INTERNATIONAL TELECOMMUNICATION UNION

ITU-T I.365.2

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

(11/95)

INTEGRATED SERVICES DIGITAL NETWORK (ISDN)

OVERALL NETWORK ASPECTS AND FUNCTIONS

B-ISDN ATM ADAPTATION LAYER SUBLAYERS: SERVICE SPECIFIC COORDINATION FUNCTION TO PROVIDE THE CONNECTION ORIENTED NETWORK SERVICE

ITU-T Recommendation I.365.2

(Previously "CCITT Recommendation")

FOREWORD

The ITU-T (Telecommunication Standardization Sector) is a permanent organ of the International Telecommunication Union (ITU). 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, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1 (Helsinki, March 1-12, 1993).

ITU-T Recommendation Q.365.2 was prepared by ITU-T Study Group 13 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 2nd of November 1995.

NOTE

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

CONTENTS

Page

SUMMARY

The ATM Adaptation Layer (AAL) is defined to enhance the services provided by the ATM layer to support the functions required by the next higher layer. One particular type of service supported by the AAL is the Connection Oriented Network Service (CONS). The AAL for CONS comprises functions necessary to support CONS data communications between peer entities in the user plane.

The AAL for CONS consists of a Segmentation And Reassembly (SAR) function, and a Convergence Sublayer which is specified as two sublayers: a Common Part Convergence Sublayer (CPCS) and a Service Specific Convergence Sublayer (SSCS). The CPCS is defined in Clause 6/I.363 [2], and is used as the underlying protocol for the service specific part for CONS. The SSCS is functionally divided into two parts: the Service Specific Connection Oriented Protocol (SSCOP), which provides an assured data transfer service, and the Service Specific Coordination Function (SSCF). The SSCOP is defined in Recommendation Q.2110 [4] and is suitable for use by various SSCFs. This Recommendation specifies the SSCF for CONS.

This Recommendation describes for the SSCF-CONS the mapping of primitives from the Synchronization and Coordination Function (SCF) (defined in Recommendation Q.923 [3]) to signals of the SSCOP and vice versa. It also specifies the exchange of signals between Layer Management and the SSCF-CONS.

KEYWORD

Asynchronous Transfer Mode (ATM), ATM Adaptation Layer (AAL), Broadband Integrated Services Digital Network (B-ISDN), Connection Oriented Network Service (CONS), Service Specific Coordination Function (SSCF).

Recommendation I.365.2

B-ISDN ATM ADAPTATION LAYER SUBLAYERS: SERVICE SPECIFIC COORDINATION FUNCTION TO PROVIDE THE CONNECTION ORIENTED NETWORK SERVICE

(Geneva, 1995)

1 Scope

This Recommendation specifies a function that is part of the ATM Adaptation Layer to support the OSI Connection Oriented Network Service (CONS) within the B-ISDN. This function is used to map the service of the Service Specific Connection Oriented Protocol (SSCOP) of the AAL to the requirements of a Network Service user as defined in Recommendation X.213 [7]. This function is called Service Specific Coordination Function to provide CONS (SSCF-CONS).

This Recommendation covers the specification of the SSCF identified in the complete AAL structure for connection oriented data communications defined in Recommendation I.363 [2], and describes the relationship to the protocol entity providing the Network Service defined in Recommendation X.213 [7], the Service Specific Connection Oriented Protocol defined in Recommendation Q.2110 [4], and Layer Management.

This Recommendation is applicable to equipment to be attached to a B-ISDN User Network Interface (UNI) or B-ISDN Network Node Interface (NNI) when the OSI Connection Oriented Network Service is to be supported.

2 Normative references

The following Recommendations and other references contain provisions which, through reference in this text, constitue provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision: all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

[1] ITU-T Recommendation I.361 (1993), *B-ISDN ATM layer specification.*

[2] ITU-T Recommendation I.363 (1993), *B-ISDN ATM Adaptation Layer (AAL) specification.*

[3] ITU-T Recommendation Q.923 (1995), *Specification of a synchronization and coordination function for the provision of the OSI connection-mode network service in an ISDN environment.*

[4] ITU-T Recommendation Q.2110 (1994), *B-ISDN ATM Adaptation Layer – Service Specific Connection Oriented Protocol (SSCOP).*

[5] ITU-T Recommendation X.200 (1994), *Information technology – Open Systems Interconnection – Basic reference model: The basic model.*

[6] ITU-T Recommendation X.210 (1993), *Information technology – Open Systems Interconnection – Basic reference model: Conventions for the definition of OSI services.*

[7] ITU-T Recommendation X.213 (1995), *Information technology – Open Systems Interconnection Network service definitions – Amendment 1: Addition of group network addressing and connectionless-mode multicast services.*

[8] ITU-T Recommendation X.223 (1993), *Use of X.25 to provide the OSI connection-mode network service for ITU-T applications.*

[9] ITU-T Recommendation Q.2951 (1995), *Stage 3 description for number identification supplementary services using D-ISDN Digital Subscriber Signalling System No. 2 – Basic Call – Clause 8 – Sub-addressing (SUB).*

[10] ITU-T Recommendation Q.2957 (1995), *Stage 3 description for additional information transfer supplementary services using B-ISDN Digital Subscriber Signalling System No. 2 (DSS2) – Basic Call – Clause 1 – User-to-User Signalling (UUS).*

3 Definitions

This Recommendation is based upon the concepts developed in Recommendation X.200 [5], and makes use of the following terms defined in that Recommendation:

a) connection oriented;

b) expedited data transfer;

c) Network Layer;

d) Network Service;

e) Network Service Access Point;

f) receipt confirmation.

This Recommendation is based upon the concepts developed in Recommendation I.363 [2], and makes use of the following terms defined in that Recommendation:

a) Asynchronous Transfer Mode Adaptation Layer;

b) Common Part Convergence Sublayer;

c) Segmentation and Reassembly Sublayer;

d) Service Specific Convergence Sublayer.

Furthermore, this Recommendation is based upon the concepts developed in Recommendation Q.2110 [4], and makes use of the following terms defined in that Recommendation:

a) Service Specific Coordination Function;

b) Service Specific Connection Oriented Protocol.

4 Abbreviations

For the purposes of this Recommendation, the following abbreviations are used.

AAL	ATM Adaptation Layer
ATM	Asynchronous Transfer Mode
CC	Connection Establishment – Confirmation (PDU)
CONS	Connection Oriented Network Service
CP	Common Part
CPCS	Common Part Convergence Sublayer
CR	Connection Establishment – Request (PDU)
DATA	(normal) Data (PDU)
DR	Connection Release – Disconnect (PDU)
ED	Expedited Data (PDU)
EDAK	Expedited Data Acknowledgement (PDU)
NS	(OSI) Network Service
NSAP	(OSI) Network Service Access Point
N-SDU	Network Service Data Unit

PCI	Protocol Control Information
PDU	Protocol Data Unit
QOS	Quality of Service
RC	Receipt Confirmation (PDU)
RCAK	Receipt Confirmation Acknowledgement (PDU)
SAAL	AAL for Signalling
SAP	Service Access Point
SAR	Segmentation And Reassembly
SCF	Synchronization and Coordination Function
SDL	Specification and Description Language
SDU	Service Data Unit
SSCF	Service Specific Coordination Function
SSCS	Service Specific Convergence Sublayer
SSCOP	Service Specific Connection Oriented Protocol
SSCOP-UU	SCOP User-to-User parameter

5 Conventions

The primitives at the AAL type 5 SAP are conventionally called "AAL-primitives". However, as defined in the General Descriptions (see clause 6) and shown in Figure 2 the SCF as defined in Recommendation Q.923 [3] is the immediate user of this AAL type 5 and the primitives there are defined in terms of N(u)-primitives, this Recommendation defines the primitives across the AAL type 5 SAP also as N(u)-primitives.

6 General description

The Service Specific Coordination Function providing the Connection Oriented Network Service (SSCF-CONS) resides in the Service Specific Convergence Sublayer (SSCS) of the ATM Adaptation Layer (AAL). It deploys the services provided by the Service Specific Connection Oriented Protocol (SSCOP) defined in Recommendation Q.2110 [4]. SSCOP also resides in the SSCS. Figure 1 illustrates the structure of the AAL.

The SSCF-CONS provides for the service that is requested by the Synchronization and Coordination Function (SCF) defined in Recommendation Q.923 [3]. This SCF in turn provides the Connection Oriented Network Service (CONS) as defined in Recommendation X.213 [7]. The SCF also utilizes the signalling capabilities defined for the C-plane. Figure 2a illustrates the B-ISDN structure of the U-plane and C-plane for switched ATM connections. For permanent ATM connections, the SCF interfaces with the M-plane instead of with the C-plane; this situation is shown in Figure 2b.

Supplementary specifications for the SCF as required by Recommendation Q.923 [3] are defined in Annex F.

The definition of the SSCF-CONS takes into consideration the principles and terminology of the Recommendations X.200 [5] and X.210 [6], the reference model and the service conventions for Open Systems Interconnection (OSI).

This Recommendation specifies:

- the interactions between the SSCF-CONS and the SCF sublayer;
- the interactions between the SSCF-CONS and the SSCOP sublayer;
- the interactions between the SSCF-CONS and the AAL management; and
- the peer-to-peer protocol that enhances the SSCOP service to provide the Connection Oriented Network Service (CONS).

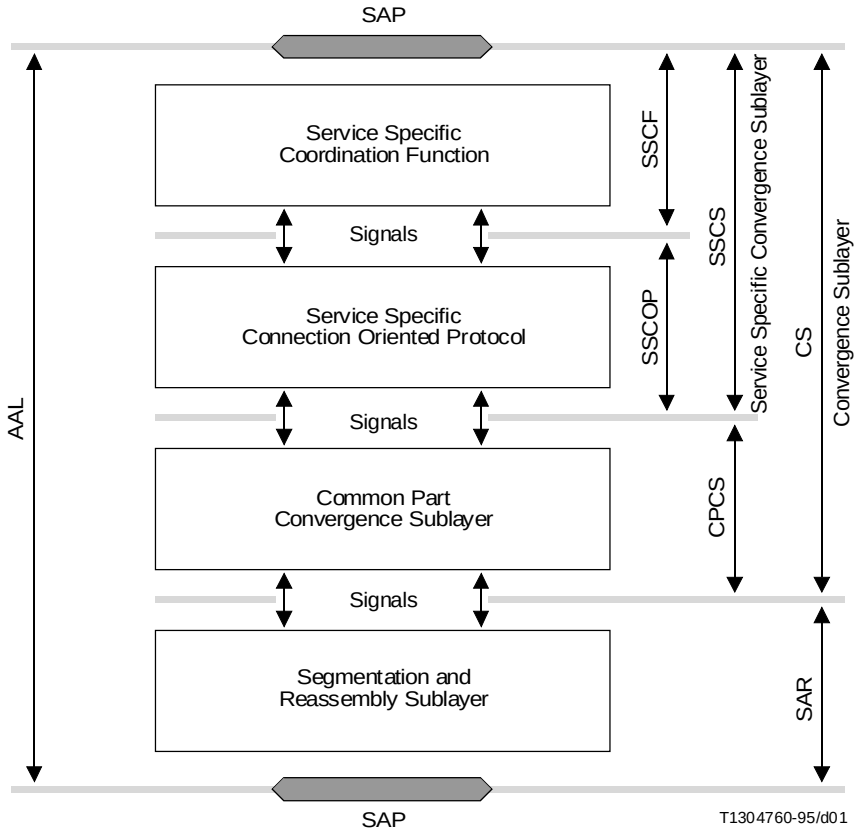


FIGURE 1/I.365.2

AAL structure

7 Services provided by the SSCF-CONS

The SSCF-CONS provides for the transparent transfer of data, i.e. SSCF-CONS user data between SSCF-CONS users. The supporting communication resources to achieve this transfer stay invisible to the SSCF-CONS user.

In particular, the SSCF-CONS service provides for:

a) *Independence from the underlying transmission media*

The SSCF-CONS service relieves its users from all concerns of the manner in which the SSCF-CONS service is provided. Except for possible influences of the quality of service, the transfer of data over heterogenous underlying networks is, thus, invisible.

b) *Transparency of the information transferred*

The SSCF-CONS service provides for the transparent transfer of octet-aligned SSCF-CONS user data and/or control information. It does not restrict the content, format, or coding of the information nor is there ever a need to interpret its structure or meaning.

c) *Connection establishment and release*

The SSCF-CONS service assists the SSCF-CONS user in the connection establishment and release. During connection establishment, the “use” or “not use” of the optional Expedited Data and/or Receipt Confirmation service is selected. Simultaneous connection establishment from both sides leads to at most one connection.

d) *Connection reset*

The SSCF-CONS service provides for a reset mechanism. Its use allows the two SSCF-CONS user entities to resynchronize.

e) *Quality of Service selection*

The SSCF-CONS service makes available to its users the means to request and agree to a quality of service for the transfer of SSCF-CONS user data. Quality of Service is specified by means of QOS-parameters representing characteristics such as throughput, transit delay, accuracy and reliability. Throughput and transit delay are subject to negotiation during connection establishment.

f) *SSCF-CONS user addressing*

The SSCF-CONS service utilizes a system of addressing (NSAP addressing) which allows SSCF-CONS users to refer unambigously to one another.

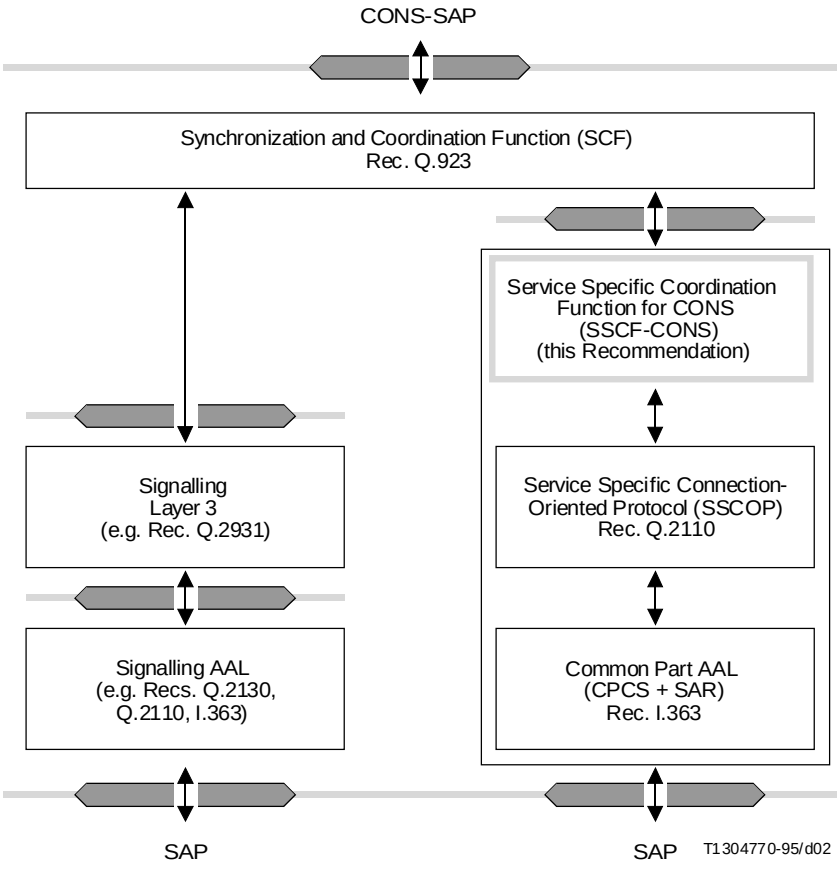


FIGURE 2a/I.365.2

Structure of the CONS provider deploying switched ATM connections

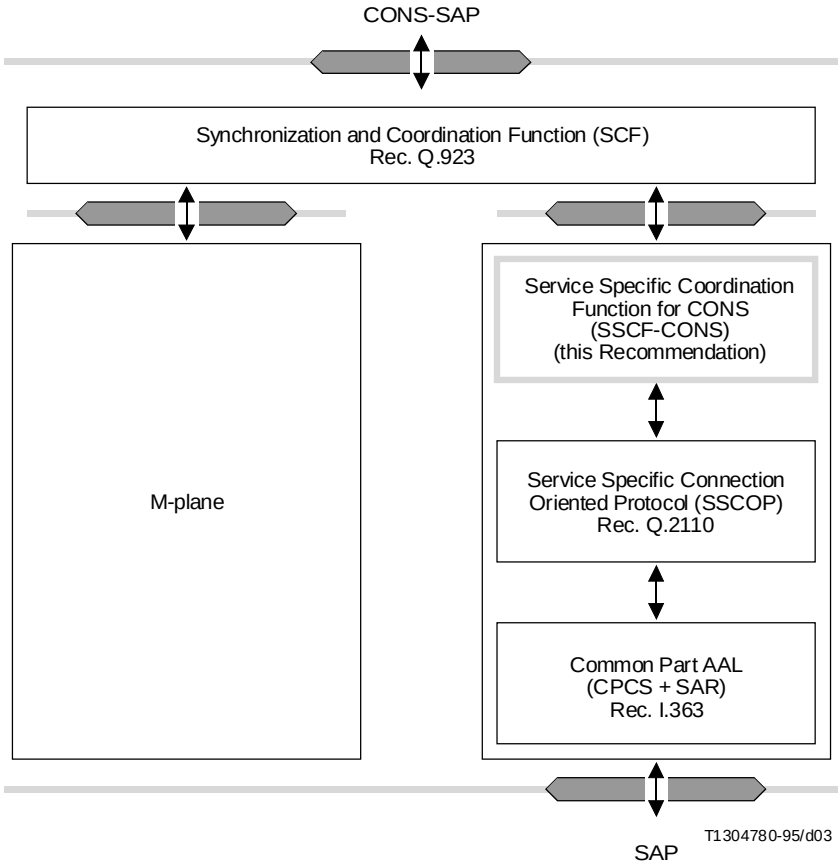


FIGURE 2b/I.365.2

Structure of the CONS provider deploying permanent ATM connections

8 Functions of the SSCF-CONS

The SSCF-CONS performs the following functions:

a) *Segmentation and Reassembly*

This function assures that the N-SDUs that exceed the maximum length dictated by the underlying sublayer specified in Recommendation Q.2110 [4] is segmented by the transmitting SSCF-CONS entity, transferred piece by piece, and reassembled by the receiving SSCF-CONS entity.

b) *Error reporting to layer management*

This function reports errors which have occurred to layer management.

c) *Connection establishment*

This function provides for the establishment of an N(u)-connection.

NOTE – The connection below the sublayer specified in Recommendation Q.2110 [4] may be established either on demand or permanently.

d) *Connection release*

This function provides for the unconditional, and therefore possibly destructive, release of an N(u)-connection by either the SSCF-CONS user or the SSCF-CONS provider.

e) *Connection reset*

This function provides for the bidirectional reset of an N(u)-connection by either the SSCF-CONS user or by the SSCF-CONS provider.

In addition, the following SSCOP services are utilized (see Recommendation Q.2110 [4]):

f) Sequence Integrity of N-SDUs.

g) Error Correction of N-SDUs.

h) Flow Control of N-SDUs.

i) Keep alive.

j) Resynchronization.

k) Unassured data transfer.

The following two functions are CONS service provider options (see clause 8/X.213).

l) *Expedited data transfer*

This function provides the means of transferring separate expedited N-SDUs in sequence. Expedited N-SDUs are limited in length and their transmission is subject to a different flow control from normal data. Errors in the transfer of expedited N-SDUs are corrected by retransmission. This function is specified in Annex C.

m) *Receipt confirmation*

This function allows an SSCF-CONS user to confirm the receipt of an N-SDU. This function is specified in Annex D.

9 Elements for Layer-to-Layer Communication

This clause defines the primitives and signals and state transition diagram for sequences of signals between SSCF-CONS and SCF, SSCOP, and Layer Management.

9.1 Primitives between SSCF-CONS and SCF

The primitives between SSCF-CONS and SCF are also defined in Recommendation Q.923 [3]; where there is a difference between the two definitions, the one in Recommendation Q.923 [3] is definitive.

The confirmed release configuration of SCF applies. The repertoire of N(u)-primitives between SCF and SSCF-CONS is defined in Table 1.

9.1.1 Definition of primitives

The definition of these primitives is as follows:

a) N(u)-CONNECT

The N(u)-CONNECT primitives are used to establish a point-to-point connection for assured information transfer between peer user entities.

b) N(u)-DISCONNECT

The N(u)-DISCONNECT primitives are used to terminate a point-to-point connection for assured information transfer between peer user entities.

c) N(u)-RESET

The N(u)-RESET primitives are used to resynchronize the N-connection.

d) N(u)-DATA

The N(u)-DATA primitives are used for the assured point-to-point (normal) transfer of N-SDUs between peer user entities.

e) N(u)-DATA-ACKNOWLEDGE

The N(u)-DATA-ACKNOWLEDGE primitives are used to confirm the receipt of (normal) N-SDUs between peer user entities.

f) N(u)-EXPEDITED-DATA

The N(u)-EXPEDITED-DATA primitives are used for the assured point-to-point (expedited) transfer of N-SDUs between peer user entities.

TABLE 1/I.365.2

Primitives and parameters between SCF and SSCF-CONS

Generic name	Type			
	request	indication	response	confirm
N(u)-CONNECT	called address calling address rec-conf-sel exp-data-sel NS-user-data Quality of Service	called address calling address rec-conf-sel exp-data-sel NS-user-data Quality of Service	responding address rec-conf-sel exp-data-sel NS-user-data Quality of Service	responding address rec-conf-sel exp-data-sel NS-user-data Quality of Service
N(u)-DISCONNECT	responding address reason NS-user-data	responding address reason NS-user-data originator	N/A	–
N(u)-RESET	reason	reason originator	–	–
N(u)-DATA	NS-user-data conf-req (Note 1)	NS-user-data conf-req (Note 1)	N/A	N/A
N(u)-DATA-ACKNOWLEDGE (Note 1)	–	–	N/A	N/A
N(u)-EXPEDITED-DATA (Note 2)	NS-user-data	NS-user-data	N/A	N/A

–	The primitive has no parameters	rec-conf-sel	receipt confirmation selection
N/A	The primitive is not defined	exp-data-sel	expedited data selection
		conf-req	confirmation request

NOTES

1 This parameter is only present and the primitive N(u)-DATA-ACKNOWLEDGE may only be used if the Receipt Confirmation option is implemented and has been selected at connection establishment.

2 This primitive may only be used if the Expedited Data transfer option is implemented and has been selected at connection establishment.

9.1.2 Parameter definition

Table 1 lists the parameters associated with the N(u)-primitives. The definition of the parameters is as follows:

a) *NS-user-data*

During connection establishment and release, the parameter “NS-user-data” is used to transfer any integer number of octets between 0 and 128 inclusive of CONS user’s data. In expedited data transfer, the parameter is used to carry any integer number of octets between 1 and 32 inclusive of CONS user’s expedited data constituting an expedited N-SDU.

In normal data transfer, the parameter is used to carry any integer number of octets greater than or equal to 1 of CONS user’s data constituting an N-SDU.

b) *Receipt confirmation selection*

The parameter “receipt confirmation selection” is used during connection establishment to negotiate the use of the receipt confirmation option. The value of this parameter is either “use of receipt confirmation” or “no use of receipt confirmation”.

c) *Expedited data selection*

The parameter “expedited data selection” is used during connection establishment to negotiate the use of the expedited data transfer option. The value of this parameter is either “use of expedited data” or “no use of expedited data”.

d) *Confirmation request*

The parameter “confirmation request” is used to request a receipt confirmation from the peer user. The value of this parameter is either “request receipt confirmation” or “no request receipt confirmation”.

e) *Originator*

The parameter “originator” indicates the source of a connection reset or release. Its value indicates either “NS user”, “NS provider”, or “undefined”.

f) *Reason*

The parameter “reason” is used during a connection reset or release to indicate the reason for the action. The value of this parameter depends on the primitive in which it is used and on the parameter “Originator”; the values are summarized in Table 2.

TABLE 2/I.365.2

Value of the “reason” parameter

Primitive	Originator	Value of the “reason” parameter
N(u)-DISCONNECT-request	(Note)	disconnection – normal condition disconnection – abnormal condition connection rejection – permanent condition connection rejection – transient condition connection rejection – QOS not available – permanent condition connection rejection – QOS not available – transient condition connection rejection – incompatible information in NS-user-data
N(u)-DISCONNECT-indication	NS-user	disconnection – normal condition disconnection – abnormal condition connection rejection – permanent condition connection rejection – transient condition connection rejection – QOS not available – permanent condition connection rejection – QOS not available – transient condition connection rejection – incompatible information in NS-user-data
	NS-provider	disconnection – normal condition disconnection – transient condition connection rejection – NSAP address unknown – permanent condition connection rejection – NSAP unreachable – permanent condition connection rejection – NSAP unreachable – transient condition connection rejection – QOS not available – permanent condition connection rejection – QOS not available – transient condition connection rejection – unspecified/permanent condition connection rejection – unspecified/transient condition
	undef.	undefined
N(u)-RESET-request	(Note)	user resynchronization
N(u)-RESET-indication	NS-user	user resynchronization
	NS-provider	congestion reason unspecified
	undef.	undefined
NOTE – The parameter “originator” is not present in this signal.		

g) *Called address*

The called address parameter is used during connection establishment and conveys an address identifying the NSAP to which the connection is to be established.

h) *Calling address*

The calling address parameter is used during connection establishment and conveys the address of the NSAP from which the connection has been requested.

i) *Responding address*

The responding address parameter is used during connection establishment and conveys the address of the NSAP to which the connection has been established. The responding address can also be used during connection release and conveys the address of the NSAP to which the connection has been established.

j) *Quality of Service*

The Quality of Service parameter is used during connection establishment to negotiate throughput and transit delay values. The N(u)-CONNECT-request primitive indicates "(sustained) target" and "minimum acceptable" values. The N(u)-CONNECT-indication primitive indicates "(sustained) available" and "minimum acceptable" values. The N(u)-CONNECT-response and the N(u)-CONNECT-confirm primitive indicate "selected" values.

NOTE – The choice of connection protection and priority is not supported.

9.2 Signals between SSCF-CONS and SSCF-CONS Layer Management

The repertoire of MN(u)-signals between SSCF-CONS and SSCF-CONS Layer Management is defined in Table 3.

TABLE 3/I.365.2

Signals and parameters between SSCF-CONS and SSCF-CONS Layer Management

Generic name	Type			
	request	indication	response	confirm
MN(u)-ERROR	N/A	Code	N/A	N/A
MN(u)-STATE	N/A	State	N/A	N/A
MN(u)-REPORT	N/A	Direction, type	N/A	N/A
MN(u)-DISCONNECT	–	N/A	N/A	N/A
MN(u)-RESET	–	N/A	N/A	N/A
– The signal has no parameters N/A The signal is not defined				

9.2.1 Signal definition

a) MN(u)-ERROR

The MN(u)-ERROR signal is used to report errors to the SSCF-CONS Layer Management.

b) MN(u)-STATE

The MN(u)-STATE signal is used to report state changes to the SSCF-CONS Layer Management.

c) MN(u)-REPORT

The MN(u)-REPORT signal is used to inform Layer Management of user data and control information exchanged with the SSCF-CONS' peer entity.

d) MN(u)-DISCONNECT

The MN(u)-DISCONNECT signal is used to request the release of an N(u)-connection by the SSCF-CONS Layer Management.

e) MN(u)-RESET

The MN(u)-RESET signal is used to request the reset of the N(u)-connection by the SSCF-CONS Layer Management.

9.2.2 Parameter definition

a) *Code*

The parameter "code" indicates the actual error that is reported. The values of this parameter are summarized in Annex A.

b) *State*

The parameter "state" indicates the new state (according to Figure 5) to Layer Management.

c) *Direction*

The parameter "direction" indicates whether information was sent ("snd") or received ("rcv").

d) *Type*

The parameter "type" indicates the type of the information exchanged; it is represented by the following symbols:

CR	Connection Establishment – Request
CC	Connection Establishment – Confirmation
DR	Connection Release – Disconnect
DATA	(normal) Data
ED	Expedited Data
EDAK	Expedited Data Acknowledgement
RC	Receipt Confirmation
RCAK	Receipt Confirmation Acknowledgement
RS	Connection Reset
RSAK	Connection Reset Acknowledgement

9.2.3 States at the boundary betwen SSCF-CONS and Layer Management

At the boundary between SSCF-CONS and Layer Management, the following states are defined:

- *State 1 – Idle*

  In this state, the N(u)-connection does not exist (or is currently releasing).

- *State 2 – Establishing*

  In this state, the N(u)-connection is being established.

- *State 3 – Resetting*

  In this state, the N(u)-connection is being reset.

- *State 4 – Data Transfer Ready*

  In this state, the N(u)-connection is in the Data Transfer state.

9.3 Signals between SSCF-CONS and SSCOP

The signals between SSCF-CONS and SSCOP are defined in Recommendation Q.2110 [4]. They are summarized in Table 4. If there is a difference between the summary and the definition in Q.2110 [4], the one in the Recommendation Q.2110 [4] is definitive.

The data retrieval function of SSCOP is not used. Further, the parameter "BR" is always set to the value "YES".

TABLE 4/I.365.2

Signals and parameters between SSCF-CONS and SSCOP

Generic name	Type			
	request	indication	response	confirm
AA-ESTABLISH	SSCOP-UU BR	SSCOP-UU	SSCOP-UU BR	SSCOP-UU
AA-RELEASE	SSCOP-UU	SSCOP-UU Source	N/A	–
AA-DATA	MU	MU SN	N/A	N/A
AA-RESYNC	SSCOP-UU	SSCOP-UU	–	–
AA-RECOVER	N/A	–	–	N/A
AA-UNITDATA	MU	MU	N/A	N/A
– The signal has no parameters N/A The signal is not defined				

9.3.1 Definition of signals

a) The AA-ESTABLISH signals are used to establish a point-to-point connection for assured information transfer between peer SSCF-CONS entities.

b) The AA-RELEASE signals are used to terminate a point-to-point connection for assured information transfer between peer SSCF-CONS entities.

c) The AA-DATA signals are used for the assured point-to-point transfer of SDUs between peer SSCF-CONS entities.

d) The AA-RESYNC signals are used to resynchronize the SSCOP connection.

e) The AA-RECOVER signals are used during recovery from protocol errors.

f) The AA-UNITDATA signals are used for the non-assured transfer of SDUs between peer SSCF-CONS entities.

9.3.2 Parameter definition

a) The Message Unit (MU) parameter is used during information transfer to convey a variable-length message. In AA-DATA-request and AA-UNITDATA-request signals, this parameter is mapped transparently into the information field of an SSCOP PDU. For AA-DATA-indication and AA-UNITDATA-indication signals, this parameter contains the contents of the information field of the received SSCOP PDU. The MU is an integral multiple of one octet.

b) The SSCOP User-to-User (SSCOP-UU) parameter is used during connection control to convey a variable length user-to-user message. The transfer of SSCOP-UU in BGN, BGAK, BGREJ, RS, and END PDUs cannot be guaranteed. In request and response signals, this parameter is mapped transparently into the SSCOP-UU (SSCOP User-to-User) field of an SSCOP PDU. For indication and confirm signals, this parameter contains the contents of the SSCOP-UU field of the received SSCOP PDU. The SSCOP-UU is an integral multiple of one octet, if it is present. The SSCOP-UU may be null (no data present).

c) The Sequence Number (SN) parameter is ignored by the SSCF-CONS entity.

d) The Buffer Release (BR) parameter is not used by the SSCF-CONS entity; its value is always set to "YES".

e) The Source parameter indicates to the SSCF-CONS entity whether the SSCOP layer or the peer SSCF-CONS entity originated the connection release. This parameter may take on one of two values: "SSCOP" or "User"; if the value is "User", the peer SSCF-CONS entity is the originator.

9.4 State transition diagram for sequences of signals at the layer boundaries of SSCF-CONS

This subclause defines the constraints on the sequences in which the signals may occur at the layer boundaries of SSCF-CONS. The sequences are related to the states at one point-to-point SSCF-CONS endpoint, between the SCF and SSCF-CONS, and between SSCF-CONS and SSCOP.

The possible overall sequences of signals at a point-to-point SSCF-CONS connection endpoint are shown in the state transition diagram, Figure 3, for the convenience of the reader. These primitives and state transitions are defined in Recommendation Q.923 [3]. If any discrepancy is detected between the representation here and the one in Recommendation Q.923 [3], the definition in Q.923 [3] shall apply.

The possible overall sequences of signals at a point-to-point SSCOP endpoint are shown in the state transition diagram, Figure 4, for the convenience of the reader. These signals and state transitions are defined in Recommendation Q.2110 [4]. If any discrepancy is detected between the representation here and the one in Recommendation Q.2110 [4], the definition in Q.2110 [4] shall apply.

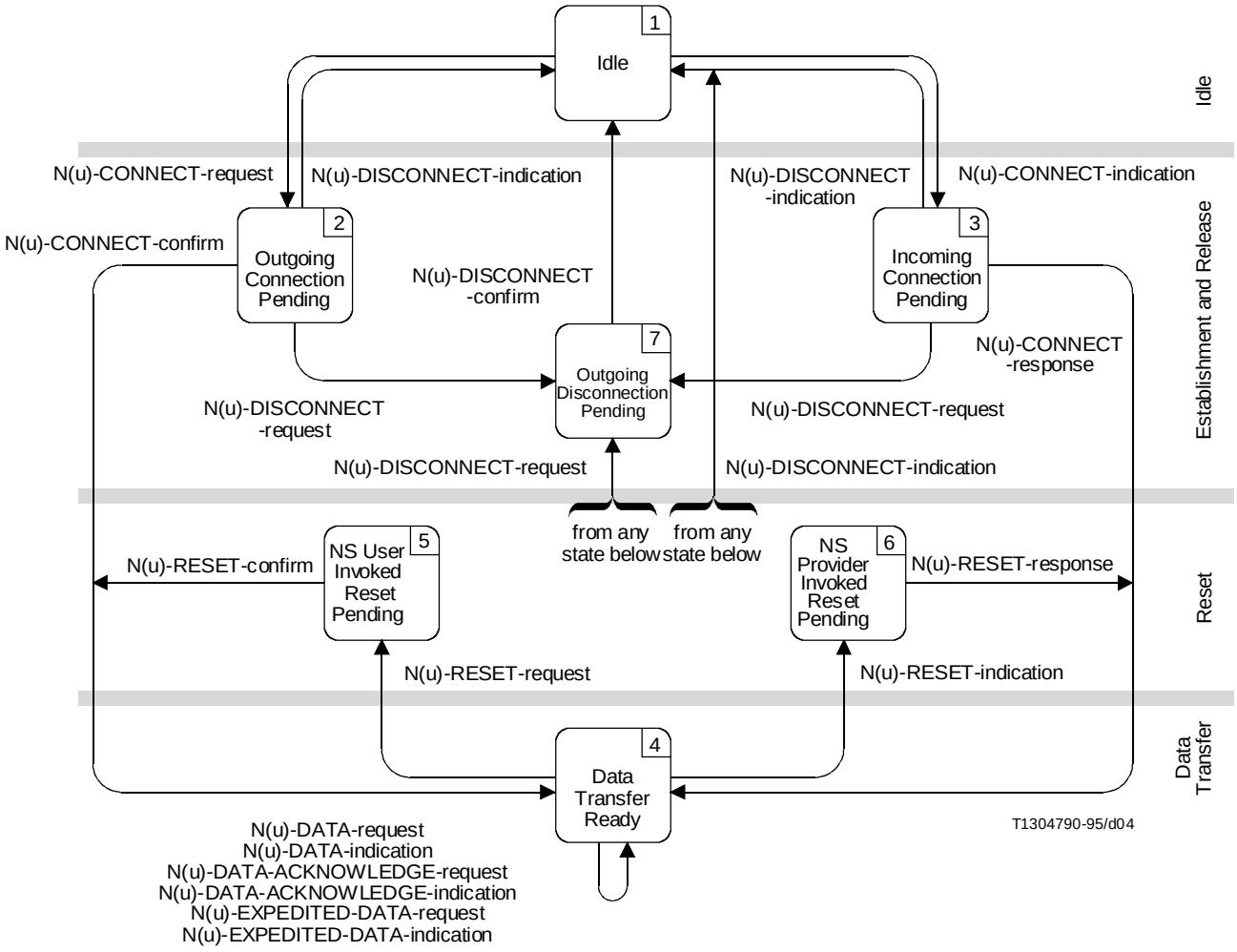


FIGURE 3/I.365.2

State transition diagram for sequences of primitives between SCF and SSCF-CONS

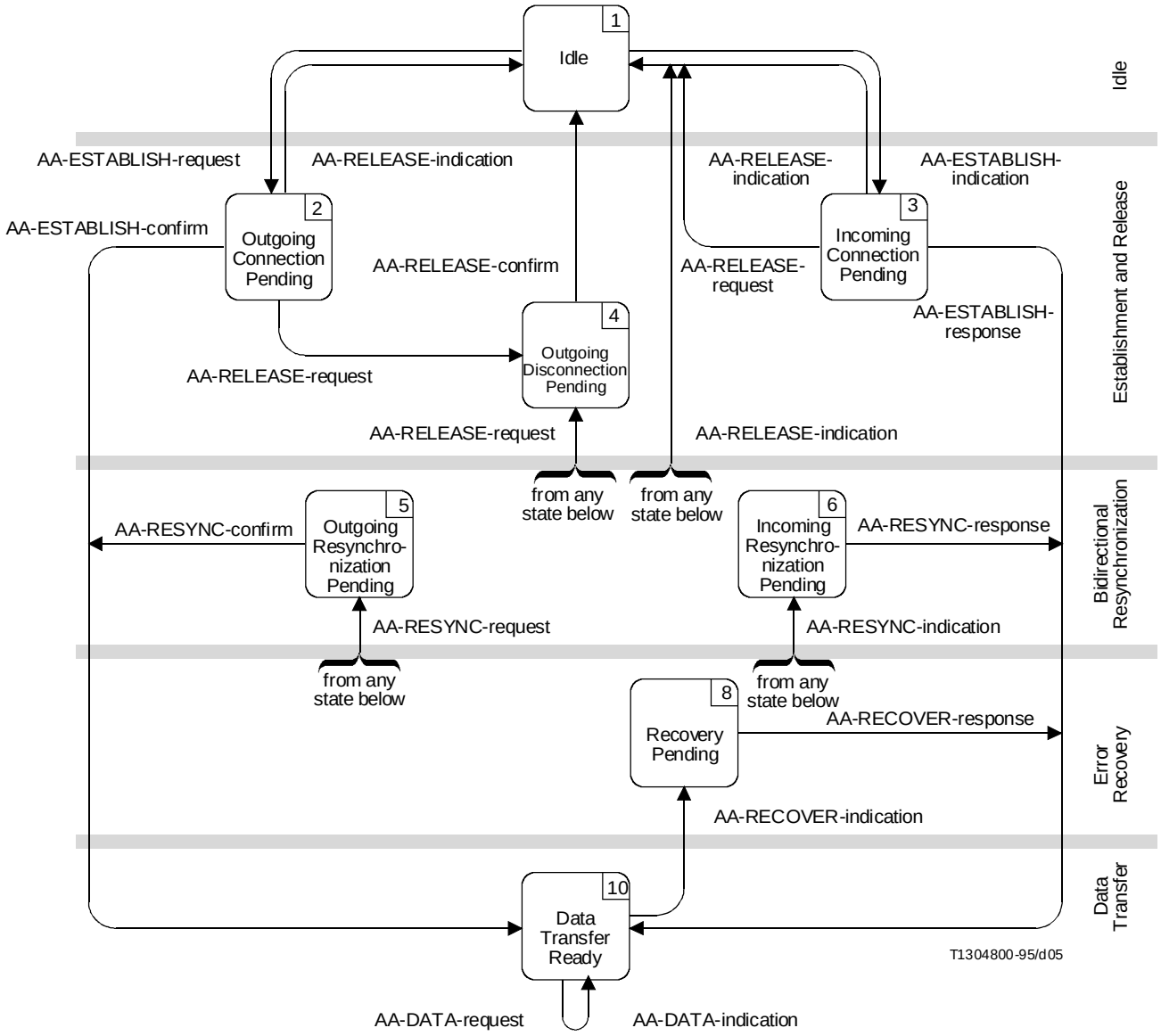


FIGURE 4/I.365.2

State transition diagram for sequences of signals between SSCF-CONS and SSCOP

The model illustrates the behavior of SSCF-CONS as seen by the SCF or the subset of behaviour of the SSCOP as deployed by the SSCF-CONS. This model assumes that a request or response signal is never issued at the same time as an indication or confirm signal. The model also assumes that the signals are serviced immediately and in zero time. In the diagram:

a) Any primitive or signal which is not shown as resulting in a transition (from one state to the same state, or from one state to a different state) is not permitted in that state.

b) It is assumed that the primitives passed between SCF and SSCF-CONS as well as the signals passed between the SSCF-CONS and SSCOP are coordinated such that collisions do not occur.

c) The IDLE state (state 1) reflects the absence of a connection. It is the initial and final state of any sequence, and once it has been reentered, the connection is released.

