0 Introduction

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

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

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

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

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

a) different throughput;

b) different error rates;

c) integrity of data requirements;

d) reliability requirements.

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

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

a) as a guide for implementors and designers;

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

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

d) as a refinement of the understanding of OSI.

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

It should be noted that, as the number of valid protocol sequences is very large, it is not possible with current technology to verify that an implementation will operate the protocol defined in this International Standard correctly under all circumstances. It is possible by means of testing to establish confidence that an implementation correctly operates the protocol in a representative sample of circumstances. It is,

however, intended that this International Standard can be used in circumstances where two implementations fail to communicate in order to determine whether one or both have failed to operate the protocol correctly.

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

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

1 Scope and field of application

This International Standard specifies

a) a single class of procedures, class 5: multicast class, when operating over the multicast network service, connection oriented network service (for future study) and the connectionless network service (for future study); for the multicast transfer of data and control information from one transport entity to a group of peer transport entities;

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

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

The procedures are defined in terms of

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

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

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

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

2 References

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

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

ISO 7498-3, *Information processing systems – Open Systems Interconnection – Basic Reference Model – Part 3: Naming and addressing.*

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

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

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

ISO/IEC 9646-1, *OSI Conformance Testing Methodology and Framework, Part 1: General Concepts.*

ISO/IEC 9646-2, *OSI Conformance Testing Methodology and Framework, Part 2: Abstract Test Suite Specification.*

CCITT X.224, Transport Protocol Specification for Open Systems Interconnection for CCITT Applications Version 1988.

Section one: General

3 Definitions

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

3.1 This International Standard is based on the concepts developed in ISO 7498 and ISO 7498/Add.1 and ISO/IEC 7498-3 and makes use of the following terms defined in it:

a) concatenation and separation;

b) segmenting and reassembling;

c) multiplexing and demultiplexing;

d) splitting and recombining;

e) flow control;

f) connectionless mode transmission;

g) nil selector value.

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

TBD

3.3 This International Standard uses the following terms defined in ISO 9646-1:

a) PICS proforma

b) protocol implementation conformance statement (PICS)

4 Symbols and abbreviations

4.1 Data units

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

4.2 Types of Transport Protocol data units

GCCR TPDU Group Conversation Activation TPDU
GCCC TPDU Group Conversation Join TPDU
GCDR TPDU Group Conversation Leave TPDU
GCDC TPDU Group Conversation Deactivate TPDU
GCDT TPDU Data TPDU
GCAK TPDU Data acknowledge TPDU
GCRJ TPDU Negative acknowledge TPDU
GCER TPDU Error TPDU
GCFL TPDU Flow control TPDU
GCST TPDU Status TPDU

4.3 TPDU Fields

LI	Length indicator (field)
TSAP-ID	Transport-service-access-point identifier (field)
DST-REF	Destination reference (field)
SRC-REF	Source reference (field)
GRP-REF	Group-id Reference (field)
EOT	End of TSDU mark
TPDU-NR	GCDT TPDU number (field)
YR-TU-NR	Sequence number response (field)
ROA	Request of acknowledgement mark

4.4 Times and associated variables

A	AGI time
RT	Retention time for NAK
S	Sequencing time
T	Retransmission time
L	Frozen Reference time
PL	TPDU lifetime

4.5 Miscellaneous

TS-user	Transport-service user
TSAP	Transport-service-access-point
NS-provider	Network service provider
AP	Network-service-access-point
QOS	Quality of service
CLNS	Connectionless network service
CONS	Connection-oriented network service

5 Overview of the Transport Protocol

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

5.1 Service provided by the Transport Layer

The protocol specified in this International Standard supports the Multipeer Data Transmission Transport Service defined in ISO 8072 section 4.

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

5.2 Service Assumed from the Network Layer

The protocol specified in this International Standard assumes the use of the Network Service defined in ISO 8348 and ISO 8348/Add.1, and the multicast network service defined in ISO 8348 part 4.

When operating over CONS, information is transferred to and from the NS-provider in the network service primitives listed in Table 2a). When operating over CLNS, information is transferred to and from the NS-provider in the network service primitives listed in table 2b). When operating over the multicast network service, information is transferred to and from the NS-provider in the network service primitives listed in table 2c).

NOTES

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

2 The parameters listed in Table 2b) are those in the current connectionless Network Service (see ISO 8348/Add.1).

3 The parameters listed in Table 2c) are those in the current multicast Network Service (see ISO 8348 part 4).

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

Table 1 – Transport Service Primitives

Phase	Service	Primitive	Parameters
GC activation	GC activate	T-GC.ACTIVATE.requestor. submit	(Called group address, calling address, expedited data selection, QOS—parameter set, AGI-parameter set)
		T-GC.ACTIVATE.acceptor. deliver	(Called group address, calling address, expedited data selection, QOS—parameter set, AGI-parameter set)
	GC.join	T-GC.JOIN- requestor.submit	(Called group address, calling address, QOS—parameter set, TS—user—data)
		T-GC.JOIN- acceptor.deliver	(Called address, calling address, QOS—parameter set, TS—user—data)
Notification	Notification	T-GC.NOTE.requestor.submit	(Called group address, calling address, notification parameters)
		T-GC.NOTE.aceptor.deliver	(Called group address, calling address, notification data)
Data transfer	Data transfer	T-GC.DATA.requestor.submit	(Called group address, Calling address, QOS requirements,TS—user—data
		T-GC.DATA.acceptor.deliver	(Called group address, Calling address, QOS requirements, TS—user—data)
	Expedited data transfer (see Note)	T-GC.EXPEDITED-DATA. requestor.submit	(Called group address, Calling address, QOS requirements, TS—user—data)
		T-GC. EXPEDITED-DATA. acceptor.deliver	(Called group address, Calling address, QOS requirements, TS—user—data)
GC deactivate	GC leave	T-GC.LEAVE.requestor.submit	(Called group address, Calling address, Reason, TS-user-data)
		T-GC.LEAVE.acceptor.deliver	(Called group address, Calling address, reason, TS—user—data)
	GC deactivate	T-GC.DEACTIVATE.request. submit	
		T-GC.DEACTIVATE.acceptor. deliver	

Note — An TS provider—option service: it may be provided in every Transport Service.

Table 2a) – Connection-Oriented Network service primitives

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

Key:
W: The usage of this parameter is a local matter, e.g. for diagnostic or to decide whether to attempt resynchronization.
X: The Transport Protocol assumes that this facility is provide in all networks.
Y: The Transport Protocol assumes that this facility is provided in some networks and a mechanism is provided to optionally use the facility.
Z: The Transport Protocol does not use this parameter.

Table 2b) – Connectionless Network Service Primitives

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

Key:

W: The usage of this parameter is a local matter, e.g. for diagnostic or to decide whether to attempt resynchronization.

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

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

Z: The Transport Protocol does not use this parameter.

Table 2c) – Multicast Network service primitives

Phase	Service	Primitive	Parameters
GC activation	GC activate	N-GC.ACTIVATE.requestor. submit	(Called group address, calling address, expedited data selection, QOS-parameter set, AGI-parameter set)
		N-GC.ACTIVATE.acceptor. deliver	(Called group address, calling address, expedited data selection, QOS-parameter set, AGI-parameter set)
	GC.join	N-GC.JOIN requestor.submit	(Called group address, calling address, QOS-parameter set, NS-user-data)
		N-GC.JOIN-acceptor.deliver	(Called address, calling address, QOS-parameter set, NS-user-data)
Notification	Notification	N-GC.NOTE.requestor.submit	(Called group address, calling address, notification parameters)
		N-GC.NOTE.acceptor.deliver	(Called group address, calling address, notification data)
Data transfer	Data transfer	N-GC.DATA.requestor.submit	(Called group address, Calling address, QOS requirements,NS-user-data
		N-GC.DATA.acceptor.deliver	(Called group address, Calling address, QOS requirements, NS-user-data)
	Expedited data transfer (see Note)	N-GC.EXPEDITED—DATA. requestor.submit	(Called group address, Calling address, QOS requirements, NS-user-data)
		N-GC.EXPEDITED—DATA. acceptor.deliver	(Called group address, Calling address, QOS requirements, NS-user-data)
GC deactivate	GC leave	N-GC.LEAVE.requestor.submit	(Called group address, Calling address, Reason, NS-user-data)
		N-GC.LEAVE.acceptor.deliver	(Called group address, Calling address, reason, NS-user-data)
	GC deactivate	N-GC.DEACTIVATE. requestor.submit N-GC.DEACTIVATE. acceptor.deliver	

Note — A NS provider-option service: it may be provided in every Network Service. The provision for an expedited service is for further study.

