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SPECIFICATIONS OF SIGNALLING SYSTEM No. 7

SIGNALLING SYSTEM No. 7 – SIGNALLING CONNECTION CONTROL PART PROCEDURES

ITU-T Recommendation Q.714

(Previously "CCITT Recommendation")

FOREWORD

The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the International Telecommunication Union. The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, established the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

ITU-T Recommendation Q.714 was revised by the ITU-T Study Group XI (1988-1993) and was approved by the WTSC (Helsinki, March 1-12, 1993).

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NOTES

1 As a consequence of a reform process within the International Telecommunication Union (ITU), the CCITT ceased to exist as of 28 February 1993. In its place, the ITU Telecommunication Standardization Sector (ITU-T) was created as of 1 March 1993. Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.

In order not to delay publication of this Recommendation, no change has been made in the text to references containing the acronyms "CCITT, CCIR or IFRB" or their associated entities such as Plenary Assembly, Secretariat, etc. Future editions of this Recommendation will contain the proper terminology related to the new ITU structure.

2 In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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SIGNALLING SYSTEM No. 7 – SIGNALLING CONNECTION CONTROL PART PROCEDURES

(Málaga-Torremolinos 1984, modified at Helsinki 1993)

1 Introduction

1.1 General characteristics of signalling connection control procedures

1.1.1 Purpose

This Recommendation describes the procedures performed by the Signalling Connection Control Part (SCCP) of Signalling System No. 7 to provide connection-oriented and connectionless network services, and SCCP management services as defined in Recommendation Q.711. These procedures make use of the messages and information elements defined in Recommendation Q.712, whose formatting and coding aspects are specified in Recommendation Q.713.

1.1.2 Protocol classes

The protocol used by the SCCP to provide network services is subdivided into four protocol classes, defined as follows:

- Class 0: Basic connectionless class
- Class 1: Sequenced connectionless class
- Class 2: Basic connection-oriented class
- Class 3: Flow control connection-oriented class

The connectionless protocol classes provide those capabilities that are necessary to transfer one Network Service Data Unit (NSDU), (i.e. one user-to-user information block) in the "data" field of a *Unitdata* or Extended Unitdata message.

When one connectionless message is not sufficient to transport the user data, a segmenting/recombining function for protocol classes 0 and 1 is provided. In this case, the SCCP at the originating node provides segmentation of the information into multiple segments prior to transfer in the "data" field of Extended Unitdata messages. Segmentation will only be performed in the originating node and never in a relay node. At the destination node, the NSDU is reassembled.

The connection-oriented protocol classes (protocol classes 2 and 3) provide the means to set-up signalling connections in order to exchange a number of related NSDUs. The connection-oriented protocol classes also provide a segmenting and reassembling capability. If a Network Service Data Unit is longer than 255 octets, it is split into multiple segments at the originating node, prior to transfer in the "data" field of *Data* messages. Each segment is less than or equal to 255 octets. At the destination node, the NSDU is reassembled.

1.1.2.1 Protocol class 0

Network Service Data Units passed by higher layers to the SCCP in the node of origin are delivered by the SCCP to higher layers in the destination node. They are transported independently of each other. Therefore, they may be delivered out-of-sequence. Thus, this protocol class corresponds to a pure connectionless network service.

1.1.2.2 Protocol class 1

In protocol class 1, the features of class 0 are complemented by an additional feature (i.e. the sequence control parameter associated with the N-UNITDATA request primitive) which allows the higher layer to indicate to the SCCP that a given stream of NSDUs have to be delivered in sequence. In outgoing messages the Signalling Link Selection (SLS) field is chosen by the originating SCCP based on the value of the sequence control parameter. The SLS chosen for a stream of NSDUs with the same sequence control parameter will be identical. The SCCP will then encode the Signalling Link Selection (SLS) field in the routing label of messages relating to such NSDUs, so that their sequence is, under normal conditions, maintained by the MTP and SCCP. Thus, this class corresponds to an enhanced connectionless service, where an additional sequencing feature is included.

1.1.2.3 Protocol class 2

In protocol class 2, bidirectional transfer of NSDUs between the user of the SCCP in the node of origin and the user of the SCCP in the destination node is performed by setting up a temporary or permanent signalling connection consisting of one or more connection sections. A number of signalling connections may be multiplexed onto the same signalling relation. Each signalling connection in such a multiplexed stream is identified by using a pair of reference numbers, referred to as "local reference numbers". Messages belonging to a given signalling connection will contain the same value of the SLS field to ensure sequencing as described in 1.1.2.2. Thus, this protocol class corresponds to a simple connection-oriented network service, where SCCP flow control and missequence detection are not provided.

1.1.2.4 Protocol class 3

In protocol class 3, the features of protocol class 2 are complemented by the inclusion of flow control, with its associated capability of expedited data transfer. Moreover, an additional capability of detection of message loss or mis-sequencing is included for each connection section; in such a circumstance, the signalling connection is reset and a corresponding notification is given by the SCCP to the higher layers.

1.1.3 Signalling connections

In all connection-oriented protocol classes, a signalling connection between the nodes of origin and destination may consist of:

- a single connection section, or;
- a number of connection sections in tandem, which may belong to different interconnected signalling networks.

In the former case, the originating and destination nodes of the signalling connection coincide with the originating and destination nodes of a connection section. During the connection establishment phase, SCCP routing and relaying functions, as described in clause 2, may be required at one or more relay points without coupling nodes. Once the signalling connection has been established, though, SCCP functions are not required at these points. This capability requires further study.

In the latter case, at any relay point with coupling where a message is received from a connection section and has to be sent on another connection section, the SCCP routing and relaying functions are involved during connection establishment. In addition, SCCP functions are required at these points during Data Transfer and Connection Release to provide the association of connection sections.

A signalling connection between two SCCP users in the same node is an implementation dependent matter.

1.1.4 Compatibility and handling of unrecognized information

1.1.4.1 Rules for forward compatibility

All implementations must recognize all messages in each protocol class offered, as indicated in Table 1/Q.713. Further study is required on the reaction to the reception of, e.g. class 3 messages when only classes 0 and 1 are supported.

General rules for forward compatibility are specified in Recommendation Q.1400.

1.1.4.2 Handling of unrecognized messages or parameters

Any message with an unrecognized message type value should be discarded. Any unrecognized parameter within a message should be ignored. Notification to the originator of the message in these two cases is for further study.

1.2 Overview of procedures for connection-oriented services

1.2.1 Connection establishment

When the SCCP functions at the node of origin receive a request to establish a signalling connection, the "called address" is analysed to identify the node towards which a signalling connection should be established. If the node is not the same the SCCP forwards a *Connection Request* (CR) message to that signalling point, using the MTP functions.

The SCCP in the node receiving the CR message via the MTP functions examines the "called party address" and one of the following actions takes place at the node:

a) If the "called party address" contained in the CR message corresponds to a user located in that signalling point and if the signalling connection may be established (i.e. establishment of a signalling connection is agreed to by the SCCP and local user), a *Connection Confirm* (CC) message is returned.

b) If the "called party address" does not correspond to a user at the signalling point, then information available in the message and at the node is examined to determine whether an association of two connection sections is required at that node.

   – If an association is required, then the SCCP establishes an (incoming) signalling connection section. Establishment of another (outgoing) connection section is initiated by sending a CR message towards the next node and this connection section is logically linked to the incoming connection section.

   – If coupling of the connection section is not required in this node, no incoming or outgoing connection section is established. A CR message is forwarded towards the next destination using the MTP routing function. This capability is for further study.

If the SCCP receives a CR message and either the SCCP or the SCCP user cannot establish the connection, then a *Connection Refused* (CREF) message is transferred on the incoming connection section.

On receipt of a CC message, the SCCP completes the set-up of a connection section. Furthermore, if coupling of two adjacent connection sections is needed, a further CC message is forwarded to the preceding node.

If no coupling of adjacent connection sections was needed during connection set-up in the forward direction, the CC message can be sent directly to the node of origin of the section, even if a number of relay points without coupling was passed in the forward direction.This capability is for further study.

When the CR and CC messages have been exchanged between all the involved nodes as described above, and the corresponding indications have been given to the higher layer functions in the nodes of origin and destination, then the signalling connection is established and transmission of messages may commence.

1.2.2 Data transfer

Transfer of each NSDU is performed by one or more *Data* (DT) messages; a *more-data* indication is used if the NSDU is to be split among more than one DT message. If protocol class 3 is used, then SCCP flow control is utilized over each connection section of the signalling connection. If, in such a protocol class, abnormal conditions are detected, then the appropriate actions are taken on the signalling connection (e.g. reset). Moreover in such a protocol class, expedited data may be sent using one *Expedited Data* message that bypasses the flow control procedures applying to *Data* messages.

A limited amount of data may also be transferred in the *Connection Request*, *Connection Refused* and *Connection Released* messages. The provision of the receipt confirmation is for further study.

1.2.3 Connection release

When the signalling connection is terminated, a release sequence takes place on all connection sections by means of two messages called *Released* and *Release Complete* (RLC). The RLC message is normally sent in reaction to the receipt of a RLSD message.

1.3 Overview of procedures for connectionless services

1.3.1 General

When the SCCP functions at the node of origin receive from an SCCP user an NSDU to be transferred by the protocol class 0 or 1 connectionless service, the "called address" and other relevant parameters, if required, are analyzed to identify the node towards which the message(s) should be sent. The NSDU is then included as the "data" parameter in a *Unitdata* (UDT) or Extended Unitdata (XUDT) message, which is sent towards the node using the MTP functions. Upon receipt of the UDT or XUDT message, the SCCP functions at that node perform the routing analysis as described in clause 2 and, if the destination of the UDT or XUDT message is a local user, deliver the NSDU to the local higher layer functions. If the "called party address" is not at that node, then the UDT or XUDT message is forwarded to the next node. This process continues until the destination is reached.

1.3.2 Segmentation/reassembly

SCCP connectionless segmentation is a service provided transparently to the SCCP user, which allows connectionless transfer of a larger block of user data that can be contained in a single UDT or XUDT message. The SCCP provides this service by breaking up a large block of user data into smaller blocks (called segments), transmitting the segments as user data in XUDT messages, and recombining the segments before passing the original block of user data to the destination SCCP user. At the originating SCCP, this process is called segmentation. At the destination SCCP, this process is called reassembly.

1.4 Structure of the SCCP and contents of specification

The basic structure of the SCCP appears in Figure 1. It consists of four functional blocks as follows:

a) *SCCP connection-oriented control* – Its purpose is to control the establishment and release of signalling connections and to provide for data transfer on signalling connections.

b) *SCCP connectionless control* – Its purpose is to provide for the connectionless transfer of data units.

c) *SCCP management* – Its purpose is to provide capabilities, in addition to the Signalling Route Management and flow control functions of the MTP, to handle the congestion or failure of the SCCP, the SCCP user or the signalling route to the SCCP/SCCP user. The current procedures are limited to entities within the same MTP network.

d) *SCCP routing* – Upon receipt of a message from the MTP or from functions a), b) or c) above, SCCP routing provides the necessary routing functions to either forward the message to the MTP for transfer, or pass the message to functions a), b) or c) above. If the "called address" or "called party address" is a local user, then the message is passed to functions a), b) or c), while one destined for a remote user is forwarded to the selected MTP for transfer to a distant SCCP user.

   Further study may be required to identify a particular MTP network in such nodes that support multiple MTP networks.

The contents of this specification are as follows. Clause 2 of this specification describes the addressing and routing functions performed by the SCCP. Clause 3 specifies the procedures for the connection-oriented services (protocol classes 2-3). Clause 4 specifies the procedures for the connectionless services (protocol classes 0 and 1). Clause 5 specifies the SCCP management procedures.

2 Addressing and routing

2.1 SCCP addressing

The "called and calling addresses" normally contain the information necessary, but not always sufficient, for the SCCP to determine an origination and destination node. In the case of the connection-oriented procedures, the addresses are the originating and destination points of the signalling connection, while in the case of the connectionless procedures, the addresses are the origination and destination points of the message.

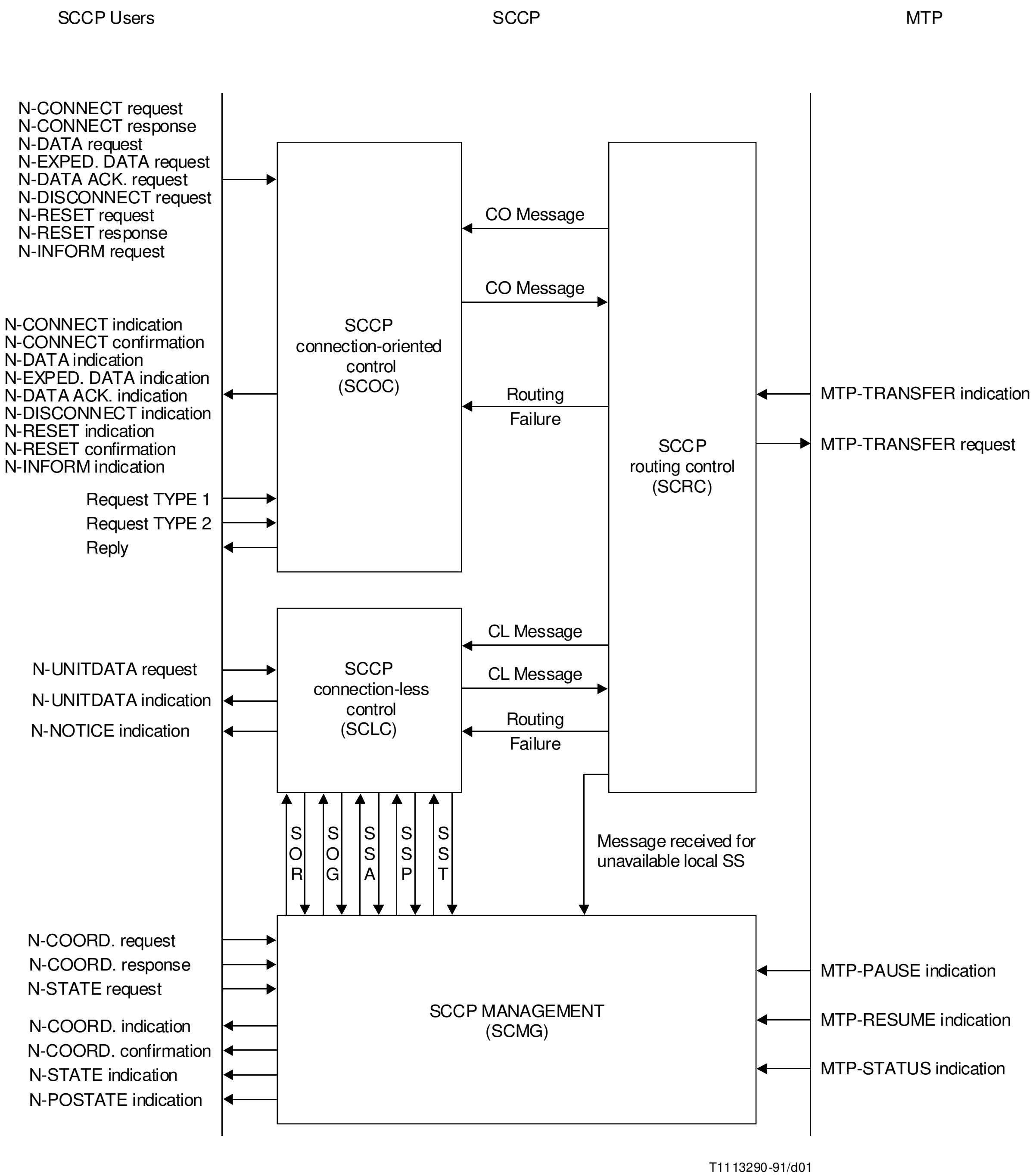

FIGURE 1/Q.714

SCCP overview

For the transfer of the CR message or connectionless messages, two basic categories of addresses are distinguished by the SCCP, address requiring translation and address requiring no translation:

1) *Global Title* – A global title is an address, such as dialled-digits, which does not explicitly contain information that would allow routing in the signalling network, that is the translation function of the SCCP is required. This translation function could be performed on a distributed basis or on a centralized basis. The last case, where a request for translation is sent to a centralized data base, may be accomplished, for example, with transaction capabilities (TC). This matter is for further study.

   In case of an E.164-based global title with the nature of address indicator included, the sending sequence of address information will be the country code, followed by the national (significant) number. Within the destination national signalling network, the address information is determined by the administration concerned.

2) *DPC + SSN* – A Destination Point Code and Subsystem Number allows direct routing by the SCCP and MTP, that is, the translation function of the SCCP is not required.

If a reply or a message return is required, the "calling party address" plus the OPC in the MTP routing label shall contain sufficient information (together with additional information present in the MTP) to uniquely identify the originator of the message. If the message requires global title translation where the OPC in the MTP routing label changes at the relay nodes, then the "calling party address" parameter should not contain an SSN only.

2.2 SCCP routing principles

The SCCP routing control (SCRC) receives messages from the Message Transfer Part for routing and discrimination, after they have been received by this MTP from another node in the signalling network. SCRC also receives internal messages from SCCP connection-oriented control (SCOC) and connectionless control (SCLC) and performs any necessary routing functions (e.g. address translation) before passing them to the selected MTP for transport in the signalling network or back to the SCCP connection-oriented or connectionless control.

2.2.1 Receipt of SCCP message transferred by a MTP

A message transferred by an MTP that requires routing will include the "called party address" parameter giving information for routing the message. These messages currently include the *Connection Request* message and all types of connectionless messages. Other messages are passed to connection-oriented control for processing.

If the "called party address" parameter is used for routing, the routing indicator determines whether routing is based on:

1) *Subsystem Number (SSN)* – This indicates that the receiving SCCP is the destination point of the message. The SSN is used to determine the local subsystem.

2) *Global Title (GT)* – The GT indicates that translation is required. Translation of the Global Title results in a destination point code (DPC) for routing the message, and possibly a new SSN or GT or both. The translation also provides the MTP network identity (for further study) and information needed for the MTP transfer (OPC, DPC, SLS and SIO).

If the destination point code is present in the "called party address" parameter, it is not used by SCRC.

2.2.2 Messages from connection-oriented or connectionless control to SCCP routing control

Addressing information, indicating the destination of the message, is included with every internal message received from connection-oriented or connectionless control. For connectionless messages, this addressing information is obtained from the "called address" parameter associated with the N-UNITDATA request primitive. For *Connection-Request* messages received by SCCP routing, the addressing information is obtained from the "Called address" parameter associated with the N-CONNECT request primitive or from the "called party address" parameter associated with the received CR message. For connection-oriented messages other than a *Connection Request* message, the addressing information (i.e. the DPC) is that associated with the connection section. The addressing information can take the following forms:

1) DPC
2) DPC + (SSN or GT or both)
3) GT
4) GT (+ SSN)

The first form applies to connection-oriented messages except the *Connection Request* message. The last two forms apply to connectionless messages and to the *Connection Request* message.

2.2.2.1 DPC present

If the DPC is present in the addressing information and the DPC is not the node itself, then the DPC is passed to the MTP using the MTP-TRANSFER request primitive and:

1) if no other addressing information is available (case 1 of 2.2.2), no "called party address" is provided in the message;
2) For case 2 of 2.2.2:
    a) if the message is a Connection Request message and the association of connection section is indicated (i.e. a relay point with coupling), then the message is passed to the MTP with the same addressing information made available to SCOC as before the association of connection sections.
    b) if the message is a connectionless message, or a Connection Request message at the node where the message originates then the DPC is used as the destination point code in the MTP-TRANSFER request primitive.

If the DPC is the node itself, (case 2 of 2.2.2), and a GT is not present, then the message is passed based on the message type to either connection-oriented control or connectionless control based on the availability of the sub-system. If the DPC is the node itself and a GT is present but not an SSN, then the message is passed to the translation function.

If the DPC is the node itself and both a GT and SSN are present, then it is an implementation-dependent matter whether or not the message is passed to the translation function.

If the DPC is not the node itself and a GT is present (but not an SSN), then the DPC identifies the node where the Global Title Translation occurs. If the DPC is not the node itself and both a GT and SSN are present, then the Routing Indicator could be set to either routing on GT or routing on SSN. The mechanism for the selection of the Routing Indicator is implementation-dependent.

2.2.2.2 DPC not present

If the DPC is not present, (case 3 of 2.2.2), then a global title translation is required before the message can be sent out. Translation results in a DPC and possibly a new SSN or new GT or both. If the GT and/or SSN resulting from a global title translation is different from the GT and/or SSN previously included in the called address, the newly produced GT and/or SSN replaces the existing one. The translation function of the SCRC will also indicate whether the routing at the destination will be based on GT or SSN. The translation function also provides the MTP network identity (for further study) and information needed for the MTP transfer (OPC, DPC, SLS and SIO). The routing procedures then continue as per subclause 2.2.2.1.

2.3 SCCP routing

The SCCP routing functions are based on information contained in the "called address".

2.3.1 Receipt of SCCP message transferred by the MTP

One of the following actions is taken by SCCP routing upon receipt of a message from the Message Transfer Part. The message is received by the SCCP when the MTP invokes a MTP-TRANSFER INDICATION.

1) If the message is a connection-oriented message other than a *Connection Request* (CR) message, then SCCP routing passes the message to connection-oriented control.

2) If the routing indicator in the "called party address" does not indicate route on global title, then SCCP routing checks the status of the subsystem.

   a) If the subsystem is available, the message is passed, based on the message type, to either connection-oriented control or connectionless control.

   b) If the system is unavailable and:

      – the message is a connectionless message, then the message return procedure is initiated;

      – the message is a connection-oriented message (a CR message), then the connection refusal procedure is initiated.

      In addition, if the subsystem is failed, SCCP management is notified that a message was received for an unavailable subsystem.

3) If the routing indicator in the "called party address" indicates route on global title, a translation of the global title must be performed.

   The SCCP Hop Counter (if present) is decremented and if a Hop Counter violation is encountered (i.e. the value zero is reached), then:

   – if the message is a connectionless message, then the message return procedure is initiated;

   – if the message is a connection-oriented message (i.e. a CR message), then the connection refusal procedure is initiated.

In addition, maintenance functions are alerted.

   a) If the translation of the global title exists, and the result of the translation is routing on SSN, then:

      i) if the DPC is the node itself, then the procedures in 2) above are followed;

      ii) if the DPC is not the node itself, the remote DPC, SCCP and SSN are available, and the message is a connectionless message, then the MTP-TRANSFER request primitive is invoked;

      iii) if the DPC is not the node itself, the remote DPC, SCCP and SSN are available, and the message is a connection-oriented message, then:

         – if an association of connection sections is required, the message is passed to connection-oriented control;

         – if no association of connection sections is required, the MTP-TRANSFER request primitive is invoked. This is for further study.

      iv) if the DPC is not the node itself, and the remote DPC, SCCP and/or SSN are not available and

         – the message is a connectionless message, then the message return procedure is initiated;

         – the message is a connection-oriented message (a CR message), then the connection refusal procedure is initiated.

   b) If the translation of the global title exists and the result of the translation is routing on GT then:

      i) if the remote DPC and SCCP are available, and the message is a connectionless message, then the MTP-TRANSFER request primitive is invoked;

      ii) if the DPC and SCCP are available, and the message is a connection-oriented message, then:

         – if an association of the connection sections is required, then the message is passed to connection-oriented control;

         – if no association of the connection section is required, then the MTP-TRANSFER request primitive is invoked. This is for further study.

      iii) if the remote DPC and/or SCCP are not available and

         – the message is a connectionless message, then the message return procedure is initiated;

         – the message is a connection-oriented message (a CR message), then the connection refusal procedure is initiated.

c) If the translation of the global title does not exist, and

– the message is a connectionless message, then the message return procedure is initiated;

– the message is a connection-oriented message (a CR message), then the connection refusal procedure is initiated.

2.3.2 Messages from connectionless or connection-oriented control to SCCP routing control

One of the following actions is taken by SCCP routing upon receipt of a message from connectionless control or connection-oriented control.

1) If the message is a *Connection Request* message at an intermediate node (where connection sections are being associated), and:

a) the remote DPC and SCCP are available and the remote SSN is available if routing is on SSN, then the MTP-TRANSFER request primitive is invoked;

b) the remote DPC and SCCP are not available and/or the remote SSN is not available if routing is on SSN, then the connection refusal procedure is initiated.

2) If the message is a connection-oriented message other than a *Connection Request* message, and:

a) the DPC and remote SCCP are available, then the MTP-TRANSFER request primitive is invoked;

b) the DPC and remote SCCP are not available, then the connection release procedure is initiated.

3) If the "Called address" in the primitive associated with a *Connection Request* or connectionless message includes one of the following combinations from Table 1, then one of the four cases described below is taken:

TABLE 1/Q.714

Actions upon receipt of a message from connectionless or connection-oriented control

	No GT No SSN	GT No SSN	No GT SSN	GT SSN
No DPC	(4)	(2)	(4)	(2)
DPC = own node	(4)	(2)	(1)	(1), (2)
DPC = remote note	(4)	(3)	(1)	(1), (2), (3)
NOTE – The choice of the appropriate action is implementation dependent.				

Action (1):

a) If the remote DPC, SCCP and SSN are available, then the MTP-TRANSFER request primitive is invoked;

b) If the remote DPC, SCCP and SSN are not available, then:

– for connectionless messages, the message return procedure is initiated;

– for connection-oriented messages (CR messages), the connection refusal procedure is initiated.

c) the DPC is the node itself, then the procedures in 2.3.1 item 2) above are followed[1].

[1] The function of routing between local subsystems is implementation-dependent.

Action (2):

a) If the translation of the global title exists, and result of the translation is routing on SSN, then:

   i) if the DPC is the node itself, then the procedures in 2.3.1 item 2), above are followed.

   ii) if the DPC is not the node itself and the remote DPC, SCCP and SSN are available, then the MTP-TRANSFER request primitive is invoked;

   iii) if the DPC is not the node itself, and the remote DPC, SCCP and/or SSN are not available and:

   – the message is a connectionless message, then the message return procedure is initiated;

   – the message is a connection-oriented message (a CR message), then the connection refusal procedure is initiated.

b) If the translation of the global title exists and the result of the translation is routing on GT, then:

   i) if the remote DPC and SCCP are available, then the MTP-TRANSFER request primitive is invoked;

   ii) if the DPC is not available and:

   – the message is a connectionless message, then the message return procedure is initiated;

   – the message is a connection-oriented message (a CR message), then the connection refusal procedure is initiated.

c) If the translation of the global title does not exist, and:

   – the message is a connectionless message, then the message return procedure is initiated;

   – the message is a connection-oriented message (a CR message), then the connection refusal procedure is initiated.

Action (3):

The same actions as action (1) apply, without checking the SSN.

Action (4):

The "called address" contains insufficient information. Error procedures are applied.

2.4 Routing failures

The SCCP recognizes a number of reasons for failure in SCCP routing control. Examples of these reasons are:

1) translation does not exist for addresses of this nature;

2) translation does not exist for this specific address;

3) MTP/SCCP/subsystem failure;

4) network/subsystem congestion, and

5) unequipped user.

The precise classification of the causes by which such failures are recognized is for further study.

When SCCP routing is unable to transfer a message due to the unavailability of a Point Code or Subsystem, one of above reasons is indicated in the *Connection Refused* message, the *Connection Released* message or the *Unitdata Service* message, or the Extended Unitdata Service message.

3 Connection-oriented procedures

3.1 Connection establishment

3.1.1 General

The connection establishment procedures consist of the functions required to establish a temporary signalling connection between two users of the Signalling Connection Control Part.

The connection establishment procedures are initiated by a SCCP user by invoking the N-CONNECT request primitive.

The ISDN-UP may initiate an SCCP connection in the same way as any other user, but may also request the SCCP to initiate a connection and return the information to the ISDN-UP for transmission in a call set-up message.

The signalling connections between two users of the Signalling Connection Control Part, which are referred to by the "Called/Calling address" parameters in the N-CONNECT request primitive, may be realized by the establishment of one or more connection sections. The SCCP user is not aware of how the SCCP provides the signalling connection (e.g. by one or more than one connection sections).

The realization of a signalling connection between two SCCP users then can be described by the following components:

1) one or more connection sections;
2) an originating node, where the "Calling address" is located;
3) zero or more intermediate nodes, where, for this signalling connection, there is no distribution to a SCCP user; and
4) a destination node, where the "Called address" is located.

The *Connection Request* message and the *Connection Confirm* message are used to set up connection sections.

3.1.2 Local reference numbers

During connection establishment both a source and destination local reference number are assigned independently to a connection section.

Source and destination local reference numbers are assigned at connection section set-up for a permanent connection section.

Once the destination reference number is known, it is a mandatory field for all messages transferred on that connection section.

Each node will select the local reference that will be used by the remote node as the destination local reference number field on a connection section for data transfer.

The local reference numbers remain unavailable for use on other connection sections until the connection section is released and the reference numbers are removed from their frozen state. See also 3.3.2.

3.1.3 Negotiation procedures

3.1.3.1 Protocol class negotiation

During connection establishment it is possible to negotiate the protocol class of a signalling connection between two SCCP users.

The N-CONNECT request primitive contains a parameter, the "Quality of service parameter set", with the preferred quality of service proposed by the SCCP user for the signalling connection.

The SCCP at the originating, intermediate and destination nodes may alter the protocol class on a signalling connection so that the quality of service assigned to the signalling connection is less restrictive (e.g. a protocol class 2 connection may be provided if a protocol class 3 connection is proposed). Information concerning the present proposed protocol class within the SCCP is carried in the *Connection Request* message and the assigned protocol class appears in the *Connection Confirm* message.

At the destination node the SCCP user is notified of the proposed protocol class using the N-CONNECT indication primitive.

The protocol class of a signalling connection may also be altered by the Called SCCP user in the same manner (i.e. less restrictive) when invoking the N-CONNECT response primitive.

The Calling SCCP user is informed of the quality of service selected on the signalling connection using the N-CONNECT confirmation primitive.

3.1.3.2 Flow control credit negotiation

During connection establishment it is possible to negotiate the window size to be used on a signalling connection for the purpose of flow control. This window size remains fixed for the life of the signalling connection. The credit field in the CONNECTION REQUEST and CONNECTION CONFIRM messages is used to indicate the window size.

The N-CONNECT request primitive contains a parameter, the "Quality of service parameter set" with the preferred quality of service proposed by the SCCP user for the signalling connection.

The SCCP at the originating, intermediate and destination nodes may alter the window size on a signalling connection so that the quality of service assigned to the signalling connection is less restrictive (e.g. a smaller window size may be provided). Information concerning the present proposed window size within the SCCP is carried in the *Connection Request* message and the assigned window size appears in the *Connection Confirm* message.

At the destination node the SCCP user is notified of the proposed window size using the N-CONNECT indication primitive.

The window size of a signalling connection may also be altered by the Called SCCP user in the same manner (i.e. less restrictive) when invoking the N-CONNECT response primitive.

The Calling SCCP user is informed of the quality of service selected on the signalling connection using the N-CONNECT confirm primitive.

3.1.4 Actions at the origination node

3.1.4.1 Initial actions

The N-CONNECT request primitive is invoked by the SCCP user at the originating node to request the establishment of a signalling connection to the "Called address" contained in the primitive. The node determines if resources are available.

If resources are not available, then the connection refusal procedure is initiated.

If resources are available, then the following actions take place at the originating node:

1) A source local reference number and an SLS code are assigned to the connection section.
2) The "Called address" is associated with the connection section.
3) The proposed protocol class is determined for the connection section.
4) If the protocol class provides for flow control, then an initial credit is indicated in the *Connection Request* message.
5) The *Connection Request* message is then forwarded to the SCCP routing function for transfer.
6) A timer T(conn est) is started.

The ISDN-UP may request the SCCP to set up a SCCP signalling connection and return the information normally carried in a *Connection request* message to the ISDN-UP for transmission in a call set-up message.

When the ISDN-UP notifies the SCCP of the need for the connection, using the REQUEST Type 1 interface element, the SCCP determines if resources are available.

If resources are not available, then the connection refusal procedure is initiated. If resources are available, then the following actions take place at the origination node:

1) A source local reference number and an SLS code is assigned to the connection section.
2) An indication that the call request is from the ISDN-UP is associated with the connection section.

3) The proposed protocol class is determined for the connection section.

4) If the protocol class provides for flow control, then an initial credit is indicated.

5) The information that would normally be included in a Connection Request message is passed to the ISDN-UP for transfer using the REPLY interface element.

6) A timer T(conn est) is started.

3.1.4.2 Subsequent actions

When an originating node receives a *Connection Confirm* message, the following actions are performed:

1) The protocol class and initial credit for flow control of the connection section are updated if necessary.

2) The SCCP user is informed of the successful establishment of the signalling connection using the N-CONNECT confirmation primitive.

3) The received local reference number is associated with the connection section.

4) The timer T(conn est) is stopped.

5) The inactivity control timers, T(ias) and T(iar), are started.

When the SCCP user at an origination node invokes the N-DISCONNECT request primitive, no action is taken prior to receipt of a *Connection Confirm* or a *Connection Refused* message or expiration of the connection establishment timer.

When an originating node receives a *Connection Refused* message, the connection refusal procedure is completed at the origination node (see 3.2.3).

When the connection establishment timer at the origination node expires, the N-DISCONNECT INDICATION primitive is invoked, the resources associated with the connection section are released, and the local reference number is frozen.

3.1.5 Actions at an intermediate node

3.1.5.1 Initial actions

When a *Connection Request* message is received at a node and the SCCP routing and discrimination function determines that the "called party address" is not a local SCCP user and that a coupling is required at this node, the intermediate node determines if resources are available to establish the connection section.

If resources are not available at the node, then the connection refusal procedure is initiated.

If resources are available at the node, then the following actions are performed:

1) A local reference number and an SLS code are assigned to the incoming connection section.

   NOTE – As an implementation option, a local reference number may be assigned later upon reception of a *Connection Confirm* message.

2) A connection section is set up to the remote node determined by SCCP Routing:

   – A local reference number and an SLS code are assigned to the outgoing connection section.

   – The protocol class is proposed.

   – An initial credit for flow control is assigned, if appropriate.

   – The *Connection Request* message is forwarded to the SCCP Routing with the same addressing information as found in the incoming *Connection Request* message.

   – The timer T(conn est) is started.

3) An association is made between the incoming and outgoing connection sections.

The ISDN-UP informs the SCCP that a connection request has been received using the REQUEST Type 2 interface element. The ISDN-UP passes the information contained in the ISDN-UP set-up message to the SCCP and indicates that a coupling is required at this node. The SCCP at the intermediate node then determines if resources are available to establish the connection section.

If resources are not available at the node, then the connection refusal procedure is initiated.

If resources are available at the node, then the following actions are performed:

1) A local reference number and an SLS code are assigned to the incoming connection section.
2) A local reference number and an SLS code is assigned to an outgoing connection section.
3) A protocol class is proposed.
4) An initial credit for flow control is assigned if appropriate.
5) An association is made between the incoming and outgoing connection sections.
6) The information that would normally be included in a connection request message is passed to the ISDN-UP for transfer in the REPLY interface element.
7) The timer T(conn est) is started.

3.1.5.2 Subsequent actions

When an intermediate node receives a *Connection Confirm* message, the following actions are performed:

1) The source local reference number in the *Connection Confirm* message is associated with the outgoing connection section.
2) The protocol class and credit for the connection section are assigned and identical to those found in the received *Connection Confirm* message.
3) A *Connection Confirm* message is transferred, using the SCCP routing function, to the originating node of the associated connection section. The protocol class and credit are identical to those indicated in the received *Connection Confirm* message.
4) The timer T(conn est) is stopped.
5) The inactivity control timers, T(ias) and T(iar), are started.

When an intermediate node receives a *Connection Refused* message, the connection refusal procedure is completed at that node (see 3.2.2).

When the connection establishment timer expires at an intermediate node, the following actions are performed:

1) The resources associated with the connection are released.
2) The local reference number is frozen (see 3.3.2).
3) If the connection section was established using a REQUEST interface element, then the N-DISCONNECT indication primitive is invoked.
4) The connection refusal procedure is initiated on the associated connection section (see 3.2.1).

3.1.6 Actions at destination node

3.1.6.1 Initial actions

When a *Connection Request* message is received at a node, and the SCCP routing and discrimination function determines that the "called party address" is a local user, the destination node determines if resources are available to establish the connection section.

If resources are not available at the node, then the connection refusal procedure is initiated.

If the resources are available at the node, then the following actions are performed:

1) The protocol class is determined for the connection section.

   NOTE – As an implementation option, a local reference number may also be assigned for the connection section.

2) An initial credit for flow control is assigned if appropriate.
3) The node informs the SCCP user of a request to establish a connection using the N-CONNECT indication primitive.

When the ISDN-UP informs the SCCP that a connection request has been received using the REQUEST Type 2 interface element, the ISDN-UP passes the information contained in the ISDN-UP set-up message to the SCCP, and informs the SCCP that the information is for a local user. The SCCP at the destination node determines if resources are available to establish the connection section.

If resources are not available at the node, then the connection refusal procedure is initiated.

If resources are available at the node, then the following actions are performed:

1) The protocol class is determined for the connection section.
2) An initial credit for flow control is assigned if appropriate.
3) The node informs the ISDN-UP of the request to establish a connection using the N-CONNECT indication primitive.

3.1.6.2 Subsequent actions

When a N-CONNECT response primitive is invoked by the SCCP user at a destination node, the following actions are performed:

1) A local reference number and an SLS code are assigned to the incoming connection section.
2) The protocol class and credit are updated for the connection section if necessary.
3) A *Connection Confirm* message is transferred, using the SCCP routing function, to the originating node of the connection section.
4) The inactivity control timers, T(ias) and T(iar), are started.

3.2 Connection refusal

The purpose of the connection refusal procedure is to indicate to the Calling SCCP user function that the attempt to set up a signalling connection section was unsuccessful.

3.2.1 Actions at node initiating connection refusal

The connection refusal procedure is initiated by either the SCCP user or the SCCP itself:

1) The SCCP user at the destination node
   a) uses the N-DISCONNECT request (originator indicates "user initiated") after the SCCP has invoked an N-CONNECT indication primitive. This is the case when the SCCP at the destination node has received the connection request directly from a preceding SCCP.
   b) uses the refusal indicator in the REQUEST Type 2 interface element when the SCCP user has received the connection request embedded in a user part message.
2) The SCCP initiates connection refusal[2] (originator indicates "network initiated") due to:
   a) limited resources at an originating, intermediate or destination node, or
   b) expiration of the connection establishment timer at an originating or intermediate node.

Initiation of the connection refusal procedure by either the SCCP or the user results in the transfer of a *Connection Refused* message on the connection section. The refusal cause contains the value of the originator in the primitives; if the refusal procedure has been initiated by using the refusal indicator in the REQUEST Type 2 interface element, the refusal cause contains "SCCP user originated".

At the originating node, a connection refusal is initiated by invoking N-DISCONNECT indication primitive.

If the connection refusal procedure is initiated at an intermediate node due to lack of resources, then a *Connection Refused* message is transferred on the incoming connection section.

If the connection refusal procedure is initiated at an intermediate node due to expiration of the connection establishment timer, then the connection release procedure is initiated on that connection section (see 3.3.4.1) and a *Connection Refused* message is transferred on the associated connection section.

In either of the two above cases at an intermediate node, if the connection set-up was initiated using a REQUEST interface element, then the SCCP user is informed by invoking the N-DISCONNECT indication primitive.

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[2] If the reason for the refusal is "destination address unknown", then the maintenance function is alerted.

3.2.2 Actions at intermediate node not initiating connection refusal

When a *Connection Refused* message is received on a connection section, the following actions are performed:

1) The resources associated with the connection section are released and the timer T(conn est) is stopped[3].
2) If the connection was established using a REQUEST interface element, then the SCCP user is informed by invoking the N-DISCONNECT indication primitive.
3) A *Connection Refused* message is transferred on the associated connection section.
4) The resources associated with the associated connection section are released.

3.2.3 Actions at the origination node not initiating connection refusal

When a *Connection Refused* message is received on a connection section, the following actions are performed:

1) The resources associated with the connection section are released and the timer T(conn est) is stopped[3].
2) The SCCP user is informed by invoking the N-DISCONNECT indication primitive.

3.3 Connection release

3.3.1 General

The connection release procedures consist of the functions required to release a temporary signalling connection between two users of the Signalling Connection Control Part. Two messages are required to initiate and complete connection release: *Released* and *Release Complete*.

The release may be performed:

a) by either or both of the SCCP users to release an established connection.
b) by the SCCP to release an established connection.

All failures to maintain a connection are indicated in this way.

3.3.2 Frozen reference

The purpose of the frozen reference function is to prevent the initiation of incorrect procedures as a connection section due to receipt of a message, which is associated with a previously established connection section.

When a connection section is released, the local reference number associated with the connection section is not immediately available for reuse on another connection section. A mechanism should be chosen to sufficiently reduce the probability of erroneously associating a message with a connection section. This particular mechanism is implementation dependent.

