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SERIES X: DATA NETWORKS AND OPEN SYSTEM COMMUNICATION

OSI networking and system aspects – Efficiency

Information technology – Open Systems Interconnection – Transport Fast Byte Protocol

ITU-T Recommendation X.634

(Previously "CCITT Recommendation")

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FOREWORD

ITU (International Telecommunication Union) is the United Nations Specialized Agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the ITU. Some 179 member countries, 84 telecom operating entities, 145 scientific and industrial organizations and 38 international organizations participate in ITU-T which is the body which sets world telecommunications standards (Recommendations).

The approval of Recommendations by the Members of ITU-T is covered by the procedure laid down in WTSC Resolution No. 1 (Helsinki, 1993). In addition, the World Telecommunication Standardization Conference (WTSC), which meets every four years, approves Recommendations submitted to it and establishes the study programme for the following period.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC. The text of ITU-T Recommendation X.634 was approved on 5th of October 1996. The identical text is also published as ISO/IEC International Standard 14699.

NOTE

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

CONTENTS

Summary

The Transport Fast Byte Protocol eliminates the round trip delay associated with the establishment and release of a transport connection, and requires very low PCI overhead. The Transport Fast Byte Protocol is intended for use in situations in which enhancements to the network QOS are not required, and efficiency of operation (e.g. reduction of round trip delays on establishment and release) is of primary concern.

Introduction

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

The Transport Fast Byte Protocol Recommendation | International Standard is positioned with respect to other related Recommendations | International Standards by the layers defined in the Reference Model for Open Systems Interconnection (see ITU-T Rec. X.200 | ISO/IEC 7498-1). It is most closely related to, and lies within the field of application of, the Transport Service definition (see ITU-T Rec. X.214 | ISO/IEC 8072). It also uses and makes reference to the Network Service definition (see ITU-T Rec. X.213 | ISO/IEC 8348), whose provisions it assumes in order to accomplish Transport Fast Byte's aims. The interrelationship of these Recommendations | International Standards is illustrated in Figure Intro. 1.

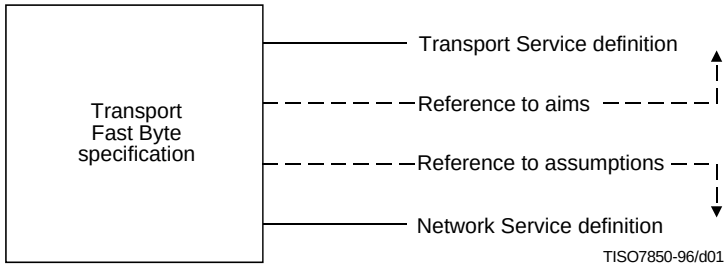

Figure Intro. 1 – Relationship between the Transport Fast Byte Protocol and adjacent services

This Recommendation | International Standard specifies a common encoding and protocol procedures. It is intended that the Transport Fast Byte Protocol should be simple and cater for a specific range of Network Service qualities possible.

The protocol is structured to give rise to two modes of operation which are designed to minimize possible incompatibilities and implementation costs. The modes are selectable with respect to the Transport and Network services in providing the required Quality of Service for the interconnection of two session entities (one mode ignores network signalled errors, the other mode does not). This Recommendation | International Standard does not define mechanisms that can be used to optimize network tariffs or enhance the quality of Network Service.

The primary aim of this Recommendation | 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:

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 Recommendation | International Standard will be designers and implementors of equipment, this Recommendation | International Standard contains, in notes or in annexes, guidance on the implementation of the procedures defined herein.

This Recommendation | International Standard contains a clause on conformance of equipment claiming to implement the procedures in this Recommendation | International Standard (see clause 8). To evaluate conformance of a particular implementation, it is necessary to have a statement of which capabilities and options have been implemented for a given OSI protocol. Such a statement is called a Protocol Implementation Conformance Statement (PICS). A PICS proforma is provided in Annex A. Attention is drawn to the fact that this Recommendation | International Standard does not contain any tests to demonstrate this conformance.

It should be noted that it may not be possible with current technology to verify that an implementation will operate the protocol defined in this Recommendation | 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 Recommendation | 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.

INTERNATIONAL STANDARD

ITU-T RECOMMENDATION

INFORMATION TECHNOLOGY – OPEN SYSTEMS INTERCONNECTION – TRANSPORT FAST BYTE PROTOCOL

1 Scope

This Recommendation | International Standard specifies:

a) Two modes of procedures when operating over the connection oriented network service:

   1) mode 0: acts on network signalled errors;

   2) mode 4: ignores network signalled errors,

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

b) The means of selecting the mode of procedures to be used by the transport entities.

c) The structure and encoding of the TPDUs 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 TPDUs;

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 applicable to instances of communication between systems which support the Transport Layer of the OSI Reference Model and wish to interconnect in the open systems environment using the Transport Fast Byte Protocol.

This Recommendation | International Standard specifies, in clause 8, conformance requirements for systems implementing these procedures and provides the PICS proforma in compliance with the relevant requirements, and in accordance with the relevant guidance, given in ITU-T Rec. X.296 and ISO/IEC 9646-7. It does not contain tests which can be used to demonstrate this conformance.

2 Normative references

The following Recommendations and International Standards contain provisions which, through reference in this text, constitute provisions of this Recommendation | International Standard. At the time of publication, the editions indicated were valid. All Recommendations and International Standards are subject to revision, and parties to agreements based on this Recommendation | International Standard are encouraged to investigate the possibility of applying the most recent edition of the Recommendations and International Standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards. The Telecommunication Standardization Bureau of the ITU maintains a list of currently valid ITU-T Recommendations.

