

# INTERNATIONAL STANDARD

# ISO/IEC 10589

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## **Information technology — Telecommunications and information exchange between systems — Intermediate System to Intermediate System intra-domain routing 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)*



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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 routing 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 routing domain to exchange configuration and routing information to facilitate the operation of the routing 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 routing protocol is intended to support large routing 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 routing domains, provision is made for intra-domain routing to be organised hierarchically. A large domain may be administratively divided into *areas*. Each system resides in exactly one area. Routing within an area is referred to as *Level 1 routing*. Routing between areas is referred to as *Level 2 routing*. Level 2 Intermediate Systems keep track of the paths to destination areas. Level 1 Intermediate Systems keep track of the routing 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 routing to the destination area, where it again travels via level 1 routing to the destination End System.





# Information technology – Telecommunications and information exchange between systems – Intermediate System to Intermediate System intra-domain routing 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 routing information for the purpose of routing within a single routing domain. The protocol specified in this International Standard relies upon the provision of a connectionless-mode underlying service.<sup>1)</sup>

This International Standard specifies:

- a) procedures for the transmission of configuration and routing information between network entities residing in Intermediate Systems within a single routing domain;
- b) the encoding of the protocol data units used for the transmission of the configuration and routing 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 routing 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*

<sup>1)</sup> 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.

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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 routing 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 Routing 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) Routing
- 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 Routing framework definitions**

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

- a) Administrative Domain
- b) Routing Domain
- c) Hop
- d) Black hole

#### **3.6 Additional definitions**

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

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**3.6.1 area:** A routing subdomain which maintains detailed routing information about its own internal composition, and also maintains routing information which allows it to reach other routing 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 routing 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 routing domain.

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

**3.6.4 circuit:** A subset of the local routing 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 routing subdomain:** a set of Intermediate systems and End systems located within the same Routing domain.

**3.6.11 level 2 subdomain:** the set of all Level 2 Intermediate systems in a Routing 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.

