INTERNATIONAL STANDARD

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Information technology — Telecommunications and information exchange between systems — Intermediate System to Intermediate System intra-domain routeing information exchange protocol for use in conjunction with the protocol for providing the connectionless-mode network service (ISO 8473)

Technologies de l'information — Communication de données et échange d'informations entre systèmes — Protocole intra-domaine de routage d'un système intermédiaire à un système intermédiaire à utiliser conjointement avec le protocole fournissant le service de réseau en mode sans connexion (ISO 8473)

Reference number
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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of the joint technical committee is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC 10589 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 6, *Telecommunications and information exchange between systems*.

This second edition cancels and replaces the first edition (ISO/IEC 10589:1992), which has been technically revised. It incorporates Cor.1:1993, Cor.2:1996, Cor.3:1996, Amd.1:1996 and Amd.2:1999.

Annexes A, E, G, H, I and J form a normative part of this International Standard. Annexes B, C, D and F are for information only.

Annexes G, H, I and J provide ICS proformas associated with intra-domain routeing protocol management information.

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.

The protocol defined in 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 protocol permits Intermediate Systems within a routeing domain to exchange configuration and routeing information to facilitate the operation of the routeing and relaying functions of the Network Layer.

The protocol is designed to operate in close conjunction with ISO 9542 and ISO 8473. ISO 9542 is used to establish connectivity and reachability between End Systems and Intermediate Systems on individual subnetworks. Data is carried using the protocol specified in ISO 8473. The related algorithms for route calculation and maintenance are also described.

The intra-domain IS-IS routeing protocol is intended to support large routeing domains consisting of combinations of many types of subnetworks. This includes point-to-point links, multipoint links, X.25 subnetworks, and broadcast subnetworks such as ISO 8802 LANs.

In order to support large routeing domains, provision is made for intra-domain routeing to be organised hierarchically. A large domain may be administratively divided into *areas*. Each system resides in exactly one area. Routeing within an area is referred to as *Level 1 routeing*. Routeing between areas is referred to as *Level 2 routeing*. Level 2 Intermediate Systems keep track of the paths to destination areas. Level 1 Intermediate Systems keep track of the routeing within their own area. For an NPDU destined to another area, a Level 1 Intermediate System sends the NPDU to the nearest level 2 IS in its own area, regardless of what the destination area is. Then the NPDU travels via level 2 routeing to the destination area, where it again travels via level 1 routeing to the destination End System.

Information technology – Telecommunications and information exchange between systems – Intermediate System to Intermediate System intra-domain routeing information exchange protocol for use in conjunction with the protocol for providing the connectionless-mode network service (ISO 8473)

1 Scope

This International Standard specifies a protocol which is used by Network Layer entities operating the protocol specified in ISO 8473 in Intermediate Systems to maintain routeing information for the purpose of routeing within a single routeing domain. The protocol specified in this International Standard 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 Intermediate Systems within a single routeing domain;
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 Intermediate system Network entities through the exchange of protocol data units;
b) the interactions between a Network entity and an underlying service provider through the exchange of subnetwork service primitives; and
c) the constraints on route determination which must be observed by each Intermediate system when each has a routeing information base which is consistent with the others.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO/IEC 7498-1:1994, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model*

ISO/IEC 7498-3:1997, *Information technology – Open Systems Interconnection – Basic Reference Model: Naming and addressing*

ISO/IEC 7498-4:1989, *Information processing systems – Open Systems Interconnection – Basic Reference Model – Part 4: Management framework*

ISO/IEC 8208:2000, *Information technology – Data communications – X.25 Packet Layer Protocol for Data Terminal Equipment*

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1) See ISO 8473 and its addendum 3 for the mechanisms necessary to realize this service on subnetworks based on ISO/IEC 8208, ISO 8802, and the OSI Data Link Service.

ISO/IEC 8348:1996, *Information technology – Open Systems Interconnection – Network Service Definition*

ISO/IEC 8473-1:1998, *Information technology – Protocol for providing the connectionless-mode network service: Protocol specification*

ISO/IEC 8473-4:1995, *Information technology – Protocol for providing the connectionless-mode network service: Provision of the underlying service by a subnetwork that provides the OSI data link service*

ISO 8648:1988, *Information processing systems – Open Systems Interconnection – Internal organization of the Network Layer*

ISO/IEC TR 8802-1:1997, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 1: Overview of Local Area Network Standards*

ISO/IEC 8802-2:1998, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 2: Logical link control*

ISO/IEC 8802-3:2000, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

ISO/IEC 8802-5:1998, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 5: Token ring access method and physical layer specifications*

ISO/IEC 8802-6:1994, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 6: Distributed Queue Dual Bus (DQDB) access method and physical layer specifications*

ISO/IEC 9314 (all parts), *Information technology – Fibre Distributed Data Interface (FDDI)*

