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Information processing systems — Open Systems Interconnection — Basic Reference Model

Addendum 1 : Connectionless-mode transmission

Systèmes de traitement de l'information — Interconnexion de systèmes ouverts — Modèle de référence de base
Additif 1 : Transmission en mode sans connexion

Contents

0 Introduction

0.1 About this addendum

0.1.1 ISO 7498 describes the Reference Model of Open Systems Interconnection. It is the intention of ISO 7498 that the Reference Model should establish a framework for coordinating the development of existing and future standards for the interconnection of systems. The assumption that a connection is a fundamental prerequisite for communication in the OSI environment permeates the Reference Model and is one of the most useful and important unifying concepts of the architecture which it describes. However, since ISO 7498 was produced it has been realized that this deeply-rooted connection orientation unnecessarily limits the power and scope of the Reference Model, since it excludes important classes of applications and important classes of communication network technology which have a fundamentally connectionless nature.

0.1.2 The architectural objectives of the Reference Model do not depend on the exclusive use of connections for all OSI communications. It is the intention of this addendum to introduce terms and define their use within the Reference Model so that the two alternatives (connection-mode transmission and connectionless-mode transmission) can be treated as complementary concepts which can be applied appropriately in the different circumstances for which each is suited.

0.2 What is connectionless-mode transmission in the Reference Model ?

0.2.1 General

0.2.1.1 The concept of connectionless-mode transmission in one form or another has always played an important role in the specification of services and protocols for data communication.

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The terms "message mode", "datagram", "transaction mode" and "connection-free" have been used in the literature to describe variations on the same basic theme : the transmission of a unit of data in a single self-contained operation without establishing, maintaining, and releasing a connection.

0.2.1.2 Since connectionless-mode transmission and connection-mode transmission are complementary concepts, they are best understood in juxtaposition, particularly since connectionless-mode transmission is defined most easily in relationship to the concept of a connection.

0.2.2 Connection-mode transmission in the Reference Model

0.2.2.1 In the formal terminology of the Reference Model, a connection is an association established for the transfer of data between two or more peer-entities. This association is established between the peer-entities themselves and between each entity and the next lower layer. The ability to establish and release a connection and to transfer data over it is provided to the entities in a given layer by the next lower layer as a connection-mode service. The use of a connection-mode service by peer-entities proceeds through three distinct phases :

a) connection establishment;

b) data transfer; and

c) connection release.

0.2.2.2 In addition to the clearly distinguishable lifetime exhibited by these phases a connection has the following fundamental characteristics :

a) it involves establishing and maintaining a three or more party agreement concerning the transmission of data between the peer-entities concerned and the layer providing the service;

b) it allows the negotiation between all the parties concerned of the parameters and options that will govern the transmission of data;

c) it provides connection identification by means of which the overheads involved in address resolution and transmission can be avoided on data transfers;

d) it provides a context within which successive units of data transmitted between the peer-entities are logically related, and makes it possible to maintain sequence and provide flow control for those transmissions.

0.2.2.3 The characteristics of connection-mode transmission are particularly attractive in applications which call for relatively long-lived, stream-oriented interactions between entities in stable configurations. Examples are provided by direct terminal use of a remote computer, file transfer, and long-term attachment of remote job entry stations. In these cases the entities involved initially discuss their requirements and agree to the terms of their interaction, reserving whatever resources they may need, transfer a series of related units of data to accomplish their mutual objective, and explicitly end their interaction, releasing the previously reserved resources.

The properties of connection-mode transmission are also relevant in a wide range of other applications.

0.2.3 Connectionless-mode transmission in the Reference Model

0.2.3.1 Again in the formal terminology of the Reference Model, connectionless-mode transmission is the transmission of a single unit of data from a source service-access-point to one or more destination service-access-points without establishing a connection. A connectionless-mode service allows an entity to initiate such a transmission by the performance of a single service access.

0.2.3.2 In contrast to a connection, an instance of the use of a connectionless-mode service does not have a clearly distinguishable lifetime. In addition it has the following fundamental characteristics :

a) it requires only a pre-arranged association between the peer-entities involved which determines the characteristics of the data to be transmitted, and no dynamic agreement is involved in an instance of the use of the service;

b) all the information required to deliver a unit of data, destination address, quality of service selection, options, etc., is presented to the layer providing the connectionless-mode service, together with the unit of data to be transmitted, in a single service access. The layer providing the connectionless-mode service is not required to relate this access to any other access.

