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Information technology — Enhanced communications transport service definition

Technologies del'information — Définition du service de transport de communications amélioré

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Contents

Foreword

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

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

International Standard ISO/IEC 13252 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 6, *Telecommunications and information exchange between systems*, in collaboration with ITU-T. The identical text is published as ITU-T Recommendation X.605.

Annex A forms an integral part of this International Standard.

Introduction

This Recommendation | International Standard defines a transport service, named Enhanced Communications Transport Service (ECTS), which provides for a multicast capability and enhanced Quality of Service (QoS). This Recommendation | International Standard defines a wide range of services ranging from unreliable unicast with best-effort QoS to reliable multicast with guaranteed QoS. In this way, this Recommendation | International Standard is meant to provide for a uniform and universal service interface between transport protocols and applications of the present and the future information age, especially for those applications requiring versatile and powerful multimedia group communication capabilities underneath. Figure Intro.1 depicts the general architectural block diagram showing how ECTS relates to other protocols in the transport, application as well as network layers.

ECTP in Figure Intro. 1 is a protocol which is supposed to support all the services defined by this Recommendation | International Standard. ECTP is (to be) defined in a separate Recommendation | International Standard.

Note that not all the transport protocols shown in Figure Intro. 1 support all the services defined by ECTS. For example, TCP provides a best-effort reliable unicast service; UDP supports a best-effort unreliable multicast service. MTP, RMP, and SRM support reliable multicast but with null QoS. RTP provides means for exchanging synchronization information but does not define mechanisms to provide the synchronization itself.

ECTP, a companion protocol to ECTS, further will utilize, wherever possible, the multicast capabilities of the underlying network infrastructures. For example, in operation in Internet, ECTP will make extensive use of the multicast capabilities of IPv4 and IPv6 and rely on RSVP for QoS provisioning by network resource reservation. As another example, in operation over intrinsic ATM networks, ECTP will rely on the ATM capabilities for both multicast and QoS.

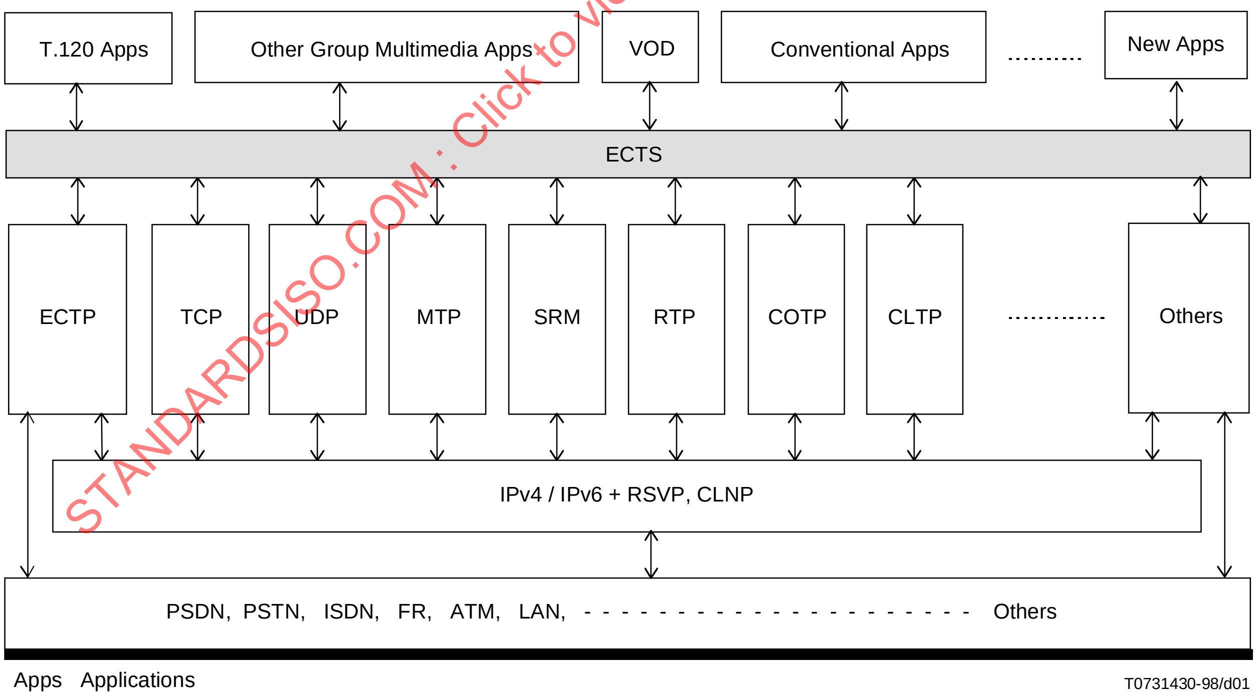


Figure Intro. 1 – Architectural block diagram for ECTS

INTERNATIONAL STANDARD

ITU-T RECOMMENDATION

INFORMATION TECHNOLOGY – ENHANCED COMMUNICATIONS TRANSPORT SERVICE DEFINITION

1 Scope

This Recommendation | International Standard defines in an abstract way the externally visible service provided by the Transport Layer in terms of:

a) the primitive actions and events of the service;

b) the parameter data associated with each primitive action and event;

c) the relationship between, and the valid sequences of, these actions and events.

The service defined in this Recommendation | International Standard is that which is provided by the Enhanced Communications Transport Protocol (in conjunction with the Network Service) and which may be used by any application protocol. The service can also be provided by other protocols possibly each supporting a subset of the services defined herein.

The primitives specified in this Recommendation | International Standard support a connection-mode service and a connectionless service. In some cases of connectionless-mode service supporting enhanced communications, certain operations may also be necessary prior to the commencement of data transfer, e.g. agreement on quality of service.

For the data transfer phase of either connection-mode or connectionless-mode services, there may be a range of data-ordering characteristics.

No implication is made in this Recommendation | International Standard regarding the inclusion or exclusion of any of the above characteristics given the service primitives specified herein.

2 Normative references

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

2.1 Identical Recommendations | International Standards

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

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

– ITU-T Recommendation X.214 (1995) | ISO/IEC 8072:1996, *Information technology – Open Systems Interconnection – Transport service definition.*

– ITU-T Recommendation X.641 (1997) | ISO/IEC 13236:1998, *Information technology – Quality of Service: Framework.*

– ITU-T Recommendation X.802 (1995) | ISO/IEC TR 13594:1995, *Information technology – Lower layers security model.*

3 Definitions

For the purposes of this Recommendation | International Standard, the following definitions apply.

3.1 Reference Model definitions

This service definition is based on the concepts developed in the OSI Basic Reference Model (see ITU-T Rec. X.200 | ISO/IEC 7498-1), and makes use of the following terms defined in it:

a) Transport Layer;

b) Transport Service;

c) transport-service-access-point;

d) transport-service-access-point address;

e) transport-service-data-unit;

f) Network Layer;

g) Network Service.

3.2 Service definition conventions

This service definition also make use of the following terms defined in ITU-T Rec. X.210 | ISO/IEC 10731, as they apply to the Transport Layer:

a) service-user;

b) service-provider;

c) primitive;

d) request;

e) indication;

f) response;

g) confirm.

3.3 Quality-of-Service Framework definitions

This service definition is compliant with the QoS Framework (see ITU-T Rec. X.641 | ISO/IEC 13236) in that it describes facilities which pertain to the Transport Layer as specified in the relevant clause of the QoS Framework:

a) QoS characteristic;

b) QoS mechanism;

c) QoS parameter.

3.4 Enhanced Communications Transport Service definitions

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

3.4.1 transport connection: A *multicast* connection established among TS-users for the purpose of transferring data. In the case where there are only two participants involved, it reduces to a peer-to-peer connection.

3.4.2 enrolled group: A group of TS-users who can participate in a transport connection, which is identified with a group TSAP address.

3.4.3 group TSAP address: A TSAP address which maps to a set of individual TSAP addresses of the enrolled group members. Note that, in general, a TSAP address may be a unicast – or group – address.

3.4.4 active group: A group of Transport Service users which maintain the shared state information required to support the mechanisms of the data transfer phase.

3.4.5 active group integrity: A set of conditions concerning the active group which must be true in order for a transport connection to enter or remain in the transfer state of the data transfer phase.

3.4.6 QoS level of agreement: The level of agreement reached during the QoS negotiation between users and the provider. It may be best-effort or guaranteed.

3.4.7 **ordering**: Ordering is concerned with the following two aspects:

i) In the case of a single sender, ordering if needed ensures that the data units generated by the sender are delivered to each receiver in the active group in the same order as they were sent.

ii) In the case of multiple senders, ordering determines the relative sequencing of data received from multiple senders. The ordering relationship defines the arrangement or interleaving of data from the multiple senders.

The ordering relationship can be: no, local, partial, causal, or total.

NOTE – When there are only two participants in the active group, local ordering, causal ordering, and total ordering are the same.

3.4.8 **TC-participant**: A TS-user that is a member of the active group participating in a transport connection.

3.4.9 **TC-owner**: A TS-user that owns the right to invite, monitor, and terminate a transport connection.

3.4.10 **focal TS-user**: A TS-user that intends to transmit on a TC and initiates the QoS negotiation of the 1×N transport channel relating to the data it transmits and the reception of that data by other TS-users.

3.4.11 **sending TS-user**: A TS-user that is a member of the active group participating in a transport connection and submits data to the Transport Service provider during the data transfer phase.

3.4.12 **receiving TS-user**: A TS-user that is a member of the active group participating in a transport connection and receives data from the Transport Service provider during the data transfer phase.

3.4.13 **transmit diversity**

i) ***Homogeneous***: Condition wherein all TS-users have agreed to a common set of transmit QoS values and so all sending TS-users transmit data at the same rate.

ii) ***Heterogeneous***: Condition wherein different sending TS-users may transmit data at different rates.

3.4.14 **receive diversity**

i) ***Receivers-wide***: Condition wherein all receiving TS-users receive the data of a given sending TS-user at the same QoS value.

In the case of a simplex TC, this term is synonymous with "connection-wide" defined in the QoS Framework.

ii) ***Receiver-selected***: Condition wherein different receivers may receive the data of the same sending TS-user at different QoS values not better than the transmit QoS. It is out of the scope of this Recommendation | International Standard how it can be made possible, through some facilities and mechanisms within the TS-provider, that data of a given QoS may be delivered at different QoS values.

3.4.15 **transmit concurrency**

i) ***Controlled***: Condition wherein only senders with a token may transmit data. The maximum number of such senders is specified by *Ntok.*

ii) ***Uncontrolled***: Condition wherein all senders may transmit data concurrently.

3.4.16 **Channel**: A 1×N simplex data flow within a transport connection.

4 Abbreviations

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

AGI	Active Group Integrity
CHQ	Controlled Highest Quality
ECTP	Enhanced Communications Transport Protocol
ECTS	Enhanced Communications Transport Service
LQA	Lowest Quality Acceptable
NSAP	Network-service-access-point
OA	Owner Arbitration

OSIE	Open Systems Interconnection Environment
OT	Operating Target
QoS	Quality of Service
SWA	Step-wise Arbitration
TC	Transport Connection
TPDU	Transport-protocol-data-unit
TS	Transport Service
TSAP	Transport-service-access-point
TSDU	Transport-service-data-unit

5 Conventions

5.1 General conventions

This service definition uses the descriptive conventions given in ITU-T Rec. X.210 | ISO/IEC 10731.

5.2 Parameters

The available parameters for each group of primitives are set out in tables in clauses 12 to 22. Each 'X' in the tables indicates that the primitive labelling the column in which it falls may carry the parameter labelling the row in which it falls.

Some entries are further qualified by items in brackets. These may be:

a) indications that the parameter is optional in some way:

(U) indicating that the inclusion of the parameter is a choice made by the user;

b) parameter specific constraints:

(=) indicating that the value supplied in an indication or confirmation primitive is always identical to that supplied in the respective previous request or response primitive issued at the peer service access point.