Key:

W: The usage of this parameter is a local matter, e.g. for diagnostic or to decide whether to attempt resynchronization.

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

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

Z: The Transport Protocol does not use this parameter.

5.3 Functions of the Transport Layer

5.3.1 Overview of Functions

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

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

These functions are grouped below into those used at all times during a transport group conversation and those concerned with conversation activation and joining, data transfer, and release.

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

a) encryption;

b) accounting mechanisms;

c) status exchanges and monitoring of QOS;

d) blocking;

e) temporary release of network connections;

f) alternative checksum algorithm.

5.3.1.1 Functions used at all times

The following functions, depending upon the selected options, are used at all times during a transport group conversation:

a) transmission of TPDUs;

5.3.1.2 Group Activation

The purpose of group activation is to establish a group conversation among a set of TS-users. The following functions of the transport layer during this phase match the TS users' requested quality of service with the services offered by the network layer:

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

b) establish the optimum TPDU size

c) select the functions that will be operational upon entering the data transfer phase;

d) map transport addresses onto network addresses;

e) provide a means to distinguish between two different group conversations.

5.3.1.3 Group Join

The purpose of group join is to permit transport entities to initiate communication with an existing, active group conversation. This purpose is achieved by way of the transmission of TPDUs from the transport entity to the active group members.

5.3.1.4 Data Transfer

The purpose of data transfer is to permit the transmission of TSDUs among TS-users participating in the group conversation. This purpose is achieved by means of n-way simultaneous communication and by the following functions, some of which are used or not used in accordance with the result of the selection performed in group activation and in the data transfer service request.

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

b) Flow control: A function used to regulate the flow of TPDUs among the transport entities participating in a group conversation;

c) transport group conversation identification: a means to uniquely identify a transport group conversation among the set of transport entities participating in the group conversation during the lifetime of the transport group conversation;

d) TSDU delimiting: A function used to determine the beginning and ending of a TSDU.

5.3.1.5 Leave

The purpose of leave is to provide disconnection of a transport entity from the group conversation regardless of the current activity.

5.3.1.6 Deactivate

The purpose of deactivate is to provide a means of terminating a group conversation. Deactivation may be destructive and can occur at any time.

5.3.1.7 Notification

The purpose of notification is to provide a means of exchanging status information about the active members of the GC.

Section two: Transport protocol specification

6 Elements of procedure

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

The procedures define the transfer of TPDUs whose structure and coding is specified in clause 8. Transport entities shall accept and respond to any TPDU received in a valid NSDU and may issue TPDUs initiating specific elements of procedure specified in this clause.

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

6.1 Group Conversation Activation

6.1.1 Purpose

The procedure for group conversation activation is used to create a new instance of a group conversation.

6.1.2 Network service primitives

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

N-DATA.

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

N-UNITDATA.

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

N-GC.DATA.

6.1.3 TPDUs and Parameters Used

The procedure uses the following TPDUs and parameters:

a) GCCR TPDU

Parameter	Value
DST-REF	= 0
SRC-REF	selected by local entity
Class	= 5
GRP-REF	selected by local entity
calling TSAP-ID	set to local entity's SAP
called TSAP-ID	set to Group Address
TPDU size	set according to rules
version number	=1
AGI	TBD
QOS	TBD

b) GCCC TPDU

Parameter	Value
DST-REF	value in GCCR TPDU
SRC-REF	selected by local entity
Class	= 5
GRP-REF	selected by local entity
calling TSAP-ID	set to local entity's SAP
called TSAP-ID	set to Group Address
TPDU size	set according to rules
version number	=1
AGI	TBD
QOS	TBD
user data	

6.1.4 Procedure for operating over CONS

The operation over CONS is for further study.

6.1.5 Procedure for operating over CLNS

The operation over CLNS is for further study.

6.1.6 Procedure for operation over the multicast network service

A transport group conversation must be activated before data exchange may occur.

A transport group conversation is activated by means of one transport entity (the activator) transmitting a GCCR TPDU to the other transport entities in the group. Each transport entity that wishes to join the group conversation replies with a GCCC TPDU.

6.1.6.1 Sending a GCCR TPDU

Before sending the GCCR TPDU, the activator assigns the transport group conversation being activated to one (or more if the splitting procedure is being used) network group conversation(s). It is this set of network group conversations over which the TPDUs are sent.

The following information is sent in the GCCR TPDU:

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

1) it shall not already be in use nor frozen,

2) it shall not be zero.

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

b) group-reference: The activator chooses a reference to be used by all peer entities which is 16 bits long and which is arbitrary under the following restrictions:

1) it shall not already be in use nor frozen,

2) it shall not be zero.

This mechanism provides identification of the group conversation independent of the network group conversation.

b) calling and called TSAP-IDs: the calling TSAP-ID shall be the that of the activator. The called TSAP-ID shall be the group address for the group being activated.

c) AGI: The initiator and the group definition define an Active Group Integrity parameter which consists of: e.g., minimum number of active group members, transmission type. The AGI parameter defines the number of GCCCs required for a successful activation.

After sending the GCCR TPDU the activator shall:

a) if the AGI specifies that the minimum number of active entities is 0 then immediately go to the activated state (waiting for a JOIN).

b) if the AGI specifies that the minimum number of active entities is > 0 then wait to receive the minimum number of GCCC TPDUs (joins). The sender of the GCCR TPDU should wait time A, the AGI time, to determine whether the conditions of the AGI are met. If the AGI fails then deactivation procedures should be initiated.

If the network group conversation fails while waiting for a JOIN, the initiating transport entity shall apply the assignment (see 6.14) and retransmission procedures (see 6.9).

6.1.6.2 Receiving a GCCR TPDU

When a GCCR TPDU is received, the transport entity shall indicate to the TS user the activation of a group conversation through the use of the T-GC.ACTIVATE.acceptor.deliver service. If the TS user indicates to the transport entity that it wishes to join the group conversation, it shall follow the procedures found in clause 6.2.

6.1.6.2.1 Duplicate GCCR TPDUs

When an unexpected duplicated GCCR TPDU is received it shall be ignored. A duplicated GCCR TPDU is one where the SRC-REF, GRP-REF, calling TSAP-ID, and called TSAP-ID are identical to one previously received.

6.1.6.2.2 GCCR TPDU Collision

If two initiators transmit GCCR TPDUs to the same group and with the same GRP-REF, there shall be one single group conversation with the GRP-REF. If the GCCR TPDUs contain different GRP-REFs, then two group conversations shall be established.

6.1.6.3 Receiving a GCCC TPDU

After receiving a GCCC TPDU for a conversation that requires reliable operation as specified by QOS, the activator shall acknowledge the GCCC TPDU using the procedures as given in 6.7.

6.2 Group Conversation Join

6.2.1 Purpose

The procedure for group conversation join is used to indicate to the active group members the joining of a new transport entity.

6.2.2 Network Service Primitives

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

The use of the CONS is for further study.

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

The use of the CLNS is for further study.

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

N-GC.DATA

N-GC.JOIN

6.2.3 TPDUs and Parameters used

The procedure uses the following TPDU and parameters:

a) GCCC TPDU

Parameter	Value
DST-REF	set to value of SRC-REF
SRC-REF	set locally
Class	= 5
calling TSAP-ID	source entity's SAP
called TSAP-ID	group address
TPDU size	=0
version number	= 1
AGI	TBD
QOS	TBD
user data (optional)	

b) optionally GCAK TPDU

6.2.4 Procedure for operating over CONS

The use of the CONS is for further study.

6.2.5 Procedure for operating over CLNS

The use of the CLNS is for further study.

6.2.6 Procedure for operating over the multicast network service

A transport entity wishing to join an active group conversation issues a GCCC TPDU.

There are two cases where the transport entity may wish to join an activated transport group conversation:

1. The transport entity knows the GRP-REF in use by the activated group conversation; and
2. The transport entity does not know the GRP-REF in use.

6.2.6.1 GRP-REF Known

In the case where the transport entity knows the GRP-REF of the activated group, it shall issue the GCCC TPDU with:

The destination reference set to 0. The GRP-REF shall be set to the value of the group-id sent in the GCCR TPDU (or established through other means). The SRC-REF shall be selected according to the procedures found in clause 6.1.

Negotiation of values of other parameters is for further study.

