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Inhalt Seite

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0 Vorbemerkungen

Die vorliegende FTZ-Richtlinie beschreibt den Nachrichtentransferteil (Message Transfer Part, MTP) des CCITT-Zeichengabesystems Nr. 7 (ZGS Nr. 7) für das nationale Netz der Deutschen Bundespost.

Diese Richtlinie ist direkt abgeleitet vom

CCITT YELLOW BOOK
VOLUME VI - FASCICLE VI.6
SPECIFICATIONS OF SIGNALLING SYSTEM No. 7
Recommendations Q.701 bis Q.707
Stand November 1980
unter Berücksichtigung der bis Juni 1982
von CCITT dokumentierten Änderungen.

Weiterhin ist die Empfehlung Q.791 des CCITT "Monitoring And Measurements For The MTP" eingearbeitet.

Änderungen der relevanten CCITT-Empfehlungen, die nach dem Juni 1982 dokumentiert wurden, sind weitgehend berücksichtigt.

Die vorliegende Ausgabe der nationalen Anwendungsspezifikation ist von der CCITT-Spezifikation für das Zeichengabesystem Nr. 7 abgeleitet unter Beibehaltung des englischen Originaltextes durch

- Streichung von nicht für die DBP benötigten optionalen Funktionen;

- Ergänzungen der in der CCITT-Spezifikation festgelegten Funktionen.

Als Textvorlage dient das CCITT-Rotbuch, Volume VI, Fascicle VI.7, Genf 1985. Alle Änderungen für den MTP für das nationale Netz der DBP sind gegenüber dieser Testvorlage markiert.

Für die Verwaltung eines Zentralen Zeichenkanal (ZZK)-Netzes ergeben sich technisch bedingte administrative Aufgaben, die jedoch nicht explizit ausgewiesen sind.

Für die Gestaltung eines ZZK-Netzes werden technische Rahmenbedingungen ausgewiesen.

Kapitel 1

Funktionale Beschreibung des 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 it link. The system is normally applied with redundancy of signalling links and 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.

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, (Auslassung in 1 TR 7: 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.

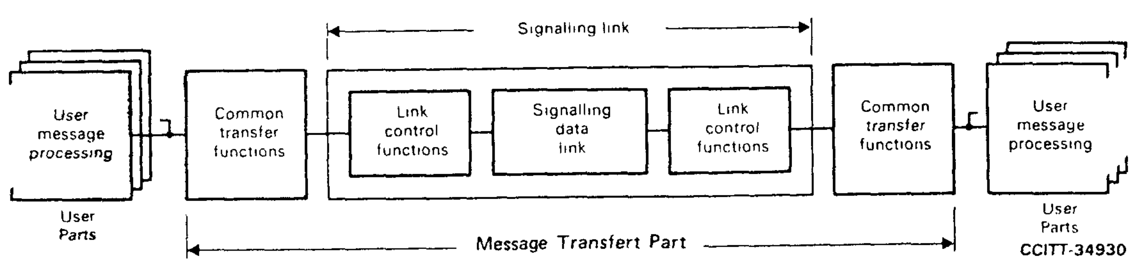


Figure 1/Q.701
Functional Diagram for the Common Channel Signalling System.

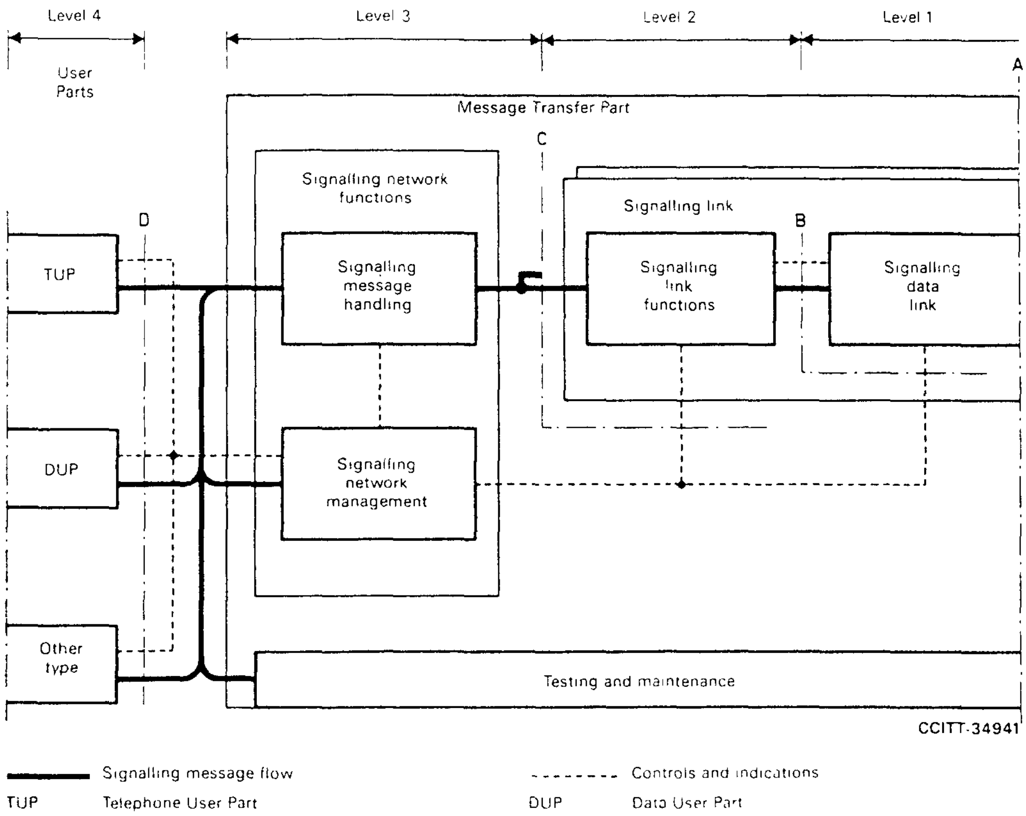


Figure 2/Q.701
General Structure of Signalling System Functions

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 (Text in 1 TR 7: is) accessed via a switching function, providing a potential for automatic reconfiguration of signalling links. Other types of data links, such as 4,8 kbit/s 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 (Auslassung in 1 TR 7: and data) call control functions with their corresponding Telephone (Auslassung in 1 TR 7: 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.

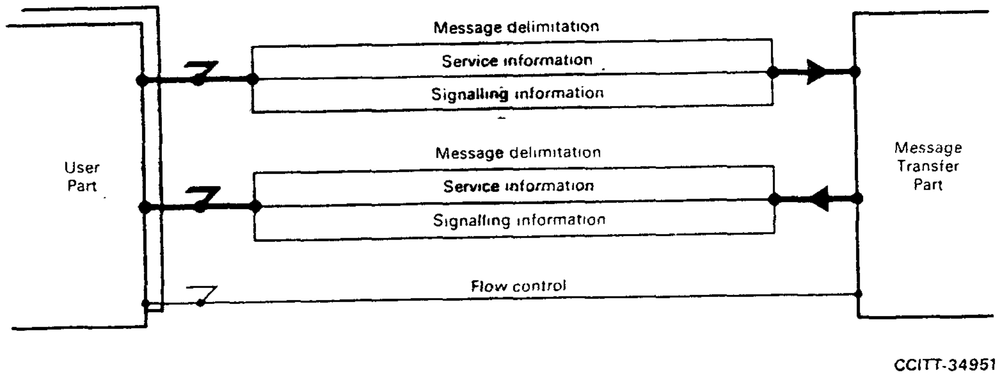


Figure 3/Q.701
Functional Interface between the Message Transfer Part and the User Parts

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 predertermined 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 ilustrated in Figure 4/Q.701.

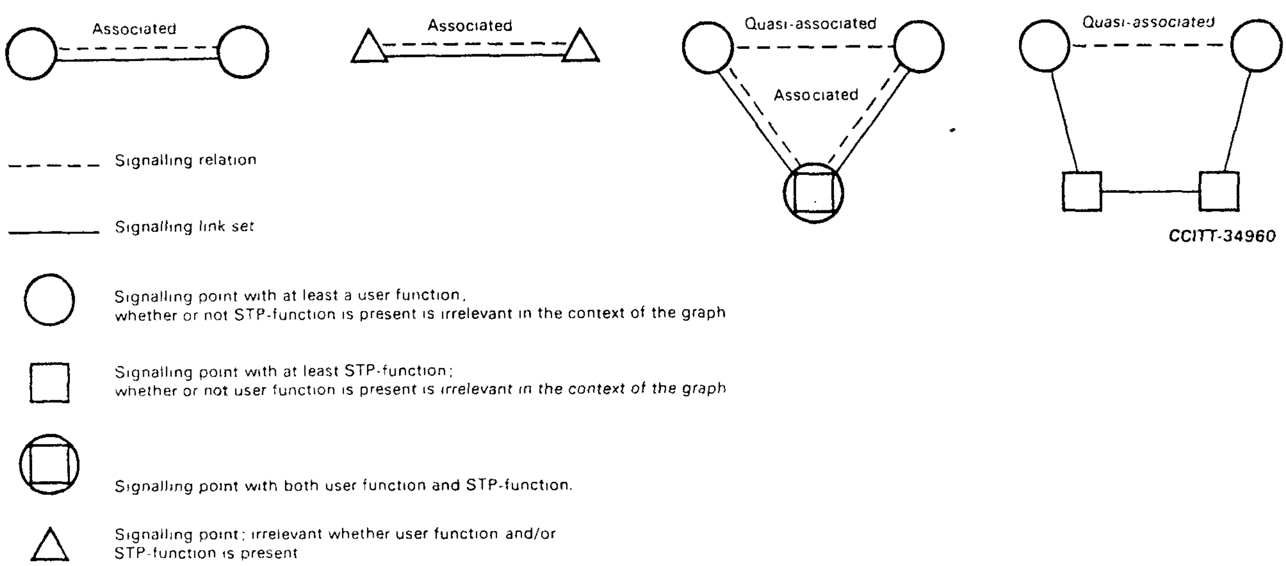


FIGURE 4/Q.701
Examples of associated and quasi-associated signalling modes and definition of signalling network graph symbols

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. that 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.

Beginn eines Zusatzes in 1 TR 7: The standard routing label is used in this national application.

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

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

Ende der Auslassung in 1 TR 7.

3.2 Signalling message handling functions

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

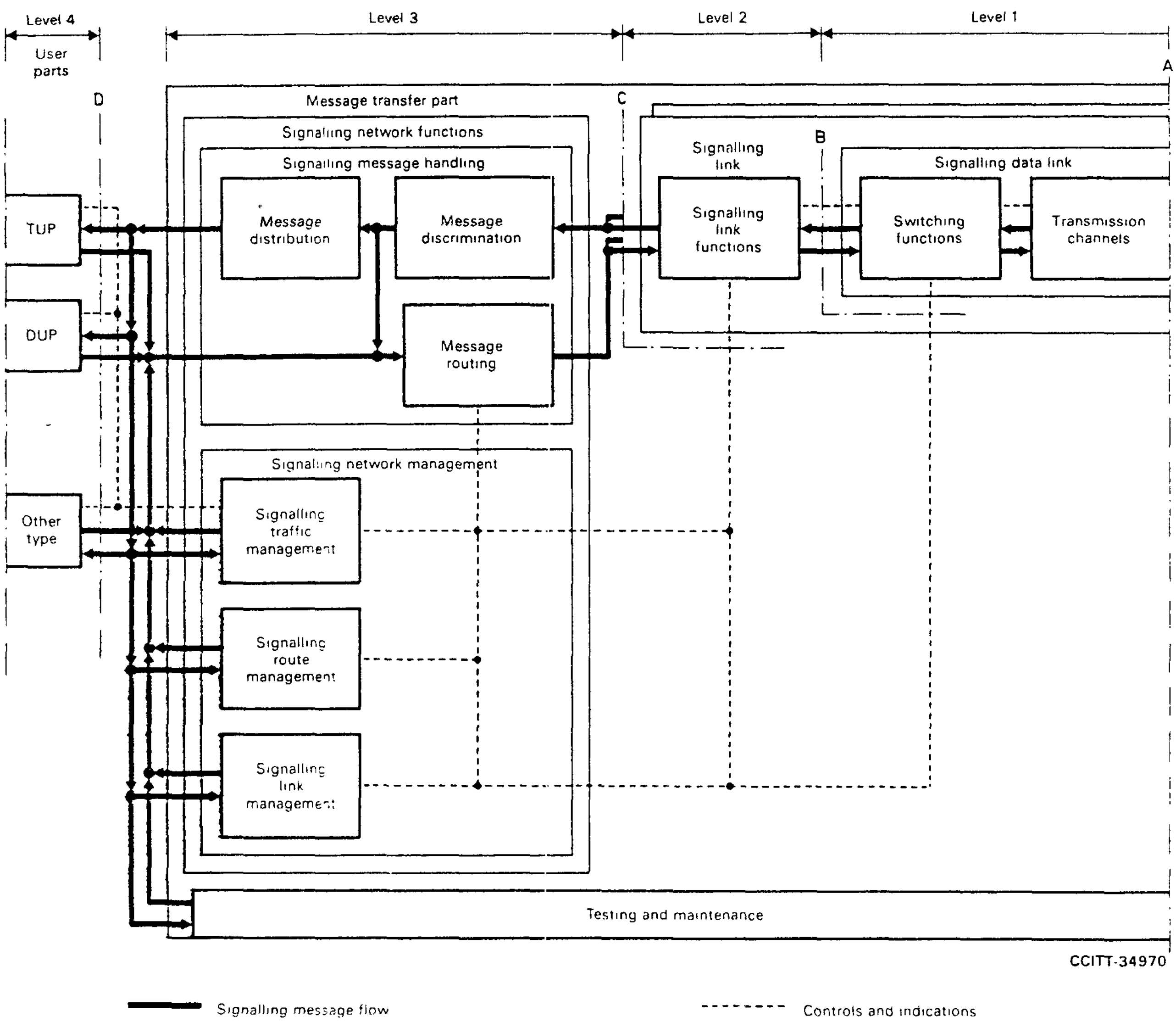


FIGURE 5/Q.701
Detailed structure of signalling system functions

3.2.1 Message routing

Message routing is the process of selecting, for each signalling message to be sent, the signalling links 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 (Text in 1 TR 7: (load sharing) is) limited to different links within a link set (Auslassung in 1 TR 7: 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.

Beginn der Auslassung in 1 TR 7.

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.

Ende einer Auslassung in 1 TR 7:

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, and the signalling point has the transfer capability, the message is delivered to the routing function for further transfer on a signalling link.

3.3 Signalling network management functione

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. The 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.

Beginn eines Zusatzes in 1 TR 7:

Überlastabwehr erfolgt in allen Ebenen des Systems als koordinierte Maßnahme. Im Level 2 erfolgt die Überlastabwehr durch Senden von "Busy LSSUs" und Einstellen des Quittierens, wenn der empfangsseitige Speicher im Level 2 gefüllt ist.

Der Level 3 überwacht sendeseitig sowohl den Wiederhol- als auch den Sendespeicher. Werden die Überlastschwellen überschritten, so beginnt der Level 3 an die, in den von der Überlast betroffenen Nachrichten angegebenen Ursprünge, Überlastnachrichten zu senden. Das Senden der Überlastnachrichten erfolgt nicht aufgrund jeder Nachricht, sondern auf Stichprobenbasis. Werden die Überlastschwellen wieder unterschritten (mit Hysterese), so wird das Senden von Überlastnachrichten eingestellt.

Bei Empfang der Überlastnachrichten geben die entfernten Level 3 entsprechende Primitives an die angeschlossenen Anwenderteile ab. Diese reduzieren dann ihren Verkehr in Stufen, abhängig von der Häufigkeit der eintreffenden Überlastnachrichten.

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

Beginn einer Auslassung in 1 TR 7: An example is the provision of an indication to the local user functions concerned that the Message Transfer Part is unable to transport messages to a particular destination in the case of total breakdown of all signalling routes to that destination point. If such a situation occurs at a signalling transfer point a corresponding indication is given to the signalling route management function for further discrimination to other signalling points in the signalling network.

Ende der Auslassung in 1 TR 7.

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 singalling data links to the extent such reconfigurations are automatic. In particular, this involves interaction, not necessarily direct, with a switching function at level 1.

Beginn eines Zusatzes in 1 TR 7:

Die für diese nationale Anwendungsspezifikation ausgewählte Methode ist in Q.704 beschrieben.

Ende des Zusatzes in 1 TR 7:

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 (Beginn einer Auslassung in 1 TR 7: e.g. nominated reserves or switched connections. Ende einer Auslassung in 1 TR 7);

- redundancy in signalling terminal devices (Beginn einer Auslassung in 1 TR 7: e.g. common pool of terminals for the whole signalling point. Ende der Auslassung in 1 TR 7);

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

- redundancy in signalling routes for each destination (Beginn einer Auslassung in 1 TR 7: possibly operating with load sharing. Ende der Auslassung in 1 TR 7).

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, Beginn eines Zusatzes in 1 TR 7: and destination point code. 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 protions of the signalling traffic. Ende des Zusatzes in 1 TR 7. Beginn einer Auslassung in 1 TR 7: 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. Ende der Auslassung in 1 TR 7.

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 information transfer. The following summarises the typical characterstics 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 Transfer Part and User Part concerned.

Beginn einer Auslassung in 1 TR 7:

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.

Ende der Auslassung in 1 TR 7.

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.

Beginn eines Zusatzes in 1 TR 7:

The total amount of Signalling information transferable in one message is limited by some parameters of the signalling system to 272 octets. Für Details siehe Q.703 § 2.

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

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.

Ende der Auslassung in 1 TR 7.

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. Beginn eines Zusatzes in 1 TR 7 (siehe auch Q.706). Ende des Zusatzes in 1 TR 7.

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 type 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}.

Kapitel 2

Zeichengabeübertragungsstrecke

Recommendation Q.702

SIGNALLING DATA LINK

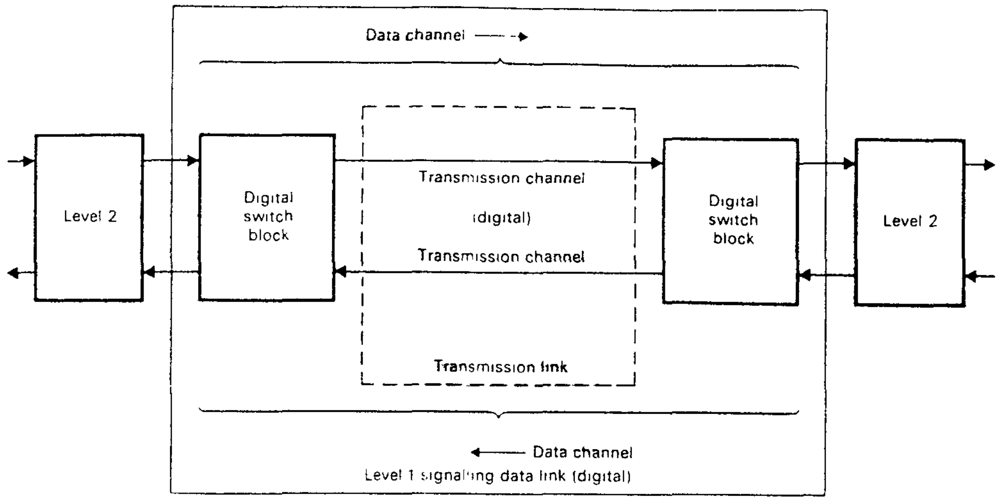
1 General

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.

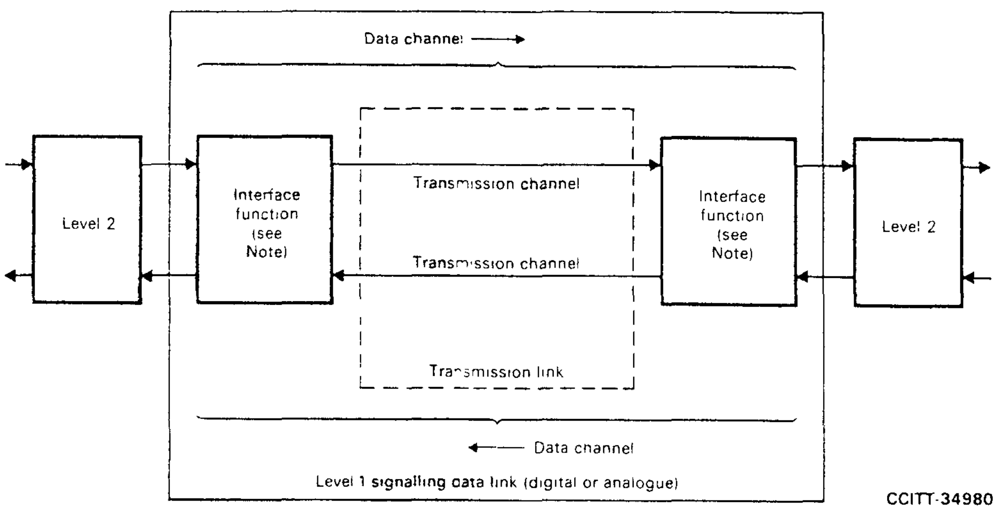
1.2 Functional configuration of a signalling data link is shown in Figure 1/Q.702.

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.Beginn eines Zusatzes in 1 TR 7: (see § 2.2). Ende des Zusatzes in 1 TR 7.

1.5 Signalling System No. 7 is capable of operating over both terrestrial and satellite transmission links [2]).

[2]) 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 converters 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.

Beginn eines Zusatzes in 1 TR 7:

2.1.2 Lower bit rates (see § 2.2)
2.1.3 The minimum signalling bit rate for the telephone call control application will be 4,8 kbit/s.
2.2 Use of bit rates lower than 64 kbit/s
Derzeit im nationalen Netz der DBP nicht vorgesehen. Bei evtl. später zu erkennendem Bedarf muß die 4,8 kbit/s-Variante nachrüstbar sein.

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

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

Ende der Auslassung in 1 TR 7

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).

Beginn einer Auslassung in 1 TR 7:

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.

Ende der Auslassung in 1 TR 7.

3 Error characteristics and availability

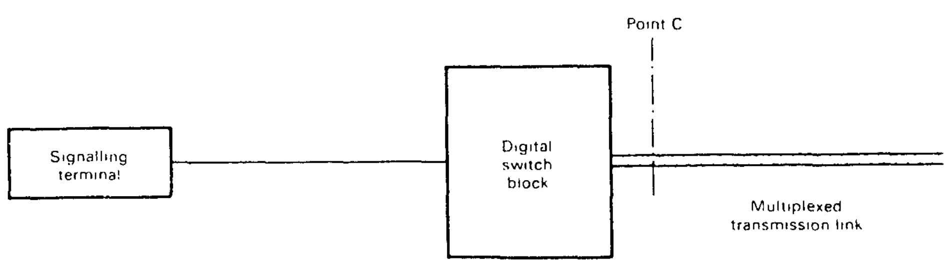
Error characteristics and availability requirements will conform to relevant Recommendations (for example, Recommendation G.821 15 on digital circuits). No additional characteristics or requirements will be specified in this Recommendation.

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 (Auslassung in 1 TR 7: and the approach toward the implementation of interface equipment adopted by each Administration.)

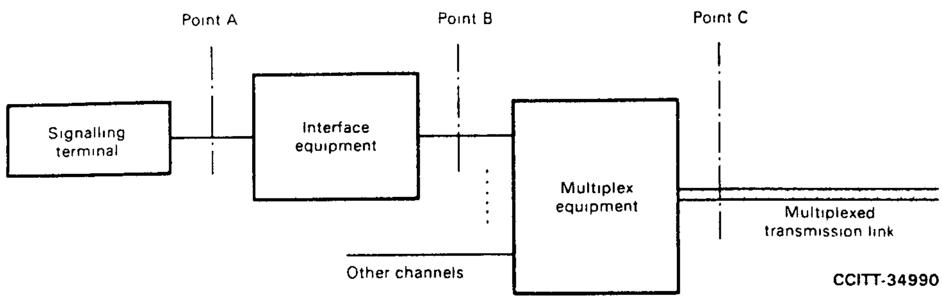
4.2 For the international (Text in 1 TR 7: national) application, interface requirements at either Point B, or Point C will apply.

4.3 Interface requirements for an international (Text in 1 TR 7: a national) digital signalling data link will be specified at Point C in accordance with the specific multiplex structure used. (See § 5).



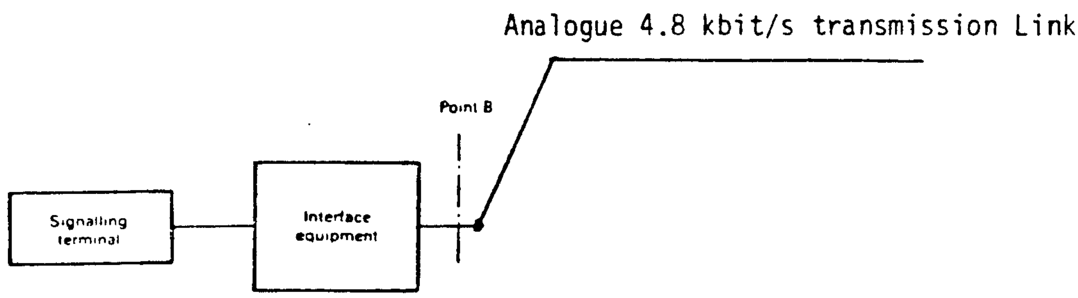
a) Example 1 – Digital signalling data link via a digital switch block

Beginn einer Auslassung im 1 TR 7



Ende der Auslassung in 1 TR 7

Beginn eines Zusatzes in 1 TR 7



Ende des Zusatzes in 1 TR 7

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 (Text in 1 TR 7: a national) analogue signalling data link will be specified at Point B on a single channel basis, (Auslassung in 1 TR 7: and thus are independent of multiplex equipment used) (See § 6).

Beginn einer Auslassung in 1 TR 7:

4.5 Interface at Point A may or may not appear in particular implementations, as each Administration may adopt different approaches toward 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.

Ende der Auslassung in 1 TR 7.

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 elctrical 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 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.

Beginn einer Auslassung in 1 TR 7:

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 [7], G.738 [8] and G.739 [9] should apply.

Ende der Auslassung in 1 TR 7.

6 Analogue signalling data link (zusätzlicher Text in 1 TR 7: see also § 2.2)

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 (Auslassung in 1 TR 7: 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.

Beginn einer Auslassung 1 TR 7:

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.

Ende der Auslassung in 1 TR 7.

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, 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.

Beginn einer Auslassung in 1 TR 7:

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. VII.

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 VIIl.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.

Ende der Auslassung in 1 TR 7.

24 CCITT Recommendation 4800 bit/s per second modems with manual equalizer standardized 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.

Kapitel 3

Zeichengabestrecke

Recommendation Q.703

SIGNALLING LINK

Beginn eines Zusatzes in 1 TR 7:

Ende des Zusatzes in 1 TR 7.

1 General

1.1 Introduction

1.1.1 This Recommendation describes the functions and procedures for and relating to the transfer of signalling 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,

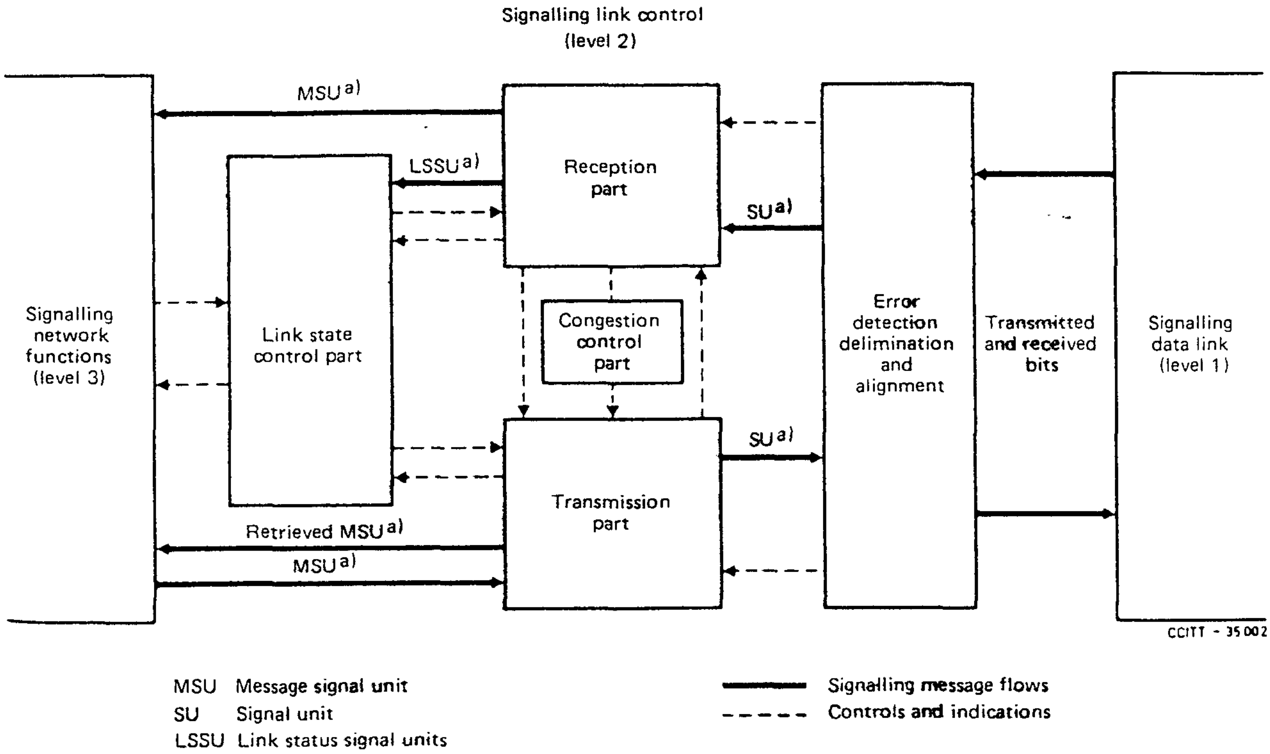
d) error correction,

e) initial alignment,

f) signalling link error monitoring,

g) flow control.

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



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

1.2 Signalling 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.

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 (Text in 1 TR 7: specified), the basic method and the preventive cyclic retransmission method. The following criteria should be used for determining (Auslassung in 1 TR 7: the international) fields of application for the two methods:

Beginn eines Zusatzes in 1 TR 7:

Anmerkung: Die PCR-Methode ist im nationalen Netz der DBP derzeit nicht vorgesehen. (PCR = preventiv cyclic retransmission).

Ende des Zusatzes in 1 TR 7

Beginn einer Auslassung in 1 TR 7:

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.

Ende der Auslassung in 1 TR 7

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 for that signal unit 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.

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

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 exists, 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 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 directives 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.

1.8 Flow control

Flow control is initiated when congestion is detected at the receiving end of the signalling link. The congested receiving end of the link notifies the remote transmitting end of the condition by means of an appropriate link status signal unit and it withholds acknowledgements of all incoming message signal units. When congestion abates acknowledgements of all incoming message signal units is resumed. While congestion exists, the remote transmitting end is periodically notified of this condition. The remote transmitting end will indicate the link as failed if the congestion continues too long.

2 Basic signal unit format

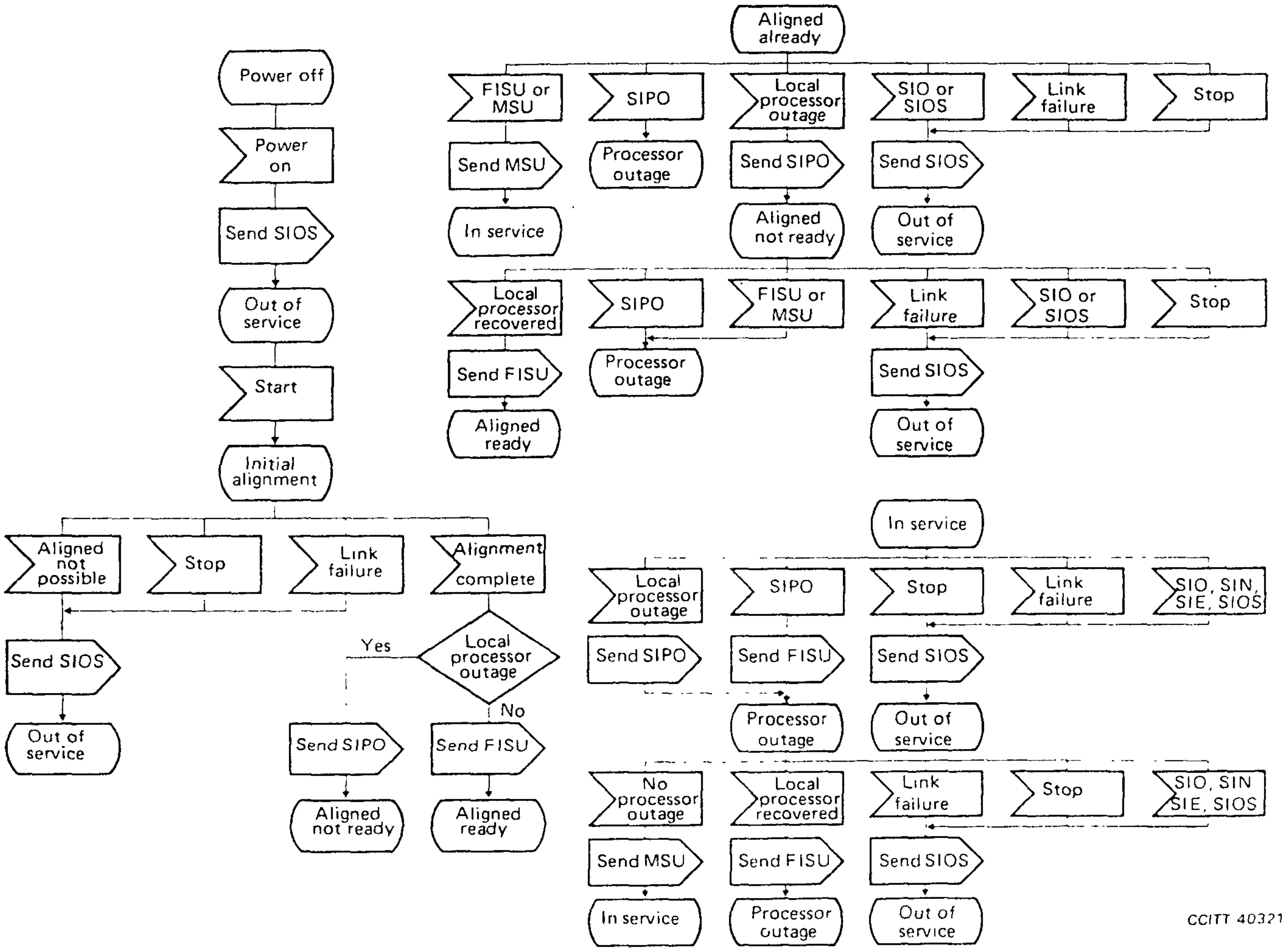
2.1 General

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 and the service information octet is replaced by a status field which is generated by the signalling link terminal.

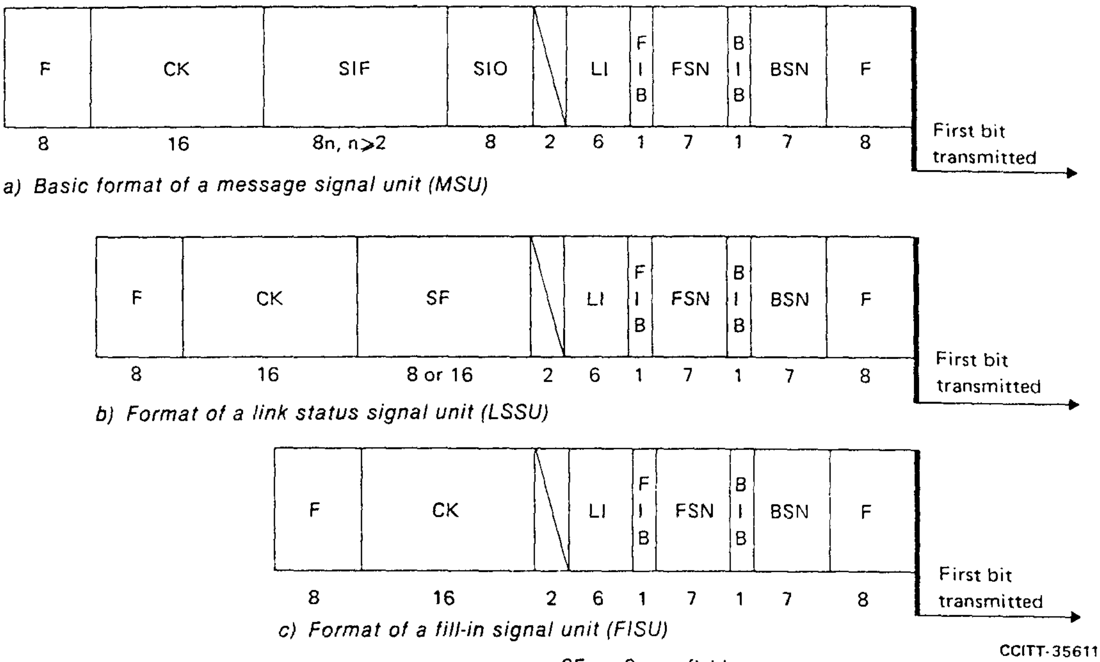
2.2 Signal unit format

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.



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



a) Basic format of a message signal unit (MSU)

b) Format of a link status signal unit (LSSU)

c) Format of a fill-in signal unit (FISU)

CK Check bits
F Flag
LI Length indicator
SF Status field
SIF Signalling information field
SIO Service information octet

Figure 3/Q.703
Signal unit formats

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

Beginn eines Zusatzes in 1 TR 7:

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

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

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

Ende der Auslassung in 1 TR 7.

2.3.4 Service information octet

The service information octet is divided into 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, § 13.2.2.

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

2.3.5 Sequence numbering

The forward sequence number is the sequence number of a 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 272.

Beginn einer Auslassung in 1 TR 7:

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

Ende der Auslassung in 1 TR 7.
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 § 11.

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).

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[2]) The value 272 allows a single message signal unit to accomodate 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.

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. However, a signalling link terminal always should be able to receive consecutive signal units with one or more multiple flags inserted between them.

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 follwos 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 or alignment error rate monitor enters the "octet counting" mode (see § 4.1.4) and the next valid flag is searched for.

Beginn eines Zusatzes in 1 TR 7:

4.1.3 After deletion of the Os inserted for transparency the received signal unit length is checked for being a multiple for 8 bits and at least 6 octets. If it is not, then the signal unit is discarded and the signal unit error rate monitor or alignment error rate monitor is incremented if not in the octet counting mode.

If more than 272+7 octets (see also § 2.3.8 and 3.1) are received before a closing flag, the "octet counting" mode is entered (see Figure 11/Q.703) and the signal unit is discarded. 272 is the maximum length of the signalling information field (in octets) allowed on a particular signalling link.

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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.

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.

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

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, including opening flag. If it is not, then the signal unit is discarded and the signal unit error rate monitor or alignment 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.

Ende der Auslassung in 1 TR 7.

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 $(x^{15}+x^{14}+x^{13}+x^{12}...+x^2+x+1)$ 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.

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, 9 and 11.

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 signalling unit is retained at the transmitting signalling link terminal until a positive acknowledgement for that signal unit is received (see § 5.2.3). In the meantime the same forward sequence number cannot be used for another message signalling 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 message 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 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.

Processing of the backward sequence number value and backward indicator bit value as described in § 5.3 is performed for message signal units and fill-in signal units except when unreasonable backward sequence number value or unreasonable forward indicator bit value is received. Discarding a signal unit means that if it is a message signal unit, it is not delivered to level 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 number assumes 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 positive acknowledgement is consecutively received a number of times no further action is taken.

In the case that a message signal unit for fill-in 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 message signal unit or fill-in signal unit is discarded.

If any two backward sequence number values in three consecutively received message signal units or fill-in 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.

A timing mechanism timer T7 [4]) shall be provided which generates an indication of excessive delay of acknowledgement if, assuming that there are at least one outstanding MSU in the retransmission buffer, no new-acknowledgement has been received within two seconds (provisional value). 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.

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[4]) Timers defined in Recommendation Q.703 are absolute time values (values and tolerance for further study); this means that, due to the possibility to insert multiple flags between signal units (see § 3.1), there may be no fixed relation between the time-out values and the number of signal units transmitted/received during the time-out periods.

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 message signal unit or a fill-in 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. The following message signal unit or fill-in signal unit is discarded.

If any two forward indicator bit values in three consecutively received message signal units or fill-in 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.

Beginn einer Auslassung in 1 TR 7:

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.

Ende der Auslassung in 1 TR 7.

6 Error correction by preventive cyclic retransmission

Beginn eines Zusatzes in 1 TR 7: siehe auch § 1.4.1

Ende des Zusatzes in 1 TR 7.

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, 9 and 11.

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 for that signal unit 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 a positive 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. Processing of the backward sequence number value as described in Section 6.3 is performed for message signal units and fill-in signal units except when unreasonable backward sequence number value is received. Discarding a signal unit means that if it is a message signal unit it is not delivered to level 3.

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 positive acknowledgement is consecutively received a number of times no further action is taken.

In the case that a message signal unit or fill-in 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 following message signal unit or fill-in signal unit is discarded.

If any two backward sequence number values in three consecutively received message signal units or fill-in 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.

A timing mechanism, (Auslassung in 1 TR 7: timer T7,) shall be provided which generates an indication of excessive delay of acknowledgement if, assuming that there is at least one outstanding MSU in the retransmission buffer, no new acknowledgement has been received within two seconds (provisional value). In the case of excessive delay in the reception of acknowledgements a link failure indication is given to level 3.

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 (N1) and the number of message signal unit octets available for retransmission (N2) are monitored continuously.

If one of them reaches its set limit, no new message signal units or fill-in signal units are sent and the retransmission cycle is continued up to the last message signal unit entered into retransmission buffer with priority, in the order in which they were originally transmitted. If all those message signal units have been sent once and neither N1 nor N2 is at its limit value, the normal preventive cyclic retransmission procedure can be resumed. If not, all the message signal units available for retransmission are sent again with priority.

6.4.2 Limitation of the values N1 and N2

N1 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 N2 is limited by the signalling link loop delay TL. It must be ensured that not more than Tr/Teb + 1 message signal unit octets are available for retransmission,

where

TL 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

Teb is the emission time of one octet.

Beginn einer Auslassung in 1 TR 7:

When some signalling data links of different loop delays are alternated for application to that signalling link, the longest possible signalling link delay may be used to calculate the value of TL.

Ende der Auslassung in 1 TR 7

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 aligment, status indication "O", "N" or "E" is received and the terminal is in the "emergency" aligment status, i.e. it must employ the short "emerency 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 singalling 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 reasosns other than processor outage (e.g. link failure) the signalling link terminal can neither receive nor transmit message signal units. Status indication OS is sent on cempletion of "power on" (see Figures 2/Q.703 and 8/Q.703) until initial alignment is started.

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 T2 [5]) is started on entry to State 01 and stopped when State 01 is left [6]).
- 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 T3 [5]) is started on entry to State 02 and stopped when State 02 is left.
- State 03, "proving"; the signalling link terminal is sending status indication "N" or "E", status indication "O" or "OS" are not received, proving has been started.

Beginn eines Zusatzes in 1 TR 7:

Bemerkung: Werke für T1 und T2 siehe § 12.2 Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

- Following successful alignment and proving procedure, the signalling terminal enters Aligned Ready state and the aligned ready time-out T1 is stopped on entry in the in service state and the duration of time-out T1 should be chosen such that the remote end can perform four additional proving attempts.

Ende der Auslassung in 1 TR 7.

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

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[5]) Timers defined in Recommendation Q.703 are absolute time values (values and tolerance for further study); this means that, due to the possibility to insert multiple flags between signal units (see § 3.1), there may be no fixed relation between the time-out values and the number of signal units transmitted/received during the time-out periods.

[6]) "If automatic allocation of signalling terminals or signalling data links is applied at both ends of a signalling link, 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). In all other cases, the value of time-out T2 can be the same at both ends of the link.

7.4 Proving periods

The values of the proving periods are:

$P_n = 2^{16}$ octet transmission time
$P_e = 2^{12}$ octet transmission time

for both 64 kbit/s and lower bit rates. These values correpond 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.

Beginn eines Zusatzes in 1 TR 7:

7.5 Inbetriebnahme-Prozedur

Nach erfolgreichem initial alignment sendet das signalling link terminal FISU und wartet auf den Empfang von FISU oder MSU.

Die Zeit bis zum Empfang der FISU oder MSU wird durch den Timer T1 [5]) "alignment ready" überwacht (Fig. 8 u. 9/Q.703).

Timer T1 wird gestartet nach Abschluß des initial alignment mit Beginn FISU-Senden und gestoppt bei Empfang von FISU oder MSU (siehe auch Fig. 8 Sheet - 4/Q.703).

Nach 5maligem erfolglosem initial alignment wird eine Fehlermeldung ausgedruckt.

Bemerkung: Wert für T1 siehe § 12.2

Ende des Zusatzes in 1 TR 7.

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 canot 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, (Auslassung in 1 TR 7: either) by receiving an explicit indication from level 3, (i.e. local signalling link blocking, see Recommendation Q.704, § 3.2.6), (Auslassung in 1 TR 7: or by recognizing a failure of level 3), it transmits link status signal units indicating processor outage and discards message signal units received. 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 proccessor outage (status indication "PO") appear in § 11.

9 Level 2 flow control

9.1 General

The procedure is used to handle a level 2 congestion situation. After the congestion is detected at the receiving end of the signalling link, both positive and negative acknowledgements to message signal units are withheld and a status indication "B" (Busy) is sent from the receiving end of the link to the remote end in order to enable the remote transmitting end to distinguish between congestion and failure situations.

This indication is carried in the status field of a link status signal unit.

Note:
The receiving end continues to process BSN and BIB carried in signal units received in order to, as far as possible, avoid disturbance of the message flow in the opposite direction and in addition may continue to accept message signal units.

Beginn einer Auslassung in 1 TR 7

9.2 Detection of congestion

The mechanism for detecting congestion at the receiving end of a signalling link is implementation dependent and not to be specified.

9.3 Procedure in the congestion situation

The receiving end of a signalling link which detected a congestion situation, periodically sends a link status signal unit containing a status indication "B" to the remote transmitting end of the link at interval T5 = 200 ms (provisional value).

The receiving level 2 also withholds acknowledgement of the message signal unit, which triggered off the congestion detection, and of message signal units received during the congestion situation; that is fill-in signal units or message signal units are sent as usual, but with the backward sequence number and backward indicator bit assigned the values which are contained in the last transmitted signal unit before the congestion is recognized.

At the remote end of the signalling link every reception of a link status signal unit containing indication "B" causes the excessive delay of acknowledgement timer T7 to be restarted. In addition first reception of the link status signal unit containing a status indication "B" starts a longer supervision timer T6 = 10 s (provisional value). Should timer T6 expire, link failure indication is generated.

Ende der Auslassung in 1 TR 7.

Beginn eines Zusatzes in 1 TR 7

9.2 Detection of congestion

When Level 2 cannot process or deliver to Level 3 message signal units sent by an adjacent signalling point Level 2 is recognized as being congested.

9.3 Procedure in conqestion situation

Congested Level 2 which detected a congestion situation, periodically sends a link status signal unit containing a status indication "B" to the remote end at interval T_5 = 80-120 ms (provisional value, see also Note 3).

Congested Level 2 also withholds acknowledgement of received message signal units, that is, sends fill in signal units or message signal units as usual, but with the backward sequence number and the backward indicator bit assigend the values which are contained in the last transmitted signal unit before the congestion is recognized. At the adjacent signalling point, every reception of a link status signal unit containing a status indication "B" causes acknowledgement timer Ta = T_7 (see also Note 2 and § 5.3.1) to be restarted.

In addition, first reception of the link status signal unit containing a status indication "B" starts a longer time-supervision T_{cg} (Note 1). When timer T_{cg} expires, link failure indication is generated (see Fig. 3a, 19).

Note 1: Timer T_{cg} = T6 guards against the following accidents:

(i) Level 2 congestion lasts too long.
(ii) A congested SP cannot cease sending "SIB" signals due to accidental failure.

Note 2: No other procedure on the timer T_a (for example, to prolong timer T_a) is needed, because the present procedure for restarting timer T_a is sufficient to achieve the above-mentioned purpose.

Anmerkung: Die Werte für T_a, T_b und T_{cg} siehe § 12.2.

Note 3: Period T_5 requirements are as follow:

(1) "SIBs" sent periodically by a congested SP must not create congestion in an opposite direction.

(2) Even if temporary signalling link interruption causes the "SIB" signal to be lost, the "SIB" signal must be received by the adjacent SP within acknowledgement time T_a.

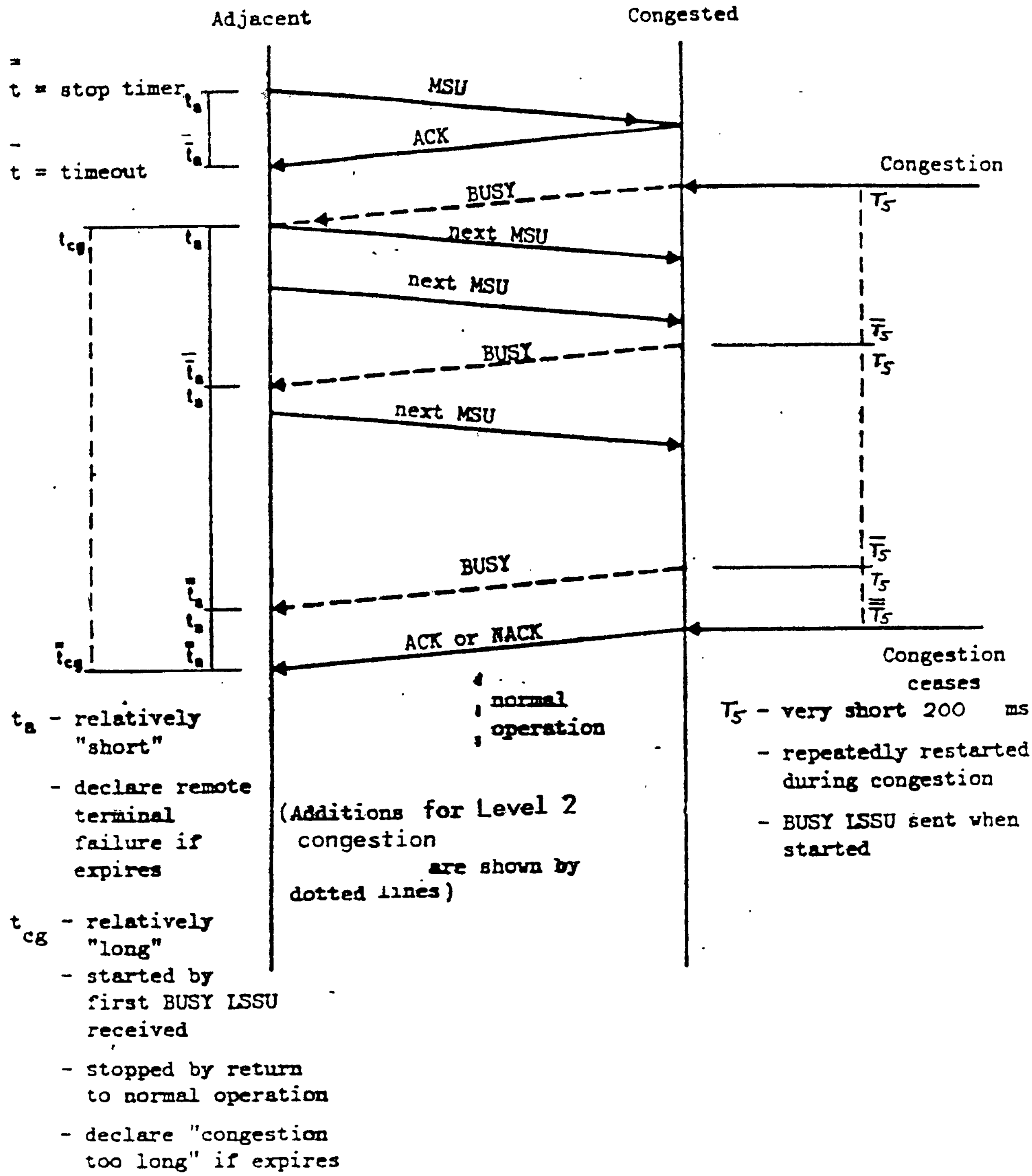


Figure 3a/Q. 703
Explicit congestion indication L2 flow control

Endes des Zusatzes in 1 TR 7.

9.4 Congestion abatement procedure

When congestion abates at the receiving end of the signalling link, transmission of link status signal unit containing a status indication "B" is stopped and normal operation resumed.

At the remote end, the supervision timer T6 is stopped when a negative or positive acknowledgement whose backward sequence number acknowledges a message signal unit in the retransmission buffer is received in case of the basic error correction method, or a positive acknowledgement in case of the PCR method.

Beginn eines Zusatzes in 1 TR 7:

Zwischen der letzten Busy LSSU eines beendeten Busy-Zustandes und der ersten Busy LSSU eines erneuten Busy-Zustandes sollte ein zeitlicher Mindestabstand in der Größenordnung von T5 eingehalten werden.

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

Note
Congestion onset and abatement detection is an implementation dependent function. Sufficient hysteresis should be provided in the implementation to prevent excessive oscillation between congested and non congested states.

Ende der Auslassung in 1 TR 7.

10 Signalling link error monitoring

10.1 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.

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

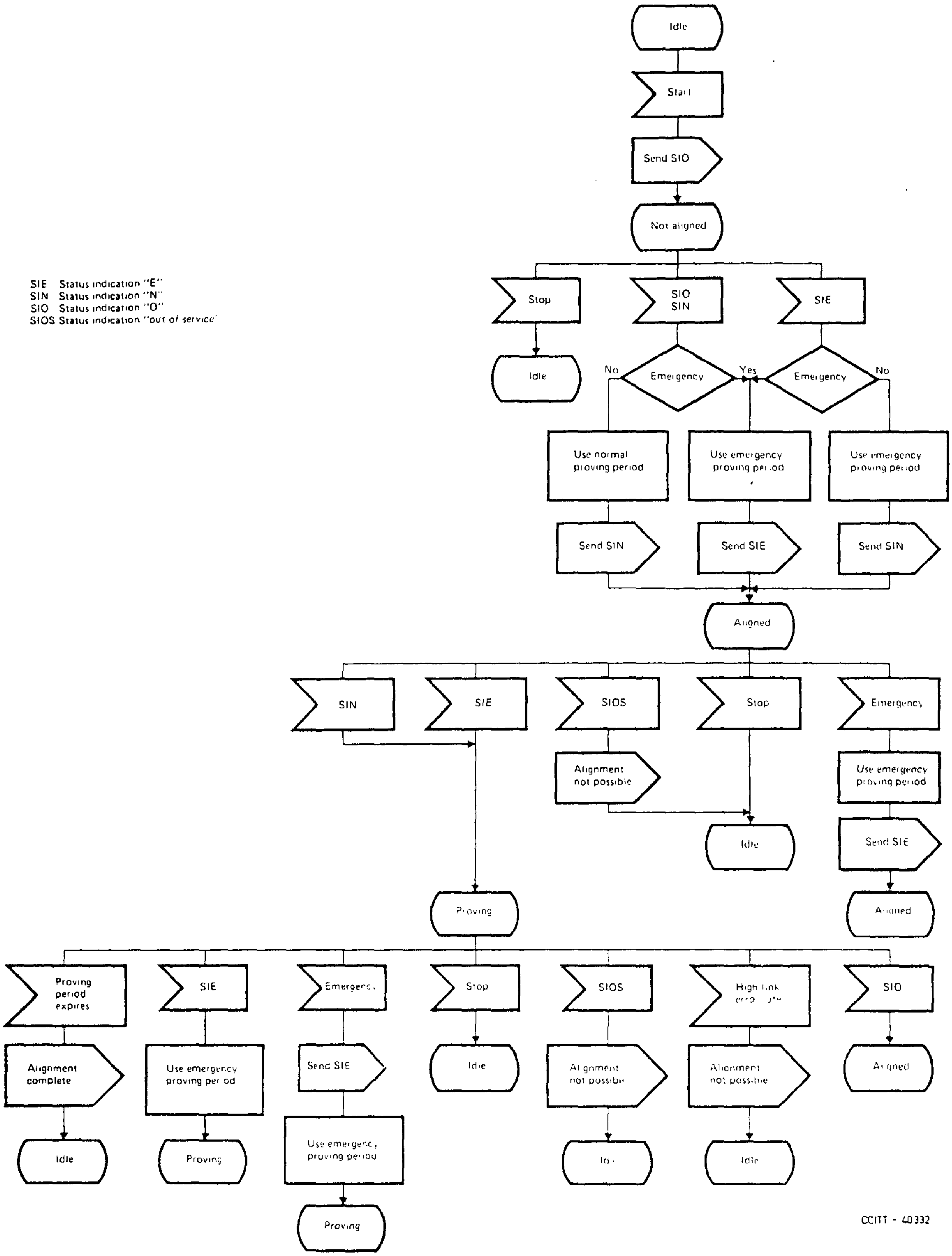


FIGURE 4/Q.703
Overview diagram of initial alignment control

10.2 Signal unit error rate monitor

10.2.1 The signal unit error rate monitor has as its function the estimation of the signal unit error rate in order to decide about the signalling link fault condition. The signal units in error are those rejected by the acceptance procedure (see § 4). The three parameters which determine the signal unit error rate monitor are: the number of consecutive signal units received in error that will cause an error rate high indication to level 3, T (signal units), 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) and the number of octets that causes an increment of the counter while in the "octet counting" mode, N (octets). (See Figure 5/Q.703).

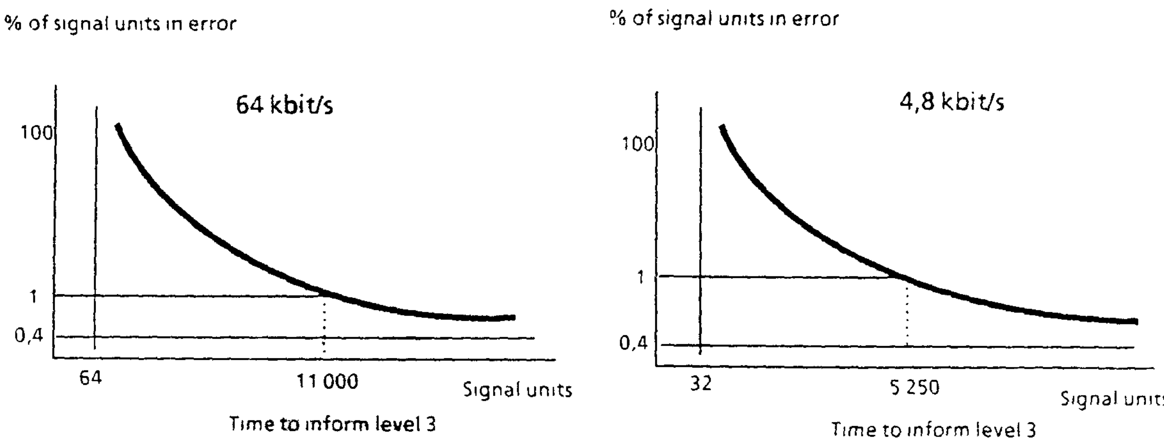


FIGURE 5/Q.703

Relationship between the expected number of signal units to fault indication and signal unit error rate

10.2.2 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 (Zusatz in 1 TR 7: if the signal unit error rate monitor is not in the octet counting mode) (see § 4), but not above the threshold T (signal units) . An excessive error rate will be indicated whenever the threshold T is reached.

10.2.3 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).

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

10.2.5 The values of the three parameters are:

T = 264 signal units D = 256 signal units/signal unit error N = 16 octets	for 64 kbit/s
T = 32 signal units D = 256 signal units/signal unit error N = 16 octets	for lower bit rates

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.

Beginn einer Auslassung in 1 TR 7:

10.2.6 In the case where only random signal unit errors occur over the signalling link, the relationship between the expected number of signal units until threshold of T (signal units) is reached and the signal unit error rate (signal unit errors/signal units) can be established. This relationship may be expressed by an orthogonal hyperbola which has parameters (T, 1/D). See Figure 5/Q.703.

Ende der Auslassung in 1 TR 7.

10.3 Alignment error rate monitor

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

10.3.2 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, if not in the octet counting mode. It is also incremented for every N octets received while in the octet counting mode, as described in § 10.2.3.

10.3.3 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".

10.3.4 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

Beginn einer Auslassung in 1 TR 7:

Note
It is noted that the emergency proving period may be successfully completed with some probability with a marginal and degraded bit error rate, i.e., around one error in 10^4 bits - Subsequently, the SUERM will quickly indicate an excessive error rate. However, short term operation on a degraded link may be acceptable (e.g. to send management messages).

Ende der Auslassung in 1 TR 7.

11 Level 2 codes and priorities

11.1 Link status signal unit

11.1.1 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.

Beginn eines Zusatzes in 1 TR 7:

Anmerkung: Es gibt derzeit keine LSSU mit einem LI = 2.

Ende des Zusatzes in 1 TR 7.

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

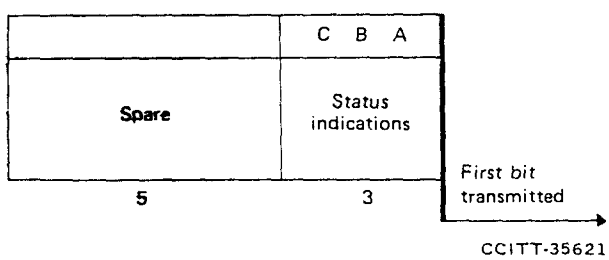


Figure 6/Q.703

Status field format

11.1.3 The use of the link status indications is described in § 7 and § 9; 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"
1	0	1	- Status indication "B"

11.2 Transmission priorities within level 2

11.2.1 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.

11.2.2 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.

11.2.3 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.

Beginn einer Auslassung in 1 TR 7:

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.

Ende der Auslassung in 1 TR 7.

12 State transition diagrams

12.1 § 12 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.

Beginn eines Zusatzes in 1 TR 7:

- Congestion control part: Figure 19/Q.703.

Ende des Zusatzes in 1 TR 7.

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 specifiy 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.

12.2 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
C	Count of aborted proving attempts Figure 9/Q.703 (sheets 2 of 3 and 3 of 3)
C	Counter of MSU in TD Fiugre 13/Q.703 (sheet 1 of 2) and Figure 15/Q.703 (sheet 1 of 3)
C	AERM count (Figure 17/Q.703)
C	SUERM count (Figure 18/Q.703)
CC	Congestion control
DAEDR	Delimitation, alignment and error detection (receiving)
DAEDT	Delimitation, alignment and error detection (transmitting)

FIB	Forward indicator bit
FIBR	FIB received
FIBT	FIB transmitted
FIBX	FIB expected
FISU	Fill-in signal unit
FSN	Forward sequence number
FSNC	Forward sequence number of last message signal unit accepted by remote level 2
FSNF	FSN of the oldest MSU in the RTB
FSNL	FSN of the last MSU in the RTB
FSNR	FSN received
FSNT	FSN of the last MSU transmitted
FSNX	FSN expected
IAC	Initial alignment control
L2	Level 2
L3	Level 3
LSC	Link state control
MGMT	Management system - Unspecified implementation dependent management function
MSU	Message signal unit
N	Correct SU count
NACK	Negative acknowledgement
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 loap delay time)
POC	Processor outage control
RC	Reception control
RTB	Retransmission buffer
RTR	If = 1 means retransmission expected
SIB	Status indication "B" ("Busy")
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
T	SUERM threshold
TB	Transmission buffer
TXC	Transmission control
T_i	AERM threshold
T_{ie}	Emergency AERM threshold
T_{in}	Normal AERM threshold
UNB	Counter of unreasonable BSN
UNF	Counter of unreasonable FIB
Z	Pointer to sequence number of next MSU to be retransmitted in transmission code

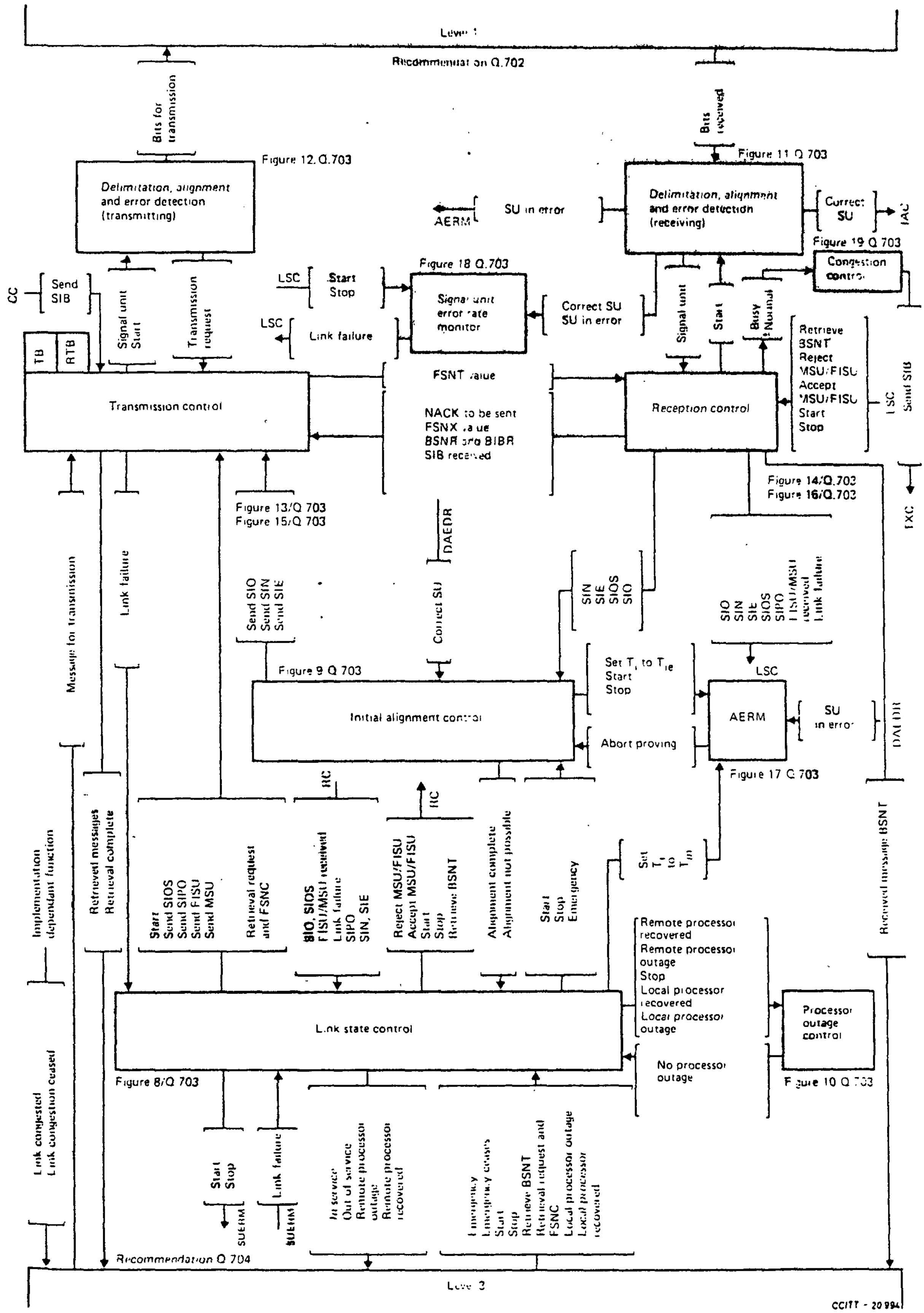
Timers used in Figures 8/Q.703 to 19/Q.703

T1	Timer "alignment ready" (§ 7.5) : 40 - 50 sec
T2	Timer "not aligned" (§ 7.3) : 5 - 150 sec
T3	Timer "aligned"(§ 7.3) : 1 - 1,5 sec
T4	Proving period timer = 2^{15} or 2^{12} octet transmission time T4 normal: nominal: 8,2 sec; range: 7,5 - 9,5 sec T4 emergency: nominal: 500 ms; range: 400 - 600 ms
T5	Timer "sending SIB" (§ 9) : 80 - 120 ms
T6	Timer "remote congestion" (§ 9) : 3 - 6 sec
T7	Timer "excessive delay of acknowledgement" terrestric: 0,5 - 2 sec; satellite: 0,8 - 2 sec.
PE	Emergency proving period
PN	Normal proving period

Beginn eines Zusatzes in 1 TR 7:

Die Werte für die Timer T1 bis T3 gelten nur bei 64 kbit/s. Für 4,8 kbit/s sind weitere Überlegungen erforderlich.

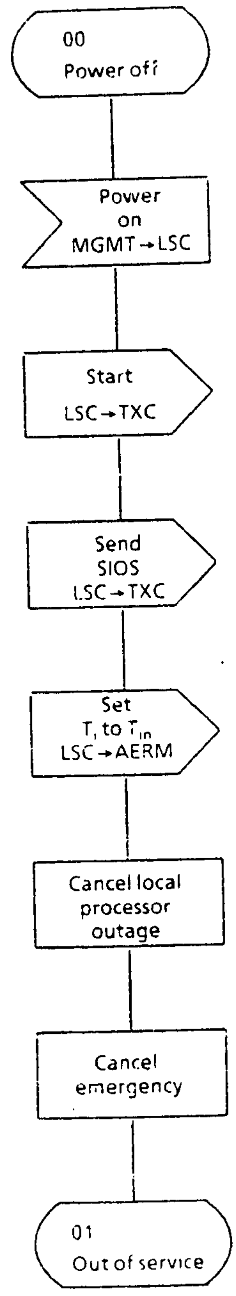
Ende des Zusatzes in 1 TR 7.



Note 1 – Abbreviated message names have been used in this diagram (i.e. origin – destination codes are omitted).

Note 2 – See the abbreviations and timers used in this figure in § 12.2.