5.3 Notations

The following notations are used in this Recommendation | International Standard to denote some numerical quantities:

a) *Nmax*: The maximum number of members that can be allowed in the active group.

b) *Nact*: The actual number of members in the active group.

c) *Ntok*: The maximum number of members that can transmit data concurrently.

6 Overview and general characteristics

The Transport Service provides for the transparent transfer of data among TS-users. It relieves the TS-users from any concern about the detailed way in which supporting communications media are utilized to achieve this transfer.

The Transport Service provides for the following:

a) *QoS selection:*

The Transport Layer is required to optimize the use of available communications resources to provide the QoS required by communicating TS-users at the minimum cost. QoS requirements are specified through the selection of values for QoS parameters.

b) *Independence of underlying communications resources:*

The Transport Service hides from TS-users the difference in the QoS provided by the Network Service. This difference in QoS arises from the use of a variety of communications media by the Network Layer to provide the Network Service.

c) *End-to-end significance:*

The Transport Service provides for the transfer of data among TS-users in end systems.

d) *Transparency of transferred information:*

The Transport Service provides for the transparent transfer of octet-aligned TS-user data and/or control information. It neither restricts the content, format, or coding of the information, nor does it ever need to interpret its structure or meaning.

e) *TS-user addressing:*

The Transport Service utilizes a system of addressing which is mapped into the addressing scheme of the supporting Network Service. Transport addresses can be used by TS-users to refer unambiguously to TSAPs.

f) *AGI monitor:*

The Transport Layer may be required to monitor the AGI of TS-users participating in the active transport connection. AGI is specified through the selection of values for AGI parameters.

7 Features of the Enhanced Communications Transport Service

ECTS provides the following features to the TS-user:

a) The means for a TC-owner to create a TC with other TS-users of the same enrolled group for the purpose of exchanging TSDUs. Only one TC may exist among the TS-users of a given enrolled group. Some QoS agreements may have been determined during enrolment. Refinement of some of these QoS agreements may occur during the create operation and others may be initially determined at that time.

b) The means for a TS-user to join an existing TC under the constraints of QoS, AGI, and other control conditions. Further QoS refinements may be made as part of the join operation.

c) The means of transferring TSDUs on a TC under the constraints imposed by QoS. The transfer of TSDUs is transparent, in that the boundaries of TSDUs and the contents of TSDUs are preserved unchanged by the Transport Service and that there are no constraints on the TSDU content imposed by the Transport Service. It may or may not be known whether any or all of the potential receivers receive the TSDUs.

d) The means of transferring TSDUs with no QoS imposed except, optionally, transit delay. The transfer of TSDUs is transparent in that no constraints on the TSDU content are imposed by ECTS and the contents of TSDUs are preserved unchanged by ECTS. It may not be known whether any or all of the potential receivers receive the TSDUs.

e) The means for a TS-user to leave a TC unconditionally and/or under the constraints of AGI and QoS.

f) The means for a TC-owner unconditionally and therefore destructively to terminate a TC.

8 Model of the Enhanced Communications Transport Service

8.1 Types of Transport Connection

Figure 1 gives the three types of TC considered in ECTS. They are:

a) Simplex TC, wherein one TC-participant, called TC-owner, is send only and all others are receive only.

b) Duplex TC, wherein one TC-participant, called TC-owner, can both send to and receive from all others whereas all other TC-participants can receive only from and send only to the TC-owner. Hence, send/receive among the TC-participants other than the TC-owner is not possible.

c) N-plex TC, wherein any TC-participant is a sender as well as a receiver. At any moment, anyone can send something, and, if someone does so, all others may receive it.

The three basic types of TC defined here are thought to cover all the other types as degenerate cases. For example, a unicast simplex TC is a degenerate case of the simplex TC. A unicast duplex (peer-to-peer) TC is a degenerate case of the N-plex TC. An M×N TC wherein M of the total N members are send-and-receive participants while the rest are receive-only can be modelled as a degenerate of the N-plex TC; some members may announce their intention not to send any data as part of QoS negotiation.

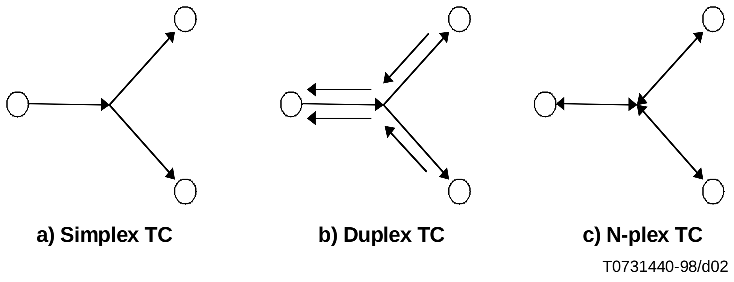


Figure 1 – Types of Transport Connections

8.2 Model of Transport Connection

An enrolled group may be involved in only one TC. Figure 2 gives an example of a TC for an enrolled group. In this example, the enrolled group consists of six TS-users A to F. The group is identified by a group TSAP address pointing to the TSAPs of the group members A to F.

In the example, TS-users A, B, C, and E are involved in a simplex TC, wherein A is the owner; they are said to form the active group for TC. TS-users D and F are not involved in any TC.

The TC is identified by the group TSAP address which is unique within the scope of OSIE. Each terminal of a TC is identified by the TSAP address of the TS-user participating in the active group.

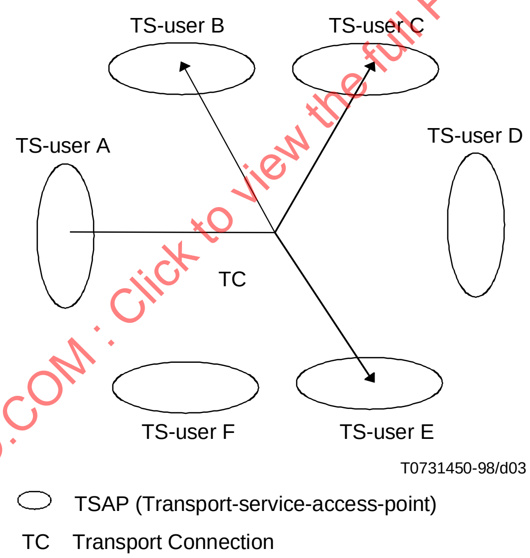


Figure 2 – An example of a TC for an enrolled group

9 Transport Connection characteristics

The TC characteristics consist of AGI and QoS. While QoS may be changed through negotiation in TC establishments, AGI is a predefined requisite for a TC and is not for negotiation. Therefore, AGI may be irrelevant for some primitives, i.e. response and confirm, where the AGI might be of a null value or even absent.

9.1 Active group integrity

The active group integrity specifies conditions on the active group membership of a TC. The following is the AGI conditions identified and defined in this Recommendation | International Standard. Inclusion of other AGI conditions is for further study.

9.1.1 AGI policy

a) *Soft*: Policy for which the TC is to be suspended when the AGI is violated. The TC is to be restored when the AGI is recovered.

b) *Hard*: Policy for which the TC is to be terminated when the AGI is violated.

9.1.2 Population

The AGI population characteristic for a TC can be one or more of the following.

a) *Mandatory*: Condition that specifies the selected enrolled group members required to be present in the active group.

b) *Minimum*: Condition that specifies the minimum number of enrolled group members required to be present in the active group.

c) *Quorum*: Condition wherein the majority of enrolled group members are required to be present in the active group.

d) *Maximum*: Condition that specifies, *Nmax*, the maximum number of members that can be allowed in the active group.

e) *Atomic*: Condition wherein all of enrolled group members are required to be present in the active group.

9.1.3 TC type

The type eligible for a group will be one of the following:

a) Simplex TC;

b) Duplex TC;

c) N-plex TC.

9.1.4 Transmit diversity

The transmit diversity eligible for a group will be one of the following:

a) Homogeneous;

b) Heterogeneous.

9.1.5 Receive diversity

The receive diversity eligible for a group will be one of the following:

a) Receivers-wide;

b) Receiver-selected.

9.1.6 Transmit concurrency

The transmit concurrency eligible for a group will be one of the following:

a) Controlled;

b) Uncontrolled.

NOTE – In the controlled mode of transmit concurrency, *Ntok* is less than *Nmax*; *Ntok* < *Nmax*. When *Ntok* equals *Nmax*, the case reduces to the uncontrolled mode.

9.2 Quality of service

The term Quality of Service (QoS) refers to certain characteristics of a TC that are managed by the TS-users and the TS-provider. They are:

– throughput, transit delay and transit delay jitter, which are classed as TC performance characteristics;

– corrupted TSDU error rate and lost TSDU error rate, which are classed as TC reliability characteristics;

– TC ordering;

– TC protection;

– TC precedence.

Definitions of these characteristics are given in 10.1.

Values for some or all of these characteristics may be agreed before the TC is operated. The nature of QoS agreements and the means by which they can be reached are specified in 10.2. The phases of establishment of a TC during which values for the various characteristics may be agreed and possibly subsequently refined are specified in 10.3.

Once agreed, QoS values apply for the duration of a TC. In some cases, different TS-users may operate with different values of QoS.

10 Quality of service for Transport Connections

10.1 QoS classification

The QoS classes and the possible values that may be imposed or agreed upon are shown in Table 1.

Table 1 – Classification of the QoS characteristics

Characteristic group	Characteristic	QoS values agreed or imposed
TC performance	Throughput	CHQ throughput value Operating target throughput value LQA throughput value
	Transit delay	Operating target transit delay value LQA transit delay value
	Transit delay jitter	Operating target transit delay jitter value LQA transit delay jitter value
TC reliability	Corrupted TSDU error rate	LQA corrupted TSDU error rate value
	Lost TSDU error rate	LQA lost TSDU error rate value
TC ordering	TC ordering	No ordering Local ordering Causal ordering Partial ordering Total ordering
Miscellaneous	TC protection	Local matter according to the security policy in force See 10.1.4.1.
	TC precedence	Imposition of: – the order in which TCs are to have their QoS degraded; or – the order in which TCs are to be broken to recover resources.

10.1.1 TC performance

10.1.1.1 Throughput

Throughput in general is a property of a channel between a pair of users which quantifies the rate of successful transfer of user data through the channel. It is defined in the QoS Framework (ITU-T Rec. X.641 | ISO/IEC 13236) as *the rate of user data output from a channel averaged over a time interval t*.

If the channel is loss-free, the rate of data output will be the same as the rate of data input, when averaged over appropriate periods. If the channel can lose data – for example if it includes a data-discarding filter – the rate of data output may be significantly less than the rate of data input.

In ECTS, throughput may need to be negotiated for a number of reasons, for example:

- to determine the maximum rate at which a transmitter should operate;
- to ensure that enough capacity is made available in the provider and in receiving TS-users;
- to set up an appropriate flow control regime.

Throughput, or equivalently transmit rate is defined for a TS-user and a given TC in terms of a sequence of at least two TSDUs in T-DATA request primitives. Given such a sequence of *n* TSDUs, where *n* is greater than or equal to 2, the transmit rate is defined to be the number of TS-user data octets contained in the last *n-1* TSDUs divided by the time between the first and last T-DATA requests in the sequence.

10.1.1.2 Transit delay

Transit delay is defined as the time elapsed between the occurrence of a T-DATA request primitive at a TSAP and the occurrences of the corresponding T-DATA indication primitives at the receiving TSAP. The requirement for transit delay in one direction of transmission may be different from the requirement for transit delay in the reverse direction.

10.1.1.3 Transit delay jitter

Transit delay jitter is defined between a pair of users, and for each direction of transmission, as the difference between the longest and the shortest transit delays in the lifetime of the TC.

10.1.2 TC reliability

For each TC, the TC reliability is defined as the combination of a TSDU corruption policy and a TSDU loss policy.

The TSDU loss policy is specified qualitatively by selecting one of two options:

a) losses of TSDUs are not accepted;

b) losses of TSDUs are accepted but indicated.