0.2.3.3 As a result of these fundamental characteristics it may also be true that :

a) each unit of data transmitted is routed independently by the layer providing the connectionless-mode service;

b) copies of a unit of data can be transmitted to a number of destination addresses.

0.2.3.4 These characteristics of connectionless-mode transmission do not preclude making available to the service user information on the nature and quality of service which may apply for a single invocation of the service or which may be observed over successive invocations of the service between pairs of service-access-points or among a set of service access points.

0.3 Structure of this addendum

This addendum has a structure which is similar to that of ISO 7498 in order to facilitate the eventual integration of the text of this addendum into a revision of ISO 7498. There are two major clauses :

Clause 5 : this clause deals with general architectural principles and the sub-clauses correspond to sub-clauses in clause 5 of ISO 7498 under which different aspects of connectionless-mode transmission need definition.

Clause 7 : this clause deals with details which are specific to the layers of the Reference Model of Open Systems Interconnection.

1 Scope and field of application

This addendum

a) provides a general description of a connectionless-mode service and of functions related to it, which may be provided by layers of the Reference Model, and

b) defines the positions within the Reference Model where the service and functions may be provided.

This addendum adds to the concepts and principles defined in ISO 7498; it does not modify them. This addendum

— does not specify services and protocols for OSI;

— is not an implementation specification;

— is not a basis for appraising the conformance of actual implementations.

2 Definitions

2.1 This addendum makes use of the following terms :

a) (N)-address;

b) acknowledgement;

c) blocking;

d) concatenation;

e) (N)-data-transmission;

f) (N)-entity;

g) (N)-facility;

h) flow control;

i) (N)-function;

j) (N)-interface-data-unit;

k) (N)-layer;

l) open system;

m) peer entities;

n) (N)-protocol;

o) (N)-protocol-control-information;

p) (N)-protocol-data-unit;

q) (N)-relay;

r) routing;

s) segmenting;

t) sequencing;

u) (N)-service;

v) (N)-service-access-point;

w) (N)-service-data-unit;

x) (N)-user-data.

2.2 For the purpose of this addendum, the following definitions also apply :

2.2.1 (N)-connection : An association established by the (N)-layer between two or more (N + 1)-entities for the transfer of data, which provides explicit identification of a set of (N)-data-transmissions and agreement concerning the (N)-data-transmission services to be provided for the set.

NOTE — This definition of (N)-connection is a refinement of the definition given in ISO 7498; it does not change it.

2.2.2 (N)-connection-mode transmission : (N)-data-transmission in the context of an (N)-connection.

2.2.3 (N)-connectionless-mode transmission : (N)-data-transmission not in the context of an (N)-connection and not required to maintain any logical relationship between (N)-service-data-units.

3 Notation

The layer notation is the same as that defined in ISO 7498.

4 Introduction to Open Systems Interconnection (OSI)

This clause makes no additions to clause 4 of ISO 7498.

5 Concepts of a layered architecture

5.1 Introduction

This addendum makes no additions to 5.1 of ISO 7498.

5.1 Principles of layering

5.2.1 This sub-clause complements 5.2 of ISO 7498.

5.2.2 In order for (N + 1)-entities to be able to communicate using an (N)-connection-mode service or an (N)-connectionless-mode service it is essential that a pre-arranged association exists between them, constituted by the pre-knowledge which it is essential that each (N + 1)-entity has of the others in order at least to initiate the use of the service. This association is established in ways which are not detailed in this addendum or in ISO 7498 and comprises four elements :

a) knowledge of the addresses of the peer entities involved;

b) knowledge of a protocol agreed by the peer entities for use at least to initiate communication;

c) knowledge of the availability for communication of the peer-entities;

d) knowledge of the quality of service available from the (N)-service.

NOTE — The pre-knowledge constituting a pre-arranged association can be acquired in many ways; some examples are listed below :

a) from information acquired manually when contracts are exchanged with a service provider;

b) from information which a network administration may provide in a directory or enquiry database;

c) from information that may be learned from previous instances of communication;

d) from information that may be provided dynamically through the operation of management protocols.