The sender of the GCCC TPDU shall immediately enter the data transfer state. It shall expect to receive data from other active group members at some future time. The sequence number of the TPDUs received will establish the earliest data to be acknowledged.

If the service type for the GC is reliable, the sender of the GCCC TPDU will receive a GCAK TPDU from each active member of the group. The sender of the GCCC TPDU shall log the references and TSAP-ids of each entity responding with a GCAK TPDU.

Note: It is possible that GCAK TPDUs may not be received from all active members due to the loss of the GCCC TPDU or the GCAK TPDU.

6.2.7.2 GRP-REF Unknown

In the case that the transport entity does not know the GRP-REF of the group-conversation it shall send the GCCC TPDU with:

The destination reference set to 0. The GRP-REF shall be set to zero. The SRC-REF shall be selected according to the procedures found in clause 6.1.

The sender of the GCCC TPDU shall enter a wait state until it receives either a GCDT TPDU with the GRP-REF of the group conversation, or it receives one or more GCST TPDUs with GRP-REF set to indicate the group conversation. In the case of more than one group conversation activated for a single group, the GCSTs TPDUs received may have different GRP-REF values. The sender of the GCCC TPDU will be considered joining all activated group conversations for the associated group address.

6.2.7.3 Receipt of GCCC TPDU

Upon receipt of a GCCC TPDU, all active group members should record the SRC-REF and calling TSAP-ID pair to enable the entity to respond to unicast acknowledgements or data transfers.

If the service type is reliable, the receiver shall acknowledge the GCCC TPDU with a GCAK TPDU. The TPDU-NR field shall be set to zero.

6.3 Data transfer

6.3.1 Purpose

Data transfer is used to exchange data among the active transport entities participating in the group conversation.

6.3.2 Network Service primitives used

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

The use of CONS is for further study.

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

The use of the CLNS is for further study.

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

N-GC.DATA

6.3.3 TPDUs and parameters used

The procedure uses the following TPDU and parameters:

a) GCDT TPDU

Parameter	Value
DST-REF	= 0
SRC-REF	set by local entity
Class	= 5
GRP-REF	set by activating entity
called TSAP-ID	set to group address
calling TSAP-ID	set to source transport entity address
TPDU-NR	sequence number
SVC-TYP	set according to group activation
QOS	TBD
user data	unrestricted

6.3.4 Data transfer when operating over CONS

The use of the CONS is for further study.

6.3.5 Data transfer when operating over CLNS

The use of the CLNS is for further study.

6.3.6 Data transfer when operating over the multicast network service

6.3.6.1 Procedure

The sender of a GCDT TPDU shall:

a) if the service requested is for multicast transfer then:

   if the sender is eligible to send TPDUs according to the flow control procedures (see 6.8), send the GCDT TPDU(s) with the SRC-REF indicating the appropriate source as specified in 6.1, the DST-REF set to 0, the GRP-ID set to the appropriate group conversation, the calling TSAP-ID set to the source, the called TSAP-ID set to group address, TPDU-NR set to the next available sequence number. The sender shall set the SVC-TYP field to the mode of operation established during the group conversation activation.

The receiver of a GCDT TPDU shall:

a) if the DST-REF is set 0 indicating a multicast transfer then:

   1. if the SVC-TYP field is set to uncorrected then

      - place the TPDU in the queue,

   2. if the SVC-TYP field is set to sequenced then

      - if the sequence number is one more than the last received, place it in the queue; else, apply the resequencing procedures found in 6.10.

   3. if the SVC-TYP field is set to reliable then

      - if the sequence number is one more than the last TPDU correctly received, place it in the queue, else apply the resequencing and retransmission procedures found in clause 6.

   4. if the SVC-TYP field is set to a type other than that specified in the group acitivation then

      it is a protocol error and invoke the procedures in 6.xx.

6.4 Data TPDU numbering

6.4.1 Purpose

Data TPDU numbering is used to enable the use of recovery, flow control and resequencing functions.

6.4.2 TPDUs and parameters used

The procedure uses the following TPDU and parameter:

GCDT TPDU

– TPDU-NR.

6.4.3 Procedure

A transport entity shall allocate the sequence number zero to the TPDU-NR of the first GCDT TPDU which it transmits for a transport group conversation. For subsequent GCDT TPDUs sent on the same transport

group conversation, the transport entity shall allocate a sequence number one greater than the previous one.

When a GCDT TPDU is retransmitted, the TPDU-NR parameter shall have the same value as in the first transmission of that GCDT TPDU

Modulo 2**32 arithmetic shall be used. In this international Standard the relationships "greater than" and "less than" apply to a set of contiguous TPDU numbers whose range is less than the modulus and whose starting and finishing numbers are known. The term "less than" means "occurring sooner in the window sequence" and the term "greater than" means "occurring later in the window sequence".

6.5 Leave

6.5.1 Purpose

The leave procedure is used by a transport entity in order to terminate its participation in a transport group conversation.

6.5.2 Network service primitives

The procedure uses the following network service primitives:

a) N-GC.LEAVE,

b) N-GC.DATA.

6.5.3 TPDUs and parameters used

The procedure uses the following TPDUs and parameters

a) GCDR TPDU

Parameter	Value
DST-REF	= 0
SRC-REF	set according to local entity
CLASS	= 5
GRP-REF	set by activation
calling TSAP-ID	set to local entity address
called TSP-ID	set to group address
TPDU size	reserved
Version number	= 1
Reason	TBD

6.5.4 Procedure for operating over CONS

The use of the CONS is for further study.

6.5.5 Leave when operating over CLNS

The use of the CLNS is for further study.

6.5.6 Leave when operating over the multicast network service

6.5.3.1 Procedure

6.5.3.1.1 Termination of Active Participation

The leave procedure is used by a transport entity in order to terminate its participation in a transport group conversation.

When the release of a transport entity from a transport group conversation is to be initiated, a transport entity

a) shall issue a GCDR TPDU with the DST-REF set to 0; SRC-REF set according to the procedures in 6.1, GRP-REF set according to the value set for the group, and the reason code set according to the reason for the release;

b) shall discard all undelivered and unsent TPDUs;

6.5.3.1.2 Rejection of Activation

A transport entity that receives a GCDR TPDU shall:

a) if appropriate, log the transport entity as inactive; and remove its reference from its tables;

b) if the transport entity is the activator or group manager, compare the AGI with the resulting AGI to determine if the AGI is still met. If the number of active participants is below the minimum, the activator or group manager shall deactivate the group conversation according to the procedures in 6.18.

A transport entity that receives a GCCR TPDU for the activation of a group conversation (see 6.1) that needs to reject the activation attempt or does not wish to be an active member may:

a) ignore the GCCR TPDU, or

b) transmit a GCDR TPDU according to the following procedures:

1) the DST-REF and SRC-REF shall be set to 0;

2) the GRP-REF set according to the value received in the GCCR TPDU, and the reason code set to reject;

6.6 Retention and acknowledgement of TPDUs

6.6.1 Purpose

The retention and acknowledgement of TPDUs procedure is used to enable and minimize retransmission after possible loss of TPDUs.

There are three variants of acknowledgement:

1. Acknowledgement (AK),
2. Request Of Acknowledgement (ROA), and
3. Negative Acknowledgement (NAK).

The GCAK variant is used only when reliable service is selected.

The request acknowledgement procedure is selected during conversation activation. It allows a transport entity to request acknowledgement of retained GCDT TPDUs by setting the ROA parameter in a transmitted GCDT TPDU. The ROA may be used during reliable service operation to force the receiving transport entities to immediately acknowledge a transmission.

The NAK variant may be used when reliable service is selected. With the NAK variant, only GCDT TPDUS that are not received correctly are negatively acknowledged to the sender. The NAK procedures may be used to limit the number of retransmissions. However, the service provided by the NAK variant will not be as reliable as that using positive ackn owledgements.

6.6.2 Network service primitives

When operating over CONS, the procedure uses the following network service primitives:

a) N-DATA;

b) N-DATA ACKNOWLEDGE.

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

N-UNITDATA.

When operating over the multicast network service, the procedure uses the following network service primitives:

N-GC.DATA

6.6.3 TPDUs and parameters used

The procedure uses the following TPDUs and parameters:

a) GCCC, GCDR and GCDC TPDUs;

b) GCAK TPDU
   – YR-TU-NR

c) GCRJ TPDU
   – YR-TU-NR;

d) GCDT TPDU
   – TPDU-NR;

6.6.4 Procedures

The transmissions of GCAK TPDUs and GCRJ TPDUs may be made using either multicast or unicast procedures. The selection of which procedure to use is a local option.

