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Information technology — Open Systems Interconnection — Transport service definition

Technologies de l'information — Interconnexion de systèmes ouverts (OSI) — Définition du service de transport

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CONTENTS

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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 8072 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.214.

This second edition cancels and replaces the first edition (ISO 8072:1986), which has been technically revised and consolidates Addendum 1:1986 and Technical Corrigendum 1:1991.

Introduction

This Recommendation | International Standard is one of a set of Recommendations | International Standards produced to facilitate the interconnection of computer systems. It is related to other Recommendations | International Standards in the set as defined by the Reference Model of Open Systems Interconnection (OSI). The OSI Reference Model (CCITT Rec. X.200 | ISO 7498) subdivides the area of standardization for interconnection into a series of layers of specification, each of manageable size.

This Recommendation | International Standard defines the Service provided by the Transport Layer to the Session Layer at the boundary between the Transport and Session Layers of the Reference Model. It provides for the designers of Session Protocols a definition of the Transport Service existing to support the Session Protocol and for designers of Transport Protocols a definition of the services to be made available through the action of the Transport Protocol over the underlying service. This relationship is illustrated in Figure Intro.1.

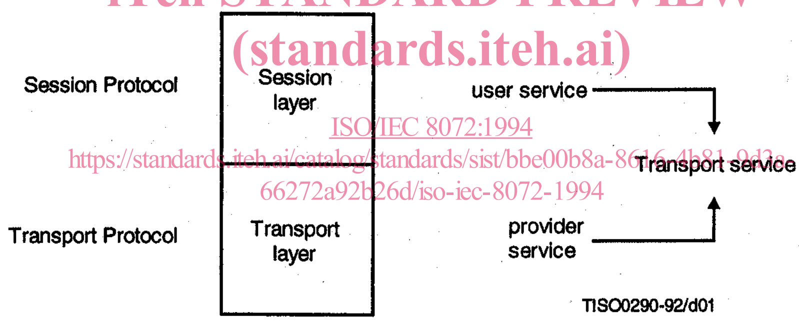

Figure Intro.1 – Relationship of the Transport Service to OSI transport and Session Protocols

Throughout the set of OSI Recommendations | International Standards, the term "Service" refers to the abstract capability provided by one layer of the OSI Reference Model to the layer above it. Thus, the Transport Service defined in this Recommendation | International Standard is a conceptual architectural Service, independent of administrative divisions.

NOTE – It is important to distinguish the specialized use of the term "Service" within the set of OSI Recommendations | International Standards from its use elsewhere to describe the provision of a service by an organisation (such as the provision of a service, as defined in other Recommendations, by an Administration).

INTERNATIONAL STANDARD

ITU-T RECOMMENDATION

INFORMATION TECHNOLOGY – OPEN SYSTEMS INTERCONNECTION – TRANSPORT SERVICE DEFINITION

SECTION 1 – GENERAL

1 Scope

This Recommendation | International Standard defines in an abstract way the externally visible service provided by the OSI 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 all OSI Transport Protocols (in conjunction with the Network Service) and which may be used by any OSI Session Protocol.

This Recommendation | International Standard does not specify individual implementations or products, nor does it constrain the implementation of entities and interfaces within a system. Conformance of equipment to this Recommendation | International Standard is achieved by conformance to the protocols specified to fulfil the Transport Service defined in this Recommendation | International Standard.

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 International Standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards. The Telecommunication Standardization Bureau of the ITU maintains a list of currently valid ITU-T Recommendations.

2.1 Identical Recommendations | International Standards

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

2.2 Paired Recommendations | International Standards equivalent in technical contents

– CCITT Recommendation X.200 (1988), *Reference model for Open Systems Interconnection for CCITT applications.*

ISO 7498:1984, *Information processing systems – Open Systems Interconnection – Basic Reference Model.*

3 Definitions

For the purpose 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 Reference Model (CCITT Rec. X.200 | ISO 7498), and makes use of the following terms defined in it:

a) expedited transport-service-data-unit;

b) transport-connection;

c) transport-connection endpoint;

d) Transport Layer;

e) Transport Service;

f) transport-service-access-point;

g) transport-service-access-point address;

h) transport-service-data-unit;

i) Network Layer;

j) Network Service;

k) network-connection;

l) interface flow control.