FIGURE 7/Q.703
Level 2 - Functional block diagramm



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

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

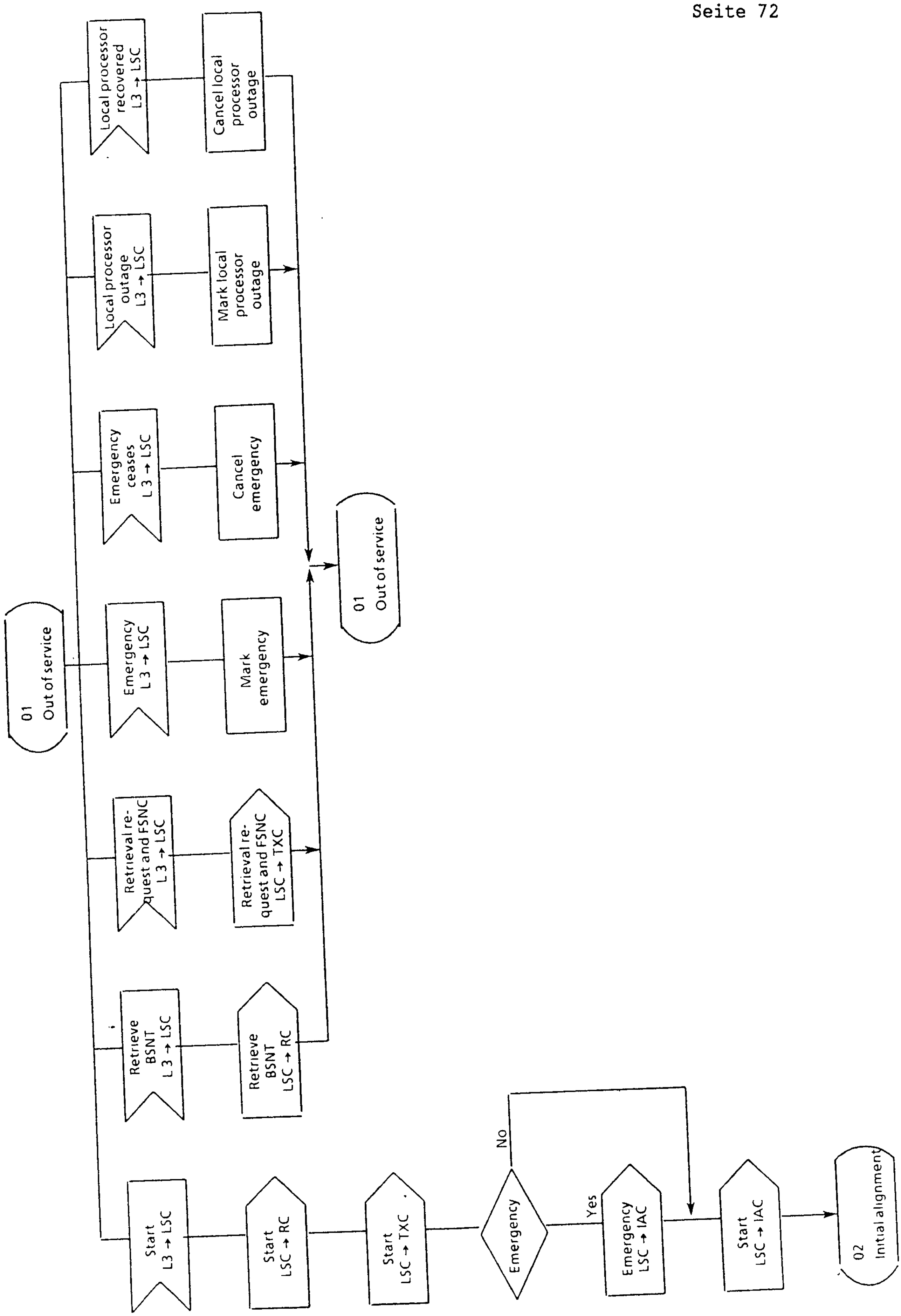


FIGURE 8/Q.703 (Sheet 2 of 7)
Link state control

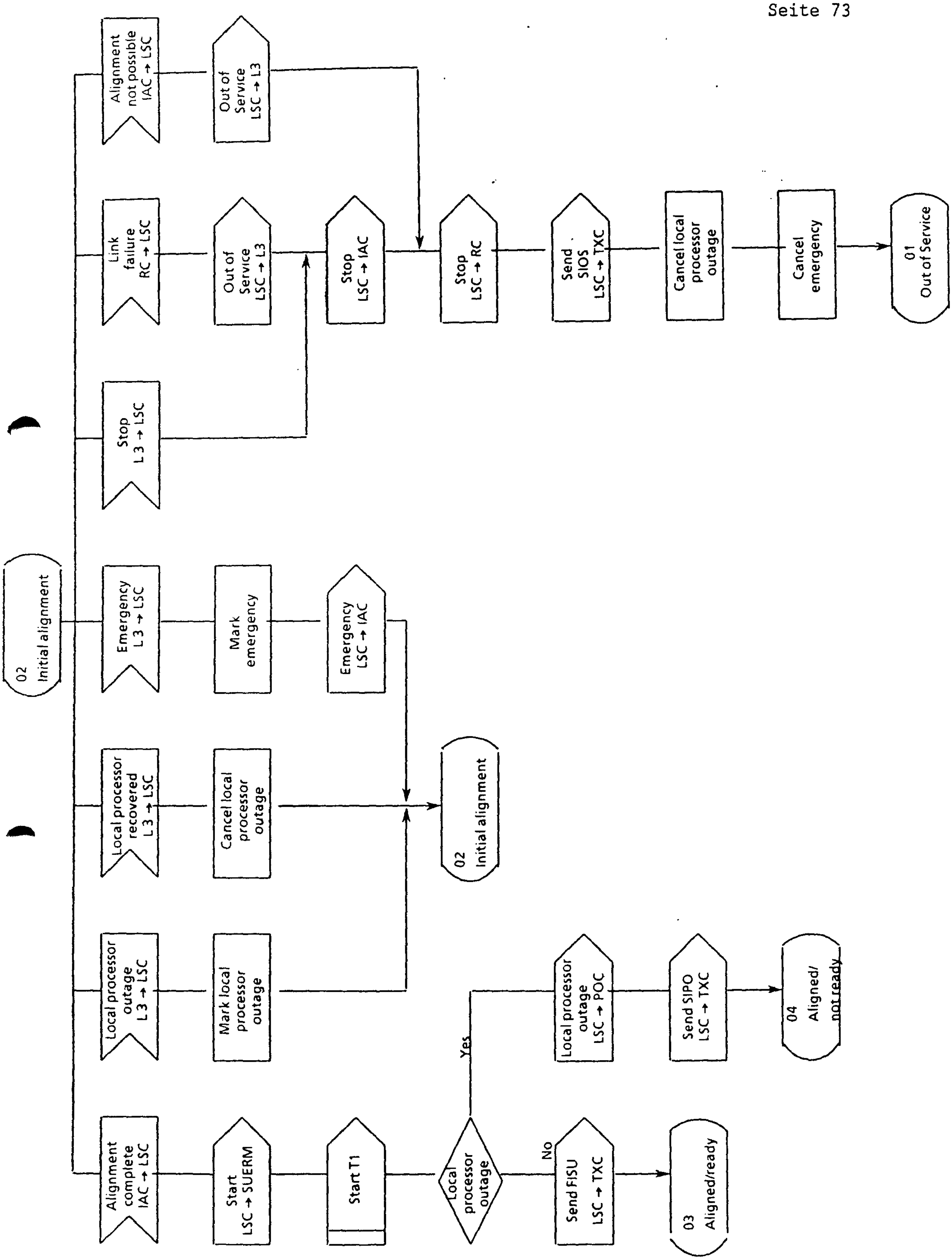


FIGURE 8/Q.703 (Sheet 3 of 7)
Link state control

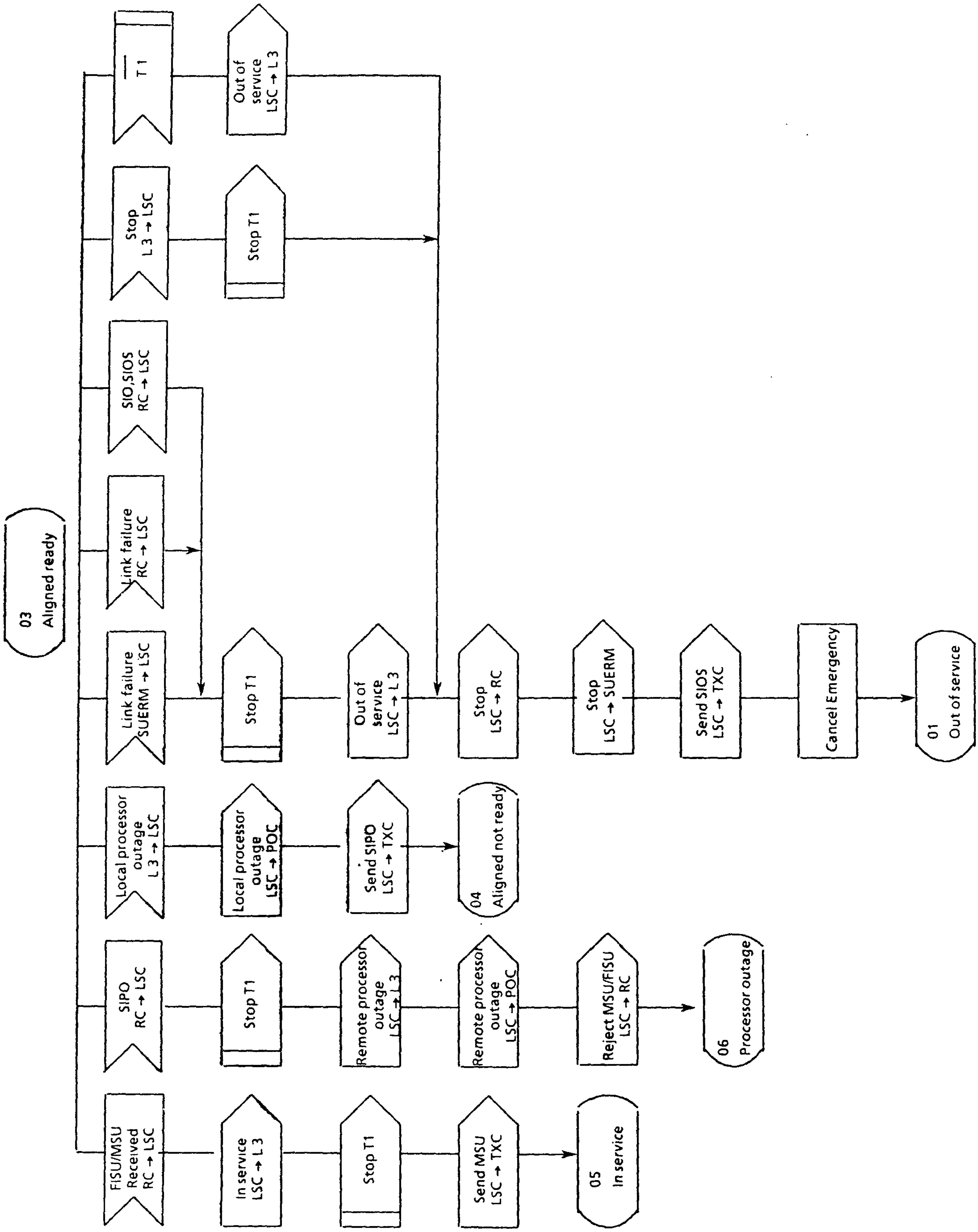
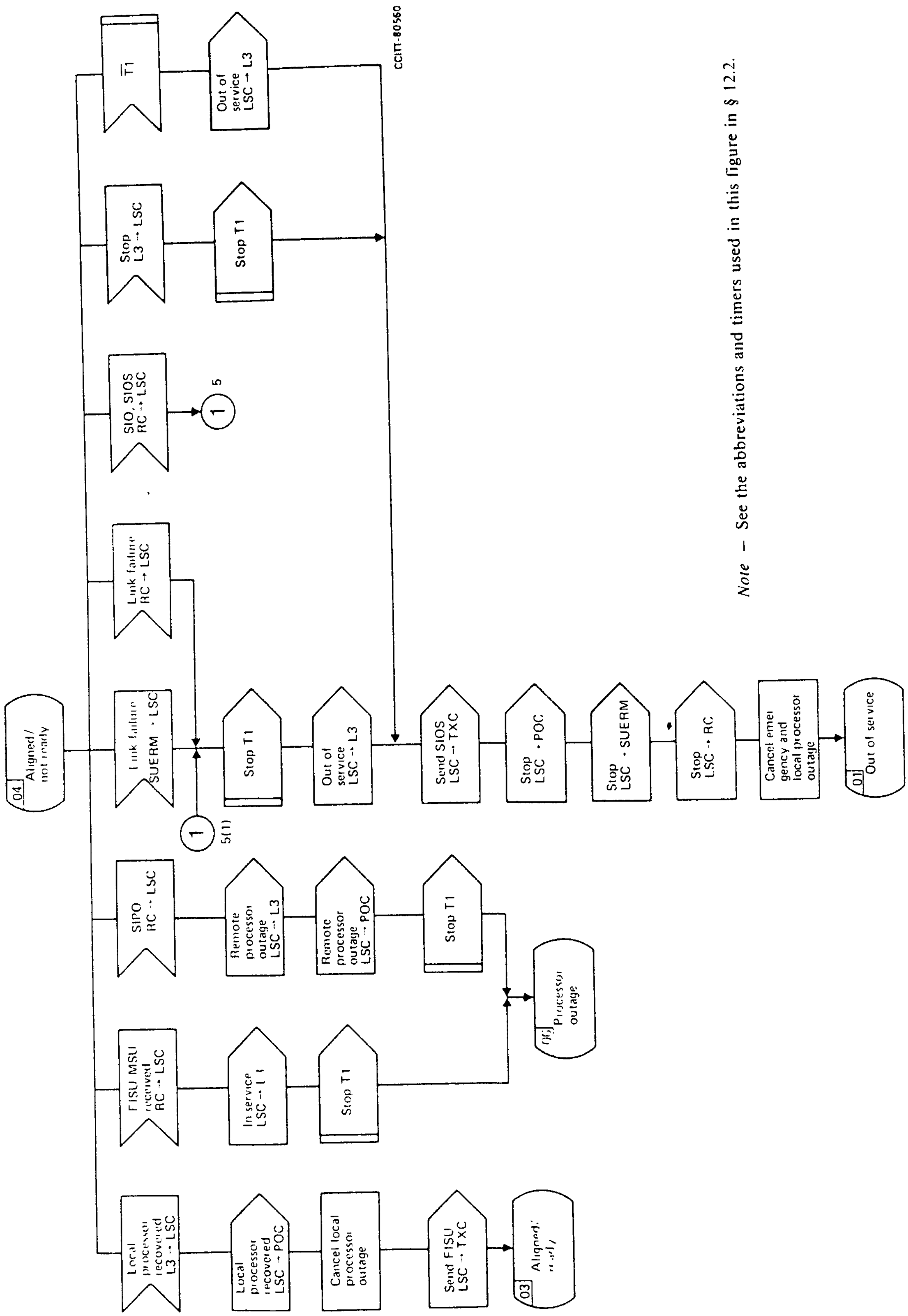
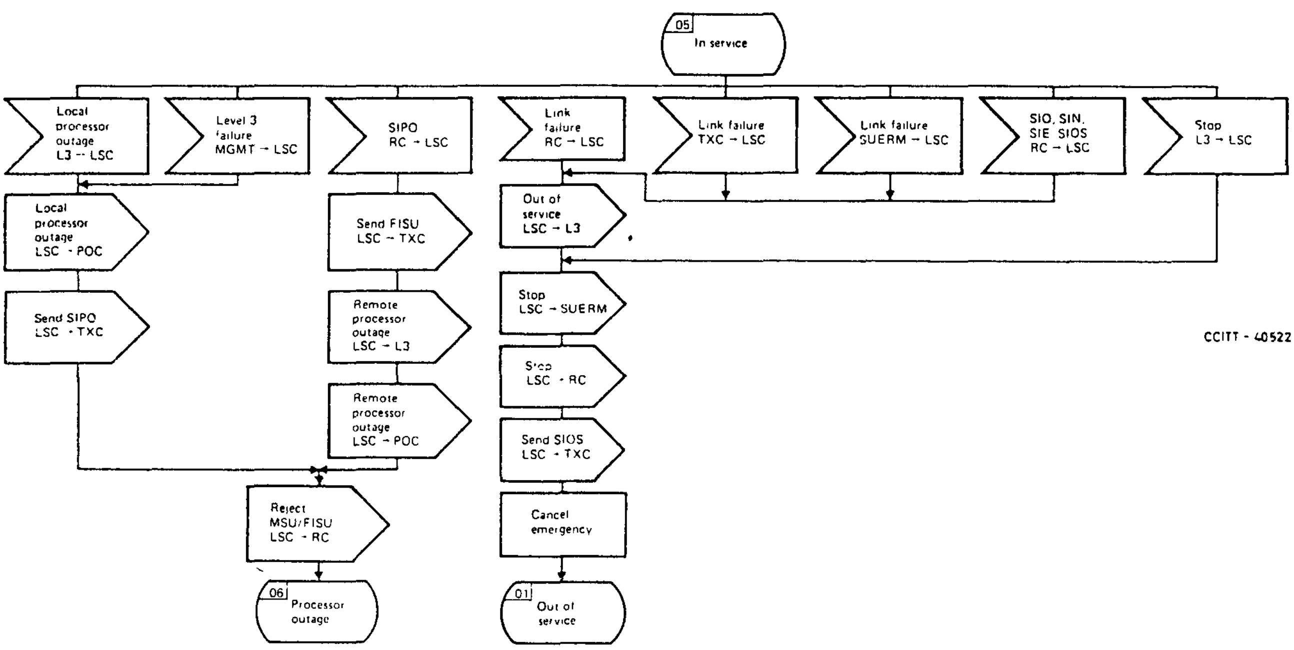


FIGURE 8/Q.703 (Sheet 4 of 7)
Link state control



Note – See the abbreviations and timers used in this figure in § 12.2.

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



Note — See the abbreviations and timers used in this figure in § 12.2.

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
L 2	Level 2
L 3	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

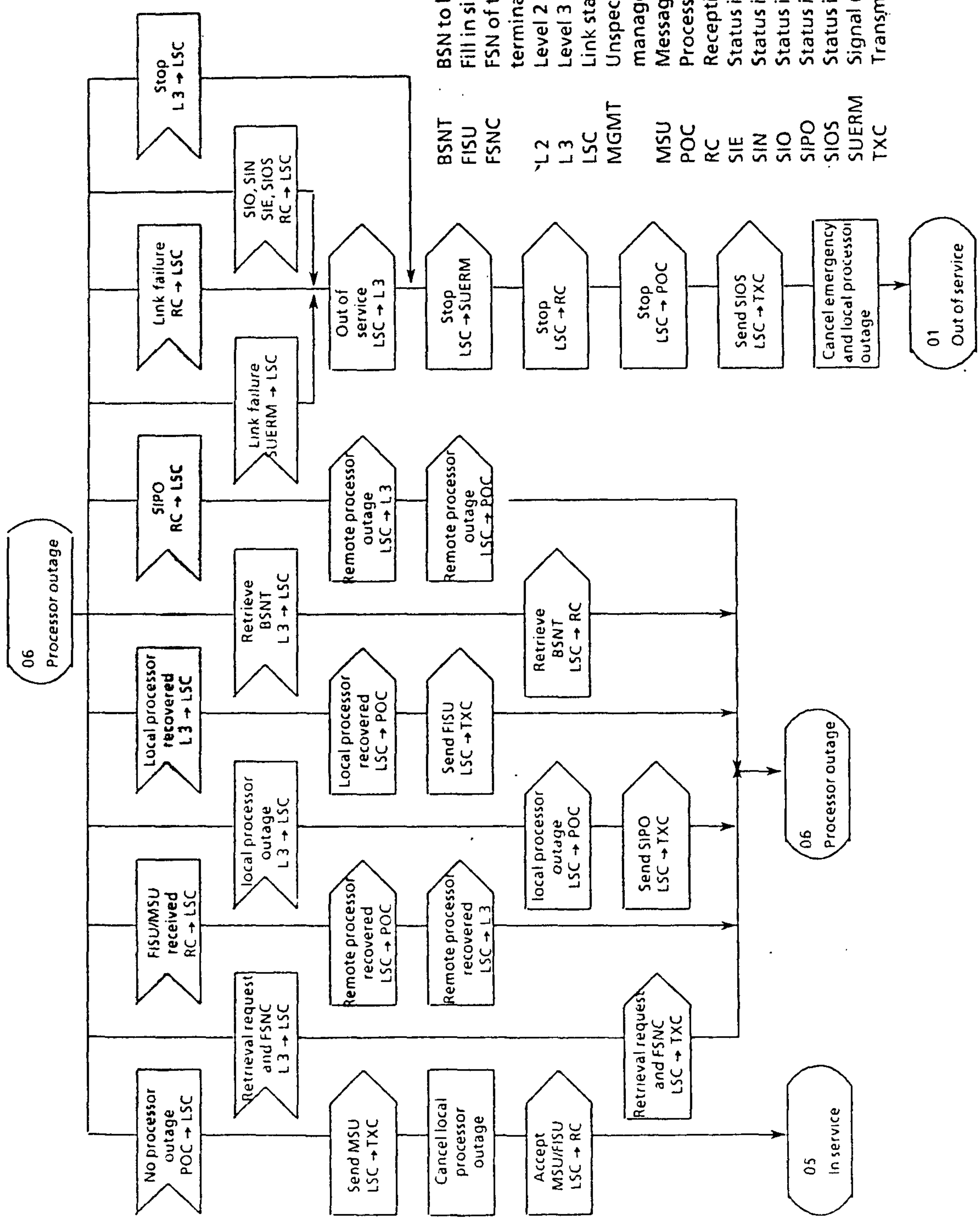


FIGURE 8/Q.703 (Sheet 7 of 7)
Link state control

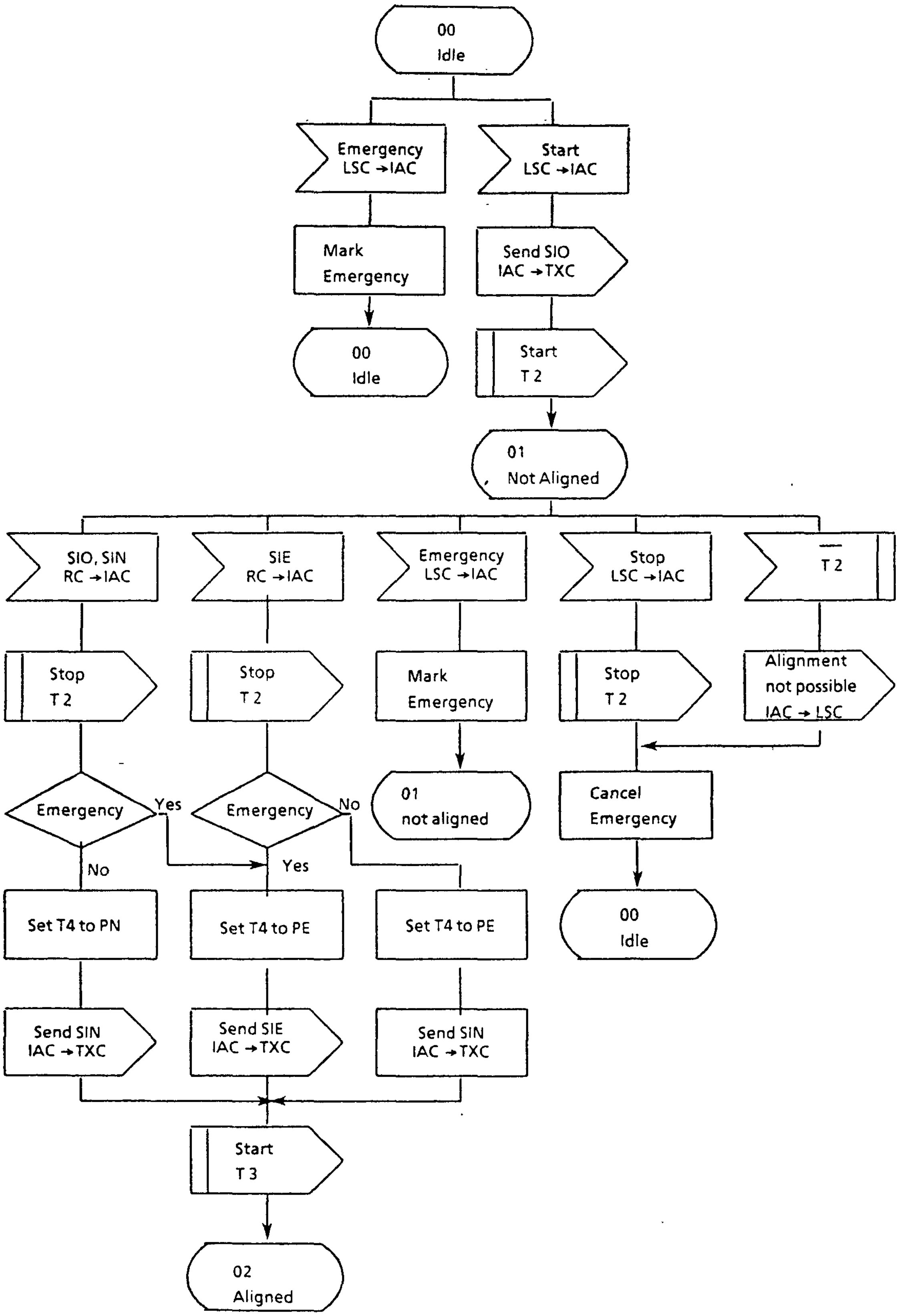
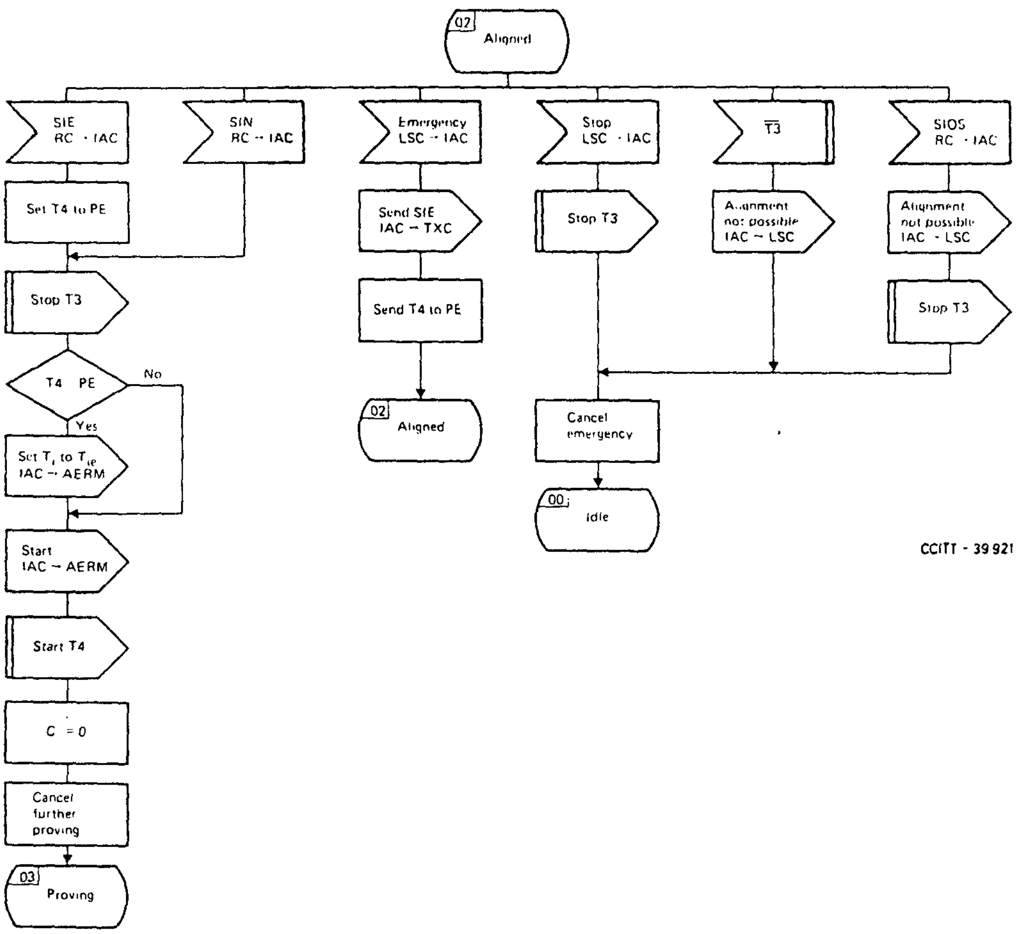
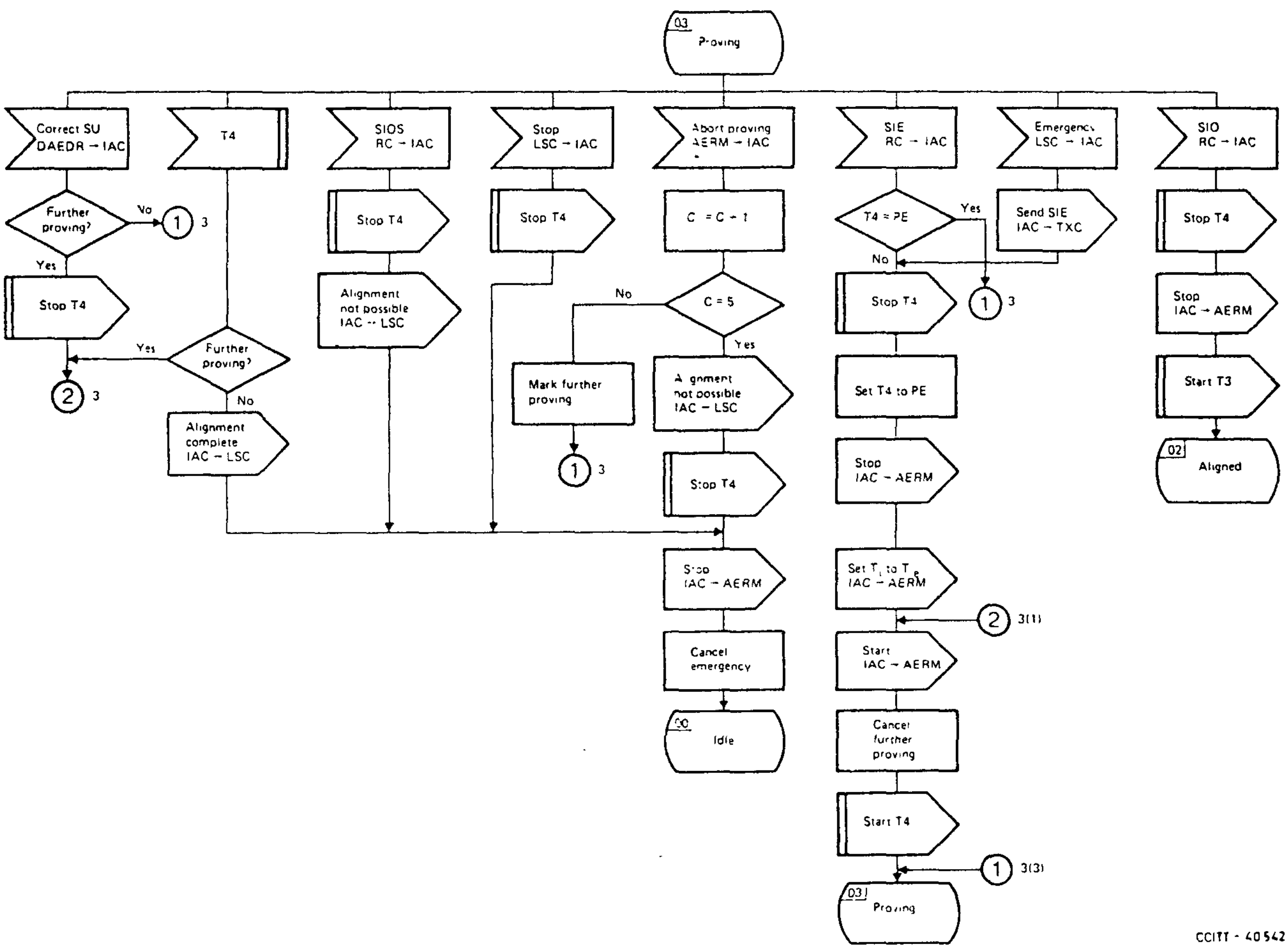


FIGURE 9/Q.703 (Sheet 1 of 3)
initial aligment control



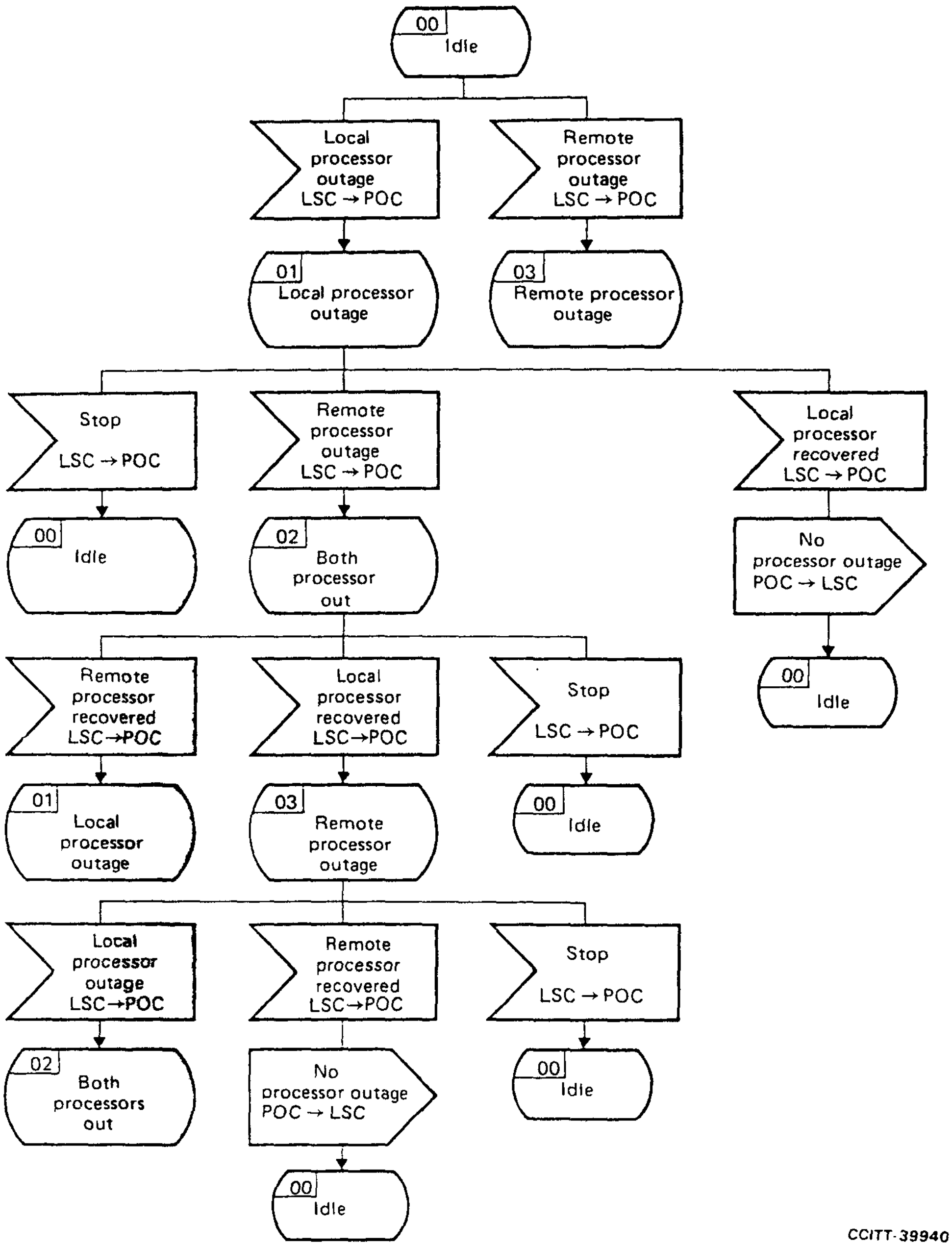
Note – See the abbreviations and timers used in this figure in § 12.2.

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



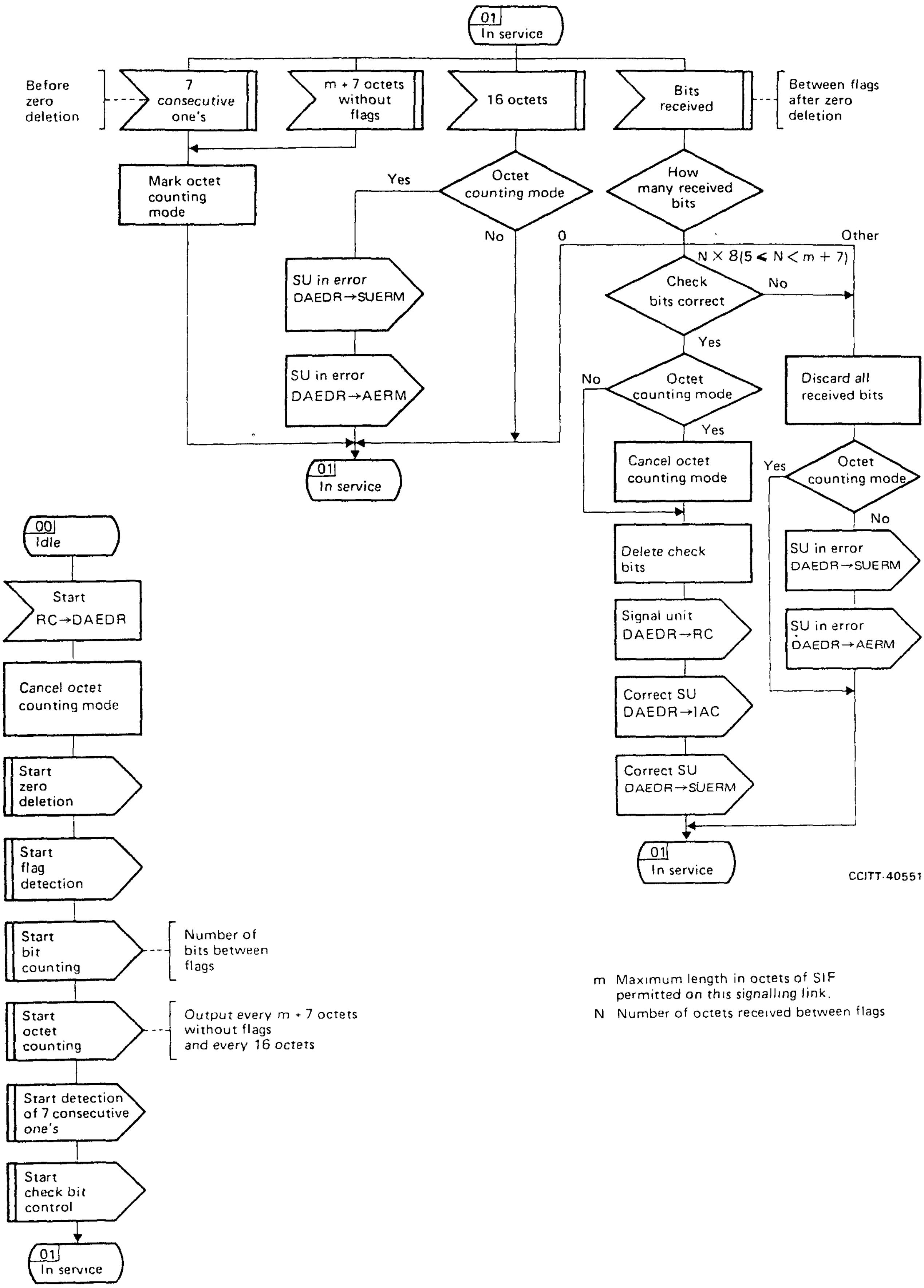
Note – See the abbreviations and timers used in this figure in § 12.2.

FIGURE 9/Q.703 (Sheet 3 of 3)
Initial aligment control



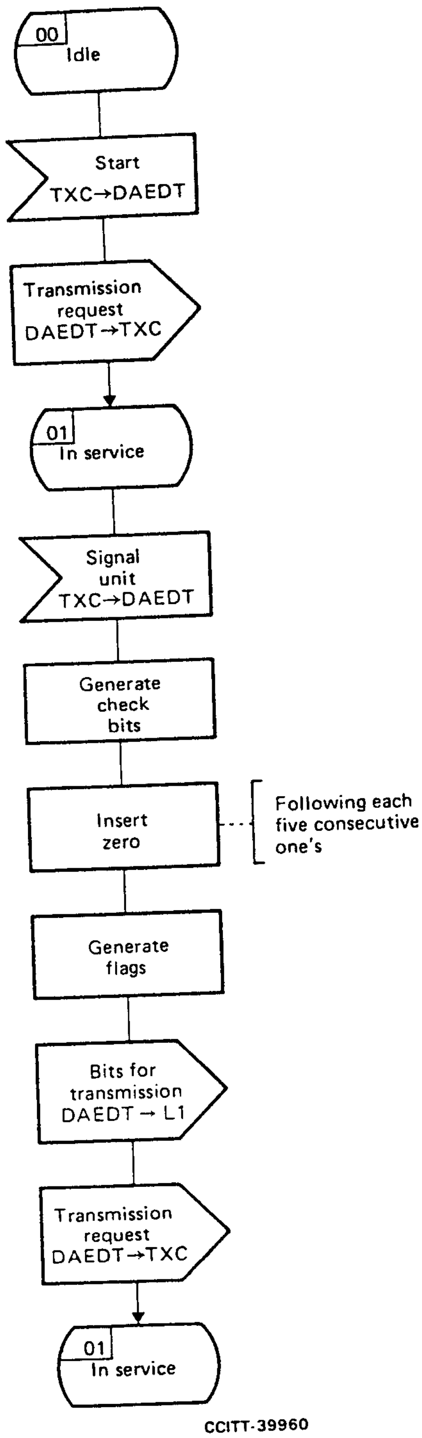
Note – See the abbreviations and timers used in this figure in § 12.2.

FIGURE 10/Q.703
Processor outage control



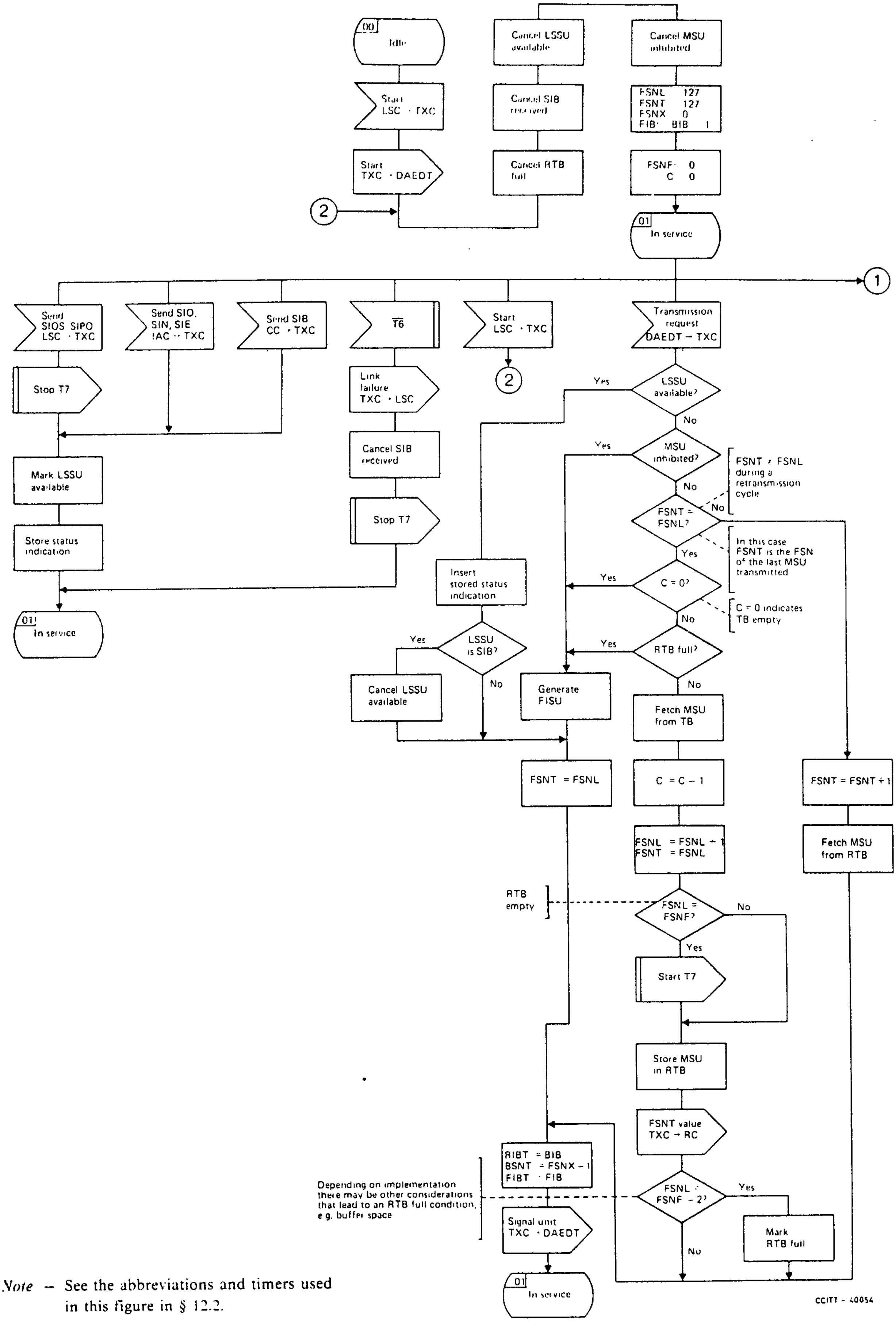
Note – See the abbreviations and timers used in this figure in § 12.2.

FIGURE 11/Q.703
Delimitation, alignment and error detection (receiving)



Note – See the abbreviations and timers used in this figure in § 12.2.

FIGURE 12/Q.703
Delimitation, aligment and error detection (transmitting)



Note – See the abbreviations and timers used in this figure in § 12.2.

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

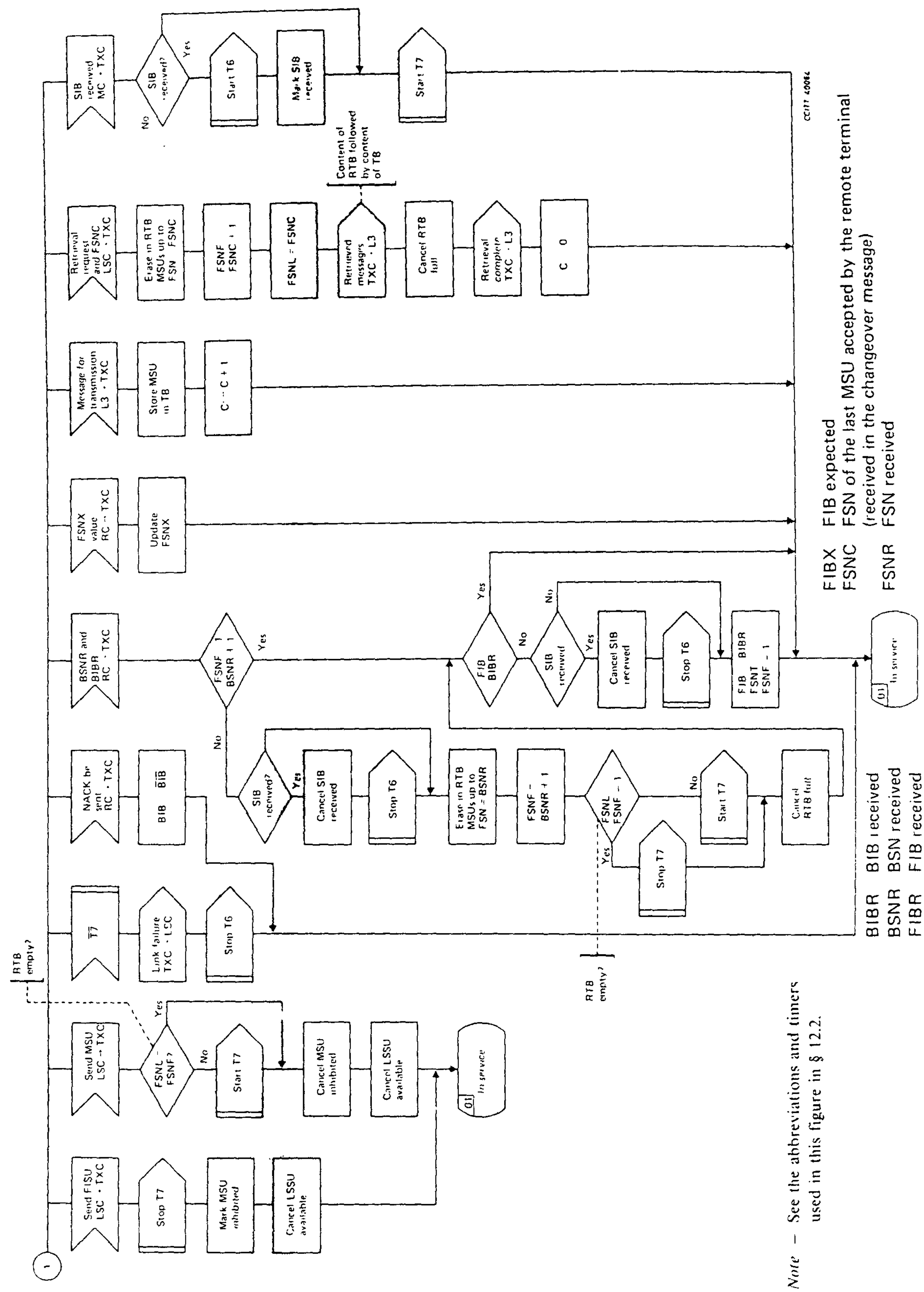


FIGURE 13/Q.703 (Sheet 2 of 2)
Basic transmission control

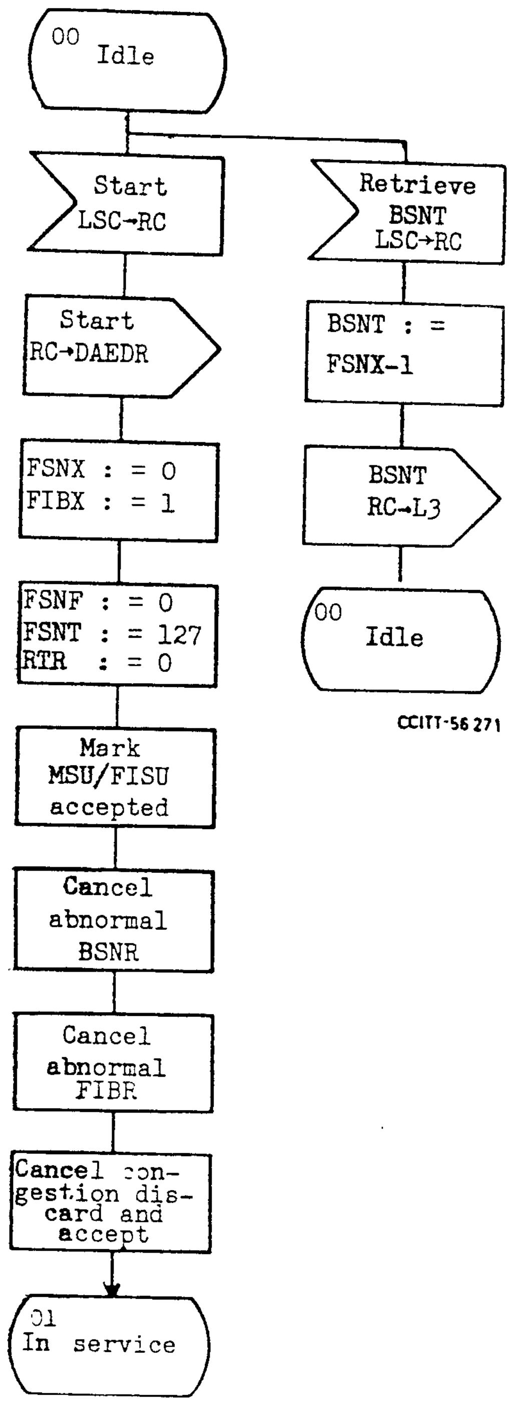


FIGURE 14/Q.703 (Sheet 1 of 4)
Basic reception control

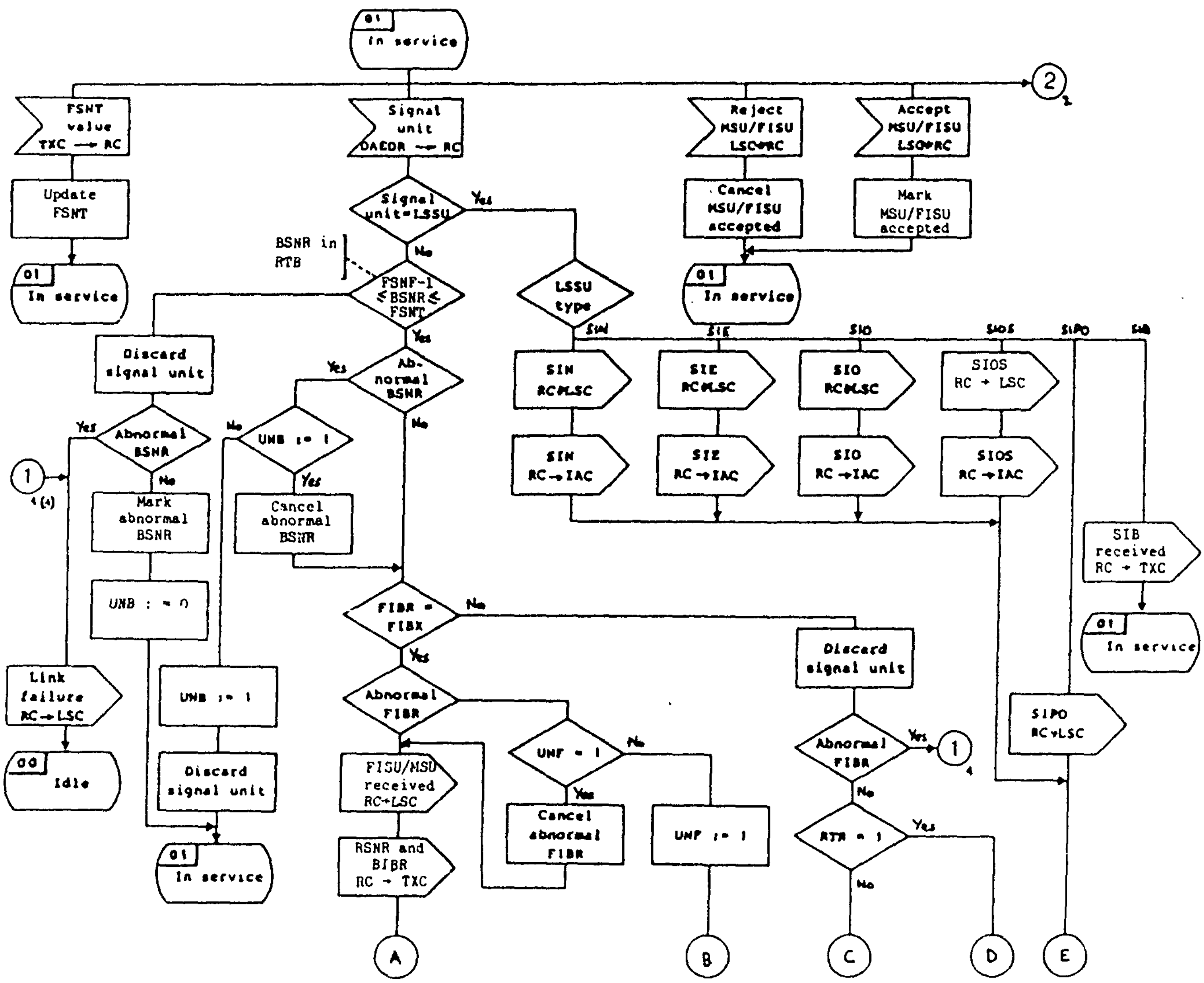


FIGURE 14/Q.703 (Sheet 2 of 4)
Basic reception control

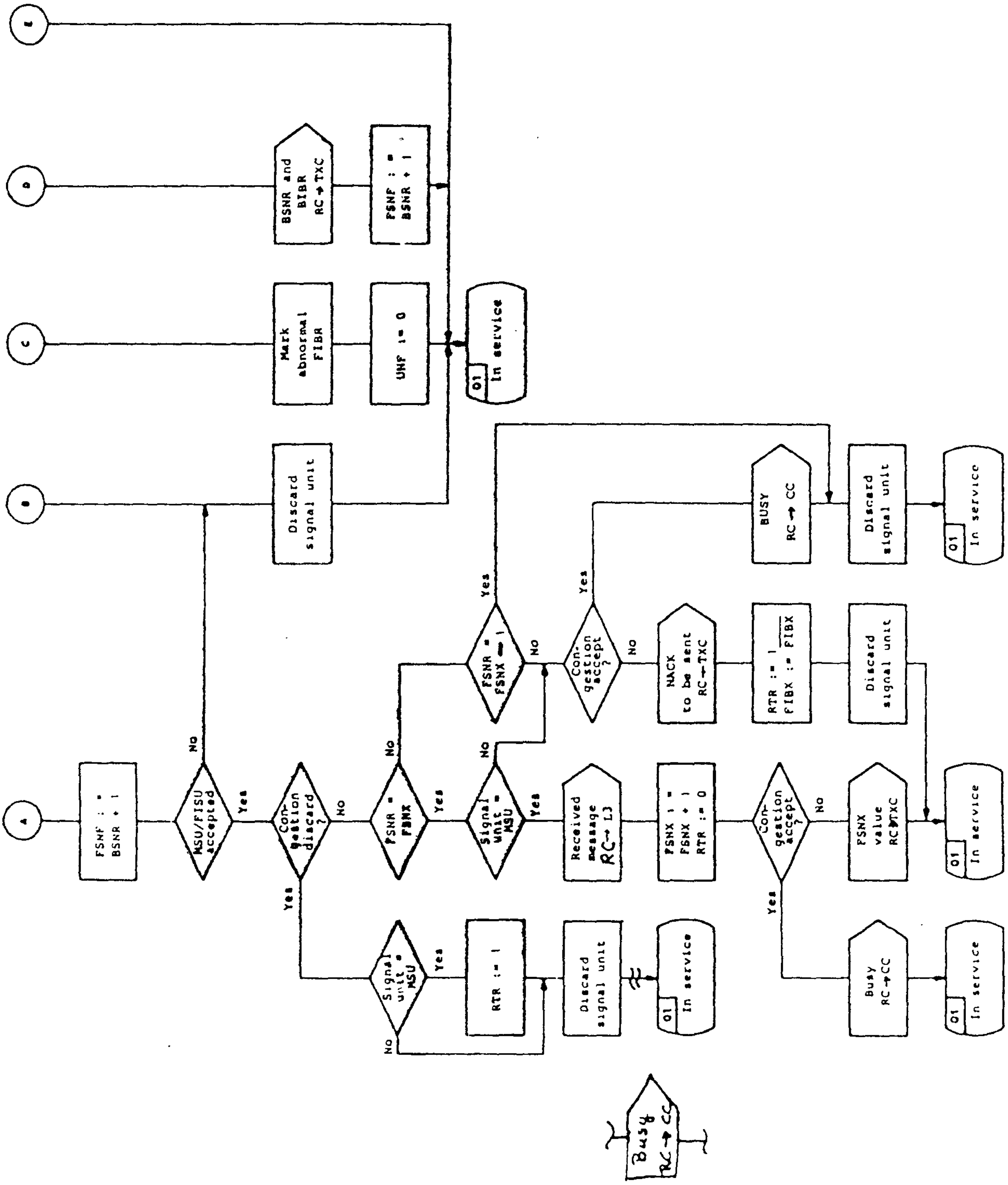
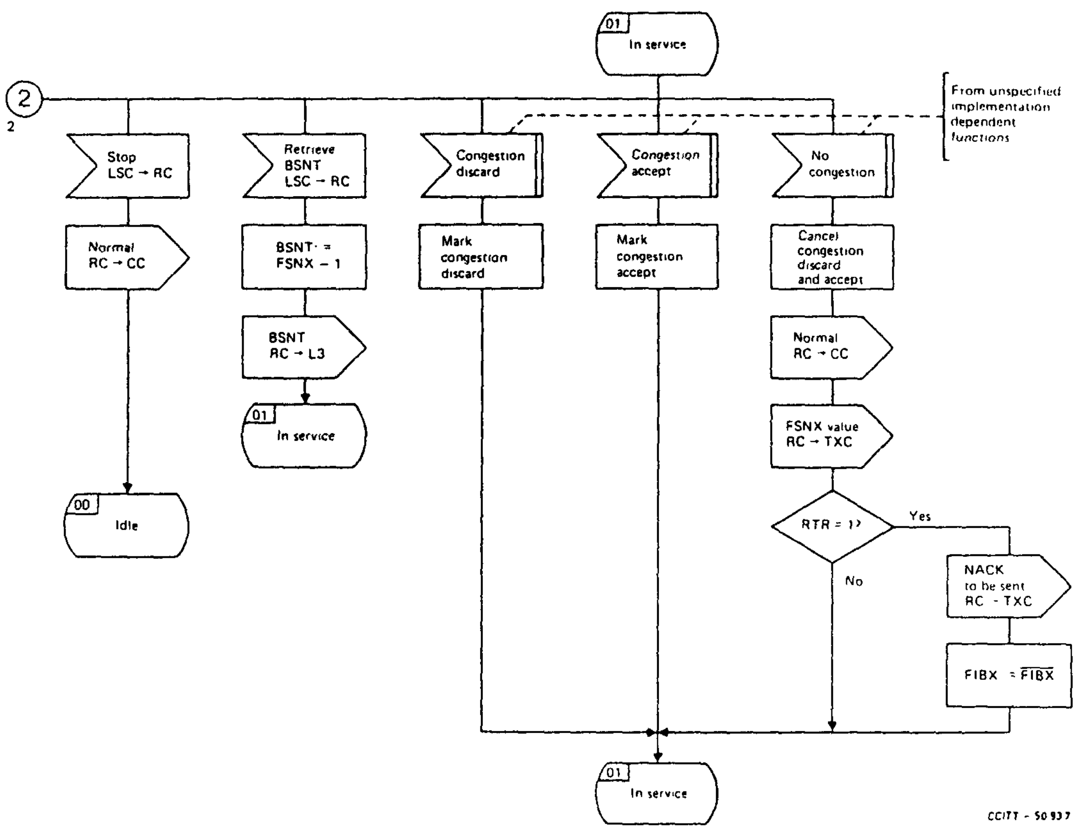


FIGURE 14/Q.703 (Sheet 3 of 4)
Basic reception control



Note – See the abbreviations and timers used in this figure in § 12.2.

FIGURE 14/Q.703 (Sheet 4 of 4)
Basic reception control

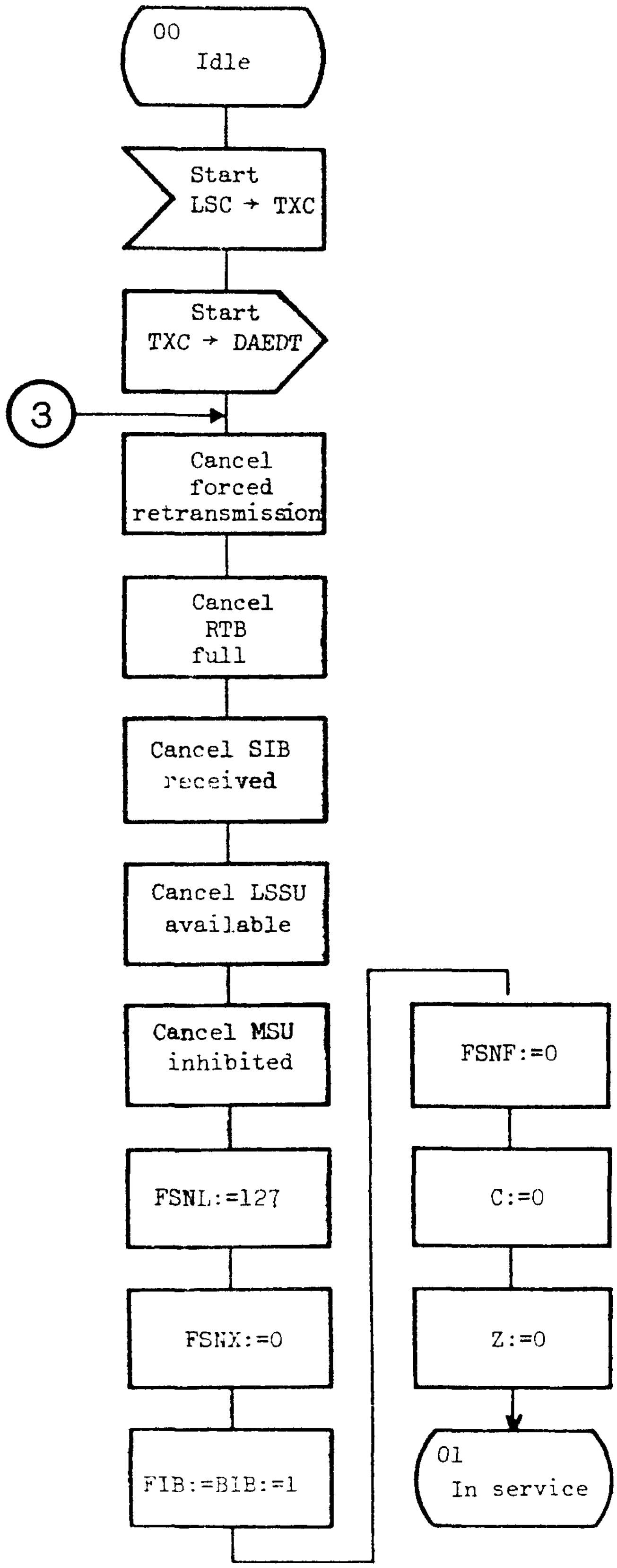
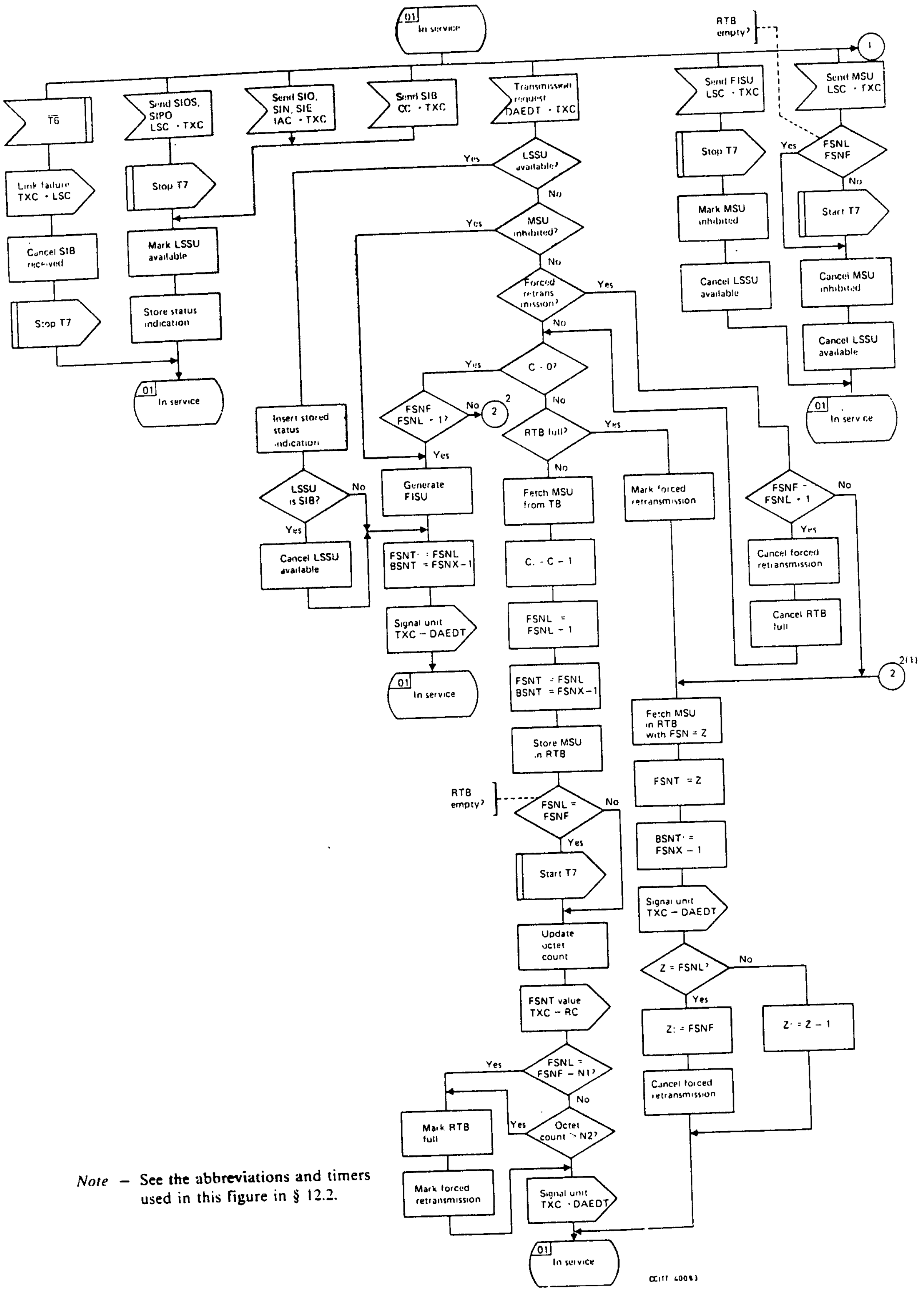
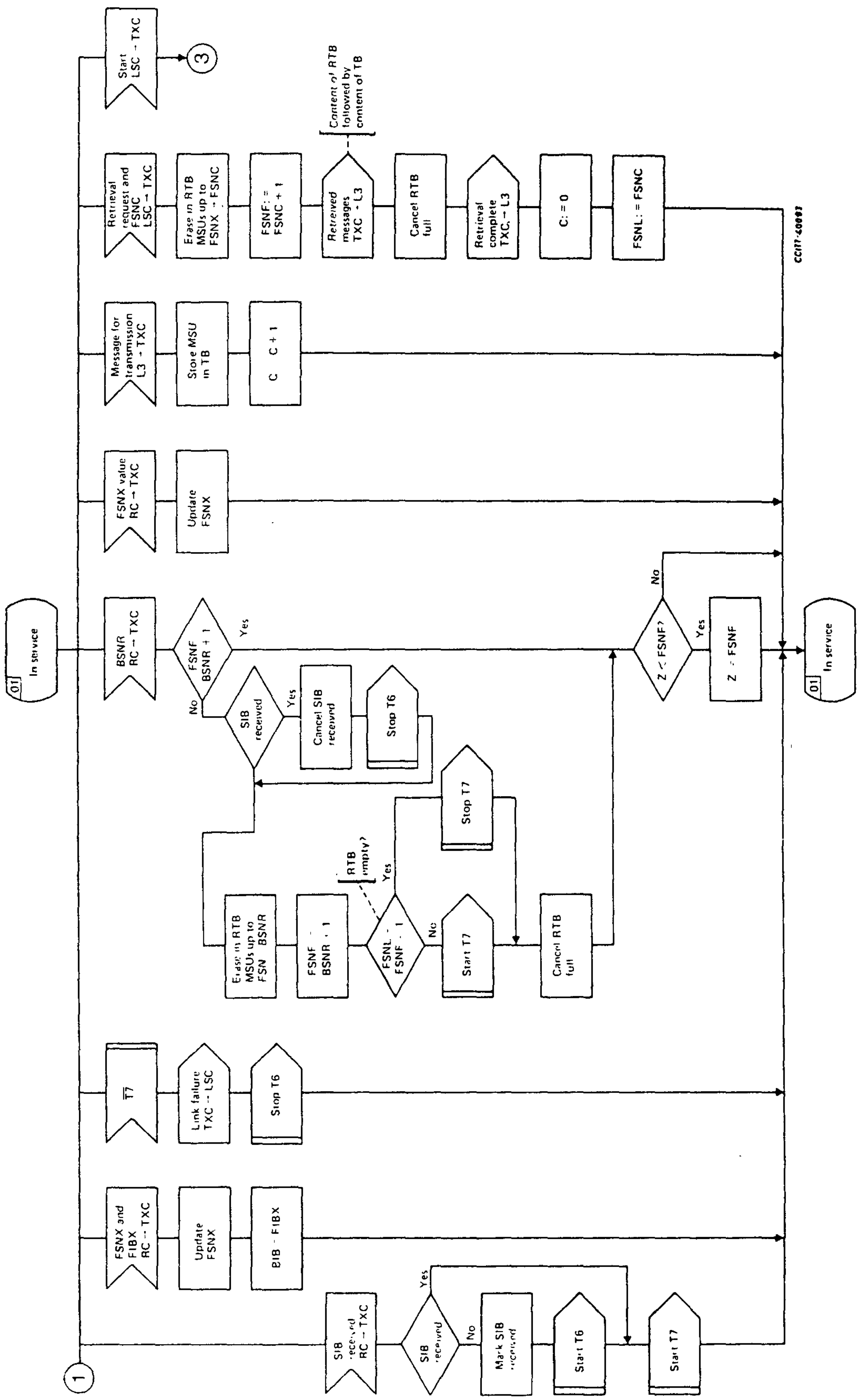


FIGURE 15/Q.703 (Sheet 1 of 3)
Preventive cycle retransmission - transmission control



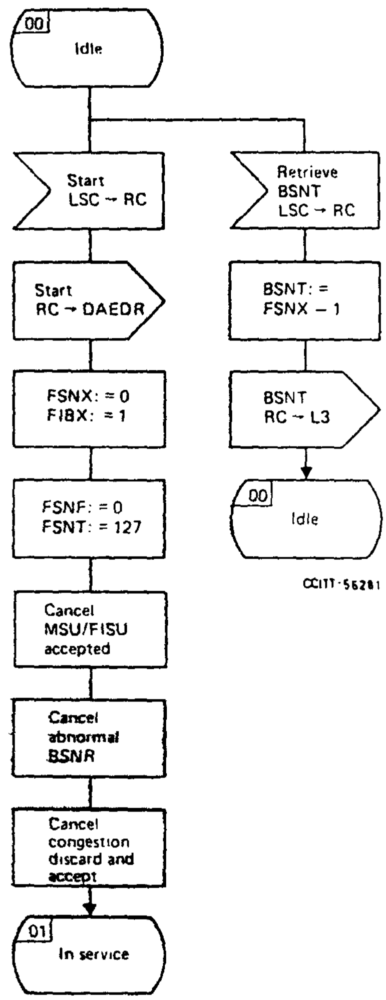
Note – See the abbreviations and timers used in this figure in § 12.2.

FIGURE 15/Q.703 (Sheet 2 of 3)
Preventive cycle retransmission – transmission control



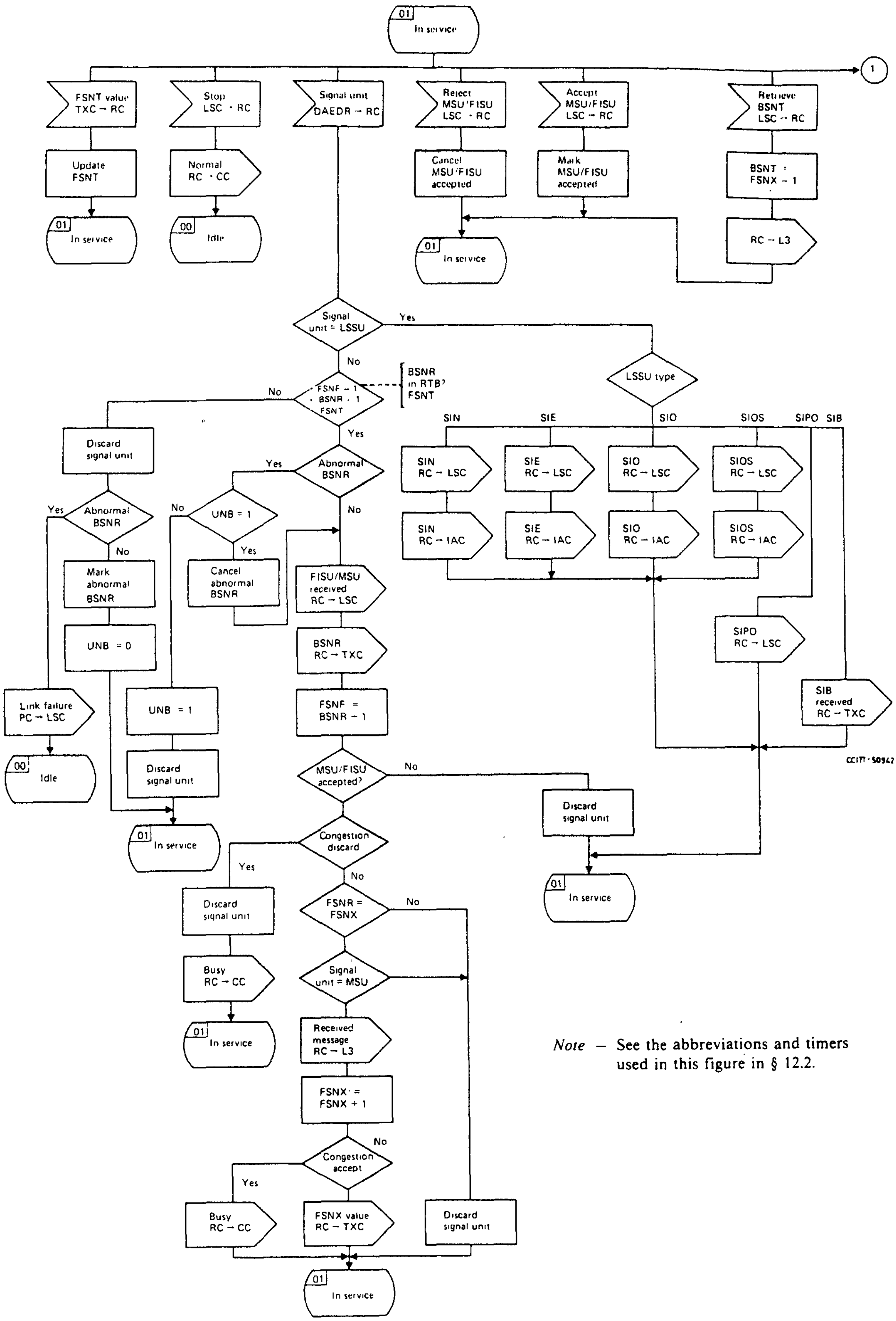
Note — See the abbreviations and timers used in this figure in § 12.2.

FIGURE 15/Q.703 (Sheet 3 of 3)
Preventive cyclic retransmission - transmission control



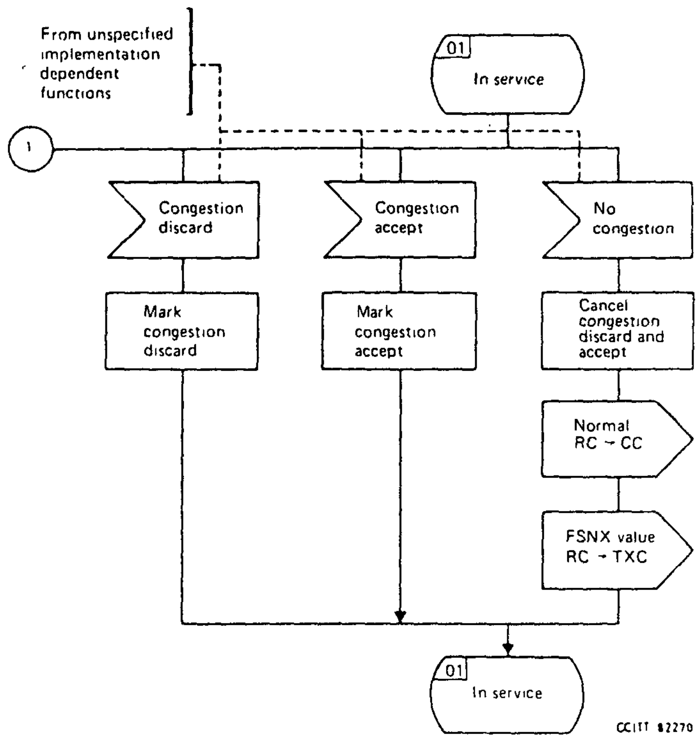
Note – See the abbreviations and timers used in this figure in § 12.2.

FIGURE 16/Q.703 (Sheet 1 of 3)
Preventive cyclic retransmission reception control



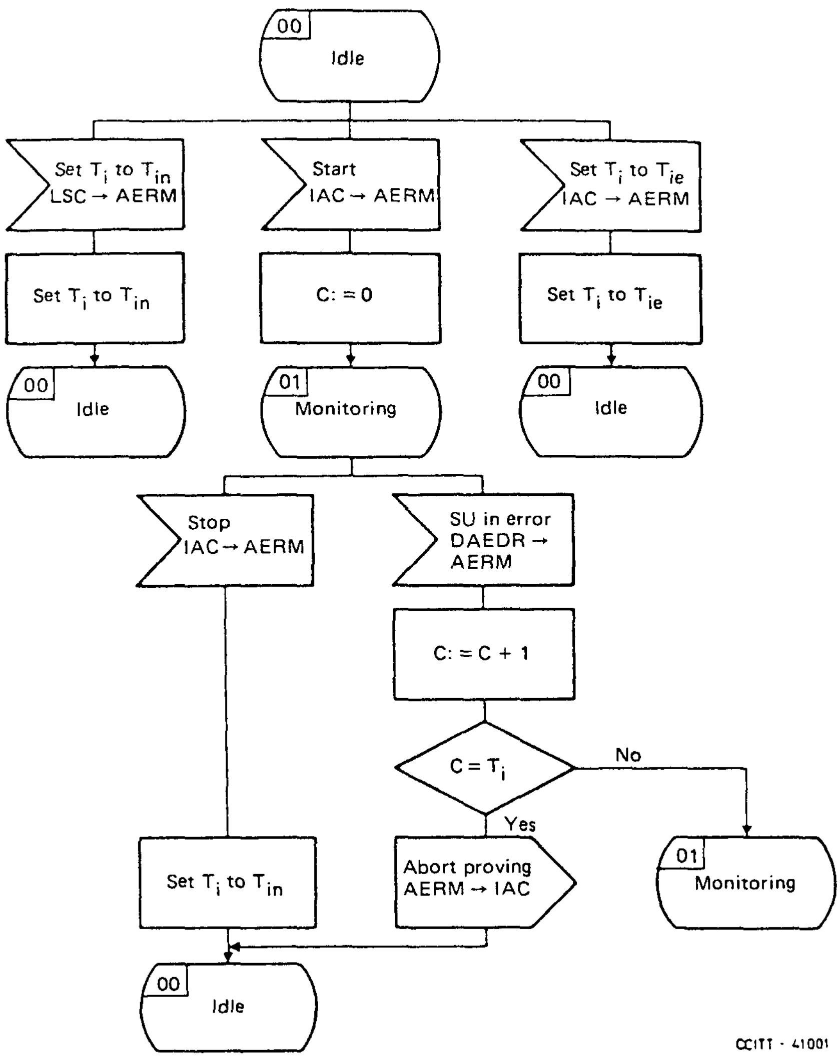
Note – See the abbreviations and timers used in this figure in § 12.2.