To transmit a TPDU using multicast procedures, the TPDU shall have the DST-REF set to the value selected by the destination transport entity for that particular group conversation.

The use of unicast retransmission procedures is for further study.

6.6.4.1 Uncorrected Service

No TPDUs shall be retained and no acknowledgements procedures are used when this service is selected.

6.6.4.2 Source Sequencing without delay

No TPDUs shall be retained for retransmission and no acknowledgements procedures are used when this service is selected.

6.6.4.3 Reliable Service

When the reliable service is selected, copies of the following TPDUs shall be retained upon transmission to permit their later retransmission:

GCCC, GCDR, and GCDT TPDUs

A copy of each of these TPDUs shall be retained if they are subject to retransmission and until

a) it is acknowledged, as specified in table 5; or

b) the transport group conversation is deactivated.

6.6.4.3.1 NAK Procedures

When negative acknowledgements are selected only GCDT TPDUs are subject to retention and retransmission.

When negative acknowledgements are selected, the receiver of GCDT TPDUs shall maintain information about the sequence of TPDUs. Upon the detection of a missing GCDT TPDU (indicated by a gap in the sequence numbers), the receiver shall send a GCRJ TPDU with the appropriate sequence number.

It is at the option of the entity transmitting the GCRJ TPDU whether to use the multicast procedures or the unicast procedures.

The GCRJ TPDU shall have the following parameters set:

Parameter	Value
SRC-REF	set to the appropriate value
DST-REF	set to the value of the destination
Class	= 5
GRP-REF	set to the appropriate value
calling TSAP-ID	set appropriately
called TSAP-ID	group address
YR-TU-NR	set to the missing TPDU

It is for futher study whether a list of YR-TU-NR values can be used.

6.6.4.3.2 ACK Procedures

When the ACK procedures are selected, GCCC, GCDT, and GCDR TPDUs are retained and are subject to retransmission.

When the ACK procedures are selected, the receiver of GCDT TPDUs shall acknowledge all correctly received, in sequence TPDUs. The receiver shall acknowledge the TPDUs by transmitting a GCAK TPDU with the sequence number of the highest TPDU correctly received.

6.6.4.3.3 Request of acknowledgement option

If the request acknowledgement procedure has been negotiated, transport entities

a) may request acknowledgement of retained GCDT TPDUs by setting the ROA parameter in a transmitted GCDT TPDU. The decision as to when the sending transport entity should request acknowledgement is a local matter.

b) On receipt of a GCDT TPDU with the ROA parameter set shall transmit an GCAK TPDU..

Table 5 – Acknowledgement of TPDUs

Retained TPDU	Variant	Retained until acknowledged by:
GCCC	ACK variant	time-out or any TPDU received
GCDT	negative ack	time-out
GCDT	ACK variant	time-out or receipt of GCAK TPDU

6.7 Flow control

6.7.1 Purpose

The flow control procedures are used to allow for the exchange of flow control information.

6.7.2 Network Service primitives used

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

The use of CONS is for further study.

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

The use of the CLNS is for further study.

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

N-GC.DATA

6.7.3 TPDUs and parameters used

The procedure uses the following TPDUs and parameters:

GCFL TPDU

Parameter	Value
DST-REF	set according to: unicast = to value selected multicast = 0
Credit	set according to local conditions
UTC	time of PDU transmission

6.7.4 Procedure for operating over the CONS

The operation over CONS is for further study.

6.7.5 Procedure for operating over CLNS

The operation over CLNS is for further study.

6.7.6 Procedure for operating over the mutlicast network service

The receiver of TPDUs may issue GCFL TPDUs at any time. Each GCFL TPDU shall use the UTC field to encode the UTC time of the transmission of the TPDU. (It is not necessary for the active group members to have synchronized clocks. The use of UTC is for sequencing of GCFLs from a single source.) Each GCFL TPDU shall indicate the relative ability of the receiver to continue to receive GCDT TPDUs. This shall be encoded as a number of TPDUs that may be received. GCFL TPDUs may be transmitted using either multicast or unicast procedures.

The use of unicast procedures is for further study.

The flow control algorithm used by each entity is a local option.

6.8 Checksum

6.8.1 Purpose

The checksum procedure is used to detect corruption of TPDUs by the NS-provider.

The use of checksums is for further study.

6.8.2 TPDUs and parameters used

6.8.3 Procedure

6.9 Frozen references

6.9.1 Purpose

This procedure shall be used in order to prevent re-use of a reference while TPDUs associated with the old use of the reference may still exist.

6.9.2 Procedure

When a transport entity determines that a particular entity is no longer active or that the group conversation has been deactivated, it shall place the reference(s) which it has allocated in a frozen state. While frozen, the reference shall not be re-used. It is recommended that references be placed in a frozen state for a period related to the maximum time that a TPDU can live in the network.

6.10 Retransmission

6.10.1 Purpose

The procedure is used to cope with unsignalled loss of TPDUs by the NS provider.

6.10.2 Network Service primitives used

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

The use of CONS is for further study.

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

The use of the CLNS is for further study.

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

N-GC.DATA

6.10.3 TPDUs and parameters used

The procedure uses the following TPDUs and parameters:

GCDT TPDUs

GCCC TPDUs

GCAK TPDUs

6.10.4 Procedure for operating over the CONS

The operation over CONS is for further study.

6.10.5 Procedure for operating over CLNS

The operation over CLNS is for further study.

6.10.6 Procedure for operating over the mutlicast network service

When GCDT TPDUs must be retransmitted, the transport entity may select to either retransmit using multicast or unicast procedures. The selection is a local entity choice.

To transmit a TPDU using multicast procedures, the TPDU shall have the DST-REF set to 0.

To transmit a TPDU using unicast procedures, the TPDU shall have the DST-REF set to the value selected by the destination transport entity for that particular group conversation.

6.10.6.1 Uncorrected Service

No retransmission procedures are used when the uncorrected service is selected.

6.10.6.2 Source Sequencing Without Delay

No retransmission procedures are used when the source sequencing without delay service is selected.

6.10.6.3 Reliable Service

The reliable service retransmission procedures are timer based.

For the transmitter of GCDT TPDUs a timer, the retention timer (RT) is used to determine how long to retain a transmitted GCDT TPDU. This timer is only used in the NAK variant.

For the transmitter of GCDT TPDUs, a timer, the retransmission timer (T), is used to determine when to retransmit missing GCDT TPDUs.

6.10.3.3.1 NAK Variant

When a transport entity transmits a GCDT TPDU it sets the timer RT to bound the time it retains transmitted GCDT TPDUs. This time is based on the ability of the transport entity to store TPDUs and the expected time for all active group members to determine that a TPDU is lost.

If a GCRJ TPDU is received from an active transport entity and the timer has not expired, the GCDT TPDU is retransmitted using either the multicast or unicast procedures.

The use of unicast procedures is for futher study.

When the RT expires, the GCDT TPDU may be discarded. If a GCRJ TPDU arrives after the expiration of the RT and the TPDU has been discarded, the transport entity shall send a GCST TPDU with an indication of timer expired. The GCST TPDU may be transmitted using the multicast or unicast procedures.

The use of unicast procedures is for futher study.

6.10.3.3.2 ACK Variant

When a transport entity transmits a GCDT TPDU, it must retain that TPDU until it is explicitly acknowledged by all known active group members. (The use of the RT to bound the wait is for further study. The use of AGI to determine when a sufficient subset of active group members have received the TPDU is for further study.) The transport entity must set the timer T to control the retransmission of TPDUs.

If the timer T expires without the arrival of the GCAK TPDUs, the transport entity shall retransmit the GCDT TPDU. The transport entity shall use the multicast procedures.

If after N retransmissions a GCDT TPDU has not been acknowledged by an active transport entity(ies), the transport entities shall be marked as inactive.

If the transmitting transport entity requires an immediate acknowledgement, it shall set the ROA parameter to force immediate acknowledgement by receiving entities.

When a GCDT TPDU is received and is in sequence and correct, the receiving transport entity shall generate an GCAK TPDU. The GCAK TPDU may be transmitted using either the multicast or unicast procedures. It is a local option to delay the transmission of GCAK TPDUs for a period of time in order to acknowledge more than one GCDT TPDU with a single GCAK TPDU.

If a GCDT TPDU is received with the ROA parameter set, the GCAK TPDU must be transmitted as soon as possible.

6.11 Resequencing

6.11.1 Purpose

The resequencing procedure is used to cope with misordering of TPDUs by the network service provider.

