible with the characteristics of the calling user's terminal, e.g. different user class of service. At the originating exchange, it results in sending an *incompatible user class of service* call progress signal to the calling user and clearing the call.

2.3.5.15 *Network congestion signal*

A signal sent in the backward direction, indicating that the call cannot be completed because of temporary congestion or temporary fault conditions encountered on the route to the called customer. At the originating exchange this signal results in sending a *network congestion* call progress signal to the calling user and clearing the call.

2.3.5.16 *Degraded service signal*

A signal sent in the backward direction, indicating that a part of the network, due to faulty conditions, has a very much reduced grade of service, which is likely to persist for some time. At the originating exchange, it results in sending a *long-term network congestion* call progress signal to the calling user and clearing the call.

2.3.5.17 *Charge/no charge indicator*

Information (for national use only) sent in the backward direction that may be used to indicate that the call should not be charged at the originating exchange.

2.3.6 *Basic call clearing and circuit state signals*

2.3.6.1 *Circuit released signal*

A signal sent in either direction indicating that the interexchange data circuit has been released.

2.3.6.2 *Circuit released acknowledgement signal*

A signal sent in either direction in response to the *circuit released* signal and indicating that the interexchange data circuit has been released.

2.3.6.3 *Reset circuit signal*

A signal sent to return the interexchange data circuit to the idle state at both ends in situations where, due to memory mutilation or other causes, the state of the circuit is ambiguous.

2.3.6.4 *Blocking signal*

A signal sent for maintenance purposes indicating to the exchange at the other end of the interexchange data circuit that the circuit has to be blocked for outgoing calls.

2.3.6.5 *Unblocking signal*

A signal sent to cancel the blocked condition at the exchange at the other end of the interexchange data circuit caused by an earlier *blocking* signal.

2.3.6.6 *Blocking acknowledgement signal*

A signal sent in response to a *blocking* signal indicating that the interexchange data circuit has been blocked.

2.3.6.7 *Unblocking acknowledgement signal*

A signal sent in response to an *unblocking* signal indicating that the interexchange data circuit has been unblocked.

2.3.7 *Additional signals relating to the closed user group facilities*

2.3.7.1 *Closed user group call indicator*

Information sent in the forward direction and in some circumstances in the backward direction, indicating whether or not the call involves a closed user group, whether an interlock code is included in the message and whether or not outgoing access is allowed for the calling user.

2.3.7.2 *Interlock code*

Information sent in the forward direction, and in some circumstances, in the backward direction, identifying a closed user group to which the calling user belongs.

2.3.8 *Additional signals relating to the bilateral closed user group and the bilateral closed user group with outgoing access facilities*

2.3.8.1 *Bilateral closed user group call indicator*

Information sent in the forward direction, indicating whether or not the call is a call within a bilateral closed user group.

2.3.8.2 *Registration request signal*

A signal sent in the forward direction, indicating that facility registration is required.

2.3.8.3 *Cancellation request signal*

A signal sent in the forward direction, indicating that facility cancellation is required.

2.3.8.4 *Registration completion signal*

A signal sent in the backward direction, indicating that facility registration is completed at the destination exchange. At the originating exchange, it results in sending a *registration/cancellation confirmed* call progress signal to the calling user.

2.3.8.5 *Registration accepted signal*

A signal sent in the backward direction, indicating that facility registration is accepted at the destination exchange. At the originating exchange it results in sending a *registration/cancellation confirmed* call progress signal to the calling user.

2.3.8.6 *Cancellation completed signal*

A signal sent in the backward direction, indicating that facility cancellation is completed at the destination exchange. At the originating exchange it results in sending a *registration/cancellation confirmed* call progress signal to the calling user.

2.3.8.7 *Local index*

Information sent in the forward direction and backward direction at bilateral closed user group registration. It indexes the subscriber file to identify the particular bilateral closed user group at the originating or destination exchange.

2.3.9 *Additional signals relating to the calling line identification facility*

2.3.9.1 *Calling line identification request indicator*

Information sent in the backward direction, indicating whether or not the calling line identity should be sent forward.

2.3.9.2 *Calling line identity indicator*

Information sent in the forward direction, indicating whether, and what form of, a calling line identity is included in the message.

2.3.9.3 *Calling line identity*

Information sent in the forward direction, consisting of a number of address signals indicating the (international) data number of the calling user.

2.3.10 *Additional signals relating to the called line identification facility*

2.3.10.1 *Called line identification request indicator*

Information sent in the forward direction, indicating whether or not the called line identity should be returned.

2.3.10.2 *Called line identity indicator*

Information sent in the backward direction, indicating whether, and what form of,the called line identity is included in the message.

2.3.10.3 *Called line identity*

Information sent in the backward direction, consisting of a number of address signals indicating the (international) data number of the called user.

2.3.11 *Additional signals relating to redirection of calls facility*

2.3.11.1 *Redirection request signal*

A signal (for national use only) sent in the backward direction, indicating that the called user has requested redirection of calls to another address.

2.3.11.2 *Redirection address indicator*

Information (for national use only) sent in the backward direction, indicating that a redirection address is included in the message.

2.3.11.3 *Redirection address*

Information (for national use only) sent in the backward direction, consisting of a number of address signals, indicating the data number to which the call is to be redirected.

2.3.11.4 *Redirected call indicator*

Information (for national use only) sent in the forward direction, indicating that the call is a redirected call. This indicator is used to prevent a further redirection, if the user at the new address has also requested redirection of calls.

2.3.11.5 *Redirected call signal*

A signal sent in the backward direction, indicating that the call has been redirected to an address other than the destination address selected by the calling user. At the originating exchange, it results in sending a *redirected* call progress signal.

2.3.12 *Additional signals relating to the connect when free and waiting allowed facilities*

2.3.12.1 *Connect when free signal*

A signal sent in the backward direction, indicating that the called user, having the *connect when free* facility, is busy and that the call has been placed in a queue. At the originating exchange it results in sending a *connect when free* call progress signal to the calling user if he has the *waiting allowed* facility or, if not, in sending the *number busy* call progress signal and clearing the call.

2.3.13 *Additional signals relating to the reverse charging and reverse charge acceptance facilities*

2.3.13.1 *Reverse charging request indicator*

Information sent in the forward direction, indicating that reverse charging is requested by the calling user.

2.3.13.2 *Reverse charge acceptance not subscribed signal*

A signal sent in the backward direction, indicating rejection of the call because the called user does not subscribe to the *reverse charge acceptance* facility. At the originating exchange it results in sending a *reverse charge acceptance not subscribed* call progress signal to the calling user.

2.3.14 *Additional signals relating to manual answer*

2.3.14.1 *Terminal called*

A signal sent in the backward direction, indicating that the called user operates with manual answer. At the originating exchange it results in sending a *terminal called* call progress signal to the calling user.

2.3.15 *Additional signals relating to the RPOA selection facilities*

2.3.15.1 *RPOA selection indicator*

Information (for national use only) sent in the forward direction, indicating whether or not the calling user requires selection of an RPOA for international call routing at the international gateway. When RPOA selection is required, it also indicates that a RPOA transit network identity is included in the message.

2.3.15.2 *RPOA transit network identity*

Information (for national use only) sent in the forward direction, identifying the requested RPOA transit network by its DNIC.

2.3.15.3 *RPOA out of order signal*

A signal (for national use only) sent in the backward direction, indicating that the call cannot be completed, because the selected RPOA transit network is not available for service. At the originating exchange, it results in sending an *RPOA out of order* call progress signal to the calling user.

2.3.16 *Additional signals relating to the network identification utilities*

2.3.16.1 *Network identity*

Information sent in either direction, identifying an originating, a transit or destination network by its DNIC.

2.3.16.2 *Originating network identification request indicator*

Information sent in the backward direction, indicating whether or not the originating network identity should be sent forward.

2.4 *Data channel signalling conditions*

These are interexchange data channel conditions employed in the call set-up and clear-down procedures. The conditions defined in § 2.4 are based on the characteristics of the relevant DTE/DCE interfaces for the circuit-switched service. The implications of other possible new DTE/DCE interfaces on these conditions have not yet been determined.

2.4.1 *Trunk free condition*

A condition transmitted in the forward or backward interexchange data channels when the circuit is free or under release at the sending exchange.

2.4.2 *Trunk seized condition*

A condition transmitted in the forward interexchange data channel when the circuit is seized but not through-connected.

2.4.3 *Call accepted condition*

A condition appearing in the backward interexchange data channel, indicating that all the succeeding exchanges involved in the connection have connected through. This condition is sent by the called user and corresponds to the *call accepted* state at the DTE/DCE interface.

2.4.4 *Clear request condition*

A condition, appearing in the forward and backward interexchange data channels, sent by the user when requesting to clear the call.

3 Formats and codes

3.1 *Basic format characteristics*

3.1.1 *General*

The data signalling messages are carried on the signalling data link by means of Signal Units (SU), the format of which is described in the specifications of the Message Transfer Part (MTP), see Recommendation Q.703.

The data signalling messages are divided into two categories, call and circuit related messages and facility registration and cancellation related messages. The Service Indicator (SI) included in each signal unit identifies tc which category the message belongs.

The signalling information of each message constitutes the Signalling Information Field (SIF) of the corresponding SU signal unit and consists of an integral number of octets. It basically contains the label, the heading code and one or more signals and/or indicators.

3.1.2 *Service information octet*

3.1.2.1 *Format*

The service information octet comprises the service indicator and the subservice field.

The service indicator is used to associate signalling information with a particular User Part and is only used with message signal units (see Recommendation Q.703).

The information in the subservice field permits a distinction to be made between national and international signalling messages. In national applications when this discrimination is not required, possibly for certain national User Parts only, the subservice field can be used independently for different User Parts.

The format of the service information octet is shown in Figure 1/Q.741.

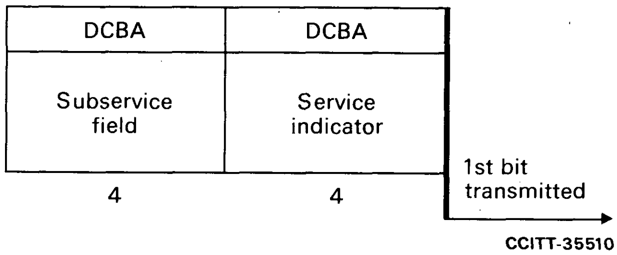


FIGURE 1/Q.741
Service information octet

3.1.2.2 *Service indicator*

The service indicator will be coded as follows:

Bits: D C B A
- 0 1 1 0 call and circuit related messages
- 0 1 1 1 facility registration and cancellation messages.

The use of other service indicator codes is specified in Recommendation Q.704.

3.1.2.3 *Subservice field*

The subservice field is coded as shown in Table 1/Q.741.

TABLE 1/Q.741

Bits:	BA	Spare
	DC	National indicator
	0 0	international message
	0 1	spare (for international use)
	1 0	national message
	1 1	reserved for national use

Note – Bits A and B are spare for possible needs that may require a common solution for all international User Parts and MTP level 3. Each bit is coded 0.

3.1.3 *Format principles*

The user generated information in the signalling information field is, in general, divided into a number of subfields which may be of either fixed or variable length. The first field is the label field, see § 3.2. Following the label field is a heading code H0 which, possibly together with a following subheader H1, identifies the structure of the message. Other fields may be mandatory or optional on a per individual message basis, the presence or absence of optional fields being indicated by field indicators. Each field indicated below is mandatory unless explicitly indicated as optional.

3.1.4 *Order of bit transmission*

Within each defined subfield the information is transmitted least significant bit first.

3.1.5 *Coding of spare bits*

Each spare bit is coded 0 unless otherwise indicated.

3.1.6 *Indicators for national use only*

A number of indicators specified are indicated as for national use only. In international use the corresponding bits are coded 0 and are, as regards their interpretation, equivalent to spare bits.

3.2 *Label*

3.2.1 *General*

The label is an item of information which forms part of every signalling message and is used by the message routing function at MTP Level 3 to select the appropriate signalling route and by the User Part function to identify the particular transaction (e.g. the call) to which the message pertains.

In general, the label information encompasses an explicit or implicit indication of the message source and destination and, depending on the application, various forms of transaction identification.

For call and circuit related messages the transaction is conveniently identified by including the corresponding circuit identity in the label. In the following, two such label structures are specified:

- a basic label structure which, consistent with the standard telephone label structure (Recommendation Q.723), is designed to meet the requirements for identification of data circuits derived from standard data multiplexers (see Recommendations X.50 [3] and X.51 [4]);
- an alternative label structure, identical to the standard telephone label structure, which may be used in applications where the data circuits use full 64-kbit/s digital circuits without submultiplexing.

For facility registration and cancellation related messages the specified label structure is equivalent to the standard routing label of the MTP.

Note – The indication (48) below the label field in Figures 5/Q.741 to 11/Q.741 refers to the basic label, which is described in § 3.2.2, but is intended to show that other label lengths are possible.

3.2.2 *Basic label for call and circuit related messages*

3.2.2.1 *General*

The basic label has a length of 48 bits and is placed at the beginning of the signalling information field. The format is as shown in Figure 2/Q.741.

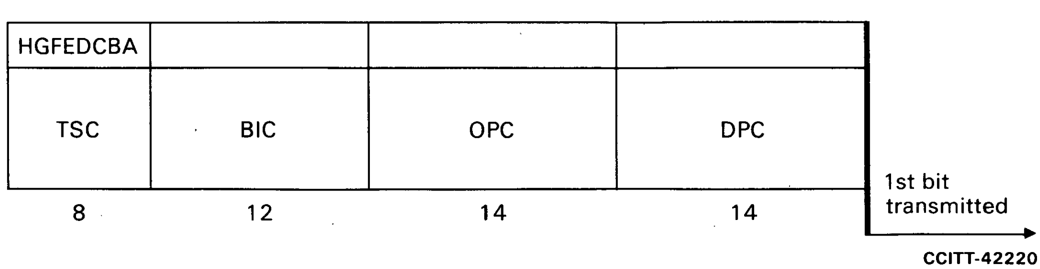


FIGURE 2/Q.741
Basic label for data call and circuit related messages

The general function of the label components is defined in § 3.2.1. The portion of the basic label that consists of the Destination Point Code (DPC) and Originating Point Code (OPC) fields and the four least significant bits of the Bearer Identification Code (BIC) field corresponds to the standard routing label specified in Recommendation Q.704.

3.2.2.2 *Destination and originating point codes*

The standard structure requires that each data switching exchange in its role as a signalling point is allocated a code from a code plan established for the purpose of unambiguous identification of signalling points.

Separate code plans will be used for the international signalling network and for different national signalling networks.

The principles of code allocation which apply to the international signalling network are for further study.

The destination point code will be the code applicable to the data switching exchange to which the message is to be delivered. The originating point code will be the code applicable to the data switching exchange from which the message is sent.

3.2.2.3 *Bearer identification code*

The allocation of bearer identification codes to individual bearers is determined by bilateral agreement and/or in accordance with applicable predetermined rules.

For bearers which form part of a 2.048-Mbit/s PCM system according to Recommendation G.734 [5], the bearer identification code contains in the 5 least significant bits a binary representation of the actual number of the time slot which is assigned to the bearer. The remaining bits of the bearer identification code are used where necessary, to identify one among several systems, interconnecting the originating point and destination point.

For bearers which form part of a 8.448-Mbit/s PCM system the bearer identification code will be coded in accordance with the scheme specified for the circuit identification code for the corresponding case in Recommendation Q.723.

3.2.2.4 *Time slot code*

The coding of the time slot code (TSC) is as follows (bit numbering as in Figure 2/Q.741):

a) In the case where the data circuit is derived from the data multiplex carried by the bearer, identified by the bearer identification code:

   – bits ABCD will contain, in pure binary representation, the channel number of the circuit within the 12.8-kbit/s (Recommendation X.50 [3]) or 12-kbit/s (Recommendation X.51 [4]) phase; the channel number being in the range (see Recommendations X.50 [3], X.51 [4], X.53 [6] and X.54 [7]):

     0-15 for 600-bit/s circuits
     0- 3 for 2400-bit/s circuits
     0- 1 for 4800-bit/s circuits
     0 for 9600-bit/s circuits

   – bits EFG will contain, in pure binary representation, the number of the 12.8-kbit/s or 12-kbit/s phase, the phase number being in the range 0-4;

   – bit H will be coded 0.

b) In the case where the data circuit uses the full 64-kbit/s bearer rate, the time slot code will be 01110000.

3.2.3 *Alternative label for call and circuit related messages*

In applications where all data circuits use full 64-kbit/s digital circuits, a label structure as shown in Figure 3/Q.741 may be used in mutual agreement.

This label structure is equivalent to the standard telephone label structure specified in Recommendation Q.704. The destination point code (DPC) and originating point code (OPC) fields are as in the basic label structure and the Circuit Identification Code (CIC) is as the bearer identification code field in the basic label structure (see § 3.2.2).

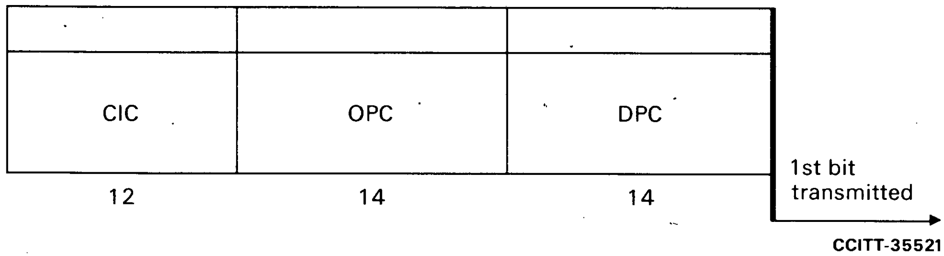


FIGURE 3/Q.741
Alternative label for data and circuit related messages

3.2.4 *Standard label for facility registration and cancellation messages*

Facility registration and cancellation messages will have a label in accordance with Figure 4/Q.741.

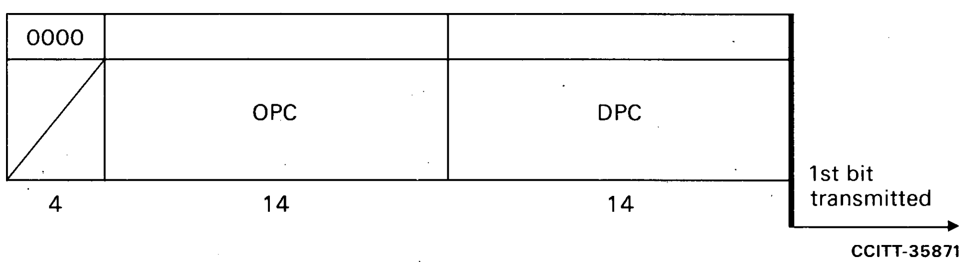


FIGURE 4/Q.741
Standard label for facility registration and cancellation messages

This label structure is equivalent to the standard routing label specified for the MTP (see Recommendation Q.704). The destination point code (DPC) and originating point code (OPC) fields are used as for the basic label, see § 3.2.2.