The total pre-knowledge constituting a pre-arranged association is likely to be acquired by a combination of the above.

5.2.3 An (N + 1)-entity provides no information to an (N)-connectionless-mode service about the logical relationships between (N)-service-data-units, apart from the source and destination (N)-service-access-point-addresses.

5.2.4 From the point of view of the (N + 1)-entity this means that it is not able to require the (N)-service to apply a particular function to a sequence of (N)-service-data-units sent by it. However, from the point of view of the (N)-layer, this does not imply any constraint on the functions which support the service.

5.2.5 An (N)-layer may offer a connection-mode service, a connectionless-mode service, or both, to the (N + 1)-layer, using the service or services provided by the (N – 1)-layer.

5.2.6 Both the (N)-connection-mode service and the (N)-connectionless-mode service are characterized by the facilities which they offer to, and the quality of service seen by, the (N + 1)-entities. For both the (N)-connection-mode service and the (N)-connectionless-mode service, functions may be provided by the (N)-layer to enhance the facilities offered to, and the quality of service seen by, the (N + 1)-entities over those which are offered to the (N)-layer by the (N – 1)-layer and, if necessary, to convert between one mode of service and another.

5.3 Communication between peer-entities

5.3.1 This sub-clause complements 5.3 of ISO 7498.

5.3.2 (N + 1)-entities can communicate using an (N)-connectionless-mode service provided that there is a pre-arranged association between them providing knowledge about each other which allows them to do so. This knowledge should allow the locations of the (N + 1)-entities to be determined, it should determine the correct interpretation of (N)-service-data-units by a receiving (N + 1)-entity, and it may define the rates of transfer, rates of response, and the protocol in use between the entities. The knowledge may result from prior agreement between the (N + 1)-entities concerning the parameters, formats and options to be used.

NOTE — Data transfer using an (N)-connection-mode service involves the establishment of an (N)-connection prior to the data transfer, setting up, dynamically, an association between the (N + 1)-entities and the (N)-connection-mode service in addition to the association identified in 5.1. This association involves elements which are not part of the pre-arranged association described in 5.1, in particular :

a) knowledge of the willingness of the peer entity or entities to undertake a specific communication, and of the willingness of the underlying service to support it; and

b) the ability for the peer entities to negotiate and renegotiate the characteristics of the communication.

5.3.3 (N + 1)-entities may require prior knowledge of the facilities offered by the service and the quality of service which they can expect to receive from it in order to choose an (N + 1)-protocol to be used for communication over an (N)-connectionless-mode service.

5.3.4 There are instances where the connectionless-mode service provided by the (N)-layer does not provide direct access between all of the (N)-service-access-points supported by the layer. Connectionless-mode transmission can still occur between these service-access-points if one or more (N + 1)-entities provide a relay (see figure 1 which complements figure 6 in ISO 7498). The fact that an (N)-connectionless-mode transmission is relayed by one or more (N + 1)-entities is known neither by the (N)-layer nor by the (N + 2)-layer.

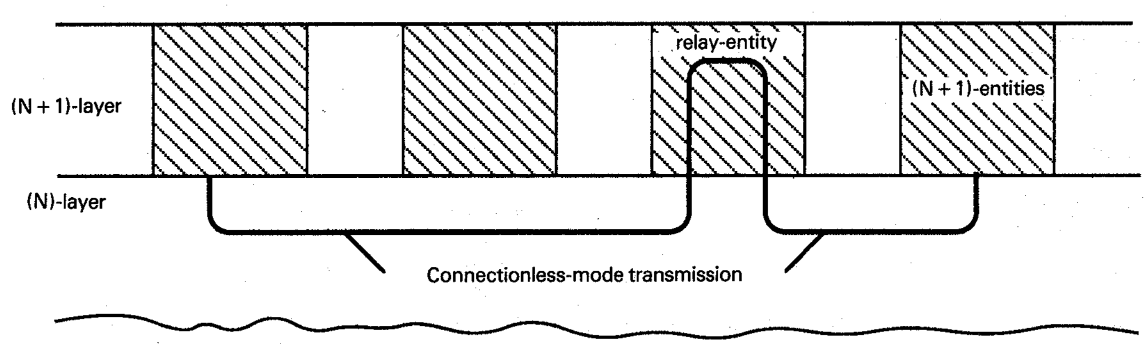


Figure 1 — Connectionless-mode transmission through a relay

5.4 Identifiers

This addendum makes no additions to 5.4 of ISO 7498.