3.2 Service (Definition) conventions

This Service Definition also makes 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 Transport Service Definitions

For the purpose of this Service Definition, the following definitions also apply.

3.3.1 transport connection: An association established by a Transport Layer between two TS users for the transfer of data, which provides explicit identification of a set of transport data transmissions and agreement concerning the services to be provided for the set.

NOTE – This definition clarifies that given in CCITT Rec. X.200 | ISO 7498.

3.3.2 calling TS user: A Transport Service user that initiates a transport connection establishment request.

3.3.3 called TS user: A Transport Service user with whom a calling TS user wishes to establish a transport connection.

NOTE – Calling TS users and called TS users are defined with respect to a single connection. A Transport Service user can be both a calling and a called TS user simultaneously.

3.3.4 transport connection-mode data transmission: The transfer of a TSDU from a source TSAP to a destination TSAP within the context of a TC that has previously been established.

3.3.5 transport connectionless-mode data transmission: The transmission of a TSDU from a source TSAP to a destination TSAP outside the context of a TC and without any requirement to maintain any logical relationship among multiple TSDUs.

3.3.6 sending TS user: A Transport Service user that acts as a source of data during the data transfer phase of a transport-connection, or during a particular instance of transport connectionless-mode data transmission.

3.3.7 receiving TS user: A Transport Service user that acts as a sink of data during the data transfer phase of a transport-connection, or during a particular instance of transport connectionless-mode data transmission.

NOTE – A Transport Service user can be both a sending and a receiving TS user simultaneously.

4 Abbreviations

TS Transport Service

TC Transport-connection

TSAP Transport-service-access-point

TSDU Transport-service-data-unit

QOS Quality of Service

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 14 and 19. 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) indicates that the inclusion of the parameter is a choice made by the user;

b) a parameter specific constraints:

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

6 Overview and general characteristics

The Transport Service provides transparent transfer of data between TS users. It relieves these 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) *Quality of Service selection*

The Transport Layer is required to optimize the use of available communications resources to provide the Quality of Service required by communicating TS users at minimum cost. Quality of Service is specified through the selection of values for Quality of Service parameters representing characteristics such as throughput, transit delay, residual error rate and failure probability.

b) *Independence of underlying communications resources*

The Transport Service hides from TS users the difference in the Quality of Service provided by the Network Service. This difference in Quality of Service 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 between two 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 does neither restrict 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.

7 Classes and types of Transport Service

There are two types of Transport Service:

a) a connection-mode service (defined in clauses 8 to 14); and

b) a connectionless-mode service (defined in clauses 15 to 19).

When referring to this Service Definition, a user or provider of TS shall state which type(s) of service it expects to use or provide.

There are no distinct classes of Transport Service defined.

SECTION 2 – DEFINITION OF THE CONNECTION-MODE SERVICE

8 Features of the connection-mode Transport Service

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

a) The means to establish a TC with another TS user for the purpose of exchanging TSDUs. More than one TC may exist between the same pair of TS users.

b) Associated with each TC at its time of establishment, the opportunity to request, negotiate, and have agreed by the TS provider a certain Quality of Service as specified by means of Quality of Service parameters.

c) The means of transferring TSDUs on a TC. The transfer of TSDUs which consist of an integral number of octets is transparent, in that the boundaries of TSDUs and the contents of TSDUs are preserved unchanged by the TS provider and there are no constraints on the TSDU content imposed by the TS provider.

d) The means by which the receiving TS user may control the rate at which the sending TS user may send octets of data.

e) The means of transferring separate expedited TSDUs when agreed to by both TS users. Expedited TSDUs transfer is subject to a different flow control from normal data across the TSAP.

f) The unconditional and therefore possible destructive release of a TC.

9 Model of the connection-mode Transport Service

9.1 General

This Service Definition uses the abstract model for a layer service defined in ITU-T Rec. X.210 | ISO/IEC 10731. The model defines the interactions between the TS users and the TS provider which take place at the two TSAPs. Information is passed between a TS user and the TS provider by service primitives, which may convey parameters.