3.2.5 *Modified label*

In cases where the data transmission service is provided by public data networks comprising few exchanges and signalling relations, it may be attractive to use shorter labels than those specified in §§ 3.2.2 to 3.2.4. In such applications a modified label, having the same order and function, but possibly different sizes, of subfields may be used in mutual agreement. In such a case the label used for MTP Level 3 messages should be modified accordingly. Also, in some national applications it may be necessary to use an extended modified label.

3.3 *Formats and codes for call and circuit related messages*

3.3.1 *Heading*

The different heading codes (H0) for the call and circuit control messages are allocated as shown in Table 2/Q.741.

TABLE 2/Q.741

0000	spare
0001	address message
0010	calling line identification messages
0011	spare
0100	call accepted messages
0101	call rejected messages
0110	clear messages
0111	circuit state messages
1000 to 1111	spare

3.3.2 *Address message*

3.3.2.1 The format of the address message is as shown in Figure 5/Q.741.

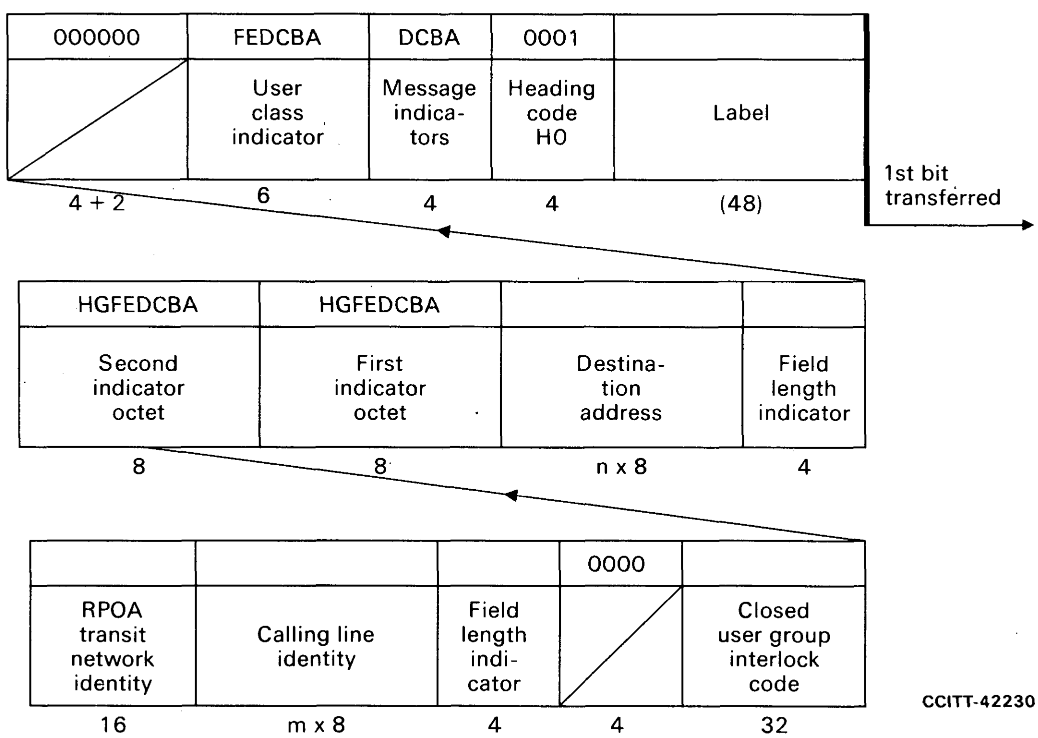


FIGURE 5/Q.741
Address message

The fields, subfields and codes are as follows:

3.3.2.2 *Label*

See § 3.2.

3.3.2.3 *Heading code H0*

See § 3.3.1.

3.3.2.4 *Message indicator*

The coding is shown in Table 3/Q.741.

TABLE 3/Q.741

Bit	
A	Field indicator of first indicator octet
0	first indicator octet not included
1	first indicator octet included
B	DCC/DNIC indicator (national use only, see § 3.1.6)
0	DCC/DNIC included in destination address
1	DCC/DNIC not included in destination address
C	National/international call indicator (national use only, § 3.1.6)
0	international call
1	national call
D	Alternative routing indicator
0	no alternative routing made
1	alternative routing made

3.3.2.5 *User class indicator*

The coding is shown in Table 4/Q.741.

TABLE 4/Q.741

Bits FEDCBA		
000000 to 100000	spare	
100001 to 100110	asynchronous user classes, as applicable; bits ABC coded as bits b1, b2, b3 of first user class character in Recommendation X.71 [8]	
100111 to 101111	spare	
110000	600 bit/s (user class 3)	Synchronous user classes corresponding to second user class charter in Recommendation X.71 [8]
110001	2 400 bit/s (user class 4)	
110010	4 800 bit/s (user class 5)	
110011	9 600 bit/s (user class 6)	
110100	48 000 bit/s (user class 7)	
110101 to 111011	spare	
111100 to 111111	reserved for national use	

3.3.2.6 *Spare bits*

3.3.2.7 *Field length indicator*

A code expressing in pure binary representation the number of address signals in the destination address.

3.3.2.8 *Destination address field*

This field is divided into an even number of semi-octets. The decimal value of each destination address digit is expressed in pure binary representation of an address signal. The digits are sent in descending order with most significant digit first. In case of an odd number of address signals a 4-bit 0000 filler code is included in the last semi-octet of the field.

3.3.2.9 *First indicator octet*

This is an optional field that is included if indicated in bit A of the message indicators. The coding is shown in Table 5/Q.741.

TABLE 5/Q.741

Bits B A	Calling line identity indicator
0 0	calling line identity not included
0 1	calling line identity without DCC/DNIC included (national use only)
1 0	DCC/DNIC only included
1 1	calling line identity with DCC/DNIC included
D C	CUG call indicator
0 0	ordinary call
0 1	spare
1 0	CUG call, outgoing access allowed
1 1	CUG call, outgoing access not allowed
E	BCUG call indicator
0	ordinary call
1	BCUG call
F	Reserved for charging information-indicator; coded 0
G	Reserved for an additional routing information indicator; coded 0
H	Field indicator of the second indicator octet
0	second indicator octet not included
1	second indicator octet included

3.3.2.10 *Second indicator octet*

This is an optional field that is included if indicated in bit H of the first indicator octet. The coding is shown in Table 6/Q.741.

TABLE 6/Q.741

Bit A	Redirected call indicator (national use only, see § 3.1.6)
0	ordinary call
1	redirected call
B	RPOA selection indicator (national use only, see § 3.1.6)
0	no RPOA code included
1	RPOA code included
C	Reverse charging request indicator
0	no reverse charging request
1	reverse charging request
D	Called line identification request indicator
0	no called line identification requested
1	called line identification requested
E, F, G	Spare
H	Reserved for field indicator for third indicator octet; coded 0

3.3.2.11 *Closed user group interlock code*

This is an optional field that is included only when indicated in bits CD in the first indicator octet. The format of the interlock code is in accordance with Figure 6/Q.741.

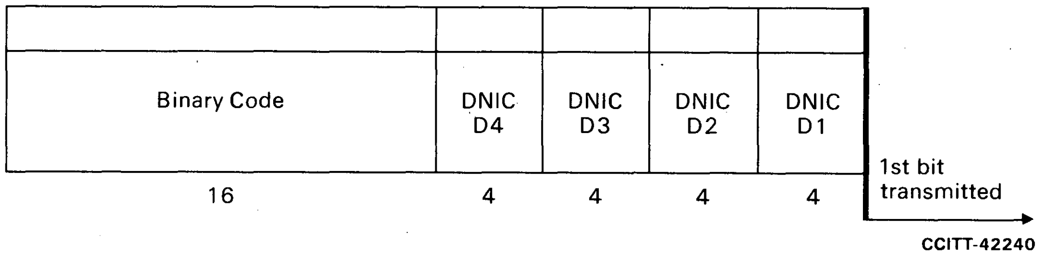


FIGURE 6/Q.741
Format of interlock code

Each of the first four semi-octets contains a decimal digit, the value of which is expressed in pure binary representation, of the DNIC (or DCC plus one digit) of the coordinating Administration of the closed user group concerned (see Recommendation X.87 [1]). The 16-bit binary code is the code assigned to the closed user group concerned.

3.3.2.12 *Spare bits*

Included only when the calling line identity is included.

3.3.2.13 *Field length indicator*

This is an optional field that is included only when the calling line identity is included. It is a code expressing in pure binary representation the number of address signals in the calling line identity included.

3.3.2.14 *Calling line identity*

This is an optional field that is included only if indicated in bits AB of the first indicator octet. This field is divided into an even number of semi-octets. It contains a number of decimal digits of the national or international data number of the calling line or of the DNIC of the originating network. The coding of each digit, their order of transmission and the use of a filler code is as specified in § 3.3.2.8.

3.3.2.15 *RPOA transit network identity*

This is an optional field that is included only if indicated in bit B in the second indicator octet. This field is divided into four semi-octets, each of which contains a decimal digit of the applicable DNIC. The coding and order of transmission of these digits is as specified in § 3.3.2.8.

3.3.3 *Call accepted message*

3.3.3.1 The format of the call accepted message is as shown in Figure 7/Q.741.

The fields, subfields and codes are as follows:

3.3.3.2 *Label*

See § 3.2.

3.3.3.3 *Heading code H0*

See § 3.3.1.

3.3.3.4 *Signal*

The signal information is coded as shown in Table 7/Q.741 (corresponding call progress signal digits, as applicable, are indicated within brackets).

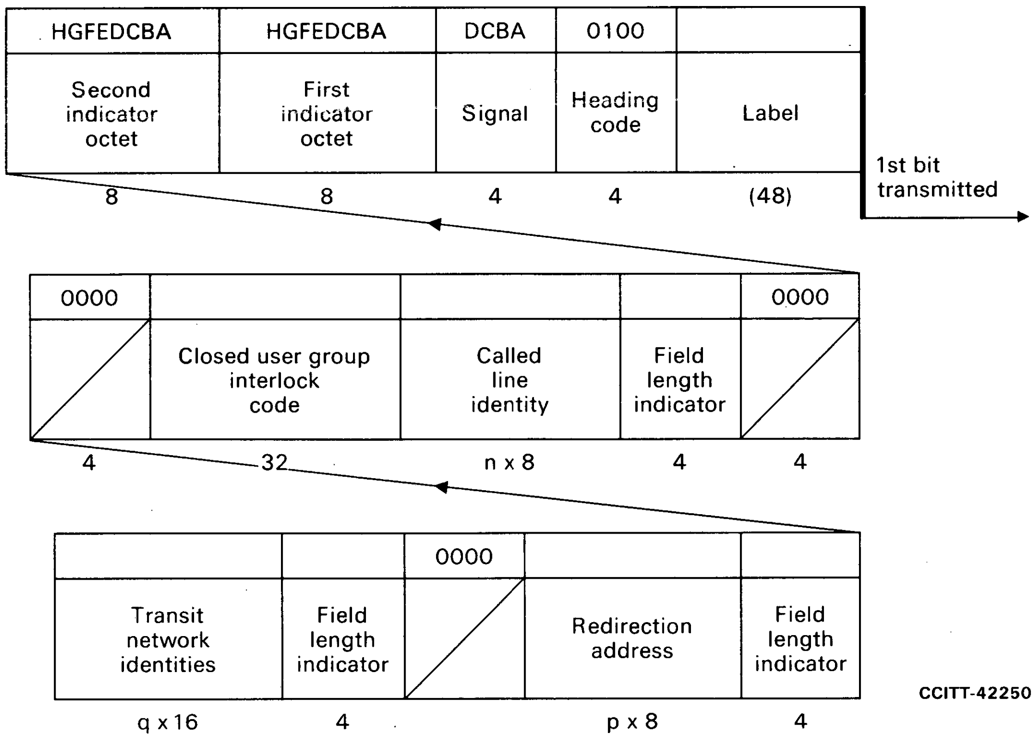


FIGURE 7/Q.741

Call accepted message

TABLE 7/Q.741

Bits DCBA	
0 0 0 0	reserved for call progress signal code 00
0 0 0 1	terminal called (01)
0 0 1 0	redirected call (02)
0 0 1 1	connect when free (03)
0 1 0 0 to 1 0 0 1	spare
1 0 1 0	call accepted
1 0 1 1	transit through connect
1 1 0 0	redirection request
1 1 0 1 to 1 1 1 1	spare

3.3.3.5 *First indicator octet*

The coding is shown in Table 8/Q.741.

TABLE 8/Q.741

Bits		
Bits	B A	Called line identity indicator
	0 0	called line identity not included
	0 1	called line identity without DCC/DNIC included (national use only)
	1 0	DCC/DNIC only included
	1 1	called line identity with DCC/DNIC included
	C	Charge/no charge indicator (national use only, see § 3.1.6)
	0	normal charging
	1	no charging
	D	Calling line identity request indicator
	0	calling line identification not requested
	1	calling line identification requested
	E	Originating network identification request indicator
	0	originating network identification not requested
	1	originating network identification requested
	F	Transit network identity indicator
	0	no transit network identity included
	1	one or more transit network identity(ies) included
	G	Spare
	H	Field indicator of the second indicator octet
	0	second indicator octet not included
	1	second indicator octet included

3.3.3.6 *Second indicator octet*

An optional field that is included if indicated in bit H of the first indicator octet. The coding is shown in Table 9/Q.741.

TABLE 9/Q.741

Bits	B A	Redirection address indicator (national use only, see § 3.1.6)
	0 0	redirection address not included
	0 1	redirection address without DCC/DNIC included
	1 0	spare
	1 1	redirection address with DCC/DNIC included
	D C	CUG call indicator (national use only, see § 3.1.6)[a]
	0 0	ordinary call
	0 1	spare
	1 0	CUG call, outgoing access allowed
	1 1	CUG call, outgoing access not allowed
	E, F, G	Spare
	H	Reserved for field indicator of a third indicator octet; code 0

[a] Note that CUG information is only applicable to CUG calls that are redirected, see Recommendation X.87 [1].

3.3.3.7 *Spare bits*

Included only when the called line identity is included.

3.3.3.8 *Field length indicator*

An optional field that is included only when the called line identity is included. It is a code expressing in pure binary representation the number of address signals in the called line identity included.

3.3.3.9 *Called line identity*

An optional field that is included only if indicated in bits AB in the first indicator octet. This field is divided into an even number of semi-octets. It contains a number of decimal digits of the national or international data number of the called line or of the DNIC of the destination network. The coding of each digit, their order of transmission and the use of the filler code is as specified in § 3.3.2.8.

3.3.3.10 *Closed user group interlock code*

An optional field that is included only if indicated in bits CD of the second indicator octet. The format and code of the interlock code is as specified in § 3.3.2.11.

3.3.3.11 *Spare bits*

An optional field that is included only when a redirection address is included.

3.3.3.12 *Field length indicator*

An optional field that is included only when a redirection address is included. It is a code expressing in pure binary representation the number of address signals in the redirection address included.

3.3.3.13 *Redirection address*

An optional field that is included only if indicated in bits AB of the second indicator octet. This field is divided into an even number of semi-octets. It contains a number of decimal digits. The coding of each digit, their order of transmission and the use of the filler code is as specified in § 3.3.2.8.

3.3.3.14 *Spare bits*

Included only when at least one transit network exchange is included.

3.3.3.15 *Field length indicator*

An optional field that is included when at least one transit network identity is included. It is a code expressing in pure binary representation the number of transit network identities, i.e. the number of 16-bit subfields in the transit network identity field.

3.3.3.16 *Transit network identities*

An optional field that is included only when indicated in bit F of the first indicator octet. This field contains one or more 16-bit subfields, each divided into 4 semi-octets. The coding of each digit and their order of transmission is as specified in § 3.3.2.8.

3.3.4 *Call rejected message*

3.3.4.1 The format of the call rejected message is as shown in Figure 8/Q.741.

			DCBA	0101	
Network identity of origin	Second digit	First digit	Indi-cators	Heading code	Label
16	4	4	4	4	(48)

1st bit transmitted →

CCITT-35550

FIGURE 8/Q.741
Call rejected message

The fields, subfields and codes are as follows:

3.3.4.2 *Label*

See § 3.2.

3.3.4.3 *Heading code*

See § 3.3.1.

3.3.4.4 *Indicators*

The coding is shown in Table 10/Q.741.

TABLE 10/Q.741

Bit	A	Reserved for a field indicator of a possible optional field for extended call progress information
	B	Field indicator of network identity of origin
	0	network identity of origin not included
	1	network identity of origin included
	C	Spare
	D	Reserved for a possible indication that immediate clearing should not take place; coded 0

3.3.4.5 *First and second digit*

Each of the two fields contains a decimal digit expressed in pure binary representation. The combination of the two decimal digits expresses the signal indicating the cause for call rejection. The values of the decimal digits are as shown in Table 11/Q.741. This coding should be consistent with the corresponding coding of DTE/DCE interface call progress signals, see Recommendation X.21 [9].

Note 1 – An interexchange signal not corresponding to a specific DTE/DCE interface call progress signal will, as required, be coded by over-decadic combination of the two digits.

Note 2 – Some of the call progress signal code groups specified in Recommendation X.21 [9] correspond to other message types than the call rejected message.

Note 3 – The reverse charge acceptance not subscribed signal has not yet been assigned a code.

TABLE 11/Q.741

Digits	20	network failure
	21	number busy
	41	access barred
	42	changed number
	43	not obtainable
	44	out of order
	45	controlled not ready
	46	uncontrolled not ready
	47	DCE power off
	48	invalid facility request[a]
	49	network fault in local loop
	51	call information service
	52	incompatible user class of service
	61	network congestion
	71	degraded service
	72	RPOA out of order

[a] Applicable to the facility registration/cancellation request rejected message only, see § 3.4.4.4.

3.3.4.6 *Network identity of origin*

This is an optional field that is included only if indicated in bit A of the indicator field. It contains the network identity of the exchange rejecting the call and thus originating the message. This field is divided into four semi-octets, each of which contains a decimal digit of the DNIC of the origin of the message. The coding and order of transmission of these digits is as specified in § 3.3.2.8. Inclusion of this field is mandatory for international traffic.

3.3.5 *Clear message*

3.3.5.1 The format of the clear message is as shown in Figure 9/Q.741.

DCBA	0110	
Signal	Heading code H0	Label
4	4	(48)

1st bit transmitted →

CCITT-35570

FIGURE 9/Q.741
Clear message

The fields and codes are as follows:

3.3.5.2 *Label*

See § 3.2.