The possible overall sequences of signals at the Layer Management boundary of SSCF-CONS is shown in the state transition diagram, Figure 5. The states 1 to 4 in Figure 5 are defined in 9.2.3.

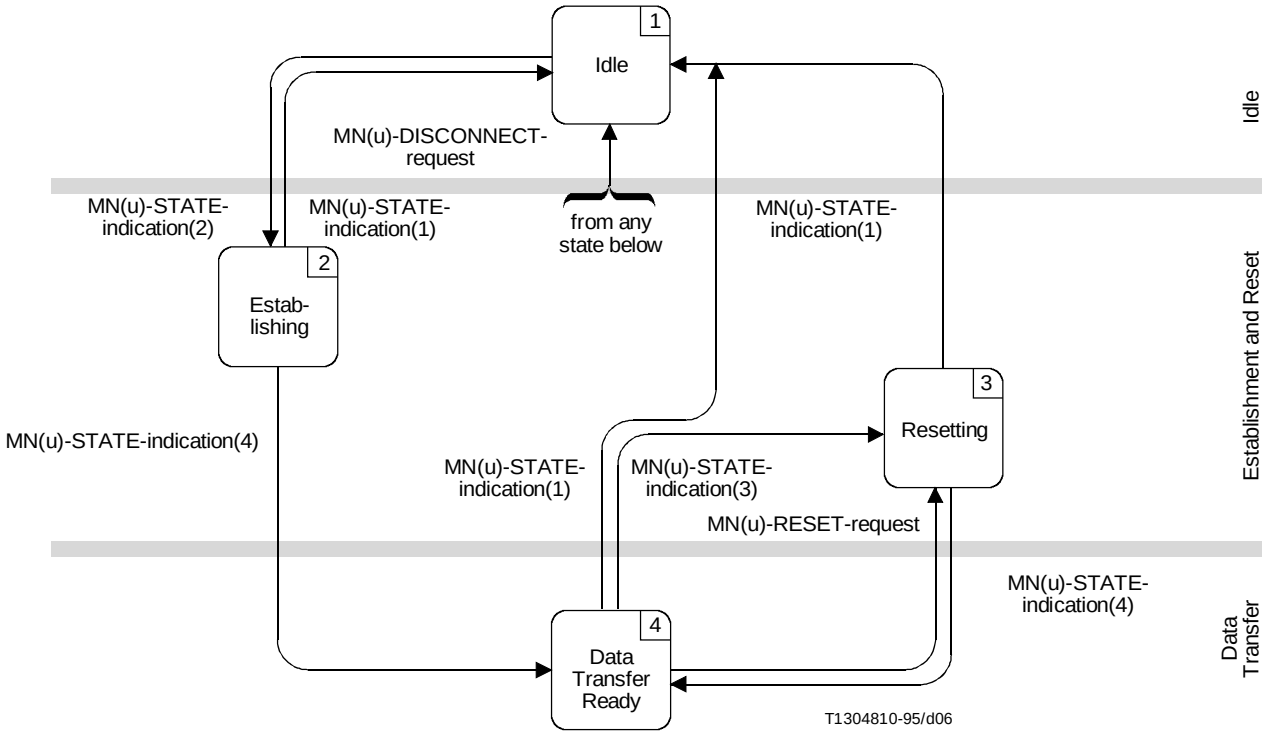


FIGURE 5/I.365.2

State transition diagram for sequences of signals between SSCF-CONS and Layer Management

10 Protocol elements for Peer-to-Peer Communication

The peer-to-peer SSCF-CONS protocol utilizes the mechanisms provided by the underlying sublayer (SSCOP, Recommendation Q.2110 [4]). In particular:

- Connection establishment and release use the corresponding service of SSCOP, i.e. the signals AA-ESTABLISH and AA-RELEASE. Additional information is conveyed via the SSCOP-UU parameter.
- Normal data transfer utilizes SSCOP's assured data transfer service including the imbedded flow control mechanism.
- The NS-user initiated reset procedure deploys SSCOP's resynchronization service, i.e. the signals AA-RESYNC. Additional information is conveyed via the SSCOP-UU parameter.
- SSCOP's error recovery service is mapped into an NS-provider initiated reset.
- SSCOP's data retrieval service is not used, i.e. SSCF-CONS never issues the signals AA-RETRIEVE-request and, hence, never receives the signals AA-RETRIEVE-indication and AA-RETRIEVE-COMPLETE-indication.

For the implementation of the optional SSCF-CONS services, SSCOP services are utilized as follows:

- The expedited data transfer service makes use of the unassured data stream that is independent of the flow control of the assured service. Error recovery from transmission errors by retransmission and a separate flow control is handled by a peer-to-peer protocol within the SSCF-CONS sublayer. The SSCOP signal used is AA-UNITDATA.

- The receipt confirmation service makes use of the unassured data stream that is independent of the flow control of the assured service. Error recovery from transmission errors by retransmission is handled by a peer-to-peer protocol within the SSCF-CONS sublayer. The SSCOP signal used is AA-UNITDATA.

10.1 SSCF-CONS PDUs

The repertoire of PDUs is shown in Table 5.

TABLE 5/I.365.2

Repertoire of SSCF-CONS PDUs

PDU name	Description
CR PDU CC PDU DR PDU	Connection Establishment – Request Connection Establishment – Confirmation Connection Release – Disconnect
DATA PDU	(normal) Data
ED PDU EDAK PDU	Expedited Data Expedited Data Acknowledgement
RC PDU RCAK PDU	Receipt Confirmation Receipt Confirmation Acknowledgement
RS PDU	Connection Reset

10.1.1 SSCF-CONS PDUs utilizing the unassured data transfer

SSCF-CONS PDUs utilizing the unassured data transfer are only deployed if the Expedited Data transfer option is implemented and has been selected at connection establishment or if the Receipt Confirmation option is implemented and has been selected at connection establishment.

10.1.2 SSCF-CONS PDUs utilizing the assured data transfer

There is one SSCF-CONS PDU utilizing the assured data transfer:

- *DATA PDU*

  The DATA PDU is used to transfer N-SDUs between peer SSCF-CONS user entities. N-SDUs may be segmented to adjust the DATA PDU size to the requirements of the maximum PDU length defined for the underlying SSCOP sublayer.

  If the Expedited Data transfer option is implemented and has been selected at connection establishment, the DATA PDU also carries synchronization information to allow the receiving SSCF-CONS entity to assure that regular data does not bypass expedited data. The fields carrying this information are N(E) and N(TS).

10.1.3 SSCF-CONS PDUs utilizing data transfer capabilities in SSCOP connection control services

- *Connection request and confirmation PDUs*

  The CR PDU and CC PDU are used for the exchange of N(u)-connection parameters and NS-user-data during the simultaneous connection establishment of SSCF-CONS and SSCOP. The CR PDU is communicated via the SSCOP-UU parameter in the AA-ESTABLISH-request and AA-ESTABLISH-indication signals. The CC PDU is communicated via the SSCOP-UU parameter in the AA-ESTABLISH-response and AA-ESTABLISH-confirm signals.

- *Disconnect request PDU*

  The DR PDU is used for the disconnect service to communicate NS-user-data, the reason for and the origin of the disconnection and – if applicable – the identification of the SSCF-CONS user requesting the disconnection. The DR PDU is communicated via the SSCOP-UU parameter in the AA-RELEASE-request and AA-RELEASE-indication signals.

- *Reset request PDU*

  The RS PDU is used for the reset service to communicate the origin and the reason of the N(u)-connection reset via the SSCOP-UU parameter in the AA-RESYNC-request and AA-RESYNC-indication signals that are used to initiate resetting.

10.2 SSCF-CONS PDU formats

Figures 6 to 9 illustrate the format of the SSCF-CONS PDUs utilized for the mandatory SSCF-CONS services.

10.2.1 Coding conventions

The coding of the SSCF-CONS PDUs conforms to the coding conventions specified in 2.1/I.361 [1].

NOTE – SSCF-CONS is trailer oriented the same as SSCOP, i.e. the Protocol Control Information (PCI) is transmitted last.

10.2.2 PDU length

The maximum length of the information field in the DATA PDU is k octets. The maximum value of k is 65 524 octets. The value of k is established as part of size negotiation procedures outside SSCF-CONS or upon bilateral agreement. It may depend on the error characteristics of the layers below the AAL. The minimum value of k is 256.

10.3 SSCF-CONS PDU fields

The SSCF-CONS PDUs contain the following fields:

a) *N-SDU Information field*

The N-SDU Information field in the DATA PDU contains (part of) an N-SDU.

b) *NS-user-data field*

The NS-user-data field in the CR PDU, CC PDU, or DR PDU contains the value of the NS-user-data parameter of the N(u)-CONNECT or N(u)-DISCONNECT primitive.

c) *M – More Data field*

The M field in the DATA PDU is set to "1" if an N-SDU is segmented and the information field does not carry the last part of the N-SDU; otherwise, it is set to "0".

d) *Origin – Originator field*

The Origin field in the DR or RS PDU conveys the information about the originator between the two peer SSCF-CONS entities. The coding is shown in Table 6.

e) *Reason – Reason field*

The Reason field in the DR or RS PDU conveys the information about the reason for the primitive between the two peer SSCF-CONS entities. The coding is shown in Table 6.

f) *N(E) – Expedited Data Synchronization field*

The N(E) field in the DATA PDU is used for the synchronization of normal and expedited data. If the Expedited Data transfer option is not implemented or has not been selected at connection establishment, this field is treated like a "Reserved" field [see item s)].

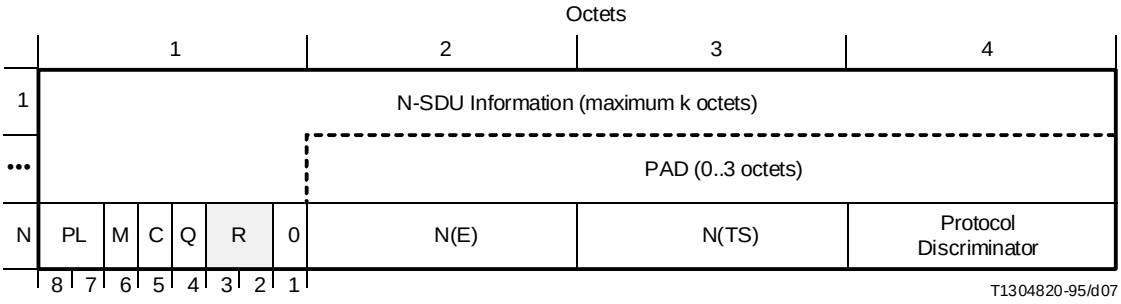


FIGURE 6/I.365.2

N-SDU information (DATA PDU)

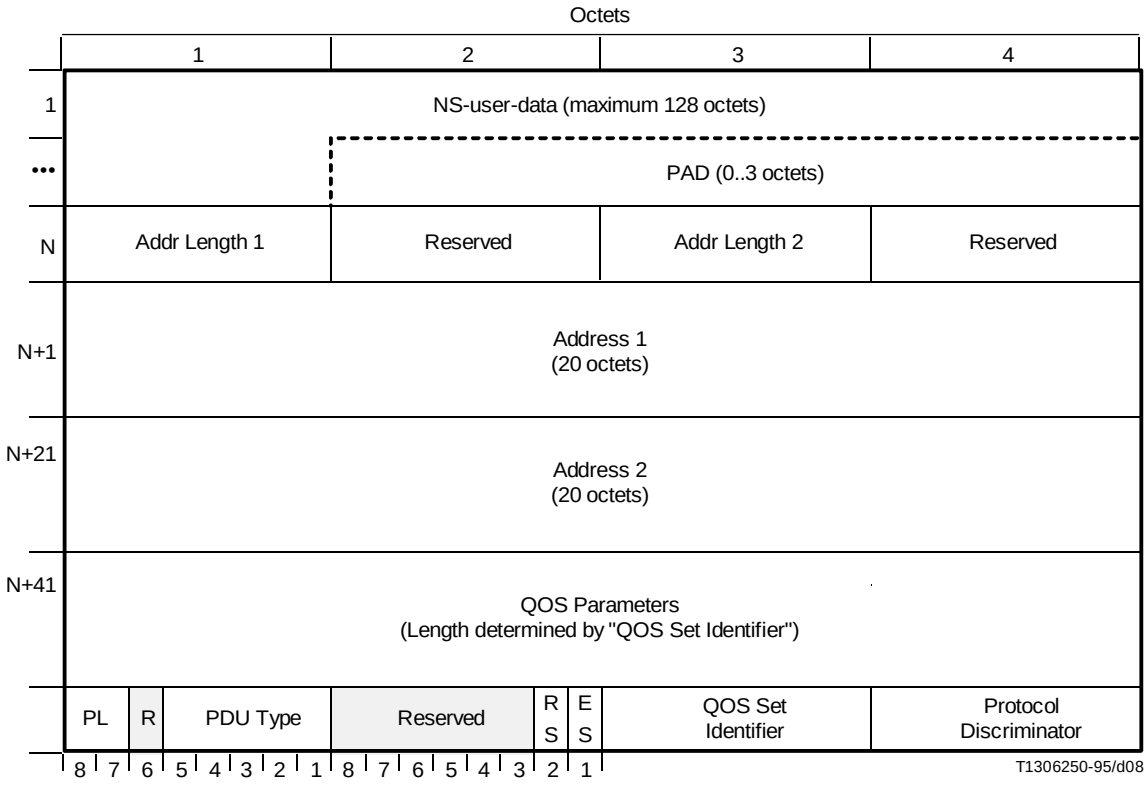


FIGURE 7/I.365.2

Connection establishment: CR PDU and CC PDU

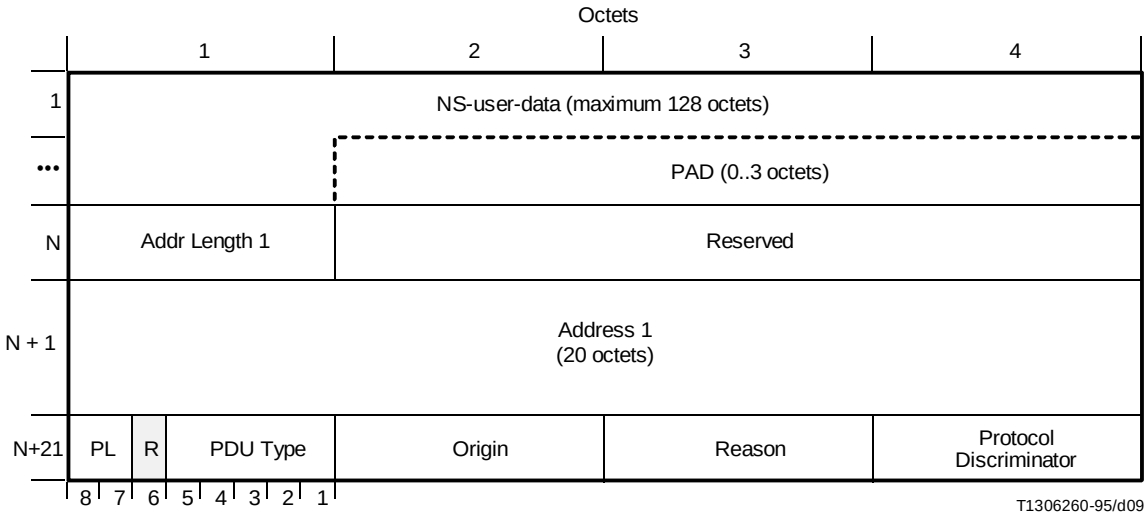


FIGURE 8/I.365.2

Connection release: DR PDU

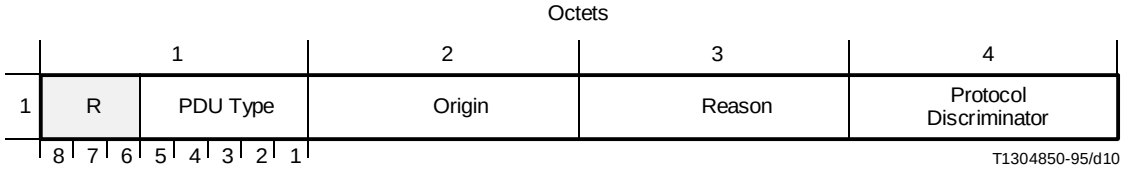


FIGURE 9/I.365.2

Connection reset: RS PDU

g) *C – Confirmation Request field*

The C field in the DATA PDU is used to request a receipt confirmation. If the Receipt Confirmation option is not implemented or has not been selected at connection establishment, this field is treated like a "Reserved" field [see item s)].

h) *Q – Qualified Data Designation field*

The Q field in the DATA PDU is reserved for interworking with the "Q"-bit of Recommendation X.25; however, such interworking is for further study. This field is treated like a "Reserved" field [see item s)].

i) *ES – Expedited Data Transfer Selection field*

The ES field in the CR PDU or CC PDU is used for the Expedited Data Transfer selection between the two peer SSCF-CONS entities. If the Expedited Data transfer option is not implemented, this field is treated like a "Reserved" field [see item s)].

TABLE 6/I.365.2

SSCF-CONS PDU field coding

Field	Code	Value
Origin field all PDUs	0 1 2 3	reserved undefined NS-provider NS-user
Reason field AA-RELEASE-request AA-RELEASE-indication Origin field = 1	0 1	reserved undefined
Reason field AA-RELEASE-request AA-RELEASE-indication Origin field = 2	0 1 2 3 4 5 6 7 8 9	reserved disconnection – permanent condition disconnection – transient condition connection rejection – NSAP address unknown – permanent condition connection rejection – NSAP unreachable – permanent condition connection rejection – NSAP unreachable – transient condition connection rejection – QOS not available – permanent condition connection rejection – QOS not available – transient condition connection rejection – unspecified/permanent condition connection rejection – unspecified/transient condition
Reason field AA-RELEASE-request AA-RELEASE-indication Origin field = 3	0 1 2 3 4 5 6 7	reserved disconnection – normal condition disconnection – abnormal condition connection rejection – permanent condition connection rejection – transient condition connection rejection – QOS not available – permanent condition connection rejection – QOS not available – transient condition connection rejection – incompatible information in NS-user-data
Reason field AA-RESYNC-request AA-RESYNC-indication Origin field = 1	0 1	reserved undefined
Reason field AA-RESYNC-request AA-RESYNC-indication Origin field = 2	0 1 2	reserved congestion reason unspecified
Reason field AA-RESYNC-request AA-RESYNC-indication Origin field = 3	0 1	reserved user resynchronization

j) *RS – Receipt Confirmation Selection field*

The RS field in the CR PDU or CC PDU is used for the Receipt Confirmation selection between the two peer SSCF-CONS entities. If the Receipt Confirmation option is not implemented, this field is treated like a "Reserved" field [see item s)].

k) *Address Length 1*

This field specifies the length in octets of the NSAP address contained in the Address 1 field.

l) *Address 1 field*

In the CR PDU, the Address 1 field carries the called party NSAP address; in the CC PDU, the responding party NSAP address is carried. The called resp. responding NSAP address shall be coded according to the "preferred binary encoding" defined in Recommendation X.213 [7]. Example codings are given in Recommendation X.223 [8].

m) *Address Length 2*

In the CR PDU, this field specifies the length in octets of the NSAP address contained in the Address 2 field. In the CC PDU, the field is treated like a "Reserved" field [see item s)].

n) *Address 2 field*

In the CR PDU, the Address 2 field carries the calling party NSAP address. The calling NSAP address shall be coded according to the "preferred binary encoding" defined in Recomendation X.213 [7]. Example codings are given in Recommendation X.223 [8]. In the CC PDU, the field is treated like a "Reserved" field [see item s)].

o) *QOS Set Identifier field*

The QOS Set Identifier field is defined in Annex E.

p) *QOS Parameters*

The QOS Parameters are defined in Annex E.

q) *PAD – PAD field*

Between the end of the N-SDU Information field in the DATA PDU or the Expedited N-SDU Information field in the ED PDU, or the NS-user-data in the CR PDU, CC PDU, or DC PDU and the PCI trailer, there are from 0 to 3 unused octets. These unused octets are called the Padding (PAD) field; they are strictly used as filler octets and do not convey any information. Any coding is acceptable. This Padding field complements the PDU to an integral number of 4 octets.

r) *PL – PAD Length field*

The PL field in the PDU indicates the number of octets in the Padding field present. It can take on any integer value from 0 to 3 inclusive.

s) *R – Reserved field*

There are one or two fields of reserved bits (R, Reserved) in each PDU. One function of the Reserved field is to achieve 32 bit alignment. Other functions are for further study. Where no functions other than 32 bit alignment are defined, the fields shall be coded as "0" and shall be ignored by the receiver.

t) *PDU Type field*

The PDU Type field carries identification to unambigously determine the type of the PDU. The coding is shown in Table 7. Where not needed, this field is not verified by the receiving SSCF-CONS entity.

NOTE – The PDU Type field is redundant in those cases where the SSCOP signal already determines the type of the PDU; the PDU Type field is retained and checked also in those cases for consistency with implementations on services other than SSCOP.

TABLE 7/I.365.2

SSCF-CONS PDU names and coding of the PDU Type field

PDU name	PDU type field	Description
CR PDU CC PDU DR PDU	00001 00011 00101	Connection Establishment – Request Connection Establishment – Confirmation Connection Release – Disconnect
DATA PDU	xxxx0	(normal) Data
ED PDU EDAK PDU	00111 01001	Expedited Data Expedited Data Acknowledgement
RC PDU RCAK PDU	01011 01101	Receipt Confirmation Receipt Confirmation Acknowledgement
RS PDU (reserved)	01111 10001	Connection Reset (reserved for Connection Reset Acknowledgement)

u) *Protocol Discriminator field*

The Protocol Discriminator field is reserved for a Protocol Discriminator and treated like a "Reserved" field [see item s)].

NOTE – In the future, this parameter may be used to discriminate SSCF-CONS from future versions of the SSCF-CONS protocol or other protocols which use the last octet of the trailer as a protocol discriminator.

v) *N(TS) – Data Transfer State Sequence Number field*

In the DATA PDU, this field carries the current value of the transmitter state variable VT(TS). If the Expedited Data transfer option is not implemented or has not been selected at connection establishment and the Receipt Confirmation option is not implemented or has not been selected at connection establishment, this field is treated like a "Reserved" field [see item s)].

10.4 SSCF-CONS state variables

This subclause describes the state variables used in the specification of the SSCF-CONS peer-to-peer protocol. The DATA PDUs are sent via the assured data transfer service of SSCOP, no sequencing information needs to be added.

10.4.1 Transmitter state variables

The state variables at the transmitter to support the Expedited Data Transfer option or Receipt Confirmation option are defined in Annexes C and D. Otherwise, the SSCF-CONS maintains no state variables at the transmitter.

10.4.2 Receiver state variables

The state variables at the receiver to support the Expedited Data Transfer option or Receipt Confirmation option are defined in Annexes C and D. Irrespective of the use of these options, the SSCF-CONS maintains the following state variables at the receiver:

- *Reassembly Buffer*

  This state variable provides for the mechanism to reassemble a segmented N-SDU; its size is application dependent.

10.4.3 Common state variables

The SSCF-CONS maintains the following common state variables at the transmitter and receiver:

a) *EDsel*

If the Expedited Data transfer option is not implemented or has not been selected at connection establishment, this state variable is fixed at the value "0".

b) *RCsel*

If the Receipt Confirmation option is not implemented or has not been selected at connection establishment, this state variable is fixed at the value "0".

NOTE – In the absence of the implementation of the optional services, the items described above are not "variables" in the usual sense. They are introduced here to allow for their use in the SDL diagrams (see 11.3).

10.5 SSCF-CONS timers

In the absence of any options, the SSCF-CONS entity supports no timers. The timers to support the Expedited Data Transfer option or Receipt Confirmation option are defined in Annexes C and D.

10.6 SSCF-CONS protocol parameter

The value of each SSCF-CONS protocol parameter is application specific and may be defined in other ITU-T Recommendations which reference this Recommendation. The following SSCF-CONS protocol parameter is defined:

- *MaxDATALength*

  The protocol parameter MaxDATALength defines the maximum length of the information field of a DATA PDU. It is used during N-SDU segmentation. The value must be an integral multiple of 4; the value shall be between 256 and 65 524 inclusive.

11 Specification of the SSCF-CONS

This clause provides a set of SDL diagrams defining the procedures of the U-plane Service Specific Coordination Function (SSCF-CONS). These SDL diagrams are the definitive description of the procedures and in case of conflict with the text, the SDL diagrams take precedence.

11.1 Overview

Figure 10 gives an overview over the states of SSCF-CONS and the major transitions between them. These states are grouped into communication control services.

These states are used in the specification of the peer-to-peer protocol. The states are conceptual and reflect general conditions of the SSCF-CONS entity in the sequences of signals and PDU exchanges with its user, peer, underlying sublayer, or Layer Management. In addition, other conditions are used in the description in order to avoid the identification of additional states, as detailed in the SDL diagrams (see 11.2).

The state numbers reflect the state of the interfaces at the three layer boundaries of SSCF-CONS. They are of the form "U.L.M." where "U" represents the state of the interface at the upper layer boundary (see Figure 3), "L" the one at the lower layer boundary (see Figure 4), and "M" at the Layer Management boundary (see Figure 5).

11.1.1 Idle

State 1.1.1 Idle

In this state, no connection is established. No data may be communicated.

11.1.2 Establishment and Release

The states in this connection control service assist SCF and Layer Management in establishing and releasing N-connections. Establishment and release takes precedence over all of the following connection control services. The following states are defined:

State 2.2.2 Outgoing Connection Pending

In this state, the local SCF instructed SSCF-CONS to establish a new connection with its peer and awaits the peer's response.

State 3.3.2 Incoming Connection Pending

In this state, SSCF-CONS received the indication that its peer wants to establish a new connection and has notified the SCF. SSCF-CONS is awaiting the response from the SCF.

State 7.4.1 Outgoing Disconnection Pending

In this state, the SCF has instructed the SSCF-CONS to release the current connection. SSCF-CONS awaits confirmation from its peer.

State 1.4.1 SSCF Invoked Disconnection Pending

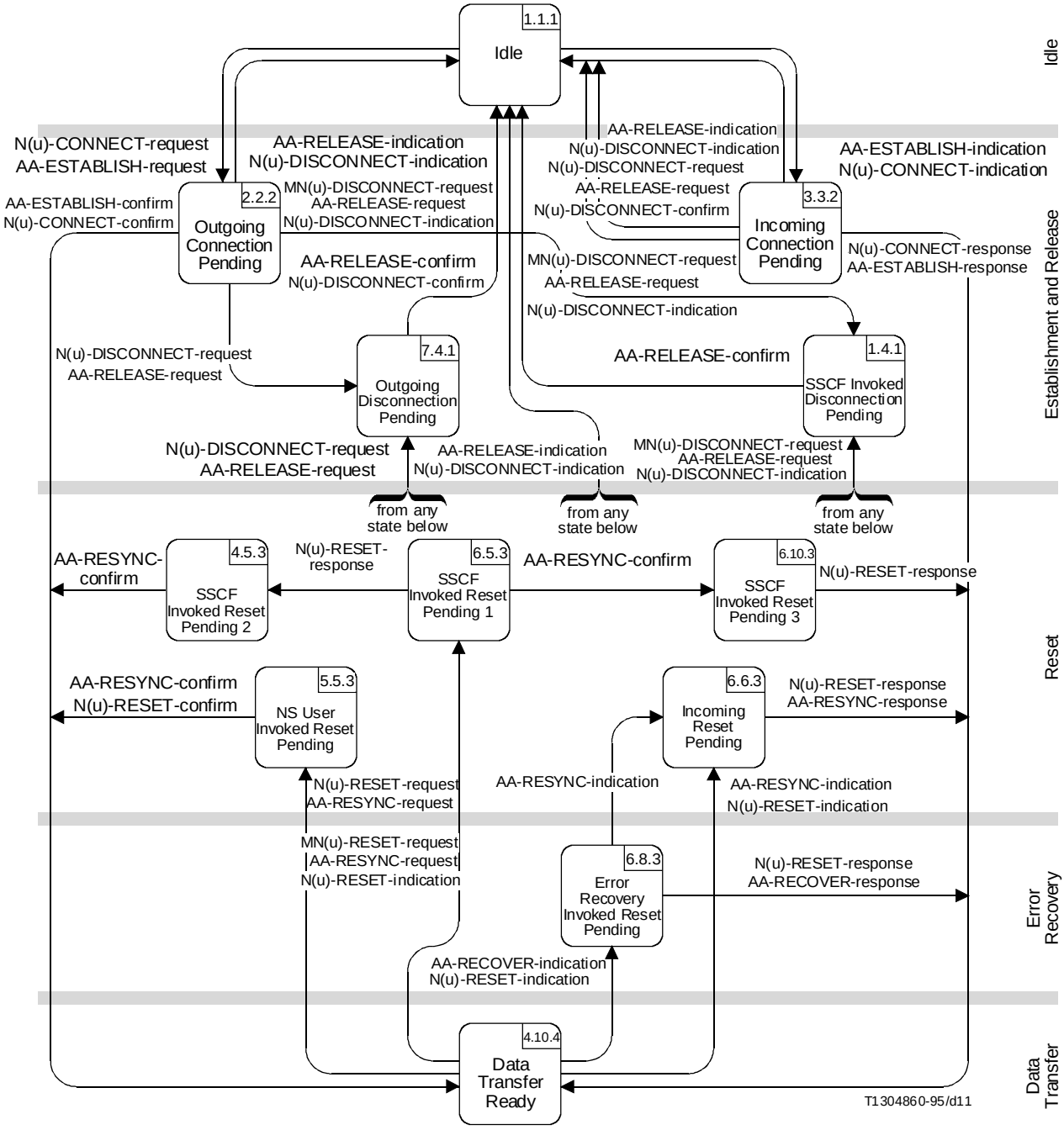
In this state, Layer Management has instructed the SSCF-CONS to release the current connection. SSCF-CONS awaits confirmation from its peer.

11.1.3 Reset

The states in this connection control service assist the SSCF-CONS in a resynchronization of both data transfer directions. The reset takes precedence over all of the following connection control services. The following states are defined:

State 5.5.3 NS User Invoked Reset Pending

In this state, the local SCF initiated a reset. SSCF-CONS' peer has been informed and its response is awaited.



NOTE – No indications to Layer Management are shown.

FIGURE 10/I.365.2

Overview of SSCF-CONS states and major transitions between states

State 6.6.3 Incoming Reset Pending

In this state, the peer SSCF-CONS has requested a reset. The SCF has been notified and its response is awaited.

State 6.5.3 SSCF Invoked Reset Pending 1

In this state, the Layer Management instructed the SSCF-CONS to initiate a reset. The SCF has been notified and its response is awaited; similarly, SSCF-CONS' peer has been informed and its response is awaited also.

State 4.5.3 SSCF Invoked Reset Pending 2

In this state, the Layer Management instructed the SSCF-CONS to initiate a reset and the SCF has responded. SSCF-CONS' peer has also been informed and its response is still awaited.

State 6.10.3 SSCF Invoked Reset Pending 3

In this state, the Layer Management instructed the SSCF-CONS to initiate a reset and SSCF-CONS' peer has responded. The SCF has also been notified and its response is still awaited.

11.1.4 Error Recovery

The state in this connection control service assists SSCF-CONS in mapping an SSCOP protocol error recovery into an NS provider invoked reset procedure. The Error Recovery takes precedence over the "Data Transfer" connection control service. The following states are defined:

State 6.8.3 Error Recovery Invoked Reset Pending

In this state, SSCOP has indicated that is performing an error recovery procedure. The SCF has been notified and its response is awaited.

11.1.5 Data Transfer

The state in this connection control service allows data transfer.

State 4.10.4 Data Transfer Ready

In this state, data transfer takes place.

If the Expedited Data transfer option is implemented and has been selected at connection establishment, the Expedited Data service procedure is running and may leave state E1.

If the Receipt Confirmation option is implemented and has been selected at connection establishment, the Receipt Confirmation service procedure is running and may leave state E1.

11.2 State Transition Table

The State Transition Table (Table 8) for SSCF-CONS describes the primitives and signals that lead to state transitions. The table only shows the major transition paths; the SDL diagrams in 11.3 show the full transitions.

11.3 SDL diagrams

The SDL diagrams are represented in Figures 11 to 13.

NOTE – Macros defined in Annex C can be ignored if the Expedited Data option is not implemented; similarly, macros defined in Annex D can be ignored if the Receipt Confirmation option is not implemented.

TABLE 8/I.365.2 (1 of 3)

State transition table

Event	State					
	1.1.1	7.4.1	1.4.1	2.2.2	3.3.2	4.5.3
N(u)-CONNECT-request	AA-ESTABLISH request 2.2.2	–	(Note 1)	–	–	–
N(u)-CONNECT-response	–	–	–	–	AA-ESTABLISH-response 4.10.4	–
N(u)-DISCON-NECT-request	–	–	–	AA-RELEASE-request 7.4.1	AA-RELEASE-request N(u)-DISCON-NECT-confirm 1.1.1	AA-RELEASE-request 7.4.1
N(u)-RESET-request	–	–	–	–	–	(Note 1)
N(u)-RESET-response	–	–	–	–	–	–
N(u)-DATA-request	–	–	–	–	–	(Note 1)
MN(u)-DISCON-NECT-request	–	–	–	N(u)-DISCON-NECT-indication AA-RELEASE-request 1.4.1	N(u)-DISCON-NECT-indication AA-RELEASE-request 1.1.1	N(u)-DISCON-NECT-indication AA-RELEASE-request 1.4.1
MN(u)-RESET-request	–	–	–	–	–	–
AA-ESTABLISH-indication	N(u)-CONNECT-indication 3.3.2	–	–	–	–	–
AA-ESTABLISH-confirm	–	–	–	N(u)-CONNECT-confirm 4.10.4	–	–
AA-RELEASE-indication	–	–	–	N(u)-DISCON-NECT-indication 1.1.1	N(u)-DISCON-NECT-indication 1.1.1	N(u)-DISCON-NECT-indication 1.1.1
AA-RELEASE-confirm	–	N(u)-DISCON-NECT-confirm 1.1.1	1.1.1	–	–	–
AA-RESYNC-indication	–	–	–	–	–	–
AA-RESYNC-confirm	–	–	–	–	–	4.10.4
AA-RECOVER-indication	–	–	–	–	–	–
AA-DATA-indication	–	–	–	–	–	–
AA-UNITDATA-indication	(Note 3) 1.1.1	(Note 3) 7.4.1	(Note 3) 1.4.1	(Note 3) 2.2.2	(Note 3) 3.3.2	(Note 3) 4.5.3
error	(Note 2) 1.1.1	–	–	N(u)-DISCON-NECT-indication AA-RELEASE-request 1.4.1	–	–

TABLE 8/I.365.2 (2 of 3)

State transition table

Event	State					
	6.5.3	6.10.3	5.5.3	6.6.3	6.8.3	4.10.4
N(u)-CONNECT-request	–	–	–	–	–	–
N(u)-CONNECT-response	–	–	–	–	–	–
N(u)-DISCONNECT-request	AA-RELEASE-request 7.4.1	AA-RELEASE-request 7.4.1	AA-RELEASE-request 7.4.1	AA-RELEASE-request 7.4.1	AA-RELEASE-request 7.4.1	AA-RELEASE-request 7.4.1
N(u)-RESET-request	–	–	–	–	–	AA-RESYNC-request 5.5.3
N(u)-RESET-response	4.5.3	4.10.4	–	AA-RESYNC-response 4.10.4	AA-RECOVER-response 4.10.4	–
N(u)-DATA-request	–	–	–	–	–	AA-DATA-request 4.10.4
MN(u)-DISCONNECT-request	N(u)-DISCONNECT-indication AA-RELEASE-request 1.4.1	N(u)-DISCONNECT-indication AA-RELEASE-request 1.4.1	N(u)-DISCONNECT-indication AA-RELEASE-request 1.4.1	N(u)-DISCONNECT-indication AA-RELEASE-request 1.4.1	N(u)-DISCONNECT-indication AA-RELEASE-request 1.4.1	N(u)-DISCONNECT-indication AA-RELEASE-request 1.4.1
MN(u)-RESET-request	–	–	–	–	–	N(u)-RESET-indication AA-RESYNC-request 6.5.3
AA-ESTABLISH-indication	–	–	–	–	–	–
AA-ESTABLISH-confirm	–	–	–	–	–	–
AA-RELEASE-indication	N(u)-DISCONNECT-indication 1.1.1	N(u)-DISCONNECT-indication 1.1.1	N(u)-DISCONNECT-indication 1.1.1	N(u)-DISCONNECT-indication 1.1.1	N(u)-DISCONNECT-indication 1.1.1	N(u)-DISCONNECT-indication 1.1.1
AA-RELEASE-confirm	–	–	–	–	–	–
AA-RESYNC-indication	–	(Note 1)	–	–	6.6.3	N(u)-RESET-indication 6.6.3
AA-RESYNC-confirm	6.10.3	–	N(u)-RESET-confirm 4.10.4	–	–	–
AA-RECOVER-indication	–	(Note 1)	–	–	–	N(u)-RESET-indication 6.8.3
AA-DATA-indication	–	(Note 1)	–	–	–	N(u)-DATA-indication 4.10.4
AA-UNITDATA-indication	(Note 3) 6.5.3	(Note 3) 6.10.3	(Note 3) 5.5.3	(Note 3) 6.6.3	(Note 3) 6.8.3	(Note 4) 4.10.4
error	–	–	–	–	–	4.10.4

TABLE 8/I.365.2 (3 of 3)

State transition table

NOTES

1 This event is legal in this state; however, if this event occurs, its action is deferred until the current state has been left.

2 If the error was detected after receipt of an N(u)-CONNECT-request primitive, the N(u)-DISCONNECT-indication primitive is issued; if the error was detected after receipt of an AA-ESTABLISH-indication signal, the AA-RELEASE-request signal is issued.

3 In this state, all AA-UNITDATA-indication signals are legal; however, they are ignored.

4 In this state, the PDU Type field of the "MU" parameter (i.e. the possible PDU) is decoded. If the Expedited Data transfer option is not implemented or has not been selected at connection establishment and an ED PDU or EDAK PDU is detected, or the Receipt Confirmation option is not implemented or has not been selected at connection establishment and an RC PDU or RCAK PDU is detected, as well if the PDU type field is unrecognizable, an error is indicated to Layer Management.

