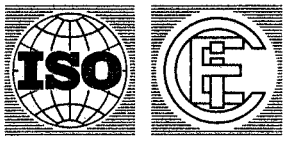
INTERNATIONAL STANDARD

ISO/IEC 8073

Second edition
1988-12-15

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

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



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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 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology.*

This second edition cancels and replaces the first edition (ISO 8073 : 1986) and includes technical revisions to the following: subclause 4.4; table 2; subclauses 6.5, 6.7, 6.9, 6.12 and 6.13; table 5; subclauses 6.14, 6.17 and 12.2; figure 4; table 7; subclauses 13.2, 13.9 and 14.6; tables 15, 17, 18 and 19; clause A.6; and tables 22 and 23.

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.

Annex A forms an integral part of this International Standard. Annex B is for information only.

Contents

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

0 Introduction

This International Standard is one of a set of International Standards produced to facilitate the interconnection of information processing systems. This set of International Standards covers the services and protocols required to achieve such interconnection.

The Transport Protocol Standard is positioned with respect to other related International Standards by the layers defined in the Reference Model for Open Systems Interconnection (ISO 7498). It is most closely related to, and lies within the field of application of the Transport Service Standard (ISO 8072). It also uses and makes reference to the Network Service Standard (ISO 8348), whose provisions it assumes in order to accomplish the transport protocol's aims. The interrelationship of these International Standards is illustrated in figure 1.

This International Standard specifies a common encoding and a number of classes of transport protocol procedures to be used with different network qualities of service.

It is intended that the Transport Protocol should be simple but general enough to cater for the total range of Network Service qualities possible, without restricting future extensions.

The protocol is structured to give rise to classes of protocol which are designed to minimize possible incompatibilities and implementation costs.

The classes are selectable with respect to the Transport and Network Services in providing the required quality of service for the interconnection of two session entities (each class provides a different set of functions for enhancement of service qualities).

This International Standard defines mechanisms that can be used to optimize network tariffs and enhance the following qualities of service :

a) different throughput;

b) different error rates;

c) integrity of data requirements;

d) reliability requirements.

It does not require an implementation to use all of these mechanisms, nor does it define methods for measuring achieved quality of service or criteria for deciding when to release transport connections following quality of service degradation.

The primary aim of this International Standard is to provide a set of rules for communication expressed in terms of the procedures to be carried out by peer entities at the time of communication. These rules for communication are intended to provide a sound basis for development in order to serve a variety of purposes i.e. :

a) as a guide for implementors and designers;

b) for use in the testing and procurement of equipment;

c) as part of an agreement for the admittance of systems into the open systems environment;

d) as a refinement of the understanding of OSI.

As it is expected that the initial users of this International Standard will be designers and implementors of equipment this International Standard contains, in notes or in annexes, guidance on the implementation of the procedures defined herein.

It should be noted that, as the number of valid protocol sequences is very large, it is not possible with current technology to verify that an implementation will operate the

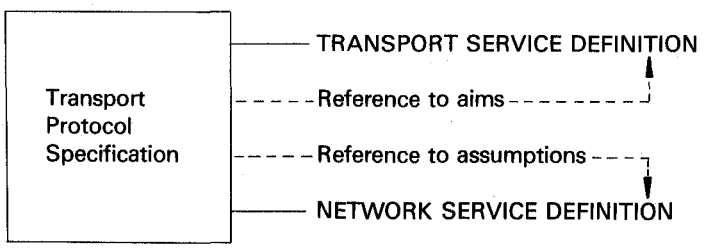


Figure 1 — Relationship between the Transport Protocol and adjacent services

protocol defined in this International Standard correctly under all circumstances. It is possible by means of testing to establish confidence that an implementation correctly operates the protocol in a representative sample of circumstances. It is, however, intended that this International Standard can be used in circumstances where two implementations fail to communicate in order to determine whether one or both have failed to operate the protocol correctly.

This International Standard contains a section on conformance of equipment claiming to implement the procedures in this International Standard. Attention is drawn to the fact that this International Standard does not contain any tests to demonstrate this conformance.

