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Information technology — Telecommunications and information exchange between systems — Definition of the relaying functions of a Network layer intermediate system

*Technologies de l'information — Télécommunications et échange
d'information entre systèmes — Définition de la fonction de transmission
d'un système intermédiaire dans la couche réseau*



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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.

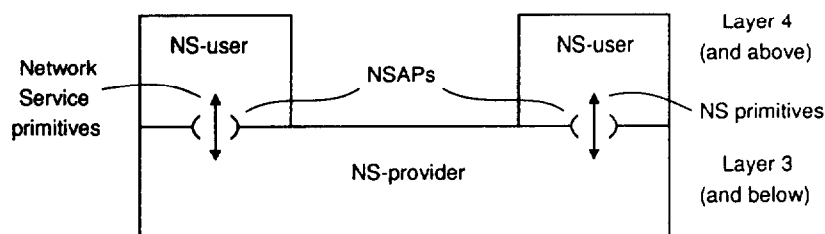
International Standard ISO/IEC 10028 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Sub-Committee SC 6, *Telecommunications and information exchange between systems*.

Annexes A, B and C are for information only.

Introduction

This International Standard is one of the set of standards associated with the Network layer of ISO 7498's Reference Model for Open Systems Interconnection (OSI). It has been developed within the architectural framework defined for the Network layer in ISO 8648.

ISO 8348 defines the OSI Network Service (NS) in terms of the behaviour of a single NS-provider operating as a "black box" between correspondent NS-users, in accordance with ISO TR 8509, as illustrated:



ISO 8648 defines an architectural organization that applies to the internal functioning of the NS-provider within the Network layer. In particular, it provides a common set of concepts and terminology for use in Network layer standards which extends and refines those of ISO 7498.

This International Standard provides a further level of detailed refinement of the description of the NS-provider, by defining the operation of intermediate systems in support of the Network service. This definition remains abstract, in the sense that it is independent of the details of particular subnetworks and protocols.

Other standards specify the use of Network layer protocols by an intermediate system in performing the functions defined in this International Standard.

This International Standard complements those defining the Network service and specifying the use of protocols for NS provision in end systems, in order to provide a complete set of Network layer standards covering each segment of the information flow between correspondent NS users. Other standards deal with associated information flows for routing and management.

Information technology — Telecommunications and information exchange between systems — Definition of the relaying functions of a Network layer intermediate system

1 Scope

This International Standard defines the abstract operation of the relaying functions of a Network entity in an intermediate system, as needed to support the OSI connection-mode Network service.

As the principal means for expressing the definition, the concept of the Network Internal Layer Service is used. This is similar to an OSI layer service, but adapted to expressing the invariants of the information flow within and throughout the layer, rather than just the external functionality of the layer provided between two service access points.

The definition includes the invocation of Network routing functions as a necessary element of the Network relaying functions, but it does not specify how those routing functions are to be realized.

The definition of Network relaying functions applies both to a subnetwork supporting all elements of the Network Service (as defined in ISO 8648), and to a Network relay system interconnecting two subnetworks according to any of the three approaches defined in ISO 8648. In the case of the hop-by-hop harmonization approach to interconnection, the definition of Network relaying functions applies to the result of harmonizing the subnetwork service(s) to the level of the Network Service. The harmonization functions, which require protocol mechanisms to be specified, are outside the scope of this International Standard.

This International Standard is intended for use in guiding the design and application of real interworking units and real subnetworks (eg, local area networks and private packet switched networks) which are to support the OSI NS. It is also intended for use in the development of standards for the Network layer, to ensure that the requirements deriving from the need for Network layer relaying are taken into account.

There are no requirements for conformance to this International Standard.

NOTE — Conformance requirements relating to Network layer relaying are to be found in the specifications for mappings between the Network Internal Layer Service and Network protocols.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

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

NOTE — See also CCITT Recommendation X.200 (1993).