5.5 Properties of service-access-points

5.5.1 This sub-clause complements 5.5 of ISO 7498.

5.5.2 An (N)-service-access-point may support :

a) (N)-connection-mode services only;

b) (N)-connectionless-mode services only; or

c) (N)-connection-mode services and (N)-connectionless-mode services concurrently.

5.5.3 A single (N+1)-entity may be using concurrently several (N)-connections and an (N)-connectionless-mode service through one or more (N)-service-access-points to which it is attached.

5.5.4 (N+1)-entities distinguish between instances of the (N)-connectionless-mode services and the (N)-connection-mode services offered concurrently through the same (N)-service-access-point by the uniqueness of the interactions prescribed for these services.

5.6 Data-units

This addendum makes no additions to 5.6 of ISO 7498.

5.7 Elements of layer operation

5.7.1 Introduction

This sub-clause complements 5.7 and 5.8 of ISO 7498, to which it relates.

5.7.2 Control of connectionless-mode transmission

5.7.2.1 This sub-clause is specific to this addendum and has no equivalent in ISO 7498.

5.7.2.2 All the information required by an (N)-connectionless-mode service to deliver an (N)-service-data-unit (destination address, quality of service required, options, etc.) is presented to it with the (N)-service-data-unit in a single logical service access by the sending (N+1)-entity.

5.7.2.3 All information related to an (N)-service-data-unit, together with the (N)-service-data-unit itself, is received from the (N)-service in a single logical service access by the receiving (N+1)-entity.

5.7.2.4 To provide the (N)-connectionless-mode service, the (N)-layer performs functions as described in 5.1. These functions are supported by (N)-protocols.

5.7.2.5 If an (N)-service-data-unit cannot be accepted by an (N+1)-entity at the time of its arrival at an (N)-service-access-point, the (N+1)-entity may apply interface flow control (see 5.7.3.2). This may result in the discarding of the (N)-service-data-unit by the (N)-service provider or, where flow control is provided, in the exercise of interface flow control at the sending (N)-service-access-point by the (N)-service provider.

5.7.2.6 An (N)-connectionless-mode service may allow the transmission of copies of an (N)-service-data-unit to a number of destination (N)-service-access-points. (N)-service-data-units transmitted from a number of source (N)-service-access-points can be received at one destination (N)-service-access-point. The (N)-layer does not assume any logical relationship between these (N)-service-data-units.

5.7.2.7 No (N)-protocol-control-information is exchanged between (N)-entities concerning the mutual willingness of the (N+1)-entities to exchange data using an (N)-connectionless-mode service.

NOTES

1 The specific interface mechanism employed by a particular implementation of a connectionless-mode service may involve more than one interface exchange to accomplish the single logical service access necessary to initiate a connectionless-mode transmission. However, this is a local implementation detail.

2 The transmission of each (N)-service-data-unit by an (N)-connectionless-mode service should be entirely self-contained. All the addressing and other information required by the (N)-layer to deliver the (N)-service-data-unit to its destination should be included in the service access for each transmission.

3 It is a basic characteristic of a connectionless-mode service that no negotiation of the parameters for a transmission takes place at the time the service is accessed and no dynamic association is set up between the parties involved. However, considerable freedom of choice can be preserved by allowing most parameter values and options (such as transfer rate, acceptable error rate, etc.) to be specified at the time the service is accessed. In a given implementation, if the local (N)-subsystem determines immediately (from information available to it locally) that the requested transmission cannot be performed under the conditions specified, it may abort the transmission, returning an implementation specific error message. If the same determination is made later, after the service access has been completed, the transmission is abandoned, since the (N)-layer is assumed not to have the information necessary to take any other action.