6.11.2 Network Service primitives used

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

The use of CONS is for further study.

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

The use of the CLNS is for further study.

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

N-GC.DATA

6.11.3 TPDUs and parameters used

The procedure uses the following TPDUs and parameters:

GCDT TPDUs

- TPDU-NR.

6.11.4 Procedure for operating over the CONS

The operation over CONS is for further study.

6.11.5 Procedure for operating over CLNS

The operation over CLNS is for further study.

6.11.6 Procedure for operating over the mutlicast network service

6.11.6.1 Uncorrected Service

No resequencing procedures are used when the uncorrected service is selected.

6.11.6.2 Source Sequencing Without Delay

Upon the receipt of an GCDT TPDU, the transport entity shall determine if the GCDT TPDU is in sequence by examining the YR-NU-TPDU parameter. The transport entity shall use time S, the sequence time, to bound the delay for resequencing. If the GCDT TPDU is not in sequence, the transport entity shall:

1. Start time S to bound the delay for resequencing,
2. Place the GCDT TPDU in a queue waiting for the arrival of out of sequence TPDUs.

If time S expires, the transport entity shall deliver the GCDT TPDU to the TS-user and:

1. Transmit a GCST TPDU indicating that the sequence error has occured.
2. If notification has been selected by the TS-user, notify the user of the sequence error.

If the GCDT TPDU sequence is maintained before the time S expires, the GCDT TPDUs are delivered to the user.

6.11.6.3 Reliable Service

6.12 Treatment of protocol errors

6.12.1 Treatment of protocol errors when operating over CONS

6.12.1.1 Purpose

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

6.12.1.2 TPDUs and parameters used

TBD

6.12.1.3 Procedure

TBD

6.12.2 Treatment of protocol errors when operating over CLNS

6.12.2.1 Purpose

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

The procedures for error reporting is for further study.

6.12.2.2 TPDUs and parameters used

6.12.2.3 Treatment of protocol errors when operating over the Multicast Network Service

6.13 Use of the network service

6.13.1 Assignment to network connection when operating over CONS

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

The use of the CONS is for further study.

6.13.2 Transmission over CLNS

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

The use of the CLNS is for further study.

6.13.3 Assignment over the multicast network service

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

6.13.3.1 Purpose

The procedure is used at all times when operating over the multicast network service.

6.13.3.2 Network service primitives

TBD

6.13.3.3 Purpose

Each transport group conversation shall be assigned to a network group conversation. The activator shall assign the transport group conversation to a new network group conversation which it creates for this purpose.

Note: The use of an existing network group conversation is for further study.

The transport entities that did not initiate the assignment becomes aware of the assignment when it receives:

a) a GCCR TPDU during the group activation procedure;

b) a GCST TPDU in response to a GCCC TPDU during the join procedures.

6.14 Transport protocol data unit (TPDU) transfer

6.14.1 Purpose

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

6.14.2 Network service primitives

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

a) N-DATA;

b) N-EXPEDITED DATA.

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

N-UNITDATA.

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

N-GC.DATA

6.14.3 Procedure

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

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

When operating over CONS transport entities shall transmit and receive TPDUs as NS-user data parameters of N-DATA primitives.

When a TPDU is put into an NS-user data parameter, the significance of the bits within an octet and the order of octets within a TPDU shall be defined in 8.2.

NOTE – TPDUs may be concatenated (see 6.4).

When operating over the multicast network service, transport entities shall transmit and receive TPDUs as NS-user data parameters of N-GC.DATA primitives.

6.15 Segmenting and reassembling

6.15.1 Purpose

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

6.15.2 TPDUs and Parameter Used

The procedure makes use of the following TPDU and parameter:

GCDT TPDU

– End of TSDU.

6.15.3 Procedure

A transport entity shall map a TSDU onto an ordered sequence of one or more GCDT TPDUs. This sequence shall not be interrupted by other GCDTs TPDUs from the same source transport entity on the group transport conversation.

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

NOTES

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

2 There is no requirement that the GCDT TPDUs shall be of the maximum length selected during group conversation activation.

6.16 Concatenation and separation

6.16.1 Purpose

The procedure for concatenation and separation is used to convey multiple TPDUs in one NSDU.

6.16.2 Procedure

A transport entity may concatenate TPDUs from the same group conversation, while maintaining the order of TPDUs for a given transport group conversation compatible with the protocol operation.

A valid set of concatenated TPDUs may contain

a) any number of TPDUs from the following list: GCAK, GCEA, GCRJ, GCER, GCDC TPDUs, provided that these TPDUs come from different TS-users;

b) no more than one TPDU from the following list: GCCR, GCDR, GCCC, GCDT, GCED TPDUs; if this TPDU is present, it shall be placed last in the set of concatenated TPDUs.

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

NOTES

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

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

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

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

6.17 Association of TPDUs with transport group conversations

6.17.1 Association of TPDUs with transport group conversations when operating over CONS

6.17.1.1 Purpose

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

6.17.1.2 Network service primitives

TBD

6.17.1.3 TPDUs and parameters used

TBD

6.17.1.4 Procedures

6.18.2 Association of TPDUs with transport group conversations when operating over CLNS

6.17.2.1 Purpose

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

6.17.2.2 Network service primitives

This procedure makes use of the following network service primitive:

TBD.

6.17.2.3 TPDUs and parameters used

TBD

6.17.2.4 Procedures

6.17.2.4.1 Identification of TPDUs

TBD

6.17.2.4.2 Association of individual TPDUs

TBD

6.17.3 Association of TPDUs with transport group conversations when operating over the multicast network service

6.17.3.1 Purpose

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

6.17.3.2 Network service primitive

The procedure uses the following network service primitives:

a) N-GC.DATA indication

6.17.3.3 TPDUs and parameters used

The procedure uses the following TPDUs and parameters:

a) any TPDU except a GCCR;
   - DST-REF;
   - GRP-REF;
   - called TSAP-ID

6.17.3.4 Procedures

6.17.3.4.1 Identification of TPDUs

If the received NSDU or expedited NSDU cannot be decoded (i.e., does not contain one or more correct TPDUs) or is corrupted (i.e., contains a TPDU with a wrong checksum) then the transport entity shall:

a) if the NSDU can be decoded but contains corrupted TPDUs, discard the TPDUs and if the reliable service is selected apply the acknowledgement procedures;

b) if the NSDU cannot be decoded discard the NSDU and apply the protocol error procedures.

If the NSDU can be decoded and is not corrupted, the transport entity shall:

a) invoke the separation procedures and for each of the individual TPDUs in the order in which they appear.and apply the procedures in 6.17.3.4.2.

6.17.3.4.2 Association of individual TPDU

If the received TPDU is a GCCR TPDU, then if the SRC-REF parameter, GRP-REF, and called and calling TSAP-IDs indicate an existing group conversation, then the GCCR is ignored (or optionally acknowledged if the ROA field is set or the AGI/QOS indicates reliable service.). Otherwise it is processed as activating a new transport group conversation.

The GRP-REF, DST-REF, and called TSAP-ID are used to identify the transport group conversation. The following cases are distinguished:

a) if the GRP-REF is not allocated to a group conversation then no association with a group conversation is made and there are three cases:

1) If the TPDU is a GCCC TPDU the transport entity may log the GRP-REF as an active group conversation. If the reply requested flag is set, the transport entity shall respond with an GCAK TPDU.

2) If the TPDU is a GCDR TPDU the transport entity may log the GRP-REF as an active group conversation.

3) If the TPDU is neither a GCCC or GCDR it shall be discarded

b) If none of the above cases apply then the TPDU is associated with the group conversation identified by the GRP-REF parameter and the called TSAP-ID.

6.18 Deactivation

6.18.1 Purpose

The deactivation procedure is used by a transport entity in order to terminate a transport group conversation.

6.18.2 Network service primitives

The procedure uses the following network service primitives:

a) N-GC.LEAVE,

b) N-GC.DATA.

6.18.3 TPDUs and parameters used

The procedure uses the following TPDUs and parameters

a) GCDC TPDU

Parameter	Value
DST-REF	= 0
SRC-REF	set according to local entity
CLASS	= 5
GRP-REF	set by activation
calling TSAP-ID	set to local entity address
called TSP-ID	set to group address
TPDU size	reserved
Version number	= 1
Reason	TBD

6.18.4 Procedure for operating over CONS

The use of the CONS is for further study.

6.18.5 Procedure for operating over CLNS

The use of the CLNS is for further study.