The TSDU corruption policy is specified qualitatively by selecting one of two options:

a) corruption of contents in TSDUs are not accepted;

b) corruption of contents in TSDUs are accepted but indicated.

The four possible combinations result in four different TC reliability policies as follows:

a) lossless and error-free;

b) lossless and corrupted;

c) lossy and error-free;

d) lossy and corrupted.

Table 2 shows the four TC reliability policies and the associated meaningful error rates.

Table 2 – The four TC reliability policies and the corresponding meaningful error rates

TC reliability policy		Loss policy	
		Losses not accepted	Losses accepted but indicated
Corruption policy	Corruption not accepted	Lossless and error-free	Lossy and error-free (Lost TSDU error rate)
	Corruption accepted but indicated	Lossless and corrupted (Corrupted TSDU error rate)	Lossy and corrupted (Corrupted TSDU error rate) (Lost TSDU error rate)

The TC reliability policies are negotiated among the TS-users only.

If neither losses nor corruption of contents are accepted on a TC, the TS-provider has to preserve unchanged the boundaries and the contents of all submitted TSDUs. That is, any TSDU delivered to the receiving TS-user via a T-DATA indication primitive shall have the same number of octets and the same value for each octet as the TSDU received from the sending TS-user in the corresponding T-DATA request primitive.

If corruption of contents is accepted, then any TSDU delivered to the receiving TS-users via a T-DATA indication primitive shall still have the same number of octets as the TSDU submitted by the sending TS-user in the corresponding T-DATA request primitive, but the values of some octets may have been altered by the TS-provider. The corruption of contents is to be indicated by the status parameter value in the T-DATA indication primitive.

If losses are accepted, then, for any lost or corrupted TSDU submitted by the sending TS-user, a zero-length TSDU is delivered to the receiving TS-user with indication by the status parameter in the T-DATA indication primitive.

The TC reliability policies are implemented by managing the QoS characteristics, corrupted TSDU error rate and lost TSDU error rate.

10.1.2.1 Corrupted TSDU error rate

The corrupted TSDU error rate is defined as the ratio of total number of TSDUs delivered to the receiving TS-user, with their contents corrupted, to the total number of TSDUs submitted by the sending TS-user to the TS-provider during a defined period.

The corrupted TSDU error rate is negotiated among the TS-users only.

10.1.2.2 Lost TSDU error rate

The lost TSDU error rate is defined as the ratio of the total number of zero-length TSDUs delivered to the receiving TS-user to the total number of TSDUs submitted by the sending TS-user to the TS-provider during a defined period.

The lost TSDU error rate is negotiated among the TS-users only.

10.1.3 TC ordering

TC ordering is concerned with the following two aspects:

a) how TSDUs of a sending TS-user are presented to the receiving TS-users;

b) how a receiving TS-user gets TSDUs from the sender(s).

In the case of a *single* sending TS-user, ordering if needed ensures that the TSDUs generated by the sending TS-user are delivered to each receiving TS-user in the active group in the same order as they were sent. In the case of *multiple* sending TS-users, ordering determines the relative sequencing of TSDU received from multiple sending TS-users. The ordering relationship defines the arrangement or interleaving of TSDU from the multiple sending TS-users. The ordering relationship can be: no, local, causal, partial, or total. Note that when there are only two participants in the active group, local ordering, causal ordering, and total ordering are the same.

NOTE – In Annex A, the ordering relationship is described in detail.

10.1.3.1 No ordering

TS-provider does not guarantee any relationship between TSDUs sent from a single sending TS-user or from multiple sending TS-users.

NOTE 1 – Even though the ordering of TSDUs is not guaranteed, the ordering of TPDUs belonging to the same TSDU is to be guaranteed.

NOTE 2 – Selection of no ordering can be used to absorb the Application Level Framing (ALF) feature of the Internet.

10.1.3.2 Local ordering

The TSDUs, generated by a particular sending TS-user, are delivered to all of the receiving TS-users in the same order in which they were generated. Local ordering does not establish any ordering relationship among TSDUs generated by different sending TS-users.

10.1.3.3 Partial ordering

The TSDUs, generated by all sending TS-users, are delivered to each receiving TS-user according to an arbitrary ordering rule.

If the TSDUs are ordered according to a rule applicable to all receiving TS-users, then each receiving TS-user receives the TSDUs generated by all the sending TS-users in the same order. If the TSDUs are ordered according to a rule determined by each receiving TS-user, then each receiving TS-user may receive the TSDUs in different orders.

10.1.3.4 Causal ordering

The causal ordering orders the TSDUs generated by all sending TS-users according to the causal dependence relationship among the sending events. A causal dependence relationship is established between two sending events, A and B, if the following applies:

a) A happens before B if A and B are sending events generated by the same sending TS-user and A is sent before B;

b) A happens before B if A and B are sending events generated by two different sending TS-users and the TSDUs generated by the event A by one sending TS-user is received by the other sending TS-user before it generates the event B.

A causal dependence relationship is established among more than two sending events if it can be established that A happens before B and that B happens before C, and it therefore follows that A happens before C. A causal dependence relationship cannot be established between the two sending events A and C if there is no possibility to establish that A happens before B and that B happens before C.

10.1.3.5 Total ordering

The TSDUs, generated by all sending TS-users, are delivered to each receiving TS-user in the same order. Every receiving TS-user sees all TSDUs from all sending TS-users in exactly the same order.

10.1.4 Miscellaneous

10.1.4.1 TC protection

Protection QoS is the degree to which the TS-provider attempts to counter security threats to the Transport Service using Security Services applied to the Transport, Network, Data Link or Physical Layers. The handling of protection QoS parameters is a local matter controlled according to the security policy in force.

NOTE – For further information on the provision of security in the lower layers and the handling of protection QoS, see ITU-T Rec. X.802 | ISO/IEC TR 13594.

10.1.4.2 TC precedence

The TC precedence characteristic specifies the relationship between TCs. This characteristic specifies the relative importance of a TC with respect to:

a) the order in which TCs are to have their QoS degraded, if necessary; and

b) the order in which TCs are to be broken to recover resources, if necessary.

This characteristic only has meaning in the context of some management entity or structure able to judge relative importance. The number of precedence levels is limited.

10.2 Levels of QoS agreement

10.2.1 Best effort level

For each QoS value negotiated at the best effort level of agreement, there is no guarantee that it will be maintained throughout the lifetime of the TC.

10.2.2 Guaranteed level

Guaranteed levels of agreement apply to QoS limits. The TS-provider monitors the achieved QoS. If it determines that it cannot maintain the QoS within the agreed limit, it will either:

a) pause the service (by issuing a T-PAUSE indication primitive), if the condition is judged to be transient; or

b) remove a TS-user (by issuing a T-LEAVE indication primitive); or

c) terminate the TC (by issuing a T-TERMINATE indication primitive).

However, in reaching the guaranteed level of agreement, the parties undertake to provide the agreed QoS, for example by dedicating resources to the TC, barring the occurrence of rare events such as equipment failure.

10.3 QoS negotiation mechanisms

For the negotiation of the ECTS QoS characteristics, two procedures are defined, namely the Owner Arbitration (OA) and Step-wise Arbitration (SWA) procedures. The QoS negotiation capabilities and mechanisms supported by these procedures are different.

10.3.1 Generic QoS negotiation

1) The focal TS-user proposes a LQA value LQAo, a CHQ value CHQo, and an OT value OTo, where LQAo < OTo < CHQo.

2) The TS-provider may refuse the request if it knows it cannot be met, i.e. if it cannot support at least LQAo.

If the TS-provider does not refuse the request, but cannot operate over the full range proposed by the focal TS-user, it may determine a new reduced CHQ value CHQi’ for each responding TS-user Ri individually. (It is also possible that the TS-provider may choose to operate internally at a higher quality, but it does not signal this fact to the responding TS-user.) CHQi’ shall not be worse than the focal-TS-user-proposed OTo; otherwise, the TS-user should leave the TC.

The TS-provider may not alter the LQA and OT values.

Thus LQAo < OTo < CHQi’ < CHQo for all i.

LQAo, OTo, and the new CHQi’ are supplied to each responding TS-user Ri.

3) Each responding TS-user may refuse the request. If it accepts, it may increase the LQA to a new value LQAi’, decrease the CHQ to a new value CHQi", and change the OT to a new value OTi’. OTi’ may be lower or higher than the TC-owner proposed OTo.

   Thus, LQAo < LQAi’ < OTi’ < CHQi" < CHQi’ < CHQo for all i.

   The new values LQAi’, CHQi", and OTi’ are returned to the TS-provider.

4) The TS-provider examines the values returned from each responding TS-user and determines LQA’max = max LQAi’, CHQ"min = min CHQi", and OT’max = max OTi’. It is a requirement for a feasible region that LQA’max < CHQ"min. In the case of the guaranteed level of agreement, responding TS-users may need to be removed until this constraint is satisfied.

   If a feasible region exists, the TS-provider selects the values LQA, CHQ, and OT such that LQA’max < LQA < OT < CHQ < CHQ"min. Typically, LQA will be close to LQA’max, CHQ to CHQ"min, and OT to OT’max.

   If a feasible region does not exist, selection of LQA, CHQ, and OT are abandoned. In the case of the guaranteed level of agreement, this results in failure of the connection establishment.

5) The selected values LQA, CHQ, and OT are returned to the focal TS-user and to all responding TS-users. They are the "agreed" values. Except in the case of the best-effort level of agreement, this meets the requirements of all TS-users since:

   LQAo < LQAi’ < LQA’max< LQA < OT < CHQ < CHQ"min < CHQi" < CHQi’ < CHQo for all i.

If the receive mode is "*receivers-wide*", the "agreed" values are also the receive QoS values of all the receiving TS-users. If the receive mode is "*receiver-selected*", although the focal TS-user transmits data according to the agreed QoS values, each TS-user may receive the data according to the QoS values it has returned to the TS-provider in its previous response.

The mechanism is illustrated in Figure 3.

10.3.2 OA QoS negotiation

The OA QoS negotiation applies to all three types of TC, i.e. simplex, duplex, and N-plex, and the procedure is the same as described in 10.3.1 with the TC-owner as the focal TS-user:

1) the TC-owner issues a T-CREATE request, multicast, containing a QoS proposal, thus initiating the generic QoS negotiation procedure of 10.3.1 for the whole TC;

2) every TS-user responds to the T-CREATE indication it receives with a T-CREATE response, which contains a set of responses to the QoS proposals made by the TC-owner;

3) the provider performs an arbitration of the QoS;

4) the provider issues T-CREATE confirm primitives containing the results of the arbitration, with AGI for the whole connection, to all TS-users.

From the point of view of QoS, the QA procedure allows the whole 1 × N QoS negotiations to be initiated and arbitrated altogether, following the sequence:

– proposal;

– provider modification;

– response;

– arbitration (local to the TC-owner).

A TC by an OA establishment is said to be homogenous, implying that all TS-users have agreed to a common set of transmit QoS values and so all sending TS-users transmit data at the same rate. It holds for all sending TS-users in the active group that:

ThroughputMin	=	LQA	–	minimum transmit rate;
ThroughputMax	=	CHQ	–	maximum transmit rate;
ThroughputOperating	=	OT	–	operating target transmit rate.

The non-TC-owners of a simplex or a duplex TC receive data from only one TS-user, i.e. the TC-owner. It holds for them that:

ReceiveRateMin	=	LQA	–	minimum receive rate;
ReceiveRateMax	=	CHQ	–	maximum receive rate;
ReceiveRateExpected	=	OT	–	expected receive rate.

The TC-owner of a duplex TC and all the TS-users of a N-plex TC receive data from multiple sending TS-users, of which the maximum number is, by definition, *Ntok*. Then, selection of the transmit rate as above has the consequence of implicitly announcing their receive capability such that:

ReceiveRateMin	=	Ntok × LQA	–	minimum aggregate receive rate;
ReceiveRateMax	=	Ntok × CHQ	–	maximum aggregate receive rate;
ReceiveRateExpected	=	Ntok × OT	–	expected aggregate receive rate.

