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ADDENDUM 2
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Information processing systems — Open Systems Interconnection — Connection oriented transport protocol specification

ADDENDUM 2 : Class four operation over connectionless network service

Systèmes de traitement de l'information — Interconnexion de systèmes ouverts — Protocole de transport en mode connexion

ADDITIF 2 : Fonctionnement de la classe 4 sur le service de réseau en mode sans connexion

Reference number
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Contents

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) together form a system for worldwide standardization as a whole. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for approval before their acceptance as International Standards. They are approved in accordance with procedures requiring at least 75 % approval by the national bodies voting.

International Standard ISO/IEC 8073/Add.2 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

Information processing systems — Open Systems Interconnection — Connection oriented transport protocol specification

ADDENDUM 2: Class four operation over connectionless network service

0 Introduction

ISO/IEC 8073 specifies the connection-oriented Transport Protocol that provides the Transport Service as described in ISO 8072. This Transport Protocol uses the connection-oriented services provided by the Network Layer as specified in ISO 8348.

This addendum adds to ISO/IEC 8073 the ability to provide the connection-mode transport service using the connectionless-mode Network Service (ISO 8348/Add. 1) based upon class 4 procedures. The addendum has a structure which is similar to that of ISO/IEC 8073 in order to facilitate cross reference between the two documents and the eventual incorporation of this addendum into ISO/IEC 8073. Table numbering from ISO/IEC 8073 has been retained in the addendum in order to maintain alignment with ISO/IEC 8073 and for re-use of reference. Clause and sub-clause references in the text of ISO/IEC 8073 should be considered, in the context of the application of this addendum, to refer to the corresponding clauses and sub-clauses of this addendum, where they exist.

Except where a variation is specified in this addendum, the procedures specified in ISO/IEC 8073 for class four operation over the connection-oriented Network Service apply also to operation over the connectionless Network Service. General references in ISO/IEC 8073 to the Network Service and to ISO 8348 should be considered to be extended to embrace the connectionless Network Service as specified in ISO 8348/Add. 1. General references to a network connection should be considered to be extended to refer to the existing association between a pair of NSAPs over which a transport connection is established or being established.

ISO 7498 describes the Basic Reference Model of Open Systems Interconnection. It is the intention of the International Standard that the Reference Model should establish a framework for coordinating the development of existing and future standards for the interconnection of open systems.

The relationship between connection-oriented transmission and connectionless-mode transmission is defined in ISO 7498/Add. 1.

In the following clauses, two fonts are used to distinguish between instructions (for incorporating this addendum into ISO/IEC 8073) and original or replacement text.

- *This italic font is used for instructions and titles in reference clause 2,*
- while this sans serif font is used for original or replacement text.

1 Scope and field of application

Modify the first item, "a) five classes of procedures:" *to read* "a) five classes of procedure when operating over the connection oriented Network Service:".

Add a new item, "b) one class of procedure when operation over the connectionless Network Service:".

Re-label the original items b) and c) as items c) and d).

This addendum specifies the use of only a single class of procedures, class 4, for the connection-oriented transfer of data control information from one transport entity to a peer transport entity, over the connectionless network service.

2 References

Add the following references:

ISO 7498/Add. 1, *Information processing systems – Open Systems Interconnection – Basic Reference Model – Addendum 1: Connectionless-mode transmission.*

ISO 8348/Add. 1, *Information processing systems – Data communications – Network service definition – Addendum 1: Connectionless-mode transmission.*

Section one : General

3 Definitions

This addendum makes use of the definitions specified in clause 3 of ISO/IEC 8073, with the following qualifications:

a) Add to sub-clause 3.1 after "ISO 7498", "and ISO 7498/Add. 1".

b) Add a new item to sub-clause 3.1, "f) connectionless mode transmission".

c) Add to end of sub-clause 3.2.28 **owner (of a network connection)**, "Only applicable when operating over the connection-oriented Network Service."

d) Add as sub-clause 3.2.30 the following additional definition:

connectionless network service: A network service providing connectionless mode transmission.

4 Symbols and abbreviations

Add to sub-clause 4.5 the following symbols and abbreviations:

CLNS	Connectionless network service
CONS	Connection-oriented network service

5 Overview of the transport procotol

5.1 Service provided by the transport layer

5.2 Service assumed from the network layer

Add to "ISO 8348", "and ISO 8348/Add. 1".

Add "When operating over CONS," *to the beginning of the paragraph which starts,* "information is transferred".

Modify "Table 2: Network service primitives" *to* "Table 2a) - Network service primitives of CONS".

