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Information processing systems — Telecommunications and information exchange between systems — End system to Intermediate system routeing exchange protocol for use in conjunction with the Protocol for providing the connectionless-mode network service (ISO 8473)

Systèmes de traitement de l'information — Téléinformatique — Protocole de routage d'un système d'extrémité à un système intermédiaire à utiliser conjointement avec le protocole fournissant le service de réseau en mode sans connexion (ISO 8473)

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Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 9542 was prepared by Technical Committee ISO/TC 97, *Information processing systems.*

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

Annex A forms an integral part of this International Standard. Annexes B and C are for information only.

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0 Introduction

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

This International Standard is positioned with respect to other related standards by the layers defined in ISO 7498 and by the structure defined in ISO 8648. In particular, it is a protocol of the Network Layer. This International Standard permits End Systems and Intermediate Systems to exchange configuration and routeing information to facilitate the operation of the routeing and relaying functions of the Network Layer.

The aspects of Network Layer routeing that are concerned with communication between End Systems and Intermediate Systems on the same subnetwork are to a great extent separable from the aspects that are concerned with communication among the Intermediate Systems that connect multiple subnetworks. This protocol addresses only the former aspects. It will be significantly enhanced by the cooperative operation of an additional protocol that provides for the exchange of routeing information among Intermediate Systems, but is useful whether or not such an additional protocol is available.

This International Standard is designed to operate in close conjunction with ISO 8473 and its addenda.

This International Standard provides solutions for the following practical problems.

a) How do End Systems discover the existence and reachability of Intermediate Systems that can route NPDUs to destinations on subnetworks other than the one(s) to which the End System is directly connected?

b) How do End Systems discover the existence and reachability of other End Systems on the same subnetwork (when direct examination of the destination NSAP address does not provide information about the destination subnetwork address)?

c) How do Intermediate Systems discover the existence and reachability of End Systems on each of the subnetworks to which they are directly connected?

d) How do End Systems decide which Intermediate System to use to forward NPDUs to a particular destination when more than one Intermediate System is accessible?

The protocol assumes that:

a) routeing to a specified subnetwork point of attachment address (SNPA) on the same subnetwork is carried out satisfactorily by the subnetwork itself, but

b) the subnetwork is not, however, capable of routeing on a global basis using the NSAP address alone to achieve communication with a requested destination.[1)]

In addition, certain protocol functions assume that:

c) the subnetwork supports broadcast, multicast, or other forms of multi-destination addressing for n-way transmission.

1) Consequently, it is not possible to use Application Layer communication to carry out the functions of this International Standard.

The protocol is connectionless, and is designed to:

- minimize the amount of a priori state information needed by End Systems before they can begin to communicate with other End Systems;
- minimize the amount of memory needed to store routeing information in end systems; and
- minimize the computational complexity of End System routeing algorithms.

1 Scope and Field of Application

This International Standard specifies a protocol which is used by Network Layer entities operating ISO 8473 in End Systems and Intermediate Systems (referred to herein as ES and IS respectively) to maintain routeing information. The Protocol herein described relies upon the provision of a connectionless-mode underlying service.[1)]

This International Standard specifies:

a) procedures for the transmission of configuration and routeing information between Network entities residing in End Systems and Network entities residing in Intermediate Systems;

b) the encoding of the protocol data units used for the transmission of the configuration and routeing information;

c) procedures for the correct interpretation of protocol control information; and

d) the functional requirements for implementations claiming conformance to this International Standard.

The procedures are defined in terms of:

a) the interactions between End System and Intermediate System Network entities through the exchange of protocol data units; and

b) the interactions between a Network entity and an underlying service provider through the exchange of subnetwork service primitives.

This International Standard does *not* specify any protocol elements or algorithms for facilitating routeing and relaying among Intermediate Systems. Such functions are intentionally beyond the scope of this International Standard.

2 References

ISO 7498, *Information processing systems — Open systems interconnection — Basic reference model.*

ISO 7498/Add.1, *Information processing systems — Open systems interconnection — Basic reference model.* ADDENDUM 1: *Connectionless-mode transmission.*

ISO 7498/Add.4, *Information processing systems — Open systems interconnection — Basic reference model.* ADDENDUM 4: *OSI Management Framework.*

ISO 8208, *Information processing systems — Data communications — X.25 Packet Level Protocol for Data Terminal Equipment.*

ISO 8348, *Information processing systems — Data communications — Network Service Definition.*

ISO 8348/Add.1, *Information processing systems — Data communications — Network Service Definition.* ADDENDUM 1: *Connectionless-mode Transmission.*