CCITT Recommendation X.213 (1992) | ISO/IEC 8348:1993, *Information technology — Open Systems Interconnection — Network service definition*.

ISO/TR 8509:1987, *Information processing systems — Open Systems Interconnection — Service conventions*.

ISO 8648:1987, *Information processing systems — Open Systems Interconnection — Internal organization of the Network layer*.

3 Definitions

3.1 Reference model definitions

This International Standard makes use of the following terms defined in ISO 7498:

- a) Network layer
- b) Network service
- c) Network service access point
- d) Network service access point address
- e) Network entity
- f) Network relay
- g) correspondent Network entities
- h) Network connection
- j) Network connection endpoint
- k) Network function

3.2 Network layer architecture definitions

This International Standard makes use of the following terms defined in ISO 8648:

- a) real subnetwork
- b) subnetwork
- c) interworking unit
- d) Network relay system
- e) intermediate system
- f) end system

3.3 Service conventions definitions

This International Standard makes use of the following terms defined in ISO/TR 8509:

- a) Network service-user
- b) Network service-provider
- c) primitive
- d) request (primitive)
- e) indication (primitive)
- f) response (primitive)
- g) confirm (primitive)

3.4 Network relaying definitions

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

3.4.1 domain: A subset of those open systems containing Network entities, in which there is a common understanding of values for certain domain-related parameters of NILS primitives.

3.4.2 domain-related parameter: A parameter of NILS primitives that does not have a set of values defined by this International Standard — whether directly, or indirectly by reference to ISO/IEC 8348 — to be applicable throughout the Network layer.

3.4.3 hop: The communication path supporting the transfer of information by NILS primitives, or by NILS primitives and Network service primitives, for an instance of communication between two Network entities that are adjacent in the modelling chosen for the Network layer interconnection.

4 Abbreviations and names of NILS elementary sequences

4.1 General abbreviations

CO	connection-mode
EES	extended end system
ENSDU	expedited Network service data unit
ISB	internal service bearer
N-	Network-
NC	Network connection
NHEP	Network hop endpoint
NILS	Network internal layer service
NISAP	Network internal service access point
NS	Network service
NSAP	Network service access point
NSDU	Network service data unit
OSI	open systems interconnection
QOS	quality of service

4.2 Names of NILS elementary sequences of primitives for N-connections

The following is a summary of the names defined in clause 8 for the elementary sequences of primitives that are used in defining the behaviour of a Network connection according to the Network internal layer service. Each item includes a brief description of the nature of the sequence's function, and a reference to the figure defining the sequence.

ABORT	NC request aborted (figure 4)
DT	Normal data transfer (figure 7)
EC	Expedited data confirmation (figure 7)
ED	Expedited data transfer (figure 7)
ESTAB	NC confirmed (figure 6)
FR	Generated flow control, of received data (figure 7)
FT	External flow control, of transmitted data (figure 7)
RC	Receipt confirmation (figure 7)
RELC	NC release, generated collision (figure 9)
RELF	NC release, forwarded (figure 9)
RELG	NC release, generated (figure 9)
RELX	NC release, external collision (figure 9)
REQ	NC request completed (figure 4)
RESC	Confirmation of forwarded reset (figure 8)
RESF	Forwarded reset (figure 8)
RESG	Generated local reset (figure 8)
RESX	External local reset (figure 8)
RETRY	NC establishment retry (figure 5)
RJ1	NC request rejected (figure 4)
SD	NC status discarded (figure 5)
SF	NC status forwarded (figure 5)
SG	NC status generated (figure 5)

5 The model of relaying by an intermediate system

5.1 Elements of the relaying model

This International Standard uses ISO 8648's structuring for intermediate systems as the basis for defining the operation of such systems in supporting the OSI connection-mode Network service.

