Mobitex Transport Protocol 1 (MTP/1)

Contents

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1 Introduction

This document describes the Mobitex Transport Protocol 1 (MTP/1) transport protocol, which is specially designed for use in Mobitex networks.

An end-to-end transport protocol such as MTP/1 may be used for applications, to ensure that all data is delivered and received correctly.

The MTP/1 protocol may be used by applications where it is necessary to be certain that all data is received correctly, for example, by applications that requires transfer of large amounts of data between an application host and a mobile terminal application.

The document contains the following chapters:

- chapter 3 *"Transport Service Definition"*
  which defines the service to be provided by the Transport Layer in a Mobitex application. The service is defined in terms of the primitive actions and events and the associated products.
- chapter 4 *"Transport Protocol Specification"*
  which describes the transport protocol in general terms, followed by a survey of the boundaries to the upper and lower layers. The rules for connection establishment, connection release and data transfer, as well as the exact structure and encoding of the data units transferred between two transport entities are described in detail.
- chapter 5 *"Recommended Timer and Counter Values for MTP/1"*
  which contains recommended values for MTP/1 timers and counters.
- chapter 6 *"State Tables"*
  which provides a more precise description of the protocol in terms of state tables, during operation of a single transport connection. The state tables show the state of a transport entity, the events that occur in the protocol, the actions taken, and the resultant state. They also define the mapping between service and protocol events that TS-users can expect.
- Appendix A: *"MTP/1 Test Suite Structure and Test Purposes"*
  which specifies the test suite structure and the set of test purposes applicable to all abstract test suites to be specified for the MTP/1.
  The chapter provides a basis for conformance test realization, for design of different abstract test suites and for design and realization of basic interconnection tests. It can also be used as a guidance of implementation and self testing of MTP/1.
- Appendix B: *"MTP/1 PICS Proforma"*
  which provides the Protocol Implementation Conformance Statement (PICS) proforma for the Mobitex transport protocol MTP/1, that explicitly defines the implementation flexibility allowed by the protocol specification.
- Appendix C: *"Cover Page Template for an MTP/1 PICS"*
  which contains a suggested layout for the mandatory cover page for the completed PICS.

2 Terminology

AK TPDU	Data acknowledge TPDU
ATS	Abstract Test Suite. A test suite composed of abstract test cases.
CC TPDU	Connection Confirm TPDU
CCAM TPDU	Connection Confirm Addressee Modified TPDU
CDT-CONST	Window Size. A constant that defines the upper window edge at connection establishment time.
CLOSED	Transport connection is closed (TC state)
Confirm (primitive)	A primitive issued by a service-provider to complete some procedure previously invoked by a request.
Connection establishment time	The Mobitex network time stamp of the packet establishing a connection.
CR TPDU	Connection Request TPDU
Data TPDU	A TPDU containing normal user-data. TPDUs in question are CR, CC/CCAM, and DT TPDUs.
DR TPDU	Disconnect TPDU
DT TPDU	Data TPDU
Indication (primitive)	A primitive issued by a service-provider either: - to invoke some procedure; or - to indicate that a procedure has been invoked by a peer service-user.
Initiator	A transport entity that initiates a connection request TPDU.
IUT	Implementation Under Test. An implementation of the MTP/1 protocol, being the part of a system which is to be studied by testing.

Local service primitive	A primitive that is related only to local conventions between a service-user and a service-provider. Not visible outside the local system.
Lower window edge	The lowest sequence number in a window.
LT	Lower Tester. The representation of the means of providing, during test execution, indirect control and observation of the lower service boundary of the IUT.
MAN	Mobitex subscription number.
MTP/1	Mobitex Transport Protocol 1
MTP/1 PICS Proforma	A document, in the form of a questionnaire, which becomes the MTP/1 PICS for an MTP/1 implementation, when completed.
N	Maximum number of re-transmissions.
NS	Network Service. The functions assumed by the TP to be provided by lower layers.
OPEN	Transport connection is established and open (TC state).
OSI	Open Systems Interconnection. Reference model for data exchange between open systems.
PCO	Protocol of Control and Observation. A point within a testing environment where the occurrence of test events is to be controlled and observed.
PICS	Protocol Implementation Conformance Statement. A statement made by the supplier of an implementation, stating which capabilities have been implemented.
PIXIT	Protocol Implementation Extra Information for Testing
Provider-optional-service	A service that may or may not be provided in the transport service.

Receive window	The set of consecutive numbers which a peer transport entity has been permitted to send at a given time. The receive window contains references to all received unacknowledged data TPDUs
Receiving TS-user	A Transport Service user that acts as a sink of data during the data transfer phase of a transport connection. (A Transport Service user that can be both a sending and a receiving TS user simultaneously.)
Request (primitive)	A primitive issued by a service-user to invoke some procedure.
Responder	A transport entity with whom an initiator wishes to establish a transport connection. (Initiator and repsonder are defined with respect to a single transport connection. A transport entity can be both an initiator and responder simultaneously.)
Response (primitive)	A primitive issued by a service-user to complete some procedure previously invoked by an indication.
Sending TS-user	A Transport Service user that acts as a source of data during the data transfer phase of a transport connection.
Service primitive	An abstract, implementation independent interaction between a service-user and a service-provider.
SUT	System Under Test. The system in which the IUT resides.
TC	Transport Connection. An association established by the transport layer between two TS users for the transfer of data.
TI	Inactivity Timer Specifies the time after which an un-utilized connection can be considered to be non-existent and the inactivity procedure is to be initiated.
TP	Transport protocol. A group of rules making possible transport layer communication between two terminals (fixed or mobile).

TPDU	Transport Protocol Data Unit. This is a quantity of data, containing protocol-control-information and possibly user-data, which is used in communication between correspondent transport entities.
Transmit window	A set of consecutive numbers which a transport entity has been authorized to send at a given time. The transmit window contains references to all outstanding unacknowledged data TPDUs
TS	Transport Service. The functions provided by TP to higher layers, that is, the interface with users of TP.
TSAP	Transport Service Access Point. A point at which the transport service is provided.
TSDU	Transport Service Data Unit. This is a quantity of user data, which is used in communication between the transport layer and the higher layers.
TS-provider	An abstract machine which models the behaviour of the totality of the entities providing the service, as viewed by the user.
TSS&TP	Test Suit Structure and Test Purposes.
TS-user	An abstract representation of the totality of those entities in a single system that make use of the transport service.
TWBAK	Timer Wait before sending Acknowledgment Specifies the time within which a receiving transport entity shall acknowledge a data TPDU. The timer is common to all TPDUs belonging to the same connection.
TWBDTR	Timer Wait before data TPDU Retransmission Specifies the time after which a sending transport entity shall start a retransmission of an unacknowledged data TPDU.
Upper window edge	The sequence number which is one greater than the highest sequence number in the window.

UT	Upper Tester. The representation of the means of providing, during test execution, indirect control and observation of the lower service boundary of the IUT.
WFCC	Wait for CC TPDU (TC state).
WFTRESP	Wait for T-CONNECT response (TC state).

3 Transport Service Definition

This chapter defines the service to be provided by the Transport Layer to the next higher layer in a Mobitex application. The service is defined in terms of the primitive actions and events and the associated parameters.

The chapter provides a basis for the design and implementation of transport protocols in a Mobitex environment, but is also used in the design of software that utilizes the services provided by the Transport Layer.

3.1 General

3.1.1 Introduction

The transport service provides transparent transmission of data between TS users, as follows:

- Transparent transmission of TSDUs of a length that is not limited to the length of a Mobitex data gram. A TS provider must comply with the requirement of handling all TSDUs of lengths up to 8,127 bytes.
- Guaranteed preservation of the sequence between the TSDUs during transmission.
- Error signalling with specified reason and identification of TSDUs during transmission.
- Positive end-to-end TS provider acknowledgment.

3.1.2 System Environment

The transport service TS is the functionality provided by the transport protocol (which corresponds to Layer 4 in the OSI model) to the next higher layer.

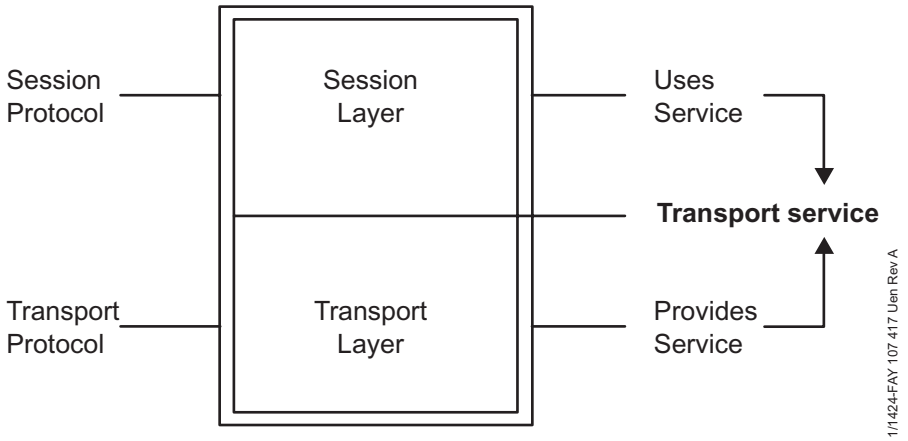

Figure 1 Relationship between TS and adjacent layers

3.1.3 Features of the Transport Service

The transport service can be utilized in one of two different ways; as a connectionless-mode service or as a connection-mode service.

Differences Between Connection-Mode and Connectionless-Mode Transport Services

We will here try to clarify the difference between connectionless-mode and connection-mode. We will start with a discussion of how these concepts are traditionally used in the literature, and then we discuss the use of the concepts in this chapter.

Traditional Meaning of the Concepts

Normally the two different service modes used are supported by different underlying protocols. The protocol is usually simpler in the connectionless-mode case. The number of transferred TPDU frames might, for example, be less, thus achieving a cheaper and faster transmission.

Connectionless-Mode Transport Service

This mode has only one set of services. These services deal with data transfer and are traditionally called T-UNITDATA request and T-UNITDATA indication. These services have lower safety than the data transfer services in the connection-mode. There is no guarantee that the data transfer has been successful. It is up to the higher application-oriented layers to recover from such eventualities.

As an example of an application that could use this mode we could mention some sort of telemetry equipment that periodically sends in reports. It might in this case not be critical if we lose one of the packets.

Connection-Mode Transport Service

This mode has two sets of services; those concerned with connection establishment and release, and those concerned with data transfer. The data transfer in the connection-mode service should be reliable.

A Newer, More Precise Terminology

In some newer literature they prefer to divide the services into the following four sub-categories:

- unreliable connectionless-mode
- reliable connectionless-mode
- unreliable connection-mode
- reliable connection-mode

Unreliable connectionless-mode corresponds to the traditional connectionless-mode. Reliable connection-mode corresponds to the traditional connection-mode.

Meaning of the Concepts in this Chapter

When referring to these concepts in this chapter the meaning is slightly different. The underlying protocol is connection-oriented in both cases. It is only the service interface between the TS-provider and the TS-user that differs.

Connectionless-Mode

This mode has, in the traditional case, one set of services. The services are called T-UNITDATA request and T-UNITDATA indication in order to differentiate them from the connection-mode services. These services have the same degree of safety as in the connection-mode.

This mode corresponds to a reliable connectionless-mode according to the newer, more precise terminology.

The traditional connectionless-mode transport service does not have any meaning in a packet switched data gram network without guaranteed packet sequencing.

Connection-Mode

This mode corresponds to a reliable connection-mode according to the newer, more precise terminology, which also makes it correspond to the traditional connection-mode transport service.

3.1.3.1 Connectionless-Mode Service

The connectionless-mode service offers the following feature to a TS user:

- The means by which a TSDU is transmitted in a single transport service access, *without* first establishing and later releasing a transport connection.

3.1.3.2 Connection-Mode Service

The connection-mode service offers the following features to a TS user:

- The means to establish a transport connection with another TS user for the purpose of exchanging TSDUs. More than one transport connection may exist between the same pair of TS users.
- The means to exchange user data during the connection establishment.
- The means of transferring TSDUs on a transport connection.
- The means to:
  - distinguish between types of user data (regular user data and qualified data[1]);
  - optionally utilize the Mobitex mailbox service;
  - choose between complete control of when to release an established connection or to delegate some decisions to the TS provider;
  - optionally utilize the protocol explicit release function.
- The conditional release of a transport connection.
- The unconditional and therefore possibly destructive release of a transport connection.

3.1.4 Service Primitives

Each TS user interacts with the TS provider by issuing, or receiving, service primitives.

The primitives are mainly of two types: request primitives and indication primitives. The connection-mode services also makes use of a response primitive and a confirm primitive. One or more parameters may be associated with each primitive.

The transport services defined in this chapter may be supplemented by functions of a local character, that is, functions that only affect one service user and its service provider. This supplementation may take the form of local parameters to existing service primitives or entirely new local primitives.

1. The first byte of the qualified data in all TSDUs is subject for study.

3.2 Connectionless-Mode Service Primitives

The service primitives described in this section correspond to the connectionless-mode transport service. A list of primitives in this group is given in the table below.

Primitive	Parameter(s)	Notes
T-UNITDATA req	Calling Address Called Address TS User-Data TSDU Reference	local
T-UNITDATA-SENT ind (local, provider-optional)	Calling Address Called Address TSDU Reference	local
T-UNITDATA-ACK ind (local, provider-optional)	Calling Address Called Address TSDU Reference	local
T-UNITDATA ind	Calling Address Called Address TS User-Data	
T-ERROR ind (local)	Calling Address Called Address TSDU Reference Reason	

3.2.1 T-UNITDATA Request, Indication

3.2.1.1 Function

The T-UNITDATA primitives described in this section are used to transparently transfer data in the form of a TSDU, from one TS user to another TS user, without explicitly establishing and later releasing a transport connection.

A TS user activates a T-UNITDATA request primitive in order to send a TSDU.

A TSDU is divided, if necessary, into a number of smaller portions by the transmitting transport entity. The receiving transport entity then reassembles the portions to form a TSDU identical with the original one.

A T-UNITDATA indication primitive tells the TS user that a TS provider has received a TSDU transmitted by another TS user and addressed to the first-mentioned user.

The indication primitive is activated only on condition that the TSDU is complete and has been correctly received. In other cases, the transport entities involved ensure that an appropriate retransmission procedure is initiated. If this also is unsuccessful, the T-ERROR primitive is used to inform the sending TS user of the result.

A further condition for activation of the indication primitive is that all TSDUs previously sent from a sending TS user to a receiving TS user have been delivered

to the receiving TS user. In other cases, the receiving TS provider waits before sending the indication primitive until the above condition has been fulfilled.

The sequence of primitives in a successful data transfer is defined in the following time sequence diagram:

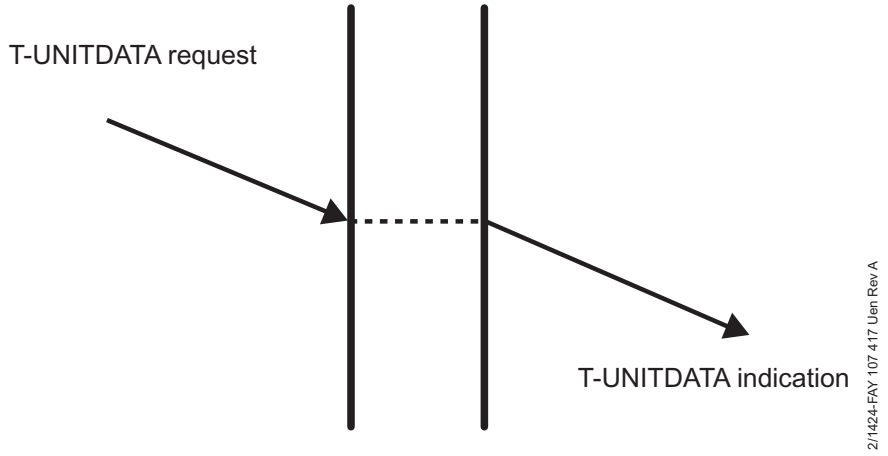

Figure 2 Sequence of primitives in data transfer

3.2.1.2 Request Parameters

The following parameters are used for making requests:

Calling Address	Consists of two sub-parameters, namely Sender (MAN) and Calling TSAP.
Called Address	Consists of two sub-parameters, namely Addressee (MAN) and Called TSAP.
TS User-Data	Used for the data TSDU that is to be transferred between TS users.
TSDU Reference	This parameter has a local function. A TS user chooses an arbitrary reference to the current TSDU. The reference is not used by the transport layer, but is returned in case of an error situation (see T-ERROR indication below).

3.2.1.3 Indication Parameters

The following parameters are used when indications are issued:

Calling Address	Consists of two sub-parameters, namely Sender (MAN) and Calling TSAP.
Called Address	Consists of two sub-parameters, namely Addressee (MAN) and Called TSAP.
TS User-Data	Used for the data TSDU that is to be transferred between TS users.

3.2.2 T-UNITDATA-SENT Indication

3.2.2.1 Function

The T-UNITDATA-SENT primitive is used to inform a TS user that a complete TSDU, sent by the TS user activating a T-UNITDATA request, has reached the Mobitex network.

The information can be utilized to inform a human user of the system about the progress.

The sequence of primitives in a successful data transfer including the T-UNITDATA-SENT primitive is defined in the following time sequence diagram:

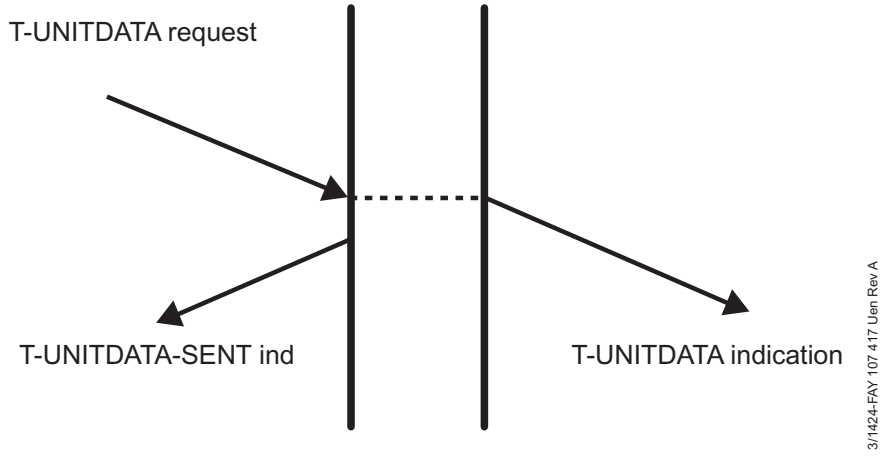

Figure 3 Sequence of primitives in data transfer

3.2.2.2 Parameters

The following parameters are used when indications are issued:

Calling Address	Identical with the corresponding parameter for the T-UNITDATA primitive.
Called Address	Identical with the corresponding parameter for the T-UNITDATA primitive.
TSDU Reference	Returns the current TSDU reference.

3.2.3 T-UNITDATA-ACK Indication

3.2.3.1 Function

The T-UNITDATA-ACK primitive is used to inform the TS user that a complete TSDU, sent by the TS user activating a T-UNITDATA request, has reached the receiving TS provider.

The information can be utilized by the TS user to release a retained copy of the TSDU.

The sequence of primitives in a successful data transfer including the T-UNITDATA-SENT and T-UNITDATA-ACK primitives is defined in the following time sequence diagram:

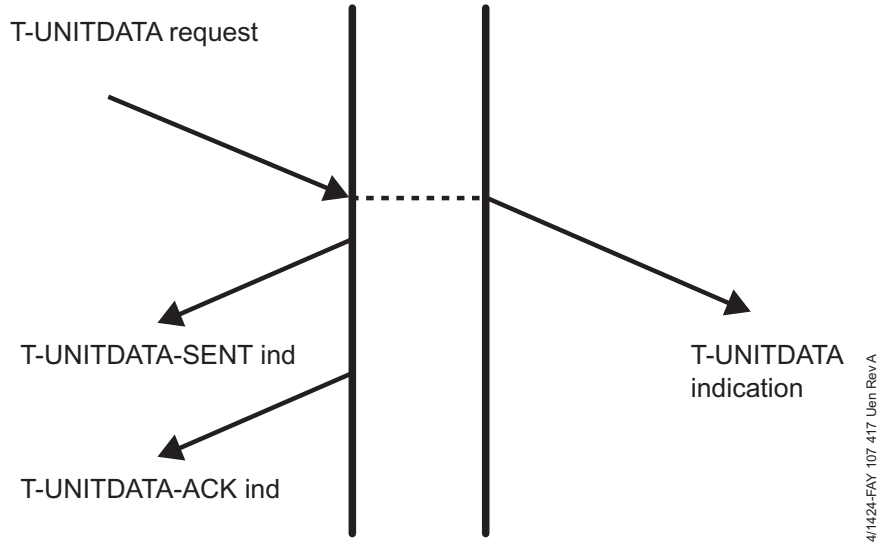

Figure 4 Sequence of primitives in data transfer

3.2.3.2 Parameters

The following parameters are used when indications are issued:

Calling Address	Identical with the corresponding parameter for the T-UNITDATA primitive.
Called Address	Identical with the corresponding parameter for the T-UNITDATA primitive.
TSDU Reference	Returns the current TSDU reference.

3.2.4 T-ERROR Indication

3.2.4.1 Function

The T-ERROR primitive is used to inform the TS user that the TS provider has failed to execute a T-UNITDATA request.

The reason for the T-ERROR being issued can be that the TS provider has been unable to store the TSDU in question or that the transport entity has failed to correctly transmit the TSDU to the peer transport entity.

The sequence of primitives in an unsuccessful data transfer including the T-UNITDATA-SENT primitive is defined in the following time sequence diagram:

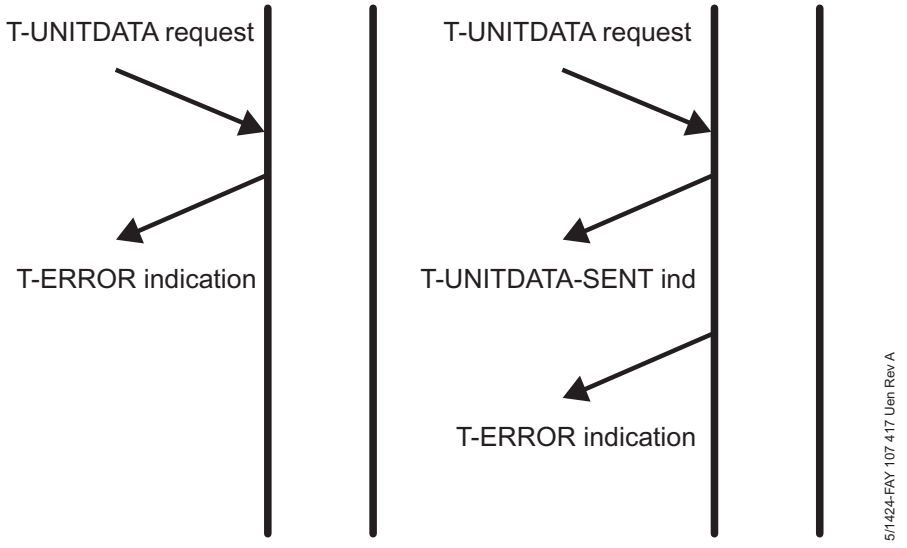

Figure 5 Sequence of primitives in an unsuccessful data transfer

3.2.4.2 Parameters

The following parameters are used when indications are issued:

Calling Address	Identical with the corresponding parameter for the T-UNITDATA primitive.
Called Address	Identical with the corresponding parameter for the T-UNITDATA primitive.
TSDU Reference	Returns the current TSDU reference.
Reason	Returns the reason for issuing the primitive.