2.1 Identical Recommendations | International Standards

– ITU-T Recommendation X.200 (1994) | ISO/IEC 7498-1:1994, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model.*

– ITU-T Recommendation X.210 (1993) | ISO/IEC 10731:1994, *Information technology – Open Systems Interconnection – Basic Reference Model: Conventions for the definition of OSI services.*

– ITU-T Recommendation X.213 (1995) | ISO/IEC 8348:1996, *Information technology – Open Systems Interconnection – Network service definition.*

- ITU-T Recommendation X.214 (1995) | ISO/IEC 8072:1996, *Information technology – Open Systems Interconnection – Transport service definition.*
- ITU-T Recommendation X.224 (1995) | ISO/IEC 8073:1997, *Information technology – Open Systems Interconnection – Protocol for providing the OSI connection-mode transport service.*
- ITU-T Recommendation X.263 (1995) | ISO/IEC TR 9577…[1)], *Information technology – Protocol identification in the Network layer.*

2.2 Paired Recommendations | International Standards equivalent in technical contents

- ITU-T Recommendation X.290 (1995), *OSI conformance testing methodology and framework for protocol Recommendations for ITU-T applications – General Concepts.*

  ISO/IEC 9646-1:1994, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 1: General concepts.*
- ITU-T Recommendation X.296 (1995), *OSI conformance testing methodology and framework for protocol Recommendations for ITU-T applications – Implementation conformance statements.*

  ISO/IEC 9646-7:1995, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 7: Implementation Conformance Statements.*

3 Definitions

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

3.1 This Recommendation | International Standard is based on the concepts developed in ITU-T Rec. X.200 | ISO/IEC 7498-1 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;

f) nil selector value;

g) connection-mode network service;

h) connection-mode transport service.

3.2 For the purposes of this Recommendation | 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 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.

3.2.3 initiator: A transport entity that acts on a T-CONNECT request from the TS-user.

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

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

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

3.2.7 error indication: An N-RESET indication that a transport entity receives from the NS-provider.

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

3.2.9 protocol error: A TPDU whose use does not comply with the procedures for the mode.

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1) To be published.

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

3.2.11 owner (of a network connection): The transport entity that issued the N-CONNECT request leading to the creation of that network connection. Only applicable when operating over the connection-oriented network service.

3.2.12 calling: A classification associated with the initiator (e.g. a calling T-SEL is the T-SEL of the initiator; a data transfer direction of calling-to-called is the direction of transfer which originates at the initiator and terminates at the responder).

3.2.13 called: A classification associated with the responder (e.g. a called T-SEL is the T-SEL of the responder; a data transfer direction of called-to-calling is the direction of transfer which originates at the responder and terminates at the initiator).

3.3 This Recommendation | International Standard uses the following terms defined in ITU-T Rec. X.290 and ISO/IEC 9646-1:

a) PICS proforma;

b) Protocol Implementation Conformance Statement (PICS).

3.4 This Recommendation | International Standard uses the following terms defined in ITU-T Rec. X.210 | ISO/IEC 10731:

a) transport service user;

b) network service provider.

4 Symbols and abbreviations

For the purposes of this Recommendation | International Standard, the following abbreviations apply:

4.1 Data units

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

4.2 TPDU types

FB-TPDU	Fast Byte TPDU

4.3 TPDU fields

EOT	End of TSDU
Null-PCI	Null PCI data transfer parameter
TPCI	Transport Layer Protocol Control Information

4.4 Miscellaneous

TS-user	Transport-service user
TS-provider	Transport-service provider
TSAP	Transport-service-access-point
T-SEL	Transport Selector
NS-provider	Network service provider
NSAP	Network-service-access-point
QOS	Quality of Service
CONS	Connection-mode Network Service

5 Overview of the Transport Fast Byte Protocol

The Transport Fast Byte Protocol eliminates the round trip delay associated with the establishment and release of a transport connection, and requires very low PCI overhead. The Transport Fast Byte Protocol is intended for use in situations in which enhancements to the network QOS are not required, and efficiency of operation (e.g. reduction of round trip delays on establishment and release) is of primary concern. The protocol ensures an interoperable method for accomplishing this, by standardizing a “mapping” between the transport and network services.

Unlike traditional protocols, the Fast Byte protocol does not define different PDU types (e.g. connect, release, reset, etc.). The Fast Byte protocol defines a single PDU, and the semantics of this PDU are dependent on the service primitive in which the PDU is received.

5.1 Service provided by the Transport Layer

The Transport Fast Byte Protocol supports the OSI connection-mode transport service defined in ITU-T Rec. X.214 | ISO/IEC 8072 with the following restrictions:

1) the length of TSAP IDs are fixed at 2 octets;

2) no enhancement of the network service QOS is provided, so that the transport service QOS approximates to the corresponding network service QOS.

This protocol is intended to complement, as opposed to replace, the existing protocol which supports the connection-mode transport service (see ITU-T Rec. X.224 | ISO/IEC 8073).

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

Table 1 – Transport service primitives

Primitives		Parameters	Notes
T-CONNECT	request indication	Called address Calling address Expedited data option Quality of Service TS-user data	1 1 2 3
T-CONNECT	response confirm	Responding address Expedited data option Quality of Service TS-user-data	1 2 3
T-DATA	request indication	TS-user-data	
T-EXPEDITED DATA	request indication	TS-user-data	
T-DISCONNECT	request	TS-user-data	3
T-DISCONNECT	indication	Disconnect reason TS-user-data	 3

NOTES

1 The length of a T-SEL is fixed at 2-octets, and a value of NIL is assigned a default encoding.

2 QOS parameter values, and QOS negotiation capabilities, are limited by those available from the underlying network service provider. The Fast Byte protocol does not support enhancement of the QOS offered by the underlying service. Where the underlying service supports a range of QOS-parameter values, the Fast Byte protocol may use the corresponding negotiation facilities of the underlying service. A similar level of QOS service may be requested from the network service or, in the presence of local knowledge, a lower level may be requested. The actual level of QOS achieved may be lower than, similar to, or even higher than that requested.

3 Maximum length = maximum length of the user-data parameter of the underlying service minus the TPCI length.

5.2 Service assumed from the Network layer

The Transport Fast Byte Protocol assumes the use of the OSI connection-mode network service (CONS) defined in ITU-T Rec. X.213 | ISO/IEC 8348.

When operating over CONS, 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 network service.

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

Table 2 – Connection-Oriented Network service primitives

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

W The Transport Fast Byte Protocol assumes that this facility is provided in some networks and a mechanism is provided to optionally use this facility.