3.3.3 Actions at an end node initiating connection release

3.3.3.1 Initial actions

When a connection release is initiated at an end node of a signalling connection, by the SCCP user invoking a N-DISCONNECT request primitive or by the node itself, the following actions are performed at the initiating node:

1) A *Released* message is transferred on the connection section.
2) A release timer T(rel) is started.
3) If the release was initiated by the SCCP, then a N-DISCONNECT indication primitive is invoked.
4) The inactivity control timers, T(ias) and T(iar), if still running, are stopped.

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[3] If the reason for the refusal is "destination address unknown", then the maintenance function is alerted.

3.3.3.2 Subsequent actions

The following actions are performed at the originating node on a connection section for which a *Released* message has been previously transferred:

1) When a *Release Complete* or *Released* message is received, the resources associated with the connection are released, the timer, T(rel), is stopped, and the local reference number is frozen.

2) When the release timer expires, a *Released* message is transferred on the connection section. The sending of the *Released* message is repeated every 4-15 seconds for an interval of up to one minute.

When the T(rel) timer expires, T(int) and T(repeat rel) timers are started. A Released message is transferred on the connection section. When T(repeat rel) expires during the duration of T(int), it is restarted. A released message is sent each time T(repeat rel) is restarted.

When T(int) expires stop T(repeat rel) if still running, release connection resources and freeze the LRN.

At this point a maintenance function is alerted.

3.3.4 Actions at intermediate node

The connection release procedure is initiated at an intermediate node by the SCCP or by reception of a *Released* message on a connection section.

3.3.4.1 Initial actions

When a *Released* message is received on a connection section, the following actions then take place:

1) A *Release Complete* message is transferred on the connection section, the resources associated with the connection are released and the local reference number is frozen.

2) A *Released* message is transferred on the associated connection section; the reason is identical to the reason in the received message.

3) If the connection was established using a REQUEST interface element, then a N-DISCONNECT indication primitive is invoked.

4) The release timer, T(rel), is started on the associated connection.

5) The inactivity control timers, T(ias) and T(iar), if still running, are stopped on both connection sections.

When the connection release procedure is initiated by the SCCP at the intermediate node during the data transfer phase, the following actions take place on both of the connection sections:

1) A *Released* message is transferred on the connection section.

2) If the connection section was established using an interface element, then a N-DISCONNECT indication primitive is invoked.

3) The release timer, T(rel), is started.

4) The inactivity control timers, T(ias) and T(iar), if still running, are stopped on both connection sections.

3.3.4.2 Subsequent actions

The following actions are performed at an intermediate node during connection release:

1) When a *Release Complete* or *Released* message is received on a connection section, the resources associated with the connection are released, the timer T(rel) is stopped, and the local reference number is frozen.

2) When the release timer expires, a *Released* message is transferred on the connection section. The sending of the Released message is repeated every 4-15 seconds for an interval of up to one minute.

3) When the T(rel) timer expires, timers T(int) and T(repeat rel) are started. A Released message is transferred on the connection section. When timer T(repeat rel) expires during the duration of T(int), it is restarted. A Released message is sent each time T(repeat rel) is restarted.

4) When timer T(int) expires, the T(repeat rel) timer is stopped if it is still running, the connection resources are released, and the LRN is frozen.

5) At this point a maintenance function is alerted.

3.3.5 Actions at an end node not initiating connection release

When a *Released* message is received at an end node of a signalling connection, the following actions are performed on the connection section:

1) A *Release Complete* message is sent on the connection section.

2) The resources associated with the connection section are released, the SCCP user is informed that a release has occurred by invoking the N-DISCONNECT indication primitive, and the local reference number is frozen.

3) The inactivity control timers, T(ias) and T(iar), if still running, are stopped.

3.4 Inactivity control

The purpose of the inactivity control is to recover from:

1) loss of a *Connection Confirm* message during connections establishment, and

2) the unsignalled termination of a connection section during data transfer, and

3) a discrepancy in the connection data held at each end of a connection.

Two inactivity control timers, the receive inactivity control timer T(iar) and the send inactivity control timer T(ias), are required at each end of a connection section. The length of the receive inactivity timer must be longer than the length of the send inactivity timer.

When any message is sent on a connection section, the send inactivity control timer is reset.

When any message is sent on a connection section, the receive inactivity control timer is reset.

When the send inactivity timer, T(ias), expires, an *Inactivity Test* (IT) message is sent on the connection section.

The receiving SCCP checks the information contained in the IT message against the information held locally. If a discrepancy is detected, the following actions (Table 2) are taken:

When the receive inactivity control timer, T(iar), expires, the connection release procedure is initiated on a temporary connection section and an OA&M function is alerted for a permanent connection section.

As an alternative to inactivity control timers in the SCCP, there is also the possibility of supervising a signalling connection by a SCCP user function.

TABLE 2/Q.714

Discrepancy	Action
Source reference number	Release connection
Protocol class	Release connection
Sequencing/segmenting[a)]	Reset connection
Credit[a)]	Reset connection

a) Does not apply to class 2 connection.

3.5 Data transfer

3.5.1 General

The purpose of data transfer is to provide the functions necessary to transfer user information on a temporary or permanent signalling connection.

3.5.1.1 Actions at the originating node

The SCCP user at the originating node requests transfer of user data on a signalling connection by invoking the N-DATA request primitive.

The *Data* message is then generated, which must be transferred on the connection section. If flow control procedures apply to the connection section, these procedures must be enacted before the message can be forwarded on the connection section.

3.5.1.2 Actions at the intermediate node

If a signalling connection consists of more than one connection section, then one or more intermediate nodes are involved in the transfer of *Data* messages on the signalling connection.

When a valid *Data* message is received on an incoming connection section at an intermediate node, the associated outgoing connection section is determined. The intermediate node then forwards the *Data* message to the associated outgoing connection section for transfer to the distant node. If flow control procedures apply to the connection sections, then the appropriate procedures must be enacted on both connection sections. On the incoming connection section, these procedures relate to the reception of a valid *Data* message and on the outgoing connection section, the procedures control the flow of *Data* messages on the connection section.

3.5.1.3 Actions at the destination node

When the destination node receives a valid *Data* message, the SCCP user (i.e. the Called Party Address) is notified by invoking the N-DATA indication primitive. If flow control procedures apply to the signalling connection, the flow control procedures relating to the reception of a valid *Data* message are enacted.

3.5.2 Flow control

3.5.2.1 General

The flow control procedures apply during data transfer only, and are used to control the flow of *Data* messages on each connection section.

The flow control procedures apply only to protocol class 3.

The reset procedure causes reinitialization of the flow control procedure.

The expedited data procedure is not affected by this flow control procedure.

3.5.2.2 Sequence numbering

For protocol class 3, for each direction of transmission on a connection section, the *Data* messages are sequentially numbered.

The sequence numbering scheme of the *Data* messages is performed modulo 128 on a connection section.

Upon initialization or reinitialization of a connection section, message send sequence numbers, P(S), are assigned to *Data* messages on a connection section beginning with P(S) equal to 0. Each subsequent *Data* message sequence number is obtained by incrementing the last assigned value by 1. The sequence numbering scheme assigns sequence numbers up to 127.

3.5.2.3 Flow control window

A separate window is defined, for each direction of transmission, on a connection section in order to control the number of *Data* messages authorized for transfer on a connection section. The window is an ordered set of W consecutive message send sequence numbers associated with the *Data* messages authorized for transfer on the connection section.

The lower window edge is the lowest sequence number in the window.

The sequence number of the first *Data* message not authorized for transfer on the connection is the value of the lower window edge plus W.

The maximum window size is set during connection establishment for temporary connection sections. For permanent connection sections, the window size is fixed at establishment. The maximum size cannot exceed 127.

Negotiation procedures during connection establishment allow for the negotiation of the window size.

3.5.2.4 Flow control procedures

3.5.2.4.1 Transfer of Data messages

If flow control procedures apply to a connection section, then all *Data* messages on the connection section contain a send sequence number, P(S), and a receive sequence number, P(R). The procedure for determining the send sequence number to be used in a *Data* message is described in 3.5.2.2. The receive sequence number, P(R), is set equal to the value of the next send sequence number expected on the connection section and P(R) becomes the lower window edge of the receiving window.

An originating or intermediate node is authorized to transmit a *Data* message if the message send sequence number of the message is within the sending window. That is, if P(S) is greater than or equal to the lower window edge and less than the lower window edge plus W. When the send sequence number of a *Data* message is outside of the sending window, the node is not authorized to transmit the message.

3.5.2.4.2 Transfer of Data Acknowledgement messages

Data Acknowledgement messages may be sent when there are no *Data* messages to be transferred on a connection section[4)].

When a node transfers a *Data Acknowledgement* message on a connection section, it is indicating that the node is ready to receive W *Data* messages within the window starting with the receive sequence number, P(R), found in the *Data Acknowledgement* message. That is, P(R) is the next send sequence number expected at the remote node on the connection section. Furthermore, P(R) also becomes the lower window edge of the receiving window.

A *Data Acknowledgement* message must be sent when a valid *Data* message, as per subclause 3.5.2.4.3 on P(S) and P(R), is received and P(S) is equal to the upper edge of the receiving window and there are no *Data* messages to be transferred on the connection section. Sending of *Data Acknowledgement* messages before having reached the upper edge of the receiving window is also allowed during normal operation.

Data acknowledgement messages may also be sent by a node encountering congestion on a connection section as described below:

Assuming nodes X and Y are the two ends of a connection section, the following procedures apply.

When a node (Y) experiences congestion on a connection section, it informs the remote node (X) using the *Data Acknowledgement* message with the credit set to zero.

Node X stops transferring *Data* messages on the connection section.

Node X updates the window on the connection section using the value of the receive sequence number, P(R), in the *Data Acknowledgement* message.

Node X begins transfer of *Data* message when it receives a *Data Acknowledgement* message with a credit field greater than zero or when a *Reset* message is received on a connection section for which a *Data Acknowledgement* message with a credit field equal to zero had previously been received.

Node X updates the window on the connection using the credit value. The credit value in a *Data Acknowledgement* message must either equal zero or equal the initial credit agreed to at connection establishment.

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4) Further study is required to determine criterion to be used to decide when Data Acknowledgement messages are sent for cases other than the congestion situation described in this subclause.

3.5.2.4.3 Reception of a Data or Data Acknowledgement message

When an intermediate or destination node receives a *Data* message, it performs the following test on the send sequence number, P(S), contained in the *Data* message:

1) If P(S) is the next send sequence number expected and is within the window, then the node accepts the *Data* message and increments by one the value of the next sequence number expected on the connection section.

2) If P(S) is not the next send sequence number expected, then the reset procedure is initiated on the connection section.

3) If P(S) is not within the window, then this is considered a local procedure error and the connection reset procedure is initiated.

4) If P(S) is not equal to 0 for the first *Data* message received after initialization or reinitialization of the connection section, this is considered a local procedure error and the connection reset procedure is initiated.

The message receive sequence number, P(R), is included in *Data*, and *Data Acknowledgement* messages. When a node receives a *Data* or *Data Acknowledgement* message on a connection section, the value of the receive sequence number, P(R), implies that the remote node has accepted at least all *Data* messages numbered up to and including P(R) – 1. That is, the next expected send sequence number at the remote node is P(R). The receive sequence number, P(R), contains information from the node sending the message, which authorizes the transfer of a limited number of *Data* messages on the connection section. When a node receives a *Data* or *Data Acknowledgement* message:

a) the receive sequence number, P(R), contained in the message becomes the lower window edge of the sending window:

   1) if the value of P(R) is greater than or equal to the last P(R) received by the node on that connection section, and also,

   2) if the value of the received P(R) is less than or equal to the P(S) of the next *Data* message to be transferred on that connection section;

b) the node initiates the reset procedure on the connection section if the receive sequence number, P(R), does not meet conditions 1) and 2).

3.5.3 Segmenting and reassembly

During the data transfer phase, the N-DATA request primitive is used to request transfer of octet-aligned data (NSDUs) on a signalling connection. NSDUs longer than 255 octets must be segmented before insertion into the "data" field of a *Data* message.

The more-data indicator (M-bit) is used to reassemble a NSDU that has been segmented for conveyance in multiple *Data* messages. The M-bit is set to 1 in all *Data* messages except the last message whose data field relates to a particular NSDU. In this way, the SCCP can reassemble the NSDU by combining the data fields of all *Data* messages with the M-bit set to 1 with the following *Data* message with the M-bit set to 0. The NSDU is then delivered to the SCCP user using the N-DATA indication. *Data* messages in which the M-bit is set to 1 do not necessarily have the maximum length.

Segmentation and reassembly are not required if the length of the NSDU is less than or equal to 255 octets.

3.6 Expedited data transfer

3.6.1 General

The expedited data procedure applies only during the data transfer phase and is applicable to protocol class 3.

For the case of expedited data transfer, each message contains one NSDU, and no segmenting and reassembly is provided.

If an *Expedited Data* or *Expedited Data Acknowledgement* message is lost, then subsequent *Expedited Data* messages cannot be forwarded on the connection section.

3.6.2 Actions at the originating node

The expedited data transfer procedure is initiated by the user of the SCCP using the N-EXPEDITED-DATA request primitive, which contains up to 32 octets of user data.

When the SCCP user invokes the N-EXPEDITED-DATA request primitive, an *Expedited Data* message with up to 32 octets of user data is transferred on the connection section once *all* previous *Expedited Data* messages for the connection section have been acknowledged.

3.6.3 Actions at intermediate node

Upon receiving a valid *Expedited Data* message, an intermediate node confirms this message by transferring an *Expedited Data Acknowledgement* message on the incoming connection section. Withholding of the *Expedited Data Acknowledgement* message is a means of providing flow control of *Expedited Data* messages.

If a node receives another *Expedited Data* message on the incoming connection section before sending the *Expedited Data Acknowledgement* message, then the node will discard the subsequent message and reset the incoming connection section.

The intermediate node determines the associated outgoing connection section. An *Expedited Data* message is then transferred on the associated outgoing connection section, once *all* previous *Expedited Data* messages on that connection section have been acknowledged.

The *Expedited Data Acknowledgement* message must be sent before acknowledging subsequent *Data* or *Expedited Data* messages received on the incoming connection section.

3.6.4 Actions at destination node

The destination node of the connection section confirms a valid *Expedited Data* message by transferring an *Expedited Data Acknowledgement* message on the connection section. Withholding of the *Expedited Data Acknowledgement* message is a means of providing flow control of *Expedited Data* messages.

If a node receives another *Expedited Data* message on a connection section before sending the *Expedited Data Acknowledgement* message, then the node will discard the subsequent message and reset the connection section.

The destination node then invokes the N-EXPEDITED DATA indication primitive.

The N-EXPEDITED-DATA indication must be issued to the SCCP user at destination node before N-DATA or N-EXPEDITED-DATA indications resulting from any subsequently issued N-DATA or N-EXPEDITED-DATA requests at the originating node of that signalling connection. The initiation of the *Expedited Data Acknowledgement* message is implementation dependent.

3.7 Reset

3.7.1 General

The purpose of the reset procedure is to reinitialize a connection section. It is applicable only to protocol class 3. It is noted that the time sequence of the primitives in the reset procedure may be varied as long as it is consistent with Recommendation X.213.

For a connection reset initiated by the SCCP, Data or Expedited Data messages should not be transferred on the connection section prior to the completion of the reset procedure.

3.7.2 Action at the initiating node

3.7.2.1 Initial actions

When a connection reset is initiated, by the SCCP user invoking a N-RESET request primitive or by the node itself, the following actions are performed at the initiating node:

1) A *Reset Request* message is transferred on the connection section.

2) The send sequence number, P(S), for the next *Data* message is set to 0. The lower window edge is set to 0. The window size is reset to the initial credit value.

3) The SCCP user is informed that a reset has taken place by:

– invoking the N-RESET indication primitive if the reset is network originated.

4) The reset timer T (reset) is started.

3.7.2.2 Subsequent actions

The following actions are performed at the initiating node on a connection section for which a *Reset Request* message has been previously transferred:

1) When a *Data*, *Data Acknowledgement*, *Expedited Data*, or *Expedited Data Acknowledgement* message is received, the message is discarded. When an N-DATA request or N-EXPEDITED DATA request primitive is received, the primitive is discarded or stored up to the completion of the reset procedure. The choice between these two is implementation dependent.

2) When the reset timer expires, the connection release procedure is initiated on a temporary connection section and maintenance functions are alerted for a permanent connection section.

3) When a *Reset Confirm* or a *Reset Request* message is received on the connection section, the reset is completed provided the SCCP has previously received an N-RESET request or response primitive from the SCCP user and, therefore, data transfer is resumed and the timer T(reset) is stopped. The SCCP user is informed that the reset is completed by invoking the N-RESET confirmation primitive.

4) When a *Released* message is received on a temporary connection section, the release procedure is initiated and the timer, T (reset), is stopped.

3.7.3 Actions at the intermediate node

3.7.3.1 Initial actions

The connection reset procedure is initiated at the intermediate node either by the SCCP at the node itself or by the reception of a *Reset Request* message.

When a *Reset Request* message is received on a connection section, the following actions take place:

1) A *Reset Confirm* message is transferred on the connection section.

2) A *Reset Request* message is transferred on the associated connection section; the reason for reset is identical to the reason in the *Reset Request* message.

3) On both the connection section and the associated connection section, the send sequence number, P(S), for the next *Data* message to be transmitted is set to 0 and the lower window edge is set to 0. The window size is reset to the initial credit value on both connection sections.

4) The data transfer procedure is initiated on the connection section.

5) The reset timer, T (reset), is started on the associated connection section.

When the connection reset procedure is initiated by the SCCP at the intermediate node, the following actions take place on both of the connection sections:

1) A *Reset Request* message is transferred.

2) The send sequence number, P(S), for the next *Data* message is set to 0. The lower window edge is set to 0. The window size is reset to the initial credit value.

3) The reset timer T (reset) is started.

3.7.3.2 Subsequent actions

If the connection reset was initiated by reception of a *Reset Request* message on a connection section, then the following actions are performed after initial actions are completed:

1) When a *Data*, *Data Acknowledgement*, *Expedited Data*, *Expedited Data Acknowledgement* message is received on the associated connection section, the message is discarded.

2) When the reset timer expires on the associated connection section, the connection release procedure is initiated on both temporary connection sections and the maintenance function is alerted on an associated permanent connection section.

3) When a *Released* message is received on a temporary connection section, the connection release procedure is initiated on both connection sections and the timer, T (reset), is stopped.

4) When a *Reset Confirm* or *Reset Request* message is received on the associated connection section, the data transfer procedure is resumed and the timer, T (reset), is stopped.

If the connection reset was initiated by the SCCP at the intermediate node, then the following actions are performed once the initial actions are completed:

1) When a *Data*, *Data Acknowledgement*, *Expedited Data*, or *Expedited Data Acknowledgement* message is received on either connection section, the message is discarded.

2) When the reset timer expires on a temporary connection section, the connection release procedure is initiated on both connection sections, and on a permanent connection section a maintenance function is alerted.

3) When a *Released* message is received on a temporary connection section, the connection release procedure is initiated on both connection sections and the timer, T (reset), is stopped .

4) When a *Reset Confirm* or *Reset Request* message is received on a connection section, data transfer is resumed on that connection and the timer, T (reset), is stopped.

3.7.4 Actions at the destination node

When a *Reset Request* message is received at a node, the following actions are performed on the connection section:

1) The send sequence number, P(S), for the next *Data* message is set to 0, the lower window edge is set to 0. The window size is reset to the initial credit value.

2) The SCCP user is informed that a reset has occurred by invoking the N-RESET indication primitive.

3) A *Reset Confirm* message is transferred on the connection section after an N-RESET response or request primitive is invoked by the user.

4) An N-RESET confirmation primitive is invoked to inform the SCCP user that the reset is completed and the data transfer can be resumed.

3.7.5 Handling of messages during the reset procedures

Once the reset procedure is initiated, the following actions are taken with respect to *Data* messages:

- those that have been transmitted, but for which an acknowledgement has not been received, are discarded, and

- those that have not been transmitted, but are contained in an M-bit sequence for which some *Data* messages have been transmitted, are discarded,

- those *Data* messages that have been received, but which do not constitute an entire M-bit sequence, are discarded.

3.8 Restart

3.8.1 General

The purpose of the restart procedure is to provide a recovery mechanism for signalling connection sections in the event of a node failure.

3.8.2 Actions at the recovered node

3.8.2.1 Initial actions

When a node recovers from its failure, the following actions are performed:

1) A guard timer, T(guard)[5], is started.
2) If the recovered node has knowledge about the local reference numbers in use before failure, then the normal procedures for temporary signalling connections are resumed with the assumption that the local reference numbers which were in use before the node failure are not assigned at least during T(guard).
3) An OA&M function is informed for the re-establishment of permanent signalling connections.

3.8.2.2 Subsequent actions

The following actions are performed at the recovered node, on every temporary signalling connection section if the node does not know the local reference numbers in use before failure, or only on the temporary signalling connection sections in operation before failure if the node has such knowledge:

a) Before the guard timer, T(guard), expires:
    1) When a *Released* message is received with both source and destination local reference numbers, a *Release Complete* message, with reversed local reference numbers, is returned to the originating point code.
    2) Any other connection-oriented messages received are discarded.
b) When the guard timer, T(guard), expires, normal procedures are resumed.

3.8.3 Actions at the non-failed far end node

The inactivity control procedure, described in 3.4, is used by the non-failed far end node to recover from the unsignalled termination of a connection section during data transfer.

3.9 Permanent signalling connections

Permanent signalling connections are set up administratively and connection establishment procedures and connection release procedures are not initiated by the SCCP user.

Permanent signalling connections are realized using one or more connection sections.

A permanent signalling connection is either in the data transfer phase or the reset phase. Therefore, all procedures relating to the data transfer phase for connection-oriented protocol classes and the reset procedures are applicable to permanent signalling connections.

3.10 Abnormalities

3.10.1 General

Errors can be classified into the three categories listed below. Examples of each category are included for clarification:

1) *Syntax errors:*
    a) Value errors - Invalid values for a single information element that lead to the impossibility to decode the message.
    b) Construction errors - Errors in the sequence or length of information elements or inconsistencies between announced and actual contents of an information element.

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[5] The guard timer must be large enough, so that all the non-failed far end nodes can detect the failure and can safely release the affected temporary signalling connection sections. This implies T(guard) > T(iar) + T(rel).

For SCCP, the following errors could be considered as syntax errors:

a) Value errors:

a_1 – unknown message type;

a_2 – invalid value of protocol class;

a_3 – invalid value of global title indicator;

a_4 – invalid value for the encoding scheme.

All other "value errors" are not considered as syntax failures. They are either ignored (as spare fields or spare values) or treated as (unknown) routing failures. The former four errors make it impossible to treat the message in any sensible way and are therefore syntax errors.

b) Construction errors:

b_1 – minimum and maximum length of a parameter according to Recommendation Q.713 is not respected;

b_2 – pointers to variable or first optional parameter point beyond end of message;

b_3 – length of an optional parameter extends beyond end of message (may be because EOP is forgotten);

b_4 – the combination of pointer values and length of parameters (or sum of length of optional parameters) results in overlapping parameters;

b_5 – length of a calling or called address is not compatible with contents as indicated in the address indicator of the address;

b_6 – in an address, no SSN is included although the routing indicator indicates "route on SSN/PC".

2) *Logical errors* – This type of error occurs when a node receives a message that is not an acceptable input to the current state of the connection section, or whose value of P(S) or P(R) is invalid. Examples of logical errors are:

– reception of an acknowledgement message when the corresponding request message has not been sent,

– reception of a *Data* message whose data field length exceeds the maximum data field permitted on the connection section,

– reception of a second *Expedited Data* message before an *Expedited Data Acknowledgement* message has been sent, and

– reception of message whose value of P(R) is not greater than or equal to the last P(R) received and is not less than or equal to the next value of P(S) to be transmitted.

3) *Transmission errors* – This type of error occurs when a message is lost or delayed. Examples of transmission errors are:

– expiration of a timer before reception of the appropriate acknowledgement message.

3.10.2 Action tables

The action tables found in Annex B, include information, in addition to that found in the text of this Recommendation regarding the actions to be performed upon receipt of a message. In particular, these tables are helpful in determining the actions to be performed upon receipt of a message resulting in a logical error.

3.10.3 Actions upon the reception of an ERR message

Upon the reception of a *Protocol Data Unit Error* (ERR) message at a node, the following actions are performed on the connection section for error causes other than "service class mismatch":

1) The resources associated with the connection are released.

2) The local reference number is frozen (see 3.3.2).

Upon the reception of a *Protocol Data Unit Error* (ERR) message at a node with the error cause "service class mismatch", the connection release procedure is initiated by the SCCP at that node (see 3.3).

4 Connectionless procedures

The connectionless procedures allow a user of the SCCP to request transfer of up to 2K octets[6] of user data without first requesting establishment of a signalling connection.

The N-UNITDATA request and indication primitives are used by the user of the SCCP to request transfer of user data by the SCCP and for the SCCP to indicate delivery of user data to the destination user. Parameters associated with the N-UNITDATA request primitive must contain all information necessary for the SCCP to deliver the user data to the destination.

Transfer of the user data is accomplished by including the user data in *Unitdata* messages or Extended Unitdata messages.

When the user of the SCCP requests transfer of user data by issuing a N-UNITDATA request primitive, there are two classes of service that can be provided by the SCCP, protocol classes 0 and 1. These protocol classes are distinguished by their message sequencing characteristics.

When the user of the SCCP requests transfer of several messages by issuing multiple N-UNITDATA request primitives, the probability of these messages being received in sequence at the destination point depends on the protocol class designated in the request primitives. For protocol class 0 the sequence control parameter is not included in the N-UNITDATA request primitive and the SCCP may generate a different SLS for each of these messages. For protocol class 1 the sequence control parameter is included in the N-UNITDATA request primitive and, if the parameter is the same in each request primitive, then the SCCP will generate the same SLS for these messages. If a global title translation is being performed, then the translation should yield identical results for every translation of the same global title.

The Signalling Connection Control Part relies on the services of the MTP for transfer of SCCP messages. Based on the characteristics of the MTP, the protocol class 1 service may be used in such a way that it provides a quality of service that has a lower probability of out-of-sequence messages than that provided by protocol class 0.

4.1 Data transfer

The N-UNITDATA request primitive is invoked by the SCCP user at an originating node to request connectionless data transfer service. The connectionless data transfer service is also used to transport SCCP management messages, which are transferred in the "data" field of *Unitdata* or Extended Unitdata messages.

The *Unitdata* or Extended Unitdata message is then transferred, using SCCP and MTP routing functions, to the "Called address" indicated in the UNITDATA request primitive.

SCCP routing and relaying functions may be required at a relay point, since complete translation and routing tables for all addresses are not required at every node.

When the *Unitdata* or Extended Unitdata message cannot be transferred to its destination, the message return procedure is initiated.

The SCCP uses the services of the MTP and the MTP may, under severe network conditions, discard messages. Therefore, the user of the SCCP may not always be informed of non-delivery of user data. The MTP notifies the SCCP of unavailable or congested remote signalling points or remote SCCP unavailability using the MTP-PAUSE indication. The SCCP then informs its users.

When a *Unitdata* or Extended Unitdata message is received at the destination node, a N-UNITDATA indication primitive is invoked, after possible reassembly of all segments, except for the SCCP management messages. The SCCP management (SCMG) messages are passed to the SCMG entity instead.

For protocol class 1, the origination node, relay point, and destination node should maintain the sequence of messages as received from the originating SCCP user with the same sequence control parameter.

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[6] This is a provisional value.

4.1.1 Segmentation/reassembly

4.1.1.1 Segmentation

4.1.1.1.1 General

When an SCCP user generates a N-UNITDATA request primitive, the SCCP may decide to segment the user data. The following conditions describe when segmentation should be performed:

- If the length of the user data is between X and Y octets[7)], then the SCCP may decide to segment the message, based on locally stored information regarding network performance and configuration.
- If the length of the user data is greater than Y octets[7)], then the SCCP should segment the message, if possible.

4.1.1.1.2 Normal procedures

If the SCCP determines that segmentation is needed, it should break the original block of user data into smaller blocks of data that can be carried as user data in Extended Unitdata (XUDT) messages. The size of the segments should be chosen so that a minimum number of segments is sent, subject to local knowledge of the network status. A maximum of 16 segments can be sent for one N-UNITDATA request primitive. The size of the first segment should be selected so that the total message size is less than or equal to the size of the first segment multiplied by the number of segments. This provides for an effective buffer management capability at the destination SCCP.

After breaking the user data into smaller segments, the SCCP should form a sequence of XUDT messages, as described below:

- the SCCP should place each segment of user data into separate XUDT messages, each with the same Called Party Address and identical MTP routing information;
- the Calling Party Address and the OPC in each XUDT message should be coded identically, in the manner described in 2.1, SCCP Addressing;
- each segmented XUDT message should include the segmentation parameter;
- the Segment Number field of the segmentation parameter should be coded with the remaining number of segments in the segmentation process. For example, in the first segment, this field should be set to one less than the total number of segments;
- the Segmentation Local Reference field of the segmentation parameter should be coded with a unique local reference, which should remain frozen for time Tx[8)];
- the F-bit in the first segment should be coded as 1; the F-bit in each remaining segment should be coded as 0;
- the same SLS code should be placed in each XUDT of the segmentation process;
- the protocol class for each segmented XUDT message should be set to 1, and the Requested Protocol Class field of the segmentation parameter should be set as indicated in the N-UNITDATA request.

4.1.1.1.3 Return on error procedures

If message return is requested by the SCCP user, then it is an implementation decision that determines which XUDT messages have return on error requested. If an XUDT message is later received, and it refers to a known segmentation process, then it is an implementation decision that determines how the SCCP should deal with the returned XUDT message.

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7) The exact specification of the X and Y values is for further study.

8) The value for timer Tx is implementation-dependent.

4.1.1.2 Reassembly

4.1.1.2.1 General

Upon receipt of an XUDT message with the F-bit set to 1 in the segmentation parameter, the destination SCCP should initiate a new reassembly process, using the Calling Party Address and Segmentation Local Reference to uniquely identify the reassembly process. Initiating a reassembly process involves the following steps:

- The SCCP should start timer Ty. If timer Ty expires before all segments are received and reassembled, the SCCP should discard the message.
- The SCCP should determine the upper bound on the total message length by multiplying the length of the first segment by one more the number of remaining segments indicated in the segmentation parameter of the first segment.
- The SCCP should extract the user data of the segment, and buffer it so that it can be concatenated with subsequent segments.

4.1.1.2.2 Normal procedures

Upon receipt of an XUDT message with the F-bit set to 0 in the segmentation parameter, the SCCP should perform the following steps when reassembling the message:

- The SCCP should associate the received XUDT with a particular reassembly process, using the unique combination of the Calling Party Address and the Segmentation Local Reference field of the segmentation parameter. If no association is possible, the SCCP should discard the message.
- The SCCP should verify that the segment is received in sequence by examining the Remaining Segments field of the segmentation parameter, which should be one less than the previous segment. If a segment is received out of sequence, or a duplicate segment is received, the SCCP should initiate the return on error procedure.
- The SCCP should extract the user data of the segment, and concatenate it with the other segments, in the order received. Segments can be any length, and not all segments of a particular segmentation process need be the same length. Thus, the destination SCCP should be able to deal with segments of any length.
- When the Remaining Segments field of the segmentation parameter is 0, and all segments are properly reassembled, the SCCP should pass the message to the appropriate SCCP user as user data in an N-UNITDATA indication primitive. The destination SCCP should examine the Requested Protocol Class field of the segmentation parameter to determine if sequencing is needed between the reassembled message and any other received message, since the protocol class will always be set to 1 in a segmented XUDT message.

4.1.1.2.3 Return on error procedures

If an error occurs during reassembly, the SCCP can return an extended Unitdata Service (XUDTS) message, containing a "first" segment of user data, if return on error was requested in an XUDT message received as part of the reassembly process. The amount of user data contained in the message is an implementation decision, but it should correspond to the first block or blocks of user data received. In some cases, this will be the first segment transmitted by the segmentation process, in other situations, it will not.

The reassembly function will never change the segment number of the segments to be returned. No specific indication will be given that there is only a "first" segment.

4.2 Message return

The purpose of message return is to discard or return messages which encounter routing failure and cannot be delivered to their final destination. Message return is also used in cases of return on error procedures during connectionless reassembly.

The message return procedure is initiated if SCCP routing is unable to transfer a connectionless message. The procedure may be initiated, for example, as a result of insufficient translation information or the inaccessibility of a subsystem or point code. Specific reasons are enumerated in 2.4.

a) If the message is a *Unitdata* or Extended Unitdata message, and
   - the option field is set to return message on error, then a *Unitdata Service* or Extended Unitdata Service message is transferred to the origination point. (If the message is originated locally, then a N-NOTICE indication primitive is invoked.)
   - the option field is not set to return on error, then the received message is discarded.

b) If the undeliverable message is a *Unitdata Service* or Extended Unitdata Service message, it is discarded.

The "data" field of the *Unitdata* or Extended Unitdata Service message and the reason for return are included in the *Unitdata Service* or Extended Unitdata Service message.

When a *Unitdata Service* or Extended Unitdata Service message is received at the destination node, after possible reassembly, a N-NOTICE indication primitive is invoked.

4.3 Syntax error

When syntax errors are detected (see 3.10.1) for a connectionless message, the message is discarded. Checking for syntax errors beyond the processing required for the SCCP connectionless message routing is not mandatory.

5 SCCP management procedures

5.1 General

The purpose of SCCP management is to provide procedures to maintain network performance by rerouting or throttling traffic in the event of failure or congestion[9] in the network.

Although SCCP management has its own subsystem number, the procedures in this subclause do not apply to it. For the cases where the SCCP management's SSN is used to indicate the availability/unavailability of the SCCP, the applicable procedures are explicitly stated as applying to SSN=1. Subsystem number "1" is assigned to SCCP management, whereas the remaining SSNs are assigned to SCCP users, except SSN=0. The status of SSN=1 is assumed to reflect the status of the entire SCCP at a node.

SCCP management is organized into two subfunctions: signalling point status management and subsystem status management. Signalling point status management and subsystem status management allow SCCP management to use information concerning the accessibility of remote signalling points and subsystems, respectively, to permit the network to adjust to failure, recovery and congestion[9].

SCCP management procedures rely on:

1) failure, recovery, and congestion information provided in the MTP-PAUSE indication, MTP-RESUME indication and MTP-STATUS indication primitives; and
2) subsystem failure, recovery and congestion information received in SCCP management messages[10].

SCCP management information is currently defined to be transferred using SCCP connectionless service with no return on error requested. Formats of these messages appear in Recommendation Q.713.

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[9] Congestion control is for further study.

[10] Further explicit definition of "concerned" subsystems or signalling points would be network/architecture/application dependent.

The information pertaining to both single and replicated nodes or subsystems is used for SCCP management purposes. This allows addresses that are specified in the form of a global title to be translated to different point codes and/or subsystem numbers depending on network or subsystem status.

Replicated nodes or subsystems may relate to their replicates in one of several ways. ("Replicate" is a term meaning one of a set of "multiple copies". A node of subsystem which is not replicated is termed "solitary".)

One mode uses a replicate in a dominant role. Traffic related to a specific SCCP user may be split among several nodes/subsystems. Under normal conditions, each portion of the traffic is routed to a preferred, or "primary", node/subsystem. When the primary node/subsystem is inaccessible, this traffic is routed to a "backup" node/subsystem. When the primary node/subsystem recovers, it reassumes its normal traffic load.

A second mode uses a replicate in a replacement role. Consider two replicates, A and B, which are "alternatives". When A becomes inaccessible, its traffic is routed to B; but when A recovers, the traffic is not moved back to A. It is only when B becomes inaccessible that traffic is shifted back to A. In addition, other modes are possible.

The current SCCP management procedures are designed to manage solitary nodes/subsystems, and replicated nodes/subsystems which operate in a dominant mode and for which any given primary node/subsystem has only one backup (i.e. duplicated nodes/subsystems). Management procedures for nodes/subsystems which operate in a mode other than the dominant mode and which have more than one backup are for further study.

SCCP management procedures utilize the concept of a "concerned" subsystem or signalling point. In this context, a "concerned" entity means an entity with an immediate need to be informed of a particular signalling point/subsystem status change, independently of whether SCCP communication is in progress between the "concerned" entity and the affected entity with the status change[11)].

In some situations, the number of concerned subsystem or signalling points for a given subsystem may be zero. In this case, when the subsystem fails, or becomes unavailable, no broadcast of the subsystem prohibited message is performed. Instead, the response method is used to return the subsystem prohibited message. Similarly, no broadcast of the subsystem allowed message is performed for that given subsystem when it recovers. The response method is again used to return a subsystem allowed message in reply to a subsystem status test.

The signalling point prohibited, signalling point allowed and signalling point congested procedures, specified in 5.2.2, 5.2.3 and 5.2.4 respectively, deal with the accessibility of a signalling point.

The subsystem prohibited and subsystem allowed procedures, detailed in 5.3.2 and 5.3.3 respectively, deal with the accessibility of a subsystem or the SCCP.

An audit procedure to ensure that necessary subsystem management information is always available is specified in the subsystem status test procedure in 5.3.4.

A subsystem may request to go out of service using the coordinated state change control procedure specified in 5.3.5.

Local subsystems are informed of any related subsystem status by the local broadcast procedure specified in 5.3.6.

Concerned signalling points are informed of any related subsystem status by the broadcast procedure specified in 5.3.7.

5.2 Signalling point status management

5.2.1 General

Signalling point status management updates translation and status based on the information of network failure, recovery, or congestion provided by the MTP-PAUSE indication, MTP-RESUME indication, or MTP-STATUS indication primitives. This allows alternative routing to backup signalling points and/or backup subsystems.

[11)] Further explicit definition of "concerned" subsystems or signalling points would be network/architecture/application dependent.

5.2.2 Signalling point prohibited

When SCCP management receives an MTP-PAUSE indication relating to a destination that becomes inaccessible, or an MTP-STATUS indication relating to an SCCP that becomes unavailable, SCCP management performs the following actions.

1) Informs the translation function to update the translation tables.
2) In the case where the SCCP has received an MTP-PAUSE indication, SCCP management marks as "prohibited" the status of the remote signalling point, the remote SCCP and each subsystem at the remote signalling point.

   In the case where the SCCP has received an MTP-STATUS indication relating to an unavailable SCCP, the SCCP marks the status of the SCCP and each SSN for the relevant destination to "prohibited" and initiates a subsystem status test with SSN=1. If the cause in the MTP-STATUS indication indicates "unequipped user", then no subsystem status test is initiated.
3) Discontinues all subsystem status tests (including SSN=1) if an MTP-PAUSE or MTP-STATUS indication is received with a cause of "unequipped SCCP". The SCCP discontinues all subsystem status tests, except for SSN=1, if an MTP-STATUS indication is received with a cause of either "unknown" or "inaccessible".
4) Initiates a local broadcast (see 5.3.6) of "User-out-of-service" information for each subsystem at that destination.
5) Initiates a local broadcast (see 5.3.6) of "signalling point inaccessible" information for that destination if an MTP-PAUSE indication is received.
6) Initiates a local broadcast of "remote SCCP unavailable" if either an MTP-PAUSE indication or an MTP-STATUS indication is received.

5.2.3 Signalling point allowed

When SCCP management receives an MTP-RESUME relating to a destination that becomes accessible, SCCP management:

1) Resets the congestion level of that signalling point if an MTP-RESUME indication is received.
2) Instructs the translation function to update the translation tables.
3) Marks as "allowed" the status of that destination, and the SCCP, if an MTP-RESUME indication is received.
4) Marks as "allowed" the status of the SCCP and all subsystems if a subsystem allowed message is received for SSN=1 or if timer T(stat info) expires.
5) Marks as "allowed" the status of remote subsystems. As a network provider option, the subsystem status can be marked as "prohibited" for a list of selected subsystems. For such subsystems, the subsystem status test procedure is initiated[12]. The application in the international network is for further study.
6) Initiates a local broadcast (see 5.3.6) of "signalling point inaccessible" information for that destination if a MTP-RESUME indication is received.
7) Initiates a local broadcast of "remote SCCP accessible" if either an MTP-RESUME indication or a subsystem status allowed message is received for SSN=1 or if timer T(stat info) expires.

5.2.4 Signalling point congested

When SCCP management receives an MTP-STATUS indication relating to signalling network congestion to a signalling point, SCCP management:

1) updates that signalling point status to reflect the congestion.
2) initiates a local broadcast (see 5.3.6) of "signalling point congested" information for that signalling point.

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[12] This may under certain circumstances be used to solve the problem of message loss when switching back from a backup to a primary node (in case of replicated subsystems in dominant node), where the status of the subsystem in the primary node is still unknown.