3.3.5.3 *Heading code H0*

See § 3.3.1.

3.3.5.4 *Signal*

The coding is shown in Table 12/Q.741.

TABLE 12/Q.741

Bits DCBA	
0000	spare
0001	spare
0010	circuit released (forward)
0011	circuit released acknowledgement (forward)
0100 to 1001	spare
1010	circuit released (backward)
1011	circuit released acknowledgement (backward)
1100 to 1111	spare

3.3.6 *Circuit state message*

3.3.6.1 The format of the circuit state message is as shown in Figure 10/Q.741.

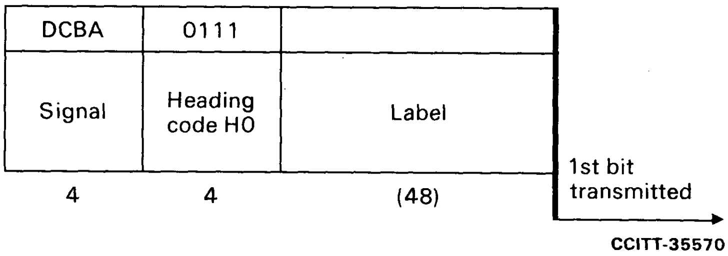


FIGURE 10/Q.741
Circuit state message

The fields and codes are as follows:

3.3.6.2 *Label*

See § 3.2.

3.3.6.3 *Heading code H0*

See § 3.3.1.

3.3.6.4 *Signal*

The coding is shown in Table 13/Q.741.

TABLE 13/Q.741

Bits DCBA	
0000	spare
0001	spare
0010	blocking
0011	blocking acknowledgement
0100	unblocking
0101	unblocking acknowledgement
0110	spare
0111	reset circuit
1000 to 1111	spare

3.3.7 *Calling line identity message*

3.3.7.1 The format of the calling line identity message is as shown in Figure 11/Q.741.

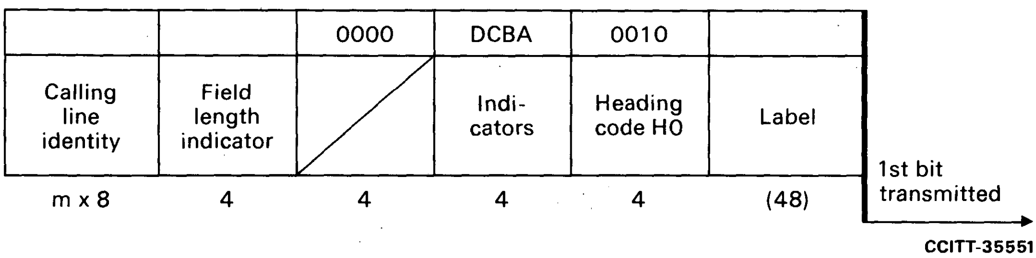


FIGURE 11/Q.741
Calling line identity message

The fields, subfields and codes are as follows:

3.3.7.2 *Label*

See § 3.2.

3.3.7.3 *Heading code H0*

See § 3.3.1.

3.3.7.4 *Indicators*

The coding is shown in Table 14/Q.741.

TABLE 14/Q.741

Bits	BA	Calling line identity indicator
	0 0	calling line identity not included[a]
	0 1	calling line identity without DCC/DNIC included (national use only)
	1 0	DCC/DNIC only included
	1 1	calling line identity with DCC/DNIC included
	C, D	Spare

[a] As presently defined, this message always includes the calling line identity.

3.3.7.5 *Spare bits*

Included only when the calling line identity is included.

3.3.7.6 *Field length indicator*

This is an optional [2] field that is included only when the calling line identity is included. It is a code expressing in pure binary representation the number of address signals in the calling line identity.

3.3.7.7 *Calling line identity*

This is an optional [2] field that is included only if indicated in bits AB of the indicator field. See also § 3.3.2.14.

3.4 *Formats and codes for facility registration and cancellation messages*

3.4.1 *Heading*

The different heading codes (H0) for the facility registration and cancellation messages are shown in Table 15/Q.741.

TABLE 15/Q.741

0000	spare
0001	facility registration/cancellation request message
0010	facility registration/cancellation accepted messages
0011	facility registration/cancellation rejected messages
0100 to 1111	spare

[2] As presently defined, this message always includes the calling line identity.

3.4.2 *Facility registration/cancellation request message*

3.4.2.1 The format of the facility registration/cancellation request message is as shown in Figure 12/Q.741.

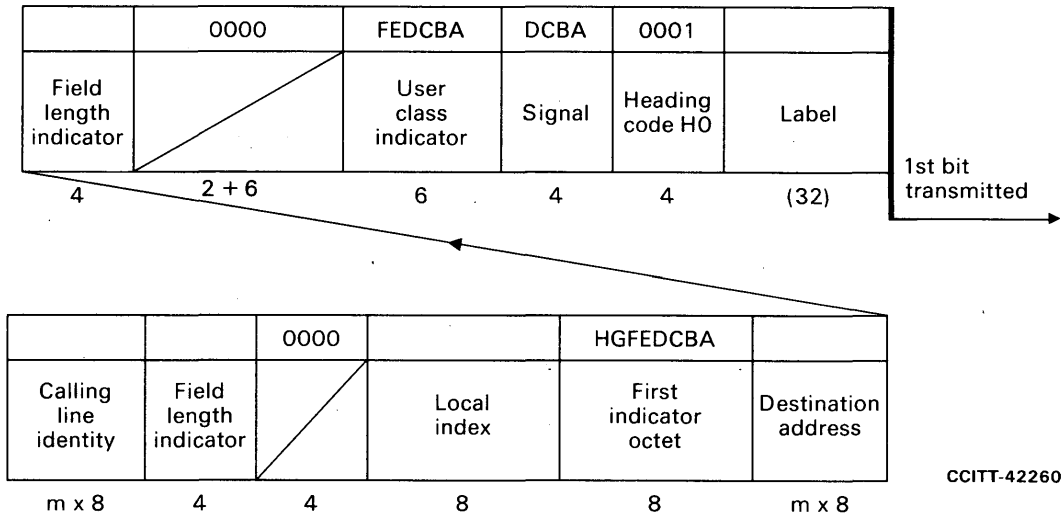


FIGURE 12/Q.741
Facility registration/cancellation request message

The fields, subfields and codes are as follows:

3.4.2.2 *Label*

See § 3.2.

3.4.2.3 *Heading code H0*

See § 3.4.1.

3.4.2.4 *Signal*

The coding is shown in Table 16/Q.741.

TABLE 16/Q.741

Bits DCBA	
0 0 0 0	spare
0 0 0 1	registration request
0 0 1 0	cancellation request
0 0 1 1 to 1 1 1 1	spare

3.4.2.5 *User class indicator*

See § 3.3.2.5.

3.4.2.6 *Spare bits*

3.4.2.7 *Field length indicator*

See § 3.3.2.7.

3.4.2.8 *Destination address*

See § 3.3.2.8.

3.4.2.9 *First indicator octet*

The coding is shown in Table 17/Q.741.

TABLE 17/Q.741

Bits BA	Calling line identity indicator
0 0	calling line identity not included
0 1	calling line identity without DCC/DNIC included (national use only)
1 0	DCC/DNIC only included
1 1	calling line identity with DCC/DNIC included
C	BCUG indicator
0	no BCUG registration/cancellation
1	BCUG registration/cancellation
D	Field indicator for local index
0	local index not included
1	local index included
E, F, G	Spare
H	Reserve for field indicator for second indicator octet; coded 0

3.4.2.10 *Local index*

This is an optional field that is included only if indicated in bit D in the first indicator octet. In the case of registration request it is the local index assigned by the user requesting registration. In the case of cancellation request it is the local index assigned by the remote user in the BCUG being cancelled.

3.4.2.11 *Spare bits*

Included only when the calling line identity is included.

3.4.2.12 *Field length indicator*

This is an optional field that is included only when the calling line identity is included. The code is as specified in § 3.3.2.13.

3.4.2.13 *Calling line identity*

This is an optional field that is included only if indicated in bits AB in the first indicator octet. The structure and codes are as specified in § 3.3.2.14.

3.4.3 *Facility registration/cancellation request accepted message*

3.4.3.1 The format of the facility registration/cancellation request message is as shown in Figure 13/Q.741.

	HGFEDCBA			0000	DCBA	0010	
Local index	First indicator octet	Desti-nation address	Field length indicator	/	Signal	Heading code H0	Label
8	8	n x 8	4	4	4	4	(32)

1st bit transmitted →

CCITT-42270

FIGURE 13/Q.741

Facility registration/cancellation request accepted message

The fields, subfields and codes are as follows:

3.4.3.2 *Label*

See § 3.2.

3.4.3.3 *Heading code H0*

See § 3.4.1.

3.4.3.4 *Signal*

The coding is shown in Table 18/Q.741.

TABLE 18/Q.741

Bits	0000	spare
	0001	registration completion
	0010	registration accepted
	0011	cancellation completed
	0100 to 1111	spare

3.4.3.5 *Spare bits*

3.4.3.6 *Field length indicator*

See § 3.3.2.7.

3.4.3.7 *Destination address*

See § 3.3.2.8.

3.4.3.8 *First indicator octet*

The coding is shown in Table 19/Q.741.

TABLE 19/Q.741

Bits	A	Spare
	B	BCUG indicator
	0	no BCUG registration/cancellation
	1	BCUG registration/cancellation
	C	Field indicator for local index
	0	local index not included
	1	local index included
	D-G	Spare
	H	Reserved for field indicator for second indicator octet; coded 0

3.4.3.9 *Local index*

This is an optional field that is included only if indicated in bit C of the first indicator octet. It contains the local index of the user at the exchange from which the message is originated.

3.4.4 *Facility registration/cancellation request rejected message*

3.4.4.1 The format of the facility registration/cancellation request rejected message is as shown in Figure 14/Q.741:

				0011	
Destination address	Field length indicator	Second digit	First digit	Heading code H0	Label
n x 8	4	4	4	4	(32)

1st bit transmitted →

CCITT-35550

FIGURE 14/Q.741

Facility registration/cancellation request rejected message

The fields, subfields and codes are as follows:

3.4.4.2 *Label field*

See § 3.2.

3.4.4.3 *Heading code*

See § 3.4.1.

3.4.4.4 *First and second digit*

Each of the two fields contains a decimal digit expressed in pure binary representation. The combination of the two decimal digits expresses the signal indicating the cause for facility registration/cancellation request rejection. The values of the decimal digits are as specified in § 3.3.4.5 for the relevant signals.

3.4.4.5 *Spare bits*

3.4.4.6 *Field length indicator*

See § 3.3.2.7.

3.4.4.7 *Destination address*

See § 3.3.2.8.

3.5 *Data channel signalling conditions*

The following conditions are those appearing in the interexchange data channels that in certain phases of a call have to be transmitted and/or detected in an exchange.

The coding of the presently specified data channel conditions is determined by the codes of the corresponding DTE/DCE interface states consistent with Recommendation X.21 [9].

The data channel signalling conditions will be coded as follows (data bits/status bit):

a) *trunk free* condition: 0 . . . 0/0 (see Notes 1 and 3),

b) *trunk seized* condition: 1 . . . 1/0,

c) *call accepted* condition: 1 . . . 1/1,

d) *call request* condition: 0 . . . 0/0.

The above codes imply that the code 0 of the status bit on an interexchange data channel results in the OFF condition at the DTE/DCE interface consistent with Recommendation X.21 [9], and that the code 1 results in the ON condition.

Note 1 – The code to be used for the *trunk free* condition in networks that cannot support bit sequence independence is for further study.

Note 2 – The implications for the data channel conditions, and their codes, of potential ISDN applications and/or of possible new DTE/DCE interfaces are a subject for further study.

Note 3 — As a national option, the data bits in the even positions of each envelope may be permanently inverted both at the transmitting and at the receiving ends of the interexchange data channels. Such inversion implies that the above specified codes (as well as information transferred during the data phase) will appear on the data channel correspondingly inverted. This option enables the *trunk free* condition in the case of the 8-bit envelope to be the same as the idle pattern for telephone channels as generated by a digital exchange complying with the standards related to the A-law.

4 Basic call control and signalling procedures

4.1 *General*

4.1.1 The call control procedures specified in this § 4 are based on the requirements of the circuit-switched data transmission service as presently defined in the Series X Recommendations. In particular, the requirements specified for exchange through-connection and data channel conditions are dependent on the characteristics of the present DTE/DCE interfaces for the circuit-switched service. Also, the implications of ISDN applications of common channel signalling for circuit-switched data transmission services have not yet been fully determined.

4.1.2 The basic call control procedure is divided into two phases: call set-up and call clear-down, which are separated from one another by the data phase. A combination of messages on the signalling link and exchanges of conditions in the interexchange data channels are used to establish and terminate the different phases of the call.

4.1.3 The procedures specified in this § 4 in principle only relate to basic calls, i.e. calls not involving any user facilities. The additional requirements to be met in the cases of calls involving user facilities and network utilities are specified in § 5 and Recommendation X.87 [1].

4.1.4 The interexchange data channel signalling conditions and the connect-through procedures specified ensure that the conditions in the network are compatible with the conditions and procedures for the present DTE/DCE interfaces.

4.1.5 Link-by-link transfer of signalling information assembled in messages is used and address information is signalled with all the elements of an address contained in one message. The network numbering is specified in Recommendation X.121 [10]. The network routing to apply is defined in Recommendation X.110 [11].

4.1.6 Requirements of interworking with decentralized signalling are specified in Recommendation X.80 [2].

4.2 *Overall call set-up and clear-down procedures*

The overall call set-up and clear-down procedures are outlined hereunder. The detailed signalling and switching procedures are covered in §§ 4.3 and 4.4 respectively. These procedures are illustrated in Tables 20/Q.741 and 21/Q.741.

4.2.1 *Call set-up*

4.2.1.1 When the originating exchange has received the complete selection information from the calling user and has determined that the call is to be routed to another exchange, it seizes a free interexchange data circuit and sends an address message on the signalling link. The address message in principle contains all of the information that is required to route and connect the call to the called user and may also include the calling line identity and other information related to any user facilities and network utilities that are required.

4.2.1.2 A transit exchange, on receipt of an address message will analyse the destination address and the other routing information to determine the routing of the call. The transit exchange then seizes a free interexchange data circuit and sends an address message to the next exchange and connects through the data path. In the case of congestion at the transit exchange it may select an alternative route, or send a call rejected message to the preceding exchange indicating congestion and clearing of the call.

4.2.1.3 Upon receipt of an address message the destination exchange will analyse the destination address to determine to which user the call should be connected. It will also check the called user's line condition and perform various checks to verify whether or not the connection is allowed. These checks will include correspondance of user class and any checks associated with user facilities. In the case where the connection is allowed, the destination exchange will call the called user in accordance with the applicable DTE/DCE interface protocol. The called user will normally respond with a *call accepted* (or corresponding) signal. If the call cannot be completed due to, for instance, the called user being busy, a call rejected message indicating this is sent to the preceding exchange and clearing takes place.

4.2.1.4 At connection of the call the destination exchange normally sends a call accepted message to the preceding exchange. Depending on the circumstances the call accepted message may include information related to specific network conditions and any user facilities or network utilities involved (see § 5).

4.2.1.5 Upon receipt of a call accepted message a transit exchange sends the corresponding call accepted message to the preceding exchange. If it is an international transit exchange the applicable transit network identity (see § 5.11) will be included in the call accepted message.

4.2.1.6 When the originating exchange receives a call accepted message indicating that the call can be completed, it prepares to connect through the data path. The originating exchange then connects through and starts charging, as applicable. In certain cases, e.g. when certain user facilities are involved, data path through-connection is preceded by the sending of a call progress signal or other information to the calling user.

4.2.1.7 In the cases when the call cannot be completed, the originating exchange will send an appropriate call progress signal, indicating the cause of call rejection, to the calling user and clear the call.

4.2.2 *Call clear-down*

4.2.2.1 Normally the clearing action initiated by a user will propagate rapidly along the connection and initiate release at each exchange involved. When both users clear at approximately the same time, clearing will propagate from both ends.

4.2.2.2 When detecting a valid *clearing* signal from the local user, the originating or destination exchange will release the connection and send a clear message to the adjoining exchange. The *clearing* signals originated by a user will pass through the local exchange and will appear on the interexchange data circuits and at the distant local exchange until such time as the *clearing* signals are acted upon and the connection is released. The actions at the exchange releasing the connection, including the condition sent on the interexchange data circuits when released, are therefore specified to be consistent with the clearing procedures of the DTE/DCE interfaces.

4.2.2.3 Clearing may also be initiated by a data exchange during call set-up when the call cannot be connected due to a user or network condition.

4.2.2.4 After release of the connection the clearing procedure is completed for each interexchange data circuit individually. A data circuit is assumed to be free for a new call at an exchange when both the forward and backward clearing indications relating to that data circuit have been sent and received.

4.3 *Normal switching procedures*

4.3.1 *General*

4.3.1.1 The switching procedures specified hereunder define the actions to be performed at call set-up and clear-down and the sequencing of these actions in relation to the handling of signalling messages and data channel signalling conditions. The specified connect-through and release actions and the coding of the data channel signalling conditions (see § 3.4) are based on the requirement for consistency with the present DTE/DCE interface protocol for the circuit- switched service.

Note – The implications for the procedure specified hereunder of possible new DTE/DCE interfaces for the circuit-switched service are for further study.

4.3.1.2 The *trunk free* condition is sent on the free interexchange data channels. Also, at release of an interexchange data circuit, the *trunk free* condition is immediately applied to its transmit channel. Both directions of transmission must be through-connected at (approximately) the same time.

TABLE 20/Q.741

Call set-up and clear-down procedure for successful basic call

Originating exchange	Interexchange data circuit →	Interexchange data circuit ←	Interexchange signalling link →	Interexchange signalling link ←	Transit exchange	Interexchange signalling link →	Interexchange signalling link ←	Interexchange data circuit →	Interexchange data circuit ←	Destination exchange
Trunk free condition	TF	TF			Trunk free condition			TF	TF	Trunk free condition
Selection information received	I	I						I	I	
Determine routing	I	I						I	I	
Free circuit seized	I	I						I	I	
Trunk seized sent	TS	I						I	I	
Address message sent	I	I	AM					I	I	
	I	I			Address message received			I	I	
	I	I			Routing determined			I	I	
	I	I			Free circuit seized			I	I	
	I	I			Data path connected			TS	I	
	I	I			Address message sent	AM		I	I	
	I	I						I	I	Address message received
	I	I						I	I	Called user determined
	I	I						I	I	State and validity checked[a]
	I	I						I	I	User called
	I	I						I	CA	Call accepted received
	I	I						I	I	Data path connected
	I	I					CAM	I	I	Call accepted message sent[a]
	I	I			Call accepted message received			I	I	
	I	I		CAM	Call accepted message sent			I	I	
Call accepted message received	I	I						I	I	
Call accepted condition received	I	CA						I	I	
Data path connected	I	I						I	I	
Charging started	I	I						I	I	

[a] Alternatively, the call accepted message can be sent before called user response.