3.2.5 Sequence of Primitives at a TC Endpoint

The possible overall allowed sequences of service primitives at a TC endpoint are defined in the following state transition diagram:

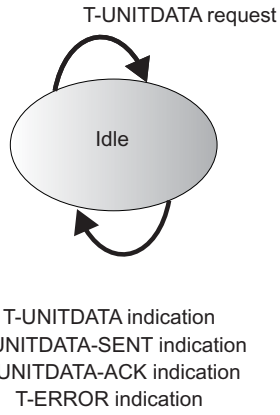

Figure 6 State transition diagram for the connectionless-mode service

3.3 Connection-Mode Service Primitives

The service primitives described in this section correspond to the connection-mode transport service. A list of primitives in this group is given below.

Primitive	Parameter	Notes
T-CONNECT request	Calling Address Called Address Closing Mode preferred Mailbox option Explicit option TS User-Data TSDU Reference Q bit TS Session PI	 local local local provider-optional
T-CONNECT indication	Calling Address Called Address Closing Mode preferred TS User-Data Q bit TS Session PI	 provider-optional
T-CONNECT response	Closing Mode selected Mailbox option Explicit option TS User-Data TSDU Reference Q bit	 local local local provider-optional
T-CONNECT confirm	Closing Mode selected TS User-Data Q bit	 provider-optional
T-DATA req	TS User-Data TSDU Reference Q bit	 local provider-optional
T-DATA-SENT ind	TSDU Reference	local, provider-optional
T-DATA-ACK ind	TSDU Reference	local, provider-optional
T-DATA ind	TS User-Data Q bit	 provider-optional
T-DISCONNECT request	Explicit option Immediate selection TS User-Data	local local
T-DISCONNECT indication	TSDU Reference Reason TS User-Data	local
T-NO-RESPONSE indication	TSDU Reference Reason	local primitive
T-RETRY request		local primitive
T-ERROR ind	TSDU Reference Reason	local primitive

3.3.1 T-CONNECT Request, Indication, Response and Confirm

3.3.1.1 Function

The T-CONNECT primitives described below are used to establish a transport connection between two TS users.

A TS user activates a T-CONNECT request in order to initiate a connection. The TS provider sends the request to a remote TS provider that issues a T-CONNECT indication to the called TS user. The user answers with a T-CONNECT response which is sent back to the original TS provider. Finally the TS user requesting the connection is informed that the connection establishment is completed by the TS provider issuing a T-CONNECT confirm.

The T-CONNECT primitives may or may not contain user data.

In some cases, an indicator may be needed with the user data to distinguish between two types of user data information. A Q bit parameter is included for this purpose. (The functionality is primarily intended to support remote PAD-setup in the Hayes and X.28/X.3 modems.)

The sequence of primitives in a successful transport connection establishment is defined in the following time sequence diagram:

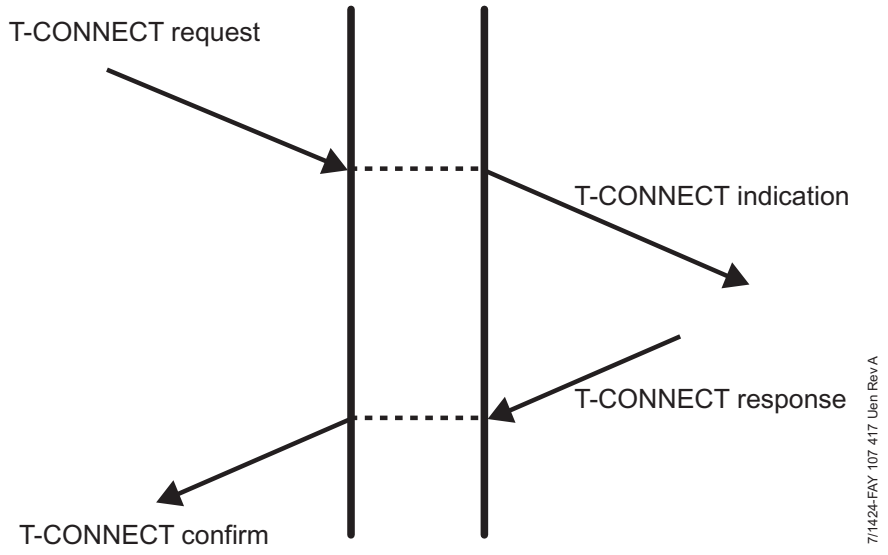

Figure 7 Sequence of primitives in a successful TC establishment

Three parameters, associated with the T-CONNECT request establishing a connection, will affect the behavior of the TS provider; the Closing Mode selection, the Mailbox option, and the Explicit option.

The value of the Closing Mode selection parameter is either “Close Mode selected” or “Non-Close Mode selected”. The value of the parameter will be transferred to the remote TS provider and user. If Close Mode is selected, the TS provider will by itself release an established connection when all attempts to transfer a TSDU have failed or the connection has not been used for a pre-defined period of time. A T-DISCONNECT indication will be invoked. If Non-Close Mode is selected the TS provider is deprived of the right to make the decision of releasing an established connection. A transmission failure or a failure to establish the connection, will result in a T-NO-RESPONSE indication.

If the Mailbox option is declared available, the Mobitex Mailbox Service will be utilized by a TS provider, assuming the receiving part to be out of network coverage. If the contact has not been regained within a limited space of time the calling TS user will be informed.

If the Explicit option is declared available, a TS provider will, if possible, inform the remote TS user about a connection release in progress.

3.3.1.2 Request Parameters

The following parameters are used for making requests:

Calling Address	Consists of two sub-parameters, namely Sender (MAN) and Calling TSAP.
Called Address	Consists of two sub-parameters, namely Addressee (MAN) and Called TSAP.
Closing Mode preferred	Indicates whether the TS provider shall operate in the Close Mode or the Non-Close Mode. The parameter value is a preferred mode and may be changed by the called TS user, but only from Close Mode to Non-Close Mode.
Mailbox option	Indicates whether the mailbox option is to be utilized on the transport connection.
Explicit option	Indicates whether the explicit option is to be utilized on the transport connection.
TS User-Data	Used for the data TSDU that is to be transferred between TS users.

TSDU Reference	This parameter has a local function. A TS user chooses an arbitrary reference to the current TSDU. The reference is not used by the transport layer, but is returned in case of an error situation (see T-DISCONNECT, T-NO-RESPONSE and T-ERROR indication below).
Q bit	Qualifier bit. The parameter allows the transfer of an indicator, associated with the user data, which will be conveyed to the called TS user by the primitive handing over the relating user data.
TS session PI	This parameter allows the transfer of a session protocol identifier, which will be conveyed to the called TS user by a T-CONNECT indication. The parameter can take values from 0 to 7.

3.3.1.3 Indication Parameters

The following parameters are used when indications are issued:

Calling Address	Identical with the corresponding parameter for the T-CONNECT request primitive.
Called Address	Identical with the corresponding parameter for the T-CONNECT request primitive.
Closing Mode preferred	Indicates the TS provider operation mode proposed by the calling TS user. The value of the parameter is either Close Mode or Non-Close Mode.
TS User-Data	Used for the data TSDU that is to be transferred between TS users.
Q bit	Qualifier bit.
TS session PI	Indicates the session protocol identifier selected by the calling TS user. The parameter can take values from zero to seven.

3.3.1.4 Response Parameters

The following parameters are used for making responses:

Closing Mode selected	Indicates the selected operation mode; either Close Mode or Non-Close Mode. A proposed “Close Mode” may be changed by the responding user to “Non-Close Mode”.
Mailbox option	Indicates whether the mailbox option is to be utilized on the transport connection.
Explicit option	Indicates whether the explicit option is to be utilized on the transport connection.
TS User-Data	Used for the data TSDU that is to be transferred between TS users.
TSDU Reference	This parameter has a local function. A TS user chooses an arbitrary reference to the current TSDU. The reference is not used by the transport layer, but is returned in case of an error situation (see T-DISCONNECT, T-NO-RESPONSE and T-ERROR indication below).
Q bit	Qualifier bit.

3.3.1.5 Confirm Parameters

The following parameters are used when confirms are issued:

Closing Mode preferred	Indicates the TS provider operation mode selected by the called TS user. The value of the parameter is either “Close Mode selected” or “Non-Close Mode selected”.
TS User-Data	Used for the data TSDU that is to be transferred between TS users.
Q bit	Qualifier bit.

3.3.2 T-DATA Request, Indication

3.3.2.1 Function

The T-DATA primitives described below are used to transparently transfer user data in the form of a TSDU, on an established transport connection from one TS user to another TS user.

A TS user activates a T-DATA request primitive in order to send a TSDU. The TS provider transmits the TSDU to the remote TS provider, that issues a T-DATA indication to the called TS user.

The exchange of TSDUs can occur in both directions simultaneously.

The sequence of primitives in a successful data transfer is defined in the following time sequence diagram:

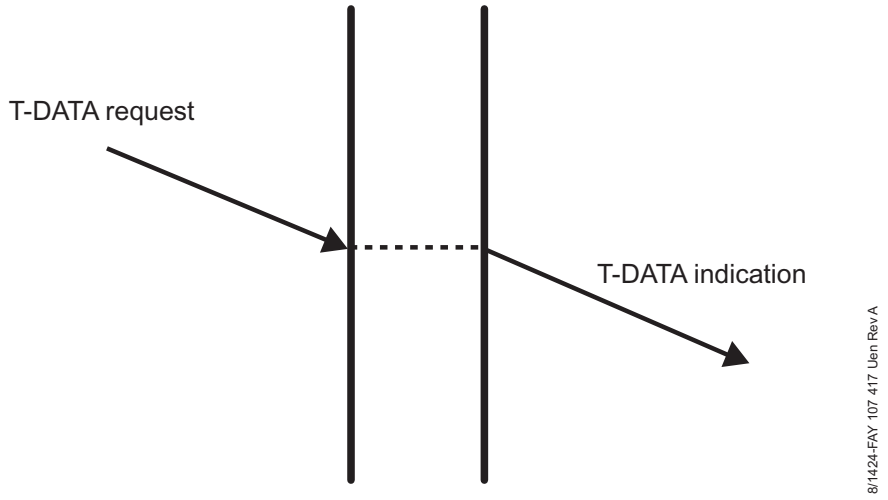

Figure 8 Sequence of primitives in data transfer.

3.3.2.2 Request Parameters

The following parameters are used for making requests:

TS User-Data	Used for the data TSDU that is to be transferred between TS users.
TSDU Reference	This parameter has a local function. A TS user chooses an arbitrary reference to the current TSDU. The reference is not used by the transport layer, but is returned in case of an error situation (see T-DISCONNECT, T-NO-RESPONSE and T-ERROR indication).
Q bit	Qualifier bit.

3.3.2.3 Indication Parameters

The following parameters are used when indications are issued:

TS User-Data	Used for the data TSDU that is to be transferred between TS users.
Q bit	Qualifier bit.

3.3.3 T-DATA-SENT Indication

See chapter 3.2.2 *"T-UNITDATA-SENT Indication"*.

3.3.4 T-DATA-ACK Indication

See chapter 3.2.3 *"T-UNITDATA-ACK Indication"*.

3.3.5 T-DISCONNECT Request, Indication

3.3.5.1 Function

The T-DISCONNECT primitives are used to release a transport connection. The release may be performed:

- by either or both of the TS users to release an established connection;
- by the TS provider, operating in Close Mode, to release an established connection; failures to transmit a TSDU and the non-use of an transport connection are indicated in this way;
- by the TS provider, operating in Close Mode, to indicate its inability to establish a requested connection.

A transport connection can be released either promptly and unconditionally and therefore possibly destructively, or after all previously requested T-DATA have been handled, that is, all TSDUs sent and acknowledged (see chapter 3.3.5.2 *"Request Parameters"*). In the latter case a T-DISCONNECT indication can be invoked to inform about the completion of the request.

A T-DISCONNECT, requesting a non-immediate release, may be followed by an immediate release request.

A transport release is permitted at any time, except for the following. The *non-immediate* T-DISCONNECT request is not permitted when the TS user is waiting for a T-CONNECT confirm.

A T-DISCONNECT indication primitive informs the TS user that a transport connection has been released by the TS provider or by the remote TS user.

The sequence of primitives in the above cases is defined in the following time sequence diagrams:

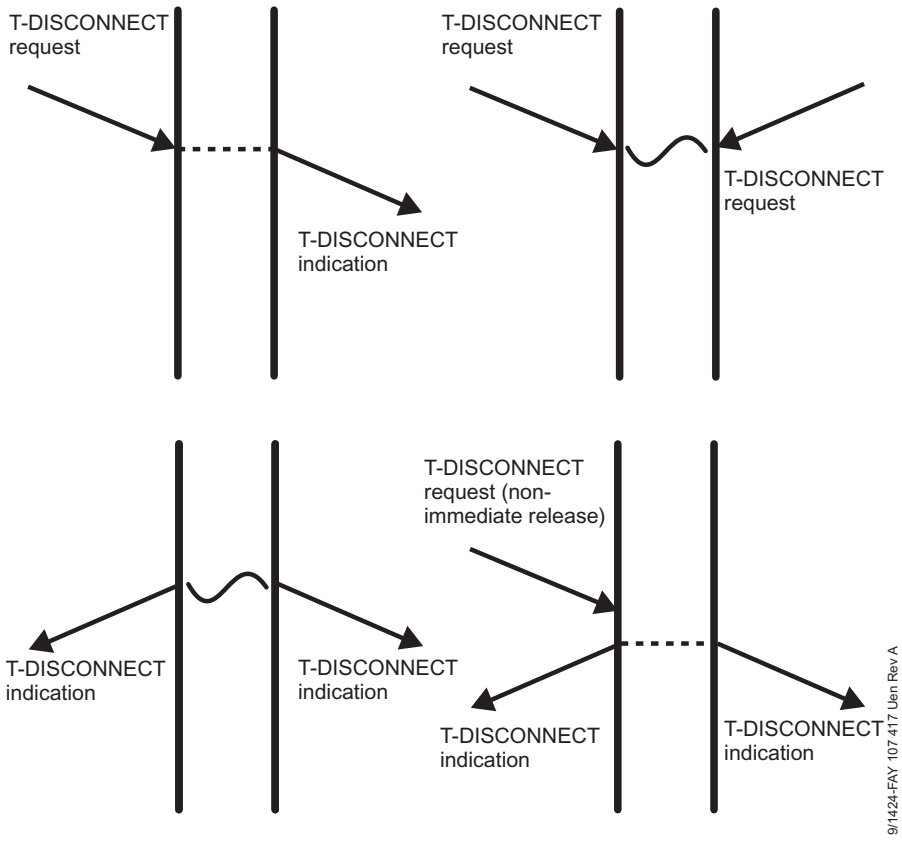

Figure 9 Sequence of primitives in a release invoked by one TS user, both TS users simultaneously, a TS provider, and one TS user (non-immediate release).

A TS user may reject a connection establishment attempt by invoking a T-DISCONNECT request. In the T-DISCONNECT indication, the Reason parameter will indicate that the rejection was initiated by the TS user.

If a TS provider is unable to establish a requested transport connection, it indicates this to the calling TS user by invoking a T-DISCONNECT indication. The Reason parameter will indicate that the rejection was initiated by the TS provider.

The sequence of primitives in these two cases is defined in the following time sequence diagrams:

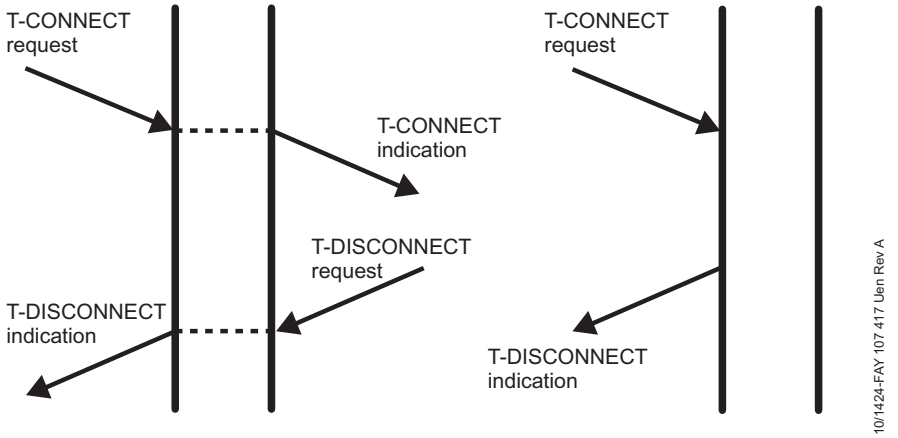

Figure 10 Sequence of primitives in a rejection of a TC establishment attempt invoked by a TS user (left) and a TS provider (right).

If two TS users try to establish a transport connection with each other simultaneously, the TS providers will reject one of the attempts and accept the other one. The TS user whose attempt is rejected will be informed by a T-DISCONNECT indication. The Reason parameter will indicate that the request was rejected due to a simultaneous request from the called TS user. The T-DISCONNECT indication will be followed by a T-CONNECT indication.

The sequence of primitives in a simultaneous connection request is defined in the following time sequence diagram:

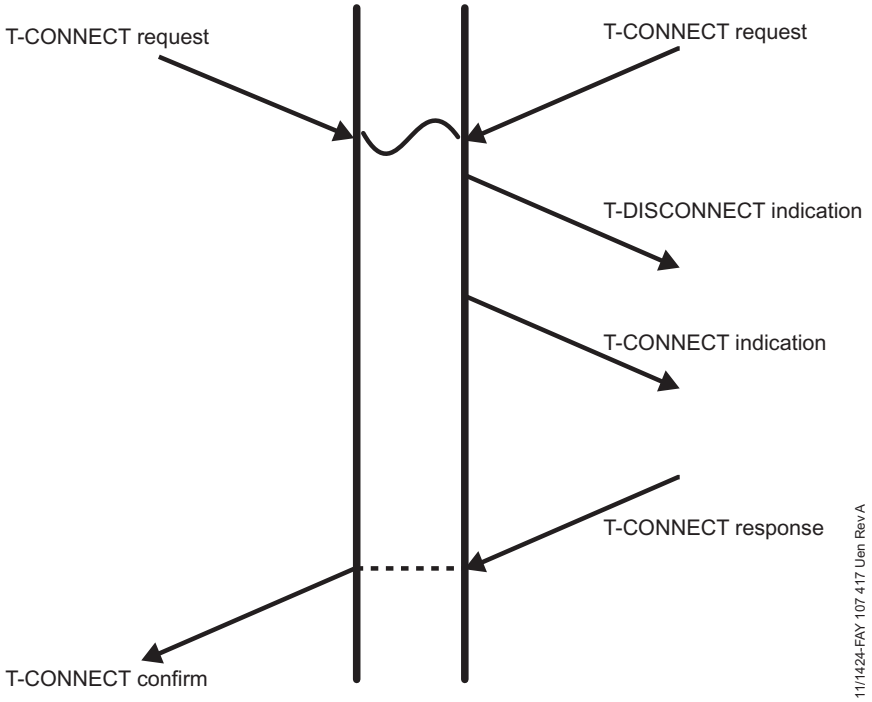

Figure 11 Sequence of primitives in a simultaneous connection request.

3.3.5.2 Request Parameters

The following parameters are used for making requests:

Explicit option	Indicates whether the explicit option is to be utilized when releasing the transport connection.
Immediate selection	Indicates whether the transport connection shall be released immediately or not until all sent TSDUs have been acknowledged.
TS User-Data	This parameter allows the transfer of TS user-data associated with the release. The parameter, if present, shall be in length between 1 and 64 bytes. Note! The first byte of the TS User Data is subject for study.

3.3.5.3 Indication Parameters

The following parameters are used when indications are issued:

TSDU Reference	Returns the TSDU reference of the first TSDU in a succession of TSDUs, if any, handed over to the TS provider but not transmitted and acknowledged before the T-DISCONNECT indication is delivered.
Reason	Conveys the reason for issuing the primitive.
TS User-Data	This parameter allows the transfer of TS user-data associated with the release. The parameter, if present, shall be in length between 1 and 64 bytes. Note! The first byte of the TS User Data is subject for study.

3.3.6 T-NO-RESPONSE Indication

3.3.6.1 Function

The T-NO-RESPONSE primitive is used in the Non-Close Mode.

The primitive informs a TS user that all attempts to establish a requested connection have failed, or that all attempts to transmit a TSDU have failed. In the latter case the transport connection will remain established.

The TS user is assumed to respond in due time, by either invoking a T-DISCONNECT or a T-RETRY.

3.3.6.2 Parameters

The following parameters are used when indications are issued:

TSDU Reference	Returns the current TSDU reference.
Reason	Conveys the reason for issuing the primitive.

3.3.7 T-RETRY Request

3.3.7.1 Function

The T-RETRY primitive is used in the Non-Close Mode.

The use of the primitive must be directly preceded by the reception of a T-NON-RESPONSE indication. The primitive will initiate a number of new transmission attempts.

3.3.7.2 Parameters

None.

3.3.8 T-ERROR Indication

3.3.8.1 Function

The T-ERROR primitive is completely local.

The primitive is used to inform a TS user that the TS provider has rejected a request from the user for local reasons or due to illegal use of primitive (see chapter 3.3.9 *"Sequence of Primitives at one TC Endpoint"*).

Note! In case of transmission failure the T-DISCONNECT or T-NO-RESPONSE primitive will be used.

3.3.8.2 Parameters

The following parameters are used when indications are issued:

TSDU Reference	Returns the current TSDU reference.
Reason	Conveys the reason for issuing the primitive.

3.3.9 Sequence of Primitives at one TC Endpoint

The possible overall allowed sequences of service primitives at a TC endpoint are defined in the following state transition diagram:

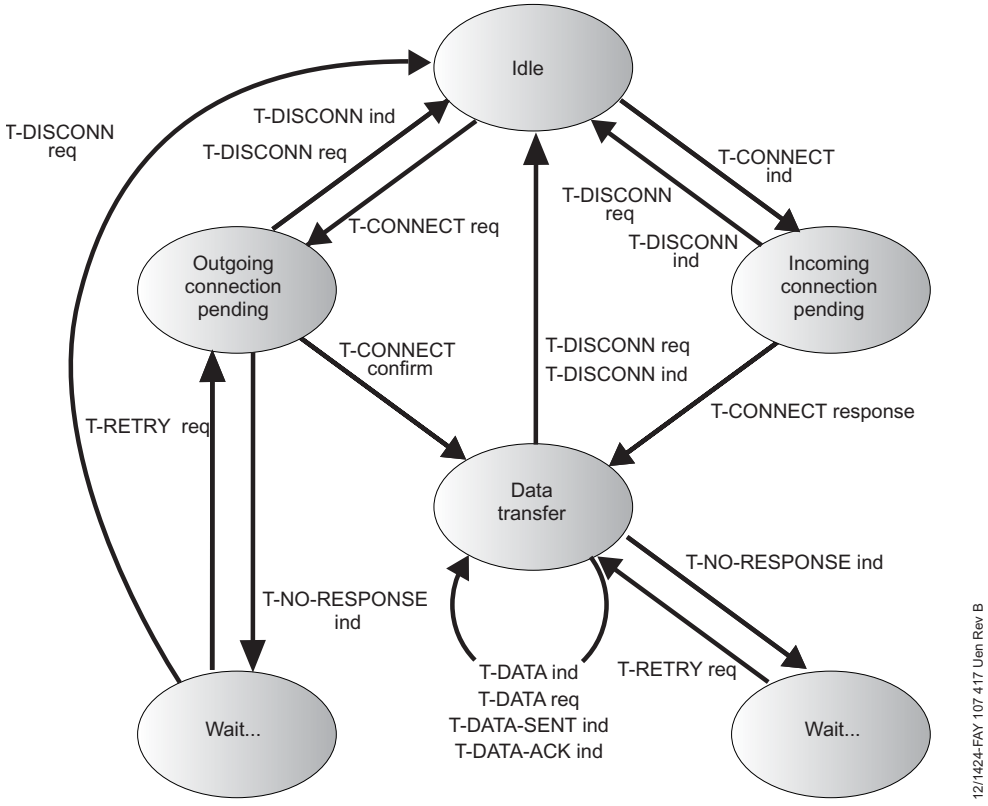

Figure 12 State transition diagram for the connection-mode service.