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

Y The Transport Fast Byte Protocol assumes that this facility is provided in all networks. The QOS-parameter values supported by the network limit the corresponding values provided to the TS-user, since there are no mechanisms in the Transport Fast Byte Protocol for enhancing the network-provided QOS.

Z Not used by the Transport Fast Byte Protocol.

5.3 Functions of the Transport Layer

5.3.1 Overview of functions

The functions in the Transport Layer are concerned with the enhancement of Quality of Service, including aspects of cost optimization. The Transport Fast Byte Protocol is intended for use in situations where the no enhancements are required, and the efficiency of operation is of primary concern. The Transport Fast Byte Protocol eliminates the round trip propagation delay associated with the establishment and release of a transport connection, and requires very low PCI overhead. The following functions are therefore not supported:

a) multiplexing and demultiplexing;

b) error recovery;

c) concatenation and separation;

d) splitting and recombining;

e) encryption;

f) accounting mechanisms;

g) status exchanges and monitoring of QOS;

h) blocking;

i) temporary release of network connections;

j) checksum.

5.3.2 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 mode that will be operational upon entering the data transfer phase (see 6.2);

b) map transport addresses onto network addresses;

c) transport of TS-user data (see 6.2).

5.3.3 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 functions in 6.7, 6.8, and 6.9, some of which are used or not used in accordance with the result of the selection performed in connection establishment (see 6.2).

5.3.4 Release

The purpose of release (see 6.3, 6.4, 6.5 and 6.6) is to provide disconnection of the transport connection, regardless of the current activity.

5.4 Modes of operation

5.4.1 General

This protocol specification defines two modes of protocol operation:

a) Mode 0 – Acts on network signalled errors by disconnecting the transport connection.

   Mode 0 is designed to have minimum functionality. It provides only the functions needed for connection establishment/release, and data transfer with reporting of network signalled errors.

   Mode 0 provides transport connections with flow control based on the network service provided flow control, and disconnection based on the network service disconnection.

b) Mode 4 – ignores network signalled errors.

   Mode 4 is designed to have minimum functionality. It provides only the functions needed for connection establishment/release, and data transfer.

   Mode 4 provides transport connections with flow control based on the network service provided flow control, and disconnection based on the network service disconnection.

Both Modes 0 and 4 are supported over CONS.

5.4.2 Operation over CONS

It is assumed that each transport entity is aware of the Quality of Service provided by particular network connections. The Transport Fast Byte Protocol has been designed to be used with network connections which have an acceptable residual error rate (for example, not signalled by disconnect or reset) and an acceptable rate of signalled errors.

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 ITU-T Rec. X.214 | ISO/IEC 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 ITU-T Rec. X.213 | ISO/IEC 8348) through one or more NSAPs (see Figure 1).

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.

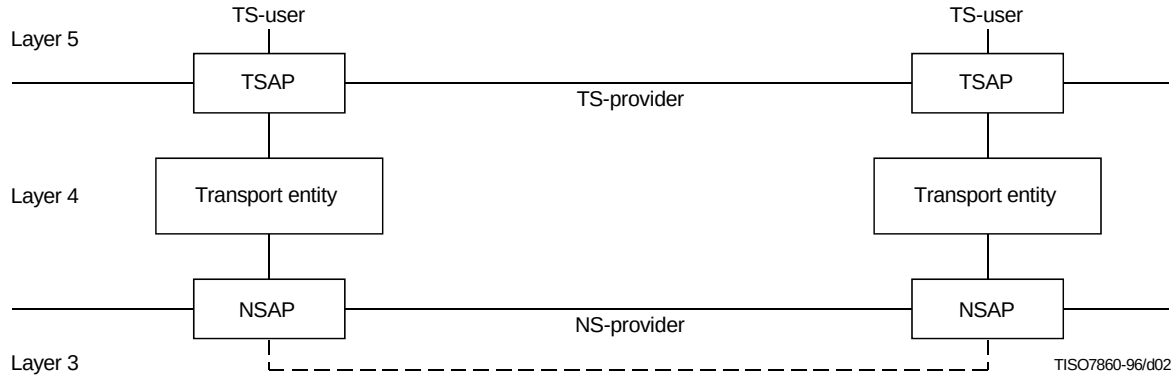


Figure 1 – Model of the transport layer

6 Transport Fast Byte Protocol specification

This clause contains elements of procedure which comprise the Transport Fast Byte Protocol specification. The transport entities shall use the following procedures:

a) Transport Protocol Data Unit (TPDU) transfer (see 6.1);

b) Connection establishment (see 6.2);

c) Connection refusal (see 6.3);

d) Normal release (see 6.4);

e) Error indication (see 6.5);

f) Abnormal release (see 6.6);

g) Data transfer (see 6.7);

h) Segmenting and reassembling (see 6.8);

i) Expedited data transfer (see 6.9);

j) Invalid TPDU (see 6.10).

The procedures define the transfer of TPDUs whose structure and coding is specified in clause 7. Transport entities shall accept and respond to a TPDU received in a valid NSDU and may issue TPDUs initiating specific elements of procedure specified in this clause.

6.1 Transport Protocol Data Unit (TPDU) transfer

6.1.1 Purpose

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

6.1.2 Network service primitives

The procedure uses the following network service primitives when operating over CONS:

a) N-DATA;

b) N-CONNECT;

c) N-DISCONNECT.

6.1.3 Procedure

The transport entities shall transmit and receive TPDUs as:

a) NS-user data parameters of N-DATA primitives;

b) NS-user data parameters of N-CONNECT primitives;

c) NS-user data parameters of N-DISCONNECT 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 clause 7.

6.2 Connection establishment

6.2.1 Purpose

The procedure for connection establishment is used by transport entities to create a transport connection.

6.2.2 Network service primitives

The procedure uses the N-CONNECT and N-DISCONNECT network service primitives.

6.2.3 Transport service primitives

The procedure uses the T-CONNECT and T-DISCONNECT transport service primitives.

6.2.4 TPDUs and parameters used

The procedure uses the FB-TPDU and the TS-user data, called or responding address, calling address, called-to-calling Data TPDU size, calling-to-called Data TPDU size, Null-PCI, and mode parameters.