ISO 8348/Add.2, *Information processing systems — Data communications — Network Service Definition.* ADDENDUM 2: *Network Layer Addressing.*

ISO 8473, *Information processing systems — Data communications — Protocol for providing the connectionless-mode Network Service.*

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

ISO 8802, *Information processing systems — Data communications - Local Area Networks.*

CCITT X.25, *Interface Between Data Terminal Equipment (DTE) and Data Circuit Terminating Equipment (DCE) for Terminals Operating in the Packet Mode and Connected to Public Data Networks by Dedicated Circuit, 1985.*

1) See Clause 8 of ISO 8473 for the mechanisms necessary to realize this service on subnetworks based on ISO 8208 and ISO 8802.

Section one: General

3 Definitions

3.1 Reference Model Definitions

ISO 9542 makes use of the following terms defined in ISO 7498.

a) Network layer
b) Network service access point
c) Network service access point address
d) Network entity
e) routeing
f) Network protocol
g) Network relay
h) Network protocol data unit

3.2 Network Layer Architecture Definitions

ISO 9542 makes use of the following terms defined in ISO 8648.

a) Subnetwork
b) End System
c) Intermediate System
d) Subnetwork Service
e) Subnetwork Dependent Convergence Function

3.3 Network Layer Addressing Definitions

ISO 9542 makes use of the following terms defined in ISO 8348/Add.2.

a) Subnetwork address
b) Subnetwork point of attachment
c) Network Protocol Address Information
d) Network Entity Title

3.4 Local Area Network Definitions

ISO 9542 makes use of the following terms defined in ISO 8802.

a) multicast address
b) broadcast medium

3.5 Additional Definitions

For the purposes of this International Standard, the following definition applies.

3.5.1 Configuration: The collection of End and Intermediate Systems attached to a single subnetwork, defined in terms of the system types, NSAP addresses present, Network Entities present, and the correspondence between systems and SNPA addresses.

4 Symbols and Abbreviations

4.1 Data Units

PDU	Protocol Data Unit
SNSDU	Subnetwork Service Data Unit
NPDU	Network Protocol Data Unit
SNPDU	Subnetwork Protocol Data Unit

4.2 Protocol Data Units

ESH PDU	End System Hello Protocol Data Unit
ISH PDU	Intermediate System Hello Protocol Data Unit
RD PDU	Redirect Protocol Data Unit

4.3 Protocol Data Unit Fields

NPID	Network Layer Protocol Identifier
LI	Length Indicator
V/P	Version/Protocol Identifier Extension
TP	Type
CS	Checksum
NETL	Network Entity Title Length Indicator
NET	Network Entity Title
DAL	Destination Address Length Indicator
DA	Destination Address
SAL	Source Address Length Indicator
SA	Source Address
BSNPAL	SN Address Length Indicator of better route to destination
BSNPA	SN Address of better route to destination
HT	Holding Time

4.4 Parameters

CT	Configuration Timer
RT	Redirect Timer
ESCT	Suggested End System Configuration Timer

4.5 Addresses

NSAP	Network Service Access Point
SNPA	Subnetwork Point of Attachment
NPAI	Network Protocol Address Information

4.6 Miscellaneous

ES	End system
IS	Intermediate system
LAN	Local area network
PICS	Protocol Implementation Conformance Statement
QoS	Quality of service
SN	Subnetwork

5 Overview of the Protocol

5.1 Information Provided by the Protocol

This International Standard provides two types of information to Network entities which support its operation:

- **Configuration information**, and
- **Route redirection information**

Configuration information permits End Systems to discover the existence and reachability of Intermediate Systems and permits Intermediate Systems to discover the existence and reachability of End Systems. This information allows ESs and ISs attached to the same subnetwork to dynamically discover each other's existence and availability, thus eliminating the need for manual intervention at ESs and ISs to establish the identity of Network entities that can be used to route NPDUs.

Configuration information also permits End Systems to obtain information about each other in the absence of an available Intermediate System.

> NOTE — The term "configuration information" is not intended in the broad sense of configuration as used in the context of OSI system management. Rather, only the functions specifically defined herein are intended.

Route redirection information allows Intermediate Systems to inform End Systems of (potentially) better paths to use when forwarding NPDUs to a particular destination. A better path could either be another IS on the same subnetwork as the ES, or the destination ES itself, if it is on the same subnetwork as the source ES. Allowing the ISs to inform the ESs of routes minimizes the complexity of routeing decisions in End Systems and improves performance because the ESs may make use of the better IS or local subnetwork access for subsequent transmissions.