4 Transport Protocol Specification

This chapter specifies the MTP/1. As an introduction the transport protocol is described in general terms, followed by a survey of the boundaries to the upper and lower layers. The rules for connection establishment, connection release and data transfer are then described in detail. The paper ends with a description of the exact structure and encoding of the data units transferred between two transport entities.

A suggested implementation including state tables can be found in chapter Appendix A: *"MTP/1 Test Suite Structure and Test Purposes"*.

The chapter shall form a base for realization, coding, verification and maintenance of the transport protocol.

4.1 General

4.1.1 Introduction

The transport protocol specified in this chapter is not a standard transport protocol as specified in the OSI model (CCITT X.224/ISO 8073). Neither is it a subset of the standard protocol. Instead it is a simple protocol, adapted for best efficiency in packet radio communication, all in the spirit of the OSI model.

Communication is in duplex and of the end-to-end type.

This protocol contains primitive flow-control functions, segmenting and reassembling, sequential control and error handling. It also includes functions for utilizing the Mobitex mailbox service.

4.1.2 System Environment

MTP/1 (which corresponds to layer 4 of the OSI model) provides services to the nearest higher layer, partly by using functions in layer 4 itself and partly by using functions provided by the nearest lower layer.

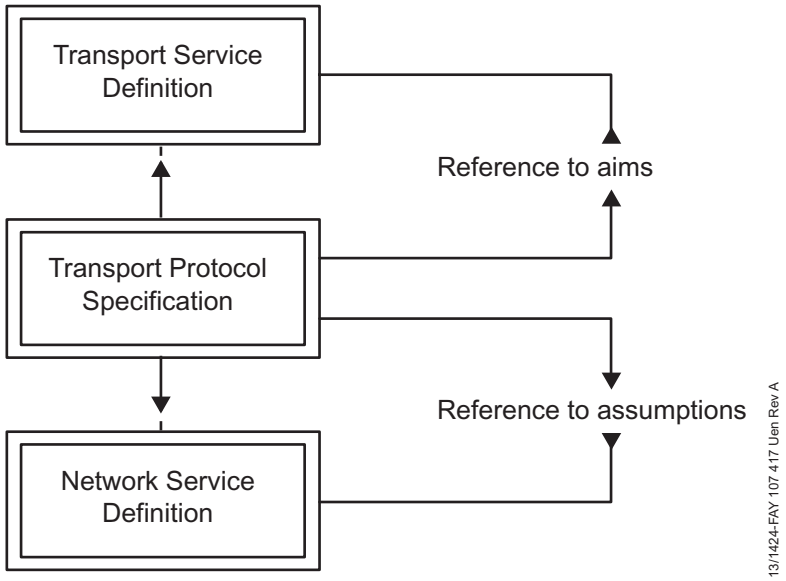

Figure 13 Relationship between MTP/1 and adjacent services.

4.2 Interface

4.2.1 Interface to Upper Layer

This protocol provides the transport service defined in chapter 3 *"Transport Service Definition"*.

Information is sent to and from a TS user through a number of TS primitives.

These primitives (which are listed below) are mainly of two types: request primitives and indication primitives. One response primitive and one confirm primitive are also used. One or more parameters can be associated with each primitive.

The transport service can be utilized in two different ways; as a connectionless-mode service, or as a connection-mode one. In both cases a transport connection will be established by the TS provider in order to send data, but in the first case the connection will be completely hidden for the TS user.

Connectionless-Mode TS Primitives:

- T-UNITDATA request, indication
- T-UNITDATA-SEND indication (local, provider-optional)
- T-UNITDATA-ACK indication (local, provider-optional)
- T-ERROR indication (local)

Connection-Mode TS Primitives:

- T-CONNECT request, indication, response and conform
- T-DATA request, indication
- T-DATA-SEND indication (local, provider-optional)
- T-DATA-ACK indication (local, provider-optional)
- T-DISCONNECT request, indication
- T-ERROR indication (local)
- T-NO-RESPONSE indication (local)
- T-RETRY request (local)

4.2.2 Interface to Lower Layer

Information is sent to and from an NS provider in the network-service primitives listed below.

Network Service Primitives:

- N-DATA request, indication
- N-COM-STATUS indication (local, provider-optional)
- N-ERROR indication (local, provider-optional)
- N-DATA-RET indication (returned MPAK)

4.3 Elements of Procedure

4.3.1 TPDUs Used

The following types of TPDU are used:

CR TPDU	Connection Request TPDU
CC TPDU	Connection Confirm TPDU
CCAM TPDU	Connection Confirm Addressee Modified TPDU
DR TPDU	Disconnect Request TPDU
DT TPDU	Data TPDU
AK TPDU	Data Acknowledgment TPDU

The following TPDU fields are used:

CLOSE	Close Mode Connection
ACK-REQ	Acknowledgment Request
TPDU code	TDPU type code
EOT	End of TSDU Mark
CLN-TSAP	Calling Transport-Service-Access-Point Identifier
CLD-TSAP	Called Transport-Service-Access-Point Identifier
TPDU-NR	DT TPDU Sequence Number
Q-BIT	Qualifier Bit
VER	Version Number
ACK-NR	CC/CCAM, AK and DT TPDU Acknowledgment Number

REASON	Reason code
CM	Connection Mode (Service mode requested by TS user)
SESS	Session Protocol Identifier
CON-ID	Connection Identifier

4.3.2 Network Time

Each TPDU is sent as an HPDATA-type MPAK in the mobitex network. The MPAK header contains a time field, whose value is set when the packet reaches the first node in the network.

The value of the time field shall be used by a transport entity in order to secure the association of a TPDU to a connection.

4.3.3 Timers Used

TWBAK	Timer Wait before sending Acknowledgment
TWBDTR	Timer Wait before data TPDU Retransmission
TI	Inactivity Timer

Timer TWBAK specifies the time within which a receiving transport entity shall acknowledge a data TPDU. The timer is common to all TPDUs belonging to the same connection.

Timer TWBDTR specifies the time after which a sending transport entity shall start a retransmission of an unacknowledged data TPDU.

Its value is given by:

$$TWBDTR >= 2*E + TWBAK_r + X_l$$

where:

E	= maximum transit delay,
$TWBAK_r$	= remote acknowledge time, and
X_l	= local processing time for a TPDU

Timer TI specifies the time after which an un-utilized connection can be considered to be non-existent and the inactivity procedure is to be initiated.

Its value is given by:

$$TI >= (N-1)*TWBDTR + 2*E + X_r + X_l$$

where:

N = maximum number of transmissions,

E = maximum transit delay,

X_r = remote processing time for a TPDU, and

X_l = local processing time for a TPDU.

The timer TI handling shall be able to take care of a value meaning endless inactivity time, that is, the inactivity time will never expire.

Appropriate timer values will be supplied by the Mobitex operator in question.

4.3.4 Parameters Associated with a Connection

Four parameters, available in the connection-mode transport service and associated with the T-CONNECT and the T-DISCONNECT request primitives, control a number of procedures described in the following sections.

4.3.4.1 Close

The CLOSE parameter is associated with the T-CONNECT primitives.

A transport entity shall be able to operate in two different modes; Close Mode and Non-Close Mode.

Close Mode

A transport entity operating in Close Mode will by itself release an established transport connection when:

a) all attempts to transfer a data message has failed;

b) the connection has not been used for data transfer for quite a long time (TI).

When releasing a connection, the transport entity will invoke a T_DISCONNECT indication.

The session layer or the application is responsible for the recovery of the data transfer.

Non-Close Mode

A transport entity operating in Non-Close Mode is deprived of the right to make the decision of releasing an established connection. If all attempts to transfer a data message fail, a T-NO-RESPONSE indication is invoked. Then the upper layer is responsible for activating:

a) a T-RETRY request, initiating a number of new retransmissions; or

b) a T-DISCONNECT request, initiating the release of the connection.

An established transport connection will not be released until a T-DISCONNECT request is activated.

4.3.4.2 Immediate

The Immediate Service is associated with the T-DISCONNECT request.

If the service is requested, a transport connection shall be released promptly and unconditionally. Otherwise all pending TSDUs shall be sent and acknowledged before releasing the connection.

If an immediate release is requested in a recent primitive, it has preference over a former requested non-immediate release.

Note! In the remaining part of the chapter release procedures are described according to the immediate alternative.

4.3.4.3 Explicit

The Explicit Service is associated with the T-CONNECT request, the T-CONNECT response, and the T-DISCONNECT request.

The service offers a possibility to force a transport entity to send a DR TPDU to a remote entity as a part of the connection release procedure. However, if the release is a result of a retransmission on time-out failure, the DR TPDU shall not be sent.

The default value of the parameter, used by a responder in Close Mode, is non-use of the service.

The parameter value conveyed in a T-DISCONNECT request has preference over a value conveyed in a former T-CONNECT primitive.

4.3.4.4 Mailbox

The Mailbox Service is associated with the T-CONNECT request and response primitives.

The service offers a possibility to utilize the optional Mobitex Mailbox Service.

4.3.5 Connection Establishment

4.3.5.1 Normal Connection Establishment

Connection Establishment is used to establish a connection between two transport entities.

The following TPDUs and parameters are used:

TPDU type	Parameter
CR TPDU	VER ACK-REQ CLOSE SESS CM CON-ID
CC TPDU	CON-ID

A connection is established by a transport entity (initiator) sending a CR TPDU to another transport entity (responder) which, in turn, responds with a CC TPDU with or without piggy-back user data.

The initiator chooses a reference, the connection identifier, to be used in the CON-ID field of all transmitted CR, CC and DR TPDUs associated to the connection. It is recommended to choose the first value randomly and then increment the value by 1 for subsequent connections.

The identifier is arbitrary and can take any value, except for zero.

The CM parameter in the CR TPDU indicates the service mode requested by the user; the connectionless user service or the connection-oriented one.

In the case of the connectionless-mode service the responder shall send the CC TPDU within TWBAK seconds or, if the ACK-REQ in the CR TPDU is set, without any delay.

In connection-mode the responder shall invoke a T-CONNECT indication handing over the parameter values contained in the SESS field and the CLOSE field. If a complete TSDU is contained in the CR TPDU the TSDU shall, together with the associated value of the Q-BIT field, be included in the T-CONNECTION indication. The responder now has to wait for a T-CONNECT response before sending the CC TPDU (without any further delay).

As far as the responder is concerned the connection has been established as soon as the CC TPDU has been sent.

In case of the initiator: timer TWBDTR will be started when the CR TPDU is sent. The transport entity shall then be prepared to receive and process all types of TPDU.

The initiator must not send any DT TPDUs until a CC TPDU has been received from the responder establishing the connection.

The value of the time field in the MPAK containing the received CR/CC TPDU defines the connection establishment time.

If no confirm is received within TWBDTR seconds the connection attempt shall be repeated. After a number of unsuccessful attempts to retransmit, a T-DISCONNECT/T-NO-RESPONSE indication (a T-ERROR indication for each pending T-UNITDATA request in connectionless-mode) shall be invoked.

When an unexpected duplicated CR TPDU is received, a CC TPDU shall be returned (see chapter 4.3.8 *"Association of TPDUs with Transport Connections"*).

If a connection already exists when a CR TPDU with a connection identifier not allocated to the connection is received, the current connection must first be terminated and a T-DISCONNECT indication (a T-ERROR indication for each pending T-UNITDATA request in connectionless-mode) invoked. No DR TPDU shall be sent. The new connection shall then be established as described above.

Only one connection can be established for each combination of calling and called address.

4.3.5.2 Negotiation During Connection Establishment

The initiator shall propose a connection mode, that is, Close Mode or Non-Close Mode, and a version number. The initiator should assume, when it sends the CR TPDU, that its proposed mode and version will be agreed to.

If the responser is unable to accept the proposal, it is free to select a response according to the following:

- A version number may be reduced stating an older version than the requested. In this case user data, if any, contained in the CRTPDU shall be discarded. The initiator will retransmit the data in a DT TPDU.
- Close Mode may be modified to Non-Close Mode. (Note that the mode selection is controlled by the responding TS user and not by the provider.)

4.3.5.3 Simultaneous Connection Requests

A CR TPDU, reaching an initiator waiting for a CC TPDU, is defined as a simultaneous connection request.

The following TPDUs and parameters are used:

TPDU type	Parameter
CR-TPDU	CON-ID

An initiator receiving a simultaneous connection request shall:

a) If the CON-ID value of the received CR TPDU is less than the transmitted CON-ID value, then discard the received CR TPDU without any further action;

b) If the CON-ID value of the received CR TPDU is greater than the transmitted CON-ID value, then discontinue the connection request attempt initiated by the local TS user and invoke a T-DISCONNECT indication primitive. Then the received CR TPDU shall be handled as a normal connection request;

c) If the value of the two CON-ID fields are equal use the sender MAN when deciding to back off or not. If the received MAN is less than the own one, then apply a), otherwise apply b).

The T-DISCONNECT indication shall contain a reason code that indicates that the previous T-CONNECT request issued by the TS user is rejected due to a simultaneous connection request.

4.3.5.4 Host Group Addressing (HGA)

The HGA concept puts some additional requirements on MTP/1. If a mobile sends a transport connection request to a logical MAN, the MTP/1 will return to the physical MAN, and the mobile will use the physical MAN in the following MPAKs. This will among other things impose a TPDU type called CCAM.

In order to guarantee robustness a transport entity must be able to recognize the CCAM TPDU, and if it does not want to deal with it, it must at least respond with a DR TPDU stating the reason for the refusal.

HGA and the Transport Service

HGA will not affect the Transport Service Definition as defined in terms of primitives and parameters associated with the primitives.

A fixed terminal, or an X.25 gateway, TS user will use its physical MAN as Sender. The Addressee will always be a physical MAN.

A mobile TS user can utilize a physical MAN or a logical MAN as Addressee. If a logical MAN is utilized, the TS provider will continue using the logical MAN in the communication with the TS user throughout the lifetime of the utilized connection.

HGA and the Transport Protocol

A transport entity receiving a CR TPDU with a logical MAN as Addressee shall apply the normal rules for connection establishment with the following three exceptions:

1. A specific confirm TPDU, Connection Confirm Addressee Modified, shall be used instead of the normal CC TPDU. In addition to the fields included in a CC TPDU, the CCAM TPDU comprises a 3-byte MAN-field, conveying the physical MAN of the responder. The logical MAN shall be used as a sender.

2. The logical MAN shall be mapped to the physical MAN. The physical MAN shall henceforth be used to identify the connection in the communication, both with the peer transport entity and the TS user;

3. If the combined addresses, the mapped physical MAN, the MAN of the initiator and the sub-addresses if any, already is utilized for an existing connection, the connection request shall be refused.

A transport entity receiving a CCAM TPDU shall:

1. Register the physical MAN, received in the MAN-field of the CCAM TPDU, to be used as the addressee of the transport connection from now on.

2. Accept and use the logical MAN in all TS user requests and indications, mapping it to/from the physical MAN used internally.

Note! If more than one Host Group is associated to the same physical MAN, only one of the Host Groups can be involved in a connection with a specific mobile at the same time (without utilizing a sub-address)

4.3.6 Connection Refusal

The connection refusal procedure is used when a transport entity refuses a transport connection in response to a CR TPDU.

The following TPDUs and parameters are used:

TPDU type	Parameter
DR TPDU	VER REASON CON-ID

If a transport connection cannot be accepted, the responder shall respond to the CR TPDU with a DR TPDU. The REASON parameter shall indicate why the connection was not accepted. The responders own version number shall be set in the VER parameter. (User data contained in the CR TPDU can be discharged.)

An initiator receiving a DR TPDU shall regard the connection as released and invoke a T-DISCONNECT indication if providing the connection-mode service.

4.3.7 Connection Release

This is used to terminate a connection between two transport entities.

The following TPDUs and parameters are used:

TPDU type	Parameter
DR TPDU	VER REASON CON-ID

The release procedure may be performed:

a) spontaneously and independent of the other party, for example, when contact with the network is lost, when there is no data to be sent, when communication does not function despite a number of retransmission attempts and when a receiver no longer receives new TPDUs (applicable in Close Mode).

b) as a result of a T-DISCONNECT request from an upper layer (applicable in both Close and Non-Close Mode)

When the release of a transport connection is to be initiated, a transport entity shall:

1. Optionally send a DR TPDU (see chapter 4.3.4.3 *"Explicit"*), unless the release is a result of a retransmission on time-out failure. Consider the connection released;

Note! It is strongly recommended to send an AK TPDU to the peer transport entity before the connection is released (the DR TPDU is sent), if the following is applicable: The release is a result of a T-DISCONNECT requesting a non-immediate release *and* all received user data has been delivered to the TS user *but* some of the received user data is unacknowledged.

2. Invoke a T-DISCONNECT indication (a T-ERROR indication for each pending T-UNITDATA request in connectionless-mode) and discard saved TPDU copies;

3. discard received TPDUs if any.

A transport entity that receives a DR TPDU shall:

1. If it has previously sent a CR TPDU that has not been acknowledged by a CC/CCAM TPDU, consider the connection refused, otherwise consider the connection released.

2. Invoke a T-DISCONNECT indication (a T-ERROR indication for each pending T-UNITDATA request in connectionless-mode) and discard saved TPDU copies;

3. Discard received TPDUs if any.

Note! Due to the one minute resolution of the Mobitex time stamp a transport entity shall not re-establish a connection by sending a CR TPDU or CC/CCAM TPDU within one minute after sending a DT TPDU that has not been acknowledge for sure. In the case of retransmission, the last sent DT TPDU must be regarded as unacknowledged.

4.3.8 Association of TPDUs with Transport Connections

This procedure is used to interpret a received NSDU as a TPDU and to associate the current TPDU with a connection.

TPDUs and parameters used:

CR, CC/CCAM and DR TPDU	CLN-TSAP CLD-TSAP CON-ID
DT and AK TPDU	CLN- TSAP CLD-TSAP

If a TPDU cannot be interpreted it is a local matter to discard it or bypass it to the upper layer. This also applies to an NSDU with an incorrect value set in the Protocol ID parameter (Protocol Identifier in MPAK HPDATA header).

The Calling Address and the Called Address in N-DATA indication, the CLN-TSAP, the CLD-TSAP and in the case of the CR, CC/CCAM, and DR, the CON-ID are used to identify the current connection.

If the received TPDU is a CR TPDU, then:

a) if it is a duplicate as recognized by the address parameters and the CON-ID, then it is associated with the transport connection created by the original copy of the CR TPDU;

    1. if a CC/CCAM has been sent, but no DT TPDU has been received on the connection, the CC/CCAM TPDU shall be retransmitted;

    2. otherwise, the CR TPDU shall be discarded.

b) if the address parameters are allocated to a transport connection, but the CR TPDU is not a duplicate, and the value of the time field is less than or equal to the transport connection establishment time, then the CR TPDU shall be discarded;

c) otherwise, it is processed as requesting the creation of a new transport connection.

If the received TPDU is a CC/CCAM TPDU, then:

a) if the address parameters and the CON-ID are allocated to a transport connection, then the TPDU is associated with the transport connection;

b) otherwise, the TPDU shall be discarded and a DR TPDU sent back. The reason code shall be set to 6 (No connection established).

If the received TPDU is a DR TPDU, then:

a) if the address parameters and the CON-ID are allocated to a transport connection, or the address parameters are allocated to a transport connection and the CON-ID is equal to zero, then the TPDU is associated with the transport connection;

b) otherwise, the TPDU shall be discarded.

If the received TPDU is a DT TPDU or an AK TPDU, and the address parameters are allocated to a transport connection, then:

a) if the value of the time field is greater than or equal to the transport connection establishment time, then the TPDU is associated with the transport connection;

b) otherwise, the TPDU shall be discarded.

If the received TPDU is a DT TPDU and the address parameters are not allocated to an established transport connection, then;

a) if a CR TPDU has been sent, but no CC TPDU has been received on the connection, the DT TPDU can either be discarded or stored for later handling, but no other action shall be taken;

b) otherwise the TPDU shall be discarded and a DR TPDU sent back. The connection id shall be set to zero and the reason code shall have the value 6 (No connection established).

If none of the above is applicable, the TPDU shall be discarded, and no other action taken.

4.3.9 Data Transfer

The purpose of data transfer is to permit transmission of TSDUs between two TS users connected by a transport connection. This is achieved by means of two-way simultaneous communication and by the procedure described in the following sections.

Error Detection and Flow Control Overview

In MTP/1 the transport entity uses ARQ (Automatic Repeat Request), to determine whether the receiving entity has correctly received a transmitted TPDU or not.

The two most common derivatives of the basic ARQ scheme are Idle RQ and Continuous RQ, where Continuous RQ normally can be divided into the two sub-categories Selective Re-transmission and Go-Back-N Mechanism. The two mentioned sub-categories of Continuous RQ both treat out of sequence data frames or ACK frames as erroneous, which is not a valid assumption in the Mobitex network.

The above mentioned schemes were designed for media where packet arrives in the same order they were sent, they are usually used for error detection and flow control in point to point data-links.

In the table below you will find some characteristics of traditional ARQ:

ARQ-group and ARQ-scheme	Basic Features
Idle RQ Send-and-wait	- If the sender of a data frame does not receive an ACK frame within a time-out interval the data frame is re-transmitted. - There is only one outstanding frame, that is, the sender waits for an ACK for the previously sent data frame before a new frame is sent. - Requires minimum buffer storage. - Low link utilisation.
Continuous RQ Selective Re-transmission	- The sender detects an out of sequence ACK frame request, and as a response re-transmit just the unacknowledged frame(s). - One ACK frame is sent for each data frame. - Requires large buffer storage. - High link utilisation.
Continuous RQ Go-Back-N	- The receiver detects an out of sequence data frame and request the sender to re-transmit all outstanding unacknowledged data frames from the last correctly received, and therefore acknowledged frame. This can be done by the use of a NAK frame. - One ACK frame is sent for each data frame - More than one outstanding frame - Requires large buffer storage - High link utilisation

The nature of radio transmission in general and the Mobitex network in particular forces us to take a few other things into consideration when choosing algorithms for error detection and flow control in MTP/1.

- Mobitex does not guarantee that the packets arrives in the same order that they are sent.
- Mobitex works with negative acknowledgment.
- Every packet sent in Mobitex is paid for by the sender.
- The throughput is low, compared to land line data media.
- We have to consider cases of temporary lost coverage.

These facts forced the development of a new error detection and flow control algorithm. This new algorithm allows the combination of continuous RQ and idle RQ, which allows the user to get high efficiency and low cost data transfer.

The MTP/1 Concept

In the initial and normal error free case, the sender uses continuous RQ. The sender can have up to the transmit window of outstanding packets. The receiver does only have to send one acknowledge for a whole window of received packets. In others words a received ACK indicates that all previous frames also are acknowledged.

If a time-out occurs to indicate an error the MTP/1 protocol allows two possible ways to handle the RQ:

- The sender will only send out one frame, this time with the A-R bit in the DT TPDU set. This demands the receiver to send an acknowledgment immediately, which mean that we change to an idle RQ scheme temporarily. If an acknowledgment is received the sender will go back to the continuous RQ scheme again.