5.7.3 Transfer of data

5.7.3.1 General principles

5.7.3.1.1 This sub-clause complements 5.7.6.1, 5.7.6.2 and 5.7.6.3 of ISO 7498.

5.7.3.1.2 Control information and user data are transferred between (N)-entities in (N)-protocol-data-units. An (N)-protocol-data-unit is a unit of data specified in an (N)-protocol and contains (N)-protocol-control-information and possibly (N)-user-data.

5.7.3.1.3 (N)-protocol-control-information is transferred between (N)-entities using an (N−1)-service. (N)-protocol-control-information is any information that supports the joint operation of (N)-entities. (N)-user-data is passed transparently between (N)-entities using an (N−1)-service.

5.7.3.1.4 An (N)-protocol-data-unit has a finite size, which may be limited by the (N – 1)-service-data-unit size and by the capabilities of the (N)-protocol. (N)-protocol-data-units are mapped into (N – 1)-service-data-units. The interpretation of an (N)-protocol-data-unit is defined by the (N)-protocol in effect for the (N)-connectionless-mode service.

5.7.3.1.5 An (N)-service-data-unit is transferred between an (N + 1)-entity and an (N)-entity, through an (N)-service-access-point, in the form of one or more (N)-interface-data-units. Each (N)-service-data-unit is transferred as (N)-user-data in one or more (N)-protocol-data-units.

5.7.3.2 Flow control

5.7.3.2.1 This sub-clause complements 5.7.6.4 of ISO 7498.

5.7.3.2.2 If flow control functions are provided, they can operate only on protocol-data-units and interface-data-units.

5.7.3.2.3 Two types of flow control are identified :

a) Peer flow control which regulates the rate at which (N)-protocol-data-units are sent between (N)-entities supporting (N)-connectionless-mode transmission between pairs of (N)-service-access-points or among a set of (N)-service-access-points. Peer flow control requires protocol definitions and is based on protocol-data-unit size; and

b) (N)-interface flow control, which regulates the rate at which (N)-interface-data-units are passed between an (N + 1)-entity and an (N)-entity that supports an (N)-connectionless-mode service. (N)-interface flow control is based on (N)-interface-data-unit size.

5.7.3.3 Segmenting, blocking and concatenation

5.7.3.3.1 This sub-clause complements 5.7.6.5 of ISO 7498.

5.7.3.3.2 Data units in different layers of the Reference Model are not necessarily compatible in size. Segmenting, blocking or concatenation may be necessary.

5.7.3.3.3 Segmenting in an (N)-layer requires the implementation of a segmenting-reassembly protocol between (N)-entities that support (N)-connectionless-mode transmission between pairs of (N)-service-access-points.

5.7.4 Quality of service

5.7.4.1 Introduction

This sub-clause complements 5.7.7 of ISO 7498.

5.7.4.2 Quality of service parameters

5.7.4.2.1 This sub-clause is specific to this addendum and has no equivalent in ISO 7498.

5.7.4.2.2 An (N)-connectionless-mode service is characterized by two groups of quality of service parameters. The parameters in the first group are defined entirely by the behaviour of a single (N)-data-transmission and are the same as those defined for the (N)-connection-mode service. These parameters are

a) expected transmission delay;

b) probability of corruption;

c) probability of loss or duplication;

d) probability of wrong delivery;

e) cost; and

f) protection from unauthorized access.

5.7.4.2.3 The parameters in the second group apply for multiple (N)-data-transmissions between pairs of (N)-service-access-points. These parameters are

a) expected throughput; and

b) probability of out-of-sequence delivery.

5.7.4.2.4 The values of the parameters in both groups at a given source (N)-service-access-point may vary with the destination (N)-service-access-point.

5.7.4.2.5 Sequencing, acknowledgement and error detection and notification functions may be used in the (N)-layer in order to enhance the quality of service offered by the (N)-connectionless-mode service over that offered by the (N – 1)-connectionless-mode service.

5.7.4.3 Sequencing

5.7.4.3.1 This sub-clause complements 5.7.6.6 of ISO 7498.

5.7.4.3.2 The (N – 1)-services provided by the (N – 1)-layer of the OSI architecture may not guarantee delivery of data between pairs of (N – 1)-service-access-points in the same order as it was submitted. If the (N)-layer provides a higher probability of in-sequence delivery than is offered by the (N – 1)-services, sequencing mechanisms must be present in the (N)-layer.