Note, in the case of *Nact* (the number of members present in the active group), being less than *Ntok*, i.e. *Nact* < *Ntok*, a resource of at least (*Ntok* – *Nact*) × CHQ per host or provider is left unused. This is a slack reserve for late joining TS-users.

In the case of a receiver-selected receive mode, ReceiveRateMin, ReceiveRateMax, and ReceiveRateExpected may be less than the ones given here.

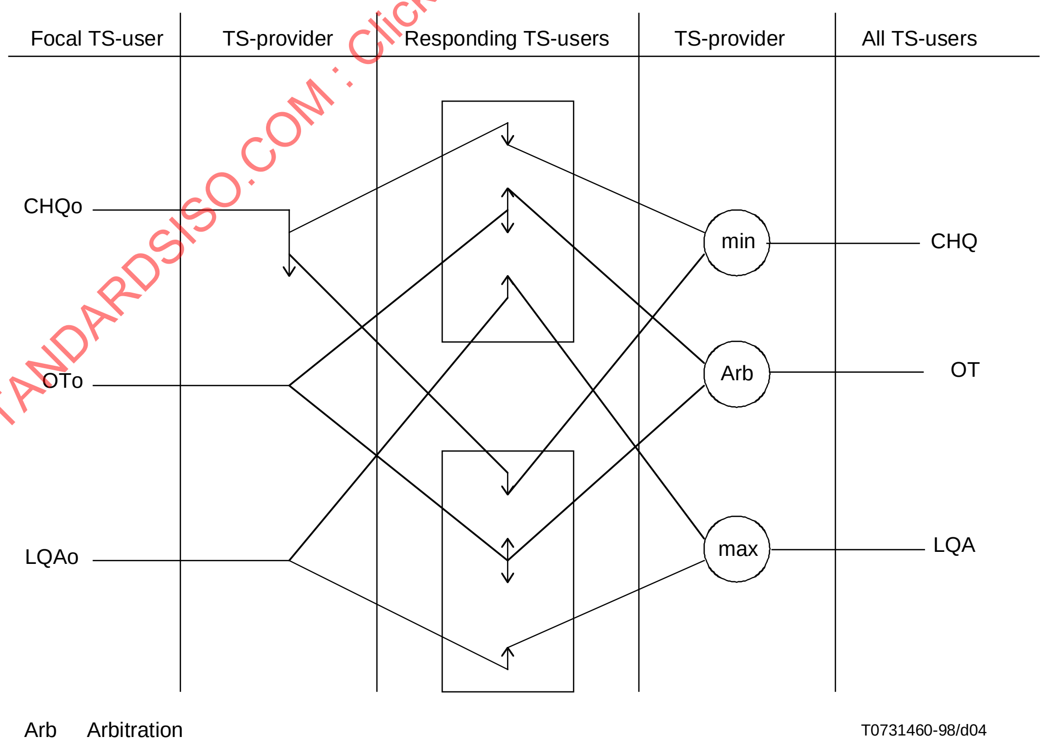


Figure 3 – Generic QoS negotiation

10.3.3 SWA QoS negotiation

The SWA QoS negotiation applies only to two of the TC types, duplex and N-plex and the procedure is the same as described in 10.3.1 with a prior invitation by the TC-owner:

1) the TC-owner issues a T-INVITE request, multicast, containing the TC-characteristics;
2) every prospective focal TS-user responds to the T-INVITE indication by issuing a T-JOIN request, thus individually initiating the generic QoS negotiation procedure of 10.3.1 for its 1×N simplex channel of the TC;
3) every TS-user responds to each T-JOIN indication it receives with a T-JOIN response, which contains a set of responses to the QoS proposals made by the focal TS-user that issued the corresponding T-JOIN request;
4) the TS-provider performs an arbitration of the QoS for each 1×N;
5) the TS-provider issues T-JOIN confirm primitives containing the results of the arbitration for the relevant 1×N, with AGI for the whole connection, to all TS-users.

From the point of view of QoS, the SWA procedure allows the individual 1×N QoS negotiations to be initiated and arbitrated independently, following the sequence:

– proposal;
– provider modification;
– response;
– arbitration (local to focal TS-user).

A TC by an SWA establishment is said to be heterogeneous, implying that different sending TS-users may transmit data at different rates. It holds for each TS-user in the active group that:

ThroughputMin	=	LQAi	–	minimum transmit rate;
ThroughputMax	=	CHQi	–	maximum transmit rate;
ThroughputOperating	=	OTi	–	operating target transmit rate.

The non-TC-owners of a duplex TC receive data from only one TS-user, i.e. the TC-owner. It holds for them that:

ReceiveRateMin	=	LQAo	–	minimum rate of the TC-owner;
ReceiveRateMax	=	CHQo	–	maximum rate of the TC-owner;
ReceiveRateExpected	=	OTo	–	expected rate of the TC-owner.

The TC-owner of a duplex TC and all the TS-users of a N-plex TC receive data from multiple sending TS-users, of which the maximum number is, by definition, *Ntok*. Then, it holds for them that:

ReceiveRateMin	=	Sum {LQAj; j=1,Ntok}	–	minimum receive rate;
ReceiveRateMax	=	Sum {CHQj; j=1,Ntok}	–	maximum receive rate;
ReceiveRateExpected	=	Sum {OTj; j=1,Ntok}	–	expected receive rate.

In the case of a receiver-selected receive mode, ReceiveRateMin, ReceiveRateMax, and ReceiveRateExpected may be less than the ones given in this Recommendation | International Standard.

10.3.4 Considerations

A zero throughput value in a response primitive is used to announce that the TS-user may want to participate in the TC simply as a receive-only user. Note that an intention of no participation at all is signalled by a T-LEAVE request primitive.

10.3.4.1 Constraints applicable to specific QoS characteristics

This Recommendation | International Standard places the following constraints on how QoS agreements are reached:

1) Corrupted TSDU error rate and lost TSDU error rate are negotiated between TS-users only, i.e. using a restricted form of the mechanisms defined above in which the TS-provider plays no part.
2) TC ordering is not subject to imposition or negotiation during CREATE or JOIN operations. See 10.1.3 for further information.

3) TC protection is determined by security policy, and is not covered by this subclause.

4) TC precedence is determined by a management policy. It may be imposed, but not negotiated.

10.3.4.2 QoS parameters of ECTS service primitives

This subclause identifies the general set of QoS parameters used in ECTS service primitives in order to impose or negotiate QoS agreements. Not all need be present in all cases: the exact set required is determined by the types of agreement on QoS it is desired to reach and the specifications of the foregoing negotiation rules.

For each QoS characteristic, other than TC-protection, the following parameters may be present in T-CREATE and T-JOIN service primitives:

- imposition or negotiation;
- type of value negotiated, i.e. operating target, LQA limit, CHQ limit;
- type of agreement required, i.e. best efforts or guaranteed;
- negotiation type, i.e. receivers-wide/receiver-selected;
- values as defined in the negotiation mechanism employed.

10.4 Phases of QoS agreement

There are several partly overlapping phases related to the operation of a TC. Some of them apply to the TC as a whole, others (namely join and leave) apply to individual TS-users. The phases are:

- the enrolment phase, during which the enrolment group is established and conditions for TCs are prepared;
- the creation phase, during which the TC is explicitly created;
- the data transmission phase, during which data are exchanged;
- the join phase, during which new TS-users join the TC;
- the leave phase, during which some TS-users leave the TC;
- the termination phase, at which the TC is terminated.

Rules may exist as to which parties may create and/or terminate such connections and therefore distinguish them from those parties which may only join and leave Transport Connections created by others. These rules thus determine the phases at which various QoS agreements may be reached.

For some characteristics, such as ordering, only those parties capable of providing the necessary function can be enrolled into any given group. The ordering characteristic is therefore determined by the end of the enrolment phase.

For other characteristics, the phase at which they may be agreed depends on whether negotiation is to take place and on the type of negotiation, e.g. receivers-wide or receiver-selected, that is required. If receivers-wide negotiation is required for a value (operating target, LQA or CHQ) associated with a given QoS characteristic, then that negotiation must take place during the enrolment phase or the creation phase, and the agreed value will then be imposed upon any TS-user that attempts to join the TC later. On the other hand, if the value is to be imposed or negotiated on a receiver-selected basis, then the agreement may be reached during the enrolment phase, the creation phase or the join phase.

Agreements reached during the enrolment phase may be on a specific value, or on a range of acceptable values. In the latter case, the agreement may be refined by selection of a specific value within the range during the creation phase or the join phase.

NOTE – The means by which agreements may be reached during the enrolment phase are beyond the scope of this Recommendation | International Standard.

Security or management policies may place further constraints on the phases at which QoS agreements may be reached.

In addition to specifying particular values or range constraints that apply to particular QoS characteristics at various phases, it is also possible to define those default values which will apply in the absence of any specification in a T-primitive. This service definition does not specify any particular default values, nor the means by which they may be established. Other specifications may specify particular defaults to be used in particular environments.

Table 3 lists QoS characteristics and indicates in which phases of a TC their values may be negotiated.

Table 3 – Classification of the QoS characteristics by phase usage

Characteristic	Enrol use	Create use	Join use
Throughput	R, V	V	SV
Transit delay	R, V	V	SV
Transit delay jitter	R, V	V	SV
Corrupted TSDU error rate	R, V	V	SV
Lost TSDU error rate	R, V	V	SV
TC ordering	V	N	N
TC protection	SP	SP	SP
TC precedence	I	I	I

R A range of values may be agreed
V A specific value may be negotiated
SV A specific value may be negotiated or imposed
SP Determined by the security policy in force
I Imposed
N Not subject to further agreement, already known

11 Enhanced Communications Transport Service primitives and parameters

11.1 Definitions

Table 4 defines the service primitives and the associated parameters which are used in ECTS. Detailed descriptions of these primitives are given in clauses 12 to 22.

NOTE – Although the TC characteristics normally consist of AGI and QoS, the AGI might be of a null value or even absent in TC characteristics parameters of response and confirm primitives.

11.2 Sequence of primitives at a TSAP

This subclause defines the constraints on the sequences in which the primitives defined in clauses 12 to 22 may occur. The constraints determine the order in which primitives may occur, but do not fully specify when they may occur. Other constraints, such as flow control of data, will affect the ability of a TS-user or a TS-provider to issue a primitive at any particular time.

A primitive issued at one TSAP will, in general, have consequences at the other TSAPs. The relations of primitives of each type to primitives at the other TC endpoints are defined in the appropriate clauses 12 to 22.