The variations and options available within this International Standard are essential as they enable a transport service to be provided for a wide variety of applications over a variety of network qualities. Thus, a minimally conforming implementation will not be suitable for use in all possible circumstances. It is important, therefore, to qualify all references to this International Standard with statements of the options provided or required or with statements of the intended purpose of provision or use.

1 Scope and field of application

This International Standard specifies

a) five classes of procedures :

1) class 0 : simple class;

2) class 1 : basic error recovery class;

3) class 2 : multiplexing class;

4) class 3 : error recovery and multiplexing class;

5) class 4 : error detection and recovery class;

for the connection oriented transfer of data and control information from one transport entity to a peer transport entity;

b) the means of negotiating the class of procedures to be used by the transport entities;

c) the structure and encoding of the transport protocol data units used for the transfer of data and control information.

The procedures are defined in terms of

a) the interactions between peer transport entities through the exchange of transport protocol data units;

b) the interactions between a transport entity and the transport service user in the same system through the exchange of transport service primitives;

c) the interactions between a transport entity and the network service provider through the exchange of network service primitives.

These procedures are defined in the main text of this International Standard supplemented by state tables in annex A.

These procedures are applicable to instances of communication between systems which support the Transport Layer of the OSI Reference Model and which wish to interconnect in an open systems environment.

This International Standard specifies, in clause 14, conformance requirements for systems implementing these procedures. It does not contain tests which can be used to demonstrate this conformance.

2 References

ISO 7498, *Information processing systems — Open Systems Interconnection — Basic Reference Model.*

ISO 8072, *Information processing systems — Open Systems Interconnection — Transport service definition.*

ISO 8348, *Information processing systems — Data communications — Network service definition.*

Section one : General

3 Definitions

NOTE — The definitions contained in this clause make use of abbreviations defined in clause 4.

3.1 This International Standard is based on the concepts developed in ISO 7498 and makes use of the following terms defined in it :

a) concatenation and separation;

b) segmenting and reassembling;

c) multiplexing and demultiplexing;

d) splitting and recombining;

e) flow control.

3.2 For the purposes of this International Standard, the following definitions apply :

3.2.1 equipment : Hardware or software or a combination of both; it need not be physically distinct within a computer system.

3.2.2 transport service user : An abstract representation of the totality of those entities within a single system that make use of the transport service.

3.2.3 network service provider : An abstract machine that models the totality of the entities providing the network service, as viewed by a transport entity.

3.2.4 local matter : A decision made by a system concerning its behaviour in the Transport Layer that is not subject to the requirements of this protocol.

3.2.5 initiator : A transport entity that initiates a CR TPDU.

3.2.6 responder : A transport entity with whom an initiator wishes to establish a transport connection.

NOTE — Initiator and responder are defined with respect to a single transport connection. A transport entity can be both an initiator and responder simultaneously.

3.2.7 sending transport entity : A transport entity that sends a given TPDU.

3.2.8 receiving transport entity : A transport entity that receives a given TPDU.

3.2.9 preferred class : The protocol class that the initiator indicates in a CR TPDU as its first choice for use over the transport connection.

3.2.10 alternative class : A protocol class that the initiator indicates in a CR TPDU as an alternative choice for use over the transport connection.

3.2.11 proposed class : A preferred class or an alternative class.

3.2.12 selected class : The protocol class that the responder indicates in a CC TPDU that it has chosen for use over the transport connection.

3.2.13 proposed parameter : The value for a parameter that the initiator indicates in a CR TPDU that it wishes to use over the transport connection.

3.2.14 selected parameter : The value for a parameter that the responder indicates in a CC TPDU that it has chosen for use over the transport connection.

3.2.15 error indication : An N-RESET indication, or an N-DISCONNECT indication with a reason code indicating an error, that a transport entity receives from the NS-provider.

3.2.16 invalid TPDU : A TPDU that does not comply with the requirements of this International Standard for structure and encoding.

3.2.17 protocol error : A TPDU whose use does not comply with the procedures for the class.

3.2.18 sequence number :

a) the number in the TPDU-NR field of a DT TPDU that indicates the order in which the DT TPDU was transmitted by a transport entity;

b) the number in the YR-TU-NR field of an AK or RJ TPDU that indicates the sequence number of the next DT TPDU expected to be received by a transport entity.