  An advantage with this method is that no additional traffic is generated.

  A disadvantage is that the utilization of the link is low when doing this, since we are now actually using the idle RQ scheme.

- The sender will send out a complete window of frames, without the ACK-REQ bit in the DT TPDU set. This is then repeated if it fails again.

  An advantage with this method is the high link utilization, which will be of use if the retransmission was due to a temporary out of coverage.

  The disadvantage with this method is that we might end up sending an unnecessary amount of packets. Which is the expected case since the strategy reminds of the traditional Go-Back-N scheme.

4.3.9.1 Segmenting and Reassembling

The transport layer is responsible for ensuring that, if necessary, data TSDUs are segmented into a number of TPDUs before transmission and that they are reassembled after reception.

The following TPDUs and parameters are used:

TPDU type	Parameter
CR, CC/CCAM and DT TPDU	EOT

Information is transferred as CR, CC/CCAM and DT TPDUs and the EOT parameter specifies the last block of the sequence.

4.3.9.2 Sequence Numbering of Data TPDUs

Sequence numbers are assigned to all DT TPDUs to ensure that:

- it is on reception possible to reassemble messages that have been segmented into several blocks before sending;
- messages are delivered to the TS user in the order in which they were sent;
- the transfer rate can be controlled;
- that the transmission can be restarted in a controlled manner after the occurrence of transmission errors.

The following TPDUs and parameters are used:

TPDU type	Parameter
DT TPDU	TPDU-NR

The first sequence number is zero (0), regardless of if the CR and CC TPDUs contained user data, and subsequent sequence numbers shall be assigned consecutively in increasing order and with an increment of 1.

When retransmitting a block the same sequence number shall be used as was used in the original transmission.

4.3.9.3 Resequencing

A receiving transport entity delivers the messages to the TS user in the order specified by the sequence number.

If a data TPDU is received out of sequence but within the receive window (see chapter 4.3.9.4 *"Flow Control"*) the block shall be buffered until it can be delivered in the correct order. Blocks outside the receive window shall be discarded. However the reception must initiate a new acknowledgment (see chapter 4.3.9.5 *"Transmission of Acknowledgments"*) as the retransmission can be the result of a lost AK TPDU.

If the sequence number space, combined with the network throughput, demands for rogue packet handling, the following definition shall be applied:

- A rogue packet is a packet having a time stamp less than the earliest time stamp of the 8 packets whose sequence numbers fall below the receive lower window edge.

Copies, that is, a data TPDU that has a TPDU-NR that is identical to a previously received, unacknowledged data TPDU, shall be discarded.

4.3.9.4 Flow Control

Flow control is used to control the transfer rate between two transport entities and thus prevent the occurrence of situations where a receiving entity cannot accept a DT TPDU, for example, due to insufficient buffer space.

During system configuration a common window size (CDT-CONST) is permanently defined for all transport entities. This cannot subsequently be altered.

The following TPDUs and parameters are used:

TPDU type	Parameter
CR and CC/CCAM TPDU	ACK-REQ
DT TPDU	ACK-REQ ACK-NR
AK TPDU	ACK-NR

When a connection is established by the transmission or reception of a CC/CCAM TPDU the transport entities set the lower and upper edges of the receive and transmit windows.

The upper edges shall be set to the value of the corresponding lower edges plus CDT-CONST. Flow control is then implemented through the receiving transport entity acknowledging received data TPDUs and thus indirectly moving the upper and lower window edges. The receive window edges must not be moved until an acknowledgment is sent.

A transport entity that receives an AK or a DT TPDU shall consider ACK-NR as the new lower edge of the transmit window and the sum of ACK-NR and CDT-CONST as the new upper edge. The CC/CCAM TPDU can be regarded as having a ACK-NR of zero.

User data in a CR TPDU is indirectly acknowledged by the CC/CCAM TPDU. User data in a CC TPDU is indirectly acknowledged by the first incoming DT or AK TPDU.

By setting the ACK-REQ parameter a sending transport entity can at any time request immediate acknowledgment of the transmitted data TPDU (and thus indirectly request acknowledgment of all previously transmitted data TPDUs).

ACK-NR in AK and DT TPDU must always be within the transmit window and must never exceed the value of the highest received sequence number plus one.

A transport entity can send an exact copy of a previously sent AK TPDU.

4.3.9.5 Transmission of Acknowledgments

The transmission of acknowledgments is used to inform a sending transport entity that an unbroken sequence of data TPDUs has been received.

The following TPDUs and parameters are used:

TPDU type	Parameter
AK and DT TPDU	ACK-NR

Acknowledgments are sent either with AK TPDU or piggy-backed on a DT TPDU. (The first user data contained in the CR TPDU is indirectly acknowledged by the CC/CCAM TPDU.)

ACK-NR shall be set to the highest consecutive sequence number of the data TPDUs received within the transmit window plus 1.

On condition that it is not already active, timer TWBAK shall be started when a data TPDU is received. An acknowledgment shall be sent to the original sender within TWBAK seconds.

When a data TPDU is received with ACK-REQ set the acknowledgment shall instead be sent as soon as the acknowledgment condition of the received TPDU is satisfied, that is, after the receipt of all data TPDUs that are within the transmit window and that have sequence numbers lower than the current data TPDU.

An acknowledgment shall be sent not later than the reception of a data TPDU with a sequence number equal to the upper receive window edge minus 1. This is because the sender will then have utilized the entire transmit window and will not be able to send additional data TPDUs. So, a sending entity should never set the ACK-REQ parameter in a TPDU that is the last one in the transmit window, because that may result in more AK TPDUs than necessary being sent.

Timer TWBAK shall always be stopped when an acknowledgment is sent.

4.3.9.6 Sequencing of Received Acknowledgments

If the ACK-NR of an acknowledgment is lower than previously received ACK-NRs the received acknowledgment shall be considered to be out of sequence and it shall be ignored. (An ACK-NR that is lower than a previously received number but is within the transmit window shall be defined as an ACK-NR greater than the previously received number (modulo effect).)

4.3.9.7 Retention Until Acknowledgment of Data TPDUs

A transport entity that sends data TPDUs shall save copies of the transmitted information until an acknowledgment is received from the receiving transport entity, either as CC/CCAM or AK TPDU or as DT TPDU with a piggy-back acknowledgment.

The following TPDUs and parameters are used:

TPDU type	Parameter
CR and CC/CCAM TPDU	
DT TPDU	TPDU-NR
AK and DT TPDU	ACK-NR

4.3.9.8 Retransmission on Time-Out

This procedure is used to handle TPDUs that become lost on the way between two transport layer entities.

The following TPDUs and parameters are used:

TPDU type	Parameter
CR and CC/CCAM TPDU	
DT TPDU	TPDU-NR ACK-REQ

When a transport entity sends a data TPDU, timer TWBDTR shall be started to check that an acknowledgment arrives within TWBDTR seconds.

The term “current data” corresponds to the first sent data TPDU that has not been acknowledged.

If no acknowledgment is received within this time the sending entity shall apply one of the following alternatives:

a) retransmit the current data TPDU and restart the TWBDTR timer, and continue to send all unacknowledged queued up TPDUs;

b) retransmit the current data TPDU with the ACK-REQ flag set and restart the TWBDTR timer. Disable retransmission of TPDUs other than the current one.

   When the retransmitted TPDU is acknowledged, enable retransmission and send all unacknowledged queued up TPDUs.

In the event of retransmission ACK-NR must be updated to reflect the current situation. ACK-REQ can also be modified. The other parameters shall remain unaltered.

After a number of unsuccessful attempts to retransmit, a transport entity shall:

a) if in the Close Mode, invoke a T-DISCONNECT indication (a T-ERROR indication for each pending T-UNITDATA request in connectionless-mode). The connection shall then be terminated and saved TPDU copies shall be discarded;

b) if in the Non-Close Mode, invoke a T-NO-RESPONSE indication for the current T-DATA request and wait for:

    1. a T-RETRY request initiating a number of new retransmissions;

    2. a T-DISCONNECT request initiating the connection release procedure.

4.3.9.9 Sending Entity out of Network Coverage

If the mobile network layer entity indicates a loss of network contact by activating an N-COM-STATUS[1] indication, the transport entity shall stop sending TPDUs. The TI timer will not be restarted.

If the TI time expires the inactivity control procedure shall be applied.

On the receipt of an N-COM-STATUS indication, informing the transport entity that the network layer entity has regained network contact, the transmission of TPDUs may be resumed and the TI timer restarted.

4.3.9.10 Receiving Entity out of Network Coverage

See chapter 4.3.4.4 *"Mailbox"*.

4.3.9.11 Inactivity Control

The inactivity control is only used in Close Mode. When providing the Non-Close Mode the inactivity timer, TI, shall never be started.

In Close Mode timer TI is used to ensure that an established connection is really used for communication. TI shall be restarted each time a relevant TPDU is sent or received.

If the inactivity time expires a transport entity shall restart the TI timer once more, and:

a) if a T-UNITDATA request is activated by the upper layer, terminate the current connection and then send a CR TPDU establishing a new connection (connectionless-mode);

b) if a T-DATA request is activated by the upper layer, initiate the connection release procedure (connection-mode);

c) if a data TPDU is received apply the normal data transfer procedures;

d) if the inactivity time TI expires initiate the connection release procedure.

1. N-COM-STATUS is a local primitive.

4.3.9.12 Mailbox

The optional Mobitex Mailbox Service is utilized when the receiving part can not be reached and the use of the Mailbox Service is authorized by the T-CONNECT primitive.

In this case the mailbox procedure will replace the normal retransmission on time-out procedure.

The following TPDUs and parameters are used:

TPDU type	Parameter
CR and CC/CCAM TPDU	
DT TPDU	TPDU-NR ACK-REQ
AK and DT TPDU	ACK-NR

If no acknowledgment of a sent data TPDU is received within TWBDTR seconds, the sending entity shall retransmit the current data TPDU with the ACK-REQ flag set and request the Mobitex mailbox service. The entity shall disable retransmission of TPDUs other than the current one, and start the TWBDTR timer.

Then there are four cases:

a) If a “Has been placed in the mailbox” acknowledgment is received, the transport entity shall stop the TWBDTR timer, issue a T-NO-RESPONSE if in the Non-Close Mode, and:

   1. if a CC/CCAM TPDU, AK TPDU or DT TPDU is received, acknowledge the retransmitted data TPDU, enable retransmission and send all unacknowledged queued up TPDUs;

   2. if the inactivity time expires initiate the connection release procedure (Close Mode);

   3. otherwise, wait for a TS-user's initiative (Non-Close Mode).

b) If the retransmitted TPDU is returned without being placed in the mailbox, the normal retransmission on time-out procedure shall be applied.

c) If a CC/CCAM TPDU, AK TPDU or DT TPDU is received, acknowledging the retransmitted data TPDU, the transport entity shall enable retransmission and send all unacknowledged queued up TPDUs;

d) If the TWBDTR time expires the normal retransmission on time-out procedure can be applied.

In the event of retransmission ACK-NR must be updated to reflect the current situation. The other parameters shall remain unaltered.

4.4 Structure and Encoding of TPDUS

4.4.1 Location in MPAK of TPDUs

A TPDU is sent as an HPDATA-type MPAK, without address list, and is located in the data section of the MPAK, starting at byte 13. The general appearance of the MPAK is shown below:

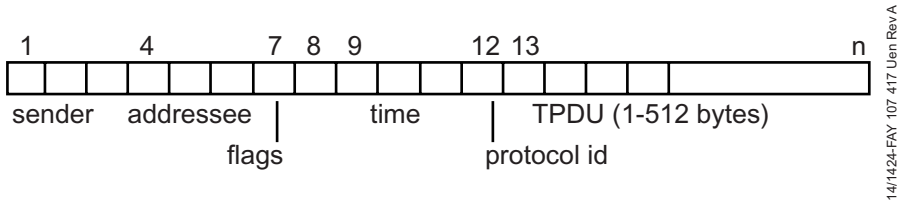

Figure 14 General appearance of the MPAK

In order to minimize the necessary MTP/1 overhead in each packet, some fields in the MPAK header are utilized by the protocol.

The fields concerned are:

Sender	Constitutes together with the CLN-TSAP field the TS user Calling Address
Addressee	Constitutes together with the CLD-TSAP field the TS user Called Address
Traffic state	Included in the flag field. Inspected when a TPDU (MPAK) is returned
Mailbox flag	Included in the flag field. Utilised when the Mailbox procedure is requested
Time	Used to secure the association of a TPDU to a connection
Protocol id	The MPAK HPDATA protocol id assigned to MTP/1 is 003

4.4.2 General

The bytes of a TPDU are numbered from 1 and upwards. The bits of each byte are numbered from 1 to 8, where 1 is the least significant bit.

In general a TPDU comprises:

a) header
   - fixed part
   - variable part (optional parameters)

b) user data (used by CR, CC/CCAM and DT TPDUs)

The general appearance of a TPDU is shown below:

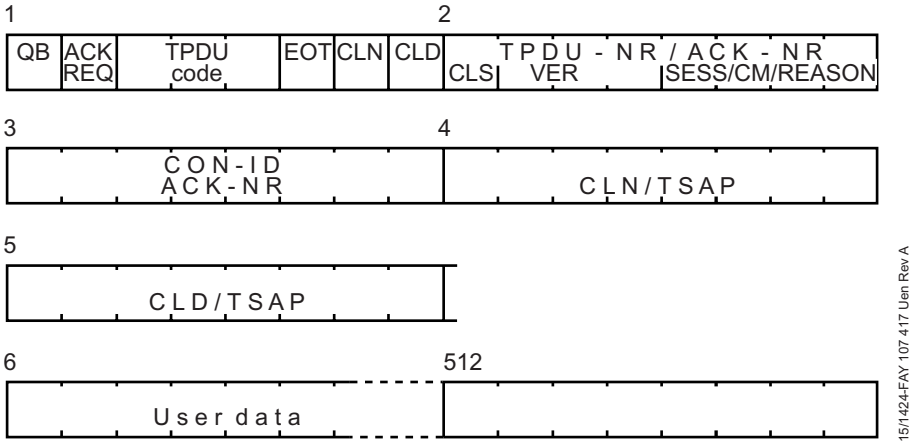

Figure 15 General appearance of a TPDU

4.4.3 TPDU Fields

QB (Q-BIT)

A flag that contains an indicator, the qualifier bit, associated to the user data. The flag shall have the same value in all TPDUs of the same TSDU. It is specified by bit 8 of byte 1 and of significance for CR, CC/CCAM and DT TPDUs containing user data.

ACK-REQ

A flag which, when set to 1, indicates that the receiver shall send an acknowledgment as soon as the acknowledgment condition of the current TPDU is satisfied. It is specified by bit 7 of byte 1. It is of significance for CR, CC/CCAM and DT TPDUs.

TPDU Code

A field that indicates TPDU type. Bits 6-4 of byte 1 are used as follows:

TPDU code = 0	DT	Data
TPDU code = 1	AK	Acknowledgment
TPDU code = 2	CR	Connection Request
TPDU code = 3	CC	Connection Confirm
TPDU code = 4	DR	Disconnection Request
TPDU code = 5	CCAM	Connection Confirm Addressee Modified
TPDU code = 6	reserved for future use	
TPDU code = 7	reserved for future use	

EOT

A flag which, when set to 1, indicates that the current data TPDU is the last in a TSDU. It is specified by bit 3 of byte 1. It is of significance for CR, CC/CCAM and DT TPDUs.

If no user data is contained in the TPDU the EOT flag shall be ignored by the receiving entity.

CLN

A flag which, when set to 1, indicates that the TSAP-ID of the sending unit follows in field CLN-TSAP in the variable part. If the TSAP is not used the CLN field shall be set to 0. It is specified in bit 2 of byte 1. It is of significance for all TPDUs.

CLD

A flag which, when set to 1, indicates that the TSAP-ID of the receiving unit follows in field CLD-TSAP in the variable part. If the TSAP is not used the CLD field shall be set to 0. It is specified in bit 1 of byte 1. It is of significance for all TPDUs.

TPDU-NR

Sequence number of DT TPDUs. It is specified by byte 2 and can take values from 0 to 255. It is of significance for all DT TPDUs.

ACK-NR

Sequence number when acknowledging. ACK-NR is specified by byte 2, for AK-TPDU, or byte 3, for DT TPDU. It can take values from 0 to 255. Sequence number specifies the next expected DT TPDU sequence number. It is of significance for acknowledgment with AK TPDUs and DT TPDUs with piggy-back acknowledgment.

CLS (CLOSE)

The CLOSE parameter is utilized when establishing a connection providing the connection-mode transport service (CM flag equal to 1).

A flag which, when set to 0, indicates that the transport entity is deprived of the right to make the decision of releasing a connection. Instead the release procedure is controlled by the T-NO-RESPONSE indication, the T-DISCONNECT request, and a received DR TPDU. The CLOSE parameter is specified by bit 8 of byte 2. It is of significance for CR and CC/CCAM TPDUs.

(When establishing a connection providing the connectionless-mode service (CM flag equal to 0), the CLOSE flag shall always be set to 1 by the sending entity and ignored by the receiving entity.)

VER

The version number of the transport protocol. It is specified in bits 7-5 of byte 2 and can take a value of between 0 and 7. The first version is No. 0 (zero).

This field is used when establishing and releasing a connection utilizing the CR, CC/CCAM and DR TPDUs.

REASON

Defines the reason for disconnecting a transport connection. Bits 4-1 of byte 2 are used as follows:

0	Reason not specified
1	Congestion at TSAP
2	Normal disconnect initiated by the session entity
3	Reserved for future use
4	Connection refusal at connect request time
5	Connection closed due to previous inactivity time-out
6	No connection established
7	HGA not implemented
8-15	Reserved for future use

The field is of significance for DR TPDUs.

SESS

A field that contains a session protocol identifier. It is specified in bits 4-2 of byte 2. It is of significance for CR TPDUs and can take values from 0 to 7. (A SESS value of zero indicates that no higher protocol is used.)

CM

A flag which indicates the service mode requested by the TS user. When set to 1 the connection mode is requested, when set to 0 the connectionless one is requested. The flag is specified by bit 1 of byte 2. It is of significance for CR TPDUs.

CON-ID

The identifier of the connection. It is specified in bits 8-1 of byte 3. The CON-ID is only included in the CR, CC/CCAM and DR TPDUs. In a CR or CC/CCAM TPDU it can take values from 1 to 255, in a DR TPDU from 0 to 255.

CLN-TSAP

This field specifies the transport service access point of the sending unit. CLN-TSAP is specified in bits 8-1 of byte 3 or 4 depending on the length of the mandatory part of the TPDU header. It can take values of between 1 and 255. (In the case of the value 0, the CLN flag shall be set to 0 and field CLN-TSAP shall be omitted.) It is of significance to all TPDUs.

CLD-TSAP

This field specifies the transport service access point of the receiving unit. CLD-TSAP is specified in bits 8-1 of byte 3, 4 or 5 depending on the length of the mandatory part of the TPDU header and the presence of the CLN-TSAP. It can take values of between 1 and 255. (In the case of the value 0 the CLD flag shall be set to 0 and field CLD-TSAP shall be omitted.) It is of significance to all TPDUs.

User Data

This field can comprise either from 0 up to 504, 505, 506 bytes, for CCAM TPDUs or from 0 up to 507,508,509 bytes for DT, CR, and CC TPDUs. The number of bytes depends on the length of the variable parts of the TPDU header.

4.4.4 TPDU Structures

The TPDU structures in this section are shown without the optional CLN-TSAP and CLD-TSAP parameters.

4.4.4.1 CR TPDU

The appearance of a CR TPDU is as follows:

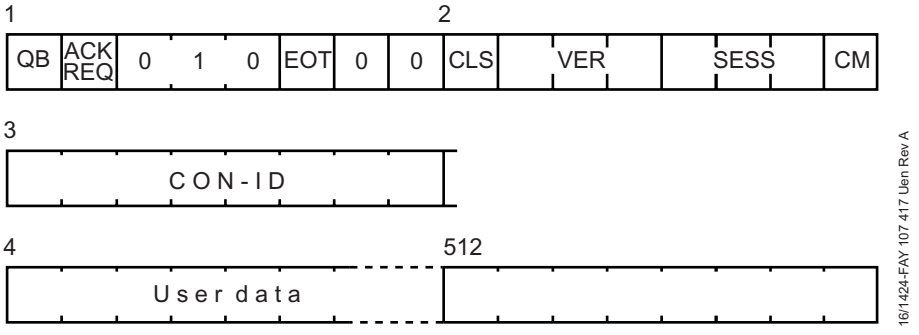

Figure 16 Appearance of a CR TPDU

4.4.4.2 CC TPDU

The appearance of a CC TPDU is as follows:

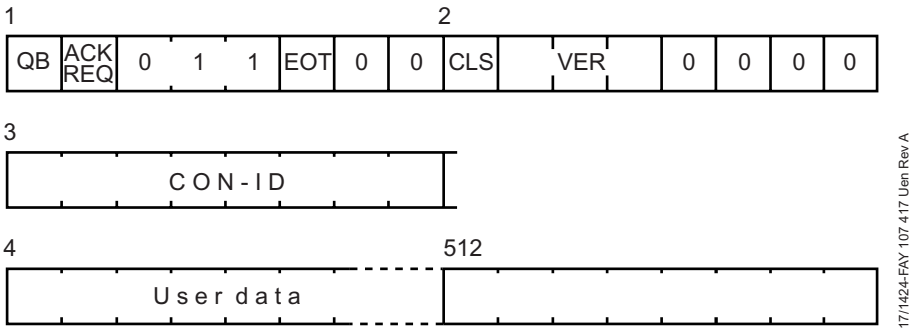

Figure 17 Appearance of a CC TPDU

4.4.4.3 CCAM TPDU

The appearance of a CCAM TPDU is as follows:

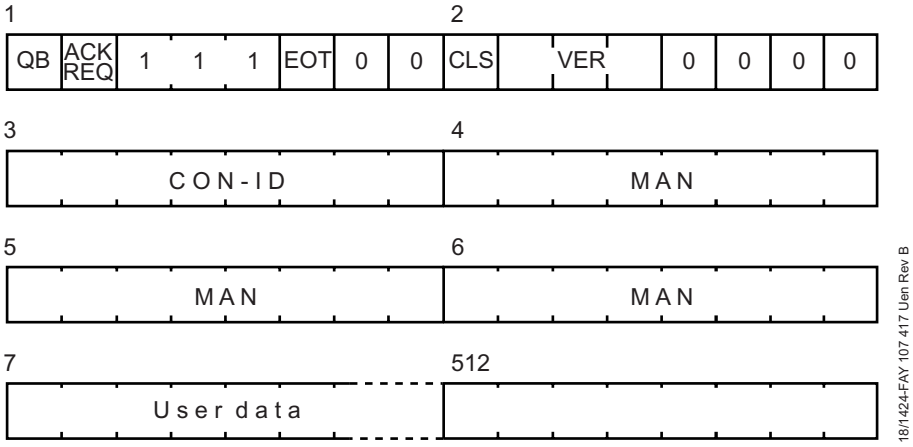

Figure 18 Appearance of a CCAM TPDU

4.4.4.4 DR TPDU

The appearance of a DR TPDU is as follows:

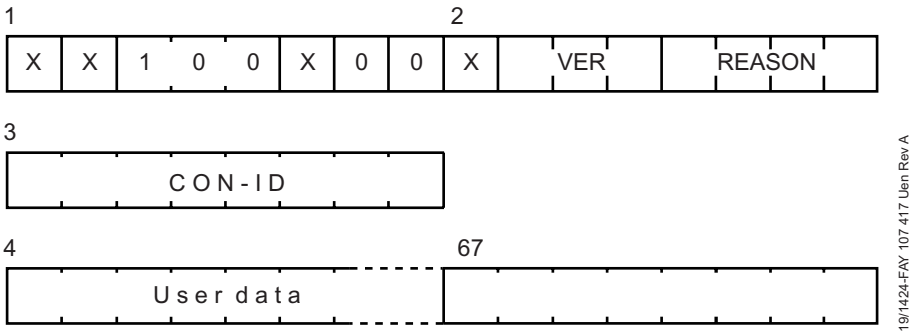

Figure 19 Appearance of a DR TPDU

4.4.4.5 DT TPDU

The appearance of a DT TPDU is as follows:

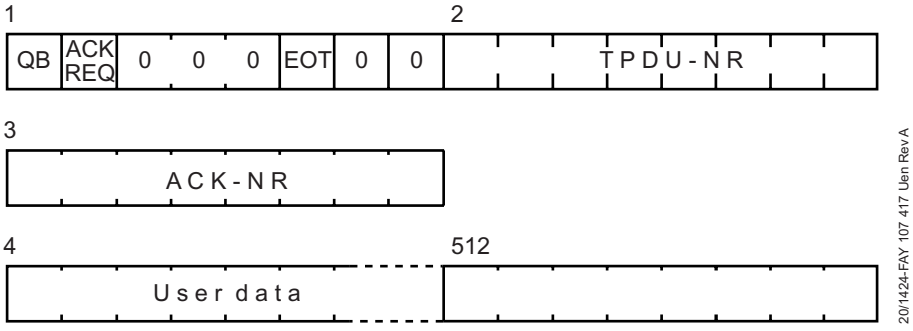

Figure 20 Appearance of a DT TPDU

4.4.4.6 AK TPDU

The appearance of an AK TPDU is as follows:

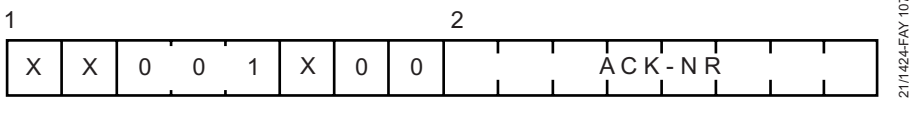

Figure 21 Appearance of an AK TPDU

5 Recommended Timer and Counter Values for MTP/1

Parameter	8k Network
TWBAK (s)	30
TWBDTR (s)	75
TI (s)	250
N	3
Window Size (CDT-CONST)	8

6 State Tables

This chapter provides a more precise description of the protocol in terms of state tables, during operation of a single transport connection.