6.18.6 Procedure for operating over the multicast network service

When the deactivation of a transport group conversation is to be initiated, a transport entity

a) shall issue a GCDC TPDU with the DST-REF set to 0; SRC-REF set according to the procedures in 6.1, GRP-REF set according to the value set for the group, and the reason code set according to the reason for the deactivation;

b) shall discard all undelivered and unsent TPDUs;

A transport entity that receives a GCDC TPDU shall:

a) log the group conversation as deactivated, and apply the procedures in 6.9.

7 Specification for class 5

7.1 Functions of class 5

7.1.1 Functions of class 5 over CONS

The use of the CONS is for further study.

7.1.2 Functions of class 5 when operating over CLNS

The use of the CLNS is for further study.

7.1.3 Functions of class 5 when operating of the Multicast Network Service

TBD

7.2 Procedures for class 5

7.2.1 Procedures available at all times

7.2.1.1 Timers used at all times

There are no timers used at all times.

7.2.1.2 General procedures when operating over CONS

7.2.1.3 General procedures when operating over CLNS

7.2.1.4 General procedures when operating over the Multicast Network Service

These procedures are for further study.

7.2.2 Procedures for group activation

These procedures are for further study.

7.2.2.1 Timers used in group activation

Timer A, the AGI timer is used to bound the wait for responses to the group activation request.

Timer T, the retransmission timer is used to determine the frequency of retransmissions.

7.2.2.2 General procedures when operating over the multicast network service

The transport entities shall use the following procedures:

a) assignment to network connection (see 6.14.3);

When a network group conversation to which the transport group conversation is assigned is deactivated (N-GC.DEACTIVATE.acceptor.deliver):

1) if a GCCR TPDU has been transmitted and the entities are waiting for GCCC TPDUs, the activator shall perform a new assignment according to AGI and QOS by retransmitting the GCCR TPDU on a new network group conversation. The retransmissions of the GCCR TPDU shall obey

the maximum number of retransmission N, and shall use the retransmission time T to determine the frequency of the retransmissions;

2) if after the completion of the AGI enforced activation procedures, the transport group conversation becomes unassigned any active transport entity may perform a new assignment;

3) if a transport entity has transmitted a GCCC TPDU and has not received an GCAK TPDU, the entity shall retransmit the GCCC TPDU subject to the retransmission procedures;

When a transport entity is released from a network group conversation (N-GC.LEAVE received):

1) the transport entity shall attempt to reassign the transport group conversation by initiating the reassignment to the same network group conversation. If the reassignment fails, the transport entity shall invoke the leave procedures.

b) conversation activation (see 6.1) and if appropriate conversation deactivation (rejection) (see 6.5) together with the additional procedures:

1) the transport entity activating the group conversation shall determine the required AGI and QOS. At a minimum, it shall encode the SVC-TYP and number of active members in the GCCR TPDU (see 8.8.3);

2) as a result of duplication or transmission, a GCCR TPDU may be received specifying a group reference which is already in use with the sending transport entity. If the receiving transport entity is in the data transfer phase, having completed the join procedures, or is waiting for the T.GC.JOIN-submit.response from the TS-user, the receiving transport entity shall discard such a TPDU.

3) as a result of duplication or retransmission, a GCCC TPDU may be received specifying references which are already in use. The activator transport entity shall only acknowledge the duplicate GCCC TPDU according to the procedure in 6.6;

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

5) the retransmission procedures are used for both the GCCR TPDU and GCCC TPDU.

7.2.2.3 Procedures for group activation rejection

The group activation may fail or be rejected through:

a) the AGI conditions have not been met before the expiration of time A

The activator shall:

1) issue a GCDC TPDU with the DST-REF set to 0, SRC-REF to that assigned by the activator, GRP-REF set according to the group conversation procedures in 6.1 and the called TSAP-ID set to the group address.

2) apply the procedures in 6.9.

b) the failure of the network group conversation; or

After an unsuccessful reassignment of the transport group conversation, the activator shall apply the procedures of 6.9.

c) the rejection by all active members.

If all active members of the transport group conversation respond with a GCDR TPDU, the activator shall:

1) transmit a GCDC TPDU with the DST-REF set to 0, SRC-REF to that assigned to the group conversation according to the procedures in 6.1, and the called TSAP-ID set to the group address.

2) apply the procedures in 6.9.

7.2.3 Procedures for Group Join

7.2.3.1 Timers used in group join

Timer T, the retransmission timer is used to determine the frequency of retransmissions.

7.2.3.2 General procedures when operating over the multicast network service

The transport entities shall use the following procedures:

a) assignment to network connection (see 6.13.3);

b) join procedures (see 6.2) together with:

1) In response to a GCCR TPDU or through *a priori* means a transport entity may join an active group by issuing a GCCC TPDU. The GCCC TPDU shall have the class set to 5, and the SVC-TYP set to the group service type. The maximum TPDU size and other AGI and QOS parameters for the active group must be obtained in the same manner as the GRP-REF.

2) If the reliable service is in use, the transport entity shall apply the retransmission procedures until it receives a GCAK TPDU, GCDT TPDU or GCDC TPDU.

3) If the transport entity does not have the GRP-REF or other QOS parameters, it may transmit a GCCC TPDU with the GRP-REF set to 0. A join with the GRP-REF set to 0 indicates that the entity wishes to join all active conversations using the group transport address. The transport entity shall wait until it receives a GCST TPDU, GCDT TPDU, or GCDC TPDU corresponding to the group transport address. The transport entity may choose to retransmit the GCCC TPDU or to wait N*T to determine if a group conversation is active. If the time expires or their is no response to the retransmitted GCCC TPDUs, the transport entity shall issue a GCDR TPDU.

4) Upon receipt of a GCCC TPDU with the GRP-REF set to 0, a transport entity shall respond with a GCST TPDU or a GCDT TPDS with the GRP-REF set to the appropriate value.

7.2.4 Procedures for data transfer

7.2.4.1 Timers used in data transfer

7.2.4.1.1 Timers used in data transfer when operating over CONS

The timers required for operation over CONS is for further study.

7.2.4.1.2 Timers used in data transfer when operating over CLNS

The timers required for operation over CONS is for further study.

7.2.4.1.2 Timers used in data transfer when operating over the multicast network service

Timer T, the retransmission timer is used to determine the frequency of retransmissions.

Timer S, the Sequence timer is used to bound the delay for resequencing.

7.2.4.2 General procedures for data transfer

The transport entities shall use the following procedures:

a) Flow control.

The sending transport entity shall use the following procedures in the following order:

1) segmenting;

2) GCDT TPDU numbering.

The receiving transport entity shall use the following procedures in the following order:

– GCDT TPDU numbering;

– resequencing;

– reassembling.

7.2.4.5 Resequencing

If the SVC-TYP field specifies either the sequenced service or the reliable service, the receiving transport entity shall deliver all GCDT TPDUs to the TS-user in the order specified by the sequence number field.

GCDT TPDUs received out-of-sequence shall not be delivered to the TS-user until all in-sequence TPDUs have been received or if the time S expires. If the selective acknowledgement option has been agreed to at connection establishment, GCDT TPDUs that have been selectively acknowledged shall be retained by the receiving transport entity until delivered to the TS-user.

Duplicate TPDUs can be detected because the sequence number matches that of previously received TPDUs. Sequence numbers shall not be reused for the period L after their previous use. Otherwise, a new, valid TPDU could be confused with a duplicated TPDU which had previously been received and acknowledged.

Duplicated DT TPDUs shall be acknowledged, since the duplicated TPDU may be the result of a retransmission resulting from the loss of an GCAK TPDU.

The data contained in a duplicated GCDT TPDU shall be discarded.

7.2.4.6 Flow control

Each receiving transport entity announces its ability to receive further TPDUs through the transmission of GCFL TPDUs. GCFL TPDUs are sequenced . The value specified in the GCFL TPDU presents an estimate of the number of total TPDUs it can accept. This amount allows other entities to determine the overall state of the active transport entities. If a transport entity reports a value of 0, no further multicast transmission may be made if the corrected service is selected.

7.2.5 Procedures for leave

7.2.5.1 Timers used for leave

There are no timers used only for leave.

7.2.5.2 General procedures for leave

The transport entity shall use the procedures for leave.

7.2.6 Procedures for Deactivation

7.2.6.1 Timers used for deactivation

Time L, the frozen reference time is used in deactivation.

7.2.6.2 General procedures for deactivation

A transport entity wishing to deactivate a group conversation shall transmit a GCDC TPDU.