Add the following text after the second paragraph:

When operating over CLNS, information is transferred to and from the NS-provider in the network service primitive listed in table 2b) below:

Add the following table after table 2a):

Table 2b) – Network service primitives of CLNS

Primitives		X	Parameters	X
N-UNITDATA	request	X	Source Address	X
		X	Destination Address	X
			Quality of service	X
			NS-user-data	X
	indication	X	Source Address	X
		X	Destination Address	X
			Quality of service	X
			NS-user-data	X

X : The transport protocol assumes that this facility is provided in all networks.

NOTES

1 The parameters listed in this table are those in the current connectionless Network Service (ISO 8348/Add. 1).

2 The way the parameters are exchanged between the transport entity and the network service provider is a local matter.

5.3 Functions of the transport layer

Add "only when operating over CONS," *to sub-clause 5.3.1.1, item b),* "multiplexing and demultiplexing" *after the phrase,* "a function".

Add "only when operating over CONS," *to sub-clause 5.3.1.2, item b),* "decide whether to multiplex" *after the phrase,* "a single network connection".

Replace sub-clause 5.3.1.3, item c), with the following text:

"splitting and recombining (see 6.23): a function allowing, only when operating over CONS, the simultaneous use of two or more network connections to support the same transport connection;".

5.4 Classes and options

Re-title sub-clause 5.4 as "**5.4 Classes and options when operating over CONS**".

Re-number sub-clause 5.5, "**Model of the transport layer**" *as sub-clause 5.6, and add the following text as the new sub-clause 5.5:*

5.5 Characteristics of class 4 transport protocol when operating over CLNS

In operation over a connectionless network service the class 4 transport procotol provides flow control between communicating peer transport entities, the capability to detect and recover from errors which occur as a result of a low grade of service available from the NS-provider, and resilience from failure of the peer entity. The kinds of error to be detected include: TPDU loss, TPDU delivery out of sequence, TPDU duplication and TPDU corruption. These errors may affect control TPDUs as well as data TPDUs.

NOTE – The transport entity is incapable of distinguishing between failure of the network service and failure of the peer entity, except optionally, by some local means, in the case of the failure of the local interface to the network service (e.g., in the failure of the local transceiver on a local area network).

There is no indication given to the transport entity about the ability of the network entity to fulfill the service requirements given in the N-UNITDATA primitive. However, it can be a local matter to make transport entities aware of the availability and characteristics (QOS) of connectionless network services, as the corresponding NSAP associations, exist logically by the nature of the connectionless network service and may be recognized by network entities.

5.6 Model of the transport layer

Add "and ISO 8348/Add. 1" *after,* "see ISO 8348".

Section two : Transport protocol specification

6 Elements of procedure

6.1 Assignment to network connection

Re-title sub-clause 6.1 as "**6.1 Use of the network service**".

Add the following title and text as the new sub-clause 6.1.1:

6.1.1 Assignment to network connection when operating over CONS

This procedure is used only when operating over the connection-oriented network service.

Re-number sub-clauses 6.1.n as 6.1.1.n, respectively.

Add the following title and text as the new sub-clause 6.1.2:

6.1.2 Transmission over CLNS

This procedure is used only when operating over the connectionless network service.

6.1.2.1 Purpose

The procedure is used to transmit TPDUs over the connectionless network service.

6.1.2.2 Network service primitives

The procedure makes use of the following network service primitive:

N-UNITDATA.

6.1.2.3 Procedure

Each TPDU shall be transmitted in a single invocation of the connectionless network service, over a pre-existing association between a pair of NSAPs. The association is considered by transport entities as permanently established and available.

6.2 Transport protocol data unit (TPDU) transfer

In sub-clause 6.2.2, after the phrase "network service primitives", *add* "when operating over CONS".

Add the following text to the end of sub-clause 6.2.2:

The procedure uses the following network service primitive when operating over CLNS:

N-UNITDATA.

Add before the second paragraph of sub-clause 6.2.3, the following text:

When operating over CLNS, the transport entities shall transmit and receive all TPDUs as NS-user data parameters of N-UNITDATA primitives.

In sub-clause 6.2.3, add to the beginning of the second paragraph, "When operating over CONS and".

6.3 Segmenting and reassembling

6.4 Concatenation and separation

In sub-clause 6.4.2, add to the beginning of note 3, "When operating over CONS,".

Add the following text to the end of note 3:

When operating over CLNS, the number of TPDUs that may be concatenated is bounded by the number of transport connections established between two NSAPs and/or the maximum available NSDU size.

6.5 Connection establishment

6.5.1 Purpose

6.5.2 Network service primitives

Add to the beginning of the sentence, "When operating over CONS,".

Add the following text to the end of sub-clause 6.5.2:

When operating over CLNS, the procedure uses the following network service primitive:

N-UNITDATA.