The possible overall sequences of primitives at a TSAP are defined in the state transition diagrams, Figures 4 to 6. In the diagrams:

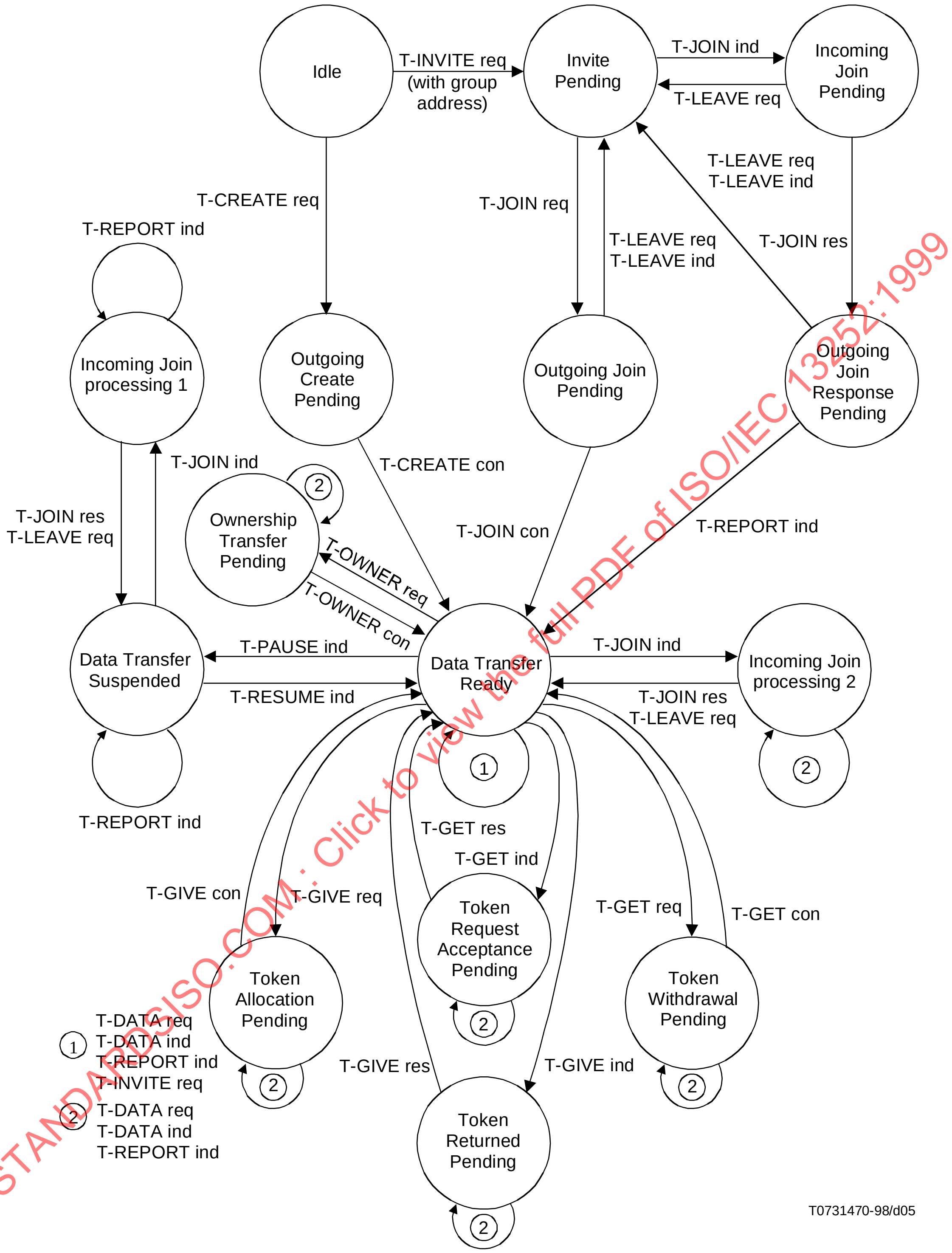
a) a primitive which is not shown as resulting in a transition (from one state to the same state, or from one state to a different state) is not permitted in that state;

b) the Idle state reflects the absence of a relationship between the TS-user and the TC. It is the initial and final state of any sequence, and upon returning to this state, the TS-user may not participate in the TC;

c) the use of a state transition diagram to describe the allowable sequences of service primitives does not impose any requirements or constraints on the internal organization of any implementations of the Transport Service.

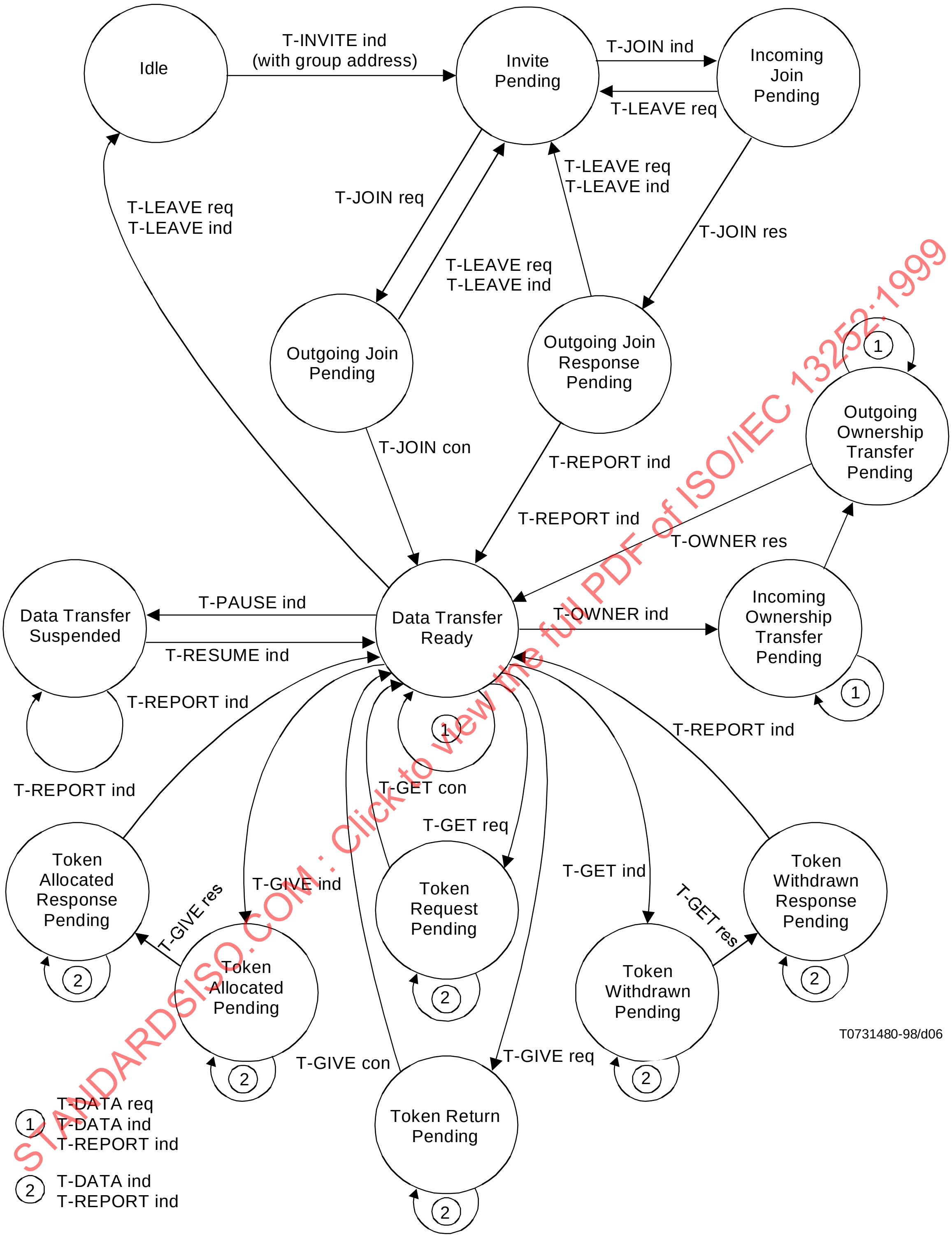
Table 4 – Enhanced Communications Transport Service primitives

Service	Primitive	Parameters
TC creation	T-CREATE request T-CREATE indication T-CREATE response T-CREATE confirm	Called address, Calling address, TC-characteristics, TS-user data Called address, Calling address, TC-characteristics, TS-user data Responding address, TC-characteristics, TS-user data Responding address, TC-characteristics, TS-user data
TC invitation	T-INVITE request T-INVITE indication	Called address, Calling address, TC-characteristics, TS-user data Called address, Calling address, TC-characteristics, TS-user data
TC join	T-JOIN request T-JOIN indication T-JOIN response T-JOIN confirm	Called address, Calling address, TC-characteristics, TS-user data Called address, Calling address, TC-characteristics, TS-user data Responding address, TC-characteristics, TS-user data Responding address, TC-characteristics, TS-user data
Data transfer Pause Resume Report	T-DATA request T-DATA indication T-UNITDATA request T-UNITDATA indication T-PAUSE indication T-RESUME indication T-REPORT indication	TS-user data Calling address, Status, TS-user data Called address, Calling address, TC-characteristics, TS-user data Called address, Calling address, TC-characteristics, Status, TS-user data Reason Reason Reason
TC leave	T-LEAVE request T-LEAVE indication	Called address, Calling address, TS-user data Called address, Reason
TC termination	T-TERMINATE request T-TERMINATE indication	TS-user data Reason, TS-user data
TC-ownership	T-OWNER request T-OWNER indication T-OWNER response T-OWNER confirm	Called address, Calling address, TS-user data Called address, Calling address, TS-user data Responding address, TS-user data Responding address, TS-user data
Token give	T-GIVE request T-GIVE indication T-GIVE response T-GIVE confirm	Called address, Calling address, TS-user data Called address, Calling address, TS-user data Responding address, TS-user data Responding address, TS-user data
Token get	T-GET request T-GET indication T-GET response T-GET confirm	Called address, Calling address, TS-user data Called address, Calling address, TS-user data Responding address, TS-user data Responding address, TS-user data



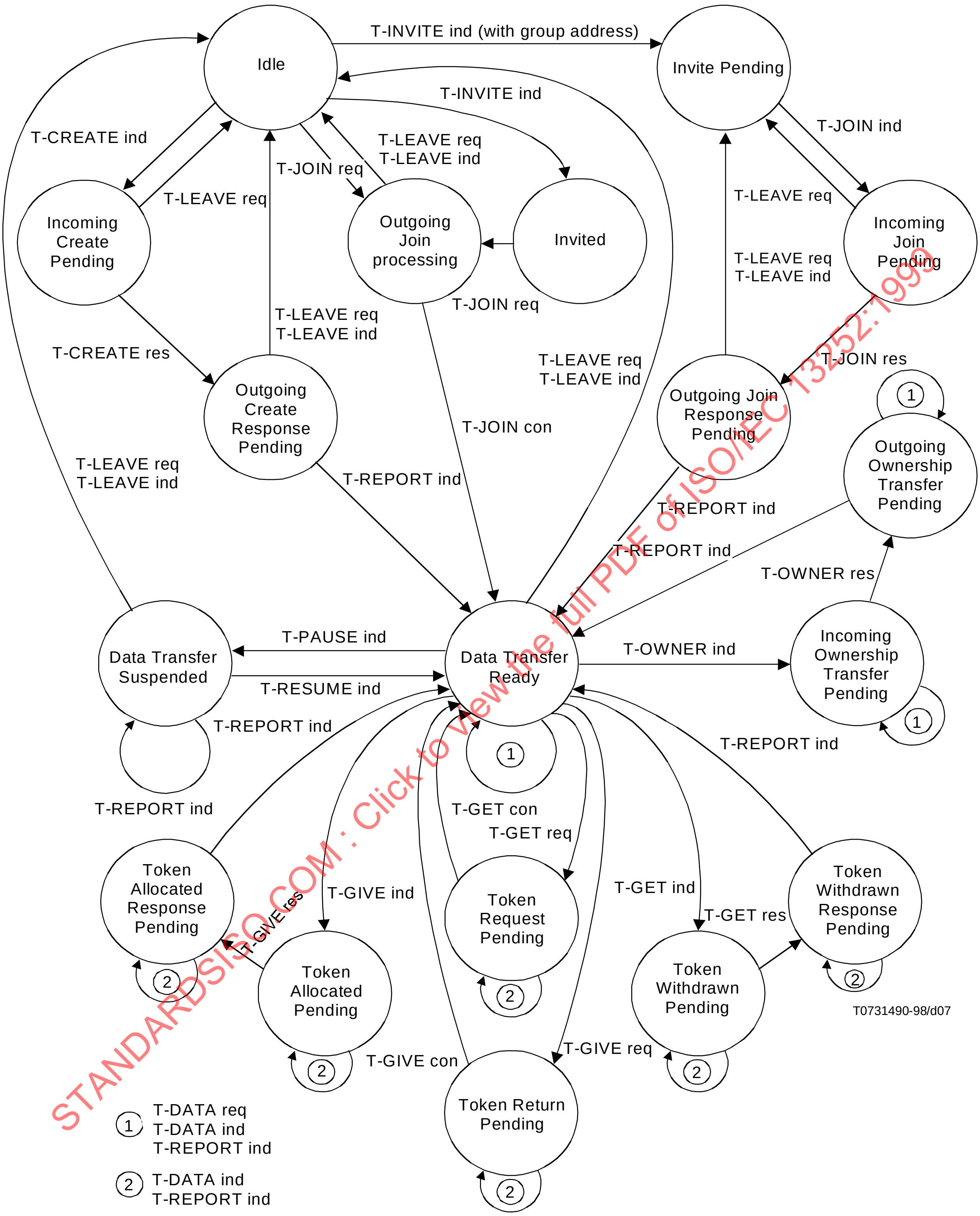
NOTE – T-TERMINATE request and/or indication may occur at any states, except the idle states, which then will lead to the Idle state. All states except the Data Transfer Suspended include a self-loop branch due to T-UNITDATA request and T-UNITDATA indication; these primitives may occur at such states without causing transition to other states.