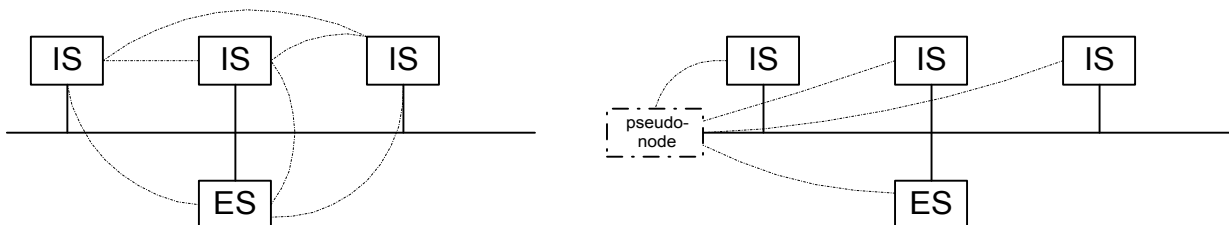


Figure 1 - Use of a pseudonode to collapse a LAN Topology

## 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
IIS 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

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

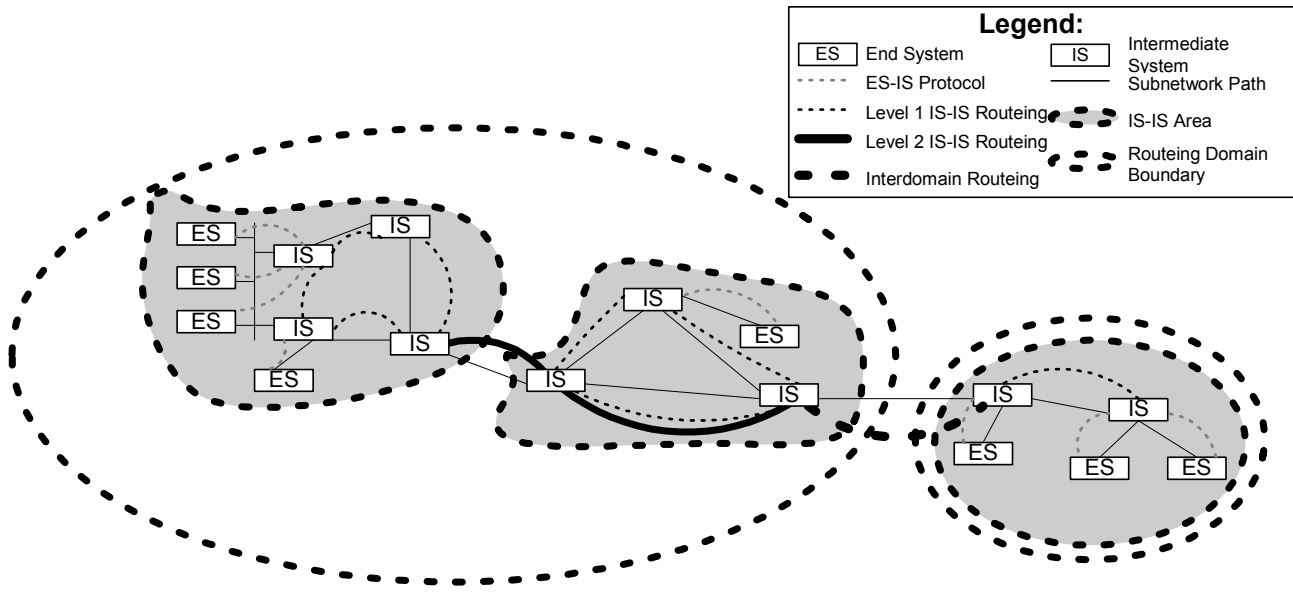


Figure 2 Topologies and Systems supported by Intradomain Routing

## 5 Typographical conventions

This International Standard makes use of the following typographical conventions:

- important terms and concepts appear in *italic* type when introduced for the first time;
- 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;
- protocol field names appear in **sansSerif** type with each word capitalised; and
- 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 routing 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 subnetworks:* 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 subnetworks:* 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 links:* 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 links:* 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 routing 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 *Routing Domains*. This has certain advantages, as described in ISO/IEC TR 9575. Furthermore, it is desirable for an intra-domain routing protocol to aid in the operation of an inter-domain routing protocol, where such a protocol exists for interconnecting multiple routing domains.

In order to facilitate the construction of such multi-domain topologies, provision is made for the entering of inter-domain routing 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 routing protocol at the ISs which have links crossing routing 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



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indication that it may be derived from the destination NSAP address (for example, an X.121 DTE address may sometimes be obtained from the IDI of the NSAP address).

The Address Prefixes are handled by the level 2 routing algorithm in the same way as information about a level 1 area within the domain. NPDUs with a destination address matching any of the prefixes present on any Level 2 Intermediate System within the domain can therefore be relayed (using level 2 routing) by that IS and delivered out of the domain. (It is assumed that the routing functions of the other domain will then be able to deliver the NPDu to its destination.)

Where multiple routing domains are interconnected using this International Standard, the model used is one in which the boundaries between routing domains are on the subnetworks which connect the Intermediate systems. A boundary for a routing domain is constructed by marking the linkage managed object associated with a circuit as being **externalDomain** rather than internal.

NOTE 4 This model also permits the construction of routing domains whose scope is not limited by the hierarchical nature of network layer address assignment. For example, it is possible to construct a routing domain, or even a single area, whose area addresses are taken from multiple addressing authorities.

**6.4 Addresses**

Within a routing domain that conforms to this International Standard, the Network entity titles of Intermediate systems must meet the requirements stated in 7.1.4. It is the routing domain administrative authority's responsibility to ensure that such is the case.

All systems shall be able to generate and forward NPDUs containing NSAP addresses in any of the formats specified by ISO 8348. However, the routing domain's administrative authority should ascertain that NSAP addresses of End systems meet the requirements set forth in 7.1.4 in order to take full advantage the routes derived by this protocol.

Within such a domain it is still possible for some End systems to have addresses assigned which do not conform to the rules set forth in 7.1.4 provided that they meet the more general requirements of ISO 8348, but these End systems may require additional configuration information to be entered into the Intermediate systems and they may obtain inferior routing performance.

NOTE 5 The procedures whereby the routing domain administrative authority obtains from an appropriate address authority Intermediate system NETs as required by this International Standard, and End system NSAP addresses as recommended by this International Standard are outside its scope.

**6.5 Functional organisation**

The intra-domain IS-IS routing functions are divided into two groups

- Subnetwork Independent Functions
- Subnetwork Dependent Functions

**6.5.1 Subnetwork independent functions**

The Subnetwork Independent Functions supply full-duplex NPDu transmission between any pair of neighbour systems. They are independent of the specific subnetwork or data link service operating below them, except for recognising two generic types of subnetworks:

- **General Topology Subnetworks**, which include HDLC point-to-point, HDLC multipoint, and dynamically established data links (such as X.25, X.21, and PSTN links), and
- **Broadcast Subnetworks**, which include ISO 8802 LANs.