6.2.5 Procedure

A transport connection is established by means of one transport entity (the initiator) transmitting an FB-TPDU to the other transport entity (the responder), which replies with an FB-TPDU.

NOTE 1 – There is a one-to-one correspondence of a transport connection to a network connection. Connection establishment occurs simultaneously.

On receipt of a T-CONNECT request, the initiating transport entity shall transmit an FB-TPDU as the NS-user data parameter of an N-CONNECT request, in order to establish a transport connection.

On receipt of an N-CONNECT indication containing an FB-TPDU, the responding transport entity shall inform the TS-user by issuing a T-CONNECT indication.

On receipt of an N-CONNECT indication not containing an FB-TPDU, the transport entity shall issue an N-DISCONNECT request with the reason parameter set to “disconnection-abnormal condition”.

On receipt of a T-CONNECT response, the responding transport entity shall transmit an FB-TPDU as the NS-user data parameter of an N-CONNECT response, in order to accept the transport connection. If the transport connection cannot be accepted by the responding TS-user (i.e. a T-DISCONNECT request is received from the TS-user), then 6.3 applies.

On receipt of an N-CONNECT confirm containing an FB-TPDU, the initiating transport entity shall consider the transport connection accepted and inform the TS-user by issuing a T-CONNECT confirm.

On receipt of an N-CONNECT confirm not containing an FB-TPDU, the initiating transport entity shall consider the transport connection not accepted and inform the TS-user by issuing a T-DISCONNECT indication. The reason parameter shall indicate "TS provider invoked". The initiating transport entity shall issue an N-DISCONNECT request. The reason parameter shall indicate "disconnection-abnormal condition".

NOTE 2 – Annex B describes a mechanism by which systems which implement ITU-T Rec. X.224 | ISO/IEC 8073 in addition to the Transport Fast Byte Protocol may fall back to the operation of ITU-T Rec. X.224 | ISO/IEC 8073 following an unsuccessful attempt to establish a Transport Fast Byte connection (e.g. the receipt of an N-CONNECT confirm not containing an FB-TPDU in response to an N-CONNECT request containing an FB-TPDU). Neither the contents of Annex B, nor the implementation of ITU-T Rec. X.224 | ISO/IEC 8073 are requirements of this protocol specification, however.

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

The following information is exchanged:

a) Initiator: mode, Null-PCI, called and calling T-SELs, and TS-user data (if any).

b) Responder: mode (equal to the mode requested by the initiator), Null-PCI, responding T-SEL, and TS-user data (if any).

The following negotiations take place:

a) Initiator:

– Called-to-calling Data TPDU length, calling-to-called Data TPDU length – The initiator shall propose the maximum size for Data TPDUs in the called-to-calling, and calling-to-called directions. The values proposed by the initiator shall not exceed the maximum NSDU size.

NOTE 3 – Transport entities may have knowledge, by some local means, of the maximum available NSDU size.

– Expedited data support – The initiator shall select the expedited data option in the N-CONNECT request primitive to request expedited data support, otherwise, the expedited data option in the N-CONNECT request shall not be selected.

– Null PCI data transfer support – The initiator shall set the Null-PCI parameter to ONE to request null PCI during the data transfer phase; otherwise, the Null-PCI parameter shall be set to ZERO.

b) Responder:

– Called-to-calling Data TPDU length, calling-to-called Data TPDU length – The responder shall select the maximum size for Data TPDUs in the called-to-calling, and calling-to-called directions. The values selected by the responder shall be equal to or less than the values proposed by the initiator.

– Expedited data support – If the responder receives a request for expedited data support in an N-CONNECT indication, the responder shall indicate acceptance by selecting the expedited data option in the N-CONNECT response, or shall decline support by not selecting the expedited data option in the N-CONNECT response. If the responder does not receive a request for expedited data support in an N-CONNECT indication, the responder shall indicate non-support by not selecting the expedited data option in the N-CONNECT response.

– Null PCI data transfer support – If the initiator set the Null-PCI parameter to ONE, the responder shall indicate acceptance of the request for null PCI during the data transfer phase by setting the Null-PCI parameter to ONE, or shall decline support by setting the Null-PCI parameter to ZERO. If the initiator set the Null-PCI parameter to ZERO, the responder shall indicate non-support by setting the Null-PCI parameter to ZERO.

6.3 Connection refusal

6.3.1 Purpose

The connection refusal procedure is used when the TS-user or a transport entity refuses a transport connection in response to an FB-TPDU.

6.3.2 Network service primitives

The procedure uses the N-DISCONNECT network service primitive.

6.3.3 Transport service primitives

The procedure uses the T-DISCONNECT transport service primitive.

6.3.4 TPDUs and parameters used

The procedure uses the FB-TPDU and TS-user data parameter.

6.3.5 Procedure

On receipt of a T-DISCONNECT request resulting from a previously issued T-CONNECT indication or if the responding transport entity refuses the transport connection, the responding transport entity shall transmit an FB-TPDU as the NS-user data parameter of an N-DISCONNECT request. The reason parameter shall indicate “disconnection-abnormal condition”. The following information is conveyed to the initiator:

- responding T-SEL;
- TS-user data, if any.

On receipt of an N-DISCONNECT indication containing an FB-TPDU which is received as a result of a previously transmitted N-CONNECT request, the initiating transport entity shall consider the transport connection not accepted and inform the TS-user by issuing a T-DISCONNECT indication. The reason parameter shall indicate “remote TS-user invoked”.

On receipt of an N-DISCONNECT indication which does not contain an FB-TPDU and the N-DISCONNECT indication originator parameter indicates “NS user”, the initiating transport entity shall consider the transport connection not accepted and inform the TS-user by issuing a T-DISCONNECT indication. The reason parameter shall indicate “TS-provider invoked”.

NOTE – Annex B describes a mechanism by which systems which implement ITU-T Rec. X.224 | ISO/IEC 8073 in addition to the Transport Fast Byte Protocol may fall back to the operation of ITU-T Rec. X.224 | ISO/IEC 8073 following an unsuccessful attempt to establish a Transport Fast Byte connection (e.g. the receipt of an N-DISCONNECT indication not containing an FB-TPDU in response to an N-CONNECT request containing an FB-TPDU, provided the originator parameter of the N-DISCONNECT indication indicates “NS user” as opposed to “NS-provider”). Neither the contents of Annex B, nor the implementation of ITU-T Rec. X.224 | ISO/IEC 8073 are requirements of this protocol specification, however.