[b] Optionally, remote user clear request condition may also be used as a release criterion.

Data circuit conditions

TF Trunk free condition
TS Trunk seized condition
CA Call accepted condition
RD Ready for data condition
CR Clear request condition
I Contiguous transmission of previous condition

Messages on signalling link

AM Address message
CAM Call accepted message
CRM Call rejected message
CLM Clear message

TABLE 20/Q.741 *(cont'd)*

Call set-up and clear-down procedure for successful basic call

Originating exchange	Interexchange data circuit		Interexchange signalling link		Transit exchange	Interexchange signalling link		Interexchange data circuit		Destination exchange
	⟶	⟵	⟶	⟵		⟶	⟵	⟶	⟵	
Ready for data received	RD	RD						RD	RD	Ready for data received
by calling user	I	I						I	I	by called user
	I	I						I	I	
Data phase	Data	Data			Data phase			Data	Data	Data phase
	I	I						I	I	
Clear request received	CR	I						CR	I	Clear request received
from calling user	I	I						I	I	by called user[b]
Data path released	I	I						I	I	
Clear message sent	I	I	CLM					I	I	
Trunk free sent	TF	I			Clear message received			I	CR	Clear request received
Clear confirmation	I	I			Data path released			I	I	from called user
sent to calling user	I	CR		CLM	Clear message sent on	CLM		I	I	Data path released
	I	I			both sides		CLM	I	I	Clear message sent
	I	TF			Free trunk sent on			TF	TF	Free trunk sent
Clear message received	I	I			both sides			I	I	Clear confirmation
(Outgoing) circuit free	I	I			(Incoming) circuit free			I	I	sent to called user
	I	I						I	I	
	I	I			Clear message received			I	I	Clear message received
	I	I			(Outgoing) circuit free			I	I	(Incoming) circuit free

[a] Alternatively, the call accepted message can be sent before called user response.

[b] Optionally, remote user clear request condition may also be used as a release criterion.

Data circuit conditions

TF Trunk free condition
TS Trunk seized condition
CA Call accepted condition
RD Ready for data condition
CR Clear request condition
I Contiguous transmission
I of previous condition

Messages on signalling link

AM Address message
CAM Call accepted message
CRM Call rejected message
CLM Clear message

TABLE 21/Q.741

Call set-up and clear-down procedure for basic call with number busy

Originating exchange	Interexchange data circuit →	Interexchange data circuit ←	Interexchange signalling link →	Interexchange signalling link ←	Transit exchange	Interexchange signalling link →	Interexchange signalling link ←	Interexchange data circuit →	Interexchange data circuit ←	Destination exchange
Trunk free condition	TF	TF			Trunk free condition			TF	TF	Trunk free condition
Call set up as for successful call	TS		AM							
					Call set up as for successful call	AM		TS		
										Address message received
										Called user busy
										Call released
							CRM			Call rejected message sent
Call rejected message received					Call rejected message received					
Call released					Call released					
Calling user cleared				CRM	Call rejected message sent					
Clear message sent			CLM		Clear message sent	CLM				
Trunk free sent	TF	TF			Trunk free sent			TF		Clear message sent
(Outgoing) circuit free					(Outgoing) circuit free					(Incoming) circuit free

Note – For legends see end of Table 20/Q.741

4.3.1.3 The signalling information content in the signalling messages is specified in § 4.4. The time-out supervisions to be performed in relation to interexchange signalling and the procedures to be followed in abnormal conditions are specified in § 4.5.

4.3.2 *Call set-up*

4.3.2.1 *Originating exchange*

The call set-up actions are illustrated by means of a Specification and Description Language (SDL) diagram (see Recommendation Z.101 [12]) in Figure 15/Q.741.

After having seized an interexchange data circuit, the originating exchange applies the *trunk seized* condition to the forward data channel. The sending of the address message and the application of the *trunk seized* condition may be performed in parallel as independent actions. The originating exchange then waits for the reception of a call accepted message or call rejected message.

Upon receipt of a call accepted message the originating exchange prepares to connect through the data path. In the case where user facilities apply, call progress signals may be sent to the calling user as applicable. The originating exchange then monitors the backward interexchange data channel for the presence of the *call accepted* condition. When this condition is detected, indicating that all succeeding exchanges have connected through, the originating exchange connects through and initiates charging where applicable.

In the cases when a call rejected message is received, the appropriate call progress signal is sent to the calling user and clearing takes place. Receipt of a call rejected message may also occur after receipt of a previous call accepted message.

Note – The possible implications for the originating exchange connect-through procedures of the provision of start-stop services, by means of the Recommendation X.20 [13] interface, in a network using common channel signalling are for further study.

4.3.2.2 *Transit exchange*

The call set-up actions are illustrated by means of an SDL diagram [12] in Figure 16/Q.741.

Having seized a free interexchange data circuit and sent an address message to the succeeding exchange, the transit exchange connects through the data path.

If a call accepted message is received from the succeeding exchange the transit exchange sends a corresponding message to the preceding exchange. If a call rejected message is received, the corresponding message is sent and clearing takes place. Receipt of a call rejected message may also occur subsequent to the receipt of a previous call accepted message.

4.3.2.3 *Destination exchange*

The call set-up actions are illustrated by means of an SDL diagram [12] in Figure 17/Q.741.

In the case where the call is to a user that is indicated as ready to receive a call, the destination exchange sends the *incoming call* (or corresponding) signal to the user. The destination exchange usually connects through the data path when:

– the *call accepted* (or corresponding) signal has been received from the user, and

– the transmission to the called user of any additional information, e.g. related to user facilities, has been completed in accordance with the applicable DTE/DCE interface protocol.

It is necessary to ensure that the *trunk seized* condition is present in the receive data channel of the interexchange data circuit before through-connection for consistency with the called user DTE/DCE interface protocol when this is in accordance with the present standards, e.g. [9], for the circuit-switched service, cf Note to § 4.3.3.2.

In the case where the call can be connected a call accepted message is sent to the preceding exchange. This message may be sent either before or after the *call accepted* (or corresponding) signal has been received from the called user. Waiting for the receipt of the *call accepted* or corresponding signal has the advantage that sending of the call accepted message is based on a positive indication that the call has been accepted by the called user. Sending the call accepted message earlier, e.g. in conjunction with the sending of the *incoming call* (or corresponding) signal to the user, has the advantage that the call set-up time is reduced in the normal condition.

In the case where certain user facilities apply, see § 5 and Recommendation X.87 [1], through-connection normally takes place in conjunction with the sending of a second call accepted message.

In the case where the call cannot be connected and completed, a call rejected message is sent to the preceding exchange and clearing takes place.

4.3.3 *Call clear-down*

4.3.3.1 *Originating exchange*

The clearing actions are illustrated by means of SDL diagrams [12] in Figures 15/Q.741 and 18/Q.741. Release of the connection is initiated by one of the following criteria (see also the Note to § 4.3.3.2):

a) detection of a *clear request* condition from the calling user,

b) optionally, detection of a *clear request* condition from the called user on the backward channel of the interexchange data circuit,

c) receipt of a call rejected message, or

d) receipt of a backward clear message.

After release of the connection a clear message is sent to the succeeding exchange and the calling user is cleared in accordance with the applicable DTE/DCE interface protocol.

4.3.3.2 *Transit exchange*

The clearing actions are illustrated by means of SDL diagrams [12] in Figures 16/Q.741 and 18/Q.741. Release of the connection is initiated by one of the following criteria:

a) failure to complete call set-up,

b) receipt of a call rejected message, or

c) receipt of a forward or backward clear message.

After release of the connection:

– a call rejected message is sent to the preceding exchange in the cases a) and b),

– a clear message is sent to the preceding exchange in the case c),

– a clear message is sent to the succeeding exchange in the cases b) or c).

Note – In the case where satellite data circuits are served by a terrestrial common channel signalling network, there is a probability that a clear message initiated by user clearing may arrive at the other end of the satellite circuit before all user data transmitted immediately before clearing has passed that end. Therefore, the action initiated by receipt of a clear message relating to a satellite circuit must be delayed by an appropriate time interval unless other release criteria have been met. The necessary arrangements to cater for such a situation are for further study.

4.3.3.3 *Destination exchange*

The clearing actions are illustrated by means of SDL diagrams [12] in Figures 17/Q.741 and 18/Q.741. Release of the connection is initiated by one of the following criteria (see also the Note to § 4.3.3.2):

a) failure to complete call set-up,

b) detection of *clear request* condition from the called user,

c) optionally, detection of a *clear request* condition from the calling user on the forward channel of the interexchange data circuit, or

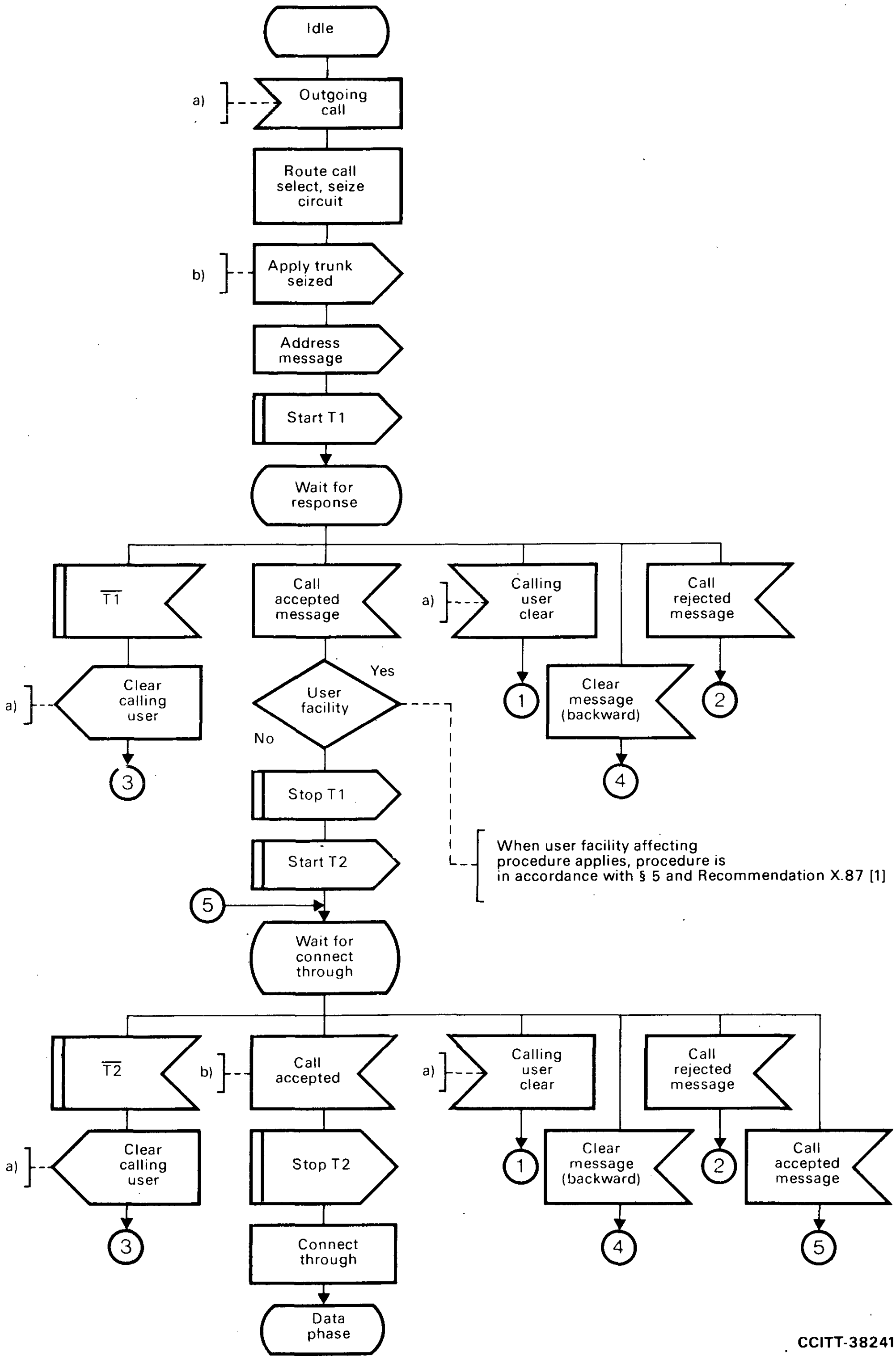
d) receipt of a forward clear message.

After release of the connection:

– a call rejected message is sent to the preceding exchange in the case a),

– a clear message is sent to the preceding exchange in the cases b), c) or d),

– the called user is cleared in accordance with the applicable DTE/DCE interface protocol in the cases b), c) and d).

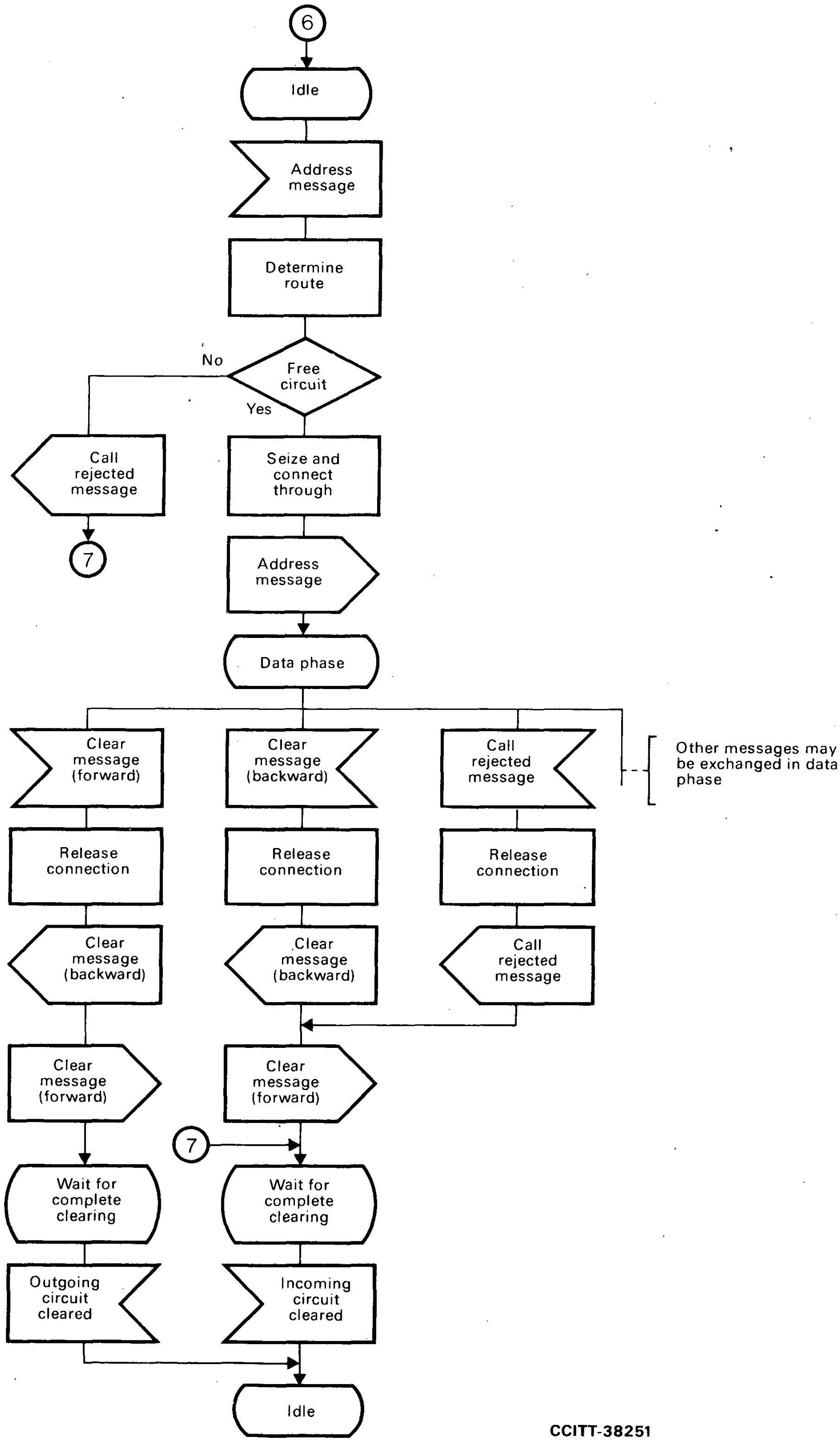


[a)] In accordance with the applicable DTE/DCE interface protocol.
[b)] In interexchange data channel.

Note - Connectors ① to ④ go to Figure 18/Q.741 which also shows clearing in data phase. Time-outs T1 and T2 as in § 4.5.3.1.