Figure 1 illustrates, in a form adapted from ISO 8648, the general model of an intermediate system and the information flow through it. That flow represents, for each instance of Network layer communication handled by the intermediate system, the use made of the Network service by the NS-users in the end systems connected to the two sides of the intermediate system; the end systems may be connected either directly or through other intermediate systems. The sides of the intermediate system are labelled A and B for convenience in referring to them.

ISO/IEC 8348 defines the Network service in terms of primitives that occur in end systems, across the upper boundary of the Network layer. The first task of this International Standard is to provide corresponding definitions to allow discussion and specification of the information flow that represents those primitives in intermediate systems, and entirely within the Network layer. This is done by defining the Network internal layer service (NILS), including the correspondence between elements of the NILS and those of the Network service. The NILS is defined in terms of primitives with associated parameters, of the four types defined (but for OSI layer services) in ISO TR 8509.

The NILS is an abstraction of the interface in an intermediate system between the protocol support for the Network service and the N-relaying and N-routing functions. It is defined at a level corresponding to ISO 8648's subnetwork independent convergence protocol

(SNICP) role. Like the OSI Network service, therefore, it is independent of the details of particular protocols and subnetworks. The definition of the NILS, however, involves less abstraction from the level of detail that is typical of protocols than does the Network service: this reflects the role of the NILS as an expression of general Network layer internal mechanisms, as opposed to just the Network layer functionality that needs to be made visible to an NS user. In figure 1, the items 1A and 1B represent instances of the NILS. Clauses 7 to 9 contain the definition of the NILS.

Item 2 in figure 1 represents the N-relaying function, which relates the elements of the two instances of the NILS. The N-relaying function is defined in clauses 8 and 9.

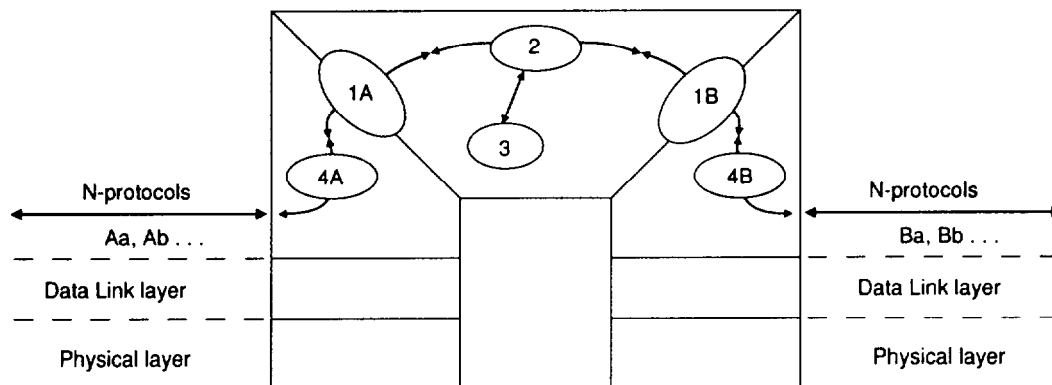


Figure 1 — Intermediate-system model

Item 3 represents the N-routing function needed to perform the relaying. The N-relaying function's interface to this is defined in clause 9.

Items 4A and 4B in figure 1 represent the mappings of the NILS to the protocol combinations used on the two sides of the intermediate system. These mappings for OSI standard Network protocols are specified in other standards.

NOTES

1 The protocol combinations on the two sides of an intermediate system may be different. If there are K such combinations, the relaying model implies that only the K protocol mappings for the NILS need to be specified in order to cover the full set of K-squared interworking possibilities.

2 The protocols used on a given side of an intermediate system may be combined "vertically", as occurs when separate protocols are used in two or more of the roles defined in ISO 8648; or they may be combined "horizontally", as for instance when an N-routing-protocol exchange is invoked in support of a particular attempt at NC establishment.