6.4 Normal release

6.4.1 Purpose

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

6.4.2 Network service primitives

The procedure uses the N-DISCONNECT network service primitive.

6.4.3 Transport service primitives

The procedure uses the T-DISCONNECT transport service primitive.

6.4.4 TPDUs and parameters used

The procedure uses the FB-TPDU and TS-user data parameter.

6.4.5 Procedure

On receipt of a T-DISCONNECT request after a transport connection has been established or after an originator has initiated a transport connection but before its acceptance, a transport entity shall transmit an FB-TPDU as the NS-user data parameter of an N-DISCONNECT request, and shall consider the transport connection to be released. The reason parameter shall indicate “disconnection-normal condition”.

The following information is conveyed:

- TS-user data (if any).

A transport entity receiving an FB-TPDU as the NS-user data parameter of an N-DISCONNECT indication after a transport connection has been established or after an originator has initiated a transport connection but before its acceptance, shall consider the transport connection to be released and so inform the TS-user by issuing a T-DISCONNECT indication. The reason parameter shall indicate “remote TS-user invoked”.

6.5 Error indication

6.5.1 Purpose

This procedure is used on the receipt of an N-RESET indication.

6.5.2 Network service primitives

The procedure uses the following service primitives:

a) N-RESET indication;

b) N-RESET response;

c) N-DISCONNECT request.

6.5.3 Transport service primitives

The procedure uses the T-DISCONNECT transport service primitive for Mode 0 operation. For Mode 4 operation, no transport service primitives are used.

6.5.4 Procedure

Mode 0 operation: When an N-RESET indication is received, both transport entities shall consider that the transport connection is released and so inform the TS-user by issuing a T-DISCONNECT indication with the reason parameter indicating "TS-provider invoked". After issuing the T-DISCONNECT indication, an N-DISCONNECT request (not containing an FB-TPDU) shall be issued. The reason parameter shall indicate "disconnection-abnormal condition".

Mode 4 operation: When an N-RESET indication is received, the transport connection is not released. On receipt of an N-RESET indication, an N-RESET response shall be issued.

6.6 Abnormal release

6.6.1 Purpose

The release procedure is used by a transport entity to release an existing transport connection on the receipt of an N-DISCONNECT indication which does not contain an FB-TPDU (i.e. resulting from an NS-provider initiated disconnect, or as a result of procedure 6.5.4 when Mode 0 operation is used).

6.6.2 Network service primitives

The procedure uses the N-DISCONNECT network service primitive.

6.6.3 Transport service primitives

The procedure uses the T-DISCONNECT transport service primitive.

6.6.4 TPDUs and parameters used

None.

6.6.5 Procedure

If a transport connection exists, and an N-DISCONNECT indication which does not contain an FB-TPDU is received, then the transport entity shall consider that the transport connection is released and inform the TS-user by issuing a T-DISCONNECT indication. The reason parameter shall indicate "TS-provider invoked".

If a transport connection does not exist, and an N-DISCONNECT indication which does not contain an FB-TPDU is received, then the transport entity shall take no action if the N-DISCONNECT indication originator parameter indicates "NS provider".

6.7 Data transfer

6.7.1 Purpose

The transfer procedure is used to convey the TS-user data of a T-DATA primitive.

6.7.2 Network service primitives

The procedure uses the N-DATA network service primitive.

6.7.3 Transport service primitives

The procedure uses the T-DATA transport service primitive.

6.7.4 TPDUs and parameters used

The procedure uses the FB-TPDU and TS-user data parameter.

6.7.5 Procedure

The transport entities shall transmit and receive an FB-TPDU as the NS-user data parameter of an N-DATA primitive. The TS-user data of a T-DATA primitive is contained within the TS-user data parameter of the FB-TPDU.

6.8 Segmenting and reassembling

6.8.1 Purpose

The segmenting and reassembling procedure is used to map a TSDU onto one or more TPDUs.

6.8.2 Network service primitives

The procedure uses the N-DATA network service primitive.

6.8.3 Transport service primitives

The procedure uses the T-DATA transport service primitive.

6.8.4 TPDUs and parameters used

The procedure uses the FB-TPDU and End of TSDU (EOT).

6.8.5 Procedure

A transport entity shall map a TSDU onto an ordered sequence of one or more FB-TPDUs. This sequence shall not be interrupted by other TPDUs.

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

NOTES

1 The EOT of an FB-TPDU indicates whether or not there are subsequent FB-TPDUs in the sequence.

2 There is no requirement that the FB-TPDUs shall be the maximum length available on the transport connection.

6.9 Expedited data transfer

6.9.1 Purpose

The transfer procedure is used to convey the TS-user data of a T-EXPEDITED DATA primitive.

6.9.2 Network service primitives

The procedure uses the N-EXPEDITED DATA network service primitive.

6.9.3 Transport service primitives

The procedure uses the T-EXPEDITED DATA transport service primitive.

6.9.4 TPDUs and parameters used

The procedure uses the FB-TPDU and TS-user data parameter.

6.9.5 Procedure

The transport entities shall transmit and receive an FB-TPDU as the NS-user data parameter of an N-EXPEDITED DATA primitive. The TS-user data of a T-EXPEDITED DATA primitive is contained within the TS-user data parameter of the FB-TPDU.

6.10 Invalid TPDU

6.10.1 Purpose

The Invalid TPDU procedure specifies the action taken on receiving a TPDU that does not comply with the requirements of this protocol specification for structure and encoding. A Null TPDU (i.e. no NS-user data in the network service primitive received) does not constitute an Invalid TPDU.

6.10.2 Procedure

A transport entity receiving an invalid TPDU shall discard the TPDU.

7 FB-TPDU structure and encoding

All the Transport Protocol Data Units (TPDUs) shall contain an integral number of octets. The octets in a TPDU are numbered starting from 1 and increasing in the order they are put into an NSDU. The bits in an octet are numbered from 1 to 8 and increase in the order they are put into an NSDU. Bit 1 is the lowest order bit of each octet.