3.2.19 transmit window : The set of consecutive sequence numbers which a transport entity has been authorised by its peer entity to send at a given time on a given transport connection.

3.2.20 lower window edge : The lowest sequence number in a transmit window.

3.2.21 upper window edge : The sequence number which is one greater than the highest sequence number in the transmit window.

3.2.22 upper window edge allocated to the peer entity : The value that a transport entity communicates to its peer entity to be interpreted as its new upper window edge.

3.2.23 closed window : A transmit window that contains no sequence number.

3.2.24 window information : Information contained in a TPDU relating to the upper and the lower window edges.

3.2.25 frozen reference : A reference that is not available for assignment to a connection because of the requirements of 6.18.

3.2.26 unassigned reference : A reference that is neither currently in use for identifying a transport connection nor which is in a frozen state.

3.2.27 transparent (data) : TS-user data that is transferred intact between transport entities and which is unavailable for use by the transport entities.

3.2.28 owner (of a network connection) : The transport entity that issued the N-CONNECT request leading to the creation of that network connection.

3.2.29 retained TPDU : A TPDU that is subject to the retransmission procedure or retention until acknowledgement procedure and is available for possible retransmission.

4 Symbols and abbreviations

4.1 Data units

TPDU	Transport-protocol-data-unit
TSDU	Transport-service-data-unit
NSDU	Network-service-data-unit

4.2 Types of Transport Protocol data units

CR TPDU	Connection request TPDU
CC TPDU	Connection confirm TPDU
DR TPDU	Disconnect request TPDU
DC TPDU	Disconnect confirm TPDU
DT TPDU	Data TPDU
ED TPDU	Expedited data TPDU
AK TPDU	Data acknowledge TPDU
EA TPDU	Expedited acknowledge TPDU
RJ TPDU	Reject TPDU
ER TPDU	Error TPDU

4.3 TPDU fields

LI	Length indicator (field)
CDT	Credit (field)
TSAP-ID	Transport-service-access-point identifier (field)
DST-REF	Destination reference (field)
SRC-REF	Source reference (field)
EOT	End of TSDU mark
TPDU-NR	DT TPDU number (field)
ED-TPDU-NR	ED TPDU number (field)
YR-TU-NR	Sequence number response (field)
YR-EDTU-NR	ED TPDU number response (field)

4.4 Times and associated variables

T1	Local retransmission time
N	The maximum number of transmissions
L	Time bound on reference and sequence number
I	Inactivity time
W	Window time
TTR	Time to try reassignment/resynchronization
TWR	Time to wait for reassignment/resynchronization
TS1	Supervisory timer 1
TS2	Supervisory timer 2
M_{LR}	NSDU lifetime local-to-remote
M_{RL}	NSDU lifetime remote-to-local
E_{LR}	Expected maximum transit delay local-to-remote
E_{RL}	Expected maximum transit delay remote-to-local
R	Persistence time
AL	Local acknowledgement time
AR	Remote acknowledgement time

4.5 Miscellaneous

TS-user	Transport-service user
TSAP	Transport-service-access-point
NS-provider	Network service provider
AP	Network-service-access-point
QOS	Quality of service

5 Overview of the Transport Protocol

NOTE — This overview is not exhaustive and has been provided for guidance.

5.1 Service provided by the Transport Layer

The protocol specified in this International Standard supports the Transport Service defined in ISO 8072.

Information is transferred to and from the TS-user in the transport service primitives listed in table 1.

5.2 Service assumed from the Network Layer

The protocol specified in this International Standard assumes the use of the Network Service defined in ISO 8348.

Information is transferred to and from the NS-provider in the network service primitives listed in table 2.

NOTES

1 The parameters listed in table 2 are those in the current network service (see ISO 8348).

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

5.3 Functions of the Transport Layer

5.3.1 Overview of functions

The functions in the Transport Layer are those necessary to bridge the gap between the services available from the Network Layer and those to be offered to the TS-users.