The primitives are abstract representations of TSAP interactions. They are solely descriptive and do not represent a specification for implementation.

9.2 Model of a Transport Connection

The operation of a TC is modelled in an abstract way by a pair of queues linking the two TSAPs. There is one queue for each direction of information flow (see Figure 1). Each TC is modelled by a separate pair of queues.

The queue model is used to introduce the flow control feature. The ability of a TS user to add objects to a queue will be determined by the behaviour of the TS user removing objects from that queue and the state of the queue. Objects are entered and removed from the queue as a result of interactions at the two TSAPs.

The pair of queues is considered to be available for each potential TC.

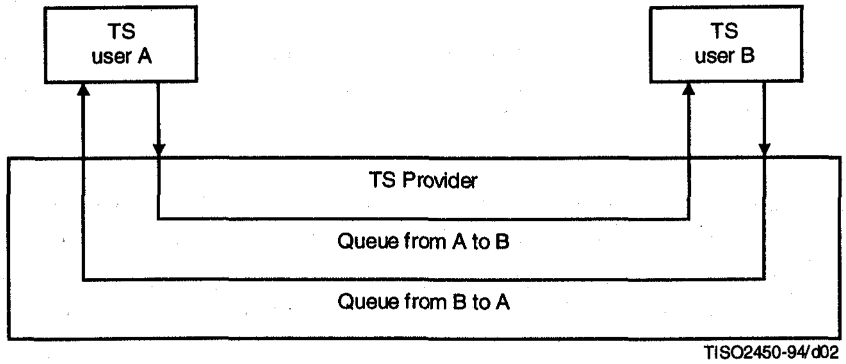

Figure 1 – Abstract model of a Transport Connection

The objects which may be placed in a queue by a TS user (see clauses 12, 13 and 14) are:

a) connect objects (each representing all parameters contained in a T-CONNECT request or T-CONNECT response primitive);

b) octets of normal data;

c) indications of end-of-TSDU (completion of a T-DATA primitive);

d) expedited TSDUs (representing all parameters of a T-EXPEDITED-DATA primitive);

e) disconnect objects (each representing all parameters contained in a T-DISCONNECT primitive).

NOTES

1 Normal and expedited TSDU transfer will result in different objects being entered into the queue.

2 The description of flow control requires a less abstract description than that used for describing sequences of primitives in clauses 11 to 14. Each TSDU associated with a T-DATA primitive is here subdivided conceptually into a sequence of octets of data followed by an end-of-TSDU indication. The T-DATA request primitive occurs when the end-of-TSDU indication is entered into the queue. The T-DATA indication primitive occurs when the end-of-TSDU indication is removed from the queue. This does not imply any particular subdivision in any real interface.

The only objects which can be placed in a queue by the TS provider are disconnect objects (representing T-DISCONNECT primitives and their parameters).

TS user A, who initiates connection establishment by entering a connect object (representing a T-CONNECT request primitive) into the queue from A to B, is not allowed to enter any other object than a disconnect object into this queue until after the connect object representing the T-CONNECT confirm has been removed. In the queue from TS user B to TS user A, objects other than a disconnect object can be entered by TS user B only after TS user B has entered a connect object corresponding to a T-CONNECT response. The insertion of a disconnect object represents the initiation of the release procedure. The release procedure may be initiated at the times permitted in clause 14 and in the manner described in 11.2. The release procedure may be destructive with respect to other objects in the two queues.

A queue relates an ordered set of distinct objects in the following ways:

a) Queues are empty before a connect object has been added and can be returned to this state, with loss of their contents, by the TS provider under the circumstances as described in h) below.

b) Objects are added to the queue, subject of control by the TS provider.

c) Objects are normally removed from the queue, subject to control by the receiving TS user.

d) Objects are normally removed in the same order that they were added [but see g) and h) below].

e) A queue has a limited capacity, but this capacity is not necessarily either fixed or determinable.

f) The management of the queue capacity shall be such that normal data and end-of-TSDU indications cannot be added to the queue when its addition would prevent addition of an expedited TSDU or disconnect object.