ISO 9542:1988, *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)*

ISO/IEC TR 9575:1995, *Information technology – Telecommunications and information exchange between systems – OSI Routeing Framework*

ISO/IEC TR 9577:1999, *Information technology – Protocol identification in the network layer*

ISO/IEC 15802-1:1995, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Common specifications – Part 1: Medium Access Control (MAC) service definition*

ISO/IEC 10165-1:1993, *Information technology – Open Systems Interconnection – Management Information Services – Structure of management information: Management Information Model*

ISO/IEC 10165-4:1992, *Information technology – Open Systems Interconnection – Structure of management information – Part 4: Guidelines for the definition of managed objects*

ISO/IEC 10733:1998, *Information technology – Elements of management information related to the OSI Network Layer*

ISO/IEC 8824-1:1998, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation*

ISO/IEC 8825-1:1998, *Information technology – ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)*

ISO/IEC 9646-7:1995, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 7: Implementation Conformance Statements*

ISO/IEC 10165-6:1997, *Information technology – Open Systems Interconnection – Structure of management information: Requirements and guidelines for implementation conformance statement proformas associated with OSI management*

NOTE 1 – ISO/IEC 9646-1:1994 and ISO/IEC 9646-2:1994 supersede ISO/IEC 9646-1:1991 and ISO/IEC 9646-2:1991 respectively. However, when this International Standard was under development, the previous editions were valid and this International Standard is therefore based on these editions, which are listed below.

ISO/IEC 9646-1:1991, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 1: General concepts*

ISO/IEC 9646-2:1991, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 2: Abstract test suite specification*

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 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

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

a) Subnetwork
b) End system
c) Intermediate system
d) Subnetwork service
e) Subnetwork Access Protocol
f) Subnetwork Dependent Convergence Protocol
g) Subnetwork Independent Convergence Protocol

3.3 Network layer addressing definitions

This International Standard makes use of the following terms defined in ISO 8348:

a) Subnetwork address
b) Subnetwork point of attachment
c) Network Entity Title

3.4 Local area network definitions

This International Standard makes use of the following terms defined in ISO 8802:

a) Multi-destination address
b) Media access control
c) Broadcast medium

3.5 Routeing framework definitions

This International Standard makes use of the following terms defined in ISO/IEC TR 9575:

a) Administrative Domain
b) Routeing Domain
c) Hop
d) Black hole

3.6 Additional definitions

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

3.6.1 area: A routeing subdomain which maintains detailed routeing information about its own internal composition, and also maintains routeing information which allows it to reach other routeing subdomains. It corresponds to the Level 1 subdomain.

3.6.2 neighbour: An adjacent system reachable by traversal of a single subnetwork by a PDU.

3.6.3 adjacency: A portion of the local routeing information which pertains to the reachability of a single neighbour ES or IS over a single circuit.

Adjacencies are used as input to the Decision Process for forming paths through the routeing domain.

A separate adjacency is created for each neighbour on a circuit, and for each level of routeing (i.e. level 1 and level 2) on a broadcast circuit.

3.6.4 circuit: A subset of the local routeing information base pertinent to a single local SNPA. The system management view of a circuit is presented in a linkage managed object.

3.6.5 link: The communication path between two neighbours.

A link is "up" when communication is possible between the two SNPAs.

3.6.6 designated IS: The Intermediate system on a LAN, which is designated to perform additional duties. In particular it generates Link State PDUs on behalf of the LAN, treating the LAN as a pseudonode.

3.6.7 pseudonode: Where a broadcast subnetwork has *n* connected Intermediate systems, the broadcast subnetwork itself is considered to be a pseudonode.

The pseudonode has links to each of the *n* Intermediate and End systems. Each of the ISs has a single link to the pseudonode (rather than *n-1* links to each of the other Intermediate systems). Link State PDUs are generated on behalf of the pseudonode by the Designated IS. This is depicted below in figure 1.

3.6.8 broadcast subnetwork: A subnetwork which supports an arbitrary number of End systems and Intermediate systems and additionally is capable of transmitting a single SNPDU to a subset of these systems in response to a single SN_UNITDATA request.

3.6.9 general topology subnetwork: A subnetwork which 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.

3.6.10 routeing subdomain: a set of Intermediate systems and End systems located within the same Routeing domain.

3.6.11 level 2 subdomain: the set of all Level 2 Intermediate systems in a Routeing domain.

3.6.12 jitter: a small random variation introduced into the value of a timer to prevent multiple timer expirations in different systems from becoming synchronised.