FIGURE 16/Q.703 (Sheet 2 of 3)
Preventive cyclic retransmission reception control



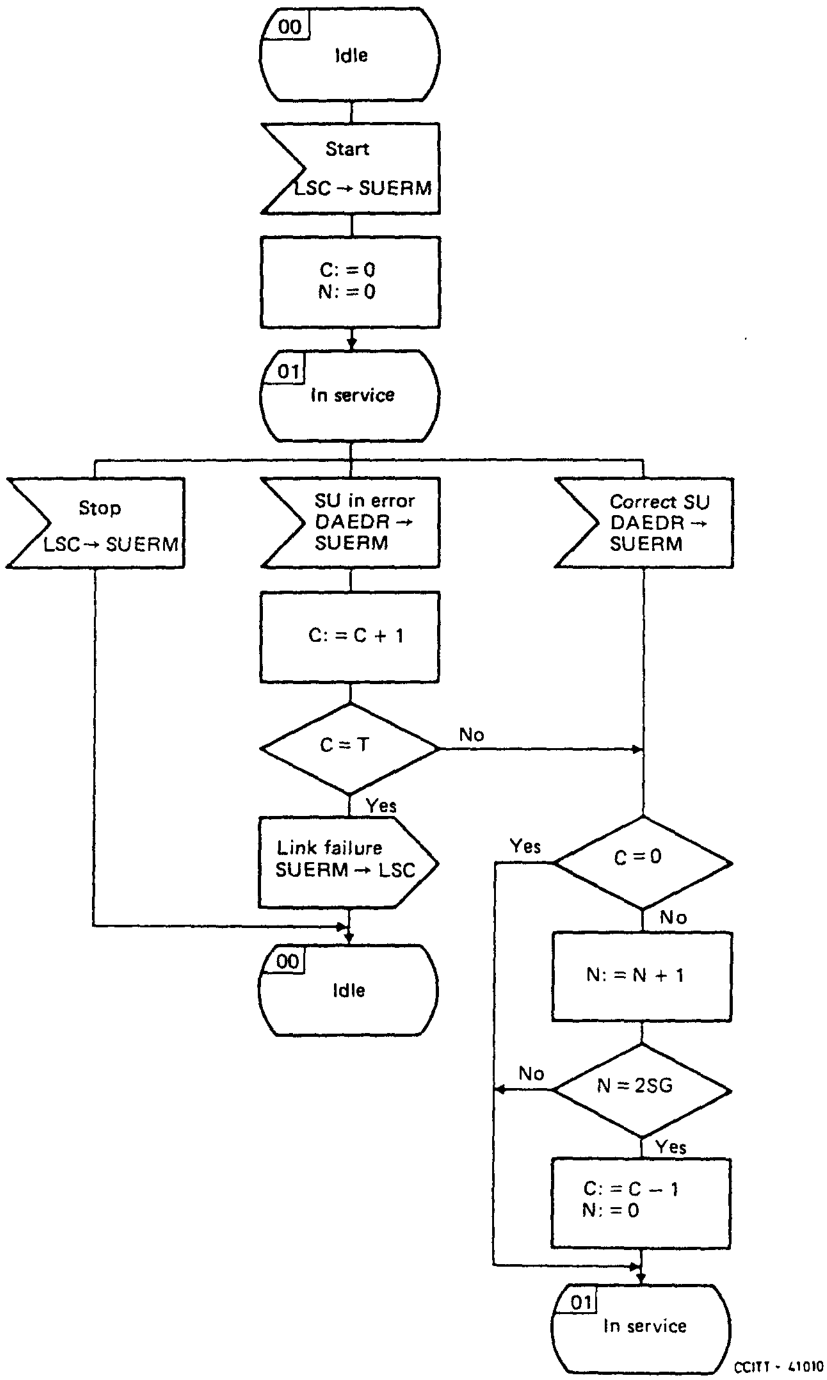
Note – See the abbreviations and timers used in this figure in § 12.2.

FIGURE 16/Q.703 (Sheet 3 of 3)
Preventive cyclic retransmission reception control



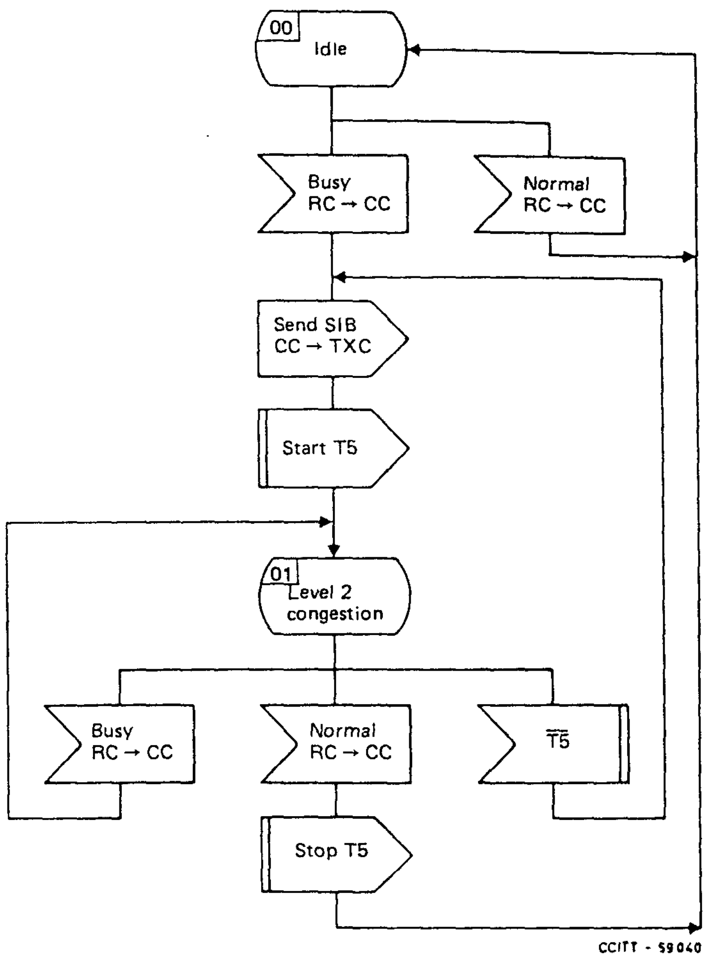
Note – See the abbreviations and timers used in this figure in § 12.2.

FIGURE 17/Q.703
Alignment error rate monitor



Note – See the abbreviations and timers used in this figure in § 12.2.

FIGURE 18/Q.703
Signal unit error rate monitor



Note – See the abbreviations and timers used in this figure in § 12.2.

FIGURE 19/Q.703
Congestion control

Kapitel 4

Zeichengabenetzfunktionen- und nachrichten

Recommendation Q.704

SIGNALLING NETWORK FUNCTIONS AND MESSAGES

Beginn eines Zusatzes in 1 TR 7:

CONTENTS

Die Switchover-Methode wird nicht angewandt, daher ist der Annex A (Signalling link management and signalling traffic management by the switchover method) nicht enthalten.

Annex B: Dimensionierungshilfen für Überlastschwellen im Zeichengabesystem Nr.7.

Ende des Zusatzes in 1 TR 7.

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 ore more intermediate signalling transfer points.

Beginn einer Auslassung vom Rotbuch in 1 TR 7, weil der Inhalt in § 2.1.5 besser ausgedrückt wird:

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.

Ende der Auslassung in 1 TR 7.

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 or not a received message is destined to the point itself. When the signalling point has the transfer capability and a message is not destined to it, that message has to be transferred to the message routing function;

- 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.

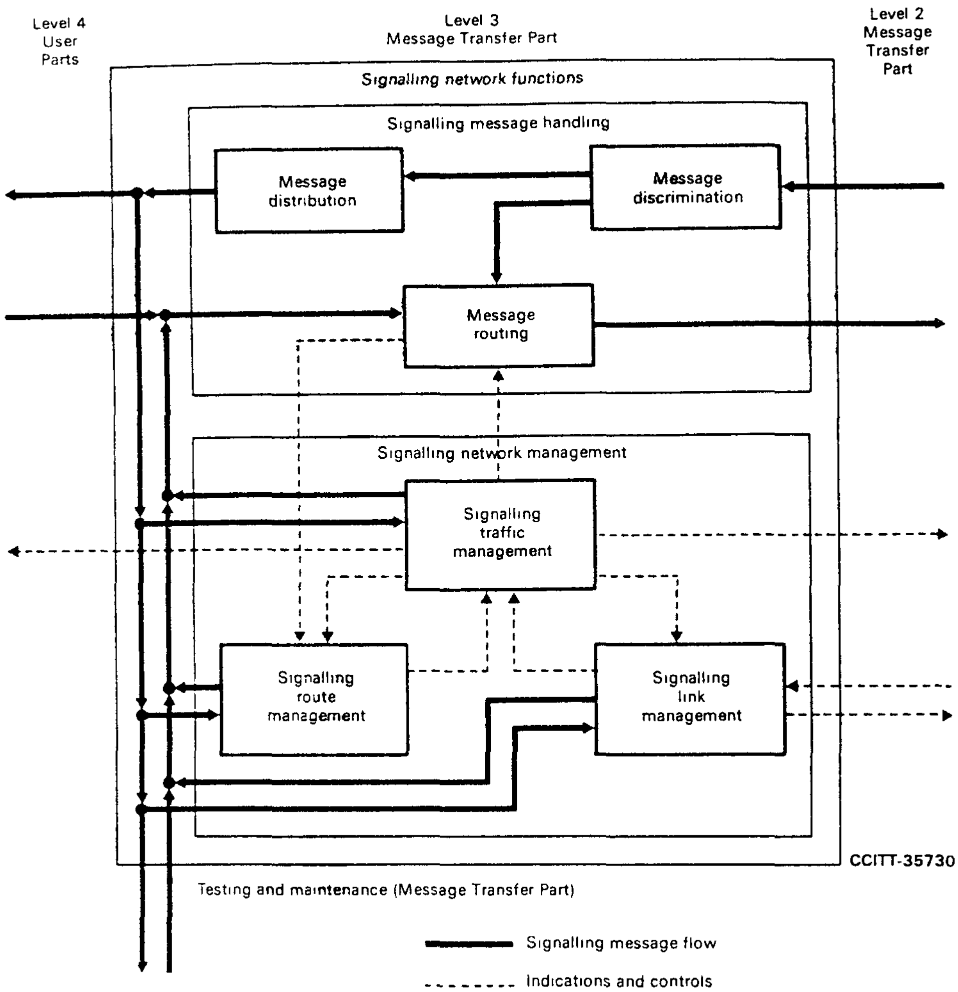


FIGURE 1/Q.704

Signalling network functions

1.3 Signalling network management

Beginn eines Zusatzes in 1 TR 7:

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 of the failures. 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.

In order to restore the required signalling traffic capability between two SP's it may be appropriate to allocate spare data links (not carrying speech traffic) and spare signalling terminals. Spare signalling links (carrying no signalling traffic) are not provided.

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

1.3.1 The purpose of the signalling network management functions is to provide reconfiguration of the signalling network in the case of ailures and to control traffic in case of congestion. Such a reconfiguration is effected by use of appropriate procedures to change to 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.

Ende der Auslassung in 1 TR 7.

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

- signalling traffic management (see § 4),
- signalling link management (see § 10), and
- signalling route management (see § 11).

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 10 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. A signalling link may be made unavailable to User Part generated traffic by means of the management inhibiting procedure described in § 9. 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 § 10.

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 § 11. (Auslassung in 1 TR 7: 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", "transfer-restricted" [1]) "transfer-controlled", "signalling-route-test" and "signalling-route-set congestion-test" [1]) procedures specified in § 12.

[1]) Nationaloption: nicht spezifiziert in 1 TR 7

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 § 13.

1.3.7 Labelling, formatting and coding of the signalling network management messages are specified in § 14.

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 § 15.

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.

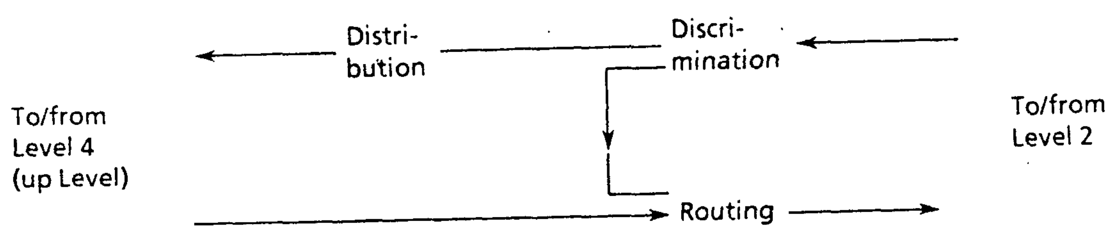


FIGURE 2/Q.704

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.

Beginn eines Zusatzes in 1 TR 7:

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).

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

2.1.3 When a message comes from level 2, the discrimination function is activated, in order to determine whether it is destined to another signalling point. When the signalling point has the transfer capability and the receiving message is not destined to it, the message has to be transmitted on an outgoing link according to the routing function.

Ende der Auslassung in 1 TR 7.

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 (Text in 1 TR 7: network) 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 § 13.2. 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 § 14 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 signalling 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 the information necessary to deliver the message to its destination point.

Beginn eines Zusatzes in 1 TR 7:

The routing label is common to all the services and applications in a given signalling network (national or international).

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

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).

Ende der Auslassung in 1 TR 7.

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.

Beginn eines Zusatzes in 1 TR 7:

National kein modifizierter Label.

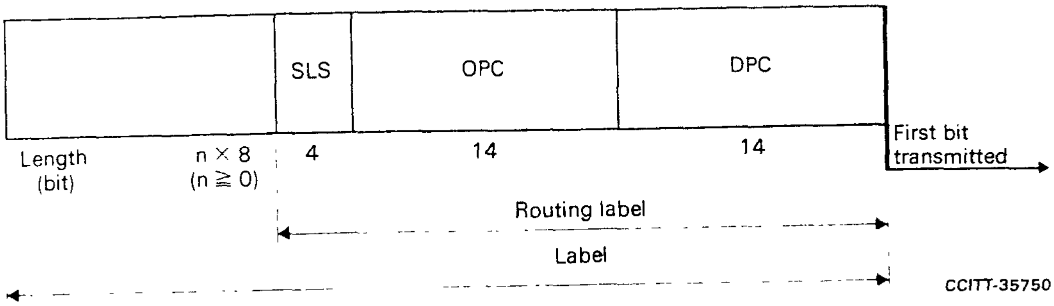
Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

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.

Ende der Auslassung in 1 TR 7.

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.



DPC Destination point code
OPC Originating point code
SLS Signalling link selection

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 (Zusatz in 1 TR 7: aber in sich strukturiert (siehe Q.705)) 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. (Zusatz in 1 TR 7: Das nationale Numerierungsschema ist in Q.705 Kap. 6 wiedergegeben.)

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 (Auslassung in 1 TR 7: of the TUP), 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. (Auslassung in 1 TR 7: In the case of all other User Parts, the SLS is an independent field in accordance with the criteria stated in § 2.2.5).

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.

Beginn einer Auslassung in 1 TR 7:

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

Ende der Auslassung in 1 TR 7.

2.3 Message routing function

Beginn eines Zusatzes in 1 TR 7:

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 network indicator may also need to be used for routing purposes. Only in case of messages concerning MTP level 3 functions, the service indicator may also need to be used for routing purposes.

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

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.

Ende der Auslassung in 1 TR 7.

<u>Note:</u>
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 § 12). 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 (Text in 1 TR 7: network) 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.

Beginn eines Zusatzes in 1 TR 7:

2.3.2 One basic case of load sharing is defined, namely: load sharing between links belonging to the same link set.

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.

Um eine evtl. Schieflast zu begrenzen, wird die Gesamtlast immer in Sechzehntel unterteilt, d.h. alle 4 bits des SLS-Feldes werden unabhängig von der Anzahl der Signalling Links im Link Set zum Load sharing herangezogen.

Die Verteilung des Verkehrs über verschiedene link sets wird auf der Basis des DPC-Codes durchgeführt (routing).

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

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.

A load sharing collection of one or more link sets is called a combined 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.

Ende der Auslassung in 1 TR 7.

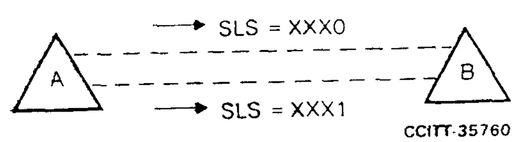


FIGURE 4/Q.704

Example of load sharing within a link set

Beginn einer Auslassung in 1 TR 7:

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.

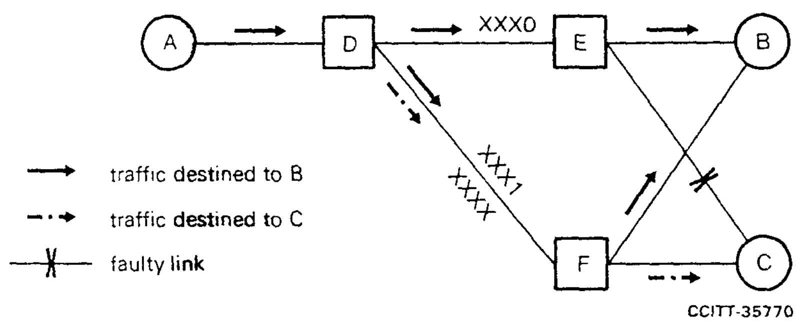


FIGURE 5/Q.704

Example of load sharing between link sets

Ende der Auslassung in 1 TR 7.

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.

2.3.4 Handling of level 3 messages

2.3.4.1 Messages not related to a signalling link have the signalling link code 0000 (e.g., transfer prohibited and transfer allowed). They are handled in accordance with the normal routing function, where the signalling link code (SLC) is used in the same way as SLS for load sharing.

2.3.4.2 Messages related to a signalling link should be subdivided into 2 groups:

a) Messages that are to be transmitted over a specific signalling link (e.g., changeback declaration (see § 6) and signalling link test messages (Recommendation Q.707), where a special routing function must ensure that these messages are transmitted exclusively over a particular signalling link.

b) Messages that must not be transmitted over a specific signalling link (e.g., changeover messages and emergency changeover messages (see § 5), whose transmission over the signalling link defined by the SLC contained in the label must be avoided.

Beginn eines Zusatzes in 1 TR 7:

Anmerkungen:

- Die Codierung der SLC-Codes bedarf der gegenseitigen Vereinbarung zwischen 2 SP's bei der Planung,

- Der SLC-Code ist pro Link Set durchnumeriert. (Es gibt nur 1 Link Set zwischen 2 benachbarten SP's.)

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

2.3.5 Handling of messages under signalling link congestion

2.3.5.1 In the international signalling network, congestion priorities of messages are only assigned and the decision to discard under congestion is only made within each User Part. Message discard will only occur in the MTP should there be an extreme resource limitation (for the MTP there is no congestion priority).

In national signalling networks, each message may be assigned by its generating User Part a congestion priority. This is used by the MTP to determine whether or not a message should be discarded under signalling link congestion. N + 1 levels of congestion priority ($0 \leq N \geq 3$) levels are accommodated in the signalling network, with 0 being the lowest and N the highest.

In national signalling networks using more than one congestion priority, the highest priority is assigned to signalling network management messages.

2.3.5.2 In national signalling networks using multiple congestion priorities

When a signalling link has been selected for transmitting a message, comparison of the congestion priority of the message is made with the congestion status of the selected signalling link (see § 3.6). If the congestion priority is not less than the signalling link congestion status, that message is transmitted using the selected signalling link.

Otherwise, a transfer-controlled message is sent in response as specified in § 12.7. In this case, the disposition of the concerned message is determined according to the following criteria:

i) If the congestion priority of the message is greater than or equal to the signalling link discard status, the message is transmitted.

ii) If the congestion priority of the message is less than the signalling link discard status, the message is discarded.

Ende der Auslassung in 1 TR 7.

2.4 Message discrimination and distribution functions

Beginn einer Auslassung in 1 TR 7:

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.

Ende der Auslassung in 1 TR 7.

The destination point code field of the received messages is examined by the discrimination function in order to determine whether or not they are destined to the receiving signalling point. When the receiving signalling point has the transfer capability and the message is not destined to it, that message has to be 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 § 12.2.

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).

Beginn eines Zusatzes in 1 TR 7:

2.4.3 In the case of a signalling point handling both international and national signalling traffic (e.g. an international gateway exchange) the network indicator is also examined in order to determine the relevant numbering scheme (international or national). Bis jetzt wird keine Notwendigkeit für verschiedene Label-Strukturen gesehen.

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

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 § 13.2).

Ende einer Auslassung

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. The disruption may be in the form of complete loss of a signalling link or signalling point, or in reduced accessibility due to congestion. 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]) or inhibited and it becomes once again available if it is recognized as "restored", "activated" or "unblocked" or uninhibited respectively. A signalling route may be considered by level 3 as "available", "restored" or "unavailable" too. A signalling route set may be "congested" or "uncongested". 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.

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 § 10).

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 § 11):

- 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:

Beginn einer Auslassung in 1 TR 7:

- transfer-controlled procedure (see §§ 12.6, 12.7, 12.8),

Ende der Auslassung in 1 TR 7.

- transfer-prohibited procedure (see § 12.2),
- transfer-allowed procedure (see § 12.3),
- signalling-route-set-test procedure (see § 12.4),

Beginn einer Auslassung in 1 TR 7:

- transfer-restricted procedure (see § 12.5),
- signalling-route-set-congestion test (see § 12.9).

Ende der Auslassung in 1 TR 7.

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.

---

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.

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).

Beginn einer Auslassung in 1 TR 7:

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

Ende der Auslassung in 1 TR 7.

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 funtion (see - § 11);

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 (in service, 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.

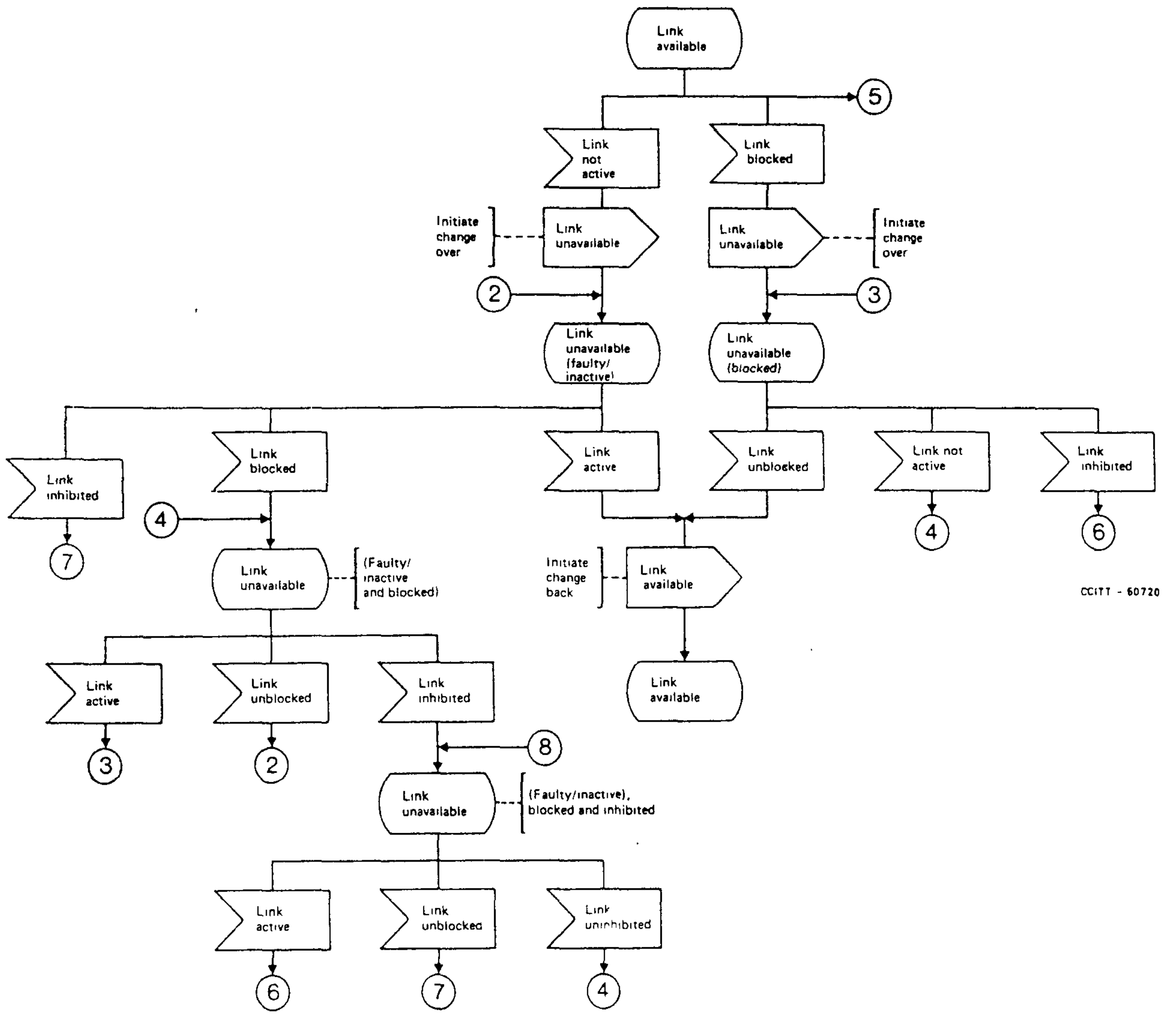
Note
A link becomes unavailable when it is failed or deactivated (Zusatz in 1 TR 7: or blocked) or (failed or deactivated) and blocked) (see Figure - 6/Q.704).

Beginn eines Zusatzes in 1 TR 7:

Link not active signal represents both link failure and link deactivation. Link active signal represents both link restoration and link activation.

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:



Signalling link availability

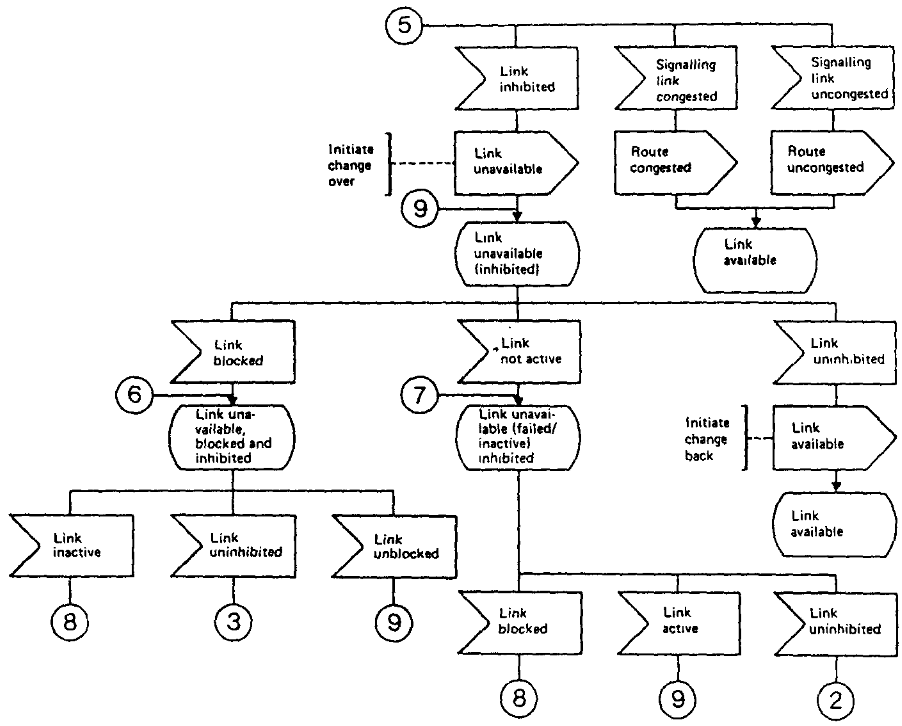
Note:
Link not active signal represents both link failure and link deactivation

Link active signal represents both link restoration and link activation.

FIGURE 6/Q.704 (sheet 1 of 3)

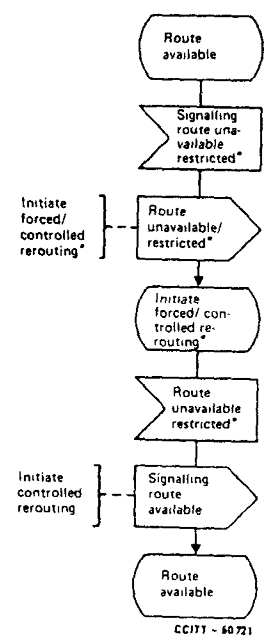
Signalling traffic management overview diagram

Fortsetzung der Auslassung in 1 TR 7:



signalling link availability

Figure 6/Q.704 (sheet 2 of 3)
Signalling traffic management overview diagram

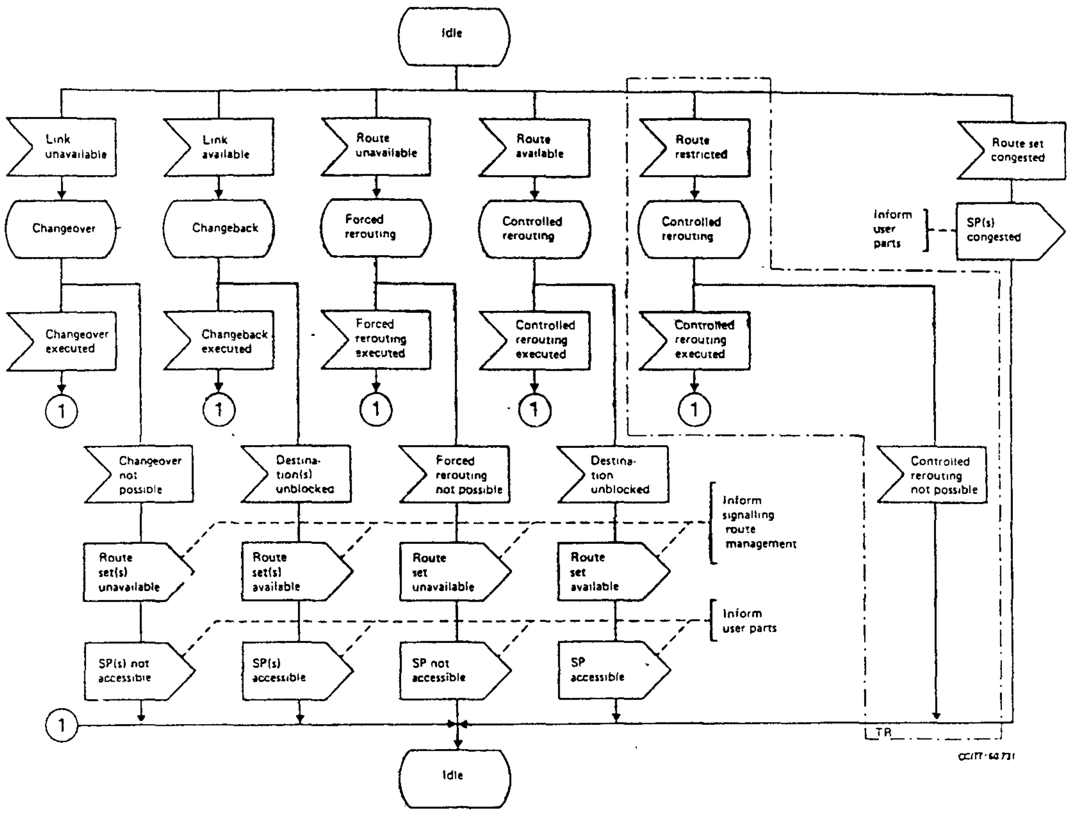


Signalling route availability status

FIGURE 6/Q.704 (sheet 2 of 3)

Signalling traffic management overview diagram

Fortsetzung der Auslassung in 1 TR 7:

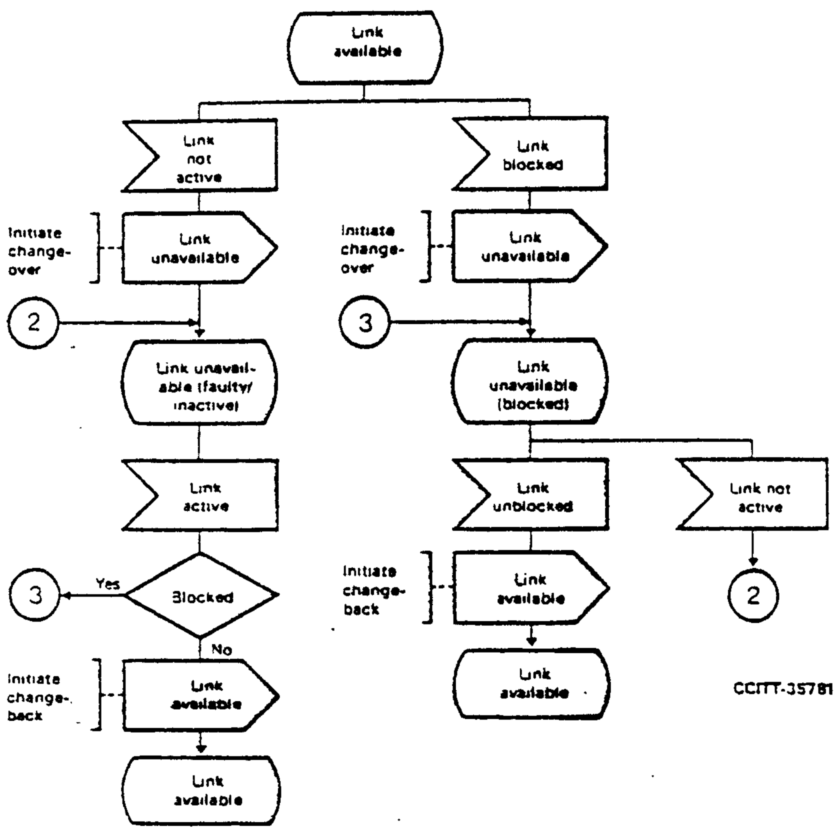


Signalling traffic reconfiguration and flow control

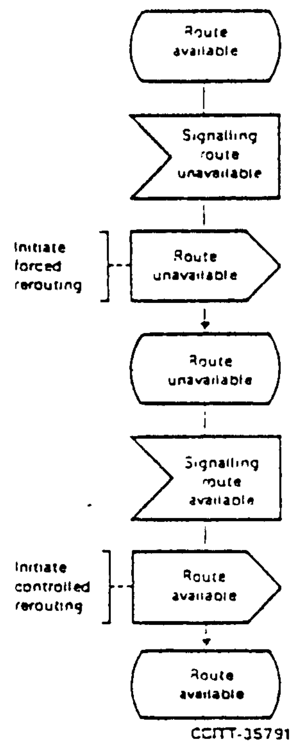
Figure 6/Q.704 (sheet 3 of 3)
Signalling traffic management overview diagram

Ende der Auslassung in 1 TR 7

Beginn eines Zusatzes in 1 TR 7:



a) Signalling link availability

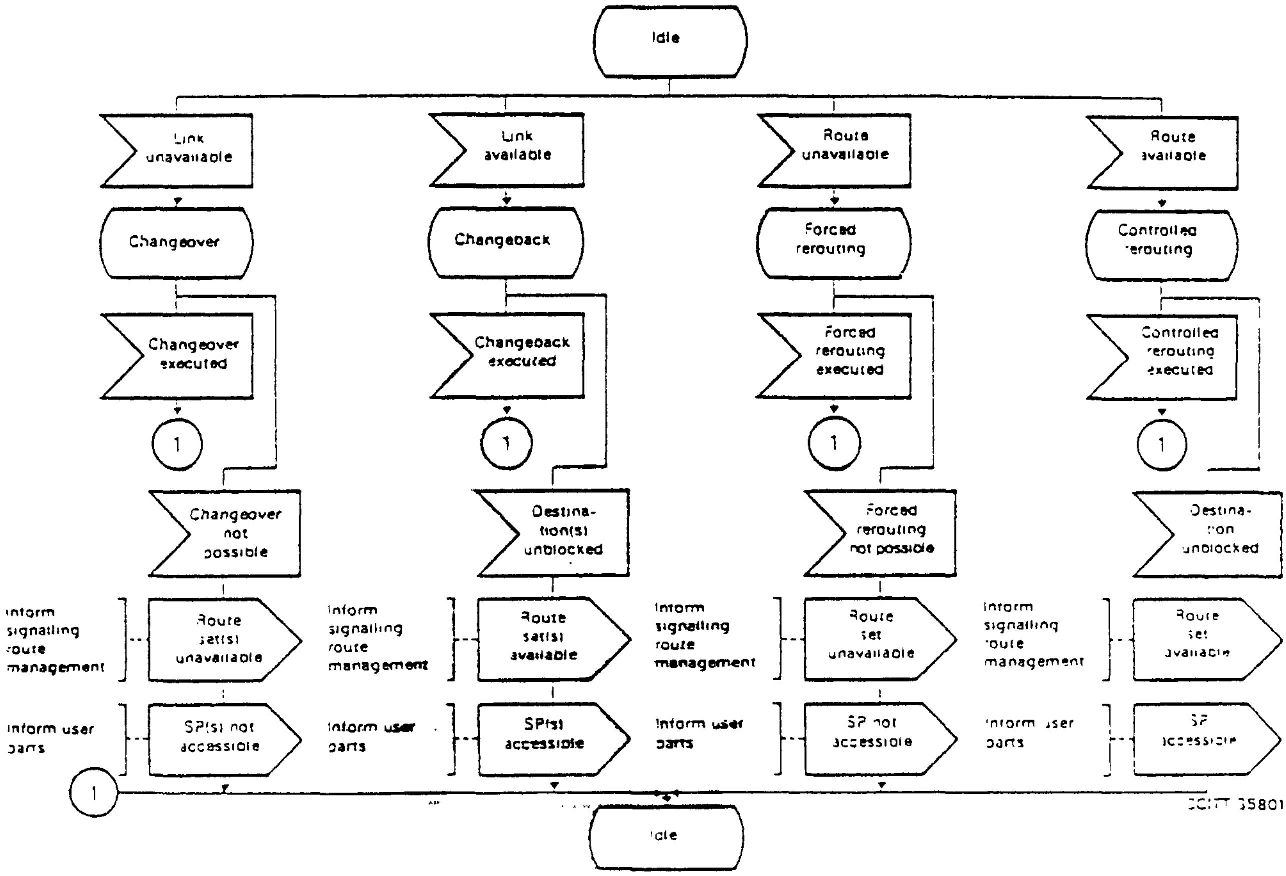


b) Signalling route availability status

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

Signalling traffic management overview diagrams

Fortsetzung des Zusatzes in 1 TR 7:



c) Signalling traffic reconfiguration

FIGURE 6/Q.704 (sheer 2 of 2)
Signalling traffic management overview diagrams

Ende des Zusatzes in 1 TR 7.

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 or unblocked or (restored or activated) and unblocked) (see Figure 6/Q.704).

Beginn einer Auslassung in 1 TR 7:

3.2.8 Signalling link inhibiting

A signalling link is recognized as inhibited when:

a) an acknowledgement is received from a remote signalling point in response to an inhibit request sent to the remote end by the local signalling link management. Level 3 has marked the link locally inhibited;

b) upon receipt of a request from a remote signalling point to inhibit a link and successful determination that no destination will become inaccessible by inhibiting the link, the link has been marked remotely inhibited by level 3.

3.2.9 Signalling link unhibiting

A signalling link previously inhibited is uninhibited when:

a) a request is received to uninhibit the link from a remote end or from a local routing fuction;

b) an acknowledgement is received from a remote signalling point in response to an uninhibit request sent to the remote end by the local signalling link management.

Ende der Auslassung in 1 TR 7.

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.

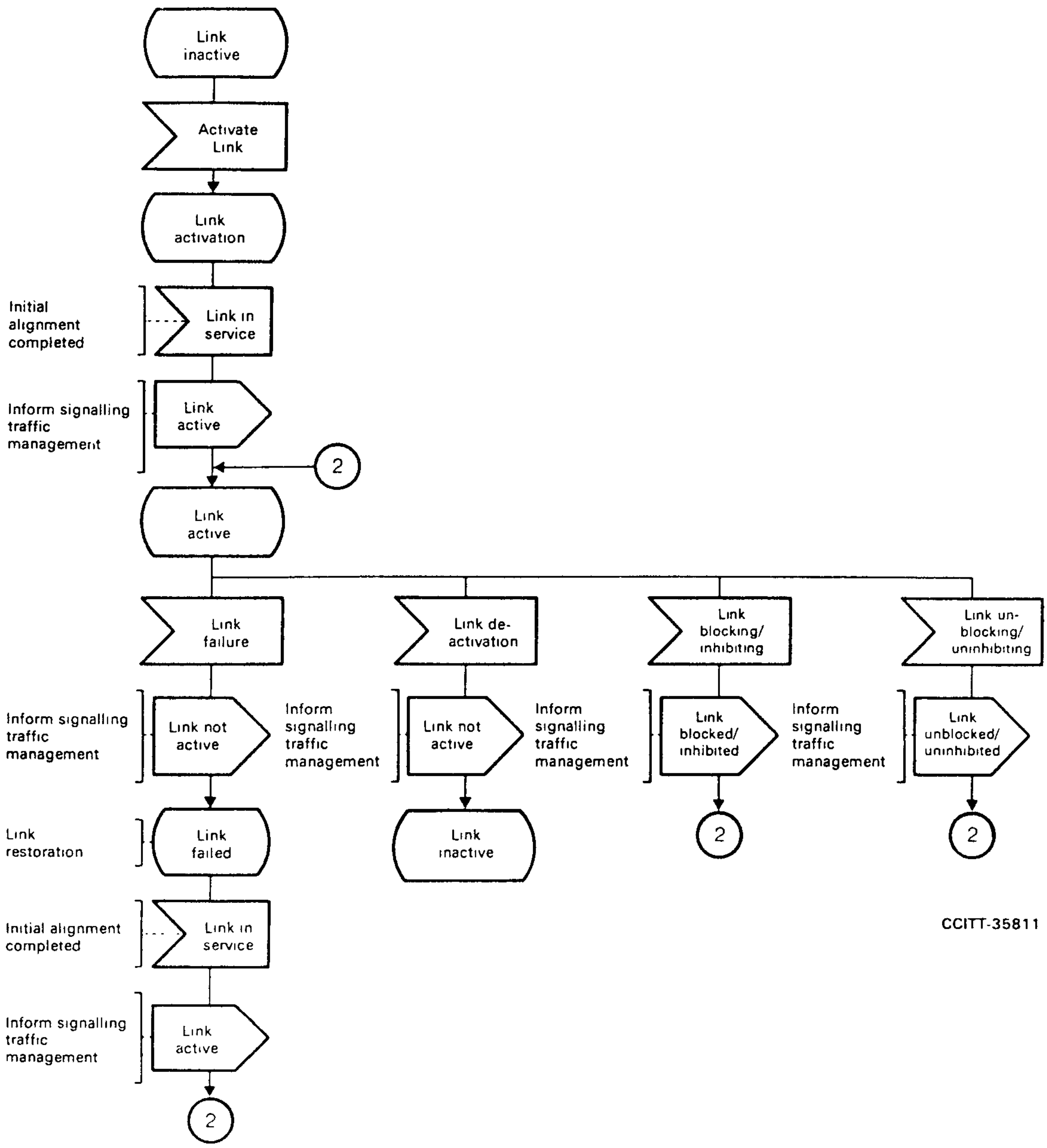


FIGURE 7/Q.704

Signalling link management overview diagram

Auslassung in 1 TR 7:

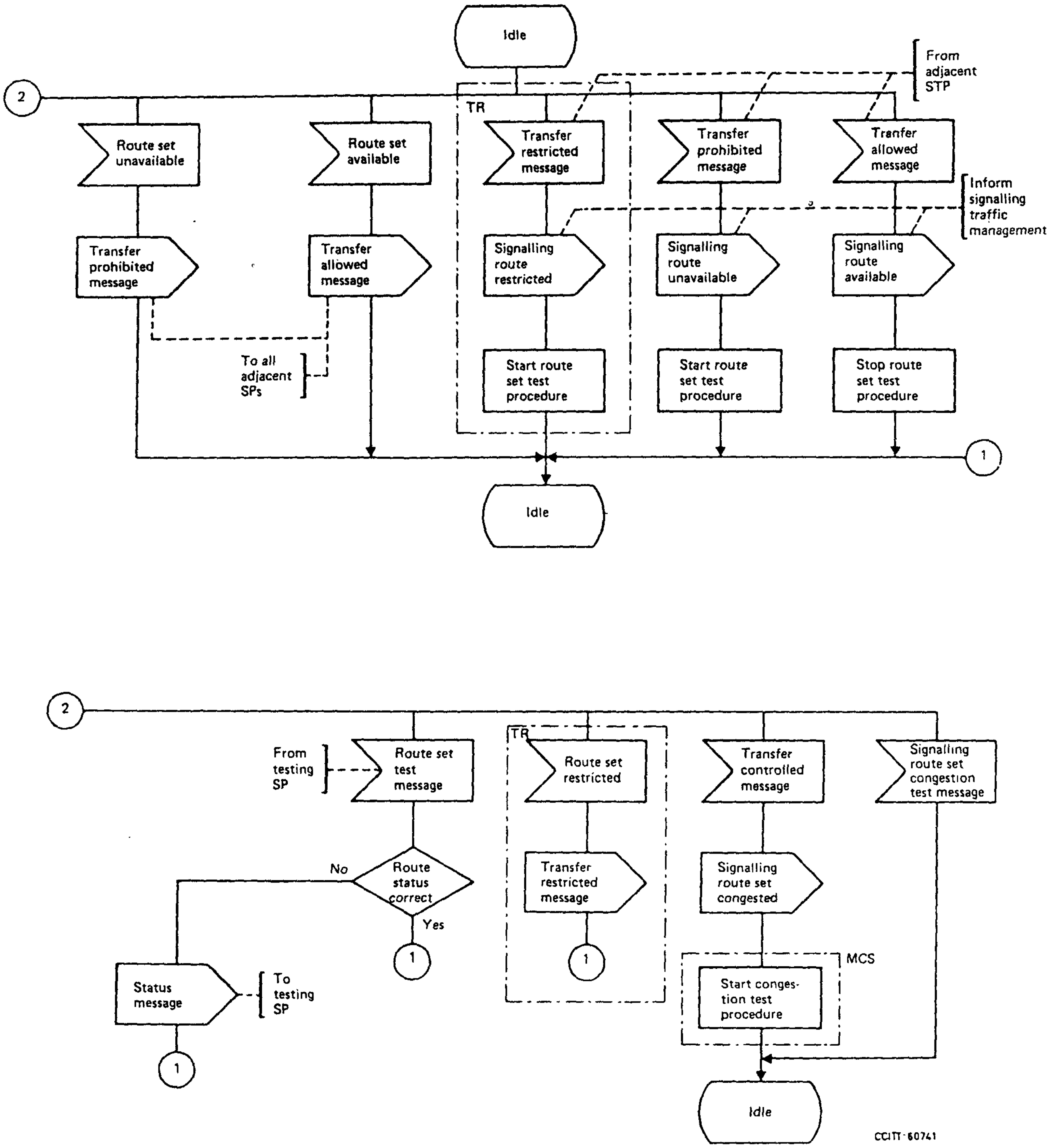


FIGURE 8/Q.704

Signalling route management overview diagram

Zusatz in 1 TR 7:

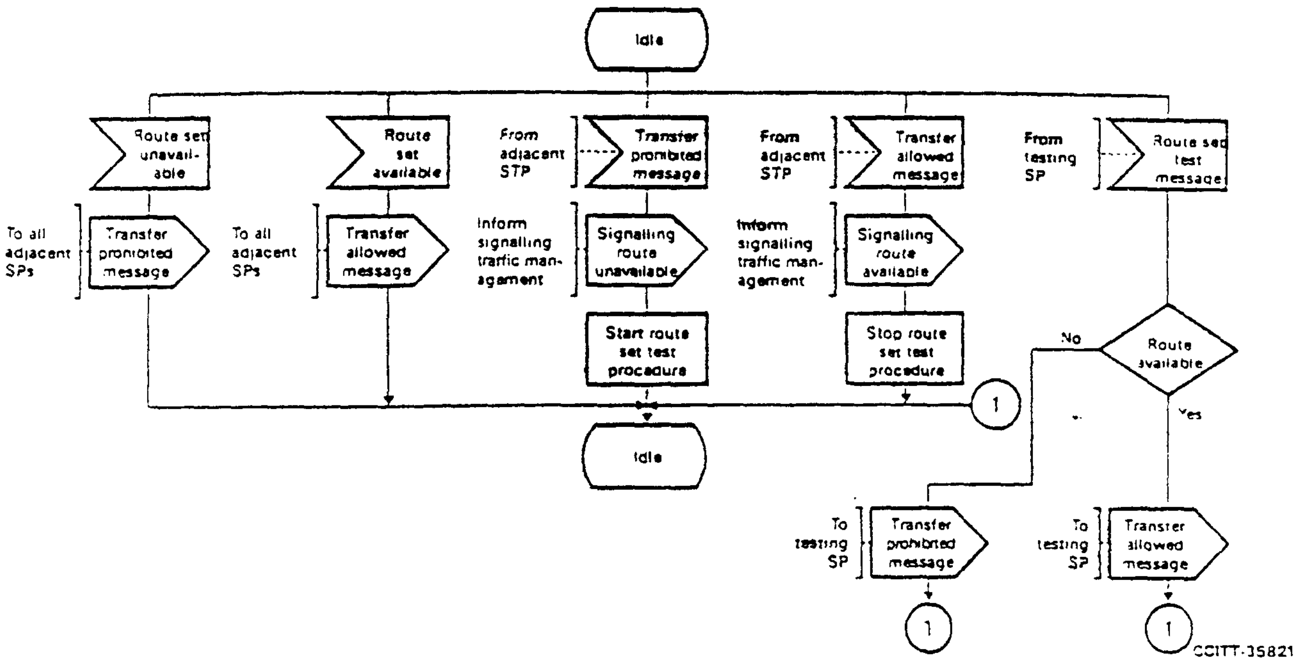


FIGURE 8/Q.704

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 § 11 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 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 or restricted [3]), the signalling transfer point which can no longer route the concerned signalling traffic applies the transfer-prohibited procedures or transfer-restricted [3]) procedures described in § 12.

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 § 11) 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 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 § 12.

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.

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[3]) National option

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 § 11 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 § 11 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 or restricted [4]), the concerned signalling transfer point applies the transfer-prohibited or transfer-restricted [4]) procedures described in § 12.

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 § 12.

[4]) National option

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.

Beginn einer Auslassung in 1 TR 7:

3.3.7 Signalling link inhibited

3.3.7.1 Signalling traffic management: as specified in § 3.1.1.1.

3.3.7.2 Signalling link management: as specified in § 3.3.3.2

3.3.8 Signalling link uninhibited

3.3.8.1 Signalling traffic management: as specified in § 3.3.2.1.

3.3.8.2 Signalling link management: as specified in § 3.3.4.2.

3.3.8.3 Signalling route management: if the link uninhibited 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 § 12.

Ende der Auslassung in 1 TR 7.

3.4 Status of signalling routes

A signalling route can be in three states for signalling traffic having the concerned destination; these are available, restricted [5]), unavailable (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 § 12).

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 § 12).

[5]) National option

Beginn einer Auslassung in 1 TR 7:

3.4.3 Signalling route restricted [5])

A signalling route becomes restricted when a transfer-restricted message, indicating that the signalling traffic towards a particular destination is being transferred with some difficulty via the signalling transfer point sending the concerned message is received (see § 12).

Ende der Auslassung in 1 TR 7.

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 § 12.

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 § 12.

Beginn einer Auslassung in 1 TR 7:

3.5.3 Signalling route restricted [6])

3.5.3.1 Signalling traffic management: the controlled rerouting procedure (see § 8) is applied; it is used to transfer signalling traffic to the concerned destination from the link set belonging to the restricted route, to an alternative link set if one is available to give more, if possible, efficient routing. It includes actions to determine the alternative route.

3.5.3.2 Signalling route management: because of restricted availability of the signalling route, the network routing is, if possible, reconfigured; procedures described in § 12 are used to advise adjacent signalling points.

3.6 Signalling network congestion

3.6.1 General

In § 3.6, criteria for the determination of signalling link congestion status and signalling route set congestion status are specified. The procedures relating to each signalling network management function, which in general are applied in connection with congestion status changes, are listed.

3.6.2 Congestion status of signalling links

3.6.2.1 When predetermined levels of MSU fill in the transmission or retransmission buffer are crossed, an indication is given to level 3 advising of congestion/congestion abatement. The location and setting of the congestion thresholds are considered to be implementation-dependent.

Note
The criterion for setting the congestion thresholds is based on: (1) the proportion of the total (transmit and retransmit) buffer capacity that is occupied, and/or (2) the total number of messages in the transmit and retransmit buffers. (The buffer capacity below the threshold should be sufficient to overcome load peaks due to signalling network management functions and remaining buffer capacity should allow User Parts time to react to congestion indications before message discard occurs.) The monitoring may be performed in different ways depending on the relative sizes of the transmit and retransmit buffers. In the case of a relatively small retransmit buffer, monitoring of the transmit buffer may be sufficient. In the case of a relatively large retransmit buffer, both the transmit buffer and retransmit buffer occupancies need to be monitored.

a) In the international signalling network, one congestion onset and one congestion abatement threshold are provided. The congestion abatement threshold should be placed lower than the congestion onset threshold in order to provide hysteresis during the process of recovering from congestion.

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[6]) National option

Fortsetzung der Auslassung in 1 TR 7:

b) In national signalling networks, with multiple congestion thresholds, N(1 ≤ N ≤ 3) separate thresholds are provided for detecting the onset of congestion. They are called congestion onset thresholds and are numbered 1,. . ., N, respectively. N separate thresholds are provided for monitoring the abatement of congestion. They are called congestion abatement thresholds and are numbered 1, . . ., N, respectively.

Each congestion abatement threshold should be placed lower than the corresponding congestion onset threshold in order to provide hysteresis during the process of recovering from congestion.

In national signalling networks with N > 1, congestion abatement threshold n (n, ..., N) should be placed higher than congestion onset threshold n - 1 so as to allow for a precise determination of signalling link congestion status.

Congestion abatement threshold 1 should be placed higher than the normally engineered buffer occupancy of a signalling link.

Under normal operation, when the signalling link is uncongested, the signalling link congestion status is assigned the zero value.

At the onset of congestion, when the buffer occupancy is increasing, the signalling link congestion status is determined by the highest congestion onset threshold exceeded by the buffer occupancy. That is, if congestion onset threshold if n(n = 1, . . ., N) is the highest congestion onset threshold exceeded by the current buffer occupancy, the current signalling link congestion status is assigned the value n (see Figure 8a/Q.704).

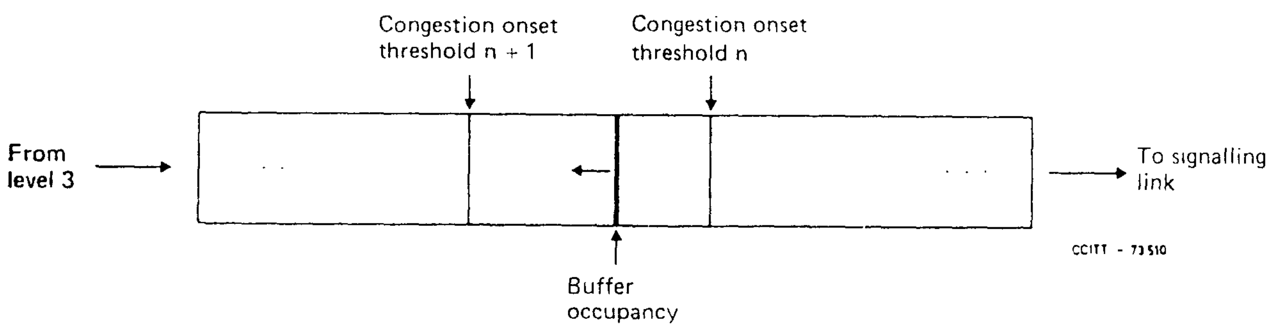


Figure 8a/Q.704
Signalling link congestion status = n (congestion onset)

At the abatement of congestion, when the buffer occupancy is decreasing, the signalling link congestion status is determined by the lowest congestion abatement threshold below which the buffer occupancy has dropped. That is, if congestion abatement threshold n(n = 1, . . ., N) is the lowest congestion abatement threshold below which the current buffer occupancy has dropped, the current signalling link congestion status is assigned the value n - 1 (see Figure 8b/Q.704).

Fortsetzung der Auslassung in 1 TR 7:

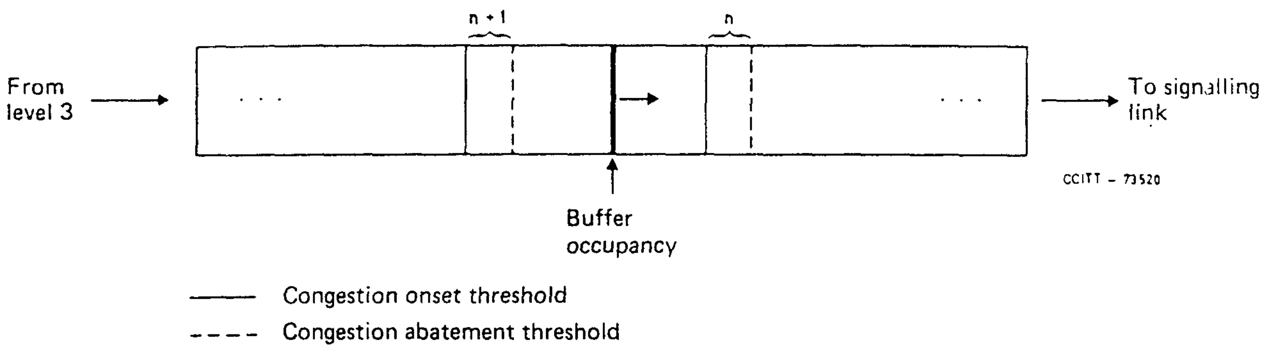


Figure 8b/Q.704
Signalling link congestion status = n (congestion abatement)

The use of the signalling link congestion status is specified in § 2.3.5.2.

3.6.2.2 In national signalling networks with multiple congestion threshold N separate thresholds are provided for determining whether, under congestion conditions, a message should be discarded or transmitted using the signalling link. They are called congestion discard threshold and are numbered 1, . . ., N, respectively.

Congestion discard threshold n(n = 1, . . ., N) is placed higher than congestion onset threshold n in order to minimize message loss under congestion conditions.

Congestion discard threshold n(n = 1, . . ., N - 1) should be placed at or lower than congestion onset threshold n + 1 in order to make congestion control effective.

When the current buffer occupancy does not exceed congestion discard threshold 1, the current signalling link discard status is assigned the zero value.

When the current buffer occupancy exceeds congestion discard threshold n (n = 1, ..., N - 1), but does not exceed congestion discard threshold n + 1, the current signalling link discard status is assigned the value n (see Figure 8c/Q.704).

Fortsetzung der Auslassung in 1 TR 7:

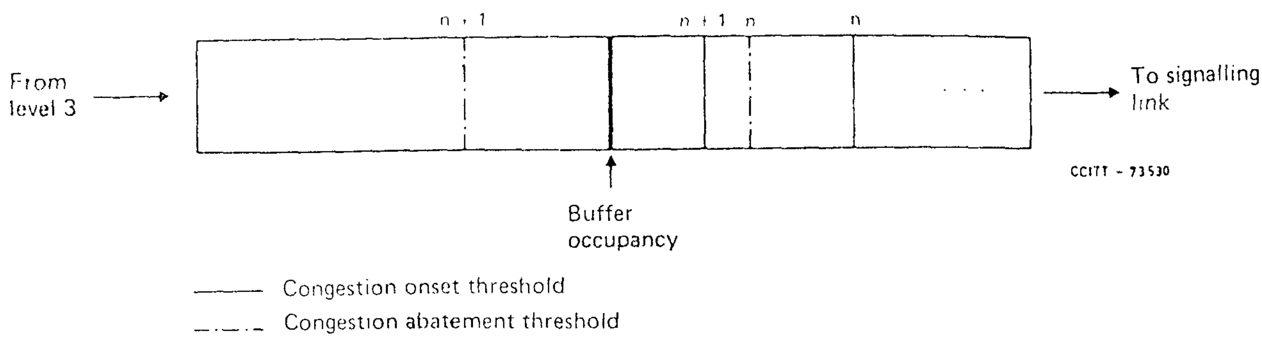


Figure 8c/Q.704
Signalling link discard status = n

When the current buffer occupancy exceeds congestion discard threshold N, the current signalling discard status is assigned the value N.

The use of the signalling link discard status is specified in § 2.3.5.2.

3.6.2.3 In national signalling networks using multiple signalling link congestion states without congestion priority , S + 1(1 $\leq$ S $\leq$ 3) level of signalling link congestion status are accommodated in the signalling network, 0 being the lowest and S the highest.

The signalling link congestion status is determined by a timing mechanism after the buffer occupancy exceeds the congestion onset threshold, or drops below the congestion abatement threshold. Under normal operation, when the signalling link is congested, the signalling link congestion status is assigned the zero value.

At the onset of congestion, when the buffer occupancy exceeds the congestion onset threshold, the first signalling link congestion status is assigned a value s predetermined in the signalling network.

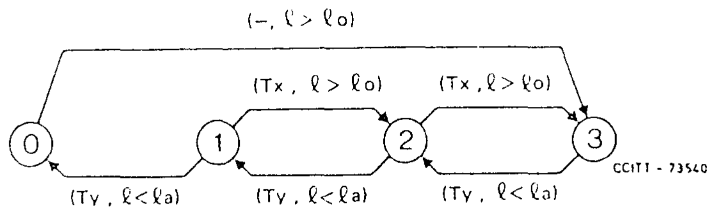
If the signalling link congestion status is set to s (s = 1, . . ., S - 1) and the buffer occupancy continues to be above the congestion onset threshold during Tx, the signalling link congestion status is updated by the new value s + 1.

Fortsetzung der Auslassung in 1 TR 7:

If signalling link congestion status is set to (s = 1, . . .,S) and the buffer occupancy continues to be below the abatement threshold during Ty, the signalling link congestion status is updated by the new value s - 1.

Otherwise, the current signalling link congestion status is maintained (see Figure 8d/Q.704).

The congestion abatement threshold should be placed lower than the congestion onset threshold.



0~3	Congestion status s
ℓ	Buffer occupancy
ℓ o	Congestion onset threshold
ℓ a	Congestion abatement threshold
(,)	Transition condition
Tx	Timing for updating s → s + 1
Ty	Timing for updating s → s − 1
–	Timing is zero

FIGURE 8d/Q.704

An example of signalling link congestion status

(using multiple signalling link congestion states without congestion priority)

3.6.3 Procedure used in connection with link congestion status changes

In § 3.6.3, the procedures relating to each signalling network management function, which in general are applied in connection with link congestion status changes, are listed.

Signalling route management: in the case when the congestion of a signalling link causes a signalling route set to become congested, the transfer-controlled procedure (see §§ 12.6 and 12.7) is used, if required, to notify originating signalling points that they should reduce the concerned signalling traffic towards the affected destination.

3.6.4 Congestion status of signalling route sets

At each originating signalling point, there is associated with each signalling route set a congestion status, which indicates the degree of congestion in the signalling route set.

Fortsetzung der Auslassung in 1 TR 7:

a) In the international signalling network, two states are provided: congested and uncongested.

If a link in a signalling route towards a given destination becomes congested, the congestion status of the signalling route set towards the affected destination is changed to congested.

When a transfer controlled message relating to a given destination is received, the congestion status of the signalling route set towards the affected destination is indicated to the level 4 User Parts in accordance with the transfer-controlled procedure specified in § 12. The congestion status is not retained by level 3 at the receiving signalling point.

b) In national signalling networks with multiple congestion levels [7]) corresponding to the N + 1 levels of signalling link congestion, there are N + 1 values of signalling route set congestion status, with 0 being the lowest and N the highest.

Normally the congestion status of a signalling route set is assigned the zero value, indicating that the signalling route set is uncongested.

If a signalling link in the signalling route set to a given destination becomes congested, the congestion status of the signalling route set is assigned the value of the signalling link congestion status, if it is higher than the current signalling route set congestion status.

When a transfer-controlled message relating to a given destination is received, the congestion status of the signalling route set towards that destination is updated, in accordance with the transfer-controlled procedure as specified in § 12.7.

The congestion status of the signalling route set towards that destination may be decremented in accordance with the signalling-route-set-congestion-test procedure as specified in § 12.9.

c) In national signalling networks using multiple congestion levels [7]) without congestion priority, there are S + 1 values of signalling route set congestion states, with 0 being the lowest and S the highest.

Normally the congestion status of a signalling route set is assigned the zero value, indicating that the signalling route set is uncongested.

If a local signalling link in the signalling route set to a given destination becomes congested, the congested status of the signalling route set is assigned the value of the signalling link congestion status, if it is larger than the current signalling route set congestion status.

When a transfer-controlled message relating to a given destination is received, the congestion status of the signalling route set towards that destination is updated in accordance with the transfer-controlled procedure as specified in § 12.8. The congestion status of the route set towards the congested destination is not retained by level 3 at the receiving signalling point.

[7]) National option

Fortsetzung der Auslassung in 1 TR 7:

3.6.5 Procedure used in connection with route set congestion status changes

In § 3.6.5, the procedures relating to each signalling network management function, which in general are applied in connection with route set congestion status changes, are listed.

3.6.5.1 Signalling traffic management: the signalling traffic flow control procedure (see § 10) is applied; it is used to regulate the input of signalling traffic from User Parts to the concerned signalling route set.

3.6.5.2 Signalling route management: as a national option, the signalling-route-set-congestion-test procedure (see § 12.9) is applied; it is used to update the congestion status of the concerned signalling route set until the congestion status is reduced to the zero value.

Ende der Auslassung in 1 TR 7.

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 or restriction [8]) 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, blocking (Auslassung in 1 TR 7: or inhibiting)): the changeover procedure (see § 5) is used to divert signalling traffic to one or more alternative links (if any);

- signalling link availability (restoration, activation, unblocking (Auslassung in 1 TR 7: or uninhibiting)): 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;

Beginn einer Auslassung in 1 TR 7:

- signalling route restricted [8]): the controlled rerouting procedure (see § 8) is used to divert signalling traffic to an alternative route (if any).

Ende der Auslassung in 1 TR 7.

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[8]) National option

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 4.7.

Beginn eines Zusatzes in 1 TR 7:

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 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 link set. 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 are defined.

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.

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

4.1.3 The signalling traffic flow control procedures are used in the case of congestion, in order to limit signalling traffic at its source. The procedures are specified in § 10.

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 in the international network, two link sets. A load sharing collection of one or more link sets is called a combined link set. 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 (combined link sets) are allocated. An alternative combined link set may consist of one or more (or all) of the remaining available link sets which may carry signalling traffic towards the concerned destination. The possible link sets (combined link sets) appear in a certain priority order. The link set (combined link set) having the highest priority is used whenever it is available. It is defined as the normal link set (combined link set) for traffic to the concerned destination. The link set (combined link set) which is in use at a given time is called the current link set (combined link set). The current link set (combined link set) consists either of the normal link set (combined link set) or of an alternative link set (combined link set).

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 signalling links (but not carrying any signalling traffic at the time) or inactive signalling links, see § 11.

Ende der Auslassung in 1 TR 7.

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:

Beginn einer Auslassung in 1 TR 7:

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

Ende der Auslassung in 1 TR 7.

b) one (Auslassung in 1 TR 7: 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 (combined link sets) in accordance with the alternative routing defined for each destination. For a particular destination, the alternative link set (combined link set) is the link set (combined 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 (Auslassung in 1 TR 7: (combined link set)) to which the available signalling links belongs, does not carry any signalling traffic (i.e. a link set (Auslassung in 1 TR 7: (combined link set)) has become available), the traffic to be transferred is the traffic for which the available link set (Auslassung in 1 TR 7: (combined link set)) has higher priority than the link set (Auslassung in 1 TR 7: (combined link set)) currently used.

The traffic is transferred from one or more link sets (Auslassung in 1 TR 7: (combined 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 currently carried by the unavailable route is transferred to an alternative route by means of forced re-routing procedure. The alternative route (i.e. the alternative link set or link sets) 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.

Beginn einer Auslassung in 1 TR 7:

4.7 Signalling route restriction [9])

When a signalling route becomes restricted (see § 3.4), signalling traffic carried by the restricted route is, if possible, transferred to an alternative route by means of the controlled rerouting procedure, if an equal priority alternative is available and not restricted. The alternative route is determined in accordance with alternative routing defined for the concerned destination (see 3.4.3.3).

Ende der Auslassung in 1 TR 7.

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 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, blocking or inhibiting) of a signalling link, in order to divert the traffic pertaining to that signalling link to one or more alternative signalling links (see § 7.1.2).

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 (see § 5.6): therefore its use should take into account the overall service dependability requirements described in Recommendation Q.706.

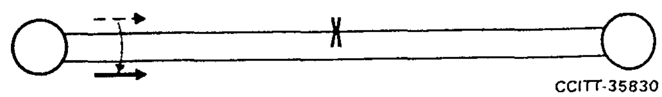

Figure 9/Q.704
Example of changeover to a parallel link

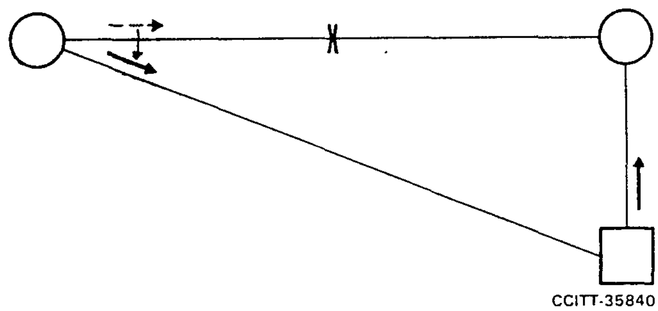

Figure 10/Q.704
Example of changeover to a signalling route passing through the remote signallig point

Unter "remote SP" ist hier immer der SP zu verstehen, der direkt hinter der Unterbrechung liegt.

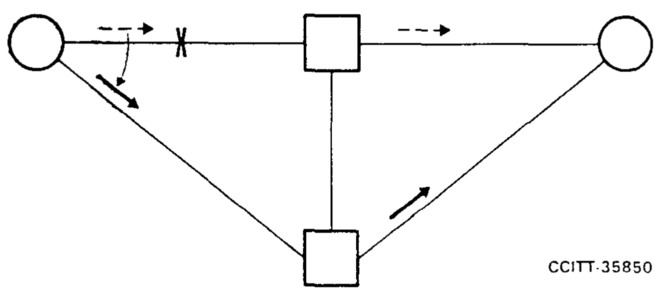

Figure 11/Q.704

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

Unter "remote SP" ist hier immer der SP zu verstehen, der direkt hinter der Unterbrechung liegt.

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 § 12.2.

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 [10]); (diese Fußnote gibt es nicht in der 1 TR 7)

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 § 12.2;

iv) the appropriate signalling link management procedures are performed, as specified in § 11.

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

5.3.4 In some cases of failures or in same 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.

Beginn eines Zusatzes in der 1 TR 7:

5.3.5 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.

5.3.6 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.

Ende des Zusatzes in der 1 TR 7.

5.4 Buffer updating procedure

Beginn einer Auslassung in der 1 TR 7:

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 § 14.

Ende der Auslassung in der 1 TR 7.

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 posssible, 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 (Text in 1 TR 7: §§ 5.3.5 and 5.3.6), 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 § 12.2) 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 changeover messages (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 = 2 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.

Beginn eines Zusatzes in der 1 TR 7:

5.7.6 Für den seltenen Fall, daß viele Changeover-Prozeduren gleichzeitig durchgeführt werden müssen, besteht die Gefahr eines nicht beherrschbaren Nachrichtenstaus. Daher kann in diesem Fall eine Ersatzschaltung ohne Retrieval und ohne Austausch von Changeover-Order und -acknowledgement sowie ohne zeitliche Verzögerung durchgeführt werden.

Ende des Zusatzes in 1 TR 7.

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 uninhibited 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.

Note:
The term "alternative signalling link(s)" refers to signalling link(s) terminating in the signalling point at which changeback is initiated (see also § 4).

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 occurence 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 occurence of changeover (see § 5.3.1); in this case a transfer-allowed procedure is performed, as specified in § 12.3.

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 § 12.2.

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 § 12.3.

Beginn einer Auslassung in 1 TR 7:

However, in national networks, when the recovered link is not on the normal route for that destination, the transfer-restricted [11]) procedure may be performed as specified in § 12.5.

6.2.4 In the case that the signalling link made available is used to carry signalling traffic towards a destination which was previously declared restricted, the following actions apply:

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

ii) when the recovered link is on the normal route for that destination, the status of the route is changed to available; otherwise, the status of the route remains unchanged.

Ende der Auslassung in 1 TR 7.

6.2.5 If the signalling point at the far end of the link made available currently is inaccessible, from 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 ore 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.

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[11]) National option

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 § 14.

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.

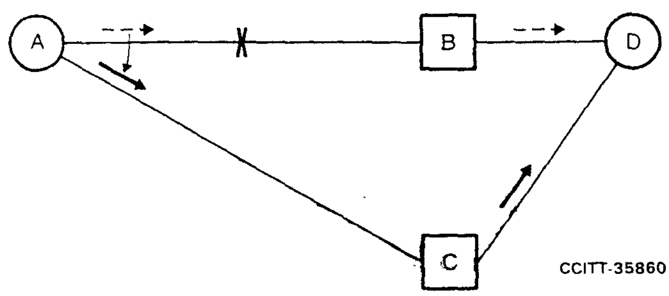

FIGURE 12/Q.704

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 re-opens 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 T 5 = 1 s (provisional value) is started. If no changeback acknowledgement is received before the expiry of T 5, 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.

Beginn eines Zusatzes in 1 TR 7:

Die folgende Tabelle erläutert die Ursachen für und die Auswirkung von der Forced rerouting Prozedur und der Changeover-Prozedur.

Ursache	Indikation	Aktion	Ergebnis im Netz
Ausfall einer eigenen Signalling link	Level 2 oder Changeover message	Changeover	Last bleibt im signalling link set
			Last wird komplett *) auf eine andere Route verlagert
Ausfall einer fernen Signalling link	Level 3 durch Transfer prohibited message	Forced rerouting	Last wird auf eine andere Route verlagert

*) eine partielle Lastverlagerung wird ausgeschlossen

Ende des Zusatzes in 1 TR 7.

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:

Beginn eines Zusatzes in 1 TR 7:

A) Für alle SP im Eigenbereich:

Ende des Zusatzes in 1 TR 7.

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 § 12.2.2).

Beginn eines Zusatzes in 1 TR 7:

B) Für alle SP im Fremdbereich erfolgen keine Aktivitäten.

Ende des Zusatzes in 1 TR 7.

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).

Beginn eines Zusatzes in 1 TR 7:

Die controlled rerouting Prozedur wird immer durchgeführt, wenn ein Zeichengabeweg mit höherer Priorität verfügbar wird (vgl. Kap. 5, Abschnitt 6.9).

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 routes) and this is not interrupted by the controlled rerouting procedure.

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

8.1.2 Controlled rerouting is the basic procedure to be used in the following two cases:

a) when 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;

b) when a transfer-restricted [12]) message is received, after signalling traffic management has decided that alternative routing is appropriate (e.g. because it would be more efficient than routing via the link set over which the transfer-restricted message was received).

Signalling links pertaining to the alternative signalling route can be carrying their own signalling traffic (relating to different routes) and this is not interrupted by the controlled re-routing procedure.

Ende der Auslassung in 1 TR 7.

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 ; (Auslassung in 1 TR 7: also when a transfer-restricted message [13]) is received.)

The following actions are then performed:

a) transmission of signalling traffic towards the concerned destination on the link set belonging to the alternative route (Auslassung in 1 TR 7: or the route over which the transfer-restricted [13]) message was received) 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 massage is sent on the route made available (Auslassung in 1 TR 7: or the alternative route in the case of reception of transfer-restricted [13]) message, if the alternative route was not previously used), and a transfer-allowed message on the alternative one (Auslassung in 1 TR 7: or on the restricted route in the case of the recepting of a transfer-restricted [13]) message (see §§ 12.2.2 and 12.3.2, respectively));

c) at the expiry of T6, the concerned signalling traffic is restarted on an outgoing link set belonging to the signalling route made available,

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[12]) National option
[13]) National option

(Auslassung in 1 TR 7: or the alternative route in the case of reception of the transfer-restricted [13]) message) 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 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 (Auslassung in 1 TR 7: or restricted [13])), when the route is made available, then the destination is declared accessible and the actions specified in §§ 6.2.3 and 6.2.4 apply (if appropriate).