5.2.5 Local MTP availability

When SCCP management receives an indication at the end of a MTP Restart, then it

1) resets the congestion level of the signalling points concerned by the restarting MTP;
2) instructs the translation function to update the translation tables, taking into account the accessibility given by the MTP indicating the end of MTP Restart;
3) marks as allowed the status of the SCCP and all subsystems for each accessible point;
4) initiates a local broadcast (see 5.3.6) of "signalling point accessible" information for the signalling points becoming accessible; and
5) initiates a local broadcast of "remote SCCP accessible" for the signalling point becoming accessible.

5.3 Subsystem status management

5.3.1 General

Subsystem status management updates translation and status based on the information of failure, withdrawal, congestion[13)], and recovery of subsystems. This allows alternative routing to backup systems, if appropriate. Local users are informed of the status of their backup subsystems. Subsystem status management procedures are also used to convey the status of the SCCP as a whole.

5.3.2 Subsystem prohibited

A subsystem prohibited message with SSN=1 is not allowed.

5.3.2.1 Receipt of messages for a prohibited subsystem (response method)

If SCCP routing control receives a message, whether originated locally or not, for a prohibited local system, SCCP routing control invokes subsystem prohibited control. A *Subsystem-Prohibited* message is sent to the signalling point identified by the OPC in the MTP-TRANSFER indication primitive, and the MTP network identity is for further study if the originating subsystem is not local. The action, if any, to be taken, if the originating subsystem is local, is for further study.

5.3.2.2 Receipt of Subsystem-Prohibited message or N-STATE request primitive or local user failed

Under one of the following conditions:

a) SCCP management receives a *Subsystem-Prohibited* message about a subsystem marked allowed, or
b) an N-STATE request primitive with "User-out-of-service" information is invoked by a subsystem marked allowed, or
c) SCCP management detects that a local subsystem has failed,

then SCCP management does the following:

1) instructs the translation function to update the translation tables;
2) marks as "prohibited" the status of that subsystem;
3) initiates a local broadcast (see 5.3.6) of "User-out-of-service" information for the prohibited subsystem;
4) initiates the subsystem status test procedure (see 5.3.4) if the prohibited subsystem is not local;
5) forwards the information throughout the network by initiating a broadcast (see 5.3.7) of *Subsystem-Prohibited* messages to concerned signalling points;
6) cancels "ignore subsystem status test" and the associated timer if they are in progress and if the newly prohibited subsystem resides at the local node.

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13) Subsystem congestion control is for further study.

5.3.3 Subsystem allowed

Under one of the following conditions:

a) SCCP management receives a *Subsystem-Allowed* message about a subsystem other than SSN=1, marked prohibited, or

b) an N-STATE request primitive with "User-in-Service" information is invoked by a subsystem marked prohibited,

then SCCP management does the following:

1) marks the translation as appropriate:

   – "translate to primary subsystem" if that subsystem is duplicated and the primary subsystem is allowed;

   – "translate to backup subsystem" if that subsystem is duplicated and the primary subsystem is prohibited.

2) marks as "allowed" the status of that subsystem.

3) initiates as a local broadcast (see 5.3.6) of "User-in-service" information for the allowed subsystem;

4) discontinues the subsystem status test relating to that subsystem if such a test was in progress;

5) forwards the information throughout the network by initiating a broadcast (see 5.3.7) of *Subsystem-Allowed* messages to concerned signalling points.

5.3.4 Subsystem status test

5.3.4.1 General

The subsystem status test procedure is an audit procedure to verify the status of a SCCP or subsystem marked prohibited.

5.3.4.2 Actions at the initiating node

a) A subsystem test is initiated when a *Subsystem-Prohibited* message is received (see 5.3.2.2).

   A subsystem status test associated with a prohibited subsystem is commenced by starting a timer (stat.info) and marking a test in progress. No further actions are taken until the timer expires.

   Upon expiration of the timer, a *Subsystem-Status-Test* message is sent to SCCP management at the node of the prohibited subsystem and the timer is reset.

   The cycle continues until the test is terminated by another SCCP management function at that node. Termination of the test causes the timer and the "test progress mark" to be cancelled.

b) A subsystem status test for SSN=1 is initiated when an MTP-STATUS indication primitive is received with "remote user inaccessibility" or "unknown" information for the SCCP at a remote signalling point.

   After sending an SST(SSN=1), the node should receive either an SSA(SSN=1) from the restarting node or it should receive an MTP-STATUS indication stating User Part Unavailable. In the case where the SST receiving node has the User Part availability control and its SCCP has not yet recovered, it should send a User Part Unavailable (UPU) message to the SST sending node. If neither an SSA(SSN=1) nor an UPU is received by the SST sending node during the duration of the T(stat info) timer, then the node should assume that the previously unavailable (SCCP) has recovered. This ensures backward compatibility with *Blue Book* nodes. If the MTP-STATUS indication stating User Part Unavailable is received before timer T(stat info) expires, then an SST(SSN=1) is sent to the unavailable node when timer T(stat info) expires.

5.3.4.3 Actions at the receiving node

When SCCP management receives a *Subsystem-Status-Test* message and there is no "ignore subsystem status test" in progress, it checks the status of the named subsystem. If the subsystem is allowed, a *Subsystem-Allowed* message is sent to the SCCP management at the node conducting the test. If the subsystem is prohibited, no reply is sent.

In the case where the Subsystem-Status-Test message is testing the status of SCCP management (SSN=1), if the SCCP at the destination node is functioning, then a Subsystem Allowed message with SSN=1 is sent to SCCP management at the node conducting the test. If the SCCP is not functioning, then the MTP cannot deliver the SST message to the SCCP. A UPU message is returned to the SST initiating node by the MTP.

As soon as its SCCP has recovered, the restarting SCCP should broadcast a Subsystem Allowed message for SSN=1 to all concerned nodes. The restarting SCCP should set the status to "allowed" for the SCCP and all subsystems of remote signalling points that it considers available, based on the MTP information at the node.

5.3.5 Coordinated state change

5.3.5.1 General

A duplicated subsystem may be withdrawn from service without degrading the performance of the network by using the coordinated state change procedure described below when its backup is not local. The procedure, if any, to be specified in case the primary and the backup subsystems are co-located, is for further study.

5.3.5.2 Actions at the requesting node

When a duplicated subsystem wishes to go out of service, it invokes an N-COORD request primitive. SCCP management at that node sends a *Subsystem-Out-of-Service-Request* message to the backup system, sets a timer (coord.chg) and marks the subsystem as "waiting for grant".

Arrival of a *Subsystem-Out-of-Service-Grant* message at the requesting SCCP management causes the timer (coord.chg) to be cancelled, the "waiting for grant" state to be cancelled, and a N-COORD confirmation primitive to be invoked to the requesting subsystem. *Subsystem-Prohibited* messages are broadcast (see 5.3.7) to concerned signalling points.

In addition, an "ignore subsystem status test" timer is started and the requesting subsystem is marked as "ignore subsystem status test". Subsystem status tests are ignored until the "ignore subsystem status test" timer expires or the marked subsystem invokes an N-STATE REQUEST primitive with "User-out-of-service" information.

If no "waiting for grant" is associated with the subsystem named in the *Subsystem-Out-of-Service-Grant* message, the *Subsystem-Out-of-Service-Grant* message is discarded and no further action is taken.

If the timer associated with the subsystem waiting for the grant expires before a *Subsystem-Out-of-Service-Grant* message is received, the "waiting for grant" is cancelled and the request is implicitly denied.

5.3.5.3 Actions at the requested node

When the SCCP management at the node at which the backup subsystem is located receives the *Subsystem-Out-of-Service-Request* message, it checks the status of local resources[14] . If the SCCP has sufficient resources to assume the increased load, it invokes an N-COORD indication primitive to the backup subsystem. If the SCCP does not have sufficient resources, no further action is taken[15].

If the backup system has sufficient resources to allow its mate to go out of service, it informs SCCP management by invoking an N-COORD response primitive. A *Subsystem-Out-of-Service-Grant* message is sent to SCCP management at the requesting node. If the backup subsystem does not have sufficient resources, no reply is returned[16].

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[14] Local resources are whatever is critical to this particular node, and are implementation dependent.

[15] The possibility of introducing an explicit Subsystem-Out-of-Service-Denial message containing additional information and associated primitive is for further study.

[16] The possibility of introducing an explicit Subsystem-Out-of-Service-Denial message containing additional information and associated primitive is for further study.

5.3.6 Local broadcast

5.3.6.1 General

The local broadcast procedure provides a mechanism to inform local allowed concerned subsystems of any related SCCP/subsystem/signalling point status information received.

5.3.6.2 User-out-of-service

A local broadcast of "User-out-of-service" information is initiated when:

a) a *Subsystem-Prohibited* message is received about a subsystem marked allowed (see 5.3.2.2); or

b) an N-STATE request primitive with "User-out-of-service" information is invoked by a subsystem marked allowed (see 5.3.2.2)[17]; or

c) a local subsystem failure is detected by SCCP management (see 5.3.2.2)[17],

d) an MTP-PAUSE indication primitive is received (see 5.2.2).

e) an MTP-STATUS indication primitive with cause "inaccessible" is received (see 5.2.2).

SCCP management then informs local allowed concerned SCCP subsystems about the subsystem status by invoking N-STATE indication primitive with "User-out-of-service" information.

5.3.6.3 User-in-service

A local broadcast of "subsystem-in-service" information is initiated when:

a) a *Subsystem-Allowed* message is received about a subsystem marked prohibited (see 5.3.3); or

b) an N-STATE request primitive with "User-in-service" information is invoked by a subsystem marked prohibited (see 5.3.3);

c) an MTP-RESUME indication primitive is received (see 5.2.3);

d) a Subsystem-Allowed message is received with SSN=1; about a remote SCCP marked prohibited (see 5.2.3);

e) timer T(stat info) expires, or; (see 5.2.3);

f) an indication of the end of MTP Restart is received.

SCCP management then informs local allowed concerned SCCP subsystems, except the newly allowed one in case d) above, about the subsystem status by invoking an N-STATE indication primitive with "User-in-service" information.

5.3.6.4 Signalling point inaccessible

A local broadcast of "signalling point inaccessible" or "remote SCCP inaccessible" information is initiated when an MTP-PAUSE primitive or MTP-STATUS primitive (with "user part unavailable" information for a SCCP) is received. SCCP management then informs local allowed concerned SCCP subsystems about the signalling point status by invoking an N-PCSTATE indication primitive with "signalling point accessible" or "remote SCCP inaccessible" information.

5.3.6.5 Signalling point remote SCCP accessible

A local broadcast of "signalling point accessible" or "remote SCCP accessible" information is initiated when an MTP-RESUME primitive, an SSA(with SSN=1) message or an indication of the end of the MTP restart is received or when timer T(stat info) expires. SCCP management then informs local allowed concerned SCCP subsystems about the signalling point status by invoking an N-PCSTATE indication primitive with "signalling point accessible" or "SCCP accessible" information.

5.3.6.6 Signalling point congested

A local broadcast of "signalling point congested" information is initiated when an MTP-STATUS primitive is received. SCCP management then informs local allowed concerned SCCP subsystems about the signalling point status by invoking an N-PCSTATE indication primitive with "signalling point congested (level)" information.

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[17] These cases are applicable when the SCCP is used for routing between local subsystems. This function is implementation dependent.

5.3.7 Broadcast

5.3.7.1 General

The broadcast procedure provides a mechanism that may be used to inform concerned signalling points of any related SCCP/subsystem status change at local or adjacent signalling points. It is an optional procedure supplementary to that defined in 5.3.2.1. This procedure is suggested not to be used on a signalling point restart. This matter is for further study.

In some circumstances, the number of concerned signalling points is zero and no broadcast is performed. The action taken in this case is described in 5.1.

5.3.7.2 Subsystem prohibited

A broadcast of *Subsystem-Prohibited* messages is initiated when:

a) a *Subsystem Prohibited* message is received about a subsystem presently marked allowed (see 5.3.2.2), and the affected point code identified in the SSP message is the same as that of the informer signalling point; or

b) an N-STATE request primitive with "User-out-of-service" information is invoked by a subsystem marked allowed (see 5.3.2.2); or

c) a local subsystem failure is detected by SCCP management (see 5.3.2.2); or

d) a *Subsystem-Out-of-Service-Grant* message arrives for a subsystem marked "waiting for grant" (see 5.3.5.2).

This broadcast permits SCCP management to inform all concerned signalling points, except the informer signalling point, about the subsystem status by *Subsystem-Prohibited* messages. SCCP management does not broadcast if the point code of the prohibited subsystem is different from that of the informer signalling point which originates the *Subsystem-Prohibited* message.

5.3.7.3 Subsystem allowed

A broadcast of *Subsystem-Allowed* messages is initiated when:

a) a *Subsystem-Allowed* message is received about a subsystem presently marked prohibited and not equal to one (see 5.3.3), and the affected point code identified in the SSA message is the same as that of the informer signalling point; or

b) an N-STATE request primitive with "User-in-service" information is invoked by a subsystem marked prohibited (see 5.3.3).

At the end of the SCCP restarting process, the restarting SCCP should broadcast a Subsystem Allowed message for SSN=1 to all concerned nodes. The restarting SCCP should set the status to "allowed" for the SCCP and all subsystems of the remote signalling points that it considers available based on MTP information at the node.

Broadcast of Subsystem Allowed messages permits SCCP management to inform all concerned signalling points, except the informer signalling point, about the subsystem status by *Subsystem-Allowed* messages. SCCP management does not broadcast if the point code of the allowed subsystem is different from that of the informer signalling point which originates the *Subsystem-Allowed* message.

5.4 MTP/SCMG restart

On a signalling restart, an indication is given to the SCCP by the MTP about the signalling points which are accessible after the restart actions. For each accessible, concerned signalling point, all subsystems and the SCCP are marked allowed. The response method is used to determine the status of the SCCP and the SCCP subsystems in those signalling points in the absence of the receipt of subsystem allowed, and subsystem prohibited messages, which may have been broadcast from them.

At the restarted signalling point, the status of its own subsystems are not broadcast to concerned signalling points. In this case, the response method is used to inform other nodes attempting to access prohibited subsystems at the restarted signalling points. At the completion of SCCP restart, the status of the SCCP is broadcast to concerned signalling points. The actions to be taken in case of a local MTP restart are described in 5.2.5.

Annex A

State diagrams for the signalling connection control part of Signalling System No. 7

(This annex forms an integral part of this Recommendation)

A.1 Introduction

This annex contains the definitions for the symbols used and defines the states of the signalling point X/Y interface and the transitions between states in the normal case.

Annex B contains the full definition of actions, if any, to be taken on the receipt of messages by a signalling point.

A.2 Symbol definition of the state diagrams at the message interface between two nodes (signalling points: X and Y) (see Figures A.1 and A.2)

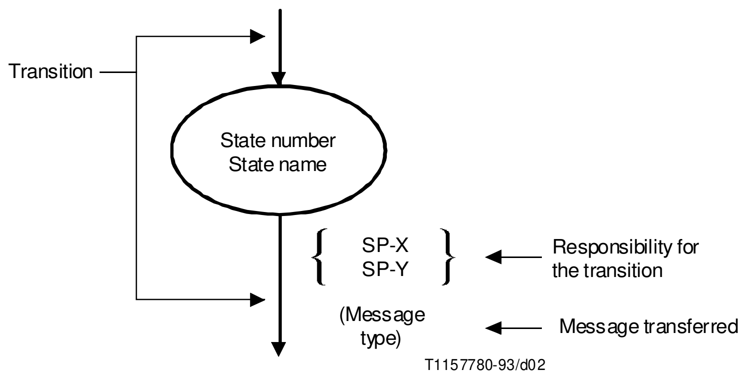
A.3 Order definition of the state diagrams

For the sake of clarity, the normal procedure at the interface is described in a number of small state diagrams. In order to describe the normal procedure fully, it is necessary to allocate a priority to the different figures and to relate a higher order diagram with a lower one. This has been done by the following means:

– Figures A.3, A.4, A.5 and A.6 are arranged in order of priority, with Figure A.3 having the highest priority and subsequent figures having lower priority. Priority means that when a message belonging to a higher order diagram is transferred, that diagram is applicable and the lower order one is not.

– The relation with a state in a lower order diagram is given by including that state inside an ellipse in the higher order diagram.

– The message abbreviations are those defined in Recommendation Q.712.



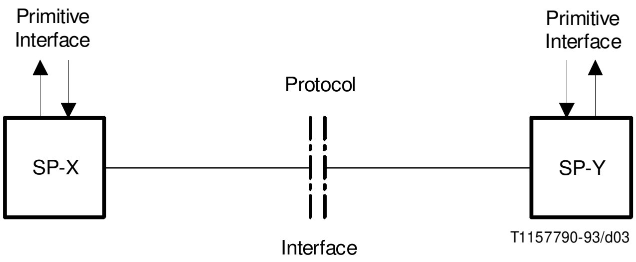
NOTES

1 Each state is represented by an ellipse wherein the state name and number are indicated.

2 Each state transition is represented by an arrow. The responsibility for the transition (SP-X or SP-Y) and the message that has been transferred is indicated beside that arrow.

FIGURE A.1/Q.714

Symbol definition of the state diagram



NOTE – SP-X and SP-Y are the signalling points X and Y denoting respectively the origin and destination of the connection section concerned.

FIGURE A.2/Q.714

Primitive and protocol interfaces

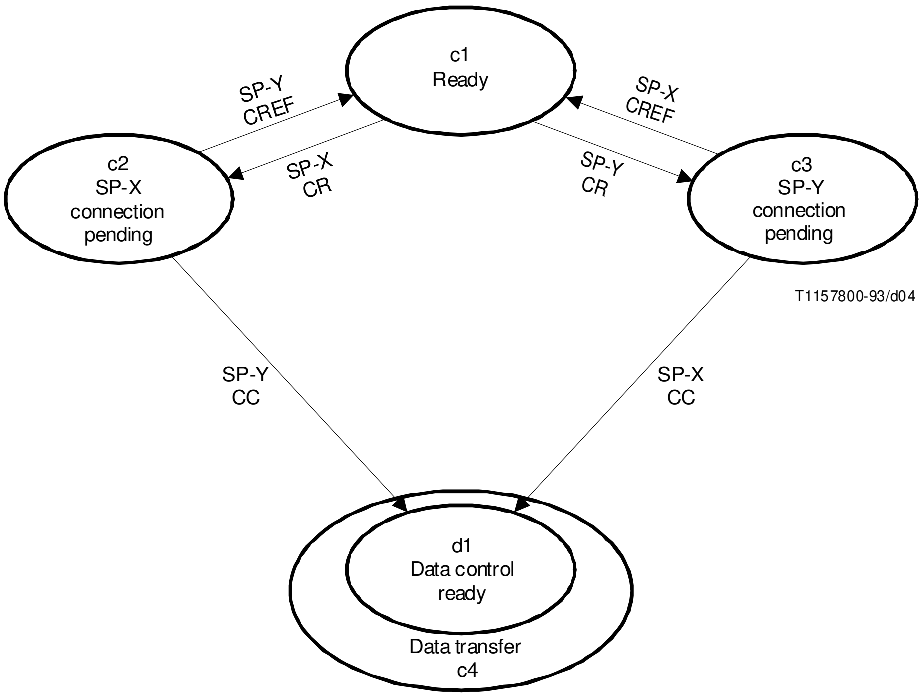
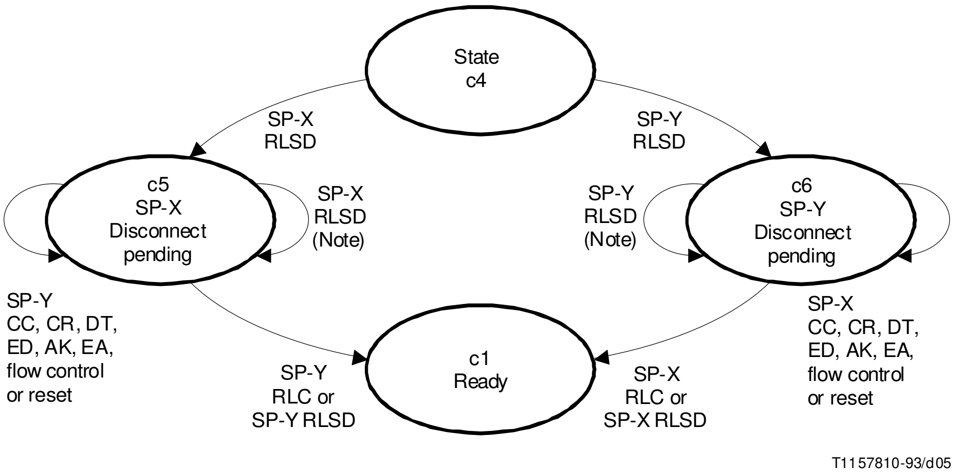


FIGURE A.3/Q.714

State transition diagram for sequences of messages during connection establishment



NOTE – This transition may take place after time-out.

FIGURE A.4/Q.714

State transition diagram for sequences of messages during connection release

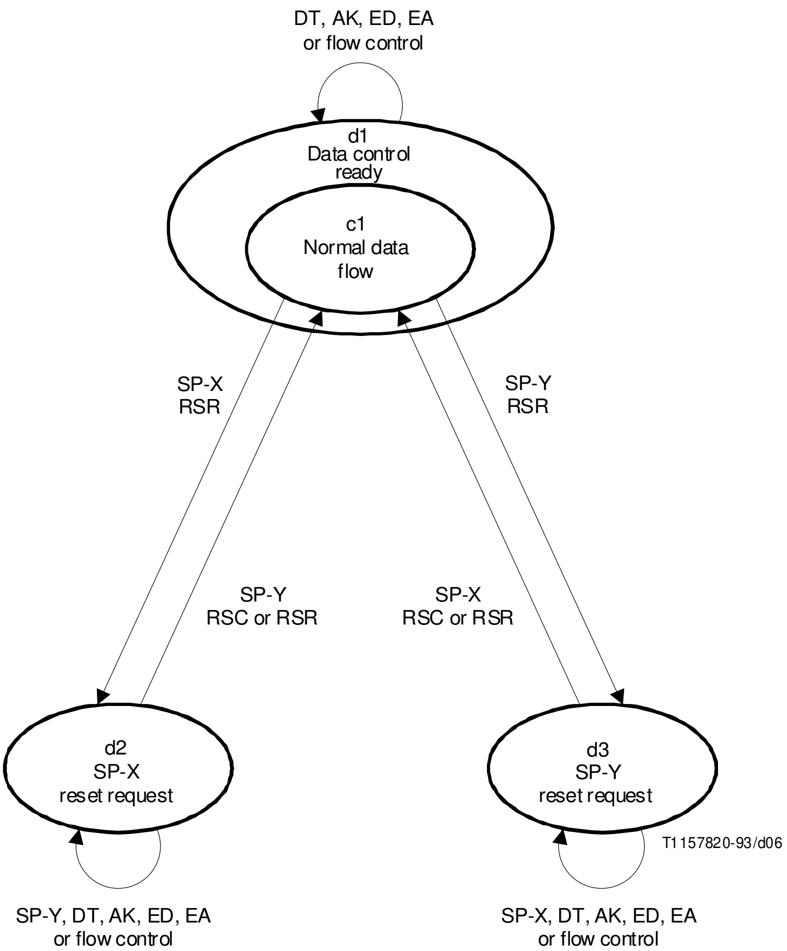


FIGURE A.5/Q.714

State transition diagram for the transfer of reset messages within the data transfer (c4) state

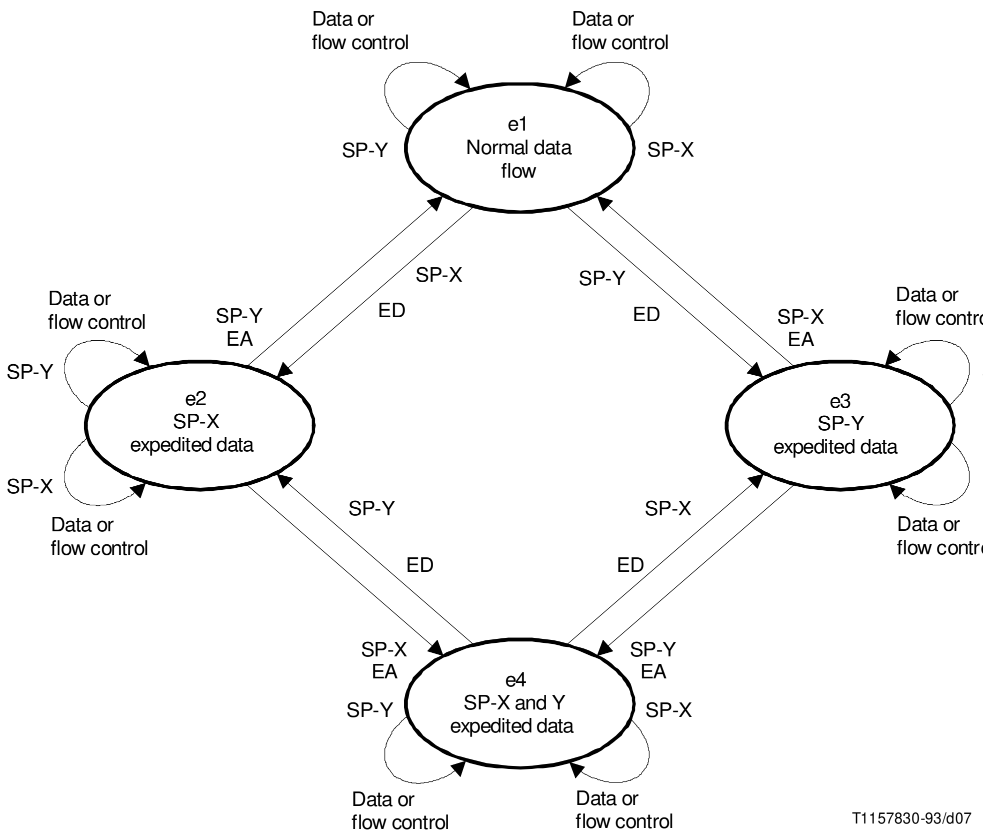


FIGURE A.6/Q.714

State transition diagram for the transfer of data, expedited data and flow control within the data transfer (c4) state

Annex B

Action tables for the signalling connection control part of Signalling System No. 7

(This annex forms an integral part of this Recommendation)

B.1 Introduction

This annex contains the definitions for the symbols used and contains the full definition of actions, if any, to be taken on the receipt of messages by a signalling point (node).

Annex A contains the full definition of states of the signalling point X/Y interface and the transitions between states in the normal case.

B.2 Symbol definition of the action tables

The entries given in Tables B.1 and B.2 indicate the action, if any, to be taken by a SP on receipt of any kind of message, and the state the SP enters, which is given in paretheses, following the action taken.

In any state it is possible to receive an Error message (ERR). The reaction, if any, depends on the contents (error cause and possible diagnostics) of the message and is specified in 3.10.3.

The reaction on messages received with procedure errors (e.g. too long, invalid P(R), not octet aligned, etc.) are normal actions and will be described in the Recommendation. So they are covered by the actions indicated as NORMAL.

B.3 Table of contents

TABLE B.1/Q.714

Action taken by SP-Y on receipt of messages

Message received by node SP-Y	State of the interface as perceived by node SP-Y
	Any state
Any message with unknown message type (Note)	DISCARD
Any message with known message type and: a) unassigned destination local reference number, or b) Originating Point Code received not equal to the PC stored locally, or c) source local reference number received not equal to the remote local reference number stored locally	See Table B.2
Any other message	See Table B.3

DISCARD: SP-Y discards the received message and takes no subsequent action.

NOTE – This notion of unknown message type depends upon the protocol class.

TABLE B.2/Q.714

Action taken by SP-Y on receipt of messages with known message type and containing mismatch information as in Table B.1 in any state

Message received by node SP-Y	Type of mismatch information		
	Unassigned destination local reference number	Source local reference number received not equal to the one stored locally	Originating Point Code received not equal to the PC stored locally (Note 1)
CR (X)	N.A.	N.A.	N.A.
CC (Y, X)	Send ERR (X) (Note 2)	N.A.	N.A.
CREF (Y)	DISCARD	N.A.	N.A.
RLSD (Y, X)	Send RLC (X, Y) (Note 2)	Send ERR (X) (Note 2)	Send ERR (X) (Note 2)
RLC (Y, X)	DISCARD	DISCARD	DISCARD
DT1 (Y)	DISCARD	N.A.	C.O.N.P.
DT2 (Y)	DISCARD	N.A.	C.O.N.P.
AK (Y)	DISCARD	N.A.	C.O.N.P.
ED (Y)	DISCARD	N.A.	C.O.N.P.
EA (Y)	DISCARD	N.A.	C.O.N.P.
RSR (Y, X)	Send ERR (X) (Note 2)	Send ERR (X) (Note 2)	Send ERR (X) (Note 2)
RSC (Y, X)	Send ERR (X) (Note 2)	Send ERR (X) (Note 2)	Send ERR (X) (Note 2)
ERR (Y)	For further study	For further study	For further study
IT (Y, X)	DISCARD	(Note 3) RELEASE	C.O.N.P.

DISCARD: SP-Y discards the received message and takes no subsequent action.

C.O.N.P. Check Optionally Not Performed.

N.A. Not applicable

NAME (d, s): NAME = abbreviation of message
d = destination local reference number
s = source local reference number.

NOTES

1 Performing this check is a national option.

2 In this situation no action is taken locally on any existing connection section. Information in any message sent back is taken from the received message.

3 One released message contains information from received message. Second released message contains information stored locally.

TABLE B.3/Q.714

Action taken by SP-Y on receipt of messages during connection establishment and release phases

Message received by node SP-Y	State of the interface as perceived by node SP-Y					
	Signalling connection control ready: r1					
	Ready (c1)	SP-X connection pending (c2)	SP-Y connection pending (c3)	Data transfer (c4)	SP-X disconnect pending (c5)	SP-Y disconnect pending (c6)
Connection request (CR)	NORMAL (c2)	(Note)				
Connection confirm (CC)		DISCARD (c2)	NORMAL (c4)	DISCARD (c4)	ERROR 1 (c6)	DISCARD (c6)
Connection refused (CREF)		DISCARD (c2)	NORMAL (c1)	DISCARD (c4)	ERROR 1 (c6)	DISCARD (c6)
Released (RLSD)	See Table B.2	DISCARD (c2)	ERROR 2 (c3)	NORMAL (c5)	DISCARD (c5)	NORMAL (c1)
Released complete (RLC)		DISCARD (c2)	ERROR 3 (c1)	DISCARD (c4)	ERROR 1 (c6)	NORMAL (c1)
Other messages		DISCARD (c2)	ERROR 3 (c1)	See Table B.4	ERROR 1 (c6)	DISCARD (c6)

NORMAL: The action taken by SP-Y follows the normal procedures as defined in the appropriate clauses of the procedure text.

DISCARD: SP-Y discards the received message and takes no subsequent action.

ERROR 1: SP-Y discards the received message and initiates a connection release by sending a RLSD message with proper invalid type cause.

ERROR 2: SP-Y returns a Released complete message using information contained in the message and takes no subsequent action.

ERROR 3: SP-Y discards the received message and releases locally.

NOTE – Reception of CR in these states is not possible because CR does not contain a destination local reference number (no search is performed).

TABLE B.4/Q.714

Action taken by node SP-Y as receipt of messages during the data transfer state

Message received by node SP-Y	State of the interface as perceived by node SP-Y		
	Data transfer: c4		
	Data control ready (d1)	SP-X reset request (d2)	SP-Y reset request (d3)
Reset request (RSR) (see Note 2)	NORMAL (d2)	DISCARD (d2)	NORMAL (d1)
Reset confirmation (RSC) (see Note 2)	ERROR (d3)	ERROR (d3)	NORMAL (d1)
Other messages	See Table B.5	ERROR (d3) (Note 1)	DISCARD (d3)

NORMAL The action taken by SP-Y follows the normal procedures as defined in the appropriate clauses of the procedure text.

DISCARD Signalling point Y discards the received message and takes no subsequent action.

ERROR Signalling point Y discards the received message and initiates a reset by transmitting a reset request message with the appropriate cause indication.

NOTES

1 If signalling point Y issues a reset by transmitting a reset request message as a result of an error condition in state d2, it should eventually consider the interface to be in the Data control ready state (d1).

2 Reception of these messages for a class 2 connection section may trigger the sending of an ERR message back if these message types are known by the receiving SCCP.

TABLE B.5/Q.714

Action taken by SP-Y on receipt of messages during the data control ready state

Message received by node SP-Y	State of interface as perceived by node SP-Y			
	Data control ready: d1			
	Normal data flow (e1)	SP-X espedited data (e2)	SP-Y expedited data (e3)	SP-X and SP-Y expedited data (e4)
Expedited data (ED)	NORMAL (d2)	ERROR (d3)	NORMAL (d4)	ERROR (d3)
Expedited data (EA) acknowledgement	DISCARD (e1)	DISCARD (e2)	NORMAL (e1)	NORMAL (e2)
Data (DT), data acknowledgement (AK) and Inactivity Test (IT)	NORMAL (e1)	NORMAL (e2)	NORMAL (e3)	(NORMAL (e4)

NORMAL The action taken by signalling point Y follows the normal procedures as defined in the appropriate clauses of the procedure text.

DISCARD Signalling point Y discards the received message and takes no subsequent action as direct result of receiving that message.

ERROR Signalling point Y discards the received message packet and indicates a reset by transmitting a reset request message with the appropriate cause indication (e.g. procedure error).

NOTE – Reception of an ED, EA, DT_2 or AK message for a class 2 connection section will cause the receiving SCCP to DISCARD any of these messages. A DT_1 message received for a class 3 connection section will also be discarded.

Annex C

State transition diagrams (STD) for the signalling connection control part of Signalling System No. 7

(This annex forms an integral part of this Recommendation)

C.1 General

This annex contains the description of the main SCCP functions (except SCCP management (SCMG)) which is contained in Annex D according to the CCITT Specification and Description Language (SDL).

For the SCCP as a whole, Figure 1 illustrates a subdivision into functional blocks, showing their functional interactions as well as the functional interactions with the other major functions of Signalling System No. 7 (e.g. MTP).

The functional breakdown shown in this diagram is intended to illustrate a reference model, and to assist interpretation of the text of the SCCP procedures. 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.

C.2 Drafting conventions

Each major function is designated by its acronym (e.g. SCOC = SCCP connection-oriented control).

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 functional blocks which are the source and the destination of the message, e.g.:

SCRC → SCOC indicates that the message is sent from SCCP routing control to SSCP connection-oriented control

Internal inputs and outputs are only used to indicate control of timers.

C.3 Figures

The list of figures is as follows[18)]

Figure C.1 SCCP routing control procedures (SCRC).

Figure C.2 Connection establishment and release procedures at originating node for SCCP connection-oriented control (SCOC).

(Sheets 1 to 3: connection establishment, and sheets 4 to 6: connection release procedures)

Figure C.3 Connection establishment and release procedures at destination node for SCCP connection-oriented control (SCOC).

(Sheets 1 to 2: connection establishment, and sheets 3 to 5: connection release procedures)

Figure C.4 Data transfer procedures at originating and destination nodes for SCCP connection-oriented control (SCOC).

Figure C.5 Expedited data transfer procedures at originating and destination nodes for SCCP connection-oriented control (SCOC).

Figure C.6 Reset procedures at originating and destination nodes for SCCP connection-oriented control (SCOC).

Figure C.7 Connection establishment and release procedures at intermediate node for SCCP connection-oriented control (SCOC).

(Sheets 1 to 4: connection establishment, and sheets 5 to 9: connection release procedures)

Figure C.8 Data transfer procedures at intermediate node for SCCP connection-oriented control (SCOC).

[18)] Figures for segmentation in connectionless SCCP are for further study.

Figure C.9 Expedited data transfer procedures at intermediate node for SCCP connection-oriented control (SCOC).

Figure C.10 Reset procedures at intermediate node for SCCP connection-oriented control (SCOC).

Figure C.11 Restart procedure for SCCP connection-oriented control (SCOC).

Figure C.12 SCCP connectionless control (SCLC).

C.4 Abbreviations and timers

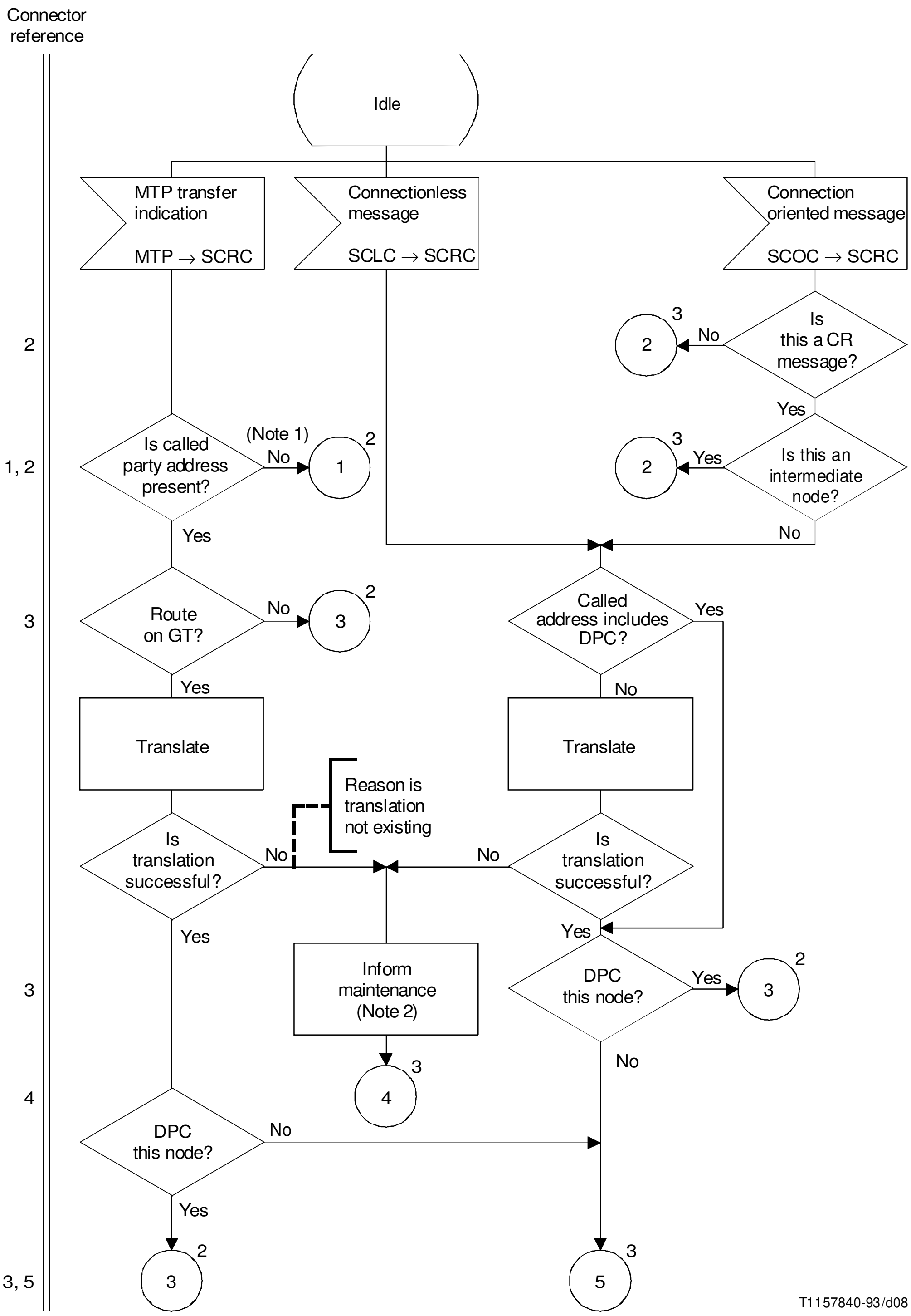
Abbreviations and timers used in Figures C.1 to C.11 are listed below.