5.7.4.4 Acknowledgement

5.7.4.4.1 This sub-clause complements 5.7.7.1 of ISO 7498.

5.7.4.4.2 An acknowledgement function may be used by peer (N)-entities supporting (N)-connectionless-mode transmission between pairs of (N)-service-access-points to obtain a higher probability of detecting protocol-data-unit loss than is provided by the (N – 1)-layer.

5.7.4.5 Error detection and notification

5.7.4.5.1 This sub-clause complements 5.7.7.2 of ISO 7498.

5.7.4.5.2 Error detection and notification functions may be supported by protocols used between (N)-entities supporting (N)-connectionless-mode transmission between pairs of (N)-service-access-points to provide a higher probability of both protocol-data-unit error detection and data corruption detection than is provided by the (N – 1)-service.

5.7.4.5.3 The error detection or notification function is only as reliable as the (N)-connectionless-mode service itself. While the (N)-service provider may attempt to provide a notification upon detection of data corruption or protocol-data-unit loss, misdelivery, etc., it cannot be relied upon to be capable of doing so for every instance of error detection.

5.8 Routing

5.8.1 This sub-clause complements 5.8 of ISO 7498.

5.8.2 An (N)-routing function enables an (N – 1)-connectionless-mode transmission to be relayed by a chain of (N)-entities. The fact that (N)-routing is being used is known by neither the (N + 1)-layer nor the (N – 1)-layer.

5.9 Management

5.9.1 This sub-clause complements 5.9 of ISO 7498.

5.9.2 Systems and layer management provide for initialization action to establish support for connectionless-mode services between systems.

5.9.3 Management facilities may be provided to allow characteristics of the nature, quality and type of connectionless-mode service provided by a layer to be conveyed to the next higher layer prior to the invocation of that service. These facilities may provide this information either prior to any invocation of the service or at any time during a period when it is available.

5.10 The relationship between services provided at adjacent layer boundaries

5.10.1 This sub-clause is specific to this addendum and has no equivalent in ISO 7498.

5.10.2 There are no architectural constraints on any vertical combination of an (N)-layer providing one type of (N)-service (connection-mode or connectionless-mode) using the other type of (N – 1)-service. In principle the services at the two layer boundaries can be

a) both connection-mode services;

b) both connectionless-mode services;

c) the (N)-service a connection-mode service and the (N – 1)-service a connectionless-mode service;

d) the (N)-service a connectionless-mode service and the (N – 1)-service a connection-mode service.

5.10.3 In order to allow combinations c) and d) two architectural elements are required :

a) a function to provide an (N)-connection-mode service using an (N – 1)-connectionless-mode service; and

b) a function to provide an (N)-connectionless-mode service using an (N – 1)-connection-mode service.

NOTE — Of these functions, function a) requires significant protocol-control-information. For example, there is a need to identify the connection which is constructed, control its state and provide sequencing of service-data-units. Function b) requires little or no additional protocol-control-information, rather, it places constraints on the way in which the connection-mode service is used.

5.10.4 An (N)-relay can either

a) join two connection-mode services to yield a connection-mode service; or

b) join two connectionless-mode services to yield a connectionless-mode service.

5.10.5 Provision of a service of a given type using services of different types requires that one of the services (either the connection-mode or the connectionless-mode one, depending upon economic and technical factors) be first converted to the other using the functions which have been identified, an (N)-relay can then operate.

5.10.6 The basic cases of relaying are illustrated in figure 2. The use of conversions between services within a layer is not explicitly constrained by the Reference Model but, where several services are connected in tandem, the use of conversions would be ordered to minimize the number of conversions necessary to arrive at a given composite service.

5.10.7 Where an (N – 1)-connectionless-mode service is enhanced to provide an (N)-connection-mode service, a number of (N)-connections may be supported by (N – 1)-connectionless-mode transmission between the same (N – 1)-service-access-points.

5.10.8 Where an (N – 1)-connection-mode service is used to provide an (N)-connectionless-mode service, (N)-connectionless-mode transmission between a number of different (N)-service-access-points may be supported by the same (N – 1)-connection.