Beginn eines Zusatzes in 1 TR 7:

9 Signalling Traffic Flow Control

9.1 Allgemeines

Die Überlast-Abwehrfunktionen dienen zur Begrenzung des Zeichengabeverkehrs an seinem Entstehungsort. Dies gilt für den Fall, daß das Zeichengabenetz aufgrund von Ausfällen oder Überlast nicht mehr sämtlichen Zeichengabeverkehr bewältigen kann, der durch die User Parts erzeugt wird. Eine zu knappe Dimensionierung des Zeichengabenetzes darf nicht auf Dauer durch Überlast-Abwehr ausgeglichen werden.

9.2 Übersicht über die Prozeduren

Die Überlast-Abwehr erstreckt sich über die Level 2, 3 und 4.

Level 2:
Sobald die Empfangsseite eines ZZK's Überlast erkennt, veranlaßt sie folgende Abwehrreaktionen:

- empfangene Messages werden nicht mehr quittiert.
- Busy-LSSU's werden in zyklischer Folge gesendet.

Die BUSY-Information wird weder von der Sende- noch von der Empfangsseite im Level 3 zu Überlast-Abwehrzwecken benutzt. Der Erkennungsmechanismus für die Überlast auf der Empfangsseite des Level 2 ist implementierungsabhängig und ist daher nicht spezifiert.

Level 3:
Die Füllung des Puffer-Raums im sendenden Level 2 wird überwacht. Die Überwachung erfolgt über einen Schwellwert, der zwischen Füllung und Leerung der Speicher eine Hysterese aufweist. Die Lage des Schwellwerts und die Größe des Puffers sind abhängig von:

- der im Mittel belegten Speicherkapazität bei 0,4 Erl. Nutz-Zeichenverkehr (MSU).

- der Anzahl der im Durchschnitt gespeicherten Messages.

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[13]) National option

- Überbrückung der Reaktionszeit bis zum Greifen der Überlast-Abwehr.

- Spitzen bei Lastumschaltung und Lastübernahme (Changeover und Rerouting).

Zu den Signalling Points, die aus den OPC's der von der Überlast betroffenen Zeichen erkennbar sind, werden auf Stichproben-Basis "Transfer Controlled Messages" gesendet, und zwar solange der Überlast-Zustand andauert. Diese Messages werden nicht quittiert. Der Level 3 in diesen die Überlast verursachenden Signalling Points informiert alle seine User Parts (Level 4) mit sog. "Congestion Primitives".

Level 4:
Jeder User Part reduziert bei Erhalt der Congestion Primitives individuell die von ihm erzeugte Verkehrslast stufenweise.

Diese Reduzierung bezieht sich nur auf Neubelegungen. Erhält der Level 4 keine Congestion Primitives mehr, so interpretiert er das als Ende der Überlast-Phase und die User Parts fahren ihre Verkehrslast individuell und stufenweise wieder hoch.

9.3 Aufteilung der Detail-Beschreibungen

Entsprechend der Aufteilung dieser Spezifikation sollen hier im Detail nur die Abwehrfunktionen im Level 3 erläutert werden. Im übrigen wird auf die Kapitel verwiesen, in welchen die entsprechenden Funktionen der anderen Levels beschrieben sind:

Level 2	Kapitel 3
TF	Teil 3, Abschnitt 5.1
TUP	Teil 4, Kapitel 6
ISDN UP	Teil 5, Abschnitt 6.1

9.4 Überlast-Abwehr im Level 3:

9.4.1 Schwellwerte in Senderichtung

Die Überwachung mit Schwellwerten ist implementierungsabhängig. Im Fall eines relativ kleinen Retransmission Buffers kann die Überwachung des Transmission Buffers ausreichend sein. Im Falle eines relativ großen Retransmisson Buffers müssen sowohl der Transmission Buffer als auch der Retransmission Buffer überwacht werden. Die Aussagen der beiden Einzelschwellwerte werden dann logisch zu einer Gesamtaussage verknüpft. Die Gesamtaussage muß eine ordnungsgemäße Abwicklung von 0,4 Erl. Nutzzeichenverkehr erlauben.

Eine gewisse Orientierungshilfe zur Festlegung der Überlastschwellen ist im Annex gegeben.

9.4.2 Lastumschaltung und Lastübernahme

Im Falle einer Lastumschaltung oder Lastübernahme können vorübergehend erhöhte Zeichenstaus auftreten. In der Regel sollen diese Staus nicht zu Überlast-Abwehrmaßnahmen führen.

9.4.3 Überlauf des Transmission Buffers

In extremen Überlastsituationen, evtl. verknüpft mit Lastumschaltung oder Lastübernahme, kann der Transmission Buffer überlaufen, d.h. es gehen Nachrichten verloren. Diese Tatsache wird erfaßt, vgl. Kap. 2.8, § 3.10.

9.4.4 Überlast des Level 3 in Empfangsrichtung

Der Erkennungsmechanismus für die Überlast auf der Empfangsseite des Level 3 ist implementierungsabhängig und ist daher nicht spezifiziert.

Um länger andauernde überhöhte Zeitverzögerungen für Nachrichten infolge Überlast des Level 3 und Rückstaus von der Empfangsrichtung auf das ferne sendende Ende des Level 2 zu vermeiden, werden auch in diesem Fall "Transfer Controlled Messages" erzeugt.

9.4.5 "Transfer Controlled Message"-Prozedur

Um die zusätzliche Steuerungslast möglichst klein zu halten, soll die Erzeugung der "Transfer Controlled Messages" auf einer "Sample"-Basis erfolgen. Das heißt, nicht jede Nachricht, die für den überlasteten Bereich eintrifft *), erzeugt eine Transfer Controlled Message zu ihrem Originating Point, sondern nur jede n-te (vorläufig n = 8). Eine Buchführung über die benachrichtigten OPC's ist nicht vorgesehen.

Bei der Stichprobennahme muß berücksichtigt werden, daß nur MSUs mit der Service Indicator ungleich 0 oder 1 zur TFC-Nachrichtenbildung verwendet werden dürfen.

Empfängt ein Level 3 eine Transfer Controlled Message, so gibt er Congestion Indication Primitives an alle bei ihm angeschlosenen Anwender. Bei Empfang von Congestion Indication Primitives verringert ein Anwenderteil die von ihm zu dem angezeigten Destination Point erzeugte Last in Stufen. Beim Ausbleiben von Congestion Indication Primitives erhöht dieser Anwenderteil seine Last wieder in Stufen (näheres siehe Beschreibung der Anwenderteile).

In allen Fällen, in denen der eigene OPC betroffen ist, muß sich der Level 3 so verhalten, als ob er eine Transfer Controlled Message mit seinem eigenen SP-Code erhalten hätte.

*) Anmerkung:
Es liegen CCITT-Spezifikationsentwürfe vor, welche die Lastabwehr auf größere Einheiten als das überlastete Link, z.B. auf alle darüber erreichbaren Destination Point Codes, beziehen.

Eine eventuelle Übernahme dieser Spezifikationsteile würde gesonderte Festlegungen erfordern.

9.5 Format der "Transfer Controlled Message"

Die Transfer Controlled Message soll nur den DPC der MSU enthalten, die zu der Überlast beigetragen hat. Das Format ist in Abschnitt 13.13 beschrieben.

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

9 Manangement inhibiting

9.1 General

Signalling link management inhibiting is requested by management when it becomes necessary, e.g., for maintenance or testing purposes, to make or keep a signalling link unavailable to User Part-generated signalling traffic. Management inhibiting is a signalling traffic management action, and does not cause any link status changes at level 2. A signalling link is marked "inhibited" under the management inhibiting procedure. In particular, a signalling link that was active and in service prior to being inhibited will remain so, and will thus be able to transmit maintenance and test messages.

Inhibiting of a singalling link may be requested by management functions at either end of the link. The request is granted, provided that the inhibiting action does not cause any previously accessible destinations to become inaccessible at either end of the signalling link. The request may also be refused under certain circumstances such as congestion.

A signalling link normally remains inhibited until uninhibiting is invoked in the signalling point at which inhibiting was initated. Uninhibiting is initiated either at the request of a management function or by routing functions at either end of the signalling link when it is found that a destination has become inaccessible for signalling traffic and the link set associated with routes to that destination contain inhibited links. Unless unavailable for other reasons, uninhibiting causes the signalling link to enter the available state and changeback to be initiated.

9.2 Inhibiting initiation and actions

When at signalling point "X" a request is received from a management function to inhibit a signalling link to signalling point "Y", the following actions take place:

a) A check is performed at signalling point "X" to determine whether, in the case of an available link, inhibiting will result in a destination becoming inaccessible, or in the case of an unavailable link, signalling point "Y" is inaccessible. If either is the case, management is informed that the inhibiting request is denied.

b) If inhibiting is permitted, signalling point "X" sends an inhibit message to signalling point "Y" indicating that it wishes to inhibit the signalling link identified in the message.

c) Signalling point "Y", on receiving the inhibit message from "X", checks whether, in the case of an available link, inhibiting will result in a destination becoming inaccessible and, if so, an inhibit denied message is returned to signalling point "X". The latter then informs the management function which requested inhibiting that the request cannot be granted.

d) If signalling point "Y" finds that inhibiting of the concerned link is permissible it sends an inhibit acknowledgement to signalling point "X" and marks the link remotely inhibited.

Fortsetzung der Auslassung in 1 TR 7:

e) On receiving an inhibit acknowledgement message, signalling point "X" marks the link locally inhibited, and informs management function that the link is inhibited.

f) For a currently available link, a transition to the processor outage state may be initiated at either end, changeover is invoked, and the link becomes unavailable. When changeover has been completed, the link is caused to return to the in-service state, so that, while inhibited, the link will be unavailable for the transfer of user-generated traffic but still permits the exchange of test messages.

g) If, for any reason, the inhibit acknowledgement message is not received, a timer T14 expires and the procedure is restarted including inspection of the status of the destination of the inhibit message. If the destination is not available, management is informed.

9.3 Uninhibiting initiation and actions

Signalling link uninhibiting is initiated at the signalling point, which originally caused the link to be inhibited, upon receipt of an uninhibit or forced uninhibit request.

In a given signalling point, an uninhibit request may be initiated for a locally inhibited link by the management or signalling routing control function, while a forced uninhibited request may be initiated for a remotely inhibited link by the signalling routing control function only.

Signalling routing control will initiate signalling link uninhibit if an inhibit link is found to be a member of a link set in a route to a destination which has become inaccessible.

9.3.1 Management-initiated uninhibiting

Upon receipt of an uninhibiting request from the management function of signalling point "X" regarding an inhibited link to signalling point "Y", the following actions take place:

a) A check is performed at signalling point "X" to determine whether an uninhibit message can be sent to signalling point "Y", either over an available route, or if all routes to signalling point "Y" are unavailable, over the concerned inhibited link. If all routes to signalling point "Y" are unavailable and the concerned inhibited link is marked failed or processor outage, management is informed that uninhibiting is not possible.

b) If uninhibiting is possible, signalling point "X" sends an uninhibit signalling link message to signalling point "Y" indicating that the link identified in the message should be uninhibited.

c) Upon receipt of the uninhibit link message, signalling point "Y" returns an uninhibit acknowledgement message to signalling point "X" and cancels the remote inhibit indication. If no local inhibited, failed or blocked condition exists on the link, it is put in the available state and changeback is initiated.

Fortsetzung der Auslassung in 1 TR 7:

d) On receipt of the uninhibit acknowledgement message, signalling point "X" cancels the local inhibit indication and informs management that the link has been uninhibited. If no remote inhibited, failed or blocked condition exists on the link, it is put in the available state and changeback is initiated.

e) If, for any reason, the uninhibit acknowledgement message is not received, a timer T12 expires and the procedure is started including inspection of the status of the destination of the inhibit message. If the destination is not available, management is informed.

9.3.2 Signalling routing control initiated uninhibiting [14]

Upon receipt of an uninhibit request from signalling routing control at signalling point "X" regarding an inhibited link to signalling point "Y", the following actions take place:

a) A check is performed at signalling point "X" to determine whether the concerned inhibited link is marked failed or blocked. If it is, then signalling point "X" is unable to transmit an uninhibit message to signalling point "Y", uninhibiting is therefore not possible, and the uninhibiting attempt is abandoned.

b) If uninhibiting is possible, a further check is performed by signalling point "X" to determine whether inhibiting initiated by "X" (local inhibiting) or inhibiting initiated by "Y" (remote inhibiting) is in effect.

c) If local inhibiting is in effect, then the actions described in §§ 9.3.1 b), c), d) and e) take place.

d) If remote inhibiting is in effect, then signalling point "X" requests forced uninhibiting of the signalling link by sending a force uninhibit signalling link message to signalling point "Y", which will then initiate uninhibiting in accordance with the description given in § 9.3.1 b), c), d) and e).

10 Signalling traffic flow control

10.1 General

The purpose of the signalling traffic flow control function 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 because of network failures or congestion situations.

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

- Failure in the signalling network (signalling links or signalling points) have resulted in route set unavailability. In this situation, flow control may provide a short term remedy until more appropriate actions can be taken.

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[14]) The procedures concerning the inhibit status of signalling links in cases of local or remote processor recovery are for further study.

Fortsetzung der Auslassung in 1 TR 7:

- Congestion of a signalling link or signalling point has resulted in a situation where reconfiguration is not appropriate.

- Failure of a part has made it impossible for the user to handle 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.

10.2 Flow control indications

The need for the following indications has been identified.

10.2.1 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 the local user parts informing them that signalling messages destined to the particular signalling point cannot be transferred via the signalling network. Each user then takes appropriate actions in order to stop generation of signalling information destined for the inaccessible signalling point.

10.2.2 Signalling route set availability

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

10.2.3 Signalling route set congestion (International Signalling Network)

10.2.3.1 When the congestion status of a signalling route set changes to congested, the following actions will be taken:

i) When a message signal unit from a local User Part is received for a congested route set the following actions are performed:

   a) the MSU is passed to level 2 for transmission;

   b) a congestion indication primitive will be returned to each level 4 User Part, for the initial message and for every n messages (n = 8 provisional value) received for the congested destination. The congestion indication primitive contains as a parameter the DPC of the effected destination.

Fortsetzung der Auslassung in 1 TR 7:

ii) When a message signal unit is received at an STP for a congested route set, the following actions take place:

a) the MSU is passed to level 2 for transmission.

b) a transfer controlled message is sent to the originating point for the initial message and for every n messages (n = 8 provisional value) received for the congested route set.

10.2.3.2 At the reception of a transfer controlled message, the receiving signalling point informs each level 4 User Part of the affected destination by means of a congestion indication primitive specified in 10.2.3.1 i).

10.2.3.3 When the status of a signalling route set changes to uncongested normal operation is resumed. Resumption of message transmission towards the concerned destination is the responsability of the level 4 User Parts.

10.2.4 **Signalling route set congestion** (National Option with congestion priorities)

In the case when the congestion status of a signalling route set changes as a result of either the receipt of a transfer controlled message relating to a particular destination (see 12.7) or an indication of local signalling link congestion, or due to the signalling-route-set-congestion test procedure (see 12.8) an indication is given from the Message Transfer Part to the local level 4 informing them about the current

congestion status of the signalling route set. Each user then takes appropriate actions in order to stop generation of signalling messages destined for the affected signalling point with congestion priorities lower than th specified congestion status. Messages received from local level 4 with congestion priorities lower than the current signalling route set e congestion status are discarded by the Message Transfer Part.

10.2.5 **Signalling route set congestion** (National Options without congestion priorities)

For national signalling networks using multiple signalling link congestion states without congestion priority, $S + 1(1 <= S <= 3)$ levels of route set congestion status are provided.

The procedure is the same as that specified in § 10.2.3, except that the congestion indication primitive contains the congestion status as parameters in addition to the DPC of the affected destination.

Ende der Auslassung in 1 TR 7.

11 Signalling link management

11.1 General

Beginn eines Zusatzes in 1 TR 7:

Derzeit wird die Manual Allocation als Basisprozedur im Zeichengabenetz der DBP angewendet. Dazu sollen im Betriebsversuch Erfahrungen gewonnen werden. Ob zu einem späteren Zeitpunkt die Automatic Allocation angewendet werden soll, kann erst auf Grund dieser Erfahrungen entschieden werden.

Ende des Zusatzes in 1 TR 7.

11.1.1 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.

Beginn einer Auslassung in 1 TR 7:

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 § 11.2) 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 § 11.4.

Ende der Auslassung in 1 TR 7.

11.1.2 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.

Beginn einer Auslassung in 1 TR 7:

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.

Ende der Auslassung in 1 TR 7.

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).

Beginn einer Auslassung in 1 TR 7:

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 11.5 and 11.6 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.

Ende der Auslassung in 1 TR 7.

11.1.3 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, § 7.3). 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 § 11.2);

b) an automatic function is provided for allocation of signalling terminals (see § 11.3);

c) automatic functions are provided for allocation of signalling terminals and signalling data links (see § 11.4).

11.2 Basic signalling link management procedures

11.2.1 Signalling link activation

11.2.1.1 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:
(Auslassung in 1 TR 7: In the typical case,) all signalling links in a link set are active in the absence of failures.

11.2.1.2 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 a signalling link is started. If the signalling link test is successful the link becomes 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 after a time T17 (delay to avoid the oscillation of initial alignment failure and link restart. The value of T17 should be greater than loop delay and less than timer T2, see Recommendation Q.703, § 7.3). If the signalling link test fails, link restoration starts (Auslassung in 1 TR 7: until the signalling link is activated or a manual intervention is made).

11.2.2 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, a signalling link test is started. If the signalling link test is successful the link becomes 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 after a time T17 until the signalling link is restored or a manual intervention is made, e.g. to replace the signalling data link or the signalling terminal.

If the signalling link test fails, restoration procedure is repeated until the link is restored or a manual intervention made.

11.2.3 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.

11.2.4 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.

11.2.4.1 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 § 11.2.1 until the signalling links are made active.

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

11.2.4.2 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.

11.2.4.3 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. (Auslassung in 1 TR 7: The values of the time-outs are for further study.)

11.3 Signalling link management procedures based on automatic allocation of signalling terminals

11.3.1 Signalling link activation

11.3.1.1 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.

11.3.1.2 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 § 11.3.4) or when a link failure occurs. In the latter case, activation starts when the restoration attempts on the faulty link are considered unsuccessful (see § 11.3.2).

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.

11.3.1.3 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 § 11.5.

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.

11.3.1.4 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 a signalling link test is started. If the signalling link test is successful the link becomes 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) after a time T17 (if any) is initiated. Successive initial alignment attempts may, however, continue on the previous (faulty) signalling link after a time T17 until it is restored or its signalling terminal is disconnected (see § 11.5).

Beginn eines Zusatzes in 1 TR 7:

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.

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

In view of the fact that if it is not possible to activate a signalling link an attempt is made to activate the next inactive signalling link in a link set, it may be that the two ends of a link set continuously attempt to activate different signalling links. By having different values of initial alignment time-out T2 at the two ends of the link set (see § 11.3.4.3) it is ensured that eventually both ends of the link set will attempt to activate the same signalling link.

Ende der Auslassung in 1 TR 7.

11.3.2 Signalling link restoration

11.3.2.1 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, a signalling link test is started. If the signalling link test is successful the link becomes restored and thus available for signalling. If the initial alignment is unsuccessful or the test fails, the signalling terminals and signalling link may be faulty and require replacement.

Beginn eines Zusatzes in 1 TR 7:

If the signalling link test fails, the restoration procedure is repeated until the link is restored or a manual intervention is made.

Ende des Zusatzes in 1 TR 7.

11.3.2.2 The signalling terminal may be automatically replaced in accordance with the principles defined for automatic allocation of signalling terminals (see § 11 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 after time T17 until a manual intervention is made or the signalling terminal is disconnected (see § 11.5).

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.

11.3.3 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 § 11.5).

11.3.4 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.

11.3.4.1 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 § 11.3.1.

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 [15]. According to the principles for automatic allocation of signalling terminals defined in § 11.5, 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 § 11.3.1, 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.

11.3.4.2 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 (of Recommendation Q.703, § 7) are employed in order to accelerate the procedure (see further § 11.2.4.2).

Beginn eines Zusatzes in 1 TR 7:

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.

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

11.3.4.3 Time-out values

The values of the initial alignment time-out T2 (see Recommendation Q.703, § 7) will be different at the two ends of the link set, if automatic allocating of signalling terminals or signalling data link is applied at both ends of a signalling link set. These values are for further study.

Ende der Auslassung in 1 TR 7.

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[15]) 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.

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

11.4.1 Signalling link activation

11.4.1.1 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.

11.4.1.2 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 § 11.4.4) or when a link failure occurs. In the latter case, activation starts when the restoration attempts on the faulty link are considered unsuccessful (see § 11.4.2).

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.

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.

11.4.1.3 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 § 11.5.

The signalling data link is allocated automatically by means of the function defined in § 11.6. However, in conjunction with link set activation the identity of the signalling data link to use may be predetermined (see further § 11.4.4). 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.

11.4.1.4 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 a signalling link test is started. If the signalling link test is successful the link becomes 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 § 11.4.1.2 above). Successive initial alignment attempts may continue on the previous signalling link after a time T17 until it is activated or its signalling terminal is disconnected (see § 11.5).

Beginn eines Zusatzes in 1 TR 7:

Fußnote:
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.

Ende des Zusatzes in 1 TR 7.

Beginn eines Zusatzes in 1 TR 7:

If the signalling link test fails, link restoration starts.

Ende des Zusatzes in 1 TR 7.

11.4.2 Signalling link restoration

11.4.2.1 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, a signalling link test is started. If the signalling link test is successful the link becomes restored and thus available for signalling.

If the initial alignment is unsuccessful (Auslassung in 1 TR 7: or if the test fails) the signalling terminal and signalling data link may be faulty and require replacement.

Beginn eines Zusatzes in 1 TR 7:

If the signalling link test fails, the restoration procedure is repeated until the link is restored or manual intervention is made.

Ende des Zusatzes in 1 TR 7.

11.4.2.2 The signalling data link may be automatically replaced by an alternative, in accordance with the principles defined in § 11.6. After the new signalling data link has been connected to the signalling terminal signalling link, initial alignment starts. If successful, the signalling link 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 § 11.4.1.2). Successive initial alignment attempts may, however, continue on the previous (faulty) signallink link after a time T17 until it is restored or its signalling terminal is disconnected.

11.4.2.3 The signalling terminal may be automatically replaced in accordance with the principles defined in § 11.5. 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 § 11.4.1.2).

Successive initial alignment attempts may, however, continue on the previous (faulty) signalling link after a time T17 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 §§ 11.4.2.2 and 11.4.2.3 above is taking place.

11.4.3 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 §§ 11.5 and 11.6).

11.4.4 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 § 11.3.4). The link set activation procedure is performed as specified in § 11.3.4, 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. § 11.6). 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 § 11.4.1).

11.5 Automatic allocation of signalling terminals

In conjunction with the signalling link activation and restoration procedures specified in §§ 11.3 and 11.4, 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 §§ 11.3 and 11.4).

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).

11.6 Automatic allocation of signalling data links

11.6.1 In conjunction with the signalling link activation and restoration procedures specified in § 11.4, 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.

Beginn einer Auslassung in 1 TR 7:

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

Ende der Auslassung in 1 TR 7.

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).

11.6.2 When a signalling data link has been chosen at a signalling point, (Auslassung in 1 TR 7: 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 message 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 § 14.

11.6.3 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 message 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, (Auslassung in 1 TR 7: 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 § 14.

11.6.4 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 § 11.4).

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 (Auslassung in 1 TR 7: 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.

11.6.5 When a signalling data link is disconnected in conjunction with signalling link restoration or deactivation, the signalling data link is made idle (Auslassung in 1 TR 7: (and available, e. g. as speech circuit)).

Beginn einer Auslassung in 1 TR 7:

11.7 Different signalling link management procedures at the two ends of a link set

Normally both ends of a link set will use the same signalling link management procedures.

However if one end uses the basic signalling link management procedures, the other end may use the signalling link management procedures based on automatic allocation of signalling terminals. In that case a signalling link includes a predetermined signalling terminal at one end, a predetermined signalling data link and at the other end, any of the signalling terminals applicable to the concerned link group.

In the case when one end of a link set uses the basic signalling link management procedures and the other end uses the signalling link management procedures based on automatic allocation of signalling terminals, the values of initial alignment time-out T2 do not have to be different at the two ends of the link set.

Ende der Auslassung in 1 TR 7.

12 Signalling route management

12.1 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, restriction [16]) and availability of a signalling route is communicated by means of the transfer-prohibited, transfer-restricted [16]) and transfer allowed procedures, respectively, specified in §§ 12.2, 12.5 and 12.3.

Recovery of signalling route status infomation is made by means of the signalling-route-set-test procedure specified in § 12.4.

Beginn einer Auslassung in 1 TR 7:

In the signalling network congestion of a route set is communicated by means of the TFC messages specified in § 12.6.

In national networks, congestion of a signalling route set may be communicated by means of the TFC as specified in §§ 12.7 and 12.8 and the signalling route set congestion test procedure specified in § 12.9.

Ende der Auslassung in 1 TR 7.

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[16]) National option: nicht in 1 TR 7.

12.2 Transfer-prohibited

12.2.1 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 which contains:

- the label, indicating the destination and originating points;

- the transfer-prohibited signal; and

- the destination for which traffic transfer is no longer possible [17]).

Format and code of these messages appear in § 14.

Transfer prohibited messages are always addressed to an adjacent signalling point. They may use any available signalling route that leads to that signalling point.

12.2.2 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 controlled 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.

Beginn eines Zusatzes in 1 TR 7:

Die Transfer prohibited Nachricht wird nur für Ziele im Eigenbereich gesendet.

Ende des Zusatzes in 1 TR 7.

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 (Broadcast method).

Beginn eines Zusatzes in 1 TR 7:

Die Transfer prohibited Nachricht wird nur für Ziele im Eigenbereich gesendet.

Ende des Zusatzes in 1 TR 7.

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[17]) 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.

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 (Response method).

Beginn eines Zusatzes in 1 TR 7:

Transfer prohibited wird nur gesendet, wenn die Nachricht einen Destination Point Code (DPC) enthält, der bekannt und im Eigenbereich, aber z.Z. nicht erreichbar ist. Ist von dem DPC bekannt, daß er nicht existiert, so wird die Nachricht weggeworfen und das Maintenance System informiert. Ist der DPC im Fremdbereich, so wird die Nachricht weggeworfen.

Ende des Zusatzes in 1 TR 7.

As long as transfer-prohibited messages for any destination are being transmitted according to criteria i) or ii) above, and also within T8 = 1 second (provisional value) after the last transfer-prohibited message was transmitted, no transfer-prohibited messages will be sent via the Response method (criterion iii) above).

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

12.2.3 When a signalling point receives a transfer-prohibited message from signalling transfer point Y 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). In other words, it may perform forced re-routing and, if appropriate, generate additional transfer-prohibited messages.

12.2.4 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 no actions are taken.

12.3 Transfer-allowed

12.3.1 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 which contains:

- the label, indicating the destination and originating points;

- the transfer-allowed signal; and

- the destination for which transfer is now possible [18].

Format and code of these messages appear in § 14.

Transfer allowed messages are always addressed to an adjacent signalling point. They may use any available signalling route that leads to that signalling point.

12.3.2 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 controlled 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. (Broadcast method.)

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

12.3.3 When a signalling point receives a transfer-allowed message from signalling transfer point Y, 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) . In other words, it may perform controlled re-routing and, if appropriate, generate additional transfer-allowed messages.

12.3.4 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 non-existent 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 no actions are taken.

12.4 Signalling-route-set-test

12.4.1 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.

The signalling-route-set-test message contains:

- the label, indicating the destination and originating points;

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[18]) 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.

- the signalling-route-set-test signal; and

- the destination, the accessibility of which is to be tested [18]).

Beginn einer Auslassung in 1 TR 7:

- the current route status of the destination being tested.

Ende der Auslassung in 1 TR 7.

Format and coding of this message appear in § 14.

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

a) When a transfer-prohibited or transfer-restricted [19]) 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 (Auslassung in 1 TR 7: or restricted), by the transfer-prohibited or transfer-restricted [19]) message, every 30 seconds (provisional value (Zusatz in 1 TR 7: T 10)) until a transfer-allowed message, indicating that the destination has become accessible, is received.

Beginn einer Auslassung in 1 TR 7:

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. Implementation of this item is a national option.

Ende der Auslassung in 1 TR 7.

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.

Beginn einer Auslassung in 1 TR 7:

In case b) above, the positive, negative or restriction [19]) responses to the test messages (i.e. the reception of transfer-allowed, transfer-prohibited or transfer-restricted [19]) messages) are used to update route status in the signalling point.

In the case of a processor re-initialization, all destinations will be initialized as "accessible". The response mechanism in the transfer-prohibited procedure will correct the status of the destinations which are not "accessible".

Ende der Auslassung in 1 TR 7.

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[18]) 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.

[19]) National option: nicht in 1 TR 7

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

Beginn eines Zusatzes in 1 TR 7:

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

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

12.4.4 At the reception of a signalling-route-set-test message, a signalling transfer point will compare the status of the destination in the received message with the actual status of the destination. If they are the same, no further action is taken. If they are different, one of the following messages is sent in response, dictated by the actual status of the destination:

Ende der Auslassung in 1 TR 7.

- 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, and via the normal routing

Beginn eines Zusatzes in 1 TR 7:

- in allen anderen Fällen wird nichts getan.

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

- a transfer-restricted [19]) message when access to the destination is possible via an alternative to the normal routing which is less efficient, but still not via the signalling point from which the signalling route-set-test was originated.

- a transfer-prohibited message in all other cases (including the inaccessibility of that destination).

Ende der Auslassung in 1 TR 7.

12.4.5 At the reception of the (Auslassung in 1 TR 7: transfer-prohibited or) transfer-allowed message, the signalling point will perform the procedures specified in §§ (Auslassung in 1 TR 7: 12.2.3 or 12.2.4) and 12.3.3 or 12.3.4 respectively.

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[19]) National option: nicht in 1 TR 7

Beginn einer Auslassung in 1 TR 7:

12.5 Transfer-restricted (national option)

12.5.1 The transfer restricted 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 should, if possible, no longer route the concerned messages via that signalling transfer point.

The transfer-restricted procedure makes use of the transfer-restricted message which contains:

- the label, indicating the destination and originating points;

- the transfer-restricted signal, and

- the destination for which traffic transfer is no longer desirable.

Formats and codes of this message appear in § 14.

Transfer-restricted messages are always addressed to an adjacent signalling point when the direct link set to that signalling point is available.

Note:
Undesirable situations result in increased signalling delays, possibly overloading portions of the network. These inefficiencies could be avoided if the traffic can be appropriately diverted.

12.5.2 A transfer-restricted message relating to a given destination "X" is sent from a signalling transfer point "Y" when, the normal link set (combined link set) used by signalling point "Y" to route to destination X experiences a long-term failure such as an equipment failure or in case of congestion on a link set used as an alternate link set. In this case, a transfer-restricted message is sent to all directly accessible adjacent signalling points.

Note - characterization of long term failure remains for further study.

12.5.3 When a signalling point receives a transfer-restricted message from signalling transfer point "Y" and has an alternative equal priority link set available and not restricted to destination "X", it performs the actions in § 8.2. In other words, it performs controlled rerouting to maintain the sequence of messages while diverting them to the alternative link set. If it cannot perform alternate routing to destination "X" because no alternative link set is available, it may generate additional transfer-restricted messages.

12.5.4 In some circumstances, it may happen that a signalling point receives either a repeated transfer-restricted message or a transfer-restricted 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); in this case, no actions are taken.

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[19]) National option: nicht in 1 TR 7

Fortsetzung der Auslassung in 1 TR 7:

12.5.5 When a transfer-restricted message is received updating a transfer-prohibited status, signalling traffic management decides if an alternative route is available or restricted; if it is not (i.e., no alternative route exists), the concerned traffic is restarted towards the signalling point from which the transfer-restricted was received. Otherwise, no other actions are taken.

12.6 Transfer controlled (International Network)

The only use made of the transfer controlled procedure in the international signalling network, is to convey the congestion indication from the SP where congestion was detected to the originating SP (see § 10.2.3) in a transfer controlled message.

The transfer controlled message contains:

- the label, indicating the destination and origination points;
- the transfer controlled signal;
- the identity of the congested destination.

Format and coding of the transfer controlled message appear in § 14.

12.7 Transfer-controlled (national option with congestion priorities)

12.7.1 The transfer-controlled procedure is performed at a signalling transfer point for messages relating to a given destination, when it has to notify one or more originating signalling points that they should no longer send to the concerned destination messages with a given priority or lower.

The transfer-controlled procedure makes use of the transfer-controlled message which contains:

- the label, indicating the destination and originating points,
- the transfer-controlled signal,
- the destination for which messages with a congestion priority lower than the specified congestion status should no longer be sent, and
- the current congestion status encountered in routing a particular message towards the concerned destination.

Format and coding of this message appear in § 14.

12.7.2 A transfer-controlled message relating to a given destination "X" is sent from a signalling transfer point "Y" in response to a received message originating from signalling point "Z" destined to signalling point "X" when the congestion priority of the concerned message is less than the current congestion status of the signalling link selected to transmit the concerned message from "Y" to "X".

Fortsetzung der Auslassung in 1 TR 7:

In this case, the transfer-controlled message is sent to the originating point "Z" with the congestion status field set to the current congestion status of the signalling link.

12.7.3 When the originating signalling point "Z" receives a transfer-controlled message relating to destination "X" and if the current congestion status of the signalling route set towards destination "X" is not greater than the congestion status in the transfer-controlled message, it assigns the congestion status of the signalling route set towards destination "X" with the value of the congestion status carried in the transfer-controlled message.

12.7.4 If within T15 = 1 second (provisional value) after the receipt of the last transfer-controlled message relating to destination "X", signalling point "Z" receives another transfer-controlled message relating to the same destination, the following action is taken. If the value of the congestion status carried in the new transfer-controlled message is not less than the current value of the congestion status of the signalling route set towards destination "X", then the current value is updated by the new value.

12.7.5 If T15 = 1 second (provisional value) expires after the last update of the signalling route set towards destination "X" by a transfer-controlled message relating to the same destination, the signalling-route-set-congestion test procedure is invoked (see § 12.9).

12.7.6 In some circumstances it may happen that a signalling point receives a transfer-controlled message relating to a destination which is already inaccessible due to previous failures; in this case the transfer-controlled message is ignored.

12.8 Transfer-controlled (national option without congestion priorities)

The only use made of the TFC procedure by the national signalling network, using multiple congestion states without congestion priority, is to convey the congestion indication primitive from the SP where congestion was detected to the originating SP (see § 9.2.5) in a transfer controlled message.

The transfer-controlled message contains:

- the label, indicating the destination and originating points;
- the transfer-controlled signal;
- the identity of congestion destination;
- the current congestion status encountered in routing a particular message towards the concerned destination;

Format and coding of this message appear in § 14.

Fortsetzung der Auslassung in 1 TR 7:

12.9 Signalling-route-set-congestion-test (national option)

12.9.1 The signalling-route-set-congestion-test procedure is used at an originating signalling point to update the congestion status associated with a route set towards a certain destination. The purpose is to test whether or not signalling messages destined towards that destination with a given congestion priority or higher may be sent.

In the case of a processor restart the congestion status of all signalling route sets will be initalized to the zero value. Response mechanism within the transfer-controlled procedure will correct signalling route sets whose congestion status does not have the zero value.

The procedure makes use of the signalling-route-set-congestion-test message, and the transfer-controlled procedure.

The signalling-route-set-congestion-test message contains:

- the label, indicating the destination and originating points, and

- the signalling-route-set-congestion-test signal.

Format and coding of this message appear in § 14.

12.9.2 The signalling-route-set-congestion-test message differs from other signalling network management messages in that it is not assigned the highest congestion priority. Instead, the congestion priority assigned to a signalling-route-set-congestion-test message to be sent to a given destination is equal to one less than the current congestion status associated with the signalling route set towards the destination.

12.9.3 If T15 = 3 seconds (provisional value) after sending a signalling-route-set-congestion-test message, a transfer-controlled message relating to the concerned destination is received, the signalling point assigns the congestion status of the signalling route set towards the concerned destination with the value of the congestion status carried in the transfer-controlled message. Following this, the procedures specified in §§ 12.9.4 and 12.9.5 are performed.

If T15 = 3 seconds (provisional value) expires after sending a signalling-route-set-congestion-test message without a transfer-controlled message relating to the concerned destination having been received, the signalling point changes the congestion status associated with the signalling route set towards the concerned destination to the next lower status.

12.9.4 Provided that the signalling route set towards destination "X" is not in the "unavailable" state, a signalling-route-set-congestion-test message is sent from an originating signalling point to destination "X" in the following cases:

Fortsetzung der Auslassung in 1 TR 7:

i) When T15 = 1 second (provisional value) expires after the last update of the congestion status of the signalling route set towards destination "X" by a transfer-controlled message relating to the same destination.

ii) When T16 = 3 seconds (provisional value) expires after sending a signalling-route-set-congestion-test message to destination "X" without a transfer-controlled message relating to the same destination having been received. After the congestion status has been decremented by one, the test is repeated, unless the congestion status is zero.

12.9.5 At the reception of a signalling-route-set-congestion-test message, a signalling transfer point will route it as an ordinary message, i.e., according to the procedure specified in § 2.3.5.

12.9.6 When a signalling-route-test-congestion-test message reaches its destination, it is discarded.

Ende der Auslassung in 1 TR 7.

13 Common characteristics of message signal unit formats

13.1 General

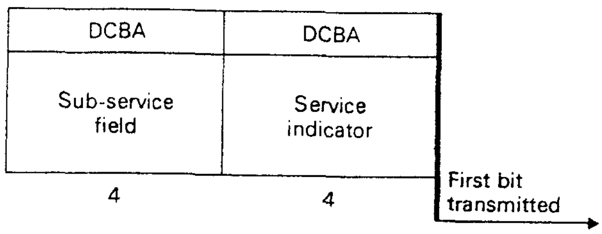
The basic signal unit format which is common to all message signal units is described in Recommendation Q.703, § 2. From the point of view of the Message Transfer Part level 3 functions, common characteristics of the message signal units are the presence of:

- the service information octet;

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

13.2 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.



CCITT-35510

Figure 13/Q.704
Service information octet

13.2.1 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).

Beginn eines Zusatzes in 1 TR 7:

The service indicator codes are allocated as follows: (dies gilt für die Kodierung DC = 10 im network indicator (national network) wie unter 13.2.2 beschrieben).

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

The service indicator codes for the international signalling network are allocated as follows:

Ende der Auslassung in 1 TR 7.

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	Spare
0 0 1 1	SCCP (in 1 TR 7: Transportfunktionsteil)
0 1 0 0	Telephone User Part
0 1 0 1	ISDN User Part
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	Spare
1 0 1 1	
1 1 0 0	
1 1 0 1	
1 1 1 0	In einem geschlossenen Netz bereits vergeben (FuFeNetz C)
1 1 1 1	Spare

Beginn einer Auslassung in 1 TR 7:

The allocation of the service indicator codes for national signalling networks is a national matter. However, it is suggested to allocate the same service indicator code to a User Part which performs similar functions as in the international network.

Ende der Auslassung in 1 TR 7.

13.2.2 Sub-service field

The sub-service field contains the network indicator (bits C and D) and two spare bits (bits A and B).

The network indicator is used by signalling message handling functions (e. g., in order to determine the relevant version of a User Part), see §§ 2.3 and 2.4.

If the network indicator is set to 00 or 01, the two spare bits, coded 00, are available for possible future needs that may require a common solution for all international User Parts.

If the network indicator is set to 10 or 11, the two spare bits are for national use. (Auslassung in 1 TR 7: They may be used, for example, to indicate message priority, which is used in the optional flow control procedure in national applications.)

The network indicator provides for discrimination between international and national messages. It can also be used, for example, for the discrimination between functionally two national signalling networks, each having different routing label structures and including up to 16 User Parts defined by the 16 possible codes of the service indicator.

Beginn einer Auslassung in 1 TR 7:

In the case of only one national signalling network the spare code of the network indicator reserved for national use can be used, for example, to define an additional 16 user parts (making a total of 32 User Parts) for that national signalling network.

Ende der Auslassung in 1 TR 7.

The network indicator codes are allocated as follows:

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

Beginn einer Auslassung in 1 TR 7:

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 network indicator between international and national messages is not used, i.e., in a closed national signalling network seen from the signalling point of view, the whole sub-service field can be used independently for different User Parts.

Ende der Auslassung in 1 TR 7.

13.3 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.

14 Formats and codes of signalling network management messages

14.1 General

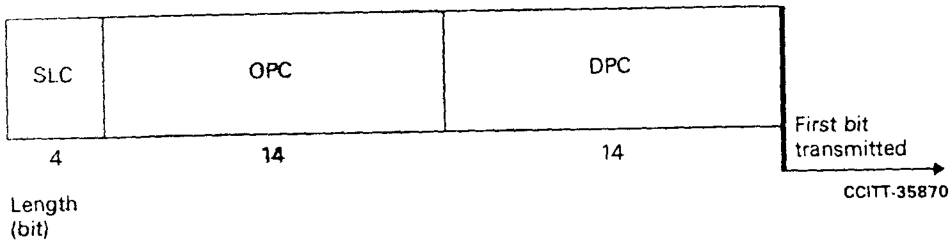
14.1.1 The signalling network management messages are carried on the signalling channel in message signal units, the format of which is described in § 13 and in Recommendation Q.703, § 2. In particular, as indicated in § 13.2 these messages are distinguished by the configuration 0000 of the service indicator (SI). The sub-service field (SSF) of the messages is used according with the rules indicated in § 13.2.2.

14.1.2 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 §§ 14.2 and 14.3 respectively; the detailed message formats are described in the following section. 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.

14.2 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.



Standard label structure
Figure 14/Q.704

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.

14.3 Heading code (HO)

The heading code (HO) 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	Transfer controlled and signalling route set congestion messages
0100	Transfer-prohibited-allowed-restricted messages
0101	Signalling-route-set-test messages
0110	Management inhibit messages
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.

14.4 Changeover message

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

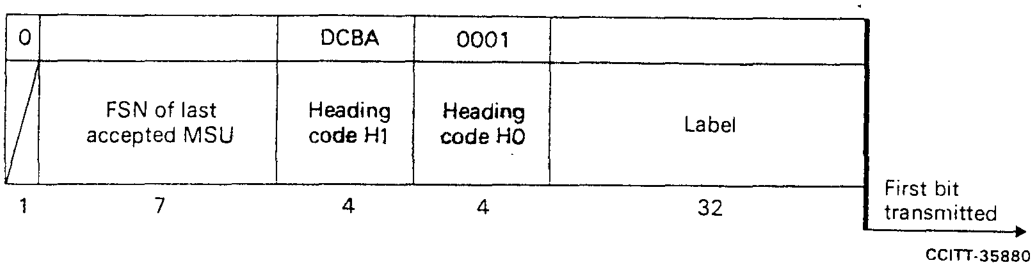


Figure 15/Q.704
Changeover message

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

- Label (32 bits): see § 14.2.
- Heading code H0 (4 bits): see § 14.3.
- Heading code H1 (4 bits): see § 14.4.3.
- Forward sequence number of last accepted message signal unit (7 bits)
- A filler bit coded 0.

14.4.3 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

14.5 Changeback message

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

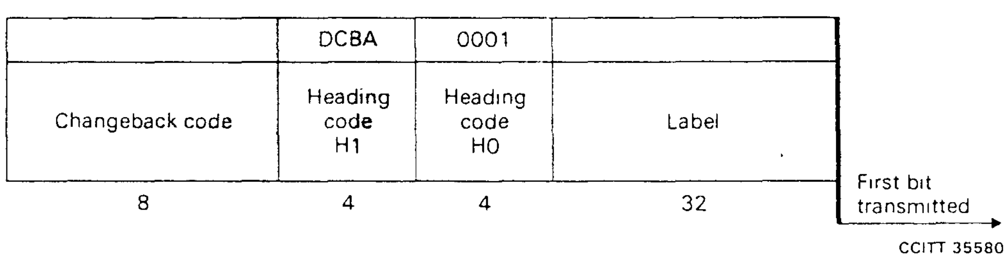


Figure 16/Q.704
changeback message

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

- Label (32 bits): see § 14.2.
- Heading code H0 (4 bits): see § 14.3.
- Heading code H1 (4 bits): see § 14.5.3.
- Changeback code (8 bits): see § 14.5.4.

14.5.3 The Heading code H1 contains signal codes as follows:

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

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

14.6 Emergency changeover message

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

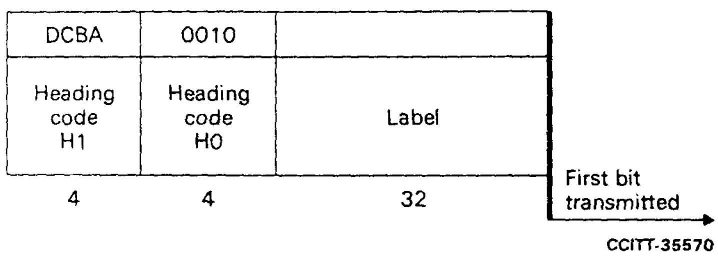


Figure 17/Q.704
Emergency changeover message

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

- Label (32 bits): see § 14.2.
- Heading code H0 (4 bits): see § 14.3.
- Heading code H1 (4 bits): see § 14.6.3.

14.6.3 The heading code H1 contains signal codes as follows:

bit	D C B A	
	0 0 0 1	Emergency changeover order signal
	0 0 1 0	Emergency changeover acknowledgement signal

14.7 Transfer-prohibited message

14.7.1 The format of the transfer-prohibited message is shown in Figure 18/Q.704.

00		DCBA	0100	
	Destination	Heading code H1	Heading code H0	Label
2	14	4	4	32

First bit transmitted

CCITT-35890

Figure 18/Q.704
Transfer prohibited message

Beginn eines Zusatzes in 1 TR 7:

<u>Fußnote:</u>
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.

Ende des Zusatzes in 1 TR 7.

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

- Label (32 bits): see § 14.2.
- Heading code H0 (4 bits): see § 14.3.
- Heading code H1 (4 bits): see § 14.7.3.
- Destination (14 bits): see § 14.7.4.
- Spare bits (2 bits) code 00.

14.7.3 The heading code H1 contains one signal code as follows:

bit D C B A

0 0 0 1 Transfer-prohibited signal

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

14.8 Transfer-allowed message

14.8.1 The format of the transfer-allowed message is shown in Figure 19/Q.704.

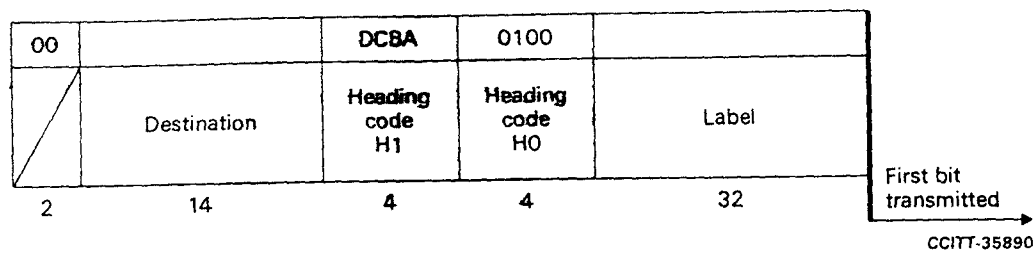


Figure 19/Q.704
Transfer allowed message

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

- Label (32 bits): see § 14.2.
- Heading code H0 (4 bits): see § 14.3.
- Heading code H1 (4 bits): see § 14.8.3.
- Destination (14 bits): see § 14.7.3.
- Spare bits (2 bits) coded 00.

14.8.3 The heading code H1 contains one signal code as follows:

bit D C B A

0 1 0 1 Transfer-allowed signal

Beginn einer Auslassung in 1 TR 7:

14.9 Transfer restricted message [28])

14.9.1 The format of the transfer-restricted message is shown in Figure-18/Q.704.

14.9.2 The transfer-restricted message is made up of the following fields:

- Label (32 bits): see § 14.2.
- Heading code H0 (4 bits): see § 14.3.
- Heading code H1 (4 bits): see § 14.9.3
- Destination (14 bits): see section 14.9.4.
- Spare (2 bits): coded 00.

14.9.3 The heading code H1 contains one signal code as follows:

bit D C B A

0 0 1 1 Transfer-restricted

14.9.4 The destination field contains the identity of the signalling point to which the message refers for the transfer restricted message.

Ende der Auslassung in 1 TR 7.

14.10 Signalling-route-set-test message

14.10.1 The format of the signalling-route-set-test message is shown in Figure 20/Q.704. Zusatz einer Fußnote in 1 TR 7: The possibility to refer to more general destination than a single signalling point (e. g. signalling region), or more restrictive than a single signalling point (e. g. an individual User Part) is for further study.

Ende des Zusatzes in 1 TR 7.

00		DCBA	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

14.10.2 This message is made up of the following fields:

- Label (32 bits): see § 14.2,
- Heading code H0 (4 bits): see § 14.3,
- Heading code H1 (4 bits): see § 14.10.3 (Text in 1 TR 7: is coded 0001),
- Destination (14 bits): see § 14.7.4,
- Spare bits (2 bits) coded 00.

Beginn einer Auslassung in 1 TR 7:

---

20) National option

14.10.3 The heading code H1 contains signal codes as follows:

bit D C B A	
0 0 0 1	Signalling-route-set-test signal for prohibited destination
0 0 1 0	Signalling-route-set-test signal for restricted destination [21]

14.11 Management inhibit message

14.11.1 The format of the management inhibit message is shown in Figure-17/Q.704.

14.11.2 The management inhibit message is made up of the following fields:

- Label (32 bits): see § 14.2,
- Heading code H0 (4 bits): see § 14.3,
- Heading code H1 (4 bits): see § 14.11.3,
- SLC (4 bits) indicating the identity of the signalling link to be inhibited.
- Spare (4 bits): coded 0000.

14.11.3 The heading code H1 contains signal codes as follows:

bit D C B A	
0 0 0 1	Link inhibit signal
0 0 1 0	Link uninhibit signal
0 0 1 1	Link inhibited acknowledgement signal
0 1 0 0	Link uninhibited acknowledgement signal
0 1 0 1	Link inhibit denied signal
0 1 1 0	Link force uninhibit signal

Ende der Auslassung in 1 TR 7.

[21] National option

14.12 Signalling-data-link-connection-order message

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

0000		DCBA	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

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

- Label (32 bits): see § 14.2.
- Heading code H0 (4 bits): see § 14.3.
- Heading code H1 (4 bits): (Text in 1 TR 7: is coded 0001) see § 14.12.3.
- Signalling data link identity (12 bits): see § 14.12.4.
- Spare bits (4 bits) coded 0000.

Beginn einer Auslassung in 1 TR 7:

14.12.3 The heading code H1 contains one signal code as follows

bit D C B A

0 0 0 1 Signalling data link connection order signal

Ende der Auslassung in 1 TR 7.

14.12.4 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.

14.13 Signalling-data-link-connection-acknowledgement message

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

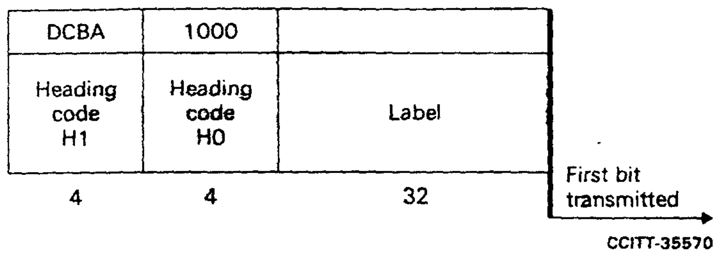


Figure 22/Q.704
Signalling-data-link-connection-acknowledgement message

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

- Label (32 bits): see § 14.2.
- Heading code H0 (4 bits): see § 14.3.
- Heading code H1 (4 bits): see § 14.13.3.

14.13.3 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

14.14 Transfer controlled message

14.14.1 The format of the TFC message is shown in Figure 22a/Q.704.

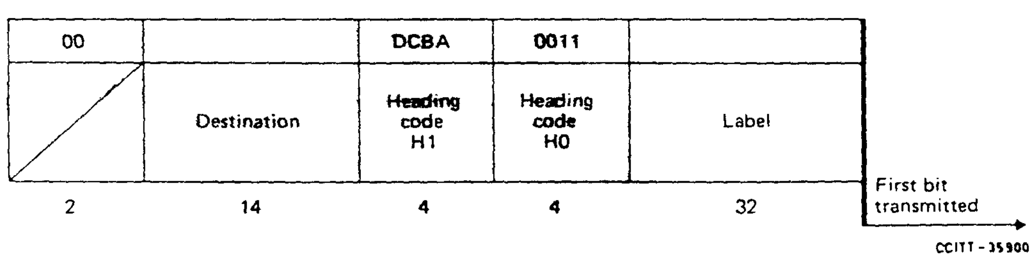


Figure 22a/Q.704
Transfer controlled message

Beginn einer Auslassung in 1 TR 7:

14.14.2 The transfer controlled message is made up of the following fields:

- Label (32 bits): see § 14.2.
- Heading Code H0 (4 bits): see § 14.3.
- Heading code H1 (4 bits): see § 14.14.3.
- Destination (14 bits): see § 14.14.4.
- Spare (2 bits): see § 14.14.5.

14.14.3 The Heading Code H1 contains one signal code as follows:

D C B A

0 0 1 0 Transfer-controlled signal

14.14.4 The destination field carries the address of the destination to which the message refers.

14.14.5 In national signalling networks using multiple congestion states, the spare bits in the transfer-controlled message are used to carry the congestion status associated with the destination.

14.15 Signalling-route-set-congestion-test message (National Option)

14.15.1 The format of the signalling-route-set-congestion-test message is shown in Figure 22b/Q.704.

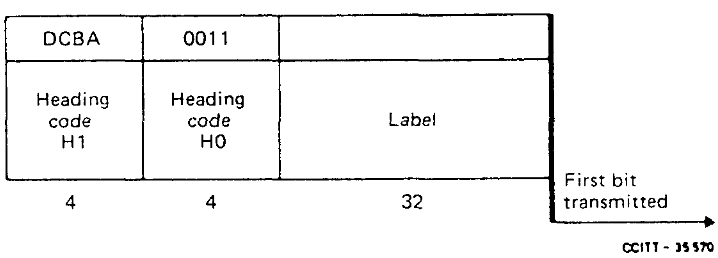


Figure 22b/Q.704
Signalling-route-set-congestion-test message

14.15.2 The signalling-route-set-congestion-test message is made up of the following fields:

- Label (32 bits): see § 14.2.
- Heading code H0 (4 bits): see § 14.3.
- Heading code H1 (4 bits): see § 14.15.3.

Fortsetzung der Auslassung in 1 TR 7:

14.15.3 The heading code H1 contains one signal code as follows:

bit	D C B A	
	0 0 0 1	Signalling-route-set-congestion-test signal

Ende der Auslassung in 1 TR 7.

Beginn eines Zusatzes in 1 TR 7:

14 Heading Code Allocation, Abbreviations and Timers (Table 1/Q.704)

Ende des Zusatzes in 1 TR 7.

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		RCT	TFC													
TFM	0100		TFP		TFR		TFA										
RSM	0101		RST	RST5)													
MIM	0110		LIN	LUN	LIA	LUA	LID	LFU									
	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
RCT	Signalling-route-set-congestion-test message
RSM	Signalling-route-set-test message
RST	Signalling-route-set-test signal
TFR	Transfer restricted signal
TFA	Transfer-allowed signal
TFC	Transfer controlled message
TFM	Transfer-prohibited-transfer-allowed-transfer-restricted-messages
TFP	Transfer-prohibited signal
MIM	Management inhibit messages
LID	Link inhibit denied signal
LFU	Link forced uninhibit signal
LIN	Link inhibit signal
LIA	Link inhibit acknowledgement signal
LUA	Link uninhibit acknowledgement signal
LUN	Link uninhibit signal

Table 1/Q.704
Heading code allocation of signalling network management messages

Beginn einer Auslassung in 1 TR 7:

15 State transition diagrams

15.1 General

§ 15 contains the description of the signalling network functions described in §§ 2 to 12 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 10;
c) signalling route management (SRM), described in § 12;
d) signalling link management (SLM) described in § 11.

Ende der Auslassung in 1 TR 7.

15.1.1 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.

Beginn einer Auslassung in 1 TR 7:

15.2 Drafting conventions

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

15.2.2 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).

15.2.3 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

Fortsetzung der Auslassung in 1 TR 7:

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

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

15.2.5 Notations for national operations

National options are included in the main body of the STDs within dotted boxes; if their use should exclude or modify some of the international logic, the relevant sections are marked "t" and a note is added to the figure. Also, the options are marked as follows:

Transfer Restricted - TR
Multiple Congestion States - MCS

15.3 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;
d) handling of messages under signalling link congestion is shown in Figure 26A/Q.704.

15.4 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 Figures 34A/Q.704 and 34B/Q.704;
h) signalling route set congestion control (TRCC) is shown in Figure 29A/Q.704.

Fortsetzung der Auslassung in 1 TR 7:

15.5 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.

15.6 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) transfer restricted control (RTRC) is shown in Figure 46C/Q.704;
d) transfer controlled control (RTCC) is shown in Figure 46A/Q.704;
e) signalling route set test control (RSRT) is shown in Figure 46/Q.704;
f) signalling route set congestion test control (RCAT) is shown in Figure 46B/Q.704.

Ende der Auslassung in 1 TR 7.

15.7 Abbreviations and timers used in Figures 23/Q.704 to 46/Q.704
(Überschrift in 1 TR 7: Abbreviations and timers)

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

Beginn einer Auslassung in 1 TR 7:

HMCG	Signalling link congestior

Ende der Auslassung in 1 TR 7.

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

Beginn einer Auslassung in 1 TR 7:

RCAT	Signalling-route-set-congestion-test control

Ende der Auslassung in 1 TR 7.

RSRT	Signalling route set test control
RTAC	Transfer allowed control

Beginn einer Auslassung in 1 TR 7:

RTCC	Transfer-controlled control

Ende der Auslassung in 1 TR 7.

RTPC	Transfer prohibited control

Beginn einer Auslassung in 1 TR 7:

RTRC	Transfer restricted control

Ende der Auslassung in 1 TR 7.

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

Beginn einer Auslassung in 1 TR 7:

TRCC Signalling route set congestion control

Ende der Auslassung in 1 TR 7.

Timers

T1 *)	500(800) to 1200 ms	Delay to avoid message mis-sequencing on changeover	see § 5.6.2
T2	0.7(1.4) to 2 s	Waiting for changeover acknowledgement	see § 5.7.2
T3 *)	500(800) to 1200 ms	Time controlled diversion - delay to avoid mis-sequencing on changeback	see § 6.4.2
T4	500(800) to 1200 ms	Waiting for changeback acknowledgement(first attempt)	see § 6.5.3
T5	500(800) to 1200 ms	Waiting for changeback acknowledgement (second attempt)	see § 6.5.3
T6 *)	500(800) to 1200 ms	Delay to avoid message mis-sequencing on controlled rerouting	see § 8.2.1
T7	2s	Waiting for signalling data link connection acknowledgement	see § 10.6.4
T8	800 to 1200 ms	Transfer prohibited inhibition timer (transient solution)	see § 11.2.4
T10	30 to 60 s	Waiting to repeat signalling route set test message	see § 11.4.2

Beginn einer Auslassung in 1 TR 7:

T11	Transfer restricted timer. (This is one way of implementing the function described in § 12.5.2 and mainly intended to simplify the STPs.)
T12	Waiting for uninhibit acknowledgement
T13	Waiting for force uninhibit
T14	Waiting for inhibition acknowledgement
T15	Waiting to start signalling route set congestion test
T16	Waiting for route set congestion status update

Ende der Auslassung in 1 TR 7.

T17	800 to 1500 ms	Delay to avoid oscillation of initial alignment failure and link restart	see § 11.4.2

Note: The volues in brackets should be used for long signalling delay routes (e.g. routes including satellite sections) as the lowest value of the range.

Beginn eines Zusatzes in 1 TR 7:

*) Es ist wahrscheinlich sinnvoll, bei Anwendung im Netz der Deutschen Bundespost diese Werte zu verkürzen. Im Pilotprojekt sollen darüber Erfahrungen gewonnen werden.

Fortsetzung des Zusatzes in 1 TR 7:

15 Wiederanlauf eines Signalling Points

Bei CCITT ist noch kein Gesamtkonzept für die Inbetriebnahme eines kompletten Signalling Points bzw. den Wiederanlauf nach einem Ausfall vorhanden, z.B. für Synchronisation des Anlaufs der einzelnen Linksets.

Bereits in Betrieb befindliche Linksets können z.B. Transferverkehr für noch nicht in Betrieb befindliche erhalten.

Deshalb werden für die Inbetriebnahme der Signalling links und die Aktualisierung der Routingdaten die bestehenden Prozeduren des MTP verwendet (Changeback, Controlled Rerouting, Transfer Prohibited/Allowed).

Ankommender Zeichenverkehr kann durch Blockierung der Signalling Links (Processor Outage) so lange verhindert werden, bis der anlaufende Signalling Point in der Lage ist, die Nachrichten zu routen bzw. zu den eigenen Usern weiterzuleiten.

Anmerkung:
Insbesondere bei großen Signalling Transfer Points sind die Auswirkungen mehrerer Changeback-, Rerouting und Transfer Prohibited/Allowed-Abläufe auf die Dynamik und die Signalling Performance des anlaufenden Signalling Transfer Points noch nicht überschaubar.

Ebenso ist in der Netzumgebung des anlaufenden Signalling Transfer Points Unruhe möglich.

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

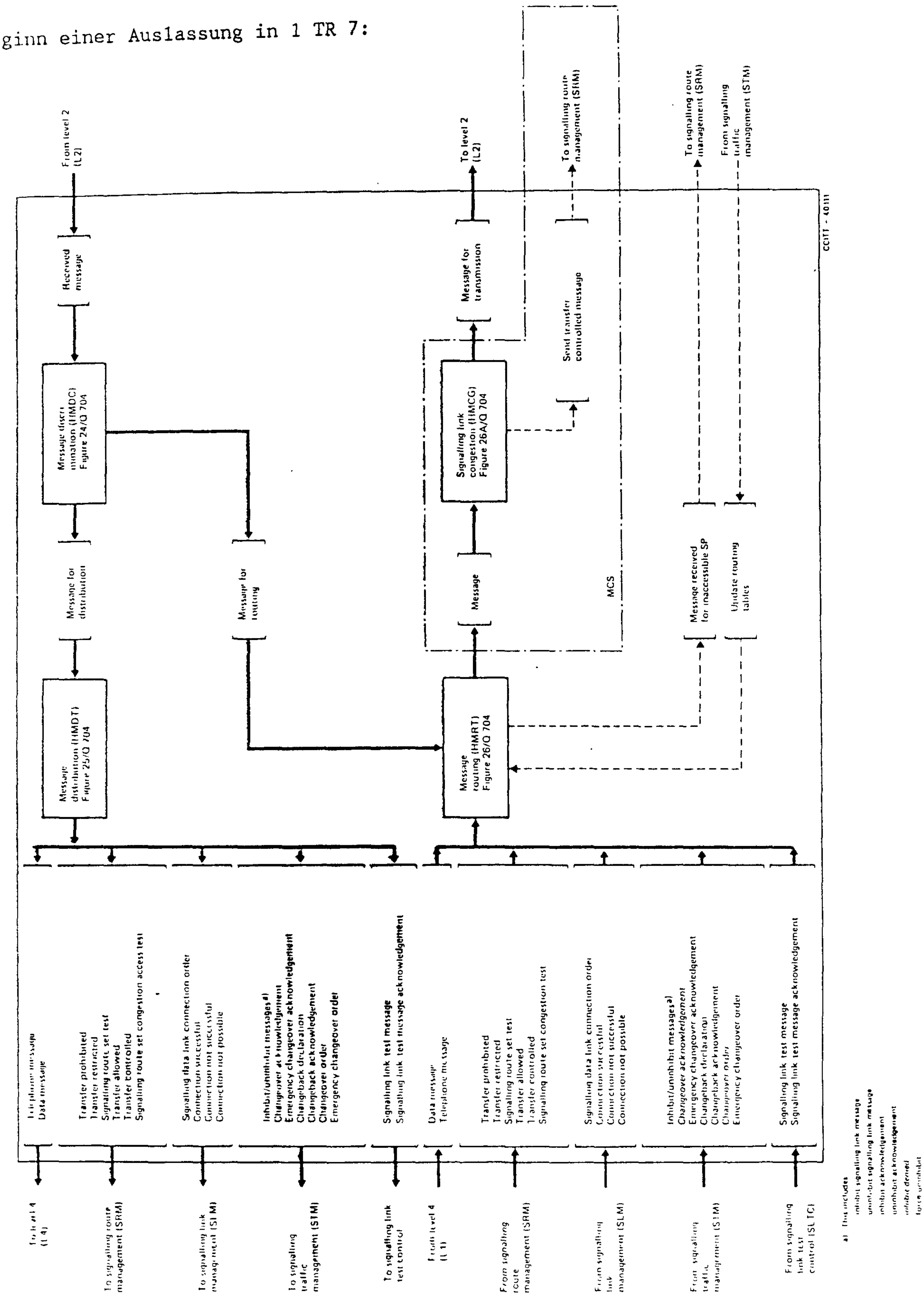


FIGURE 23/Q.704

Level 3 - Signalling message handling (SMH); funcional block interactions

Fortsetzung der Auslassung in 1 TR 7:

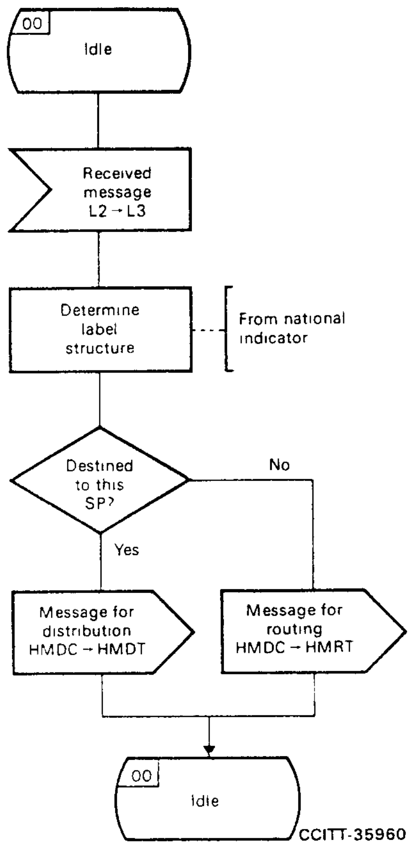


FIGURE 24/Q.704

Signalling message handling: message discrimination (HMDC)

Fortsetzung der Auslassung in 1 TR 7:

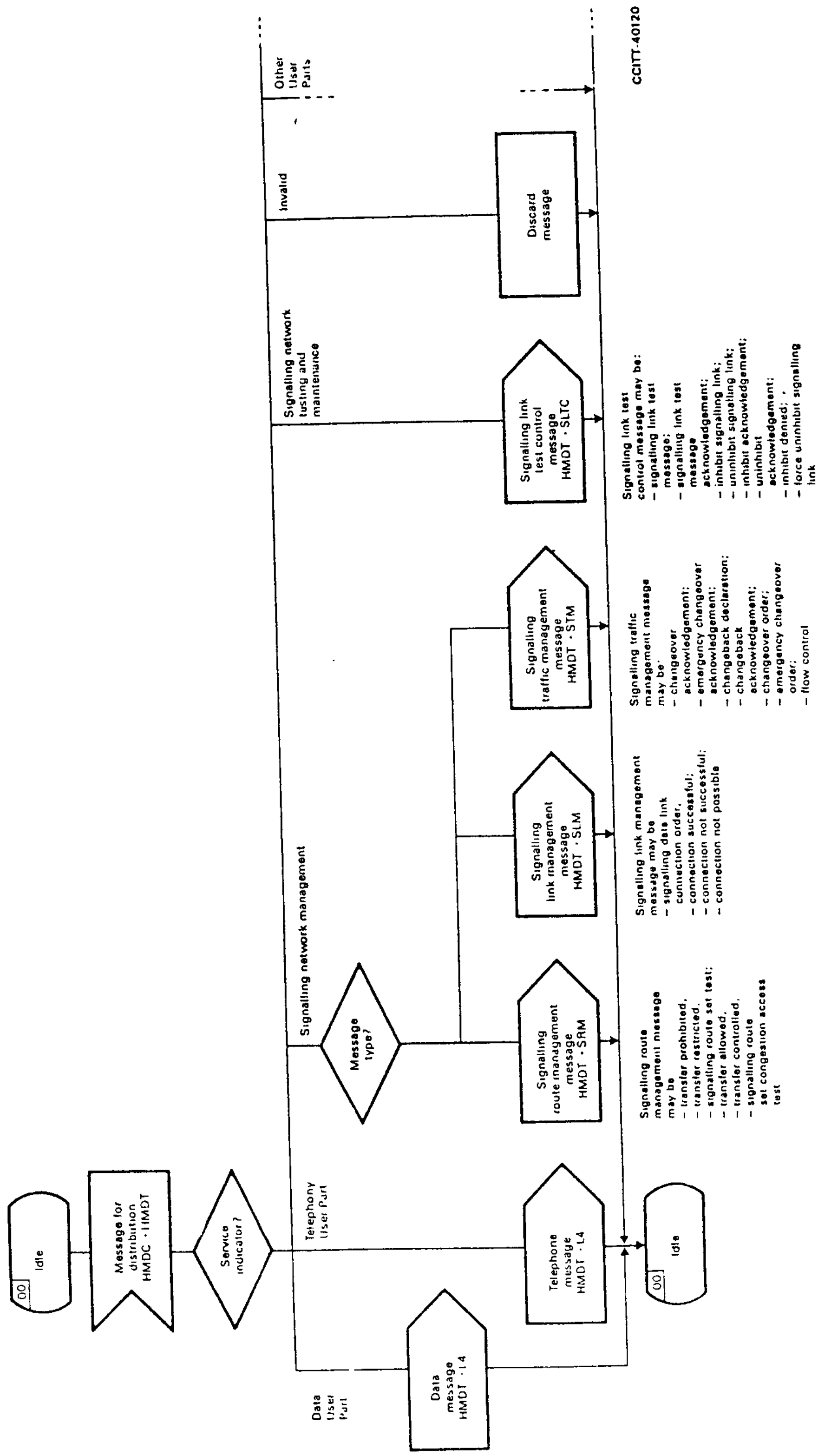


FIGURE 25/Q.704

Signalling message handling: message distribution (HMDT)

Fortsetzung der Auslassung in 1 TR 7:

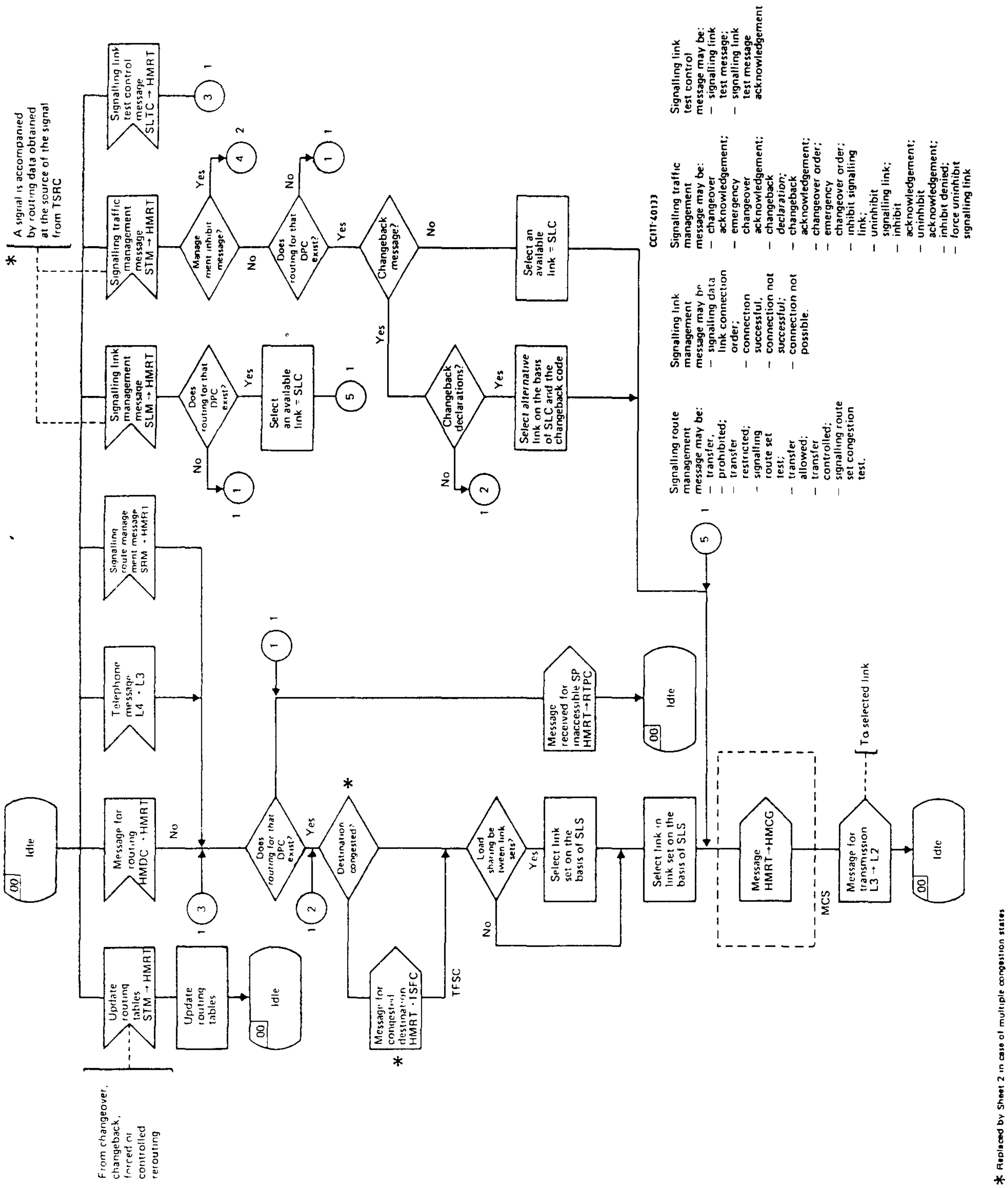


FIGURE 26/Q.704 (sheet 1 of 2)

Signalling message handling: message routing (HMRT)

Fortsetzung der Auslassung in 1 TR 7:

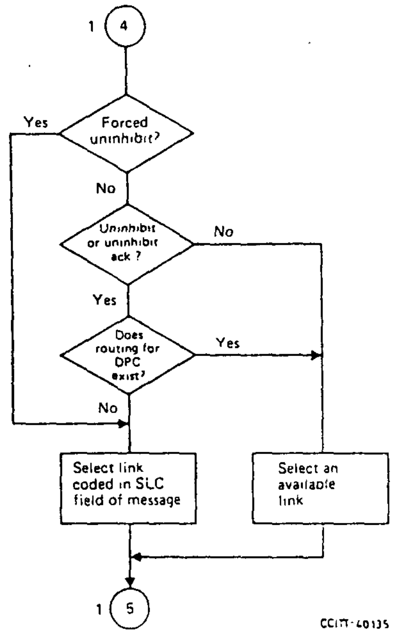


FIGURE 26/Q.704 (sheet 2 of 2)

Signalling message handling: message routing (HMRT)

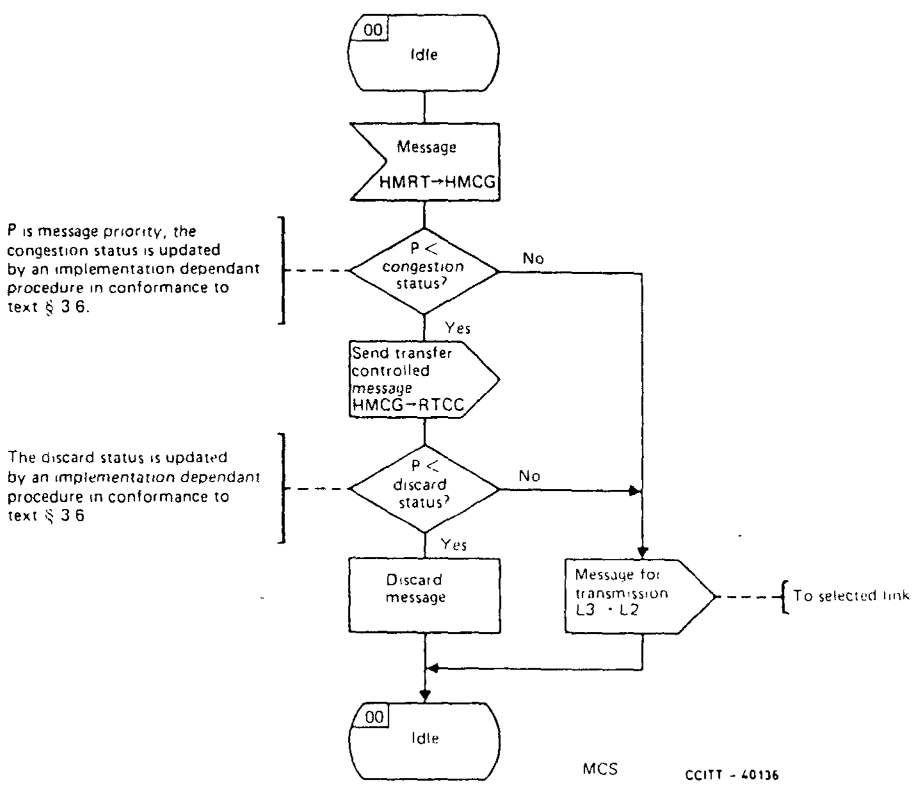


FIGURE 26A/Q.704

Signalling message handling: signalling link congestion (HMCG)