3 The OSI abstract modelling technique means that the NILS primitives at a given side of an intermediate system are to be considered as a direct abstraction from the NPDUs transmitted and received by the system. Thus items 4A and 4B in figure 1 truly represent mappings between those NPDUs and NILS primitives: they do not represent, for example, Network protocol implementations, with the implied possibility that these can intervene, below the NILS interface, in the flow of Network-service-level information represented by the NILS. To the extent that such interventions are observable outside the intermediate system, the model ascribes them all — apart perhaps from those resulting from protocol violations — to the relaying function shown as item 2.

5.2 Interconnection of intermediate systems

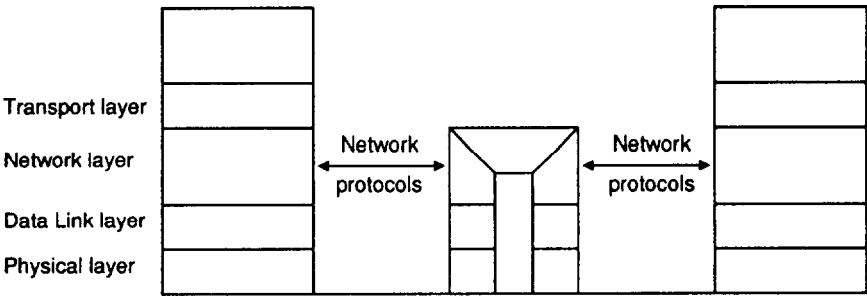
This subclause considers how the model of a single intermediate system, introduced in 5.1, is used where multiple Network entities are interconnected in supporting an instance of Network layer communication. The concern throughout is with Network layer operation considered at the level of the NILS or the OSI Network service. In particular, this subclause provides the framework for defining the correspondence between the OSI Network service, at end systems, and the operation of the NILS at intermediate systems involved in supporting the Network service.

The simplest interconnection scenario involving relaying is that shown in figure 2A, where two end systems communicate via a single intermediate system (representing, for example, a real subnetwork).

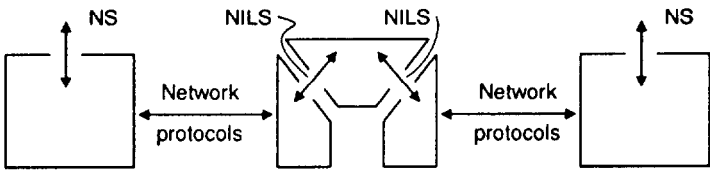
The concern with the Network layer only, and with the NS and NILS level of abstraction within that layer, is expressed in a diagrammatic representation that is simplified and abstracted from that used in figures 1 and 2A. Figure 2C is the representation corresponding to figure 2A, when the relaying function of the intermediate system is isolated for separate consideration.

NOTE 1 — Figure 2B is provided purely to clarify the derivation of figure 2C from figure 2A, by illustrating an intermediate step.

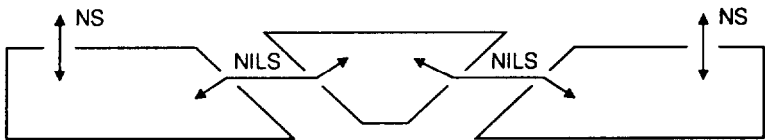
Figures 3A and 3B show a more complex interconnection scenario and its representation. The new feature here is the communication between two intermediate systems, considered as Network relay systems, via a third intermediate system considered as a subnetwork.