Table 1 — Transport service primitives

Primitives		Parameters
T-CONNECT	request indication	Called Address Calling Address Expedited data option Quality of service TS-user-data
T-CONNECT	response confirm	Responding address Quality of service Expedited data option TS-user-data
T-DATA	request indication	TS-user-data
T-EXPEDITED DATA	request indication	TS-user-data
T-DISCONNECT	request	TS-user-data
T-DISCONNECT	indication	Disconnect reason TS-user-data

Table 2 — Network service primitives

Primitives		X/Y	Parameters	X/Y/Z
N-CONNECT	request	X	Called Address	X
			Calling Address	X
	indication	X	Receipt confirmation selection	Y
			Expedited data selection	Y
			QOS parameter set	X
			NS-user-data	Z
N-CONNECT	response	X	Responding Address	X
	confirmation	X	Receipt confirmation selection	Y
			Expedited data selection	Y
			QOS parameter set	X
			N-user-data	Z
N-DATA	request	X	N-user-data	X
	indication	X	Confirmation request	Y
N-DATA ACKNOWLEDGE	request	Y		
	indication	Y		
N-EXPEDITED DATA	request	Y	NS-user-data	Y
	indication	Y		
N-RESET	request	X	Reason	Z
	indication	X	Originator	Z
			Reason	Z
N-RESET	response	X	—	
	confirm	X	—	
N-DISCONNECT	request	X	Reason	Z
			NS-user-data	Z
			Responding address	Z
	indication	X	Originator	Z
			Reason	Z
			NS-user-data	Z
			Responding address	Z

Key :

X : The Transport Protocol assumes that this facility is provided in all networks.

Y : The Transport Protocol assumes that this facility is provided in some networks and a mechanism is provided to optionally use the facility.

Z : The Transport Protocol does not use this parameter and will ignore it when received in the network service primitive.

The functions in the Transport Layer are concerned with the enhancement of quality of service, including aspects of cost optimization.

These functions are grouped below into those used at all times during a transport connection and those concerned with connection establishment, data transfer and release.

NOTE — This International Standard does not include the following functions which are under consideration for inclusion in future editions of this International Standard :

a) encryption;

b) accounting mechanisms;

c) status exchanges and monitoring of QOS;

d) blocking;

e) temporary release of network connections;

f) alternative checksum algorithm.

5.3.1.1 Functions used at all times

The following functions, depending upon the selected class and options, are used at all times during a transport connection :

a) transmission of TPDUs (see 6.2 and 6.9);

b) multiplexing and demultiplexing (see 6.15) : a function used to share a single network connection between two or more transport connections;

c) error detection (see 6.10, 6.13 and 6.17) : a function used to detect the loss, corruption, duplication, misordering or misdelivery of TPDUs;

d) error recovery (see 6.12, 6.14, 6.18, 6.19, 6.20, 6.21 and 6.22) : a function used to recover from detected and signalled errors.

5.3.1.2 Connection Establishment

The purpose of connection establishment is to establish a transport connection between two TS-users. The following functions of the transport layer during this phase match the TS-users' requested quality of service with the services offered by the network layer :

a) select the network service which best matches the requirement of the TS-user taking into account charges for various services (see 6.5);

b) decide whether to multiplex multiple transport connections onto a single network connection (see 6.5);

c) establish the optimum TPDU size (see 6.5);

d) select the functions that will be operational upon entering the data transfer phase (see 6.5);

e) map transport addresses onto network addresses;

f) provide a means to distinguish between two different transport connections (see 6.5);

g) transport of TS-user data (see 6.5).