Fortsetzung der Auslassung in 1 TR 7:

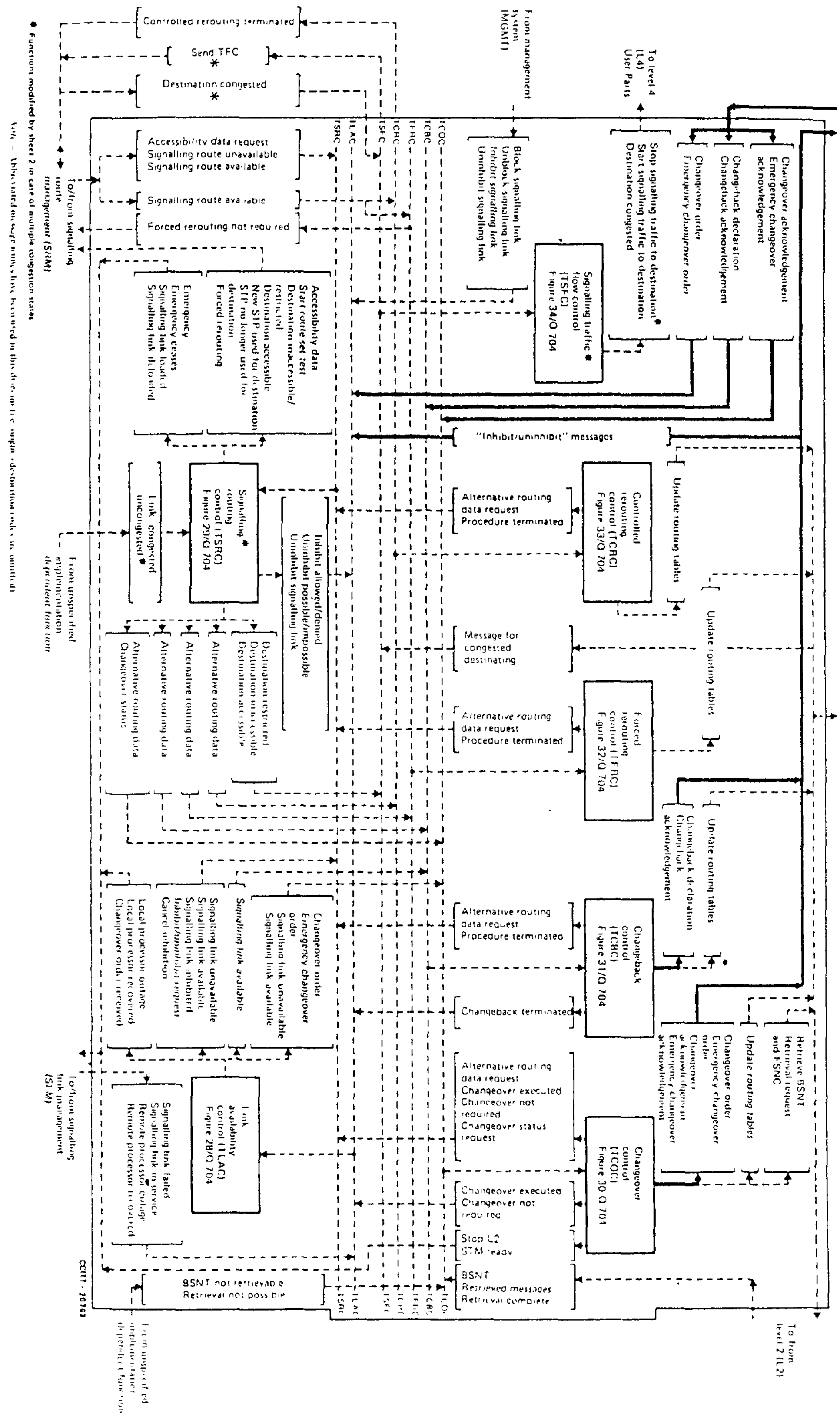


FIGURE 27/Q.704 (sheet 1 of 2)

Level 3 - Signalling traffic management (STM); functional block interactions

Fortsetzung der Auslassung in 1 TR 7:

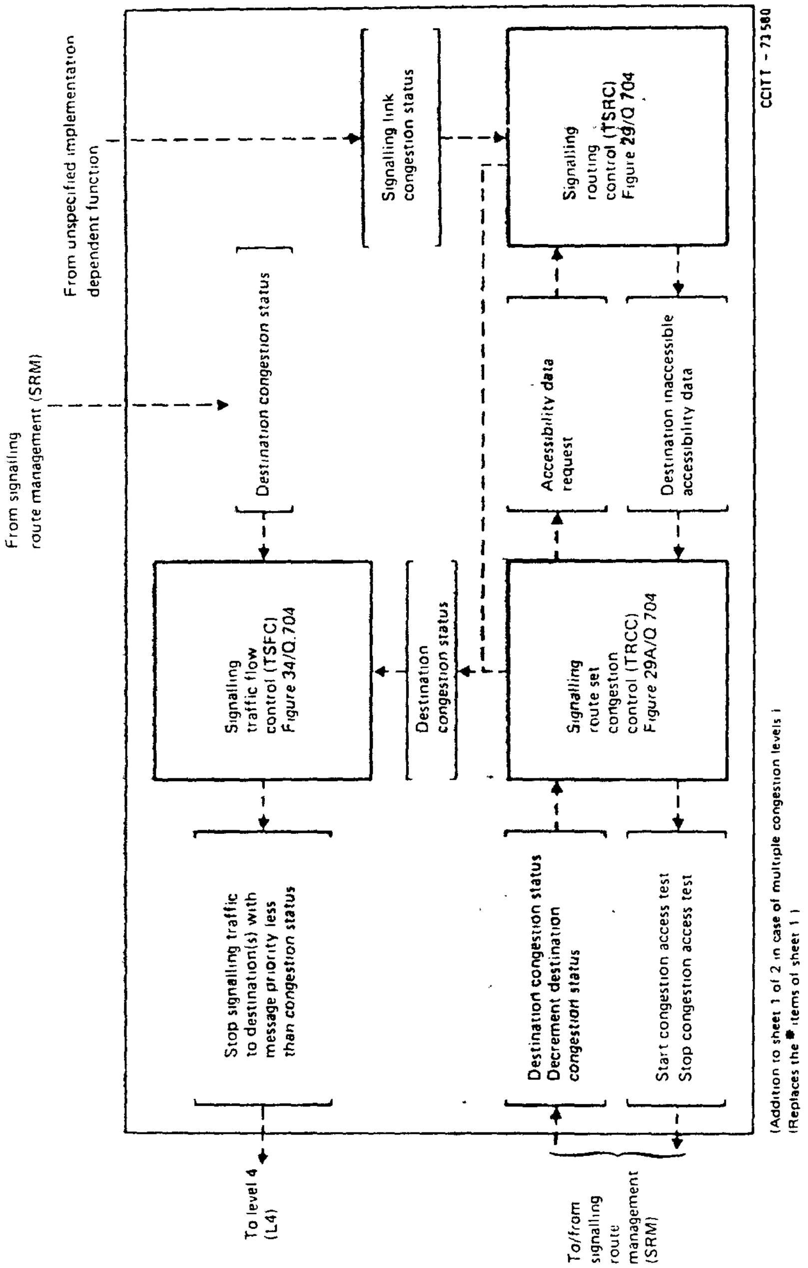


FIGURE 27/Q.704 (sheet 2 of 2)

Level 3 - Signalling traffic management (STM); functional block interactions

Fortsetzung der Auslassung in 1 TR 7:

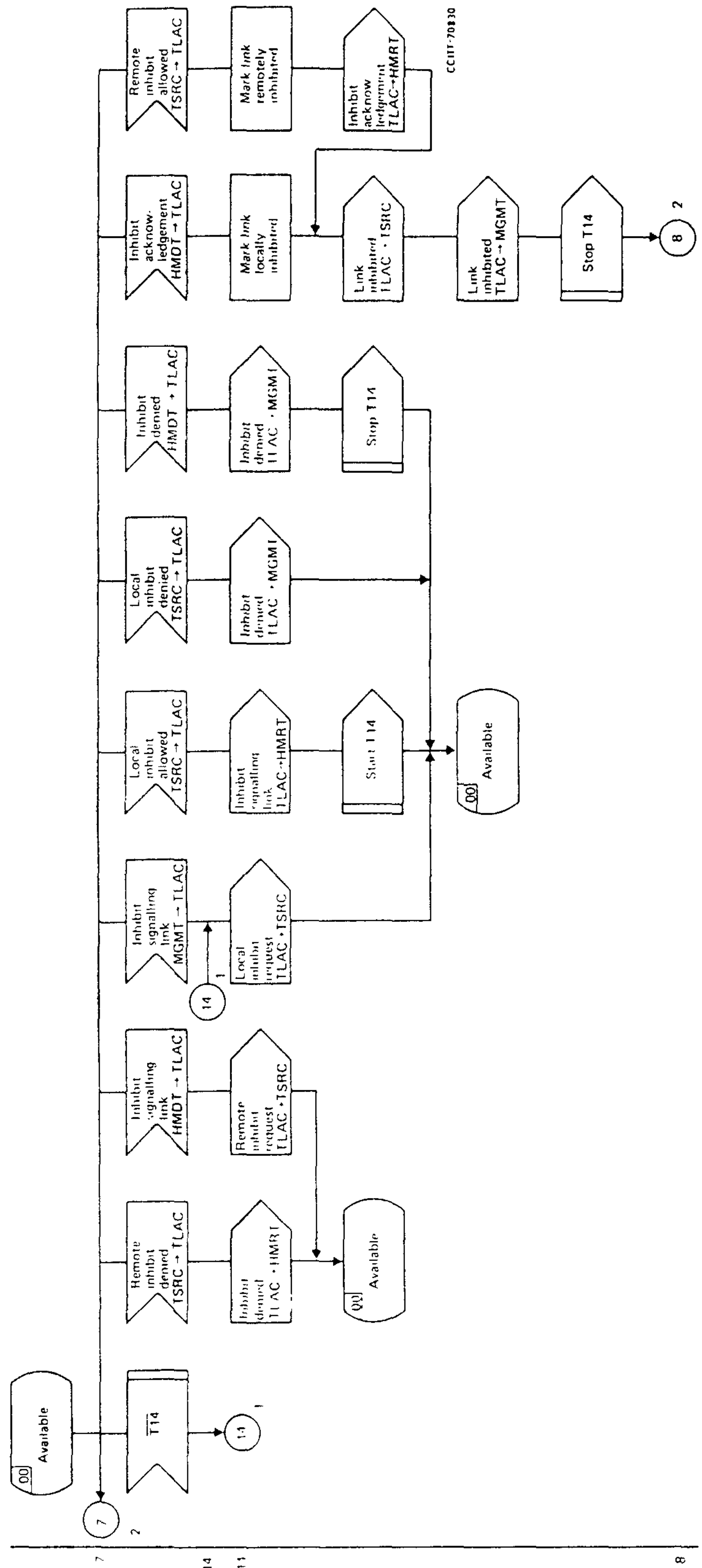


FIGURE 28/Q.704 (sheet 1 of 5)

Signalling traffic management; link availability control (TLAC)

Fortsetzung der Auslassung in 1 TR 7:

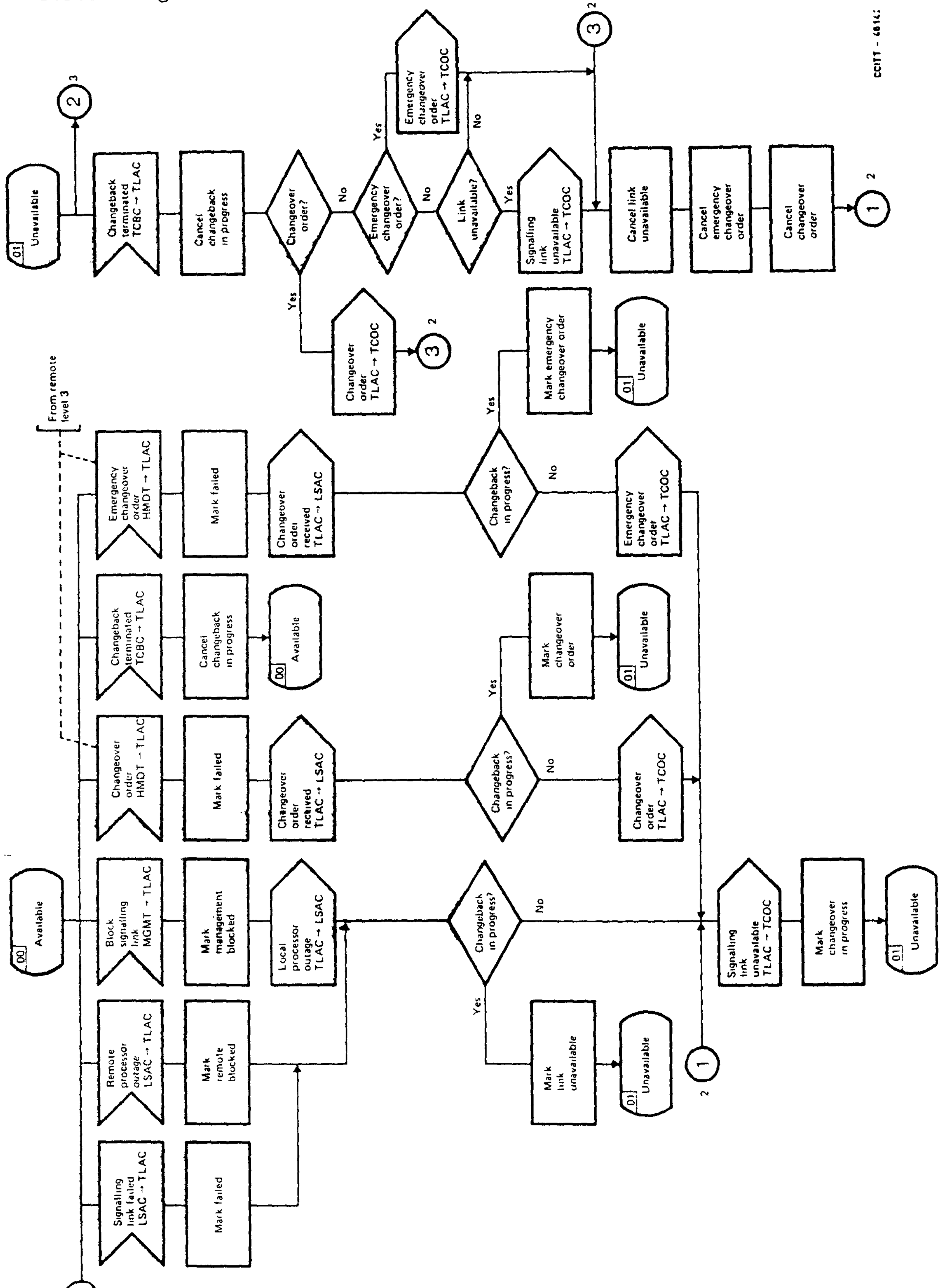


FIGURE 28/Q.704 (sheet 2 of 5)

Signalling traffic management; link availability control (TLAC)

Fortsetzung der Auslassung in 1 TR 7:

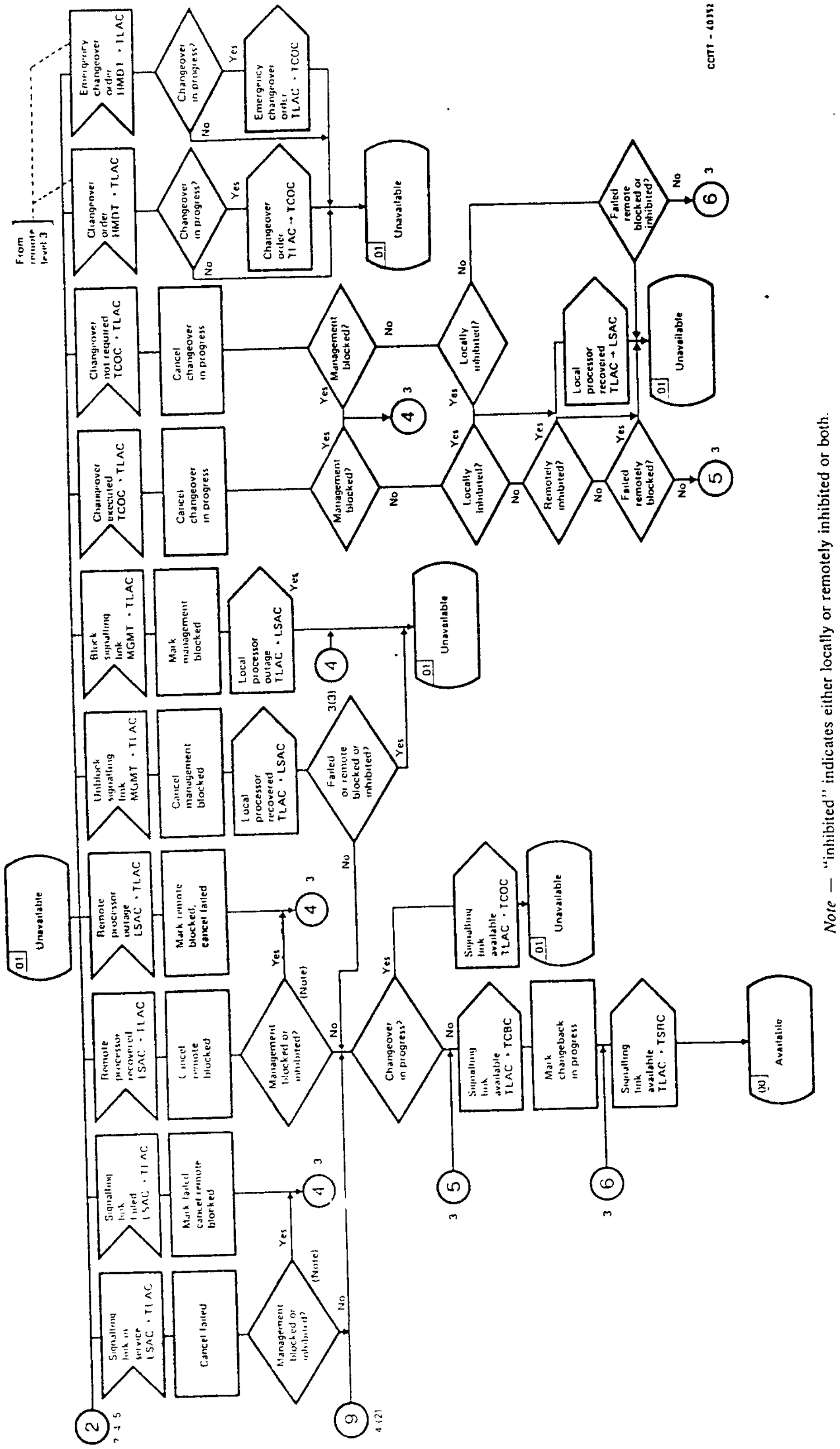


FIGURE 28/Q.704 (sheet 3 of 5)

Signalling traffic management; link availability control (TLAC)

Fortsetzung der Auslassung in 1 TR 7

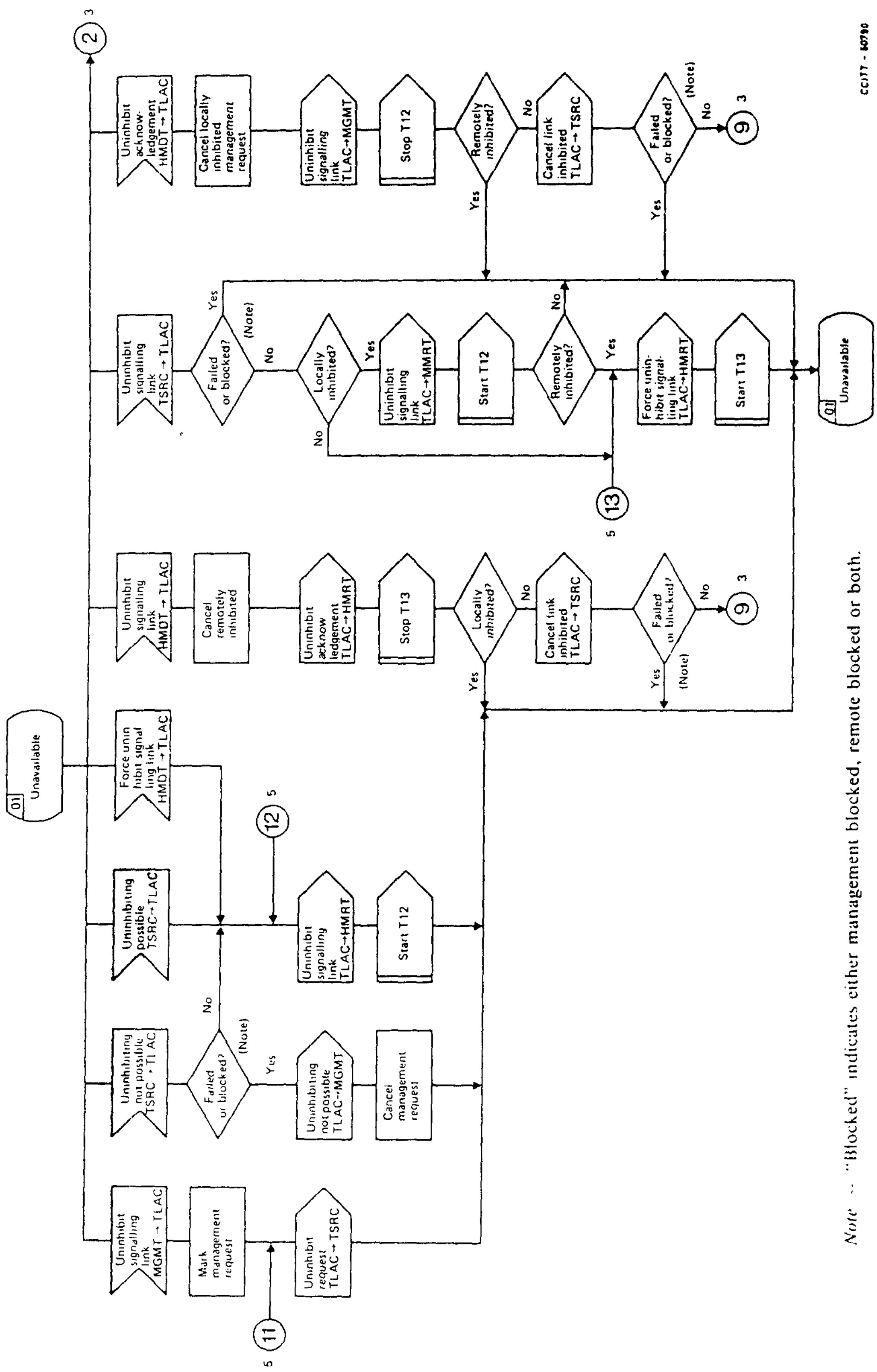


FIGURE 28/Q.704 (sheet 4 of 5)

Signalling traffic management; link availability control (TLAC)

Fortsetzung der Auslassung in 1 TR 7:

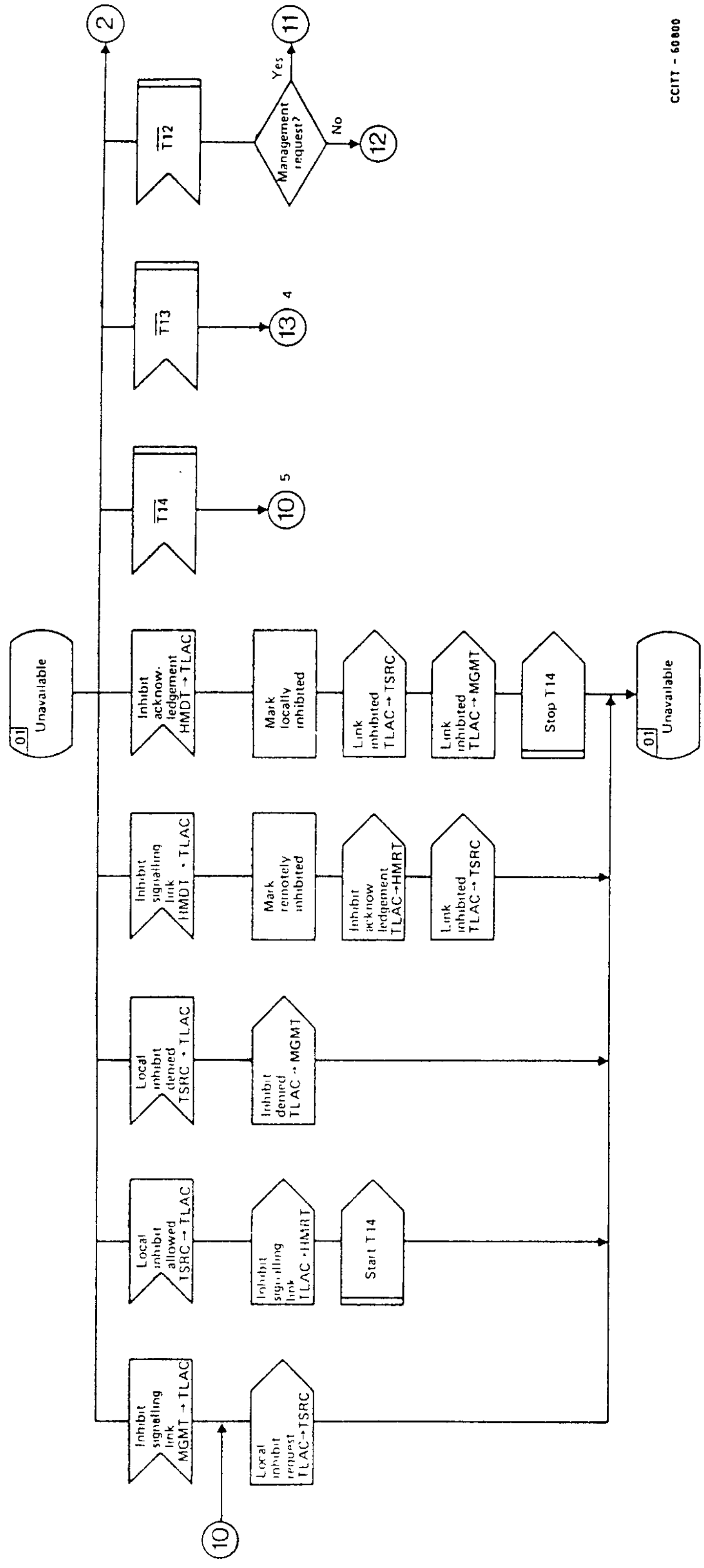


FIGURE 28/Q.704 (sheet 5 of 5)

Signalling traffic management; link availability control (TLAC)

Fortsetzung der Auslassung in 1 TR 7:

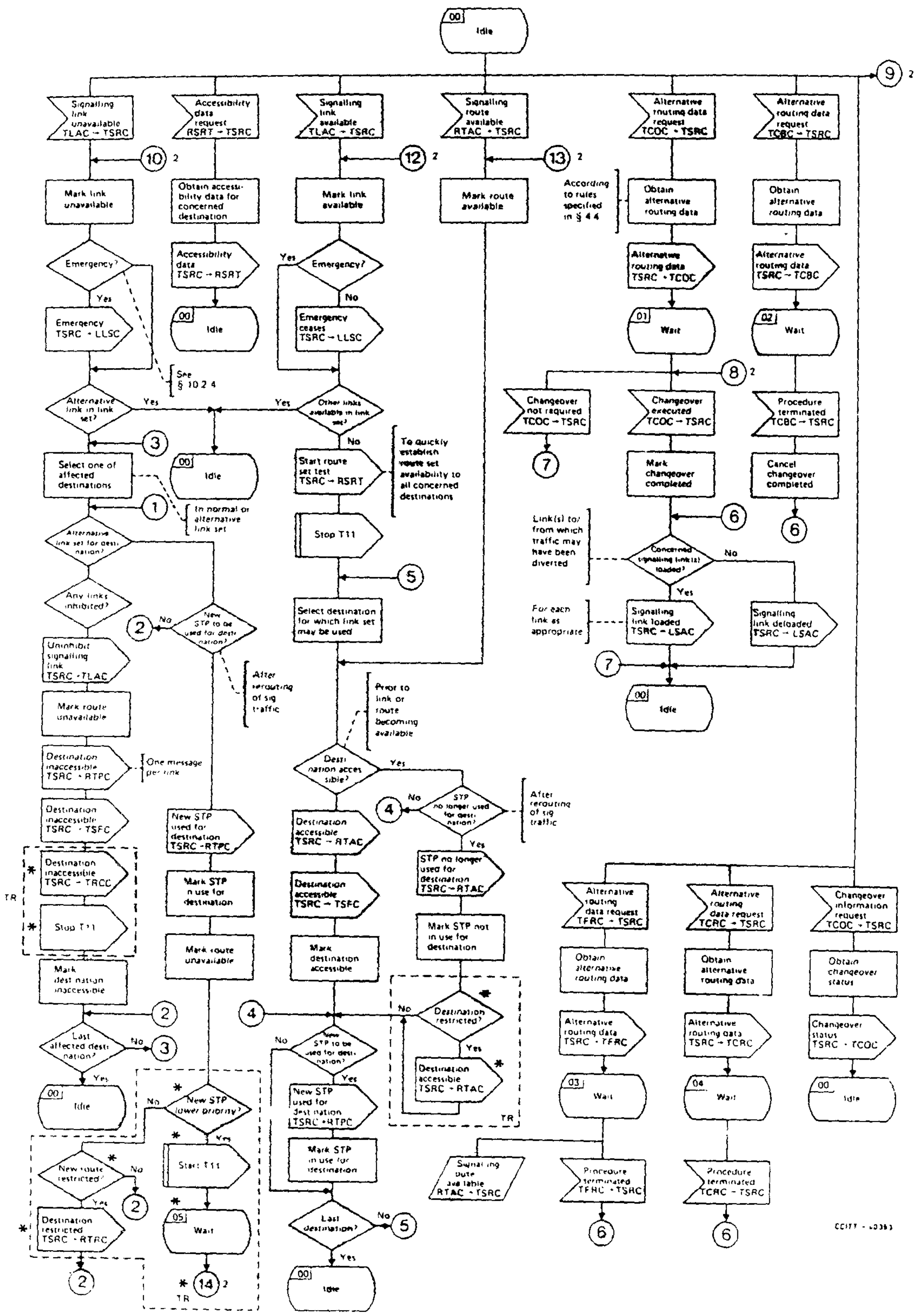


FIGURE 29/Q.704 (sheet 1 of 3)

Signalling traffic management; signalling routing control (TSRC)

Fortsetzung der Auslassung in 1 TR 7:

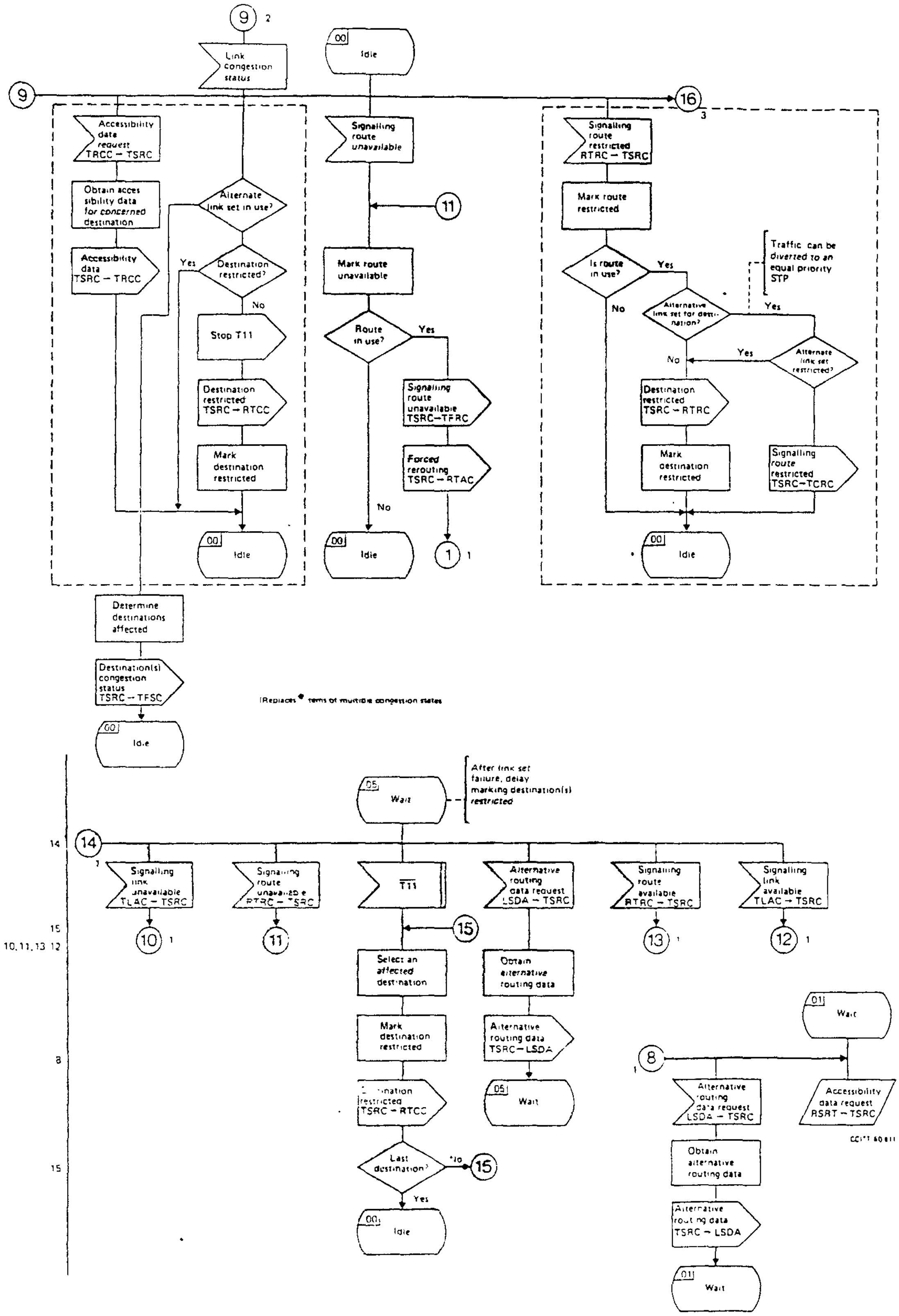


FIGURE 29/Q.704 (sheet 2 of 3)

Signalling traffic management; signalling routing control (TSRC)

Fortsetzung der Auslassung in 1 TR 7:

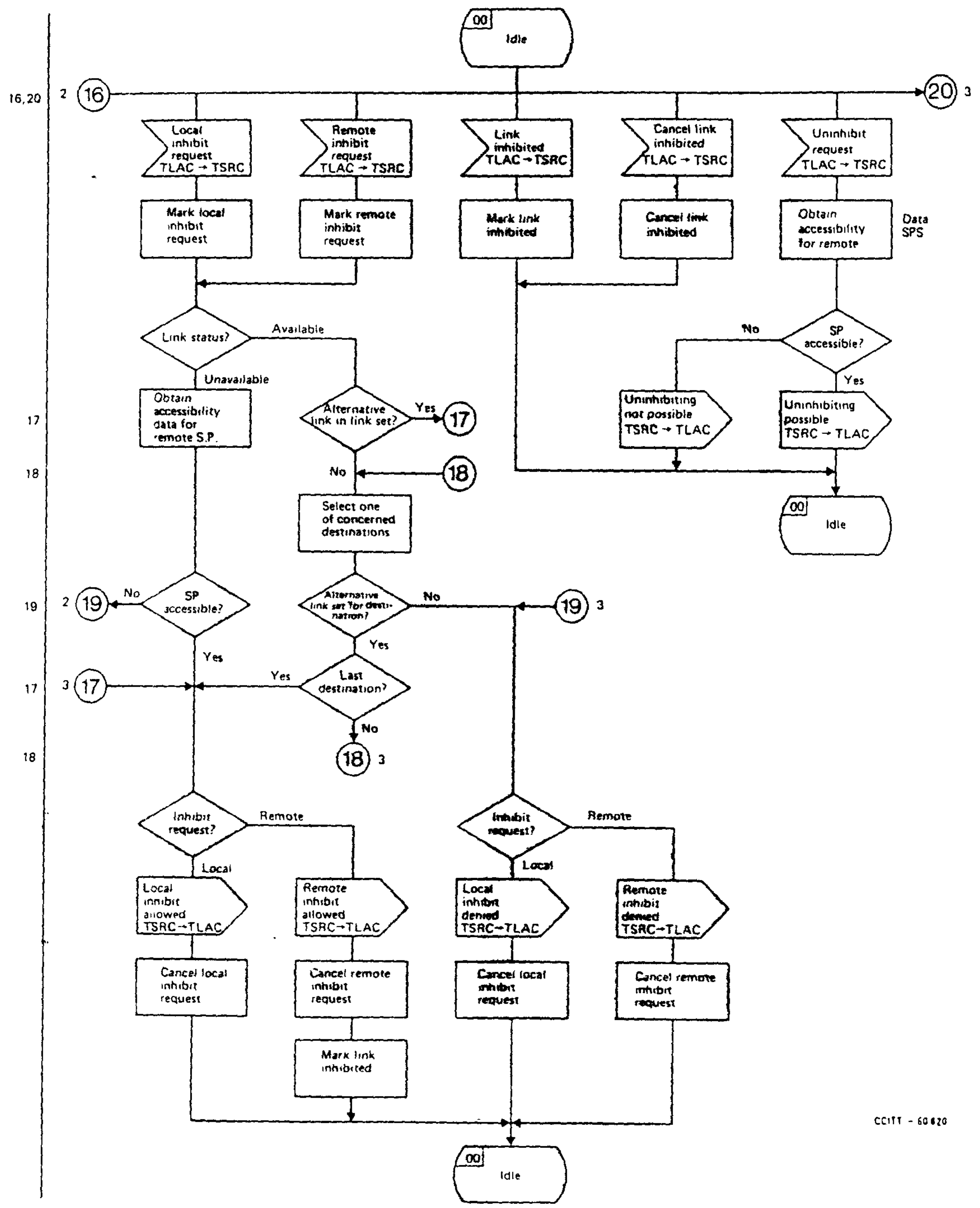


FIGURE 29/Q.704 (sheet 3 of 3)

Signalling traffic management; signalling routing control (TSRC)

Fortsetzung der Auslassung in 1 TR 7:

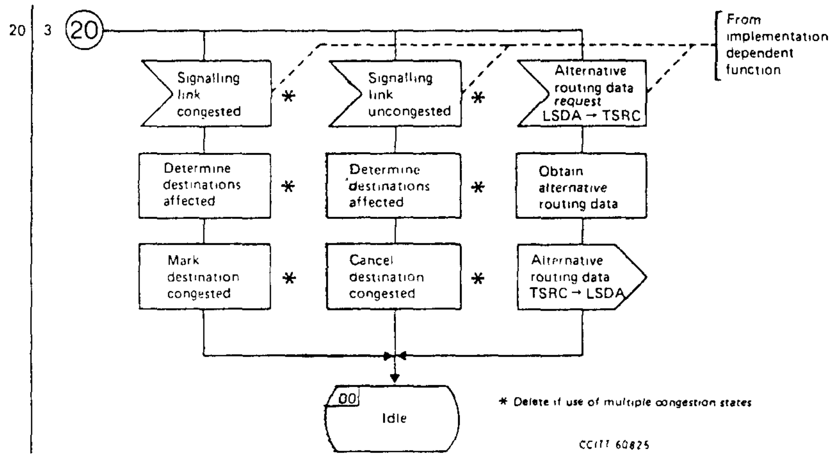


FIGURE 29/Q.704 (sheet 3 of 3)

Signalling traffic management; signalling routing control (TSRC)

Fortsetzung der Auslassung in 1 TR 7:

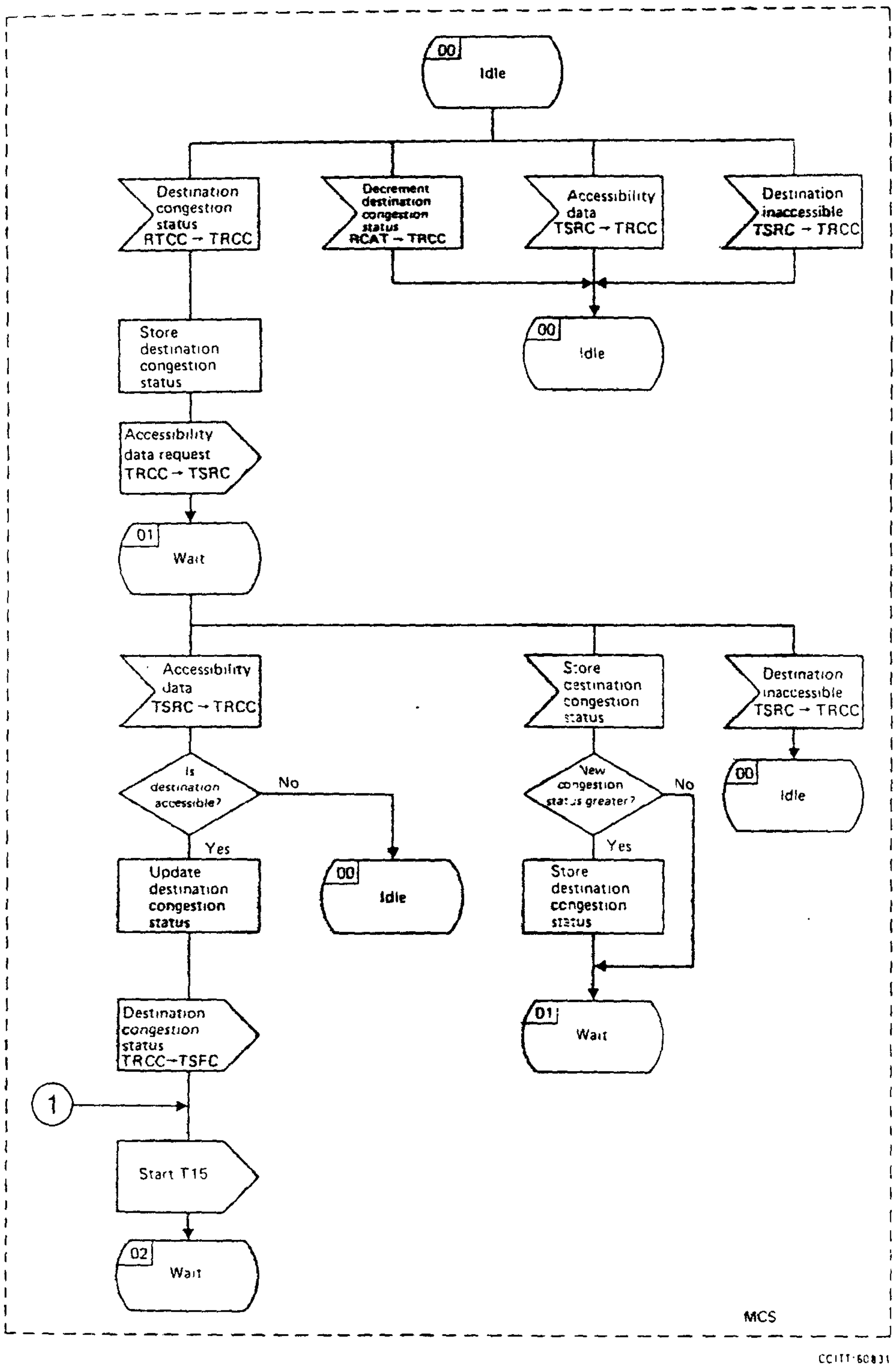
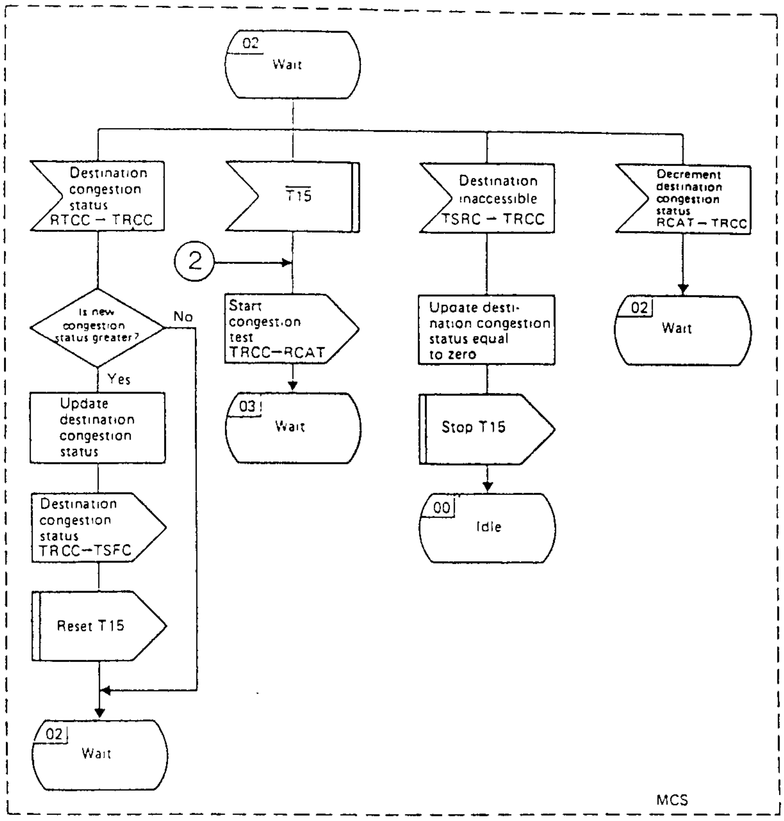


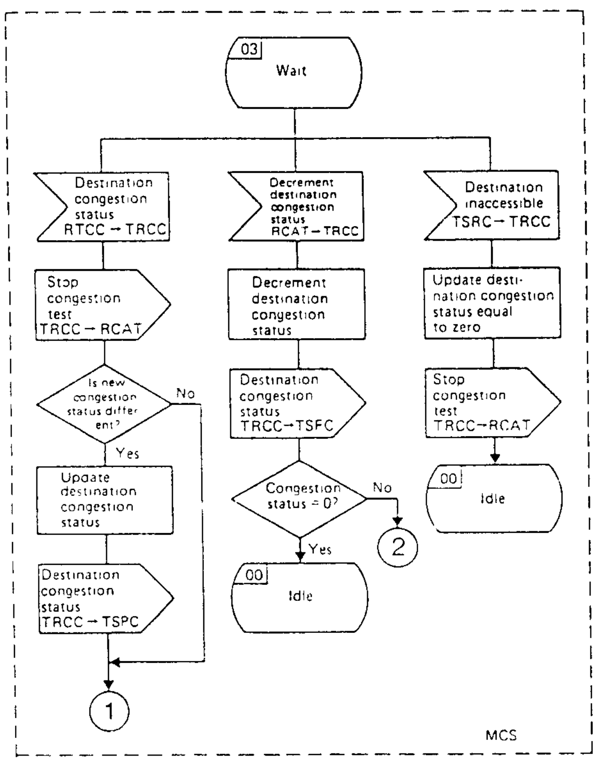
FIGURE 29A/Q.704 (sheet 1 of 2)

Signalling traffic management;
signalling route set congestion control (TRCC)

Fortsetzung der Auslassung in 1 TR 7:



CCITT-60841



CCITT-60842

FIGURE 29A/Q.704 (sheet 2 of 2)

Signalling traffic management;
signalling route set congestion control (TRCC)

Fortsetzung der Auslassung in 1 TR 7:

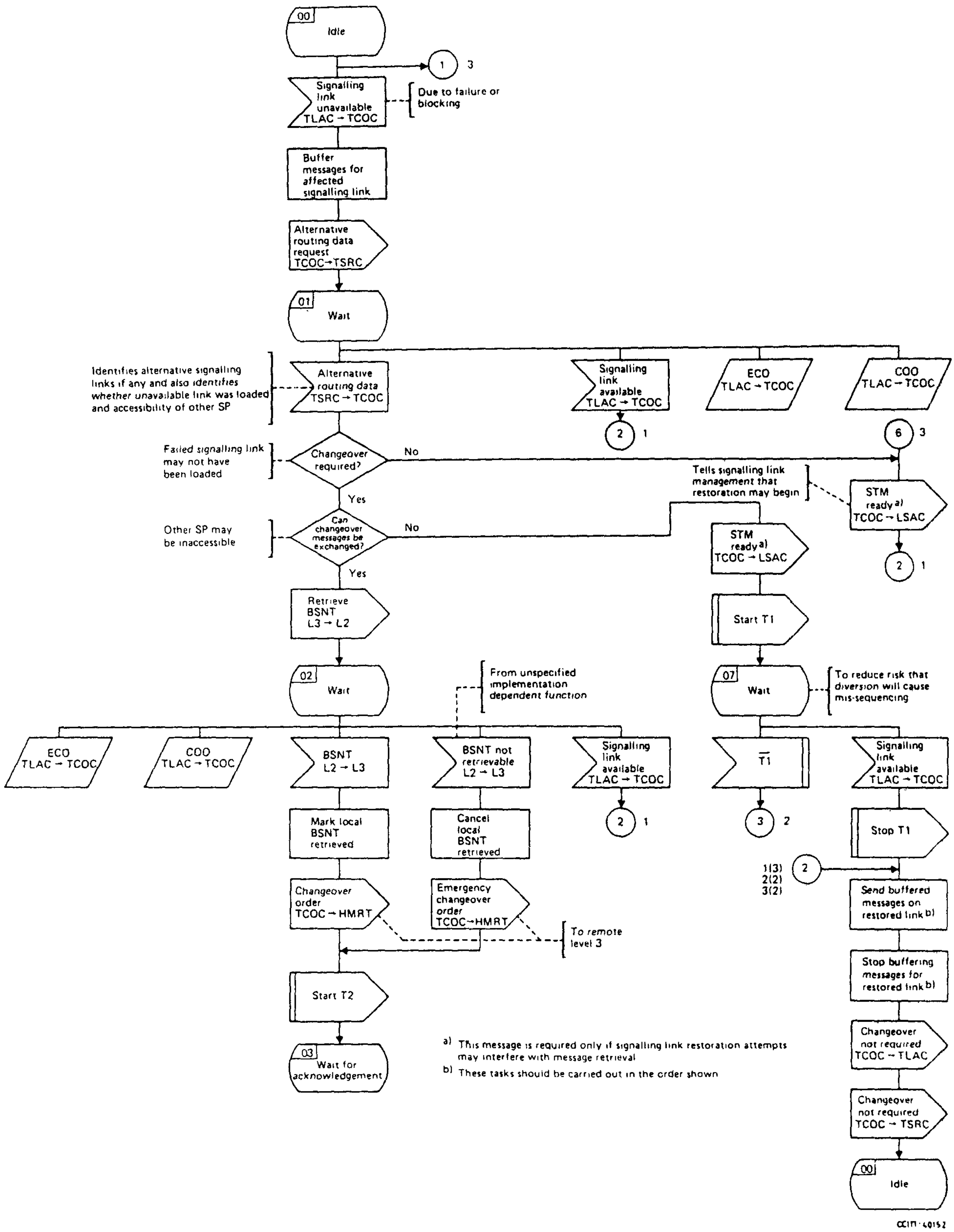


FIGURE 30/Q.704 (sheet 1 of 3)

Signalling traffic management; changeover control (TCOC)

Fortsetzung der Auslassung in 1 TR 7:

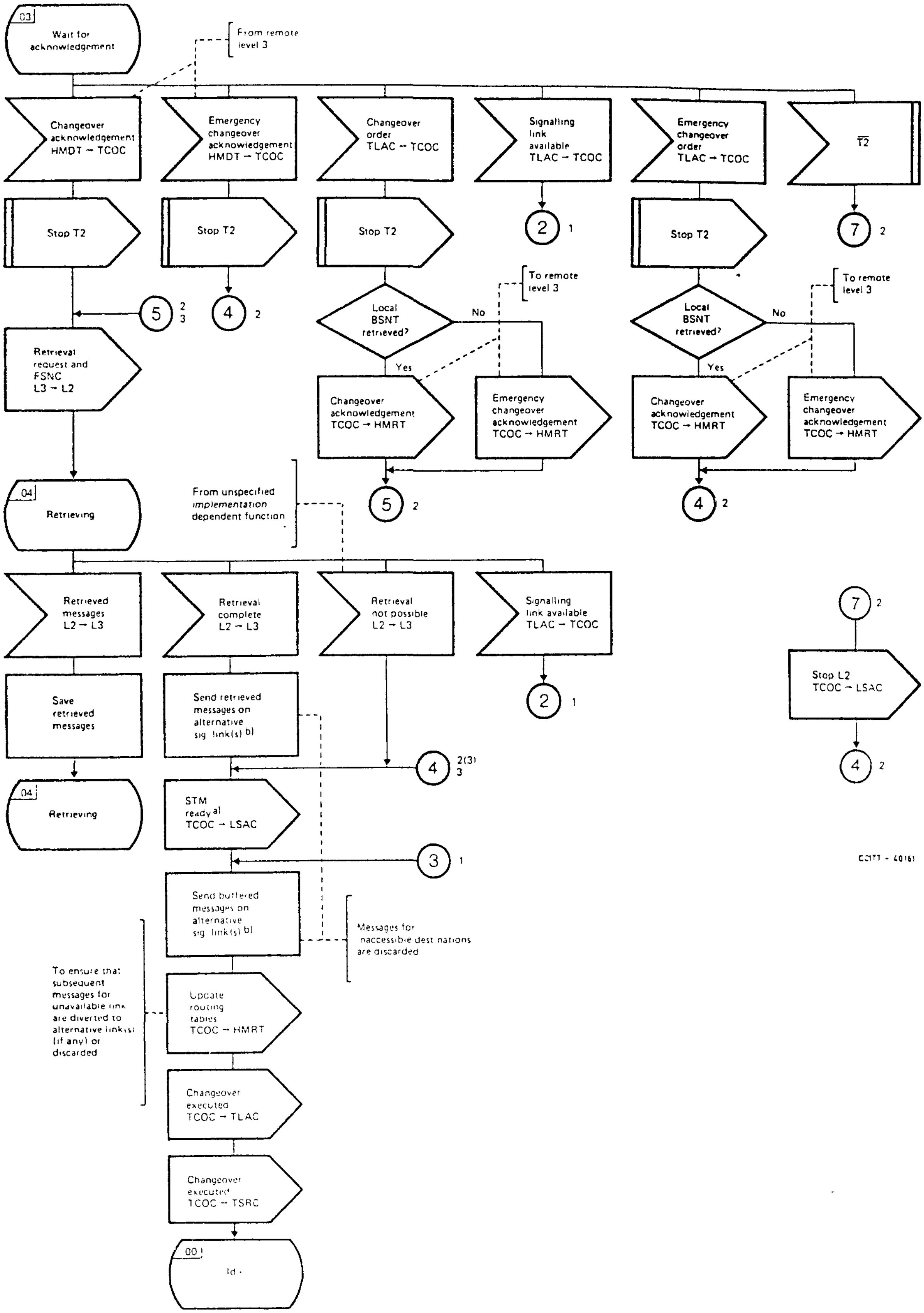


FIGURE 30/Q.704 (sheet 2 of 3)

Signalling traffic management; changeover control (TCOC)

Fortsetzung der Auslassung in 1 TR 7:

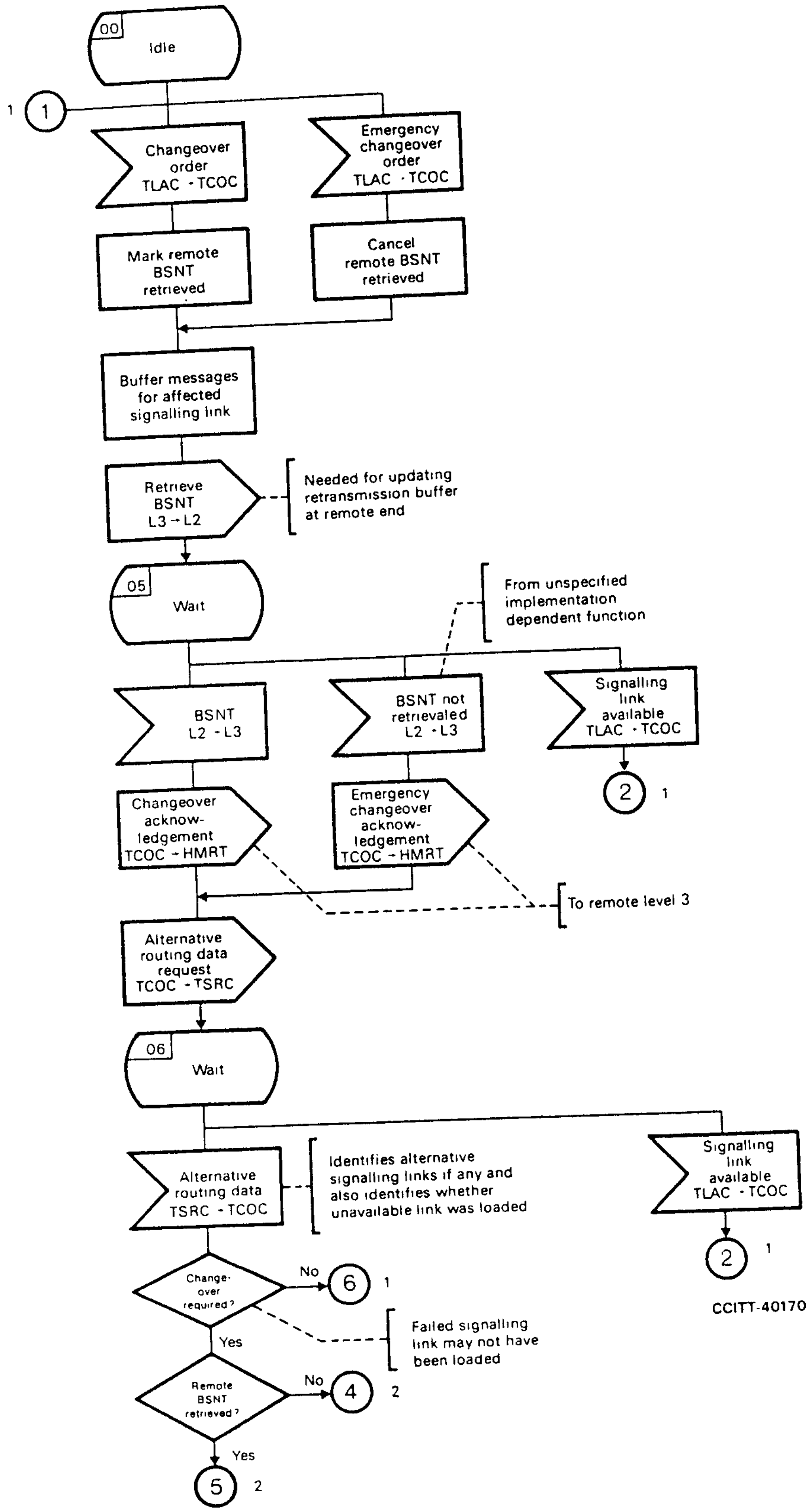
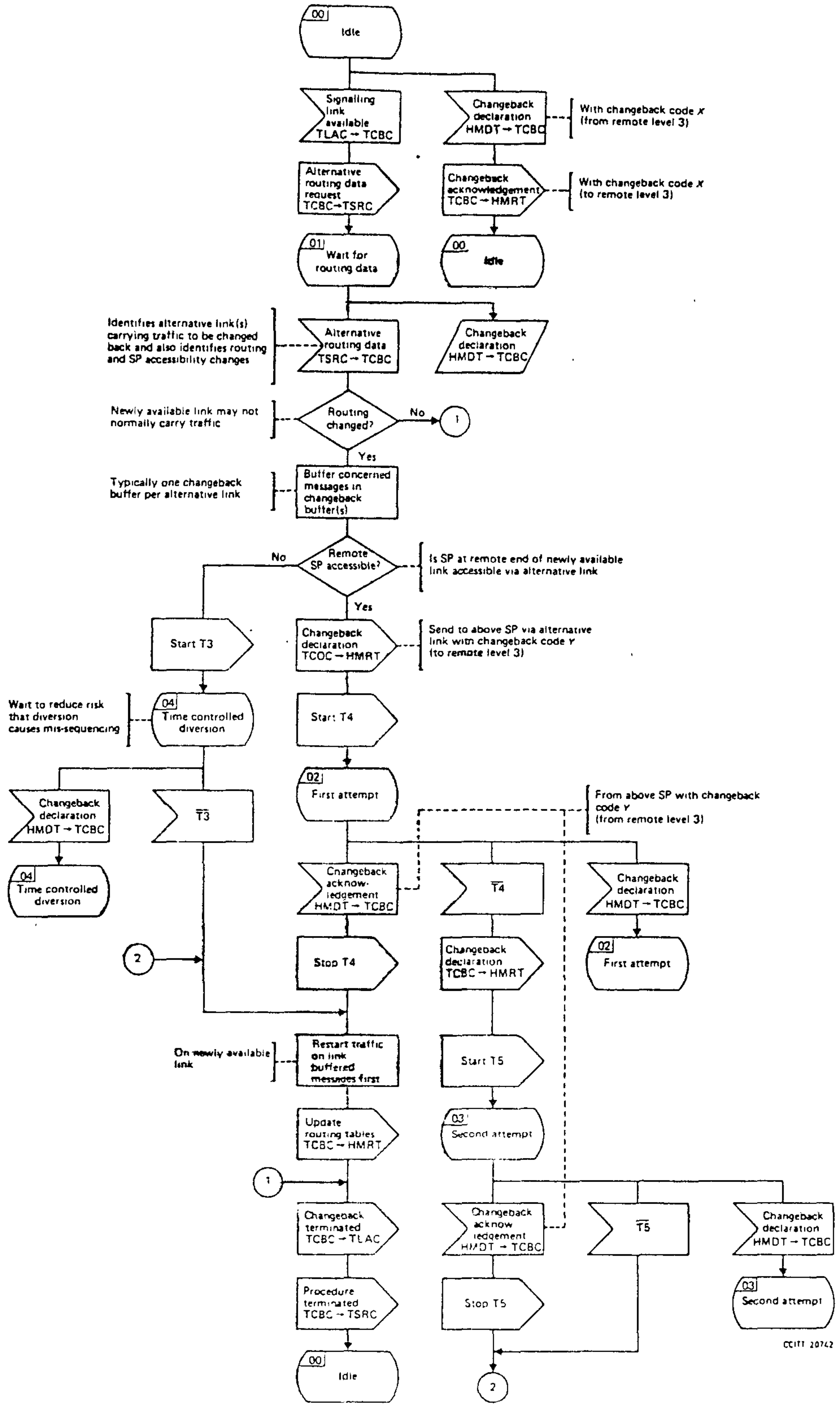


FIGURE 30/Q.704 (sheet 3 of 3)

Signalling traffic management; changeover control (TCOC)

Fortsetzung der Auslassung in 1 TR 7:



Note – For simplicity, changeback from only one alternative link is shown

FIGURE 31/Q.704

Signalling traffic management; changeback control (TCBC)

Fortsetzung der Auslassung in 1 TR 7:

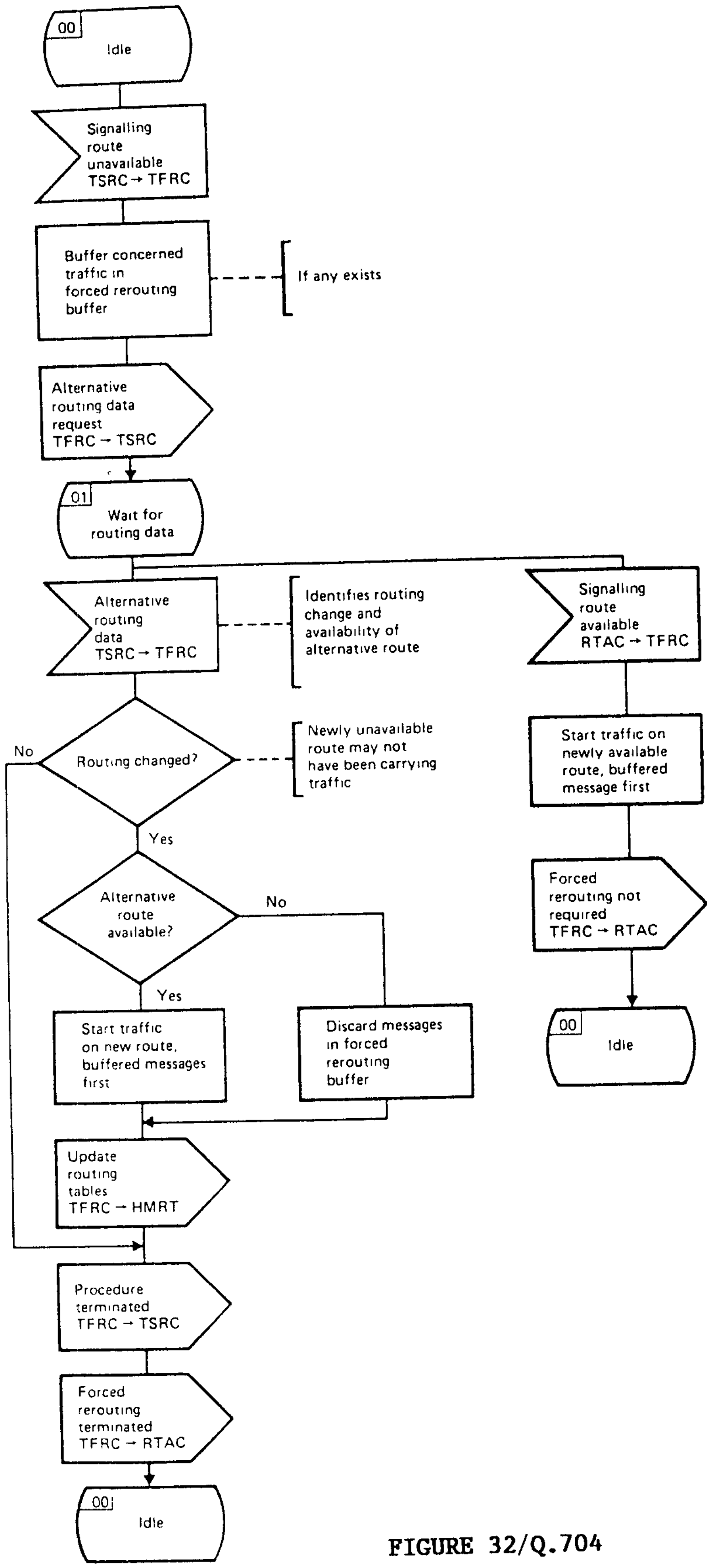


FIGURE 32/Q.704

Signalling traffic management; forced rerouting control (TFRC)

Fortsetzung der Auslassung in 1 TR 7:

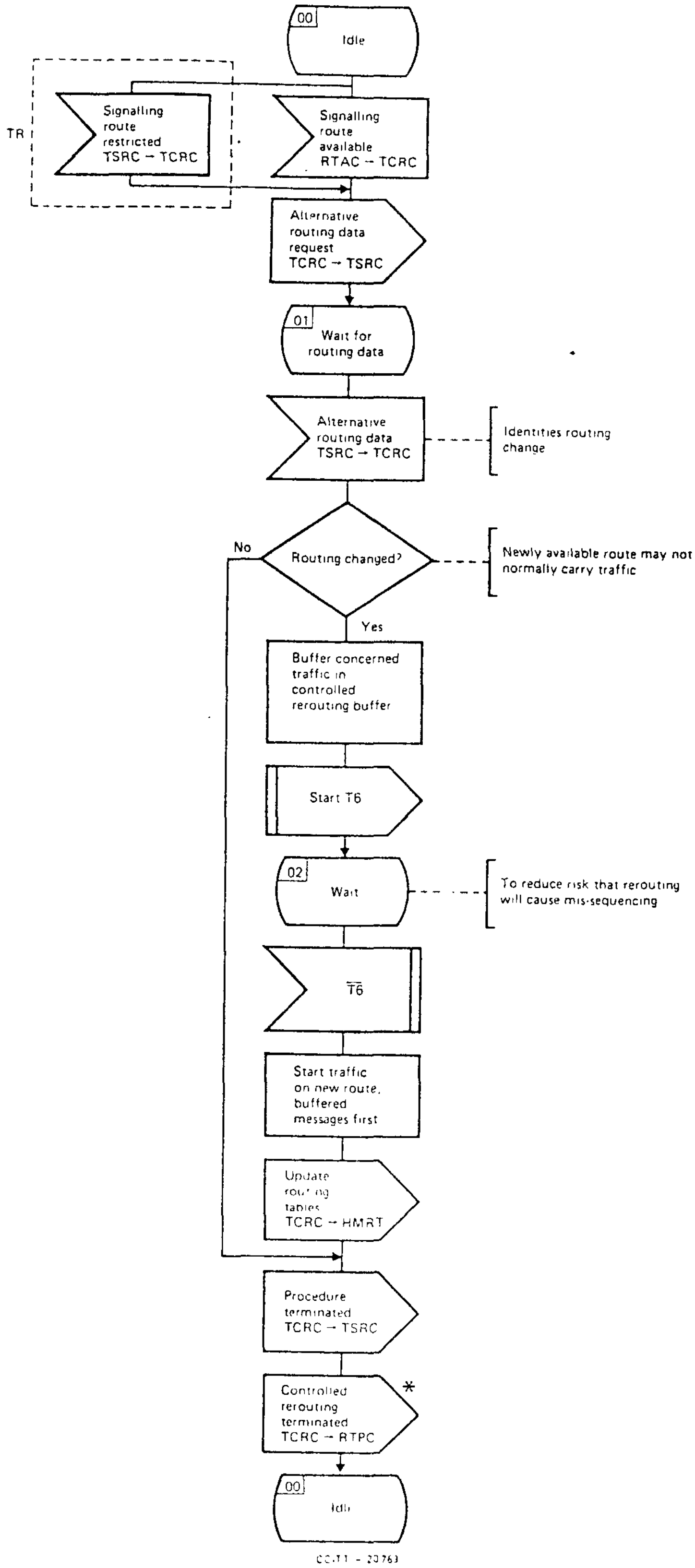


FIGURE 33/Q.704

Signalling traffic management; controlled rerouting control (TCRC)

Fortsetzung der Auslassung in 1 TR 7:

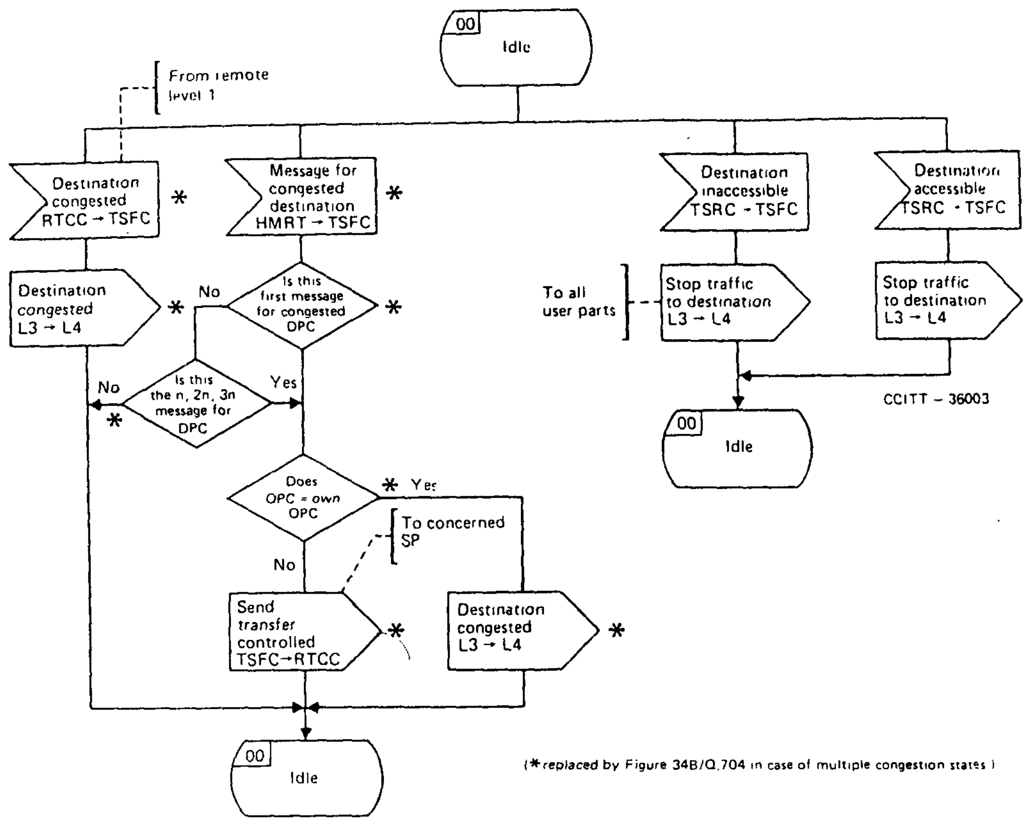


FIGURE 34A/Q.704

Signalling traffic management; signalling traffic flow control (TSFC)

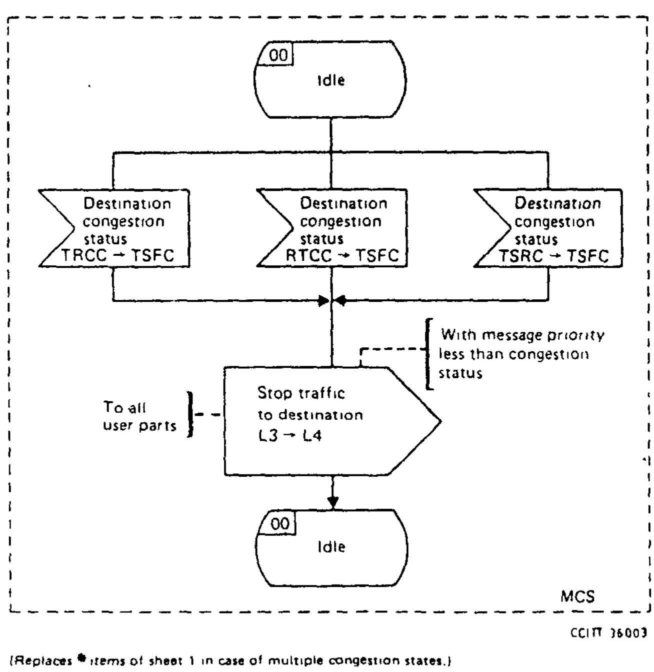
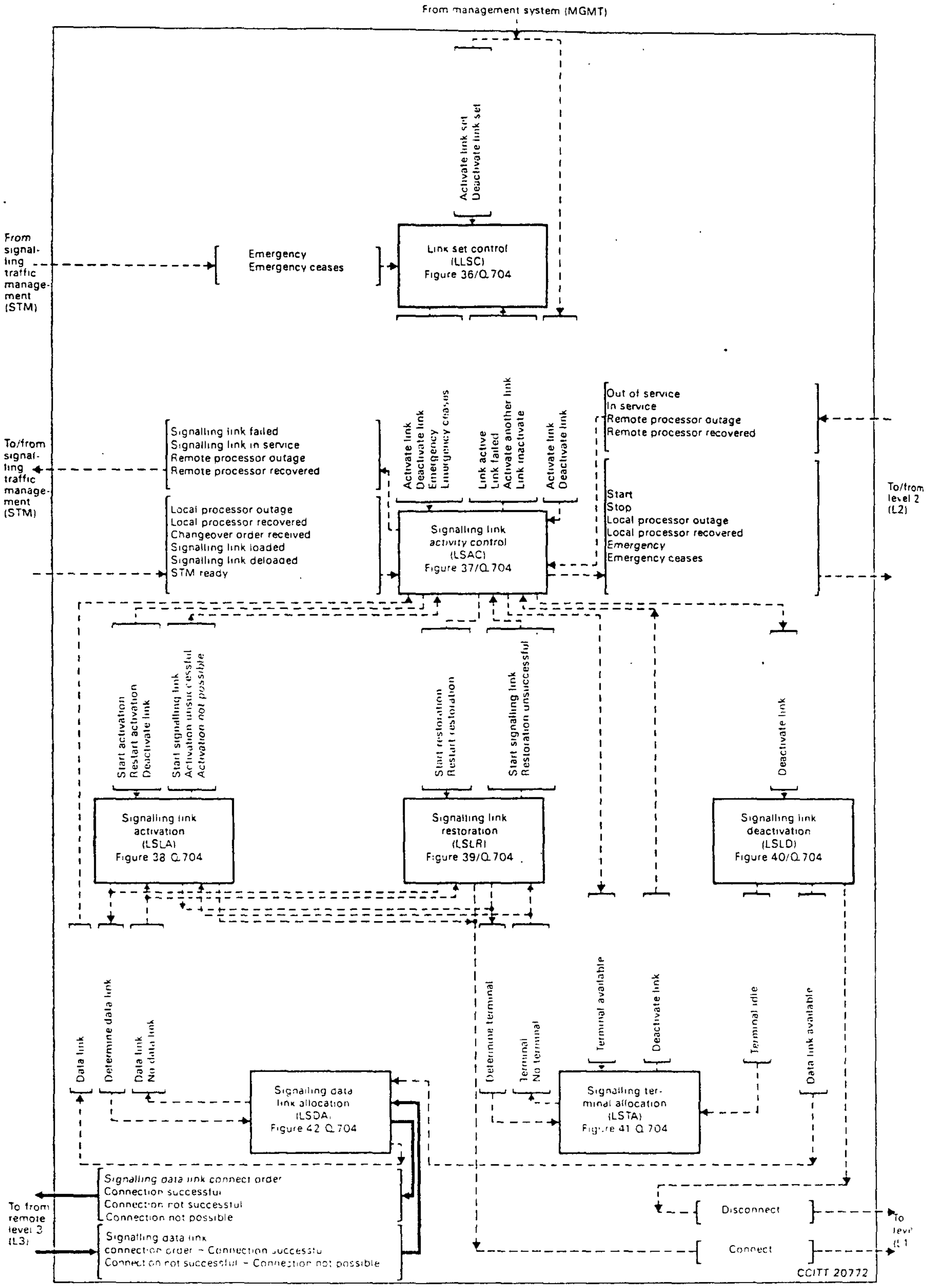