A. ISO 8648 representation, with relay model

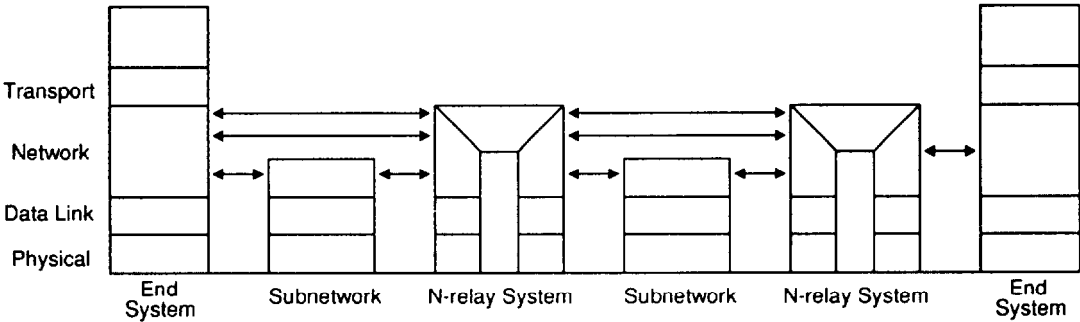


B. Network layer elements only, with relaying component separated

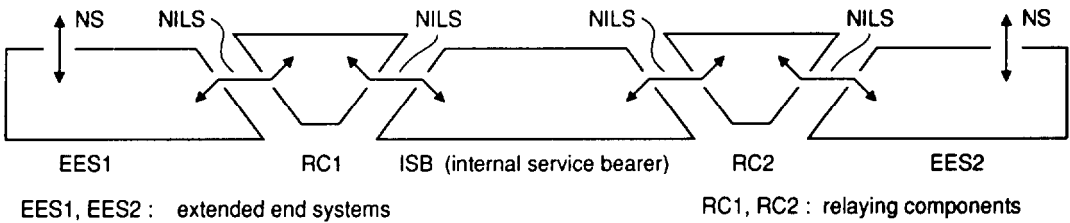


C. Service-level representation: protocol details abstracted

Figure 2 — End system / intermediate system / end system interconnection



A. Full architectural model (ISO 8648)



B. Network layer service-level representation

Figure 3 — Interconnected intermediate systems (Network relay systems and subnetworks)

Figure 3B contains three different kinds of element, which participate in conveying the information flow through the Network layer and interface to each other by means of the NILS. These three kinds of element are enough to express any interconnection scenario; they are described by the following terminology.

- a) A relaying component (of an intermediate system) performs the mapping between corresponding NILS primitives at the interfaces on its two sides.
- b) An extended end system (EES) provides the Network service to an NS user; it maps between Network service primitives at an NSAP and corresponding NILS primitives at its other interface, which is always to a relaying component.
- c) An internal service bearer (ISB) maps between corresponding NILS primitives at its two interfaces (which are always with relaying components).

NOTE 2 — A relaying component represents part of the functionality of real equipment that is represented as a single Network entity in the modelling chosen for the Network-layer interconnection. An ISB or an EES represents parts of the functionality of at least two distinct Network entities, together with the Network protocol or protocols that convey the N-layer information flow between them.

Additional related terms for use in defining and discussing the NILS are as follows.

- d) The communication path represented by an EES or ISB for a single instance of Network layer communication is termed a hop.
- e) The point at which NILS primitives are exchanged between a relaying component and an EES or ISB is termed a Network internal service access point (NISAP).
- f) NILS primitives occurring at a given NISAP and belonging to a single NC are considered to occur at a Network hop end point (NHEP); this is distinct from the NHEP of any other NC, and from the NHEP of any other hop of the same NC, at the given NISAP. For a hop of an NC passing through an EES, the Network connection end point at the NSAP is also termed a Network hop end point, in order to provide a uniform terminology for use in defining the NILS.

NOTE 3 — The role of an NHEP in relation to the NILS is analogous to that of a Network connection end point in relation to the Network service.

The role of a NISAP in relation to the NILS is analogous to that of an NSAP in relation to the OSI Network service. However, unlike an NSAP, an NISAP needs no global identification mechanism such as is provided for NSAPs by Network addresses: NISAPs are purely a modelling abstraction. Because of this, each Subnetwork Point of Attachment (SNPA) of a Network relay system is defined to be associated with exactly one NISAP; more than one SNPA can be associated with one given NISAP. Many-to-one or many-to-many mappings of NISAPs to SNPAs do not occur, by definition.