Figure 4 – State transition diagram of a TC-owner



NOTE – T-TERMINATE request and/or indication may occur at any states, except the idle states, which then will lead to the Idle state. All states except the Data Transfer Suspended include a self-loop branch due to T-UNITDATA request and T-UNITDATA indication; these primitives may occur at such states without causing transition to other states.

Figure 5 – State transition diagram of a focal TS-user in a heterogeneous TC



NOTE – T-TERMINATE request and/or indication may occur at any states, except the idle states, which then will lead to the Idle state. All states except the Data Transfer Suspended include a self-loop branch due to T-UNITDATA request and T-UNITDATA indication; these primitives may occur at such states without causing transition to other states.

Figure 6 – State transition diagram of a non-focal TS-user

12 TC Creation service

12.1 Function

The TC Creation primitives can be used by the TC-owner to establish a homogeneous TC, provided the enrolled TS-users exist and are known to the TS-provider.

TC-characteristics, i.e. AGI and QoS, are assumed to have been defined and known both to the TS-users and the TS-provider beforehand.

The TC Creation service will further refine the QoS, if necessary, and check the identities of the TC-participants to validate the AGI condition.

It is assumed that there exists one and only one TC-owner who possesses the right to create and terminate a TC of a given enrolled group.

12.2 Types of primitives and parameters

Table 5 lists the types of primitives and parameters associated with a TC Creation.

Table 5 – TC Creation primitives and parameters

	T-CREATE request	T-CREATE indication	T-CREATE response	T-CREATE confirm	T-REPORT indication
Called address	X	X (=)			
Calling address	X (Note 1)	X (=)			
Responding address			X (Note 1)	X (Note 2)	
TC characteristics	X	X	X	X (Note 3)	
TS-user data	X (U)	X (=)	X (U)	X (=)	
Reason					X (Note 3)

NOTE 1 – This parameter may be implicitly associated with the TSAP at which the primitive is issued.

NOTE 2 – This is a list of addresses of the responding TS-users.

NOTE 3 – This includes the OA QoS values.

12.2.1 Called address

The called address parameter conveys a TSAP address that identifies the TS-user(s) expected to participate in the TC being established.

12.2.2 Calling address

The calling address parameter conveys the TSAP address of the TC-owner by whom the TC Creation has been requested.

12.2.3 Responding address

The responding address parameter conveys the address of the TSAP of the TS-user to participate in the TC and to which TS-user data should be delivered when the TC is in the Data Transfer state.

12.2.4 TC-characteristics

The TC-characteristics parameter conveys the AGI and QoS for the TC. Whereas the AGI parameters are not for negotiation, the QoS values may be changed in the sequel of primitives. The QoS in the request primitive is the one proposed by the TC-owner; that in the indication primitive is the one modified by the TS-provider; that in the response primitive is the one counter-proposed by the responding TS-users; that in the confirm primitive is the one arbitrated by the TS-provider.

12.2.5 TS-user data

The TS-user data parameter allows the transfer of TS-user data among TS-users without modification by the TS-provider.

12.2.6 Reason

The reason parameter of the REPORT indication primitive conveys the TC-characteristics including the OA QoS values.

12.3 Sequence of primitives

The sequence of primitives in a successful TC Creation is defined by Figure 7. Note that a confirm primitive is delivered only to the TC-owner who has previously issued the request primitive and other TS-users are supplied with a T-REPORT indication.

The TC Creation procedure may fail either due to the inability of the TS-provider to establish a TC, due to the unsuccessful negotiation of the QoS, or due to the failure of the AGI condition.

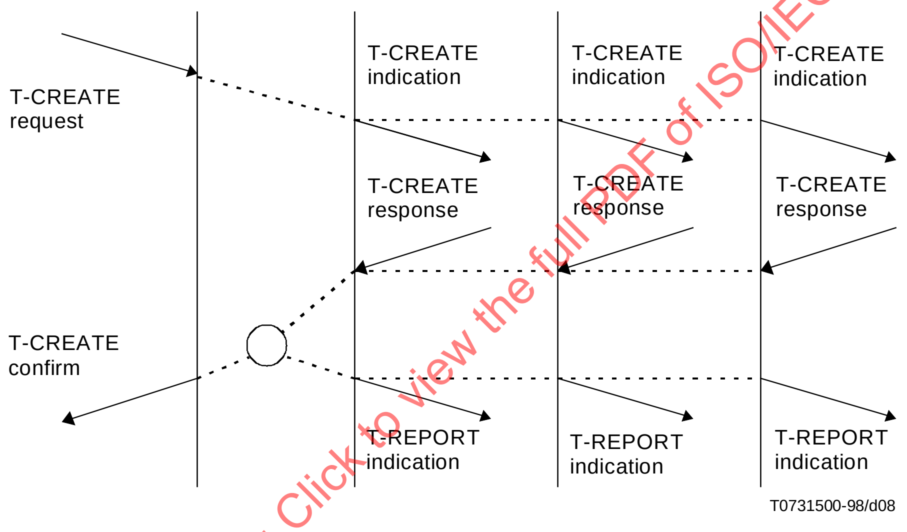


Figure 7 – Sequence of primitives in a successful TC Creation

13 TC Invitation service

13.1 Function

The TC Invitation primitives can be used by the TC-owner to invite the TS-users to collectively establish a heterogeneous TC, provided the enrolled TS-users exist and are known to the TS-provider. A heterogeneous TC is established by individual establishment of multiple 1×N simplex channels, each by every focal TS-user through Join primitives. The TC Invitation primitive can also be used by the TC-owner to invite a TS-user to join an already existing TC.

In both cases, the TC Invitation service is normally followed by the TC Join service.

TC-characteristics, i.e. AGI and QoS, are assumed to have been defined and known both to the TS-users and the TS-provider beforehand.

The TC Invitation service does not change the TC-characteristics it conveys.

It is assumed that there exists one and only one TC-owner who possesses the right to invoke the Invitation service.

13.2 Types of primitives and parameters

Table 6 lists the types of primitives and parameters associated with a TC Invitation.

Table 6 – TC Invitation primitives and parameters

	T-INVITE request	T-INVITE indication
Called address	X	X (=)
Calling address	X	X (=)
TC characteristics	X	X (=)
TS-user data	X (U)	X (=)

13.2.1 Called address

In the invitation to establish a heterogeneous TC, the called address parameter conveys a TSAP address that identifies the TS-user(s) expected to participate in the heterogeneous TC being established. In the invitation to an existing TC, the called address parameter conveys a TSAP address that identifies the TS-user being invited.

13.2.2 Calling address

The calling address parameter conveys the TSAP address of the TC-owner by whom the TC Invitation has been requested.

13.2.3 TC-characteristics

The TC-characteristics parameter conveys the AGI and QoS for the TC. Both the AGI and the QoS parameters are not changed in the sequel of primitives.

13.2.4 TS-user data

The TS-user data parameter allows the transfer of the TC-owner data to other TS-users.

13.3 Sequence of primitives

13.3.1 Invitation for a heterogeneous TC

The TC Invitation primitives can be used by the TC-owner to invite the TS-users to collectively establishing a heterogeneous TC. The sequence of primitives in a TC Invitation is defined by Figure 8. Note that the TC Invitation primitives are normally followed each by a JOIN request primitive defined below, thus initiating the Join service depicted in the time-sequence diagram of Figure 10.

The TC Invitation procedure may fail either due to the inability of the TS-provider or due to the failure of the AGI condition.

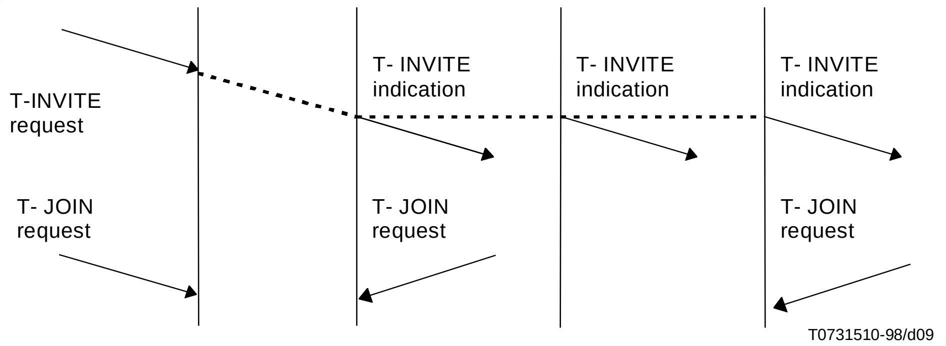


Figure 8 – Sequence of primitives in a TC Invitation

13.3.2 Invitation for a late join

The TC Invitation primitives can be used by the TC-owner to invite a specified TS-user to join an already existing TC. The sequence of primitives in such a TC Invitation is defined by Figure 9.

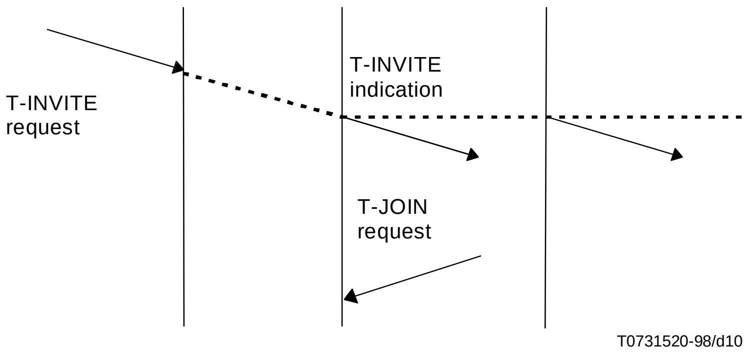


Figure 9 – Sequence of primitives in a TC Invitation for a specified TS-user to join an already existing TC

14 TC Join service

14.1 Function

The TC Join primitives can be used by the focal TS-user to establish a heterogeneous TC, provided the enrolled TS-users exist and are known to the TS-provider.

The primitive can also be used by a TS-user to join an already existing homogenous TC as a send and/or receive TS-user or a heterogeneous TC as a receive-only user.

TC-characteristics, i.e. AGI and QoS, are assumed to have been defined and known both to the TS-users and the TS-provider beforehand.

The TC Join service will further refine the QoS, if necessary, and check the identities of the TC-participants to validate the AGI condition.

14.2 Types of primitives and parameters

Table 7 lists the types of primitives and parameters associated with a TC Join.

Table 7 – TC Join primitives and parameters

	T-JOIN request	T- JOIN indication	T- JOIN response	T- JOIN confirm	T-REPORT indication
Called address	X	X (=)			
Calling address	X (Note 1)	X (=)			
Responding address			X (Note 1)	X (Note 2)	
TC characteristics	X	X	X	X (Note 3)	
TS-user data	X (U)	X (=)	X (U)	X (=)	
Reason					X (Note 3)

NOTE 1 – This parameter may be implicitly associated with the TSAP at which the primitive is issued.

NOTE 2 – This is a list of addresses of the responding TS-users or the address of the TC-owner.

NOTE 3 – This includes the arbitrated QoS values.