FIGURE 15/Q.741

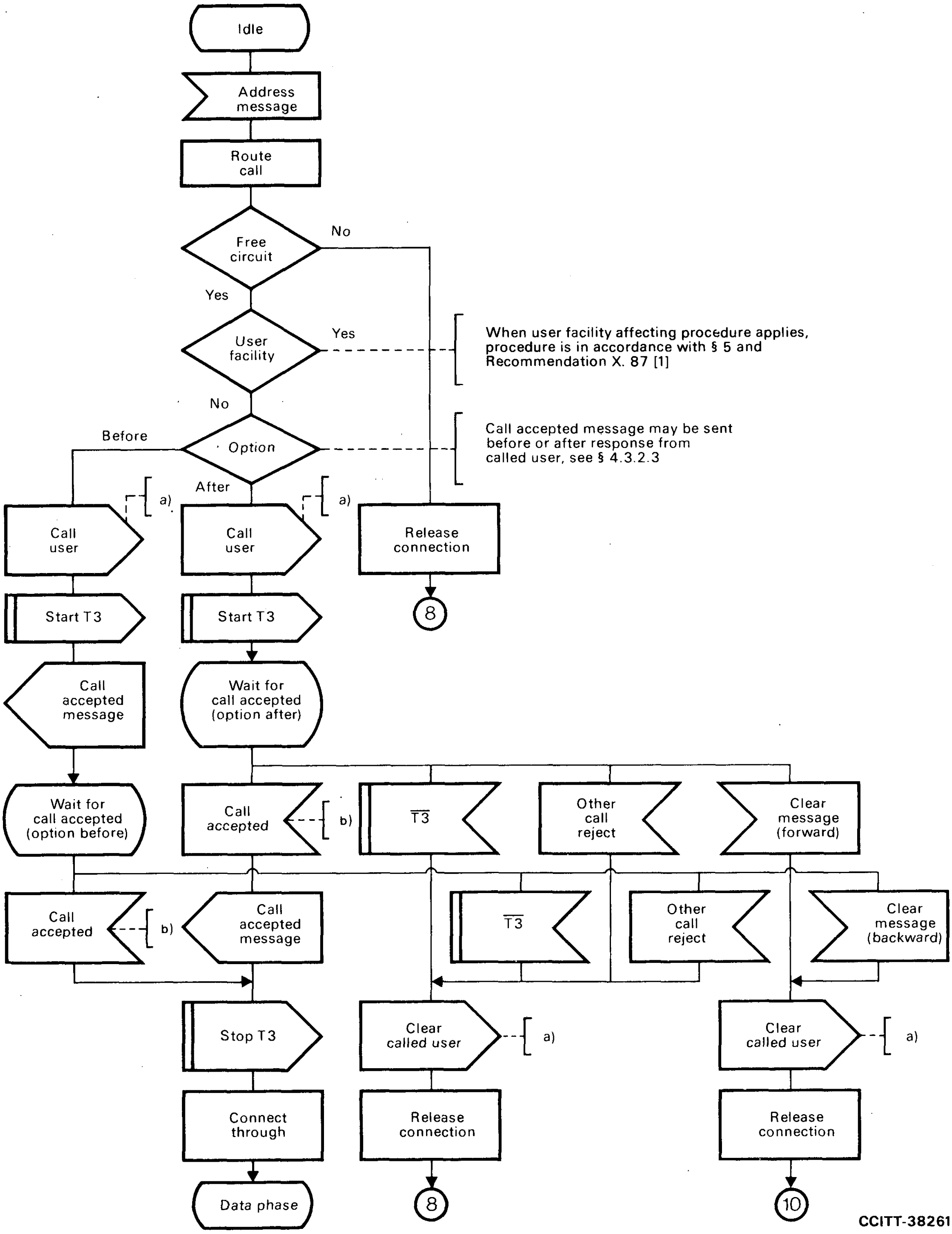
Call set-up at originating exchange



Note – Detailed clearing procedures are shown in Figure 18/Q.741.

FIGURE 16/Q.741

Call set-up at transit exchange

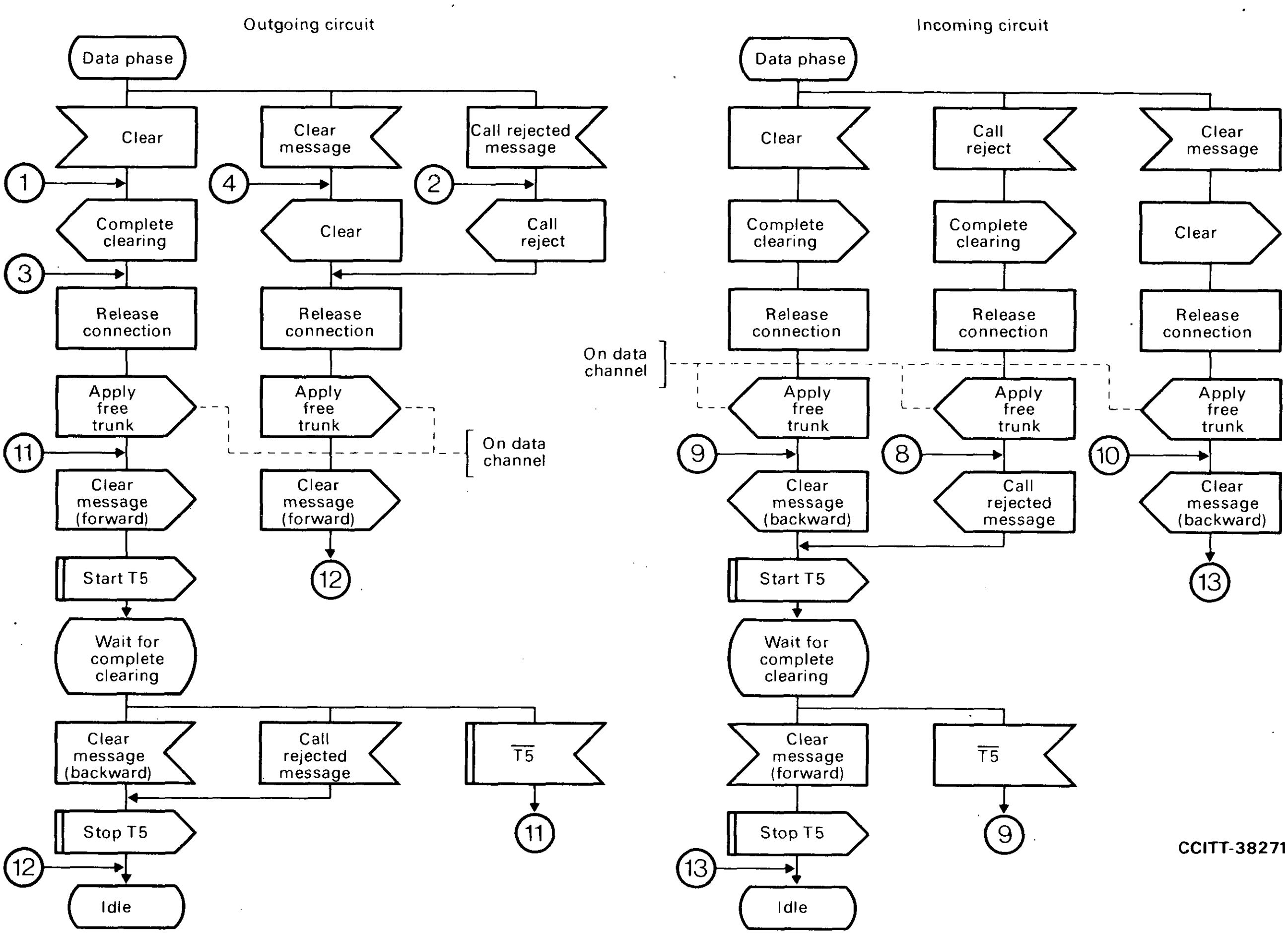


[a] In accordance with the applicable DTE/DCE interface protocol.
[b] Call accepted state, or corresponding, from called user.

Note - Connectors ⑧ to ⑩ go to Figure 18/Q.741, which also shows clearing in data phase. Time-out T3 as in § 4.5.3.2.

FIGURE 17/Q.741

Call set-up at destination exchange



Note – Connectors ① to ④ from Figure 15/Q.741 and ⑧ to ⑩ from Figure 17/Q.741. Time-out T5 and delayed maintenance alarm in case of ineffective release as in § 4.5.3.4.

FIGURE 18/Q.741

Clearing of interexchange data circuits

4.4 *Detailed signalling procedures under normal conditions*

The signalling information content of the different signalling message types is specified in § 3. The general function of the different signalling information components is defined in § 2. In the following, requirements are detailed for the signalling information components that are involved in normal basic calls. The requirements for sending the messages and for the principal actions at their reception are specified in § 4.2.

4.4.1 *Address message*

In the international network the *destination* address will be the complete international data number of the called user in accordance with Recommendation X.121 [10], i.e. including the DCC/DNIC.

The *DCC/DNIC* indicator is provided to cater for discrimination in national networks between cases where the destination address does or does not include the DCC/DNIC component. Depending on the national numbering and routing plans, this indicator may be necessary or useful for interpretation of the destination address and to determine the routing of the call. It may, for example, be used to identify an outgoing international call.

The *national/international call* indicator is provided to cater for discrimination in national networks between national and international calls. Depending on the implementation of user facilities and network functions that imply different handling of national and international calls, this indication may be a necessary or useful means for such differentiation. It may, for example, be used to determine whether a called line identity sent from the destination exchange should include the DNIC.

The *user class* indicator provides information about the user class of the calling user. At a transit exchange the user class information is used for selection of an appropriate type of data circuit. At the destination exchange the user class information is used to verify that the calling and the called users have compatible user classes of service.

The *alternative routing* indicator is set in the case where alternative routing is performed. It may be used to prevent the call being subjected to alternative routing more than once.

Provision is made for transfer in a national network of the calling line identity as part of the basic procedures, e.g. for call management purposes.

An address message may also contain additional signalling information relating to user facilities and network utilities the procedures of which are covered in § 5 and Recommendation X.87 [1].

4.4.2 *Call accepted message*

The *call accepted* signal is used at the time of connection of the call to a called user having automatic answer. In some cases when a user facility applies, or when the called DTE operates with manual answer, another signal is used in the first call accepted message. In such cases the *call accepted* signal is used in a second call accepted message when the call is completed by receipt of a *call accepted* (or corresponding) signal from the called user. At receipt of the *call accepted* signal the originating exchange prepares normal connect through.

In some situations of interworking with decentralized signalling the *transit through-connect* signal will be used as specified in Recommendation X.80 [2]. It will normally be followed by a second call accepted message. At receipt of the *transit through-connect* signal the originating exchange waits for a further call accepted message.

In some cases when the called user has a user facility, an alternative signal to the *call accepted* signal and/or additional signalling information will be used as covered in § 5 and Recommendation X.87 [1]. Depending on the facility involved this may result in an alternative connect through procedure at the destination exchange.

Provision is made for transfer in a national network of the called line identity as part of the basic procedures, e.g. for call management purposes.

4.4.3 *Call rejected message*

This message contains a signal indicating the cause for call rejection. The signal to be used in a particular case and the applicable translation at the originating exchange to a *DTE/DCE* call progress signal is as defined in § 2.3.

Receipt of a call rejected message will initiate clearing (see § 4.3.2). In international operation the network identity of the exchange originating the signal will be included in the message.

4.4.4 *Clear message*

A clear message containing a *circuit released* signal will be sent after release of the connection in the case when a clear message or a call rejected message has not been received for the same call and circuit. In the case where a clear message or a call rejected message has been received for the same call and circuit, the clear message sent will contain a *circuit released acknowledgement* signal. The signal sent will in both cases be coded as forward and backward respectively depending on the direction of the call at call set-up.

An interexchange data circuit is considered to be free for a new call when a clear message or a call rejected message has been sent, or received, subsequent to receipt, or sending, of those types of messages.

4.4.5 *Other messages*

Other types of messages are also provided for control of user facilities and network utilities as covered in § 5 and Recommendation X.87 [1]. Also, some message types are used in abnormal conditions as specified in § 4.5.

4.4.6 *Head-on collision*

When both-way working is used on a group of circuits, head-on collision can occur, i.e. the exchanges at each end may seize the same interexchange data circuit at approximately the same time. Head-on collision is detected when after sending of an address message, an address message is received as the first "backward" message.

In international operation it may be necessary to employ preventive measures to reduce the probability of head-on collisions and to take actions to minimize their effects. The necessary field of application and the form of such arrangements are for further study. However, the following offers some tentative possibilities.

Examples of the rules for circuit selection to reduce the probability of head-on collisions are given in Recommendations X.71 [8] and Q.724.

A method for minimizing the effects of head-on collisions by means of assigning priority to one end for each circuit is given in Recommendation Q.724.

4.5 *Call handling in abnormal conditions*

4.5.1 *Sending of a second backward message at call set-up*

As specified in § 4.3.1.3, the call accepted message can be sent before receipt of a *call accepted* (or corresponding) signal from the called user. If subsequently a condition occurs, e.g. *call collision*, that prevents the call from being completed, a call rejected message indicating this condition is sent. In these cases sending of the call rejected message will clear the call. At the originating exchange, receipt of the call rejected message will result in sending the applicable call progress signal to the calling user.

In some interworking situations and with some user facilities, sending of a second call accepted message may apply in the normal condition.

4.5.2 *Blocking and unblocking sequences*

Sending of a *blocking* signal will have the effect of prohibiting outgoing calls from the distant end of the relevant circuit, but will in itself not prohibit incoming calls to the exchange. Sending of the *unblocking* signal will have the effect of cancelling the blocked condition effected by the *blocking* signal. Acknowledgement sequences are always required for both the *blocking* and *unblocking acknowledgement* signals respectively. The acknowledgement is not sent until the relevant action, i.e. blocking or unblocking of the circuit, has been taken.

Removal (restoration) of a circuit from (to) traffic from both ends thus requires completion of a blocking and blocking acknowledgement (unblocking and unblocking acknowledgement) signal sequence relating to both directions.

Blocking of a circuit may be made during a call. In such a case the blocking sequence will be completed but the progress of the call will not be affected. However, after clearing of the call by means of the normal clearing signal sequence, the *blocked* condition will prevent the circuit from being seized by a new call. A *blocked* condition may in some situations be cancelled by a *reset circuit* signal (see § 4.5.6).

Blocking and unblocking sequences may be initiated by automatic or manual actions.

4.5.3 *Time-out supervision*

At various stages in the call set-up and clear-down procedures it is necessary to wait for receipt of a signal or condition from an adjoining exchange or user. The duration of such periods has to be controlled by appropriate time-outs. See also Figures 15/Q.741 to 18/Q.741. The operation of some of the time-outs will be affected by certain user facilities, see § 5. The values specified for the time-outs in the following are all provisional and subject to change following further study.

All time-outs related to call set-up are terminated in the case that clearing takes place before expiry of the time-out.

4.5.3.1 *Originating exchange*

The following time-outs are necessary at call set-up:

a) T1 = 10-20 s; the time between the sending of the address message and the receipt of a call accepted message. On expiry of the time-out T1 the originating exchange will send the *no connection* call progress signal to the calling user and clear the call.

b) T2 = 5-10 s; the time between the receipt of the first call accepted message and detection of the *call accepted* condition. On expiry of time-out T2 the originating exchange will send the *no connection* call progress signal to the calling user and clear the call.

Note – The operation of time-out T2 is modified when certain user facilities apply (see § 5).

4.5.3.2 *Destination exchange*

The following time-outs are necessary at call set-up:

a) T3: value as specified for the relevant DTE/DCE interface; the time between the sending of the *incoming call* (or corresponding) signal to the called user and the receipt of the *call accepted* (or corresponding) signal from the called user. On expiry of time-out T3, as specified for the applicable DTE/DCE interface protocol, the destination exchange will send a call rejected message containing a *network failure* signal and thus clear the call.

b) T4 = 5-10 s; the time between the sending of the call accepted message and receipt of a calling line identity message (when identification is requested). On expiry of time-out T4, the destination exchange will send a call rejected message containing a *network failure* signal and thus clear the call.

4.5.3.3 *Transit exchange*

Because a transit exchange is through-connected without waiting for an external event, no time-out supervision is required at call set-up.

4.5.3.4 *Circuit supervision*

The following time-outs are required in all exchanges:

a) T5 = 5-10 s; the time between sending of the clear message, containing a *circuit released* signal, or a call rejected message and the receipt of a clear message or a call rejected message (relating to the same interexchange data circuit and clearing action). On expiry of time-out T5, a new clear message containing a *circuit released* signal will be sent. Should clearing continue to be ineffective, a maintenance alarm will be activated after an appropriate time interval, and the circuit is kept busy. No time-out will apply following sending of the clear message containing a *circuit released acknowledgement* signal.

b) T6 = 5-10 s; the time between sending of a *blocking* or *unblocking* signal and receipt of a *blocking acknowledgement* or *unblocking acknowledgement* signal (respectively). On expiry of time-out T6, the *blocking* or *unblocking* signal will be repeated. Should blocking or unblocking continue to be ineffective, a maintenance alarm will be activated after an appropriate time interval.

4.5.4 *Call clear-down before completion of call set-up*

In some circumstances of call clear-down in abnormal conditions, signalling information relating to the call may subsequently be received. With the exception in § 4.5.6 such information will in all cases be discarded.

In the case where user clearing is detected or a clear message is received during the call set-up, the call set-up process is terminated and normal clear-down is performed. If the originating exchange has seized an interexchange data circuit, a clear message will not be sent unless an address message has already been sent.

In some cases it may be required to clear a call for management purposes. This can be achieved by initiating at any exchange the clearing procedures. See also § 4.5.5.

4.5.5 *Circuit resetting in abnormal situations*

In the case where the state of an interexchange data circuit becomes ambiguous, due to for example memory mutilation or processor disturbances at an exchange (X), the reset circuit may be used by that exchange to align the state of the circuit at both ends. The *reset circuit* signal is always acknowledged by a *circuit released acknowledgement* signal.

When receiving a *reset circuit* signal an exchange (Y) will:

a) respond with a *circuit released acknowledgement* signal in the case where the circuit is indicated as free;

b) release the circuit and respond with a *circuit released acknowledgement* signal in the case where the circuit is busy;

c) respond with a *blocking* signal followed by a *circuit released acknowledgement* signal in the case where the circuit is unconnected but indicated as being blocked at exchange X by exchange Y;

d) release the circuit and respond with a *blocking* signal followed by a *circuit released acknowledgement* signal in the case where the circuit is busy and indicated as being blocked at exchange X by exchange Y;

e) cancel a *blocked* condition (for outgoing calls) indicated as initiated by the distant end and act as in a)-d) above, as applicable, in the case where such a *blocked* condition exists at exchange Y in addition to one of the conditions a)-d).

Note – If the exchange (X) sending the *reset circuit* signal wants to preserve a *blocked* condition at the other end (Y), it (X) has to send a *blocking* signal subsequent to the *reset circuit* signal.

After sending a *reset circuit* signal, the exchange (X) will regard the circuit as unavailable for traffic until a response is received (from Y) at which time the exchange will:

i) return the circuit to the *idle* condition when a *circuit released acknowledgement* signal is received;

ii) regard it as operational but blocked by the distant end (Y) for outgoing calls when a *blocking* signal is received.

Appropriate means to cover situations in which no response to a *reset circuit* signal is received should be provided.

Note – The possible provision of means for resetting a group of circuits by a single action is for further study.

4.5.6 *Receipt of unreasonable signalling information*

The Message Transfer Part of the signalling system will avoid mis-sequencing of or double delivery of messages with a high reliability. However, undetected errors at the signalling link level and exchange malfunctions may produce unreasonable signalling information in messages that are either ambiguous or inappropriate.

In order to resolve some possible ambiguities in the state of a circuit when unreasonable signals are reccived, the following will apply:

a) If a *circuit released* signal is received relating to an idle circuit, it will be acknowledged with a *circuit released acknowledgement* signal.

b) If a *circuit released acknowledgement* signal is received relating to an idle interexchange data circuit, it will be discarded.

c) If a *circuit released acknowledgement* signal is received relating to a busy interexchange data circuit for which a circuit released signal has not been sent, the circuit will be released and a circuit released signal will be sent.

d) If a *blocking* signal is received for a blocked interexchange data circuit, a *blocking acknowledgement* signal will be sent.

e) If an *unblocking* signal is received for an unblocked interexchange data circuit, an *unblocking acknowledgement* signal will be sent.