Abbreviations:

CR	Connection Request
DPC	Destination Point Code
GT	Global Title
IT	Inactivity Test
MSG	Message
MTP	Message transfer Part
NPDU	Network Protocol Data Unit
NSDU	Network Service Data Unit
PC	Point Code
SCCP	Signalling Connection Control Part
SCLC	SCCP Connectionless Control
SCMG	SCCP Management
SCOC	SCCP Connection-Oriented Control
SCRC	SCCP Routing Control
SLS	Signalling Link Selection
SS	Sub-system
SSN	Sub-System Number
SSPC	Sub-System Prohibited Control

Timers:

T(conn est):	1 to 2 minutes
T(ias):	1 to 2 minutes} provisional values
T(iar):	3 to 6 minutes} provisional values
T(rel):	10 to 20 seconds
T(guard):	8 to 16 minutes} provisional value
T(reset):	10 to 20 seconds
T(reassembly):	10 to 20 seconds
T(stat info):	increasing value, starting from 5 to 10 seconds to a maximum of 10 to 20 minutes
T(coord chg):	1 to 2 minutes
T(ignore SST):	selected by management
T(interval):	extending to 1 minute
T(repeat rel):	extending to 20 seconds



NOTES

1 This will always be a connection oriented message excluding a CR message.

2 Maintenance functions are for further study.

FIGURE C.1/Q.714 (sheet 1 of 3)

SCCP routing control procedures (SCRC)

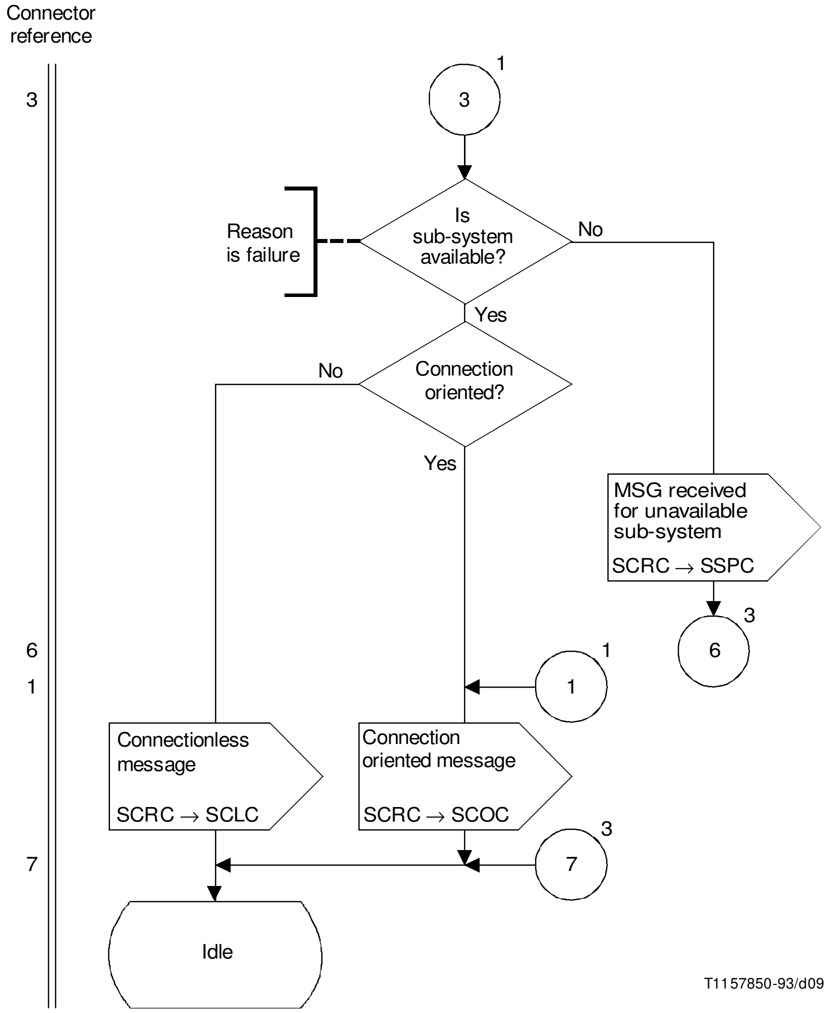
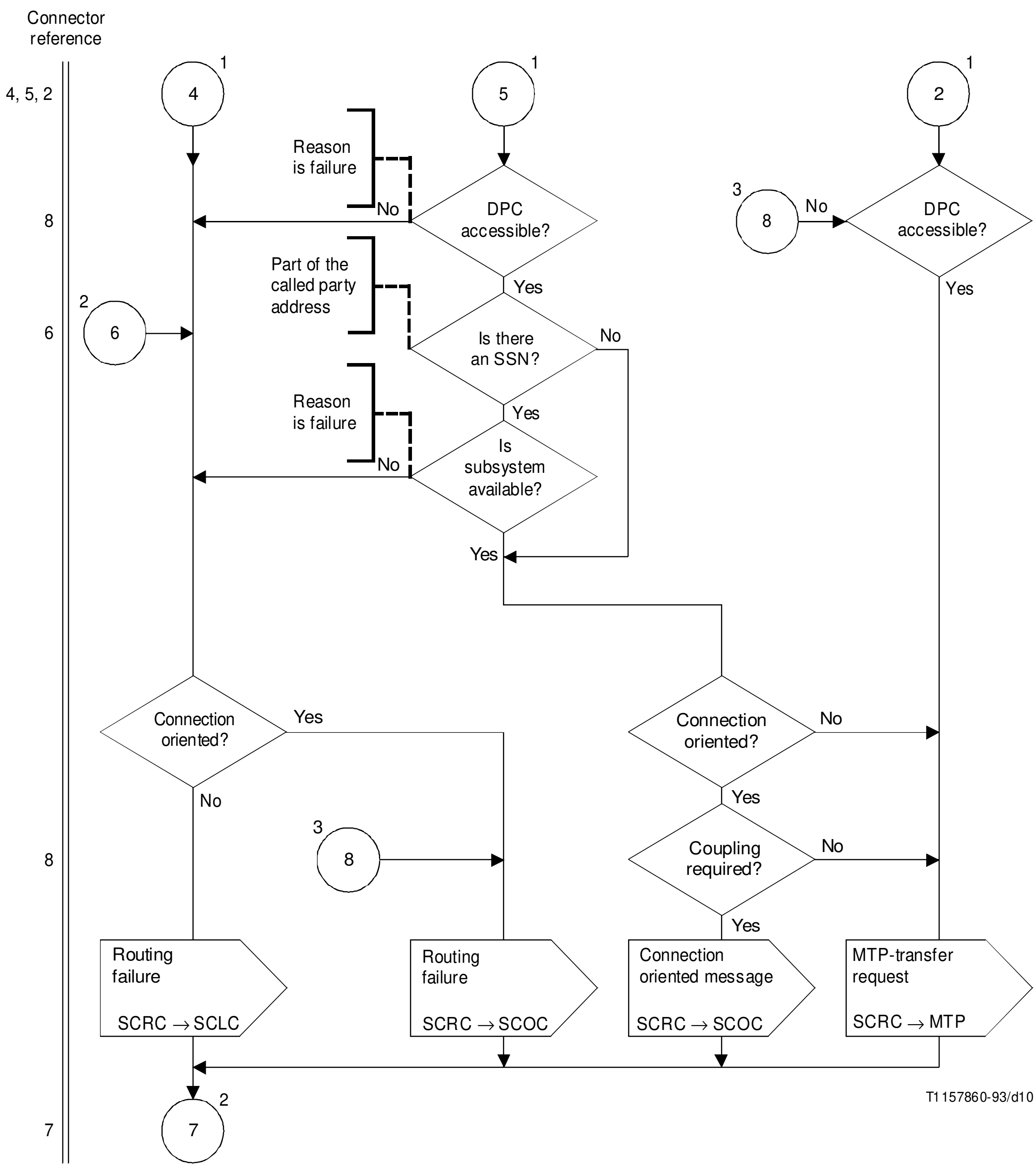


FIGURE C.1/Q.714 (sheet 2 of 3)

SCCP routing control procedures (SCRC)



NOTE – Actions for a DPC congested are for further study.

FIGURE C.1/Q.714 (sheet 3 of 3)

SCCP routing control procedures (SCRC)

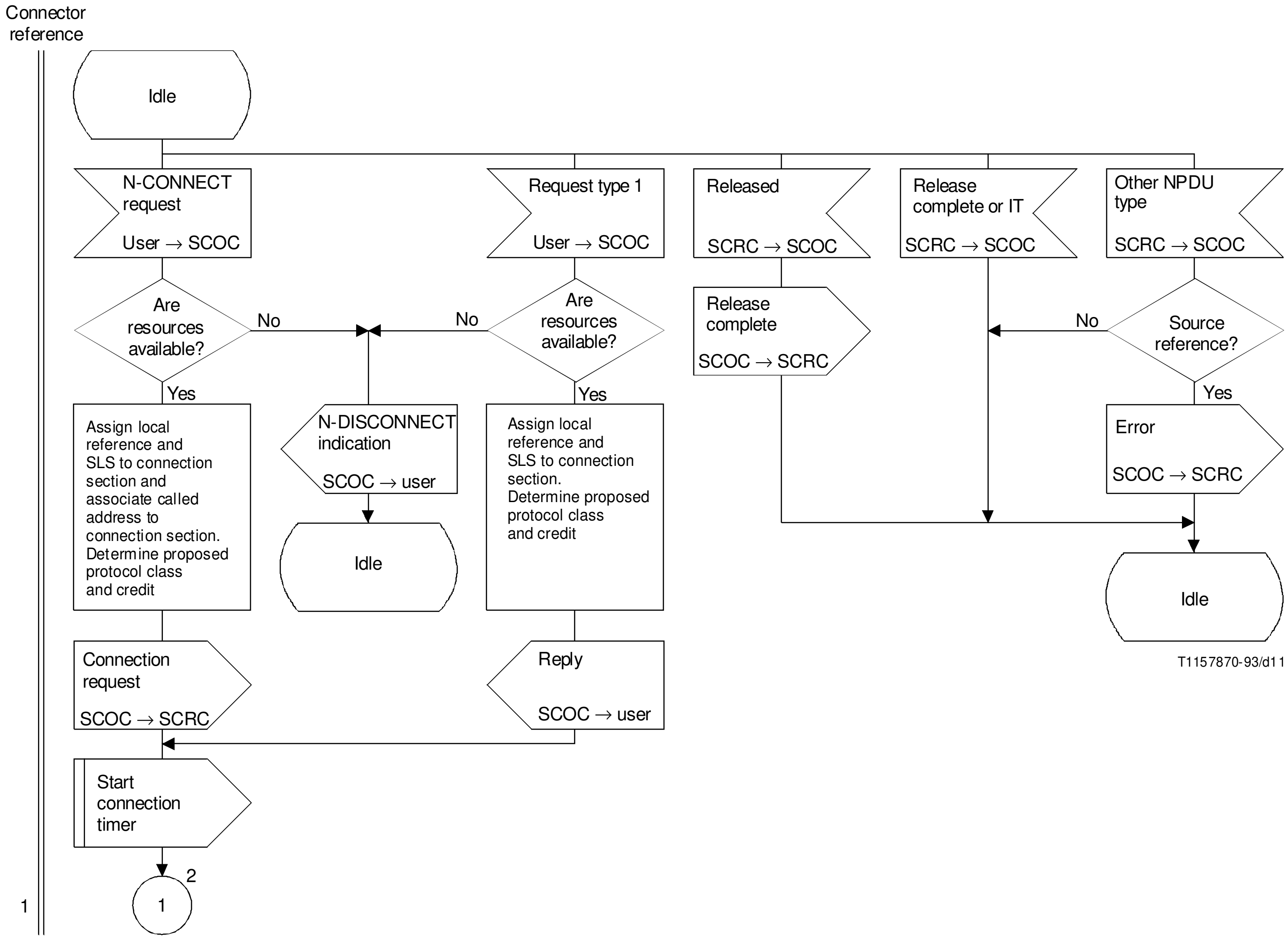


FIGURE C.2/Q.714 (sheet 1 of 6)

Connection establishment procedures at originating node for SCCP connection-oriented control (SCOC)

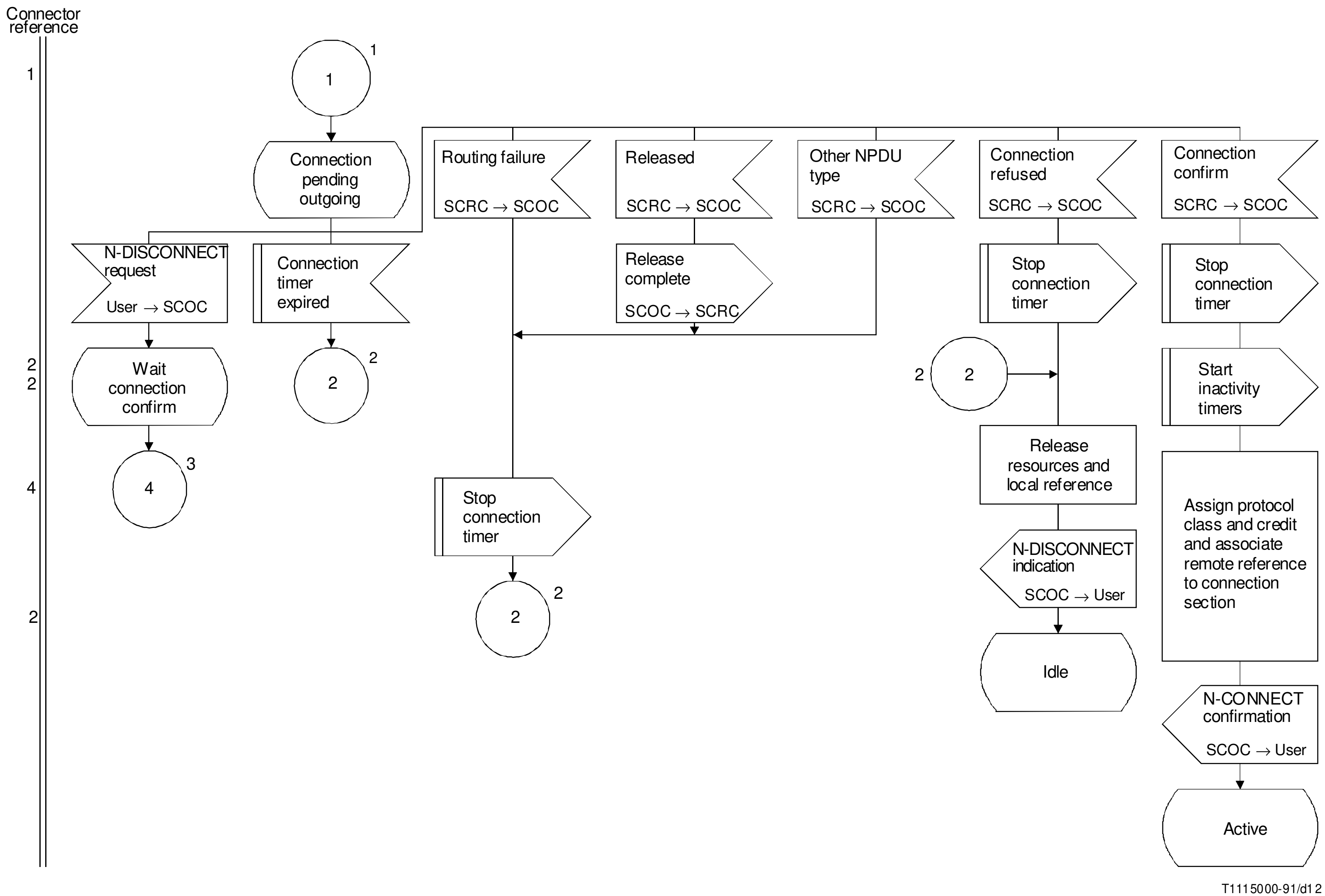
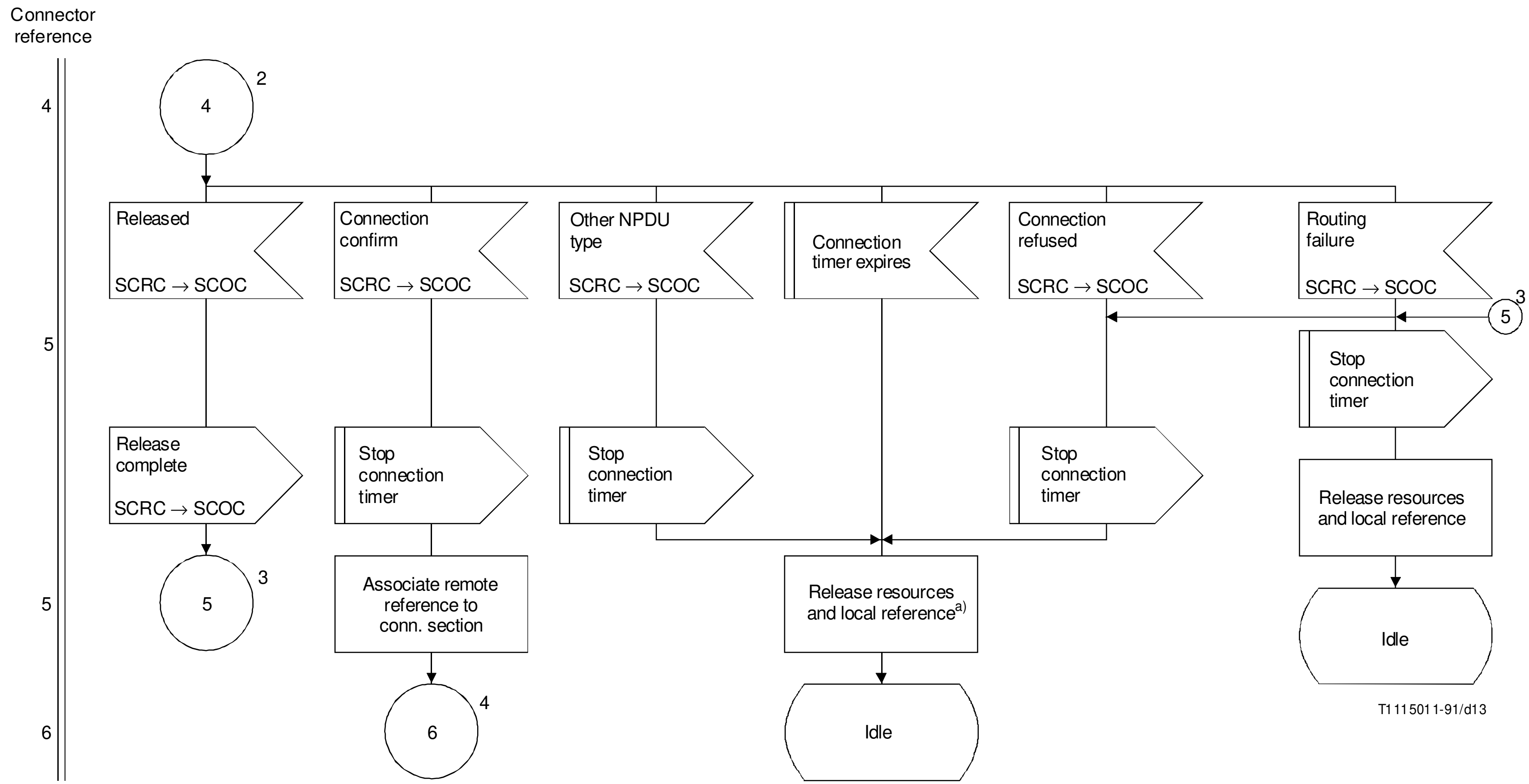


FIGURE C.2/Q.714 (sheet 2 of 6)

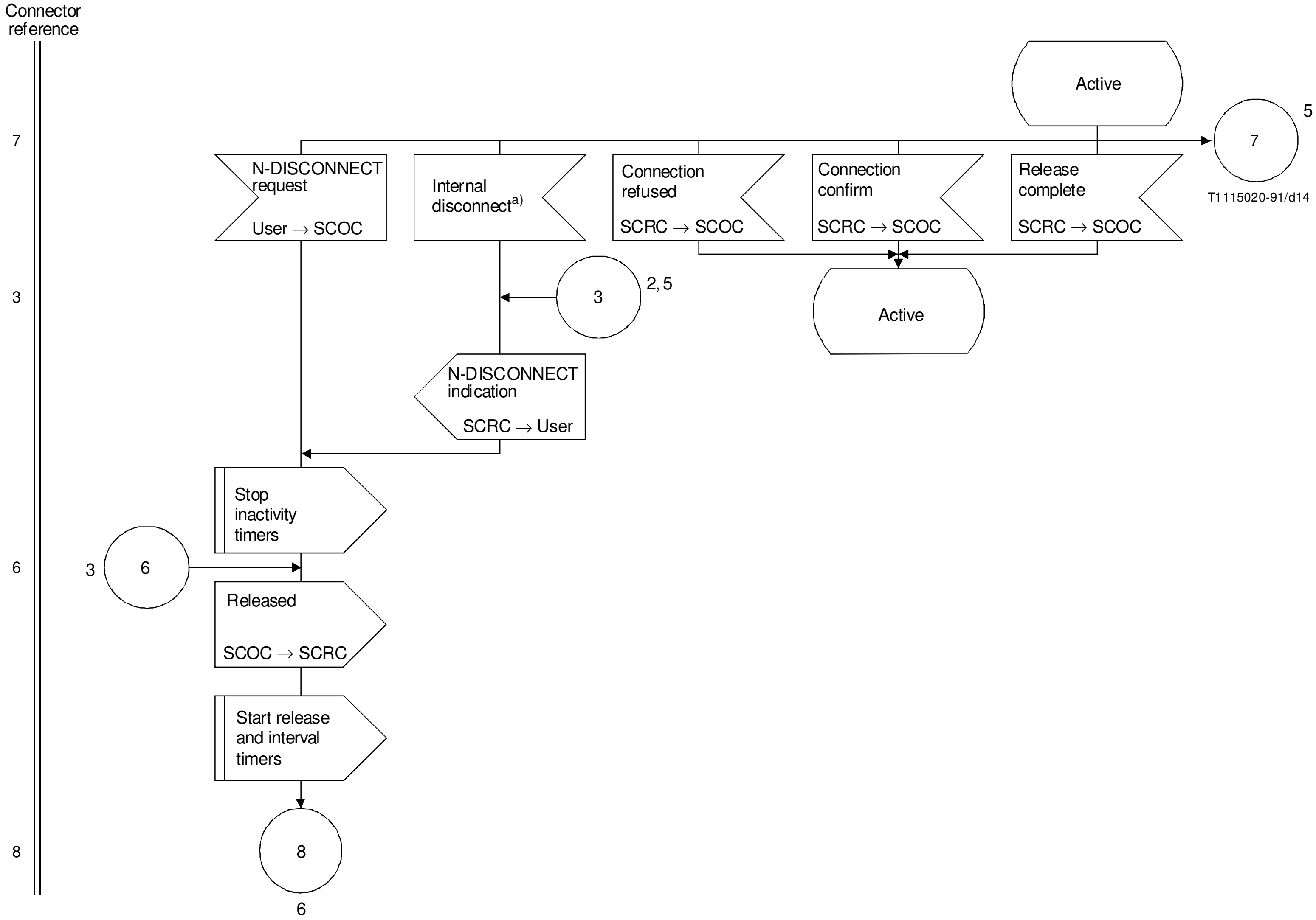
Connection establishment procedures at originating node for SCCP connection-oriented control (SCOC)



a) Freeze local reference.

FIGURE C.2/Q.714 (sheet 3 of 6)

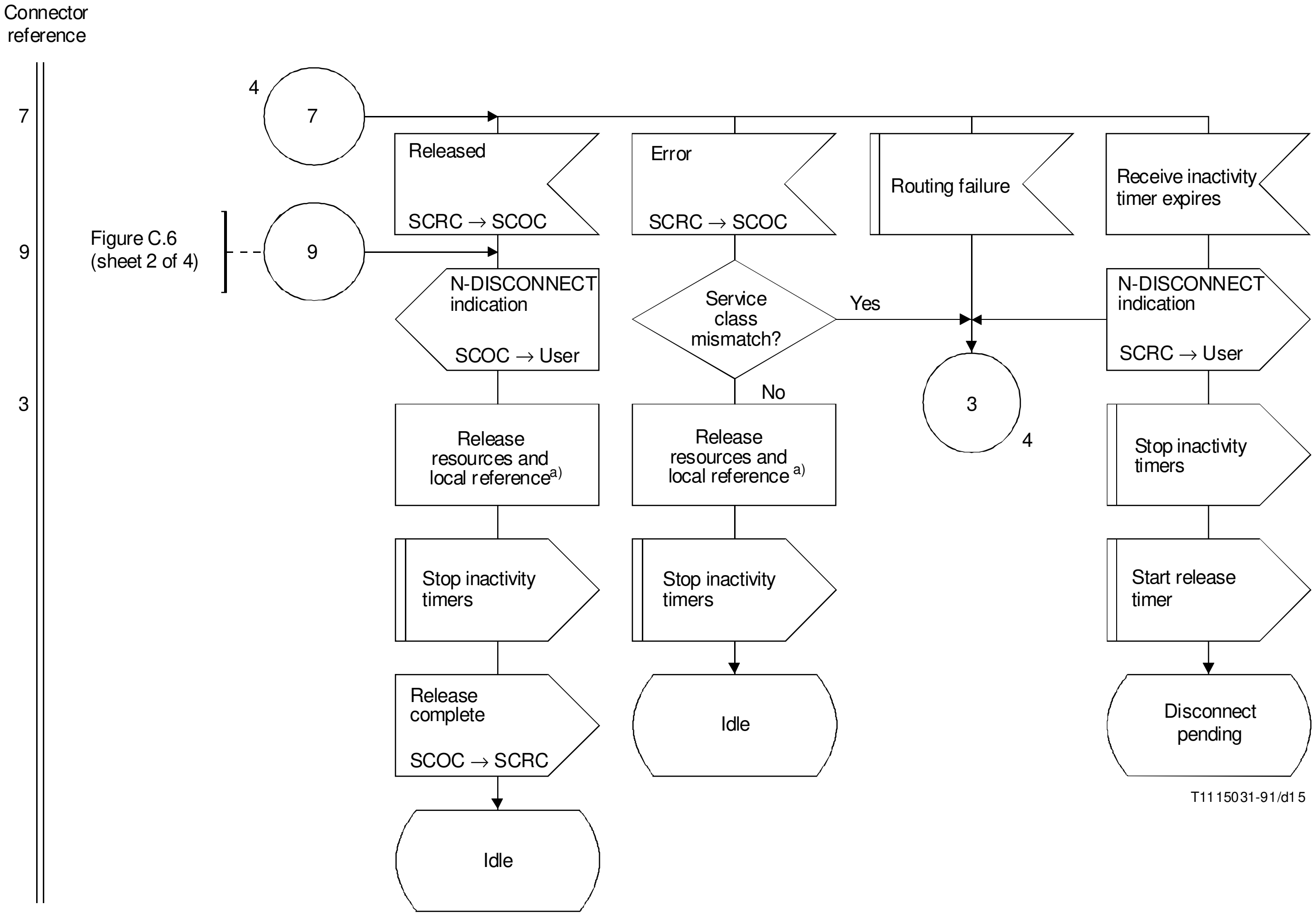
Connection establishment procedures at originating node for SCCP connection-oriented control (SCOC)



[a] To cater for abnormal disconnect conditions (i.e. Table B.3).

FIGURE C.2/Q.714 (sheet 4 of 6)

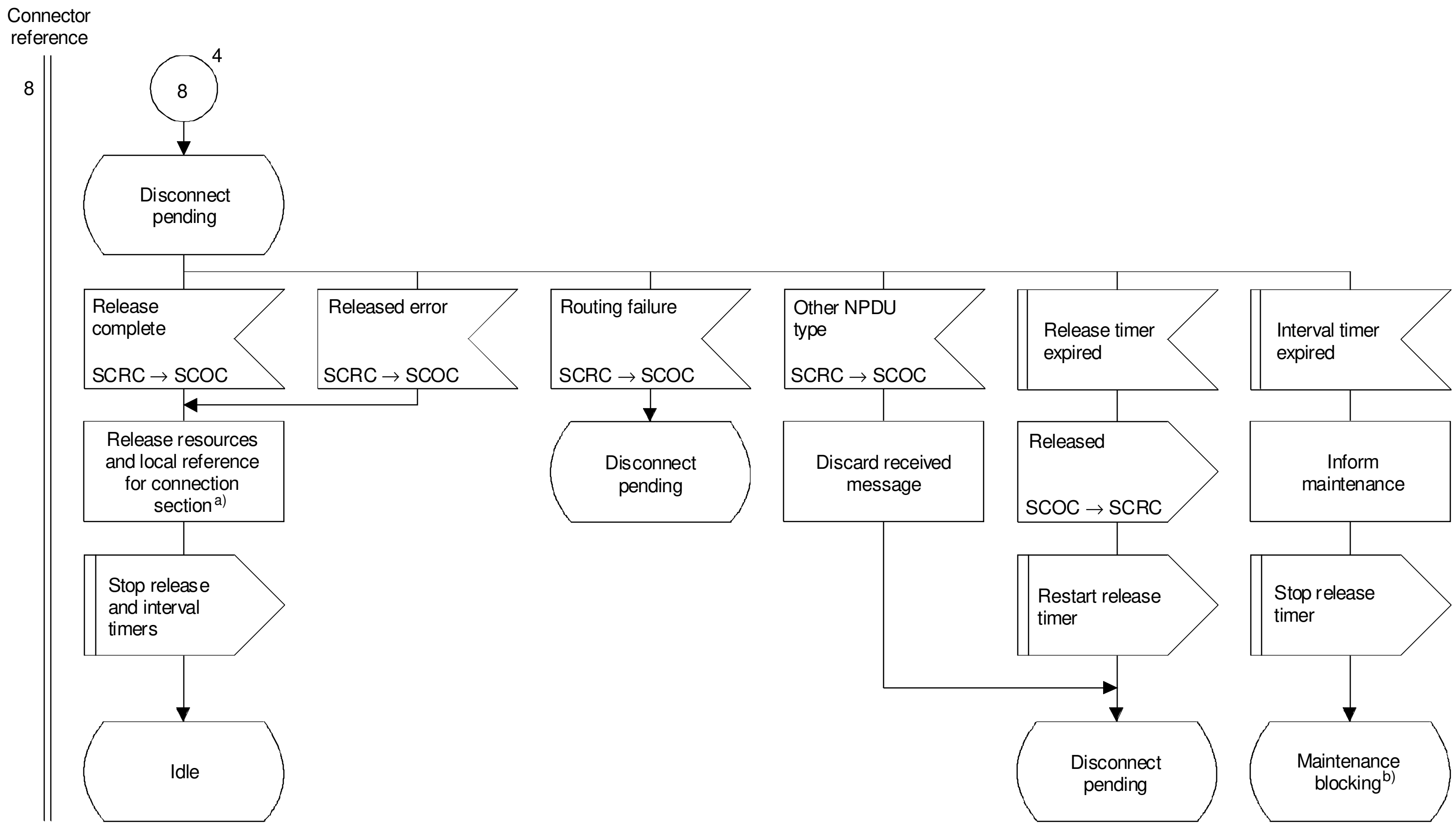
Connection release procedures at originating node for SCCP connection-oriented control (SCOC)



a) Freeze local reference.

FIGURE C.2/Q.714 (sheet 5 of 6)

Connection release procedures at originating node for SCCP connection-oriented control (SCOC)

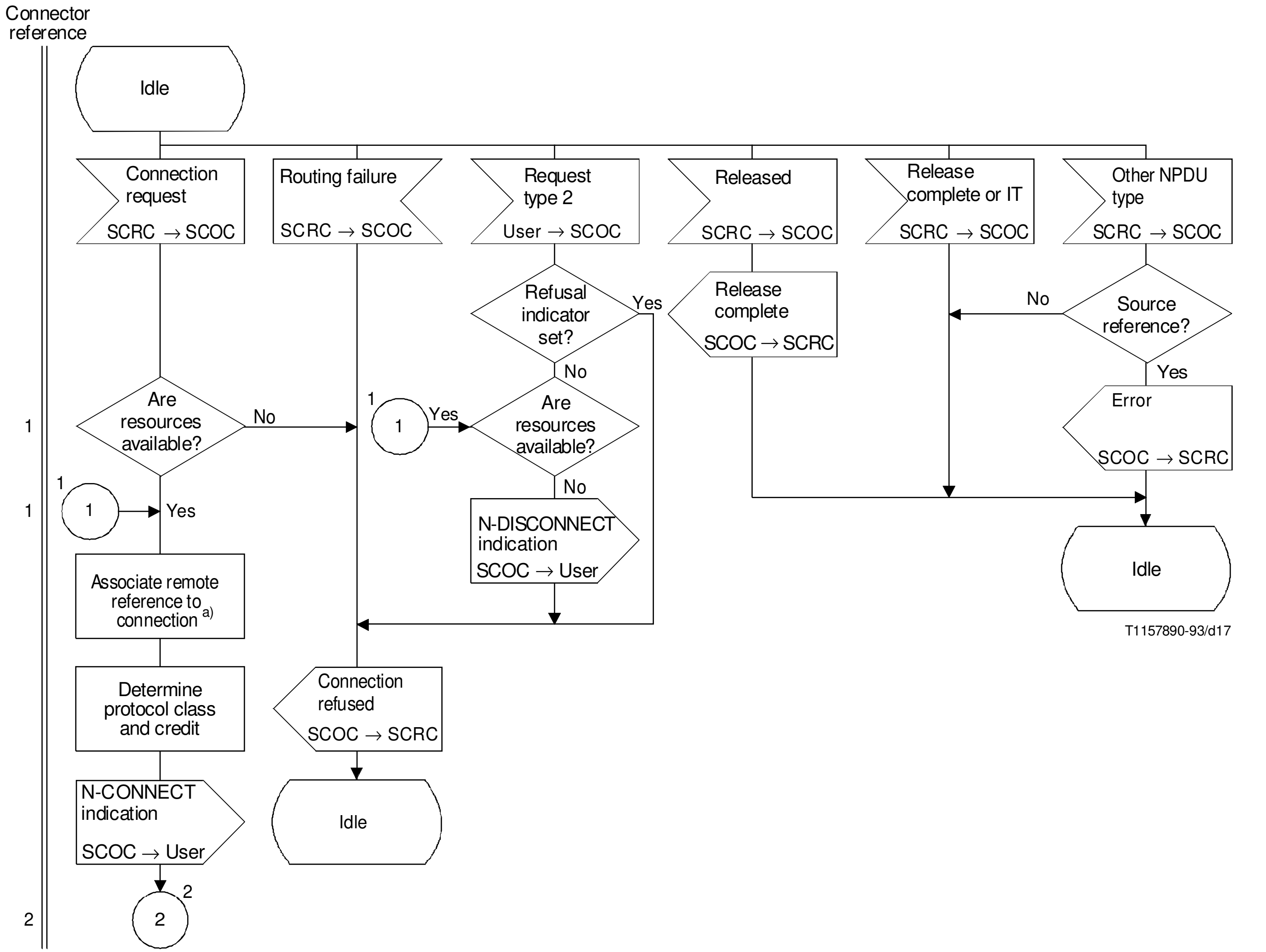


a) Freeze local reference.

b) Maintenance functions are for further study.

FIGURE C.2/Q.714 (sheet 6 of 6)

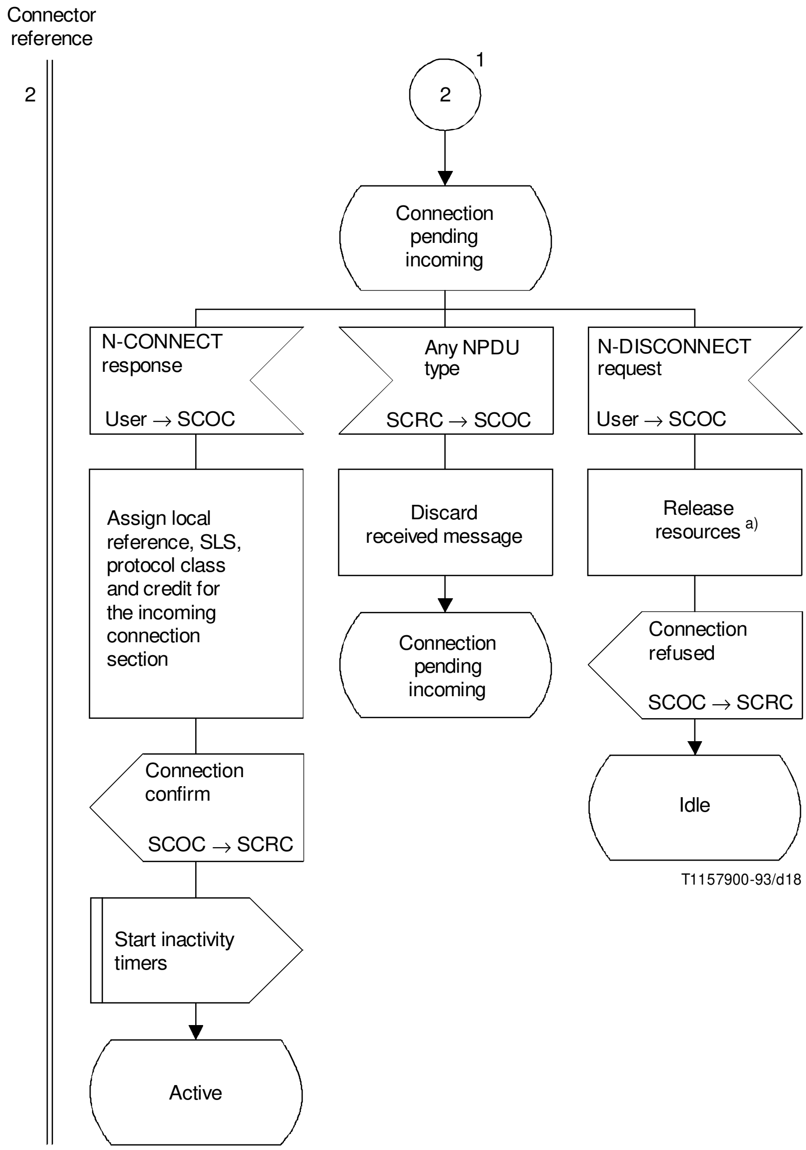
Connection release procedures at originating node for SCCP connection-oriented control (SCOC)



a) The assignment of the local reference can be done at this point or as shown in Figure C.3 (sheet 2 of 5): this is implementation dependent.

FIGURE C.3/Q.714 (sheet 1 of 5)

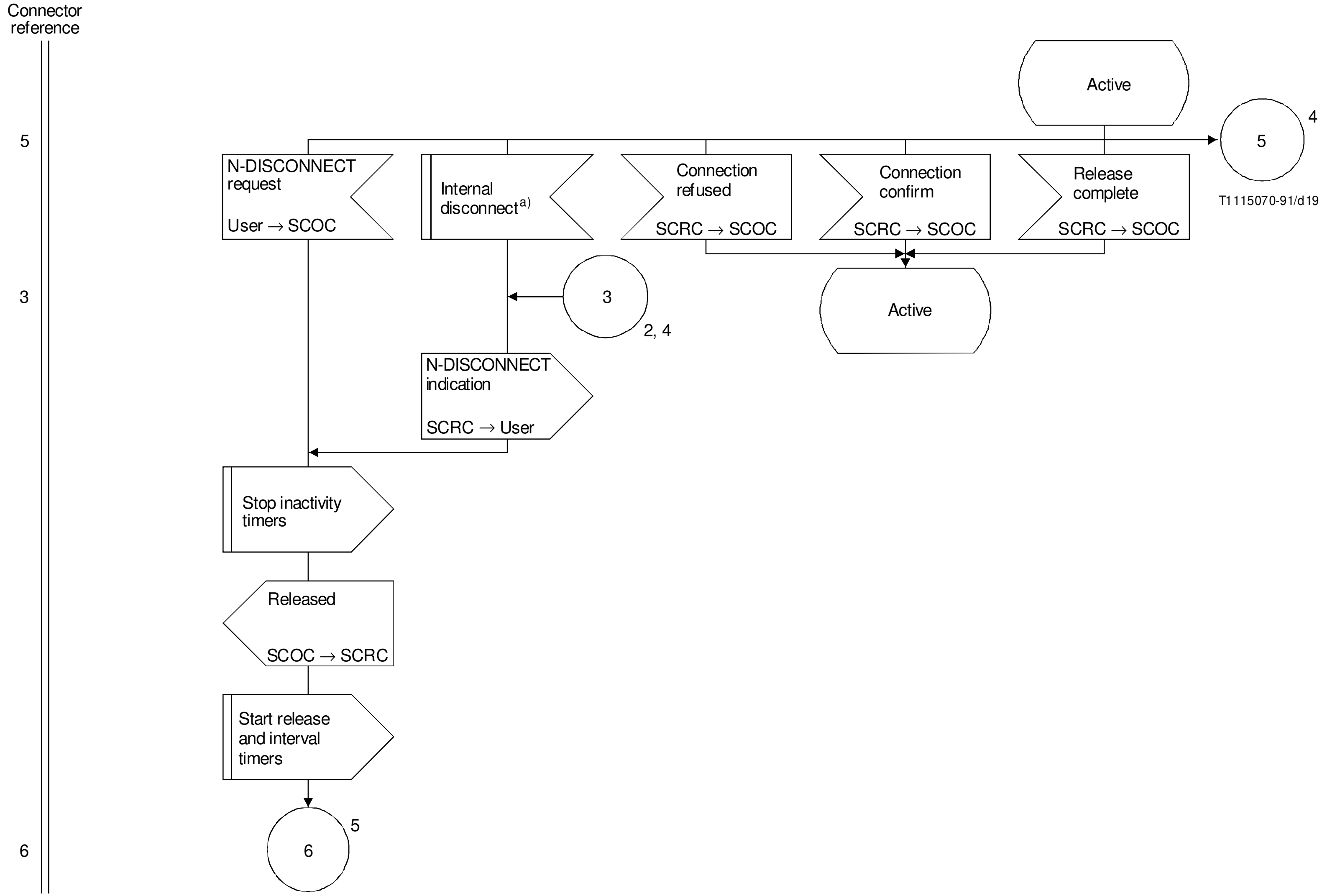
Connection establishment procedures at destination node for SCCP connection-oriented control (SCOC)



a) The local reference may have to be released and frozen if it has been previously assigned.