FIGURE 34B/Q.704

Signalling traffic management; signalling traffic flow control (TSFC)

Fortsetzung der Auslassung in 1 TR 7:



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

Fortsetzung der Auslassung in 1 TR 7:

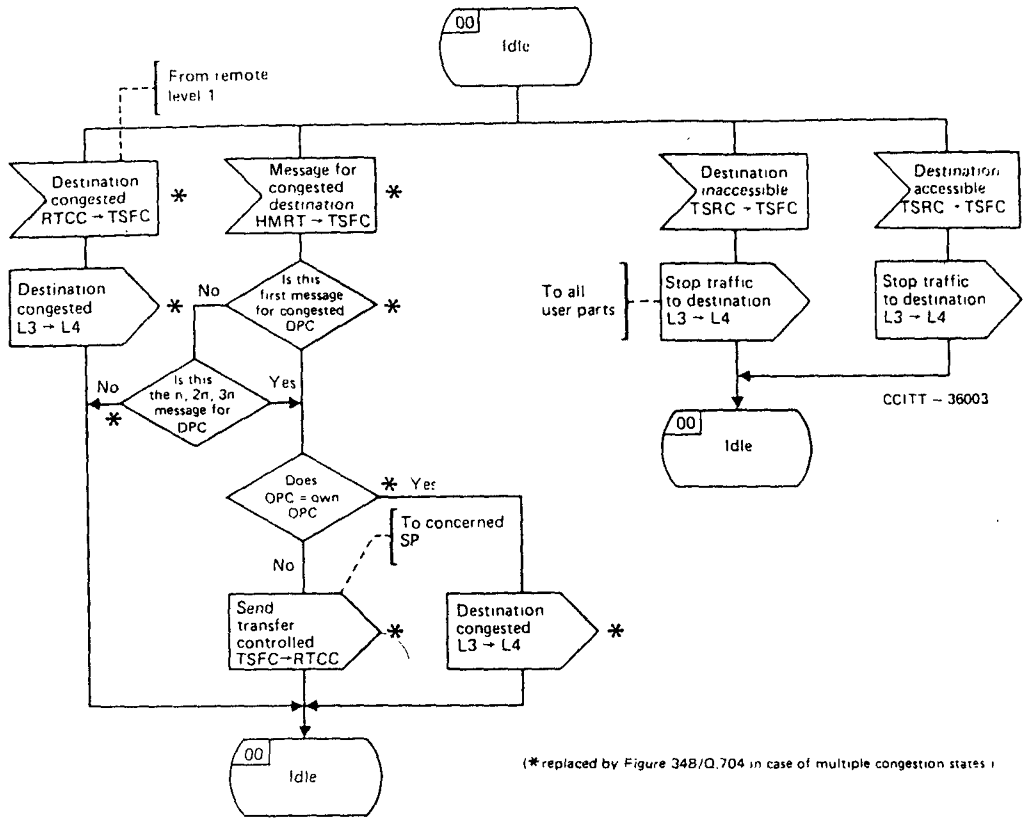


FIGURE 34A/Q.704

Signalling traffic management; signalling traffic flow control (TSFC)

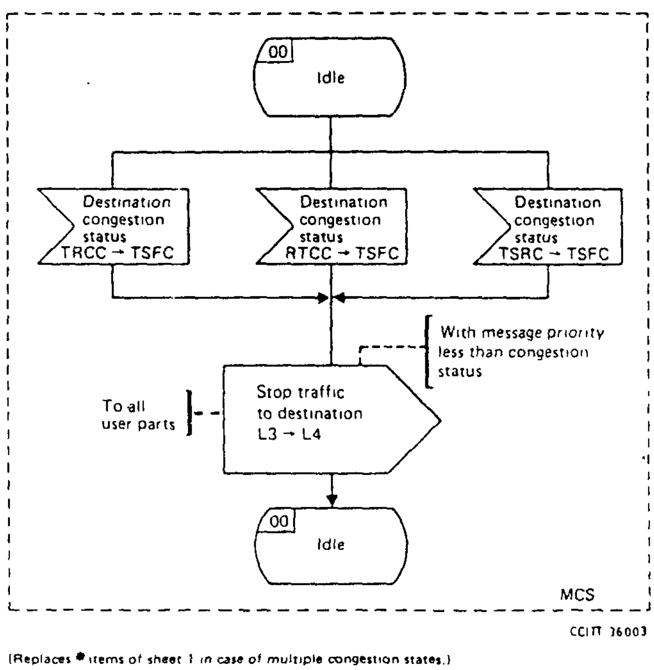


FIGURE 34B/Q.704

Signalling traffic management; signalling traffic flow control (TSFC)

Fortsetzung der Auslassung in 1 TR 7:

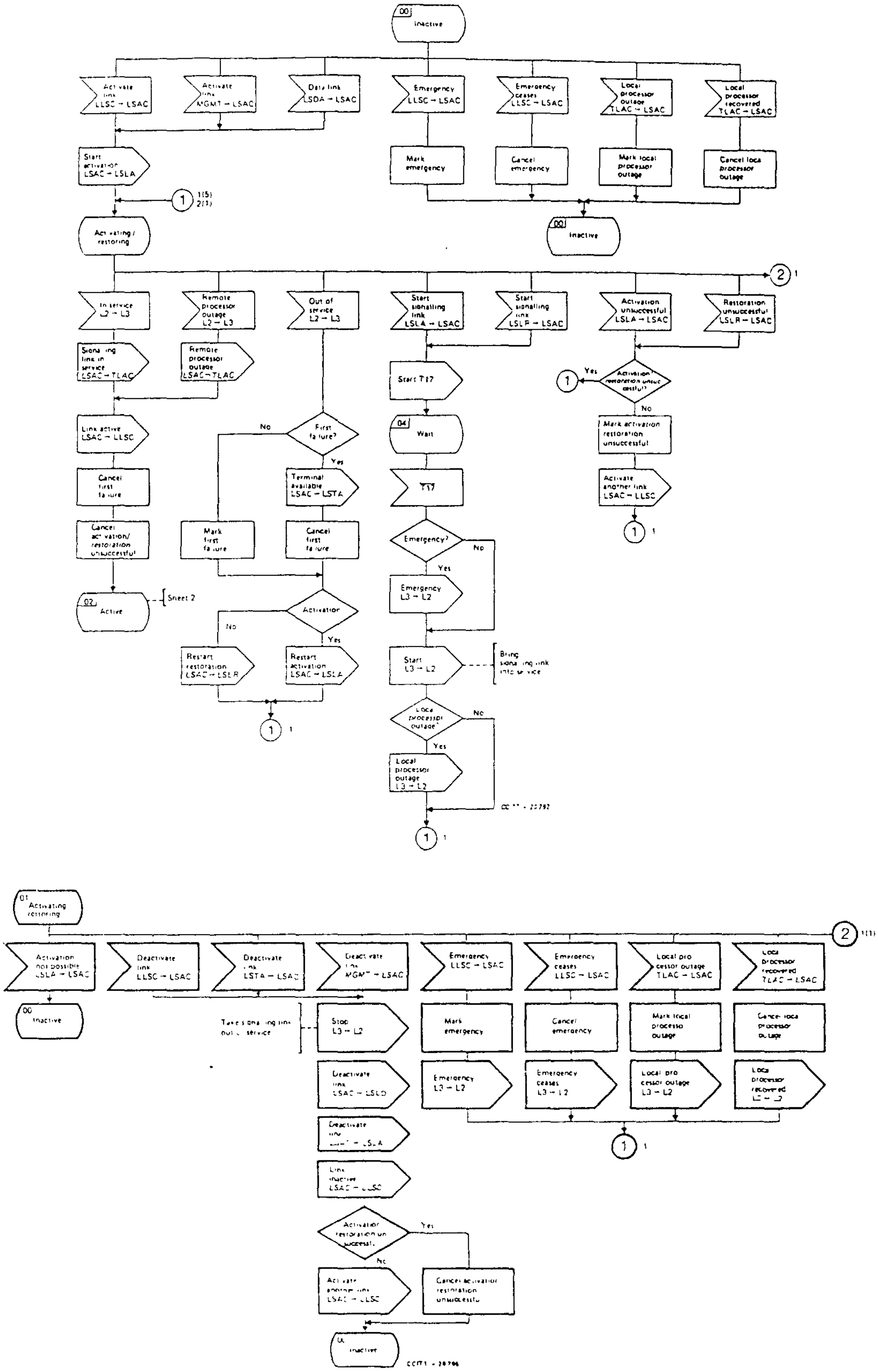


FIGURE 37/Q.704 (sheet 1 of 2)

Signalling link management; signalling link activity control (LSAC)

Fortsetzung der Auslassung in 1 TR 7:

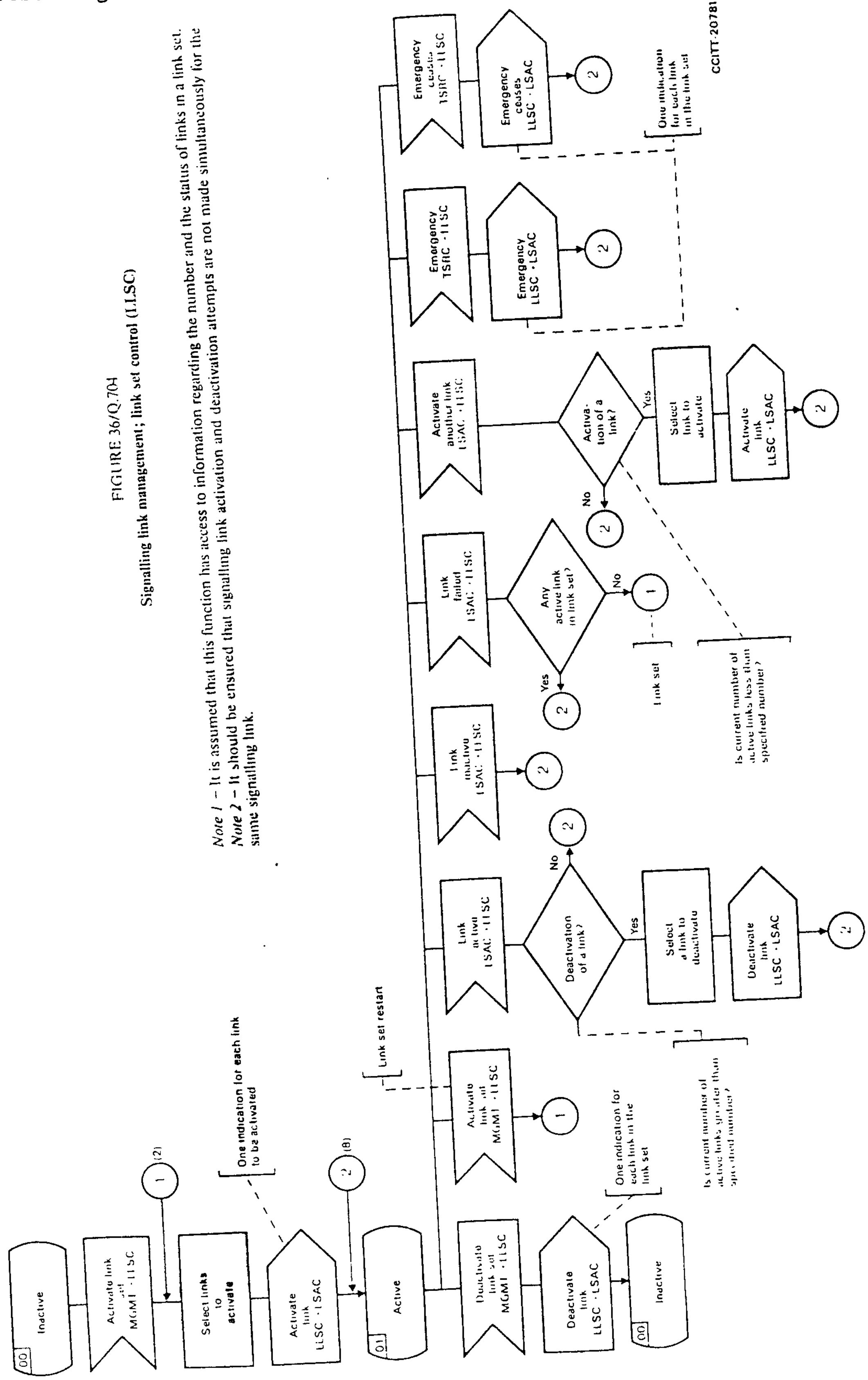


FIGURE 36/Q.704

Signalling link management; link set control (LLSC)

Fortsetzung der Auslassung in 1 TR 7:

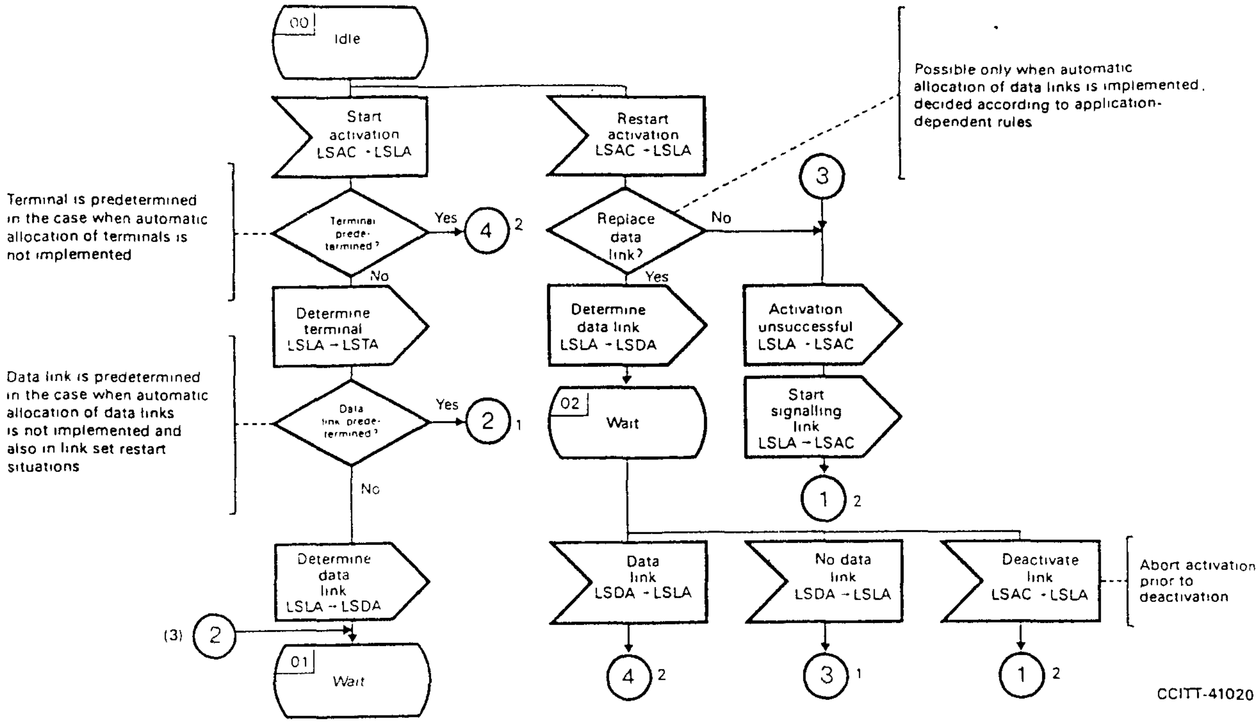


FIGURE 38/Q.704 (sheet 1 of 2)

Signalling link management; signalling link activation (LSLA)

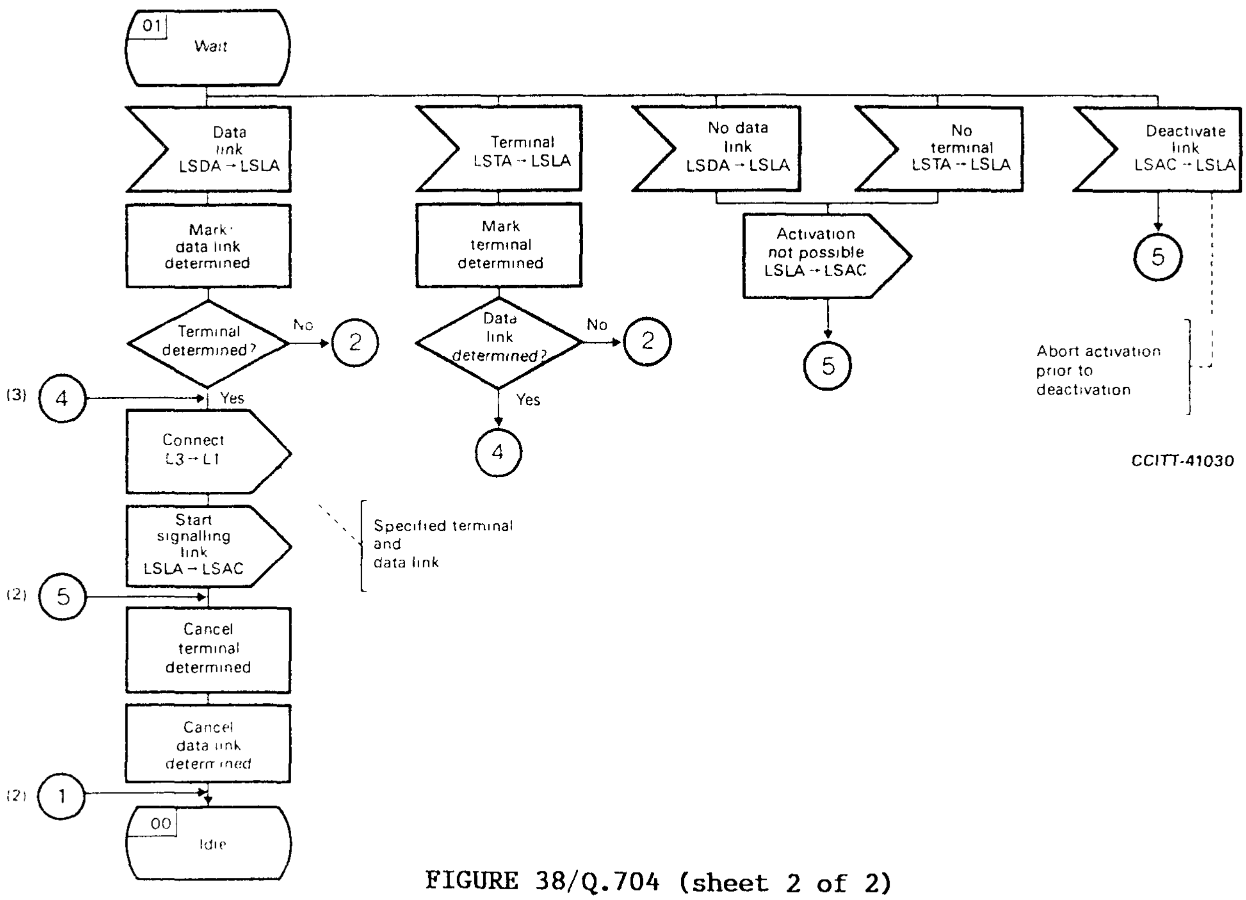


FIGURE 38/Q.704 (sheet 2 of 2)

Signalling link management; signalling link activation (LSLA)

Fortsetzung der Auslassung in 1 TR 7:

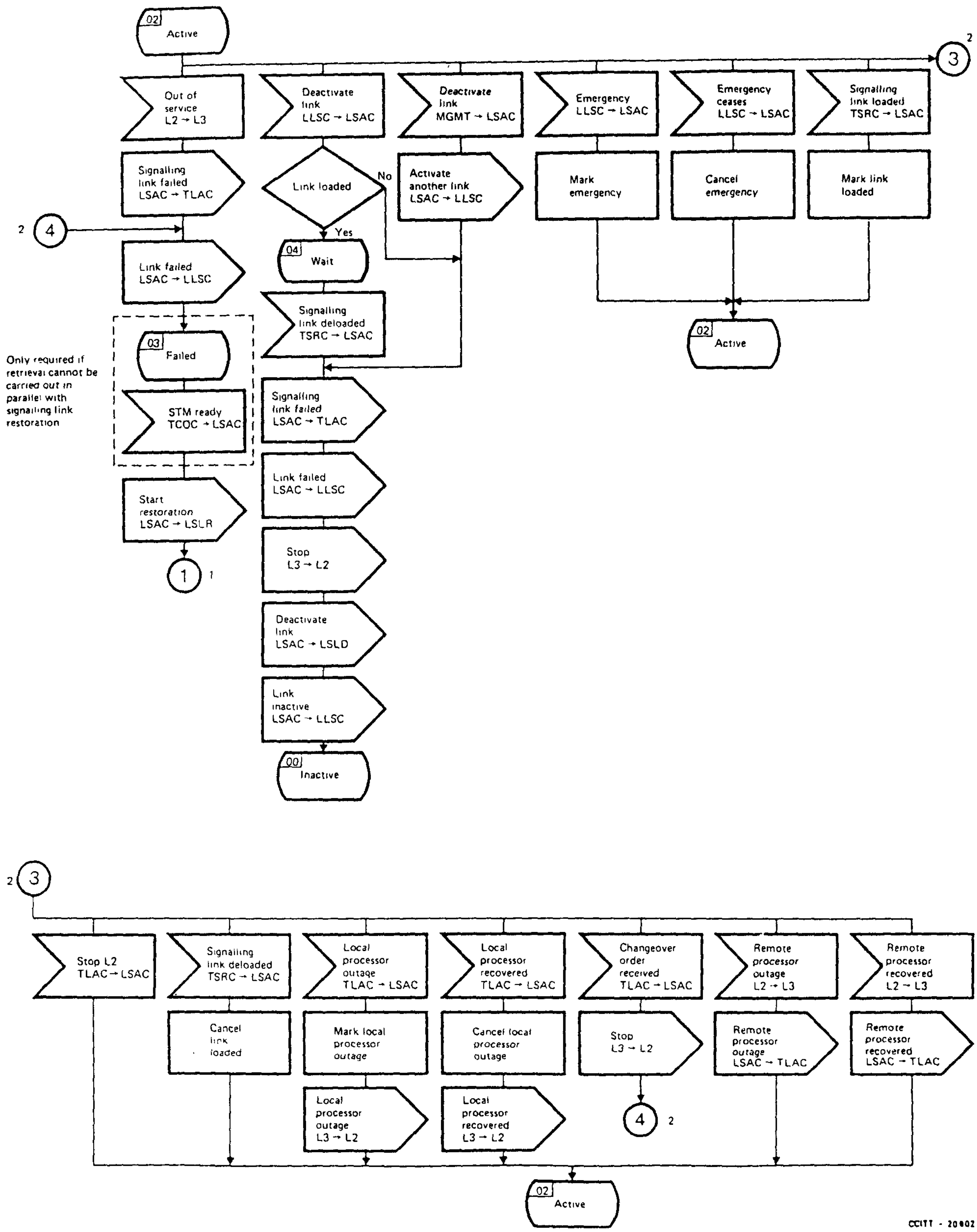


FIGURE 37/Q.704 (sheet 2 of 2)

Signalling link management; signalling link activity control (LSAC)

Fortsetzung der Auslassung in 1 TR 7:

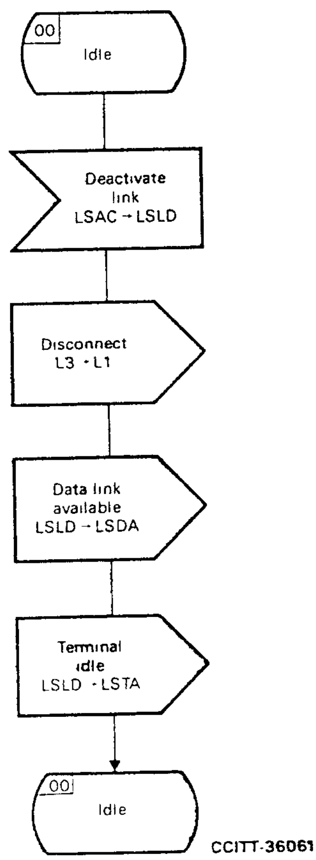


FIGURE 40/Q.704

Signalling link management; signalling link deactivation (LSLD)

Fortsetzung der Auslassung in 1 TR 7:

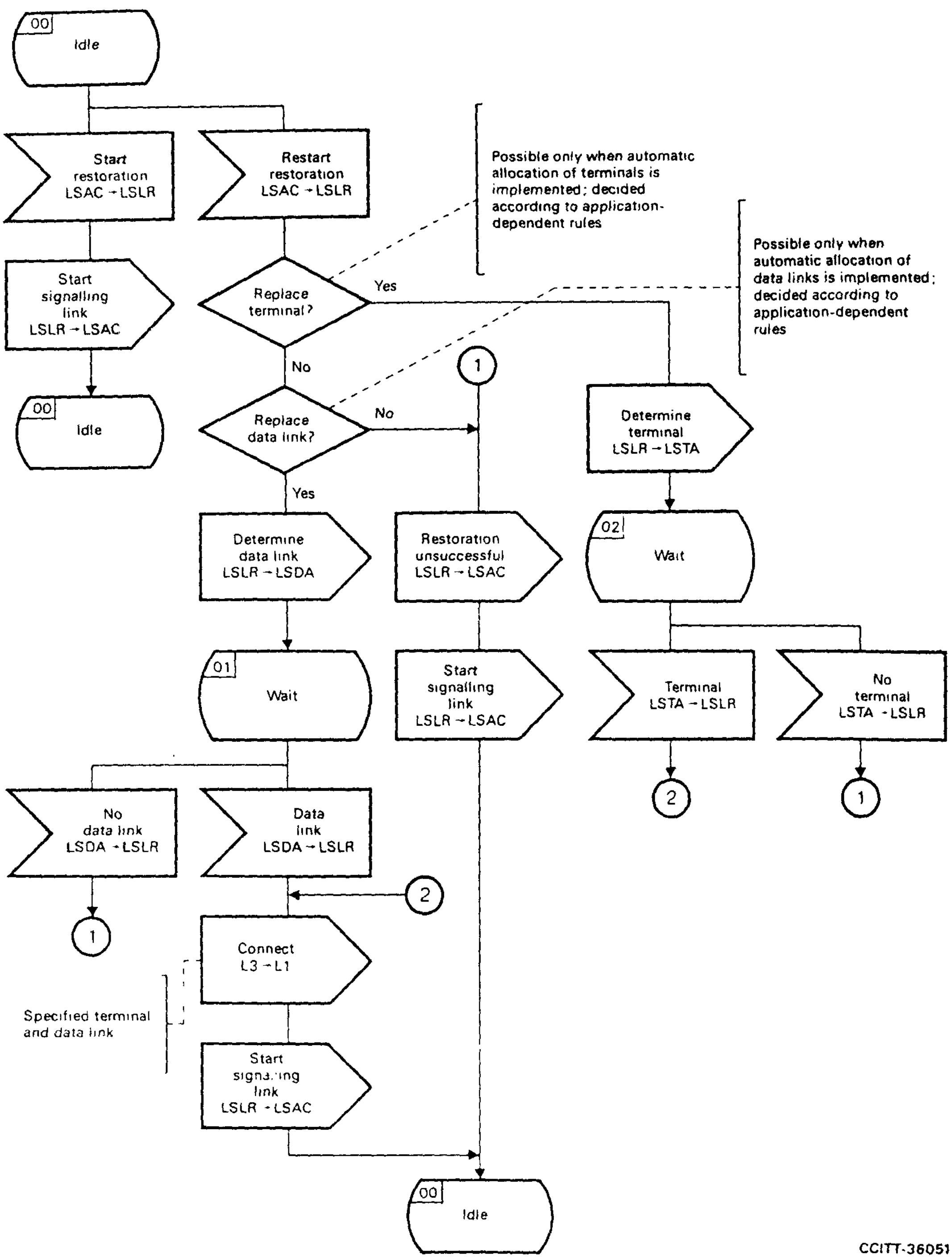


FIGURE 39/Q.704

Signalling link management; signalling link restoration (LSLR)

Fortsetzung der Auslassung in 1 TR 7:

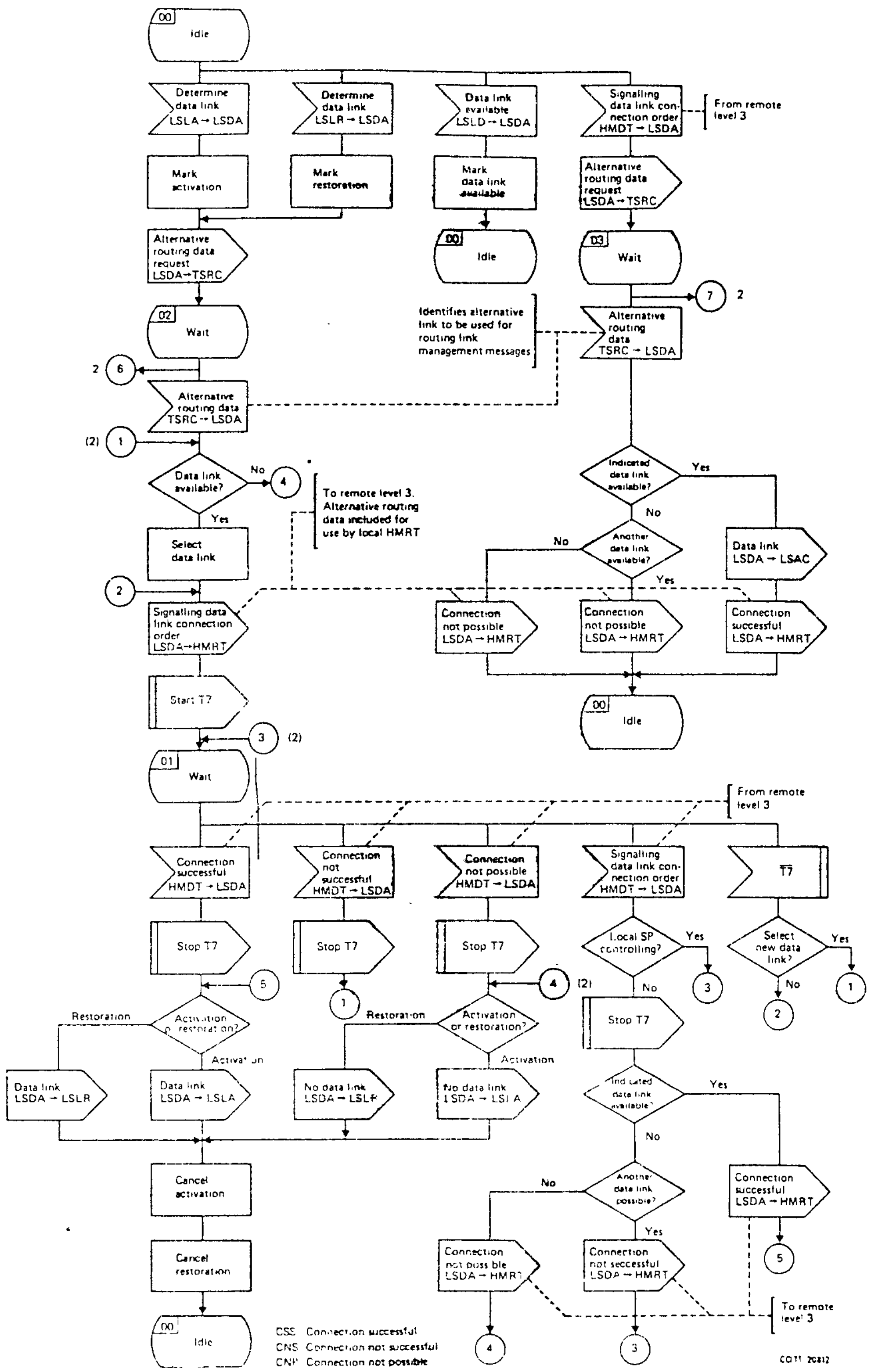


FIGURE 42/Q.704 (sheet 1 of 2)

Signalling link management; signalling data link allocation (LSDA)

Fortsetzung der Auslassung in 1 TR 7:

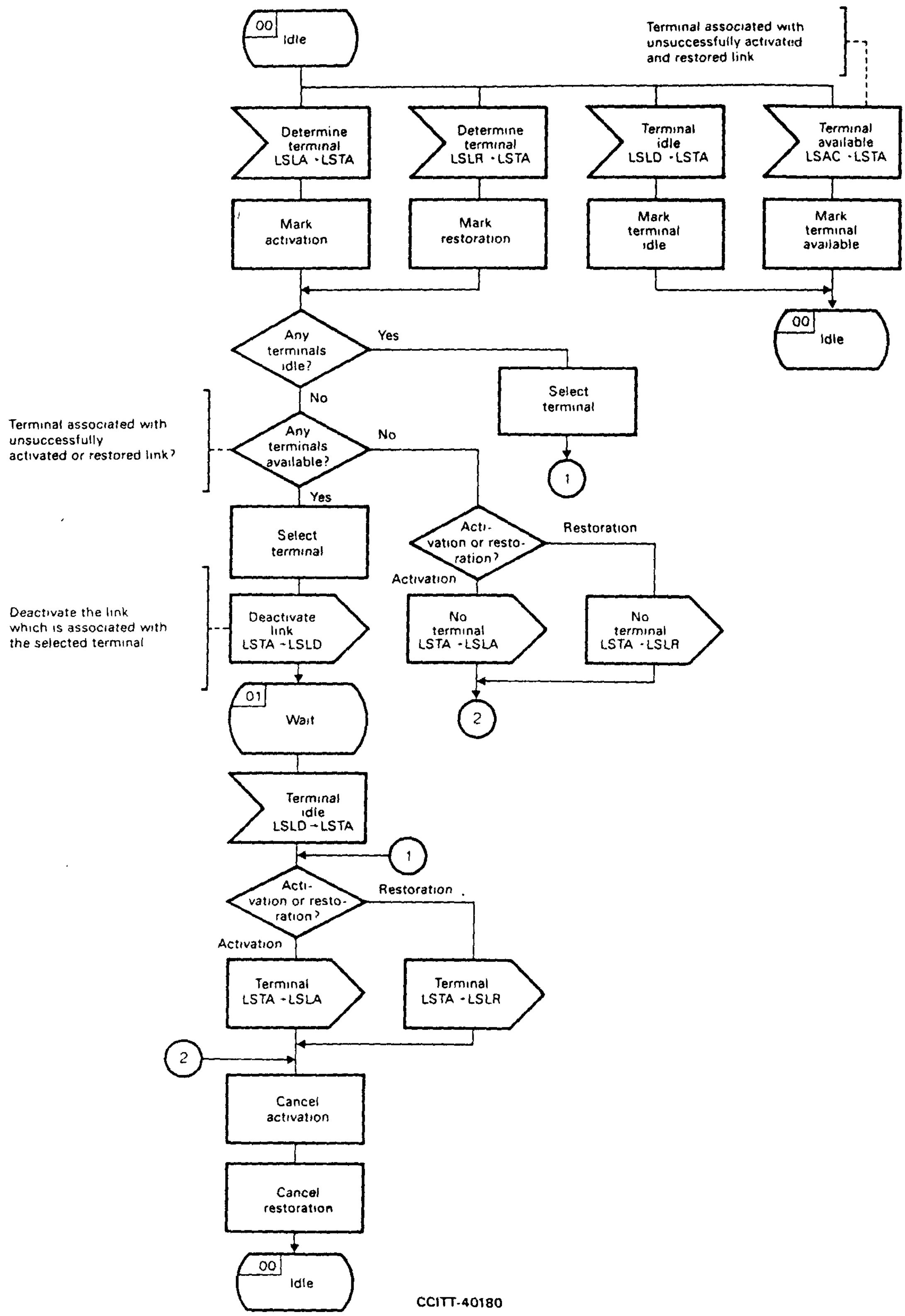
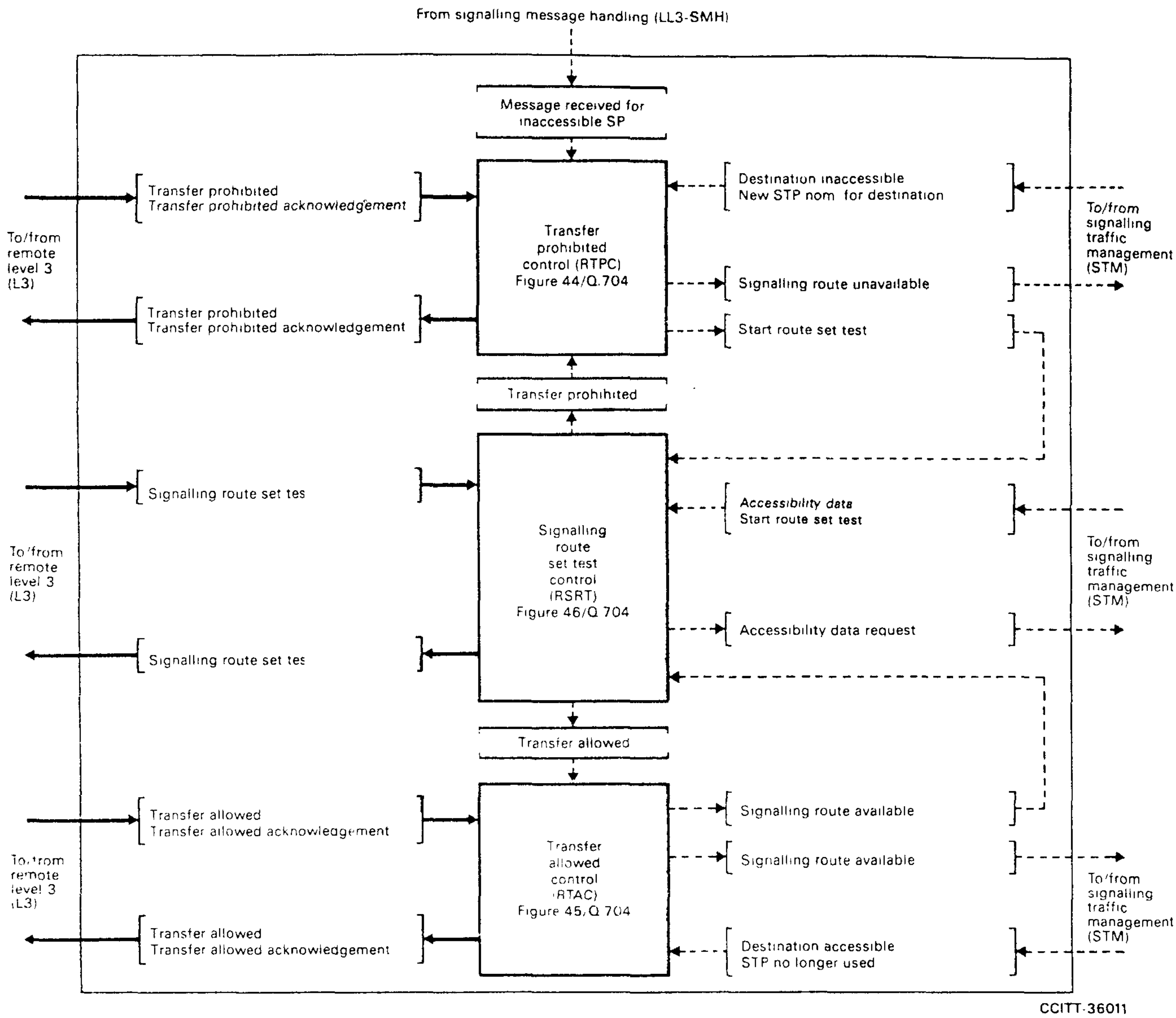


FIGURE 41/Q.704

Signalling link management; signalling terminal allocation (LSTA)

Fortsetzung der Auslassung in 1 TR 7:



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

FIGURE 43/Q.704 (sheet 1 of 2)

Level 3 – Signalling route management (SRM); functional block interactions

Fortsetzung der Auslassung in 1 TR 7:

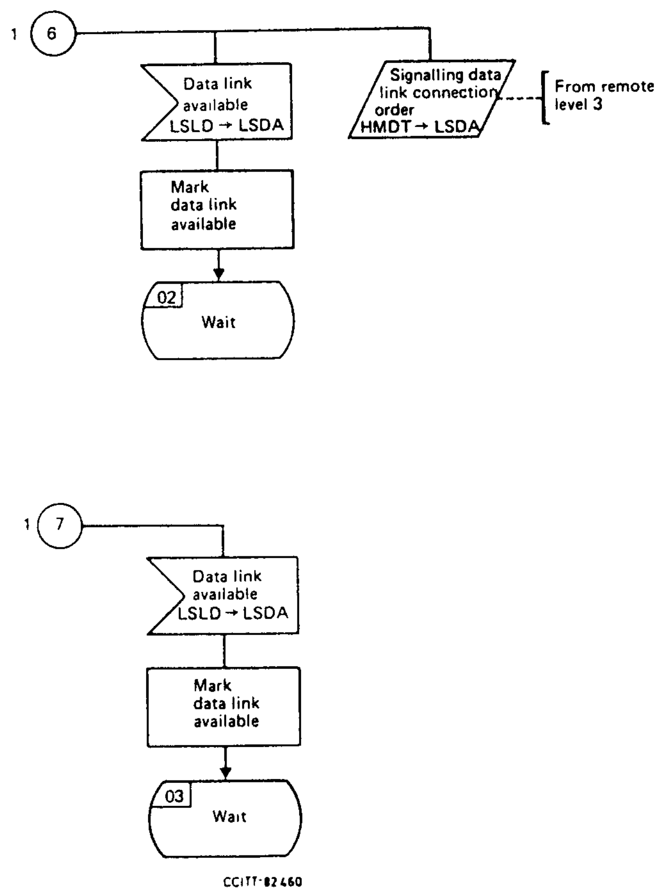


FIGURE 42/Q.704 (sheet 2 of 2)

Signalling link management; signalling data link allocation (LSDA)

Fortsetzung der Auslassung in 1 TR 7:

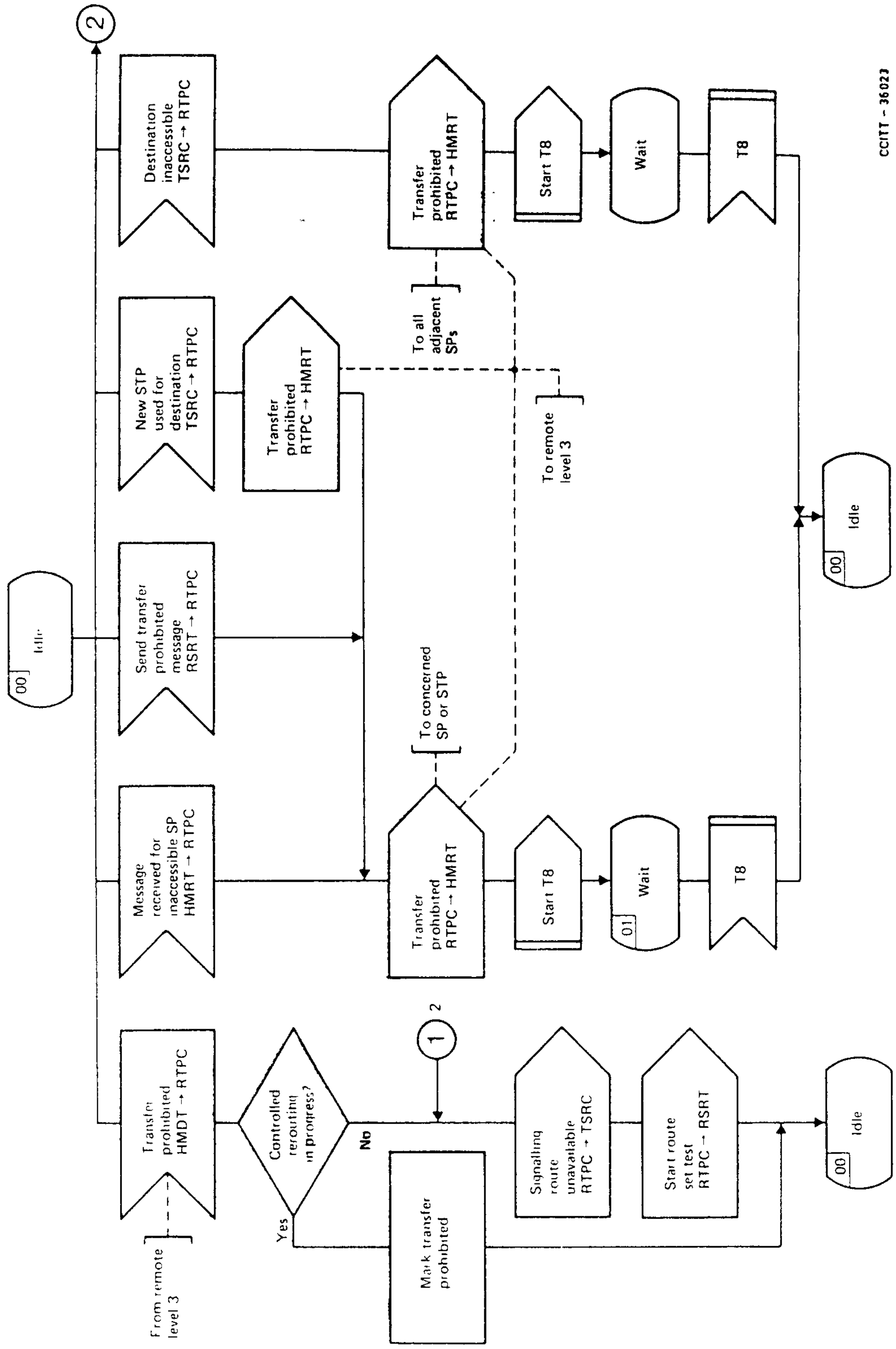


FIGURE 44/Q.704 (sheet 1 of 2)

Signalling route management; transfer prohibited control (RTPC)

Fortsetzung der Auslassung in 1 TR 7:

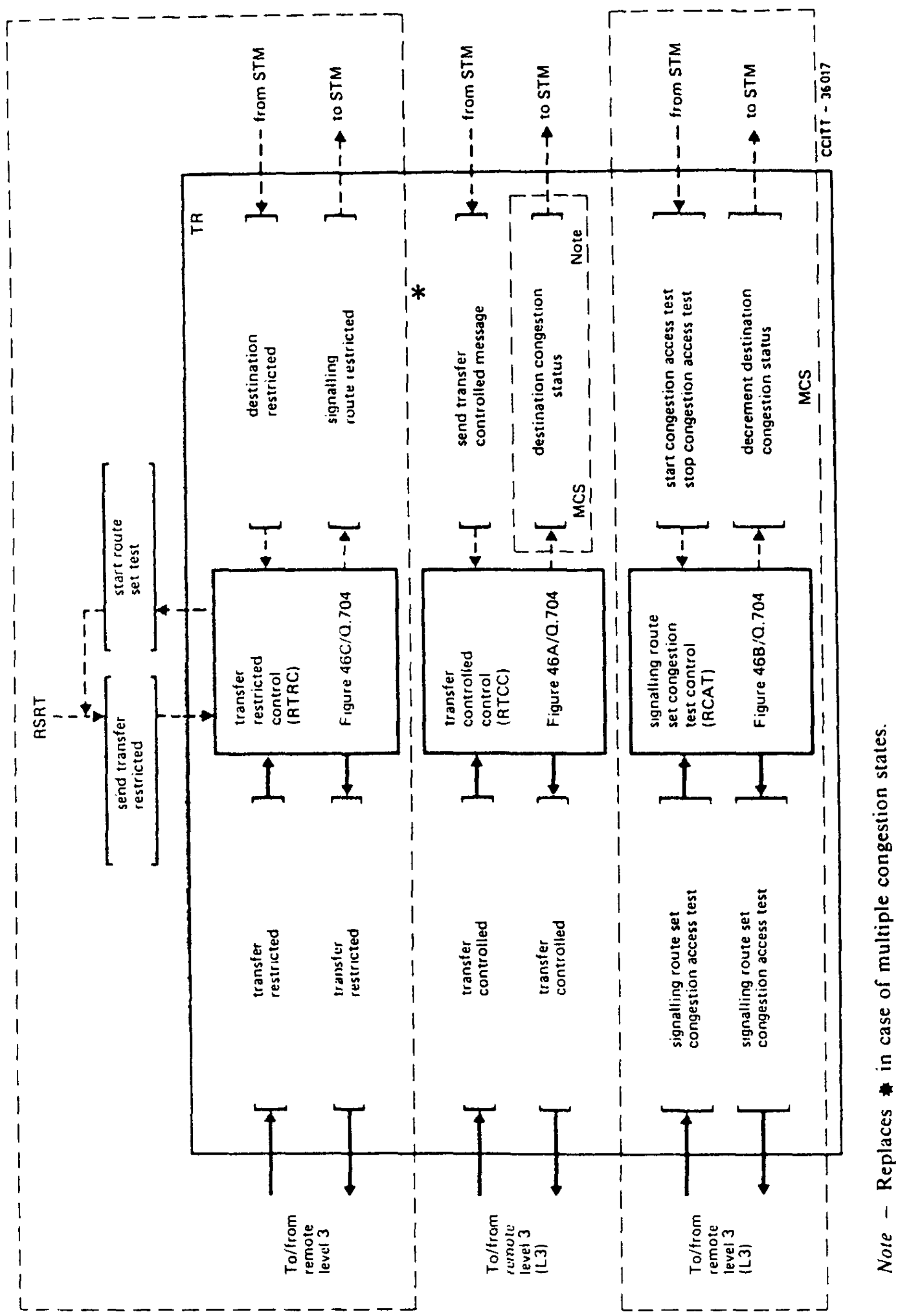


FIGURE 43/Q.704 (sheet 2 of 2)

Level 3 – Signalling route management (SRM); functional block interactions

Fortsetzung der Auslassung in 1 TR 7:

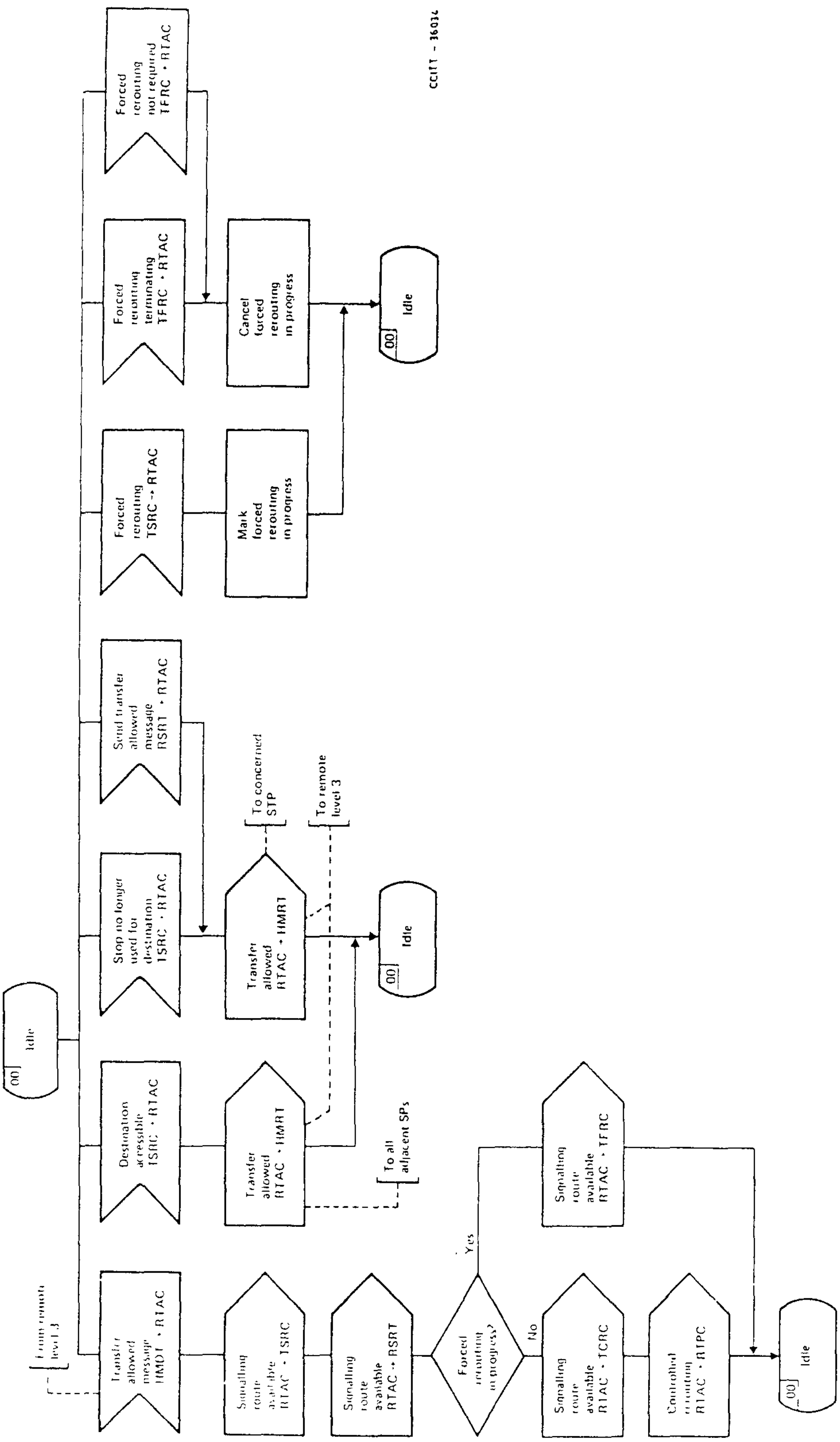


FIGURE 45/Q.704

Signalling route management; transfer allowed control (RTAC)

Fortsetzung der Auslassung in 1 TR 7:

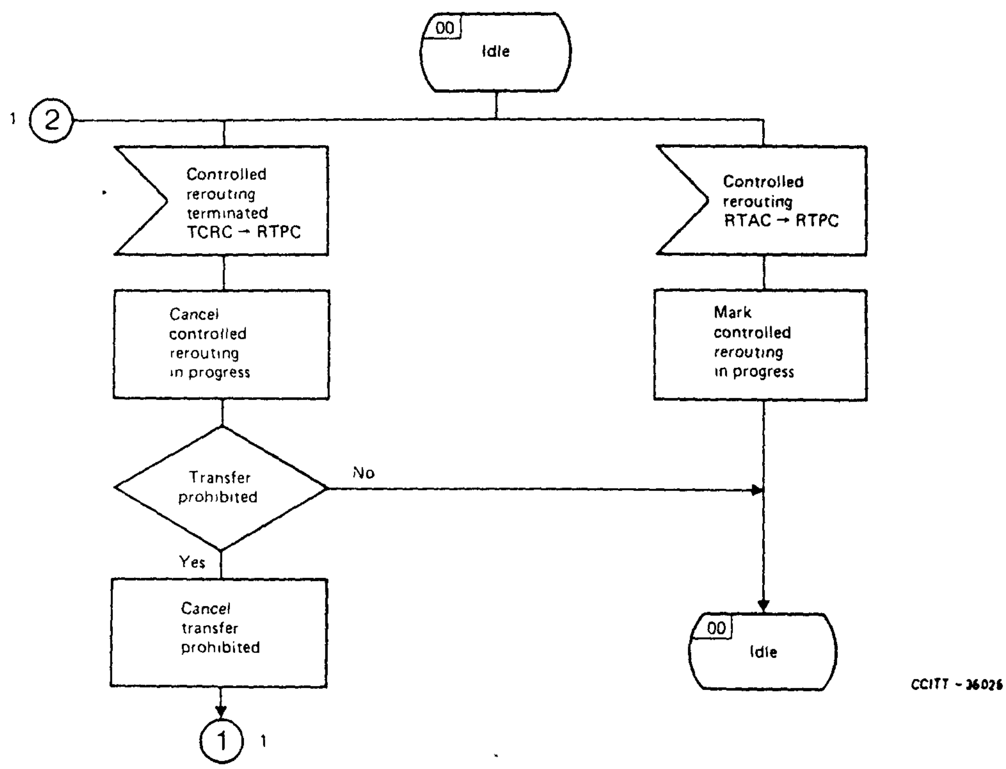


FIGURE 44/Q.704 (sheet 2 of 2)

Signalling route management; tranfer prohibited control (RTPC)

Fortsetzung der Auslassung in 1 TR 7:

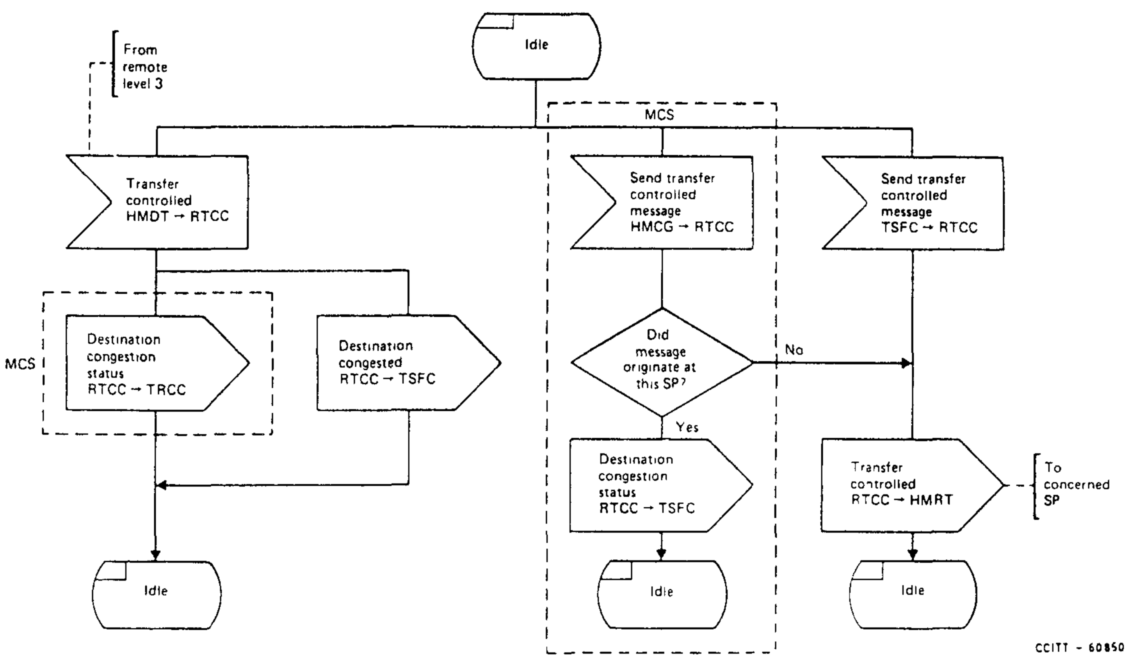


FIGURE 46A/Q.704

Signalling route management; transfer controlled control (RTCC)

Fortsetzung der Auslassung in 1 TR 7:

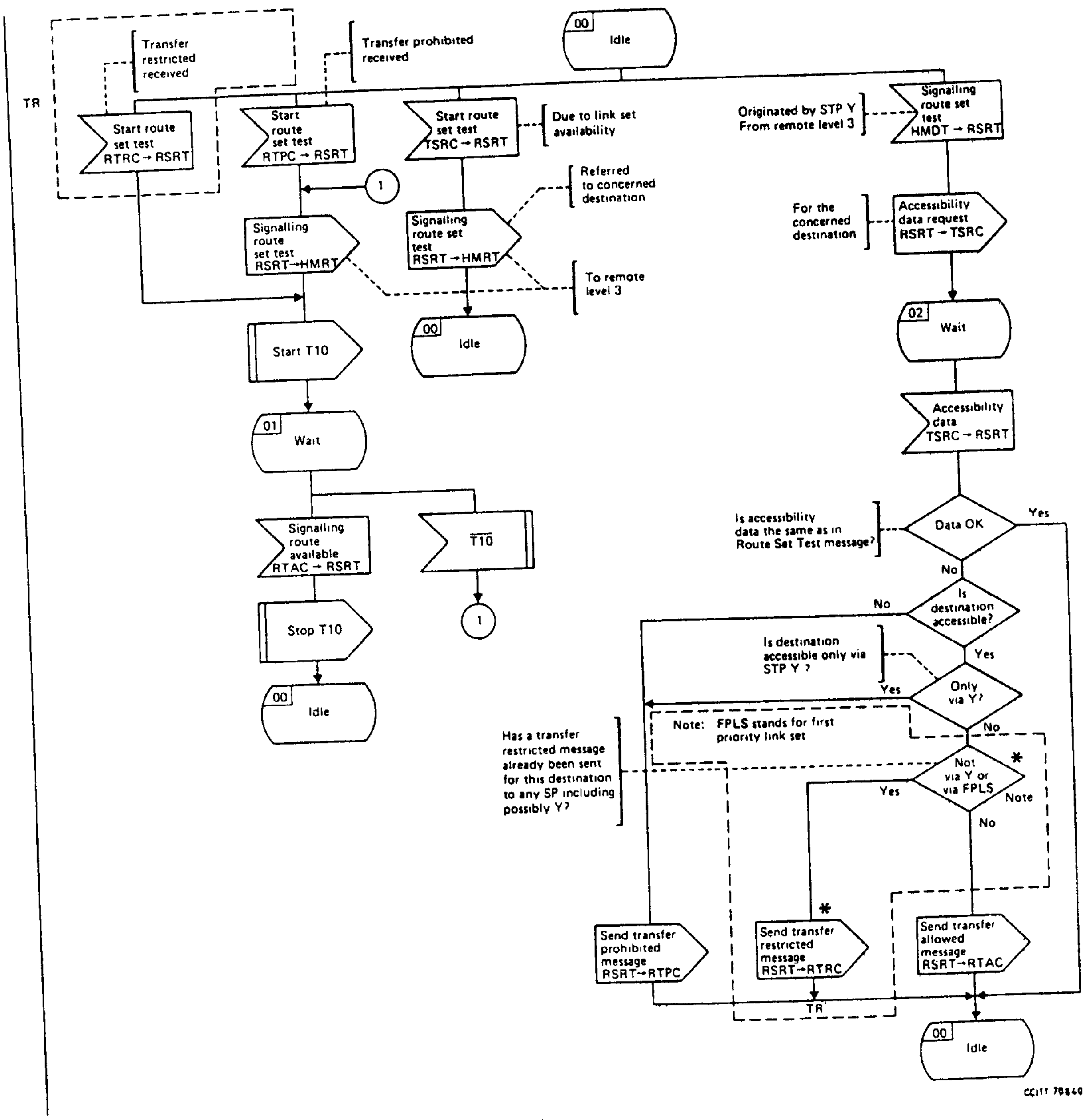


FIGURE 46/Q.704

Signalling route management; signalling route set test control (RSRT)

Fortsetzung der Auslassung in 1 TR 7:

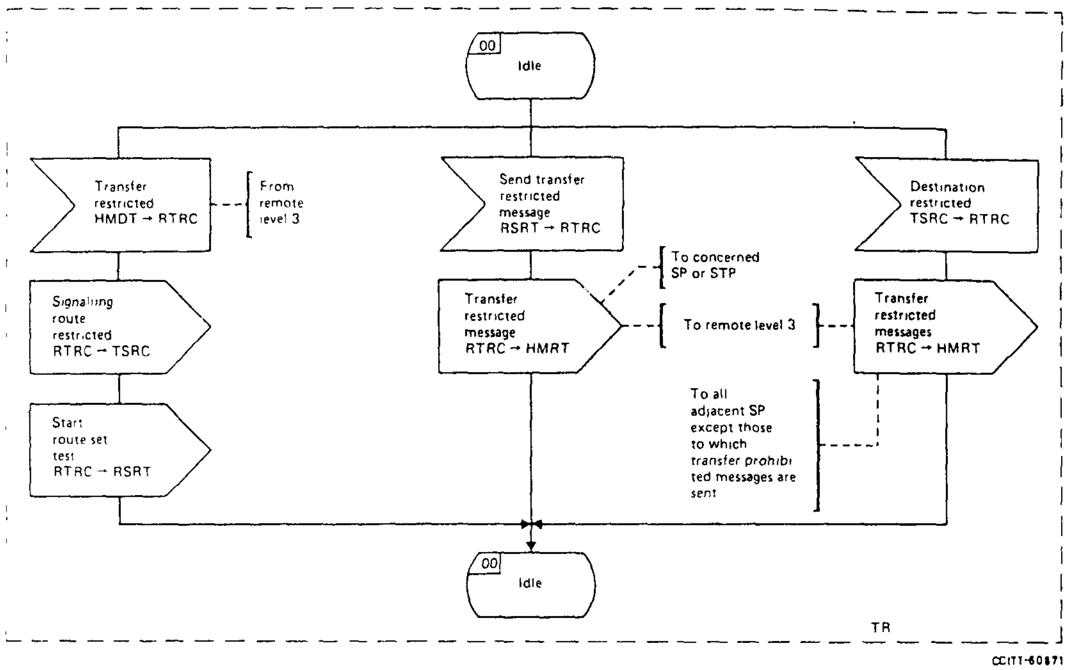


FIGURE 46C/Q.704

Signalling route management; transfer restricted control (RTRC)
test control (RCAT)

Ende der Auslassung in 1 TR 7.

Fortsetzung der Auslassung in 1 TR 7:

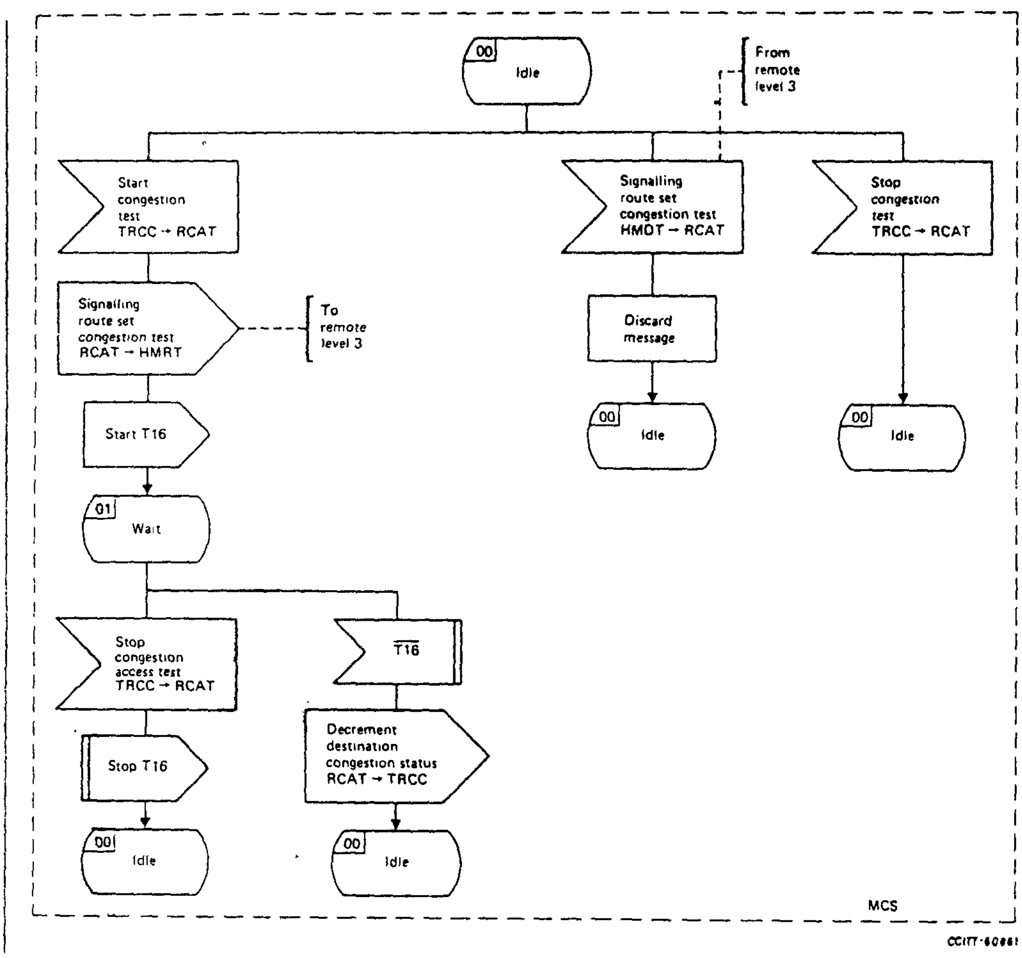


FIGURE 46B/Q.704

Signalling route management;
signalling route set congestion test control (RCAT)

Fortsetzung des Zusatzes in 1 TR 7:

Es ergibt sich damit eine abgeschätzte maximale Quittungszeit tqu3 von 250 ms.

tqu3 = 250 ms

2.2 Zeit bis zur Durchführung eines Changeover (tch)

Als ungünstigster Fall wird der Ausfall der Übertragungsstrecke betrachtet. Der Ausfall der Übertragungsstrecke (Data Link) wird nach Q 703, Abs. 9.2.5 nach etwa 128 ms erkannt. Es wird abgeschätzt, daß nach tch1 = 150 ms das Changeover eingeleitet wird.

Für die Zeit bis zum Eintreffen der Changeover-Quittung wird tqu3 angesetzt.

Das normale Cangeover wird damit unter den angenommenen Bedingungen nach etwa 400 ms durchgeführt.

tch1 = 150 ms

tch = 400 ms

Wenn das normale Changeover nicht durchgeführt werden kann, dann werden die Meldungen nach Q.704, Abs. 5.6.2 nach 1 sec durch ein Emergency Changeover auf die Ersatzverbindung umgeleitet.

Das Changeover wird dann nach der Zeit tche = 1200 ms wirksam.

tche = 1200 ms

2.3 Zeit bis zur Durchführung des Rerouting (tr)

Entsprechend Q.704, Abs. 7, wird ein Forced rerouting durchgeführt, wenn durch den Ausfall eines Linkset ein STP die Meldung nicht mehr zu ihrem Ziel leiten kann.

Die Zeit bis zur Durchführung des Rerouting setzt sich zusammen aus der Zeit bis zum Erkennen des Data-Link-Ausfalls, der Zeit zum Generieren und Übertragen einer Transfer Prohibited Meldung und der Bearbeitung dieser Meldung im Punkt, wo das Rerouting durchgeführt wird.

Für die Erkennung und Bearbeitung des Ausfalls werden entsprechend 2.2, 150 ms angenommen. Für die Übertragung des Transfer Prohibited werden 3 STP-Durchgänge mit zusammen 60 ms angenommen und für die Bearbeitung im Rerouting-Punkt werden 40 ms veranschlagt.

Die Zeit bis zur Durchführung des Rerouting beträgt damit 250 ms.

tr = 250 ms.

2.4 Zeit bis zur Durchführung von Überlastmaßnahmen (tü)

Für die Zeit bis zur Wirksamkeit von Überlastabwehrmaßnahmen wird die Quittungslaufzeit (tqu3) eingesetzt. Zusätzlich werden 250 ms angesetzt, um

Beginn eines Zusatzes in 1 TR 7:

Annex (zu Kap. 2.4)

Dimensionierungshilfen für Überlastschwellen im Zeichengabesystem Nr. 7

1 Annahmen

Bei den Betrachtungen wird von folgenden Voraussetzungen ausgegangen:

Übertragungsrate	64 kbit/s
Meldungslänge	1 m = 128 bit = 16 octets
Meldungsdauer	tm = 2 ms

Die Meldungen treffen statistisch verteilt ein.

2 Zeiten

Die Zahl der benötigten Pufferplätze ist abhängig von verschiedenen Reaktionszeiten innerhalb des Zeichengabesystems.

2.1 Quittungslaufzeit

2.1.1 Quittungslaufzeit im Level 2 (tqu2)

Die Quittungslaufzeit im Level 2 ist die Zeit, die zwischen dem Absenden einer FSN und dem Eintreffen der entsprechenden BSN mit richtigem Indikatorbit vergeht.

Einflußgrößen sind die Verarbeitungszeit sowie Laufzeit und Fehlerrate auf der Übertragungsstrecke.

Die Quittungslaufzeit tqu2 wird mit 50 ms abgeschätzt.

<u>tqu2 = 50 ms</u>

2.1.2 Quittungslaufzeit für Level 3 Meldungen (tqu3)

Die Quittungslaufzeit ist die Zeit, die zwischen dem Absenden einer Level 3 Meldung und Empfang einer entsprechenden Antwort vergeht. Sie ist abhängig von der Zahl der zu durchlaufenden STP, der Verarbeitungszeit in den Endpunkten und der Laufzeit und Fehlerrate auf den Übertragungsstrecken.

Zur Abschätzung von tqu3 wird von einer Referenzverbindung mit 4 MTPs ausgegangen.

Die einfache Durchlaufzeit wird mit 20 ms angesetzt, so daß sich eine Gesamtdurchlaufzeit von 160 ms ergibt.

Für den Zielpunkt werden 50 ms Bearbeitungszeit angenommen.

Für die verbleibenden Einflußgrößen werden weitere 40 ms geschätzt.

Fortsetzung des Zusatzes in 1 TR 7:

Die Werte können dem Bild 2 entnommen werden. Man sieht, daß im Normalfall bei 0,2 Erl, ungestörtem Betrieb und Antwortzeiten von tqu2 = 50 ms im Mittel 5 Meldungen im Wiederholspeicher stehen. Bei 0,4 Erlang verdoppelt sich die Meldungszahl.

3.3 Warteschlangen im Empfangsspeicher

Die Zahl der im Empfangsspeicher wartenden Meldungen ist abhängig von der Zahl der Meldungen, die durch den Level 3 pro Zeiteinheit aufgenommen werden und der Art, wie sie abgenommen werden (Scan-Cyclus).

3.4 Warteschlangen bei Changeover

Beim Data-Link-Ausfall stauen sich bis zum Erkennen des Ausfalls die Meldungen im Retransmission-Speicher. Die Erkennungszeit wurde unter 2.2 mit 150 ms abgeschätzt.

Die Anzahl der danach im Wiederholspeicher wartenden Meldungen errechnet sich dann mit

$\underline{nrch = A \cdot (tqu2 + tch1)/tm}$

Die Werte können dem Bild 2 entnommen werden.

Mit A = 0,2 Erl., tqu = 50 ms und tch1 = 150 ms ergibt sich, daß die Warteschlange des Wiederholspeichers durchschnittlich auf 20 Meldungen angewachsen ist.

Bei A = 0,4 Erlang sind es 40 Meldungen.

Im Übertragungsspeicher werden die Meldungen angestaut, die zwischen dem Erkennen des Link-Ausfalls und der Umleitung des Verkehrs eintreffen.

$$\underline{ntch = A \cdot tqu3/tm}$$

Mit A = 0,2 Erl. und tqu = 250 ms warten durchschnittlich 25 Meldungen, bei 0,4 Erl. 50.

In der Summe werden also im Changeover-Fall bei 0,4 Erl 90 Meldungen gespeichert, die kurzfristig in den Übertragungsspeicher einer anderen Zeichengabestrecke übertragen werden.