Any other unreasonable signalling information received will be discarded (see, however, § 4.4.6). If the discarding of the information prevents a call from being completed; that call will eventually be cleared by the expiry of a time-out.

5 Additional call control and signalling procedures

5.1 *General*

§ 5 refers to the call control and signalling procedures that apply, in addition to the basic procedures specified in § 4, where user facilities and network utilities are involved.

The principles and procedures for realization of international user facilities and network utilities are defined in Recommendation X.87 [1], which thus gives the basis for the common channel signalling procedures. Therefore, the following is limited to an outline of the implications for the common channel signalling procedures of such user facilities and network utilities.

The additional signalling information components particular to user facilities and network utilities are indicated in § 2. The corresponding formats and codes are specified in § 3.

5.2 *Closed user group facilities*

Depending on whether a closed user group is involved, the address message may include a *closed user group call* indication and an *interlock code.*

In certain cases of redirection of a closed user group call, that closed user group information included in the address message will also be returned back, within a call accepted message, to the exchange controlling redirection.

5.3 *Bilateral closed user group facilities*

The signalling system is capable of supporting automatic user controlled procedures for registration and cancellation of bilateral closed user groups. Three types of messages:

- facility registration/cancellation request message,
- facility registration/cancellation request accepted message, and
- facility registration/cancellation request rejected message,

which may include a number of signalling indications relating to bilateral closed user groups, are provided for those procedures.

At call set-up within a bilateral closed user group, the address message will contain a *bilateral closed user group call* indication.

Note – Subject to further study, it may be necessary to include further information relating to this facility in the address message, see Recommendation X.87 [1].

5.4 *Calling line identification*

The signalling system provides for transfer of the calling line identity:

a) in the address message, systematically or selectively, or

b) in a calling line identity message, on request from the destination exchange as indicated in the call accepted message.

5.5 *Called line identification*

The called line identity is transferred in the call accepted message on request from the originating exchange as indicated in the address message.

The *national/international* indicator included in the address message may be used by the destination exchange to determine whether the called line identity should be the national or the complete international data number of the called user.

5.6 *Redirection of calls*

The signalling system provides a number of signals that cater for the *redirection of calls* facility.

In the case where the call is released back to a controlling exchange at redirection, the call accepted message will contain the *redirection request* signal, a *redirection address* indication and the *redirection address.* The original forward connection is cleared from the controlling exchange.

The address message sent for a call that during redirection is set up towards the new number (i.e. the *redirection address*) will contain a *redirected call* indication.

When a redirected call has been connected to the *redirection address*, the call accepted message sent towards the originating exchange will contain the *redirected call* signal. The *redirected call* signal is equivalent to the *call accepted* signal but has also the additional function of sending a *call progress* signal to the called user.

5.7 *Connect when free and waiting allowed*

The call accepted message sent from the destination exchange, when a call to a busy user having the *connect when free* facility is put in a queue, will contain the *connect when free* signal. At the originating exchange this signal will among other actions inhibit time-out T2.

When the waiting call is connected to the called user, a second call accepted message, now containing the *call accepted* signal, will be sent.

5.8 *Reverse charging and reverse charge acceptance*

When a reverse charging request from a calling user is allowed by the originating network, the address message will contain a *reverse charging request* indication. In the case where reverse charging is rejected because the called user does not have the *reverse charge acceptance* facility, the call rejected message will contain the *reverse charge acceptance not subscribed* signal. Otherwise the call is accepted or rejected as an ordinary call.

Note – The principles for accounting of reverse charging calls have not yet been determined; thus the possible implications of special accounting arrangements for the switching or interexchange signalling procedures have not yet been determined.

5.9 *Manual answer*

The call accepted message sent from the destination exchange at connection of a call to a user who employs *manual answer*, will contain the *terminal called* signal. At receipt of the *terminal called* signal at the originating exchange, through-connection will be prepared but time-out T2 will be lengthened to 2-4 minutes.

When the called user responds by a *call accepted* signal, a second call accepted message, now containing the *call accepted* signal, will be sent.

5.10 *RPOA selection*

In the case where a calling user selects a particular RPOA, an address message sent in the originating network will contain an *RPOA selection* indication and the applicable *RPOA transit network identity*. If such a call is rejected because the selected RPOA transit network cannot handle the call, the call rejected message sent will contain the *RPOA out-of-order* signal.

5.11 *Network identification utilities*

The capability for *originating network identification* on request from the destination network is mandatory for international calls. When this utility is employed the call accepted message will contain an *originating network identification request* indication. The identity of the originating network is then sent in a calling line identity message.

The signalling system also provides for transfer of the identity of the originating network within the address message.

Destination network identification and transit network identification by means of transfer of the network identities in the call accepted message are mandatory for international calls.

6 Signalling performance and traffic characteristics in data applications

6.1 *Signalling reliability*

6.1.1 *General*

Recommendation Q.706 details the factors that influence the performance of the message transfer service provided by a signalling network that uses the Message Transfer Part of Signalling System No. 7. It also provides information that may be used to estimate that performance in particular applications.

6.1.2 *Unsuccessful calls due to signalling malfunctions*

Although the Message Transfer Part is designed to provide a high reliability for transfer of messages through a signalling network, certain irregularities in message transfer cannot be prevented in certain situations.

Loss of the message will in most cases result in an unsuccessful call. The proportion of lost messages will primarily depend on the reliability of equipment used to realize certain signalling functions. The requirements specified for such equipments in Recommendation Q.706 will ensure that the proportion of lost calls in typical applications is 1 in 10^5 or better.

In certain extreme conditions, it is also possible that the message transfer function delivers faulty messages with reasonable information or delivers messages out-of-sequence. The probability of such malfunctions is, however, negligible from the circuit-switched data service point of view, see Recommendation Q.706.

6.1.3 *Availability of signalling*

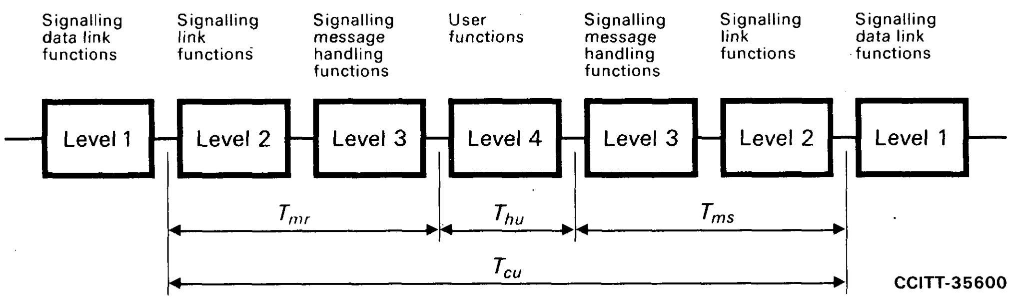
The availability of signalling primarily depends on the reliability of the equipment used to realize the signalling functions and the redundancy with which such equipment is provided.

No availability requirements for international signalling for the circuit-switched data service have yet been defined.

6.2 *Message transfer times*

6.2.1 *Functional reference points and signal transfer time components*

See Figure 19/Q.741.



T_{cu} Cross-office transfer time

T_{hu} Data User Part handling time

T_{mr} Message Transfer Part receiving time

T_{ms} Message Transfer Part sending time

} The definitions of these times are given in Recommendation Q.706.

FIGURE 19/Q.741

Functional diagram of the signal transfer time

6.2.2 *Definitions*

6.2.2.1 **cross-office transfer time, T_{cu}**

T_{cu} is the period which starts when the last bit of the signal unit leaves the incoming signalling data link and ends when the last bit of the signal unit enters the outgoing signalling data link for the first time. It also includes the queueing delay in the absence of disturbances but not the additional queueing delay caused by retransmission.

6.2.2.2 **Data User Part handling time, T_{hu}**

T_{hu} is the period which starts when the last bit of the message has entered the Data User Part and ends when the last bit of the derived message has left the Data User Part.

6.2.3 *Queueing delay*

An example of the queueing delays which may be expected in a particular case is shown in Appendix I to this Recommendation, see also § 6.3.

6.3 *Data signalling traffic models*

The characteristics of the signalling traffic generated for data call control will primarily depend on factors such as:

- the data traffic volume (call/s),
- the mix of different call types (international/national, successful/unsuccessful, etc.),
- the proportion of calls involving user facilities and network utilities and the mix of such facilities and utilities.

Appendix I contains two data signalling traffic models that indicate the mix of message types and lengths that result from particular sets of assumed conditions. The appendix also gives an example of the loading capacity of a signalling link for data call control signalling.

APPENDIX I

(to Recommendation Q.741)

Examples of signalling traffic characteristics

I.1 *Signalling traffic models*

I.1.1 Tables I-1 and I-2/Q.741 show two examples of mixes of data signalling message types and lengths. The models are simplified and do not fully reflect the possible variation of message lengths.

The following applies for both models:

- a mix of national and international calls is assumed with 8 and 12 digits in the data numbers respectively;
- the closed user group facility applies for 50% of the calls;
- the basic label specified in § 3.2.2.1 is used;
- the message length shown in the tables is the number of octets in the signalling information field of the corresponding signal unit; the overall length of the signal unit on the line is approximately 7 octets longer.

I.1.2 Table I-1/Q.741 assumes that the calling line identity is always sent in the address message and that called line identification applies for 10% of the calls.

TABLE I-1/Q.741

Example 1 of data signalling message mix

Message type	Messages/call	Message length (octets)
Address message	0.575	24
	0.425	18
Call accepted message	0.1	14
	0.9	8
Clear message	2	7

Message per call = 4
Average message length = 11 octets
Total amount of information per call = 576 bits

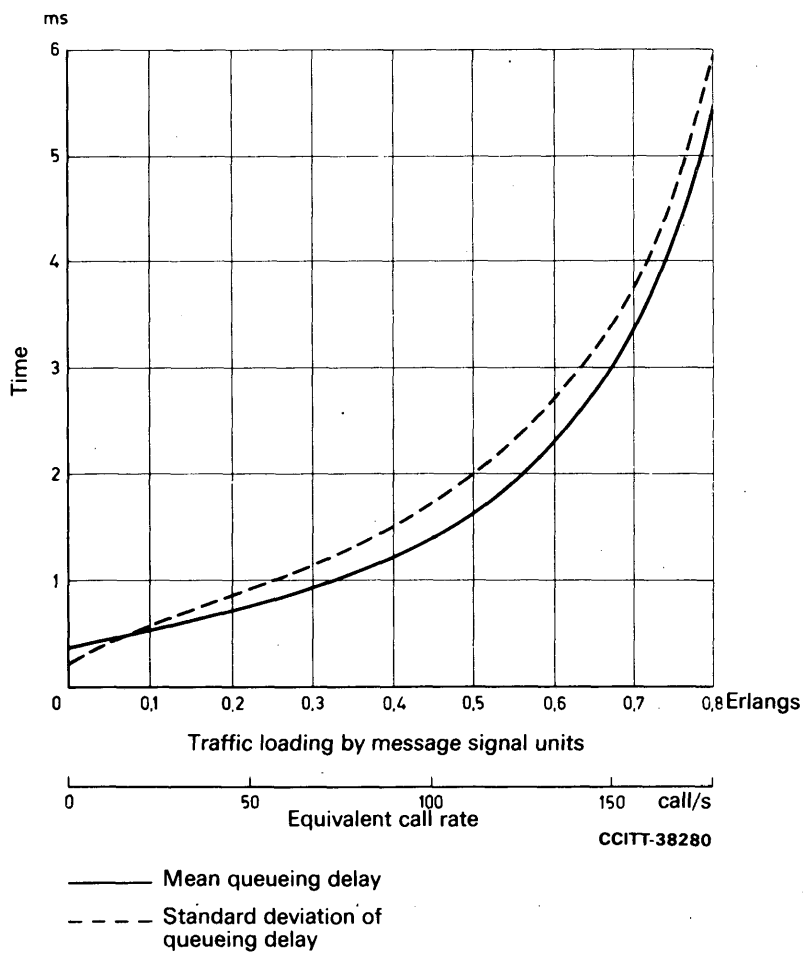
I.1.3 Table I-2/Q.741 assumes that the calling line identity is sent on request for 10% of the calls.

TABLE I-2/Q.741

Example 2 of data signalling message mix

Message type	Messages/call	Message length (octets)
Address message	0.575	18
	0.425	14
Call accepted message	1	8
Calling line identity message	0.1	14
Clear message	2	7

Messages per call = 4.1
Average message length = 9.7
Total amount of information per call = 548 bits



T_m 2.252 ms (144.1 bits and 64 kbit/s)
T_f 0.75 ms (48 bits and 64 kbit/s)
k_1 1.123
k_2 1.421

FIGURE I-1/Q.741

Example of queueing delay as a function of link load

I.2 *Queueing delay and link loading*

Figure I-1/Q.741 shows the mean value and standard deviation of message queueing delays for different signalling link loads.

The queueing delays shown in Figure I-1/Q.741 assume:

- a message mix according to Table I-1/Q.741,
- error-free operation of a signalling link using the basic error correction method.

The theoretical basis for calculation of the queueing delays and information about the performance of the signalling system under error conditions are included in Recommendation Q.706.

The equivalent call rate shown in the figure assumes an even distribution of the calls in both directions of transmission.

References

[1] CCITT Recommendation *Principles and procedures for realization of international user facilities and network utilities in public data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.87.

[2] CCITT Recommendation *Interworking of interexchange signalling systems for circuit switched data services*, Vol. VIII, Fascicle VIII.3, Rec. X.80.

[3] CCITT Recommendation *Fundamental parameters of a multiplexing scheme for the international interface between synchronous data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.50.

[4] CCITT Recommendation *Fundamental parameters of a multiplexing scheme for the international interface between synchronous data networks using 10-bit envelope structure*, Vol. VIII, Fascicle VIII.3, Rec. X.51.

[5] CCITT Recommendation *Characteristics of 2048-kbit/s frame structure for use with digital exchanges*, Vol. III, Fascicle III.3, Rec. G.734.

[6] CCITT Recommendation *Numbering of channels on international multiplex lines at 64 kbit/s*, Vol. VIII, Fascicle VIII.3, Rec. X.53.

[7] CCITT Recommendation *Allocation of channels on international multiplex lines at 64 kbit/s*, Vol. VIII, Fascicle VIII.3, Rec. X.54.

[8] CCITT Recommendation *Decentralized terminal and transit control signalling system on international circuits between synchronous data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.71.

[9] CCITT Recommendation *Interface between data terminal equipment (DTE) and data circuit terminating equipment (DCE) for synchronous operation on public data networks*, Vol. VIII, Fascicle VIII.2, Rec. X.21.

[10] CCITT Recommendation *International numbering plan for public data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.121.

[11] CCITT Recommendation *Routing principles for international public data services through switched public data networks of the same type*, Vol. VIII, Fascicle VIII.3, Rec. X.110.

[12] CCITT Recommendation *General explanation and description language (SDL)*, Vol. VI, Fascicle VI.7, Rec. Z.101.

[13] CCITT Recommendation *Interface between data terminal equipment (DTE) and data circuit terminating equipment (DCE) for start-stop transmission services on public data networks*, Vol. VIII, Fascicle VIII.2, Rec. X.20.

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GLOSSARY OF TERMS SPECIFIC TO SIGNALLING SYSTEM No. 7

active signalling link

F: canal sémaphore (à l'état) actif

S: enlace de señalización activo

A signalling link which has successfully completed the initial alignment procedures and carries (or is ready to carry) signalling traffic.

adjacent signalling points

F: points sémaphores adjacents

S: puntos de señalización adyacentes

Two signalling points that are directly interconnected by (a) signalling link(s).

alignment error rate monitoring

F: surveillance du taux d'erreur pendant la procédure d'alignement

S: monitor de tasa de errores en la alineación

A procedure by which the error rate of a signalling link is measured during the initial alignment.

alternative routing (of signalling)

F: acheminement (de signalisation) de secours

S: encaminamiento alternativo (de señalización)

The routing of a given signalling traffic flow in case of failures affecting the signalling links, or routes, involved in the normal routing of that signalling traffic flow.

associated mode (of signalling)

F: mode (de signalisation) associé

S: modo (de señalización) asociado

The mode where messages for a signalling relation involving two adjacent signalling points are conveyed over a directly interconnecting signalling link.

backward indicator bit

F: bit indicateur vers l'arrière

S: bit indicador inverso (hacia atrás)

A bit in a signal unit requesting, by its status change, retransmission at the remote end when a signal unit is received out of sequence.

backward sequence number

F: numéro de séquence vers l'arrière

S: número secuencial inverso (hacia atrás)

A field in a signal unit sent which contains the forward sequence number of a correctly received signal unit being acknowledged.

basic (error correction) method

F: méthode (de correction d'erreur) de base

S: método básico (de corrección de errores)

A non-compelled, positive/negative acknowledgement, retransmission error control system.

changeback

F: retour sur canal sémaphore normal

S: retorno al enlace de servicio

The procedure of transferring signalling traffic from one or more alternative signalling links to a signalling link which has become available.

changeback code

F: code de retour sur canal sémaphore normal

S: código de retorno al enlace de servicio

A field in the signalling network management messages used in the changeback procedure; it is used to discriminate messages relating to different changeback procedures performed at the same time towards the same signalling link.

changeover

F: passage sur canal sémaphore de secours

S: paso a enlace de reserva

The procedure of transferring signalling traffic from one signalling link to one or more different signalling links, when the link in use fails or is required to be cleared of traffic.

check bit

F: bit de contrôle

S: bit de control

A bit associated with a character or block for the purpose of checking the absence of error within the character or block.

check loop

F: boucle pour contrôle de continuité

S: bucle de pruebas de continuidad

A device which is attached to interconnect the Go and Return paths of a circuit at the incoming end of a circuit to permit the outgoing end to make a continuity check on a loop basis.

common channel signalling

F: signalisation par canal sémaphore

S: señalización por canal común

A signalling method in which a single channel conveys by the means of labelled messages, signalling information relating to a multiplicity of circuits or calls and other information such as that used for network management.

continuity check

F: contrôle de continuité

S: prueba (verificación) de continuidad

A check made to a circuit or circuits in a connection to verify that an acceptable path (for transmission of data, speech, etc) exists.

continuity check transponder

F: répondeur pour contrôle de continuité

S: transpondedor (transmisor-respondedor) para pruebas de continuidad

A device which is used to interconnect the Go and Return paths of a circuit at the incoming end which on detection of a check tone transmits another check tone to permit a continuity checking of a 2-wire circuit.

controlled rerouting

F: retour sous contrôle sur route normale

S: reencaminamiento controlado

A procedure of transferring in a controlled way, signalling traffic from an alternative signalling route to the normal signalling route, when this has become available.

cross-office check

F: contrôle de continuité à travers un commutateur

S: prueba (verificación) de continuidad a través de la central

A check made across the exchange to verify that an acceptable speech path exists.