FIGURE C.3/Q.714 (sheet 2 of 5)

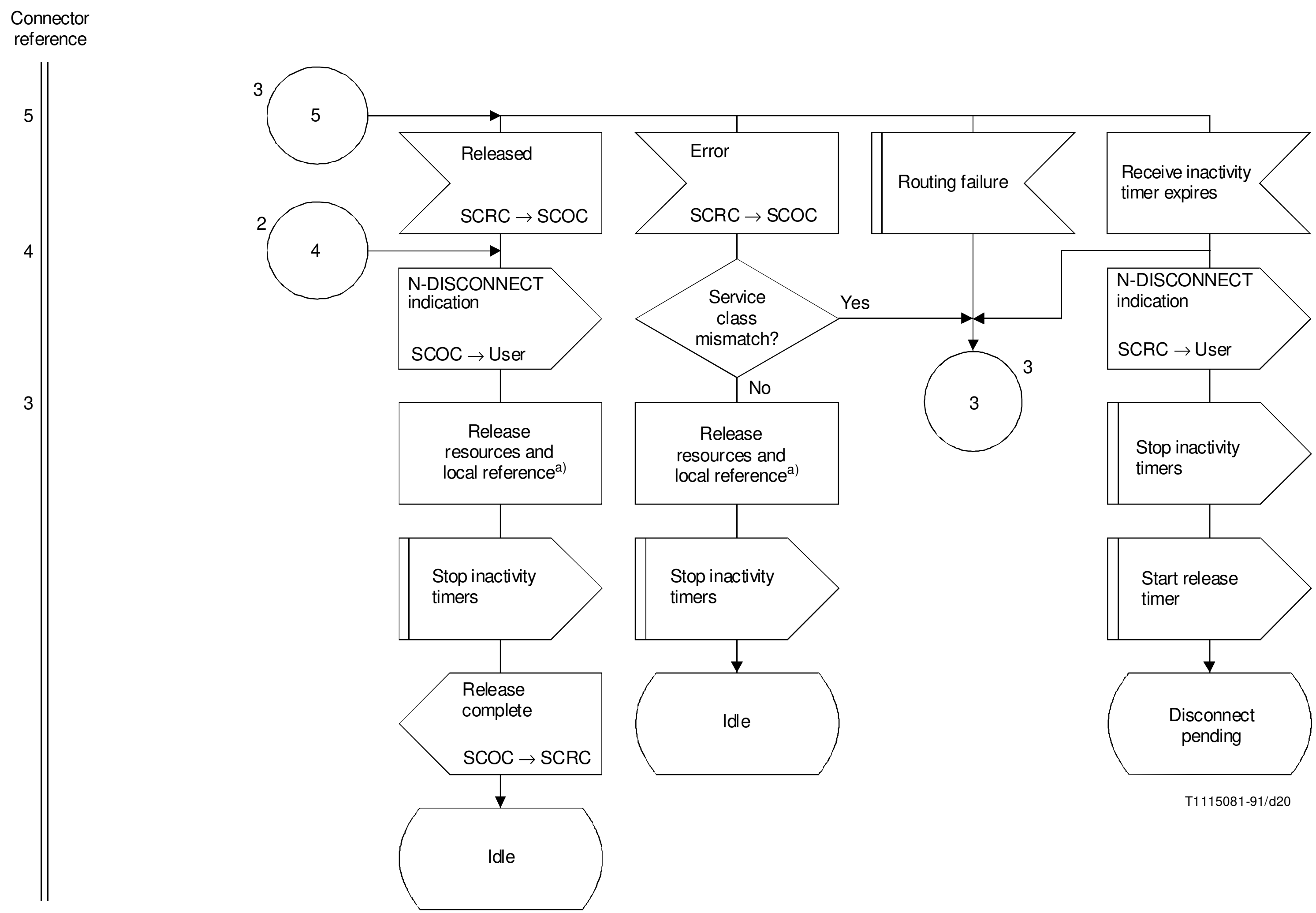
Connection establishment procedures at destination node for SCCP connection-oriented control (SCOC)



[a] To cater for abnormal disconnect conditions (i.e. Table B.3).

FIGURE C.3/Q.714 (sheet 3 of 5)

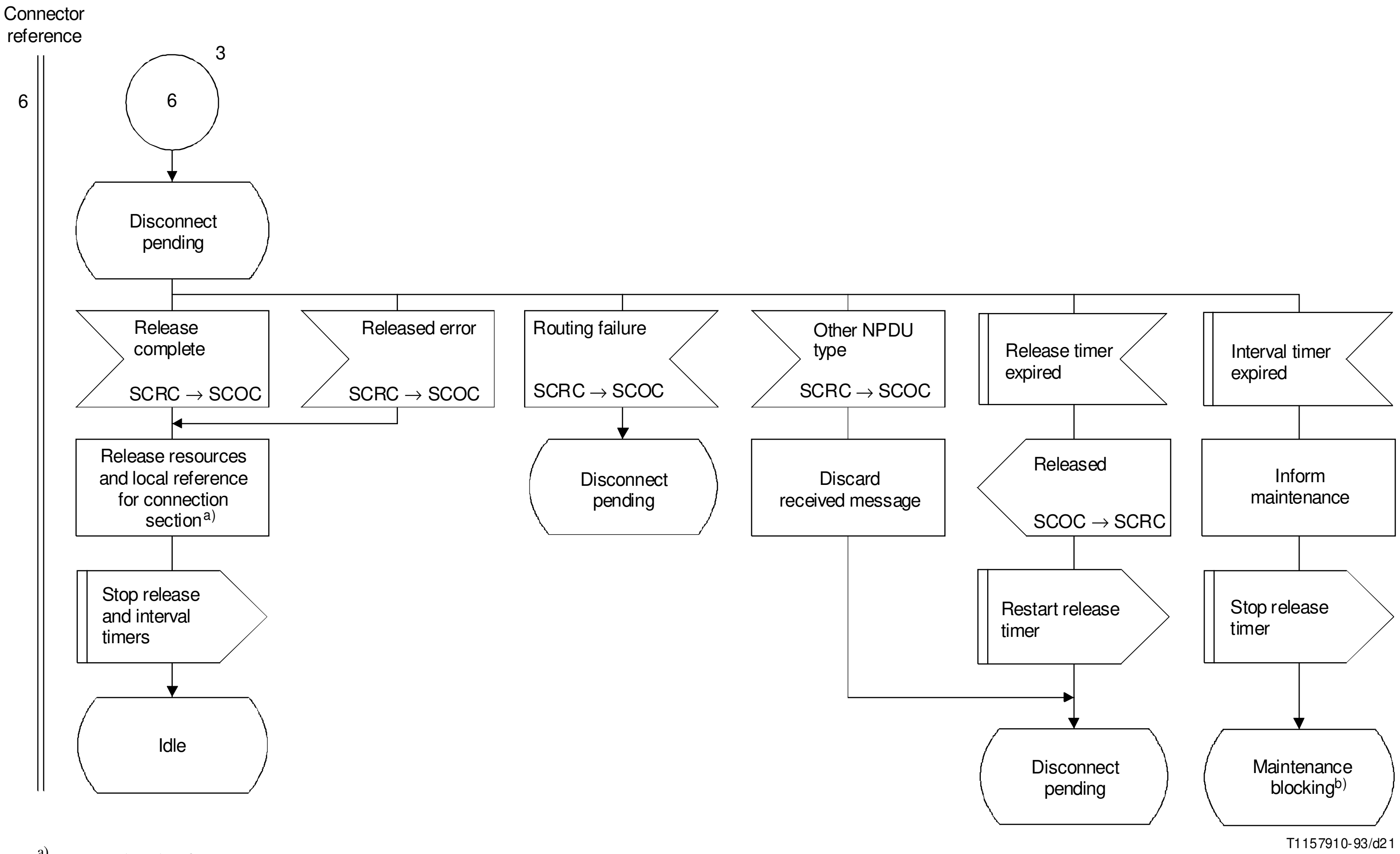
Connection release procedures at destination node for SCCP connection-oriented control (SCOC)



a) Freeze local reference.

FIGURE C.3/Q.714 (sheet 4 of 5)

Connection release procedures at destination node for SCCP connection-oriented control (SCOC)

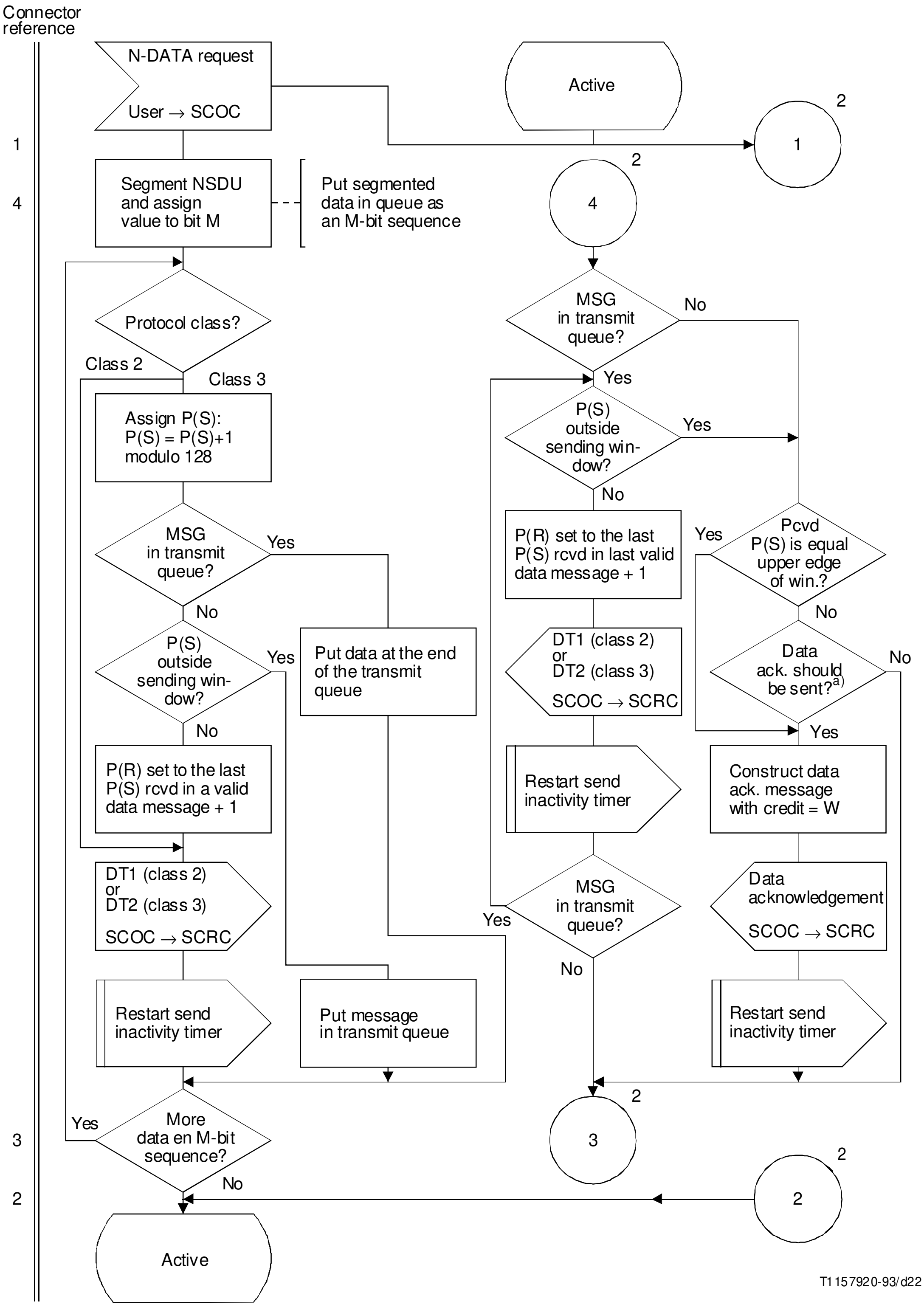


a) Freeze local reference.

b) Maintenance functions are for further study.

FIGURE C.3/Q.714 (sheet 5 of 5)

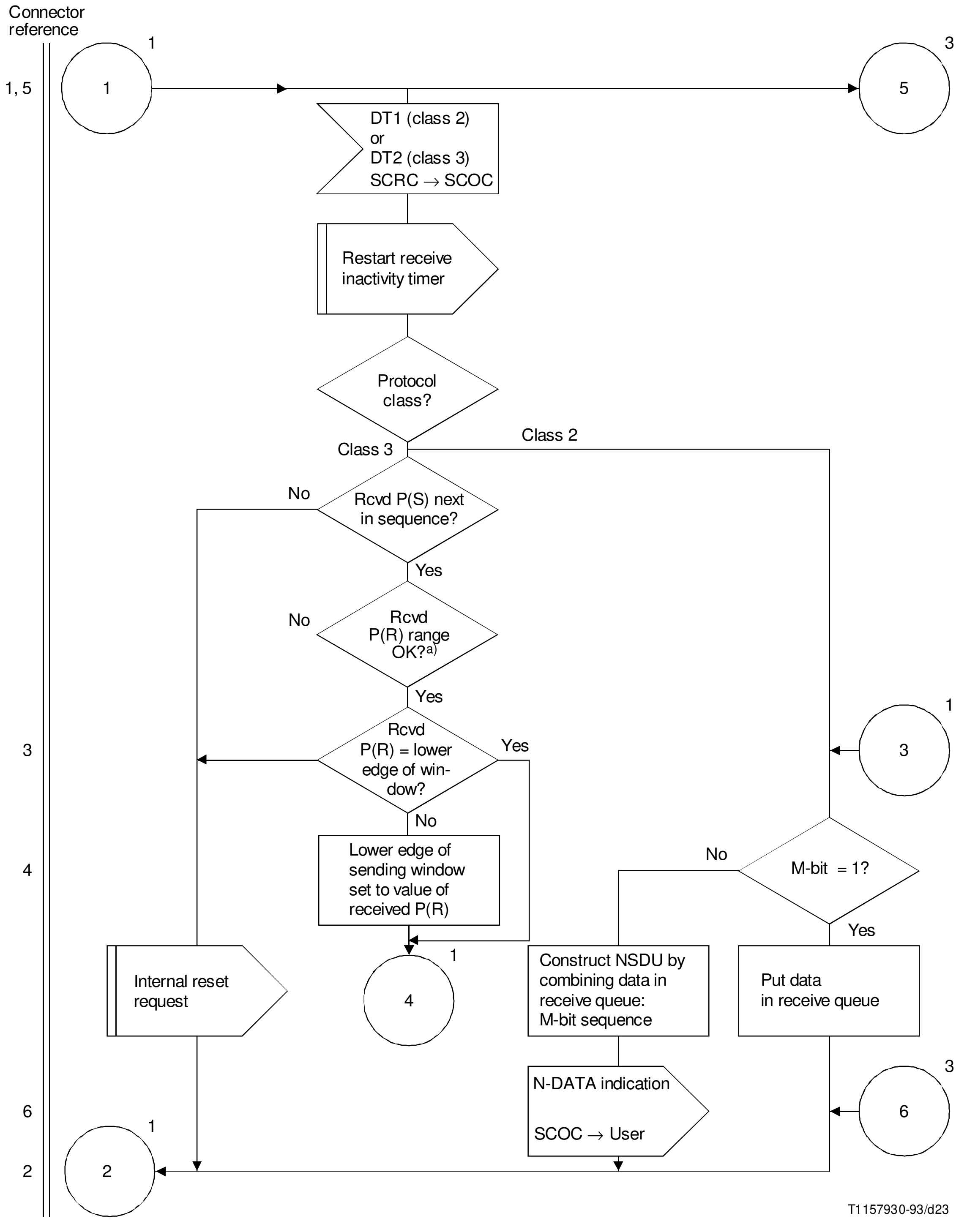
Connection release procedures at destination node for SCCP connection-oriented control (SCOC)



a) This criterion is implementation dependent.

FIGURE C.4/Q.714 (Sheet 1 of 4)

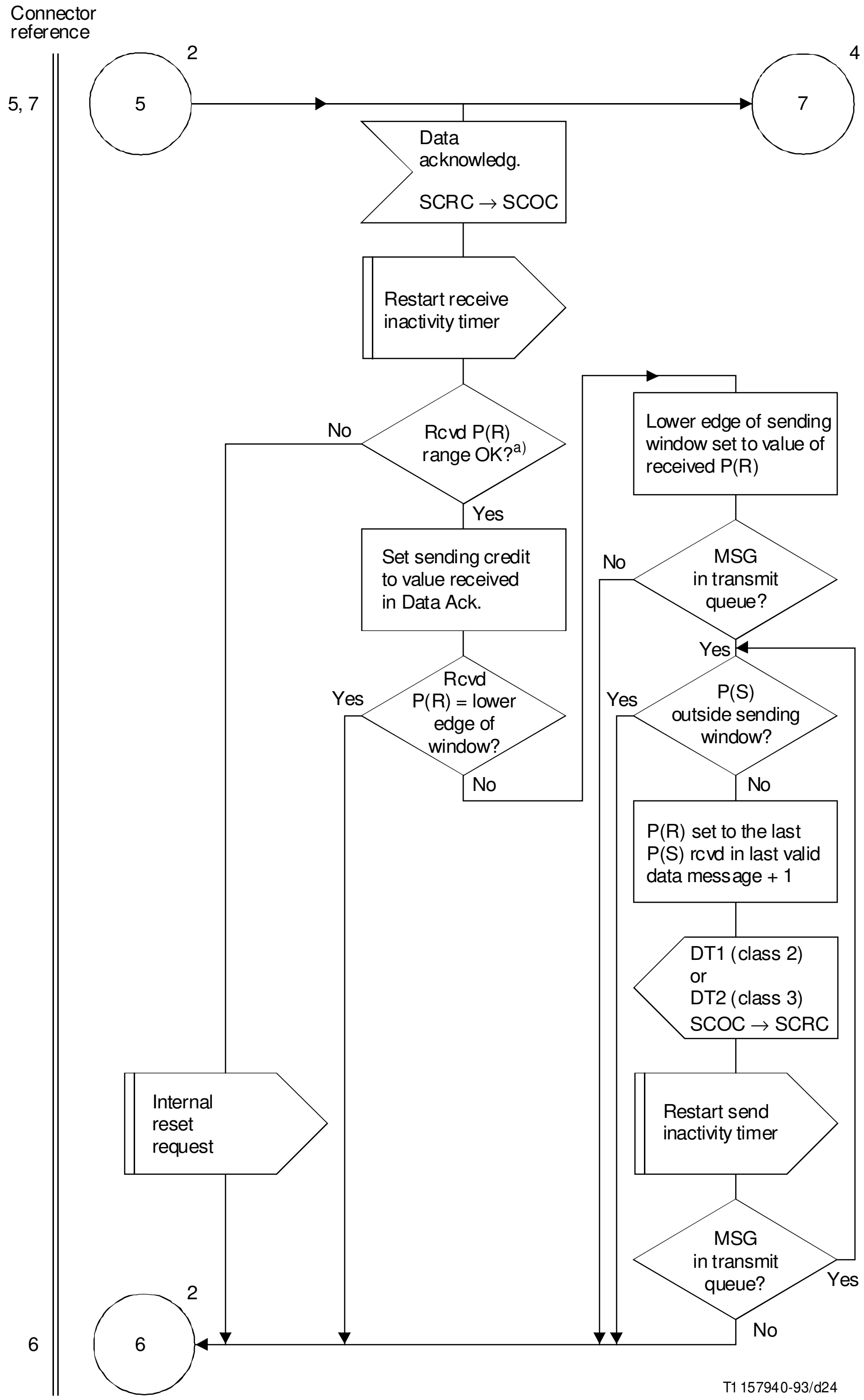
Data transfer procedures at originating and destination nodes for SCCP connection-oriented control (SCOC)



a) Value of P(R) received must be within the range from the last P(R) received up to including the send sequence number of next message to be transmitted.

FIGURE C.4/Q.714 (Sheet 2 of 4)

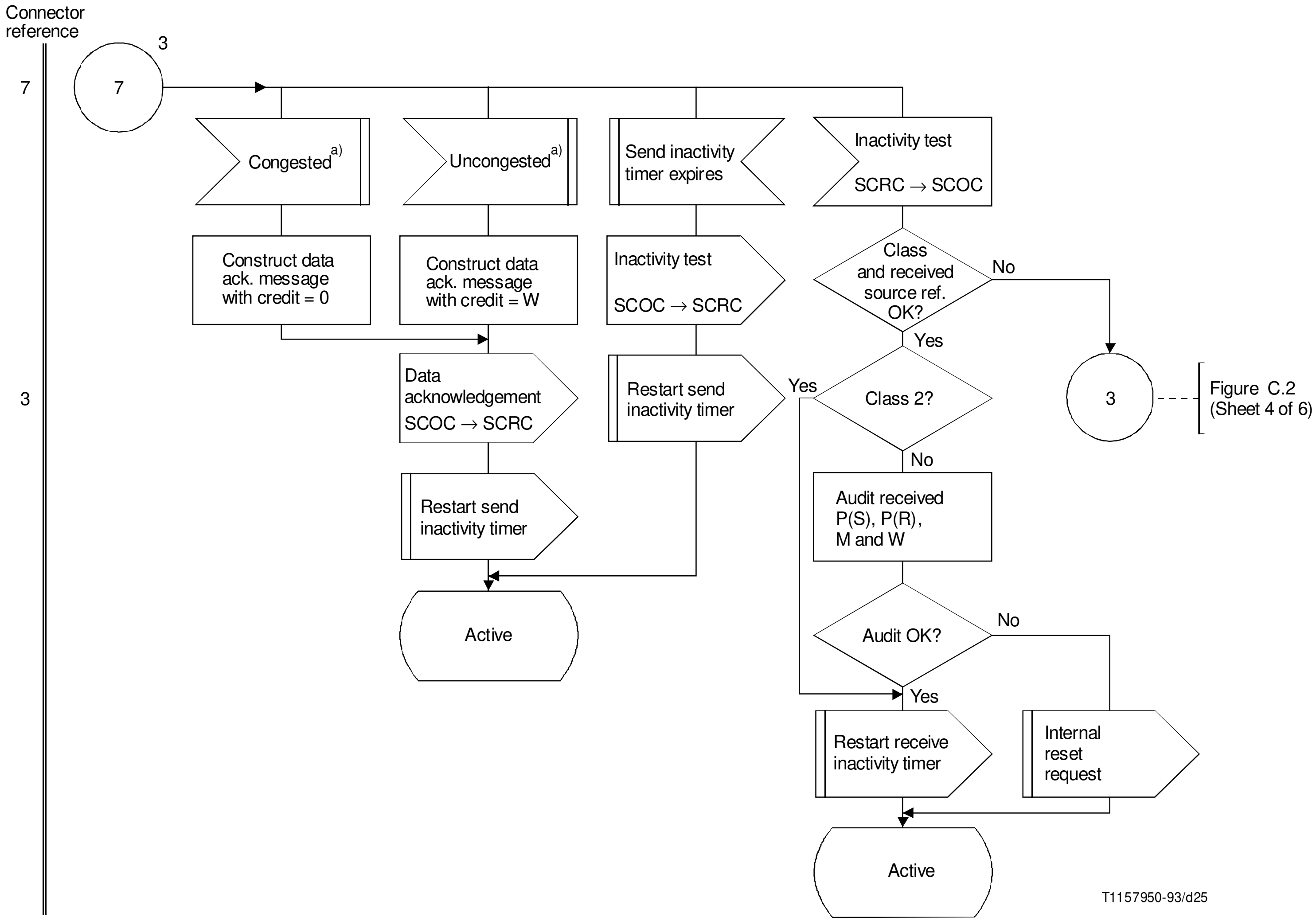
Data transfer procedures at originating and destination nodes for SCCP connection-oriented control (SCOC)



[a] Value of P(R) received must be within the range from the last P(R) received up to including the send sequence number of next message to be transmitted.

FIGURE C.4/Q.714 (Sheet 3 of 4)

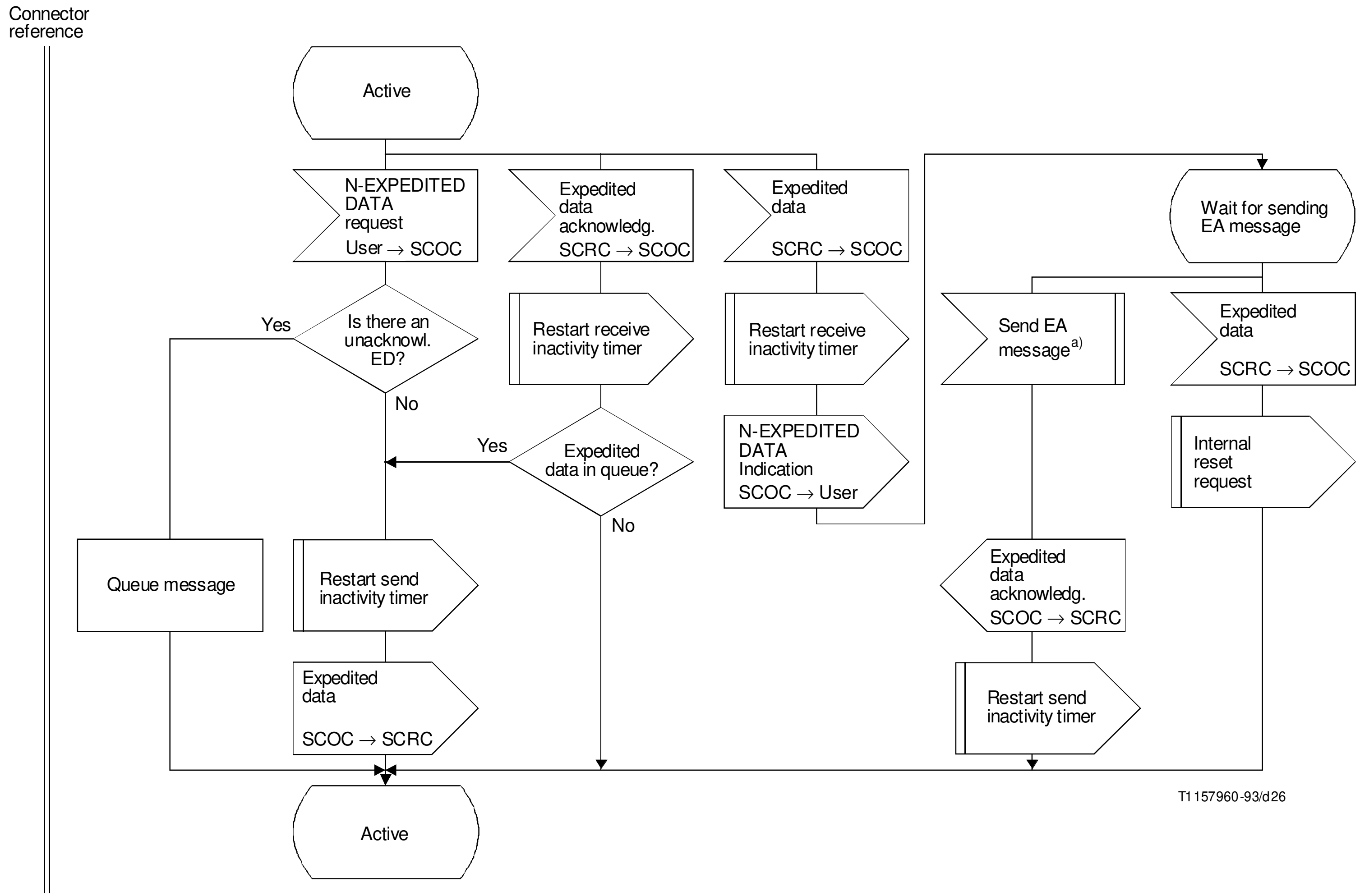
Data transfer procedures at originating and destination nodes for SCCP connection-oriented control (SCOC)



a) From an implementation dependent function.

FIGURE C.4/Q.714 (Sheet 4 of 4)

Data transfer procedures at originating and destination nodes for SCCP connection-oriented control (SCOC)



[a] From an implementation dependent function.

FIGURE C.5/Q.714

Expedited data transfer procedures at originating and destination node for SCCP connection-oriented control (SCOC)

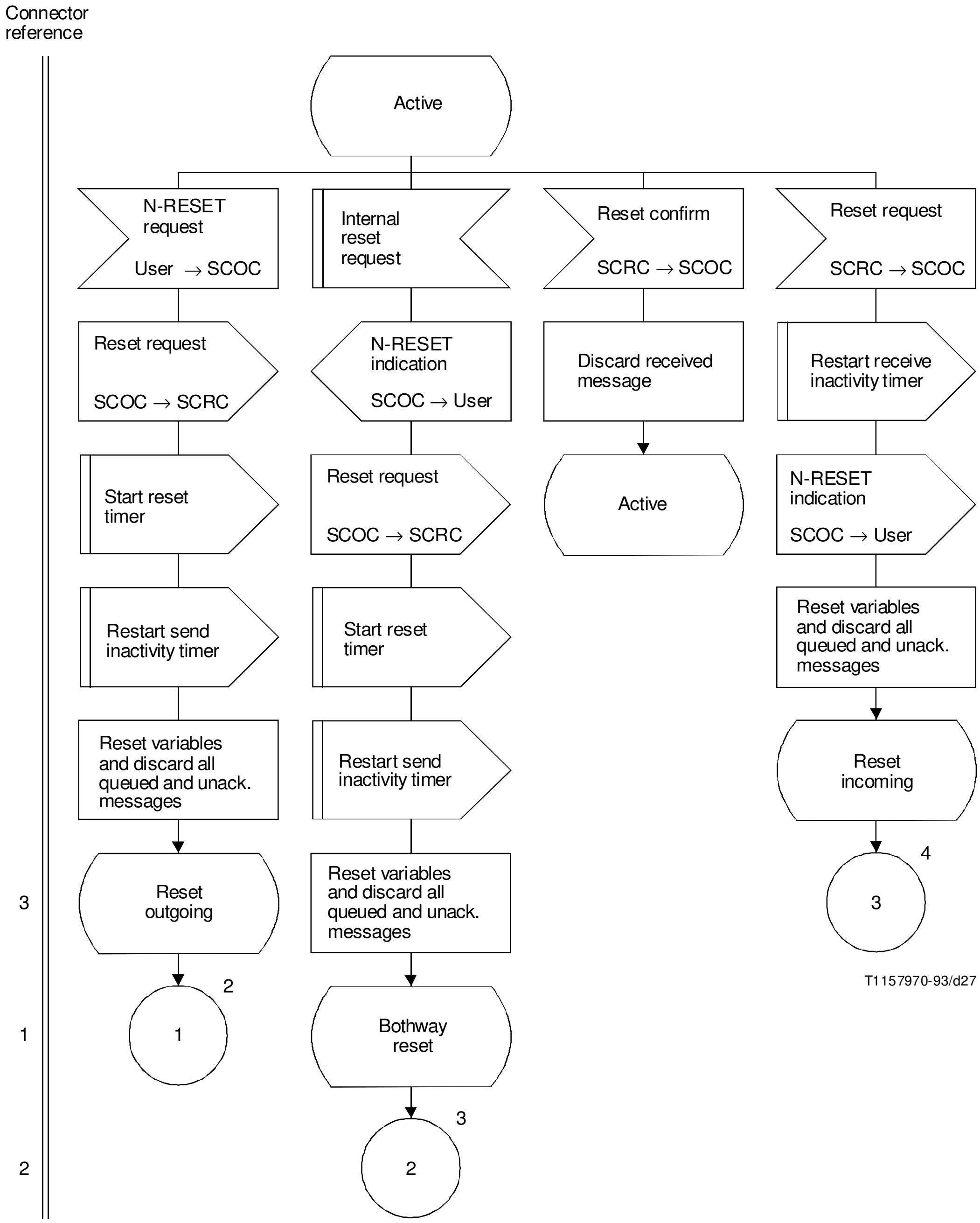


FIGURE C.6/Q.714 (Sheet 1 of 4)

Reset procedures at originating and destination node for SCCP connection-oriented control (SCOC)

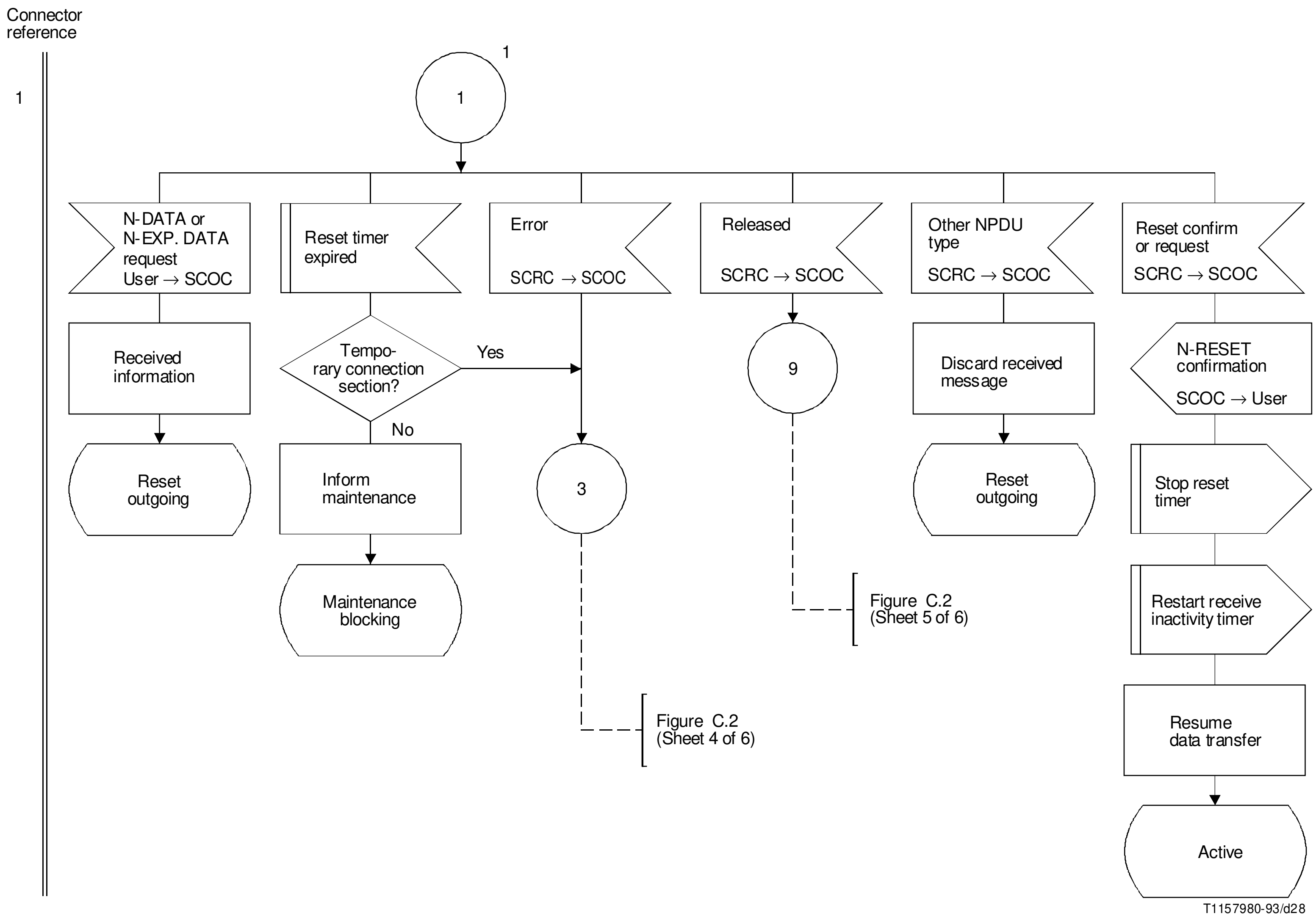


FIGURE C.6/Q.714 (Sheet 2 of 4)

Reset procedures at originating and destination node for SCCP connection-oriented control (SCOC)

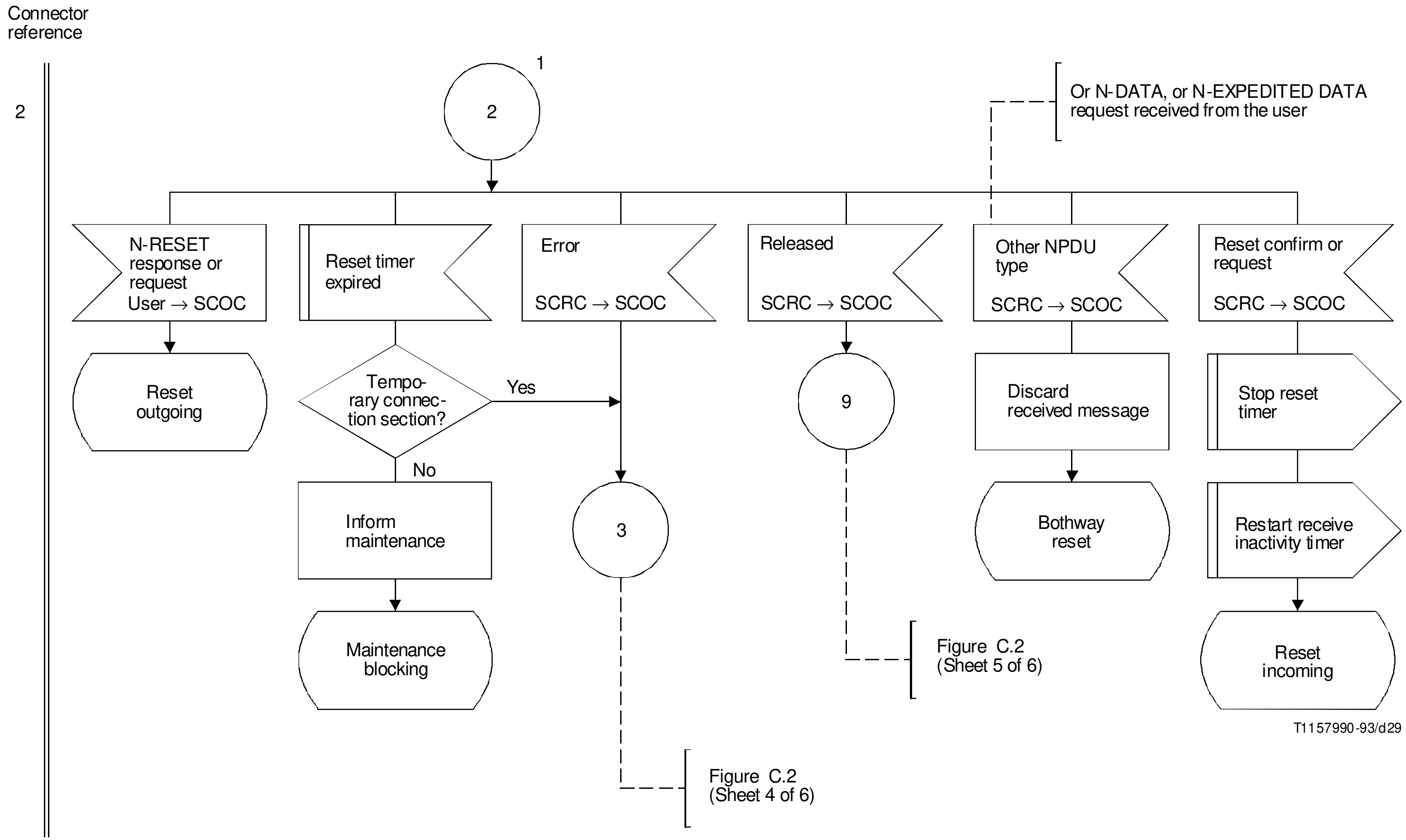


FIGURE C.6/Q.714 (Sheet 3 of 4)

Reset procedures at originating and destination node for SCCP connection-oriented control (SCOC)