6.5.3 TPDUs and parameters used

6.5.4 Procedure

Re-title sub-clause 6.5.4 as "**6.5.4 Procedure for operating over CONS**".

Insert the following text as sub-clause 6.5.5:

6.5.5 Procedure for operating over CLNS

A transport connection is established by means of one transport entity (the initiator) transmitting a CR TPDU to the other transport entity (the responder), which replies with a CC TPDU. During this exchange, all information and parameters needed for the transport entities to operate shall be exchanged or negotiated. When an unexpected duplicated CR TPDU is received (with class 4 as preferred class) a CC TPDU shall be returned.

After receiving the CC TPDU, the initiator shall acknowledge the CC TPDU as defined in table 5 (see 6.13 of ISO 8073).

The following information is exchanged:

a) references : Each transport entity chooses a reference to be used by the peer entity which is 16-bits long and which is arbitrary under the following restrictions:

   1) it shall not already be in use nor frozen (see 6.18 of ISO/IEC 8073).
   2) it shall not be zero.

   This mechanism is symmetrical and provides identification of the transport connection itself. The range of references used for transport connections, in a given transport entity, is a local matter.

b) called and calling TSAP-IDs (optional): Indicates the calling and called transport service access points. When either the network address unambiguously defines the transport address, this information may be omitted.

c) initial credit:

d) user data: Up to 32 octets.

e) acknowledgment time:

f) checksum parameter:

g) protection parameter: This parameter and its semantics are user defined.

h) protocol class: Class 4 is the only valid value for the preferred protocol class proposed by the initiator, and for the class selected by the responder. An alternative class is not permitted.

The following negotiations take place:

i) TPDU size: The initiator may propose a maximum size for TPDUs in the set of values available [see 13.3.4b), ISO/IEC 8073]. This value may be limited by the maximum available NSDU size if known, and cannot exceed the maximum NSDU size for connectionless network service as defined in ISO 8348/Add. 1.

The responder may accept this value or respond with any value between 128 and the proposed value in the set of values available [see 13.3.4b), of ISO/IEC 8073].

NOTES

1 The length of the CR TPDU does not exceed 128 octets (see 13.3 of ISO/IEC 8073).

2 The transport entities may have knowledge, by some local means, of the maximum available NSDU size.

j) normal or extended format: Either normal or extended is available. When extended is used this applies to CDT, TPDU-NR, ED TPDU-NR, YR-TU-NR and YR-EDTU-NR parameters.

k) checksum selection: This defines whether or not TPDUs of the connection are to include a checksum.

l) quality of service parameters: This defines the throughput, transit delay, priority and residual error rate.

NOTE — The transport service defines transit delay as requiring a previously stated average TSDU size as a basis for any specification. This protocol as specified in 13.3.4.n) of ISO/IEC 8073, uses a value at 128 octets. Conversion to and from specifications based upon some other value is a local matter.

m) use of expedited data transfer service [item r) in ISO/IEC 8073]: This allows both TS-users to negotiate the use or non-use of the expedited data transport service as defined in the transport service (ISO 8072).

The following information is sent only in the CR TPDU:

n) version number [item s) in ISO/IEC 8073]: This defines the version of the transport protocol standard used for this connection.

6.6 Connection refusal

6.7 Normal release

Re-number sub-clauses 6.7.n and all references to them as 6.7.1.n respectively, and insert a new title:

6.7.1 Normal release when operating over CONS

Add the following text as sub-clause 6.7.2:

6.7.2 Normal release when operating over CLNS

6.7.2.1 Purpose

The release procedure is used by a transport entity in order to terminate a transport connection.

6.7.2.2 Network service primitives

The procedures makes use of the following network service primitive:

N-UNITDATA.

6.7.2.3 TPDUs and parameters used

The procedure uses the following TPDUs and parameters:

a) DR TPDU;
   - reason;
   - user data;
   - SRC-REF;
   - DST-REF;

b) DC TPDU.

6.7.2.4 Procedure

When the release of a transport connection is to be initiated, a transport entity shall send a DR TPDU and shall discard all subsequently received TPDUs except for a DR or a DC TPDU.

On the receipt of a DR or a DC TPDU, it shall consider the transport connection to be released and the local reference shall be frozen (see 6.8). If a CC TPDU has been previously sent or received by the transport connection, then the remote reference is known and shall be used for the DST-REF in the DR TPDU to be sent. If the remote reference is not known, then the DST-REF in the DR TPDU may be set to zero, or the entity may wait until a CC TPDU is received before sending the DR TPDU.