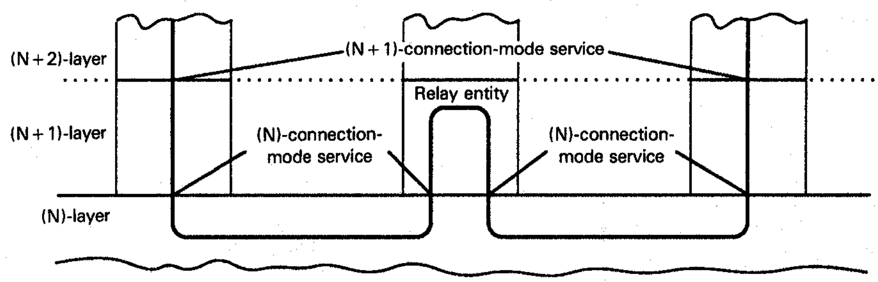
6 Introduction to the specific layers of the Reference Model

6.1 Introduction

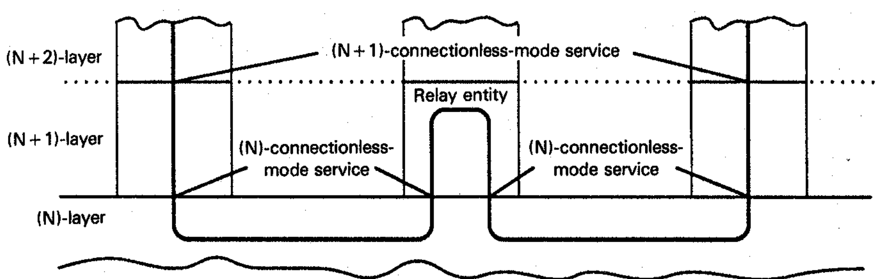
This clause complements clause 6 of ISO 7498.

6.2 General principles

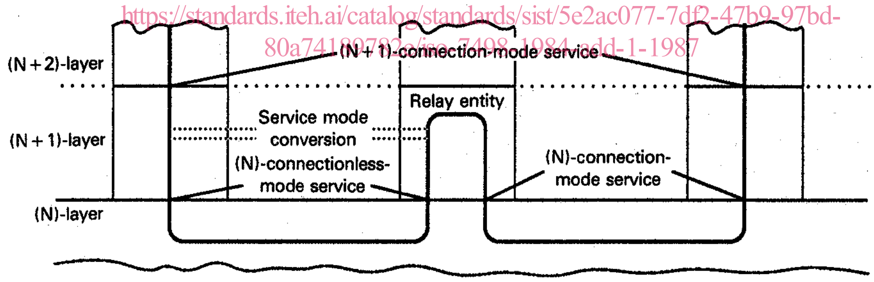
6.2.1 A connectionless-mode service for a particular layer may include none, some, or all of the detailed services and it may be characterized by none, some, or all of the quality of service parameters defined for the layer in ISO 7498 and in 5.7.4 of this addendum (for example error notification).



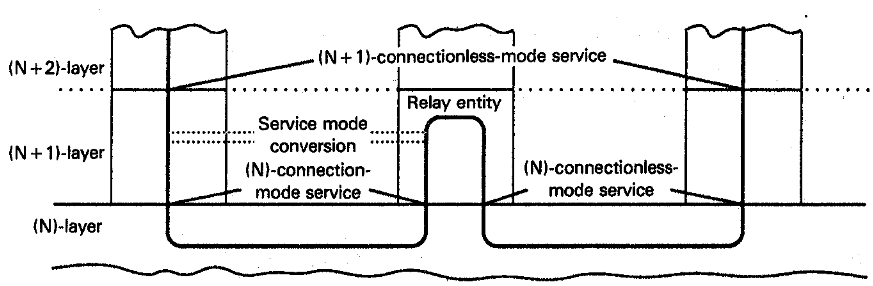
a) Relaying between two connection-mode services



b) Relaying between two connectionless-mode service



c) Connection- and connectionless-mode services yielding a connection-mode service



d) Connection- and connectionless-mode services yielding a connectionless-mode service

Figure 2 — The basic cases of relaying involving connection-mode and connectionless-mode services

6.2.2 The provision of connectionless-mode and connection-mode services in specific layers of the Reference Model and the characteristics of these services, together with the provision of functions providing for conversion within a layer between one mode of service and another, should be such as to ensure that it is possible to determine whether or not interworking between open systems is possible. In order to maximize the possibility of interworking and to limit protocol complexity, there is a restriction on the number of layers within which conversion between one mode of service and the other may take place.