The state tables show the state of a transport entity, the events that occur in the protocol, the actions taken, and the resultant state. They also define the mapping between service and protocol events that TS-users can expect.

CCAM is not discussed in the State Tables, but it is handled identically to CC, except for handling of logical and physical MAN. For more information, see chapter 4.3.5.4 *"Host Group Addressing (HGA)"*.

6.1 Conventions

The states are represented in the tables by their abbreviated name as defined in chapter 6.2 *"States"*.

The incoming events are represented in the state tables by their abbreviated name as defined in chapter 6.3 *"Incoming Events"*.

An invalid intersection between state and event is marked with a - (dash). The action to be taken in this case is one of the following:

a) for an event related to the transport service (that is, coming from the TS-user), take no action.

b) for an event related to a received TPDU, discard the TPDU and take no further action.

c) for an event falling into neither of the above categories (including those which are impossible by the definition of the behavior of the transport entity or NS-provider) take no action.

At each intersection of state and event which is valid the state table specify an action which may include one of the following:

a) one action constituted of a list of any number of outgoing events given by their abbreviated name, defined in chapter 6.4 *"Outgoing Events"*, followed by the abbreviated name of the resultant state.

b) conditional actions separated by semi-colon. Each conditional action contains a predicate followed by a colon and by an action as defined in a) above. The predicates are boolean expressions given by their abbreviated name and defined in chapter 6.6 *"Predicates"*. Only the action corresponding to the condition which is true is to be taken. The sequence of the conditional actions in the list is significant.

c) an action as defined in a) followed by an action as defined in b).

The state tables also include:

a) references to notes defined in chapter 6.8 *"Specific Notes"* using the following notation: (note number).

b) references to other actions as defined in chapter 6.7 *"Specific Actions"* using the following notation: [action number].

6.2 States

Abbreviation	Name
WFCC	Wait for the connection confirm acknowledgment
WFTRESP	Wait for T-CONNECT response
OPEN	Transport connection is open
CLOSING	Connection release approaching (TI has expired)
CLOSED	Transport connection is closed
CONWAIT	Wait for frozen connection time
OPEN-DIS	Wait for acknowledgment before releasing

6.3 Incoming Events

Abbreviation	Category	Name
TCONreq	TS-user	T-CONNECT request primitive
TCONresp	TS-user	T-CONNECT response primitive
TDTreq	TS-user	T-DATA request primitive
TUDTreq	TS-user	T-UNITDATA request primitive
TDISreq	TS-user	T-DISCONNECT request primitive
TRTYreq	TS-user	T-RETRY request primitive
CR	TPDU	Connection Request TPDU
CC	TPDU	Connection Confirm TPDU
CCAM	TPDU	Connection Confirm Addressee Modified TPDU
DR	TPDU	Disconnect Request TPDU
DT	TPDU	Data TPDU
AK	TPDU	Data Acknowledgment TPDU
NDTind	NS-provider	N-DATA indication primitive
NDTRind	NS-provider	N-DATA-RET indication primitive
NERRind	NS-provider	N-ERROR indication primitive

6.4 Outgoing Events

Abbreviation	Category	Name
TCONind	TS-provider	T-CONNECT indication primitive
TCONconf	TS-provider	T-CONNECT confirm primitive
TDTind *)	TS-provider	T-DATA indication primitive
TUDTind *)	TS-provider	T-UNITDATA indication primitive
TDISind	TS-provider	T-DISCONNECT indication primitive
TERRind	TS-provider	T-ERROR indication primitive
TNORESPind	TS-provider	T-NO-RESPONSE indication primitive
CR	TPDU	Connection Request TPDU
CC	TPDU	Connection Confirm TPDU
DR	TPDU	Disconnect Request TPDU
DT	TPDU	Data TPDU
AK	TPDU	Data Acknowledgment TPDU
NDTreq	NS-user	N-DATA request primitive
*) implicit		

6.5 Timers and Times

Abbreviation	Name
TI	Inactivity time
TWBDTR	Time to wait before data retransmission
TWBAK	Time to wait before transmission of acknowledgment
TWBREE1	Time to wait before re-establishing a connection (timer started/restarted when sending DT TPDUs, stopped when all data acknowledged)
TWBREE2	Time to wait before re-establishing a connection (timer started/restarted when retransmitting DT TPDUs, never stopped)

6.6 Predicates

Abbreviation	Name
P0	Request is acceptable
P1	SendTries = SendTriesMax
P2	Packet of HPDATA type with correct PI
P6	DT TPDU received inside the receive window
P8	Data TPDU to send
P9	SequenceNumber >= upper window edge
P10	Acknowledge requested and conditions fulfilled
P11	Connection request is acceptable
P12	Received TPDU is a duplicate
P13	Spurious time-out, data TPDU already acknowledged
P14	MPAK traffic state of "close connection" type
P15	N-ERROR indication of "close connection" type
P16	Acknowledgment condition for window utilization fulfilled (Latest SequenceNumber = upper window edge - 1)
P17	Connection-oriented mode
P18	Immediate release
P19	Connectionless-mode
P20	Explicit release
P21	User data contained
P22	DT TPDU received
P23	Connection parameters identical
P24	Close-Mode
P25	All data sent and acknowledged
P26	T-NO-RESPONSE issued
P27	First unacknowledged data TPDU
P28	Has been placed in the mailbox
P29	TPDU associated with current connection
P30	Retransmission disabled
P31	TPDUs marked for retransmission
P32	Time field is less or equal to connection establishment time
P33	Time field is less than connection establishment time
P34	Request queued up
P35	TWBREE1 or TWBREE2 running
P36	VER acceptable
P37	Received CON-ID less than own CON-ID *or* if equal MAN less than own MAN (simultaneous conn. requests)

6.7 Specific Actions

Abbreviation	Name
[0]	Store/queue request
[1]	SendTries = 0
[2]	Set initial upper and lower window edges for the transmit window
[3]	SequenceNumber = 0
[4]	AcknowledgeNumber = 0
[5]	Build next DT/CC TPDU to be sent
[6]	Increment SequenceNumber if DT TPDU
[7]	Update ACK-NR field in current TPDU (DT)
[8]	Store received TPDU conveyed user data, if present
[9]	Bypass or discard received TPDU
[10]	Build AK/CC TPDU
[11]	Update upper and lower window edges for the transmit window
[12]	Release retained data TPDUs according to ACK-NR
[13]	Set parameter value to be used in this connection
[14]	Discard received TPDU
[15]	Set AcknowledgeRequested if appropriate (ACK-REQ field in TPDU = 1)
[16]	Set initial upper and lower window edges for the receive window
[17]	Increment SendTries
[18]	Start/restart retransmission timer for current TPDU
[19]	Register new connection (decrease VER if appropriate)
[20]	Issue TDTind if appropriate
[21]	Stop retransmission timers for acknowledged TPDUs
[22]	Discard stored requests
[23]	Set AcknowledgeRequested (unconditional, CR TPDU)
[24]	Stop retransmission timer for current TPDU
[25]	Start acknowledgment timer if not already running
[26]	Update AcknowledgeNumber, if appropriate
[27]	Stop acknowledgment timer
[28]	Update upper and lower window edges for the receive window
[29]	Reset AcknowledgeRequested if appropriate
[30]	Stop retransmission timer for all data TPDUs
[31]	Release all retained data TPDU
[32]	Discard all received data TPDUs
[33]	Start/restart inactivity timer, if Close Mode connection
[34]	Increment CON-ID
[35]	If conveyed user data present, and VER older or equal than own version store user data, else discard it

Abbreviation	Name
[36]	Store connection parameters
[37]	Build CR TPDU
[39]	Build DR TPDU
[42]	Set MPAK mailbox flag, if mailbox service authorized
[43]	Set T-NO-RESPONSE issued flag
[44]	Disable further retransmission
[45]	Set ACK-REO field in TPDU
[46]	Mark/Queue for later retransmission
[47]	Mark CC to be sent
[48]	Build CC TPDU, if not already done
[49]	Un-mark retransmitted TPDU (matching [46])
[50]	Enable retransmission, if unacknowledged retransmitted TPDU acknowledged
[51]	Enable retransmission
[52]	Reset T-NO-RESPONSE issued flag
[56]	Enable T-requests
[58]	Start/restart TWBREE1 if DT TPDU
[59]	Start/restart TWBREE2 if DT TPDU
[60]	Stop TWBREE1, if all DT TPDUs acknowledged
[61]	Update sequence number for acknowledgment if VER older or equal than own version
[62]	Send AK TPDU if appropriate (see chapter 4.3.7 “*Connection Release*”)

6.8 Specific Notes

Abbreviation	Name
(1)	Continue with CR, CC, DT, AK or DR depending on TPDU type
(2)	Process stored T-DATA requests according to DT (send)
(3)	Process received data (DT/OPEN(OPEN-DIS))
(4)	Concerns all stored and uncompleted requests
(5)	Local matter
(6)	New connection, (CR/CLOSED)
(7)	Continue with Returned TPDU
(8)	Continue and re-establish connection
(9)	DT or CC, see specific action [47]
(10)	AK or CC, see specific action [47]
(11)	Process received acknowledgment (AK)
(12)	Only if explicit release
(13)	Only if connection-oriented mode
(14)	In a more sophisticated implementation data can be queued up for processing when a CC has arrived
(15)	Loop until all queued up TPDUs retransmitted
(16)	Loop until conditions not met
(17)	Concerns all TPDUs to be transmitted
(18)	If non-immediate release
(19)	Reuse CC TPDU CON-ID
(21)	May contain data if complete TSDU conveyed in the CR TPDU
(22)	Depending on if TWBREE1 or TWBREE2 is running or not
(23)	If TWBDTR > = 1 minute
(24)	Will result in a CR retransmission
(25)	Continue with TCONreq/CONWAIT or TCONreq/CLOSED depending on if TWBREE1 or TWBREE2 is running or not
(26)	In a more sophisticated implementation the request can be queued up for later processing

6.9 State Transition Diagram

The following State Transition Diagram represents the state transitions in an easier, conceptual manner. Although this diagram, as well as the following state tables, has been developed from the specifications, it does not describe all possible combinations of sequences of events at the transport service boundary.

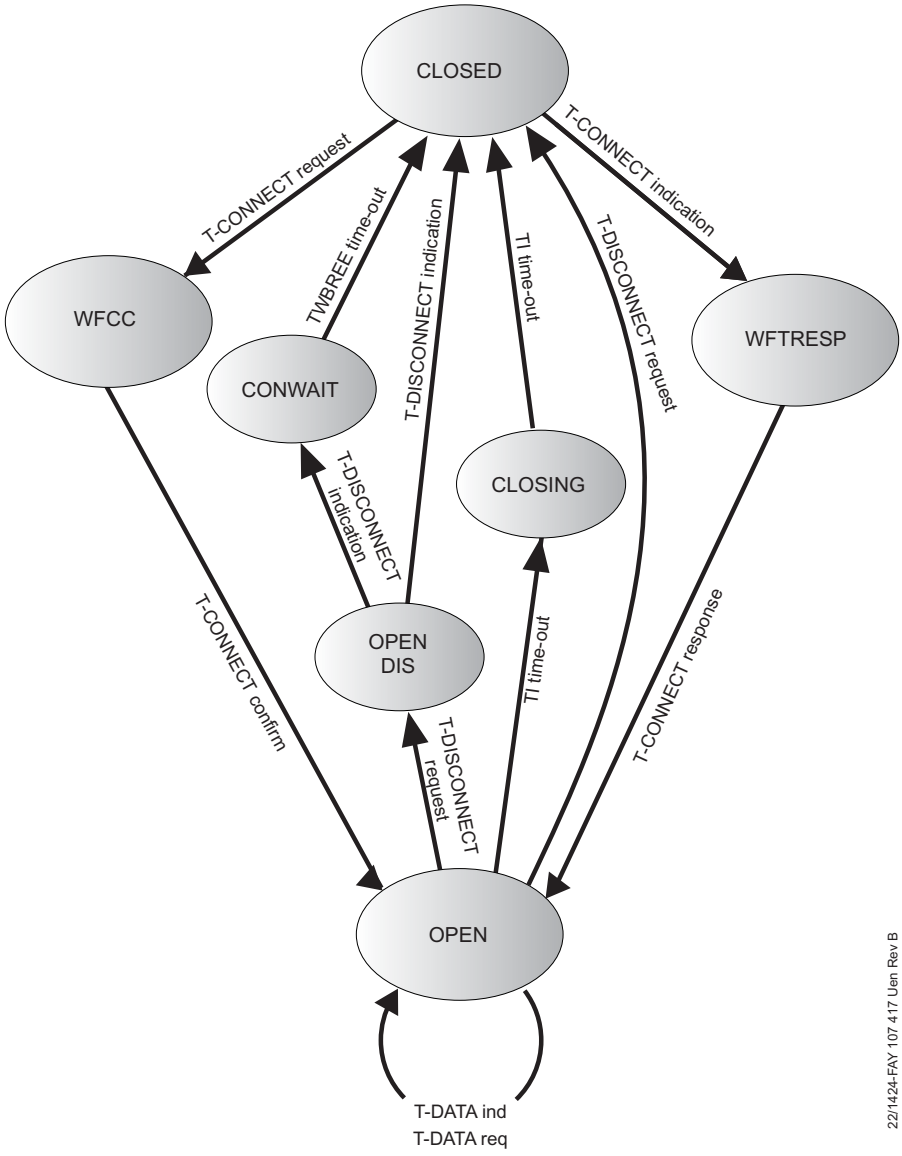

Figure 22 MTP/1 state transition diagram

6.10 State Table

STATE EVENT	OPEN S2	OPEN-DIS S3	CLOSED S4	WFCC S5	CLOSING S7	CONWAIT S8	WFTRESP S9
TCONreq	P17: TERRind OPEN; P19 & P25: [32] CONWAIT/ CLOSED; (25) P19 & not P25: TERRind OPEN; (26)	-	not P0: TDISind CLOSED; P0: [33] [0,36] [1,2,3,4] [37,34] NDTreq (CR) [17,18] WFCC	P17: TERRind WFCC; P19: TERRind WFCC (26)	P17: TERRind CLOSING; P19: [0,32,39] NDTreq DR [33] [0,36] [1,2,3,4] [37,34] NDTreq (CR) [17,18] WFCC	not P0: TERRind CONWAIT; P0: [0] CONWAIT	-
TDTreq (Connection-oriented mode)	not P0 or P19: TERRind OPEN; P0: [33] [0] OPEN (2)	-	-	-	not P0 or P19: TERRind CLOSING; P0: [32,39] NDTreq (DR,12) TDISind (13) CLOSED	-	-
TUDTreq (Connection-less mode)	not P0 or P17: TERRind OPEN; P0: [33] [0] OPEN (2)		not P0: TERRind CLOSED; P0: [33] [0,36] [1,2,3,4] [37,34] NDTreq (CR) [17,18] WFCC	not P0 or P17: TERRind WFCC; P0: [33] [0] WFCC	not P0 or P17: TERRind CLOSING; P0: [0,39] NDTreq (DR) CLOSED (8)	not P0: TERRind CONWAIT; P0: [0] CONWAIT	-

STATE EVENT	OPEN S2	OPEN-DIS S3	CLOSED S4	WFCC S5	CLOSING S7	CONWAIT S8	WFTRESP S9
TDISreq	P19: TERRind OPEN; P25 & P20: [27,62,32,39] NDTreq (DR) TDISind (18) CONWAIT/ CLOSED; (22) not P25 & not P18: OPEN-DIS; not P25 & P18 & P20: [30,31,22] [27,62,32,39] NDTreq (DR) CONWAIT/ CLOSED; (22) not P25 & P18 & not P20: [30,31,22] [27,62,32] CONWAIT/ CLOSED (22)	not P18: TERRind OPEN-DIS; P20: [30,31,22] [27,62,32,39] NDTreq (DR) CONWAIT/ CLOSED; (22) not P20: [30,31,22] [27,62,32] CONWAIT/ CLOSED (22)	-	P19 or not P18: TERRind WFCC; P20: [24,31] [22] [39] NDTreq (DR) CLOSED; not P20: [24,31] [22] CLOSED	P19: TERRind CLOSING; P20: [39] NDTreq (DR) TDISind (18) CLOSED; not P20: TDISind (18) CLOSED	P19 or not P0: TERRind (5) CONWAIT; P17: [22] CONWAIT	[27,32,39] NDTreq (DR) TDISind (18) CLOSED;
TCONresp	-	-	-	-	-	-	[0] OPEN (2)
NDTind	not P2: [9] OPEN; P2: [33] (1)	not P2: [9] OPEN-DIS; P2: [33] (1)	not P2: [9] CLOSED; P2: [33] (1)	not P2: [9] WFCC; P2: [33] (1)	not P2: [9] CLOSING; P2: [33] (1)	not P2: [9] CONWAIT; P2: [33] (1)	not P2: [9] WFTRESP; P2: [33] (1)

STATE EVENT	OPEN S2	OPEN-DIS S3	CLOSED S4	WFCC S5	CLOSING S7	CONWAIT S8	WFTRESP S9
NDTRind	not P2: [9] OPEN; P2: OPEN (7)	not P2: [9] OPEN-DIS; P2: OPEN-DIS (7)	not P2: [9] CLOSED; P2: CLOSED (7)	not P2: [9] WFCC; P2: WFCC (7)	not P2: [9] CLOSING; P2: CLOSING (7)	not P2: [9] CONWAIT; P2: CONWAIT (7)	not P2: [9] WFTRESP; P2: WFTRESP (7)
TRTYreq	P19 or not P26: TERRind OPEN; P26: [1] (17) [51,52] OPEN (2)	P19 or not P26: TERRind OPEN-DIS; P26: [1] (17) [51,52] OPEN-DIS (2)	-	P19 or not P26: TERRind WFCC; P26: [1,33] [52] NDTreq (CR) [17,18] WFCC	-	-	-
CC	not P29: [14,39] (19) NDTreq (DR) OPEN; P21: OPEN (3); not P21: OPEN (11)	not P29: [14,39] (19) NDTreq (DR) OPEN-DIS; P21: OPEN-DIS (3); not P21: OPEN-DIS (11)	[14,39] (19) NDTreq (DR) CLOSED	not P29: [14,39] (19) NDTreq (DR) WFCC; not P36: [24,31,22,39] NDTreq (DR) TDIS/TERRind CLOSED; P21: [19,16] TCONconf (13) OPEN (3); not P21: [21,16,11,12] [19] TCONconf (13) OPEN (2)	not P29: [14,39] (19) NDTreq (DR) CLOSING; P29: [14] CLOSING	[14,39] (19) NDTreq (DR) CONWAIT	not P29: [14,39] (19) NDTreq (DR) WFTRESP; P29: [14] WFTRESP

STATE EVENT	OPEN S2	OPEN-DIS S3	CLOSED S4	WFCC S5	CLOSING S7	CONWAIT S8	WFTRESP S9
CR	P32 & not P12: [14] OPEN; P12 & P22: [14] OPEN; P12 & not P22: [14,48] NDTreq (CC) OPEN; not P12 & P19: [30,31,22] [27,32] TERRind (4) CLOSED (6); not P12 & P17: [30,31,22] [27,32] TDISind CLOSED (6)	P32 & not P12: [14] OPEN-DIS; P12 & P22: [14] OPEN-DIS; P12 & not P22: [14,48] NDTreq (CC) OPEN-DIS; not P12: [30,31,22] [27,32] TDISind CLOSED (6)	not P11: [14] [39] NDTreq (DR) CLOSED; P19: [2,3,4,16] [13,19] [25,35,20] [15,61,47] OPEN (2); P17: TCONind (21) [2,3,4,16] [13,19] [35] [23,61,47] WFTRESP	P37: [14] WFCC; not 37: [24,31] [22] TDIS/TERRind CLOSED (6)	P19: [32] CLOSED (6); P17: [32] TDISind CLOSED (6)	[14] CONWAIT (24)	P32 & not P12: [14] WFTRESP; P12: [14] WFTRESP; not P12: (& P17) [27,32] TDISind CLOSED (6)
DR	not P29: [14] OPEN; P19: [30,31,22] [27,32] TERRind (4) CONWAIT/ CLOSED; (22) P17: [30,31,22] [27,32] TDISind CONWAIT/ CLOSED (22)	not P29: [14] OPEN-DIS; P29: [30,31,22] [27,32] TDISind CONWAIT/ CLOSED (22)	[14] CLOSED	not P29: [14] WFCC; P19 [24,31] [22] TERRind (4) CLOSED; P17: [24,31] [22] TDISind CLOSED	not P29: [14] CLOSING; P19: [32] CLOSED; P17: [32] TDISind CLOSED	[14] CONWAIT	not P29: [14] WFTRESP; P17: [32] TDISind CLOSED