NOTE – In case that the entity decides to wait for the arrival of the CC TPDU for the connection, deadlock, which could result from a CC TPDU that never arrives, is prevented by the expiration of the CR TPDU retransmission counter, which forces the DR TPDU to be sent.

A transport entity which receives a DR TPDU shall

a) consider the transport connection to be released if it has previously sent a DR TPDU for that connection;

b) consider the transport connection to be refused (see 6.6) if it has previously sent a CR TPDU for that connection and no CC TPDU has been received in acknowledgment;

c) consider the transport connection to be released and send a DC TPDU in all other cases. If the received DR TPDU has the DST-REF field set to zero, then a DC TPDU with SRC-REF set to zero shall be sent, regard less of the local reference.

6.8 Error release

Re-title sub-clause 6.8, as "**6.8 Error release when operating over CONS**".

6.9 Association of TPDUs with transport connections

Re-number sub-clauses 6.9.n and all references to them as 6.9.1.n respectively, and insert a new title:

6.9.1 Association of TPDUs with transport connections when operating over CONS

Add the following text as sub-clause 6.9.2:

6.9.2 Association of TPDUs with transport connections when operating over CLNS

6.9.2.1 Purpose

This procedure is used to interpret a received NSDU as TPDU(s) and, if possible, to associate each such TPDU with a transport connection.

6.9.2.2 Network service primitives

This procedure makes use of the following network service primitive:

N-UNITDATA.

6.9.2.3 TPDUs and parameters used

This procedure makes use of the following TPDUs and parameters:

a) all TPDUs except CR TPDU:
   – DST-REF;
b) CR, CC, DR and DC TPDUs:
   – SRC-REF.

6.9.2.4 Procedures

6.9.2.4.1 Identification of TPDUs

If the received NSDU cannot be decoded (i.e., does not contain one or more correct TPDUs) or is corrupted (i.e., contains a TPDU with a wrong checksum) then the transport entity shall ignore (discard) the TPDUs. If the NSDU can be decoded and is not corrupted, the transport entity shall invoke the separation procedures and for each of the individual TPDUs in the order in which they appear in the NSDU apply the procedure in 6.9.2.4.2.

6.9.2.4.2 Association of individual TPDUs

Association of a received TPDU with a transport connection is generally performed by attempting to match the DST-REF in the received TPDU and the NSAP pair over which it was received with those of an existing transport connection. There are three exceptions to this general procedure: when the received TPDU is a CR TPDU, the SRC-REF is used instead of the DST-REF; when the received TPDU is either a DR or a DC TPDU, the SRC-REF is used in addition to the DST-REF; and when the received TPDU is a CC TPDU, whose DST-REF parameter identifies an open connection (one for which a CC TPDU has been previously received), then the SRC-REF is used in addition to the DST-REF.

The following actions shall be taken in consequence to the inability to match the TPDU to an existing transport connection:

a) For a CR TPDU, a new transport connection shall be created.
b) For a CC TPDU, a DR TPDU shall be sent using the SRC-REF and DST-REF from the received CC TPDU as the DST-REF and SRC-REF, respectively, of the DR TPDU.
c) For a DR TPDU, there are four cases:
   1) if a CR TPDU is unacknowledged for the connection identified by the DST-REF in the DR TPDU, then the DR TPDU is associated with that connection regardless of the SRC-REF in the DR TPDU.

2) if the CR TPDU for the connection identified by the DST-REF of the DR TPDU has been acknowledged and the SRC-REF is not as expected, then a DC TPDU using the SRC-REF of the DR TPDU as DST-REF is sent and no association is made.
3) if the DST-REF in the DR TPDU is zero and there is an unacknowledged CC TPDU or a T-CONNECT response is awaited for a transport connection holding remote reference equal to the SRC-REF of the DR TPDU, then the DR TPDU is associated with that transport connection.
4) in all other situations, the DR TPDU is associated with the transport connection identified by the DST-REF of the DR TPDU.

d) For all other TPDU types, the TPDU is discarded.

6.10 Data TPDU numbering

6.11 Expedited data transfer

Re-number sub-clauses 6.11.n, as 6.11.1.n respectively, and insert a new title:

6.11.1 Expedited data transfer when operating over CONS

Add the following text as sub-clause 6.11.2:

6.11.2 Expedited data transfer when operating over CLNS

6.11.2.1 Purpose

Expedited data transfer procedures are selected during connection establishment.

6.11.2.2 Network service primitives

The procedure makes use of the following network service primitive:

N-UNITDATA.

6.11.2.3 TPDUs and parameters used

The procedures makes use of the following TPDUs and parameters:

a) ED TPDU;
   – ED TPDU-NR;
b) EA TPDU;
   – YR-EDTU-NR.