5.3.1.3 Data transfer

The purpose of data transfer is to permit duplex transmission of TSDUs between the two TS-users connected by the transport connection. This purpose is achieved by means of two-way simultaneous communication and by the following functions, some of which are used or not used in accordance with the result of the selection performed in connection establishment :

a) concatenation and separation (see 6.4) : a function used to collect several TPDUs into a single NSDU at the sending transport entity and to separate the TPDUs at the receiving transport entity;

b) segmenting and reassembling (see 6.3) : a function used to segment a single data TSDU into multiple TPDUs at the sending transport entity and to reassemble them into their original format at the receiving transport entity;

c) splitting and recombining (see 6.23) : a function allowing the simultaneous use of two or more network connections to support the same transport connection;

d) flow control (see 6.16) : a function used to regulate the flow of TPDUs between two transport entities on one transport connection;

e) transport connection identification : a means to uniquely identify a transport connection between the pair of transport entities supporting the connection during the lifetime of the transport connection;

f) expedited data (see 6.11) : a function used to bypass the flow control of normal data TPDU. Expedited data TPDU flow is controlled by separate flow control;

g) TSDU delimiting (see 6.3) : a function used to determine the beginning and ending of a TSDU.

5.3.1.4 Release

The purpose of release (see 6.7 and 6.8) is to provide disconnection of the transport connection, regardless of the current activity.

5.4 Classes and options

5.4.1 General

The functions of the Transport Layer have been organized into classes and options.

A class defines a set of functions. Options define those functions within a class which may or may not be used.

This International Standard defines five classes of protocol :

a) class 0 : simple class;

b) class 1 : basic error recovery class;

c) class 2 : multiplexing class;

d) class 3 : error recovery and multiplexing class;

e) class 4 : error detection and recovery class.

NOTES

1 Transport connections of classes 2,3 and 4 may be multiplexed together onto the same network connection.

2 Classes 0 to 3 do not specify mechanisms to detect unsignalled network transmission failures.

5.4.2 Negotiation

The use of classes and options is negotiated during connection establishment. The choice made by the transport entities will depend upon

a) the TS-users' requirements expressed via T-CONNECT service primitives;

b) the quality of the available network services;

c) the user required service versus cost ratio acceptable to the TS-user.

5.4.3 Choice of network connection

The following list classifies network services in terms of quality with respect to error behaviour in relation to user requirements; its main purpose is to provide a basis for the decision regarding which class of transport protocol should be used in conjunction with given network connection :

a) Type A : Network connection with acceptable residual error rate (for example not signalled by disconnect or reset) and acceptable rate of signalled errors.

b) Type B : Network connections with acceptable residual error rate (for example not signalled by disconnect or reset) but unacceptable rate of signalled errors.

c) Type C : Network connections with unacceptable residual error rate.

It is assumed that each transport entity is aware of the quality of service provided by particular network connections.

5.4.4 Characteristics of class 0

Class 0 provides the simplest type of transport connection and is fully compatible with the CCITT Recommendation T.70 for teletex terminals.

Class 0 has been designed to be used with type A network connections.

5.4.5 Characteristics of class 1

Class 1 provides a basic transport connection with minimal overheads.

The main purpose of the class is to recover from network disconnect or reset.

Selection of this class is usually based on reliability criteria. Class 1 has been designed to be used with type B network connections.

5.4.6 Characteristics of class 2

5.4.6.1 General

Class 2 provides a way to multiplex several transport connections onto a single network connection. This class has been designed to be used with type A network connections.

5.4.6.2 Use of explicit flow control

The objective is to provide flow control to help avoid congestion at transport-connection-end-points and on the network connection. Typical use is when traffic is heavy and continuous, or when there is intensive multiplexing. Use of flow control can optimize response times and resource utilization.

5.4.6.3 Non-use of explicit flow control

The objective is to provide a basic transport connection with minimal overheads suitable when explicit disconnection of the transport connection is desirable. The option would typically be used for unsophisticated terminals, and when no multiplexing onto network connections is required. Expedited data is never available.

5.4.7 Characteristics of class 3

Class 3 provides the characteristics of class 2 plus the ability to recover from network disconnect or reset. Selection of this class is usually based upon reliability criteria. Class 3 has been designed to be used with type B network connections.

5.4.8 Characteristics of class 4

Class 4 provides the characteristics of class 3, plus the capability to detect and recover from errors which occur as a result of the low grade of service available from the NS-provider. 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.

This class also provides for increased throughput capability and additional resilience against network failure.