Beim Emergency Changeover gelten für den Wiederholspeicher die gleichen Bedingungen wie beim Changeover. Da diese Meldungen nicht auf der Ersatzstrecke erneut übertragen werden, gehen demnach 20 bzw. 40 Meldungen beim Emergency Changeover verloren. Im Transmission Buffer sammeln sich die Meldungen.

$$\underline{ntche = A \cdot 1s/tm}$$

Für 0,2 Erlang ist ntche = 100, bei 0,4 Erl. 200.

Diese Meldungen werden kurzfristig in den Übertragungsspeicher einer anderen Zeichengabestrecke übertragen.

Fortsetzung des Zusatzes in 1 TR 7:

die Verzögerungszeit durch den Auswahlprozeß bei der Erzeugung von Überlastmeldungen zu berücksichtigen.

tü = 500 ms

3 Pufferplätze pro Zeichengabestrecke

Pro Zeichengabestrecke ist ein Übertragungsspeicher (transmission buffer) und ein Wiederholungsspeicher (Retransmission buffer) und ein Empfangsspeicher (Reception buffer) vorgesehen.

Im Übertragungsspeicher werden die Meldungen zwischengespeichert, die nicht unmittelbar übertragen werden können. In dem Wiederholungsspeicher wird jede Meldung solange gespeichert, bis vom anderen Ende der Übertragungsstrecke quittiert wurde, daß die Meldung korrekt übertragen wurde. Im Empfangsspeicher werden die empfangenen Meldungen zwischengespeichert, bis sie vom Level 3 weitergearbeitet werden.

Für ein eventuelles Rerouting ist ein Reroutingsspeicher vorgesehen.

3.1 Warteschlangen im Übertragungsspeicher

Die mittlere Wartezeit (tw) einer Meldung ist abhängig vom Angebot A auf den Zeichengabekanal und der Meldungslänge. Bei der mittleren Meldungslänge (tm) ergibt sich für die Meldungen, die warten müssen, eine mittlere Wartezeit

$$t_w = \frac{tm}{1-A}$$

Die mittlere Wartezeit einer Meldung beträgt $tw^x = tm \frac{A}{1-A}$

Die Zahl der wartenden Meldungen (nw) ergibt sich mit

$$nw = \frac{tw^x}{tm} = \frac{A}{1-A}$$

Die Abhängigkeit zwischen n_w und A wird im Bild 1 dargestellt. Es zeigt sich, daß im Mittel im Übertragungsspeicher bei ungestörtem Betrieb, selbst bei einem Angebot von 0,6 Erlang, durchschnittlich weniger als zwei Meldungen warten.

3.2 Füllstand des Wiederholspeichers

Der Füllstand (nr) des Wiederholspeichers ist abhängig von der Quittierungslaufzeit tqu2 und dem Angebot für die Leitung A.

Die Zahl der wartenden Meldungen errechnet sich nach der Formel

$$nr = A \cdot tqu2/tm$$

Fortsetzung des Zusatzes in 1 TR 7:

Es wird dabei davon ausgegangen, daß für beide Speicher ein gemeinsamer Speicherraum benutzt wird, der wahlweise als Übertragungs- oder Wiederholungsspeicher benutzt werden kann. Die Zahl der Meldungen, die im Wiederholungsspeicher-Anteil abgelegt ist, ist auf 127 begrenzt.

Der Sendespeicher sollte ca. 8k byte oder im Mittel 512 Meldungen umfassen. Die Überlastschwelle sollte bei 2k byte oder im Mittel 128 Meldungen liegen.

Es ist so möglich, alle Changeover mit hoher Wahrscheinlichkeit ohne Einleitung von Überlastabwehrmaßnahmen durchzuführen.

Bei Emergency Changeover steigt die Wahrscheinlichkeit, daß Überlastabwehrmaßnahmen eingeleitet werden. Da jedoch durch den Meldungsverlust der Verkehr auf den Nutzkanälen bereits beeinträchtigt wurde und ein Emergency Changeover ein extremer Ausnahmefall ist, kann dieses Fehlverhalten hingenommen werden.

Durch die 384 Warteplätze für Überlastsituationen kann die Zeit "t" bis zum Ansprechen der Überlastmaßnahmen überbrückt werden.

$$\underline{t = n \cdot tm/A}$$

Werte sind Bild 3 zu entnehmen.

4.2 Empfangsspeicher

Die Untersuchungen ergeben keine Aussagen über die Größe des Empfangsspeichers.

Durch die Möglichkeit des Rückstaus in den Transmission-Speicher ergeben sich hier große Freiheitsgrade.

Fortsetzung des Zusatzes in 1 TR 7:

3.5 Warteschlange bei Rerouting

Der Füllstand des Rerouting-Speichers wird durch die Bearbeitungszeit der Transfer prohibited Meldung bestimmt. Hierfür werden nur wenige ms benötigt, so daß nur wenige Speicherplätze benötigt werden.

Der Verlust von Meldungen wird durch die in 2.3 abgeschätzte Zeit bis zur Durchführung des Rerouting bestimmt.

Es gilt:

$$\underline{nrr = A \cdot tr/tm}$$

Mit A = 0,2 Erl und tr = 250 ms ist nrr = 25,
bei 0,4 Erl ist nrr = 50.

3.6 Warteschlangen durch Überlast

Überlast besteht, wenn das Angebot A für einen Zeichengabekanal höher ist, als der Zeichengabekanal zu diesem Zeitpunkt abnehmen kann.

Es wird davon ausgegangen, daß dieses Überangebot Aü im Durchchnitt 0,4 Erl nicht überschreitet.

Bis zum ersten Wirken der Überlastabwehrmaßnahmen sammeln sich nül Meldungen.

$$\underline{\text{nül} = \text{Aü} \cdot \text{tü/tm}}$$

Mit Aü = 0,4 Erl und tü = 500 ms ist nül = 100.

Bis zum ersten Greifen der Überlastmaßnahmen würden sich bei den gegebenen Bedingungen 100 zusätzliche Meldungen stauen.

Da jedoch auch bei 100 % Reduzierung von Neubelegungen für Nutzkanäle die Zahl der Zeichengabemeldungen zunächst nur langsam abnimmt, und die bereits bestehenden Verbindungen weiterbehandelt werden sollen, muß auch nach dem Einschalten der Überlastmaßnahmen mit einem Fortbestehen eines Überangebots gerechnet werden.

4 Dimensionierung von Speichern und Überlastschwellen

Bei der Dimensionierung der Speicher muß berücksichtigt werden, daß Changeover und Überlast möglichst nicht zu Meldungsverlust führen.

Die Überlastschwellen müssen so gewählt werden, daß es beim Changeover möglichst nicht zu Überlastabwehrmaßnahmen kommt.

4.1 Übertragungs- und Wiederholspeicher

Übertragungs- und Wiederholspeicher können als gemeinsamer Sendespeicher betrachtet werden, da sie in direktem Zusammenhang stehen.

Fortsetzung des Zusatzes in 1 TR 7:

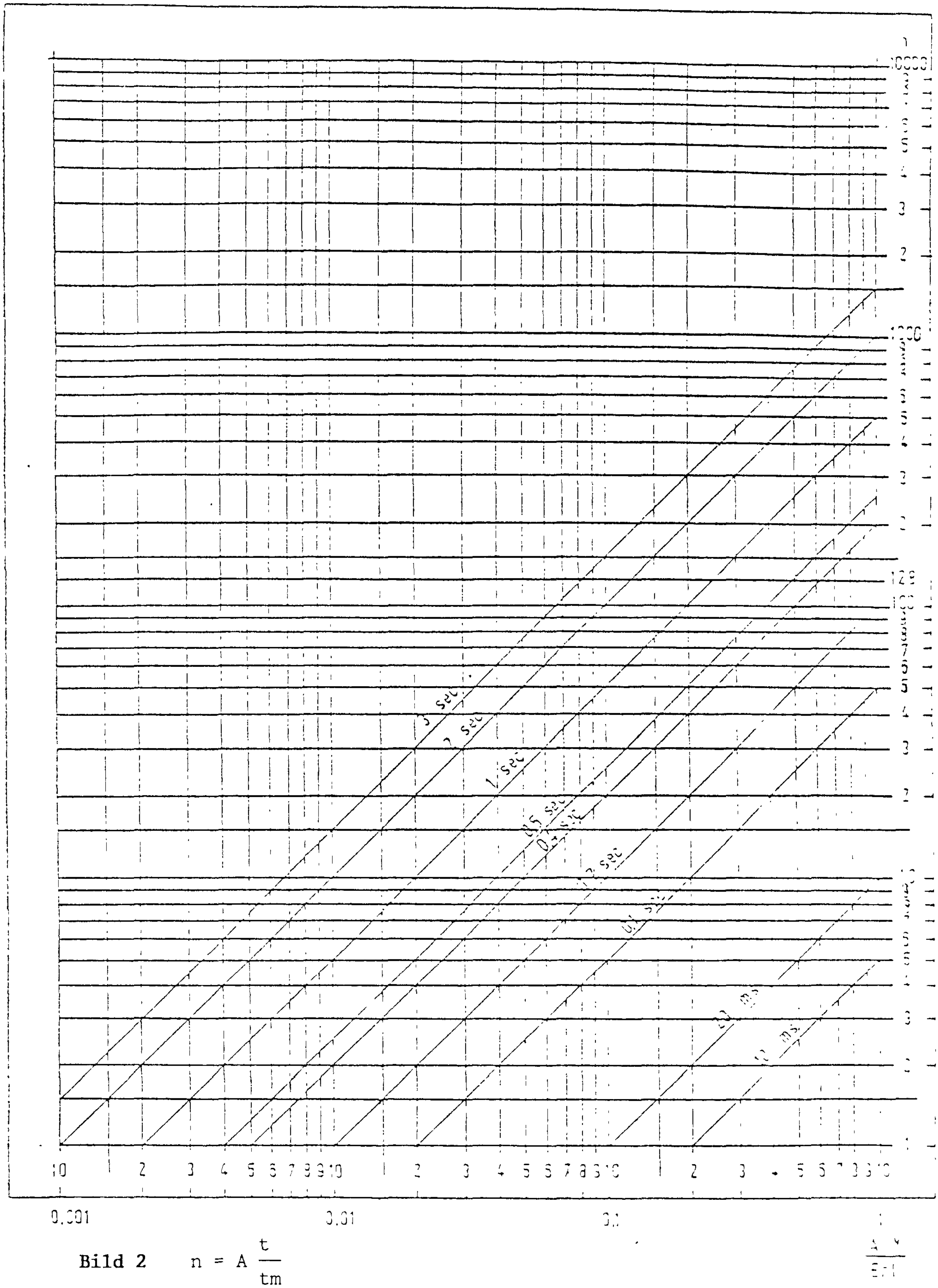


Bild 2 $n = A \frac{t}{tm}$

Fortsetzung des Zusatzes in 1 TR 7:

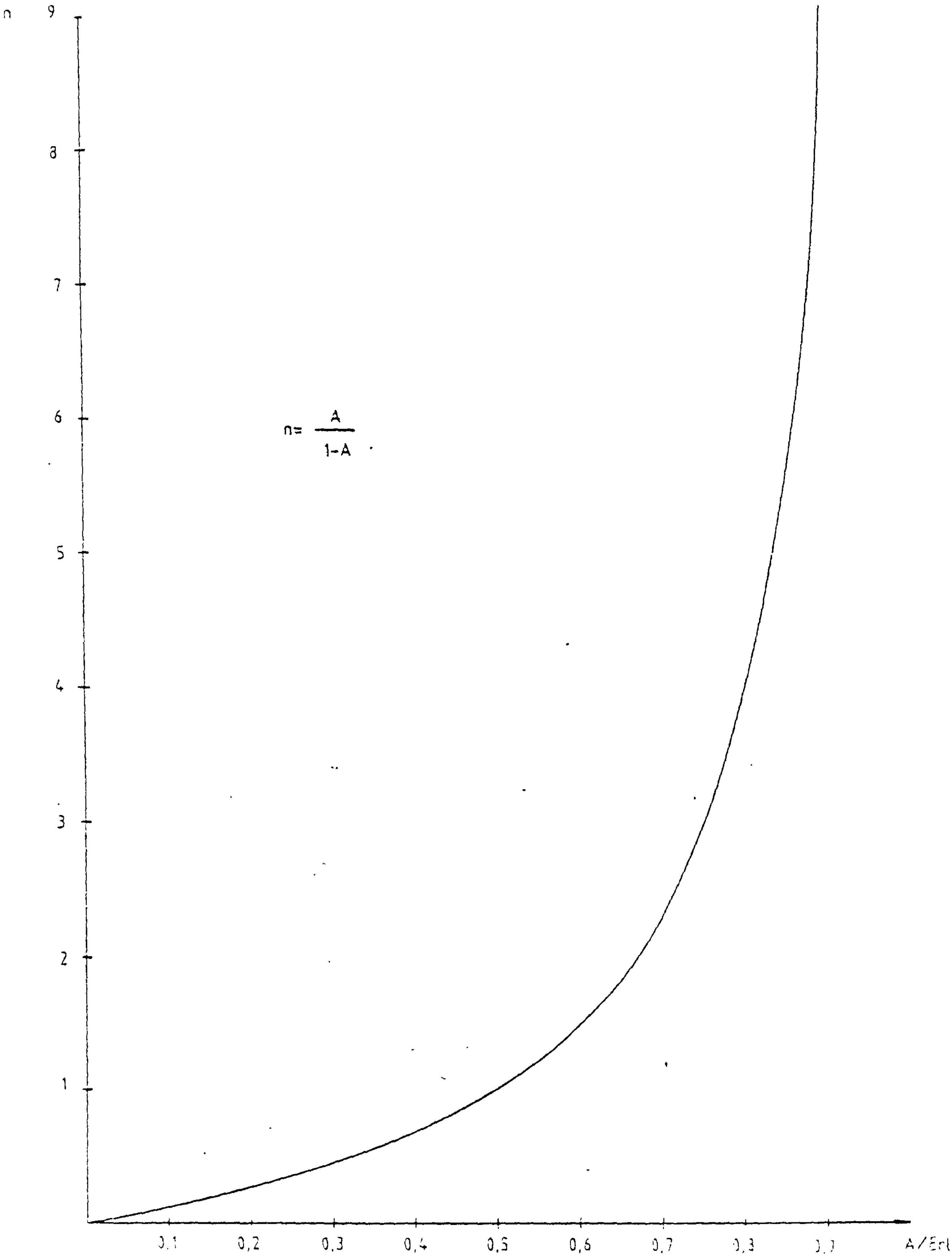


Bild 1: Zahl der wartenden Meldungen im Übertragungsspeicher

Beginn einer Auslassung in 1 TR 7:

Annex A

Signalling Link Management and Signalling Traffic Management by the Switchover Method

A.1 General

A1.1 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 characterized 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 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 form 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

Fortsetzung des Zusatzes in 1 TR 7:

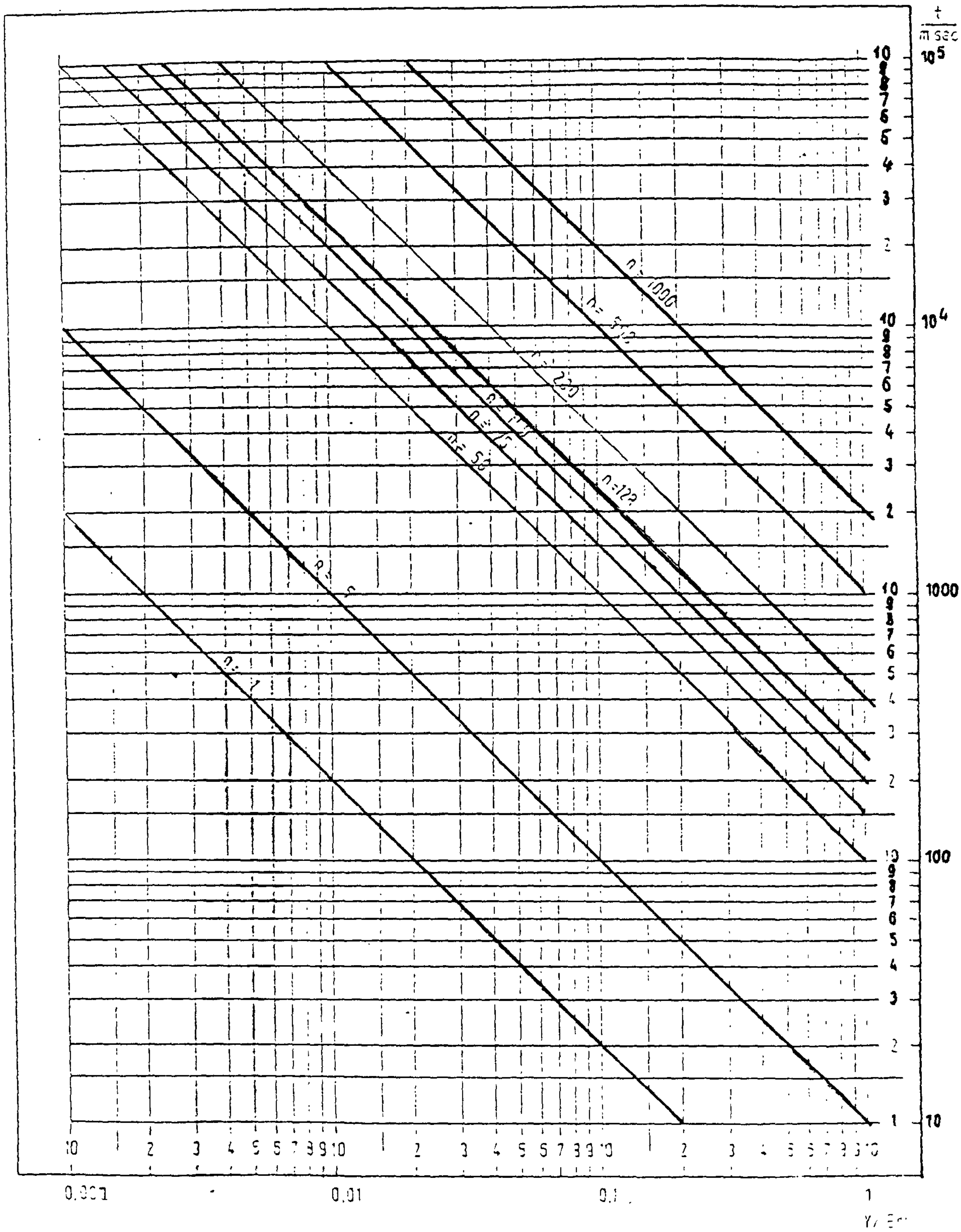


Bild 3 $\quad t = \frac{n \cdot tm}{A}$

Ende des Zusatzes in 1 TR 7.

Fortsetzung der Auslassung in 1 TR 7:

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 decribed 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 link points A and B in Figure A-1/Q.704 as a result of management system action (automatic or manuel) 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.

Fortsetzung der Auslassung in 1 TR 7:

principles of the switchover method may be described with reference to the simple configuration shown in Figure A-1/Q.704.

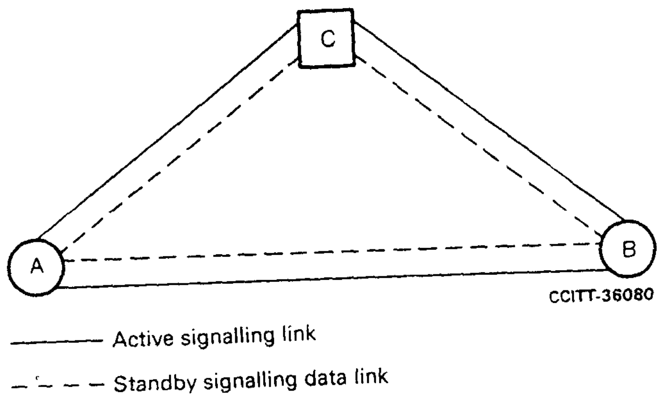


Figure A-1/Q.704
Simple network configuration to illustrate the switchover method

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.

Fortsetzung der Auslassung in 1 TR 7:

The procedure is dependent one 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.4.1.1 If standby data link selection is initiated at the local end of the concerned signalling link but no signalling data link is availabe, 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).

Fortsetzung der Auslassung in 1 TR 7:

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.

Fortsetzung der Auslassung in 1 TR 7:

TABELE A-1/Q.704

Impact of the switchover method on Message Transfer Part functions - summary

Functional level	Function	Impact	
		Type	Figure
3	Signalling link management: - signalling link activity control	additional logic	A-2/Q.704 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 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.

Fortsetzung der Auslassung in 1 TR 7:

A.5 Procedures 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.

Fortsetzung der Auslassung in 1 TR 7:

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

Fortsetzung der Auslassung in 1 TR 7:

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 links avalability 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 functions (see Recommendation Q.703). The modifications relate to the addition of two 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).

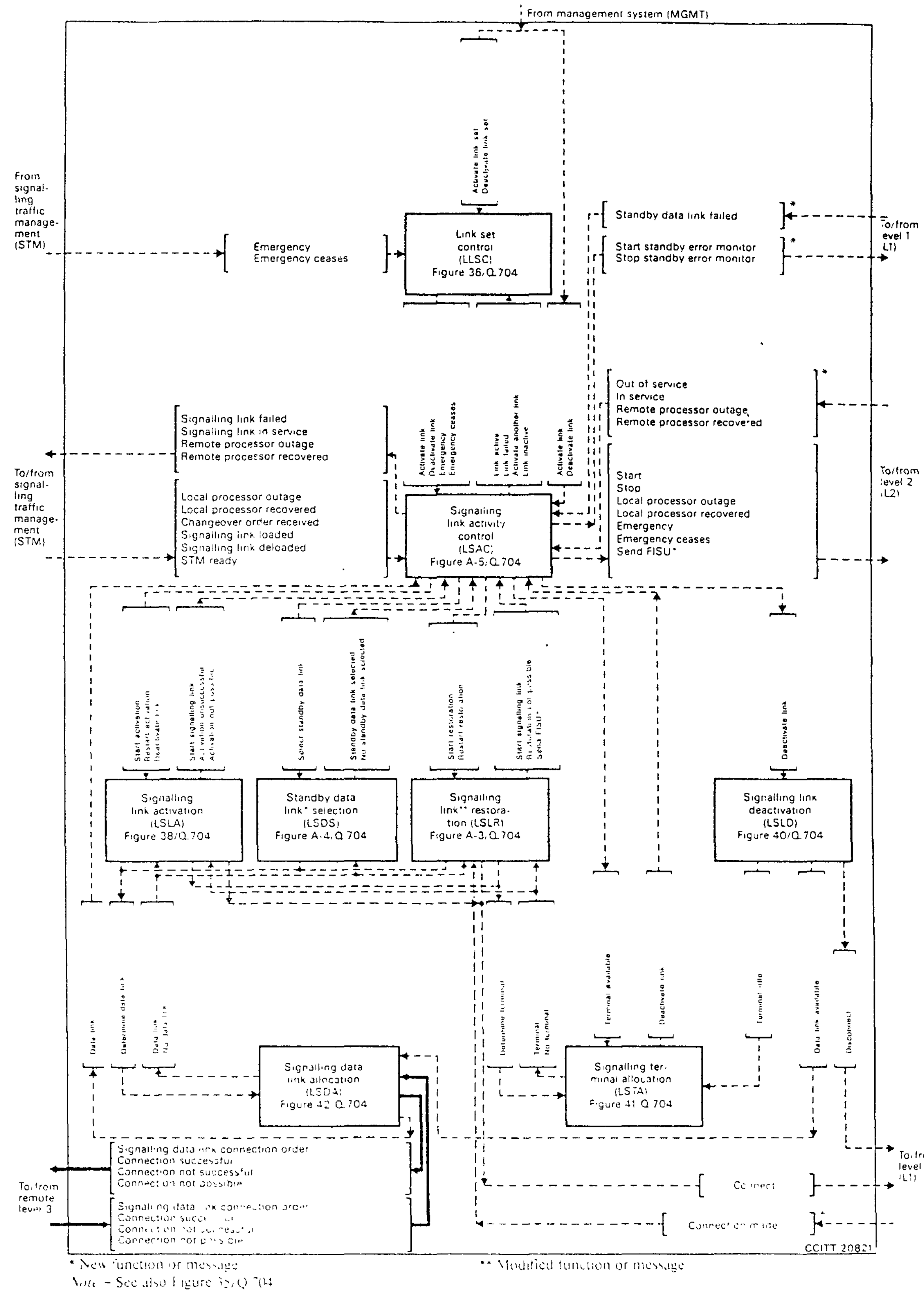
The required additions are illustrated in Figure A-8/Q.704.

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).

Fortsetzung der Auslassung in 1 TR 7:



* 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)

Fortsetzung der Auslassung in 1 TR 7:

Timers

TA1 Waiting for connection of new signalling data link (during switch-over)

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

Fortsetzung der Auslassung in 1 TR 7:

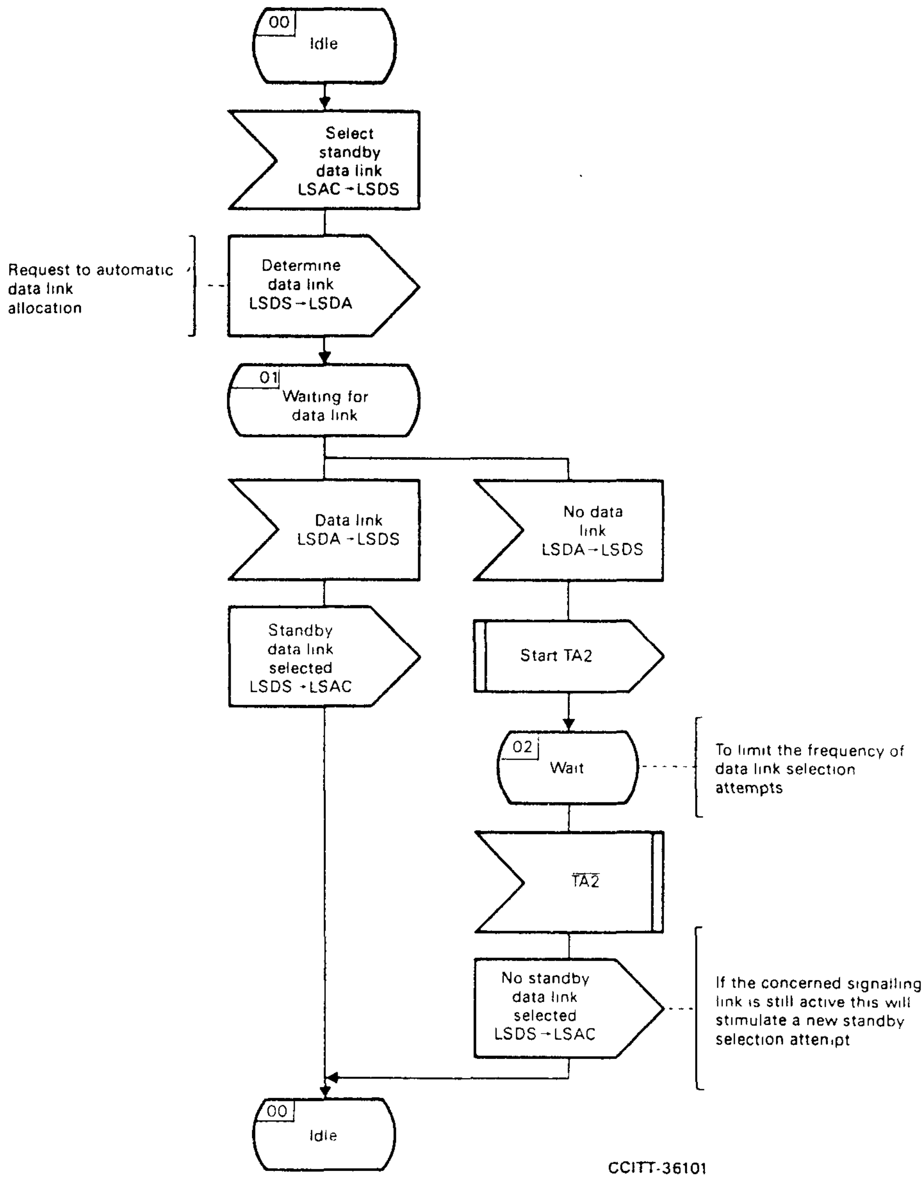
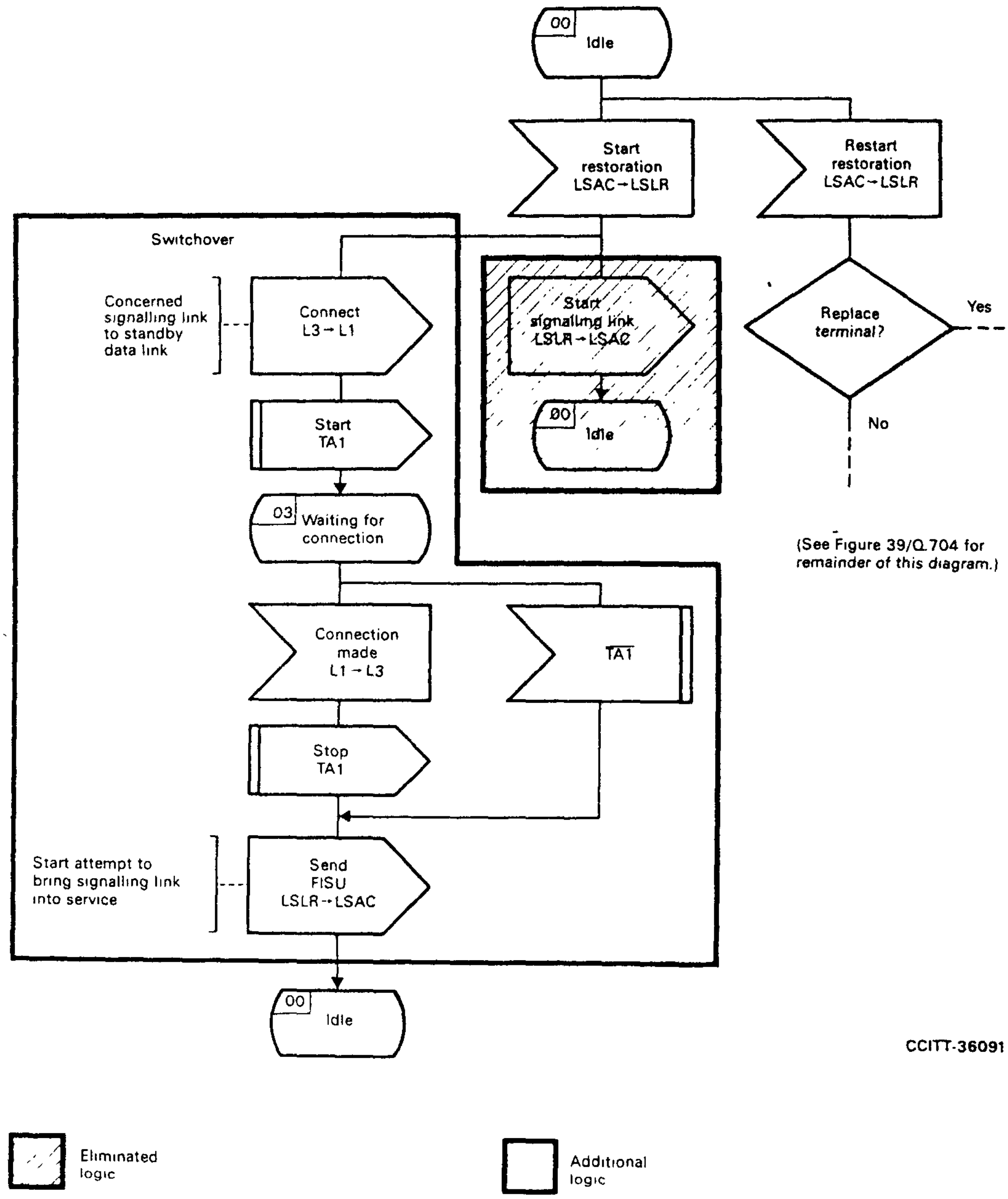


FIGURE A-4/Q.704

Level 3 - signalling link management; standby data link selection (LSDS) (new function required for the switchover method)

Fortsetzung der Auslassung in 1 TR 7:

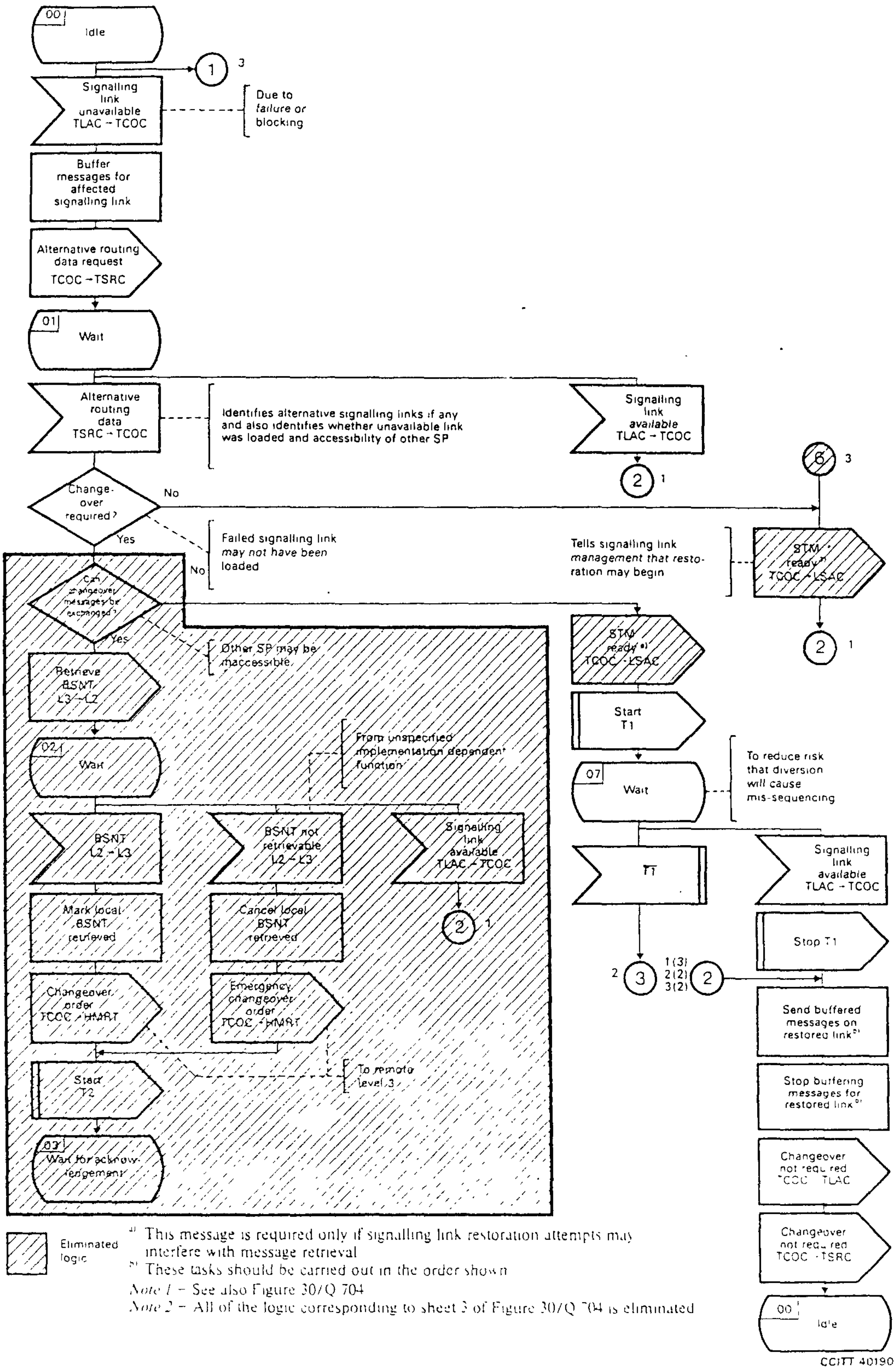


Note – See also Figure 39/Q.704.

FIGURE A-3/Q.704

Level 3 - signalling link management; signalling link restoration (LSLR) (impact of switchover method)

Fortsetzung der Auslassung in 1 TR 7:

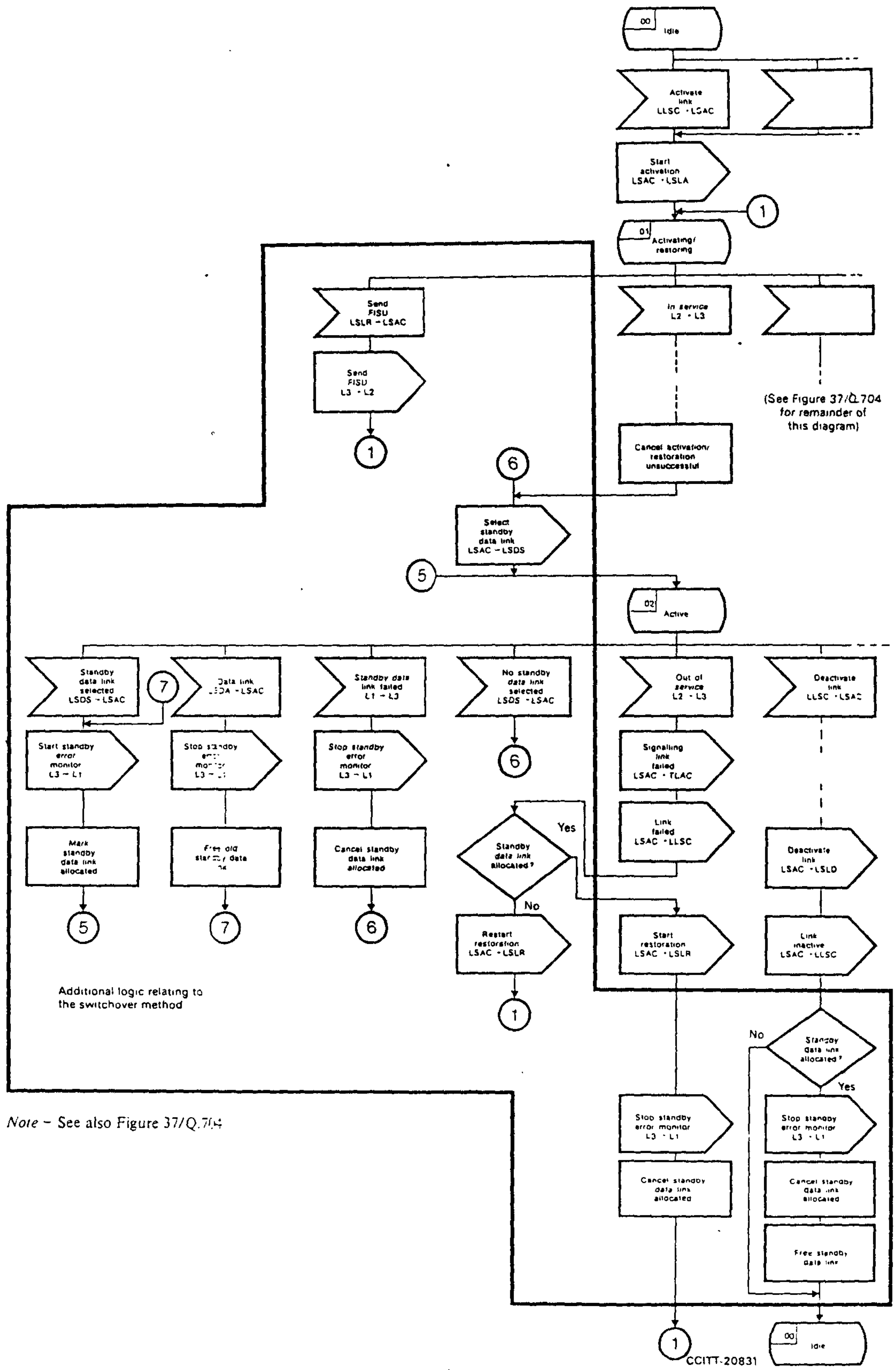


[a] This message is required only if signalling link restoration attempts may interfere with message retrieval
[b] These tasks should be carried out in the order shown
Note 1 – See also Figure 30/Q 704
Note 2 – All of the logic corresponding to sheet 3 of Figure 30/Q 704 is eliminated

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

Level 3 – signalling traffic management; changeover control (TCOC) (impact of switchover method)

Fortsetzung der Auslassung in 1 TR 7:



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)

Fortsetzung der Auslassung in 1 TR 7:

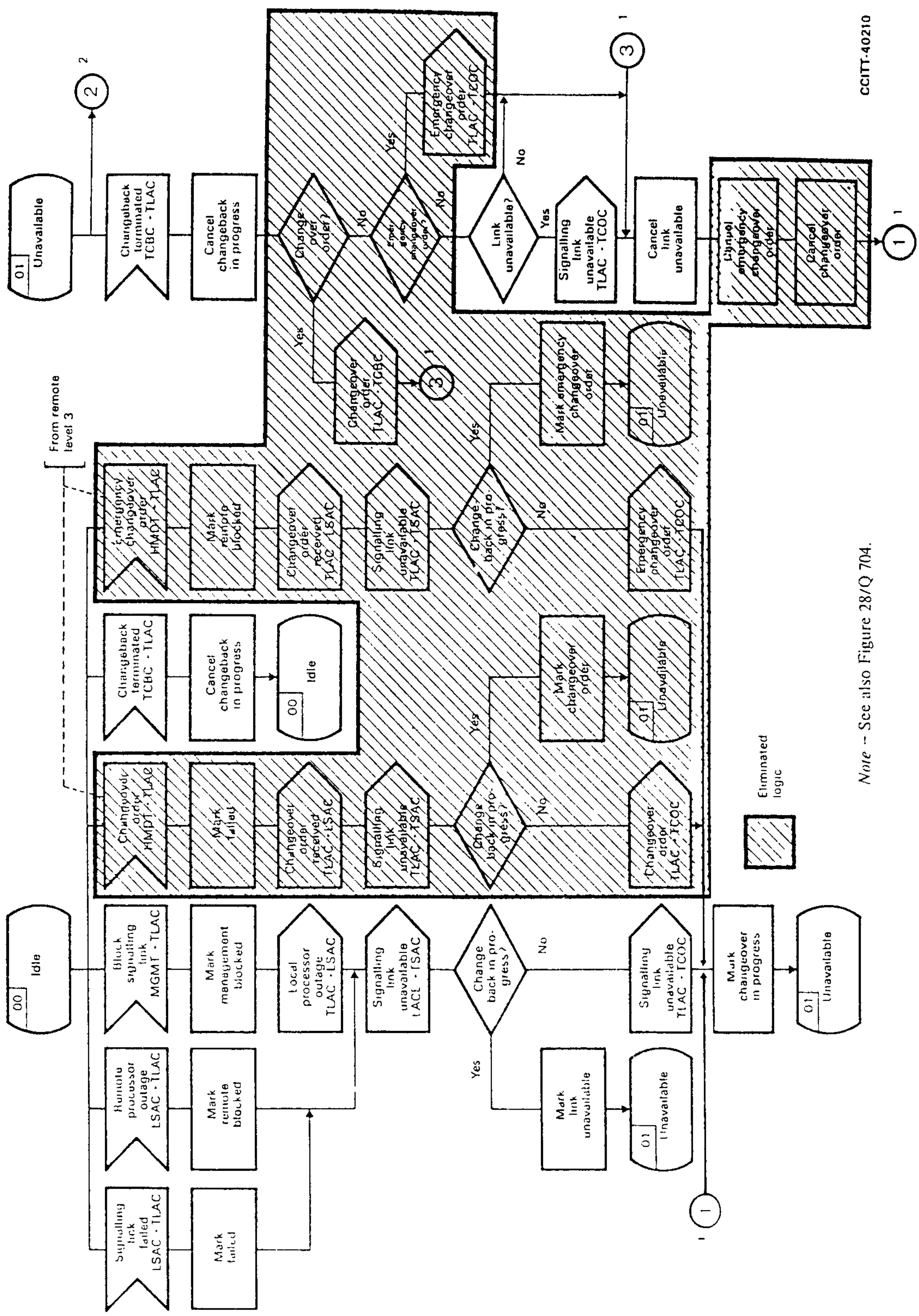
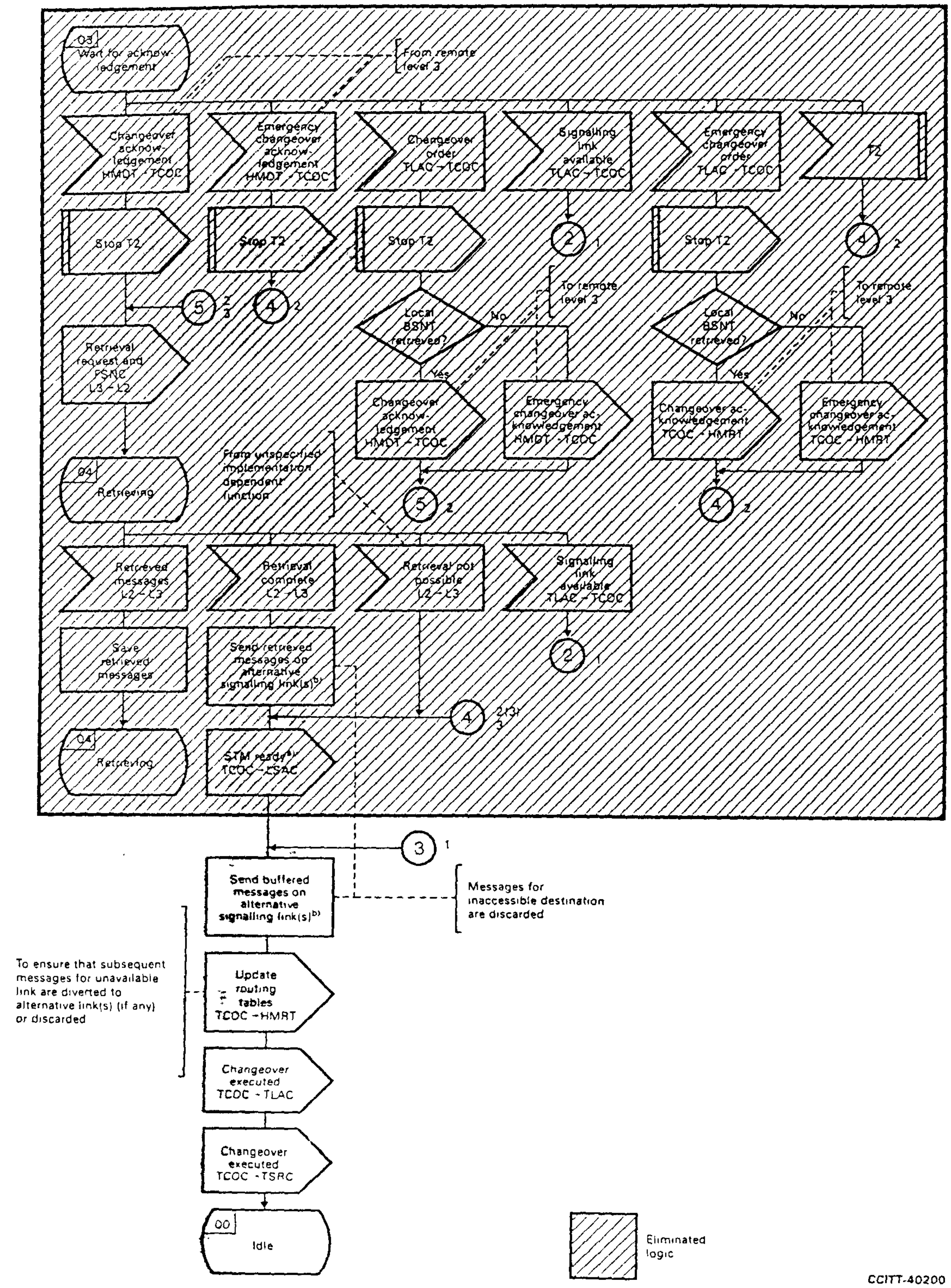


FIGURE A-7/Q.704 (sheet 1 of 2)

level 3 - signalling traffic management; link availability control (TLAC) (impact of switchover method)

Fortsetzung der Auslassung in 1 TR 7:

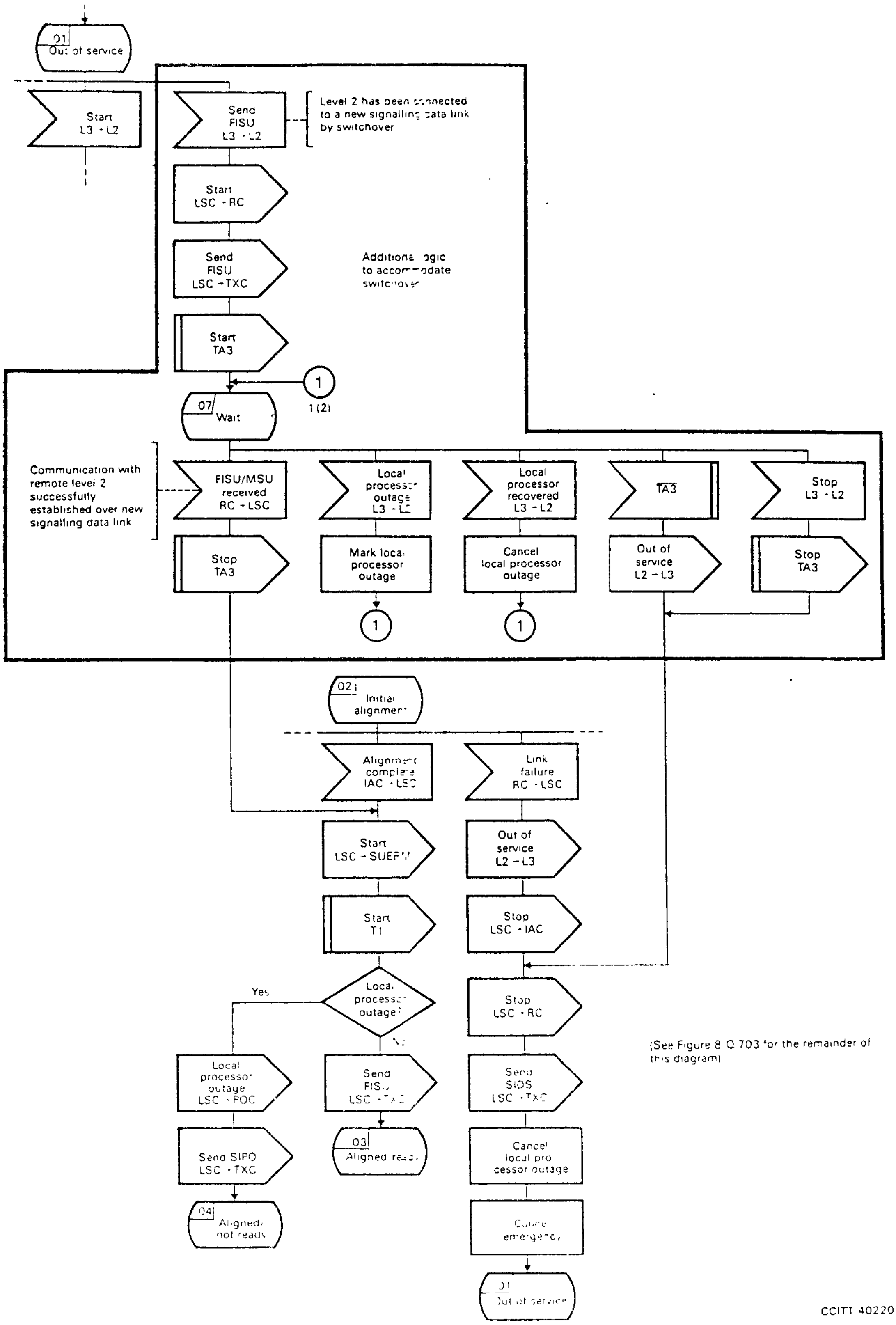


Note – See also Figure 30/Q.704.

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

Level 3 – signalling traffic management; changeover control (TCOC)
(impact of switchover method)

Fortsetzung der Auslassung in 1 TR 7:



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)

Fortsetzung der Auslassung in 1 TR 7

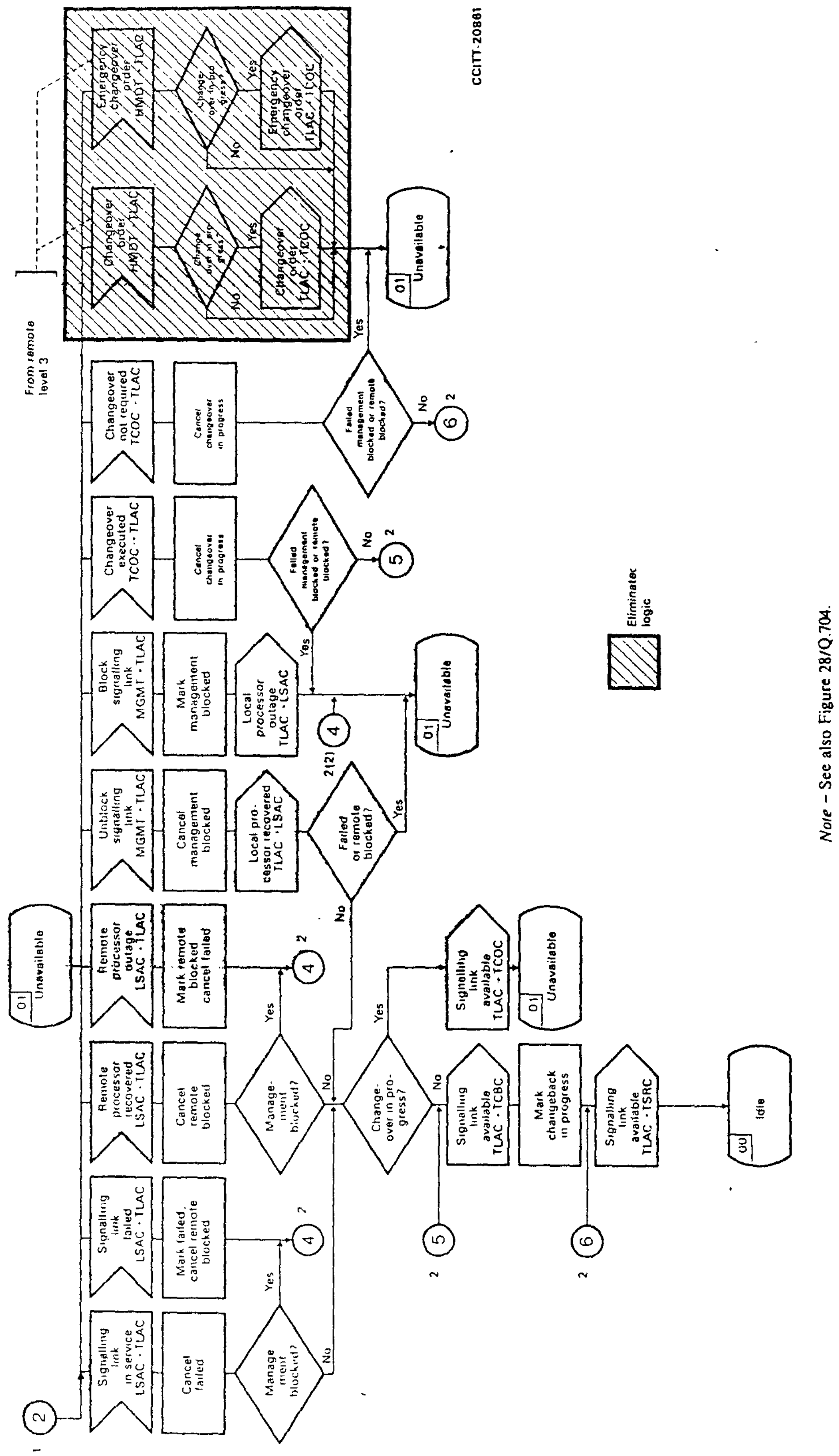
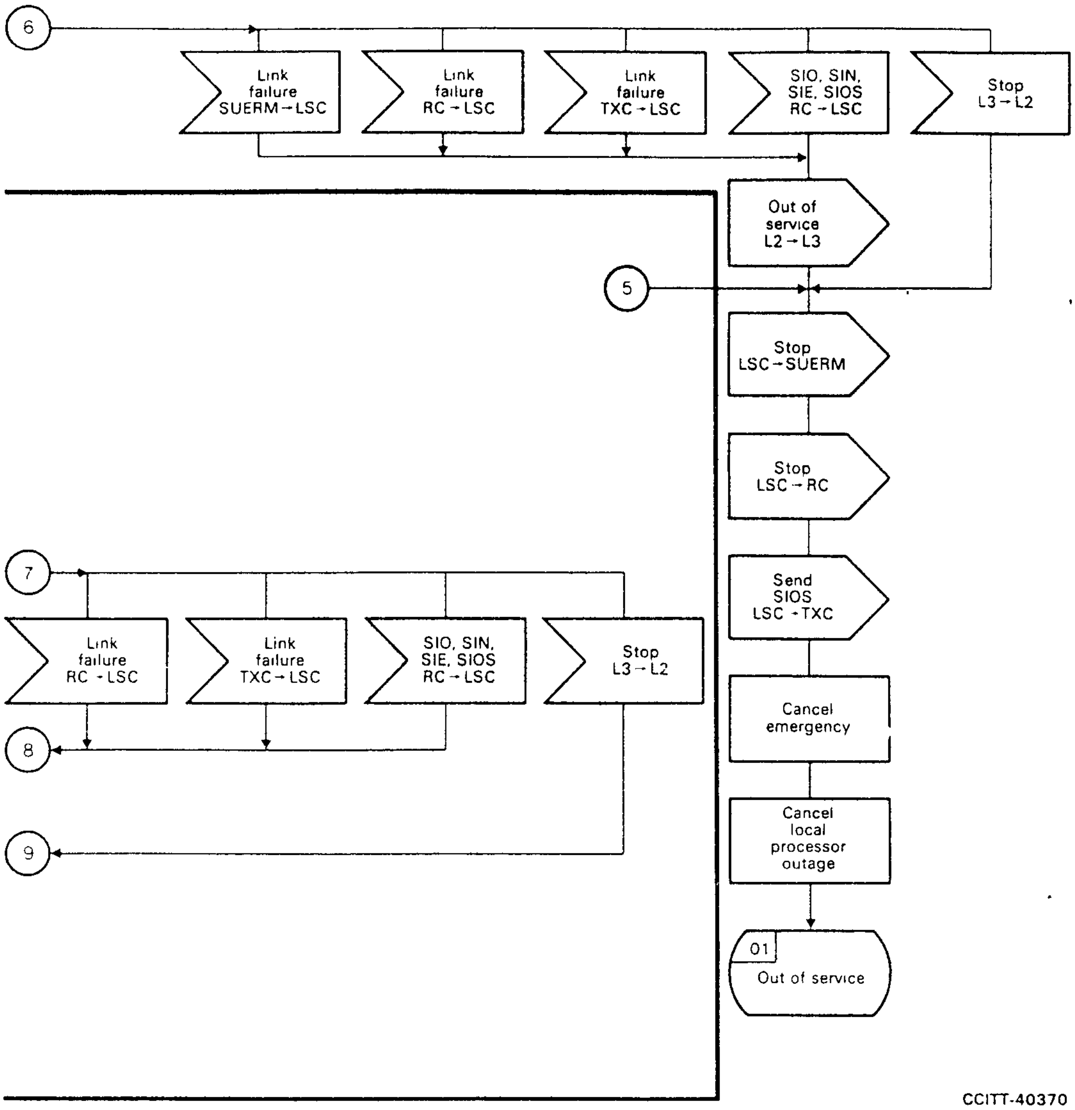


FIGURE A-7/Q.704 (sheet 2 of 2)

Level 3 - signalling traffic management; link availability control (TLAC)
(impact of switchover method)

Fortsetzung der Auslassung in 1 TR 7:



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)

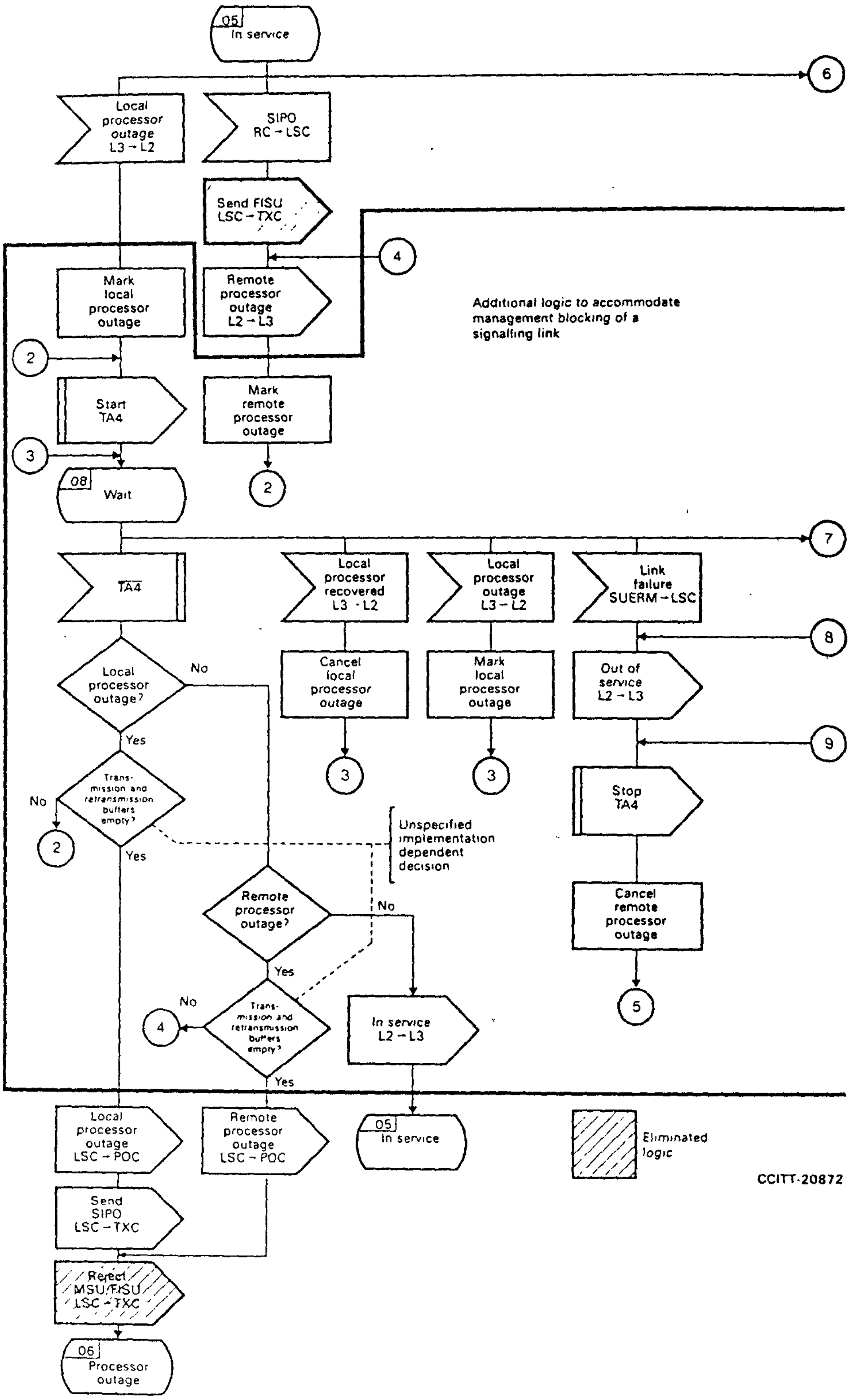
References

(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.

Ende der Auslassung in 1 TR 7.

Fortsetzung der Auslassung in 1 TR 7:



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)

Kapitel 5

Zeichengabenetz

The most elementary signalling network consists of orginating 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. (Auslassung in 1 TR 7: Such a network may be respesented 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 (NSP) (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.

Recommendation Q.705

SIGNALLING NETWORK STRUCTURE

CONTENTS

1 Introduction

Beginn einer Auslassung in 1 TR 7:

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.

Ende der Auslassung in 1 TR 7.

Beginn eines Zusatzes in 1 TR 7:

This Recommendation describes aspects which are pertinent to and should be considered in the design of the national signalling network.

Ende des Zusatzs in 1 TR 7.

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.

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) [Auslassung in 1 TR 7: (see Recommendation Q.709)].

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. [Zusatz in 1 TR 7: (see Recommendation Q.706, § 5.4)].

Load sharing requires at least two signalling links for all bit rates, (Auslassung in 1 TR 7: 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.

Beginn einer Auslassung in 1 TR 7:

4.5 Satellite working

Due to the considerable increase in overall signalling delay, the use of satellites in Signalling System No. 7 connections requires consideration, and further study is required.

In international operation, when the network served by the signalling network is routed on terrestrial circuits, only in exceptional circumstances should a satellite circuit be employed for the supporting signalling connection.

Ende der Auslassung in 1 TR 7.

- international signalling point (ISP) (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)

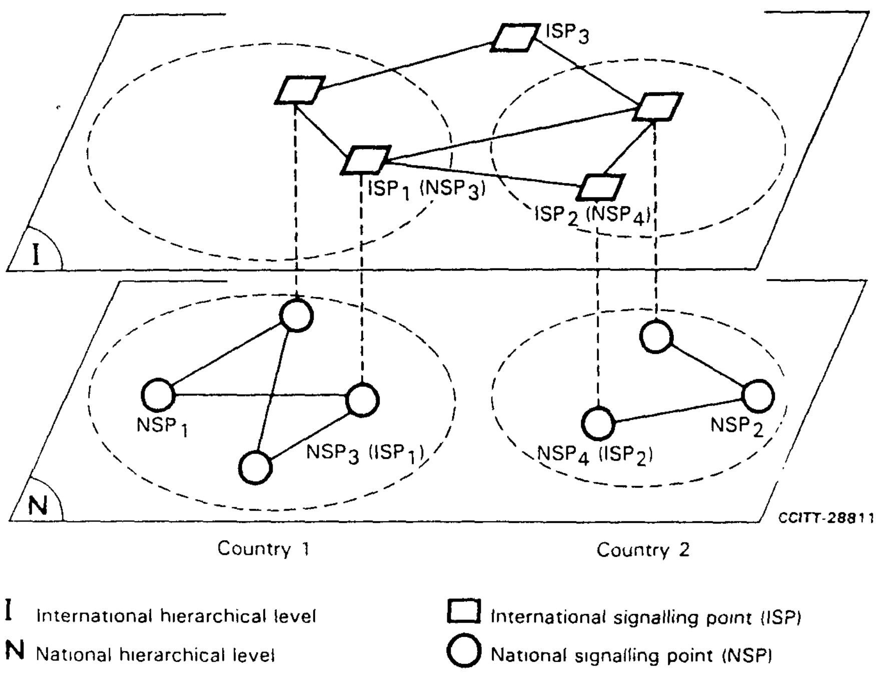


Figure 1/Q.705
International and national signalling networks

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 [Auslassung in 1 TR 7: (see Recommendation Q.709)].

Fortsetzung des Zusatzes in 1 TR 7:

6.6 Numerierung der Zeichengabepunkte

Ein 14-Bit-Kode wird zur Numerierung der Zeichengabepunkte benutzt.

6.6.1 Struktur der Numerierung

Es ist keine bereichsweise Numerierung vorgesehen, sondern eine freie geordnete Numerierung. Daher ist bei der Implementierung keine Numerierungsstruktur zu berücksichtigen.

Eine eventuell aus administrativen Gründen einzuführende Numerierungsstruktur soll keinen Einfluß auf die Implementierung haben.

6.6.2 Numerierungsplan

(wird nachgeliefert, nicht implementierungsrelevant)

6.7 Grundregeln für das Routing der Zeichen

6.7.1 Routing aufgrund des DPC

Das Routing, d. h. die Auswahl des signalling link sets, findet immer aufgrund des vollständigen DPC statt.

Noch nicht vorgesehene SP-Codes sind als "unknown SP" zu kennzeichnen.

Es können fü eine Zeichengabebeziehung bis zu 3 Ersatzwege neben dem Regelweg vorgesehen sein.

6.7.2 Lastteilung aufgrund des SLS-Feldes

Der signalling link wird aufgrund des SLS-Feldes ermittelt. Die Last wird grundsätzlich in Sechzehntelportionen unterteilt.

6.8 Anzahl und Größe der signalling link sets

Zwischen zwei Punkten im Zeichengabenetz existiert höchstens ein direkter signalling link set mit höchstens 16 signalling links. Parallele link sets sind nicht vorgesehen.

6.9 Vorkehrungen für den Störungsfall

Für Störungsfälle sind im Zeichengabenetz redundante Zeichengabewege vorzusehen. Die redundanten Wege werden auch im ungestörten Betrieb zur Abwicklung des Zeichenverkehrs benutzt. Im Störungsfall übernehmen sie dann sofort den von den ausgefallenen Netzteilen getragenen Verkehr.

Beginn eines Zusatzes in 1 TR 7:

5 International signalling network

(Für die Anwendung im nationalen Zeichengabenetz der DBP nicht relevant)

6 Zeichengabenetz der DBP

6.1 Geltungsbereich

Die nachfolgenden Spezifikationen gelten für das nationale, auf dem CCITT-ZGS Nr. 7 basierende Zeichengabenetz der DBP insofern es die Telekommunikationsnetze der DBP bedient (z.B. Netz für Fernsprechen, ISDN, O & M).

Sie gelten nicht für folgende Netze:

- FuFeD Netz C
- Behördennetze
- Private Sondernetze

6.2 Allgemeines

Im Zeichengabenetz der DBP werden die Prozeduren benutzt, die in der nationalen Anwendungsspezifikation für das Zeichengabesystem Nr. 7 im Netz der DBP festgelegt sind.

6.3 Anzahl der Zeichengabetransferpunkte in einer Zeichengabebeziehung

(Wird nachträglich eingebracht, nicht implementierungsrelevant).

6.4 Struktur des Zeichengabenetzes

(wird nachträglich eingebracht, nicht implementierungsrelevant).

6.5 Zeichengabereferenzverbindungen

6.5.1 Nationaler Abschnitt der internationalen hypothetischen Zeichengabe-Referenzverbindung

Für die Bundesrepublik Deutschland - eingestuft als ein mittelgroßes Land - können die in der CCITT-Empfehlung Q.709 angegebenen Werte für die nationale Zeichengabe-Referenzverbindung eingehalten werden.

Sowohl für den abgehenden als auch für den ankommenden Auslandsverkehr gilt:

Die 50 % - Forderung (≤ 2 0/DP) und die 95 % (≤ 3 0/DP) werden ohne besondere zusätzliche Eingriffe in die Struktur des Sprechwegenetzes erfüllt.

Da der zugehörige Zeichenverkehr im wesentlichen assoziiert zum Kennzahlweg des Sprechwegenetzes abgewickelt wird, werden auch die Bedingungen hinsichtlich der Anzahl der STP erfüllt.

6.5.2 Nationale hypothetische Zeichengabe-Referenzverbindung

(wird nachgeliefert, nicht implementiertierungsrelevant).

Fortsetzung des Zusatzes in 1 TR 7:

6.11.4 Belastbarkeit während der Wiederholungsphase

Nach einer Übertragungsstörung oder einem changeover bzw. changeback ist es wünschenswert, daß der entstandene Zeichenstau möglichst schnell abgebaut wird. Zu diesem Zweck ist es erforderlich, daß die Zeichengabestrecke für den kurzen Zeitraum des Stauabbaus eine Übertragungskapazität bereitstellt, die möglichst nahe an 1 Erlang liegt.

Ende des Zusatzes in 1 TR 7.

Fortsetzung des Zusatzes in 1 TR 7:

6.9.1 Lastumlenkung in den Endpunkten des Zeichengabenetzes

In den Endpunkten des Zeichengabenetzes müssen neben der Lastübernahmemöglichkeit innerhalb der signalling link sets bis zu 3 Lastumlenkmöglichkeiten realisierbar sein. In welcher Reihenfolge diese Lastumlenkungen wirksam werden sollen, muß für jeden Endpunkt gesondert festgelegt werden.

6.9.2 Lastumlenkung in den Zeichentransferpunkten

In den Zeichentransferpunkten müssen neben der Lastübernahmemöglichkeit innerhalb der signalling link sets bis zu 3 Lastumlenkungsmöglichkeiten realisierbar sein.

6.10 Verfügbarkeit

Eine Zeichengabebeziehung zwischen zwei aktiven Anwendern darf - unabhängig von ihrer Konfiguration im Zeichengabenetz - nicht länger als 10 min pro Jahr unverfügbar sein.

6.11 Belastung einer Zeichengabestrecke

Zur Bemessung des Zeichengabenetzes dient der Planlastwert.

6.11.1 Definition des maximalen Planlastwertes

Der maximale Planlastwert für eine Zeichengabestrecke ist der maximal zulässige Mittelwert des Zeichenverkehrs an MSU auf einer Zeichengabestrecke während der vier aufeinanderfolgenden Viertelstunden ihrer stärksten Benutzung im normalen Betrieb (siehe auch internationale Definition der Hauptverkehrsstunde).

6.11.2 Festlegen des maximalen Planlastwertes

Der maximale Planlastwert wird für Zeichengabestrecken im Zeichengabenetz der DBP auf 0,2 Erlang festgelegt.

6.11.3 Belastbarkeit bei Lastübernahme

Für den Fall von Ausfällen im Zeichengabenetz, bei denen die Last auf (eine) andere Zeichengabestrecke(n) übernommen werden muß, ist es erforderlich, daß die Zeichengabestrecken für eine begrenzte Zeit deutlich höhere Nutzzeichenverkehrslasten als 0,2 Erlang tragen können. Der Mindestwert dafür ist 0,4 Erlang. Für Not- und Katastrophenfälle ist es wünschenswert, daß auch mehr als 0,4 Erlang Belastung möglich wären.

Fortsetzung der Auslassung in 1 TR 7:

Two alternative arrangements of the signalling network for cross-border traffic are provided so that Administrations may adopt either alternative upon a bilateral agreement.

6.2 Use of international hierarchical level

6.2.1 This arrangement could be applied in the case that there is only a relatively small number of signalling points in a country which serve for cross-border traffic.

6.2.2 The signalling points and the signalling transfer points which are involved in a signalling of cross-border traffic should belong to the international hierarchical level described in § 3. When those signalling points or signalling transfer points are also involved in signalling of national traffic, they should belong to their national hierarchical level as well. Therefore the double numbering of signalling point codes based on both the international and national numbering schemes should be required.

6.2.3 A discrimination between international and national point codes is made by the network indicator in the service information octet (see Recommendation Q.704, Section 13.2).

6.2.4 Signalling network management procedures in this network arrangement require further study.

6.3 Integrated numbering of national signalling networks

6.3.1 By this arrangement the signalling points, which serve cross-border traffic, should be identified by common national signalling point codes.

6.3.2 Common block of national signalling point codes is provided by bilateral agreement (further study is required).

6.4 Interworking of national signalling networks

At the cross-border signalling network interface, the international specification of Signalling System No. 7 should be preferred without exclusion of bilateral agreements.

7 National signalling network

Any specific structures for national signalling networks are not required to be included in the Recommendation, however, Administrations should cater for requirements imposed on a national network for the protection of international services in terms of network related user requirements such as availability and performance of the network perceived by users, (see Recommendation Q.709).

Beginn einer Auslassung in 1 TR 7:

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 scheme of international signalling point codes is defined in Recommendation Q.708.

5.4 Routing rules

5.4.1 In order to ensure full flexibility for the routing of signalling in the System No. 7 international signalling network it appears desirable that at least one signalling point in each country should provide means for the international STP function. Such an approach should ease the use of Signalling System No. 7 on small traffic routes.

5.4.2 Other routing rules (for further study).

5.5 Structures

(Requires further study.)

5.6 Procedures

(Requires further study.)

6 Signalling network for cross-border traffic

6.1 General

For cross-border traffic between signalling points, the need for a special signalling network configuration is identified, because their common interests are such as to generate a considerable volume of traffic between them.

Fortsetzung der Auslassung in 1 TR 7:

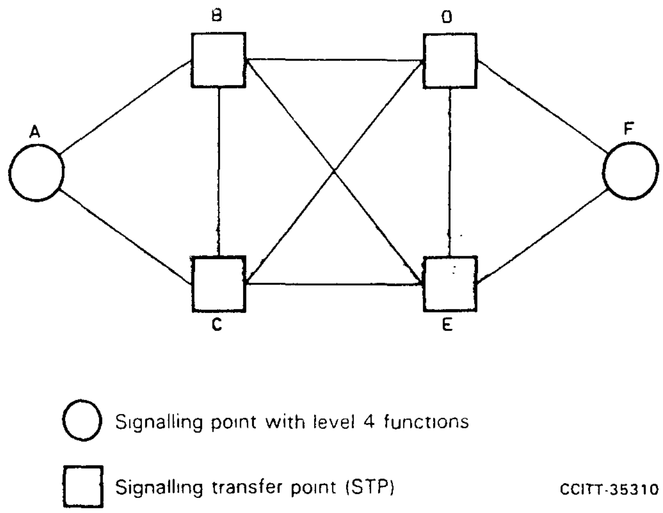


Figure A-1/Q.705

Basic mesh network

A.3 Routing

A.3.1 General

This section gives some routing examples in the basic mesh network in Figure A-1/705. 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

Fortsetzung der Auslassung in 1 TR 7:

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 strukture 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:

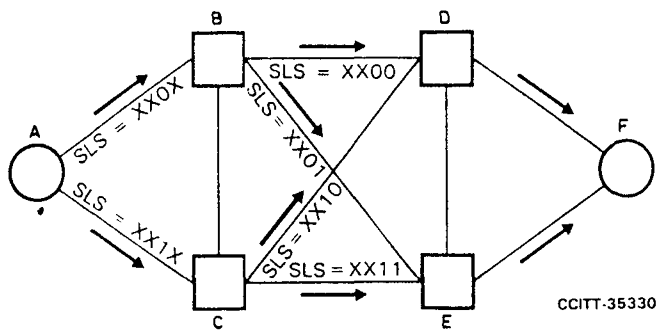
a) two out of four intersignalling transfer point link sets;

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.