NOTE 6 This protocol is intended to operate on any broadcast subnetwork which meets the general requirements listed in 6.7. However, the remainder of this International Standard specifically addresses ISO 8802 LANs. Other LANs, such as FDDI, are believed to be adequately covered by the specification for ISO 8802 LANs. Other broadcast subnetworks, such as ISO 8802-6 MANs, may not be adequately covered at this time.

The following Subnetwork Independent Functions are identified:



- **Routeing.** The routeing function determines NPDU paths. A path is the sequence of connected systems and links between a source ES and a destination ES.

The combined knowledge of all the Network Layer entities of all the Intermediate systems within a routeing domain is used to ascertain the existence of a path, and route the NPDU to its destination. The routeing component at an Intermediate system has the following specific functions:

- It extracts and interprets the routeing PCI in an NPDU.
  - It performs NPDU forwarding based on the destination address.
  - It manages the characteristics of the path. If a system or link fails on a path, it finds an alternate route.
  - It interfaces with the subnetwork dependent functions to receive reports concerning an SNPA which has become unavailable, a system that has failed, or the subsequent recovery of an SNPA or system.
  - It informs the ISO 8473 error reporting function when the forwarding function cannot relay an NPDU, for instance when the destination is unreachable or when the NPDU would have needed to be segmented and the NPDU requested “no segmentation”.
- **Congestion control.** Congestion control manages the resources used at each Intermediate system.

## 6.5.2 Subnetwork dependent functions

The subnetwork dependent functions mask the characteristics of the subnetwork or data link service from the subnetwork independent functions. These include:

- Operation of the Intermediate system functions of ISO 9542 on the particular subnetwork, in order to
  - determine neighbour Network entity title(s) and SNPA address(es);
  - determine the SNPA address(es) of operational Intermediate systems.
- Operation of the requisite Subnetwork Dependent Convergence Function as defined in ISO 8473, in order to perform
  - data link initialisation;
  - hop by hop fragmentation over subnetworks with small maximum SNSDU sizes; and
  - call establishment and clearing on dynamically established data links.

## 6.6 Design goals and non-goals

### 6.6.1 Goals

This International Standard supports the following design requirements. The correspondence with the goals for OSI routeing stated in ISO/IEC TR 9575 are noted.

- **Network Layer Protocol Compatibility:** It is compatible with ISO 8473 and ISO 9542. (See 7.5 of ISO/IEC TR 9575),
- **Simple End systems:** It requires no changes to End systems, nor any functions beyond those supplied by ISO 8473 and ISO 9542. (See 7.2.1 of ISO/IEC TR 9575),
- **Multiple Organisations:** It allows for multiple routeing and administrative domains through the provision of static routeing information at domain boundaries. (See 7.3 of ISO/IEC TR 9575)
- **Deliverability:** It accepts and delivers NPDUs addressed to reachable destinations and rejects NPDUs addressed to destinations known to be unreachable,
- **Adaptability:** It adapts to topological changes within the routeing domain, but not to traffic changes, except potentially as indicated by local queue lengths. It splits traffic load on multiple equivalent paths. (See 7.7 of ISO/IEC TR 9575),