14.2.1 Called address

In the case of a heterogeneous TC establishment, the called address parameter conveys a (group) TSAP address that identifies the TS-user(s) expected to participate in the TC being established. In the case of a late join wherein a TS-user attempts to join an existing TC, the called address conveys the group address of the TC to join.

14.2.2 Calling address

In the case of a heterogeneous TC establishment, the calling address parameter conveys the TSAP address of the focal TS-user by whom the TC join has been requested. In the case of a late join, the calling address conveys the address of the TS-user attempting to join the existing TC.

14.2.3 Responding address

In the case of a heterogeneous TC establishment, the responding address parameter conveys the address of the TSAP of the TS-user to participate in the TC and to which TS-user data should be delivered when the TC is in the Data Transfer state. In the case of a late join, the responding address conveys the address of the TC-owner.

14.2.4 TC-characteristics

The TC-characteristics parameter conveys the AGI and QoS for the TC. Whereas the AGI parameters are not for negotiation, the QoS values may be changed in the sequel of primitives for the establishment of each $1 \times N$ simplex channel. The QoS in the request primitive is the one proposed by the focal TS-user; that in the indication primitive is the one modified by the TS-provider; that in the response primitive is the one counter-proposed by the responding TS-users; that in the confirm primitive is the one arbitrated by the TS-provider.

In the case of a late join, the QoS may not be changed. The late-coming TS-user either obeys the QoS of the homogeneous TC or joins a heterogeneous TC as a receive-only member.

14.2.5 TS-user data

The TS-user data parameter allows the transfer of TS-user data among TS-users without modification by the TS-provider.

14.2.6 Reason

The reason parameter of the REPORT indication primitive conveys the TC-characteristics including the arbitrated QoS values.

14.3 Sequence of primitives

The sequence of primitives in a successful TC Join in the case of a heterogeneous TC establishment is defined by Figure 10. Note that a confirm primitive is delivered only to the TS-user who has previously issued the request primitive and other TS-users are supplied with a T-REPORT indication.

The sequence of primitives in a successful TC late join is defined by Figure 11. Note that both a confirm and a report primitive are delivered to the late-joining TS-user while other TS-users are supplied only with a report primitive.

The TC Join procedure may fail either due to the inability of the TS-provider to establish a TC, due to the unsuccessful negotiation of the QoS, or due to the failure of the AGI condition.

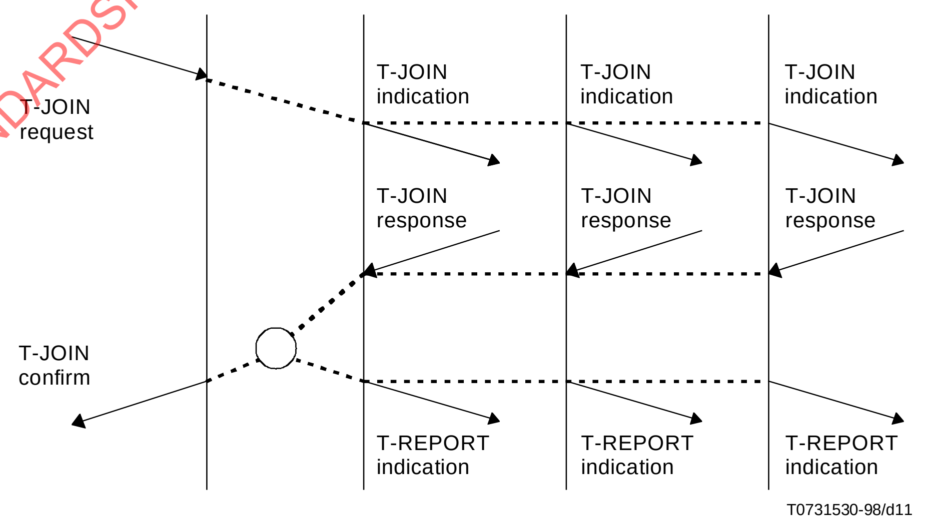


Figure 10 – Sequence of primitives in a successful TC Join by a focal TS-user

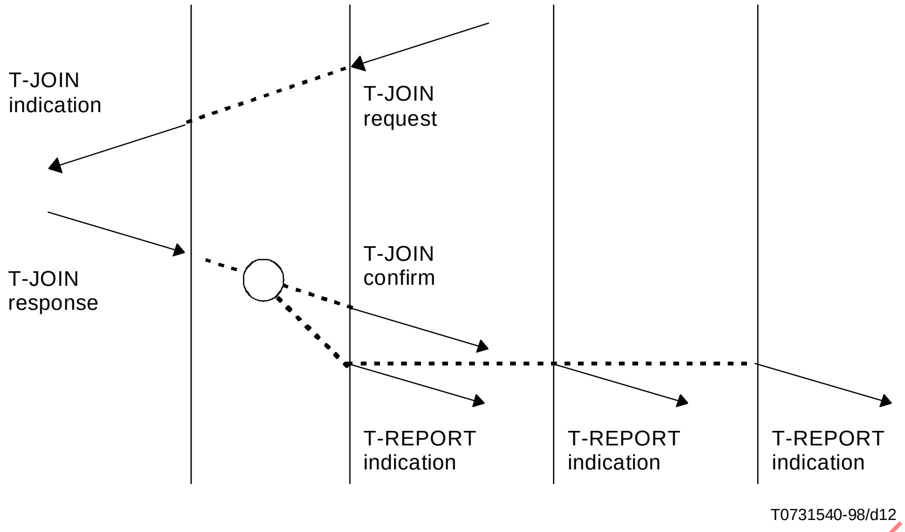


Figure 11 – Sequence of primitives in a successful TC Join by a TS-user in a homogeneous TC or by a receive-only TS-user in a heterogeneous TC

15 Data Transfer service

15.1 Function

The Data Transfer service provides for two types of transfer of TSDUs from a sending TS-user to the other receiving TS-user(s). In one type, data transfer takes place over a successfully established TC using T-DATA primitives. In the other type, data transfer takes place at any phase of a TC using T-UNITDATA primitives; it may take place even when no TC is available between the sending and the receiving TS-users.

15.2 Types of primitives and parameters

Table 8 indicates the types of primitives and the parameters for the Data Transfer service.

Table 8 – Data transfer primitives and parameters

	T-DATA request	T-DATA indication	T-UNITDATA request	T-UNITDATA indication
Called address			X	X (=)
Calling address		X	X	X (=)
TC characteristics			X	X (=)
Status		X		X
TS-user data	X	X (=)	X	X (=)

15.2.1 Called address

The called address parameter may be present only in T-UNITDATA primitives and conveys a TSAP address that identifies the TS-user(s) expected to receive the data sent.

15.2.2 Calling address

The calling address parameter conveys a TSAP address that identifies the TS-user who has sent the data.

15.2.3 TC-characteristics

The TC-characteristics parameter may be present only in T-UNITDATA primitives. All parameters of the TC-characteristics except the transit delay shall be of null value.

15.2.4 Status

The notification of detected but not corrected errors is signalled through the status parameter to the TS-user.

The status parameter conveys a notification to the TS-user that:

a) the TS-user data is corrupted (errors detected but not corrected); or

b) the TS-user data is substituted (errors detected and substituted); or

c) the TS-user data is of zero length (TSDU lost or corrupted).

15.2.5 TS-user data

The TS-user data parameter consists of an integral number of octets greater than or equal to zero and allows the transfer of data from a sending TS-user to the receiving TS-user(s), without modification by the TS-provider.

15.3 Sequence of TS primitives

The sequence of primitives in a successful data transfer is defined by Figures 12 and 13.

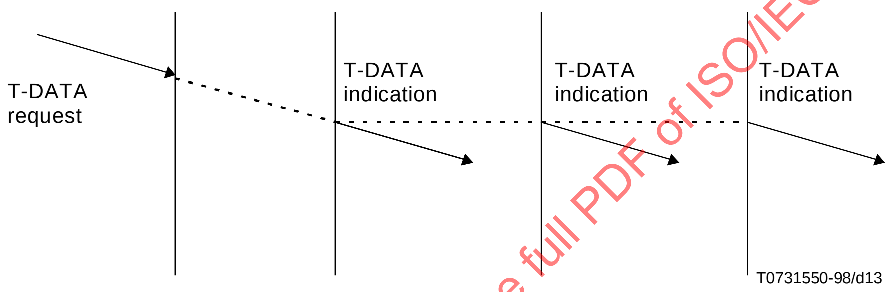


Figure 12 – Sequence of primitives in data transfer using T-DATA primitives

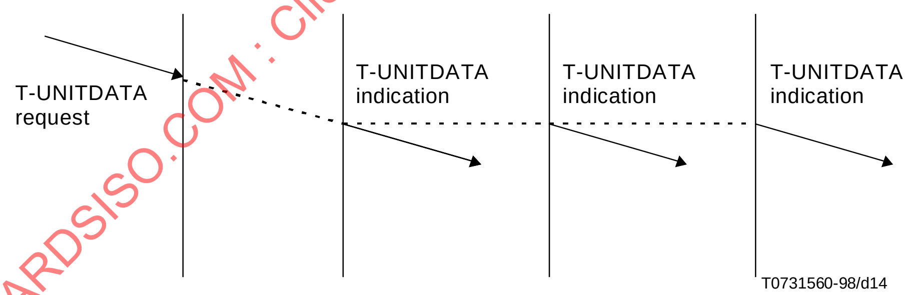


Figure 13 – Sequence of primitives in data transfer using T-UNITDATA primitives

16 Pause service

16.1 Function

The Pause service provides for the TS-provider to indicate, with the T-PAUSE indication primitive to the active group TS-user(s), that the TC has entered the state where the data transfer is not allowed. The reason parameter within the T-PAUSE indication primitive should deliver the reason, e.g. violation of the QoS or the AGI.

Until the TS-users are notified that TC-characteristics are met again, no T-DATA request primitives may be issued. Data transfer resumes by the RESUME service.

16.2 Types of primitive and parameters

Table 9 indicates the types of primitives and the parameters for the Pause service.

Table 9 – Pause primitives and parameters

	T-PAUSE indication
Reason	X

16.2.1 Reason

The reason parameter gives information indicating the cause of the data transfer suspension. The reason is one of the following:

a) temporary lack of local or remote resources at the TS-provider;

b) a QoS parameter temporarily below an agreed LQA level;

c) AGI temporarily below the minimum level.

16.3 Sequence of TS primitives suspending data transfer

The sequence of primitives in the Pause service is defined by Figure 14.

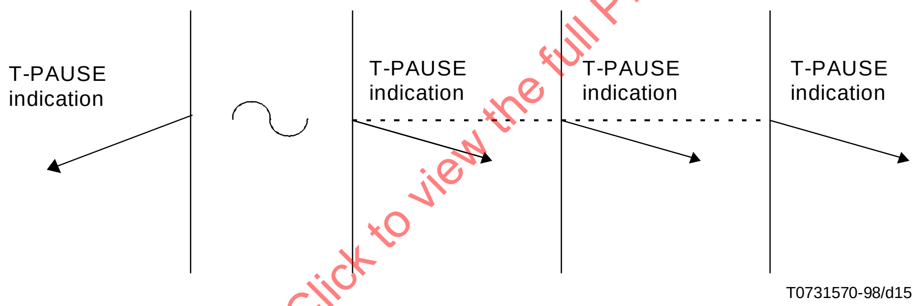


Figure 14 – Sequence of primitives in TS-provider invoked suspension of data transfer

17 Resume service

17.1 Function

The Resume TS primitives are used to resume the data transfer recovering from the temporarily violated TC-characteristics. After the receipt of the T-RESUME indication primitive, the active group TS-user may restart issuing T-DATA request primitives, or receiving T-DATA indication primitives.

17.2 Types of primitive and parameters

Table 10 indicates the types of primitives and the parameters for the Resume service.

Table 10 – Resume primitives and parameters

	T-RESUME indication
Reason	X

17.2.1 Reason

The reason parameter gives information indicating the reason for the resumption of the data transfer. The reason may usually be the recovery from the bottleneck that caused the previous Pause service.