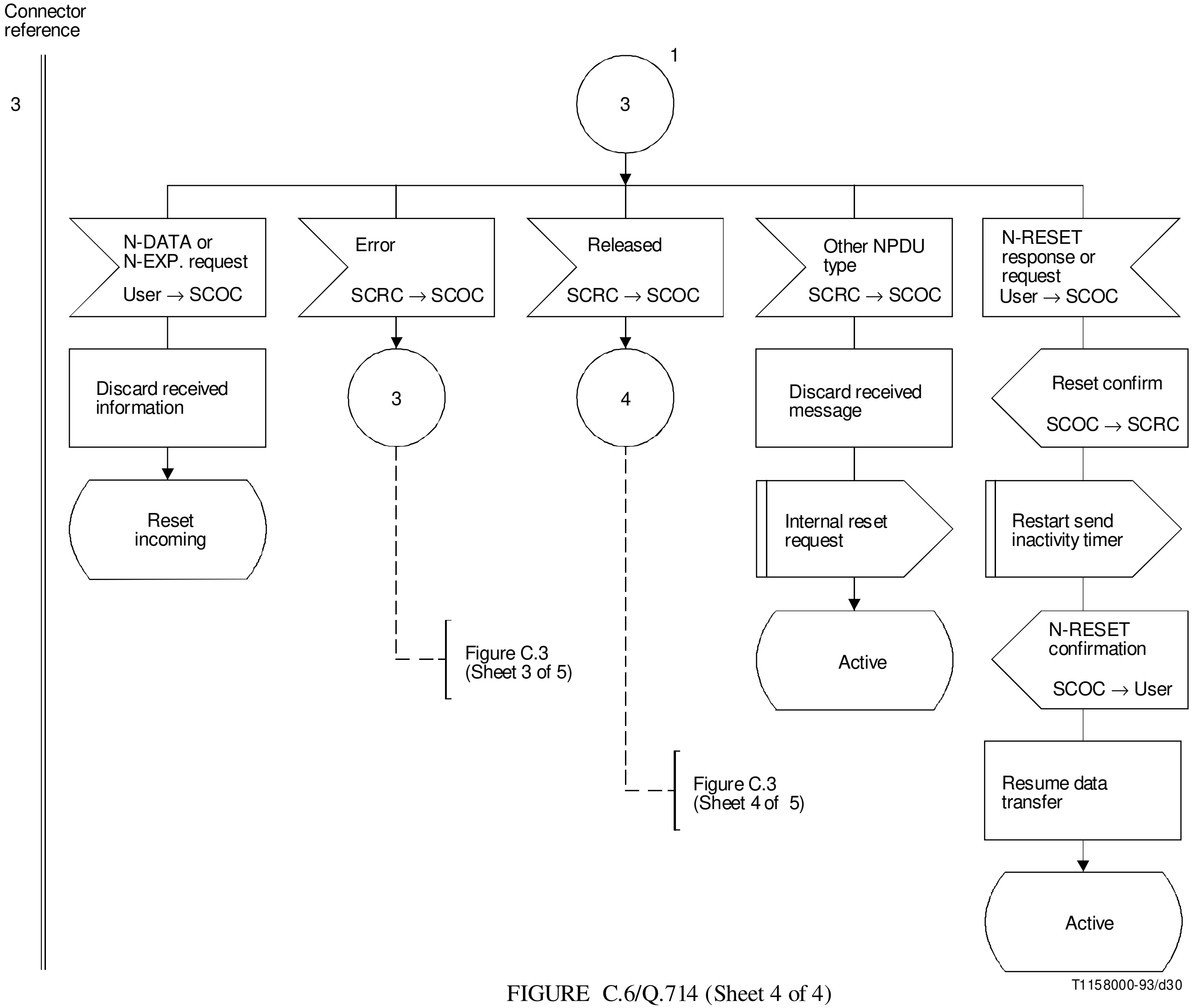
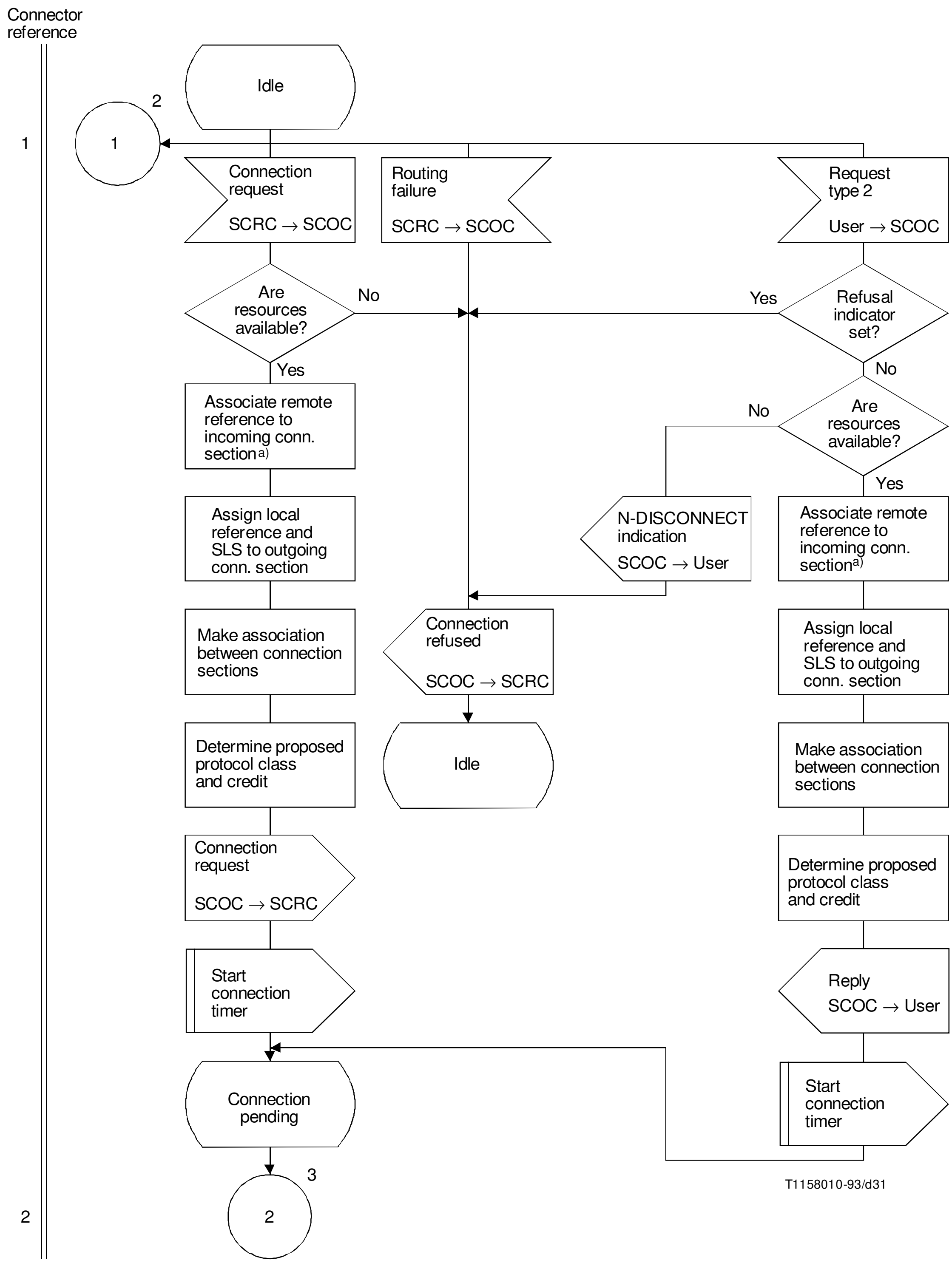


FIGURE C.6/Q.714 (Sheet 4 of 4)

Reset procedures at originating and destination node for SCCP connection-oriented control (SCOC)



a) The assignement of the local reference can be done at this point or as shown in Figure C.7 (Sheet 3 of 9): this is implementation dependent.

FIGURE C.7/Q.714 (Sheet 1 of 9)

Connection establishment procedures at the intermediate node for SCCP connection-oriented control (SCOC)

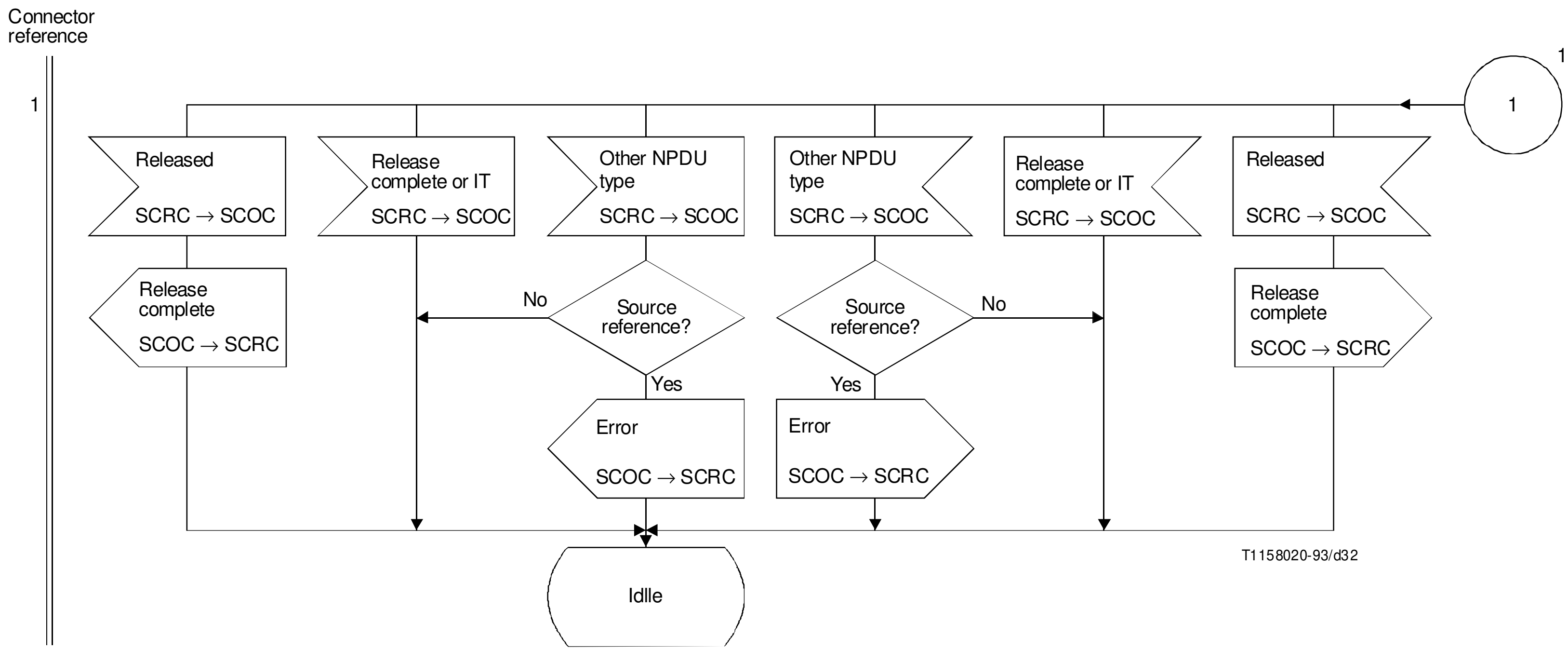
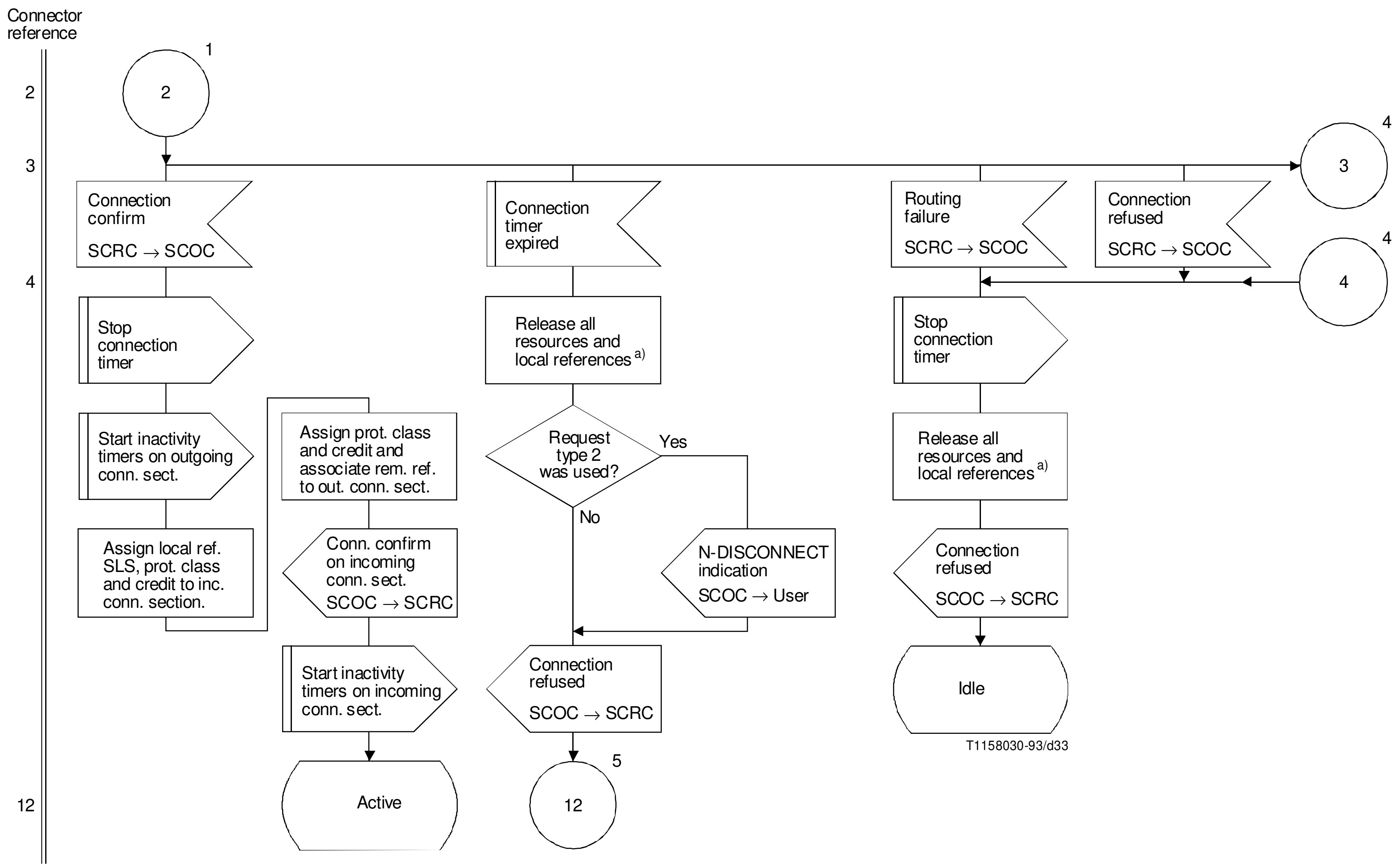


FIGURE C.7/Q.714 (Sheet 2 of 9)

Connection establishment procedures at the intermediate node for SCCP connection-oriented control (SCOC)



a) Freeze local references.

FIGURE C.7/Q.714 (Sheet 3 of 9)

Connection establishment procedures at the intermediate node for SCCP connection-oriented control (SCOC)

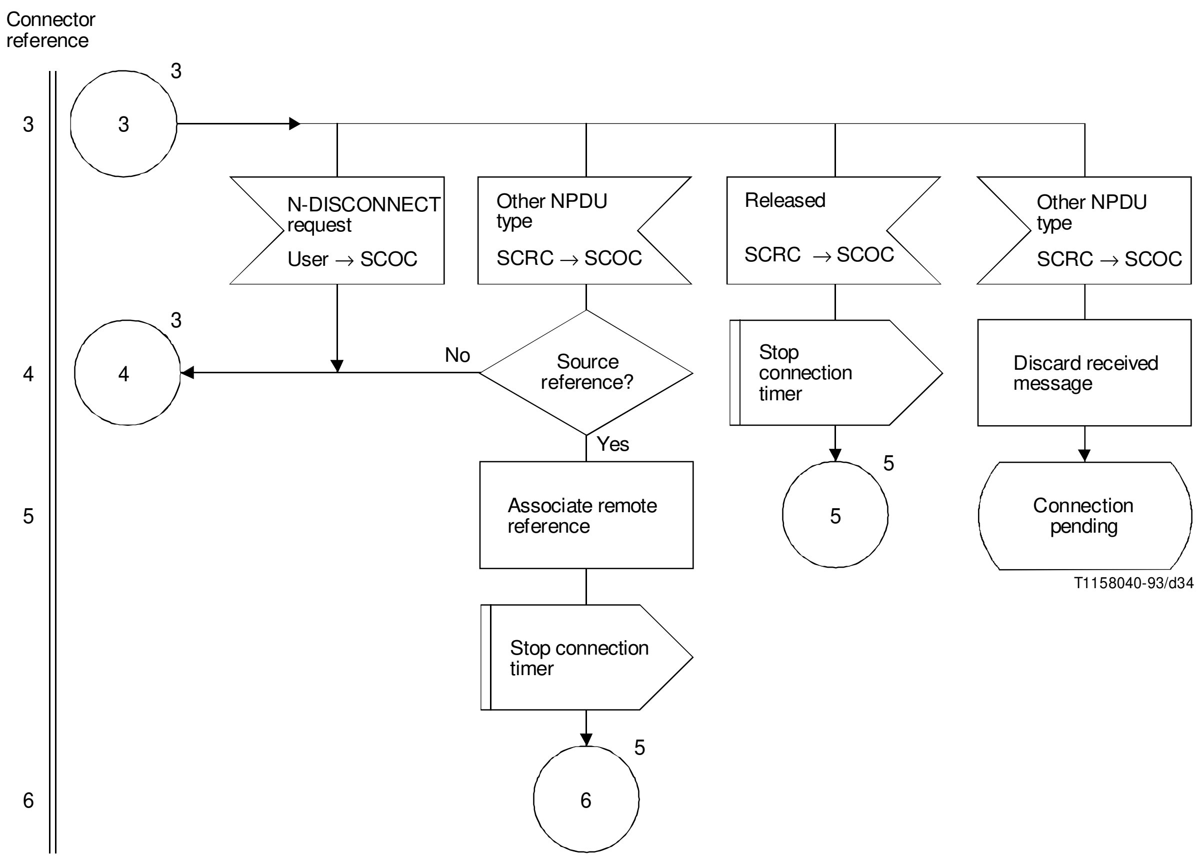
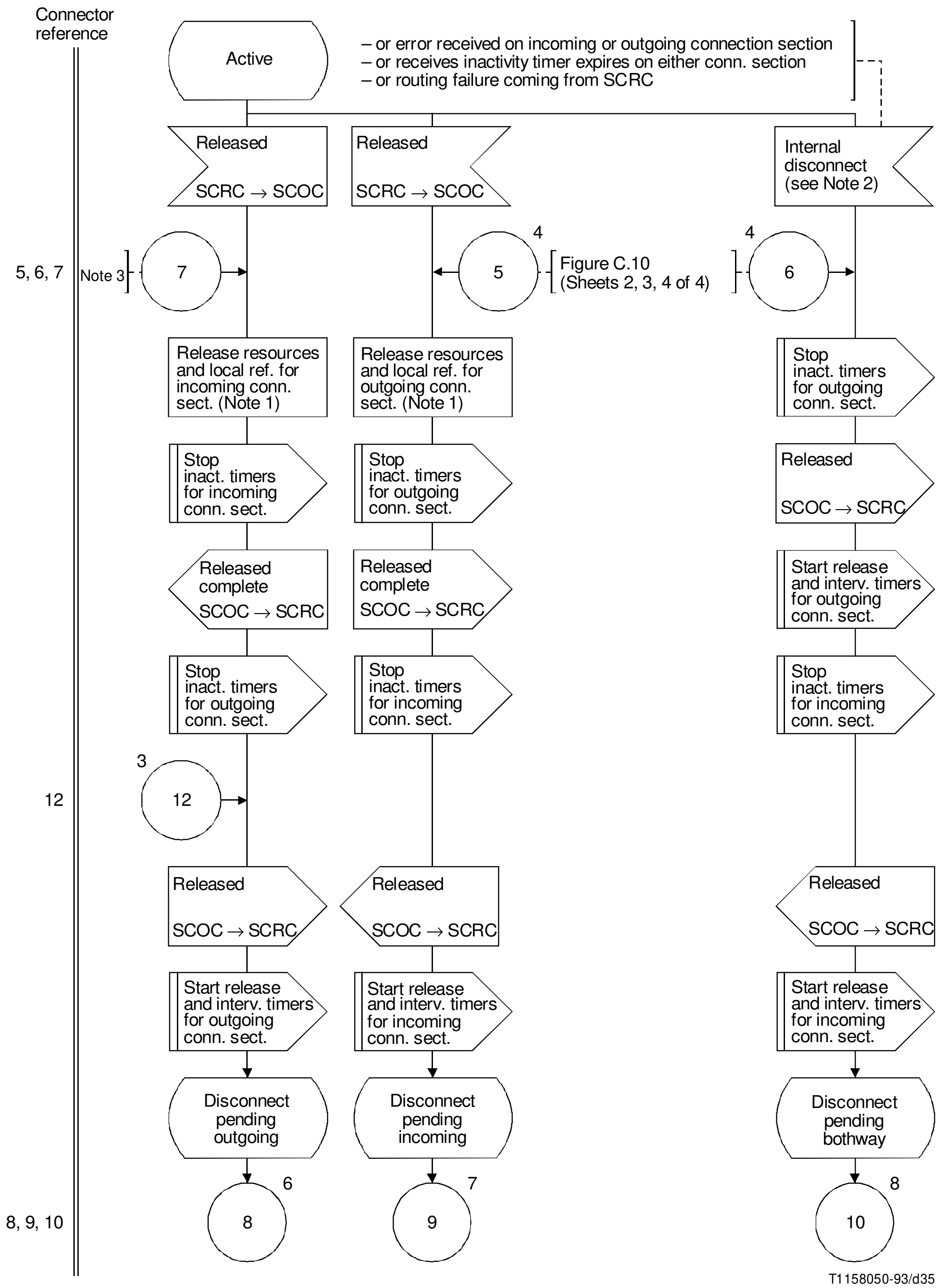


FIGURE C.7/Q.714 (Sheet 4 of 9)

Connection establishment procedures at the intermediate node for SCCP connection-oriented control (SCOC)



NOTES

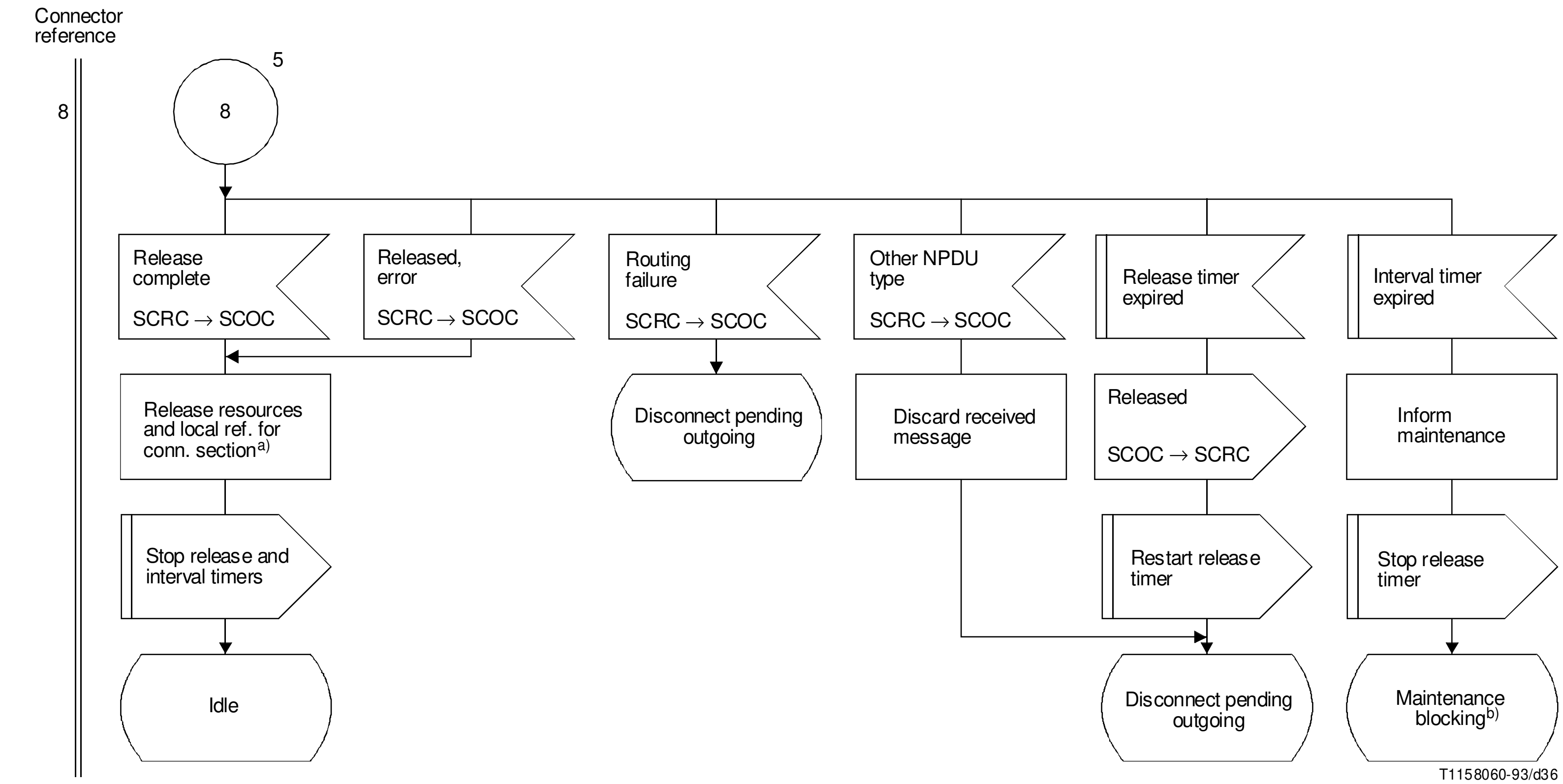
1 Freeze local references.

2 To cater for abnormal disconnect conditions (i.e. Table B.3).

3 Figure C.10 (Sheets 2, 3, 4 of 4).

FIGURE C.7/Q.714 (Sheet 5 of 9)

Connection release procedures at intermediate node for SCCP connection-oriented control (SCOC)

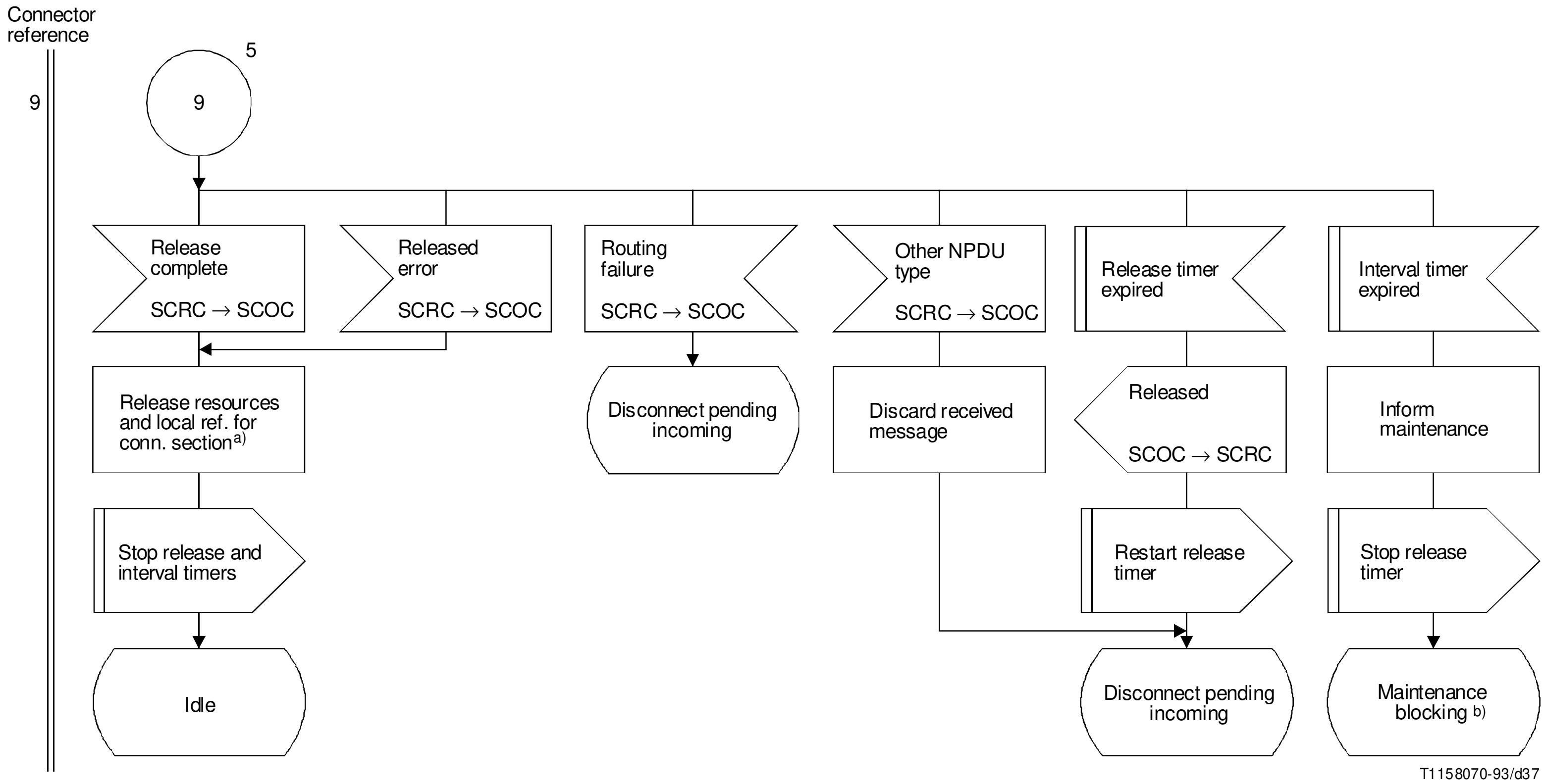


a) Freeze local reference.

b) Maintenance functions are for further study.

FIGURE C.7/Q.714 (Sheet 6 of 9)

Connection release procedures at intermediate node for SCCP connection-oriented control (SCOC)

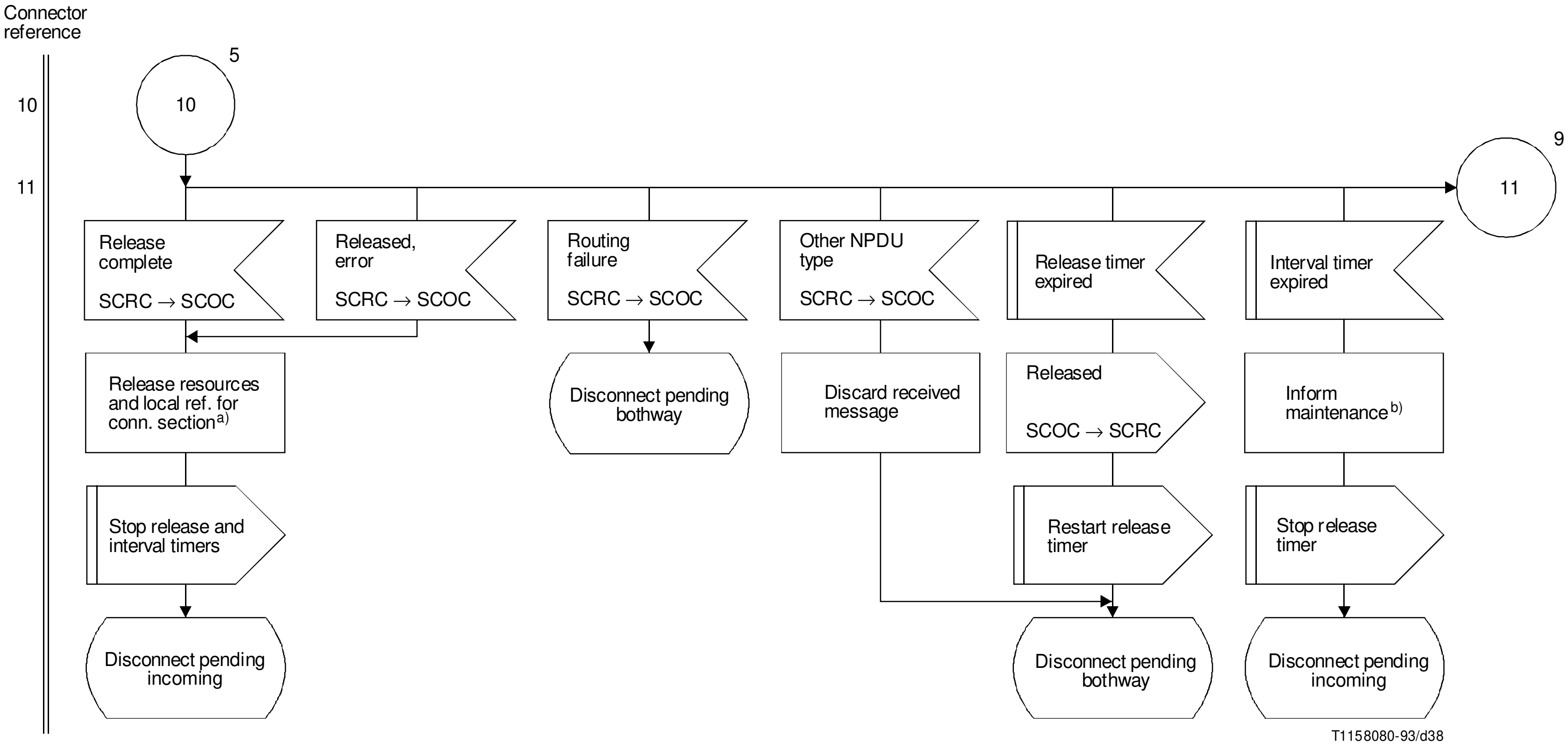


a) Freeze local reference.

b) Maintenance functions are for further study.

FIGURE C.7/Q.714 (Sheet 7 of 9)

Connection release procedures at intermediate node for SCCP connection-oriented control (SCOC)

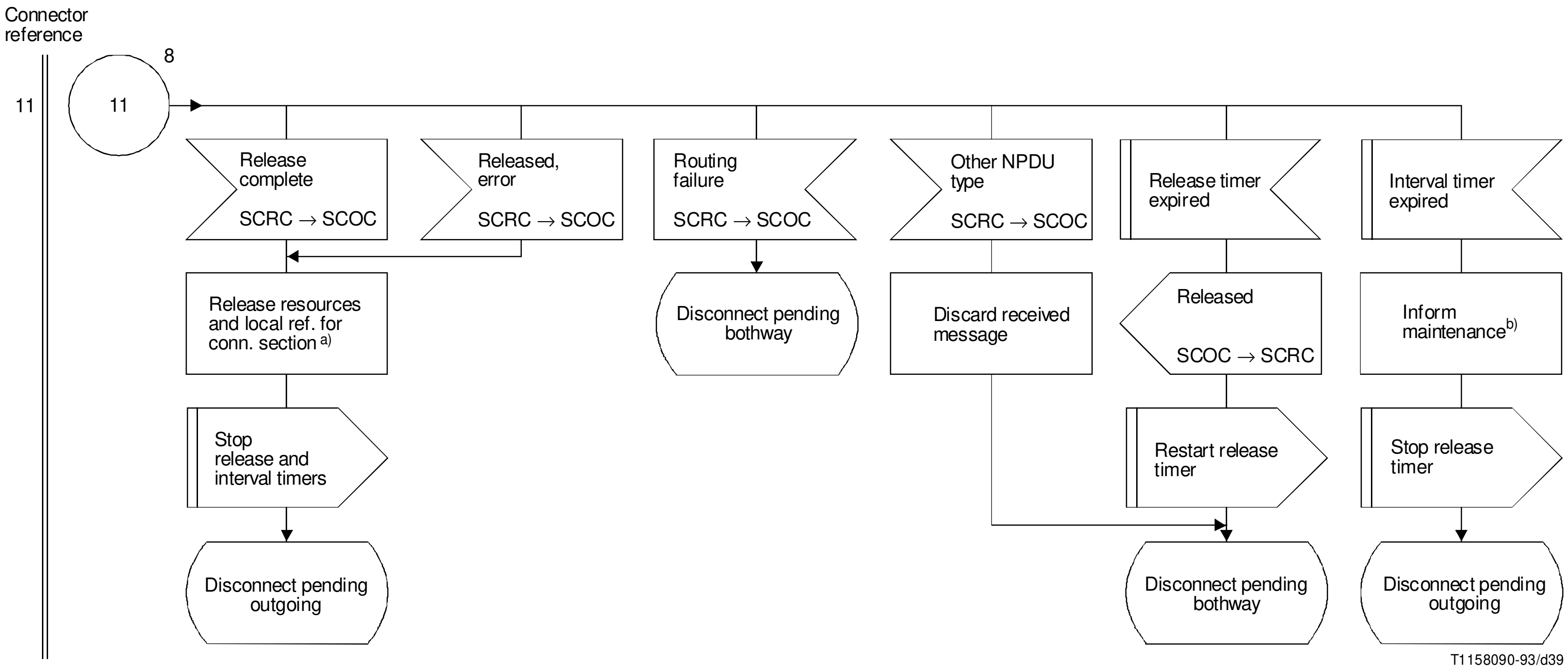


a) Freeze local reference.

b) Maintenance functions are for further study.

FIGURE C.7/Q.714 (Sheet 8 of 9)

Connection release procedures at intermediate node for SCCP connection-oriented control (SCOC)

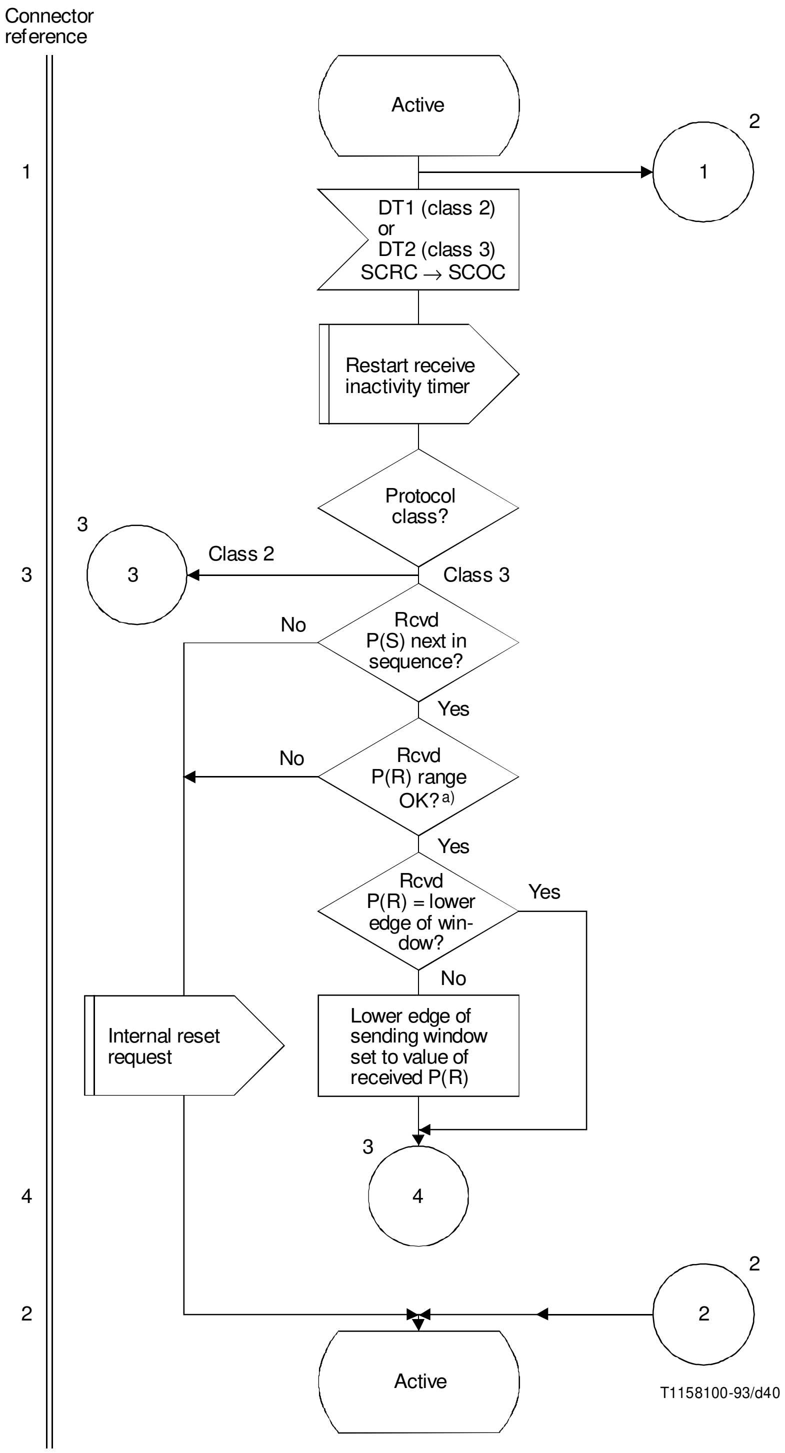


a) Freeze local reference.

b) Maitenance functions are for further study.