When only the NILS is considered, the difference between a relaying component and an ISB is simply a reversal of the sense of the basic primitive types. That is, request and response primitives are inputs to an ISB but outputs from a relaying component, and conversely for indication and confirm primitives. When the roles of the various elements are considered in detail, however, different elements of the relaying model are seen to apply to relaying components and to ISBs, and the distinction is seen to relate closely to the choices made in modelling intermediate systems as Network relay systems or as subnetworks.

6 Features of the Network internal layer service

This clause outlines the features provided by the NILS. Clause 7 defines the primitives and parameters of the NILS and relates them to the corresponding elements of the OSI Network service. Clauses 8 and 9 define how the NILS primitives are used in supporting the features of the connection-mode Network service.

The NILS includes all the features of the OSI connection-mode Network service as defined in ISO/IEC 8348, in order to support the provision of the CO NS between NS-users in end systems. In addition, the NILS offers a number of features related to the operation of the CO NS and the needs of management.

NILS features that correspond directly to the features of the connection mode Network service are as follows.

- a) NC establishment: the means to establish a Network connection through an intermediate system, for the purpose of transferring NS-user-data between NS-users in end systems interconnected via the intermediate system.
- b) QOS negotiation: the establishment of an agreement associated with an NC, between the NS-users and the various N-entities making up the NS-provider for the NC, for a certain quality of service.
- c) Normal data transfer: the means of transferring NSDUs in sequence and transparently on an NC.
- d) Flow control: the means by which a receiving N-entity, in an end system or intermediate system, can control the rate at which a peer N-entity may send NS-user-data. (Such flow control between N-entities can result from flow control exerted, by local mechanisms, by a receiving NS-user in an end system; or can cause flow control to be exerted, again by local mechanisms, on a transmitting NS-user in an end system.)

- e) Expedited data transfer: as a selectable option of the NS-provider, the means of transferring separate expedited NSDUs in sequence on an NC.
- f) Receipt confirmation: as a selectable option of the NS-provider, the means to convey confirmation that an NS-user has received certain NSDUs.
- g) NC reset: the means by which an NC can be returned to a defined state with the activities of the two NS-users synchronized, invoked by either NS-user or by a Network-entity forming part of the NS-provider for the NC.
- h) NC release: the unconditional and therefore possibly destructive release of an NC by either NS-user or by a Network-entity forming part of the NS-provider for the NC.

Additional features relating to the internal operation of the Network layer are as follows.

- j) Connection control: the means of exchanging information between intermediate systems in relation to their co-operation in establishing an NC.
- k) Error diagnostics: the means of transferring diagnostic information associated with NC resets and NC release.
- l) Accounting information: the means of transferring information related to the costs of an NC, at NC release.

The quality of service (QOS) for a Network connection is as defined in ISO/IEC 8348.

Expedited data transfer and receipt confirmation are provider options of the NILS in the same sense as in the CO NS, ISO/IEC 8348.

The operation of an NC is considered as being divided into three phases: NC establishment phase, items (a), (b) and (j) above; data transfer phase, items (c) - (g) and (k) above; and NC release phase, items (h), (k) and (l) above.

7 Primitives and parameters of the Network internal layer service

7.1 Definitions of NILS primitives

The first and third columns of table 1 define, respectively, the NILS primitives, and the parameters associated with each primitive; the fourth column provides references to the definitions of the parameters.

The second and fifth columns of table 1, together with 7.1.1 and 7.1.2, define the basic correspondence between the NILS primitives and parameters and those of the OSI Network service. This correspondence relates one NS primitive and its parameters to one NILS primitive and its parameters, except in the case of N-DATA where the correspondence is as defined in 7.1.3.