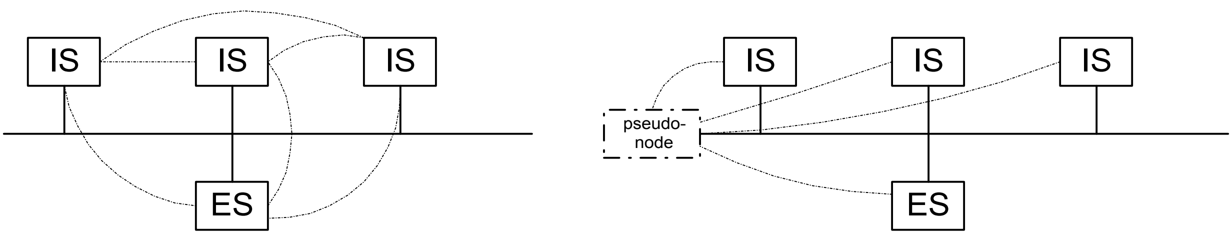

Figure 1 - Use of a pseudonode to collapse a LAN Topology

4 Symbols and abbreviations

4.1 Data units

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

4.2 Protocol data units

ESH PDU	ISO 9542 End System Hello Protocol Data Unit
ISH PDU	ISO 9542 Intermediate System Hello Protocol Data Unit
RD PDU	ISO 9542 Redirect Protocol Data Unit
IIH PDU	Intermediate System to Intermediate System Protocol Data Unit
LSP	Link State Protocol Data Unit
SNP	Sequence Numbers Protocol Data Unit
CSNP	Complete Sequence Numbers Protocol Data Unit
PSNP	Partial Sequence Numbers Protocol Data Unit

4.3 Addresses

AFI	Authority and Format Indicator
DSP	Domain Specific Part
IDI	Initial Domain Identifier
IDP	Initial Domain Part
NET	Network Entity Title
NPAI	Network Protocol Addressing Information
NSAP	Network Service Access Point
SNPA	Subnetwork Point of Attachment

4.4 Miscellaneous

DA	Dynamically Assigned
DED	Dynamically Established Data Link
DTE	Data Terminal Equipment
ES	End System
IS	Intermediate System
HDLC	High Level Data Link Control
ISDN	Integrated Services Digital Network
FDDI	Fiber Distributed Data Interface
L1	Level 1
L2	Level 2
LAN	Local Area Network
MAC	Media Access Control
MAN	Metropolitan Area Network
MCS	Management conformance summary
MICS	Management information conformance statement
MOCS	Managed object conformance statement
MRCS	Managed relationship conformance statement
NLPID	Network Layer Protocol Identifier
PSTN	Public Switched Telephone Network
OSIE	Open Systems Interconnection Environment

PCI	Protocol Control Information
QoS	Quality of Service
SN	Subnetwork
SNAcP	Subnetwork Access Point
SNDCP	Subnetwork Dependent Convergence Protocol
SNICP	Subnetwork Independent Convergence Protocol
SRM	Send Routeing Message
SSN	Send Sequence Numbers
SVC	Switched Virtual Circuit

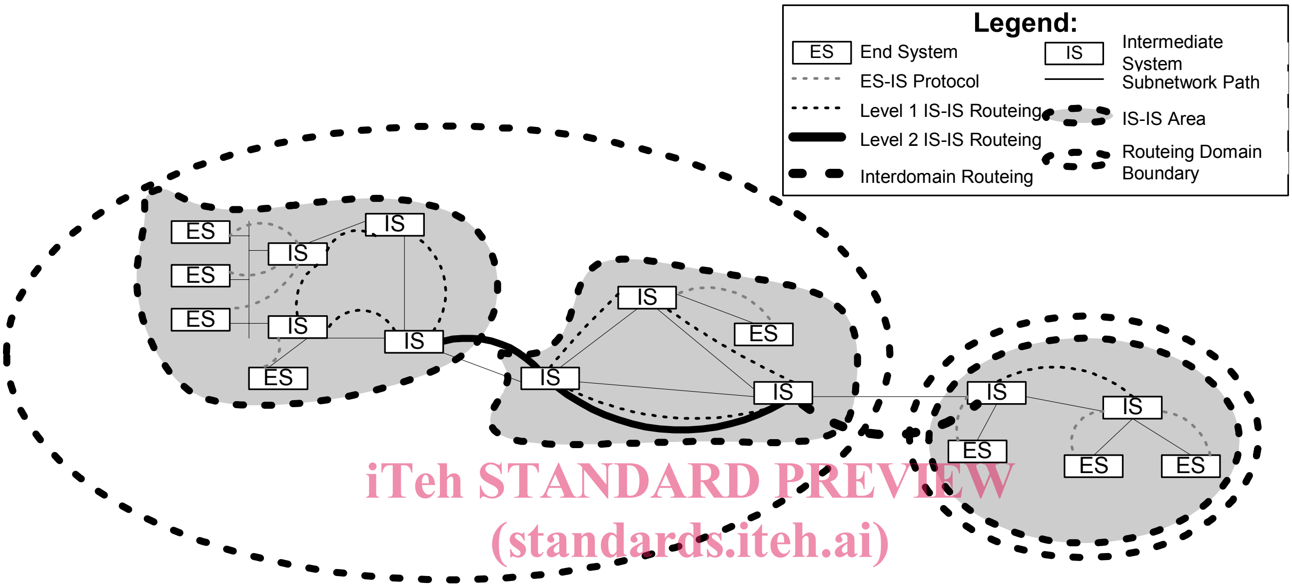

Figure 2 Topologies and Systems supported by Intradomain Routeing

5 Typographical conventions

This International Standard makes use of the following typographical conventions:

a) important terms and concepts appear in *italic* type when introduced for the first time;

b) protocol constants and management parameters appear in sansSerif type with multiple words run together. The first word is lower case, with the first character of subsequent words capitalised;

c) protocol field names appear in sansSerif type with each word capitalised; and

d) values of constants, parameters, and protocol fields appear enclosed in “double quotes”.

6 Overview of the protocol

6.1 System types

For the purposes of this International Standard, systems are classified according to the following types:

End Systems: These systems deliver NPDUs to other systems and receive NPDUs from other systems, but do not relay NPDUs. This International Standard does not specify any additional End system functions beyond those supplied by ISO 8473 and ISO 9542.

Level 1 Intermediate Systems: These systems deliver and receive NPDUs from other systems, and relay NPDUs from other source systems to other destination systems. They route directly to systems within their own area, and route towards a level 2 Intermediate system when the destination system is in a different area.

Level 2 Intermediate Systems: These systems act as Level 1 Intermediate systems in addition to acting as a system in the subdomain consisting of level 2 ISs. Systems in the level 2 subdomain route towards a destination area, or another routeing domain.

NOTE 2 Operation of a level 2 IS may be restricted on a per circuit basis by setting manualL2OnlyMode to "True". This indicates that the circuit is to be used only for Level 2 traffic. If all circuits in a Level 2 IS have manualL2OnlyMode set to "True" then the IS does not operate as a Level 1 IS in the area.

These systems and their topological relationship are illustrated in figure 2.

6.2 Subnetwork types

For the purposes of this International Standard, subnetworks are classified according to the following types:

a) *broadcast subnetwork*s: These are multi-access subnetworks that support the capability of addressing a group of attached systems with a single NPDU, for instance ISO 8802-3 LANs.

b) *general topology subnetwork*s: These are modelled as a set of point-to-point links each of which connects exactly two systems.

There are several generic types of general topology sub-networks:

1) *multipoint link*s: These are links between more than two systems, where one system is a primary system, and the remaining systems are secondary (or slave) systems. The primary is capable of direct communication with any of the secondaries, but the secondaries cannot communicate directly among themselves.

2) *permanent point-to-point link*s: These are links that stay connected at all times (unless broken, or turned off by system management), for instance leased lines or private links.

3) *dynamically established data links (DEDs):* These are links over connection oriented facilities, for instance X.25, X.21, ISDN, or PSTN networks.

Dynamically established data links can be used in one of two ways:

i) *static point-to-point (Static):* The call is established upon system management action and cleared only on system management action (or failure).

ii) *dynamically assigned (DA):* The call is established upon receipt of traffic, and brought down on timer expiration when idle. The address to which the call is to be established is determined dynamically from information in the arriving NPDU(s). No IS–IS routeing PDUs are exchanged between ISs on a DA circuit.

NOTE 3 For the operation of the protocol, a permanent point-to-point link and a static point-to-point DED are equivalent (see 7.3.7, 7.3.9).

All subnetwork types are treated by the Subnetwork Independent functions as though they were connectionless subnetworks, using the Subnetwork Dependent Convergence functions of ISO 8473 where necessary to provide a connectionless subnetwork service. The Subnetwork Dependent functions do, however, operate differently on connectionless and connection-oriented subnetworks.

6.3 Topologies

A single organisation may wish to divide its *Administrative Domain* into a number of separate *Routeing Domains.* This has certain advantages, as described in ISO/IEC TR 9575. Furthermore, it is desirable for an intra-domain routeing protocol to aid in the operation of an inter-domain routeing protocol, where such a protocol exists for interconnecting multiple routeing domains.

In order to facilitate the construction of such multi-domain topologies, provision is made for the entering of inter-domain routeing information. This information is in the form of a set of *Reachable Address Prefixes* which may be entered either by System Management, or provided by an inter-domain routeing protocol at the ISs which have links crossing routeing domain boundaries. The prefix indicates that any NSAPs whose NSAP address matches the prefix may be reachable via the SNPA with which the prefix is associated. Where this SNPA is connected to a multi-destination subnetwork (e.g., dynamically assigned DED, broadcast), the prefix also has associated with it the required subnetwork addressing information, or an