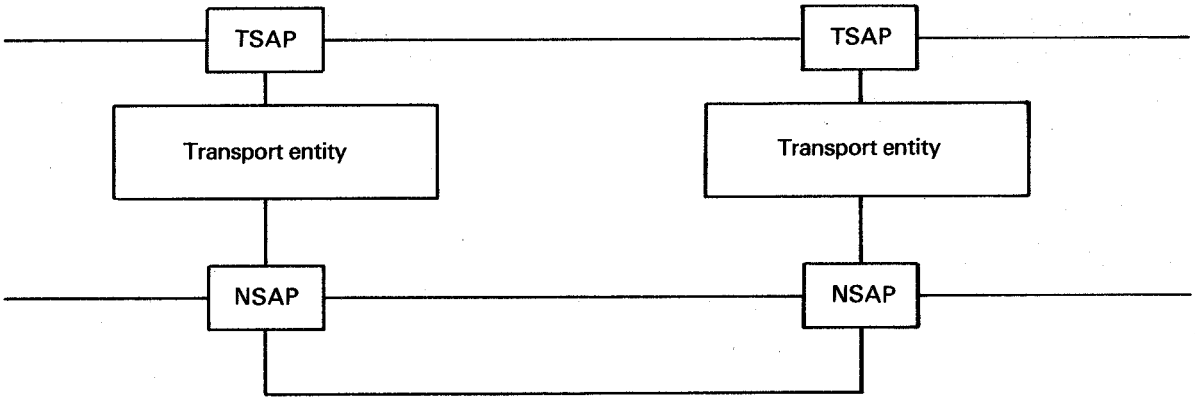
Class 4 has been designed to be used with type C network connections.

5.5 Model of the transport layer

A transport entity communicates with its TS-users through one or more TSAPs by means of the service primitives as defined by the transport service definition (see ISO 8072). Service primitives will cause or be the result of transport protocol data

unit exchanges between the peer transport entities supporting a transport connection. These protocol exchanges are effected using the services of the Network Layer as defined by the network service definition (see ISO 8348) through one or more NSAPs.

Transport connection endpoints are identified in end systems by an internal, implementation dependent, mechanism so that the TS-user and the transport entity can refer to each transport connection.



NOTE — For the purposes of illustration, figure 2 shows only one TSAP and one NSAP for each transport entity. In certain instances, more than one TSAP and/or more than one NSAP may be associated with a particular transport entity.

Figure 2 — Model of the transport layer

Section two : Transport protocol specification

6 Elements of procedure

This clause contains elements of procedure which are used in the specification of protocol classes in clauses 7 to 12. These elements are not meaningful on their own.

The procedures define the transfer of TPDUs whose structure and coding is specified in clause 13. Transport entities shall accept and respond to any TPDU received in a valid NSDU and may issue TPDUs initiating specific elements of procedure specified in this clause.

NOTE — Where network service primitives, TPDUs and parameters used are not significant for a particular element of procedure, they have not been included in the specification.

6.1 Assignment to network connection

6.1.1 Purpose

The procedure is used in all classes to assign transport connections to network connections.

6.1.2 Network service primitives

The procedure uses the following network service primitives :

a) N-CONNECT;

b) N-DISCONNECT.

6.1.3 Procedure

Each transport connection shall be assigned to a network connection. The initiator may assign the transport connection to an existing network connection of which it is the owner or to a new network connection (see note 1) which it creates for this purpose.

The initiator shall not assign or reassign the transport connection to an existing network connection if the protocol class(es) proposed or the class in use for the transport connection are incompatible with the current usage of the network connection with respect to multiplexing (see note 2).

During the resynchronization (see 6.14) and reassignment after failure (see 6.12) procedures, a transport entity may reassign a transport connection to another network connection joining the same NSAPs, provided that it is the owner of the network connection and that the transport connection is assigned to only one network connection at any given time.

During the splitting procedure (see 6.23), a transport entity may assign a transport connection to any additional network connection joining the same NSAPs, provided that it is the owner of the network connection and that multiplexing is possible on the network connection.

The non-owner (of the network connection) becomes aware of the assignment when it receives

a) a CR TPDU during the connection establishment procedure (see 6.5); or

b) an RJ TPDU or a retransmitted CR or DR TPDU during the resynchronisation (see 6.14) and reassignment after failure (see 6.12) procedures; or

c) any TPDU when splitting (see 6.23) is used.