In addition the TS provider may manipulate pairs of adjacent objects in the queue to allow:

g) *Reordering*

The order of any pair of objects may be reversed if, and only if, the following object is of a type defined to take precedence over the preceding object. Expedited TSDUs take precedence over octets of normal data and end-of-TSDU indications (see Table 1).

h) *Deletion*

Disconnect objects take precedence over any other object. Any object other than a disconnect object may be deleted by the TS provider if, and only if, the following one is a disconnect object (see Table 1).

If a connect object associated with a T-CONNECT request primitive is deleted in this manner, the disconnect object is also deleted. If a connect object associated with a T-CONNECT response primitive is deleted, the disconnect object is not deleted.

Whether the TS provider performs actions of types g) and h) or not, will depend on the behaviour of the TS users and on the agreed Quality of Service. In general, if the objects are not removed from the queue due to flow control expressed by the receiving TS user, the TS provider shall, after some unspecified period of time, perform all permitted actions of types g) and h).

NOTES

1 The internal mechanisms which support the operation of a queue are not visible in the Transport Service. A queue is one particular way of expressing the mutual interaction between primitives at different TSAPs. There may also be, for example:

a) constraints on the local ability to invoke primitives;

b) service procedures defining particular sequencing constraints on some primitives.

2 A TC endpoint identification mechanism must be provided locally if the TS user and the TS provider need to distinguish between several TCs at a TSAP. All primitives must then make use of this identification mechanism to identify the TC to which they apply. This implicit identification is not shown as a parameter of the TS primitives, and must not be confused with the address parameters of the T-CONNECT primitives.

Table 1 – Precedence table

The queue object x has precedence over queue object y	Connect object	Octets of normal data	End-of-TSDU indication	Expedited TSDU	Disconnect object
Connect object	–	No	-	No	Yes [see h)]
Octets of normal data	–	No	No	Yes [see g)]	Yes [see h)]
End-of-TSDU indication	–	No	No	Yes [see g)]	Yes [see h)]
Expedited TSDU	–	No	No	No	Yes [see h)]
Disconnect object	–	–	–	–	No [see h)]

– Not applicable.
No No precedence exists.
Yes Precedence exists.

10 Quality of connection-mode Transport Service

The term Quality of Service (QOS) refers to certain characteristics of a TC as observed between the endpoints.

QOS is described in terms of QOS parameters.

These parameters give TS users a method of specifying their needs, and give the TS provider a basis for protocol selection.

The QOS is normally negotiated between the TS users and the TS provider on a per TC basis, using the T-CONNECT request, indication, response, and confirm TS primitives defined in clause 11. The QOS requested by the calling TS user may be made poorer either by the TS provider following the T-CONNECT request, or by the called TS user, following the T-CONNECT indication. In applying this to some QOS parameters this may mean that:

a) a delay becomes longer;

b) a throughput becomes lower;

c) the error rate becomes higher;

d) the priority becomes lower;

e) the failure probability becomes higher.

However the TC protection parameter remains unchanged by the TS provider.

The so negotiated QOS values then apply throughout the lifetime of the TC.

NOTE – Users of the Transport Service should be aware that there is no guarantee that the originally negotiated QOS will be maintained throughout the Transport Connection lifetime, and that changes in QOS are not explicitly signalled by the Transport Service provider.

The view of QOS at each end of an established TC is always the same.

This clause does not specify particular values, or classes of values, for the QOS parameters. Possible choices and default values for each parameter will normally be specified at the time of initial TS provider installation. The values for any or all parameters may be fixed for a given TS provider, in which case QOS negotiation on a per TC basis is not required. When a QOS value is specified; the TS user may also indicate whether the request is an absolute requirement or whether a degraded value is acceptable.

The QOS parameters include parameters which express TS performance and parameters which express other TS characteristics.

The QOS parameters specified in this clause are defined below. A classification of the performance QOS parameters is shown in Table 2.