5.2 Addressing

The **Source Address** and **Destination Address** parameters referred to in this International Standard are OSI Network Service Access Point Addresses. The syntax and semantics of an OSI Network Service Access Point Address are described in ISO 8348/Add.2.

5.3 Underlying Service Assumed by the Protocol

The underlying service required to support this International Standard is defined by the primitives in table 1.

> NOTE — These service primitives are used to describe the abstract interface which exists between the protocol machine and an underlying real subnetwork or a Subnetwork Dependent Convergence Function which operates over a real subnetwork or real data link to provide the required underlying service. [1)]

5.3.1 Subnetwork Addresses

The source and destination addresses specify the points of attachment to a public or private subnetwork(s) involved in the transmission (known as Subnetwork Points of Attachment, or SNPAs). Subnetwork addresses are defined in the service definition of each individual subnetwork.

This International Standard is designed to take advantage of subnetworks which support *broadcast*, *multicast*, or other forms of multi-destination addressing for *n*-way transmission. It is assumed that the SN_Destination_Address parameter may take on one of the following multi-destination addresses in addition to a normal single destination address:

- All End System Network entities
- All Intermediate System Network entities

Where a real subnetwork does not inherently support broadcast or other forms of transmission to multi-destination addresses, a convergence function may be used to provide *n*-way transmission to these multi-destination addresses.

When the SN_Destination_Address on the SN_UNITDATA.Request is a multi-destination address, the SN_Destination_Address parameter in the corresponding SN_UNITDATA.Indication shall be the same multi-destination address.

1) See Clause 8 of ISO 8473 for the mechanisms necessary to realize this service on subnetworks based on ISO 8208 and ISO 8802.

Table 1 – Service Primitives for Underlying Service

SN_UNITDATA	.Request .Indication	SN_Destination_Address, SN_Source_Address, SN_Quality_of_Service, SN_Userdata

The syntax and semantics of subnetwork addresses, except for the properties described above, are not defined in this International Standard.

5.3.2 Subnetwork User Data

The SN_Userdata is an ordered multiple of octets, and is transferred transparently between the specified subnetwork points of attachment.

The underlying service is required to support a service data unit size of at least that required to operate ISO 8473.

5.4 Subnetwork Types

In order to evaluate the applicability of this International Standard in particular configurations of End Systems, Intermediate Systems and subnetworks, three generic types of subnetwork are identified. These are:

a) the **point-to-point** subnetwork,

b) the **broadcast** subnetwork, and

c) the **general topology** subnetwork

These subnetwork types are discussed in the following clauses.

5.4.1 Point-to-Point Subnetworks

A *point-to-point* subnetwork supports exactly two systems. The two systems may be either two End Systems, or an End System and a single Intermediate System. A single point-to-point data link connecting two Network entities is an example of a point-to-point subnetwork.

5.4.1.1 Configuration information on a point-to-point Subnetwork

On a point-to-point subnetwork the configuration information of this International Standard informs the communicating Network entities of the following:

a) whether the topology consists only of two End Systems, or

b) one of the two systems is an Intermediate System.

NOTE — On a point-to-point subnetwork, if both systems are Intermediate Systems, then this International Standard is inapplicable to the situation, since an IS-to-IS protocol should be employed instead. However, there is no reason why the configuration information could not be employed in an IS-to-IS environment to ascertain the topology and initiate operation of an IS-to-IS protocol.

The Intermediate System is informed of the NSAP address(es) supported by the Network entity in the End System. This permits reachability information and routeing metrics concerning these NSAPs to be disseminated to other Intermediate Systems for the purpose of calculating routes to/from this End System.

5.4.1.2 Route redirection information on a point-to-point Subnetwork.

Redirection information is not employed on point-to-point subnetworks because there are never any alternate routes.

5.4.2 Broadcast Subnetworks

A *broadcast* subnetwork supports an arbitrary number of End Systems and Intermediate Systems, and additionally is capable of transmitting a single SNPDU to all or a subset of these systems in response to a single SN_UNITDATA.Request. An example of a broadcast subnetwork is a LAN (local area network) conforming to ISO 8802-2, type 1 operation.