5 No indications to Layer Management are shown.

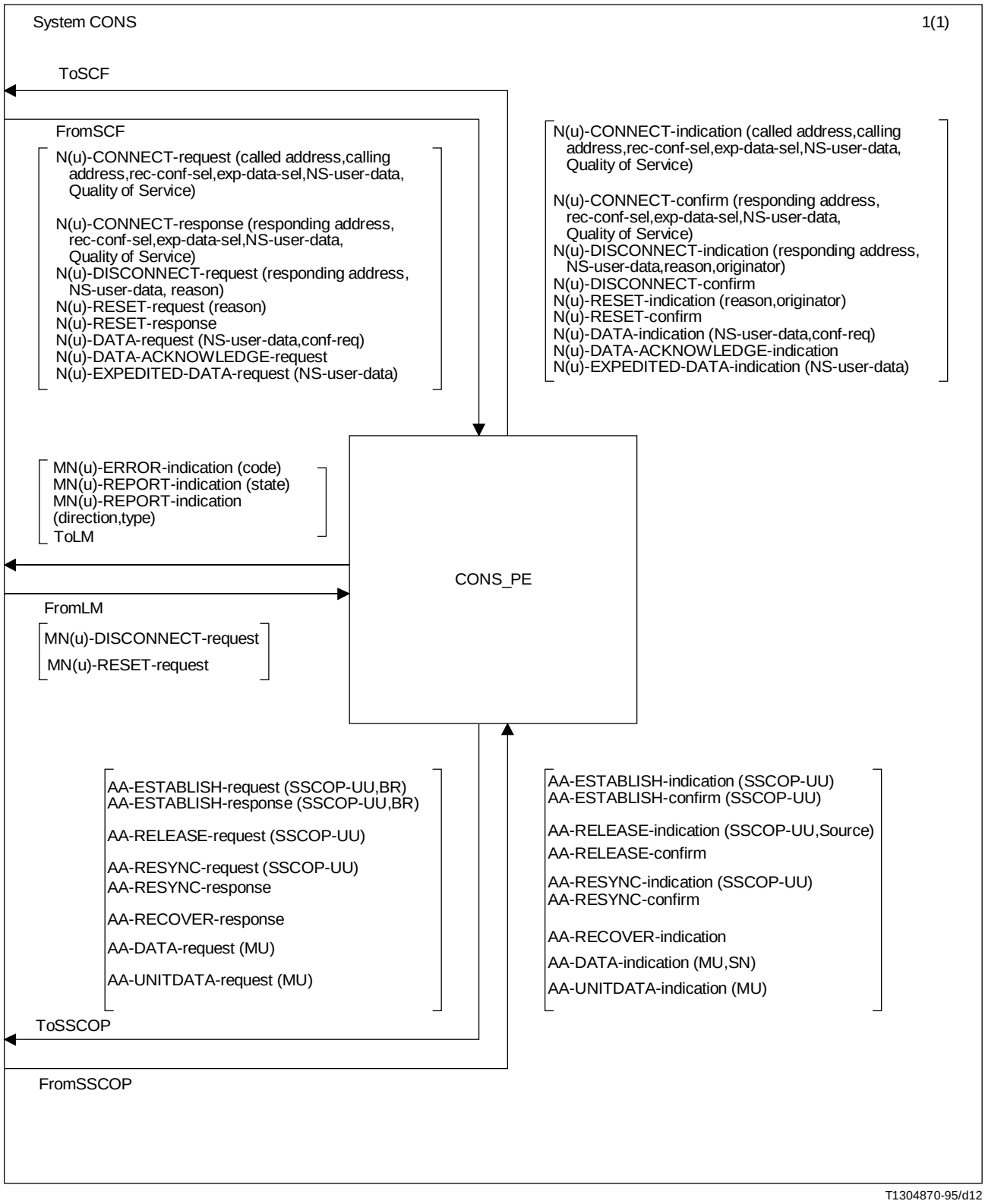


FIGURE 11/I.365.2

System SSCF-CONS SDL diagram

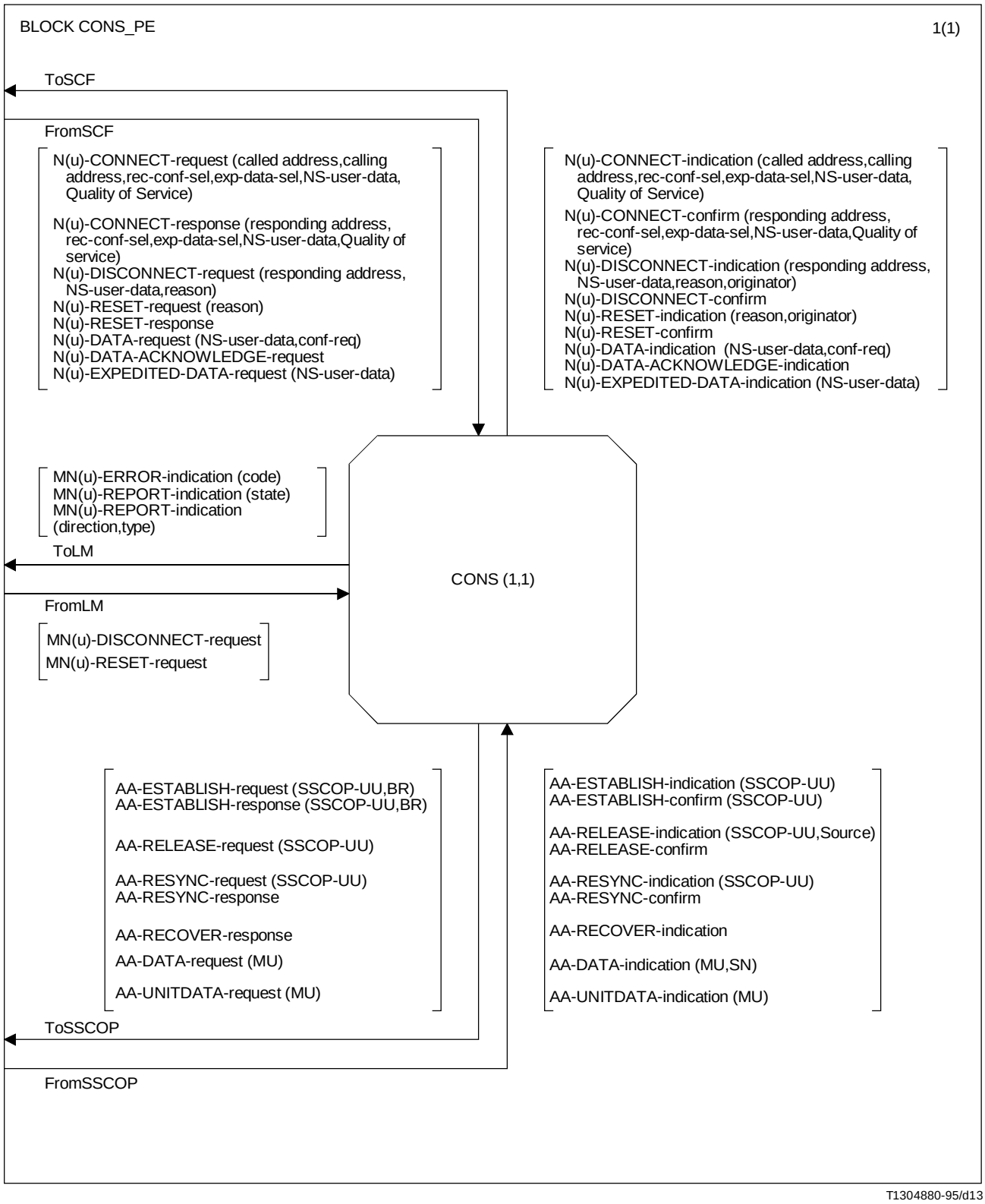


FIGURE 12/I.365.2

Block SSCF-CONS SDL diagram

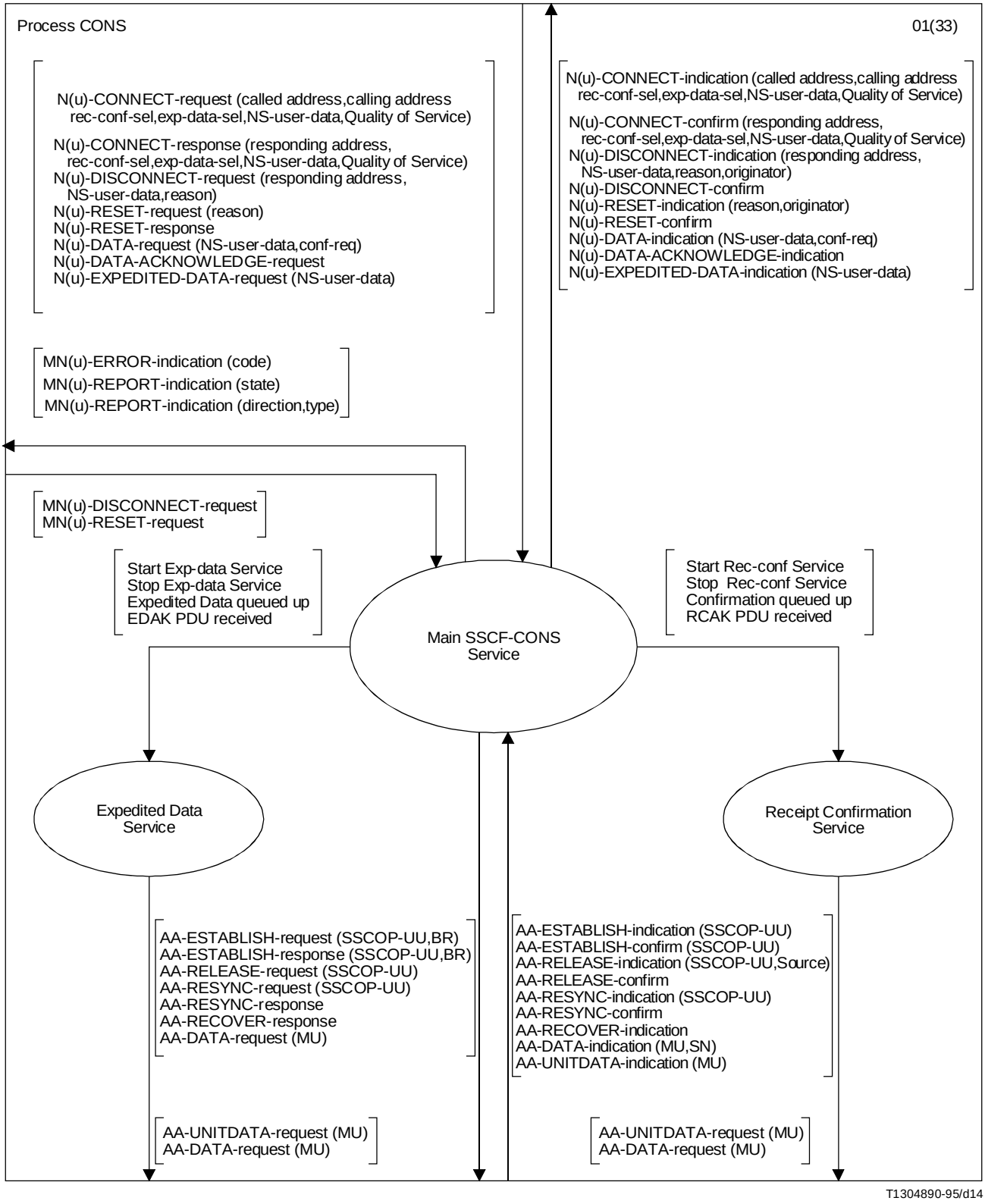


FIGURE 13/I.365.2 (sheet 1 of 21)

Procedure SSCF-CONS-Main Service SDL diagram

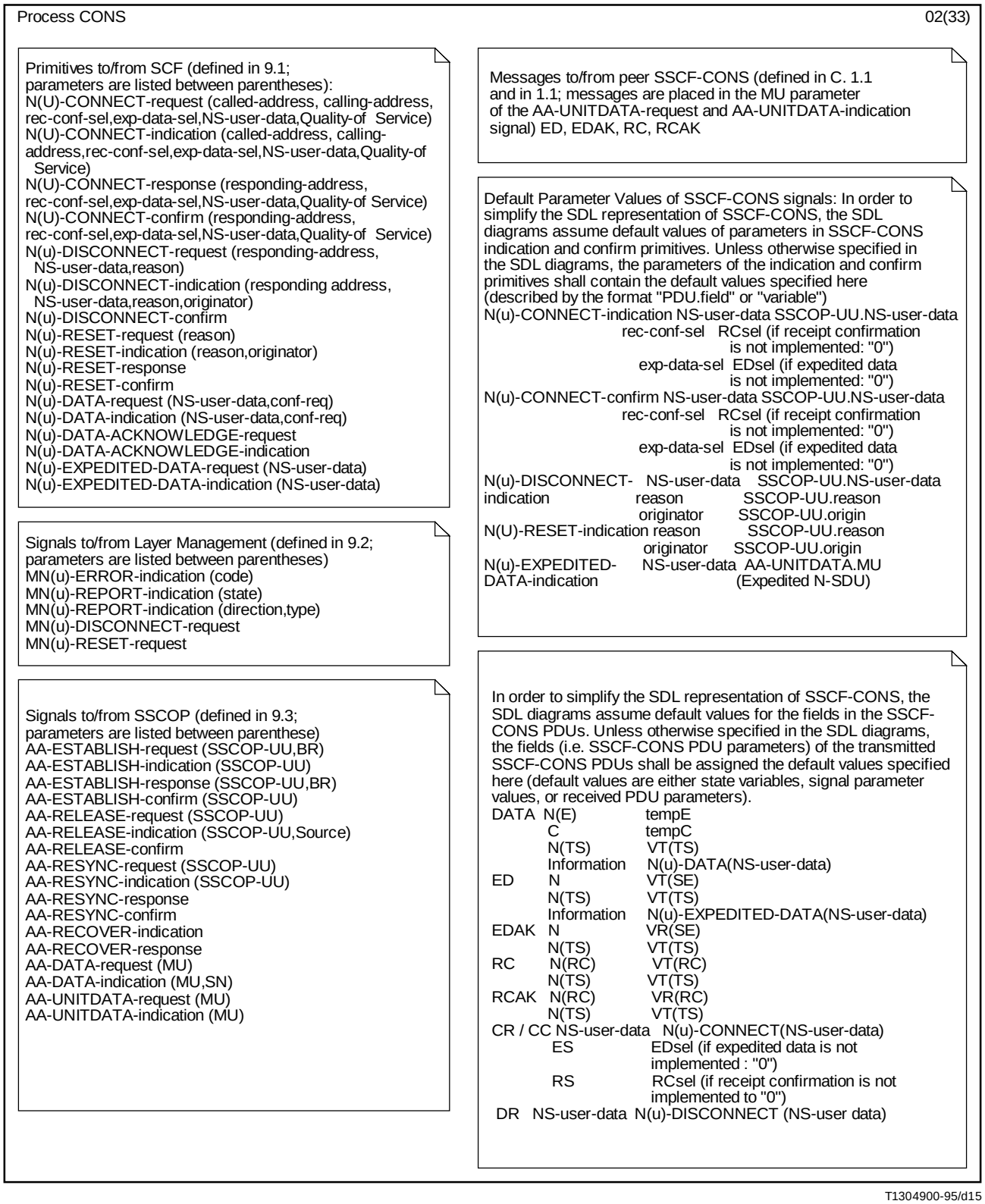


FIGURE 13/I.365.2 (sheet 2 of 21)

Procedure SSCF-CONS-Main Service SDL diagram

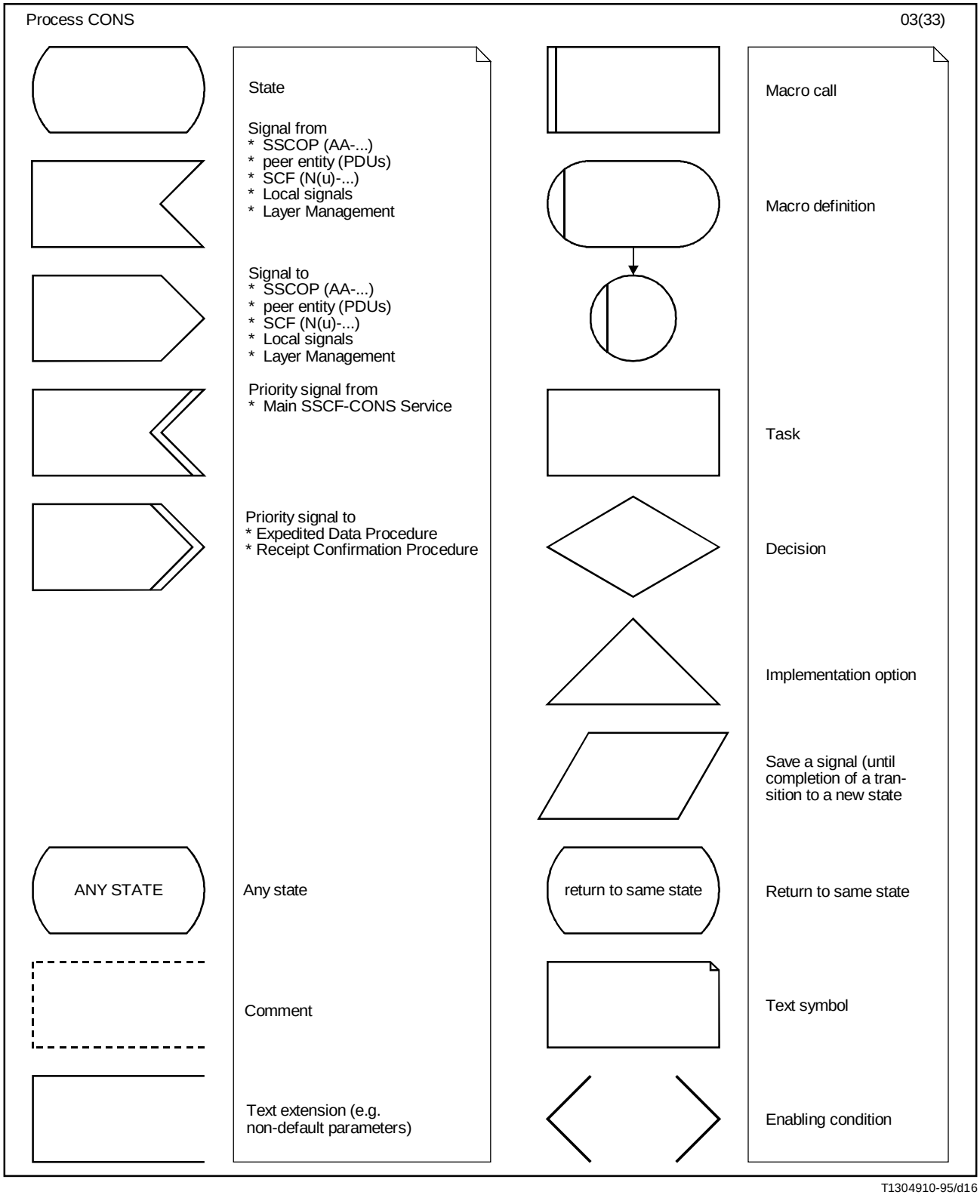


FIGURE 13/I.365.2 (sheet 3 of 21)

Procedure SSCF-CONS-Main Service SDL diagram

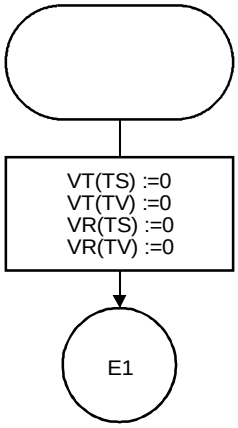
NOTE 1 – (on the use of queues and buffers):
To enable a satisfactory representation of the SSCF-CONS entity, a conceptual queue for the ED PDU has been explicitly brought out. This conceptual queue (ED queue) is finite but unbounded and should in no way restrict the implementation of the point-to-point procedures. One internal (local) signal has been provided in order to cause the servicing of this queue to be initiated: "ED PDU queued up". In the SDL diagrams, this signal is handled by the same "event queue" that handles other signals entering this process. The data itself is kept in the queue, hence, the order of the internal signals in the SDL event queue is insignificant.
In addition, the SDL diagrmas assume the following queues and buffers: At the receiver: Delivery queue (assured data not yet to be delivered until an Expedited N-SDU has been delivered) and Reassembly buffer (assured segmented data being reassembled). Also these conceptual queues and buffers are finite but unbounded as above.
NOTE 2 – Signals which are ignored for a given state (inopportune signals) are not included in the SDL diagrams.
NOTE 3 – Modulo arithmetic is performed on the following state variables: VT(SE), VT(RC), VR(SE), and VR(RC). VT denotes a transmitter variable, and VR denotes a receiver variable. The modulus equals 2E16 for VT(RC), and VR(RC); and the modulus equals 2 for VT(SE) and VR(SE).
NOTE 4 – The variables "tempC" , "tempE", "tempPDU", "tempL", "base", and "len" are temporary variables used in some transitions within the SDL diagrams. These variables do not constitute SSCF-CONS state variables or parameters.
NOTE 5 – In the SDL diagrams, the following abbreviations of variable names are used:

exp-data-sel	expedited data selection
rec-conf-sel	receipt confirmation selection
conf-req	confirmation request
qual-data-sel	qualified data selection

Where arithmetic is performed on these variables, the arithmetic value used is defined in Tables C.1 and D.1;
the conf-req parameter is coded as follows:

0:	receipt confirmation not requested
1:	request receipt confirmation

The value of the parameters in the N(u)-DISCONNECT and N(u)-RESET primitives are shown as codes whose interpretation is defined in Table 6.



NOTE – If neither the Expedited Data nor the Receipt Confirmation service is implemented, the variables VT(TS), VT(TV), VR(TS) and VR(TV) are clamped to zero.

T1304920-95/d17

FIGURE 13/I.365.2 (sheet 4 of 21)

Procedure SSCF-CONS-Main Service SDL diagram

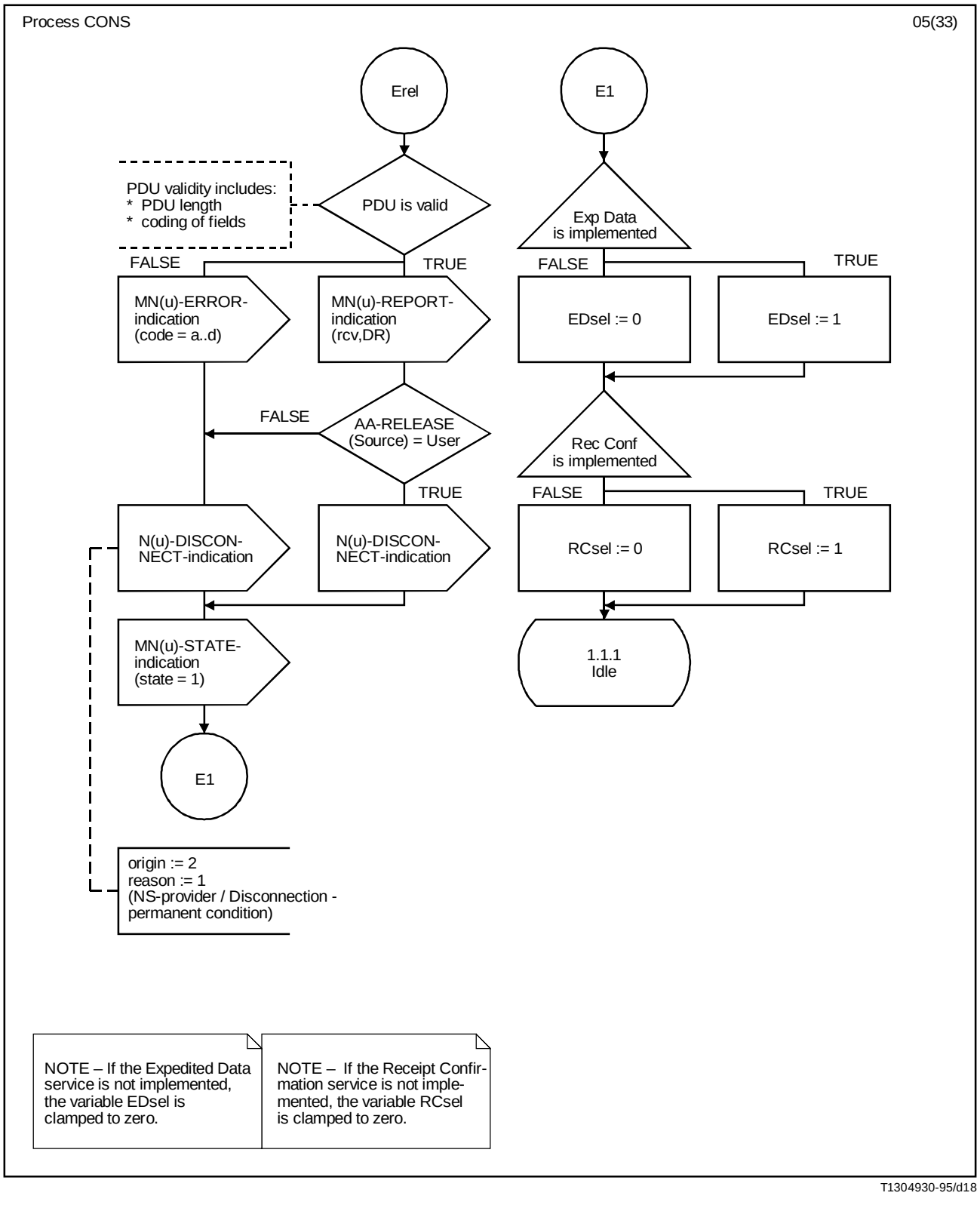


FIGURE 13/I.365.2 (sheet 5 of 21)

Procedure SSCF-CONS-Main Service SDL diagram

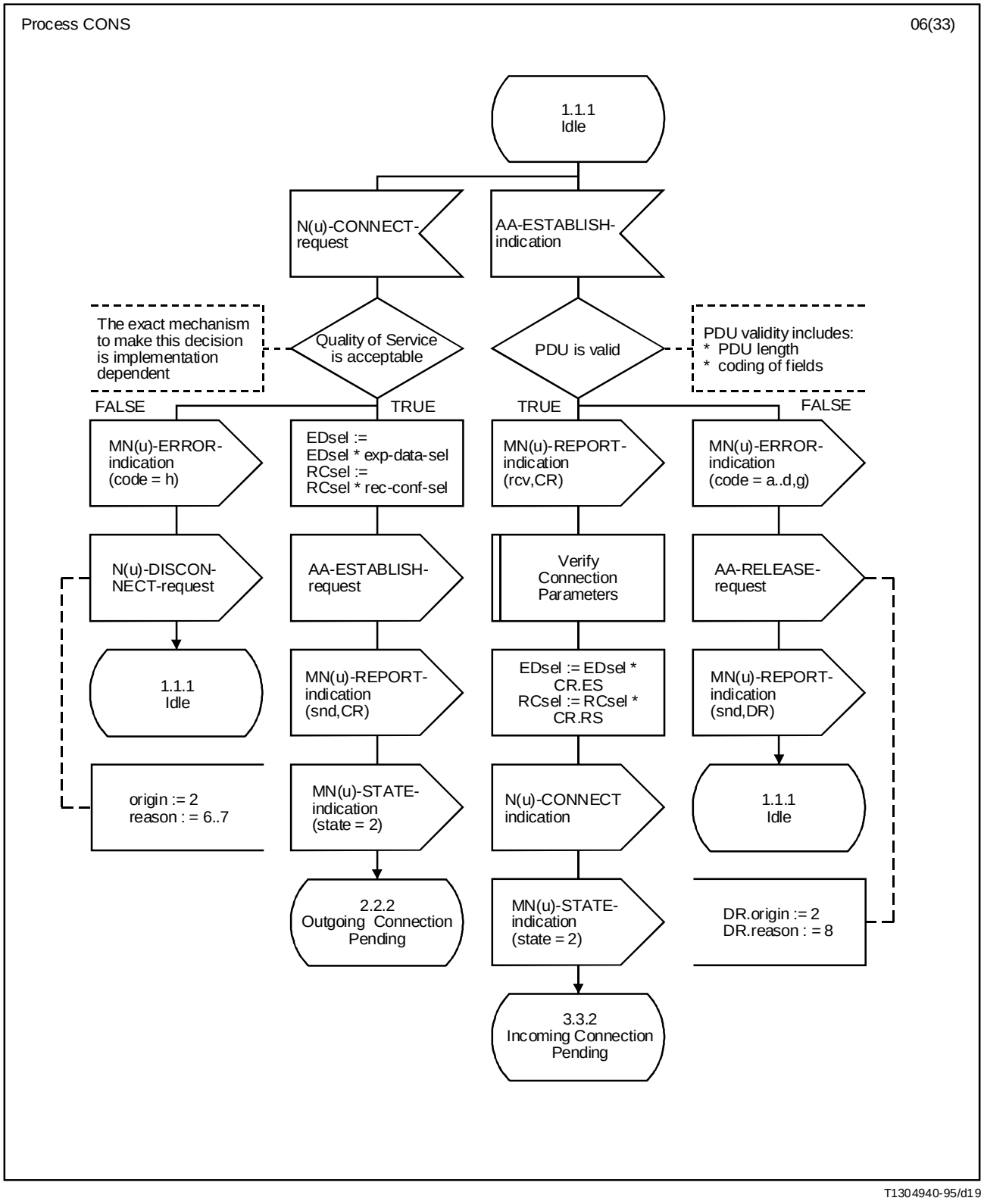


FIGURE 13/I.365.2 (sheet 6 of 21)

Procedure SSCF-CONS-Main Service SDL diagram

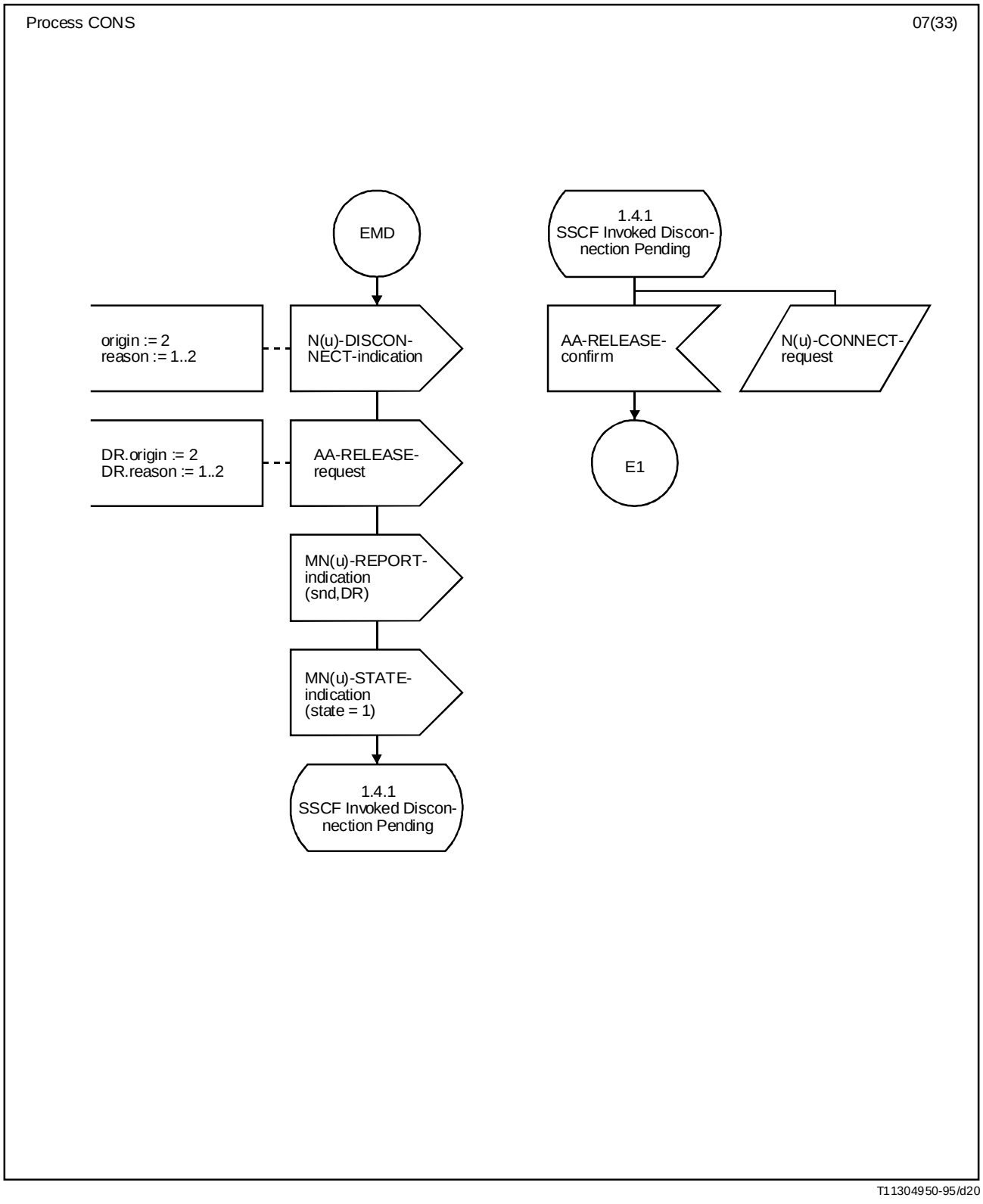


FIGURE 13/I.365.2 (sheet 7 of 21)

Procedure SSCF-CONS-Main Service SDL diagram

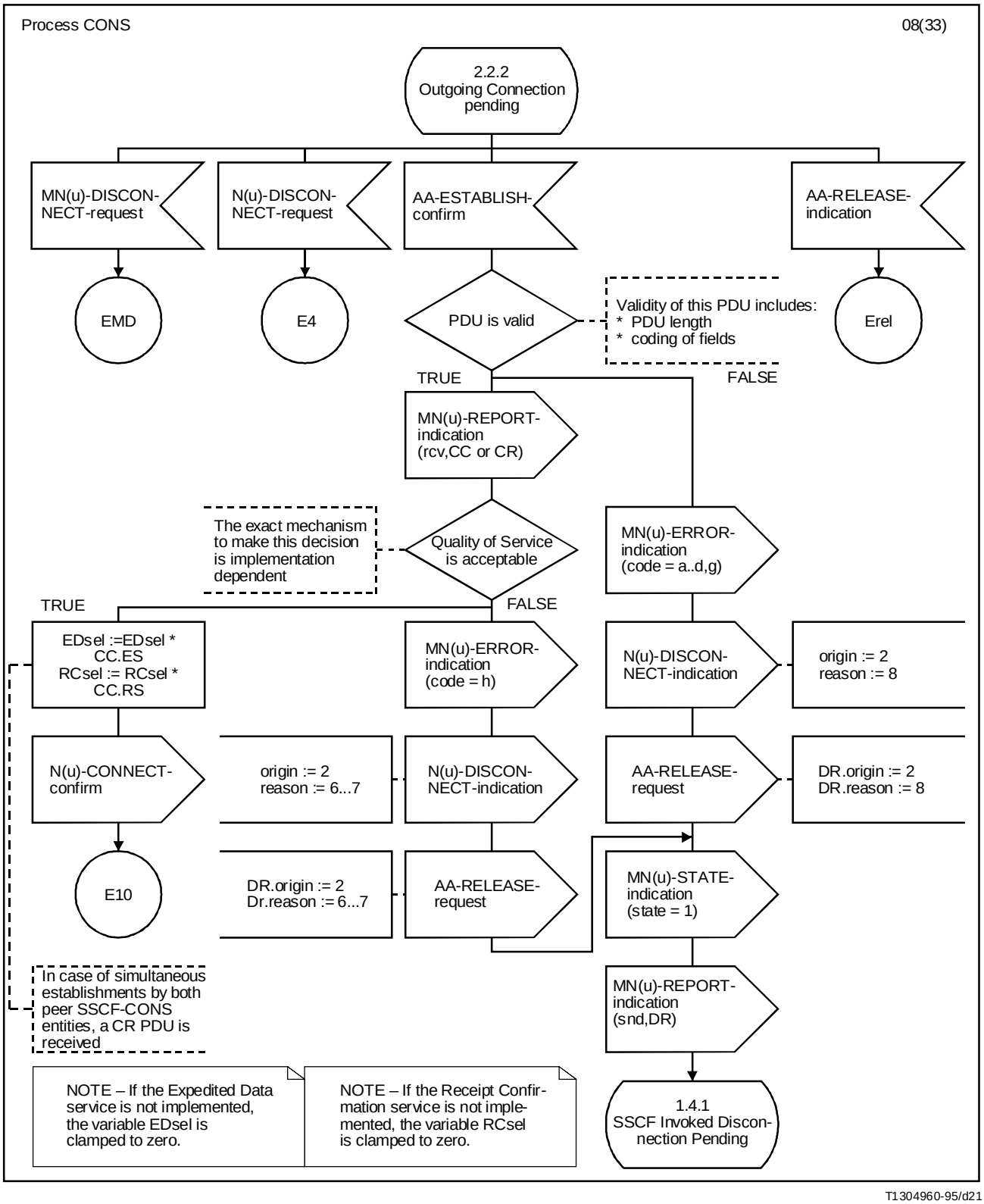


FIGURE 13/I.365.2 (sheet 8 of 21)

Procedure SSCF-CONS-Main Service SDL diagram

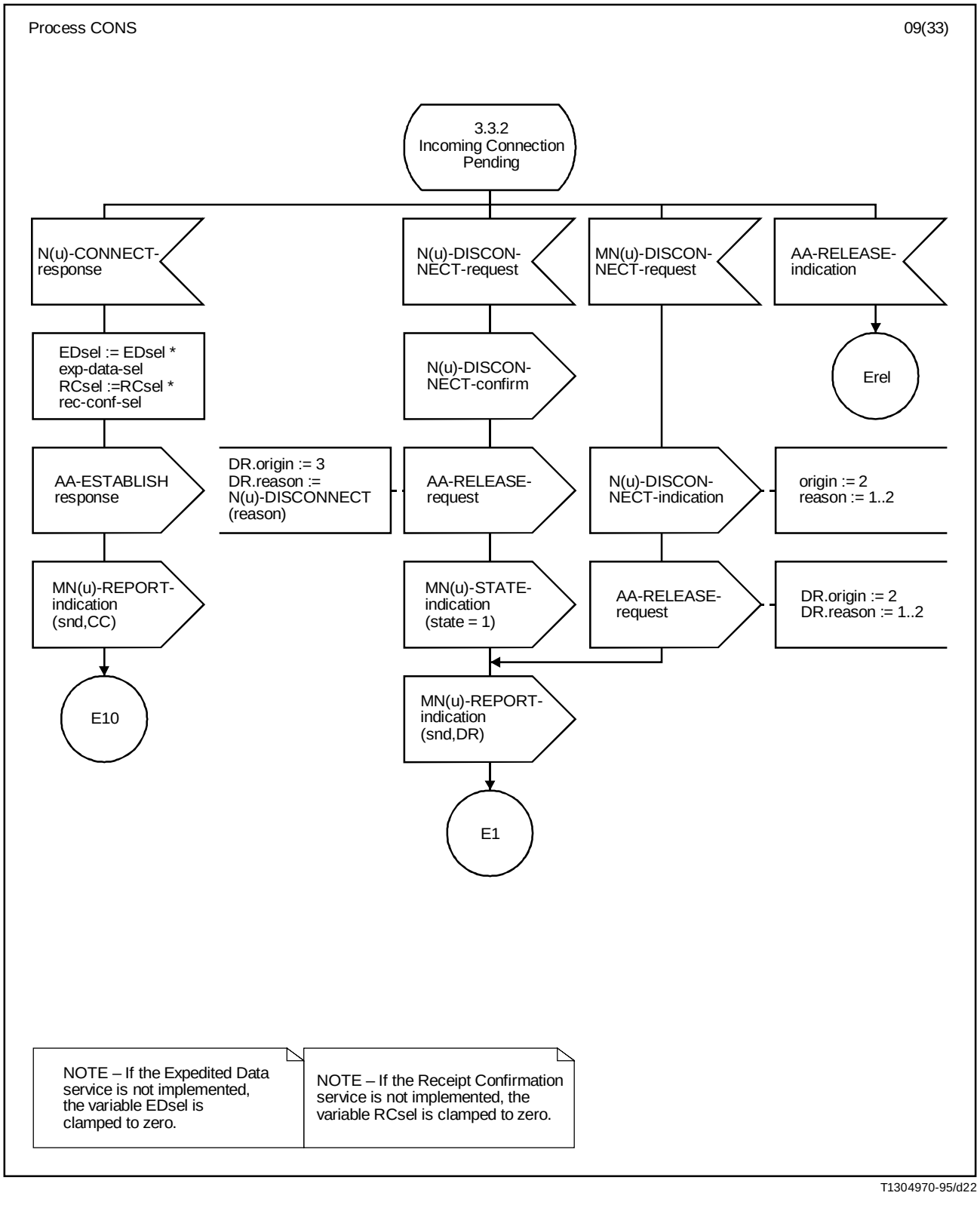


FIGURE 13/I.365.2 (sheet 9 of 21)