FIGURE C.7/Q.714 (Sheet 9 of 9)

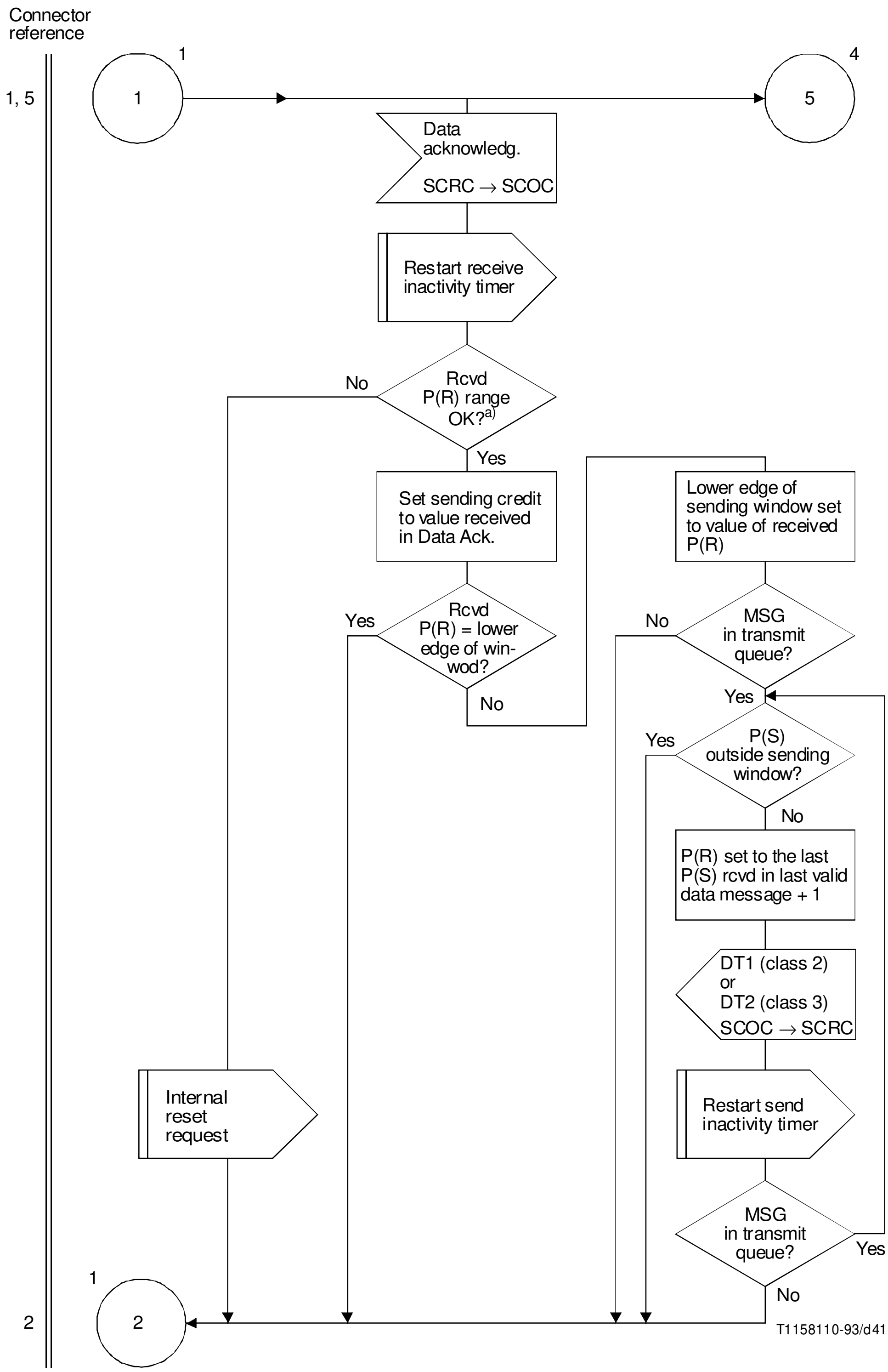
Connection release procedures at intermediate node for SCCP connection-oriented control (SCOC)



[a] Value of P(R) received must be within the range from the last P(R) received up to including the send sequence number of next message to be transmitted.

FIGURE C.8/Q.714 (Sheet 1 of 4)

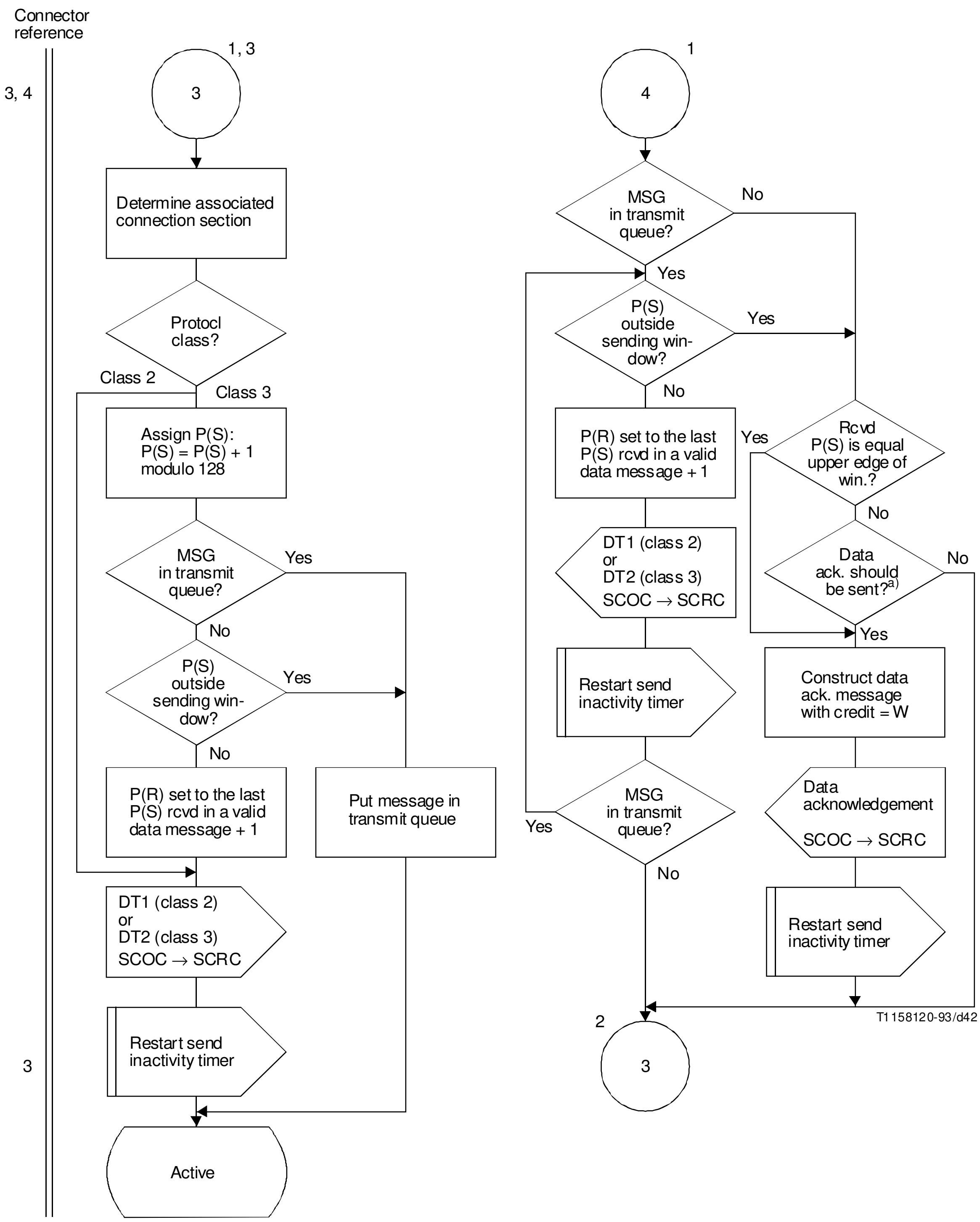
Data transfer procedures at intermediate node for SCCP connection-oriented control (SCOC)



a) Value of P(R) received must be within the range from the last P(R) received up to including the send sequence number of next message to be transmitted.

FIGURE C.8/Q.714 (Sheet 2 of 4)

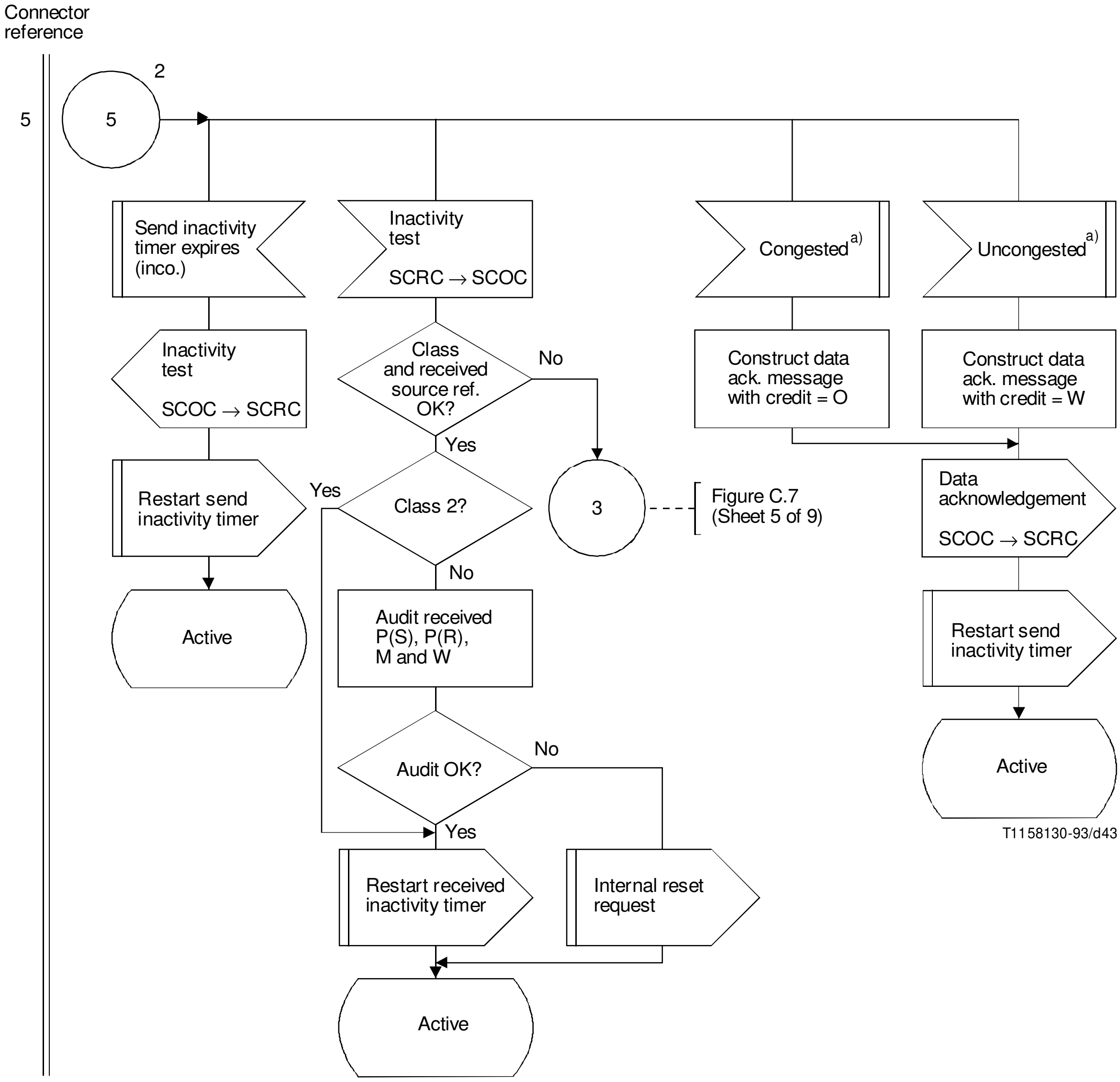
Data transfer procedures at intermediate node for SCCP connection-oriented control (SCOC)



a) This criterion is implementation dependent.

FIGURE C.8/Q.714 (Sheet 3 of 4)

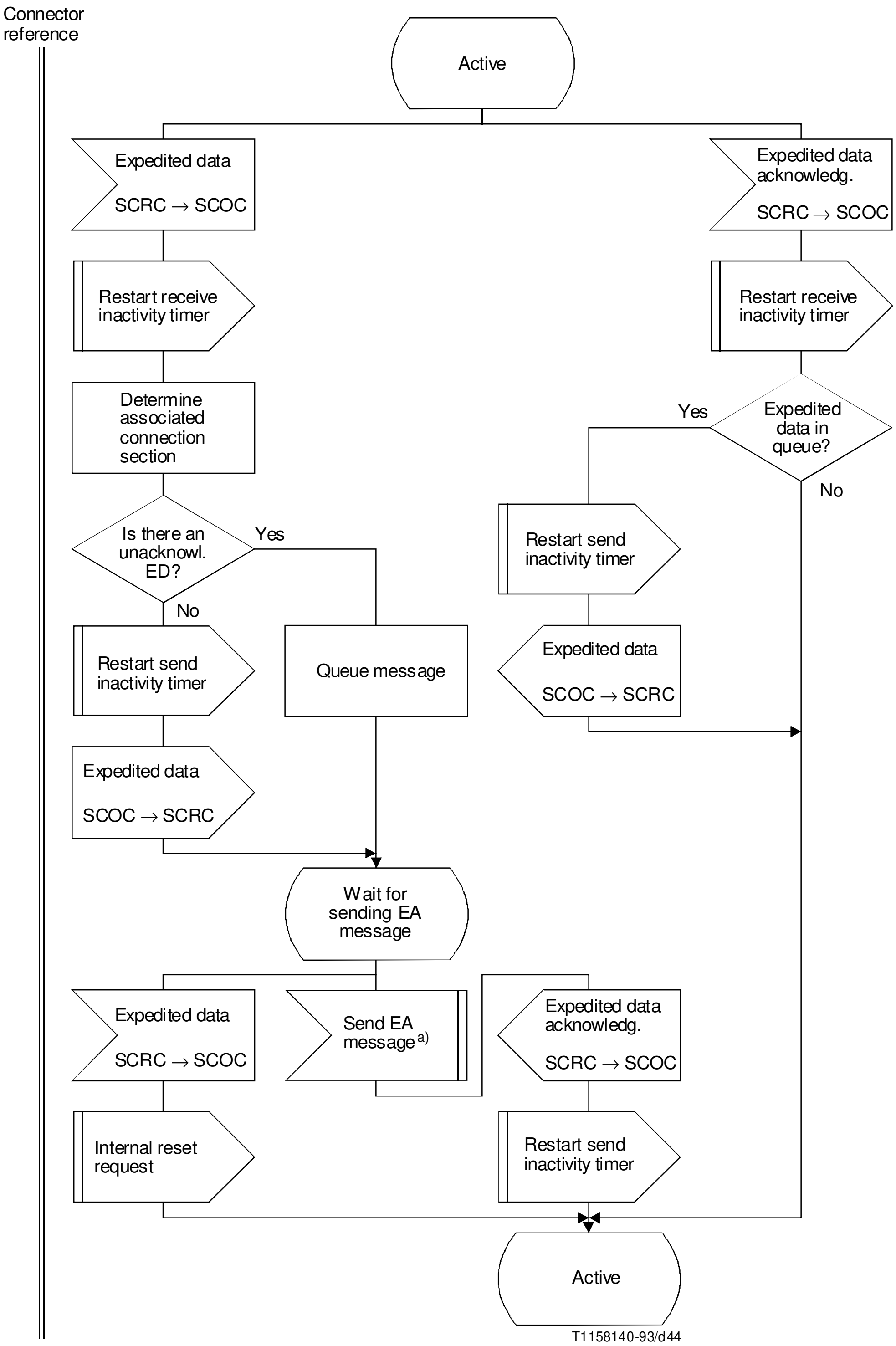
Data transfer procedures at intermediate node for SCCP connection-oriented control (SCOC)



a) From an implementation dependent function.

FIGURE C.8/Q.714 (Sheet 4 of 4)

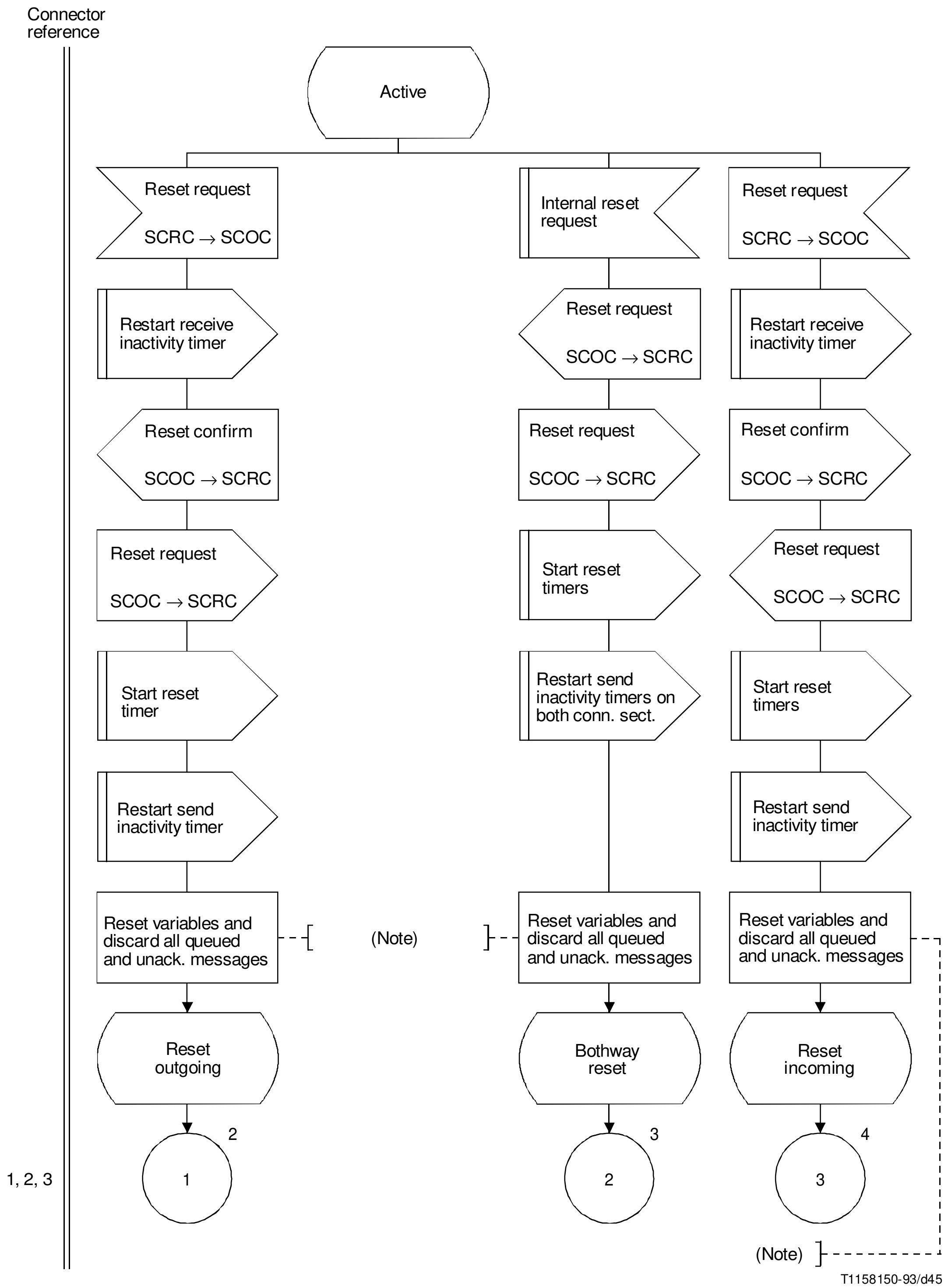
Data transfer procedures at intermediate node for SCCP connection-oriented control (SCOC)



a) From an implementation dependent function.

FIGURE C.9/Q.714

Expedited data transfer procedures at intermediate node for SCCP connection-oriented control (SCOC)



NOTE – On both connection sections.

FIGURE C.10/Q.714 (Sheet 1 of 4)

Reset procedures at intermediate node for SCCP connection-oriented control (SCOC)

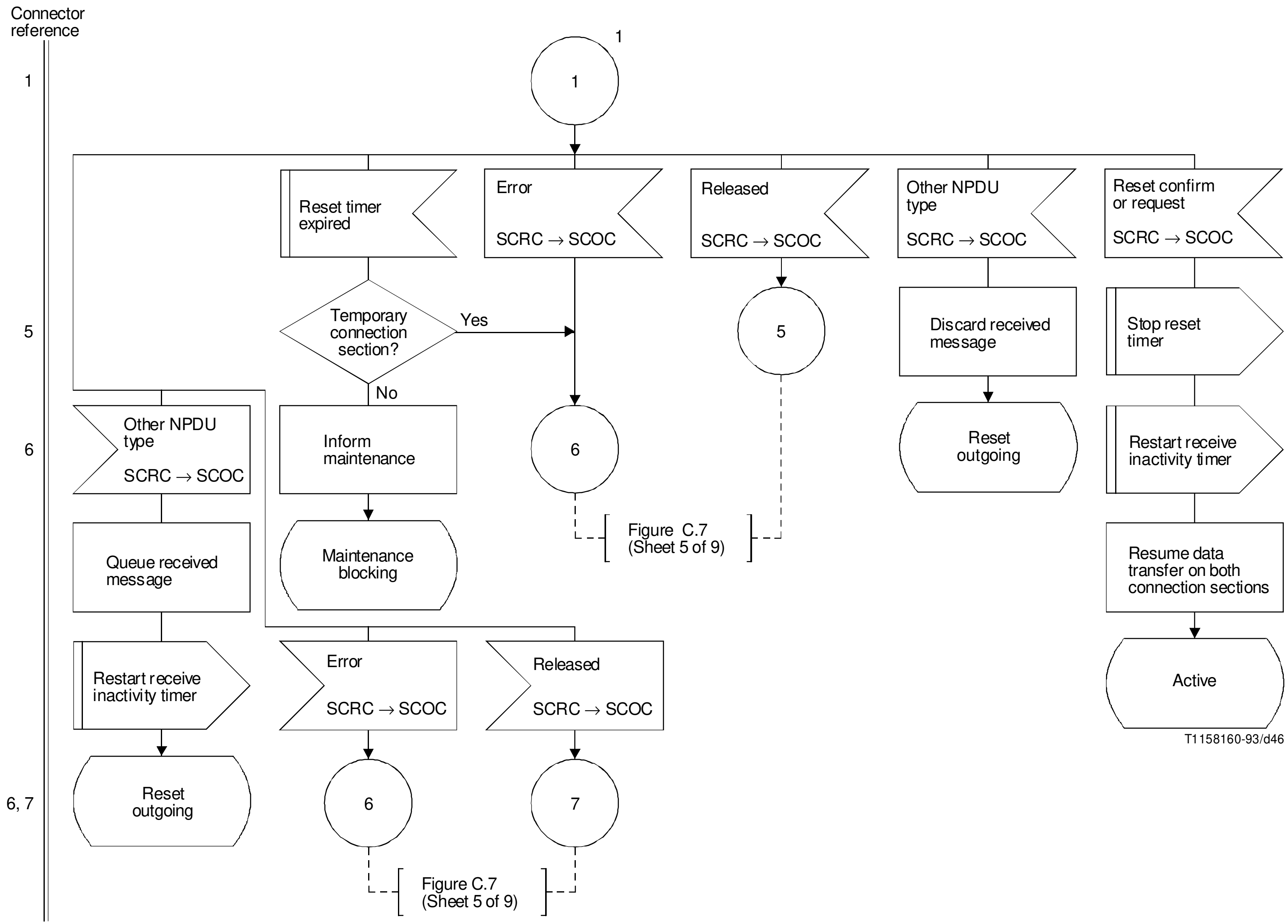


FIGURE C.10/Q.714 (Sheet 2 of 4)

Reset procedures at intermediate node for SCCP connection-oriented control (SCOC)

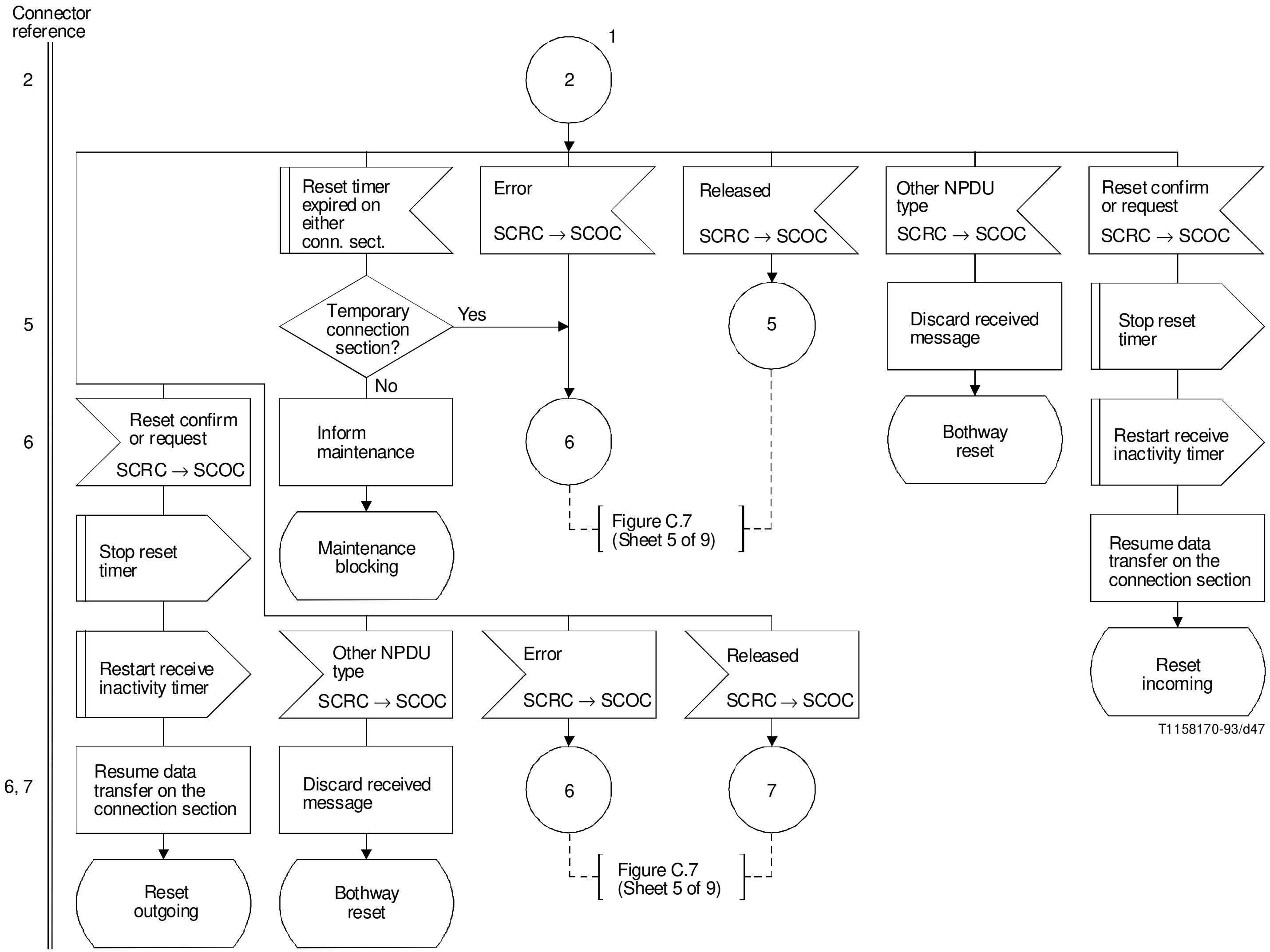


FIGURE C.10/Q.714 (Sheet 3 of 4)

Reset procedures at intermediate node for SCCP connection-oriented control (SCOC)

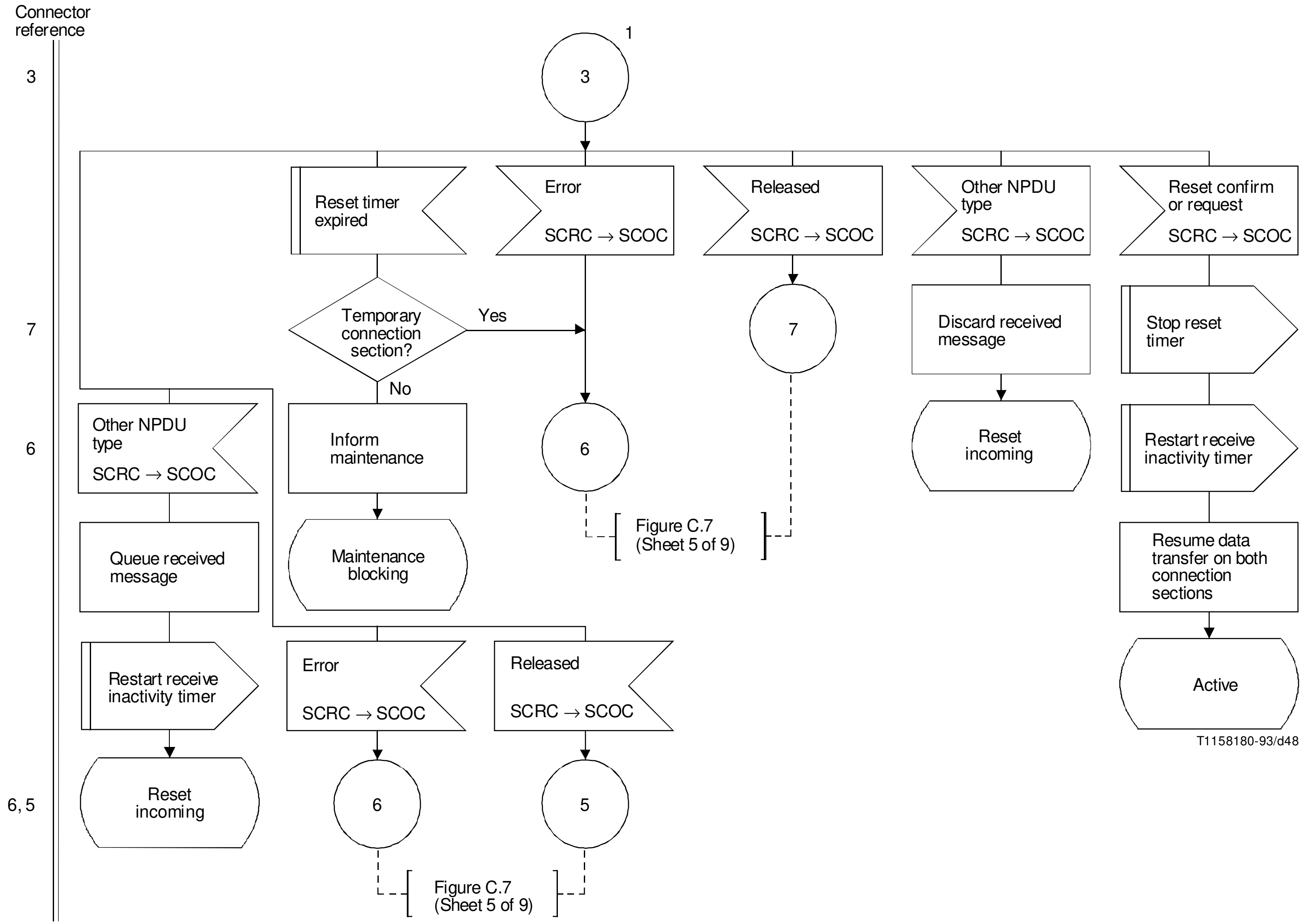


FIGURE C.10/Q.714 (Sheet 4 of 4)

Reset procedures at intermediate node for SCCP connection-oriented control (SCOC)

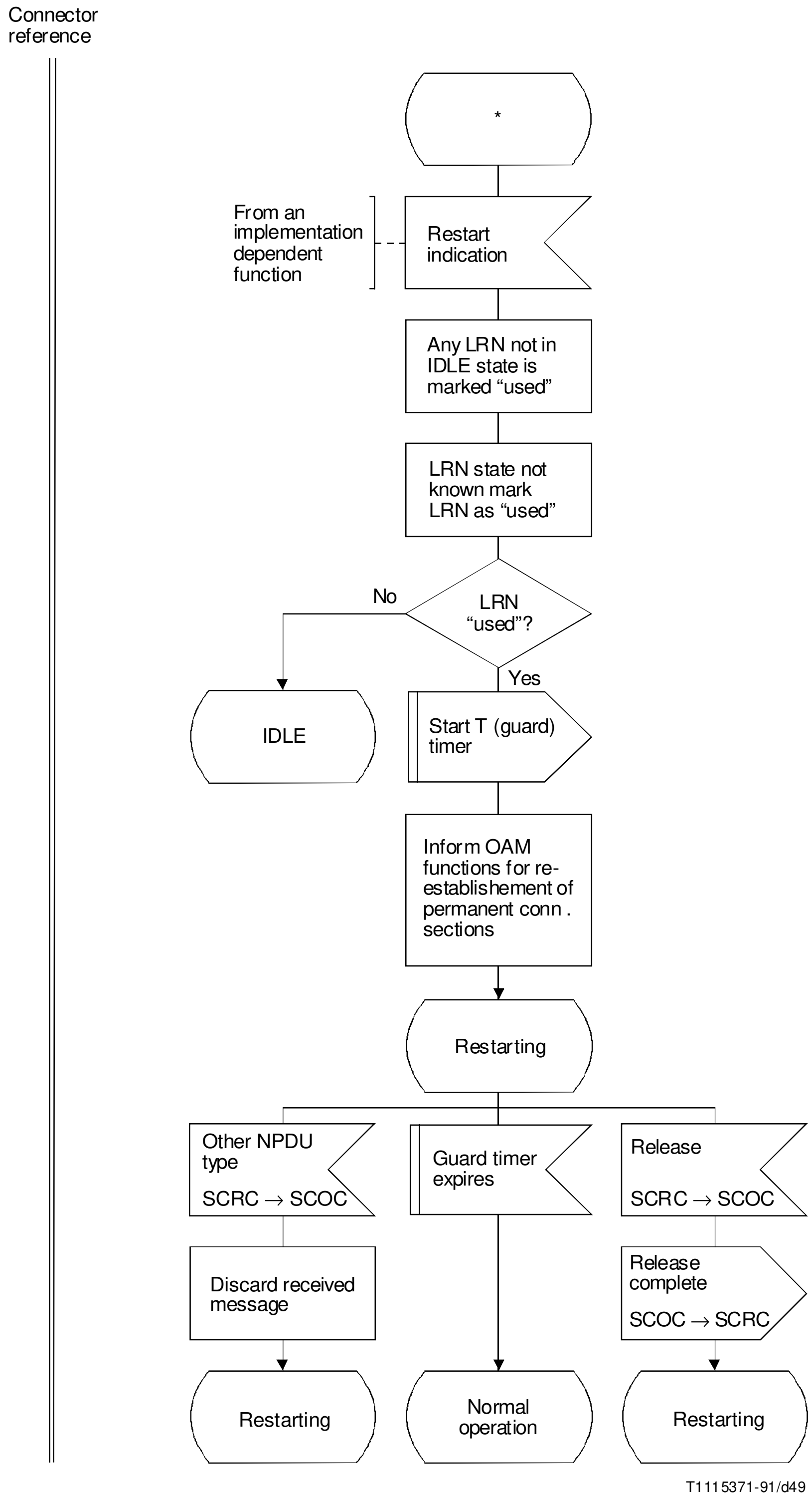


FIGURE C.11/Q.714

Restart procedure for SCCP connection-oriented control (SCOC)

Annex D

State transition diagrams (STD) for SCCP management control

(This annex forms an integral part of this Recommendation)

D.1 General

This annex contains the description of the SCCP management (SCMG) function according to the CCITT Specification and Description Language (SDL).

For the SCCP management function, Figure D.1 illustrates a subdivision into functional blocks, showing their functional interactions as well as the functional interactions with the other major functions (e.g. SCCP connectionless control (SCLC)). This is followed by Figures D.2 to D.10 showing state transition diagrams for each of the functional blocks.

The detailed functional breakdown shown in the following diagrams is intended to illustrate a reference model, and to assist interpretation of the text of the SCCP management procedures. 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.

D.2 Drafting conventions

Each major function is designated by its acronym (e.g. SCMG = SCCP management).

Each functional block is also designated by an acronym which identifies it (e.g. SSAC = Sub-System Allowed Control).

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 functional blocks which are the source and the destination of the message, e.g.:

SSAC → SSTC indicates that the message is sent from Sub-System Allowed Control to Sub-System Test Control.

Internal inputs and outputs are only used to indicate control of timers.

D.3 Figures

Figure D.1 shows a subdivision of the SCCP management function (SCMG) into smaller functional blocks, and also shows the functional interactions between them. Each of these functional blocks is described in detail in a state transition diagram as follows:

a) Signalling Point Prohibited Control (SPPC) is shown in Figure D.2;

b) Signalling Point Allowed Control (SPAC) is shown in Figure D.3;

c) Signalling Point Congested Control (SPCC) is shown in Figure D.4;

d) Sub-System Prohibited Control (SSPC) is shown in Figure D.5;

e) Sub-System Allowed Control (SSAC) is shown in Figure D.6;

f) Sub-System Status Test Control (SSTC) is shown in Figure D.7;

g) Coordinated State Change Control (CSCC) is shown in Figure D.8;

h) Local Broadcast (LBCS) is shown in Figure D.9;

i) Broadcast (BCST) is shown in Figure D.10.

D.4 Abbreviations and timers

Abbreviations and timers used in Figures D.1 to D.10 are listed below.