NOTES

1 When a new network connection is created, the quality of service requested is a local matter, although it will normally be related to the requirements of transport connection(s) expected to be assigned to it.

2 An existing network connection may also not be suitable if, for example, the quality of service requested for the transport connection cannot be attained by using or enhancing the network connection.

3 A network connection with no transport connection(s) assigned to it, may be available after initial establishment, or because all of the transport connections previously assigned to it have been released. It is recommended that only the owner of such a network connection should release it. Furthermore, it is recommended that it not be released immediately after the transmission of the final TPDU of a transport connection; either a DR TPDU in response to CR TPDU or a DC TPDU in response to DR TPDU. An appropriate delay will allow the TPDU concerned to reach the other transport entity allowing the freeing of any resources associated with the transport connection concerned.

4 After the failure of a network connection, transport connections which were previously multiplexed together may be assigned to different network connections, and vice versa.

6.2 Transport protocol data unit (TPDU) transfer

6.2.1 Purpose

The TPDU transfer procedure is used in all classes to convey transport protocol data units in user data fields of network service primitives.

6.2.2 Network service primitives

The procedure uses the following network service primitives :

a) N-DATA;

b) N-EXPEDITED DATA.

6.2.3 Procedure

The transport protocol data units (TPDUs) defined for the protocol are listed in 4.2.

When the network expedited variant has been selected for class 1, the transport entities shall transmit and receive ED and EA TPDUs as NS-user data parameters of N-EXPEDITED DATA primitives.

In all other cases, transport entities shall transmit and receive TPDUs as NS-user data parameters of N-DATA primitives.

When a TPDU is put into an NS-user data parameter, the significance of the bits within an octet and the order of octets within a TPDU shall be as defined in 13.2.

NOTE — TPDUs may be concatenated (see 6.4).

6.3 Segmenting and reassembling

6.3.1 Purpose

The segmenting and reassembling procedure is used in all classes to map TSDUs onto TPDUs.

6.3.2 TPDUs and parameter used

The procedure makes use of the following TPDU and parameter :

DT TPDUs

— End of TSDU.

6.3.3 Procedure

A transport entity shall map a TSDU on to an ordered sequence of one or more DT TPDUs. This sequence shall not be interrupted by other DT TPDUs on the same transport connection.

All DT TPDUs except the last DT TPDU in a sequence greater than one shall have a length of data greater than zero.

NOTES

1 The EOT parameter of a DT TPDU indicates whether or not there are subsequent DT TPDUs in the sequence.

2 There is no requirement that the DT TPDUs shall be of the maximum length selected during connection establishment.

6.4 Concatenation and separation

6.4.1 Purpose

The procedure for concatenation and separation is used in classes 1, 2, 3 and 4 to convey multiple TPDUs in one NSDU.

6.4.2 Procedure

A transport entity may concatenate TPDUs from the same or different transport connections, while maintaining the order of TPDUs for a given transport connection compatible with the protocol operation.

A valid set of concatenated TPDUs may contain

a) any number of TPDUs from the following list : AK, EA, RJ, ER, DC TPDUs, provided that these TPDUs come from different transport connections;

b) no more than one TPDU from the following list : CR, DR, CC, DT, ED TPDUs; if this TPDU is present, it shall be placed last in the set of concatenated TPDUs.

A transport entity shall accept a valid set of concatenated TPDUs.

NOTES

1 The TPDUs within a concatenated set may be distinguished by means of the length indicator parameter.

2 The end of a TPDU containing data is indicated by the termination of the NSDU.

3 The number of concatenated TPDUs referred to in 6.4.2.a) is bounded by the maximum number of transport connections which are multiplexed together except during assignment or reassignment.

6.5 Connection establishment

6.5.1 Purpose

The procedure for connection establishment is used in all classes to create a new transport connection.

6.5.2 Network service primitives

The procedure uses the following network service primitive :

N-DATA.