Procedure SSCF-CONS-Main Service SDL diagram

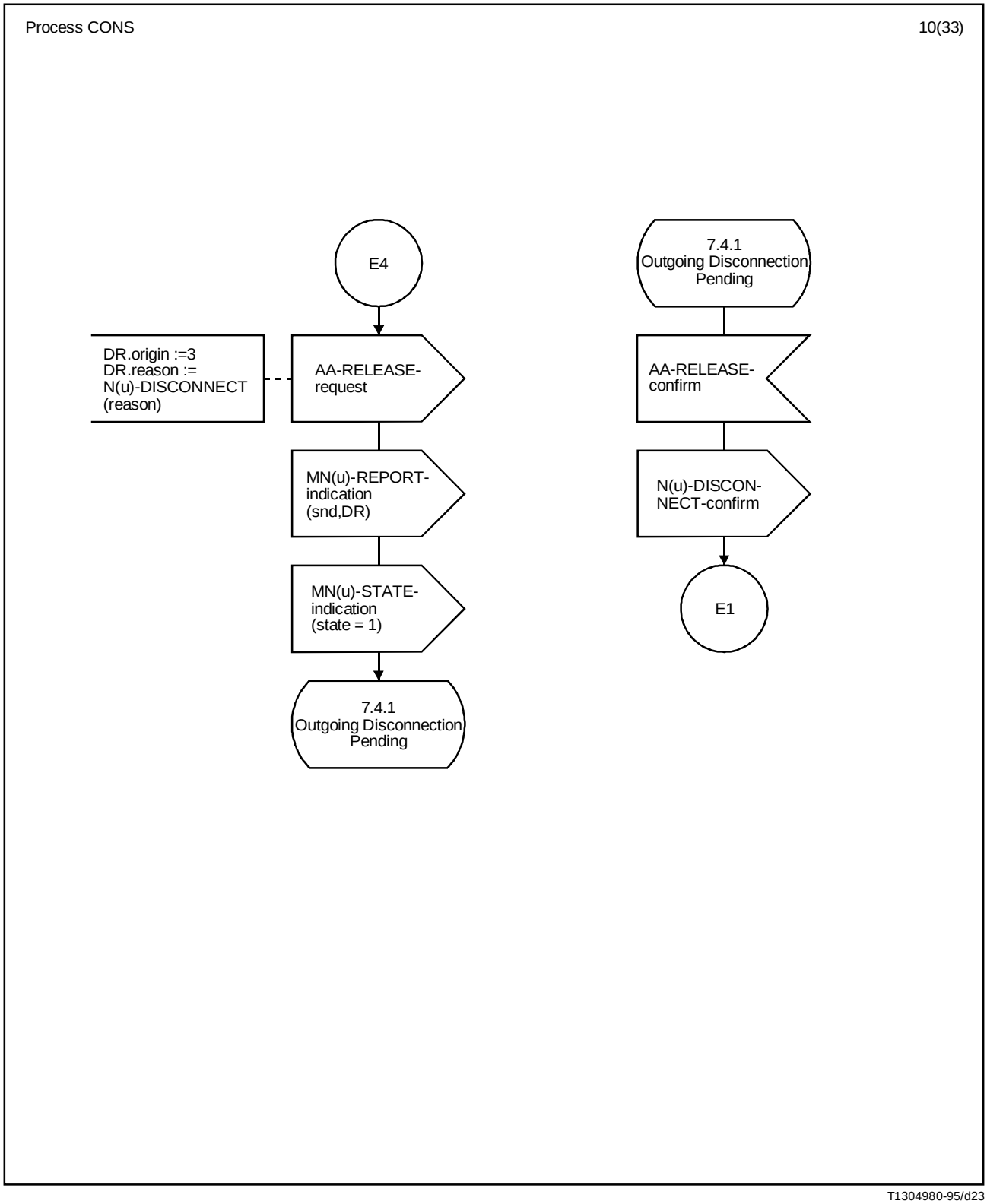


FIGURE 13/I.365.2 (sheet 10 of 21)

Procedure SSCF-CONS-Main Service SDL diagram

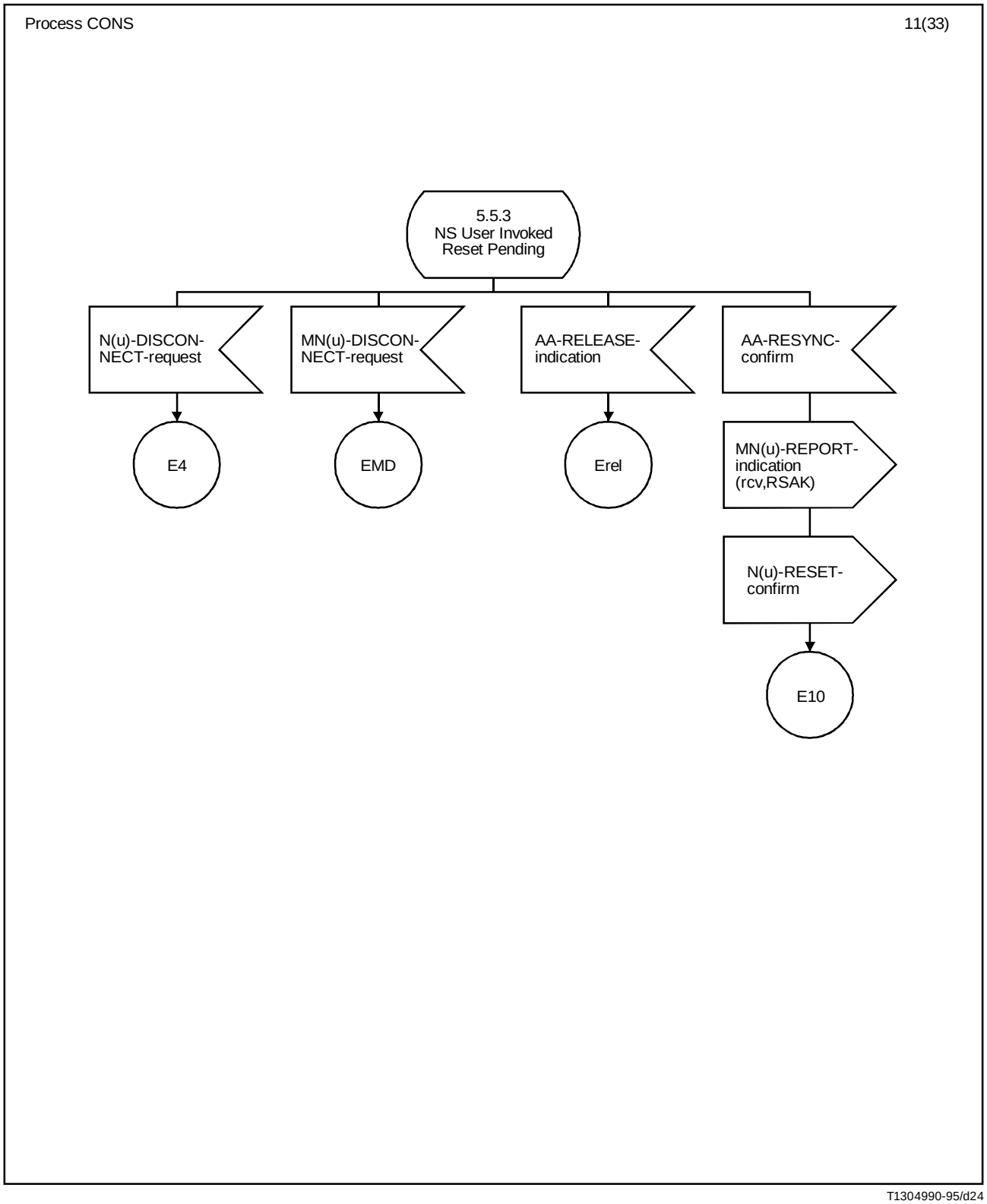


FIGURE 13/I.365.2 (sheet 11 of 21)

Procedure SSCF-CONS-Main Service SDL diagram

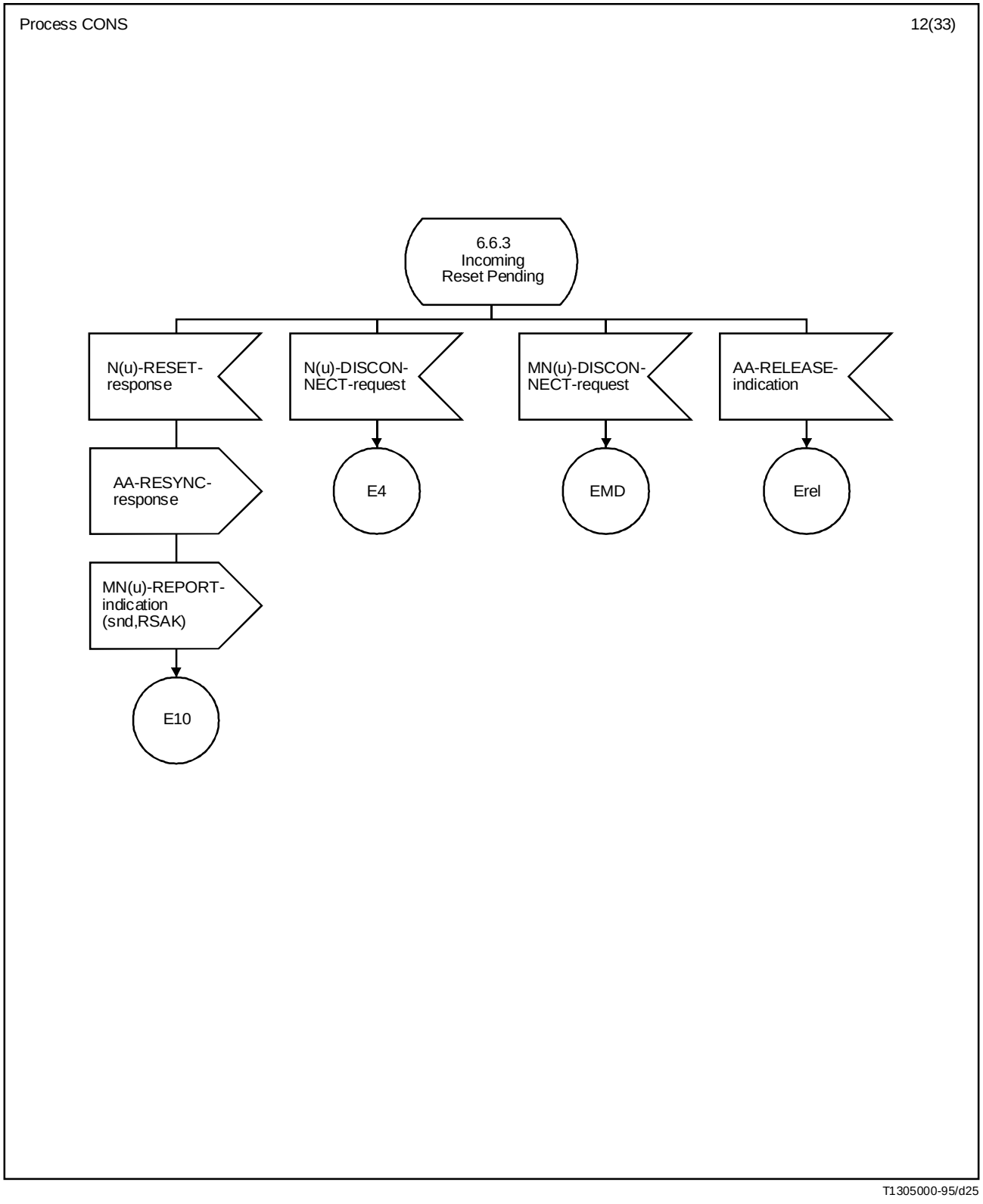


FIGURE 13/I.365.2 (sheet 12 of 21)

Procedure SSCF-CONS-Main Service SDL diagram

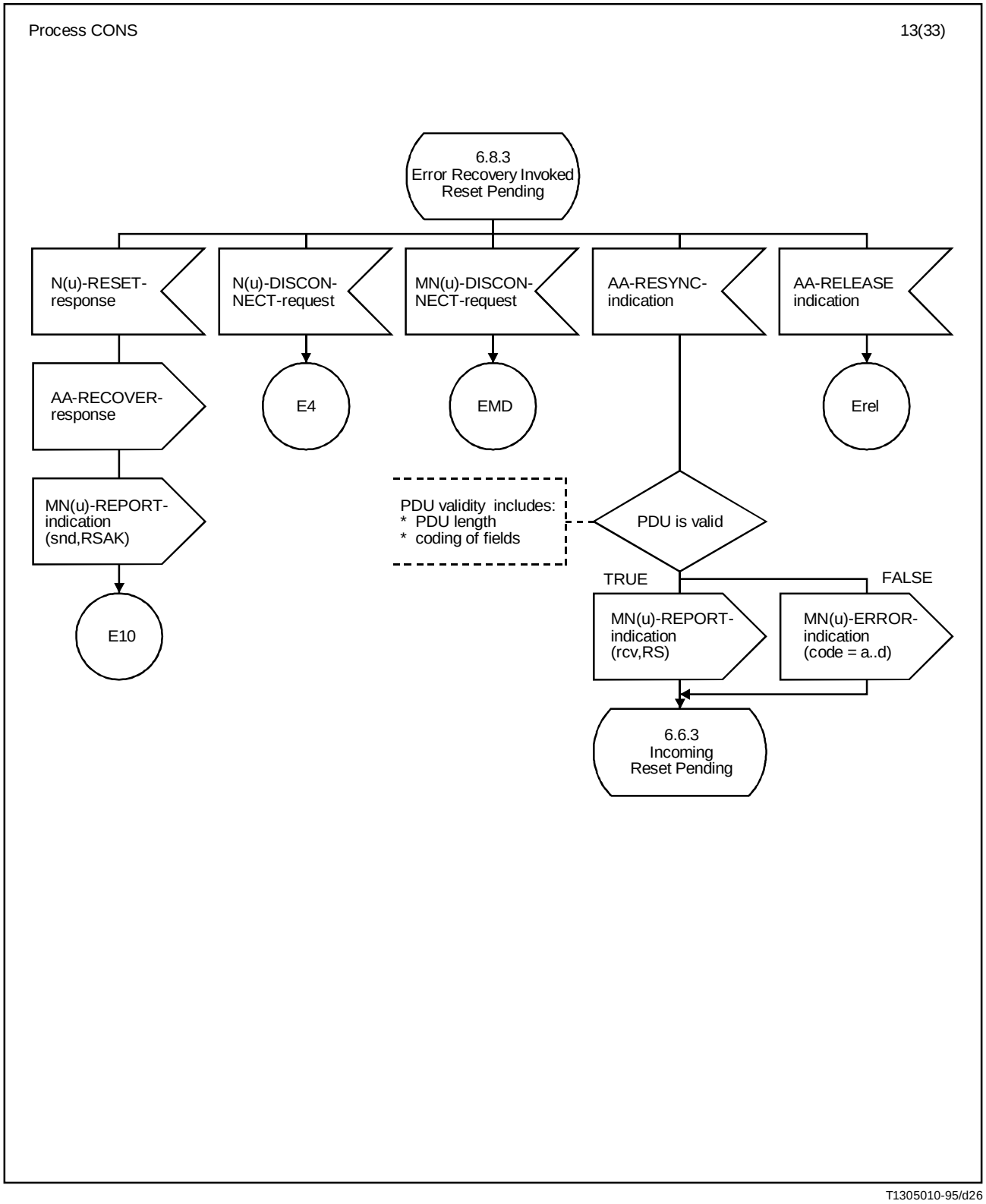


FIGURE 13/I.365.2 (sheet 13 of 21)

Procedure SSCF-CONS-Main Service SDL diagram

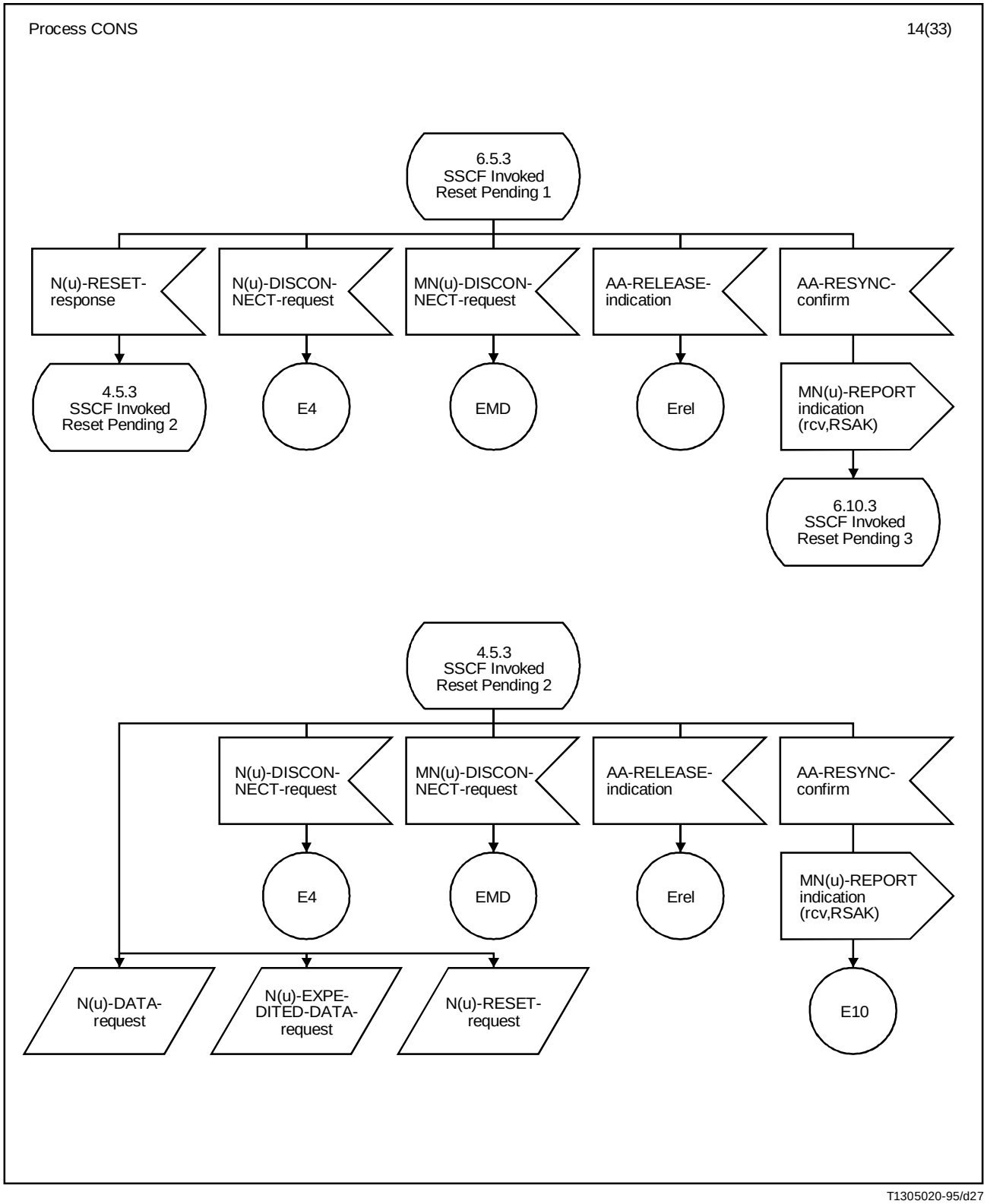


FIGURE 13/I.365.2 (sheet 14 of 21)

Procedure SSCF-CONS-Main Service SDL diagram

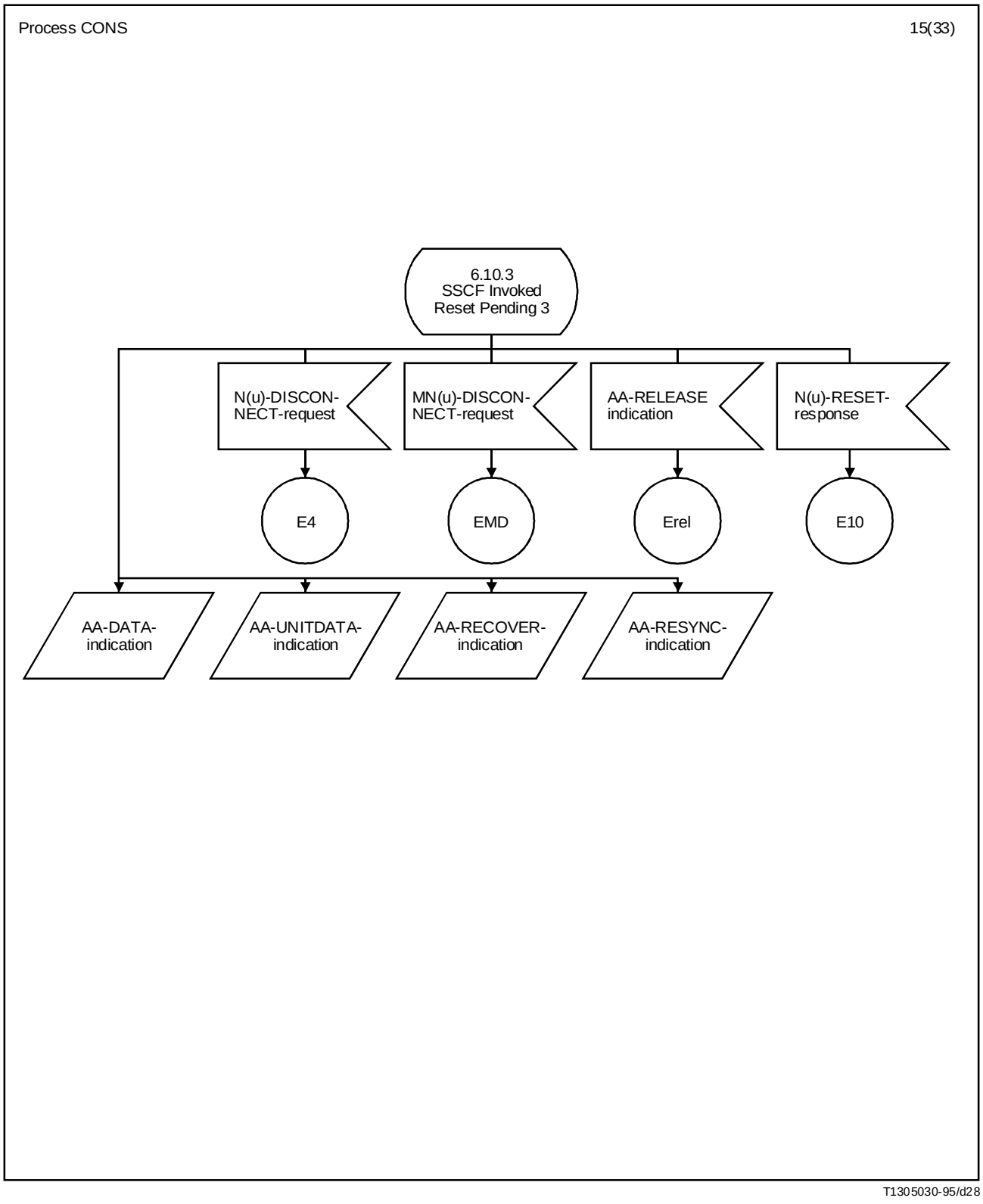


FIGURE 13/I.365.2 (sheet 15 of 21)

Procedure SSCF-CONS-Main Service SDL diagram

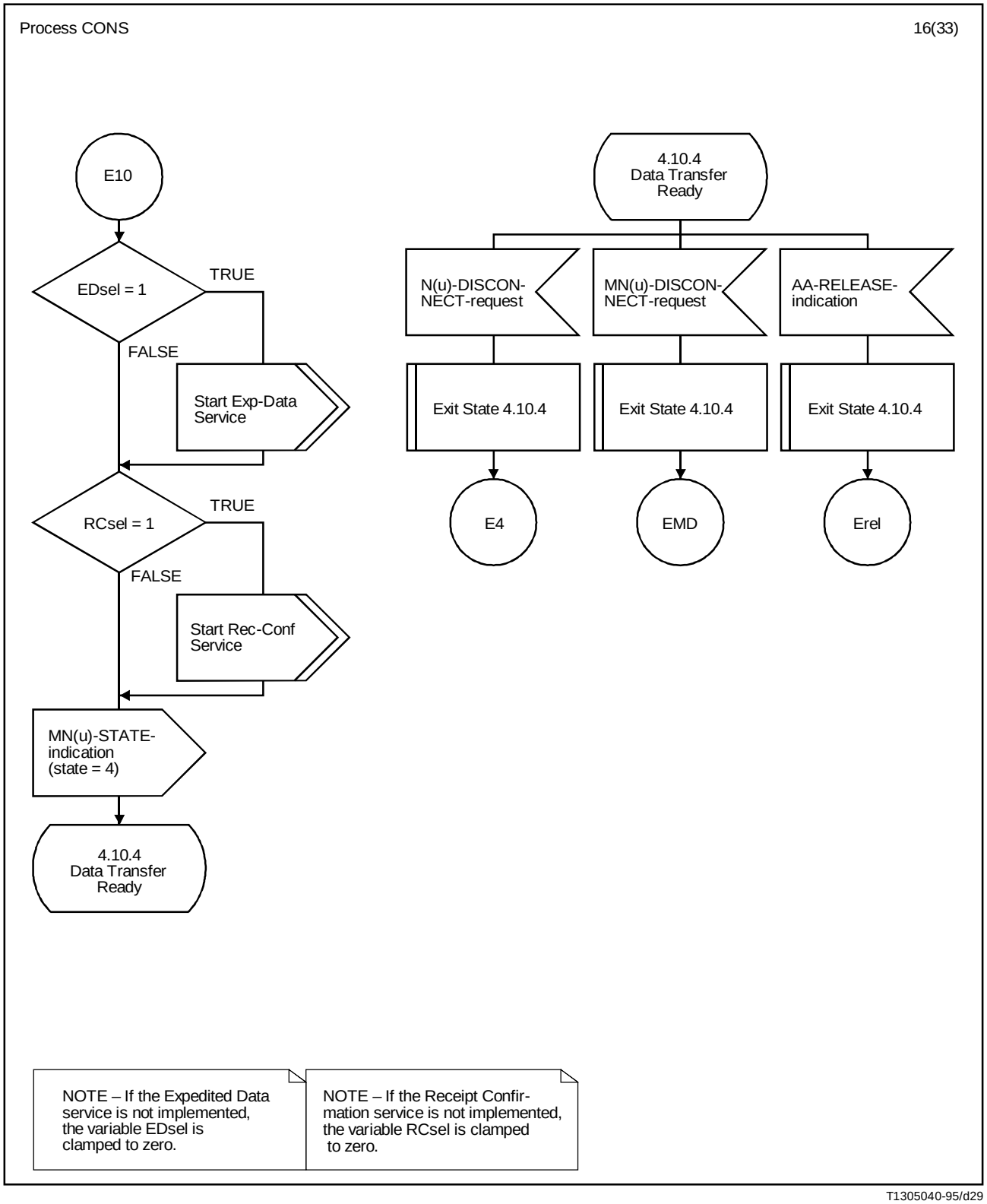


FIGURE 13/I.365.2 (sheet 16 of 21)

Procedure SSCF-CONS-Main Service SDL diagram

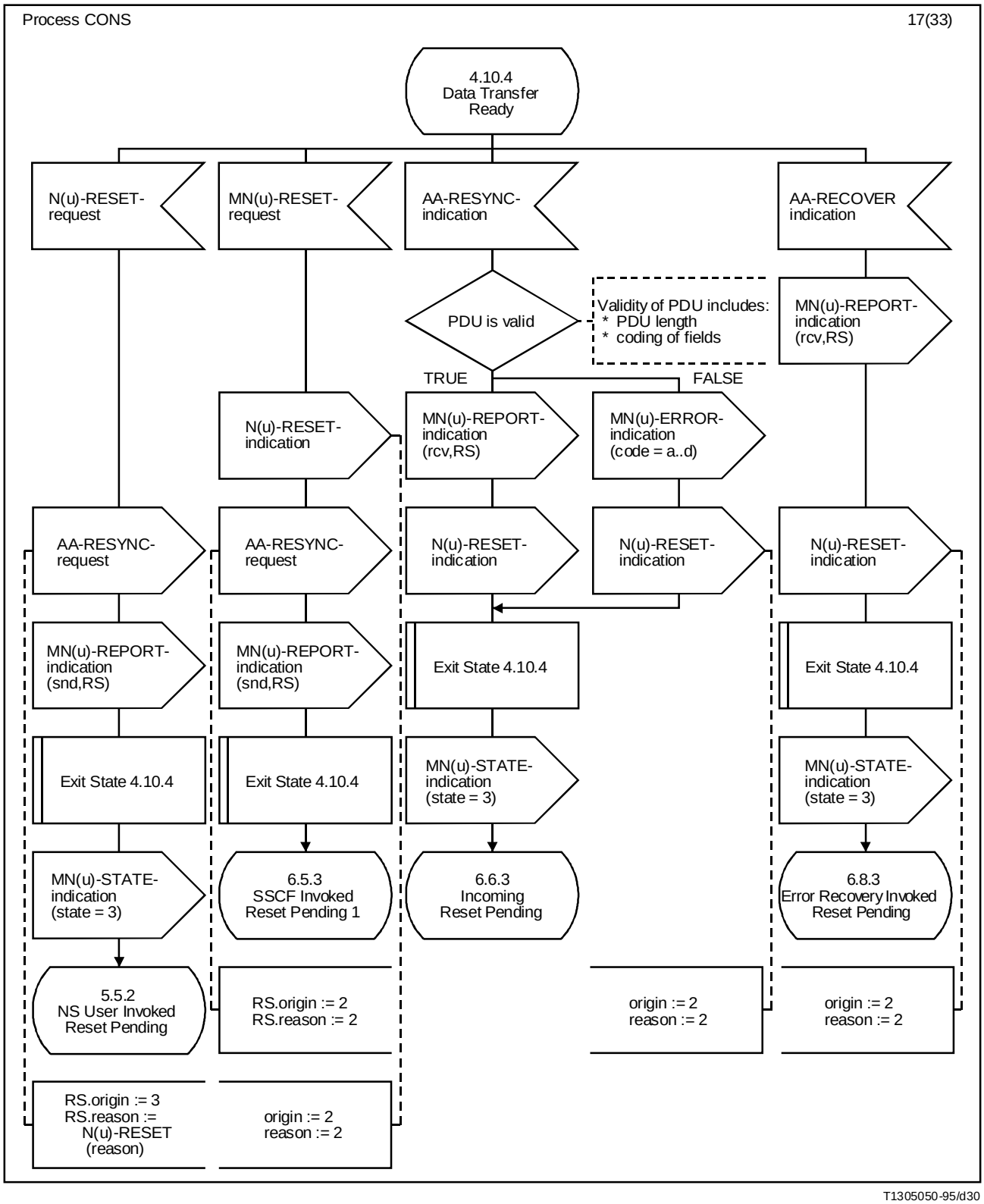


FIGURE 13/I.365.2 (sheet 17 of 21)

Procedure SSCF-CONS-Main Service SDL diagram

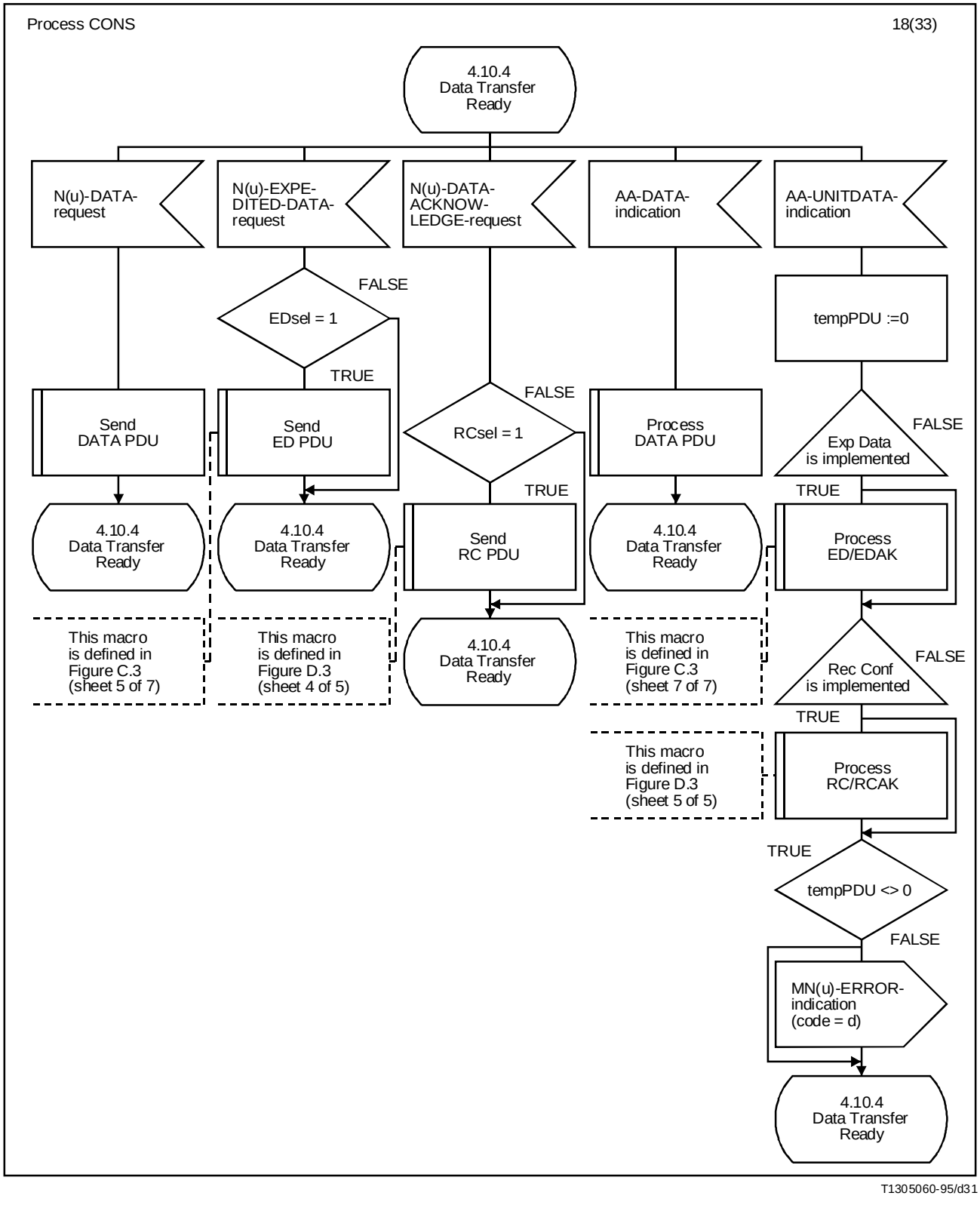


FIGURE 13/I.365.2 (sheet 18 of 21)

Procedure SSCF-CONS-Main Service SDL diagram

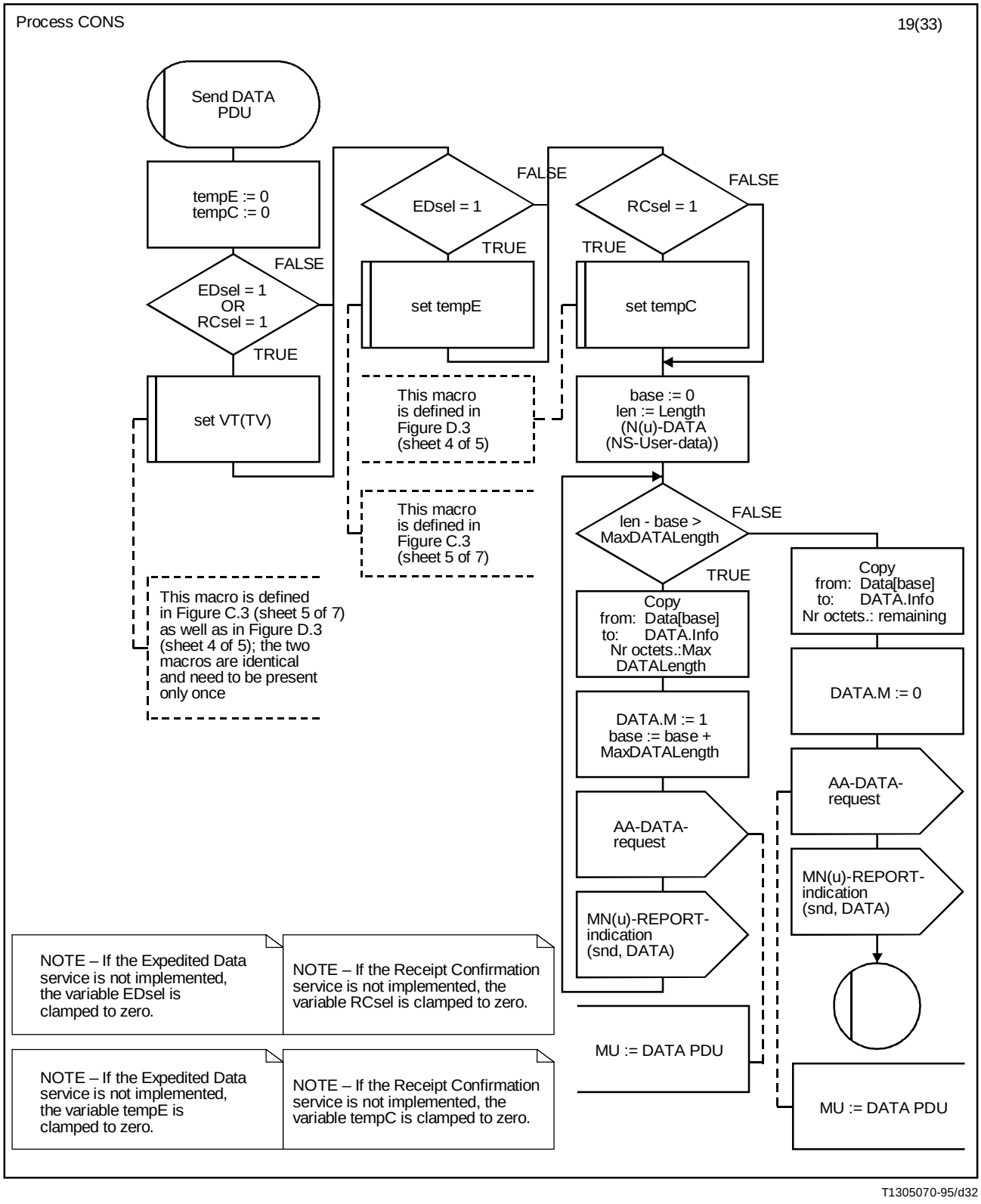


FIGURE 13/I.365.2 (sheet 19 of 21)