17.3 Sequence of primitives

The sequence of primitives in the resumption of a previously suspended data transfer is defined by Figure 15.

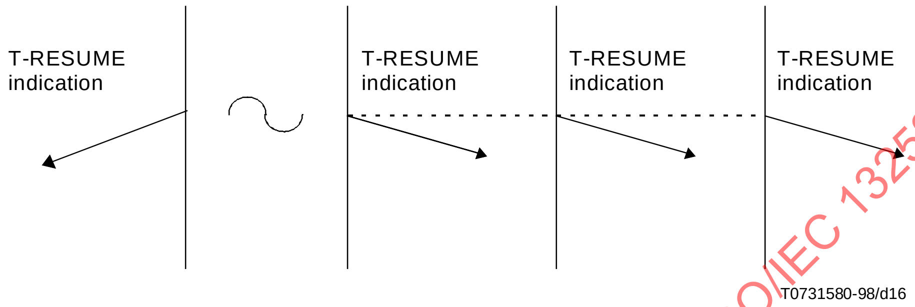


Figure 15 – Sequence of primitives in TS-provider resumption of data transfer

18 Report service

18.1 Function

The report TS primitives are used to notify the change or selection of TC-characteristics to the active TS-users during data transfer or in TC establishments.

If the value of some TC-characteristic is changed, but not below the minimum level, the TS-provider alters the TS-user(s) by issuing a T-REPORT indication.

NOTE – If the value of some TC-characteristic is below its minimum level and is not recoverable in data transfer, the TS-provider issues a T-TERMINATE indication or a T-LEAVE indication to the TS-user.

18.2 Types of primitive and parameters

Table 11 indicates the types of primitives and the parameters for the Report service.

Table 11 – Report primitives and parameters

	T-REPORT indication
Reason	X

18.2.1 Reason

The reason parameter gives information indicating the cause of the report. The reason is one of the following:

a) minor lack of local or remote resources at the TS-provider;

b) detected but not fatal QoS change, e.g. degradation of QoS below some threshold;

c) detected but not fatal AGI change.

A non-fatal change may be signalled by a T-REPORT indication, whereas a fatal change will result in a T-LEAVE or T-TERMINATE indication.

The reason parameter may also convey:

a) the arbitrated TC-characteristics in TC establishments, or

b) the result of the TC-ownership service; or

c) the result of the TC-token service; or

d) additional information provided by the TS-provider.

NOTE 1 – The TS-provider may provide additional information (e.g. accounting) for management purposes.

NOTE 2 – The TS-provider may replicate the TS-user data of some related primitives.

18.3 Sequence of TS primitives

The sequence of primitives in the Report service as used by the TS-provider is defined by Figure 16.

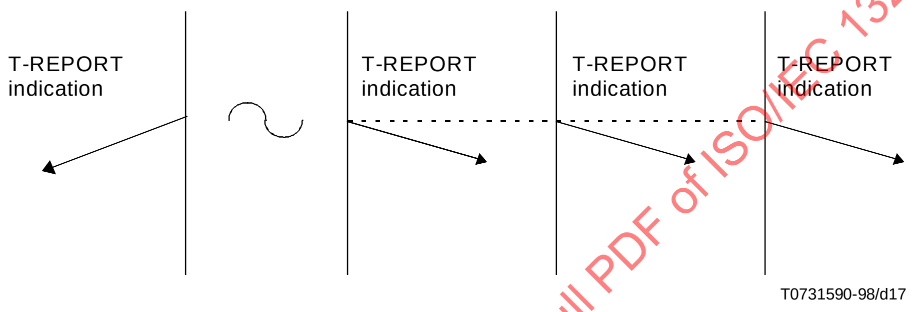


Figure 16 – Sequence of primitives during data transfer when the TS-provider is to give warning or notification

19 TC Leave service

19.1 Function

The TC Leave primitives are used to remove a TS-user from the TC. The leave may be performed:

a) by a TS-user to leave the TC;

b) by a TS-provider to exclude a TS-user;

c) by a TS-user to reject TC Create or TC Join;

d) by a TS-provider to reject TC Join.

19.2 Types of primitives and parameters

Table 12 indicates the types of primitives and parameters associated with the TC Leave service.

Table 12 – TC Leave primitives and parameters

	T-LEAVE request	T-LEAVE indication
Called address	X	X
Calling address	X	
Reason		X

19.2.1 Called address

The called address parameter conveys:

a) in the T-LEAVE request primitive, a group TSAP address that identifies the TC to leave;

b) in the T-LEAVE indication primitive, the TSAP address of the TS-user to be excluded from the TC.

19.2.2 Calling address

The calling address parameter conveys the TSAP address of the TS-user wishing to leave the TC.

19.2.3 Reason

The reason parameter gives information on the cause of the Leave. The reason is one of the following:

a) QoS parameter below an agreed LQA level;

b) lack of local or remote resources at the TS-provider;

c) called address unknown.

19.3 Sequence of primitive

19.3.1 TS-user rejection of a TC Creation

A TS-user may reject a TC Creation request by a T-LEAVE request. The sequence of primitives is defined by Figure 17.

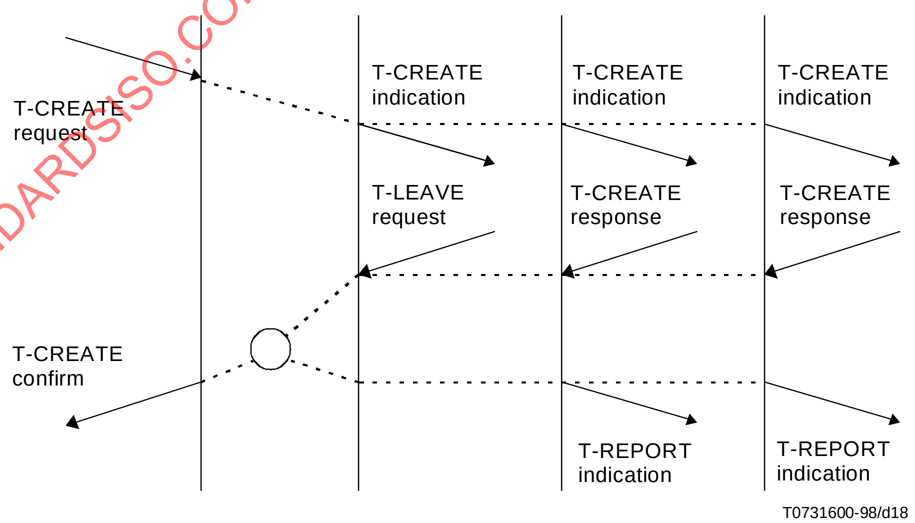


Figure 17 – Sequence of primitives in a successful TC Creation with some TS-user rejection(s)

19.3.2 TS-user rejection of a TC Join

A TS-user may reject a TC Join request by a T-LEAVE request. The sequence of primitives is defined by Figure 18.

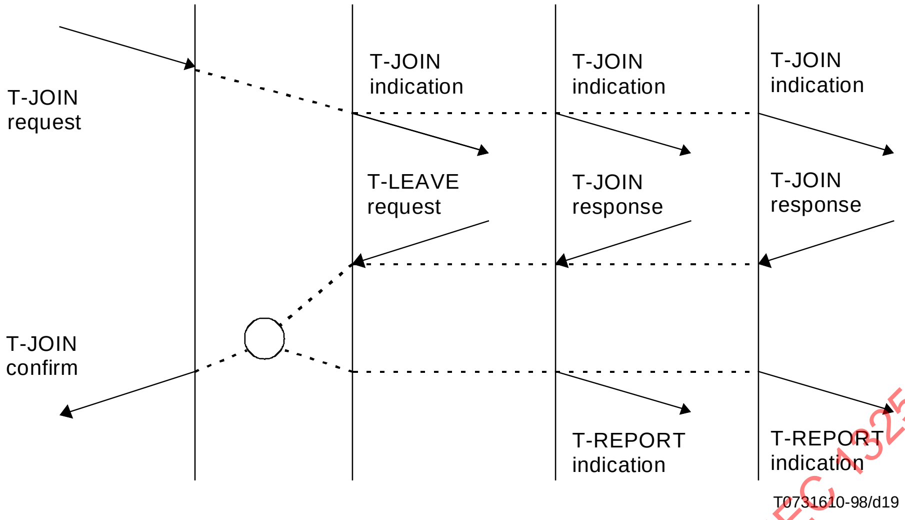


Figure 18 – Sequence of primitives in a successful TC Join with some TS-user rejection(s)

19.3.3 TS-provider rejection of a TC Join attempt

If the TS-provider is unable to establish a TC requested by a T-JOIN request, it indicates this to the TS-user by T-LEAVE indication primitive with a reason parameter. The sequence of primitives is defined by Figure 19.

Figure 19 – Sequence of primitives in TS-provider rejection of a TC Join attempt

19.3.4 TS-user invoked Leave

A TS-user may remove itself from the TC by a T-LEAVE request. The sequence of primitives is defined by Figure 20.

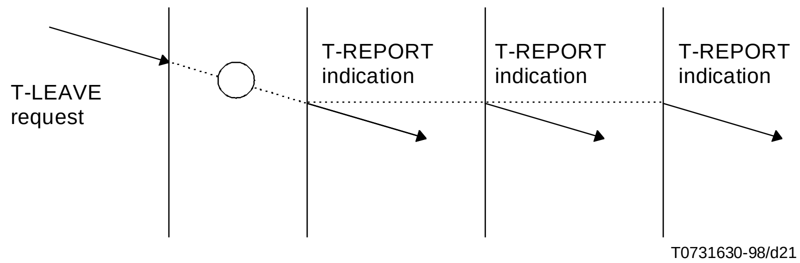


Figure 20 – Sequence of primitives in a TS-user leaving the active TC

19.3.5 TS-provider expulsion of a TS-user Leave

The TS-provider may expel a TS-user. The sequence of primitives is defined by Figure 21.

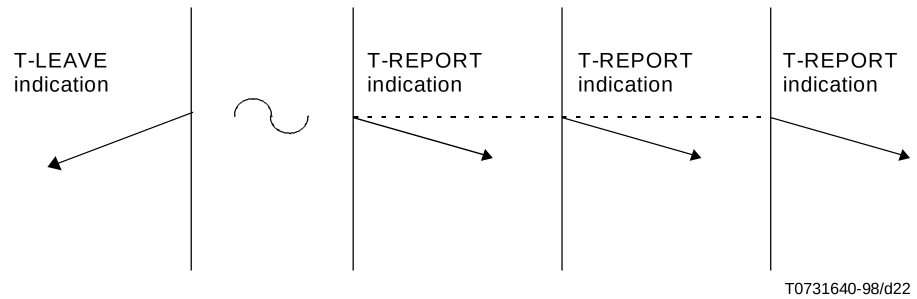


Figure 21 – Sequence of primitives in TS-provider expulsion of TS-user

20 TC Termination service

20.1 Function

The TC termination primitives are used to terminate a TC. The termination may be initiated by:

a) the TC-owner; or

b) the TS-provider due to fatal failure of some TC-characteristics.

TC termination is permitted at any time regardless of the state of the TC. A request for termination cannot be rejected. The Transport Service does not guarantee delivery of any TS-user data once the termination procedure is entered.

20.2 Types of primitives and parameters

Table 13 indicates the types of primitives and parameters associated with the TC Termination service.

Table 13 – TC Termination primitives and parameters

	T-TERMINATE request	T-TERMINATE indication
Reason		X
TS-user data	X (U)	X (=)

20.2.1 Reason

The reason parameter gives information regarding the cause of the termination. The reason is one of the following:

a) TC-owner invoked termination;

b) lack of local or remote resource at the TS-provider;

c) QoS below an agreed LQA level;

d) called address unknown;

e) AGI below the minimum level.

20.2.2 TS-user data

The TS-user data parameter is present in the T-TERMINATE request and indication primitives when a termination request was originated by the TC-owner.