5.4.2.1 Configuration information on a broadcast Subnetwork

On a broadcast subnetwork the configuration information of this International Standard is employed to inform the communicating Network entities of the following:

a) End Systems are informed of the reachability, Network Entity Title, and SNPA address(es) of each active Intermediate System on the subnetwork.

b) Intermediate Systems are informed of the NSAP addresses supported by each End System and the

SNPA address(es) of the ES. Once the Intermediate System obtains this information, reachability information and routeing metrics concerning these NSAPs may be disseminated to other ISs for the purpose of calculating routes to/from each ES on the subnetwork.

c) In the absence of an available Intermediate System, End Systems may query over a broadcast subnetwork to discover whether a particular NSAP is reachable on the subnetwork, and if so, what SNPA address to use to reach that NSAP.

5.4.2.2 Route redirection information on broadcast Subnetworks.

Redirection information may be employed on broadcast subnetworks to permit Intermediate Systems to inform End Systems of superior routes to a destination NSAP. The superior route might be another IS on the same subnetwork as the ES, or it might be the destination ES itself, if it is directly reachable on the same subnetwork as the source ES.

5.4.3 General Topology Subnetworks

A *general topology* subnetwork supports an arbitrary number of End Systems and Intermediate Systems, but does not support a convenient multi-destination connectionless transmission facility as does a broadcast subnetwork. An example of a general topology subnetwork is a subnetwork employing X.25 or ISO 8208.

NOTE — The crucial distinguishing characteristic between the broadcast subnetwork and the general topology subnetwork is the "cost" of an n-way transmission to a potentially large subset of the systems on the subnetwork. On a general topology subnetwork, the cost is assumed to be close to the cost of sending an individual PDU to *each* SNPA on the subnetwork. Conversely, on a broadcast subnetwork the cost is assumed to be close to the cost of sending a single PDU to *one* SNPA on the subnetwork. Intermediate situations between these extremes are of course possible. In such cases it would be possible to treat the subnetwork as in either the broadcast or general topology category.

5.4.3.1 Configuration information on a general topology Subnetwork.

On a general topology subnetwork the configuration information is generally not employed because the protocol can be very costly in the utilization (and charging for) subnetwork resources.

5.4.3.2 Route redirection information on a general topology Subnetwork.

Redirection information may be employed on general topology subnetworks to permit Intermediate Systems to inform End Systems of superior routes to a destination NSAP. The superior route might be another IS on the same subnetwork as the ES, or it might be the destination ES itself, if it is directly reachable on the same subnetwork as the source ES.

Section two: Specification of the protocol

6 Protocol Functions

This section describes the functions performed as part of the protocol.

Implementations are not required to perform all of the functions: Clause 8.1 specifies which functions are mandatory and which are optional.

6.1 Protocol Timers

Many of the protocol functions are timer based. This means that they are executed upon expiration of a timer rather than upon receipt of a PDU or invocation of a service primitive. The two types of timer employed by the protocol are the Configuration Timer (CT) and the Holding Timer (HT).

NOTE — It is recommended that the timer values be implemented with a resolution not worse than one second.

6.1.1 Configuration Timer

The Configuration Timer is a local timer (i.e. maintained independently by each system) which assists in performing the Report Configuration function (see 6.2). The timer determines how often a system reports its availability to the other systems on the same subnetwork. The shorter the Configuration Timer, the more quickly other systems on the subnetwork will become aware when the reporting system becomes available or unavailable. There is a trade off between increased responsiveness and increased use of resources in the subnetwork and in the recipient systems.

6.1.2 Holding Timer

The Holding Timer applies to both configuration information and route redirection information. The value of a Holding Timer is set by the source of the information and transmitted in the Holding Time field of the appropriate PDU. The recipient of the information is expected to retain the information no longer than the Holding Timer. Old configuration or redirection information shall be discarded after the Holding Timer expires to ensure the correct operation of the protocol.

Further discussion of the rationale for these timers and guidelines for their use may be found in Annex B.

6.2 Report Configuration Function

The Report Configuration Function is used by End Systems and Intermediate Systems to inform each other of their reachability and current subnetwork address(es). This function is invoked every time the local Configuration Timer (CT) expires in an ES or IS. The function may optionally be invoked on other occasions. For example, when one of the system's SNPAs becomes operational, this function may be executed more frequently than on Configuration Timer expiry. This enables other systems to notice the change in configuration quickly.

6.2.1 Report Configuration by End Systems

An End System Network entity constructs and transmits ESH PDUs to inform other systems about the NSAPs it serves. This may be done by constructing one ESH PDU for each NSAP. Alternatively, ESH PDUs may be constructed which convey information about more than one NSAP at a time, up to the limits imposed by the permitted SNSDU size and the maximum header size of the ESH PDU. Each ESH PDU is transmitted by issuing an SN-UNITDATA.Request with the following parameters:

SN_Userdata (SNSDU) ← ESH PDU
SN_Destination_Address ← multi-destination address that indicates *"All Intermediate System Network Entities"*.