When consecutive octets are used to represent a binary number, the lower octet number has the most significant value.

NOTES

1 The numbering of bits within an octet is a convention local to this protocol specification.

2 The use of the terms “high order” and “low order” is common to this protocol specification and to adjacent layer Recommendations | International Standards.

3 The use of the above conventions does not affect the order of bit transmission on a serial communications link.

4 Both transport entities respect these bit and octet ordering conventions, thus allowing communication to take place.

5 In this clause the encoding of TPDUs is represented in the following form:

a) octets are shown with the lowest numbered octet on the top; higher numbered octets being further below;

b) within an octet, bits are shown with bit 8 to the left and bit 1 to the right.

The FB-TPDU consists of 3 parts, each of which may or may not be present, as described below.

Part	Described in subclause	When used
Header Part	7.1	If Null PCI data transfer support has been negotiated, then the Header part shall not be present in FB-TPDUs associated with procedures 6.7 and 6.9; otherwise, the Header part shall always be present in an FB-TPDU.
Control Part	7.2	The control part shall be present in FB-TPDUs associated with procedures 6.2 and 6.3 (Connection establishment and refusal). The Control part shall not be present in FB-TPDUs associated with procedures 6.4, 6.5, 6.6, 6.7, 6.8 and 6.9.
Data Part	7.3	The data part shall always be present in an FB-TPDU when TS-user data is being conveyed, but shall not be present in an FB-TPDU when TS-user data is not being conveyed.

The parts are ordered in an FB-TPDU such that the control part (if present) does not precede the header part, and the data part (if present) does not precede either the control part or the header part.

7.1 Header part

If Null PCI data transfer support has been negotiated, then the Header part shall not be present in FB-TPDUs associated with procedures 6.7 and 6.9. Otherwise, the Header part shall always be present in an FB-TPDU.

The Header part consists of the following fields in the order listed:

1) The Fast Byte identifier octet – The value is set to binary 1010 0010 to identify this protocol.

2) The Parameter field:

a) Bit 8 is the extension bit (x):

– when the x is set to ONE, the parameter field is not extended;

– when the x is set to ZERO, the parameter field is extended.

In this version of the Transport Fast Byte Protocol specification, when originating an FB-TPDU, x is set to ONE; if an FB-TPDU is received with a parameter field in which x is set to ZERO, then subsequent Parameter Extension octets (defined in a future version of this protocol specification) are ignored.

b) Bit 7 is the mode parameter (m):

– when the m is set to ZERO, mode 0 is selected;

– when the m is set to ONE, mode 4 is selected.

c) Bit 6 is the Null-PCI parameter (n):

– when the n is set to ZERO, Null PCI data transfer support is not selected;

– when the n is set to ONE, Null PCI data transfer support is selected.

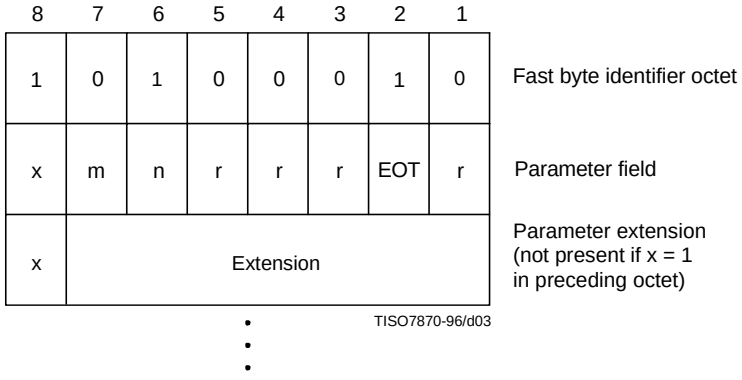
d) Bits 5, 4, 3, 1 are reserved (r) for future use, and set to ZERO when originating an FB-TPDU; the value is ignored by the receiving transport entity.

e) Bit 2 is the End of TSDU (EOT):

– when the EOT is set to ONE, the FB-TPDU is the last data unit of a complete FB-TPDU sequence;

– when the EOT is set to ZERO, the FB-TPDU is not the last data unit of a complete FB-TPDU sequence.

The Header part is illustrated below.



7.2 Control part

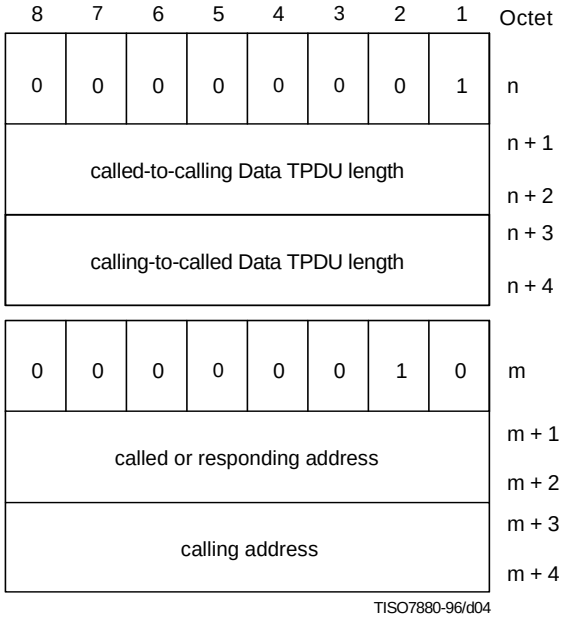
The Control part shall be present in FB-TPDUs associated with procedures 6.2 and 6.3 (Connection establishment and Connection refusal). The Control part shall not be present in FB-TPDUs associated with procedures 6.4, 6.5, 6.6, 6.7, 6.8, and 6.9.

The Control part consists of the following fields in the order listed:

1) Data TPDU length parameter set – The Data TPDU length parameter set contains a 2-octet called-to-calling Data TPDU length for which the value is a binary integer and indicates the maximum Data TPDU length in octets, and a 2-octet calling-to-called Data TPDU length for which the value is a binary integer and indicates the maximum Data TPDU length in octets. If the parameter set is omitted, then a default Data TPDU length of 512 octets in both directions shall apply.