6.11.2.4 Procedures

The TS-user data parameter of each T-EXPEDITED DATA request shall be conveyed as the data field of an Expedited Data (ED) TPDU.

Each ED TPDU received shall be acknowledged by an Expedited Acknowledge (EA) TPDU.

No more than one ED TPDU shall remain unacknowledged at any time for each direction of a transport connection.

An ED TPDU with a zero length data field shall be treated as a protocol error (see 6.22).

6.12 Reassignment after failure

Re-title sub-clause 6.12 as "**6.12 Reassignment after failure when operating over CONS**".

6.13 Retention until acknowledgment of TPDUs

6.13.1 Purpose

6.13.2 Network service primitives

Add to the beginning of the first sentence, "When operating over CONS,".

Add to the end of sub-clause 6.13.2 the following text:

When operating over CLNS, the procedure uses the following network service primitive:
N-UNITDATA.

Add the following qualification after the word "NOTES" *in sub-clause 6.13.4,* "(Only apply when operating over CONS)".

6.14 Resynchronization

6.15 Multiplexing and demultiplexing

Re-title sub-clause 6.15 as "**6.15 Multiplexing and demultiplexing when operating over CONS**".

Sub-clauses 6.16 to 6.21 remain unchanged.

6.22 Treatment of protocol errors

Renumber sub-clauses 6.22.n and all references to them as 6.22.1.n respectively, and insert a new title:

6.22.1 Treatment of protocol errors when operating over CONS

Add the following text as sub-clause 6.22.2:

6.22.2 Treatment of protocol errors when operating over CLNS

6.22.2.1 Purpose

The procedure for treatment of protocol errors is used to deal with invalid TPDUs.

6.22.2.2 TPDUs and parameters used

The procedure uses the following TPDUs and parameters:

a) ER TPDU;
   – reject cause;
   – invalid TPDU;
b) DR TPDU;
   – reason.

6.22.2.3 Procedure

Invalid TPDUs and protocol errors shall be ignored (no action and TPDU discarded, or responded to with an ER TPDU), except for the following case: a CC TPDU is received in which the class field does not specify class 4 and a previously sent CR TPDU has not yet been acknowledged. In this case, the transport connection shall be terminated (See 6.7).

6.23 Splitting and recombining

Re-title sub-clause 6.23 as "**6.23 Splitting and recombining when operating over CONS**".

7 Protocol classes

Re-title the right hand column, "4" in table 6 as "Class 4 CONS".

Add the following column to the right hand side of table 6. The names of the protocol mechanisms are included to help cross-referencing.

	Class 4 CLNS
Assignment to network connection	
TPDU transfer	X
Segmenting and reassembling	X
Concatenation and separation	X
Connection establishment	X
Connection refusal	X
Normal release	X
Error release	
Association of TPDUs with transport connection	X
TPDU numbering	m
	o
Expedited data transfer	X
Reassignment after failure	
Retention until acknowledgement of TPDUs	X
Resynchronization	
Multiplexing and demultiplexing	
Explicit flow control (with)	X
Explicit flow control (without)	
Checksum (use of)	m
Checksum (non-use of)	o
Frozen references	X
Retransmission of time-out	X
Resequencing	X
Inactivity control	X
Treatment of protocol errors	X
Splitting and recombining	

Clauses 8 to 11 remain unchanged.

12 Specification for class 4 : Error detection and recovery class

12.1 Functions of class 4

Add the following new sub-clause title before the first paragraph:

12.1.1 Functions of class 4 when operating over CONS

Add the following text as sub-clause 12.1.2:

12.1.2 Functions of class 4 when operating over CLNS

Class 4 provides flow control between peer transport entities, the capability to detect and recover from errors which occur as a result of a low grade service available from the network service provider and resilience from failure of the peer entity – the kind of errors to be detected include: TPDU loss, TPDU delivery out of sequence, TPDU duplication and TPDU corruption – these errors may affect control TPDUs as well as data TPDUs.

The detection of errors is made by use of DT TPDU numbering, by time-out mechanisms and additional procedures such as the use of a checksum mechanism. The use of the checksum mechanism shall be available but its use or its non use is subject to negotiation.

12.2 Procedures for class 4

12.2.1 Procedures available at all times

12.2.1.1 Timers used at all times

12.2.1.2 General procedures

Re-title sub-clause 12.2.1.2 as **"12.2.1.2 General procedures when operating over CONS"**.