The GRP-REF shall be frozen and the timer L started.

All data shall be discarded.

A transport entity receiving a GCDC TPDU shall discard all data and place the GRP-REF in the frozen state.

8 Structure and encoding of TPDUs

8.1 Validity

Table 8 specifies those TPDUs which are valid for each class and the code for each TPDU.

Table 8 – TPDU codes

	clause	Code
GCCR: group conversation activation	8.3	0100 0001
GCCC: group conversation join	8.4	0100 0010
GCDR: group conversation release	85	0100 0011
GCDC: group conversation deactivate	8.6	0100 0100
GCDT: data	8.7	0100 0101
GCED: expedited data (for further study)	8.8	0100 0110
GCAK: data acknowledgement (for further study)	8.9	0100 0111
GCEA: expedited data acknowledgement (FFS)	8.10	0100 1000
GCRJ: reject	8.11	0100 1001
GCER: TPDU error	8.12	0100 1010
GCST status	8.13	0100 1011

8.2 Structure

All the transport protocol data units (TPDUs) shall contain an integral number of octets. The octets in a TPDU are numbered starting from 1 and increasing in the order they are put into an NDSU. The bits in an octet are numbered from 1 to 8, where bit 1 is the lowest order bit.

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

NOTES

1 The numbering of bits within an octet is a convention local to this International Standard.

2 The use of the terms "high order" and "low order" is common to this International Standard and to adjacent layer standards.

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

4 As described in 6.2.3, both transport entities respect these bit and octet ordering conventions, thus allowing communication to take place.

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

a) octets are shown with the lowest numbered octet to the left; higher numbered octets being further to the right;

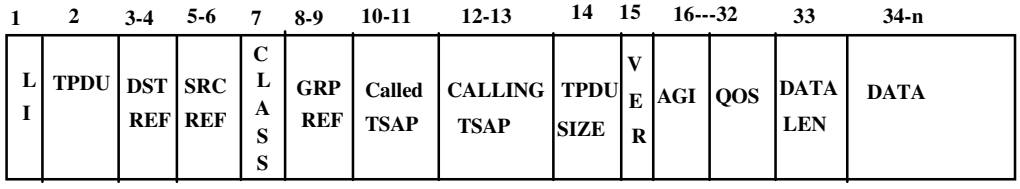
b) within an octet, bits are shown with bit 8 to the left and bit 1 to the right.

TPDUs shall contain, in the following order:

a) the header, comprising
   1) the length indicator (LI) field;
   2) the fixed part;

b) the data field, if present.

The structure is illustrated below:



8.2.1 Length indicator field

The field is contained in the first octet of the TPDUs. The length is indicated by a binary number, with a maximum value of 254 (1111 1110). The length indicated shall be the header length in octets including parameters, but excluding the length indicator field and user data, if any. The value 255 (1111 1111) is reserved for possible extensions.

If the length indicated exceeds or is equal to the size of the NS-user data which is present, this is a protocol error.

For the multicast transport class, the value of the length indicator field is always 31(0001 0000).

8.2.2 Fixed part

8.2.2.1 General

The fixed part contains frequently occurring parameters including the code of the TPDU. The length and the structure of the fixed part are defined by the TPDU code and in certain cases by the protocol class and the formats in use (normal or extended). If any of the parameters of the fixed part have an invalid value, or if the fixed part cannot be contained within the header (as defined by LI), this is a protocol error.

8.2.2.2 TPDU code

This field contains the TPDU code and is contained in octet 2 of the header. It is used to define the structure of the remaining header.

Only those codes defined in 8.1 are valid.

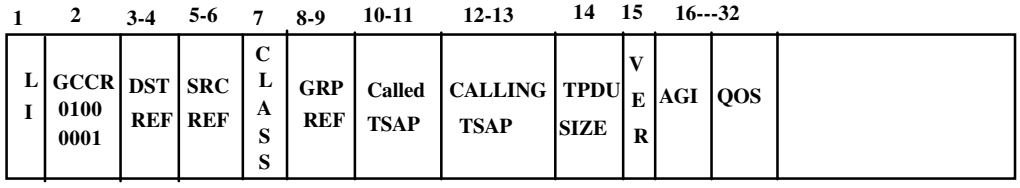
8.2.3 Data field

This field contains transparent user data. Restrictions on its size are noted for each TPDU.

8.3 Group Conversation Activation (GCCR) TPDU

8.3.1 Structure

The structure of the GCCR TPDU shall be as follows:



8.3.2 LI

See 18.2.1.

8.3.3 Fixed part (octets 2 to 32)

The structure of this part shall contain:

a) GCCR: Conversation activation code: 0100 0001 as octet 2;

b) DST-REF: Set to zero;

c) SRC-REF: Reference selected by the transport entity initiating the GCCR TPDU to identify the requested transport group conversation;

d) CLASS: Bits 8 to 5 of octet 7 define the preferred transport protocol class to be used. This field shall take the following value:

0101 Class 5

Bits 4 to 1 of octet 7 define options to be used on the requested transport connection as follows:

BIT	OPTION
4	= 0 Always
3	= 0 Always
2	= 0 Always
1	= 0 Always

Bits related to options particular to a class are not meaningful if that class is not proposed and may therefore take any value.

e) GRP-REF: Reference selected by the transport entity or by a priori group definition to identify the group conversation.

f) Called (group) TSAP-ID: Group address of transport entities

g) Calling TSAP-ID: address of the transport entity activating the group.

h) TPDU size: maximum TPDU size allowed specified as a binary value in multiples of 128 octets. The value selected shall be used by all active group members. There is no negotiation.

i) version number initially set to 1

j) AGI

k) QOS

In octet one:

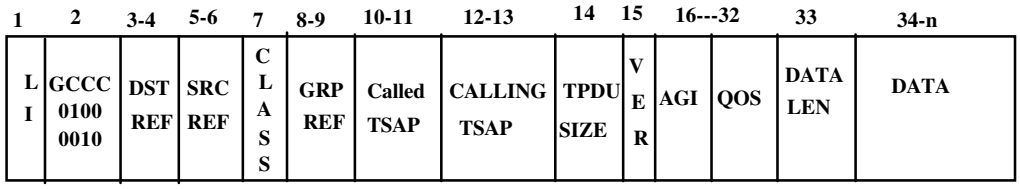
BIT	OPTION
8	= 0 Always
7	= 0 Always
6	= 0 Always
5	= 0 Always
4	= 0 Always
3	= 1 for reliable service
2	= 1 for sequenced without delay service
1	= 1 for uncorrected service

Only one option set according to bits 1-4 may be set and one bit must be set. All other settings shall be treated as a protocol error.

8.4 Group Conversation Join (GCCC) TPDU

8.4.1 Structure

The structure of the GCCC TPDU shall be as follows:



8.4.2 LI

See 8.2.1.

8.4.3 Fixed part (octets 2 to 32)

The fixed part shall contain

a) GCCC: Group conversation join code: 0100 0010 of octet 2;

b) DST-REF: Set to 0;

c) SRC-REF: Reference selected by the transport entity initiating the GCCC TPDU to identify the group conversation;

d) CLASS: Defines the selected transport protocol class (Class 5).

e) GRP-REF: Reference selected by the transport entity or by a priori group definition to identify the group conversation. May be set to 0 to join all active groups defined by the called TSAP-ID

f) Called (group) TSAP-ID: Group address of transport entities

g) Calling TSAP-ID: address of the transport entity activating the group.

h) TPDU size: set to value in GCCR TPDU in joins. TPDU length is set during activation only and is not subject to negotiation.

i) version number initially set to 1

j) AGI

k) QOS

In octet one:

BIT	OPTION
8	= 0 Always
7	= 0 Always
6	= 0 Always
5	= 0 Always
4	= 0 Always
3	= 1 for reliable service
2	= 1 for sequenced without delay service
1	= 1 for uncorrected service

Only one option set according to bits 1-4 may be set and one bit must be set. All other settings shall be treated as a protocol error. It shall be set with the same setting as found in the GCCR TPDU.

l) Data length: set to the length of data. If no data is present is shall be set to 0.

m) data

8.5 Group Conversation Release (GCDR) TPDU

8.5.1 Structure

The structure of the GCDR TPDU shall be as follows:

1	2	3-4	5-6	7	8-9	10-11	12-13	14	15	16---32	33	34-n
LI	GCDR 0100 0011	DST REF	SRC REF	CLASS	GRP REF	Called TSAP	CALLING TSAP	TPDU SIZE	VER	AGI	QOS	DATA LEN	DATA

8.5.2 LI

See 8.2.1.