STATE EVENT	OPEN S2	OPEN-DIS S3	CLOSED S4	WFCC S5	CLOSING S7	CONWAIT S8	WFTRESP S9
DT (data)	not P29: [14,39] NDTreq (DR) OPEN; P33 or not P6: [14] OPEN; not P12: [21,60,11,12] [25] [8,20] [15,26] [50] OPEN (2); P12: [21,60,11,12] [25,14,15] [50] OPEN (2)	not P29: [14,39] NDTreq (DR) OPEN-DIS; P33 or not P6: [14] OPEN-DIS; P12: [21,60,11,12] [25] [8,20] [15,26] [50] OPEN-DIS (2); P12: [21,60,11,12] [25,14,15] [50] OPEN-DIS (2)	[14,39] NDTreq (DR) CLOSED	not P29: [14,39] (19) NDTreq (DR) WFCC; P29: [14] WFCC (14)	not P29: [14,39] NDTreq (DR) CLOSING; P29: OPEN (3)	[14,39] NDTreq (DR) CONWAIT	not P29: [14,39] NDTreq (DR) WFTRESP; P29: [14] WFTRESP

STATE EVENT	OPEN S2	OPEN-DIS S3	CLOSED S4	WFCC S5	CLOSING S7	CONWAIT S8	WFTRESP S9
DT (send)	P31 & not P30: [33] [27,7] NDTreq (9) [17,18,59,49] [28,29] OPEN (15); P8 & P9 & not P30: [33] [27,1,5] NDTreq (9) [6,17,18] [58,28,29] OPEN (16); P10 or P16: [33,27,10] NDTreq (10) [28,29] OPEN; not P10 & not P16: OPEN	P31 & not P30: [33] [27,7] NDTreq (DT) [17,18,59,49] [28,29] OPEN-DIS (15); P8 & P9 & not P30: [33] [27,1,5] NDTreq (9) [6,17,18] [58,28,29] OPEN-DIS (16); P25 & P20: [33] [27,62,32,39] NDTreq (DR) TDISind CONWAIT/ CLOSED; (22) P10 or P16: [27,10] NDTreq (AK) [28,29] OPEN-DIS; not P10 & not P16: OPEN-DIS	-	-	-	-	-
AK	P33: OPEN; not P33 [21,11,12,60] [50] OPEN (2)	P33: OPEN-DIS; not P33 [21,11,12,60] [50] OPEN-DIS (2)	-	-	-	-	-

STATE EVENT	OPEN S2	OPEN-DIS S3	CLOSED S4	WFCC S5	CLOSING S7	CONWAIT S8	WFTRESP S9
Retransm. time-out (TWBDTR)	P13: OPEN; P1 & P19: [30,31] [27,32,22] TERRind (4) CLOSED; (23) P1 & P17 & P24: [30,31] [27,32,22] TDISind CLOSED; (23) P1 & P17 & not P24 & not P26: TNORESPind [43,46] OPEN; P1 & P17 & not P24 & P26: [46] OPEN; not P1 & P27: [33,44] [42] [27,7,45] NDTreq (9) [17,18,59] [28,29] OPEN; not P1 & not P27: [46] OPEN	P13: OPEN-DIS; P1 & P24: [30,31] [27,32,22] TDISind CLOSED; (23) P1 & not P24 & not P26: TNORESPind [43,46] OPEN-DIS; P1 & not P24 & P26: [46] OPEN-DIS; not P1 & P27: [33,44] [42] [27,7,45] NDTreq (9) [17,18,59] [28,29] OPEN-DIS; not P1 & not P27: [46] OPEN-DIS	-	not P1: [33] [42] NDTreq (CR) [17,18] WFCC; P19: [31,22] TERRind (4) CLOSED; (23) P17 & P24: [31,22] TDISind CLOSED: (23) P17 & not P24: TNORESPind [43] WFCC	-	-	-
Acknowledge Send time-out (TWBAK)	[33] [10] NDTreq (10) [28] OPEN	[33] [10] NDTreq (10) [28] OPEN-DIS	-	-	-	-	-

STATE EVENT	OPEN S2	OPEN-DIS S3	CLOSED S4	WFCC S5	CLOSING S7	CONWAIT S8	WFTRESP S9
Activity time-out (TI)	[33] CLOSING	-	-	-	P19: CLOSED; P17 & P20: [39] NDTreq (DR) TDISind CLOSED; P17 & not P20: TDISind CLOSED	-	P17 & P20: [39] NDTreq (DR) TDISind CLOSED; P17 & not P20: TDISind CLOSED
TWBREE1 & TWBREE2	-	-	-	-	-	P35: CONWAIT; not P34: CLOSED; P34: [33,0,36] [1,2,3,4] [37,34] NDTreq (CR) [17,18,56] WFCC	-

STATE EVENT	OPEN S2	OPEN-DIS S3	CLOSED S4	WFCC S5	CLOSING S7	CONWAIT S8	WFTRESP S9
Returned TPDU containing user data	not P29: [14] OPEN; P14 & P19: [30,31] [27,32] [22] TERRind (4) CONWAIT/ CLOSED; (22) P14 & P24: [30,31] [27,32,22] TDISind CONWAIT/ CLOSED; (22) P14 & not P24: TNORESPind [43] OPEN; not P14 & P28 & P24: [24] OPEN; not P14 & P28 & not P24: [24] TNORESPind [43] OPEN; not P14 & not P28: OPEN	not P29: [14] OPEN-DIS; P14 & P24: [30,31] [27,32,22] TDISind CONWAIT/ CLOSED; (22) P14 & not P24: TNORESPind [43] OPEN-DIS; not P14 & P28: [24] OPEN-DIS; not P14 & not P28: OPEN-DIS	-	not P29: [14] WFCC; P14 & P19: [24,31] [22] TERRind (4) CLOSED; P14 & P24: [24,31] [22] TDISind CLOSED; P14 & not P24: TNORESPind [43] WFCC; not P14 & P28 & P24: [24] WFCC; not P14 & P28 & not P24: [24] TNORESPind [43] WFCC; not P14 & not P28: WFCC	-	-	-
Returned TPDU not containing user data	-	-	-	(see above)	-	-	-

STATE EVENT	OPEN S2	OPEN-DIS S3	CLOSED S4	WFCC S5	CLOSING S7	CONWAIT S8	WFTRESP S9
NERRind	not P29: [14] OPEN; P15 & P19: [30,31] [27,32] [22] TERRind (4) CONWAIT/ CLOSED; (22) P15 & P24: [30,31] [27,32,22] TDISind CONWAIT/ CLOSED; (22) P15 & not P24: TNORESPind [43] OPEN; not P15: OPEN	not P29: [14] OPEN-DIS; P15 & P24: [30,31] [27,32,22] TDSind CONWAIT/ CLOSED; (22) P15 & not P24: TNORESPind [43] OPEN-DIS; not P15: OPEN-DIS	-	not P29: [14] WFCC; P15 & P19: [24,31] [22] TERRind (4) CLOSED; P15 & P24: [24,31] [22] TDISind CLOSED; P15 & not P24: TNORESPind [43] WFCC; not P15 & not P28: WFCC	-	-	-

Appendix A: MTP/1 Test Suite Structure and Test Purposes

This chapter specifies the test suite structure and the set of test purposes (TSS&TP) applicable to all abstract test suites (ATSs) to be specified for the MTP/1.

The specification of the TSS&TP is a part of the complete process of accomplishing all conformance testing activities necessary to establish whether an MTP/1 implementation conforms to the standardized protocol and service documents (see chapter 3 *"Transport Service Definition"* and chapter 4 *"Transport Protocol Specification"*).

A list of test cases composing a basic interconnection test is provided at the end of the chapter.

The chapter provides a basis for conformance test realization, for design of different ATSs and for design and realization of basic interconnection tests. It can also be used for the guidance of implementation and self-testing of MTP/1.

A.1 General

A.1.1 Introduction

The methodology of this chapter is based on the international standard Open Systems Interconnection - Conformance testing methodology and framework (ISO/IEC 9646 part 1-2 (1991), CCITT X.290, X291 (1991)). However, the chapter does not comply to the entire standard.

A.1.2 Conformance Testing

The conformance assessment process involves three phases: preparation for testing; test operations; and test report production. The first phase, preparation for testing, involves:

a) production of System Conformance Statement, PICS and PIXIT;

b) choice of Abstract Test Method and ATS;

c) preparation of the SUT and Means of Testing.

A basis for the specification of ATSs is the Test Suite Structure and Test Purposes, which is defined in this chapter.

A.1.3 Types of Testing

ISO/IEC 9646 distinguishes four types of testing, according to the extent to which they provide an indication of conformance; basic interconnection tests, capability tests, behavior tests and conformance resolution tests.

A.1.3.1 Basic Interconnection Tests

The basic interconnection test provides limited testing of an MTP/1-implementation in relation to the main features in the protocol specifications, to establish that there is sufficient conformance for interconnection to be possible, without trying to perform thorough testing. See chapter 3 *"Transport Service Definition"* and chapter 4 *"Transport Protocol Specification"*.

The basic interconnection test is provided in chapter A.3 *"Basic Interconnection Tests"* as a list of selected capability and behavior tests from the test suite structure specified in chapter A.2 *"Test Suite Structure and Test Purposes"*.

A.1.3.2 Capability and Behavior Tests

Capability and behavior tests compose the conformance test suite, which provides testing of an MTP/1-implementation, to establish whether the implementation conforms to the protocol specifications (see chapter 3 *"Transport Service Definition"* and chapter 4 *"Transport Protocol Specification"*).

Since the number of possible combinations of events, timing of events and event parameters is infinite, it is impossible to make the test suite exhaustive. Besides, the possibility to control and observe the interaction between the implementation and the tester may be limited by the available test method. Therefore, it is possible that a non-conforming implementation may pass the conformance test suite. The aim of the design of the test suite is to minimize the number of times this occurs.

Capability and behavior tests are elements of the test structure defined in chapter A.2 *"Test Suite Structure and Test Purposes"*.

A.2 Test Suite Structure and Test Purposes

Conformance resolution tests are non-standardized, system-specific tests to fulfil test purposes not defined in the test standard. These tests are outside the scope of this chapter.

A.2.1 Introduction

The Test Suite Structure is common to all conformance testing and the basis of all Abstract Test Suites designed for use with different test methods.

A test suite has a hierarchical structure with the test case as the most important level. To provide a logical ordering of the test cases, nested test groups are used. There are many ways of structuring the same test suite into test groups; no one way is

necessarily right. In this specification the test suite is structured according to the outline of the protocol specification (see chapter 4 *"Transport Protocol Specification"*).

Capability tests
- Mandatory capabilities
- Optional capabilities

Behaviour tests: Connection Establishment
- Normal connection establishment
- Negotiation during connection establishment
- Simultaneous connection requests
- Host Group Addressing (HGA)
- Connection establishment failure

Behaviour tests: Connection Refusal

Behaviour tests: Connection Release

Behaviour tests: Association of TPDUs

Behaviour tests: Data Transfer
- Segmenting and reassembling
- Sequence numbering of data TPDUs
- Resequencing
- Flow control
- Transmission of acknowledgments
- Sequencing of received acknowledgments
- Retention until acknowledgment of data TPDUs
- Retransmission on time-out
- Inactivity control
- Mailbox

Behaviour tests: Response to invalid behaviour by peer implementation
- Invalid behaviour during connection establishment
- Invalid behaviour during data transfer
- Test Suite Structure

For each test group, and nested sub-group, the test group objective is defined and the relation to the protocol specification stated. When designing test cases, the verification of a possible non-conforming behavior that would be of no harm, either for a peer entity or the network, will not be included in the test suite structure.

A.2.2 Conventions

A.2.2.1 Test Case Purpose

When defining the purpose of a test case the following conventions have been used.

- The transport service mode in question is the connection-mode service if nothing else stated.
- All TPDUs are assumed to be associated with one and the same transport connection if nothing else stated.
- The following TC states are referred to; CLOSED, WFCC, WFTRESP and OPEN. These states are not necessarily the states defined in chapter Appendix A: *"MTP/1 Test Suite Structure and Test Purposes"*, but rather generic states in any MTP/1 state table.

A.2.2.2 Initial Testing States

Initial testing states utilized in the test case behavior below:

Closed State	A stable testing state in which there is no transport connection established
Open State	A stable testing state in which there is one Close Mode Connection established, providing connection-oriented services.
Open State, Non-Close	A stable testing state in which there is one Non-Close Mode Connection established, providing connection-oriented services.
Open State, Connectionless	A stable testing state in which there is one connection established, providing connectionless services.

A.2.2.3 Parameter Default Values

Parameter	Default Value
Closing Mode	Close Mode
Immediate selection	Immediate
Explicit option	Explicit
Mailbox option	No mailbox
TS_UserData_0	A TSDU that can be conveyed in 1 data TPDU (CR, CC or DT)
TS_UserData_1	A TSDU that must be conveyed in 4 data TPDUs (CR, CC or DT)
TS_UserData_2	A TSDU that must be conveyed in 8 data TPDUs (CR, CC or DT)

A.2.3 Capability Tests

A.2.3.1 Mandatory Capabilities

A.2.3.1.1 Reception of CR TPDU

Verify that the IUT will issue a T-CONNECT indication when receiving a CR TPDU, not associated to an established connection, requesting the connection-mode service. (TC in CLOSED state.)

Reference: chapter Appendix C: *"Cover Page Template for an MTP/1 PICS"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send CR, CM=1	
2	UT		Receive T-CONNECT indication

A.2.3.1.2 Transmission of CC TPDU

Verify that the IUT will send a CC TPDU when receiving a T-CONNECT response in the WFTRESP state.

Reference: chapter Appendix C: *"Cover Page Template for an MTP/1 PICS"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send CR, CM=1	
2	UT		Receive T-CONNECT indication
3	UT	Send T-CONNECT response	
4	LT		Receive CC

A.2.3.1.3 Transmission of CR TPDU

Verify that the IUT will send a CR TPDU requesting the connection-mode service when receiving a T-CONNECT request in the CLOSED state.

Reference: chapter Appendix C: *"Cover Page Template for an MTP/1 PICS"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-CONNECT request	
2	LT		Receive CR, CM=1

A.2.3.1.4 Reception of CC TPDU

Verify that the IUT will issue a T-CONNECT confirm when receiving a CC TPDU in the WFCC state.

Reference: chapter Appendix C: *"Cover Page Template for an MTP/1 PICS"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-CONNECT request	
2	LT		Receive CR, CM=1
3	LT	Send CC	
4	UT		Receive T-CONNECT confirm

A.2.3.1.5 Reception of CR TPDU Requesting Connectionless Service

Verify that the IUT will send a CC TPDU when receiving a CR TPDU, not associated to an established connection, requesting the connectionless-mode service. (TC in CLOSED state.)

Reference: chapter Appendix C: *"Cover Page Template for an MTP/1 PICS"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send CR, CM=0	
2	LT		Receive CC

A.2.3.1.6 Reception of DT TPDU

Verify that the IUT will issue a T-DATA indication when receiving a DT TPDU associated to an established connection. (TC in OPEN state.)

Reference: chapter Appendix C: *"Cover Page Template for an MTP/1 PICS"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send DT, EOT=1	
2	UT		Receive T-DATA indication

A.2.3.1.7 Transmission of DT TPDU

Verify that the IUT will send a DT TPDU when receiving a T-DATA request. (TC in OPEN state.)

Reference: chapter Appendix C: *"Cover Page Template for an MTP/1 PICS"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-DATA request, TS_UserData_0	
2	LT		Receive DT

A.2.3.1.8 Reception of DR TPDU, TC in OPEN

Verify that the IUT will issue a T-DISCONNECT indication when receiving a DR TPDU releasing an established connection. (TC in OPEN state.)

PICS and reference: chapter 4.3.6 *"Connection Refusal"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send DR	
2	UT		Receive T-DISCONNECT indication

A.2.3.1.9 Transmission of DR TPDU, TC in OPEN

Verify that the IUT will send a DR TPDU releasing an established connection when receiving a T-DISCONNECT request. (TC in OPEN state.)

PICS and reference: chapter 4.3.7 *"Connection Release"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-DISCONNECT request	
2	LT		Receive DR

A.2.4 Behavior Tests: Connection Establishment

The objective of this test group is to establish that the IUT conforms to the Connection Establishment procedures specified in chapter 4.3.5 *"Connection Establishment"*.

The test group is composed of a number of nested test groups.

A.2.4.1 Normal Connection Establishment

The objective of this test group is to establish that the IUT conforms to the Normal Connection Establishment procedures specified in chapter 4.3.5.1 *"Normal Connection Establishment"*.

The test group is composed of a number of test cases.

A.2.4.1.1 Reception of CR TPDU, TC in OPEN

Verify that the IUT will issue a T-DISCONNECT indication immediately followed by a T-CONNECT indication, when receiving a CR TPDU in the OPEN state, requesting the connection-mode service.

Reference: chapter 4.3.5 *"Connection Establishment"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send CR, identical addresses, new CON-ID	
2	UT		Receive T-DISCONNECT indication
3	UT		Receive T-CONNECT indication
Additional Comments: Check that no DR TPDU is sent from the IUT.			

A.2.4.1.2 Re-Establishment of a TC, Initiator

Verify that the IUT does not re-establish a TC by sending a CR TPDU when receiving a T-CONNECT request within the minute the connection has been utilized for sending an unacknowledged DT TPDU from the IUT.

Reference: chapter 4.3.7 *"Connection Release"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-DATA request, TS_UserData_0	
2	LT		Receive DT
3		Start TEST_TIMER	
4	UT	Send T-DISCONNECT request	
5	LT		Receive DR
6	UT	Send T-CONNECT request	
7	LT		Receive CR
8		Read TEST_TIMER	
9			TEST_TIMER >= 60 seconds
Additional Comments: If the design of the IUT calls for a different way measuring the time delay, the time stamps from item number 2 and 7 can be compared instead of using the TEST_TIMER.			

A.2.4.1.3 Re-Establishment of a TC, Responder

Verify that the IUT does not re-establish a TC by responding to a CR TPDU received within the minute the connection has been utilized for sending an unacknowledged DT TPDU from the IUT.

Reference: chapter 4.3.7 *"Connection Release"*

Test Case Dynamic Behaviour

Test Case Id:
Initialisation: Open State
Comments:

Test Body

No.	PCO	Action	Expected Result
1	UT	Send T-DATA request, TS_UserData_0	
2	LT		Receive DT
3		Start TEST_TIMER (60 seconds)	
4	LT	Send DR	
5	UT		Receive T-DISCONNECT indication
6	LT	Send CR, identical addresses	
7		Time-out TEST_TIMER	
8	LT	Send (retransmit) CR	
9	UT		Receive T-CONNECT indication
10	UT	Send T-CONNECT response	
11	LT		Receive CC

Additional Comments:

Check that the indication in item number 9 does not occur before the expiration of the TEST-TIMER.
If the design of the IUT calls for a different way measuring the time delay, the implementor shall explain how the IUT supports the delay requirements.

A.2.4.2 Negotiation During Connection Establishment

The objective of this test group is to establish that the IUT conforms to the Negotiation during Connection Establishment procedures specified in chapter 4.3.5.2 *"Negotiation During Connection Establishment"*.

The test group is composed of a number of test cases.

A.2.4.2.1 Not Supported Version

Verify that the IUT will respond with a CC TPDU stating version 0 when receiving a CR TPDU with the VER field equal to 1.

Verify that the IUT will discard user data contained in a CR TPDU with the VER field equal to 1.

Reference: chapter 4.3.5.2 *"Negotiation During Connection Establishment"*.

Test Case Dynamic Behaviour			
Test Case Id: **Test Preamble:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send CR, VER=1, TP_UserData_0	
2	UT		Receive T-CONNECT indication
3	UT	Send T-CONNECT response	
4	LT		Receive CC, VER=0
Additional Comments: Check that user data received in the CR TPDU will be discarded by the IUT.			

A.2.4.2.2 Negotiation About Close Mode, Initiator

Verify that the IUT after sending a CR TPDU requesting a connection-mode service with Close Mode preferred, will accept the reception of a CC TPDU with the Non-Close Mode selected. The IUT shall issue a T-CONNECT conform.

Reference: chapter 4.3.5.2 *"Negotiation During Connection Establishment"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-CONNECT request, Close Mode preferred	
2	LT		Receive CR, CLS=1
3	LT	Send CC, CLS=0	
4	UT		Receive T-CONNECT confirm, Non-Close Mode selected

A.2.4.2.3 Negotiation About Close Mode, Responder

Verify that the IUT, after receiving a CR TPDU requesting a connection-mode service with Close Mode preferred, will accept a T-CONNECT response with the Non-Close Mode selected. The IUT shall send a CC TPDU with the CLS flag set to 0.

Reference: chapter 4.3.5.2 *"Negotiation During Connection Establishment"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send CR, CLS=1	
2	UT		Receive T-CONNECT indication, Close Mode preferred
3	UT	Send T-CONNECT response, Non-Close Mode selected	
4	LT		Receive CC, CLS=0

A.2.4.3 Simultaneous Connection Requests

The objective of this test group is to establish that the IUT conforms to the Simultaneous Connection Requests procedures specified in chapter 4.3.5.3 *"Simultaneous Connection Requests"*.

The test group is composed of a number of test cases.

A.2.4.3.1 Lower Tester Back off

Verify that the IUT will ignore a received CR TPDU defined as a simultaneous connection request without precedence.

Reference: chapter 4.3.5.3 *"Simultaneous Connection Requests"*

Test Case Dynamic Behaviour			
Test Case Id: LT_BACK_OFF **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-CONNECT request	
2	LT		Receive CR
3	LT	Send CR, lower-ranking CON-ID	
4	LT	Send CC, original CON-ID	
5	UT		Receive T-CONNECT confirm

A.2.4.3.2 IUT Back off

Verify that the IUT will accept a received CR TPDU defined as a simultaneous connection request with right of precedence, issue a T-DISCONNECT indication and establish the connection requested by the lower tester.

Reference: chapter 4.3.5.3 *"Simultaneous Connection Requests"*

Test Case Dynamic Behaviour			
Test Case Id: IUT_BACK_OFF **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-CONNECT request	
2	LT		Receive CR
3	LT	Send CR, higher-ranking CON-ID	
4	UT		Receive T-DISCONNECT indication
5	UT		Receive T-CONNECT indication
6	UT	Send T-CONNECT response	
7	LT		Receive CC

A.2.4.3.3 IUT Back off 2

Verify that the IUT will accept a received CR TPDU defined as a simultaneous connection request with right of precedence, issue a T-DISCONNECT indication and establish the connection requested by the lower tester.

Reference: chapter 4.3.5.3 *"Simultaneous Connection Requests"*

Test Case Dynamic Behaviour			
Test Case Id: IUT_BACK_OFF **Initialisation:** Closed State **Comments:** This test presupposes that the CON-ID in item number 2 and 3 are equal.			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-CONNECT request	
2	LT		Receive CR
3	LT	Send CR, higher-ranking sender MAN	
4	UT		Receive T-DISCONNECT indication
5	UT		Receive T-CONNECT indication
6	UT	Send T-CONNECT response	
7	LT		Receive CC

A.2.4.4 Host Group Addressing (HGA)

The objective of this test group is to establish that the IUT conforms to the Host Group Addressing procedures specified in chapter 4.3.5.4 *"Host Group Addressing (HGA)"*.

The test group is composed of a number of test cases.

A.2.4.4.1 Reception of CCAM TPDU

Verify that the IUT, not supporting the HGA, will send a DR TPDU and issue a T-DISCONNECT indication discontinuing a connection establishment procedure initiated by the upper tester, when receiving a CCAM TPDU. (TC in WFCC state.)

Reference: chapter 4.3.5.4 *"Host Group Addressing (HGA)"*, PICS

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-CONNECT request	
2	LT		Receive CR
3	LT	Send CCAM	
4	LT		Receive DR, REASON=7
5	UT		Receive T-DISCONNECT indication
Additional Comments: Item number 4 and 5 may occur in reverse order.			

A.2.4.5 Connection Establishment Failure

The objective of this test group is to establish that the IUT conforms to the procedures regarding connection establishment failure specified in chapter 4.3.5 *"Connection Establishment"* and chapter 4.3.9.8 *"Retransmission on Time-Out"*.