Add the following text as sub-clause 12.2.1.3:

12.2.1.3 General procedures when operating over CLNS

The transport entity shall use the following procedures:

a) TPDU transfer (see 6.2);

b) association of TPDUs with transport connections (see 6.9);

c) treatment of protocol errors (see 6.22);

d) checksum (see 6.17);

e) retention until acknowledgment of TPDUs (see 6.13);

f) frozen references (see 6.18);

g) retransmission procedures; when a transport entity has some outstanding TPDUs that require acknowledgment, it will check that no T1 interval elapses without the arrival of a TPDU that acknowledges at least one of the outstanding TPDUs.

If the timer expires, except if the TPDU to be retransmitted is a DT TPDU and it is outside the transmit window due to credit reduction, the first TPDU is retransmitted and the timer is restarted. After N transmissions (i.e. N-1 retransmissions) it is assumed that useful two-way communication is no longer possible and the release procedure is used, and the TS-user is informed.

NOTES

1) This procedure may be implemented by different means. For example:

   a) one interval is associated with each TPDU. If the timer expires the associated TPDU will be transmitted and the timer T1 will be restarted for all subsequent TPDUs; or

   b) one interval is associated with each transport connection:

      1) if the transport entity transmits a TPDU requiring acknowledgment, it starts timer T1;

      2) if the transport entity receives a TPDU that acknowledges one of the TPDUs to be acknowledged, it restarts timer T1 unless the received TPDU is an AK which explicitly closes the transmit window;

      3) if the transport entity receives a TPDU that acknowledges the last TPDU to be acknowledged, it stops timer T1.

   For a decision whether the retransmission timer T1 is maintained on a per TPDU or on a per transport connection basis, throughput considerations have to be taken into account.

2) For DT TPDUs it is a local choice to retransmit either only the first DT TPDU or all TPDUs waiting for an acknowledgment up to the upper window edge.

3) It is recommended that after N transmission, the transport entity waits $T1 + W + M_{RL}$ to provide a higher possibility for receiving an acknowledgment before entering the release phase. For other TPDU types which may be retransmitted, it is recommended that after N transmissions the transport entity waits $T1 + M_{RL}$ to provide an higher possibility of receiving the expected reply.

12.2.2 Procedures for connection establishment

12.2.2.1 Timers used in connection establishment

12.2.2.2 General procedures

Re-title sub-clause 12.2.2.2 as "**12.2.2.2 General procedures when operating over CONS.**

Add the following text as sub-clause 12.2.2.3:

12.2.2.3 General procedures when operating over CLNS

The transport entity shall use the procedure of connection establishment (see 6.5) and if appropriate connection refusal (see 6.6) together with the additional procedures:

1) a connection is not considered established until the successful completion of a three-way TPDU exchange. The sender of a CR TPDU shall respond to the corresponding CC TPDU by immediately sending a DT, ED, DR or AK TPDU;

2) as a result of duplication or retransmission, a CR TPDU may be received specifying a source reference which is already in use with the sending transport entity. If the receiving transport entity is in the data transfer phase, having completed the three-way TPDU exchange procedure, or is waiting for the T-CONNECT response from the TS-user, the receiving transport entity shall discard such a TPDU. Otherwise a CC TPDU shall be transmitted;

3) as a result of duplication or retransmission, a CC TPDU may be received specifying a paired reference which is already in use. The receiving transport entity shall only acknowledge the duplicate CC TPDU according to the procedure in 12.2.2.3.b)1);

4) a CC TPDU may be received specifying a reference which is in the frozen state. The response to such a TPDU shall be a DR TPDU;

5) the retransmission procedures (see 12.2.1.3) are used for both the CR TPDU and CC TPDU.

NOTE – After receiving a CR TPDU, it is recommended that the transport entity enforce a time limit upon the transport service user so that late acceptance of the transport connection will not cause a delayed CC TPDU to be sent.

12.2.3 Procedures for data transfer

12.2.3.1 Timers used in data transfer

Insert the following sub-clause title before the first sentence:

12.2.3.1.1 Timers used in data transfer when operating over CONS

Add the following text as sub-clause 12.2.3.1.2:

12.2.3.1.2 Timers used in data transfer when operating over CLNS

The data transfer procedures use two additional timers:

a) Inactivity time (I)

To protect against failure of the network service or failure of the peer transport entity (half-open connections), each transport entity maintains an inactivity interval.

NOTE – A suitable value for I is given by $2 * (N *$ maximum of $(T1, W))$ unless local needs indicate another more appropriate value.

b) Window time (W)

A transport entity maintains a timer interval to ensure that there is a bound on the maximum interval between window updates.

12.2.3.2 General procedures for data transfer

12.2.3.3 Inactivity control

12.2.3.4 Expedited data

Insert the following sub-clause title before the first sentence:

12.2.3.4.1 Expedited data when operating over CONS

Add the following text as sub-clause 12.2.3.4.2:

12.2.3.4.2 Expedited data when operating over CLNS

The transport entities shall follow the expedited data transfer procedures in sub-clause 6.11 of this addendum, if the use of the transport expedited data service option has been agreed during connection establishment.