8.5.3 Fixed part (octets 2 to 32)

The fixed part shall contain

a) GCDR: Group leave code: 0100 0011;

b) DST-REF: Set to 0;

c) SRC-REF: Reference identifying the transport group conversation at the transport entity initiating the TPDU. Value zero when reference is unassigned;

d) CLASS: Set to 5.

e) Called (group) TSAP-ID: Group address of transport entities

f) Calling TSAP-ID: address of the transport entity activating the group.

g) TPDU size: set to 0.

h) version number initially set to 1

i) AGI

j) QOS

In octet one:

REASON: Defines the reason for leaving the group conversation. This field shall take one of the following values:

The following values may be used:

The reason values are for further study.

BIT	Reason
8	TBD
7	TBD
6	TBD
5	TBD
4	TBD
3	TBD
2	TBD
1	TBD

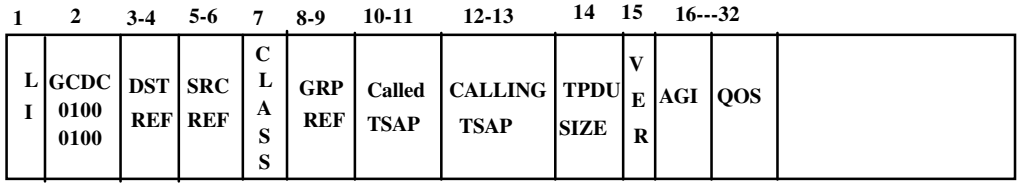
k) Data length: set to the length of data. If no data is present is shall be set to 0.

l) data

8.6 Group Conversation Deactivate (GCDC) TPDU

8.6.1 Structure

The structure of the GCDC TPDU shall be as follows:



8.6.2 LI

See 8.2.1.

8.6.3 Fixed part (octets 2 to 32)

The fixed part shall contain

a) GCDC: Group deactivation code: 0100 0100;

b) DST-REF: Set to 0;

c) SRC-REF: Reference identifying the transport group conversation at the transport entity initiating the TPDU. Value zero when reference is unassigned;

d) CLASS: Set to 5.

e) Called (group) TSAP-ID: Group address of transport entities

f) Calling TSAP-ID: address of the transport entity activating the group.

g) TPDU size: set to 0.

h) version number initially set to 1

i) AGI

j) QOS

In octet one:

REASON: Defines the reason for deactivating the group conversation. This field shall take one of the following values:

The reason values are for further study.

BIT	Reason
8	TBD
7	TBD
6	TBD
5	TBD
4	TBD
3	TBD
2	TBD
1	TBD

8.7 Data (GCDT) TPDU

8.7.1 Structure

The GCDT TPDU shall have the following structure:

1	2	3-4	5-6	7	8-9	10-11	12-13	14 ---17	18-32	33	34-n
LI	GCDT 0100 0101	DST REF	SRC REF	CLASS	GRP REF	Called TSAP	CALLING TSAP	TPDU-NR	QOS	DATA LEN	DATA

8.7.2 LI

See 8.2.1.

8.7.3 Fixed part

The fixed part shall contain

a) GCDT: Data transfer code: 0100 0101.

b) DST-REF: Set to 0;

c) SRC-REF: Reference identifying the transport group conversation at the transport entity initiating the TPDU. Value zero when reference is unassigned;

d) CLASS: Set to 5.

e) Called (group) TSAP-ID: Group address of transport entities

f) Calling TSAP-ID: address of the transport entity activating the group.

g) TPDU size: set to length of this TPDU. Value = 31+ length of data.

h) version number initially set to 1

i) AGI

j) QOS

In octet one:

EOT: Mark the end-of-TSDU

ROA: Request of acknowledgement mark: If the request acknowledgement procedures has not been agreed during connection establishment, bit 1 shall be set to 0 in all GCDT TPDUs.

When the request acknowledgement procedure has been agreed during conversation activation, bit 1 (ROA) is used to request acknowledgement. When set to one, ROA indicates that the sending transport entity requests an acknowledgement from the receiving transport entity. Otherwise ROA is set to zero.

SVC-TYP: Service in use

BIT	QOS OCTET 1
8	EOT = 1 for end-of-TSDU
7	ROA =1 request of ack
6	Reserved
5	Reserved
4	Reserved
3	= 1 if reliable service is in use
2	= 1 if sequenced without delay service is in use
1	= 1 if uncorrected service is in use

k) TPDU-NR: sequence number.

l) Data length: set to the length of data.

8.7.4 User data field

This field contains data of the TSDU being transmitted.

NOTE – The length of this field is limited to the selected TPDU size for this transport group conversation minus 32 octets for the header information.

8.8 Expedited data (GCED) TPDU

TBD

8.8.1 Structure

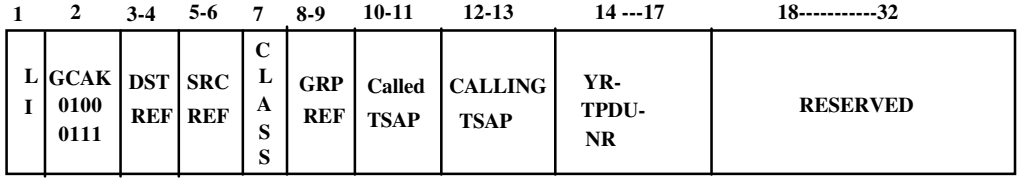
TBD

8.9 Data acknowledgement (GCAK) TPDU

TBD

8.9.1 Structure

The GCAK TPDU shall have the following structure:



8.9.2 LI

See 8.2.1.

8.9.3 Fixed part

The fixed part shall contain

a) GCAK: Acknowledge code: 0100 0111.

b) DST-REF: Set to 0;

c) SRC-REF: Reference identifying the transport group conversation at the transport entity initiating the TPDU. Value zero when reference is unassigned;

d) CLASS: Set to 5.

e) Called (group) TSAP-ID: Group address of transport entities

f) Calling TSAP-ID: address of the transport entity activating the group.

g) YR-TPDU-NR: Sequence number of the next expected in sequence GCDT TPDU.

8.10 Expedited data acknowledgement (GCEA) TPDU

The use of the GCEA and its structure are for further study.

8.10.1 Structure

8.11 Reject (GCRJ) TPDU

8.11.1 Structure

The GCRJ TPDU shall have the following format:

1	2	3-4	5-6	7	8-9	10-11	12-13	14 ---17	18----------32
LI	GCRJ 0100 1001	DST REF	SRC REF	CLASS	GRP REF	Called TSAP	CALLING TSAP	YR-TPDU-NR	RESERVED

8.11.2 LI

See 8.2.1.

8.11.3 Fixed part

The fixed part shall contain the following parameters:

a) GCRJ: Reject code: 0100 1001;

b) DST-REF: Set to 0;

c) SRC-REF: Reference identifying the transport group conversation at the transport entity initiating the TPDU. Value zero when reference is unassigned;

d) CLASS: Set to 5.

e) Called (group) TSAP-ID: Group address of transport entities

f) Calling TSAP-ID: address of the transport entity activating the group.

g) YR-TPDU-NR: Sequence number of GCDT TPDU not received.

8.13 Status TPDU

8.13.1 Structure

The GCST TPDU shall have the following format:

1	2	3-4	5-6	7	8-9	10-11	12-13	14	15	16---32	33	34-n
LI	GCST 0100 1011	DST REF	SRC REF	CLASS	GRP REF	Called TSAP	CALLING TSAP	TPDU SIZE	VER	AGI	QOS	DATA LEN	DATA

8.13.2 LI

See 8.2.1.

8.13.3 Fixed part

The fixed part shall contain the following parameters:

a) GCST: Reject code: 0100 1011;

b) DST-REF: Set to 0;

c) SRC-REF: Reference identifying the transport group conversation at the transport entity initiating the TPDU. Value zero when reference is unassigned;

d) CLASS: Set to 5.

e) Called (group) TSAP-ID: Group address of transport entities

f) Calling TSAP-ID: address of the transport entity activating the group.

g) TPDU size: set to 0

h) version number initially set to 1

i) AGI

j) QOS

In octet one:

SVC-TYP: Service in use

BIT	QOS OCTET 1
8	Reserved
7	Reserved
6	Reserved
5	Reserved
4	Reserved
3	= 1 if reliable service is in use
2	= 1 if sequenched service is in use
1	= 1 if uncorrected service is in use