The test group is composed of a number of test cases.

A.2.4.5.1 Responder Not Answering

Verify that the IUT, acting as an initiator, will discontinue a connection establishment attempt and issue a T-DISCONNECT indication when not receiving any response at all from the peer transport entity (LT). The IUT shall transmit/ retransmit the CR TPDU N times before discontinuing the attempt.

Reference: chapter 4.3.5.1 *"Normal Connection Establishment"*

Test Case Dynamic Behaviour

Test Case Id:
Initialisation: Closed State
Comments:

Test Body

No.	PCO	Action	Expected Result
1	UT	Send T-CONNECT request	
2	LT		Receive CR
3		Time-out TWBDTR	
4	LT		Receive CR
5		Time-out TWBDTR	
6	UT		Receive T-DISCONNECT indication

Additional Comments:

Item number 3-4 shall be repeated N-2 times.
If the Mobitex mailbox service is utilised during connection establishment the expected sub-results will be slightly different.

A.2.4.5.2 Responder Not Answering, Non-Close Mode

Verify that the IUT, acting as an initiator, will suspend a connection establishment attempt and issue a T-NO-RESPONSE indication when not receiving any response at all from the peer transport entity (LT). The IUT shall transmit/retransmit the CR TPDU N times before suspending the attempt.

Reference: chapter 4.3.5.1 *"Normal Connection Establishment"*

Verify that the IUT will restart the retransmission procedure when receiving a T-RETRY request.

Reference: chapter 4.3.9.8 *"Retransmission on Time-Out"*

Test Case Dynamic Behaviour

Test Case Id:
Initialisation: Closed State
Comments:

Test Body

No.	PCO	Action	Expected Result
1	UT	Send T-CONNECT request, Non-Close Mode preferred	
2	LT		Receive CR, CLS=0
3		Time-out TWBDTR	
4	LT		Receive CR, CLS=0
5		Time-out TWBDTR	
6	UT		Receive T-NO-RESPONSE indication
7		Delay	
8	UT	Send T-RETRY request	
9	LT		Receive CR, CLS=0

Additional Comments:

Item number 3-4 shall be repeated N-2 times.

The IUT will continue retransmitting after item number 9, repeating from item number 3.

If the Mobitex mailbox service is utilised during connection establishment the expected sub-results will be slightly different.

A.2.5 Behavior Tests: Connection Refusal

The objective of this test group is to establish that the IUT conforms to the Connection Refusal procedures specified in chapter 4.3.6 *"Connection Refusal"*.

The test group is composed of a number of test cases.

A.2.5.1 Reception of DR TPDU

Verify that the IUT will issue a T-DISCONNECT indication when receiving a DR TPDU refusing a requested connection. (TC in WFCC state.)

Reference: chapter 4.3.6 *"Connection Refusal"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-CONNECT request	
2	LT		Receive CR
3	LT	Send DR	
4	UT		Receive T-DISCONNECT indication

A.2.5.2 Transmission of DR TPDU

Verify that the IUT will send a DR TPDU refusing a requested connection when receiving a T-DISCONNECT request in the WFTRESP state.

Reference: chapter 4.3.6 *"Connection Refusal"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send CR	
2	UT		Receive T-CONNECT indication
3	UT	Send T-DISCONNECT request	
4	LT		Receive DR

A.2.6 Behavior Tests: Connection Release

The objective of this test group is to establish that the IUT conforms to the Connection Release procedures specified in chapter 4.3.7 *"Connection Release"*.

A.2.6.1 Reception of DR TPDU, TC in WFTRESP

Verify that the IUT will issue a T-DISCONNECT indication when receiving a DR TPDU discontinuing a connection establishment procedure initiated by the lower tester. (TC in WFTRESP state.)

Reference: chapter 4.3.7 *"Connection Release"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send CR	
2	UT		Receive T-CONNECT indication
3	LT	Send DR	
4	UT		Receive T-DISCONNECT indication

A.2.6.2 Transmission of DR TPDU, TC in WFCC

Verify that the IUT will send a DR TPDU discontinuing a connection establishment procedure initiated by the upper tester, when receiving a T-DISCONNECT request. (TC in WFCC state.)

Reference: chapter 4.3.7 *"Connection Release"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-CONNECT request	
2	LT		Receive CR
3	UT	Send T-DISCONNECT request	
4	LT		Receive DR

A.2.7 Behavior Tests: Association of TPDUs

The objective of this test group is to establish that the IUT conforms to the procedures specified in chapter 4.3.8 *"Association of TPDUs with Transport Connections"*, stating how to associate a received TPDU with a connection.

A.2.7.1 Reception of Duplicate CR TPDU 1

Verify that the IUT will re-transmit a CC TPDU when receiving a duplicate CR TPDU before any DT TPDUs have been received. (TC in OPEN state.)

Reference: chapter 4.3.8 *"Association of TPDUs with Transport Connections"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send CR (duplicate)	
2	LT		Receive CC
Additional Comments: Check that the IUT does not invoke any other actions, releasing or re-establishing the connection.			

A.2.7.2 Reception of Rogue CR TPDU

Verify that the IUT will discard a received CR TPDU without any other action, if the TPDU by the time stamp is identified as a rogue TPDU. (TC in OPEN state.)

Reference: chapter 4.3.8 *"Association of TPDUs with Transport Connections"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:** This requirement may not be possible to test using the Mobitex net			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send CR (rogue)	

A.2.7.3 Reception of Non-Associated CC TPDU

Verify that the IUT will send a DR TPDU when receiving a CC TPDU not associated with any connection.

Reference: chapter 4.3.8 *"Association of TPDUs with Transport Connections"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send CC	
2	LT		Receive DR
Additional Comments: Check that the CON-ID in the DR TPDU is identical to the one in the CC TPDU.			

A.2.7.4 Reception of Rogue DT TPDU

Verify that the IUT will discard a received DT TPDU without delivering the user data contained, if the TPDU by the time stamp is identified as a rogue TPDU. (TC in OPEN state.)

Reference: chapter 4.3.8 *"Association of TPDUs with Transport Connections"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:** This requirement may not be possible to test using the Mobitex net			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send DT (rogue), TP_UserData_0 (EOT=1)	
Additional Comments: Check that the IUT does not deliver the user data to the UT.			

A.2.7.5 Reception of Non-Associated DT TPDU

Verify that the IUT will send a DR TPDU when receiving a DT TPDU not associated with any connection.

Reference: chapter 4.3.8 *"Association of TPDUs with Transport Connections"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send DT	
2	LT		Receive DR, CON-ID=0
Additional Comments:			

A.2.7.6 Reception of Duplicate CR TPDU 2

Verify that the IUT will discard a received CR TPDU without any other action, if the TPDU is identified as a copy of a previously received CR TPDU and a DT TPDU has already been received on the connection. (TC in OPEN state.)

Reference: chapter 4.3.8 *"Association of TPDUs with Transport Connections"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send DT	
2	LT	Send CR (duplicate)	
Additional Comments: Check that the IUT does not invoke any action, releasing or re-establishing the connection.			

A.2.7.7 Reception of DT TPDU Before CC TPDU

Verify that the IUT will carry on a connection establishment procedure, when receiving a DT TPDU in the WFCC state.

Reference: chapter 4.3.8 *"Association of TPDUs with Transport Connections"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-CONNECT request	
2	LT		Receive CR
3	LT	Send DT, TPDU-NR=0	
4	LT	Send CC	
5	UT		Receive T-CONNECT confirm
Additional Comments: Check that the IUT does not send any DR TPDU, releasing the connection, after item number 3.			

A.2.8 Behavior Tests: Data Transfer

The objective of this test group is to establish that the IUT conforms to the Data Transfer procedures specified in chapter 4.3.9 *"Data Transfer"*.

This test group is composed of a number of nested test groups.

A.2.8.1 Segmenting and Reassembling

The objective of this test group is to establish that the IUT conforms to the segmenting and reassembling procedures specified in chapter 4.3.9.1 *"Segmenting and Reassembling"*.

The test group is composed of a number of test cases.

A.2.8.1.1 Segmenting User Data in a T-CONNECT Request

Verify that the IUT will segment user data conveyed in a T-CONNECT request when necessary. The IUT shall send the first part in the transmitted CR TPDU and then the remaining part in one or more DT TPDUs after receiving a CC TPDU.

Reference: chapter 4.3.9.1 *"Segmenting and Reassembling"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-CONNECT request, TS_UserData_1	
2	LT		Receive CR, EOT=0
3	LT	Send CC	
4	UT		Receive T-CONNECT confirm
5	LT		Receive DT, EOT=0, TPDU-NR=0-1
6	LT		Receive DT, EOT=1, TPDU-NR=2

A.2.8.1.2 Segmenting User Data in a T-CONNECT Response

Verify that the IUT will segment user data conveyed in a T-CONNECT response when necessary. The IUT shall send the first part in the transmitted CC TPDU and then the remaining part in one or more DT TPDUs.

Reference: chapter 4.3.9.1 *"Segmenting and Reassembling"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send CR	
2	UT		Receive T-CONNECT indication
3	UT	Send T-CONNECT response, TS_UserData_1	
4	LT		Receive CC, EOT=0
5	LT		Receive DT, EOT=0, TPDU-NR=0-1
6	LT		Receive DT, EOT=1, TPDU-NR=2

A.2.8.1.3 Segmenting User Data in a T-DATA Request

Verify that the IUT will segment user data conveyed in a T-DATA request when necessary.

Reference: chapter 4.3.9.1 *"Segmenting and Reassembling"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-DATA request, TS_UserData_1	
2	LT		Receive DT, EOT=0, TPDU-NR=0-2
3	LT		Receive DT, EOT= 1, TPDU-NR= 3

A.2.8.1.4 Reassembling User Data in CR and DT TPDUs

Verify that the IUT will reassemble user data conveyed in two or more TPDUs. The first TPDU shall be a CR TPDU.

Reference: chapter 4.3.9.1 *"Segmenting and Reassembling"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send CR, EOT=0 (user data included)	
2	UT		Receive T-CONNECT indication
3	UT	Send T-CONNECT response	
4	LT		Receive CC
5	LT	Send DT, EOT=0, TPDU-NR=0-1	
6	LT	Send DT, EOT=1, TPDU-NR=2	
7	UT		Receive T-DATA indication

A.2.8.1.5 Reassembling User Data in CC and DT TPDUs

Verify that the IUT will reassemble user data conveyed in two or more TPDUs. The first TPDU shall be a CC TPDU.

Reference: chapter 4.3.9.1 *"Segmenting and Reassembling"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-CONNECT request	
2	LT		Receive CR
3	LT	Send CC, EOT=0 (user data included)	
4	UT		Receive T-CONNECT confirm
5	LT	Send DT, EOT=0, TPDU-NR=0-1	
6	LT	Send DT, EOT=1, TPDU-NR=2	
7	UT		Receive T-DATA indication

A.2.8.1.6 Reassembling User Data in DT TPDUs

Verify that the IUT will reassemble user data conveyed in two or more DT TPDUs.

Reference: chapter 4.3.9.1 *"Segmenting and Reassembling"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send DT, EOT=0, TPDU-NR=0-2	
2	LT	Send DT, EOT=1, TPDU-NR=3	
3	UT		Receive T-DATA indication

A.2.8.2 Sequence Numbering of Data TPDUs

The objective of this test group is to establish that the IUT conforms to the Sequence numbering of data TPDUs procedures specified in chapter 4.3.9.2 *"Sequence Numbering of Data TPDUs"*.

The test group is composed of a number of test cases.

A.2.8.2.1 Sequence Number in First DT TPDU

Verify that the IUT will assign the value zero (0) as sequence number to the first DT TPDU to be sent after a connection establishment initiated by the IUT. The CR TPDU sent in the connection establishment procedure shall contain a complete TSDU.

Reference: chapter 4.3.9.2 *"Sequence Numbering of Data TPDUs"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-CONNECT request, TS_UserData_0	
2	LT		Receive CR, EOT=1
3	LT	Send CC	
4	UT		Receive T-CONNECT confirm
5	UT	Send T-DATA request, TS_UserData_0	
6	LT		Receive DT, EOT=1, TPDU-NR=0

A.2.8.2.2 Sequence Number in First DT TPDU

Verify that the IUT will assign the value zero (0) as sequence number to the first DT TPDU to be sent after a connection establishment not including exchange of user data.

Reference: chapter 4.3.9.2 *"Sequence Numbering of Data TPDUs"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-DATA request, T_UserData_0	
2	LT		Receive DT, EOT=1, TPDU-NR=0

A.2.8.3 Resequencing

The objective of this test group is to establish that the IUT conforms to the resequencing procedures specified in chapter 4.3.9.3 *"Resequencing"*.

The test group is composed of a number of test cases.

A.2.8.3.1 Resequencing, DT TPDU Out of Sequence

Verify that the IUT will buffer a DT TPDU containing a complete TSDU, received out of sequence but within the transmit window.

Reference: chapter 4.3.9.3 *"Resequencing"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send DT, EOT=0, TPDU-NR=1-3	
2	LT	Send DT, EOT=1, TPDU-NR=4	
3	LT	Send DT, EOT=1, TPDU-NR=0	
4	UT		Receive T-DATA indication (0)
5	UT		Receive T-DATA indication (1-4)
Additional Comments: Check that the IUT delivers the TSDUs in the correct order. The data delivered in item number 4 must be the data sent in item 3.			

A.2.8.3.2 DT TPDU Outside Transmit Window

Verify that the IUT will discard a DT TPDU received outside the transmit window.

Reference: chapter 4.3.9.3 *"Resequencing"*

Test Case Dynamic Behaviour			
Test Case Id:			
Initialisation: Open State			
Comments: The scenario below presupposes a window size of 8.			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send DT, EOT=1, TPDU-NR=0	
2	UT		Receive T-DATA indication (0)
3	LT	Send DT, EOT=1, TPDU-NR=8	
4	LT	Send DT, EOT=0, TPDU-NR=1-3	
5	LT	Send DT, EOT=1, TPDU-NR=4	
6	UT		Receive T-DATA indication (1-4)
7	LT	Send DT, EOT=0, TPDU-NR=5-7	
8		Time-out TWBAK	
9	LT		Receive AK, ACK-NR=8
10	LT	Send DT, EOT=1, TPDU-NR=6	
11	UT		Receive T-DATA indication (5-8)
Additional Comments: Check that the IUT discards the DT TPDU in item number 3 and does not deliver the user data to the UT. Check that the ACK-NR in item 9 is equal to 8 (and not 9).			

A.2.8.3.3 Copies of DT TPDUs

Verify that the IUT will discard a received DT TPDU, defined as a copy of a previously received TPDU.

Reference: chapter 4.3.9.3 *"Resequencing"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send DT, EOT=0, TPDU-NR=0-2	
2	LT	Send DT, EOT=1, TPDU-NR=3	
3	UT		Receive T-DATA indication (0-3)
4	LT	Send DT, EOT=1, TPDU-NR=3 (copy)	
Additional Comments: Check that the IUT discards the DT TPDU in item 4, and does not deliver the duplicate user data to UT.			

A.2.8.3.4 Copies of CC TPDU

Verify that the IUT will discard a received CC TPDU without any other action, if the TPDU is identified as a copy of a previously received CC TPDU. (TC in OPEN state.)

Reference: chapter Appendix A: *"MTP/1 Test Suite Structure and Test Purposes"*

Test Case Dynamic Behaviour			
Test Case Id:			
Initialisation: Open State			
Comments: The CC TPDU shall contain user data.			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send CC, EOT=1 (duplicate)	
Additional Comments: Check that the IUT discards the CC TPDU, and does not deliver the duplicate user data.			

A.2.8.4 Flow Control

The objective of this test group is to establish that the IUT conforms to the Flow control procedures specified in chapter 4.3.9.4 *"Flow Control"*.

The test group is composed of a number of test cases.

A.2.8.4.1 Moving the Receive Window Edges 1

Verify that the IUT, after sending an acknowledgment concerning all received data, will accept a suite of (window size) DT TPDUs.

Reference: chapter 4.3.9.4 *"Flow Control"*

Test Case Dynamic Behaviour			
Test Case Id:			
Initialisation: Open State			
Comments: The scenario below presupposes a window size of 8			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send DT, EOT=1, TPDU-NR=0	
2	UT		Receive T-DATA indication (0)
3		Time-out TWBAK	
4	LT		Receive AK TPDU. ACK-NR=1
5	LT	Send DT, EOT=0, TPDU-NR=1-7	
6	LT	Send DT, EOT=1, TPDU-NR=8	
7	UT		Receive T-DATA indication (1-8)
Additional Comments: An AK TPDU will be sent by the IUT just prior to or after the indication in item 7.			

A.2.8.4.2 Moving the Receive Window Edges 2

Verify that the IUT, after responding to a received CR TPDU conveying user data, will accept a suite of (window size) DT TPDUs.

Reference: chapter 4.3.9.4 *"Flow Control"*

Test Case Dynamic Behaviour			
Test Case Id:			
Initialisation: Closed State			
Comments: The scenario below presupposes a window size of 8			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send CR EOT=1 TP_UserData_0	
2	UT		Receive T-CONNECT indication
3	UT	Send T-CONNECT response	
4	LT		Receive CC
5	LT	Send DT, EOT=0, TPDU-NR=1-7	
6	LT	Send DT, EOT=1, TPDU-NR=8	
7	UT		Receive T-DATA indication (1-8)
Additional Comments: An AK TPDU will be sent by the IUT just prior to or after the indication in item 7.			

A.2.8.4.3 Moving the Transmit Window Edges

Verify that the IUT, after receiving an acknowledgment concerning all sent data, will be able to send a suite of (window size) DT TPDUs without receiving any additional acknowledgments.

Reference: chapter 4.3.9.4 *"Flow Control"*

Test Case Dynamic Behaviour			
Test Case Id:			
Initialisation: Open State			
Comments: The scenario below presupposes a window size of 8			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-DATA request, TS_UserData_0	
2	LT		Receive DT, EOT=1, TPDU-NR=0
3	LT	Send AK TPDU, ACK-NR=1	
4	UT	Send T-DATA request, TS_UserData_3	
5	LT		Receive DT, EOT=0, TPDU-NR=1-8
Additional Comments: Check that the TPDU-NR in the last DT TPDU of item 5 is equal to 8.			

A.2.8.5 Transmission of Acknowledgments

The objective of this test group is to establish that the IUT conforms to the Transmission of acknowledgments procedures specified in chapter 4.3.9.5 *"Transmission of Acknowledgments"*.

The test group is composed of a number of test cases.

A.2.8.5.1 Transmission of Acknowledgments, AK TPDU After Time-Out

Verify that the IUT will send an AK TPDU within TWBAK seconds when receiving a DT TPDU.

Reference: chapter 4.3.9.5 *"Transmission of Acknowledgments"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send DT, EOT=0, TPDU-NR=0	
2		Time-out TWBAK	
3	LT		Receive AK TPDU, ACK-NR=1
Additional Comments: Check that the ACK-NR in the DT TPDU of item 3 is equal to 1.			

A.2.8.5.2 Piggy-Backed Acknowledgment

Verify that the IUT will fill out the ACK-NR field in the DT TPDU, acknowledging received data when sending DT TPDUs.

Reference: chapter 4.3.9.5 *"Transmission of Acknowledgments"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send DT, EOT=0, TPDU-NR=0	
2	UT	Send T-DATA request, TS_UserData_0	
3	LT		Receive DT TPDU, ACK-NR=1
Additional Comments: Check that the ACK-NR in the DT TPDU of item 3 is equal to 1.			

A.2.8.5.3 Sending AK TPDU Upon Request 1

Verify that the IUT will send an AK TPDU immediately when receiving a DT TPDU with ACK-REQ set.

Reference: chapter 4.3.9.5 *"Transmission of Acknowledgments"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send DT, ACK-REQ=1, EOT=0, TPDU-NR=0	
2	LT		Receive AK TPDU, ACK-NR=1
Additional Comments: Check that the ACK-NR in the DT TPDU of item 2 is equal to 1.			

A.2.8.5.4 Sending AK TPDU Upon Request 2

Verify that the IUT will send an AK TPDU, as soon as the acknowledgment condition of the received TPDU is satisfied, when receiving a DT TPDU with ACK-REQ set.

Reference: chapter 4.3.9.5 *"Transmission of Acknowledgments"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send DT, ACK-REQ=1, EOT=0, TPDU-NR=1	
2	LT	Send DT, ACK-REQ=0, EOT=0, TPDU-NR=0	
3	LT		Receive AK TPDU, ACK-NR=2
Additional Comments: Check that the ACK-NR in the AK TPDU of item 3 is equal to 2.			

A.2.8.5.5 Sending AK TPDU when Entire Window Utilized

Verify that the IUT will send an AK TPDU not later than upon the reception of a DT TPDU with a sequence number equal to the upper window size minus 1.

Reference: chapter 4.3.9.5 *"Transmission of Acknowledgments"*

Test Case Dynamic Behaviour			
Test Case Id:			
Initialisation: Open State			
Comments: The scenario below presupposes a window size of 8			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send DT, EOT=0, TPDU-NR=0-7	
2	LT		Receive AK TPDU, ACK-NR=8
Additional Comments: The time elapsed between the transmission of the first DT TPDU and the reception of the AK TPDU shall be less than TWBAK seconds to guarantee the verification.			

A.2.8.5.6 Copies of DT TPDUs

Verify that the IUT will send an AK TPDU when receiving a DT TPDU, defined as a copy of a previously received TPDU.

Reference: chapter 4.3.9.3 *"Resequencing"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	LT	Send DT, EOT=0, TPDU-NR=0	
2		Time-out TWBAK	
3	LT		Receive AK TPDU, ACK-NR=1
4	LT	Send DT, EOT=0, TPDU-NR=0 (duplicate)	
5		Time-out TWBAK	
6	LT		Receive AK TPDU, ACK-NR=1

A.2.8.5.7 Copies of CC TPDUs

Verify that the IUT will send an AK TPDU when receiving user data conveyed in a CC TPDU, defined as a copy of a previously received CC TPDU.

Reference: chapter 4.3.9.3 *"Resequencing"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-CONNECT request	
2	LT		Receive CR
3	LT	Send CC, EOT=1	
4	UT		Receive T-CONNECT confirm
5		Time-out TWBAK	
6	LT		Receive AK TPDU, ACK-NR=0
7	LT	Send CC, EOT=1, (duplicate)	
8		Time-out TWBAK	
9	LT		Receive AK TPDU, ACK-NR=0

A.2.8.6 Sequencing of Received Acknowledgments

The objective of this test group is to establish that the IUT conforms to the sequencing of received acknowledgments procedures specified in chapter 4.3.9.6 *"Sequencing of Received Acknowledgments"*.

The test group is composed of a number of test cases.

A.2.8.6.1 Modulus Operations

Verify that the IUT will accept an acknowledgment with ACK-NR equal to 0 (zero) following an acknowledgment with ACK-NR equal to 256 minus the window size. (Both acknowledgments within the transmit window.)

Reference: chapter 4.3.9.6 *"Sequencing of Received Acknowledgments"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
.			
.			
.			
n+1	UT	Send T-DATA request, TS_UserData_0	
n+2	LT		Receive DT TPDU, TPDU-NR=247
n+3	LT	Send AK, ACK-NR=248	
n+4	UT	Send T-DATA request, TS_UserData_2	
n+5	LT		Receive DT TPDU, TPDU-NR=248-255
n+6	LT	Send AK, ACK-NR=0	
n+7	UT	Send T-DATA request, TS_UserData_0	
n+8	LT		Receive DT TPDU, TPDU-NR=0

A.2.8.7 Retention Until Acknowledgment of Data TPDUs

The objective of this test group is to establish that the IUT conforms to the Retention until acknowledgment of data TPDUs procedures specified in chapter 4.3.9.7 *"Retention Until Acknowledgment of Data TPDUs"*.