7.1.1 Correspondence between NS and NILS primitives

The "request or indication" parts of the entries in table 1 are to be read as meaning that an NILS primitive of type request may correspond to an NS primitive either of type request or of type indication, and an NILS primitive of type indication may also correspond to either type of NS primitive; and similarly for the "response or confirm" entries.

The correspondence defined here is between primitives considered as classes of possible instances. An instance of an NS primitive at an NSAP may correspond to zero, one, or several instances of the corresponding NILS primitives at different NISAPs; that level of correspondence is a consequence of the definitions in clause 8.

NOTES

- 1 All primitives of the OSI CO NS are present in table 1, with corresponding NILS primitives defined.
- 2 Three request / indication pairs of NILS primitives are defined that have no corresponding NS primitives: these are NI-CONNECT-PROCEEDING, NI-PAUSE and NI-CONTINUE. The NILS also has NI-EXPEDITED-DATA response and confirm primitives that have no corresponding NS primitives.

7.1.2 Correspondence between parameters of NS and NILS primitives

For those parameters marked "(=)" in table 1, the value of such a parameter in an instance of an NILS primitive other than NI-DATA is equal to the value of the parameter of the same name in any corresponding instance of an NS primitive; the NS-provider has a passive role with respect to these parameters, conveying them unchanged.

For those parameters marked "(*)", the value of such a parameter in an instance of an NILS primitive can be different from the value of the parameter of the same name in a corresponding instance of an NS primitive; the NS-provider can have an active part in negotiating or generating these parameters — see clause 9.

NOTE — The parameters of all OSI CO NS primitives except N-DATA are present in table 1, marked "(*)" or "(=)" to define their correspondence with

NILS parameters; the missing parameters of N-DATA correspond to parameters of NI-DATA as defined in 7.1.3.

7.1.3 Correspondence between N-DATA and NI-DATA primitives

An N-DATA primitive with an NS-User-Data parameter of length L octets corresponds to a sequence of L NI-DATA primitives, as follows:

- the value of the NS-User-Data-Octet parameter in the n th NI-DATA primitive of the sequence, $0 < n < L+1$, is the value of the n th octet of the NS-User-Data parameter;
- the value of the NSDU Qualifier parameter in the n th NI-DATA primitive of the sequence, $0 < n < L$, is "Normal";
- the value of the NSDU Qualifier parameter in the L th NI-DATA primitive of the sequence is "Last" if the N-DATA primitive does not contain the Confirmation Request parameter, and otherwise is "Last with Confirmation Request".

NOTE — The qualifying symbol "(=)" is used against the parameters of NI-DATA in table 1, since the above correspondence conveys the content of a corresponding N-DATA primitive's parameters without change.

Table 1 — Primitives and parameters of the NILS, and correspondence with OSI connection-mode Network service

NILS primitive	NS primitive	NILS Parameters	Reference	Note
NC establishment				
NI-CONNECT request or indication	N-CONNECT request or indication	Called Address Calling Address Receipt Confirmation Selection Expedited Data Selection QOS-Parameter Set NS-User-Data NI Connection Control	7.2.2 7.2.2 7.2.3 7.2.4 7.2.5 7.2.8 7.2.11	(=) (=) (*) (*) (*) (=) 3
NI-CONNECT response or confirm	N-CONNECT response or confirm	Responding Address Receipt Confirmation Selection Expedited Data Selection QOS-Parameter Set NS-User-Data NI Connection Control	7.2.2 7.2.3 7.2.4 7.2.5 7.2.8 7.2.11	(=) (=) (=) (=) (=) 3
NI-CONNECT-PROCEEDING request or indication	none	none		2
NC release				
NI-DISCONNECT request or indication	N-DISCONNECT request or indication	Originator Reason NS-User-Data Responding Address NI Diagnostic NI Location NI Accounting	7.2.6 7.2.7 7.2.8 7.2.2 7.2.12 7.2.13 7.2.14	(*) (*) (=), 1 (=), 1 1, 3 1, 3 1, 3