6.2.3 For each layer, the sub-clauses of clause 7 identify those items which have relevance to the connectionless-mode service provided by that layer. Detailed descriptions are given only of those items which are specific to the connectionless-mode service; detailed descriptions of other items can be found in ISO 7498.

6.2.4 The basic (N)-connectionless-mode service is a service which meets the following conditions :

a) it is not required to exhibit any minimum values of the quality of service measures, in particular the sequence of (N)-service-data-units need not be maintained; and

b) it is not required to exhibit peer flow control.

Any (N)-connectionless-mode service definition should allow this basic service.

6.2.5 Since the basic service is not required to maintain the sequence of (N)-service-data-units, there is no requirement for any (N)-layer to provide sequencing functions. However, in real implementations the characteristics of the underlying medium or of real subnetworks may offer a high probability of in-sequence delivery and this may be reflected in the characteristics of the connectionless-mode services offered by higher layers.

6.2.6 Although no architectural limit on the size of (N)-service-data-units is defined in clause 5, in order to limit protocol complexity, segmentation and reassembly functions are not provided in layers above the Network Layer. Consequently, the size of service-data-units in layers above the Network Layer is limited by the size of the service-data-unit provided by the service of the layer below and by the size of the protocol-control-information for the layer itself.

6.3 Combinations of connection-mode and connectionless-mode service

6.3.1 As indicated in 6.2.2, there is a restriction on the number or layers within which conversion from a connection-mode service to a connectionless-mode service (or vice-versa) may take place. This restriction applies to the layers as follows :

a) Special considerations apply to the Physical and Data Link layers. Connection-mode and connectionless-mode services are not differentiated for the Physical Layer. The services of the Physical Layer are determined by the characteristics of the underlying medium and are too diverse to allow categorization into connection-mode and connectionless-mode operation. Functions in the Data Link Layer must convert between the services offered by the Physical Layer and the type of Data Link service needed.

b) Conversion may be provided in the Network Layer to support a Network service of a given mode over a Data Link or subnetwork service of the other mode. This, in conjunction with relaying, provides an end-to-end Network service of a given mode over concatenated subnetworks and/or Data Link services of either mode (see 5.10). Support of such conversions, where they are necessary to provide a given mode of Network service, is a requirement of OSI standards.

c) Conversion may be provided in the Transport Layer on condition that this makes use of only limited additional protocol functions over those required to support a given mode of Transport service over the same mode of Network service. Since relaying is not permitted in the Transport Layer, such conversions can only be applied between end-systems. Support for such conversions is not a requirement of OSI standards.

d) Conversion at the Session Layer and above is not permitted.

NOTE — It is not possible (since a Transport Protocol operates between end-systems) for a Transport Protocol to provide the Transport Service in an instance of communication between two end-systems utilising (in that instance of communication) different modes of Network Service.

6.3.2 It follows from these restrictions that

a) A real system which is fully open as defined in 4.1.2 of ISO 7498 shall support a given mode of Transport service over a Network service of the same mode (utilising conversion within the Network Layer if necessary); such a system may, in addition, provide conversion in the Transport Layer.

b) A real system which only supports a given mode of Transport service by providing conversion in the Transport Layer from a Network service of the other mode is not fully open as defined in 4.1.2 of ISO 7498, since such a system would be incapable of communicating with a system which only supports the given mode of Transport service over a Network service of the same mode.

NOTE — The restriction that a given mode of Transport Service has to be supported by the same mode of Network Service is applied so that systems may communicate without requiring prior agreement on the mode of Network Service to be used. Where prior agreement exists this restriction need not apply, although the requirements for systems to be fully open are as stated in 6.3.2a).

7 Detailed description of the resulting OSI architecture

7.1 Application Layer

7.1.1 Introduction

This sub-clause complements 7.1 of ISO 7498.