The test group is composed of a number of test cases.

A.2.8.7.1 User Data in Retransmitted DT TPDU

Verify that the user data of a DT TPDU retransmitted by the IUT is identical to the user data of the originally sent DT TPDU.

Reference: chapter 4.3.9.7 *"Retention Until Acknowledgment of Data TPDUs"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-DATA request, TS_UserData_0	
2	LT		Receive DT, EOT=1, TPDU-NR=0
3		Time-out TWBDTR	
4	LT		Receive DT, EOT=1, TPDU-NR=0
Additional Comments: Check that the user data in item 2 and 4 are identical.			

A.2.8.8 Retransmission on Time-Out

The objective of this test group is to establish that the IUT conforms to the Retransmission on time-out procedures specified in chapter 4.3.9.8 *"Retransmission on Time-Out"*.

The test group is composed of a number of test cases.

A.2.8.8.1 Retransmission on Time-Out, Alternative a)

Verify that the IUT will retransmit a suite of previously sent DT TPDUs, when not receiving any acknowledgments.

Verify that the IUT will update the piggy-backed ACK-NR when retransmitting DT TPDUs.

Reference: chapter 4.3.9.8 *"Retransmission on Time-Out"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-DATA request, TS_UserData_1	
2	LT		Receive DT, TPDU-NR=0-3, ACK-NR=0
3	LT	Send DT, TPDU-NR=0, ACK-NR=2	
4		Time-out TWBDTR	
5	LT		Receive DT, TPDU-NR=2-3, ACK-NR=1

A.2.8.8.2 Retransmission on Time-Out, Alternative b)

Verify that the IUT will retransmit just the first DT TPDU out of a suite of previously sent DT TPDUs, when not receiving any acknowledgments.

Check that all unacknowledged DT TPDUs will be retransmitted, when finally an AK TPDU is received acknowledging some of the previously sent DT TPDUs.

Verify that the IUT will update the piggy-backed ACK-NR when retransmitting DT TPDUs.

Reference: chapter 4.3.9.8 *"Retransmission on Time-Out"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-DATA request, TS_UserData_1	
2	LT		Receive DT, TPDU-NR=0-3, ACK-NR=0
3		Time-out TWBDTR	
4	LT		Receive DT, A-R=1, TPDU-NR=0
5	LT	Send DT, TPDU-NR=0, ACK-NR=2	
6	LT		Receive DT, TPDU-NR=2-3, ACK-NR=1

A.2.8.8.3 Release of Connection in Close Mode

Verify that the IUT will release the connection after a number of unsuccessful retransmission attempts in Close Mode.

Reference: chapter 4.3.6 *"Connection Refusal"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-DATA request, TS_UserData_0	
2	LT		Receive DT
3		Time-out TWBDTR	
4	LT		Receive DT
5		Time-out TWBDTR	
6	UT		Receive T-DISCONNECT indication
Additional Comments: Item number 3-4 shall be repeated N-2 times.			

A.2.8.8.4 Issue of T-NO-RESPONSE and Restart of Retransmission

Verify that the IUT will issue a T-NO-RESPONSE indication after a number of unsuccessful retransmission attempts in Non-Close Mode.

Verify that the IUT will restart the retransmission procedure when receiving a T-RETRY request.

Reference: chapter 4.3.9.8 *"Retransmission on Time-Out"*

Test Case Dynamic Behaviour

Test Case Id:

Initialisation: Open State, Non-Close

Comments:

Test Body

No.	PCO	Action	Expected Result
1	UT	Send T-DATA request, TS_UserData_0	
2	LT		Receive DT
3		Time-out TWBDTR	
4	LT		Receive DT
5		Time-out TWBDTR	
6	UT		Receive T-NO-RESPONSE indication
7		Delay	
8	UT	Send T-RETRY request	
9	LT		Receive DT

Additional Comments:

Item number 3-4 shall be repeated N-2 times.
The IUT will continue retransmitting after item 9, repeating from item 3.

A.2.8.9 Inactivity Control

The objective of this test group is to establish that the IUT conforms to the Inactivity control procedures specified in chapter 4.3.9.11 *"Inactivity Control"*.

The test group is composed of a number of test cases.

A.2.8.9.1 Release and Re-Establishment of TC after TI-Time-Out

Verify that the IUT will first release and then re-establish a connection, when receiving a T-UNITDATA request after the first but before the second expiration of the inactivity timer (TI). (Connectionless-Mode Service)

Reference: chapter 4.3.9.11 *"Inactivity Control"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State, Connectionless **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1		Time-out TI	
2	UT	Send T-UNITDATA request, TS_UserData_0	
3	LT		Receive DR
4	LT		Receive CR, EOT=1
Additional Comments: Item 3 may be omitted.			

A.2.8.9.2 Release of TC after TI-Time-Out 1

Verify that the IUT will release a connection, when receiving a T-DATA request after the first but before the second expiration of the inactivity timer (TI). (Connection-Mode Service)

Reference: chapter 4.3.9.11 *"Inactivity Control"* and chapter 6.9 *"State Transition Diagram"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1		Time-out TI	
2	UT	Send T-DATA request, TS_UserData_0	
3	LT		Receive DR
4	UT		Receive T-DISCONNECT indication
Additional Comments: Item number 3 and 4 may occur in reverse order.			

A.2.8.9.3 Release of TC after TI-Time-Out 2

Verify that the IUT will send a DR TPDU and issue a T-DISCONNECT indication releasing an established connection, at the second expiration of the inactivity timer (TI).

Reference: chapter 4.3.9.11 *"Inactivity Control"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1		Time-out TI	
2		Time-out TI	
3	LT		Receive DR
4	UT		Receive T-DISCONNECT indication
Additional Comments: Item number 3 and 4 may occur in reverse order.			

A.2.8.10 Mailbox

The objective of this test group is to establish that the IUT conforms to the Mailbox procedures specified in chapter 4.3.9.12 *"Mailbox"*.

The test group is composed of a number of test cases.

A.2.8.10.1 Placed in Mailbox, Restart

Verify that the IUT will retransmit just the first DT TPDU out of a suite of previously sent DT TPDUs, when not receiving any acknowledgments. The IUT shall request the Mobitex mailbox service.

Check that all unacknowledged DT TPDUs will be retransmitted, when a "Has been placed in the mailbox" acknowledgment followed by an AK TPDU acknowledging the mailboxed DT TPDUs is received.

Reference: chapter 4.3.9.12 *"Mailbox"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-DATA request, TS_UserData_1	
2	LT		Receive DT, TPDU-NR=0-3
3		Time-out TWBDTR	
4	LT		Receive DT, A-R=1, TPDU-NR=0, mailbox requested
5	LT	Send (return) DT with traffic state = 2	
6	LT	Send AK, ACK-NR=1	
7	LT		Receive DT, TPDU-NR=1-3
Additional Comments: -			

A.2.8.10.2 Placed in Mailbox, Release

Verify that the IUT after placing a DT TPDU in the mailbox will release the connection at the expiration of the inactivity timer (TI).

Reference: chapter 4.3.9.12 *"Mailbox"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-DATA request, TS_UserData_0	
2	LT		Receive DT, TPDU-NR=0
3		Time-out TWBDTR	
4	LT		Receive DT, A-R=1, TPDU-NR=0, mailbox requested
5	LT	Send (return) DT with traffic state = 2	
6		Time-out TI	
7	LT		Receive DR
8	UT	Receive T-DISCONNECT indication	
Additional Comments: Item number 7 and 8 may occur in reverse order.			

A.2.8.10.3 Sent to Mailbox, Restart

Verify that the IUT after sending a DT TPDU to the mailbox will retransmit all unacknowledged DT TPDUs, when an AK TPDU is received acknowledging some of the previously sent DT TPDUs.

Reference: chapter 4.3.9.12 *"Mailbox"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-DATA request, TS_UserData_1	
2	LT		Receive DT, TPDU-NR=0-3
3		Time-out TWBDTR	
4	LT		Receive DT, A-R=1, TPDU-NR=0, mailbox requested
5	LT	Send AK, TPDU-NR=2	
6	LT		Receive DT, TPDU-NR=2-3
Additional Comments: -			

A.2.8.10.4 Sent to Mailbox, No Response

Verify that the IUT after sending a DT TPDU to the mailbox will continue with normal retransmission at the expiration of the retransmission timer (TWBDTR).

Reference: chapter 4.3.9.12 *"Mailbox"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-DATA request, TS_UserData_1	
2	LT		Receive DT, TPDU-NR=0-3
3		Time-out TWBDTR	
4	LT		Receive DT, A-R=1, TPDU-NR=0, mailbox requested
5		Time-out TWBDTR	
6	LT		Receive DT, A-R=1, TPDU-NR=0
Additional Comments: -			

A.2.9 Behavior Tests: Response to Syntactically Invalid Behavior by Peer Implementation

A.2.9.1 Invalid Behavior During Connection Establishment

The objective of this test group is to establish that the IUT responds correctly to syntactically invalid behavior by peer implementation during connection establishment.

The test group is composed of a number of test cases.

A.2.9.1.1 Invalid Negotiation About Close Mode, Initiator

Verify that the IUT after sending a CR TPDU requesting a connection-mode service with Non-Close Mode preferred, will detect the reception of a CC TPDU with the Close Mode selected. The IUT shall respond with a DR TPDU and issue a T-DISCONNECT indication discontinuing the connection establishment procedure.

Reference: chapter 4.3.5.2 *"Negotiation During Connection Establishment"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Closed State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-CONNECT request, Non-Close Mode preferred	
2	LT		Receive CR, CLS=0
3	LT	Send CC, CLS=1	
4	LT		Receive DR
5	UT		Receive T-DISCONNECT indication
Additional Comments: Item number 4 and 5 may occur in reverse order.			

A.2.9.2 Invalid Behavior During Data Transfer

The objective of this test group is to establish that the IUT responds correctly to syntactically invalid behavior by peer implementation during data transfer.

The test group is composed of a number of test cases.

A.2.9.2.1 Acknowledgment Outside Transmit Window

Verify that the IUT will ignore an acknowledgment with ACK-NR outside the transmit window and greater than previously received ACK-NRs.

Reference: chapter 4.3.9.4 *"Flow Control"*

Test Case Dynamic Behaviour			
Test Case Id: **Initialisation:** Open State **Comments:**			
Test Body			
No.	**PCO**	**Action**	**Expected Result**
1	UT	Send T-DATA request, TS_UserData_0	
2	LT		Receive DT, TPDU-NR=0
3	LT	Send AK, ACK-NR=9	
4		Time-out TWBDTR	
5	LT		Receive DT, TPDU-NR=0
Additional Comments: The DT TPDU in item 5 shall be a retransmission of the TPDU in item 2.			

A.3 Basic Interconnection Tests

The basic interconnection tests are provided as a list of selected capability and behavior tests from the test suite structure specified in chapter A.2 *"Test Suite Structure and Test Purposes"*.

The test cases in the following chapters are appropriate:

- chapter A.2.3.1.2 *"Transmission of CC TPDU"*
- chapter A.2.3.1.4 *"Reception of CC TPDU"*
- chapter A.2.3.1.5 *"Reception of CR TPDU Requesting Connectionless Service"*
- chapter A.2.3.1.6 *"Reception of DT TPDU"*
- chapter A.2.3.1.7 *"Transmission of DT TPDU"*
- chapter A.2.5.1 *"Reception of DR TPDU"*
- chapter A.2.5.2 *"Transmission of DR TPDU"*
- chapter A.2.4.2.2 *"Negotiation About Close Mode, Initiator"*
- chapter A.2.5.1 *"Reception of DR TPDU"*
- chapter A.2.6.1 *"Reception of DR TPDU, TC in WFTRESP"*
- chapter A.2.7.7 *"Reception of DT TPDU Before CC TPDU"*
- chapter A.2.8.1.1 *"Segmenting User Data in a T-CONNECT Request"*
- chapter A.2.8.1.2 *"Segmenting User Data in a T-CONNECT Response"*
- chapter A.2.8.1.3 *"Segmenting User Data in a T-DATA Request"*
- chapter A.2.8.1.4 *"Reassembling User Data in CR and DT TPDUs"*
- chapter A.2.8.1.5 *"Reassembling User Data in CC and DT TPDUs"*
- chapter A.2.8.1.6 *"Reassembling User Data in DT TPDUs"*
- chapter A.2.8.3.1 *"Resequencing, DT TPDU Out of Sequence"*
- chapter A.2.8.5.1 *"Transmission of Acknowledgments, AK TPDU After Time-Out"*
- chapter A.2.8.8.1 *"Retransmission on Time-Out, Alternative a)"* or chapter A.2.8.8.2 *"Retransmission on Time-Out, Alternative b)"*.

Appendix B: MTP/1 PICS Proforma[1]

This chapter provides the Protocol Implementation Conformance Statement (PICS) proforma for the Mobitex transport protocol MTP/1, that explicitly defines the implementation flexibility allowed by the protocol specification.

The suggested layout for the mandatory cover page for the completed PICS can be found in chapter Appendix C: *"Cover Page Template for an MTP/1 PICS"*.

The MTP/1 PICS proforma is to be used by implementors, who need to document their implementations and by ATS specifiers, who need to ensure that the structure of the test suite matches the allowed implementation flexibility.

B.1 Introduction

To evaluate conformance of a particular protocol implementation, it is necessary to have a statement of which capabilities and options have been implemented for a given protocol. Such a statement is called a PICS.

Each protocol-defining group is responsible for providing a PICS proforma in the form of a questionnaire or checklist to be completed by the supplier or implementor of the protocol. This PICS proforma is unique for the protocol.

B.2 General Requirements

The supplier of an MTP/1 implementation which is claimed to conform to the protocol specifications (see chapter 3 *"Transport Service Definition"* and chapter 4 *"Transport Protocol Specification"*) is required to complete a copy of the PICS proforma, and to provide the information necessary to identify both the supplier and the implementation.

The completed PICS proforma becomes the PICS for the specific implementation.

The PICS itself shall include a cover page identifying:

a) the implementation and the system in which it resides;

b) the supplier of the system;

c) the person to contact if there are any queries concerning the content of the PICS.

1. Copyright release for PICS proforma. Users of this specification may freely reproduce the PICS proforma in this chapter so that it can be used for its intended purpose, and may further publish the completed PICS

B.3 Identification of the Protocol

This PICS proforma is applied to the MTP/1 protocol specification, see chapter 4 *"Transport Protocol Specification"*.

B.4 Global Statement of Conformance

Have all mandatory capabilities according to this proforma been implemented?[1]

Yes:.....No:.....

Is the performed conformance test based on the MTP/1 test specification (see chapter Appendix A: *"MTP/1 Test Suite Structure and Test Purposes"*)?

Yes:..... No, on a different document:.....

B.5 Capabilities

B.5.1 Conventions

This section is presented in the form of a number of tables. Each table contains a column to give a reference number to each row, one or more columns to name a particular item, and one or more sets of columns to specify and record the support of the item. Each such set represents a distinct context in which the support is to be specified, for example, transmit, receive, or processing.

A set of columns may contain:

a) a status column to specify the status of the item (for example, mandatory, optional), as defined in the specifications;

b) an allowed values column stating any restrictions or prescriptions on the values to be supported;

c) a support column, in which a response shall be made.

1. Answering "No" to this question indicates non-conformance to the protocol specification. Non-supported mandatory capabilities are to be identified in the PICS, with an explanation of why the implementation is non-conforming.

The symbols used in the tables in this section are as follows:

Symbols for the Status columns	m for mandatory; o for optional; c for conditional; n/a or - (dash) for not applicable
Symbols for the Support columns	y, Y, or Yes for implemented; n, N, or No for not implemented; a length, a value, or a range of values if the support differs from the value specified in the Allowed column.

All references made in the “Ref” columns in the following sections are stated below the table.

B.5.2 TPDU Support

The table below covers all TPDUs defined for MTP/1.

Supported TPDUs								
			Transmit		Receive[a]		Processing[b]	
Item	TPDU	Ref	Status	Support	Status	Support	Status	Support
1	CR	[i]	o		m		m	
2	CC	[i]	m		m (1)		c1	
3	CCAM	[ii]	o		m (2)		c2	
4	DR	[iii]	m		m		m	
5	DT	[iv]	o		m		m	
6	AK	[v]	m		m (3)		c3	

Conditional expressions and other comments:
c1: IF sending CR supported THEN m ELSE n/a.
c2: IF sending CR supported THEN o ELSE n/a.
c3: IF sending user data supported THEN m ELSE n/a.
1) If processing not supported, a DR shall be sent as response [vi].
2) If processing not supported, a DR shall be sent as response [ii].
3) If processing not supported, the TPDU can be discarded without any other action.

a. Receive means just receive and, if processing not supported, termination of the received information according to the protocol specification.
b. Processing means entire support and treatment of the received information.

References:

[i] chapter 4.3.5 *"Connection Establishment"*

[ii] chapter 4.3.5.4 *"Host Group Addressing (HGA)"*

[iii] chapter 4.3.6 *"Connection Refusal"* and chapter 4.3.7 *"Connection Release"*

[iv] chapter 4.3.9 *"Data Transfer"*

[v] chapter 4.3.9.5 *"Transmission of Acknowledgments"* and chapter 4.3.9.6 *"Sequencing of Received Acknowledgments"*

[vi] chapter 4.3.8 *"Association of TPDUs with Transport Connections"*

B.5.3 TPDU Fields

The table below covers all TPDU fields for which some kind of implementation flexibility exists.

Supported Fields								
			Values		Transmit		Processing	
Item	TPDU	Field	Allowed	Support	Status	Support	Status	Support
1 2	CR	Q-BIT	0 1		m o		o o (1)	
3		VER	0		m		m	
4 5		SESS	0 1-7		m o		o o	
6		CON-ID	1-255		m		m	
7 8	CC/ CCAM	Q-BIT	0 1		m o		o o (1)	
9		VER	0		m		m	
10		CON-ID	1-255		m		m	
11	DR	VER	0		m		m	
12 13		REASON	0 1-7		m o		o o	
14		CON-ID	0, 1-255		m		m	
15 16		User data	0 1-64 bytes		m o		o o	
17 18	DT	Q-BIT	0 1		m o		o o (1)	

Conditional expressions and other comments:
1) If processing not supported, TPDUs with Q-BIT equal to 1 shall be handled in the normal way, including sending acknowledgment to the peer entity, but no user data shall be delivered to the upper layer.

B.6 Connectionless-Mode Services

The transport service can be provided in two different ways; as a connectionless-mode service or as a connection-mode service (see chapter 3 *"Transport Service Definition"*). It is optional to implement both services, but if a service is implemented it must follow the conditions specified in the applicable tables.

Has the connectionless-mode service been implemented?

Yes:.....No:.....

If yes, the tables in chapter B.6.1 *"Parameters Associated with a Connection"* and chapter B.6.2 *"Service Primitives"*shall be filled out.

If no, continue with chapter B.7 *"Connection-Mode Services"*.

B.6.1 Parameters Associated with a Connection

Supported Services						
Item	**Parameter**	**Ref**	**Value**	**Status**	**Support**	**Comments**
1 2	Close	[i]	Close Non-Close	m n/a (1)		
3 4	Immediate	[ii]	Immediate Non-Immediate	m n/a		
5 6	Explicit	[iii]	Explicit Non-Explicit	m n/a		
7	Mailbox	[vi]	Use of mailbox	o		

Comments:
1) If a CR TPDU requesting the Non-Close Mode is received, the request shall be refused sending a DR TPDU.

References:

[i] chapter 4.3.4.1 *"Close"*

[ii] chapter 4.3.4.2 *"Immediate"*

[iii] chapter 4.3.4.3 *"Explicit"*

[iv] chapter 4.3.4.4 *"Mailbox"*

B.6.2 Service Primitives

Supported Service Primitives				
Item	**Primitive**	**Status**	**Support**	**Comments**
1	T-UNITDATA req	o (1)		
2	T-UNITDATA-SENT ind	o		
3	T-UNITDATA-ACK ind	o		
4	T-UNITDATA ind	m		
5	T-ERROR ind	m		

Comments:
1) If the primitive is supported, but the length of the user data is limited to just one TPDU or to a limited number of user data bytes, the restriction shall be specified in the Comments column.

B.7 Connection-Mode Services

The transport service can be provided in two different ways; as a connectionless-mode service or as a connection-mode service (see chapter 3 *"Transport Service Definition"*). It is optional to implement both services, but if a service is implemented it must follow the conditions specified in the applicable tables.

Has the connection-mode service been implemented?

Yes:.....No:.....

If yes, the tables in chapter B.7.1 *"Parameters Associated with a Connection"* and chapter B.7.2 *"Service Primitives"*shall be filled out.

If no, continue with chapter B.8 *"Retransmission on Time-Out"*

B.7.1 Parameters Associated with a Connection

Supported Services						
Item	**Parameter**	**Ref**	**Value**	**Status**	**Support**	**Comments**
1 2	Close	[i]	Close Non-Close	o m		
3 4	Immediate	[ii]	Immediate Non-Immediate	m o		
5 6	Explicit	[iii]	Explicit Non-Explicit	m o		
7	Mailbox	[vi]	Use of mailbox	o		
Comments: -						

References:

[i] chapter 4.3.4.1 *"Close"*

[ii] chapter 4.3.4.2 *"Immediate"*

[iii] chapter 4.3.4.3 *"Explicit"*

[iv] chapter 4.3.4.4 *"Mailbox"*

B.7.2 Service Primitives

Supported Service Primitives				
Item	**Primitive**	**Status**	**Support**	**Comments**
1	T-CONNECT req	o (1)		
2	T-CONNECT indication	m		
3	T-CONNECT response	m (2)		
4	T-CONNECT confirm	c1		
5	T-DATA req	o (1)		
6	T-DATA-SENT ind	o		
7	T-DATA-ACK ind	o		
8	T-DATA ind	m		
9	T-DISCONNECT request	m		
10	T-DISCONNECT ind	m		
11	T-NO-RESPONSE ind	m		
12	T-RETRY request	o		
13	T-ERROR ind	m		
14				
15				
16				
17				
18				
19				
20				

Conditional expressions and other comments:
cl: IF T-CONNECT request supported THEN m ELSE n/a
1) If the primitive is supported, but the length of the user data is limited to just one TPDU or to a limited number of user data bytes, the restriction shall be specified in the Comments column.
2) If the length of the user data is limited to just one TPDU or to a limited number of user data bytes, the restriction shall be specified in the Comments column

B.8 Retransmission on Time-Out

The protocol specifies a choice of actions that shall be taken when not receiving any acknowledgment of transmitted data.

Which alternative is implemented (see chapter 4.3.9.8 *"Retransmission on Time-Out"*) if no acknowledgment is received?

Alternative a).....Alternative b) .....

B.8.1 Timer and Counter Values

Supported Timer and Counter Values		
Item	**Parameter**	**8k Network**
1	TWBAK (s)	
2	TWBDTR (s)	
3	TI (s)	
4	N	
5	Window Size (CDT-CONST)	

B.9 Additional Information

Additional information provided by the MTP/1 implementor.

Appendix C: Cover Page Template for an MTP/1 PICS

MTP/1

Protocol Implementation Conformance Statement

This document refers to the MTP/1 implementation in.....

.....

Date of completion of this document.....

The product is supplied by:

Company Name.....

Company Address.....

Telephone.....

Fax.....

If there are any queries concerning the content of this document, please contact:

Name.....

Title.....

Direct telephone.....

Fax.....

E-mail.....