The ED TPDU shall have a TPDU-NR which is allocated from a separate sequence space from that of the DT TPDUs.

A transport entity shall allocate the sequence number zero to the ED TPDU-NR of the first ED TPDU which it transmits for a transport connection. For subsequent ED TPDUs sent on the same transport connection, the transport entity shall allocate a sequence number one greater than the previous one.

Modulo 2^7 arithmetic shall be used when normal formats have been selected and modulo 2^{31} arithmetic shall be used when extended formats have been selected.

The receiving transport entity shall transmit an EA TPDU with the same sequence number in its YR-EDTU-NR field. If this number is one greater than in the previously received in-sequence ED TPDU, the receiving transport entity shall transfer the data in the ED TPDU to the TS-user.

If a transport entity does not receive an EA TPDU in acknowledgment to an ED TPDU it shall follow the retransmission procedures (see note and 12.2.1.3).

The sender of an ED TPDU shall not send any new DT TPDUs created from the last TSDU received across the transport service boundary subsequent to the ED TPDU until it receives the EA TPDU.

NOTE – This procedure ensures that ED TPDUs are delivered to the TS-user in sequence and that the TS-user does not receive data corresponding to the same ED TPDU more than once.

13 Structure and encoding of TPDUs

13.1 Validity

13.2 Structure

13.3 Connection request (CR) TPDU

13.3.1 Structure

13.3.2 LI

13.3.3 Fixed part (octets 2 to 7)

Modify item "e) CLASS OPTION" *as, follows:*

Add "When operating over CONS," *to the beginning of the second sentence,* "This field shall take".

Add the following text before the third sentence which begins, "The CR TPDU contains the first choice":

When operating over CLNS, this field shall take the value 0100 to indicate class 4.

13.3.4 Variable part (octets 8 to p)

Add "or when operating over CLNS" *to the end of the qualification of item g),* "Alternative protocol class(es) (not used if class 0 is the preferred class)"

Section three : Conformance

14 Conformance

Add the following after 14.6.a):

b) Whether class 4 can be operated over the connectionless-mode network service;

Existing paragraphs 14.6.b) to 14.6.d) become 14.6.c) to 14.6.e), respectively.

Annex A

State tables

(This annex forms part of the standard.)

Clauses A.1 to A.5 remain unchanged.

A.6 State tables for class 4

Re-title clause A.6 as **"A.6 State tables for class 4 over CONS"**.

Re-title table 20 as "Table 20 – Predicates for class 4 over CONS".

Re-title table 21 as "Table 21 – Specific actions for class 4 over CONS".

Re-title table 22 as "Table 22 – Specific notes for class 4 over CONS".

Re-title table 23 as "Table 23 – Class 4 connection/disconnection over CONS".

Add the following text and tables as the new clause A.7:

A.7 State tables for class 4 over CLNS

This clause provides a more precise description of a class 4 transport connection when operating over CLNS.

Tables 24, 25, 26 give the predicates, actions and notes for class 4 respectively.

Table 27 is the state table for a class 4 transport connection when operating over CLNS.

The following assumption and notations are used:

a) local-ref: the reference (local) of the TC is chosen when sending the CR or when accepting a CR;
remote-ref: the reference of the remote entity is initially set to zero and initialized when processing the CC except if the CC is ignored;
SRC-REF: designates the corresponding field of the received TPDU;
DST-REF: designates the corresponding field of the received TPDU;
src-ref, dst-ref: designates the corresponding fields of the sent TPDU;
count: designates the number of times a TPDU has been sent (retransmissions);

b) the data transfer phase is not completely described in the state table but refers to the main text;

c) it is assumed that the network service is continuously available;

The operations resulting from signalled inaccessibility of the network service are a local matter.

Table 24 – Predicates for class 4 over CLNS

Name	Description
P0	T-CONNECT request is acceptable.
P3	Local choice.
P7	Count = maximum.
P8	Acceptable CR TPDU.
P9	Acceptable class 4 CC TPDU.