Fortsetzung der Auslassung in 1 TR 7:



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

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	AC AB	1 1
Signalling transfer point B	BA BC BE BD	BC None BD BC BE BC	2 1 2 1 2

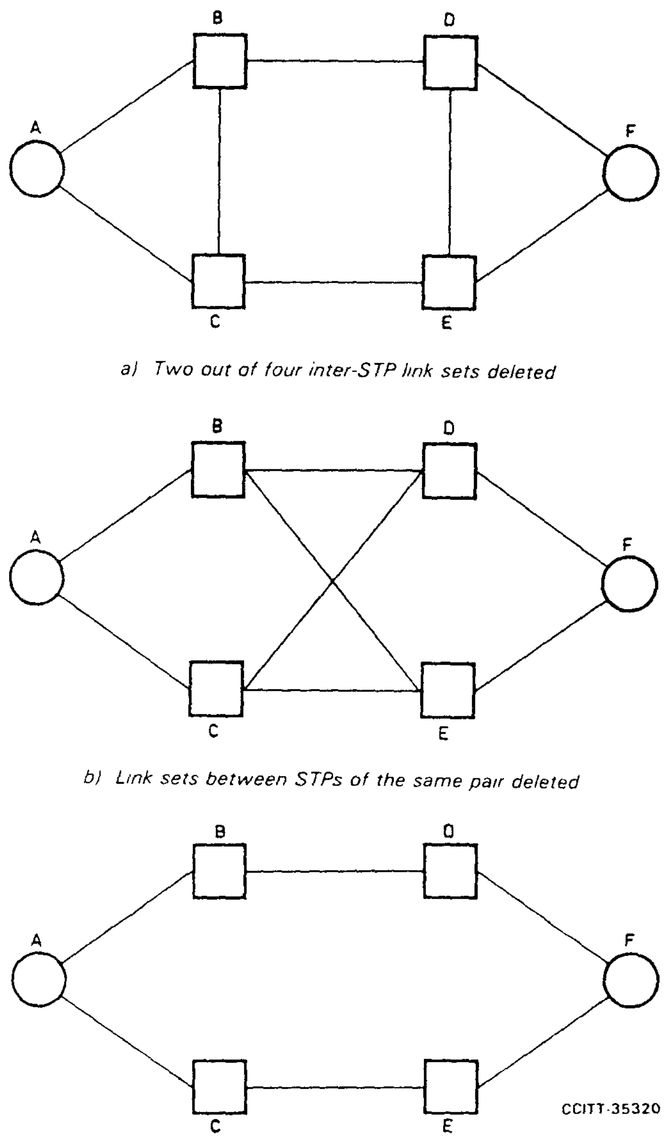
[a)] *Priority 1* — used with normal link set on load-sharing basis in the absence of failures.
Priority 2 — used only when all the link sets with priority 1 become unavailable.

Fortsetzung der Auslassung in 1 TR 7:

the use of signalling link selection (SLS) codes so that traffic will be distributed over four available routes evenly. In the example, orginating 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

Fortsetzung der Auslassung in 1 TR 7:

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 point 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.

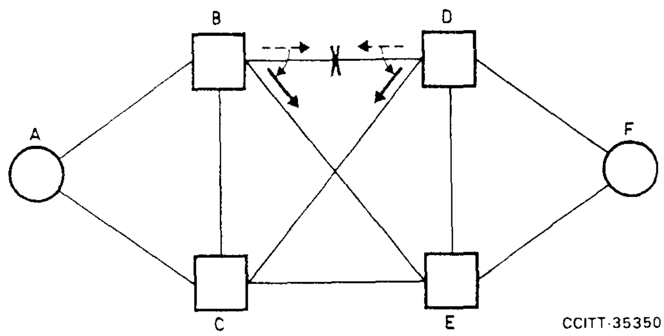


Figure A-5/Q.705
Failure of link BD

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.

Fortsetzung der Auslassung in 1 TR 7:

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.

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).

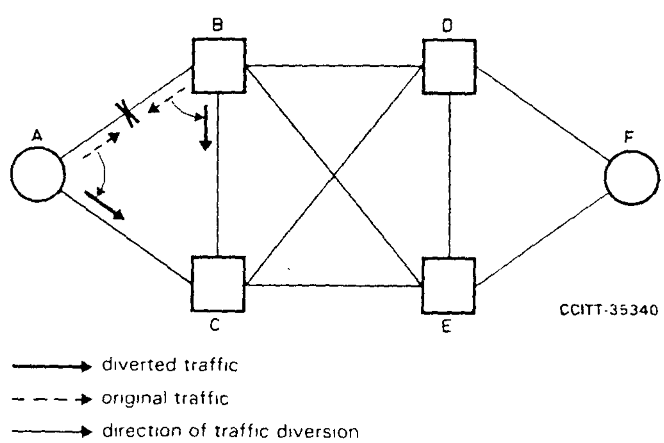


Figure A-4/Q.705
Failure of link AB

Fortsetzung der Auslassung in 1 TR 7:

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.

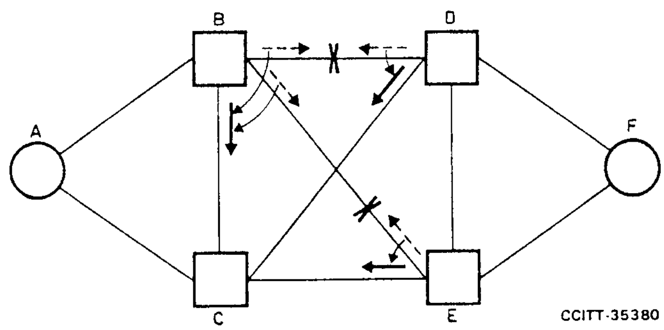


Figure A-8/Q.705
Failure of links BD and BE

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.

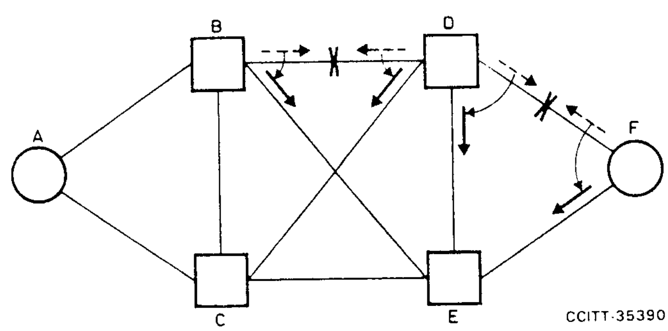


Figure A-9/Q.705
Failure of links BD and DF

Fortsetzung der Auslassung in 1 TR 7:

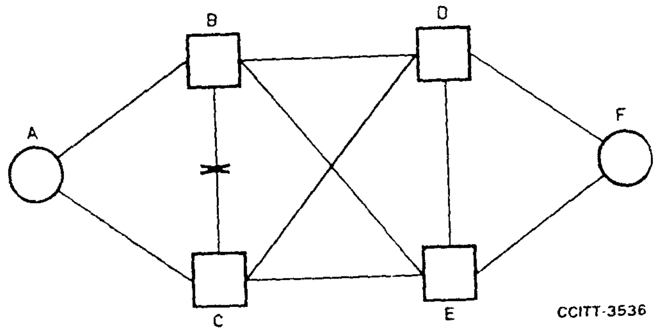


Figure A-6/Q.705
Failure of link BC

A.3.3.3 Multiple link failure examples

As there is 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.

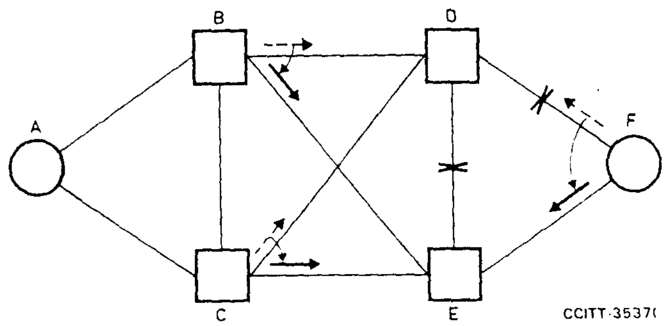


Figure A-7/Q.705
Failure of links DE and DF

Example 2:
Failure of two intersignalling transfer point links (e. g. links BD, BE) (see Figure A-8/Q.705).

Fortsetzung der Auslassung in 1 TR 7:

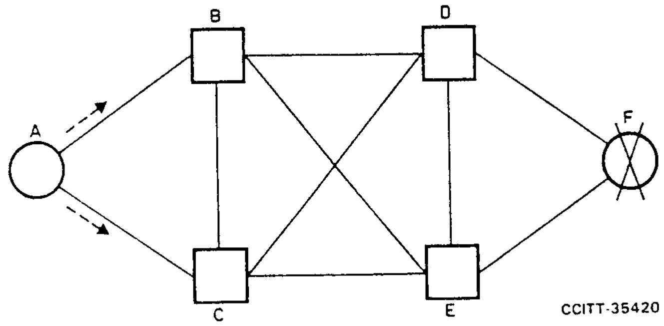


Figure A-12/Q.705
Failure of signalling point F

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.

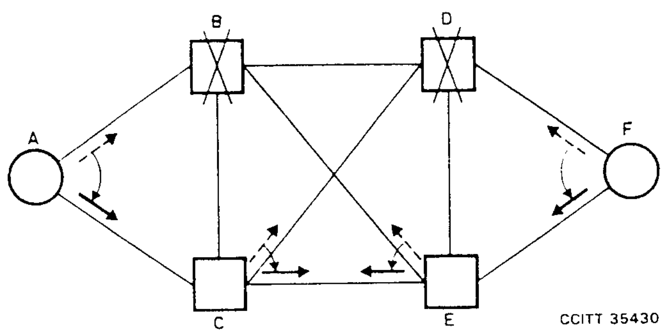


Figure A-13/Q.705
Failure of signalling transfer points B and D

Fortsetzung der Auslassung in 1 TR 7:

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.

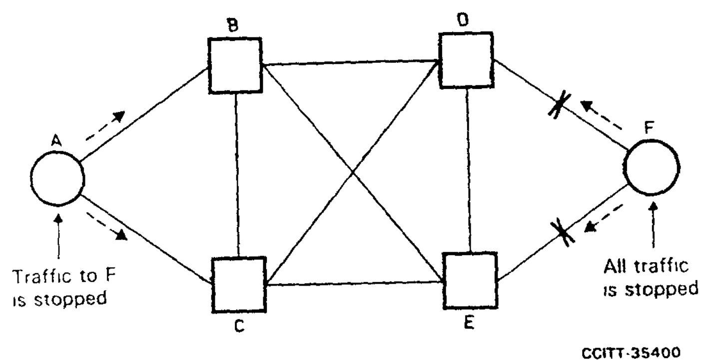


Figure A-10/Q.705
Failure of links DF and EF

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).

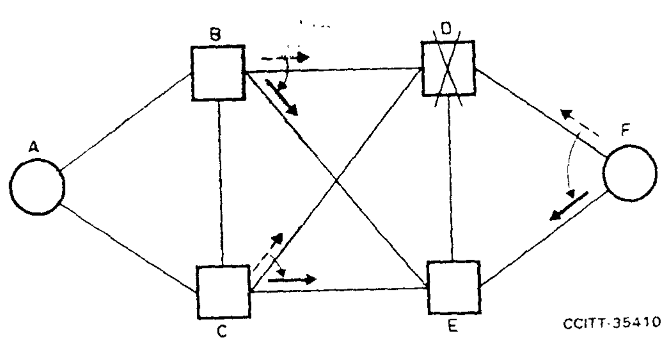


Figure A-11/Q.705
Failure of signalling transfer point D

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.

Fortsetzung der Auslassung in 1 TR 7:

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, § 12.2.2).

c) On the reception of the transfer-prohibited message, C starts the periodic sending of signalling-route-set-test messages, referred to A, to B (see Recommendation Q.704, § 12.4.2).

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, §12.3.2). 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.

Fortsetzung der Auslassung in 1 TR 7:

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.

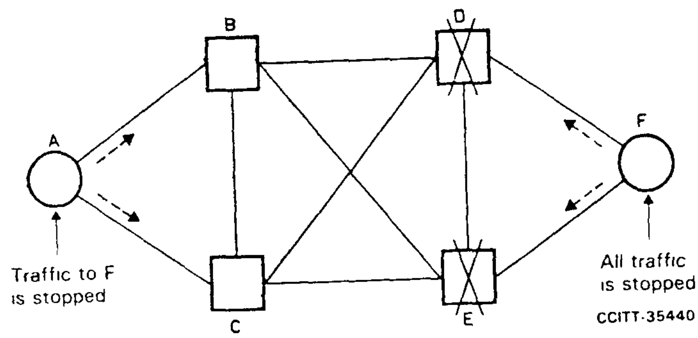


Figure A-14/Q.705
Failure of signalling transfer points D and E

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.)

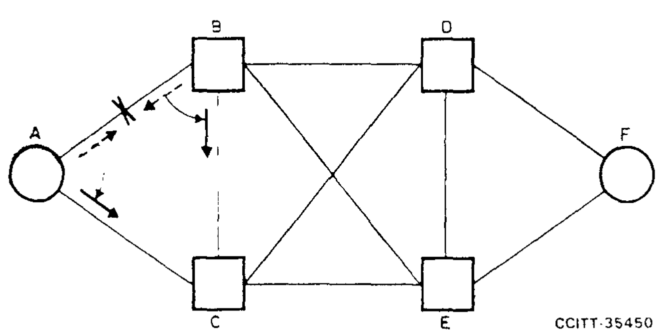


Figure A-15/Q.705
Failure of link AB

Fortsetzung der Auslassung in 1 TR 7:

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) 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; § 12.2.2). 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.4.3 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).

Fortsetzung der Auslassung in 1 TR 7:

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.)

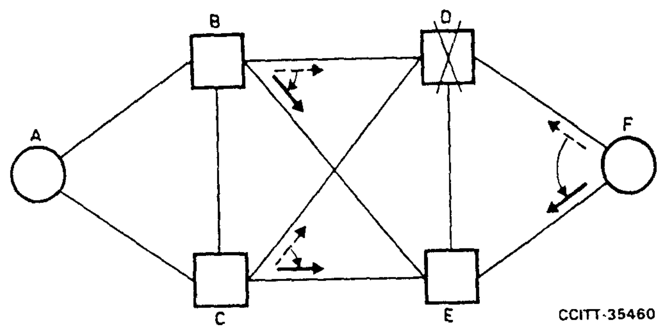


Figure A-16/Q.705
Failure of signalling transfer point D

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 acknowledgement 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.

Fortsetzung der Auslassung in 1 TR 7:

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 rerouting 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 missequencing messages.

A.4.3.4 Restoration of link DE

On recovery of link DE it is marked available at sigalling 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 points 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).

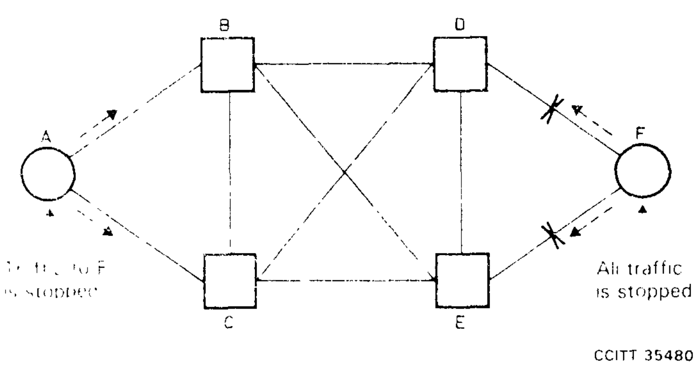


Figure A-18/Q.705
Failure of links DF and EF

Fortsetzung der Auslassung in 1 TR 7:

(Same as § A.3.3.3 Example 1.)

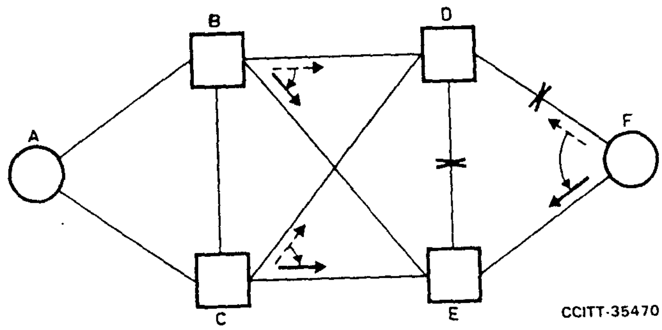


Figure A-17/Q.705
Failure of links DE and DF

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 DE the following actions occur:

   i) Signalling point D which no longer has access to sigalling 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 caused by a fault in a remote part of the network.

Fortsetzung der Auslassung in 1 TR 7:

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 message to D.

Note:
According to the rules stated in Recommendation Q.704, § 12.3.2, 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, talking 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 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 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

Fortsetzung der Auslassung in 1 TR 7

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 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.

Fortsetzung der Auslassung in 1 TR 7:

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 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.

Ende der Auslassung in 1 TR 7.

Kapitel 6

Leistungsfähigkeit des MTP

The unavailibility of a signalling route set should not exceed a total of 10 minutes per year.

The unavailibility 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 characteristics 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.

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 neccessarily 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, [Auslassung in 1 TR 7: 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 (Zusatz in 1 TR 7: signalling relation)

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.

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 structur 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 Systems 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 exp (-6) 1 ;

b) a medium-term bit error rate of less than 10 exp (-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

Beginn einer Auslassung in 1 TR 7:

(Needs further study.)

Ende der Auslassung in 1 TR 7

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. (Auslassung in 1 TR 7: 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.

Beginn eines Zusatzes in 1 TR 7:

2.2.5 Belastung der Zeichenstrecke (s. Kap. 5, Abschnitt 6.11)

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

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 or 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.

Beginn eines Zusatzes in 1 TR 7:

(s. auch Kap. 2, Abschnitt 2.2)

Ende des Zusatzes in 1 TR 7.

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.

Beginn einer Auslassung in 1 TR 7:

4.1.1 International signalling network

(Needs further study.)

4.1.2 National signalling network

(Needs further study.)

Ende der Auslassung in 1 TR 7.

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 delay: queueing delay in the absence of disturbances and total queueing delay.

Beginn eines Zusatzes in 1 TR 7:

Die weiteren Betrachtungen werden nicht in die nationale Anwendungsspezifikation der DBP aufgenommen, da sie vorwiegend von theoretischem Character sind.

Aus diesem Grunde sind die Seiten 182-188 der Gelbbücher nicht vorhanden.

Ende des Zusatzes in 1 TR 7.

Fortsetzung der Auslassung in 1 TR 7:

$a_3 = \exp(-at_L)$: traffic loading caused by fill-in signal units.

$$a_2 = 1 - a - a_3$$

$$H_1 = at_L$$

$$H_2 = at_L(k_1 + at_L)$$

$$H_3 = at_L(k_2 + 3at_Lk_1 + a^2t_L^2)$$

$$F_1 = at_L/2$$

$$F_2 = at_L(k_1/2 + at_L/3)$$

$$F_3 = at_L(k_2/2 + at_Lk_1 + a^2t_L^2/4$$

$$q_a = \frac{k_1(a + a_2) + a_3t_f}{2(1 - a)}$$

$$s_a = \frac{ak_1}{1 - a} q_a + \frac{k_2(a + a_2) + a_3t_f^2}{3(1 - a)}$$

$$t_a = \frac{3ak_1s_a + 2ak_2q_a}{2(1 - a)} + \frac{(a + a_2)k_3 + a_3t_f^3}{4(1 - a)}$$

$$Z_1 = 2 + P_u(1 + H_1)$$

$$Z_2 = 4K_1 + P_u(5k_1 + 3H_1 + H_2)$$

$$Z_3 = 8k_2 + P_u(19k_2 + 27k_1H_1 + 9H_2 + H_3)$$

$$Y_2 = s_a + 4k_1 + F_2 + 2\{q_a(2 + F_1) + 2F_1\}$$

$$Y_3 = t_a + 8k_2 + F_3 + 3\{s_a(2 + F_1) + q_a(4k_1 + F_2) + 2F + 2 + 4k_1F_1\} + 12q_aF_1$$

$$\alpha = \frac{1 - a\{Z + P_u(1 + at_L)\}}{2 + q_a + at_L/2}$$

$$q_d = \frac{aZ_2 + \alpha Y_2}{2(1 - aZ_1)}$$

$$s_d = \frac{aZ_2}{1 - aZ_1} q_d + \frac{aZ_3 + \alpha Y_3}{3(1 - aZ_1)}$$

$$q_b = \frac{q_a + 1 + F_1}{1 - a}$$

$$s_b = \frac{s_a + k_1 + f_2}{(1 - a)^3} + \frac{2\{\varphi a(1 + F_1) + F_1\}}{(1 - a)^2}$$

$$q_c = \frac{q_d + 1 + P_u(1 + H_1)}{1 - a}$$

$$s_c = \frac{s_d + k_1 + P_u(3k_1 - H_2)}{(1 - a)^3} + 2\,\frac{q_d + P_u\{q_d(1 + H_1) + 2H_1\}}{(1 - a)^2}$$

$$P_V = P_u a \frac{q_a + Z + at_L/2}{1 - 2a}\left(1 + P_u \frac{a + a^2t_L}{1 - 2a}\right)$$

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 Tx is:

Fortsetzung der Auslassung in 1 TR 7:

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

$$k_1 = \frac{\text{2nd moment of message signal units emission time}}{T_m^2}$$

$$k_2 = \frac{\text{3rd moment of message signal units emission time}}{T_m^3}$$

$$k_3 = \frac{\text{4th moment of message signal units emission time}}{T_m^4}$$

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 preventive cyclic retransmission (PCR) method,

Fortsetzung der Auslassung in 1 TR 7:

Table 1/Q.706
Queueing delay formula

Error correction method	Disturbance	Mean Q	Variance σ^2
Basic	Absence	$\frac{Q_u}{T_m} = \frac{t_f}{2} + \frac{a k_1}{2(1 - a)}$	$\frac{\sigma_u^2}{T_m^2} = \frac{t_f^2}{12} + \frac{a[4k_2 - (4k_2 - 3k_1^2)a]}{12\,(1 - a)^2}$
	Presence	$\frac{Q_t}{T_m} = \frac{t_f}{2} + \frac{aE_2}{2(1 - aE_1)} + E_1 - 1$	$\frac{\sigma_t^2}{T_m^2} = \frac{t_f^2}{12} + \frac{a[4E_3 - (4E_1E_3 - 3E_2^2)a]}{12(1 - aE_1)^2} + P_u(1 - P_u)\,t_L^2$
Preventive cyclic retransmission	Absence	$\frac{Q_u}{T_m} = q_u$	$\frac{\sigma_u^2}{T_m^2} = s_u^2 - q_u^2$
	Presence	$\frac{Q_t}{T_m} = (1 - P_u - P_s)\,q_a + P_u q_b + P_s q_c$	$\frac{\sigma_t^2}{T_m^2} = (1 - P_u - P_s)\,s_a + P_u s_b + P_s\,s_c - \frac{Q_t^2}{T_m^2}$

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.

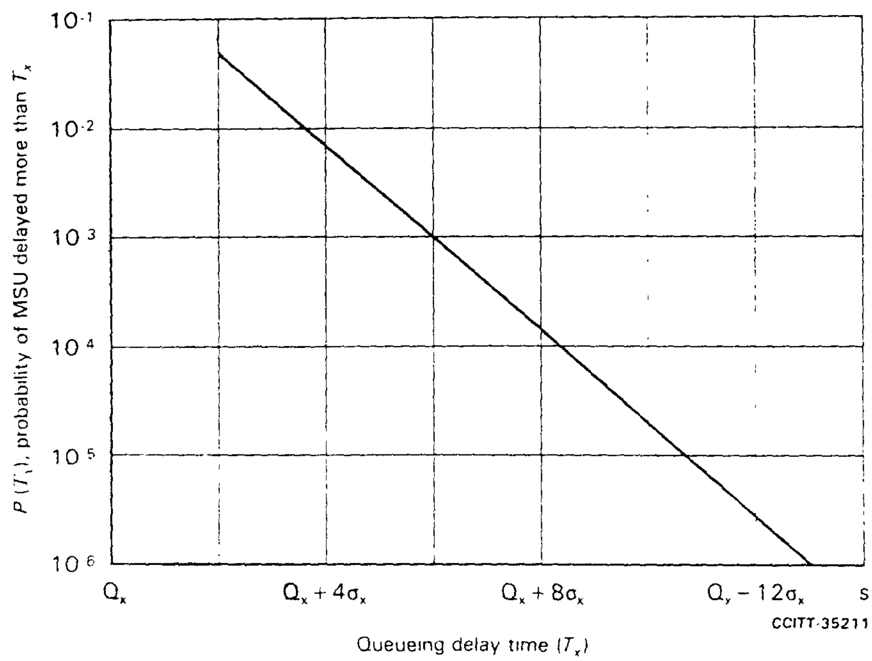
Table 2/Q.706
Traffic model

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	
k 3	1,0	3,8	

Fortsetzung der Auslassung in 1 TR 7:

$$P(T_x) \simeq \exp\left(-\frac{T_x - Q_x + \sigma_x}{\sigma_x}\right)$$

where Qx and x denote the mean and the standard deviation of queueing delay, respectively. This approximation is better suited in absence of disturbances. In the presence of disturbances the actual distribution may be deviated further. Relation between P (Tx) and Tx 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 Tx.

Fortsetzung der Auslassung in 1 TR 7:

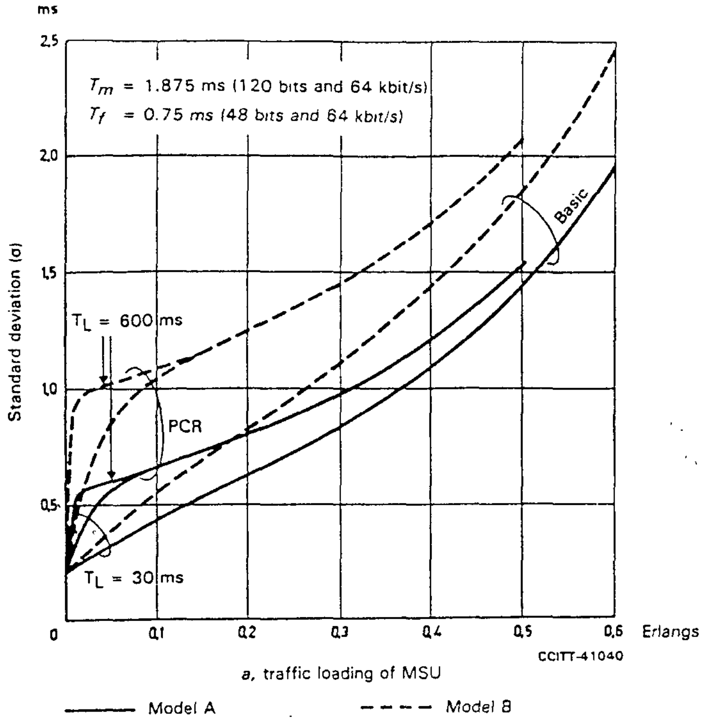


FIGURE 3/Q.706
Standard deviation of queueing delay of each channel of traffic in absence of disturbance

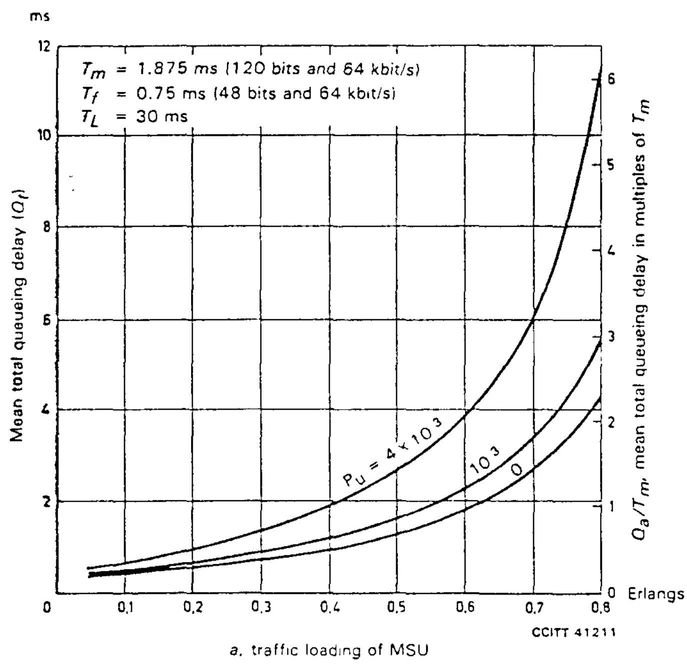


FIGURE 4/Q.706
Mean total queueing delay of each channel of traffic; basic error correction method

Fortsetzung der Auslassung in 1 TR 7:

TABLE 3/Q.706
List of examples

Figure	Error control	Queueing delay	Distrubance	Model
2/Q.706	Basic/PCR	Mean	Absence	A und B
3/Q.706	Basic/PCR	Standard deviation	Absence	A und B
4/0.706	Basic	Mean	Presence	A
5/Q.706	Basic	Standard deviation	Presence	A
6/Q.706	PCR	Mean	Presence	A
7/Q.706	PCR	Standard deviation	Presence	A

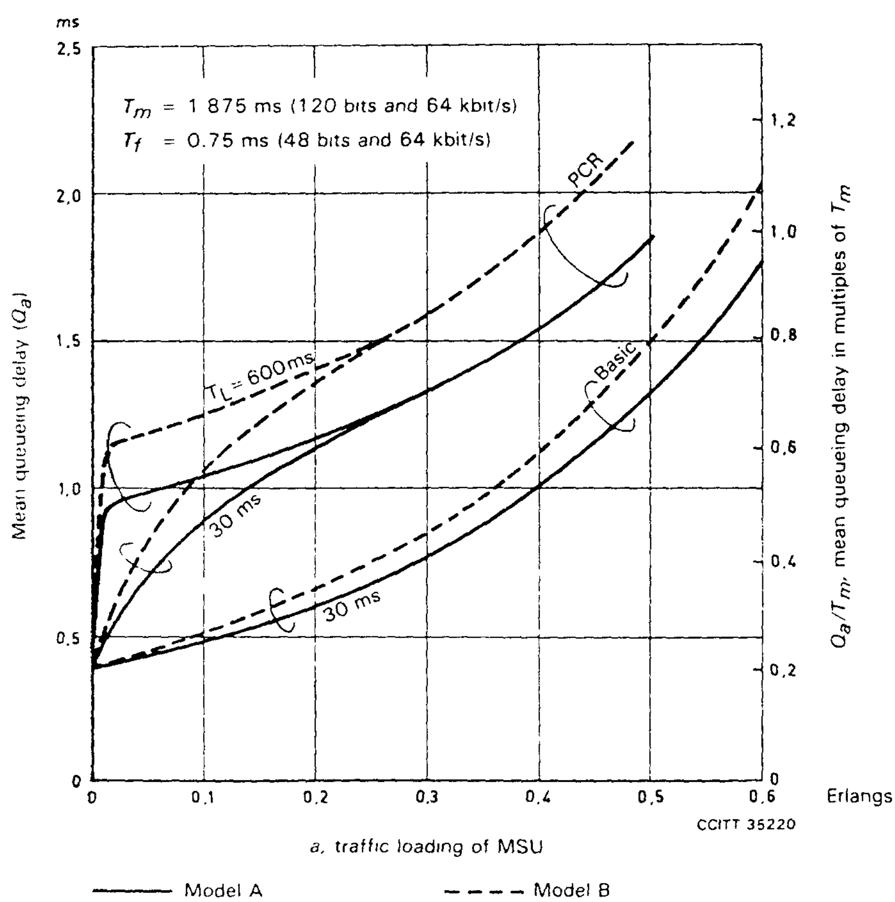


FIGURE 2/Q.706
Mean queueing delay of each channel of traffic in absence of disturbance

Fortsetzung der Auslassung in 1 TR 7:

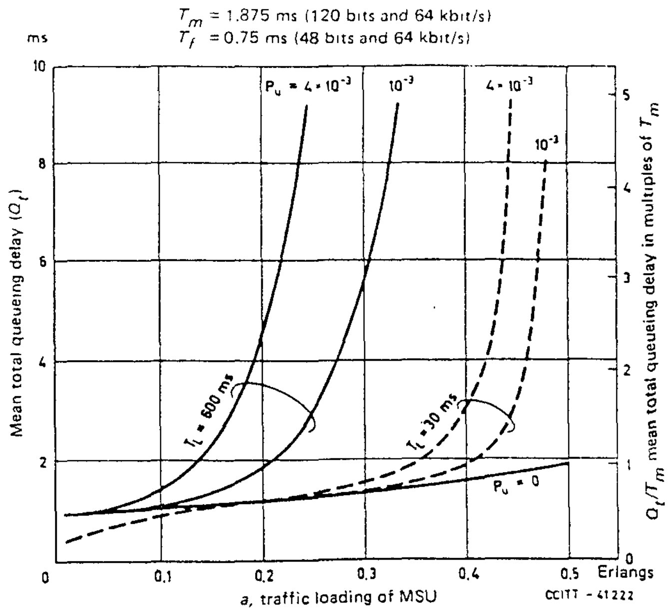


FIGURE 6/Q.706
Mean total queueing delay of each channel of traffic; preventive cyclic retransmission error correction method

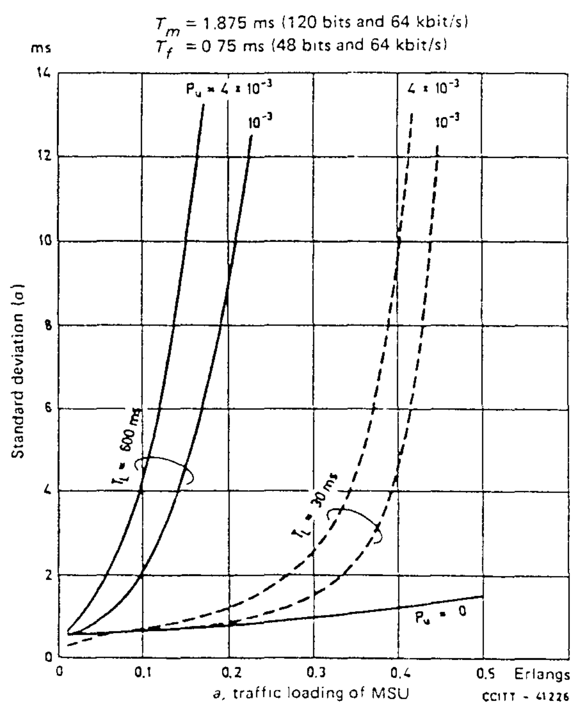


FIGURE 7/Q.706
Standard deviation of queueing delay of each channel of traffic; preventive cyclic retransmission error correction method

Ende der Auslassung in 1 TR 7.

Fortsetzung der Auslassung in 1 TR 7:

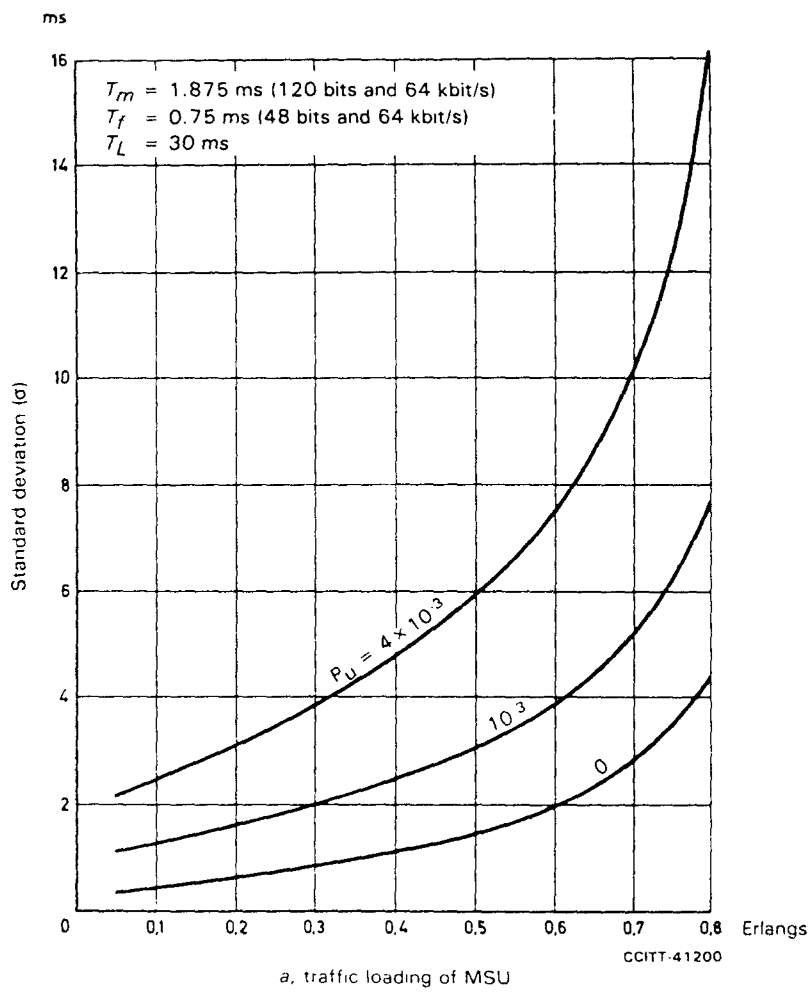


FIGURE 5/Q.706
Standard deviation of queueing delay of each channel of traffic; basic error correction method

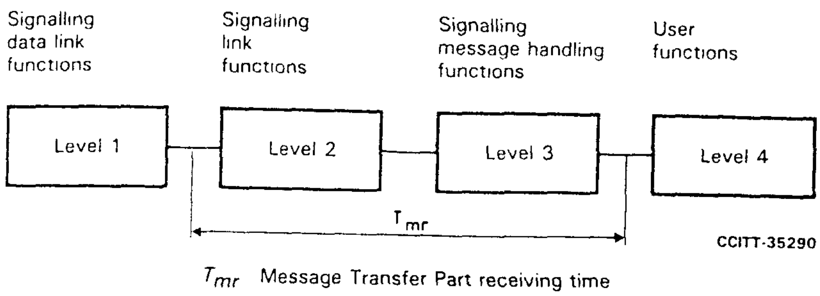


Figure 10/Q.706
Functional diagram of the Message Transfer Part receiving time

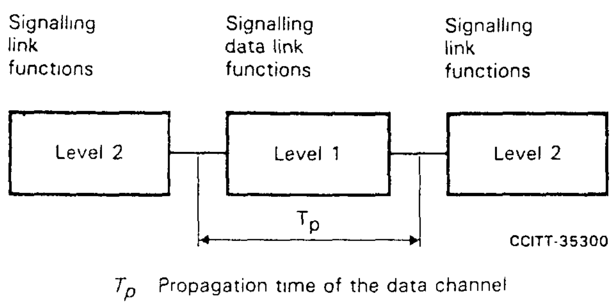


FIGURE 11/Q.706
Functional diagram for the propagation time

4.3.2 Definitions

4.3.2.1. Message Transfer Part sending time Tms

F: temps d'emission du Sous-systeme Transport de Messages Tms,
S: tiempo de emision de la parte de transferencia de mensajes Tms,

Tms 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 Tcs

F: temps de transfert des messages aux points de transfert semaphore Tcs
S: tiempo de transferencia de mensajes en los puntos de transferencia de la senalizacion Tcs

Tcs 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 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 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-(8/Q.706).

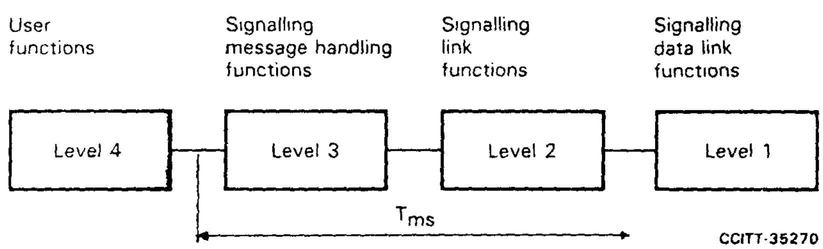
b) Signalling transfer point function (see Figure 9/Q.706).

c) Message Transfer Part receiving function at the point of destination (see Figure 10/Q.706).

d) Signalling data link propagation time (see Figure 11/Q.706).

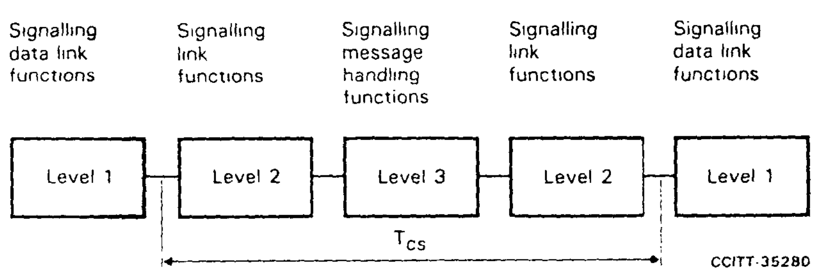
e) Queueing delay.

   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 8/Q.706
Functional diagram of the Message Transfer Part sending time



T_{cs} Message transfer time at signalling transfer points

Figure 9/Q.706
Functional diagram of the message transfer time at signalling transfer points

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 Tmr, Tms and Tcs will be presented in the form of:

- mean values,
- 95% level values.

The estimates for Tcs for a signalling transfer point are given in Table 4/Q.706.

TABLE 4/Q.706
(provisional values)

STP signalling traffic load	Message transfer time at an STP (Tcs) in ms	
	Mean	95 %
Normal	20	40
+ 15 %	40	80
+ 30 %	100	200

Beginn eines Zusatzes in 1 TR 7:

Die oben angegebenen Werte stellen Richtwerte dar, über deren Einhaltbarkeit im Pilotprojekt Erfahrungen gewonnen werden sollen.

Ende des Zusatzes in 1 TR 7.

These figures are related to 64kbit/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. (Auslassung in 1 TR 7: 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.

4.3.2.3 Message Transfer Part receiving time Tmr,

F: temps de reception du Sous-systeme Transport de Messages Tmr,
S: tiempo de reception de la parte de transferencia de mensajes Tmr,

Tmr 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 Tp,

F: temps de propagation sur la voie de donnees, Tp,
S: tiempo de propagacion del canal de datos Tp,

Tp is the period which starts when the last bit of the signal unit has enterred 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 To is referred to the signalling relation. To starts when the message has left the user part (level 4) at the point of orgin 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

$$T_o = T_{oa} + \sum (Q_t - Q_a)$$

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.

4.5.2 Security requirements

(Auslassung in 1 TR 7: 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. [Auslassung in 1 TR 7: (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 qualitiy 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

Beginn eines Zusatzes in 1 TR 7:

Bei Verfügbarkeitsberechnungen für die Zeichengabe kann entsprechend TL FTZ 163 TL 21 EWSD/F, sowie TL FTZ 163 TL TL 22 S12/F davon ausgegagen werden, daß Zeichengabepunkte nicht länger als 1 Std. pro Jahr unverfügbar sind.

Wie groß die wirkliche Verfügbarkeit im Sinne der Zeichengabe ist, bedarf wegen des unterlegten Berechnungsmodus weiterer Untersuchungen.

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

(needs further study)

Ende der Auslassung in 1 TR 7

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 missequencing 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 arranements have an essential influence on the observance of the 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 (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 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.

4.7 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).

Beginn einer Auslassung in 1 TR 7:

5 Performance under adverse conditions

5.1 Adverse conditions

(needs further study.)

5.2 Influence of adverse conditions

(needs further study.)

Ende der Auslassung in 1 TR 7.

Reference

(1) CCITT Recommendation Error performance on an international digital connection forming part of an integrated services digital network, Vol. III, Rec. G.821.

Kapitel 7

Prüfen und Unterhalten

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.

Ende der Auslassung in 1 TR 7.

Beginn eines Zusatzes in 1 TR 7:

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 when the signalling link is just activated. The signalling link only becomes available when the signalling link test was successful.

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 test the common meaning of the SLC code, used in level 3 messages. Therefore it is assumed that the code of the signalling link on which the signalling link acknowledgement message is received is known. This allows to verify that the remote level 3 uses the same link for a given SLC.

The testing of a signalling link is performed independently from each end.

Ende des Zusatzes in 1 TR 7.

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 test 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). Te 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,

---

1) In case, the signalling link is marked at level 3 as congested, the signalling link test procedure is stopped on that link test failure indications (for the concerned link) are ignored during congestion.

Recommendation Q.707

TESTING AND MAINTENANCE

1 General

In order to realize the performance requirements described in Recommendation Q.706, means and procedure 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 function 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 must be taken (Zusatz in 1 TR 7: within the maintenance concept) 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, § 10 (Text in 1 TR 7: § 9), also provide means for detecting deterioration of a signalling data link.

Further studies are required with reference to Recommendation V.51 (2).
(Zusatz in 1 TR 7: As far as analog 4,8 kbit/s data links are used, refer to Rec. 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.

Beginn einer Auslassung in 1 TR 7:

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 to be used when a signalling link is activated. The signalling link becomes available only if the test is successful. 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.

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). A collection of such measurements is to be found in Tables 1 to 6 of Kapitel 8 (Messungen und Überwachungen im MTP).

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 Recomendation 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 structuring as the label of signalling network management messages (see Recommendation Q.704, § 13.2).

5.3 Heading code HO

The heading code HO 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.

Beginn eines Zusatzes in 1 TR 7:

c) a signalling link test acknowledgement message is received on the wrong signalling link,

Ende des Zusatzes in 1 TR 7.

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.

Beginn einer Auslassung in 1 TR 7:

2.3 Signalling route test

In addition to the procedures specified in the Recommendation Q.704, § 12, 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 contained in Recommendatons Q.791 and Q.795.

Ende der Auslassung in 1 TR 7.

Beginn eines Zusatzes in 1 TR 7:

2.3 Signalling route test

The procedure specified in the Recommendation Q.704, § 11.4 (signalling-route-set-test) is sufficient, because in addition each link is supervised individually by the signalling link test.

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 will use the signalling link test messages in § 5.4.

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.

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	First bit transmitted
n[a] x 8	4[a]	4[a]	4	4	32	

[a] Provisional value.

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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), [Zusatz in 1 TR 7:(value 0100)]
- Test pattern: (n x 8 bits with n < 16) [2] [Zusatz in 1 TR 7: (4 x 8 bits)]

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.

Beginn einer Auslassung in 1 TR 7:

The test pattern is an integral number of octets and is chosen at the discretion of the originating point.

Ende der Auslassung in 1 TR 7.

Beginn eines Zusatzes in 1 TR 7:

The test pattern to be sent preferably consists of 4 octets:

0000 0000, 1111 1111, 0101 0101, 1010 1010.

Ende des Zusatzes in 1 TR 7.

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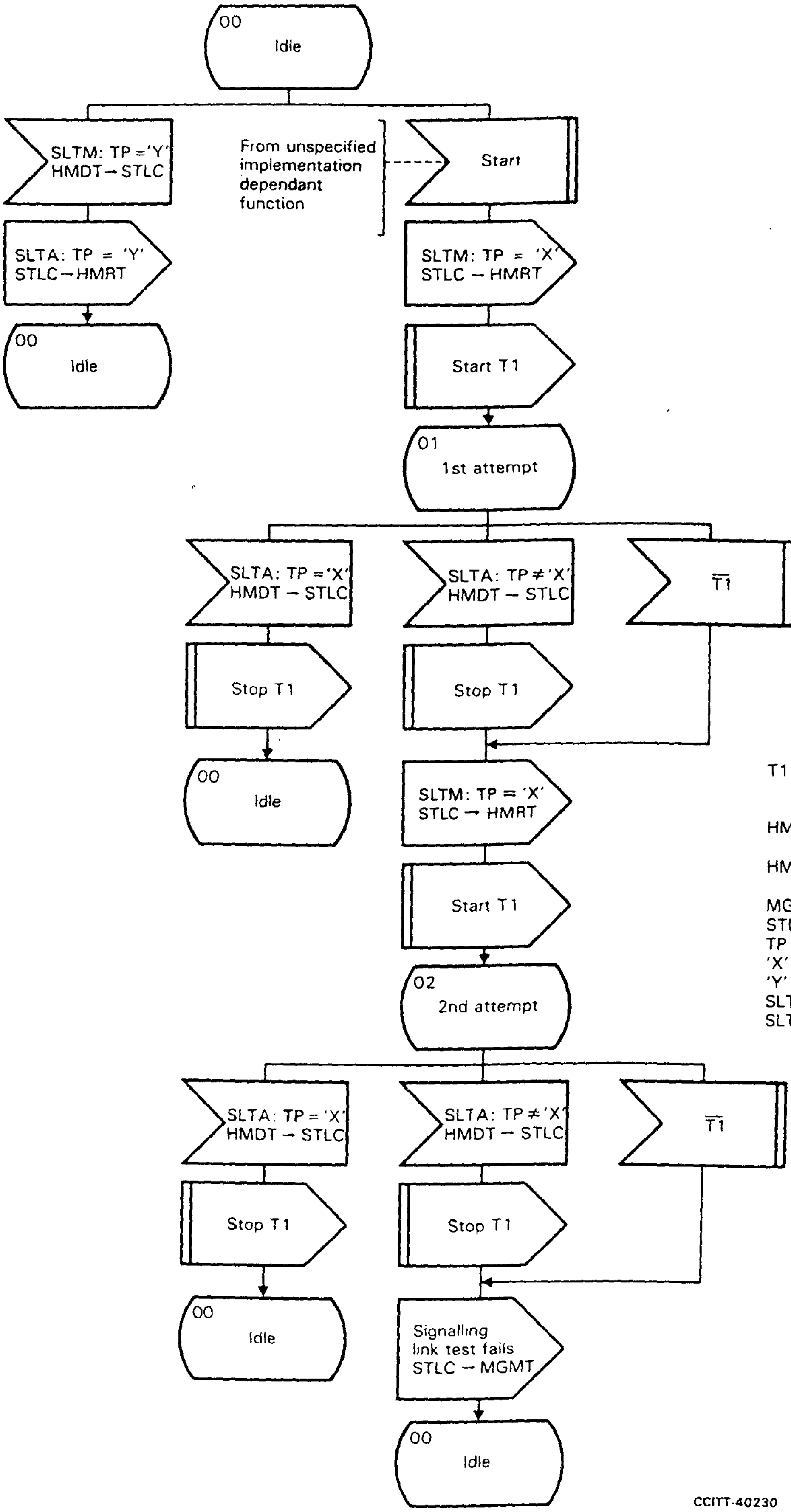
2) Provisional value

References:

[1] CCITT Recommendation Lining up an international point-to-point leased circuit, Vol. IV, Rec. M.1050.

[2] CCITT Recommendation Organization of the maintenance of international telephone-type circuits used for data transmission, Vol. VIII, Rec. V. 51.

[3] Ibid., § 5.



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

Kapitel 8

Messungen und Überwachungen im MTP

1.3.2 A tabular listing of the primitive measurements according to the resource being measured is provided (see Section 3). The tabular listing of the primitve measurements include for each measurement an indication of the appropriate categories and reference to the relevant Q-recommendations (if appropriate).

1.4 Guidelines for use and analysis

1.4.1 The measurements may be used singly, or in conjunction with other measurements. An example of the latter case is quality of service. Guidelines are defined for consistent use of the primitive measurements, at least, for international signalling.

Beginn eines Zusatzes in 1 TR 7:

1.4.2 It is not the intent of the recommendation to specify the computations and algorithms to be applied to the primitve measurements. Guidelines however are provided for some analysis of measurements for international signalling so that, for example, the view at both ends of an international link is consistent.

Ende des Zusatzes in 1 TR 7.

2 Definition of Terms

2.1 Operations

2.1.1 The operation of MTP resources utilizes measurements that are used in real time, or at most, short time intervals. The results of these measurements, in general, are not retained for long periods of time. Operations activities include signalling network surveillance.

2.1.2 Signalling network management measurements include those which monitor and measure the MTP response to abnormal conditions.

2.1.3 Signalling network surveillance measurements include those which monitor and measure the MTP resources to ensure that the appropriate quality of service and performance is maintained.

2.2 Maintenance

2.2.1 The measurements may indicate a problem, maintenance activity will then be undertaken to correct the problem. This action may include further monitoring of the problem.

2.3 Administration

2.3.1 The administration of MTP resources utilizes measurements that are used on a long term basis and are in general retained external to the MTP resources.

Recommendation Q.791

MONITORING AND MEASUREMENTS FOR THE MTP

1 General

1.1 Introduction

1.1.1 In order to effectively manage the resources provided by the Message Transfer Part (MTP) of a Signalling System No. 7 network, it is necessary to monitor and measure the present and estimate the future performance, utilization, and availability of these resources. Principles and scope of this recommendation are:

- measurements made on the MTP are known as "raw" or primitive measurements and in general only these measurements are identified in this recommendation;

- the recommended primitive measurements and, at times other measurements, whose computation using the primitive measurements is described, are those required for the effective management of the resources of the MTP;

- a basic set of MTP measurements is recommended for international networks, but it is intended that a subset is used for national networks; [1])

- monitoring and measuring are considered to be passive processes, and although the results of monitoring and measuring may be used to invoke maintenance actions and procedures, it is left to other recommendation to provide details of such actions and procedures;

- Q.791 is not intended to recommend test and maintenance procedures; such procedures are provided by Q.707.

Note [1]):
Der subset für das Zeichengabenetz der DBP ist in Tabellen 1 bis 6 enthalten.

1.2 Local and Global View

1.2.1 The MTP measurements can provide both a local view and a global network view of the performance of the MTP. The primitive measurements which provide the two views are not necessarily different in the two cases. Rather the global view is a result of the summary of primitive measurements from more than a single signalling point so that the behaviour of the MTP resources is centrally observable.

A global view of the performance of the MTP, in general, becomes more useful as the network becomes larger (i. e. more signalling points or multiple users).

1.3 Classification of Measurements

1.3.1 Each primitive measurements is classified into one or more categories, called operations, maintenance or administration (see Section 2).

3.3 Table 3/Q.791

3.3.1 The notation "3/2" in the Level column indicates that the measured octets are those transferred across the Level 3/Level 2 boundary in the appropriate direction.

3.3.2 The inclusion of the opening flag and the check bits (Item 3.2) is for further study.

3.3.3 The signalling congestion (Items 3.6-3.11) refers to link status "congested" at Level 3. A link is marked at Level 3 as congested when a congestion threshold is reached at the transmit side (see Recommendationh Q 704, § 3.6 on Signalling Network Congestion and § 10 on Signalling Traffic Flow Control).

Ende der Auslassung in 1 TR 7.

Beginn eines Zusatzes in 1 TR 7:

4 Auswertung der Messungen

Folgende Messungen sind auszuwerten und auszugeben:

4.1 Dauer der Unverfügbarkeit eines Signalling link geordnet nach Gründen:

- Fehler
- manueller Eingriff, (2.4; 2.7; 2.8 in Tab. 2)

4.1.1 Randbedingungen

- Beobachtungszeitraum: n x 1 Std ($1 \leq n \leq 24$)
- Die Messung erfolgt auf Aktivierung und mit Hilfe der Zeitauftragsverwaltung
- Ausdruck am Ende des Beobachtungszeitraums auf Blattschreiber
- Beobachtbar müssen sein
  - einzelne Signalling links
  - mehrere Signalling links gleichzeitig
  - alle Signalling links eines SP gleichzeitig

4.2 Belastung der Signalling links (3.1-3.4, Tab. 3)

- Belastung der Signalling links in MSU-Oktetts in Senderichtung
- Anzahl der MSU in Senderichtung
- Belastung der Signalling links in MSU-Oktetts in Empfangsrichtung
- Anzahl der MSU in Empfangsrichtung

2.3.2 MTP administration activities include planning and dimensioning (engineering) the MTP resources, including determination of the resource quantities, e. g. number of links in a link set, and resource configuration, e. g. routing.

3 Listing of Measurements

Beginn eines Zusatzes in 1 TR 7:

Die Funktionen, die gemessen oder überwacht werden sollen, sind in den Tabellen 1 bis 6 aufgelistet. Die Tabellen sind so zu interpretieren, daß sie nur Aussagen über die Meßwert-Erfassung liefern. Die Interpretation und Verarbeitung dieser Meßwerte ist Gegenstand der Abschnitte 4 und 5.

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7

3.1 General

3.1.1 The recommended measurements are presented in Tables 1 to 6. Explanatory notes relating to the contents of these Tables are giben below.

3.1.2 The obligatory column is used to indicate those measurements which must be provided at an SP. The additional ACT/PERM column indicates whether these measurements are permanently activated, or activated on demand. In non-obligatory cases, if the measurement is provided, the administration must also decide whether the measurement will be activated on demand or permanently active.

3.1.3 The count items in the Tables, identified in the Units column as "events/SP", "MSUs/SL", etc. implies the total count of events in the specified period.

3.1.4 The event items in the Table which are recorded "on occurrence" are intended to be recorded with a time stamp, giving the unique network time when the event indicator was generated (see Recommendation Q.795, § 2.4). The The resolution and accuracy of the time stamp should be as high as possible, to increase the ability to resolve complex and rapid sequences of events.

3.1.5 The periods specified in the Duration of Measurement colums are provisional.

3.2 Table 1/Q.791

3.2.1 The measurement of Signalling Link (SL) failure is recommended (Item 1.2). However, the specific cause for the failure (Items 1.3 - 1.6) is an additional optional measurement.

MEASUREMENTS

TABLE 1

DESCRIPTION OF MEASUREMENTS	UNITS	DURATION OF MEASUREMENT	LEVEL	Ableitbar (A) aus	ACT./ PERM.	REMARKS
1.1 Duration of link in-service	secs/SL	s. Abschn. 4.1	2		perm.	
1.2 SL failure - all reasons	events/SL	on occur.	2		perm.	
1.4 SL failure - excessive delay of ack.	events/SL	on occur.	2		perm.	Q.703, § 5.3.1
1.5 SL failure - excessive error rate	events/SL	on occur.	2		perm.	Q.703, § 9.2.2
1.8 Automatic changeovers	events/SL	on occur.	3		perm.	Q.704, § 5
1.10 Remote manual changeovers	events/SL	on occur.	3		perm.	Proc. not yet available
1.11 Automatic changeback	events/SL	on occur.	3		perm.	Q.704, § 6
1.14 Remote manual changebacks	events/SL	on occur.	3		perm.	Proc. not yet available

Fortsetzung des Zusatzes in 1 TR 7

4.2.1 Randbedingungen

- Meßzeitraum: n x 24 h, $1 \leq n \leq 9$
- Messbar müssen sein

  • einzelne Signalling links
  • alle Signalling links eines SP gleichzeitig

- Die Messung erfolgt auf Aktivierung und mit Hilfe der Zeitauftragsverwaltung

- Ausgabe auf Magnetband
  (s. TL DIV Pkt. 144)

- Es sind Viertelstundenwerte zu bilden

4.3 Verkehrsstrukturmessung

Zum Zwecke der Verkehrsstrukturmessung läßt sich pro SP eine Tracefunktion einschalten, welche für jede m-te zu routende MSU die für die Messung wichtigen Daten aufzeichnet. Es erfolgt eine Nachbearbeitung mit Hilfe einer DV-Anlage.

4.3.1 Randbedingungen

- Meßzeitraum: n x 24 h, $1 \leq n \leq 9$

- Die Messung erfolgt für den ganzen Signalling Point

- Die Messung erfolgt auf Aktivierung und mit Hilfe der Zeitauftragsverwaltung

- Jede m-te zu routende MSU wird registriert. Der Wert m ist einstellbar.

Anmerkung:
Für den Betriebsversuch ist m auf 100 einzustellen und muß leicht änderbar sein. Ob der Wert m per MML einstellbar sein muß, soll auf Grund der Erfahrungen im Betriebsversuch entschieden werden.

- Pro registrierter MSU werden aufgezeichnet:

  Längenindikator
  Service Indicator Octet
  Routing Label

- Ausgabe auf Magnetband
  (s. TL DIV Pkt. 144)

- Alle 15 Minuten wird eine Zeitmarke auf das Magnetband geschrieben.

Ende des Zusatzes in 1 TR 7.

TABLE 3

SIGNALLING LINK UTILIZATION

DESCRIPTION OF MEASUREMENTS	UNITS	DURATION OF MEASUREMENT	LEVEL	Ableitbar (A) aus	ACT./PERM.	REMARKS
3.1 No. of SIF and SIO octets transmitted	octets/SL	15 min.	3/2		act.,	Q.703, § 2.3.8
3.2 Octets retransmitted	octets/SL	15 min.	2		act.,	Q.703,§5
3.3 No. of message signalling units transmitted	MSU/SL	15 min.	3/2		act.	
3.4 No. of SIF and SIO octets received	octets/SL	15 min.	3/2		act.	
3.4a No. of message signal units received	MSU/SL	15 min.	3/2		act.	
3.7 Start of SL congestion	event/SL	on occurance	3		perm.	s. Abschn.5.6
3.8 Stop of SL congestion	event/SL	on occurance	3		perm.	
3.10 congestion event resulting in loss of MSUs	event/SL	on occurance	3		perm.	

TABLE 2

SIGNALLING LINK AVAILABILITY

DESCRIPTION OF MEASUREMENTS	UNITS	DURATION OF MEASUREMENT	LEVEL	Ableitbar (A) aus	ACT./PERM.	REMARKS
2.1 Duration of SL unavailability	secs/SL	s. Abschn. 4.1	3		perm.	
2.4 Duration of SL unavailability due to failure	secs/SL	s. Abschn. 4.1	3		perm.	
2.7 Start of remote blocking	event/SL	on occurance	3		perm.	
2.8 Stop of remote blocking	event/SL	on occurance	3		perm.	

TABLE 5

SIGNALLING POINT STATUS

DESCRIPTION OF MEASUREMENTS	UNITS	DURATION OF MEASUREMENT	LEVEL	Ableitbar (A) aus	ACT./PERM.	REMARKS
5.1 Prozessor Überlast (1)	event	on occurance	3	A 5.3 u. 5.4	perm.	
5.2 Start of Proz. Überlast (1)	event	on occurance	3		perm.	
5.3 End of Proz. Überlast (1)	event	on occurance	3		perm.	
5.4 Adjacent SP inaccessible	event/SP	on occurance	3	A 5.7 u. 5.8	perm.	
5.5 Start of adjacent SP inaccessible	event/SP	on occurance	3		perm.	
5.6 End of adjacent SP inaccessible	event/SP	on occurance	3		perm.	

(1) Definition der Prozessor Überlast:
Prozessor Überlast liegt immer dann vor, wenn implementierungsabhängig TFC-Nachrichten und/oder "Congestion Indication Primitives" vom Level 3 gesendet werden, die nicht in unmittelbarem Zusammenhang mit einer "Signalling Link Congestion" (entspr. 3.7 und 3.8 Tabelle 3) stehen.

TABLE 4

SIGNALLING LINK SET AND ROUTE AVAILABILITY

DESCRIPTION OF MEASUREMENTS	UNITS	DURATION OF MEASUREMENT	LEVEL	Ableitbar (A) aus	ACT./PERM.	REMARKS
4.1 Unavailability of signalling linkset	event/ linkset	on occurance	3			
4.2 Duration of unavailability of signalling linkset	secs/ linkset	on occurance	3	A 4.3 u. 4.4		s. Ab- schn.5.8
4.3 Start linkset failure/unavailability	event/ linkset	on occurance	3		perm.	
4.4 End linkset failure/unavailability	event/ linkset	on occurance	3		perm.	
4.7 Unavailability of signalling route (to a given destination) due to TFP receipt	event/ route	on occurance	3			
4.8 Duration of above	secs/ route	on occurance	3			s. Ab- schn. 5
4.9 Unavailability of route set to a given destination	event/ destination	on occurance	3	A 4.11	perm.,	Q.706, § 1
4.10 Duration of above	secs/ destination	on occurance	3	A 4.11 u. 4.12	perm.	
4.11 Start of 4.9	event/ destination	on occurance	3		perm.	
4.12 End of 4.9	event/ destination	on occurance	3		perm.	

TABLE 6

SIGNALLING TRAFFIC DISTRIBUTION (SIGNLLING ROUTE UTILIZATION)

DESCRIPTION OF MEASUREMENTS	UNITS	DURATION OF MEASUREMENT	LEVEL	Ableitbar (A) aus	ACT./PERM.	REMARKS
6.1 No. of SIF and SIO octets received with given OPC	octets/OPC	30 min.	3			
6.2 No. of SIF and SIO octets transmitted with given DPC	octets/DPC	30 min.	3			
6.3 No. of SIF and SIO octets handled with given SIO	octets/SIO	30 min.	3			
6.4 No. of SIF and SIO octets received with given OPC and SIO	octets/SIO, OPC	30 min.	3			
6.5 No. of SIF and SIO octets transmitted with given DPC and SIO	octets/SIO, DPC	30 min.	3			
6.6 No. of SIF and SIO octets handled with given OPC, DPC and SIO	octets/SIO, OPC, DPC	30 min.	3			

Die Grunddaten für die Meßwerte 6.1 bis 6.6 werden mit Hilfe der in Abschnitt 4.3 beschriebenen TRACE-Funktion auf statischer Basis erfaßt.

Beginn eines Zusatzes in 1 TR 7:

5 Auswertung der Überwachungen

Die Überwachungen sind wie folgt auszuwerten und auszugeben:

Ereignis (Feststellbar mit den Erfassungen Nr.)	je Ereignis	Schwellwert (einstellbar) Häufigkeit Zeiteinheit	Anhalten des Zustandes	dringender Alarm	nichtdringender Alarm	Blattschreiberausdruck ständig/bzw. bei überschreiten der Schwelle	auf Abruf	Einzustellender Schwellwert für den Betriebsversuch	Bemerkung
	1	2	3	4	5	6	7	8	9
1. Signalling link-Ausfall (1.2) (Häufigkeit)	-	x	-	-	x	x	-	3 h^{-1}	
2. Signalling link-Ausfall. Gründe (1.4; 1.5 und andere)	-	-	-	-	-	-	x	-	Als Abruf gilt das Überschreiten der Schwelle in Zeile 1.
3. Signalling link-Ausfall (1.8 u. 1.11) (Dauer)	x	-	x	-	x	x	-	1 min	Alarm und Dokumentation soll erst dann erfolgen, wenn der Ausfall länger als 3 min andauert.
4. Remote manual Changeover (1.10)	x	-	-	-	-	x	-	-	
5. Remote manual Changeback (1.14)	x	-	-	-	-	x	-	-	
6. Signalling link Überlast (3.7; 3.8)	x	-	-	-	-	x	-	-	1)
7. Verlust MSUs durch Überlast (3.10)	x	-	-	-	-	x	-	-	
8. Signalling link set-Ausfall (4.1 bis 4.12)	x	-	x	x	-	x	-	-	Beginn, Ende und Dauer sind zu dokumentieren
9. Signalling route-Ausfall (4.1 bis 4.12)	x	-	-	-	x	x	-	-	Beginn, Ende und Dauer sind zu dokumentieren
10. Signalling route set-Ausfall (4.1 bis 4.12)	x	-	-	-	x 2)	x	-	-	Beginn, Ende und Dauer sind zu dokumentieren
11. Processor Überlast (5.2, 5.3)	x	-	-	-	-	x	-	-	1)
12. Adjecent SP Inaccessible (5.5, 5.6)	x	-	-	-	-	x	-	-	

1) Beginn und Ende eines Überlastzustandes sind getrennt zu dokumentieren. Bei rasch aufeinander folgender (oszillierender) Überlast soll der Endausdruck ca. 1 min nach dem Ende des Oszillierens gegeben werden, um unnötige Ausdrucke zu vermeiden.

2) Nur nicht dringender Alarm, da immer mit Sign. Link Set-Ausfall verbunden.

Ende des Zusatzes in 1 TR 7.

TABLE 6

SIGNALLING TRAFFIC DISTRIBUTION (SIGNLLING ROUTE UTILIZATION)

DESCRIPTION OF MEASUREMENTS	UNITS	DURATION OF MEASUREMENT	LEVEL	Ableitbar (A) aus	ACT./PERM.	REMARKS
6.1 No. of SIF and SIO octets received with given OPC	octets/OPC	30 min.	3			
6.2 No. of SIF and SIO octets transmitted with given DPC	octets/DPC	30 min.	3			
6.3 No. of SIF and SIO octets handled with given SIO	octets/SIO	30 min.	3			
6.4 No. of SIF and SIO octets received with given OPC and SIO	octets/SIO, OPC	30 min.	3			
6.5 No. of SIF and SIO octets transmitted with given DPC and SIO	octets/SIO, DPC	30 min.	3			
6.6 No. of SIF and SIO octets handled with given OPC, DPC and SIO	octets/SIO, OPC, DPC	30 min.	3			

Die Grunddaten für die Meßwerte 6.1 bis 6.6 werden mit Hilfe der in Abschnitt 4.3 beschriebenen TRACE-Funktion auf statischer Basis erfaßt.

Beginn eines Zusatzes in 1 TR 7:

5 Auswertung der Überwachungen

Die Überwachungen sind wie folgt auszuwerten und auszugeben:

Ereignis (Feststellbar mit den Erfassungen Nr.)	je Ereignis	Schwellwert (einstellbar) Häufigkeit Zeiteinheit	Schwellwert (einstellbar) Anhalten des Zustandes	dringender Alarm	nichtdringender Alarm	Blattschreiberausdruck ständig/bzw. bei Überschreiten der Schwelle	Blattschreiberausdruck auf Abruf	Einzustellender Schwellwert für den Betriebsversuch	Bemerkung
	1	2	3	4	5	6	7	8	9
1. Signalling link-Ausfall (1.2) (Häufigkeit)	-	x	-	-	x	x	-	3 h^{-1}	
2. Signalling link-Ausfall. Gründe (1.4; 1.5 und andere)	-	-	-	-	-	-	x	-	Als Abruf gilt das Überschreiten der Schwelle in Zeile 1.
3. Signalling link-Ausfall (1.8 u. 1.11) (Dauer)	x	-	x	-	x	x	-	1 min	Alarm und Dokumentation soll erst dann erfolgen, wenn der Ausfall länger als 3 min andauert.
4. Remote manual Changeover (1.10)	x	-	-	-	-	x	-	-	
5. Remote manual Changeback (1.14)	x	-	-	-	-	x	-	-	
6. Signalling link Überlast (3.7; 3.8)	x	-	-	-	-	x	-	-	1)
7. Verlust MSUs durch Überlast (3.10)	x	-	-	-	-	x	-	-	
8. Signalling link set-Ausfall (4.1 bis 4.12)	x	-	x	x	-	x	-	-	Beginn, Ende und Dauer sind zu dokumentieren
9. Signalling route-Ausfall (4.1 bis 4.12)	x	-	-	-	x	x	-	-	Beginn, Ende und Dauer sind zu dokumentieren
10. Signalling route set-Ausfall (4.1 bis 4.12)	x	-	-	-	x 2)	x	-	-	Beginn, Ende und Dauer sind zu dokumentieren
11. Processor Überlast (5.2, 5.3)	x	-	-	-	-	x	-	-	1)
12. Adjacent SP Inaccessible (5.5, 5.6)	x	-	-	-	-	x	-	-	

1) Beginn und Ende eines Überlastzustandes sind getrennt zu dokumentieren. Bei rasch aufeinander folgender (oszillierender) Überlast soll der Endausdruck ca. 1 min nach dem Ende des Oszillierens gegeben werden, um unnötige Ausdrucke zu vermeiden.

2) Nur nicht dringender Alarm, da immer mit Sign. Link Set-Ausfall verbunden.

Ende des Zusatzes in 1 TR 7.

Beginn einer Auslassung in 1 TR 7:

5 Uses of measurements

5.1 Introduction

5.1.1 This section provides a context for the measurements listed in Tables 1-6/Q.791. It describes briefly the operational, maintenance and administrative activities likely to be associated with a Signalling System No. 7 network and how the measurements may be used to support these activities.

5.1.2 A list of supporting measurements (if any) follows each description. Each measurements is identified by its table number followed by decimal point and the sequence number of the measuremnt within the Table (e.g. Item 1.1 is the first measurement of Table 1/Q.791).

5.2 Operational uses

5.2.1 Surveillance of network status

5.2.1.1 This activity is concerned with survbeillance of the network as a whole, in order to coordinate and assign priorities to maintenance actions. The information to support this activity will come from indicators of the operational and congestion status. These indicators may be found in the tables designated as Uage "O" and Duration of Measurement "on-occurrence".

5.2.2 Monitoring of link and network traffic performance

5.2.2.1 This activity is concerned with ensuring that congestion levcels and the numbers of discarded messages are within specification. If, for example, the number of MSUs discarded due to a routing data error exceeds limits, the Routing Verification Test described in Recommendation Q.795 could be initiated to identify the source and type of routing data error.

5.2.2.2 Discarded message counts may be gathered signalling point by signalling point and added together to give a total network performance measure.

5.2.2.3 One aspect of traffic performance can be monitored by measuring the amount of time that a given link is congested. The link loading or congestion duration must match the criteria upon which provisioning of links has been based.

Measurements to monitor links:

- number to SIF and SIO octetw transmitted (Item 3.1)
- cumulative duration of SL congestion (Item 3.7)

Measurements of MSUs discarded:

- due to congestion (Item 3.10)
- due to routing data error (Item 5.5

Fortsetzung der Auslassung in 1 TR 7:

5.2.2.4 Duration measurements in Table 4 measure signalling link set and route set availability, by individual signalling link set and route set. These measurements identify the effects of congestion or failure upon the surrounding network.

5.3 Maintenance uses

5.3.1 Introduction

5.3.1.1 The activities described in this section relate basically to the detection of degraded performance and to the maintenance of a partiular signalling point and the signalling links associated with that signalling point. They may be used on a near real time basis, or may be monitored over a period of days or weeks to detect unfavourable trends. They are designed so that one signalling point can monitor its own status without relying on measurements from adjacent signalling points.

5.3.2 Detection of increases in link SU error rates

5.3.2.1 This activity ensures that the signalling data link error rate is not rising beyond specification. The SU Error Rate Monitor is the basic instrument for monitoring signalling data link performance.

5.3.2.2 Operational measurements counting error events provide supplementary information to warn of impending failures or give a running assessment of signalling data link quality.

Measurements:

- number of SUs in error (monitors incoming performance): (Item 1.8):
- number of NACKs received (monitors outgoing performance). (Item 1.9)

5.3.2.3 Counting total Signal unit errors alloows the estimation of Signalling Data Link bit error rates (see Recommendation Q.706, § 3.1) assuming that errors are random. The estimate uses measurement 1.1, duration of link in the in-service state, multiplied by the link transmission rate.

5.3.3 Detection of marginal links performance

5.3.3.1 The SU Error Rate Monitor applies to lost alignment as well as corrupted data. Usually both condictions are caused by degraded performance of the transmission facility. Alignment and proving failures often inddicate a marginally performing link.

Measurements:

- SL alignment failure or proving failure (Item 1.7)

5.3.3.2 This activity is concerned with detecting routing instabilities caused by marginal link performance.

Measurements:

- automatic changeovers. (Item 1.10).

Fortsetzung der Auslassung in 1 TR 7:

5.3.4 Detection of link failure events in either direction

5.3.4.1 By "link failure" is meant an event which causes a particular link to be unvailable for signalling (i.e. a failure at Level 1 or Level 2). Signalling link failure measurements are summarized not only for specific link sets, but also across many different link sets, where these may involve common transmission systems or signalling points. The distribution of failure and degration sources may be randomly located but if specific network elements appear to be common to a large number of the failures, then they are suspect as a significant failure source, requiring further maintenance action.

Measurements:

- number of link failures. (Items 1.2, 1.3, 1.4, 1.5, 1.6).

5.3.5 Detection of routing and distribution table errors

5.3.5.1 In operation, the Signalling System No. 7, routing tables will be updated frequently as the network changes. It is necessary to keep track of routing problems on a routine basis (see Recommendation Q.795, § 2.2).

Measurements:

- number of MSUs discarded due to a routing data error. (Item 5.5).

Ende der Auslassung in 1 TR 7.