Data User Part

F: Sous-système Utilisateur Données

S: parte de usuario de datos

The User Part specified for data services.

destination point code

F: code du point de destination

S: código del punto de destino

A part of the label in a signalling message which uniquely identifies, in a signalling network, the (signalling) destination point of the message.

dual seizure

F: prise simultanée

S: doble toma (toma simultánea)

The condition which occurs when in bothway operation two exchanges attempt to seize the same circuit at approximately the same time.

emergency changeover

F: passage d'urgence sur canal sémaphore de secours

S: paso de emergencia a enlace de reserva

A modified changeover procedure to be used whenever the normal one cannot be accomplished, i.e. in case of some failures in the signalling terminal equipment or in case of inaccessibility between the two involved signalling points.

error burst

F: paquet d'erreurs

S: ráfaga de errores

A group of bits in which two successive erroneous bits are always separated by less than a given number (x) of correct bits. The number x should be specified when describing an error burst.

Note – The last erroneous bit in a burst and the first erroneous bit in the following burst are accordingly separated by x correct bits or more.

fill-in signal unit

F: trame sémaphore de remplissage

S: unidad de señalización de relleno

A signal unit containing only error control and delimitation information, which is transmitted when there are no message signal units or link status signal units to be transmitted.

flag

F: fanion

S: bandera

The unique pattern on the signalling data link used to delimit a signal unit.

forced rerouting

F: passage sous contrainte sur route de secours

S: reencaminamiento forzado

A procedure of transferring signalling traffic from one signalling route to another, when the signalling route in use fails or is required to be cleared of traffic.

forward indicator bit

F: bit indicateur vers l'avant

S: bit indicador directo (hacia adelante)

A bit in a signal unit which indicates the start of a retransmission cycle.

forward sequence number

F: numéro de séquence vers l'avant

S: número secuencial directo (hacia adelante)

A signal unit used to identify the transmitted message signal units.

inactive signalling link

F: canal sémaphore (à l'état) inactif

S: enlace de señalización inactivo

A signalling link which has been deactivated and cannot therefore carry signalling traffic.

initial alignment

F: alignement initial

S: alineación inicial

A procedure by which a signalling link becomes able to carry signalling traffic either for the first time or after a failure has occured.

initial signal unit alignment

F: alignement initial des trames sémaphores

S: alineación inicial de unidades de señalización

Signal unit alignment applicable to activation and to restoration of the link.

integrated digital network

F: réseau numérique intégré

S: red digital integrada

A network in which connections established by digital switching are used for the transmission of digital signals.

integrated services digital network

F: réseau numérique avec intégration des services

S: red digital de servicios integrados

An integrated digital network in which the same digital switches and digital paths are used to establish connections for different services, for example, telephony, data.

interruption control

F: contrôle d'interruption

S: protección contra las interrupciones

A system which monitors a pilot for interruptions on FDM systems and which transmits an indication to the switching equipment.

label

F: étiquette

S: etiqueta

Information within a signalling message used to identify typically the particular circuit, call or management transaction to which the message is related.

length indicator

F: indicateur de longueur

S: indicador de longitud

A six bit field which differentiates between message signal units, link status signal units and fill-in signal units and in the case that its binary value is less than 63 indicates the length of a signal unit.

link status signal unit

F: trame sémaphore d'état du canal sémaphore

S: unidad de señalización del estado del enlace

A signal unit which contains status information about the signalling link in which it is transmitted.

load sharing (general)

F: partage de charge (en général)

S: compartición de carga (en general)

A process by which signalling traffic is distributed over two or more signalling or message routes, in view of traffic equalization or security.

long-term bit error rate

F: taux d'erreur à long terme sur les bits

S: tasa de errores en los bits a largo plazo

Bit error rate measured over a sufficiently long time period, e.g. one month.

medium-term bit error rate

F: taux d'erreur à moyen terme sur les bits

S: tasa de errores en los bits a plazo medio

Bit error rate that can be encountered for relatively short time periods, e.g. some minutes, due to temporary malfunctions of, for example, transmission equipment.

message signal unit

F: trame sémaphore de message

S: unidad de señalización de mensaje

A signal unit containing a service information octet and a signalling information field which is retransmitted by the signalling link control if it is received in error.

Message Transfer Part

F: Sous-système Transport de Messages

S: parte de transferencia de mensajes

The functional part of a common channel signalling system which transfers signalling messages as required by all the users, and which performs the necessary subsidiary functions, for example error control and signalling security.

national indicator

F: indicateur national

S: indicador nacional

Information within a signalling message which permits typically a distinction to be made between national and international messages.

nonassociated mode (of signalling)

F: mode (de signalisation) non associé

S: modo (de señalización) no asociado

The mode where messages for a signalling relation involving two (nonadjacent) signalling points are conveyed, between those signalling points, over two or more signalling links in tandem passing through one or more signalling transfer points.

No. 7 exchange

F: commutateur n° 7

S: central N.° 7

An exchange utilizing Signalling System No. 7.

No. 7 exchange – first

F: premier commutateur n° 7

S: central N.° 7 – primera

The exchange closest to the calling party in each No. 7 section of a connection where, unless it is the calling party's exchange, interworking with other signalling systems takes place.

No. 7 exchange – last

F: dernier commutateur n° 7

S: central N.° 7 – última

The exchange closest to the called party in each No. 7 connection where, unless it is the called party's exchange, interworking with other signalling systems takes place.

normal routing (of signalling)

F: acheminement normal (de signalisation)

S: encaminamiento normal (de señalización)

The routing of a given signalling traffic flow in normal conditions (i.e. in the absence of failures).

originating point code

F: code du point d'origine

S: código del punto de origen

A part of the label in a signalling message which uniquely identifies, in a signalling network, the (signalling) originating point of the message.

pilot

F: onde pilote

S: piloto

Sinusoidal signal transmitted over analogue FDM links for regulation and supervision purposes.

preventive cyclic retransmission (error control) method

F: méthode (de correction d'erreur) avec retransmission cyclique préventive

S: método (de protección contra errores) por retransmisión cíclica preventiva

A noncompelled, positive acknowledgement, cyclic retransmission forward error correction system.

processor outage

F: processeur hors service

S: interrupción del procesador

A situation in which a signalling link becomes unavailable, due to factors at a functional level higher than level 2. This may be because of, for example, a central processor failure. It may also be due to a manually initiated blocking of an individual signalling link.

quasi-associated mode (of signalling)

F: mode (de signalisation) quasi associé

S: modo (de señalización) cuasiasociado

A nonassociated mode (of signalling) in which the (signalling) message route is determined basically, for each signalling message, by information contained in this message (namely in its routing label) and is fixed in normal operation.

random errors

F: erreurs aléatoires

S: errores aleatorios

Errors distributed over the digital signal so that they can be considered statistically independent from each other.

retransmission buffer

F: tampon de retransmission

S: memoria tampón de retransmisión

Storage in the signalling link control for signal units transmitted but not yet positively acknowledged.

retrieval

F: récupération

S: recuperación

The process of transferring all those messages in the retransmission buffer of a signalling link (A), which have not yet been positively acknowledged, to the transmission buffers of alternative signalling links.

routing label

F: étiquette d'acheminement

S: etiqueta de encaminamiento

The part of the message label that is used for message routing in the signalling network. It includes the destination point code, the originating point code and the signalling link selection field.

service indicator

F: indicateur de service (utilisateur)

S: indicador de servicio

Information within a signalling message identifying the user to which the message belongs.

service information (octet)

F: octet de service

S: (octeto de) información de servicio

Eight bits, contained in a message signal unit, comprising the service indicator and the sub-service field.

signal unit

F: trame sémaphore

S: unidad de señalización

A group of bits forming a separately transferable entity used to convey information on a signalling link.

signal unit alignment

F: alignement des trames sémaphores

S: alineación de unidades de señalización

Signal unit alignment exists when flags are received at intervals which correspond to integral numbers of octets and which fall within certain upper and lower limits.

signal unit error rate monitoring

F: surveillance du taux d'erreur sur les trames sémaphores

S: monitor de tasa de errores en las unidades de señalización

A procedure by which the error rate of an active signalling link is measured on the basis of a count of correctly checking and erroneous signal units.

(signalling) destination point

F: point (sémaphore) de destination

S: punto de destino (de la señalización)

A signalling point to which a message is destined.

signalling information (field)

F: information de signalisation (domaine d')

S: (campo de) información de señalización

The bits of a message signal unit which carry information particular to a certain user transaction and always contain a label.

signalling link

F: canal sémaphore

S: enlace de señalización

A transmission means which consists of a signalling data link and its transfer control functions, used for reliable transfer of a signalling message.

signalling link blocking

F: blocage d'un canal sémaphore

S: bloqueo de un enlace de señalización

An event causing the unavailability of a signalling link, typically consisting in a "processor outage" condition at one end of that signalling link.

signalling link code

F: code de canal sémaphore

S: código de enlace de señalización

A field of the label in the signalling network management messages, which indicates the particular signalling link to which the message refers among those interconnecting the two involved signalling points.

signalling link error monitoring

F: surveillance des erreurs sur un canal sémaphore

S: monitor de errores en el enlace de señalización

This comprises two functions: initial alignment error rate monitoring and signal unit error rate monitoring.

signalling link failure

F: défaillance d'un canal sémaphore

S: avería (o fallo) del enlace de señalización

An event causing the unavailability of a signalling link, typically consisting in a failure in signalling terminal equipment or in the signalling data link.

signalling link group

F: groupe de canaux sémaphores

S: grupo de enlaces de señalización

A set of signalling links directly connecting two signalling points and having the same physical characteristics (bit rate, propagation delay, etc.).

signalling link management functions

F: fonctions de gestion des canaux sémaphores

S: funciones de gestión de enlaces de señalización

Functions that control and take actions, when required, to preserve integrity of locally connected signalling links, e.g. by reconfiguration of the signalling link sets.

signalling link restoration

F: rétablissement d'un canal sémaphore

S: restablecimiento de enlaces de señalización

An event consisting in the completion of the initial alignment procedure on a signalling link following the removal of the previous causes of failure; if no other causes of unavailability exist (i.e. a signalling link blocked condition) then the signalling link becomes available.

signalling link selection field

F: domaine de sélection du canal sémaphore

S: campo de selección de enlace de señalización

A field of the routing label which is typically used by the message routing function to perform load sharing among different signalling links/ link sets.

signalling link set

F: faisceau de canaux sémaphores

S: conjunto de enlaces de señalización

A set of signalling link(s) directly connecting two signalling points.

signalling link unblocking

F: déblocage d'un canal sémaphore

S: desbloqueo de un enlace de señalización

An event consisting in the removal of the previous causes of signalling link blocking; if no other causes of unavailability exist (i.e. a signalling link failed condition), then the signalling link becomes available.

signalling message

F: message de signalisation

S: mensaje de señalización

An assembly of signalling information pertaining to a call, management transaction, etc. that is transferred as an entity.

(signalling) message discrimination

F: discrimination des messages (de signalisation)

S: discriminación de mensajes (de señalización)

The process which decides, for each incoming message, whether the signalling point is destination point or if it should act as signalling transfer point for that message and accordingly, whether the message should be handled to (signalling) message distribution or to (signalling) message routing functions.

(signalling) message distribution

F: distribution des messages (de signalisation)

S: distribución de mensajes (de señalización)

The process of determining, upon receipt of a signalling message at its destination point, to which User Part the signalling message is to be delivered.

signalling message handling functions

F: fonctions d'orientation des messages de signalisation

S: funciones de tratamiento de mensajes de señalización

Functions that, at the actual transfer of a message, direct the message to the proper signalling link or User Part.

(signalling) message route

F: route de message (de signalisation)

S: ruta de mensaje (de señalización)

The signalling link or consecutive links connected in tandem that are used to convey a signalling message from an originating point to its destination point.

(signalling) message routing

F: acheminement des messages (de signalisation)

S: encaminamiento de mensajes (de señalización)

The process for selecting, for each signalling message to be sent, the signalling link to be used.

signalling network

F: réseau sémaphore

S: red de señalización

A network used for signalling by one or more users and consisting of signalling points and connecting signalling links.

signalling network functions

F: fonctions du réseau sémaphore

S: funciones de la red de señalización

The functions which are performed by the Message Transfer Part at level 3 and are common to, and independent of, the operation of individual signalling links. They include the signalling message handling functions and the signalling network management functions.

signalling network management functions

F: fonctions de gestion du réseau sémaphore

S: funciones de gestión de la red de señalización

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.

(signalling) originating point

F: point (sémaphore) d'origine

S: punto de origen (de la señalización)

A signalling point in which a message is generated.

signalling point

F: point sémaphore

S: punto de señalización

A node in a signalling network which either originates and receives signalling messages, or transfers signalling messages from one signalling link to another, or both.

signalling point code

F: code d'un point sémaphore

S: código de punto de señalización

A binary code uniquely identifying a signalling point in a signalling network. This code is used, according to its position in the label, either as destination point code or as originating point code.

signalling relation

F: relation sémaphore

S: relación de señalización

A relation between two signalling points involving the possibility of information interchange between corresponding User Part functions.

signalling route

F: route sémaphore

S: ruta de señalización

A predetermined path described by a succession of signalling points that may be traversed by signalling messages directed by a signalling point towards a specific destination point.

signalling route management functions

F: fonctions de gestion des routes sémaphores

S: funciones de gestión de rutas de señalización

Functions that transfer information about changes in the availability of signalling routes in the signalling network.

signalling route-set-test procedure

F: procédure de test de faisceau de routes sémaphores

S: procedimiento de prueba de conjunto de rutas de señalización

A procedure, included in the signalling route management which is used to test the availability of a given signalling route, previously declared unavailable.

(signalling) traffic flow control

F: contrôle de flux de trafic (sémaphore)

S: control del flujo del tráfico (de señalización)

Actions and procedures intended to limit signalling traffic at its source in the case when the signalling network is not capable of transferring all signalling traffic offered by the User Parts, because of network failures or overload situations.

signalling traffic management functions

F: fonctions de gestion du trafic sémaphore

S: funciones de gestión del tráfico de señalización

Functions that control and, when required, modify routing information used by the Message routing function and control the transfer of signalling traffic in a manner that avoids irregularities in message flow.

signalling transfer point

F: point de transfert sémaphore

S: punto de transferencia de señalización

A signalling point with the function of transferring signalling messages from one signalling link to another and considered exclusively from the viewpoint of the transfer.

status field

F: domaine d'état

S: campo de estado

The bits of a link status signal unit which indicate one of the major signalling link states.

Telephone User Part

F: Sous-système Utilisateur Téléphonie

S: parte de usuario de telefonia

The User Part specified for telephone services.

transfer-allowed (procedure)

F: transfert autorisé (procédure de)

S: (procedimiento de) autorización de transferencia

A procedure, included in the signalling route management, which is used to inform a signalling point that a signalling route has become available.

transfer-prohibited (procedure)

F: transfert interdit (procédure de)

S: (procedimiento de) prohibición de transferencia

A procedure, included in the signalling route management, which is used to inform a signalling point of the unavailability of a signalling route.

transmission buffer

F: tampon d'émission

S: memoria tampón de transmisión

Storage in the signalling link control for signal units not yet transmitted.

User Part

F: Sous-système Utilisateur

S: parte de usuario

A functional part of the common channel signalling system which transfers signalling messages via the Message Transfer Part. Different types of User Parts exist (e.g. for telephone and data services), each of which is specified to a particular use of the signalling system.

user (of the signalling system)

F: utilisateur du système de signalisation

S: usuario (del sistema de señalización)

A functional entity, typically a telecommunication service, which uses a signalling network to transfer information.