2) Address parameter set – The Address parameter set contains the called or responding address field for which the value is a 2-octet T-SEL, and the calling address field for which the value is a 2-octet T-SEL. If the parameter set is omitted, then the value of both T-SELs is NIL.

The Control part is illustrated below.



7.3 Data part

The Data part shall always be present in an FB-TPDU when TS-user data is being conveyed, but shall not be present in an FB-TPDU when TS-user data is not being conveyed.

The Data part identifier has a binary value of 4 (0000 0100). The Data part identifier, when present in the Data part, is the first octet of the Data part.

When TS-user data is being conveyed, and Null PCI data transfer support has not been negotiated, the Data part identifier is present in the Data part.

When TS-user data is being conveyed, and Null PCI data transfer support has been negotiated, the Data part identifier is not included in the Data part of an FB-TPDU which is associated with procedures 6.7 and 6.9, but is included in the Data part of FB-TPDUs which are associated with procedures other than 6.7 and 6.9.

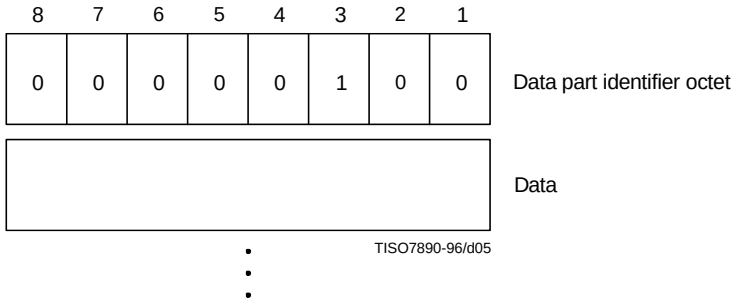
During the transport layer connection establishment and release phases, the remainder of the Data part may contain any number of octets up to the maximum length of the user-data field of the underlying protocol minus the length of the Header part minus the length of the Control part minus 1.

During the transport layer data transfer phase, the remainder of the Data part may contain any number of octets up to a maximum of:

a) the maximum length of the user-data field of the underlying protocol minus the length of the Header part minus 1 – if Null PCI data transfer support has not been negotiated; or

b) the maximum length of the user-data field of the underlying protocol – if Null PCI data transfer support has been negotiated.

The Data part is illustrated below:



8 Conformance

8.1 A system claiming to implement the procedures specified in this protocol specification shall comply with the requirements in 8.2, 8.3 and 8.4.

8.2 The system shall implement the procedures for both Mode 0 and Mode 4 as specified in clause 6.

8.3 The system shall implement the encodings specified in clause 7.

8.4 The supplier of a protocol implementation which is claimed to conform to this protocol specification shall complete a copy of the PICS proforma provided in Annex A and shall provide the information necessary to identify both the supplier and the implementation.

Annex A

Protocol Implementation Conformance Statement (PICS) proforma[2)]

(This annex forms an integral part of this Recommendation | International Standard)

A.1 General

A.1.1 Symbols used

Status symbols:

M	Mandatory
O	Optional to implement. If implemented the feature may or may not be used.
O.<n>	Optional but support of at least one of the group of options labelled by the same numeral <n> in this PICS proforma is required.
<index>:	This predicate symbol means that the status following it applies only when the PICS states that the feature identified by the index is supported. In the simplest case, <index> is the identifying tag of a single PICS item. <index> may also be a Boolean expression composed of several indices.
<index>::	When this group predicate is true, the associated clause should be completed.

Support symbols:

Yes	Supported
No	Not supported
N/A	Not applicable

A.1.2 Instructions for completing the PICS proforma

The main part of the PICS proforma is a fixed-format questionnaire divided into a number of clauses. Answers to the questionnaire are to be provided in the rightmost column either by simply marking an answer to indicate a restricted choice (such as Yes or No) or by entering a value or a range of values or entering what action is taken.

A.2 Identification

A.2.1 Implementation identification

Supplier	
Contact point for queries about the PICS	
Implementation Names(s) and Version(s)	
Other information necessary for full identification – e.g. name(s) and version(s) of machines and/or operating systems; System Name(s)	

NOTES

1 Only the first three items are required for all implementations; other information may be completed as appropriate in meeting the requirement for full identification.

2 The terms Name and Version should be interpreted appropriately to correspond with a supplier's terminology (e.g. Type, Series, Model).

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2) **Copyright release for PICS proforma**

Users of this Recommendation | International Standard may freely reproduce the PICS proforma in this annex so that it can be used for its intended purpose and may further publish the completed PICS.

A.2.2 Protocol Summary

Identification of protocol specification	ITU-T Rec. X.634 | ISO/IEC 14699
Identification of Amendments and Corrigenda to this PICS proforma which have been completed as part of this PICS	
Protocol Version(s) supported	Version 1
Have any Exception items been required? No [ ] Yes [ ] (The answer Yes means that the implementation does not conform to ITU-T Rec. X.634 | ISO/IEC 14699)	

Date of statement	

A.3 Indices used in this annex

A.4 Modes implemented

Index	Mode	References	Status	Support
M0	Mode 0	5.4	M	Yes
M4	Mode 4	5.4	M	Yes

A.5 Initiator/responder capability to establish connection

Index		References	Status	Support
IR1	Initiating a transport connection	6.2.5	O.1	Yes No
IR2	Accepting a transport connection	6.2.5	O.1	Yes No

A.6 Supported functions

The following functions are mandatory.