Table 25 – Specific actions for class 4 over CLNS

Name	Description
[0]	Set reference timer
[1]	Count = count + 1
[2]	Count = 0
[3]	Set retransmission timer
[4]	Stop retransmission timer if running
[5]	Set window timer
[6]	Stop window timer if running
[7]	Set inactivity timer
[8]	Stop inactivity timer if running
[9]	Set initial credit for sending according to the received CR/CC TPDU
[10]	Set initial credit for controlling reception according to the sent CR/CC TPDU
[15]	Send the DR TPDU. This DR TPDU is sent with src-ref = local-ref and dst-ref = remote-ref (may be zero)
[16]	Send the DR TPDU. The DR TPDU is sent with src-ref = 0 and dst-ref = remote-ref
[17]	Send a TPDU according to data transfer procedure
[20]	Store request and exercise flow control to the user
[21]	Send a DR TPDU with src-ref field set to zero
[22]	Send a DC TPDU except if the SRC-REF field of the received DR TPDU is equal to zero
[23]	Send a DR TPDU with src-ref = local-ref and dst-ref = SRC-REF in CC TPDU

Table 26 – Specific notes for class 4 over CLNS

Name	Description
(5)	Not a duplicated CR TPDU. If the CR TPDU is duplicated, ignore it.
(7)	As a local choice it is also possible to apply the following [0], TDISind, REFWAIT.
(8)	Association to this Transport connection is done regardless of the SRC-REF field. If SRC-REF is not zero, a DC TPDU is set back.
(9)	At least an AK TPDU shall be sent if the transport entity is the initiator in order to ensure that the responder will complete its three-way handshake.
(10)	If association has been made, and DST-REF is zero, then the DC TPDU contains a src-ref field set to zero.
(11)	If the CLOSING state has been entered, coming from WFCC state, the remote-ref is zero. The SRC-REF field of the CC TPDU is ignored (i.e. if the DR TPDU is retransmitted, it will be with the dst-ref field set to zero).
(13)	The DR TPDU may be either repeated immediately or when T1 will run out.
(15)	Previously stored T-DATA or T-EXPEDITED-DATA requests are ready for processing according to data transfer procedures.
(16)	See data transfer procedures.

Table 27 – Class 4 connection/disconnection over CLNS (1 of 2)

STATE / EVENT	REFWAIT	CLOSED	WFCC	WBCL	OPEN	WFTRESP	AKWAIT	CLOSING
TCONreq		not P0: TDISind CLOSED: P0: [1,3,10],CR WFCC: P2: [13,12,10];						
TCONresp						[3,2,1,10] CC AKWAIT		
TDISreq			P3: WBCL: not P3: [4,3,2,1,15] CLOSING;		[6,8,4,3,2,1,15] CLOSING	[16] CLOSED	[4,3,2,1,15] CLOSING	
TDTreq TEXreq					[16] OPEN		[20] AKWAIT	
Retrans-timer			P7 and P3: [0] TDISind REFWAIT; P7 and (not P3): [3,2,1,15] TDISind CLOSING; not P7: [1,3],CR WFCC;	P7 and P3: [0] REFWAIT; P7 and (not P3): [3,2,1,15] CLOSING; not P7: [1,3],CR WBCL;	P7: [6,8,3,2,1,15] TDISind CLOSING; not P7: (16) OPEN;		P7: [3,2,1,15] TDISind CLOSING; not P7: [1,3],CC AKWAIT;	P7: [0] REFWAIT; not P7: [1,3,15] CLOSING;
Inactivity-Timer					[6,4,3,2,1,15] TDISind CLOSING (7)			
Reference-Timer	CLOSED							
CR		not P8: [21] CLOSED: P8: [1,9,3] TCONind WFTRESP (5);			[8,7] OPEN	WFTRESP	CC AKWAIT	CLOSING (13)

Table 27 – Class 4 connection/disconnection over CLNS (2 of 2)

STATE / EVENT	REFWAIT	CLOSED	WFCC	WBCL	OPEN	WFTRESP	AKWAIT	CLOSING
CC	DR REFWAIT	DR CLOSED	P9: [9,2,4,5,7,17] TCONconf (9) OPEN; not P9: [4,3,2,1,23] TDISind CLOSING;	P9: [2,4,3,1,15] CLOSING;	[17,8,7] [9] OPEN			P9: (11) CLOSING;
ER	REFWAIT	CLOSED	[0] TDISind REFWAIT	[0] REFWAIT	[6,8,4,3,2,1,15] TDISind CLOSING		[4,3,2,1,15] TDISind CLOSING	[0] REFWAIT
DR	[22] REFWAIT	[22] CLOSED	(8) [0] TDISind REFWAIT	(8) [0] REFWAIT	DC (10) [0] TDISind REFWAIT	DC (10) TDISind CLOSED	DC (10) [0] TDISind REFWAIT	[0] REFWAIT
DC	REFWAIT	CLOSED						[0] REFWAIT
EA	REFWAIT	CLOSED			[8,7] OPEN (16)			CLOSING (13)
DT/AK/ED	REFWAIT	CLOSED			[8,7] OPEN (16)		[7] OPEN (15) (16)	CLOSING (13)