6.5.3 TPDUs and parameters used

The procedure uses the following TPDUs and parameters :

a) CR TPDU

— CDT;

— DST-REF (set to zero);

— SRC-REF;

— CLASS and OPTIONS (i.e. preferred class, use of extended format, non-use of explicit flow control in class 2);

— calling TSAP-ID;

— called TSAP-ID;

— TPDU size (proposed);

— version number;

— protection parameter;

— checksum;

— additional option selection (i.e. use of network expedited in class 1, use of receipt confirmation in class 1, non-use of checksum in class 4, use of transport expedited data transfer service);

— alternative protocol class(es);

— acknowledge time;

— throughput (proposed);

— residual error rate (proposed);

— priority (proposed);

— transit delay (proposed);

— reassignment time;

— user data;

b) CC TPDU

- CDT;
- DST-REF;
- SRC-REF;
- CLASS and OPTIONS (selected);
- calling TSAP-ID;
- called TSAP-ID;
- TPDU size (selected);
- protection parameter;
- checksum;
- additional option selection (selected);
- acknowledge time;
- throughput (selected);
- residual error rate (selected);
- priority (selected);
- transit delay (selected);
- user data.

6.5.4 Procedure

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.

Before sending the CR TPDU, the initiator assigns the transport connection being created to one (or more if the splitting procedure is being used) network connection(s). It is this set of network connections over which the TPDUs are sent.

NOTE — Even if the initiator assigns the transport connection to more than one network connection, all the CR TPDUs (if repeated) or DR TPDU(s) with DST-REF set to zero which are sent prior to the receipt of the CC TPDU shall be sent on the same network connection, unless an N-DISCONNECT indication is received. (This is necessary because the remote entity may not support class 4 and therefore may not recognize splitting.) If the initiator has made other assignments, it will use them only after receipt of a class 4 CC TPDU (see also the splitting procedure 6.23).

During this exchange, all information and parameters needed for the transport entities to operate shall be exchanged or negotiated.

NOTE — Except in class 4, it is recommended that the initiator starts an optional timer TS1 at the time the CR TPDU is sent. This timer should be stopped when the connection is considered as accepted or refused or unsuccessful. If the timer expires, the initiator should reset or disconnect the network connection and, in classes 1 and 3, freeze the reference (see 6.18). For all other transport connection(s) multiplexed on the same network connection the procedures for reset or disconnect as appropriate should be followed.

When an unexpected duplicated CR TPDU is received (with class 4 as preferred class) it shall be ignored in classes 0, 1, 2 and 3 and a CC TPDU shall be returned in class 4.

After receiving the CC TPDU for a class which includes the procedure for retention until acknowledgement of TPDUs the initiator shall acknowledge the CC TPDU as defined in table 5 (see 6.13)

When the network expedited variant of the expedited data transfer (see 6.11) has been agreed (possible in class 1 only), the responder shall not send an ED TPDU before the CC TPDU is acknowledged.

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),

2) it shall not be zero.

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

b) calling and called TSAP-IDs (optional) : when either network address unambiguously defines the transport address this information may be omitted.

c) initial credit : Only relevant for classes which include the explicit flow control function.

d) user data : Not available if class 0 is the preferred class (see the note). Up to 32 octets in other classes.

NOTE — If class 0 is a valid response according to table 3, inclusion of user data in the CR TPDU may cause the responding entity to refuse the connection (for example if it only supports class 0).

e) acknowledgement time : Only in class 4.

f) checksum parameter : Only in class 4.

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

The following negotiations take place :

h) protocol class : The initiator shall propose a preferred class and may propose any number of alternative classes which permit a valid response as defined in table 3. The initiator should assume when it sends the CR TPDU that its preferred class will be agreed to, and commence the procedures associated with that class, except that if class 0 or class 1 is an alternative class, multiplexing shall not commence until a CC TPDU selecting the use of classes 2, 3 or 4 has been received.

NOTE — This means, for example, that when the preferred class includes resynchronization (see 6.14) the resynchronization will occur if a reset is signalled during connection establishment.

The responder shall select one class defined in table 3 as a valid response corresponding to the preferred class and to the class(es), if any, contained in the alternative class parameter of the CR TPDU. It shall indicate the selected class in the CC TPDU and shall follow the procedures for the selected class.