Where an End System supports more than one SNPA, the information about each NSAP served by the End System shall be transmitted on each SNPA. It is not required that the distribution of NSAPs among ESH PDUs be the same on each SNPA.

NOTE — The necessity to inform other systems about individual NSAPs served by the Network entity arises from the lack of a formalized relationship between Network entity titles and NSAP addresses. If this relationship could be constrained to require that all NSAP addresses be assigned as leaf subdomains of a domain represented by the local Network entity's Network entity title, then a single ESH PDU could be transmitted containing the ES's Network entity title. The Network entity title would then imply which NSAPs might be present at that End System.

The Holding Time (HT) field is set to approximately twice the ES's Configuration Timer (CT) parameter.

The value shall be large enough so that even if every other ESH PDU is discarded (due to lack of resources), or otherwise lost in the subnetwork, the configuration information will still be maintained. The value should be set small enough so that Intermediate Systems can respond in a timely fashion to End Systems becoming available or unavailable.

NOTE — The actual value of the SN_Destination_Address used to mean *"All Intermediate System Network Entities"* is subnetwork dependent and will most likely vary from subnetwork to subnetwork. It is of course desirable on widely-used subnetwork types (such as those based on ISO 8802) that this value, and the value of the *"All End System Network Entities"* multi-destination address, be standardized.

6.2.2 Report Configuration by Intermediate Systems

An Intermediate System constructs a single ISH PDU containing the IS's Network entity title and issues one SN_UNITDATA.Request on each SNPA to which it is attached with the following parameters:

SN_Userdata (SNSDU) ← ISH PDU
SN_Destination_Address ← multi-destination address that indicates *"All End System Network Entities"*

The Holding Time (HT) field is set to approximately twice the Intermediate System's Configuration Timer (CT) parameter. This variable shall be set to a value large enough so that even if every other ISH PDU is discarded (due to lack of resources), or otherwise lost in the subnetwork, the configuration information will still be maintained. The value should be set small enough so that End Systems will quickly cease to use ISs that have failed, thus preventing "black holes" in the network.

An IS may optionally suggest a value for End Systems on the local subnetwork to use as their Configuration Timers (CT) by including the ESCT option in the transmitted ISH PDU. Setting this option permits an IS to influence the frequency with which ESs transmit ESH PDUs.

NOTE — An IS may wish to so influence End Systems in order to trade off the subnetwork resources consumed by the transmission of ESH PDUs against the length of time it is willing to tolerate obsolete configuration information about an ES.

6.3 Record Configuration Function

The Record Configuration function receives ESH or ISH PDUs, extracts the configuration information, and updates the information in the local Network entity's routeing information base.

NOTE — If an ES so desires, it may decide to enable the appropriate multi-destination address, thus permitting it to process ESH PDUs multicast by other End Systems. There is potentially some performance improvement to be gained by doing this, at the expense of extra memory, and possibly extra processing cycles in the End System. The ES, by recording other ESs' configuration information, may be able to route NPDUs directly to ESs on the local subnetwork without first being redirected by an Intermediate System.

Similarly, Intermediate Systems may choose to receive the ISH PDUs of other ISs, allowing this International Standard to be used as the initialization and topology maintenance portion of a full IS-to-IS routeing protocol.

The receiving system is not required to process any option fields in a received ESH or ISH PDU.

NOTE — When a system chooses to process these optional fields, the precise actions are not specified by this International Standard.

6.3.1 Record Configuration by Intermediate Systems

On receipt of an ESH PDU an IS extracts the configuration information and stores the {NSAP,SNPA} pairs in its local routeing information base replacing any other information for the same {NSAP,SNPA} pair. If insufficient space is available to store the new configuration information the PDU is discarded.

6.3.2 Record Configuration by End Systems

On receipt of an ISH PDU an ES extracts the configuration information and stores the {NET,SNPA} pairs in its local routeing information base replacing any other information for the same {NET,SNPA} pair. If insufficient space is available to store the new configuration information the PDU is discarded.

In addition, an ES may also recompute its Configuration Timer based on receipt of an ISH PDU containing the *Suggested ES Configuration Timer* (ESCT) optional field. If an End System chooses to use a computed CT rather than a local value supplied by System Management, it performs the operations described below.

- It examines its local routeing information base and ascertains whether any IS for which the ES is maintaining configuration information has supplied an ESCT. If no IS has suggested an ES configuration timer, the ES uses the value supplied by its local System Management.