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- **Promptness:** The period of adaptation to topological changes in the domain is a reasonable function of the domain diameter (that is, the maximum logical distance between End Systems within the domain) and Data link speeds. (See 7.4 of ISO/IEC TR 9575),
- **Efficiency:** It is both processing and memory efficient. It does not create excessive routing traffic overhead. (See 7.4 of ISO/IEC TR 9575),
- **Robustness:** It recovers from transient errors such as lost or temporarily incorrect routing PDUs. It tolerates imprecise parameter settings. (See 7.7 of ISO/IEC TR 9575),
- **Stability:** It stabilises in finite time to “good routes”, provided no continuous topological changes or continuous data base corruptions occur,
- **System Management control:** System Management can control many routing functions via parameter changes, and inspect parameters, counters, and routes. It will not, however, depend on system management action for correct behaviour,
- **Simplicity:** It is sufficiently simple to permit performance tuning and failure isolation,
- **Maintainability:** It provides mechanisms to detect, isolate, and repair most common errors that may affect the routing computation and data bases. (See 7.8 of ISO/IEC TR 9575),
- **Heterogeneity:** It operates over a mixture of network and system types, communication technologies, and topologies. It is capable of running over a wide variety of subnetworks, including, but not limited to: ISO 8802 LANs, ISO/IEC 8208 and X.25 subnetworks, PSTN networks, and the OSI Data Link Service. (See 7.1 of ISO/IEC TR 9575),
- **Extensibility:** It accommodates increased routing functions, leaving earlier functions as a subset,
- **Evolution:** It allows orderly transition from algorithm to algorithm without shutting down an entire domain,
- **Deadlock Prevention:** The congestion control component prevents buffer deadlock,
- **Very Large Domains:** With hierarchical routing, and a very large address space, domains of essentially unlimited size can be supported. (See 7.2 of ISO/IEC TR 9575),
- **Area Partition Repair:** It permits the utilisation of level 2 paths to repair areas which become partitioned due to failing level 1 links or ISs. (See 7.7 of ISO/IEC TR 9575),
- **Determinism:** Routes are a function only of the physical topology, and not of history. In other words, the same topology will always converge to the same set of routes,
- **Protection from Misdelivery:** The probability of misdelivering a NPDU, i.e. delivering it to a Transport entity in the wrong End System, is extremely low,
- **Availability:** For domain topologies with cut set greater than one, no single point of failure will partition the domain. (See 7.7 of ISO/IEC TR 9575),
- **Service Classes:** The service classes of *transit delay*, *expense*<sup>1)</sup>, and *residual error probability* of ISO 8473 are supported through the optional inclusion of multiple routing metrics,
- **Authentication:** The protocol is capable of carrying information to be used for the authentication of Intermediate systems in order to increase the security and robustness of a routing domain. The specific mechanism supported in this International Standard however, only supports a weak form of authentication using passwords, and thus is useful only for protection against accidental misconfiguration errors and does not protect against any serious security threat. In the future, the algorithms may be enhanced to provide stronger forms of authentication than can be provided with passwords without needing to change the PDU encoding or the protocol exchange machinery.

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<sup>1)</sup> “Expense” is referred to as “cost” in ISO 8473. The latter term is not used here because of possible confusion with the more general usage of the term to indicate path cost according to any routing metric.

## 6.6.2 Non-goals

The following are not within the design scope of the intra-domain IS-IS routing protocol described in this International Standard:

- **Traffic adaptation:** It does not automatically modify routes based on global traffic load,
- **Source-destination routing:** It does not determine routes by source as well as destination,
- **Guaranteed delivery:** It does not guarantee delivery of all offered NPDUs,
- **Level 2 Subdomain partition repair:** It will not utilise Level 1 paths to repair a level 2 subdomain partition. For full logical connectivity to be available, a connected level 2 subdomain is required,
- **Equal treatment for all ES implementations:** The End system poll function defined in 8.4.5 presumes that End systems have implemented the suggested ES Configuration Timer option of ISO 9542. An End system which does not implement this option may experience a temporary loss of connectivity following certain types of topology changes on its local subnetwork.

## 6.7 Environmental requirements

For correct operation of the protocol, certain guarantees are required from the local environment and the Data Link Layer.

### 6.7.1 The required local environment guarantees are:

- a) Resource allocation such that the certain minimum resource guarantees can be met, including
  - 1) memory (for code, data, and buffers)
  - 2) processing;
 See 12.2.4 for specific performance levels required for conformance
- b) A quota of buffers sufficient to perform routing functions;
- c) Access to a timer or notification of specific timer expiration; and
- d) A very low probability of corrupting data.

### 6.7.2 The required subnetwork guarantees for point-to-point links are:

- a) Provision that both source and destination systems complete start-up before PDU exchange can occur;
- b) Detection of remote start-up;
- c) Provision that no old PDUs be received after start-up is complete;
- d) Provision that no PDUs transmitted after a particular startup is complete are delivered out of sequence;
- e) Provision that failure to deliver a specific subnetwork SDU will result in the timely disconnection of the subnetwork connection in both directions and that this failure will be reported to both systems; and
- f) Reporting of other subnetwork failures and degraded sub-network conditions.
- g) The following events are “very low probability”, which means that performance will be impacted unless they are extremely rare, on the order of less than one event per four years
  - 1) Delivery of NPDUs with undetected data corruption.

### 6.7.3 The required subnetwork guarantees for broadcast links are:

- a) Multicast capability, i.e., the ability to address a subset of all connected systems with a single PDU;
- b) The following events are “low probability”, which means that they occur sufficiently rarely so as not to impact performance, on the order of once per thousand PDUs
  - 1) Routing PDU non-sequentiality,