Table 2 – Classification of performance QOS parameters

Phase	Performance criterion	
	Speed	Accuracy/Reliability
TC establishment	TC establishment delay	TC establishment failure probability (misconnection/TC refusal)
Data transfer	Throughput Transit delay	Residual error rate (corruption, duplication/loss) Resilience of the TC Transfer failure probability
TC release	TC release delay	TC release failure probability

10.1 TC establishment delay

TC establishment delay is the maximum acceptable delay between a T-CONNECT request and the corresponding T-CONNECT confirm primitive.

NOTE – This delay includes TS user dependent components.

10.2 TC establishment failure probability

TC establishment failure probability is the ratio of total TC establishment failures to total TC establishment attempts in a measurement sample.

A TC establishment failure is defined to occur when a requested TC is not established within the specified maximum acceptable TC establishment delay as a result of misconnection, TC refusal, or excessive delay on the part of the TS provider. TC establishment attempts which fail as a result of error, TC refusal, or excessive delay on the part of a TS user are excluded in calculating the TC establishment failure probability.

10.3 Throughput

Throughput is defined, for each direction of transfer, in terms of a sequence of at least two successfully transferred TSDUs. Given such a sequence of n TSDUs, where n is greater than or equal to two, the throughput is defined to be the smaller of:

a) 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; and

b) 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 indications in the sequence.

Successful transfer of the octets in a transmitted TSDU is defined to occur when the octets are delivered to the intended receiving TS user without error, in the proper sequence, prior to release of the TC by the receiving TS user.

Throughput is only meaningful for a sequence of complete TSDUs and each specification is based on a previously stated average TSDU size.

Throughput is specified separately for each direction of transfer on a TC. In each direction, a specification of throughput will consist of a *maximum throughput* and an *average throughput* value. The *maximum throughput* value represents the maximum rate at which the TS provider can continuously accept and deliver TSDUs, in the absence of sending TS user input delays or flow control applied by the receiving TS user. Thus, the sequence of TSDUs in the calculation above are defined to be presented continuously at the maximum rate. The *average throughput* value represents the expected transfer rate on a TC including the effects of expected user-attributable delays (e.g. non-continuous TSDU input, receiving TS user flow control). Thus, the sequence of TSDUs in the calculation above are defined to be presented at a rate which includes components representing *average* user delays.

It is possible for either the input or the output of a sequence of TSDUs to be excessively delayed by the TS users. Such occurrences are excluded in calculating *average throughput* values.

For each direction of transfer, and for each of the *maximum throughput* and *average throughput* specifications, the throughput QOS for a particular TC will be negotiated among the TS users and the TS provider (see 12.2.6).

10.4 Transit Delay

Transit delay is the elapsed time between a T-DATA request and the corresponding T-DATA indication. Elapsed time values are calculated only on TSDUs that are successfully transferred.

Successful transfer of a TSDU is defined to occur when the TSDU is transferred from the sending TS user to the intended receiving TS user without error, in the proper sequence, prior to release of the TC by the receiving TS user.

Transit delay is specified independently for each direction of transfer. In general, each transit delay specification will define both the average value and the maximum value expected for a TC. Each specification will be based on a previously stated average TSDU size.

The transit delay for an individual TSDU may be greatly increased if the receiving TS user exercises interface flow control. Such occurrences are excluded in calculating both average and maximum transit delay values.

10.5 Residual error rate

Residual error rate is the ratio of total incorrect, lost and duplicate TSDUs to total TSDUs transferred across the TS boundary during a measurement period. The relationship among these quantities is defined for a particular TS user pair, as shown in Figure 2.

10.6 Transfer failure probability

Transfer failure probability is the ratio of total transfer failures to total transfer samples observed during a performance measurement.

A transfer sample is a discrete observation of TS provider performance in transferring TSDUs between a specified sending and receiving TS user. A transfer sample begins on input of a selected TSDU at the sending TS user boundary, and continues until the outcome of a given number of TSDU transfer attempts has been determined. A transfer sample will normally correspond to the duration of an individual TC.

A transfer failure is a transfer sample in which the observed performance is worse than a specified minimum acceptable level. Transfer failures are identified by comparing the measured values for three supported performance parameters with specified transfer failure thresholds. The three supported performance parameters are throughput, transit delay and residual error rate.