Procedure SSCF-CONS-Main Service SDL diagram

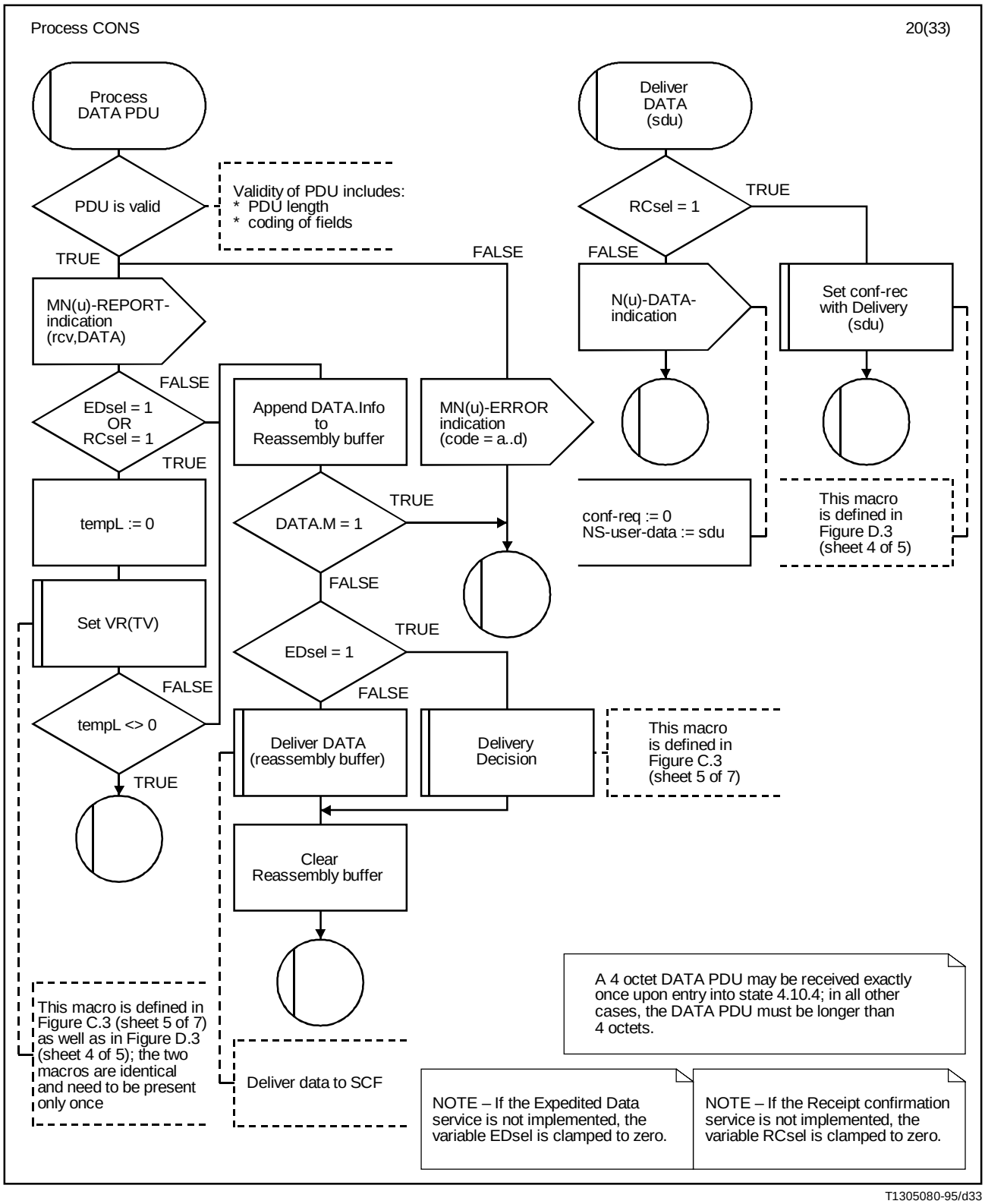


FIGURE 13/I.365.2 (sheet 20 of 21)

Procedure SSCF-CONS-Main Service SDL diagram

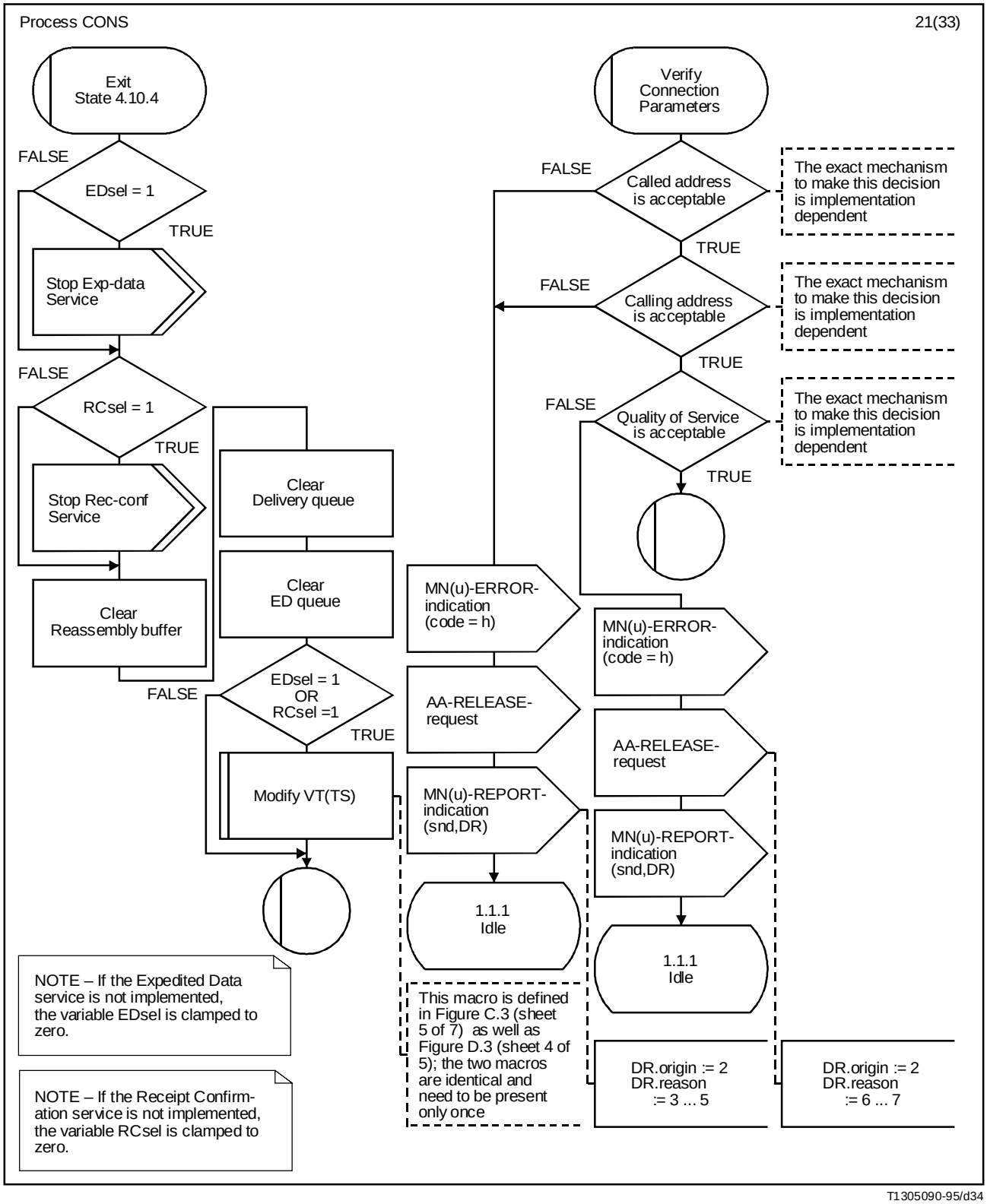


FIGURE 13/I.365.2 (sheet 21 of 21)

Procedure SSCF-CONS-Main Service SDL diagram

Annex A

Management error indications

(This annex forms an integral part of this Recommendation)

A number of events will cause errors to be submitted to the layer management entity. The associated error parameter contains the error code that describes the specific error conditions.

The column entitled “Error condition” together with the “Affected states” describes specific protocol error events and the state of the SSCF-CONS entity at the point that the MN(u)-ERROR-indication primitive is generated. See Table A.1.

TABLE A.1/I.365.2

Error conditions reported to Layer management

Error class		Error code	Error condition	Affected states
i)	SSCOP errors	A - X	Defined in Recommendation Q.2110	Reported by SSCOP
ii)	Illegal PDU	a	Invalid ED of EDAK PDU	1.1.1, 2.2.2, 4.10.4, 6.8.3
		b	Invalid RC or RCAK PDU	1.1.1, 2.2.2, 4.10.4, 6.8.3
		c	Invalid PDU of recognizable PDU Type (other than ED, EDAK, RC, or RCAK)	1.1.1, 2.2.2, 4.10.4, 6.8.3
		d (Note)	Unrecognizable PDU Type	1.1.1, 2.2.2, 4.10.4, 6.8.3
iii)	Inopportune PDU	e	Inopportune ED or EDAK PDU	4.10.4
		f	Inopportune RC or RCAK PDU	4.10.4
iv)	Illegal or inopportune PDU parameter	g	Inappropriate parameter in PDU of recognizable PDU Type	1.1.1, 2.2.2
v)	SSCF-CONS initiated causes	h	Local SSCF-CONS rejected connection (unacceptable QOS or address)	1.1.1, 2.2.2
NOTE – If the expedited data service or the receipt confirmation service is not implemented, the corresponding PDUs are treated as unrecognizable PDUs.				

Annex B

Default values for SSCOP parameters and timers

(This annex forms an integral part of this Recommendation)

This annex provides for suggested SSCOP parameter values that can be used for supporting SSCF-CONS. Table B.1 summarizes the default protocol parameters for four environments; however, these values provide satisfactory performance over a wider range of operating environments. A proper set of parameters may differ depending on the use, condition, link rate, round trip delay, and receiver resequencing buffer size; therefore, the parameters should be configurable. As a general guide, Timer_POLL should be set to as large a value as possible that still maintains throughput efficiency and satisfies the average and maximum delay requirements for delivery of data.

The tolerance of timers is not addressed in this Recommendation.

NOTE – Appendix II gives further considerations for the default values for the SSCOP's parameters and timers.

TABLE B.1/I.365.2

Default values for SSCOP parameters and timers

Parameter	Value				Unit
Condition: Bitrate at Interface (UNI) max. SSCF-CONS PDU rate Round trip Delay	1.544 1.366 60	2.048 1.811 60	155.520 132.530 10	155.520 132.530 600	Mbit/s Mbit/s ms
k (maximum SSCOP SDU size)	4096	4096	4096	4096	octet
j (maximum SSCOP-UU size)	256	256	256	256	octet
Timer_POLL	100	100	10	500	ms
Timer_NO-RESPONSE	2000	2000	200	1000	ms
Timer_KEEPALIVE	300	300	50	500	ms
Timer_IDLE	1 ... 5	1 ... 5	0.2	1.0	s
Timer_CC	100	100	100	700	ms
MaxCC	4	4	4	4	
MaxPD	500	500	500	500	
MaxSTAT	67	67	67	67	
NOTE – For Timer_POLL and Timer_KEEPALIVE it does not matter if the first expiry occurs in less time than the stated value, but subsequent expiries shall occur within the nominal tolerance of the stated value.					

Annex C

Expedited Data Transfer Service

(This annex forms an integral part of this Recommendation)

This annex specifies the protocol elements and the protocol for the Expedited Data Transfer option.

NOTE – This option is a provider option.

C.1 Protocol elements for peer-to-peer communication

The expedited data transfer service makes use of the unassured data stream that is independent of the flow control of the assured service. Error recovery from transmission errors by retransmission and a separate flow control is handled by a peer-to-peer protocol within the SSCF-CONS sublayer. The SSCOP signal type used is AA-UNITDATA.

C.1.1 SSCF-CONS PDUs

The Protocol Data Units (PDUs) are listed and described in Table 7.

The definitions of the SSCF-CONS PDUs utilizing the unassured data transfer are as follows:

a) *ED PDU (Expedited Data)*

The ED PDU is used to transfer Expedited N-SDUs between the two peer NS-users.

b) *EDAK PDU (Expedited Data Acknowledgement)*

The EDAK PDU is used to acknowledge receipt of an ED PDU; it is also used for flow control of the expedited data transfer.

C.1.2 SSCF-CONS PDU formats

Figures C.1 and C.2 illustrate the format of the PDUs for the Expedited Data Transfer service.

The maximum length of the information field in the ED PDU is 32 octets; its minimum length is 1 octet.

NOTE – 32 octets of NS-user-data plus 4 octets of SSCF-CONS PCI plus 4 octets of SSCOP PCI plus 8 octets of AAL type 5 Common Part (see clause 6/I.363 [2]) PCI fits into a single ATM information field.

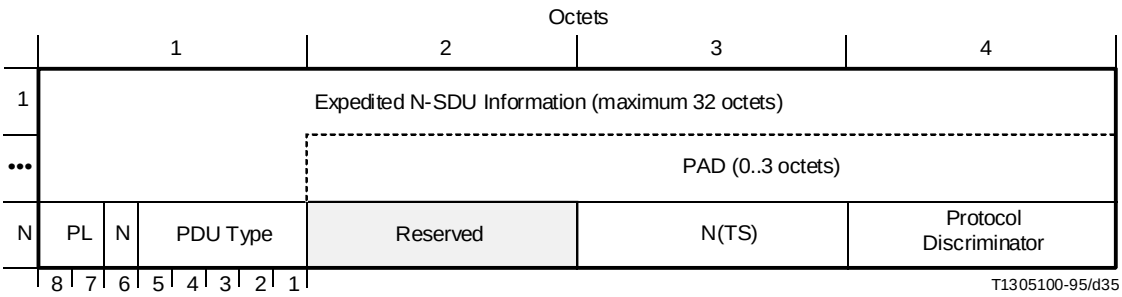


FIGURE C.1/I.365.2

Expedited Data (ED PDU)

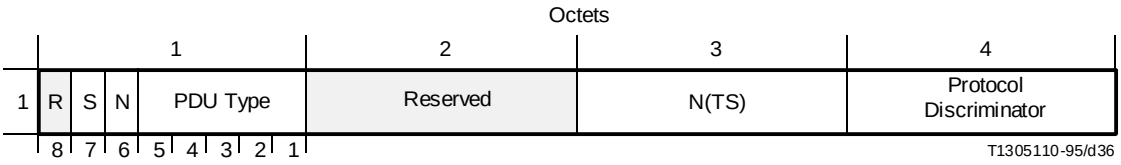


FIGURE C.2/I.365.2

Expedited Data Acknowledgement (EDAK PDU)

C.1.3 SSCF-CONS PDU parameter fields

The SSCF-CONS PDUs contain the following parameter fields in addition to those specified in 10.3:

a) *PDU Type – PDU Type field*

The PDU Type field's coding is defined in Table 7.

b) *Expedited N-SDU Information field*

The Expedited N-SDU Information field in the ED PDU contains the value of the NS-user-data parameter of the N(u)-EXPEDITED-DATA primitive.

c) *S – Expedited Data Flow Control field*

The S field (stop bit) in the EDAK PDU is set to "0" if transmission of further ED PDUs is allowed; otherwise, the S field is set to "1".

d) *N – Expedited Data Sequence Number field*

The N field carries the current value of the state variable VT(SE) in the ED PDU and the value of the state variable VR(SE) in the EDAK PDU.

The SSCF-CONS PDU parameters already defined in 10.3 that are "reserved" in the absence of the implementation and the selection at connection establishment are defined as follows:

e) *N(TS) – Data Transfer State Identity Number field*

In the ED PDU and EDAK PDU, this field carries the current value of the transmitter state variable VT(TS).

f) *ES – Expedited Data Transfer Selection field*

During connection establishment, the ES field in the CR and CC PDUs conveys the Expedited Data Transfer selection between the two peer SSCF-CONS entities (see Figure 7 and 10.3). The coding is shown in Table C.1.

g) *N(E) – Expedited Data Synchronization field*

The N(E) field in the DATA PDU contains the value of the state variable VT(E) before it is set to "0"; it represents the number of N(u)-Expedited-Data-indications that must be delivered before the N(u)-DATA-indication associated with this DATA PDU may be delivered (see Figure 6 and 10.3). If segmentation occurs, the N(E) field is set to the same value in all DATA PDUs.

TABLE C.1/I.365.2

SSCF-CONS PDU field coding

Field	Code	Value
ES field	0 1	No use of expedited data User of expedited data

C.1.4 Additional states of the SSCF-CONS protocol entity

For the assured transfer of expedited data, a service procedure is running whenever the SSCF-CONS entity is in the Data Transfer Ready state (state 4.10.4). This Expedited Data service procedure has the following basic states:

State E0 Expedited Data Wait

The Expedited Data service procedure of an SSCF-CONS entity is conceptually initiated in the Expedited Data Wait state. It remains or returns to this state unless the SSCF-CONS entity is in the Data Transfer Ready state (state 4.10.4).

State E1 Expedited Data Idle

When the SSCF-CONS entity is in state 4.10.4 and no acknowledgement of an ED PDU is outstanding, the Expedited Data service procedure is in the Expedited Data Idle state.

State E2 Expedited Data Sent

The Expedited Data service procedure has transmitted an ED PDU and is awaiting its acknowledgement in the Expedited Data Sent state.

State E3 Expedited Data Busy

The Expedited Data service procedure has received the acknowledgement of a transmitted ED PDU but has not received credit to send further ED PDUs; credit is awaited in the Expedited Data Busy state.

C.1.5 Additional SSCF-CONS state variables

The ED PDUs are sequentially numbered; as only one ED PDU acknowledgement is allowed to be outstanding, a sequence number modulo 2 is sufficient.

NOTE – The Expedited Data service procedure shares the state variables with the main procedure.

C.1.5.1 Transmitter state variables

To support the Expedited Data Transfer option, SSCF-CONS maintains the following state variables at the transmitter:

a) *VT(SE) – Expedited Data Send state variable*

This state variable contains the sequence number of the next ED PDU to be transmitted. It is incremented after the acknowledgement of an ED PDU. When the SSCF-CONS entity enters state 4.10.4 (Data Transfer Ready), this state variable is set to "0". Arithmetic on the value of this state variable is modulo 2.

b) *VT(E) – Expedited Data Synchronization Send state variable*

This state variable counts the number of N(u)-EXPEDITED-DATA-request primitives received between normal N(u)-DATA-request primitives. When the SSCF-CONS entity enters state 4.10.4 (Data Transfer Ready), this state variable is set to "0". The value of this state variable is copied into the Expedited Data Synchronization field N(E) otherwise, no arithmetic is performed on this state variable.

NOTE 1 – The N(E) field in the DATA PDU contains a value other than "0" if N(u)-EXPEDITED-DATA-request primitives were received between this and the last N(u)-DATA-request; otherwise, the N(E) field is set to "0". If segmentation occurs, the N(E) field is set to the same value in all DATA PDUs.

c) *VT(TS) – Data Transfer State Identity Number state variable*

This state variable contains the identity number of the entry into the Data Transfer Ready state (state 4.10.4, see Figure 10). This state variable is copied into the N(TS) field of the DATA PDU, ED PDU, and EDAK PDU.

NOTE 2 – If the the Receipt Confirmation option is implemented and has been selected at connection establishment in conjunction with the Expedit, options share this single state variable.

d) *VT(TV) – Data Transfer State Identity Validity state variable*

This state variable contains the information whether the identity number in the state variable VT(TS) has been sent in a DATA PDU with an appropriately set N(TS).

NOTE 3 – If the the Receipt Confirmation option is implemented and has been selected at connection establishment in conjunction with the Expedit, options share this single state variable.

C.1.5.2 Receiver state variables

To support the Expedited Data Transfer option, SSCF-CONS maintains the following state variables at the receiver:

a) *VR(SE) – Expedited Data Receive state variable*

This state variable contains the sequence number of the next in-sequence ED PDU expected. It is incremented after the receipt of the next in-sequence ED PDU. This state variable assists the receiver to detect retransmissions. When the SSCF-CONS entity enters state 4.10.4 (Data Transfer Ready), this state variable is set to "0". Arithmetic on the value of this state variable is modulo 2.

b) *VR(E) – Expedited Data Synchronization Receive state variable*

This state variable contains synchronization information to assure that normal data may not bypass expedited data. When an ED PDU is received, this state variable is incremented; the N(E) field of a DATA PDU is subtracted from this state variable before a delivery decision is made. When the SSCF-CONS entity enters state 4.10.4 (Data Transfer Ready), this state variable is set to "0". Whenever the value of this state variable is negative, received normal data may not be delivered to the SSCF-CONS user but must be queued until the value of this state variable becomes zero or greater.

NOTE 1 – Buffers may be shared with SSCOP and SSCOP's flow control may be used to protect also the resources possibly being consumed by the queueing described; however, this is not subject to standardization.

c) *VR(TS) – Data Transfer State Identity Number state variable*

This state variable contains the identity number of the entry into the Data Transfer Ready state (state 4.10.4, see Figure 10) from the peer transmitter. It is set with the value of the N(TS) field of received DATA PDUs.

NOTE 2 – An ED PDU or EDAK PDU with a different N(TS) field is considered to be out of place and is discarded.

NOTE 3 – If the the Receipt Confirmation option is implemented and has been selected at connection establishment in conjunction with the Expedit, options share this single state variable.

d) *VR(TV) – Data Transfer State Identity Validity state variable*

This state variable contains the information whether the identity number in the state variable VR(TS) has been updated by a received DATA PDU with an appropriately set N(TS).

NOTE 4 – If the the Receipt Confirmation option is implemented and has been selected at connection establishment in conjunction with the Expedit, options share this single state variable.

C.1.5.3 Common state variables

For the support of the Expedited Data Transfer option, the SSCF-CONS maintains the following common state variables at the transmitter and receiver:

- *EDsel*
  This state variable contains the result of the Expedited Data Transfer option selection. If the option is selected, this state variable is set to "1"; otherwise, it is set to "0".

C.1.6 SSCF-CONS timers

The Expedited Data service procedure requires the following timers:

NOTE – The timers are only active, if the Expedited Data transfer option is implemented and has been selected at connection establishment and 4.10.4 (Data Transfer Ready).

a) Timer_ECC

If the Expedited Data service procedure is in state E2 (Expedited Data Sent), the Timer_ECC is running. It protects the transfer of Expedited N-SDUs against transmission errors. Expiry of this timer may lead to retransmissions of ED PDUs. This timer should be greater than a round trip delay.

b) Timer_Ebusy

If the Expedited Data service procedure is in state E3 (Expedited Data Busy), the Timer_Ebusy is running. It polls the peer SSCF-CONS entity until a credit to transmit a further Expedited N-SDUs is received. Expiry of this timer may lead to retransmissions of ED PDUs.

C.2 Specification of the Expedited Data service procedure

The State Transition Table (Table C.2) for SSCF-CONS describes the signals and events that lead to state transitions in the Expedited Data service procedure. The table only shows the major transition paths; the SDL diagrams show the full transitions.

SDL diagrams for the Expedited Data service procedure are represented in Figure C.3.

TABLE C.2/I.365.2

State transition table

Event	State			
	E0	E1	E2	E3
Main service moves into state 4.10.4	if (EDsel = 1) then E1 else E0	–	–	–
Main service leaves state 4.10.4	E0	E0	E0	E0
Expedited data queued up	–	AA-UNITDATA-request(ED PDU) E2	E2	E3
timer_ECC expires	–	–	AA-UNITDATA-request(ED PDU) E2	–
timer_Ebusy expires	–	–	–	AA-UNITDATA-request(ED PDU) E2
AA-UNITDATA-indication (EDAK PDU) AND EDAK.S = 0 AND valid EDAK.N(TS)	–	–	E1	E1
AA-UNITDATA-indication (EDAK PDU) AND EDAK.S = 1 AND valid EDAK.N(TS)	–	–	E3	E3
AA-UNITDATA-indication (EDAK PDU) AND invalid EDAK.N(TS)	E0	E1	E2	E3

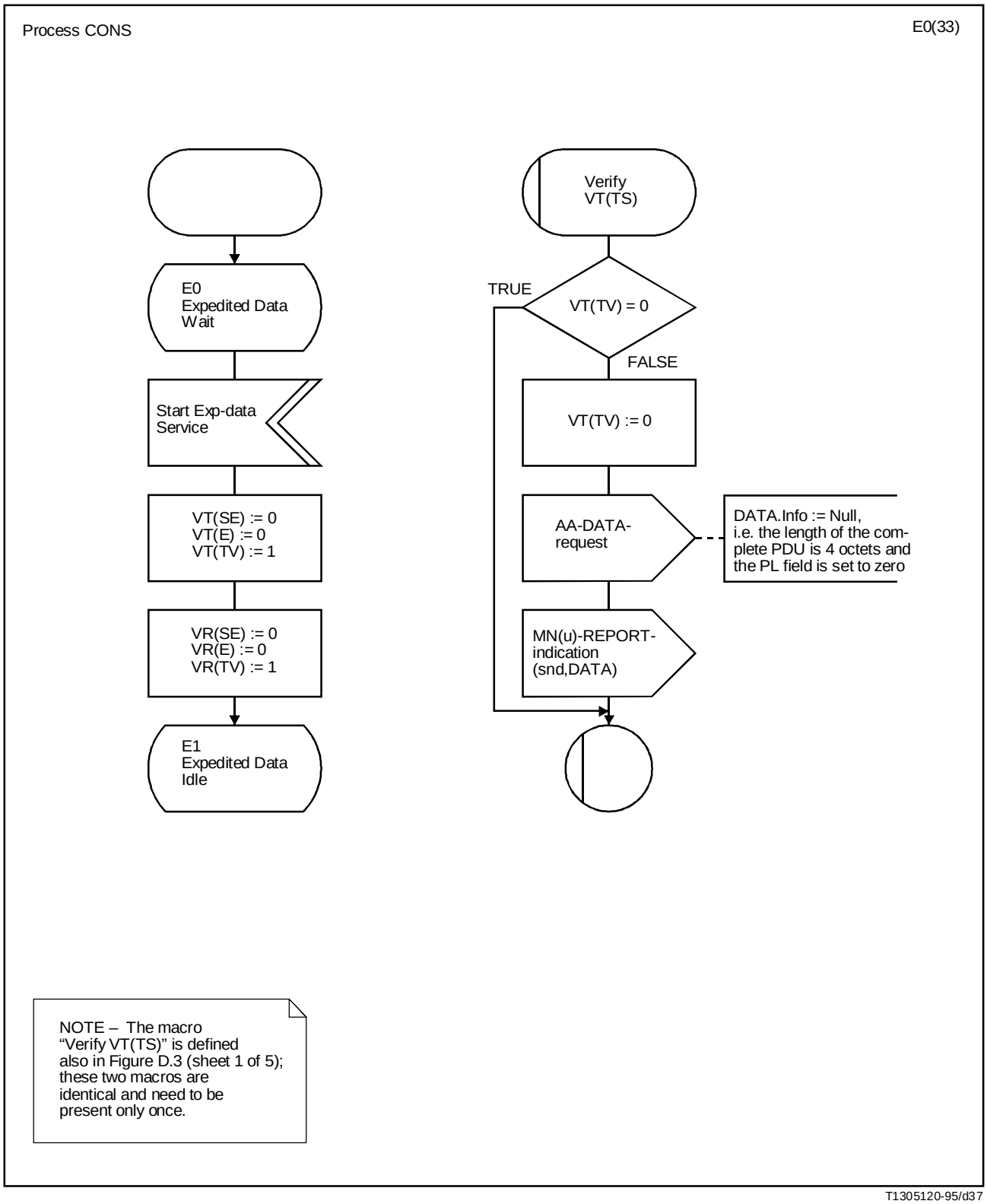


FIGURE C.3/I.365.2 (sheet 1 of 7)

Procedure SSCF-CONS – Service Expedited Data SDL diagram

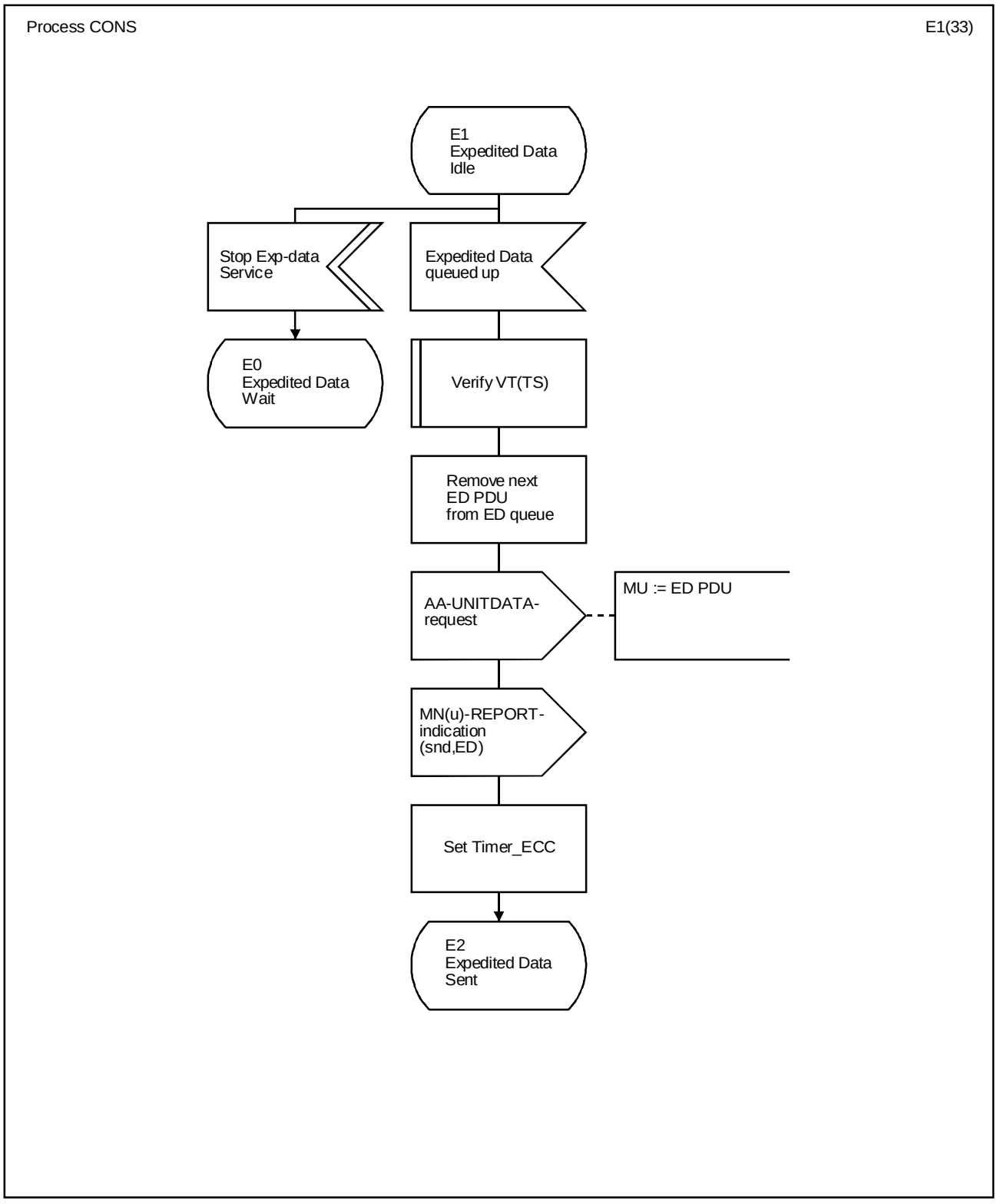


FIGURE C.3/I.365.2 (sheet 2 of 7)

Procedure SSCF-CONS – Service Expedited Data SDL diagram

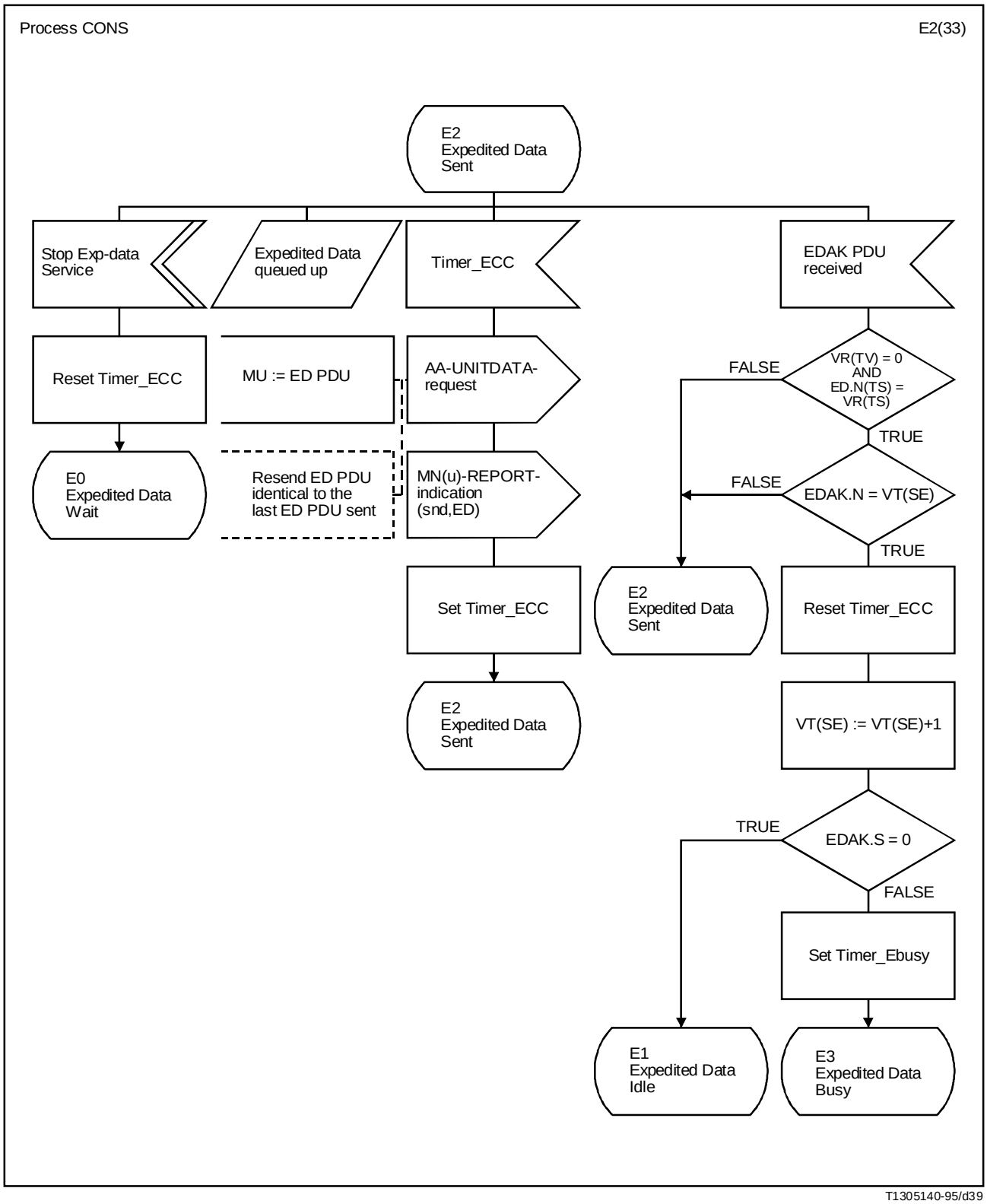


FIGURE C.3/I.365.2 (sheet 3 of 7)

Procedure SSCF-CONS – Service Expedited Data SDL diagram

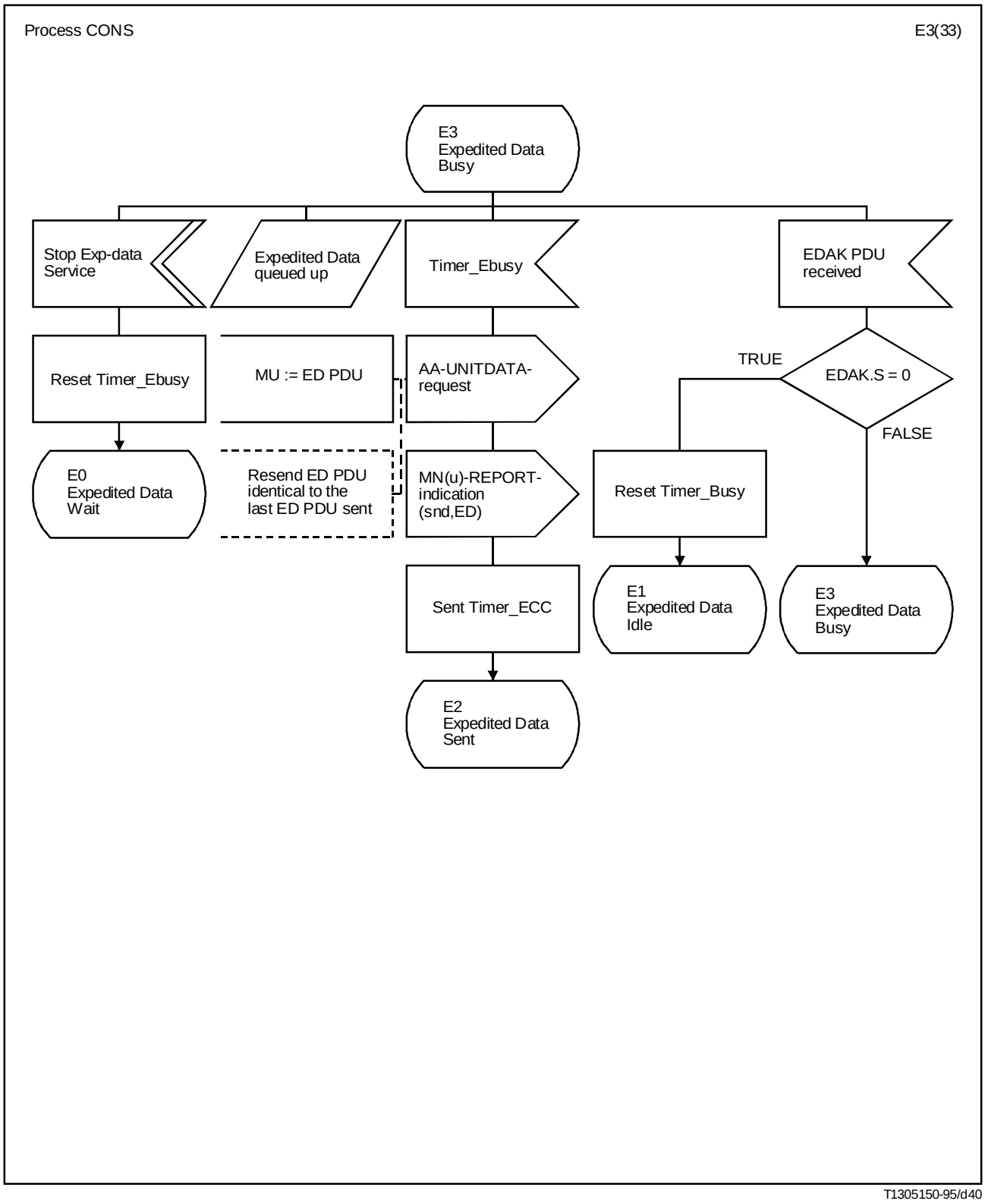


FIGURE C.3/I.365.2 (sheet 4 of 7)