Abbreviations

BCST	Broadcast
CSCC	Cooordinated State Change Control
DPC	Destination Point Code
LBCS	Local Broadcast
MSG	Message
MTP	Message Transfer Part
SCCP	Signalling Connection Control Part
SCLC	SCCP Connectionless Control
SCMG	SCCP Management
SCOC	SCCP Connection-Oriented Control
SCRC	SCCP Routing Control
SOG	Sub-System Out of Service Grant
SOR	Sub-System Out of Service Request
SP	Signalling Point
SPAC	Signalling Point Allowed Control
SPCC	Signalling Point Congested Control
SPPC	Signalling Point Prohibited Control
SS	Sub-System
SSA	Sub-System Allowed
SSAC	Sub-System Allowed Control
SSP	Sub-System Prohibited
SSPC	Sub-System Prohibited Control
SST	Sub-System Status Test
SSTC	Sub-System Status Test Control
UIS	User In Service
UOS	User Out of Service

Timers

T(stat. info.)	Delay between requests for sub-system status information
T(coord. chg.)	Waiting for grant for sub-system to go out of service
T(ignore SST)	Delay for sub-system between receiving grant to go out of service and actually going out of service

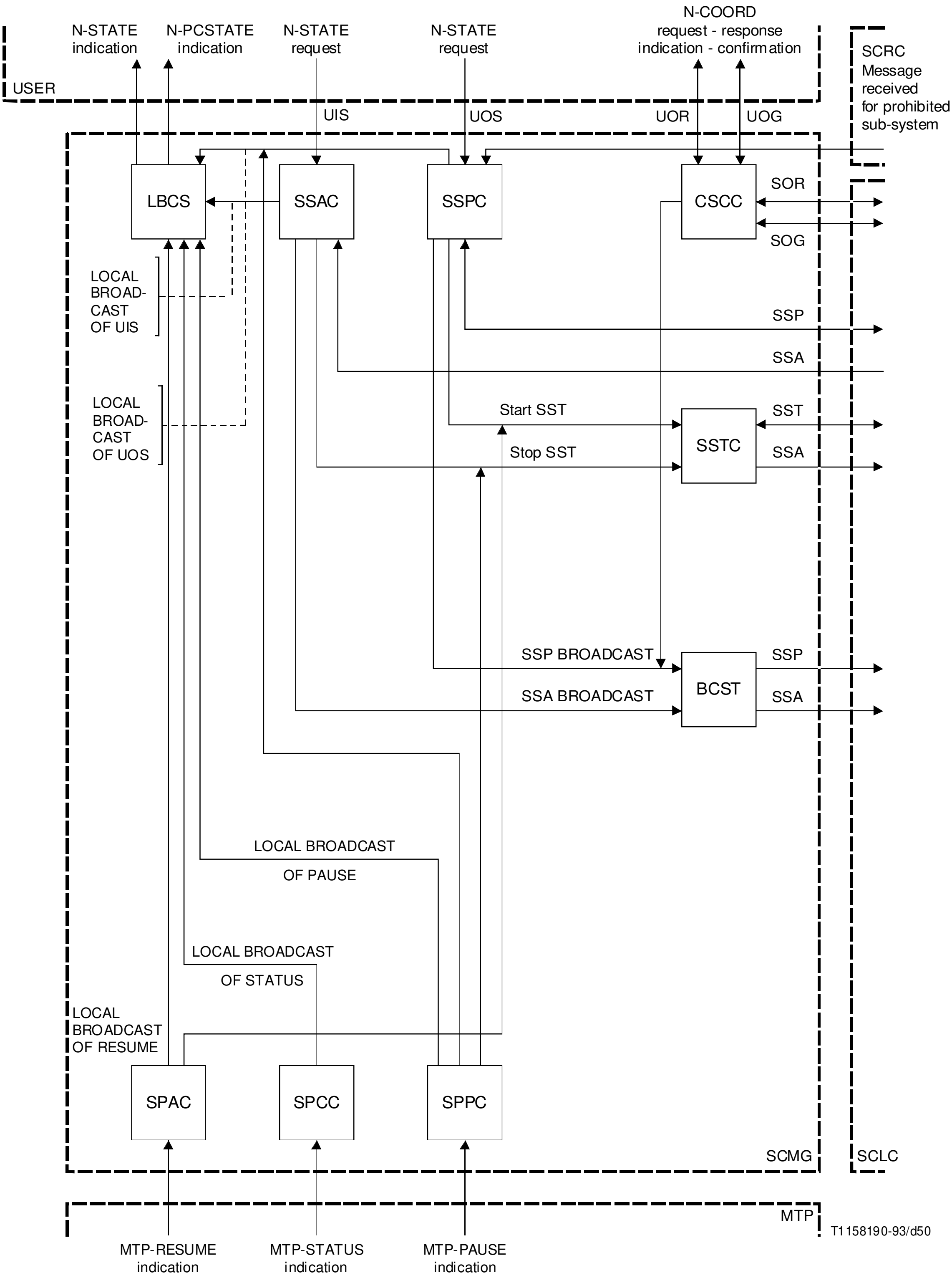


FIGURE D.1/Q.714

SCCP management overview (SCMG)

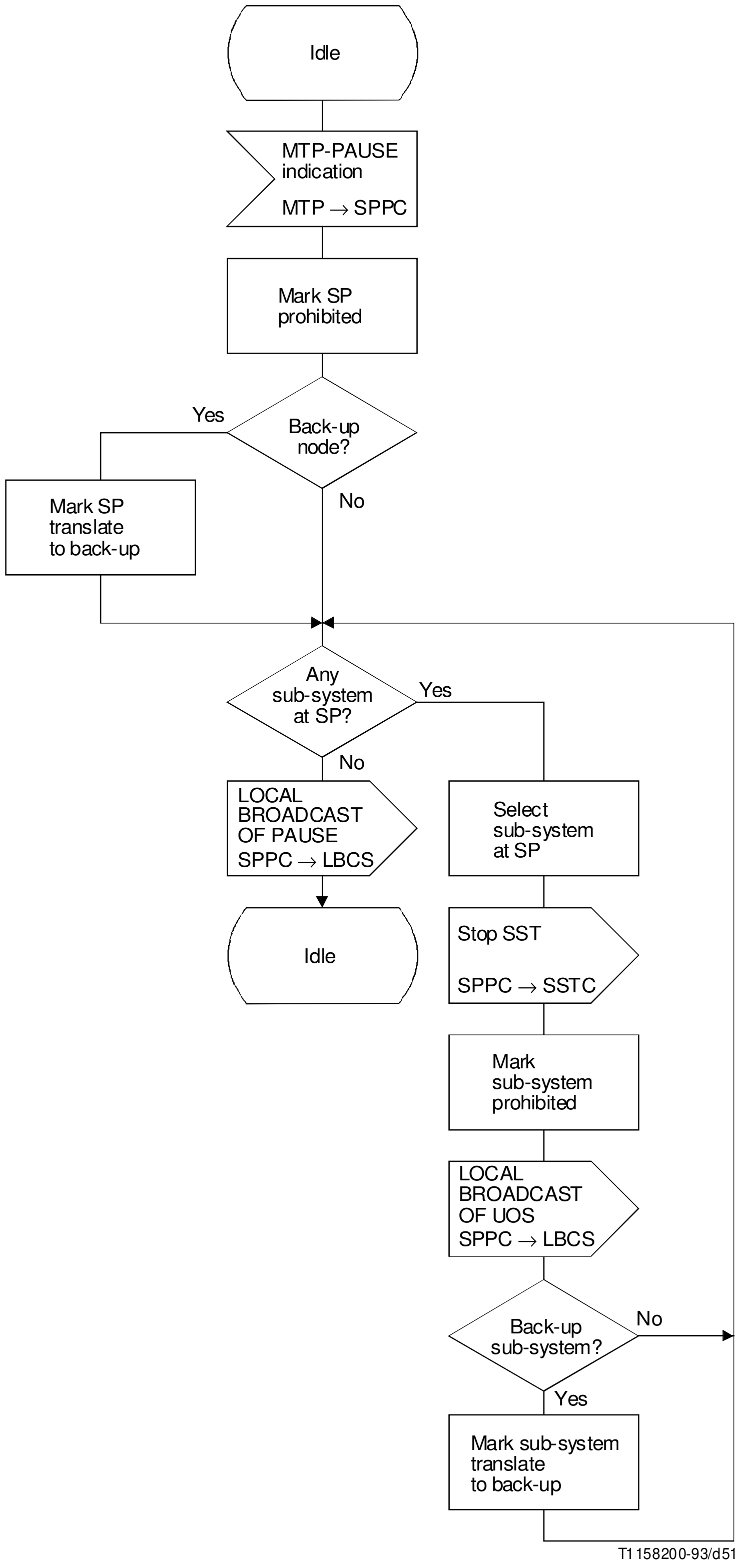


FIGURE D.2/Q.714

Signalling point prohibited control (SPPC)

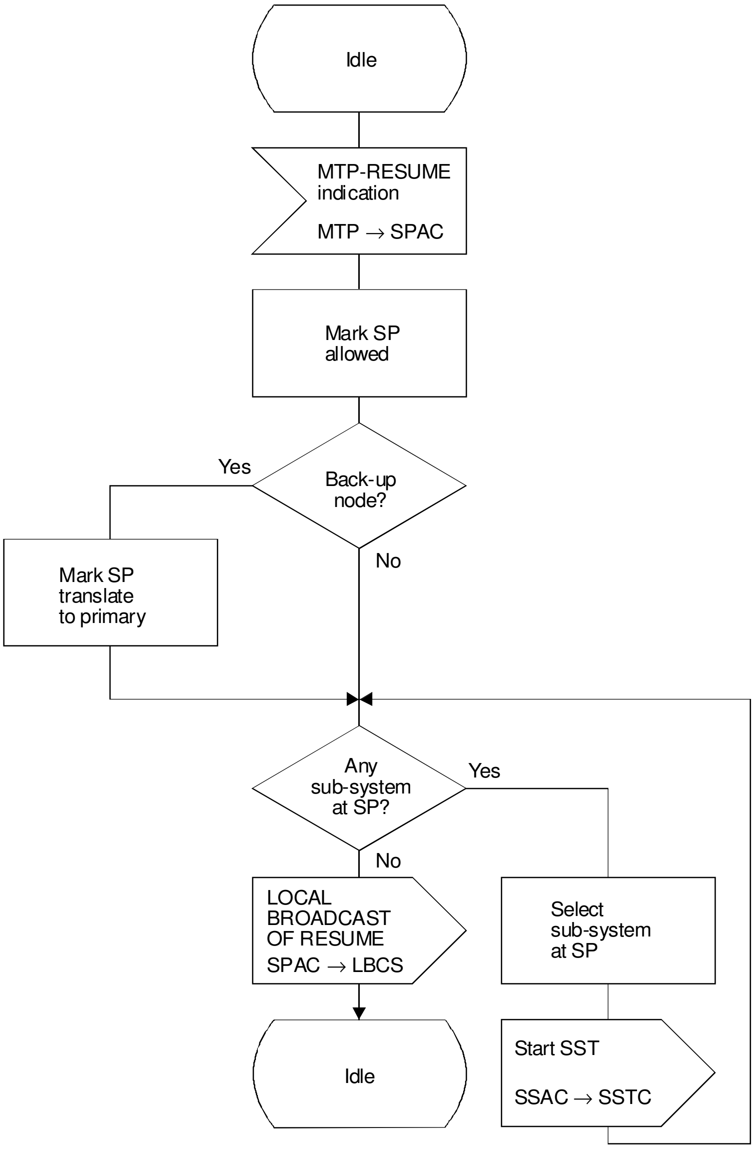


FIGURE D.3/Q.714

Signalling point allowed control (SPAC)

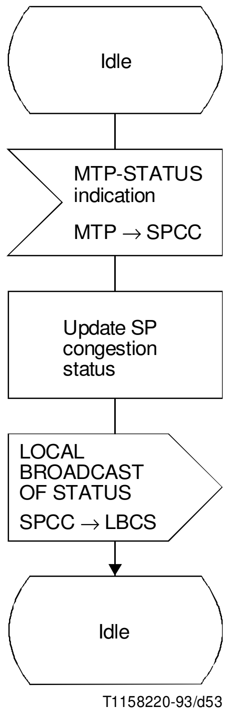


FIGURE D.4/Q.714

Signalling point congested control (SPCC)

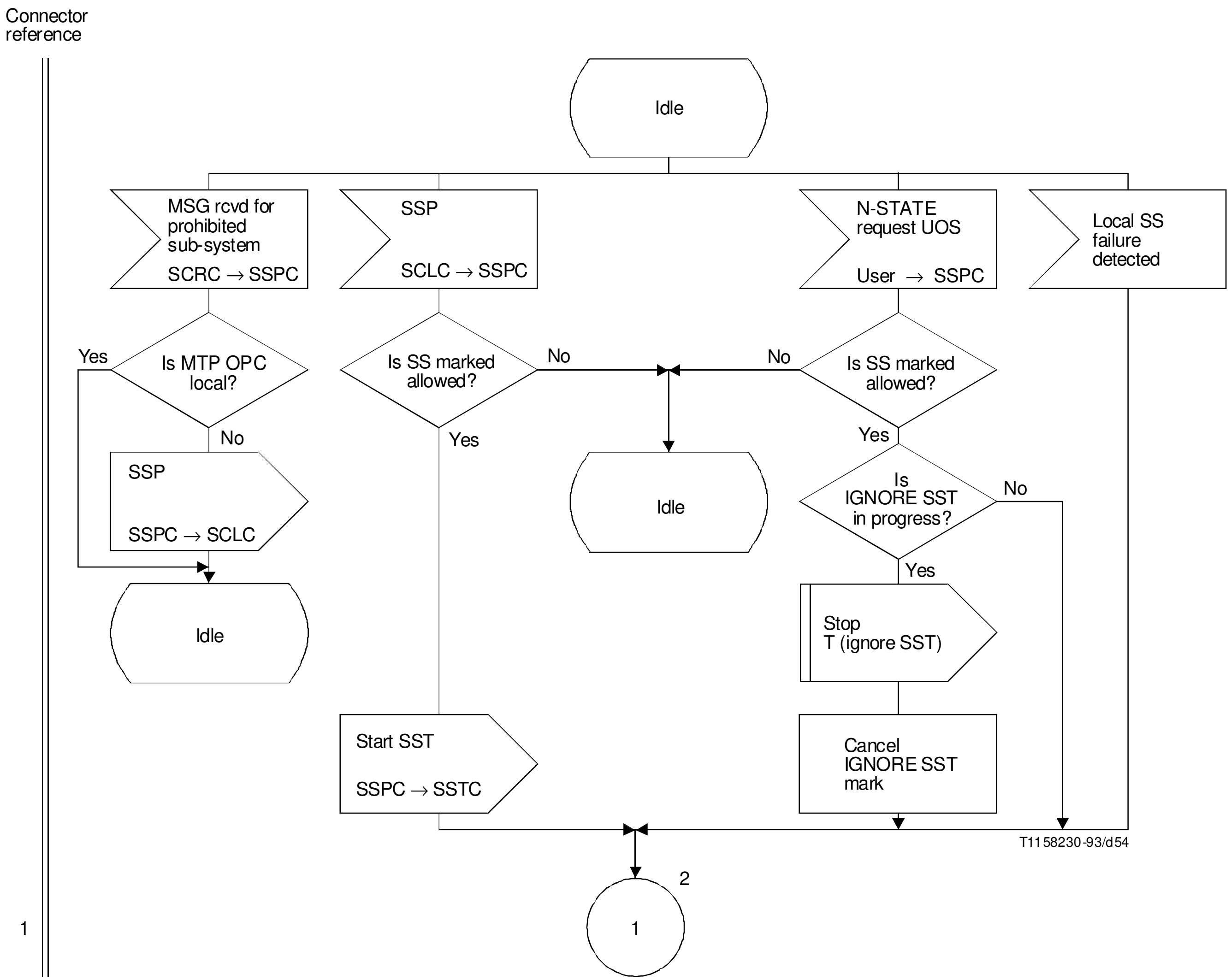


FIGURE D.5/Q.714 (Sheet 1 of 2)

Sub-system prohibited control (SSPC)

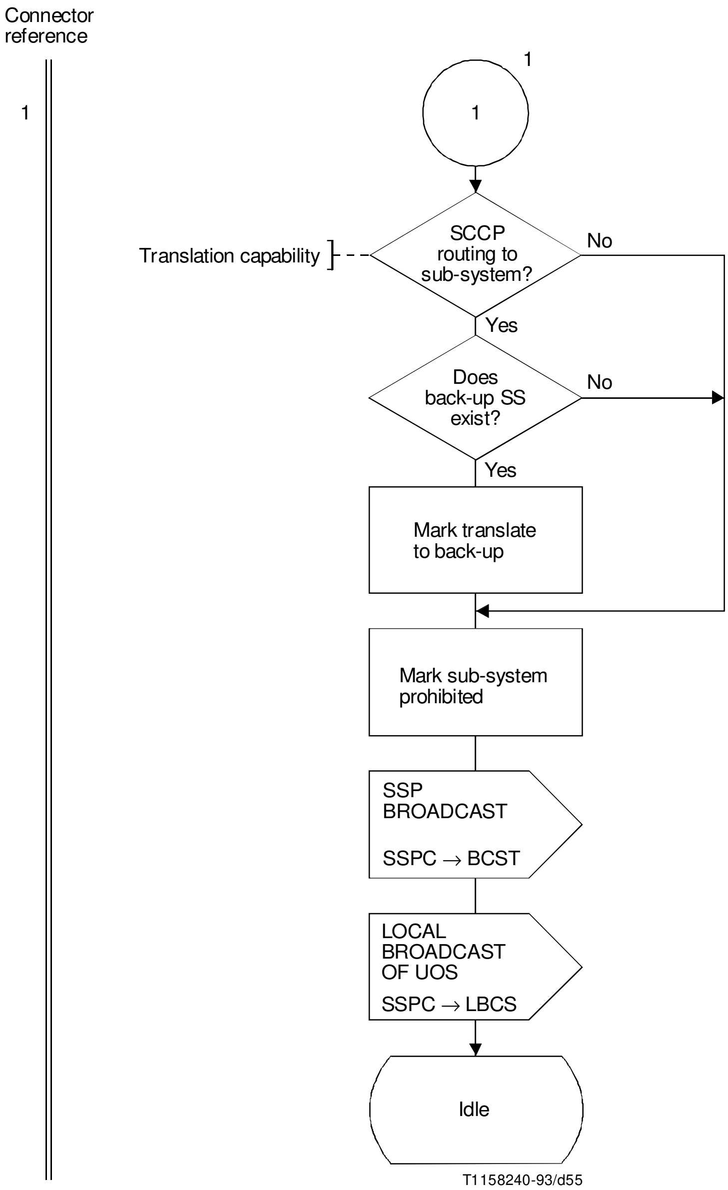


FIGURE D.5/Q.714 (Sheet 2 of 2)

Sub-system prohibited control (SSPC)

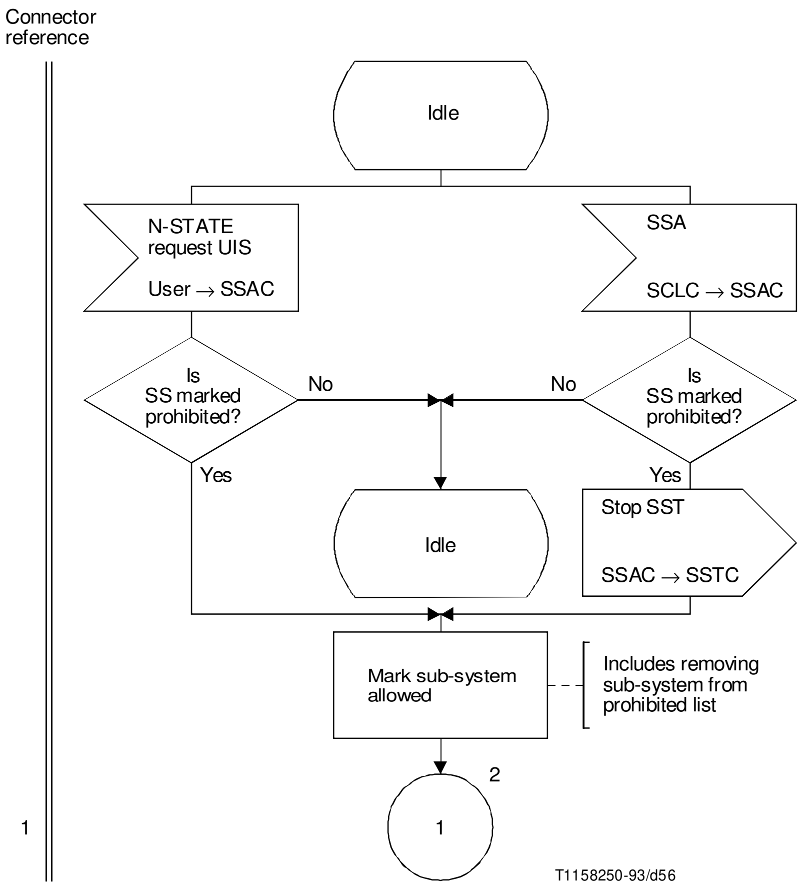


FIGURE D.6/Q.714 (Sheet 1 of 2)

Sub-system allowed control (SSAC)

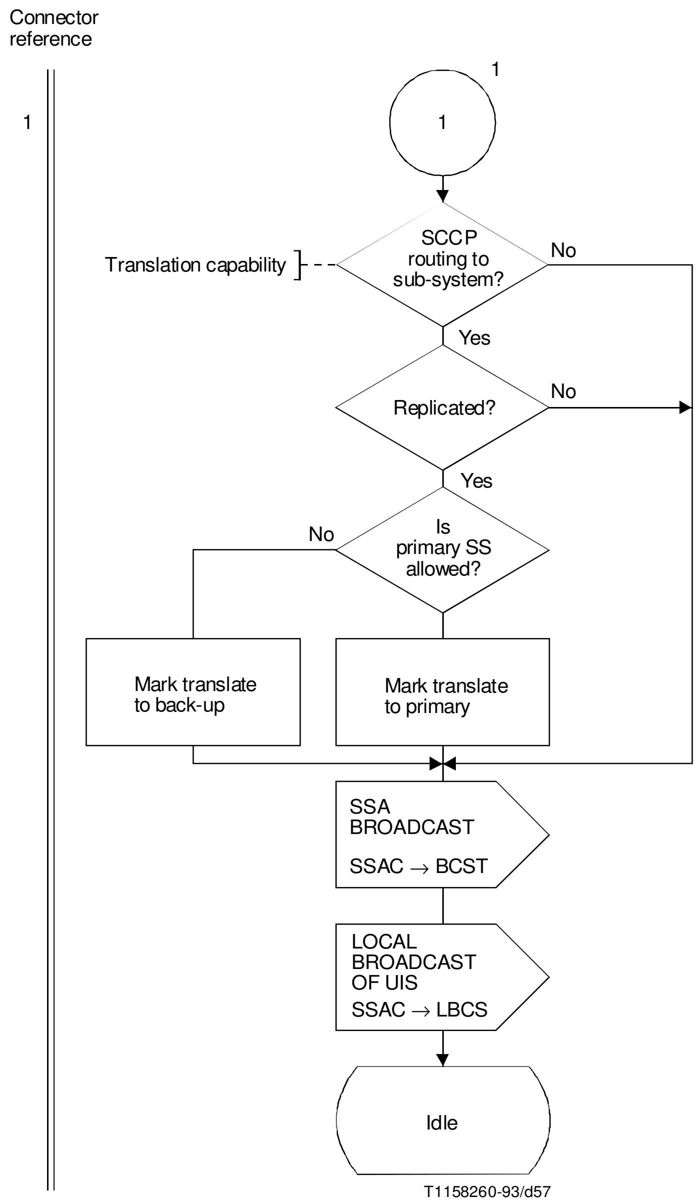


FIGURE D.6/Q.714 (Sheet 2 of 2)

Sub-system allowed control (SSAC)

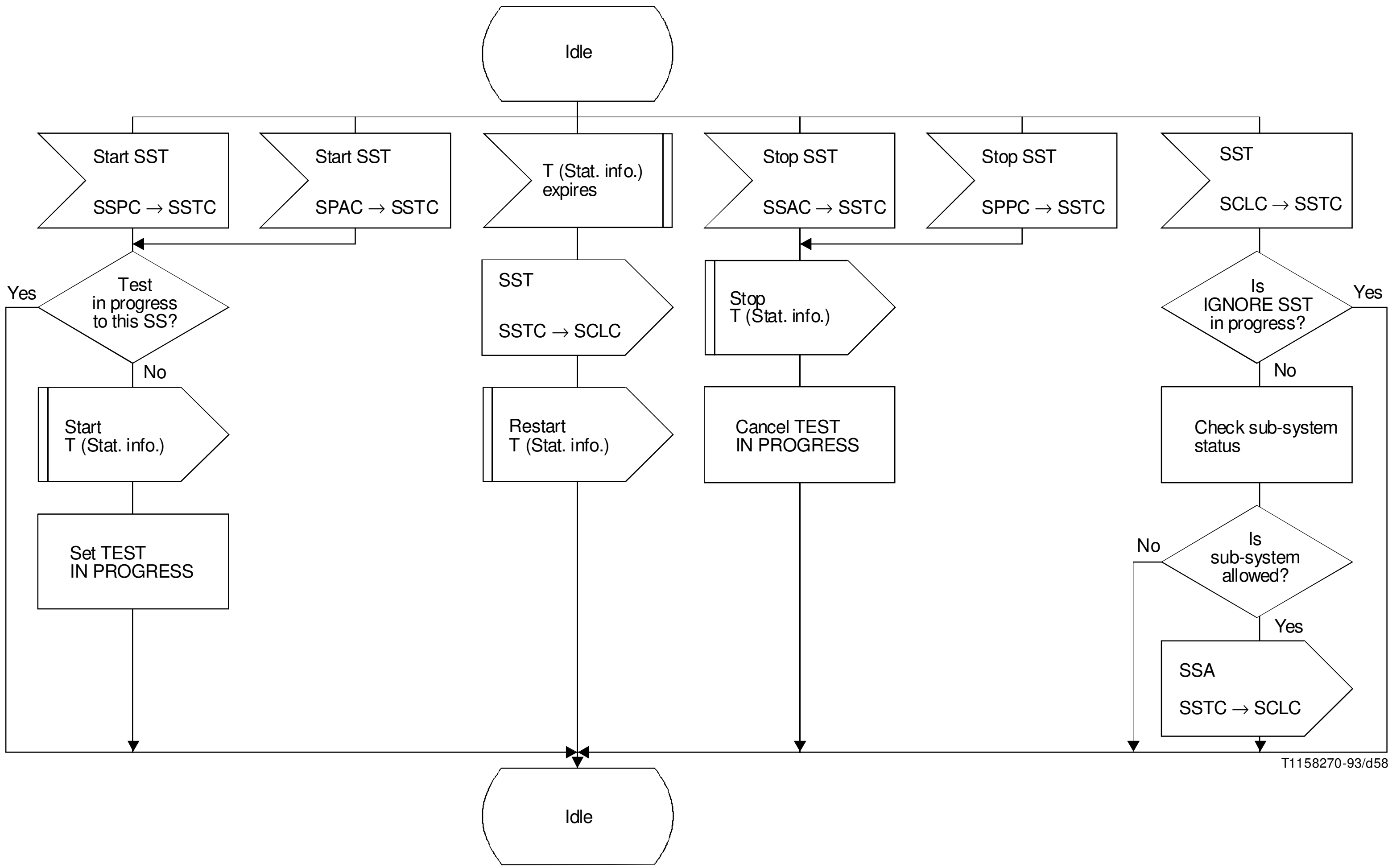


FIGURE D.7/Q.714

Sub-system Status Test Control (SSTC)

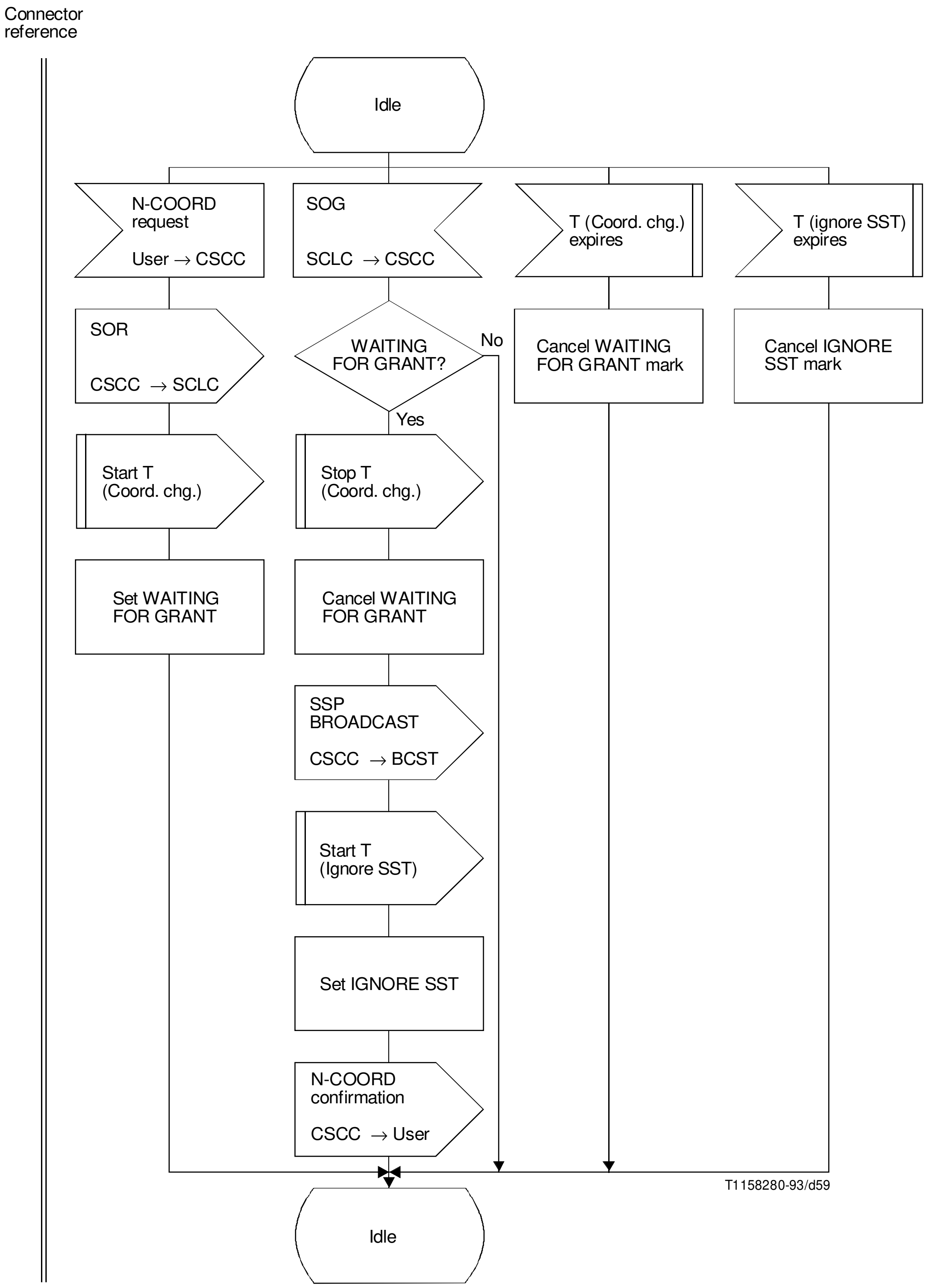


FIGURE D.8/Q.714 (Sheet 1 of 2)

Coordinated State Change Control (CSCC)
at the requesting node

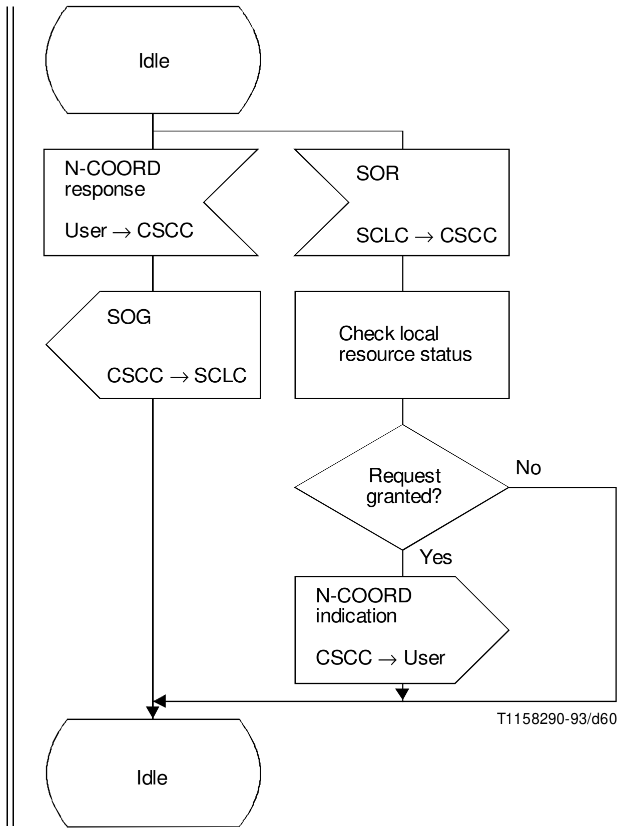
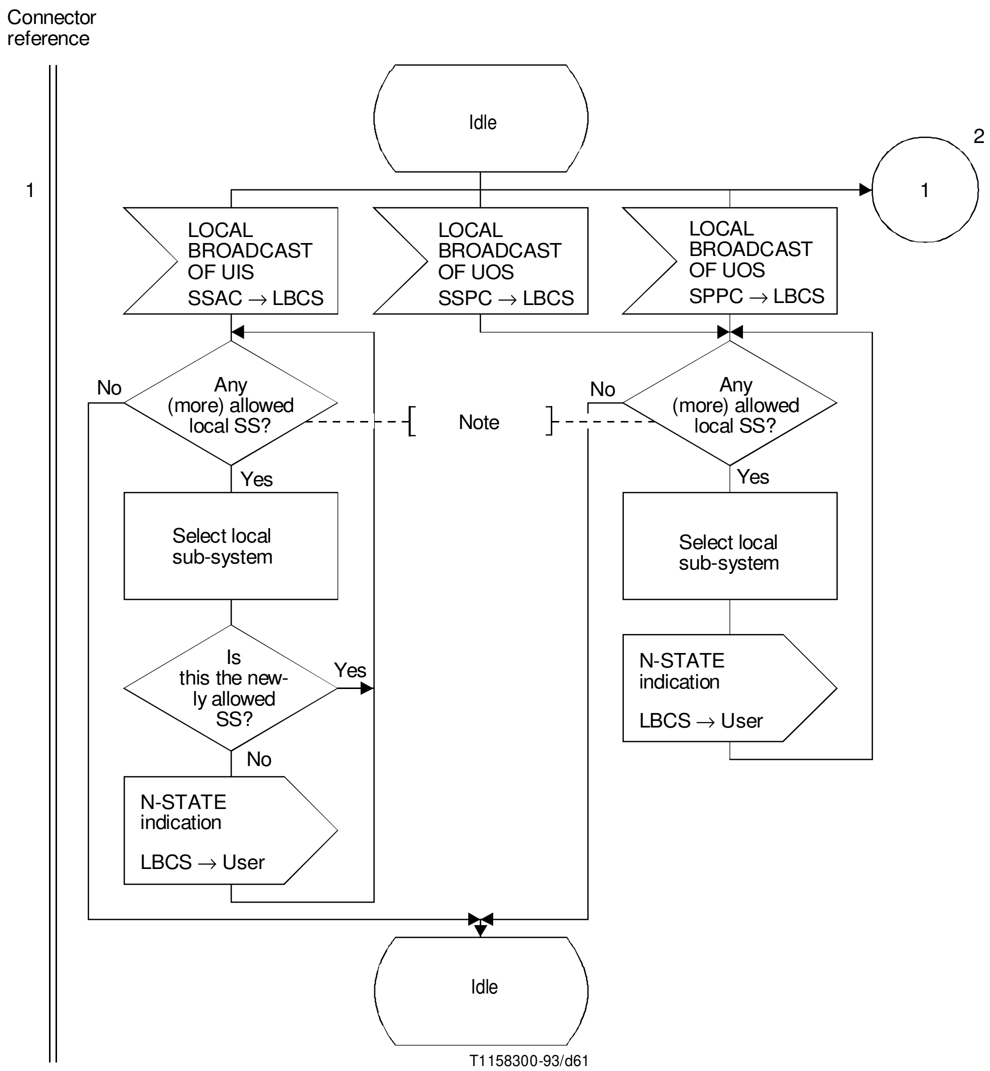


FIGURE D.8/Q.714 (Sheet 2 of 2)

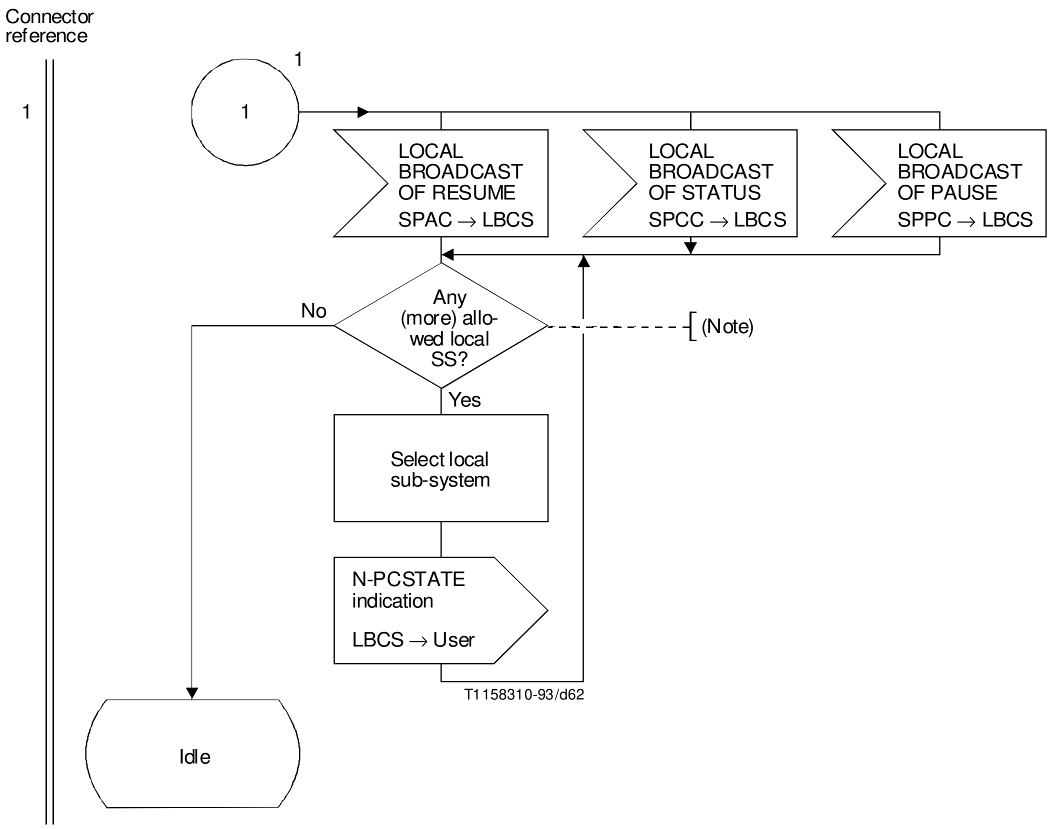
Coordinated State Change control (CSCC)
at the granting node



NOTE – As specified in 5.3.6.1, only concerned sub-systems are informed.

FIGURE D.9/Q.714 (Sheet 1 of 2)

Local broadcast (LBCS)



NOTE – As specified in 5.3.6.1, only concerned sub-systems are informed.

FIGURE D.9/Q.714 (Sheet 2 of 2)

Local broadcast (LBCS)

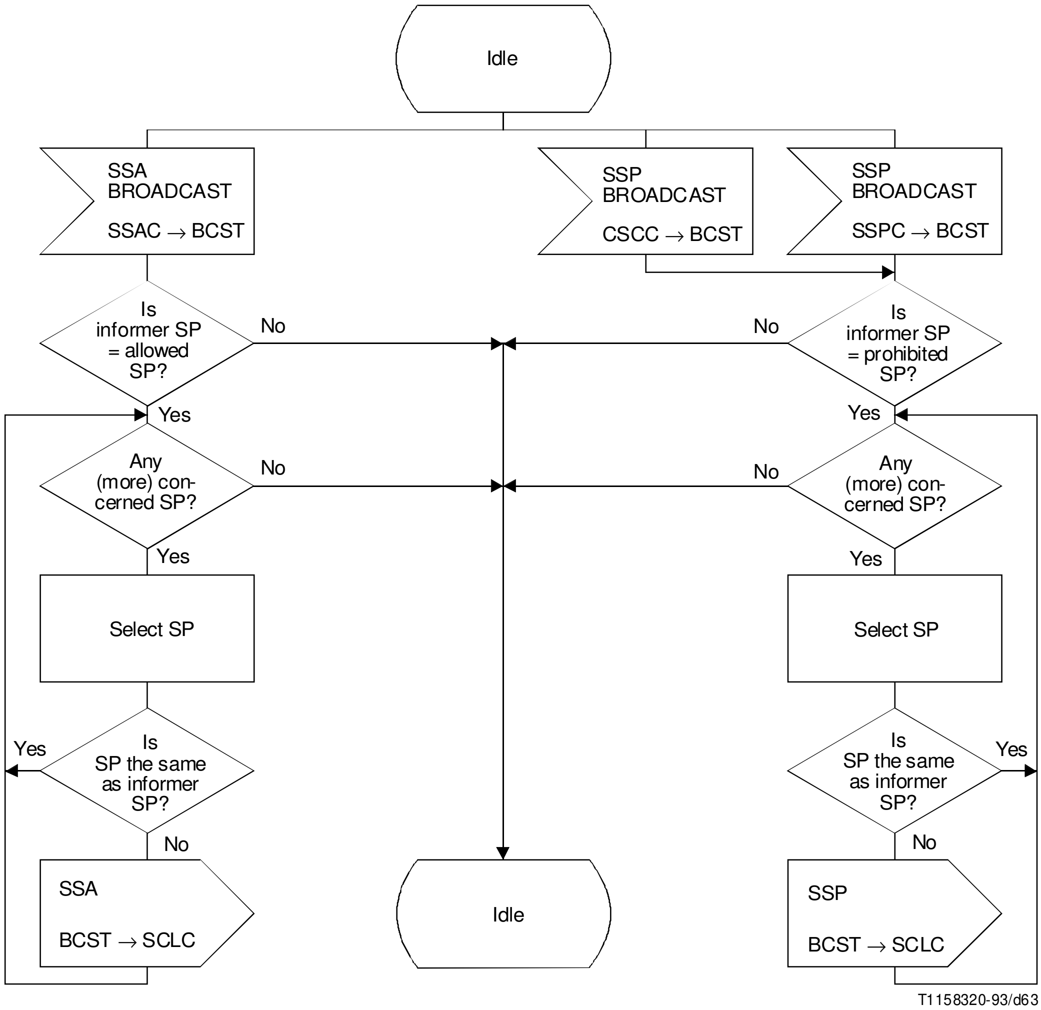


FIGURE D.10/Q.714

Broadcast (BCST)

Annex E

Guidelines for the use of the address information elements in the international network

(This annex forms an integral part of this Recommendation)

E.1 SCCP routing in the international network is normally done on global title. In case SCCP users have to be addressed in the international network, routing on DCP/SSN is also allowed.

E.2 In case SCCP routing is done on GT, only GT indicator type "4" will be used for the SCCP called party address. In addition, a SSN address element will always be present in the SCCP called party address, but its value will be coded "0" if the SSN was not used. A PC may be present in the SCCP called party address, but is not required.

In case SCCP routing is done on DPC/SSN, GT indicator type "0" is also allowed for the SCCP called party address.

E.3 GT indicator type "4" will be normally used for the SCCP calling party address. In case the communicating SCCP users form part of the international network. GT indicator type "0" may also be used.

E.4 In case a GT is present in the SCCP calling and/or called party addresses, the structure of the global title in the addresses will adhere to the following rules (deviations are only possible if multilateral agreements are obtained):

- in the absence of a specific agreement for the use of the translation type for a specific application, the default value of this field should be "0";
- the supported numbering plans are:
  - a) ISDN/Telephony numbering plan (E.164);
  - b) ISDN/Mobile numbering plan (E.214).

In the future, support of other numbering plans may be required.

- the nature of address indicator will always indicate "international number";
- the maximum length of address informa;tion present, the maximum number of digits permitted in accordance with the indicated numbering plan.