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ABBREVIATIONS SPECIFIC TO SIGNALLING SYSTEM No. 7

English	French	Spanish	Meaning
ACM	ACO	MDC	Address complete message Table 3/Q.723, Figure 3/Q.724
ADI	ADI	SDI	Address incomplete signal Table 3/Q.723, Figure 3/Q.724
AERM	STEA	MA	Alignment error rate monitor Figures 7-9/Q.703 and 11-17/Q.703
ANC	RAT	RCT	Answer signal, charge Table 3/Q.723, Figure 3/Q.724
ANN	RST	RST	Answer signal, no charge Table 3/Q.723
BIB	BIR	BII	Backward indicator bit Figures 3/Q.703, 13/Q.703 and 15/Q.703
BLA	BLA	ARB	Blocking-acknowledgement signal Table 3/Q.723
BLO	BLO	BLO	Blocking signal Table 3/Q.723
BSM	DE	MPE	Backward set-up message Table 3/Q.723
BSN	NSR	NSI	Backward sequence number Figures 3/Q.703, 14/Q.703 and 16/Q.703
BSNR	NSR-R	NSIR	Backward sequence number received Figures 7/Q.703, 13/Q.703, 14/Q.703, 16/Q.703
BSNT	NSR-E	NSIT	Backward sequence number of next SU to be transmitted Figures 7-9/Q.703 and 13-16/Q.703, Figures 27 and 30/Q.704.
CBA	RCA	ARS	Changeback acknowledgement signal Table 3/Q.704
CBD	RCO	ORS	Changeback declaration signal Table 3/Q.704
CBK	RAC	COL	Clear-back signal Table 3/Q.723, Figure 3/Q.724
CCF	CCN	FCO	Continuity-failure signal Table 3/Q.723
CCI	CCE	PCL	Continuity check incoming Recommendation Q.724, § 10.3, Figures 3/Q.724, 5/Q.724, 6/Q.724
CCM	SC	MSC	Circuit supervision message Table 3/Q.723
CCO	CCS	PCS	Continuity-check outgoing Recommendation Q.723, § 10.3 Figures 3/Q.724, 4/Q.724
CCR	CCD	PPC	Continuity-check-request signal Table 3/Q.723 Figures 2/Q.724, 3/Q.724, 6/Q.724 and 7/Q.724
CCS	CS	SCC	Common channel signalling Recommendation Q.701, § 1.1
CFL	ECH	SLI	Call-failure signal Table 3/Q.723, Figure 3/Q.724
CGC	EFC	CHC	Circuit-group-congestion Table 3/Q.723, Figure 3/Q.724
CHG	TAX	MTA	Charging message Table 3/Q.723
CHM	PR	MPA	Changeover and changeback messages Table 1/Q.704

English	French	Spanish	Meaning
CIC	CIC	CIC	Circuit identification code Recommendation Q.704, § 13.10.3, Recommendation Q.723, § 2.2.1
CIR	IDD	PIL	Calling-line-identity-request signal Table 3/Q.723
CK	CRT	BCE	Check bits Figure 3/Q.703
CLF	FIN	FIN	Clear-forward signal Table 3/Q.723, Figure 2/Q.724, 3/Q.724, 6/Q.724, 7/Q.724
CLI	IDL	MIL	Calling-line-identity message Table 3/Q.723
CLU	IDN	MIN	Calling-line-identity-unavailable signal Table 3/Q.723
CNP	CLI	CIM	Connection-not-possible signal Table 1/Q.704
CNS	CLN	CIN	Connection-not-successful signal Table 1/Q.704
COA	PCA	APR	Changeover acknowledgement signal Table 1/Q.704
COO	PCO	OPR	Changeover order signal Table 1/Q.704
COT	CCP	CON	Continuity signal Table 3/Q.723, Figure 3/Q.724
CPC	STA	CTL	Call processing control Recommendation Q.724, § 10.2 Figures 1-7/Q.724
CRI	CRE	RPL	Continuity recheck incoming Recommendation Q.724, § 10.1, Figures 1/Q.724, 2/Q.724, 3/Q.724, 6/Q.724, 7/Q.724
CRO	CRS	RPS	Continuity-recheck outgoing Recommendation Q.724, § 10.1, Figures 1-3/Q.724, 6/Q.724
CSM	SA	MSL	Call supervision message Table 3/Q.723
CSS	CLR	ACC	Connection-successful signal Table 1/Q.704
DAEDR	DAD-R	DADR	Delimitation, alignment, error detection (reception) Figures 7/Q.703, 9/Q.703, 11/Q.703, 14/Q.703, 16/Q.703, 17/Q.703, 18/Q.703
DAEDT	DAD-E	DADT	Delimitation, alignment, error detection (transmitting) Figures 12/Q.703, 13/Q.703, 15/Q.703
DCE	ETCD	ETCD	Data circuit terminating equipment Figure 1/Q.702
DLC	CLO	CED	Signalling-data-link-connection-order signal Table 1/Q.704
DLM	CL	MED	Signalling-data-link-connection-order message Table 1/Q.704
DPC	CPD	CPD	Destination point code Recommendation Q.704, §§ 2.2.3, 13.2, Figure 3/Q.704, 14/Q.704, 26/Q.704 Recommendation Q.706, § 3, Recommendation Q.723, § 2.2.1
DUP	SSUD	PUD	Data user part Recommendation Q.701, § 2.1, Figure 2/Q.701
EAM	EXR	MAR	Extended-answer-message indication Table 3/Q.723
ECA	PUA	AER	Emergency changeover acknowledgement signal Table 1/Q.704
ECM	PU	MEP	Emergency changeover message Table 1/Q.704
ECO	PUO	PER	Emergency changeover order signal Table 1/Q.704

English	French	Spanish	Meaning
EUM	EXT	IAL	Extended-unsuccessful-backward set-up information message indication Table 3/Q.723
F	F	BAN	Flag Figure 3/Q.703
FAM	AD	MDA	Forward-address message Table 3/Q.723
FCM	CF	MCF	Signalling traffic flow control messages Table 1/Q.704
FDM	MRF	MDF	Frequency division multiplex Recommendation Q.723, § 2.2.3, Recommendation Q.724, § 9
FIB	BIA	BID	Forward indicator bit Figures 3/Q.703, 13/Q.703, 15/Q.703
FISU	TSR	USR	Fill-in signal unit Figures 7/Q.703, 8/Q.703, 13-16/Q.703, Figures A-2/Q.704, A-3/Q.704, A-8/Q.704
FOT	IOP	INT	Forward-transfer signal Table 3/Q.723
FSM	EA	MEL	Forward set-up message Table 3/Q.723
FSN	NSA	NSD	Forward sequence number Figures 3/Q.703, 13/Q.703
HMDC	ODC	HDCM	Message discrimination Recommendation Q.704, § 14.3, Figures 23-26/Q.704
HMDT	ODT	HDTM	Message distribution Recommendation Q.704, § 14.3, Figures 23-25/Q.704, 28/Q.704, 30/Q.704, 31/Q.704, 42/Q.704, 44-46/Q.704, 2/Q.707
HMRT	OAC	HENM	Message routing Recommendation Q.704, § 14.3, Figures 23/Q.704, 24/Q.704, 26/Q.704, 27/Q.704, 30/Q.704, 31/Q.704, 32/Q.704, 33/Q.704, 42/Q.704, 44/Q.704, 45/Q.704, 46/Q.704, A-6/Q.704, 2/Q.707
HO	HO	EO	Heading code Recommendation Q.704, § 13.3, Figure 16/Q.704, Recommendation Q.707, § 5.3, Figure 1/Q.707, Recommendation Q.723, §§ 3.1 and 3.2
H1	H1	E1	Heading code Recommendation Q.704, § 13.4.3, Figure 16/Q.704, Recommendation Q.723, § 3.1
IAC	CAI	CAI	Initial alignment control Figures 7-9/Q.703, 11/Q.703, 13-17/Q.703, A-8/Q.704
IAI	MIS	MIA	Initial address message with additional information Table 3/Q.723
IAM	MIA	MID	Initial address message Table 3/Q.723, Figures 3/Q.724, 6/Q.724, Table 2/Q.725
ISP	PSI	PSI	International signalling point Recommendation Q.705, § 3, Figure 1/Q.705
L1	N1	N1	Level 1 Figures 12/Q.703, 35/Q.704, 38-40/Q.704, A-2/Q.704, A-3/Q.704, A-5/Q.704
L2	N2	N2	Level 2 Figures 8/Q.703, 9/Q.703, 12/Q.703, 13/Q.703, 15/Q.703, 23/Q.704, 24/Q.704, 26/Q.704, 27/Q.704, 30/Q.704, 35/Q.704, 37/Q.704, A-2/Q.704, A-5/Q.704, A-8/Q.704
L3	N3	N3	Level 3 Figures 8/Q.703, 9/Q.704, 13/Q.703, 15/Q.703, 23/Q.704, 24/Q.704, 26/Q.704, 30/Q.704, 31/Q.704, 34/Q.704, 35/Q.704, 37/Q.704, 38/Q.704, 39/Q.704, A-3/Q.704, A-5/Q.704, A-8/Q.704
L4	N4	N4	Level 4 Figures 23/Q.704, 25-27/Q.704, 34/Q.704
LI	INL	IL	Length indicator Recommendation Q.703, § 2.2, Figure 3/Q.703

English	French	Spanish	Meaning
LLSC	GCSF	CCE	Link set control Figures 29/Q.704, 35-37/Q.704, A-2/Q.704, A-5/Q.704
LOS	LHS	LFS	Line-out-of-service signal Table 3/Q.723, Figure 3/Q.724
LSAC	GCSA	CAE	Signalling link activity control Recommendation Q.704, § 14.6, Figures 28-30/Q.704, 35-41/Q.704, A-2/Q.704, A-3/Q.704, A-4/Q.704, A-5/Q.704, A-7/Q.704
LSC	SET	CEE	Link state control Figures 7-10/Q.703, 13-18/Q.703, Recommendation Q.704, § 14.6, Figures 41/Q.704, A-2/Q.704, A-5/Q.704, A-8/Q.704
LSDA	GCAL	AED	Signalling data link allocation Recommendation Q.704, § 14.6, Figures 35/Q.704, 37-40/Q.704, 42/Q.704, A-2/Q.704, A-4/Q.704, A-5/Q.704
LSDS	GCLR	SED	Stand-by data link selection Figures A-2/Q.704, A-4/Q.704, A-5/Q.704
LSLA	GCAC	AES	Signalling link activation Recommendation Q.704, § 14.6, Figures 35/Q.704, 37/Q.704, 38/Q.704, 41/Q.704, 42/Q.704, A-2/Q.704, A-5/Q.704
LSLD	GCDA	DES	Signalling link deactivation Recommendation Q.704, § 14.6, Figures 35/Q.704, 37/Q.704, 40/Q.704, 41/Q.704, 42/Q.704, A-2/Q.704, A-5/Q.704
LSLR	GCRE	RES	Signalling link restoration Recommendation Q.704, § 14.6, Figures 35/Q.704, 37/Q.704, 39/Q.704, 41/Q.704, 42/Q.704, A-2/Q.704, A-3/Q.704, A-5/Q.704
LSSU	TSE	UEE	Link status signal units Figures 13-16/Q.703
LSTA	GCAT	ATS	Signalling terminal allocation Recommendation Q.704, § 14.6, Figures 35/Q.704, 38/Q.704, 39/Q.704, 40/Q.704, 41/Q.704, A-2/Q.704
MGMT	GES	SGE	Management system Figures 8/Q.703, 27/Q.704, 28/Q.704, 35-37/Q.704, A-2/Q.704, A-7/Q.704, 2/Q.707
MSU	TSM	USM	Message signal unit Recommendation Q.701, § 2.3, Figures 7/Q.703, 8/Q.703, 14/Q.703, 15/Q.703, 16/Q.703, A-8/Q.704
MTP	SSTM	PTM	Message transfer part Recommendation Q.701, § 2.1, Recommendation Q.721, § 1
NACK	ACN	RN	Negative acknowledgement Figures 7/Q.703, 13/Q.703, 14/Q.703
NNC	ERN	CRN	National-network-congestion signal Table 3/Q.723, Figure 3/Q.724
NSP	PSN	PSN	National signalling point Recommendation Q.705, § 3, Figure 1/Q.705
OPC	CPO	CPO	Originating point code Recommendation Q.704, §§ 2.2.3 and 13.2, Figures 3/Q.704 and 14/Q.704, Recommendation Q.706, § 3, Recommendation Q.723, § 2.2.1
PCM	MIC	MIC	Pulse code modulation Recommendation Q.702, § 5.3
PCR	RCP	RCP	Preventive cyclic retransmission Tables 1/Q.706, 2/Q.706
POC	SIP	CBP	Processor outage control Figures 8/Q.703, 10/Q.703, A-8/Q.704
RAN	NRP	RRE	Reanswer signal Table 3/Q.723, Figure 3/Q.724
RC	REC	CR	Reception control Figures 8/Q.703, 9/Q.703, 11/Q.703, 13-16/Q.703, A-8/Q.704
RLG	LIG	LGU	Release-guard signal Table 3/Q.723, Figures 2/Q.724, 3/Q.724, 6/Q.724, 7/Q.724

English	French	Spanish	Meaning
RSC	RZC	RCI	Reseat-circuit signal Table 3/Q.723
RSM	TR	MPR	Signalling-route-set-test message Table 1/Q.704
RSRT	GRTF	CPC	Signalling route set test control Recommendation Q.704, § 14.5, Figures 23/Q.704, 29/Q.704, 43-46/Q.704
RST	TRS	PRS	Signalling-route-set-test signal Table 1/Q.704
RTAC	GRTA	CTA	Transfer allowed control Recommendation Q.704, § 14.5, Figures 29/Q.704, 33/Q.704, 37/Q.704, 43/Q.704, 45/Q.704, 46/Q.704
RTB	TRT	MRT	Retransmission buffer Figures 7/Q.703, 13/Q.703, 15/Q.703
RTPC	GRTI	CTP	Transfer prohibited control Recommendation Q.704, § 14.5, Figures 26/Q.704, 29/Q.704, 43/Q.704, 44/Q.704, 46/Q.704
SAM	MSA	MSD	Subsequent-address message Table 3/Q.723, Figure 3/Q.724, Table 2/Q.725
SAO	MSS	SDU	Subsequent-address message with one signal Table 3/Q.723
SBM	SE	MEC	Successful-backward-set-up information message Table 3/Q.723
SDL	LDS	LED	Functional specification and description language Recommendation Q.704, § 14.1, Recommendation Q.724, § 10.1
SEC	EEC	CEC	Switching-equipment-congestion signal Table 3/Q.723, Figure 3/Q.724
SF	ETC	CE	Status field Figure 3/Q.703
SI	INS	IS	Service indicator Recommendation Q.704, § 13.1.1
SIE	ETAU	IAE	Status indication "emergency terminal status" Recommendation Q.703, §§ 7.2, 7.3 and 10.1.3, Figures 2/Q.703, 4/Q.703, 7-9/Q.703, 13-16/Q.703
SIF	INF	CIS	Signal information field Figure 3/Q.703
SIN	ETAN	IAN	Status indication "normal terminal status" Recommendation Q.703, §§ 7.2, 7.3 and 10.1.3, Figures 2/Q.703, 4/Q.703, 7-9/Q.703, 13-16/Q.703
SIO	SER	OIS	Service information octet Figure 3/Q.703
SIO [1]	ETAP	IFA	Status indication "out of alignment" Recommendation Q.703, §§ 7.2, 7.3 and 10.1.3, Figures 2/Q.703, 4/Q.703, 7-9/Q.703, 13-16/Q.703
SIOS	ETHS	IFS	Status indication "out of service" Recommendation Q.703, §§ 7.2, 7.3 and 10.1.3, Figures 2/Q.703, 4/Q.703, 7-9/Q.703, 13-16/Q.703, A-8/Q.704
SIPO	ETIP	IBP	Status indication "processor outage" Recommendation Q.703, § 10.1.3, Figures 2/Q.703, 7/Q.703, 8/Q.703, 13-16/Q.703, A-8/Q.704
SLC	COC	COE	Signalling link code Recommendation Q.704, §§ 13.2 Figure 14/Q.704
SLM	GCS	GES	Signalling link management Recommendation Q.704, §§ 14.1 and 14.6, Figures 23/Q.704, 25/Q.704, 26/Q.704, 27/Q.704, 29/Q.703

[1] In English, another abbreviation will have to be found for *status indication "out of alignment"*, since the abbreviation SIO is already used for *service information octet.*

English	French	Spanish	Meaning
SLS	SCS	SES	Signalling link selection code Recommendation Q.704, § 2.2.4, Figures 3/Q.704, 4/Q.704, 26/Q.704, A-3.1/Q.705
SLTM	ESCO	MPES	Signalling link test message Figure 2/Q.707
SMH	OMS	TMS	Signalling message handling Recommendation Q.704, §§ 14.1 and 14.3, Figures 23/Q.704, 43/Q.704
SP	PS	PS	Signalling point Figures 8/Q.704, 23/Q.703, 24/Q.703, 26/Q.703, 27/Q.703, 30/Q.703, 31/Q.703, 42-44/Q.703
SPRC	CPS	CPS	Signalling procedure control Recommendation Q.724, § 10.1, Figures 1-7/Q.724
SRM	GRS	GRS	Signalling route management Recommendation Q.704, §§ 14.1 and 14.5, Figures 23/Q.704, 25-27/Q.704, 43/Q.704
SSB	OCC	ABO	Subscriber-busy signal (electrical) Table 3/Q.723, Figure 3/Q.724
SSF	DSS	CSS	Sub-service field Recommendation Q.704, § 13.1.1
SST	TSI	TIE	Send-special-information-tone signal Figures 1-7/Q.724
ST	ST	SFN	End-of-pulsing signal Recommendation Q.724, § 1.3
STLC	ESC	CPES	Signalling link test control Figures 25/Q.704, 26/Q.704, 2/Q.707
STM	GTS	GTS	Signalling traffic management Recommendation Q.704, §§ 14.1 and 14.4, Figures 23/Q.704, 25-27/Q.704, 30/Q.704, 35/Q.704, 39/Q.704, 43/Q.704, A-2/Q.704
STP	PTS	PTS	Signalling transfer point Figure 4/Q.701, Recommendation Q.705, § 3, Figures A-1/Q.705, A-2/Q.705, Recommendation Q.706, § 4.3.3, Table 3/Q.706
SU	TS	US	Signal unit Figures 2/Q.703, 7/Q.703
SUERM	STTS	MUS	Signal unit error rate monitor Figures 7/Q.703, 8/Q.703, 11/Q.703, 18/Q.703, A-8/Q.704
TAA	TAA	ATA	Transfer-allowed acknowledgement signal Table 1/Q.704, Figure 45/Q.704
TB	TEM	MT	Transmission buffer Figures 7/Q.703, 13/Q.703, 15/Q.703
TCBC	GTCN	TCRS	Changeback control Recommendation Q.704, § 14.4, Figures 27-29/Q.704, 31/Q.704, A-7/Q.704
TCOC	GTCS	TCER	Changeover control Recommendation Q.704, § 14.4, Figures 27-30/Q.704, 37/Q.704, A-6/Q.704, A-7/Q.704
TCRC	GTRN	TCRC	Controlled rerouting control Recommendation Q.704, § 14.4, Figures 27/Q.704, 29/Q.704, 33/Q.704, 45/Q.704
TFA	TAO	TRA	Transfer-allowed signal Table 1/Q.704
TFM	TF	MTR	Transfer-prohibited and transfer-allowed messages Table 1/Q.704
TFP	TIO	PTR	Transfer-prohibited signal Table 1/Q.704
TFRC	GTRS	TCRF	Forced rerouting control Recommendation Q.704, §§ 14.4, Figures 27/Q.704, 29/Q.704, 32/Q.704

English	French	Spanish	Meaning
TLAC	GTSD	TCDE	Link availability control Recommendation Q.704, § 14.4, Figures 27-31/Q.704, 37/Q.704, A-5/Q.704, A-6/Q.704, A-7/Q.704
TPA	TIA	APT	Transfer-prohibited acknowledgement signal Table 1/Q.704, Figure 44/Q.704
TSFC	GTFX	CFTS	Signalling traffic flow control Figures 27/Q.704, 29/Q.704, 34/Q.704
TSRC	GTAC	CEN	Signalling routing control Recommendation Q.704, § 14.4, Figures 27-34/Q.704, 36/Q.704, 37/Q.704, 44-46/Q.704, A-6/Q.704, A-7/Q.704
TUP	SSUT	PUT	Telephone user part Recommendation Q.701, § 2.1, Figure 2/Q.701, Recommendation Q.721, § 1
TXC	EMI	CT	Transmission control Figures 8/Q.703, 9/Q.703, 12-16/Q.703, A-8/Q.704
UBA	DBA	ARD	Unblocking-acknowledgement signal Table 3/Q.723
UBL	DBO	DBL	Unblocking signal Table 3/Q.723
UBM	EE	MEI	Unsuccessful-backward-set-up-information message Table 3/Q.723
UNN	NNU	NNA	Unallocated-national-number signal Table 3/Q.723, Figure 3/Q.724
UP	SSU	PU	User part Figure 2/Q.704

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