Procedure SSCF-CONS – Service Expedited Data SDL diagram

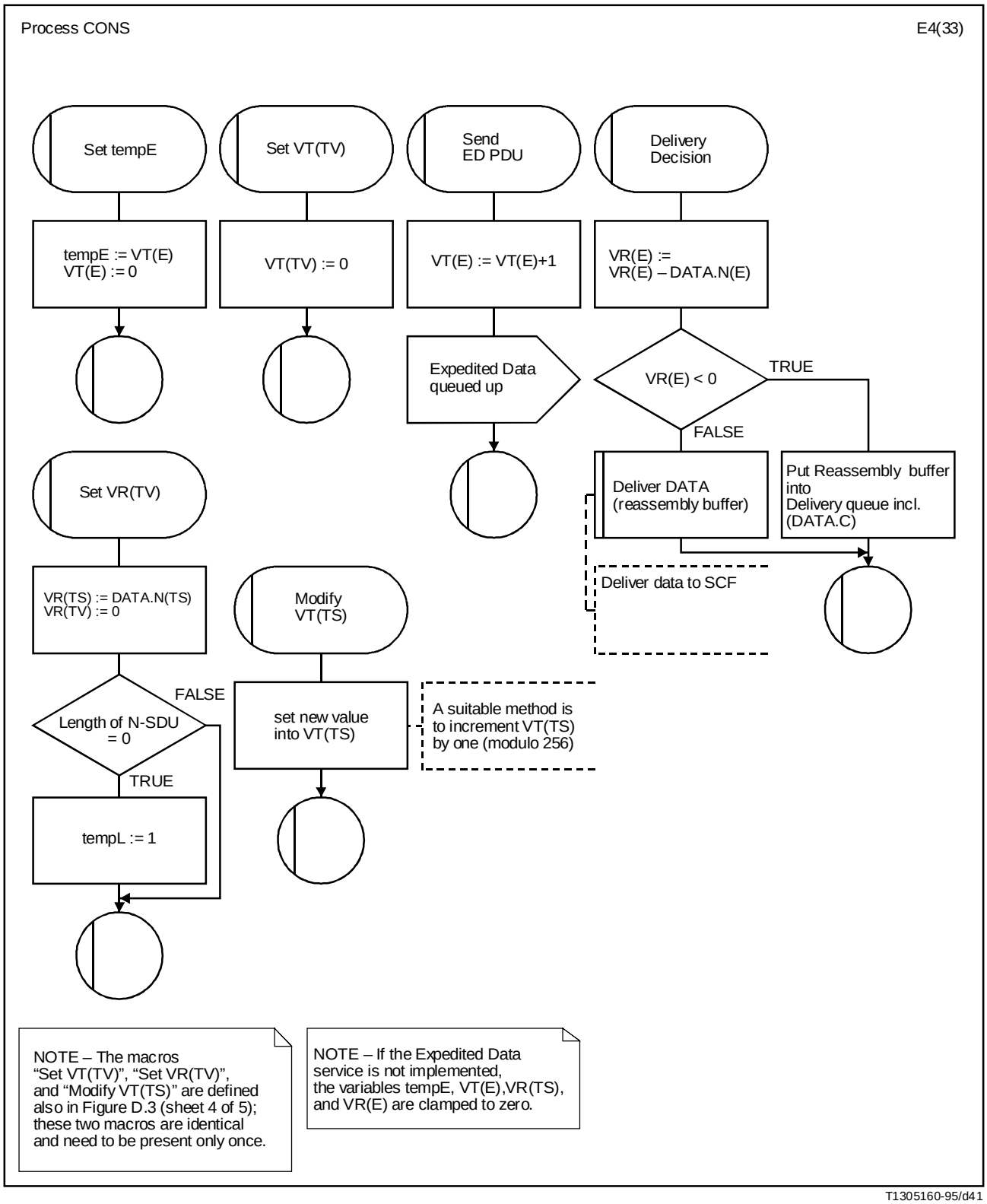


FIGURE C.3/I.365.2 (sheet 5 of 7)

Procedure SSCF-CONS – Service Expedited Data SDL diagram

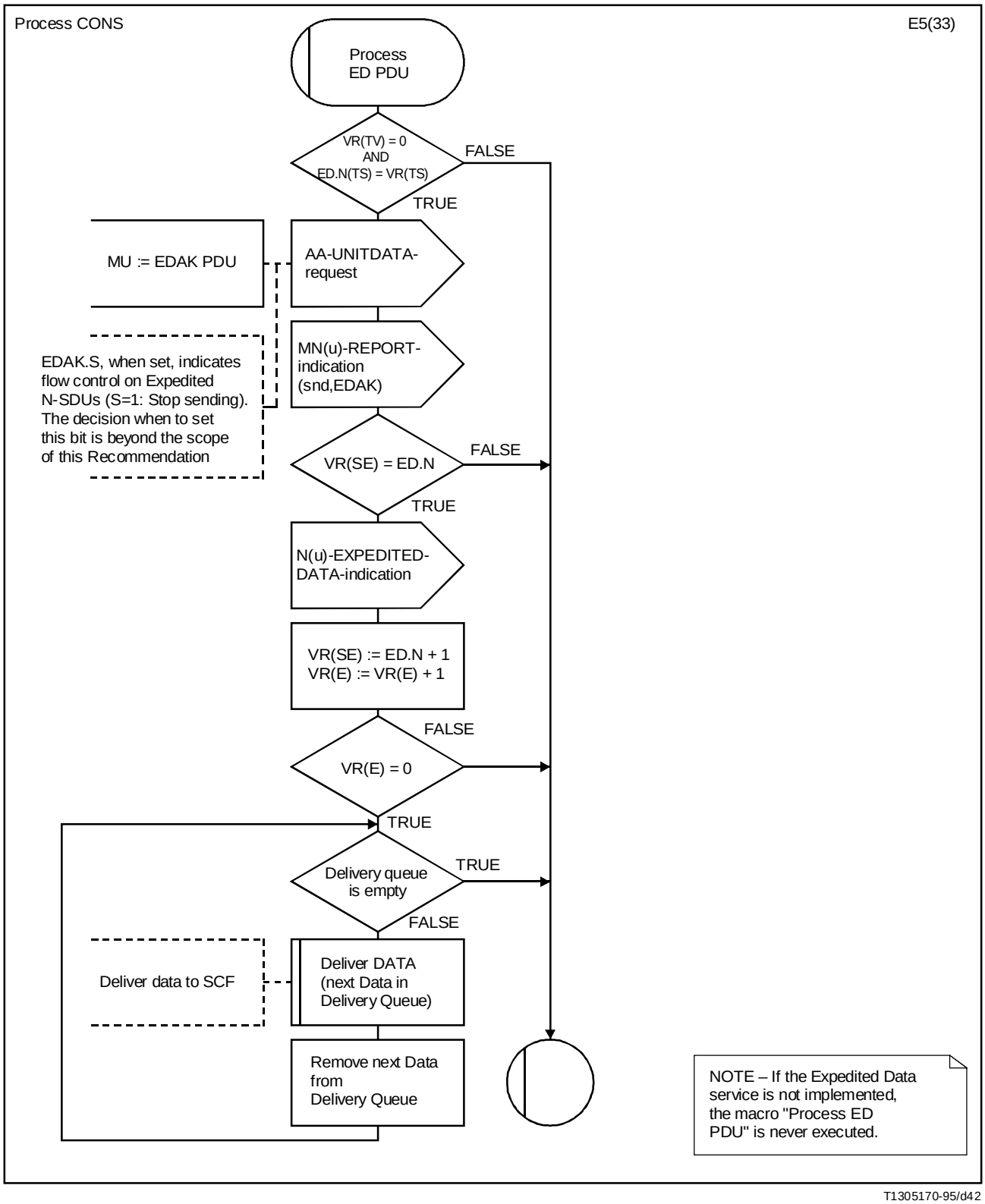


FIGURE C.3/I.365.2 (sheet 6 of 7)

Procedure SSCF-CONS – Service Expedited Data SDL diagram

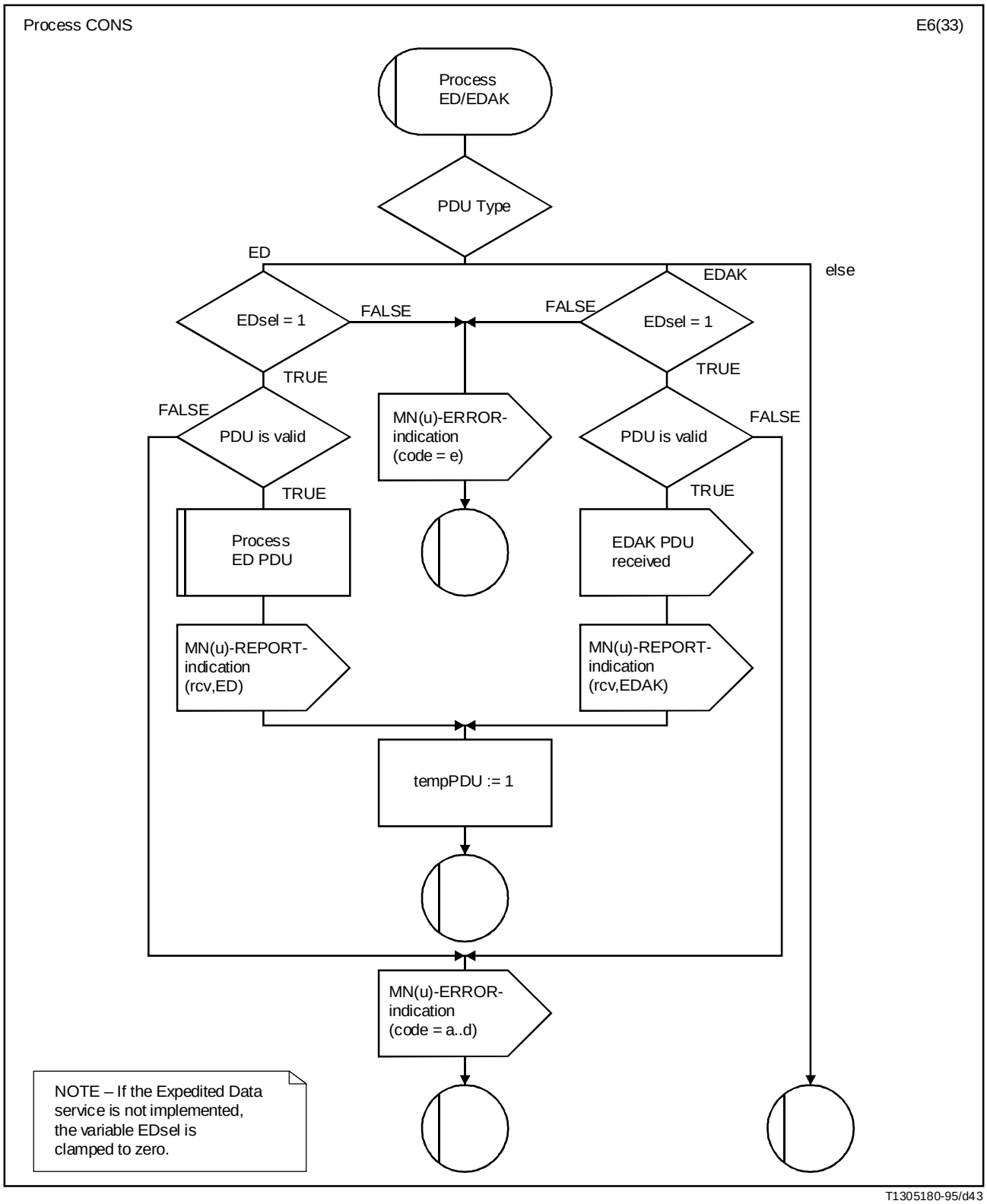


FIGURE C.3/I.365.2 (sheet 7 of 7)

Procedure SSCF-CONS – Service Expedited Data SDL diagram

Annex D

Receipt Confirmation service

(This annex forms an integral part of this Recommendation)

This annex specifies the protocol elements and the protocol for the Receipt Confirmation option.

NOTE – This option is a provider option.

D.1 Protocol elements for peer-to-peer communication

The receipt confirmation service makes use of the unassured data stream that is independent of the flow control of the assured service. Error recovery from transmission errors by retransmission is handled by a peer-to-peer protocol within the SSCF-CONS sublayer. The SSCOP signal type used is AA-UNITDATA.

D.1.1 SSCF-CONS PDUs

The Protocol Data Units (PDUs) are listed and described in Table 7.

The definitions of the SSCF-CONS PDUs utilizing the unassured data transfer are as follows:

a) *RC PDU (Receipt Confirmation)*

The RC PDU is used to transfer an NS-user's receipt confirmation of N-PDUs to its peer entity.

b) *RCAK PDU (Receipt Confirmation Acknowledgement)*

The RCAK PDU is used to acknowledge receipt of one or more RC PDUs.

D.1.2 SSCF-CONS PDU formats

Figures D.1 and D.2 illustrate the format of the PDUs for the Receipt Confirmation service.

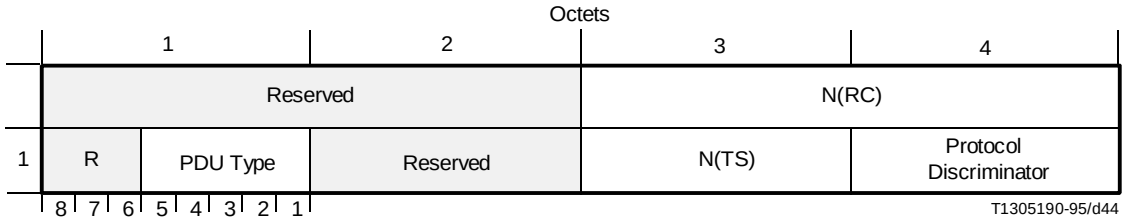


FIGURE D.1/I.365.2

Receipt Confirmation (RC PDU)

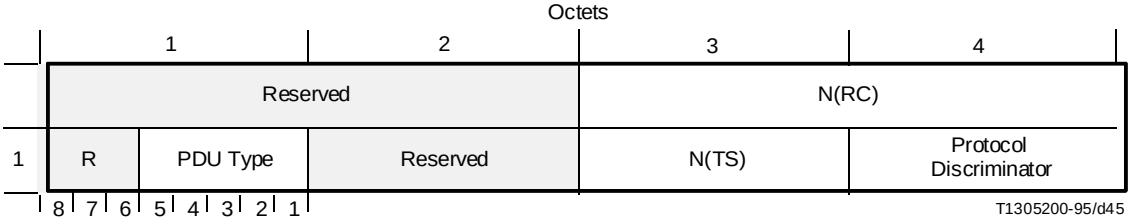


FIGURE D.2/I.365.2

Receipt Confirmation Acknowledgement (RCAK PDU)

D.1.3 SSCF-CONS PDU parameter fields

The SSCF-CONS PDUs contain the following parameter fields in addition to those specified in 10.3:

a) *PDU Type – PDU Type field*

The PDU Type field's coding is defined in Table 7.

b) *N(RC) – Confirmation Sequence Number field*

The N(RC) field carries the current value of the state variable VT(RC) in the RC PDU and the value of the state variable VR(RC) in the RCAK PDU.

The SSCF-CONS PDU parameters already defined in 10.3 that are "reserved" in the absence of the implementation and the selection at connection establishment are defined as follows:

c) *N(TS) – Data Transfer State Identity Number field*

In the RC PDU and RCAK PDU, this field carries the current value of the transmitter state variable VT(TS).

d) *C – Confirmation Request field*

The C field in the DATA PDU is set to "1" when the conf-req parameter of the N(u)-DATA-request primitive has the value "request receipt confirmation"; otherwise, the C field is set to "0" (see Figure 6 and 10.3). If segmentation occurs, the C field is set to the same value in all DATA PDUs.

e) *RS – Receipt Confirmation Selection field*

The RS field in the CR and CC PDUs during connection establishment conveys the Receipt Confirmation selection between the two peer SSCF-CONS entities (see Figure 7 and 10.3). The coding is shown in Table D.1.

TABLE D.1/I.365.2

SSCF-CONS PDU field coding

Field	Code	Value
RS field	0 1	No use of receipt confirmation User of receipt confirmation

D.1.4 Additional states of the SSCF-CONS protocol entity

For the assured transfer of receipt confirmations, a service procedure is running whenever the SSCF-CONS entity is in the Data Transfer Ready state (state 4.10.4). This Receipt Confirmation service procedure has the following basic states:

State R0 Receipt Confirmation Wait

The Receipt Confirmation service procedure of an SSCF-CONS entity is conceptually initiated in the Receipt Confirmation Wait state. It remains or returns to this state unless the SSCF-CONS entity is in the Data Transfer Ready state (state 4.10.4).

State R1 Receipt Confirmation Idle

When the SSCF-CONS entity is in state 4.10.4 and no acknowledgement of an RC PDU is outstanding, the Receipt Confirmation service procedure is in the Receipt Confirmation Idle state.

State R2 Receipt Confirmation Sent

The Receipt Confirmation service procedure that has transmitted an RC PDU and is awaiting its acknowledgement in the Receipt Confirmation Sent state.

D.1.5 Additional SSCF-CONS state variables

The RC PDUs are independently numbered with a sequence number modulo 2^{16}; hence, the sequence number field in the PDU may contain any value from 0 to 2^{16}–1 (65 535) inclusive.

NOTE – The Receipt Confirmation service procedure shares the state variables with the main procedure.

D.1.5.1 Transmitter state variables

To support the Receipt Confirmation option, SSCF-CONS maintains the following state variables at the transmitter:

a) *VT(RC) – Receipt Confirmation Send state variable*

This state variable contains the N(RC) of the next N(u)-DATA-ACKNOWLEDGE-request primitive. It is incremented upon the receipt of an N(u)-DATA-ACKNOWLEDGE-request primitive. When the SSCF-CONS entity enters state 4.10.4 (Data Transfer Ready), this state variable is set to "0". Arithmetic on the value of this state variable is modulo 2^{16}.

NOTE 1 – The value of this state variable is transmitted with the next RC PDU and assists the receiver to determine, how many N(u)-DATA-ACKNOWLEDGE-indication primitives it has to issue.

b) *VT(TS) – Data Transfer State Identity Number state variable*

This state variable contains the identity number of the entry into the Data Transfer Ready state (state 4.10.4, see Figure 10). This state variable is copied into the N(TS) field of the DATA PDU, RC PDU, and RCAK PDU.

NOTE 2 – If the Expedited Data transfer option is implemented and has been selected at connection establishment in conjunction with the Receipt, options share this single state variable.

c) *VT(TV) – Data Transfer State Identity Validity state variable*

This state variable contains the information whether the identity number in the state variable VT(TS) has been sent in a DATA PDU with an appropriately set N(TS).

NOTE 3 – If the Expedited Data transfer option is implemented and has been selected at connection establishment in conjunction with the Receipt, options share this single state variable.

D.1.5.2 Receiver state variables

To support the Receipt Confirmation option, SSCF-CONS maintains the following state variables at the receiver:

a) *VR(RC) – Receipt Confirmation Receive state variable*

This state variable contains the sequence number of the latest RC PDU received from the peer SSCF-CONS entity. By comparing the value of this state variable with the value of the N(RC) field of the next RC PDU received, the receiver can determine, how many N(u)-DATA-ACKNOWLEDGE-indication primitives it has to issue; thereafter, the value of the N(RC) field is copied into this state variable. When the SSCF-CONS entity enters state 4.10.4 (Data Transfer Ready), this state variable is set to "0". Arithmetic on the value of this state variable is modulo 2^{16}.

NOTE 1 – The value of this state variable is transmitted with the next RCAK PDU and assists the transmitter to determine, whether retransmissions of RC PDUs are required.

b) *VR(TS) – Data Transfer State Identity Number state variable*

This state variable contains the identity number of the entry into the Data Transfer Ready state (state 4.10.4, see Figure 10) from the peer transmitter. It is set with the value of the N(TS) field of received DATA PDUs.

NOTE 2 – An RC PDU or RCAK PDU with a different N(TS) field is considered to be out of place and is discarded.

NOTE 3 – If the Expedited Data transfer option is implemented and has been selected at connection establishment in conjunction with the Receipt, options share this single state variable.

c) *VR(TV) – Data Transfer State Identity Validity state variable*

This state variable contains the information whether the identity number in the state variable VR(TS) has been updated by a received DATA PDU with an appropriately set N(TS).

NOTE 4 – If the Expedited Data transfer option is implemented and has been selected at connection establishment in conjunction with the Receipt, options share this single state variable.

D.1.5.3 Common state variables

For the support of the Receipt Confirmation option, the SSCF-CONS maintains the following common state variables at the transmitter and receiver:

- RCsel
  This state variable contains the result of the Receipt Confirmation option selection. If the option is selected, this state variable is set to "1"; otherwise, it is set to "0".

D.1.6 SSCF-CONS timer

The Receipt Confirmation service procedure requires the following timer:

NOTE – The timer is only active, if the Receipt Confirmation option is implemented and has been selected at connection establishment and is in state 4.10.4 (Data Transfer Ready).

- Timer_RCC
  When the Receipt Confirmation service procedure is in state R2 (Receipt Confirmation Sent), the Timer_RCC is running. It protects the transfer of receipt confirmations against transmission errors. Expiry of this timer may lead to retransmissions of RC PDUs.

D.2 Specification of the Receipt Confirmation service procedure

The State Transition Table (Table D.2) for SSCF-CONS describes the signals and events that lead to state transitions in the Receipt Confirmation service procedure. The table only shows the major transition paths; the SDL diagrams show the full transitions.

The SDL diagrams for the Receipt Confirmation service procedure are represented in Figure D.3.

TABLE D.2/I.365.2

State transition table

Event	State		
	R0	R1	R2
Main service moves into state 4.10.4	if (RCsel = 1) then R1 else R0	–	–
Main service leaves state 4.10.4	R0	R0	R0
Confirmation queued up	–	AA-UNITDATA-request(RC PDU) R2	AA-UNITDATA-request(RC PDU) R2
timer_RCC expires	–	–	AA-UNITDATA-request(RC PDU) R2
AA-UNITDATA-indication (RCAK PDU) AND valid RCAK.N(TS)	–	–	if (RCAK.N(RC) = VT(RC) then R1 else R2
AA-UNITDATA-indication (RCAK PDU) AND invalid RCAK.N(TS)	R0	R1	R2

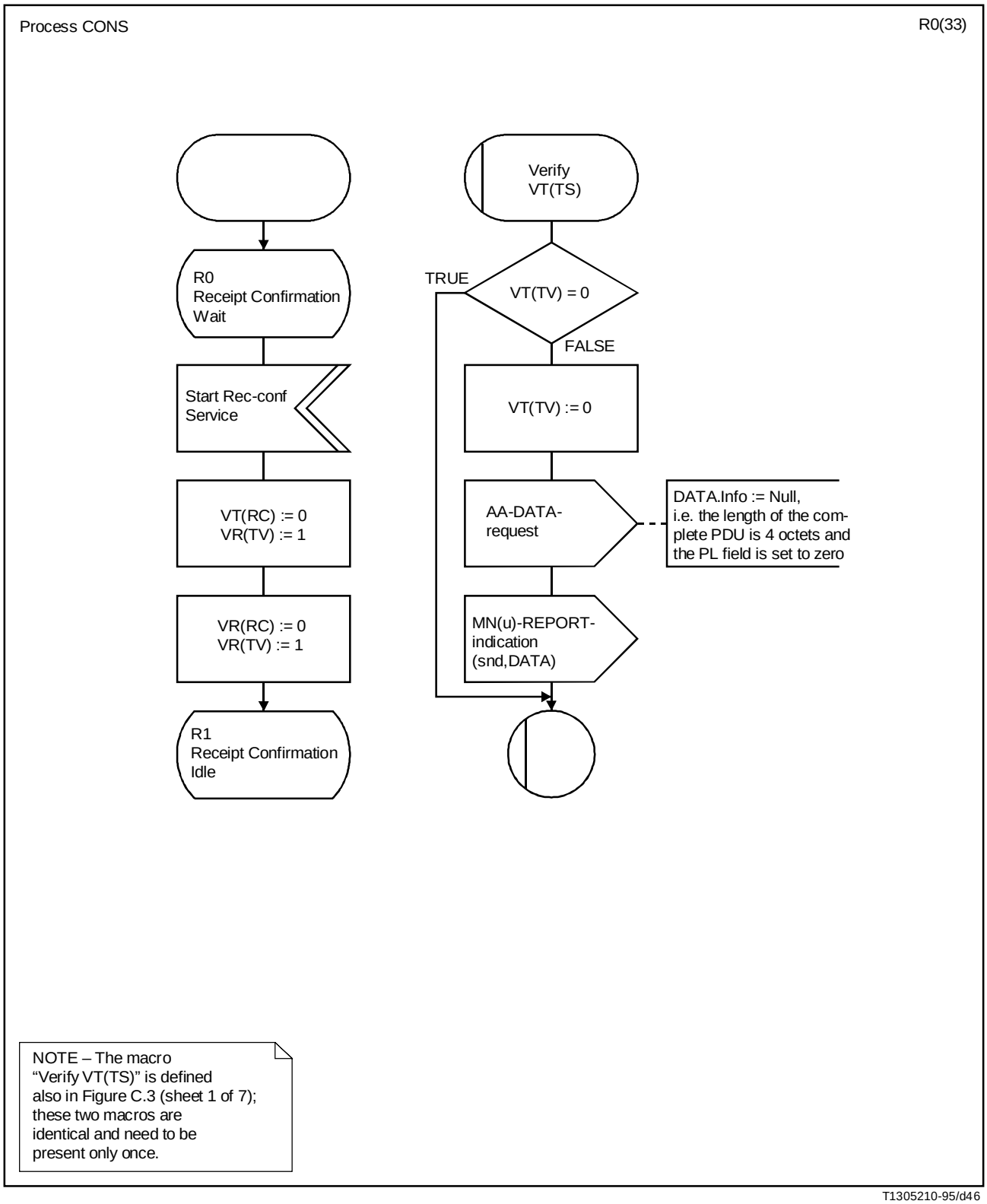


FIGURE D.3/I.365.2 (sheet 1 of 5)

Procedure SSCF-CONS – Service Receipt Confirmation SDL diagram

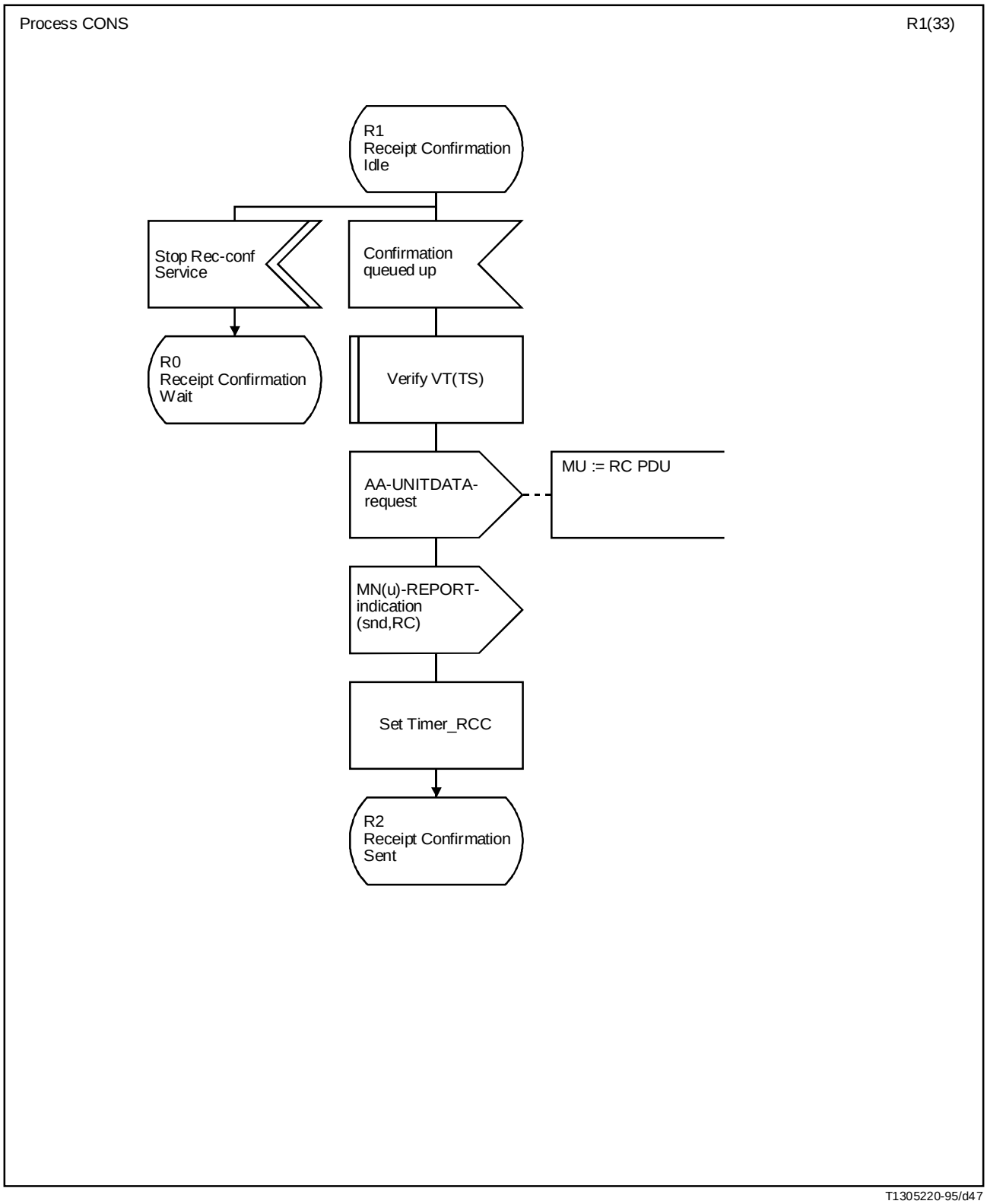


FIGURE D.3/I.365.2 (sheet 2 of 5)

Procedure SSCF-CONS – Service Receipt Confirmation SDL diagram

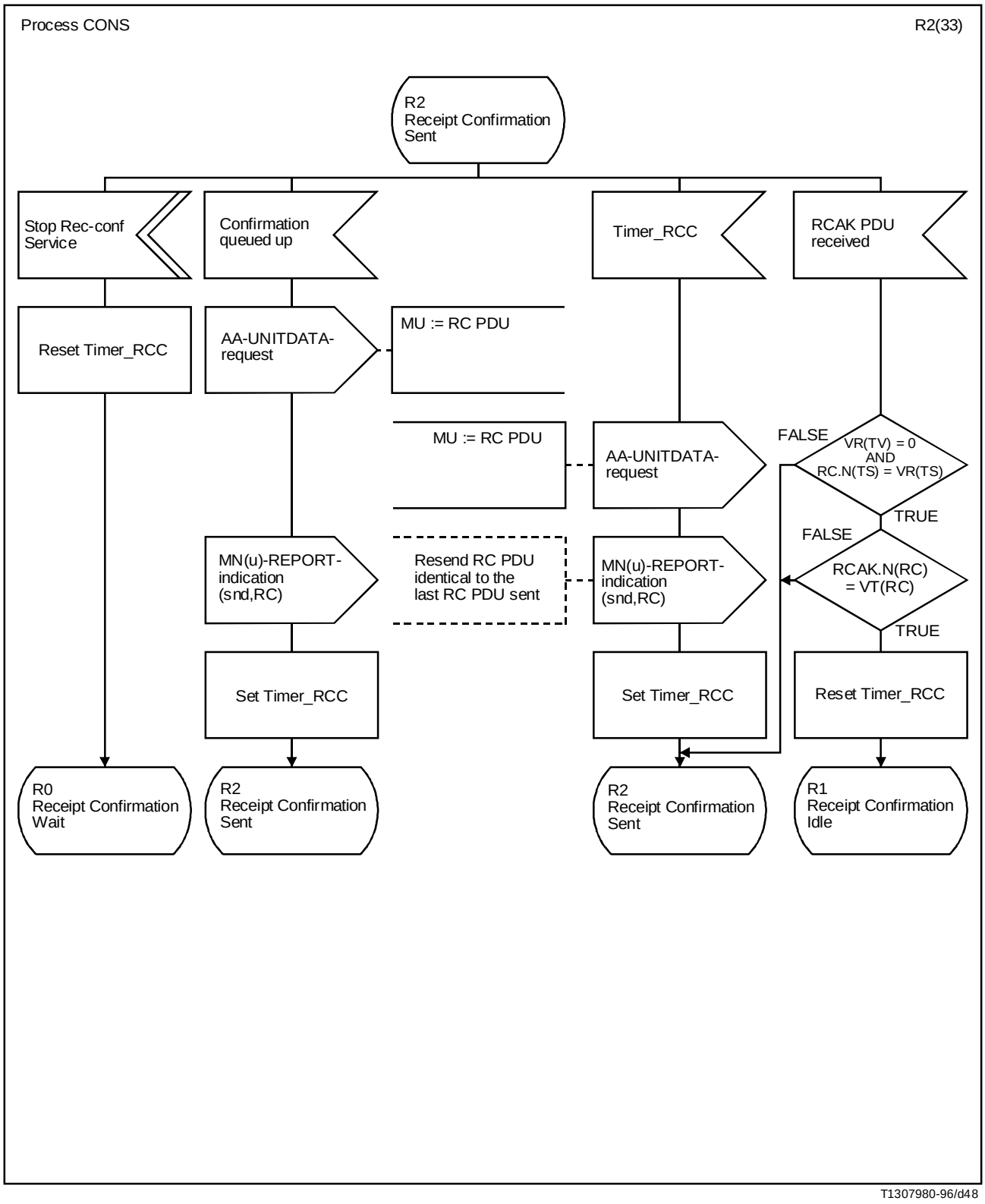


FIGURE D.3/I.365.2 (sheet 3 of 5)

Procedure SSCF-CONS – Service Receipt Confirmation SDL diagram

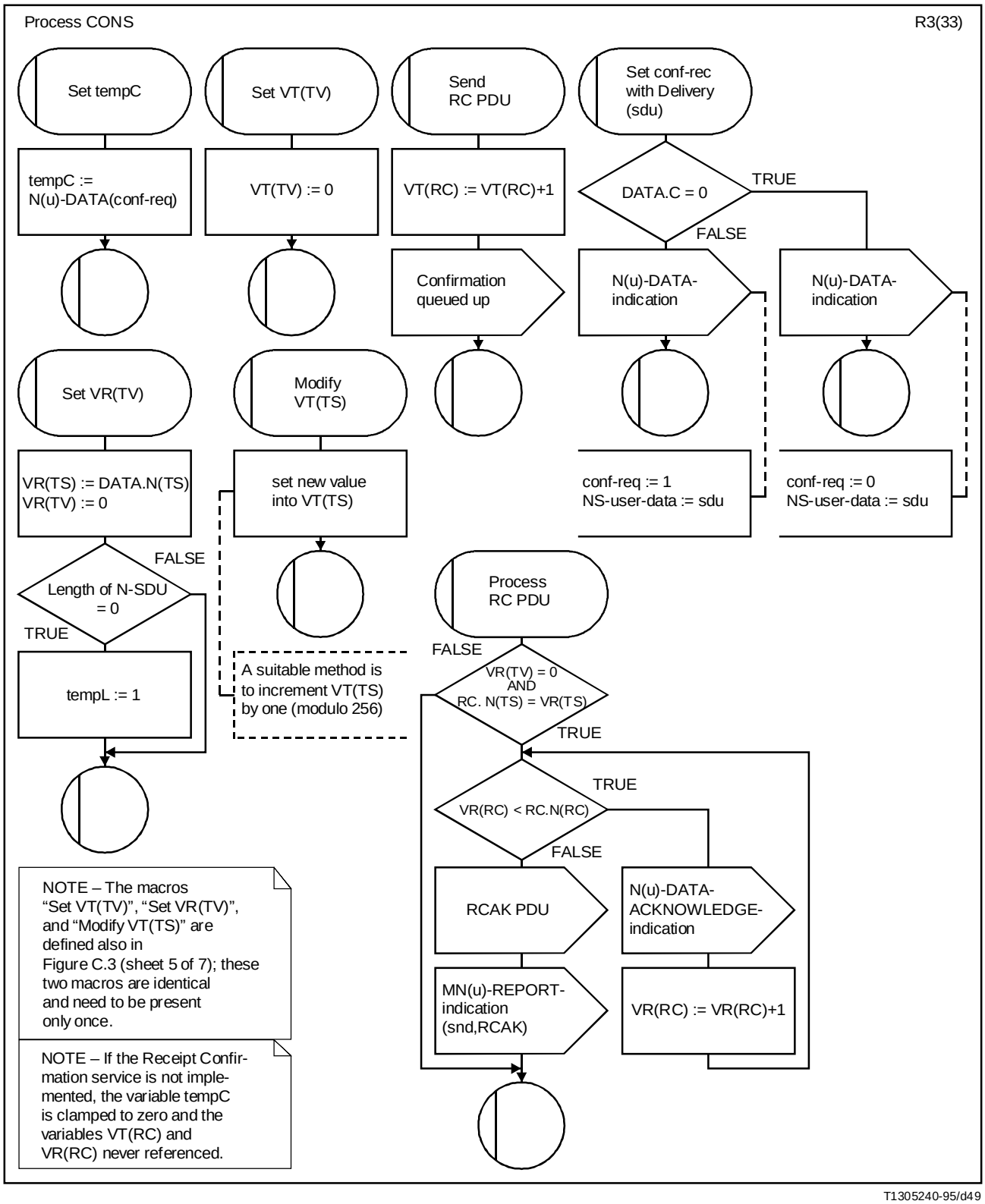


FIGURE D.3/I.365.2 (sheet 4 of 5)

Procedure SSCF-CONS – Service Receipt Confirmation SDL diagram

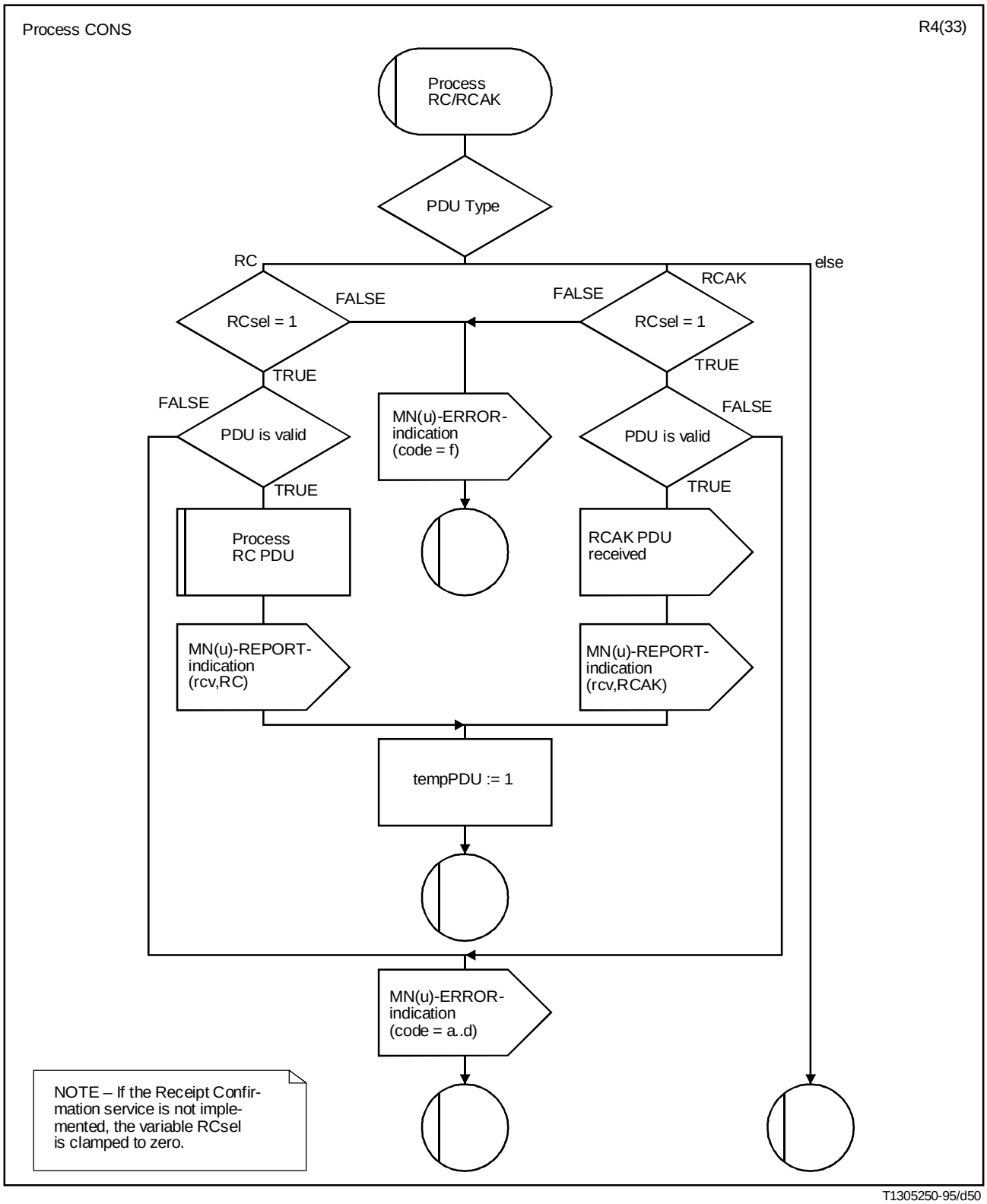


FIGURE D.3/I.365.2 (sheet 5 of 5)

Procedure SSCF-CONS – Service Receipt Confirmation SDL diagram

Annex E

Quality of Service parameter negotiation

(This annex forms an integral part of this Recommendation)

This annex defines sets of QOS parameters, the coding of these parameters in the CR PDU and CC PDU, and the negotiation procedures within the SSCF-CONS applicable to connection establishment. Within the CR PDU and the CC PDU, the correct interpretation of the set of parameters is derived from the coding of the "QOS Set Identifier" field of these PDUs. The coding of the QOS Set Identifier field is shown in Table E.1. The negotiation procedures applicable for each QOS parameter set are discussed in the subsequent subclauses of this annex.