Index	Function	References	Status	Support
F1	TPDU transfer	6.1	M	Yes
F2	Connection establishment	6.2	M	Yes
F3	Connection refusal	6.3	M	Yes
F4	Normal release	6.4	M	Yes
F5	Error indication	6.5	M	Yes
F6	Abnormal release	6.6	M	Yes
F7	Data transfer	6.7	M	Yes
F8	Segmenting and reassembling	6.8	M	Yes
F9	Expedited data transfer	6.9	M	Yes
F10	Invalid TPDU	6.10	M	Yes

A.7 Supported TPDUs

Index	TPDUs	References	Status	Support
ST1	FB	7	M	Yes

A.8 Supported FB-TPDU fields and parameters

Index	Supported FB-TPDU fields and parameters	References	Status	Support
SP1	Fast Byte identifier octet	7.1 1)	M	Yes
SP2	Parameter field	7.1 2)	M	Yes
SP3	Data TPDU length parameter set	7.2 1)	O	Yes No
SP4	Address parameter set	7.2 2)	O	Yes No
SP5	Data part identifier	7.3	M	Yes
SP6	Data	7.3	M	Yes

A.9 Negotiation and selection

A.9.1 Mode selection

Index		References	Status	Support
MS1	Can the initiator select Mode 0?	6.2.5	IR1:O.2	Yes No N/A
MS2	Can the initiator select Mode 4?	6.2.5	IR1:O.2	Yes No N/A
MS3	Responder shall accept the Mode 0 if selected by the initiator	6.2.5	IR2:M	Yes N/A
MS4	Responder shall accept the Mode 4 if selected by the initiator	6.2.5	IR2:M	Yes N/A

A.9.2 Data TPDU size negotiation

Index		References	Status	Support
TS1	The initiator shall propose the maximum size for Data TPDUs in the called-to-calling, and calling-to-called directions. The values proposed by the initiator shall not exceed the maximum NSDU size.	6.2.5	IR1:M	Yes N/A
TS2	The responder shall select the maximum size for Data TPDUs in the called-to-calling, and calling-to-called directions. The values selected by the responder shall be equal or less than the values proposed by the initiator.	6.2.5	IR2:M	Yes N/A

A.9.3 Null PCI data transfer negotiation

Index		References	Status	Support
NP1	Can the initiator select Null PCI data transfer support?	6.2.5	IR1:O.3	Yes No N/A
NP2	Can the initiator select non-use of Null PCI data transfer support?	6.2.5	IR1:O.3	Yes No N/A
NP3	Can the responder accept an initiator request for Null PCI data transfer support?	6.2.5	IR2:O	Yes No N/A

A.9.4 Expedited data negotiation

Index	Expedited data negotiation	References	Allowed values	Supported values
ED1	Can the initiator map the expedited data selection parameter from a T-CONNECT request to an N-CONNECT request?	6.2.5	IR1:M	Yes N/A
ED2	Can the initiator map the expedited data selection parameter from an N-CONNECT confirm to a T-CONNECT confirm?	6.2.5	IR1:M	Yes N/A
ED3	Can the responder map the expedited data selection parameter from an N-CONNECT indication to a T-CONNECT indication?	6.2.5	IR2:M	Yes N/A
ED4	Can the responder map the expedited data selection parameter from a T-CONNECT response to an N-CONNECT response?	6.2.5	IR2:M	Yes N/A

A.10 Error handling

A.10.1 Actions on receipt of an invalid TPDU

Index	Event	References	Status	Support
RR1	A transport entity receiving an invalid TPDU shall discard the TPDU.	6.10	M	Yes

Annex B

Fallback procedures for systems implementing ITU-T Rec. X.224 | ISO/IEC 8073 in addition to the Transport Fast Byte Protocol

(This annex does not form an integral part of this Recommendation | International Standard)

B.1 Scope

This annex describes a mechanism by which systems which implement ITU-T Rec. X.224 | ISO/IEC 8073 in addition to the Transport Fast Byte Protocol may fall back to the operation of ITU-T Rec. X.224 | ISO/IEC 8073 following an unsuccessful attempt to establish a Transport Fast Byte connection.

The fallback procedures contained in this annex may be initiated by the transport entity which initiated the unsuccessful Transport Fast Byte connection establishment attempt. However, fallback procedures that could be initiated by the transport entity which responded to the unsuccessful Transport Fast Byte connection establishment attempt are beyond the scope of this annex.

NOTES

1 Implementation of ITU-T Rec. X.224 | ISO/IEC 8073 is not a requirement of this Protocol specification. A system may implement this Protocol specification without implementing ITU-T Rec. X.224 | ISO/IEC 8073.

2 The choice of either attempting to establish the transport connection using ITU-T Rec. X.224 | ISO/IEC 8073 or considering the transport connection not accepted is a local matter.

3 There is no guarantee that the attempt to establish the transport connection with ITU-T Rec. X.224 | ISO/IEC 8073 will be successful (i.e. the remote system may not support ITU-T Rec. X.224 | ISO/IEC 8073, but might support some other protocol which is neither ITU-T Rec. X.224 | ISO/IEC 8073 nor the Transport Fast Byte Protocol).

B.2 Fallback procedures

When the initiating transport entity attempts to establish a Transport Fast Byte connection by issuing an N-CONNECT request containing an FB-TPDU as described in 6.2, and the receiving transport entity does not support the Transport Fast Byte Protocol, then:

a) if in response to the N-CONNECT request, the initiating transport entity receives an N-CONNECT confirm not containing an FB-TPDU then B.2.1 applies; or

b) if in response to the N-CONNECT request, the initiating transport entity receives an N-DISCONNECT indication not containing an FB-TPDU, then B.2.2 applies provided the originator parameter of the N-DISCONNECT indication indicates “NS user”. If the originator parameter of the N-DISCONNECT indication indicates “NS provider”, then an abnormal release has occurred, and 6.6 applies.

B.2.1 The initiating transport entity shall either:

a) attempt to establish the transport connection using ITU-T Rec. X.224 | ISO/IEC 8073 during the network service data transfer phase; or

b) shall consider the transport connection not accepted and inform the TS-user by issuing a T-DISCONNECT indication. The reason parameter shall indicate “TS provider invoked”. The initiating transport entity shall issue an N-DISCONNECT request. The reason parameter shall indicate “disconnection-abnormal condition”.

B.2.2 The initiating transport entity shall either:

a) attempt to re-establish the transport connection using ITU-T Rec. X.224 | ISO/IEC 8073; or

b) consider the transport connection not accepted and inform the TS-user by issuing a T-DISCONNECT indication. The T-DISCONNECT indication reason parameter shall indicate “TS-provider invoked”.

ITU-T RECOMMENDATIONS SERIES

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