Other QOS Parameter sets and the associated procedures are for further study.

TABLE E.1/I.365.2

QOS negotiation set and the coding of the QOS Set Identifier field of CC and CR PDUs

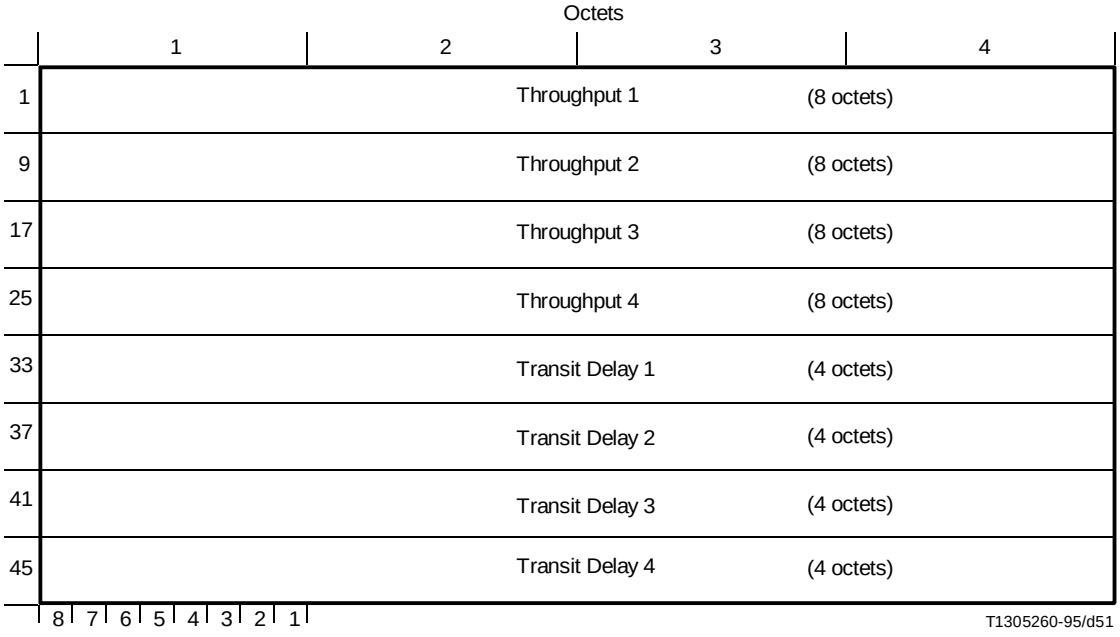
QOS Set Identifier	QOS Set Name	Description
0	Empty	No QOS negotiation
1	Standard	QOS negotiation supporting Recommendation X.213
All others		Reserved for future QOS parameter sets

E.1 Parameters and their negotiation for the "Empty" QOS set

No QOS parameter negotiation takes place hence, no parameters need to be transmitted nor are any procedures defined.

E.2 Parameters and their negotiation for the "Standard CONS" QOS set

The format of the QOS parameter set transmitted in the CR PDU and the CC PDU is shown in Figure E.1. For the format of the entire PDUs, see 10.2.



NOTE – Throughput *x* fields are binary counts in units of 100 bytes/sec. Transit Delay *x* fields are binary counts in units of milliseconds.

FIGURE E.1/I.365.2

Format of the Standard QOS Set parameters

E.2.1 QOS Parameters at the SSCF-CONS/SSCF-CONS user boundary

The parameters defined by Recommendation X.213 [7] for modeling negotiation of throughput and delay QOS parameters in support of CONS and the relevant primitives across the SSCF-CONS/SSCF-CONS user boundary are summarized in Table E.2.

TABLE E.2/I.365.2

QOS parameters used in N(u)-CONNECT type primitives

Primitive	QOS parameters		
Direction of communication	Local to peer	Peer to local	Both
N(u)-CONNECT-request	OU_TFL, OU_TFT	OU_TBL, OU_TBT	OU_DL, OU_DT
N(u)-CONNECT-indication	RU_TFL, RU_TFT	RU_TBL, RU_TBT	RU_DL, RU_DT
N(u)-CONNECT-response	RU_TFS	RU_TBS	RU_DS
N(u)-CONNECT-confirm	OU_TFS	OU_TBS	OU_DS

NOTE – The parameters identified in Table E.2 have the following definitions:

Parameter	*Information*
OU_DL	Largest acceptable transit delay in both directions
OU_DS	Selected transit delay in both directions
OU_DT	Target transit delay in both directions
OU_TBL	Lowest acceptable throughput in the direction from the peer entity to the local entity
OU_TBS	Selected throughput in the direction from the peer entity to the local entity
OU_TBT	Target throughput in the direction from the peer entity to the local entity
OU_TFL	Lowest acceptable throughput in the direction from the local entity to the peer entity
OU_TFS	Selected throughput in the direction from the local entity to the peer entity
OU_TFT	Target throughput in the direction from the local entity to the peer entity
RU_DL	Largest acceptable transit delay in both directions
RU_DS	Selected transit delay in both directions
RU_DT	Target transit delay in both directions
RU_TBL	Lowest acceptable throughput in the direction from the peer entity to the local entity
RU_TBS	Selected throughput in the direction from the peer entity to the local entity
RU_TBT	Target throughput in the direction from the peer entity to the local entity
RU_TFL	Lowest acceptable throughput in the direction from the local entity to the peer entity
RU_TFS	Selected throughput in the direction from the local entity to the peer entity
RU_TFT	Target throughput in the direction from the local entity to the peer entity

E.2.2 Negotiation of QOS Parameters

The originating SSCF-CONS user conveys the necessary QOS information to the SSCF-CONS as modeled in the N(u)-CONNECT-request primitive.

Each SSCF-CONS entity uses the following local information to determine the acceptability of the requested QOS parameters:

Parameter	*Information*
OP_TFM	Maximum available throughput in the direction from the local entity to the peer entity
OP_TBM	Maximum available throughput in the direction from the peer entity to the local entity
OP_DM	Minimum available transit delay in both directions

If any of the following relations is true, then the local SSCF-CONS entity aborts the connection establishment due to unacceptable QOS parameters, in accordance with the procedures of clause 11:

OP_TFM	<	OU_TFL; or
OP_TBM	<	OU_TBL; or
OP_DM,	>	OU_DL

Otherwise, the SSCF-CONS entity constructs a CR PDU with the QOS parameters set to the following values:

Throughput 1	:=	min(OU_TFT, OP_TFM)
Throughput 2	:=	OU_TFL
Throughput 3	:=	min(OU_TBT, OP_TBM)
Throughput 4	:=	OU_TBL
Transit delay 1	:=	max(OU_DT, OP_DM)
Transit delay 2	:=	OU_DL
Transit delay 3	:=	max(OU_DT, OP_DM)
Transit delay 4	:=	OU_DL

If any of the following relations is true, then the receiving SSCF-CONS entity aborts the connection establishment due to unacceptable QOS parameters, in accordance with the procedures of clause 11:

OP_TFM	<	Throughput 4; or
OP_TBM	<	Throughput 2; or
OP_DM	>	Transit Delay 2

Otherwise, the SSCF-CONS conveys the QOS information to the SSCF-CONS user as modeled with the N(u)-CONNECT-indication primitive.

This information is derived as follows:

RU_TFT	:=	min(Throughput 3, OP_TFM)
RU_TFL	:=	Throughput 4
RU_TBT	:=	min(Throughput 1, OP_TBM)
RU_TBL	:=	Throughput 2
RU_DT	:=	max(Transit Delay 1, OP_DM)
RU_DL	:=	Transit Delay 2

If the recipient SSCF-CONS user finds the throughput and delay objectives acceptable, it sends an N(u)-CONNECT-response primitive to the SSCF-CONS. A correct throughput and delay selection requires that all the following relationships are true:

RU_TFT	≥	RU_TFS	≥	RU_TFL
RU_TBT	≥	RU_TBS	≥	RU_TBL
RU_DT	≤	RU_DS	≤	RU_DL

Upon receipt of an N(u)-CONNECT-response primitive, the SSCF-CONS entity constructs a CC PDU with QOS parameters containing the following values:

Throughput 1	:=	RU_TFS
Throughput 2	:=	RU_TFS
Throughput 3	:=	RU_TBS
Throughput 4	:=	RU_TBS
Transit delay 1	:=	RU_DS
Transit delay 2	:=	RU_DS
Transit delay 3	:=	RU_DS
Transit delay 4	:=	RU_DS

If the recipient SSCF-CONS user cannot accept the connection establishment, it aborts the connection establishment due to unacceptable QOS parameters, in accordance with the procedures of clause 11.

Upon receipt of a CC PDU or a CR PDU (in case of connection establishment collision), the originating SSCF-CONS entity examines the received QOS parameters.

If Throughput 1	<	OU_TBL; or
if Throughput 2	>	min(OU_TBT, OP_TBM); or
if Throughput 3	<	OU_TFL; or
if Throughput 4	>	min(OU_TFT, OP_TFM); or
if Transit Delay 1	>	OU_DL; or
if Transit Delay 2	<	max(OU_DT, OP_DM);

then the QOS selected is unacceptable and the SSCF-CONS entity shall abort the connection establishment, in accordance with the procedures of clause 11.

If the parameters are acceptable, the selected QOS parameters are communicated to the SSCF-CONS user via the N(u)-CONNECT-confirm primitive with the following values:

OU_TFS	:=	min(Throughput 3, OU_TFT, OP_TFM)
OU_TBS	:=	min(Throughput 1, OU_TBT, OP_TBM)
OU_DS	:=	max(Transit Delay 1, OU_DT, OP_DM)

Annex F

Supplementary specification for the SCF (Recommendation Q.923)

(This annex forms an integral part of this Recommendation)

This annex provides the supplementary definitions for the SCF as required to complete the SCF specification contained in Recommendation Q.923 [3]; the following areas are further defined:

- Selection of predicates influencing the behaviour of the SCF; and
- Definition of the mapping function of the C-plane Sub-N-Service to the Q.2951 [9] call control procedures.

F.1 Selection of predicates

The predicates are set as follows:

- P1 TRUE NS user involved in call establishment within C-plane.
- P2 TRUE Confirmed release service within U-plane.
- P3 FALSE for application of switched ATM connections.
  TRUE for application of permanent ATM connections.

F.2 Mapping of the C-plane Sub-N-Service

This subclause provides the specification of the mapping between messages and some of their information elements specified in Recommendation Q.2951 [9] and N(c)-primitives according to Recommendation Q.923 [3] at the upper boundary of the C-plane Sub-N-Service which is provided by the call control at the user's side of the User Network interface. See Tables F1, F.2 and F.3.

TABLE F.1/I.365.2

Mappings for ATM Connection Establishment Phase

N(c)-primitives according to Recommendation Q.923 [3] and their parameters	Messages according to Recommendation Q.2951 [9] CS1 and referenced supplementary service Recommendations
Primitives:	Messages:
N(c)-CONNECT-request N(c)-CONNECT-indication N(c)-CONNECT-response N(c)-CONNECT-confirm	SETUP(U→N) SETUP(N→U) CONNECT(U→N) CONNECT(N→U)
Parameters:	Information elements:
Called address Calling address Responding address Receipt confirmation selection Expedited data selection QOS parameter set: Throughput Transit delay NS-User-Data	Called party number Called party sub-address Calling party number Calling party sub-address according to Recommendation Q.2951 [9] Connected party number Connected party sub-address (Note 1) (Note 1) (Note 1) ATM Traffic Descriptor End-to-end transit delay (Note 1)
NOTES 1 This parameter is carried in the user-to-user information element according to Recommendation Q.2957 [10] (see Table F.3). 2 Each parameter might be transferred on both C-plane and U-plane.	

TABLE F.2/I.365.2

Mappings for ATM Connection Release Phase

N(c)-primitives according to Recommendation Q.923 [3] and their parameters	Messages according to Recommendation Q.2951 [9] CS1 and referenced supplementary service Recommendations
Primitives:	Messages:
N(c)-DISCONNECT-request N(c)-DISCONNECT-indications	RELEASE(U→N), RELEASE COMPLETE(U→N) RELEASE(N→U), RELEASE COMPLETE(N→U), RESTART(N→U)
Parameters:	Information elements:
Originator, Reason Responding address NS-User-Data	Cause Connected party number Connected party sub-address according to Recommendation Q.2957 [10] User-to-user information
NOTE – Each parameter might be transferred on both C-plane and U-plane.	

TABLE F.3/I.365.2

Coding of the user-to-user information element

Message	Coding of the user-to-user information element
SETUP(U→N) and SETUP(N→U) CONNECT(U→N) and CONNECT(N→U)	Complete CR PDU (see 10.2) Complete CC PDU (see 10.2)

Appendix I

N(u)-primitive sequences at the UNI for connection establishment, reset, and release within the U-plane and their relationship to AA-signals and SSCOP PDU sequences

(This appendix does not form an integral part of this Recommendation)

This appendix presents the most relevant sequences for an analysis of the procedures. The peer-to-peer sequences of SSCOP PDUs are related to AA-signals and N(u)-primitives.

Figures I.1 to I.4 illustrate various connection establishment cases including collisions and corruption (loss) of PDUs.

NOTE 1 – Connection establishment affects both transmission directions simultaneously.

Figure I.5 illustrates a case where a connection establishment request is rejected.

Figures I.6 and I.7 illustrate two connection rejection cases due to insufficient Quality of Service or an unreachable address.

Figures I.8 to I.11 illustrate various connection release cases including collisions and corruption (loss) of PDUs.

NOTE 2 – Connection release affects both transmission directions simultaneously.

Figures I.12 to I.15 illustrate various connection reset cases including collisions and corruption (loss) of PDUs. The CONS user initiated reset is supported by the resynchronization mechanism of SSCOP.

NOTE 3 – Connection reset affects both transmission directions simultaneously.

Figures I.16 to I.19 illustrate various provider initiated reset cases including collisions and corruption (loss) of PDUs. Provider initiation of the reset procedure is signalled via the AA-RECOVER-indication signal.

NOTE 4 – Provider initiated connection reset affects both transmission directions simultaneously.

Figures I.20 to I.22 illustrate various contention cases where differing connection control services such as reset and release are invoked concurrently. The resolution of such contention is governed by a priority mechanism stipulated by the graphical representation of the services in Figure 11.

Figures I.23 to I.27 illustrate various cases where a connection control service is invoked before the previous one has been completed by both peers.

Figures I.28 to I.30 illustrate various cases where connection control services are invoked simultaneously.

Figure I.31 illustrates a case where corruption of PDUs, contention between different connection control services, and concurrency are combined. This example demonstrates the robustness of SSCF-CONS and SSCOP.

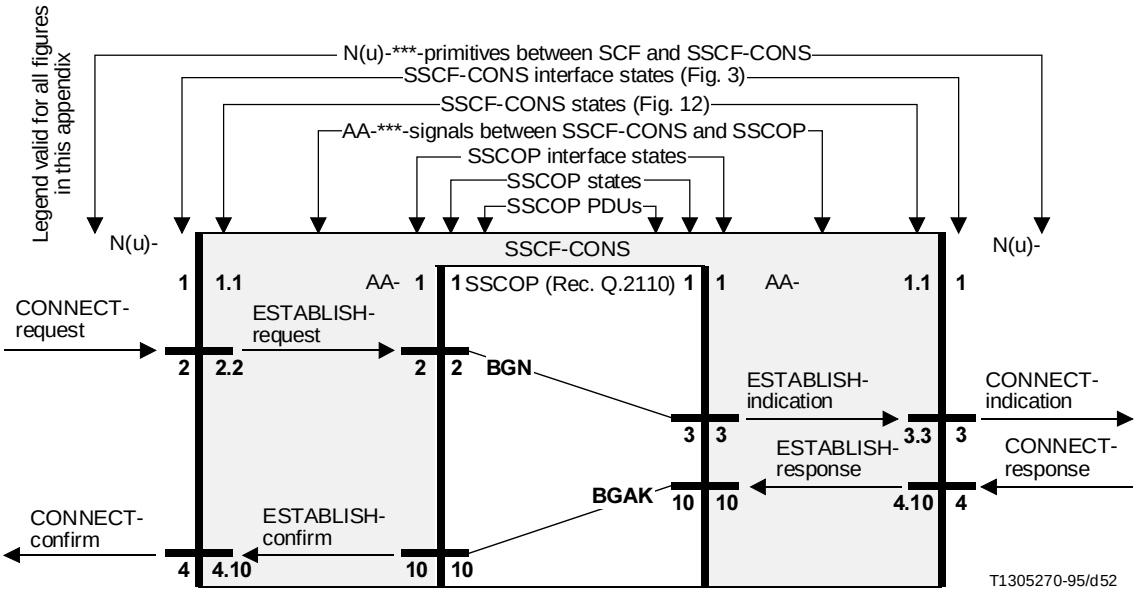


FIGURE I.1/I.365.2

Sequences for establishing an N(u)-connection

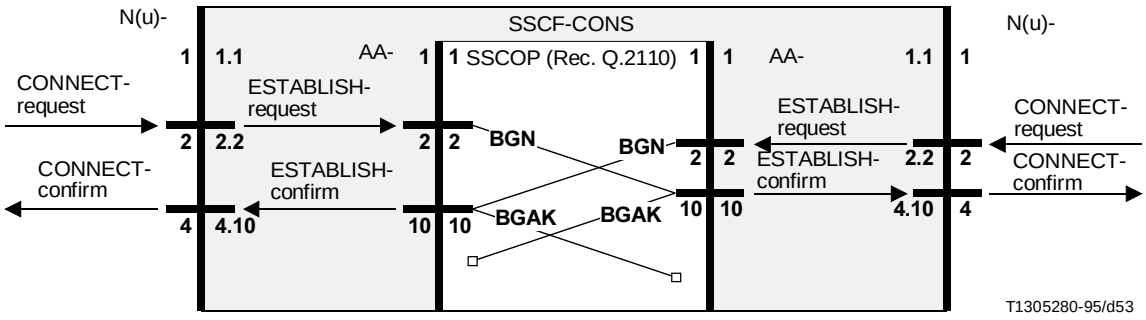


FIGURE I.2/I.365.2

Sequences for establishing an N(u)-connection with collision

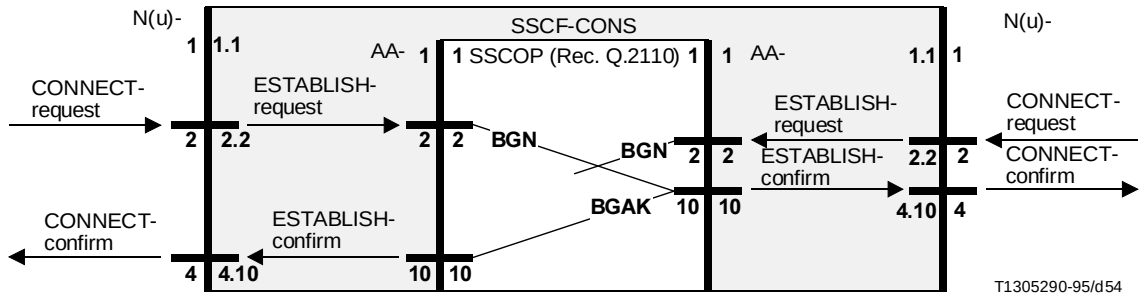


FIGURE I.3/I.365.2

Sequences for establishing an N(u)-connection with collision and corruption

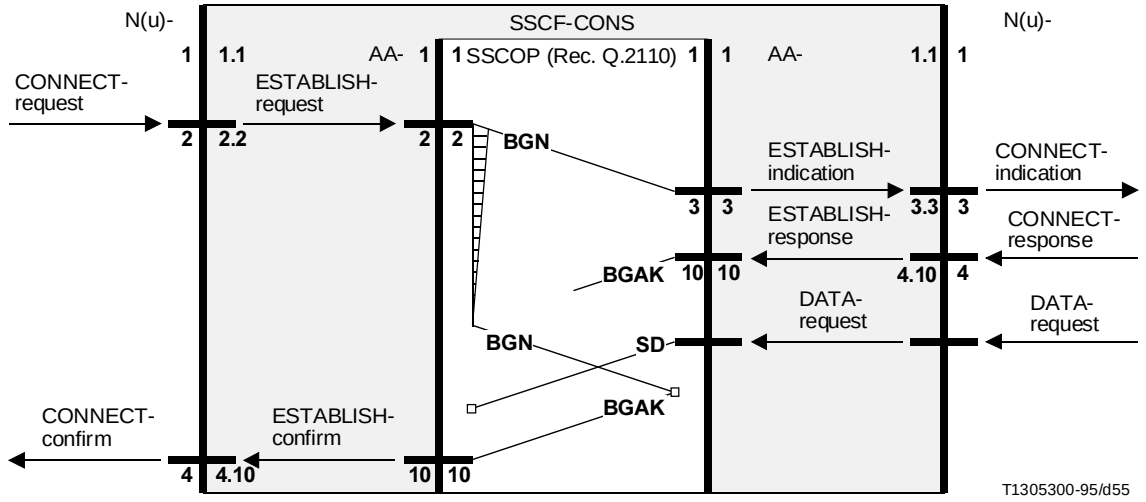


FIGURE I.4/I.365.2

Sequences for establishing an N(u)-connection with corruption and premature DATA-PDU

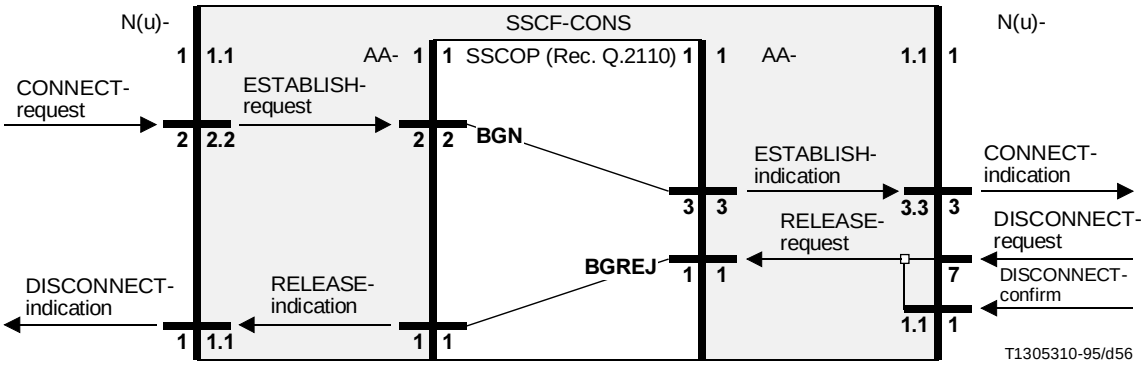


FIGURE I.5/I.365.2

Sequences for attempting to establish an N(u)-connection (rejection)

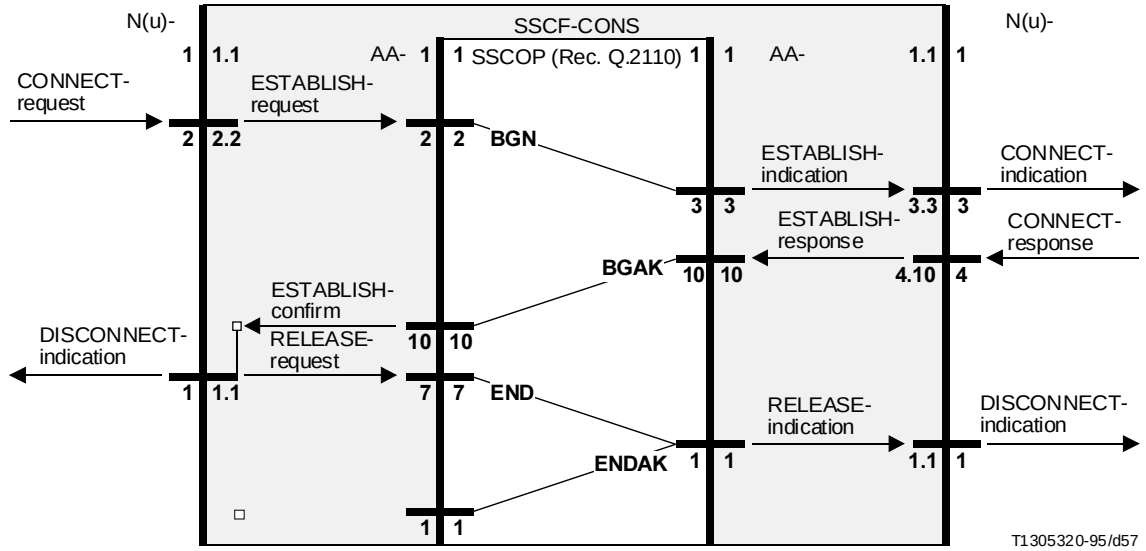


FIGURE I.6/I.365.2

Sequences for attempting to establish an N(u)-connection (rejection)

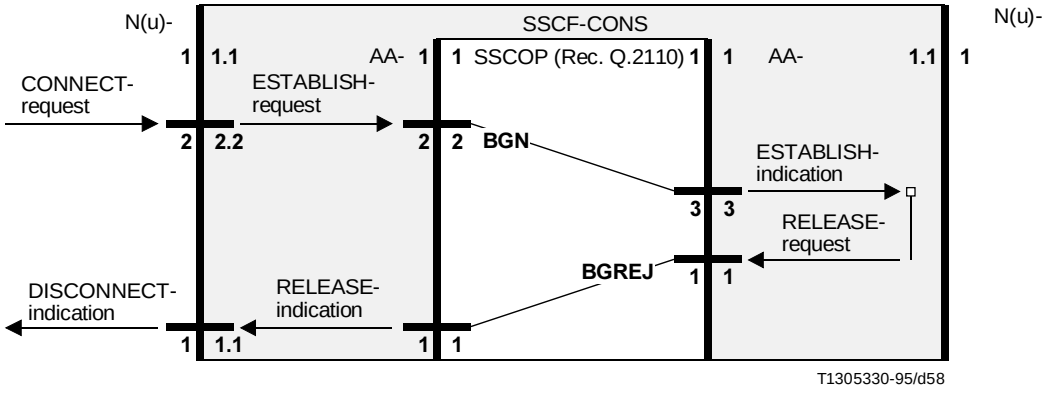


FIGURE I.7/I.365.2

Sequences for attempting to establish an N(u)-connection (rejection)

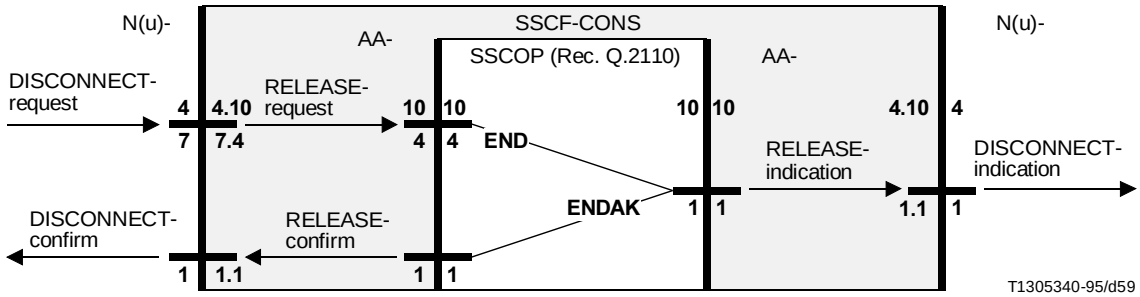


FIGURE I.8/I.365.2

Sequences for releasing an N(u)-connection

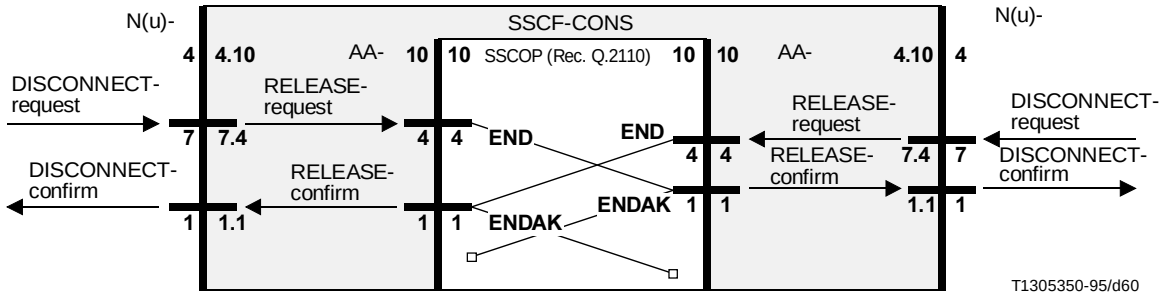


FIGURE I.9/I.365.2

Sequences for releasing an N(u)-connection with collision

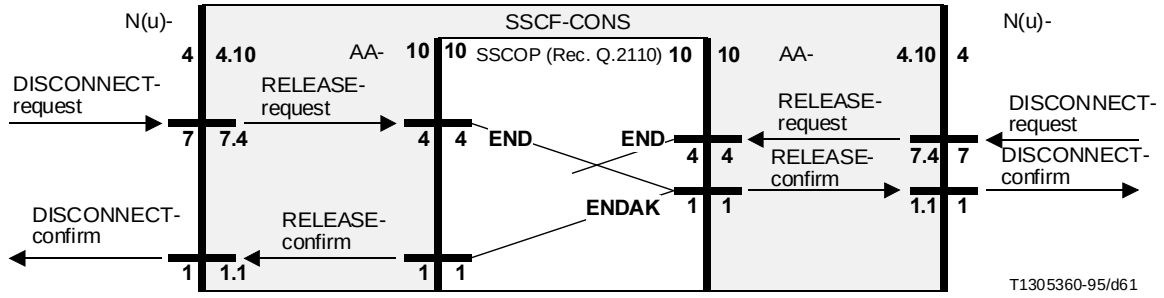


FIGURE I.10/I.365.2

Sequences for releasing an N(u)-connection with collision and corruption

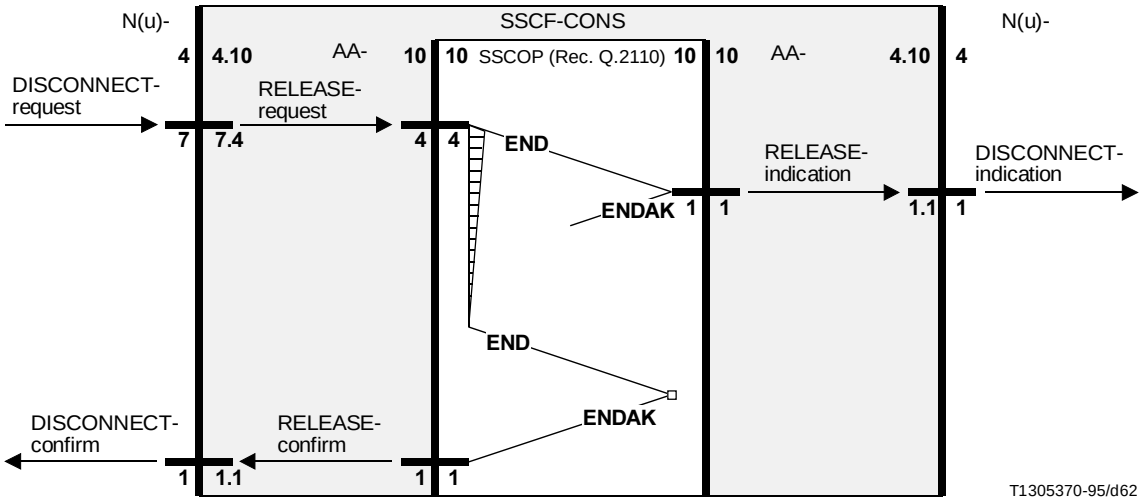


FIGURE I.11/I.365.2

Sequences for releasing an N(u)-connection with corruption

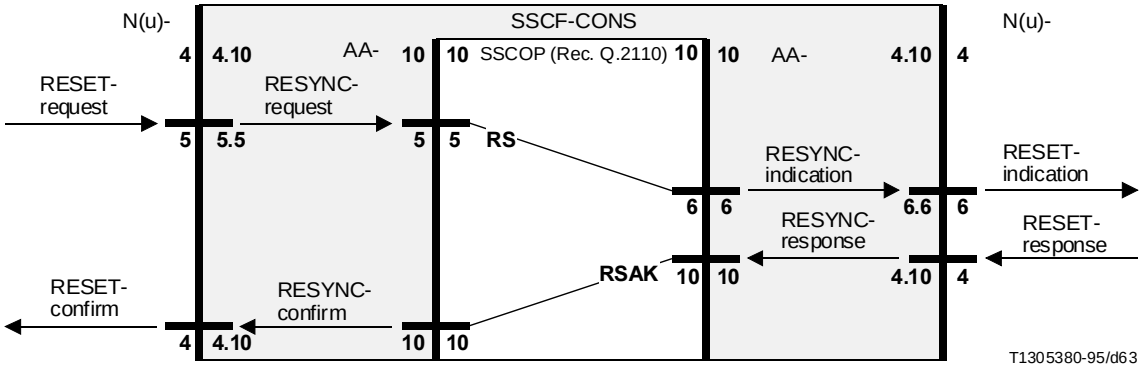


FIGURE I.12/I.365.2

Sequences for resetting an N(u)-connection

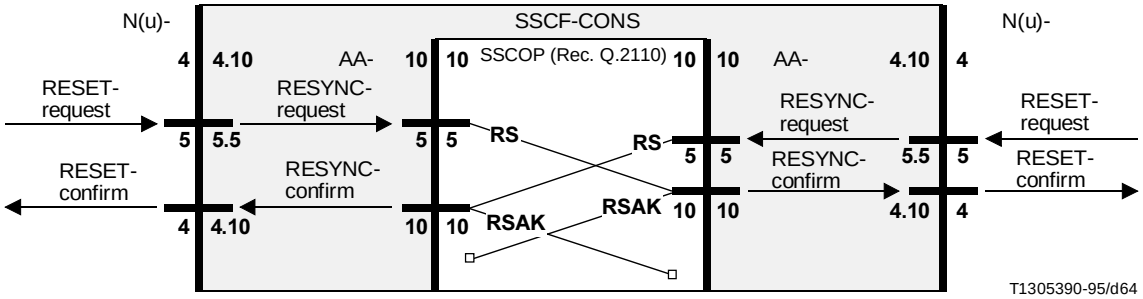


FIGURE I.13/I.365.2

Sequences for resetting an N(u)-connection with collision

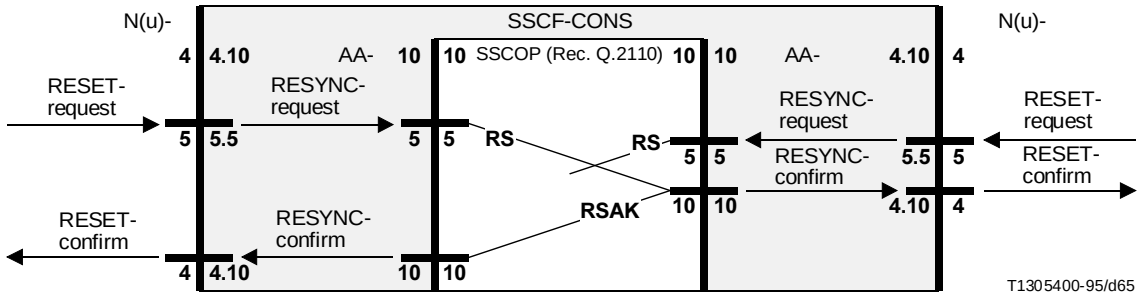


FIGURE I.14/I.365.2

Sequences for resetting an N(u)-connection with collision and corruption

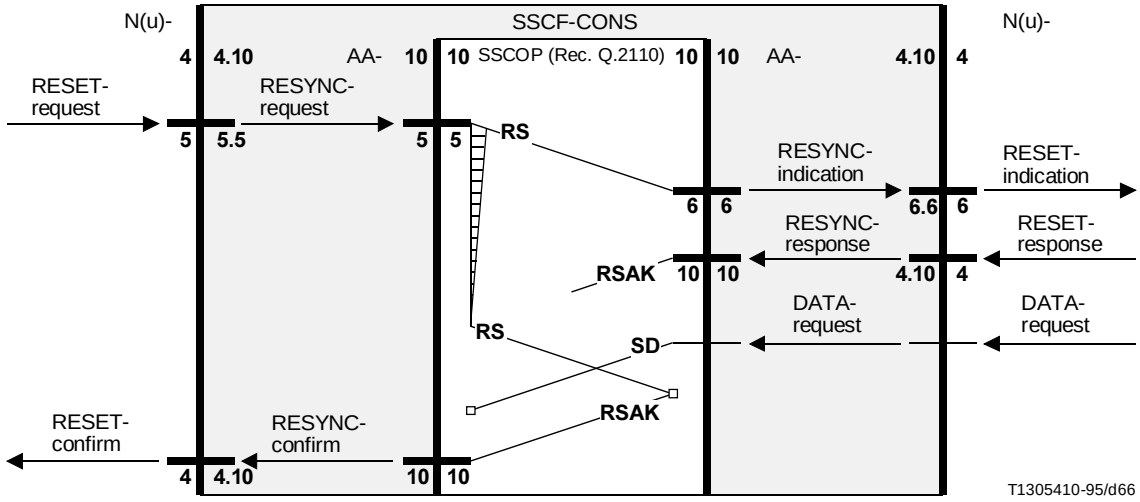


FIGURE I.15/I.365.2

Sequences for resetting an N(u)-connection with corruption and premature DATA-PDU

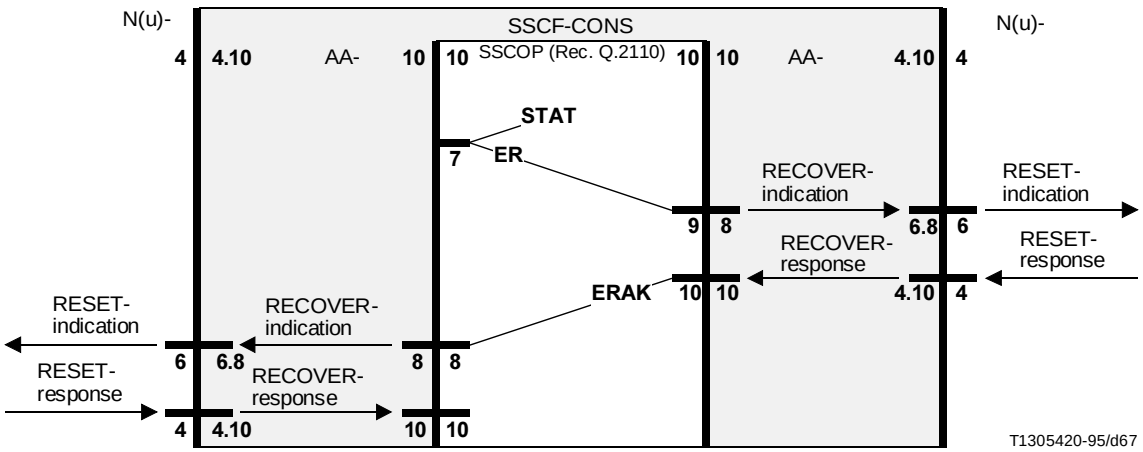


FIGURE I.16/I.365.2

Sequences for provider initiated reset of an N(u)-connection

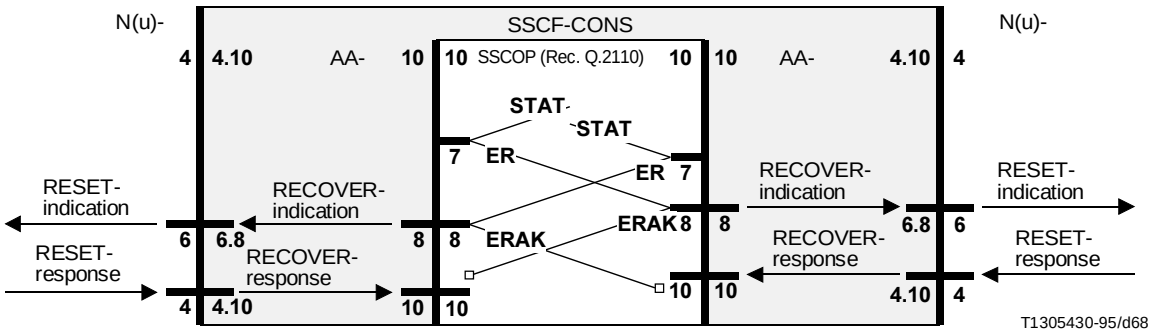


FIGURE I.17/I.365.2

Sequences for provider initiated reset of an N(u)-connection with collision

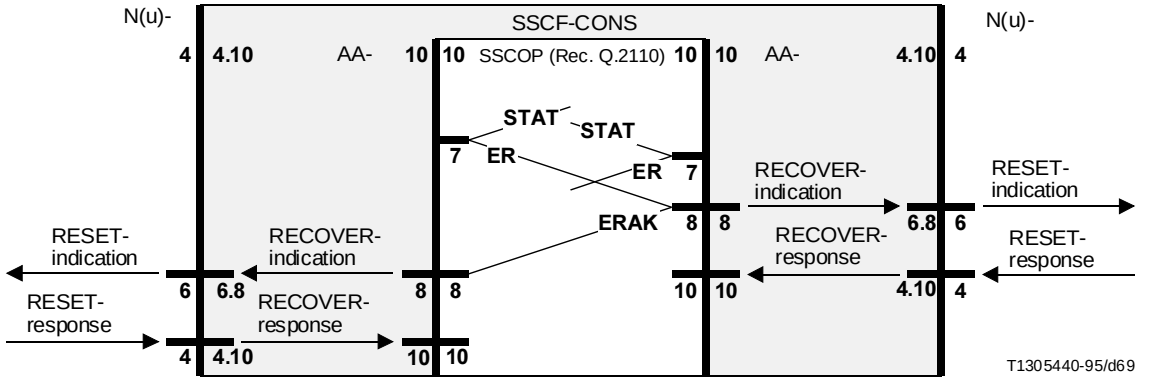


FIGURE I.18/I.365.2

Sequences for provider initiated reset of an N(u)-connection with collision and corruption

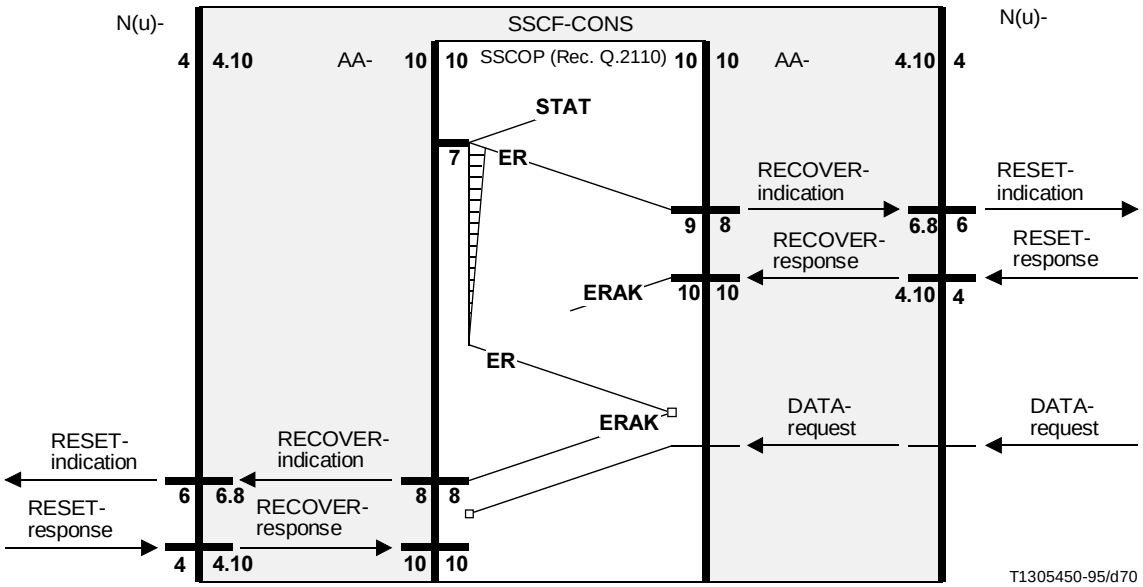


FIGURE I.19/I.365.2

Sequences for provider initiated reset of an N(u)-connection with corruption and premature DATA-PDU

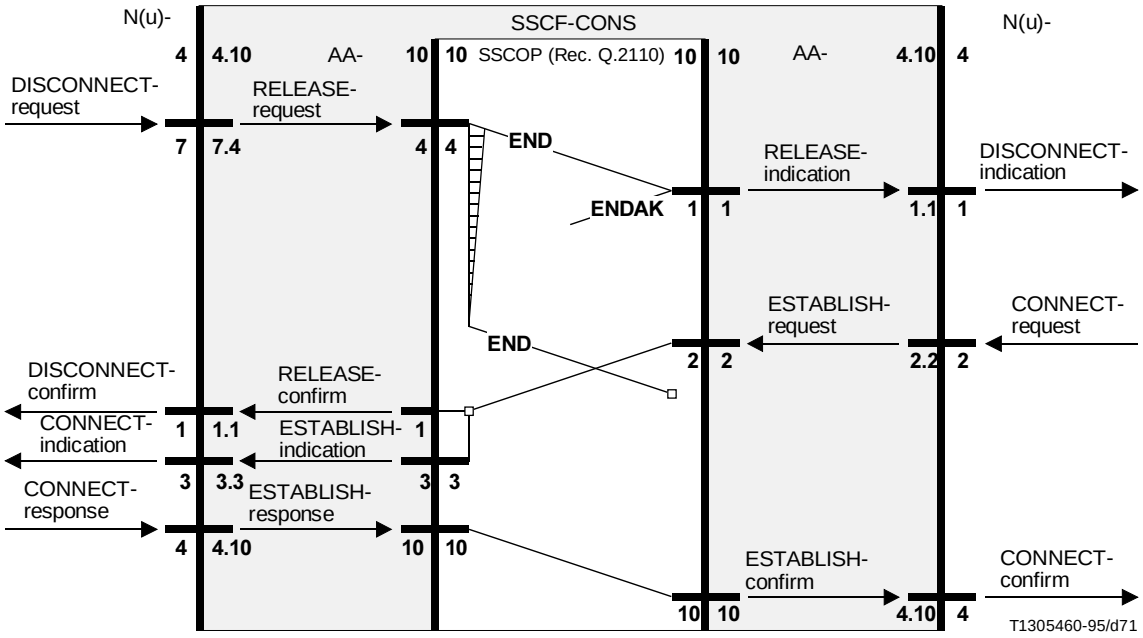


FIGURE I.20/I.365.2

Sequences for release of an N(u)-connection with PDU corruption followed by an N(u)-connection establishment

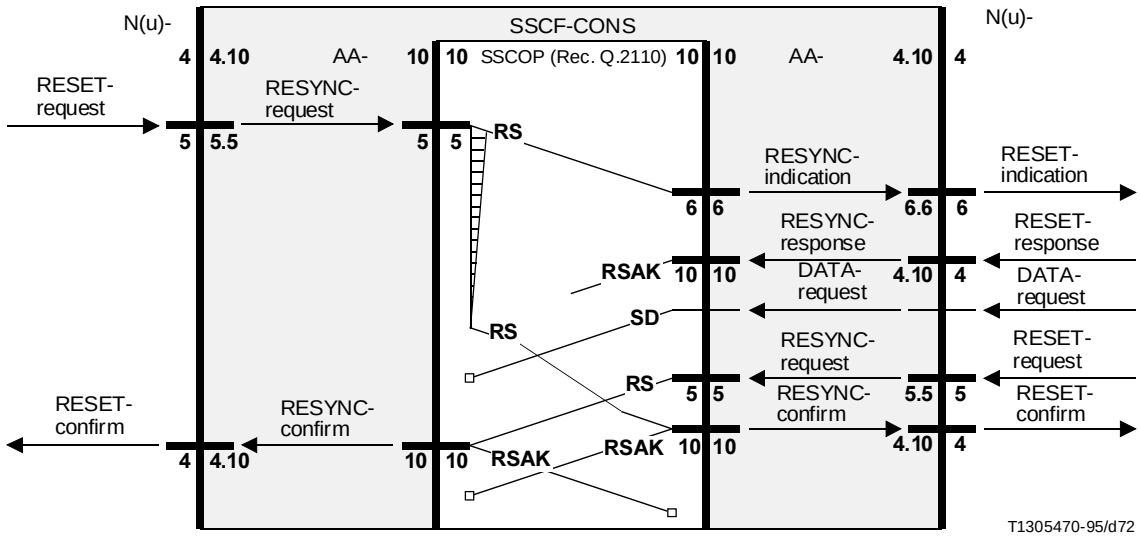


FIGURE I.21/I.365.2

Sequences for user initiated N(u)-connection reset with corruption followed by another reset

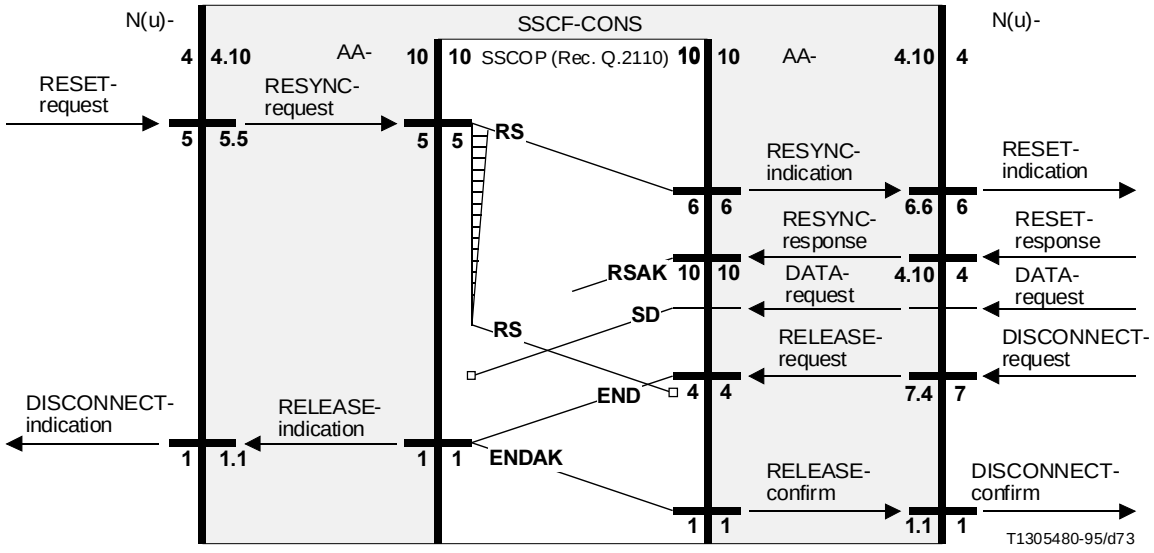


FIGURE I.22/I.365.2

Sequences for user initiated N(u)-connection reset with corruption followed by a connection release

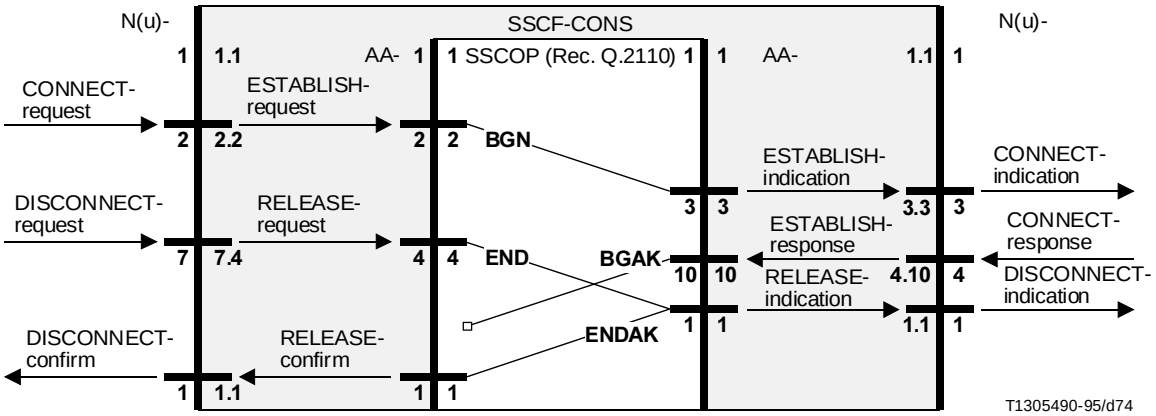


FIGURE I.23/I.365.2

Sequences for establishing an N(u)-connection followed immediately by a release

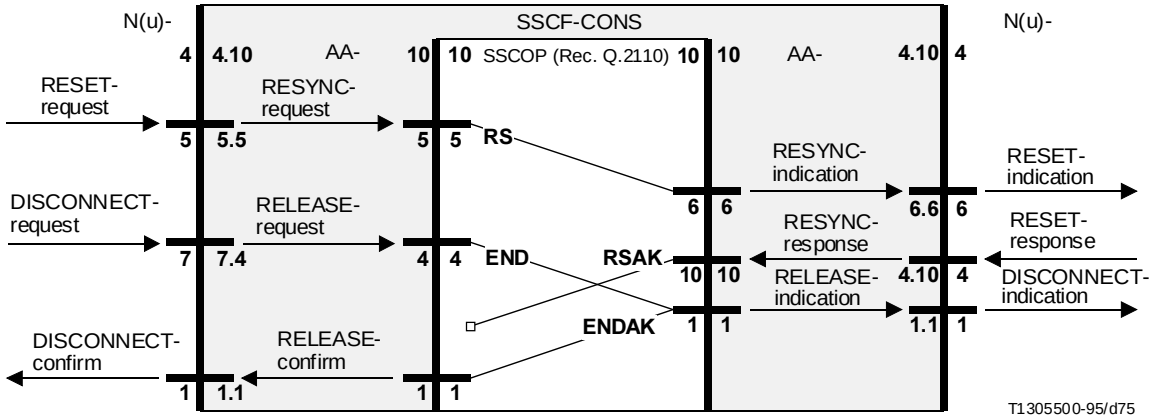


FIGURE I.24/I.365.2

Sequences for a provider initiated reset of an N(u)-connection in contention with a user initiated reset

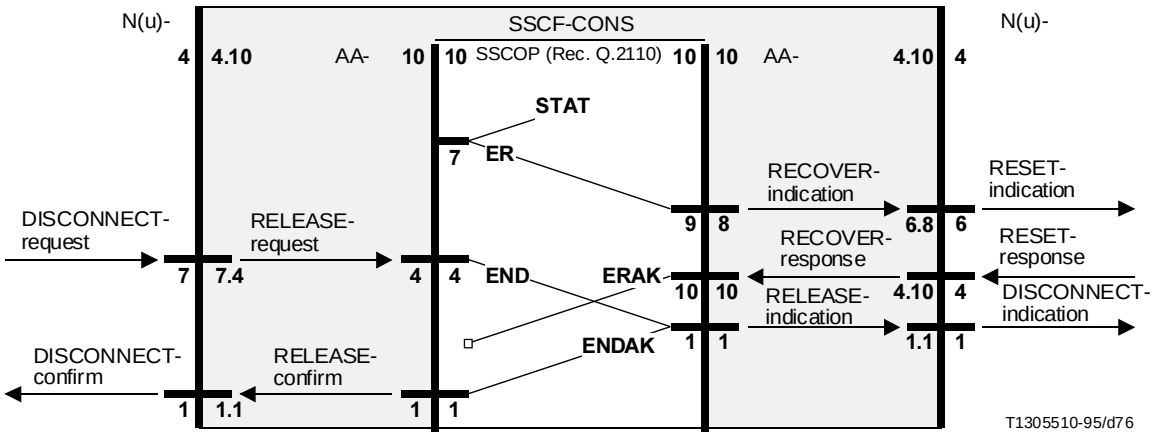


FIGURE I.25/I.365.2

Sequences for a provider initiated reset of an N(u)-connection followed immediately by a release

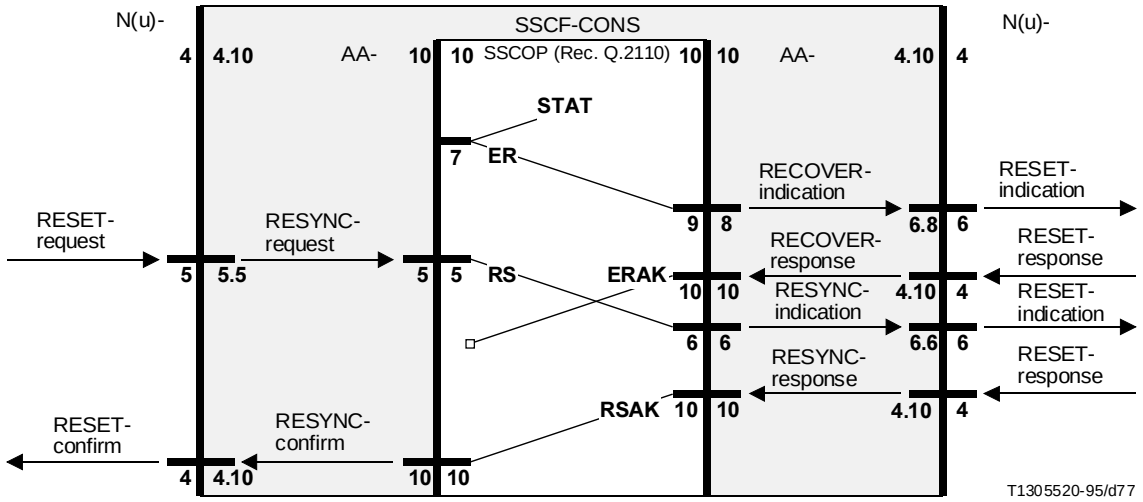


FIGURE I.26/I.365.2

Sequences for a provider initiated reset of an N(u)-connection in contention with a user initiated reset

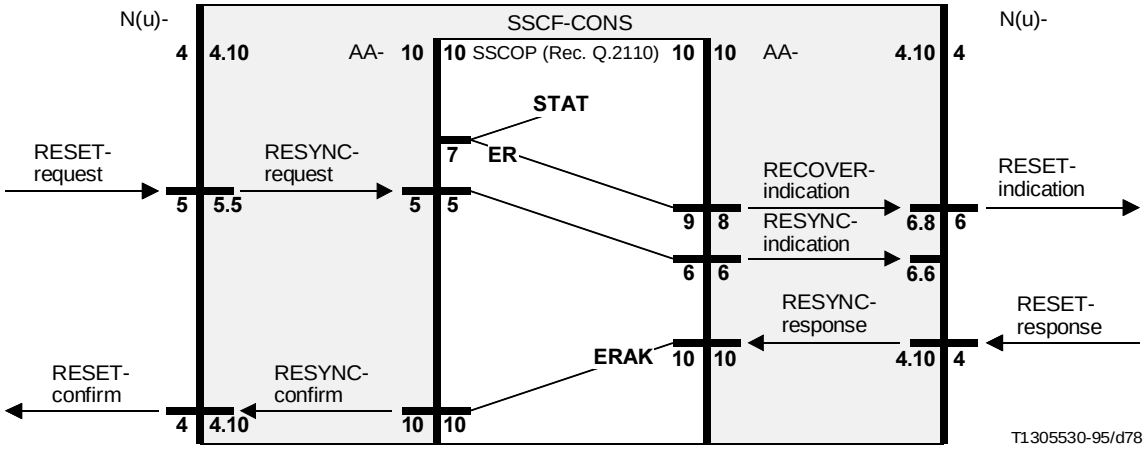


FIGURE I.27/I.365.2

Sequences for a provider initiated reset of an N(u)-connection in contention with a user initiated reset

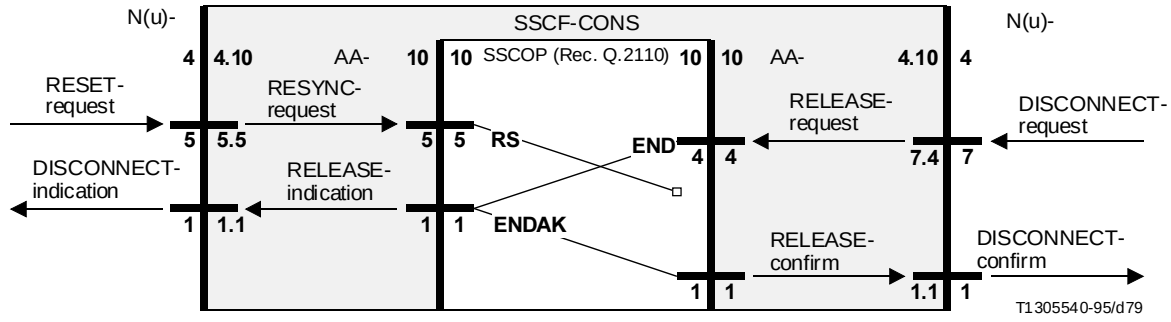


FIGURE I.28/I.365.2

Sequences for release of an N(u)-connection concurrently with a user invoked reset

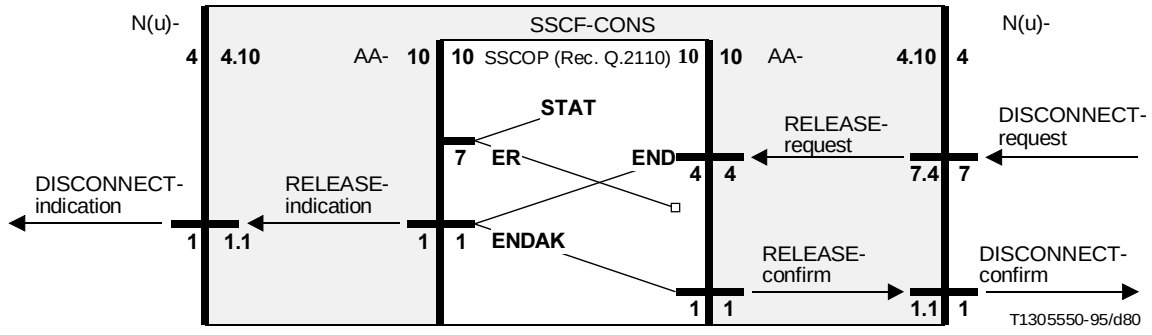


FIGURE I.29/I.365.2

Sequences for release of an N(u)-connection concurrently with a provider initiated reset

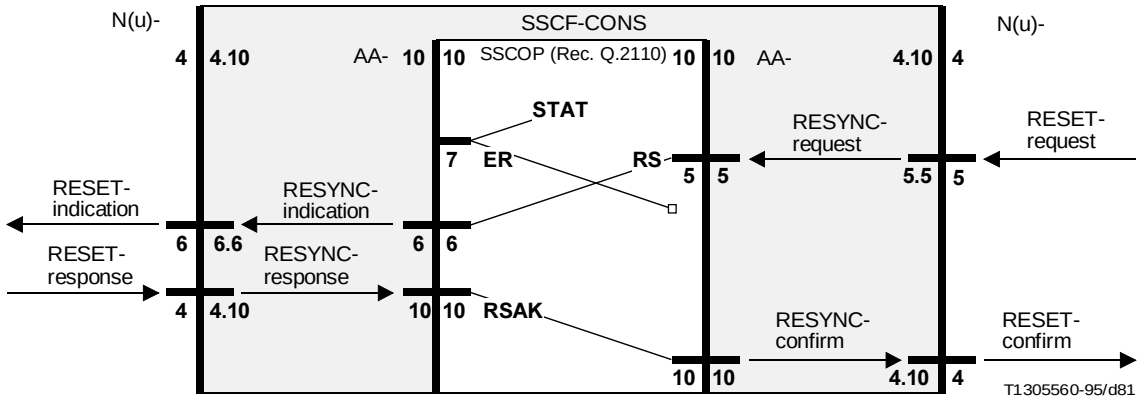


FIGURE I.30/I.365.2

Sequences for a user invoked reset of an N(u)-connection concurrently with a provider initiated reset

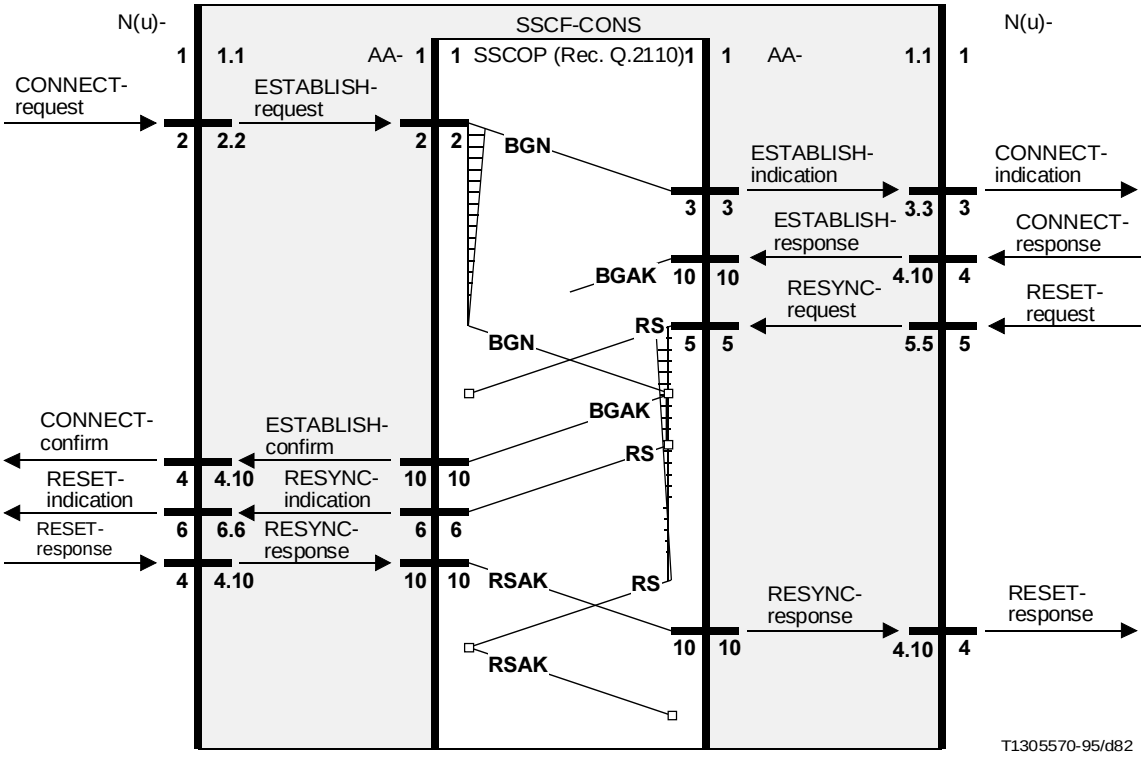


FIGURE I.31/I.365.2

Sequences for establishing an N(u)-connection with corruption followed by a user invoked reset

Appendix II

Further considerations for the default values for the SSCOP parameters and timers

(This appendix does not form an integral part of this Recommendation)

This appendix presents a short discussion on the interdependence of some of SSCOP's parameters.

II.1 Definitions

Mark	Unit	Description	
r	bit/s	Transmission rate	
rtd	s	Round trip delay	
tr	bit	Bandwidth-delay-product	$r \cdot rtd$
z	octet/frame	Frame size	
Tr	frame	Bandwidth-delay-product	$\frac{r \cdot rtd}{8 \cdot z}$
e		Bit error ratio	
p		Frame error ratio	$1 - (1 - e)^{8 \cdot z}$
tp	s	Timer_POLL	
Tp	frame	Timer_POLL	$\frac{r \cdot tp}{8 \cdot z}$
W	frame	Window	
T	s/frame	Time slot	$\frac{8 \cdot z}{r}$
TR	frame	Bandwidth-delay-product	$\lceil (Tr)$
TP	frame	Timer_POLL	$\lceil (Tp)$

The transmission rate "r" is the negotiated maximum channel bit rate, e.g. allocated via a peak bit rate negotiation. For the sake of the analysis in this appendix, the time axis is considered to be quantized with the time required to transmit a full size frame. The direct bandwidth-delay-product "tr" is measured in "bit" however, the entity "Tr" is more appropriate to the ensuing discussion if measured in "frame"; considering in addition the quantized time axis, "TR" is the bandwidth-delay-product rounded up to the next integer value.

Similar considerations hold for Timer_POLL "tp" that is normally expressed in "s" (seconds) and "Tp" that for our discussion is expressed in "frame"; the rounded value is indicated by "TP".

II.2 Goal

For a given environment where SSCOP is utilized and that is characterized by the triplet (r, rtd, e) the relationship between the throughput, efficiency and the protocol parameter triplet (W, z, tp) is sought.

II.3 Frame size

Figure II.1 shows the relationship between bit-error rate "e", frame size "z", and frame error rate "p". For similar performances with varying bit-error rates, the frame size needs to be adapted. In general, with better (i.e. smaller) bit-error rate, the frames can be made larger and the per frame protocol overhead can be reduced.

NOTE – For this analysis, bit errors in cell headers are considered negligible.

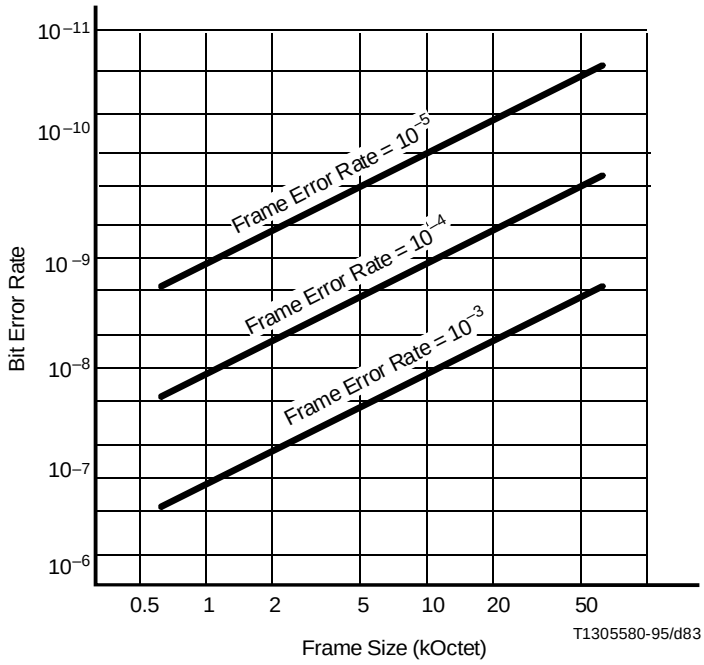


FIGURE II.1/I.365.2

Relationship between "bit-error rate", "frame size", and "frame error rate"

II.4 Qualitative analysis

II.4.1 Assumptions

For the qualitative analysis it is assumed that the transmission time of the SSCOP PDUs "POLL", "STAT", and "USTAT" does not influence the timing, i.e. their transmission time and bandwidth requirement are ignored.

It is also assumed that the transmitter has enough data to send such that no sending intermissions need to be considered for the time duration of the observations. This fact can be utilized to define a time slot "T" that is equivalent to the time required to send a frame. The round trip delay can also be expressed in number of frames "Tr" and rounded up to the next integer value of time slots "TR". Similarly, the Timer_POLL "tp" expressed in frames "Tp" rounded up is identified by "TP".

II.4.2 Timing in the absence of errors

Figure II.2 shows the timing when no frames are corrupted. The status of the frame transmitted immediately after a POLL PDU has been transmitted is requested with the next POLL PDU, i.e. after TP time slots. The associated STAT PDU is interpreted by the transmitter after another TR time slots. Therefore, the credit update at the transmitter will take place at time TR + TP.

Hence, in order to sustain the transmission of frames, the window "W" must be at least TR + TP. If the window size is smaller, the sender has not enough credits for continuous transmission of frames.

NOTE – In the absence of corrupted frames, there are no resequencing buffers required at the receiver.

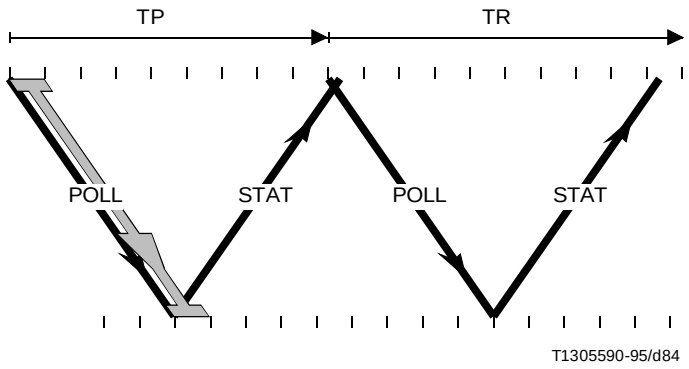


FIGURE II.2/I.365.2

Timing in the absence of errors

II.4.3 Timing for single corrupted data frame correction

Figure II.3 shows the timing when frames may be corrupted. The first frame at the left is fully transmitted at time "1" and is assumed to be corrupted and, therefore, lost. It should have been received at time Tr/2 + 1. However, the receiver will notice the loss only after receipt of the next frame at time Tr/2 + 2. The USTAT will be immediately sent back to the transmitter where it will arrive at Tr + 2 and will be interpreted at time TR + 2. The frame can be retransmitted immediately and has then left the transmitter again at time TR + 3 as indicated in the figure.

In general, Timer_POLL is not synchronized with the corruption of data. However, for the worst case analysis, it is assumed that a POLL PDU has been sent at time TR + 2 just before the retransmission was initiated. The next POLL PDU will not be sent before TP time slots; the return and interpretation of the STAT PDU acknowledging the retransmitted frame requires another TR time slots (see Figure II.3).

Therefore, the credit update at the transmitter will take place at time $2 \cdot TR + TP + 2$. If the window "W" is at least $2 \cdot TR + TP + 1$, the transmitter will never idle due to window closure.

NOTES

1 One time slot was used for retransmission of a frame, this does not consume a credit.

2 In Figure II.3 not all POLL and STAT PDUs are shown.

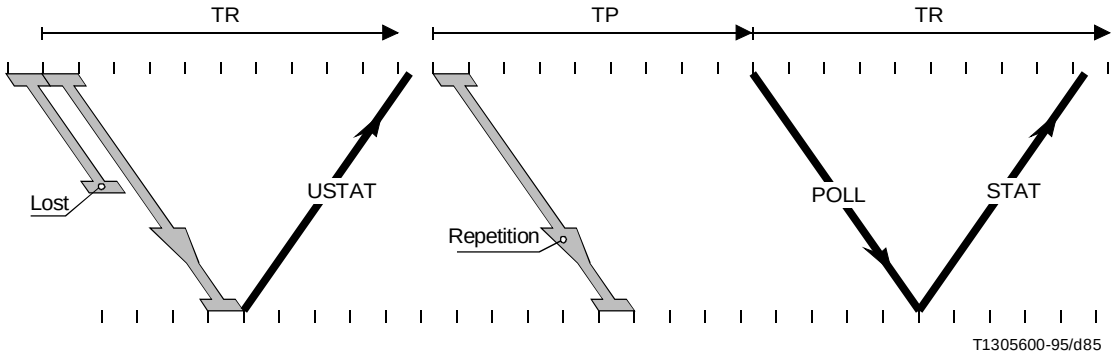


FIGURE II.3/I.365.2

Timing for single error correction (DATA PDU)

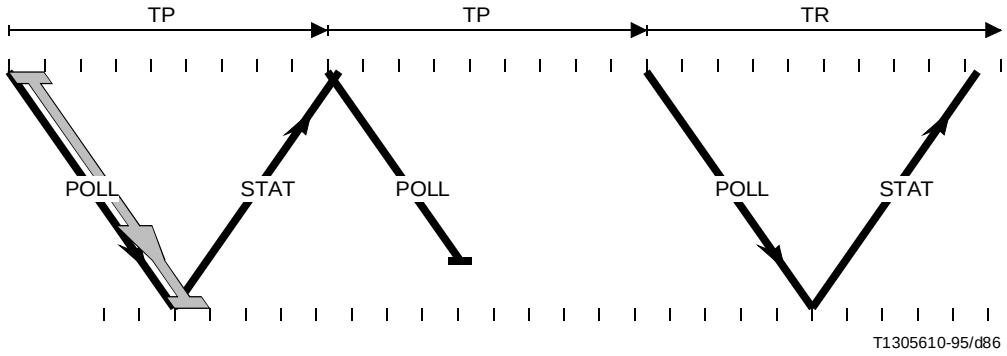


FIGURE II.4/I.365.2

Timing for single error correction (POLL PDU)

II.4.4 Timing for single corrupted POLL or STAT PDU

Figure II.4 shows the timing when a POLL or STAT PDU is corrupted. The worst case concerns the longest outstanding frame acknowledgement which in the figure is shown at the left. It can be seen that the window "W" must be at least $2 \cdot TP + TR$.

NOTE – For this situation, there are no resequencing buffers required at the receiver and no information is retransmitted.

II.4.5 Multiple errors

The analysis in the previous subclauses assumed that all retransmissions were successful. The probability of a frame being delivered in k or fewer attempts is $(1 - p^k)$ or $(1 - (1 - (1 - e)^{8 \cdot z})^k)$. In general, therefore, the assumption above is valid for frame error rates "p" better than 10^{-3}.

II.5 Conclusion

With the frame size adjusted to an acceptable frame error rate, it is suggested that the credit window "W" (in frames) offered by the receiver to the transmitter be the larger of either $2 \cdot TR + TP + 1$ or $2 \cdot TP + TR$, where "TP" and "TR" are defined in II.1. This will compensate for single PDU loss events while maintaining the potential for uninterrupted data transfer.